PMTurkeyCOLPEm Resource

From: Franzone, Steve <Steve.Franzone@fpl.com>
Sent: Friday, June 10, 2016 1:22 PM
To: Comar, Manny
Cc: TurkeyCOL Resource; Maher, William; Burski, Raymond
Subject: [External_Sender] Chap. 8 vs Bulletin 2012-01
Attachments: 2012-01_PagesfromPART_10.pdf; Supplemental Response to NRC RAI Letter No 65.pdf; Pages from FSAR_CHAP08.pdf

Manny
As we discussed yesterday, I have attached our response to NRC Bulletin 2012-01 and the pages out of COLA Rev 7 which show where we updated our application.

Please let me know if you have further questions.

Thanks
Steve Franzone
NNP Licensing Manager - COLA
"The difference between a successful person and others is not a lack of strength, not a lack of knowledge, but rather in a lack of will." ~ Vince Lombardi
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Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. The plant calorimetric uncertainty and plant instrumentation performance is bounded by the 1% calorimetric uncertainty value assumed for the initial reactor power in the safety analysis.	Inspection will be performed of the plant operating instrumentation installed for feedwater flow measurement, its associated power calorimetric uncertainty calculation, and the calculated calorimetric values.	a) The as-built system takes input for feedwater flow measurement from a Caldon [Cameron] LEFM CheckPlus™ System; b) the power calorimetric uncertainty calculation documented for that instrumentation is based on an accepted Westinghouse methodology and the uncertainty values for that instrumentation are not lower than those for the actual installed instrumentation; and c) the calculated calorimetric power uncertainty measurement values are bounded by the 1% uncertainty value assumed for the initial reactor power in the safety analysis.

Add the following information to the information provided in the referenced DCD Tier 1 following Section 2.5.10:

2.5.11 Meteorological and Environmental Monitoring System
No entry for this system

2.5.12 Closed Circuit TV System
No Entry for this system

Add the following information to the information provided in the referenced DCD Tier 1 Section 2.6.1, as new item 4.g under the Design Description section:

4.g) The ECS provides an alarm in the MCR and automatic protection actuation if an undervoltage condition is detected on any one or more AC phases of either switchgear ECS-ES-1 or ECS-ES-2.

Add the following information to the information provided in the referenced DCD Tier 1 Section 2.6.1, as new item 4.g) in Table 2.6.1-4:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4.g) The ECS provides an alarm in the MCR and automatic protection actuation if an undervoltage condition is detected on any one or more AC phases of either switchgear ECS-ES-1 or ECS-ES-2.	i) Testing of the as-built ECS will be conducted by simulating an undervoltage condition on ECS-ES-1 and ECS-ES-2 to confirm that an MCR alarm is generated when one or more ECS bus phase voltages is below setpoint on either switchgear ECS-ES-1 or ECS-ES-2.	i) Undervoltage relays on ECS-ES-1 and ECS-ES-2 provide alarm when one or more AC phases on the 6.9 kV buses are below setpoint.
	ii) Testing of the as-built ECS will be conducted by simulating an undervoltage condition on ECS-ES-1 and ECS-ES-2 to confirm that loss of one or more ECS bus phases automatically actuates the electrical protection function logic.	ii) Undervoltage relays on ECS-ES-1 and ECS-ES-2 initiate protective action when one or more AC phases on the 6.9 kV buses are below setpoint.

Add the following information to the information provided in the referenced DCD Tier 1 following Section 2.6.11:

2.6.12 Transmission Switchyard and Offsite Power System

Table 2.6.12-1 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria for the offsite power system.

2.6.13 Offsite Retail Power System

No entry for this system.

The following non-system based site specific ITAAC are provided:

Pipe Rupture Hazard Analysis ITAAC

The ITAAC for Pipe Rupture Hazard Analysis are included in attached Table 3.8-2.

Piping Design ITAAC

The ITAAC for Piping Design are included in attached Table 3.8-3.

Waterproof Membrane ITAAC

The ITAAC for Waterproof Membrane are included in attached Table 3.8-4.

Concrete Fill ITAAC

The ITAAC for Concrete Fill are included in attached Table 3.8-5.

**Table 2.6.12-1 (Sheet 2 of 2)
Offsite Power System**

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
7. The credited GDC 17 offsite power source is monitored by an open phase condition monitoring system that can detect the following at the high voltage terminals of the transformer connecting to the offsite source, over the full range of transformer loading from no load to full load: (1) loss of one of the three phases of the offsite power source a. with a high impedance ground fault condition, or b. without a high impedance ground fault condition; or (2) loss of two of the three phases of the offsite power source a. with a high impedance ground fault condition, or b. without a high impedance ground fault condition. Upon detection of any condition described above, the system will actuate an alarm in the main control room.	i) Analysis shall be used to determine the required alarm set points for the open phase condition monitoring system to indicate the presence of open phase conditions described in the design commitment. ii) Testing of the credited GDC-17 offsite power source open phase condition monitoring system will be performed using simulated signals to verify that the as-built open phase condition monitoring system detects open phase conditions described in the design commitment and at the established set points actuates an alarm in the main control room.	i) Alarm set points for the open phase condition monitoring system to indicate the presence of open phase conditions as described in the design commitment have been determined by analysis. ii) Testing demonstrates the credited GDC 17 offsite power source open phase condition monitoring system detects open phase conditions described in the design commitment and at the established set points actuates an alarm in the main control room.

FPL.

L-2015-082
10 CFR 52.3

March 30, 2015

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

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Supplemental Response to NRC Request for
Additional Information Letter No. 065 (eRAI 6750)
Standard Review Plan Section 08.03 – Stability of Offsite Power Systems

References:

1. NRC Letter to FPL dated September 26, 2012, Request for Additional Information Letter No. 065 Related to SRP Section 08.03 – Stability of Offsite Power Systems for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application
2. FPL Letter L-2012-214 to NRC dated November 12, 2012, Schedule for Response to NRC Request for Additional Information Letter No. 065 (eRAI 6750) Standard Review Plan Section 08.03 – Stability of Offsite Power Systems
3. FPL Letter L-2012-421 to NRC dated December 4, 2012, Response to NRC Request for Additional Information Letter No. 065 (eRAI 6750) Standard Review Plan Section 08.03 – Stability of Offsite Power Systems
4. NRC Letter to Duke Energy Florida dated August 14, 2013, Request for Additional Information Letter No. 114 (eRAI 7208) Related to SRP Chapter 8.0, Electrical Power, for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application (ML13226A124)
5. Duke Energy Letter NPDNRC-2014-009 to NRC dated March 21, 2014, Christopher M. Fallon to NRC Document Control Desk, Levy County Nuclear Plant, Units 1 and 2 Supplement 2 to Response to Request for Additional Information Letter No. 114 (eRAI 7208) (ML14086A656)
6. Duke Energy Carolinas, LLC Letter WLG2014.08-02 to NRC dated August 28, 2014, William States Lee III Nuclear Supplemental Response to Request for Additional Information Letter No. 108 (eRAI 6751) (ML1425A470)

Florida Power & Light Company (FPL) provides, as Attachment 1 to this letter, its position regarding the applicability of NRC Bulletin 2012-01, Design Vulnerability in Electric Power System, to Turkey Point Units 6 & 7 and the electrical power portion of the AP1000 standard plant design.

D097
NRO

FPL provides, as Attachment 2 to this letter, its supplemental response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) 08-1 provided by NRC RAI letter No. 065 (eRAI 6750) dated September 26, 2012, (Reference 1). FPL provided a schedule for the response in FPL Letter L-2012-214 dated November 12, 2012, (Reference 2). FPL provided the initial response in FPL Letter L-2012-421 dated December 4, 2012, (Reference 3). Attachment 2 identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

The attached FPL responses are technically identical to the AP1000 pilot response provided by Duke Energy Letter NPDNRC-2014-009 to NRC dated March 21, 2014, Christopher M. Fallon to NRC Document Control Desk, Levy County Nuclear Plant, Units 1 and 2 Supplement 2 to Response to Request for Additional Information Letter No. 114 (eRAI 7208) and the Duke Energy Carolinas, LLC Letter WLG2014.08-02 to NRC dated August 28, 2014, William States Lee III Nuclear Supplemental Response to Request for Additional Information Letter No. 108 (eRAI 6751).

If you have any questions, or need additional information, please contact me at 561-691-7490.

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

Executed on March 30, 2015.

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/GRM

Attachments:

1. FPL Position Regarding the Applicability of Bulletin 2012-01 to Turkey Point Units 6 & 7
2. Supplemental Response to NRC RAI No. 08-1 (eRAI 6750)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

FPL Position Regarding the Applicability of Bulletin 2012-01 to Turkey Point Units 6 & 7

On July 27, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Bulletin 2012-01, "Design Vulnerability in Electric Power System," to all holders of operating licenses and combined licenses for nuclear power reactors. Bulletin 2012-01 requested information about each facility's electric power system designs, in light of recent operating experience involving the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station, Unit 2.

