SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO EXEMPTION AND AMENDMENT NO. 84 AND 83

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

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

GEORGIA POWER COMPANY

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VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4

DOCKET NOS. 52-025 AND 52-026

1.0 INTRODUCTION

By letter dated February 22, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17053A425), Southern Nuclear Operating Company (SNC/licensee) submitted License Amendment Request (LAR) 17-003 requesting that the U.S. Nuclear Regulatory Commission (NRC or Commission) amend the combined licenses (COL) for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, COL Numbers NPF-91 and NPF-92, respectively, regarding changes to inspections, tests, analyses and acceptance criteria (ITAAC) and Updated Final Safety Analysis Report (UFSAR) descriptions related to locations where hydrogen venting could occur during specific severe accident sequences from openings inside passive core cooling system (PXS) rooms inside containment.

SNC requests an exemption from elements of Tier 1 information. Tier 1 means the portion of the design-related information contained in the generic design control document (generic DCD) that is approved and certified by Appendix D to 10 CFR Part 52 “Design Certification Rule for the AP1000 Design” (Tier 1 information). Tier 1 information includes: definitions and general provisions; design descriptions; ITAAC; significant site parameters; and significant interface requirements.

SNC also requests amendments to depart from approved AP1000 Design Control Document (DCD) Tier 2 information. Tier 2 means the portion of the design-related information contained in the generic DCD that is approved but not certified by Appendix D to 10 CFR Part 52 (Tier 2 information). The request includes changes to Tier 2 information in Chapters 6 and 19 of the UFSAR. The request submitted by SNC is essentially technically identical to the exemption and

departure request previously submitted by Duke Energy Florida (DEF). The DEF request addressed changes to hydrogen vent related ITAAC, in support of the Levy Nuclear Plant (LNP) combined license application (COLA). The staff's review of the LNP exemption and departure request to address hydrogen venting is provided in Section 21.4 of the staff's safety evaluation report (SER) for the LNP COLA (ADAMS Accession No. ML16068A418).

This present evaluation makes use of an audit conducted in February 2015 by the staff (ADAMS Accession No. ML16139B053) related to the same Tier 2 information supporting the LNP exemption and departure. In LAR 17-003, Enclosure 4, "Applicability and Endorsement of Prior Docketed Information," SNC included, for informational purposes, a list of responses to staff's Requests for Additional Information from the LNP audit, which staff considered in its evaluation of LAR-17-003.

SNC has also requested exemptions, one for each unit, from the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, Appendix D, "Design Certification Rule for the AP1000 Design," Section III.B, "Scope and Contents." The requested exemptions would allow a departure from the corresponding portions of the certified information in Tier 1 of the generic DCD.[1] The staff's review of the exemption request, as well as the LAR, is included in this safety evaluation.

In letter dated June 2, 2017, (ADAMS Accession No. ML17153A362), SNC provided additional information that supplemented the application. This information did not expand the scope of the application, and did not change the NRC staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on March 28, 2017 (82 FR 15377). The staff's review of the LAR is included in this safety evaluation.

2.0 REGULATORY EVALUATION

The requested actions (i.e., license amendments and exemptions) concern changes to the locations for the hydrogen venting primary openings in the PXS valve/accumulator rooms inside containment. Enclosure 1 to the application provided the following description of the function of the containment hydrogen control system and associated hydrogen venting, stating that to prevent accumulation of hydrogen in a dead-ended compartment during a beyond design basis accident, hydrogen may be vented from the PXS-A and PXS-B compartment (Rooms 11206 and 11207, respectively) to the Core Make-up Tank (CMT)-A and CMT-B compartments (Room 11300) through openings in the floor of Room 11300. SNC proposes to reconfigure the openings in Room 11206 to allow for access to perform maintenance activities on the equipment in Room 11206, and to use actual distances to the containment vessel in analyses of hydrogen venting from those rooms. SNC asserted that a diffusion flame hydrogen burn at the proposed venting locations does not challenge containment integrity.

