REQUEST FOR ADDITIONAL INFORMATION 213-1951 REVISION 1

2/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.07.03 - Seismic Subsystem Analysis
Application Section: 3.7.3

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)

03.07.03-1

RAI 3.7.3-1

In Section 3.7.3.1.7.2 of the DCD, the applicant proposed to combine support group responses by the square root of the sum of the squares (SRSS) method for the independent support motion (ISMRS) response spectrum analysis of subsystems consisting of multiple spans. The staff's position on combination of group responses for ISMRS analysis is provided in SRP subsection 3.7.3.II.9 that makes reference to NUREG 1061, Volume 4. The staff position in NUREG 1061, Volume 4 is to combine group responses by the absolute sum method. Provide bases and technical justification for the proposed combination of support group responses by the SRSS method for the independent support motion response spectrum analysis.

RAI 3.7.3-2

In Section 3.7.3.1.2 of the DCD, the applicant proposed various factors that need to be applied to the applicable in-structure response spectra for an equivalent static analysis of structures, equipment, or component which can be idealized as a single degree of freedom system. The SRP subsection 3.7.2.II.1 B provides staff's acceptance criteria which specifies a factor of 1.5 to the peak spectral acceleration of the applicable in-structure response spectra. Clarify how the factor of 1.5 is intended to be used.

RAI 3.7.3-3

In Section 3.7.3.1.2 of the DCD reference is made to ASCE 4-98 for determining equivalent static load base shear and moment for structures that are modeled as cantilever beams with uniform mass distribution. The staff has not reviewed and endorsed ASCE 4-98 for this application. Currently this ASCE standard is under revision. Provide bases and technical justification for the proposed factors used to determine base shear and base moment.

RAI 3.7.3-4

In Section 3.7.3.1.2 of the DCD, provide bases and justification for using a factor of 1.0 for the equivalent static seismic load for simply-supported, fixed-simply supported, or fixed-fixed beams configurations independent of their frequency calculations.

RAI 3.7.3-5

In Section 3.7.3.1.5 of the DCD, a methodology for response spectrum broadening and smoothing is discussed. Clarify and discuss what is meant by 'filling in the valleys between all peaks' and how it is accomplished and describe the methodology used for peak broadening.

RAI 3.7.3-6

In Section 3.7.3.1.6 of the DCD, a seismic response peak shifting method is discussed. This method is not addressed in the SRP guidance or in RG 1.122. Provide bases and technical justification for the use of the seismic response peak shifting method.

RAI 3.7.3-7

Provide criteria and procedures used in establishing the number of earthquake cycles resulting from the seismic events and the maximum number of cycles for which applicable Category I subsystems and components are designed. This information is required in accordance with SRP Section 3.7.3.I.2. to review the design adequacy of subsystems and equipment.

RAI 3.7.3-8

Provide criteria and procedures used to separate fundamental frequencies of components and equipment from the forcing frequencies of the support structure. This information is required in accordance with SRP Section 3.7.3.I.4. to review the design adequacy of subsystems and equipment.

RAI 3.7.3-9

In Section 3.7.3.3 of the DCD, a Rayleigh damping in proposed for use in the seismic analysis of subsystems. Discuss in details the applications in which the Rayleigh damping will be used. The staff guidance on the Rayleigh damping is not addressed in SRP Section 3.7.2.II.13. Provide bases and technical justification for the use of Rayleigh damping.

RAI 3.7.3-10

In the second paragraph of section 3.7.3.3 of the DCD clarify what is meant by "alternately, the minimum damping value may be used for these systems'.

RAI 3.7.3-11

In the seismic design of seismic category I subsystems, provide the design criteria to account for the seismic motion of non-category I subsystems (or portions thereof). This

information is required in accordance with SRP Section 3.7.3.I.8. to review the design adequacy of subsystems and equipment.

RAI 3.7.3-12

Provide details of the methods used to consider torsional effects in the seismic analysis of category I subsystems. This information is required in accordance with SRP Section 3.7.3.I.11 to review the design adequacy of subsystems and equipment.

RAI 3.7.3-13

In Section 3.7.3.2 of the DCD, procedures for analytical modeling of subsystems are described. It is stated that the procedures used for analytical modeling of subsystems may be different than used for the major Seismic Category I and II building structures described in section 3.7.2.3. Identify all exceptions taken to the analytical procedures described in section 3.7.2.3 for seismic category I structures and provide technical justification for each exception. Also, provide the subsystem coupling requirements if different from those described in section 3.7.2.3.4 of the DCD.

RAI 3.7.3-14

Describe the criteria used to confirm the adequacy of the number of discrete mass degrees of freedom for the reactor coolant loop (RCL) subsystem model discussed in Appendix 3C and in Reference 3.7-18 of the DCD. The SRP Subsection 3.7.2.II.1.A (iv) provides an acceptable method to the staff.

RAI 3.7.3-15

In DCD Section 3.7.3.1.3, the applicant proposed that subsystems with multiple dynamic degrees of freedom (MDOF) can be analyzed by an equivalent static load method in which the seismic demand is determined using 1.5 times the peak acceleration from the applicable ISRS. The concern is the potential for misapplication of the equivalent static load method. This typically arises during equipment qualification when the dynamic models of subsystems do not contain sufficient detail to produce an applicable ISRS at an appropriate point (e.g., valve) in the system. Moreover, the static methodology does not check for closely-spaced modes that can cause additional amplification in the MDOF system. The guidelines in SRP Section 3.7.2.II.1.B, state that in order to use an equivalent static load method to calculate seismic demands on SSCs, justification must be provided that the system or subsystem can be realistically represented by a simple model, and that the method produces conservative results in terms of responses.

Provide the criteria and justification for MDOF subsystems that will be analyzed by an equivalent static load method, and demonstrate that this method will produce conservative results. Also, in the absence of any ISRS for these subsystems, discuss the methodology to analyze the seismic response of the safety-related components (such as valves, electrical equipment) in such subsystems.