MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

October 4, 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-10267

Subject: Response to the NRC Request for Additional Information on "Thermal Design Methodology" MUAP-07009 Rev. 0

References: 1) "Request for Additional Information Topical Report Thermal Design Methodology MUAP-07009 Rev. 0, dated September 1, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to the NRC Request for Additional Information on topical report Thermal Design Methodology MUAP-07009".

Enclosed are the responses to 8 RAIs contained within Reference 1. Additional supporting materials for the RAI responses are provided on an Optical Storage Medium ("OSM"). The specific files contained on the OSM are listed on the associated enclosure cover sheet.

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 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 the NRC Request for Additional Information on "Thermal Design Methodology" MUAP-07009 Rev. 0 (proprietary version)

3. Response to the NRC Request for Additional Information on "Thermal Design Methodology" MUAP-07009 Rev. 0 (non-proprietary version)

4. OSM : Additional Supporting Documentation

The files contained in CD are listed in Attachment 1 hereto.

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

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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-10267

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 the NRC Request for Additional Information on "Thermal Design Methodology", MUAP-07009 Rev. 0" (Enclosures 2 and 3) and the enclosed Optical Storage Medium ("OSM", Enclosure 4) all dated October 4, 2010 and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages of Enclosure 2 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 OSM (Enclosure 4) contains the proprietary documents "Modifications between VIPRE-01 MOD 2.2.1 and VIPRE-01M MOD2.2.1/M1.2.0, 5*AS-UAP-20100018(R0)", and "US-APWR Quality Assurance Manual Design Verification Procedure, PQF-HD-18041-022(R3)". The all information in the OSM 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 unique thermal and hydraulic design developed by MHI and not being used in the exact form by any 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.

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 the development of the thermal and hydraulic design. 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 plant safety, and reduced operation and maintenance costs associated with the thermal and hydraulic design.

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 4th day of October, 2010.

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

Docket No. 52-021
MHI Ref: UAP-HF-10267

Enclosure 3

UAP-HF-10267, Rev.0
Docket No. 52-021

Response to the NRC Request for Additional Information on "Thermal Design Methodology", MUAP-07009 Rev. 0

October 2010
(Non-Proprietary)

Response to the NRC Request for Additional Information on

"THERMAL DESIGN METHODOLOGY", MUAP-07009-P Rev.0

Non-proprietary Version

1. *Round 4 - Requests for Additional Information*

4.1 Provide documentation which details the changes made to VIPRE between VIPRE-01 MOD 2.2.1 (the version of VIPRE obtained by MHI from CSA) and VIPRE-01M MOD 2.2.1 MHI 1.2.0 (MHI's version of VIPRE submitted to the NRC).

Response:

All the code changes made between VIPRE-01 MOD 2.2.1 (the version of VIPRE obtained by MHI from CSA) and VIPRE-01M MOD2.2.1/M1.2.0 (MHI's version of VIPRE submitted to the NRC) are described in Reference 4.1-1. The entire details of the modifications have been recorded in the MHI internal documents as described in Reference 4.1-1. These documents were generated for internal use by MHI designers/analysts, so they were written in Japanese and have not been translated into English. However, the NRC staff will be able to confirm the contents during the code inspection that will be held in October 2010.

Reference

4.1-1 T. Suemura "Modifications between VIPRE-01 MOD 2.2.1 and VIPRE-01M MOD2.2.1/M1.2.0," 5*AS-UAP-20100018 Rev.0, September, 2010. (proprietary)

4.2 Provide documentation which demonstrates that the user manual provides guidance for selecting or calculating all input parameters and code options.

Response:

The VIPRE-01M user manual (Reference 4.2-1) has been submitted with the letter UAP-HF-0954 dated on October 30, 2009.

Users can find the background information and guidance for various code options in Chapter 4 of the user manual. The definition of each input parameter is

described in Attachment 1 of the manual. The Chapter 4 along with the Attachment 1 provides sufficient information to the user for selecting and calculating input data for VIPRE analyses.

