

KHNPDCDRAIsPEm Resource

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Sent: Thursday, January 28, 2016 8:46 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Erin Wisler
Cc: Thomas, Matt; Karas, Rebecca; Ward, William; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 379-8476 (07-19 Branch Technical Position - Guidance for Evaluation of Diversity and Defense-in-Depth in Digital Computer-Based Instrumentation and Control Systems)
Attachments: APR1400 DC RAI 379 SRSB 8476.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 RAI question response times. We may adjust the schedule accordingly.

07-1: 30 days
07-2: 30 days
07-3: 90 days
07-4: 90 days
07-5: 30 days

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

Thank you,

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Protecting People and the Environment

REQUEST FOR ADDITIONAL INFORMATION 379-8476

Issue Date: 01/28/2016

Application Title: APR1400 Design Certification Review – 52-046

Operating Company: Korea Hydro & Nuclear Power Co. Ltd.

Docket No. 52-046

Review Section: 07-19 Branch Technical Position - Guidance for Evaluation of Diversity and Defense-in-Depth in Digital Computer-Based Instrumentation and Control Systems

Application Section: Chapter 7.8

QUESTIONS

07-1

The applicant provided a quantitative diversity and defense-in-depth (D3) analysis regarding the steam line break (SLB) outside containment event in Section 5.4.2.2 of APR1400-Z-A-NR-14019-P, Rev. 0, "CCF [common cause failure] Coping Analysis." In the calculation, the applicant determined that a small amount of fuel may experience DNB and is therefore be considered to fail. This maximum amount of fuel failure is used as the source term for the radiological analysis.

In accordance with Branch Technical Position (BTP) 7-19, "Guidance for Evaluation of Diversity and Defense-In-Depth in Digital Computer-Based Instrumentation and Control Systems," Section B, 1.4, Point 2, which is quoted from the SRM on SECY-93-087 (ML003708056), the applicant shall demonstrate adequate diversity in the design of the digital I&C safety systems to ensure that a SLB outside containment concurrent with a CCF does not challenge the plant's safety more than a SLB outside containment as analyzed in Chapter 15 of the DCD. Based on the applicant's current analysis, the staff is unable to confirm that the applicant's source term for the radiological analysis (i.e. the assumed amount of failed fuel for this event) is adequate; therefore, the staff cannot conclude the applicant is in compliance with BTP 7-19 Point 2.

The staff requests the applicant to provide a response demonstrating how the amount of fuel failing due to exceeding specified acceptable fuel design limits (SAFDLs) was determined for the SLB event.

07-2

The applicant provided a quantitative D3 analysis regarding the reactor coolant pump (RCP) rotor seizure event in Section 5.4.2.4 of APR1400-Z-A-NR-14019-P, Rev. 0, "CCF Coping Analysis." In this section of the technical report, the applicant stated that the minimum departure from nuclear boiling ratio (MDNBR) occurred at 178.6 seconds into the transient. However, Figure 5-25, " of the technical report shows the MDNBR occurs right after the event initiation (i.e. <5 seconds into the event).

In accordance with BTP 7-19 Point 2, which is quoted from the SRM on SECY-93-087, the applicant shall demonstrate adequate diversity in the design of the digital I&C safety systems to ensure that an RCP rotor seizure concurrent with a CCF does not challenge the plant's safety more than an RCP rotor seizure as analyzed in Chapter 15 of the DCD. The staff is unable to confirm that the applicant's current analysis is adequate; therefore, the staff cannot conclude the applicant is in compliance with BTP 7-19 Point 2.

The staff requests the applicant to provide a response addressing this inconsistency.

REQUEST FOR ADDITIONAL INFORMATION 379-8476

07-3

The applicant provided a qualitative D3 analysis regarding the uncontrolled control element assembly (CEA) withdrawal from subcritical or low-power startup condition event in Section 5.3.4.1 of APR1400-Z-A-NR-14019-P, Rev. 0, "CCF Coping Analysis." In this section of the technical report, the applicant concluded that the DPS high pressurizer pressure trip would terminate the event prior to the DNBR SAFDL being reached because the D3 event utilizes nominal pressurizer pressure which is 75 psi higher than in the Chapter 15 analysis. However, in Figure 15.4.1-3, "Uncontrolled CEA Withdrawal at low Power: RCS Pressure vs. Time," of the DCD, the RCS pressure response shows a peak pressure of approximately 2250 psia at approximately 33 seconds. Figure 15.4.1-4, "Uncontrolled CEA Withdrawal at Low Power: Minimum DNBR vs. Time," of the DCD shows the MDNBR occurred at approximately 29 seconds following a variable overpower trip. Because the MDNBR occurs approximately 4 seconds before the peak pressure is obtained in the Chapter 15 analysis of the event, and because the DNBR decreases at a rapid rate prior to the trip, the staff was unable to conclude that the D3 event transient could be arrested via the DPS high pressurizer pressure trip before a DNBR SAFDL would be violated.

