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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400

Subject: Response to NRC Bulletin 2012-01, *Design Vulnerability in Electric Power System*

Reference: NRC Bulletin 2012-01, *Design Vulnerability in Electric Power System*, dated July 27, 2012.

Ladies and Gentlemen:

On July 27, 2012, the Nuclear Regulatory Commission issued NRC Bulletin 2012-01, *Design Vulnerability in Electric Power Systems*. The bulletin requires licensees to provide information within 90 days of the date of the bulletin confirming compliance 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. Carolina Power & Light Company hereby submits the required response to that bulletin for the Shearon Harris Nuclear Power Plant, Unit 1 under the provisions of 10 CFR 50.54(f).

This document contains no regulatory commitments. Please refer any questions regarding this submittal to Dave Corlett at (919) 362-3137.

I declare, under penalty of perjury, that the foregoing is true and correct.
Executed on [OCT. 25, 2012 ].

Sincerely,

George T. Hamrick

Enclosure: Response to NRC Bulletin 2012-01, *Design Vulnerability in Electric Power System*

cc: Mr. J. D. Austin, NRC Sr. Resident Inspector, HNP
Ms. A. T. Billoch Colón, NRC Project Manager, HNP
Mr. W. L. Cox III, Section Chief, N.C. DENR
Mr. V. M. McCree, NRC Regional Administrator, Region II

**Shearon Harris Nuclear Power Plant, Unit 1**

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**Subject: Response to NRC Bulletin 2012-01,**

***Design Vulnerability in Electric Power System***

**Contents**

**Attachment 1**

**System Description**

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

> ***2. Briefly describe the operating configuration of the ESF (Engineered Safety Features) buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).***

The normal source of power for the ESF buses is the main generator/unit auxiliary transformers. ESF buses 1A-SA and 1B-SB are powered from upstream BOP buses 1D and 1E respectively. Buses 1D and 1E are normally powered from the unit auxiliary transformers, UAT-1A and UAT-1B respectively. Upon loss of the main generator the system is capable of an automatic fast bus transfer to start up auxiliary transformers SUT-1A and SUT-1B.

See Attachment 2, for a simplified one-line diagram.

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

The Start-up Transformers (SUT-1A and SUT-1B) are three phase, three winding transformers with wye-wye configuration. The high side has a solidly grounded neutral and each low voltage winding is high resistance grounded with a neutral grounding transformer and resistor.

The main transformer consists of three single phase transformers with a wye-delta configuration. The high voltage wye winding neutral is solidly grounded.

The Unit Auxiliary Transformers (UAT-1A and UAT-1B) are three-phase, three-winding transformers with delta-wye configuration. The low voltage wye windings are high resistance grounded with a neutral grounding transformer and resistor.

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

> ***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.***

For at power (normal operating condition) configurations, ESF buses are not powered by offsite sources. Offsite power transformers (SUTs) do not carry any loads during normal operations.

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

Attachment 3, Table 3 for ESF bus major loads energized by offsite power during normal power operations is not applicable because ESF buses are not powered by offsite power during normal power operations.

> ***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.***

The onsite AC power distribution system (including ESF buses) receives power under normal operating conditions from the main generator through two unit auxiliary transformers.

The following at power (normal operating condition) configurations have been confirmed to be consistent with the current licensing basis as described in FSAR Section 8.1.2 "Offsite Power System," FSAR Section 8.1.3 "Onsite Power System," and FSAR Section 8.3.1.1.1 "AC Power Systems-General."

1. Power to ESF buses via main generator (UATs)

See Attachment 3 Tables 1 (or 2) for any changes in the offsite power source alignment to the ESF buses from the original plant licensing.

**System Protection**

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

> ***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. Also, include the following information:***

Consistent with the current licensing basis and GDC 17, existing protective circuitry will separate the ESF buses from a connected failed 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.

The electrical distribution system protection capability with regards to single-phase open circuits and high impedance ground faults is presented below.

