KHNPDCDRAIsPEm Resource

From:	Ciocco, Jeff
Sent:	Monday, February 01, 2016 9:55 AM
To:	apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Christopher Tyree
Cc:	Carlson, Donald; Karas, Rebecca; Steckel, James; Lee, Samuel
Subject:	APR1400 Design Certification Application RAI 387-8485 (15.00.02 - Review of Transient and Accident Analysis Methods 01/2006)
Attachments:	APR1400 DC RAI 387 SRSB 8485.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.

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

Thank you,

Jeff Ciocco
New Nuclear Reactor Licensing
301.415.6391
jeff.ciocco@nrc.gov

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From: Ciocco, Jeff

Created By: Jeff.Ciocco@nrc.gov

Recipients:
"Carlson, Donald" <Donald.Carlson@nrc.gov>
Tracking Status: None
"Karas, Rebecca" <Rebecca.Karas@nrc.gov>
Tracking Status: None
"Steckel, James" <James.Steckel@nrc.gov>
Tracking Status: None
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"apr1400rai@khnp.co.kr" <apr1400rai@khnp.co.kr>
Tracking Status: None
"KHNPDCDRAIsPEm Resource" <KHNPDCDRAIsPEm.Resource@nrc.gov>
Tracking Status: None
"Harry (Hyun Seung) Chang" <hyunseung.chang@gmail.com>
Tracking Status: None
"Andy Jiyong Oh" <jiyong.oh5@gmail.com>
Tracking Status: None
"Christopher Tyree" <Christopher.tyree@aecom.com>
Tracking Status: None

Post Office: HQPWMSMRS07.nrc.gov

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REQUEST FOR ADDITIONAL INFORMATION 387-8485

Issue Date: 02/01/2016
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

15.00.02-1

Transient pressure options in HERMITE 1.6 calculations for DCD Section 15.3 events

In 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects or anticipated operational occurrences (AOOs). GDC 20 requires, in part, that the protection system be designed to initiate automatically the operation of appropriate systems to ensure that SAFDLs are not exceeded as a result of AOOs. GDC 25 requires the protection system to be designed to ensure that SAFDLs are not exceeded for any single malfunction of the reactivity control systems.

Section 15.0.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Subsection III.6, states that the following attributes of the evaluation model should be considered when determining the extent to which the full review process may be reduced for a specific application: (a) Novelty of the revised evaluation model compared to the currently acceptable model, (b) The complexity of the event being analyzed, (c) The degree of conservatism in the evaluation model, and (d) The extent of any plant design or operational changes that would require a reanalysis.

Technical report APR1400-Z-A-NR-14006-P indicates that more accurate methods and additional features were added to HERMITE. The following statement is made in the report (Section 3.7.4): “HERMITE code was initially approved by NRC in 1976 and the CE-Methodology with several improvements was approved in 1992 in the Amendment No. 61 of NPF-41 . HERMITE code version in 1992 was 1.5 while current version is 1.6 with added transient pressure option. There is no significant methodology change for this code after the last approval by NRC in 1992, thus this code is applicable to the transient and accident events for the DCD, Tier 2 Chapter 15.” The HERMITE User’s Manual [CE-CES-091-P, Rev. 4] confirms this code change.

Reference VV-FE-0416, Rev. 0, provides the software verification and validation of HERMITE 1.6. Section 3.0 of this document describes the code changes necessary to implement the transient pressure option. Section 5.0 describes eleven test cases used to verify this new feature, and the results indicate that the transient pressure option is working as expected. The results of the independent software review were included in Appendix A. There are two transient pressure options available in HERMITE for inputting pressure versus time tables. The first is an input of pressure ratios relative to the input system pressure, and the second is an input of pressure differences relative to the input system pressure.

However, the applicant has not described how, or if, these new code options are used in the analysis of Section 15.3 events. The staff is therefore concerned that evaluation models for these events have not been adequately described.

Please provide details regarding the use of the transient pressure options in HERMITE 1.6 and their impacts on the analyses of Section 15.3 events. As appropriate, the applicant should ensure that the requested information is either added to the DCD itself or else provided in supporting documents that are docketed and listed for incorporation by reference.

15.00.02-2

Calculation of 1-D cross sections for HERMITE

In 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects or anticipated operational occurrences (AOOs). GDC 20 requires, in part, that the protection system be designed to initiate automatically the operation of appropriate systems to ensure that SAFDLs are not exceeded as a result of AOOs. GDC 25 requires the protection system to be designed to ensure that SAFDLs are not exceeded for any single malfunction of the reactivity control systems.

Section 15.0.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Subsection II.6, Item (A) states that the documentation should include: “An overview of the evaluation model which provides a clear roadmap describing all parts of the evaluation model, the relationships between them, and where they are located in the documentation.”

