KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Tuesday, February 23, 2016 3:27 PM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Andy Jiyong Oh; James Ross
Cc: Carlson, Donald; Karas, Rebecca; Vera, John; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 419-8517 (04.03 - Nuclear Design)
Attachments: APR1400 DC RAI 419 SRSB 8517.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.

04.03-7: 45 days
04.03-8: 30 days
04.03-9: 30 days

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

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Hearing Identifier: KHNP_APR1400_DCD_RAI_Public
Email Number: 469

Mail Envelope Properties (0a95efae6dfb47518bd6002be1efeaa5)

Subject: APR1400 Design Certification Application RAI 419-8517 (04.03 - Nuclear Design)
Sent Date: 2/23/2016 3:27:20 PM
Received Date: 2/23/2016 3:27:24 PM
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
"Vera, John" <John.Vera@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
"Andy Jiyong Oh" <jiyong.oh5@gmail.com>
Tracking Status: None
"James Ross" <james.ross@aecom.com>
Tracking Status: None

Post Office: HQPWMSMRS07.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	687	2/23/2016 3:27:24 PM
APR1400 DC RAI 419 SRSB 8517.pdf	100880	
image001.jpg	5040	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

REQUEST FOR ADDITIONAL INFORMATION 419-8517

Issue Date: 02/23/2016
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 04.03 - Nuclear Design
Application Section:

QUESTIONS

04.03-7

10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the reactor core design to include appropriate margin to ensure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation or anticipated operational occurrences (AOOs). GDC 13 requires provision of instrumentation and controls (I&C) to monitor variables and systems that can affect the fission process over anticipated ranges for normal operation, anticipated operational occurrences and accident conditions, and to maintain the variables and systems within prescribed operating ranges. GDC 20 requires automatic initiation of the reactivity control systems to assure that SAFDLs are not exceeded as a result of AOOs and that automatic operation of systems and components important to safety occurs under accident conditions.

To assess compliance with these requirements, Section 4.3 of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” (SRP) states that the reviewed information on core power distribution should demonstrate that “A reasonable probability exists that in normal operation the design limits will not be exceeded, based on consideration of information received from the power distribution monitoring instrumentation; the processing of that information, including calculations involved in the processing; the requirements for periodic check measurements; the accuracy of design calculations used in developing correlations when primary variables are not directly measured; the uncertainty analyses for the information and processing system; and the instrumentation alarms for the limits of normal operation (e.g., offset limits, control bank limits) and for abnormal situations (e.g., tilt alarms for control rod misalignment).”

DCD Section 4.3.3.1.1.4 briefly describes how fixed-source adjoint neutron transport calculations are performed with the MCNP (Monte Carlo, N-particle) code to determine the axial shape annealing functions used by the Core Protection Calculator System (CPCS). The staff has not previously reviewed this use of MCNP. The staff needs to evaluate how the MCNP code is used and verified in support of the power distribution monitoring system of the CPCS. During an audit discussion of this topic on January 20, 2016, the applicant displayed an internal technical report that appears to include much or all of the information needed for the staff’s review.

Please submit for NRC review a technical report that details and verifies the use of the MCNP code to calculate shape annealing functions in support of the CPCS. The applicant should cite the report in the DCD and either (a) add the report to the list of documents to be incorporated by reference, or (b) insert a detailed summary into an appropriate section of the DCD.

04.03-8

10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the reactor core design to include appropriate margin to ensure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation or anticipated operational occurrences (AOOs). GDC 13 requires provision of instrumentation and controls (I&C) to monitor variables and systems that can affect the fission process over anticipated ranges for normal operation, anticipated operational occurrences and accident

conditions, and to maintain the variables and systems within prescribed operating ranges. GDC 20 requires automatic initiation of the reactivity control systems to assure that SAFDLs are not exceeded as a result of AOOs and that automatic operation of systems and components important to safety occurs under accident conditions.

