SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NO. 28

TO THE COMBINED LICENSE NO. NPF-93 AND LICENSE NO. NPF-94

SOUTH CAROLINA ELECTRIC AND 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 September 11, 2014, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14254A371), South Carolina Electric & Gas (SCE&G/licensee) submitted license amendment request (LAR) 13-36 requesting the U.S. Nuclear Regulatory Commission's (NRC or the Commission) approval for amendments to the Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 combined licenses (COLs) NPF-93 and NPF-94, respectively.

The LAR proposes to revise the VCSNS Updated Final Safety Analysis Report (UFSAR) by clarifying human diversity during the lifecycle development design process for the Component Interface Module (CIM) and Diverse Actuation System (DAS).

The LAR proposes to add Appendix 7A to VCSNS Units 2 and 3 UFSAR Chapter 7 to modify design information related to human diversity, as presented in Tier 2* document WCAP-17179-P and WCAP-17179-NP, "AP1000 Component Interface Module Technical Report," Revision 2 (ADAMS Accession No. ML102170259), and two Tier 2 documents, WCAP-15775, "AP1000 Instrumentation and Control Defense-in-Depth and Diversity Report," Revision 4 (ADAMS Accession No. ML101530048) and WCAP-17184-P, "AP1000 Diverse Actuation System Planning and Functional Design Summary Technical Report," Revision 2 (ADAMS Accession No. ML102170263), which are incorporated in the VCSNS Units 2 and 3 UFSAR. In the above-referenced reports, □P□ indicates a report that contains proprietary information while □NP□ indicates a report that does not contain proprietary information. The ADAMS Accession No. refers to the □NP□ version of the report. This safety evaluation does not contain any proprietary information.

By letter dated March 17, 2014 (ADAMS Accession No. ML14076A173), Southern Nuclear Operating Company (SNC), the licensee for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, submitted LAR 13-020. VCSNS's LAR 13-36 is identical in technical content with LAR 13-020. The review and audit details below are applicable to both the VEGP LAR 13-020 and VCSNS LAR 13-36 review. On December 24, 2014 the NRC issued License Amendment 28 for VEGP Units 3 and 4 (ADAMS Accession No. ML14329A298).

To support the NRC staff's evaluation of VEGP LAR 13-020 the NRC staff conducted a technical document review audit at the Westinghouse Electric Company (Westinghouse) Twinbrook facility located in Rockville, Maryland. The audit was conducted during the period from June 9 ─ 12, 2014. The purpose of this audit was to review design details regarding the proposed lifecycle human diversity requirement revisions to the UFSAR for the CIM, Safety Remote Node Controller (SRNC), and DAS in order to determine if the proposed revisions and modifications to the UFSAR continue to conform to applicable regulations, standards, guidance, plans, and procedures. The staff reviewed the implementation of the proposed design process changes and the licensee's analysis results and conclusions of these changes. This audit was also applicable to the VCSNS LAR 13-36 review.

By letter dated July 17, 2014 (ADAMS Accession No. ML14198A481), the NRC staff provided SNC with the Audit Report contained in Enclosure 1 of the letter and a Request for Additional Information (electronic RAI (eRAI) 7572) which was contained in Enclosure 2 of the letter.

Since Summer LAR 13-36 addresses the same information related to Vogtle eRAI 7572, by letter dated October 15, 2014 (ADAMS Accession No. ML14288A609), SCE&G submitted a supplement to provide the same information on the docket required for the VEGP review. In letter dated December 18, 2014 (ADAMS Accession No. ML14353A079) SCE&G corrected an error in its October 15, 2014 submittal.

The additional information in supplement LAR 13-36S2 did not expand the scope of the application as originally noticed and did not change the NRC staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on December 9, 2014 (79 FR 73111).

2.0 REGULATORY EVALUATION

The AP1000 safety-related Protection and Safety Monitoring System (PMS) provides detection of off-nominal conditions and actuates the appropriate safety-related components and functions that are necessary to achieve and maintain the plant in a safe shutdown condition as described in VCSNS Units 2 and 3 UFSAR Section 7.1.2. The PMS controls safety-related field components in the plant. The AP1000 plant control system (PLS), a non-safety related system, performs non-safety related instrumentation and control functions to regulate the operating conditions in the plant automatically in response to changing plant conditions and changes in plant load demand as described in VCSNS Units 2 and 3 UFSAR Section 7.1.3. The safety-related CIM, which is a part of the PMS, provides the interface between safety-related field components, the PMS and the PLS. The CIM provides the priority logic (i.e., which system actuation signal has the highest priority to control field components) between the PMS and the PLS. Communication between the CIM and the PMS is accomplished through the safety-related SRNC which is also a part of the PMS. Both the CIM and the SRNC are programmable logic-based modules that do not use microprocessors or software for operation. The logic for the CIM and SRNC are developed using field programmable gate array (FPGA) technology. The LAR states that the term "CIM" refers to both the FPGA-based CIM and its companion FPGA-based SRNC. Therefore, when this safety evaluation (SE) references the CIM, it is applicable to the SRNC as well.

The AP1000 DAS is a non-safety related system that provides a diverse backup to the PMS as described in VCSNS Units 2 and 3 UFSAR Section 7.7.1.11. In the event the PMS fails to

function when required, the DAS would automatically actuate protective functions to lessen the probability of plant damage. The DAS utilizes a platform that is also based on FPGA technology to implement the DAS automatic actuation functionality. Both the DAS and the CIM/SRNC design utilize FPGAs that were produced by the same manufacturer. Furthermore, the DAS and CIM/SRNC logic were developed and implemented by the same vendor.

