ArevaEPRDCPEm Resource

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Sent: Wednesday, June 09, 2010 12:04 PM
To: Tesfaye, Getachew
Cc: ROMINE Judy (AREVA NP INC); SLAY Lysa M (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: DRAFT RAI 371 Supplement 2 response for question 03.07.01-29
Attachments: RAI 371 Supplement 2 Response US EPR DC - DRAFT.pdf

Getachew,

Attached is a draft response for RAI 371 Supplement 2 question 03.07.01-29. The date for the final to be submitted is July 8, 2010 as indicated in RAI 371 Supplement 1 provided on June 7, 2010. Let me know if the staff has any questions.

Thanks

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Response to

Request for Additional Information No. 371, Supplement 2

3/25/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.07.01 - Seismic Design Parameters
SRP Section: 03.07.02 - Seismic System Analysis

Application Section: 03.07

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

Question 03.07.01-29:

Follow Up to RAI 215, Question 03.07.01-22:

The applicant has provided a comparison between modal damping using RG 1.61 and Rayleigh damping using assumed values for alpha and beta. The alpha and beta values used to develop the Rayleigh damping curve in Figure 3.7.1-22-1 are 0.9 and 0.00045, respectively. According to Appendix 3C.4.2.1.1 of the U.S. EPR FSAR these values are not the values used for seismic analysis as was requested by staff but are the values used for the RCS four-loop high energy line break analysis. In Appendix 3C.4.2.2 a different set of values of alpha and beta are given for the RCS seismic analysis. These values are 1.7 for alpha and .00055 for beta. As such there is inconsistency between the applicant's response to RAI 03.07.01-22 and the FSAR Appendix 3C.4.2.1.1. Use of higher values of alpha and beta can result in damping values that may not be conservative.

1. The applicant is requested to explain why two different sets of alpha and beta values were used and provide justification for the use of the higher damping values in the RCS seismic analysis and include this information in Appendix 3C of the FSAR.
2. Appendix 3C.4.2.2.1 states that a cutoff frequency of 35 cycles was used in the linear modal analysis. Now that Bell Bend response spectra curves will be included in the certified design and as these curves contain significant responses above 35 cps, the applicant is requested to provide a basis for using a cutoff frequency of 35 cps in the RCS seismic analysis. Please include the technical basis for your response and update the FSAR accordingly.

Response to Question 03.07.01-29:

1. As stated in Appendix 3C.4.2.1.1 of the U.S. EPR FSAR Tier 2, the high energy line break structural analysis of the U.S. EPR reactor coolant system (RCS) used values of 0.9 and 0.00045 for alpha and beta, respectively. These values provide conservatively low damping as compared to the modal damping values calculated using RG 1.61 guidance. Due to severity of seismic ground accelerations, a set of greater, yet still conservative, alpha and beta damping values was used to reduce RCS seismic analysis conservatism. U.S. EPR FSAR Tier 2, Appendix 3C.4.2.2.1 states that the alpha and beta values used in U.S. EPR RCS seismic structural analysis were 1.7 and 0.00055, respectively.

   Figure 03.07.01-29-1 graphically compares results of alpha-beta damping values used for high energy line break and seismic analysis with results produced using RG 1.61 damping guidance.

   Alpha-beta damping curves increase significantly as frequencies increase beyond 30 Hz, thus AREVA has evaluated the effect of modes in this frequency range on U.S. EPR reactor coolant system dynamic response. Approximately 99.5 percent of the effective mass of the RCS is accounted for by considering frequencies below 28 Hz. This indicates that the effect on the response of any modes above 28 Hz is negligible. Additionally, 98 percent of lateral effective mass (Global X and Z directions) is accounted for below 18 Hz. Vertical effective mass (Global Y direction) is higher frequency because of rigidity of vertical supports and component shells in the axial direction.

