FPL

L-2012-374
10 CFR 50.54(f)
October 16, 2012

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

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
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, July 27, 2012.

The Nuclear Regulatory Commission (NRC) Bulletin 2012-01 requests all holders of active operating licenses to provide information confirming compliance with the regulatory requirements of General Design Criteria (GDC) 17, "Electric Power Systems," Appendix A to 10 CFR Part 50, or the applicable principal design criteria specified in the updated final safety analysis report; and the design criteria for protection systems under 10 CFR 50.55a(h)(2), 10 CFR 50.55a(h)(3) in writing within 90-days of the date of this bulletin. The attachment to this letter provides the information requested by the Bulletin.

Attachment 3 of the enclosure identifies those regulatory actions committed to by FPL. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments. This letter also does not revise any existing commitments.

Should you have any questions regarding this submittal, please contact Mr. Robert J. Tomonto, Licensing Manager, at (305) 246-7327.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on October 16, 2012.

Very truly yours,

for M. Kiley
Michael Kiley
Site Vice President
Turkey Point Nuclear Plant

Enclosure

cc: USNRC Regional Administrator, Region II
USNRC Project Manager, Turkey Point Nuclear Plant
USNRC Senior Resident Inspector, Turkey Point Nuclear Plant

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Enclosure
Turkey Point Units 3 and 4

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

Overview:

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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 1, for a simplified one-line diagram.

Turkey Point Nuclear Plant (PTN) consists of two nuclear generating stations. Unit 3 drives a 1032 MVA main generator at 22 KV while unit 4 drives an 894 MVA main generator at 22 KV (Pre Power Up-rate). An isolated phase bus system is used to connect the main generator to the main and auxiliary transformers. The 245.29 KV/22 KV main transformer supplies electricity to the NextEra transmission system via the Turkey Point switchyard. The 22 KV output of the generator is stepped up to 240 KV by the main transformer and connected to the switchyard. The high voltage (245.29 KV) windings are connected in a Wye configuration with a grounded neutral and the low voltage (22 KV) windings are connected in a Delta configuration. The 20.9 KV/4.16 KV auxiliary transformer (22 KV/4.38 KV unit 4) supplies power to the Engineered Safeguards Features (ESF) 4.16 KV buses A and B during normal plant operation. The primary side of the transformer is supplied with 22 KV, through disconnect links, from the main isophase bus duct which runs between the main generator and the main transformer. Its primary winding and its two secondary windings are all connected in a Delta configuration. One secondary winding supplies the ESF 4.16 KV bus A and the other secondary winding supplies ESF 4.16 KV bus B.

During normal plant operations, ESF 4.16 KV buses A and B receive power from the auxiliary transformer which is supplied by the main generator. The ESF 4.16 KV D bus will normally be energized from either the A or B bus. During startup, shutdown, or refueling conditions the ESF 4.16 KV buses A and B receive power from the startup transformers. The 230.112 KV/4.16 KV startup transformer (unit 3 & 4) supplies power to the ESF 4.16 KV buses A and B when the main generator is shutdown or when the buses are automatically transferred over to the startup from the auxiliary transformer in response to inadequate voltage or unit trip condition. During normal plant operation the startup transformers are energized and unloaded in a standby configuration. The primary side of the startup transformer is supplied with 240 KV from the switchyard. Its primary winding is connected in a Wye configuration, with a grounded neutral, and its two secondary windings are connected in a Delta configuration. The secondary winding which supplies the ESF 4.16 KV A bus can also supply the opposite Unit's ESF 4.16 KV A bus. The other secondary winding only supplies the ESF 4.16 KV B bus of its associated unit.

If for any reason the auxiliary or startup transformers are not available, each 4.16 KV bus can be powered by its associated emergency diesel generator (EDG). Each EDG is capable of starting and providing power within 15 seconds of receiving a start signal. To prevent overloading the EDGs after starting, all loads are initially tripped and essential loads are later sequenced on by an emergency load sequencer.

The ESF 4.16 KV buses supply power to the ESF 480 V load centers through 1000 KVA load center transformers. There are four ESF 480 V load centers (A, B, C, D) powered from the ESF 4.16 KV buses through 4.16 KV/ 480 V Delta to grounded Wye transformers with a fifth ESF 480 V load center (H) powered from either the 480 V C or D load centers.

Non-safety-related (NNS) bus C receives power from its own C-bus transformer which is supplied directly from the switchyard. The NNS C transformers have the capability to supply either NNS C buses. The primary side of the NNS C transformers are supplied with 240 KV. Primary windings are connected in a Wye configuration, with a grounded neutral, and the two secondary windings are connected in a Delta configuration. The C-bus transformer is a non-safety-related component and will supply only non-vital loads that are not necessary for a safe shutdown.

Both Turkey Point Unit 3 and Unit 4 nuclear plants are connected to the offsite grid through a common switchyard. Connections to the switchyard through individual bays for both units include the Main Transformer, Startup Transformer, and C-bus Transformer all utilizing a breaker and a half scheme. Nine transmission lines connect the Turkey Point switchyard to six separate grid substations. Following the OE from the Byron event, the insulators and overall health of the switchyard was reviewed. The insulators throughout the Turkey Point switchyard are not the same make or vintage of those that failed at Byron, and all insulators have been replaced within the last 8 years. Although not required, FPL is improving the electrical transmission system to improve system reliability for hurricanes and environmental events. As a result of these efforts, switchyard hardening is scheduled to take place at Turkey Point during the next upcoming outages, which will minimize the number of connection points between the switchyard and each offsite power transformer.

