Progress Energy

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September 14, 2012

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

LEVY NUCLEAR PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030
RESPONSE TO NRC RAI LETTER 109 – STABILITY OF OFFSITE POWER SYSTEMS

Reference: 1. Letter from Jerry Hale (NRC) to Christopher Fallon (PEF), dated August 15, 2012, "Request for Additional Information Letter No. 109 Related to SRP Section 8.3 for the Levy County Nuclear Plant, Units 1 and 2 Combined License Application."

Ladies and Gentlemen:

Progress Energy Florida, Inc. (PEF) hereby submits a response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) provided in Reference 1.

A response addressing the information requested in the RAI is contained in the enclosure.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (704) 382-9248.

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

Executed on September 14, 2012.

Sincerely,

Christopher M. Fallon

Christopher M. Fallon
Vice President
Nuclear Development

Enclosure

cc : U.S. NRC Region II, Regional Administrator
Mr. Donald Habib, U.S. NRC Project Manager
Mr. Jerry Hale, U.S. NRC Project Manager

Progress Energy Florida, Inc.
P.O. Box 14042
St. Petersburg, FL 33733

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NRO

Levy Nuclear Plant Units 1 and 2 (LNP)
Response to NRC Request for Additional Information Letter No. 109 Related to SRP Section 8.3, Dated 8/15/2012

NRC RAI #	Progress Energy RAI #	Progress Energy Response
08-1	L-1008	Response enclosed – see following pages

NRC Letter No.: LNP-RAI-LTR-109

NRC Letter Date: August 15, 2012

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08-1

Text of NRC RAI:

Subject: SRP Section 08-03 – Stability of Offsite Power Systems

To confirm that the proposed Levy facility complies with 10 CFR 50.55a(h)(3), and Appendix A to 10 CFR Part 50, GDC 17, the NRC requests the Applicant to address the following two issues related to its electric power systems:

Given the requirements above, describe how the protection scheme for ES-1 and ES-2 buses 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 source.

Also, include the following information:

a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).
b. The differences (if any) of the consequences of a loaded (i.e., ES bus normally aligned to offsite power transformer) or unloaded (e.g., ES buses normally aligned to unit auxiliary transformer) power source.
c. If the design does not detect and automatically respond to all single-phase open circuit condition or high impedance ground fault conditions on a credited offsite power circuit or another power source, describe the consequences of such an event and the plant response.
d. Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

Briefly describe the operating configuration of the ES-1 and ES-2 buses at power (normal operating condition). Include the following details:

a. Are the ES buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.
b. If the ES buses are not powered by offsite power sources, explain how 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.
c. Confirm that the operating configuration of the ES buses is consistent with the current licensing basis. Describe any departures in offsite power source alignment to the ES buses from the original plant licensing.
d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ES buses?
e. If a common or single offsite circuit is used to supply redundant ES buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ES buses.

PGN RAI ID #: L-1008

PGN Response to NRC RAI:

The proposed Levy facility employs the AP1000 advanced passive pressurized water reactor for each of its two plants. The AP1000 design was certified, as amended, on December 30, 2011, based on the design control document (DCD) for the AP1000 design at Revision 19.

1.0 INTRODUCTION

The information requested in this RAI appears to be closely related to the information requested by the NRC in Bulletin 2012-01, Design Vulnerability in Electric Power System, issued on July 27, 2012. The Bulletin specifically states the following as it relates to the AP1000 design:

- "The plants with combined licenses reference the standard AP1000 design certified in 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants," Appendix D. For AP 1000 reactors, the main alternating current (ac) power system is non-Class 1E and is not safety-related. During a loss of offsite power, ac power is supplied by the onsite standby diesel-generators, which are also not safety-related. However, the ac power system is designed such that plant auxiliaries can be powered from the grid under all modes of operation. Further, the ac power systems do supply power to equipment that is important to safety since that equipment serves defense-in-depth functions, as follows: The offsite power supply system provides power to the safety-related loads through the battery chargers, and both the offsite power system and the standby diesel generators provide defense-in-depth functions to supplement the capability of the safety-related passive systems for reactor coolant makeup and decay heat removal. In this regard, offsite power is the preferred power source, and supports the first line of defense. In addition, the safety analyses take credit for the grid remaining stable to maintain reactor coolant pump operation for three seconds following a turbine trip in accordance with the guidance of RG 1.206. Accordingly, these electric power systems are important to safety, and subject to the requirements of GDC 17."
- "For the AP1000 reactors, the ac power system is designed such that plant auxiliaries can be powered from the grid or the standby non-class 1E system under all modes of operation. The offsite power system provides power to the safety-related loads through the battery chargers and provides defense-in-depth capabilities for reactor coolant make-up and decay heat removal during normal, abnormal, and accident conditions. Since the primary means for accident and consequence mitigation in these reactors are not dependent on ac power, the ac power systems are not as risk-important as they are in currently operating plants. While the AP1000 passive reactors are exempt from the requirements of GDC 17 for a second offsite power supply circuit (*see* 10 CFR Part 52, App. D, § V.B.3), the regulatory requirements noted in the above paragraph apply to the single offsite power circuit, and the open phase issue as described in this bulletin could be a potential compliance issue. As such, a response from combined license holders is warranted for this bulletin."

