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SCE&G
A SCANA COMPANY

October 24, 2012
RC-12-0121

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) Unit 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
SOUTH CAROLINA ELECTRIC & GAS COMPANY'S REQUEST
FOR EXTENSION OF THE 90-DAY RESPONSE TO BULLETIN 2012-01,
"DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM"

Reference: BULLETIN 2012-01, "DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM," DATED JULY 27, 2012

On July 27, 2012, the Nuclear Regulatory Commission (NRC) issued Bulletin 2012-01, requesting that each licensee submit a written response in accordance with 10 CFR 50.54(f) within 90 days of the bulletin to provide the following information:

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. Also, include the following information:

    a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).
    b. The difference (if any) of the consequences of a loaded (i.e. ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF bus normally aligned to unit auxiliary transformer) power source.
    c. If the design does not detect and automatically respond to a single-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.
    d. Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

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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:

    a. Are the ESF buses powered by offsite power source? If so, explain what major loads are connected to the buses including their ratings.
    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.
    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.
    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?
    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 attachments to this letter contains South Carolina Electric & Gas Company's (SCE&G) response to the above information in accordance with 10 CFR 50.54(f).

If you have any questions about this letter, please contact Mr. Bruce L. Thompson at (803) 931-5042.

I certify under penalty of perjury that the forgoing is true and correct.

10/24/12
Executed on

[signature]
Thomas D. Gatlin

JMW/TDG/ts
Attachments : 3

1. SCE&G's Response to NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System"
2. Simplified One-Line Diagram
3. Tables

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RTS (CR-12-03187)
File (815.02)
PRSF (RC-12-0121)

VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) Unit 1
DOCKET NO. 50-395
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ATTACHMENT 1

SCE&G's Response to NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System"

References

1. NRC Bulletin 2012-01: Design Vulnerability In Electric Power System
2. NUREG 0717 - V.C. Summer Unit 1 Safety Evaluation Report
3. VCSNS Drawing 206-005 - Simplified Plant Electrical Distribution
4. NRC Branch Technical Position PSB-1
5. Regulatory Guide - 1.6 (Rev 0, 1971)
6. Regulatory Guide - 1.32 (Rev 2, 1977)
7. V.C. Summer Nuclear Station Unit 1 UFSAR
8. VCSNS Calculation DC08220-007 - 1E Protective Relay Settings
9. VCSNS Calculation DC08210-001 - Non-1E Protective Relay Settings
10. VCSNS Drawing 207-015 - Three Line Diagram Switchgear Bus 1DX
11. VCSNS Drawing 207-016 - Three Line Diagram Switchgear Bus 1DA
12. VCSNS Drawing 207-017 - Three Line Diagram Switchgear Bus 1DB
13. INPO IER L2-12-14 - Automatic Reactor Scram Resulting from a Design Vulnerability in the 4.16-kV Bus Under voltage Protection Scheme
14. VCSNS Drawing 206-011 - One Line and Relay Diagram BOP (FSAR Figure 8.2-3)
15. VCSNS Drawing 206-012 - One Line and Relay Diagram ESF (FSAR Figure 8.2-4)
16. VCSNS Drawing 203-010 - 7.2 kV Bus 1DA-1DB Undervoltage Relaying (FSAR Figure 8.3-0o)
17. "A Practical Guide for Detecting Single-Phasing on a 3 Phase Power System", John Horak and Gerald F. Johnson, Basler Electric Company, Presented at the Western Protective Relaying Conference, October 2002
18. "ABB Design and Sequence Impedance Information for South Carolina Electric and Gas - V.C Summer Station", July 25, 2012
19. VCSNS Drawing 206-001 - One Line Relay Diagram Notes, Legend, and References
20. VCSNS Calculation DC08200-001 - Under voltage Relay Logic and Setting
21. VCSNS Drawing 224-213 Sheet 121 - MCB Device Sheet XCP6117 Voltmeter
22. VCSNS Drawing 224-214 Sheet 5 - MCB Device Sheet XCP6118 Digital Indicator
23. VCSNS Drawing 208-037-ES108 - Miscellaneous Alarms ES System
24. VCSNS Operations Administrative Procedure OAP-106.1 - Operating Rounds
25. VCSNS Surveillance Test STP-125.001 - Electric Power Systems Weekly Test
26. VCSNS Drawing 229-071 - Three Line 230kV Substation Bus Section 3 Potential Elementary Part 1
27. GE Instruction Manual GEH-1788L - Time Over-current Relays (IAC53A)
28. GE Instruction Manual GEK-34053G - Time Over-current Relays (IAC51A)
29. GE Instruction Manual GEH-1814J - Time Over-current Relays (IAV53K)
30. VCSNS Operations Department Station Order 12-04, Rev 1
31. VCSNS System Operating Procedure - SOP-304 115kV/7.2kV Operations
32. 10 CFR 50.55a(h)(2) - IEEE Std. 279, "Criteria for Protection Systems for Nuclear Power Generating Stations
33. VCSNS Drawing 229-006 - Overhead Line Arrangement 230kV and 115kV Outdoor Transformer Area
34. V. C. Summer Nuclear Station Technical Specifications
35. VCSNS Drawing 1MS-28-026 - Wiring Diagram Main Control Board XCP6118
36. 10 CFR Part 50 Appendix A General Design Criteria 17