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

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

Note: There is one of each of the following transformers per nuclear unit; PTN has two units (3, 4).

Main Transformers: The 245.29 KV/ 22 KV main transformers at PTN take the 22 KV output of the main generators and step it up to 240 KV for output to the switchyard and ultimately the NextEra transmission system. The unit 3 main transformer is rated for 970 MVA and the unit 4 is rated for 850 MVA. Both transformers have a Wye connected winding for the high 240 KV side and a Delta connected winding for the low 22 KV side. The neutral of the high 240 KV Wye winding is grounded and monitored by a ground overcurrent relay.

Auxiliary Transformers: The 20.9 KV/4.16 KV unit 3 auxiliary transformer (22 KV/4.38 KV unit 4) supplies power to the ESF 4.16 KV buses during normal operation. The auxiliary transformers are rated for 50 MVA and have an ungrounded Delta connected primary side and two ungrounded Delta connected secondary windings. One of the secondary windings supplies ESF 4.16 KV bus A while the other supplies ESF 4.16 KV bus B during normal plant operations.

Startup Transformers: The 230.112 KV/ 4.16 KV startup transformers at PTN are normally energized and unloaded during at power operation. The startup transformers will automatically supply the A and B ESF buses via a fast transfer should the normal supply from the auxiliary transformers be interrupted. The startup transformers are rated for 33.6/44.8 MVA and have a Wye connected winding for the primary side and two Delta connected secondary windings. One of the secondary windings can supply either units ESF 4.16 KV A bus while the other winding is specifically for the associated units ESF 4.16 KV B bus. The neutral of the primary Wye winding is grounded and monitored by a ground overcurrent relay.

C Bus Transformers: The 233.025 KV/ 4.16 KV C bus transformers at PTN supplies power to the NNS 4.16 KV busses during normal operation. The C bus transformers are rated for 40/50 MVA and have a Wye connected primary side and two Delta connected secondary windings. One of the secondary windings supplies the NNS 4.16 KV bus C for its associated unit and the other secondary winding is connected to the opposite units NNS 4.16 KV C bus. The neutral of the primary Wye winding is grounded and monitored by a ground overcurrent relay.

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.

See Attachment 2, Tables 1 and 2 for ESF bus power sources

For at power (normal operating condition) configurations, ESF buses are not powered by offsite sources. The ESF buses are powered exclusively by the auxiliary transformer which is supplied from the output of the main generator. As stated above, the startup transformers are energized and in a standby configuration in the event that the supply from the auxiliary transformers is interrupted, and a fast transfer to the startup transformers is required. The below charts list the connections and loading to the ESF 4.16 KV unit 3 buses. The connections and loading is typical for unit 4 as well.

ESF 4.16 KV 3A BUS Connections/Loads					
BREAKER NO.	Bkr Position @ Normal Operation	COMPONENT	Safety Classification	Horse Power Rating	Full Load Amps
3AA01	CLOSED	Reactor Coolant Pump (3A)	Quality Related	6,000	760
3AA02	CLOSED	Unit 3 Auxiliary Transformer Supply	-	-	-
3AA03	CLOSED	Steam Generator Feed Pump (3A)	Quality Related	7,000	853
3AA05	OPEN	Unit 3 Startup Transformer Supply	-	-	-
3AA07	CLOSED	Heater Drain Pump (3A)	Non Nuclear Safety	800	102
3AA08	CLOSED	Load Center 3A Feeder	Safety Related	-	-
3AA09	OPEN	BUS TIE to 3B or 3C Switchgear	-	-	-
3AA11	CLOSED	Turbine Plant (3A) Cooling Water Pump	Non Nuclear Safety	400	54
3AA12	CLOSED	Component Cooling Water Pump (3A)	Safety Related	450	57
3AA13	OPEN	Safety Injection Pump (3A)	Safety Related	350	44.1
3AA14	CLOSED	Load Center 3C Feeder	Safety Related	-	-
3AA15	OPEN	Residual Heat Removal Pump (3A)	Safety Related	300	38
3AA16	CLOSED	Circulating Water Pump (3A1)	Non Nuclear Safety	1250	182
3AA17	CLOSED	ESF 4.16 KV D Bus Feeder	Safety Related	-	-
3AA18	CLOSED	Circulating Water Pump (3A2)	Non Nuclear Safety	1250	182
3AA19	CLOSED	Intake Cooling Water Pump (3A)	Safety Related	325	45
3AA20	OPEN	Emergency Diesel Generator Supply	Safety Related	-	-
3AA21	CLOSED	Condensate Pump (3A)	Non Nuclear Safety	2250	276
3AA22	OPEN	UNIT 4 Startup Transformer Supply	-	-	-

