
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: NO. 709-5489 REVISION 2
SRP SECTION: 03.07.01 – Seismic Design Parameters
APPLICATION SECTION: 3.7.1
DATE OF RAI ISSUE: 03/07/11

QUESTION NO. RAI 03.07.01-13 (03.07.01-17):

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 3.7.1, "Seismic Design Parameters."

In its response dated November 11, 2010 to staff's RAI No. 643-4967, Revision 1, (Question NO. 03.07.1-16), the applicant made certain statements with regard to the applicability of the US-APWR certified standard design response spectra (CSDRS) to hard rock sites in Central and Eastern United States (CEUS), relative to response spectra characteristic in the high-frequency range. Specifically, the applicant stated the following:

1. It is recognized that for some of the hard rock sites in Central and Eastern United States (CEUS), the US-APWR CSDRS does not envelope the response spectra characteristic in the high-frequency range.
2. CSDRS are expected to envelope many sites in the central and eastern United States in order to maximize the applicability of the US-APWR standard plant design; however it is anticipated that there are some site-specific instances, particularly on hard rock sites in high seismic areas, where high-frequency exceedances of the CSDRS may occur.

In order to determine whether the requested US-APWR standard design is usable for a multiple number of units or at a multiple number of sites in the United States without reopening or repeating the staff's review, the staff requests that MHI provide quantitative information and details of specific analyses and data developed to support its response to RAI No. 643-4967, Revision 1, (Question NO. 03.07.1-16), dated November 11, 2010, particularly regarding the two statements noted above. The staff also requests that the applicant discuss whether the analysis of the site specific variation for the hard rock sites, where the US-APWR CSDRS does and does not envelope the response spectra characteristic in the high-frequency range, will lead to site-specific variations in the plant designs among plants that reference the US-APWR design. The applicant should also discuss the extent of such variations, as appropriate.

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-11111.

This question and response also supersede the question and response for Question 03.07.01-16, of RAI 643-4967, which asked:

“The staff requests that the applicant provide a technical bases and justification that shows that the SSCs for the standard design certification are adequately designed for hard rock site conditions that are expected in Central and Eastern United States (CEUS). Otherwise, state in the US-APWR DCD that the exception is taken to hard rock site conditions expected in Central and Eastern United States (CEUS).”

Part a: Provide quantitative information and details of specific analyses and data developed to support response to Question 03.07.01-16 of RAI 643-4967.

During the development of the site parameters that are applicable to the US-APWR standard plant, compliance has been maintained with the definition of *Standard Design* in 10 CFR Part 52, Section 52.1, which states in part:

“*Standard design* means a design which ... is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review.”

As stated in DCD Subsection 3.7.1.1 and documented in Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1, the horizontal and vertical certified seismic design response spectra (CSDRS) for safe-shutdown earthquake (SSE) are derived from RG 1.60. To enhance the CSDRS in the high frequency range, the RG 1.60 spectral control points at 9 Hz and 33 Hz were shifted to 12 Hz and 50 Hz, respectively, for both the horizontal and the vertical spectra of the CSDRS. To address sites, which are not bounded by the CSDRS, the Interim Staff Guidance, “Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications,” (DC/COL-ISG-01) Section 4, “Staff Guidance/Position on Addressing HF Ground Motion Evaluations,” states that:

“When the ground motion response spectra (GMRS) or foundation input response spectra (FIRS) exceed the CSDRS (or associated foundation level spectra), the staff will follow the review process outlined in Section 3.7.1 of NUREG-0800, “SRP for Review of Safety Analysis Reports for NPPs” (hereafter referred to as the SRP). These exceedances are expected in the HF range.”

Therefore, the Code of Federal Regulation recognizes that standard design site parameters (of which the CSDRS is one) are not expected to bound every site, and the DC/COL-ISG-01 therefore accommodates the review process for site-specific high frequency exceedances, particularly for hard rock sites in high seismic areas.

