MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

July 3, 2009

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-09344

Subject: MHI's Response to US-APWR DCD RAI No. 308-2340 Revision 2

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. 308-2340 Revision 2". The enclosed materials provide MHI's response to the NRC's "Request for Additional Information (RAI) 308-2340 Revision 2," dated May 4, 2009.

As indicated in the enclosed materials, 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 in this package (Enclosure 3). In the non-proprietary version, the proprietary information, bracketed in the proprietary version, is 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), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all material designated as "Proprietary" in Enclosure 2 be withheld from 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 this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

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

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NRO

Enclosures:

1. Affidavit of Yoshiki Ogata
2. MHI's Response to US-APWR DCD RAI No. 308-2340 Revision 2 (proprietary)
3. MHI's Response to US-APWR DCD RAI No. 308-2340 Revision 2 (non-proprietary)

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

Contact Information

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ENCLOSURE 1

Docket No. 52-021

MHI Ref: UAP-HF-09344

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, being duly sworn according to law, depose and 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 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. 308-2340 Revision 2" dated July 3, 2009, and have determined that the document contains 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 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 3rd day of July, 2009.

Y. Ogata

Yoshiki Ogata

ENCLOSURE 3

UAP-HF-09344
Docket No. 52-021

MHI's Response to US-APWR DCD RAI No. 308-2340 Revision 2

July 2009

(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/03/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 308-2340 REVISION 2**
SRP SECTION:	**15.04.01 – UNCONTROLLED CONTROL ROD ASSEMBLY WITHDRAWAL FROM A SUBCRITICAL OR LOW POWER STARTUP CONDITION**
APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-1

TWINKLE-M is used to analyze the uncontrolled RCCA withdrawal event from zero power using a one-dimensional model. It is claimed that with the assumptions used, the methodology will lead to a conservative result. Show comparisons with the results of a three-dimensional model to justify that this approach is conservative.

ANSWER:

MHI has compared the 1-D model to two cases of 3-D model TWINKLE-M calculations. The first case is a conservative 3-D case whose main analysis conditions are coordinated to match the 1-D case. The reactivity insertion rate is 75 pcm/sec and is input using an external model, the same as the 1-D model. The main difference between the 1-D and 3-D analysis conditions is in the Doppler feedback. A Doppler weighting factor of 1.0 is applied for the 1-D case for conservatism (no radial power shape weighting), but a realistic radial power distribution effect is modeled in the 3-D calculation.

The second case is a more realistic 3-D case. The main analysis conditions are basically the same as the conservative 3-D case, except that the control rod bank withdrawal from the hot zero power insertion limit position is realistically modeled and no external reactivity insertion is modeled.

The results of the 1-D and both 3-D cases were compared for the key parameters for this event. The transient analysis results for reactor power, DNBR, and fuel centerline temperature are shown below in Figures 15.4.1-1.1 to 15.4.1-1.3, respectively. The minimum DNBR and maximum fuel centerline temperature values are summarized below in Table 15.4.1-1.1. As can be seen from the table and figures, the 1-D case is more conservative than the conservative 3-D case due to the difference in Doppler feedback. The conservative 3-D case is more conservative than the realistic 3-D case due to the difference in reactivity insertion modeling. In conclusion, the 1-D model presented in the DCD is a conservative approach for the uncontrolled RCCA withdrawal event from zero power.

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.

Table 15.4.1-1.1
Minimum DNBR and Fuel Temperature Summary

Calculation Model	Minimum DNBR	Fuel Centerline Temperature (°F)
DCD Case (1-D)		
3-D Conservative Case		
3-D Realistic Case		

Figure 15.4.1-1.1 **Reactor Power versus Time**
Comparison between 1-D and 3-D Results

Figure 15.4.1-1.2 DNBR versus Time
Comparison between 1-D and 3-D Results

Figure 15.4.1-1.3 Fuel Temperature versus Time
Comparison between 1-D and 3-D Results

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APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-2

Explain what is meant by the statement "appropriate cross section data is selected to assure minimum Doppler feedback conditions" made in Section 15.4.1.3.2.

