
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.: 375-8466
SRP Section: 09.05.03 – Lighting Systems
Application Section:
Date of RAI Issue: 01/28/2016

Question No. 09.05.03-9

In response to RAI 8179, Question 09.05.03-1, the applicant stated that the isolation devices between the Class 1E buses and the non-Class 1E lighting circuits have the proper capabilities according to RG 1.75 and IEEE Std. 384-1992. The applicant provided a markup for Section 9.5.3 of the DCD Tier 2, which incorporated the above response. However, the applicant did not discuss how they conform to RG 1.75 in the DCD markup.

Please revise Section 9.5.3.3 of the DCD Tier 2 to incorporate a discussion of the conformance of the isolation devices with RG1.75.

Response

RG 1.75 as endorsed by IEEE Std. 384-1992 requires that the isolation devices be properly coordinated and periodically tested to ensure that overall protection coordination remains.

During every refueling outage, periodic testing of the electrical isolation devices is to be performed so that the overall coordination scheme is demonstrated to remain within the limits specified in the design criteria, in accordance with RG 1.75.

DCD Tier 2, Subsection 8.3.1.1.2.3 will be revised to incorporate the description of the periodic testing of electrical isolation devices as shown in the attachment of the response to RAI 203-8214, Question 08.03.01-19. And DCD Tier 2, Subsection 9.5.3.3 will be revised to refer to DCD Tier 2, Subsection 8.3.1.1.2.3 for the more details on the isolation devices between the Class 1E buses and the non-Class 1E lighting circuits.

Impact on DCD

DCD Tier 2, Subsection 9.5.3.3 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.

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- d. For firefighting, the self-contained battery lightings provide emergency lighting for safe movement of the personnel to the access and egress routes.
- e. The self-contained battery lightings located in Class 1E equipment areas meet seismic Category I requirements. The self-contained battery lightings located in all other areas meet seismic Category II requirements.
- f. The emergency ac lighting powered from the Class 1E sources is classified as non-Class 1E circuits. Lighting circuits are electrically isolated from Class 1E circuits by the use of isolation devices and separation distance as indicated in IEEE Std. 384-1992. 
The isolation devices are described in detail in Subsection 8.3.1.1.2.3.
- g. Lamps with mercury content are not to be installed in the fuel handling areas and inside the containment.

9.5.3.4 Inspection and Testing Requirements

The lighting system is inspected and tested prior to plant operation. Preoperational testing on the lighting systems is performed during initial startup as described in Subsections 14.2.12.1.80 and 14.2.12.1.81.

The normal lighting circuits are normally energized and require no periodic testing. The emergency lighting is inspected and tested periodically.

9.5.3.5 Instrumentation Requirements

There is no specific instrumentation associated with the lighting systems.

9.5.4 Emergency Diesel Engine Fuel Oil System

The emergency diesel engine fuel oil system (EDEFOS) provides for the required storage capacity and continuous supply of fuel oil to each of the four Class 1E emergency diesel generators (EDGs) to safely shut down the plant and maintain a safe shutdown condition following a design basis accident (DBA) concurrent with a loss of offsite power (LOOP) by supplying power to essential loads. Diesel fuel for each emergency diesel generator is supplied by fuel oil transfer pumps from a fuel oil storage tank to a fuel day tank.

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Application Section:
Date of RAI Issue: 01/28/2016

Question No. 09.05.03-10

In response to RAI 8179, Question 09.05.03-2, the applicant provided the illumination levels, measured in unit of lux, for normal lighting in different areas of the APR1400 standard design. The staff converted the APR1400 illuminances from lux to foot candles (fcd) (1 lux = 0.0929 foot candles) for a comparison with the levels recommended by NUREG 0700, Tables 12.1 and 12.10. The staff notes that the APR1400 illuminances or lower limits of the illuminance ranges in some areas of the plant are lower than the recommended illuminances in NUREG 0700, as shown in the table below. For example, illuminances in the reactor building are 27.87 fcd and 18.58 fcd versus the recommended 50 fcd in NUREG 0700; the lower limit of the illuminances range at the auxiliary panel is 23.23 fcd compared to 50 fcd recommended by NUREG 0700.

