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.:	**415-8503**
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:	**02/22/2016**

Question No. 15.06.05-13

Demonstrate that loop seal clearing is being treated conservatively or reasonably well by using

General Design Criterion (GDC) 35, “Emergency Core Cooling,” in 10 CFR Part 50, Appendix A, mandates the requirements for the emergency core cooling system (ECCS) that need to be satisfied by conforming to the ECCS acceptance criteria for light-water reactors given in 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-water Nuclear Power Reactors.” 10CFR50.46(b)(1) identifies the peak cladding temperature (PCT) requirement; and 10CFR50.46(b)(5) requires that after any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time to prevent the core from being uncovered. These requirements, along with 10CFR50.46(a)(1), specify the need to calculate the ECCS cooling performance using an acceptable evaluation model for a number of postulated loss-of-coolant accidents (LOCAs) of different sizes, locations, and other properties sufficient to provide assurance that the most severe LOCAs have been evaluated.

The staff’s review of the small-break LOCA (SBLOCA) analysis results presented in the APR1400 DCD Section 15.6.5, “Loss-of-Coolant Accidents Resulting from the Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary,” and the referenced Technical Report (TeR) APR1400-F-A-NR-14001-P, Rev.0,“Small Break LOCA Evaluation Model,” has raised several questions as submitted in this RAI. The regulatory bases identified above are applicable to all subsequent questions in this RAI. The applicant is also requested to update the DCD and the TeR as appropriate to ensure that the analysis method and results are documented.

The staff needs to understand the justification for the CEFLASH-4AS model nodalization that combines the two intact loop cold legs into a single equivalent cold leg, as illustrated in Fig. 3.1-1 of the TeR. The applicant is requested to explain how this lumped cold leg modeling of two loop seals as a single loop seal would lead to a conservative prediction of the loop seal clearing and the PCT for all break sizes. The applicant is requested to justify why it would be acceptable if the 2-combined loop seal blows out and one of the single loop seals does not. Since there is a range of break sizes where only 2 or 3 loop seals will clear, how can we be sure that the KHNP methodology won't clear one too many loop seals if it is modeling 2 loop seals as a single loop seal. Alternatively, the applicant could change the CEFLASH-4AS model to explicitly model all four loop seals instead of three.

Response

As explained in the response to RAI 431-8504, 15.00.02-11, the S1M has been licensed to continue to be used for SBLOCA analyses for CE-designed PWR's after the NRC reviewed CE responses to the II.K.3.30 issues after the TMI-2 accident. The basis of approving continued usage of S1M is its built-in conservatism. It was recognized that it had some limitations in predicting more realistic transient behaviors. This is the reason why CE developed a more realistic model to demonstrate the conservatism of S1M. The nodalization of the cold legs is an intrinsic part of the methodology and it has shown that this approach produces most limiting conditions to be consistent with the S1M conservatism.

One of the most important plant design parameters affecting loop seal clearing and core uncovery is the distance from the top of the core to the top of the horizontal pipe section of the cross-over leg from SG to RCP. This distance affects the level of core uncovery.

The distance for APR1400 is about the same as the one for YGN-3&4 (CE-designed PWR) as shown in Figure 15.06.05-13-1. All other design differences including fuel designs are secondary because of the nature of slow transient of a manometric balance before a loop seal clearing. Therefore, the rationale for S2M approval for CE-designed PWR applies to the APR1400 design.

In addition to the above discussion, the intrinsic nature of uncertainty in a loop seal clearing, a conservative approach taken in S1M and S2M is considered to be appropriate.

