Chapter 3 Design of Structures, Components, Equipment, and Systems

3.1 Conformance with NRC General Design Criteria

This section of the referenced DCD is incorporated by reference with no departures or supplements.

3.2 Classification of Structures, Systems and Components

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following sentence at the end of Section 3.2.

STD CDI

There are no site-specific safety-related or non-safety related RTNSS systems beyond the scope of the DCD.

Table 3.2-1 Classification Summary

Replace the note for System P73 with the following.

STD CDI

The site-specific plant design includes the HWCS. See Section 9.3.9 for further details

Replace the note for System P74 with the following.

NAPS CDI

The site-specific plant design includes the Zinc Injection System. See Section 9.3.11 for further details.

Replace the note for System U78 with the following.

NAPS CDI

The site-specific plant design does not include the cold machine shop.

3.3 Wind and Tornado Loadings

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

NAPS SUP 3.3-1

3.3.2.4 Extreme Hurricane Winds

Section 2.3 defines the site-specific extreme hurricane wind speed in accordance with RG 1.221, “Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants.” The site-specific extreme hurricane wind speed is less than the maximum tornado wind speed listed in Table 2.0-201.

3.4 Water Level (Flood) Design

This section of the referenced DCD is incorporated by reference with no departures or supplements.

3.5 Missile Protection

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.5.1.4 Missiles Generated by Natural Phenomena

Add the following paragraph after the fourth paragraph.

NAPS SUP 3.5-3

Section 2.3 defines the site-specific extreme hurricane winds in accordance with RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants." The site-specific extreme hurricane wind speed is less than the maximum tornado wind speed listed in Table 2.0-201. Table 3.5-201 lists the NA3 site hurricane missile spectrum and velocities in accordance with the guidance in RG 1.221. Potential missiles generated by the NA3 site-specific extreme hurricane wind are less severe than the missiles generated by the standard plant design basis tornado.

3.5.1.5 Site Proximity Missiles (Except Aircraft)

Add the following sentence after the first sentence in the first paragraph.

STD SUP 3.5-1

Site-specific missile sources are addressed in Section 2.2.

3.5.1.6 Aircraft Hazards

Add the following at the end of the first paragraph.

STD SUP 3.5-2

Site-specific aircraft hazard analysis and the site-specific critical areas are addressed in Section 2.2.

Table 3.5-201 **NA3 Site-Specific Hurricane Missile Spectrum**

Missile Type	Missile Velocity[a]
Automobile (4,000 lb)	74 mph horizontal 58 mph vertical
6” Schedule 40 Pipe (287 lb)	55 mph horizontal 58 mph vertical
1” Solid Steel Sphere (0.147 lb)	48 mph horizontal 58 mph vertical

(a) Missile velocities based on RG 1.221 Table 2 for 140 mph site-specific extreme hurricane wind speed

3.6 Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping

This section of the referenced DCD is incorporated by reference with no departures or supplements.

3.7 Seismic Design

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.7.1 Seismic Design Parameters

Replace the last four sentences of this section with following.

NAPS DEP 3.7-1

SSE design ground motion for purposes of seismic design, analysis, and qualification of Unit 3 plant SSCs, is defined by two sets of ground motion acceleration response spectra:

- the single envelope design ground motion response spectra or Certified Seismic Design Response Spectra (CSDRS) described in Section 3.7.1.1.3 that defines the SSE design motion for seismic design of ESBWR Standard Plant, and
- the site-specific FIRS described in Section 3.7.1.1.4.2, representative of the Unit 3 site specific seismological and geological conditions.

The SSE design ground motion is used in operability assessments to demonstrate plant safety for the as-found conditions of safety-related SSCs.

Figures 2.0-201 through 2.0-204 present these 5 percent damped acceleration response spectra that define the site-specific design ground motion as a free-field outcrop motion at the foundation bottom of each Seismic Category I structure. In addition, Figure 3.7.1-285 presents the SSI input response spectra for the FWSC at the average elevation of the bottom of the concrete fill (Elevation 220 ft) as further discussed in Section 3.7.1.1.4.2.3. DCD Figures 2.0-1 and 2.0-2 present the standard design CSDRS.

The August 23, 2011 **M** 5.8, Mineral, Virginia earthquake is considered in development of the Unit 3 SSE. The strong motion records of the earthquake are discussed in Section 2.5.2.1.3. Comparisons of the ARS of the Unit 1 containment mat recordings with the Unit 3 site-specific partial column outcrop FIRS and the CSDRS confirms that the ARS of the

Unit 1 containment mat recorded motions in East-West, North-South, and vertical directions are enveloped by the Unit 3 CSDRS at all frequencies. As described above, the horizontal and vertical CSDRS are included in the Unit 3 SSE as the licensing basis for all Seismic Category I SSCs. Therefore, the August 23, 2011 **M** 5.8, Mineral, Virginia earthquake Unit 1 containment mat recordings are considered for the Unit 3 SSCs.

For each structure and each equipment location within the buildings, in-structure response spectra (ISRS) are developed. The site-specific ISRS that exceed the standard design ISRS, are used in conjunction with the standard design ISRS for seismic design and qualification of equipment and components.

This approach applies to SSCs that are required to withstand SSE loads. Similarly, other SSCs that are specifically required to meet SSE seismic demands are designed, analyzed, and qualified using the process in Sections 3.7.1 and 3.7.2 for applying the CSDRS and site-specific FIRS. The same approach is applied for the Seismic Category II and Radwaste Building structures.

The Unit 3 plant-shutdown OBE response spectrum limit is established to ensure: 1) that, if not exceeded, plant equipment designed to withstand seismic loads have margin to the design ground motion response spectra; and 2) that the seismic instrumentation system alerts plant operators within four hours of an event (as described in Section 3.7.4.3) and supports decision-making within eight hours of an event as to whether or not to shut down the plant following a seismic event.

The plant shutdown OBE is defined as one-third of the SSE. The following two sets of horizontal and vertical response spectra serve as the reference against which OBE exceedance checks are performed at grade for the purpose of plant shutdown:

(a) One-third of the CSDRS presented in Figures 2.0-201 and 2.0-202 that define the free-field ground motion at the bottom of the RB/FB and CB foundations; and

(b) One-third of the site-dependent SSE manifestation at grade as described in Section 3.7.1.1.6

Because all safety related SSCs are designed, analyzed, and qualified to meet both the CSDRS and site-specific FIRS, plant shutdown is required if both response spectra in (a) and (b) are exceeded, as described in

Section 3.7.4.4. Exceedance of the response spectra (a) and (b) is evaluated independently (i.e., an envelope of the two response spectra is not used). For example, a response spectrum that falls below the envelope of the two response spectra but exceeds (b) at a low frequency and exceeds (a) at a higher frequency is considered as exceeding the OBE, thus requiring shutdown of the plant if other criteria as discussed in Section 3.7.4.4 are also met.

The use of CSDRS in (a) above as the basis for defining the OBE at grade for the purpose of plant shutdown is conservative since it neglects the amplifications of the standard design ground motion as it propagates from the bottom of the RB/FB and CB foundations to the plant grade. The OBE ground motion defined with the criteria above constitutes a single OBE ground motion for the entire site. See Section 3.7.4.2 for discussion on seismic monitoring instrumentation.

3.7.1.1 Design Ground Motion

Add the following at the end of this section.

NAPS SUP 3.7-7

As shown in Figures 2.0-201 through 2.0-204, the site-specific FIRS calculated for Seismic Category I structures of Unit 3 exceed the CSDRS. Therefore, site-specific SSI analyses of these structures are carried out using the site-specific seismic design parameters described in this section. The site-specific seismic design parameters are developed as described in detail in Sections 3.7.1.1.4 and 3.7.1.1.5. These design parameters include the SSI input strain compatible soil profiles, SSI input response spectra, and SSI input acceleration time histories for the following Seismic Category I structures:

- Reactor Building/Fuel Building
- Control Building
- Firewater Service Complex

The development of the site-dependent SSE manifestation at-grade and the site-dependent OBE at-grade spectra are described in Section 3.7.1.1.6.

3.7.1.1.3 Single Envelope Ground Motion

Add the following at the beginning of this section.

NAPS DEP 3.7-1

This section provides information regarding the single envelope ground response spectra used for seismic design of the ESBWR Standard Plant. The comparisons in Figures 2.0-201 through 2.0-204 show that Unit 3 sites-specific FIRS exceed these single envelope ground response spectra, thus indicating that it is necessary to perform the site-specific SSI analysis presented in Section 3.7.2.4, using the site-specific design parameters described in Sections 3.7.1.1.4 and 3.7.1.1.5. Structures, systems, and components are seismically designed, analyzed, and qualified to multiple response spectra for both generic and site-specific seismic and subgrade conditions, as described in Section 3.7.2, and for equipment seismic qualification as described in Section 3.10. The CSDRS is one of two spectra used for ensuring that SSCs meet the requirements for seismic design adequacy.

DCD Table 3.7-2 provides the single envelope design ground motion at foundation level for the structures that are designed to meet Seismic Category I requirements and which is referred to as the CSDRS for the ESBWR Standard Plant. The site-specific SSI analyses indicate that additional ground motion response spectra apply, as described in Section 3.7.2.

The information below relates to the CSDRS used for seismic design of the ESBWR Standard Plant. These design ground motion response spectra are used in conjunction with the site-specific ground motion response spectra, as described in Section 3.7.1.1.4.2.

NAPS SUP 3.7-1

3.7.1.1.4 Site-Specific Design Ground Motion Response Spectra

3.7.1.1.4.1 SSI Strain-Compatible Soil Profiles

Best estimate (BE), lower bound (LB), and upper bound (UB) soil properties are calculated consistent with the FIRS for each Seismic Category I structure from their corresponding probabilistic full column site response analysis results and are presented in the following sections. The details of the site response analysis are described in Section 2.5.2.5.

3.7.1.1.4.1.1 SSI Strain-Compatible Soil Profiles for the RB/FB

From the probabilistic full column site response analyses of the RB/FB soil column set (presented in Section 2.5.2.5), a set of 60

strain-compatible soil properties is obtained for each of the 4 input rock cases (10^{-4} and 10^{-5} annual-frequency-of-exceedance (1E-4 and 1E-5 hazard level) low frequency (LF) and high frequency (HF) as described in Section 2.5.2.4). The log-mean (μ_{ln}) and log-standard deviation (log-SD, σ_{ln}) for each of the 4 sets of shear wave velocity (V_s) and damping ratios are calculated. These values are used to establish the log-mean and log-SD of the strain compatible properties that are consistent to FIRS motions using A_R and DF factors (described in Section 2.5.2.6), calculated for the acceleration response spectra (ARS) at the ground surface.

The simulated (randomized) profiles described in Section 2.5.2.5 include a variation in the thickness of different strata (a stratum is defined as a thickness of rock or soil having the same initial dynamic and static properties). For deterministic SSI analysis, the strain-compatible soil profiles are obtained from the strain-compatible soil properties of the simulated profiles using the data for each soil layer type within the profile. The stratum log-mean and log-standard deviation strain compatible properties are used with the BE thicknesses for each stratum to obtain the LB, BE, and UB SSI input strain-compatible soil profiles.

The log-mean values of the FIRS-consistent strain-compatible damping ratios are used to determine the BE damping ratio profile. The LB and UB values for the strain compatible damping ratios are calculated as plus/minus one log-standard deviation from the log-mean values by applying Equations 3.7.1.1-1 and 3.7.1.1-2.

Lower bound and upper bound V_s corresponding to FIRS are calculated by applying Equations 3.7.1.1-1 and 3.7.1.1-2 in conjunction with the FIRS-consistent log-mean and log-standard deviation as described above. In these equations, M refers to damping or shear wave velocity, μ_{ln} refers to the log-mean of FIRS-consistent shear wave velocity or damping ratio and σ_{ln} refers to the corresponding log-standard deviations. However, lower bound shear wave velocity profiles are calculated as the minimum resulting from Equation 3.7.1.1-1 and $(V_S)_{FIRS}/(\sqrt{1.5})$, and upper bound shear wave velocity profiles are calculated as the maximum resulting from Equation 3.7.1.1-2 and $(V_S)_{FIRS} \times \sqrt{1.5}$ to satisfy the minimum variation requirements of ASCE 4-98, where $(V_S)_{FIRS}$ is the best estimate strain compatible shear wave velocity corresponding to the FIRS level of motion.

$$M_{LB} = \exp(\ln(\mu_{\ln}) - \sigma_{\ln}) \quad (3.7.1.1\text{-}1)$$

$$M_{UB} = \exp(\ln(\mu_{\ln}) + \sigma_{\ln}) \quad (3.7.1.1\text{-}2)$$

Primary (P- or compression) wave velocity V_P is calculated using Equation 3.7.1.1-3 (Reference 3.7-201), where Poisson's ratio ν values, at different depths, are provided in Section 2.5.4.

$$V_P = V_S\sqrt{\frac{2-2\nu}{1-2\nu}} \quad (3.7.1.1\text{-}3)$$

For soil layers below water table, a minimum P-wave velocity of 4800 ft/sec is maintained and, as needed, the Poisson's ratio is adjusted to obtain the minimum P-wave velocity. The maximum value of Poisson's ratio used is 0.48 to avoid numerical instability.

Figure 3.7.1-201 presents the SSI shear wave velocity profiles for the RB/FB. SSI damping and P-wave velocity profiles for this structure are presented in Figures 3.7.1-202 and 3.7.1-203, respectively. The depth of 0 ft in Figures 3.7.1-201, 3.7.1-202, and 3.7.1-203 corresponds to the top of the soil column at Elevation 290 ft. The lower shear wave and P-wave velocities are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile. Table 3.7.1-201 presents the digital values for the RB/FB SSI input strain-compatible soil profiles. The provided soil profiles correspond to the fully embedded SSI analysis of the RB/FB. The top 17 ft of this profile (the top 7 layers in Table 3.7.1-201) correspond to saprolite and are removed in the partially embedded SSI analysis of the RB/FB.

As described in Section 2.5.4, adjacent to the structure, the in-situ saprolite is replaced by structural fill and Zone III rock is replaced by concrete fill. The strain-compatible properties for the structural fill for the RB/FB are obtained following the steps described above for the in-situ profile and applied to a companion fill profile for the RB/FB. The companion RB/FB profile is identical to the in-situ profile except that randomized saprolite and Zone III rock properties are replaced with randomized structural fill and concrete fill properties, respectively.

The lower bound and upper bound shear wave velocities, P-wave velocities, and damping ratios for the structural fill compatible with FIRS are calculated following the methodology described above and presented in Table 3.7.1-202. The same table provides the LB, BE, and UB values for the concrete fill to be used in the SSI analysis model. The concrete fill

is considered as linear material for the purpose of site response and SSI analyses.

3.7.1.1.4.1.2 SSI Strain-Compatible Soil Profiles for the CB

The SSI strain-compatible soil profiles for the CB are calculated from the probabilistic full column site response analyses of the CB soil column set (presented in Section 2.5.2.5) following the same approach as described above for the RB/FB structure.

Figure 3.7.1-204 presents the SSI shear wave velocity profiles for the CB. SSI damping and P-wave velocity profiles for this structure are presented in Figures 3.7.1-205 and 3.7.1-206, respectively. The depth of 0 ft in Figures 3.7.1-204, 3.7.1-205, and 3.7.1-206 corresponds to the top of the soil column at Elevation 290 ft. The lower shear wave and P-wave velocities are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile. Table 3.7.1-203 presents the digital values for the CB SSI input strain-compatible soil profiles. The provided soil profiles correspond to the fully embedded SSI analysis of the CB. The top 25 ft of this profile (the top 10 layers in Table 3.7.1-203) correspond to saprolite and are removed in the partially embedded SSI analysis of the CB.

As described in Section 2.5.4, adjacent to the structure, the in-situ saprolite is replaced by structural fill and Zone III rock is replaced by concrete fill. Table 3.7.1-204 provides the LB, BE, and UB values for the concrete fill to be used in the SSI analysis model. The concrete fill is considered as linear material for the purpose of site response and SSI analyses. The strain compatible properties for the structural fill for the CB are similarly obtained as those for the RB/FB and presented in Table 3.7.1-204.

3.7.1.1.4.1.3 SSI Strain-Compatible Soil Profiles for the FWSC

The SSI strain-compatible soil profiles for the FWSC are calculated from the probabilistic full column site response analyses of the FWSC soil column set (presented in Section 2.5.2.5) following the same approach as described above for the RB/FB structure.

Figure 3.7.1-207 presents the SSI shear wave velocity profiles for the FWSC. SSI damping and P-wave velocity profiles for this structure are presented in Figures 3.7.1-208 and 3.7.1-209, respectively. The lower shear wave and P-wave velocities are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile.

Table 3.7.1-205 presents the digital values for the FWSC SSI input strain-compatible soil profiles.

As described in Section 2.5.4, for the FWSC, the foundation of the structure is supported by concrete fill situated on Zone III-IV rock. Adjacent to the structure, the in-situ saprolite is replaced by structural fill and Zone III rock is replaced by concrete fill. Table 3.7.1-206 provides the LB, BE, and UB values for the concrete fill to be used in the SSI analysis model. The concrete fill is considered as linear material for the purpose of site response and SSI analyses. The strain compatible properties for the structural fill for the FWSC are similarly obtained as those for the RB/FB and presented in Table 3.7.1-206.

3.7.1.1.4.2 **Site-Specific SSI Input Response Spectra**

The FIRS for all Seismic Category I structures are presented in Section 2.5.2.6. For each Seismic Category I structure, the site-specific SSI input response spectra are obtained from its corresponding FIRS by ensuring that the requirements of ISG-17 (Reference 3.7-202) with regards to the adequacy of the input motion for embedded SSI analyses are met. This verification is referred to as the NEI check in reference to the Nuclear Energy Institute (NEI) white paper (Reference 3.7-203). Once the NEI check is done for a given FIRS and any necessary adjustments are made, the resulting spectra is termed the “SSI input response spectra.”

In addition, the site-specific SSI input response spectra are augmented by the broadband horizontal and vertical response spectra defined in RG 1.60 anchored at 0.1g to satisfy the minimum design ground motion requirements of 10 CFR 50, Appendix S. The resulting ARS are labeled as “Final SSI Input Response Spectra.” The development of these spectra for all Seismic Category I structures is described in the following sections.

3.7.1.1.4.2.1 **SSI Input Response Spectra for the RB/FB**

The site-specific SSI input response spectra are calculated for SSI analysis of the RB/FB structure as partially embedded (only considering embedment in rock) and as fully embedded. The corresponding partial column outcrop FIRS and full column outcrop FIRS for this structure as well as the full column performance-based surface response spectra (PBSRS) are presented in Section 2.5.2.6.

The NEI check is conducted for the RB/FB by convolving the full column and partial column outcrop FIRS (from the foundation level, Elevation 224 ft NAVD88) through their corresponding LB, BE, and UB strain compatible soil profiles of the RB/FB (Section 3.7.1.1.4.1), and comparing the envelope of the resulting top-of-the-column ARS with the corresponding full column and partial column PBSRS. The partial column PBSRS are calculated consistent with the partially embedded SSI analyses, at the top of the partial columns (after removal of the saprolite layers) using the same methodology as described for the full column PBSRS in Section 2.5.2.6. The horizontal FIRS are convolved to the top of the soil column using vertically propagating shear waves and the vertical FIRS are convolved to the surface through vertically propagating P-waves. Shear wave damping is used for both horizontal and vertical analyses. The analyses are carried out linearly with no further degradation of the strain-compatible profiles. The horizontal and vertical 5 percent damped ARS at the top of the soil columns corresponding to each SSI input soil profile are determined and the horizontal and vertical envelope resulting from the LB, BE, and UB soil columns for the structure is compared to the horizontal and vertical PBSRS.

For each direction (horizontal or vertical) and each embedment configuration (fully or partially embedded FIRS), if the envelope of the LB, BE, and UB ARS (at the top of the SSI input soil column) does not envelope the corresponding PBSRS, the FIRS must be adjusted. The frequency dependent adjustment factor is either unity or the ratio of PBSRS to the envelope of LB, BE, and UB ARS, whichever is greater. In order to satisfy the NEI check, this adjustment factor is applied to the computed FIRS at the foundation level to yield the full column and partial column horizontal and vertical SSI input response spectra for the RB/FB.

Figures 3.7.1-210 and 3.7.1-211 present the envelope of the ground surface ARS for the horizontal and vertical full column FIRS, respectively. Figures 3.7.1-212 and 3.7.1-213 present the horizontal and vertical envelope ARS at surface as well as their corresponding FIRS and PBSRS. For the RB/FB full column FIRS, the adjustment occurs for the horizontal FIRS below 6.9 Hz with the largest adjustment factor being 1.27. For the vertical FIRS, the adjustment is much more significant, especially between frequencies of 1 Hz and 20 Hz with the maximum adjustment factor being 1.79. The adjusted full column FIRS for RB/FB

are referred to as the full column SSI input response spectra for RB/FB and are also presented in Figures 3.7.1-212 and 3.7.1-213.

The NEI check for the partial column FIRS for RB/FB are carried out in a similar manner. The corresponding figures are provided in Figures 3.7.1-214 through 3.7.1-217. The surface ARS and PBSRS corresponding to the partial columns are calculated consistent with the partially embedded SSI analyses, at the top of the partial soil columns after removal of the saprolite layers. The necessary adjustment factors for RB/FB partial column FIRS are less than 1.01 for both horizontal and vertical directions. The adjusted partial column FIRS are referred to as the partial column SSI input response spectra for RB/FB and are presented in Figures 3.7.1-216 and 3.7.1-217.

For the full column analyses (applicable to fully embedded SSI analyses), the final horizontal and vertical SSI input response spectra are calculated as the envelope of the full column SSI input response spectra and the minimum required response spectra which are adopted from the horizontal and vertical broadband spectra defined in RG 1.60 and anchored at 0.1g. Similarly, for the partial soil column analyses (applicable to SSI analyses of the structures as partially embedded), the final horizontal and vertical SSI input motions are calculated as the envelope of the partial column SSI input response spectra and the minimum required response spectra. These final SSI input response spectra are presented in Figures 3.7.1-218 through 3.7.1-220 and tabulated in Table 3.7.1-207. These spectra are used as target ARS for development of SSI input time histories in subsequent analyses.

3.7.1.1.4.2.2 **SSI Input Response Spectra for the CB**

The site-specific SSI input response spectra are calculated for SSI analysis of the CB structure as partially embedded (only considering embedment in rock) and as fully embedded. The corresponding partial column outcrop FIRS and full column outcrop FIRS for this structure as well as the full column PBSRS are presented in Section 2.5.2.6.

The SSI input response spectra for the CB are obtained after adjusting the FIRS as necessary for the NEI check following the same approach as described for RB/FB. For the CB, Figures 3.7.1-221 and 3.7.1-222 present the envelope of the ground surface ARS for the horizontal and vertical full column FIRS, respectively. Figures 3.7.1-223 and 3.7.1-224 present the horizontal and vertical envelope ARS at surface as well as

their corresponding FIRS and PBSRS. Where the PBSRS exceed the envelope of surface ARS, the FIRS is adjusted (upward adjustment only, i.e., adjustment factor is always larger than one) by the ratio of the PBSRS to the envelope of surface ARS at each frequency. For the CB full column FIRS, the adjustment occurs for the horizontal FIRS below 0.4 Hz with the largest adjustment factor being 1.05. For the vertical full column FIRS, the adjustment is much more significant, especially between frequencies of 2 Hz and 15 Hz with the maximum adjustment factor being 1.39. The adjusted full column FIRS for CB are referred to as the full column SSI input response spectra for CB and are presented in Figures 3.7.1-223 and 3.7.1-224.

The NEI check for the partial column FIRS for the CB is carried out in a similar manner. The corresponding figures are provided in Figures 3.7.1-225 through 3.7.1-228. The surface ARS and PBSRS corresponding to the partial columns are calculated consistent with the partially embedded SSI analyses, at the top of the partial soil columns after removal of the saprolite layers. The necessary adjustment factors for the CB partial column FIRS are less than 1.07 for horizontal and less than 1.16 for vertical directions. The adjusted partial column FIRS are referred to as the partial column SSI input response spectra for CB and are presented in Figures 3.7.1-227 and 3.7.1-228.

For the full column analyses (applicable to fully embedded SSI analyses), the final horizontal and vertical SSI input response spectra are calculated as the envelope of the full column SSI input response spectra and the minimum required response spectra which are adopted from the horizontal and vertical broadband spectra defined in RG 1.60 and anchored at 0.1g. Similarly, for the partial soil column analyses (applicable to SSI analyses of the structures as partially embedded), the final horizontal and vertical SSI input motions are calculated as the envelope of the partial column SSI input response spectra and the minimum required response spectra. These final SSI input response spectra are presented in Figures 3.7.1-229 through 3.7.1-231 and tabulated in Table 3.7.1-208. These spectra are used as target ARS for development of SSI input time histories in subsequent analyses.

3.7.1.1.4.2.3 **SSI Input Response Spectra for the FWSC**

Two sets of site-specific SSI input response spectra with control motion, defined at the bottom of the FWSC foundation (Elevation 282 ft NAVD88) and at the average elevation of the bottom of the concrete fill

(Elevation 220 ft NAVD88), are calculated for SSI analysis of the FWSC. The geologic outcrop FIRS for this structure is calculated at Elevation 282 ft corresponding to the bottom of the foundation and top of the considered FWSC soil column, as presented in Section 2.5.2.6. The FWSC geologic outcrop FIRS also represent the PBSRS for the FWSC soil column. Additional NEI check for the FWSC SSI input response spectra is not warranted because the SSI results from the application of the SSI input motions at the top of the soil column and Elevation 220 ft are enveloped by the design basis for this structure as described in Section 3.7.2.4.

The final horizontal and vertical SSI input response spectra at Elevation 282 ft for FWSC are calculated as the envelope of the geologic outcrop FIRS and the minimum required response spectra which are adopted from the horizontal and vertical broadband spectra defined in RG 1.60 and anchored at 0.1g. The final SSI input response spectra at Elevation 282 ft are presented in Figures 3.7.1-232 through 3.7.1-234 and tabulated in Table 3.7.1-209. Similarly, the final horizontal and vertical SSI input response spectra at Elevation 220 ft are calculated as the envelope of the design response spectra (DRS) at Elevation 220 ft and the minimum required response spectra. The DRS at Elevation 220 ft are calculated consistent with the FIRS for FWSC using the same methodology as described in Sections 2.5.2.5 and 2.5.2.6. The final SSI input response spectra at Elevation 220 ft are presented in Figures 3.7.1-283 through 3.7.1-285. These spectra are used as target ARS for development of SSI input time histories in subsequent analyses.

NAPS SUP 3.7-2

3.7.1.1.5 Site-Specific Design Ground Motion Time History

3.7.1.1.5.1 SSI Input Acceleration Time Histories

Corresponding to each set of horizontal and vertical final SSI input response spectra, described in Section 3.7.1.1.4.2, a three component set (two horizontal and one vertical) of spectrum compatible acceleration time histories is developed for use as input time histories for SSI analysis. The starting seed time histories are selected from the database of acceleration time histories in NUREG/CR-6728 (Reference 3.7-204). The candidate time histories were considered from the CEUS rock database bin with magnitudes between moment magnitude (**M**) 6 and **M**7 and distances between 10 km and 50 km. This magnitude-distance bin was selected based on the high frequency deaggregation of the PSHA having mean magnitude and distance values of **M**5.9 and 22 km for the

10^{-4} hazard level, and **M**6.1 and 15 km for the 10^{-5} hazard level (Section 2.5.2.4). For the low frequency hazard deaggregation, the results are a magnitude of **M**7.1 and a distance of 340 km for the 10^{-4} and **M**6.4 and a distance of 21 km for the 10^{-5} hazard levels (Section 2.5.2.4). Based on the large distance associated with the low frequency 10^{-4} controlling event, the selected seed input acceleration time history for the spectral matching procedure was governed by the high frequency controlling events.

In selecting a candidate acceleration time history set from the applicable magnitude-distance bin from NUREG/CR-6728, the following aspects of a given time history set were considered:

- Similarity between the spectral shape of the candidate acceleration time history and the target spectrum
- Total time history duration of at least 20 seconds
- Zero-lag cross correlation coefficient between any two components of acceleration time histories should be less than 0.16
- Appropriate magnitude and distance values relative to the controlling event values
- Non-stationary phasing consistent with seismological principals.
- Uniform normalized Arias intensity curves

Following these selection guidelines, the strong ground motion time history from the 1984 **M**6.2 Morgan Hill earthquake recorded at the station Gilroy–Gavilan College was selected as the seed input time history set for the spectral matching presented here. This selected time history from the CEUS magnitude-distance database bin of NUREG/CR-6728 is based on the original empirical recording from the Morgan Hill earthquake at the Gilroy–Gavilan College station with the additional modification of the empirical time history to adjust for more CEUS hard rock conditions. The details for this selected seed time history, including the filter corners, peak ground motion parameters, associated ratios and duration values from the NUREG/CR-6728 database, are listed in Table 3.7.1-220.

3.7.1.1.5.1.1 SSI Input Acceleration Time Histories for the RB/FB

Two sets of three statistically independent acceleration time histories of motions (i.e., two horizontal and one vertical component) are developed for the full column and partial column final SSI input motion spectra.

These time histories are modified to be spectrum compatible following Option 1, Approach 2 of SRP 3.7.1. Additionally, the power spectrum density (PSD) of the spectrum matched time histories are computed to allow for the conclusion that these spectrum compatible time histories do not contain any significant gaps in energy over the SRP 3.7.1 defined frequency range.

The input seed time histories are modified to be spectrum compatible using the computer program RSPM. The baseline correction program BLINE, a component program of RSPM, is also used in the process after each iteration of RSPM.

For each time history, the average ratio between the acceleration time history response spectrum and the corresponding target acceleration response spectrum (both at a spectral damping of 5 percent) was greater than 1.0. In addition, the spectral matching criteria given in SRP 3.7.1 for Option 1, Approach 2 were satisfied in each spectral matching case.

For the RB/FB partial column spectrally matched time histories, the comparisons between the scaled spectrum compatible acceleration response spectra and the target spectra and boundary range are plotted in Figures 3.7.1-235 through 3.7.1-237 for the first horizontal direction (H1), second horizontal direction (H2) and the vertical direction (UP), respectively. Similar plots for the RB/FB full column spectrally matched time histories are presented in Figures 3.7.1-238 through 3.7.1-240.

The zero-lag cross-correlation for each three component sets of spectrum compatible acceleration time histories are computed to verify the acceptability of the acceleration time histories. The zero-lag cross-correlations for the partial column and full column RB/FB cases are listed in Table 3.7.1-210. These computed values are all less than the required minimum value of 0.16.

In addition to the cross-correlation values, the peak ground motion parameters and associated ratios are listed in Table 3.7.1-211. PGA, PGV, and PGD refer to the peak ground acceleration, peak ground velocity, and peak ground displacement, respectively. Overall, these peak values (i.e., PGA, PGV, and PGD) are consistent with the averaged bin values provided in NUREG/CR-6728. The target spectra used in the spectral matching procedure are a composite of both the high frequency and low frequency cases (i.e., the deaggregation values are bi-modal), which results in PGV/PGA and PGA*PGD/PGV^2 ratios that deviate from

the average bin values reported in NUREG/CR-6728. This observed deviation from the reported bin values is caused by the relatively large PGA value from the high frequency case (i.e., small magnitude event at a relatively close distance) compared to the intermediate and longer spectral period range PGV and PGD which are partially controlled by the low frequency case (i.e., large magnitude event at a relatively large distance). This leads to a slightly lower PGV/PGA ratio and a larger PGA*PGD/PGV^2 ratio. Given this understanding of the composite nature of the target spectra used in the spectral matching procedure, the peak ground motion parameter values and associated ratios in Table 3.7.1-211 are acceptable.

The total duration of the time histories is approximately 30 seconds, which is greater than the required minimum of 20 seconds. In addition, the Arias durations (5-75 percent duration) given in Table 3.7.1-211, are longer than the minimum value of 6 seconds defined in SRP 3.7.1 and fall within the bin value ranges given in NUREG/CR-6728.

The acceleration, velocity, and displacement time histories for the H1, H2, and UP spectrally matched to the RB/FB partial column final SSI input response spectra are respectively provided in Figures 3.7.1-241 through 3.7.1-243. Similar figures for the RB/FB full column case are presented in Figures 3.7.1-244 through 3.7.1-246.

The one-sided PSD is computed following SRP 3.7.1, Appendix B, Equation 1, based on a defined time window, Fourier Transform and associated duration, T_D. This duration represents the duration of near maximum and nearly stationary power of an acceleration time history and should be consistent with the time window used in the calculation of the Fourier Transform. Several different quantitative definitions of strong motion duration may be defined, while the guidance provided in NUREG/CR-5347, Appendix B, qualitatively states that the duration should be the time range over which the power is nearly constant and near maximum. This can variously be estimated by analysis of the normalized Arias Intensity of a given acceleration time history, while a common estimate of duration is based on the 5-75 percent duration window for the normalized Arias Intensity.

For each spectrum compatible time history, two PSDs were computed based on different time windows for the Fourier Transform and the associated T_D duration values. For the first case, the full time history (i.e., total time history length of 29.98 seconds) was used for the Fourier

Transform and the T_D was estimated from the extrapolation of the computed 5–75 percent values to 0–100 percent values. This extrapolation was implemented to account for the fact that the Fourier Transform is based on the full time window of the given acceleration time history and the expectation that the stationary characteristics of the given time history would not be over the entire time window length, but rather an extrapolated time window based on the 5–75 percent duration value. The use of the full time history for the calculation of the Fourier Transform and PSD function can be considered to be more consistent with the application of the time histories in the SSI analyses which use the full time history in estimating the full frequency content of the given time history.

The second PSD is computed based on taking a windowed section of the given time history for the Fourier Transform. This window duration is based on the 5–75 percent normalized Arias Intensity duration. Prior to the calculation of the Fourier Transform, a cosine taper was applied immediately prior to the start and immediately following the end of this windowed time history and for the PSD calculation the T_D value for the denominator was taken as the 5–75 percent duration value.

For each PSD the prescribed smoothing window of ± 20 percent was used. The PSD results for the RB/FB partial column are provided in Figures 3.7.1-268 through 3.7.1-270. The PSD results for the RB/FB full column are provided in Figures 3.7.1-271 through 3.7.1-273. As expected, the amplitude of the computed PSDs varies as a function of spectral frequency. It can also be observed that the selection of the time window and associated T_D value can produce different characteristics of the PSDs as a function of frequency and also in absolute amplitude. The variation between these PSDs is not significant in most cases, indicating a certain degree of robustness in the two approaches.

For the H1 component, the largest difference between the PSDs computed using the full window length and the 5–75 percent truncated window length is in the frequency range of about 25–50 Hz. For the full record length cases, the PSD is nearly constant over the frequency range of about 30–40 Hz with a slight dip in the PSD around 25 Hz. In contrast, the PSDs computed from the truncated 5–75 percent window are smoothly attenuating over the frequency range of 25–50 Hz. These observations indicate that the full window time history contains energy in this high frequency range outside of the 5–75 percent duration time

window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the H2 component, the same observations in the high frequency range of 25–50 Hz are noted. For the truncated 5–75 percent windowed cases, the PSD is again more smoothly varying and is approximately constant or slightly less for frequencies between about 25-40 Hz. These observations also indicate that the full window time history for the H2 component contains energy in this high frequency range outside of the 5–75 percent duration time window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the vertical component, the same comparison plots of the computed PSD using the two different time windows are presented. However, unlike the two horizontal cases, the PSDs from the truncated 5–75 percent windowed cases do not show a reduction in the relative amplitude of the PSD in the 30–40 Hz frequency range. In general the same relative increase in amplitude around the 30 Hz frequency and relative decrease in the 20–25 Hz range is observed for both time window PSD calculations. This variation in the PSD is similar in amplitude to the horizontal components using the full time window and could indicate that for the vertical component the relative increase in energy in the 30–40 Hz range is present within the truncated 5–75 percent duration time window. For the truncated 5–75 percent windowed cases, additional minima are observed for frequencies less than about 1 Hz and around 2 Hz. These observations of the relative minima in the vertical component PSDs can be interpreted as an indication of the non-stationarity of the time history because these relative minima are not observed for longer duration windows based on the 5–85 percent and 5–95 percent normalized Arias Intensity values.

The input time histories needed for SSI analysis of the RB/FB with embedded foundation (for both partially embedded and fully embedded cases) are in-column (within) motions corresponding to each of the SSI strain-compatible soil profiles. As such, for each case (partially embedded or fully embedded), each of the outcrop acceleration time histories (H1, H2, and UP), is used as input at the foundation level of the RB/FB to a SHAKE2000 soil column model of the SSI strain compatible soil profiles (LB, BE and UB), and their corresponding in-column time histories are obtained at the same horizon. The horizontal acceleration

time histories are applied using strain compatible shear wave velocities and the vertical acceleration time history is applied using corresponding P-wave velocities. The strain-compatible shear wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. These analyses result in a total of 18 in-column SSI input time histories corresponding to the three SSI strain compatible profiles (LB, BE, and UB), the three time history components (H1, H2, and UP), and two embedment cases (full column or partial column). These time histories are used as input in the subsequent SSI analyses of the structure.

As described in Section 3.7.1.1.4.2.1, the NEI check for the full column and partial column SSI analyses of the RB/FB are performed directly for the response spectra using Random Vibration Theory (RVT). Because the SSI analyses are performed using the spectrally matched time histories, a confirmatory NEI check is performed using the surface ARS corresponding to the spectrally matched time histories for the fully embedded and the partially embedded SSI analyses of the building.

For the purpose of the confirmatory NEI check for the RB/FB, the PBSRS corresponding to the soil column used in the SSI analysis of the RB/FB are used as opposed to the overall site PBSRS. The horizontal and vertical components of the full column and partial column RB/FB PBSRS are calculated using the same methodology as described for the full column PBSRS in Section 2.5.2.6, except that only the DRS corresponding to the appropriate RB/FB soil column is used.

For the considered fully embedded condition of the RB/FB, the SSI input time histories are propagated in the full column RB/FB LB, BE, and UB SSI input soil profiles from the foundation elevation to the top of the soil columns using a linear wave propagation analysis without any further degradation of the nonlinear material. The time histories in the horizontal directions are propagated using the shear-wave velocities and damping ratios of each soil profile and the vertical time history is propagated using the P-wave velocities and damping ratios. The envelope of the resulting surface ARS is calculated and compared with the full column PBSRS for the RB/FB soil column. Similarly, for the partial column embedment condition of the RB/FB, the enveloped ARS at the top of the truncated LB, BE, and UB input soil profiles are calculated and compared with the

partial column PBSRS for the RB/FB. These comparisons are provided in Figures 3.7.1-295 through 3.7.1-300.