Overview

The response to this NRC Bulletin follows the NEI Response Template developed by industry and NRC input. This template was reviewed and accepted by the NRC as an acceptable means of responding to the bulletin. The response is arranged as follows:

1. System Description - Items 2, 1.d, 2.a, 2.c
2. System Protection - 1, 1.a, 2.b, 2.d
3. Consequences - 1.b, 1.c, 2.e
4. Attachment 1 - This document
5. Attachment 2 - Simplified One-Line Diagram
6. Attachment 3 - Tables
    a) Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)
    b) Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)
    c) Table 3 - ESF Buses Normally Energized Major Loads
    d) Table 4 - Offsite Power Transformers
    e) Table 5 - Protective Devices

Responses

System Description

Items 2, 1.d, 2.a, and 2.c request system information and will be addressed in this section.

1. **Response to Question 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).**

    See Attachment 2 for a simplified one-line diagram.

    During normal operating conditions, VCSNS Unit 1 ESF buses are continuously connected to two separate offsite power sources. One offsite power source is 230kV nominal and is normally aligned to Train B (Bus 1DB) via Emergency Aux Transformer XTF31. The second offsite source is 115kV nominal and is normally aligned to Train A (Bus 1DA) via ESF Transformer XTF4 alone or XTF4 in series with Voltage Regulating Transformer XTF6 or via XTF5 alone. Each of the two offsite sources serves as the emergency source for the opposite train via a manual transfer. During normal operation (station generating electricity), Train A is aligned to the 115kV offsite source via XTF4/6 and Train B is aligned to the 230kV source via XTF31. The ability to use XTF4, XTF4 with XTF6, or XTF5 to power the ESF buses is selected using intermediate bus (1DX).

2. **Response to Question 1.d. - Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.**

    See Attachment 3, Table 4, for offsite power transformer winding and grounding configurations.

3. Response to Question 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.

Yes. For at-power (normal operating condition) configurations, both ESF buses are powered by separate and independent offsite sources. The amount of load on each train depends on the amount of connected loads in-service. XTF31 also serves as an emergency source for one of three non-1E 7.2kV buses (XSW1C). During normal operations (station generating electricity, 100% power) XTF31 does not carry XSW1C loads.

See Attachment 3, Tables 1 and 2, for ESF bus power sources.

See Attachment 3, Table 3, for ESF bus major loads energized during normal power operations, including their ratings.

4. Response to Question 2.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.

As stated in Section 8.2.1 of the VCSNS Unit 1 UFSAR, two (2) separate sources of offsite power are provided for the Class 1E electric system, which is in compliance with General Design Criterion 17 and Regulatory Guide 1.32.

A review of the plant's licensing basis was performed. This review concluded the station's licensing basis includes the following relevant regulations. These regulations include the separation and reliability requirements of 10CFR50 Appendix A GDC 17, under-voltage and degraded voltage requirements of NRC Branch Technical Position PSB-1, Regulatory Guide 1.6 (Rev 0, 1971), and Regulatory Guide 1.32 (Rev 2, 1977). In short, the failure of one offsite source does not impact the availability of the second source to power the VCS ESF buses. Further, the ESF actuation system complies with the requirements of IEEE Std. 279 which is in accordance with 10 CFR 50.55a(h)(2). This design was submitted and accepted by the NRC during the initial plant license submittal process.

The following at power (normal operating condition) configurations have been confirmed to be consistent with the original and current licensing basis:

a) Unit 1, 230kV Source – Normal power to ESF Train B (Bus 1DB) via XTF31, Emergency source to ESF Train A (Bus 1DA).
b) Unit 1, 115kV Source – Normal power to ESF Train A (Bus 1DA) via XTF4 and XTF6 or via XTF5. Emergency source to ESF Train B (Bus 1DB) via these same transformers.

As shown in Attachment 3, Tables 1 and 2, there have been no changes to the alignments of the VCSNS ESF bus to their credited GDC17 offsite sources from the original plant licensing.

