RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**338-8426**
SRP Section:	**08.01 – Electric Power – Introduction**
Application Section:	**8.1**
Date of RAI Issue:	**12/17/2015**

Question No. 08.01-14

In RAI 7915, Question 08.01-1 (ADAMS Accession ML15142A611), the staff stated in part that the proposed design of the APR1400 power distribution system did not meet the 10 CFR Part 50, GDC 17 requirement and the guidance provided in SRP 8.3 and SECY-91-078. The staff also noted that in SECY 91-078 the Commission requires at least one offsite circuit to each redundant safety division that is supplied directly from an offsite power source with no intervening non-safety buses.

In response to RAI 7915, Question 08.01-1 dated June 22, 2015 (ADAMS Accession ML15173A092), the applicant (KHNP) stated in part the following:

- The APR1400 offsite power system is designed in accordance with IEEE Std. 765, which provides detail design guidance and design criteria to properly meet GDC 17. In particular, the APR1400 adopts the enhanced preferred power supply (PPS) design mentioned in Subsection 4.5.c of IEEE Std. 765.

- Since each PPS circuit connects directly to redundant 4.16 kV Class 1E buses, failure of a non-Class 1E bus does not prevent the PPS circuit from supplying the offsite power to the Class 1E buses, provided the failure is properly isolated by the protective devices.

- The Class 1E buses are not subject to potential failure due to a failure of the non-Class 1E buses since the non-Class 1E electrical equipment is designed to preclude adverse effects on Class 1E electrical equipment due to its failure during normal, accident, or post accident modes of plant operation and each Class 1E and non-Class 1E buses are protected by properly coordinated Class 1E and non-Class 1E protection devices as described in DCD Tier 2 Chapter 8, Subsections 8.1.3.2.j and 8.3.1.3.4.

- KHNP recognizes that in case of a specific failure, e.g. fail-to-open of the bus incoming breaker upon the fault at a non-Class 1E MV bus, the fault effect could propagate to the Class 1E buses which are fed from the same SAT or UAT as the faulted non-Class 1E bus.

- KHNP plans to implement design enhancement to the incoming breakers at the non-Class 1E MV buses to address potential risk associated with fault at non-Class 1E MV bus affecting Class 1E MV bus.

The applicant proposed to enhance the design by providing two independent circuit breakers, connected in series, and used as incoming breakers for all non-Class 1E 13.8 kV and 4.16 kV switchgears. The applicant explained that the design enhancement would significantly reduce the probability of failure of the non-Class 1E incoming breakers in case of a bus fault. The applicant also explained that only one of the two independent circuit breakers will be used for switching operation and protection, while the other breaker will be used only for protection. They also explained that to avoid a common cause failure of the two circuit breakers, each circuit breaker will be independent from the other, both physically and functionally, and will have its own protective relaying provisions.

The staff has reviewed the applicant’s responses and determined that in accordance with SECY-91-078, the Commission requires evolutionary advance light water reactor (ALWR) design such as APR 1400 should include an alternate power source to the non-safety loads unless the design can demonstrate that the design margins in the evolutionary ALWR will result in transients for a loss of non-safety power event that is less severe than those associated with the turbine trip only event in current existing plant designs. SECY-91-078 also states that the staff’s position is that at least one offsite circuit to each redundant safety division should be supplied directly from one of the offsite power sources with no intervening non-safety buses, in such a manner that the offsite source can power the safety buses upon failure of any non-safety bus.

The applicant states that the APR1400 offsite power system is designed in accordance with IEEE Std. 765, which provides detail design guidance and design criteria to properly meet GDC 17. However, the NRC staff has not endorsed IEEE Std. 765 in applicable RGs (RG 1.32, RG 1.75). IEEE Std. 308-2001 guidance as endorsed by RG 1.32, states that the non-Class 1E circuits shall meet the independence and isolation requirements as established in IEEE Std. 384-1992. IEEE Std. 384-1992 guidance as endorsed by RG 1.75 states that the applicant should follow the guidance in IEEE Std. 384 to address independence and isolation of Class 1E and non-Class 1E circuits. The staff believes that the new proposed enhanced design still does not meet the intent of the GDC 17 and the Commission direction in SRM-SECY-91-078, and that further explanation is needed.

