MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

April 5, 2012

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-12087

Subject: MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3 (SRP 15.4.8)

Reference:
1) "Request for Additional Information No. 911-6326 Revision 3, SRP Section: 15.04.08 - Spectrum of Rod Ejection Accidents (PWR) - Application Section: 15.4.8", dated March 12, 2012.
2) "Supplemental Documentation in Support of MHI's Revised 15th Response to NRC's Requests for Additional Information on US-APWR Topical Report: Non-LOCA Methodology, MUAP-07010-P (R1)", MHI letter UAP-HF-11277, dated August 31, 2011 (ML112550251).

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the document entitled "MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3 (SRP 15.4.8)" and the Optical Storage Medium ("OSM") entitled "Non-LOCA Methodology Topical Report MUAP-07010 (R3)".

Enclosed is the response to the RAI contained within Reference 1. Also enclosed is an OSM that contains a revision to MUAP-07010 "Non-LOCA Methodology", previously transmitted via Reference 2. This new revision reflects a clarification of the rod ejection analysis methodology described in the enclosed RAI response. This topical report supplements the materials provided in the "Design Control Document for the US-APWR" ("DCD"), and is incorporated by reference in the DCD, but there is no impact on the DCD itself.

As indicated in the enclosed materials, the enclosed RAI response document and OSM contain 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. Accordingly, the topical report is being submitted in two versions on separate OSMs. One version (Enclosure 4) contains the complete proprietary version of the topical report. The non-proprietary version of the topical report is included in Enclosure 5. In the non-proprietary version, the proprietary information, bracketed in the proprietary version, is replaced by the designation "[ ]". Similarly, a non-proprietary version of the RAI response 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 of the RAI response (Enclosure 2), a copy of the non-proprietary version of the RAI response (Enclosure 3), a proprietary OSM (Enclosure 4), a non-proprietary OSM (Enclosure 5), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all material designated as "Proprietary" in Enclosures 2 and 4 be withheld from disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

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NRO

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc., if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata
Director - APWR Promoting Department
Mitsubishi Heavy Industries, Ltd.

Enclosures:

1. Affidavit of Yoshiki Ogata
2. MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3 (SRP 15.4.8) (proprietary)
3. MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3 (SRP 15.4.8) (non-proprietary)
4. OSM 1: Non-LOCA Methodology Topical Report MUAP-07010 (R3) (proprietary)
5. OSM 2: Non-LOCA Methodology Topical Report MUAP-07010 (R3) (non-proprietary)

The files contained on OSM 1 and OSM 2 are listed in Attachments 1 and 2 hereto, respectively.

CC: J. A. Ciocco
J. Tapia

Contact Information

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ENCLOSURE 1

Docket No. 52-021
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MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, being duly sworn according to law, depose and state as follows:

1. I am Director, 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 "MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3 (SRP 15.4.8)" and the enclosed OSM entitled "OSM 1: Non-LOCA Methodology Topical Report MUAP-07010 (R3)", both dated April 5, 2012, and have determined that the document and OSM 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 and the OSM indicate that information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

3. The basis for holding the referenced information confidential is that it describes the unique design of the safety analysis, developed by MHI (the "MHI Information").

4. The MHI Information is not used in the exact form by any of MHI's competitors. This information was developed at significant cost to MHI, since it required the performance of research and development and detailed design for its software and hardware extending over several years. Therefore public disclosure of the materials would adversely affect MHI's competitive position.

5. The referenced information has in the past been, and will continue to be, held in confidence by MHI and is always subject to suitable measures to protect it from unauthorized use or disclosure.

6. The referenced information is not available in public sources and could not be gathered readily from other publicly available information.

7. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of supporting the NRC staff's review of MHI's application for certification of its US-APWR Standard Plant Design.

8. 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 and testing of new systems and components. Disclosure of the information identified as proprietary would therefore have negative impacts on the competitive position of MHI 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 5th day of April, 2012.

Yoshiki Ogata
Director - APWR Promoting Department
Mitsubishi Heavy Industries, Ltd.

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ENCLOSURE 3

UAP-HF-12087
Docket No. 52-021

MHI's Response to US-APWR DCD RAI No. 911-6326 Revision 3

April 2012

(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/05/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 911-6326 REVISION 3**
SRP SECTION:	**15.04.08 – SPECTRUM OF ROD EJECTION ACCIDENTS (PWR)**
APPLICATION SECTION:	**15.4.8**
DATE OF RAI ISSUE:	**03/12/2012**

QUESTION NO.: 15.04.08-12

Follow-on to RAI 2361, Question 15.4.8-8
In response to RAI 2361, Question 15.4.8-8, MHI stated that the dynamic gap conductance is based on the Ross-Stoute model. No explanation was provided as whether the Ross-Stoute model is acceptable or conservative when used for the short-term, rods in DNB or peak RCS pressure cases. Provide a basis as to why the Ross-Stoute dynamic gap conductance model can be used for the short-term, rods in DNB and peak RCS pressure REA cases.

