KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Wednesday, February 03, 2016 7:03 AM
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Cc: Haider, Syed; Segala, John; Umana, Jessica; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 394-8460 (6.2.1.3: Mass and Energy Release Analyses for Postulated Loss-of Coolant Accidents)
Attachments: APR1400 DC RAI 394 SCVB 8460.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 394-8460

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: 06.02.01.03 - Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents (LOCAs)
Application Section: 6.2.1.3: Mass and Energy Release Analyses for Postulated Loss-of Coolant Accidents

QUESTIONS

06.02.01.03-5

Conservatisms in the Limiting LOCA M&E Release Calculations from the Containment Perspective

General Design Criterion (GDC) 50, "Containment design basis," and Appendix K to 10 CFR Part 50, "ECCS Evaluation Models" require, in part, analyzing the most severe consequences for the spectrum of postulated pipe breaks sizes, locations, and single failures. NUREG-0800, SRP Section 6.2.1.3, "Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents (LOCAs)" lays out several acceptance criteria to ensure that that containment mass and energy (M&E) release calculations are performed for the worst design basis accident (DBA). In this regard, the staff seeks the following information to address concerns about the conservative treatment of M&E release calculations for the the limiting LOCA analysis from the containment perspective. The applicant is also requested to update the APR1400 DCD or the KHNP Technical Report (TeR) APR1400-Z-A-NR-14007-P/NP (LOCA Mass and Energy Release Methodology) to document the explanations. (The regulatory bases identified in the above are applicable to all subsequent questions in this RAI.)

SRP Section 6.2.1.3 Acceptance Criterion No. 1C(ii) suggests that mass release rates should be calculated using a model that has been demonstrated to be conservative by comparison to experimental data. Even though the DCD and TeR mention that the LOCA M&E release is analyzed using the computer codes CEFLASH-4A and FLOOD3 for the blowdown and reflood/post-reflood periods respectively, they do not comment on whether these codes have been validated against experimental data. The applicant is requested to document this information in the DCD.

06.02.01.03-6

DCD Tier 2, Section 6.2.1.3 makes the following two statements regarding the nature of two-phase flow from the LOCA break: (1) "During blowdown, most of the initial primary coolant is released to the containment as a two-phase mixture." (2) "The onset of the two-phase release to the containment may or may not occur before the end of reflood; typically, this occurs close to the end of the reflood." The applicant is requested to reconcile the two statements and update the DCD accordingly.

06.02.01.03-7

SRP Section 6.2.1.3 Acceptance Criterion No. 1C(ii) suggests that calculations of heat transfer from the secondary coolant to the steam generator (SG) tubes for pressurized water reactor (PWRs) should be based on natural convection heat transfer for tube surfaces immersed in water and condensing heat transfer for the tube surfaces exposed to steam. It is not clear whether the application has followed the suggested approach. The applicant is requested to add an appropriate description in the DCD and justify the approach used.

06.02.01.03-8

SRP Section 6.2.1.3 Acceptance Criterion No. 1C(iii) specifies that the calculations of liquid entrainment, i.e., carryout rate fraction (CRF), which is the mass ratio of liquid exiting the core to the liquid entering the core, should be based on the pressurized water reactor (PWR) full length emergency cooling heat transfer experiments. The DCD or TeR do not document the technical basis of the CRF values used in the M&E calculations. The applicant is requested to justify their CRF selection.

06.02.01.03-9

SRP Section 6.2.1.3 Acceptance Criterion No. 1C(iii) asks for a justification for the assumption of steam quenching by comparison with applicable experimental data. No information was provided either to ascertain if the liquid entrainment calculations considered the effect on the CRF of the increased core inlet water temperature caused by steam quenching assumed to occur from mixing with the emergency core cooling system (ECCS) water. The DCD or TeR do not mention whether or not steam quenching was assumed. Acceptance Criterion No. 1C(iii) also suggests to assume the steam leaving the SGs to be superheated to the temperature of the secondary coolant. The DCD does mention the discharge fluid to be superheated steam but does not mention what assumption was made about its temperature. The applicant is requested to include these descriptions into the DCD.

06.02.01.03-10

SRP Section 6.2.1.3 Acceptance Criterion No. 1C(iv) asks for a description of the long-term cooling (or post-reflood) model. However, the DCD or TeR do not provide any discussion or justification of the methods used to calculate the core inlet and exit flow rates and removal of the sensible heat from primary system metal surfaces and the steam generators (SGs). Liquid entrainment correlations for fluid leaving the core and entering the SGs are neither described nor justified by comparison with experimental data. No statements are made about steam quenching by ECCS water or the applicable experimental data, or whether and how all the remaining stored energy in the primary and secondary systems would be removed during the post-reflood phase. No references are made to compare the results of post-reflood analytical models with the applicable experimental data. The applicant is requested to add these descriptions in the DCD, or appropriately reference them.

06.02.01.03-11

According to SRP Section 6.2.1.3 Acceptance Criterion No. 1C(v), the fission product decay energy model is acceptable if it is equal to or more conservative than the decay energy model given in SRP Section 9.2.5. However, the DCD or TeR provides no information to ascertain how conservative the decay energy model is compared to the one given in SRP Section 9.2.5. SRP Section 6.2.1.3

Acceptance Criterion No. 1C(v) also suggests that steam from decay heat boiling in the core should be assumed to flow to the containment by the path which produces the minimum amount of mixing with ECCS injection water. No such description is found in the DCD or the TeR. The applicant is request to clarify these two aspects in the DCD.

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