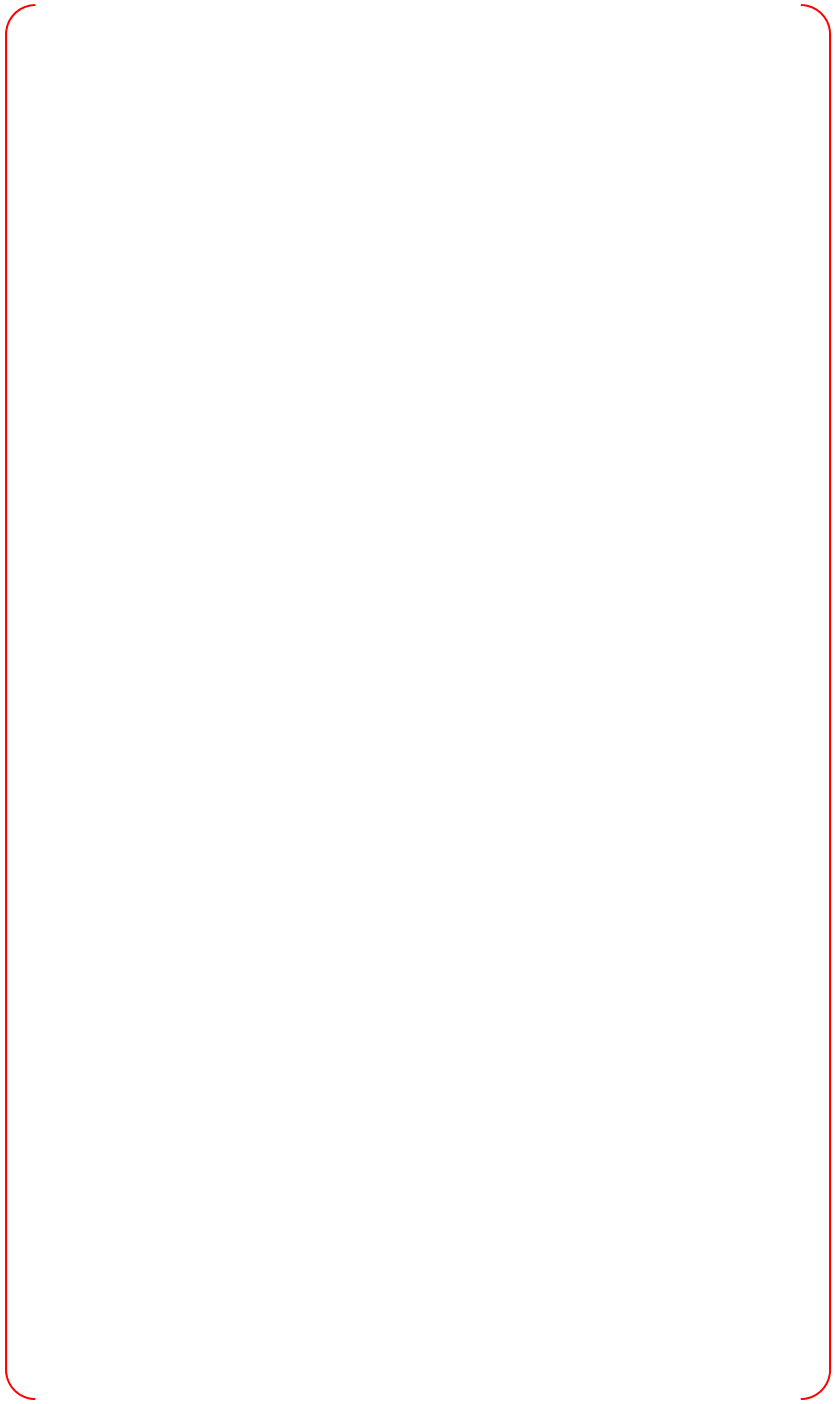

Figure 15.06.05-13-1 Nodalization of cold leg

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.

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Question No. 15.05.05-19

According to CENPD-137P Report, “Calculative Methods for the C-E Small Break LOCA Evaluation Model,” August 1974, page 47, the evaluation model assumes a homogeneous flow with a constant 50% quality within the loop seal. Please justify this assumption as conservative or realistic, as it is used to simulate the removal of the liquid retained in the pump side of the loop seals.

Response

As explained in the response to RAI 431-8504, 15.00.02-11, the NRC-approved Westinghouse Small Break Loss of Coolant Accident (SBLOCA) Analysis Methodology (S1M) has been licensed to continue to be used for SBLOCA analyses for CE-designed Pressurized Water Reactors (PWRs) after the NRC reviewed CE responses to the II.K.3.30 issues after the TMI-2 accident. The basis of approving continued usage of S1M is its built-in conservatism. It was recognized that it had some limitations in predicting more realistic transient behaviors. This is the reason why CE developed a more realistic model to demonstrate the conservatism of S1M. The nodalization of the cold legs is an intrinsic part of the methodology and it has shown that this approach produces most limiting conditions to be consistent with the S1M conservatism.

KHNP uses the S1M for APR1400. The main justification of continued use of S1M is its conservatism compared to more realistic calculations.

CE developed a special code version of CEFLASH-4AS for Semiscale test simulation to account for unique features of the test facility and implemented best-estimate features to make the code behave like a best-estimate (BE) code.

This code calculated results agreed with the test data very well. Then the code was converted to a semi-BE code by reverting BE features important for water hold-up and core uncovery to their original CEFLASH-4AS counterparts. The simulation with this semi-BE code showed that the results were in acceptable agreement with test data.

This study showed that the CEFLASH-4AS models which are important to steam generator liquid hold-up and core uncover adequately predicted the vessel liquid level depression observed in Semiscale Test S-UT-8. Therefore, it was concluded that CEFLASH-4AS can acceptably calculate the pre-loop seal clearing core water level depression of S-UT-8.

Finally, the SER with no condition for S1M stated that the currently approved CE Small Break LOCA Evaluation Model results in conservatively high cladding temperatures for the break spectrum analysis of a Nuclear Steam Supply System (NSSS).

The NRC review of the responses concluded that CE could continue to use the S1M considering the models' substantial conservatism in predicting SBLOCA transients.

The assumption of [ ]^{TS} within the loop seal is an approach which CEFLASH-4AS introduced to overcome the limitation of the homogeneous two-phase calculation so that the water in the loop seal could be removed. This approach is a part of conservatism of the S1M since the S1M is developed and approved with implementing conservatism and overall transient calculations show conservative results as explained in above.

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.