
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 776-5851 REVISION 3
SRP SECTION: 03.07.02 – Seismic Systems Analysis
APPLICATION SECTION: 3.7.2
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QUESTION NO. RAI 03.07.02-81:

In Section 5.5 of MUAP-11001 (R0), “Structural Integrity Evaluation Results,” the second paragraph (page 70) states, “The required reinforcement due to out-of-plane bending moments and in-plane forces are calculated by program “WALL” and is shown in Table 5.5-2. Similarly, the required reinforcement due to out-of-plane bending moments and out-of plane shear force in slabs are calculated by program “SLAB”. These required reinforcements are calculated in element level and are defined as “Demands.”

The Applicant is requested to clarify how the effect of concrete cracking are considered in the calculation of the design forces and moments.

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by letter UAP-HF-11262 (ML11228A129).

Technical Report MUAP-11001 has been superseded and the relevant information incorporated into Technical Report MUAP-10006, Rev. 3. The reactor building (R/B), prestressed concrete containment vessel (PCCV), containment internal structure, east and west power source buildings (PS/Bs), auxiliary building (A/B), and essential service water pipe chase (ESWPC) are now structurally integrated and supported on a combined basemat to form the R/B complex. Technical Report MUAP-10006, Rev. 3 presents the information relevant to the added A/B and PS/Bs as well as the other buildings that make up the R/B complex.

The analyses results documented in Section 03.4.0 of Technical Report MUAP-10006, Rev. 3 are performed in addition to the uncracked condition by also using 50% reduced stiffness both for out-of-plane bending and the shear directions to account for cracking of the reinforced concrete walls and slabs of the R/B complex. The resulting seismic accelerations used to compute moments and shears by the ANSYS program are consistent with these stiffness values. As stated in Section 02.1.0 of Technical Report MUAP-10006, “Two SSI analyses of the R/B complex are performed for each soil profile corresponding to each of the two bounding levels of stiffness and damping. The responses obtained from the two SSI analyses for each soil profile, i.e., twelve analyses in all, are enveloped in order to address the possible range of effects of concrete cracking on the seismic response of the building.”

The walls and slabs of the A/B will be evaluated in standard design calculations with the ANSYS post-processing FORTRAN routines "wall.exe" and "slab.exe," respectively. In both of the post-processors, axial load (in-plane horizontal forces in the case of slabs) and out-of-plane moment are used with computed axial and moment capacity interaction curves to evaluate the interaction between out-of-plane flexure and in-plane forces. The development of these curves is based on stress and strain compatibility considering cracked section behavior across the cross-sections of the shell elements using the assumptions of Section 10.2 of ACI 349-06. The programs also apply the general principles and requirements for the design of cross-section due to flexure and axial loads of Section 10.3 of ACI 349-06.

In both processors, the interaction between in-plane forces and transverse shear is evaluated through the inclusion of in-plane forces (N_u in Chapter 11 of ACI 349-06) in the determination of the transverse shear capacity, V_c , of the element or cross-section. If the in-plane forces are compressive, N_u is positive and formula 11-4 of Section 11.3.1.2 is used to calculate V_c . If the in-plane forces are tensile, N_u is negative and formula 11-8 of Section 11.3.2.3 is used to calculate V_c . If shear reinforcing is required at a particular cross-section, it is designed to the requirements of Section 11.5.6 of ACI 349-06.

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.