KHNPDCDRAIsPEm Resource

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Sent: Wednesday, February 03, 2016 7:49 AM
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Cc: Gilmer, James; Karas, Rebecca; McKirgan, John; Steckel, James; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 398-8457 (15.06.05 - Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary)
Attachments: APR1400 DC RAI 398 SRSB 8457.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, 60 days to respond to this RAI. We may adjust the schedule accordingly.

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

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 398-8457

Issue Date: 02/03/2016
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: 15.6.5.2, 15.6.5.3

QUESTIONS

15.06.05-5

REGULATORY BASIS

Title10 of the Code of Federal Regulations, Part 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 required by the long-lived radioactivity remaining in the core. Additionally, 10CFR50, Appendix A, General Design Criterion 35, *Emergency core cooling*, requires that a system to provide abundant emergency core cooling shall be provided.

ISSUE

Additional specific information is needed to complete the review of the long term cooling Technical Report APR1400-F-A-NR-14003-P, Rev.0

REQUESTS

1. Section 2 of the Long-Term Cooling (LTC) technical report indicates that the procedure to distinguish a large break from a small break is based on whether the pressure is above or below 450 psia at approximately 8 hours after initiation of the event. The implicit assumption is that the primary system is refilled and that the operators can switch to shutdown cooling (SDC). How is it determined that there are no voids trapped in the primary system that could impede operation of the SDC? Could the Safety Injection Tanks (SITs) have injected noncondensable gas that is trapped in the system? What is the basis for increasing the pressure from the lower value in CENPD-154?

2. The analysis does not appear to account for reduced injection flow during the switchover to hot leg injection at 3 hours (Section 3.5.4). Is there a reduced flow during this transition period and how is it addressed in the calculation?

3. As shown in Figure 2-1, between 2 and 3 hours, the switch is made to align SI flow to the hot legs and the DVI nozzles. This is apparently done regardless of the break size. How is it assured that most or all of the SI flow does not go to a break located in the loop between the DVI and hot leg injection points, stagnating the core flow and resulting in a heatup and continued buildup of the boron concentration in the core?

4. The number of axial nodes in the heated core region is less than that for other plants that use variations of the interim methodology. Ten nodes are used in the core region. However, the subscript Z_{20} in Equation 1 indicates that CEFLASH-4AS (the reference for this equation) uses 20 nodes in the core region. Twenty nodes is closer to the number

used in other applications of the interim methodology. How was the use of only 10 nodes justified as a sufficient number to yield a conservative void fraction at each node?

5. To make an understandable licensing record, all of the variables in equations 1 through 13 must be clearly defined in a nomenclature list. Provide this list, and also explain the relationship between the nomenclature in the technical report and that in Section II D of CEFLASH-4AS topical report that is cited as the source of the phase separation model.

6. In Section 2.3, it is noted that the "*small and large break LOCA bring for distinctly different responses in the long-term cooling plan*". It appears that the analysis addresses the small breaks, e.g., CELDA calculates the long-term depressurization and refill of the RCS for small breaks and determines whether the refilling of RCS is achieved for small breaks. The CELDA analysis is initialized from the CEFLASH-4AS analysis that is performed for the early part of accident. CEFLASH-4AS is a SBLOCA code. If CELDA is used for large breaks, how is it initialized?

   The discussion of how the computer codes are used for the LTC analysis appears to address only the small breaks. Further information is needed on how the large breaks are addressed. For example how is it determined that "*The LTC analysis also determines that the large-break procedures can flush the core for break sizes down to 0.004 ft^2*." Please identify any computer codes in addition to the BORON code that are used for the LBLOCA analysis and provide information on their approval status.

7. Early in a LBLOCA, the steam upflow from the core may entrain the hot leg injection flow and prevent the hot leg injection from flushing the high boron concentration coolant from the core. How does the analysis account for this possibility? Provide justification for any CCFL correlation used for this application.

8. In Section 3.5.2, it is stated that the BORON code has been modified due to the difference between the RWT and the IRWST. Although the equations in the BORON code documentation are not numbered, please identify which equations were modified and the extent of the modifications.

9. It is mentioned that for C-E plants when the RWT is emptied, ECC injection is switched to the sump. Is the BORON code modification simply to continue injection from the IRWST with no switch to the sump? The BORON code also includes injection from a boric acid storage tank (BAST). How is this injection path addressed for AP1400?

10. The documentation for the BORON code makes a statement to the effect that "*for core flush conditions an evaluation of the code equations indicates that a time step interval of one hour or less gives conservative results*." Provide justification that the BORON code analysis has reached a converged solution.

11. The solubility limit of 29.3 wt % is greater than that at 212 F, the saturation temperature of pure water at 14.7 psia. According to Table 3-6, the solubility limit used in the analysis is based on a temperature of 217.9 F, presumably the boiling temperature of the boric acid solution at 14.7 psia. Were the liquid density used to calculate the wt % of boron and the water properties used to calculate the boiloff rate based on this same temperature?

12. Figure 4-2 shows that the “Pressure after Refill” as a function of break size settles out to approximately 80 psia for breaks between 0.04 and 0.07 ft^2. What physical phenomenon is causing the pressure to remain constant for this wide range of break sizes?

13. Figure 4-3 shows the buildup of boric acid concentration which depends on the boiloff rate and appears to be independent of break size? For smaller breaks where natural circulation is mixing the coolant, the switch to hot leg injection could possibly hinder the natural circulation by introducing cold liquid into the hot side of the natural circulation loop. How does the approach used address this possibility?

14. In the CENPD-254 methodology, the maximum break size for the small break analysis is determined by the auxiliary feedwater capacity. There is no mention of auxiliary feedwater capacity in the technical report. How was the upper limit size determined for the small break?

15. Assumption 2d. states “RCS cooldown begins at 2 hours post-LOCA.” How is this assumption used in the analysis? Tables 3-2 and 3-5 show values starting at 1 hour. Tables 3-3 and 3-4 show values beginning at 0.0083 hours. In section 3.5.3 decay heat is calculated at one hour.

16. In calculating the boiloff rates at various times, was only the decay heat varied? Was a pressure of 14.7 psi used for all pressure dependent calculations? If not, what pressure was used?

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