REQUEST FOR ADDITIONAL INFORMATION 657-5135 REVISION 2

11/15/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.08.05 - Foundations
Application Section: 3.8.5

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)

03.08.05-36

RAI 3.8.5-36

In the response to Question 03.08.05-23, MHI states that "Figure 3.8.5-5 is a plan view and not a cross section." This is somewhat confusing because in MHI's previous response to the initial Question 03.08.05-23, it is stated that Figure 3.8.5-5 is a cross section. Figure 3.8.5-5 cannot be both a cross section and not a cross section. MHI is requested to clarify this inconsistency.

It is further noted that results of the seismic response analyses of the revised model (made necessary by changes in the R/B geometry) will be provided in the revised technical report MUAP-08005. The staff will review this revised report when it is received**.** In addition, the staff will review the changes in the R/B geometry (including the coordinates of the mass centers of basemat and the structures supported on it) and the changes in the seismic analysis and structural design will be incorporated into a future revision of the DCD.

03.08.05-37

RAI 3.8.5-37

In the response to Question 03.08.05-27, MHI states that the rigid elements used in the model couple the motion of the nodes that they connect with in all six degree of freedom. The shell elements modeling the walls of the building are extended into the layer of solid elements to transmit nodal rotations to the solid elements. The staff finds that additional information is needed in order to complete its evaluation of the response. For example, is the use of the rigid elements equivalent to providing fixed boundary condition to the rotational degree of freedom of the shell element? Further, how do shell elements transmit nodal rotations to the solid elements by extending into the layer of solid elements? MHI is requested to provide answers to these questions.

03.08.05-38

RAI 3.8.5-38

In its response to Part 5 of Question 03.08.05-28, MHI states that the high water table will not affect the soil spring stiffness for the R/B-PCCV analyses. However, the Applicant does not present any data to substantiate this claim. The staff disagrees with this position because the equations of motion for elastic waves in fluid-saturated porous media are different from those used in the derivation of the soil springs given in ASCE 4-98. MHI is requested to provide numerical data to support their argument that the high water table has no effect on the soil spring constants.

In the response to Part (c), MHI states that Figures 3.8.5-11 and 3.8.5-12 of US-APWR DCD Revision 2 indicate that the dent in the R/B basemat is filled with concrete and becomes part of the structural basemat. However, the staff notices that the description of the basemat presented in the first paragraph of the US-APWR DCD Revision 2 Subsection 3.8.5.1.1 has not been updated. MHI is requested to update this description.

03.08.05-39

RAI 3.8.5-39

In the response to Part 1 of Question 03.08.05-30, MHI states that the total dynamic lateral pressure is the sum of the Wood's pressure and the Westergaard's hydrodynamic pressure. The staff does not accept this answer unless additional data are provided to support this response by MHI. The Wood's solution is based on the classical elastic wave theory which is not applicable for the fluid-saturated porous media. MHI is requested to provide numerical data to support the statement that the lateral pressure based on the elastic wave theory in the porous media is enveloped by the Wood's pressure.

In the response to Part 2, MHI states that the lateral earth pressure induced by the vertical earthquake is given by $K_0 (a_v/g)\gamma_e Z_w$ in which K_0 is at-rest coefficient of soil. The staff is not aware of this equation. MHI is requested to provide the technical basis for this equation.

In the response to Part 3, MHI provides a detailed answer that includes the explanation of the active and passive pressure. The staff finds the response somewhat hard to follow. Perhaps the question asked by the staff was not clearly stated. Reiterating its concern as expressed in the initial RAI question: the staff noticed that Wood's solution does not consider the earth pressure due to the rotation of the wall at its base and requested that the Applicant provide information addressing this earth pressure. Notice that the rotation of the wall at its base is a result of the SSI analysis. So, the earth pressure should be calculated within the frame of theory of elasticity, because the SSI analysis performed is within the frame of linear elasticity. MHI is requested to address this concern.

03.08.05-40

RAI 3.8.5-40

In the response to Part 1 of Question 03.08.05-31, MHI provides a technical rationale for choosing 1/3 of the estimated maximum settlement for the differential settlement. The

staff reviewed this response and considers the answer to be acceptable. However, the staff notices that in US-APWR DCD Revision 2 Table 2.0-1, Key Site Parameters, the last row specifies that the maximum tilt of R/B complex foundation generated during operational life of the plant is limited to 1/2000. Given the size of the R/B foundation, B_{equiv}, as 240ft, 1/2000 of 240ft is 1.44 in. However, 1/3 of the maximum settlement specified is 2 in. which is larger than 1.44 in. MHI is requested to clarify this discrepancy. In the response to Part c of the question, MHI states that the stresses generated by the 2 in. differential settlement are not critical for the design of the mat. The staff accepts this answer; however, in the response, MHI did not address the effects of the 2 in. on the super structure and supported equipment. For example, the p-Δ effect on the structural members and the possibility of pounding between structures and supported equipment should be considered. MHI is requested to provide information that indicates these effects have been included in the study.

03.08.05-41

RAI 3.8.5-41

In the response to Question 03.08.05-33, MHI states that the value of the coefficient of friction, μ, for concrete-to-concrete friction ranges from 0.6 to 1.4 per ACI 349 Section 11.7. The value of μ=0.6 is for concrete placed against hardened concrete not intentionally roughened, while the value of 1.4 is for concrete placed monolithically. MHI further states that the construction sequence of the foundation for US-APWR will allow the use of the value of 0.7 and quotes the publication "State of the Art Report on Finite Element Analysis of Reinforced Concrete: ASCE," as the supporting document. The staff disagrees with this position since US-APWR is stated to be designed in accordance with ACI 349, and not a report of ASCE. MHI also states that at certain sites minor roughening of the fill concrete surface *may* be required. The staff finds that unless the requirement for a "roughened surface" is specified in DCD, a conservative value should be used in the analyses, i.e., μ=0.6. MHI is requested to specify "roughened surface" for the fill concrete to justify use of μ=0.7, or to use μ=0.6 in the analysis.