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**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

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**03/29/2013**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

**RAI NO.:** NO. 905-6311 REVISION 3

**SRP SECTION:** 03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments

**APPLICATION SECTION:** 3.8.3

**DATE OF RAI ISSUE:** 01/25/2012

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**QUESTION NO. 03.08.03-77:**

Section 6.0 of the MHI Technical Report (TR) MUAP-11019-P (R0) discusses the development of design equations for the out-of-plane shear strength of SC walls. The concrete contribution ( $V_c$ ) to the shear strength of a structural member depends on the direction (tension or compression) of the axial load applied to the member, as shown in the ACI code for RC structures and by the recommended corresponding equations for SC walls. To ensure the design for out-of-plane shear strength for SC members is acceptable, the following information is needed:

1. For equation 6.2-3 presented in Section 6.2 for SC members subjected to axial tension load, a note similar to the one given in ACI 349-06 Section 11.3.2.3 should be added, i.e., “but not less than zero, where  $N_u$  is negative for tension.”
2. Section 6.4 of the report states that “as mentioned in ACI 349-06 Section 11.3.1.3, in the presence of significant axial tension, the out of plane shear strength can be calculated by considering the contribution of the shear reinforcement ( $V_s$ ) alone and neglecting the contribution ( $V_c$ ) of the concrete.” Clarify what is meant by the phrase “can be calculated,” i.e., explain what approach is used in the design of the out of plane shear strength for all of the APWR SC walls when tension loads exist. Explain whether  $V_c$  is always conservatively neglected for all out-of-plane shear strength calculations, or is equation 6.2-3 sometimes used to consider the effect of the magnitude of the axial tension force. If it is the latter, then confirm that both plus and minus member forces due to seismic loadings are considered which would eliminate or diminish the benefit of using Equation 6.2-3
3. If any of the three equations 6.2-1, 6.2-2, and/or 6.2-3 will be used to include the shear strength from the concrete infill, then explain why reducing the factor from 2.0 to 1.5 for  $V_c$  is adequate. Based on Figure 6.2-1 of the TR, the use of the 1.5 factor does not result in a lower bound to the data points for shear strength provided by concrete for sections corresponding to 36 inches or more (which match the SC section thicknesses).
4. In addition to Section 6.4 discussed above, there are several other locations in the TR where the phrase “can be estimated,” “can be used,” “can be calculated,” or “may be used” .... are utilized. As example, p 2-4 of the TR states that “The maximum axial compressive

strength of the US-APWR SC modules can be estimated according to ACI Equation 10-2 shown in Figure 2.2-2. To avoid confusion, the wording should be revised to state definitively whether this approach or equation(s) are used or only sometimes used because the phrases indicate “can be...” or “may be...”

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**ANSWER:**

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-12108 (ML12138A217).

Technical Report MUAP-11019, Rev. 1, has been updated to incorporate the above changes. Specifically, Equation 6.2-3 in Technical Report MUAP-11019, Rev. 1, has been updated to clarify that  $V_c$  shall not be taken as less than zero; the phrase “can be calculated” in the first sentence of Section 6.4 has been replaced with “is calculated,” the remaining discussion in this Section has been reworded to clarify the intended approach; and the phrases “can be” and “may be” have been revised to be prescriptive when defining the design approach to be used throughout the Technical Report.

Confirmatory tests performed using full-scale, (48-inch) thick SC wall specimens representative of the US-APWR design have demonstrated that the out-of-plane shear strength estimated using the equations in Technical Report MUAP-11019, Rev. 1, Section 6 is conservative. The results of the confirmatory, full-scale tests are presented in Technical Report MUAP-11013, Rev. 2, Appendix B, Section 9.0.

**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.

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This completes MHI’s response to the NRC’s question.