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Docket No. 50-443

SBK-L-12220

October 22, 2012

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

Seabrook Station

Response to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System

Pursuant to Section 50.54(f) of Title 10 of the Code of Federal Regulations, NextEra Energy Seabrook, LLC (NextEra) is submitting its response to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System.

The enclosure to this letter provides NextEra's response to Bulletin 2012-01.

Should you have any questions regarding this letter, please contact Mr. Michael O'Keefe, Licensing Manager, at (603) 773-7745

Sincerely,

NextEra Energy Seabrook, LLC

Kevin T. Walsh
Site Vice President

cc: NRC Region I Administrator
NRC Project Manager
NRC Senior Resident Inspector

IE76
NRR

NEXTera ENERGY SEABROOK

AFFIDAVIT

SEABROOK STATION UNIT 1

Facility Operating License NPF-86

Docket No. 50-443

Response to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System

I, Kevin T. Walsh, Site Vice President of NextEra Energy Seabrook, LLC hereby affirm that the information and statements contained within this response to NRC Bulletin 2012-01 are based on facts and circumstances which are true and accurate to the best of my knowledge and belief.

Sworn and Subscribed before me this 22 day of October, 2012

Notary Public

Kevin T. Walsh
Site Vice President

MICHAEL D. O'KEEFE
MY COMMISSION EXPIRES FEB. 13, 2013
NOTARY PUBLIC
NEW HAMPSHIRE

Enclosure to SBK-L-12220

Response to NRC Bulletin 2012-01, Design Vulnerability in Electric Power System

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System Description

Bulletin items 2., 1.d, 2.a and 2.c 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).

Seabrook Station Response:

The following description provides a brief overview of Seabrook Station's onsite and offsite electrical power systems and normal operating configuration of Seabrook Station's emergency buses.

The transmission grid connections that provide offsite power to Seabrook Station consist of three 345kV transmission lines, as shown in Attachment 2, Simplified One-Line Diagram. These lines are designed and built to provide the electrical and structural independence necessary to ensure continuity of offsite electrical power to the station. At Seabrook Station, the three lines terminate at separate terminating structures. From the terminating structures each circuit is routed in metal-enclosed, Sulphur Hexafluoride (SF6) gas-insulated bus to a common switching station as shown in Attachment 2. Two separate and independent safety-related 4.16kV emergency buses and associated diesel generators are the source of power for the plant auxiliaries, protection system and Engineered Safety Features (ESF) loads during normal, abnormal and accident conditions. The normal supply to Train A (Bus E5) and Train B (Bus E6) 4.16kV emergency buses is supplied from separate Unit Auxiliary Transformers (UATs). When the unit is operating, the turbine generator output is supplied through the generator circuit breaker and the UATs to the emergency buses. When the unit is shutdown, the generator breaker is opened and the current flow is reversed through the Generator Step-Up Transformer (GSU) and supplied to the UATs. The Reserve Auxiliary Transformers (RATs) provide an alternate source of power to the emergency buses. On loss of normal supply (UAT) to a bus, the alternate supply (RAT) is automatically connected. In addition to a normal and alternate supply, each emergency bus has an emergency power supply in the form of an emergency diesel generator.

The offsite electric power system complies with General Design Criterion 17 (ref. UFSAR Section 8.2.1.5). General Design Criterion 17 requires two physically independent circuits to supply electric power from the transmission network to the onsite electric distribution system, designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions.

One of the required, independent offsite circuits is connected to the onsite distribution system, including all of the emergency buses, through the unit auxiliary transformers. The supply to the unit auxiliary transformers can be traced from the transformers through the generator isolated phase bus, the generator step-up transformers, the gas-insulated isolated phase bus of the 345kV switching station, and then to an offsite transmission line. The second required, independent offsite circuit is connected to the onsite distribution system, including all of the emergency buses, through the reserve auxiliary transformers. This circuit can be traced from the reserve auxiliary transformers through a different portion of the gas-insulated isolated phase bus of the 345kV switching station, and then to another offsite transmission line.

The connections from the transformers to the onsite distribution system of these two circuits are made with separate nonsegregated phase bus ducts, which provide the necessary separation to minimize the likelihood of simultaneous failure of these circuits to the extent practical.
Both of these circuits are designed for immediate access to the onsite distribution system, thus meeting the preferred design of Regulatory Guide 1.32.

In addition to two 4.16kV ESF buses, the onsite AC power systems include two 4.16kV non-ESF and two 13.8kV non-ESF buses. In addition to one ESF bus, each UAT provides normal supply to one 4.16kV non-ESF bus and one 13.8kV Non-ESF bus. Each RAT is the reserve source for one 4.16kV ESF, one 4.16kV non-ESF and one 13.8kV non-ESF bus.

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

Seabrook Station Response:

See Attachment 4, Table 4, Offsite Power Transformers, 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.

Seabrook Station Response:

For at power (normal operating condition) configurations, ESF buses are not powered by offsite sources. For ESF buses major loads energized during normal power operation, see Attachment 4, Table 3, ESF Buses Normally Energized Major Loads.

2.c. Confirm that the operating 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.

Seabrook Station Response:

The operating configurations of the Seabrook Station ESF buses have been confirmed to be consistent with the current licensing basis. The normal supply to Train A (Bus E5) and Train B (Bus E6) 4.16kV emergency buses is supplied from separate Unit Auxiliary Transformers

(UATs). When the unit is operating, the turbine generator output is supplied through the generator circuit breaker and the UATs to the emergency buses. When the unit is shutdown, the generator breaker is opened and the current flow is reversed through the Generator Step-Up Transformer (GSU) and supplied to the UATs. The Reserve Auxiliary Transformers (RATs) provide an alternate source of power to the emergency buses. On loss of normal supply (UAT) to a bus, the alternate supply (RAT) is automatically connected.

The Seabrook Substation Reliability Upgrade Project was undertaken in 2009 with the main goal of improving the reliability of the five key transmission elements interconnected at Seabrook Substation (main generator/GSU bus, RAT bus, and three transmission lines). The first phase of the switchyard reliability upgrade project was implemented in 2009, which involved installing five new Gas Insulated Substation (GIS) breakers, three new breaker positions and two replacements. This project improved the reliability of the Seabrook Station 345kV substation by changing the switchyard topology and by replacing aging equipment with new equipment of a more reliable design. The second phase of the switchyard reliability upgrade project was implemented in 2011, which involved relocating the main generator/GSU bus connection from the existing 345kV Bus-3 breaker bay to 345kV Bus-6 located in a new breaker bay. Overall, the switchyard reliability upgrade project implemented under 10 CFR 50.59 to improve the GIS reliability and improve the availability of the main generator and offsite power supply for the Seabrook station does not make significant change to the original licensing in regard to the offsite power source alignment to the ESF buses.

