



**MITSUBISHI HEAVY INDUSTRIES, LTD.**  
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TOKYO, JAPAN

September 30, 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-10266

**Subject: MHI's Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R1) "Small Break LOCA Methodology for US-APWR" on 09/28/2010**

**Reference:** 1) REQUEST FOR ADDITIONAL INFORMATION US-APWR TOPICAL REPORT: SMALL BREAK LOCA METHODOLOGY, MUAP-07013-P(R1), dated September 28, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") an official document entitled 'MHI's Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R1) "Small Break LOCA Methodology for US-APWR" on 09/28/2010'. In the enclosed document, MHI provides the 3 (three) items requested in Reference 1. In addition, the modified M-RELAP5 source code, executable, input/output files, and source diff file are submitted in the Optical Storage Medium (OSM) enclosed with this letter.

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). Any proprietary information that is written inside a bracket in the proprietary-version is replaced by the designation "[ ]" without any text, in the non-proprietary-version.

This letter includes a copy of proprietary version (Enclosure 2), a copy of non-proprietary version (Enclosure 3), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the bases of MHI request that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4). In addition, two supplementary reports entitled 'M-RELAP5 M1.6 Code Modification' (Enclosure 4) and 'Errors in Groeneveld CHF lookup table' (Enclosure 5), and one optical storage medium entitled 'M-RELAP5 M1.6 Package' (Enclosure 6) are included in this letter, which should 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 this submittal. His contact information is provided below.

DOB  
NR5

Sincerely,



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

Enclosures:

1. Affidavit of Yoshiaki Ogata
2. MHI's Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R1) "Small Break LOCA Methodology for US-APWR" on 09/28/2010 (proprietary)
3. MHI's Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R1) "Small Break LOCA Methodology for US-APWR" on 09/28/2010 (non-proprietary)
4. M-RELAP5 M1.6 Code Modification (proprietary)
5. Errors in Groeneveld CHF lookup table (proprietary)
6. M-RELAP5 M1.6 Package (optical storage medium, proprietary)

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

Contact Information

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# ENCLOSURE 1

Docket No.52-021  
MHI Ref: UAP-HF-10266

## 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 'MHI's Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R1) "Small Break LOCA Methodology for US-APWR" on 09/28/2010', "M-RELAP5 M1.6 Code Modification", "Errors in Groeneveld CHF lookup table" and "M-RELAP5 M1.6 Package" (optical storage medium), and have determined that portions of the report 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 technical report 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 in the report identified as proprietary by MHI 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 unique codes and files developed by MHI for the fuel of the US-APWR and also contains information provided to MHI under license from the Japanese Government. These codes and files 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. MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI and the Japanese Government.
5. 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.
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 fuel 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 30<sup>th</sup> day of September, 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 tail on the "a".

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

**ENCLOSURE 3**

UAP-HF-10266

**MHI's Response to the NRC's Request for Additional Information  
on Topical Report MUAP-07013-P (R1)  
"Small Break LOCA Methodology for US-APWR" on 09/28/2010**

September 2010  
(Non-Proprietary)

## REQUEST 1

Confirmatory calculations performed by the staff with version 1.5 of MRELAP5 showed that the Henry-Fauske critical flow correlation is sometimes being used to calculate the break flow when the upstream conditions are two-phase. For most of the time when the Henry-Fauske correlation is used, the calculated critical flow is lower than what would be calculated using the Moody correlation. 10-CFR-50, Appendix K, Section I.C.1.b, Discharge Model, states "For all times after the discharge fluid has been calculated to be two-phase in composition, the discharge rate shall be calculated by use of the Moody model (F. J. Moody, "Maximum Flow Rate of a Single Component, Two-Phase Mixture", Journal of Heat Transfer, Trans American Society of Mechanical Engineers, 87 No. 1, February 1965). The discharge model in version 1.5 of M-RELAP5 does not meet this requirement.

MHI modified the M-RELAP5 code and produced a new version 1.6 that modifies the break flow model to conform to the Appendix K requirement cited above.

Provide a description of the code changes made to the break flow model, the source code for version 1.6, the PC Windows executable for version 1.6 and plots of break flow and PCT versus time for the limiting SBLOCA case. Confirm that version 1.6 includes an edit that identifies which critical flow model is being used at any time to facilitate confirmation that the Moody model is being used as required by Appendix K. In addition to adding a minor edit/plot variable, a good way to display this information in a major edit would be to print out a count of how many times each critical flow correlation was used since the last major edit.

## RESPONSE

The following modifications have been made for M-RELAP5 M1.6:

[

Details of the code modification are described in Enclosure 4 of this document. The source code and PC-windows executable for M-RELAP5 M1.6 are in Enclosure 6 (OSM). The plots of break flow and PCT versus time for the limiting SBLOCA case (bottom of cold leg 1-ft<sup>2</sup> break) are shown in Figure RAI-1.1 and 1.2, respectively. The edit of the critical flow model flag is shown in Figure RAI-1.3. [

]

