KHNP Input Regarding RAI 252-8299, Question 03.07.02-7

1. Slab Modeling in RCB Structural Analysis Model

The information about slab modeling in the structural analysis model is already provided as response to RAI 208-8245, Question No. 03.08.03-5. The following is part of response related to the slab issues.

a. *Operating floor slabs between the secondary shield walls and the containment shell are included as masses in the FEM. The decoupling criteria in SRP 3.7.2 allow decoupling if the mass ratio of the substructure is less than 0.1 but above 0.01 (0.01 ≤ mass ratio (R_m) ≤ 0.1), and if the frequency ratio of the substructure is less than 0.8 or above 1.25 (frequency ratio (R_f) ≤ 0.8 or 1.25 ≤ frequency ratio (R_f)). The R_m for concrete slabs and internal structure is .051 and the fundamental frequencies of the concrete slabs are lower than 18.7 Hz which is 0.80 of the dominant frequency of internal structures. Thus, internal structures and operating concrete slabs may be decoupled.*

   Regarding the analysis and design of subelements, the concrete slabs at elevations 114'-0", 136'-6", and 156'-0" between secondary shield wall and containment wall are structurally analyzed using the FE (Finite Element) analysis program GTSTRUDL. A separate analysis model simulating each floor level is prepared and evaluated for each specified design load condition. The span direction for concrete slabs is considered in determining the tributary areas. To incorporate the proper vertical seismic load on each slab, slab self-weights and attachment loads are multiplied by the peak acceleration of slab response spectra at each elevation. The equivalent-static loads are determined by multiplying the structure, equipment, or component masses by an acceleration equal to 1.5 times the peak acceleration. The thickness of the slab is generally determined by the requirements of radiation shielding, missile protection, and structural integrity. Based on the enveloped results of FE analysis, the slab reinforcements are determined for flexure and out-of-plane shear in accordance with ACI 349.

b. *The floors are supported by structural steel beams which span the secondary shield wall and the containment wall. Each end of the steel beams have a fixed connection at the secondary shield wall and a sliding connection at the containment wall. The fixed connection is composed of a beam seat, a bumper, and a web angle connection. The beam seat supports vertical load, the bumper supports shear load, and the web angle connection supports vertical and axial load. The sliding connection at the containment wall is composed of a beam seat, a bumper, and a gap between the end of the steel beam and the containment wall to allow radial displacements due to seismic and thermal loads.*

2. Seismic Live Load and Slab Modeling in RCB Seismic Analysis Model

Like the structural analysis model, the slabs between secondary shield walls and containment shell are not modeled in the seismic analysis model in accordance with the decoupling criteria in SRP 3.7.2. All the masses of slabs considering the self-weight of the slabs, the 50 psf of misc. dead load, and the major equipment loads are lumped onto the secondary shield walls. The secondary shield walls are considered the main supporting elements of these weights.

Since the slabs in the reactor containment building are not large, and the increase of the mass due to the addition of seismic live load 50 psf is not great compared to the existing mass of secondary shield walls, the consideration of seismic live load does not significantly affect seismic responses of the secondary shield walls.

For evaluation of the effect of seismic live load on the seismic response of the secondary shield walls, the transient time history analyses are performed with fixed-base condition using two ANSYS models. One is original reactor containment building ANSYS coarse model, and the other is modified model considering the seismic live load. The masses equivalent to the seismic live loads which are applied to the slabs at EL. 114'-0", 136'-6", and 156'-0" of the reactor containment building are added to the secondary shield walls of the modified model. Then, the 4%-damped ISRS of secondary shield wall are compared between two models as presented in Figures 1 through 3. The nodes used in envelopment of the APR1400 ISRS of the secondary shield wall are identically used to generate enveloped ISRS for comparison. As shown in the comparison figures, the variation of ISRS due to the consideration of the seismic live load in containment building seismic analysis model is negligibly small.

