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.:	**28-7942**
SRP Section:	**08.02 – Offsite Power System**
Application Section:	**08.02**
Date of RAI Issued:	**06/15/2015**

Question No. 08.02-1

Standard Review Plan (SRP) states that "adequate provisions are made in the design of the plant and the offsite and onsite power systems for grounding, surge protection, and lightning protection. The reviewer evaluates the plant/station grounding systems, the methods of equipment and structural grounding, ac power system neutral grounding and ground fault current limiting features, surge and lightning protection features for outdoor equipment and circuits, and the measures for isolation of instrumentation grounding systems. Regulatory Guide (RG) 1.204 and IEEE Std. 665, 666, 1050, and C62.23, provide acceptable guidelines for the design, installation, and performance of station grounding systems and surge and lightning protection systems.

RG1.206, Section C.I.8.2.1 states that "the applicant should identify the potential effects that must be considered during testing, the margins being applied, and how the design incorporates these requirements for offsite power supplies, including, but not limited to, high-voltage transmission networks, medium-voltage distribution networks, switchyard equipment (bus work, transformers, circuit breakers, disconnect switches, surge protective devices, control, communication, grounding, and lightning systems), switching capacitors, and voltage control equipment between the switchyard and the plant."

The applicant states in the DCD Tier 2, Section 8.2.2.2, "Conformance with NRC Regulatory Guides" that APR1400 design conforms with RG 1.204 and has additional information in Section 8.3.1.1.8. COL item 8.3(2) states the COL applicant is to describe and provide detailed ground grid and lightning protection. COL item 8.3(5) states that the COL applicant is to provide insulation coordination of surge and lightning protection.

The staff requests, per RG 1.206, identify the potential effects that must be considered during testing, the margins being applied, and how the design incorporates these requirements for

offsite power supplies, specifically regarding the surge protective devices, grounding, and lightning systems.

Response

Since the test procedures for the offsite power system components are to be provided by a COL applicant as described in COL item 8.2(8), the potential effects during the testing are also to be identified by the COL applicant. Accordingly, KHNP will revise COL item 8.2(8) to clarify the responsibility of the COL applicant.

Basically, the margins being applied to the surge protective devices, grounding, and lightning systems have been considered in the referenced codes and standards described in DCD Tier 2, Subsections 8.3.1.1.8 and 8.3.1.3.5. In some instances (e.g., margin in fault current duration in ground grid for sizing of ground mesh conductors), appropriate design margins will be considered and applied in the detailed design phase.

Incorporation of the design requirements and applicable regulations for the above mentioned system components is addressed in DCD Tier 2, Subsections 8.3.1.1.8 and 8.3.1.3.5.

In order to more closely align the structure of the relevant DCD sections and subsections with the standard DCD structure per RG 1.206 and to provide further necessary information, KHNP will revise DCD Tier 2, Subsection 8.3.1.3.5 and add DCD Tier 2, Subsection 8.3.1.3.8 and a COL item, COL 8.3(9).

Impact on DCD

DCD Tier 2, Section 1.8 and Subsections 8.2.1.3, 8.2.3, 8.3.1.3.5, 8.3.1.3.8, and 8.3.3 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.

Table 1.8-2 (10 of 29)

Item No.	Description
COL 8.2(1)	The COL applicant is to identify the circuits from the transmission network to the onsite electrical distribution system that are supplied by two physically independent circuits.
COL 8.2(2)	The COL applicant is to provide information on the location of rights-of-way, transmission towers, voltage level, and length of each transmission line from the site to the first major substation that connects the line to the transmission network.
COL 8.2(3)	The COL applicant is to describe the switchyard voltage related to the transmission system provider/operator (TSP/TSO) and the formal agreement between the nuclear power plant and the TSP/TSO. The COL applicant is to describe the capability and the analysis tool of the TSP. The COL applicant is also to describe the protocols for the plant to remain cognizant of grid vulnerabilities.
COL 8.2(4)	The COL applicant is to describe and provide layout drawings of the circuits connecting the onsite distribution system to the preferred power supply.
COL 8.2(5)	The COL applicant is to describe site-specific information for the protective devices, ac power, and dc power that control the switchyard equipment.
COL 8.2(6)	The COL applicant is to provide an FMEA for switchyard components. In addition, the COL applicant is to provide the results of grid stability analyses to demonstrate that the offsite power system does not degrade the normal and alternate preferred power sources to a level where the preferred power sources do not have the capacity or capability to support the onsite Class 1E electrical distribution system in performing its intended safety function.
COL 8.2(7)	The COL applicant is to design the offsite power system to detect, alarm, and automatically clear a single-phase open circuit condition.
COL 8.2(8)	The COL applicant is to describe how testing is performed on the offsite power system components.
COL 8.2(9)	The COL applicant is to provide the required number of immediate access circuits from the transmission network.

