SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NO. 69

TO THE COMBINED LICENSE NOS. NPF-93 AND NPF-94

SOUTH CAROLINA ELECTRIC & GAS COMPANY

SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

VIRGIL C. SUMMER NUCLEAR STATION, UNITS 2 AND 3

DOCKET NOS. 52-027 AND 52-028

1.0 INTRODUCTION

By application dated July 19, 2016, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16202A035), the South Carolina Electric & Gas Company (SCE&G) on behalf of itself and the South Carolina Public Service Authority (both hereafter called the licensee) submitted license amendment request (LAR) 16-04 requesting the U.S. Nuclear Regulatory Commission's (NRC or the Commission) approval for amendments to the Combined Licenses (COL) Nos. NPF-93 and NPF-94 for the Virgil C. Summer Nuclear Station (VCSNS), Units 2 and 3, respectively.

This LAR requested changes to the Units 2 and 3 plant-specific Updated Final Safety Analysis Reports (UFSARs) in the form of departures of those UFSARs from the incorporated AP1000 Design Control Document (DCD) Tier 2 information. This LAR also proposed related changes to the COL Appendix A Technical Specifications (TS). The changes to the UFSAR Tier 2 information and TS were proposed to revise the AP1000 protection and safety monitoring system (PMS) functional logic to comply with the standards on operating bypasses in Clause 6.6, "Operating Bypasses" of the Institute of Electrical and Electronics Engineers (IEEE) Std. 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations." 10 CFR 50.55a(h)(3), "Safety Systems," requires compliance with IEEE Std. 603-1991 and the correction sheet dated January 30, 1995. Specifically, Clause 6.6, in IEEE Std. 603-1991 imposes requirements on the operating bypasses (i.e., "blocks" and "resets") used for safety systems.

In the certified AP1000 design, safety functions are initiated by the PMS. In Revision 19 of the AP1000 DCD, Chapter 7, all safety functions initiated by the PMS comply with IEEE Std. 603-1991, Clause 6.6, "Operating Bypasses," with one exception. The exception is the manually activated operating bypass of the safety function called the boron dilution block from the source range neutron flux doubling logic. The boron dilution blocking function is normally activated when neutron flux doubles too quickly while reactor power is in the source range. However, bypassing this block is permitted above a certain temperature when boron dilution can no longer lead to inadvertent criticality. The certified AP1000 design of the PMS flux doubling logic for the

boron dilution block did not meet the operating bypass requirements of IEEE Std. 603-1991 because the logic programmed into the PMS did not include a permissive to allow the block of the flux doubling function under the appropriate conditions.

Therefore, the licensee submitted this LAR proposing changes to the safety-related PMS functional logic for blocking and resetting the source range neutron flux doubling signal to fully comply with the requirements specified in Clause 6.6 of IEEE Std. 603-1991 on operating bypasses. Under certain conditions, it may be acceptable to bypass a safety function, but all of the conditions that permit bypassing the function must exist before the bypass is activated. If an operating bypass has been activated and plant conditions change so that the bypass is no longer permissible, the safety system must automatically do one of three things: restore plant conditions so that bypass is permissible, remove the active bypass, or initiate the safety function. The detailed evaluation is discussed in below in Section 3.2 of this evaluation.

The NRC staff's proposed no significant hazards consideration determination was published in the *Federal Register* on August 30, 2016 (81 FR 59659).

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(h)(3), "Safety Systems," requires COLs under 10 CFR Part 52 to comply with the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995. The NRC staff found that the changes to the AP1000 PMS functional logic, as proposed in this LAR, were related to the requirements specifically in Clause 6.6 of IEEE Std. 603-1991 on operating bypasses for safety systems. The NRC staff found that this regulatory requirement on operating bypasses for safety systems is found applicable to the proposed changes included in this LAR.

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 13 provides that instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. The NRC staff found that the changes proposed in this LAR do not modify the conditions under which the source range flux doubling boron dilution isolation mechanism performs its design function or the way in which the designed function is performed. Therefore, the compliance with GDC 13 in the certified AP1000 design was not impacted.

10 CFR Part 50, Appendix A, GDC 28 provides that reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steam line rupture, changes in reactor coolant temperature and pressure, and cold water addition. The NRC staff found that the changes requested in this LAR do not change the conditions under which source range neutron flux doubling boron dilution isolation mechanism performs its designed function nor does it change the way in which this designed function is performed. Therefore, the compliance with GDC 28 in the certified AP1000 design was not impacted.