For both fully embedded and partially embedded SSI analyses, except at some instances discussed below, within the frequency range used for the SSI analysis (up to a maximum cutoff frequency of 70 Hz), the enveloped ARS at surface exceeds the PBSRS by a large margin. Note that some dips below the PBSRS in the enveloped ARS at surface are expected because the enveloped ARS at surface corresponds to the response spectrum of a single time history. This time history is matched to the SSI input response spectrum following the spectrum matching criteria of SRP 3.7.1 (criterion (1.B.ii.c) for spectrum matching of time histories using Option 1, Approach 2) which allows for dips less than 10 percent over 9 or fewer adjacent frequency points. A sensitivity study confirmed that such dips, where the envelope of the surface ARS falls below the PBSRS over a limited number of frequency points, do not affect the site specific response analyses. The only other instance, not considered negligible, where the enveloped ARS at surface falls below the PBSRS is in the case of the vertical component of the input time history for the fully embedded case, which falls below the PBSRS between 16.6 Hz and 20.4 Hz (10 adjacent frequency points) by a maximum of 11 percent. This dip is considered insignificant because the ISRS response of the RB/FB is obtained as the broadened envelope of the SSI analysis for the partially embedded and fully embedded conditions as discussed in Section 3.7.2. The enveloped ARS at surface for the partially embedded case, as shown in Figure 3.7.1-300, is considered adequate over this frequency range. Moreover, in the vertical direction, the RB/FB structure is supported on the mat foundation and surrounding rock. The vertical input motion to the structure and the load transfer from the building primarily occur at the foundation-rock interface. The effects of vertical ground motion near the ground surface are considered insignificant for structural responses. Therefore, the effect of free field surface vertical motion (and its slight dip below the PBSRS) on the structural response is negligible. Also, as evident from the RB/FB outcrop transfer functions (i.e. transfer function of the structural response to the outcrop SSI input motion), the structural frequencies of the RB/FB in the vertical direction are outside this frequency range. Therefore, the effect of this dip on the structural response is negligible. Furthermore, the dip does not correspond to a missing soil column frequency in the analysis, rather it reflects different methods of calculation of the enveloped surface ARS

(through P-wave propagation) and the vertical PBSRS (by applying a smooth V/H ratio curve to the horizontal PBSRS).

In summary, the ARS corresponding to the SSI input time histories calculated at the surface of the SSI soil profiles for the RB/FB do not exhibit any gaps in the site response frequencies at the surface of the SSI input soil columns and, except for negligible instances as discussed above and addressed by the consideration of both partially embedded and fully embedded conditions, bound the PBSRS for the building, thus satisfying the NEI check requirements.

3.7.1.1.5.1.2 **SSI Input Acceleration Time Histories for the CB**

Two sets of three statistically independent acceleration time histories of motions (i.e., two horizontal and one vertical component) are developed for the full column and partial column final SSI input motion spectra for the CB. The same methodology described in Section 3.7.1.1.5.1.1 for the RB/FB is used to develop these time histories.

For the CB partial column spectrally matched time histories, the comparisons between the scaled spectrum compatible acceleration response spectra and the target spectra and boundary range are plotted in Figures 3.7.1-247 through 3.7.1-249 for the H1, H2 and UP directions, respectively. Similar plots for the CB full column spectrally matched time histories are presented in Figures 3.7.1-250 through 3.7.1-252.

The zero-lag cross-correlations for the partial column and full column CB cases are listed in Table 3.7.1-212. These computed values are all less than the required minimum value of 0.16.

In addition to the cross-correlation values, the peak ground motion parameters and associated ratios are listed in Table 3.7.1-213. Since the discussion provided for the RB/FB in Section 3.7.1.1.5.1.1 regarding the composite nature of the target spectra used in the spectral matching procedure is also applicable to the CB, the peak ground motion parameter values and associated ratios are acceptable.

The total duration of the time histories is approximately 30 seconds, which is greater than the required minimum of 20 seconds. In addition, the Arias durations (5-75% Duration), given in Table 3.7.1-213 are longer than the minimum value of 6 seconds defined in SRP 3.7.1.

The acceleration, velocity and displacement time histories for the H1, H2, and UP spectrally matched to the CB partial column final SSI input

response spectra are respectively provided in Figures 3.7.1-253 through 3.7.1-255. Similar figures for the CB full column case are presented in Figures 3.7.1-256 through 3.7.1-258.

The one-sided PSD is computed following SRP 3.7.1, Appendix B, Equation 1, based on a defined time window, Fourier Transform and associated duration, T_D. This duration represents the duration of near maximum and nearly stationary power of an acceleration time history and should be consistent with the time window used in the calculation of the Fourier Transform. Several different quantitative definitions of strong motion duration may be defined, while the guidance provided in NUREG/CR-5347, Appendix B, qualitatively states that the duration should be the time range over which the power is nearly constant and near maximum. This can variously be estimated by analysis of the normalized Arias Intensity of a given acceleration time history, while a common estimate of duration is based on the 5–75 percent duration window for the normalized Arias Intensity.

For each spectrum compatible time history, two PSDs were computed based on different time windows for the Fourier Transform and the associated T_D duration values. For the first case, the full time history (i.e., total time history length of 29.98 seconds) was used for the Fourier Transform and the T_D was estimated from the extrapolation of the computed 5–75 percent values to 0–100 percent values. This extrapolation was implemented to account for the fact that the Fourier Transform is based on the full time window of the given acceleration time history and the expectation that the stationary characteristics of the given time history would not be over the entire time window length, but rather an extrapolated time window based on the 5–75 percent duration value. The use of the full time history for the calculation of the Fourier Transform and PSD function can be considered to be more consistent with the application of the time histories in the SSI analyses which use the full time history in estimating the full frequency content of the given time history.

The second PSD is computed based on taking a windowed section of the given time history for the Fourier Transform. This window duration is based on the 5–75 percent normalized Arias Intensity duration. Prior to the calculation of the Fourier Transform, a cosine taper was applied immediately prior to the start and immediately following the end of this

windowed time history and for the PSD calculation the T_D value for the denominator was taken as the 5–75 percent duration value.

For each PSD the prescribed smoothing window of ± 20 percent was used. The PSD results for the CB partial column are provided in Figures 3.7.1-274 through 3.7.1-276. The PSD results for the CB full column are provided in Figures 3.7.1-277 through 3.7.1-279. As expected, the amplitude of the computed PSDs varies as a function of spectral frequency. It can also be observed that the selection of the time window and associated T_D value can produce different characteristics of the PSDs as a function of frequency and also in absolute amplitude. The variation between these PSDs is not significant in most cases, indicating a certain degree of robustness in the two approaches.

For the H1 component, the largest difference between the PSDs computed using the full window length and the 5–75 percent truncated window length is in the frequency range of about 25–50 Hz. For the full record length cases, the PSD is nearly constant over the frequency range of about 30–40 Hz with a slight dip in the PSD around 25 Hz. In contrast the PSDs computed from the truncated 5–75 percent window are smoothly attenuating over the frequency range of 25–50 Hz. These observations indicate that the full window time history contains energy in this high frequency range outside of the 5–75 percent duration time window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the H2 component, the same observations in the high frequency range of 25–50 Hz are noted. For the truncated 5–75 percent windowed cases, the PSD is again more smoothly varying and is approximately constant or slightly less for frequencies between about 25–40 Hz. These observations also indicate that the full window time history for the H2 component contains energy in this high frequency range outside of the 5–75 percent duration time window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the vertical component the same comparison plots of the computed PSD using the two different time windows are presented. However, unlike the two horizontal cases, the PSDs from the truncated 5–75 percent windowed cases do not show a reduction in the relative amplitude of the PSD in the 30–40 Hz frequency range. In general the same relative increase in amplitude around the 30 Hz frequency and relative decrease

in the 20–25 Hz range is observed for both time window PSD calculations. This variation in the PSD is similar in amplitude to the horizontal components using the full time window and could indicate that for the vertical component the relative increase in energy in the 30–40 Hz range is present within the truncated 5–75 percent duration time window. For the truncated 5–75 percent windowed cases, additional minima are observed for frequencies less than about 1 Hz and around 2 Hz. These observations of the relative minima in the vertical component PSDs can be interpreted as an indication of the non-stationarity of the time history because these relative minima are not observed for longer duration windows based on the 5–85 percent and 5–95 percent normalized Arias Intensity values.

The input time histories needed for SSI analysis of the CB with embedded foundation (for both partially embedded and fully embedded cases) are in-column (within) motions corresponding to each of the SSI strain-compatible soil profiles. As such, for each case (partially embedded or fully embedded), each of the outcrop acceleration time histories (H1, H2, and UP), is used as input at the foundation level of the CB to a SHAKE2000 soil column model of the SSI strain-compatible soil profiles (LB, BE and UB), and their corresponding in-column time histories are obtained at the same horizon. The horizontal acceleration time histories are applied using strain-compatible shear wave velocities and the vertical acceleration time history is applied using corresponding P-wave velocities. The strain-compatible shear wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. These analyses result in a total of 18 in-column SSI input time histories corresponding to the three SSI strain compatible profiles (LB, BE, and UB), the three time history components (H1, H2, and UP), and two embedment cases (full column or partial column). These time histories are used as input in the subsequent SSI analyses of the structure.

As described in Section 3.7.1.1.4.2.2, the NEI check for the full column and partial column SSI analyses of the CB are performed directly for the response spectra using RVT. Because the SSI analyses are performed using the spectrally matched time histories, a confirmatory NEI check is performed using the surface ARS corresponding to the spectrally

matched time histories for the partially embedded and fully embedded SSI analyses of the building.

For the purpose of the confirmatory NEI check for the CB, the PBSRS corresponding to the soil column used in the SSI analysis of the CB are used as opposed to the overall site PBSRS. The horizontal and vertical components of the full column and partial column CB PBSRS are calculated using the same methodology as described for the full column PBSRS in Section 2.5.2.6, except that only the DRS corresponding to the appropriate CB soil column is used.

For the considered fully embedded condition of the CB, the SSI input time histories are propagated in the full column CB LB, BE, and UB SSI input soil profiles from the foundation elevation to the top of the soil columns using a linear wave propagation analysis without any further degradation of the nonlinear material. The time histories in the horizontal directions are propagated using the shear-wave velocities and damping ratios of each soil profile and the vertical time history is propagated using the P-wave velocities and damping ratios. The envelope of the resulting surface ARS is calculated and compared with the full column PBSRS for the CB soil column. Similarly, for the partial column embedment condition of the CB, the enveloped ARS at the top of the truncated LB, BE, and UB input soil profiles are calculated and compared with the partial column PBSRS for the CB. These comparisons are provided in Figures 3.7.1-301 through 3.7.1-306.

For the fully embedded SSI analyses, except at some instances discussed below, within the frequency range used for the SSI analysis (up to a maximum cutoff frequency of 70 Hz), the enveloped ARS at surface exceeds the PBSRS by a large margin. For the partially embedded SSI analysis, the enveloped ARS at surface generally envelop the corresponding PBSRS. However, a few dips below the PBSRS in the enveloped ARS at surface are observed. A sensitivity study confirmed that such dips, where the envelope of the surface ARS falls below the PBSRS over a limited number of frequency points, do not affect the site specific response analyses.

In summary, the ARS corresponding to the SSI input time histories calculated at the surface of the SSI soil profiles for the CB do not exhibit any gaps in the site response frequencies at the surface of the SSI input soil columns and, except for negligible instances as discussed above,

bound the PBSRS for the building, thus satisfying the NEI check requirements.

3.7.1.1.5.1.3 SSI Input Acceleration Time Histories for the FWSC

Two sets of three statistically independent acceleration time histories of motions (i.e., two horizontal and one vertical component) are developed for the final SSI input motion spectra at Elevation 282 ft and Elevation 220 ft for the FWSC. The same methodology described in Section 3.7.1.1.5.1.1 for the RB/FB is used to develop these time histories.

For the FWSC spectrally matched time histories at Elevation 282 ft, the comparisons between the scaled spectrum compatible acceleration response spectra and the target spectra and boundary range are plotted in Figures 3.7.1-259 through 3.7.1-261 for the H1, H2 and UP directions, respectively. Similar plots for the FWSC spectrally matched time histories at Elevation 220 ft are presented in Figures 3.7.1-286 through 3.7.1-288.

The zero-lag cross correlations for the FWSC spectrally matched time histories at Elevations 282 ft and 220 ft are listed in Tables 3.7.1-214 and 3.7.1-218, respectively. These computed values are all less than the required minimum value of 0.16.

In addition to the cross correlation values, the peak ground motion parameters and associated ratios for the spectrally matched time histories at Elevations 282 ft and 220 ft are listed in Tables 3.7.1-215 and 3.7.1-219, respectively. Since the discussion provided for the RB/FB in Section 3.7.1.1.5.1.1 regarding the composite nature of the target spectra used in the spectral matching procedure is also applicable to the FWSC, the peak ground motion parameter values and associated ratios are acceptable.

The total duration of the time histories is approximately 30 seconds, which is greater than the required minimum of 20 seconds. In addition, the Arias durations (5-75% Duration), given in Tables 3.7.1-215 and 3.7.1-219 are longer than the minimum value of 6 seconds defined in SRP 3.7.1.

The acceleration, velocity and displacement time histories for the H1, H2, and UP spectrally matched to the FWSC final SSI input response spectra at Elevation 282 ft are provided in Figures 3.7.1-262 through 3.7.1-264, respectively.

Similar plots for the acceleration, velocity and displacement time histories for the H1, H2, and UP spectrally matched to the FWSC final SSI input response spectra at Elevation 220 ft are provided in Figures 3.7.1-289 through 3.7.1-291, respectively.

The one-sided PSD is computed following SRP 3.7.1, Appendix B, Equation 1, based on a defined time window, Fourier Transform and associated duration, T_D. This duration represents the duration of near maximum and nearly stationary power of an acceleration time history and should be consistent with the time window used in the calculation of the Fourier Transform. Several different quantitative definitions of strong motion duration may be defined, while the guidance provided in NUREG/CR-5347, Appendix B, qualitatively states that the duration should be the time range over which the power is nearly constant and near maximum. This can variously be estimated by analysis of the normalized Arias Intensity of a given acceleration time history, while a common estimate of duration is based on the 5–75 percent duration window for the normalized Arias Intensity.

For each spectrum compatible time history, two PSDs were computed based on different time windows for the Fourier Transform and the associated T_D duration values. For the first case, the full time history (i.e., total time history length of 29.98 seconds) was used for the Fourier Transform and the T_D was estimated from the extrapolation of the computed 5–75 percent values to 0–100 percent values. This extrapolation was implemented to account for the fact that the Fourier Transform is based on the full time window of the given acceleration time history and the expectation that the stationary characteristics of the given time history would not be over the entire time window length, but rather an extrapolated time window based on the 5–75 percent duration value. The use of the full time history for the calculation of the Fourier Transform and PSD function can be considered to be more consistent with the application of the time histories in the SSI analyses which use the full time history in estimating the full frequency content of the given time history.

The second PSD is computed based on taking a windowed section of the given time history for the Fourier Transform. This window duration is based on the 5–75 percent normalized Arias Intensity duration. Prior to the calculation of the Fourier Transform, a cosine taper was applied immediately prior to the start and immediately following the end of this

windowed time history and for the PSD calculation the T_D value for the denominator was taken as the 5–75 percent duration value.

For each PSD the prescribed smoothing window of ± 20 percent was used. The PSD results for the FWSC at Elevation 282 ft are provided in Figures 3.7.1-280 through 3.7.1-282. The PSD results for the FWSC at Elevation 220 ft are provided in Figures 3.7.1-292 through 3.7.1-294. As expected, the amplitude of the computed PSDs varies as a function of spectral frequency. It can also be observed that the selection of the time window and associated T_D value can produce different characteristics of the PSDs as a function of frequency and also in absolute amplitude. The variation between these PSDs is not significant in most cases, indicating a certain degree of robustness in the two approaches.

For the H1 component, the largest difference between the PSDs computed using the full window length and the 5–75 percent truncated window length is in the frequency range of about 25–50 Hz. For the full record length cases, the PSD is nearly constant over the frequency range of about 30–40 Hz with a slight dip in the PSD around 25 Hz. In contrast the PSDs computed from the truncated 5–75 percent window are smoothly attenuating over the frequency range of 25–50 Hz. These observations indicate that the full window time history contains energy in this high frequency range outside of the 5–75 percent duration time window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the H2 component, the same observations in the high frequency range of 25–50 Hz are noted. For the truncated 5–75 percent windowed cases, the PSD is again more smoothly varying and is approximately constant or slightly less for frequencies between about 25–40 Hz. These observations also indicate that the full window time history for the H2 component contains energy in this high frequency range outside of the 5–75 percent duration time window and would not indicate a potential gap in frequency content, but rather an increase in the 30–40 Hz frequency range.

For the vertical component the same comparison plots of the computed PSD using the two different time windows are presented. However, unlike the two horizontal cases, the PSDs from the truncated 5–75 percent windowed cases do not show a reduction in the relative amplitude of the PSD in the 30–40 Hz frequency range. In general the same relative increase in amplitude around the 30 Hz frequency and relative decrease

in the 20–25 Hz range is observed for both time window PSD calculations. This variation in the PSD is similar in amplitude to the horizontal components using the full time window and could indicate that for the vertical component the relative increase in energy in the 30–40 Hz range is present within the truncated 5–75 percent duration time window. For the truncated 5–75 percent windowed cases, additional minima are observed for frequencies less than about 1 Hz and around 2 Hz. These observations of the relative minima in the vertical component PSDs can be interpreted as an indication of the non-stationarity of the time history because these relative minima are not observed for longer duration windows based on the 5–85 percent and 5–95 percent normalized Arias Intensity values.

The input time histories needed for SSI analysis of the FWSC with the control motion at Elevation 220 ft are in-column (within) motions corresponding to each of the SSI strain-compatible soil profiles. As such, each of the outcrop acceleration time histories (H1, H2, and UP) at Elevation 220 ft, is used as input at the same elevation to a SHAKE2000 soil column model of the FWSC SSI strain-compatible soil profiles (LB, BE and UB), and their corresponding in-column time histories are obtained at Elevation 220 ft. The horizontal acceleration time histories are applied using strain-compatible shear wave velocities and the vertical acceleration time history is applied using corresponding P-wave velocities. The strain-compatible shear wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. These analyses result in a total of nine in-column SSI input time histories corresponding to the three SSI strain-compatible profiles (LB, BE, and UB) and the three time history components (H1, H2, and UP). These time histories are used as input in the subsequent SSI analyses of the FWSC with the control input motion at Elevation 220 ft.

3.7.1.1.6 Site-Dependent SSE Manifestation At-Grade and Site-Dependent OBE At-Grade Response Spectra

The site-dependent SSE manifestation at grade is defined by enveloping the following two spectra:

1. PBSRS calculated at grade (Elevation 290 ft) from full soil column analyses for RB/FB and CB and,

2. The minimum required response spectra defined as the RG 1.60 broadband horizontal and vertical response spectra at 5 percent damping anchored to 0.1g at PGA to satisfy the requirements of SRP 3.7.1.

The site-dependent OBE at grade is defined as one-third of the site-dependent SSE manifestation at grade. The site-dependent OBE response spectra at grade will serve as one reference against which OBE exceedance checks are to be performed for the purpose of plant shutdown, as described in Section 3.7.1. Section 3.7.4.4 includes the criteria that are used to determine whether a plant shutdown is required following a seismic event.

The horizontal and vertical PBSRS at grade is presented in Section 2.5.2.6. The horizontal and vertical 5 percent damped site-dependent SSE spectra manifested at grade are presented in Figures 3.7.1-265 and 3.7.1-266, respectively.

The horizontal and vertical free-field site-dependent OBE at grade are calculated as one-third of the site-dependent SSE manifestation at grade and presented in Figure 3.7.1-267.

The 5 percent damped pseudo velocity response spectra (VRS) for site-dependent OBE at grade is determined by dividing the ARS values at each frequency point (f) by $2\pi f$. The digital values for the site-dependent SSE manifested at-grade and OBE at-grade spectra are presented in Tables 3.7.1-216 and 3.7.1-217, respectively.

3.7.1.2 Percentage of Critical Damping Values

Add the following at the end of the first paragraph.

NAPS DEP 3.7-1

OBE structural damping values consistent with RG 1.61 Revision 1 are used in the Unit 3 site-specific SSI analyses unless SSE damping in DCD Table 3.7-1 is justified by stress demand. Section 3A.13.2 describes the damping values used in the Unit 3 site-specific SSI analyses.

3.7.1.3 Supporting Media for Seismic Category I Structures

Add the following at the end of the first paragraph.

NAPS SUP 3.7-3

The Seismic Category I structures for Unit 3 have concrete mat foundations founded on rock or concrete fill on rock.

NAPS SUP 3.7-1

Table 3.7.1-201 **Strain-Compatible SSI Input Properties for RB/FB (In-situ Material)**

				BE-RB/FB			LB-RB/FB			UB-RB/FB		
Layer #	**Thickness (ft)**	**Top-Depth (ft)**	**Unit Weight (kcf)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**
1	2.00	0	0.125	908	2224	2.07	616	1508	3.50	1339	3279	1.22
2	2.50	2	0.125	875	2498	3.38	534	1523	7.02	1435	4095	1.63
3	2.50	4.5	0.125	875	2498	3.38	534	1523	7.02	1435	4095	1.63
4	2.50	7	0.13	1302	5471	2.89	814	4152	5.52	2081	8745	1.52
5	2.50	9.5	0.13	1302	5471	2.89	814	4152	5.52	2081	8745	1.52
6	2.50	12	0.13	1887	5082	2.50	1259	4800	4.40	2829	7616	1.42
7	2.50	14.5	0.13	1887	5082	2.50	1259	4800	4.40	2829	7616	1.42
8	3.00	17	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
9	3.00	20	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
10	3.00	23	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
11	3.00	26	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
12	3.00	29	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
13	3.00	32	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
14	3.00	35	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
15	2.00	38	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
16	3.00	40	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
17	3.00	43	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
18	3.00	46	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
19	4.00	49	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
20	3.00	53	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33

NAPS SUP 3.7-1 Table 3.7.1-201 **Strain-Compatible SSI Input Properties for RB/FB (In-situ Material)** *(continued)*

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-RB/FB Vs (ft/sec)	BE-RB/FB Vp (ft/sec)	BE-RB/FB Damping (%)	LB-RB/FB Vs (ft/sec)	LB-RB/FB Vp (ft/sec)	LB-RB/FB Damping (%)	UB-RB/FB Vs (ft/sec)	UB-RB/FB Vp (ft/sec)	UB-RB/FB Damping (%)
21	3.00	56	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
22	3.00	59	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
23	4.00	62	0.145	4324	10593	0.58	3212	7869	1.02	5821	14259	0.33
24	3.00	66	0.163	5449	13347	1.00	4037	9888	1.82	7355	18017	0.55
25	4.00	69	0.163	5449	13347	1.00	4037	9888	1.82	7355	18017	0.55
26	4.00	73	0.163	5449	13347	1.00	4037	9888	1.82	7355	18017	0.55
27	4.00	77	0.163	5449	13347	1.00	4037	9888	1.82	7355	18017	0.55
28	4.00	81	0.163	5449	13347	1.00	4037	9888	1.82	7355	18017	0.55
29	4.00	85	0.163	5178	12682	1.00	3471	8501	1.82	7724	18920	0.55
30	4.00	89	0.163	5178	12682	1.00	3471	8501	1.82	7724	18920	0.55
31	4.00	93	0.163	5178	12682	1.00	3471	8501	1.82	7724	18920	0.55
32	4.00	97	0.163	5178	12682	1.00	3471	8501	1.82	7724	18920	0.55
33	5.00	101	0.163	5178	12682	1.00	3471	8501	1.82	7724	18920	0.55
34	4.00	106	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
35	5.00	110	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
36	5.00	115	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
37	5.00	120	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
38	5.00	125	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
39	5.00	130	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
40	5.00	135	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55

NAPS SUP 3.7-1

Table 3.7.1-201 **Strain-Compatible SSI Input Properties for RB/FB (In-situ Material)** *(continued)*

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-RB/FB			LB-RB/FB			UB-RB/FB		
				Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)
41	5.00	140	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
42	5.00	145	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
43	5.00	150	0.164	8800	15678	1.00	7185	12801	1.82	10778	19201	0.55
44		155	0.164	9200	16390	1.00	7512	13383	1.82	11268	20074	0.55

The top 7 layers correspond to saprolite and are removed in the partially embedded SSI analysis of the RB/FB.
Groundwater table is considered at the top of the fourth layer at Elevation 283 ft.

NAPS SUP 3.7-1

Table 3.7.1-202 **Strain-Compatible SSI Input Properties for RB/FB (Structural Fill and Concrete Fill)**

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-RB/FB			LB-RB/FB			UB-RB/FB		
				Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)
1	2.00	0	0.130	734	1372	2.18	531	993	3.12	1014	1897	1.52
2	2.50	2	0.130	649	1213	4.24	418	781	7.00	1007	1884	2.57
3	2.50	4.5	0.130	649	1213	4.24	418	781	7.00	1007	1884	2.57
4	2.50	7	0.130	710	3619	5.13	444	2262	8.45	1135	4800	3.11
5	2.50	9.5	0.130	710	3619	5.13	444	2262	8.45	1135	4800	3.11
6	2.50	12	0.130	736	3752	5.80	469	2392	9.40	1154	4800	3.58
7	2.50	14.5	0.130	736	3752	5.80	469	2392	9.40	1154	4800	3.58
Concrete Fill		17	0.145	7000	10909	1.00	6000	9350	1.80	8000	12467	0.55

Groundwater table is considered at the top of the fourth layer at Elevation 283 ft.

Table 3.7.1-203 **Strain-Compatible SSI Input Properties for CB (In-situ Material)**

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-CB Vs (ft/sec)	BE-CB Vp (ft/sec)	BE-CB Damping (%)	LB-CB Vs (ft/sec)	LB-CB Vp (ft/sec)	LB-CB Damping (%)	UB-CB Vs (ft/sec)	UB-CB Vp (ft/sec)	UB-CB Damping (%)
1	2.50	0	0.125	873	1773	2.78	590	1198	4.83	1292	2625	1.60
2	2.50	2.5	0.125	873	1773	2.78	590	1198	4.83	1292	2625	1.60
3	2.50	5	0.125	1007	4231	3.93	611	2567	7.42	1659	6975	2.08
4	2.50	7.5	0.125	1007	4800	3.93	611	3114	7.42	1659	6975	2.08
5	2.50	10	0.125	1007	4800	3.93	611	3114	7.42	1659	6975	2.08
6	2.50	12.5	0.125	1007	4800	3.93	611	3114	7.42	1659	6975	2.08
7	2.50	15	0.13	1419	5966	3.78	990	4800	6.53	2036	8557	2.19
8	2.50	17.5	0.13	1419	5966	3.78	990	4800	6.53	2036	8557	2.19
9	2.50	20	0.13	1419	5966	3.78	990	4800	6.53	2036	8557	2.19
10	2.50	22.5	0.13	1419	5966	3.78	990	4800	6.53	2036	8557	2.19
11	2.50	25	0.145	2024	6184	0.62	1545	4800	1.06	2651	8100	0.36
12	2.50	27.5	0.145	2024	6184	0.62	1545	4800	1.06	2651	8100	0.36
13	2.50	30	0.145	2024	6184	0.62	1545	4800	1.06	2651	8100	0.36
14	2.50	32.5	0.145	2024	6184	0.62	1545	4800	1.06	2651	8100	0.36
15	2.50	35	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
16	2.50	37.5	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
17	2.50	40	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
18	2.50	42.5	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
19	2.50	45	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
20	1.50	47.5	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35

Table 3.7.1-203 **Strain-Compatible SSI Input Properties for CB (In-situ Material)** *(continued)*

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-CB Vs (ft/sec)	BE-CB Vp (ft/sec)	BE-CB Damping (%)	LB-CB Vs (ft/sec)	LB-CB Vp (ft/sec)	LB-CB Damping (%)	UB-CB Vs (ft/sec)	UB-CB Vp (ft/sec)	UB-CB Damping (%)
21	3.50	49	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
22	2.50	52.5	0.145	2475	7561	0.63	1841	5625	1.14	3327	10163	0.35
23	2.50	55	0.145	2660	8127	0.53	2172	6635	0.96	3258	9953	0.29
24	2.50	57.5	0.145	2660	8127	0.53	2172	6635	0.96	3258	9953	0.29
25	2.50	60	0.145	2660	8127	0.53	2172	6635	0.96	3258	9953	0.29
26	2.50	62.5	0.145	2660	8127	0.53	2172	6635	0.96	3258	9953	0.29
27	1.00	65	0.163	6483	13861	1.00	5293	11318	1.82	7940	16976	0.55
28	3.00	66	0.163	6483	13861	1.00	5293	11318	1.82	7940	16976	0.55
29	3.00	69	0.163	6483	13861	1.00	5293	11318	1.82	7940	16976	0.55
30	3.00	72	0.163	6483	13861	1.00	5293	11318	1.82	7940	16976	0.55
31	3.00	75	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
32	2.00	78	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
33	5.00	80	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
34	5.00	85	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
35	5.00	90	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
36	5.00	95	0.163	7942	15135	1.00	6485	12358	1.82	9727	18536	0.55
37	5.00	100	0.163	7942	15135	1.00	6485	12358	1.82	9727	18536	0.55
38	5.00	105	0.164	8655	15657	1.00	7067	12784	1.82	10600	19176	0.55
39	5.00	110	0.164	8655	15657	1.00	7067	12784	1.82	10600	19176	0.55
40	5.00	115	0.164	8242	15707	1.00	6730	12824	1.82	10094	19236	0.55

NAPS SUP 3.7-1

Table 3.7.1-203 **Strain-Compatible SSI Input Properties for CB (In-situ Material)** *(continued)*

				BE-CB			LB-CB			UB-CB		
Layer #	**Thickness (ft)**	**Top-Depth (ft)**	**Unit Weight (kcf)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**
41	5.00	120	0.164	8242	15707	1.00	6730	12824	1.82	10094	19236	0.55
42	5.00	125	0.164	8658	16198	1.00	7069	13225	1.82	10604	19838	0.55
43	5.00	130	0.164	8658	16198	1.00	7069	13225	1.82	10604	19838	0.55
44	5.00	135	0.164	8822	15491	1.00	7203	12648	1.82	10805	18972	0.55
45	5.00	140	0.164	8822	15491	1.00	7203	12648	1.82	10805	18972	0.55
46	5.00	145	0.164	9340	16897	1.00	7626	13796	1.82	11439	20694	0.55
47	5.00	150	0.164	9340	16897	1.00	7626	13796	1.82	11439	20694	0.55
48	5.00	155	0.164	9198	17208	1.00	7510	14050	1.82	11265	21075	0.55
49	5.00	160	0.164	9198	17208	1.00	7510	14050	1.82	11265	21075	0.55
50		165	0.164	9200	15729	1.00	7512	12843	1.82	11268	19264	0.55

The top 10 layers correspond to saprolite and are removed in the partially embedded SSI analysis of the CB.
Groundwater table is considered at the top of the fourth layer at Elevation 282.5 ft.

NAPS SUP 3.7-1

Table 3.7.1-204 **Strain-Compatible SSI Input Properties for CB (Structural Fill and Concrete Fill)**

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-CB Vs (ft/sec)	BE-CB Vp (ft/sec)	BE-CB Damping (%)	LB-CB Vs (ft/sec)	LB-CB Vp (ft/sec)	LB-CB Damping (%)	UB-CB Vs (ft/sec)	UB-CB Vp (ft/sec)	UB-CB Damping (%)
1	2.50	0	0.130	649	1214	3.14	440	823	4.98	958	1791	1.98
2	2.50	2.5	0.130	649	1214	3.14	440	823	4.98	958	1791	1.98
3	2.50	5	0.130	747	1397	4.41	486	909	7.17	1149	2149	2.72
4	2.50	7.5	0.130	747	3809	4.41	486	2477	7.17	1149	4800	2.72
5	2.50	10	0.130	751	3831	5.21	478	2436	8.38	1182	4800	3.24
6	2.50	12.5	0.130	751	3831	5.21	478	2436	8.38	1182	4800	3.24
7	2.50	15	0.130	759	3872	5.92	492	2507	9.11	1173	4800	3.84
8	2.50	17.5	0.130	759	3872	5.92	492	2507	9.11	1173	4800	3.84
9	2.50	20	0.130	813	4147	5.67	515	2626	8.93	1284	4800	3.60
10	2.50	22.5	0.130	813	4147	5.67	515	2626	8.93	1284	4800	3.60
Concrete Fill		25	0.145	7000	10909	1.00	6000	9350	1.80	8000	12467	0.55

Groundwater table is considered at the top of the fourth layer at Elevation 282.5 ft.

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Table 3.7.1-205 **Strain-Compatible SSI Input Properties for FWSC (In-situ Material)**

				BE-FWSC			LB-FWSC			UB-FWSC		
Layer #	**Thickness (ft)**	**Top-Depth (ft)**	**Unit Weight (kcf)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**	**Vs (ft/sec)**	**Vp (ft/sec)**	**Damping (%)**
1	3.00	0	0.125	742	3783	4.18	483	2460	6.63	1141	4800	2.64
2	3.00	3	0.125	742	3783	4.18	483	2460	6.63	1141	4800	2.64
3	3.00	6	0.125	742	3783	4.18	483	2460	6.63	1141	4800	2.64
4	3.00	9	0.125	742	3783	4.18	483	2460	6.63	1141	4800	2.64
5	3.00	12	0.125	979	4800	5.00	605	3083	8.25	1585	6661	3.03
6	3.00	15	0.125	979	4800	5.00	605	3083	8.25	1585	6661	3.03
7	3.00	18	0.125	979	4800	5.00	605	3083	8.25	1585	6661	3.03
8	4.00	21	0.125	979	4800	5.00	605	3083	8.25	1585	6661	3.03
9	4.00	25	0.125	979	4800	5.00	605	3083	8.25	1585	6661	3.03
10	4.00	29	0.13	1416	5952	3.97	1018	4800	6.08	1970	8280	2.60
11	3.00	33	0.13	1955	5974	2.89	1431	4800	4.37	2672	8164	1.92
12	2.00	36	0.13	1955	5974	2.89	1431	4800	4.37	2672	8164	1.92
13	4.00	38	0.145	2503	7647	0.64	1907	5825	1.14	3286	10040	0.36
14	4.00	42	0.145	2503	7647	0.64	1907	5825	1.14	3286	10040	0.36
15	4.00	46	0.145	2503	7647	0.64	1907	5825	1.14	3286	10040	0.36
16	4.00	50	0.145	2503	7647	0.64	1907	5825	1.14	3286	10040	0.36
17	4.00	54	0.145	2693	8228	0.53	2150	6568	0.94	3373	10306	0.30
18	4.00	58	0.145	2693	8228	0.53	2150	6568	0.94	3373	10306	0.30
19	3.00	62	0.163	6483	13861	1.00	4803	10269	1.82	8751	18711	0.55
20	3.00	65	0.163	6483	13861	1.00	4803	10269	1.82	8751	18711	0.55

NAPS SUP 3.7-1

Table 3.7.1-205 **Strain-Compatible SSI Input Properties for FWSC (In-situ Material)** *(continued)*

				BE-FWSC			LB-FWSC			UB-FWSC		
Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)
21	3.00	68	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
22	4.00	71	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
23	4.00	75	0.163	6983	14018	1.00	5701	11445	1.82	8552	17168	0.55
24	3.00	79	0.164	7942	15135	1.00	6485	12358	1.82	9727	18536	0.55
25	4.00	82	0.164	7942	15135	1.00	6485	12358	1.82	9727	18536	0.55
26	4.00	86	0.164	7942	15135	1.00	6485	12358	1.82	9727	18536	0.55
27	3.00	90	0.164	8655	15657	1.00	7067	12784	1.82	10600	19176	0.55
28	4.00	93	0.164	8655	15657	1.00	7067	12784	1.82	10600	19176	0.55
29	4.00	97	0.164	8655	15657	1.00	7067	12784	1.82	10600	19176	0.55
30	3.00	101	0.164	8242	15707	1.00	6730	12824	1.82	10094	19236	0.55
31	4.00	104	0.164	8242	15707	1.00	6730	12824	1.82	10094	19236	0.55
32	4.00	108	0.164	8242	15707	1.00	6730	12824	1.82	10094	19236	0.55
33	3.00	112	0.164	8658	16198	1.00	7069	13225	1.82	10604	19838	0.55
34	4.00	115	0.164	8658	16198	1.00	7069	13225	1.82	10604	19838	0.55
35	4.00	119	0.164	8658	16198	1.00	7069	13225	1.82	10604	19838	0.55
36	3.00	123	0.164	8822	15491	1.00	7203	12648	1.82	10805	18972	0.55
37	4.00	126	0.164	8822	15491	1.00	7203	12648	1.82	10805	18972	0.55
38	4.00	130	0.164	8822	15491	1.00	7203	12648	1.82	10805	18972	0.55
39	3.00	134	0.164	9340	16897	1.00	7626	13796	1.82	11439	20694	0.55
40	4.00	137	0.164	9340	16897	1.00	7626	13796	1.82	11439	20694	0.55

Table 3.7.1-205 **Strain-Compatible SSI Input Properties for FWSC (In-situ Material)** *(continued)*

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-FWSC Vs (ft/sec)	BE-FWSC Vp (ft/sec)	BE-FWSC Damping (%)	LB-FWSC Vs (ft/sec)	LB-FWSC Vp (ft/sec)	LB-FWSC Damping (%)	UB-FWSC Vs (ft/sec)	UB-FWSC Vp (ft/sec)	UB-FWSC Damping (%)
41	4.00	141	0.164	9340	16897	1.00	7626	13796	1.82	11439	20694	0.55
42	3.00	145	0.164	9198	17208	1.00	7510	14050	1.82	11265	21075	0.55
43	4.00	148	0.164	9198	17208	1.00	7510	14050	1.82	11265	21075	0.55
44	4.00	152	0.164	9198	17208	1.00	7510	14050	1.82	11265	21075	0.55
45		156	0.164	9200	15729	1.00	7512	12843	1.82	11268	19264	0.55

Depth is measured with respect to the bottom of the foundation at Elevation 282 ft.
Groundwater table is considered at the top of the first layer at Elevation 282 ft.

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Table 3.7.1-206 **Strain-Compatible SSI Input Properties for FWSC (Structural Fill and Concrete Fill)**

Layer #	Thickness (ft)	Top-Depth (ft)	Unit Weight (kcf)	BE-FWSC			LB-FWSC			UB-FWSC		
				Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)	Vs (ft/sec)	Vp (ft/sec)	Damping (%)
1	3.00	0	0.130	745	3799	4.74	479	2440	7.33	1160	4800	3.06
2	3.00	3	0.130	759	3872	4.83	491	2504	7.50	1174	4800	3.11
3	3.00	6	0.130	784	4000	4.97	503	2567	7.85	1223	4800	3.15
4	3.00	9	0.130	783	3991	5.33	507	2586	8.29	1208	4800	3.42
5	3.00	12	0.130	845	4311	5.17	526	2683	8.02	1358	4800	3.33
6	3.00	15	0.130	830	4234	5.47	509	2593	8.50	1356	4800	3.52
7	3.00	18	0.130	830	4235	5.65	518	2640	8.54	1332	4800	3.74
8	4.00	21	0.130	852	4347	5.67	520	2654	8.87	1396	4800	3.63
9	4.00	25	0.130	848	4325	5.96	514	2620	9.19	1400	4800	3.87
10	4.00	29	0.130	894	4558	5.75	551	2809	8.74	1451	4800	3.78
11	3.00	33	0.130	890	4538	5.95	531	2706	9.35	1492	4800	3.79
12	2.00	36	0.130	890	4538	5.95	531	2706	9.35	1492	4800	3.79
Concrete Fill		38	0.145	7000	10909	1.00	6000	9350	1.82	8000	12467	0.55

Depth is measured with respect to the bottom of the foundation at Elevation 282 ft.
Groundwater table is considered at the top of the first layer at Elevation 282 ft.

