MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

May 30, 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-12127

Subject: MHI's Amended Response to US-APWR DCD RAI No. 839-6103 Revision 3 (SRP 06.02.02)

References:
[1] "Request for Additional Information No. 839-6103 Revision 3, SRP Section: 06.02.02 – Containment Heat Removal System –Application Section: 6.2." dated October 14, 2011 (ML112920559).
[2] MHI Letter UAP-HF-12021, "MHI's Response to US-APWR DCD RAI No. 839-6103 Revision 3 (SRP 06.02.02)" dated January 31, 2012 (ML12033A282).
[3] MHI Letter UAP-HF-12131, "MHI's 2nd Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.03)" dated May 2012.
[4] MHI Letter UAP-HF-12126, "MHI's 3rd Amended Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)" dated May 2012.
[5] MHI Letter UAP-HF-12128, "MHI's Response to US-APWR DCD RAI No. 921-6415 Revision 0 (SRP 06.02.02)" dated May 2012.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Response to Request for Additional Information No. 839-6103 Revision 3 (SRP 06.02.02)". In Reference 2, MHI provided the original response to the NRC's Request for Additional Information ("RAI") in Reference 1.

Enclosed is the amended response to Questions 06.02.02-64 through 06.02.02-73 that are contained within Reference 1. This response supersedes the previous response that was transmitted in Reference 2 in its entirety.

The enclosed RAI response is related to the hold-up water volume calculation related to GSI-191. MHI changed the design of the recirculation water flow path under post-LOCA conditions, as described in response to RAI 815-5986 in Reference 3, after the RAI in Reference 1 was issued. In order to appropriately reflect the design change, the response to RAI 839-6103 was revised (see Enclosure 2 and 3). With regard to the hold-up volume calculation, two other RAI responses are being transmitted with the same timing as this letter in order to appropriately reflect the design change of the recirculation flow path (References 4 and 5).

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

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information identified as proprietary redacted and replaced by the designation "[ ]".

This letter includes a copy of the proprietary version (Enclosure 2) of the response, a copy of the non-proprietary version (Enclosure 3) of the response, 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 provided below.

Sincerely,

Y. Ogata

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

Enclosures:

1. Affidavit of Yoshiki Ogata

2. Amended Response to Request for Additional Information No. 839-6103 Revision 3 (SPR 06.02.02) (proprietary version)

3. Amended Response to Request for Additional Information No. 839-6103 Revision 3 (SRP 06.02.02) (non-proprietary version)

CC: J. A. Ciocco
J. Tapia

Contact Information
Joseph Tapia, General Manager of Licensing Department
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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-12127

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 "Amended Response to Request for Additional Information No. 839-6103 Revision 3 (SRP 06.02.02)" dated May 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 30th day of May, 2012.

Y. Ogata

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

Enclosure 3

UAP-HF-12127
Docket No. 52-021

Amended Response to Request for Additional Information No. 839-6103 Revision 3

May 2012
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 839-6103 REVISION 3**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**10/14/2011**

QUESTION NO. : 06.02.02-69

Follow-up to RAI 740-5719 response and Revision 5 of MUAP-08001:

Request MHI clarify how the RWSP minimum volume margin was calculated, as depicted in MUAP 08001-P (R5), Figure 3-11. As part of the response provide the volume of RWSP water from 0% RWSP level to 4 ft. elevation (Min. Water Level Design Basis). How do volumes used to develop the RWSP minimum volume margin account for submerged SSC volumes?

In addition, request MHI clarify if water in transition from the 25' 3" elevation through the ten, 18 inch transfer pipes to the RWSP minimum water level elevation (~ 4 foot elevation) was accounted for in the calculation of "Return Water on the way to the RWSP" (MUAP-08001 Table 3-10)? If this water in transition was not accounted for, provide an update to Table 3-10 and explain how this volume of water impacts the margin depicted in MUAP-08001-P (R5) Figure 3-11?

Reference: MHI's Amended Response to US-APWR DCD RAI No. 740-5719; MHI Ref: UAP-HF-11280; dated August 31, 2011; ML11245A189.