System Protection

Bulletin items 1, 1.a, 2.b and 2.d 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 off-site power circuit or another power sources.

Seabrook Station 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 schemes 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.

The Seabrook Station protection scheme does not have sufficient sensitivity to detect and automatically respond to all single-phase open circuit or high impedance ground fault conditions on off-site power supplies to ESF buses. The Seabrook Station safety-related 4.16 kV Bus Loss-of-Voltage and Degraded-Voltage relay undervoltage protection schemes are similar to Byron in that they require a 2-out of -2 logic to initiate undervoltage protection. However, contrary to Byron Unit 2, the Seabrook Station design and configuration of 345kV switchyard and station buses are unique. Seabrook Station utilizes the Unit Auxiliary Transformers (UATs) to run electrical auxiliaries, with the Reserve Auxiliary Transformers (RATs) remaining unloaded. Based on Seabrook Station's unique design and configuration of 345kV switchyard and station buses, the loss of single phase on a supply circuit to or from any of the auxiliary transformers (RATs or UATs) is not a credible event. See Attachment 3, Byron vs. Seabrook Station Switchyard Comparison, for a discussion on why an initiating event similar to the Byron event is not credible at Seabrook Station due to Seabrook Station's unique design.

In addition, the following provides a discussion on why a high impedance ground fault condition will not result in unbalanced voltages on the ESF buses.

Under normal operation, the main generator supplies electrical power to the 345kV grid through the generator step-up transformer and to the plant through the unit auxiliary transformers. During startup and shutdown, auxiliary power may be taken from the 345kV system in one of two ways:

- Back-fed through the generator step-up transformer and unit auxiliary transformers when the generator circuit breaker is open
- From the reserve auxiliary transformers

345kV System:

Seabrook Station's 345kV system is a solidly grounded system and the neutral connections of the RATs and the GSU are solidly grounded. The Seabrook Station GSUs and RATs are connected to the 345 kV switchyard via SF6 gas-insulated isolated phase bus. Based on Seabrook Station's 345kV switchyard design, a high resistance ground fault on the gas-insulated isolated phase buses is not credible. A ground fault on the 345kV gas-insulated isolated phase buses from the air termination yard to the gas-insulated switchyard will be detected by the 345kV bus differential protective devices, whose function is to isolate the faulted portion of the bus by tripping the appropriate breakers. A ground fault between the switchyard power circuit breakers (PCB) and the GSU will be detected by the 345kV Bus 6 differential protective devices, whose function is to isolate the GSU by opening the switchyard PCBs and the feeder breakers to the station's 13.8kV and 4.16kV buses.

The GSU neutral ground fault relay (Device 51N) monitors for ground fault current from any portion of the GSU transformer's high voltage windings or its connected bus returns to the GSU transformer through the neutral ground tap. This relay activates the GSU transformer backup protection lockout relay (86SB), whose function is to actuate various tripping (and block- close) relays including the following pertinent functions:

- trip the connecting 345kV switchyard breaker and initiate the associated 345kV breaker failure circuit
- trip the generator circuit breaker and initiate the associated breaker failure circuit
- trip the all 13.8kV buses incoming breakers (Buses 1 and 2)
- trip the 4.16kV buses incoming breakers (Buses 3, 4, E5 and E6)

Each RAT has two ground fault relays. One of the ground fault relays (Device 51NH) is placed on the grounded neutrals of the primary, and the other (Device 51NX) on the neutral grounding resistor off the transformer's 13.8 kV secondary winding. If the current flow to the ground exceeds the setpoint for the ground fault relays, the relays operate. Relays 51NH or 51NX will activate the RAT transformer primary protection lockout relay (86RP), whose function is to actuate various tripping (and block- close) relays including the following pertinent functions:

- trip the connecting 345kV switchyard breaker and initiate the associated 345kV breaker failure circuit
- trip the all 13.8kV buses incoming breakers (Buses 1 and 2)
- trip the 4.16kV buses incoming breakers (Buses 3, 4, E5 and E6)

Other local and remote relaying on the 345kV transmission lines protects the lines from ground faults. If the ground on the 345kV system is sufficiently large, it would create momentary voltage dips and voltage unbalance on the ESF buses; however, a fault of this magnitude will be isolated quickly by the activation of appropriate protective relays and there will be no adverse affect on the energized equipment. A single high impedance ground fault which does not generate sufficient current to actuate the differential and ground fault relays cannot result in a voltage imbalance due to this section of the system being directly connected to the 345kV grid; the entire grid voltage would have to be distorted (imbalanced) as a result of the high impedance fault, which is not credible.

25kV System:

The turbine generator armature winding is connected to ground through a high impedance circuit made up of a neutral grounding transformer, neutral resistor and neutral reactor. When the generator breaker is closed, the neutral grounding equipment detects a ground anywhere on the 25kV section of the generator distribution system (Devices GP1/TG1 & 64 TG1). The components of this circuit are sized such that a full phase-to- ground fault will result in only 5 Amp of current flow to ground. If the ground is sufficiently large to affect plant operation, protective relaying will isolate the generator. Since the system is connected to ground through a high impedance circuit, a single high impedance ground fault with all three phases intact will not result in unbalanced phase to phase voltages on the ESF buses and have no affect on the energized equipment.

During times when station buses are back-fed through the GSU and UATs with the generator circuit breaker open, the ground fault voltage relay (Device 64B) associated with the isolated phase bus monitors the portion of the bus extending from the generator breaker to the GSU transformer and UATs. This relay activates the Generator/Transformer Overall Protection Lockout Relays (86GT), whose function is to actuate various tripping (and block- close) relays including the following pertinent functions:

- trip the connecting 345kV switchyard breaker and initiate the associated 345kV breaker failure circuit
- trip the generator circuit breaker
- trip the UAT supply breakers to all 13.8kV buses (Buses 1 and 2)
- trip the UAT supply breakers to all 4.16kV buses (Buses 3, 4, E5 and E6

While in the back-feed mode, a single high impedance ground fault in this portion of the 25kV distribution system (high impedance grounded) will have no affect on the phase to phase voltages on the 4.16kV ESF buses or the energized equipment.

