Omaha Public Power District
444 South 16th Street Mall
Omaha, NE 68102-2247

October 24, 2012
LIC-12-0148

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

References:
1. Docket No. 50-285
2. NRC Bulletin 2012-01: Design Vulnerability in Electric Power System, dated July 27, 2012 (NRC-12-0069)(ML12074A115)
3. Nuclear Energy Institute (NEI), "Template for Responses to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System (ML12074A115)," dated September 5, 2012 (APC 12-31)

SUBJECT: 90-Day Response to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System, for Fort Calhoun Station

This letter provides the Omaha Public Power District's (OPPD's) responses to the Nuclear Regulatory Commission (NRC) Bulletin 2012-01, Design Vulnerability in Electric Power System, for Fort Calhoun Station (FCS), Unit No. 1.

In Reference 2, the NRC requested that licensees provide responses to two issues related to their electric power systems within 90 days of the date of the bulletin. OPPD's responses to the NRC bulletin are provided in the attachment to this letter. OPPD used the Nuclear Energy Institute (NEI) template in Reference 3 for responding to the NRC bulletin.

There are no regulatory commitments being made in this letter.

If you should have any questions, please contact Mr. Bill R. Hansher, Supervisor-Nuclear Licensing, at 402-533-6894.

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

Louis P. Cortopassi
Site Vice President and CNO

LPC/SRM/CJS/JCA/dll

Attachment

c: E. E. Collins, Jr., Regional Administrator, Region IV
L. E. Wilkins, NRC Project Manager
J. C. Kirkland, NRC Sr. Resident Inspector

IE76
NRR

Omaha Public Power District
Fort Calhoun Station, Unit No. 1,
Responses to NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System"

By letter dated July 27, 2012, (Agencywide Documents Access and Management System Accession No. ML12074A115), Omaha Public Power District (OPPD, the licensee) received Bulletin 2012-01, Design Vulnerability in Electric Power System, from the U.S. Nuclear Regulatory Commission (NRC) staff. To confirm that licensees comply 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, the NRC requests that licensees address the following...issues related to their electric power systems within 90 days of the date of this bulletin:

System Description

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

NRC Request No. 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).**

OPPD Response to NRC Request No. 2:

The two 4160 volt (V), engineered safety features (ESF) buses, 1A3 and 1A4, are normally powered directly from the 161 kilovolt (kV) offsite power source and are not connected to the main generator during normal operation. The 161 kV system provides power from Substation (Sub) 1251 to two house service transformers (HSTs), T1A-3 and T1A-4 which are normally aligned to ESF buses 1A3 and 1A4, respectively.

The 345 kV system provides offsite power to unit auxiliary transformers (UATs), T1A-1 and T1A-2, via the main generator step-up (GSU) transformer T1 which connects the 345 kV source to the main generator 22 kV bus. The UATs are normally aligned to two non-ESF 4160 V buses 1A1 and 1A2.

All four 4160 V buses can be powered from either the UATs or the HSTs. An automatic 4160 V breaker control scheme provides the capability for fast transfer of a 4160 V bus if the normal source of power is lost.

(See Figure 1 below for a simplified one-line diagram.)