Therefore, in determining whether an amendment to a combined license will be issued, the Commission will be guided by the considerations which govern the issuance of initial combined licenses to the extent applicable and appropriate. In its review of the proposed technical changes in LAR 17-003, the staff considered the following regulatory requirements, which are

[1] While SNC 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 generic 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.

related to hydrogen and containment integrity, and which apply to the certified information found in the AP1000 DCD, which was incorporated by reference into the VEGP's licensing basis:

- 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 41, "Containment atmosphere cleanup," as it applies to the ability of the systems to control hydrogen that may be released into the reactor containment in order to maintain the concentration of hydrogen such that containment integrity is maintained;

- 10 CFR Part 50.34(f)(2)(ix), which requires in part that combustible concentrations of hydrogen will not collect in areas where unintended combustion or detonation could cause loss of containment integrity or loss of appropriate mitigating features;

- 10 CFR 50.44(c)(2), (c)(3) and (c)(5), which require in part that all combined license holders must provide means to limit hydrogen concentrations in containment during and following an accident that releases an equivalent amount of hydrogen as would be generated by 100 percent fuel clad-coolant reaction, uniformly distributed, to less than 10 percent by volume and maintain containment structural integrity and appropriate accident mitigating features; and to establish and ensure safe shutdown and containment integrity with systems and components capable of performing their functions during and after exposure to the burning of hydrogen;

- 10 CFR 50.90, which requires in part that a license holder that desires to amend their combined license must file an application for an amendment as specified in 10 CFR 52.3 fully describing the changes desired and following as far as applicable, the form prescribed for original applications; and

- 10 CFR Part 50.34(f)(2)(ix), 10 CFR 50.44(c)(2), (c)(3) and (c)(5), and GDC 41 are applicable to this specific LAR because they apply to the changes that prompted reanalysis of the hydrogen flame in order to demonstrate containment integrity is maintained. Staff found the above requirements represent the applicable set of requirements for this particular LAR.

3.0 TECHNICAL EVALUATION

3.1 EVALUATION OF EXEMPTION REQUEST

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.

The plant-specific design control document ("plant-specific DCD" or "PS DCD") is the document that is maintained by a licensee who references Appendix D to 10 CFR Part 52. It consists of the information in the generic DCD as modified and supplemented by the plant-specific departures and exemptions made under Section VIII of Appendix D. In LAR-17-003, the Tier 1 information in the PS DCD for which the licensee requested a plant-specific departure and exemption relates to the PXS. The result of this exemption would be that SNC could implement modifications to Tier 1 information to the UFSAR as well as departures from a PS DCD Tier 2 table, and a COL Appendix C table. 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 17-003, as supplemented. 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, is met and so long as the special circumstances defined in 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.

3.1.1 AUTHORIZED BY LAW

This exemption would allow SNC to implement a revision to Tier 1 Section 2.3.9-3 and corresponding changes to COL Appendix C in the plant-specific DCD. This exemption is a permanent exemption limited in scope to particular Tier 1 information. Subsequent changes to Tier 1 Section 2.3.9-3 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). Based on 10 CFR Part 52, Appendix D, Section VIII.A.4, the NRC staff has determined that granting of the licensee's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations. Therefore, pursuant to 10 CFR 52.7 and 10 CFR 50.12(a)(1), the exemption is authorized by law.

3.1.2 NO UNDUE RISK TO PUBLIC HEALTH AND SAFETY

The underlying purpose of Appendix D to 10 CFR Part 52 is to ensure that a licensee will construct and operate the plant based on the approved information found in the DCD incorporated by reference into a licensee's licensing basis. The changes proposed by SNC do not add or delete systems or equipment as described in Tier 1 of the AP1000 DCD. These changes will not impact the ability of the systems or equipment to perform their design function. Because they will not alter the operation of any plant equipment or systems, these changes do not present an undue risk from existing equipment or systems. The description changes do not

introduce any new industrial, chemical, or radiological hazards that would represent a public health or safety risk, nor do they modify or remove any design or operational controls or safeguards intended to mitigate any existing on-site hazards. Furthermore, the proposed changes would not allow for a new fission product release path, result in a new fission product barrier failure mode, or create a new sequence of events that would result in significant fuel cladding failures. Accordingly, these changes do not present an undue risk from any new equipment or systems, because there remains no challenge to containment integrity as a result of hydrogen generation due to the proposed changes. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that there is no undue risk to public health and safety.

3.1.3 CONSISTENT WITH COMMON DEFENSE AND SECURITY

The proposed exemption would allow SNC to implement modifications to the dimensions associated with the CMT access openings, as presented in the ITAAC tables in the plant-specific DCD Tier 1, 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 SSCs 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.