ESF 4.16 KV 3B BUS Connections/Loads					
BREAKER NO.	Bkr Position @ Normal Operation	COMPONENT	Safety Classification	Horse Power Rating	Full Load Amps
3AB01	CLOSED	Reactor Coolant Pump (3B)	Quality Related	6,000	760
3AB02	CLOSED	Unit 3 Auxiliary Transformer Supply	-	-	-
3AB05	OPEN	Unit 3 Startup Transformer Supply	-	-	-
3AB06	CLOSED	Reactor Coolant Pump (3C)	Quality Related	6,000	760
3AB09	CLOSED	Load Center 3B Feeder	Safety Related	-	-
3AB10	CLOSED	Heater Drain Pump (3B)	Non Nuclear Safety	800	102
3AB11	CLOSED	Turbine Plant (3B) Cooling Water Pump	Non Nuclear Safety	400	54
3AB12	OPEN	Safety Injection Pump (3B)	Safety Related	350	44.1
3AB13	CLOSED	Component Cooling Water Pump (3B)	Safety Related	450	57
3AB14	CLOSED	Load Center 3D Feeder	Safety Related	-	-
3AB15	OPEN	Residual Heat Removal Pump (3B)	Safety Related	300	38
3AB16	CLOSED	Circulating Water Pump (3B1)	Non Nuclear Safety	1250	182
3AB17	CLOSED	Intake Cooling Water Pump (3B)	Safety Related	325	45
3AB18	CLOSED	Circulating Water Pump (3B2)	Non Nuclear Safety	1250	182
3AB19	OPEN	ESF 4.16 KV D Bus Feeder	Safety Related	-	-
3AB20	OPEN	Emergency Diesel Generator Supply	Safety Related	-	-
3AB21	CLOSED	Condensate Pump (3B)	Non Nuclear Safety	2250	276
3AB22	OPEN	BUS TIE To 3A and 3C Switchgear	-	-	-

ESF 4.16 KV 3D BUS Connections/Loads					
BREAKER NO.	Bkr Position @ Normal Operation	COMPONENT	Safety Classification	Horse Power Rating	Full Load Amps
3AD01	Either	ESF 4.16 KV A Bus Supply	Safety Related	-	-
3AD04	CLOSED	Component Cooling Water Pump (3C)	Safety Related	450	57
3AD05	CLOSED	Intake Cooling Water Pump (3C)	Safety Related	325	45
3AD06	Either	ESF 4.16 KV B Bus Supply	Safety Related	-	-
3AD07	OPEN	Blackout Crosstie to ESF 4.16 3D/4D Bus	Safety Related	-	-

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.

Each unit is provided with two offsite sources of power. One of the offsite power sources for each unit, an independent 240 kV overhead feed from the Switchyard, feeds the unit's 4.16 kV "A" and "B" buses through the associated dual-secondary Startup Transformer. The other offsite source for each unit is the 4.16 kV feeder from the adjacent units' Startup Transformer to the 4.16 kV "A" bus of the unit. This alternate feed is capable of supporting the loads necessary for achieving and maintaining safe shutdown of the unit it feeds.

Four onsite Emergency Diesel Generators (EDGs) are provided with two EDGs dedicated to each unit. Although dedicated to a specific unit, each of the EDGs supplies loads which are common to both units (e.g., safety injection pumps and vital DC battery chargers). The "A" EDGs feed the "A" 4.16 kV buses and the "B" EDGs feed the 4.16 kV "B" buses of their respective units. Also, the 4.16 kV "D" bus of each unit is a swing bus, which can be powered by either of its respective 4.16 kV "A" or "B" buses.

UFSAR 8.1.1
Turkey Point Units 3 and 4 were designed prior to the implementation of 10 CFR 50, Appendix A, General Design Criteria (GDC) for Nuclear Power Plants, and utilized the criteria of 1967 proposed GDC 39, Emergency Power for Engineered Safety Features, in the design of the site electric power systems. Subsequently, 1967 proposed GDC 39 was implemented in 1971 as GDC 17, Electric power systems, and established more specific requirements than previously identified. An evaluation of the site electrical system design was performed in 1982 and concluded (Reference: FPL letter L-82-509, November 16, 1982) that Turkey Point complies with the requirements of GDC 17.

Criteria: 1. 1967 Proposed GDC 39
"Alternate power systems shall be provided and designed with adequate independency, redundancy, capacity and testability to permit the functioning required of the engineered safety features. As a minimum, the onsite power system and the offsite power system shall each, independently, provide this capacity assuming a failure of a single active component in each system."

2. GDC 17, Electric Power Systems

In order to satisfy the above criteria, independent alternate power systems are provided for each unit. These alternate power systems have adequate capacity to supply the power required for engineered safety features and protection systems. The following normal, standby and emergency power sources are available:

1. The source of auxiliary power during normal operation is the main generator and switchyard. The auxiliary transformer is connected to the generator isolated phase bus and the C bus transformer is connected to the switchyard. Both supply power to the 4.16 kV system.

2. Standby power during unit startup, shutdown and after unit trip is supplied from a startup transformer and a C bus transformer, which are connected to the switchyard 240 kV bus and feed the 4.16 kV system.

3. Four EDGs supply emergency power. Each EDG is connected to a separate power train, two per unit. With any credible single failure, the EDGs are capable of assuring a safe shut down of both units with a loss of offsite power concurrent with Maximum Hypothetical Accident (MHA) conditions in one unit.

4. Emergency power for vital instrumentation and controls is supplied from four 125V DC station batteries. Each is capable of feeding its associated load for two hours without charging. A spare 125V DC Station Battery is also provided which can be substituted for any of the four 125V DC Station Batteries to allow for maintenance or testing.

5. For each unit, a non-safety related 125V DC bus provides power to the non-safety related C-bus 4.16 kV and 480V switchgear, C-bus transformer relay panels and the turbine emergency oil pumps.

