October 25, 2012

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BL 2012-01

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

Duane Arnold Energy Center
Docket No. 50-331
Renewed Op. License No. DPR-49

NextEra Energy Duane Arnold, LLC Response to NRC Bulletin 2012-01
Design Vulnerability in Electric Power System

Reference: (1) U.S. Nuclear Regulatory Commission, "Design Vulnerability in Electric Power System," NRC Bulletin 2012-01, July 27, 2012 (ML12074A115)

Via Reference (1), the Nuclear Regulatory Commission (NRC) issued Bulletin (BL) 2012-01, "Design Vulnerability in Electric Power System." The BL requested NextEra Energy Duane Arnold, LLC (NextEra) provide information regarding the Duane Arnold Energy Center (DAEC) electric power system design. This request was in response to recent operating experience that involved the loss of one of the three phases of the offsite power circuit at Byron Station, Unit 2. Enclosure 1 contains the NextEra response to BL 2012-01. Please contact Ken Kleinheinz, Engineering Director, at (319) 851-7231, if you require further information.

This letter contains no new Regulatory Commitments and no revisions to existing Regulatory Commitments.

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

Richard L. Anderson
Vice President, Duane Arnold Energy Center
NextEra Energy Duane Arnold, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, DAEC, USNRC
Resident Inspector, DAEC, USNRC

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ENCLOSURE

NEXTERA ENERGY DUANE ARNOLD, LLC RESPONSE TO NRC BULLETIN 2012-01 DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

SYSTEM DESCRIPTION

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

Bulletin Item 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).

NextEra Response

See Attachment 1 for a simplified one-line diagram.

During normal operating conditions the ESF buses (1A3 & 1A4) are powered from the 161kV grid in the switchyard via the three winding 161/4.16 kV Start-Up Transformer (1X003 (also referred to as 1X3 in some plant documents)).

Under various outage, emergency or abnormal operating scenarios the buses can also be powered by the Standby Transformer (Grid powered – 34.5/4.16 kV – 1X004) or the Diesel Generators (1G021 & 1G031).

Bulletin Item 1.d.

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

NextEra Response

See Attachment 2, Table 4 for offsite power transformer winding and grounding configurations.

Bulletin Item 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.

NextEra Response

For at power (normal operating condition) configurations, ESF buses are powered by offsite sources. Also note that under normal operating conditions, the ESF buses (1A3/1A4) also provide power to some buses (1B33, 1B35, 1B43, 1B45) which only supply power to non-safety loads.

See Attachment 2, Tables 1 and 2 for ESF bus power sources. See Attachment 2, Table 3 for ESF bus major loads energized during normal power operations, including their ratings.

Bulletin Item 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.

NextEra Response

The plant was originally designed to meet the requirements of the Institute of Electrical and Electronic Engineers (IEEE) Criteria for Class 1E Electrical Systems for Nuclear Power Generating Systems (Standard 308-1971). Each essential bus is capable of receiving power from reliable offsite power sources through either the Startup (normal operating configuration) or Standby Transformers and from one of two diesel generators located in the plant. There have been no significant changes to the offsite power source alignment since original plant licensing.

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

> Both ESF buses (1A3 & 1A4) powered from the offsite grid via the three winding 161/4.16 kV Startup transformer.

There have been no significant 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:

Bulletin Item 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.

NextEra Response

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 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-phase open condition is beyond the approved design and licensing basis of the plant.

An electrical analysis for off-site circuits has not yet been completed with regard to high impedance grounds. Ground protection schemes and a qualitative assessment are covered later in this response.

Bulletin Item 1.a.

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

NextEra Response

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 a single phase open circuit condition. See Attachment 2, 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 2, Table 5 lists ground protection on the ESF buses and the basis for the device setpoint(s).

Bulletin Item 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.

NextEra Response

Not Applicable - the ESF buses at Duane Arnold Energy Center (DAEC) are powered by offsite power sources. Refer to the responses to items 1.c and 2.e below for additional information concerning detection.

Bulletin Item 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?