Code of *Federal Regulations* (CFR), Title 10, Part 50, Appendix A (10 CFR 50, Appendix A), General Design Criterion (GDC) 22, "Protection System Independence," states, in part, that design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function. In the VCSNS Units 2 and 3 UFSAR, Revision 2, Section 3.1, "Conformance with Nuclear Regulatory Commission General Design Criteria," and Section 3.1.3, "Protection and Reactivity Control Systems" (ADAMS Accession No. ML14206B019), it states in part, that for compliance with GDC 22, the DAS is diverse and independent from the PMS from the sensors up to the actuation devices. 10 CFR 50.62, "Requirements for Reduction of Risk From Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants," requires, in part, that each pressurized water reactor must have equipment from sensor output to the final actuation device, that is diverse from the reactor trip system to automatically initiate the auxiliary (or emergency) feedwater system and initiate a turbine trip under conditions indicative of an ATWS. Sections 15.8.2, "Anticipated Transients Without Scram in the AP1000," and 15.8.3, "Conclusion," of VCSNS Units 2 and 3 UFSAR, Revision 2 (ADAMS Accession No. ML14206B115), states that for compliance with the requirements of 10 CFR 50.62, the AP1000 is equipped with a DAS which provides the ATWS mitigation system actuation circuitry protection features mandated for Westinghouse plants by 10 CFR Part 50.

Conformance to the diversity criterion listed above requires that the DAS is adequately and sufficiently diverse from the PMS. Utilization of common/similar components, technology, and/or devices (i.e., FPGAs), that are produced and manufactured by the same company in both the safety system (PMS) and the DAS requires a demonstration that adequate and sufficient diversity exist between the PMS and DAS designs. The NRC staff evaluated whether the proposed LAR human diversity design revisions continue to provide adequate and sufficient diversity between the PMS and DAS and whether the LAR proposed human diversity design revisions still conform to the applicable regulatory diversity criterion. The NRC staff used the guidance in Branch Technical Position 7-19 (BTP-7-19), "Guidance for Evaluation of Diversity and Defense-in-Depth in Digital Computer-Based Instrumentation and Control Systems" (ADAMS Accession No. ML110550791), Revision 6, when assessing the adequate diversity between the two designs. BTP-7-19 endorses NUREG/CR-6303, "Method for Performing Diversity and Defense-in-Depth Analysis of Reactor Protection Systems" (ADAMS Accession No. ML071790509). The guidance of NUREG/CR-6303 lists six types of diversity to consider: human diversity, design diversity, software diversity, functional diversity, signal diversity, and equipment diversity. The LAR states that for all listed NUREG/CR-6303 diversity categories, with the exception of human diversity, the present design adequately meets current licensing commitments. The LAR proposes to revise the licensed design process and licensing basis documentation for human diversity only as it relates to CIM and DAS FPGA development lifecycle human diversity.

To address the human diversity guidance of NUREG/CR-6303, the AP1000 CIM Tier 2* Technical Report, WCAP-17179, Section 2.9.4, "Human Diversity," states that the purpose of human diversity "…is to reduce the chance of common errors in similar designs." The licensing

basis human diversity design commitments between the CIM and DAS are stated in WCAP-17179 as:

- For any functionality that is similar between the two designs, different designers were used for the CIM and DAS designs.

- In addition different design teams and different test teams will be used to test the CIM and DAS designs.

Likewise, for the non-safety related DAS human diversity licensing basis design commitments, it states in Technical Report WCAP-17184, Section 9.4, "Human Diversity," that:

- It is a requirement of the DAS that different people (personnel not assigned to safety system engineering) will be responsible for its design and fabrication.

The LAR states that the results of a review of CIM and DAS design documents demonstrated that there were human diversity overlaps with designers, engineers, testers, and independent verification and validation (IV&V) personnel where complete (i.e., licensed) human diversity requirements were not maintained during certain phases of the CIM and DAS development lifecycles.

In the NRC staff's safety evaluation report (SER), NUREG-1793, Volume 1, Supplement 2, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design" (ADAMS Accession No. ML11293A199), Section 7.8.2, "Diverse Actuation System Assessment," the NRC staff concluded that:

> The applicant also revised WCAP-15775 to Revision 4 to address the specific requirement of diversity between CIM and DAS. The applicant demonstrated in Section 2.11 of WCAP-17179-P, Revision 2, and Section 9 of WCAP-17184-P, Revision 2, how the requirements of diversity are met between CIM and DAS. For example, for the human diversity, the applicant states in the two TRs, that different designers are used for the CIM and DAS designs. In addition, the different design teams and different test teams will be used to test the CIM and DAS designs. The staff concludes that the applicant has provided sufficient information demonstrating conformance with regulatory policies and criteria concerning diversity.

Therefore, NRC staff reviewed the LAR stated human diversity overlaps to evaluate the likelihood of common design errors being introduced into both the CIM and DAS final products. The NRC staff also evaluated the proposed Appendix 7A human diversity licensing basis design revisions and modifications to ensure that adequate and sufficient diversity continue to exist between the CIM and DAS designs after implementation of the LAR proposed human diversity design revisions and that the applicable NRC regulatory criterion and policies concerning diversity are still met.

Tier 2* Information is defined in 10 CFR 52, Appendix D, Section II.F and is subject to the change process described in Section VIII.B.6. The proposed revisions in LAR 13-36 are required to meet the following requirements:

- 10 CFR Part 52, Appendix D, VIII.B.6 requires prior NRC approval for departure from Tier 2* information. The proposed changes to the design process for human diversity require changes to information presented in WCAP-17179, which is referenced in the UFSAR as a Tier 2* document. Therefore, a license amendment request is required as proposed in LAR 13-36.

  10 CFR Part 52, Appendix D, Section VIII.B.5.a allows an applicant or licensee who references this appendix to depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information, Tier 2* information, or the Technical Specifications, or requires a license amendment under paragraphs B.5.b or B.5.c of the section. The proposed changes to information presented in Tier 2 documents, WCAP-17184 and WCAP-15775, involves a change to plant-specific Tier 2* information, and thus requires prior NRC approval for the involved Tier 2 departures.

- 10 CFR 50.62, "Requirements For Reduction Of Risk From Anticipated Transients Without Scram (ATWS) Events For Light-Water-Cooled Nuclear Power Plants," requires that each pressurized water reactor must have equipment from sensor output to final actuation device, that is diverse from the reactor trip system, to automatically initiate the auxiliary (or emergency) feedwater system and initiate a turbine trip under conditions indicative of an ATWS. This equipment must be designed to perform its function in a reliable manner and be independent (from sensor output to the final actuation device) from the existing reactor trip system.

- 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 22, "Protection System Independence," requires that the protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.

