SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NOS. 82 AND 81

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

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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 March 11, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16071A404), Southern Nuclear Operating Company (SNC/licensee) submitted license amendment request (LAR) 15-012 and requested that the U.S. Nuclear Regulatory Commission (NRC) amend the combined licenses (COL) for Vogtle Electric Generating Plant Units 3 and 4 (VEGP), COL Numbers NPF-91 and NPF-92, respectively. LAR 15-012 consists of changes to the Updated Final Safety Analysis Report (UFSAR) in the form of departures from the incorporated plant-specific Design Control Document (DCD) Tier 2* information and associated Tier 2 information. The proposed changes are related to the design of the floor modules and the connections between the floor modules and structural wall modules in the containment internal structures. These changes allow for variations in specific design of these structures to accommodate local loading conditions and geometry.

In a letter dated July 12, 2016 (ADAMS Accession No. ML16196A099), the licensee submitted LAR 15-012 Revision 1 (LAR 15-012 R1) which updated Enclosures 1 and 2 of the March 11, 2016 request, addressing NRC staff's comments from a public meeting on March 31, 2016 (ADAMS Accession No. ML16050A442). In the updated enclosures, the licensee specified the floor modules affected by the LAR to be those that make up the maintenance floor at Elevation 107'-2" and the operating deck at Elevation 135'-3", added notes to UFSAR Figure 3.8.3-3 to identify variation in the floor design elements, and removed representation of the truss design elements (channels and angles) in the module wall.

In a letter dated October 20, 2016 (ADAMS Accession No. ML16294A526), the licensee submitted a Supplement to LAR 15-012 R1 (LAR 15-012 R1S) which included responses to NRC staff's comments from a public meeting on August 11, 2016 (ADAMS Accession No. ML16209A091). The staff's comments included a need for information on demand-to-capacity ratios for representative connection designs covered by the LAR. In response to the staff's request, the licensee provided design analysis information, including demand-to-capacity ratios, for a representative connection between the CA37 structural module floor and the CA01 module wall.

In a letter dated May 05, 2017 (ADAMS Accession No. ML17125A069), the licensee submitted LAR 15-012 R2 which reflects NRC staff's comments from the November 3, 2016, public meeting (ADAMS Accession No. ML16307A030) and February 23, 2017, public meeting (ADAMS Accession No. ML17010A248), including the removal of materials pertaining to connections for wall modules that do not extend above the floor elevation as they are outside the scope of the LAR, clarifying that the floor to wall connection design meets the applicable codes at locations without top or bottom reinforcement dowels, and including a demand-to-capacity ratio table corresponding to the heavily loaded floor connection design.

On August 16, 2016, the NRC staff published a proposed no significant hazards consideration determination in the *Federal Register* (81 FR 54617) for the proposed amendment. The October 20, 2016, supplement and May 5, 2017, revision 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.

2.0 REGULATORY EVALUATION

Modular construction techniques are used extensively in AP1000 containment internal structures. The UFSAR Section 3.8.3 "Concrete and Steel Internal Structures of Steel Containment" provides a design description of the floor modules, the structural wall modules, and the connection between the floor and wall modules in the containment internal structures. The structural wall modules are composite structures consisting of steel plates filled with concrete. Representative design details of the floor modules are shown in UFSAR Figure 3.8.3-3, "Structural Floor Module," and representative design details of the connection between the floor and wall modules are shown in UFSAR Figure 3.8.3-17 (Sheets 1 and 2), "Structural Modules – Design Details of Standard and Heavily Loaded Floor Connection." The texts in UFSAR Subsections 3.8.3.1.4, "Structural Floor Modules," and 3.8.3.5.4, "Structural Floor Modules," describe the structural floor modules and reference UFSAR Figure 3.8.3-3. The texts in UFSAR Subsections 3.8.3.1.3, "Structural Wall Modules," and 3.8.3.5.8.1, "Structural Wall Modules," describe the structural wall modules and their connection with the floor modules and reference UFSAR Figure 3.8.3-17. The floor modules, the structural wall modules, and the connection of the floor to wall modules are designed to satisfy the applicable requirements of the American Concrete Institute (ACI) Code, ACI 349, "Building Code Requirements for Nuclear Safety-Related Structures," and the American Institute of Steel Construction (AISC) Standard, AISC N690, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities."

In the LAR, the licensee proposed to depart from Tier 2* information in VEGP Units 3 and 4 UFSAR Figure 3.8.3-17 (Sheets 1 and 2) and from associated Tier 2 information in VEGP Units 3 and 4 UFSAR Subsections 3.8.3.1.3, 3.8.3.1.4, 3.8.3.5.4, and 3.8.3.5.8.1, and UFSAR Figure 3.8.3-3. The purpose of the departure is to address changes to design details for the floor

modules and for the connections between the floor modules and structural wall modules in the containment internal structures. UFSAR Figure 3.8.3-3 is revised to show shear studs on top of the bottom plate of the floor module and to add notes about the design variations. UFSAR Figure 3.8.3-17 is revised to accommodate changes to the design details of the connections and to add notes about the design variations. The text references in related UFSAR Subsections mentioned above are expanded to identify the design elements for which the design details may vary. These changes apply to connections between the structural wall modules and the floor modules that make up the maintenance floor at Elevation 107'-2" and the operating deck at Elevation 135'-3". The structural wall module design for the three critical sections identified in the first paragraph of UFSAR Subsection 3.8.3.5.8.1 is not affected.