The applicant is requested to provide explanation as to how the proposed design meets GDC 17 requirement, and guidance in SRP 8.3, SECY-91-078, RG 1.32, RG 1.75, and applicable industry standards or provide analysis to demonstrate that the design margins will result in transients from a loss of non-safety power event that is less severe than those associated with the turbine trip only event in current existing plant designs. The applicant is requested to discuss how the electrical system provides a direct connection with no intervening non-safety buses from the offsite power source to the onsite Class 1E system.

Response

The following provides a detailed explanation on how the proposed APR1400 electric power system design complies with GDC 17, SECY-91-078 and other relevant regulations.

Background

In the staff requirements memorandum (SRM) of December 15, 1989 the Commission wanted SERs on the EPRI Utility Requirements Document (URD) submitted to ACRS for review and for the Commission to approve policy issues not previously decided. The EPRI URD consists of three volumes; Volume II contains 13 chapters for an evolutionary nuclear plant. SECY-91-078 (henceforth referred to as the SECY) dated March 25, 1991 presented the staff's draft SER for EPRI URD Volume II Chapter 11, "Electrical Power Systems" and identified two issues in which they proposed departures from current regulatory requirements or felt there was a need to supplement existing guidance: 1) Alternate Source of Power for Non-Safety Loads and 2) Connection of Safety Bus Offsite Power Sources Through Nonsafety Buses. Of the two issues that were presented, the second issue pertains to the discussion of this response. (Note: compliance with the first issue of SECY-91-078 was provided in the response to RAI 177-8166, Question 6 (ref. KHNP submittal MKD/NW-15-15-0374L, dated December 18, 2015; ML15352A275)).

Enclosure 1 of the SECY provides an overview of the issue and states that the staff concludes that feeding the safety buses from the offsite power sources through non-safety buses or from a common transformer winding with non-safety loads is not the most reliable configuration. Such an arrangement increases the difficulty in properly regulating voltage at the safety buses, subjects the safety loads to transients caused by the non-safety loads, and adds additional failure points between the offsite power sources and safety loads. <u>Therefore, it is the staff's position that at least one offsite circuit to each redundant safety division should be supplied directly from one of the offsite power sources with no intervening non-safety buses, in such a manner that the offsite source can power the safety buses upon a failure of any non-safety bus.</u> The underlined portion was added by the staff to aid in readily identifying their position.

The APR1400 does not have an intervening non-safety bus in the current offsite to onsite electrical configuration; however, the design does include non-safety and safety buses coming from the same secondary side 4.16 kV transformer winding.

The draft SER for Chapter 11 presented as Enclosure 2, Section 4.2.2 of SECY-91-078 provides additional detail on the issue, stating that even though it has been the staff's experience that the benefits to safety of not connecting safety buses to common transformer windings usually outweighs whatever safety benefits may be achieved, the configuration must be viewed in the context of the overall plant electrical system design, and that some of the ALWR design concepts and objectives such as the three-tier concept and the objective to simplify the design bear on the choices made by EPRI. Therefore, the staff concluded with the position underlined above as a minimum requirement.

The Commission in SRM dated April 1, 1991 stated that there was no objection to the issuance of the draft SER. The ACRS was provided the draft of the final SER, SECY-92-172, on Chapter 11 on May 12, 1992 and reviewed the content in meetings held July 9-11, 1992 and August 6-8, 1992 and provided their approval as sent in the meeting minutes dated August 18, 1992.

SECY-93-087 dated April 2, 1993 provided the staff's final position on the issue and was presented to the Commission for their approval. It is stated that the staff proposes to implement the final positions on these matters as approved by the Commission through individual design certifications and generic rulemaking as appropriate. The enclosure of that SECY paper states that the Commission approved the staff's position in its SRM of August 15, 1991.

The staff incorporated their position into NUREG 0800 the Standard Review Plan Section 8.2 in Revision 4, dated 2007, which includes a reference to SECY-91-078.

Offsite Power System Design: APR1400 vs EPRI ALWR

Since the SECY is based on the EPRI ALWR and the staff acknowledged that the configuration must be viewed in the context of the overall plant electrical system design, this section is to provide the specific design features of the APR1400 offsite power system in comparison to EPRI ALWR generic design which was the subject of the review documented in SECY-91-078.

1) Current APR1400 Design

   The APR1400 has a normal preferred power supply (PPS) connection through the unit auxiliary transformers (UATs) and an alternate PPS connection through the standby auxiliary transformers (SATs) to the onsite power system.