Technical Specification Bases for T.S. 3/4.8.1
Two physically independent A.C. circuits exist between the offsite transmission network and the onsite Class 1E Distribution System by utilizing the following:
(1) A total of nine transmission lines which lead to six separate transmission substations tie the Turkey Point Switchyard to the offsite power grid;

(2) Two dual-winding startup transformers each provide 100% of the A and B train 4160 volt power from the switchyard to its associated unit.

In addition, each startup transformer has the capability to supply backup power of approximately 2500 kw to the opposite unit's A-train 4160 volt bus. Two emergency diesel generators (EDG) provide onsite emergency A.C. power for each unit. EDGs 3A and 3B provide Unit 3 A-train, and 3 B-train emergency power, respectively. EDGs 4A and 4B provide Unit 4 A-train and 4 B-train emergency power, respectively.

Summary
The current licensing basis for the ESF buses was reviewed and compared to the current operating configuration. The current plant operating configuration is consistent with the licensing basis. In the power generation mode, station loads are normally powered by the main generating unit through the associated unit auxiliary transformer. However, the credited offsite power circuits for both units are the two standby startup transformers as follows:

1. Unit 3 Circuit #1- Power to ESF buses via 240 KV switchyard (Unit 3 Startup Transformer)
2. Unit 3 Circuit #2- Power to ESF Bus 3A via 240 KV switchyard (Unit 4 Startup Transformer)
3. Unit 4 Circuit #1- Power to ESF buses via 240 KV switchyard (Unit 4 Startup Transformer)
4. Unit 4 Circuit #2- Power to ESF Bus 4A via 240 KV switchyard (Unit 3 Startup Transformer)

There have been no significant changes to the original plant licensing in regard to the offsite power source alignment to the ESF buses. During a dual unit outage in the early 90s two additional Emergency Diesel Generators (Unit 4 EDGs) and the D ESF buses were added to provide additional redundancy and capacity for a Loss of Offsite Power event as well as the ability to crosstie the two units during a Station Blackout scenario. These additions did not affect the offsite power source alignment to the ESF buses.

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.***

Brief Protection Discussion:
The safety related 'A' and 'B' 4.16kV safety busses for each unit are normally supplied by the Auxiliary Transformers with the Startup Transformers unloaded and in standby. Each bus has a pair of instantaneous loss of voltage relays, monitoring across the A-B and B-C phases through an open-delta PT arrangement. These relays will drop out within the range of 45% – 60% of nominal voltage and with a 2/2 logic made up, start the LOOP process for the associated train.

The Startup Transformers have feeder breaker over current protection, differential relay protection for the transformer itself and a separate zone for the switchyard breakers up to the transformer, and primary winding neutral overcurrent protection. All of these schemes if triggered will isolate the Startup Transformer from the switchyard, which would then trigger the above loss of voltage scheme, taking the unit into the LOOP process, if the safety buses were being supplied by the Startup Transformer at the time of the triggering.

The safety related load centers are supplied from the 'A' and 'B' 4.16kV safety busses. Each load center has a delta to wye-g step-down transformer which drops the voltage to 480 V level. Multiple undervoltage/degraded voltage relay schemes monitor two of the 480 V phases (A-B, B-C) from an open-delta PT arrangement similar to the monitoring at the 4.16kV busses. The setpoints for these 2/2 logic arrangements are approximately 90% of nominal voltage, and when actuated will start the LOOP process for the associated train.

Loss of Phase at PTN:
The loss of a single phase to the primary winding of a transformer has different effects on the resultant primary and secondary voltages depending on the transformer winding configurations (i.e. delta, wye or wye-g). In the Byron event, the loss of a single phase to the primary side of their wye-g to wye-g transformer caused degraded voltage conditions on two of their secondary phases. This affect is directly related to the physical configuration of a wye-g to wye-g transformer, which will yield the voltage and current ratio change from the primary to the secondary side. As stated above, the Turkey Point Startup Transformers are physically connected in a wye-g to delta configuration, and normally in standby with no load being supplied. The lost primary phase to a non-loaded transformer is not detectable by any protection scheme or monitoring capability at PTN. The following discussion will assume that the Startup transformer (wye-g to delta) is supplying the safety buses.

The paper "A Practical Guide for Detecting Single-Phasing on a Three-Phase Power System" written and presented to the Western protective Relay Conference in October of 2002 by Basler Electric Company, concludes that a single open phase on the primary side of a wye-g to delta transformer will ideally have no affect on the voltages and currents on the secondary side. On page 31 of this paper it is stated that "If a single phase is lost in the wye source the phase to neutral voltage of the lost phase will be fairly well reproduced via the delta winding feed-back process". A key physical characteristic of the delta transformer is that the summing of the voltages in the delta loop equal 0 (VA + VB + VC = 0) and that the positive and negative sequence components in the delta loop always sum to zero. Therefore, even with a winding of the delta not receiving any energy from the primary side, the voltage across the terminals of that winding, on condition that the other two phase voltages of the primary side are normal voltages, will be equal in magnitude to the other secondary voltages. This can be seen on an open delta metering circuit where all phase voltages are available. In addition, the voltage on the open primary side phase will be back-fed from the delta secondary. Therefore, the voltages on both the wye-g and delta transformer phases are not expected to exhibit unbalanced characteristics.