Specifically, the changes proposed in the LAR include the following:

(1) Adding shear studs welded to the bottom steel plate, using channel as well as wide flange as structural shapes, and changing reinforcement size and spacing in the design of internal containment floor modules;

(2) Changing reinforcement size and spacing; plate size and spacing; type, size, and spacing of structural shapes; design of reinforcement hooks in the wall modules; design of couplers connecting the floor reinforcement to the hooks in the wall modules; design of seat angles, beam seats, clip angles, shear plates, face plates, backup structures, and other design elements supporting the floor modules and connecting the floors to the wall modules; and

(3) Updating applicable sections of the licensing basis documents as a result of the proposed changes.

Title 10 of the *Code of Federal Regulations (*10 CFR), Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Appendix D, “Design Certification Rule for the AP1000 Design,” Section VIII.B.6, requires prior NRC’s approval for changes to Tier 2* information. The proposed changes affect Tier 2* information, and therefore require NRC approval.

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

The regulations in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion (GDC) 1, “Quality Standards and Records,” require that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

The regulations in 10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection against Natural Phenomena,” require that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

The regulations in 10 CFR Part 50, Appendix A, GDC 4, “Environmental and Dynamic Effects Design Bases,” require that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions

associated with normal operation, maintenance, testing and postulated accidents, including loss-of-coolant accidents.

The regulations in 10 CFR Part 50, Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” require that nuclear power plants shall be designed so that, if safe-shutdown earthquake (SSE) ground motion occurs, certain structures, systems and components (SSCs) will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of structures, systems, and components must be assured during and after the vibratory ground motion associated with the SSE ground motion through design, testing, or qualification methods.

The regulations in 10 CFR Part 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” as it relates the quality assurance criteria for nuclear power plants.

The regulations in 10 CFR 52.80(a), which require that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the Atomic Energy Act, and the Commission's rules and regulations.

3.0 TECHNICAL EVALUATION

To perform the technical evaluation, the staff considered VEGP Units 3 and 4 UFSAR Section 3.8, “Design of Category I Structures.” The staff also examined portions of NUREG-1793, Supplement 2, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design” (NUREG-1793) (ADAMS Accession No. ML112061231), and the “Final Safety Evaluation Report for the Vogtle Electric Generating Plant Units 3 and 4 Combined License Application,” (ADAMS Accession No. ML110450302) documenting the staff’s technical evaluation of those aspects of the AP1000 DCD and VEGP Units 3 and 4 COL application, respectively. The staff reviewed the licensee’s proposed actions to evaluate the impact of the requested VEGP Units 3 and 4 UFSAR changes related to floor modules and the connection between floor modules and structural wall modules in the containment internal structures (CIS) only on the overall safety of the plant.

The NRC staff’s technical evaluation of these design detail changes, and the impact of the changes to the safety of the nuclear power plant, are summarized below.

3.1 Structural Floor Module

UFSAR Subsection 3.8.3.5.4 indicates that the design details shown in UFSAR Figure 3.8.3-3 are the representative design for a specific portion of the operating deck floor in containment. The licensee proposed changes to design details depicted in UFSAR Figure 3.8.3-3 and associated texts in UFSAR Subsections 3.8.3.1.3, 3.8.3.1.4, 3.8.3.5.4, and 3.8.3.5.8.1. The staff’s evaluation of structural floor module is described in Sections 3.1.1 through 3.1.4 of the safety evaluation report (SER) below.

3.1.1 Shear Studs (UFSAR Figure 3.8.3-3, Note 5; UFSAR Subsections 3.8.3.1.4 and 3.8.3.5.4)

In the LAR, the licensee proposed to add shear studs welded on the top of the floor bottom plate as shown in UFSAR Figure 3.8.3-3 and described in Subsection 3.8.3.1.4. The licensee also proposed to add Note 5 to UFSAR Figure 3.8.3-3 that refers to revised UFSAR Subsection 3.8.3.5.4 for information about the shear studs, which states that the shear studs are not credited in the composite section design but supplement the natural bottom plate-to-concrete bond capability.

The staff reviewed the proposed addition of shear studs in UFSAR Figure 3.8.3-3 and associated texts in UFSAR Subsections 3.8.3.1.4 and 3.8.3.5.4. The staff finds the proposed addition of shear studs to the top of the floor bottom plate acceptable because the licensee does not rely on shear studs to take loads for composite action of the floor module, and the licensee takes the same approach to the composite design of the floor module as described in UFSAR Subsection 3.8.3.5.4 without considering shear studs.

3.1.2 Structural Shapes for Floor Module Beams (UFSAR Figure 3.8.3-3, Notes 1, 3, 4; UFSAR Subsection 3.8.3.1.4)

In the LAR, the licensee proposed to add channel to the list of structural shapes for beams used in the floor modules in UFSAR Subsection 3.8.3.1.4. The licensee also added Notes 1, 3 and 4 to UFSAR Figure 3.8.3-3 to state that channels and wide flange beams used in some locations are not shown, that the floor design elements shown are for locations away from openings, penetrations and other obstructions, and that the design of the plates, beams, and stiffeners in the floor, including plate size and spacing, type, size, and spacing of structural shapes varies and satisfies the requirements of AISC N690.

