KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Monday, February 22, 2016 7:26 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Andy Jiyong Oh; Christopher Tyree
Cc: Budzynski, John; Karas, Rebecca; Steckel, James; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 411-8505 (15.00.02 - Review of Transient and Accident Analysis Methods 01/2006)
Attachments: APR1400 DC RAI 411 SRSB 8505.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, 45 days to respond to the RAI questions. We may adjust the schedule accordingly.

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

Hearing Identifier: KHNP_APR1400_DCD_RAI_Public
Email Number: 461

Mail Envelope Properties (200206069e81471194032d896c976f7d)

Subject: APR1400 Design Certification Application RAI 411-8505 (15.00.02 - Review of Transient and Accident Analysis Methods 01/2006)
Sent Date: 2/22/2016 7:25:55 AM
Received Date: 2/22/2016 7:25:56 AM
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Files	**Size**	**Date & Time**
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APR1400 DC RAI 411 SRSB 8505.pdf	109698	
image001.jpg	5040	

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Priority: Standard
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REQUEST FOR ADDITIONAL INFORMATION 411-8505

Issue Date: 02/22/2016
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 15.00.02 - Review of Transient and Accident Analysis Methods 01/2006
Application Section:

QUESTIONS

15.00.02-6

Provide evidence that the STRIKIN-II computer code has previously been approved for conservatively calculating fuel and clad temperatures during steam line break (SLB) events

Regulatory Basis

10 CFR 52.47(a)(4) requires that applications for standard design certifications include an analysis and evaluation of the design and performance of structures, systems, and components (SSCs) with the objective of assessing the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.Additionally, NUREG-0800, Standard Review Plan (SRP) Section 15.0.2, “Review of Transient and Accident Analysis Methods,” specifies that an evaluation model must be able to predict important physical phenomena reasonable well from both qualitative and quantitative points of view or should treat the phenomena conservatively.

Technical Basis

STRIKIN-II was originally developed and designed for the analysis of LOCAs. However, a non-LOCA version of STRIKIN-II was derived from the LOCA analysis version and has been maintained independently with various modifications since 1975. In the APR1400 Chapter 15 safety analysis, STRIKIN-II is used to simulate the heat conduction within reactor fuel rods and its associated surface heat transfer during CEA ejection and SLB events to calculate the cladding and fuel temperatures for an average or hot fuel rod. The staff has previously reviewed and accepted STRIKIN-II in the SER to CENPD-190 for use in calculating fuel and clad temperatures for CEA ejection accidents. STRIKIN-II was also approved as an acceptable method for CE System 80+ non-LOCA fuel thermal analysis in the NUREG-1462 FSER.

Question

The use of STRIKIN-II to calculate fuel and clad temperatures for SLB has not previously been approved. The applicant is requested to provide evidence of prior approval of STRIKIN-II for SLB analysis or provide justification for the acceptability of STRIKIN-II for conservatively calculating cladding and fuel temperatures for SLB events.

15.00.02-7

Provide additional information on the moderator reactivity feedback model used in the analysis of SLB events

Regulatory Basis

10 CFR 52.47(a)(4) requires that applications for standard design certifications include an analysis and evaluation of the design and performance of structures, systems, and components (SSCs) with the objective of assessing the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents. Additionally, NUREG-0800, Standard Review Plan (SRP) Section 15.0.2, "Review of Transient and Accident Analysis Methods," requires a verification that parameters used in the analyses are suitably conservative. For instance, Section III.2.B of the SRP for Section 15.0.2 requires confirmation that the equations in the evaluation model are correct. Section I.6.C.i of the SRP for 15.0 requires a verification of the evaluation model used to perform transient and accident analyses. Section I.6.C.ii of the SRP for 15.0 requires a verification that parameters used in the analyses are suitably conservative.

