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.:	**312-8343**
SRP Section:	**SRP 19**
Application Section:	**19.1**
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Question 19-16

SRP Chapter 19.0, Revision 3 (Draft), Section II, “Acceptance Criteria,” Item 14 on Page 19.0-16 states, “The staff will determine that FSAR Chapter 19 includes PRA qualitative results, including the identification of key PRA assumptions, the identification of PRA-based insights, and discussion of the results and insights from importance, sensitivity, and uncertainty analyses.” The staff reviewed APR1400 DCD Chapter 19 and found insufficient information regarding reactor coolant pump (RCP) seal assumptions, leakage, detailed modeling, and failure information.

Therefore, in order for the staff to reach a reasonable assurance finding on the conformance to the SRP regarding the PRA results and insights, please provide the evaluation of RCP seal leakage and how it is modeled in the APR14000 PRA. Also include in the response the following information and revise the DCD as appropriate:

1. Seal LOCA failure probability and the reason for choosing engineering judgement as its basis
2. Failure modes and consequences
3. Leakage rates during normal operation and accidents
4. Timing of seal failure and conditional probability given a loss of power or seal cooling

Response

The evaluation of RCP seal leakage and the seal LOCA failure probability are documented in APR1400-A-M-NR-16001-P, Revision 0, “Model for RCP Seal Failure Given Loss of Seal Cooling for APR1400 KSB HDD-254 Type F RCP Seals,”

The RCP Seal LOCA is not modeled explicitly at the event tree level, but is modeled as a point estimate in the applicable event tree branches (see APR1400-K-P-NR-013102-P).

1. Seal LOCA failure probability documented in APR1400-A-M-NR-16001-P is [ ]^{TS} per RCP seal, which results in [ ]^{TS} for four RCPs. The current PRA model uses seal LOCA failure probability of 4.00E-03 for four RCPs based on a conservative engineering judgement (see APR1400-K-P-NR-013104-P). A sensitivity case using [ ]^{TS}, instead of 4.00E-03 showed about 9% decrease in CDF for the full power internal events, and this will be reflected in the future PRA update where [ ]^{TS} will be used as the base case.

2. The loss cooling from Division I CCW to the RCP thermal barrier may damage the RCP seals and lead to a seal LOCA. The RCP seal LOCA is considered in the following event trees: PLOCCW, TLOCCW, PLOESW, TLOESW, SBO, and GRID-SBO.

   Upon a loss of cooling for the RCP seals, the operators will manually trip the reactor and then the RCPs to prevent damage to the pumps and to avoid a challenge to the RPS. Failure of the reactor trip will result in either core damage or an ATWS situation depending on the integrity of RCP seals. If the RCP seals remain intact, then the sequence is evaluated as an ATWS. However, failure of the RCP seals, which is a LOCA, in conjunction with failure of reactor trip is assumed to result in core damage.

   Secondary Heat Removal (SHR) is required via AFW or the startup feedwater pump and steam relief. If SHR is successful and RCP seals remain intact, then core damage is averted. However, if SHR is successful but RCP seals fail, then SI injection is required to maintain RCS inventory allow continued decay heat removal. With the release of reactor coolant through the failed RCP seals, long term containment heat removal is required.

   If SHR is unavailable, then feed and bleed can be used for decay heat removal. Because feed and bleed cooling results in release of reactor coolant, the status of RCP seals is irrelevant to scenarios where SHR fails. During feed and bleed operation, the decay heat is transferred to the IRWST and containment. In order to maintain long term feed and bleed, decay heat removal requires either IRWST or containment spray cooling.

3. Limiting leakage rates during normal operation is 10 gpm per Tech Specs LCO 3.4.12, and the leakage rates during accidents is less than [ ]^{TS} gpm per RCP upon loss of a seal cooling.

4. Given a loss of power or seal cooling, the timing of seal failure is assumed to be T = 0, and the conditional probability is assumed to be 4.00E-03 in the current PRA model.

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 Environment Report.