RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 850-6002 REVISION 3**
SRP SECTION:	**03.07.01 – Seismic Design Parameters**
APPLICATION SECTION:	**3.7.1**
DATE OF RAI ISSUE:	**10/21/11**

QUESTION NO. RAI 03.07.01-19:

Section 4.2 of MUAP-10001(R3), “Development of Soil Profiles and Strain Compatible Properties” (Page 4-5) states that a whole new suite of soil properties were developed for the new seismic analysis reported herein. The last two sentences in the first paragraph states, “The number of available profiles generally decreases rapidly with depth as noted in "Surface Geology Based Strong Motion Amplification Factors for the San Francisco Bay and Los Angeles Areas" (Reference 7). Therefore, judgment has to be used to extend the generic profiles at the deeper depths.”

The staff believed that the US-APWR seismic analyses are to be applicable to a large number of sites in the Central and Eastern United States (CEUS), nonetheless, the reference cited (Reference 7) is meant for the Western US regions (specifically California). The Applicant is requested to explain: (1) how the material in Reference 7 in MUAP-10001(R3) is applied to the CEUS sites; and (2) describe the nature, extent, and the basis of the judgment that was necessary to determine the soil profiles that are applicable to and representative of the CEUS sites.

ANSWER:

This answer revises and replaces the previous MHI response that was transmitted by letter UAP-HF-11417 (ML11339A013).

Technical Report MUAP-10001, Rev. 3 has now been superseded and the development of soil profiles and strain compatible properties is incorporated into Technical Report MUAP-10006, Rev. 3.

(1) The cited discussion in Section 4.2 and Reference 7 of Technical Report MUAP-10001, Rev. 3) is now presented in Section 01.4.2 of Technical Report MUAP-10006 Rev. 3. Section 01.4.2 describes the methodology used to develop the generic soil profiles, and the selection process which is focused on soil conditions that are typical for potential sites across much of the Central and Eastern United States (CEUS). Reference 01-7 illustrates the process of developing a generic soil profile as an average of multiple measured profiles with similar surficial geology and the judgment process of extending the average to depths where only

limited number of measured data exists. The information used from this reference is independent of the soil properties used for development of generic soil profiles for the US-APWR standard design. The methodology implemented for the development of US-APWR generic profiles has been validated by modeling recorded motions at over 500 sites from about 15 earthquakes (EPRI, 1993, Reference 1; Silva et al., 1996, Reference 2; Silva, 1997, Reference 3) for sites worldwide.

(2) The soil/rock profiles as well as the soil degradation curves representing the soil stiffness (G/G_{max}) and hysteretic damping as function of strain are generally similar between western North America (WNA) and central and eastern North America (CENA) because the geologic processes in North America do not change at 105^{o} W longitude. Sands, clays, and gravels, Holocene soils, Pleistocene soils, soft, firm, and hard rock sites have similar dynamic material properties between WNA and CENA. It is only the relative distributions of these properties that differ. For example, loess and till sites exist in both WNA and CENA but with more concentrated in CENA. Similarly glacially showered sites are in WNA and CENA but again are more widespread in the CENA. Hard rock sites as well as hard rock beneath soils exist in WNA but are much more common in CENA. Residual and saprolitic soils exist across the U.S. but are more common in CENA. As a result, generic G/G_{max} and hysteretic damping degradation curves are used worldwide and are not specific to any particular tectonic regime. The same tectonic independence applies to soil/rock velocity profiles with the exception of the differences in the occurrence of hard basement rock between WNA and CENA. Hard basement rock beneath soils is more prevalent in the CENA than in the WNA, however, there are also large regions across the CENA with significantly lower velocity sedimentary rock beneath the soils. As shown in Figure 1, the area comprising the Gulf Coast (EPRI, 1993, Reference 1) as well as the large region of the gas bearing Marcellus and Devonian shales, with both regions comprising a significant portion of the CENA, have sedimentary rock comprised of siltstones, sandstones, mudstones, shales, and some limestones underlying the soils.

Section 01.4.2.1 of MUAP-10006 Rev. 3 presents the approach used for selection of the generic profiles that provide realistic representation of the following site conditions at potential sites within CEUS:

- Two soil sites representative of layers of dense cohesionless soil and/or over-consolidated stiff clay with depths of 200 ft and 500 ft above rock foundations consisting of sedimentary or weathered rock section overlying Precambrian basement material.

- A hard soil profile representative of 500 ft thick strata of glacial till consisting of highly consolidated mixtures of fine and course grained soils over 1000 ft deep strata of sedimentary or weather rock resting on the rock basement.

- Two soft rock profiles with depths of 100 ft and 200 ft.

- A firm rock profile representative of a residual soil (saprolite) over weathered rock and underlain by hard rock intended to reflect hard rock foundation depths after removal of the soft surficial residual soils.