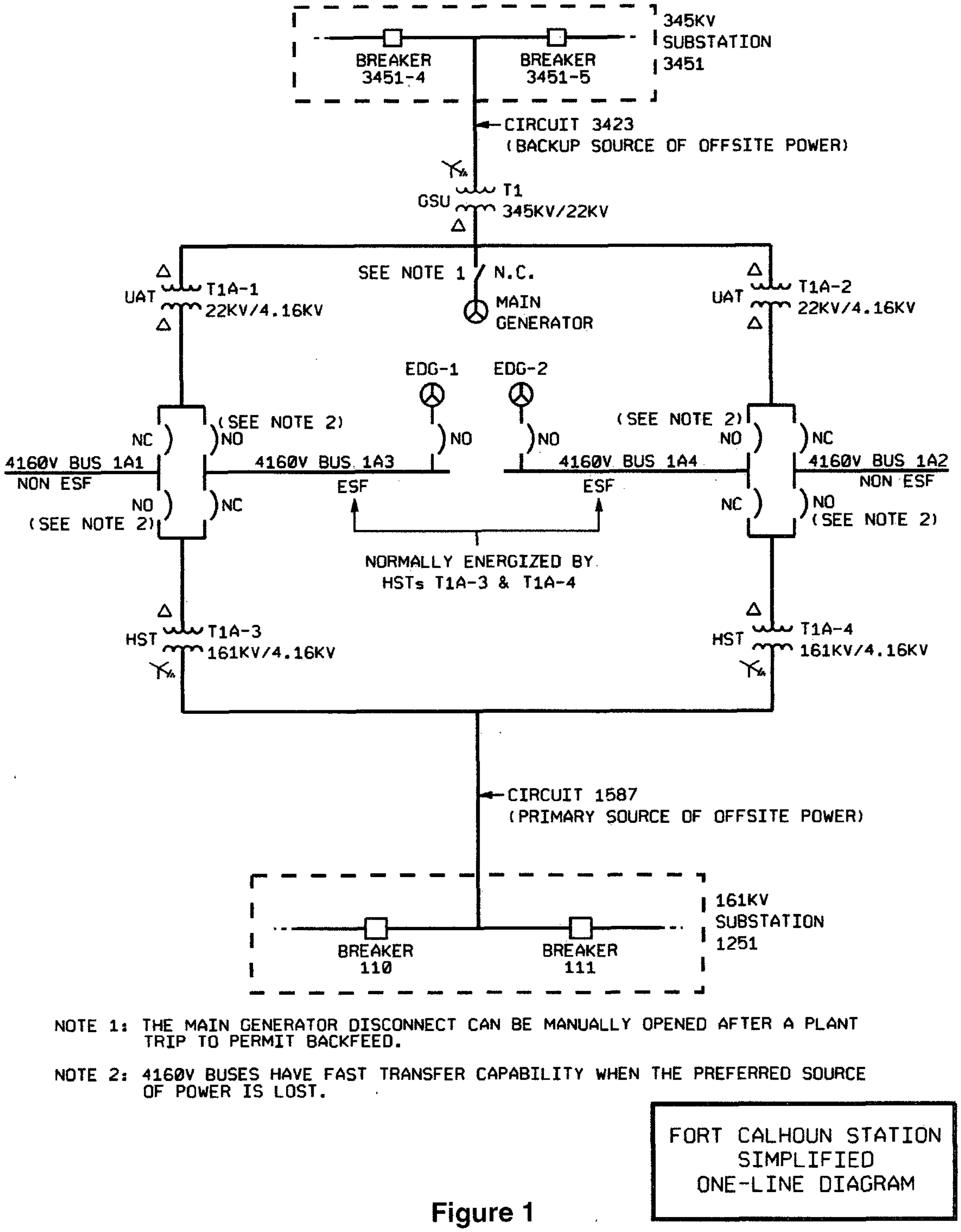
345KV
SUBSTATION
3451
BREAKER
3451-4
BREAKER
3451-5
CIRCUIT 3423
(BACKUP SOURCE OF OFFSITE POWER)
T1
GSU
345KV/22KV
SEE NOTE 1
N.C.
MAIN
GENERATOR
UAT
T1A-1
22KV/4.16KV
UAT
T1A-2
22KV/4.16KV
EDG-1
EDG-2
(SEE NOTE 2)
NC
NO
NO
NO
(SEE NOTE 2)
NO
NC
4160V BUS 1A1
NON ESF
4160V BUS 1A3
ESF
4160V BUS 1A4
ESF
4160V BUS 1A2
NON ESF
NO
(SEE NOTE 2)
NC
NC
NO
(SEE NOTE 2)
NORMALLY ENERGIZED BY
HSTs T1A-3 & T1A-4
HST
T1A-3
161KV/4.16KV
HST
T1A-4
161KV/4.16KV
CIRCUIT 1587
(PRIMARY SOURCE OF OFFSITE POWER)
161KV
SUBSTATION
1251
BREAKER
110
BREAKER
111
NOTE 1: THE MAIN GENERATOR DISCONNECT CAN BE MANUALLY OPENED AFTER A PLANT TRIP TO PERMIT BACKFEED.
NOTE 2: 4160V BUSES HAVE FAST TRANSFER CAPABILITY WHEN THE PREFERRED SOURCE OF POWER IS LOST.
FORT CALHOUN STATION
SIMPLIFIED
ONE-LINE DIAGRAM

Figure 1

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

OPPD Response to NRC Request 1.d:

Offsite power transformer and grounding configurations are shown in Table 1 below.