13.8kV System:

The 13.8kV System is a low-resistance grounded system. The ground fault relays (Device 51NX) on the neutral grounding resistor off the UATs and RATs 13.8 kV secondary winding protect the transformers and connecting buses from ground faults. Ground fault relays have also been provided on each motor feeder and load center feeder and each incoming line. The feeder ground fault relays are set low enough (10Amp at 0.1 second) to isolate the faulted portion of the system by tripping appropriate circuit breakers. A single high impedance ground fault on the 13.8kV system will not result in unbalanced phase to phase voltages on the 4.16kV ESF buses and will have no affect on the energized equipment on the ESF buses.

4.16kV System:

The 4.16kV system is a high resistance grounded system. In order to detect grounds, ground sensors have been provided on each motor circuit and load center feeder and each incoming line, including the diesel generator. Inputs from ground sensors and ground detection circuits are furnished to the station computer. The grounding scheme used allows single ground faults to be alarmed only and the equipment to continue operation. Therefore, a single ground fault with all three phases intact on the 4.16kV system will not result in unbalanced phase to phase voltages and will have no affect on the energized equipment.

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

Seabrook Station 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 or a high impedance ground fault condition. See Attachment 4, Table 5, Protective Devices, for undervoltage and ground fault protective devices 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.

Seabrook Station Response:

As discussed in the response to question 2, Seabrook Station's ESF buses are not powered by offsite sources during normal operation and the loss of single phase on a supply circuit to or from any of the auxiliary transformers (RATs or UATs) is not a credible event at Seabrook Station due to the unique design of the Seabrook Station switchyard. Although, the loss of single phase is not a credible event, the following actions were performed in response to the Byron single open phase event:

In response to NRC NRR Event Notice EN47636, on 2/7/2012, Design Engineering conducted a review of the ability of the undervoltage protection relay schemes at Seabrook Station to detect a similar loss-of-phase event. Upon completion of this review, Engineering provided technical guidance to the site Operations Department in order to aid plant operators in the detection and response to such an event. Operations issued this guidance as a briefing document to alert operators to the event. Operations Department also initiated AR1732579 to review and revise the Loss-of-Power (voltage)/Low (Degraded)-Voltage alarm response procedures identified in the technical guidance from Engineering. The alarm response procedures for emergency Buses E5 and E6 Loss of Power (F7300, "Bus E5 Loss of Power", F7310 "Bus E6 Loss of Power") and Bus E5 and E6 Low Voltage (F7301, "Bus E5 Voltage Low", F7311 "Bus E6 Voltage Low") were revised to aid plant operators in detecting and responding to such an event. INPO IER-L2-12-14, Automatic Scram Resulting from a Design Vulnerability in the 4.16-kV Undervoltage Protection Scheme, and changes to the Loss-of-Voltage/Degraded-Voltage alarm response procedures were covered in Lesson Plan SBK LOP L5076C123, LORT Phase 12-03 Self-Study/Reading Package, during License Operator Requalification Training Phase 12-03. This event was also covered in Lesson Plan SBK LOP L3554C122, Transformer Fires, during License Operator Requalification Training Phase 12-02.

Attachment 1

Bulletin Response

The following procedures have been revised to help operators diagnose and respond to an open phase condition.

- Procedure OX1446.01, "AC Power Source Weekly Surveillance", was revised to verify currents on each phase of the offsite transmission lines. No current on any phase could be indicative of either a line out of service or loss of a phase and help operators diagnose open phase condition on the offsite transmission line.

- Procedure OX1446.03, "Electric Bus Weekly Operability (Operating)", was revised to verify voltages on each phase of the ESF buses.

- Procedure OS1246.02, "Degraded Vital AC Power (Plant Operating)", was revised to help operators diagnose an open phase condition and respond to this condition.

The following Video Alarm Response Operating Procedures (VPROs) have been revised to help operators diagnose open phase condition and respond to this condition.

- F7300, Bus E5 Loss of Power
- F7301, Bus E5 Voltage Low
- F7310, Bus E6 Loss of Power
- F7311, Bus E6 Voltage Low

The following Main Control Board Hardwire Annunciator Alarm Response Procedures have been revised to help operators diagnose an open phase condition and respond to this condition.

- MM-UA-54 E-4, 480V Bus 51/52/53 Volts Low
- MM-UA-55 E-4, 480V Bus 61/62/63 Volts Low

Based on Seabrook Station's unique design and configuration of 345kV switchyard and station buses, the high impedance ground fault condition is not expected to result in unbalanced voltages on the 4.16kV ESF buses. Since high impedance ground faults above the setpoints of conventional protection systems such as ground fault, overcurrent, differential, etc., usually cannot readily be detected; at present there are no surveillance tests being performed to verify the high impedance ground fault condition. However, a weekly PM activity performs detailed inspections of the Seabrook Station 345kV SF6 gas-insulated switchyard and air termination yard. This PM activity looks for abnormal conditions on any equipment. In-house switchyard qualified resources are utilized to perform these maintenance activities. This weekly surveillance activity most likely will detect equipment issues in the air termination yard, and also, based on gas insulated bus design, a high impedance ground fault is not a credible event at Seabrook Station.

2.d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phase of the ESF buses?

Seabrook Station Response:

In response to the Byron single open phase event, the following procedures have been revised to specifically include verification of the voltages/currents on all three phases of the ESF buses/ offsite transmission lines to help operators diagnose an open phase condition and respond to this condition.

- Procedure OX1446.01, "AC Power Source Weekly Surveillance," was revised to verify currents on each phase of the offsite transmission lines. No current on any phase or current unbalance could be indicative of either a line out of service, loss of a phase or high impedance ground fault and help operators diagnose these conditions on the offsite transmission line.

- Procedure OX1446.03, "Electric Bus Weekly Operability (Operating)," was revised to verify voltages on each phase of the ESF buses.

The following Video Alarm Response Operating Procedures (VPROs) have been revised to verify voltages on each phase of the ESF buses.

- F7300, Bus E5 Loss of Power
- F7301, Bus E5 Voltage Low
- F7310, Bus E6 Loss of Power
- F7311, Bus E6 Voltage Low

The following Main Control Board Hardwire Annunciator Alarm Response Procedures have been revised to verify voltages on each phase of the ESF buses.

- MM-UA-54 E-4, 480V Bus 51/52/53 Volts Low
- MM-UA-55 E-4, 480V Bus 61/62/63 Volts Low

Consequences

Bulletin items 1.b, 1.c, and 2.e 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 unit auxiliary transformer) power source

Seabrook Station Response:

Installed relays were not designed to detect single phase open circuit or high impedance ground fault 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 (e.g., ESF buses normally aligned to UATs) in the event of a single phase open circuit or high impedance ground fault condition on a credited off-site power circuit from the Reserve Auxiliary Transformers (RATs) because there is insufficient current to detect a single-phase open circuit or high impedance ground for this configuration. The plant response for a loaded power source cannot be calculated without the amount of loading and the specific loads involved. However, based on Seabrook Station's unique design and configuration of 345kV switchyard and station buses, the loss of a single phase on a supply circuit to or from any of the auxiliary transformers (RATs or UATs) is not a credible event and the high impedance ground fault condition is not expected to result in unbalanced voltages on the 4.16kV ESF buses.

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.

Seabrook Station Response:

Seabrook Station did not credit in the Current Licensing Basis (CLB) 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 or high impedance ground fault condition on the credited off-site power source as described in the UFSAR and Technical Specifications.

The offsite electric power system complies with General Design Criterion 17 (ref. UFSAR Section 8.2.1.5). General Design Criterion 17 requires two physically independent circuits to supply electric power from the transmission network to the onsite electric distribution system, designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions.

One of the required, independent, offsite circuits is connected to the onsite distribution system, including all of the emergency buses, through the unit auxiliary transformers. The supply to the unit auxiliary transformers can be traced from the transformers through the generator isolated phase bus, the generator step-up transformers, the gas-insulated isolated phase bus of the 345kV switching station, and then to an offsite transmission line. The second required, independent, offsite circuit is connected to the onsite distribution system, including all of the emergency buses, through the reserve auxiliary transformers.

Since Seabrook Station did not credit the ESF bus protection scheme as being capable of detecting and automatically responding to a single phase open circuit or high impedance ground condition, an open phase fault or high impedance ground was not included in the design criteria for either the loss of voltage, the degraded voltage relay (DVR) scheme or secondary level undervoltage protection system (SLUPS) design criteria. Since open phase or high impedance ground detection was not credited in the Seabrook Station design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

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 Seabrook Station 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 Seabrook Station specific Class 1E electric distribution system (EDS)). However, based on Seabrook Station's unique design and the configuration of the 345kV switchyard and station buses, the loss of single phase on a supply circuit to or from any of the auxiliary transformers (RATs or UATs) is not a credible event and a high impedance ground fault on a supply circuit to or from any of the Seabrook Station auxiliary transformers is not expected to result in unbalanced voltages on the 4.16kV ESF buses. No interim or long term actions are being pursued to provide automatic protection from single-phase open circuit or high impedance ground fault conditions for off-site power sources supplying Class 1E vital buses.

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.

Seabrook Station Response:

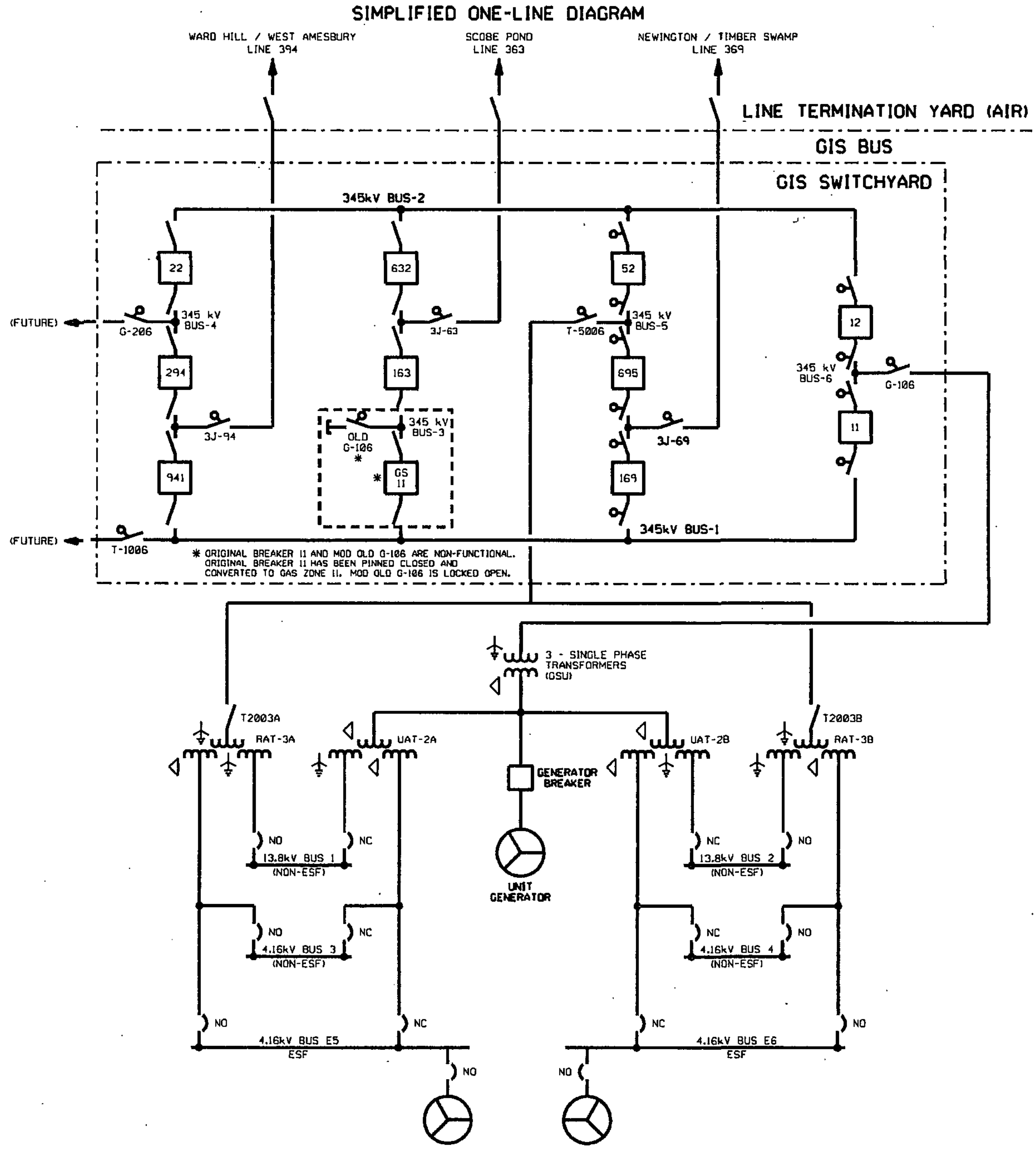
Consistent with the Current Licensing Basis and GDC 17, protective circuitry will separate the ESF buses from a failed offsite source due to a loss of voltage or a sustained balanced degraded grid voltage concurrent with certain design basis accidents. The relay systems were not specifically designed to detect an open single phase of a three phase system. Detection of a single-open phase condition is beyond the approved design and licensing basis of the plant. No calculations for this scenario have been done. Also, consistent with the current station design, protective circuitry will protect from a ground fault condition with all three phases intact.