ANSWER:

As stated in the response to the previous RAI 313-2361 Question 15.4.8-8, MHI uses the dynamic gap model in the VIPRE-01M analyses for the short-term rods in DNB and RCS pressure cases in the rod ejection event. The dynamic gap model is used because the gap conductance increases due to the pellet thermal expansion and consequently the heat release from the fuel rod increases. The VIPRE-01M model, a simplified version of the one from the widely known fuel rod performance codes, GAPCON and FRAP, is identical to the one which was originally implemented in the EPRI version of VIPRE-01 and was approved by the NRC to be utilized in licensing analyses (Ref. 15.04.08-12.1).

Since the gap conductance increases during the transient, it is necessary to adequately model these increases to prevent the results from being non-conservative. One way to model these increases is to conservatively assume that the gap conductance rapidly increases to the maximum possible value. DCD Section 15.3.3.3.2 describes the maximum gap heat transfer coefficient to be a conservative value of 14,000 BTU/ft^2-h-°F. This gap conductance analysis assumption is currently used in the rod ejection analysis for the cladding temperature analysis. However, MHI considers this approach to be overly conservative for the short-term rods in DNB and RCS pressure cases.

Instead, MHI uses the VIPRE-01M model to realistically calculate the gap conductance increases. The VIPRE-01M model calculates gap width based on pellet and cladding thermal expansion and elastic strain, and calculates thermal conductivity from gap temperature and gap gas compositions. (The gap gas compositions are input from the FINE code results.) Then from the gap width and thermal conductivity, the VIPRE-01M model can determine Hgap. This model does not include details such as fission gas release due to burnup, etc., which are included in the fuel design code FINE, which is a much more detailed code except for transient calculation capability and is used in

fuel design calculations in DCD Chapter 4 (Ref. 15.04.08-12.2). However those detailed model effects are essentially included in VIPRE-01M analysis initial conditions, since the initial gap condition of VIPRE-01M analysis is provided so as to be consistent with the FINE result [ ] As the reviewer indicated, this dynamic gap model does not have direct validation results showing its conservativeness due to the lack of adequate experiments. Therefore, MHI has compared the gap conductance calculated by VIPRE-01M with that calculated by the fuel design code FINE at a wide range of linear heat rate conditions that covers the transient conditions. Since the transient behavior of the fuel pellet-cladding gap is dominated by the thermal expansion of the fuel pellet and gap gas temperature and the transient behavior in the short time period of the VIPRE-01M analysis, such as the additional fission product gas release from the pellet is negligible, this comparison with the steady state results of the FINE code provides a meaningful conclusion. Figure 15.04.08-12.1 shows the gap conductance calculated by the dynamic gap model of VIPRE-01M compared with the FINE results at the same linear heat rate conditions. [ ] Figure 15.04.08-12.1 shows that VIPRE-01M is able to calculate the relative gap conductance changes due to the fuel rod power changes as well as FINE. Therefore, the adequacy of the VIPRE-01M gap model is confirmed by the comparison with FINE. This ensures that the gap conductance used in the VIPRE-01M calculation will be realistic (i.e. will not be non-conservative) and the overall conservativeness of the analyses will be ensured based on the conservative assumptions utilized for other key parameters such as the reactivity insertion and the hot spot peaking factor.

In order to demonstrate this, MHI has performed a sensitivity study to the gap conductance for the short-term rods in DNB case. [ ]

The descriptions of the gap conductance assumptions for each of the rod ejection analysis cases are provided in Section 5.3 (5) (c) of the Non-LOCA Methodology Topical Report MUAP-07010. However, the current description (R2) for the rods in DNB cases says that the gap conductance remains constant at the initial value. This is incorrect. Therefore, MHI has revised the Non-LOCA Methodology Topical Report MUAP-07010 Section 5.3 (5) (c) to correct this error. Note that DCD Section 15.4.8 only provides the limiting cases. For the rods in DNB calculation, the short-term case is not the limiting case. Therefore, the gap conductance assumption (i.e. realistic increases) for the short-term rods in DNB case is not described in the DCD.