   Under normal power operating conditions, the safety and non-safety related loads (including permanent non-safety loads) are supplied from the UATs. If power from the normal PPS is unavailable, the offsite power source for the Class 1E and non-Class 1E onsite power system is automatically transferred to the alternate PPS through the SATs. The UATs and SATs supply offsite power to both the safety and non-safety loads from the same connected 4.16 kV secondary winding.

   A simplified single line diagram is depicted in Figure 1 to illustrate the APR1400 offsite power circuits. For simplicity, the diagram shows only one electrical division and the buses of the same classification and voltage level are indicated as one bus.

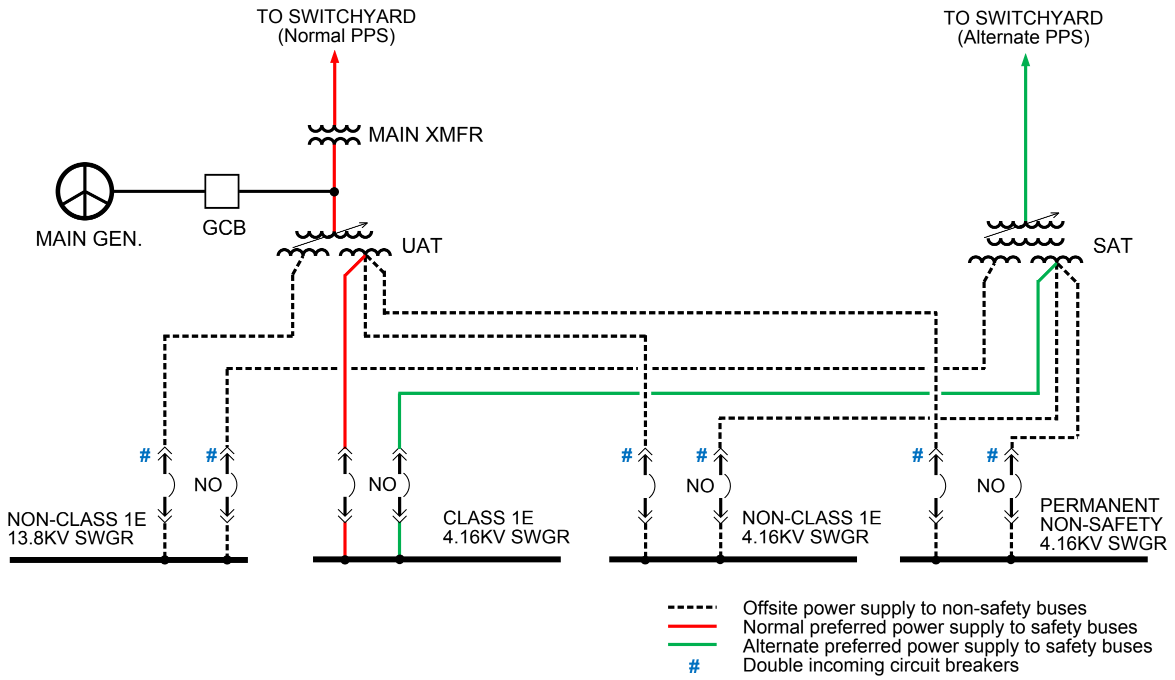

Figure 1 Simplified Single Line Diagram of APR1400 Offsite Power Circuits

2) EPRI ALWR (PWR) Design

The medium voltage ac distribution system is designed to supply power to the safety and non-safety loads including permanent non-safety (PNS) loads from the normal source of offsite power (i.e., the unit auxiliary transformers (UATs)).

During normal operation, the non-safety and permanent non-safety buses are fed from the common winding of each UAT and the safety buses are powered from the PNS buses. If there is a loss of power from the UATs, the safety and PNS loads are automatically transferred to the reserve source of offsite power (i.e., the reserve auxiliary transformer (RAT)) and are then fed from the common transformer windings of the RAT.

An additional (third) path of offsite power is provided for a direct connection to the safety buses to ensure offsite power for the safety bus upon a failure of PNS buses.

A simplified single line diagram is depicted in Figure 2 to illustrate the EPRI ALWR offsite power circuits. For simplicity, the single line diagram shows only one electrical division and the buses of the same classification and voltage level are indicated as one bus.

