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.:	**407-8447**
SRP Section:	**19.03 – Beyond Design Basis External Event (APR1400)**
Application Section:	**19.3**
Date of RAI Issue:	**02/17/2016**

Question No. 19.03-25

DCD Tier 2, Section 19.3.2.3 and the technical report (TR), APR1400-E-P-NR-14005-P, "Evaluations and Design Enhancements to Incorporate Lessons Learned from Fukushima Dai-Ichi Nuclear Accident," describe the details of the proposed mitigation strategies. The applicant performed analyses to demonstrate the capability of the proposed mitigation strategies for core and SFP cooling, and containment function. The proposed acceptance criteria are as follows:

· Core Cooling – Appendix A, Section A.3 of the TR states that the acceptance criteria for core cooling are (1) core cooling being maintained, (2) no fuel failures.

· Spent Fuel Pool Cooling – Appendix B, Section B.1 of the TR states that the acceptance criterion for SFP cooling is that fuel in the SFP remains water covered.

· Containment Function – DCD Tier 2, Section 19.3.2.3.3 states that the containment pressure is controlled within the ultimate pressure capacity (UPC) limit.

NEI 12-06, Section 3.2.1.1 states that, for core cooling in a PWR, the requirement is to keep the fuel in the reactor covered. In Table 5-9 Item 3.2.1.1 of the TR, the applicant indicates that APR1400 complies with NEI guidance. However, the staff found that the applicant's criteria for core cooling are inconsistent with the NEI guidance regarding keeping the fuel covered.

The applicant is requested to:

a) Explain the inconsistency and justify the deviation in regards to the criteria for maintaining core cooling.

b) Confirm the acceptance criterion for the containment function.

The NRC staff believes that the above acceptance criteria for the mitigation strategies are part of the licensing bases for APR1400 design and should be documented in the DCD instead of being captured in a technical report.

The applicant is requested to include the acceptance criteria for mitigation strategies in the DCD.

Response – (Rev.1)

a) The supporting analysis for the APR1400 FLEX core-cooling strategy was performed by the best-estimate code, RELAP5 which has the capability to perform the fuel heat-up calculation. The results of the fuel heat-up analysis show that the fuel temperatures are maintained at low temperatures (Figures A-8, A-18, and A-28 of Technical Report APR1400-E-P-NR-14005-P, Rev.0). The results of the fuel heat-up calculation show that the core cooling capability is sufficiently maintained and there is no possibility of fuel failure.

   In Technical Report APR1400-E-P-NR-14005-P, Rev.0, the criterion "no fuel failure" is used instead of the NEI 12-06 guidance “keep the fuel in the reactor covered,” because the mixture level in the reactor is not clearly defined in the supporting analysis using RELAP5. Instead of calculating the mixture level, the core cooling capability is ensured by the fuel heat-up analysis which directly calculates the fuel temperature.

   The acceptance criteria for mitigation strategies will be documented in Section 19.3.2.3.1 of DCD Tier 2 and Table 5-9 item 3.2.1.1 of Technical Report APR1400-E-P-NR-14005-P, Rev.0 will be revised to reflect the above justification for the general criteria.

b) The requirements with regards to the containment integrity described in the SECY 11-0093 is that the licensee provides reasonable protection from beyond design basis external events (BDBEEs) and add additional equipment necessary to mitigate events that are similar to those of the Fukushima Dai-Ichi.

   Based on the requirement, the UPC value (158 psi) is chosen as the acceptance criteria upper limit to ensure the containment integrity and the emergency containment spray backup system (ECSBS) is used to maintain the containment pressure lower than the UPC limit against BDBEEs.

   The acceptance criterion regarding containment integrity will be documented in Section 19.3.2.3.3 of DCD Tier 2 and Section 5.1.2.5.2 of Technical Report APR1400-E-P-NR-14005-P, Rev.0 as described in the response for RAI 401-8402 Question 19.03-16.

Impact on DCD

DCD Tier 2, section 19.3.2.3.1 will be revised as indicated on the attachment markup.