FPL Turkey Point 6 & 7 Position:

AP1000 Design:

The Electric Power portion of the AP1000 standard plant design is comprised of several systems as described in Chapter 8 of the AP1000 Design Control Document, Revision 19. These include:

- Class 1E and Emergency Power Systems
  - IDS, Class 1E DC and UPS System
- Non-Class 1E Power Systems
  - ECS, Main AC Power System
  - EDS, Non-Class 1E DC and UPS System
  - ZOS, Onsite Standby Power System

<u>Off-site Preferred Source</u>

The Preferred AC Power Supply is connected to the main generator bus and through the unit auxiliary transformers (UAT) 2A and 2B to the plant electrical distribution system and is designated as the GDC 17 credited supply.

Because of its passive safety features, the AP1000 design passive plant does not require AC power to place the plant in a safe, stable shutdown condition. The AP1000 design was granted a partial exemption from GDC 17, specifically exempting the AP1000 design from the requirement for a second GDC 17 credited offsite power source. Therefore, a second credited source of AC power from the power grid is not required. The Onsite Standby Power System (ZOS), powered by onsite standby diesel generators 2A and 2B, is non 1E and not required for safe shutdown of the plant. It does provide an alternate source of AC power to the plant electrical distribution system through medium voltage buses ES-1 and ES-2 for defense-in-depth shutdown loads.

Because of the partial GDC 17 exemption, the Maintenance Power Supply, fed through reserve auxiliary transformers (RAT) 4A and 4B, is not considered a credited GDC 17 power source. However, the medium voltage buses ES-1 and ES-2 can be manually aligned to receive power through the RATs. The medium voltage buses will automatically transfer from the UATs to the RATs in the event the credited Preferred AC Power Supply becomes unavailable due to an electrical fault.

As stated by the NRC staff in Subsection 8.2.3.2, "Conformance to Criteria (Part Exemption from GDC 17 for AC Offsite Power Sources)" of the Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design (NUREG-1793, Initial Report), "The underlying purpose of the requirement of GDC 17 to provide two offsite

power sources to the plant is to ensure sufficient power to accomplish safety functions. The AP1000 design does not rely on power from the offsite system to accomplish safety functions, and therefore, the underlying purpose of the rule is met."

Availability of offsite AC power is *"preferred"* for all modes of AP1000 plant operation including safe shutdown. However, this credited source is non-safety related and is neither designed nor required to be single-failure proof, and as such, may experience credible faults such as an open phase condition with or without high impedance ground faults. Detection of such a fault on the high side of the transformer does not improve or ensure offsite circuit capacity, capability, or reliability. The AP1000 passive design does not rely on power from the offsite circuit to perform safety functions.

<u>MSU and RAT Medium Voltage Protection</u>

The protection for the main step-up transformers (MSU) and the RATs is accomplished with a primary and a backup multifunction microprocessor-based relay. Each multifunction relay actuates a different lockout device, which in turn energizes a separate set of trip coils on each transformer breaker to isolate the affected zone.

Current transformers (CT) on each phase of the MSUs provide indication of current unbalance resulting from load imbalance, high or low impedance faults which occur concurrent with an open phase on the high side of the transformer during moderately or heavily loaded conditions. Although the existing electrical protection scheme can detect a loss of phase during heavily or moderately loaded operating conditions, detection of a loss of phase during lightly loaded conditions is improbable as the current draw approaches magnetizing currents.

The Maintenance Power Supply fed through the RATs is not a GDC 17 credited offsite power supply and is not required for safe shutdown of the plant. The Maintenance Power Supply serves as an alternate/maintenance source of AC power and was incorporated into the AP1000 design as an enhancement. All of the auxiliary transformers are fitted with the same protective features. These features are consistent with the power system protection principles outlined in IEEE 242, "IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems".

<u>Analysis and Setting of Relays</u>

The AP1000 electrical protection relay setpoints and supporting analyses have not yet been completed. If required, these will be completed prior to system turnover.

<u>Detection, Alarm, and Protection</u>

The design of the AP1000 differs significantly from the design of the existing fleet operating units. For the design of the operating units in the existing fleet the two required preferred power sources end at the safety related medium voltage busses. For the AP1000 design the one required preferred power source ends at the input to the 4 safety related battery chargers as there is no safety related AC non-safety related power. Degradation of the DC output power from the battery chargers to the batteries will be detected and alarmed in the control room. As described above, the existing

AP1000 design provides reasonable assurance that a dropped phase at the high side of the MSU will be detected within a timely manner, given that the AP1000 design is not time critical relative to the existing fleet.

If an unacceptable electrical distribution system voltage condition occurs due to a loss of phase at the high voltage side of the GDC 17 credited supply, the AP1000 plant design has means to preserve the power supply for defense-in-depth loads and to detect, alarm and protect safety related systems and components from adverse effects of unacceptable electrical distribution system voltage conditions including:

- Three phase voltage sensing, alarm, and protection on the 6.9 kV medium voltage buses ES-1 thru ES-7,
- Motor management relays for the medium voltage motors that sense, alarm and protect individual non-safety related motors from damage due to high negative sequence currents,
- Electrical protection relays on the safety related DC power source (IDS) battery chargers that sense unacceptable AC input voltage and generate alarms in the main control room (MCR), and
- Electrical monitoring and protection features on the IDS battery chargers to alert operators to other unacceptable operating conditions.

While the three phase voltage sensing relays may not detect the condition for all levels of transformer loading, the combination of these indications will provide the operator ample information to identify the dropped phase, make decisions, and take actions to restore power to defense-in-depth equipment.

Current transformers (CT) on each phase of the MSUs provide indication of current unbalance resulting from load imbalance, high impedance faults (which occur concurrent with an open phase on the high side of the transformer) or low impedance faults (which occur concurrent with an open phase on the high side of the transformer) during all conditions except lightly loaded conditions. Although the existing electrical protection scheme can detect a loss of phase during heavily or moderately loaded operating conditions, detection of a loss of phase during lightly loaded conditions is improbable as the current draw approaches magnetizing currents. Detection of an open phase on the high voltage side of the MSU with or without a high impedance fault is unlikely during lightly loaded conditions. The major challenge in selecting an open phase detection scheme is finding suitable sensing equipment. It is very difficult to find a CT with a ratio low enough to detect magnetizing currents that will not become damaged while constantly operating at saturation conditions.

The design features provided for detecting unacceptable input voltage conditions at the ES-1 and ES-2 medium voltage buses have changed. At the time of the initial response to NRC Bulletin 2012-01 (September 2012), the AP1000 design plant used an open-delta under-voltage detection scheme with 2-out-of-2 logic to provide alarm and protection functions for the 6.9 kV medium voltage buses (ES-1 thru ES-7). Subsequently, a design modification has been initiated to supplant the existing open-delta undervoltage detection scheme with a wye-wye detection scheme that uses 3 sets

of potential transformers (PT) to monitor phase to ground voltages. This upgraded connection method allows monitoring of all three phases, and detection of an unacceptable bus voltage on any phase. Electrical protection action occurs on 2 out of 3 logic and main control room (MCR) alarming on a 1 out of 3 logic.

A single high voltage open phase and/or high impedance fault condition would manifest itself as an unacceptable voltage on the medium voltage buses, during normal loading conditions, and provide multiple alarms in the MCR. Multiple alarms associated with the same phase on different medium voltage buses would support operator recognition and action including:

- Perform a controlled transfer of the affected medium voltage bus to the associated RAT, or
- Isolate the affected medium voltage bus from the electrical distribution system and enable the onsite standby diesel generators to restore AC power to the ES-1 and ES-2 bus and associated defense-in-depth loads.

If, during a single high voltage open phase and/or high impedance fault condition, the plant is minimally loaded to a point where an unacceptable voltage is undetectable via the medium voltage bus undervoltage protection and relaying scheme, high negative sequence motor trips or other running load trip alarms would provide alarms in the MCR to enable detection.

The AP1000 passive plant design inherently provides at least 72 hours for the operator to recognize unacceptable electrical system conditions and perform appropriate actions. There are no adverse impacts to the AP1000 design safe shutdown capabilities in any operating mode, including refueling and midloop operation, due to an unacceptable voltage condition on the GDC 17 credited circuit which is the Preferred AC Power Supply.

<u>DC</u>

All safety related loads for the AP1000 design are powered from the Class 1E 250 VDC batteries and the associated Class 1E 120 VAC instrument buses. These safety related loads are listed in the AP1000 Design Contol Document (DCD) Tables 8.3.2-1, 8.3.2-2, 8.3.2-3, and 8.3.2-4. There are four independent divisions of Class 1E 250 VDC battery systems. Divisions B and C have two battery banks; one battery bank is sized to supply power to safety related loads for at least 24 hours and the other battery bank is sized to supply power to a second set of safety related loads for at least 72 hours following a design basis event (including the loss of all AC power). Divisions A and D each have one 24-hour battery bank. The loads are assigned to each battery bank, depending on their required function, during the 72 hour coping period so that no manual or automatic load shedding is required for the first 24 hours.

As stated in Section 8 of the DCD:

> "The Class 1E DC and uninteruptable power supply system (UPS) provides reliable power for the safety related equipment required for the plant instrumentation, control, monitoring, and other vital functions needed

for safe shutdown of the plant. In addition, the Class 1E DC and UPS system provides power to the normal and emergency lighting in the main control room and at the remote shutdown workstation.

