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April 19, 2011

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-11111

Subject: MHI's Responses to US-APWR DCD RAI No. 709-5489 Revision 2 (SRP 03.07.01)

Reference: 1) "Request for Additional Information No. 709-5489 Revision 2, SRP Section: 03.07.01 – Seismic Design Parameters," dated 3/7/2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 709-5489, Revision 2."

Enclosed are the responses to one RAI contained within Reference 1. This transmittal completes the response to this RAI.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,



Yoshiaki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Response to Request for Additional Information No. 709-5489, Revision 2

CC: J. A. Ciocco
C. K. Paulson

Contact Information

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Docket No. 52-021
MHI Ref: UAP-HF- 11111

Enclosure 1

UAP-HF-11111
Docket No. 52-021

Response to Request for Additional Information No. 709-5489,
Revision 2

April, 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/19/2011

**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: 3/7/2011

QUESTION NO. RAI 3.7.1-17:

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:

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

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 10CFR 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 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 permits the COL Applicant to perform site-specific soil-structure interaction (SSI) analyses, in which seismic wave transmission incoherence and analysis of the cumulative absolute velocity (CAV) of the ground input motion may be considered. Consideration of incoherence, and/or consideration of the cumulative absolute velocity in the ground input motion, will generally result in reduced seismic demands for those hard rock sites with high-frequency exceedances of the CSDRS.

Related to the discussion of standard plant applicability, Revision 3 of DCD Tier 1 deleted Subsection 2.2.2.4 from Section 2.2.2, Protection Against Hazards. Subsection 2.2.2.4 was deleted as not applicable to the regulatory statements within Tier 1 of the DCD. Similarly, DCD Tier 2 Section 2.0 contains the statement "These parameters bound an estimated 75% to 80% of the United States (US) landmass, including all sites under current consideration" that is not applicable to the pertinent Acceptance Criteria relative to standard plant design as stated in Standard Review Plan (SRP) 2.0. Therefore, the last sentence of the first paragraph in Section 2.0 will be deleted from the DCD.

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 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 Central and Eastern United States (CEUS). The EPRI Technical Update 1015108, "Program on Technology Innovation: The Effects of High Frequency Ground Motion on Structures, Components, and Equipment in Nuclear Power Plant" issued in June, 2007 (which is essentially unchanged from EPRI Draft White Paper, "Considerations for NPP Equipment and Structures Subjected to Response Levels Caused by High Frequency Ground Motions," transmitted to NRC March 19, 2007) concludes that high frequency spectral exceedances are considered to cause negligible additional response stresses within typical nuclear plant structures, systems and components (SSCs), but may be significant to the functional performance of vibration sensitive components, such as relays. 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 does not change since the dominant natural frequencies for the standard plant structures, which are the major contributors to the seismic response of the structures, are less than 10 Hz. 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 in the CSDRS portion of DCD Subsection 3.7.1.1, 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 things such as:

- 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 (PRA)

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 and activities.

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

See Attachment 1 for the mark-up of DCD Tier 2, Section 2.0, changes to be incorporated.

- Delete the following sentence from the first paragraph in Section 2.0: "These parameters bound an estimated 75% to 80% of the United States (US) landmass, including all sites under current consideration."

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.

