Duke Energy
Carolinas

10 CFR 50.54(f)

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October 23, 2012

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

Subject: Duke Energy Carolinas, LLC (Duke Energy)
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413, 50-414
Response to NRC Bulletin 2012-01

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

On July 27, 2012, the Nuclear Regulatory Commission issued NRC Bulletin 2012-01: Design Vulnerability in Electric Power Systems to all power reactor licensees and holders of combined licenses for nuclear power reactors. The purpose of this bulletin is to notify Licensees of a recent operating experience concerning the loss of one of the three phases of the offsite power circuit at Byron Station, Unit 2 in order to determine if further regulatory action is warranted. NRC Bulletin 2012-01 requires that each licensee provide a response to the Requested Actions within 90 days of the date of this bulletin. Attachment 1 provides the response to the Requested Actions.

There are no regulatory commitments contained in this letter.

Please address any comments or questions regarding this matter to Paul Simbrat at 803 701-3424.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 23, 2012.

Respectfully,

Kelvin Henderson
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Attachment: Catawba Response to NRC Bulletin 2012-01 Requested Actions

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NRR

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Overview:

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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 buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).***

A simplified diagram of the offsite power system interface with the two essential buses (designated as 1ETA and 1ETB) for Catawba Unit 1 is presented on page 7. The configuration for Unit 2 is similar (for 2ETA and 2ETB).

On each unit, the offsite transmission network is connected to the onsite power system by two physically independent circuits. Each circuit for each unit consists of one half-size Main Step-Up Transformer (MSU, designated as 1A, 1B, 2A, 2B), one Unit Auxiliary Transformer (UAT, designated as 1T1A, 1T2A, 1T1B, 1T2B, 2T1A, 2T2A, 2T1B, 2T2B), one Auxiliary Power System Transformer (1ATC, 1ATD, 2ATC, 2ATD), and the associated incoming breaker on the 4 kV essential bus. These circuits are the preferred power source for the essential buses.

An additional alternate source of offsite power to each essential bus is available by two separate and independent Shared Auxiliary Power System transformers that can be shared between units, designated SATA and SATB. These transformers provide an additional source of preferred power to each essential bus; however, they are not required by GDC-17. These additional circuits must be manually aligned. Each essential bus also has a standby source of power available through a dedicated Emergency Diesel Generator (EDG) that starts and loads automatically on a loss-of-power to the associated essential bus.

During normal operation, the main generator for each unit supplies power through two generator circuit breakers to the two MSUs and the four UATs. Therefore, during normal operation, station auxiliary power is supplied by the main generator through the UATs.

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

The transformer winding and grounding configurations are presented in Table 4 on page 11.

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 normal operating condition configurations, the essential buses are aligned to offsite sources, but powered from the main generator. This is true, whether the buses are powered through the designated Auxiliary Power System transformer, or the shared Auxiliary Power System transformer. The major loads and the ratings that are powered by the buses during normal operations are presented in Tables 1 and 2 on pages 8 and 9.

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.

Catawba's operating configuration for the essential buses as discussed in the UFSAR and Technical Specifications is consistent with the current licensing basis. Furthermore, as stated in the UFSAR, the onsite and offsite power system designs are in compliance with General Design Criterion 17. No changes were made in the offsite power circuit alignment from the original plant licensing. The various operating configurations for the essential buses are presented in Table 3 on page 10, and are consistent with the current licensing basis.

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:

The relaying circuitry was not specifically designed to detect an open single-phase of an offsite power system. Detection of an open single-phase conductor is not included in the approved design and licensing basis of the plant.

Consistent with the current licensing basis and GDC 17, a loss of voltage or a sustained degraded grid voltage sensed at the essential bus is detected by protective relaying circuitry designed to separate the essential bus from the respective offsite sources. Two levels of undervoltage protection are provided for each essential bus; one level provides a degraded voltage protection, while the other provides loss-of-voltage protection. Each level is provided with two out-of three actuation logic. When power is lost to an essential bus, as sensed by the loss-of-voltage protection, the Load Sequencer starts the EDG, load sheds the bus, and energizes the required loads.