In 10 CFR 50.36, the NRC established its regulatory requirements related to the content of TS. In doing so, the NRC placed emphasis on those matters related to the prevention of accidents and the mitigation of accident consequences. Accordingly, 10 CFR 50.36(c) requires that TS contain (1) safety limits and limiting safety system settings, (2) limiting conditions for operation, (3) surveillance requirements, (4) design features, and (5) administrative controls.

Paragraph (c)(2)(ii) of 10 CFR 50.36 requires that a Limiting Condition for Operation (LCO) be established in TS for each item meeting one or more of the following four criteria (referred to as LCO selection criteria):

(A) Criterion 1. Installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary.

(B) Criterion 2. A process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

(C) Criterion 3. A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

(D) Criterion 4. A structure, system, or component which operating experience or a probabilistic risk assessment has shown to be significant to public health and safety.

10 CFR Part 52, Appendix D, Section VIII.B.5.a allows a licensee who references this appendix to depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information, Tier 2* information, or the TS, or requires a license amendment under 10 CFR Part 52, Paragraphs B.5.b or B.5.c of Section VIII. The Tier 2 changes proposed in this LAR involve modifications to the TS and, therefore, require prior NRC approval.

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

3.0 TECHNICAL EVALUATION

This LAR proposed changes to the TS and design information in the UFSAR, which includes the plant-specific DCD Tier 2 information, to update the PMS to align with the requirements in IEEE Std. 603-1991, Clause 6.6. The PMS functional logic for blocking the source range neutron flux doubling signal, shown in UFSAR Figure 7.2-1 (Sheet 3), requires revision to fully comply with the requirement on operating bypasses. This proposed change also necessitates an amendment to TS and the UFSAR. The safety evaluation is provided below on all changes proposed in this LAR.

3.1 TECHNICAL EVALUATION FROM INSTRUMENTATION AND CONTROL PERSPECTIVES

Operating bypasses are usually included in the reactor safety instrumentation and control system design to permit some safety functions to be bypassed, so that normal plant operations can occur without actuating safety systems unnecessarily. The implementation of operating bypasses for safety functions are required to meet the requirements in Clause 6.6 of IEEE Std. 603-1991, which is required by regulation in accordance with 10 CFR 50.55a(h)(3).

The licensee has incorporated the certified AP1000 DCD for the VCSNS COLs. However, the licensee proposed the design changes in this LAR because it found that the design in the safety-related PMS for bypassing the source range neutron flux doubling logic input to the boron dilution block, which is a safety function as shown in Figure 7.2-1 (Sheet 3 of 21) in the certified AP1000 DCD, did not meet the requirements in Clause 6.6 of IEEE Std. 603- 1991. Hence, the licensee submitted this LAR proposing the following design changes to ensure that the regulatory requirements on operating bypasses for safety functions are met in the PMS design:

- Added a new permissive, P-8. Blocking of the source range (SR) flux doubling signal during reactor startup, when the plant is above the P-8 setpoint, is permitted by this new permissive. The P-8 permissive is set to be the minimum reactor coolant system (RCS) temperature needed for criticality as defined by TS LCO 3.4.2.

- Added an additional reset of source range neutron flux doubling signal when RCS temperature decreases below the P-8 permissive setpoint. The PMS design will continue to reset the source range flux doubling signal when the neutron flux decreases below the P-6 permissive setpoint.

- Added PMS logic to initiate a closure signal for chemical and volume control system (CVS) Valves 136A and 136B (PMS Division A closes Valve 136A and PMS Division C closes Valve 136B) if the SR flux doubling signal is blocked when RCS temperature is less than the P-8 setpoint. This change is proposed to meet the requirements in Clause 6.6 of IEEE Std. 603-1991 by initiating the appropriate safety function if the applicable permissive conditions are not met.

In its submitted LAR, the licensee also included revised logic Figure 7.2-1, Sheet 3 of 21, and specific markups for Sections 7.3.1.2.14 and 7.3.1.2.1, Tables 7.3-1 and 7.3-2, to show the incorporation of the above proposed design changes, which are evaluated below.