ANSWER:

1. RWSP Minimum Volume Margin and 0-4 ft RWSP Volume

See the response to Question No. 06.02.02-70 below for the calculation of the RWSP minimum volume margin of 1,370 ft^3 (2.9 in).

RWSP minimum water level is at EL. 7'-7" which is 4 ft above floor level. And 0% water level is at EL.4'-7". Therefore, the level difference between 0% and the minimum water level is 3 ft. The water volume between 0% and the minimum water level could be calculated using the level difference and RWSP surface area as shown below. The surface area is also shown in the response to RAI Question No. 06.02.02-70.

0%-minimum water level volume $= 3\ ft \times 5{,}654\ ft^2$

$= 16{,}962\ ft^3$

2. Submerged SSCs Volume

The sump strainers are located below the RWSP minimum water level. Therefore, the strainer volume does not have an impact on the minimum water level calculation.

The calculated volume of the SSCs such as platforms, ladders, piping, and supports located above the minimum water level in RWSP is 85.4 ft^3.

As shown in Attachment 1 of the response to Question No. 06.02.02-70 below, the 0-100% RWSP nominal water volume is 84,750 ft^3. The calculated 0-100% RWSP water volume neglecting submerged SSCs is approximately 85,000 ft^3. The actual 0-100% RWSP water volume could be calculated by subtracting the submerged SSC volume from the calculated RWSP volume, which would be about 84,910 ft^3. The actual 0-100% RWSP holdup volume is still larger than the nominal 0-100% water volume. Therefore, accounting for the volume of the submerged SSCs does not impact the RWSP minimum water volume calculation because the calculation uses the "nominal" RWSP water volume.

3. Water Volume in Transition

The water in transition through the ten 18" transfer pipes is no longer a factor because the pipes have been deleted from the design. New openings to the reactor cavity and header compartment were added inside the SG compartments on 2nd floor as shown in Figure 1.

Figure 1: Floor Openings on 2nd Floor

The height of water overflowing the weirs around the floor openings is 4 in. as the water enters the opening. The water thickness along the inside of the opening will be greater at the top of the opening due to gravity and will decrease with the falling height because the flow rate is constant. Therefore, a water thickness of 4 in. is conservatively assumed to exist from the 2nd floor to the lower floor as indicated by red dash line in Figure 2.

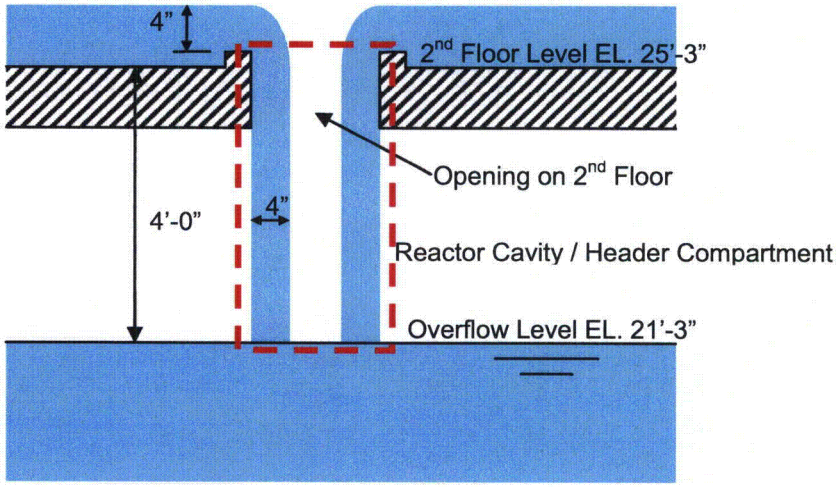

Figure 2: Water Volume Inside Openings on 2nd Floor

The sum of the perimeters of the openings on the 2nd floor is about 100 ft (See Figure 1). So the water volume flowing through the openings is 134 ft^3.
The water volume is accounted for in the "volume of water in piping and floor opening on 2nd floor" of Attachment 1 of the response to Question No. 06.02.02-70.