3.1.4 SPECIAL CIRCUMSTANCES

Special circumstances, in accordance with 10 CFR 50.12(a)(2)(ii), are present 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. Special circumstances are present in the particular circumstances discussed in LAR 17-003 as supplemented because the application of the specified Tier 1 information does not serve the underlying purpose of the rule. The underlying purpose of the Tier 1 information is to ensure that SNC 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's licensing basis. The underlying purpose of the rule would not be satisfied in the context of the changes proposed by the licensee in the LAR, because the maintenance activities specified in the LAR could not be performed in the configuration specified by the certified design.

The proposed changes would allow SNC to implement modifications to the dimensions associated with the CMT access openings, as presented in Tier 1 ITAAC Table 2.3.9-3. These changes will enable SNC safely to construct and to operate the AP1000 facility consistent with the design certified by the NRC by changing the information mentioned above found in Tier 1 Table 2.3.9-3 of the DCD and corresponding changes to Appendix C.

The proposed change implements changes to the dimensions associated with the CMT access openings, as presented in Tier 1 ITAAC. This exemption request and associated revisions to Tier 1 Table 2.3.9-3 corresponding changes to Appendix C demonstrate that the applicable regulatory requirements will continue to be met. 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. Therefore, 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.

3.1.5 SPECIAL CIRCUMSTANCES OUTWEIGH REDUCED STANDARDIZATION

This exemption would allow the implementation of changes to Tier 1 Table 2.3.9-3 in the DCD and corresponding changes to Appendix C that are being proposed. The design functions of the system associated with this request will continue to be maintained because the associated revisions to Table 2.3.9-3 demonstrate that the applicable regulatory requirements will continue to be met. Staff did not identify any decrease in safety as a result of the changes proposed in LAR. Therefore, the special circumstances continue to outweigh any decrease in safety from the reduction in standardization because the key design function of the containment hydrogen control system associated with this request continues to be maintained. 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. Based on the foregoing reasons, as required by 10 CFR Part 52.63(b)(1), the staff finds that the special circumstances outweigh the effects the departure has on the standardization of the AP1000 design.

3.1.6 NO SIGNIFICANT REDUCTION IN SAFETY

This exemption would allow the implementation of changes to Tier 1 Table 2.3.9-3 in the DCD and corresponding changes to Appendix C that are being proposed in the LAR. The exemption request proposes to depart from the certified design by changing to the dimensions associated with the CMT access openings. SNC proposed the changes to make maintenance simpler. The changes will not impact the functional capabilities of this system. The proposed changes will not adversely affect the ability of the PXS 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 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.

3.2 EVALUATION OF PROPOSED CHANGES

The containment hydrogen control system is designed to promote hydrogen burning at the onset of the lower flammability limit of hydrogen within containment. The purpose of the ITAAC in COL Appendix C (and plant specific Tier 1) Table 2.3.9-3, Item 3 (ITAAC 2.3.09.03.iii) is to keep postulated diffusion flame sources away from the containment pressure boundary to mitigate potential for over temperature leading to failure of the containment shell, hatches, and penetrations.

As part of LAR 17-003, SNC stated that the openings in the PXS-A compartment (Room 11206) are proposed to be reconfigured to allow better access for maintenance activities. A review by SNC following the reconfiguring showed that the combination of the equipment access opening and the CMT-A opening would make up the primary openings from the compartment (with greater than 98 percent of the vent path area), and that the CMT-A opening is less than the 19 feet from the containment vessel specified in the acceptance criteria of ITAAC 2.3.09.03.iii. Because the distance from the opening to the containment shell was less than previously analyzed, SNC performed an assessment of a potential diffusion flame from the CMT-A opening. SNC also analyzed the potential from venting from the PXS-B compartment (Room 11207).

The staff's technical evaluation is based on a combination of the information presented in the LAR and an audit the staff conducted in 2015 (ADAMS Accession No. ML16139B053) as part of the LNP COLA review.

3.2.1 Hydrogen Diffusion Flame and Temperature Distribution Evaluation

SNC first performed a computational fluid dynamics (CFD) sensitivity analysis to evaluate the location of hot spots and any flow split variation effects from the PXS-A room below. Using the insights gained from the CFD analysis, SNC then performed a one-dimensional (1D) analysis to calculate temperature distributions on the containment pressure boundary in the CMT-A area near the lower equipment hatch for a hydrogen diffusion flame from the PXS-A room vents following a beyond design basis accident. SNC stated in the LAR that the CFD analysis was used only as a sensitivity analysis and to identify non-conservative assumptions, while the 1D calculation was used as the basis to evaluate the effect of increased temperatures on the containment vessel. This treatment is consistent with the information presented in the LAR and audited by the staff.