Single Phase Open Circuit Condition

During normal plant operation the emergency buses (ESF buses) are powered from two unit auxiliary transformers (UATs). An open phase on the main transformer (MT) 230kV side would have no effect on the safety bus voltage. Since each UAT is tied directly to the generator terminals, they will continue to receive three phase voltage on its primary side for as long as the generator remains online. If the generator trips on negative sequence due to the open MT phase, the safety buses and the upstream balance of plant (BOP) buses D and E will automatically transfer to their alternate source (SUT-1A and SUT-1B, respectively). Therefore, an open phase on the MT high side while the plant is in normal operation is not of concern. During normal plant operation an open single-phase on either SUT primary has no effect on safety bus voltage since the safety buses are powered from the UAT. The SUTs are energized but unloaded during Normal operation. Should one phase be open, the problem would not impact the safety buses as long as they continued to be supplied by the UATs.

High Impedance Ground Fault Conditions

The electrical analyses for off-site circuits have been reviewed with regard to high impedance grounds. The effect of a high impedance ground has been analyzed to be as follows.

*SUT and MT 230kV Side*

The high voltage neutral connections of the SUTs and the main transformer are solidly grounded. A high impedance ground fault between the switchyard Circuit Breakers (CBs) and the SUTs will be detected by differential overcurrent relays 87/STUA and 87/STUB, “230KV Connection to Start-up Transformers.” A high impedance ground fault that does not generate sufficient current to actuate the differential relays, could not result in a voltage imbalance due to the “stiffness” of the 230 KV grid to which this section of the system is directly connected. The entire grid voltage would have to be imbalanced as a result of the high impedance fault, which is not credible. A high impedance fault capable of producing imbalanced 230 KV bus voltages could not be sustained; it would rapidly propagate into a full blown ground fault that would be cleared by the differential protection circuit.

*UAT Primary/MT Secondary and Isophase Bus (22kV)*

The generator neutral connection is high resistance grounded via a neutral grounding transformer. Maximum ground fault current is approximately 9A. With the generator online, ground fault protection (tripping) in this portion of the distribution system is provided by the generator ground detection relay 64/37/G. In the UAT backfeed mode, with the generator offline and the disconnect links removed, a ground in this portion of the distribution system can go undetected and can affect line to ground voltages, transformer line to line voltages are not affected. Therefore, a ground in this section of the distribution system cannot result in imbalanced voltages on the 6.9kV buses.

*UAT/SUT Secondary (6.9kV)*

The neutral connection of the secondary windings (X and Y) of these transformers is high resistance grounded via neutral grounding transformers. Maximum ground current for the first ground of any impedance is limited to approximately 24A, incapable of producing an imbalance in the transformer secondary voltage. A second ground is effectively a phase to phase short circuit. Ground detection relays (64) monitor the neutral grounding transformer voltage and provide control room annunciation. There is no tripping for a single phase to ground fault on the 6.9kV system.

Based on the above, grounds of any impedance value anywhere in the distribution system, including transformer connections to the switchyard CBs, will either be rapidly detected and automatically isolated by ground and /or differential protection relay circuitry or will have no adverse affect with respect to bus voltage imbalance.

***1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(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 specifically designed to detect a single phase open circuit condition. See Attachment 3, Table 5 for undervoltage protective devices and the basis for the device setpoint(s).

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

***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.***

In accordance with Tech Spec Surveillance 4.8.1.1.1, Operations Surveillance Test OST-1023 verifies proper breaker alignment in the switchyard and the 6.9kv buses feeding the ESF buses and availability of control power to the breakers that would need to operate to supply offsite power to the safety buses. As part of the surveillance, visual inspection is done of the above ground connections to identify any potential concerns.

***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?***

In response to the station review of the Byron event, plant operating procedure OP-156.02 has been revised to verify voltages on all three phases of the secondary windings of the SUTs and UATs as well as BOP buses 1D and 1E to validate voltage levels on the buses prior to transferring loads to the buses.

