PSEG Nuclear LLC
P.O. Box 236, Hancocks Bridge, NJ 08038-0236

PSEG Nuclear LLC

OCT 23 2012

10 CFR 50.54(f)

LR-N12-0325

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

Salem Generating Station Units 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket No. 50-272 and 50-311

Subject: 90-Day Response to NRC Bulletin 2012-01: Design Vulnerability In Electric Power System

References:

1. NRC Bulletin 2012-01: Design Vulnerability in Electric Power System, dated July 27, 2012

On July 27, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to all power reactor licensees and holders of combined licenses for nuclear power reactors. Reference 1 requires that each licensee must provide a response to the requested actions within 90 days of the date of this bulletin. Attachments 1, 2, and 3 provide the responses to the requested actions. This response follows the Nuclear Energy Institute (NEI) template issued on September 5, 2012.

This letter contains no new regulatory commitments.

Should you have any questions concerning the content of this letter, please contact Brian Thomas at 856-339-2022.

IE76
NRR

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 10/23/12.
(Date)

Sincerely,

Carl J. Fricker
Site Vice President
Salem Generating Station

Attachments (3):
Attachment 1 – Response to Bulletin Required Actions
Attachment 2 – Simplified One-Line of Offsite Power Connection to ESF Buses
Attachment 3 – Tables

cc: W. Dean, Regional Administrator - NRC Region I
J. Hughey, Project Manager - USNRC
NRC Senior Resident Inspector – Salem
P. Mulligan, Manager IV, NJBNE
Commitment Coordinator – Salem
PSEG Commitment Coordinator – Corporate

Salem 2012-01 Bulletin Response

Overview:

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

System Description

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

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).

See Attachment 2, for a simplified one-line diagram.

Salem Unit 1 and 2 have three offsite sources of 500kV power as described in section 8.2 of the Updated Final Safety Analysis Report (UFSAR). The 500kV sources supply a 500kV ring-bus common to Unit 1 and Unit 2. The 500kV ring-bus is divided into two (normally connected) sections which supply redundant 13.8kV through two 500/13.8kV station power transformers (SPT) to the south 13.8kV bus sections. The south 13.8kV bus sections provide offsite power to four (4) 13.8/4.16kV station power transformers (13, 14, 23, and 24). The 13 and 14 SPTs provide normal and alternate power to the three (3) Unit 1 ESF buses (1A, 1B, and 1C) along with the Unit 1 circulating water buses. The 23 and 24 SPTs provide normal and alternate power to the three (3) Unit 2 ESF buses (2A, 2B, and 2C) along with the Unit 2 circulating water buses.

Several key features characterize Salem's onsite power distribution system:

- Three ESF buses (A, B & C) are normally powered directly from one of two independent sources of offsite power. Two (2) buses are aligned to one SPT and one (1) bus is aligned to the other SPT.
- Normal power to each individual ESF bus is automatically transferred to alternate offsite power source if the primary becomes unavailable.
- If no offsite power source is available for an ESF bus, the bus is transferred to the standby emergency diesel generator (EDG) within 13 seconds.

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

See Attachment 3, Table 4 for offsite power transformer winding and grounding configurations.

2.a. Are the ESF buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.

For at-power (normal operating condition) configurations, ESF buses are powered by offsite sources.

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

The offsite power transformers normally supplying the ESF buses also provide power to the two circulating water (CW) buses on each unit as shown in attachment 2. Each CW bus provides power to three CW motors (2000 HP Each), which are normally in operation.

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.

Salem Units 1 and 2 were originally licensed to the Atomic Energy Commission (AEC) proposed General Design Criteria (GDC) Criterion 39, Emergency Power for Engineered Safety Features, and subsequently reviewed to ensure that the design conformed with the intent of the "General Design Criteria for Nuclear Power Plants," dated July 7, 1971, as documented in the Salem USFAR. As discussed in the Salem Unit 1 and 2 Technical Specification bases, 'the minimum specified independent and redundant A.C. power sources and distribution systems satisfy the requirements of General Design Criterion 17 of Appendix 'A' to 10 CFR Part 50." The GDC-17 redundant offsite power sources are the load paths from the termination of the 500kV transmission network at the 500kV ring bus to the infeed breakers at each 4.16kV ESF Bus.

