ArevaEPRDCPEm Resource

From: Snyder, Amy
Sent: Thursday, May 23, 2013 2:52 PM
To: usepr@areva.com
Cc: Patel, Amrit; Donoghue, Joseph; Gleaves, Bill; Akstulewicz, Frank; Segala, John; Hawkins, Kimberly; Ader, Charles
Subject: DRAFT RAI - 8th Round RAI on ANP-10285P, "US EPR FUEL ASSEMBLY MECHANICAL DESIGN TOPICAL REPORT"
Attachments: DRAFT Eighth Roundd RAI- ANP-10285P.docx

Attached please find **draft** RAIs for the **Topical Report**, “U.S. EPR Fuel Assembly Mechanical Design Topical Report” (ANP-10285P). If you have any questions or need clarification regarding this draft RAI, please let me know as soon as possible, I will have our technical Staff available to discuss them with you.

Please also review the draft RAI to ensure that we have not inadvertently included proprietary information. If there are any proprietary information, please let me know within the next ten days. If I do not hear from you within the next ten days, I will assume there are none and will make the draft RAI publicly available.

I request that you let me know when you will be able to provide an advanced response. I will then issue the RAI as final via a letter.

Thank You,
Amy

Amy Snyder, U.S. EPR Design Certification Lead Project Manager
Licensing Branch 1 (LB1)
Division of New Reactor Licensing
Office of New Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
301-415-6822
amy.snyder@nrc.gov

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From: Snyder, Amy

Created By: Amy.Snyder@nrc.gov

Recipients:
"Patel, Amrit" <Amrit.Patel@nrc.gov>
Tracking Status: None
"Donoghue, Joseph" <Joseph.Donoghue@nrc.gov>
Tracking Status: None
"Gleaves, Bill" <Bill.Gleaves@nrc.gov>
Tracking Status: None
"Akstulewicz, Frank" <Frank.Akstulewicz@nrc.gov>
Tracking Status: None
"Segala, John" <John.Segala@nrc.gov>
Tracking Status: None
"Hawkins, Kimberly" <Kimberly.Hawkins@nrc.gov>
Tracking Status: None
"Ader, Charles" <Charles.Ader@nrc.gov>
Tracking Status: None
"usepr@areva.com" <usepr@areva.com>
Tracking Status: None

Post Office:

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RAI 73: Addressing Damping Assumptions for U.S. EPR Fuel Seismic Response Analysis with Detailed Regulatory Basis

Background

Recent operating experience at nuclear power plants has shown that full RCS flow is not likely to be maintained following a seismic event due to a loss of offsite power (LOOP). Maintaining full RCS flow requires several reactor coolant pumps (RCPs) to be operating at full speed, and these RCPs are not connected to safety-related, seismically qualified, electrical buses. During a LOOP, all RCPs would coastdown in a relatively short period of time. Loss of other non-seismically qualified equipment during a seismic event, such as the turbine, could also cause RCPs to coastdown, resulting in decreased core flow. The staff's concern is that before the reactor is shutdown (i.e. operating at greater than hot zero power), maximum ground acceleration could occur in conjunction with decreased core flow, reducing the flow rate dependent critical damping ratio, which could cause larger spacer grid impact loads than assumed in the existing analysis.

The guidance that is used to evaluate external forces on fuel assemblies is NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," (SRP) Section 4.2, "Fuel System Design," Revision 3, March 2007, Appendix A, "Evaluation Of Fuel Assembly Structural Response To Externally Applied Forces." SRP 4.2, Appendix A, Section II.2, states that "analytical methods used in performing structural response analyses should be reviewed." This includes the bases for the various input assumptions, such as the critical damping ratio, that have a direct impact on the spacer grid impact loads. SRP 4.2, Appendix A, Section IV.2, which gives the safe-shutdown earthquake (SSE) acceptance criteria, further states that "control rod insertability must be assured," and it must be assured for "SSE loads alone if [SRP 4.2, Appendix A] Subsection IV.1 does not require an analysis for combined loads." This means that control rod insertability still needs to be demonstrated for SSE-only loads even if the combined loads analysis does not exceed P(crit) – the spacer grid crushing load.

Analyses typically compare maximum spacer grid loads to P(crit) to show that control rod insertability will be maintained since there is a presumption that significant permanent grid deformation does not occur for loads less than P(crit), and that only buckling could prevent control rod insertion. However, for the U.S. EPR design, significant permanent grid deformation is predicted under maximum spacer grid loads without spacer grid buckling, which could challenge control rod insertability. Therefore, if the maximum spacer grid impact loads are being under-predicted due to the use of a non-conservative critical damping ratio, then spacer grid impact loads would need to be updated accordingly, and control rod insertability may need to be re-evaluated.

Regulatory Basis and Acceptance Criteria

General Design Criterion (GDC) 2 states:

> Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

The applicable component is the fuel, with the safety functions being maintenance of fuel integrity and control rod insertability. The applicable natural phenomenon for the fuel seismic response analysis is the most severe earthquake, which is the SSE. Fuel integrity is typically demonstrated by showing that coolability is always maintained – specifically by demonstrating that the departure from nucleate boiling ratio (DNBR) is always maintained above an appropriate lower limit under all normal conditions of operation in accordance with SRP Section 4.4, and for all anticipated operational occurrences in accordance with SRP Chapter 15.

The current AREVA fuel seismic response analysis does not justify the appropriateness of the assumed critical damping ratio corresponding to full reactor coolant system flow based on the above considerations in Topical Report ANP-10285P, "U.S. EPR Fuel Assembly Mechanical Design Topical Report." Therefore, the staff can not conclude that the U.S. EPR design meets the requirements of GDC 2.

Request for Additional Information

SRP 4.2, Appendix A discusses fuel coolability criteria related to a loss-of-coolant accident (LOCA), which is based on the assumption of combined loads, and addresses the impact on the ECCS analysis. The U.S. EPR design has shown that it may be necessary to perform additional coolability and control rod insertability evaluations above decay heat power levels, including full power operation, in order to address permanent spacer grid deformation caused by spacer grid impact forces that do not exceed P(crit) under SSE-only loads.

Since the assumed critical damping ratio has a direct impact on the predicted spacer grid impact loads, it will also have a direct impact on the amount of permanent grid deformation that is predicted. Therefore, the predicted permanent grid deformation resulting from a reduced critical damping ratio during a LOOP following a seismic event should be evaluated for the U.S. EPR design with respect to control rod insertability and fuel rod coolability.

Justify the critical damping ratio used in the fuel assembly structural response analysis for the U.S. EPR. Address the following points in your response:

a. Quantify any change to the critical damping ratio assumed in the analysis based on RCP coastdown considerations.

b. Include considerations for both the unirradiated and irradiated cases. Additionally, provide the Rayleigh damping coefficients being used for the irradiated fuel assembly cases in the fuel assembly structural response analysis for the U.S. EPR.

c. Quantify the damping ratio margin (i.e. the difference between the critical damping ratio derived from test data and that credited in the analysis) change for both the unirradiated and irradiated fuel assembly cases.

d. Address both SSE-only and combined SSE and LOCA loads analyses.