**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:

***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.***

During Normal operation power is provided to the ESF buses via 2 UAT's powered from the main generator. The SUTs are energized but unloaded. An open single phase on the SUTs will not impact the ESF buses while they are powered from the UATs.

Installed relays were not designed to detect single phase open circuit conditions. Existing loss of voltage and degraded voltage relays may respond depending on load and possible grounds. In general, there will be no plant response for an unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source in the event of a single-phase open circuit on a credited off-site power circuit because there is insufficient current to detect a single-phase open circuit for this configuration. The plant response for a loaded power source cannot be calculated without specifying the amount of loading and the specific loads involved.

***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.***

HNP did not credit in the Current Licensing Basis that the Class 1E protection scheme (for the ESF buses) was designed to detect and automatically respond to a single-phase open circuit condition on the credited off-site power source as described in the UFSAR and Technical Specifications.

Since HNP 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 was not included in the design criteria for either the loss of voltage, the degraded voltage relay (DVR) scheme or secondary level undervoltage protection system (SLUPS) design criteria. Since open phase detection was not credited in the HNP design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

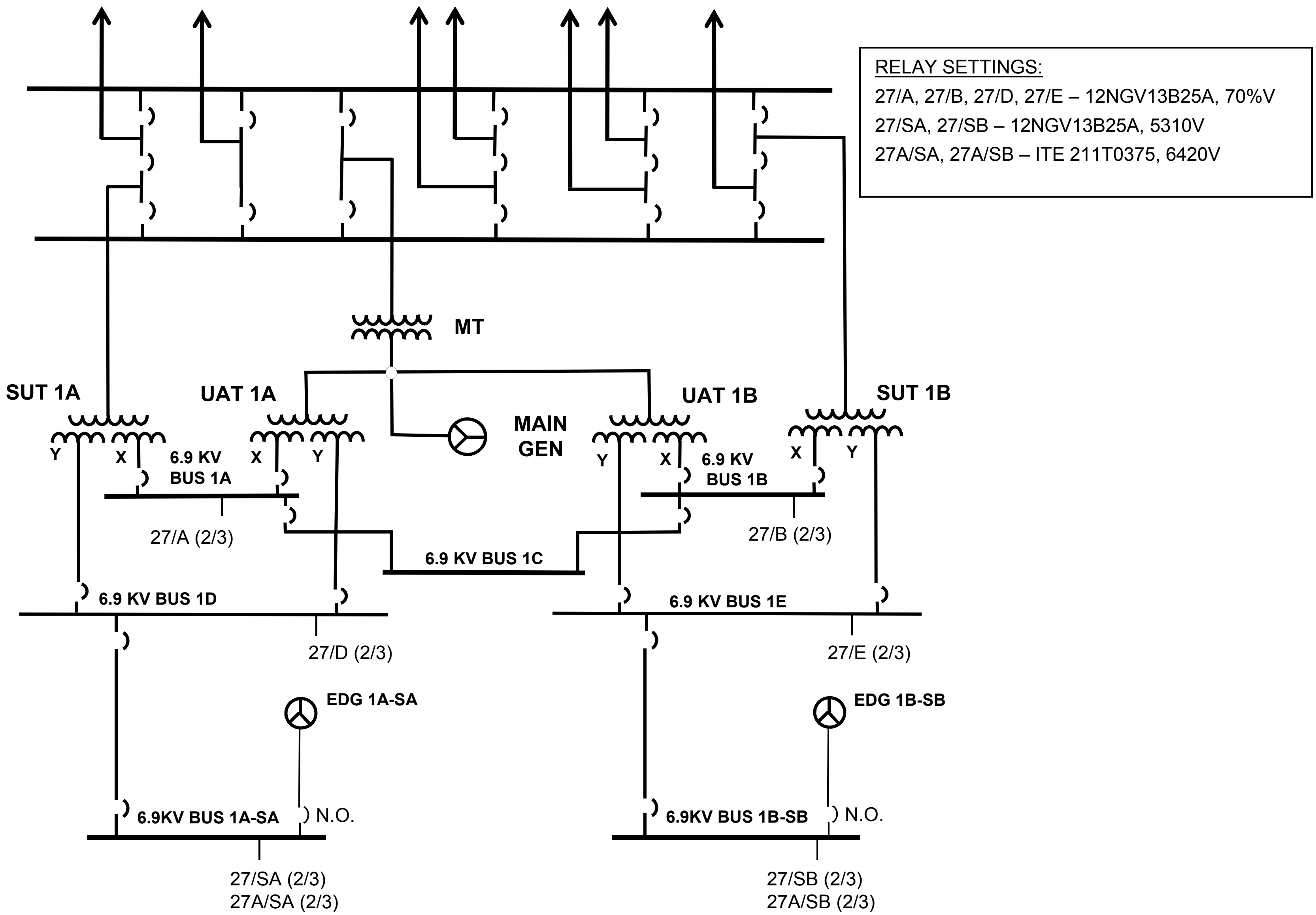
Without formalized engineering calculations or engineering evaluations, the electrical consequences of such an open phase event (including plant response), can only be evaluated to the extent of what has already been published by EPRI and Basler; which is a generic overview. The difficulty in applying these documents to the HNP 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 HNP specific Class 1E electric distribution system [EDS]).

