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.:	**32-7946**
SRP Section:	**08.03.01 – AC Power Systems (Onsite)**
Application Section:	**08.03.01**
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Question No. 08.03.01-1

General Design Criterion (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. A switchyard common to both circuits is acceptable. 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. 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."

DCD Tier 2, Section 8.3.1.1, Page 8.3-1, states that "In case the power is unavailable from the UATs, the power source for the connected onsite power system Class 1E and non-Class 1E buses is automatically transferred to the standby auxiliary transformers (SATs)."

Please address the following:

1. How a loss of voltage at any one of the Class 1E buses of one division initiates an automatic fast transfer of the offsite power source to an unaffected bus of another division by switching the affected bus to an unaffected SAT

2. How the automatic transfer to a faulted bus will be prevented

3. For a potential failure in the fast transfer scheme (such as failure of a circuit breaker, or failure of control power), address the vulnerability of the scheme so that the fast transfer scheme failure does not affect the capability of the Class 1E emergency diesel generators (EDG) to perform their safety function of supplying electrical power to the Class 1E emergency buses in a loss of voltage condition

4. Discuss how the automatic fast transfer prevents a bus transfer to an out-of-phase source, and discuss the sync-check logic scheme

Response

KHNP provides the following information in response to the staff's request concerning the automatic fast transfer.

1. How an automatic fast transfer is initiated

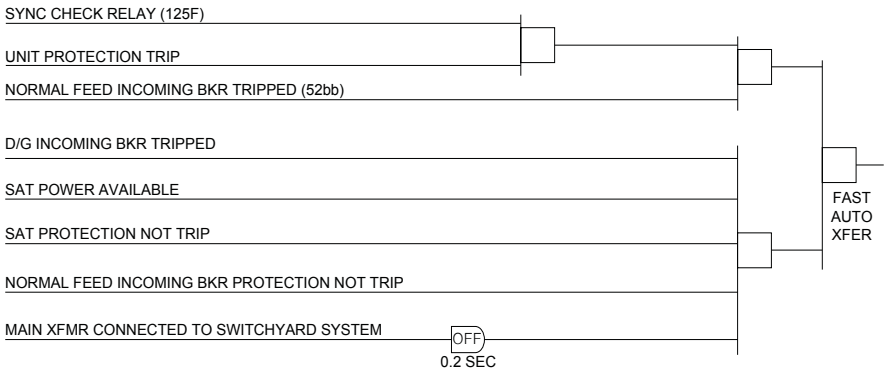
   A loss of voltage at any Class 1E bus of one division does not initiate the automatic fast transfer of the offsite power source. The automatic fast transfer is initiated only in a case when there is a unit protection trip at the normal preferred power supply (PPS) circuit.

   The procedure of the automatic fast transfer is as follows:

   - The unit protection trip due to failure of the unit auxiliary transformers (UATs), isolated phase bus (IPB), generator circuit breaker (GCB), main transformer (MT), or switchyard circuit breakers gives trip signals to the normal feed incoming breakers of all MV buses of both divisions and close signals to the alternate feed incoming breakers of the MV buses.

   - For each bus, closing of the alternate feed incoming breaker is permitted by output of the synchro-check relay for fast transfer and the open status of the normal feed incoming breaker and EDG feeder breaker.

   For more information, a simplified control logic diagram for the automatic fast transfer is provided below:



If the fast transfer is blocked by the synchro-check relay (125F) output, a residual transfer will be performed automatically when the condition is met.

2. Prevention of the automatic transfer to a faulted bus

If there is a fault at an MV bus, initiation of the automatic fast transfer is blocked by the interlock circuit of “no protection relay trip of the normal feed incoming breaker.”