The staff reviewed UFSAR Subsection 3.8.3.5.4 and UFSAR Figure 3.8.3-3, and identified that the details shown in UFSAR Figure 3.8.3-3 are the representative design for a specific portion of the operating deck floor in containment and that steel Tee is shown in UFSAR Figure 3.8.3-3. The notes clarifying that floor design elements shown are for locations away from openings, penetrations and other obstructions are acceptable to the staff because floor design elements shown in UFSAR Figure 3.8.3-3 are not located near openings, penetrations, or other obstructions. Due to different loading conditions and geometry of the floor modules, use of channels and wide flange beams in other locations are acceptable to the staff because the licensee follows the same design methodology for the composite design of the floor module as described in UFSAR Subsection 3.8.3.5.4 and because the floor modules are designed as a composite structure of concrete slab and steel beams in accordance with AISC N690. On this basis, the staff finds the licensee's proposed changes to add additional structural shape for the beams embedded in the floor modules are acceptable.

3.1.3 Reinforcement Size and Spacing (UFSAR Figure 3.8.3-3, Notes 2, 3; UFSAR Subsection 3.8.3.1.4)

In the LAR, the licensee proposed to remove designation of top reinforcement size and spacing from the UFSAR Figure 3.8.3-3. The licensee also proposed to add Notes 2 and 3 to UFSAR Figure 3.8.3-3 identifying that the reinforcement use, size, and spacing in the floor module concrete satisfy the requirements of ACI 349, the reinforcement size range is #7 to #11, and the reinforcement shown is for locations away from openings, penetrations and other obstructions. The licensee added texts to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 stating that design details for the floor modules including the size and spacing of the reinforcement are provided for background information and vary based on loading conditions and geometry.

The staff reviewed UFSAR Figure 3.8.3-3 and UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 along with UFSAR Figure 3.8.3-17, Sheets 1 and 2. The staff finds that removing designation of top reinforcement size and spacing in the floor module is acceptable because the design details in UFSAR Figure 3.8.3-3 can be used for floor modules with different loading conditions. The staff also finds that the top reinforcement size in UFSAR Figure 3.8.3-3 is in a range of #7 to #11, which is consistent with the top reinforcement size range designated in UFSAR Figure 3.8.3-17, Sheets 1 and 2, evaluated in SER Sections 3.2.1.2 and 3.2.2.2 below. The staff finds the proposed changes to UFSAR Figure 3.8.3-3 and UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 regarding the floor module top reinforcement design acceptable because the reinforcement design of the floor module is in accordance with the applicable provisions of ACI 349 and reinforcement size and spacing are determined based on design loads for the specific floor.

3.1.4 Other Changes to Floor Modules

In the LAR, the licensee proposed to remove a designation of the elevation for top of concrete (TOC) from UFSAR Figure 3.8.3-3. The staff considers the proposed change acceptable because the licensee intends to use the floor module design depicted in UFSAR Figure 3.8.3-3 at more than one floor elevation.

In addition, the licensee proposed to change the text, “Although the bottom flange of the steel section is not encased within concrete” to “Although the bottom plate of the floor, which is welded to the web and acts as the bottom flange, is not encased within concrete” in the UFSAR Subsection 3.8.3.5.4. The staff considers the proposed change acceptable because the revised text describes the actual condition of the bottom plate in UFSAR Figure 3.8.3-3.

In conclusion, the staff finds licensee’s proposed changes to the structural floor module design details acceptable.

3.2 Floor-to-Wall Module Connections

UFSAR Figure 3.8.3-17 shows design details representative of connections between the floor modules and structural wall modules in the containment internal structures; Sheet 1 of 2 represents the standard floor connection and Sheet 2 of 2 represents the heavily loaded floor connection. In the LAR, the licensee states that the detail design of floor-to-wall module connections vary based on the loading conditions and geometry of the floor modules. The licensee proposed changes to UFSAR Figure 3.8.3-17 and associated texts in UFSAR Subsections 3.8.3.1.3, 3.8.3.5.4, and 3.8.3.5.8.1 to allow variation in design detailing of the connections.

The staff’s evaluations of the floor-to-wall connections are described in Sections 3.2.1 and 3.2.2 of this SER below.

3.2.1 Standard Floor Connection

3.2.1.1 Applicable Floor Modules (UFSAR Figure 3.8.3-17, Sheet 1 of 2, Note 1; UFSAR Subsection 3.8.3.1.3)

In the LAR, the licensee proposed to remove the designation of elevations for TOC and bottom of steel (BOS) in UFSAR Figure 3.8.3-17. The licensee added Note 1 to the UFSAR Figure to clarify the applicability of the design to floor modules at Elevations 107'-2" and 135'-3" and their

connection to structural wall modules inside containment. The licensee also modified UFSAR Subsection 3.8.3.1.3 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 1 of 2.