and identify the potential effects that must be considered during testing

add

Table 1.8-2 (11 of 29)

Item No.	Description
COL 8.3(1)	The COL applicant is to provide and to design a mobile generator and its support equipment.
COL 8.3(2)	The COL applicant is to describe and provide detailed ground grid and lightning protection.
COL 8.3(3)	The COL applicant is to provide testing, inspection, and monitoring programs for detecting insulation degradation of underground and inaccessible power cables within the scope of 10 CFR 50.65.
COL 8.3(4)	The COL applicant is to provide protective device coordination.
COL 8.3(5)	The COL applicant is to provide insulation coordination of surge and lightning protection.
COL 8.3(6)	The COL applicant is to develop the maintenance program to optimize the life and performance of the batteries.
COL 8.3(7)	The COL applicant is to provide short circuit analysis of onsite dc power system with actual data.
COL 8.3(8)	The COL applicant is to describe any special features of the design that would permit online replacement of an individual cell, group of cells, or entire battery.
COL 8.4(1)	The COL applicant is to identify local power sources and transmission paths that could be made available to resupply power to the plant following the loss of a grid or the SBO.
COL 8.4(2)	The COL applicant is to develop detailed procedures for manually aligning the alternate AC power supply when two (Trains A and B) of the four diesel generators are unavailable during a loss of offsite power event.
COL 9.1(1)	The COL applicant is to provide operational procedures and maintenance program as related to leak detection and contamination control.
COL 9.1(2)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 9.1(3)	The COL applicant is to address the load-handling procedures. Load-handling procedures are established for component handling procedures and plant operating procedures in accordance with ASME B30.2. ASME B30.2 requires establishing component handling procedures that include (1) a safe load path for lifting heavy loads to perform special handling component inspections, (2) acceptance criteria prior to lift, and (3) use of steps and proper sequence in handling the load. ASME B30.2 requires plant operating procedure guidelines that include appropriate crane operator training and crane inspections. ASME B30.2 also requires that the load-handling procedures include preparing operating procedures for preoperational load testing and checkouts of interlocks, brakes, hoisting cables, control circuitry, and lubrication of OHLHS equipment.

add

COL 8.3(9)	The COL applicant is to provide the analysis for the station and switchyard grounding system with underlying assumptions, based on the site-specific parameters including soil resistivity and site layout (COL 8.3(9)).

closed and the MG is connected to the transmission system through the MT and also supplies power to the UATs. The alternate preferred circuit is connected to the high-voltage side of the SATs. In case the power supply is unavailable from the UATs, the power supply is maintained because the onsite non-safety-related and safety-related bus connections are transferred automatically from the UATs to the SATs. When the normal preferred power supply is restored, the transfer from the SATs to the UATs is accomplished manually. The UATs and SATs are three-winding transformers connected to the onsite non-safety-related and safety-related buses through their low-voltage side windings. Both non-safety-related and safety-related buses are normally supplied from the UATs.

The IPB is used to connect the MG to the GCB. The IPB provides the electrical connection among the GCB, the MT, and the two UATs. The MT is composed of three single-phase transformers that are connected to the two UATs through the IPB.

The GCB is used as a means of providing immediate access of the onsite ac power systems to the offsite power system by isolating the MG from the MT and the UATs and allowing backfeeding of offsite power to the onsite ac power system. The GCB is capable of interrupting normal load current and maximum fault current during transient and various fault conditions. The APR1400 is designed to follow the guidance in Appendix A of Standard Review Plan (SRP) Section 8.2 (Reference 6). After the MT is connected to the transmission network by closing the switchyard breakers with the GCB open, the UATs supply plant startup power to auxiliary and service loads of the APR1400. As part of the normal turbine-generator shutdown process, the GCB is opened to separate the MG from the switchyard when the MG output has been reduced to almost no-load condition. After the MG is disconnected from the switchyard by opening the GCB, the MT remains connected to the network system and backfeeds plant shutdown power to the APR1400 through the UATs during plant shutdown.

The COL applicant is to design the offsite power system to detect, alarm, and automatically clear a single-phase open circuit condition at the primary sides of MT or SATs in accordance with NRC BL-2012-01 (COL 8.2(7)) (Reference 7).

The COL applicant is to describe how testing is performed on the offsite power system components (COL 8.2(8)). The ratings of the MG, GCB, MT, UATs, SATs, and IPB are shown in Table 8.2-1.

and identify the potential effects that must be considered during testing

add

COL 8.2(7) The COL applicant is to design the offsite power system to detect, alarm, and automatically clear a single-phase open circuit condition.

COL 8.2(8) The COL applicant is to describe how testing is performed on the offsite power system components.

add

and identify the potential effects that must be considered during testingd

COL 8.2(9) The COL applicant is to provide the required number of immediate access circuits from the transmission network.

8.2.4 References

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," U.S. Nuclear Regulatory Commission.