Technical Basis

Sections 2.3 and 3.1.2.1 of technical report APR1400-Z-A-NR-14006-P state that for Steam Line Breaks (SLB), the calculation of moderator reactivity feedback is based on a density computed using the "cold edge enthalpy" of the affected side where the "cold edge enthalpy" is defined as the enthalpy of the fluid from the cold legs of the loop with the ruptured SG without the effect of mixing with fluid from the intact loop. However, the CESEC-III code descriptions, CENPD-107 and Enclosure 1-P to LD-82-001, do not discuss or mathematically define "cold edge enthalpy". CENPD-107 instead states that moderator reactivity feedback accounts for unequal inlet temperatures by calculating the lowest possible average core temperature defined as the average core temperature minus one-half the difference in cold leg inlet temperatures. The amount of conservatism in the evaluation models for SLB with respect to moderator reactivity feedback needs to be verified.

Question

The applicant is requested to provide additional information regarding the actual moderator reactivity feedback model used for SLB analysis, the documentation and Validation & Verification of this model, and an explanation of how the conservatism of the model has been quantified.

15.00.02-8

Provide additional information on the use of Reynold's number independent friction and form losses and the reliance on pressure drop proportional to velocity squared

Regulatory Basis

10 CFR 52.47(a)(4) requires that applications for standard design certifications include an analysis and evaluation of the design and performance of structures, systems, and components (SSCs) with the objective of assessing the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents. Additionally, NUREG-0800, Standard Review Plan (SRP) Section 15.0.2, "Review of Transient and Accident Analysis Methods," requires a verification that parameters used in the analyses are suitably conservative. For instance, Section III.2.B of the SRP for 15.0.2 requires confirmation that the equations in the evaluation model are correct. Section I.6.C.i of the SRP for Section 15.0 requires a verification of the evaluation model used to perform transient and accident analyses. Section I.6.C.ii of the SRP for Section 15.0 requires a verification that parameters used in the analyses are suitably conservative.

Technical Basis

Section 2.5.2 of technical report APR1400-Z-A-NR-14006-P states that the COAST computer code assumes that pressure losses due to friction and geometric losses are assumed proportional to the flow velocity squared. Neither Section 2.5.2 nor the COAST code description, CENPD-98-A, discuss the possibility that friction and geometric losses can be Reynold's number dependent and not follow the "squared" relationship between pressure losses and velocity. Proper calculation of pressure losses as a function of flow is especially important during loss-of-flow events and the use of the "squared" relationship with fixed geometric losses could result in a non-conservative flow versus time calculation. The effect of Reynold's number dependent friction and geometric losses on the "squared" relationship should be evaluated based on comparison of COAST calculations to experimental data.

Question

The applicant is requested to provide additional information as to how Reynold's number dependent friction and form losses are accounted for in COAST for loss-of-flow events or how the assumption that friction and geometric losses are proportional to the flow velocity squared has been determined to be suitably conservative.

15.00.02-9

Thermal Conductivity Degradation Effects

Regulatory Basis

10 CFR 52.47(a)(4) requires that applications for standard design certifications include an analysis and evaluation of the design and performance of structures, systems, and components (SSCs) with the objective of assessing the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents. Additionally, NUREG-0800, Standard Review Plan (SRP) Section 15.0.2, "Review of Transient and Accident Analysis Methods," requires a verification that parameters used in the analyses are suitably conservative. Section 15.0 analysis acceptance criteria specifies that fuel cladding integrity must be maintained by ensuring that the minimum departure from nucleate boiling ratio (DNBR) remains above the 95/95 DNBR limit for PWRs. This is necessary to ensure that specified

acceptable fuel design limits(SAFDLs) are met (as required by GDC 10). Additionally, the release of radioactive material shall not result in offsite doses in excess of the guidelines of 10 CFR Part 100.

Question

The LBLOCA evaluation was performed considering the thermal conductivity degradation effects. It is not clear that other events evaluated in Chapter 15 have also accounted for this effect.

The applicant is requested to provide evidence that the effect of thermal conductivity degradation has been included for all Chapter 15 events or to justify why the effect need not be considered.

15.00.02-10

10 CFR 52.47(a)(4) requires that applications for standard design certifications include an analysis and evaluation of the design and performance of structures, systems, and components (SSCs) with the objective of assessing the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents. Additionally, Section 15.0 of the Standard Review Plan (NUREG-0800) requires a verification that parameters used in the analyses are suitably conservative.

NRC staff is questioning if the friction and form losses calculated in the COAST code are suitably conservative. Please explain how the friction and form loss coefficients are calculated and explain why this method is suitably conservative.


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