This condition of a lost phase to the primary side of the Startup Transformer would increase the currents on both the unaffected primary phases to make up for the missing phase. Additionally, the transformer is expected to have reduced capacity when under these conditions. Thus, if the loading is high at the time of the event, the transformer ratings could be exceeded. An overloaded transformer condition would eventually result in a transformer trouble alarm, and plant operations would take appropriate actions (i.e. reduce load, or place buses on the EDG per plant operating procedures). The voltages on the secondary side of the transformer during this event could be lower due to the capability of the transformer, but the voltages are expected to remain balanced via the delta windings. With the voltages balanced all the degraded and undervoltage protection schemes would work as designed, and down stream equipment would also function as expected.

The specific voltage and currents on the secondary side of the transformer, and ultimately on the safety buses during this event at Turkey Point, with loading considerations and transformer characteristics, can not be completely determined without sophisticated modeling and analysis. A full modeling and analyses to evaluate all the transients and magnetic characteristics involved would be needed to understand all the affects and validate the conclusions of the Basler paper. Turkey Point does not presently have a program with this capability.

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-open phase condition is beyond the approved design and licensing basis of the plant. However, due to the secondary Delta windings of PTNs startup transformers an unbalanced condition on the secondary voltages is not expected to occur. Therefore, if the open phase condition results in a balanced yet degraded voltage condition then the undervoltage and degraded voltage protection schemes will respond to this condition by isolating the affected startup transformer and loading the associated EDG to the bus.

Normal Plant Operation Considerations:
During normal plant operation the ESF buses are powered from the unit auxiliary transformer which is supplied by the output of the main generator. An open phase on the main transformer 240kV side would have no effect on the ESF bus voltages. Since the auxiliary transformer is tied directly to the generator output terminals, it will continue to receive three phase voltage on its primary side for as long as the generator remains online. If the generator trips on negative sequence due to the open

main transformer phase, the ESF buses will automatically transfer to the standby startup transformers. Therefore, an open phase on the main transformer high side while the plant is in normal operation is not of concern.

An open phase on the auxiliary transformer primary side while the isophase generator and main transformer connections remain intact is not credible due to the isophase bus connection arrangement. It is not credible that a phase would open within the isophase bus and its housing without also shorting to ground and tripping the generator.

During normal plant operation an open single-phase on the startup transformer primary has no effect on safety bus voltage since the ESF buses are powered from the auxiliary transformer. The startup transformer is energized and in an unloaded state during normal plant operation. Thus an open single-phase on the startup transformer primary during normal operation would not affect any equipment and will not be detectable by any protection or monitoring equipment. Therefore, a walkdown of the physical connections from dedicated switchyard bay to the primary of the startup transformer has been instituted on a weekly basis. This frequency may be reevaluated in the future based on robustness of plant equipment and operating experience.

High Impedance Ground Faults

The ESF 4.16 KV buses carry large amounts of current and are housed in 4.16 KV metal clad switchgears A, B and D. 4.16 KV switchgears A and B are located in and completely enclosed by the concrete switchgear house. The ESF 4.16 KV buses are high resistance grounded, which prevents damage or abnormal operation should a single ground occur. Therefore, a 4KV bus ground will annunciate in the control room and the 4 KV Bus Ground procedure will direct operators to selectively swap equipment and open each breaker on the bus until the ground is identified. Additionally, a high impedance ground fault that occurs on the secondary side of the supplying transformer will only affect one train of the ESF buses. The other redundant ESF train will be unaffected and continue to operate as designed.

The startup transformers at Turkey Point are normally unloaded and in standby configuration should power from the auxiliary transformer be interrupted. A high impedance ground fault on the primary side of the startup transformers would not affect the ESF buses during normal operation. When the startup transformers are supplying the ESF buses, a high impedance ground fault of 240 Amps or higher, which is equivalent to a 0 + j7 Ohm or lower fault, would actuate the startup transformer neutral overcurrent protective relaying and transfer the ESF buses to their respective Emergency Diesel Generators. Additionally, the differential protection scheme that encompasses the high side primary connection at the startup transformers and beyond the switchyard supply breakers, will actuate for a fault of 397.2 Amps or higher on unit 3 (289 Amps or higher on unit 4) generated by a high impedance of 0 + j321 Ohms (0 + j441 Ohms unit 4) or lower. If the value of the high impedance is above these ohmic values then the ESF buses would continue to be supplied by the startup transformers. However, due to the high energy level and nature of a high impedance fault the condition would not remain constant for a significant period of time. Additionally, due to the secondary delta winding of the startup transformer, the secondary voltages are not expected to be unbalanced by a high impedance ground fault condition on the primary side of the transformer.

As with the single open phase event this high impedance ground fault scenario would need to be analyzed using sophisticated modeling and programming to determine actual voltages and currents that would be seen on the ESF buses. Florida Power & Light Turkey Point Plant is looking into the possibility of utilizing the ETAP 12.0.0N unbalanced load flow software to model and analyze these scenarios.

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 event, but were not designed to detect a single phase open circuit condition. However, due to the characteristics of a secondary Delta winding, the secondary voltages are not expected to be unbalanced in response to an open phase condition on the primary side of the transformer. Therefore, all analyses and calculations to determine the setpoints and protection schemes are considered valid and will respond as designed for this event. 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 on the secondary side of the supply transformers. Attachment 2, Table 5 lists ground alarm on the high resistance grounded 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.

