REVISED 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.:	**102-8017**
SRP Section:	**08.03.01 – AC Power Systems (Onsite)**
Application Section:	**8.3.1**
Date of RAI Issue:	**07/22/2015**

Question No. 08.03.01-10

Cables and Raceways:

DCD Tier 2, Section 8.3.1.1.10 provides Cable and Raceway Design Criteria. The staff has the following questions to evaluate that the design meets the GDC 17, since GDC 17 relates to the safety related onsite power system's capacity and capability:

1. DCD Tier 2, Section 8.3.1.1.4, Electrical Equipment Layout states that all 4 emergency diesel generators (EDGs) are located in one building in separate rooms as shown in layout Figure 8.2-1. Discuss the cabling and raceways to be designed to provide physical separation and independence, for all 4 trains of cables/raceways originating from the Class 1E switchgear building and ending at the EDG building.

2. COL Item, 8.3 (3) states that 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.

    - Describe inspection, testing and monitoring programs to detect the degradation of inaccessible or underground power cables that support EDGs, offsite power, essential service water, component cooling water and other systems that are within the scope of 10 CFR 50.65.

    - Provide a description of the condition monitoring methods that would be used to detect cable insulation degradation.

3. Operating experience, as documented in NRC Generic Letter (GL) 2007-01, has shown that undetected degradation of electric cables could result in multiple equipment failures. Please discuss how the APR1400 design addressed the concerns detailed in NRC GL 2007-01, and also, why this GL is not included in DCD Tier 2.

Response – Rev. 1

KHNP provides answers to the staff's request as follows:

1. Of the four Class 1E EDGs, two EDGs (Train A and Train B) are each located in separate rooms of the EDG building and the other two EDGs (Train C and Train D) are each located in separate rooms of the auxiliary building. Each Class 1E switchgear of all four trains is located in separate room of the auxiliary building according to the geographical quadrant division of the auxiliary building by train.

   Cables between the EDG and the Class 1E switchgear of each train run on the raceways (trays or conduits) designated to each train. The raceways of each train do not interfere with the other trains since the quadrant division of the auxiliary building also applies to the raceway design.

   A graphical expression of the cabling between the EDG and the Class 1E switchgear of each train is provided in Attachment 1.

2. Cables and terminations are periodically monitored to detect the degradation by infrared imaging thermography inspection, partial discharge test, visual inspection, and very-low-frequency ac testing, as applicable. For inaccessible or underground power cables, the very-low-frequency ac test is performed every two to five years according to importance of the cables. In parallel, partial discharge tests will be performed when required.

   Condition monitoring to detect cable insulation degradation will be periodically implemented by the very-low-frequency ac test in accordance with EPRI 1013187 (LCM MV Cables and Accessories) and EPRI 1013085 (Advanced diagnostics and life estimation of extruded dielectric cable).

   As stated in DCD Tier 2, Subsection 8.3.1.1.10, program details and detection method(s) will be established and chosen by the COL applicant.

3. In the APR 1400 design, electrical duct banks and underground tunnels in which electric cables are installed are designed to keep cables from degrading due to the submergence as follows:

   A. Electrical duct bank (EDB)

      - A uniform slope of 1/16" (minimum) per 1 ft shall be maintained in all duct banks. The slope shall be such to drain the duct bank toward a manhole. If drainage to a manhole is not possible, a drain point shall be installed and sloped down from the duct bank to allow draining.

      - All conduits and cable duct joints shall be watertight.

      - Conduit sleeves passing through the wall shall be installed with offset.

   B. Underground Tunnel (underground common tunnel, high voltage cable tunnel, gas insulated bus tunnel, transformer area cable tray tunnel)

All tunnels have sumps and pits to collect water at specified points. Sump pumps installed in the sumps operate automatically as the water level reaches the set point of the level transmitters. Water drained by the sump pumps flows out to storm drain manholes.

Furthermore, inaccessible or underground power cables are monitored by infrared imaging thermography inspection, partial discharge test, visual inspection, and very-low-frequency ac test, as applicable.

DCD Tier 2, Table 1.9-5, Subsections 8.1.3.3, 8.3.1.1.10, and 8.3.4 will be revised to incorporate the design aspects mentioned above.

Impact on DCD

DCD Tier 2, Table 1.9-5, Subsections 8.1.3.3, 8.3.1.1.10, and 8.3.4 will be revised as shown in Attachment 2.