<u>System Protection</u>

Items 1, 1.a, 2.b, and 2.d request information regarding electrical system protection and will be addressed in this section:

5. Response to Question 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 sources.

Consistent with the current licensing basis and GDC 17, existing protective circuitry will separate the ESF buses from a connected offsite source due to a loss of voltage or a sustained, balanced degraded grid voltage. The relay systems were not specifically designed to detect an open single phase of a three phase system. Detection of a single-open phase condition is beyond the approved design and licensing basis of the plant.

During normal plant operation, one ESF bus is aligned to the 115kV preferred source via either ESF Transformers XFT4 in series with XTF6 or via XTF5. The second ESF bus is aligned to the 230kV preferred source via Emergency Auxiliary Transformer XTF31.

On the 1E system, Degraded Voltage Relays (DVR) (XPN5275-27B-1DA-1/2/3, XPN5276-27B-1DB-1/2/3) and the Loss of Voltage Relays (LVR) (XSW1DA-10-27-1DA-1/2/3; XSW1DB-10-27-1DB-1/2/3) monitor each ESF Bus for a loss of voltage or a sustained, balanced degraded grid voltage conditions. The DVR relay scheme and the LVR relay scheme each use 3 of 3 coincident logic to automatically separate the affected ESF bus from the offsite power sources.

The offsite power system is designed and configured such that a single open phase condition on one credited offsite power circuit does not affect the remaining credited offsite power supply.

Detailed computer simulations involving a single open phase scenario have not been performed, however, the following anticipated electrical system responses are postulated based on the guidance set forth in Reference 17.

GDC17 Credited Offsite Power Circuits:

a) For an open phase condition on the 230 kV supply line to XTF31 transformer, nearly normal voltages are expected on the secondary of the transformer. This result is related to the 3 legged core form design of the transformer (Reference 17, pages 7 and 8 and Reference 15). Because the transformer is only moderately loaded, even during accident conditions (4.4 MW on 12/20 MVA winding), the accident mitigation loads may perform as expected for this open phase condition.

Because the voltages are expected to be close to normal on the secondary side of XTF31, no automatic tripping and/or alarming is expected from either the DVRs and/or LVRs.

The current flows on the 230kV side of the transformer are postulated to be highly unbalanced with one phase being zero and the other two phases being nearly equal and opposite. However, the existing protection scheme in the switchyard may not be able to detect this unbalance.

b) For an open phase condition on the 115kV supply line to either XTF4 or XTF5, distorted voltages on the secondary are postulated even though these transformers are also 3 legged core form designs. The transformer winding configurations are Delta - Zig Zag and the Delta winding on the 115kV side will cause the "3 phase transformer" to act similarly to three "single phase transformers" (Reference 17 page 20). The phasor mathematics shown in Reference 17 of a Delta - Zig Zag suggest that for Phase B being open on the high side suggest the line - neutral voltages on the 7.2kV side of the transformer will be depressed on Phases A and C with Phase B falling to 0 volts.

Both the DVRs and LVRs monitor phase to phase voltages. The phase to phase voltages were determined for Vab and Vbc to be approximately half per unit of Vca.

Two of the three phase to phase voltages are below the pickup setting of both the DVR (0.9134 per unit) and the LVR (0.81 per unit). However, since all three are not below these values there will be no automatic tripping.

In addition to these 1E relays, the 115kV ESF Line is monitored for ground faults by Over/Under-Voltage Relay 115kV-27/59. Although the protection scheme at VCSNS Unit 1 was not designed to detect and automatically respond to a single-phase open circuit condition on a credited off-site power circuit, a preliminary assessment has shown that the 115kV-27/59 relay will respond to this condition.

Relay 115kV-27/59 is an Over/Under-Voltage Relay which senses on the high side of XTF4/5 using 3 PTs connected in a "broken-delta" configuration. An assessment has shown this relay detects an open phase condition in approximately 2.6 seconds. Actuation of this relay automatically trips the transformer low side switchgear breakers (XSW1DX). This results in an automatic isolation of the supplied ESF bus from the offsite 115kV source experiencing the open phase and an automatic start of the EDG on the impacted ESF train via the Loss of Voltage Relays. Therefore, based on this assessment, this relay could potentially detect an open phase between the PTs located above ESF Transformers XTF4/5 and the Parr Generating Complex. However, it will potentially be unable to detect an open phase between the PTs and the XTF4/5 HV bushings.

The 27/59 relay scheme described on the 115kV preferred source does not exist for the 230kV preferred source. See Table 5 for a summary of the relevant protective devices and the basis for their settings.

