

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
Application Section: 03.08.05
Date of RAI Issue: 10/19/2015

Question No. 03.08.05-17

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 4.1.2, "Differential Displacement," describes the approach used to develop the differential displacements within the NI and between the NI and the adjacent TGB. For seismic loading, the relative displacements were determined at only two specific time steps where the maximum average and minimum average of displacements over the entire time history were determined. Also, APR1400-E-S-NR-14006-P, Rev.1, Section 4.1.2 indicates that the differential settlement for seismic loading is calculated based on the maximum and minimum displacements of the basemat (not the differential settlements per 50 ft). This information is not clear. 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 explain how the differential displacements were determined. Also explain why this does not consider the differential displacements at all time steps, which might lead to a higher differential displacement.

Additionally, in TR APR1400-E-S-NR-14006-P, Rev 1, "Stability Check for NI Common Basemat," Section 4.1.2, "Differential Settlement," the applicant provided Table 4-3, "Differential Settlements Between NI Basemat and TGB Basemat (Static Loading Case)," which shows the differential settlement between between the NI basemat and the TGB basemat. The staff reviewed the table and noted that the differential settlement for S4 (for moderate site properties), which is 0.250", is much larger than the differential settlements for S1, which is 0.091", and S8, which is 0.018", (for weak and strong site properties, respectively). The applicant is requested to address this discrepancy.

Response - Rev. 1

In accordance with SRP 3.8.5 Section II 4, static and dynamic differential settlement was evaluated. According to Table 2.0-1 in DCD, 0.5 inch per 50ft in any direction for the seismic category I structures are the acceptance criteria for maximum allowable differential settlement. The acceptance criteria are considered under static plus seismic load. So, these are incorporated in DCD Tier 1 Table 2.1-1 and Tier 2 Table 2.0-1 as shown attachment 1.

For static loading, the dead and live loads (D+L) are applied in the NI common basemat model considered boussinesq effect. To check differential settlement, the nodes are chosen within a distance of approximately 50ft. DCD Figure 3.8A-18 shows the node locations of the NI common basemat. The maximum differential settlement per 50ft for S1, S4, and S8 are 0.21, 0.09, 0.04 inch, respectively.

For the detailed evaluation of dynamic differential settlement due to seismic loading, all of the displacement data from SASSI analysis corresponding to all time steps and soil profiles are considered by following procedure on check points as shown in Figure 4-5 of the technical report (TeR), APR1400-E-S-NR-14006-P/NP (Rev.1),

- a) Organize the vertical displacement corresponding to each seismic excitation (X, Y, Z) by each time step and node. Then, Combine the three vertical displacements by SRSS method per each node and time step.
- b) At the same time step, choose the maximum combined response (A) and minimum combined response (B) within check points (basemat SASSI nodes). Then, calculate the differential settlement (A-B). Repeat step b) for all time step
- c) Envelope the calculated differential settlement within all time steps. (Column 2nd of Table 1)
- d) Differential settlement summarized in Table 1 was calculated by following equation to evaluate differential settlement per 50ft. (Column 4rd in Table 1)

$$\frac{(A - B) \times 50}{\text{Distance}}$$

Where, A is maximum displacement

B is minimum displacement

- e) Repeat step a) ~ c) corresponding to soil profiles (S1 ~ S9).

According to procedure above, the results such as maximum and minimum displacement are summarized in Table 1 of response.

Table 1 summarizes the maximum displacement, the minimum displacement, and the differential settlement at the time when the differential settlements are maxima for each soil profile. So, the combined differential settlement for D+L+Es is summarized in Table 2.

