

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

December 14, 2010

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-10331

**Subject:** MHI's Response to US-APWR DCD RAI No. 653-5208 (SRP 04.05.02)

**References:** 1) "Request for Additional Information No. 653-5208 Revision 2, SRP Section: 04.05.02 – Reactor Internal and Core Support Structure Materials, Application Section: DCD, Tier 2 – Section 4.5.2" dated 11/01/2010.

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. 653-5208-Revision 2."

Enclosed are the responses to the question 04.05.02-24 of the RAI (Reference 1).

As indicated in the enclosed materials, this submittal contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential. A non-proprietary version of the document is also being submitted with the information identified as proprietary redacted and replaced by the designation "[ ]" (brackets).

This letter includes a copy of the proprietary version (Enclosure 2), a copy of the non-proprietary version (Enclosure 3), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) and 10 C.F.R. § 9.17 (a)(4).

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.

D081  
NRD

Enclosures:

1. Affidavit of Yoshiki Ogata
2. Response to Request for Additional Information No. 653-5208, Revision 2 (Proprietary)
3. Response to Request for Additional Information No. 653-5208, Revision 2 (Non-Proprietary)

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

Contact Information

C. Keith Paulson, Senior Technical Manager  
Mitsubishi Nuclear Energy Systems, Inc.  
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Monroeville, PA 15146  
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## Enclosure 1

Docket No. 52-021  
MHI Ref: UAP-HF-10331

### **MITSUBISHI HEAVY INDUSTRIES, LTD.**

#### **AFFIDAVIT**

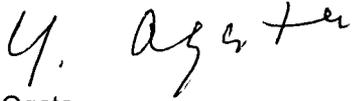
I, Yoshiki Ogata, state as follows:

1. I am General Manager, APWR Promoting Department, of Mitsubishi Heavy Industries, LTD ("MHI"), and have been delegated the function of reviewing MHI's US-APWR documentation to determine whether it contains information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential.
2. In accordance with my responsibilities, I have reviewed the enclosed document entitled "Response to Request for Additional Information No. 653-5208, Revision 2", dated December, 2010, and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages contain proprietary information are identified with the label "Proprietary" on the top of the page, and the proprietary information has been bracketed with an open and closed bracket as shown here "[ ]". The first page of the document indicates that all information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).
3. The information identified as proprietary in the enclosed document has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.
4. The basis for holding the referenced information confidential are as follows:
  - A. They include the know-how and outputs of analyses used by mathematical models developed at significant cost to MHI. It required the performance of detailed design calculations, supporting analyses and testing extending over several years. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.
  - B. They include the information from documents the copyrights of which are reserved by third parties.
5. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.
6. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without the costs or risks associated with the design

of new systems and components. Disclosure of the information identified as proprietary would therefore have negative impacts on the competitive position of MHI and the Licensors in the U.S. nuclear plant market.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 14<sup>th</sup> day of December 2010.

A handwritten signature in black ink, appearing to read "Y. Ogata". The signature is written in a cursive style with a large initial "Y" and a long, sweeping underline.

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

Enclosure 3

UAP-HF-10331  
Docket No. 52-021

Response to Request for Additional Information No. 653-5208,  
Revision 2

December, 2010  
(Non-Proprietary)

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**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

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12/13/2010

**US-APWR Design Certification  
Mitsubishi Heavy Industries  
Docket No. 52-021**

**RAI NO.:** NO. 653-5208 REVISION 2  
**SRP SECTION:** 4.5.2 – REACTOR INTERNALS AND CORE SUPPORT  
STRUCTURE MATERIALS  
**APPLICATION SECTION:** 04.05.02  
**DATE OF RAI ISSUE:** 11/01/2010

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**QUESTION NO.: 04.05.02-24**

