US-APWRRAIsPEm Resource

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Subject: US-APWR Design Certification Application RAI 1032-7098 (9.1.2)
Attachments: US-APWR DC RAI 1032 SEB1 7098.pdf

MHI,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, MHI requests and we grant 45 days to respond to the RAI. We will adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 1032-7098

Issue Date: 5/13/2013

Application Title: US-APWR Design Certification - Docket Number 52-021

Operating Company: Mitsubishi Heavy Industries

Docket No. 52-021

Review Section: 09.01.02 - New and Spent Fuel Storage
Application Section: 9.1.2

QUESTIONS

09.01.02-28

In MUAP-07033P (R0), Section 3.1.3, “Simulation and Solution Methodology,” the paragraph at the top of Page 7 states, in part, “The solver computer algorithm, implemented in the Holtec Proprietary Code MR2v300 (a.k.a. DYNARACK) …” and in Section 3.5, “Computer Codes,” (Page 13) the paragraph states that “All computer codes used in this analysis are presented in Table 3-3.”

The staff notices that the computer code, MR2v300, is not listed in Table 3-3. The applicant is requested to correct this error.

09.01.02-29

In MUAP-07033P (R0), Section 2.0, “US-APWR Fuel Racks,” (Page 1) the last sentence of the second paragraph states that “The cell wall thickness of the new fuel rack (NFR) is 0.209 inches. For conservatism, however, the structural calculations for the NFR presented in this report assume that the cell wall thickness is only 0.18 inches.”

The staff disagrees with the applicant’s conclusion on conservatism by using a thinner cell wall thickness for the NFR rather than its actual thickness. Changing the wall thickness may not be always conservative because the stiffness and mass will also be changed; as a result of this, the natural frequency of the structure will change. This shift of natural frequency may result in a higher or lower acceleration for the thinner cell wall than that corresponds to the natural frequency calculated from a thicker cell wall. The applicant is requested to use the actual thickness in the analysis or provide a justification for the stated conservatism.

09.01.02-30

In MUAP-07033P (R0), Section 3.1.1, “Acceleration Time Histories,” (Page 2) the first paragraph states, in part, that “The synthetic time-histories must meet the criteria of statistical independence, envelope the target design response spectra, and envelope the target Power Spectral Density function associated with the target response spectra.”
Based on the above sentence, the staff assumes that the target design response spectra is located at the pit level, and then the synthetic time-histories are generated to envelope them. The applicant is requested to provide the following information:

- Provide the target response spectra at the pit slab location that were used to generate the synthetic time histories
- Were the target response spectra derived from the soil-structure-interaction analysis? If not, provide justification for not including the soil-structure-interaction effect.
- What are the seeds of earthquake ground motions used to generate the synthetic time histories?
- What are the record length and the time increment of the synthetic time histories?

09.01.02-31

In MUAP-07033P (R0), Section 3.1.1, “Acceleration Time Histories,” (Page 2) the first sentence of the second paragraph states that “The SFRs [spent fuel racks] and NFRs [new fuel racks] have been analyzed using four different sets of acceleration time histories, which correspond to different soil conditions.”
The applicant is requested to provide the following information:

- Identify the soil profiles used and confirm that they are consistent with those used in the seismic analysis of the standard plant.
- Explain why the fuel rack analysis did not include the remaining two soil profiles.
- Explain the applicant's plan to show the safety of the rack design uder the remaining two soil profiles.

09.01.02-32

In MUAP-07033P (R0), Section 3.1.1, “Acceleration Time Histories,” the first sentence of the first paragraph (page 2) states that “The response of a freestanding rack module to seismic inputs is highly nonlinear and involves a complex combination of motions (sliding, rocking, twisting, and turning), resulting in impacts and frictional effects. Linear methods, such as modal analysis and response spectrum techniques, cannot accurately replicate the response of such a highly nonlinear structure to seismic excitation,” and the first sentence of the second paragraph states that “The SFRs [spent fuel racks] and NFRs [new fuel racks] have been analyzed using four different sets of acceleration time histories, which correspond to different soil conditions.”

The approach stated above does not meet the acceptance criteria in SRP 3.7.1 for the design time histories Option 2, “Multiple Sets of Time Histories,” which states that for nonlinear structural analyses, the number of time histories must be greater than four and the technical basis for appropriate number of time histories are reviewed on a case-by-case basis.” The applicant is requested to provide a technical basis for considering only four time histories.

09.01.02-33

In MUAP-07033P (R0), Section 3.1.4, “Conservatisms Inherent in the Methodology,” (Page 8) item (2) states “All stored fuel assemblies are conservatively assumed to rattle in unison,” which exaggerates the impact momentum between the fuel and the rack.”