The staff reviewed the proposed changes regarding the applicability of USFAR Figure 3.8.3-17, Sheet 1 of 2, to multiple floor modules in containment. The staff finds that UFSAR Subsection 3.8.3.1.3 clarifies its intent to use the floor module to wall module standard connection in the maintenance floor at Elevation 107'-2" and operating deck at Elevation 135'-3", and that the connection design continues to satisfy ACI 349 and AISC N690 criteria and requirements. On this basis, the staff finds that the proposed addition of Note 1 and removal of TOC and BOS elevations in UFSAR Figure 3.8.3-17 are acceptable because the wall module to floor module standard connection can be used at more than one floor elevation.

3.2.1.2 Reinforcement, Reinforcement Hook and Reinforcement Bar Connectors (UFSAR Figure 3.8.3-17, Sheet 1 of 2, Notes 2, 4, 5; UFSAR Subsection 3.8.3.1.3)

Standard Hook Modification in the Wall Module

The licensee proposed to modify on of the reinforcement hook lengths within the wall module in UFSAR Figure 3.8.3-17, Sheet 1 of 2, and further clarified, in Note 2 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, that the design of the standard hooks in the wall modules satisfies the requirements of ACI 349.

The staff reviewed the reinforcement hook within the wall module in UFSAR Figure 3.8.3-17, Sheet 1 of 2, and finds that the licensee shortened the extra length of reinforcement hook in the wall module. The staff also finds that the standard hooks within the wall modules satisfy ACI 349 requirements as described in UFSAR Subsection 3.8.3.1.3. On this basis, the staff finds the proposed modification to reinforcement hook length within the wall module acceptable.

Reinforcement Bar Connectors

In the LAR, the licensee proposed to change the reinforcement bar connector on the faceplate to be consistent with the type of connector used, and clarified, in Note 2 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, that the design of reinforcement bar connectors (or couplers) connecting the floor reinforcement to hooks in the wall modules satisfies the requirements of ACI 349. The licensee further indicated that a typical mechanical connection between two reinforcing bars to create a tension splice is made with a taper-threaded couplers, which are often referred to as “form savers.”

The staff finds the proposed changes to reinforcing bar connectors acceptable because the mechanical connectors used are mechanical splices that develop at least 125 percent of the specified yield strength of the spliced bar based on the requirements of ACI 349, Section 12.14.3.

Reinforcement

In UFSAR Figure 3.8.3-17, Sheet 1 of 2, Revision 5, the licensee did not identify any reinforcement size and spacing. In the LAR, the licensee added Notes 2 and 4 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, to clarify that (1) reinforcement use, size, and spacing in the floor module concrete satisfy the requirements of ACI 349 and the reinforcement size ranges from #7 to #11 (Note 2), and (2) the reinforcement and floor design elements shown are for locations away from openings, penetrations, and other obstructions (Note 4). The licensee also modified

UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 1 of 2.

The staff reviewed the proposed changes to the steel reinforcement in UFSAR Figure 3.8.3-17, Sheet 1 of 2 and associated texts in UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1. The staff also reviewed Table 1-1, "CA37 Standard Connection Design Interaction Ratios (IR) Corresponding to Figure 3.8.3-17, Sheet 1 of 2", which the applicant provided in Enclosure 5 of the LAR 15-012 R2. Specifically, the staff compared reinforcement demands and capacities for both top and bottom dowels presented in Table 1-1 and confirmed that the demands are bounded by the corresponding capacities of the reinforcement dowels. However, the staff further noted that the demand for the bottom dowel is greater than the demand for the top dowel. Since the floor to wall module standard connection is designed as "fully fixed" condition, the staff considered that the top reinforcement would be in tension and the concrete in the lower portion of the section in compression and thus the demand for the top dowel should be greater than that of the bottom dowel. Therefore, the staff asked the licensee for a clarification. In its response, the licensee described in LAR 15-012 R2, that the reinforcement demand is calculated from enveloping load combinations. The licensee further described that the top dowel exhibits a higher demand under normal operation loading combinations and that the bottom dowel demand is associated with an abnormal loading combination that is primarily controlled by seismic and flood-thermal loading cases which contributes the larger net tension in the bottom dowels. The staff finds the licensee's approach to calculating reinforcement demand acceptable because the licensee properly considered loads and load combinations as described in UFSAR Subsection 3.8.3.3, "Loads and Load Combinations." On this basis, the staff finds the reinforcement size ranging from #7 to #11 in the floor module acceptable because the licensee demonstrated that the reinforcement demand is enveloped by the capacity provided by the reinforcement, and because the reinforcement design is in accordance with the applicable provisions of ACI 349 and reinforcement size and spacing are determined based on design loads for the specific floor.

The staff also reviewed Note 4 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, stating that the reinforcement and floor design elements shown are for locations away from openings, penetrations, and other obstructions. The staff finds adding Note 4 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, acceptable because the standard floor connection design shown in UFSAR Figure 3.8.3-17, Sheet 1 of 2, does not apply to connections located near openings, penetrations, or other obstructions.

Omission of Bottom Reinforcing Bars at the Beam Connection

The licensee added Note 5 to the UFSAR Figure 3.8.3-17, Sheet 1 of 2, stating that, in some locations, reinforcement at the connection is not required because the loads are transferred through the steel section directly to the backup structures or the seat angle and the design of the floor meets the applicable requirements of ACI 349 and AISC N690.

