MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

June 28, 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-12186

Subject: MHI's Response to US-APWR DCD RAI No. 932-6408 Revision 0 (SRP 06.03)

References:
[1] "Request for Additional Information No. 932-6408 Revision 0, SRP Section: 06.03 – Emergency Core Cooling System –Application Section: 6.3," dated May 29, 2012.
[2] MHI Letter UAP-HP-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)," dated May 2012.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the response to the RAI contained in Reference 1, which is related to the method of evaluating the debris transport time to the core that is described in Reference 2.

As indicated in the enclosed materials, the RAI response 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 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 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 below.

Sincerely,

Y. Ogata

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

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NRO

Enclosures:

1. Affidavit of Yoshiki Ogata

2. MHI's Response to Request for Additional Information No. 932-6408 Revision 0 (SRP 06.03) (proprietary version)

3. MHI's Response to Request for Additional Information No. 932-6408 Revision 0 (SRP 06.03) (non-proprietary version)

CC: J. A. Ciocco
J. Tapia

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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-12186

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, 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 Request for Additional Information No. 932-6408 Revision 0 (SRP 06.03)" dated June 2012, and have determined that portions of the document 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 design and methodology developed by MHI for performing the nuclear design of the US-APWR reactor.

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 development of methodology related to the analysis.

B. Loss of competitive advantage of the US-APWR created by benefits of modeling information.

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 28th day of June, 2012.

Y. Ogata

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

Enclosure 3

UAP-HF-12186
Docket No. 52-021

MHI's Response to Request for Additional Information No. 932-6408 Revision 0 (SRP 06.03)

June 2012
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/28/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 932-6408 REVISION 0**
SRP SECTION:	**06.03 – Emergency Core Cooling System**
APPLICATION SECTION:	**6.3**
DATE OF RAI ISSUE:	**5/29/2012**

QUESTION NO. : 06.03-105

During the public meeting on February 9th, 2012, MHI described twelve overflow pipes that return ECCS and CS water back to the RWSP. These twelve pipes are arranged in three sets, with four pipes in each set. One set of pipes is located in the reactor cavity and two sets are located in the header compartment. Provide information that describes the flow rates into, between, and out of the reactor cavity and header compartments during a LOCA and if there is a difference in the water level between these two compartments.

ANSWER:

1. **Introduction**

   The US-APWR has two horizontal tunnels between the reactor cavity and the header compartment to equalize water level in these rooms. However, pressure loss occurs when the water flow in the horizontal tunnels and the water level in these rooms is different.

   The tunnel size and number is optimized considering the water level difference and air leaks from the openings during normal operation.

   The water level difference between these rooms has the potential to impact the evaluations of debris transport time to the core, hold-up water volume, and debris split ratio per one sump strainer.

   This response provides a detailed calculation of the water level difference (Sections 3 through 6) and an impact assessment for these evaluations (Section 2). The detailed calculation also describes the flow rate into and out of these rooms through the horizontal tunnels.

2. **Impact assessment of the water level difference**

   <u>Debris transport time to the core</u>

   The calculation result in Section 6 below shows that the header compartment water level is approximately 1.5 in. higher than the reactor cavity.

In the transport time calculation, MHI calculated the water volume in the buffer area below the overflow piping top elevation on the basis that water level in the reactor cavity and the header compartment is same. Therefore, if the header compartment water level is 1.5 in. higher than that of in the reactor cavity, buffer area capacity will be reduced by the 1.5 in. height volume in the reactor cavity. This reduced buffer area volume is approximately 13.5 ft^3 (0.38 m^3). See Figure 1 for the image of reduced water volume in buffer area colored in red for debris transport time evaluation.

Since the design basis volume in of the buffer area of the header compartment and the reactor cavity is 29,810 ft^3, the impact on the debris transport time calculation is very small and the volume is negligible for transport time calculation. However, the small difference in water level between these two compartments results in a driving force for flow in to, between, and out of the reactor cavity and header compartment. Therefore, each individual flow rate is also calculated as described in Section 5 below.