In addition to the water volume in the openings on 2nd floor, there are overflow pipes from the reactor cavity and the header compartment to the RWSP. The piping will be filled with water during the post-LOCA condition because the piping is part of the water recirculation flow path. The piping is also filled with water during normal operation. As illustrated in Figure 3, the overflow piping is filled with water during both normal and post-LOCA conditions. Therefore, the water volume in the overflow piping is neglected from the RWSP minimum water level calculation.

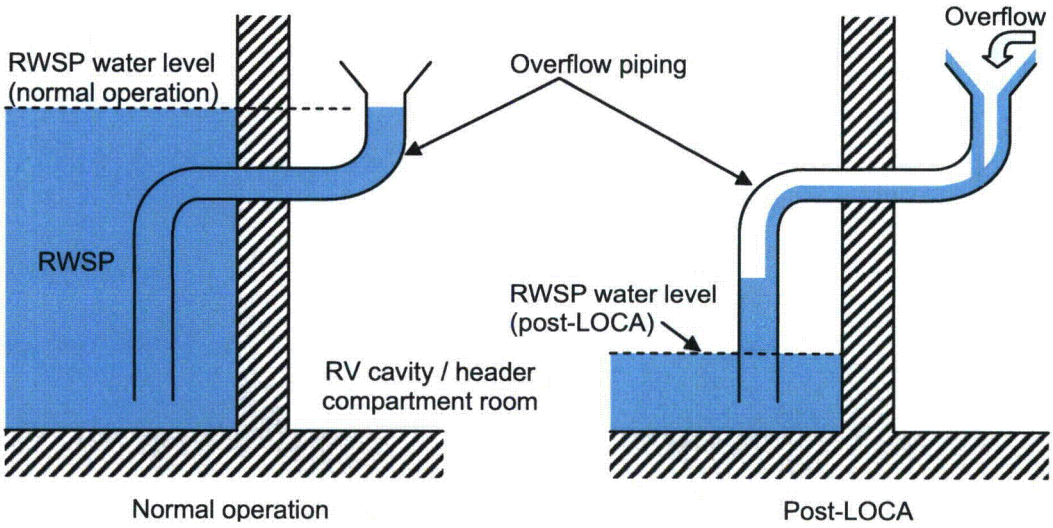

Figure 3: Water in Overflow Piping

4. 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)",May 2012.
2) MHI Letter No. UAP-HF-12135, "US-APWR DCD GSI-191 Tracking Report", dated May 2012.
3) MHI Letter No. UAP-HF-12125, MUAP-08001 Revision 6, "US-APWR Sump Strainer Performance", dated May 2012.

Impact on DCD

See note below.

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

See note below.

Impact on Technical/Topical Report

See note below.

Note
Impacts of the response on the DCD and Technical Report due to this response are reflected to the GSI-191 DCD Tracking Report (Reference 2) and the revised Technical Report (Reference 3).

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 839-6103 REVISION 3**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**10/14/2011**

QUESTION NO. : 06.02.02-70

Follow-up based on RAI 740-5719 response, MUAP-08001-P Revision 5, and GSI-191 tracking report (UAP-HF-11287, dated August 31, 2011):

In MUAP-08001-P (R5) Figure 3-11, MHI depicts margin (volume) existing between the "Min. water level (design basis)" and the "Min water level (calculated)". Given the amount of margin, the staff request that MHI provide the uncertainty associated with "Return Water on the Way to RWSP" and "Ineffective Pools" listed in Table 3-10 of MUAP-08001 (R5) and DCD Table 6.2.1-3 (updated with GSI-191 Tracking report, dated August 31, 2011). As part of the discussion, clarify/explain what approach was used to calculate each volume, for example, a bounding conservative approach, best estimate approach, or combination, and any uncertainties applied to these volumes.

ANSWER:

RWSP minimum water level from 0% water level is calculated by following equation.

