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January 31, 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-12020

Subject: MHI's 2nd Amended Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)

Reference:
[1] "Request for Additional Information No. 740-5719 Revision 2, SRP Section: 06.02.02 – Containment Heat Removal System –Application Section: 6.2." dated April 26, 2011.
[2] MHI Letter UAP-HF-11181, "MHI's Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)" dated July 14, 2011 (ML11168A008)
[3] MHI Letter UAP-HF-11280, "MHI's Amended Response to US-APWR DCD RAI No. 740-5719 Revision 2 (SRP 06.02.02)" dated August 31, 2011 (ML11245A189)
[4] MHI Letter UAP-HF-11449, "Updated Closure Plan for Issues Associated with GSI-191 for the US-APWR Design Certification" dated December 21, 2011
[5] MHI Letter UAP-HF-12019, "MHI's Amended Response to US-APWR DCD RAI No. 815-5986 Revision 3 (SRP 06.02.02)" dated January 31, 2012

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "2nd Amended Response to Request for Additional Information No. 740-5719 Revision 2". In Reference 2, MHI provided the original response to the NRC's Request for Additional Information ("RAI") in Reference 1.

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

The enclosed RAI response is regarding to GSI-191. MHI's closure plan that describes outline of design change for GSI-191 (Reference 3) was submitted to the NRC in December 2011. With the closure plan and Enclosure 2 and 4 of RAI No. 815-8986 response (Reference 5), design change regarding to the GSI-191 is described. Reflecting the design change some part of the response was revised.

As indicated in the enclosed materials, this document contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to

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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 response (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 Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittal. His contact information is below.

Sincerely,

Y. Ogata

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

Enclosure:

1. Affidavit of Yoshiki Ogata

2. 2nd Amended Response to Request for Additional Information No. 740-5719 Revision 2 (proprietary version)

3. 2nd Amended Response to Request for Additional Information No. 740-5719 Revision 2 (non-proprietary version)

CC: J. A. Ciocco
J. Tapia

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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-12020

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 "2nd Amended Response to Request for Additional Information No. 740-5719 Revision 2" dated January 31, 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 31st day of January, 2012.

Y. Ogata

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

Docket No. 52-021
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Enclosure 3

UAP-HF-12020
Docket No. 52-021

2nd Amended Response to Request for Additional Information
No. 740-5719 Revision 2

January 2012
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2012

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.:	**NO. 740-5719 REVISION 2**
SRP SECTION:	**06.02.02 – Containment Heat Removal System**
APPLICATION SECTION:	**6.2**
DATE OF RAI ISSUE:	**4/26/2011**

QUESTION NO.: 06.02.02-64

On April 7th, 2011, the staff performed an audit of 4CS-UAP-20070029 Rev1, "Hold-up Water volume calculation sheet during LOCA" describing the calculation of hold-up water volume following a loss of coolant accident to be used in determining the NPSH available for safety related pumps that draw suction from the RWSP. Describe how this calculation was conservative for the NPSH evaluation. Include the following considerations.

a. The NaTB baskets and associated drain piping were not discussed in the hold-up volume calculation.
It appears that they should be as they are designed to collect spray water and then deliver flow to the RWSP.

b. Appropriate reference and justification should be provided for the applied methodology and selected input values used in the hold-up water calculation to demonstrate how the hold-up amount is conservative from a NPSH perspective. The following areas require additional information:

o Containment spray water droplets – Amount of water is a function of flow volume, fall height, and fall time. Method used for evaluating the fall time did not consider atmospheric resistance. This method under-predicts the fall time and therefore the spray water hold-up in the atmosphere. In addition, the flowrate and fall height values selected were not referenced to a document nor was a description provided that explained why the selected values were conservative for calculating hold-up amounts. Please explain how the treatment of spray water droplets in your calculation will provide conservative results.