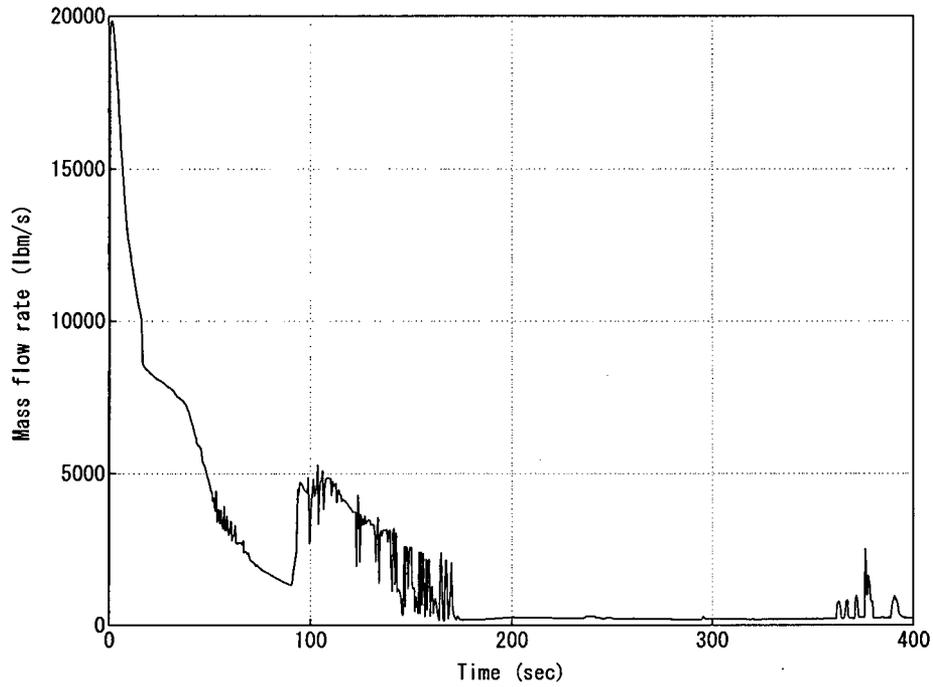


Figure RAI-1.1 Break Flow Rate

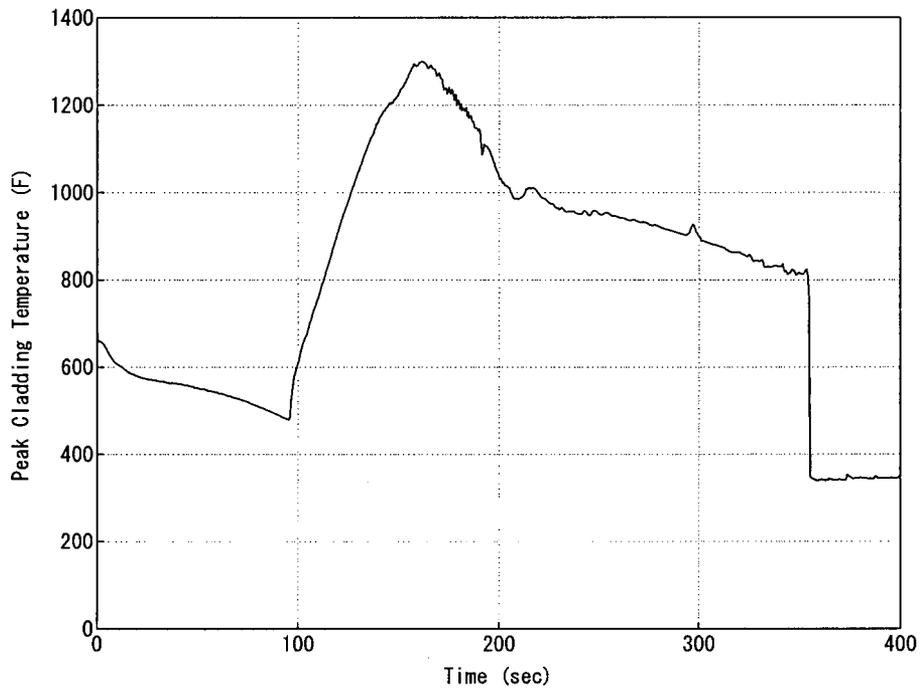


Figure RAI-1.2 Peak Cladding Temperature



**Figure RAI-1.3 Choking Flag**

## **REQUEST 2**

The staff modified version 1.5 of the M-RELAP5 code by implementing a critical flow model selection criterion based upon void fraction rather than quality. With this selection criterion the code used the Moody model to calculate break flow during the time when the conditions upstream of the break were predicted to be two-phase. Confirmatory calculations performed by the staff with this modified code version showed that the bottom of cold leg break became limiting. MHI's calculations with version 1.5 of M-RELAP5 showed the top of cold leg break to be limiting.

Provide the results of calculations with version 1.6 of M-RELAP5 that identify the limiting break location with respect to PCT.

## **RESPONSE**

The PCTs with M-RELAP5 M1.6 are shown in Table RAI-2.1, and the limiting break location is the bottom of the cold leg 1-ft<sup>2</sup> break.

**Table RAI-2.1 The Lists of Peak Cladding Temperature**

Break Orientation Break Size & Location	Bottom	Top	Side	Homogeneous
1-ft <sup>2</sup> at cold leg	1302 (°F)	1298 (°F)	1292 (°F)	1213 (°F)

### **REQUEST 3**

MHI identified one code improvement for the mass conservation in the accumulator component, and one error related to the CHF model.

Provide a description of them and the code changes made in M-RELAP5 version 1.6. Include an evaluation of the effect on PCT for the limiting SBLOCA case.

### **RESPONSE**

The details of the code modification are described in Enclosure 4 of this document. The effect of these code modifications on PCT for the limiting case of M-RELAP5 M1.5 is -11 °F.