

US-APWRRAlSPeM Resource

From: Buckberg, Perry
Sent: Friday, February 07, 2014 1:40 PM
To: 'us-apwr-rai@mhi.co.jp'; US-APWRRAlSPeM Resource
Cc: Lee, Samuel; Galvin, Dennis; Shams, Mohamed; Thomas, Vaughn; Kallan, Paul
Subject: US-APWR Design Certification Application RAI 1078-7242 (03.08.05 - Foundations)
Attachments: US-APWR DC RAI 1078 SEB1 7242.pdf

MHI,

The attachment contains 'Foundations' related request for additional information (RAI). This RAI was sent to you in draft form on December 17, 2013 resulting in no need for clarification. Your licensing review schedule assumes technically correct and complete responses when the response is issued.

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

Thanks,

Perry Buckberg

Senior Project Manager

phone: (301)415-1383

fax: (301)415-6406

perry.buckberg@nrc.gov

U.S. Nuclear Regulatory Commission

Office of New Reactors

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Created By: Perry.Buckberg@nrc.gov

Recipients:

"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"Galvin, Dennis" <Dennis.Galvin@nrc.gov>
Tracking Status: None
"Shams, Mohamed" <Mohamed.Shams@nrc.gov>
Tracking Status: None
"Thomas, Vaughn" <Vaughn.Thomas@nrc.gov>
Tracking Status: None
"Kallan, Paul" <Paul.Kallan@nrc.gov>
Tracking Status: None
"us-apwr-rai@mhi.co.jp" <us-apwr-rai@mhi.co.jp>
Tracking Status: None
"US-APWRRAlSPEm Resource" <US-APWRRAlSPEm.Resource@nrc.gov>
Tracking Status: None

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REQUEST FOR ADDITIONAL INFORMATION 1078- 7242

Issue Date: 2/7/2014

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

Operating Company: Mitsubishi Heavy Industries

Docket No. 52-021

03.08.05 - Foundations

QUESTIONS:

03.08.05-68

In Section 3.8.5.4, "Design and Analysis Procedures," of Revision 4 of the DCD, the first paragraph states, "Based on the premise that seismic Category I buildings basemats are not supported on bed rock, a computer analysis of the SSI is performed for static and dynamic loads."

DCD Section 3.8.5.4, describes that both the ACS-SASSI and the ANSYS computer codes were used in the analysis of the Reactor Building (R/B) Complex, Containment Internal Structures (CIS), and the Prestressed Concrete Containment Vessel (PCCV). Further, DCD Section 3.7.2 indicates that a two-step process is used for analysis. Step 1 is a SASSI time history analysis and Step 2 is an ANSYS response spectrum analysis (RSA) of the aforementioned building structures. However, staff review of these DCD sections finds the description of the modeling approach for the Step 2 analysis to be unclear. To assist the staff in its evaluation of the adequacy of the seismic analysis for the R/B Complex, CIS and the PCCV, the applicant is requested to address the following questions and clarify the DCD where appropriate:

1. Given that Step 1 SASSI model is not constrained against rocking and torsional modes, it is not clear how the applicant ensures that conservative seismic demands are developed from the ANSYS RSA model(s) which are constrained against rocking and torsional modes.

The applicant is requested to provide a clear description in the DCD of each of the Step 2 models (R/B Complex, CIS, PCCV), and describe the approach to ensure that conservative seismic demands are used in the design of these structures.

2. The response should also clarify whether the RSA models utilized broadened or un-broadened input and provide justification for not using broadened input, if applicable.

03.08.05-69

DCD, Revision 4, Subsection 3.8.5.4.2, "Analyses for Basemat Loads During Operation," states:

"The results of the linear analysis are combined with non-linear analyses to form the governing load combinations. The results from these analyses include the forces, shears, and moments in the basemat; the bearing pressure under the basemat; and the area of the basemat that is uplifted."

