RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

05/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 985-6948 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:	**01/08/2013**

QUESTION NO. 03.08.03-106:

The staff reviewed the applicant's response to RAI 905-6311, Question 03.08.03-71 regarding how construction loads are considered in the design of tie bars and related structural elements. Regarding the construction of the revised tie bar arrangement, the response stated that the two flat plates of a tie bar will be welded one by one to each of the two opposing steel-concrete (SC) faceplates first. It is unclear to the staff how the use of jigs discussed in the RAI response will assure the precise location/alignment of the flat plates so as to limit the offset between the two flat plates. Explain how this will be achieved, what is the acceptable tolerance for the offset in the direction perpendicular to plane of the flat plates, and how the stresses in a tie bar due to the offset are evaluated and included in the design calculations, if significant.

Regarding the design considerations of stresses/forces in the faceplates due to the concrete pour, the RAI response stated that, under wet concrete pressures, there are highly localized stresses in the faceplate at the tie bar attachment plate corners near the bottom of the casting height. However, no explanation is provided on how their effects are considered in design. Therefore, the staff requests that the applicant explain whether and how the highly localized stresses in the faceplate due to wet concrete pressures are considered in design. If not considered, explain why not.

ANSWER:

The tolerance for fabrication of the tie bars will be in accordance with the steel-concrete (SC) Fabrication Plan described in Technical Report MUAP-12006, Rev. 0. The stresses in the tie bar due to the offset are not evaluated or included in the design calculations. The highly localized stresses in the faceplate (at the tie bar locations) due to wet concrete pressure are not evaluated or included in the design calculations. These stresses are accounted for in the design as described in Technical Report MUAP-11019, Rev. 1, Section 8.7, which places limitations on the demand-to-capacity ratios.

Both of these issues are similar to residual stresses produced by fabrication and welding of steel structural elements. For example, fabrication and welding procedures produce residual

stresses approximately equal to the steel yield stress. These residual stresses and strains do not have a significant influence on the strength (load capacity) of structural components with non-slender cross-sections, and are not considered in the Load and Resistance Factor Design (LRFD) approach, which is an ultimate strength design approach.

All the full-scale and large-scale specimens of the steel-concrete (SC) confirmatory testing program summarized in Technical Report MUAP-11013, Rev. 2, Appendix B were fabricated with a tolerance of **[ ]** on the geometric dimensions. This included the tolerance on dimensional offset between the two plates comprising the US-APWR tie bars. Additionally, the steel and concrete properties were measured by conducting material tests in accordance with American Society of Testing and Materials (ASTM) standards, such as ASTM E8 for steel tensile properties and ASTM C39 for concrete compressive strength. These full-scale and large-scale specimens included residual stresses and strains due to: (i) complex fabrication procedures due to rolling, cutting, heating, welding, etc. and (ii) concrete casting. These residual stresses and strain did not have a significant influence, and the specimens developed their ultimate strength (load capacity), which was greater than the values calculated using Technical Report MUAP-11019, Rev. 1 design criteria. The comparisons of the specimen strengths with the design strengths are summarized in Technical Report MUAP-11013, Rev. 2, Appendix B, Section 1.

In summary, localized stresses due to fabrication, erection, and construction processes are not considered in the design because they do not significantly affect the ultimate strength of the SC wall steel components, as shown by the US-APWR confirmatory testing program. The steel components are made from non-slender elements, and designed in accordance with Load and Resistance Factor Design (LRFD), which is an ultimate strength design approach.

Impact on DCD

There is no impact on the DCD.

Impact on R-COLA

There is no impact on the R-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.

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