NextEra Response

The current plant operating procedure for the ESF buses (OI 304.2), including operating procedures for some off-normal alignments, specifically call for verification of the voltages on all three phases of the ESF buses. The operators can determine if a potential open phase issue exists for the ESF buses by monitoring the phase power lights for the buses in the main control room. If the power available light is out (or abnormal (e.g. dim)) for the same phase on both ESF buses, an open phase condition is highly probable and investigated.

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:

Bulletin Item 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.

NextEra Response

The 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. An unloaded offsite transformer is not applicable to the DAEC since the ESF buses are not powered from the unit Auxiliary transformer, but are powered from the Startup Transformer during normal operations.

The plant response for a loaded power source cannot be calculated without specifying the amount of loading and the specific loads involved. Further analysis would be required.

The normal power supply for the ESF buses is the Startup Transformer (1X003). If a ground (as measured by high current on the neutral of the Y windings) is sensed on any of the windings (primary or either secondary) the Startup Transformer lockout relay (386/ST) will energize which opens the switchyard supply breaker to the transformer and the ESF loads are transferred to the Standby Transformer (1X004). If the Standby Transformer indicates similar problems, thereby indicating that the problem is in the switchyard or power grid, the ESF buses are transferred to the station's Standby Diesel Generators. Control room alarms also actuate to indicate the condition and the load transfer. The current at which the sensing relay is set is intended to prevent damage to the ESF equipment.

For cases of high impedance grounds, if the impedance is so high that the resulting current is too low to trip the ground sensing overcurrent relay, it is reasonable to assume that the ground current and resulting voltage impacts will be too small to have a noticeably negative impact on the ESF loads. However, this is a complicated power system analysis problem which needs to be performed to provide further study and analysis.

Bulletin Item 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.

NextEra Response

A high impedance ground will have no immediate effect on plant operation. If the ground is sufficiently large to affect plant operation, protective relaying will isolate the ground automatically.

1. The DAEC did not credit in the Current Licensing Basis that the Class 1E protection scheme (for the emergency safeguard feature (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.

   The offsite power circuits at the DAEC consist of two independent circuits. The normal circuit supplies power from the 161 kV portion of the transmission grid in the station switchyard, through switchyard breakers 5550 or 5560 to the 161/4.16 kV Startup Transformer (1X003) and on to the ESF buses (1A3 & 1A4). The other supplies a secondary/backup source of power from the 34.5 kV feed off of the T1 transformer in the station switchyard, through switchyard breaker 8490 to the 34.5/4.16 kV Standby Transformer (1X004) and on to the ESF buses (1A3 & 1A4). Reference Tech Spec Bases B3.8.1 and UFSAR Chapters 8.2 and 8.3.

2. Since DAEC 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 fault was not included in the design criteria for either the loss of voltage, the degraded voltage relay scheme or secondary level undervoltage protection system (SLUPS) design criteria. Since open phase detection was not credited in the DAEC design or licensing basis, no design basis calculations or design documents exist that previously 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 EPRI and Basler; which is a generic overview. The difficulty in applying these documents to the DAEC 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 DAEC specific Class 1E electric distribution system (EDS)).

The loss of a single phase of either the startup or standby transformer would not reliably actuate the loss of power instrumentation degraded voltage relays, to isolate the essential buses from an unbalanced degraded or no voltage condition. Specifically, each bus is monitored for the

Degraded Voltage Function by four relays whose contacts form a coincidence logic matrix such that either of the A1 or A2 (A to B phase monitor) contacts and either of the B1 or B2 (B to C phase Monitor) contacts must close to initiate the required actions in the associated division (i.e., one-out-of-two taken twice). Regardless of the loading on the transformer, a loss of the A phase only de-energizes the A1/A2 portion and a loss of the C phase only de-energized the B1/B2 portion of the circuitry. Neither loss would actuate the logic. This instrumentation was installed in accordance with BTP PSB-1 and was not designed to provide isolation due to an open phase connection resulting from a component failure. The loss of voltage and degraded voltage logic is designed to detect a balanced, degraded voltage condition on the essential bus caused by local grid voltage drop due to loss of generation or other three phase transmission issues. DAEC is vulnerable to the event.