(RWSP minimum water level) = {(96% RWSP water volume) – (Holdup water volume)} / (RWSP surface area)

$= (79{,}920\ ft^3 - 61{,}580\ ft^3) / (5{,}654\ ft^2)$

= 3.243 ft

= 3 ft 2.9 in

The design value of the RWSP minimum water level is 3 ft above the 0% water level (i.e., EL. 7'-7"). Therefore, the 2.9 in. water level difference margin results in a volume margin that is determined as follows:

Margin = 2.9 in x $5{,}654\ ft^2$

$= 1{,}370\ ft^3$

The water volume and water level in the RWSP is summarized in Figure 1, and the calculation results and the approach of evaluating the "Ineffective Pools" and "Return Water on the Way to RWSP" is also summarized in Attachment 1 of this RAI response.

Figure 1: Water Volume and Water Level of RWSP

References

1) MHI Letter No. UAP-HF-12135, "US-APWR DCD GSI-191 Tracking Report", dated May 2012.
2) MHI Letter No. UAP-HF-12125, MUAP-08001 Revision 6, "US-APWR Sump Strainer Performance", dated May 2012.

Impact on DCD

See note below.

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

See note below.

Impact on Technical/Topical Report

See note below.

Note
Impacts of the response on the DCD and Technical Report due to this response are reflected to the GSI-191 DCD Tracking Report (Reference 1) and the revised Technical Report (Reference 2).

Attachment 1: Calculation Summary of Holdup Volume

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 839-6103 REVISION 3**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**10/14/2011**

QUESTION NO. : 06.02.02-71

Follow-up to RAI 740-5719 response:

The water depth on the 25' 3" elevation floor was estimated using the formula, $Q = C*B*h^{3/2}$, which was developed for a rectangular weir geometry (Reference 8 in RAI 740-5719 response). Request MHI justify use of this formula given that MHI has circular weir geometry (transfer pipe configuration).

ANSWER:

1. Overflow height calculation using circular weir formula

Figure 1: Illustration of Vent Hole

2. Uncertainty

3. Sensitivity of Overflow Height

4. 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)",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) United States Department of the Interior, Bureau of Reclamation, "Design of Small Dams", Third Edition, 1987.
4) MHI Letter No. UAP-HF-12135, "US-APWR DCD GSI-191 Tracking Report", 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

See note below.

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

See note below.

Impact on Technical/Topical Report

See note below.

Note
Impacts of the response on the DCD and Technical Report due to this response are reflected to the GSI-191 DCD Tracking Report (Reference 4) and the revised Technical Report (Reference 5)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 839-6103 REVISION 3**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**10/14/2011**

QUESTION NO. : 06.02.02-72

Follow-up to RAI 740-5719 response:

In the evaluation of the weir overflow height at the transfer pipes, MHI assumes all ten transfer pipes/weirs perform as independent transfer pipes/weirs. However, the pipes are situated in pairs and near RWSP tank walls and other structures. Request MHI provide justification that the transfer pipe weir/curb design, given their proximity to each other and other structures, supports treatment as independent weirs/curbs for the analysis of overflow height.

ANSWER:

As described in the GSI-191 closure plan (Reference 1), the ten 18" transfer pipes have been deleted from the design.

The two openings on the 2nd floor discharging into the reactor cavity are close to each other and to walls (See Figure 1). MHI conservatively assumed that only one opening is available (i.e., considered only one opening length as the weir length that is used for the overflow height calculation).
The proximity effect was evaluated as shown below to prove the adequacy of this assumption.

Figure 1 Neighboring Openings

MHI modeled the two openings and the surrounding structures as illustrated in Figure 2. The pressure loss at the narrow point of the water flow path was calculated and the effect was evaluated using the model.

1. Conditions and Assumptions

The conditions and assumptions used to evaluate the effect are:

Conditions

- Flow rate:	0.162 m^3/sec (1.01 m^3/sec × 16%) Where, 1.01 m^3/sec: SI and CS/RHR pump flow (Total 15,960 gpm) 16%: Flow ratio to one opening
- Height of weir:	0.05 m (2 inches)
- Length of weir:	0.15 m (6 inches)
- Water depth in front:	0.15 m (6 inches)

Assumptions

Figure 2 Model around Openings on 2nd Floor (Plan View)

Figure 3 Model around Openings on 2nd Floor (Section View)

2. Calculation

3. Evaluation

As calculated above, the total pressure loss will be 0.83 in and the overflow height will be decreased by 0.83 in. Considering the proximity effect, the overflow rate was calculated using an equation provided in Ref. 1 and the flow rate from two openings was determined to be 12.4 ft^3/sec.
However, the flow rate through only one opening, which does not consider the proximity effect (i.e., 4 in overflow height), is 8.0 ft^3/sec.

