FENOC™
FirstEnergy Nuclear Operating Company

5501 North State Route 2
Oak Harbor, Ohio 43449

Raymond A. Lieb
Vice President, Nuclear

419-321-7676
Fax: 419-321-7582

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L-12-360

10 CFR 50.54(f)

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

SUBJECT:
Davis-Besse Nuclear Power Station
Docket No. 50-346, License No. NPF-3
Response to NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System"

On July 27, 2012, the Nuclear Regulatory Commission (NRC) staff issued Bulletin 2012-01, "Design Vulnerability in Electric Power System," requesting information on electric power system design, to determine if further regulatory action is warranted. Licensees are required to provide a written response in accordance with 10 CFR 50.54(f) within 90 days of the date of the bulletin.

FirstEnergy Nuclear Operating Company hereby provides the requested information for the Davis-Besse Nuclear Power Station, as an attachment.

There are no regulatory commitments contained in this submittal. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at 330-315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 24, 2012.

Sincerely,

Raymond A. Lieb

Attachment: Response to NRC Bulletin 2012-01 for Davis-Besse Nuclear Power Station

cc: NRC Region III Administrator
NRC Resident Inspector
NRC Project Manager
Utility Radiological Safety Board

IE76
NRR

Nuclear Regulatory Commission (NRC) Bulletin 2012-01, "Design Vulnerability in Electric Power System," requested information regarding single-phase open-circuit conditions or high impedance ground fault conditions. The NRC-requested information is identified using bolded and italicized text, followed by the FirstEnergy Nuclear Operating Company (FENOC) response. The following outline identifies the order the NRC requests are addressed in, with similar items grouped together.

Outline of Bulletin Response:

- System Description – NRC Items 2., 1.d, 2.a, 2.c
- System Protection - NRC Items 1., 1.a, 2.b, 2.d
- Consequences - NRC Items 1.b, 1.c, 2.e
- Figure 1 - Simplified One-Line Diagram
- Tables:
  - Table 1 - Essential Buses Continuously Powered From Offsite Power Source(s)
  - Table 2 - Essential Buses Not Continuously Powered From Offsite Power Source(s)
  - Table 3 - Major Essential Bus Loads Normally Powered From Offsite Power Source(s)
  - Table 4 - Offsite Power Transformers
  - Table 5 - Protective Devices

System Description

Items 2., 1.d, 2.a, and 2.c request system descriptions, and are grouped 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).***

Response:

See Figure 1 for a simplified one-line diagram. This figure is based on Davis-Besse Nuclear Power Station (DBNPS) Updated Safety Analysis Report (USAR) Figures 8.3-1 and 8.3-2.

When at power, the engineered safety feature (ESF) buses (herein referred to as the essential buses) are powered via the main generator, through Auxiliary Transformer 11. The auxiliary transformer (via two separate low voltage windings) provides power to non-essential 13.8 kV switchgear buses A and B, which ultimately provide power to the 4.16 kV essential buses C1 and D1 via Bus Tie Transformers AC and BD, respectively.

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

Response:

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.***

Response:

No. As described above, when DBNPS is at power in its normal operating condition, the essential buses are not powered by offsite sources.

Therefore, Table 1, "Essential Buses Continuously Powered From Offsite Power Source(s)," and Table 3, "Major Essential Bus Loads Normally Powered From Offsite Power Source(s)," are not applicable to DBNPS. Table 2 lists the essential buses not continuously powered from offsite power sources.

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.

Response:

The design of DBNPS meets the intent of Appendix A to 10CFR50, the General Design Criterion (GDC) for Nuclear Power Plants as published in the *Federal Register* on February 20, 1971, and as amended in the *Federal Register* on July 7, 1971 (as detailed in Section 3D.1 of the DBNPS USAR).

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

1. 4.16 kV essential bus C1 is powered from 13.8 kV bus A via Bus Tie Transformer AC. Bus A is powered from the auxiliary transformer, which is fed from the main generator.

2. 4.16 kV essential bus D1 is powered from 13.8 kV bus B via Bus Tie Transformer BD. Bus B is powered from the auxiliary transformer, which is fed from the main generator.

Table 2, “Essential Buses Not Continuously Powered From Offsite Power Source(s),” identifies that both of the above sources were part of the original plant licensing basis.