The offsite power circuits at the HNP consist of two independent circuits from HNP switchyard to the SUTs which feed the plant ESF buses. The high-voltage circuits of each start-up transformer utilize low-pressure oil filled cable and are routed in separate underground concrete trenches. The “A” and “B” circuits are terminated separately, and can be fed from either bus in the 230 kV switchyard. The “A” and “B” start-up transformers are physically separated from each other to prevent a single accident from jeopardizing the operation of the other transformer. The onsite power system at HNP includes two 6.9kV ESF buses (1A-SA and 1B-SB). The two ESF buses supply safety related loads. Two independent redundant divisions of ESF equipment are provided in the onsite system. Each redundant ESF division can supply sufficient power to its safety related loads.

***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.***

Not applicable; HNP does not use a common or single offsite circuit to supply redundant ESF busses.

Attachment 2 – Simplified One-Line Diagram



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) |
|---|---|---|
| N/A | N/A | N/A |

**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) |
|---|---|---|
| UAT-1A | 6.9kV 1A-SA | Y |
| UAT-1B | 6.9kV 1B-SB | Y |

**Table 3 - ESF Buses Powered by Offsite Sources Normally Energized Major Loads**

| ESF Bus | Load | Voltage Level | Rating (HP) |
|---|---|---|---|
| Not Applicable-No ESF buses are normally powered by Offsite sources. | | | |

**Table 4 - Offsite Power Transformers**

| Transformer | Winding Configuration | MVA Size<br><br>(AO/FA/FA) | Voltage Rating<br><br>(Primary/Secondary) | Grounding Configuration |
|---|---|---|---|---|
| Start-up Transformer 1A | Wye-Wye-Wye (3 Leg) | 36/48/60 | 226/6.9/6.9 | Neutral Grounded |
| Start-up Transformer 1B | Wye-Wye-Wye (3 Leg) | 36/48/60 | 226/6.9/6.9 | Neutral Grounded |

**Table 5 - Protective Devices**

| Protection Zone | Protective Device | UV Logic | Setpoint (Nominal) | Basis for Setpoint |
|---|---|---|---|---|
| 6.9kv ESF Buses | Loss of Voltage Relay | 2 of 3 | 5310V (77% of 6900V)<br><br>≤ 1 sec. | To actuate upon complete loss of ESF Bus voltage condition |
| 6.9kv ESF Buses | Degraded Grid | 2 of 3 | 6420V (93% of 6900V)<br><br>13 sec. with SIAS signal<br><br>54 sec. w/out SIAS signal | To actuate upon degraded voltage condition |
| 6.kv ESF Buses/Equipment | Ground Fault Alarm | | 5A | To alarm upon detection ground conditions on the 6.9kv system |