ANSWER:

The cross section data is generated using the nuclear design analysis methodology. The cross section data by itself is not conservative. Therefore, the conservatism in the safety analysis is added by using a conservative multiplier in TWINKLE-M to decrease the fast absorption cross section. This is described in the first bulleted item of DCD Subsection 15.4.1.3.2. The Doppler temperature coefficient is adjusted towards zero by 20% from the design value as shown in DCD Table 15.0-1.

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.

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APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-3

In DCD Section 15.4.1.3.2, explain why assuming "the effective multiplication factor to be one" maximizes the neutron flux peak?

ANSWER:

If the control rod bank withdrawal from startup conditions is realistically modeled with an initial effective multiplication factor of less than one, the reactor may trip on the source range trip function and the core may not actually go critical under such realistic conditions. Therefore, in order to assure that criticality occurs, the effective multiplication factor should be one. The neutron flux peak will be a maximum for the case where criticality occurs. However, MHI uses an external reactivity insertion of 75 pcm/sec to bound the reactivity insertion rate condition. The external reactivity insertion continues at that same rate until the reactor trips. Under this conservative assumption, criticality is attained and therefore the analysis is not sensitive to the initial effective multiplication factor.

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.

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APPLICATION SECTION: **15.4.1**

DATE OF RAI ISSUE: **5/04/2009**

QUESTION NO.: 15.4.1-4

How does the "conservative" withdrawal rate of 75 pcm/s for the uncontrolled RCCA bank withdrawal compare with the rate expected for both zero and full power initial conditions?

ANSWER:

The 75 pcm/sec maximum positive reactivity insertion rate used in the Chapter 15 safety analysis conservatively bounds the assumption that two control banks are withdrawn simultaneously from core bottom to core top at the hot zero power condition for both BOC and EOC. The maximum positive reactivity insertion rate based on the core calculation results is derived from multiplying the maximum differential control rod worth (pcm/step) by the maximum control rod drive speed (step/sec).

The maximum value of positive reactivity insertion rate for the first cycle described in Section 4.3 of the US-APWR DCD is ( ) which is bounded by the 75 pcm/sec assumed value with sufficient margin.

Based on established control rod insertion limits, all control rods are fully withdrawn at the hot full power condition except for control group bank D at the bite position. Therefore, two control banks cannot be withdrawn simultaneously. When a transient analysis is performed at the hot full power condition, the maximum positive reactivity insertion rate described above is conservatively applied to the analysis.

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.

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APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-5

Are the most limiting axial and radial power shapes used for the bank withdrawal analysis calculated with ANC or TWINKLE-M? What is the control rod configuration that gives the most limiting shape?

ANSWER:

The key parameters for this event are the peaking factor and reactivity insertion rate. These parameters are evaluated by ANC, and bounding conditions are determined based on the ANC results for input to TWINKLE-M and VIPRE-01M. In the TWINKLE-M calculation, the bounding reactivity insertion rate is provided as an input parameter. The 1-D model calculation is adopted to neglect the distortion of the radial power distribution caused by the rod insertion and thus conservatively underestimates the Doppler feedback. Based on ANC calculation results, the reactivity insertion rate is maximized for the bottom skewed axial power distribution condition, so the bottom skewed axial power distribution is used for the TWINKLE-M calculation. If the axial power distribution is top skewed, then the reactivity insertion rate is smaller than the bottom skewed case and is bounded by the DCD calculation. For the purpose of defining the maximum reactivity insertion rate for this event, the required overlap sequence is conservatively ignored. The resultant limiting control rod positions are:

In the VIPRE-01M fuel rod calculation, the limiting radial power distribution from ANC is used, and the same axial power distribution as the TWINKLE-M calculation is used. In the DNBR calculation, a top skewed axial power distribution is normally conservative, but for this event, the reactivity insertion rate with a top skewed axial power distribution is small and the minimum DNBR is bounded by the DCD calculation.