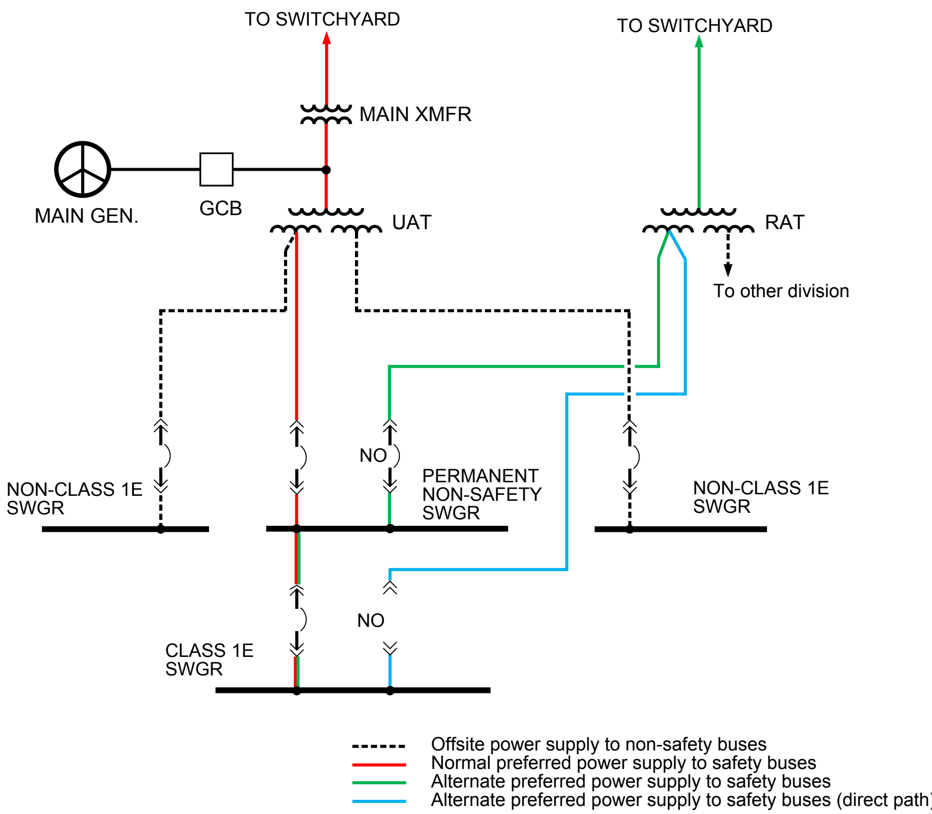

Figure 2 Simplified Single Line Diagram of ALWR Offsite Power Circuits

3) Comparison of Design Features Between the APR1400 and EPRI ALWR

In the EPRI ALWR design, the second tier of onsite power distribution system (i.e., PNS buses) establishes intervening connections between the UATs and the safety buses as shown in Figure 2. This is a case of indirect connection through an intervening bus which could cause both the offsite power paths to be unavailable if a non-safety bus (i.e., PNS bus) should fail. For this reason, the EPRI ALWR design makes the provision of a third path, in addition to the existing offsite power supply paths, to provide for a direct connection to the safety buses; thus, making the design satisfy the staff's position in SECY-91-078.

The APR1400 does not need to utilize the third path like the ALWR generic design since the offsite power sources of APR1400 have direct connections to the Class 1E buses. Failure of the non-Class 1E bus will not disable or disconnect the normal or alternate path from the offsite power supply to the Class 1E buses.

In the ALWR design, a direct connection between the offsite power supply and the safety buses is achieved by manually aligning a dedicated path in the event of problems with the non-safety buses (i.e., PNS buses). For the APR1400 design, the direct connection is normally maintained and secured in the event of a problem with any non-Class 1E bus by proper and secure isolation of the failed non-Class 1E bus. In fact, the APR1400 has enhanced the isolation configuration through a redundant breaker scheme to ensure that a loss of the non-safety bus will not impact the safety bus should one of the breakers fail to open.

As stated above, the offsite power systems of both the APR1400 and EPRI ALWR have auxiliary transformers (UAT and SAT for the APR1400; UAT and RAT for the EPRI ALWR) that feed safety and non-safety loads from common windings.

