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. 03.08.05-18

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 5.0, "Construction Sequence Analysis," describes the construction sequence analyses performed for the NI basemat, and indicates that Sites S1 and S8 were used for the calculations. Figure 2-1, "Shear Wave Velocity of Generic Site Categories," indicates that site S□2 is softer than Site S1 in the top 10' of the profile and will be expected to lead to larger construction settlements and structural demands. 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 provide the basis for using the Site S1 rather than S-2. Also, if any site considered for construction of the APR1400 design has soil conditions that lead to settlements greater than those computed for S1 and S8 in the DCD and technical report, explain how that will be addressed.

Additionally, the staff believes that most construction sequence studies are based on assuming either (1) a sand profile where settlements occur instantaneously as load is applied, or, (2) a fine-grained soil where settlements are delayed due to potential time-consolidation effects. These two bounding profiles can lead to different demands on the structural elements. Also, an evaluation of short term and long term settlements are normally evaluated for the basemat and the superstructures, and incorporated into the design. The above considerations could not be identified in the analysis and design of the basemat and superstructures. Therefore, the applicant is requested to address how settlement and construction sequences during the short term condition of the basemat and superstructure, as well as long term condition were considered in the analysis studies and in the design of the basemat and superstructures.

Also, it is not clear how a differential displacement of 0.5 in. per 50 ft. can be used by the COL

applicant to confirm the design adequacy of the basemat and superstructure. Usually, displacement of basemat results in bending distortion between adjacent points, not simply differential displacements. Therefore, the applicant is requested to explain how the COL applicant is supposed to check for settlements, and revise the technical report, applicable sections of the DCD, and COL item(s) accordingly.

Response

1) The applicant is requested to provide the basis for using the Site S1 rather than S2 soil profile.

Soil profile S1 is chosen as the representative soil profile even though soil profile S2 is softer than S1 at some depths. To find the weakest of the site profiles, the subgrade moduli of S1 and S2 are compared, as shown below in Table 1. The subgrade moduli are calculated using the methodology described in technical report APR1400-E-S-NR-14006-P, Rev. 1, "Stability Check for NI Common Basemat," Section 2.2.1 "Elastic Modulus of Soil Sites." The values or S1 are presented in Table 2-4, "Equivalent Subgrade Moduli of Site Profiles" of the TeR. Since the subgrade modulus of S1 is less than S2, S1 has been selected for the construction sequence analyses performed for the NI basemat. If the site specific soil information identified by the COL applicant as a result of performing the actions required by COL 3.8(10) is not enveloped by soil profiles S1 ~ S2 and the soil condition leads to greater settlement, the COL applicant shall perform the analysis required by COL 3.8 (11) (please see KHNP's response to RAI 255-8285, Question 03.08.05-7) and determine the acceptability of the site specific settlements obtained.

Table 1 Comparison of Soil Profile 1 and Soil Profile 2

Site Profile	Max.Displacement (ft)	Subgrade modulus (kcf)
NI Basemat		
S1	0.028046 (Z,Vertical)	Kv=35.66
S2	0.020109 (Z,Vertical)	Kv=49.73

2) The applicant is requested to address how settlement and construction sequences during the short term condition of the basemat and superstructure, as well as long term condition were considered in the analysis studies and in the design of the basemat and superstructures.

Evaluation of short term and long term settlement analysis for the NI common basemat and superstructure analysis is to be performed by the COL applicant; COL 3.8 (11) is to be added to DCD Tier 2, as indicated in the applicant's response to RAI 255-8285, Question 03.08.05-7 to require the COL to perform the analyses. Two categories of settlements are to be evaluated; (1) Short term settlement, at the end of construction, and (2) Long term settlement, at the end of the operational life of the plant. The end of construction is defined as the time when building structures and major equipment are in place. The loading scenarios for the construction sequence analysis will be set by the COL applicant. Moreover,

the effect of both immediate and time dependent deformation, including bending distortion produced up to the end of construction, and end of life, will be calculated based on primary consolidation theory and viscous deformation analysis by the COL applicant. Also, the COL applicant shall check the integrity of the basemat and superstructure design based on the results of the settlements.

3) The staff believes that most construction sequence studies are based on assuming either (1) a sand profile where settlements occur instantaneously as load is applied, or, (2) a fine-grained soil where settlements are delayed due to potential time-consolidation effects.

According to IBC, Section 1613; ASCE 7-05; and NAVFAC DM 7.01, Chapter 5, soils whose shear wave velocities are between 600 and 1200 feet per second are considered to be stiff soils, as shown in Table 2 below. .

Table 2 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100feet		
		Soil shear wave velocity, Vs	Standard penetration resistance (N)	Soil undrained shear strength (S_U)
A	Hard rock	Vs>5,0	N/A	N/A
B	Rock	500<Vs≤5,000	N/A	N/A
C	Very dense soil and soft rock	1,200<Vs ≤ 2,500	N>50	S_U≥2,000
D	Stiff soil profile	600<Vs≤1,200	15<N<50	1000≤S_U≤2,000
E	Soft soil profile	Vs<600	N<15	S_U≤1,000

The smallest shear wave velocity of any soil layer for the nine (S1 through S9) APR1400 generic soil profiles is the first layer in site profile S1; the shear wave velocity of this layer is 1173 ft/sec. The stiff soil is considered to be sand. The fine-grain soil characteristic for time consolidation effects was not considered in the basemat analysis due to site profile S1 not being classified as soft soil. The COL applicant will use site specific soil characteristics in their evaluation of differential settlement, as required by COL 3.8(11), as added by KHNP's response to RAI 255-8285, Question 03.08.05-7.

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.