To assess compliance with these requirements, Section 4.3 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) states that the reviewed information on core power distribution should demonstrate that "A reasonable probability exists that in normal operation the design limits will not be exceeded, based on consideration of information received from the power distribution monitoring instrumentation; the processing of that information, including calculations involved in the processing; the requirements for periodic check measurements; the accuracy of design calculations used in developing correlations when primary variables are not directly measured; the uncertainty analyses for the information and processing system; and the instrumentation alarms for the limits of normal operation (e.g., offset limits, control bank limits) and for abnormal situations (e.g., tilt alarms for control rod misalignment)."

The DIT/ROCS nuclear design code was first approved by the NRC staff in 1983 and again in 1988 as modified for use in analyzing cores with gadolinium burnable poison. The code documentation indicates that the DIT/ROCS nuclear data libraries for almost all nuclides, including gadolinium, were derived from Evaluated Nuclear Data File Volume B, Version IV (ENDF/B-IV). The staff notes however that ENDF/B-IV includes only elemental data for gadolinium and that data for the individual isotopes of gadolinium first appeared in a later release of ENDF/B-V. It is nevertheless clear that DIT/ROCS employs isotopic cross section data for gadolinium. Accordingly, it is not clear how the gadolinium cross section data used by DIT/ROCS can in fact be based on ENDF/B-IV.

Please clarify the source of the gadolinium isotopic data used by DIT/ROCS. The applicant should either insert the requested information into appropriate sections of the DCD or provide the information in a separate report that is cited in the DCD and included in the list of documents to be incorporated by reference.

04.03-9

10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the reactor core design to include appropriate margin to ensure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation or anticipated operational occurrences (AOOs). GDC 13 requires provision of instrumentation and controls (I&C) to monitor variables and systems that can affect the fission process over anticipated ranges for normal operation, anticipated operational occurrences and accident conditions, and to maintain the variables and systems within prescribed operating ranges. GDC 20 requires automatic initiation of the reactivity control systems to assure that SAFDLs are not exceeded as a result of AOOs and that automatic operation of systems and components important to safety occurs under accident conditions.

To assess compliance with these requirements, Section 4.3 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) states that the reviewed information on core power distribution should demonstrate that "A reasonable probability exists that in normal operation the design limits will not be exceeded, based on consideration of information received from the power distribution monitoring instrumentation; the processing of that information, including calculations involved in the processing; the requirements for periodic check measurements; the accuracy of design calculations used in developing correlations when primary variables are not directly measured; the uncertainty analyses for the information and processing system; and the instrumentation alarms for the limits of normal operation (e.g., offset limits, control bank limits) and for abnormal situations (e.g., tilt alarms for control rod misalignment)."

REQUEST FOR ADDITIONAL INFORMATION 419-8517

For ex-core monitoring of the core axial power distribution by the Core Protection Calculator System (CPCS), CENPD-170 discusses conversion of the ex-core detector responses to peripheral core power at three core rings and then to a 20-node axial shape using up to eight algorithm constants. These are apparently pre-calculated to represent flat-, saddle-, top-, or bottom-peaked axial shapes at various times over the fuel cycle. It appears that the CPCS uses some degree of pattern recognition on the 3-ring axial power distribution to determine which of the four types of power shapes are present and then uses a cubic spline fit to data.

Please explain how the algorithm constants are developed, whether they are cycle-dependent or bunup-dependent within one cycle, how the 20-node shapes are generated by the DIT/ROCS code and selected to represent a full range of allowed CEA positions and transient axial xenon effects, and how the shapes will be verified against in-core plant data. The explanations should include the addition of clarifying statements to discussion of axial power shapes in DCD Section 4.3 and may include pointers to any supporting details in various sections of the DCD and in referenced technical reports. The applicant should provide the requested information in the DCD itself or in a separate report that is cited in the DCD and included in the list of documents to be incorporated by reference.


U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment