REQUEST FOR ADDITIONAL INFORMATION 916-6343 REVISION 3

3/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.09.02 - Dynamic Testing and Analysis of Systems Structures and Components
Application Section: 3.9.2

QUESTIONS for Engineering Mechanics Branch 2 (ESBWR/ABWR Projects) (EMB2)

03.09.02-93

In Section 3.5 of Revision 2 of the Technical Report MUAP-07027-P (R2), the Category 2 acceptance criterion for modal frequency states that the measured frequencies for the fundamental beam mode and the lowest shell modes must not differ from the predicted values by more than 10%. However, on page 21 of the Technical Report, the applicant states that the predicted beam mode frequency for the top slotted column was higher than the measured frequency exceeding the acceptance criterion. The applicant neither commented on this difference nor proposed any corrective action to improve the prediction and meet the acceptance criterion. The NRC staff request further explanation on how this discrepancy has been resolved.

03.09.02-94

Figure 3.1.1-1 on page 19 of Technical Report MUAP-07027-P (R2) shows a flow chart of the dynamic analysis procedure of the US-APWR Reactor Internals. The validation procedure in the flow chart suggests that if the calculated response of J-APWR does not agree with the scale model test measured response, a correction factor of the forcing function is determined. The applicant is requested to explain what is meant by this correction factor and if any correction factors are used in the validation procedure to formulate the flow-induced vibration forces acting on the internal structures of the US-APWR. The applicant is also requested to explain why a correction factor in the forcing function is sought rather than in the FE modeling, damping values or any other input parameters of the analysis procedure.

03.09.02-95

Figure 3.2.3-1 on page 49 of Technical Report MUAP-07027-P (R2) compares the analysis results with experimental data obtained for the 1/5 scale model test (SMT) of the J-APWR. The predicted frequency of the relative displacement is higher than the measured frequency exceeding the acceptance criterion. The applicant is requested to explain the reason(s) of this discrepancy and how this difference is compatible with the acceptance criterion of 10% difference between the measured and calculated frequencies.

03.09.02-96

In Technical Report MUAP-07027-P (R2), the applicant added samples of the time history of the cross-flow forcing functions. For example, Figure 3.3.2-2 on page 70 shows cross flow vibration loading on columns of the US-APWR. The applicant is requested to confirm that the procedure used to generate these forcing functions is similar to that used in Section 3.2.2.2 of the Technical Report.

03.09.02-97

As stated in Section 3.3.2.2 of Technical Report MUAP-07027, in the original analysis, the amplitude of the reactor coolant pump (RCP) pulsation was determined from the pressure fluctuation at the outlet of APWR RCPs. In the revised analysis, the ratios of the acoustic pulsations at the shaft rotation and the blade passing frequencies were determined based on the spectral analysis of acoustic pulsations generated by generic RCPs. The applicant is requested to explain the source of these spectral measurements, the test conditions of the pumps, and the type of tested pumps in comparison to those used in the US-APWR.

03.09.02-98

In the stress evaluation procedure described on page 87 (item 2(a) of Section 3.3.3.2.) of Technical Report MUAP-07027-P (R2), the applicant states that:

> *Since the uniform cross sections of the core barrel and column structures have lower stress, a stress concentration factor 5 was used. The cross-shaped legs in the fixed parts of the column structures, however, have the higher stress due to the larger loads. Therefore, a stress concentration factor 2 was used to calculate the peak stress according to the FE model analysis*.

It is not clear why the stress concentration factor depends on the stress level and not only on the geometrical properties of the analysed structure. The applicant is requested to explain this procedure in more detail by means of typical examples of stress calculations and associated stress concentration factors for structure components of the US-APWR.

03.09.02-99

On page 96 of Technical Report MUAP-07027-P (R2), the applicant added Table 3.4.1-1 which lists the cross flow margins of fluid elastic instability for the US-APWR. This table shows a smaller margin for the lower diffuser plate support column. Please provide additional information on the method used to ensure a conservative estimate of the damping logarithmic decrement which is used to compute the critical velocity.

03.09.02-100

Regarding acceptance criterion 2 for the stress due FIV and RCP loads on page 97 Technical Report MUAP-07027-P (R2), the applicant added the statement that: “For

random stresses, the root mean square (rms) stresses as deduced from the measured rms strains must be within a factor of 3.0 of the corresponding computed values, with the correction of damping ratios between measured and analysis condition."
This statement is unclear. The applicant is requested to explain this statement in a clearer manner.

03.09.02-101

Regarding the cross flow forcing functions in the upper plenum, which are discussed in the first question in this RAI (Question 03.09.02-93), the applicant is requested to explain the phase which was imposed on the forcing function along the length of the analysed structure.

03.09.02-102

In Technical Report MUAP-07027-P (R2), the cross flow forcing functions in the upper plenum are modified by dividing the structures into several segments in elevation to account for the cross flow velocity distribution along the structures. As an example, Appendix-I illustrates the rod cluster control assembly (RCCA) guide tube (GT) forcing functions for different elevations. The applicant is requested to explain how the local flow velocities were obtained and discuss the margin of error in estimating these local velocities at different elevations.