- a. Please provide justifications for illuminances that are lower than the levels recommended by NUREG 0700.
- b. In DCD Tier 2, Section 1.2.14, the applicant provided a summary of the APR1400 standard design plant arrangement, which includes the following buildings: emergency diesel generator (EDG) building, alternate alternating current (AAC) gas turbine generator (GTG) building, and component cooling water (CCW) heat exchanger building. The applicant stated that the auxiliary building also houses two EDG rooms and an emergency core cooling system (ECCS) equipment area. In addition, in Section 9.3.3.2.5 of the DCD Tier 2, the applicant stated that ESF equipment rooms are located in the auxiliary building.

Please provide the illuminance levels in fcd units for the above buildings and equipment rooms/areas. If these illuminances are different than that recommended by NUREG 0700, please provide justifications for the differences.

Building	Area	APR1400 Recommended Lux	APR1400 (Lux converted to foot candles)	NUREG 0700 (Recommended foot candles from Tables 12.10 and 12.1)
Reactor Containment	Operator Deck	300	27.87	50
	Others	200	18.58	50
Auxiliary	Main Control Room			
	a. Operator Console	300~100	27.87~92.9	100
	c. Safety Console and Auxiliary Control Panel	250~750	23.23~69.68	50
	Computer Room	700	65.03	100
	Technical Support Center	700	65.03	100
	I&C Equipment Room	300	27.87	50
	Remote Shutdown Room	300~1000	27.87~92.9	100
	Sample Room	700	65.03	100
	Fuel Handling over Pools	300	27.87	50
	Fuel Transfer Pit	400	37.16	50
Ohers	100~500	9.29~46.45	20 and 50 depending on the areas	
Turbine Generator	Operator Deck	200	18.58	50
	Others	200	18.58	50
Compound	Laboratory, Instrument Repair Room	700	65.03	100
	Secondary Sample Room	700	65.03	100
	Office	500	46.45	100
	Operational Support Center	700	65.03	100
	Counting Room	700	65.03	100
	Control Room	750	69.68	100
Others	General Office	500	46.45	100
	Essential Service Water	200	18.58	50
	Circulating Water Pump House	200	18.58	50
	Electrical Equipment Room such as Switchgear, MCC, LC, Relay, and Protection Panel	300	27.87	50

Response

- a. The recommended illumination levels shown previously in the response to RAI 8179, Question 09.05.03-2 are the typical values for representative areas in the plant. To avoid confusion, the revised nominal illumination levels are provided in foot candles as indicated in the attachment.
 - b. The illumination levels for EDG building, AAC GTG building, CCW heat exchanger building, EDG room, ECCS equipment area, and ESF equipment rooms in the auxiliary building are 20-50 foot candles. This is consistent with the illumination level recommended by NUREG-0700, which is based on Illuminating Engineering Society of North America (IESNA) Lighting Handbook.
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Impact on DCD

There is no impact on the DCD.

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.

Building	Area	Nominal Illumination Level (Foot candles)
Reactor Containment	Operator Deck	20-50
	Others	10-20
Auxiliary	Main Control Room	
	a. Operator Console	100
	b. LDP Area	50
	c. Safety Console and Auxiliary Control Panel	75
	Computer Room	50-100
	Technical Support Center	50-100
	I&C Equipment Room	20-50
	Remote Shutdown Room	100
	Sample Room	50-100
	Fuel Handling over Pools	20-50
Fuel Transfer Pit	20-50	
Ohers	10-20	
Turbine Generator	Operator Deck	20-50
	Others	10-20
Compound	Laboratory, Instrument Repair Room	50-100
	Secondary Sample Room	50-100
	Office	50-100
	Operational Support Center	50-100
	Counting Room	50-100
	Control Room	50-100
	Other	20-50
Others	Battery Room	20-50
	General Office	50-100
	Chemical Storage Room	10-20
	Wash Room, Locker Room	20-50
	Corridors	10-20
	Stairway	10-20
	ESW Building, CW Pump House	20-50
	Radioactivity Pollute Area (Sump Pump Area)	10-20
	Cable Spreading Area	5-10
	Fire Pump & Water/Wastewater Treatment Building	20-50
	Electrical Equipment Room such as Switchgear, MCC, LC, Relay, and Protection Panel	20-50
	Machine Room such as HVAC, Pump, and Valve Room	20-50
	Outdoor Switchyard Areas	1
	Outdoor Transformer Areas	2-5
	Tunnels	5-10
	Roadway	1
	Lobby	10-20