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.

Security-Related Information - Withhold Under 10 CFR 2.390

Security-Related Information - Withhold Under 10 CFR 2.390

Table 1.9-5

Generic Communications Applicability to APR1400

GC No.	Title	Comment	DCD Tier 2 Section
GL 2008-01	Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems.	The APR1400 conforms with this Generic Letter.	6.2.2, 6.3.2.5.2
BL 2007-01	Security Officer Attentiveness	Not applicable (COL)	N/A
BL 2011-01	Mitigation Strategies	Not applicable	N/A
BL 2012-01	Design Vulnerability in Electric Power System	Not applicable (COL)	N/A
GL 2007-01	Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients	The APR1400 conforms with this Generic Letter	8.3.1.1.10

add

Generic Letters

- GL 77-07, "Reliability of Standby Diesel Generator (DG) Units," December 15, 1977.
- GL 79-17, "Reliability of Onsite Diesel Generators at Light Water Reactors," April 18, 1979.
- GL 84-15, "Proposed Staff Actions to Improve and Maintain Diesel Generator Reliability," July 2, 1984.
- GL 88-15, "Electric Power Systems – Inadequate Control Over Design Processes," September 12, 1988.
- GL 91-11, "Resolution of Generic Issues 48, 'LCOs for Class 1E Vital Instrument Buses,' and 49, 'Interlocks and LCOs for Class 1E Tie Breakers,' Pursuant to 10 CFR 50.54(f)," July 18, 1991.
- GL 94-01, "Removal of Accelerated Testing and Special Reporting Requirements for Emergency Diesel Generators," May 31, 1994.
- GL 96-01, "Testing of Safety-Related Logic Circuits," January 10, 1996.
- GL 2006-02, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," February 1, 2006.

Industrial Standards

- ASME NQA-1-2008, "Quality Assurance Requirements for Nuclear Facility Applications," 2008.
- ASME NQA-1a, "Quality Assurance Requirements for Nuclear Facility Applications," 2009.
- IEEE Std. 80, "IEEE Guide for Safety in AC Substation Grounding," 2000.

add

- GL 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation System or Cause Plant Transients," February 7, 2007.

protect the EPAs from damage due to short-circuit current or overload, primary and backup protections are provided. For MCCs, backup protection is provided with two thermal-magnetic breakers in series. For 480V load centers and 13.8 kV medium-voltage switchgears for the reactor coolant pump, backup protection is provided by the main breaker and overcurrent relays coordinated with the feeder breaker to protect the electrical penetration assemblies.

8.3.1.1.10 Cable and Raceway Design Criteria

The power cables are designed, fabricated, and tested in accordance with NEMA WC 74 (Reference 33) and NEMA WC 70 (Reference 34). The control cables are designed, fabricated, and tested in accordance with NEMA WC 57 (Reference 35). The instrumentation cables are designed, fabricated, and tested in accordance with NEMA WC 57. Safety-related cables are qualified for the design life of the plant in accordance with IEEE Std. 323.

Cable conductor size selection for medium and low-voltage power and control cables is based on cable ampacity and voltage drop considerations. In addition, the conductors of all medium- and low-voltage power cables are sized to withstand the maximum available fault current. The cable ampacity is based on the maximum cable ambient temperature, the rated cable insulation temperature of 90 ºC (194 ºF), the cable raceway design, and cable routing paths. IEEE Std. 835 (Reference 36) and NEMA WC 51/ICEA P-54-440 (Reference 37) are used for cable conductor size selections.

NRC RG 1.218 (Reference 38) requires that the plant have monitoring techniques for electric cables. Cable monitoring programs include cable tests to measure and trend the condition of the cable. Tests that can be used for detecting insulation degradation in underground cable include partial discharge testing, time-domain reflectometry, dissipation factor testing, and very-low-frequency ac testing.

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(3)) (Reference 39).

add

In order to properly address the concerns of cable degradation as per NRC GL 2007-01 (Reference 62), electrical duck banks (EDB) and underground tunnels in which electric cables are installed are designed not to degrade cables due to the submergence by means of slope of EDB and sump pumps for drainage. Furthermore, cables are monitored in accordance with NRC RG 1.218.

61. IEEE Std. C37.16-2009, “IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers,” Institute of Electrical and Electronics Engineers, 2009.

add

62. Generic Letter 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients"