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.:	**437-8540**
SRP Section:	**08.01 – Electric Power - Introduction**
Application Section:	**8.1**
Date of RAI Issue:	**03/08/2016**

Question No. 08.01-17

In RAI 8166, Question 08.01-4, dated August 31, 2015, the staff stated in part that APR1400 DCD Table 8.1-2, “Criteria and Guidelines for Electric Power Systems” regulations including 10 CFR 50.55a, 10 CFR 52.47 (b)(1), 10 CFR 52.80(a), 10 CFR 50.34(f)(2)(v), and 10 CFR 50.34(f)(2)(xiii) are applicable to the design, but the DCD did not discuss how the design meets these requirements. Therefore, the staff requested that the applicant discuss how the APR1400 design conforms to the above requirements. In response to RAI 8166, Question 08.01-4, dated December 11, 2015, ADAMS Accession ML15345A339, the applicant stated that the electric power system of the APR1400 design conforms to the requirements of 10 CFR 50.55a, 10 CFR 52.47 (b)(1), 10 CFR 52.80(a), 10 CFR 50.34(f)(2)(v), and 10 CFR 50.34(f)(2)(xiii). With regard to 10 CFR 50.55a, the applicant stated that in DCD Tier 2, Subsection 8.3.1.2.2 and 8.3.2.2.2, the Class 1E onsite ac and dc power systems of the APR1400 are designed to conform with the requirements of IEEE Std. 603-1991, including the correction sheet which is endorsed by NRC RG 1.153. However, the applicant did not provide a statement or discussion in the DCD to indicate applicability of 10 CFR 50.55a. With regard to 10 CFR 52.47 (b)(1) and 10 CFR 52.80(a), the applicant stated that the APR1400 facility will be constructed and will be operated in accordance with the design certification, the facility will be constructed and will be operated in conformity with the combined license, the ITAAC proposed for the electrical systems of APR1400 are described in DCD Tier 2, Subsection 14.3.2.6 and Tier 1, Section 2.6 and are sufficient to meet the requirements of 10 CFR. However, the applicant did not provide a statement or discussion in the DCD to indicate applicability of 10 CFR 52.47 (b)(1) and 10 CFR 52.80(a). With regard to 10 CFR 50.34(f)(2)(v) and 10 CFR 50.34(f)(2)(xiii), the applicant stated in part that the a new subsection, 8.3.1.2.3, was proposed to Chapter 8 of the DCD, as a result of KHNP’s response to RAI 134-8033, Question No. 08.03.01-12 (Reference KHNP submittal MKD/NW-15-0228L, dated October 28, 2015, ML15301A925). The staff reviewed the response to RAI 134-8033, Question No. 08.03.01-12 referenced in the response and found that this part of the response was acceptable with the changes made in subsection, 8.3.1.2.3. Therefore, the staff requests that the applicant provide a statement or discussion in the DCD to indicate applicability of 10 CFR 50.55a and its relationship with IEEE Std. 603-1991. Staff also requests

that the applicant provide a statement or discussion in the DCD to indicate applicability of 10 CFR 52.47(b)(1) and 52.80(a).

Response

To indicate the applicability of 10 CFR 50.55a and its relationship to IEEE 603-1991, a new subsection, 8.3.1.2.5, will be added that provides the detail corresponding to the information supplied in response to RAI 8166 Question 08.01-4. Reference to the electrical design in accordance with 10 CFR 50.55a will also be included in other applicable subsections of 8.3.1 and 8.3.2.

To indicate the applicability of 10 CFR 52.47(b)(1) and 10 CFR 52.80(a), a new subsection, 8.2.2.4 will be added that provides the detail corresponding to the information supplied in response to RAI 8166 Question 08.01-4. Reference to the electrical design in accordance with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a) will also be included in other applicable subsections of 8.3.1, 8.3.2, and 8.4.2.

Impact on DCD

New Subsections 8.2.2.4, 8.3.1.2.5, 8.3.1.2.6, 8.3.2.2.4, 8.3.2.2.5, and 8.4.2.3 will be added to DCD Tier 2 and Subsections 8.3.1.2 and 8.3.2.2 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.

NRC Regulatory Guide 1.204

NRC RG 1.204 (Reference 21) is related to the guidelines for lightning protection of nuclear power plants.

The lightning protection of the APR1400 is described in Subsection 8.3.1.1.8. The APR1400 is designed to meet the requirements related to the lightning protection of nuclear power plants in IEEE Std. 665 (Reference 22), IEEE Std. 666 (Reference 23), IEEE Std. 1050 (Reference 24), and IEEE Std. C62.23 (Reference 25).

8.2.2.3 Conformance with NUREG-0800

Standard Review Plan, Section 8.2, Appendix A

The APR1400 has a GCB that is designed and tested in accordance with the SRP Section 8.2, Appendix A. The GCB is designed to perform its intended function during steady-state operation, power system transients, and major faults.