In the certified AP1000 design, when the reactor is shut down from power operations, the PMS design for the block of the flux doubling logic safety function met the criteria in Clause 6.6 of IEEE Std. 603-1991 regarding the operating bypass because the flux doubling logic safety function will be automatically reset to remove its block when the neutron flux falls below the existing Permissive P-6 setpoint. However, when the reactor starts up, the certified design of the PMS did not meet the regulatory requirement to impose permissive conditions for the manual block of the flux doubling logic safety function at any time because there were no permissive conditions implemented in the PMS design for the manual block of the flux doubling logic safety function for the boron dilution block. In addition, for the flux doubling logic safety function, the PMS design in the certified AP1000 DCD did not include control logic to reinstate permissive conditions or initiate appropriate safety function when the permissive conditions do not exist.

To address the above design deviations from the regulatory requirement on operating bypasses, the licensee proposed in this LAR to create a new permissive, P-8, by using the RCS temperature to permit blocking the flux doubling logic during reactor startup. The setpoint for the new Permissive P-8 is set to be the minimum reactor coolant system temperature needed for criticality, which is defined by TS LCO 3.4.2. The staff found that this proposed design change will provide the necessary permissive condition to allow manual bypass of the flux doubling logic safety function during the plant startup.

The licensee also proposed to add an additional reset of source range flux doubling logic when the RCS temperature falls below the setpoint for the new Permissive P-8. The staff found that this proposed design change will address the lack of the control logic in the current PMS design to reinstate permissive conditions to manually block the flux doubling logic safety function.

When the RCS temperature falls below the setpoint for the new P-8 permissive, the licensee proposed to add logic in the PMS to force CVS Valves 136A and 136B closed. The CVS in the AP1000 DCD is designed to avoid or terminate boron dilution events by isolating sources of unborated water to the RCS during all modes of operation when signaled to do so by the PMS. Valves 136A and 136B are installed on the demineralized water supply (DWS) line for isolating the unborated demineralized water to the CVS system. The staff found that this proposed change could prevent and/or terminate a boron dilution event from happening when the RCS temperature is below the new P-8 permissive setpoint if the flux doubling logic safety function is blocked. The NRC staff found that this proposed change meets the requirements in Clause 6.6 of IEEE Std. 603-1991 by initiating the appropriate safety function if the applicable permissive conditions are not met.

Overall, from the above evaluations and discussions the staff concludes that, because the changes to the PMS functional logic design proposed in this LAR comply with requirements on operating bypasses in Clause 6.6 of IEEE Std. 603-1991, the proposed changes are acceptable.

3.2 TECHNICAL EVALUATION FROM REACTOR SYSTEM PERSPECTIVES

The NRC staff reviewed the licensing basis document changes presented in this LAR with respect to the boron dilution analysis presented in AP1000 DCD, Revision 19, Section 15.4.6. The design changes include adding a P-8 permissive, which limits the ability to manually block the flux doubling calculation during plant startup and logic to force applicable CVS DWS isolation valves closed if the flux doubling logic is blocked.

The inclusion of the new permissive, P-8, does not change the approach and underlying assumptions used in the analysis for boron dilution as presented in DCD Section 15.4.6. The logic presented in the LAR includes the automatic closure of the CVS valves if a manual block of the flux doubling logic is implemented below the P-8 permissive. The closure of CVS valves would block the potential source of unborated water and would be consistent with the termination method for a boron dilution event for Modes 1 through 4 as discussed in DCD Section 15.4.6.2. When above the P-8 permissive, the manual block of the flux doubling logic may be permitted to allow for plant startup. The logic associated with the new P-8 permissive is also consistent with the description of dilution during startup (Mode 2) as described in DCD Section 15.4.6.2.5.

Based on the staff's review of the new permissive and associated logic, the staff concludes that the boron dilution analysis presented in DCD Section 15.4.6 remains applicable given the

changed descriptions presented in this LAR. As a result, the NRC staff found that the design changes discussed in this LAR do not impact the approach and underlying assumptions used in the boron dilution analysis as presented in UFSAR Section 15.4.6 and, therefore, are acceptable.

3.3 TECHNICAL EVALUATION FROM TECHNICAL SPECIFICATIONS PERSPECTIVES

The following TS and Bases changes are proposed. The proposed changes, to the PMS design, are submitted to improve the level of protection provided by the PMS flux doubling boron dilution block feature by bringing it into compliance with the requirements in Clause 6.6 of IEEE Std. 603-1991.

