REQUEST FOR ADDITIONAL INFORMATION 636-4732 REVISION 0

9/23/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.06.02 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping
Application Section: 3.6.2

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

03.06.02-40

Follow-up RAI 03.06.02-10 S02

This is the supplemental RAI for RAI 71-986, 03.06.02-10 and RAI 459-3331, 03.06.02-29

In its response to the staff's RAI, the applicant continues to assert that the pressures induced by blast waves on surrounding structures in US-APWR plants will be negligible. In its justification, the applicant ignores the effects of surrounding structures and walls, and the pressure wave reflections they would cause. The applicant also assumed that the blast wave loading time history is a step function, rising from ambient pressure to a peak pressure and remaining at the peak pressure indefinitely. In actuality, blast wave pressure time histories will peak, and then decrease. More importantly, this is generally followed by shock reflections, pressure increases and subsequent expansions, often to pressures below ambient pressure. The applicant also considers only barrier structures, and resonance frequencies below 50 Hz, in their response. The applicant is advised that the staff is concerned about not only barrier structures, but other structures, and safety-related components and systems. The staff is also concerned about all structural resonances which could be strongly excited by blast waves, not only the fundamental modes. The applicant is requested again to provide a rigorous explanation of appropriate and conservative blast wave estimating procedures to be applied to the US-APWR design and to document those procedures in a revised version of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 439-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-41

Follow-up RAI 03.06.02-11(a) S02

This is the supplemental RAI for RAI 71-986, 03.06.02-11(a) and RAI 459-3331, 03.06.02-30

In its response to the staff's RAI, the applicant continues to use ANS 58.2 to assess jet impingement loading on US-APWR structures and components. It should be noted that several inaccuracies in the ANS 58.2 Standard are identified and the Standard is no longer considered universally acceptable for jet impingement loading evaluation by the staff. Although the applicant cites several papers that contain experimental data from tests conducted in Japan, it does not appear that the applicant uses those data to define their jet impingement loads, nor to justify using ANS 58.2 methodology/procedures. The applicant is therefore requested again to substantiate that the use of ANS 58.2 methodology/procedures in US-APWR application is conservative. The applicant may submit different procedures (perhaps using the measurements cited in MHI references 1-6), along with substantiation that those procedures are conservative.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-42

Follow-up RAI 03.06.02-12(a) S02

This is the supplemental RAI for RAI 71-986, 03.06.02-12(a) and RAI 459-3331, 03.06.02-31

In its response to RAI 459-3331, 03.06.02-31, the applicant agrees that the pressure distribution is non-uniform. The applicant also states that it will uniformly use the maximum pressure in their non-uniform pressure distribution, which is conservative. However, the applicant did not include this commitment in a revision to the DCD. The applicant is requested to document their commitment to use the maximum pressure in its assumed uniform pressure distribution in a revised version of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-43

Follow-up RAI 03.06.02-12(b) S02

This is the supplemental RAI for RAI 71-986, 03.06.02-12(b) and RAI 459-3331, 03.06.02-32

In RAI 459-3331, 03.06.02-32, the staff requested the applicant to expand on a table provided by the applicant in its previous RAI response to include all postulated pipe break locations, along with internal and external properties and the analysis approach to be used for the jet impingement load evaluation. In its response to this RAI, the applicant provided the requested table. However, the applicant did not include this table in a revision to the DCD. The applicant is therefore requested to include this table in a revised version of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-44

Follow-up RAI 03.06.02-13 S02

This is the supplemental RAI for RAI 71-986, 03.06.02-13 and RAI 459-3331, 03.06.02-33

In its response to the staff's RAI, the applicant discounts the possibility of feedback amplification of dynamic jet loads on the grounds that the sound speed within the jet plumes of two-phase flows is much smaller than the sound speed outside the plumes. However, the acoustic waves which cause feedback and the amplification of shed vortices from the pipe break propagate outside the jet plume at the sound speed of the external, quiescent fluid (Ho and Nossier, 1981), and are not strongly affected by the sound speed within the jet plume. Thus, even supersonic jets have similar feedback mechanisms. The applicant is therefore requested to provide a conservative methodology for assessing jet impingement loading at resonant jet conditions. The applicant is also requested to provide a conservative methodology for assessing the effects of jet impingement loading oscillations at non-resonant conditions (without strong feedback amplification), and a methodology for assessing the effects of oscillating jet loads on impinged-upon structures. Furthermore, the applicant is requested to document these methodologies in a revision of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-45

Follow-up RAI 03.06.02-14 S02

This is the supplemental RAI for RAI 71-986, 03.06.02-14 and RAI 459-3331, 03.06.02-34

In its response to the staff's RAI, the applicant stated that jet reflection effects would be "assessed considering the changes in direction and expansion with decaying by distance." This response is vague, and does not constitute a substantiated, conservative approach for assessing the effects of jet reflections. Also, the applicant has not documented an approach for jet reflection assessment in a revision of the DCD. The applicant is therefore requested to provide a jet reflection assessment approach and to document it in a DCD revision.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-46

Follow-up RAI 03.06.02-15 S02

This is the supplemental RAI for RAI 71-986, 03.06.02-15 and RAI 459-3331, 03.06.02-35