o Condensate water on containment surfaces – Equation listed for film condensation correlation used to calculate film thickness could not be readily verified (reference in Japanese) and was not found in standard textbooks on heat and mass transfer. Appropriate reference and justification should be provided for the applied methodology and selected input values. Film thickness will be a function of the surface height. Justify estimated vertical surface area and corresponding heights used in the calculations.

o Vapor in the containment atmosphere – No basis provided for vapor amount assumed in the hold-up analysis. Please provide the reference and basis for the atmospheric conditions used to calculate the vapor amount.

o Water retained on the floors – Reference and basis was not provided for selected equation (method of evaluation) or input values used to evaluate dynamic retention on containment floor (result was 6" water height above floor). No evaluation was provided for assessing the dynamic retention on upper floors in containment (assumed 2" height above floor). Please provide the reference and basis and for calculating the dynamic water retention heights to include method and input values.

c. Describe how the volume of water in the reactor system and the volume of water re-injected into the reactor system from the safety injection system is evaluated.

d. Provide a proposed ITAAC for inspection of the as built containment. The purpose of the inspection is to confirm that all potential water retention locations have been identified and the amount of water retention has been conservatively estimated for each potential location.

e. Provide a correlation to permit converting RWSP water volume (gallons) to RWSP water level (feet).

ANSWER:

a. Hold-up volume of NaTB baskets and associated drain piping

The calculation will be revised to account for the NaTB basket and piping volumes in the total "Hold-up Volume".

- NaTB baskets: 2,950ft^3 (Ineffective Pool)
  (5% manufacturing error was considered as uncertainty)
- Associated drain piping: 160 ft^3 (Return Water on the Way to RWSP)

Water volume in associated drain piping is accounted as "Volume of water in piping and floor opening on 2nd floor" of Attachment 1 of RAI answer to question No. 06.02.02-70 (Ref. 10)

The overall impact of this change is discussed in the "Summary" at the end of this response.

b. Clarification of hold-up water calculations and related references

- Containment spray water droplets

  The terminal velocity of containment spray droplets was re-calculated under the assumptions for the accident fluid condition in the containment with different elevations as described in Table b-1. As a result, the calculated fall times in the containment atmosphere above the operating floor are approximately 10 sec to 25 sec considering atmospheric resistance as a function of Reynolds number.

Spray droplet terminal velocity and fall time within the containment dome atmosphere were calculated in the following manner.

For the transition and turbulent region ($500 < Re < 1.0 \times 10^5$), the resistance coefficient for a spherical shape is defined as:

$$C_D = 0.44 \text{ (Ref. 1)}$$

Since Re for this calculation case is above 500, terminal velocity can be calculated as follows,

$$m\frac{dv}{dt} = mg - D$$

where *m* is the droplet mass for one particle, *v* is particle velocity, *D* is resistance force and *g* is gravitational acceleration. *D* can be derived from Stokes law with C_D for the transition and turbulent region as

$$D = \frac{1}{2}C_D \rho v^2 S = 0.22\rho\pi r^2 v^2$$

where ρ is the containment atmospheric density, μ is viscosity and *S* is particle surface area (cross section normal to velocity).

Terminal velocity *v* can be derived from the above equations by assuming free fall as:

$$v = \sqrt{\frac{mg}{0.22\rho\pi r^2}}.$$

Then, the fall time *t* for the transition and turbulent regions ($C_D = 0.44$) can be solved for the different elevations shown in Table b-1.

For the fall time calculation, since the droplet reaches terminal velocity quickly, it is possible to simply apply the C_D for the transition and turbulent regions and neglect C_D for the laminar region. Based on the obtained fall times (about 16 seconds to operating floor and about 20 seconds to refueling cavity floor), the total spray water droplet volume was calculated to be about 2,640 gallons.
The "Return Water on the Way to RWSP" volume in DCD Table 6.2.1-3 will be revised to reflect a total of 2,640 gal.

The overall impact of this change is discussed in the "Summary" at the end of this response.