In its response to RAI 374-2446 Question 03.09.05-9 relative to IASCC, the applicant stated that its assessment of IASCC was performed in accordance with EPRI's MRP175 guidelines. The staff notes that Appendix B to MRP-175 provides screening criteria for PWR internals for the combination of stress and neutron exposure. The applicant's response to RAI 374-2446 Question 03.09.05-9 provides the stress threshold and neutron exposure for the US-APWR neutron reflector block alignment pin, neutron reflector tie-rod, and core barrel. The staff confirmed that the stress threshold for IASCC provided in this response was calculated in accordance with the guidance of MRP-175. However, the applicant's response to RAI 374-2446 Question 03.09.05-9 does not clearly provide the operational stress for the alignment pin, tie-rod, and core barrel or whether the operational stress will be below the MRP-175 stress threshold for IASCC. Please discuss (1) the anticipated operational stress for the US-APWR neutron reflector alignment pin, neutron reflector tie-rod, and core barrel and (2) whether this operational stress is predicted to be below the MRP-175 stress threshold for IASCC. If the applicant cannot confirm that these components fall below the MRP-175 stress threshold for IASCC, provide an assessment that IASCC is not a concern for these components during the design life of 60 years or define an acceptable program for assessing and managing the effects of IASCC on reactor internals.

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**ANSWER:**

In operating 4-loop plants, the baffle bolts are used in the most severe conditions from the viewpoint of IASCC because of its high stress and locations facing the core. The baffle plate design has been replaced by a neutron reflector in the US-APWR. In this design, the high stressed parts for junctions such as the block alignment pins or tie rods are located in the outer portion of the reflector where the neutron flux is lower. In addition, the irradiation on the core barrel is also greatly reduced by the neutron reflector. Therefore, the risk for IASCC for the US-APWR reactor internals is lower than the conventional plants with a baffle design.

Further quantitative assessment of IASCC was performed for the neutron reflector block alignment pins, tie rods and the core barrel in accordance with EPRI MRP-175 guidelines. In MRP-175, the neutron dose of [3] dpa is suggested as an initial screening criteria for the PWR

reactor internals. <sup>(1)</sup> Structures on which the exposure exceeds the initial screening criteria are evaluated using a stress threshold curve proposed for IASCC initiation of austenitic stainless steels. This curve takes into account the observed baffle bolt failures in Europe and is represented by the following equation: <sup>(2)</sup>



As shown in Table 1, the neutron exposure during 60-year operation on each structure exceeds the screening criteria [3] dpa. Therefore, the stress thresholds based on the neutron exposure are evaluated as the second step of screening.

The stress on each structure in normal operating conditions is also provided and compared with the stress threshold for IASCC in Table 1.

The stress on the neutron reflector block alignment pin is a bearing stress due to the thermal deformation of the ring blocks of the neutron reflector. The stress on the tie rod is from the pre-load tension and thermal expansion of the neutron reflector ring blocks. The pre-load tension of the tie rods is adjusted so that the total stress does not exceed 0.9 Sy where Sy is the yield stress of the material. As a result, the operating stresses on both parts of the neutron reflector are lower than the screening threshold for IASCC.

The core barrel is fabricated by welding of the core barrel flange, three segments of barrel shells and the lower core support plate. The weld joint located in height of the effective core is selected for the screening because of the combination of the residual stress on weld junction and higher irradiation. The stress relaxation by irradiation is not taken into account for a conservative assumption. The result shows that the stress on the middle weld junction does not exceed the IASCC stress threshold.

As a summary, the operating stresses of the neutron reflector block alignment pins, tie rods and the core barrel weld joint are lower than the stress threshold for IASCC suggested by EPRI MRP-175 guidelines. The other components that make up the reactor internals are not of a concern in terms of IASCC because the neutron exposure during 60-year operation does not exceed the screening criteria of [3] dpa.

**References:**

- (1) Materials Reliability Program: PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values (MRP-175), Appendix-B: IRRADIATION ASSISTED CORROSION CRACKING, the third paragraph of Page B-7, EPRI 2005.
- (2) Materials Reliability Program: PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values (MRP-175), Appendix-B: IRRADIATION ASSISTED CORROSION CRACKING, Figure B-3, EPRI, 2005.

Table 1 Assessment of IASCC for US-APWR Neutron Reflector parts and Core Barrel

	Neutron Exposure (dpa)	Stress Threshold for IASCC (ksi)	Stress in Normal Operation (ksi)	Assessment
Neutron Reflector Block Alignment Pin	[			No IASCC
Neutron Reflector Tie Rod				No IASCC
Core Barrel (Weld Joint in Core Elevation )				No IASCC

**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.