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Table 3.7.1-207 **5% Damped Final SSI Input Response Spectra for RB/FB**

	Final Full Column SSI Input Response Spectra		Final Partial Column SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**	**Horizontal (g)**	**Vertical (g)**
100	0.563	0.563	0.586	0.586
90	0.605	0.627	0.632	0.656
80	0.677	0.739	0.708	0.772
70	0.795	0.899	0.821	0.929
60	0.953	1.10	0.992	1.14
50	1.09	1.26	1.13	1.30
45	1.13	1.26	1.19	1.32
40	1.17	1.22	1.21	1.26
35	1.18	1.16	1.22	1.20
30	1.21	1.13	1.20	1.13
25	1.16	1.02	1.17	1.03
20	1.13	0.98	1.16	0.962
15	1.11	1.15	1.19	0.938
12.5	1.09	1.22	1.17	0.905
10	1.00	1.22	1.05	0.790
9	0.943	1.18	0.953	0.715
8	0.868	1.11	0.841	0.631
7	0.776	1.00	0.713	0.535
6	0.754	0.866	0.587	0.440
5	0.674	0.695	0.474	0.355
4	0.508	0.481	0.367	0.292
3	0.327	0.288	0.305	0.261
2.5	0.312	0.224	0.312	0.224
2	0.261	0.185	0.261	0.185
1.5	0.206	0.145	0.206	0.145
1.25	0.177	0.124	0.177	0.124
1	0.147	0.103	0.147	0.103

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Table 3.7.1-207 **5% Damped Final SSI Input Response Spectra for RB/FB** *(continued)*

	Final Full Column SSI Input Response Spectra		Final Partial Column SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**	**Horizontal (g)**	**Vertical (g)**
0.9	0.135	0.0938	0.135	0.0938
0.8	0.123	0.0848	0.123	0.0848
0.7	0.110	0.0757	0.110	0.0757
0.6	0.0969	0.0664	0.0969	0.0664
0.5	0.0834	0.0569	0.0834	0.0569
0.4	0.0694	0.0470	0.0694	0.0470
0.3	0.0548	0.0368	0.0548	0.0368
0.2	0.0302	0.0202	0.0302	0.0202
0.167	0.0210	0.0141	0.0210	0.0141
0.125	0.0118	0.00798	0.0118	0.00792
0.1	0.00852	0.00639	0.00842	0.00631

NAPS SUP 3.7-1 Table 3.7.1-208 **5% Damped Final SSI Input Response Spectra for CB**

	Final Full Column SSI Input Response Spectra		Final Partial Column SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**	**Horizontal (g)**	**Vertical (g)**
100	0.749	0.749	0.800	0.838
90	0.807	0.837	0.854	0.932
80	0.896	0.977	0.948	1.08
70	1.04	1.18	1.08	1.27
60	1.26	1.45	1.33	1.60
50	1.43	1.65	1.51	1.85
45	1.48	1.65	1.57	1.88
40	1.51	1.58	1.63	1.87
35	1.56	1.53	1.67	1.81
30	1.59	1.49	1.63	1.67
25	1.53	1.34	1.61	1.52
20	1.48	1.22	1.70	1.48
15	1.45	1.23	1.79	1.46
12.5	1.42	1.29	1.74	1.37
10	1.33	1.27	1.44	1.10
9	1.26	1.23	1.22	0.928
8	1.16	1.15	0.988	0.749
7	1.03	1.03	0.786	0.594
6	0.861	0.885	0.626	0.473
5	0.679	0.708	0.498	0.375
4	0.483	0.488	0.382	0.293
3	0.322	0.292	0.305	0.261
2.5	0.312	0.224	0.312	0.224
2	0.261	0.185	0.261	0.185
1.5	0.206	0.145	0.206	0.145
1.25	0.177	0.124	0.177	0.124
1	0.147	0.103	0.147	0.103

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Table 3.7.1-208 **5% Damped Final SSI Input Response Spectra for CB** *(continued)*

	Final Full Column SSI Input Response Spectra		Final Partial Column SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**	**Horizontal (g)**	**Vertical (g)**
0.9	0.135	0.0938	0.135	0.0938
0.8	0.123	0.0848	0.123	0.0848
0.7	0.110	0.0757	0.110	0.0757
0.6	0.0969	0.0664	0.0969	0.0664
0.5	0.0834	0.0569	0.0834	0.0569
0.4	0.0694	0.0470	0.0694	0.0470
0.3	0.0548	0.0368	0.0548	0.0368
0.2	0.0302	0.0202	0.0302	0.0202
0.167	0.0210	0.0141	0.0210	0.0141
0.125	0.0118	0.00794	0.0118	0.00793
0.1	0.00845	0.00642	0.00844	0.00633

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Table 3.7.1-209 **5% Damped Final SSI Input Response Spectra at Elevation 282 ft for FWSC**

	Final SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**
100	0.691	0.691
90	0.708	0.734
80	0.735	0.802
70	0.783	0.886
60	0.859	0.989
50	0.972	1.12
45	1.05	1.17
40	1.14	1.18
35	1.23	1.20
30	1.35	1.26
25	1.45	1.28
20	1.59	1.31
15	1.64	1.29
12.5	1.59	1.22
10	1.57	1.18
9	1.56	1.17
8	1.51	1.13
7	1.38	1.04
6	1.21	0.908
5	1.01	0.758
4	0.766	0.575
3	0.497	0.373
2.5	0.358	0.269
2	0.261	0.186
1.5	0.206	0.145
1.25	0.177	0.124
1	0.147	0.103

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Table 3.7.1-209 **5% Damped Final SSI Input Response Spectra at Elevation 282 ft for FWSC** *(continued)*

	Final SSI Input Response Spectra	
Frequency (Hz)	**Horizontal (g)**	**Vertical (g)**
0.9	0.135	0.0938
0.8	0.123	0.0848
0.7	0.110	0.0757
0.6	0.0969	0.0664
0.5	0.0834	0.0569
0.4	0.0694	0.0470
0.3	0.0548	0.0368
0.2	0.0302	0.0202
0.167	0.0210	0.0141
0.125	0.0118	0.00799
0.1	0.00853	0.00640

NAPS SUP 3.7-2

Table 3.7.1-210 **Zero-Lag Cross-Correlation Coefficients for the Final Scaled Spectrum Compatible Acceleration Time-Histories for the RB/FB**

RB/FB Full Profile

Components	Zero-Lag Cross-Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.018
H1 – UP	0.015
H2 – UP	-0.014

RB/FB Partial Profile

Components	Zero-Lag Cross-Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.042
H1 – UP	0.033
H2 – UP	-0.016

NAPS SUP 3.7-2

Table 3.7.1-211 **Peak Ground Motion Parameters, Associated Ratios, and Strong Motion Duration Values for the Final Scaled Spectrum Compatible Acceleration Time-Histories for the RB/FB**

Parameter	H1	H2	UP
RB/FB Full Profile			
PGA (g)	0.572	0.565	0.568
PGV (cm/sec)	21.622	15.950	18.257
PGD (cm)	7.964	8.745	7.279
PGV/PGA (cm/sec/g)	37.769	28.243	32.142
PGA*PGD/PGV^2	9.562	19.033	12.162
5-75% Duration Time (sec)	7.495	10.215	6.420
5% Duration Time (sec)	1.085	1.245	0.960
75% Duration Time (sec)	8.580	11.460	7.380
0% Extrapolated Duration Time (sec)	0.550	0.515	0.501
100% Extrapolated Duration Time (sec)	11.257	15.108	9.673
0-100% Extrapolated Duration Time (sec)	10.707	14.593	9.171
RB/FB Partial Profile			
PGA (g)	0.586	0.587	0.591
PGV (cm/sec)	21.446	14.915	16.383
PGD (cm)	7.527	8.795	7.359
PGV/PGA (cm/sec/g)	36.586	25.408	27.706
PGA*PGD/PGV^2	9.405	22.755	15.897
5-75% Duration Time (sec)	7.590	10.465	7.380
5% Duration Time (sec)	1.070	1.210	0.985
75% Duration Time (sec)	8.660	11.675	8.365
0% Extrapolated Duration Time (sec)	0.528	0.463	0.458
100% Extrapolated Duration Time (sec)	11.371	15.413	11.001
0-100% Extrapolated Duration Time (sec)	10.843	14.950	10.543

NAPS SUP 3.7-2

Table 3.7.1-212 **Zero-Lag Cross-Correlation Coefficients for the Final Scaled Spectrum Compatible Acceleration Time-Histories for the CB**

CB Full Profile

Components	Zero-Lag Cross-Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.041
H1 – UP	0.024
H2 – UP	-0.022

CB Partial Profile

Components	Zero-Lag Cross-Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.040
H1 – UP	0.031
H2 – UP	-0.025

NAPS SUP 3.7-2

Table 3.7.1-213 **Peak Ground Motion Parameters, Associated Ratios, and Strong Motion Duration Values for the Final Scaled Spectrum Compatible Acceleration Time-Histories for the CB**

Parameter	H1	H2	UP
CB Full Profile			
PGA (g)	0.745	0.753	0.756
PGV (cm/sec)	20.604	18.030	17.793
PGD (cm)	6.862	7.384	6.355
PGV/PGA (cm/sec/g)	27.656	23.959	23.551
$PGA*PGD/PGV^2$	11.808	16.759	14.870
5-75% Duration Time (sec)	7.975	10.840	6.180
5% Duration Time (sec)	1.085	1.240	0.955
75% Duration Time (sec)	9.060	12.080	7.135
0% Extrapolated Duration Time (sec)	0.515	0.466	0.514
100% Extrapolated Duration Time (sec)	11.908	15.951	9.342
0-100% Extrapolated Duration Time (sec)	11.393	15.486	8.829
CB Partial Profile			
PGA (g)	0.798	0.807	0.838
PGV (cm/sec)	19.890	16.990	15.259
PGD (cm)	7.072	7.917	6.186
PGV/PGA (cm/sec/g)	24.922	21.045	18.203
$PGA*PGD/PGV^2$	13.988	21.711	21.836
5-75% Duration Time (sec)	7.910	10.725	6.320
5% Duration Time (sec)	1.055	1.195	1.000
75% Duration Time (sec)	8.965	11.920	7.320
0% Extrapolated Duration Time (sec)	0.490	0.429	0.549
100% Extrapolated Duration Time (sec)	11.790	15.750	9.577
0-100% Extrapolated Duration Time (sec)	11.300	15.321	9.029

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Table 3.7.1-214 **Zero-Lag Cross-Correlation Coefficients for the Final Scaled Spectrum Compatible Acceleration Time Histories for the FWSC at Elevation 282 ft**

Components	Zero-Lag Cross-Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.016
H1 – UP	-0.012
H2 – UP	0.017

NAPS SUP 3.7-2

Table 3.7.1-215 **Peak Ground Motion Parameters, Associated Ratios, and Strong Motion Duration Values for the Final Scaled Spectrum Compatible Acceleration Time Histories for the FWSC at Elevation 282 ft**

Parameter	H1	H2	UP
PGA (g)	0.697	0.686	0.668
PGV (cm/sec)	21.061	19.057	16.151
PGD (cm)	9.360	9.108	6.072
PGV/PGA (cm/sec/g)	30.212	27.793	24.190
$PGA*PGD/PGV^2$	14.424	16.860	15.238
5-75% Duration Time (sec)	7.120	10.185	6.505
5% Duration Time (sec)	1.085	1.340	0.955
75% Duration Time (sec)	8.205	11.525	7.460
0% Extrapolated Duration Time (sec)	0.576	0.613	0.490
100% Extrapolated Duration Time (sec)	10.748	15.163	9.783
0-100% Extrapolated Duration Time (sec)	10.171	14.550	9.293

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Table 3.7.1-216 **Site-Dependent SSE Manifestation at-Grade and OBE at-Grade 5% Damping Acceleration Response Spectra**

Frequency (Hz)	Horizontal SSE Manifestation at Grade (g)	Vertical SSE Manifestation at Grade (g)	Horizontal OBE at Grade (g)	Vertical OBE at Grade (g)
100	0.894	0.894	0.298	0.298
90	0.949	0.984	0.316	0.328
80	1.04	1.13	0.347	0.378
70	1.18	1.34	0.394	0.446
60	1.38	1.59	0.461	0.531
50	1.56	1.79	0.519	0.598
45	1.69	1.88	0.564	0.628
40	1.84	1.91	0.612	0.638
35	1.87	1.83	0.622	0.610
30	1.89	1.77	0.629	0.589
25	1.83	1.61	0.610	0.537
20	1.87	1.54	0.622	0.513
15	1.93	1.52	0.643	0.507
12.5	1.96	1.51	0.654	0.504
10	1.90	1.43	0.635	0.476
9	1.81	1.36	0.603	0.452
8	1.67	1.25	0.555	0.417
7	1.48	1.11	0.492	0.369
6	1.26	0.942	0.419	0.314
5	0.994	0.746	0.331	0.249
4	0.679	0.509	0.226	0.170
3	0.402	0.302	0.134	0.101
2.5	0.312	0.224	0.104	0.075
2	0.261	0.185	0.0869	0.0617
1.5	0.206	0.145	0.0686	0.0483
1.25	0.177	0.124	0.0590	0.0414

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Table 3.7.1-216 **Site-Dependent SSE Manifestation at-Grade and OBE at-Grade 5% Damping Acceleration Response Spectra** *(continued)*

Frequency (Hz)	Horizontal SSE Manifestation at Grade (g)	Vertical SSE Manifestation at Grade (g)	Horizontal OBE at Grade (g)	Vertical OBE at Grade (g)
1	0.147	0.103	0.0491	0.0342
0.9	0.135	0.0938	0.0451	0.0313
0.8	0.123	0.0848	0.0409	0.0283
0.7	0.110	0.0757	0.0367	0.0252
0.6	0.0969	0.0664	0.0323	0.0221
0.5	0.0834	0.0569	0.0278	0.0190
0.4	0.0694	0.0470	0.0231	0.0157
0.3	0.0548	0.0368	0.0183	0.0123
0.2	0.0302	0.0202	0.0101	0.00673
0.167	0.0210	0.0141	0.00701	0.00469
0.125	0.0118	0.00796	0.00393	0.00265
0.1	0.00850	0.00638	0.00283	0.00213

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Table 3.7.1-217 **Site-Dependent SSE Manifestation at-Grade and OBE at-Grade 5% Damping Pseudo Velocity Response Spectra**

Frequency (Hz)	Horizontal SSE Manifestation at Grade (in/sec)	Vertical SSE Manifestation at Grade (in/sec)	Horizontal OBE at Grade (in/sec)	Vertical OBE at Grade (in/sec)
100	0.549	0.549	0.183	0.183
90	0.648	0.673	0.216	0.224
80	0.800	0.872	0.267	0.291
70	1.04	1.17	0.346	0.392
60	1.42	1.63	0.472	0.544
50	1.92	2.21	0.638	0.736
45	2.31	2.57	0.771	0.858
40	2.82	2.94	0.940	0.980
35	3.28	3.21	1.09	1.07
30	3.87	3.62	1.29	1.21
25	4.50	3.96	1.50	1.32
20	5.74	4.74	1.91	1.58
15	7.91	6.23	2.64	2.08
12.5	9.65	7.44	3.22	2.48
10	11.7	8.78	3.90	2.93
9	12.4	9.27	4.12	3.09
8	12.8	9.61	4.27	3.20
7	13.0	9.73	4.32	3.24
6	12.9	9.66	4.29	3.22
5	12.2	9.17	4.08	3.06
4	10.4	7.83	3.48	2.61
3	8.25	6.19	2.75	2.06
2.5	7.67	5.51	2.56	1.84
2	8.01	5.69	2.67	1.90
1.5	8.43	5.94	2.81	1.98
1.25	8.71	6.10	2.90	2.03

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Table 3.7.1-217 **Site-Dependent SSE Manifestation at-Grade and OBE at-Grade 5% Damping Pseudo Velocity Response Spectra** *(continued)*

Frequency (Hz)	Horizontal SSE Mani-festation at Grade (in/sec)	Vertical SSE Mani-festation at Grade (in/sec)	Horizontal OBE at Grade (in/sec)	Vertical OBE at Grade (in/sec)
1	9.06	6.31	3.02	2.10
0.9	9.24	6.41	3.08	2.14
0.8	9.43	6.52	3.14	2.17
0.7	9.66	6.65	3.22	2.22
0.6	9.93	6.81	3.31	2.27
0.5	10.3	6.99	3.42	2.33
0.4	10.7	7.23	3.56	2.41
0.3	11.2	7.55	3.74	2.52
0.2	9.28	6.21	3.09	2.07
0.167	7.75	5.18	2.58	1.73
0.125	5.80	3.92	1.93	1.31
0.1	5.23	3.92	1.74	1.31

NAPS SUP 3.7-2

Table 3.7.1-218 **Zero-Lag Cross Correlation Coefficients for the Final Scaled Spectrum Compatible Acceleration Time Histories for the FWSC at Elevation 220 ft**

Components	Zero-Lag Cross Correlation Coefficient of Final Matched Time Histories
H1 – H2	0.019
H1 – UP	0.043
H2 – UP	-0.019

NAPS SUP 3.7-2

Table 3.7.1-219 **Peak Ground Motion Parameters, Associated Ratios, and Strong Motion Duration Values for the Final Scaled Spectrum Compatible Acceleration Time Histories for the FWSC at Elevation 220 ft**

Parameter	H1	H2	UP
PGA (g)	0.556	0.553	0.552
PGV (cm/sec)	18.131	15.590	14.323
PGD (cm)	6.523	9.159	4.814
PGV/PGA (cm/sec/g)	32.614	28.183	25.932
$PGA*PGD/PGV^2$	10.817	20.440	12.707
5-75% Duration Time (sec)	7.560	11.770	7.675
5% Duration Time (sec)	1.095	1.245	0.955
75% Duration Time (sec)	8.655	13.015	8.630
0% Extrapolated Duration Time (sec)	0.555	0.404	0.407
100% Extrapolated Duration Time (sec)	11.355	17.219	11.371
0-100% Extrapolated Duration Time (sec)	10.800	16.814	10.964

NAPS SUP 3.7-2

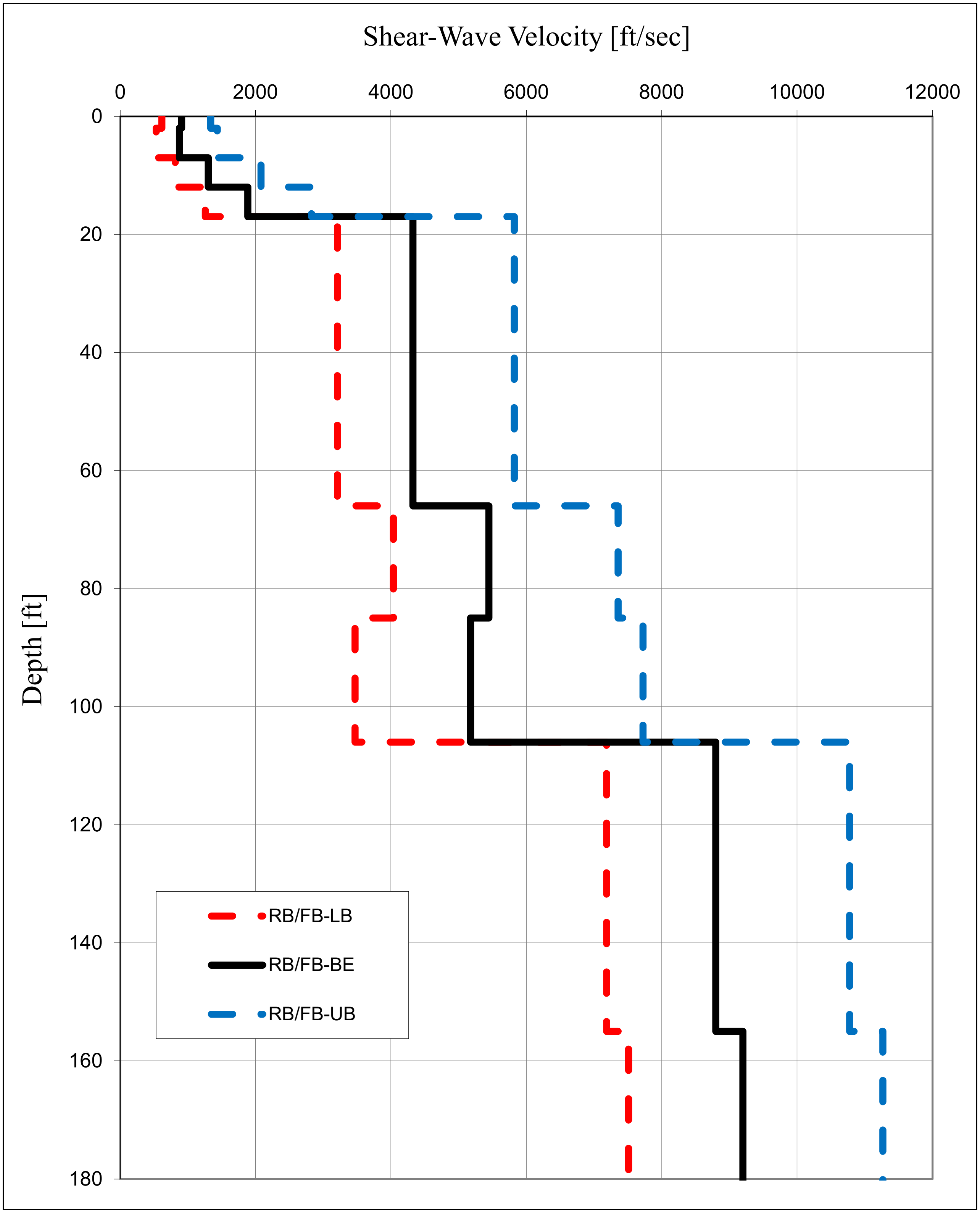
Table 3.7.1-220 **Filter Corners, Peak Ground Motion Parameters, Associated Ratios, and Strong Motion Duration Values for the Selected Seed Input Time History from the NUREG/CR-6728 Database**

Earthquake: **1984 Morgan Hill (M6.2)**
Station: **Gilroy – Gavilan College (R=16.2 km)**

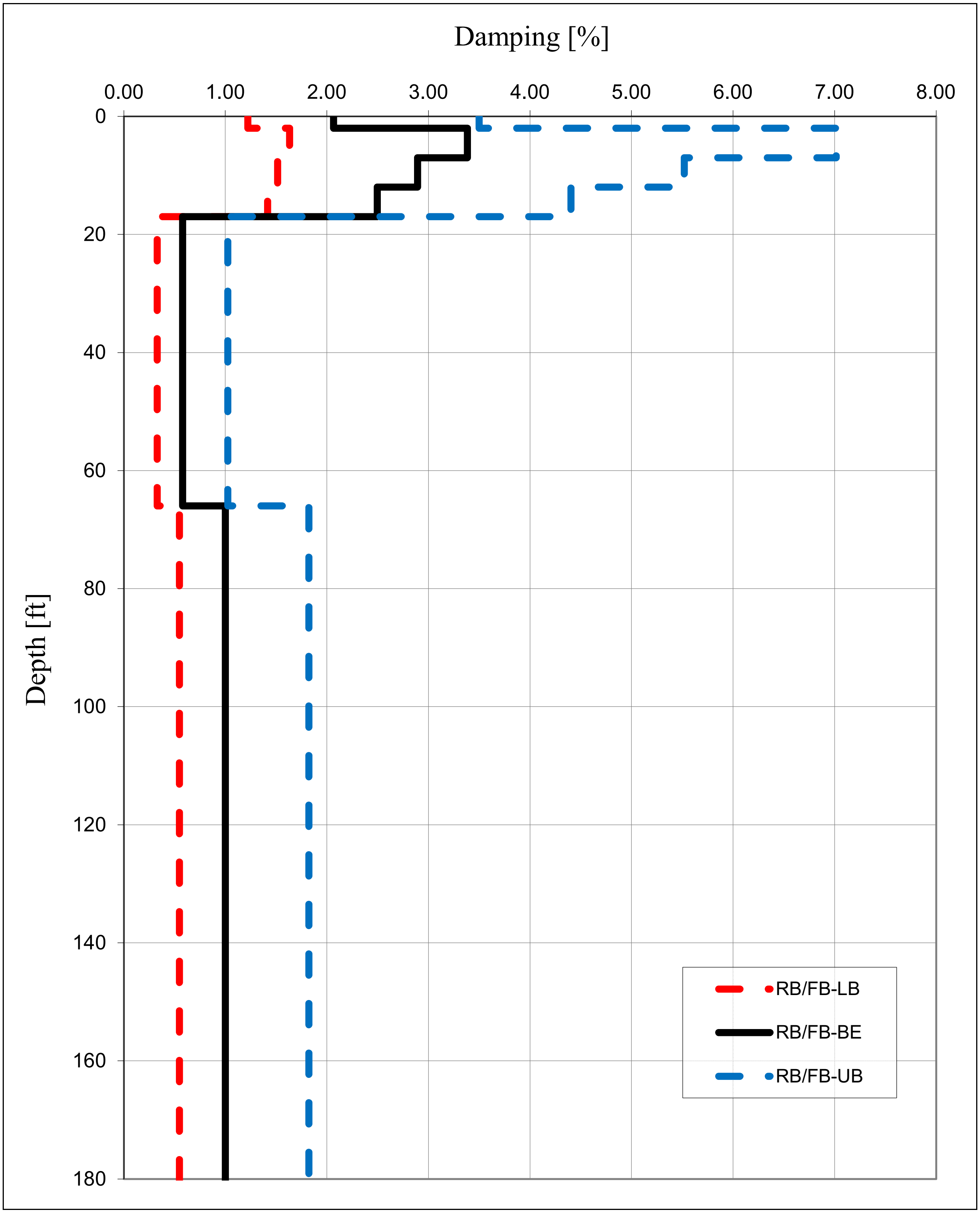
Parameter	H1	H2	UP
High Pass Filter (Hz)	0.10	0.10	0.50
Low Pass Filter (Hz)	30.0	30.0	42.0
PGA (g)	0.276	0.196	0.161
PGV (cm/sec)	5.2	3.6	3.5
PGD (cm)	0.83	0.97	0.55
PGV/PGA (cm/sec/g)	18.8	18.4	21.7
$PGA*PGD/PGV^2$	8.3	14.4	7.1
Duration Time[a] (sec)	7.1	10.3	5.7

a. Duration time is defined as the acceleration time history interval in which the normalized Arias Intensity is between 5% and 75% of the total normalized value.

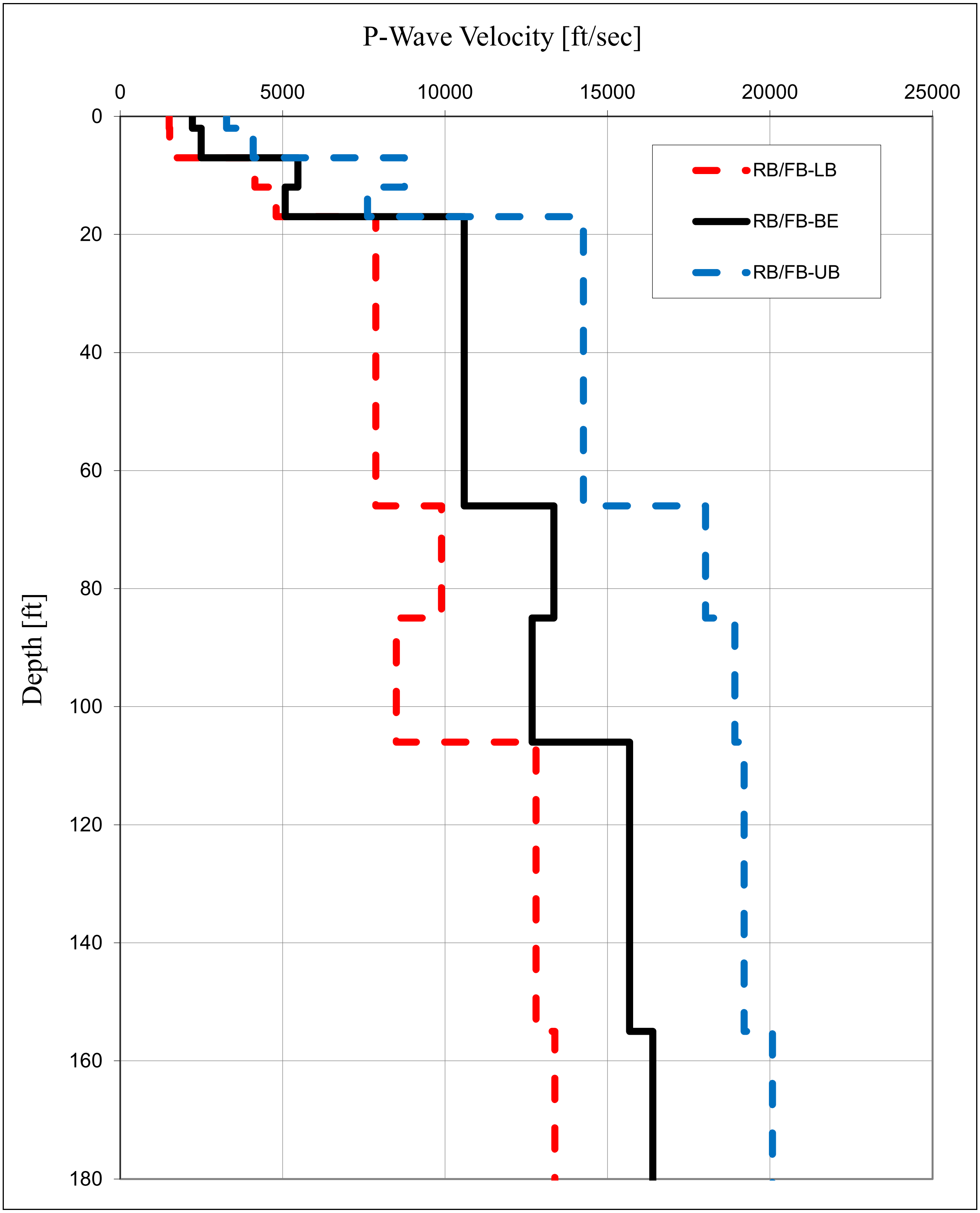
NAPS SUP 3.7-1 Figure 3.7.1-201 **SSI Input Strain Compatible Shear-Wave Velocity Profiles – RB/FB**



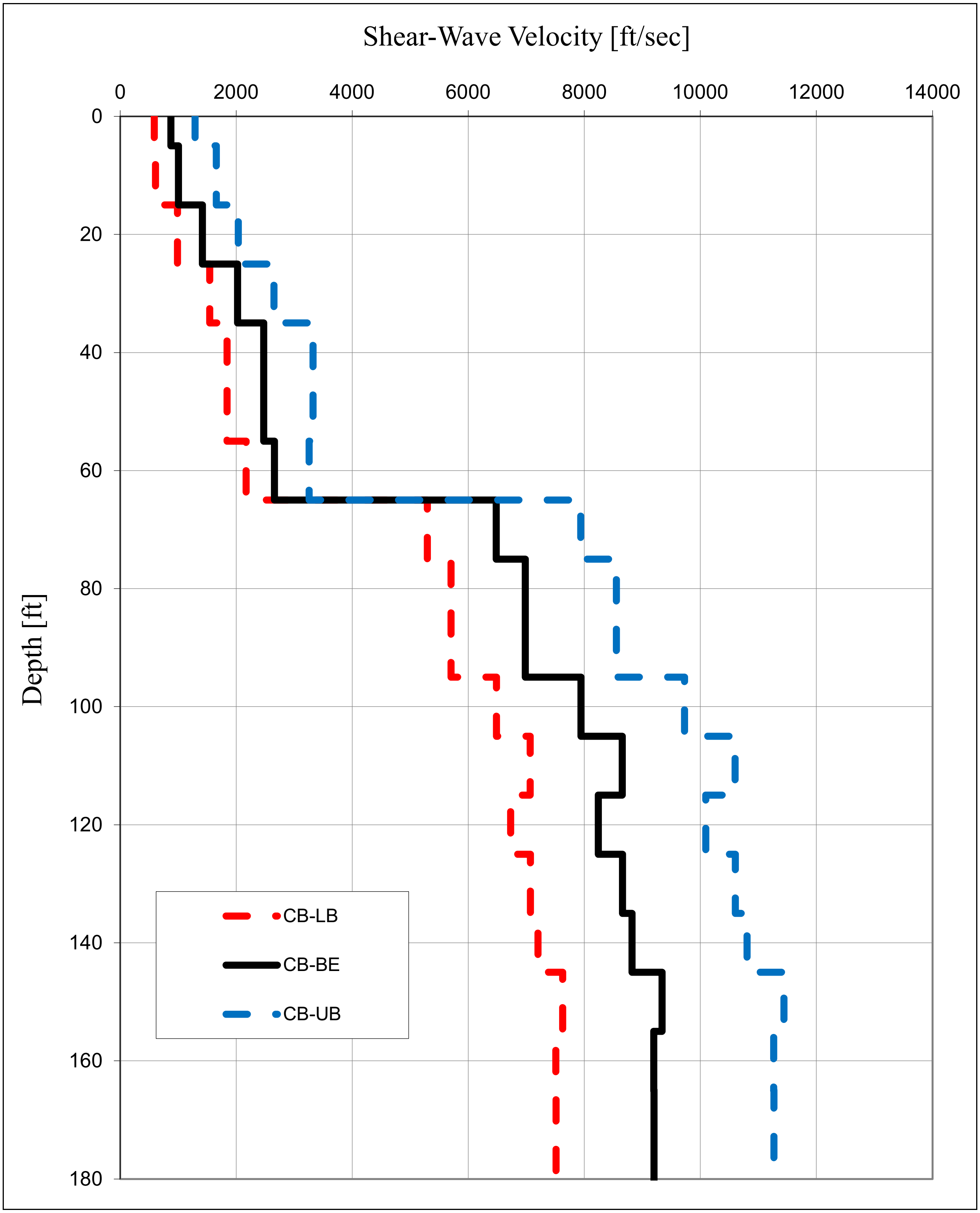
NAPS SUP 3.7-1 Figure 3.7.1-202 **SSI Input Strain Compatible Damping Profiles – RB/FB**



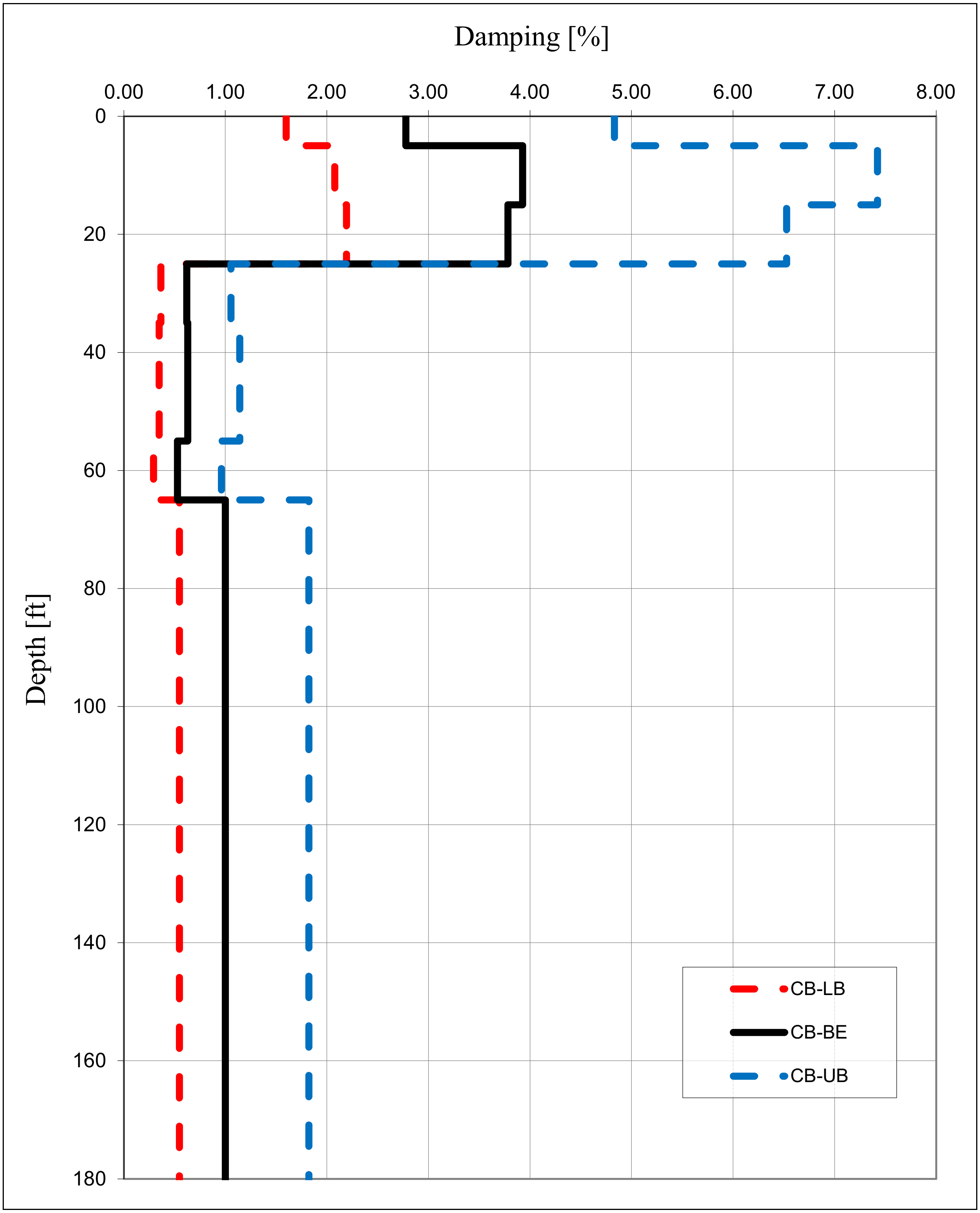
NAPS SUP 3.7-1 Figure 3.7.1-203 **SSI Input Strain Compatible P-Wave Velocity Profiles – RB/FB**



