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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Attention: Document Control Desk

Subject: Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 Combined License (COL) Numbers NPF-93 and NPF-94 - Docket Numbers 52-027 and 52-028, Response to Nuclear Regulatory Commission (NRC) Bulletin 2012-01: Design Vulnerability In Electric Power System.

Reference:
(1) NRC Bulletin 2012-01: Design Vulnerability In Electric Power System, dated July 27, 2012
(2) 10 CFR 50.55a(h)(3)
(3) Appendix A to 10CFR Part 50, General Design Criteria For Nuclear Power Plants (GDC) 17: Electric Power Systems
(4) V.C. Summer Nuclear Station Units 2 and 3 Updated Final Safety Analysis Report, Figure 8.3.1-1 "AC Power Station One Line Diagram"

On July 27, 2012 the NRC issued Bulletin 2012-01: "Design Vulnerability in Electric Power Systems", Reference 1, to all holders of operating licenses and combined licenses for nuclear power reactors, except those who have permanently ceased operation and have certified that fuel has been removed from the reactor vessel.

In Reference 1, the NRC required South Carolina Electric & Gas company (SCE&G) to confirm compliance with 10 CFR 50.55a(h)(3), Appendix A to 10 CFR Part 50, GDC 17, and to address two issues related to the electric power system within 90 days of its issuance.

Enclosure 1 provides the SCE&G response to Reference 1. It also includes a confirmation of compliance with References 2 and 3, and a response to both issues identified in Reference 1. Enclosure 2 provides a detailed evaluation of

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compliance with Reference 3. Reference 4 identifies the one line diagram of the AC power system under consideration in Enclosure 1.

This letter contains no new regulatory commitments.

Should you have any questions, please contact Mr. Alfred M. Paglia by telephone at 803-941-9876, or by email at apaglia@scana.com.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 25th day of October, 2012.

Sincerely,

Ronald A. Jones
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DK/RAJ/dk
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Enclosure 1

Response to REQUESTED ACTION from NRC Bulletin 2012-01

References

1. AP1000 Design Control Document (DCD), Revision 19
2. NRC Bulletin 2012-01: Design Vulnerability In Electric Power System issued July 27, 2012
3. NUREG 1793, Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design

REQUESTED ACTION (Bolded items are the requested actions from Bulletin 2012-01): To confirm that licensees comply with 10 CFR 50.55a(h)(2), 10 CFR 50.55a(h)(3), and Appendix A to 10 CFR Part 50, GDC 17, or principal design criteria specified in the updated final safety analysis report, the NRC requests that licensees address the following two issues related to their electric power systems within 90 days of the date of this bulletin:

Compliance with 10 CFR 50.55a(h)(3):

- The SSCs that 50.55a(h)(3) applies to on the AP1000 standard plant design are wholly, completely, and exclusively powered by the Onsite Class 1E DC Power System (IDS). Each IDS charger has monitoring features that detect the loss of input phase voltage resulting from a grid loss of single phase or high impedance ground fault, and isolates the Class 1E system from the Non 1E system.

Compliance with GDC-17: The following descriptions of the AP1000 compliance to GDC 17 are cited from NUREG-1793:

- Section 8.2.3.5, Offsite Power:
  - With respect to the offsite power system interfaces, the staff considers the applicant's description to be acceptable on the basis that sufficient information is provided for the scope of the offsite circuit. Further, pursuant to 10 CFR 50.12, the staff considers acceptable an exemption to the requirements of GDC 17 concerning the need for two offsite power sources. Therefore, the staff concludes that the design of the offsite power system for the AP1000 is acceptable.
- Section 8.3.2.1.4, Onsite Power:
  - The applicant has met the requirements of GDC 17 with respect to the Class 1E dc and UPS system's (1) capacity and capability to permit functioning of SSCs important to safety, (2) the independence and redundancy to perform its safety function assuming a single failure, and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network.

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- In addition, the VCSNS 2 &3 FSER confirmed GDC 17 compliance:
    - 'With respect to GDC 17, the NRC staff finds that the results of the grid stability analysis demonstrate the offsite source capacity and capability to power plant components during normal, shutdown, startup, and turbine trip conditions. The results of the failure modes and effects analysis demonstrate the reliability of the offsite source, which minimizes the likelihood of its failure under normal, abnormal and accident conditions. Therefore, the NRC staff concludes that the VCSNS Units 2 and 3 offsite power systems design meets the requirements of GDC 17, as it is applicable to AP1000 design; therefore, this item is resolved.'
- GDC 17 compliance is discussed further in Enclosure 2: Additional Detailed Evaluation of GDC 17 Compliance.