For the 1-D HERMITE solution described in Section 3.5.2.1 of the technical report APR1400-Z-A-NR-14006-P, cross sections are used that incorporate all reactivity feedback mechanisms including xenon. These cross sections are stated to have been derived from the 3-D ROCS solution at each axial level. However, it is not clear what flux or reaction weightings were used in collapsing the cross sections from 3-D to 1-D. The staff is therefore concerned that the evaluation model has not been adequately described in this regard.

Please provide details on the calculation of 1-D cross sections used for HERMITE, including how these cross sections are flux-weighted and collapsed from the 3-D cross sections obtained from the ROCS solution. As appropriate, the applicant should ensure that the requested information is either added to the DCD itself or else provided in supporting documents that are docketed and listed for incorporation by reference.

15.00.02-3

Verification of ROCS-NEM in relation to ROCS-HOD

In 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects or anticipated operational occurrences (AOOs). GDC 20 requires, in part, that the protection system be designed to initiate automatically the operation of appropriate systems to ensure that SAFDLs are not exceeded as a result of AOOs. GDC 25 requires the protection system to be designed to ensure that SAFDLs are not exceeded for any single malfunction of the reactivity control systems.

Section 15.0.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Subsection III.6, indicates that the following attributes of the evaluation model should be considered when determining the extent to which the full review process may be reduced for a specific application: (a) Novelty of the revised evaluation model compared to the currently acceptable model, (b) The complexity of the event being analyzed, (c) The degree of conservatism in the evaluation model, and (d) The extent of any plant design or operational changes that would require a reanalysis.

Report CENPD-266-P-A documents the ROCS/DIT code system. In that report, ROCS was approved for use as a PWR core design and analysis code by the NRC. In addition, DIT and its associated data library were found to be acceptable for the generation of few-group cross sections to predict the physical processes important for PWR design. The regulatory position on the ROCS/DIT system in 1983 is summarized as follows: “*We have reviewed the ROCS and DIT computer codes as described in CENPD-266-P and CENPD-266-NP and find them to be acceptable for nuclear core design and safety-related neutronics calculations made by CE in licensing actions for power distributions, control rod worths, depletion, reactivity coefficients and reactivity differentials. We also conclude that the ROCS code, including the fine mesh module MC, is of sufficient accuracy for the generation of coefficient libraries for the in-core instrumentation. The staff, however, recommends that CE perform further verification when the NEM is incorporated into the ROCS code in order to be assured that equivalent calculational biases and uncertainties are obtained with ROCS-NEM as compared to ROCS-HOD.*”

Table 4.1-4 of the DCD indicates that the Nodal Expansion Method (NEM) was used for APR1400 design and analysis. This is confirmed based on Section 4.3.3.1.1.2 of the DCD, which states the following: “*The ROCS program is designed to perform two-dimensional or three-dimensional coarse-mesh reactor core calculations based on a two-group nodal expansion method, with full-core, half-core, or quarter-core symmetric geometries.*” Based on the regulatory position quoted above, further verification of the ROCS-NEM code is needed.

Please provide verification of the ROCS-NEM solver and discuss the impacts relative to the ROCS-HOD solver. In addition, please provide verification that “equivalent calculational biases and uncertainties are obtained with ROCS-NEM as compared to ROCS-HOD.” As appropriate, the applicant should ensure that the requested information is either added to the DCD itself or else provided in supporting documents that are docketed and listed for incorporation by reference.

15.00.02-4

MCXSEC code for generating macroscopic cross sections

In 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the core and associated coolant, control, and protection systems to be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects or anticipated operational occurrences (AOOs). GDC 20 requires, in part, that the protection system be designed to initiate automatically the operation of appropriate systems to ensure that SAFDLs are not exceeded as a result of AOOs. GDC 25 requires the protection system to be designed to ensure that SAFDLs are not exceeded for any single malfunction of the reactivity control systems.

Section 15.0.2 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Subsection II.1, Item (A) states that the documentation must include “An overview of the evaluation model which provides a clear roadmap describing all parts of the evaluation model, the relationships between them, and where they are located in the documentation.”

In DCD Section 4.3.3.1.1.3, the following statement is made: “The ROCS embedded calculation uses a macroscopic cross-section model based on interpolation of multi-dimensional macroscopic tables. These tables are created by the MCXSEC code, which processes DIT results for all assembly types, and are typically burnup, enrichment, moderator, and fuel temperature dependent for each fine-mesh pin cell type.” However, the applicant has not provided adequate details on the MCXSEC code and its use with the DIT and ROCS codes to allow the staff to complete its review of this portion of the evaluation model.

Please provide details on the MCXSEC code as it used to generate macroscopic cross sections for ROCS based on results from DIT. As appropriate, the applicant should ensure that the requested information is either added to the DCD itself or else provided in supporting documents that are docketed and listed for incorporation by reference.

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