Seabrook Station uses a common or single offsite circuit to supply redundant ESF buses. However, based on Seabrook Station's unique design and configuration of the 345kV switchyard and station buses, the loss of single phase on a supply circuit to or from any of the auxiliary transformers (RATs or UATs) is not a credible event and a high impedance ground fault on a supply circuit to or from any of the Seabrook Station auxiliary transformers is not expected to result in unbalanced voltages on the 4.16kV ESF buses.

Enclosure to SBK-L-12220

Attachment 2

Simplified One-line Diagram



Attachment 3

Byron vs. Seabrook Station Switchyard Comparison

Byron Station recently had a switchyard event where failure of an insulator stack in their air-insulated switchyard resulted in a loss of one phase in the circuit supplying their System Auxiliary Transformer. This resulted in a voltage imbalance for the station auxiliary buses. This voltage imbalance was not detected due to the design of the emergency bus undervoltage relaying scheme.

An initiating event similar to the Byron event is not likely at Seabrook Station because of the design differences associated with the switchyard configuration and the bus runs to and from the auxiliary transformers.

The Seabrook Station 345kV switchyard uses an SF6 gas-insulated isolated phase bus design. The switchyard ring bus is connected to the grid by three overhead air-insulated transmission lines. Each transmission line, associated 345kV buses and circuit breakers have the capacity to supply the power requirements of station auxiliaries under all pant conditions. Failure of one phase on one of the air-insulated transmission lines would not result in an imbalance at the station auxiliary buses because balanced phase voltages would be maintained by the remaining two transmission lines. A simultaneous open circuit failure on the same phase of all three transmission lines in not a credible event.

The Seabrook Station Generator Step-Up Transformers (GSUs) and the Unit Auxiliary Transformers (UATs) are connected to the ring bus through two circuit breakers (11 & 12). The Seabrook Station Reserve Auxiliary Transformers (RATs) are also connected to the ring bus through two circuit breakers (52 & 695). As such, it is not credible that a single failure in one breaker would result in a loss of one phase in the switchyard supply circuit to either the GSU/UAT circuit or the RAT circuit.

The Seabrook Station GSUs and RATs are connected to the 345 kV switchyard via SF6 gas-insulated isolated phase bus. Each single-phase bus section consists of two concentric tubes of aluminum. The inner tube is the conductor and the outer tube is the solidly grounded enclosure for each isolated phase. Two types of insulators, gas-barrier and non-barrier, are used to support the center conductor within the enclosure. The gas-barrier type is a full circumference type insulator and the non-barrier type is of a tri-post design. These type insulators keep the conductor centered and fully supported within the enclosure. The conductors in adjacent bus sections are interconnected using a plug and socket design that is not susceptible to open circuit failure. The conductor connection at the GSU and RAT bushings is a manually operated sliding link (plug & socket) design that is closed during normal operation. The bus enclosure sections are bolted together. This design is not susceptible to the same failure mode as the Byron event where an air-insulated line insulator failed and dropped the conductor. Based on this design, it is not credible that a single insulator failure will result in an open circuit. The conductor bus will remain in position due to the balance of remaining insulators and the rigidity of the plug and socket connections. With the SF6 bus design, should an internal insulator failure occur, it is postulated to initiate a phase-to-ground fault between the conductor and the enclosure and result in isolation of all phases in the affected circuit.

Attachment 3

Byron vs. Seabrook Station Switchyard Comparison

Motor-operated and manually-operated disconnect switches in the 345kV SF6 GSU and RAT circuits incorporate similar design features as the SF6 bus. These switches are maintained in the closed position during normal operation.

The Seabrook Station Unit Auxiliary Transformers (UATs) are connected to the 25 kV system via air-insulated isolated-phase bus. Each single-phase bus section consists of two concentric tubes of aluminum. The inner tube is the conductor and the outer tube is the solidly grounded enclosure for each isolated phase. Insulators (bus support assemblies) are used to support the center conductor within the enclosure. This type insulator keeps the conductor centered and fully supported within the enclosure. Conductor joints are welded except for connections to equipment which utilize multiple flexible links with bolted connections. Based on this design, it is not credible that a single insulator failure will result in an open circuit. The conductor bus will remain in position due to the balance of remaining insulators and the rigidity of the bolted connections. This design is not susceptible to the same failure mode as the Byron event where an air-insulated line insulator failed and dropped the conductor. With the air-insulated isolated-phase bus design, should an internal insulator failure occur, it is postulated to initiate a phase-to-ground fault between the conductor and the enclosure and result in isolation of all phases in the affected circuit.

The connections from the RATs and UATs to the station's 13.8 kV and 4.16 kV buses are via three-phase non-segregated phase bus duct. This design consists of all three phase conductors being supported within a common metal enclosure. The bus bars are covered with insulation sufficient to withstand the full line voltage rating. The bus bars are supported internally within the enclosure by either polyester glass insulating channels (5 kV bus) or porcelain insulators (15 kV bus). To connect one section of bus to another, the bus bar conductors are mechanically bolted together. This provides a rigid connection where failure by open circuit is not credible. Multiple flexible links with bolted connections are used to connect the bus conductors to other equipment such as transformer bushing terminals. Again, with this construction, an open circuit failure is not credible. With this design, should an internal insulator failure occur, it is postulated to initiate a phase-to-ground or phase-to-phase fault. For the low resistance grounded 13.8 kV buses, either a phase-to-ground or phase-to-phase fault would result in isolation of the affected circuit. For the high resistance grounded 4.16 kV buses, a phase-to-phase fault would result in isolation of the affected circuit. A phase-to-ground fault would initiate an alarm only.