The staff reviewed the licensee's proposed statement in Note 5 to the UFSAR Figure 3.8.3-17, Sheet 1 of 2, particularly the situation in which reinforcement at the connection is not required. The staff reviewed the licensee's technical evaluation in Enclosure 1 of the LAR which indicates that the bottom dowels are not provided at the location of the steel beam in the one location along the north side of floor CA58. The licensee described there is no backup structure within the wall and the steel beam is short in span and has insignificant upward loading and insignificant axial demand. The staff identified that the load path is achieved directly through the bottom plate welded to the seat angle and transferred to the CA01 wall, which is consistent with

a key feature of the connection design that the design elements provide a direct load path from the floor into the wall as described in UFSAR Subsection 3.8.3.5.8.1. On this basis, the staff finds the omission of bottom reinforcing bars at the location of the steel beam in the one location along the north side of floor CA58 to wall CA01 and adding Note 5 to the UFSAR Figure 3.8.3-17, Sheet 1 of 2, acceptable.

3.2.1.3 Steel Elements in Floor Modules (UFSAR Figure 3.8.3-17, Sheet 1 of 2, Note 3; UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.4)

The licensee added Note 3 to UFSAR Figure 3.8.3-17 to state that design of the plates, beams, and stiffeners in the floor, including plate size and spacing, and type, size, and spacing of structural shapes varies and satisfies the requirements of AISC N690. The licensee also added related text to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.4.

The staff reviewed the variation in the design of the structural elements used in the floor modules. The staff reviewed UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.4 to confirm that the stated requirements of AISC N690 are appropriate for the design of structural elements including steel plates, beams, and stiffeners. Because the floor design is applicable to multiple floor modules with differing structural demands and because the design is in conformance with the applicable standard, the proposed variation to design details of the floor structural elements is acceptable. Therefore, the staff determined the proposed addition of Note 3 to UFSAR Figure 3.8.3-17 and related modifications to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.4 are acceptable.

3.2.1.4 Floor and Beam Supports (UFSAR Figure 3.8.3-17, Sheet 1 of 2, Note 6; UFSAR Subsection 3.8.3.1.3)

The licensee proposed to replace one of the clip angles with a shear plate that connects the beam to the faceplate of the wall module. The licensee also added Note 6 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, to clarify that the detail design, location, and attachment of the floor and beam supports meet the requirements of AISC N690 and that the support configurations, including the use of plates, structural shapes, and stiffeners, are based on the considerations of loading conditions and local geometry.

The staff reviewed the proposed changes to the floor and beam support details. The staff also reviewed UFSAR Subsection 3.8.3.1.3 to confirm that the stated requirements of AISC N690 are appropriate for the design of steel elements used in the floor and beam supports. Because the designs of floor and beam supports are applicable to multiple floor modules with differing loading conditions and geometry and because the designs are in conformance with the applicable standard, the proposed variation to design details of the floor and beam supports are acceptable. Therefore, the staff determined the use of shear plate and clip angle for beam connection, the proposed addition of Note 6 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, and related modification to UFSAR Subsections 3.8.3.1.3 are acceptable.

3.2.1.5 Connections and Backup Structures within Wall Modules (UFSAR Figure 3.8.3-17, Sheet 1 of 2, Notes 7 and 8; UFSAR Subsection 3.8.3.1.3)

The licensee proposed not to show the representation of the truss angles and channels inside the wall modules in UFSAR Figure 3.8.3-17, Sheet 1 of 2. The licensee also added Note 7 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, clarifying that the designs of the connections and backup structures within the wall modules, including plate size and spacing, type, size, and spacing of

structural shapes, and use, size, and spacing of shear studs, vary and satisfy the requirements of AISC N690. Also, the licensee added Note 8 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, clarifying that the thickness of the adjacent wall is based on the wall design requirements and location.

The staff reviewed the proposed changes to the design details of the connections and backup structures within the wall modules. The staff also reviewed UFSAR Subsection 3.8.3.1.3 to confirm that the stated requirements of AISC N690 are appropriate for the design of steel elements used in the connections and backup structures within the wall modules. Because the designs of the connections and backup structures within the wall modules are applicable to multiple wall modules with differing structural demands and because the designs are in conformance with the applicable codes, the proposed variations to design details of the connections and backup structures within the wall modules are acceptable. Further adding notes to clarify that the thickness of the adjacent wall depends on the wall design requirements and location is acceptable because the wall design is in accordance with the applicable requirements specified in the AP1000 DCD and there is no change to the wall module design in this LAR. The angle and channel that are part of the truss in the wall modules are not shown only for clarity of the connection detailing because the angle and channel are already shown in UFSAR Figure 3.8.3-8. On this basis, the staff determined that the no showing of the representation of the truss angles and channels inside the wall modules, the proposed addition of Notes 7 and 8 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, and related modifications to UFSAR Subsections 3.8.3.1.3 are acceptable.