The Class 1E DC and UPS system is capable of providing reliable power for the safe shutdown of the plant without the support of battery chargers during a loss of all AC power sources coincident with a design basis accident (DBA). The system is designed so that no single failure will result in a condition that will prevent the safe shutdown of the plant."

The Class 1E Battery Chargers are qualified as IEEE 384 isolation devices. These provide the required separation between the non-1E AC input power and the Class 1E Battery system. Their design and qualification ensure that neither failures nor transients on the non-1E system will prevent the Class 1E batteries from performing their safety related function.

The IDS battery chargers will perform their normal charging function until an unacceptable voltage condition is sensed at the equipment input terminal. When the equipment input or output monitored electrical parameters become unacceptable and the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems. This condition results in one or more alarms in the MCR due to electrical operating conditions that do not meet acceptance criteria.

AC

Provided in DCD Figure 8.3.1-1 is the AC Power Station One Line Diagram showing high voltage and medium voltage interconnections and major equipment configurations.

From this figure, it can be seen that the AP1000 design main generator is connected to the high voltage generator bus through a generator circuit breaker. The grid is connected to the generator high voltage bus through the main step-up transformers and the grid breakers. Unit auxiliary transformers are used to step down the high voltage generator bus to the medium voltage electrical system. The medium voltage system uses the 6.9 kV switchgear to support operation of plant auxiliary systems. For example, the reactor coolant pumps are connected to the medium voltage buses through dedicated 6.9 kV breakers. RATs provide an alternate supply from the grid to the medium voltage buses.

During normal plant operation the main generator supplies power to the grid via the isophase bus. Some of this generated electrical power is directed to the medium voltage buses to support plant auxiliary systems (including the reactor coolant pumps).

Key design features of the AP1000 design electrical system that are unique in comparison to the current operating plant fleet include:

A. A GDC 17 exemption that requires only one offsite power circuit due to the use of passive safety features.

B. Use of a generator circuit breaker that enables backfeed of the medium voltage buses via the main step-up transformers (one per phase) following a generator trip.
C. An automatic transfer scheme for the medium voltage buses to enable continued electrical power supply under a zone electrical fault.
D. The majority of the medium voltage and low voltage electrical systems, including the onsite standby diesel generator portion, are non-Class 1E due to the use of passive safety features and are not required for safe shutdown of the plant.
E. The reactor coolant pump 6.9 kV switchgear is Class 1E to ensure that these pumps are tripped during a LOCA.
F. The non-Class 1E to Class 1E electrical system interface occurs at the 480 VAC interface for IDS UPS equipment (e.g., battery charger and regulating transformer). This interface is an isolation function, not a safety related load. The battery charger provides support of loads and recharging of the plant batteries when AC power is available (See DCD, Table 8.3.2-7).
G. Extended Class 1E DC battery sizing capability (24 and 72 hours).
H. Capability to accommodate a 100% load rejection transient without reactor trip.

The AP1000 design AC power system is non-safety and is not relied upon to mitigate design basis accidents or to bring the plant to a safe shutdown.

The importance of nonsafety related systems, structures and components, which include the nonsafety related AC power system, in the AP1000 has been evaluated using Probabilistic Risk Assessment (PRA) insights to identify systems, structures, and components that are important in protecting the utilities investment and for preventing and mitigating severe accidents. Technical Specifications are not required for these systems, structures and components, which includes the nonsafety related AC power system, because they do not satisfy the Technical Specification screening criteria of 10CFR50.36, c(2)(ii). In addition, the safety importance of the nonsafety related AC power system was evaluated in accordance with SECY-95-132, Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs, which sets forth the NRC policy regarding how to assess the risk importance of nonsafety related systems in passive light water reactors.

There are several criteria that are used to perform a RTNSS assessment. The first step includes evaluating nonsafety related system against criteria in the probabilistic and deterministic areas to identify the significant nonsafety related SSCs. Probabilistic criteria include the PRA event mitigation evaluation and the importance of the systems in the determination of PRA initiating frequency. AC power was not determined to be important to PRA accident mitigation. AC power was determined to have some importance during shutdown reduced inventory operation. As a result, a short-term availability control (STAC) is defined in DCD Section 16.3 that indicates that 2 out of 3 AC power supplies (2 standby diesel generators (DG) and 1 offsite connection) should be available before entering into this MODE. Also note that an additional short term availability control was added on the AC power system to be available at power to add margin for the PRA; this control indicates that 1 DG should be available in MODEs of applicability. The STACs indicate that the DGs should be maintained during power

operation because they are less risk important in that MODE than during shutdown Modes when RNS is not normally in operation.

The previously discussed STAC requires that stable onsite (from at least 1 of 2 DG) and offsite power availability (UAT or RAT) is confirmed prior to entering Modes 5 and 6, and that actions are taken if one offsite power and one onsite power supply is unavailable and cannot be restored within 12 hours. Administrative controls could be developed for operator confirmation on a 12 hour frequency prior to entries into and during these Modes.

The AP1000 design "Focus PRA" (Section 50.5.4 & 50.5.5 of the AP1000 Probabilistic Risk Assessment, APP-GW-GL-022, Revision 8) contains sensitivity runs that do not take credit for non-safety Defense in Depth systems (i.e., only credits safety related equipment and manual direct actuation system (DAS).

The Focus PRA bounds the loss of phase event in that the non-safety related AP1000 design defense in depth systems (ZOS, CCS, SWS, RNS), which are similar in function to those emergency core cooling systems (ECCS) (used in current operating plant fleet) made unavailable by a loss of all AC event at Byron, were assumed to be unavailable in the Focus PRA. The results of the Focus PRA meet the NRC goals for Core Damage Frequency and Large Release Frequency with sufficient margin.

Detection of Dropped Phase(s)

There are two conditions which should be addressed, lightly loaded conditions on the transformer and above lightly loaded. Lightly loaded meaning the transformer load level is not sufficient to cause bus voltage imbalances that result in automatic protective action from the 6.9 kV bus under-voltage detection devices. Operation in those lightly loaded conditions would be infrequent making a dropped phase during that time period less probable. In the lightly loaded condition with dropped phase(s) on the high side of the MSU with or without a high impedance fault then either high negative sequence motor trips or other running load trips would provide alarms in the MCR to support operator diagnosis and recovery actions. The motor trips would be expected to occur sporadically. The cause is identified by the operator and technical support staff, and corrective action initiated. The AP1000 design is not time critical which provides the operator ample time to make this diagnosis and take corrective action. The lightly loaded condition would only be expected to occur during a refueling outage.

During a refueling outage, normal decay heat removal is provided by the Normal Residual Heat Removal System (RNS) pumps, which are supported by the CCS and SWS. During a refueling outage, electrical system bus configurations and defense-in-depth loads are managed considering shut down risks as evaluated in the regulatory treatment of non-safety systems. Failure of the RNS (whether due to loss of offsite power, failure of a supporting system or due to direct RNS pump trip) is considered in the design, as the RNS and its supporting systems are non-safety related.

During refueling operations, the reactor vessel head is removed and the containment refueling cavity is flooded as described in the AP1000 DCD, Revision 19, subsection

6.3.3.4.4. If normal decay heat removal capability by the non-safety related RNS is lost, the containment is closed prior to reactor cavity steaming, and containment recirculation maintains core decay heat removal indefinitely.

During midloop operations, the plant is designed to remove core decay heat in the event the non-safety related RNS system is lost due to an AC power system disturbance. In the event that normal residual heat removal by the defense-in-depth RNS pumps is interrupted, core decay heat removal is achieved by the safety related passive core cooling system, using gravity injection of the in-containment refueling water storage tank and venting of the RCS through the automatic depressurization system valves as described in the AP1000 DCD, Revision 19, subsection 6.3.3.4.3. This operation continues until such time as the in-containment refueling water storage tank level drops and containment recirculation begins.

This demonstrates AC power disturbances due to a loss of phase will not affect the ability of the plant to meet the requirements of GDC 34, Residual Heat Removal, during refueling or midloop operations, as the safety related core decay heat removal capability does not depend on the normal, AC powered residual heat removal systems. Whether the voltage imbalance is detected and the Class 1E systems receive power from the batteries, or the plant motor loads begin to trip in response to negative sequence current, the safety related systems will be available to remove decay heat.

In response to operating experience and lessons learned since the Byron event, a design modification was made to supplant the existing open-delta under-voltage detection scheme with a phase-to-ground detection scheme. This upgraded connection method allows monitoring of all three phases for each medium voltage bus, and detection of an unacceptable bus voltage on any phase. The ES-1 and ES-2 buses use 3 PTs per phase. An alarm is annunciated in the main control room (MCR) in the event unacceptable voltage is sensed by 1 out of 3 PTs on any phase and an automatic electrical protection action occurs in the event unacceptable voltage is sensed by 2 out of 3 PTs on any phase.