Table 1: FCS Offsite Power Transformer Winding and Grounding Configurations

Transformer	Winding Configuration	MVA Size (OA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
UAT T1A-1	Delta-Delta	12/16 (55 °C) 13.4/17.4 (65°C)	22000/4160	N/A
UAT T1A-2	Delta-Delta	12/16 (55 °C) 13.4/17.4 (65°C)	22000/4160	N/A
HST T1A-3	Wye-Delta	12/16 (55 °C) 13.4/17.9 (65°C)	157000/4160	Solid Neutral Grounded
HST T1A-4	Wye-Delta	12/16 (55 °C) 13.4/17.9 (65°C)	157000/4160	Solid Neutral Grounded
GSU T1	Wye-Delta	578 (55 °C)/ 648 (65°C) FOA	353625/22000	Solid Neutral Grounded

NRC Request 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.

OPPD Response to NRC Request 2.a:

4160 V ESF buses 1A3 and 1A4 and associated 480 V buses are powered from the 161 kV source during normal (at power) operating conditions. HSTs T1A-3 and T1A-4 which normally provide power to ESF buses 1A3 and 1A4 also provide power to non-safety loads during normal power operation.

ESF bus power sources are shown in Table 2. All ESF buses at FCS are powered from offsite power sources with diesel generator backup.

Table 2: FCS ESF Buses Continuously Powered from Offsite Power Sources

Description of ESF Bus Power Source	ESF Bus Name (Normal Operating Condition).	Original Licensing Basis Configuration (Y/N)
161 kV Substation via HST T1A-3	1A3	Y
161 kV Substation via HST T1A-4	1A4	Y

Table 3: FCS ESF Buses Not Continuously Powered from Offsite Power Sources

Description of ESF Bus Power Source	ESF Bus Name (Normal Operating Condition).	Original Licensing Basis Configuration (Y/N)
N/A	N/A	N/A

The ESF bus major loads energized during normal power operations, including their ratings, are shown in Table 4.

Table 4: Major Loads Normally Connected to ESF Buses (> 100 HP)

ESF Bus	Train (A/B)	Load	Voltage Level (V)	Rating (HP)	Safety Class (NS/SR)*
1A3	A	RC-3C, Reactor Coolant Pump	4160	3650	NS
1A3	A	AC-10A, Raw Water Pump	4160	200	SR
1A3	A	AC-10C, Raw Water Pump	4160	200	SR
1B3A (via 1A3)	A	VA-3A, Containment Air Cooling Fan	480	250	SR
1B3A-4A (via 1A3)	A	CA-1C, Air Compressor	480	150	NS
1B3B (via 1A3)	A	AC-3A, Component Cooling Water Pump	480	250	SR
1B3B (via 1A3)	A	FW-8A, Condenser Evacuation Pump	480	125	NS
1B3B (via 1A3)	A	CW-3A, Screenwash Pump	480	125	NS
1B3B (via 1A3)	A	DW-46A, Vacuum Dearator	480	150	NS
1B3C (via 1A3)	A	CA-1A, Air Compressor	480	150	NS
1B3C-4C (via 1A3)	A	VA-7C, Containment Air Cooling Fan	480	125	SR
1B3C-4C (via 1A3)	A	AC-3C, Component Cooling Water Pump	480	250	SR
1A4	B	RC-3D, Reactor Coolant Pump	4160	3650	NS
1A4	B	FW-4C, Main Feedwater Pump	4160	3500	NS
1A4	B	CW-1C, Main Circulating Water Pump	4160	1250	NS
1A4	B	FW-2C, Condensate Pump	4160	2000	NS
1A4	B	FW-5C, Heater Drain Pump	4160	600	NS
1A4	B	AC-10B, Raw Water Pump	4160	200	SR
1A4	B	AC-10D, Raw Water Pump	4160	200	SR
1B4A (via 1A4)	B	AC-3B, Component Cooling Water Pump	480	250	SR
1B4A (via 1A4)	B	FW-8B, Condenser Evacuation Pump	480	125	NS
1B4A (via 1A4)	B	CW-3B, Screenwash Pump	480	125	NS
1B4B (via 1A4)	B	DW-46B, Vacuum Deaerator	480	150	NS
1B4B (via 1A4)	B	CA-1B, Air Compressor	480	150	NS
1B3B-4B (via 1A4)	B	FW-8C, Condenser Evacuation Pump	480	125	NS
1B3B-4B (via 1A4)	B	VA-7D, Containment Air Cooling Fan	480	125	SR
1B4C (via 1A4)	B	VA-3B, Containment Air Cooling Fan	480	250	SR
*NS – Non Safety-Related SR – Safety-Related					

