RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 854-6088 REVISION 3**
SRP SECTION:	**03.07.02 – Seismic System Analysis**
APPLICATION SECTION:	**3.7.2**
DATE OF RAI ISSUE:	**10/24/11**

QUESTION NO. RAI 03.07.02-151:

During the staff's review of MUAP-11007(R0), the staff identified several items in need of clarification. The applicant is requested to provide clarification to the following items:

(a) The title of MUAP-11007 (R0) "Results of Evaluation Using LMSM for R/B Complex" is misleading on a number of levels. The staff notes that Revision 0 of the report does not include any analysis results, but only presents the methodology to be followed. It is stated that the results, when available, will be incorporated in a subsequent Revision 1. In addition, the report not only discusses the analysis of the R/B complex, but also analyses of the PS/B and the Aux Bldg. Finally, the report not only discusses the LMSM but also the design-basis dynamic FE model that will be used for the ground water table elevation evaluation of the R/B complex as stated in section 3.4.2. The applicant is requested to consider using a more appropriate title for this report to avoid confusion.

(b) The applicant did not state clearly whether the evaluation results of the embedment and ground water table elevation effects will become part of the design basis, and will be included in the design envelope, or whether these analyses are intended solely to justify prior assumptions of neglecting these effects. The staff considers these effects to be part of the design basis and therefore these effects should be included in the design envelope unless it is demonstrated that the effects are negligible and do not provide additional contribution to and are bounded by the design envelope. The applicant is requested to clarify how the embedment and ground water table elevation effects will be considered in the design basis of standard plant SSCs.

(c) In the second to last sentence of Subsection 1.3 of MUAP-11007 (R0), it is stated that the SSE ground motion is applied in the three orthogonal directions simultaneously. However, in the last sentence of Subsection 3.1, it is stated that the three components of the earthquake are applied to the models separately. Per Subsection 4.3.2, the staff understands that the sliding and overturning stability calculations are to be performed using ACS SASSI, which is inconsistent with the statement that the ground motion components are applied simultaneously. The applicant is requested to explain clearly how the SSE ground motion is applied in the three orthogonal directions for each of the studies reported in MUAP -11007 (R0).

(d) There appears to be a number of instances where the information provided in MUAP-11007 (R0) is inconsistent with the information provided in MUAP-10001(R3) "Seismic Design Bases of the US-APWR Standard Plant." In several RAIs, the staff has requested the applicant to address specific inconsistencies. To assist the staff's review, the applicant is requested to identify any

additional instances, not highlighted by the staff, where the methodology and analysis assumptions described in MUAP-11007(R0) deviate from those in MUAP-10001(R3).

(e) In Section 3.2 "Site Conditions," it is stated that "the modeled soil half space is represented vertically by 10 viscoelastic layers to simulate the dynamic properties of the subgrade layers that are located 650 feet and 250 feet below the foundation elevations for the R/B and PS/B, respectively." The applicant is requested to clarify its use of the term "viscoelastic" in describing the soil layers. The staff understands that SASSI is a linear elastic analysis code, and is not capable of modeling time-dependent creep and stress relaxation.

(f) In Section 4.2.2, "Development of the Unsaturated Soil Profiles," it is stated that below groundwater table elevation, the P-wave velocity of the saturated soil is set to be equal to or greater than the 5,000 fps. The Poisson ratio of the softer strata of saturated soil is approaching values close to 0.5. If the S-wave velocity of the soil is determined by P-wave velocity and Poisson ratio, then the calculated S-wave velocity may not be realistic because (a) the S-wave velocity will not change much after the soil is saturated and (b) the assumed Poisson ratio value of close to 0.5 cannot give realistic S-wave velocity values. The applicant is requested to clarify how the S-wave velocity profile is determined, and the technical basis for the approach.

(g) In Section 4.3.1, "Design Basis," an URS report (reference 7.8) is cited as providing the design basis for sliding and overturning stability. The design basis should reference criteria in the DCD, not in a contractor document. Alternatively, the URS report could be converted into a technical report and incorporated by reference into the DCD. The applicant is requested to clarify the design basis for sliding and overturning stability.

ANSWER:

The seismic design basis has been updated to perform soil-structure interaction (SSI) analysesusing dynamic finite element (FE) models of the re-configured reactor building (R/B) complex, which now consists of the R/B, prestressed concrete containment vessel (PCCV), containment internal structure, east power source building (PS/B), west PS/B, auxiliary building (A/B), and essential service water pipe chase(ESWPC) supported on a combined basemat as documented in Technical Report MUAP-10006, Rev. 3.

The detailed responses below follow the lettered format of the RAI question:

(a) Technical Report MUAP-11007,Rev 2 is only a study of the effects of groundwater on the soil structure interaction (SSI).Therefore, the title of Technical Report MUAP-11007, Rev. 2has been changed to "GroundwaterEffects on SSI." The studies are performed using the dynamic FE model described above.

(b) The design basis SSI analysis provided in Technical Report MUAP-10006, Rev. 3 considers the R/B complex to be fully embedded in saturated soil. Technical Report MUAP-11007, Rev.2, demonstrates that the assumption of fully saturated conditions is appropriate by developing results for unsaturated conditions and comparing those results to MUAP-10006 Rev. 3.The SSI analyses of unsaturated soil conditionsin Technical Report MUAP-11007, Rev. 2, produced some instances and locations where the in-structure response spectra (ISRS) and base reaction results are not enveloped by the SSI results corresponding to the saturated soil conditions. Technical Report MUAP-11007, Rev. 2, concludes that the effects of groundwater level variation on the seismic design basis response for the R/B complex are minor and that the use of saturated soil profiles will result in a standard plant design that envelops the seismic demands at a majority of candidate sites within the central and eastern United States (CEUS).

(c) Stability evaluations of the R/B complex and the PS/Bsthat were discussed in Rev. 0 of Technical Report MUAP-11007 have been removed.

The groundwater SASSI analyses are conducted separately for each earthquake direction (north-south, east-west, and vertical).

(d) The approaches in Technical Reports MUAP-10006, Rev.3, and MUAP-11007, Rev.2, are consistent. The same SASSI models and input time histories are used. The properties of the soil are altered to reflect the unsaturated condition, but are otherwise the same.

(e) The term “viscoelastic” has been removed from Technical Report MUAP-11007 which does not develop the soil profiles. An equivalent discussion, in Section 03.3.1 of Technical Report MUAP-10006, Rev.3 has been updated and states:

> "The site models in the ACS SASSI (Reference 03-2) analyses use infinite horizontal layers (referred to as fixed layers whose depths vary with soil profiles) to represent the approximately 1000 ft of the top soils. An additional 10 layers, referred to as variable layer, represents a halfspace of visco-elastic medium.”

(f) As described in Section 2.3 of Technical Report MUAP-11007, Rev. 2, the shear wave velocity of saturated soil layers developed in Technical Report MUAP-10006, Rev. 3 are used for unsaturated soil layers in Technical Report MUAP-11007, Rev 2.

(g) The stability evaluations of the R/B complex indicated in Rev. 0 have been removed from Technical ReportMUAP-11007,Rev 2.The design basis for sliding stability is addressed in DCD Subsection 3.8.5 based on the results of a sliding evaluation that is presented in MHI Technical Report MUAP-12002, Rev. 1.The design basis for overturning stability is presented in DCD Subsection 3.8.5.5.

Impact on DCD

There is no impact on the DCD.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-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.