The Startup Transformers at PTN are normally energized and not loaded. The transformers are in a standby configuration awaiting a fast transfer signal to supply the safety related busses should the power being supplied by the auxiliary transformer be interrupted. Plant procedure "Startup Transformers and Onsite A.C. Power Distribution Verification", provides the prerequisites, precautions/limitations, and instructional guidance for verifying correct breaker alignments and indicated power availability for the Startup Transformers and the Onsite A.C. Power Distribution. This surveillance satisfies the requirements of Technical Specification Section 4.8.1.1.1.a "Determined OPERABLE at least once per 7 days by verifying correct breaker alignments, indicated power availability". As documented in the Corrective Action Program, periodic visual inspections are being performed of all three high side lines from the switchyard breakers to the connections at the Startup Transformers every 7 days. In the future, this frequency maybe reevaluated in the future based on robustness of plant equipment and operating experience. The visual inspections are looking for breaks in the continuity of the cables, and areas where high impedance faulting may occur.

In addition to the visual walkdowns to inspect the high voltage lines, a night order information bulletin was sent throughout the Operations department. The night order informed Operations of the Byron event and what occurred. Additionally, this order heightened awareness to the symptoms observed at Byron during the event and the need to observe available voltage indication of the safety related busses should similar conditions occur. An unbalanced voltage condition on both safety related busses and/or multiple equipment trips on over current, while being supplied by a single source would be indicative of the problems faced by Byron during their loss of a single phase event.

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?

After a review of the plant operating procedures, no specific steps were found that call for the Operators to verify the voltage of all three phases on the ESF buses. In addition, the only location that Operations has to view the 4.16 KV phase voltage is in the control room where only one phase can be seen at a time. The Operator has to cycle through the phases with a selector switch to view all three. As discussed previously, the startup transformers are not normally loaded. The auxiliary transformer provides the power to the ESF buses during normal operation. Therefore, even if the voltages were cycled through on a periodic basis, the voltages observed would be directly off the bus which is being supplied by the auxiliary transformer.

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:

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.

Installed relays were not designed to detect single phase open circuit conditions. Existing loss of voltage and degraded voltage relays will respond due to the inherent characteristics of the Delta secondary windings of the transformers. In general, there will be no consequence for an unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source in the event of a single-phase open circuit on a credited off-site power circuit because there is insufficient current to detect a single-phase open circuit for this configuration.

The specific consequence for a loaded power source cannot be calculated without specifying the amount of loading and the specific loads involved. With a Delta secondary winding on both of Turkey Point's startup and auxiliary transformers, the secondary voltages are not expected to be unbalanced by the loss of a single phase. Therefore, the designed undervoltage and degraded voltage schemes would provide adequate protection for this event. Modeling of Turkey Points distribution system and the characteristics of the transformers would be needed to identify what all the specific effects would be on the safety buses and plant equipment due to the loss of a single phase of the off site source. Florida Power & Light Turkey Point Plant is looking into utilizing the ETAP 12.0.0N unbalanced load flow software to model and analyze the loss of a single phase event at the station.

As discussed previously, a high impedance ground fault on the secondary side of the supplying transformers would cause annunciation due to the high resistive grounding on the ESF buses. Operations would then clear the ground condition. Additionally, the high impedance ground fault could only affect one train at a time leaving the other ESF bus and train unaffected and fully capable of performing its design function. Should the fault occur on the primary side of the supply transformers, then the delta secondary windings of the transformers would prevent the secondary voltages from being unbalanced.

Similar to the loss of a single phase, a full modeling and analysis will be needed to determine actual voltages and currents on Turkey Points ESF buses during the proposed scenarios. Florida Power & Light Turkey Point Plant is looking into utilizing the ETAP 12.0.0N unbalanced load flow software to model and analyze this high impedance ground fault scenario.

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.

1. Turkey Point 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, more specifically, Chapter 8 of the UFSAR and Technical Specification 3.8.1.1. Response 2.c provides a summary of the licensing bases of Turkey Point's ESF Class 1E protection scheme.

   The offsite power circuits at Turkey Point consist of two independent circuits from the startup transformers to the ESF supply breakers.

2. Since Turkey Point 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 (DVR) scheme or secondary level undervoltage protection system (SLUPS) design criteria. Furthermore, since open phase detection was not credited in the Turkey Point 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 Turkey Point 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 Turkey Point specific Class 1E electric distribution system (EDS)).

A high impedance ground fault condition will have no immediate effect on plant operation due to the fact that the voltages are not expected to be unbalanced. If the ground is sufficiently large to affect plant operation, protective relaying will isolate the ground automatically on the primary side, and bring in the bus ground annunciator on the secondary side of the supply transformer.

The credited offsite power source for PTN's safety related busses is supplied through the station startup transformers. Both unit 3 and unit 4 have a startup transformer that is normally energized (unloaded) and in standby should the need arise to transfer station loads from the auxiliary transformer which is supplied by the output of the main generator. In this unloaded condition it is not possible to detect a single-phase open circuit condition between the safety related buses and the offsite source. With this setup the event would be a single-phase open circuit undetected on the startup transformer when the ESF buses are automatically, or manual transferred to the startup transformers.