System Protection

Items 1., 1.a, 2.b, and 2.d request information regarding electrical system protection, and are grouped 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*** [sic]**.**

Response:

The essential buses are connected to an offsite power source when the main generator is not available, such as when the plant is shut down or starting up. During such periods, consistent with the current licensing basis and the intent of GDC 17, existing protective circuitry on each of the available offsite power circuits will separate the essential 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 was not required for licensing of the plant.

Although the protection scheme is not designed to detect and automatically respond to a single-phase open circuit condition, the following information is provided regarding at power, normal operating conditions. During such periods, the essential buses (C1 and D1) are powered from the auxiliary transformer. An open phase on the main transformer 345 kV side would have no effect on the essential bus voltage. With the auxiliary transformer tied directly to the main generator terminals, it will continue to receive three phase voltage on its primary side as long as the main generator remains online. If the main generator trips from either the generator or transformer protective relays, due to an open phase on the main transformer, the fast bus transfer scheme would cause the 13.8 kV buses A and B to automatically transfer to their alternate source, start-up transformers 01 and 02, respectively. As depicted in Figure 1, 13.8 kV buses A and B ultimately provide power to essential buses C1 and D1 via Bus Tie Transformers AC and BD, respectively. Therefore, an open phase on the main transformer high side while the plant is at power (normal operating condition) is not of concern. An open phase on the auxiliary transformer primary side while the main generator and main transformer connections remain intact is not credible due to the isophase bus connection arrangement, which makes it highly unlikely that a phase would open without also shorting to ground and tripping the generator. When the plant is at power (normal operating condition) an open single-phase on the start-up transformers primary has no effect on essential bus voltage since the essential buses are powered from the auxiliary transformer.

With regard to high impedance grounds, the electrical protection for offsite circuits has been reviewed and the effect of a high impedance ground has been analyzed to be:

- For the offsite source supply from switchyard bus J to start-up transformer 01, a high impedance single line to ground fault would be detected by the existing protective relays and cause the switchyard breakers supplying bus J to open, and additionally open the low side breakers of start-up transformer 01 to isolate the fault. This would be recognized by operators in the control room by an alarm.

- For the offsite source supply from the switchyard bus K to start-up transformer 02, a high impedance single line to ground fault would be detected by the existing protective relays and cause the switchyard breakers supplying bus K to open, and additionally open the breakers at a remote switchyard to isolate the fault. The control room operators would become aware of this from a computer point for the DBNPS switchyard breakers, which goes into alarm when the breakers open.

- A high impedance ground on the offsite source may cause one of the two offsite sources to become inoperable, and the appropriate Technical Specification would be followed. A high impedance ground would affect only one of the essential buses.

For the offsite source supply from the switchyard bus G to the main transformer when aligned using the backfeed, a high impedance single line to ground fault would be detected by the existing protective relays and cause the switchyard breakers supplying bus G to open. This would be recognized by operators in the control room by an alarm. When bus G de-energizes, the fast bus transfer scheme would cause the 13.8 kV buses A and B to automatically transfer to their alternate source (start up transformers 01 and 02, respectively). As depicted in Figure 1, 13.8 kV buses A and B ultimately provide power to essential buses C1 and D1 via Bus Tie Transformers AC and BD, respectively.

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

Response:

Consistent with the current licensing basis and the intent of GDC 17, existing electrical protective devices are designed to detect design basis conditions like a loss of voltage or a degraded voltage but were not designed to detect a single-phase open circuit condition. Table 5 lists the undervoltage protective devices and the basis for the device setpoint(s).

Existing electrical protective devices are sufficiently sensitive to detect a ground fault. Table 5 lists ground protection on the essential 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.

Response:

Periodic surveillances (seven day Technical Specification Frequency) and operator walkdowns (three times per week minimum) are in place to specifically monitor for a single-phase open circuit condition in the offsite power supply. Additionally, open-phase checks are performed immediately preceding planned transfers to the offsite power source.

Surveillance tests are not performed to detect a high impedance ground on an offsite power circuit. If a high impedance ground were to occur on the offsite power circuit, it would be detected by protective relays as described in response to question 1.

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?

Response:

The current plant operating procedures, including operating procedures for off-normal alignments, specifically call for verification of the voltages on all three phases of the essential buses.

Consequences

Items 1.b, 1.c, and 2.e request information regarding the electrical consequences of an event, and are grouped 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.

Response:

Installed relays were not specifically 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 power source (for example, essential buses normally aligned to unit auxiliary transformer) in the event of a single-phase open circuit on a credited offsite 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.