This 1D calculation was based on first principle heat transfer and thermodynamic correlations. A conservative hydrogen plume temperature is calculated and the radiation and convection heat transfer is assessed to calculate a maximum containment wall temperature. The temperature distribution was then used as input to a containment structural model to assess the containment pressure boundary severe accident survivability under the heat load from a hydrogen diffusion flame.

The hydrogen venting scenario from the PXS-A room is for a beyond design basis event involving significant core damage and hydrogen generation due to fuel cladding oxidation. The scenario pertains to only one specific initiating event, a direct vessel injection (DVI) double-ended or large-line break which spills into the PXS-A compartment below the CMT room floor. The break must be large enough to defeat injection through the DVI line for the accident to progress to core damage. The PXS-B line must also fail to inject. Multiple failures of the Automatic Depressurization System (ADS)-4 valves must occur for the hydrogen generated in the core to reach the DVI line break and be released into the PXS-A compartment. This potential challenge applies only to a small subset of severe accident scenarios by frequency. As stated in the LAR, the cut set frequency for this scenario is 6.4E-09/reactor-year.

The purpose of the 1D calculation was to perform a simple heat transfer calculation independent of the CFD analysis, to calculate potential pressure boundary transients during a diffusion flame hydrogen burn in the CMT-A compartment for the bounding hydrogen release scenario described above. The source term for the hydrogen and steam from the PXS-A vents are from a Modular Accident Analysis Program analysis, referenced in documentation audited by the staff in 2015 for the Levy Nuclear Plant (ADAMS Accession No. ML16139B053).

The diffusion flame hydrogen temperature is calculated from the heat balance on the plume, which is modeled as a cylinder. The area for heat transfer to the containment wall is based on the hydraulic radius of the source, the distance from the source to the wall, and the height of the CMT-A compartment. The calculation assumed that the hydrogen igniters are operable and preventing global hydrogen combustion. The temperature distributions are based on the peak temperatures assuming that 100 percent of the hydrogen release is from the equipment access floor hatch. As stated in the LAR, sensitivity analyses in the CFD calculation, audited by the staff in 2015, showed that the hydrogen release from the floor hatch does not challenge containment integrity. These assumptions result in a conservatively modeled hydrogen flame.

A layout of the affected area is shown in Figure 3-1 of the LAR. The area includes the containment shell and equipment hatch, which is comprised of an insert plate, door barrel, and door cover. The door barrel contains ethylene propylene diene monomer (EPDM) rubber seals. The suitability of the seals is also evaluated as part of the analysis.

The 1D heat transfer analysis creates two temperature distributions on the containment pressure boundary based on insights from the CFD analysis and identifies the location of maximum temperature, referred to as the hot spot (the local area where the hot plume impacts the containment pressure boundary). The first distribution, Temperature Distribution No. 1, assumes the plume creates a hot spot that spans the lower containment equipment hatch cover, the hatch barrel, the insert plate, and the containment shell, as depicted in Figure 3-2 of the LAR. The second distribution, Temperature Distribution No. 2, locates the hot spot on the containment shell at the vent exit (opening in ceiling above the lower equipment hatch), as depicted in Figure 3-3 of the LAR.

Heat transfer to the hot spot consists of radiation and convection from the hydrogen diffusion flame. Heat transfer to the containment shell away from the hot spot consists of radiation from the hydrogen diffusion flame. For the structural analysis, the allowable surface temperatures within the hot spot are assumed to be the bounding temperature limits of the containment shell and the hatch door cover. For the hatch barrel hot spot temperature, where the hatch seals are located, the allowable average wall temperature is assumed to be the temperature limit of the EPDM rubber seals, and the corresponding surface temperature is reported.

Zone 1 is the area of the containment pressure boundary above the hot spot in contact with the plume flow up the containment wall. The heat transfer consists of radiation and flat plate parallel flow convection. Zone 2 is the area of the containment pressure boundary below the hot spot where the containment shell is not in contact with the plume flow but is receiving radiation from the plume.

