REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**255-8285**
SRP Section:	**03.08.05 – Foundations**
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Question No. 03.08.05-12

10 CFR 50.55a and Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, provide the regulatory requirements for the design of the containment internal structures. Standard Review Plan (SRP) 3.8.5, Section II specifies analysis and design procedures applicable to the foundation of seismic Category I structures.

Technical Report (TR) APR1400-E-S-NR-14006-P, Rev 1, “Stability Check for NI Common Basemat,” Section 3.2.5, “Applied Loads,” states, “The reactions from seismic analyses of the RCB shell and dome, RCB internal structure, and AB are applied as the seismic loads in the basemat model. The response spectrum analysis is used for the RCB shell and dome and RCB internal structure and the equivalent static analysis is used for the AB for seismic analyses of superstructures.” The applicant did not provide a justification for using the two different methods. Per 10 CFR 50.55a; Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50; and SRP 3.8.5, the applicant is requested to address the following:

a. Provide a justification for using the two different methods, the spectrum analysis and the equivalent static methods, for the seismic design of RCB shell and dome; and the RCB internal structures

b. Explain whether this was done only for stability check or for all aspects of design: developing member forces for design, stability evaluation (sliding and overturning), uplift evaluation analysis, basemat soil bearing pressure calculation, settlement analysis, and lateral soil pressure on foundation walls. Wherever, this approach was used should be justified

c. Section 3.2.5 also states that “In the response spectrum analysis, the maximum values of individual modes occur simultaneously; hence, the combined effect is obtained by using algebraic (considering signs) summation of the individual modal responses.” This is not consistent with combining modes as described in NRC RG. 1.92. Therefore, the basis for this approach needs to be justified.

Response – (Rev. 1)

a. For consideration of seismic loads in the NI common basemat analysis, the approach is revised to equivalent static acceleration methods from the previous methodology that used reactions from seismic analyses of the RCB shell and dome, RCB internal structures, and AB. In addition, linear analysis for uplift and non-linear analysis for no-uplift are performed. For detailed descriptions of the consideration of seismic loads in the NI common basemat analysis refer to response RAI 255-8285, Question 03.08.05-8, Rev.1.

Additionally, Refer to RAI 255-8285 Question 03.08.05-11 for a comparison between SSI analysis and static analysis used in equivalent static method. The response in Question 03.08.05-11 shows the equivalent static method is a sufficiently conservative method.

b. For developing member forces for design, enveloped results from both the linear case and nonl-inear case using the equivalent static acceleration method are used. For the stability evaluations (sliding and overturning) against seismic loading, the seismic analysis results of SASSI were used to obtain the axial force, shear force, and moment. The settlement evaluations under seismic loading are not considered in accordance with RAI 255-8285 Question 03.08.05-17, Rev.2.

The maximum dynamic soil bearing pressure was determined based on the contact pressure obtained from design load combinations 08 ~ 105. For the justifications of phasing of the responses from each of the three superstructures, dynamic bearing pressures from three analyses (non-linear analysis, linear analysis, SASSI analysis) are compared on soil profile S08.

SASSI bearing pressure is calculated by checking the stress of the relatively stiff spring elements which connect between the NI basemat and the underlying soil in the ACS SASSI model. In the cases of non-linear and linear analysis, bearing pressure is calculated at the contact surface between the bottom of NI common basemat and the top of foundation media model.

Due to a singularity, dynamic bearing pressures near the edge of the foundation tend to result in higher values than other areas of the foundation. However, as reported in the technical literature (see F.E. Richart and R.V. Whitman, "Footing Vibrations - Comparison of Test Results with Theory," University of Michigan, IP-755, November 1966), theoretical equations result in very high bearing pressures near the edges of the basemat due to a singularity. In accordance with the postulated pressure distribution for the combined static and dynamic loads, the bearing failure point moves away from the edge of the basemat. Therefore, it demonstrates a need for a more realistic treatment of the theoretically derived peak pressures near the edges. Maximum dynamic bearing pressures are calculated to consider the redistribution of peak bearing pressures over a more reasonable range of distances from the edge or corner of the basemat.