Applicable diversity guidance:

- BTP 7-19, "Guidance for Evaluation of Diversity and Defense-in-Depth in Digital Computer-Based Instrumentation and Control Systems," of NUREG-0800, "Standard Review Plan," provides guidance for evaluating an applicant's diversity and defense-in-depth (D3) assessment, design, and the design of manual controls and displays to ensure conformance with the NRC position on D3 for instrumentation and control systems incorporating digital, software-based or software-logic-based reactor trip systems, engineered safety features actuation systems, auxiliary supporting features, and other auxiliary features as appropriate (ADAMS Accession No. ML110550791).

- NUREG/CR-6303, "Method for Performing Diversity and Defense-in-Depth Analyses of Reactor Protection Systems," describes a method for analyzing computer-based nuclear reactor protection systems that discovers and identifies design vulnerabilities to common-mode failure (ADAMS Accession No. ML071790509).

3.0 TECHNICAL EVALUATION

In order to clarify the NRC staff's evaluation of LAR 13-36, it should be noted that in an effort to prevent the design descriptions from being read out of context and to minimize the potential for their misinterpretation, Enclosure 4 of LAR 13-36S1, proposes to delete from the LAR 13-36 text the sentence:

> DAS documents are independently verified by individuals who were not responsible for the design process and who did not work on CIM.

The NRC staff agrees that this sentence may lead to the design descriptions being read out of context and concludes that the deletion of the above sentence from LAR 13-36 does not reduce the adequacy or sufficiency of design descriptions necessary to understand the proposed LAR 13-36 design revisions and their compliance to the applicable regulatory criterion. For example, the above sentence could be incorrectly interpreted to mean that an independent sub-contractor, vendor, or independent company verified the DAS design documents. In addition, this is not a licensing basis requirement, but an LAR 13-36 design description that was not clear. Thus it does not reduce the sufficiency of the design descriptions in LAR 13-36.

3.1 Human Diversity Overlaps

The LAR states that during the implementation of CIM and DAS design requirements, simulation testing and implementation phases, complete human diversity, as originally licensed, was not maintained and there were some "overlaps" between CIM and DAS designers, engineers, testers, IV&V personnel. The LAR states that a review of the authors and reviewers of the design documents for the CIM and DAS products identified instances where personnel served as designer and/or reviewer on both CIM and DAS product design documents. This is contrary to the current licensing basis which states that CIM and DAS personnel are to be different and separate. The safety concern is the possibility of similar common-cause-failure design errors being introduced into the CIM and DAS FPGA products due to the noted overlaps in designers, engineers, and testing personnel (i.e., loss of human diversity). To support the NRC staff's review, the NRC staff conducted an audit at the Westinghouse Twinbrook facility located in Rockville, Maryland. The audit was conducted during the period from June 9─12, 2014. In trying to determine where in the development lifecycle human diversity overlaps occurred and where human diversity was maintained, the NRC staff could not discern a clear difference between the requirements phase and the design phase. Appendix C to the VCSNS Units 2 and 3 license, Table 2.5.2-8, "Inspections, Tests, Analyses, and Acceptance Criteria," Items 14a to 14e, list the CIM lifecycle development phases in the acceptance as:

- Design Requirements Phase;
- System Definition Phase;
- Hardware and Software Development Phase (Design and Implementation);
- System Integration and Test Phase; and
- Installation Phase

Appendix C to the VCSNS Units 2 and 3 license, Table 2.5.1-4, “Inspections, Tests, Analyses, and Acceptance Criteria,” Items 4a, 4b, and 4c, list the DAS hardware and software lifecycle stages under “Design Commitment” as:

- Development phase
- System test phase
- Installation phase

The CIM development lifecycle shows that both the design and the requirements phases occur at the same time in development and for the DAS development lifecycle there is not an identified “design” or “requirements” phase. On July 17, 2014, the NRC staff issued RAIs to SNC to request additional design and technical information which is also applicable to the LAR 13-36 review. In RAI Question No. 3(a), the NRC staff requested that the licensee provide detailed descriptions, throughout each phase of the lifecycle development process, where human diversity "overlaps" occurred and where complete human diversity requirements were maintained. On October 15, 2014, the licensee provided a responses in Enclosure 3 to LAR 13-36S1. The licensee’s response to RAI Question No. 3(a) states that during the “development phases” for both the CIM and DAS is where the FPGA component development lifecycle phase for “requirements” and “design” occurs. Reviewing LAR Table 2, “Modified Human Diversity Position,” along with the RAI Question No. 3(a) response, demonstrates that during the CIM and DAS system’s development phase is where the CIM and DAS FPGA component development lifecycle phase for FPGA requirements generation is performed. This phase is where CIM and DAS designer and engineer overlaps occurred. The response to RAI Question No. 3(a) also states that the FPGA component "design phase" was the design portion of the CIM and DAS system’s development phases. An activity associated with the FPGA component design phase is development of the detailed FPGA component logic. According to the table provided in the response to RAI Question No. 3, during the FPGA component design phase, where the development of the FPGA component logic occurs, is where human diversity licensing commitments were met. Specifically, CIM FPGA component logic designers were separate from DAS FPGA component logic designers. The LAR also states that human diversity was maintained for the CIM and DAS implementation phases. However, the NRC staff was not able to identify an "implementation phase" for the DAS. In RAI Question No. 3(b) the NRC staff requested the licensee to provide detailed descriptions of the DAS "implementation phase" that the LAR is referencing. The licensee’s response to RAI Question No. 3(b), states that the implementation phase occurs during the development phase of the CIM and DAS system lifecycles. The activities associated with the DAS FPGA component implementation phase includes coding of the FPGA logic, simulation testing of the FPGA logic by the design team, and IV&V simulation testing of the application FPGA logic. Hardware implementation includes fabrication of the first article including the production of the first article cabinets and flashing of the application logic onto the system's FPGA(s) in preparation for system testing.