Table b-1 Calculation Assumptions

Parameter	Description	Value
Spray Droplet Shape	Sphere	N/A
Spray Droplet Diameter	Constant to Sauter mean diameter	1,000 micro meters (Ref. 2)
Initial Speed	Not Considered	0
Spray Nozzle Level	Highest level of spray nozzle	EL 224'-5"
Floor Level	Operating floor	EL 76'-5"
	Refueling cavity floor	Each refueling cavity floor level (EL 46'-11" etc.)
Containment Atmosphere Fluid Condition	LOCA Peak Pressure/Temperature (Mixture of steam, air and nitrogen released from accumulator)	74.2 psia 284 °F (Ref. 3)

- Condensate water on containment surfaces

Condensate film thickness was calculated from Eq. 11 in the hold-up volume calculation based on the fluid conditions. The calculation follows the methodology of theoretically solving the Nusselt film heat transfer correlation, which is widely known (References 4 and 5).

The steps of deriving Eq. 11 are shown as follows:

Assume constant condensation and liquid flow on structure surfaces (Figure b-1).

Mass Conservation

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \qquad \text{(Eq. 1)}$$

Momentum Conservation

$$\rho_L u \frac{\partial u}{\partial x} + \rho_L v \frac{\partial u}{\partial y} = \mu_L \frac{\partial^2 u}{\partial y^2} + g(\rho_L - \rho_v)\sin\varphi \qquad \text{(Eq. 2)}$$

Energy Conservation

$$c_{pL}\rho_L u \frac{\partial \theta}{\partial x} + c_{pL}\rho_L v \frac{\partial u}{\partial y} = \lambda_L \frac{\partial^2 \theta}{\partial y^2} \qquad \text{(Eq. 3)}$$

Where:

- u : Liquid velocity for y axis (horizontal)
- v : Liquid velocity for x axis (vertical)
- ρ_L : Liquid film density
- μ_L : Liquid film viscosity
- ρ_v : Vapor (steam) density
- φ : Heat structure surface angle from horizontal (90°)
- c_{pL} : Liquid film heat capacity
- θ : Temperature
- λ_L : Liquid film heat conductivity

Boundary conditions are as follows:

u=v=0 and $\theta=\theta_W$ at y=0 (structure surface),

$\mu_L \dfrac{\partial u}{\partial y} = 0$ and $\theta=\theta s$ at $y=\delta$ (film surface) (Eq. 4)

Where

θ_w : Structure surface temperature

θ_s : Film surface temperature

Additionally, assuming thermal equilibrium from x=0 to x=x in the liquid film at steady state and condensation latent heat L, energy balances can be written as follows:

$$L\int_0^\delta \rho_L u dy + L\int_0^\delta \rho_L u c_{pL}(\theta s-\theta)dy = \int_0^x \lambda_L \left(\frac{\partial\theta}{\partial y}\right)_{y=0} dx$$

Simplifying gives:

$$L\rho_L \int_0^\delta u\left\{1+\frac{c_{pL}(\theta s-\theta)}{L}\right\}dy = \lambda_L \int_0^x \left(\frac{\partial\theta}{\partial y}\right)_{y=0} dx \quad \text{(Eq. 5)}$$

Generally, $\dfrac{c_{pL}(\theta s-\theta)}{L}$ is much smaller than 1 and thus the thermal conductance in the liquid film can be ignored. This further simplifies Eq. 5 to:

$$L\rho_L \int_0^\delta u dy = \lambda_L \int_0^x \left(\frac{\partial\theta}{\partial y}\right)_{y=0} dx \quad \text{(Eq.6)}$$

Applying the same assumption to Eq.3, $\dfrac{\partial^2\theta}{\partial y^2}$ can be considered very small and therefore assumed to be zero. Integrating Eq. 3 (with $\dfrac{\partial^2\theta}{\partial y^2}$ set to zero) and considering boundary conditions, temperature distribution in the liquid film is given as:

$$\theta = \theta_W + (\theta_S - \theta_W)\frac{y}{\delta} \quad \text{(Eq. 7)}$$

