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0CAN101201

October 25, 2012

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

SUBJECT: 90-Day Response to Bulletin 2012-01, *Design Vulnerability in Electric Power System*
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

REFERENCE: 1. NRC letter to Entergy, Bulletin 2012-01 *Design Vulnerability in Electric Power System*, dated July 27, 2012 (0CNA071207)

Dear Sir or Madam:

On July 27, 2012, the NRC issued Bulletin 2012-01 (Reference 1), requesting that each licensee submit a written response in accordance with 10 CFR 50.54(f) within 90 days of the bulletin to provide requested information. This letter provides Entergy Operations, Inc. 90-day response to Reference 1 for Arkansas Nuclear One (ANO), Units 1 and 2 in the attachment.

There are no new commitments contained in this submittal. Should you have any questions concerning the content of this letter, please contact Stephenie Pyle at 479.858.4704.

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

Sincerely,

Original signed by Christopher J. Schwarz

CJS/mkh

Attachment: 90-Day Response to NRC Bulletin 2012-01

cc: Mr. Elmo E. Collins
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Attachment to

0CAN101201

90-Day Response to NRC Bulletin 2012-01

90-Day Response to NRC Bulletin 2012-01

Overview

- System Description - Items 2, 1.d, 2.a, and 2.c
- System Protection - Items 1, 1.a, 2.b, and 2.d
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- Tables
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System Description

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

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 simplified one-line diagram.

The main turbine-generator for each unit supplies power to the unit auxiliary transformer (UAT) for Arkansas Nuclear One (ANO), Unit 1 (ANO-1) and Unit 2 (ANO-2). Both ESF buses (480V and 4160V) and non-ESF buses (480V, 4160V, and 6900V) are normally supplied by the UAT for each ANO unit.

The 500kV system provides offsite power via the autotransformer to the 22kV bus that supplies startup transformer #1 (SUT-1) for ANO-1 and startup transformer #3 (SUT-3) for ANO-2. At power operations, these transformers are normally energized but not connected to any ESF bus load. SUT-1 and SUT-3 are normally energized and ready for fast transfer of plant 6900V and 4160V buses from the UAT.

The 161kV system provides offsite power to startup transformer #2 (SUT-2), which is shared by both of the ANO units. At power operations, SUT-2 is normally energized but not connected to any load. SUT-2 is available as a backup offsite source for both ANO units. ESF 4160V buses A-3 and A-4, for ANO-1, are fed from non-ESF buses A-1 and A-2, respectively. During normal power operations, only bus A-1 is aligned for fast transfer to SUT-2 should SUT-1 not be available. The same is true for ANO-2 in that the ESF 4160V buses 2A-3 and 2A-4 are fed from non-ESF buses 2A-1 and 2A-2, respectively. During normal power operations, only bus 2A-1 is aligned for fast transfer to SUT-2 should SUT-3 not be available.

1.d Describe the offsite power transformer (e.g., startup, reserve, station auxiliary) winding and grounding configurations.

See 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 configurations (normal operating condition), ESF buses are not powered by offsite sources. See Tables 1, 2, and 3.

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

For ANO-1, the ESF buses, A-3 and A-4, are fed from non-ESF buses A-1 and A-2, respectively. Buses A-1 and A-2 receive power from the UAT which is fed from the main turbine-generator. The offsite sources, SUT-1 and SUT-2, are available for supplying power should all onsite alternating current (AC) power be lost. Normally SUT-1 is the preferred offsite source and has fast transfer capabilities to buses H-1, H-2, A-1, and A-2. With the exception of bus A-1, ANO-1 is prevented from automatic transfer to SUT-2 during normal power operations.

For ANO-2, the ESF buses, 2A-3 and 2A-4, are fed from non-ESF buses 2A-1 and 2A-2, respectively. Buses 2A-1 and 2A-2 receive power from the UAT which is fed from the main turbine-generator. The offsite sources, SUT-3 and SUT-2, are available for supplying power should all onsite AC power be lost. Normally, SUT-3 is the preferred offsite source and has fast transfer capabilities to buses 2H-1, 2H-2, 2A-1, and 2A-2. With the exception of bus 2A-1, ANO-2 is prevented from automatic transfer to SUT-2 during normal power operations.

Both the current licensing basis and the original licensing basis for ANO-1 and ANO-2 indicate that during normal power operations, the ESF buses receive power from the UAT, and that two offsite sources (SUT-1 and SUT-2 for ANO-1)(SUT-3 and SUT-2 for ANO-2) are available for automatic or manual transfer of plant buses if the UAT becomes unavailable.