When a single high voltage open phase and/or high impedance fault condition manifests itself as an unacceptable voltage on the medium voltage buses, multiple alarms will be provided in the MCR. Multiple alarms associated with the same phase on different medium voltage buses would support operator diagnosis and recovery actions including:

- Isolate all the medium voltage buses from the electrical distribution system, and
- Enable the onsite standby diesel generators to restore AC power to the ES-1 and ES-2 buses and associated defense-in-depth loads, or
- Perform a controlled transfer of all the medium voltage buses to the associated RAT (although not a credited GDC 17 offsite power supply and not required for safe shutdown of the plant).

Since the AP1000 design plant does not require AC power to achieve safe shutdown, the operator is allowed up to 72 hours to initiate mitigating strategies, i.e., starting and loading the ancillary diesels.

As stated previously, the AP1000 design electrical protection relay setpoints and supporting analyses have not yet been completed. These will be completed prior to fuel load.

The IDS battery charger has conventional input voltage monitoring of each input phase using two redundant Class 1E under-voltage relays per phase (27D and 27E). In Chapter 7 of the AP1000 Design Control Document (DCD), Revision 19, Figure 7.2-1 shows the interface of these relays to the safety related Protection and Safety Monitoring System (PMS) functional logic.

The 27D and 27E relays are included in the system design to detect an unacceptable input voltage" from the non-safety low voltage electrical distribution system. This design feature detects loss of AC power events.

In addition, the IDS battery charger employs several design features which provide protection and downstream DC bus support when the battery charger input or output monitored electrical parameters are unacceptable.

Plant electrical analyses, once completed, will demonstrate the voltage level imposed by normal operations (e.g., motor start transient) that the battery charger will be required to ride through without taking protective action or causing nuisance alarms.

There are no plant electrical analyses planned that will demonstrate the magnitude of voltage at the charger input terminals under a high voltage grid-side open phase with or without a ground fault condition across varying levels of fault impedance. Such analyses are not necessary since the isolation features of the IDS battery chargers and the proper operation of safety related components are not adversely influenced by AC system parameters. A formal type test will be performed on an IDS battery charger to verify expected AC input and charger DC output voltage characteristics. This data will provide input into final equipment protection setpoints.

When MCR alarms are actuated from multiple IDS battery chargers, the condition provides indication of an electrical power disturbance for a range of events, including a high voltage MSU transformer open phase condition. In the event that IDS input or output monitored electrical parameters do not fall below any of the alarm/action setpoints during an unacceptable electrical system voltage condition, the IDS battery charger will continue to provide its normal charging function with no adverse charger or Class 1E DC system impacts.

<u>Compliance Response to GDC 17</u>

In Subsection 8.2.3.2, “Conformance to Criteria (Part Exemption from GDC 17 for AC Offsite Power Sources)” of the Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design (NUREG-1793, Initial Report), the NRC states:

“The underlying purpose of the requirement of GDC 17 to provide two offsite power sources to the plant is to ensure sufficient power to accomplish safety functions. The AP1000 design does not rely on power from the offsite system to accomplish safety functions, and therefore, the underlying purpose of the rule is met without the need for two independent offsite circuits. The staff concluded that special circumstances exist, in

that, the regulation need not be applied in this particular circumstance to achieve the underlying purpose of having two offsite power sources. This meets the requirements for an exemption to GDC 17, as described in 10 CFR 50.12. Therefore, the staff concludes that an exemption to the requirements of GDC 17 for two physically independent offsite circuits is justified."

Chapter 3.1.2 of the AP1000 Design Control Document (DCD), Revision 19 describes the AP1000 design compliance to GDC 17.

Specifically, the AP1000 plant design supports an exemption to the requirement of GDC 17 for two physically independent offsite circuits by providing safety related passive systems for core cooling and containment integrity, and multiple non-safety related onsite and offsite electric power sources for other functions. Chapter 6.3 of the DCD provides additional information on the systems for core cooling.

The AP1000 plant design provides for a reliable safety related DC power source (IDS) supplied by batteries that provide power for the safety related valves and instrumentation to actuate the safety related passive systems during transient and accident conditions. This system includes the associated safety related 120 VAC distribution equipment that provides electrical power to the Class 1E protection and monitoring system (PMS). The DCD GDC 17 compliance section specifically states:

- "Although the AP1000 is designed with reliable non-safety related offsite and onsite AC power that are normally expected to be available for important plant functions, non-safety related AC power is not relied upon to maintain the core cooling or containment integrity."
- "The non-safety related AC power system is designed such that plant auxiliaries can be powered from the grid under all modes of operation."

The DCD also states that the AP1000 design onsite standby power system is not required for safe shutdown of the plant.

Provided below are specific portions of Criterion 17—Electric power systems – along with a discussion of how that topic relates to the AP1000 standard plant design.

The AP1000 design provides both an onsite and offsite electric power system. The capability of supporting the function of SSC's important to safety (safety related) is provided through the use of the Class 1E DC Power System (IDS) without reliance upon the main AC power system (ECS). Although provided by the design, availability of the main AC power system is not required to achieve or maintain plant safety. Additionally, a loss of AC event is a very low PRA contributor since it only results in the loss of some non-safety related defense in depth SSC's. The only safety function of the ECS system is to provide circuit breakers (2 per pump) for tripping of the RCP's. This function is redundant, is Class 1E and is designed to meet the single failure criterion for each pump. This function is initiated from the protection system (PMS) based on nuclear system parameters and not through the plant electrical system (ECS) relaying capabilities.

The IDS system comprises four shutdown divisions any two of which can achieve shutdown. Independent divisions of the IDS support the sole safety function of the ECS by providing redundant Class 1E control power to the trip circuit. Assuming a single division failure coincident with a loss of all AC, the remaining divisions provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. By providing both the capability and capacity with a single safety failure, the four IDS divisions have the capability to provide the required assurances and also provide the required control power support to the ECS safety function of RCP trip. Beyond the capability to trip the RCPs described previously, the AP1000 design does not require any AC power capacity or capability to assure the above conditions.

As indicated in DCD Table 8.1-1, GDC-17 is only applicable to the onsite Class 1E DC Power system as part of the plant safety bases. The IDS system is designed to provide all of the independence, redundancy, and testability associated with a Class 1E distribution system fully compliant with the single failure criterion. Only the Class 1E DC and associated AC instrument and control bus power distribution systems have Operability, Limiting Condition for Operation and Surveillance Test Requirements in the licensing basis. Unlike operating plants, there are no Technical Specification requirements for the Offsite AC Sources in the AP1000 design Tech Specs. In the Investment Protection Short Term Availability Controls, one offsite AC source and one onsite AC source is recommended to be operable in Mode 5 with the RCS open and in Mode 6 with upper internals in place or the reactor cavity less than full to support RNS System operation during shutdown periods, but the PXS system is the credited system to mitigate postulated events during Mode 5 and 6 which only requires Class 1E DC and associated AC instrument and control bus power distribution systems to perform its safety function.

GDC 17 states that electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) 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. However, the AP1000 design has an exemption to the requirement for a second offsite source. Therefore the preceding information (of this paragraph) is not applicable.

The AP1000 design requires a safety analysis input of three (3) seconds of AC power following a turbine trip with no electrical faults. However, in the Chapter 15 analyses, if the initiating event is an electrical system failure, the analyses do not assume operation of the RCPs following the turbine trip and therefore require no support from the non-Class 1E electrical system (ECS).

This defines the only requirement of the ECS system with respect to power availability during postulated events and as shown above is not a requirement if the initiating event is an electrical fault.

The AP1000 design meets these criteria. The single offsite circuit is normally available within a few seconds. The AP1000 design includes two offsite circuits; however, because only one circuit is required, the circuit does not and is not required to meet a single failure criterion or similar level of fault tolerance. If all offsite circuits are lost due to a single failure, there is no impact to credited core cooling, containment integrity, and vital safety functions while a circuit is restored assuming a coping time of 72 hours to provide alternate PCS cooling means. Additionally, provisions are included in the design to repower the PCS system pumps and PAMS cabinets plus MCR lighting and temporary cooling from the Ancillary AC diesel generators after 72 hours if power cannot be restored from an offsite circuit or from the onsite standby diesel generators.

This requirement encompasses the grid stability provision. Generally, the licensee demonstrates that the stability analysis demonstrates adequate voltage and frequency support for the following contingencies: loss of the in-unit main generator, loss of the closest unit (electrically) on the grid, loss of the largest unit on the grid, loss of the worst case transmission line, close in faults, etc.

The AP1000 design only requires the grid to be available for 3 seconds following a turbine trip with no electrical faults. This is recognized and accepted in the AP1000 design FSER based on the incredible probability of a coincident electrical fault with a reactor transient requiring RCP flow above coast down.

In addition, the SSCs that 10 CFR 50.55a(h)(3) applies to on the AP1000 standard plant design are wholly, completely, and exclusively powered by the Onsite Class 1E DC Power System (IDS). Each IDS charger has monitoring features that detect the loss of input phase voltage resulting from a grid loss of single phase or high impedance ground fault, and isolates the Class 1E system from the Non 1E system.