To provide reasonable assurance of sufficient availability and reliability of the offsite power supply upon a failure of a non-safety bus or connection, a detailed failure mode effects analysis (FMEA) has been performed as provided in Table 1. The FMEA demonstrates that the APR1400 offsite power system retains its ability to feed the safety loads of both divisions through both (normal and alternate) PPS upon a single failure on the non-safety bus. The FMEA also demonstrates higher reliability and availability of the offsite power supply in comparison to the EPRI ALWR generic design assuming an additional consequential failure that could occur in addition to single failure event of a non-Class 1E bus.

Justification of the APR1400 Design Compliance with GDC 17, SECY-91-078 and Other Regulatory Guides

1) Conformance with GDC 17

The APR1400 offsite power system design complies with GDC 17 requirements and corresponding staff interpretations of GDC 17 for the deterministic requirements for the offsite power system provided in SRP 8.1, Table 8-2. The compliance description of the APR1400 offsite power system design with GDC 17 is provided in Table 2 of this response.

2) Conformance with the second issue of SECY-91-078

As stated previously, the offsite power source to the APR1400 has direct connections to the safety buses such that the offsite power supply will not be prevented from supplying power to the safety buses upon a failure of any non-safety bus. The direct connection is normally maintained for the APR1400 design as shown in Figure 1 and also adequately secured in the event of a problem with any non-safety bus by proper isolation of the faulted non-safety bus.

Concerns on the common transformer windings were raised in the discussion of SECY-91-078; however, viewing in the context of overall plant electrical design, the concerns were not included in the final staff position of SECY-91-078. The EPRI ALWR (PWR) design feature, which was accepted by the staff, also provides common transformer windings for the safety and non-safety loads when the loads are being fed from either UATs or RAT, as stated in EPRI ALWR Design section above.

Thus, KHNP considers the APR1400 design satisfies the staff's position stated as a minimum requirement in SECY-91-078.

From the discussions addressed in the SECY (Enclosures 1 and 2), it is clear that the issue of concern is the safety related loads having a reliable offsite power supply and the reliability of offsite power not being challenged by failures that the non-safety bus could cause.

Based on the above, it is shown that the current configuration of the APR1400 satisfies the staff's minimum requirements, and also properly addresses the staff issued concerns beyond the minimum requirement: voltage regulation of the safety buses, ensuring transients caused by non-safety loads do not impact the safety buses, and ensuring that failure points between the offsite power supply and the safety buses are minimized and can be accommodated. Details on how the design addresses these concerns are provided as follows.

- Voltage regulation of the safety buses

  Technical report "Onsite AC Power System Analysis" (APR1400-E-E-NR-14001-P) includes a description of the voltage regulation study that was performed on the framework of the onsite power system analysis. The on-load tap changers (OLTCs) that are equipped at the primary side of the UATs and SATs ensure that the voltage regulation at the medium voltage (MV) safety buses is maintained in the range of 97.5% to 102%. The voltage range of the MV safety buses satisfies the criteria for acceptable operating voltage conditions of the safety loads under design conditions.

- Transients on the safety buses caused by the non-safety buses

  The safety buses have the potential transients to be caused by a variety of accident or operating occurrences on the non-safety buses such as large motor starting, motor re-acceleration during a bus transfer condition, or a short circuit accident on a non-safety bus. The potential impact of transients from the non-safety loads were properly identified and assessed for the APR1400 design. A large motor starting study has been performed and the results of the study demonstrate that voltage variation at the safety buses is maintained within acceptable limits during the non-safety large motor starting condition (discussions are contained in technical report APR1400-E-E-NR-14001-P). The transient effect of re-acceleration of non-safety motors during a bus transfer is assessed by the fast bus transfer study (also contained in technical report APR1400-E-E-NR-14001-P) and the result of the study concludes that the reacceleration of non-safety motors do not hinder the re-acceleration of the safety motors.

  A short-circuit event is another non-safety load transient condition that could have a potential impact on the safety loads. When a short-circuit event occurs (such as a phase fault or ground fault) on a non-safety load or bus, the event can cause a temporary voltage dip on the safety buses which share the same transformer winding with the faulted non-safety load or bus. To prevent unintended tripping of the safety buses during a temporary fault condition, a time delay is provided for the protective devices (i.e., under-voltage relays) on the safety buses such that the safety buses remain connected during the fault clearing time of the non-safety circuit. These relays are Class 1E, which have proven to be reliable in the industry and will be periodically tested.