NRC Request 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.**

<u>OPPD Response to NRC Request 2.c:</u>

Updated Safety Analysis Report (USAR) Section 8.1.2 (Electrical Systems, Description and Operation), and USAR Figure 8.1-1 (Simplified One Line Diagram, Plant Electrical System), describe the two offsite power sources and the normal operating configuration of the ESF buses. These references show that ESF buses 1A3 and 1A4 are normally connected to the 161 kV supply and that the 345 kV source can be used to backfeed offsite power to plant buses after a generator trip by manually opening the main generator disconnect switch. The basis for Technical Specifications (TS) Section 2.7, Electrical Systems, is consistent with this description. The configuration of the sources of power to plant buses has not changed from original plant licensing.

FCS was licensed in accordance with the 70 draft General Design Criteria (GDC) published for comment in the Federal Register (32 FR 10213) on July 11, 1967. 10 CFR 50, Appendix A contains updated (non-draft) NRC GDC, including GDC 17. OPPD is not licensed to 10 CFR 50, Appendix A, GDC 17 with respect to electrical design configuration and maintaining connection to the preferred offsite power source.

System Protection

NRC Bulletin 2012-01 Requests 1, 1.a, 2.b, and 2.d request information regarding electrical system protection and will be addressed in this section:

NRC Request 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:**

<u>OPPD Response to NRC Request 1:</u>

Current Licensing Basis:

Consistent with the current licensing basis, 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 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 a single-open phase condition is beyond the approved design and licensing basis of the plant.

Normal Plant Operation Considerations:

During normal plant operation, both 4160 V ESF buses are powered from the 161 kV source which is the preferred source of offsite power. A loss of a phase on the 161 kV source will result in a voltage imbalance on both ESF trains which will not be reliably detected by undervoltage or degraded voltage protection relays. The 161 kV source has no negative sequence protection.

A loss of a phase on the 345 kV source which is considered to be a backup source of power to ESF buses would likely result in actuation of negative sequence protection associated with the main generator which would trip the unit. In this scenario, the ESF buses would not be subjected to an imbalance since the degraded condition of the 345 kV circuit would be isolated from the normal ESF bus source of power.

Consideration of High Impedance Grounds:

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 under no load conditions with the generator on-line:

Circuit 1587 (161 kV supply to the plant):

1. High impedance single line to ground fault with all three phases intact.

   A. The existing current differential relays will detect this condition for fault impedances up to approximately 160 ohms. This will result in a separation of the ESF buses from the primary offsite power source and a fast transfer of these buses to the alternate source of offsite power.

   B. The existing current differential relays will not detect a single line to ground fault with fault impedance greater than 160 ohms. The existing relay schemes were not designed to detect high impedance ground faults of this magnitude. Such high impedance ground faults have not been considered to be sustainable.

2. High impedance single line to ground fault concurrent with the loss of the same phase.

   A. For a high impedance ground fault on the Sub 1251 side of the open phase, the existing current differential relays will respond as described in 1.A. and 1.B.