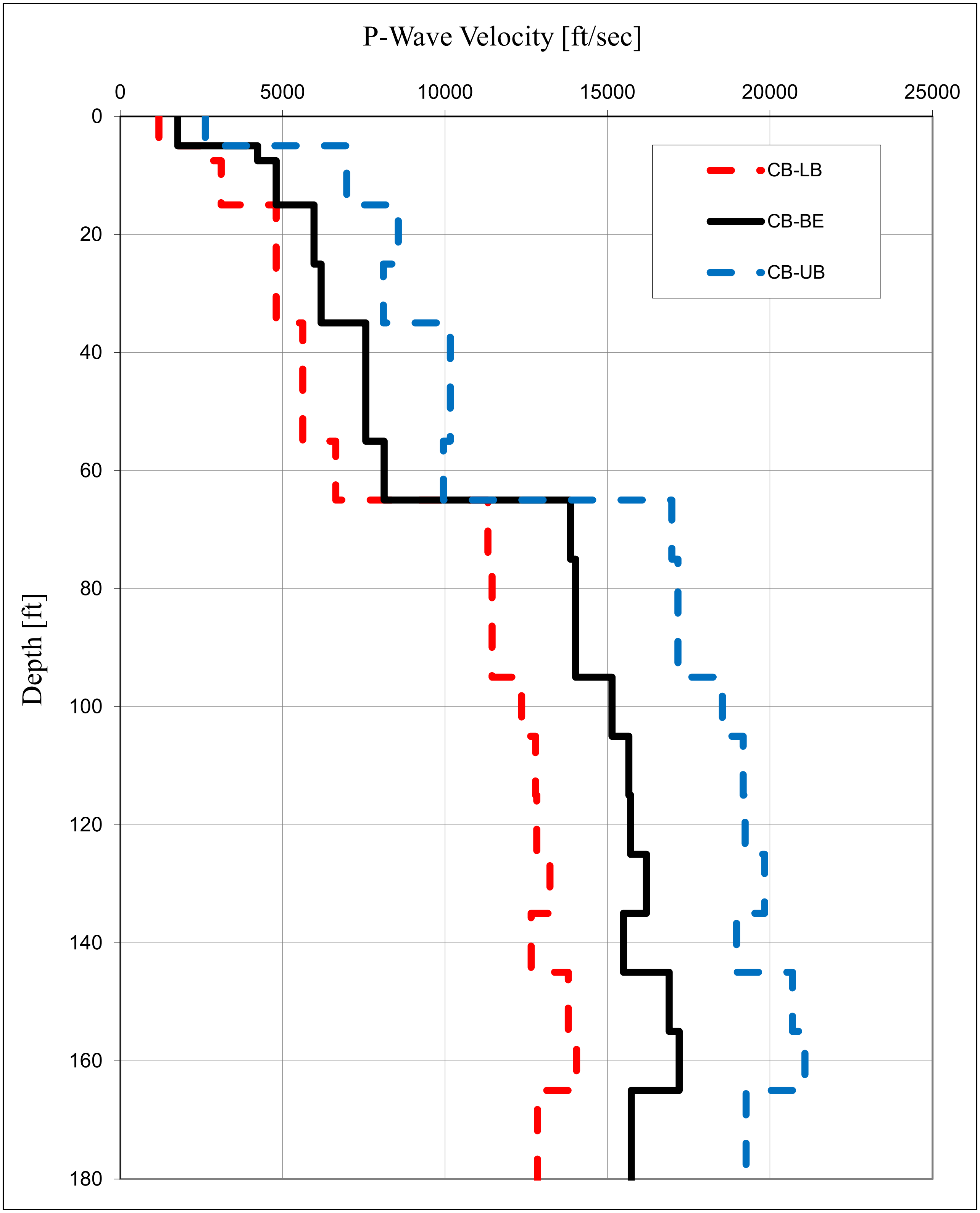
NAPS SUP 3.7-1 Figure 3.7.1-204 **SSI Input Strain Compatible Shear-Wave Velocity Profiles – CB**



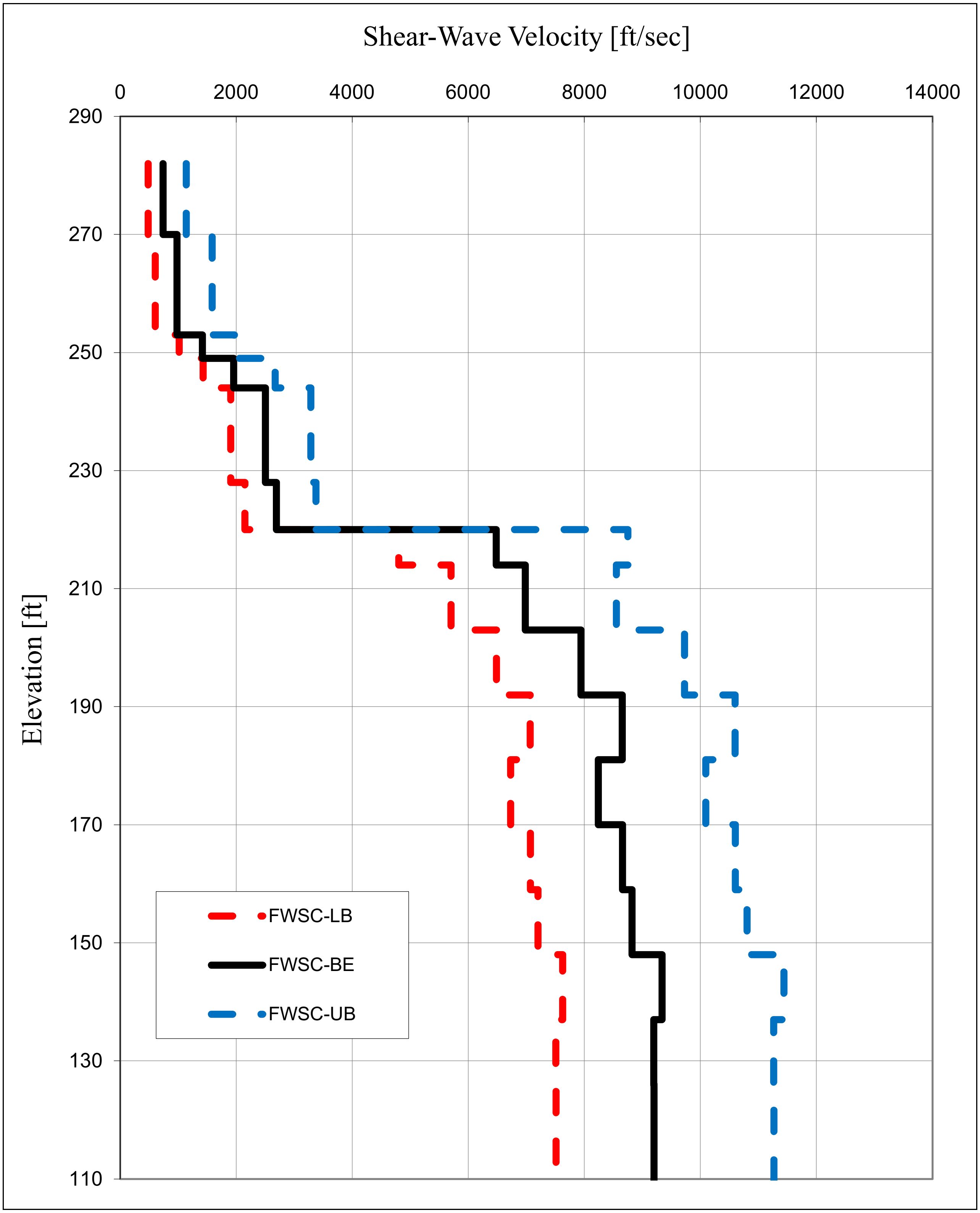
NAPS SUP 3.7-1 Figure 3.7.1-205 **SSI Input Strain Compatible Damping Profiles – CB**



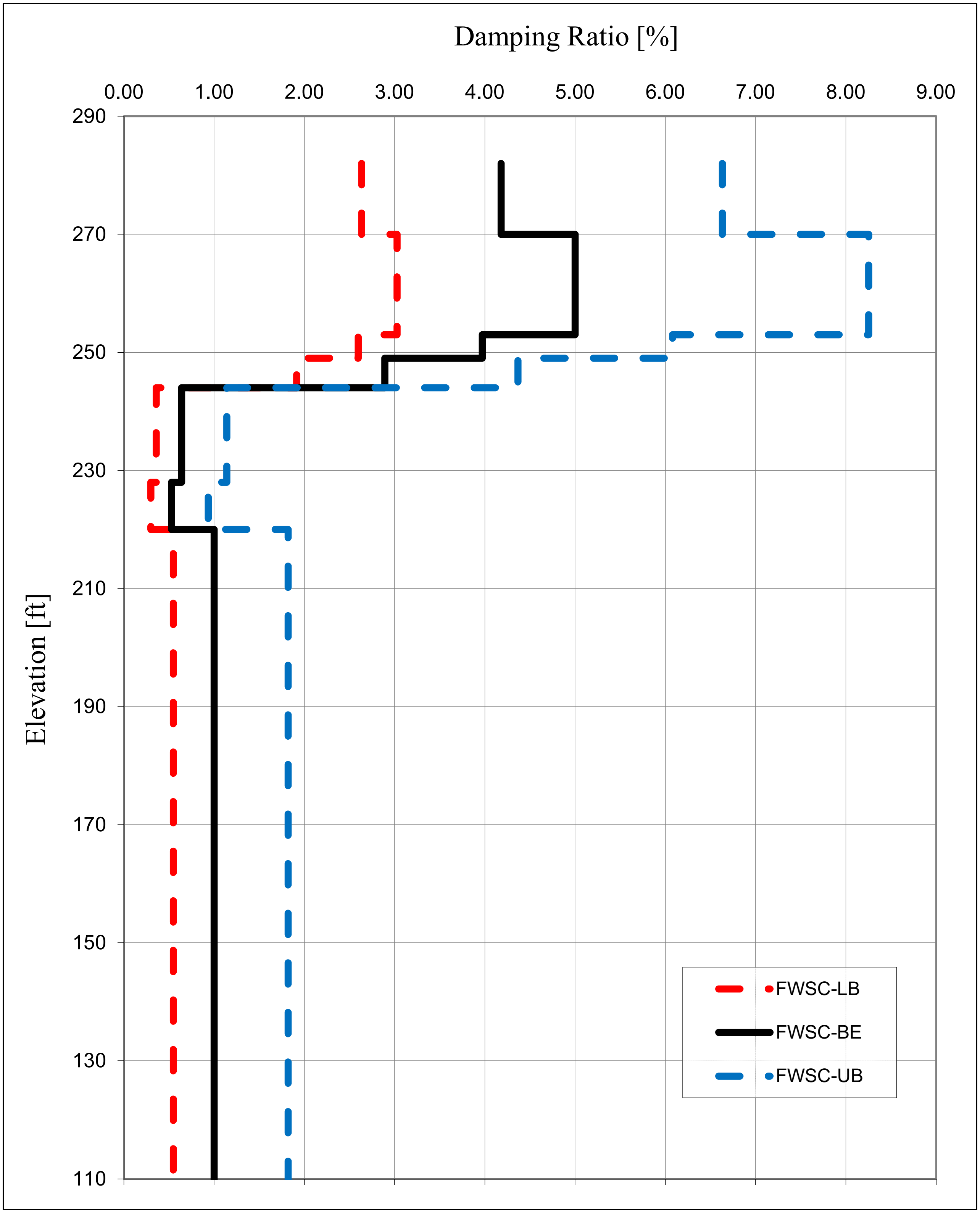
NAPS SUP 3.7-1 Figure 3.7.1-206 **SSI Input Strain Compatible P-Wave Velocity Profiles – CB**



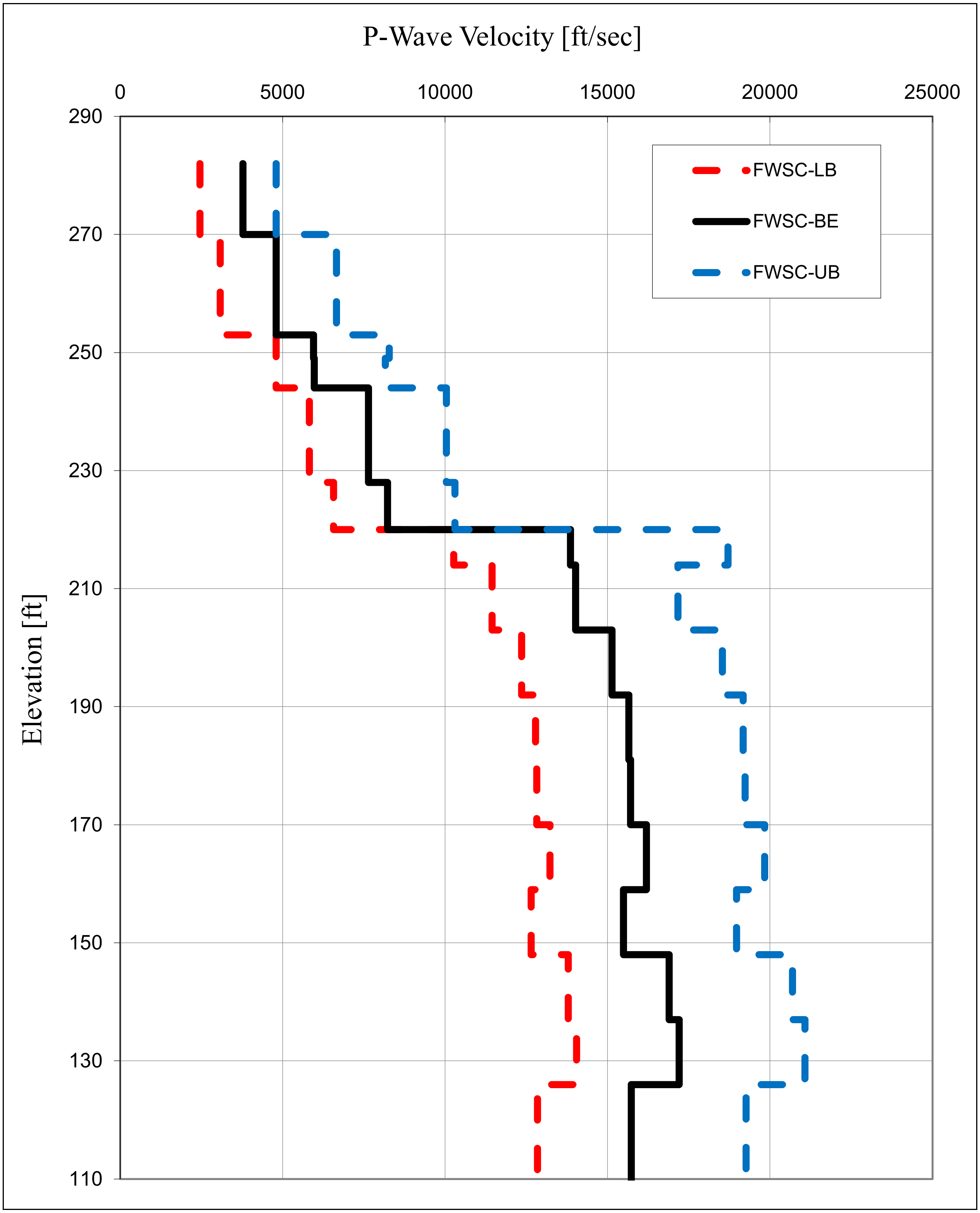
NAPS SUP 3.7-1 Figure 3.7.1-207 **SSI Input Strain Compatible Shear-Wave Velocity Profiles – FWSC**



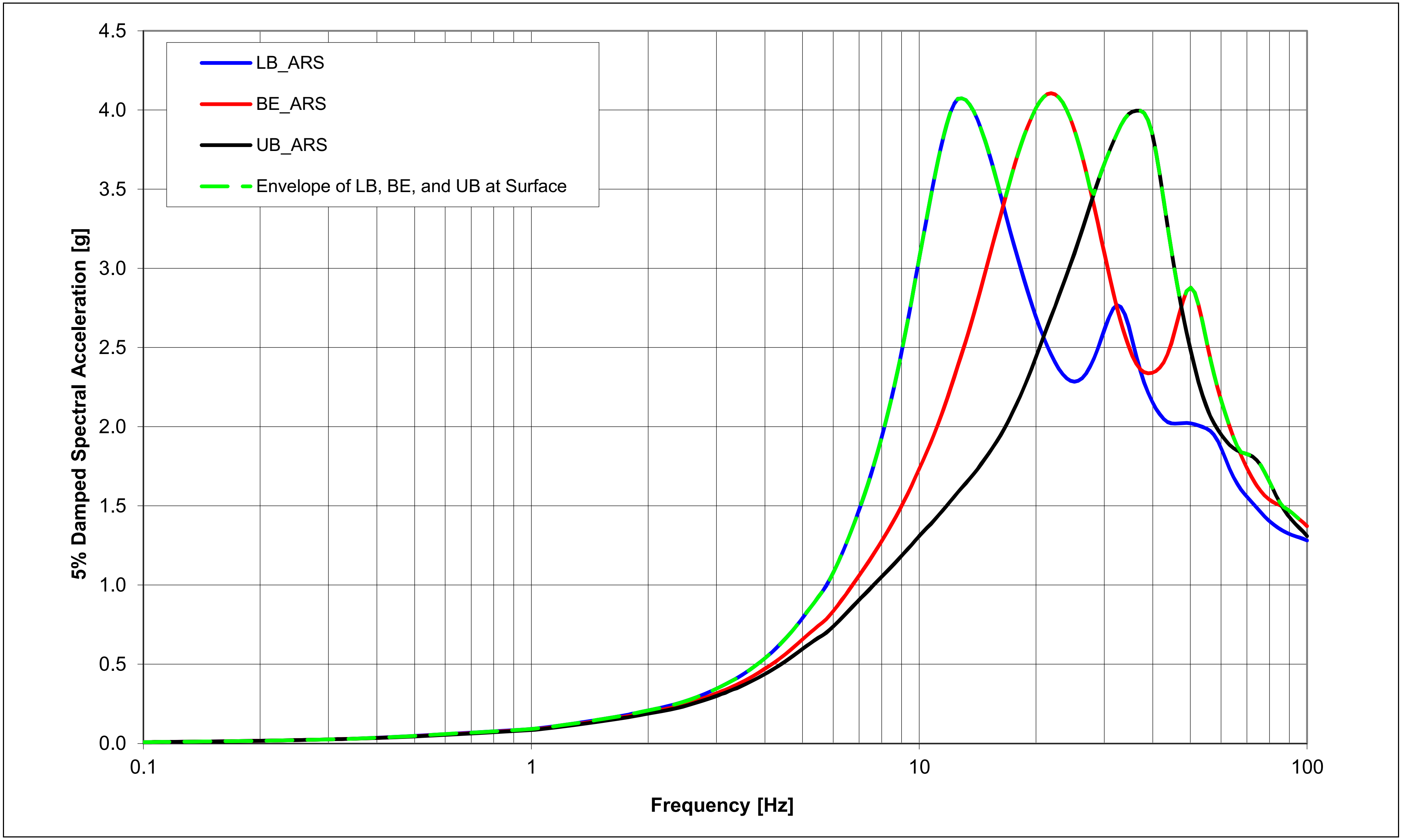
NAPS SUP 3.7-1 Figure 3.7.1-208 **SSI Input Strain Compatible Damping Profiles – FWSC**



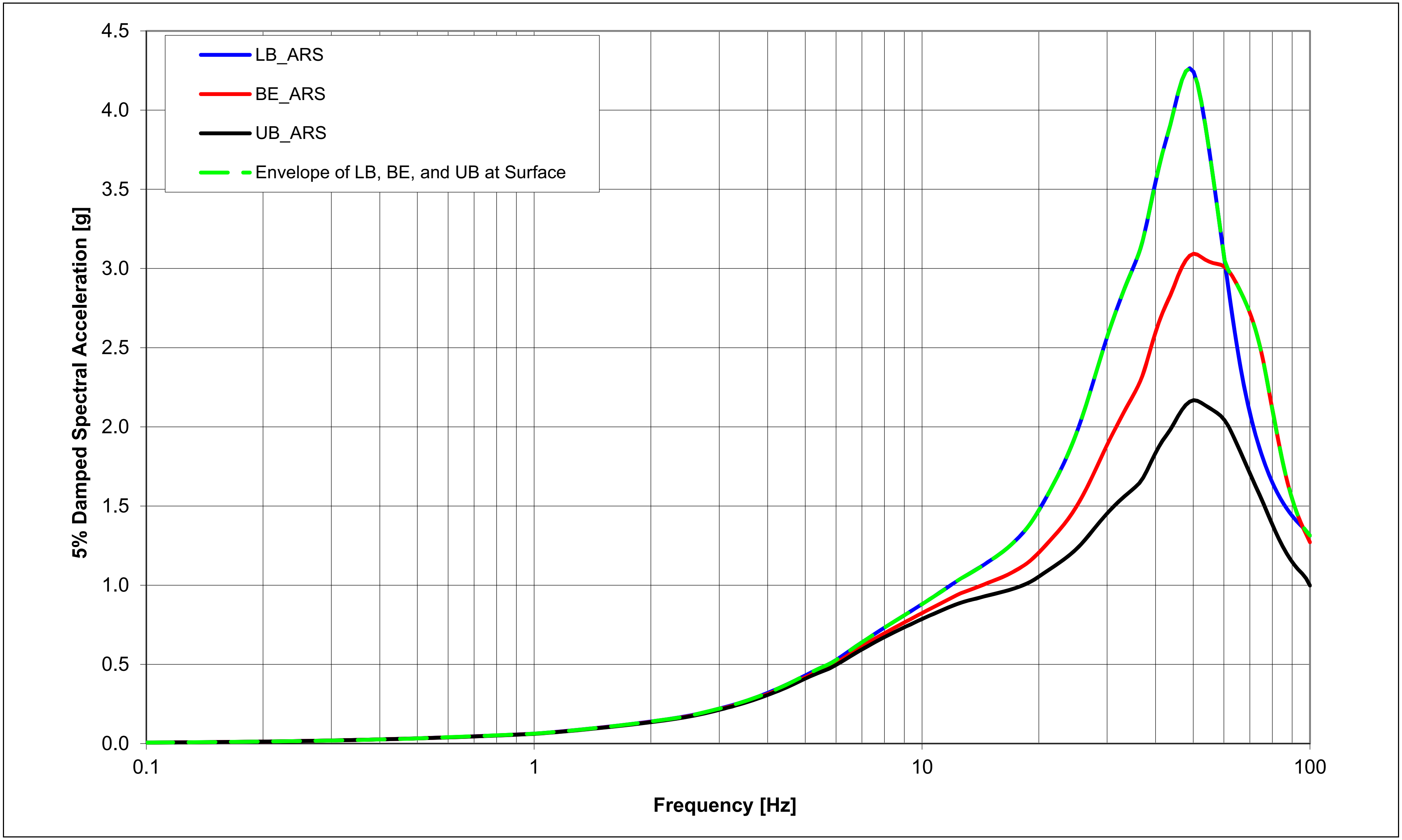
NAPS SUP 3.7-1 Figure 3.7.1-209 **SSI Input Strain Compatible P-Wave Velocity Profiles – FWSC**



NAPS SUP 3.7-1 Figure 3.7.1-210 **Envelope of Horizontal FIRS Propagated to the Ground Surface through Full Column SSI Input Profiles – RB/FB**



NAPS SUP 3.7-1 Figure 3.7.1-211 **Envelope of Vertical FIRS Propagated to the Ground Surface through Full Column SSI Input Profiles – RB/FB**



NAPS SUP 3.7-1 Figure 3.7.1-212 **NEI Check and SSI Input Response Spectra for Horizontal Full Column FIRS – RB/FB**

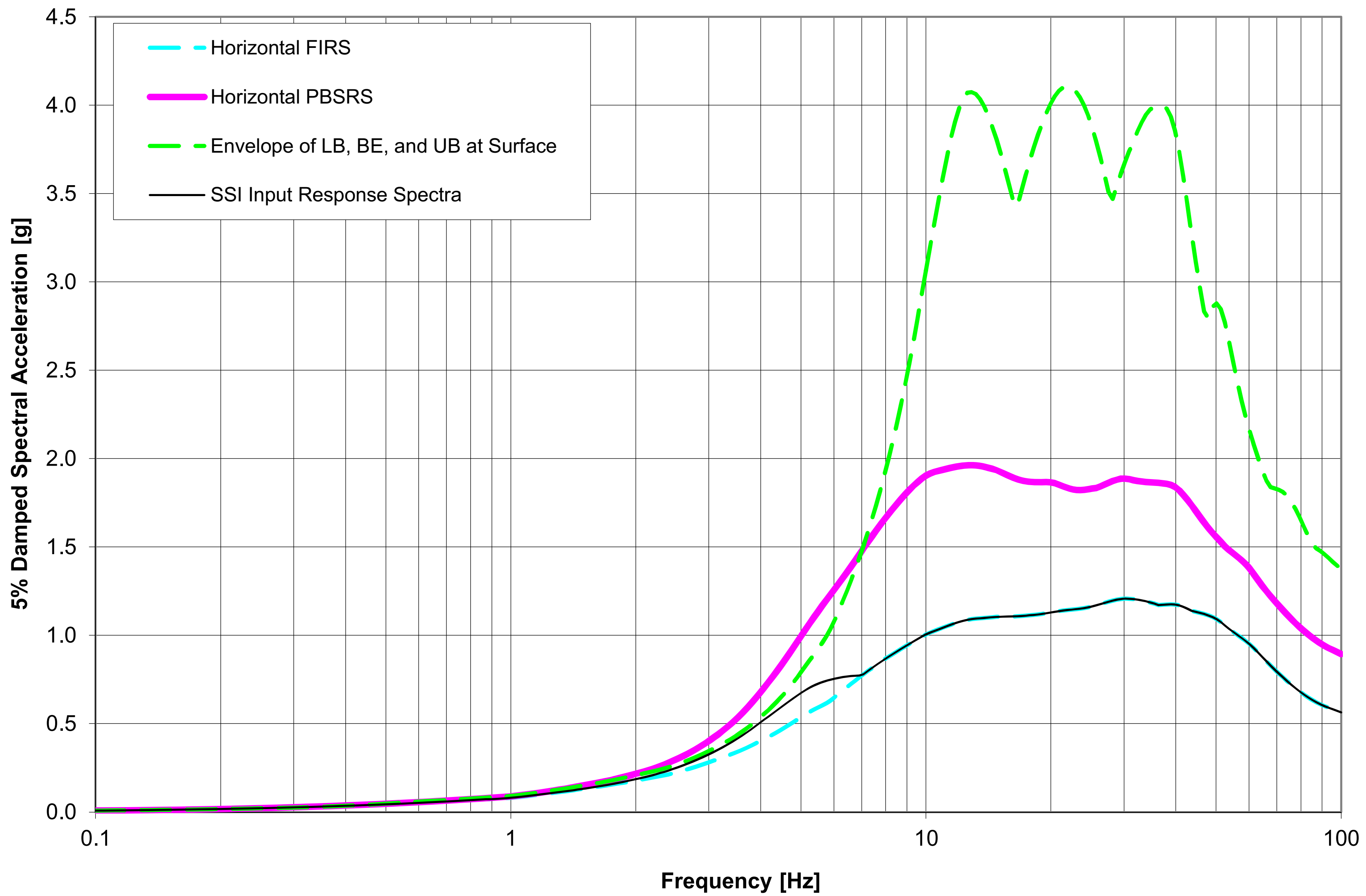


Figure 3.7.1-213 **NEI Check and SSI Input Response Spectra for Vertical Full Column FIRS – RB/FB**

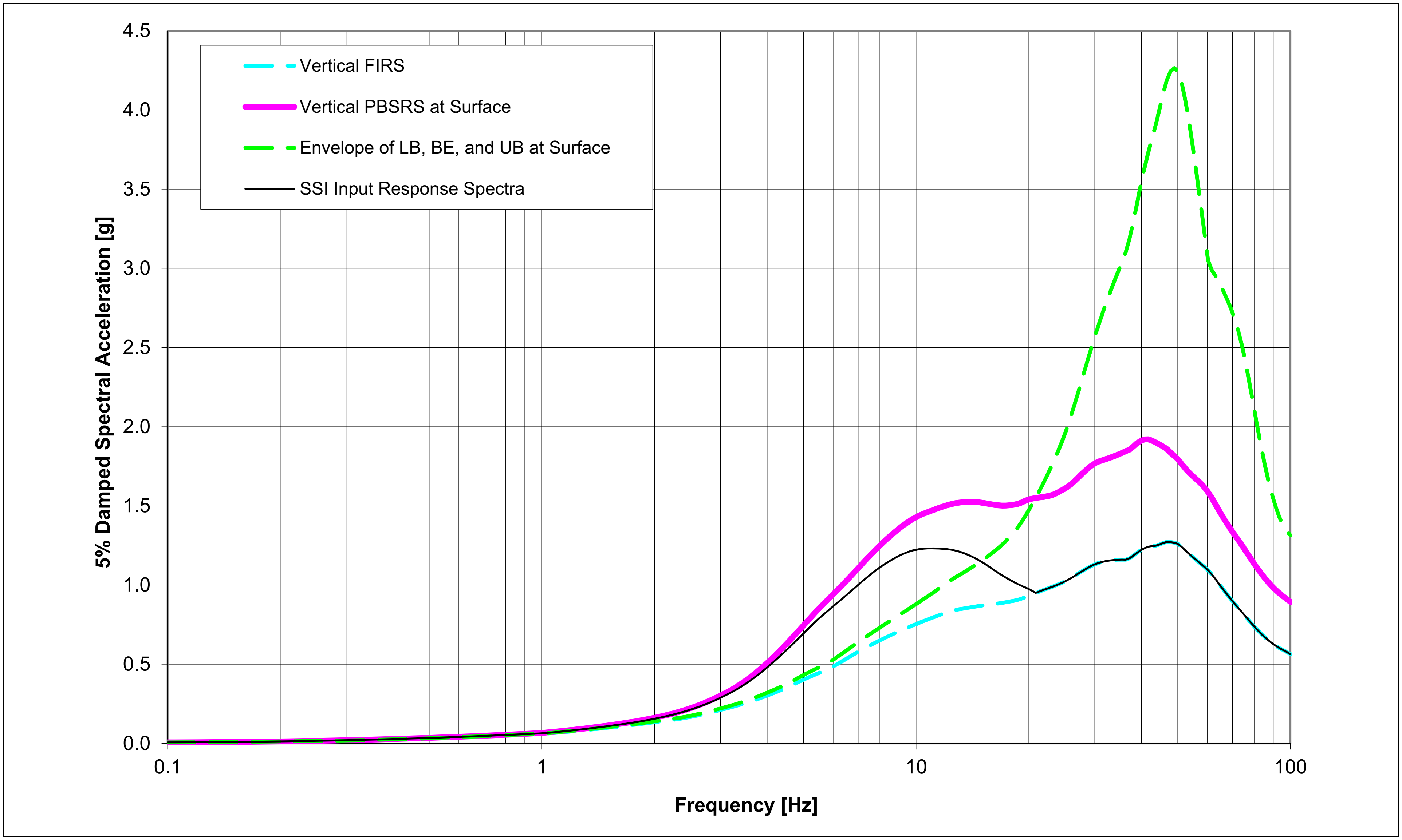
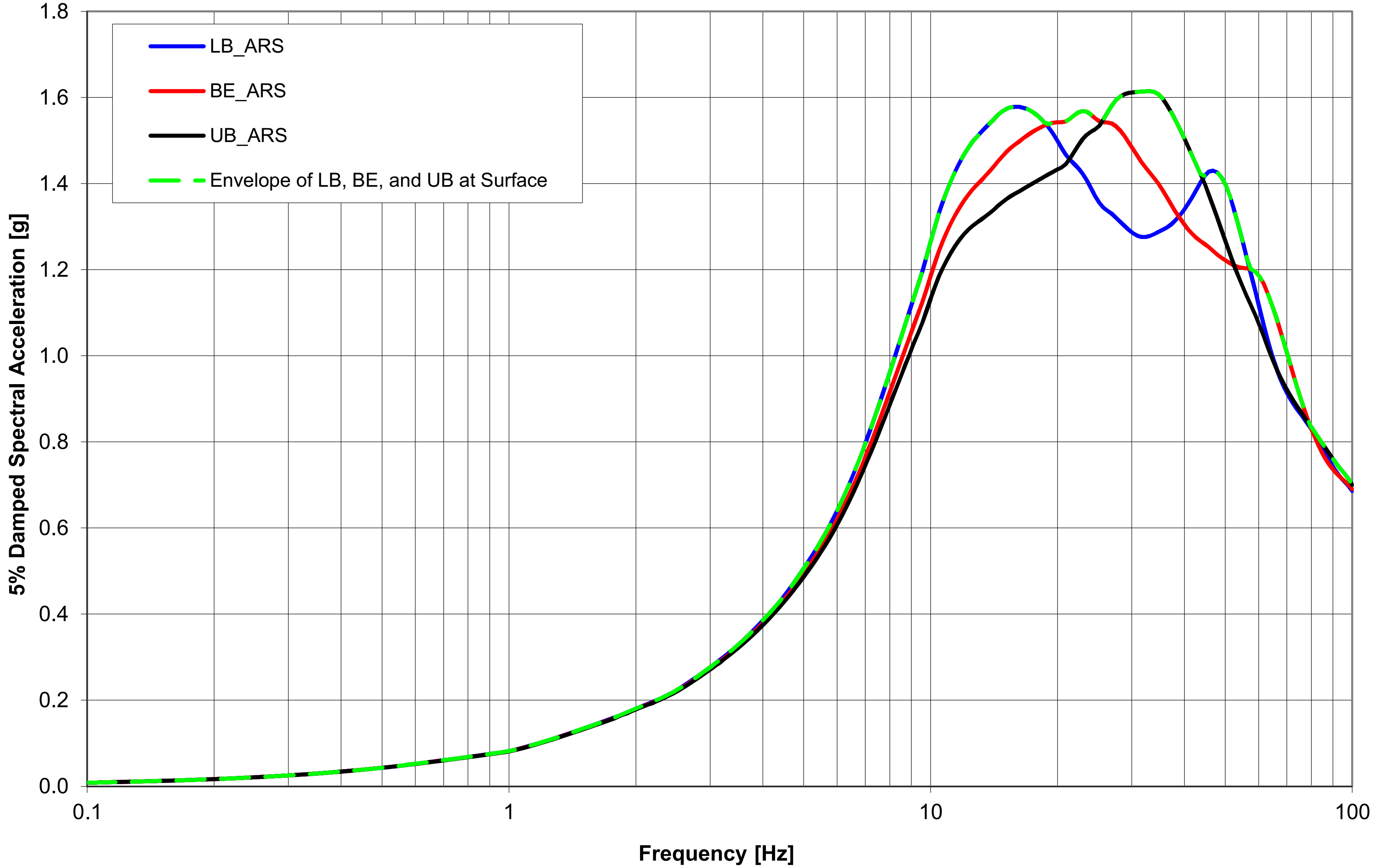


Figure 3.7.1-214 **Envelope of Horizontal FIRS Propagated to the Ground Surface through Partial Column SSI Input Profiles – RB/FB**



NAPS SUP 3.7-1 Figure 3.7.1-215 **Envelope of Vertical FIRS Propagated to the Ground Surface through Partial Column SSI Input Profiles – RB/FB**

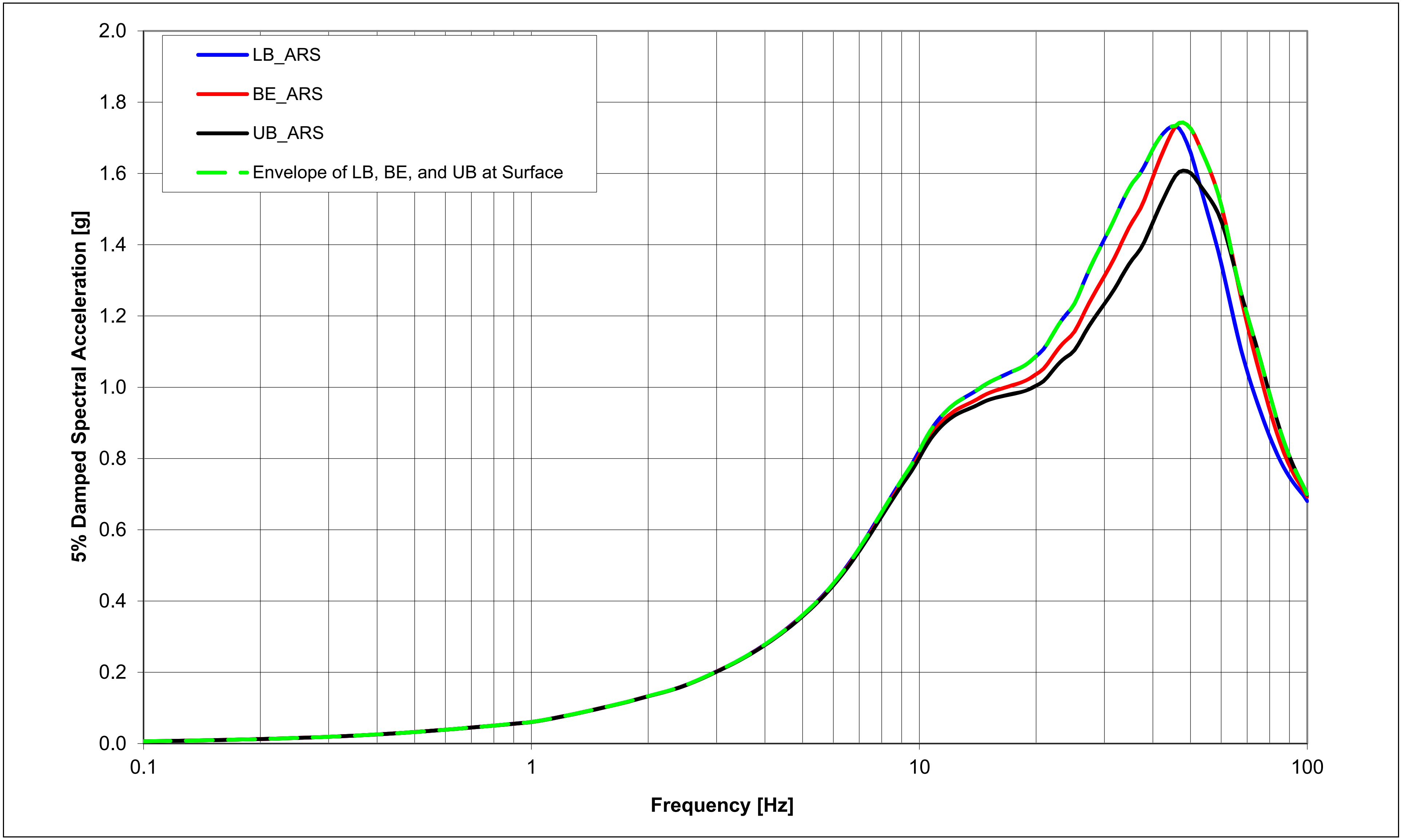


Figure 3.7.1-216 **NEI Check and SSI Input Response Spectra for Horizontal Partial Column FIRS – RB/FB**