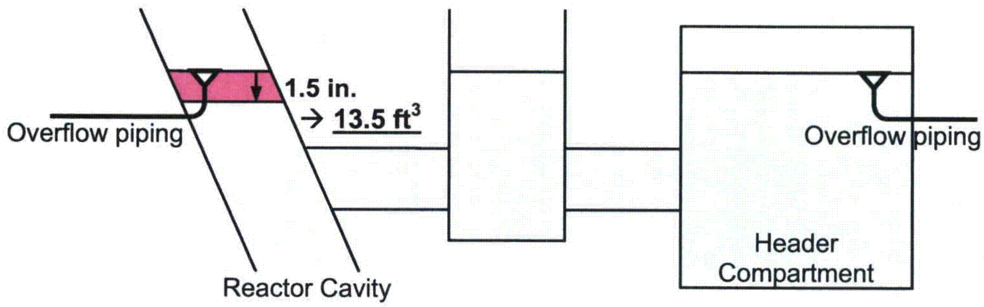


Figure 1: Image of reduced buffer area volume for debris transport time evaluation

Hold-up water volume

Hold-up water volume is calculated assuming a water elevation 5 in. higher than the elevation of the top of the overflow piping. Simply and conservatively assuming that header compartment water elevation increases 1.5 in. due to the water level difference, results in 280 ft^3 increase in the hold-up volume because as described in response to Question No. 06.02.02-90 of RAI 921-6415 (Reference 4) the floor area in the header compartment is 2,230 ft^2. In addition, considering vertical shafts volume increases 1.5 in., the water volume increases about 10.4 ft^3 because the floor area of the shafts are approximately 83 ft^2. See Figure 2 for the image of increased water volume in header compartment and vertical shafts colored in red for hold-up water volume calculation.

As described in the response to Question No. 06.02.02-90, the US-APWR has 1,370 ft^3 of hold-up water volume margin and the conservatively evaluated increase of the 280 ft^3 + 10.4 ft^3 is sufficiently bounded by the existing margin volume.

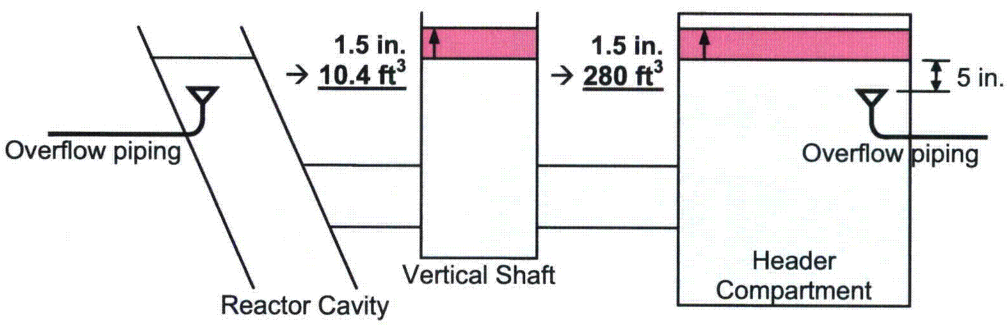
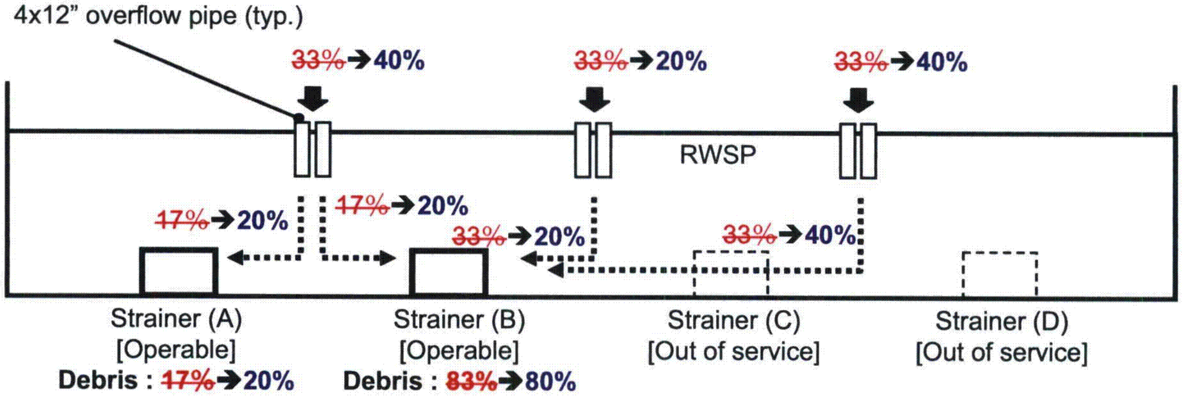