FSAR changes or ITAAC are not necessary because the Turkey Point Units 6 and 7 AP1000 design meets current regulatory, licensing, and design requirements as described above. The credited source is neither designed nor required to be single-failure proof, and as such may experience credible faults such as open phase condition with or without high impedance ground faults. Additional detection of such a fault on the high side of the transformer does not improve or ensure offsite source capacity, capability, or reliability. The AP1000 design does not rely on power from the offsite system to accomplish safety functions, and therefore, it is not required for the designated circuit to meet the GDC 17 requirement that the offsite power source to the plant ensure sufficient power to accomplish safety functions. As stated by the NRC staff in Subsection 8.2.3.2, Conformance to Criteria (Part Exemption from GDC 17 for AC Offsite Power Sources), of the Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design (NUREG-1793, Initial Report),

> The underlying purpose of the requirement of GDC 17 to provide two offsite power sources to the plant is to ensure sufficient power to accomplish safety functions. The AP1000 design does not rely on power from the offsite system to accomplish safety functions, and therefore, the underlying purpose of the rule is met.

However, although the design does meet the requirements of GDC 17, FPL has determined it would be prudent to install offsite power monitoring instrumentation in order to detect and alarm in the main control room. This is discussed in further detail in Attachment 2 of this letter.

Attachment 2

Supplemental Response to NRC RAI No. 08-1 (eRAI 6750)

Supplemental Reqponse to NRC RAI Letter No. PTN-RAI-LTR-065

SRP Section: 08.03 – Branch Technical Position - Stability of Offsite Power Systems

NRC RAI Number: 08-1 (eRAI 6750)

Introduction:

The initial Turkey Point Unit 6 & 7 response FPL Letter L-2012-421 dated December 4, 2012, was to NRC RAI Letter No. 065, dated September 26, 2012. However, the latest NRC questions concerning the design vulnerability in the electric power system described in NRC Bulletin 2012-01 are documented in NRC RAI Letter 114 issued on the Levy Nuclear Plant docket, dated August 14, 2013 (ML13226A124). Therefore, the following provides responses to the NRC staff's request for additional information in RAI Letter 114 with respect to the Turkey Point Units 6 & 7 combined license application (COL). These responses are equivalent to those documented in the Levy Nuclear Plant submittal to the NRC, dated March 21, 2014 (ML14086A656). All emphasis is copied from the original request (NRC to RAI Letter 114 on the Levy COL docket). Additional clarification concerning terminology is provided as follows.

- The terminology "Class 1E," "safety related," "nonsafety related," and "important to safety" are used several times in the staff's requests and in the Bulletin. For the purposes of this discussion of the AP1000 plant electrical design capabilities, the terms "Class 1E," and "important to safety" are interpreted to mean "safety related." The terms "defense-in-depth" and "nonsafety related" are used to refer to "nonsafety related" components.

NRC Request 1:

Identify which offsite circuit is credited to meet the GDC 17 requirements, considering the partial exemption for AP1000 plants.

FPL Response 1:

The credited GDC 17 offsite power supply for the AP1000 plant is the Preferred AC Power Supply shown in Figure 1. The Preferred AC Power Supply is backfed through the three single phase MSUs, labeled "MAIN STEP-UP XFMR" as shown on Figure 1. The Preferred AC Power Supply is connected to the main generator bus and through the unit auxiliary transformers (UATs) 2A and 2B to the plant electrical distribution system.

Because of its passive safety features, the AP1000 passive plant does not require AC power to place the plant in a safe, stable shutdown condition. The AP1000 design was granted a partial exemption from GDC 17, specifically exempting the AP1000 plant from the requirement for a second GDC 17 credited offsite power source. Therefore, a second credited source of AC power from the power grid is not required. The Onsite Standby Power System (ZOS), powered by onsite standby diesel generators 2A and 2B, provides an alternate source of AC power to the plant electrical distribution system through medium voltage buses ES-1 and ES-2 for defense-in-depth shutdown loads.

Because of the partial GDC 17 exemption, the Maintenance Power Supply, fed through reserve auxiliary transformers (RATs) 4A and 4B, is not considered a credited GDC 17 power source. However, the medium voltage buses ES-1 and ES-2 can be manually aligned to receive power through the RATs. The medium voltage buses will automatically transfer from the UATs to the RATs in the event the credited Preferred AC Power Supply becomes unavailable due to an electrical fault at either the MSU, the isophase bus, the UATs or the 6.9 kV non-segregated bus duct.

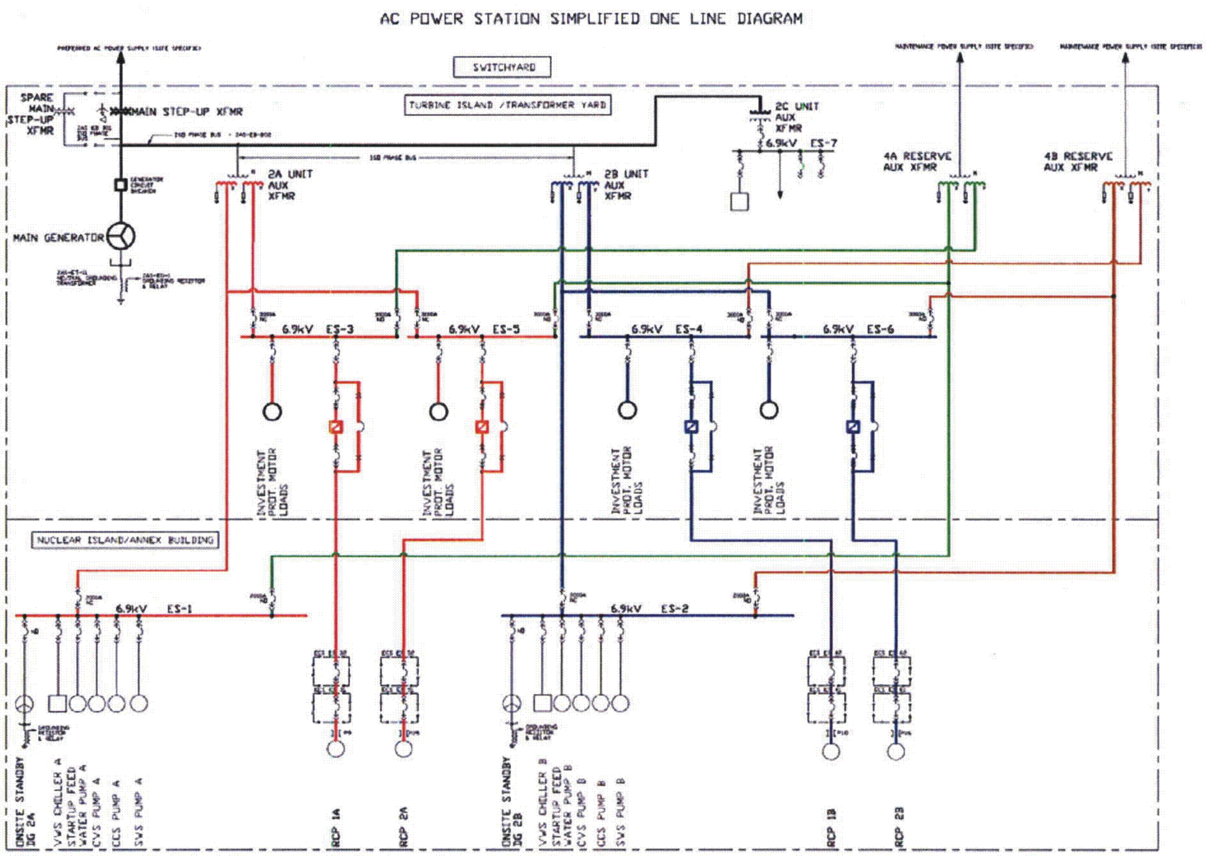

Figure 1: Main AC Power Station Simplified One-Line Diagram

NRC Request 2:

Provide details of the analyses and relay settings which can detect voltage unbalance on high voltage (HV) side of main transformer and reserve auxiliary transformer (RAT) due to the open phase condition (without and with concurrent high impedance ground on HV side of transformers) under all loading conditions including the light load conditions, and under all operating configurations. If analyses and setting of relays are not readily available, explain how these actions will be completed prior to fuel load.

FPL Response 2:

MSU and RAT Protection:

The protection for the MSUs and the RATs is accomplished with a primary and a backup multifunction microprocessor-based relay. Each multifunction relay actuates a different lockout device (86), which in turn energizes a separate set of trip coils on each transformer breaker to isolate the affected zone.

Current transformers (CT) on each phase of the MSUs provide indication of current unbalance resulting from load imbalance, high or low impedance faults which occur concurrently with an open phase on the high side of the transformer during all conditions except lightly loaded conditions. Although the existing electrical protection scheme can detect a loss of phase during heavily or moderately loaded operating conditions, detection of a loss of phase during lightly loaded conditions is improbable as the current draw approaches magnetizing currents.

The AP1000 electrical protection relay setpoints and supporting analyses have not yet been completed. These will be completed prior to fuel load.