- Additional failure points between the offsite power sources and the safety loads

  Unlike the EPRI ALWR design, the safety buses of APR1400 are directly connected to offsite power source through the normal and alternate PPS circuits. Since the offsite power source is directly connected to the safety power system, there is no electrical bus and its associated components (e.g. circuit breakers, relays, etc.) that constitute a failure point between the offsite power source and the safety buses.

  With the current design, failure of the connections from the SAT or UAT secondary windings to non-Class 1E buses is possible. The coverage of UAT (or SAT) protection zone encompasses the connections to Class 1E and non-Class 1E buses. An electrical fault (short circuit fault or ground fault) on a connection to safety or non-safety bus will be detected by UAT (or SAT) differential relay or UAT (or SAT) neutral ground overcurrent relay and this will result in tripping of the upstream circuit breaker (e.g., generator circuit breaker and switchyard circuit breakers, as applicable) and causing a swap of the power to the alternate PPS or to the EDG power source.

3) Industry standards endorsed by regulatory guides

   Since the discussions and regulatory positions of RG 1.32 and RG 1.75 cover only the electrical safety systems that are Class 1E, the offsite power system and its connection provisions, which are classified as non-Class 1E, are not subject to the above mentioned regulatory guides.

   The incoming circuit breakers located in the Class 1E buses are isolation devices between the offsite power system and Class 1E power system and they comply with the requirements of IEEE Std. 308, 384, and 603, which are endorsed by RG 1.32 and RG 1.75, as applicable.

   Each Class 1E incoming circuit breaker is automatically tripped upon receipt of a trip signal from the offsite power system or upon detection of fault current such that the independence of the Class 1E onsite power system is maintained.

US Operating Fleet Conformance

As stated in the SECY, EPRI in its letter of July 23, 1990 stated that in many current designs of U.S. plants, safety buses are fed from common transformer windings and operating experience with these designs has not indicated any particular shortcomings. As a result of the NRC's review of the URD and Commission approval, there were no generic actions taken for the existing domestic nuclear fleet to address the issue, either through design change or analysis of their current configuration. This conclusion means that the operating plants with the current configuration of safety and non-safety buses from the same transformer winding meet GDC 17 and that there is an insufficient safety impact to warrant a modification under 10CFR50.54(f) or a justifiable backfit. Therefore, since it can be concluded that there is not a safety issue warranting correction with the existing fleet, it can also be concluded that a similar configuration in an advanced designed plant (though not the most optimum configuration) does not result in any non-compliance with the regulations nor imply that there is a significant impact to plant or public safety.

The requirement to provide additional justification for safety and non-safety buses from the same transformer was not adopted into the License Renewal requirements, nor considered in the extended license renewal guidance documents. These offered additional opportunities for the NRC to incorporate requirements for the operating fleet to review and rectify their current configuration, if necessary.

Table 1 Failure Mode and Effects Analysis of APR1400 Offsite Power Supply (upon a failure of non-safety bus)