Staff review of this DCD section, as well as information reviewed during the November 4-8, 2013 structural design audit, has identified the following questions:

1. Staff review finds that the combination of linear and nonlinear analysis results for the design of a structural element or member is inconsistent with standard engineering practice and should be avoided or, at a minimum, needs to be further justified. The justification should demonstrate that conservative estimates of demand are obtained using such an approach as compared to a fully linear or a fully non-linear analysis.

2. During the November 4-8, 2013 structural audit, the applicant described the nonlinear analysis performed for the basemat design. It is the staff's understanding that this analysis was based on linear material properties for the structural and soil elements and that the only nonlinearity was due to the use of nonlinear gap elements used as compression-only springs. As the DCD is unclear in this regard, the applicant is requested to confirm the staff's understanding and update the DCD to describe the analysis approach more adequately.

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3. It is the staff's understanding that the applicant has performed a parametric study using time history analyses to demonstrate that consideration of the reactor building (R/B) complex basemat uplift results in a contact area between the basemat and the supporting soil of approximately 80%. The applicant is requested to provide the results of this study and to provide a description of the study in the DCD indicating the consistency of the approach with SRP Section 3.7.2, "Seismic System Analysis," Revision 4. If not consistent with SRP Section 3.7.2, Revision 4, explain why the approach used is adequate.
4. The applicant is requested to explain its rationale for asserting that the seismic analysis results obtained from the SASSI soil-structure interaction (SSI) analysis are adequate despite the fact that the SASSI analysis is a linear analysis and does not account for uplift.
5. The applicant is requested to describe its approach to ensure that the seismic demands used in the design of the basemat are conservative and have sufficient margin to account for the approximations made in the stepped analysis approach and modeling the flexibility of the basemat. The applicant is requested to include this description in DCD Section 3.8.5.
6. During the November 4-8, 2013 structural audit, the applicant described that the analysis of the R/B complex basemat considered two soil profiles based on the assertion that the demands calculated for those two profiles envelope the demands for the remaining four profiles. Staff review of DCD Section 3.8.5 finds no basis supporting the assumption of the sufficiency of the two soil profiles. Also there appears to be an inconsistency between the two controlling soil profiles mentioned in the DCD and MUAP-10006, "Soil-Structure Interaction Analysis and Results for the US-APWR Standard Plant," Revision 3 (i.e. 2032-100 and 900-100 or 200) and those discussed regarding the basemat design during the audit (i.e. 2032-100 and 270-500). To address this issue, staff requests the applicant to provide the technical rationale to support that assertion. A parametric study with a simplified structure model on the basemat may be an acceptable approach to provide the required insights. Also the applicant is requested to address the inconsistency between the DCD, MUAP-10006, and the audit information regarding basemat and update the DCD accordingly.
7. The applicant is requested to assess the effect of variable soil modulus (a.k.a dishing effect) on the seismic demands calculated for the basemat on soft soil.

03.08.05-70

In the applicant's response to RAI 1045-7141, Question 03.08.05-57, the applicant stated that all gaps between independently founded standard plant structures have been opened to a minimum of 16 inches. Therefore, there are no gap closure calculations for the current design. However, in Subsection 3.8.5.4.4 of DCD Tier 2 Revision 4, the text still indicates that there are gap closure calculations.

The applicant is requested to revise the DCD to indicate that there are no gap calculations.

03.08.05-71

During the November 4-8, 2013 structural audit, the staff reviewed the design of the reinforced concrete shearwalls in the Reactor Building (R/B) Complex and noticed that lateral ties to restrain buckling of the vertical wall reinforcement had not been provided in all reinforced concrete shearwalls with vertical reinforcing area greater than 0.01 times the gross concrete area. Section 14.3.6 of ACI 349-06, requires that lateral ties be provided when the area of compression reinforcement exceeds this limit.

The staff requests that the Applicant provide additional information concerning the need for lateral ties in these walls and whether this issue was evaluated in accordance with Section 14.3.6 of the ACI 349 Code.