The Maintenance Power Supply fed through the RATs is not a GDC 17 credited offsite power supply and is not required for safe shutdown of the plant. The Maintenance Power Supply serves as an alternate/maintenance source of AC power and was incorporated into the AP1000 design as an enhancement. Although they are not powered by the GDC 17 credited power supply, the RATs are fitted with protective features similar to those provided for the MSUs. These features are consistent with the power system protection principles outlined in IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

Open Phase Condition Monitoring System:

FPL will also provide an MSU transformer HV input power source open phase condition monitoring system to address the vulnerabilities described in NRC Bulletin 2012-01. The dedicated MSU transformer HV source open phase condition monitoring system will provide an alarm to the operators in the control room should an open phase condition occur on one or more phases under any transformer loading condition. The open phase condition monitoring system will be designed considering the type of open phase condition monitoring systems implemented worldwide on operating nuclear plants, particularly considering the open phase condition monitoring system(s) selected for and implemented on the NextEra Energy operating nuclear fleet plants. The system design will utilize commercially available components including state of the art digital relaying equipment and input parameters as required to provide continuous open phase condition detection and alarm capability.

NRC Request 3:

Describe the design features provided for Turkey Point Units 6 & 7 in detail and the analysis performed to verify that, in the event of a single high voltage open phase and/or high impedance fault condition, the input voltage to the safety related IDS equipment would be detected and alarmed in the main control room and the IDS chargers would automatically isolate from the degraded nonsafety related input voltage

condition for all loading conditions and operating configurations. Also, explain the design features provided and analysis performed to verify the applicant's statement that one or more main control room alarms would be generated from the safety related subsystems as a result of an undervoltage condition at the input of each IDS charger.

FPL Response 3:

There are two parts to this question that cover the medium voltage and low voltage portions of the AP1000 electrical distribution system.

Medium Voltage:

The design features provided for detecting unacceptable input voltage conditions at the ES-1 and ES-2 medium voltage buses have changed. At the time of the initial response to NRC Bulletin 2012-01 (September 2012), the AP1000 plant used an open-delta undervoltage detection scheme with 2-out-of-2 logic to provide alarm and protection functions for the 6.9 kV medium voltage buses (ES-1 thru ES-7). In response to operating experience and lessons learned since the Byron event, a design modification was made to supplant the existing open-delta undervoltage detection scheme with a phase-to-ground detection scheme. This upgraded connection method allows monitoring of all three phases for each medium voltage bus, and detection of an unacceptable bus voltage on any phase. The ES-1 and ES-2 buses use 3 potential transformers (PT) per phase, and an automatic electrical protection action occurs in the event unacceptable voltage is sensed by 2 out of 3 PTs on any single phase. In addition, an alarm is annunciated in the main control room (MCR) in the event unacceptable voltage is sensed by 1 out of 3 PTs on any single phase.

When a single high voltage open phase and/or high impedance fault condition manifests itself as an unacceptable voltage on the medium voltage buses, multiple alarms will be provided in the MCR. Multiple alarms associated with the same phase on different medium voltage buses would support operator diagnosis and recovery actions including:

- Isolate the affected medium voltage bus from the electrical distribution system, and
- Enable the onsite standby diesel generators to restore AC power to the ES-1 and ES-2 buses and associated defense-in-depth loads, or
- Perform a controlled transfer of the affected medium voltage bus to the associated RAT (although not a credited GDC 17 offsite power supply and not required for safe shutdown of the plant).

Since the AP1000 plant does not require AC power to achieve safe shutdown, the operator is allowed up to 72 hours to initiate mitigating strategies, i.e., starting and loading the ancillary diesels.

During a single high voltage open phase and/or high impedance fault condition where the plant is lightly loaded to a point an unacceptable voltage on the high voltage side of the MSUs is undetectable by the medium voltage bus undervoltage protection and relaying scheme, then either high negative sequence motor trips or other running load

trips would provide alarms in the MCR to support operator diagnosis and recovery actions.

Low Voltage:

The IDS battery chargers would continue to supply power to the Class 1E DC electrical system unless the battery charger input or output monitored electrical parameters are unacceptable. At that point, the Class 1E DC electrical system would receive power from the applicable IDS battery and the battery charger would continue to maintain isolation between the AC system and the DC system. This would subsequently result in one or more alarms in the MCR.

The AP1000 electrical protection relay setpoints and supporting analyses have not yet been completed. These will be completed prior to fuel load.

NRC Request 4:

Explain the design features provided and analyses performed to verify the applicant's statement that if the undervoltage condition manifests down to the 480 V load centers/motor control centers (MCC) fed from ES-1 and ES-2, the safety related IDS battery charger would detect an unacceptably low input phase voltage and isolate the Class 1E system from the Non 1E power system.

FPL Response 4:

The IDS battery charger has conventional input voltage monitoring of each input phase using two redundant Class 1E undervoltage relays per phase (27D and 27E). In Chapter 7 of the AP1000 Design Control Document (DCD), Revision 19, Figure 7.2-1 shows the interface of these relays to the safety related Protection and Safety Monitoring System (PMS) functional logic.

The 27D and 27E relays are included in the system design to detect "loss of acceptable input voltage" from the non-safety low voltage electrical distribution system. This design feature detects loss of AC power events.

In addition, the IDS battery charger employs several design features which provide protection and downstream DC bus support when the battery charger input or output monitored electrical parameters are unacceptable.

Plant electrical analyses, once completed, will demonstrate the voltage level imposed by normal operations (e.g., motor start transient) that the battery charger will be required to ride through without taking protective action or causing nuisance alarms.

There are no plant electrical analyses planned that will demonstrate the magnitude of voltage at the charger input terminals under a high voltage grid-side open phase with or without a ground fault condition across varying levels of fault impedance. Such analyses are not necessary since the isolation features of the IDS battery chargers and the proper operation of safety related components are not adversely influenced by AC system parameters. A formal type test will be performed on an IDS battery charger to verify expected AC input and charger DC output voltage characteristics. This data will provide input into final equipment protection setpoints.

When MCR alarms are actuated from multiple IDS battery chargers, the condition provides indication of an electrical power disturbance for a range of events, including a high voltage MSU transformer open phase condition. In the event that IDS input or output monitored electrical parameters do not fall below any of the alarm/action setpoints during an unacceptable electrical system voltage condition, the IDS battery charger will continue to provide its normal charging function with no adverse charger or Class 1E DC system impacts.

NRC Request 5:

In the event that an open phase condition on the high side of the transformer results in Unit trip and the plant house loads are supplied through the same transformer with no bus transfer or clear indication of degraded power source, provide details on the consequences on operating equipment and any impact on safe shut down capability. Explain how the defense in depth systems perform their intended design functions in this situation.

FPL Response 5:

Given that the assumed high voltage open phase condition results in a unit trip and plant house loads are supplied from the same transformer (GDC 17 source), the following conditions would exist:

- The plant would be in Mode 3; therefore, the auxiliary electrical system would not be lightly loaded
- House loads would be supplied from the MSUs via the UATs

When the phase is lost, several of the electrical system undervoltage protective relays would be expected to sense an undervoltage condition and initiate alarms in the MCR indicating that an unacceptable phase voltage exists on one or more 6.9 kV buses.

If the transformer load level is not sufficient to cause bus voltage imbalances that result in automatic protective action from the 6.9 kV bus undervoltage detection devices, then individual motor loads (including the Component Cooling Water System (CCS) and Service Water System (SWS) defense-in-depth motor loads) may begin to trip due to negative sequence motor currents higher than the trip/alarm setpoint of the motor current imbalance protective relay. These motor trips initiate alarms in the MCR and prompt operator response.

The IDS battery chargers continue to perform their normal charging function unless the battery charger input or output monitored electrical parameters are unacceptable. When the input or output monitored electrical parameters are unacceptable and the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems. This condition results in one or more alarms in the MCR.

The AP1000 passive safety systems can adequately remove core decay heat for 72 hours, without operator intervention, after a reactor trip due to a loss of phase event. This time frame is considered adequate for the operator to diagnose a phase imbalance

and perform the appropriate recovery actions. There are no adverse impacts to the AP1000 safe shutdown capabilities due to the loss of an AC phase.

Once power is restored to ES-1 and ES-2, the defense-in-depth loads are restarted manually or automatically via the diesel sequencer, depending on whether the buses are powered from the Maintenance Power Supply or the onsite standby diesel generators, respectively.

NRC Request 6:

In the event of an open phase condition occurring during a refueling outage, provide details on consequences on equipment supporting decay heat removal. Provide details if the events were to occur during mid loop operations and any malfunctions are being evaluated.

FPL Response 6:

During a refueling outage, normal decay heat removal is provided by the Normal Residual Heat Removal System (RNS) pumps, which are supported by the CCS and SWS. During a refueling outage, electrical system bus configurations and defense-in-depth loads are managed considering shut down risks as evaluated in the regulatory treatment of nonsafety systems. Failure of the RNS (whether due to loss of offsite power, failure of a supporting system or due to direct RNS pump trip) is considered in the design, as the RNS and its supporting systems are nonsafety related. System response is dependent on whether the 6.9 kV bus undervoltage condition can be detected.

If the bus loading levels are adequate to cause voltage imbalances sufficient to actuate the 6.9 kV bus undervoltage detection devices, then the bus undervoltage alarms annunciate in the MCR. The supply breaker for the ES-1 and ES-2 buses will open, disconnecting them from the faulted power source. The onsite standby diesel generators will start, the diesel load sequencers will initiate, and loads will be stripped from the ES-1 and ES-2 buses. The load sequencers subsequently restart defense-in-depth loads in groups as shown in the AP1000 DCD, Revision 19, Table 8.3.1-1 and Table 8.3.1-2 once the diesel generators are tied to the ES-1 and ES-2 buses.

