REQUEST FOR ADDITIONAL INFORMATION 210-1948 REVISION 1

2/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.06.03 - Leak-Before-Break Evaluation Procedures
Application Section: 3.6.3

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

03.06.03-1

The US APWR DCD Tier 1 information on ITAAC for LBB contained in Tables 2.4.2-5 item 16, 2.4.4-5 item 13, 2.4.5-5 item 14 and 2.7.1-5 item 12 have summaries for the Inspections, Tests, and Analyses (2nd column) and for the Acceptance Criteria (3rd column) that should be clarified. The 2nd column currently states, "Inspections will be performed on the evaluation report for LBB or the protection from dynamic effects of a pipe break, as specified in Section 2.3." Should this 2nd column read "Analysis will be performed in the evaluation report for LBB or the protection from dynamic effects of pipe break as specified in Section 2.3." The 3rd column currently states "The LBB acceptance criteria are met by the as-built piping and piping materials, or the protection is provided for the dynamic effects of the piping break." Should this 3rd column state, "The LBB acceptance criteria and BACs are met using the as-built piping and piping materials, or the protection is provided for the dynamic effects of the piping break." Please provide additional clarification of the entries in the ITAAC tables related to LBB.

03.06.03-2

Leak-Before-Break (LBB) evaluations as performed in accordance with SRP 3.6.3 Section III.2 requires an evaluation of elbows and other fittings and industry experience to demonstrate that wall thinning will not reduce wall thicknesses below ASME Code minimum wall thickness. The submittal in US-APWR section 3.6.3.3.3 evaluates wall thinning for the SA333 Grade 6 carbon steel of the main steam piping and concludes that wall thinning is not credible. The alloys selected for the main steam piping inside containment play an important role in preventing flow accelerated corrosion (FAC). However, the evaluation in the DCD does not specifically address FAC on elbows and other fittings. The application does not discuss in detail how the alloy selected will prevent FAC. Please provide additional information on FAC and also address elbows and fittings for the main steam piping. Provide more detail on the information in the DCD used to conclude that wall-thinning is not credible and the wall thickness of main steam piping will not be reduced below ASME Code minimum wall-thicknesses.

03.06.03-3

LBB evaluations as performed in accordance with SRP 3.6.3 requires an evaluation to demonstrate that stress corrosion cracking will not impact the structural

integrity of piping. The US-APWR Appendix 3B Figures 3B-7 through 3B-10 indicates that the RCL pipe materials are SA-182 F316LN and SA-182 F316. The specific weld alloys that will be used in the US-APWR and the potential for weld cracking were not identified in the LBB evaluation. The submittal in Section 3.6.3.3.4 evaluates stress corrosion cracking of stainless steel piping and the SA333 Grade 6 carbon steel of the main steam piping. The submittal concludes that SCC cracking is not a credible mechanism for stainless steels of the RCL, RCL branch piping and the ferritic steels of the main steam piping. The submittal addressed SCC, but did not specifically address Primary Water Stress Corrosion Cracking (PWSCC, see SRP, section III.3). Provide additional information to support the submittals conclusion and to address the following questions:

1) Provide additional information and evaluations on why PWSCC is not a potential source of pipe rupture and the selection of pipe material grades and weld alloys that are resistant to cracking by PWSCC. Clarify in the LBB evaluations which pipe material grades and weld alloys will be used in the US-APWR.
2) Provide information on the weld alloys used and the potential for cracking in welds by SCC or PWSCC. Please provide detailed information on what weld practices will be used to ensure PWSCC is not a concern due to chromium content, dilution effects, cleaning methods, weld qualifications and environmental effects on crack growth in Alloy 690.
3) Provide additional information on the guidelines the COL applicant should follow to maintain favorable water chemistries for the main steam piping.

03.06.03-4

The applicant in US-APWR Section 3.6.3.3 addresses the evaluation of potential failure mechanisms including: water hammer, creep damage, wall thinning induced by erosion/corrosion, SCC, fatigue, and thermal aging. The last sentence of Section 3.6.3.3 states that each failure mechanism and degradation source is evaluated below and confirmed as credible, thereby confirming LBB eligibility. The approach in SRP 3.6.3 is to evaluate these failure mechanisms to confirm that they are not credible. Clarify whether this sentence should have read, "…confirmed as not being credible, thereby confirming LBB eligibility."

03.06.03-5

The applicant addresses water hammer for RCL branch piping in Section 3.6.3.3.1 of the DCD and it states, "That water hammer has been reported in ECCS piping in the past. In US-APWR however, operational control is applied in a way that avoids water hammer." Also, the applicant addresses water

hammer in the Main Steam Piping and states that protection against water hammer is provided through operations and maintenance procedures and proper draining. Guidance in the SRP Section III.5 allows for the use of historical frequencies, operating procedures and design configurations to demonstrate that water hammer will not be a significant contributor. The SRP also indicates that measures to abate water hammer frequency and magnitude will be effective for the life of the plant. The US-APWR will be relying on operational controls, maintenance procedures and design configurations in a way that will avoid water hammer for the ECCS piping and Main Steam Piping. Please address the following questions:

1) Provide additional information in the DCD regarding the design features that will be in place to ensure that water hammer will not be a concern for the life of the plant.
2) Determine if a COL item is required to address the operational and maintenance controls described above that ensure water hammer will be avoided.

