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.:	**24-7928**
SRP Section:	**08.04 – Station Blackout**
Application Section:	**08.04**
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Question No. 08.04-1

In Section 8.4.1.2 of the DCD Tier 2, the applicant stated that the emergency alternating current (EAC) power system for the APR1400 consists of two redundant systems that have four independent Class 1E emergency diesel generators (EDGs). One Class 1E EDG (train A in Division 1 or train B in Division 2) is required to operate the ac-powered decay heat removal systems. The applicant selected the EAC power configuration group “C” in accordance with Table 3, “Emergency AC Power Configuration Groups,” of NRC RG 1.155. However, it is not clear to the staff why the applicant selected the configuration group C. According to Table 3 of RG 1.155, (1) the number of EAC power sources is the total number of dedicated EAC sources for all units; and (2) the number of EAC power sources required to operate AC-powered decay heat removal systems is based on all the AC loads required to remove decay heat (including AC-powered decay heat removal systems) to achieve and maintain safe shutdown at all units at the site with offsite power unavailable. APR1400 has 4 Class 1E EDGs in total. Section 8.3.1.1.2.3 of the DCD Tier 2 stated that, following a loss of offsite power (LOOP), the Class 1E EDGs are started and the safety buses are isolated from offsite sources and fed solely from their associated EDGs. Since one EDG is required to power the decay heat removal systems in each division during a LOOP, a total of 2 EDGs are required to operate the decay heat removal systems in both divisions following a LOOP. Therefore, based on Table 3 of RG1.155, the EAC power configuration group would not be “C.”

Please explain how the applicant selected the EAC power configuration group C. Also, please clarify whether each of the 4 EDGs is 100% redundant between the divisions. If the EAC power configuration is different than group C, please provide the appropriate SBO coping duration.

Response

KHNP confirms, as mentioned in DCD Tier 2, Subsection 8.4.1.2.a, that only one Class 1E EDG (train A or train B) is required to operate AC powered decay heat removal systems during a LOOP since one EDG (train A or train B) has 100% capability for decay heat removal during a LOOP. The four EDGs do not provide 100% redundancy between divisions, only train A or train B EDGs can supply 100% of the decay heat removal loads.

Since one out of two EDGs (train A or train B) is required to remove decay heat to achieve and maintain safe shutdown, the APR 1400 onsite power supply system falls into EAC power configuration group “C” according to Table 3 of NRC RG 1.155.

Between divisions, each of the two divisions (division I and division II) provides redundancy to the other and one of the two divisions (train A plus C or train B plus D) is required to supply the loads for safe shutdown during LOCA concurrent with a LOOP as described in DCD Tier 2, Subsection 8.3.1.1.2.1.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on 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 and Environmental Reports.

Question No. 08.04-2

Section 8.4.1.1 of the DCD Tier 2 states: “The AAC GTG is started and manually connected to the set of required shutdown equipment within 10 minutes in accordance with Position C.3.2.5 of NRC RG 1.155.” In Section 8.4.1.4, the applicant also stated that the station blackout (SBO) loads for the alternate ac gas turbine generator (AAC GTG) are energized by manual operation.

Please clarify whether the AAC GTG is capable of energizing the SBO loads within 10 minutes of the onset of the SBO. If not, please revise the statement to identify the intended equipment (e.g., buses).

Response

“Shutdown equipment” mentioned in DCD Tier 2, Subsection 8.4.1.1 was intended to mean “shutdown bus”. In order to avoid any misunderstanding, the sentence will be re-phrased as the following:

"The AAC GTG is started and manually connected to the shutdown bus within 10 minutes in accordance with Position C.3.2.5 of NRC RG 1.155 (reference 3)".

Impact on DCD

DCD Tier 2 Section 8.4.1.1 will be revised as shown in the Attachment.

Impact on PRA

There is no impact on 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 and Environmental Reports.

Question No. 08.04-3

Section 8.4.1.1 of the DCD Tier 2 states: "During an SBO, a non-class 1E AAC gas turbine generator (GTG) with sufficient capacity, capability, and reliability provides power for the set of required shutdown loads (non-design-basis accident (non-DBA)) to bring the plant to safe shutdown."

As defined in 10 CFR 50.2, safe shutdown (non-DBA) for SBO means "bringing the plant to those shutdown conditions specified in plant technical specifications as Hot Standby or Hot Shutdown, as appropriate." Please clarify the shutdown conditions (i.e., hot standby or hot shutdown) in which the AAC GTG is capable of bringing the plant.

Response

Given the SBO coping duration of 16 hours specified in Subsection 8.4.1.2, the AAC GTG is capable of supplying power for the shutdown loads required to bring the plant to the hot shutdown condition during an SBO.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on 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 and Environmental Reports.

Question No. 08.04-4

In Section 8.4.1.3, the applicant stated that the alternate ac gas turbine generator (AAC GTG) is manually aligned to power two permanent non-safety (PNS) 4.16 kV switchgears (division I and II) through two in-series normally-open circuit breakers during a loss of offsite power (LOOP) event. The staff notes that since the AAC GTG will be aligned to power the Class 1E 4.16 kV buses during a station blackout (SBO), the PNS 4.16 kV buses will be without power during the SBO.

Please clarify whether there is any equipment that that is normally powered from the PNS buses, and that needs to operate during an SBO. If so, please confirm that the equipment will have reliable power to operate during the SBO.

Response

The PNS buses does supply normal power to equipment loads; however, none of the loads are required to operate during an SBO.

As stated in DCD Tier 2, Subsection 8.3.1.1, AAC GTG back-up power supply to PNS buses is implemented only during a LOOP.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on 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 and Environmental Reports.

