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## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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1/31/2013

### US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

**RAI NO.:** NO. 660-5134 REVISION 2  
**SRP SECTION:** 03.07.02 – Seismic System Analysis  
**APPLICATION SECTION:** 3.7.2  
**DATE OF RAI ISSUE:** 11/15/10

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#### QUESTION NO. RAI 03.07.02-30 (03.07.02-57):

This request for additional information (RAI) is necessary for the staff to determine if the application meets the requirements of 10 CFR Part 50, Appendix A, General Design Criteria 2; 10 CFR Part 50 Appendix S; and 10 CFR Part 100; as well as the guidance in NUREG-0800, 'Standard Review Plan for the Review of Safety Analysis for Nuclear Power Plants,' Chapter 3.7.2, "Seismic System Analysis."

Table 3-4 of MHI's Topical Report, MUAP-10006 (R0), provides maximum frequencies and cut-off frequencies used for the SSI analyses of the R/B and PS/B. The method for computing the maximum frequencies is unclear to the staff. To better understand the methodology, the staff requests the applicant to explain how the maximum frequencies for the R/B and PS/B were calculated and what they represent.

In addition, the applicant should provide justification for not incorporating models that support transmitting frequencies of up to 50 Hz value recommended by ISG-01.

RAIs 3.7.2-37 and 3.7.2-49

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#### ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-10355 (ML110040071).

The US-APWR standard plant design has been updated such that power source buildings, the auxiliary building, and the essential service water pipe chase are integrated with the reactor building (R/B) structure to form the updated design configuration of the R/B complex on a larger common basemat foundation. Part 2 of Technical Report MUAP-10006, Rev. 3, documents the development and validation of the updated dynamic finite element (FE) model for the R/B complex. Section 02.4.1.2 of MUAP-10006 describes the validation approach implemented to demonstrate that the R/B complex model is capable of accurately capturing structural modes of vibrations with frequencies up to 50 Hz as recommended by ISG-01.

As described in Section 03.3.3.5 of MUAP-10006, the maximum frequencies of analyses are determined by the wave passage frequency ( $f_{pass}$ ) of the soil layers in the generic site models and

the size of FE in the excavated volume models. The wave passage frequency is the maximum frequency of the shear wave that the model is capable of transmitting through the soil layer. The values of the wave passage frequencies are calculated based on the guidelines provided in the ACS SASSI manual that the thickness of the soil layer should not exceed one fifth of the wavelength of the seismic wave being transmitted. The maximum wavelength frequency that the model can transmit is calculated as follows:

$$f_{pass} = \frac{V_s}{5 \cdot d}$$

Where:  $V_s$  is the soil shear wave velocity and  $d$  is either the thickness of a soil layer in the site model or the maximum FE size in the excavated volume FE model.

Tables 03.3.1-1 through Table 03.3.1-6 of MUAP-10006 in the last column provide the passing frequencies of each soil/rock layer of the SASSI site models of generic profiles used for US-APWR standard plant soil-structure interaction (SSI) and structure-soil-structure interaction (SSSI) analyses. The second column in Table 03.3.5-2 of MUAP-10006 summarizes the maximum shear wave passage frequencies for the different generic profiles calculated as the minimum value of the passage frequencies of all layers in the profile. Table 03.3.5-2 of MUAP-10006 in the last column provides the maximum frequencies of the shear waves that can be transmitted through the model at the bottom of foundation-soil interface. Tables 03.3.4.1-1 through 03.3.4.1-3 of Technical Report MUAP-10006, provide the maximum frequency of the seismic shear waves that can be transmitted through the excavated volume models in vertical, north-south and east and west direction, respectively.

The cut-off frequency is the highest natural frequency used in the site response analysis of the SSI system. Table 03.3.5-1 of MUAP-10006 presents the cut-off frequencies used for the SSI and structure-soil-structure interaction analyses of different generic soil profiles. The SSI analysis of the US-APWR standard plant R/B complex for the hard soil profile 560-500 and rock profiles 900-100, 900-200, and 2032-100 are analyzed to a cut-off frequency of 50 Hz. The SSI analyses of the US-APWR standard plant R/B complex for generic soil profiles 270-200 and 270-500 are analyzed to a cut-off frequency of 40 Hz. Section 03.3.5 of Technical Report MUAP-10006, Rev. 3, provides justification of the 40 Hz cutoff frequencies. As described in Sections 03.3.5 and 03.3.3.5 of MUAP-10006, these cut of frequencies of analyses are set slightly higher than the wave passage frequency of the analyzed SSI and structure-soil-structure interaction models. A review of the acceleration transfer function results at frequencies beyond the minimum frequencies is conducted to demonstrate the accuracy of the results.

The envelop of seismic responses obtained from the SSI analyses of all generic profiles provide an adequate standard seismic design basis that envelopes seismic responses of up to 50 Hz as required by ISG-01.

#### **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 a Technical/Topical Report

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