The LAR states that complete human diversity was not maintained for simulation testing and verification activities. Both the CIM and DAS system development lifecycles have defined system "test" phases. However, it is not clear to the NRC staff when simulation and simulation testing occurs during the CIM and DAS system “testing” phases. The NRC staff reviewed LAR Table 1, “Licensed Human Diversity Position,” and LAR Table 2, “Modified Human Diversity Position,” but the tables do not relate design activities according to the CIM/SRNC and DAS lifecycle development phases. In addition, the LAR uses the terms “simulation” and “simulation

testing" and the NRC staff could not identify a definition for the two terms. In RAI Question No. 4, Part a), the NRC staff requested the licensee to provide a table such as LAR Tables 1 and 2 that lists the UFSAR Tier 1 CIM/SRNC and DAS development lifecycles and for each of the CIM/SRNC and DAS lifecycle phases, to (1) display where simulation occurs, to (2) discuss where simulation diversity overlaps occurred, and to define the term simulation as discussed in the LAR and the different simulation types (i.e., simulation versus simulation testing). In the licensee's response to RAI Question No. 4, Part a), the licensee refers to the table provided in the response to RAI Question No. 3, Part a), which identifies in Row 3 of the table that simulation activities occur in the "hardware and software development" phases of the CIM and DAS. Row 3 of this table also identifies IV&V simulation testing as the simulation activity with overlaps in human diversity. The licensee also states in its response to RAI Question No. 4, Part a) that simulation and simulation testing are equivalent terms in the LAR.

To better understand and evaluate the effects of the noted human diversity overlaps, the NRC staff developed a lifecycle phase description table to provide clarity of the lifecycle development process for the CIM and DAS. The table below demonstrates the difference between the CIM and DAS system development lifecycle phases and the CIM and DAS FPGA component development lifecycle phases. As shown in Table 1, "FPGA Lifecycle Phase Description," the FPGA component lifecycle phases are a part on the CIM and DAS system development lifecycle phase.

Table 1 - FPGA Lifecycle Phase Description[1]

CIM System (as listed in Tier 1 ITAAC)	**DAS System** (as listed in Tier 1 ITAAC)	***CIM FPGA Component***	***DAS FPGA Component***	**FPGA Human Diversity Overlaps** [CIM and DAS designers, engineers, testers and/or IV&Vers NOT different/separate]	**Human Diversity IAW Appendix 7A Revisions**
Design Requirements					
System Definition					
Hardware, Software Development	Development	1) Requirements 2) Design 3) Implementation	1) Requirements 2) Design 3) Implementation	*FPGA Requirements Phase* -FPGA requirements generation *FPGA Implementation Phase* -Tester and IV&V simulation testing of FPGA logic; -IV&V simulation testing verification activities	*FPGA Design Phase* -Development of FPGA Logic *FPGA Implementation Phase* -Coding of FPGA logic, flashing of logic onto FPGA
System Integration and Test	System Test				Black box testing (testing in target hardware)
Installation	Installation				

[1] Table 1 was created from LAR design descriptions, LAR Tables 1 and 2, and the licensee's responses to RAI Question Nos. 3 and 4.

3.2 Evaluation of Human Diversity Overlaps during the FPGA Component Requirements Phase

As shown in Table 1 above, the FPGA component lifecycle occurs during the development phase for the CIM and DAS systems. Therefore, the human diversity overlaps occurred during the development phases of the CIM and DAS systems' development lifecycles. During the FPGA component "requirements" phase is where the licensee performed a review of the CIM and DAS FPGA requirements design documents and identified overlaps of common CIM and DAS personnel serving as authors and/or reviewers on both the CIM and DAS requirements product design documents. This could lead to a common designer creating similar requirement errors in both the CIM and DAS requirements documents. The NRC staff referred to the guidance of BTP-7-19, Revision 6, Section 3.8, "Diversity Types" (or Section 3, "Acceptance Criteria," of Revision 4), which state that functional diversity and signal diversity are considered to be particularly effective and that functional diversity and signal diversity lead to different software and logic requirements and form a stronger basis for diversity. The guidance of NUREG/CR-6303, Section 2.6.4, "Functional Diversity," states that two systems are functionally diverse if they perform different physical functions though they may have overlapping safety effects. Demonstrating that the CIM and DAS FPGAs are both physically different and perform different physical functions would also demonstrate that the requirements generated for the CIM and DAS FPGAs would most likely be different versus similar. The LAR design descriptions listing the physical and functional differences between the CIM and DAS, state that:

- The CIM internal communication bus structure is different from the DAS backplane communication bus. The CIM interfaces to the PMS and PLS and receives digital logic inputs. The DAS receives and reads field inputs.

- The CIM and DAS use different FPGA versions produced by the same manufacturer. The CIM uses the ProASICplus device and the DAS uses the ProASIC3/EL device. Both FPGA devices are made by Microsemi Corporation (formerly Actel Corporation), but the parts are different in structure and design.

- The CIM and DAS FPGAs contain different chip geometries and are produced on different manufacturing lines. A chip manufacturing line has unique hardware to make a specific geometry of the device. Since two different geometries are used, the same production lines cannot be used.[2]

- The CIM and DAS have different power supplies and no common hardware or parts in common except for simple, single purpose, passive parts like resistors and capacitors on the circuit boards.

- The DAS generates the required actuation signals based on the functional logic required for reactor trip and engineered safety features calculations. The CIM does not generate actuation signals - actuation signals are inputs to the CIM.

[2] The NRC staff requested that the licensee, in RAI Question No. 8, demonstrate that the CIM and DAS FPGA chips have two different geometries and that the same FPGA production line cannot manufacture these two geometrically different FPGA chips. The licensee's response to RAI Question No. 8 stated that the results of a proprietary internal diversity analysis between the CIM/SRNC and DAS concluded that the two FPGAs are fabricated with different chip geometries on different manufacturing lines and that this point was confirmed with the FPGA manufacturer, Microsemi.

- The DAS reads field inputs, performs system-level functional logic to determine safety actuations, and generates output actuation signals to field components through different paths from the CIM. In contrast, the CIM performs priority logic and interfaces to and controls individual plant components.

- The DAS does not perform field component control logic. The CIM executes single component control logic algorithms.

- There is no common system or sub-system application-specific functional logic between the DAS and CIM.

- The DAS time response is a greater time scale than the CIM time response.

- Due to the different FPGA models used by the CIM and DAS, the output of the software tool used for the generation of functional logic and the associated mapping needed to configure the FPGA internal elements, is device specific, and the tool uses two unique libraries for the different FPGA models used by the CIM and the DAS.

