
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.: 183-8197
SRP Section: 03.07.02 – Seismic System Analysis
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Question No. 03.07.02-4

10 CFR 50 Appendix S requires that the safety functions of structures, systems, and components (SSCs) must be assured during and after the vibratory ground motion associated with the safe shutdown earthquake (SSE) ground motion through design, testing, or qualification methods. In accordance with 10 CFR 50 Appendix S, the staff reviews the adequacy of the seismic analysis methods used to demonstrate that SSCs can withstand seismic loads and remain functional. Per the guidance in SRP Section 3.7.2.II.4, the staff reviews the calculation of the ground contact ratio to ensure that linear SSI analysis remains valid. The ground contact ratio is defined as the minimum ratio of the area of the foundation in contact with the soil to the total area of the foundation, computed in each time step throughout the SSI analysis. The acceptance criterion is that linear SSI analysis methods are appropriate provided the ground contact ratio is equal to or greater than 80 percent. The ground contact ratio can be calculated from the linear SSI analysis using the minimum basemat area that remains in compression with the soil. If the ratio is less than 80 percent, then the effect of the nonlinearity due to the foundation uplift should be evaluated.

In Sections 4.1.1 and A.4.1.1 in APR1400-E-S-NR-14006-P, Rev. 1 the applicant described its ground contact ratio calculation for the nuclear island (NI) common basemat and EDGB/DFOT basemat respectively. Further, Tables 4-1 and A-2 of the report provide the calculated ground contact ratios for the NI common basemat and EDGB/DFOT basemat, respectively. Per the guidance in SRP Section 3.7.2.II.4, in order to assist the staff in its review of the adequacy of the calculated ground contact ratios, the applicant is requested to clarify whether the specified ground contact ratios represent the minimum ratio of the area of the foundation in contact with the soil to the total area of the foundation, computed in each time step throughout the SSI analysis time history. If not, provide the technical basis for the adequacy of the alternate method used to calculate the ground contact ratio as applicable.

Response

The specified ground contact ratios in Tables 4-1 and A-2 of technical report APR1400-E-S-NR-14006-P, Rev. 1, "Stability Check for NI Common Basemat" for the NI common basemat and the emergency diesel generator building/ diesel fuel oil tank (EDGB/DFOT) room basemat, respectively, are not calculated directly from the SSI analysis results of each time step.

The ground contact ratios are calculated from the structural analysis models and their results instead of the seismic analysis models and the SSI analysis results in order to include all the applicable load cases that are considered in the uplift check.

When combining the load cases, the reactions from the response spectrum analyses of the reactor containment building (RCB) shell and dome and the RCB internal structure using in-structure response spectra, and the equivalent static analyses of the auxiliary building (AB) and the EDGB/DFOT are applied as the seismic loads (maximum SSI analysis results) in their basemat models.

Because the maximum values of individual modes occur simultaneously in the response spectrum analysis, the individual modal responses are summed algebraically. Three directional reaction forces from the seismic analysis of superstructures in each seismic excitation are combined using the 100-40-40 rule. All possible seismic load sign (\pm) combinations of the three directional reactions are considered. These calculations and combination sequences give the most critical condition in the uplift check.

In addition to the ground contact ratio calculation mentioned above, the calculation is performed according to the guidance in SRP Section 3.7.2.II.4. The same site profiles (S01, S04, and S08) are considered to calculate the area of the basemat in contact with the soil. The nodal displacements of the NI basemat relative to the free-field in the vertical direction which are computed in each time step throughout the SSI analysis of NI structures are combined with the vertical displacements from the static load analyses which include the dead load, the live load, and the buoyancy load due to groundwater.

Load combinations consider all possible permutations of the z-directional displacements resulting from the three directional seismic inputs (total of eight combinations). Due to the different mesh configuration between the seismic analysis model and the structural analysis model, the nodal displacement of the seismic model is combined with the displacement of the nearest node of the structural model. The minimum contact ratios of the area of the basemat in contact with the soil to the total area of the basemat throughout the analysis time history are the following:

Site Profile	Contact Ratio (%)
S01U	100.0
S01C	100.0
S04U	100.0
S04C	100.0
S08U	100.0
S08C	100.0

Because the vertical displacements from the static loads, including dead load, are relatively larger than those from the seismic load, no uplift occurs from the contact ratio calculation results. If it is needed, the procedures and results of the less conservative contact ratio calculation will be included in technical report APR1400-E-S-NR-14006.

Impact on DCD

There is no impact on the DCD.

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

There is no impact on any Technical, Topical, or Environmental Report.