Current Electrical System Alignment:

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

1. 500kV switching station aligned in a breaker-and-a-half ring bus configuration with all tie breakers normally closed.

2. Three (3) 500kV Transmission sources connecting the Salem 500kV switching station to adjacent Bulk Electric switching stations located at New Freedom (5024 Line), Orchard (5021 Line) and Hope Creek (5037 Line).

3. Two (2) 500kV/13.8kV Station Power Transformers (3 SPT and 4 SPT) are supplied from the 500kV ring bus via solid bus work. 3 SPT and 4 SPT then feed 13.8kV isolated bus sections A and D that supply the 4.16kV ESF and Circulating Water Buses via (4) SPTs (13, 14, 23, 24).

4. Two (2) 500kV/13.8kV Station Power Transformers (1 SPT and 2 SPT) are supplied from the 500kV ring bus via solid bus work. 1 SPT feeds isolated 13.8kV bus sections 2 and 6, and 2 SPT feeds isolated 13.8kV bus sections 3

and 5. These 13.8kV bus sections supply power to four (4) Station Power transformers (11, 12, 21, 22) which feed the four (4) 4.16kV non-ESF buses per unit.

5. Two (2) 25kV/4.16kV three (3) Winding Aux Power Transformers (APT 1, APT 2), one per unit, with each secondary winding feeding two (2) non-ESF buses (4 total per unit) during at power operation. The transformers are connected to the main generator via the main generator isolated phase bus.

6. Two (2) 13.8/4.16kV SPT per Unit normally fed as follows:
   a. Unit 1: 13 SPT (From Bus Section A), 14 SPT (From Bus Section D)
   b. Unit 2: 23 SPT (From Bus Section D), 24 SPT (From Bus Section A)

7. Three (3) ESF buses per Unit normally fed with two (2) buses on one SPT and one (1) bus on the other SPT with the ability to automatically transfer between redundant GDC-17 sources upon actuation of the first level undervoltage protection (typical configuration below):
   a. Unit 1: ESF Bus 1A from 14 SPT, ESF Bus 1B from 13 SPT, ESF Bus 1C from 13 SPT
   b. Unit 2: ESF Bus 2A from 24 SPT, ESF Bus 2B from 23 SPT, ESF Bus 2C from 23 SPT

8. Two (2) circulating water buses per Unit normally fed as follows with the ability to transfer between redundant transformers automatically after a set time delay:
   a. Unit 1: CW Section 13 from 13 SPT, CW Section 14 from 14 SPT
   b. Unit 2: CW Section 23 from 23 SPT, CW Section 24 from 24 SPT

9. Non-ESF source alignments:
   a. Unit 1:
      i. 1E, 1H (APT 1 –At Power, 11 SPT – Startup/Shutdown)
      ii. 1F, 1G (APT 1 –At Power, 12 SPT – Startup/Shutdown)
   b. Unit 2:
      i. 2E, 2H (APT 2 –At Power, 21 SPT – Startup/Shutdown)
      ii. 2F, 2G (APT 2 –At Power, 22 SPT – Startup/Shutdown)

Onsite Distribution System Upgrade:

The Salem Unit 1 and 2 switchyard from the 500kV transmission connections to the 4.16kV buses was modified in the early 1990s. In the original plant design, the non-ESF and ESF buses shared common SPTs. This configuration caused large voltage disturbances during switching of large loads from the APT to the SPT which challenged the protective relaying systems. During the upgrade, six new station power transformers were added (3, 4, 13, 14, 23 & 24). The addition of these transformers provided completely independent power sources to the non-ESF and ESF buses.