A high impedance ground on the offsite source when at power (normal operating condition) with the essential bus aligned to the auxiliary transformer would result in one offsite source becoming inoperable and the appropriate Technical Specification requirements would be followed.

A high impedance ground on the offsite source (start-up transformers 01 or 02) with the offsite source aligned to the essential bus would result in one offsite source and one of the essential buses becoming unavailable.

> ***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*** [sic], ***describe the consequences of such an event and the plant response.***

Response:

With respect to single-phase open circuit conditions, the DBNPS Class 1E protection scheme (for the essential buses) did not credit the ability to detect and automatically respond to a single-phase open circuit condition. Since the essential bus protection scheme was not credited 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 loss of voltage or the degraded voltage relay scheme. Since open phase detection was not credited in the DBNPS design or licensing basis, no design basis calculations or design documents exist that previously considered this condition. Although formal engineering calculations or evaluations are not available, it is possible to provide a generic assessment of the consequences of an open-phase event using information from operating experience and guidance from published literature. However, such an assessment cannot be formally credited as the basis for an accurate response, because the consequences of an open-phase event are highly dependent on the specific characteristics of each plant electrical system. Detailed plant-specific models would need to be developed (including 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 DBNPS-specific Class 1E electric distribution system.

At DBNPS, the credited offsite power source is unloaded and in standby when at power (normal operating condition), and if a failure of the power source from the main generator were to occur, fast transfer to the offsite source would take place. If a single open phase did exist, it would affect only one essential bus. As noted above, periodic checks are in place to specifically monitor for a single-phase open circuit condition in the offsite power supply. Additionally, open-phase checks are performed immediately preceding planned transfers to the offsite power source.

With respect to a high impedance ground condition, such a condition on the offsite source would not have a direct effect on the essential buses. The high impedance ground may cause one of the two offsite sources to become inoperable, and the appropriate Technical Specification would be followed.

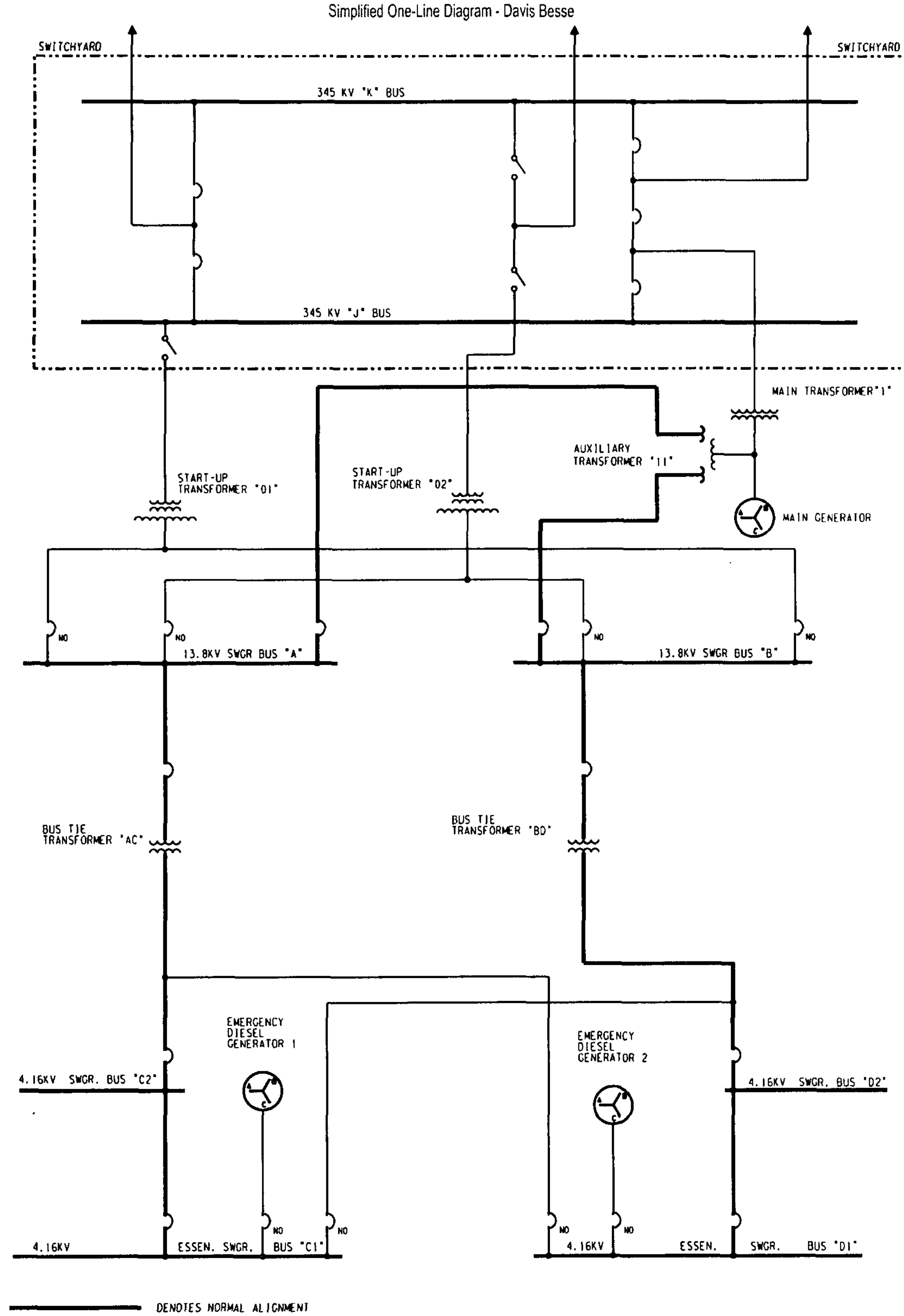
2.e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