The protection scheme at PTN is similar to the protection scheme at Byron station. The undervoltage protection that monitors for degraded and loss of voltage conditions consists of 2/2 logic. These relays monitor only the A-B and B-C phases, and would require setpoints reached on both to initiate an automatic response from the protective system. However, PTN Startup Transformers are not similar to the Byron Station Transformers. Byron has a grounded Wye primary winding to a grounded Wye secondary, which caused degraded voltage conditions on two of the three secondary phases with the loss of a single primary phase. PTN has a grounded Wye primary winding and a Delta secondary. Based on the Basler paper, bus voltages (all 3 phases) would be adequate and balanced during the loss of a phase to the primary side of the startup transformer. With the bus voltages remaining balanced in response to a single open phase event, the protective relays would respond to any degraded voltage conditions below their respective set points. Therefore, even though the protection scheme would not specifically detect a single-phase event, the secondary voltage would remain balanced which would eliminate the ill effects of a single-phase open circuit which hindered Byron station.

Even though it is expected that the voltages remain balanced at the ESF buses in response to these events, a modeled analysis at Turkey Point for specific transformer characteristics and loading considerations is needed to determine specific voltage and current levels on the plant distribution system. Florida Power & Light Turkey Point Plant is looking into the possibility of utilizing the ETAP 12.0.0N unbalanced load flow software to model and analyze these scenarios.

Periodic visual inspections are being performed of all three high side lines from the switchyard breakers to the connections at the startup transformers every seven days. This frequency maybe reevaluated in the future based on robustness of plant equipment and operating experience. The inspection will look for breaks in the continuity of the cables, and areas in which high impedance faults may occur.

A night order information bulletin was also sent throughout the Operations department. The night order informed Operations of the Byron event and what occurred. Additionally, this order heightened awareness to the symptoms observed at Byron during the event and the need to observe available voltage indication of the safety related busses should similar conditions occur. An unbalanced voltage condition on both safety related busses and/or multiple equipment trips on over current, while being supplied by a single source would be indicative of the symptoms experienced at Byron due to a loss of a single-phase of their offsite supply.

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.

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 performed. However, at PTN the secondary windings of the single offsite circuit (startup transformer) are wound in a Delta connection which would maintain the voltages on the secondary side balanced. Therefore, if the open phase condition results in a degraded voltage condition then the undervoltage and degraded voltage protection schemes would actuate and perform their intended function.

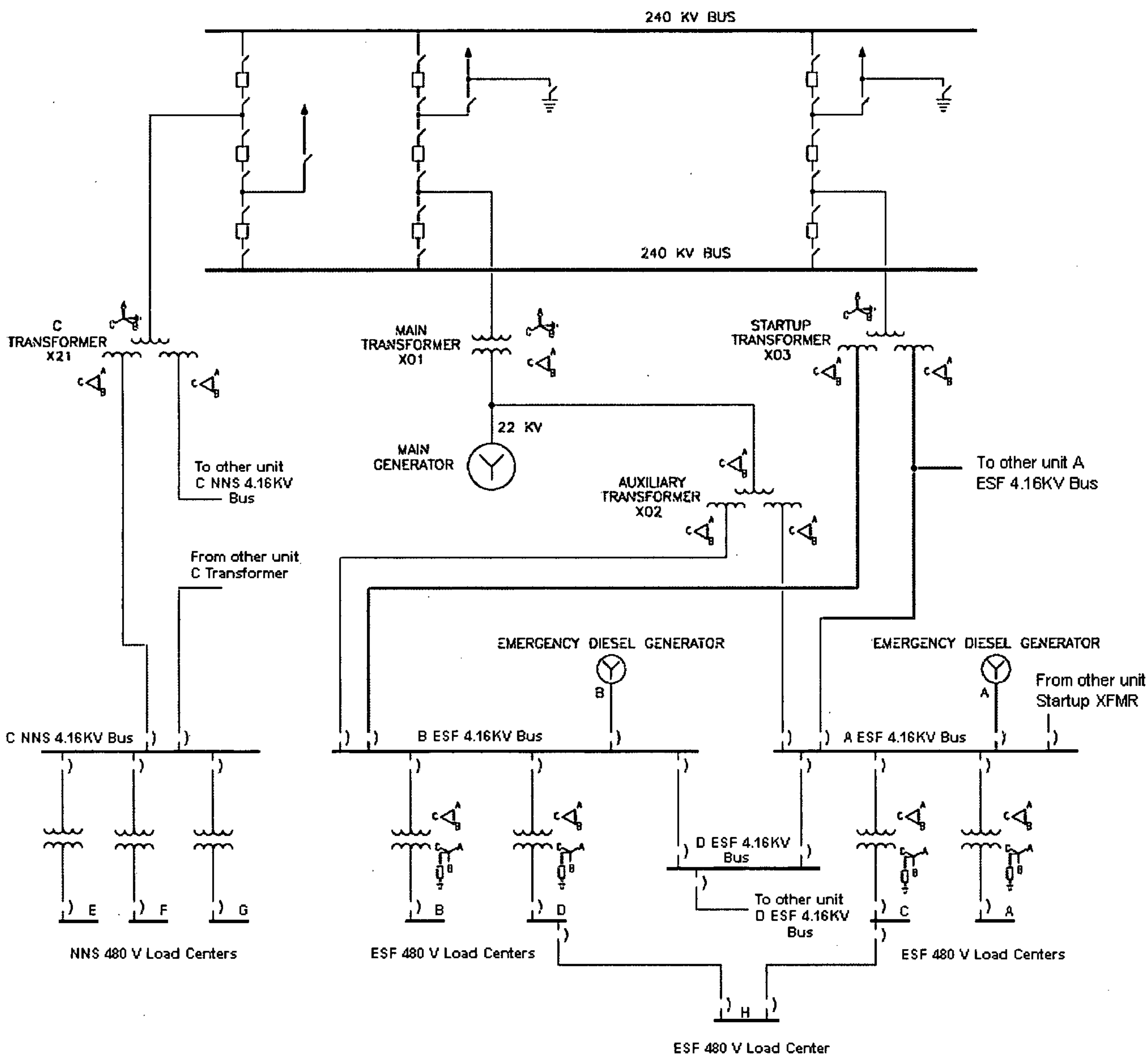
Consistent with the current station design, protective circuitry will protect from a ground fault condition with all three phases intact.