For the momentum conservation, neglecting the kinetic term and assuming no change in velocity (steady state) in Eq. 2, the following equation is obtained:

$$\mu_L \frac{\partial^2 u}{\partial y^2} = -g(\rho_L - \rho_v)\sin\varphi \quad \text{(Eq. 8)}$$

With integration and boundary conditions, Eq.8 can be expressed as:

$$u = \frac{g(\rho_L - \rho_v)\sin\varphi}{2\mu_L}\left(2\delta y - y^2\right) \quad \text{(Eq. 9)}$$

In order to obtain the liquid film thickness, combining Eq.7 and Eq. 8 with Eq. 6 gives:

$$\frac{\delta^3}{3} = \frac{c_{pL}(\theta_S - \theta_W)}{L} \frac{\nu_L \kappa_L}{g\left(\frac{\rho_L - \rho_V}{\rho_L}\right)\sin\varphi} \int_0^x \frac{dx}{\delta} \qquad \text{(Eq. 10)}$$

where ν is kinetic viscosity and κ is thermal conductivity of the liquid.

With an integration and boundary condition δ=0 at x=0, liquid film thickness is given by the following equation:

$$\delta = \sqrt{2}\left\{\frac{c_{pL}(\theta_S - \theta_W)}{L}\right\}^{\frac{1}{4}} \frac{1}{(Gr_x Pr_L)^{\frac{1}{4}}} x \qquad \text{(Eq. 11)}$$

Local heat transfer coefficient for film condensation is calculated from the well-known Nusselt equation which is obtained through the derivative of Eq. 7:

$$h_x = \frac{\lambda_L \left.\frac{\partial\theta}{\partial y}\right|_{y=0}}{\theta_S - \theta_W} = \frac{\lambda_L}{\delta}$$

and substitution into Eq.11:

$$Nu_x = \frac{h_x x}{\lambda_L} = \frac{1}{\sqrt{2}}\left\{\frac{L}{c_{pL}(\theta_S - \theta_W)}\right\}^{0.25} (Gr_x Pr)^{0.25}$$

Condensation liquid thickness on the surface of the heat structure is predicted by Eq. 11. The height used for this calculation was 40 meters (about 130 feet), and the resulting condensation film thickness (based on 40 meters height) was applied to all surfaces. The vertical portion of containment from the second floor level (EL 25'-3") is about 129 feet. If the vertical height (x) increases, the liquid film thickness also increases as shown in Eq. 11. However, the liquid thickness calculated based on a 40 meter height was conservatively applied to all surfaces.

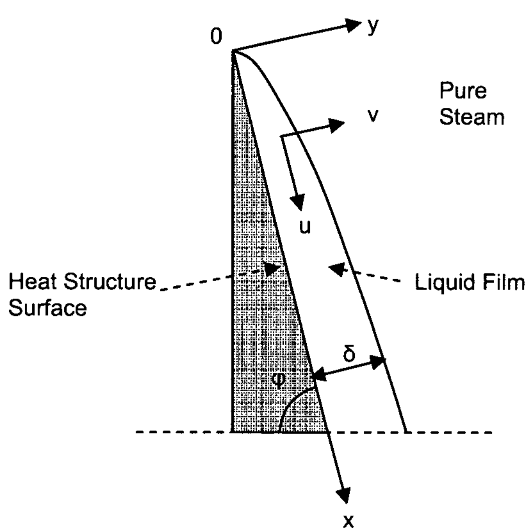

Figure b-1 Film Condensation at Structure Surface

The vertical surface area of the containment was calculated using "Concrete Outline Drawings," which indicate the frame shape of the building and the dimensions, and a 5% margin was added to the total area.

There is no change to the previously calculated RWSP water volumes in DCD Table 6.2.1-3.