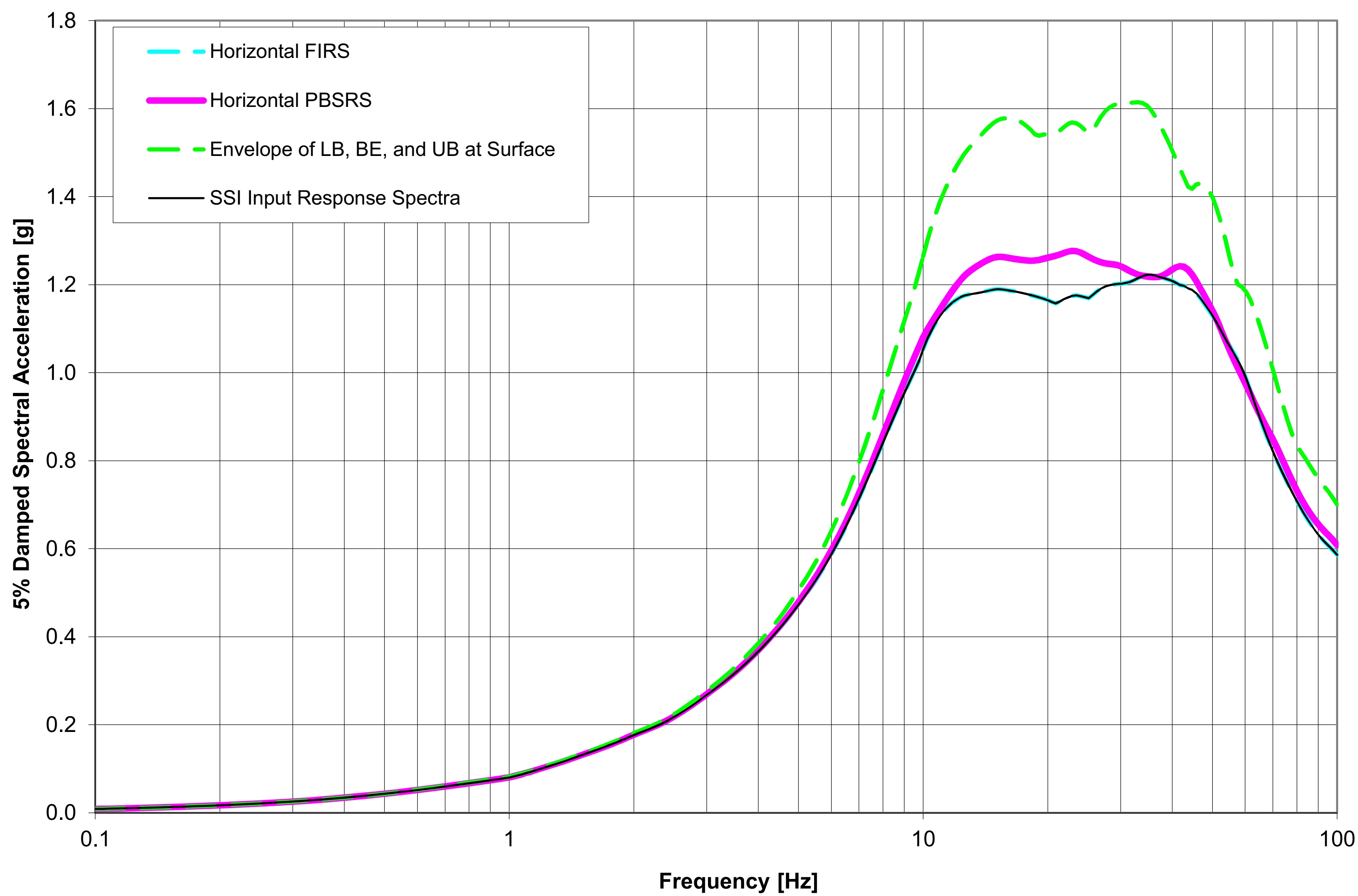


Figure 3.7.1-217 **NEI Check and SSI Input Response Spectra for Vertical Partial Column FIRS – RB/FB**

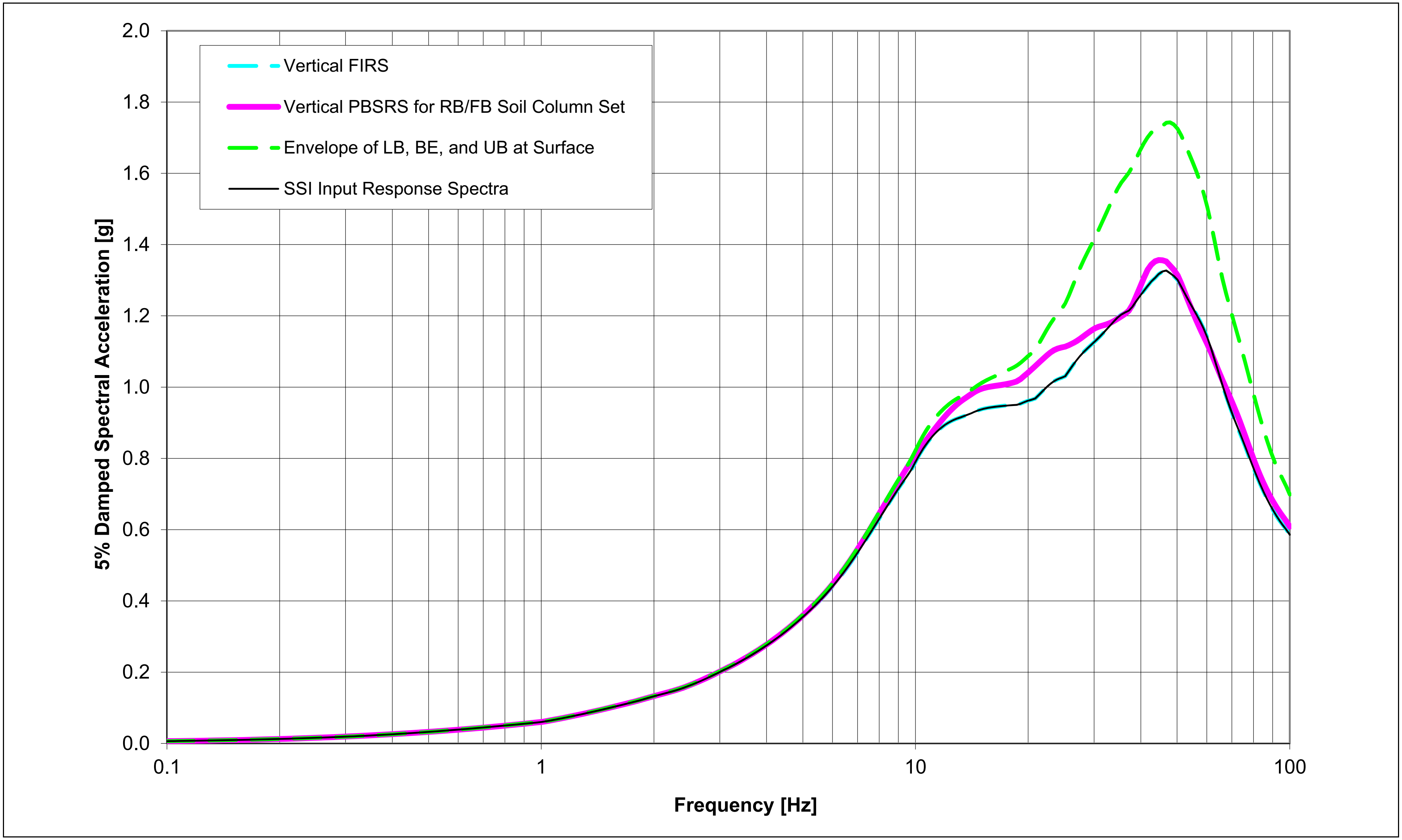
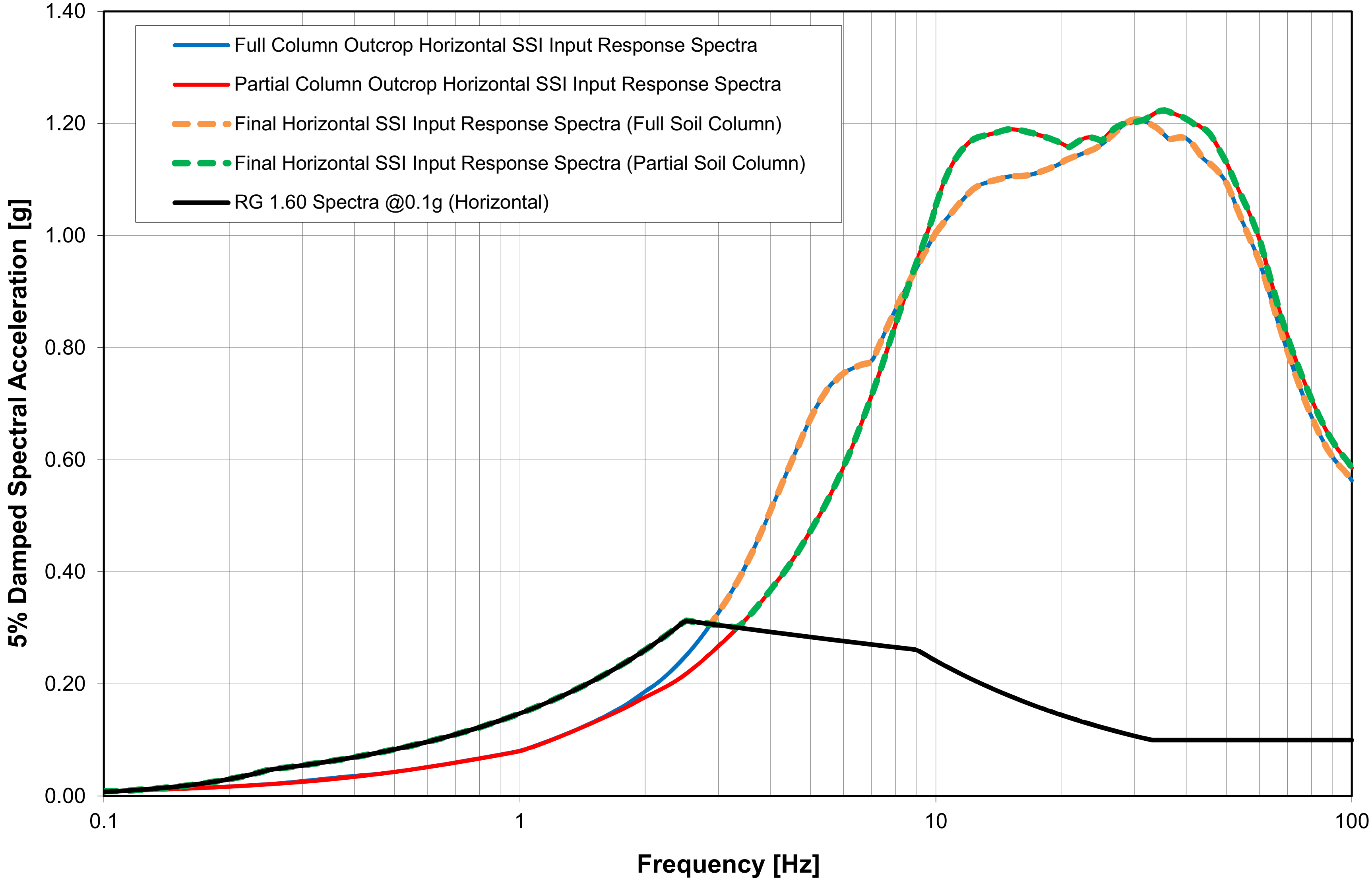
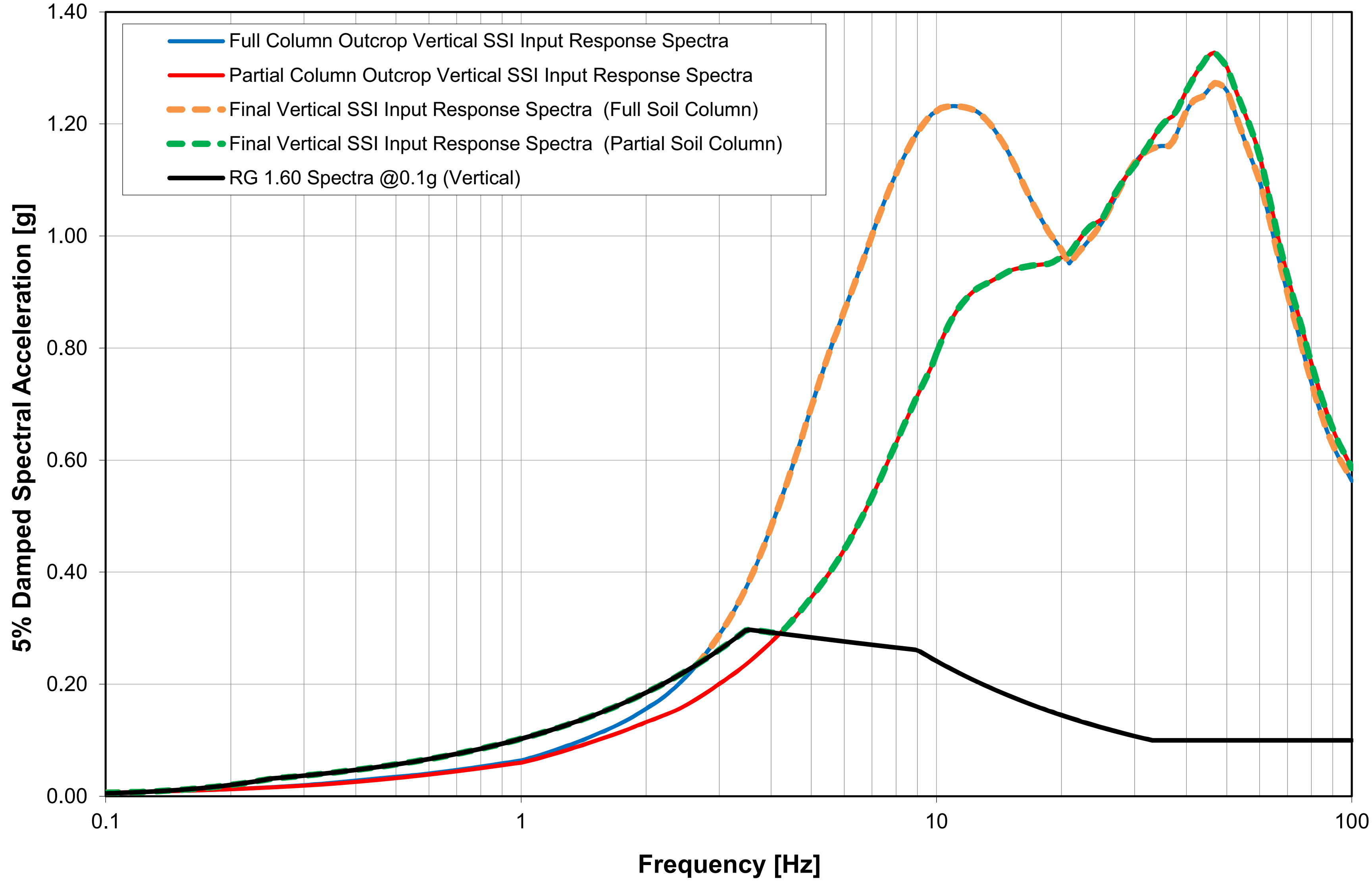


Figure 3.7.1-218 **Development of 5% Damped Final Horizontal SSI Input Response Spectra for RB/FB**



NAPS SUP 3.7-1 Figure 3.7.1-219 **Development of 5% Damped Final Vertical SSI Input Response Spectra for RB/FB**



NAPS SUP 3.7-1 Figure 3.7.1-220 **5% Damped Final SSI Input Response Spectra for RB/FB**

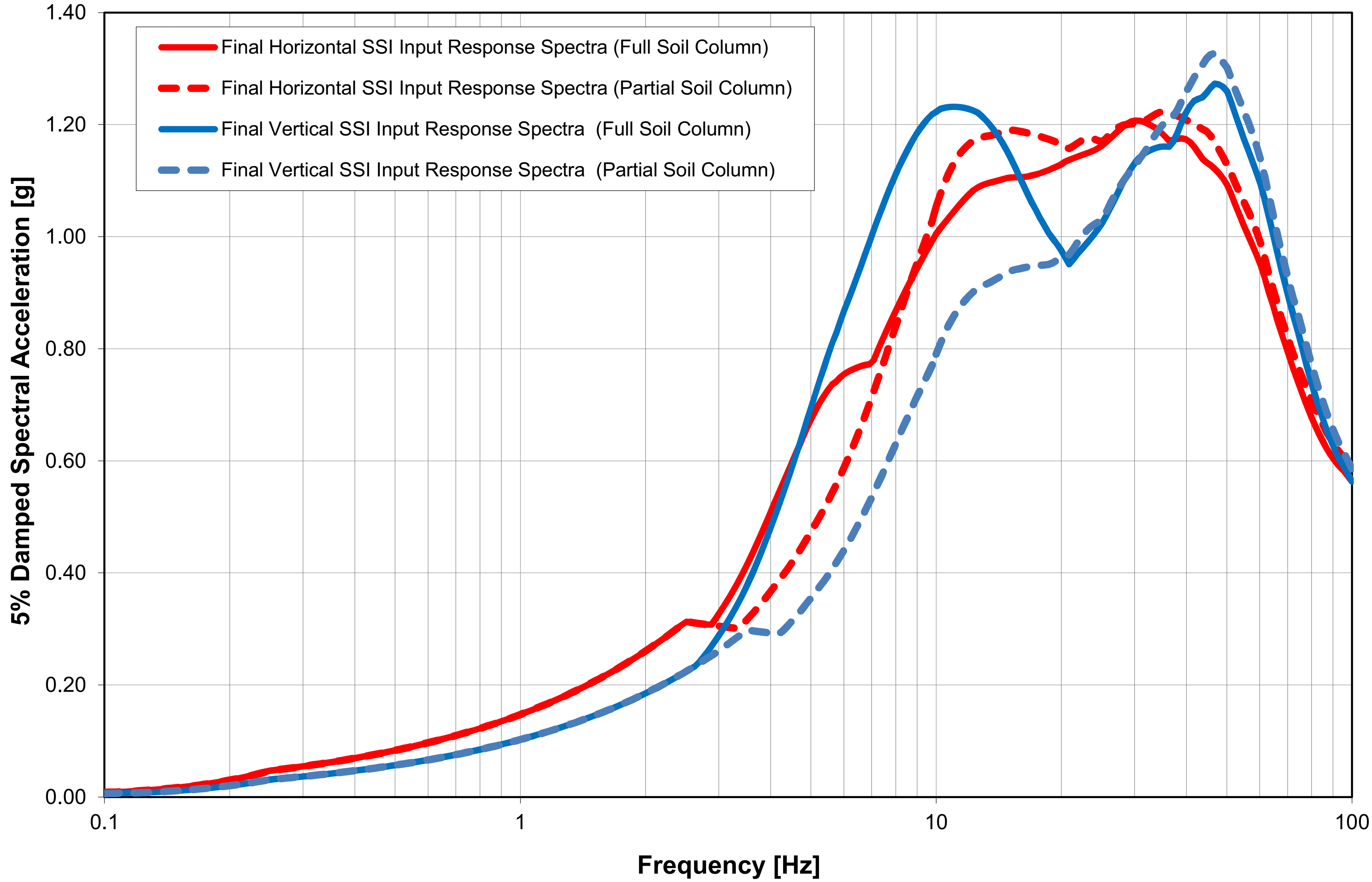
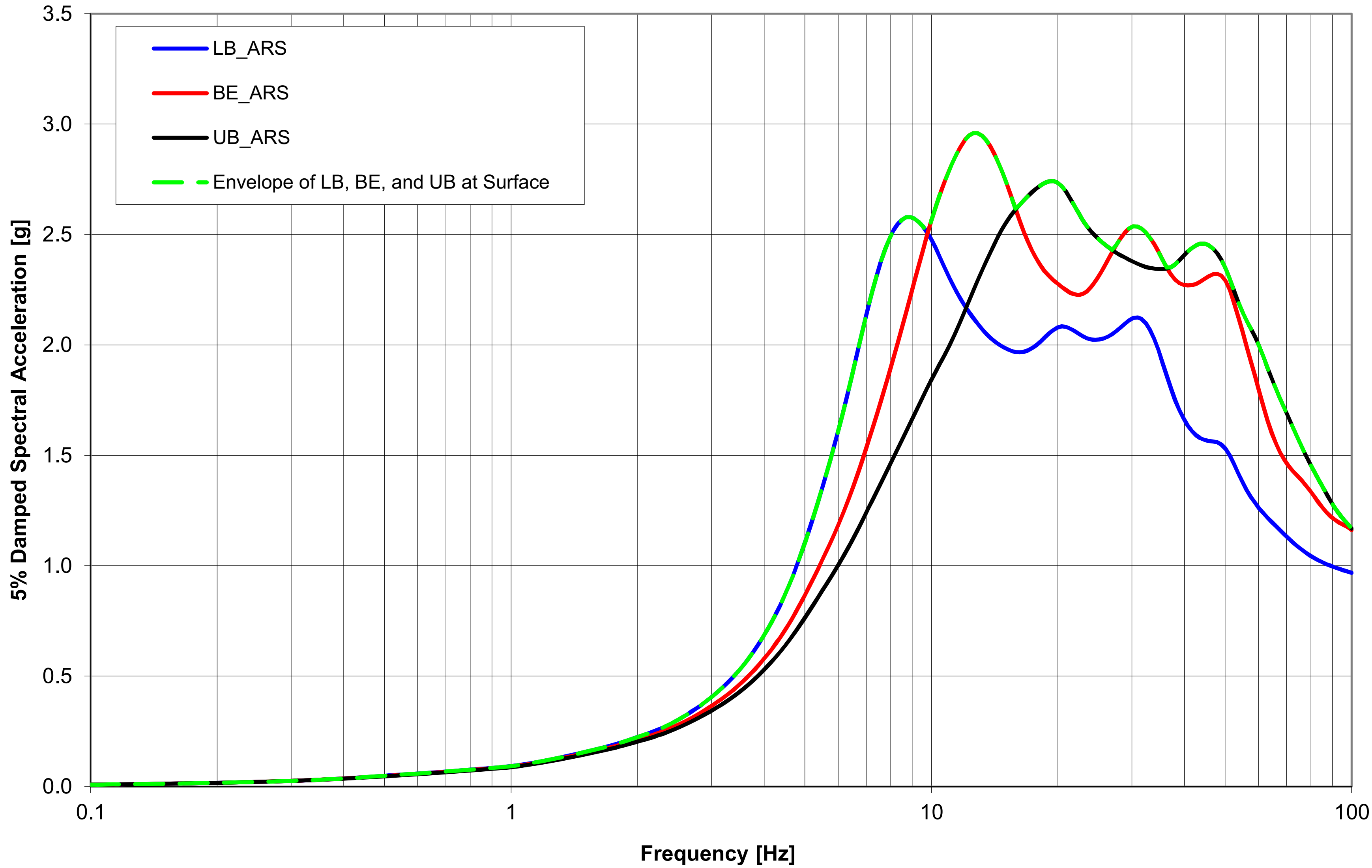


Figure 3.7.1-221 **Envelope of Horizontal FIRS Propagated to the Ground Surface through Full Column SSI Input Profiles – CB**



NAPS SUP 3.7-1 Figure 3.7.1-222 **Envelope of Vertical FIRS Propagated to the Ground Surface through Full Column SSI Input Profiles – CB**

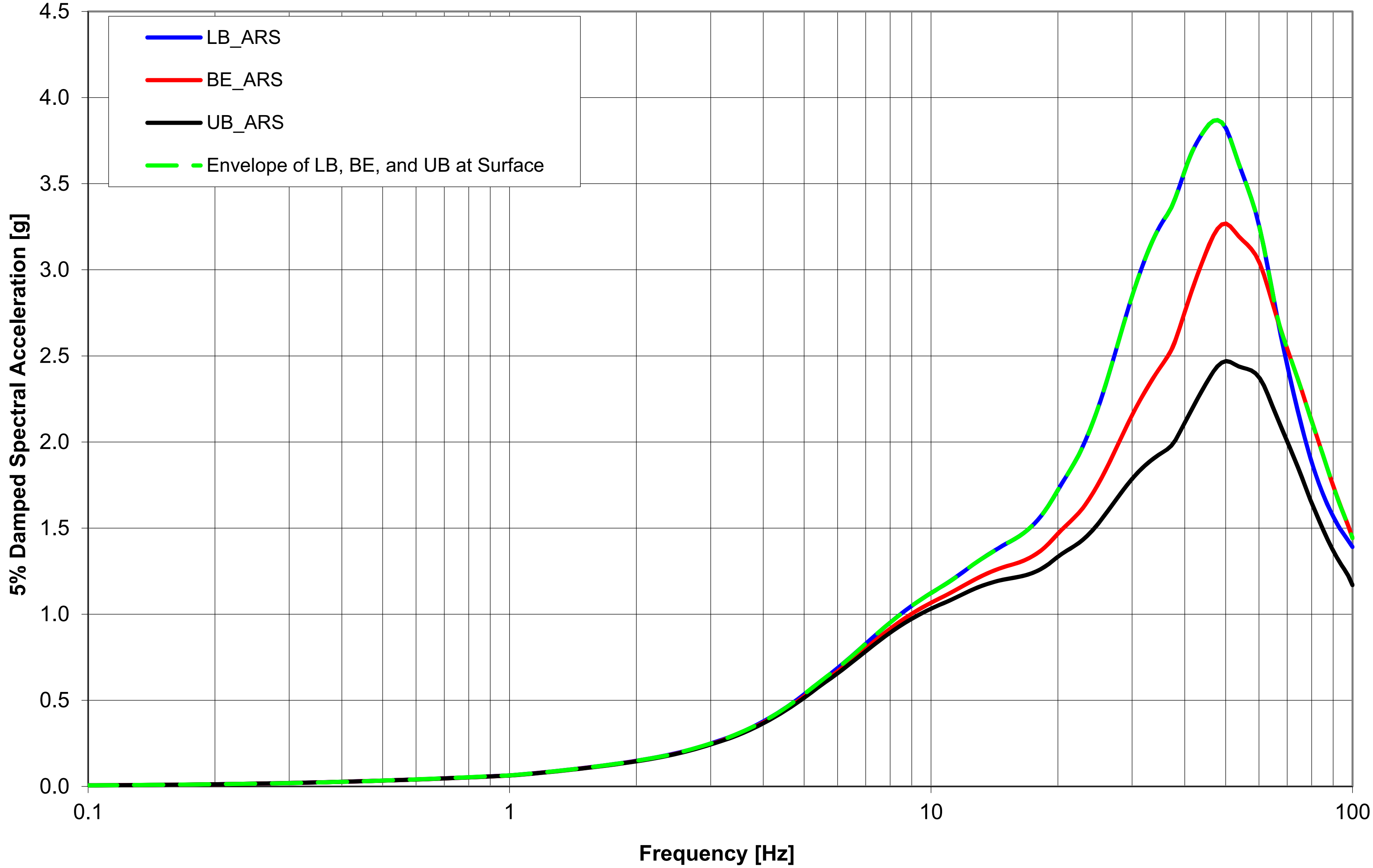


Figure 3.7.1-223 **NEI Check and SSI Input Response Spectra for Horizontal Full Column FIRS – CB**

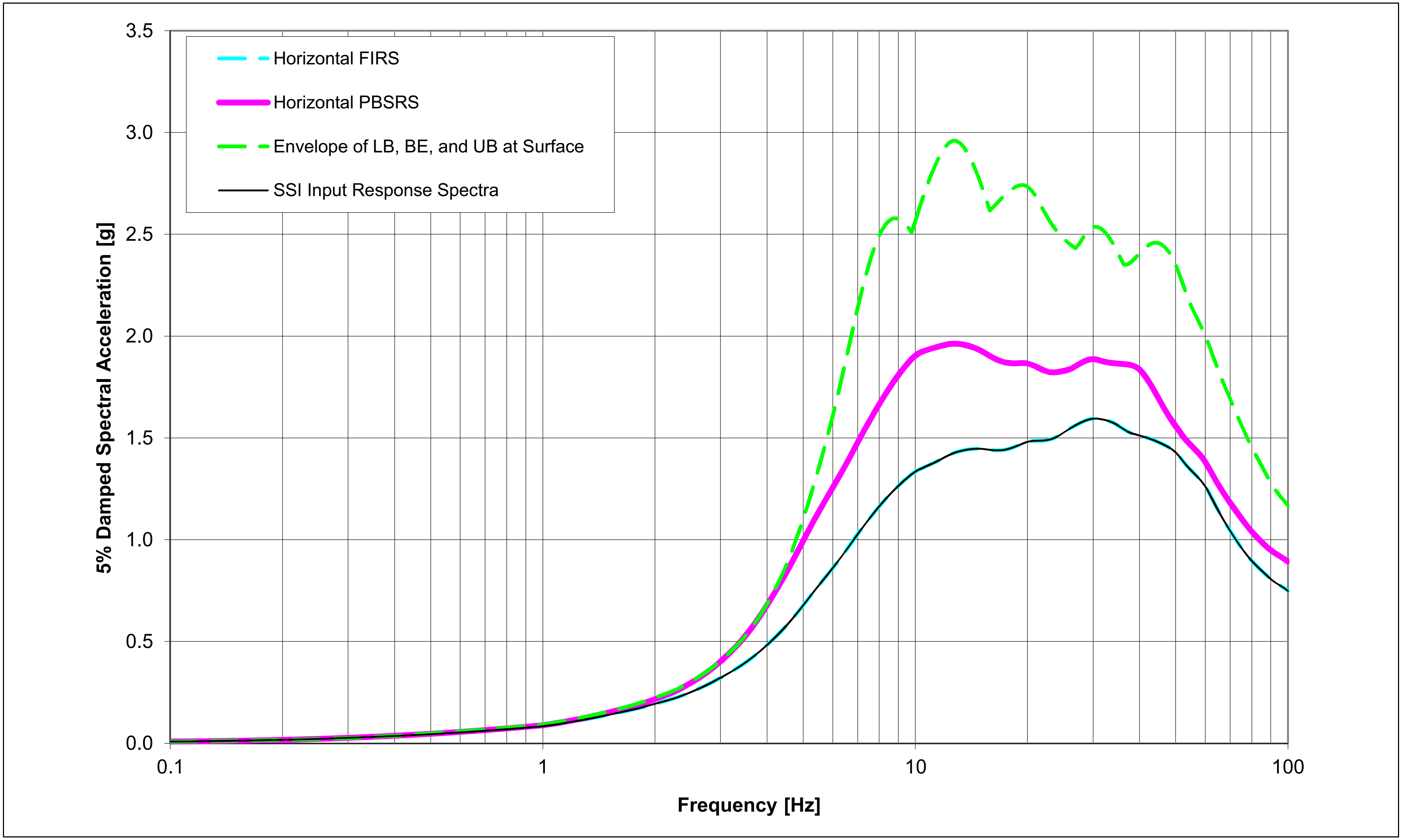
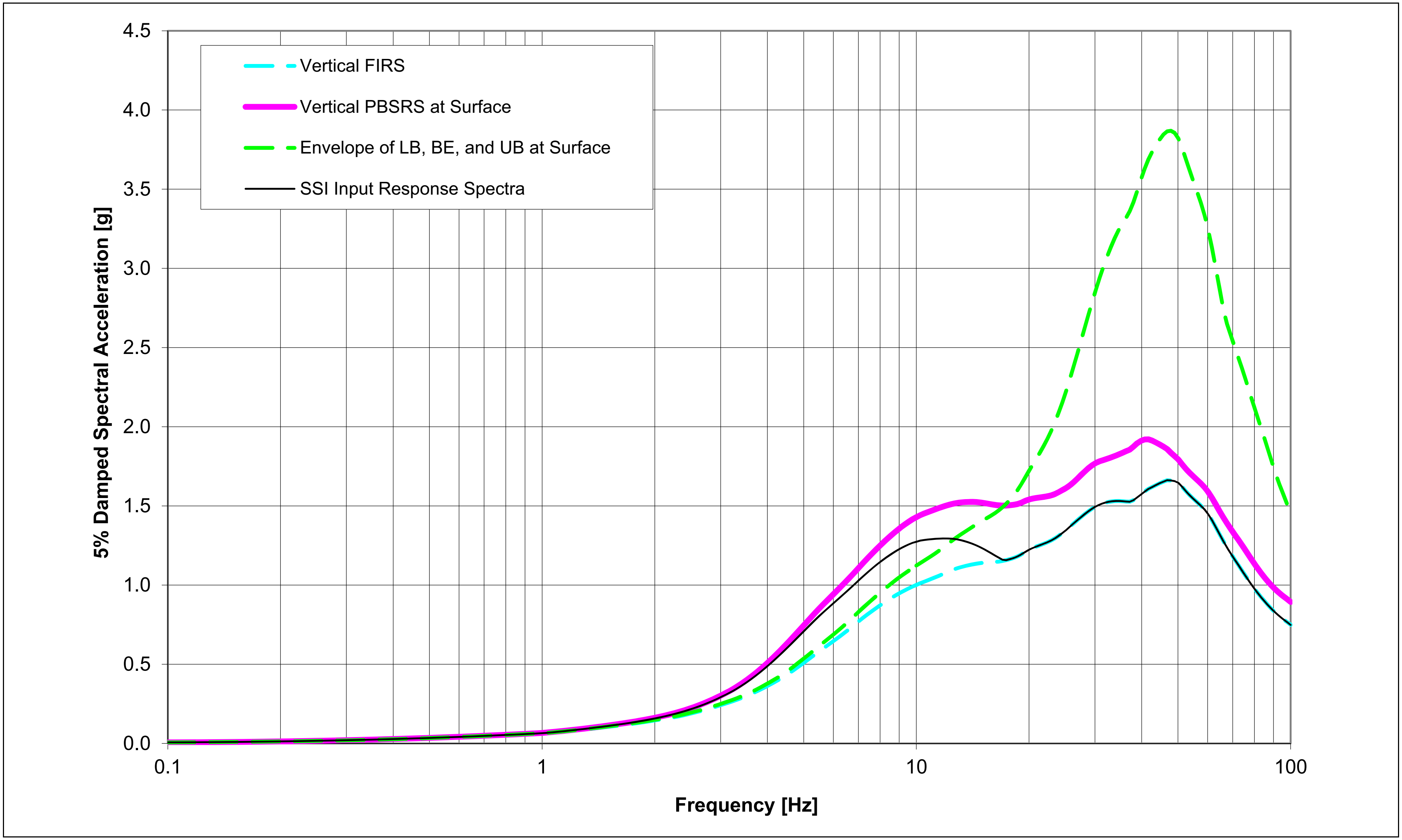
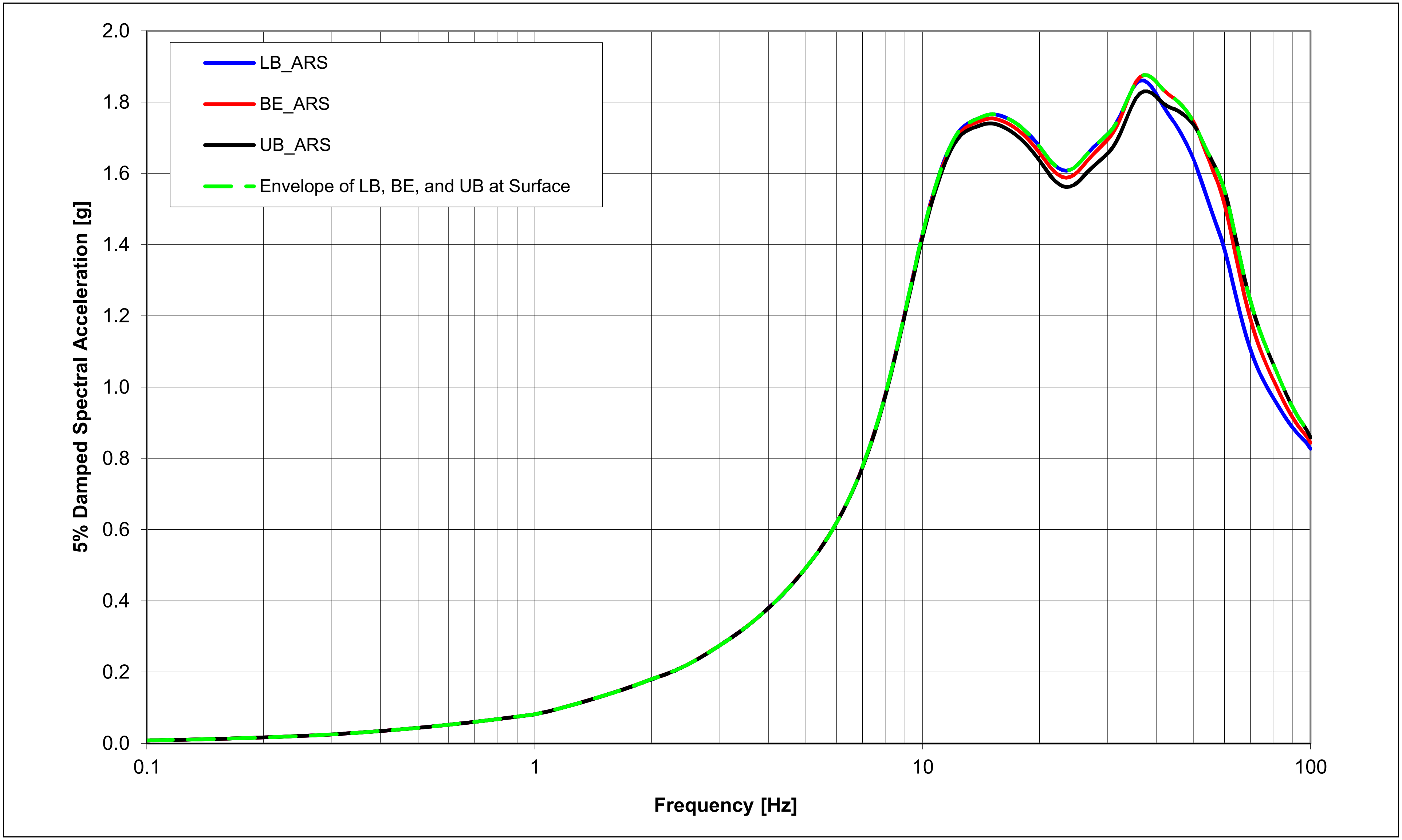


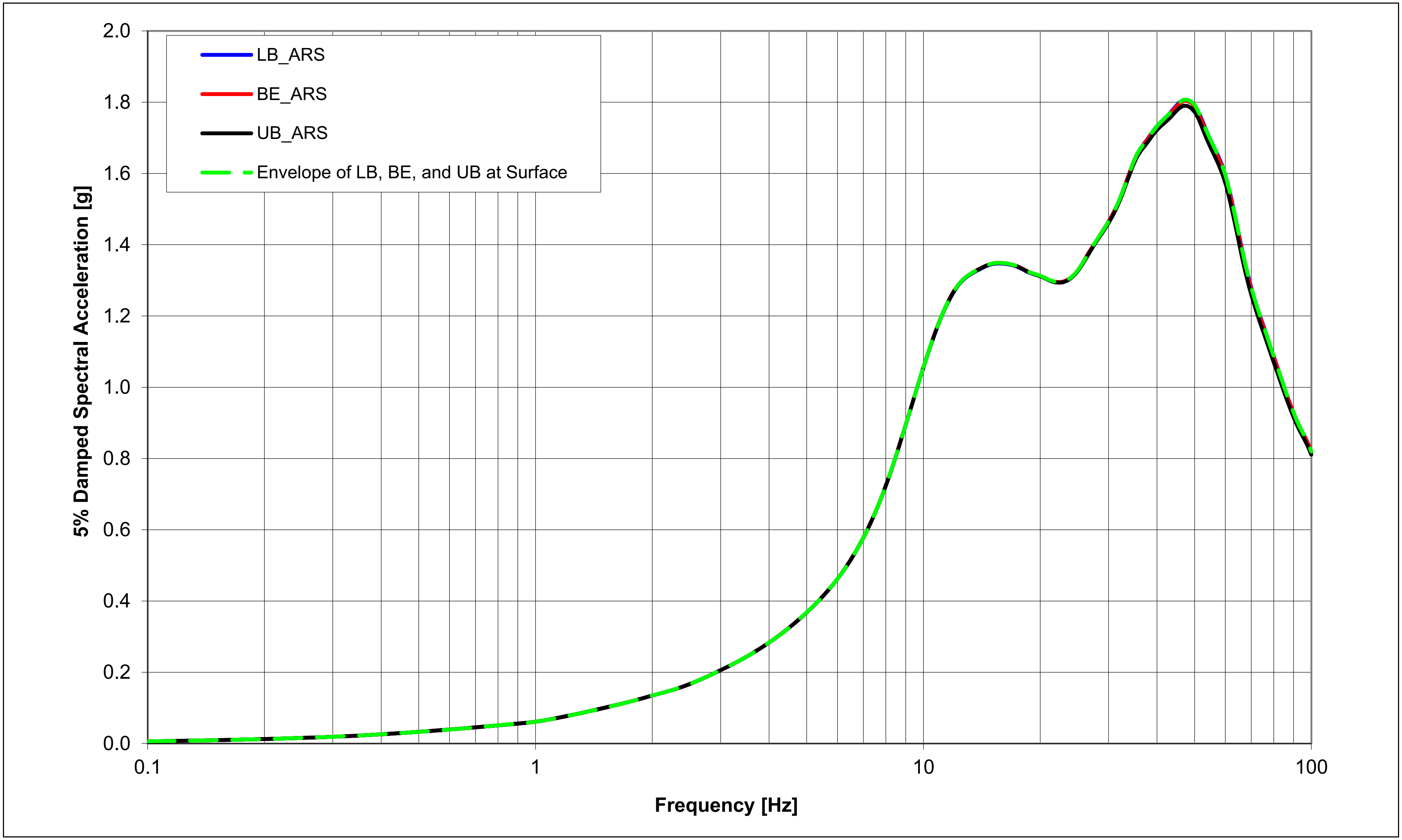
Figure 3.7.1-224 **NEI Check and SSI Input Response Spectra for Vertical Full Column FIRS – CB**