   B. For a ground fault on the HST side of an open phase, the existing line and transformer current differential relays will not operate. The line to ground voltages on the 4160 V ESF buses will be unbalanced for this condition which will not be reliably detected by undervoltage or degraded voltage protection relays. The existing relay schemes were not designed to reliably detect a high impedance ground fault on the transformer side of an open phase.

Circuit 3423 (345 kV supply to the plant):

3. High impedance single line to ground fault with all three phases intact.

   A. The existing overall current differential relays will detect this condition for fault impedances up to approximately 375 ohms. This will result in a trip of the main generator and a fast transfer of the two non-ESF 4160 V buses to the alternate source of offsite power.

   B. The existing overall current differential relays will not detect a single line to ground fault with fault impedance greater than 375 ohms. The existing relay schemes were not designed to detect high impedance ground faults of this magnitude. Such high impedance ground faults have not been considered to be sustainable.

4. High impedance single line to ground fault concurrent with the loss of the same phase.

   A. For a high impedance ground fault on the Sub 3451 side of the open phase, the existing overall current differential relays will respond as described in 3.A. and 3.B.

   B. A high impedance ground fault on the GSU side of the open phase will be detected (with time delay) by the existing generator negative sequence overcurrent protection for fault impedances up to approximately 600 ohms. This will result in a trip of the main generator and a fast transfer of the two non-ESF 4160 V buses to the alternate source of offsite power.

   C. Fault impedances greater than 600 ohms are not considered sustainable. Consequently, the existing relay schemes were not designed to detect high impedance ground faults of this magnitude.

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

<u>OPPD Response to NRC Request 1.a:</u>

Consistent with the current licensing basis, 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 a single phase open circuit condition. Table 5 lists undervoltage protective devices and the basis for the device setpoints.

Preliminary studies have been performed to determine if a loss of phase on the 161 kV or 345 kV sources would result in a condition that could be detected by existing relay protection. The results of the studies show that, for Mode 1 scenarios during which the plant is operating at full power and 4160 V buses are aligned normally, a loss of a phase conductor on the 345 kV circuit would result in actuation of negative sequence relay protection associated with the main generator. This actuation would result in a plant trip and isolation of plant buses from the separated phase.

Case studies of a loss of a phase conductor on the 161 kV power source show that the condition would not reliably result in actuation of undervoltage relay protection or alarm circuits or overload trips or alarms on transformers or large motors for most normal voltage conditions on the transmission line and normal plant bus loading.

Existing electrical protective devices are sufficiently sensitive to detect a sustainable ground fault. Table 5 lists ground protection on the ESF buses, Circuit 1587 (161 kV source), Circuit 3423 (345 kV source), and the basis for the device setpoint(s).

Table 5: Protective Devices

Protection Zone	Protective Device	UV Logic	Setpoint (Nominal)	Basis for Setpoint
4 kV ESF Bus	Loss of Voltage Relay	2 of 2	3099 V (75% of 4160V)	Actuates upon complete loss of ESF Bus voltage condition
4 kV ESF Bus	Degraded Grid Undervoltage Relay	2 of 4	3990 (96% of 4160)	Ensures that ESF motors will operate at or above 90% of nameplate
4 kV ESF Bus	Ground Voltage Relays	N/A	Pick-up: Zero Sequence Voltage=555 V	Alarm only for ground faults on 4160V buses. (Un-grounded source)
Circuit 1587	Line Differential Relays	N/A	Pick-up: 600 A (161kV) (Percentage Differential w/ 25% slope)	Detection of faults internal to Circuit 1587 with multiple sources out of service. Restraint for faults external to Circuit 1587 with all sources in service.
Circuit 3423 GSU 22kV Bus Generator	Overall Differential Relay	N/A	Pick-up: 549 A (345kV) 9935 A (22kV) (Percentage Differential w/ 25% and 75% slopes)	Detection of faults internal to the overall differential zone of protection with multiple sources out of service. Restraint for faults external to the overall differential zone of protection with all sources in service.
Generator	Generator Relay (Negative Sequence (I2) Overcurrent Element)	N/A	Pick-up: I2=1376 A	IEEE C37.102, Section 4.5.2 and generator negative sequence current capability.

