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. 15.06.05-14

Demonstrate that loop seal clearing is being treated conservatively or reasonably well by using the licensing basis codes in the SBLOCA analyses. Provide a comparison between the licensing basis calculations and RELAP5 SBLOCA simulations for the 18.6 cm^2 and 372 cm^2 direct vessel injection (DVI) line breaks, and 46.5 cm^2 and 465 cm^2 cold leg breaks. The staff requests all cases to be run until Tclad≈Tsat or until 1800 sec, whichever comes first. Details of the loop seals clearing for each break size analyzed and any core uncovery are also requested that should include the respective transient plots for the peak cladding temperature (PCT), 2 phase mixture levels in the core and the loop seals, average void fractions in the core and the cold legs, vapor mass flow rate through the loop seals, injection flow rate, core pressure, and break flowrate. Also provide the core void fraction distributions along the core height for the limiting DVI line break and cold leg (CL) break. Document the reasons or assumptions behind multiple core uncoveries during the initial phase of SBLOCA analyzed. Please outline the conservatisms used in the analysis, such as the decay heat multiplier, etc., and explain the criteria used to identify the most limiting SBLOCA.

Response

The SBLOCA results with the comparison between CENPD and RELAP5 for the 18.6 cm^2 and 372 cm^2 direct vessel injection (DVI) line breaks, and 46.5 cm^2 and 465 cm^2 cold leg breaks are shown in Figures 15.06.05-14-1 through 15.06.05-14-36.

The cases for the CENPD SBLOCA show a higher core pressure and a larger flow rate through the break than the cases for the RELAP5 SBLOCA in the initial break accident. Also, CENPD SBLOCA cases show the safety injection time is delayed in comparison with RELAP5 SBLOCA cases. In the case of the core level, the level expression methods are different according to methodology and codes. RELAP5 SBLOCA indicates a collapsed water level and CENPD SBLOCA indicates a 2-phase level. So, the results of the RELAP5 SBLOCA

looks like a core uncover, but we know that all core nodes of RELAP5 SBLOCA are not empty from the results of the core void fraction (Figure 15.06.05-14-26, 28, 30, 32). However, the core level of the CENPD SBLOCA results indicates the 2-phase level. Therefore, the time of Peak Cladding Temperature occurrence is predictable.

In the case of Peak Cladding Temperature, there are generally two kinds of peak cladding temperature during SBLOCA. One is the DNB PCT. The other one is the boil-off PCT. When it comes to the DNB PCT, as shown in Figures 15.06.05-14-13 through Figure 15.06.05-14-16, DNB PCT of the CENPD SBLOCA generally occurs right after the reactor trip caused by RCP coast down. On the other hand, DNB PCT doesn't occur in the RELAP5 SBLOCA. For the boil-off PCT caused by core uncover, it does not occur in the 18.6 cm^2 (DVI) and 46.5 cm^2 (CL) break cases (Figures 15.06.05-14-13, and 15) because there is no core uncover during SBLOCA. But, for the 372 cm^2 (DVI) and 465 cm^2 (CL) break cases (Figures 15.06.05-14-14, and 16), the boil-off PCT is shown only in the CENPD SBLOCA results. The RELAP5 SBLOCA does not show the boil-off PCT because there is no core uncover during the SBLOCA transient. So, the CENPD SBLOCA methodology is more conservative than the using RELAP5 for SBLOCA.

The specific conservatisms of CENPD methodology are described in CENPD-137("Calculative Methods for the C-E Small Break LOCA Evaluation Model," August 1974). It is approved by the Nuclear Regulatory Commission. And also, the most limiting SBLOCA is selected by break spectrum sensitivity analysis. The break location and size of the highest temperature is the most limiting SBLOCA.

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Figure 15.06.05-14-1. Core Pressure - DVI Break (18.6cm^2)

Figure 15.06.05-14-2. Core Pressure - DVI Break (372cm^2)

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Figure 15.06.05-14-3. Core Pressure - CL Break (46.5cm^2)

Figure 15.06.05-14-4. Core Pressure - CL Break (465cm^2)

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Figure 15.06.05-14-5. Break Flow Rate - DVI Break (18.6cm^2)

Figure 15.06.05-14-6. Break Flow Rate - DVI Break (372cm^2)

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Figure 15.06.05-14-7. Break Flow Rate - CL Break (46.5cm^2)

Figure 15.06.05-14-8. Break Flow Rate - CL Break (465cm^2)

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Figure 15.06.05-14-9. SIP Flow Rate - DVI Break (18.6cm^2)

Figure 15.06.05-14-10. SIP Flow Rate - DVI Break (372cm^2)

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Figure 15.06.05-14-11. SIP Flow Rate - CL Break (46.5cm^2)

Figure 15.06.05-14-12. SIP Flow Rate - CL Break (465cm^2)

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Figure 15.06.05-14-13. Peak Cladding Temperature - DVI Break (18.6cm^2)

Figure 15.06.05-14-14. Peak Cladding Temperature - DVI Break (372cm^2)

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Figure 15.06.05-14-15. Peak Cladding Temperature - CL Break (46.5cm^2)

Figure 15.06.05-14-16. Peak Cladding Temperature - CL Break (465cm^2)

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Figure 15.06.05-14-17. Loop Seal Steam Flow Rate (Relap5) - DVI Break (18.6cm^2)

Figure 15.06.05-14-18. Loop Seal Mixture Level (CENPD) - DVI Break (18.6cm^2)

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Figure 15.06.05-14-19. Loop Seal Steam Flow Rate (Relap5) - DVI Break ($372cm^2$)

Figure 15.06.05-14-20. Loop Seal Mixture Level (CENPD) - DVI Break ($372cm^2$)

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Figure 15.06.05-14-21. Loop Seal Steam Flow Rate (Relap5) - CL Break (46.5cm^2)

Figure 15.06.05-14-22. Loop Seal Mixture Level (CENPD) - CL Break (46.5cm^2)

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Figure 15.06.05-14-23. Loop Seal Steam Flow Rate (Relap5) - CL Break (465cm^2)

Figure 15.06.05-14-24. Loop Seal Mixture Level (CENPD) - CL Break (465cm^2)

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Figure 15.06.05-14-25. Core Collapsed Level (Relap5) - DVI Break (18.6cm^2)

Figure 15.06.05-14-26. Core Void Fraction (Relap5) - DVI Break (18.6cm^2)

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Figure 15.06.05-14-27. Core Collapsed Level (Relap5) - DVI Break (372cm^2)

Figure 15.06.05-14-28. Core Void Fraction (Relap5) - DVI Break (372cm^2)

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Figure 15.06.05-14-29. Core Collapsed Level (Relap5) - CL Break (46.5cm^2)

Figure 15.06.05-14-30. Core Void Fraction (Relap5) - CL Break (46.5cm^2)

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Figure 15.06.05-14-31. Core Collapsed Level (Relap5) - CL Break (465cm^2)

Figure 15.06.05-14-32. Core Void Fraction (Relap5) - CL Break (465cm^2)

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Figure 15.06.05-14-33. Core 2-Phase Level (CENPD) - DVI Break (18.6cm^2)

Figure 15.06.05-14-34. Core 2-Phase Level (CENPD) - DVI Break (372cm^2)

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Figure 15.06.05-14-35. Core 2-Phase Level (CENPD) - CL Break (46.5cm^2)

Figure 15.06.05-14-36. Core 2-Phase Level (CENPD) - CL Break (465cm^2)

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.