Temperatures outside of Zones 1 and 2 are assumed unaffected and remain at 200 °F (93 °C). The calculations are performed to capture the maximum temperature on the inside surface of the heat sink in each region. The average temperatures in each region are also reported because the structural analysis uses the average through-wall temperatures for assessing integrity.

The peak surface and average temperatures from the limiting scenario identified by the sensitivity analysis for each of the zones are shown Table 3-1 of the LAR. The peak average through-wall temperatures are assigned to the structural model. For Temperature Distribution No. 1, the temperatures were assigned as both a gradient from the hot spot outward to the base shell temperature and also as a constant value over the zone. Temperature Distribution No. 2 also conservatively used the worst case from Temperature Distribution No. 1. These modeling choices are appropriately conservative and adequately capture the effects resulting from the hydrogen plume. The component surface temperatures within each zone are calculated from these distributions.

Table 3-1 of the LAR provides the results of the applicant's heat transfer calculations for Zone 1 and Zone 2 and compares them to the applicant's maximum allowable temperature for the hot spot. The results show that the applicant's calculated peak surface temperatures and peak average wall temperatures are below the allowable limits. It should be noted that the column labeled "hot spot" in Table 3-1 represents the allowable maximum temperature limit from

American Society of Mechanical Engineers (ASME) Code Service Level C for SA 738 Grade B. As noted in the LAR, this allowable limit is further modified for the insert plate/barrel to correspond to the EPDM rubber seal acceptance criterion. The acceptability of the applicant's maximum allowable temperatures is discussed in Subsection 3.2.2, below, which is an excerpted from the LNP safety evaluation, and is incorporated by reference to this request.

Based on the above evaluation, the staff concludes that the methodology and assumptions in the analysis for determining the temperature source terms from the hydrogen burns are appropriately conservative, and the results are acceptable to be used as input to the structural analysis below. These inputs reflect the hydrogen controls required by 10 CFR 50.34(f)(2)(ix), 10 CFR 50.44(c)(2) "Combustible gas control", and (c)(5) "Structural Analysis" and GDC 41, because as stated above in the regulatory evaluation, the pertinent portion of the regulatory requirement for this LAR is to demonstrate containment integrity is maintained in the event of a potential hydrogen burn. The conditions for the hydrogen burn, resulting from a release of an equivalent amount of hydrogen as would be generated by 100 percent fuel clad-coolant reaction, have been appropriately calculated in the inputs to the analyses. The effect of burning the hydrogen that is produced must be shown not to challenge containment integrity, and this latter portion of the requirements is evaluated in the following section.

3.2.2 Containment Structural Evaluation of Hydrogen Venting

The staff considered UFSAR, Revision 5, Section 3.8, "Design of Category I Structures" to perform the technical evaluation. The staff also considered portions of NUREG–1793, Supplement 2, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design" (ADAMS Accession No. ML112061231), and the Final Safety Evaluation Report (FSER), Chapter 21 for the LNP, Units 1 and 2 (ADAMS Accession No. ML16068A418) that addressed the generic AP1000 design issue of the PXS and the chemical and volume control compartments in containment, which allow for venting of hydrogen through the floor at 107'-2" into the CMT room above for beyond design basis and severe accidents. The staff also considered the findings of an audit (ADAMS Accession No. ML16139B053) it had performed of Westinghouse Electric Company's calculation packages for the generic issue of hydrogen burn and challenging thermal loads on the containment shell to support FSER, Chapter 21 for the LNP, Units 1 and 2.

The licensee's submittal identifies the actual design distances between the PXS vents and the containment shell, including consideration of construction tolerances that pertain to the ITAAC in AP1000 DCD Tier 1 Table 2.3.9-3, Item 3. This submittal also contains proposed changes to AP1000 DCD Tier 2, Section 6.2.4.5.1, "Preoperational Inspection and Testing for the Hydrogen Ignition Subsystem," Tier 2 Section 19.41, "Diffusion Flame Analysis," Tier 2 Section 19.59, "Combustible Gases Generation and Burning," and Tables 19.59-18 and 19D-7. This section of the SER evaluates containment survivability and confirms that containment integrity is not challenged due to diffusion flame hydrogen burn in the containment compartments.