The electrical upgrade provided two additional physically independent offsite power sources (preferred power supply system) between the offsite transmission network and the Salem onsite Class 1E distribution system (ESF bus system). These two additional physically independent sources are dedicated to provide power to the 4.16kV ESF and CW buses, whereas the original configuration shared the same supplies with the 4.16kV non-ESF buses during startup and abnormal operating alignments. The upgrade provided the benefit of isolating the 4.16kV ESF buses from the electrical transients experienced when starting large non-ESF bus loads and fast transfers between non-ESF bus sources (APT to SPT).

In the previous configuration the 1A, 1B, and 1C buses were powered by the 13.8kV north bus sections via the No. 11 and 12 SPTs and the 2A, 2B, and 2C buses were powered by the 13.8kV north bus sections via the No. 21 and No. 22 SPTs. The modification changed the configuration by having the 4.16kV ESF buses fed by the new 13, 14, 23 and 24 13.8kV/4.16kV SPTs. These SPTs are fed by the south 13.8kV Bus Section, providing two physically independent sources of offsite power to the Class 1E ESF buses.

See Attachment 3 Tables 1 for any 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:

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:

Consistent with the current licensing basis and GDC 17, existing protective circuitry is designed to separate the ESF buses from a connected offsite source due to a loss of voltage or a sustained, balanced degraded grid voltage. The protective relay systems were not specifically designed to detect a single-phase open of a three phase system. Detection of a single-phase open condition is beyond the approved design and licensing basis of the plant. The station is not currently analyzed for high impedance grounds on the offsite power system and the impact to downstream plant equipment.

500kV Switchyard - Open Phase Protection

An open circuit condition in the 500kV system will result in a minimal voltage unbalanced 13.8kV or 4.16kV offsite power source, due to the wye-g to delta configuration of the 500kV / 13.8kV SPTs. Therefore an open phase in the 500kV system is not expected to be detected or result in an isolation of offsite power at the 4.16kV Class 1E buses.

13.8kV Switchyard - Open Phase Protection

The 13.8kV yard is a delta connected ungrounded system. Only differential relay and ground fault protection schemes are used for bus protection and there is no undervoltage protection provided.

4.16kV System - Open Phase Protection

Although the degraded voltage protection scheme on Salem's 4.16kV ESF buses is not credited in the UFSAR to detect and automatically respond to a single-phase open circuit condition, preliminary review has shown that the Degraded Voltage Relays (SLUP) will respond to this condition by isolating the affected power source and automatically transferring the ESF bus to the EDG if the 4.16kV ESF bus single open phase persists for greater than 13 seconds.

High Impedance Faults

Salem is designed with a 500kV breaker-and-a-half ring bus configuration with three offsite transmission sources normally terminated at the ring bus. Solid buswork is run from the ring bus to the 500kV/13.8kV Station Power Transformers in the GDC-17 load path. The station is not currently analyzed for high impedance grounds on the offsite power system and the impact to downstream plant equipment, however the following design features exist which minimize the likelihood or impact of a postulated high impedance ground:

1. Based on the ring bus configuration, high impedance grounds on a single phase of an incoming transmission line would not result in discontinuity of voltage on the impacted phase due to voltage support provided by the other two lines and station generator when online connected to the bus.
2. The bus work from the 500kV ring bus to the low side of the 500kV/13.8kV station power transformers is outfitted with high speed differential relaying which rapidly clears faults upon operation.
3. The 500kV Switchyard is operated under a vegetation management program to ensure all original design clearances from bus work to ground are maintained in the current switchyard configuration.

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

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 3, 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 3, Table 5 lists ground protection and alarms on the ESF buses and the basis for the device setpoint(s).

2.b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.

Not Applicable - the ESF buses at Salem are powered by offsite power sources.

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?