During normal plant operation, offsite power is aligned to the essential buses through MSUs, UATs, and Auxiliary Power System Transformers. An open phase on the primary-side of the MSU Transformer would have no direct effect on essential bus voltage since the main generator feeds three phase power to the primary-side of the UATs and onto the essential buses. If the main generator trips from such a condition (possibly due to negative sequence currents), power may be lost to the essential bus(es), thus actuating the protective relaying at the essential bus(es). Response of the essential buses or the response of the main generator to such a condition was not specifically evaluated for an open MSU phase, however.

High impedance ground faults were not specifically evaluated for offsite power circuits. However, if a high impedance fault on an offsite power circuit is such that it affects the essential buses, the protective relaying will respond by isolating the offsite power circuit such that the equipment supplied by the essential buses are not impaired or operated outside of their designed ratings.

As indicated above, even in the presence of an open phase or a high impedance ground condition, degraded voltage and loss-of-voltage protection is still active at the essential buses to provide protection for the loads powered by the buses (reference Item 1.a, below, for further detail).

1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).

At each 4 kV essential bus, voltage is monitored for a Loss-of-Voltage (LOV) condition by three single-phase undervoltage relays. These relays are configured in a two-out-of three (2/3) logic arrangement with each relay monitoring voltage across two phases through potential transformers (PTs). Actuation of any two of the three channels actuates the D/G Load Sequencer for that train, which in-turn provides a start signal for the EDG. After an 8.5-second time-delay to confirm the loss-of-voltage condition, the Sequencer initiates load shedding and separation of the essential bus from offsite power. Load sequencing then begins.

A degraded voltage condition is also monitored at each 4 kV essential bus by three single-phase undervoltage relays. These relays are configured in a 2/3 logic arrangement with each relay monitoring voltage across two phases through PTs. Actuation of any two of the three channels initiates two timers; a 5-second timer provides a Control Room alarm, and a 10-minute timer automatically trips the incoming breaker after the time-delay. The occurrence of a safety injection signal subsequent to the 5-second delay will immediately separate the Class 1E and offsite power sources. Once the incoming breaker is tripped, the LOV Relays, as described above, actuate.

The incoming breakers for the 4.16 kV switchgear are provided with 51G Ground Overcurrent Relays, which trip the incoming breakers on detection of a ground. The incoming breakers for the 6.9 kV switchgear are provided with 51G Ground Overcurrent Relays, which also trips the incoming breakers on detection of a ground.

Consistent with the current licensing basis and GDC 17, existing electrical protective devices are sufficiently sensitive to detect design basis conditions, such as a loss of voltage or a degraded voltage described above, but were not necessarily designed to detect a single-phase open circuit condition from an offsite power source. They will, however, detect a single-phase open circuit condition present at the 4 kV bus level if voltage is affected.

See Table 5 on page 12 for the protective devices, their setpoints, and the basis for their setpoints.

To summarize, all phases of the essential buses are monitored by the 2/3 trip logic for loss-of-voltage and degraded voltage conditions. Also, a ground of sufficient magnitude is sensed at the associated 6.9 kV or 4.16 kV bus level. See the response to Items 2 and 2.c in the System Protection section, above, for more information on the offsite power circuit alignments and configurations.

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.

The essential buses at Catawba are aligned to offsite power sources during normal operation, but are powered by the main generator. However, surveillance procedures may not detect a high impedance ground fault condition.