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Dynamic Effects Design Bases," U.S. Nuclear Regulatory Commission.

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components," U.S. Nuclear Regulatory Commission.

4. 10 CFR Part 50, Appendix A, General Design Criterion 17, "Electric Power Systems," U.S. Nuclear Regulatory Commission.

5. 10 CFR Part 50, Appendix A, General Design Criterion 18, "Inspection and Testing of Electric Power Systems," U.S. Nuclear Regulatory Commission.

6. NUREG-0800, Standard Review Plan, Section 8.2, Appendix A, "Guidelines for Generator Circuit Breakers/Load Break Switches," Rev. 5, U.S. Nuclear Regulatory Commission, May 2010.

7. BL 2012-01, "Design Vulnerability in Electric Power System," U.S. Nuclear Regulatory Commission, July 27, 2012.

8. IEEE Std. 765-2006, "IEEE Standard for Preferred Power Supply (PPS) for Nuclear Power Generating Stations (NPGS)," Institute of Electrical and Electronics Engineers, 2006.

transformer, and switchyard facilities. Insulation coordination is performed in accordance with IEEE Std. C62.82.1 (Reference 49) and IEEE Std. 1313.2 (Reference 50). The COL applicant is to provide the insulation coordination of surge and lightning (COL 8.3(5)).

add

The guidelines for the design of the surge and lightning protection are described in Subsection 8.3.1.1.8.

8.3.1.3.6 Power Quality Limits

Nonlinear loads such as battery chargers and inverters contribute total harmonic distortion (THD) to the distribution power system. THD degrades electric power quality, causing increased heating due to copper and iron losses at harmonic frequencies on electrical equipment such as motors, transformers, and switchgears. Therefore, the electrical distribution system is designed so that THD does not affect Class 1E equipment. THD is maintained within the acceptance criteria in accordance with IEEE Std. 519 (Reference 51). An analysis is performed so that THD is less than or equal to 5 percent. Reasonable assurance of the protective device application within the power quality that is needed for the device to operate, is provided.

8.3.1.3.7 Monitoring and Testing

Monitoring of the distribution power system is provided with information such as the quantitative value of equipment, circuit breaker status, and the protective device alarm by ESF-CCS and QIAS-P for Class 1E and the P-CCS and IPS for non-Class 1E equipment in the main control room and remote shutdown console. The operator can use the information that is necessary for efficient operation of the unit. All control room I&C is designed in accordance with the human factors engineering design criteria and implementation methods as described in Chapter 18.

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8.3.1.3.8 Grounding

The grounding system complies with the guidelines in IEEE Std. 665 and IEEE Std. 1050, as endorsed by RG 1.204. The grounding system consists of station grounding, system grounding, equipment grounding, safety grounding, and instrumentation grounding.

The station grounding consisting of interconnected bare copper conductors is provided to protect personnel and equipment from the hazard voltages. System grounding is intended to provide grounds of neutral points of MG, UATs, SATs, load center transformers, EDG, and AAC GTG. Equipment grounding is provided for the ground fault return path via the raceway system. Safety grounding is for protecting personnel from injury and property from damage. Instrumentation grounding is intended to establish the signal reference and minimize degradation of instrumentation signals by grounding signal cable shields, instrumentation applications, and signal return conductors. Guidelines for the design of the grounding system are described in Subsection 8.3.1.1.8.

The COL applicant is to provide the analysis for the station and switchyard grounding system with underlying assumptions, based on the site-specific parameters including soil resistivity and site layout (COL 8.3(9)).

The ground detector has an alarm in the MCR to monitor constant grounding and recording. The ground detector has high sensitivity.

8.3.3 Combined License Information

COL 8.3(1) The COL applicant is to provide and to design a mobile generator and its support equipment.

COL 8.3(2) The COL applicant is to describe and provide detailed ground grid and lightning protection.

COL 8.3(3) The COL applicant is to provide testing, inspection, and monitoring programs for detecting insulation degradation of underground and inaccessible power cables within the scope of 10 CFR 50.65.

COL 8.3(4) The COL applicant is to provide protective device coordination.

COL 8.3(5) The COL applicant is to provide insulation coordination of surge and lightning protection.

COL 8.3(6) The COL applicant is to develop the maintenance program to optimize the life and performance of the batteries.

COL 8.3(7) The COL applicant is to provide a short-circuit analysis of the onsite dc power system with actual data.

COL 8.3 (8) The COL applicant is to describe any special features of the design that would permit online replacement of an individual cell, group of cells, or entire battery.

add

COL 8.3(9) The COL applicant is to provide the analysis for the station and switchyard grounding system with underlying assumptions, based on the site-specific parameters including soil resistivity and site layout (COL 8.3(9)).

8.3.4 References

1. IEEE Std. 141-1993, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants," Institute of Electrical and Electronics Engineers, 1993.