KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Tuesday, June 23, 2015 9:11 AM
To: apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Yunho Kim; Christopher Tyree
Cc: Carlson, Donald; Li, Zhian; McKirgan, John; Olson, Bruce; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 47-7959 (04.03 - Nuclear Design)
Attachments: APR1400 DC RAI 47 SRSB 7959.pdf; image001.jpg

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
"Li, Zhian" <Zhian.Li@nrc.gov>
Tracking Status: None
"McKirgan, John" <John.McKirgan@nrc.gov>
Tracking Status: None
"Olson, Bruce" <Bruce.Olson@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
"Yunho Kim" <yshh8226@gmail.com>
Tracking Status: None
"Christopher Tyree" <Christopher.tyree@aecom.com>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

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REQUEST FOR ADDITIONAL INFORMATION 47-7959

Issue Date: 06/23/2015
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: 4.3.3

QUESTIONS

04.03-1

RAI 4.3-3, Area of Applicability of the DIT/ROCS code benchmarking to APR1400 nuclear design

REQUIREMENTS

10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the reactor core to include appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation or anticipated operational occurrences (AOOs). GDC 11, "Reactor Inherent Protection," requires that, in the power operating range, the prompt inherent nuclear feedback characteristics tend to compensate for a rapid increase in reactivity. GDC 20, "Protection System Functions," 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. In addition, GDC 28, "Reactivity Limits," requires that the effects of postulated reactivity accidents neither result in damage to the reactor coolant pressure boundary greater than limited local yielding nor cause sufficient damage to impair significantly the capability to cool the core.

To assure safety, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 4.3, item 8 explicitly requires the staff to verify if correct code and cross section library are used in the nuclear design calculations and the analytical methods are compared with measured data.

ISSUE

The applicant states in Section 4.3 of the DCD that it used the DIT/ROCS computer code suite in its nuclear design calculations. The NRC approved this code package in 1983 for use for PWR core design. However, there is no information in the DCD on whether this code package was benchmarked against experimental data for the PLUS7 fuel with gadolinium poison, particularly the complex fuel/poison loadings as shown in Figure 4.3-2 and 4.3-3 of the DCD. In addition, in Section 4.3.4 of the DCD, the applicant states: "The APR1400 plant nuclear design is very similar to the System 80+ design, having the same core size and fuel lattice type (16 × 16 C-E fuel type), which was licensed [certified] by the NRC in 1997. There is no significant nuclear design change compared to the System 80+ design." The staff, however, notes that the System 80+ design approved by the NRC uses erbium as burnable poison. Therefore, it was not clear if the codes are adequately benchmarked for the new APR1400 reactor design, including fuel enrichment, poison loads, and fuel/poison loading patterns in the various fuel assembly designs as shown in Figures 4.3-2 and 4.3-3 of the APR1400 DCD, Rev. 0. The applicant is requested to provide detailed information on code benchmarking data and justification for the applicability of the codes to the APR1400 nuclear design. The information should include, but are not limited to:

1. Experimental data used to benchmark the code and justifications to demonstrate that the selected experiments are applicable to the APR1400 with the PLUS7 fuel design. The information should include fuel enrichments, rod pitches, assembly pitches, fuel/moderator ratio, gadolinium poison loads that cover the range of the fuel assembly designs;
2. Provide the bias and bias uncertainty of the codes as the results of the code benchmarking analyses;
3. Provide trending analyses and results of the benchmarking results against, but are not limited to, fuel enrichment, burnable poison loading, and fuel burnup (up to 60 GWd/MTU); and
4. Explain how the bias and uncertainty obtained through code benchmarking are applied in the APR1400 nuclear design.

INFORMATION NEEDED

Using measurement data from operating reactors to benchmark code is a reasonable approach. However, when using this type of data, the applicant needs to demonstrate:

i. The fuel assembly designs are sufficiently similar to that of the APR1400 fuel design with respect to:
   a. Fuel assembly geometric dimensions, such as fuel load, rod pitch, etc,
   b. Fuel enrichment ranges,
   c. Assembly fuel/poison loading patterns;

ii. The reactor cycle operating parameters are sufficiently similar with respect to:
   a. Power distributions at various core burnup;
   b. Average and maximum operating temperatures of the fuel and moderator;

c. Core Doppler reactivity;

d. Reactivity coefficients at various core burnup;

e. Critical soluble boron concentrations; and

f. Core cycle length.

The applicant is requested to assess the accuracy of the current nuclear design and key core parameters such as power distribution, reactivity coefficients, and they impacts on core safety provide adjustments to the core design and safety analyses if necessary. The applicant should provide detailed information on the code benchmarking analyses for the APR1400 nuclear design in its response to this RAI. The applicant is expected to provide a revised DCD to provide a high level summary on what has been done to address this issue.

The staff needs this information to determine if the nuclear design of the APR1400 meets the regulatory requirements.


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