Plant operating procedures do not specifically require verification of all phase voltages on the 4.16kV ESF buses. However, operating procedures require confirmation of offsite 500kV power sources each week. This validation of offsite power consists of logging the voltages, and phase currents of each of three 500kV offsite sources. ESF buses are powered from one of two possible offsite sources (i.e., two transformers, each with a separate infeed breaker to the ESF bus.) All three phases are monitored at each ESF infeed breaker. Each phase supplied to the ESF infeed breakers is monitored by 70% undervoltage relays. Loss of any or all of these phases supplying the ESF infeed breakers will result in an immediate overhead alarm to the control room operator.

<u>Consequences</u>
Items 1.b, 1.c, and 2.e request information regarding the electrical consequences of an event and will be addressed in this section:

1.b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.

Salem ESF buses are always connected to one of two offsite power sources (i.e., loaded.) In the event that both offsite sources become unavailable, as evidenced by operation of the degraded voltage or loss-of-voltage relays, the affected ESF bus(es) will be automatically transferred to the EDG following a 13-second start as noted in the UFSAR.

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.

Salem 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 condition on the credited off-site power source as described in the UFSAR and Technical Specifications. The offsite power circuits at Salem consist of two independent circuits from the offsite 500kV lines to the ESF buses as noted in the UFSAR.

Since Salem 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 undervoltage or secondary level undervoltage protection system (SLUPS). Since open phase detection was not credited in the Salem 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 in technical literature; which is a generic overview. The difficulty in applying these documents to the Salem 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 Salem specific Class 1E electric distribution system (EDS)).

Although the UFSAR does not explicitly credit single-phase open protection of the ESF buses, the buses are protected against single phasing by the ESF Second Level Undervoltage Protection (SLUP) relays. Potential transformers (PTs) are identically connected on each of the three ESF buses. Each ESF bus is equipped with two PTs measuring all three phases in a configuration which allows verification of the voltage on each phase (A-B, B-C & C-A). The undervoltage (70%), and the SLUP relays sense these PT signals and contacts from these relays provide input to the Safeguards Equipment Control (SEC) cabinets.

The configuration of the UV and SLUP relays, and the coincidence logic of the SEC, provides an SEC Mode-II, Loss-Of-Offsite-Power (LOOP) action upon loss of any single phase exceeding a 13 second period. SEC Mode-II initiates the following general sequence on the affected ESF bus(es):

1) Trips the ESF bus infeed breaker,
2) Starts the emergency diesel generators,
3) Closes the EDG infeed breaker for the ESF bus,
4) Sequences the ESF bus loads.

Salem station is therefore designed to transfer all affected ESF buses to standby power sources (EDGs) in case of a 13 second detected single-phase open condition on any 4.16kV ESF Bus. The purpose of the 13 second delay is to remain connected to the offsite power during the brief voltage sag that occurs when starting large motors such as service water pumps or circulator water pumps.

<u>500kV Switchyard:</u>

A single-phase open in the 500kV power source will affect the 500kV to 13.8kV transformer connected to that bus. Any 13.8kV bus supplied by that transformer will be affected. Any 13.8kV to 4.16kV transformer supplied by an affected 13.8kV bus will be affected. Any 4.16kV bus connected to an affected 13.8kV to 4.16kV transformer will be affected. During normal conditions, only one of the two 13.8kV buses for each unit will be affected and at most two out of the three 4.16kV buses on a unit will be affected. Based on industry technical literature, for an open phase in the primary of a Wye grounded -Delta transformer, the secondary voltages will be affected only by voltage drop due to the unbalanced currents in the primary of the transformer. The 500kV to 13.8kV transformers are lightly loaded (based on review of connected loads) and the impact of the additional unbalanced primary currents is assumed to be limited to additional voltage drop. It is assumed no protective system for the transformer or 500kV bus operates because there is no differential in current, and no over-current condition. Since the voltage phase angles are correct, and voltage is only affected by additional voltage drop in the primary windings of the 500kV to 13.8kV transformer, the transformers and buses supplied by the affected 13.8kV bus would be subject to only a voltage drop condition which is not likely to result in actuation of the SLUP relays.

A single-phase open at the 500kV level will, at the most, affect only one offsite power source.