SNC performed a one-dimensional heat transfer analysis and computational fluid dynamics analysis to develop temperature profiles from the postulated hydrogen burn at the vent location and to confirm that the containment integrity was not challenged due to a diffusion flame hydrogen burn in the containment compartments. The licensee's calculation developed two temperature distributions, each of which identified the location of a hot spot and two zones relative to the location of features on the containment shell. The licensee's results in Table 3-1 show that Zone 1 and 2 are not affected by the hydrogen burn and remain below the

ASME NE-3000 maximum service temperature limit of 650 °F. The hot spot area is a local area where burning plume flow impacts the containment pressure boundary. The hot spot area is about 2 meters in diameter and located on the equipment hatch at the top and covers the hatch barrel. SNC calculated the maximum resultant stress intensity that would be experienced at the hot spot locations on the equipment hatch and containment shell. SNC calculated maximum resultant stress intensity of 15.25 ksi on the equipment hatch that is less than ASME Service Level C allowable of 63.6 ksi. Therefore, although at the hot spot the equipment hatch cover peak temperature (780 °F) exceeds the maximum service level temperature (650 °F), the maximum resultant stress intensity is less than the ASME service Level C allowable limit.

The staff in its audit (ADAMS Accession No. ML16139B053) to support FSER, Chapter 21 for LNP, Units 1 and 2, confirmed that the calculated maximum resultant stress intensity on the equipment hatch is 15.25 ksi that is less than ASME Service Level C allowable of 63.6 ksi resultant stress intensity and therefore meets the Service Level C requirements of ASME Code Section III, Division 1, Subsection NE3230. For the hot spot within the hatch barrel where the hatch seal is located, the peak allowable average wall temperature of 390 °F is based on the temperature limit of the EPDM rubber seal located within the hatch. The EPDM rubber seal is behind the lip of the hatch cover and, therefore, it is exposed to lesser temperature than the surrounding area of the hatch door. However, the seals exceed their design temperature of 300°F. The maximum average wall temperatures in Zone 1 and Zone 2 for the insert plate/barrel component as shown in Table 3-1 are well below the licensee's 390 °F, the acceptance criteria for the EPDM rubber seals.

SNC justified the integrity of the seals at 390°F based on tests that had been performed on the EPDM rubber seals. SNC stated that EPDM rubber samples were tested at 572°F and the tests showed that the strain-strain curve is linear at temperature below 482°F. SNC also discussed the compression set tests performed for EPDM rubber in which the EPDM was heated for a minimum of 24 hours at temperatures of 392°F, 437°F, and 482°F. The predicted duration that the seals are above their design temperature of 300°F is short (on the order of 2 hours) compared to the tested duration of minimum 24 hours. Based on this, SNC stated that the material properties of the EPDM rubber remain essentially unchanged at temperatures up to 482°F for 2 hours and that the compression and pressure retaining capabilities of the EPDM are therefore not affected at 390°F and its structural integrity is maintained.

SNC performed additional analysis to evaluate any potential path for leakage through the equipment hatch. SNC evaluated the equipment hatch for the uneven heating due to the asymmetric thermal loading condition. According to SNC, this uneven heating could lead to potential distortion of the equipment hatch cover relative to the barrel flange resulting in potential leakage. The two rubber seals inside the flange function to prevent leakage. The rubber seals are designed with a high temperature resistance and elasticity. Based on this design, as long as the bolts around the perimeter of the equipment hatch cover are not stressed and stretched beyond the acceptable recovery of the seals, there is no path for leakage. SNC performed an ANSYS finite element analysis to evaluate equipment hatch bolt deformations. SNC provided a summary of an ANSYS three dimensional equipment hatch finite element model that included the contact between the barrel flanges as well as a stiffness representation for the bolts holding the equipment hatch cover in place. The analysis considered the dead load of the containment vessel shell and polar crane, internal pressure of 7.5 psig, and the hydrogen plume temperature. Conservatively, the licensee did not consider the pretension load on the bolts that helps maintain the seal of the joint. Based on its analysis, SNC reported that the maximum calculated bolt stress is 15.9 ksi which is much lower than the allowable bolt stress of 92 ksi. The bolts around the perimeter of the equipment hatch cover are stressed to only 17

percent of the allowable stress and therefore the equipment hatch bolts remain well within the elastic limit.