If the transformer loading level is not sufficient to cause bus voltage imbalances that result in the actuation of the 6.9 kV bus voltage undervoltage detection devices, then motor trips due to negative sequence motor currents higher than the trip/alarm setpoint of the motor current imbalance protective relay would provide alarms in the MCR and prompt operator response.

Regardless of whether the undervoltage condition is detected, the IDS battery chargers would continue to perform their normal charging function unless the battery charger input or output monitored electrical parameters are unacceptable. When the input or output monitored electrical parameters are unacceptable and the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems. This condition results in one or more alarms in the MCR.

During refueling operations, the reactor vessel head is removed and the containment refueling cavity is flooded as described in the AP1000 DCD, Revision 19, subsection 6.3.3.4.4. If normal decay heat removal capability by the nonsafety related RNS is lost, the containment is closed prior to reactor cavity steaming, and containment recirculation maintains core decay heat removal indefinitely.

During midloop operations, the plant is again designed to remove core decay heat in the event the nonsafety related RNS system is lost due to an AC power system disturbance. In the event that normal residual heat removal by the defense-in-depth RNS pumps is interrupted, core decay heat removal is achieved by the safety related passive core cooling system, using gravity injection of the in-containment refueling water storage tank and venting of the RCS through the automatic depressurization system valves as described in the AP1000 DCD, Revision 19, subsection 6.3.3.4.3. This operation continues until such time as the in-containment refueling water storage tank level drops and containment recirculation begins.

This demonstrates AC power disturbances due to a loss of phase will not affect the ability of the plant to meet the requirements of GDC 34, Residual Heat Removal, during refueling or midloop operations, as the safety related core decay heat removal capability does not depend on the normal, AC powered residual heat removal systems. Whether the voltage imbalance is detected and the Class 1E systems receive power from the batteries, or the plant motor loads begin to trip in response to negative sequence current, the safety related systems will be available to remove decay heat.

NRC Request 7:

The AP1000 accident analyses assumes DC power is available for the first 72 hours of the accident and safe shutdown conditions are maintained for extended period using the onsite or offsite AC power systems. Provide a detailed explanation of impact on maintaining shutdown conditions if the offsite power source is used to support safe shutdown condition, the offsite source transformer is lightly loaded and has a loss of phase, the proposed protective relaying does not detect the adverse condition and induced voltage at the 480V level maintains the battery charger system with no alarm condition.

FPL Response 7:

If the plant is maintained in a safe shutdown condition supported by offsite power, the nonsafety related defense-in-depth RNS system (supported by the CCS and SWS) is the preferred means of residual heat removal.

If the transformer loading level is not sufficient to cause bus voltage imbalances that result in undervoltage protective actions or alarms, then motor loads are expected to trip due to negative sequence motor currents higher than the trip/alarm setpoint of the motor current imbalance protective relay, which would create alarms in the MCR and prompt operator response.

Even if the high-voltage open phase condition is disguised by impressed voltages at the IDS battery chargers, the battery chargers will continue to perform their charging function. That is, if the IDS charger DC output voltage does not fall below the monitored alarm/action setpoint, the IDS battery chargers will continue to supply power to the IDS

system. The IDS battery charger maintains isolation between the Class 1E and Non-Class 1E electrical power systems and the IDS safety functions remain operational.

In the event of loss of normal RNS cooling after a safe shutdown, the passive residual heat removal heat exchanger provides the safety related heat removal flow path. The AP1000 passive plant design allows at least 72 hours for the operator to recognize such indications and perform the appropriate actions. There are no adverse impacts to the AP1000 safe shutdown capabilities due to phase imbalance events. Long-term plant response and recovery guidance would be provided to the operating staff by the Technical Support Center.

The FPL Response to Request 4 provides a detailed description of the IDS response to an unacceptable voltage condition due to a high-voltage open phase condition.

NRC Request 8:

Explain what is meant by expected voltage imbalances on the HV side of main transformer and RAT under normal operating conditions.

FPL Response 8:

Expected voltage imbalances are defined as the average of 0-3.0 percent from approximately 98 percent of electrical supply systems surveyed per data gathered from NEMA C84.1-2011, Electric Power Systems and Equipment – Voltage Ratings (60 Hertz), January 1, 2011.

NRC Request 9:

Explain what is meant by light load conditions. Identify loads (important to safety) expected to be running under light load conditions.

FPL Response 9:

Light loading is defined as a loading condition under which the magnitude of the MSU transformer high-voltage current is equal to or less than the magnitude required for direct detection by the protective equipment of the system, described in the FPL Response to Request 2. This definition is independent of whether a high impedance fault exists.

There are no loads or systems associated with the AP1000 passive plant that are specifically categorized as "important to safety." There are only "safety related" and "nonsafety related" loads. There are several safety related components that could be operating under lightly loaded conditions. However, these systems do not require AC power to align to their safe positions or maintain their safety function.

Conclusion:

Open phase condition monitoring of the MSU transformer HV input power source that can detect an open phase condition on one or more phases under any transformer loading condition will be provided. The open phase condition monitoring system design will provide an alarm to the operators in the control room should an open phase condition on the HV source to the MSU transformers occur.

If an unacceptable electrical distribution system voltage condition occurs due to a loss of phase at the high voltage side of the GDC 17 credited MSUs or the non-credited RATs, the AP1000 plant design has means to preserve the onsite standby electrical system for defense-in-depth loads and to detect, alarm and protect safety related systems and components from adverse effects of unacceptable electrical distribution system voltage conditions including:

- Three phase voltage sensing, alarm, and protection on the 6.9 kV medium voltage buses ES-1 thru ES-7,
- Motor management relays for the medium voltage motors that sense, alarm and protect individual nonsafety related motors from damage due to high negative sequence currents,
- Electrical protection relays on the IDS battery chargers that sense AC input voltage out-of-tolerance and generate alarms in the MCR, and
- Electrical monitoring and protection features on the IDS battery chargers to alert operators to other unacceptable operating conditions.

The IDS battery chargers will perform their normal charging function until equipment input or output monitored electrical parameters are sensed out-of-tolerance. When the equipment input or output monitored electrical parameters become unacceptable and the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems. This condition results in one or more alarms in the MCR. The IDS battery chargers include additional design features that monitor critical electrical operating conditions, and are designed to create alarms in the MCR in the event electrical operating conditions do not meet acceptance criteria.

There may be auxiliary equipment loading levels, depending on plant conditions, which impede the ability of the AP1000 electrical protective relaying system to automatically isolate the Main AC Power System (ECS) 6.9 kV buses from the offsite power supply in response to an open phase condition on the high-voltage side of the MSU transformer with or without a high impedance fault. In such cases, other indications, such as battery charger trouble or medium voltage motor high negative sequence current protective relay trip alarms within the MCR would be available to alert plant operators to an abnormal condition. The AP1000 passive plant design inherently provides at least 72 hours for the operator to recognize unacceptable electrical system conditions and perform appropriate actions. There are no adverse impacts to the AP1000 safe shutdown capabilities in any operating mode, including refueling and midloop operation, due to an unacceptable voltage condition on the GDC 17 credited Preferred AC Power Supply.

In addition to the responses to the nine items requested to be addressed by the NRC, changes to the Turkey Point Units 6 & 7 COLA have been developed and are identified below. A future revision of the Turkey Point 6 & 7 COLA will reflect the changes discussed in this response.

Although this response is **PLANT SPECIFIC**, it is technically identical to AP1000 pilot response provided by Duke Energy Levy Nuclear Plant Units 1 and 2 dated March 21, 2014 (Reference 4) and the Duke Energy Carolinas, LLC Letter dated August 28, 2014 (Reference 5).

References:

1. NRC Letter to FPL dated September 26, 2012, Request for Additional Information Letter No.065 Related to SRP Section 08.03 – Stability of Offsite Power Systems for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application
2. FPL Letter L-2012-421 to NRC dated December 4, 2012, Response to NRC Request for Additional Information Letter No. 065 (eRAI 6750) Standard Review Plan Section 08.03 – Stability of Offsite Power Systems
3. NRC Letter to Duke Energy Florida dated August 14, 2013, Request for Additional Information Letter No. 114 (eRAI 7208) Related to SRP Chapter 8.0, Electrical Power, for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application
4. Duke Energy Letter NPDNRC-2014-009 to NRC dated March 21, 2014, Christopher M. Fallon to NRC Document Control Desk, Levy County Nuclear Plant, Units 1 and 2 Supplement 2 to Response to Request for Additional Information Letter No. 114 (eRAI 7208) (ML14086A656)
5. Duke Energy Carolinas, LLC Letter WLG2014.08-02 to NRC dated August 28, 2014, William States Lee III Nuclear Supplemental Response to Request for Additional Information Letter No. 108 (eRAI 6751)

ASSOCIATED COLA REVISIONS:

1. COLA Part 2, FSAR Chapter 8, Subsection 8.2.1.2.3 is added as follows:

8.2.1.2.2 Plant Response to High Voltage Open Phase Condition

A monitoring system is installed on the credited GDC 17 offsite power circuit that provides continuous open phase condition monitoring of the MSU transformer HV input power supply (see Reference 202). The system detects an open phase condition (with or without a concurrent high impedance ground on the HV side of the transformer) on one or more phases under all transformer loading conditions. The open phase condition monitoring system provides an alarm to the operators in the control room should an open phase condition occur on the HV source to the MSU transformers. The system design utilizes commercially available components including state of the art digital relaying equipment and input parameters as required to provide loss of phase detection and alarm capability.