In accordance with BTP 7-19 Point 2, which is quoted from the SRM on SECY-93-087, the applicant shall demonstrate adequate diversity in the design of the digital I&C safety systems to ensure that an uncontrolled CEA withdrawal from low power or subcritical conditions event concurrent with a CCF does not challenge the plant's safety more than the event does as analyzed in Chapter 15 of the DCD. The staff is unable to confirm that the applicant's current analysis is adequate; therefore, the staff cannot conclude the applicant is in compliance with BTP 7-19 Point 2.

The staff requests the applicant to provide a detailed analysis of the uncontrolled CEA withdrawal from subcritical or low power conditions concurrent with a CCF.

07-4

The applicant provided a discussion regarding the uncontrolled CEA withdrawal at power event in Section 5.3.4.2 of APR1400-Z-A-NR-14019-P, Rev. 0, "CCF Coping Analysis." In this section of the technical report, the applicant concluded this event need not be analyzed because its evaluation is essentially similar to the evaluation of the event at subcritical or low power conditions. The applicant reports in the Chapter 15 analysis of the event (15.4.2) that the variable overpower trip arrests the transient; however, given that this trip is not available assuming a CCF, the staff cannot determine that adequate diversity and defense-in-depth is provided by the APR1400 design. Furthermore, the staff is unable to conclude that an uncontrolled CEA withdrawal at power event concurrent with a CCF is less limiting than the same event at low power or startup conditions.

In accordance with BTP 7-19 Point 2, which is quoted from the SRM on SECY-93-087, the applicant shall demonstrate adequate diversity in the design of the digital I&C safety systems to ensure that an uncontrolled CEA withdrawal at power event concurrent with a CCF does not challenge the plant's safety more than the event does as analyzed in Chapter 15 of the DCD. The staff is unable to confirm that the applicant's current analysis is adequate; therefore, the staff cannot conclude the applicant is in compliance with BTP 7-19 Point 2.

The staff requests the applicant to first provide a qualitative analysis of the uncontrolled CEA withdrawal at power event concurrent with a CCF to determine if a detailed (computer) analysis is necessary. If the applicant concludes that a detailed quantitative analysis is necessary, the staff requests the applicant to provide it as well.

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07-5

The applicant provided a qualitative analysis regarding the large-break loss of coolant accident (LBLOCA) event in Section 5.3.6.5 of APR1400-Z-A-NR-14019-P, Rev. 0, "CCF Coping Analysis." Furthermore, the applicant provided a quantitative analysis regarding the LBLOCA event in Section 5.4.2.7 of the technical report. In this section of the technical report, the applicant concluded the D3 analysis of this event is bounded by the Chapter 15 analysis due to the use of best-estimate conditions; however, the staff noted that the applicant did not provide much information regarding the D3 analysis for a small-break LOCA (SBLOCA). The staff is unable to conclude that a SBLOCA concurrent with a CCF is bounded by the corresponding Chapter 15 analysis. In addition, regarding the D3 analysis of SBLOCA, an RCP trip will not occur due to the assumed CCF in the RPS. The lack of an automatic RCP trip for SBLOCA is not in conformance with TMI Action Plan (NUREG-0737) Requirement II.K.3.5 (automatic trip of reactor coolant pumps during loss-of-coolant accident). However, the staff has accepted a manual RCP trip for SBLOCA based, for example, on zero degrees hot leg subcooling indication (GL 85-12, "Implementation of TMI Action Item II.K.3.5, Automatic Trip of Reactor Coolant Pumps").

In accordance with BTP 7-19 Point 2, which is quoted from the SRM on SECY-93-087, the applicant shall demonstrate adequate diversity in the design of the digital I&C safety systems to ensure that a LOCA concurrent with a CCF does not challenge the plant's safety more than the event does as analyzed in Chapter 15 of the DCD. The staff is unable to confirm that the applicant's current analysis is adequate; therefore, the staff cannot conclude the applicant is in compliance with BTP 7-19 Point 2.

The staff requests the applicant to first provide a detailed qualitative analysis of a SBLOCA concurrent with a CCF to determine if a detailed quantitative analysis is necessary. If the applicant concludes that a detailed quantitative analysis is necessary, the staff requests the applicant to provide it as well. The evaluation should address the lack of an automatic RCP trip in the diverse actuation system (DAS).