Other Non-GDC17 Credited Power Sources:

VCSNS has an additional power source that is not credited for GDC17 which can supply either of the station's ESF buses 1DA or 1DB. This power source uses a direct buried 13.8kV underground line which connects the Parr Generating Complex to the station's ESF buses via XTF5052 and intermediate Bus 1DX. This line can be powered from either the Parr Hydro Power Station or from the Parr 115kV Switchyard. XTF5052 is a 13.2/7.2kV delta-wye transformer. The wye side of this transformer is also resistance grounded with a 7 ohm resistor. The loading of the additional power source onto either one of two ESF buses is done manually.

The additional power source is required by Tech Spec LCO-3.8.1.1, Action b.4 when entering into a 14 day EDG Maintenance outage for a single ESF Train.

Based on Table 11 of Reference 17, a loss of Phase B on the 13.2 kV side of XTF5052 is postulated to result in the following line-line voltages on the 7.2kV side of the transformer.

Vab = 0.866 per unit at -30 degrees (line-line base)
Vbc = 0 per unit at 0 degrees
Vca = 0.866 per unit at 150 degrees

All three of these voltages are below the DVR set point (0.9134 per unit) so it is possible that this open phase condition would be detected and the 1E buses would be disconnected from the off-site source with an open phase and re-energized with the Emergency Diesel Generator. The exact system response to this open phase situation would have to be determined with a detailed computer simulation since the expected results are close to the DVR relay set point. The variability of the expected results is also demonstrated by Table 12 in Reference 17. Using that particular table would result in the DVR not operating because the voltage levels on the phases are above the set point.

6. Response to Question 1.a. - The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device set point(s).

Consistent with the current licensing basis and GDC 17, existing electrical protective devices are sufficiently sensitive to detect design basis conditions like a loss of voltage or a degraded voltage, but were not designed to detect and are not postulated to operate for a single phase open circuit condition. See Attachment 3, Table 5, for under-voltage protective devices and the basis for the device set point(s).

Existing electrical protective devices are also sufficiently sensitive to detect a ground fault. Attachment 3, Table 5, lists ground protection on the ESF buses and the basis for the device set point(s).

The VCSNS 7.2kV ESF buses use a high impedance ground system. The resistor is sized to limit fault current to 595A.

Ground fault protection for the 7.2kV ESF buses XSW1DA and XSW1DB is provided by bus ground over current relays 51BN1DA and 51BN1DB (IAC51A). These relays monitor the 7.2kv ESF busses that are set to trip at 200A primary current using a Time Dial setting of 2.0. To address the sensitivity of this relay to detect high impedance grounds, a high impedance ground current of 180A (90% of trip value) and 300A (150%) is postulated. Using the characteristic curves for this GE IAC51A relay, a ground current of 180A will not trip the relay. A ground current of 300A will trip in 2.25 sec.

Ground fault protection for the 7.2kV side of Emergency Aux Transformer XTF31 is provided by relay 51NL31 (IAC53A). This relay is set to trip at 300A primary current using a Time Dial setting of 5. To address the sensitivity of this relay to detect high impedance grounds, a high impedance ground current of 270A (90% of trip value) and 450A (150%) is postulated. Using the characteristic curves for this GE IAC53A relay, a ground current of 270A will not trip the relay. A ground current of 450A will trip in 16 sec.

Ground fault protection for the 230kV side of Emergency Aux Transformer XTF31 is provided by relay 51NH31 (IAC53A). This relay is set to trip at 300A primary current using a Time Dial setting of 2. To address the sensitivity of this relay to detect high impedance grounds, a high impedance ground current of 270A (90% of trip value) and 450A (150%) is postulated. Using the characteristic curves for this GE IAC53A relay, a ground current of 270A will not trip the relay. A ground current of 450A will trip in 6 sec.

Ground fault protection for the 7.2kV side of ESF Transformer XTF4 and XTF5 is provided by relays 51NL4 and 51NL5 (IAC53A). These relays are set to trip at 300A primary current using a Time Dial setting of 5. To address the sensitivity of this relay to detect high impedance grounds, a high impedance ground current of 270A (90% of trip value) and 450A (150%) is postulated. Using the characteristic curves for this GE IAC53A relay, a ground current of 270A will not trip the relay. A ground current of 450A will trip in 16 sec.

Ground fault protection for the 115kV side of ESF Transformers XTF4 and XTF5 are provided by relays 51NH4 and 51NH5 (IAC51A). These relays are set to trip at 20A primary current using a Time Dial setting of 2. To address the sensitivity of this relay to detect high impedance grounds, a high impedance ground current of 18A (90% of trip value) and 30A (150%) is postulated. Using the characteristic curves for this GE IAC51A relay, a ground current of 18A will not trip the relay. A ground current of 30A will trip in 2.2 sec.