In its response to the staff's RAI, the applicant references the response to RAI 03.06.02-28. In that response, the applicant discounts the possibility of feedback amplification of dynamic jet loads on the grounds that the sound speed within the jet plumes of two-phase flows is much smaller than the sound speed outside the plumes. However, the acoustic waves which cause feedback and the amplification of shed vortices from the pipe break propagate outside the jet plume at the sound speed of the external, quiescent fluid (Ho and Nossier, 1981), and are not strongly affected by the sound speed within the jet plume. The applicant is therefore requested to provide a conservative methodology for assessing jet impingement loading on shields and barriers at resonant jet conditions and to document the methodology in a revision of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08258; dated November 7, 2008; ML083180225.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

03.06.02-47

Follow-up RAI 03.06.02-6 S01

This is the supplemental RAI for RAI 71-986, 03.06.02-6

In its response to the staff's RAI, the applicant stated that the BTP 3-4, Part B, Item B(iii)(1)(b) criterion will be added to Revision 2 of USAPWR DCD Subsection 3.6.2.1.2.2. The staff reviewed this subsection of Revision 2 of DCD and found that the information in the DCD is not consistent with the BTP requirement. Specifically, it should state that leakage cracks are postulated for ASME Code, Section III, Class 1 piping systems, where the stress range calculated by Eq. (10) in NB-3653 is more than (as opposed to "less than" as stated in DCD) 1.2 $S_{m.}$ The applicant is therefore requested to make this correction in the next revision of the DCD.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08226; dated October 7, 2008; ML082840135.

03.06.02-48

Follow-up RAI 03.06.02-39 S01

This is the supplemental RAI for RAI 71-986, 03.06.02-18 and RAI 459-3331, 03.06.02-39

The applicant did not adequately address the staff's concerns included in RAI 459-3331, 03.06.02-39. In that RAI, the applicant was requested to include a description in DCD Tier 2 Section 3.6.2 that clearly outlines the information that will be included in the pipe break hazard analysis report along with its (as-design aspect) closure milestone. The applicant was also requested to clarify that pipe break hazard analysis will be performed for all the piping systems (including the non-safety class piping) that are within the scope of SRP Section 3.6.2.

In its RAI response, the applicant provides a list of information under a proposed new DCD Section 3.6.2.6, Pipe Break Hazard Analysis Methodology. However, the staff found that the title of that DCD subsection, "Pipe Break Hazard Analysis Methodology", is not consistent with the content of that subsection. Specifically, DCD Section 3.6.2.6 outlines the information that will be included in the pipe break hazard analysis report rather than pipe break hazard analysis methodology. In addition, the third bullet, identification of SSCs that are safety-related or required for safe shutdown, included in that list of information needs clarification that for each postulated pipe break/crack location, the applicant will identify (in the pipe break hazard analysis report) all the safety-related or required for safe shutdown that are in close proximity to the postulated pipe rupture. Furthermore, the applicant is again requested to clarify that pipe break hazard analysis will be performed for all the piping systems (including the non-safety class piping) that are within the scope of SRP Section 3.6.2. The applicant is requested to address these staff's concerns.

In its RAI response, the applicant proposed some changes to DCD Tier 1, Section 2.3. Specifically, the applicant proposed changes to Items 4 and 5 in Table 2.3-2 to include both as-designed and as-built aspects of pipe break hazard analysis. However, the applicant referred to "reports" for both aspects of the pipe break hazard analysis report. It does not make it clear that both as-designed and as-built pipe break analysis will contain all the information as outlined in DCD Tier 2 Section 3.6.2.6. As a minimum, the title of Section 3.6.2.6 (after it is revised to address the staff's concern identified in the second paragraph of this RAI) should be used in the ITAAC table. In addition, the ITAAC should make clear that Item 4 is for the as-designed plant while Item 5 is for the as-built reconciliation respectively and for both aspects, the pipe break hazard analysis performed will be clearly documented in the pipe break hazard analysis report. Furthermore, both DCD Section 3.6.2.6 and ITAAC Table 2.3-2 need to make it clear that pipe break hazard analysis will be performed for all the piping systems (including the non-safety class piping) that are within the scope of SRP Section 3.6.2. Finally, the current description of design commitment and acceptance criteria for the as-built aspect of pipe break hazard analysis is not clear. It needs to make it clear that the as-built pipe break analysis is to be reconciled with the as-designed pipe break hazard analysis. Also, the as-built pipe break analysis is to be performed for both high energy and moderate energy piping to ensure that the as-built safety related SSCs are appropriately protected against or qualified to withstand the dynamic and the environmental effects associated with postulated failures for all the piping systems (including the non-safety class piping) that are within the scope of SRP Section 3.6.2. The applicant is requested to address these staff's concerns.

Lastly, the applicant did not clearly address staff's concern concerning the closure milestone for as-designed pipe break hazard analysis report. The applicant is requested to clarify whether the MHI's design completion plan as described in UAP-HF-08123 is still valid. Also, in that plan, the applicant did not include the completion schedule for all the piping systems (including the non-safety class piping) that are within the scope of SRP Section 3.6.2.

References:

MHI's Response to US-APWR DCD RAI No. 71-986; MHI Ref: UAP-HF-08226; dated October 7, 2008; ML082840135.

MHI's Responses to US-APWR DCD RAI No. 459-3331; MHI Ref: UAP-HF-09542; dated December 1, 2009; ML093370091.

Additional Information for Design Completion Plan of US-APWR Piping Systems and Components; MHI Ref: UAP-HF-08123; dated July 14, 2008; ML082030589.