SNC also presented the equipment hatch gasket design specification data and stated that based on its design configuration a design squeeze of 22 percent is calculated if it is fully compressed and that this compression retains 59 psi internal pressure. SNC assumed the largest joint gap at the gasket midline and computed the resulting compression of 14 percent that is sufficient to retain the 7.5 psi pressure. Based on its review, the staff finds that (1) the EPDM rubber compression set is tested to a temperature of 482°F for a minimum period of 24 hours, which is beyond the seals temperature of 390°F, and occurs for a short duration of 2 hours, (2) the stresses in the equipment hatch bolts are low and remain within the elastic limit and therefore the hatch connection is not distorted, and (3) the computed compression in the equipment hatch gasket (14 percent) is sufficient to retain the 7.5 psi pressure. Based on the above, the staff concludes that there is reasonable assurance that the equipment hatch seal integrity will be maintained and will not provide a path for leakage through the equipment hatch for the beyond-design basis event. Therefore, the containment remains leak tight following a hydrogen burn at the vent openings in Rooms 11206 and 11207.

Based on the creep calculation results reviewed during the audit of the LNP, Units 1 and 2, the time required to rupture at 800 °F (427 °C) is 6.3 E+07 hours and temperature required to rupture at stress level of 15.25 ksi (105.1 MPa) is 1291 °F (699 °C) for a 1-hour duration. Considering the time duration containment shell and hatch cover are exposed to the elevated temperature is short (less than 10 minutes), the staff concluded that the creep is not significant factor for the containment to rupture for the hydrogen burn event.

According to Regulatory Guide 1.216, “Containment Structural Integrity Evaluation for Internal Pressure Loadings above Design Bases Pressure,” Regulatory Position 2(b), an instability (buckling) calculation is not required for the steel containments. Therefore, buckling is not an issue for the hydrogen burn event.

The staff also reviewed Enclosure 5 in the licensee’s submittal of February 22, 2017. In this enclosure, SNC provided a comparison of its proposed changes with the set of proposed changes to the LNP, Units 1 and 2, Docket Nos. 52-029 and 52-030, Letter NPD-NRC-2016-001, Enclosure 3, dated January 6, 2016, (ADAMS Accession No. ML16008A082). Enclosure 3 of SNC’s letter provided a set of proposed changes to the LNP Licensing Basis Documents. The staff’s review finds that the licensee’s proposed changes are technically consistent with the staff’s approved changes to the LNP, Units 1 and 2 referenced above.

Based on the staff’s evaluation of containment survivability, discussed above, the staff finds that containment integrity is not challenged due to diffusion flame hydrogen burn in the containment CMT-A and B compartments from the PXS-A and PXS-B compartment (Rooms 11206 and 11207, respectively) because the containment meets the Service Level C requirements of ASME Code, Section III, Division 1 Subsection NE-3230 and Regulatory Guide 1.216, and the containment remains leak tight following a hydrogen burn. Therefore, the staff finds that licensee’s revisions to the UFSAR and ITAAC revisions as proposed in Enclosure 3 of the February 22, 2017, submittal are acceptable, and meet the requirements of 10 CFR part 50.34(f)(2)(ix), 10 CFR part 50.44(c)(3) (“Equipment Survivability”) and (c)(5) (“Structural Analysis”) and GDC 41, because the hydrogen burn resulting from the accident sequences described in the LAR do not challenge containment integrity. Containment integrity, including

the function of the associated components discussed above, is required to establish and maintain safe shutdown.

3.2.3 Risk Results and Insights

This design departure does not materially alter the description of AP1000 design features that reduce the risk associated with generation of combustible gases. It does not modify the plant-specific probabilistic risk assessment model used for licensing. Consequently, there is no change to the risk profile described in the license. The risk insights concerning hydrogen control in UFSAR Section 19.59, Table 19.59-18, Item 31, are expressed more precisely. Similarly, the discussions in UFSAR Section 19.41.7, "Diffusion Flame Analysis," and in UFSAR Section 19.59.95.6, "Combustible Gases Generation and Burning," have been clarified. The staff's conclusions remain the same. Consistent with DC/COL-ISG-003, "PRA Information to Support Design Certification and Combined License Applications," the plant-specific PRA remains acceptable to the staff.

3. 3 TECHNICAL CONCLUSION OF THE PROPOSED CHANGES

As part of the staff review discussed above, the NRC staff reviewed LAR 17-003 and checked the referenced plant-specific DCD. The NRC staff's review confirmed that the applicant addressed the required information relating to the design change for the PXS dimensions due to the potential for hydrogen venting, and there is no outstanding information expected to be addressed in the UFSAR for VEGP Units 3 and 4 related to this amendment.