7. Response to Question 2.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.

Not Applicable - the ESF buses at VCSNS Unit 1 are continually powered by offsite power sources during normal plant operation.

8. **Response to Question 2.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?**

Yes. Operations Administrative Procedure OAP-106.1 - Operating Rounds, explicitly instructs operations personnel in Attachment I to check all three phases and record the average of the three voltage levels at the 7.2kV ESF Buses XSW1DA and XSW1DB.

Consequences

Items 1.b, 1.c, and 2.e request information regarding the electrical consequences of an event and will be addressed in this section:

9. **Response to Question 1.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.**

VCSNS does not align the ESF buses to the Unit Aux Transformer (XTF2) during normal operation. Both offsite power transformers are normally loaded with a single ESF Train.

10. **Response to Question 1.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.**

Should an open phase occur on one offsite source, it would only affect the single source and the single ESF train aligned to that source. The second train would be unaffected by the open phase and would be capable of performing its current licensing and design basis functions.

Without formalized engineering calculations or engineering evaluations, the electrical consequences of such an open phase event (including plant response), can only be evaluated to the extent of what has already been published by EPRI and Basler. The difficulty in applying these documents to the VCSNS specific response is that these are generic assessments and cannot be formally credited as a basis for an accurate response. The primary reason is that detailed plant specific models would need to be developed (e.g., transformer magnetic circuit models, electric distribution models, motor models; including positive, negative, and zero sequence impedances (voltage and currents), and the models would need to be compiled and analyzed for the VCSNS specific Class 1E electric distribution system. The above-mentioned EPRI and Basler documents have been utilized in the assessment presented in the response to Question 1.

The response to Question 1 suggests that if an open phase condition were to occur on the 230kV system, there is a possibility that the accident mitigation loads on the affected ESF train would perform as expected. Detailed computer simulations would be required to confirm or refute this. If the open phase condition were to occur on the 115kV supply line to XTF4/5, it would likely be detected by Relay 27/59. This relay automatically trips the transformer low side switchgear breakers (XSW1DX). This results in an automatic isolation of the supplied ESF bus from the offsite 115kV source experiencing the open phase and an automatic start of the EDG on the impacted ESF train via the Loss of Voltage Relays. If however, the open phase condition occurred on the 115kV system and it went undetected (open phase between PTs and XTF4/5 HV bushings) then no automatic action would be expected to occur. The accident mitigation loads would not perform as expected and they may or may not be damaged due to excessive negative sequence currents prior to them being disconnected.

Detailed computer simulations will be necessary to quantify the impact of various high impedance faults coincident with an open phase event.

Since VCSNS did not credit the ESF bus protection scheme as being capable of detecting and automatically responding to a single phase open circuit condition, an open phase fault was not included in the design criteria for either the DVR scheme of the LVR scheme design criteria. Since open phase detection was not credited in the VCSNS design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

VCSNS has taken interim actions to reduce the station's vulnerability to a loss of phase event and to provide operators with tools to aid in recognizing the condition so appropriate action can be taken. Station Order 12-04 was issued to provide immediate interim actions to detect and diagnose an open phase on the offsite power sources. This station order trained Operations Department personnel on recognizing the symptoms of phase loss, provided instructions to minimize alignment of both ESF Trains to the 230kV offsite source, and provided recommended response actions. Note that aligning both trains to a single offsite power source is not considered a normal operation alignment since the VCSNS enters an LCO for this maintenance alignment per SOP-304, Enclosure B.

In addition to these completed actions, additional interim actions have been entered into the Station's Corrective Action Program and include the following:

a) Operations departmental procedures are being reviewed and will be revised as needed to aid operators in promptly diagnosing and responding to a loss of phase condition on the offsite power sources feeding the 1E buses (CR-12-00681, Action 12).
b) Operations departmental procedures are being reviewed and revised as needed to minimize aligning ESF Trains A and B simultaneously to the 230kV preferred source (CR-12-00681, Action 14).
c) Operations departmental procedures are being reviewed and will be revised if needed to instruct personnel to confirm the integrity of the offsite power source by monitoring the HV side voltmeters and ammeters and confirm all three phases show consistent values after placing safety related loads on the 230kV preferred source (CR-12-00681, Action 15).
d) Operations departmental procedures are being reviewed and will be revised if needed to instruct personnel conducting operator rounds to perform a visual inspection (at ground level) of the pipe bus, conductors, insulators, bushings, etc. for anything abnormal (bushings cracked/broken/out of place, bus out of place, etc.) in the transformer yard (once per shift) and switchyard (weekly). Additionally, the

frequency of the switchyard round frequency is recommended to be increased to once per shift (CR-12-00681, Action 16).

e) Operations departmental procedures are being reviewed and will be revised if needed to instruct personnel to confirm the phase currents as read at XSW1DA/1DB are consistent phase to phase after performing train swaps which align the in-service train to XTF31 (CR-12-00681, Action 17).