As noted in Tables 1 and 2 there are no 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 are 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 offsite power circuit or another power source. Also, include the following information:

Consistent with the current licensing basis and General Design Criteria (GDC) 17, existing protective circuitry would separate the ESF buses from a connected failed offsite source due to a loss of voltage or a sustained, balanced degraded grid voltage concurrent with certain design basis accidents. The relay systems were not specifically designed to detect an open single phase of a three-phase system. Detection of an open-phase condition is beyond the approved design and licensing basis of the plant. Independence is maintained because the two offsite sources (SUT-1 and SUT-2 for ANO-1 and SUT-3 and SUT-2 for ANO-2) are fed from separate switchyard buses (500kV and 161kV) so that an open-phase condition does not affect both offsite sources.

1.a Provide 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 designed to detect an open-phase condition. See Table 5 for the undervoltage protective devices and the basis for the device setpoint(s).

Analysis has not been performed to determine if the existing electrical protective devices are sufficiently sensitive to detect a high impedance ground fault. Table 5 lists ground protection on the ESF buses and the basis for the device setpoint(s).

ANO-1 and ANO-2 non-ESF 4160V buses have negative sequence overvoltage relays that can detect an open-phase condition and provide an alarm. These relays alarm upon detecting negative sequence voltages greater than 5%. Although it is expected that an open-phase condition would result in this relay alarm, it should be recognized that this benefit is beyond original design intent, and thus, no formal calculation or analysis exits. The ESF 4160V buses are normally fed from the non-ESF 4160V buses. Thus, when the buses are fed from the startup transformers, an open-phase condition could cause an alarm in the control room. Annunciator corrective action procedures for both units provide operator actions in the event of these alarms.

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 offsite power circuit is detected.

Additional log readings are being taken via the weekly operations' switchyard log. The readings record an inspection of components on the 161kV bus from the ring bus feeding SUT-2 voltage regulator and lines to SUT-2. Inspections are performed on the 22kV lines and bus work from the autotransformer to the SUT-1 and SUT-3 voltage regulators. The inspections are looking for any open circuits in the associated equipment including disconnected bus work, disconnected lines, and open disconnect stabs. If any discrepancies are found, the Control Room Supervisor is immediately informed.

Daily inspections of SUT-1, SUT-2 and SUT-3 supply lines in the transformer yard are being performed via the operations' logsheets. These inspections look for lines that are not connected, disconnects not seated, and damage to lines and insulators.

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?

The startup transformers are not normally connected to the ESF buses and thus, monitoring the voltage on all three phases of the ESF buses would not detect an open-phase condition on the high side of the startup transformer. While at normal operating conditions, an open-phase condition on the high side of a startup transformer has no effect on the ESF buses since they are supplied by the UAT. For off-normal periods when the startup transformers supply power to the ESF buses, existing negative sequence overvoltage relays are available to detect an open-phase condition and provide an alarm in the control room. Annunciator corrective action procedures for both units provide operator actions in the event of these alarms.

<u>Consequences</u>

Items 1.b, 1.c, and 2.e request information regarding the electrical consequences of an event and are 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 UAT) power source.

Installed relays were not designed to detect open-phase conditions. Existing loss-of-voltage and degraded voltage relays may respond depending on load and possible grounds. In general, there would be no plant response for an unloaded (e.g., ESF buses normally aligned to UAT) power source in the event of an open-phase condition on a credited offsite power circuit because there is insufficient current to detect an open-phase condition for this configuration.

The plant response for a loaded power source cannot be determined 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.

A high impedance ground fault on the credited offsite power circuit would have no immediate effect on plant operation since the ESF buses are fed from the UAT during normal operating conditions. Analysis has not been performed to confirm that a ground, sufficiently large enough to affect plant operation, would be automatically detected and isolated by protective relaying.

Regarding detection and response to an open-phase condition:

1. ANO-1 and ANO-2 do 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 an open-phase condition on the credited offsite power source as described in the final safety analysis report and technical specifications.

   The offsite power circuits for ANO-1 consists of two independent circuits. The preferred offsite source is from SUT-1 to the 4160V buses A-3 and A-4 via A-1 and A-2, respectively. The second offsite power source is from SUT-2 to buses A-3 and A-4 via A-1 and A-2, respectively.

   The offsite power circuits for ANO-2 consists of two independent circuits. The preferred offsite source is from SUT-3 to the 4160V buses 2A-3 and 2A-4 via 2A-1 and 2A-2, respectively. The second offsite power source is from SUT-2 to buses 2A-3 and 2A-4 via 2A-1 and 2A-2, respectively.