3.2.2 Heavily Loaded Floor Connection

3.2.2.1 Applicable Floor Modules (UFSAR Figure 3.8.3-17, Sheet 2 of 2, Note 1; UFSAR Subsection 3.8.3.1.3)

In the LAR, the licensee proposed to remove the designation of elevations for TOC and BOS in UFSAR Figure 3.8.3-17, Sheet 2 of 2. The licensee added a Note 1 to this UFSAR Figure to clarify the applicability of the design to floor modules at elevations 107'-2" and 135'-3" and their connection to structural wall modules inside containment. The licensee also modified UFSAR Subsection 3.8.3.1.3 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 2 of 2.

The staff's evaluation of "Applicable Floor Modules" for standard floor connection documented in SER Section 3.2.1.1 above also applies to the heavily loaded floor connection.

3.2.2.2 Reinforcement, Reinforcement Hook, and Reinforcement Bar Connectors (UFSAR Figure 3.8.3-17, Sheet 2 of 2, Notes 2, 4 and 5; UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1)

<u>Standard Hook Modification in the Wall Module and Reinforcement Bar Connectors</u>

In the LAR, the licensee proposed to modify one of reinforcement hook length within the wall module in UFSAR Figure 3.8.3-17, Sheet 2 of 2, and further clarified that the design of the standard hooks in the wall modules satisfies the requirements of ACI 349 in Note 2 to UFSAR Figure 3.8.3-17, Sheet 2 of 2. The licensee also changed the reinforcement bar connector on the faceplate to be consistent with the type of connector used, and clarified, in Note 2 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, that the reinforcement bar connectors (couplers) connecting the floor reinforcement to hooks in the wall modules satisfies the requirements of ACI 349. The

licensee modified UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 2 of 2.

The staff's evaluations of "Standard Hook Modification in the Wall Module" and "Reinforcement Bar Connectors" for standard connection documented in SER Section 3.2.1.2 above also apply to the heavily loaded floor connection.

Reinforcement

In UFSAR Figure 3.8.3-17, Sheet 2 of 2, Revision 5, the licensee did not identify any reinforcement size and spacing. In the LAR, the licensee added Notes 2 and 4 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, to clarify that (1) reinforcement use, size, and spacing in the floor module concrete satisfy the requirements of ACI 349 and the reinforcement size ranges from #7 to #11 (Note 2), and (2) the reinforcement and floor design elements shown are for locations away from openings, penetrations, and other obstructions (Note 4). The licensee also modified UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 2 of 2.

The staff reviewed the proposed changes to the steel reinforcement in UFSAR Figure 3.8.3-17, Sheet 2 of 2 and associated text in UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1. The licensee provided reinforcement demand and its capacity for both top dowels and bottom dowels in the Table 1-1 in Enclosure 5 of this LAR. The license described in the LAR that the reinforcement demands shown in Table 1-1 are values from enveloping load combination and they represent the largest dowel demand in all of CA3X floors; therefore, the staff's evaluation of reinforcement size and its design for standard floor connection documented in Section 3.2.1.2 of this SER also applies to the heavily loaded floor connection. On this basis, the staff finds the reinforcement size ranging from #7 to #11 in the floor module acceptable because the licensee demonstrated that the reinforcement demand is enveloped by the capacity provided by the reinforcement and the reinforcement size and spacing are designed in accordance with ACI 349.

The staff also reviewed Note 4 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, stating that the reinforcement and floor design elements shown are for locations away from openings, penetrations, and other obstructions. The staff finds that adding Note 4 to UFSAR Figure 3.8.3-17, Sheet 2 of 2 is acceptable because the heavily loaded floor connection design shown in UFSAR Figure 3.8.3-17, Sheet 2 of 2, does not apply to connections located near openings, penetrations, or other obstructions.

Omission of Reinforcing Bars in Heavily Loaded Floor Connection

In the LAR, the licensee removed both top and bottom reinforcement for the section at beams for the heavily loaded floor connection in UFSAR Figure 3.8.3-17, Sheet 2 of 2. The licensee also added Note 5 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, stating that, in some locations, reinforcement at the connection is not required because the loads are transferred through the steel section directly to the backup structures or the seat angle and the design of the floor meets the applicable requirements of ACI 349 and AISC N690. The licensee also modified UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 2 of 2.

Because the staff considered the removal of reinforcing bars from the connection design as a significant change, the staff requested that the licensee provide information that justifies such a change. In the Table 1-2 "CA37 Heavily Loaded Floor Connection Design Interaction Ratios

(IR) Corresponding to UFSAR Figure 3.8.3-17, Sheet 2 of 2" in Enclosure 5 of the LAR 15-012 R2, the license provided load demands and capacities for the beam seat and beam connection plates, in the absence of top and bottom reinforcing bars. The licensee selected the CA37 structural module floor connected with the CA01 module wall as representative for heavily loaded connections because it is one of the most heavily loaded floors. The staff compared the structural demands and capacities for the beam seat and beam connection plates presented in Table 1-2 and confirmed that the demands are bounded by the corresponding capacities, in the absence of reinforcing bars in the connection design. The beam seats are analyzed in a similar fashion as the continuous stiffened seat angle with the exception that they support larger loads. The connection plate attaches the floor beam to the wall module and provides a direct load path to transfer shear, axial and flexural loads from the floor beam to the CA01 wall through the backup structures, which is consistent with a key feature of the connection design that the design elements provide a direct load path from the floor into the wall as described in UFSAR Subsection 3.8.3.5.8.1. On this basis, the staff finds the removal of both top and bottom reinforcement from the design for the section at beams for the heavily loaded connection acceptable because the design elements provide a direct load path from the floor into the wall and the design of floors satisfies the applicable requirements of ACI 349 and AISC N690 without both top and bottom reinforcement for the section at beams.