To support any future analysis that may be required, VCSNS is obtaining detailed internal parameters from the manufacturers of transformers which connect our 1E buses to the GDC 17 credited offsite power sources. These parameters would permit detailed transformer modeling and aid in understanding the plants electrical response to an open phase condition on the offsite power sources.

11. Response to Question 2.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.

Under normal conditions, VCSNS does not use a single offsite circuit to supply redundant ESF buses.

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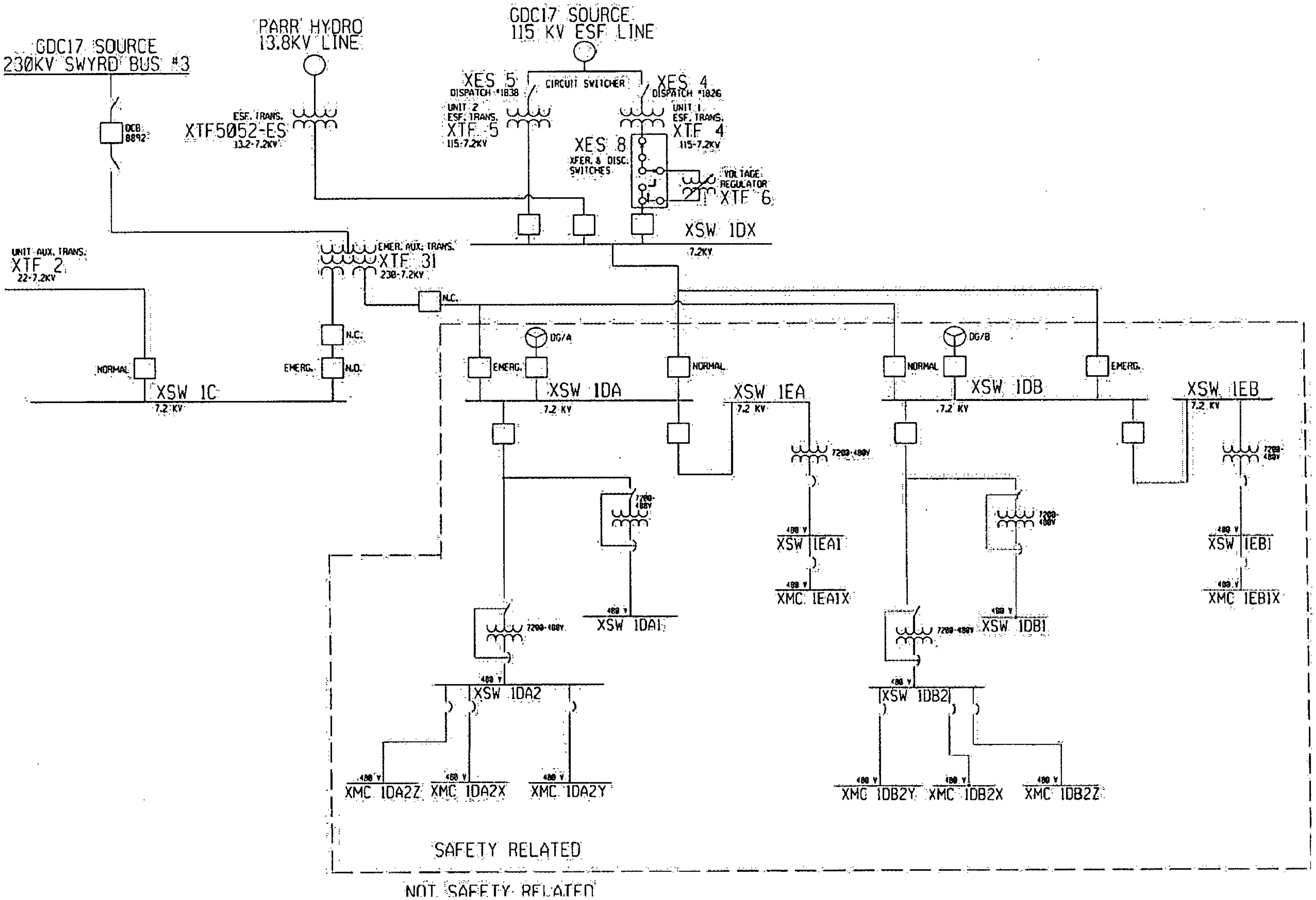
ATTACHMENT 2