NAPS SUP 3.7-1 Figure 3.7.1-225 **Envelope of Horizontal FIRS Propagated to the Ground Surface through Partial Column SSI Input Profiles – CB**



NAPS SUP 3.7-1 Figure 3.7.1-226 **Envelope of Vertical FIRS Propagated to the Ground Surface through Partial Column SSI Input Profiles – CB**



NAPS SUP 3.7-1 Figure 3.7.1-227 **NEI Check and SSI Input Response Spectra for Horizontal Partial Column FIRS – CB**

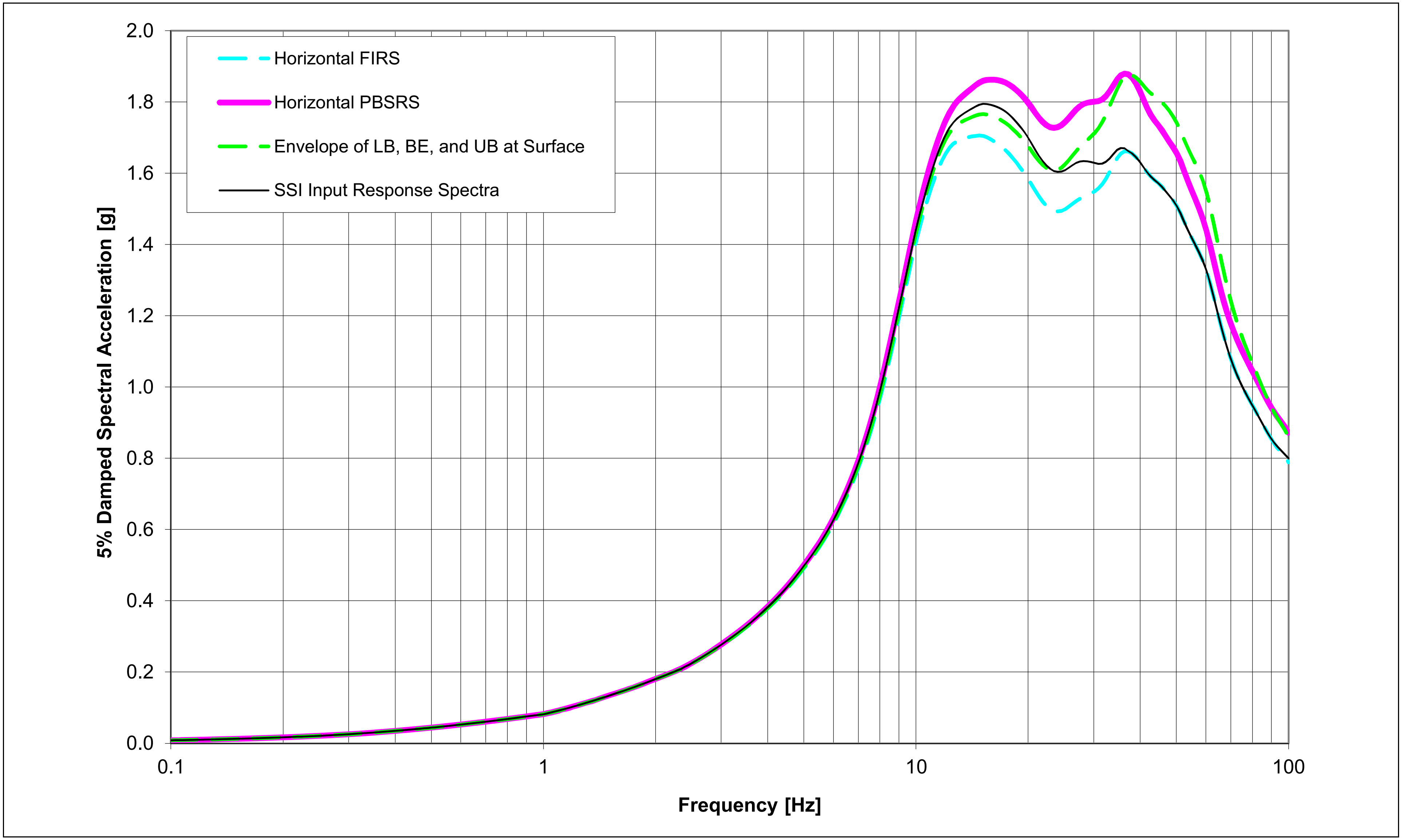
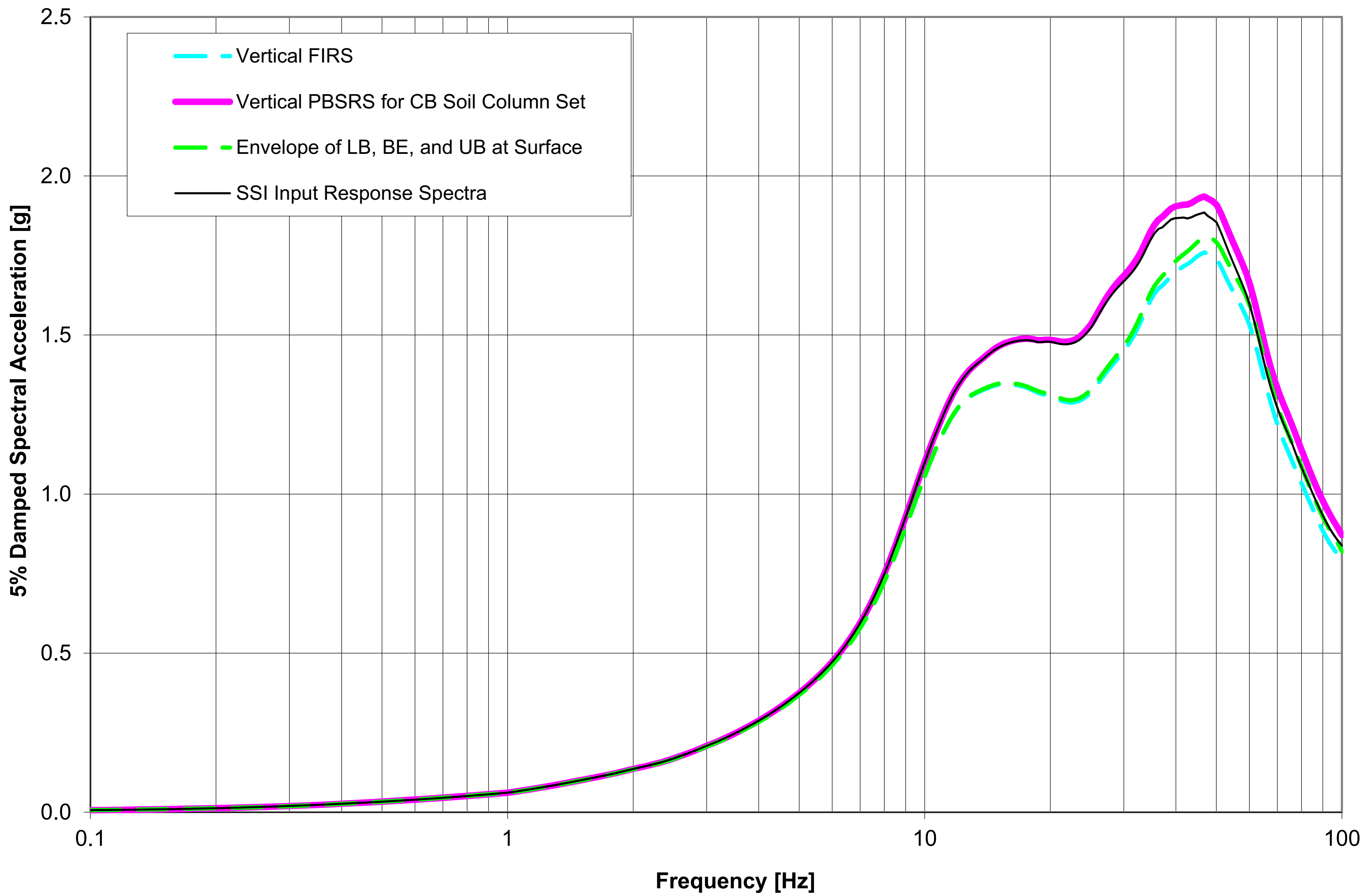


Figure 3.7.1-228 **NEI Check and SSI Input Response Spectra for Vertical Partial Column FIRS – CB**



NAPS SUP 3.7-1 Figure 3.7.1-229 **Development of 5% Damped Final Horizontal SSI Input Response Spectra for CB**

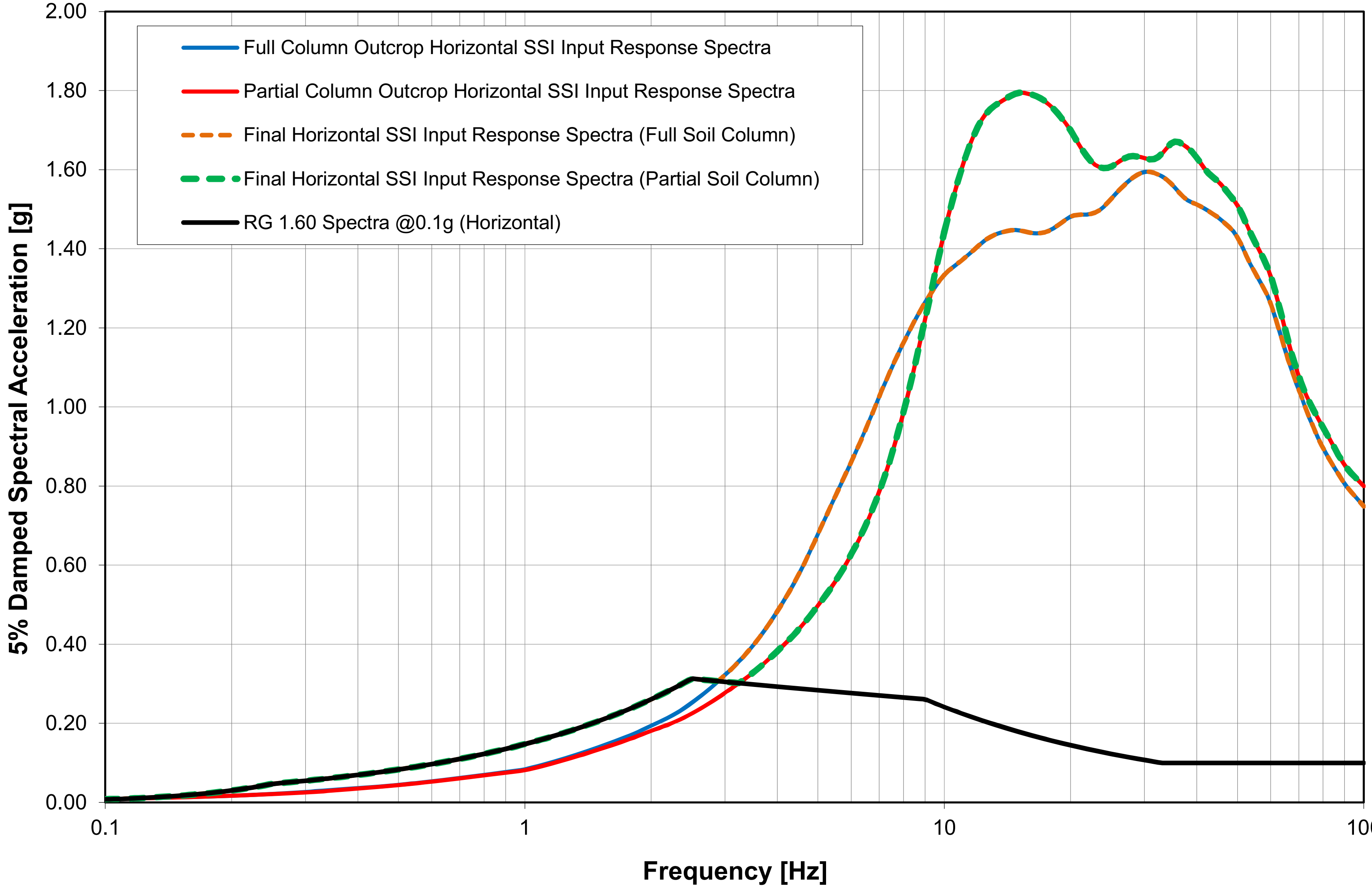
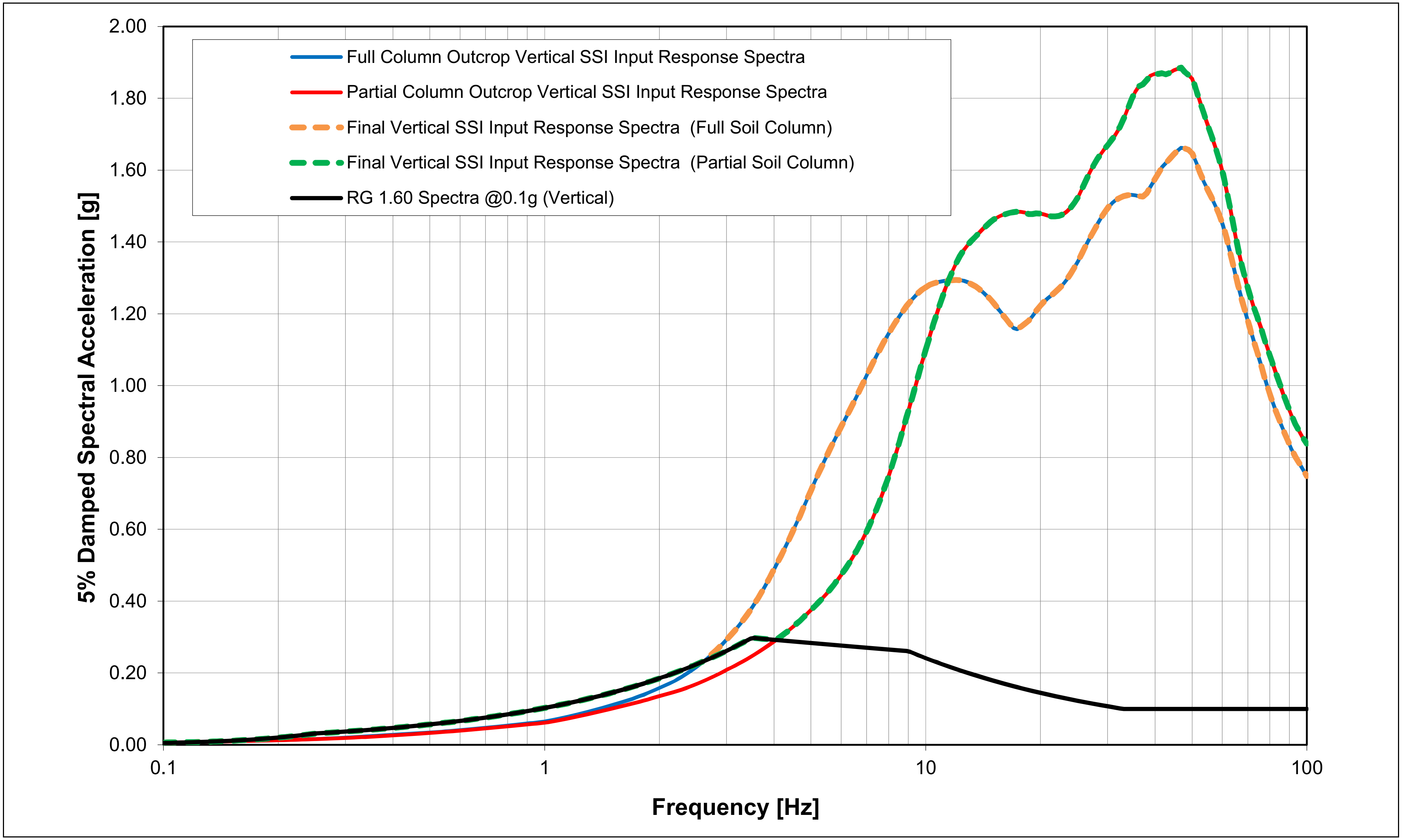
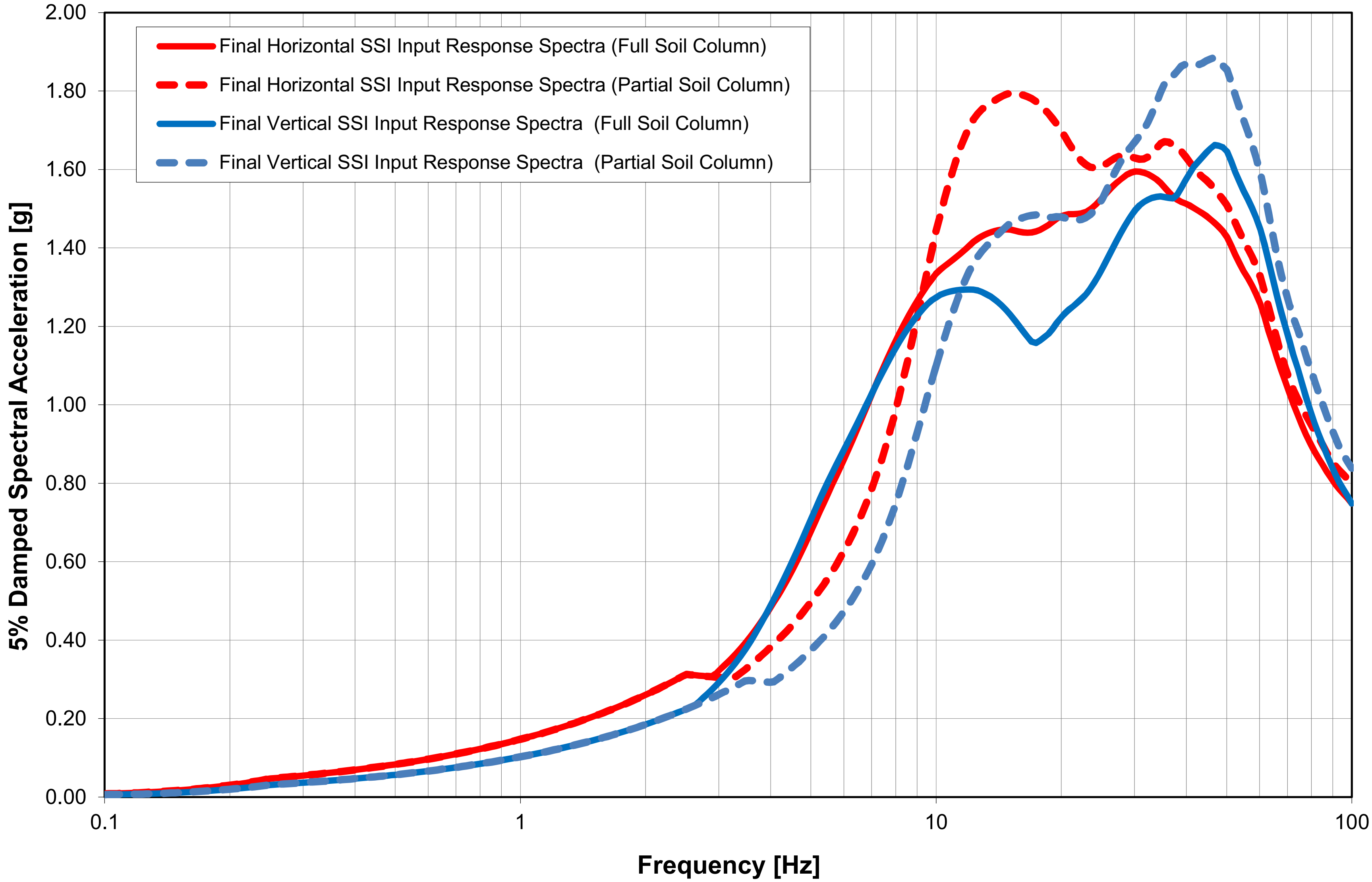


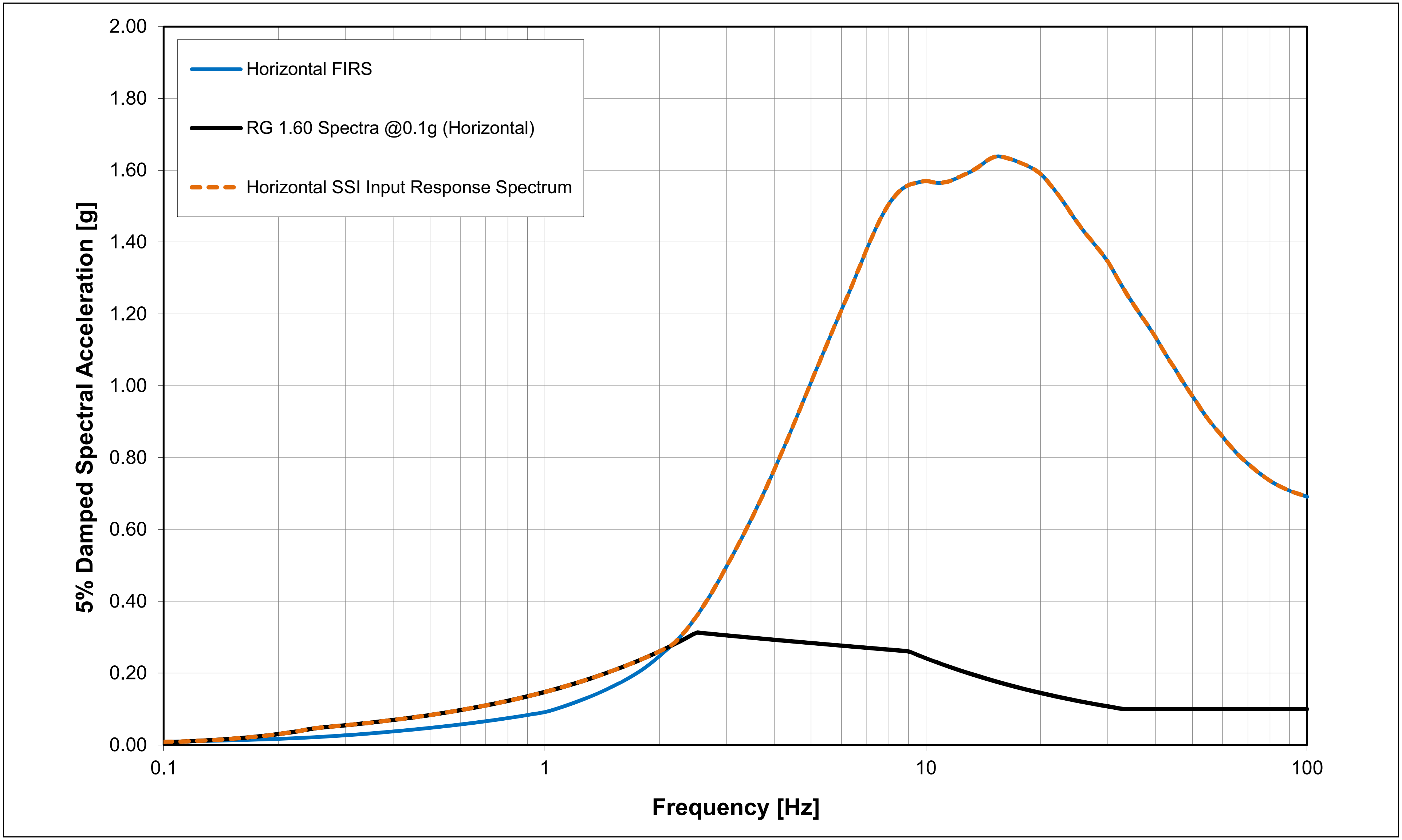
Figure 3.7.1-230 **Development of 5% Damped Final Vertical SSI Input Response Spectra for CB**



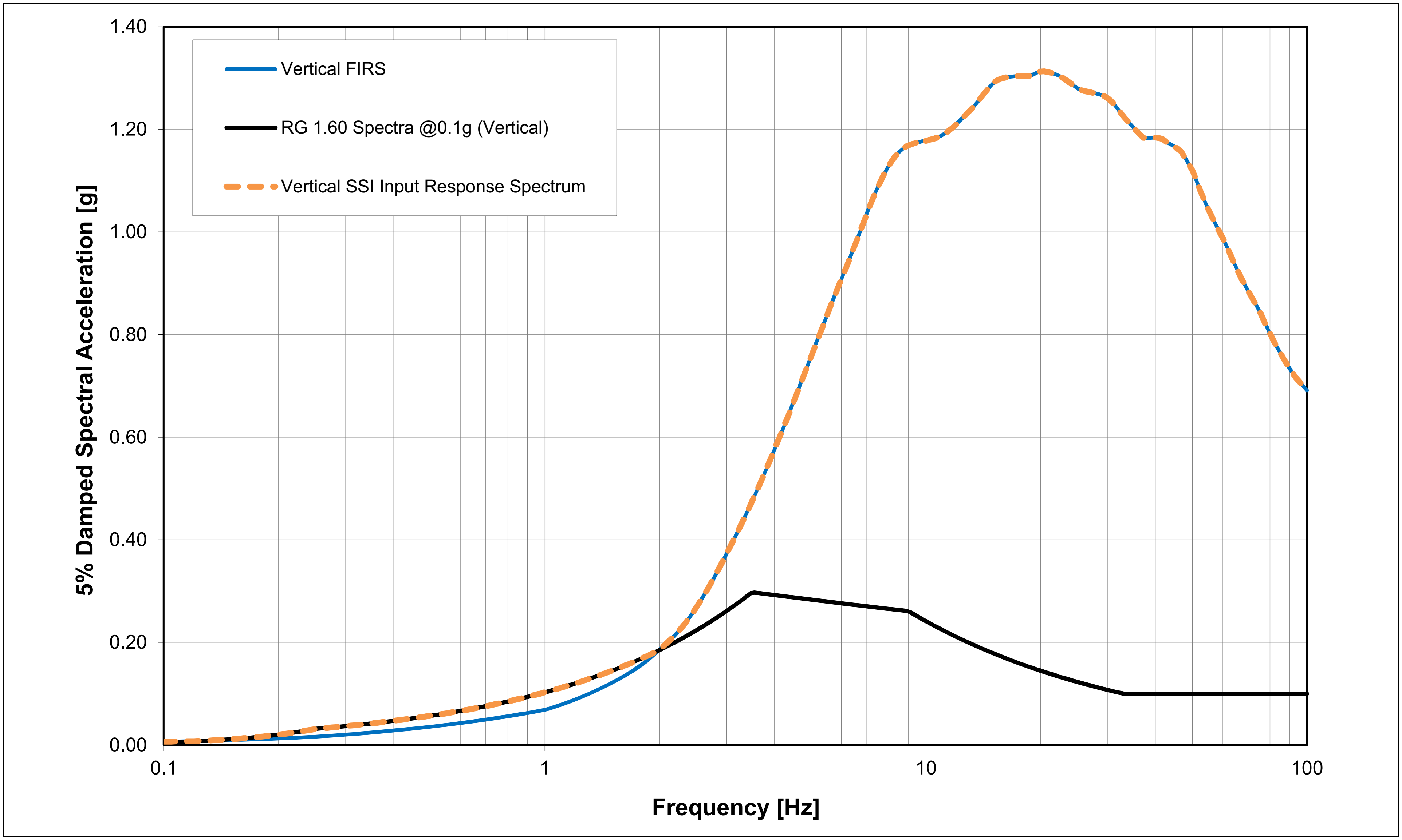
NAPS SUP 3.7-1 Figure 3.7.1-231 **5% Damped Final SSI Input Response Spectra for CB**



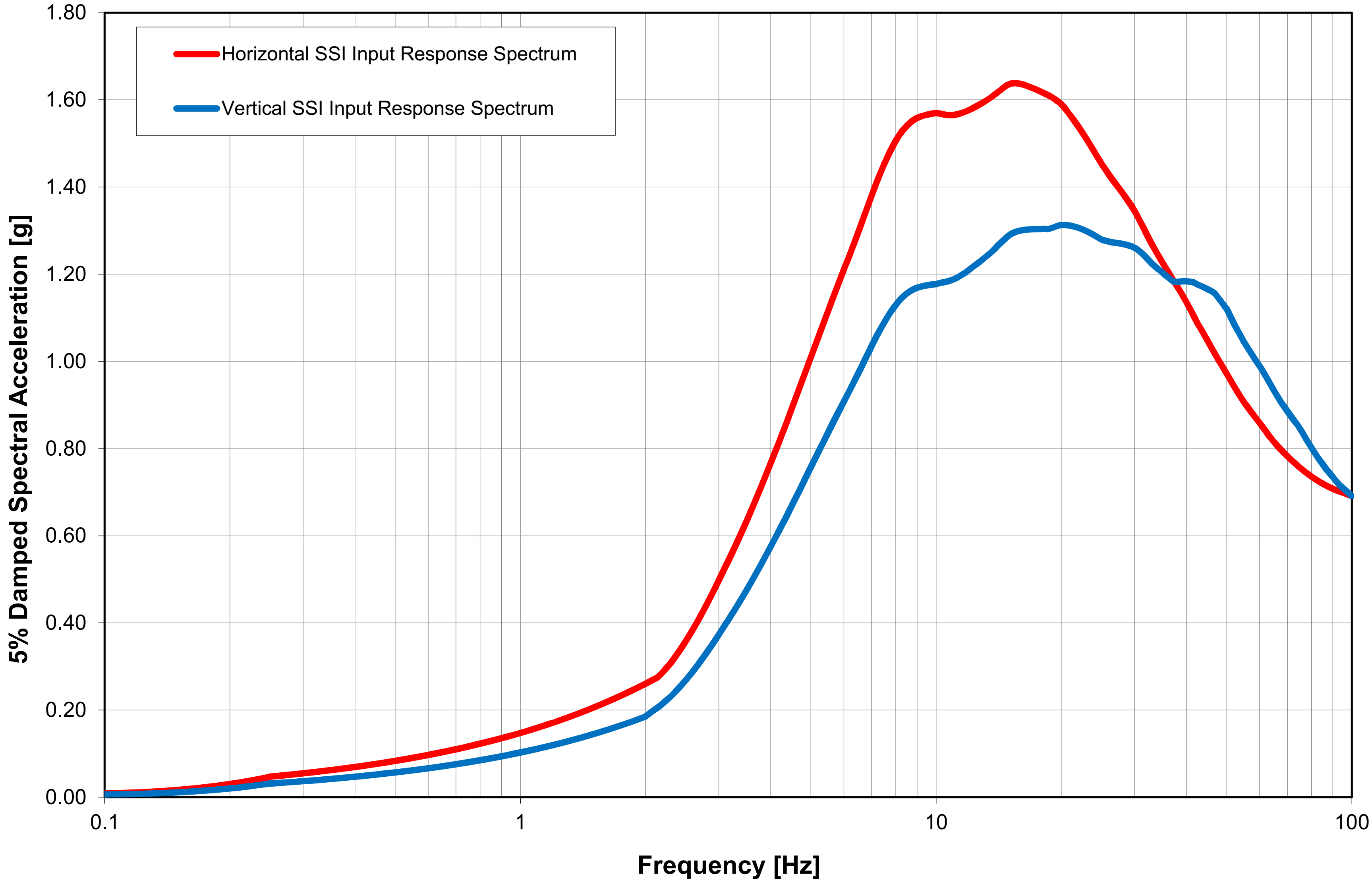
NAPS SUP 3.7-1 Figure 3.7.1-232 **Development of 5% Damped Final Horizontal SSI Input Response Spectrum at Elevation 282 ft for FWSC**



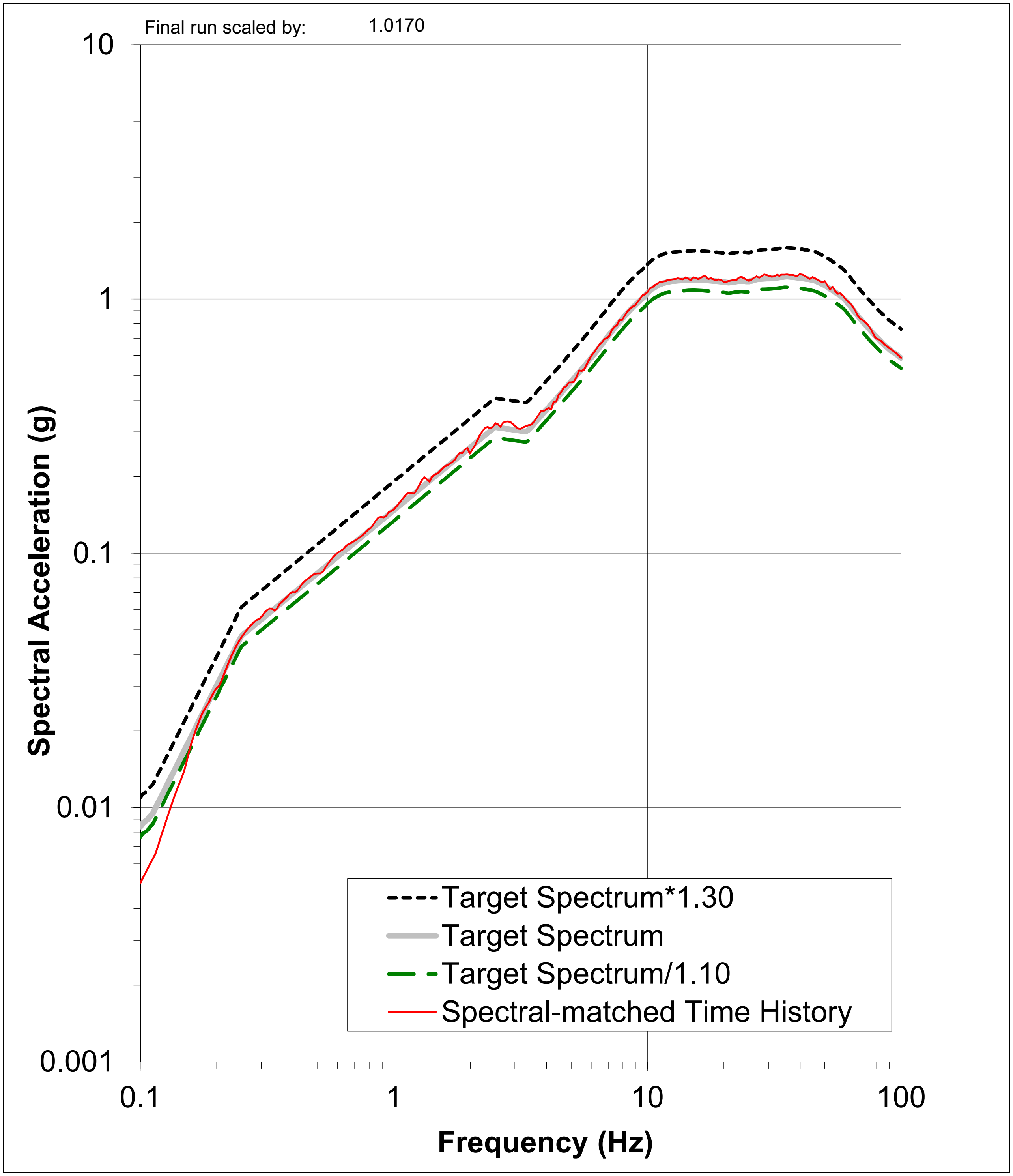
NAPS SUP 3.7-1 Figure 3.7.1-233 **Development of 5% Damped Final Vertical SSI Input Response Spectrum at Elevation 282 ft for FWSC**



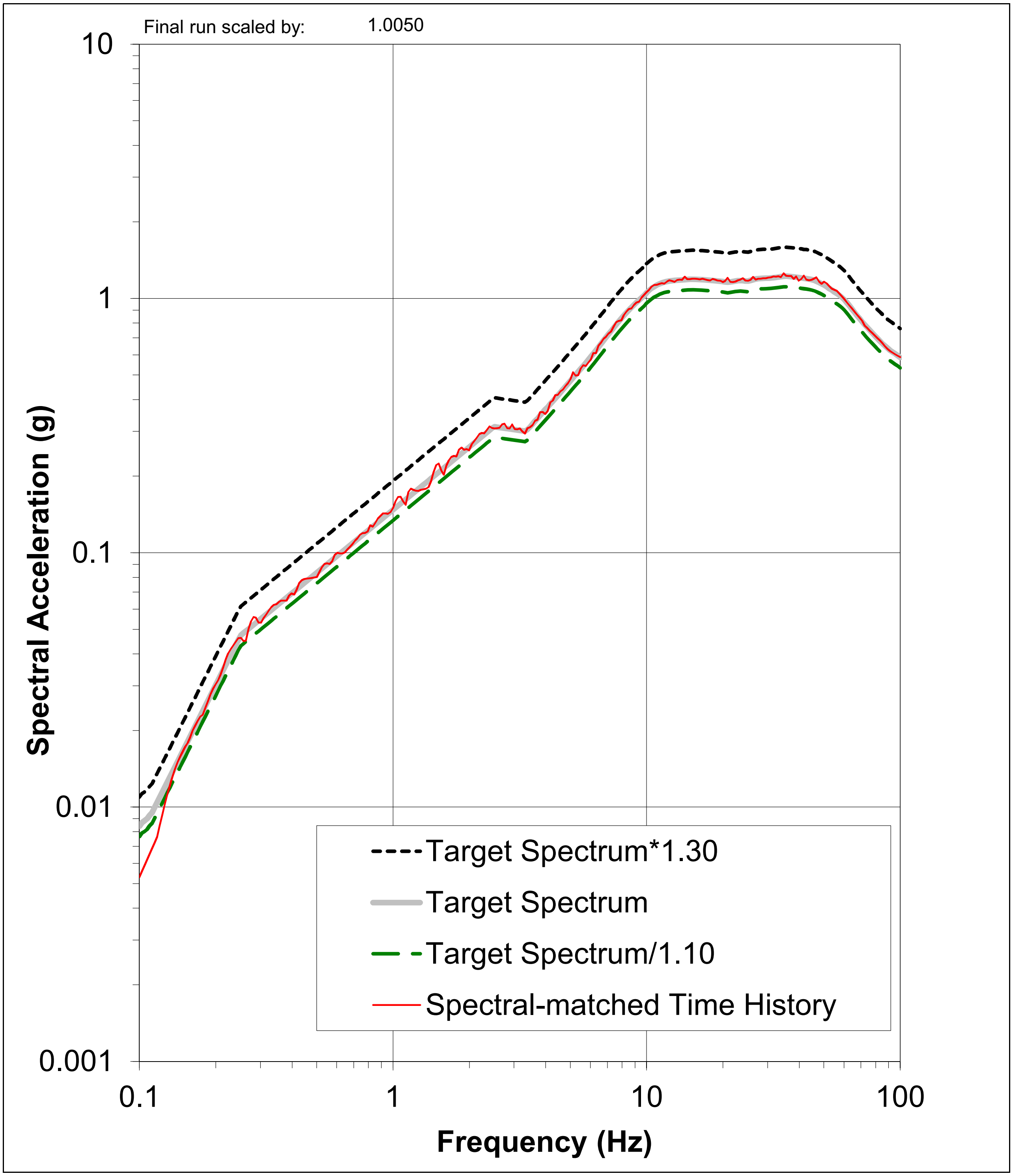
NAPS SUP 3.7-1 Figure 3.7.1-234 **5% Damped Final SSI Input Response Spectra at Elevation 282 ft for FWSC**