Question No. 08.04-5

Section 8.4.2.2 of the DCD Tier 2 states: “NRC RG 1.155 Position C.3.4 is related to the training and procedures for all operator actions necessary to cope with an SBO. Conformance with NRC RG 1.155 position C.3.4 is described in Sections 13.2 and 13.5.” RG 1.155 provides guidance on procedures and training for (a) restoring EAC when the EAC is unavailable (Position C.1.3), (b) restoring offsite power and use nearby power sources when offsite power is unavailable (Position C.2), and (c) coping with SBO for at least the coping duration and restoring normal long-term cooling (Position C.3.4). The staff finds no specific procedures and training related to RG 1.155 in DCD Sections 13.2 and 13.5.

Please clarify whether the COL applicant is required to address training and procedures related to RG 1.155 positions C.1.3, C.2, and C.3.4. If so, please provide the COL item for the RG 1.155 positions C.1.3, C.2, and C.3.4, or provide justification for any exception.

Response

A COL applicant will also address procedures related to RG 1.155 positions C.1.3 and C.2. Accordingly, part of DCD Tier 2, Section 8.4.2.2 will be revised to reflect RG 1.155 positions C1.3 and C.2 as follows:

“NRC RG 1.155 Position C.3.4 is related to the training and procedures for all operator actions necessary to cope with an SBO, Position C.1.3 is related to the procedures for the actions to restore emergency ac power when the emergency ac power system is unavailable, and Position C.2 is related to the procedures for the actions to restore offsite power when offsite power is unavailable.

The procedures per NRC RG 1.155 Positions C1.3, C.2 and C3.4 are addressed in Section 13.5 and the training per NRC RG 1.155 Position C.3.4 is addressed in Section 13.2".

Impact on DCD

DCD Tier 2 Section 8.4.2.2 will be revised as shown in the Attachment.

Impact on PRA

There is no impact on 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 and Environmental Reports.

8.4 Station Blackout

8.4.1 System Description

Station blackout (SBO) is the complete loss of alternating current (ac) electric power to the Class 1E and non-Class 1E switchgear buses in the APR1400. The SBO involves the loss of offsite power (LOOP) concurrent with a turbine trip and failure of the onsite emergency ac power system, but it does not include the loss of available ac power to buses fed by station batteries through inverters or the loss of the power from the alternate ac (AAC) source.

8.4.1.1 Description

The offsite and onsite power systems are designed with sufficient independence, capacity, and capability to meet the requirements of General Design Criterion (GDC) 17 (Reference 1). The offsite and onsite systems are also designed to permit periodic inspection and testing in accordance with GDC 18 (Reference 2). The electrical connections between the offsite power system and onsite power systems are described in Section 8.2. The onsite power system is described in Section 8.3.

During an SBO, a non-Class 1E AAC gas turbine generator (GTG) with sufficient capacity, capability, and reliability provides power for the set of required shutdown loads (non-design-basis accident) to bring the plant to safe shutdown. The AAC GTG is started and manually connected to the ~~set of required~~ shutdown ~~equipment~~ bus within 10 minutes in accordance with Position C.3.2.5 of NRC RG 1.155 (Reference 3).

Training and procedures necessary to cope with an SBO for APR1400 plant operators are described in Section 13.2 and Section 13.5.

8.4.1.2 Station Blackout Coping Duration

The SBO coping duration is determined by the following four design factors as specified in 10 CFR 50.63 (Reference 4) and NRC RG 1.155 Position C.3.1.

NRC Regulatory Guide 1.155

The following requirements of NRC RG 1.155 are related to the AAC GTG and the loads applied for SBO coping conditions.

a. NRC RG 1.155 requires that each nuclear power plant have the capability to withstand and recover from an SBO lasting a specified minimum duration. The specified duration of SBO is based on the four factors as described in Subsection 8.4.1.2. Conformance with NRC RG 1.155 Position C.3.1 is described in Subsection 8.4.1.2.

b. There are two SBO coping methods. The first method is the "AC-Independent" approach. In this approach, nuclear power plants rely on available process steam, dc power, and compressed air to operate equipment necessary to achieve safe shutdown conditions until offsite power sources or EAC power sources are restored. The second method is the "Alternate AC" approach. This met use of equipment that is capable of being electrically isolated offsite and emergency onsite ac power sources. The A F "Alternate AC" approach. NRC RG 1.155 specifies that no needed if the AAC power source is available within 10 minutes SBO. Therefore, the APR1400 is not required to perform an S However, additional coping analysis for the APR1400 is perf and extended SBO. Conformance with NRC RG 1.155 Position C.3.2 and C.3.3 is described in Subsection 8.4.1 and Section 19.2.

, Position C.1.3 is related to the procedures for the action to restore emergency ac power when the emergency ac power system is unavailable, and Position C.2 is related to the procedures for the actions to restore offsite power when offsite power is unavailable.

c. NRC RG 1.155 Position C.3.4 is related to the training and procedures for all operator actions necessary to cope with an SBO. ~~Conformance with NRC RG 1.155 position C.3.4 is described in Sections 13.2 and 1~~3.5.

d. NRC RG 1.155 Position C.3.5 is related to the quality assurance (QA) activities and specification for a non-safety-related AAC that is installed to meet an SBO. The non-safety equipment installed to meet an SBO does not degrade the existing safety-related systems. The QA guidance for the AAC GTG is described in Chapter 17.

The procedures per NRC RG 1.155 Positions C1.3, C.2 and C3.4 are addressed in Section 13.5 and the training per NRC RG 1.155 Positoin C.3.4 is addressed in Section 13.2.