Dominant natural frequencies of the RCS components in the lateral directions are:

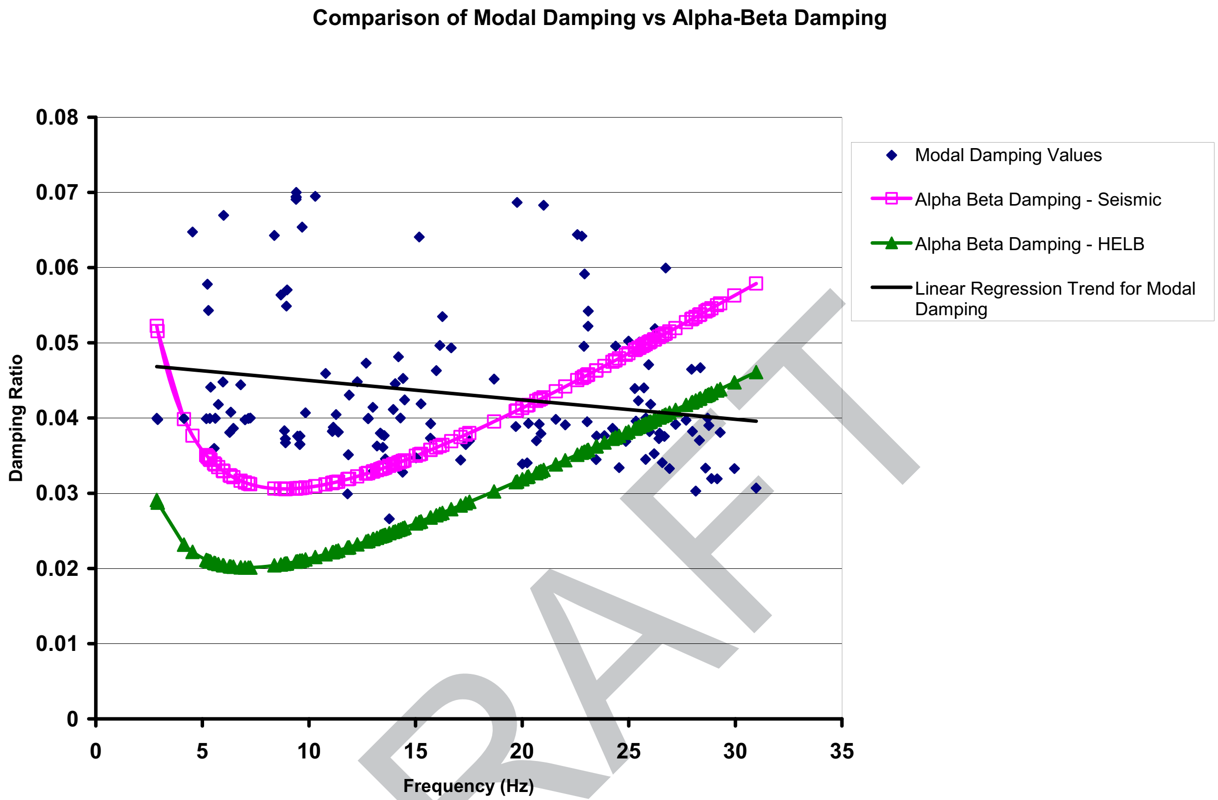
- Reactor Vessel: ~10 Hz
- Steam Generators: ~6.5 Hz
- Reactor Coolant Pumps: ~14 Hz
- Pressurizer: ~14.5 Hz

The linear regression trend in Figure 03.07.01-29-1 represents a curve fit for the applied modal damping values. This figure shows that the seismic alpha-beta damping curve falls below the curve fit up to a frequency of 20 Hz. More than 98 percent of the lateral effective mass of the RCS components is accounted for below a frequency of 20Hz. The alpha-beta curve for High Energy Line Break analysis intersects the linear regression curve fit at about 28 Hz indicating that 99.5 percent of the RCS effective mass in all directions is damped below the modal damping allowed by RG 1.61.

Alpha-beta values used in the seismic analysis, as well as those used in the high energy line break analysis, are conservative.

2. As stated in U.S. EPR FSAR Tier 2, Appendix 3C.4.2.2.1, a cutoff frequency of 35 Hz was used for seismic analysis for the design certification soil cases included in the effort. Recognizing that the ground response spectra for Bell Bend and other future sites may have significant accelerations at frequencies greater than 35 Hz, AREVA has evaluated the effect of these high frequency accelerations on U.S. EPR RCS seismic response. Approximately 99.5 percent of the effective mass of the RCS is accounted for by considering the frequencies below 28 Hz. This indicates that the effect on the response of any frequency content above 28 Hz is negligible.

Figure 03.07.01-29-1: Comparison of Alpha-Beta / RG 1.61 Damping – HELB/Seismic



FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question. The analyses methodology described in Appendix 3C does not need to be modified as a result of this response and hence there is no FSAR impact.