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.:	**420-8482**
SRP Section:	**19.03 – Beyond Design Basis External Event (APR1400)**
Application Section:	**DCD 19.3, Ch. 8, Ch. 9**
Date of RAI Issue:	**02/29/2016**

Question No. 19.03-30

NRC Commission paper SECY-12-0025 stated that the NRC staff expected new reactor design certification applications to address the Commission-approved Fukushima actions in their applications to the fullest extent practicable. In performing its review of the APR1400 design certification application, the NRC staff followed the guidance for satisfying the Commission directives regarding BDBEE mitigation strategies in Japan Lesson-Learned Project Directorate JLD-ISG-2012-01, Revision 0, which endorsed with clarifications the methodologies described in NEI 12–06, Revision 0. The guidance in JLD-ISG-2012-01 describes one acceptable approach for satisfying the Commission directives regarding BDBEE mitigation strategies (i.e., Order EA-12-049). TR APR1400-E-P-NR-14005-P, Rev. 0 provides details regarding mitigating strategies and design enhancements to meet Near-Term Task Force (NTTF) recommendations, NRC orders, and agency guidance related mitigation strategy during Beyond Design Basis External Events (BDBEE).

In Design Control Document (DCD) Tier 2 Section 19.3.2.3.4 (Reference 5), Technical Report (TR), APR1400-E-P-NR-14005-P, Revision 0 “Evaluations and Design Enhancements to Incorporate lessons Learned from Fukushima Dai-Ichi Nuclear Accident,” Section 5.1.2.3.1.1.2 explains that the Phase 1 coping time can be extended to 16 hours because additional cooling is not required in the main control room (MCR), electrical, turbine driven auxiliary feed-water pump (TDAFWP), and instrumentation and control (I&C) equipment rooms; and that the TDAFWPs are powered from the Class 1E batteries in Trains C/D for 16 hours without load shedding. TR, APR1400-E-P-NR-14005-P, Revision 0, Section 5.1.2.6.1.2, “DC Power” states in part that Train C and D batteries have a capacity of 8,800 amp hour (Ah) and can supply direct current (dc) power up to 16 hours without load shedding.

1. Clarify whether the TDAFWPs are powered from the Class 1E batteries, or are only the instrumentation/controls associated TDAFWPs being powered by the Class 1E batteries?

2. Provide load analysis and methodology used in order to demonstrate that the batteries have the capacity to last for both 8 hours and 16 hours without load shedding.

3. Provide the battery duty cycle diagram for Train C and D that depicts the direct current (dc) load profile and the battery division(s) providing power to the corresponding loads along the timeline for the mitigating strategies to maintain core cooling, containment, and spent fuel pool cooling during all modes of operation.

4. Provide the basis for the assumed minimum battery voltage that is required to ensure proper operation of all electrical equipment as included in the load profile.

5. Are the batteries serving trains C and D being recharged during and after phase 1?

Response

1. The TDAFWPs are driven by steam, and the driving steam supplied to the auxiliary feedwater pump turbine is taken from the main steam lines in the main steam system. All instrumentation, controls and valves that are essential to the operation of the steam turbine driven pump train (trains C and D) are powered from the Class 1E batteries of Trains C/D for 16 hours without load shedding.

   The list of trains C and D Class 1E 125 Vdc battery loads with the time intervals is provided as Attachment 1 (pages 5 thru 8) of response to RAI 441-8549 Question No. 08.03.02-3 (Reference KHNP submittal MKD/NW-16-0498L dated May 13, 2016; ML16134A351).

2. Each battery is sized based on the duty cycle of the respective subsystems. Each battery is capable of supplying power to the worst-case operating loads for a period of the battery duty cycle. The sizing of the battery is performed in accordance with IEEE Std. 485-2010.

   - As a result of the load analyses for trains C and D Class 1E 125 Vdc, the list of battery loads for battery sizing is provided as Attachment 1 (pages 5 thru 8) of response to RAI 441-8549 Question No. 08.03.02-3.

   - The duty cycle diagrams of trains C and D Class 1E 125 Vdc batteries for battery sizing are provided as Attachment 2 (Figure 3 and 4) of response to RAI 441-8549 Question No. 08.03.02-3.

   - The cell sizing worksheets of trains C and D Class 1E 125 Vdc batteries as per guidance provided in IEEE Std. 485 for battery sizing are provided as Attachment 3 (pages 3 thru 38) of response to RAI 441-8549 Question No. 08.03.02-3.

   Since, the capacity of trains C and D Class 1E 125 Vdc batteries are sized to last for 16 hours without load shedding, additional demonstration for the 8 hour capacity of the batteries are not required.

   3. The dc battery load requirements for BDBEE mitigation strategies have been incorporated in the list of trains C and D Class 1E 125 Vdc battery loads and the battery duty cycle diagrams for trains C and D Class 1E 125 Vdc battery loads which

were provided as Attachment 1 (pages 5 thru 8) and Attachment 2 (Figure 3 and 4) of response to RAI 441-8549 Question No. 08.03.02-3.

4. According to IEEE Std. 946-2004, equipment specifications for components powered by dc systems should require the equipment to operate, as designed and without damage, over the input terminal voltage range corresponding to the variation in system voltage. For designs in which the battery is equalized while connected to the load, this range should cover the variation from equalize to the final end-of-discharge voltage.

   Voltage drop from the battery terminals to the terminals of the component should be addressed. In addition, large loads, such as motor starting and charging capacitor inrush may result in suppression of system voltage. Because of this variation, the rated (nameplate) maximum and minimum voltage of the components governs the allowable maximum and minimum voltage at the upstream battery terminals, while also including allowance for cable voltage drop.

   As described in Table 1 of IEEE Std. 946-2004, the minimum operating voltage of dc loads varies according to the type of load (from 70V to 100V). Considering voltage drop across the cable between the dc bus and equipment terminals, Class 1E 125 Vdc system of the APR1400 design was determined as 105 V at the dc bus terminal for proper component operation.

   The size of each equipment feeder is designed to limit the voltage drop to maintain the minimum operating voltage of the equipment assuming that the battery provides the power at the minimum voltage (105 V) of the 125 Vdc power system.

5. The Train C or D Class 1E batteries are not recharged during the BDBEE coping phases (Phases 1, 2, and 3).

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.