   Both ANO-1 and ANO-2 are prevented from an automatic transfer to SUT-2 during normal power operations for all buses except buses A-1/A-3 (ANO-1) and 2A-1/2A-3 (ANO-2). Procedures administratively control ANO-1 and ANO-2 access to SUT-2.

2. Since ANO did not credit the ESF bus protection scheme as being capable of detecting and automatically responding to an open-phase condition, an open-phase fault was not included in the design criteria for either the loss-of-voltage or the degraded voltage relay scheme. Since open-phase detection was not credited in the ANO design or licensing basis, no design basis calculations or design documents exist that considered this condition.

3. 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 Electric Power Research Institute and Basler, which is a generic overview. The difficulty in applying these evaluations to the ANO-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,

and motor models including positive, negative, and zero-sequence impedances (voltage and currents)). In addition, the models would need to be compiled and analyzed for the ANO-specific Class 1E electric distribution system.

4. Preliminary analysis has determined that the existing ANO plant protective relays may not be able to provide automatic protection for an open-phase condition on the primary side of SUT-1, SUT-2, and SUT-3. However, during normal power operations, power for the ESF buses at ANO is normally supplied by the UAT. Therefore, an open phase on the primary side of SUT-1, SUT-2, or SUT-3 has no effect on the ESF buses while the buses are being supplied by the UAT.

5. Existing negative sequence overvoltage relays on the non-ESF 4160V buses can detect an open-phase condition and provide an alarm. Thus, when the buses are fed from the startup transformers, an open-phase condition that causes a negative sequence voltage greater than the relay setpoint, would be detected and provide an alarm in the control room. Annunciator corrective action procedures for both ANO-1 and ANO-2 provide operator actions in the event of these alarms.

6. Since the startup transformers are not normally connected to the ESF buses, the ANO plant protective relays cannot detect an open-phase condition on the primary side of the transformers. Interim measures taken to aid in the detection of an open-phase condition on the high side of the startup transformers include walkdowns of the transformer yard and switchyard.

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.

Consistent with the current licensing basis and GDC 17, protective circuitry separates the ESF buses from a 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 an open-phase condition is beyond the approved design and licensing basis of the plant. Calculations have not been performed for this scenario.

