RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

08/01/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1045-7141 REVISION 3**
SRP SECTION:	**03.08.05 – Foundations**
APPLICATION SECTION:	**3.8.5**
DATE OF RAI ISSUE:	**07/08/2013**

QUESTION NO. 03.08.05-58:

On April 3, 2013, the applicant submitted a markup of DCD Tier 2 Section 3.8 to provide updated information related to a seismic design change.

In Subsection 3.8.5.4.4, "Analyses of Settlement," the third paragraph (top of Page 3.8-101) states, "The weight of the AC/B [access building] is the analysis (3000 ft by 2400 ft in a horizontal plane, and 960 ft in depth) is chosen to be sufficient to avoid the effects of boundary conditions on the resulting settlements."

The above statement is not clear to the staff. The staff requests the applicant to explain and/or revise that statement.

ANSWER:

The noted paragraph has been replaced by:

"The AC/B was modeled as an equivalent mat having the weight of the structure. The volume of subgrade included in the analysis (3000 ft by 2400 ft in a horizontal plane, and 960 ft in depth) was sufficiently extended to avoid the effects of boundary conditions on the resulting settlements."

Impact on DCD

DCD Section 3.8.5.4.4 will be revised as indicated on Attachment 1.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical Report

There is no impact on the Technical/Topical Report.

This completes MHI's response to the NRC's question.

defined as the maximum difference between settlements of any two neighboring points on the basemats, each of them on one of the adjacent structures. Differential settlements between adjacent structures are important for key connections between buildings and commodities and their supports and tunnels. MIC-03-03-00057

The modeling and analysis procedures for settlement account for the flexibility of structures and subgrade. Settlements are calculated by 3D FE analysis using ANSYS for short term (resulting from dead loads introduced during plant construction) and long term static loads (acting over the operating life of plant). ANSYS FE models of both the R/B complex and the T/B are placed on a layered subgrade modeled by solid elements. ~~The weight of the AC/B is also included in the model for the settlement analysis. The volume of subgrade included in the analysis (3000 ft by 2400 ft in a horizontal plane, and 960 ft in depth) is chosen to be sufficient to avoid the effects of boundary conditions on the resulting settlements.~~ The Access Building (AC/B) was modeled as an equivalent mat having the weight of the structure. The volume of subgrade included in the analysis (3000 ft by 2400 ft in a horizontal plane, and 960 ft in depth) was sufficiently extended to avoid the effects of boundary conditions on the resulting settlements. Two sets of 3D settlement analyses are performed; one for a predominantly sand site and the other for a predominantly clay site. The results of the settlement analyses indicate that soil sites composed predominantly of clay layers have the maximum total and differential settlements. The deformability properties of the subgrade layers are established to simulate immediate and time dependent deformability of natural soil materials using soil deformation properties similar to profile 270-500 (see Table 3.7.1-6), which is the most deformable subgrade profile considered for the standard plant. The subgrade layers placed 500 ft or deeper below the plant grade were assigned rock properties equivalent to the corresponding layers described in profile 270-500. The settlements obtained for the 270-500 profile envelope results for all other design-basis profiles listed in Table 3.7.1-6. MIC-03-03-00060 DCD_03.08.05-58 MIC-03-03-00060

The timeline of loading considered in the standard plant settlement analyses is illustrated in Figure 3.8.5-14. Subgrade settlements consist of immediate settlements that occur at load application and are elastic-plastic, and time-dependent settlements that develop in time under constant load (viscous deformations, primary consolidation settlements). All immediate settlements and most of the time-dependent settlements will occur by the time of completion of construction. To capture the relatively complex nonlinear and time-dependent behavior with a linear elastic numerical model, the soil deformation moduli used in the model are calculated as equivalent elastic secant moduli at two significant points in time: end of construction and end of plant life. The secant moduli are calculated based on primary consolidation theory and viscous deformation analysis. These secant moduli are determined in an iterative process from the condition that the average settlements of each structure at end of life and end of construction obtained from the linear analyses are approximately equal to the corresponding settlements that account for time dependent deformability and are produced after a time T_C (for the construction phase) and after a time T_L (for the entire life of the plant). As illustrated symbolically in Figure 3.8.5-15, total deformations at end of construction at every location in each structure and the subgrade, δ_{EoC}, are calculated using secant moduli at end of construction, E_{EoC}, and loading during the construction phase. Similarly, the total deformations at end of life at every location, δ_{EoL}, are calculated in a separate 3D FE analysis using secant moduli at end of life, E_{EoL}, and loading during the plant operational