- Vapor in the containment atmosphere

  The amount of vapor is calculated from the conditions for the worst case pressure inside containment during a LOCA described in DCD Section 6.2.1. The calculation is based on the mass and energy release during a LOCA as described in DCD Section 6.2.1.3 and Tables 6.2.1-18, 6.2.1-20 and 6.2.1-5 and the assumption of minimum condensation volume as described in DCD Section 6.2.1and Tables 6.2.1-4 and 6.2.1-5.

  There is no change to the previously calculated RWSP water volumes in Table DCD 6.2.1-3.

- Water retained on the floors

  Water depth on the floors is calculated based on the following general expressions:

  $$Q = CBh^{3/2} \qquad (1)$$

  Where:
  Q: Overflow volume
  C: Flow coefficient
  B: Length of weir
  h: Overflow height

  Overflow volume is calculated from pump flow rate by a conservatively assuming the maximum flow rate considering four train SI and CS/RHR pump operation. The total flow rate is:
  Q = 1,540 gpm (SI pump) x 4 (train) + 2,450 gpm (CS/RHR pump) x 4 (train)
  = 15,960 gpm
  = 1.01 m^3/sec

  The flow coefficient was calculated for the weir based on References 7 and 8 as follows:
  C = 1.444 + 0.352(h/L)
  = 1.665
  Where, L = 6 in ≈ 0.15 m (Length of weir)
  h = 0.094 m (Assumption value: overflow height)

  Total length of the weir is approximately 26.4 m (1,040 in). The weir length was conservatively extracted considering proximity effect that is described in RAI 839-6103 Question No. 06.02.02-72 (Reference 10). See Figure b-2 for the 2nd floor opening sizes. Although a debris interceptor is installed at the each of the openings on the 2nd floor, it was conservatively assumed that 20% of weir length is blocked. Assuming complete blockage of one opening, maximum about 14% length of weir will be blocked. Therefore, the 20% blockage assumption is enough conservative.

Figure b-2 Floor openings on 2nd floor

Then, the length of the weir is:

$B = 26.4 \text{ m} \times 80\%$

$= 21.12 \text{ m} \ (832 \text{ in})$

From Eq. (12) the overflow height is determined as follows;

$h = (Q / (C \times B))^{2/3}$

$= (1.01 / (1.665 \times 21.12))^{2/3}$

$= 0.094 \text{ m}$

$\approx 0.1 \text{ m}$ (Roundup)

$\approx 4 \text{ in}$

The above overflow level calculation can only be applied inside the SG compartment room on 2nd floor. The over flow height will be 1 in higher outside the SG compartment than inside (i.e., 5 in) because recirculation water flow from outside to inside causes a pressure drop to occur at the narrow entrance. See RAI 839-6103 answer to a question No. 06.02.02-73 of Reference 10 for a detailed calculation of overflow height of outside the SG compartment room.

Although this overflow level change has an impact on Table DCD 6.2.1-3, there are also other changes due to the response to RAI 839-6103 (Reference 10). Therefore, the overall changes regarding the hold-up volume calculation are summarized in Attachment 1 of RAI 839-6103 answer to a question No. 06.02.02-70 the response.

c. Reactor system and re-injection water volume

The overall effects of RCS and re-injection water volumes are not included in the evaluation, but the effect is conservative based on the following.

Following a LOCA, the reactor system water immediately begins to spill out from the broken pipe section, and flows into the RWSP, raising its water level. Soon after the water in the reactor vessel will be supplemented with the water re-injected by the ECCS. Although the re-injected water is from the RWSP, the RWSP water level will not decrease because the volume of the reactor system water that flows into the RWSP is larger than that of re-injected water. Therefore, if the reactor system water and the re-injected water were taken into account, the RWSP water level would be higher. Consequently, excluding these water volumes results in conservative evaluation of hold-up water in view of minimum water level calculation.

There is no change to the previously calculated RWSP water volumes in DCD Table 6.2.1-3.

d. ITAAC

Tier 1 and ITAAC provide top-level information that includes the principal performance characteristics and safety functions of SSC. MHI understands the importance of verifying as-built water retention locations, but considers this to be within the scope of the existing ITAAC.