NRC Request 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.

OPPD Response to NRC Request 2.b:

Not applicable: The ESF buses, 1A3 and 1A4, are powered from an offsite power source.

NRC Request 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?

OPPD Response to NRC Request 2.d:

The current FCS operating procedures do not specifically call for verification of the voltages on all three phases of the ESF buses. Please note that FCS is currently in an extended outage and in a cold shutdown condition (Mode 5). The vulnerability of the plant to a loss of phase event is reduced from that in a Mode 1 condition due to the light loading on plant buses. The procedure changes are being tracked under the operating experience (OE) process for INPO IER L2-12-14, the corrective action program, and are currently under review for implementation under engineering change (EC) 57976.

Consequences

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

NRC Request 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.**

OPPD Response to NRC Request 1.b:

The installed undervoltage relays were not designed to detect single phase open circuit conditions on the offsite power circuits. Case studies of a loss of a single phase conductor show that heavily loaded buses will not experience a reduction in phase-phase voltage at the 4160 V bus level that could be reliably detected by existing relays. For lower mode scenarios during which 4160 V bus loading is less than the Mode 1 cases, the reduction in voltage is less pronounced (i.e., there was a larger magnitude change in phase-phase voltage at the 4160 V buses when the loading was heavier as it normally is in Mode 1).

A high impedance ground fault study was performed for Circuit 1587 and Circuit 3423 under no load conditions with the generator on-line. OPPD does not currently have the capability to perform ground fault studies under loaded conditions.

High impedance single line to ground faults with all three phases intact that are not detected by the existing current differential relays have little effect on the Circuit 1587 and Circuit 3423 voltages. Therefore, the voltage at the 4160 V bus level will remain unaffected. Additional load will not change how the current differential relays respond. However, additional load may reduce voltage magnitudes at the 4160 V bus level. The voltage reduction cannot be calculated without appropriate analytical software.

High impedance single line to ground faults on the transformer side of an open phase that are not detected by the existing current differential relays will cause unbalanced voltages at the 4160 V bus level. Additional load will not change how the current differential relays respond. However, additional load may increase the amount of voltage imbalance at the 4160 V bus level. Again, this cannot be calculated without appropriate analytical software.

NRC Request 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.**

OPPD Response to NRC Request 1.c:

Single-Phase Open Circuit Condition:

OPPD does 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 on the credited off-site power source as described in the USAR and TS for FCS. Since FCS did not credit such ESF bus protection for this failure scenario, an open phase fault was not included in the design criteria for either loss of voltage or degraded voltage. Since open phase detection was not credited in the FCS design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

For 4160 V bus loading conditions that normally exist when the plant is operating in Mode 1, recently performed preliminary case studies show that a loss of a phase at the 161 kV level would result in voltage imbalances at the 4160 V level that would not be reliably detected by undervoltage relays. The voltage imbalance is at its highest magnitude when the buses are most heavily loaded. This worst case imbalance is determined to be approximately 3% on the most heavily loaded ESF bus. (The actual maximum phase-phase voltage difference seen under the most heavily loaded case was approximately 150 V at the 4160 V buses.)

A loss of phase on the 345 kV supply would result in a trip of the main generator and subsequent reactor trip if the plant is on-line during the failure. The tripping of the main generator would result in isolation of the failed conductor from plant buses. In contrast, there is likely to be little initial indication in the control room that a loss of phase has occurred on the 161 kV supply. It is possible that a low voltage alarm could occur on one or both of the ESF buses and there would be a detectable indication of unusual voltage and current differences in the phases of the house service transformers (HSTs) that supply power to the ESF buses. The studies also show that the resulting imbalance is not likely to result in overload trips of motors because the change in magnitude of motor currents will not be large enough to actuate overload relays.