Additionally, a high-voltage open phase condition with or without a ground fault can manifest itself as an unacceptable voltage on the 6.9 kV medium

voltage ES-1 and ES-2 buses during normal loading conditions. The presence of unacceptable voltages on the ES-1 and ES-2 buses results in isolation of the affected medium voltage bus from the offsite power supply and enables the onsite standby diesel generators to start and restore AC power to the ES-1 and ES-2 buses and associated defense-in-depth loads. The onsite AC power system is described in DCD Section 8.3.1.

Motor management relays for the medium voltage motors on ES-1 and ES-2 provide detection of unacceptably high negative sequence currents. High negative sequence current motor trips or other running load trips provide alarms in the MCR, which can assist in the detection of a high-voltage open phase condition with or without a ground fault. Electric circuit protection for the medium voltage system and equipment is described in DCD Section 8.3.1.1.1.1.

A high-voltage open phase condition with or without a ground fault can also manifest itself as an unacceptable voltage on the 480 VAC low-voltage buses powered from ES-1 and ES-2. The safety related IDS battery chargers are powered from the low-voltage buses and continue to charge the IDS batteries unless the battery charger input or output monitored electrical parameters are unacceptable. If the monitored electrical parameters degrade to the point that the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems which generates alarms in the MCR. The onsite AC power system is described in DCD Section 8.3.1 and the Class 1E DC power system is described in DCD Section 8.3.2.1.1.

Operator actions and maintenance and testing activities are addressed in procedures, as described in Section 13.5. Plant operating procedures, including off-normal operating procedures associated with the monitoring system will be developed prior to fuel load. Maintenance and testing procedures, including calibration, surveillance testing, setpoint determination and troubleshooting procedures associated with the monitoring system will be developed prior to fuel load.

Control Room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be conducted in accordance with the milestones for Non Licensed Plant Staff and Reactor Operator Training Programs in Table 13.4-201.

2. COLA Part 2, FSAR Chapter 8, a new Reference 202 is added as follows:

8.2.6 References

202. NRC Bulletin 2012-01, Design Vulnerability in Electric Power System, July 27, 2012.

3. COLA Part 10, Appendix B. Inspections, Tests, Analyses, and Acceptance Criteria, insert the following after Section 2.5.12, Closed Circuit TV System and before the discussion on DCD Tier 1 Section 2.6.11:

Add the following information to the information provided in the referenced DCD Tier 1 Section 2.6.1, as new item 4.g under the Design Description section:

4.g) The ECS provides an alarm in the MCR and automatic protection actuation if an undervoltage condition is detected on any one or more AC phases of either switchgear ECS-ES-1 or ECS-ES-2.

Add the following information to the information provided in the referenced DCD Tier 1 Section 2.6.1, as new item 4.g) in Table 2.6.1-4:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4.g) The ECS provides an alarm in the MCR and automatic protection actuation if an undervoltage condition is detected on any one or more AC phases of either switchgear ECS-ES-1 or ECS-ES-2.	**i) Testing of the as-built ECS will be conducted by simulating an undervoltage condition on ECS-ES-1 and ECS-ES-2 to confirm that an MCR alarm is generated when one or more ECS bus phase voltages is below setpoint on either switchgear ECS-ES-1 or ECS-ES-2.**	**i) Undervoltage relays on ECS-ES-1 and ECS-ES-2 provide alarm when one or more AC phases on the 6.9 kV buses are below setpoint.**
	ii) Testing of the as-built ECS will be conducted by simulating an undervoltage condition on ECS-ES-1 and ECS-ES-2 to confirm that loss of one or more ECS bus phases automatically actuates the electrical protection function logic	**ii) Undervoltage relays on ECS-ES-1 and ECS-ES-2 initiate protective action when one or more AC phases on the 6.9 kV buses are below setpoint.**

4. COLA Part 10, Appendix B. Inspections, Tests, Analyses, and Acceptance Criteria, add the following information as a new line item 7 in Table 2.6.12-1:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
7. The credited GDC 17 off-site power source is monitored by an open phase condition monitoring system that can detect the following at the high voltage terminals of the transformer connecting to the off-site source, over the full range of transformer loading from no load to full load: (1) loss of one of the three phases of the offsite power source a. with a high impedance ground fault condition, or b. without a high impedance ground fault condition; or (2) loss of two of the three phases of the offsite power source a. with a high impedance ground fault condition, or b. without a high impedance ground fault condition. Upon detection of any condition described above, the system will actuate an alarm in the main control room.	**i) Analysis shall be used to determine the required alarm set points for the open phase condition monitoring system to indicate the presence of open phase conditions described in the design commitment.**	**i) Alarm set points for the open phase condition monitoring system to indicate the presence of open phase conditions as described in the design commitment have been determined by analysis.**
	ii) Testing of the credited GDC-17 off-site power source open phase condition monitoring system will be performed using simulated signals to verify that the as-built open phase condition monitoring system detects open phase conditions described in the design commitment and at the established set points actuates an alarm in the main control room.	**ii) Testing demonstrates the credited GDC 17 off-site power source open phase condition monitoring system detects open phase conditions described in the design commitment and at the established set points actuates an alarm in the main control room.**

ASSOCIATED ENCLOSURES:

None

- Each of the 500 kV and 230 kV transmission lines is protected by two independent pilot systems that provide high-speed clearing for a fault anywhere on the line.
- The switchyard 500/230 kV autotransformers and switchyard buses have primary and secondary protective relaying systems that provide high-speed clearing for a fault within the switchyard.
- The 230 kV circuits to the main step-up and reserve auxiliary transformers have primary and secondary protective relaying systems located in the switchyard control building that communicate via fiber optics to the associated protective relaying system located in the plant.

Breaker failure relays are provided for all switchyard breakers to isolate a failed breaker from all switchyard sources. In addition, for the switchyard breakers connected to the main step-up and reserve auxiliary transformers, the remote sources are isolated using direct transfer trip communication.

The protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip.

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8.2.1.2.2 Plant Response to High Voltage Open Phase Condition

A monitoring system is installed on the credited GDC 17 offsite power circuit that provides continuous open phase condition monitoring of the main step-up (MSU) transformer high voltage (HV) input power supply (Reference 202). The system detects an open phase condition (with or without a concurrent high impedance ground on the HV side of the transformer) on one or more phases under all transformer loading conditions. The open phase condition monitoring system provides an alarm to the operators in the control room should an open phase condition occur on the HV source to the MSU transformers. The system design utilizes commercially available components including state of the art digital relaying equipment and input parameters as required to provide loss of phase detection and alarm capability.

Additionally, a high-voltage open phase condition with or without a ground fault can manifest itself as an unacceptable voltage on the 6.9 kV medium voltage ES-1 and ES-2 buses during normal loading conditions. The presence of unacceptable voltages on the ES-1 and ES-2 buses results in isolation of the affected medium voltage bus from the offsite power supply and enables the onsite

standby diesel generators to start and restore AC power to the ES-1 and ES-2 buses and associated defense-in-depth loads. The onsite AC power system is described in DCD Section 8.3.1.

Motor management relays for the medium voltage motors on ES-1 and ES-2 provide detection of unacceptably high negative sequence currents. High negative sequence current motor trips or other running load trips provide alarms in the main control room (MCR), which can assist in the detection of a high-voltage open phase condition with or without a ground fault. Electric circuit protection for the medium voltage system and equipment is described in DCD Section 8.3.1.1.1.1.

A high-voltage open phase condition with or without a ground fault can also manifest itself as an unacceptable voltage on the 480 VAC low-voltage buses powered from ES-1 and ES-2. The safety related IDS battery chargers are powered from the low-voltage buses and continue to charge the IDS batteries unless the battery charger input or output monitored electrical parameters are unacceptable. If the monitored electrical parameters degrade to the point that the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation between the Non-Class 1E AC and Class 1E DC power systems which generates alarms in the MCR. The onsite AC power system is described in DCD Section 8.3.1 and the Class 1E DC power system is described in DCD Section 8.3.2.1.1.

Operator actions and maintenance and testing activities are addressed in procedures, as described in Section 13.5. Plant operating procedures, including off-normal operating procedures associated with the monitoring system, will be developed prior to fuel load. Maintenance and testing procedures, including calibration, surveillance testing, setpoint determination and troubleshooting procedures associated with the monitoring system, will be developed prior to fuel load.

Control Room operator and maintenance technician training associated with the operation and maintenance of the monitoring system will be conducted in accordance with the milestones for Non-Licensed Plant Staff and Reactor Operator Training Programs in Table 13.4-201.