The following information for the AP1000 standard plant design is included as part of this RAI response since it is pertinent to the specific information requested for the Levy plant.

2.0 NRC GOVERNING ELECTRICAL SYSTEM REQUIREMENTS

10CFR50, Appendix A, General Design Criteria (GDC) 17 establishes the NRC's governing requirements for the electric design of nuclear power plants. The GDC requires both an onsite electric power system and an offsite electric power system be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) is to 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.

GDC 17 also requires electric power from the transmission network ("grid") to the onsite electric distribution system 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.

As is discussed in the following sections, the AP1000 plant design is substantially different than the current operating plant fleet for which GDC 17 was originally written, and as such, a partial exemption is applicable to the AP1000 for GDC 17.

3.0 AP1000 ELECTRICAL SYSTEM OVERVIEW

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

Provided in DCD Figure 8.3.1-1 is the AC power system one line diagram showing high voltage and medium voltage interconnections and major equipment configurations.

As reflected on this figure, the AP1000 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 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. Reserve auxiliary transformers 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 generator 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 electrical system that are unique in comparison to the current operating plant fleet include:

a) A GDC 17 exemption that requires only one offsite source 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 opening of the generator circuit breaker (e.g., 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 emergency generator portion, are non-Class 1E due to the use of passive safety features.
e) The reactor coolant pump 6.9 kV switchgear is Class 1E to ensure that these pumps are tripped, as dictated by plant safety analyses.
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 capability (24 and 72 hours).
h) Capability to accommodate a 100% load rejection transient without reactor trip.

4.0 AP1000 DCD COMPLIANCE RESPONSE TO GDC 17

4.1 OVERVIEW

Chapter 3.1.2 of the AP1000 Design Control Document (DCD), Revision 19 describes the AP1000 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 nonsafety-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 nonsafety-related offsite and onsite ac power that are normally expected to be available for important plant functions, nonsafety-related ac power is not relied upon to maintain the core cooling or containment integrity."*

- *"The nonsafety-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 onsite standby power system is not required for safe shutdown of the plant.

4.2 DETAILED ASSESSMENT

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.

"An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety."

The AP1000 design provides both an onsite and offsite electric power system. The capability of supporting the function of SSCs important to safety 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 SSCs. The only safety function of the ECS system is to provide circuit breakers (2 per pump) for tripping of the RCPs. 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 three 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.

"The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure."

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. No other onsite or offsite electrical distribution system is required to meet 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 second generation plants, there are no Technical Specification requirements for the Offsite AC Sources in the AP1000 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.

"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. A switchyard common to both circuits is acceptable."

The AP1000 design has an exemption to the requirement for a second offsite source. Therefore the preceding information is not applicable.

"Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies [and the other offsite electric power circuit], to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded."

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.

"One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained."

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.

"Provisions shall be included to minimize the probability of losing electric power from [any of the remaining] supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies."

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 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 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.

5.0 SAFETY IMPORTANCE OF AP1000 NON-SAFETY AC POWER

As discussed in an earlier section, the AP1000 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 non-safety AC power system does not have Technical Specifications because it does not satisfy the Technical Specification screening criteria (which include PRA importance measures). In addition, the safety importance of the non-safety 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 safety importance of non-safety systems in passive light water reactors.

There are several criteria that are used to perform this assessment. They include the PRA risk mitigation importance and the importance of the system 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 is defined in DCD Section 16.3 that indicates that 2 out of 3 AC power supplies (2 DGs 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 this MODE. The short-term availability controls indicate that the DGs should be maintained during power operation because they are less risk important in that MODE than during shutdown MODEs.

The AP1000 "Focus PRA" (Section 50.5.4 & 50.5.5 of 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 DAS). The Focus PRA bounds the loss of phase event in that the non safety related AP1000 defense in depth systems (ZOS, CCS, SWS, RNS), which are similar in function to those ECCS systems (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's goals for Core Damage Frequency and Large Release Frequency with sufficient margin.

