RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

03/29/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 810-5874 REVISION 3**
SRP SECTION:	**03.07.02 – SEISMIC SYSTEM ANALYSIS**
APPLICATION SECTION:	**3.7.2**
DATE OF RAI ISSUE:	**08/22/2011**

QUESTION NO. 03.07.02-93:

In Subsection 3.7.2.3.7 of DCD (R3), "Shear Stiffness", item "i" of the fourth paragraph (page 3.7-22) states, "A FE model of the containment internal structure above the upper level of the basemat, considering the walls, columns and floor slabs, is developed using brick, shell and beam elements."

The Applicant is requested to provide information that explains how the SC module is modeled by finite element models. The information should include the type of the elements used and the name of the element (if ANSYS is used). The Applicant is also requested to demonstrate that the FE model for SC module can reproduce the test results of the SC module

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-11402 (ML11332A148).

The entire text of DCD Subsection 3.7.2.3.7 has been revised since the lumped mass stick model is no longer used. Technical Report MUAP-10006, Rev. 3, presents the revised approach for seismic analyses for development of the reactor building (R/B) complex dynamic finite element (FE) model, which consist of the R/B, prestressed concrete containment vessel (PCCV), containment internal structures (CIS), east and west power source buildings (PS/Bs), auxiliary building (A/B), and essential service water pipe chase (ESWPC), now combined and supported on a common basemat.

Table 02.4.1.1.1-1 of Technical Report MUAP-10006, Rev. 3, lists the element types used for modeling the CIS and steel concrete (SC) modules. Figure 3.8.3-5 of Design Control Document (DCD) (Rev. 3) shows SC module isometrics. Figure 3.8.3-7 of DCD (Rev. 3) shows typical details of SC modules. Table 02.4.1.1.1-2 of Technical Report MUAP-10006, Rev. 3, defines the concrete strength of the SC modules as f'_c = 4,000 psi and the steel yield strength as F_y = 50 ksi. Refer to Section 4 of Technical Report MUAP-11018, Rev. 1, for the composite properties (stiffness) of the SC Modules used in the dynamic FE model. MUAP-11018, Rev. 1, contains methodology for modeling stiffness and damping of the SC modules.

These stiffnesses for walls with thicknesses less than or equal to 56 in. are derived from supporting experimental data for the SC modules. Table 02.4.1.1.3-2 of Technical Report MUAP-10006, Rev. 3, includes stiffness and damping values for SC modules for two loading conditions: A) seismic + operating thermal; and B) seismic + accident thermal. The loading condition A and condition B are defined in Technical Report MUAP-11018, Rev. 1, Section 3.1.

Adjustment of Dynamic Properties of SC Modules:

Simplifications in the geometry of the otherwise complex structure are introduced in the dynamic CIS model in order to produce a coarser FE mesh and to minimize the size of the model in order to be suitable for soil-structure interaction (SSI) analyses using ACS SASSI. Stiffness and mass properties of elements modeling some of the SC walls of the CIS are adjusted in order to calibrate the dynamic response of the simplified dynamic FE model to match the actual response of the CIS as represented in the Detailed FE Model. The adjustments of the unit density and the elastic moduli of the shell elements are introduced to capture the actual distribution of mass and stiffness. The calibration of the model properties is performed based on the results of a 1-g static analysis, and then verified using the results of modal analysis and dynamic response analysis using Harmonic base excitation.

As stated in Section 02.4.1.2 of Technical Report MUAP-10006, Rev. 3, due to the complexity of the CIS, different stiffness and damping values are assigned to different types of structural components for the two bounding stiffness and damping conditions.

Technical Report MUAP-11018, Rev. 1, describes the stiffness values applied to the CIS FE analysis model, including consideration for cracking of the concrete of SC modules, reinforced concrete slabs and massive concrete portions. The stiffness values used for the SC modules reproduce the stiffness behavior exhibited in physical tests. The validity of the stiffness values are demonstrated experimentally as detailed in Technical Report MUAP-11018, Rev. 1.

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.