Simplified One-Line Diagram


GDC17 SOURCE
230KV SWYRD BUS #3
PARR HYDRO
13.8KV LINE
GDC17 SOURCE
115 KV ESF LINE
XES 5
CIRCUIT SWITCHER
XES 4
XTF5052-ES
XTF 5
XTF 4
XES 8
VOLTAGE REGULATOR
XTF 6
XSW 1DX
XTF 2
XTF 31
XSW 1C
XSW 1DA
XSW 1EA
XSW 1DB
XSW 1EB
XSW 1EA1
XMC 1EA1X
XSW 1EB1
XMC 1EB1X
XSW 1DA1
XSW 1DB1
XSW 1DA2
XSW 1DB2
XMC 1DA2Z
XMC 1DA2X
XMC 1DA2Y
XMC 1DB2Y
XMC 1DB2X
XMC 1DB2Z
SAFETY RELATED
NOT SAFETY RELATED

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ATTACHMENT 3

Tables

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

Description of ESF Bus Power Source	ESF Bus Name (normal operating condition)	Original licensing basis configuration (Y/N)
VCSNS Unit 1 230kV Switchyard Bus 3	XSW1DB	Y
Parr 115kV ESF Line	XSW1DA	Y

Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)

Description of ESF Bus Power Source	ESF Bus Name (normal operating condition)	Original licensing basis configuration (Y/N)
None	None	Y

Table 3 - ESF Buses Normally Energized Major Loads
(Reference 20)

ESF Bus	Load	Voltage Level	Rating (HP)/kW	Operating When Train In Service
Train A				
XSW1DA	Charging/HHSI Pump (XPP43A)	7.2kV	900	X
XSW1DA	Component Cooling Pump (XPP1A)	7.2kV	600	X
XSW1DA	Pressurizer Heaters	7.2kV	750 kW (2)	X
XSW1EA	Service Water (XPP39A)	7.2kV	700	X
XSW1DA1	HVAC Chiller (XHX1A)	480V	321	X
XSW1DA1	Service Water Booster Pump (XPP45A)	480V	350	N/A (1)
XSW1DA1	Reactor Building Cooling Unit (XFN64A & XFN65A)	480V	150	X
XSW1DA2	HVAC Chilled Water Pump (XPP48A)	480V	60	X
XSW1DA2	Fuel Handling Bldg Exhaust Fan (XFN23A)	480V	60	X
XMC1DA2X	Control Room Normal Supply Fan (XFN32A)	480V	25	X
XMC1DA2X	Relay Room Supply Fan (XFN36A)	480V	15	X
XMC1DA2X	Battery Room Supply Fan (XFN38A)	480V	10	X
XMC1DA2X	Battery Room Exhaust Fan (XFN39A)	480V	5	X
XMC1DA2X	XSW1DA Switchgear Room Cooling Unit (XFN50)	480V	25	X
XMC1DA2X	Component Cooling Pump Speed Switch Cooling Fan (XFN106A)	480V	10	X
XMC1DA2X	EFW Pump Area Cooling (XFN83A)	480V	5	X
XMC1DA2Y	Aux Building MCC Switchgear Air Handling (XFN132)	480V	3	X
XMC1DA2Y	Charging/HHSI Pump Room Cooling Unit (XFN46A)	480V	3	X
XMC1DA2Y	Charging/HHSI Pump Aux Oil Pump (ALOP1)	480V	2	
XMC1DA2Z	EDG Room Supply Fans (XFN75A & B)	480V	60	X
XMC1EA1X	Service Water Traveling Screens (XRS2A)	480V	1	X
XMC1EA1X	Service Water Pump House Supply Fan (XFN80A)	480V	50	

(1) Service Water Booster Pump (XPP45A) is not used during normal plant operating modes.
(2) 750 kW is approximately 1007 HP.