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.

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QUESTION NO.: 15.4.1-6

The discussion of bank withdrawal from zero power event does not consider LOOP and neither does the dropped RCCA event, presumably because there is no reactor trip. How do these events take into account LOOP?

ANSWER:

For the bank withdrawal from zero power event, the turbine-generator is disconnected. Therefore, the reactor trip will not cause any disturbance to the electrical grid, and there is no need to account for a LOOP. However, for this response, a LOOP is hypothetically assumed to occur 3 seconds after the reactor trip (since the turbine is disconnected). Figure 15.4.1-6.1 below provides the transient DNBR curve and Figure 15.4.1-6.2 below provides the transient fuel centerline temperature for the DCD Subsection 15.4.1 event (bank withdrawal from zero power) considering a LOOP. For comparison, the same event without LOOP is also shown in the figures.

For the dropped RCCA event, there is no reactor trip or turbine-generator trip, so there is no disturbance to the electrical grid, and there is no need to account for a LOOP.

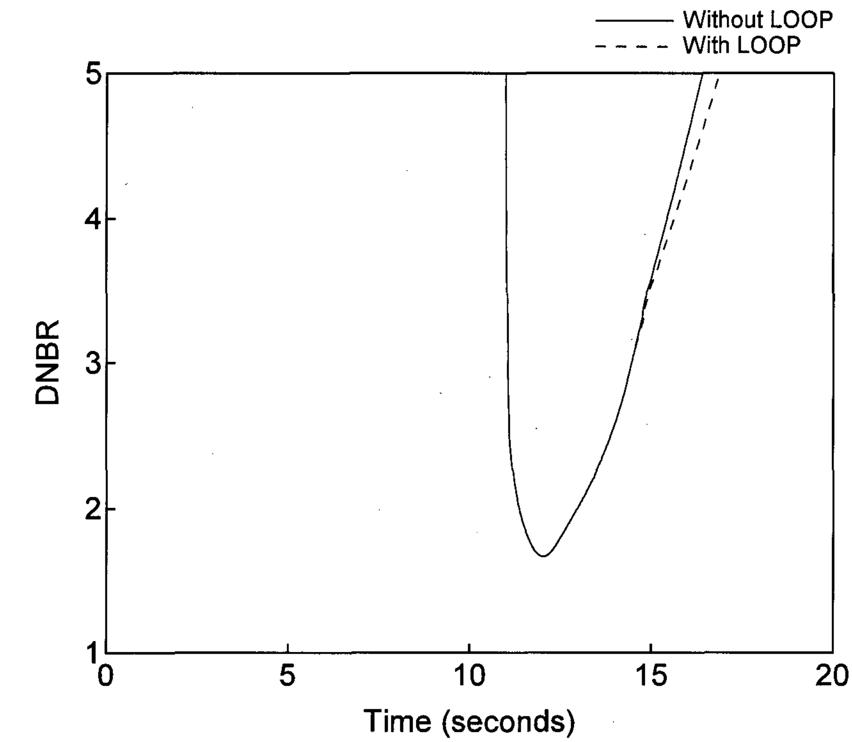

Figure 15.4.1-6.1 **DNBR versus Time with and without LOOP**
Uncontrolled Control Rod Assembly Withdrawal from Subcritical

