RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

03/29/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 662-5131 REVISION 2**
SRP SECTION:	**03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments**
APPLICATION SECTION:	**3.8.3**
DATE OF RAI ISSUE:	**11/15/2010**

QUESTION NO. 03.08.03-32:

The staff's evaluation of MHI's amended response to Question 03.08.03-15 is unchanged from that for the initial response. In that response, MHI states that under the SSE loading the concrete of the SC modules does not crack. However, in the response to Question 03.08.03-7, MHI states that concrete of SC modules will crack under thermal load. Unless the SSE event occurs before the occurrence of thermal load, the concrete will crack and the concrete of SC modules under the SSE loading needs to be considered to be cracked.

MHI needs to provide evidence that the SSE event occurs before the occurrence of thermal load (with an appropriate margin of safety); otherwise, the concrete of the SC modules needs to be considered as cracked under the SSE load. MHI is requested to provide the actual timelines for each of the loads, and to provide the rationale supporting the assumptions for these timelines.

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-10358 (ML092670585).

MHI agrees that the steel concrete (SC) module concrete may crack due to either the safe shutdown earthquake (SSE) condition or the accidental thermal condition. MHI also recognizes that it is impossible to define an explicit temporal relationship between these two loading conditions. The accidental thermal condition may occur coincidently with the SSE event, or it may occur independently. Thus it may not be appropriate to use the specific stiffness degradations calculated for one of these events in the analysis for the other. Instead, the seismic analysis for the containment internal structure (CIS) uses stiffness degradations appropriate for the form and extent of cracking caused by the seismic loads, and the thermal analysis uses stiffness degradations warranted for the cracking caused by the thermal loads.

The maximum element stress resultants obtained from the cracked seismic and thermal analyses are combined for design of the SC modules in accordance with Load Combination

C-8 given in Appendix C of American Concrete Institute (ACI) 349-06. Section C.2.5 states that maximum values of P_a, T_a, R_a, Y_j, Y_r, and Y_m shall be used in this load combination "unless an appropriate time-history analysis is performed to justify otherwise." One might interpret this to indicate that reduced values of the SC wall accidental thermal forces may be combined with maximum seismic forces, considering the length of time required to develop the worst-case through-wall temperature distributions versus the relatively short duration of seismic ground motion. However, the commentary in Section RC.2 states that time-history analysis is permitted only to account for the time lag between the pipe rupture loads themselves (e.g., between P_a and T_a). Furthermore the commentary states that "Load Combination (C-8) has unit load factors on all loads because it represents an extremely unlikely combination of events." From these commentaries, it is understood that the intent of the code is for maximum values of T_a and SSE stress resultants to be combined.

In keeping with the above discussion, CIS in-structure-response-spectra (ISRS) are based on certified design Reactor Building (R/B) soil-structure interaction (SSI) analyses and consider stiffness reductions due to SC module concrete cracking. Technical Report MUAP-10006, Rev.3, Sections 02.4.1 and 02.4.2 describe the CIS dynamic three-dimensional finite element (FE) modeling approach. Subsection 02.5.1.3.3 discusses validation the CIS dynamic FE model. Technical Report MUAP-11018, Rev. 1, describes SC module test data and stress analyses that establish the bases for the stiffness and damping values used in the seismic analysis.

The SC module members can experience varying levels of stress resulting in different patterns of concrete cracking under the different loading conditions that can exist in the reactor containment. Depending on the reactor operating conditions, the CIS members can be subjected to design seismic loads in combination with normal operating or accidental thermal loads resulting in different levels of stiffness reduction due to concrete cracking. Therefore, the seismic analysis is performed considering two CIS structural stiffness conditions corresponding to:

1. Load Condition "A": Normal operating conditions characterized with insignificant reduction of stiffness and concrete cracking; and

2. Load Condition "B": Accidental conditions characterized with significant reduction of stiffness due to cracking of the concrete under high accidental thermal loads.

Different material damping values are assigned to the different members depending on the level of stresses and corresponding concrete cracking. As discussed in Technical Report MUAP-11018, Rev. 1, Section 7.0, since the Category 1 SC walls are the primary lateral load resisting system and their response dominates the amplified range of the overall structural response, constant damping ratios of 4 percent for Condition A and 5 percent for Condition B are used for the CIS seismic analyses.

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.