- If the open phase occurs in one of the lines, before the connection to the Salem switchyard, the open phase will only affect that power source. The open phase will have no effect on the connected loads since the other offsite power sources are paralleled through the breaker and a half scheme bus work. Current plant operating procedures require confirmation of offsite 500kV power sources each shift. This validation of offsite power consists of logging the phase voltages, and phase currents of each of three 500kV offsite sources.
- Because the 500kV ring bus connects all offsite sources with all onsite transformers which supply offsite station power requirements, any single open-circuit failure of the 500kV ring bus will not result in loss of both offsite station power transformers which supply the 4.16kV ESF buses.
- If the open phase occurs in the 500kV bus section or the connection to the 500kV to 13.8kV transformer, the open phase will affect only that transformer, the other 500kV to 13.8kV transformer is connected to the other 500kV bus and is unaffected.

13.8kV System

A single-phase open in the 13.8kV power source will affect any 4.16kV bus supplied by a transformer connected to the 13.8kV bus with the open phase. During normal conditions, this will only affect at most two out of three ESF buses on a unit. For an open phase in the primary of a Delta-Wye grounded transformer, the transformer will provide essentially no voltage to one phase. The voltage contribution to the open phase thru back feed from the line to line connected loads on the 4.16 kV bus will develop voltage less than the degraded-voltage setpoint. Therefore the voltage on one phase to the other two phases will be less than the degraded voltage setpoint, resulting in two out three phases less than the degraded voltage setpoint, and the affected buses will be automatically transferred to the standby power source.

4.16 kV System

The degraded voltage protection system (SLUP) consists of potential transformers on two phases which develop accurate voltage inputs for all three phases. A degraded-voltage protective relay is connected to each phase. Actuation of any degraded-voltage relay in the degraded voltage protective scheme will cause transfer of the associated bus to the standby power source (the associated diesel generator). Actuation of the degraded-voltage relays in the degraded voltage protection system occurs when voltage is less than 3935v, and following a 13-Second delay.

The loads on the 4.16kV ESF buses are minimal during normal operation, however the transformers feeding the 4.16kV ESF buses also feed the circulating water 4.16kV buses that are loaded during normal operation.

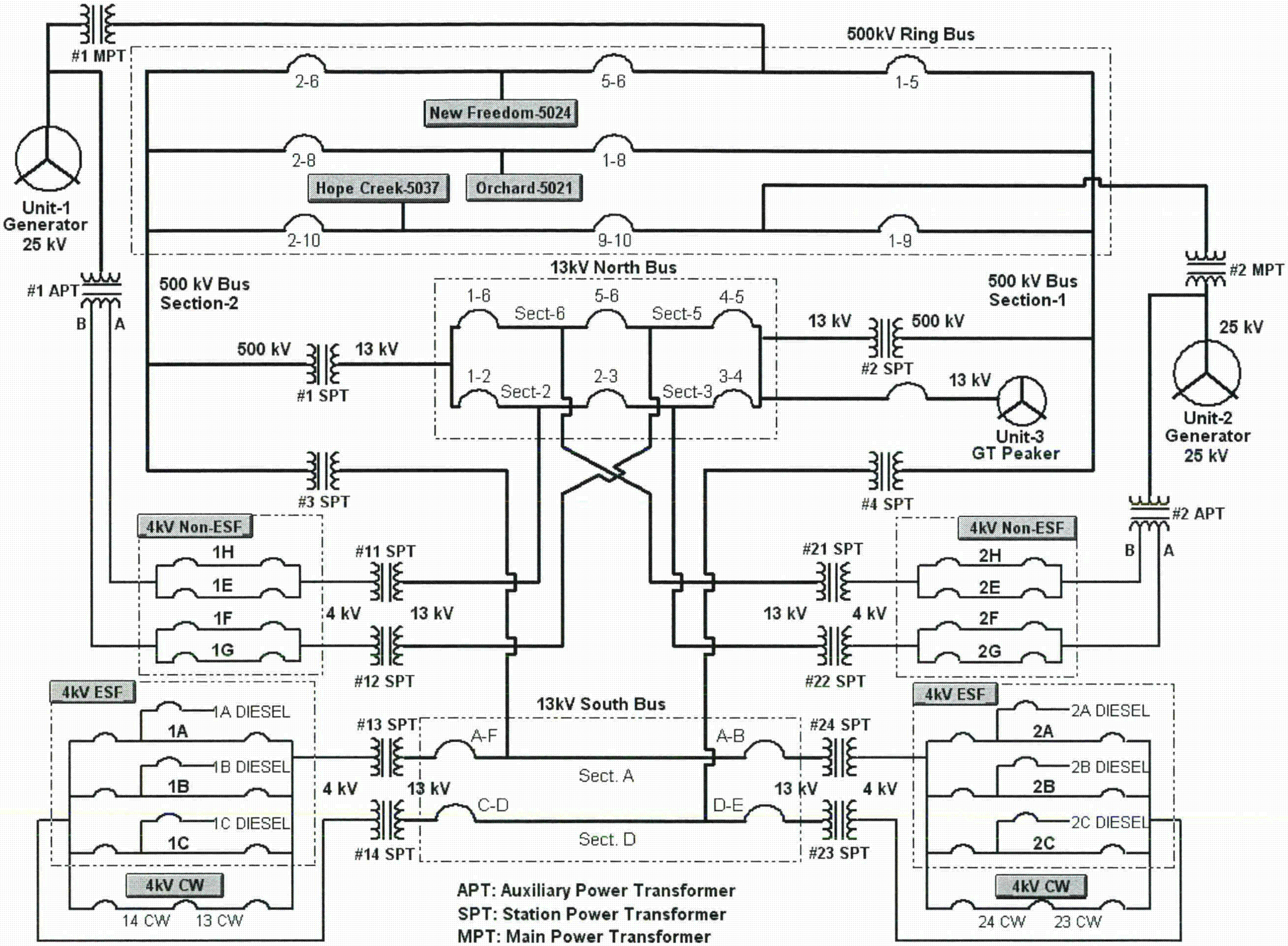
A single open phase in a 4.16kV power source will affect only the 4.16kV buses aligned to that source. During normal conditions, this will only affect at most two out of three ESF buses on a unit. There is no transformer interposed between the open phase and the degraded-voltage relays in the degraded voltage protection system. The voltage contribution to the open phase thru back feed from the line to line connected loads is assumed to develop minimal voltage compared to the degraded-voltage setpoint. Therefore the voltage on the open phase to the other two phases will be less than the degraded voltage setpoint, resulting in two out of three phases less than the degraded voltage setpoint, and the affected buses will be automatically transfer to the EDGs.

High Impedance Ground

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.

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

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



APT: Auxiliary Power Transformer
SPT: Station Power Transformer
MPT: Main Power Transformer

Two 4kV ESF buses are normally aligned to one SPT, and the remaining bus is normally aligned to the other SPT.

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)
13 SPT Via 13.8kV Bus Section A OR 14 SPT Via 13.8kV Bus Section D	1A VITAL 4.16kV	N
	1B VITAL 4.16kV	N
	1C VITAL 4.16kV	N
23 SPT Via 13.8kV Bus Section D OR 24 SPT Via 13.8kV Bus Section A	2A VITAL 4.16kV	N
	2B VITAL 4.16kV	N
	2C VITAL 4.16kV	N

Notes:

1) Buses are listed only down to the 4.16kV level.
2) 13.8kV Bus Section-A is supplied from 3 SPT (supplied from redundant 500kV offsite sources)
3) 13.8kV Bus Section-D is supplied from 4 SPT (supplied from redundant 500kV offsite sources)