03.06.03-6

US-APWR DCD Section 3.6.3.3.5 address low-cycle and high-cycle fatigue and states that the US-APWR is designed to address the potential for fatigue failures. What specific design features are used to reduce the potential for fatigue failures in addition to the application of the ASME Code Section III? Clarify what operational controls are in place for vibration induced fatigue for the US APWR certified design. Please provide additional information on the methods used to mitigate the potential for fatigue failures.

03.06.03-7

US-APWR DCD Section 3.6.3.4.10 states that the bounding analysis results will be provided in the Technical Report (Reference 3.6-24). Reference 3.6-24 is titled “US-APWR Leak-Before-Break Evaluation” MHI Technical Report and states that it will be provided “Later.” Discuss when this report will be provided as part of the DCD documentation and when a copy will be available for NRC staff review. In addition, provide copies of a sample of LBB calculations. The sample calculations may include those for the Main Steam Line, the Pressurizer Surge Line, and RCS Loops, and should include both high stress and low stress conditions.

03.06.03-8

US-APWR DCD Figure 3.6-4 “LBB Evaluation Procedure of the US-APWR” is not consistent with a similar figure in Appendix 3B. Figure 3B-6 in Appendix 3B uses “Break: Restraints” for the no path and “Leak: No restraints” for the yes path. Figure 3.6-

4 uses “Not Qualified for LBB” for the no path and “Qualified for LBB” for the yes path. Please correct these figures so they are consistent or provide justification for why they should be different.

03.06.03-9

The US APWR DCD Appendix 3B titled “Bounding Analysis Curve Development for Leak-Before-Break Evaluation of High-Energy Piping for US-APWR” cites Reference 3B-16 titled “ESBWR Design Control Document, 26A6642AL, Rev. 2, 2006” Appendix 3E. This document is the source for the Ramberg-Osgood stress-strain curve and the J-T curve used for the evaluation of LBB for the main steam piping. It has been learned that Revision 4 of the ESBWR submittal has removed Appendix 3E because LBB will not be used for the ESBWR. An alternative reference should be provided as an appropriate source for Ramberg-Osgood and J-T curves that are applied to develop BAC curves for the US-APWR main steam piping.

03.06.03-10

The BAC curves of Figures 3B-11 through 3B-17 show lower cutoff on the normal stress axis that serves as a minimum value of normal stress for the curve. Section 3B.3.1.1 of Appendix B describes the steps used to construct the BAC plots and cites “Case 1” that equates this minimum stress value to the membrane stress P_m due to internal pressure under normal operation. Most of the curves of Figures 3B-11 through 3B-17 appear to be consistent with this definition. However, some of the Figures appear to be inconsistent. For example, Figure 3B-13 shows a lower limit value of about 3.9 ksi whereas the NRC review has calculated a value of 5.3 ksi ($P_m = pD_\circ/4t$ = 2235x10.74/4x1.125 = 5.3ksi). Please provide additional information and resolve the source of this apparent inconsistency.

03.06.03-11

The BAC curve for the main steam piping addresses the operating temperature of 535˚F. Standard Review Plan 3.6.3 (Section III.11.Biv) cites the need for calculations to address possible fracture at temperatures lower than the temperature of normal operation (e.g. hot standby). These calculations would account for the possibility of reduced toughness at the lower temperatures. Please provide additional information on the basis for performing the LBB evaluation for the main steam piping only for the normal operating temperature.

03.06.03-12

Two BAC plots are provided in Section 3.6.3 for the surge line. Figure 3B-11 is for normal operation at a pressure of 2235 psi and a temperature of 653˚F,

whereas Figure 3B-12 is for a pressure of 400psi and a temperature of 449˚F. What is the significance of the loading condition (lower temperature and pressure) used for Figure 3B-2? Please provide additional information and the rationale for selecting this loading condition.

03.06.03-13

The US APWR DCD Appendix 3B presents bounding analysis curves (Figures 3B-7 through 3B-17) for piping that is within the scope of the LBB evaluation. Please provide a consistent table that lists all piping that will use LBB evaluations, giving key parameters including systems, pipe diameters/wall thicknesses, piping materials, normal operating pressures, and normal operating temperatures.

03.06.03-14

US APWR DCD Appendix 3B, Table 3B-1 and Figure 3B-5 provide critical inputs to the LBB evaluation for the main steam piping. This is the only piping in the submittal that is constructed of ferritic steel and which therefore requires the more complex tearing instability calculations. Provide justification that these inputs provide a conservative or bounding basis for the LBB calculations. Provide additional information and the steps that will be taken to verify that the selected Ramberg-Osgood stress strain curve and $(J\text{-}T)_{mat}$ curve are suitable bounds for the properties of the as-built main steam piping.