Enclosure

Attachments

Attachment 1: Turkey Point Unit 3 or 4 Simplified One-Line Diagram
Attachment 2: Tables
Attachment 3: Regulatory Commitments

Attachment 1 - Turkey Point Unit 3 or 4 Simplified One-Line Diagram



Attachment 2 - 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	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)
Unit 3 Auxiliary Transformer (UAT 3)	4.16 KV bus 3A	Y
Unit 3 Auxiliary Transformer (UAT 3)	4.16 KV bus 3B	Y
4.16 KV 3A or 3B	4.16 KV bus 3D	N Added bus in early 1990's
Unit 4 Auxiliary Transformer (UAT 4)	4.16 KV bus 4A	Y
Unit 4 Auxiliary Transformer (UAT 4)	4.16 KV bus 4B	Y
4.16 KV 4A or 4B	4.16 KV bus 4D	N Added bus in early 1990's

Table 3 - ESF Buses Normally Energized Major Safety Loads

ESF Bus	Load	Voltage Level	Rating (HP)
A	Component Cooling Water A	4.16 KV	450
A	Intake Cooling Water Pump A	4.16 KV	325
B	Component Cooling Water B	4.16 KV	450
B	Intake Cooling Water Pump B	4.16 KV	325
D	Component Cooling Water C	4.16 KV	450
D	Intake Cooling Water Pump C	4.16 KV	325

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA Size (ONAN/ONAF)	Voltage Rating (Primary/Secondary)	Grounding Configuration
Unit 3 Startup Transformer	Wye-Delta-Delta	33.6 / 44.8	230.112 KV / 4.16 KV	Primary Neutral Grounded
Unit 4 Startup Transformer	Wye-Delta-Delta	33.6 / 44.8	230.112 KV / 4.16 KV	Primary Neutral Grounded
Unit 3 Main Transformer	Wye-Delta	970	245.29 KV / 22 KV	Primary Neutral Grounded
Unit 4 Main Transformer	Wye-Delta	850	245.29 KV / 22 KV	Primary Neutral Grounded
Unit 3 C Transformer	Wye-Delta-Delta	40 / 50	233.025 KV / 4.16 KV	Primary Neutral Grounded
Unit 4 C Transformer	Wye-Delta-Delta	40 / 50	233.025 KV / 4.16 KV	Primary Neutral Grounded

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint (Nominal)	Basis for Setpoint
4 KV ESF Bus	*Loss of Voltage Relay*	*2 of 2*	*2912V (70% of 4160V)*	*To actuate upon complete loss of ESF Bus voltage condition*
4 KV ESF Bus	*Ground Detection*	*1 of 1*	*~24V (Across a 238 resistor to G)*	*High resistance grounded buses, Annunciation only. 10% of voltage for A phase to ground bus fault.*
480V ESF Bus	*Under Voltage Relay*	*2 of 2*	*~430V (89.6% of 480)*	*Instantaneous in conjunction with Safety Injection signal. Slightly different setpoints depending on Load Center.*
480V ESF Bus	*Degraded Voltage Relay*	*2 of 2*	*~424V (88.3% of 480)*	*Equipped with a 1 minute time delay. Slightly different setpoints depending on Load Center.*
480V ESF Bus	*Degraded Voltage Relay*	*2 of 2*	*~395V (82.3% of 480)*	*Inverse time delay for faster response on decreasing voltage. Slightly different setpoints depending on Load Center.*
Startup Transformer & Switchyard	*Neutral Overcurrent Relay*	*1 of 1*	*240 Amps (TAP 4 with 1.5 dial)*	*The Startup Transformer Neutral Time Overcurrent relay (64ST3, 64ST4) setpoints are based on the detection of a ground faults on the Turkey Point 240kV bus and to coordinate with transmission line backup relays.*
Startup Transformer	*Startup Differential Zone Protection*	*1 of 1*	*63 Amps (30% of 3.5 Tap High Side)*	*The High Impedance Bus Differential settings are mainly based on not operating for a fault external to the zone of protection following guidelines in the manufacturer's instruction manual. These relays are generally sensitive to internal faults.*
240 KV Switchyard	*Differential Zone Protection*	*1 of 1*	*397 Amps (unit 3)* *289 Amps (unit 4)*	*The High Impedance Bus Differential settings are mainly based on not operating for a fault external to the zone of protection following guidelines in the manufacturer's instruction manual. These relays are generally sensitive to internal faults.*

Attachement 3 – Regulatory Commitments

The following table identifies those actions committed to by FPL in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

REGULATORY COMMITMENT	DUE DATE/EVENT
Periodic visual inspections are being performed of all three high side lines from the switchyard breakers to the connections to the primary of the startup transformers.	Complete