The above LAR listing of the physical and functional differences between the CIM and DAS FPGA components, using the guidance as stated above in BTP-7-19 and NUREG/CR-6303, would demonstrate that these CIM and DAS functional and physical differences would lead to different logic requirements. Therefore, similar authors generating the requirements for both the CIM and DAS FPGA component functions would be unlikely to create similar requirement errors in both the CIM and DAS requirement documents. Evaluating signal diversity, the LAR states that the CIM receives digital inputs from the PMS and/or PLS and that the CIM does not read any field process sensor inputs. By contrast, the LAR states that the DAS inputs are received from field sensor signal inputs which then have to go through analog-to-digital conversion logic in the DAS. Using the guidance of BTP-7-19 and NUREG/CR-6303, signal diversity would demonstrate that these diverse signal inputs into the CIM and DAS would lead to different logic requirements and common authors generating the requirements for both the CIM and DAS FPGA component functions would be unlikely to create similar requirement errors in both the CIM and DAS requirement documents. The LAR also states that there is no sharing of input signals between PMS and DAS.

3.3 Evaluating CIM and DAS Common Functions

The LAR also states that CIM and DAS common functions such as power up, power down, actuation methods, and internal communications were evaluated by an independent third party review team. The NRC staff was not able to identify the diversity analysis process or guidance utilized by the independent third party reviewers for these common CIM and DAS functions in the LAR design information submitted. During the technical documents audit, the NRC staff reviewed the analysis performed by the independent third party reviewers that were contained in proprietary document (1) "Independent Review of AP1000 CIM/SRNC-DAS Diversity," January 11, 2013, and proprietary document (2) "Independent Review of AP1000 ALS/DAS versus CIM/SRNC Human Diversity Overlap," May 23, 2013. In the Vogte RAI Question No. 7 the NRC staff requested that the licensee submit these documents on the docket. In SCE&G submittal, dated October 15, 2014, the licensee's response to Vogtle RAI Question No. 7, the licensee incorporates the proprietary (not publicly available) documents by reference to be

included in the VCSNS Units 2 & 3 dockets (ADAMS Accession No. ML14288A609). The NRC staff's review of the proprietary documents found that the independent third party reviewers analyzed design requirement documents for the CIM and DAS that had a common author and performed a forward and backwards requirements trace to and from lower level CIM and DAS functional requirements specifications down to the logic of the CIM and DAS FPGA components to determine whether the respective CIM and DAS functional behaviors were specified in the same way due to the fact that the selected design documents that describe the CIM and DAS FPGA component behaviors were authored by the same individual. The independent third party reviewers performed several analyses on selected digital system component behaviors that would be expected in a digital system. The documented results of the independent third party analysis contained in proprietary document (2) for power-up and reset/initialization behaviors between the CIM and DAS FPGA components found that the requirements were diverse. This review consisted of examining some of the actual logic used to implement the FPGA binary codes in each system and then tracing the logic back to the requirements documents for each system. The NRC staff reviewed the lower level design specification documents and the tracing of the lower level design specifications up to the requirements documents that were authored by a common author, as listed in the proprietary documents. The CIM and DAS lower level logic implementation and their related upper level requirements specification were all found to be functionally diverse. The independent reviewers examined the design documentation for CIM and DAS FPGA core redundancy checker and found through examination of upper level requirement specification documents and lower level design specification documents that the CIM and DAS core redundancy checking algorithms and resultant outputs of the CIM and DAS algorithms were functionally diverse. The NRC staff reviewed the listed CIM and DAS core redundancy checking block diagrams and upper level listed requirements documents. By examination, the independent reviewers found that the CIM and DAS specified functional behaviors were functionally diverse and were traceable from upper tier requirement documents down to implementation design specification documents. The purpose of these tasks were to determine if requirements had been specified in the same way due to the fact that a primary individual authored certain design documents that were previously believed to have been authored according to human diversity requirements. The conclusion of the independent reviewers found that for the documents reviewed for the tasks reviewed, the use of a common author did not produce undue influences on CIM and DAS FPGA functional diversity.

3.4 Simulation Testing Overlaps during the FPGA Component Implementation Phase

The LAR states that human diversity was not maintained at the testing phase of the CIM and DAS design lifecycles for simulation testing. The NRC staff was not clear as to what lifecycle phase simulation testing overlaps occurred. Since the CIM and DAS systems have defined testing phases, it was not clear to the NRC staff in the LAR whether simulation testing occurred during the CIM and DAS system's testing phase (see Table 1 above). The staff requested that the licensee, in Vogtle RAI Question No. 5, clarify the human diversity commitments for system test phase activities as they are described in the LAR. In the licensee's response to RAI Question No. 5 the license clarified that "testing phase" is referring to the "development phases" of the CIM and DAS system design lifecycles.

The independent third party reviewers documented in "Independent Review of AP1000 ALS/DAS versus CIM/SRNC Human Diversity Overlap," dated May 23, 2013, their results of a supplemental review of the simulation testing. This review was performed to assess the potential for propagation of undetected design or testing anomalies between the CIM and DAS

FPGA products as a result of not implementing full human diversity during IV&V simulation testing. The reviewers noted that each unique module containing an FPGA device requires a custom IV&V simulation (ISE) test to fully test and validate a design. In the case of the CIM-SRNC, there is a custom ISE for CIM and another for the SRNC. For the DAS, there are over 14 custom ISE's to address each of the unique cards in the basic DAS platform as well as a custom ISE for the specific DAS logic. The individual test routines are typically defined for each defined requirement for a given module. The independent third party reviewers also documented that the performance of the testing activity cannot induce anomalies into either the CIM or DAS designs and that the module designs are not impacted by the testing process other than to report identified anomalies from the testing for resolution. The third party independent reviewers concluded that the likelihood of common anomalies being implemented or overlooked during testing of both systems by a common individual is very low. This conclusion was partly based on the fundamental functional differences between the CIM and DAS. In addition, in response to the NRC staff's Vogtle RAI Question No. 4(a), where the NRC staff requested that the licensee define simulation types, the licensee responded to RAI Question No. 4(a), by stating that the design team performed simulation of the design using the Verilog language and simulated their designs using Aldec Riviera Pro and the IV&V team performed a parallel simulation of the design using the SystemVerilog language and simulated using Synopsys VCS (Verilog Compiled code Simulator).