1. Given the requirements above, describe how the protection scheme for ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited off-site power circuit or another power source.

The AP1000 Main AC power system is non-safety related and is not relied upon to mitigate design basis accidents or to bring the plant to a safe shutdown. The AP1000 design does not utilize medium voltage ESF buses.

The AP1000 non-safety related medium voltage buses are configured fundamentally different than the Byron 2 design as described in the subject Bulletin. During full power plant operation, the AP1000 medium voltage electrical buses are normally supplied from the main generator via one of three unit auxiliary transformers (UATs). The reserve auxiliary transformers (RATs) would normally be in an energized, but standby (unloaded) condition.

The AP1000 electrical design includes the following medium voltage bus features:

a) Monitoring of each phase of the generator bus voltage and status information provided in the main control room (MCR).
b) Electrical protection for the medium voltage switchgears (ECS-ES-1 through ECS-ES-6 and ECS-ES-7) and interconnected loads consist of multifunction, software-based microprocessor digital relaying schemes having metering and testing capabilities for electrical protection schemes. The protective relays provide status information in the MCR.
c) Medium voltage motors protected by a multifunction microprocessor-based digital relay thermal overload function (49) and a loss of phase function (46) that protects the motor against overloads and locked rotor conditions.

- Bus undervoltage function 27B1 is set at approximately 75% of the nominal voltage, which is below the minimum voltage experienced during motor start, to trip all motors and package loads containing motors on the bus and start the onsite standby diesel generator (buses ES-1 and ES-2 only), for an undervoltage condition. A time delay setting of approximately 3.0 seconds is used to allow the faults to be cleared by overcurrent devices.
- Bus undervoltage function 27B2 is set at approximately 30% of nominal voltage with a 3-second time delay to provide permissions for residual bus transfer and trip the respective source breaker, and one-out-of-two logic to alarm for blown fuses.
- Bus undervoltage function 27B3 is set at approximately 90% of the nominal voltage to alarm after approximately 30 seconds.
- The AP1000 open delta bus undervoltage detection scheme monitors two (2) phase-to-phase conditions to indicate an undervoltage condition (2/2 logic).

e) Summary
- An open delta voltage sensing scheme is used to detect a bus undervoltage condition on the non-safety medium voltage buses.
- With use of an open delta configuration, loss of the shared phase would be detected.
- Low impedance faults would be detected by ground fault relay schemes.
- High impedance faults (defined herein as those faults of sufficient impedance to remain below the setting level of the ground fault relays) in combination with a single phase open circuit condition will respond similarly to the open circuit condition described throughout the response.
- The AP1000 relay and protection methodology applicable to the Non-1E buses has not been designed to detect all single-phase open circuit conditions or high impedance ground fault conditions directly.
- The turbine-generator is provided with sequence protection that would initiate a generator trip with a loss of phase or high impedance ground fault.
- Medium voltage breakers for motors are provided with a loss of phase relay.

a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).
- An open delta undervoltage sensing scheme cannot detect all open phase or high impedance ground fault conditions.
- For the protection schemes described herein that would respond to the open phase or high impedance ground fault condition, setpoints and equipment sensitivities have not been finalized.

b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.
- The use of the open delta potential transformer undervoltage detection scheme is not sensitive to the load on the source transformer.

- The use of the open delta potential transformer undervoltage detection scheme is not sensitive to the load on the source transformer.

c. If the design does not detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources, describe the consequences of such an event and the plant response.

NOTE: It should be noted specifically that a qualitative assessment is made below. The AP1000 AC electrical design is in the design finalization stage, and relay settings, detailed coordination studies, etc. are not yet available.

- With the generator online during full power operation with the medium voltage buses normally aligned, single open phase conditions or high impedance ground fault in combination with a single phase open circuit condition would result in a direct turbine/generator trip due to generator protection, resulting in the opening of the generator circuit breaker.
- The Non 1E medium voltage buses would be automatically backfed from the grid via the Main Step-Up Transformers (MSUs).
- Auxiliary loads on the Non 1E medium voltage buses would likely trip due to phase overcurrent condition.
- The non-safety diesel generators, that provide a defense in depth onsite supply source for the ES-1 and ES-2 buses, would remain in standby condition.
- A reactor trip condition, if not already present, would occur.
- The passive residual heat removal system would be automatically initiated to remove reactor core decay heat.
- The IDS division batteries and inverters provide the safety-related source of onsite AC and DC power for safety-related functions. Each IDS charger has features that detect the loss of input phase voltage and isolate the Class 1E electrical systems from the Non 1E AC electrical system.

d. Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

- The Main Step-Up Transformers (MSUs) are four separate single phase transformers (three connected phases and one spare) connected in three phase wye-delta configuration. The HV (wye) side is a solidly grounded neutral.
- Each of Unit Auxiliary Transformers (UATs) 2A and 2B are three phase three winding transformers with delta-wye configuration. Each LV (wye) winding is low resistance grounded.
- Unit Auxiliary Transformer 2C is a three phase two winding transformer with delta-wye configuration. The LV (wye) winding is low resistance grounded.
- The Reserve Auxiliary Transformers (RATs) are three phase three winding transformers with wye-wye configuration with an embedded tertiary winding. The HV side is a solidly grounded neutral and the LV side is low resistance grounded.

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition). Include the following details:

- During normal power production, the main generator directs power to the medium voltage buses via the UATs. UAT 2A (RAT 4A) provides power to the Non 1E buses 1, 3, and 5 and UAT 2B (RAT 4B) provides power to the Non 1E buses 2, 4, and 6. UAT 2C provides power to only ES-7.
- The RATs (4A & 4B) would normally be in an energized, standby (unloaded) condition. This equipment is capable of providing grid power to the Non 1E medium voltage buses ES-1 through ES-6.
- The onsite non-safety-related diesel generators would normally be in a standby condition. This equipment is capable of providing onsite power to the medium voltage buses ES-1 and ES-2.

a. Are the ESF buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.

- No. The Non 1E medium voltage buses are normally aligned to the main generator during normal operations at power and are not directly powered by offsite power sources.

b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.

- For the maintenance source, the Reserve Auxiliary Transformers (RATs), a surveillance test is not performed nor required since only one offsite circuit is required to meet the AP1000 GDC 17 requirements. The RATs are not credited and are available as a maintenance source of power as described in the AP1000 DCD. The credited GDC 17 circuit is the connection from the Main Step Up transformer (MSU) to the 230kV switchyard. At power, this connection is supplied from the main generator which is supplying power to the offsite power system via the MSU.

c. Confirm that the operating configuration of the ESF buses is consistent with the current licensing basis. Describe any changes in offsite power source alignment to the ESF buses from the original plant licensing.

- The VC Summer 2 and 3 electrical system configuration is consistent with the AP1000 Certified Design plus applicable AP1000 Certified Design exemptions.

d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ESF buses?

- Generic AP1000 Plant Operating Procedures are under development. A review of the Generic Procedures did not identify specific operator actions related to phase voltage verifications on the 3 phases.

e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

- The AP1000 non-safety related electrical system has not been designed to detect all single-phase open circuit or high impedance ground fault conditions. In the cases where the open phase (or high impedance ground fault) is detected, then the affected medium voltage bus would separate from the faulted source and be repowered from either the associated Reserve Auxiliary Transformer or the associated onsite standby diesel generator. If the fault is not detected, the AP1000 safety functions would continue to be supported by its passive systems and the onsite DC safety-related power system (IDS).

Enclosure 2:

Additional Detailed Evaluation of GDC 17 Compliance:

Overview

Chapter 3.1.2 of the AP1000 Design Control Document (DCD), Revision 19 describes the AP1000 compliance to GDC 17. Specifically, the AP1000 plant design supports an exemption to the requirement of GDC 17 for two physically independent offsite circuits by providing safety-related passive systems for core cooling and containment integrity, and multiple nonsafety-related onsite and offsite electric power sources for other functions. Chapter 6.3 of the DCD provides additional information on the systems for core cooling.

The AP1000 plant design provides for a reliable safety-related dc power source (IDS) supplied by batteries that provide power for the safety-related valves and instrumentation to actuate the safety-related passive systems during transient and accident conditions. This system includes the associated safety-related 120 VAC distribution equipment that provides electrical power to the Class 1E protection and monitoring system (PMS). The DCD GDC 17 compliance section specifically states:

- *"Although the AP1000 is designed with reliable nonsafety-related offsite and onsite ac power that are normally expected to be available for important plant functions, nonsafety-related ac power is not relied upon to maintain the core cooling or containment integrity."*
- *"The nonsafety-related ac power system is designed such that plant auxiliaries can be powered from the grid under all modes of operation."*

The DCD also states that the AP1000 onsite standby power system is not required for safe shutdown of the plant.

Detailed Assessment

Items 1-6 below in italics are specific portions of GDC 17—Electric power systems – along with a discussion of how that topic relates to the AP1000 standard plant design.

1. *"An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety."*

   The AP1000 design provides both an onsite and offsite electric power system. The capability of supporting the function of SSCs important to safety is provided through the use of the Class 1E DC Power System (IDS) without reliance upon the main AC power system (ECS). Although provided by the design, availability of the main AC power system is not required to achieve or maintain plant safety. Additionally, a loss of AC event is a very low PRA contributor since it only results in the loss of some Non-Safety related Defense in Depth SSCs. The only safety function of the ECS system is to provide circuit breakers (2 per pump) for tripping of the RCPs. This function is redundant, is Class 1E and is designed to meet the single failure criterion for each pump. This function is initiated from the protection system (PMS) based on nuclear system parameters and not through the plant electrical system (ECS) relaying capabilities.

The IDS system comprises four shutdown divisions any three of which can achieve shutdown. Independent divisions of the IDS support the sole safety function of the ECS by providing redundant Class 1E control power to the trip circuit. Assuming a single division failure coincident with a loss of all AC, the remaining divisions provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. By providing both the capability and capacity with a single safety failure, the four IDS divisions have the capability to provide the required assurances and also provide the required control power support to the ECS safety function of RCP trip. Beyond the capability to trip the RCPs described previously, the AP1000 design does not require any AC power capacity or capability to assure the above conditions.

2. *"The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure."*

   As indicated in DCD Table 8.1-1, GDC-17 is only applicable to the onsite Class 1E DC Power system as part of the plant safety bases. The IDS system is designed to provide all of the independence, redundancy, and testability associated with a Class 1E distribution system fully compliant with the single failure criterion. No other onsite or offsite electrical distribution system is required to meet the single failure criterion. Only the Class 1E DC and associated AC instrument and control bus power distribution systems have Operability, Limiting Condition for Operation and Surveillance Test Requirements in the licensing basis. Unlike second generation plants, there are no Technical Specification requirements for the Offsite AC Sources in the AP1000 Tech Specs. In the Investment Protection Short Term Availability Controls, one offsite AC source and one onsite AC source is recommended to be operable in Mode 5 with the RCS open and in Mode 6 with upper internals in place or the reactor cavity less than full to support RNS System operation during shutdown periods, but the PXS system is the credited system to mitigate postulated events during Mode 5 and 6 which only requires Class 1E DC and associated AC instrument and control bus power distribution systems to perform its safety function.

3. *"Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits*

(not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable."

The AP1000 design has an exemption to the requirement for a second offsite source. Therefore the preceding information is not applicable.

4. *"Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies [and the other offsite electric power circuit], to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded."*

   The AP1000 design requires a safety analysis input of three (3) seconds of AC power following a turbine trip **with no electrical faults**. However, in the Chapter 15 analyses, if the initiating event is an electrical system failure, the analyses do not assume operation of the RCPs following the turbine trip and therefore require no support from the non-Class 1E electrical system (ECS). This defines the only requirement of the ECS system with respect to power availability during postulated events and as shown above is not a requirement if the initiating event is an electrical fault.

5. *"One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained."*

   The AP1000 design meets these criteria. The single offsite circuit is normally available within a few seconds. The AP1000 design includes two offsite circuits; however, because only one circuit is required, the circuit does not and is not required to meet a single failure criterion or similar level of fault tolerance. If all offsite circuits are lost due to a single failure, there is no impact to credited core cooling, containment integrity, and vital safety functions while a circuit is restored assuming a coping time of 72 hours to provide alternate PCS cooling means. Additionally, provisions are included in the design to repower the PCS system pumps and PAMS cabinets plus MCR lighting and temporary cooling from the Ancillary AC diesel generators after 72 hours if power cannot be restored from an offsite circuit or from the onsite standby diesel generators.

6. *"Provisions shall be included to minimize the probability of losing electric power from [any of the remaining] supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies."*

   This requirement encompasses the grid stability provision. Generally, the licensee demonstrates that the stability analysis demonstrates adequate voltage and frequency support for the following contingencies: loss of the in-unit Main Generator, loss of the closest unit (electrically) on the grid, loss of the largest unit on the grid, loss of the worst case transmission line, close in faults, etc. The AP1000 design only requires the grid to be available for 3 seconds following a turbine trip **with no electrical faults.** This is recognized and accepted in the AP1000 FSER based on the incredible probability of a coincident electrical fault with a reactor transient requiring RCP flow above coast down.