- TS Table 3.3.8-1, Function 17 (Source Range Neutron Flux Doubling)
    - Note (j) is revised. The note now requires the function to be operational if unborated water source flow paths are not isolated. It continues to permit the operators to block the SR neutron flux doubling signal when critical or during an intentional approach to criticality. This note continues to be applicable in Modes 2 and 3.
    - Note (l) is added to the table and applied to the SR neutron flux doubling function for Modes 4 and 5. This note permits the operators to block the SR neutron flux doubling signal during shutdown conditions only when unborated water source flow paths are isolated.
- TS Bases 3.3.1
    - The description of the Intermediate Range Neutron Flux, P-6 interlock is corrected to match the information provided in UFSAR Figure 7.2-1 (Sheet 3) and Table 7.2-3. Specifically, item (3) is revised to state that, on decreasing power, the P-6 interlock automatically resets the flux doubling block control ensuring the source range neutron flux doubling circuit is enabled.
- TS Bases 3.3.8
    - The description of the P-6 permissive is updated to match the information provided in UFSAR Figure 7.2-1 (Sheet 3) and Table 7.2-3.
    - A description of the P-8 permissive is added.
    - The boron dilution block section is updated to be consistent with the changes already described and Figure 7.2-1.
    - The SR neutron flux doubling section (Function 17) is updated to be consistent with the TS changes.

The following TS provides adequate inadvertent boron dilution protection:

- The ability to terminate (Modes 1, 2, 3, 4, and 5) inadvertent boron dilution events is assured by satisfying TS 3.1.9 and TS 3.3.8.
    - TS 3.1.9 requires the demineralized water isolation Valves and CVS makeup line isolation valves to be OPERABLE in Modes 1, 2, 3, 4, and 5.

- TS 3.3.8 requires four SR neutron flux doubling circuits to be OPERABLE in Modes 2, 3, 4, and 5 with exceptions for the approach to criticality. Modes 2 and 3 Applicability retains the exception but also includes a new exception for when unborated water source flow paths are isolated. The current Operability requirements in Modes 4 and 5 have no exception, but they are being revised to include a new exception when unborated water source flow paths are isolated. These exceptions are discussed in further detail below.

- During refueling operations (Mode 6), inadvertent boron dilution events are avoided by satisfying TS 3.9.2. TS 3.9.2 provides administrative controls to preclude the possibility of boron dilutions by isolating unborated water sources. Operators verify that the appropriate CVS valves (i.e., Valves 092, 108, 126, and 136A/B) are secured closed to isolate the unborated makeup water flow paths to the RCS. Makeup required during refueling is provided by the CVS makeup pumps using borated water in the boric acid tank. TS 3.9.2 will remain unchanged.

- In Modes 2 or 3, the modified TS Table 3.3.8-1, Function 17 applicability requires unborated water source flow paths to be isolated if operators block the SR neutron flux doubling signal when below the P-8 setpoint.

- When in Modes 4 or 5, TS Table 3.3.8-1, Function 17 applicability, is modified to require operability of the SR neutron flux doubling function if unborated water source flow paths are not isolated.

The proposed TS changes are made to align the TS with the UFSAR changes to the PMS in order to meet requirements in Clause 6.6 of IEEE Std. 603-1991. The TS changes meet the requirements of 10 CFR 50.36 because it ensures that LCOs are met. Based on the above evaluation, the NRC staff found the proposed TS revisions acceptable. In addition, the NRC staff found proposed TS Bases changes to be consistent with the proposed TS revisions.

4.0 STATE CONSULTATION

In accordance with the Commission regulations in 10 CFR 50.91(b), the designated South Carolina State official was notified of the proposed issuance of the amendment. The State of South Carolina official had no comment.

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, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (*Federal Register,* 81 FR 59659, published on August 30, 2016). 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.

6.0 CONCLUSION

The NRC staff has concluded, based on the evaluations and considerations above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner; (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations; and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public. Therefore, the NRC staff found that the changes to the plant specific TS, PMS functional logic design, and other associated Tier 2 material proposed in this LAR are acceptable.

7.0 REFERENCES

1. South Carolina Electric & Gas Company, Virgil C. Summer Nuclear Station, Units 2 and 3 Request for License Amendment: PMS Logic Changes for Source Range Flux Doubling (LAR 16-04), dated July 19, 2016 (ADAMS Accession No. ML16202A035).

2. Virgil C. Summer Nuclear Station, Units 2 and 3, Updated Final Safety Analysis Report, Revision 4, dated July 1, 2016 (ADAMS Accession No. ML16193A096).

3. Electrical and Electronics Engineers (IEEE) 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

4. Westinghouse Advanced Passive 1000 (AP1000) Design Control Document, Revision 19, dated June 21, 2011 (ADAMS Accession No. ML11171A500).