The NRC staff compared the difference between the licensee's CIM and DAS FPGA testing licensing basis human diversity requirements and the NRC's 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion III, "Design Control," which states in part that "The verifying or checking process shall be performed by individuals or groups other than those who performed the original design, but who may be from the same organization." This quality assurance (QA) criterion is applicable to the safety-related CIM and SRNC components and systems. This QA criterion does not state that the IV&V testing personnel cannot verify or check both the CIM/SRNC and DAS products (e.g., the licensing basis requirement). Rather, the criterion states that if a person designed the CIM or DAS products, then this same person cannot be credited with performing the independent verification and/or checking activities for the products. Therefore, the deletion from the licensing basis of the human diversity testing commitment that different people will be responsible for the DAS verification and validation and that different test teams will be used to test the CIM and DAS designs, do not violate the 10 CFR 50, Appendix B, Criterion III, design control requirement that verifying or checking shall be performed by individuals other than those who performed the original design, as long as the IV&V simulation testers did not design what they tested for safety-related components.

3.5 Other Diversity Considerations

The LAR states that the DAS uses no operating system or executable software loops for its control functions and that DAS uses no software for its control functions. During the technical audit the NRC staff reviewed the proprietary diversity analysis Document 6105-00012, "CIM/SRNC versus DAS Diversity," Revision 1. Part of the diversity analysis results of the proprietary document concluded that the CIM and SRNC FPGAs contain no software. However, the documented results did not find or conclude the same for the DAS. In RAI Question No. 9, the NRC staff requested the licensee to provide details of the DAS's utilization of software during (1) plant start-up and shut down, (2) during normal online plant operations and (3) during the DAS's performance of mitigation actions and protective functions. The

licensee's response to Vogtle RAI Question No. 9 states that the use of software in the DAS is limited to the ALS Service Unit (ASU) which is the DAS's maintenance work station and that there is no software that affects (1) plant start-up and shut down, (2) normal online plant operations and (3) DAS's performance of mitigation actions and protective functions. The NRC staff also requested the licensee in Vogtle RAI Question No. 9 to submit on the docket the proprietary Document 6105-00012, "CIM/SRNC versus DAS Diversity," Revision 1. The licensee incorporates this document by reference to be included in the VCSNS Units 2 and 3 dockets in the October 15, 2014 supplement.

3.6 Conclusion Regarding Human Diversity Overlaps

Based on the NRC staff's review of the LAR's listing of both the physical and functional differences between the CIM and DAS FPGA components, the staff concludes that the CIM and DAS FPGA components are functionally diverse from one another. Based on the NRC staff's evaluation of the LAR's listing of the different signal inputs to the CIM, PMS, and DAS, the NRC staff concludes that this demonstrates adequate NUREG/CR-6303 signal diversity between the systems. Due to the CIM and DAS being functionally diverse and using diverse signal inputs, this would suggest that the CIM and DAS FPGAs would utilize non-similar requirements to perform their function. Therefore, the NRC staff concludes that, for the reasons listed, common authors generating requirements for both the CIM and DAS FPGA components would be unlikely to generate similar requirement design errors in both CIM and DAS requirements design documents.

Based on the NRC staff's review of the independent third party proprietary documents discussing how each unique CIM and DAS module containing an FPGA device requires a custom IV&V simulation testing to fully test and validate a design and that individual test routines are typically defined for each defined requirement for a given FPGA module, the staff concludes that the potential for the propagation of undetected design errors being implemented into the final FPGA product or common testing anomalies being inserted into both the CIM and DAS FPGA products, as a result of common IV&V simulation testers testing both the CIM and DAS FPGA logic during IV&V simulation testing, is very low. In addition, this overlap of IV&V testing personnel testing both the CIM and DAS logic does not violate the independence of checkers and verifiers of Criterion III of 10 CFR 50, Appendix B.

3.7 Evaluation of Proposed VCSNS Units 2 and 3 UFSAR Revisions

3.7.1 Evaluation of Proposed Changes in Referencing Topical Reports

The NRC staff requested, during a public meeting on August 21, 2014, that the licensee specifically reference the licensing basis revision numbers for WCAP-15775, WCAP-17179 and WCAP-17184 at each location in which references to these documents are cited. The licensee provided a response to this public meeting request in their response to Vogtle RAI Question No. 1 which stated that a review of the licensing basis documentation identified the need to revise several references in the VCSNS Units 2 and 3 UFSAR, Technical Reports WCAP-15775, WCAP-17179, and WCAP-17184, as well as a reference to WCAP-15775 in another document (WCAP-16438-P/NP) that is incorporated by reference in the VCSNS Units 2 and 3 UFSAR. Therefore, to maintain consistency throughout the VCSNS Units 2 and 3 UFSAR and the documents incorporated by reference in the VCSNS Units 2 and 3 UFSAR, changes to add the licensing basis revision numbers for Technical Reports WCAP-17184, WCAP-17179, and

WCAP-15775, along with the reference to the changes provided in VCSNS Units 2 and 3 UFSAR Appendix 7A at each location in which these three WCAPs are referenced in the UFSAR including Appendix 7A. The licensee provided the proposed UFSAR mark-ups in Enclosure 4 to LAR-13-36S1 for VCSNS Units 2 and 3 UFSAR Table 1.6, Chapter 7 Sections 7.1.2.14.1, 7.1.7 and 7.2.4 and proposed Appendix 7A. The NRC staff reviewed the proposed VCSNS Units 2 and 3 UFSAR mark-ups and revision updates provided in Enclosure 4 to LAR 13-36S1 and Enclosure 5 to LAR 13-36S2 and concludes that these changes are acceptable.