DAEC procedures have been revised with interim compensatory actions to:

- Require that a designated Operator be utilized in the Main Control Room to trip the Startup Transformer bus feed breaker if the voltmeter indications shows a loss of a single phase on the ESF safety-related buses.
- The Operator will monitor the white bus power available indicating lights for each phase of power to the ESF buses on control room panel 1C08. A loss of a single phase would affect both sets of lights identically. Any abnormal indication of the white lights will be investigated using ESF bus voltmeters.

Further analysis is required to model and analyze the open phase and high impedance ground issues to eliminate or mitigate the impacts of open phase or high impedance grounds in the electrical power supply system on the ESF buses of the DAEC plant.

Bulletin Item 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.

NextEra Response

Consistent with the Current Licensing Basis and GDC 17, protective circuitry will separate the ESF buses from a 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 circuit is beyond the approved design and licensing basis of the plant. No calculations for this scenario have been done.

Consistent with the current station design, protective circuitry will protect from a ground fault condition with all three phases intact.

As stated above, the normal power supply for the ESF buses is the Startup Transformer (1X003). If a ground (as measured by high current on the neutral of the Y windings) is sensed on any of the windings (primary or either secondary) the Startup Transformer lockout relay (386/ST) will energize which opens the switchyard supply breaker to the transformer and the ESF loads are transferred to the Standby Transformer (1X004). Control room alarms also actuate to indicate the condition and the load transfer. The current at which the sensing relay is set is intended to prevent damage to the ESF equipment.

For cases of high impedance grounds, if the impedance is so high that the resulting current is too low to trip the ground sensing overcurrent relay, it is reasonable to assume that the ground current and resulting voltage impacts will be too small to have and noticeably negative impact on the ESF loads. However, this is a complicated power system analysis problem that would need to be performed to provide further study and analysis.

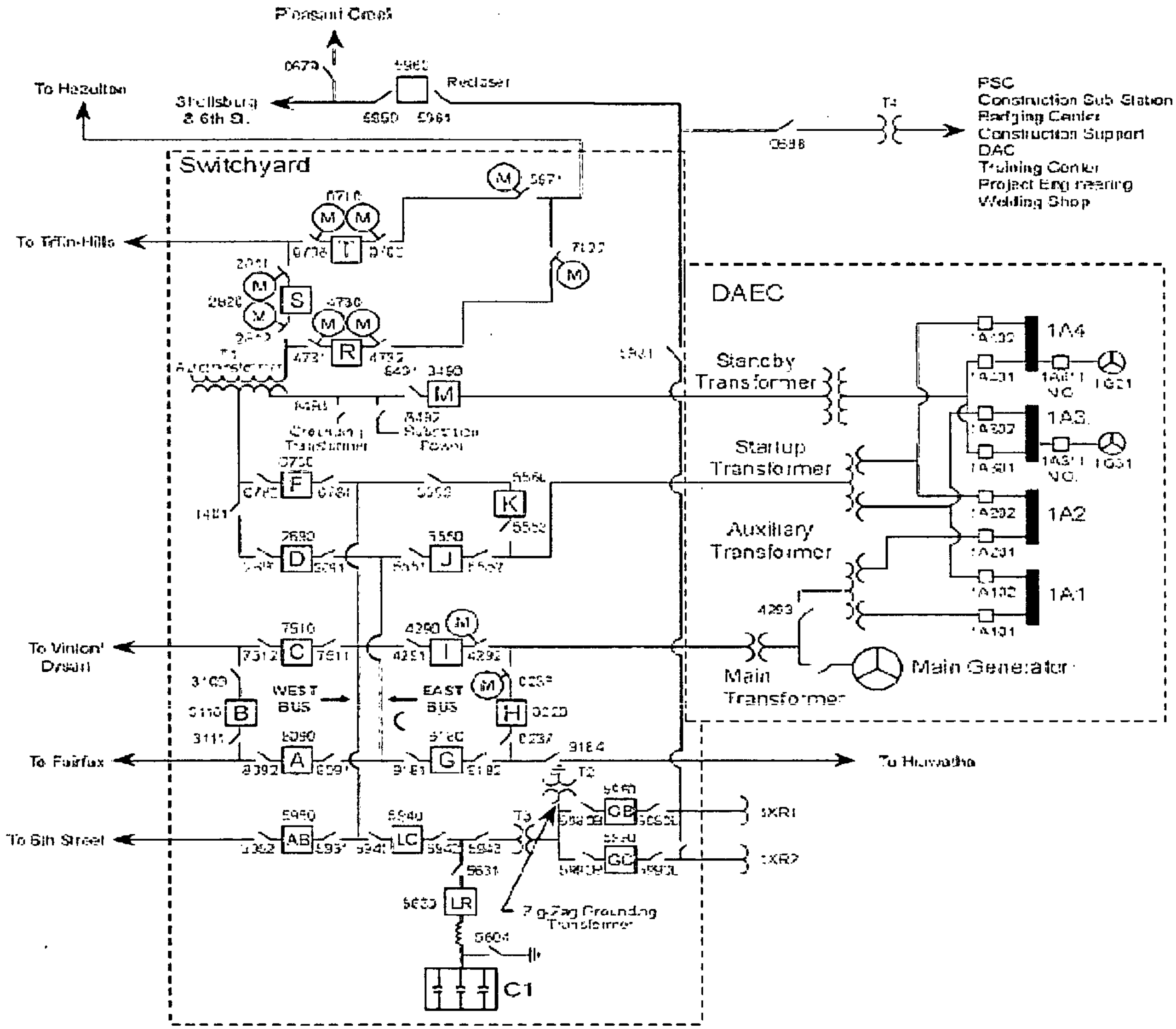
The applicable DAEC operation procedures have been revised to warn operations personnel of the potential problems associated with an open-phase event and to provide guidance in detecting such an event and isolating the essential electrical power system from it.