Failure Mode	Detection	Effects & Consequences	Effects on the Class 1E power system	Expected Effects & Consequences of the EPRI ALWR Design
1. Fault at a non-Class 1E bus	● (Redundant) overcurrent relay(s) at bus incoming feeder ● (Redundant) ground overcurrent relay(s) at bus incoming feeder	● The faulted bus is isolated from power source by redundant protective devices. ● The associated MV motors and LV buses are de-energized. ● The other buses remain unaffected.	● The safety loads remain fed from the same PPS as the one before the event.	Fault at a non-safety bus ● Same as APR1400 design Fault at a PNS bus ● The faulted PNS bus is isolated by protective devices. ● A third path (from RAT) is manually aligned to the safety bus which was fed from the faulted PNS bus (note 1). ● The other safety bus (supplied from UAT) is unaffected.
2. Fault at a non-Class 1E bus and interrupting failure of the incoming CB (without application of double incoming CBs)	● Overcurrent relay of UAT protection ● Ground overcurrent relay of UAT protection ● Breaker failure protect relay at bus incoming feeder	2a. Fed from UAT ● Interrupting failure of the non-safety bus results in tripping of upstream network of UATs (i.e., GCB, switchyard CBs) and all Class 1E and non-Class 1E bus incoming CBs for normal PPS. ● Normal PPS is lost. ● The Class 1E and non-Class 1E buses (except for the failed bus) of both divisions are automatically transferred to the alternate PPS (from SAT).	● The Class 1E buses are automatically transferred to the alternate PPS. ● The safety loads are fed from the alternate PPS (through SAT).	Fault at non-safety bus ● Interrupting failure of the non-safety bus results in tripping of upstream network of UATs (i.e., GCB, switchyard CB). ● No electric power is available for the non-safety buses. ● PPS I (normal PPS) is lost. ● PNS buses of both divisions are automatically transferred to the alternate PPS (through RAT). Fault at PNS bus ● Interrupting failure of the PNS bus results in tripping of upstream network of UATs and RATs (i.e., GCB, switchyard CB). ● When the PNS bus was fed from the UAT: A third path (from RAT) is manually aligned to the safety buses of both divisions (note 1). ● When the PNS bus was fed from the RAT: no offsite power is available for the safety buses (loss of offsite power condition). The EDGs should supply the safety loads of both divisions.
	● Overcurrent relay of SAT protection ● Ground overcurrent relay of SAT protection ● Breaker failure protect relay at bus incoming CBs ● Undervoltage relays at Class 1E bus	2b. Fed from SAT ● Interrupting failure of the non-safety bus results in tripping of upstream network of SATs (i.e., switchyard CBs) and all Class 1E and non-Class 1E bus incoming CBs for alternate PPS. ● Alternate PPS is lost. ● Upon detection of a loss of voltage (LOV) at each Class 1E bus, each Class 1E EDG is automatically started and supplies the Class 1E loads (note 3).	● Each Class 1E bus is separated from the alternate PPS and connected to its associated EDG. ● The safety loads are fed from the EDGs.	
3. Fault at a non-Class 1E bus and simultaneous interrupting failure of one of redundant bus incoming CBs (with application of double incoming CBs)	Same as Failure Mode No.1	Same as Failure Mode No.1	Same as Failure Mode No.1	N/A (note 2)

Failure Mode	Detection	Effects & Consequences	Effects on the Class 1E power system	Expected Effects & Consequences of the EPRI ALWR Design
4. Fault at a connection of transformer winding to non-Class 1E bus	● Differential relay of UAT protection ● Ground overcurrent relay of UAT protection ● Undervoltage relays at Class 1E buses	4a. Fault at UAT connections when energized ● UAT protection system trips upstream network (i.e., GCB, and SWYD CBs) and all Class 1E and non-Class 1E bus incoming CBs for normal PPS (note 4). ● Normal PPS is lost. ● The Class 1E and non-Class 1E buses of both divisions are automatically transferred to the alternate PPS (from SAT)	● The Class 1E buses are automatically transferred to the alternate PPS. ● The safety loads are fed from the alternate PPS (through SAT).	Expected effects and consequences of the ERPI ALWR design is mostly same than APR 1400.
	● Differential relay of SAT protection ● Ground overcurrent relay of SAT protection ● Undervoltage relays at Class 1E buses	4b. Fault at SAT connections when energized ● SAT protection system trips upstream network (i.e., SWYD CBs) and all Class 1E and non-Class 1E bus incoming CBs for alternate PPS (note 4). ● Alternate PPS is lost. -- ● If normal PPS was not available before this event, the loss of voltage condition is detected by undervolage relays at each Class 1E buses. ● Upon detection of a loss of voltage (LOV) at each Class 1E bus, each Class 1E EDG is automatically started and supplies the Class 1E loads.	● The safety loads remain fed from the normal PPS (through UAT) if it was available before the event. --- ● If the normal PPS was not available before the event, each Class 1E bus is separate from the alternate PPS and connected to its associated EDG. ● The safety loads are fed from the EDGs.	

Note)
1. In the ALWR design the alignment of the Class 1E bus to the alternate PPS (third path) is accomplished by racking out normal source incoming CB and inserting it in an empty alternate incoming CB position.
2. The EPRI ALWR applies single bus incoming CBs.
3. Automatic EDG starting and load sequencing are performed when the Class 1E buses are isolated from the normal and alternate PPS (upon detection of a LOV at the Class 1E bus).
4. The UAT (or SAT) protection zone covers up to connections to Class 1E and non-Class 1E buses. Therefore, a failure at a connection to a non-Class 1E bus causes same consequences as a failure of auxiliary transformer.