3.7.2 Evaluation of Proposed Appendix 7A

Figure 1-1, "DAS Life Cycle Phases," in WCAP-17184 displays a diversity model for CS Innovations (CSI) and Westinghouse. The figure describes CSI as wholly responsible for all system test phase activities. The development of the DAS was a joint effort between Westinghouse and CSI. At that time, CSI was an independent company that was founded in 2004 and is based in Scottsdale, Arizona. As of August 2009, Westinghouse acquired CSI. Currently, Westinghouse performs the DAS system test phase activities. Furthermore, one of the Appendix 7A revisions proposes to remove the name CS Innovations from the DAS Technical Report, WCAP-17184. Therefore, the NRC staff requested the licensee in Vogtle RAI Question No. 5 to provide appropriate updates and mark-ups to Figure 1-1 to ensure that it is consistent with current UFSAR Tier 1 design commitments and to perform a review for all Tier 2* and Tier 2 documents listed in Appendix 7A to ensure that current CIM, SRNC, and DAS diversity descriptions are current, accurate and technically correct. The licensee responded to Vogtle RAI Question No. 5 and states that Westinghouse has an open corrective action item which was provided to the staff during the technical document audit to correct Figure 1-1 in a future revision of WCAP-17184 and to include this in a separate Tier 2 departure. The licensee also responded that a review of the documents listed in the proposed Appendix 7A confirmed that the CIM, SRNC, and DAS diversity revision descriptions are current, accurate, and technically correct.

With regard to human diversity licensing basis revisions in Appendix 7A, the LAR requests approval of the proposed addition of VCSNS Units 2 and 3 UFSAR Appendix 7A, as submitted in Enclosure 4 to LAR 13-36S1, and the resultant revisions to information presented in Tier 2* reference document WCAP-17179, and Tier 2 reference documents, WCAP-17184 and WCAP-15775, as presented in Appendix 7A. The proposed addition of VCSNS Units 2 and 3 UFSAR Appendix 7A, "Instrumentation and Controls Licensing Basis Document Changes," modifies information in UFSAR reference documents. Appendix 7A will capture the revised CIM and DAS lifecycle development diversity design requirements for the listed VCSNS Units 2 and 3 UFSAR reference documents. However, the NRC staff was not able to identify in the LAR when or how the final updates to the reference documents would be submitted to the NRC. The NRC staff's concern is that the WCAP documents would contain information different from the new Appendix 7A. This condition may be sufficient on a temporary basis, but eventually the WCAP documents would also need to be revised to avoid any future inconsistencies. The NRC staff requested the licensee in Vogtle RAI Question No. 1 to provide details about the process and schedule that will be utilized to submit the final revision updates of the referenced documents listed in the proposed Appendix 7A. The licensee responded to RAI Question No. 1 by stating that they do not intend to incorporate the newer revisions of these WCAPs into the plant's licensing basis immediately following approval of this LAR because the new WCAP revisions also include other changes that will be evaluated as departures in future licensing

change packages or LARs. Following NRC approval of the LARs that affect Technical Reports WCAP-17179, WCAP-17184, and WCAP-15775, the licensee plans to process an "administrative departure," in accordance with the 10 CFR Part 52, Appendix D, Section VIII departure evaluation requirements, to incorporate the final revisions of the WCAPs into the licensing basis and delete Appendix 7A. The final departure is currently characterized as an administrative change because the technical changes to the WCAPs will have already been approved via the previous LARs (such as this LAR on CIM/DAS Diversity).

Appendix 7A states, in several places, that "The FPGA [field programmable gate array] Logic used in the DAS, as compared to the FPGA logic used in the CIM, is humanly diverse..." The NRC staff was not able to identify a definition for the term "humanly diverse" or understand how this term addresses the human diversity guidance of NUREG/CR-6303. The NRC staff, via Vogtle RAI Question No. 2, requested the licensee to define the term "humanly diverse" as it relates to NRC's regulatory diversity criterion and guidance and discuss how the use of this term addresses the human diversity guidance of NUREG/CR-6303. In the licensee's response to RAI Question No. 2, the licensee states that Appendix 7A markups will be revised to remove the term "humanly diverse" and proposed to revise the sentence in the Appendix 7A markups for WCAP-15775, WCAP- 17179, and WCAP-17184, to read as:

> The FPGA Logic used in the DAS maintains human diversity with respect to the FPGA Logic used in the CIM for the following lifecycle activities.

The NRC staff concludes that the deletion of the term "humanly diverse" and the revision of the sentence as provided in the RAI response is acceptable.

The NRC staff also noted that Enclosure 2 of the LAR incorrectly identifies Items 3 and 4 in the proposed update VCSNS Units 2 and 3 UFSAR Table 1.6, as Tier 2* material (the Title Cell for Topical Report Number WCAP-17184-P (P), under DCD Section Number 7.1 and the Title cell for Westinghouse Topical Report Number WCAP-17184-P, under DCD Section Number 7.7). The licensee responded to Vogtle RAI Question No. 6 by stating that the marked up text does correctly present the Tier 2 document information and that the document introductions listing them as Tier 2* were incorrect. The licensee submitted the corrections in the response to RAI Question No. 6 which the NRC staff concludes is acceptable.

The Appendix 7A resultant human diversity design revisions redefine where in the CIM and DAS FPGA component design lifecycle human diversity occurs. In summary, after the requirements phase for the FPGA component lifecycle development (see Table 1 above) is where the revised licensing basis, as listed in Appendix 7A, would commit to human diversity. The revised licensing basis in Appendix 7A no longer requires human diversity for CIM and DAS requirements generation during the requirements phase. Appendix 7A no longer requires different/separate CIM and DAS IV&V personnel for testing during the FPGA component lifecycle design and implementation phases. Appendix 7A establishes that the human diversity requirement for different CIM and DAS IV&V test teams occurs during the CIM and DAS system lifecycle "test phase" (see Table 1 above) for black box testing of a component or system in the target hardware. Appendix 7A also provides a definition for black box testing which states that black box testing is the testing of a component or system in the target hardware without reference to the internal structure of the component or system and that this testing focuses solely on the outputs generated in response to selected inputs and execution conditions.