Figure 2: Image of increased water volume for hold-up water volume evaluation

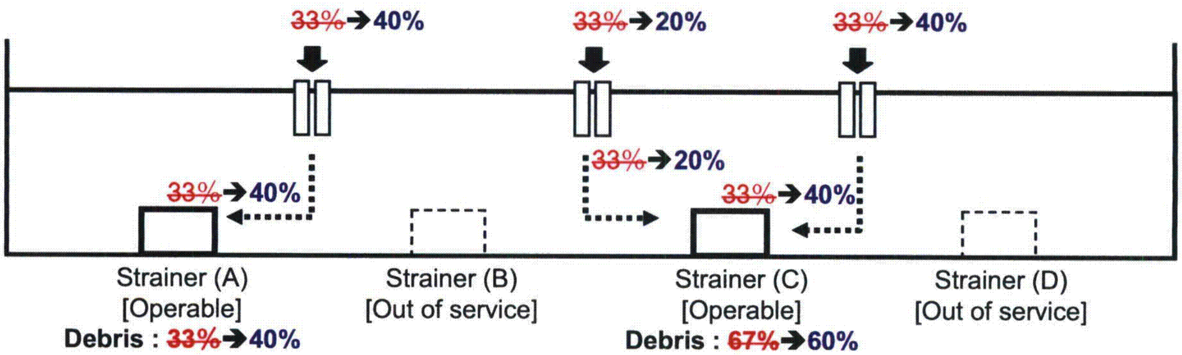
Debris split ratio per one sump strainer

Table 2 shows the overflow piping flow rate from the reactor cavity and the header compartment to the RWSP when considering water level difference. The table says that flow rate from the reactor cavity (i.e., one set of four overflow pipes in the reactor cavity) becomes about 20% of total flow of all 12 overflow pipes. Under this flow scenario the debris split ratio to one sump strainer that is provided in Figure 3-5 of MUAP-08001 Revision 6 “US-APWR Sump Strainer Performance” would vary as shown in Figure 3. However, the maximum debris split ratio per one sump strainer is reduced when water level difference occurs and thus there is no impact to the debris split ratio evaluation.

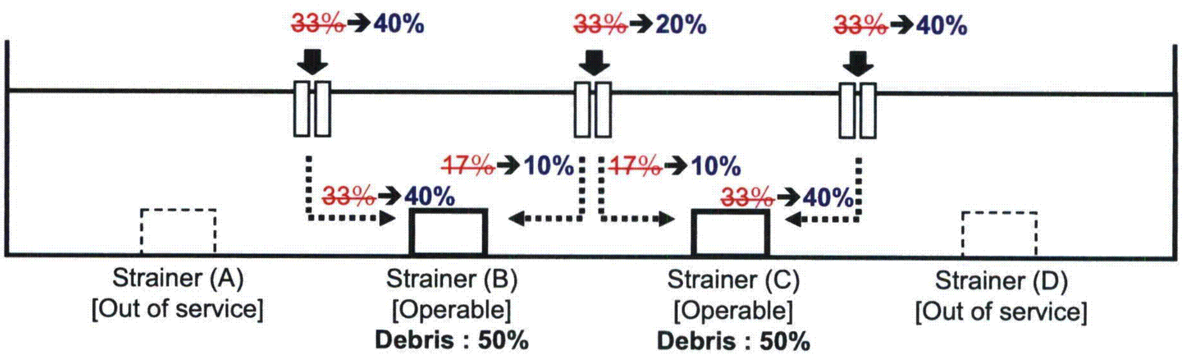
Design basis evaluation of debris split ratio used for sump strainer head loss testing shall not be changed due to this RAI response since the design basis value of the debris split ratio bounds the value evaluated in the Figure 3.



Pattern-[1] 80%(←~~83%~~) Debris Allocation on Sump Strainer (Worst case)



Pattern-[2] 60%(←~~67%~~) Debris Allocation on Sump Strainer



Pattern-[3] 50% Debris Allocation on Sump Strainer

Figure 3: Debris Allocation Ratio per One Sump Strainer
(when considering water level difference)

3. Calculation model

4. Calculation procedures

5. Calculation

6. Calculation result

7. References

1) MHI Letter No. UAP-HF-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)", dated May 2012.
2) Rao N.S. Govinda, Muralidhar D. "Discharge characteristics of weirs of finite crest width". J La Houille Blanche 1963;18(5):537–45.
3) I.E. Idelchik. "Hydraulic Resistance 3rd Edition," Begell House, 1996
4) MHI Letter No. UAP-HF-12128, "MHI's response to US-APWR DCD RAI 921-6415 Revision 0 (SRP 06.02.02)", dated May 2012.
5) MHI Letter No. UAP-HF-12125, MUAP-08001 Revision 6, "US-APWR Sump Strainer Performance", dated May 2012.

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

There is no impact on the Technical/Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/28/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 932-6408 REVISION 0**
SRP SECTION:	**06.03 – Emergency Core Cooling System**
APPLICATION SECTION:	**6.3**
DATE OF RAI ISSUE:	**5/29/2012**

QUESTION NO. : 06.03-106

The T1 analysis (time, as described in ML12034A062) treats the hold-up volume for the three buffer rooms (reactor cavity, header compartment, and CV drain pump room) as one volume in the analysis. It appears that treatment as one volume is not consistent with the design given that the reactor cavity and header compartment are cross connected post accident whereas the CV drain pump room is independent. Treatment as one volume could be a potential non-conservatism in the analysis if the buffer rooms fill up at different rates such that the reactor cavity and header compartment overflow sooner than the T1 analysis indicates. Provide information to demonstrate that the header compartment and the reactor cavity will reach their overflow elevation consistent with the T1 analysis considering that the buffer rooms/areas are not one volume.