6.0 AP1000 ELECTRICAL DESIGN FEATURES

As described in the AP1000 DCD, plant safety analyses assume that the RCPs can receive power from either the main generator or the grid for a minimum of 3 seconds following a turbine trip. It should be noted that this criteria was established for the case where there is no concurrent electrical fault condition. During power operation if a turbine trip was to occur, the motive power (steam) to the turbine is removed. The generator will attempt to keep the shaft rotating at synchronous speed (governed by the grid frequency) by acting like a synchronous motor. The AP1000 electrical design includes a reverse-power relay that monitors generator power. After a time delay of at least 15 seconds, the generator circuit breaker would open. During this delay time, the generator will be able to provide voltage support to the RCPs. The RCPs will receive power from the grid for at least 3 seconds following the turbine trip. Utility grid stability analysis demonstrate that, with no electrical system faults, the grid will remain stable and the reactor coolant pump bus voltage will remain above the voltage required to maintain the reactor core flow assumed in the Chapter 15 analyses (See DCD subsection 8.2.5). If the initiating event is an electrical system failure (such as failure of the isophase bus), the Chapter 15 safety analyses do not assume operation of the reactor coolant pumps following the turbine trip.

The AP1000 plant is designed with passive safety-related systems for core cooling and containment integrity and, therefore, does not depend on the electric power grid or the non-1E portion of the electrical power system. This feature of the AP1000 design significantly reduces the importance of the grid connection.

The AP1000 non-safety related medium voltage buses are configured fundamentally different than the Byron 2 design as described in the subject Bulletin. During full power plant operation, the AP1000 medium voltage electrical buses are normally supplied from the main generator via one of three unit auxiliary transformers (UATs). The reserve auxiliary transformers (RATs) would normally be in an energized, but standby (unloaded) condition.

There are several offnormal configurations where one or more medium voltage bus can be powered directly from the grid as noted below:

a) In the event of an electrical fault on the high voltage generator bus, main step-up and unit auxiliary transformers or interfacing grid/switchgear connections, a fast bus transfer of the medium voltage buses (ES-1 through ES-6) to its associated RAT would occur. The RATs provide an alternate 3 phase interconnection to the grid.

b) The AP1000 design enables each medium voltage bus to be manually aligned to the alternate grid connection via the RATs (except Bus ES-7, which does not feed any RCPs or loads required for plant operation).

c) The AP1000 design enables backfeed from the grid via the main step-up transformers to the medium voltage buses during periods when the main generator is offline (e.g., plant start-up/shutdown modes).

The AP1000 electrical design includes the following medium voltage bus features:

d) Monitoring of each phase of the generator bus voltage and status information provided in the main control room (MCR).

e) Electrical protection for the medium voltage switchgears (ECS-ES-1 through ECS-ES-6 and ECS-ES-7) and interconnected loads consist of multifunction, software-based microprocessor digital relaying schemes having metering and testing capabilities for electrical protection schemes. The protective relays provide status information in the MCR.

f) Medium voltage motors protected by a multifunction microprocessor-based digital relay thermal overload function (49) and a loss of phase function (46) that protects the motor against overloads and locked rotor conditions.

g) Each medium voltage switchgear bus is furnished with microprocessor digital relays that provide three undervoltage functions (27B1, 27B2, and 27B3). Voltage transformers connected open delta are used for relaying and metering as noted below:

- Bus undervoltage function 27B1 is set at approximately 75% of the nominal voltage, which is below the minimum voltage experienced during motor start, to trip all motors and package loads containing motors on the bus and start the onsite standby diesel generator (buses ES-1 and ES-2 only), for an undervoltage condition. A time delay setting of approximately 3.0 seconds is used to allow the faults to be cleared by overcurrent devices.
- Bus undervoltage function 27B2 is set at approximately 30% of nominal voltage with a 3-second time delay to provide permissions for residual bus transfer and trip the respective source breaker, and one-out-of-two logic to alarm for blown fuses.
- Bus undervoltage function 27B3 is set at approximately 90% of the nominal voltage to alarm after approximately 30 seconds.
- The AP1000 open delta bus undervoltage scheme monitors two (2) phase-to-phase conditions to indicate an undervoltage condition (2/2 logic).

7.0 LEVY RAI RESPONSES

"Given the requirements above, describe how the protection scheme for ES-1 and ES-2 buses 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 source."

- An open delta protection scheme is used to detect a bus undervoltage condition on the non-safety medium voltage buses including ES-1 and ES-2.
- With use of an open delta configuration, loss of the shared phase would be detected.
- Low impedance faults would be detected by ground fault relay schemes.
- High impedance faults (defined herein as those faults of sufficient impedance to remain below the setting level of the ground fault relays) in combination with a single phase open circuit condition will respond similarly to the open circuit condition described throughout the response.
- The AP1000 relay and protection methodology applicable to the ES-1 and ES-2 buses has not been designed to detect all single-phase open circuit conditions or high impedance ground fault conditions directly.
- The turbine-generator is provided with sequence protection that would initiate a generator trip with a loss of phase or high impedance ground fault.
- Medium voltage breakers for motors are provided with a loss of phase relay.