BTP 8-3, "Stability of Offsite Power Systems"

The COL applicant is to analyze the stability of the offsite power systems, as described in GDC 17 (COL 8.2(6)).

BTP 8-6, "Adequacy of Station Electric Distribution System Voltages"

BTP 8-6 (Reference 26) is related to adverse effects on the Class 1E loads that are caused by sustained low grid voltage conditions when the Class 1E buses are connected to offsite power. The APR1400 provides a second level of undervoltage protection with time delays to protect the Class 1E equipment from sustained undervoltages. Conformance with BTP 8-6 is addressed in Subsection 8.3.1.1.3.12.

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A

8.2.2.4 Conformance with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a)

10 CFR 52.47(b)(1) requires that a design certification (DC) application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, than a plant that incorporates the APR 1400 design certification has been constructed and will be operated in accordance with the design certification.

10 CFR 52.80(a) requires that a DC or a combined license (COL) application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee will perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will be operated in conformity with the combined license.

The proposed ITAAC and those applicable to emergency planning are described in Subsection 14.3.2.6 and Section 13.3, respectively. Thus, the electrical design of the APR1400 conforms with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a).

d. Control

e. Instrumentation

If the trays are stacked, the order from top to bottom is as shown above.

Cables of each train run in separate raceways are physically separated from cables of the other trains. Separation of trains is in accordance with IEEE Std. 384, as endorsed by NRC RG 1.75. Raceways for non-Class 1E are separated from each Class 1E train A, B, C, and D in accordance with IEEE Std. 384. The raceway in the cable spreading area, main control room, and other congested areas is designed in accordance with IEEE Std. 384. The power and control wiring in control boards or panels is separated in accordance with IEEE Std. 420 (Reference 40).

Medium-voltage power cables are routed in an open-top ladder-type cable tray in a single layer with maintained spacing. The distance between adjacent cables within a tray is one-quarter the diameter of the larger cable. The cable tray fill criterion for low-voltage power cables does not exceed 30 percent of the cross-sectional area of the open-top ladder-type tray. The cable tray fill criterion for control cable does not exceed 50 percent of the cross-sectional area of the open-top ladder-type tray. Solid-bottom and solid-cover type cable trays are used for routing instrumentation cables, with an allowable fill of 50 percent of tray cross-sectional area. Cable splicing in a raceway is prohibited.

8.3.1.2 Analysis

The APR1400 Class 1E ac power system is designed to meet the requirements of GDCs 2, 4, 5, 17, 18, 33, 34, 35, 38, 41, 44, 50, and the intent of NRC RGs 1.6, 1.9, 1.32, 1.47, 1.53, 1.63, 1.75, 1.81, 1.106, 1.118, 1.153, 1.155, 1.160, and 1.204, and 10 CFR 50.55a(h), 10 CFR 52.47(b)(1), and 10 CFR 52.80(a). The criteria and guidelines are shown in Table 8.1-2 and include their applicability in the electrical system design.

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NRC RG 1.160 endorses Revision 4A of NUMARC 93-01 (Reference 45), which provides methods for complying with the provisions of 10 CFR 50.65 with some provisions and clarifications. Conformance with NRC RG 1.160 is addressed in Section 1.9.

NRC Regulatory Guide 1.204

NRC RG 1.204 is related to the guidelines for lightning protection of nuclear power plants.

The APR1400 onsite ac power system is designed to meet the requirements of IEEE Std. 665, IEEE Std. 666, IEEE Std. 1050, and IEEE Std. C62.23 (Reference 46), which are related to the lightning protection of nuclear power plants.

NRC Regulatory Guide 1.218

NRC RG 1.218 provides the cable design and maintenance criteria for the performance of periodic testing as part of the condition-monitoring techniques for the electric cables that are used in nuclear power plants. The inaccessible cable condition-monitoring techniques related to NRC RG 1.218 are addressed in Subsection 8.3.1.1.10.

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8.3.1.3 Electrical Power System Calculations and Distribution System Studies for AC System

The analysis of load flow, voltage regulation, and short-circuit studies is performed by using ETAP, version 12.0.0N, which is qualified for nuclear power plants in accordance with 10 CFR Part 21, 10 CFR Part 50, Appendix B (Reference 47), and ASME NQA-1 (Reference 48).

8.3.1.3.1 Load Flow/Voltage Regulation Studies and Under/Overvoltage Protection

Load flow studies of onsite power systems are performed to demonstrate that acceptance voltage regulation is maintained within 90 to 110 percent of the rated voltage at the equipment terminals under the worst-case condition among normal, startup, hot standby, and LOCA operation mode. Lager motor starting studies calculate the voltage drop so that motor terminal voltages are maintained at not less than acceptance voltage of 75 percent of motor rating for Class 1E motors and 80 percent of motor rating for non-Class 1E motors.