In conclusion, the staff determined that the proposed additions of Notes 2, 4 and 5 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, and related modifications to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 are acceptable.

3.2.2.3 Steel Elements in Floor Modules (UFSAR Figure 3.8.3-17, Sheet 2 of 2, Note 3)

The licensee added Note 3 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, stating that design of the plates, beams, and stiffeners in the floor, including plate size and spacing, and type, size, and spacing of structural shapes varies and satisfies the requirements of AISC N690. The licensee also added related text to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.4.

The staff's evaluation of "Steel Elements in Floor Modules" for standard floor connection documented in SER Section 3.2.1.3 above also applies to the heavily loaded floor connection.

3.2.2.4 Floor and Beam Supports (UFSAR Figure 3.8.3-17, Sheet 2 of 2, Notes 6 and 9)

In the LAR, the licensee replaced one of clip angles with a shear plate for the beam connection and added Note 6 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, to clarify that the detail design, location, and attachment of the floor and beam supports are designed to the requirements of AISC N690 and that the support configurations, including the use of plates, structural shapes, and stiffeners, are based on loading and local geometry considerations.

The staff's evaluation of adding Note 6 to UFSAR Figure 3.8.3-17, Sheet 1 of 2, for standard floor connection is documented in Section 3.2.1.4 of this SER which also applies to the heavily loaded floor connection.

In the LAR, the licensee replaced a seat angle with a beam seat that supports the beam and connects it to the faceplate of the wall module for the heavily loaded floor connection at beams. The licensee also added Note 9 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, clarifying that a beam seat shown is not used at all beam locations but a seat angle is used at other locations.

The staff reviewed the proposed design changes to beam supports for heavily-loaded floor

connections depicted in UFSAR Figure 3.8.3-17, Sheet 2 of 2, and related descriptions added to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1. The staff identified that the design of beam supports for heavily-loaded floor connections are commensurate with the structural load demands at the locations and are in accordance with applicable provisions of AISC N690, which is acceptable to the staff. Also, Note 9 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, clarifying that a seat angle, instead of a beam seat, is used at other locations, is acceptable because the type of support is determined by the load demands at these locations and the design is in accordance with the acceptable code. On this basis, the staff determined the proposed addition of Notes 6 and 9 to Figure 3.8.3-17, Sheet 2 of 2, detailing variations to the floor and beam support for heavily loaded floor connection and related modifications to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 are acceptable.

3.2.2.5 Connections and Backup Structures (UFSAR Figure 3.8.3-17, Sheet 2 of 2, Notes 7 and 8)

In the LAR, the licensee proposed to remove the plate thickness for the backup structure in UFSAR Figure 3.8.3-17, Sheet 2 of 2. The licensee also proposed not to show the angle and channel that are part of the truss in the wall modules. In addition, the licensee added Note 7 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, clarifying that the designs of the connections and backup structures within the wall modules, including plate size and spacing, type, size, and spacing of structural shapes, vary and satisfy the requirements of AISC N690. The licensee further added Note 8 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, clarifying that the thickness of the adjacent wall is based on the wall design requirements and location. The licensee also modified UFSAR Subsection 3.8.3.1.3 and 3.8.3.5.8.1 to reflect changes made to USFAR Figure 3.8.3-17, Sheet 2 of 2.

The staff reviewed the designs of the connections and backup structures within the wall modules described in the UFSAR Section 3.8.3, Rev. 5. The staff reviewed UFSAR Subsection 3.8.3.1.3 and confirmed that the stated requirements of AISC N690 are appropriate for the design of steel elements used in the connections and backup structures within the wall modules. The staff also reviewed UFSAR Subsection 3.8.3.5.8.1 and noted that details of the connection design, including plate thickness, structural shape type and size, use of specific design elements vary based on local loads. Because the designs of the connections and backup structures within the wall modules are applicable to multiple wall modules with differing structural demands and geometry and because the designs are in conformance with the applicable codes, the proposed variation to design details of the connections and backup structures within the wall modules is acceptable to the staff. Further, a Note 7 is added to the UFSAR Figure to clarify variations in the connection detailing. On this basis, the staff finds the proposed design changes replacing one of clip angles with a shear plate for the beam connection, removing the plate thickness for the back-up structure as a design variation, and variations to the connections and backup structures within the wall modules acceptable.

Further, adding Note 8 to the UFSAR Figure clarifying that the thickness of the adjacent wall depends on the wall design requirements and location is acceptable to the staff because the wall design is in accordance with the requirements of AP1000 DCD and there is no change made to the wall module in this LAR. The angle and channel that are part of the truss in the wall modules are not shown because this information is not needed to show the connection design and is included in UFSAR Figure 3.8.3-8.