Reference

4.2-1 M. Kawachi, et al., "VIPRE-01M Code Manual," 5*AS-UAP-2009052 Rev.0, MHI 2009. (proprietary)

4.3 Provide documentation which demonstrates that the guidance in the VIPRE-01M manual specifies the required and acceptable code options for the specific licensing calculations.

Response:

In Topical Report MUAP-07009, MHI defined the code options to be used for the licensing calculations in accordance with Condition No. 3 of the NRC's Safety Evaluation Report for the original VIPRE-01 MOD1 code.

As described in Chapter 5 of the user manual (Reference 4.3-1), the guidance stated in Chapter 4 is consistent with the code options validated in MUAP-07009.

Reference

4.3-1 M. Kawachi, et al., "VIPRE-01M Code Manual," 5*AS-UAP-2009052 Rev.0, MHI 2009. (proprietary)

4.4 Provide documentation which demonstrates that required input settings are hardwired into the input processor so that the code stops with an error message if the required input is not provided or if the input is not within an acceptable range of values or that administrative controls (an independent reviewer QA check) are in place that accomplish the same purpose.

Response:

VIPRE-01M code checks input data so that the code stops if certain input values are not within its defined acceptable range. While most of the input parameters have default values which are suitable for the licensing calculations, the code stops if the required input that has no default value is not provided. This can be

confirmed by reading the source listing of VIPRE-01M.

In addition to the above automatic check, the QA procedure manual (Reference 4.4-1) requires an independent reviewer to review the design inputs as part of the design work.

The NRC staff will be able to confirm the records of the above procedures during the code inspection that will be held in October 2010.

Reference

4.4-1 "US-APWR Quality Assurance Manual Design Verification Procedure," PQF-HD-18041-022 Rev.3, September, 2008. (proprietary)

4.5 *Provide documentation which demonstrates that computer codes that are used for multiple accidents and transients include guidelines that are specific to each transient or accident..*

Response:

The US-APWR DCD Chapter 15 safety analyses are performed by following the events to evaluate and the acceptance criteria provided in SRP Chapter 15. MHI utilizes design analyses plans and safety analyses guidelines that provide explicit instructions on how to analyze each event. The design analyses plans and safety analyses guidelines are event-specific so that they can be used by the engineer(s) to perform the safety analysis in accordance with the event-specific acceptance criteria in SRP Chapter 15. The list of these plans and guidelines used for the US-APWR non-LOCA safety analyses, including the MHI document number, is shown in Table 4.5-1. These documents were developed for internal use by MHI, so they are written in Japanese and have not been translated to English. However, the NRC staff will be able to confirm that MHI performs the safety analysis in accordance with the MHI Nuclear Engineering Center Quality Assurance Manual during the NRC QA audit that will be held in December 2010.

Table 4.5-1 Guidelines and Plans Used for Non-LOCA Safety Analysis

Document Number	Document Title

4.6 Provide the documentation which demonstrates that all code options that are to be used in the accident simulation are appropriate and are not used merely for code tuning.

Response:

The US-APWR design and safety analysis work procedures maintained by the MHI Nuclear Engineering Center fulfill the requirements of the Quality Assurance Manual (PQF-HD-18041 series), which is based on ASME NQA-1-1994. Before performing the actual analyses, standard inputs and their associated documentation are prepared. This documentation includes the technical rationale for the input data and selection of code options. According to the design analysis and design verification procedure, the standard input and the documentation are reviewed and verified by a competent person who is not directly involved in the design analysis (i.e. an independent review). These documents were developed for internal use by MHI, so they are written in Japanese and have not been translated to English. However, the NRC staff will be able to confirm that MHI performs the safety analysis in accordance with the MHI Nuclear Engineering Center Quality Assurance Manual during the NRC QA audit that will be held in December 2010.