Simplified One-Line Diagram

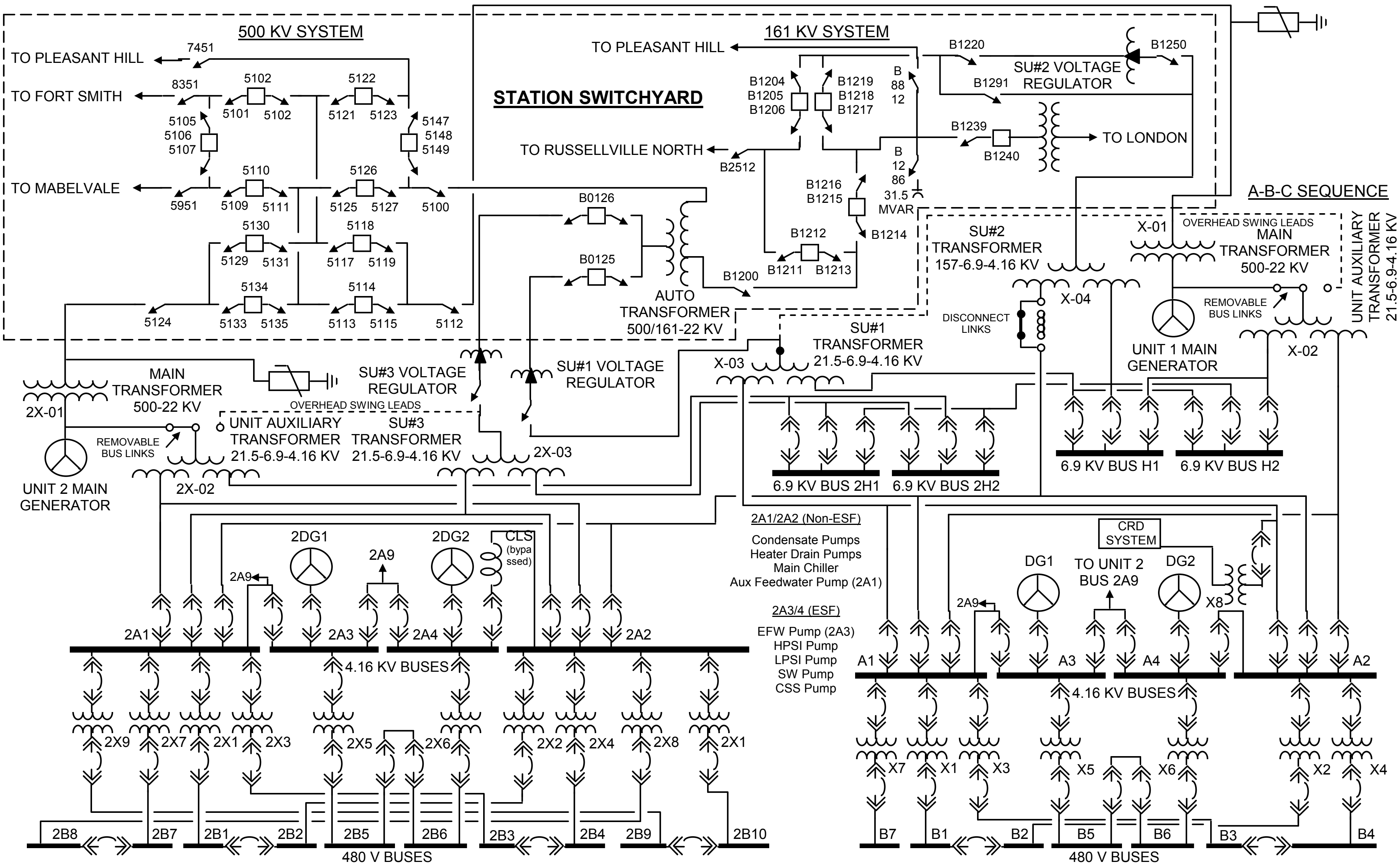

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

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 (ANO-1)	4160V bus A-3	Y
UAT (ANO-1)	4160V bus A-4	Y
UAT (ANO-1)	480V bus B-5	Y
UAT (ANO-1)	480V bus B-6	Y
UAT (ANO-2)	4160V bus 2A-3	Y
UAT (ANO-2)	4160V bus 2A-4	Y
UAT (ANO-2)	480V bus 2B-5	Y
UAT (ANO-2)	480V bus 2B-6	Y

Table 3 - ESF Buses Major Loads Normally Energized by the Startup Transformers

ESF Bus	Load	Voltage Level (V)	Rating (HP)
A3	None	4160	N/A
A4	None	4160	N/A
B5	None	480	N/A
B6	None	480	N/A
2A3	None	4160	N/A
2A4	None	4160	N/A
2B5	None	480	N/A
2B6	None	480	N/A

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA Size (OA/FA/FOA)	Voltage Rating (kV) (Primary/Secondary)	Grounding Configuration
SUT-1 (ANO-1 only)	Delta-Wye-Wye (3 Leg)	H – 30/40/50 X – 16/21.3/26.7 Y – 14.4/19.2/24	21.5 – 6.9 – 4.16	X and Y winding neutral resistance grounded
SUT-2 (Shared between ANO-1 and ANO-2)	Wye-Wye-Wye (3 Leg) With embedded delta stabilizing winding	H – 27/36/45 X – 15/20/25 Y – 12.6/16.8/21	157 – 6.9 – 4.16	H winding neutral solidly grounded; X and Y winding neutral resistance grounded
SUT-3 (ANO-2 only)	Delta-Wye-Wye (3 Leg)	H – 35.2/46.8/58.5 X – 19.7/26.2/32.8 Y – 15.5/20.6/25.7	21.5 – 6.9 – 4.16	X and Y winding neutral resistance grounded

OA-Oil-immersed Self-cooled
FA-Forced Air
FOA-Forced Oil and Air

Table 5 - Protective Devices

Protection Zone	Protective Device	Undervoltage Logic	Setpoint (Nominal)	Basis for Setpoint
4160V ESF Buses	Loss of Voltage Relay	1 of 2	2450V (61.25% of 4000V)	To actuate upon complete loss of safety bus voltage
480V ESF Buses	Degraded Voltage Relay	2 of 2	429.6V (93.4% of 460V) with a nominal 8 second time delay	To actuate upon a degraded voltage condition of all three phases
4160V non-ESF Bus feed to ESF Buses	Negative Sequence Overvoltage Relay	N/A	5% Negative Sequence Voltage	To provide an alarm for negative sequence voltage (factory set at 5%)
SUT-1	Ground Fault Protection (151G-ST1Y)	N/A	320A	To coordinate with upstream and downstream protective devices
SUT-2	Ground Fault Protection (151G-ST2Y)	N/A	320A	To coordinate with upstream and downstream protective devices
SUT-3	Ground Fault Protection (151G-ST3Y)	N/A	320A	To coordinate with upstream and downstream protective devices