In regard to the impact of a 3% voltage imbalance on the operation of plant equipment, a search of industry documents was performed to determine the effect of voltage imbalance on motor operation. NEMA Motor Standard MG-1, Section 14.36 states that motors operated at a voltage imbalance of 1% or greater should be derated to reduce the possibility of damage to the motor. IEEE Standard 242, Section 10.3.3.1, states "a 5% voltage unbalance produces a stator negative-sequence current equal to 30% of full-load current. This situation can lead to a 40% to 50% increase in temperature rise." IEEE 242 also states, in Section 10.3.3.2, that motors with higher horsepower ratings can be seriously damaged by negative-sequence current heating, even though the stator currents are low enough to go undetected by overload protection. IEEE Standard C37.96, Section 5.7.2.3 further states that rotor heating is substantial for minor voltage unbalance and excessive heating may occur with phase current less than the rated current of the motor.

The industry information stated here leads to the conclusion that a loss of phase on the 161 kV supply and the subsequent 4160 V bus imbalance of approximately 3% could possibly result in motor damage if the condition were allowed to exist for an extended period of time. Since both ESF buses are supplied from a single offsite power source, it is also concluded that ESF motors powered from both trains of ESF buses could be adversely impacted if the loss of phase condition existed concurrent with the onset of a design basis accident.

High Impedance Ground Fault Condition:

High impedance single line to ground faults on Circuit 1587 or Circuit 3423 that result in unbalanced voltages at the 4160 V bus level, will subject the connected motor load to a degraded power supply. However, the following design features exist which minimize the likelihood or impact of a postulated high impedance ground:

1. Both Circuits 1587 and 3423 are constructed entirely on OPPD owner controlled property.
2. Circuits 1587 and 3423 are relatively short, being only 0.35 and 0.5 miles long, respectively.
3. Available fault currents at the 161 kV and 345 kV switchyards are of a magnitude (>29 kilo-Amperes (kA) and >18 kA, respectively) which ensures any intermittent high resistance ground would self-clear or manifest itself into a typical low impedance fault.
4. Circuits 1587 and 3423 are equipped with high speed differential relaying which rapidly clear faults upon operation.

Interim Actions:

A plan has been developed for implementation of interim actions to provide guidance to operators to detect and respond to a loss of phase on the 161 kV circuit supplying power to the plant. However, these interim actions have not been implemented at this time. OPPD plans to implement the remaining portions of the plan prior to plant startup, which include:

- Providing training to licensed operators on the Byron loss of phase event and on FCS vulnerabilities in regard to the detection and response to such an event.
- Implementing procedure changes to require periodic verification of phase-to-phase voltages and phase current on the HSTs and to require reference to an abnormal operating procedure if significant variations are observed between the phases.
- Implementing procedure changes to require daily walkdowns of the high voltage circuits providing power to the plant to ensure continuity between the substations and plant transformers.
- Changing the annunciator response procedures for high reactor coolant pump motor temperature and vibration to check the condition of voltage and current balance on the HSTs.
- Verification of offsite power source feeders' insulators and conductors to ensure that the potential for a failure of the connections is minimized.

Note that FCS is currently in an extended outage and in a cold shutdown condition. The vulnerability of the plant to a loss of phase event is reduced from that in a Mode 1 condition due to the light loading on plant buses. Implementation of the remaining interim actions prior to startup will ensure that appropriate controls are in place prior to return to an operating condition which has increased vulnerability to a loss of phase event.

NRC Request 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.**

<u>OPPD Response to NRC Request 2.e:</u>

Consistent with the current licensing basis, protective circuitry will separate the ESF buses 1A3 and 1A4 from a failed offsite source due to a loss of voltage or a sustained balanced degraded grid voltage at the 161 kV source concurrent with certain design basis accidents. The protective relay systems were not specifically designed to detect an open single phase of a three-phase system or high impedance ground fault. Detection of a single open phase condition on the high voltage offsite power source is beyond the approved design and licensing basis of the plant. No design basis calculations have been prepared for this scenario.

Since both ESF buses are supplied from a single offsite power source, it is concluded that ESF motors powered from both trains of ESF buses could be adversely impacted if a loss of phase or high impedance fault condition existed concurrent with the onset of a design basis accident.