Catawba Technical Specification Section 3.8 requires two OPERABLE circuits between the offsite transmission system and the onsite essential power system during Modes 1 through 4, and one OPERABLE circuit during Modes 5, 6, and during irradiated fuel movement. Surveillance procedures verify proper breaker alignment from the Switchyard to the essential buses, and verification of voltage from the 22 kV, the 6.9 kV, and the 4.16 kV levels. Voltages on all three phases are only verified at the 4.16 kV switchgear. This surveillance is performed weekly. An additional surveillance is performed when verifying remaining operable power sources if an offsite power source or D/G becomes inoperable, but only one phase of voltage on the essential bus is verified.

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?

Voltages on all three phases of the essential bus are verified during the weekly Tech Spec surveillance. During off-normal conditions, the abnormal procedures and emergency procedures do not address verification of voltage values.

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.***

Unless de-energized for maintenance, Catawba's essential buses are either solely aligned to offsite power (and either powered by offsite power or the main generator), aligned to offsite power while paralleled with the EDG (typically for testing or swapping of offsite power sources), or isolated from offsite power and powered by the EDG. Offsite power to each essential bus is aligned either through the normal auxiliary transformer or the shared auxiliary transformer. As such, they are always considered "loaded".

Installed relays were not designed to detect single-phase open circuit conditions from an offsite power source. Existing loss of voltage and degraded voltage relays may respond, depending on bus loading and location of the open circuit. No analysis has been performed to determine the response of the undervoltage protection circuitry to potential open circuit failures.

> ***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.***

As described in the current licensing basis, Catawba did not credit the Class 1E protection scheme (for the essential buses) to detect and automatically respond to a single-phase open circuit condition on the credited offsite power source.

From Catawba's Technical Specifications (and associated Tech Spec Bases) and UFSAR, the credited offsite power circuits for Catawba consist of two independent circuits from the Switchyard, through the MSUs, the UATs, the 6.9 kV Switchgear, the Auxiliary Power System Transformers, and the Incoming Feeder Breakers supplying the Class 1E essential buses.

Since the capability of detecting and automatically responding to a single-phase open circuit condition was not included in the design basis of Catawba, an open phase condition was not addressed in any design basis calculation or design document. 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 Catawba's specific electric distribution system.

Typically, a high impedance ground will have no immediate effect on plant operation. A ground fault of sufficient magnitude sensed at the 6.9kV bus or the 4.16 kV essential buses will trip the associated incoming breaker. This may actuate the 2/3 LOV relaying as described in the response to Item 1.a, and will separate the ground from the essential bus automatically.

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 since Catawba does not use a common or single offsite circuit to supply redundant essential buses.