B

8.3.1.2.5 Conformance with 10 CFR 50.55a(h)

10 CFR 50.55a(h) is related to the codes and standards for protection and safety systems.

IEEE Std. 603, incorporated and specified in 10 CFR 50.55a(h), provides minimum functional and design requirements for the power, instrumentation, and control portions of safety systems for nuclear power plants. The Class 1E ac and dc power system is designed to conform with the requirements of 10 CFR 50.55a(h) and IEEE Std. 603.

8.3.1.2.6 Conformance with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a)

See Subsection 8.2.2.4.

The inverters that provide reliable I&C power have sufficient capacity and capability to perform their intended function. The Class 1E 120 Vac I&C power system loads are listed in Table 8.3.2-3 and the inverter rating is shown in Table 8.3.2-4.

A 125 Vdc control center is provided for each of the 125 Vdc power system load groups. Each control center supplies power to its assigned bus and equipment and is powered directly from its associated 125 Vdc battery and battery chargers irrespective of the condition of other control centers. The Class 1E dc control center supplies power to one dc distribution panel and one static inverter.

8.3.2.1.2.7 Class 1E 125 Vdc Power System and 120 Vac Instrumentation and Control Power System Status Information

The parameters or status that are monitored in the MCR for the 125 Vdc power system and 120 Vac I&C power system are listed in Table 8.3.2-5.

Ammeters provided to monitor battery current have the capability to monitor both charge and discharge currents. Voltmeters are supplied to monitor dc and ac voltage of the buses and inverter distribution panels. The indications and alarms in the dc control center, battery charger control panel, and inverter distribution panel are listed in Table 8.3.2-5.

Ground fault detectors and their corresponding ground monitoring alarms are provided with sufficient sensitivity.

8.3.2.2 Analysis

The APR1400 Class 1E 125 Vdc power system is designed to meet the requirements of GDCs 2, 4, 5, 17, 18, 33, 34, 35, 38, 41, 44, and 50 and the intent of NRC RGs 1.6, 1.32, 1.47, 1.53, 1.63, 1.75, 1.81, 1.106, 1.118, 1.128, 1.129, 1.153, 1.155, 1.160, and 1.212. Table 8.1-2 includes their applicability of the GDC and NRC RGs to the electrical system design.

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, and 10 CFR 50.55a(h), 10 CFR 52.47(b)(1), and 10 CFR 52.80(a).

NRC Regulatory Guide 1.212

NRC RG 1.212 is related to sizing of lead-acid storage batteries. IEEE Std. 485, endorsed by NRC RG 1.212, provides recommended practice for sizing lead-acid batteries for stationary applications.

The Class 1E dc batteries are designed to conform with the requirements of NRC RG 1.212 and IEEE Std. 485.

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8.3.2.3 Electrical Power System Calculations and Distribution System Studies for DC System

Analysis of load flow, voltage regulation, and short-circuit studies is performed by using ETAP, which is qualified for nuclear power plants in accordance with 10 CFR Part 21 (Reference 60), 10 CFR Part 50 Appendix B, and ASME NQA-1.

8.3.2.3.1 Load Flow and Under/Overvoltage Protection

Load flow studies are implemented to check whether the equipment terminal voltage is maintained within the acceptable voltage range under the most severe loading condition. Voltage drops at equipment terminals are also derived from the largest discharge current conditions. Consequently, terminal voltages of equipment meet the voltage range that is recommended in IEEE Std. 946.

8.3.2.3.2 Short-Circuit Studies

Short-circuit studies are implemented to calculate the magnitudes of the expected currents in the power system during the most severe fault condition. In case of Class 1E dc bus short-circuit calculations, the contributing short-circuit current sources are the batteries and battery chargers because there are no dc motors directly connected to the Class 1E dc buses. The maximum short-circuit current in the calculation is used to select the circuit breaker rating based on IEEE Std. C37.16 (Reference 61). The COL applicant is to provide the short-circuit analysis of onsite dc power system with actual data (COL 8.3(7)).

8.3.2.4 Conformance with 10 CFR 50.55a(h)
See Subsection 8.3.1.2.5.
8.3.2.5 Conformance with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a)
See Subsection 8.2.2.4.

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 method is named for its use of equipment that is capable of being electrically isolated from the preferred offsite and emergency onsite ac power sources. The APR1400 selects the "Alternate AC" approach. NRC RG 1.155 specifies that no coping analysis is needed if the AAC power source is available within 10 minutes of the onset of an SBO. Therefore, the APR1400 is not required to perform an SBO coping analysis. However, additional coping analysis for the APR1400 is performed for the SBO 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.

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 13.5.

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.

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8.4.2.3 Conformance with 10 CFR 52.47(b)(1) and 10 CFR 52.80(a)

See Subsection 8.2.2.4.