

## 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. 03.08.05-18**

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 100' 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) 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 in Table 1 below. 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 of S1 are presented in Table 2-4, "Equivalent Subgrade Moduli of Site Profiles" in 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 ~ S9 and the soil condition leads to greater settlement, the COL applicant shall perform the analysis required by COL 3.8 (11) (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

| Soil 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) Settlement and construction sequences during short term condition of the basemat and superstructure and long term conditions considered in the analysis and in the design of the basemat and superstructures.

According to DCD table 3.7A-1, the soil profiles in the APR1400 project consist of sand, soft rock and rock. Considering the characteristics of sand and rock for settlement, the settlement of the APR1400 basemat will be controlled by the instantaneous settlement of sand. Therefore, it is not necessary to consider the time-consolidation effects of sand in the APR1400 DC project. The loads after construction which are applied to the basemat analysis are much larger than the construction stages. Therefore, it is expected that the settlement after construction will be enveloped by all settlement during the construction stages. In other word, the settlement during construction will be smaller than the settlement described in the technical report section 4.1.2.

From the construction sequence analysis for the NI common basemat described in section 5.0 of the technical report (APR1400-E-S-NR-14006-P, Rev. 1), the settlements distribution contour for soil profiles S1 and S8 shows that soft soil profile (S1) governs the stiff soil profile (S8) due to the concentration of settlement around the NI common basemat. DCD Table 2.0-1 provides guidance to the COL applicant on predictions of settlements and differential settlement that are acceptable without further evaluation. The predicted settlements will cover the periods before construction begins through the construction phase and for the subsequent plant operating period or otherwise justified.

---

**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.