MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

April 23, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09186

Subject: MHI's Response to US-APWR DCD RAI No. 210-1948

References: 1) "Request for Additional Information No. 210-1948 Revision 1, SRP Section: 03.06.03 – Leak-Before-Break Evaluation Procedures, Application Section: DCD, Tier 1 – Section 3.6.3," dated 2/25/2009.
2) "MHI's Response to US-APWR DCD RAI No. 210-1948," UAP-HF-09148, dated April 9, 2009

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 210-1948 Revision 1."

Enclosed are the responses to questions 2 and 3 of the RAI (Reference 1). This transmittal, in addition to Reference 2, completes the response to this RAI.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. Response to Request for Additional Information No. 210-1948, Revision 1

D081
NRO

CC: J. A. Ciocco
C. K. Paulson

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Docket No. 52-021
MHI Ref: UAP-HF-09186

Enclosure 1

UAP-HF-09186
Docket No. 52-021

Response to Request for Additional Information No. 210-1948,
Revision 1

April, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 210-1948 REVISION 1**
SRP SECTION:	**03.06.03 – Leak-Before-Break Evaluation Procedures**
APPLICATION SECTION:	**03.06.03**
DATE OF RAI ISSUE:	**2/25/2009**

QUESTION NO.: 3.6.3-2

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.

ANSWER:

DCD Subsection 10.3.6.3 describes flow assisted corrosion (FAC), including elbows for the main steam piping. Subsection 10.3.6.3 lists five design controls that have been used to address FAC:

1. Selection of corrosion resistant materials
2. Chemistry controls to minimize corrosion
3. Pipe schedule and wall thickness for design life of the plant
4. Corrosion allowances that meet either ASME Section III or ASME B31.1, as applicable
5. Flow velocities with industry standards

In addition, the COL applicant will be responsible for implementing a FAC monitoring program.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 210-1948 REVISION 1**
SRP SECTION:	**03.06.03 – Leak-Before-Break Evaluation Procedures**
APPLICATION SECTION:	**03.06.03**
DATE OF RAI ISSUE:	**2/25/2009**

QUESTION NO.: 3.6.3-3

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.

ANSWER:

1) The wrought stainless steel alloys SA-182 F316LN and SA-182 F316 are used for the piping. Compatible stainless steel GTA and SMA weld filler materials will generally be used for all welds between the stainless steel piping and between the piping and the reactor coolant pumps, steam generators and the reactor vessel. The dissimilar metal welds joining the piping and ferritic nozzles will be constructed with Alloy 52M/152 nickel-based weld filler metal. Note that Alloy 52M and Alloy 152 have similar alloy content to Alloy 690 wrought material. The weldments typically would consist of a butter application to the end of the ferritic nozzle and then joined by the same filler material directly to the stainless steel pipe or

safe end following the vessel post weld heat treatment (PWHT). This fabrication sequence avoids sensitization of the stainless steel weld heat affected zone due to the PWHT.

2) Limiting the amount of carbon and welding heat input reduces susceptibility of stainless steel weld material in PWR coolant to Primary Water Stress Corrosion Cracking (PWSCC). The stainless steel materials, including the welds, have not shown susceptibility to PWSCC in a PWR primary water environment. The only material in existing PWR plants that has exhibited susceptibility to PWSCC is Alloy 600 and its compatible weld filler metals, Alloy 82/182. These materials are found in the dissimilar metal welds joining the ferritic nozzles to the stainless steel piping or safe-ends. For Alloy 182, the Cr content can be as low as 14%. This is well below the accepted threshold for high resistance to PWSCC (24% Cr). Both Alloy filler metals 52M and 152 contain nominally 30% Cr, which is well above the accepted threshold that has been qualified by testing as being highly resistant to PWSCC. This qualification is documented in MRP-139 (Reference 1, below), where PWSCC resistant materials are identified as including high nickel materials and resistant welding materials, including Alloy 52M for GTAW and Alloy 152 for SMAW, having nominally 30% chromium.

   To assure that PWSCC will not be a concern for the dissimilar metal welds, the following weld practices will be followed:

   1. The weld material will be procured to an ASME specification that requires that the material meet the requirements for ERNiCrFe7A (Alloy 52M) or ENiCrFe7A (Alloy 152) or equivalents. The composition of each lot of weld filler metal shall be certified by the manufacturer to meet the ASME chemical requirements for those weld filler materials.

   2. All dissimilar metal welds joining austenitic stainless steel pipe to ferritic steel nozzles, shall be qualified to establish that the filler materials and welding procedure will produce a chromium level in the initial layers adjacent to the dissimilar metals to a level equal to or greater than 24% Cr. This requirement shall be validated by a representative mock up, welding procedure qualification test, or both. Machine GTA welding shall be limited to a maximum of 45 kJ/in and shall establish an effective Power Ratio range (as defined by Section IX) to control weld dilution and provide quality weld deposits. SMA welding may be controlled by heat input limits only.

   3. Cleaning and other preparation methods shall use only materials that are compatible with the nickel based material and are designed so as to not contaminate these materials with regards to weldability issues and/or service corrosion performance.

   4. As required by Section IX of the ASME Code, weld qualification tests and procedure qualifications shall be performed, as required, to verify the procedure is capable of producing welds that meet the required mechanical and chemical properties for the material specifications. All field welds shall be designed to meet these requirements.

3) Subsection 10.3.5.1 describes water chemistry. This information will be used as guidelines by the COL applicant.

Reference 1 - EPRI MRP-139, *Material Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline*, Rev. 1, December 2008

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes MHI's responses to the NRC's questions.