MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

January 29, 2010

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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10020

Subject: MHI's Response to US-APWR DCD RAI No. 509-4114 REVISION 2

Reference: 1) "Request for Additional Information No. 509-4114 Revision 2, SRP Section: 05.02.03 - Reactor Coolant Pressure Boundary Materials, Application Section: DCD Tier 2, Section 5.2.3" dated December 15, 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. 509-4114 Revision 2."

Enclosed is the response to the RAI contained within Reference 1.

As indicated in the enclosed material, this document 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 "[ ]".

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).

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

Sincerely,

Y. Ogata

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

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Enclosures:

1. Affidavit of Yoshiki Ogata

2. Response to Request for Additional Information No. 509-4114 Revision 2 (Proprietary version)

3. Response to Request for Additional Information No. 509-4114 Revision 2 (Non-proprietary version)

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

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ENCLOSURE 1

Docket No.52-021
MHI Ref: UAP-HF-10020

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. 509-4114 Revision 2", and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages containing 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 is that it describes the actual plant experience, unique design methodology and acceptance criteria developed by MHI for the Fuel assemblies of the US-APWR. These technologies and information were developed at significant cost to MHI, since they required the performance of detailed calculations, 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.

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. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

7. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without incurring the costs or risks associated with the design of the subject systems. Therefore, disclosure of the information contained in the

referenced document would have the following negative impacts on the competitive position of MHI in the U.S. nuclear plant market:

A. Loss of competitive advantage due to the costs associated with establishments of design technology of the fuel system. Providing public access to such information permits competitors to duplicate or mimic the methodology without incurring the associated costs.

B. Loss of competitive advantage of the US-APWR created by benefits of enhanced safety and reliability of the fuel system.

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 29th day of January, 2010.

Y. Ogata

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

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Enclosure 3

UAP-HF-10020
Docket Number 52-021

Response to Request for Additional Information
No. 509-4114 Revision 2

January 29, 2010
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION 509-4114 (R2)

1/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO.509-4114 REVISION 2**
SRP SECTION:	**05.02.03- Reactor Coolant Pressure Boundary Materials**
APPLICATION SECTION:	**5.2.3**
DATE OF RAI ISSUE:	**12/15/2009**

QUESTION NO. : 05.02-03-18

Background

DCD Section 5.2.3.2.1 states that a soluble zinc (Zn) compound depleted of Zn-64 may be added to the reactor coolant as a means to reduce radiation fields within the primary system. DCD Section 5.2.3.2.1 further states that when used, the target system zinc concentration is normally maintained to a concentration no greater than 10 ppb. The staff reviewed several reports documenting industry experience with zinc addition in PWR's, which indicate that there is no concern with crud deposition for plants with low duty or medium-duty cores (Reference 1, 2), and, in fact, zinc addition typically leads to thinner, more evenly distributed crud on fuel. However, there is currently insufficient operating experience with zinc addition in plants with high-duty cores to be able to conclude that zinc injection would not cause a problem with crud deposition in such plants. Core duty is a measure of the amount of subcooled nucleate boiling (SNB) occurring in the core. Plants with high-duty cores are those with high fluid temperatures and high surface heat flux at the fuel clad causing a portion of the total heat transfer to the coolant to occur by sub-cooled nucleate boiling (SNB). Although favorable for thermal efficiency, the combination of high temperature and SNB leads to more severe duty on the fuel, and surface boiling is known to enhance the formation of corrosion product deposits (crud) at the cladding surface. The tendency for SNB can be quantified by means of the High Duty Core Index (HDCI), calculated in accordance with Appendix F of Reference 3. Cores with an HDCI of $\geq$ 150 are considered to be high duty plants, medium duty plants have HDCI of 120-149, and a plant with HDCI $\leq$ 119 is considered a low-duty plant. Staff calculations based on thermal-hydraulic data from DCD Chapter 4 indicate the US-APWR core may be considered high-duty. There may be alternate methods to determine the amount of SNB other the HDCI, such as detailed thermal hydraulic computer models. Potential problems with crud deposition could include excessively thick fuel crud, or uneven crud thickness that could lead to crud induced power shift (CIPS), also known as axial offset anomaly (AOA). Reference 2 recommends a fuel surveillance program for high-duty plants implementing zinc addition. DCD Section 4.2.1.7 describes the fuel surveillance program for the US-APWR, which will specify the inspection items, inspection criteria, methodology, schedule, for a number of different aspects, including crud deposition. However, the inspection method and acceptance criteria for crud on the fuel are not described.

Requested Information

1. Is the US-APWR core design as described in DCD Revision 2 considered a highduty core when the HDCI is calculated in accordance with Appendix F of Reference 3, or an alternate method of evaluation?

