

---

---

**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

---

---

1/31/2013

**US-APWR Design Certification  
Mitsubishi Heavy Industries  
Docket No. 52-021**

**RAI NO.:** NO. 852-6003 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 03.07.02-112:**

With reference to Section 4.1 of MUAP 10001 (R3), "CSDRS Compatible Ground Motion Time Histories," the applicant is requested to provide the following additional information.

(A) "the BAL (Mt Baldy, CA) recording of the January 14, 1994, Northridge earthquake (magnitude M6.7), is used as the seed ground motion for generating the time history motions. The Northridge BAL recording was selected because it has the required duration and correlation (statistical independence among the three components comprising the time history earthquake)." The staff noted that many record sets possess appropriate duration and independence characteristics. The results of a recent study (see reference cited below) demonstrate that the computed seismic response of structures is sensitive to the seed record selected during the development of the synthetic time histories which are used as input to SSI analyses. In order to reduce the potential for underpredicting the computed response of the structure, it is generally recommended that when a single seed ground motion is used, a comparison of spectral shapes at 2% and 20% damping is also made to ensure that the resulting artificial records are appropriate for use in SSI analyses that are typically associated with high values of radiation damping. Thus, the applicant is requested to provide comparisons between the CSDRS spectra and the spectra generated from the synthetic time histories for both 2% and 20% damping and discuss the quality of the matches at 2% and 20%.

Reference: "Investigation of the Impact of Seed Record Selection on Structural Response;" PVP2010-25919; Proceedings of the ASME 2010 Pressure Vessels & Piping Division / K-PVP Conference, July 18-22, 2010, Bellevue, Washington, USA. [[www.osti.gov/servlets/purl/1019557-1rQA93/](http://www.osti.gov/servlets/purl/1019557-1rQA93/)]

(B) "the method used here to generate the time history motions is also appropriate to generate other multiple time history motions to perform non-linear analyses." The purpose of this statement is not clear to the staff. The applicant is requested to describe the characteristics of the spectral matching process that are specifically appropriate for performing non-linear analysis. In addition, the applicant is requested to clarify if the nonlinear analyses are included in the design-basis methodology and describe the specific applications of non-linear analysis and how the analysis results are used in the design of standard plant SSCs.

Also, from the review of MUAP-10001(R3), the staff could not identify at what elevation the CSDRS are applied. It is the staff's understanding from the DCD (R3) that the CSDRS are applied at the foundation level in the superseded lumped mass stick model SSI analyses. The Applicant is requested to define the elevation (e.g., surface, bottom of foundation, other) at which the CSDRS are applied in the updated SSI analyses.

---

**ANSWER:**

Please note that the material content of Technical Report MUAP-10001 has been superseded and replaced with Parts 1 and 2 of Technical Report MUAP-10006, Rev. 3.

- (A) Option 1, Approach 2 of SRP 3.7.1 previously used, has now been changed to Option 1, Approach 1. Per SRP 3.7.1, for Approach 1, the spectrum from the artificial ground motion time history must envelop the free-field design response spectra for all damping values used in the seismic response analysis. In compliance with Option 1 Approach 1, the response spectra derived for the US-APWR artificial time histories are shown to envelope the certified seismic design response spectra (CSDRS) for the damping values 2%, 3%, 5%, 7% and 10% in Technical Report MUAP-10006, Sections 01.3.1, 01.4.1, and 01.5.1.

The 20% damping curve is not required by the SRP and therefore is not included in Technical Report MUAP-10006.

By utilizing Option 1 Approach 1 and developing the time histories to match/envelope the CSDRS at 2%, 3%, 5%, 7% and 10% damping values, as well as ensuring the power spectra density target curves are bounded, the concern about under predicting the response of the structures has been addressed.

- (B) Non-linear analyses are not used for the design-basis soil-structure interaction (SSI) analyses. The statement "the method used here to generate the time history motions is also appropriate to generate other multiple time history motions to perform non-linear analyses" has been eliminated from Technical Report MUAP-10006, Rev. 3.
- (C) The CSDRS are applied at the bottom of foundation level in the SSI analyses presented in Technical Report MUAP-10006, Rev. 3.

**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.