MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

August 1, 2013

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-13199

Subject: MHI's Response to US-APWR DCD RAI No. 1042-7143 (SRP 15.06.05)

Reference: 1) "Request for Additional Information No. 1042-7143, SRP Section: 15.06.05 - Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary, Application Section: 15.6.5" dated July 3, 2013.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the official document entitled "Response to Request for Additional Information No. 1042-7143."

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

As indicated in the enclosed material, the proprietary version of the 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 versions of the RAI response (Enclosure 2), a copy of the non-proprietary versions of the RAI response (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).

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.

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NRO

Sincerely,

Yoshiki Ogata,
Executive Vice President
Mitsubishi Nuclear Energy Systems, Inc.
On behalf of Mitsubishi Heavy Industries, LTD

Enclosures:

1. Affidavit of Yoshiki Ogata

2. Response to Request for Additional Information No. 1042-7143 (Proprietary version)

3. Response to Request for Additional Information No. 1042-7143 (Non-proprietary version)

CC: J. A. Ciocco
J. Tapia

Contact Information

Joseph Tapia, General Manager of Licensing Department
Mitsubishi Nuclear Energy Systems, Inc.
1001 19th Street North, Suite 710
Arlington, VA 22209
E-mail: joseph_tapia@mnes-us.com
Telephone: (703) 908-8055

ENCLOSURE 1

Docket No.52-021
MHI Ref: UAP-HF-13199

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

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

1. I am Executive Vice President of Mitsubishi Nuclear Energy Systems, and have been delegated the function of reviewing Mitsubishi Heavy Industries, Ltd ("MHI") 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 "Response to Request for Additional Information No. 1042-7143", 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 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 unique codes and files for the analysis of Loss-Of-Coolant Accident for US-APWR, developed by MHI. 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.

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 the subject systems. 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.

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 development of the US-APWR LOCA analysis codes and methodologies. Providing public access to such information permits competitors to duplicate or mimic the LOCA analysis codes and methodologies information without incurring the associated costs.

   B. Loss of competitive advantage of the US-APWR created by benefits of enhanced US-APWR LOCA analysis codes and methodologies development costs associated with the Emergency Core Coolant 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 1st day of August, 2013.

Yoshiki Ogata,
Executive Vice President
Mitsubishi Nuclear Energy Systems, Inc.

Enclosure 3

UAP-HF-13199
Docket No. 52-021

Response to Request for Additional Information No. 1042-7143

August 2013

(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

8/1/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1042-7143 REVISION 0**
SRP SECTION:	**15.06.05 – LOSS OF COOLANT ACCIDENTS RESULTING FROM SPECTRUM OF POSTULATED PIPING BREAKS WITHIN THE REACTOR COOLANT PRESSURE BOUNDARY**
APPLICATION SECTION:	**15.6.5**
DATE OF RAI ISSUE:	**07/03/2013**

QUESTION NO.: 15.06.05-102

In Technical Report MUAP-13001, Section 2.2.4.4 MHI states that the natural circulation resumes [ ] as shown in Table 2-3 and Figure 2-3. [ ] However, the PKL III E2.2 test results show that intact loops 3 and 4 clear first while the broken loop with SI clears later. [ ] Provide a qualitative and quantitative explanation of this apparent difference in loop seal clearing order.

ANSWER:

The PKL test provides experimental data to reproduce long-term plant behaviors under small break LOCA conditions including termination and resumption of natural circulation with reflux condensation. [ ] observed in the PKL tests is explained below and its applicability to the US-APWR for GSI-185 is discussed.

1. Observation for PKL Experimental Test Result 1 (Effect of ECC Injection)

Section 4.1.5 of Reference 1 and Section 3.2.3 of Reference 2 describe that the resumption of natural circulation in the loops with ECC (Emergency Core Cooling) injection is delayed as follows. *During the filling of the SGs (Steam Generators), a portion of the subcooled emergency coolant injected into the cold legs travels via the RCPs (Reactor Coolant Pumps) into the corresponding loop seals. As a result the water column formed in the pump-side leg of the loop seal is colder than that in the SG-side leg. This difference in temperature and density counteracts the natural circulation.* This indicates that the higher density coolant in the pump-side leg of loop seal results in higher frictional pressure loss, as calculated using equation (1), when natural circulation starts resuming and coolant velocity increases.

$$\Delta P = f \cdot \frac{L}{D} \cdot \frac{\rho \cdot V^2}{2} \quad (1)$$

ΔP : pressure drop
f : friction factor
L/D : the ratio of length to diameter of the pipe
ρ : the density of fluid
V : the mean velocity of the flow

[

]

2. Observation for PKL Experimental Test Result 2 (Effect of Break)

Section 3.2.3 of Reference 2 describes that [

]. *As a result of the pressure conditions, water flows to the break point from both sides so that in addition to the water injected, inventory is also transported to the break point from the loop seal. In this manner, the cold water column on the pump side, which counteracts the natural circulation, is slowly reduced, and natural circulation can begin earlier than in intact loop with cold leg ECC injection.*

3. Explanation for US-APWR GSI-185 Natural Circulation Resumption

The US-APWR HHIS (High-Head Injection System) provides DVI (Direct Vessel Injection) instead of cold leg injection, and thus the effect of ECC injection is not the reason [

]. In the GSI-185 scenario for the US-APWR, however, the primary system depressurization is manually initiated by SG cool down. This depressurization allows the accumulators to inject cold safety coolant prior to the resumption of natural circulation. [

] The smaller temperature difference induces early resumption of the natural circulation, as was observed in the PKL test.

Figure 15.06.05-102.1 shows the temperature differences of the broken loop (Loop-A) and intact loop (Loop-C) for the 2-inch cold leg break case. At 9,000 seconds, a manual depressurization starts and accumulators briefly inject safety coolant around 12,000 seconds. [

] as is indicated in Table 2-2 of Reference 3.

In conclusion, [

] is applicable to the US-APWR GSI-185 scenario, although a difference exists between the layout of the PKL and US-APWR ECC injection systems.

References:

1. K. Umminger, T. Mull, B. Schoen, "Final Report of the PKL Experimental Program within the OECD/SETH Project," FANP NGTT1/04/en/04, December 2004.
2. K. Umminger, W. Kstner, J. Libert, T. Mull "Thermal hydraulics of PWRS with respect to boron dilution phenomena. Experimental results from the test facilities PKL and UPTF," Nuclear Engineering and Design Volume 204, Issues 1-3, February 2001, Pages 191-203.
3. Mitsubishi Heavy Industries, Ltd., "US-APWR Criticality Evaluation Following Small Break LOCAs," MUAP-13001-P(R0), January 2013.

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.

Figure 15.06.05-102.1 Liquid Temperature Difference between Uphill-Side (Pump-Side) Leg of Loop Seal and SG-Side Leg