As described above, the flow rate through one opening is smaller than the flow rate through two openings considering the proximity effect. Therefore, the assumption of considering only one opening is adequate.

4. References

1) MHI Letter No. UAP-HF-12125 "MHI's 3rd Amended Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)", dated May 2012.
2) MHI Letter No. UAP-HF-12135, "US-APWR DCD GSI-191 Tracking Report", dated May 2012.
3) MHI Letter No. UAP-HF-12125, MUAP-08001 Revision 6, "US-APWR Sump Strainer Performance", dated May 2012.

Impact on DCD

See note below.

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

See note below.

Impact on Technical/Topical Report

See note below.

Note
Impacts of the response on the DCD and Technical Report due to this response are reflected to the GSI-191 DCD Tracking Report (Reference 2) and the revised Technical Report (Reference 3)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/29/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 839-6103 REVISION 3**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**10/14/2011**

QUESTION NO. : 06.02.02-73

Follow-up to RAI 740-5719 response:

During a design basis accident, water spilled from the reactor and from containment spray can collect (pool) on floors inside containment. The 25' 3" elevation floor, often referred to as the 2nd floor, contains the floor inside the SG compartment and the floor outside the SG compartment. MHI calculates a water height on the floor outside the SG compartment and applies this water height to the entire 2nd floor. The staff request that MHI provide justification that use of a water height calculated from outside the SG compartment is appropriate for use on the floor inside the SG compartment. As part of the response, provide the method of analysis, inputs and assumptions, and justification for their selection.

ANSWER:

As the staff indicated, the water height outside the SG compartments ("outside") and inside the SG compartments ("inside") during an accident will differ due to the pressure loss at the narrow entrance.

1. Conditions

Due to the design change described in Enclosure 2 of Reference 1, the water flow path changed as shown in Figure 1. After the design change, spray/blowdown water will flow from "inside" to the RWSP through the reactor cavity or the header compartment and there is no direct flow path from "outside" to the RWSP. Spray water coming to the "outside" will flow to the "inside" through four narrow entrances located in the secondary shield wall at 45, 135, 225 and 315 degrees. Water coming to the "outside" will be about 30% of the total spray flow, because most of spray drops on 4th floor and the dropped water goes to the "inside" through four large openings on 4th floor above the reactor coolant pumps. The flow rate from "outside" to "inside" is:

Flow rate from "outside" to "inside" through one entrance = 0.62m^3/sec (9800gpm) × 30% / 4
= 0.0465 m^3/sec (approx. 1.6 ft^3/sec)

Figure 1: Water Flow Path Model (Post-LOCA)

Figure 2: Model of Water Depth Difference between "Inside" and "Outside"

2. Calculations

3. **Design basis overflow height**

4. **Sensitivity of overflow height**

5. 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) MHI Letter No. UAP-HF-12126, "MHI's 3rd Amended Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)", dated May 2012.
3) Rao N.S. Govinda, Muralidhar D. "Discharge characteristics of weirs of finite crest width". J La Houille Blanche 1963;18(5):537–45.
4) MHI Letter No. UAP-HF-12128, "MHI's Response to US-APWR DCD RAI No. 921-6415 (SRP 06.02.02)", dated May 2012.
5) MHI Letter No. UAP-HF-12135, "US-APWR DCD GSI-191 Tracking Report", dated May 2012.
6) MHI Letter No. UAP-HF-12125, MUAP-08001 Revision 6, "US-APWR Sump Strainer Performance", dated May 2012.

Impact on DCD

See note below.

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

See note below.

Impact on Technical/Topical Report

See note below.

Note
Impacts of the response on the DCD and Technical Report due to this response are reflected to the GSI-191 DCD Tracking Report (Reference 5) and the revised Technical Report (Reference 6)