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.:	**399-8510**
SRP Section:	**15.06.05 – Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary**
Application Section:	**15.6.5**
Date of RAI Issue:	**02/03/2016**

Question No. 15.06.05-6

Provide additional information regarding the choice of assumptions with respect to LOOP in context of a LBLOCA

Regulatory Basis:

NUREG-0800, Section 15.6.5, requires that the evaluation of a LBLOCA address whether the appropriate break locations, break sizes, and initial conditions were selected in a manner that conservatively predicts the consequences of the LOCA for evaluating ECCS performance; and whether an adequate analysis of possible failure modes of ECCS equipment and the effects of the failure modes on the ECCS performance have been provided. For postulated break sizes and locations, the reactor systems review includes the postulated initial reactor core and reactor system conditions, the postulated sequence of events including time delays prior to and after emergency power actuation, the calculation of the power, pressure, flow and temperature transients, the functional and operational characteristics of the reactor protective and ECCS systems in terms of how they affect the sequence of events, and operator actions required to mitigate the consequences of the accident.

Technical Basis:

The applicant states that LOOP is assumed at the beginning of the LBLOCA transient evaluation and that the reactor coolant pumps (RCPs) are assumed to coast down. Additionally, the applicant takes no credit for control element assembly (CEA) insertion at the same time the power is lost to the RCPs.

Question:

1. Has loss of RCP flow been demonstrated to be more limiting than the same event with the

RCPs operating?

2. With the assumption of LOOP, why is no credit taken for CEA insertion at the same time the power is lost to the RCPs? (CEA insertion and turbine trip are delayed until the low pressure trip).

3. Has the stuck/windmilling flow resistance (both flow directions) for the RCPs been measured as part of a test program and are these data used to develop the homologous curves used in RELAP5/MOD/3.3K?

Response

1)

Figure 1, provided below, shows the calculated clad temperatures for with and without operation of the RCPs. The peak clad temperature (PCT) without operation of the RCPs is [ ]^{TS}, and PCT with operation of the RCPs is [ ]^{TS}. And reflood PCTs for both cases are [ ]^{TS} for without and with operation of RCPs, respectively.

The PCT without operation of the RCPs occurred at the 14th heat structure node, whereas the PCT with operation of RCPs occurred at the 15th heat structure node. Thus, the quench time difference is caused by the PCT elevation.

Consequently, the loss of RCP flow case was determined to be the more limiting case based on the PCT results.

2)

During LBLOCA condition, vaporization in the core rapidly increases due to depressurization of the RCS. According to the moderator density vs. reactivity design of the APR1400 used in the analysis, negative reactivity occurs due to increase of the void fraction in the core. For this reason, the core power is rapidly decreasing whether CEA insertion is credited or not.

A plant calculation with and without CEA insertion was performed and is shown in Figures 2 and 3. When CEA insertion is not credited, core power from the fuel rods is higher than the CEA insertion credited case as shown in Figure 2. The higher core power causes higher PCT as shown in Figure 3. The LBLOCA analysis model does not credit CEA insertion and confirms the performance of ECCS for the APR1400 under this severe thermal hydraulic condition.

3)

In the homologous curves, zero pump speed data for forward and reverse flow are produced by considering stuck flow resistance or a locked rotor K-factor. And zero torque data are produced by considering windmilling flow resistance. Pump homologous curve data are obtained from the pump test and this curve data are used in LBLOCA analysis.

TS

Figure 1. Comparison of Clad Temperatures for With and Without Pump Operation

TS

Figure 2. Comparison of Normalization Total Core Power for With and Without CEA Insertion

TS

Figure 3. Comparison of Cladding Temperature for With and Without CEA Insertion

Impact on DCD

There is no impact on DCD.

Impact on PRA

There is no impact on PRA.

Impact on Technical Specifications

There is no impact on Technical Specifications.

Impact on Technical/Topical/Environmental Report

There is no impact on any Technical, Topical, or Environmental Report.

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Question No. 15.06.05-8

LBLOCA evaluation with a stuck check valve in the SIT

Regulatory Basis:

General Design Criterion (GDC) 35, as it relates to demonstrating that the ECCS would provide abundant emergency core cooling to satisfy the ECCS safety function of transferring heat from the reactor core following any loss of reactor coolant at a rate that (1) fuel and clad damage that could interfere with continued effective core cooling would be prevented, and (2) clad metal water reaction would be limited to negligible amounts. The analysis should consider the possibility of a single failure.

Technical Basis:

It is not clear that the applicant has considered the potential for a check valve in the SIT to stick. The single failure could occur prior to, or at any time during, the design basis event for which the safety system is required to function.

Question:

Provide a LBLOCA evaluation with a stuck check valve in the SIT (potential single failure). If no evaluation exists, provide a justification for not considering this potential failure.

Response

General Design Criterion (GDC) 35 in 10 CFR 50 Appendix A explains as follows:

“Criterion 35- Emergency core cooling. A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.”

10 CFR 50 Appendix A also states about single failures as follows:

“Single failures of passive components in electric systems should be assumed in designing against a single failure. The conditions under which a single failure of a passive component in a fluid system should be considered in designing the system against a single failure are under development.”

From GDC 35 and the statements about single failures in 10 CFR 50 Appendix A, single failure of check valve in SIT which is a passive component does not need to be considered.

Impact on DCD

There is no impact on 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.