ESF Bus	Load	Voltage Level	Rating (HP)/kW	Operating When Train In Service
Train B				
XSW1DB	Charging/HHSI Pump (XPP43B)	7.2kV	900	X
XSW1DB	Component Cooling Pump (XPP1B)	7.2kV	600	X
XSW1DB	Pressurizer Heaters	7.2kV	750 kW (2)	X
XSW1EB	Service Water (XPP39B)	7.2kV	700	X
XSW1DB1	HVAC Chiller (XHX1B)	480V	321	X
XSW1DB1	Service Water Booster Pump (XPP45B)	480V	350	N/A (1)
XSW1DB1	Reactor Building Cooling Unit (XFN64B & XFN65B)	480V	150	X
XSW1DB2	HVAC Chilled Water Pump (XPP48B)	480V	60	X
XSW1DB2	Fuel Handling Bldg Exhaust Fan (XFN23B)	480V	60	X
XMC1DB2X	EFW Pump Area Cooling (XFN83B)	480V	5	X
XMC1DB2X	Control Room Normal Supply Fan (XFN32B)	480V	25	X
XMC1DB2X	Relay Room Supply Fan (XFN36B)	480V	15	X
XMC1DB2X	Battery Room Supply Fan (XFN38B)	480V	10	X
XMC1DB2X	Battery Room Exhaust Fan (XFN39B)	480V	5	X
XMC1DB2X	XSW1DB Switchgear Room Cooling Unit (XFN76)	480V	25	X
XMC1DB2X	Component Cooling Pump Speed Switch Cooling Fan (XFN106B)	480V	10	X
XMC1DB2Y	Aux Building MCC Switchgear Air Handling (XFN133)	480V	3	X
XMC1DB2Y	Charging/HHSI Pump Room Cooling Unit (XFN46B)	480V	3	X
XMC1DB2Y	Charging/HHSI Pump Aux Oil Pump (ALOP2)	480V	2	
XMC1DB2Z	EDG Room Supply Fans (XFN45A & B)	480V	60	X
XMC1EB1X	Service Water Pump House Supply Fan (XFN80B)	480V	50	X
XMC1EB1X	Service Water Traveling Screens (XRS2B)	480V	1	

(1) Service Water Booster Pump (XPP45B) is not used during normal plant operating modes.
(2) 750 kW is approximately 1007 HP.
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Table 4 - Offsite Power Transformers
(References 14, 15, and 18)

Transformer	Winding Configuration (HV/LV)	MVA Size (AO/FA/FA)	Voltage Rating (Primary/Secondary) kV	Grounding Configuration
XTF4 and XTF5	Delta / Zig-Zag	10/12.5 (55 deg. C) 14 (65 deg. C)	115/7.2	LV Resistance Ground (7 ohms, 595A)
XTF31	Wye / Wye / Wye with buried LV delta	24/32/40 (55 deg. C) 44.8 (65 deg. C)	230/7.2/7.2	HV Solid Ground / LV Resistance Ground (7 ohms, 595A)
XTF6	Autotransformer (Wye)	15	7.2/7.2	LV Resistance Ground (7 ohms, 595A)

Table 5 - Protective Devices
(Reference 8, 9, and 19)

Protection Zone	Protective Device	UV Logic	Set point (Nominal)	Basis for Set point
7.2 kV ESF Bus	Loss of Voltage Relay (27-1DA and 27-1DB)	3 of 3	81% of 7200V (5832V) at 0.25 sec.	To actuate upon a loss of voltage condition. The setting should be lower than the minimum allowable voltages for motor running and starter coil pickup. A level high enough to permit rapid detection of a loss of voltage is desired. It should not pickup during motor starting events. Reference 20.
7.2 kV ESF Bus	Degraded Grid (27B-1DA and 27B-1DB)	3 of 3	91.34% of 7200V (6576V) at 3 sec.	To actuate upon a degraded voltage condition. Bottom-up analysis of the 1E electrical system to ensure sufficient terminal voltage is present during sustained low voltage conditions. Reference 20.
115kV GDC17 Source	27/59	1 of 1	Pickup = 55V tap. Time delay at 200% of pickup = 2.6 sec.	Monitors 115kV GDC17 source for phase imbalance / ground fault, over / under voltage. Reference 9.
HV Side of XTF4 and XTF5	51NH4 & 51NH5	1 of 3	20A primary current with a Time Dial setting of 2.	Monitors high side of ESF transformers XTF4 and XTF5 for phase ground fault. Reference 8.
LV Side of XTF4 and XTF5	51NL4 & 51NL5	1 of 1	300A with a Time Dial setting of 5.	Monitors XTF4 and XTF5 LV side for ground faults. Reference 8.
HV Side of XTF31	51NH31	1 of 1	300A with a Time Dial setting of 2.	Monitors HV side of XTF31 for ground faults. Reference 9.
LV Side of XTF31	51NL31	1 of 1	300A with a Time Dial setting of 5.	Monitors LV Side of XTF31 for ground faults. Reference 9.
ESF Train A Bus up to XSW1DX	51BN1DA	1 of 1	200A with a Time Dial setting of 2.	Monitors ESF Bus Train A for ground faults. Reference 8.
ESF Train B Bus up to XSW1DX	51BN1DB	1 of 1	200A with a Time Dial setting of 2.	Monitors ESF Bus Train B for ground faults. Reference 8.