For a reasonable range of distances from the edge or corner of the basemat, distance inward from the edge of a basemat equal to the wall thickness plus 1/2 of the basemat thickness is used. Twenty-five percent of the length in significant stiffness wall connecting to the basemat is determined as length of redistribution along the edge of the basemat based on contact pressure contour.

Based on explanation above,

Inward distance: wall thickness (4 feet) + 1/2 basemat thickness (10 feet) = 9 feet

Length of redistribution along the edge of basemat: Refer to Figure 1.

Figure1 Redistribution areas for maximum toe bearing pressure

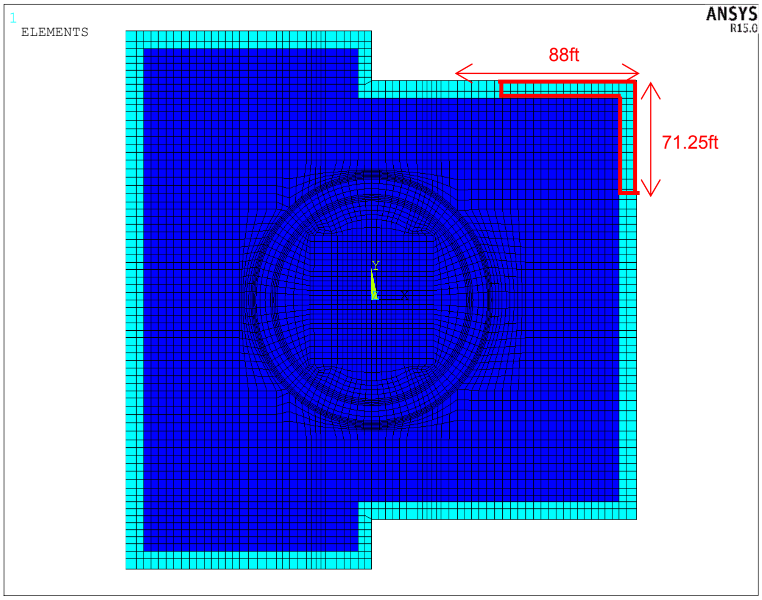

Table1 Summary of maximum bearing pressure from three cases

Soil Profile 08		
Condition	Maximum Bearing pressure (ksf)	Remark
Static	14.64	Static Case (D+L) Based on soil spring considering boussinesq effect
Nonlinear	54.01	Load Combination (Static loads + Es01 thru Es98)
Linear	29.68	Seismic Only (SRSS method)
	44.32	D + L + Seismic loads (SRSS method)
	31.98	Seismic Only (Es01 thru Es24) (100-40-40)
	46.62	D + L + Seismic loads (Es01 thru Es24) (100-40-40)
SASSI	15.15	Seismic Only (Crack,100-100-100)
	29.79	D + L + Seismic loads (Crack,100-100-100)

Therefore, the maximum static and dynamic bearing pressure from all load combinations is smaller than the allowable bearing pressure capacity (20ksf static and 60ksf dynamic) specified in DCD Tier 2, Table 2.0-1.

Lastly, in the case of later soil pressure loads, including static earth pressure and dynamic earth pressure on embedded walls, it was applied as reaction forces and moments from the auxiliary building structural analysis in the new NI common basemat. For a discussion regarding to the dynamic earth pressure, refer to RAI 227-8274 Question 03.08.04-7.

c.

For the basemat analysis, as described in response (a), the approach is changed to equivalent static acceleration methods for RCB shell and dome, RCB internal structures, and AB.

Impact on DCD

Markups for the above information will be provided in RAI 255-8285 Question 03.08.05-16, Rev.1.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Markup for the above information will be provided in RAI 255-8285 Question 03.08.05-8, Rev.2.