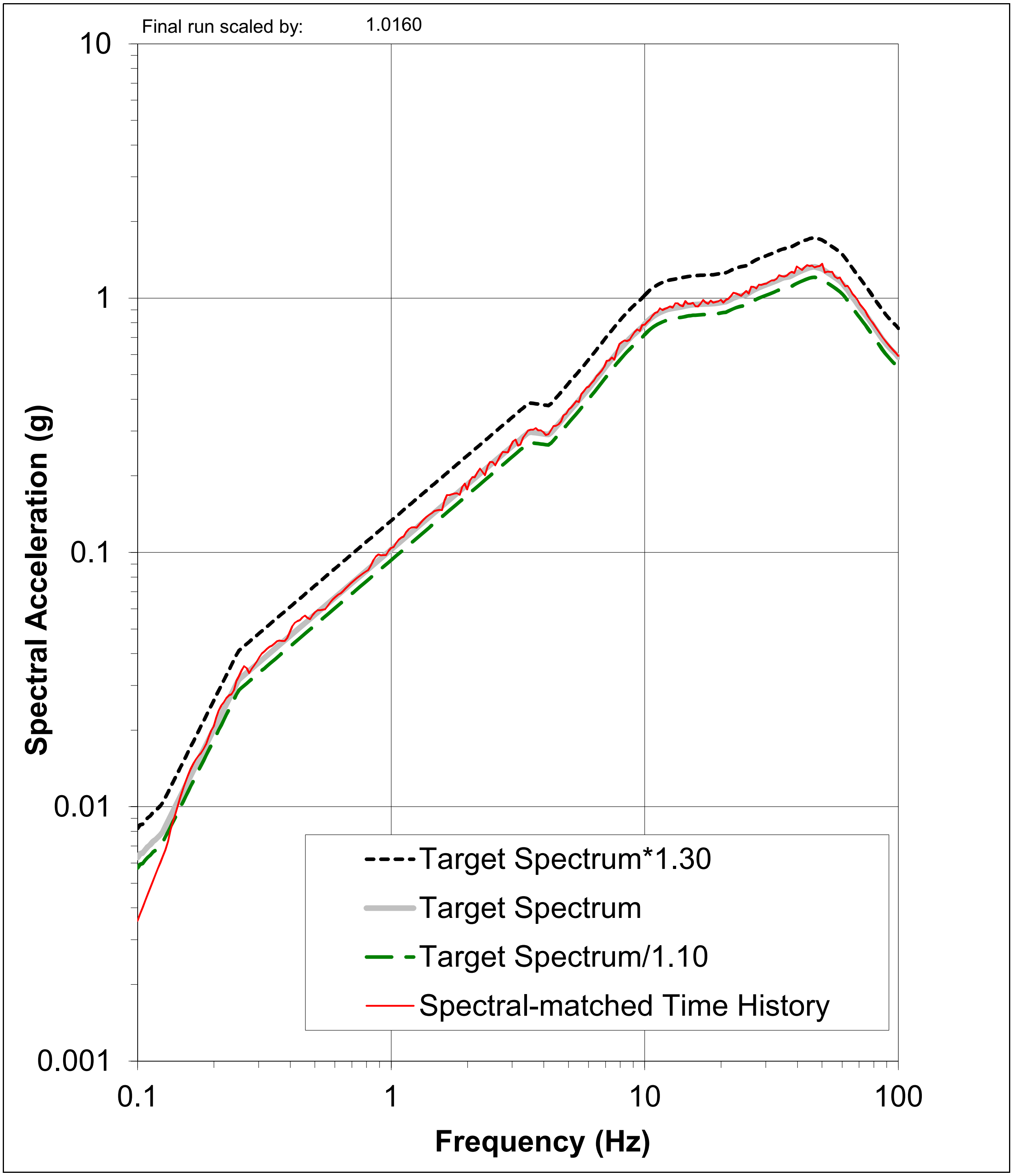
NAPS SUP 3.7-2 Figure 3.7.1-235 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column RB/FB case, H1 Component**



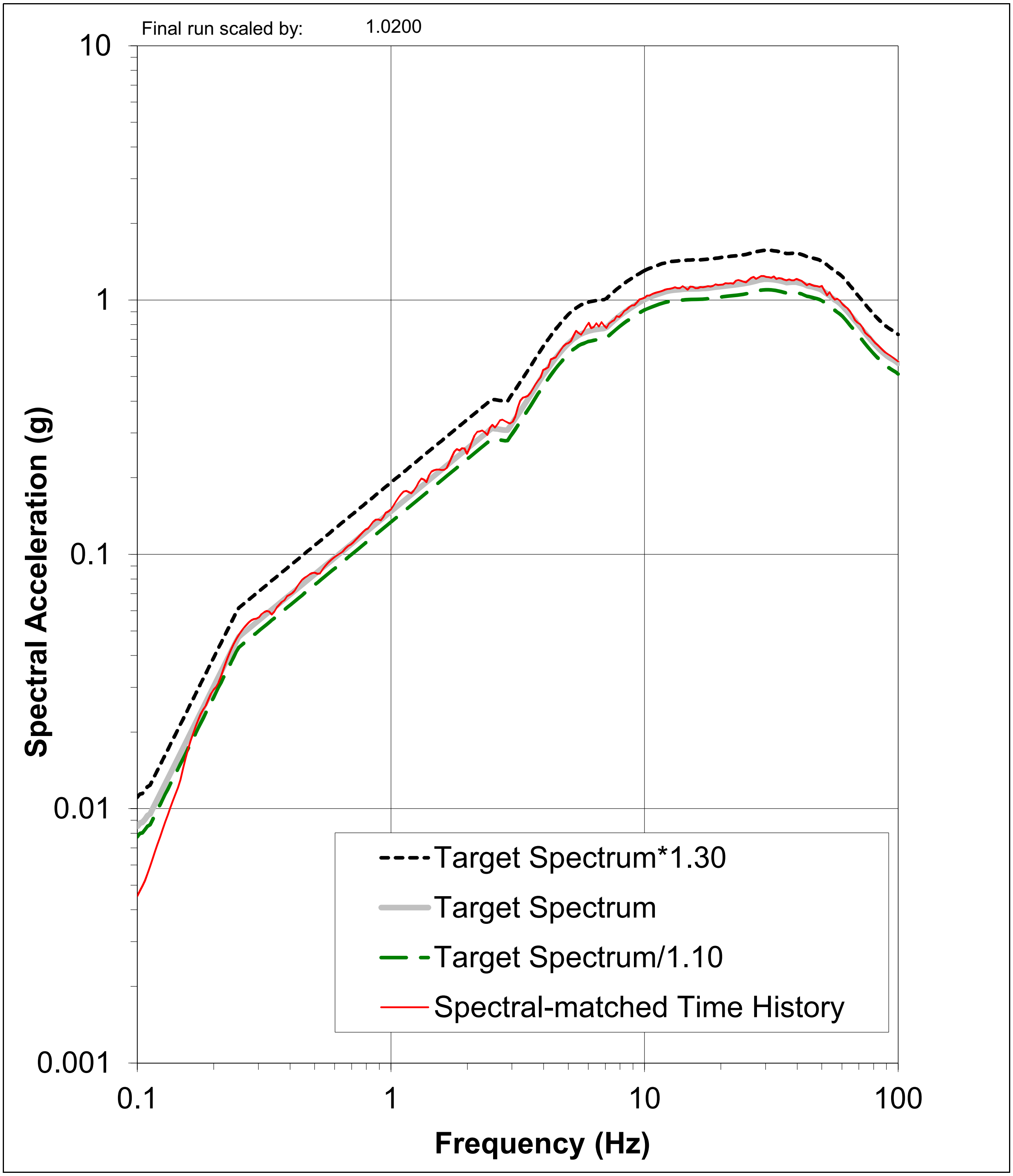
NAPS SUP 3.7-2 Figure 3.7.1-236 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column RB/FB case, H2 Component**



NAPS SUP 3.7-2 Figure 3.7.1-237 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column RB/FB case, UP Component**

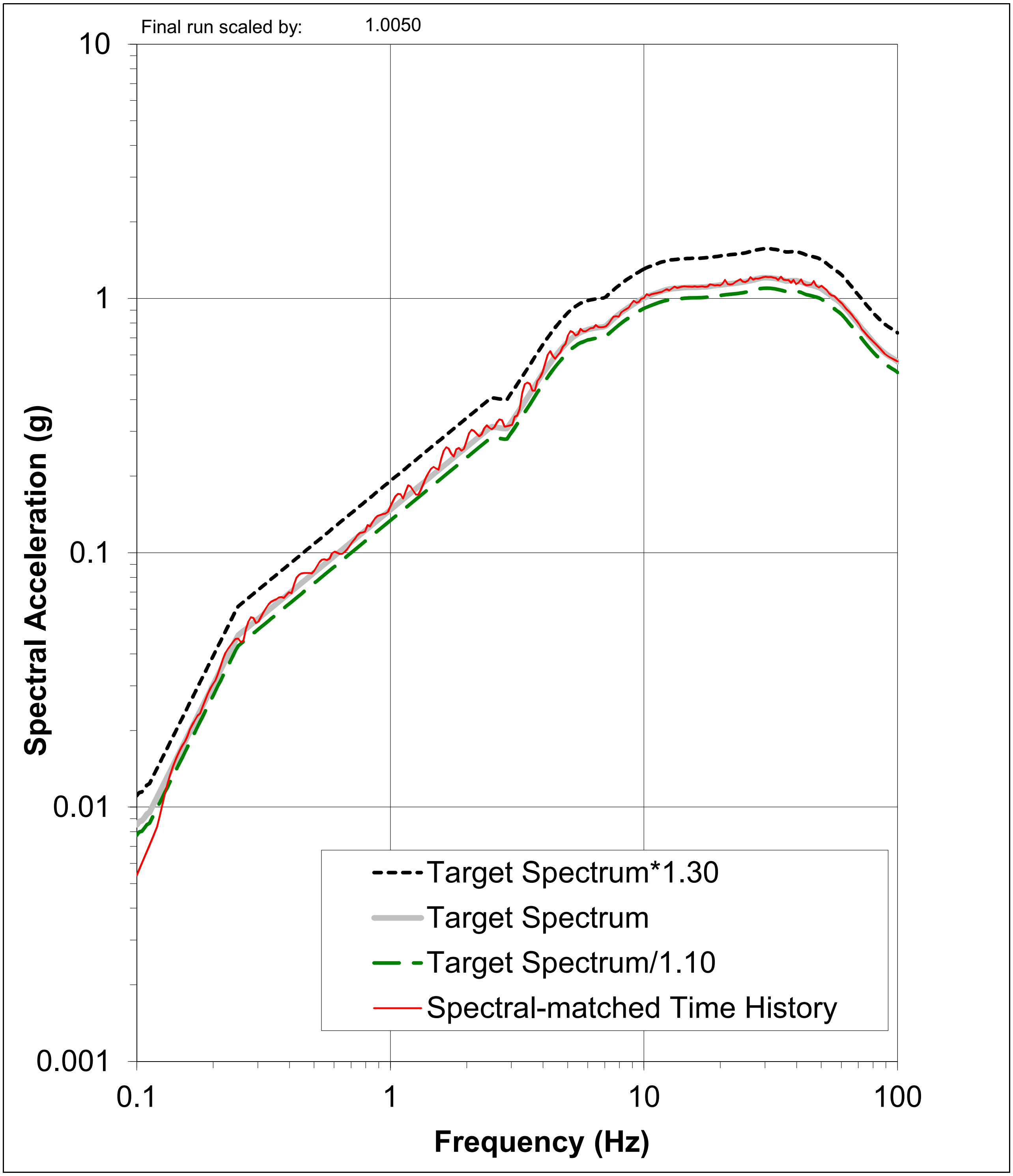


NAPS SUP 3.7-2 Figure 3.7.1-238 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column RB/FB case, H1 Component**



NAPS SUP 3.7-2

Figure 3.7.1-239 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column RB/FB case, H2 Component**



NAPS SUP 3.7-2 Figure 3.7.1-240 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column RB/FB case, UP Component**

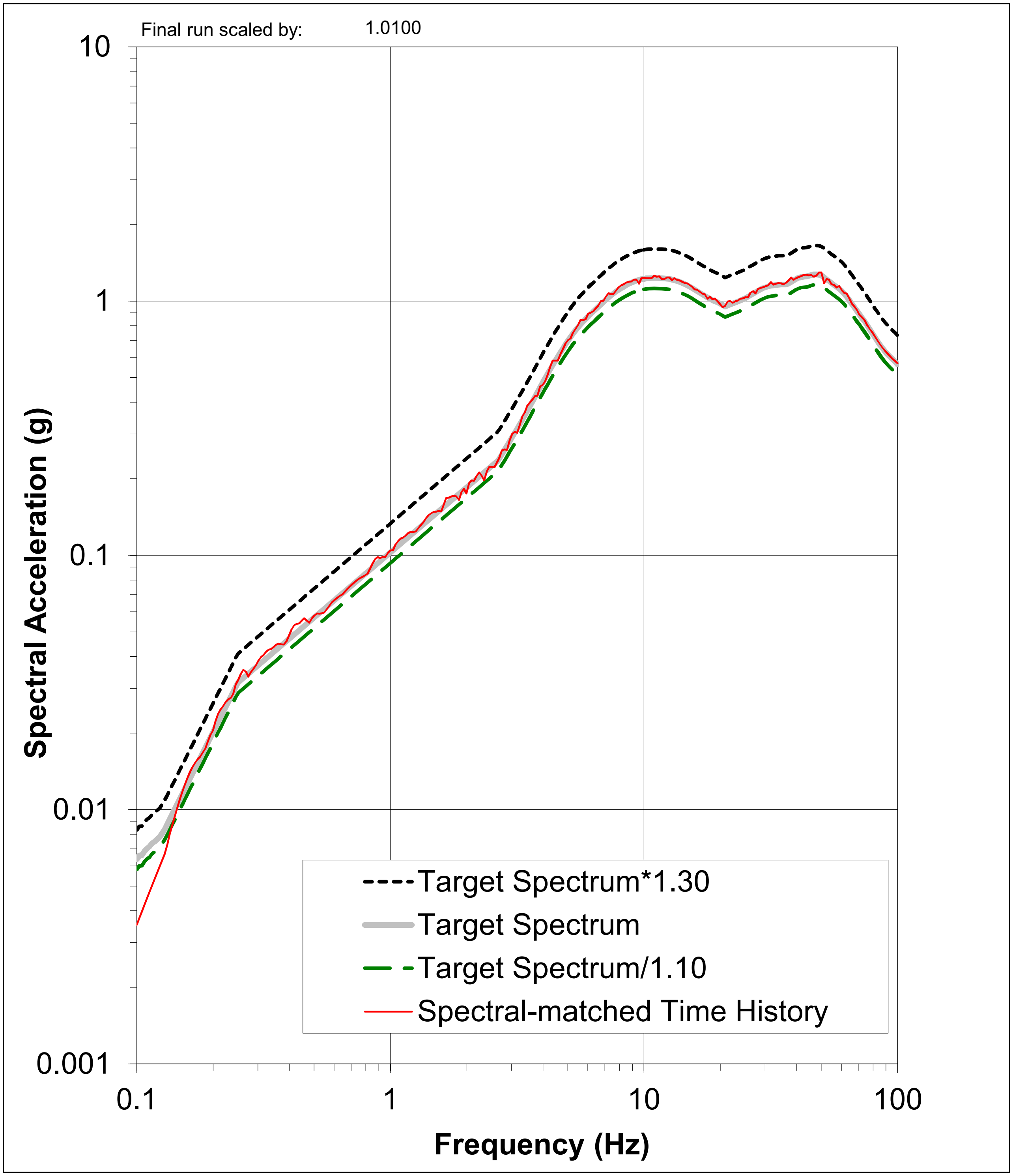


Figure 3.7.1-241 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for RB/FB, H1 Component**

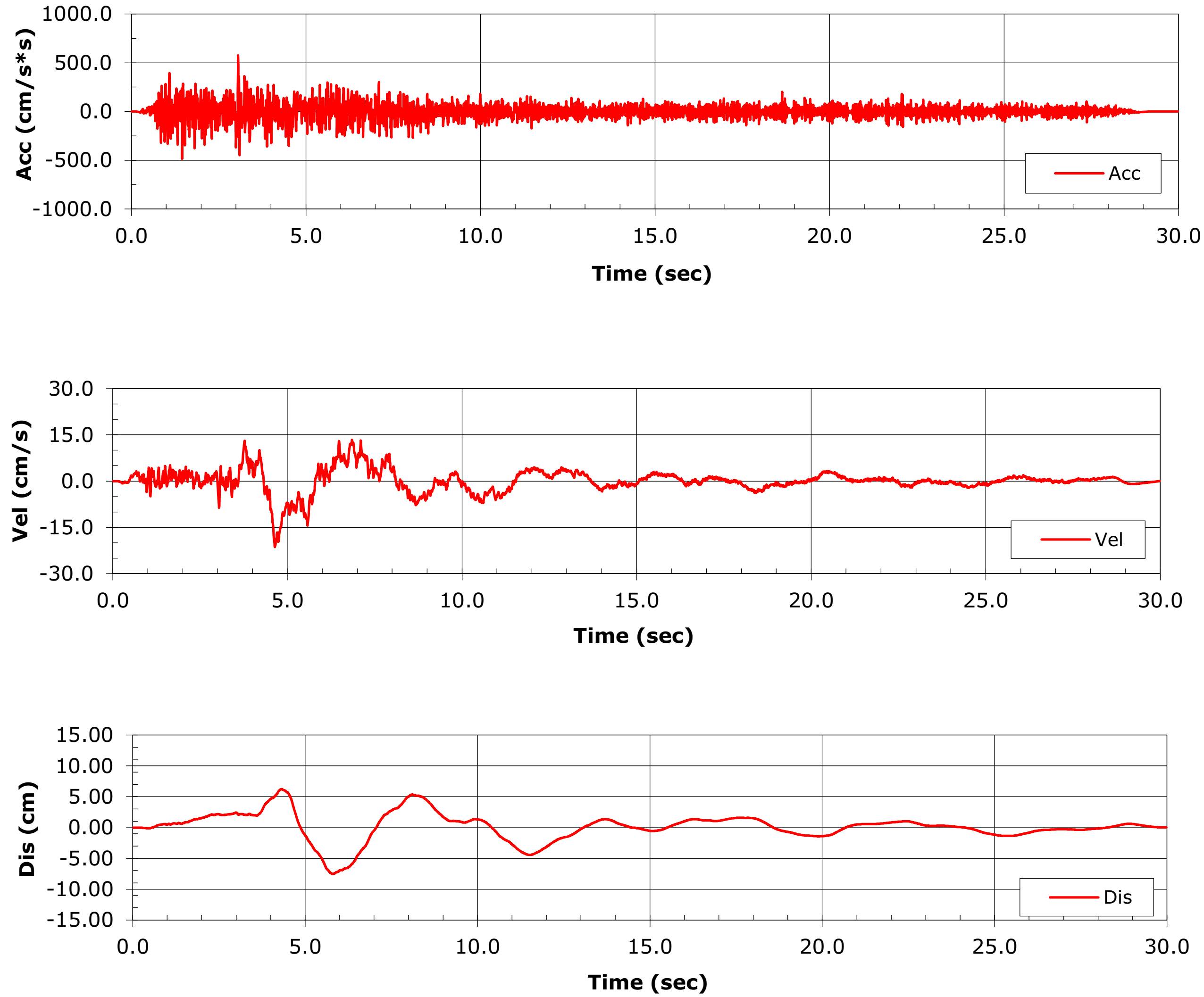


Figure 3.7.1-242 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for RB/FB, H2 Component**

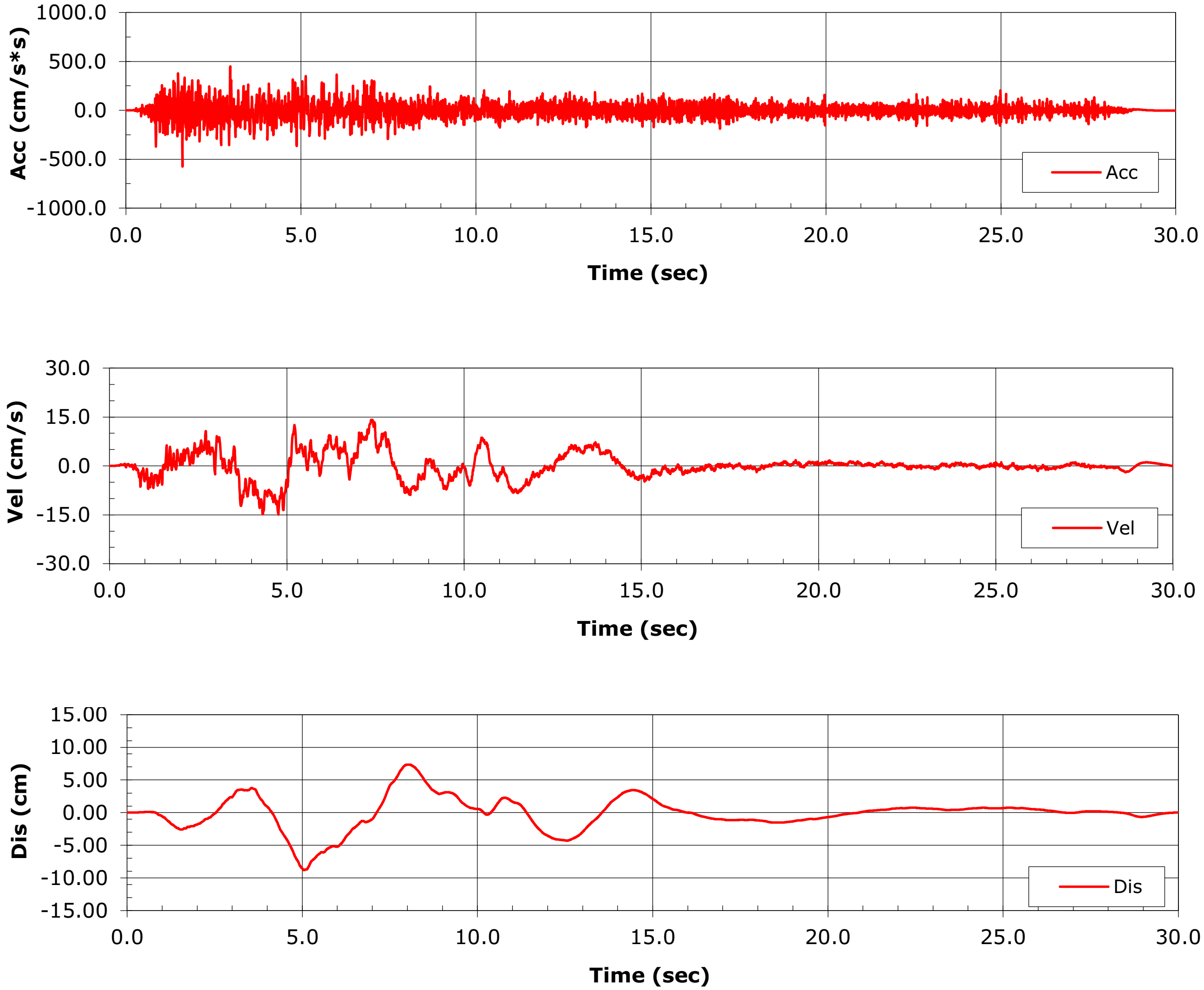
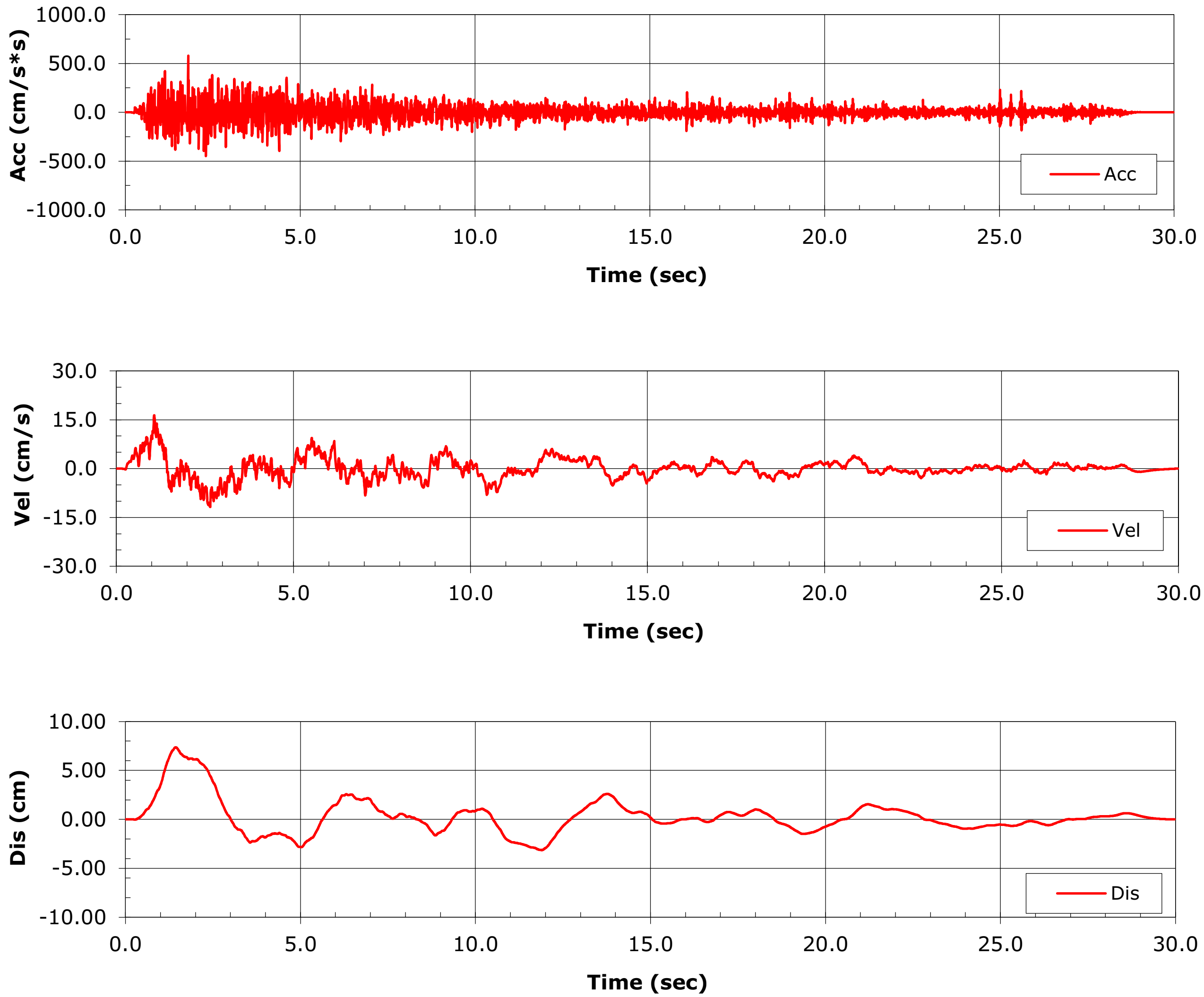


Figure 3.7.1-243 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for RB/FB, UP Component**



NAPS SUP 3.7-2 Figure 3.7.1-244 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for RB/FB, H1 Component**

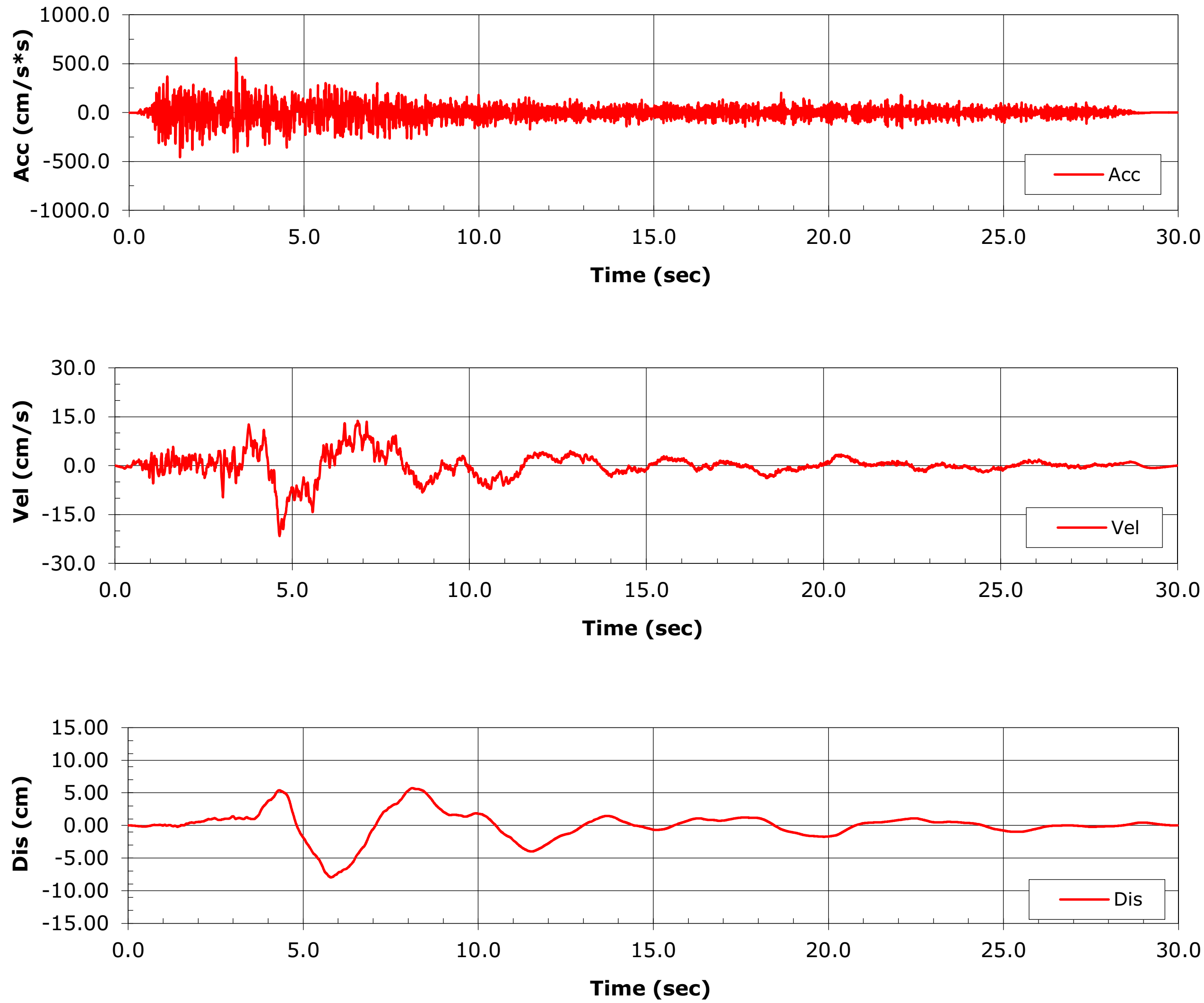


Figure 3.7.1-245 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for RB/FB, H2 Component**

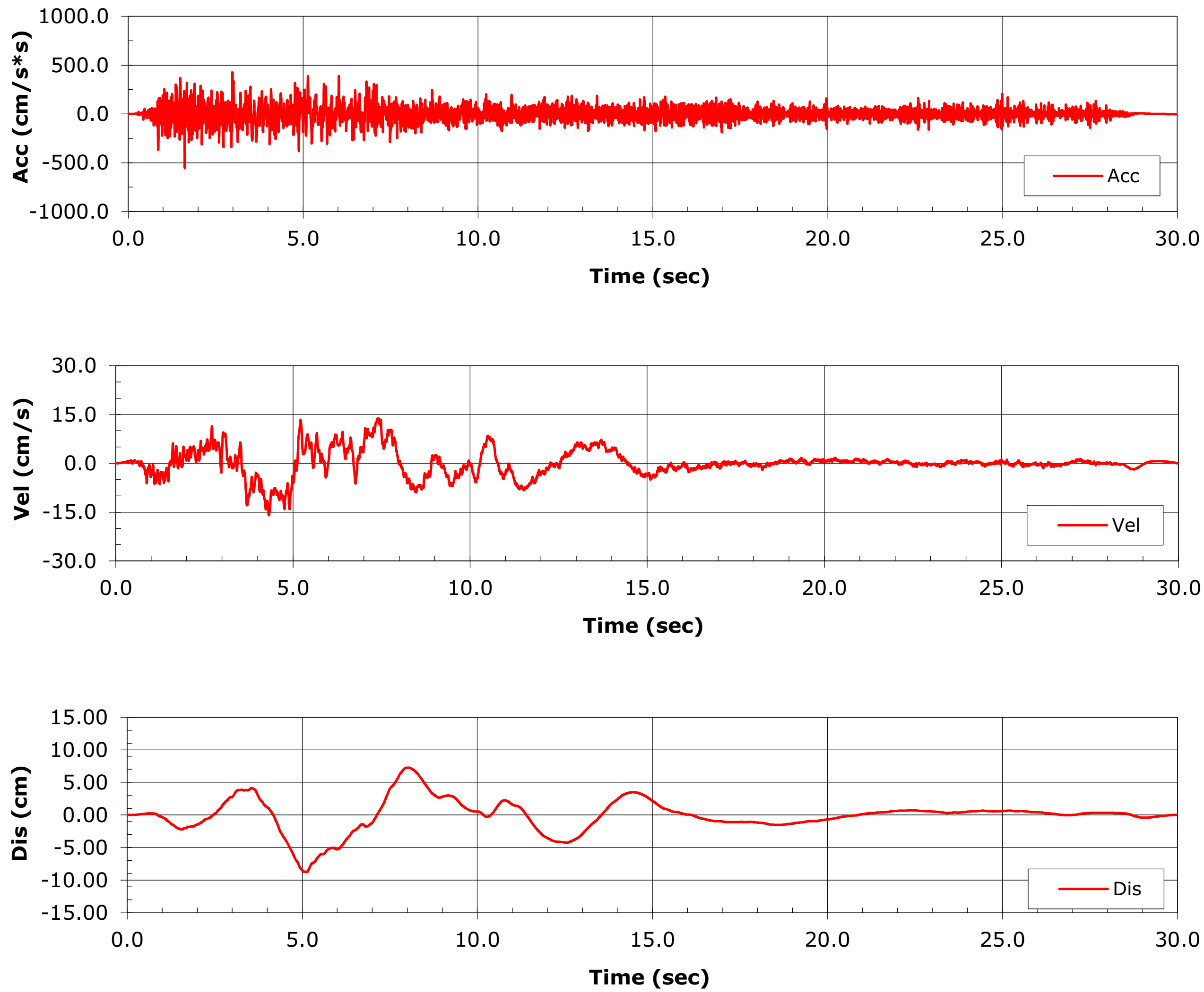
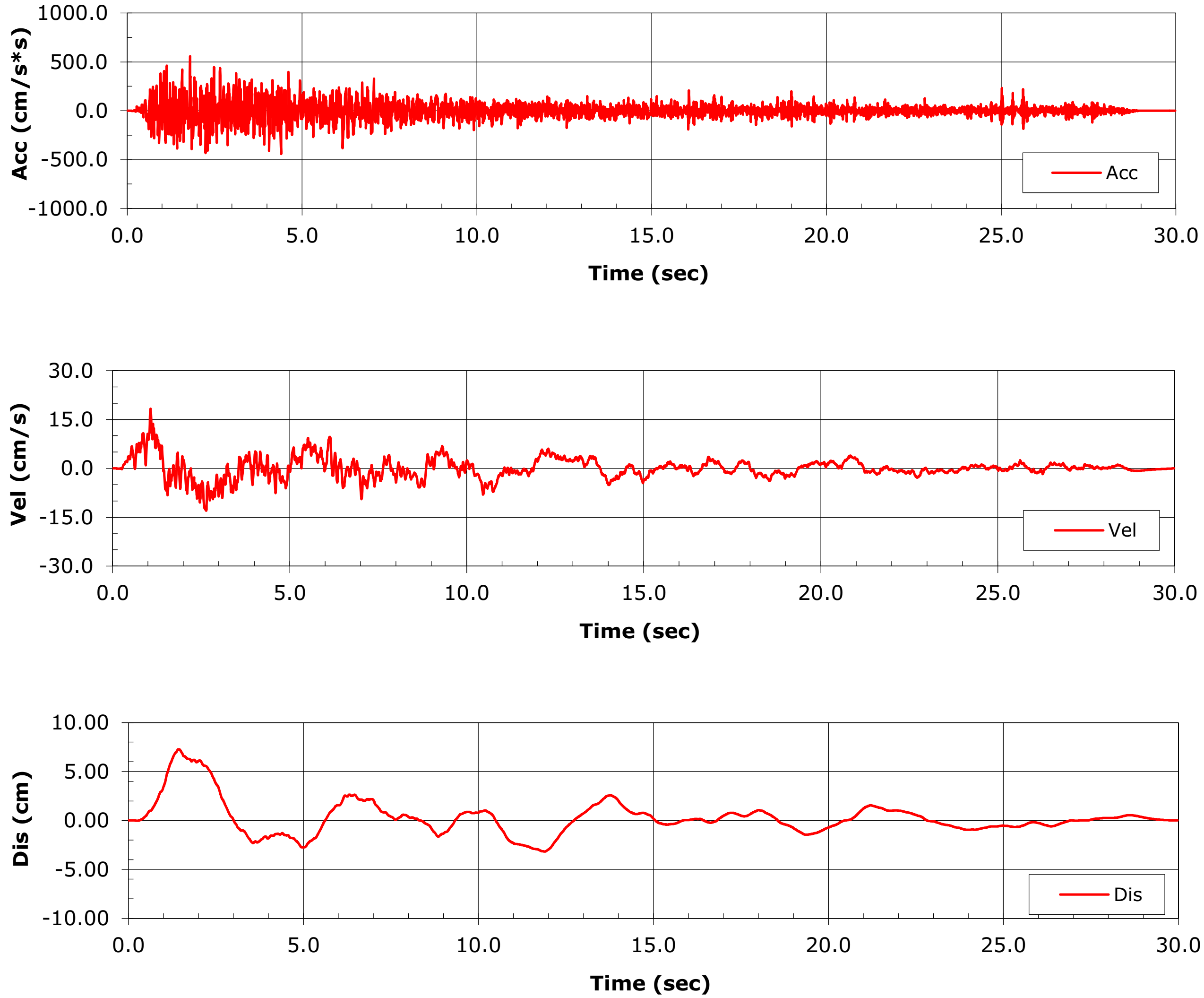
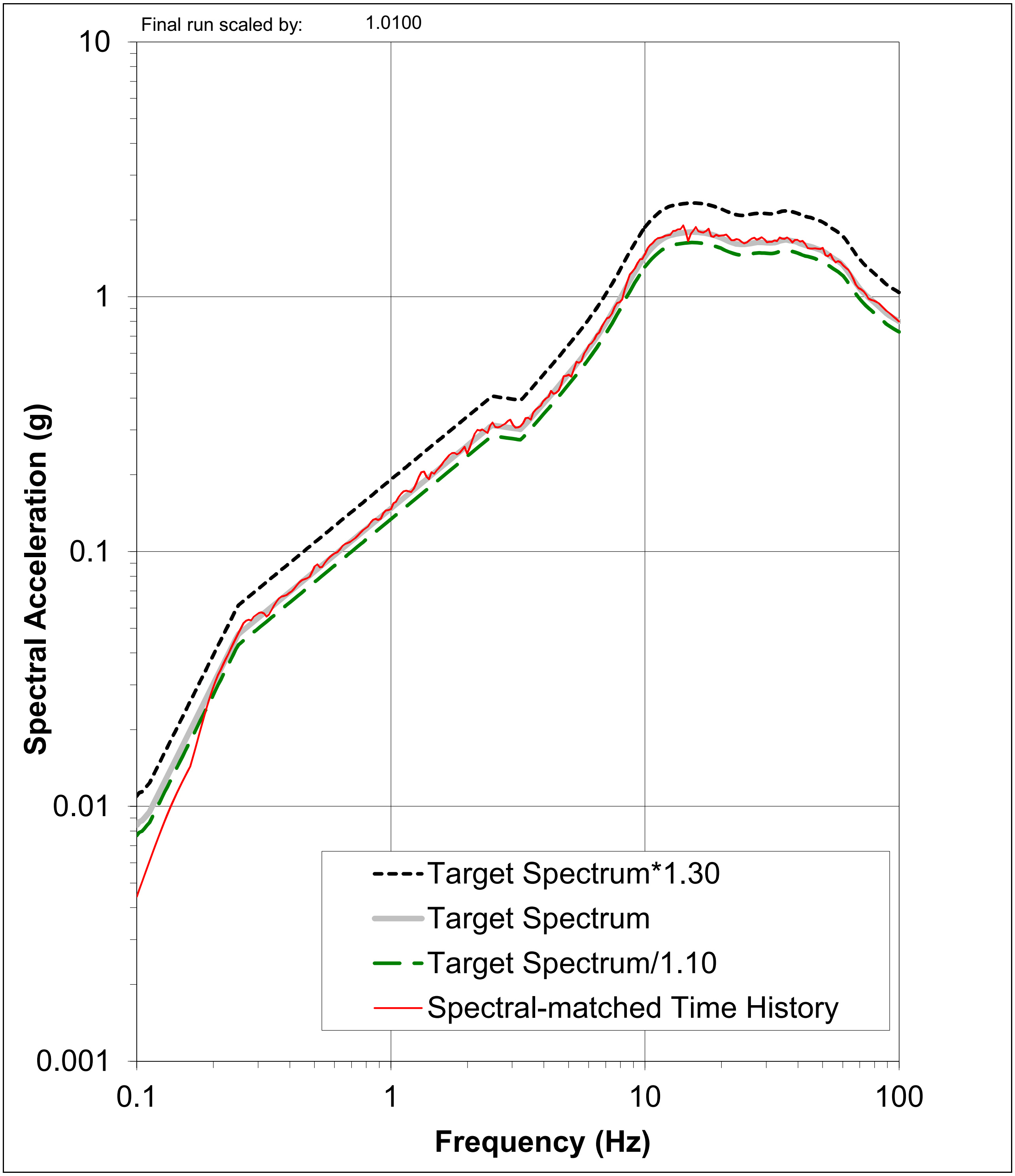