3. Analysis of the vulnerability of the fast transfer scheme

The vulnerability of the fast transfer scheme is analyzed in the following table:

Failure Mode	Consequences
Failure of alternate feed incoming breaker	• No PPS circuit energizes the Class 1E bus. • Bus voltage decreases. • Undervoltage relay at the Class 1E bus is picked up and initiates the EDG starting and load sequencing process. • The EDG corresponding to the bus energizes the bus and supplies backup power.
Control power failure	Control power failure results in the same effects as the failure of the alternate feed incoming breaker.
Failure limited to fast transfer control circuitry or control logic	• As the automatic fast transfer is not attempted, the bus voltage decreases and reaches the value (e.g., 0.2 pu) that constitutes a condition for residual transfer. • The alternate feed incoming breaker is closed by an automatic closing command sent from the component control system (CCS). • The bus is energized and supplied by the alternate PPS.

The above analysis shows that a failure of the fast transfer scheme does not affect the capability of the Class 1E EDG to supply power to the Class 1E emergency buses in a loss of voltage condition.

4. How the automatic fast transfer prevents a bus transfer to an out-of-phase source

The synchro-check relay (125F) is used to permit automatic fast transfer only in case the conditions for the automatic fast transfer are met. The relay settings for the automatic fast transfer should be such that differences of the voltage angle and the V/Hz between the

running bus (upstream of the alternate feed incoming breaker) and the incoming bus (MV bus) at the point of breaker closing should not exceed the following criteria per National Electrical Manufacturers Association (NEMA) C50.41.

- Phase angle difference ($\Delta \delta$) < 90°
- Difference of the V/Hz phasor < 1.33 pu

Impact on DCD

DCD Tier 2, Subsection 8.3.1.1 will be revised as shown in the attachment.

Impact on PRA

There is no impact on the PRA.

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.

APR1400 DCD TIER 2

8.3 Onsite Power Systems

8.3.1 AC Power Systems

8.3.1.1 Description

The onsite ac power system includes standby power sources, distribution systems, and auxiliary supporting systems that are provided to supply power to safety-related equipment or equipment important to safety for all normal operating and accident conditions. There are four Class 1E emergency diesel generators (EDGs) and one non-Class 1E gas turbine generator (GTG). The alternate alternating current (AAC) source is used as a standby power source for the onsite ac power system. The four Class 1E EDGs provide backup power to the Class 1E 4.16 kV buses in the event of a loss of offsite power (LOOP). One Class 1E EDG is dedicated to the respective Class 1E 4.16 kV bus. The non-Class 1E AAC GTG provides backup power to the permanent non-safety (PNS) buses during a LOOP and the dedicated Class 1E 4.16 kV bus during a station blackout (SBO).

The Class 1E ac power system is supplied power from one of the two mobile generators in case of a beyond-design-basis external event. The connection box provided for the connection of a cable between the mobile generator and the 4.16 kV Class 1E bus is watertight. The connection box is installed in the entry and exit of the auxiliary building where the connection boxes are readily accessible to the mobile generator. The COL applicant is to provide and to design a mobile generator and its support equipment (COL 8.3(1)). In addition, Class 1E switchgear rooms are also designed with watertight exterior barriers and doors to prevent the inflow of floodwater.

The onsite power system consists of the Class 1E power system and the non-Class 1E power system. The onsite power system is normally powered from two unit auxiliary transformers (UATs). ~~In case the power is unavailable from the UATs, the power source for the connected onsite power system Class 1E and non-Class 1E buses is automatically transferred to the standby auxiliary transformers (SATs).~~

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If the normal preferred power source from UATs is unavailable, all Class 1E and non-Class 1E buses are automatically transferred to the alternate preferred power source from standby auxiliary transformers (SATs) by the fast and residual transfer scheme. For the automatic fast transfer, the synchro-check relay for each bus is used to supervise the voltage difference between the switchgear bus and upstream of the alternate feed incoming breaker and to provide a permissive for closing of the alternate feed incoming breaker to preclude unintended bus transfer. In case the fast transfer is not successful, residual transfer is performed automatically. The fast and residual transfer on each bus are permitted only when the alternate preferred power source from the SATs is available and the protection relay for the bus is not tripped.