4.7 In response to RAI 3.2, MHI provided a table with operating conditions for Cases 1 and 2. There is a discrepancy between the table provided by MHI and the table in the VIPRE Manual which describes the input to the same case. Confirm that the correct operating conditions were used in the VIPRE-01M assessment

Response:

Three cases are described in the response to RAI 3.2: Case 1, Case 2-1, and Case 2-2. These cases correspond to the tables in Reference 4.7-1 as such.

MHI Case 1 versus Table 4-1 in Reference 4.7-1

MHI Case 2-1 versus Case no. 1 of Table 4-2 in Reference 4.7-1

MHI Case 2-2 versus Case no. 2 of Table 4-2 in Reference 4.7-1

No MHI case versus Case no. 3 of Table 4-2 in Reference 4.7-1

The Table 4-2 in Reference 4.7-1 includes one additional case (case no. 3), which is essentially just a repeat of case no. 2 above. Case no.3 of Table 4-2 in Reference 4.7-1 was mainly established to test the capability of running stacked-up runs. Although MHI had done this stacked-up run case for the assessment of the implementation of VIPRE-01M, this case was omitted from the response to RAI3.2 because Case no. 2 and Case no.3 use the same operating conditions. Including Case no. 3 became redundant.

Reference

4.7-1 C. W. Stewart, et al., "VIPRE-01: A Thermal-Hydraulic Code for Reactor Cores, Volumes 2 (Revision 4): User's Manual," NP2511-CCM-A, Electric Power Research Institute (EPRI), February 2001

4.8 In response to RAI 1.20, the Baker-Just equation is manipulated such that it can be used in VIPRE to calculate the thickness of the Zircaloy reacted. The derivation from Equation 1 to Equation 2 assumes that the Temperature is not a function of time. However, Equation 3 and following assumes that the temperature is a function of time. Shouldn't the derivative of Equation 1 be taken assuming that Temperature is a function of time? Also, MHI is using the planar form of the Baker-Just equation. Would it be more appropriate to use the cylindrical form?

Response:

Baker-Just equation, Equation 1, described in the response to RAI 1.20, is an equation that provides the cumulative reaction for a certain period of time based on

the experimental results under the constant temperature conditions. On the other hand, VIPRE-01M analysis needs the overall reaction under the variable temperature conditions.

To reconcile the different physical conditions described above, MHI took the first order differentiation on Equation 1 and resulted in Equation 2, which provided instantaneous "reaction rate" at a specified temperature.

Equation 2 was then integrated to obtain Equation 3 during the infinite time interval in which the temperature varied. This and the following processes assumed time-dependent temperature condition that was predicted from VIPRE-01M fuel rod temperature calculations.

In the case of cylindrical or spherical configuration, the reacting surface area decreases when the oxide layer thickness grows. This makes the reaction rate for those configurations smaller than that of planar configuration. Baker and Just estimated that such effect is sufficiently small as long as the oxide layer thickness is relatively small. According to Appendix B of Reference 4.8-1, the difference in reaction rate is estimated less than 10% until 25% of the total spherical volume has been reached. Therefore, Equation 1 above was developed based on a simple planar form of parabolic rate law, regardless the data were obtained from the wire or particle type specimen. Furthermore, the fuel cladding thickness is very thin so that 10% of cladding volume corresponds to just about 2% of the total fuel rod volume.

Equation 1 is thus adopted for the VIPRE-01M use as for other LOCA codes which comply with Appendix K to 10CFR5.

Reference

4.8-1 L. Baker Jr. and L. C. Just, "Studies of Metal-Water Reactions at High Temperatures," ANL-6548, Argonne National Laboratory, May, 1962.

ATTACHMENT 1

FILE CONTAINED IN CD

CD : OSM : Additional Supporting Documentation"

	File Name	Size	Sensitivity Level
1.	001_Reference-1(4.1-1)	458 KB	Proprietary
2.	002_Reference-2(4.4-1)	2163 KB	Proprietary