Table 1. SRSS-Combined Vertical Displacement (UZ) from SASSI in NI Basemat

Site Profile	Difference (ft)	Distance (ft)	Differential Settlement per 50ft (ft)	Time (sec)
S1	0.018	288.630	0.003	8.62
S2	0.014	187.159	0.004	12.56
S3	0.011	187.159	0.003	12.52
S4	0.010	165.162	0.003	13.55
S5	0.004	253.804	0.001	15.30
S6	0.006	337.350	0.001	13.25
S7	0.005	402.351	0.001	13.22
S8	0.002	182.023	0.001	15.29
S9	0.003	90.256	0.001	15.29

Table 2. Combined Maximum Differential Settlement for D+L+Es in NI basemat

Loading Case	Differential Settlement (inch)		
	S1	S4	S8
Static (D+L)	0.21	0.09	0.04
Seismic (Es)	0.038	0.035	0.007
Combined (+)	0.248	0.125	0.047
Combined (-)	0.172	0.055	0.033

For static loading, the dead and live loads (D+L) are applied in the EDG and DFOT structure model with soil springs. This model was not considered by boussinesq effect. It does not effect on the basemat analysis due to their small size. To check differential settlement, the nodes are chosen within a distance of approximately 50ft. RAI 255-8285 Question 03.08.05-10 shows the node locations of the EDG and DFOT structure model. The maximum differential settlement per 50ft for S1, S4, and S8 are 0.178, 0.101, 0.042 inch (EDGB), 0.284, 0.110, 0.021 inch (DFOT) respectively.

For differential settlement in Emergency Diesel Generator block (EDG) and Diesel Fuel Oil Storage Tank (DFOT) due to seismic loading, all of the displacement data from SASSI analysis corresponding to all time steps and soil profiles are considered by the same procedure like NI basemat. The check points for EDG and DFOT is SASSI nodes as shown in figure 1 and 2. Table 3 and 4 summarizes the maximum displacement, the minimum displacement, and the differential settlement at the time when the differential settlements are maxima for each soil profile in EDG and DFOT.



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Figure 1. Location of EDG Basemat SASSI nodes for Relative Displacement Calculation



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Figure 2. Location of DFOT Basemat SASSI nodes for Relative Displacement Calculation

Table 3. SRSS-Combined Vertical Displacement (UZ) from SASSI in EDG

Site Profile	Difference (ft)	Distance (ft)	Differential Settlement per 50ft (ft)	Time (sec)
S1	0.005	72.043	0.0037	7.605
S2	0.006	97.645	0.0031	8.5
S3	0.005	55.856	0.0043	7.62
S4	0.003	72.043	0.0024	7.61
S5	0.003	41.463	0.0032	10.49
S6	0.004	113.536	0.0017	7.61
S7	0.005	113.536	0.0024	6.745
S8	0.001	88.827	0.0003	10.51
S9	0.001	113.536	0.0004	10.575

Table 4. SRSS-Combined Vertical Displacement (UZ) from SASSI in DFOT

Site Profile	Difference (ft)	Distance (ft)	Differential Settlement per 50ft (ft)	Time (sec)
S1	0.0024	47.347	0.0025	8.605
S2	0.0031	47.347	0.0032	8.61
S3	0.0008	89.567	0.0004	7.575
S4	0.0008	66.500	0.0006	7.915
S5	0.0007	72.954	0.0005	10.5
S6	0.0003	34.740	0.0005	15.15
S7	0.0004	72.954	0.0003	13.15
S8	0.0003	67.887	0.0002	7.3
S9	0.0004	47.347	0.0004	9.77

Differential settlement between the NI common basemat and the TGB basemat is evaluated within seismic category I structure. So, TGB analysis is not performed due to not including seismic category I structure. In addition, safety system and piping in TGB are not connected between NI and TGB basemat. Technical report, APR1400-E-S-NR-14006-P, Rev. 1, "Stability Check for NI Common Basemat," Table 4-3 and description on differential settlement between NI and TGB basemat in subsection 4.1.2 will be deleted as shown attachment.

Impact on DCD

DCD Tier 1 Table 2.1-1 and Tier 2 Table 2.0-1 will be revised, as indicated in Attachment 1 to this response.

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

Technical report APR1400-E-S-NR-14006-P/NP, Rev.1 Section 4.1.2 and Table 4-3 will be revised, as indicated in Attachment 2 to this response.

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