Figure 1 provided in this response is a comparison of the US-APWR CSDRS with the publicly available ground motion for new plant applications. The graph reflects that of the 19 ground motion curves, eleven curves are bounded by the CSDRS in the high-frequency range. The ground motion for these sites therefore reflects US-APWR compliance with the definition of *Standard Design* in 10 CFR Part 52, whereby the CSDRS “is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review.” Further, DCD Section 3.7.1.1 requires the COL Applicant to perform site-specific seismic analyses [COL 3.7(22)]. The site-specific soil structure interaction (SSI) analyses may consider seismic wave

transmission incoherence, and the development of the ground input motion may consider analysis of the cumulative absolute velocity (CAV) as discussed in RG 1.208. Consideration of incoherence, and/or consideration of the CAV in the ground input motion, will generally result in reduced seismic demands for those hard rock sites with high-frequency exceedances of the CSDRS.] With regard to adequate design for hard rock conditions with high frequency content in the input motion, Section 02.4.1.1.2 and 02.4.1.2 of Technical Report MUAP-10006, Rev. 3, show that the structural model of the seismic category I reactor building (R/B) complex can accurately capture seismic responses with frequencies up to 50 Hz, which meets the provisions of ISG-01, Section 3.1. Similarly, Section 03.3.5 of Technical Report MUAP-10006, Rev. 3, explains how the meshing of the subgrade in the dynamic model is capable of capturing seismic responses up to 50 Hz.

The statement, "These parameters bound an estimated 75% to 80% of the United States landmass, including all sites under current consideration," has been deleted from DCD Tier 2, Section 2.0, because it is not applicable to the pertinent Acceptance Criteria relative to standard plant design that are stated in Standard Review Plan (SRP) 2.0.

Part b: Discuss whether the analysis of site specific variation for hard rock sites, where US-APWR CSDRS does and does not envelope the response spectra characteristic in the high-frequency range, will lead to site-specific variations in the plant designs among plants that reference the US-APWR design.

It is recognized that there are site-specific instances where the US-APWR CSDRS does not envelope the response spectra, particularly where high-frequency exceedances of the CSDRS occur at hard rock sites in CEUS. The EPRI White Paper, "Seismic Screening of Components Sensitive to High Frequency Vibratory Motions," issued June, 2007, states that high frequency spectral exceedances have been shown to be non-damaging for virtually all nuclear plant structures, systems and components (SSCs) and need not be explicitly evaluated, except that they may be significant to the functional performance of vibration sensitive components, such as relays, contactors, switches and some measuring devices. The following generic discussion summarizes certain aspects of the standard plant design and the effects of high frequency input.

When the site-specific ground motion for natural frequencies above 10 Hz are determined to exceed the CSDRS (see Figure 1), the design of standard plant structures is not expected to change since the dominant SSI frequencies for the standard plant structures are less than 10 Hz (refer to Section 03.4.1.1 of Technical Report MUAP-10006, Rev. 3 for a summary of first-peak SSI frequencies for the R/B complex). This conclusion is made since the seismic design for these hard rock sites are bounded by the CSDRS values for natural frequencies less than 10 Hz (the low-frequency outlier is a soft soil site). Similarly, there is no impact to the core internals and fuel rods because the dominant frequencies are also less than 10 Hz. Therefore, the seismic design for the standard plant structures, the core internals and fuel rods are not affected for hard rock sites in CEUS.

The design of primary reactor coolant loop (RCL) components and ASME Class 1 piping for hard rock sites in CEUS are also not impacted, because in general the dominant natural frequencies and seismic responses of these components and piping are enveloped by the CSDRS curve, which is enhanced by broadening in the high frequency range as described above and additional margin is incorporated in the design of the system where high frequency is prevalent.

There are, however, certain categories of plant items/activities that might be functionally affected by high frequency spectral input. This may include:

- Seismic qualification of certain equipment potentially sensitive to high-frequency vibration, such as I/C and gas turbine generator
- Equipment anchorages other than the primary RCL components

- System supports (piping, electrical cable tray, HVAC, etc.)
- Probability Risk Assessment

The COL Applicant is required to assess the impact(s), if any, of site-specific high frequency spectral exceedances of the CSDRS for potentially affected SSCs [COL 3.10(9)].

Site-specific variations in the plant designs among plants that reference the US-APWR design are discussed as applicable in each site-specific FSAR, and are not within the scope of the US-APWR Design Control Document. However, the COL Applicant does have the option of performing site-specific SSI analyses considering incoherence and CAV of the ground input motion. Consideration of these phenomena at hard rock sites generally reduces or eliminates exceedances of the seismic demand for standard plant subsystems, where high-frequency effects are important for the design.