As described in Section 0.1.3.2 of MUAP-10006 Rev. 3, the goal of the soil profile selection process is to provide a suite of soil profiles, which together with the certified seismic design response spectra will result in a seismically qualified design that can be constructed at a variety of CEUS potential sites. The results presented in Section 03.4.1.1 of MUAP-10006 Rev. 3, demonstrate that the selected generic profiles provide a range of soil-structure

interaction responses that envelope the seismic demands at a vast number of candidate sites within CEUS.

1) Guidelines for Determining Design Basis Ground Motions, Volumes 1-5, TR-102293, Electric Power Research Institute, Palo Alto, CA, 1993.

- Vol.1: Methodology and Guidelines for Estimating Earthquake Ground Motion in Eastern North America
- Vol. 2: Appendices for Ground Motion Estimation
- Vol. 3: Appendices for Field Investigations
- Vol. 4: Appendices for Laboratory Investigations
- Vol. 5: Quantification of Seismic Source Effects

2) Silva, W.J., N. Abrahamson, G. Toro and C. Costantino, "Description and Validation of the Stochastic Ground Motion Model," Report Submitted to Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973, Contract No. 70573, 1996.

3) Characteristics of Vertical Strong Ground Motions for Applications to Engineering Design, NCEER-97-0010, Proceedings of the FHWA/NCEER Workshop on the National Representation of Seismic Ground Motion for New and Existing Highway Facilities, I.M. Friedland, M.S Power and R. L. Mayes eds., Silva, W.J., 1997.

The above references are cited in Section 01.6.0 of Technical Report MUAP-10006, Rev. 3.

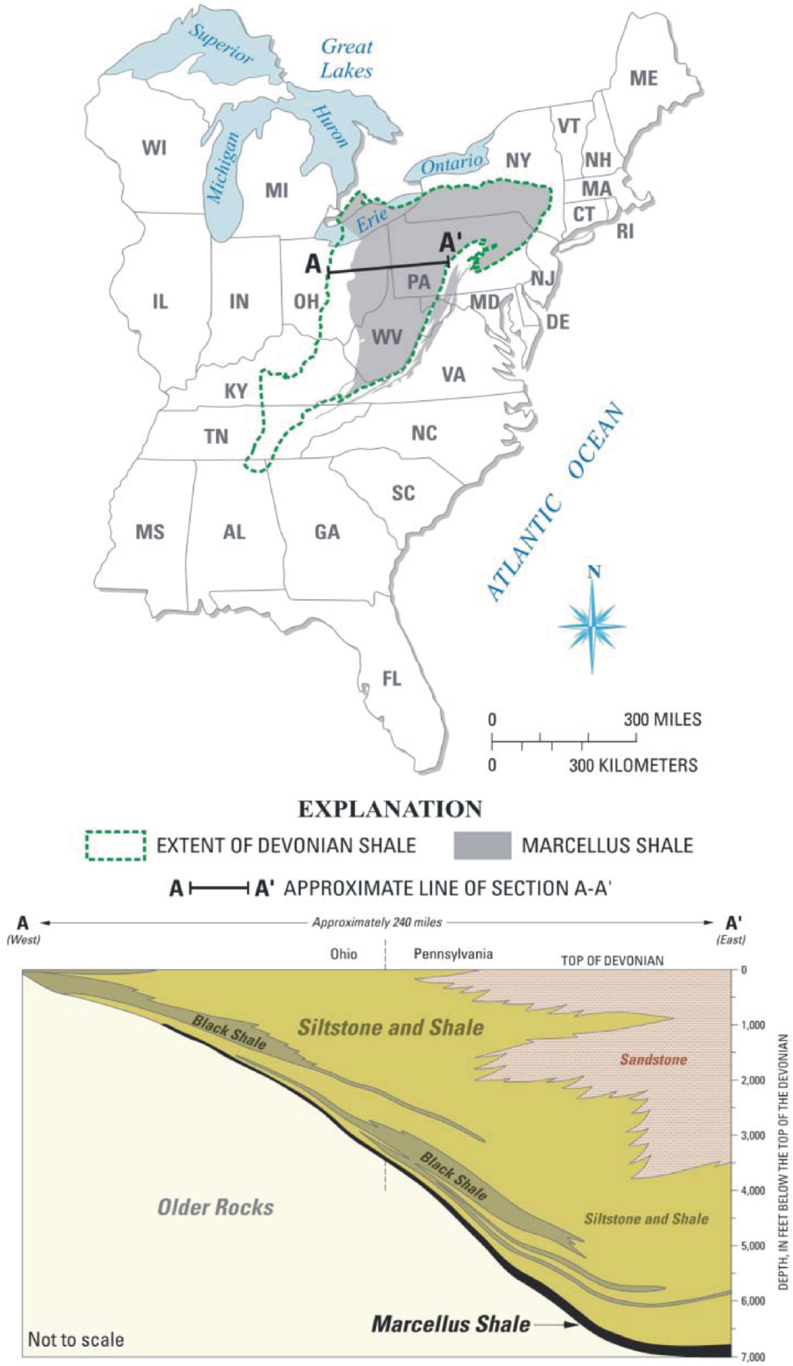

Figure 1 – Regions of Marcellus and Devonian Shales

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.