ANSWER:

The US-APWR is designed such that the C/V drain pump room is filled up earlier than the other buffer areas in case of LOCA. The reason is described below.

- The C/V drain pump room capacity (6,520 ft^3) is much smaller than the total capacity of the header compartment and the reactor cavity (29,810 ft^3).
- Debris interceptors are not installed over the floor openings to the C/V drain pump room and therefore have a lower possibility of clogging compared to other openings with a debris interceptor. In addition, the opening size is designed to be larger than potential debris with an area of approximately 20 ft^2 per opening.

Although not considered as part of the design basis, if it is very conservatively assumed that the openings connected to the C/V drain pump room are clogged (i.e., not crediting the C/V drain pump room as buffer area), the T1 value will be shorter than the design basis value. However, the T1 evaluation contains a lot of conservativeness. The best estimate T1 value exceeds the design basis T1 value when excluding this conservativeness as shown in curves 1 through 3 of Figure 1.

Four curves are shown in the figure and each of them shows released water volume in various conditions as follows:

-Design basis value (black colored curve)
All phases of break flow (steam, drops, and liquid) are taken into account when determine the released mass, and all of the released mass is consider to inflow to the buffer area. Also, spray flow is assumed to start after the 0 sec from the LOCA initiation.

-Curve 1 (blue colored curve)
Steam mass in the break flow is not considered in the buffer area inflow mass. (steam mass is subtracted from inflow mass to the buffer area)

-Curve 2 (pink colored curve)
In addition to the Curve 1 condition, delay time of spray water falls on the 2nd floor was taken into account.

-Curve 3 (red colored curve)
In addition to the Curve 2 condition, retaining water volume on the 2nd floor was taken into account.

Summarizing the discussion, MHI does not consider that the C/V drain pump room fills up later than the other buffer area as the design basis evaluation. However, the situation in which the C/V drain pump room is not filled with water was evaluated and the T1 value is still bounded by the margin associated with the design basis T1 evaluation.

Figure 1: T1 Value Excluded Margin Analysis

References

1) MHI Letter No. UAP-HF-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)", dated May 2012.

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

There is no impact on the Technical/Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/28/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 932-6408 REVISION 0**
SRP SECTION:	**06.03 – Emergency Core Cooling System**
APPLICATION SECTION:	**6.3**
DATE OF RAI ISSUE:	**5/29/2012**

QUESTION NO. : 06.03-107

The T1 and T2 analyses (as described in ML12034A062) depend on the actuation / operation of certain components (e.g. rupture plates) to route water between rooms. Provide a summary of all such components which require activation or operation including the quantity and location. Describe the safety function(s) of these components and describe how the safety function(s) are achieved.

ANSWER:

There are no active components installed in the return flow path for recirculation operation during LOCA. Although MHI had described a design containing rupture plates during the February 9, 2012 public meeting, the current design as described in Reference 1 does not include any rupture plates. Therefore, the T1 and T2 analysis does not depend on any active components.

References

1) MHI Letter No. UAP-HF-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)", dated May 2012.

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

There is no impact on the Technical/Topical Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/28/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 932-6408 REVISION 0**
SRP SECTION:	**06.03 – Emergency Core Cooling System**
APPLICATION SECTION:	**6.3**
DATE OF RAI ISSUE:	**5/29/2012**

QUESTION NO. : 06.03-108

Provide the technical basis, in the T2 analysis, for the uniform flow assumption into the RWSP from the three sets of overflow pipes.

ANSWER:

To ensure uniform flow from the three sets of overflow pipes, US-APWR design includes the following features:

- two horizontal tunnels connecting the reactor cavity and the header compartment to equalize water depth in these rooms,
- installing debris interceptors to prevent clogging of the overflow piping
- using a consistent configuration for all three sets of overflow piping (i.e., same diameter, distance between each pipe, etc.).

However, as described in response to RAI Question No. 06.03-105, there is small flow rate difference between the header compartment and the reactor cavity and thus the flow rate for each set will be different.

Therefore, MHI evaluated T2 for the non-uniform flow case as shown in Figure 1. As shown in the figure, the flow coming to the critical section does not change in case that the overflow piping flow rate changes.

Figure 1: Case Study of Flow Distribution

References

1) MHI Letter No. UAP-HF-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)", dated May 2012.

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

There is no impact on the Technical/Topical Report.