KHNPDCDRAIsPEm Resource

From:	Ciocco, Jeff
Sent:	Tuesday, November 24, 2015 6:26 AM
To:	apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Christopher Tyree
Cc:	Haider, Syed; McKirgan, John; Steckel, James; Lee, Samuel
Subject:	APR1400 Design Certification Application RAI 318-8337 (15.6.5 Loss-of-Coolant Accidents Resulting from the Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary)
Attachments:	APR1400 DC RAI 318 SRSB 8337.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, the following response times for the RAI questions. We may adjust the schedule accordingly.

15.06.05-2: 120 days
15.06.05-3: 45 days
15.06.05-4: 120 days

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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United States Nuclear Regulatory Commission
Protecting People and the Environment

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REQUEST FOR ADDITIONAL INFORMATION 318-8337

Issue Date: 11/24/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review 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 Loss-of-Coolant Accidents Resulting from the Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary

QUESTIONS

15.06.05-2

SBLOCA Break Spectrum Analysis & Core Two-Phase Level

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." 10 CFR 50.46(b)(1) identifies the peak cladding temperature (PCT) requirement; and 10 CFR 50.46(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 10 CFR 50.46(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 three questions, as submitted in the current RAI.

The break spectrums presented in Table 15.6.5-10 of the DCD are insufficient to ensure that the limiting SBLOCA has been identified. Both the direct vessel injection (DVI) and the pump discharge (PD) break spectrums show a trend of increasing PCT for decreasing break size. It is therefore possible that a break smaller than the smallest break analyzed could be more limiting. The SRP Section 15.6.5 notes that in the analysis of small breaks, evaluating integer diameter break sizes (i.e., 1, 2, 3, 4-inch, etc.) is considered insufficient to determine the worst break because the break areas associated with these integer diameters are too coarse to adequately identify the highest PCT. The applicant is requested to provide the results of a finer break spectrum for both the DVI line and PD line breaks to establish that the ECCS will function to meet acceptance criteria specified in 10 CFR 50.46. The results must include the PCT as well as the number of loop seals clearing for each SBLOCA break size in the following table.

ID, in	A, ft^2	A,cm^2	ID, in	A, ft^2	A,cm^2
0.5	0.0014	1.3	5.5	0.1650	153.3

1	0.0055	5.1	6	0.1963	182.4
1.5	0.0123	11.4	6.5	0.2304	214.1
2	0.0218	20.3	7	0.2673	248.3
2.5	0.0341	31.7	7.5	0.3068	285.0
3	0.0491	45.6	8	0.3491	324.3
3.5	0.0668	62.1	8.57	0.4006	372.2
4	0.0873	81.1	9[a]	0.4418	410.4
4.5	0.1104	102.6	9.5[a]	0.4922	457.3
5	0.1364	126.7	10[a]	0.5454	506.7

[a] PD spectrum only

The applicant is also requested to make available to staff any analysis or calculation results that demonstrate meeting the acceptance criteria, and to update the DCD and the TeR as appropriate to ensure that the analysis method and results are documented.

15.06.05-3

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.” 10 CFR 50.46(b)(1) identifies the peak cladding temperature (PCT) requirement; and 10 CFR 50.46(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 10 CFR 50.46(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.

For the 18.6 cm^2 DVI line break, the two-phase level is shown to be about 2 meters above the top of the core when PCT occurs at approximately 1200 seconds (Figures 15.6.5-31E, 15.6.5-31F, and15.6.5-31H). The applicant is requested to explain whether the calculations showing the core covered by the two-phase level are sufficient proof that the core will remain cooled and will not undergo a PCT. Also explain how the core could be covered with a two-phase mixture and yet the cladding temperature be more than 100 K higher than the saturation temperature. In this backdrop, describe how the two-phase level in the core is defined and calculated for the figures presented in the DCD Section 15.6.5.

15.06.05-4

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.” 10 CFR 50.46(b)(1) identifies the peak cladding temperature (PCT) requirement; and 10 CFR 50.46(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 10 CFR 50.46(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 SRP Section 15.6.5 analytical procedures that the staff uses to establish that the ECCS will function to meet acceptance criteria specified in 10 CFR 50.46, emphasize that the cladding temperature be reduced to near the saturation temperature. However, for several of the break sizes shown in DCD Section 15.6.5 the cladding temperature is more than 100°C higher than the saturation temperature when the calculation is terminated. The applicant is requested to provide the results of all break sizes in the above table out to the time when the cladding temperatures approach the saturation temperature, in order to address the staff concerns about potential core reheating. The applicant is also requested to update the DCD and the TeR as appropriate to ensure that the analysis method and results are documented.

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