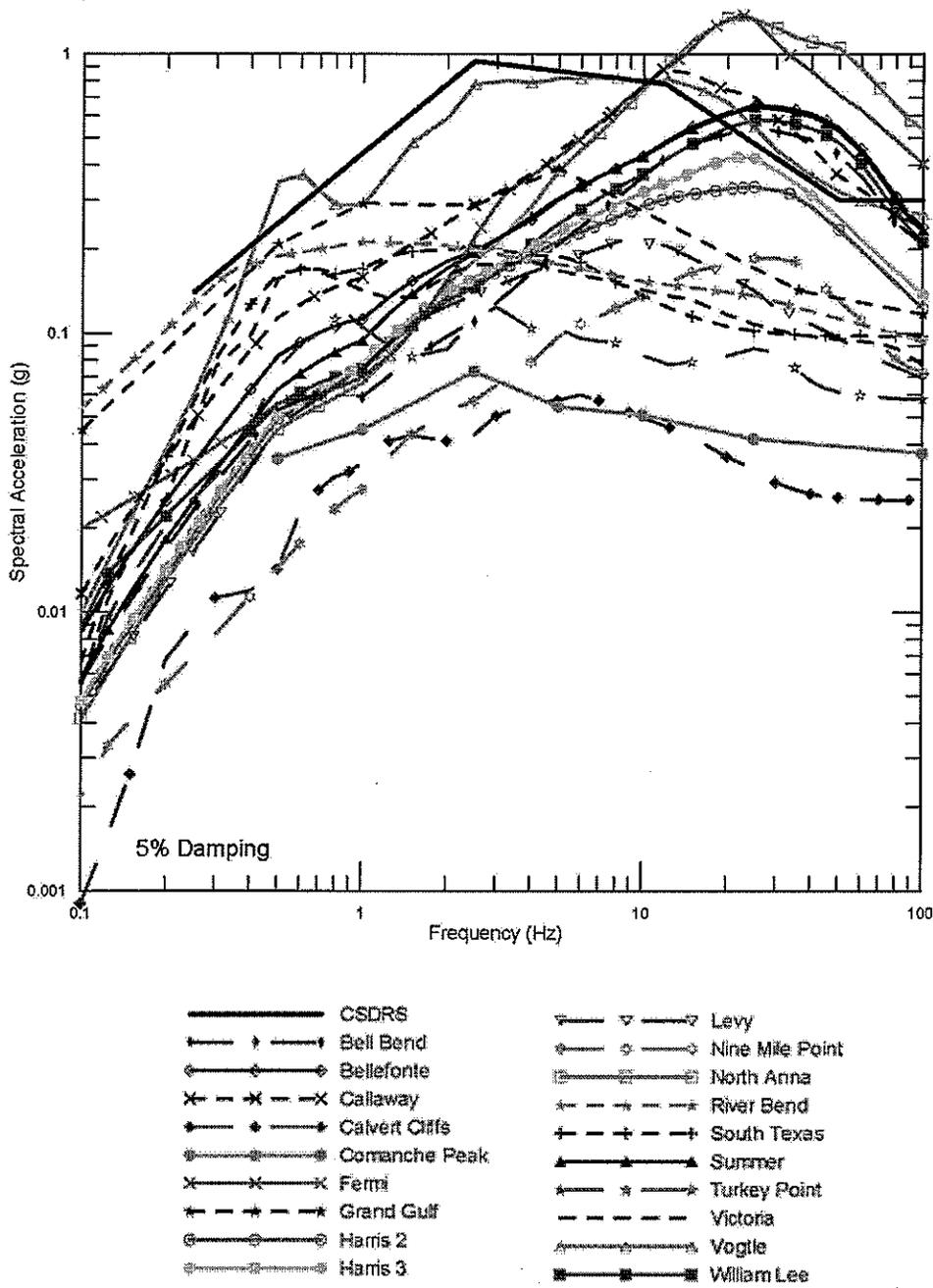


Figure 1

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

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

2.0 SITE CHARACTERISTICS

This chapter contains site-related parameters for the US-APWR. ~~These parameters bound an estimated 75% to 80% of the United States (US) landmass, including all sites under current consideration.~~

For the purposes of the US-APWR, the site is the contiguous real estate on which nuclear facilities are located and for which one or more licensees has the legal right to control access by individuals and to restrict land use for purposes of limiting potential doses from radiation or radioactive material during normal operation of the facilities.

Chapter 2 of the Combined License Application (COLA) and Final Safety Analysis Report (FSAR) provide information concerning the geological, seismological, hydrological, environmental, and meteorological characteristics of the site and vicinity, in conjunction with present and projected population distribution including land use relative to site activities and controls. Table 2.0-1 is a summary table identifying specific site parameters for the US-APWR.