On this basis, the staff determined the proposed removal of plate thickness designation and no showing of angle and channel from the backup structure in the wall module in UFSAR Figure

3.8.3-17, Sheet 2 of 2, and addition of Notes 7 and 8 to this UFSAR Figure and related modifications to UFSAR Subsections 3.8.3.1.3 and 3.8.3.5.8.1 are acceptable.

3.2.2.6 Other Changes to Floor-to-Wall Connection

The licensee proposed to replace the term “plate girder” with “beam” in UFSAR Figure 3.8.3-17, Sheet 2 of 2, which is acceptable to the staff because this is consistent with the use of the term “beam” in USFAR Figure 3.8.3-17, Sheet 1 of 2.

The licensee proposed to move symbols identifying the location of “Section A” in UFSAR Figure 3.8.3-17, Sheet 2 of 2, which is acceptable to the staff because this adds clarity to the details in this UFSAR Figure.

The licensee proposed to add size and spacing for the angles welded on top of bottom plate for section at beams in floor, which is acceptable to the staff because this is consistent with the size and spacing of the angles for section between beams in floor as shown in UFSAR Figure 3.8.3-17, Sheet 2 of 2.

The licensee proposed to add Note 10 to UFSAR Figure 3.8.3-17, Sheet 2 of 2, which is acceptable to the staff because UFSAR Subsection 3.8.3.5.4 provides information about the shear studs in the floor module.

In conclusion, the staff finds licensee’s proposed changes to the floor-to-wall module connection detailing acceptable.

3.3 Summary

The staff reviewed the licensee’s proposed changes provided in the LAR. Based on the staff’s technical evaluation, the staff finds that:

(1) The proposed changes to the design of the containment internal floor modules are acceptable because the design conforms to ACI 349 and AISC N690 requirements. The licensee provided sufficient justification for variations in the design of the structural elements including shear studs, beam structural shapes, and reinforcing bars. The changes are acceptable as they are in compliance with 10 CFR 52.79(a)(41) and meet the structural acceptance criteria in Section 5 of Standard Review Plan (SRP) (NUREG-0800) Section 3.8.3.

(2) The proposed changes to the design of the connections between the containment internal floor modules and the structural wall modules are acceptable because the design conforms to ACI 349 and AISC N690 requirements. The licensee provided sufficient justification for variations in the design of the structural elements including reinforcing bars, floor beams, beam supports, rebar couplers and hooks, and backup structures in the wall modules. The licensee additionally provided sufficient justification for the omission of reinforcement at connection in some locations. The changes are acceptable as they are in compliance with 10 CFR 52.79(a)(41) and meet the structural acceptance criteria in Section 5 of SRP Section 3.8.3.

For the reasons specified above, the staff finds that the proposed UFSAR changes to Subsections 3.8.3.1.3, 3.8.3.1.4, 3.8.3.5.4, and 3.8.3.5.8.1 are acceptable. The staff also finds the proposed changes to UFSAR Figure 3.8.3-3 and UFSAR Figure 3.8.3-17, Sheet 1 of 2 and

Sheet 2 of 2, acceptable.

Based on these findings, the staff concludes that there is reasonable assurance that the proposed UFSAR changes do not impact the licensee's compliance with the requirements in GDC 1, GDC 2, GDC 4, Appendix S to 10 CFR Part 50, Appendix B to 10 CFR Part 50, and 10 CFR 52.80(a). Therefore, the staff finds the proposed changes to be acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations in 10 CFR 50.91(b), 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 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 (*Federal Register,* 81 FR 54617 (August 16, 2016). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Under 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The staff has concluded, based on the considerations discussed in Section 3.0 of this SER and confirming that these changes do not change an analysis methodology, assumptions, or the design itself, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed activities, (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.

7.0 REFERENCES

1. Request for License Amendment: Containment Internal Floor Module Connections (LAR 15-012), letter from Southern Nuclear Operating Company (SNC) dated March 11, 2016 (ADAMS Accession No. ML16071A404).

2. Revised Request for License Amendment: Containment Internal Floor Module Connections (LAR 15-012 R1), letter from SNC dated July 12, 2016 (ADAMS Accession No. ML16196A099).

3. Supplement to Revised Request for License Amendment: Containment Internal Floor Module Connections (LAR 15-012 R1S), letter from SNC dated October 20, 2016 (ADAMS Accession No. ML16294A526)

4. Revised Request for License Amendment: Containment Internal Floor Module Connections (LAR 15-012 R2), letter from SNC dated May 5, 2017 (ADAMS Accession No. ML17125A069)

5. Vogtle Electric Generating Plant Updated Final Safety Analysis Report (UFSAR), Revision 5, dated April 6, 2016 (ADAMS Accession No. ML16174A168).

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

7. Final Safety Evaluation Report (FSER) for Vogtle Electric Generating Plant Units 3 and 4 Combined License Application, dated August 5, 2011 (ADAMS Accession No. ML110450302 – FSER package).

8. 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).

9. American Concrete Institute (ACI), Code Requirements for Nuclear Safety Related Concrete Structures, ACI 349-01.

10. American Institute of Steel Construction (AISC), Specification for the Design, Fabrication and Erection of Steel Safety Related Structures for Nuclear Facilities, AISC-N690-1994.

11. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” March 2007. (ADAMS Accession No. ML070660036)