This sentence appears to imply that all racks are fully loaded. The staff is not convinced that assuming the full loading for every rack is conservative. Considering the following scenario: Assume a fully loaded rack subjected to an earthquake does not slide; Now consider two racks with one rack empty; and the other rack fully loaded. During the same earthquake, the lighter rack slides because its friction force at the base is now less than if it were fully loaded. The fully loaded one by itself would not slide; however, it may slide due to the impact from the lighter rack; thus, the whole system (the lighter rack and the fully loaded rack) slides. Based on the above example, the applicant is requested to provide a technical rationale that the assumption of all fully loaded racks is conservative. Otherwise, the applicant needs to consider the loading patterns in the analyses. The loading patterns considered should include the case of all racks completely empty.

09.01.02-34

In MUAP-07033P (R0), Section 3.1.2.2, "Specific Modeling Details for Rack," the second paragraph under the title "Stiffness Matrix," (Page 6) states that "The SFR [spent fuel rack] and NFR [new fuel rackk] are subject to the SSE [safe-shutdown earthquake] earthquakes described in Section 3.1.1. Eight runs have been performed (Four each for the SFR and NFR) using a random value of coefficient of friction, with an upper and lower bound limits of 0.8 and 0.2 respectively."
The applicant is requested to provide the following information:

1. The value of coefficient of friction (COF) used with a particular analysis for all analyses.
2. Use the actual value of COF to replace the word "Random" in Tables 3-4 thru 3-8.

09.01.02-35

In MUAP-07033P (R0), Section 3.1.2, "Modeling Methodology," the applicant described that "added mass" is used to model the effect of hydrodynamics. The staff notices that "added mass" appears to represent the impulsive part of the effect of hydrodynamics. The "sloshing" part of the effect of hydrodynamics is not mentioned in the report. The applicant is requested to explain how sloshing effects are addressed in the analysis.

09.01.02-36

In MUAP-07033P (R0), Section 3.7.3.2, "Weld Stress," the item (3), "Cell-to-Cell-Welds," (Page 17) the paragraph states that "These weld stresses are conservatively calculated by assuming that fuel assemblies in adjacent cells are moving out of phase with one another so that impact loads in two adjacent cells are in opposite directions."

The 3-D dynamic model described in Section 3.1.2, "Modeling Methodology," does not have individual cells. The applicant is requested to describe how the weld stresses in adjacent cells are obtained when the adjacent cells are moving out of phase with one another.

09.01.02-37

In MUAP-07033P (R0), Section 3.1.2.2, "Specific Modeling Details for Rack," (Page 4) the first paragraph, in part, states that "While the horizontal motion of the rattling fuel mass is associated with five separate masses, the totality of the fuel mass is associated with the vertical motion and it is assumed that there is no fuel rattling in the vertical direction. In other words, the vertical displacement of the fuel is coupled with the vertical displacement of the rack (i.e., degree of freedom "P3" in Figure 3-1) by lumping the entire stored fuel mass (in the vertical direction only) with the vertical rack mass at the baseplate level."
In reality, the fuel assembly may separate from the baseplate during vertical ground motion. Therefore, the applicant is requested to provide a technical rationale for lumping the entire stored fuel mass at the baseplate level in the vertical direction.

09.01.02-38

In MUAP-07033P (R0), Section 3.1.2.2, “Specific Modeling Details for Rack,” the paragraph under the title of “Stiffness Matrix,” (page 6) states that “The spring stiffnesses associated with the elastic elements that model the behavior of the assemblage of cells within a rack are based on the representation developed in (Reference 6-11). Tension-compression behavior and twisting behavior are each modeled by a single spring with linear or angular extension involving the appropriate coordinates at each end of the rack beam model. For simulation of the beam bending stiffness, a model is used consistent with the techniques of the reference based on a bending spring and a shear spring for each plane of bending, which connects the degrees of freedom associated with beam bending at each end of the rack.”
There are a number of spring stiffnesses mentioned in this paragraph. Is there a study for the sensitivity of the impact forces to the variations in the spring stiffnesses used to model the behavior of the rack? If yes, the applicant is requested to provide a discussion and tabulate the results. If no, the applicant is requested to provide a technical rationale to support that the spring stiffnesses used will lead to conservative results.

09.01.02-39

In MUAP-07033P (R0), Section 3.2.4, “Stress Limits for Various Conditions Per ASME,” (Page 8) the paragraph, in part, states that “The SFR [spent fuel rack] and NFR [new fuel rack] are freestanding; thus, there is minimal or no restraint against free thermal expansion at the base of the rack. Moreover, thermal stresses are secondary which, strictly speaking, have no stipulated stress limits in Class 3 structures or components. Thermal loads applied to the rack are, therefore, not included in the stress combinations.”

The staff agrees with the applicant that the thermal stress may be excluded from the stress combination. However, the thermal expansion will reduce the gaps between the fuel assembly and the cell as well as between racks. The gap reduction increases the possibility for impact between the fuel assembly and the cell as well as between racks. The applicant is requested to conduct the stress analyses considering the reduced gaps due to thermal expansions.

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