In addition, the staff concludes that the relevant information presented in LAR 17-003 is acceptable and meets the relevant requirements associated with 10 CFR Part 50, Appendix A, GDC 41, 10 CFR Part 50.34(f)(2)(ix), and 10 CFR 50.44(c)(2), (c)(3) and (c)(5) as well as the other regulatory requirements discussed in Section 2.0 of this safety evaluation report. The staff based its conclusion on the following:

- the methodology and assumptions used in the applicant's analysis for determining the temperature source terms from the hydrogen burns are appropriately conservative, and the results are acceptable to be used as input to the structural analysis, and
- the containment meets the Service Level C requirements of ASME Code, Section III, Division 1 Subsection NE-3230 and Regulatory Guide 1.216, and the staff confirmed that the containment integrity is not challenged due to diffusion flame hydrogen burn in the containment compartment.

As such, the staff finds that the revised analysis demonstrates that hydrogen that may be released into the reactor containment for the accident scenarios impacted by the LAR is limited in concentration of hydrogen such that containment integrity is maintained, pursuant to GDC 41, and that a system is provided for hydrogen control such that concentrations are limited and unintended combustion or detonation will not cause loss of containment integrity, pursuant to 10 CFR Part 50.34(f)(2)(ix), and 10 CFR 50.44(c)(2), (c)(3) and (c)(5), and therefore the proposed changes meet the aforementioned regulatory requirements.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations in 10 CFR 50.91(b)(2), the Georgia State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 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, "*Standards for Protection Against Radiation*." 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. Also, 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 (82 FR 15377, published on March 28, 2017). 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.

6.0 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, (5) the special circumstances outweigh the potential decrease in safety due to reduced standardization, and (6) does not significantly reduce the level of safety at the licensee's facility. Therefore, the staff grants SNC an exemption from the Tier 1 information specified by SNC in LAR 17-003 and evaluated in Section 3.0 of this safety evaluation.

Based on the considerations discussed in Section 3.0, the staff concluded that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by construction and operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, including 10 CFR Part 50.34(f)(2)(ix), 50.44(c), and GDC 41, as the containment will continue to perform its role as a reliable, leak-tight barrier based on the considerations discussed above, and (3) there is reasonable assurance that 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.

7.0 REFERENCES

1. Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, "Request for License Amendment and Exemption: Hydrogen Venting from Passive Core Cooling System (PXS) Compartments," dated February 22, 2017 (ADAMS Accession No. ML17053A425).

2. Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, "LAR 17-003S1: Voluntary Supplement to VEGP Units 3&4 Request for License Amendment and Exemption: Hydrogen Venting from Passive Core Cooling System (PXS) Compartments," dated June 2, 2017 (ADAMS Accession No. ML17153A362).

3. Vogtle Units 3 and 4 Updated Final Safety Analysis Report, Revision 5 and Tier 1, dated May 5, 2012 (ADAMS Accession No. ML11180A100).

4. AP1000 Design Control Document, Revision 19, dated June 13, 2011 (ADAMS Accession No. ML11171A500).

5. Combined License NPF-91 for Vogtle Electric Generating Plant Unit 3, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A106).

6. Combined License NPF-92 for Vogtle Electric Generating Plant Unit 4, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A135).

7. Levy Nuclear Plant, Units 1 and 2 FSER, Chapter 21 "Design Changes Proposed in Accordance with ISG-11," dated June 2, 2016 (ADAMS Accession No. ML16068A418)

8. U.S. Nuclear Regulatory Commission, Audit Summary for Levy COL Review Hydrogen Vent ITAAC, dated May 23, 2006 (ADAMS Accession No. ML16139B053).

9. Regulatory Guide, 1.216 "Containment Structural Integrity Evaluation for Internal Pressure Loadings above Design Bases Pressure" U.S. Nuclear Regulatory Commission, Washington, DC, dated August 2010.

10. Levy Nuclear Plant, Units 1 and 2, Docket No. 52-029 and 52-030, Revised Partial Response to Request for Additional Information Letter No. 121 Related to SRP Section 6.2.5 "Combustible Gas Control in Containment," dated January 6, 2016 (ADAMS Accession No. ML16008A082).

11. U.S. Nuclear Regulatory Commission, "PRA Information to Support Design Certification and Combined License Application" Interim Staff Guidance COL1DC-ISG-003, dated June 4, 2008.