In addition, extensive Preventive Maintenance (PM) activities have been developed for the Seabrook Station 345kV SF6 gas-insulated switchyard and air switchyard. PMs are included and scheduled in accordance with the Seabrook Station PM program. In-house switchyard qualified resources are utilized to perform these maintenance activities. Included in the scope of the Electrical Maintenance PM activities is an activity for detailed switchyard rounds inspections. This weekly PM activity performs detailed inspections of the entire switchyard looking for abnormal conditions on any equipment. Any physical degradation or failure of SF6 gas-insulated bus work system or structures would be observed and reported during these inspections. The results of weekly switchyard rounds are reviewed by Electrical Maintenance Supervision prior to closeout. Action Requests (AR) are initiated for any unanticipated conditions.

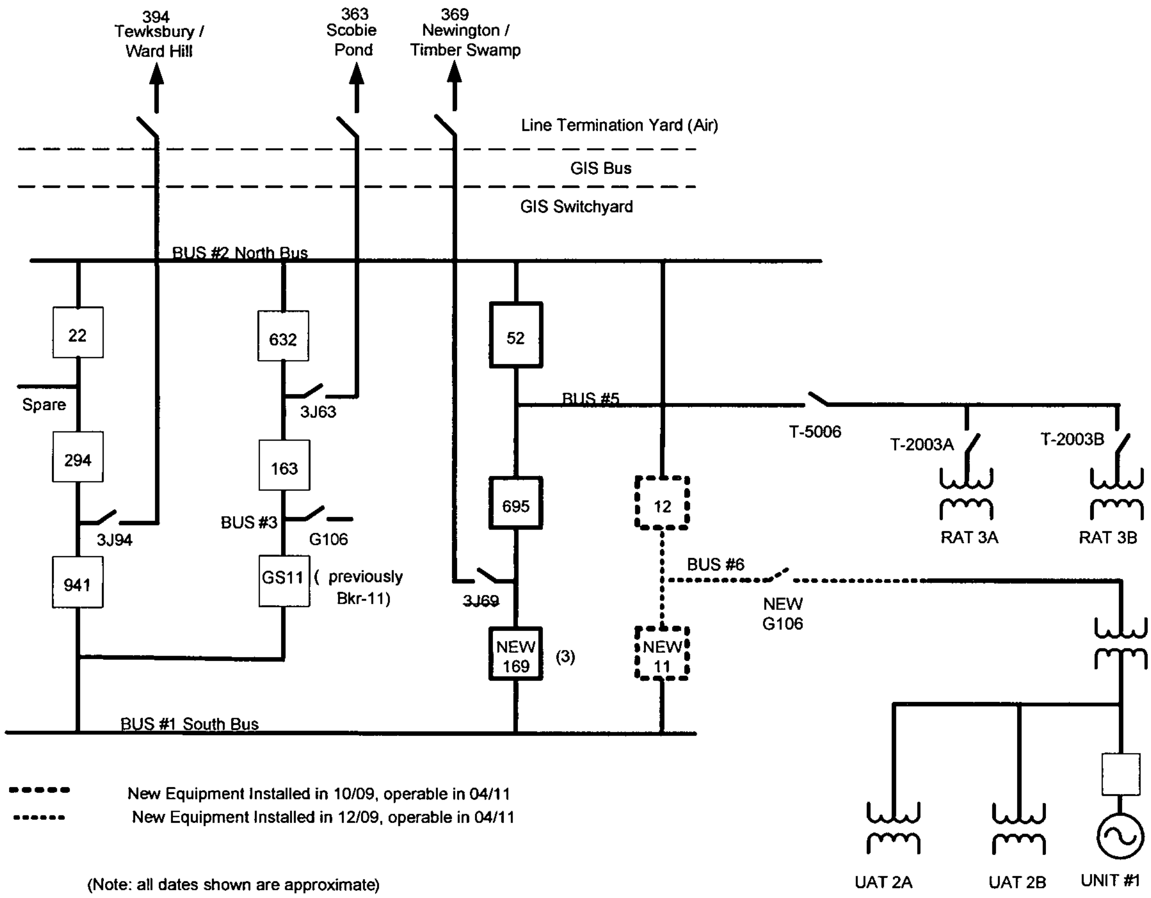
Based on the above, due to Seabrook Station's unique design, configuration of 345kV switchyard and station buses, and proper operating and maintenance practices, the initiating event similar to the Byron event is not credible at Seabrook Station.

<u>**Enclosure to SBK-L-12220**</u>

Attachment 3

Byron vs. Seabrook Station Switchyard Comparison

Single Line Drawing for Seabrook Station



Attachment 4

Tables

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 Note: Seabrook Station's ESF or non-ESF buses are not continuously powered from offsite power sources, therefore, Table 1 is not applicable to Seabrook Station.	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 2A	4.16kV bus E5	Y
UAT 2B	4.16kV bus E6	Y

Attachment 4

Tables

TABLE 3 - ESF BUSES NORMALLY ENERGIZED MAJOR LOADS

ESF Bus	Load	Voltage Level	Rating
E5/E6	CHARGING PUMPS CS-P-2A or 2B	4kV	600 HP
E5	PCCW PUMPS CC-P-11A or 11C	4kV	700 HP
E6	PCCW PUMPS CC-P-11 B or 11D	4kV	700 HP
E5	SERVICE WATER PUMPS SW-P-41A or 41C	4kV	600 HP
E6	SERVICE WATER PUMPS SW-P-41B or 41D	4kV	600 HP
E5	480V UNITSUBSTATION AND ASSOCIATED MOTOR CONTROL CENTER SUPPLIED LOADS	480V	VARIOUS
E6	480V UNITSUBSTATION AND ASSOCIATED MOTOR CONTROL CENTER SUPPLIED LOADS	480V	VARIOUS

Note: Seabrook Station's ESF buses are not powered by offsite sources during normal operation (at power).