"Also, include the following information:

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

- An open delta undervoltage protection scheme cannot detect all open phase or high impedance ground fault conditions.
- For the protection schemes described herein that would respond to the open phase or high impedance ground fault condition, setpoints and equipment sensitivities have not been finalized.

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

- The use of the open delta undervoltage protection scheme is not sensitive to the load on the source transformer.

"c. If the design does not detect and automatically respond to all single-phase open circuit condition or high impedance ground fault conditions on a credited offsite power circuit or another power source, describe the consequences of such an event and the plant response."

NOTE: It should be noted specifically that a qualitative assessment is made below. The AP1000 AC electrical design is in the design finalization stage, and relay settings, detailed coordination studies, etc. are not yet available.

- With the generator online during full power operation with the medium voltage buses normally aligned, single open phase conditions or high impedance ground fault in combination with a single phase open circuit condition would result in a direct turbine/generator trip due to generator protection, resulting in the opening of the generator circuit breaker.

- The ES medium voltage buses would be automatically backfed from the grid via the Main Step-Up Transformers (MSUs).

- Auxiliary loads on the ES-1 and ES-2 buses (and other ES loads) would likely trip due to phase overcurrent condition.

- The non-safety diesel generators, that provide a defense in depth onsite supply source for the ES-1 and ES-2 buses, would remain in standby condition.

- A reactor trip condition, if not already present, would occur.

- The passive residual heat removal system would be automatically initiated to remove reactor core decay heat.

- The IDS division batteries and inverters provide the safety-related source of onsite AC and DC power for safety-related functions. Each IDS charger has features that detect the loss of input phase voltage and isolate the Class 1E system from the Non 1E system.

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

- The Main Step-Up Transformers (MSUs) are four separate single phase transformers (including one spare) connected in three phase wye-delta configuration. The HV (wye) side is a solidly grounded neutral.

- Each of Unit Auxiliary Transformers (UATs) 2A and 2B are three phase three winding transformers with delta-wye configuration. Each LV (wye) winding is low resistance grounded.

- Unit Auxiliary Transformer 2C is a three phase two winding transformer with delta-wye configuration. The LV (wye) winding is low resistance grounded.

- The Reserve Auxiliary Transformers (RATs) are three phase three winding transformers with wye-wye configuration with an embedded tertiary winding. The HV side is a solidly grounded neutral and the LV side is low resistance grounded.

"Briefly describe the operating configuration of the ES-1 and ES-2 buses at power (normal operating condition). Include the following details:

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

- No. The ES buses are normally aligned to the main generator during normal operations at power.
- Major energized loads (and nominal ratings) on the ES-1 and ES-2 buses include:
  - Component Cooling Water Pump – 700 HP
  - Service Water Pump – 500 HP
  - Central Chilled Water Chiller – 1500 KW
  - Raw Water Pump – Not to Exceed 1100 KVA including auxiliaries

"b. If the ES 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."

- For the standby RATs, a surveillance test is not performed nor required since only one offsite circuit is required and this circuit would normally be inservice (either by receiving power generation or in a backfeed mode when the generator is offline).

"c. Confirm that the operating configuration of the ES buses is consistent with the current licensing basis. Describe any departures in offsite power source alignment to the ES buses from the original plant licensing."

- The Levy electrical system design is consistent with the AP1000 Certified Design plus applicable AP1000 Certified Design exemptions.

"d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ES buses?"

- Generic AP1000 Plant Operating Procedures are under development and there are no approved Levy procedures at this time. A review of the Generic Procedures did not identify specific operator actions related to phase voltage verifications on the 3 phases. As currently designed with open-delta PT configuration this verification would not be achieved.

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

- During normal power production, the main generator directs power to the medium voltage buses via the UATs. UAT 2A (RAT 4A) provides power to ES buses 1, 3, and 5 and UAT 2B (RAT 4B) provides power to ES buses 2, 4, and 6. UAT 2C provides power to only ES-7.

- The RATs (4A & 4B) would normally be in an energized, standby (unloaded) condition. This equipment is capable of providing grid power to the medium voltage buses ES-1 through ES-6.

- The onsite non-safety-related diesel generators would normally be in a standby condition. This equipment is capable of providing onsite power to the medium voltage buses ES-1 and ES-2.

- As stated in the initial response section, the AP1000 non-safety related electrical system has not been designed to detect all single-phase open circuit or high impedance ground fault conditions. In the cases where the open phase (or high impedance ground fault) is detected, then the affected medium voltage bus would separate from the faulted source and be repowered from either the associated Reserve Auxiliary Transformer or the associated onsite standby diesel generator. If the fault is not detected, the AP1000 safety functions would continue to be supported by its passive systems and the onsite DC safety-related power system (IDS).