3.7.3 Conclusion Regarding Proposed UFSAR Appendix 7A Revisions

The CIM/SRNC and DAS design includes the NUREG/CR-6303 functional diversity factors of (1) different control logic and actuation means and (2) different response time scale. The CIM/SRNC and DAS design includes the NUREG/CR-6303 signal diversity factor of (1) the same reactor or process parameter sensed by a different redundant set of similar sensors. The CIM/SRNC and DAS design includes the NUREG/CR-6303 equipment diversity factors for two items of equipment of (1) different versions of the same design and (2) different bus structure. Based on the functional design diversity and signal diversity attributes that exist between the AP1000 CIM/SRNC and DAS design, in accordance with the guidance of BTP-7-19, these diversity attributes would lead to different system and logic requirements and form a sufficient basis for diversity. If the CIM and DAS design functionality lead to different requirements, then the potential to create the same or common requirement error in both designs is very low even when considering that common designers were used to create the requirements and review the requirements for both systems. This would not be the case if the CIM and DAS FPGA components were not designed to operate functionally different. The CIM/SRNC and DAS designs utilize signal diversity. Therefore, the potential for the same system error causing signal to be input into both systems to cause common system failure, simultaneously and concurrently, during a design basis event, is very low. Therefore, based on the functional diversity and signal diversity designed and implemented within the AP1000 CIM and DAS FPGAs, the NRC staff concludes that it is acceptable, as proposed by Appendix 7A, to remove the CIM/SRNC and DAS FPGA human diversity development design requirements from the VCSNS Units 2 and 3 licensing basis which state:

1) It is a requirement of the DAS that different people will be responsible for its design and fabrication, including verification and validation (WCAP-15775).

2) For any functionality that is similar between the two designs, different designers were used for the CIM and DAS designs. In addition the different design teams and different test teams will be used to test the CIM and DAS designs (WCAP-17179);

3) It is a requirement of the DAS that different people (personnel not assigned to safety system engineering) will be responsible for its design and fabrication (WCAP-17184);

The systems required to conform to the applicable regulatory diversity criteria are the safety-related protection system (PMS) and the diverse system that is designed to conform to the requirements of 10 CFR 50.62 and the staff's requirements memorandum to SECY-93-087, Item II.Q, "Defense Against Common-Mode Failures in Digital Instrumentation and Control Systems" (ADAMS Accession No. ML003708056). This diverse system for the AP1000 is the DAS. Appendix 7A adds a licensing basis requirement in both of the Tier 2 reference documents (WCAP-15775 and WCAP-17184) that "At the system level, different design and IV&V teams are used on the DAS and PMS systems." Based upon the NRC staff's LAR review, technical audit, and findings made in this SER, the NRC staff concludes that the Appendix 7A revisions do not change the NRC staff's AP1000 safety findings and conclusions made in NUREG-1793, Volume 1, Supplement 2, FSER, about the adequacy and sufficiency of diversity that exist between the PMS and DAS designs. Therefore, the NRC staff concludes that the Appendix 7A revisions do not change the staff's AP1000 safety conclusions for conformance to the 10 CFR 50.62 diversity requirements for the DAS. The NRC staff concludes that the

Appendix 7A revisions do not change the staff's AP1000 safety conclusions for conformance to 10 CFR Part 50, Appendix A, GDC 22 diversity requirements for the PMS and DAS.

3.8 Other Safety Evaluation Notes

The licensee provided details and summary results of a diversity analysis in the LAR 13-36 section titled "NUREG/CR-7007 Analysis." NUREG/CR-7007, "Diversity Strategies for Nuclear Power Plant Instrumentation and Control Systems," February 2010 (ADAMS Accession No. ML100880143) was issued by the NRC as a research document, but was not included as part of the Standard Review Plan (NUREG-0800). Therefore, the NRC staff did not utilize information from the LAR 13-36 section titled "NUREG/CR-7007 Analysis" in its evaluation and conclusions.

NRC staff approval for this LAR was based largely on plant-specific information to justify a decrease in human diversity commitments that did not impact plant safety. The NRC staff does not consider approval of this LAR to be precedence for generic reduction of human diversity for plant designs not similar to VCSNS Units 2 and 3. Any future licensing actions would need to provide a commensurate level of plant-specific information to justify alternative proposals to human diversity.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations 10 CFR 50.91(b)(2), the South Carolina 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, 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,* 79 FR 73111*,* dated December 9, 2014). 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 issuing the amendment.

6.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that there is reasonable assurance that (1) the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical the common defense and security or the health and safety of the public. Therefore, the staff concludes that the Tier 2*, and associated Tier 2 changes proposed in LAR 13-36, as supplemented, are acceptable.

7.0 REFERENCES

1. Virgil C. Summer Nuclear Station (VCSNS) Updated Final Safety Analysis Report (UFSAR), Revision 2, dated July 22, 2014 (ADAMS Accession No. ML14206A850).

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

3. Virgil C. Summer Nuclear Station Final Safety Evaluation Report, dated August 17, 2011 (ADAMS Accession No. ML110450305).

4. Letter from April R. Rice, South Carolina Electric & Gas Company to U.S. Nuclear Regulatory Commission, "VCSNS Units 2 & 3 LAR 13-36: Request for License Amendment: Component Interface Module (CIM) / Diverse Actuation System (DAS) Diversity," dated September 11, 2014 (ADAMS Accession No. ML14254A371).

5. Letter from Ronald A. Jones, South Carolina Electric & Gas Company to U.S. Nuclear Regulatory Commission, "VCSNS Units 2 & 3 LAR 13-36S1: Supplement to License Amendment Request 13-36 Component Interface Module (CIM) / Diverse Actuation System (DAS) Diversity," dated October 15, 2014 (ADAMS Accession No. ML14288A609).

6. Letter from David H. Jaffe, U.S. Nuclear Regulatory Commission, to B. L. Ivey, Southern Nuclear Operating Company, "Audit Report and Request for Additional Information Letter 01 Related to License Amendment Request (LAR-13-020) for the Vogtle Electric Generating Plant Units 3 and 4: Component Interface Module (CIM)/Diverse Actuation System (DAS) Diversity," dated July 17, 2014 (ADAMS Accession No. ML14198A481).

7. Letter from , South Carolina Electric & Gas Company to U.S. Nuclear Regulatory Commission, "VCSNS Units 2 & 3 LAR 13-36S2: Supplement to License Amendment Request 13-36 Component Interface Module (CIM) / Diverse Actuation System (DAS) Diversity," dated December 18, 2014 (ADAMS Accession No. ML14353A079).