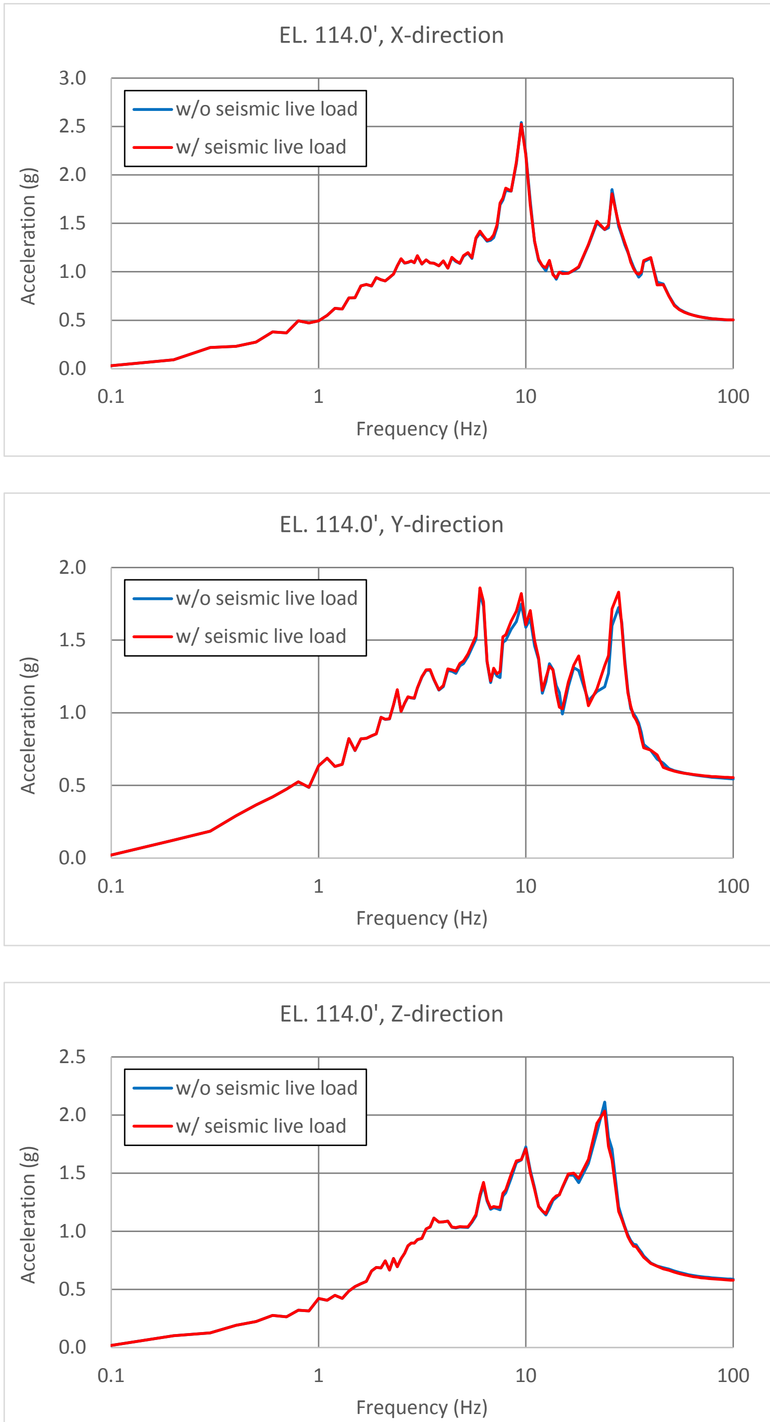

Figure 1 Comparison of Secondary Shield Wall ISRS, EL. 114’-0”