ENCLOSURE
ATTACHMENT 1

NEXTERA ENERGY DUANE ARNOLD, LLC RESPONSE TO NRC BULLETIN 2012-01 DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

SIMPLIFIED ONE-LINE DIAGRAM

1 page follows



DAEC SWITCHYARD

Breakers That Can Be Operated Remotely: (Downtown or Control House)

161KV Bkrs
8090 "A"
3110 "B"
6780 "F"
0220 "H"

5950 "AB"
2690 "D"
9180 "G"
7510 "C"

345 KV Bkrs
4730 "R"
2820 "S"
0710 "T"

Breakers Equipped with Reclosers:

345 KV Bkrs
4730 "R"
2820 "S"
0710 "T"

161 KV Bkrs
3110 "B"
7510 "C"

5950 "AB"
9180 "G"
8090 "A"

Disconnects That Can Be Operated By The Control Room:

0236
4292

Breakers That Can Be Operated By The Control Room:

5930 "GB"
0220 "H"
5550 "J"
5940 "LQ"

5990 "GC"
4290 "I"
5560 "K"
8490 "M"

ENCLOSURE
ATTACHMENT 2

NEXTERA ENERGY DUANE ARNOLD, LLC RESPONSE TO NRC BULLETIN 2012-01
DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

TABLES

3 pages follow

ENCLOSURE
ATTACHMENT 2 - TABLES

NEXTERA ENERGY DUANE ARNOLD, LLC REPOSNSE TO NRC BULLTEN 2012-01
DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

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)
1X003 - 161KV/4160VAC START-UP TRANSFORMER	1A3 - Division 1 – 4160 VAC Essential Switchgear	Y
1X003 - 161KV/4160VAC START-UP TRANSFORMER	1A4 – Division 2 – 4160 VAC Essential Switchgear	Y
1A3	1B3 – Control Building 480VAC Essential Load Center	Y
1A3	1B9 – Intake Structure 480VAC Load Center	Y
1B3	1B32 – Control Building 480VAC Essential Motor Control Center	Y
1B32	1B36 – Pump House 480 VAC Motor Control Center	Y
1B3	1B34 – Reactor Building 786' Level 480VAC Motor Control Center	Y
1B34	1B34A - Reactor Building 786' Level 480VAC Motor Control Center	Y
1B34A	1B37 - Reactor Building 786' Level 480VAC Motor Control Center	Y
1B9	1B91 - Intake Structure 480VAC Load Center	Y
1A4	1B4 - Control Building 480VAC Essential Load Center	Y
1A4	1B20 - Intake Structure 480VAC Load Center	Y
1B4	1B42 - Control Building 480VAC Essential Load Center	Y
1B42	1B46 - Pump House 480VAC Motor Control Center	Y
1B4	1B44 – Reactor Building 757' Level 480VAC Motor Control Center	Y
1B44	1B44A - Reactor Building 757' Level 480VAC Motor Control Center	Y
1B20	1B21 - Intake Structure 480VAC Load Center	Y

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)
N/A – All ESF Buses are normally powered from Offsite	N/A	Y

Table 3 - ESF Buses Normally Energized Major Loads

ESF Bus	Load	Voltage Level	Rating (HP)
1A3 - Division 1 – 4160 VAC Essential Switchgear	1P089(A/C) General Service Water Pump (1 of 2 normally energized)	4160 V	250 HP
1A4 – Division 2 – 4160 VAC Essential Switchgear	1P089(B/D) General Service Water Pump (1 of 2 normally energized)	4160 V	250 HP
1A3 or 1A4	1P209 (A/B) – CRD Feed Pump (1 of 2 normally energized)	4160 V	250 HP
1B3	1V-CH-001A (1 of 2 (See 1B4 Bus) normally energized)	480 V	200 HP
1B32	1G051 - Reactor Protection MG Set A	480 V	30 HP
1B34	1V-EF-18A - Off Gas Stack Exhaust Fan A	480 V	10 HP
1B34A	No major loads normally energized	480 V	-
1B36	No major loads normally energized	480 V	-
1B37	No major loads normally energized	480 V	-
1B9	1P117(A/C) – River Water Supply Pump (1 of 4 (See 1B20 Bus) normally energized)	480 V	125 HP
1B91	No major loads normally energized	480 V	-
1B4	1V-CH-001B (1 of 2 (See 1B3 Bus) normally energized)	480 V	200 HP
1B42	1G061 - Reactor Protection MG Set A	480 V	30 HP
1B44	No major loads normally energized	480 V	-
1B44A	No major loads normally energized	480 V	-
1B46	No major loads normally energized	480 V	-
1B20	1P117(B/D) – River Water Supply Pump (1 of 4 (See 1B9 Bus) normally energized)	480 V	125 HP
1B21	No major loads normally energized	480 V	-

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA Size (AO/FA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
1X003 - 161KV/4160VAC Start Up Transformer	Wye-Delta Wye	12.5 MVA (OA/FOA/FOA)	161/4.16 & 4.16 kV (2 Secondary Windings)	Neutral Grounded on Primary (Solid) and Secondary (Resistor)
1X004 - 34.5KV/4160VAC Standby Transformer	Delta-Wye	7.5 MVA (OA/FA)	34.5/4.16 kV	Neutral Grounded on Secondary(Transformer Resistor)

Table 5 - Protective Devices

Protection Zone	Protective Device	UV Logic	Setpoint (Nominal)	Basis for Setpoint
Each 4160 V ESF Bus (1A3/4)	Loss of Voltage Relay	2 of 2	2730V = (65% of 4200)	To actuate upon complete loss of ESF Bus voltage condition
Each 4160 V ESF Bus (1A3/4)	Degraded Grid	1 of 2 twice	3798V = (91.3% of 4160)	To actuate just above minimum analyzed acceptable degraded bus voltage value.
Startup Transformer (1X003)	Ground Protection	1 of 1	160A (High Side) 320A (X Winding) 320A (Y Winding)	High neutral currents used to detect probable ground faults.