Attachment 4
Tables

TABLE 4 - OFFSITE POWER TRANSFORMERS, PAGE 1 OF 3
Generator Step-Up Transformer (GSU)

TRANSFORMER DESCRIPTION/ CONNECTIONS DETAILS	WINDING/GROUNDING CONFIGURATIONS/ MVA SIZE	TRANSFORMER FUNCTIONS	TYPE OF FAULTS SUSCEPTIBLE	PROTECTIONS
Generator Step-Up Transformer (GSU) H Winding - 345kV, SF6 insulated bus connects the H winding to the 345kV switchyard via motor-operated disconnect switches (MODS) and power circuit breakers (PCBs). X winding - 25kV, isophase bus connects the X winding to the Generator Circuit Breaker (GCB) and the UATs	3 Single Phase GSU Transformers have four legged core construction. Each transformer has single primary and a single secondary winding. H winding is connected in a solidly grounded Wye configuration. X winding is connected in a Delta configuration. MVA SIZE AT 55°C (FOA) 410 MVA MVA SIZE AT 65°C (FOA) 460 MVA	1. When unit is generating power, the GSUs steps-up 25kV generator output voltage to 345kV for distribution to the power grid. 2. When unit is shutdown, the GSU steps-down 345kV power grid voltage to 25kV for use by the UATs in supplying station 13.8kV and 4.16kV systems.	• High/Low Side Open • Ground Fault • Phase-to-Phase • Internal • External	The GSUs have three protection schemes, primary, backup and Generator/Transformer Overall as described below. 87SP- Differential Current Relays- These relays monitor for a differential phase current across the GSU transformer. The protective zone for these relay includes only the low voltage and high voltage windings of the transformer. These relays activate the GSU transformer primary protection lockout relays (86SP). 63FPX-Sudden Pressure Relays- These relays monitor for a sudden increase in pressure inside any one of the single-phase transformer tanks. These relay activate the GSU transformer backup protection lockout relays (86SB). 51N- 345 kV Neutral Ground Fault Relay – This relay monitors for the ground fault current from any portion of the transformer's high voltage windings or its connected bus returns to the GSU transformer through the neutral ground tap. This relay activates the GSU transformer backup protection lockout relays (86SB). 87GT-Differential Current Relays- These relays monitor for a differential current condition in each phase within a protective zone including the generator, the GSU transformer, and the isolated phase bus (87 GT). These relays activate the Generator/Transformer Overall Protection Lockout Relays (86GT). 87B- Differential Current Relays- These relays monitor for a differential current condition in each phase across the isolated phase bus alone (87 B). These relays activate the Generator/Transformer Overall Protection Lockout Relays (86GT). 64B- Ground Fault Relay – This relay monitors for a ground condition on the isolated phase bus (generator breaker open). This relay activates the Generator/Transformer Overall Protection Lockout Relays (86GT). Other Protection: Mechanical Protection Fire Protection

Attachment 4
Tables

TABLE 4 - OFFSITE POWER TRANSFORMERS, PAGE 2 OF 3
Reserve Auxiliary Transformers (RATs)

TRANSFORMER DESCRIPTION/ CONNECTIONS DETAILS	WINDING/GROUNDING CONFIGURATIONS/ MVA SIZE	TRANSFORMER FUNCTIONS	TYPE OF FAULTS SUSCEPTIBLE	PROTECTION
Reserve Auxiliary Transformers (RATs). There are two 3 phase Reserve Auxiliary transformers (RATs). H Winding - 345kV, SF6 insulated bus connects the H winding to the 345 kV switchyard via motor-operated disconnect switches (MODS) and power circuit breakers (PCBs). X winding – 13.8kV, non-segregated bus connects the X winding of each RAT to one 13.8kV non-safety bus. Y Winding – 4300V, non-segregated bus connects the Y winding of each RAT to one train of 4.16kV emergency bus and to one 4.16kV nonessential bus. By this arrangement, a separate RAT feeds each emergency bus.	3 phase Reserve Auxiliary Transformers (RATs) have shell form construction with a single primary and two secondary windings. H winding is connected in a solidly grounded Wye configuration. X winding is connected in a low resistance grounded Wye configuration. Y winding is connected in a Delta configuration. MVA SIZE AT 55°C OA/FA/ FOA(FUTURE) H- 27 / 36 / (45) MVA X- 18 / 24 / (30) MVA Y- 12 / 16 / (20) MVA MVA SIZE AT 65°C OA/FA/ FOA(FUTURE) H-30.24 / 40.32 / (50.4) MVA X- 20.16 / 26.88 / (33.6) MVA Y- 13.44 / 17.92 / (22.4) MVA	The RATs provide an alternate source of power to the 4.16 kV and 13.8 kV systems. Note: The UATs are the preferred source of power to the 4.16 kV and 13.8 kV systems. The RATs are supplied directly from the 345 kV switchyard. The RATs are normally energized with the secondary supply breakers to the 4.16kV and 13.8 kV systems open. On a loss of the normal supply to a bus, the alternate supply is automatically connected to the bus (synchronism is readily permissible as the sources are from interconnected 345kV ring bus), minimizing power disruption time. Two RATs provide a second immediate access circuit from the offsite source to the onsite electrical distribution system, providing power for all loads including all the engineered safety features loads. Each RAT has the capacity to supply the power requirements of the connected load under all plant condition. The UATs are the preferred power supply and the RATs are the alternate power supply when the UATs or the GSU are not available.	• High/Low Side Open • Ground Fault • Phase-to-Phase • Internal • External	The RATs have two protection schemes, primary and backup as described below: 87RP- Differential Current Relays- These relays monitor for a total current flow through each phase of the transformer. The protective zone for these relays includes only the transformer. These relays activate the RAT transformer primary protection lockout relays (86RP). 51NH and 51NX- Ground Fault Relays- There are two ground fault relays, one of the ground fault relays is placed on the grounded neutrals of the primary, and the other on the neutral grounding resistor off the transformer's 13.8 kV secondary winding. If the current flow to the ground exceeds the setpoint for the ground fault relay, the relay operates. These relays activate the RAT transformer primary protection lockout relays (86RP). 63FPX-Sudden Pressure Relay- This relay detects internal faults within the transformer. This relay activates the RAT backup protection lockout relays (86RB). 87RB- Differential Current Relays- These relays monitor for a differential current condition in each phase within a protective zone including the transformer and the 13.8 kV, non-segregated, the 4.16 kV connecting busses. These relays activate the RAT transformer backup protection lockout relays (86RP). Other Protection: Mechanical Protection Fire Protection

TABLE 4 - OFFSITE POWER TRANSFORMERS, PAGE 3 OF 3
Unit Auxiliary Transformers (UATs)