Reference:

15.04.08-12.1 "VIPRE-01: A Thermal-Hydraulic Code for Reactor Cores," NP-2511-CCM-A Revision 4, Electric Power Research Institute (EPRI), February 2001.

15.04.08-12.2 "Mitsubishi Fuel Design Criteria and Methodology", MUAP-07008-P Rev.2 (Proprietary) and MUAP-07008-NP Rev.2 (Non-Proprietary), Mitsubishi Heavy Industries, July 2010.

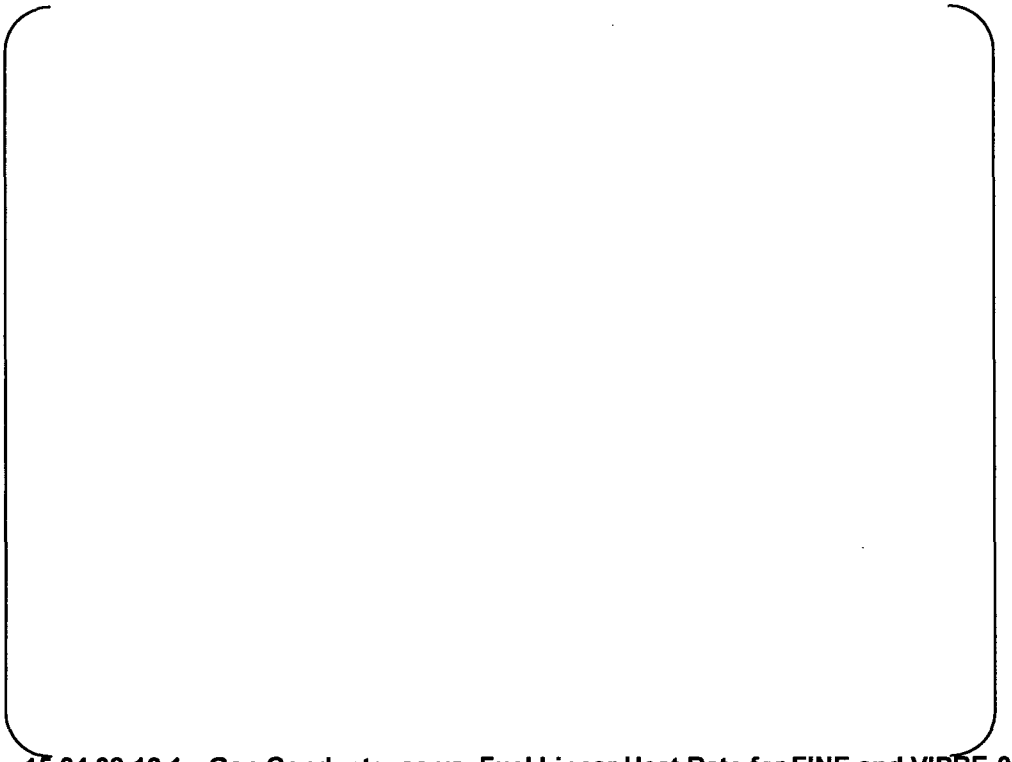

Figure 15.04.08-12.1 Gap Conductance vs. Fuel Linear Heat Rate for FINE and VIPRE-01M Gap Conductance Sensitivity Study

Figure 15.04.08-12.2 Gap Conductance vs. Fuel Linear Heat Rate for FINE and VIPRE-01M Gap Conductance Sensitivity Study

Figure 15.04.08-12.3 Hot Channel Heat Flux vs. Time
Gap Conductance Sensitivity Study

Figure 15.04.08-12.4 DNBR vs. Time
Gap Conductance Sensitivity Study

Impact on DCD

There is no impact on the DCD.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical Report

The Non-LOCA Methodology Topical Report, MUAP-07010, is revised as described in the response above. Revision 3 of MUAP-07010 is included as an enclosure to this RAI response.

This completes MHI's response to the NRC's question.

ATTACHMENT 1

Docket No. 52-021
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FILES CONTAINED ON OSM 1

OSM 1: Non-LOCA Methodology Topical Report MUAP-07010 (R3) (proprietary)

Contents of CD

	File Name	Size	Sensitivity Level
1.	001_MUAP-07010-P_R3.pdf	2339 KB	Proprietary

ATTACHMENT 2

Docket No. 52-021
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FILES CONTAINED ON OSM 2

OSM 2: Non-LOCA Methodology Topical Report MUAP-07010 (R3) (non-proprietary)

Contents of CD

	File Name	Size	Sensitivity Level
1.	001_MUAP-07010-NP_R3.pdf	1849 KB	Non-Proprietary