Response:

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

Figure 1

Simplified One-Line Diagram - Davis Besse



Tables

Table 1 – Essential Buses Continuously Powered From Offsite Power Source(s)

Description of Essential Bus Power Source	Essential Bus Name (normal operating condition)	Original licensing basis configuration (Y/N)
N/A	N/A	N/A

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

Description of Essential Bus Power Source	Essential Bus Name (normal operating condition)	Original licensing basis configuration (Y/N)
Auxiliary Transformer 11 [Winding 1]	4.16 kV* Bus C1	Y
Auxiliary Transformer 11 [Winding 2]	4.16 kV Bus D1	Y

Table 3 - Major Essential Bus Loads Normally Powered From Offsite Power Source(s)

Essential Bus	Load	Voltage Level	Rating (HP)
N/A	N/A	N/A	N/A

* kV = kilovolts

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA[†] Size (Cooling[‡])	Voltage Rating (Primary/Secondary)	Grounding Configuration
Start-Up Transformer 01	Wye-Delta-Wye	39/52/65 MVA (OA/FOA/FOA)	345 kV / 13.8 kV	High side solid neutral grounded Low side 20 ohm resistance neutral grounded
Start-Up Transformer 02	Wye-Delta-Wye	39/52/65 MVA (OA/FOA/FOA)	345 kV / 13.8 kV	High side solid neutral grounded Low side 20 ohm resistance neutral grounded
Auxiliary Transformer 11 (backfeed configuration only)	Delta-Wye-Wye	52/69 MVA (OA/FA)	25 kV / 13.8 kV	High and low side have 20 ohm resistance neutral grounded
Main Transformer (backfeed configuration only)	Wye - Delta	980 MVA (FOA)	345 kV / 23.75 kV	High side solid neutral grounded

[†] MVA = Megavolt Amperes

[‡] OA/FA/FOA = Oil Air / Forced Air / Forced Oil Air

Table 5 - Protective Devices

Protection Zone	Protective Device	UV Logic	Setpoint	Basis for Setpoint
Essential Buses C1(D1)	Degraded Voltage	1 out of 2 (twice)	Trip at 3734 VAC[§], nominal time delay of 7.5 seconds, reset@ 3759 VAC	To actuate upon degraded essential bus voltage condition. The trip setpoint is based on the analytical limit of 3700 VAC. Setpoints are selected to ensure that the voltage at the essential buses will not drop below the minimum value at which all safety related loads will have sufficient voltage to perform their intended design function.
Essential Buses C1(D1)	Loss of Voltage	1 out of 2 (twice)	Trip at 2429 VAC, nominal time delay of 0.5 seconds, reset@ 2466 VAC	To actuate upon complete loss of essential bus voltage condition. The minimum voltage (dropout) setpoint is based on ensuring the relays will not actuate until below the lowest (worst case) bus voltage expected during the start of the large 4.16 kV motors and block loading of emergency loads.
Essential Buses C1 (D1)	Ground Fault	1 out of 1	30 A[**] primary pick-up: trip in 9 seconds at 3 times pick-up, 0.96 seconds at 10 times pick-up	To actuate a lock out of the essential bus on a ground fault.

[§] VAC = Volts AC

[**] A = Amps