2. If the US-APWR core is considered high-duty, how will the risk of CIPS be evaluated? Will zinc addition be considered in this evaluation?

3. Describe the test methods and acceptance criteria that will be included in the fuel surveillance program for crud on fuel surfaces. Will a COL information item be included to ensure the COL establishes the fuel surveillance program?

References

1. Overview Report on Zinc Addition in Pressurized Water Reactors—2004, 1009568 Final Report, December 2004, Electric Power Research Institute

2. Pressurized Water Reactor Primary Water Zinc Application Guidelines 1013420 Final Report, December 2006, Electric Power Research Institute

3. PWR Axial Offset Anomaly (AOA) Guidelines, Revision ,1008102, Final Report, June 2004, Electric Power Research Institute

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ANSWER:

1. The HDCI of the US-APWR core has been discussed with the NRC, Reference 1-1. The HDCI for the US-APWR is [
] as defined in Appendix F of Reference 1-2. [

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2. According to EPRI's classification, core of US-APWR may be high-duty core. However, deposited crud amount on fuel of US-APWR will be little, concerning about actual result of Japanese PWR. It was reported that crud amount of Tsuruga 2 on fuel surface was less than $2mg/dm^2$. (Reference 2-1) And it was reported that long-term zinc injection would reduce a plant's risk of AOA by reducing out-of-core corrosion and release rate. (Reference 2-2) Therefore, amount of crud on fuel surface with zinc injection will be less than without zinc injection.

3. MHI will implement a crud measurement surveillance program, in addition to the cladding oxide surveillance program identified in the response to Question 48, RAI on Topical report MUAP-07008-P(0) (Reference 3-2), and the assembly growth, assembly bow, total gap and rod bow surveillance programs identified in the response to Question 04.02-19, RAI No.129-1673 (Reference 3-1), to validate the Safety Analysis. Some of the US-APWR fuel assemblies loaded in the initial core and reload core will be examined to confirm their performance.

The crud will be measured in the spent fuel pit by the following procedure:

(1) Crud samples will be scraped from the fuel rods using the "deposit sampling equipment" to collect the crud samples. The "deposit sampling equipment" used for Japanese plants is shown in Reference 3-3,

(2) The crud surface concentrations will be calculated by measuring the weight of crud and area scraped, and

(3) The crud chemical composition will be determined by chemical analysis.

The acceptance criterion for the US-APWR crud surveillance is [ ]. The existence of crud can affect subcooled boiling characteristics and therefore the DNB analyses. Although VIPRE-01M does not directly account for the effects of crud, it has been demonstrated to conservatively bound the conventional THINC analyses (in which a [ ] crud layer is used) due to selecting the conservative VIPRE-01M subcooled void model (Reference 3-4).

The tentative surveillance program is shown in Table 3-1. Utility concurrence will be obtained for the items to be measured and the number of assemblies or samples to be inspected.

References

(1-1) " Transmittal of the ACRS Subcommittee meeting materials regarding AOA issue...", UAP-HF-08256, October 31, 2008

(1-2) "PWR Axial Offset Anomaly (AOA) Guidelines", Revision 1,1008102, Final Report, June 2004, Electric Power Research Institute

(2-1) K. Hisamune, et al., "New Aspect of DH control in PWR Primary Water Chemistry", 1998 JAIF International Conference on Water Chemistry in Nuclear Power Plants, Oct. 13-16,1998 Kashiwazaki, Japan

(2-2) Pressurized Water Reactor Primary Water Zinc Application Guidelines 1013420 Final Report, December 2006, Electric Power Research Institute

(3-1) "MHI's Responses to US-APWR DCD RAI NO.12-1673 Revision 1", UAP-HF-09024-P (R0) (Proprietary) and UAP-HF-09024-NP (R0) (Non-Proprietary), January 30, 2009

(3-2) "MHI's Amended Responses to NRC's RAI "Mitsubishi Fuel Design Criteria and Methodology", UAP-HF-09538-P (R0) (Proprietary), January 30, 2009, November 2009

(3-3) M.Yamada,etal., "Correlation between Deposition Fuel, pH Control and Radiation Field Trend", 1988 JAIF International Conference on Water Chemistry in Nuclear Power Plants, April 19-22,1988,Tokyo

(3-4) "Thermal Design Methodology", MUAP-07009-P (Proprietary) and MUAP-07009-NP (Non-Proprietary), May 2007.

Table 3-1 Tentative Surveillance Program
Crud Measurements for Fuel Assemblies loaded into the Initial Core

Measurements	Number of Assemblies/spans/samples	Inspection Method	Acceptance Criteria

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 response to the NRC's question.