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Question No. 09.05.03-11

In response to RAI 8179, Question 09.05.03-4, the applicant clarified Section 9.5.3.3 of the DCD Tier 2 stating:

Illumination during [loss of offsite power] LOOP, [safe shutdown earthquake] SSE, and [station blackout] SBO is provided by the emergency DC [direct current] lighting powered from both the station battery and the individual self-contained battery. The self-contained battery fixtures are provided in sufficient quantity in areas to be needed for operation of safe shutdown and for access and egress route thereto. Where sufficient illumination for safe-shutdown operations can't be provided only with self-contained battery pack lighting fixtures, DC lighting fixtures fed from non-Class 1E 125 VDC station batteries are provided to ensure required the illumination level in the area.

The applicant did not revise the DCD to reflect the above clarification. The current statement, "the emergency DC lighting powered from the station battery or the individual self-contained battery provides adequate illumination for safe shutdown operations," in Section 9.5.3.2 is not consistent with the above clarification.

Please revise Section 9.5.3.2 of the DCD Tier 2 to incorporate the above clarification.

Response

DCD Tier 2, Subsection 9.5.3.2 will be revised to incorporate the response to RAI 164-8179, Question 09.05.03-4.

Impact on DCD

DCD Tier 2, Subsection 9.5.3.2 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.

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The self-contained battery lighting fixtures are equipped with sealed-beam, an 8-hour battery, and a battery charger. The power is automatically provided from the self-contained battery upon loss of normal or emergency ac lighting power.

The self-contained battery lighting provides more than 0.1 foot-candles of illumination at the areas where emergency ac lightings are provided.

c. Security lighting system

A minimum illumination level of 0.2 foot-candles is provided and measured horizontally at ground level in the isolation zones and appropriate exterior areas within the protected area. The security lighting is powered from offsite and backed up by the AAC source upon loss of offsite power.

The COL applicant is to provide offsite power for the security lighting system.

9.5.3.3 Safety Evaluation

The normal lighting is not available during LOOP, SSE, and SBO conditions.

- a. The emergency ac lighting is normally turned on and supplements the normal lighting. The emergency dc lighting is normally turned off.
- b. During LOOP, SSE, and SBO, the emergency ac lighting fed from the Class 1E 480 Vac bus is interrupted until the power supply to the Class 1E ac buses is restored. During this period, emergency dc lighting powered from the station battery ~~or~~ the individual self-contained battery provides adequate illumination for safe shutdown operations and for movement of personnel to the access and egress routes. and
- c. Emergency ac or dc lighting provides a minimum illumination level of 10 foot-candles in the MCR and RSR. Emergency dc lighting provides illumination when emergency ac lighting is lost.

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Question No. 09.05.03-12

In response to RAI 8237, Question 09.05.03-5, the applicant provided additional areas where emergency lighting system is required for firefighting, control, and maintenance of equipment used for implementing safe shutdown of the plant during all plant operation conditions as recommended by NUREG-0800. Based on its review, the staff noted that the areas listed by the applicant do not include areas such as the alternate alternating current (AAC) gas turbine generator (GTG) building where equipment used for implementing safe shutdown of the plant during a station blackout (SBO) event are located.

Please identify other areas required for firefighting, control, and maintenance of equipment used for implementing safe shutdown of the plant during an SBO event, and confirm whether the GTG building is included as one of the aforementioned areas.

Response

There are no additional areas other than the areas for emergency lighting system that are provided in response to RAI 8237, Question 09.05.03-5.