Simplified One-Line Diagram

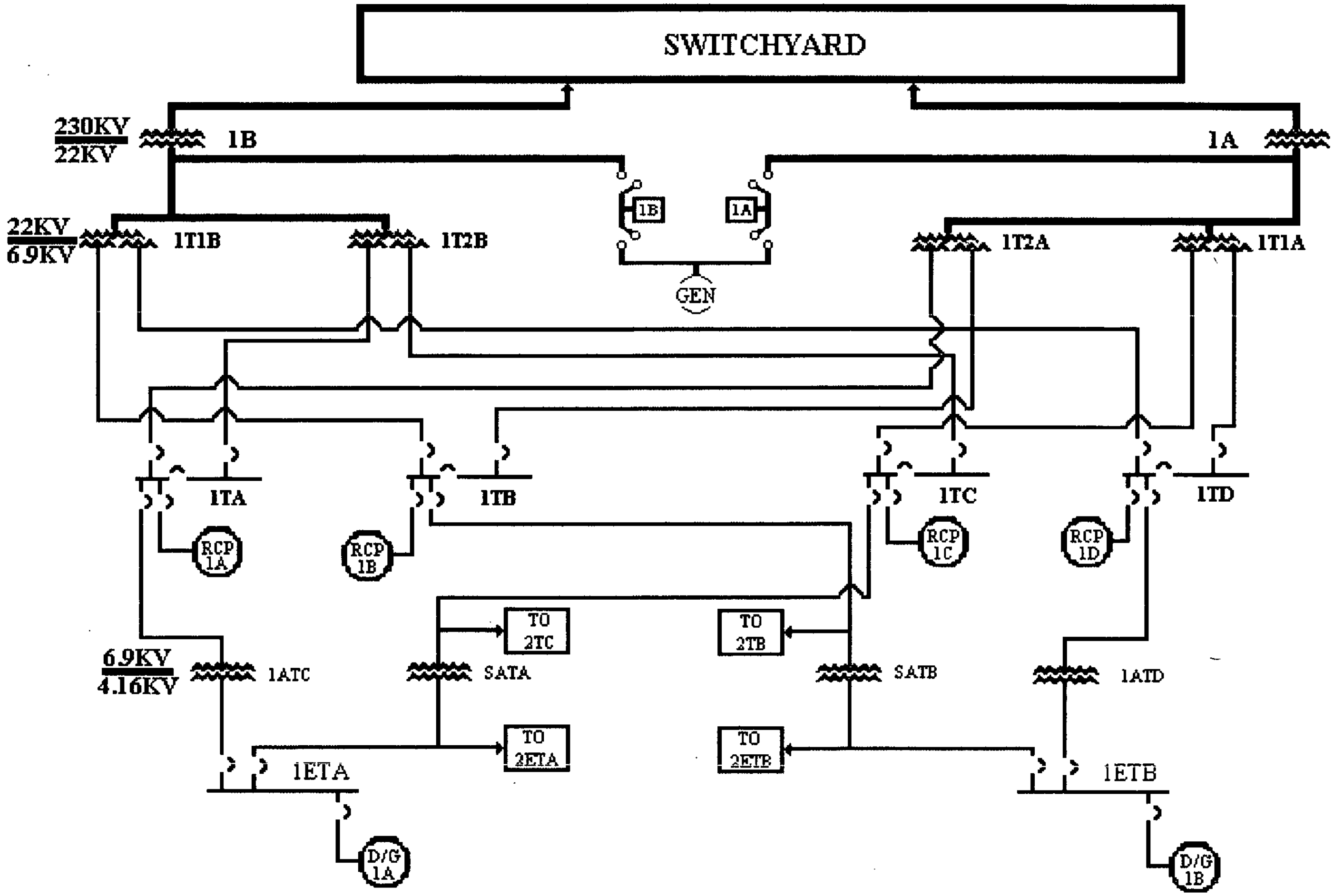

Table 1 - Unit 1 4.16 KV ESF Buses Normally Energized Major Loads

Unit/Essential Bus Designation	Load	Rating (HP)
1ETA	Component Cooling Water Pump 1A1	250
1ETA	Component Cooling Water Pump 1A2	250
1ETA	Centrifugal Charging Pump 1A	600
1ETA	Nuclear Service Water Pump 1A	1000
1ETA	Fuel Pool Cooling Pump 1A	300
1ETA	Control Room Chiller A (supplied by 1ETA or 2ETA)	(479 kW)
1ETB	Component Cooling Water Pump 1B1	250
1ETB	Component Cooling Water Pump 1B2	250
1ETB	Centrifugal Charging Pump 1B	600
1ETB	Nuclear Service Water Pump 1B	1000
1ETB	Fuel Pool Cooling Pump 1B	300
1ETB	Control Room Chiller B (supplied by 1ETB or 2ETB)	(479 kW)

Table 2 - Unit 2 4.16 KV ESF Buses Normally Energized Major Loads

Unit/Essential Bus Designation	Load	Rating (HP)
2ETA	Component Cooling Water Pump 2A1	250
2ETA	Component Cooling Water Pump 2A2	250
2ETA	Centrifugal Charging Pump 2A	600
2ETA	Nuclear Service Water Pump 2A	1000
2ETA	Fuel Pool Cooling Pump 2A	300
2ETA	Control Room Chiller A (supplied by 1ETA or 2ETA)	(479 kW)
2ETB	Component Cooling Water Pump 2B1	250
2ETB	Component Cooling Water Pump 2B2	250
2ETB	Centrifugal Charging Pump 2B	600
2ETB	Nuclear Service Water Pump 2B	1000
2ETB	Fuel Pool Cooling Pump 2B	300
2ETB	Control Room Chiller B (supplied by 1ETB or 2ETB)	(479 kW)