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.

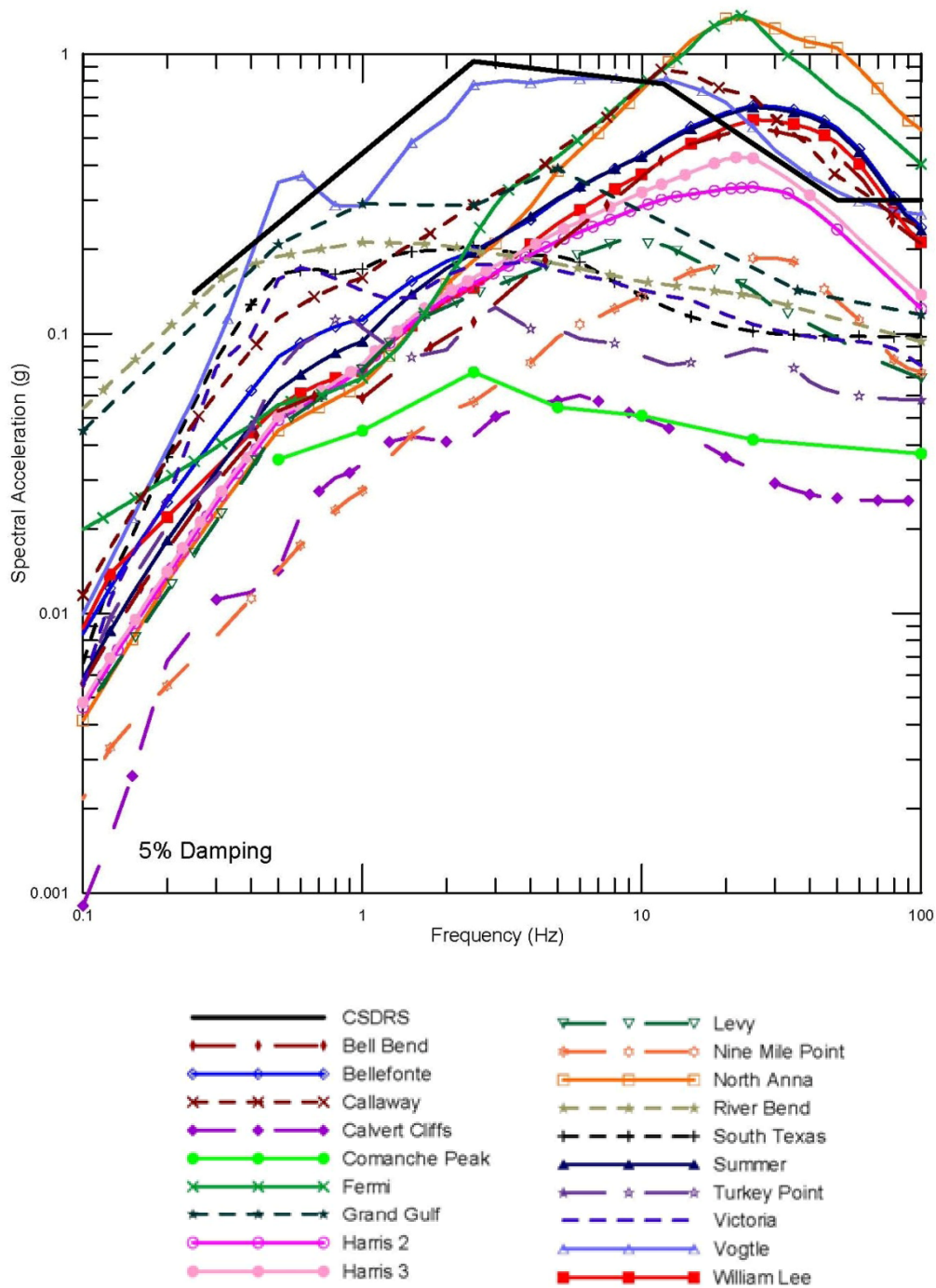


Figure 1, Comparison of US-APWR CSDRS and Ground Motion from New Reactor Applications

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