RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

03/29/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 977-6899 REVISION 0**
SRP SECTION:	**03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments**
APPLICATION SECTION:	**3.8.3**
DATE OF RAI ISSUE:	**11/20/2012**

QUESTION NO. 03.08.03-101:

The staff evaluated the applicant's response to RAI 879-6196, Question 03.08.04-52, dated March 26, 2012, regarding the MHI approach for overstrength connection design in the containment internal structure (CIS) where it is not feasible to use the full strength connection design approach. For Item No. 4, the RAI response provided an analytical evaluation to show that the use of a 2.0 factor applied to the demands in the overstrength connection design methodology achieves a minimum high confidence low probability of failure high confidence of low probability of failure (HCLPF) margin of safety equal to 1.67, while utilizing the approach specified in ACI 349-06 Appendix D for the overstrength connection design. In order to demonstrate this, the RAI response uses several expressions such as: the HCLPF seismic margin factor of 1.0, which based on a design following the ASCE/SEI 43-05 Standard, and minimum HCLPF margin of safety equal to 1.67, which is achieved when the design utilizes a Load Increase Factor (LIF) of 2.0. To conclude that the load increase factor of 2.0 is adequate, the applicant needs to clarify several items listed below:

(1) Explain whether the above statements from the RAI response mean that the HCLPF seismic margin factors (or the HCLPF margin of safety) represent the ratio of the HCLPF seismic capacity to the safe shutdown earthquake (SSE) demand (certified seismic design response spectra (CSDRS) based demand in this case), and if not, provide a description of the HCLPF seismic margin factors.

(2) Explain whether the HCLPF margin of safety equal to 1.67 arises from the seismic margin guideline as described in the NRC staff requirements memorandum (SRM to SECY 93-087) and staff's Interim Staff Guidance (DC/COL-ISG-20, Seismic Margin Analysis for New Reactors Based on Probabilistic Risk Assessment"), and that the seismic margin factor of 1.0 arises if a design is performed in accordance with the ASCE/SEI 43-05 Standard. If not, provide basis for the margin of safety factors of 1.67 and 1.0.

(3) The RAI response indicates that any component designed following the ASCE/SEI 43-05 Standard will achieve roughly a HCLPF seismic margin factor of 1.0. Therefore, explain whether all applicable structural components, which are within the accident

sequences leading to core damage or containment failures, will also need to increase their strengths (or equivalently increase the demand loads on their design by a load factor) to achieve a HCLPF seismic margin factor of 1.67, as did the overstrength connection design which required a LIF of 2.0.

ANSWER:

1. In our response, we assumed that the high confidence of low probability of failure represents the margin of safety, or the ratio of the seismic capacity to the safe shutdown earthquake (SSE) demand which is based on the certified seismic design response spectrum (CSDRS). A high confidence of low probability of failure of 1.0 would correspond to 0.3g since our CSDRS was anchored to a 0.3g zero point accelerations ground response spectrum. In our response to RAI 879-6196, Question 03.08.04-52, part 4, we used a very conservative assumption that the high confidence of low probability of failure margin factor of 1.0 is obtained using American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 43-05 Standard Median Strength Conservatism Ratio, R_s, from Eq. (C-16). Using R_s, results in essentially deterministic code strength (American Concrete Institute (ACI) 340-06). It neglects the Median Conservatism Ratio, R_D, (Eq. C1-7) and the Median Nonlinear Conservatism Ratio, R_N, (Eq. C1-8(a)) provided in ASCE/SEI 43-05. Many high confidence of low probability of failure calculations have shown that the high confidence of low probability of failure will typically have a larger margin of safety than that provided by code equations. A conservative approach was used to show that when a Load Increase Factor of 2.0 is used, the connection strength will have a high confidence of low probability of failure that will be significantly larger than 1.67 which is the minimum required. It is also understood that a site specific plant level has not yet been made and therefore the approach provided in our response will provide a sufficient level of conservatism.

2. The high confidence of low probability of failure margin of safety of 1.67 is based on the SECY 93-087, position 17, as clarified in Staff Requirements Memorandum on the same subject. It is also consistent with the Interim Staff Guidance (DC/COL-ISG-20). Though we conservatively assumed that a high confidence of low probability of failure margin of 1.0 is obtained when the strength design obtained in accordance with ASCE/SEI 43-05, we do not think that this is an assumption that should be made for all structural components. Indeed, we expect that a component designed in accordance with this standard will have high confidence of low probability of failure margins much larger than 1.0. A conservative assumption was used to show that using a Load Increase Factor of 2.0 will produce a connection design with little likelihood of governing the plant high confidence of low probability of failure.

3. The assumption, that a high confidence of low probability of failure equal to 1.0 is associated with a strength determined in accordance with ASCE/SEI 43-05, is very conservative and it is not intended to be applicable to structural components in general. ASCE/SEI 43-05 assumes that strength is specified in terms of the ACI ultimate strength, the American Institute of Steel Construction (AISC) code load and resistance factor design Limit State strengths including the code specified strength reduction factors (φ), and the American Society of Mechanical Engineers Code Service Level D strengths. It also assumes that the seismic demand is specified in terms of the ASCE 4 requirements. This conservative assumption was used to demonstrate that when a Load Increase Factor of 2.0 is used, the connection will have little likelihood of governing the plant level high confidence of low probability of failure. When a fragility analysis of a structural component is performed, not only the

Median Strength Conservatism Ratio but also the Median Demand Conservatism and the Median Nonlinear Conservatism Ratios will also be specified. This will produce a high confidence of low probability of failure value larger than the deterministically derived code strength value.

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.

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