RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

08/01/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1040-7139 REVISION 3**
SRP SECTION:	**03.08.01 – Concrete Containment**
APPLICATION SECTION:	**3.8.1**
DATE OF RAI ISSUE:	**07/01/2013**

QUESTION NO. 03.08.01-19:

On April 3, 2013, the applicant submitted a markup of DCD Tier 2 Section 3.8 to provide updated information related to a seismic design change.

In Subsection 3.8.1.4.1.2, "Thermal Analysis," the last sentence of the second paragraph (Page 3.8-12) states, "This uni-dimensional heat flow is normalized and the average and equivalent linear gradients are created and applied to the FE [finite element] model of the PCCV [prestressed concrete containment vessel]."

The applicant is requested to explain why the uni-dimensional heat flow needs to be normalized and exactly how is it being normalized.

ANSWER:

The uni-dimensional heat flow analysis results in a non-linear temperature distribution within the PCCV shell immediately following a LOCA. Since the temperature gradient is applied to the FE model as surface temperatures on the inside and outside faces of the shell, the non-linear temperature distribution must be normalized by creating an equivalent linear temperature distribution. The equivalent linear temperature distribution is calculated using the methodology presented in Figure RE.1 of ACI 349-06, Appendix RE. A detailed explanation of the methodology used and corresponding results was provided in the updated answer to Question No. 03.08.01-07 of RAI No. 223-1996, transmitted by letter UAP-HF-13154, dated July 8, 2013.

Impact on DCD

Section 3.8.1.4.1.2 of the DCD will be revised as shown in Attachment 1.

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.

temperature transients result in a nonlinear temperature distribution within the PCCV shell and the resulting profiles are calculated in a uni-dimensional heat flow analysis. ~~Temperatures within the concrete wall are calculated in a unidimensional heat flow analysis and the average and equivalent linear gradients considering thermal stress of the liner plate, are applied to the FE model of the PCCV, as during normal operation~~This uni-dimensional heat flow is normalized using the methodology presented in Appendix RE of ACI 349-06 (Reference 3.8-8), and the average temperature distribution and equivalent linear gradients are created and applied to the FE model of the PCCV. MIC-03-03-00046 DCD_03.08.01-19 DCD_03.08.01-7

3.8.1.4.1.3 Variation of Physical Material Properties

In the design analysis of the PCCV, the physical properties of materials are based on the values specified in applicable codes and standards. ~~The design analysis takes into account the minimum/maximum values permitted by the codes and standards as appropriate to capture worst case analysis scenarios.~~ DCD_03.08.01-20

3.8.1.4.2 Design Methods

The design of the PCCV structure is based on the membrane forces, shear forces and bending moments resulting from the loads and load combinations defined in Subsection 3.8.1.3. The membrane forces, shear forces and bending moments in selected sections are obtained from the linear FE analysis ~~performed using the computer program ANSYS. The global analysis considers the major structural configurations, including the PCCV, R/B, and containment internal structure on a common basemat, using solid element modeling and linear material assumptions~~. MIC-03-03-00046

3.8.1.4.2.1 Concrete Cracking Considerations

As discussed in SRP 3.8.1 (Reference 3.8-7) Section II.4.D, concrete cracking can affect the stiffness of the PCCV and cause shifting of the natural frequency, thereby affecting the response/loads used to design the PCCV. Accordingly, the analysis used to calculate the dynamic response of the PCCV resulting from dynamic loads such as earthquake and hydrodynamic loads considers the potential effects of concrete cracking where significant. The addition of stiffness to the concrete sections due to the presence of the liner is not considered in the analysis and design of the PCCV concrete shell. MIC-03-03-00046

The concrete and reinforcement stresses are calculated considering the extent of concrete cracking at these sections. The following are assumptions for calculations:

- The concrete is isotropic and linear elastic but with zero tensile strength
- The thermal forces and moments are reduced according to the concrete cracking depth
- The redistribution of section forces and moments that occurs due to concrete cracking is taken into account

The depths of cracks were determined using an iterative process that initially determines the total load applied to an uncracked section. A crack ~~length~~depth is then postulated on MIC-03-03-00046 MIC-03-03-00057