Table 3 - Operating Configurations of ESF Buses

Unit 1 Essential Bus 1ETA

Circuit #	Load
1	MSU-1A, UAT-1T2A, 1TA, 1ATC, 1ETA
2	MSU-1A, UAT-1T1A, 1TC, SATA, 1ETA
3 (from Unit 2)	MSU-2A, UAT-2T1A, 2TC, SATA, 1ETA

Unit 1 Essential Bus 1ETB

Circuit #	Load
1	MSU-1B, UAT-1T1B, 1TD, 1ATD, 1ETB
2	MSU-1B, UAT-1T1B, 1TB, SATB, 1ETB
3 (from Unit 2)	MSU-2B, UAT-2T1B, 2TB, SATB, 1ETB

Unit 2 Essential Bus 2ETA

Circuit #	Load
1	MSU-2A, UAT-2T2A, 2TA, 2ATC, 2ETA
2	MSU-2A, UAT-2T1A, 2TC, SATA, 2ETA
3 (from Unit 1)	MSU-1A, UAT-1T1A, 1TC, SATA, 2ETA

Unit 2 Essential Bus 2ETB

Circuit #	Load
1	MSU-2B, UAT-2T1B, 2TD, 2ATD, 2ETB
2	MSU-2B, UAT-2T1B, 2TB, SATB, 2ETB
3 (from Unit 1)	MSU-1B, UAT-1T1B, 1TB, SATB, 2ETB

Table 4 - Transformer Configurations

Transformer	Winding Configuration	Transformer Rating (AO/FA/FA)	Voltage Rating Primary/Secondary	Grounding Configuration
Main Step-Up Transformers (1A, 1B, 2A, 2B)	Wye-Delta	750 MVA (FOA @ 65°C)	230kV / 20.9kV	Solidly Grounded
Unit Auxiliary Transformers (1T1A, 1T2A, 1T1B, 1T2B, 2T1A, 2T2A, 2T1B, 2T2B)	Delta-Wye-Wye	42/56/70 MVA (OA/FOA/FOA)	20.9kV / 6.9 kV	Impedance Grounded
Auxiliary Power System Transformers (1ATC, 1ATD, 2ATC, 2ATD)	Delta-Wye	7.5 MVA	6.9 kV / 4.16 kV	Impedance Grounded
Shared Auxiliary Power System Transformers (SATA, SATB)	Delta-Wye	7.5 MVA	6.9 kV / 4.16 kV	Impedance Grounded

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint (Nominal)	Basis for Setpoint
4.16 kV Essential Bus	Degraded Voltage Relay	2 out-of 3	3766 V (90.5% of 4160 V nominal bus voltage)	Based on minimum required steady-state bus voltage that ensures adequate voltage at motor terminals, while accounting for uncertainty in measurement of bus voltage.
4.16 kV Essential Bus	Loss of Voltage Relay	2 out-of 3	3500 V (84.1% of 4160 V nominal bus voltage)	Minimum starting voltage capability of the 4 kV motors is 80%, or 3200 V. The closest relay tap about this value was selected (3500 V).
4.16 kV Essential Bus	Bus Ground Overcurrent Relay (incoming breakers)	N/A	120 A (1.6 sec. @ 300%)	Provides ground protection for the essential bus.
6.9 kV Bus	Bus Ground Overcurrent Relay (incoming breakers)	N/A	60 A (1.3 sec. @ 300%)	Provides ground protection for the 6.9 kV bus.