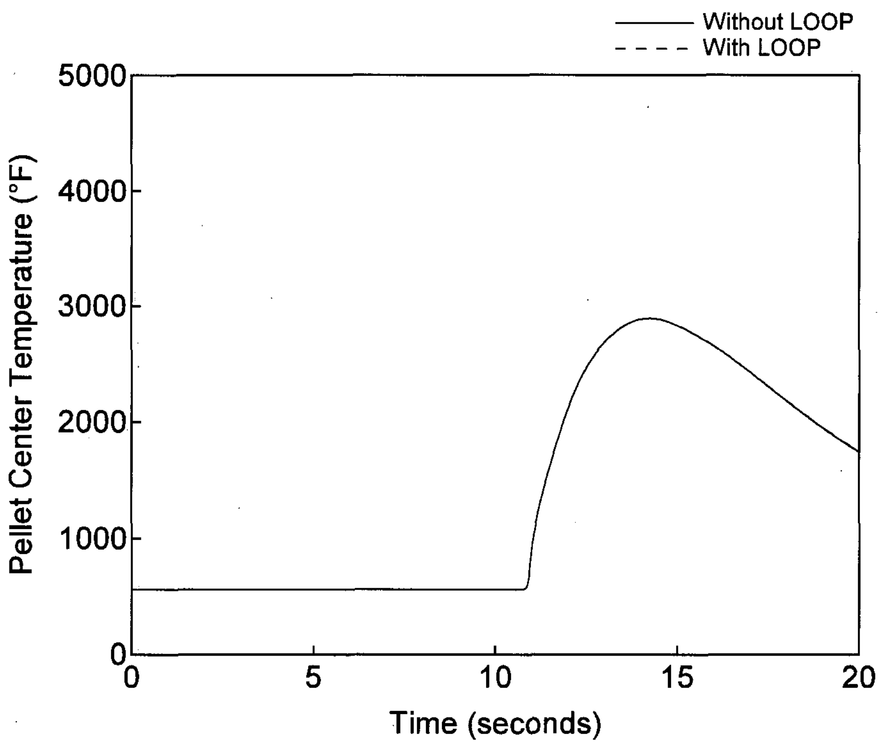

Figure 15.4.1-6.2 **Fuel Temperature versus Time with and without LOOP**
Uncontrolled Control Rod Assembly Withdrawal from Subcritical

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.

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DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-7

In Section 15.4.1.5 and 15.4.2.5, it is stated that the radiological consequences for these AOOs are bounded by those calculated for a PA. It is understood that there are no radiological consequences for these events and this should be stated.

ANSWER:

The analyses in DCD Subsections 15.4.1 and 15.4.2 both show that the DNBRs remain above the 95/95 limit and, therefore, no fuel failures occur. The analyses also show that the integrity of the reactor coolant pressure boundary and the main steam system pressure boundary are maintained. However, in the case where there is primary-to-secondary leakage from normal plant operations, there is an available path for radiation to be released to the environment. So in DCD Subsections 15.4.1.5 and 15.4.2.5, it is stated that the radiological consequences for these AOOs are bounded by those calculated for a PA.

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.

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APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-8

Verify that the positive reactivity insertion rate of 75 pcm/s used in the one-dimensional core simulation bounds the simultaneous withdrawal of 2 sequential RCCA banks of maximum worth at maximum speed in the three-dimensional case.

ANSWER:

Please refer to the responses to Questions 15.4.1-4 and 15.4.1-5 of this RAI.

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.

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APPLICATION SECTION:	**15.4.1**
DATE OF RAI ISSUE:	**5/04/2009**

QUESTION NO.: 15.4.1-9

Plot and submit the peak fuel rod power as a function of time for the Section 15.4.1 analysis.

ANSWER:

The peak fuel rod power (hot spot) as a function of time for the DCD Subsection 15.4.1 analysis is shown in Figure 15.4.1-9.1 below. It is obtained by multiplying the core average nuclear flux (reactor power) by the peaking factor (F_Q). The core average nuclear flux as a function of time is shown in DCD Figure 15.4.1-1 and the peaking factor (F_Q) is[ ].

Figure 15.4.1-9.1 Peak Fuel Rod Power versus Time
Uncontrolled Control Rod Assembly Withdrawal from Subcritical

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.