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	**N/A**	**N/A**

Table 3 - ESF Buses Normally Energized Major Loads

ESF Bus	Load	Voltage Level	Rating (HP)
2A	21 Component Cooling Pump	4160	300
	22 Service Water Pump		1000
	21 Service Water Pump		1000
	2A 460 Vital Bus Transformer		1000 kVA
	2A 230 Vital Bus Transformer		300 kVA
2B	22 Component Cooling Pump		300
	24 Service Water Pump		1000
	23 Service Water Pump		1000
	2B 460 Vital Bus Transformer		1000 kVA
	2B 230 Vital Bus Transformer		300 kVA
2C	23 Component Cooling Pump		300
	26 Service Water Pump		1000
	25 Service Water Pump		1000
	2C 460 Vital Bus Transformer		1333 kVA
	2C 230 Vital Bus Transformer		300 kVA

Notes:

1) Two to four Service Water pumps are normally operating.
2) Two Component Cooling pumps are normally operating.
3) Unit-1 Loads are similar and are not listed.
4) Other ESF pump loads are occasionally started for Surveillance testing, maintenance, etc., but are not normally operating.

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA Size (AO/FA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
1 through 4 Station Power Transformers (SPT)	*525kV: Wye 13.8kV: Delta*	*112 MVA (FOA)*	*525kV / 13.8 kV*	*525kV: Grounded Neutral 13.8kV: Ungrounded*
11, 12, 13, 14, 21, 22, 23, 24 Station Power Transformers (SPT)	*13.8kV: Delta 4.16kV: Wye*	*28 MVA (FOA)*	*13.8kV / 4.16kV*	*4.16kV: Low-Impedance Grounded Neutral*

Table 5 - Protective Devices

Protection Zone	Protective Device	UV Logic	Setpoint (Nominal)	Basis for Setpoint
4.16kV ESF Buses	*Undervoltage Sustained Degraded Voltage Relay*	*2 of 3 (one phase of three) (Note-1)*	*3935v (13-Sec.) (94.6% of 4160V)*	*Three Second Level Undervoltage Protection (SLUP) relays (one for each phase) monitor each of the 4.16kV ESF buses for a sustained degradation of Offsite power. When the voltage on any phase of these buses is detected below 94.6% of the rated voltage during a 13-Second period, the affected SLUP relays drop-out. The drop-out action of these relays isolates the buses from the offsite sources, and initiates the SEC to accomplish Safeguards Loading. The 13-Second time delay is designed to prevent separation of ESF buses during worst-case anticipated plant transients.*
4.16kV ESF Buses	*Under- Voltage Relay*	*2 of 3 (one phase of three) (Note-2)*	*2912V (70% of 4160V)*	*The first level Undervoltage relays monitor the 4.16kV ESF buses to detect loss of Offsite power. When the voltage on these buses drops below 70% of the rated voltage, the undervoltage relays drop-out. The drop-out action of these relays isolates the buses from the offsite sources, and initiates the SEC to accomplish Safeguards Loading. The 70% drop-out setpoint is designed sufficiently low to prevent separation of ESF buses during worst-case anticipated plant transients.*
13.8kV Bus	*Ground Fault CV-7*	*N/A*	*140 VAC*	*To detect a phase-to-ground fault on any 13.8kV phase.*
13.8/4.16kV SPTs	*Ground Fault IAC77A*	*N/A*	*96 Amps*	*To detect 4.16kV phase-to-ground fault via high current in the neutral grounding CT.*
500kV Bus	*Differential Current*	*N/A*	*25% Slope*	*To detect system faults within the transformer differential protection zone.*

Notes:

1) Each ESF bus is designed with three (3) 94.6% UV relays (13-Second delay on drop-out), each monitoring a distinct phase. The drop-out action of any two (2) out of these three (3) 94.6% UV relays (*Single ESF Bus Degraded Voltage*) will isolate the affected ESF bus from the offsite sources, and initiate Safeguards loading.
2) Three (3) 70% UV relays each monitor one (1) distinct phase of each ESF bus. The drop-out action of any two (2) 70% UV relays (*Station Blackout*) will isolate all ESF buses from the offsite sources, and initiate Safeguards loading.