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

Table 5-9 item 3.2.1.1 of Technical Report APR1400-E-P-NR-14005-P, Rev.0 will be revised as indicated on the attachment markup.

The guidance for developing, implementing, and maintaining mitigation strategies from JLD-ISG-2012-01 (Reference 6) and the methodology to establish baseline coping capability from Nuclear Energy Institute (NEI) 12-06 (Reference 7) were considered in developing the APR1400 FLEX strategy. Each FLEX strategy follows a three-phase approach as required in the Order EA-12-049.

The three phases are:

a. Phase 1 – Initial response phase using installed equipment

b. Phase 2 – Transition phase using portable equipment and consumables

c. Phase 3 – Indefinite sustainment of these functions using offsite resources

19.3.2.3.1 Core Cooling

The following acceptance criteria are applied to core cooling during the ELAP concurrent with LUHS.
a. Core cooling is maintained
b. No fuel failures

The APR1400 FLEX strategy can be divided into two sets of operational strategies, as follows:

a. FLEX strategy for Modes 1 through 4 (full-power operation, startup, hot standby, hot shutdown) and Mode 5 operation (cold shutdown) with steam generators (SGs) available

b. FLEX strategy for Modes 5 and 6 operations with SGs not available

Supporting analysis is performed to demonstrate the APR1400 baseline coping capability based on both of the FLEX strategies. In the support analysis, the full-power operation case is selected as a representative one for the operational strategy for the Modes 1 through 5 with SGs available. Mid-loop operation case is selected as a representative one for the operational strategy for Mode 5 and 6 with SGs not available.

The initiating event is assumed to be a loss of offsite power (LOOP) with concurrent loss of all ac power and LUHS during the full-power operation or mid-loop operation. Based on the analysis performed, the APR1400 will consider the three-phase approach as shown in Table 19.3-1 to address FLEX strategies for the various plant operations, namely, full-power operation, low-power, and shutdown operations, with and without SGs available.

Table 5-9 Conformance with NEI 12-06, Rev. 0 (4 of 20)

NEI 12-06, Rev. 0			APR1400
Section		Summary	
2.4	Programmatic Controls	The programmatic controls for implementation of FLEX include: • quality attributes • equipment design • equipment storage • procedure guidance • maintenance and testing • training • staffing • configuration control Procedures and guidance to support deployment and implementation including interfaces to EOPs, special event procedures, abnormal event procedures, and system operating procedures, will be coordinated within the site procedural framework.	COL applicants are responsible to establish the programmatic controls for implementation of FLEX and to coordinate them within the site procedural framework.
2.5	Synchronization with Offsite Resources	The timely provision of effective offsite resources will need to be coordinated by the site and will depend on the plant-specific analysis and strategies for coping with the effects of the beyond-design-basis external event. Arrangements will need to be established by each site for the offsite equipment and resources that will be required for the offsite phase. The offsite response interfaces for FLEX capabilities are described in Section 12.	COL applicants are responsible to arrange the offsite e[illegible] p[illegible]
3.2	Performance Attributes	See below.	
3.2.1	General Criteria and Baseline Assumptions	See below.	
3.2.1.1	General Criteria	Procedures and equipment relied upon should ensure that satisfactory performance of necessary fuel cooling and containment functions are maintained. A simultaneous ELAP and LUHS challenges both core cooling and spent fuel pool cooling due to interruption of normal ac powered system operations. For a PWR, an additional requirement is to keep the fuel in the reactor covered. For both PWRs and BWRs, the requirement is to keep fuel in the spent fuel pool covered.	The APR1400 FLEX strategy complies with the guidance.

However, the criterion "no fuel failure" is used instead of the guidance "keep the fuel in the reactor covered," because the mixture level in the reactor is not clearly defined in the supporting analysis using RELAP5. Instead of calculating the mixture level, the core cooling capability is ensured by the fuel heat-up analysis which directly calculates the fuel temperature.

in terms of the criteria "maintain fuel cooling," "maintain containment function," and "keep fuel in the spent fuel pool covered."