TRANSFORMER DESCRIPTION/ CONNECTIONS DETAILS	WINDING/GROUNDING CONFIGURATIONS/ MVA SIZE	TRANSFORMER FUNCTIONS	TYPE OF FAULTS SUSCEPTIBLE	PROTECTION
Unit Auxiliary Transformers (UATs) There are two 3 phase Unit Auxiliary Transformers (UATs). H winding – 25kV, Isophase bus connects the H winding to the Generator Circuit breaker and the GSU transformers low voltage side. X winding – 13.8kV, non-segregated bus connects the X windings of each UAT to the non-safety 13.8kV bus. Y Winding – 4300V, non-segregated bus connects the Y winding of each UAT to one train of 4.16kV emergency bus and to one 4.16kV nonessential bus. By this arrangement, a separate UAT feeds each emergency bus.	3 phase Unit Auxiliary Transformers (UATs) have three legged core construction with a single primary and two secondary windings. H winding is connected in a Delta configuration. X winding is connected in a low resistance grounded Wye configuration Y winding is connected in a Delta configuration. MVA SIZE AT 55°C OA/FA/ FOA(FUTURE) H- 27 / 36 / (45) MVA X- 18 / 24 / (30) MVA Y- 12 / 16 / (20) MVA MVA SIZE AT 65°C OA/FA/ FOA(FUTURE) H-30.24 / 40.32 / (50.4) MVA X- 20.16 / 26.88 / (33.6) MVA Y- 13.44 / 17.92 / (22.4) MVA	The UATs are the normal source of power to the 4.16 kV and 13.8 kV systems. When the unit is operating and producing electrical power, the turbine generator output is supplied to the 4.16 kV and 13.8 kV systems through the UATs. During periods when the unit is shutdown, current flow is reversed through the GSU and supplied to the UATs from 345 kV switchyard. Two UATs provide an immediate access circuit from the offsite source to the onsite electrical distribution system, providing power for all loads including all the engineered safety features loads. The UAT is the preferred power supply and the RAT is the alternate power supply.	• High/Low Side Open • Ground Fault • Phase-to-Phase • Internal • External	The UATs have two protection schemes, primary and backup as described below: 87UP- Differential Current Relays- These relays monitor for a total current flow through each phase of the transformer and its associated busses. The protective zone for these relays extends from the connection to the generator isophase busses to the switchgear side of the associated 13.8 kV and 4.16 kV incoming supply breakers. These relay activate the UAT transformer primary protection lockout relays (86UP). 63FPX-Sudden Pressure Relay- This relay detects internal faults within the transformer. This relay activates the UAT backup protection lockout relays (86UB). 51- Timed Overcurrent Relays – These relay monitor the current flow from A and C phases into the UAT. These relays activate the UAT backup protection lockout relays (86UB). 51NX-Ground Fault Relay- This relay monitors the ground fault current. The ground fault current from any portion 13.8 kV non-segregated bus, or the 13.8 kV switchgear bus or its connected loads return to the transformer through the grounding resistor. If the current flow to the grounding resistor exceeds the setpoint for the ground fault relay, the relay operates. This relay activates the GSU transformer backup protection lockout relay (86UB). Other Protections: Mechanical Protection Fire Protection

TABLE 5 - PROTECTIVE DEVICES

Protection Zone	Protective Device	Logic	Setpoint (Nominal)	Basis for Setpoint
4.16kV Bus E5/E6	Loss of Voltage Relays (Device 27B)	2 of 2	2975V (approximately 71.5% of 4160V)	To actuate upon complete loss of ESF Bus voltage condition
4.16kV Bus E5/E6	Degraded Voltage Relays (Device 27D)	2 of 2	3933V (approximately 95% of 4160V)	To actuate upon degraded ESF Bus voltage condition
345KV (GSU)	345 kV GSU Neutral Ground Fault Relay (Device 51N)	1 of 1	Tap- 4.0 Minimum - 4.0 Amps Set 0.6 second at 15X Pickup Instantaneous- 80 amps	The ground fault current from any portion of the transformer's high voltage windings or its connected bus returns to the GSU transformer through the neutral ground tap. If the current flow to the neutral ground trap exceeds the relay setpoints, the relay activates the GSU transformer backup protection lockout relays (86SB).
345kV (RAT)	345 kV RAT Neutral Ground Fault Relay (Device 51NH)	1 of 1	Tap- 0.5 Minimum - 0.5 Amp Set 0.6 second at 20X Pickup Instantaneous- 80 Amps	The ground fault current from any portion of the transformer's high voltage winding or its connected bus returns to the RAT transformer through the neutral ground tap. If the current flow to the neutral ground trap exceeds the relay setpoints, the relay activates the RAT transformer primary protection lockout relays (86RP).
25kV (Generator Stator)	Generator stator Ground Fault Relays (Devices GP1/TG1 and 64 TG-1)	1 of 1	GP1/TG1 64G1P – 5.0V 64G1D - 0.80 Seconds 64G2P- 0.5 V 64RAT- 0.8 64G2D - 0.80 Seconds 64GTC - 1 64-TG1 Tap A, 5.4V Minimum 5.4V Set – 0.8 Second at 60V	These relays detect a ground anywhere on the 25kV section of the generator distribution system. These relays activate to isolate the generator.
25kV (Isophase Bus)	Isophase Bus Ground Fault Relay (Device 64B)	1 of 1	Tap B, 24V Set –1.0 Second at 120V	This relay monitors the portion of the bus extending from the generator breaker to the GSU transformer and UATs. This relay activates the Generator/Transformer Overall Protection Lockout Relays (86GT).
13.8kV (UAT & RAT)	51NX	1 of 1	Time Unit Tap 2.5A, T.D. 1 Instantaneous -10Amp	The ground fault current from any portion 13.8 kV non-segregated bus, or the 13.8 kV switchgear bus or its connected loads return to the transformer through the grounding resistor. The UAT ground fault relay activates the GSU transformer backup protection lockout relay (86UB) and the RAT ground fault relay activate the RAT transformer primary protection lockout relays (86RP). In addition, the ground fault relays have been provided on each incoming line to the bus and the load feeder breakers. When energized these relays trips the appropriate circuit breakers.
4.16kV	Various	Alarm Only	Various- Alarm Only	In order to detect grounds, ground sensors have been provided on each motor circuit and load center feeder and each incoming line, including the diesel generator. Inputs from ground sensors and ground detection circuits are furnished to the station computer.