Inspection of containment after construction to determine if all potential water retention locations have been identified and the amount of water has been conservatively estimated for each potential location, does not meet the SRP 14.3 selection criteria. MHI considers a separate ITAAC for this purpose to represent an inappropriate level of detail and, therefore, to be unnecessary.

US-APWR DCD Revision 3 Tier 1 Table 2.4.4-5 ITAAC #1 verifies ECCS functional arrangement, and ITAAC #7.d verifies adequate safety injection pump available and required NPSH. The verification of NPSH available will include inspection of the as-built containment drawings to verify the hold-up water volumes, in order to confirm the minimum RWSP water level. Therefore, the existing ITAAC adequately verify the water retention locations at the proper level of detail.

e. Conversion of RWSP water volume to RWSP water level

The effective area of the RWSP will vary with the height from the bottom of the RWSP (EL 3'-7") since there are an elevator pit and concrete ducts inside the RWSP. Table e-1 shows the relationship between the height from the RWSP bottom and the specific water level increase per gallon.

Table e-1: Height from RWSP Bottom vs. Water Level Increase Ratio

Height from RWSP bottom	Effective area of RWSP	Water level increase per gallon
0 – 12' 2"	8.15×10^5 in^2	2.84×10^{-4} in/gal
12' 2" – 15' 11"	7.19×10^5 in^2	3.22×10^{-4} in/gal
15' 11' -	7.06×10^5 in^2	3.28×10^{-4} in/gal

There is no change to the previously calculated RWSP water volumes in DCD Table 6.2.1-3. However, the revised RWSP areas above resulted in an increase of 3,000 gallons to the calculated RWSP liquid volume in DCD Table 6.2.1-5.

Summary

This RAI response results in an impact on the DCD, because the hold-up water volume changed. However, RAI 839-6103 (Reference 10) also impacts the description of the hold-up volume calculation. Therefore, the overall hold-up water volume calculation is summarized in Attachment 1 of RAI 839-6103 Question No. 06.02.02-70 of Reference 10. As described in closure plan (Reference 9), summarized change markup of DCD associated with GSI-191 including the hold-up volume calculation shall be submitted to the NRC by end of May 2012.

References

1) Bird, Stewart and Lightfoot, Transport Phenomena, Second Edition, p. 187
2) Subsection 6.2.2.3, DESIGN CONTROL DOCUMENT FOR THE US-APWR Chapter 6, Engineered Safety Features, MUAP- DC006 Revision 3, March 2011
3) Table 6.2.1-6, DESIGN CONTROL DOCUMENT FOR THE US-APWR Chapter 6, Engineered Safety Features, MUAP- DC006 Revision 3, March 2011
4) Nusselt, W., Die Oberflachenkondesation des Wasserdamffs the surface condensation of water. Zetrshr. Ver. Deutch. Ing., 60 (1916), 541-546
5) Bird, Stewart and Lightfoot, Transport Phenomena, Second Edition,.p.452
6) Mitsubishi Heavy Industries, LTD., US-APWR Sump Strainer Performance, MUAP-08001 Revision 5, August 2011.
7) JIS B8302, Measurement methods of pump discharge, 2002 Edition, Japanese Standards Association.
8) Rao N.S. Govinda, Muralidhar D. "Discharge characteristics of weirs of finite crest width". J La Houille Blanche 1963;18(5):537–45.
9) Transmittal No. UAP-HF-11449, "Updated Closure Plan for Issues Associated with GSI-191 for the US-APWR Design Certification", December 21, 2011.
10) Transmittal No. UAP-HF-12021, "MHI's Response to US-APWR DCD RAI No. 839-6103 Revision 3 (SRP 06.02.02)", January 31, 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

There is no impact on the PRA.

Impact on **Technical / Topical Report**

See note below.

<u>Note</u>
As described in summary and Reference 9, summarized change markup of DCD and Technical Report associated with GSI-191 including the RWSP minimum water volume/level calculation shall be submitted to the NRC by end of May 2012.