Lighting in the AAC GTG building consists of normal lighting and emergency dc lighting from self-contained battery lighting fixtures. The emergency dc lighting provides adequate lighting during an SBO event before the AAC source is provided. The normal lighting is fed from a non-Class 1E 480 Vac bus, which is located in the AAC GTG building and backed up by the non-Class 1E AAC source and provides adequate lighting after the AAC source is provided.

Impact on DCD

There is no impact on the DCD.

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.

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Question No. 09.05.03-13

In response to RAI 8237, Question 09.05.03-7, the applicant states: “The lighting system equipment located in safety-related areas meets seismic Category II requirements not to impact safety-related equipment when subjected to seismic loading of a safe shutdown earthquake. Lighting system equipment in other areas is classified as seismic Category III.” The applicant stated that Section 9.5.3.3 of the DCD Tier 2 will be revised with the above statement.

Please discuss and revise the above statement to clarify the term “safety-related areas.”

Response

The term “safety-related areas” applies to areas containing equipment or structures required for safe shutdown (including accident mitigation). For more details, refer to DCD Tier 2, Table 3.2-1, note No. (1).

Impact on DCD

There is no impact on the DCD.

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.

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Question No. 09.05.03-14

In response to RAI 8237, Question 09.05.03-8, the applicant stated that the emergency lighting is inspected and tested periodically in accordance with the plant operating and maintenance procedures, which is identified in Section 13.5.2 of the DCD Tier 2. The applicant provided a markup of Section 9.5.3.4, which incorporated the above information in the response. However, reference to Section 13.2 was omitted from the markup.

Please revise Section 9.5.3.4 of the DCD Tier 2 to incorporate the above statement including the reference to Section 13.5.2. In addition, since the COL applicant is required to develop operating and maintenance procedures as stated in Section 13.5.2, provide in Section 9.5.3.4, the COL item(s) in Section 13.5.2 that address the operating and maintenance procedures related to the emergency lighting systems.

Response

DCD Tier 2, Subsection 9.5.3.4 will be revised to incorporate the reference to Subsection 13.5.2. COL 13.5(6) will be provided in Subsection 9.5.3.4 for the operating and maintenance procedures related to the emergency lighting system.

Impact on DCD

DCD Tier 2, Subsection 9.5.3.4 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.

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- d. For firefighting, the self-contained battery lightings provide emergency lighting for safe movement of the personnel to the access and egress routes.
- e. The self-contained battery lightings located in Class 1E equipment areas meet seismic Category I requirements. The self-contained battery lightings located in all other areas meet seismic Category II requirements.
- f. The emergency ac lighting powered from the Class 1E sources is classified as non-Class 1E circuits. Lighting circuits are electrically isolated from Class 1E circuits by the use of isolation devices and separation distance as indicated in IEEE Std. 384-1992.
- g. Lamps with mercury content are not to be installed in the fuel handling areas and inside the containment.

9.5.3.4 Inspection and Testing Requirements

The lighting system is inspected and tested prior to plant operation. Preoperational testing on the lighting systems is performed during initial startup as described in Subsections 14.2.12.1.80 and 14.2.12.1.81.

RAI 375-8466 - Question 09.05.03-14

RAI 204-8237 - Question 09.05.03-8

The normal lighting circuits are normally energized and require no periodic testing. The emergency lighting is inspected and tested periodically.

, in accordance with the plant operating and maintenance procedures, which is identified in DCD Tier 2, Subsection 13.5.2 (COL 13.5(6))

9.5.3.5 Instrumentation Requirements

There is no specific instrumentation associated with the lighting systems.

9.5.4 Emergency Diesel Engine Fuel Oil System

The emergency diesel engine fuel oil system (EDEFOS) provides for the required storage capacity and continuous supply of fuel oil to each of the four Class 1E emergency diesel generators (EDGs) to safely shut down the plant and maintain a safe shutdown condition following a design basis accident (DBA) concurrent with a loss of offsite power (LOOP) by supplying power to essential loads. Diesel fuel for each emergency diesel generator is supplied by fuel oil transfer pumps from a fuel oil storage tank to a fuel day tank.