RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 496-3735 REVISION 0**
SRP SECTION:	**03.08.05 - Foundations**
APPLICATION SECTION:	**3.8.5**
DATE OF RAI ISSUE:	**12/01/09**

QUESTION NO. RAI 03.08.05-27:

In its response to Question 3.8.5-6, MHI explains the shell elements used in the three-dimensional FE models, including a figure that shows the types and locations of elements used.

In reviewing the response, the staff finds that MHI did not provide enough information for the staff to perform an evaluation of the response. The applicant is requested to provide additional information such as how the degree-of-freedoms of these elements (shell, brick, and rigid elements) are matched to each other shown in the left figure of Figure 1 in the response, and how the shell elements are connected to the brick elements in the right figure of Figure 1. MHI is also requested to provide technical information that verifies that the stresses and displacements are continuous through the shell to brick connections.

Reference: MHI response to RAI 340-2004, dated 7/3/2009, MHI Ref: UAP-HF-09363, ML091900557.

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-10032 (ML100430770).

Technical Report MUAP-10006, Rev. 3, Subsection 02.4.1.1.1, describe the connection between finite element types. Shell elements that model walls extend into the solid elements so that the moments are transferred to at least 2 layers of solid element nodes as shown in Figure 1 below (Technical Report MUAP-10006, Figure 02.4.1.1.1-5). Shell elements that provide this connection have stiffness properties identical to the wall shells but have zero mass.

Each shell element node of the dynamic model has five (5) degrees of freedom. Forces and bending moments of shell elements can be transferred to beams by stiffness matrix assembly of the beam and shell elements connected at the same node but connecting at the same node does not transfer the torsional or drilling moments to the shell element. To enable the transfer of the drilling moment to the shell element from beams, massless beam elements that are very stiff to simulate rigid behavior are generated near the surface of the shell or solid elements as shown in Figures 2 and 3 below (Technical Report MUAP-10006, Figures 02.4.1.1.1-7 and 02.4.1.1.1-8) to

provide transfer of moments from beams in all three rotational degrees of freedom by connecting separated nodes of the shell or solid elements. For beams or columns modeled with this technique connecting to slabs or walls in the reactor building complex model, the effect of adding drilling stiffness to the slab and wall shell elements (Allman in-plane rotational stiffness in ANSYS SHELL63 element) does not significantly affect stiffness.

Figure 1 – Connection of Shell to Solid Elements

Figure 2 – Connection of Beam to Solid Elements

Figure 3 – Connection of Beam to Shell Elements

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 a Technical/Topical Report

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