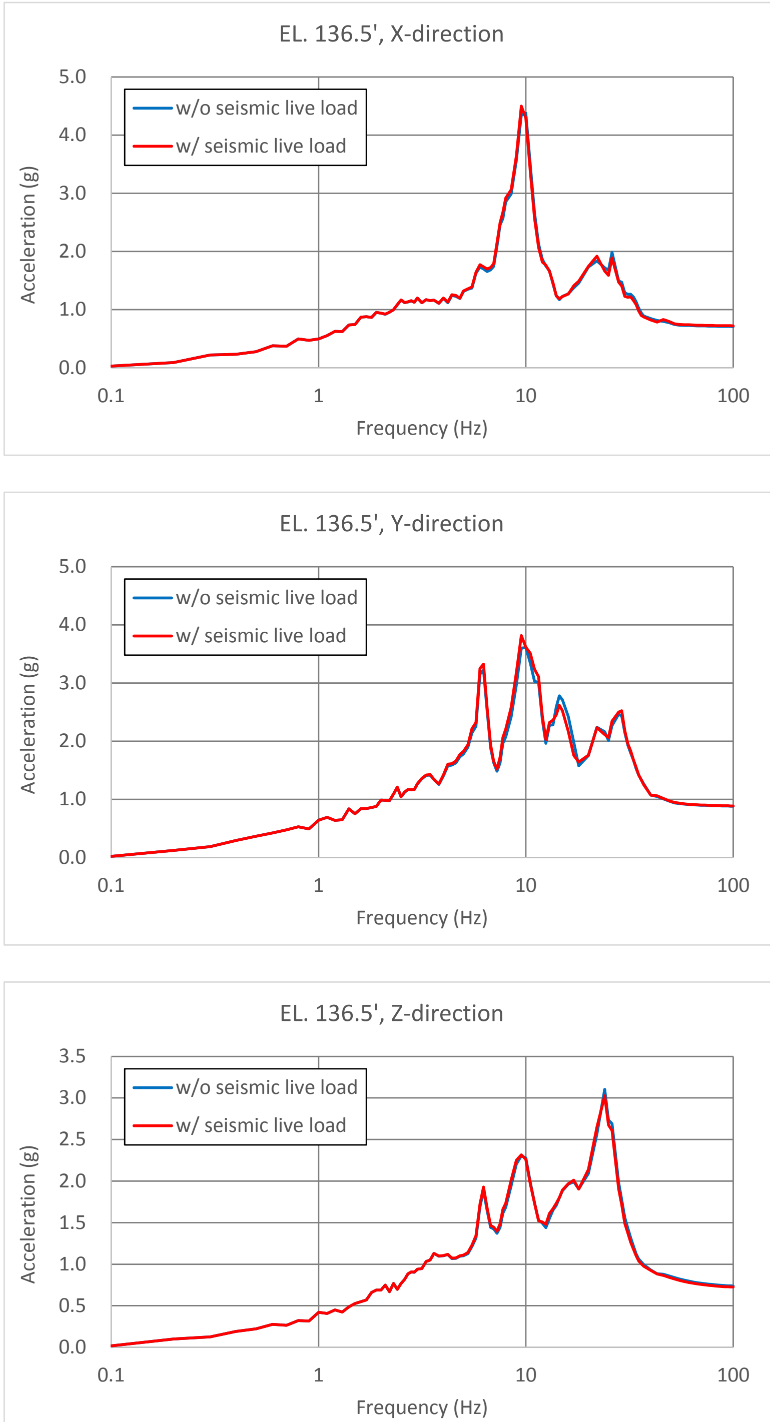

Figure 2 Comparison of Secondary Shield Wall ISRS, EL. 136’-6”

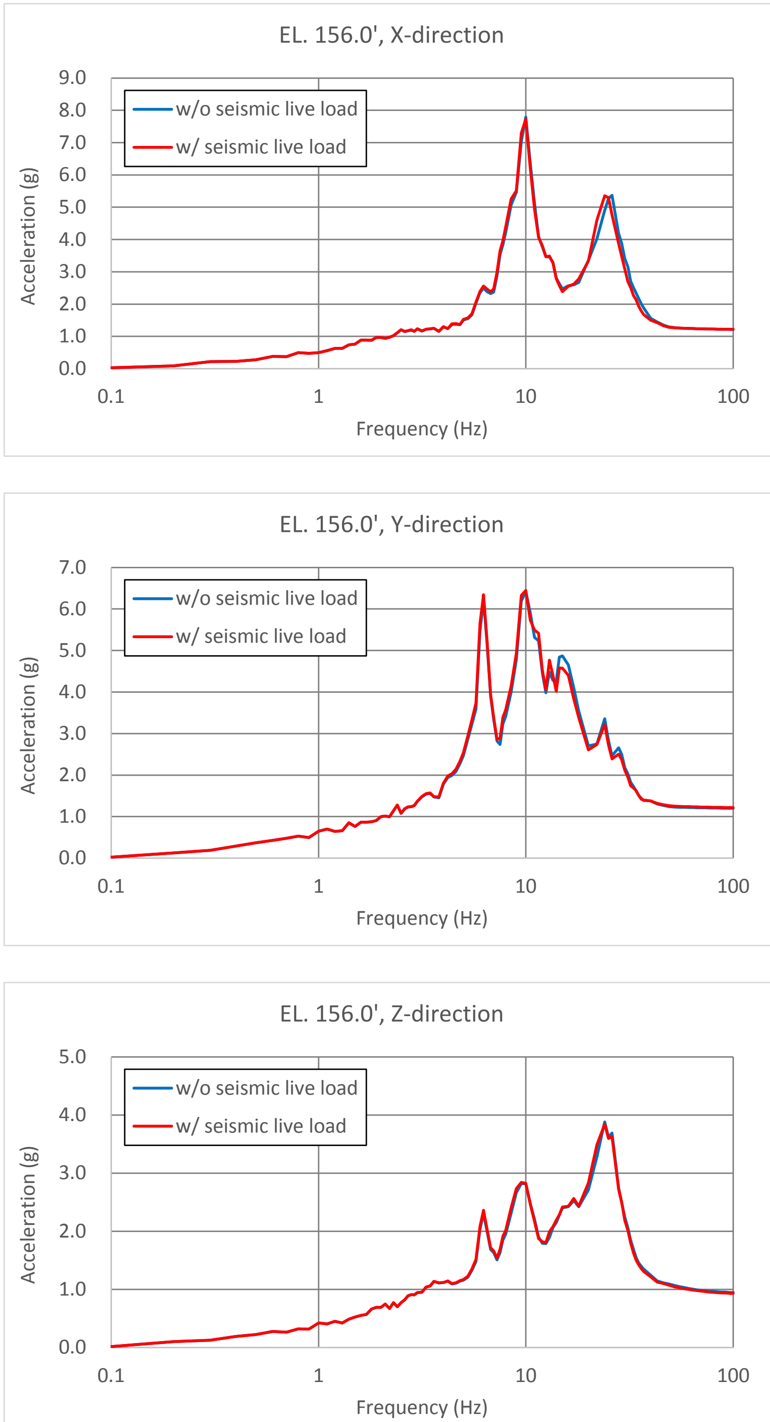

Figure 3 Comparison of Secondary Shield Wall ISRS, EL. 156’-0”