Table 2 Design Compliance of the APR1400 Offsite Power System with GDC 17 Requirements

GDC 17	Staff Interpretation	APR1400 Design Compliance
Criterion 17—Electric power systems. 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 safety function for each system (assuming the other system is not functioning) shall be 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.	a. Both an offsite and onsite power system shall be provided, each independent of the other and capable of providing power for all safety functions. (The offsite and onsite power systems considered together must meet the single failure criterion on a system basis without losing the capability to provide power for all safety functions. In addition, in view of requirement (b) below, the two systems considered together must be capable of sustaining a complete loss of offsite power and a single failure in onsite system, without losing the capability to provide power for the minimum required safety functions.)	The APR1400 is connected to the offsite power system through two independent preferred power circuits and each independent circuit has sufficient capacity and capability to supply power for all safety loads during all plant operation modes as described in DCD Tier 2, Subsections 8.2.1.1 and 8.2.1.4. The associated electrical components, such as unit auxiliary transformers (UATs) and standby auxiliary transformers (SATs), are sized to provide the full load requirements of their respective loads groups as described in DCD Tier 2, Subsections 8.1.3.1.
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	c. The offsite system shall be comprised of two physically independent circuits connecting the transmission network (grid) to the onsite distribution system (safety buses). (Separate transmission line towers are required but common switchyard structures are acceptable. No requirement for meeting the single failure criterion and, in the absolute sense, this	The safety power system is connected to the transmission network through two physically and electrically separated preferred power circuits as described in DCD Tier 2, Subsections 8.2.1.3 and 8.2.1.4. The transmission network design, such as location of transmission line tower and common switchyard for units, is to be provided by the COL applicant as

<table>
<tr><th>GDC 17</th><th>Staff Interpretation</th><th>APR1400 Design Compliance</th></tr>
<tr><td>common to both circuits is acceptable.</td><td>criterion cannot be met because there is only one power source, the grid.)</td><td>described in COL 8.2(2).</td></tr>
<tr><td>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.</td><td>d. Each of the two required offsite power circuits shall be designed to be available in sufficient time to effect safe shutdown in the event of a loss of all onsite power and the loss of the other offsite circuit. (The staff has designated the second circuit as the “delayed access circuit.” The offsite power system (i.e., the two circuits considered together) must meet the single failure criterion, but only with respect to the delayed access circuit function.)</td><td rowspan="2">Both preferred power circuits are designed as immediate access circuits and available within a few seconds following a loss of coolant accident (LOCA) and loss of one offsite circuit as described in DCD Tier 2, Subsections 8.1.1 and 8.2.1.3.

The normal preferred power circuit provides immediate access of the onsite power system in the event of a LOCA by isolating the main generator from the main transformer and unit auxiliary transformers, and allowing back-feeding of offsite power to the onsite power system.

The alternate power circuit supplies power to the onsite power system by transferring the normal preferred power circuit to the alternate preferred power circuit within a few seconds when the normal preferred power circuit is not available.</td></tr>
<tr><td>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.</td><td>e. One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident. (The staff has designated this circuit as the “immediate access circuit.” Because only one such circuit is required, the offsite power system need not meet the single failure criterion with respect to its immediate access function.)</td></tr>
</table>

GDC 17	Staff Interpretation	APR1400 Design Compliance
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.	f. Analyses (performed by the utility) must verify that the grid remains stable in the event of a loss of the nuclear unit generator, the largest other unit on the grid, or the most critical transmission line. (There is no specific requirement for meeting the single failure criterion. However, overlapping requirement (a) above requires the offsite/onsite power systems to meet this criterion on a system basis.)	To verify that the grid remains stable under grid disturbances and loss of unit generator event, the COL applicant is to perform a grid stability analysis as described in COL 8.2(6). The APR1400 has adopted the generator circuit breaker (GCB) which is capable of interrupting maximum fault current during various fault conditions as described in DCD Tier 2, Subsections 8.2.1.3. In the event of generator failure or a loss of unit power, the GCB automatically opens and allows the offsite power to supply the Class 1E buses.

Impact on DCD

Refer to the response to RAI 16-7915 (Reference KHNP submittal MKD/NW-15-0029L, dated June 22, 2015; ML15173A091).

Impact on PRA

Refer to the response to RAI 16-7915 (Reference KHNP submittal MKD/NW-15-0029L, dated June 22, 2015; ML15173A091).

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.