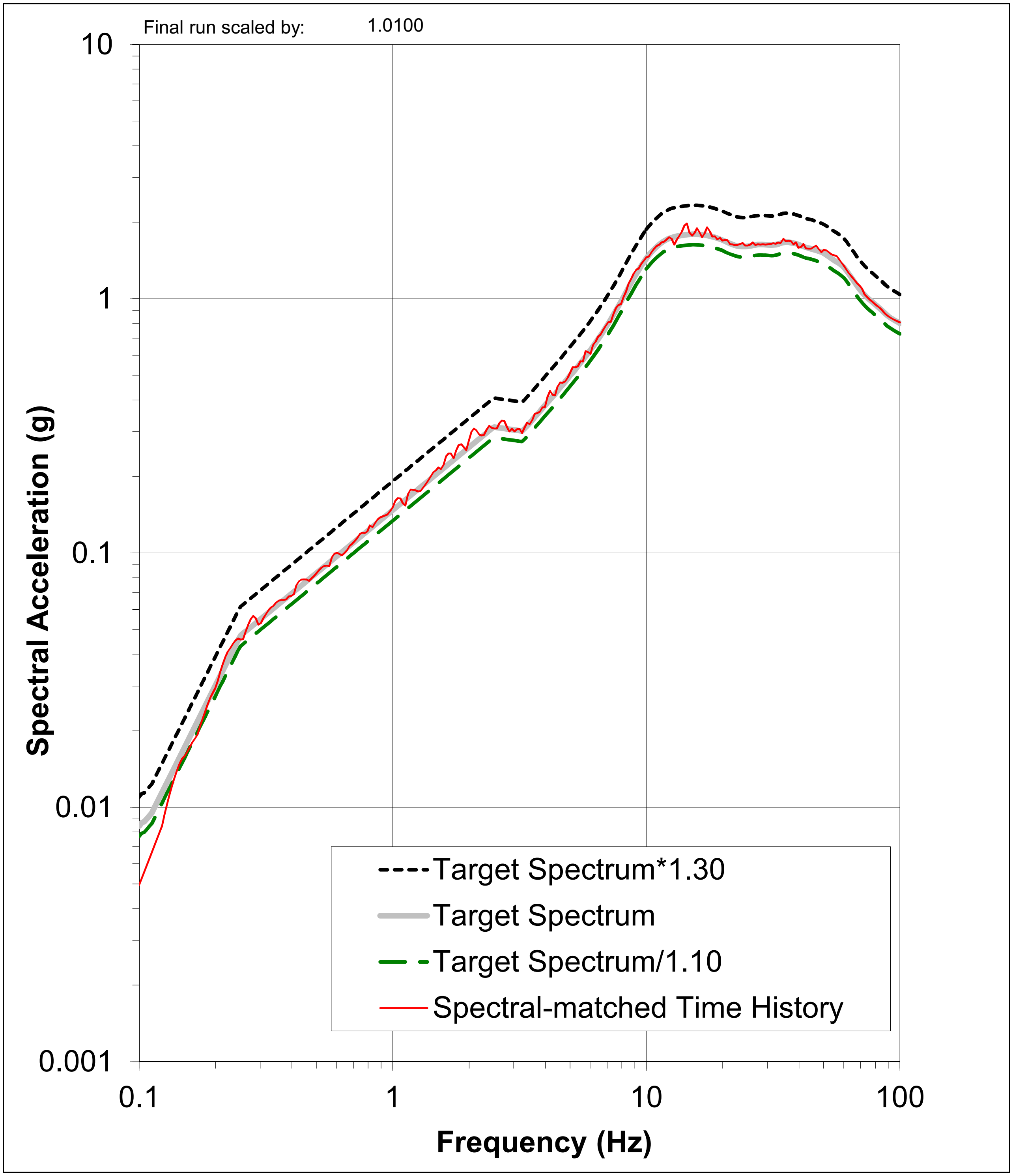
Figure 3.7.1-246 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for RB/FB, UP Component**



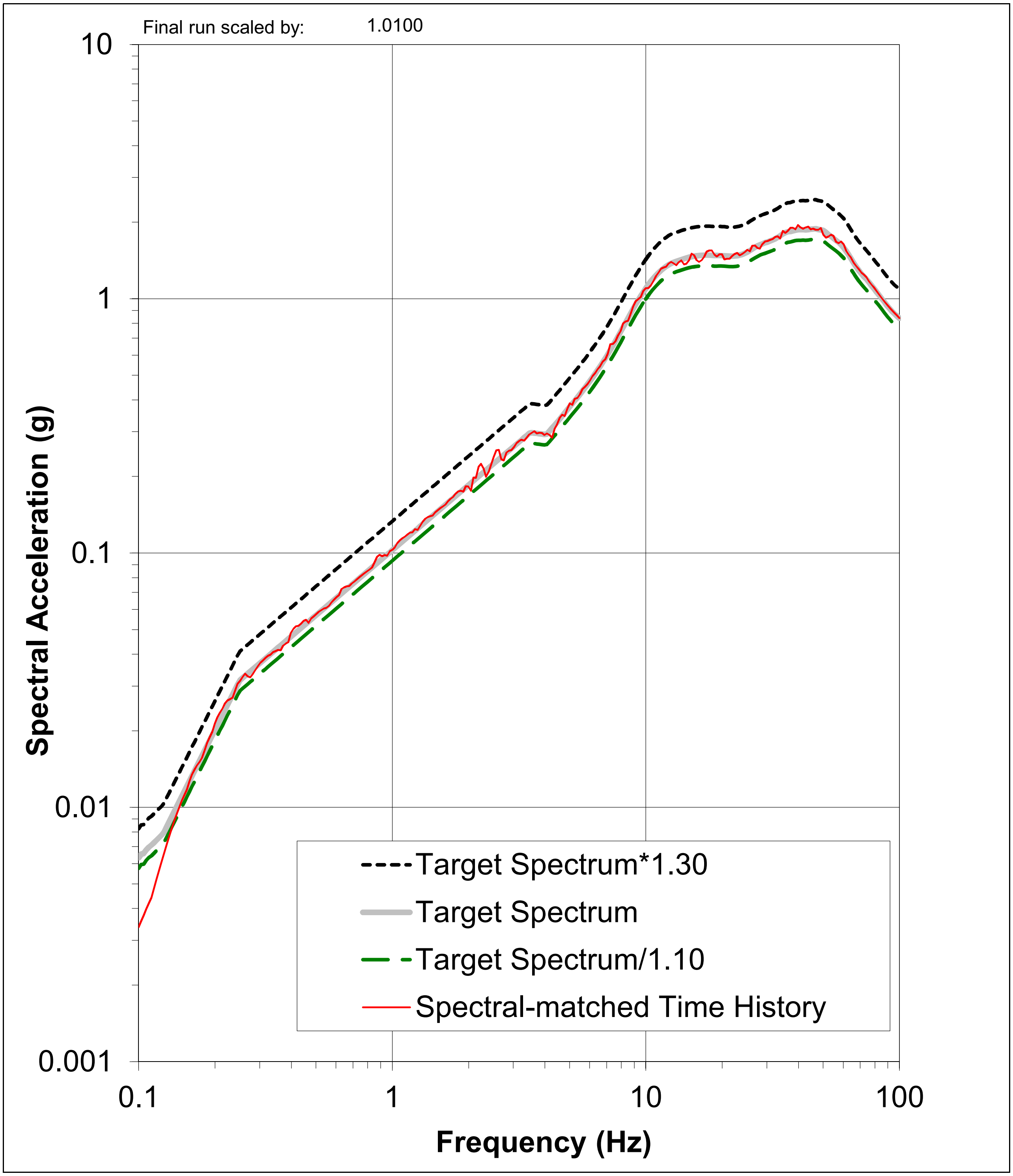
NAPS SUP 3.7-2 Figure 3.7.1-247 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column CB case, H1 Component**



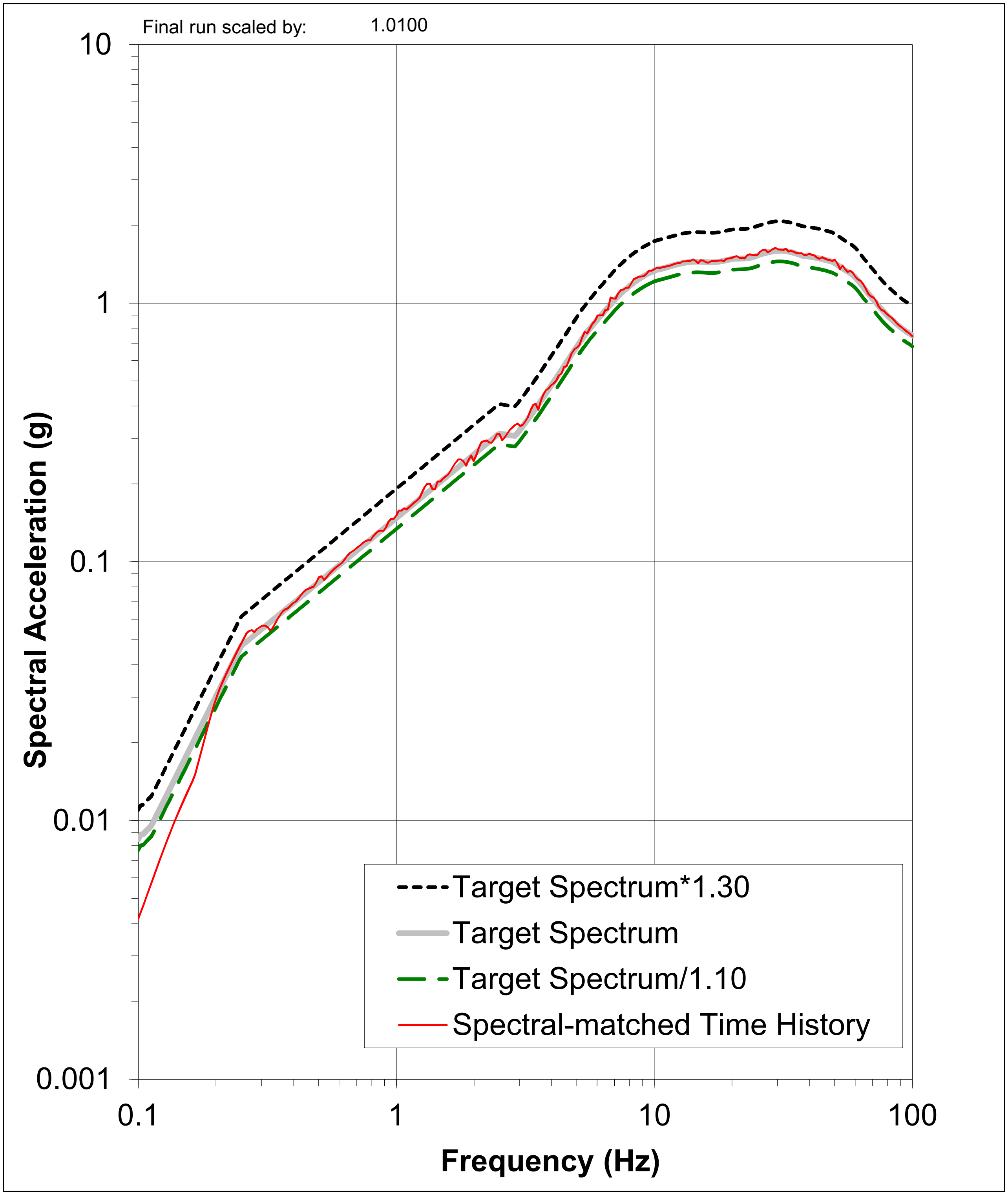
NAPS SUP 3.7-2 Figure 3.7.1-248 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column CB case, H2 Component**



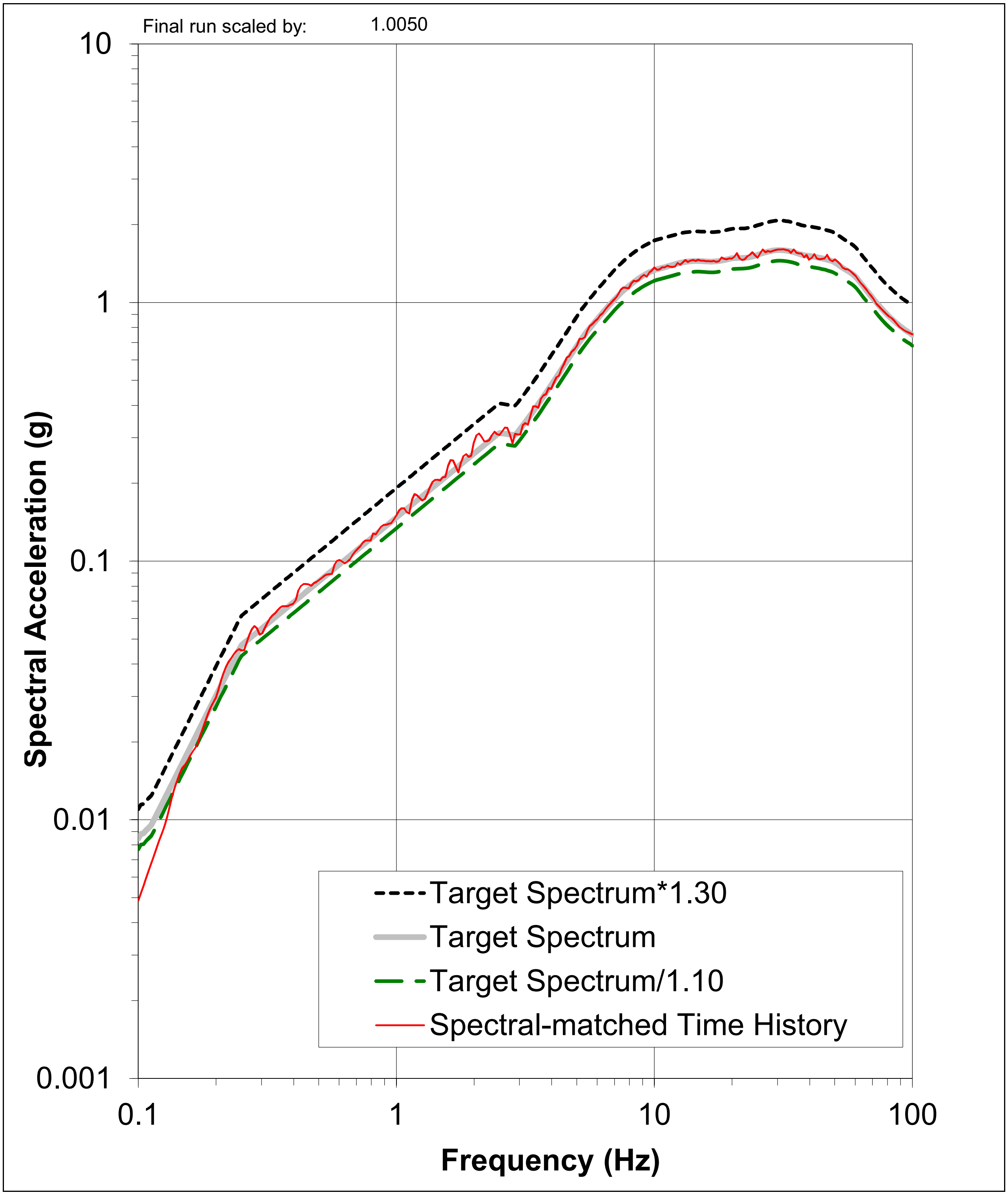
NAPS SUP 3.7-2 Figure 3.7.1-249 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Partial Column CB case, UP Component**



NAPS SUP 3.7-2 Figure 3.7.1-250 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column CB case, H1 Component**



NAPS SUP 3.7-2 Figure 3.7.1-251 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column CB case, H2 Component**



NAPS SUP 3.7-2 Figure 3.7.1-252 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the Full Column CB case, UP Component**

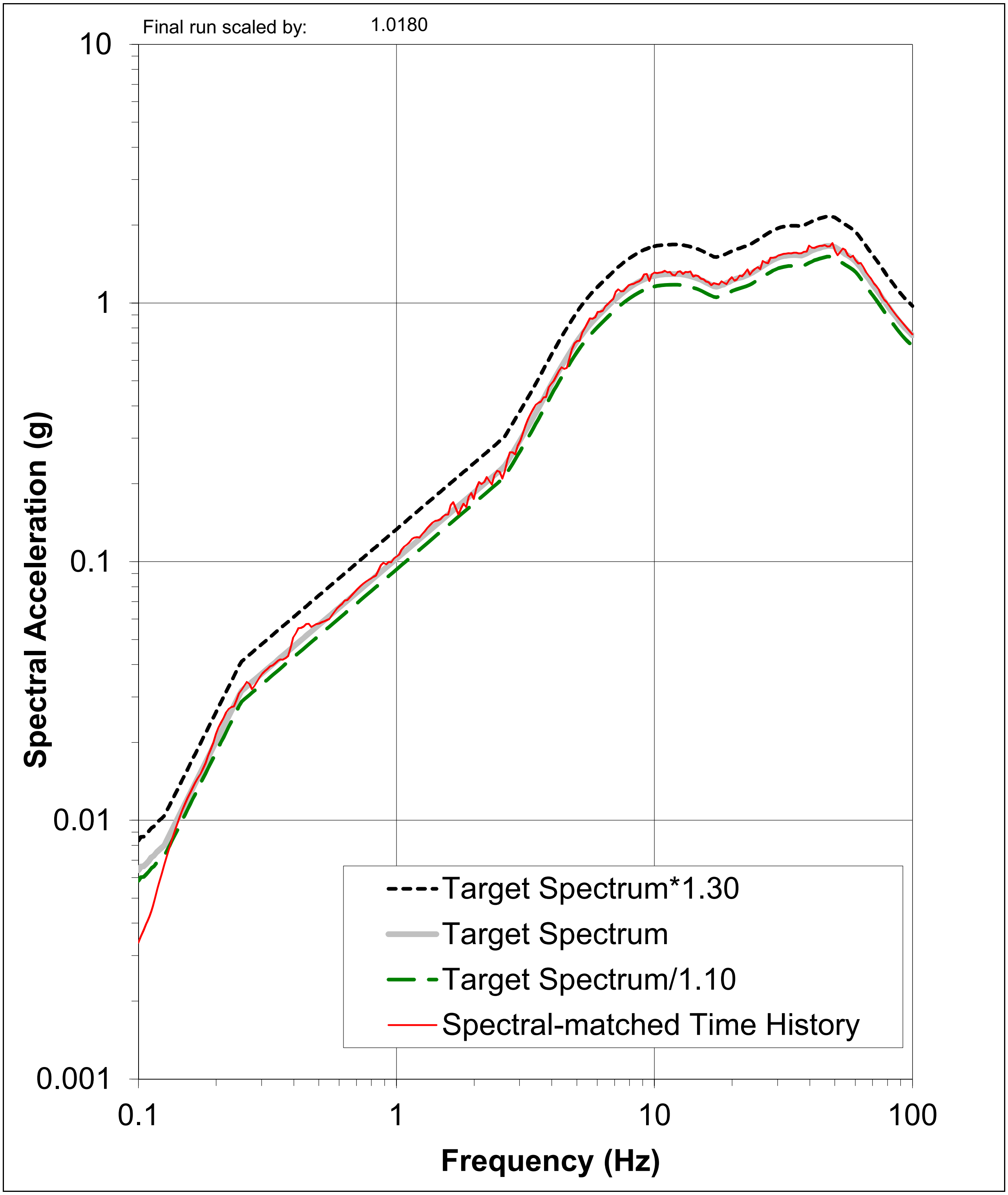


Figure 3.7.1-253 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for CB, H1 Component**

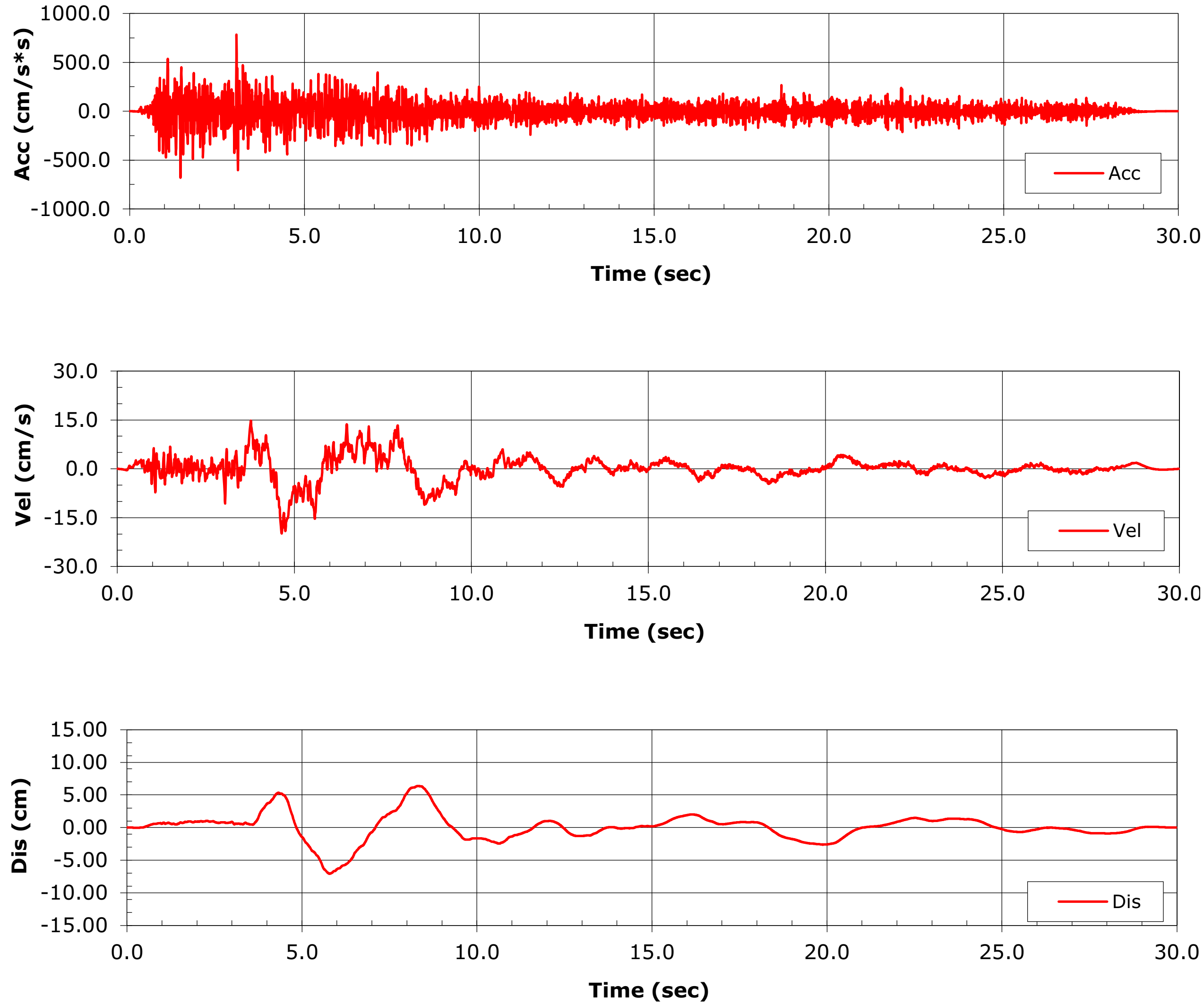


Figure 3.7.1-254 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for CB, H2 Component**

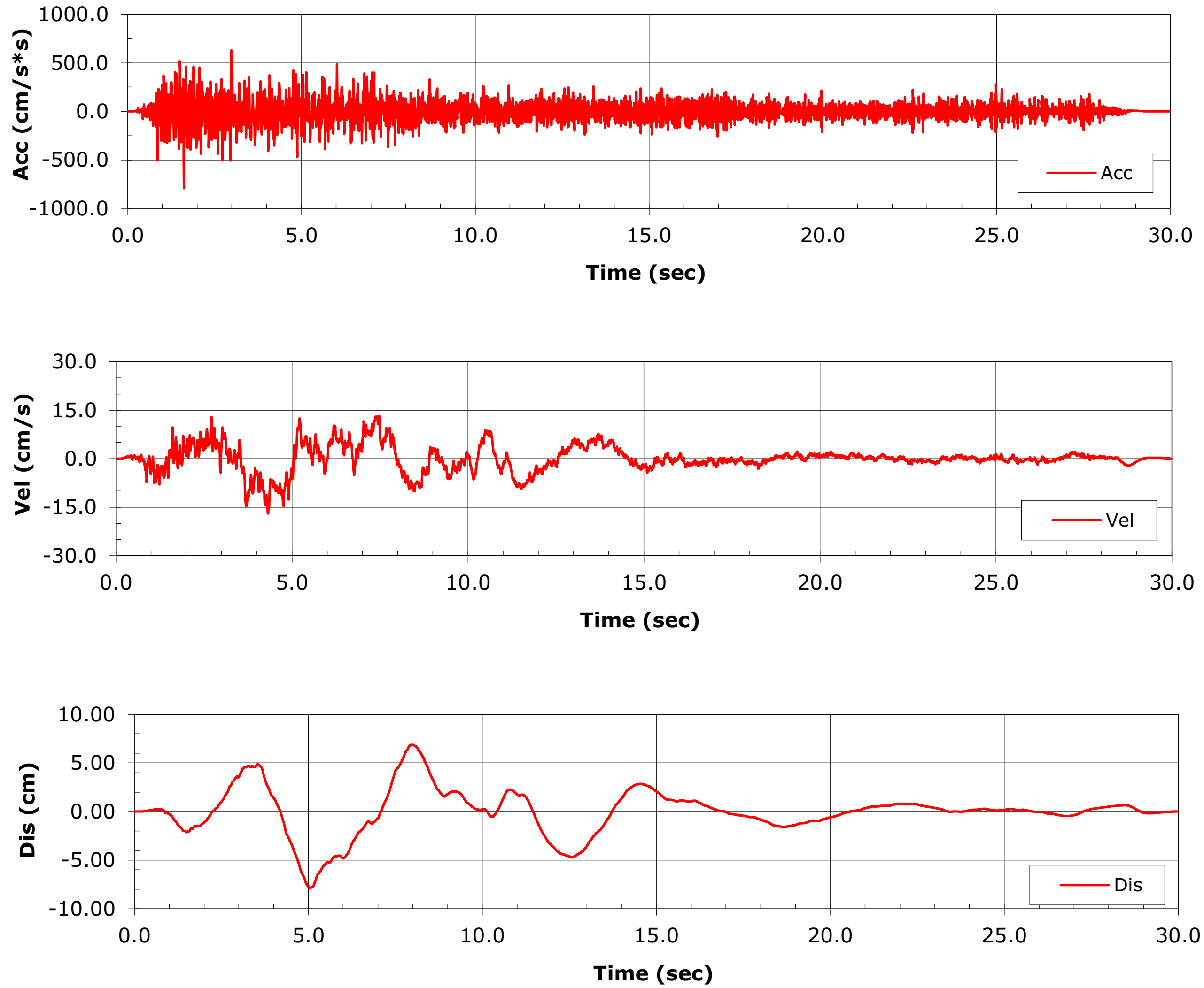


Figure 3.7.1-255 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time-Histories for CB, UP Component**

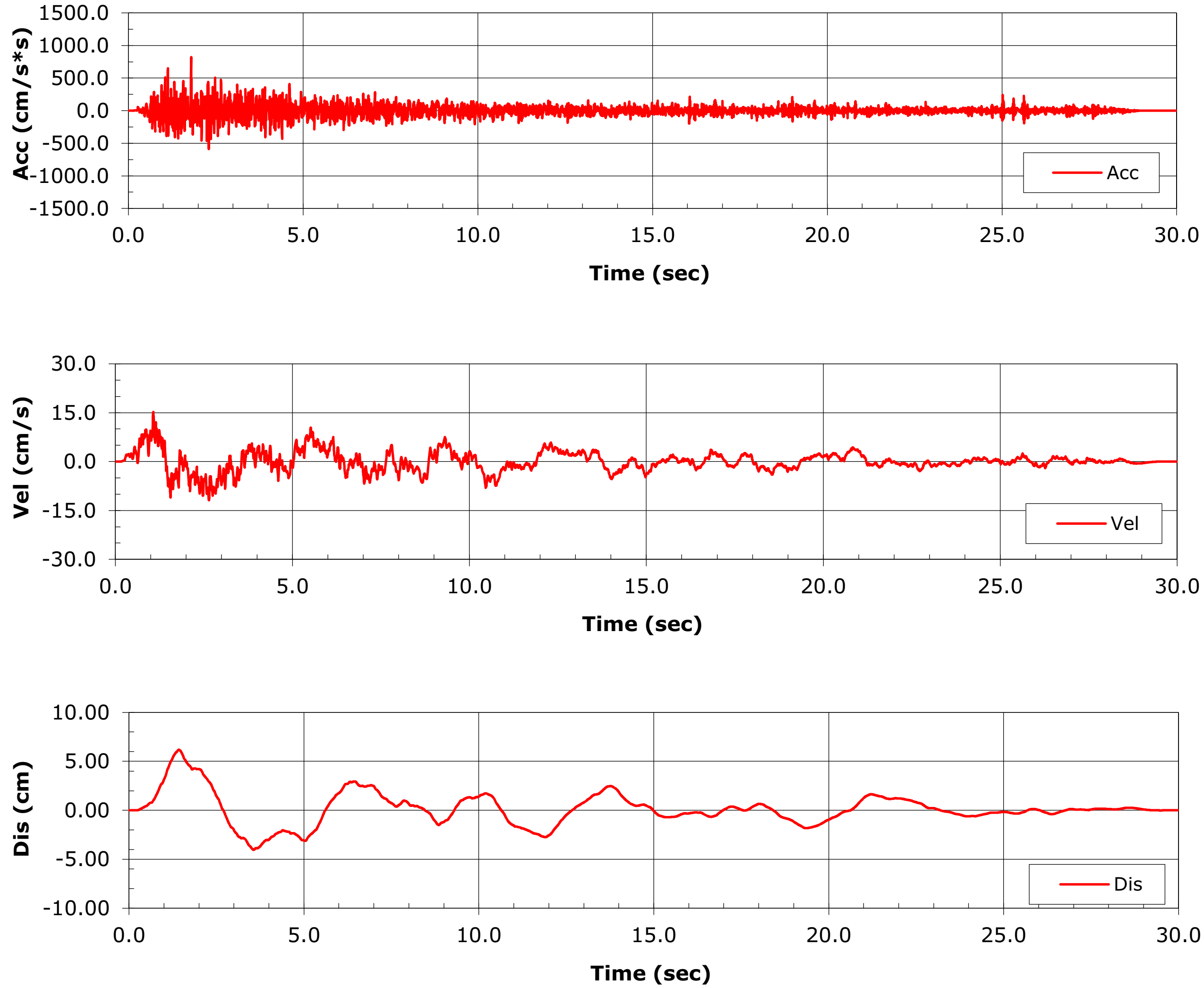
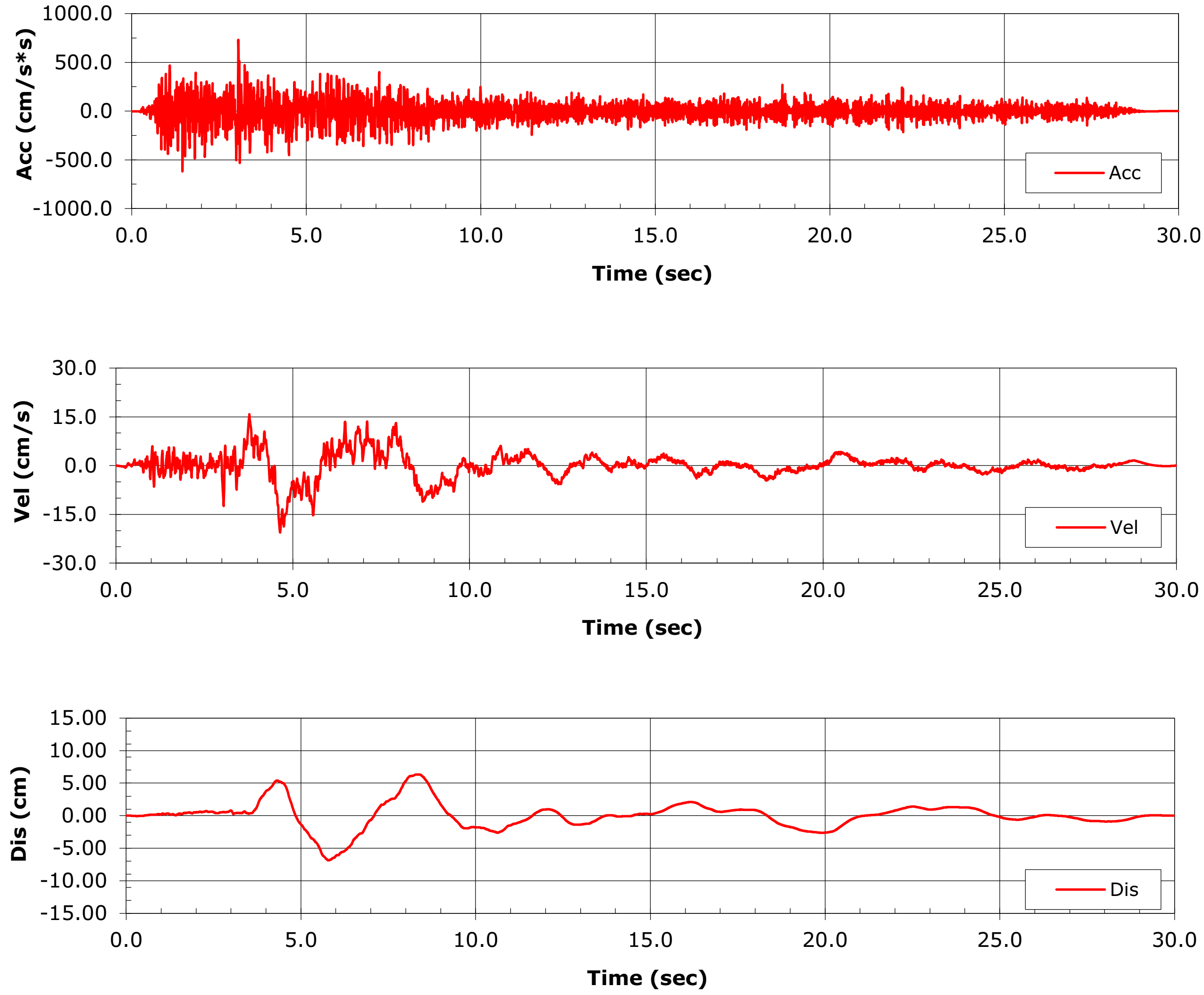


Figure 3.7.1-256 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for CB, H1 Component**



NAPS SUP 3.7-2

Figure 3.7.1-257 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for CB, H2 Component**

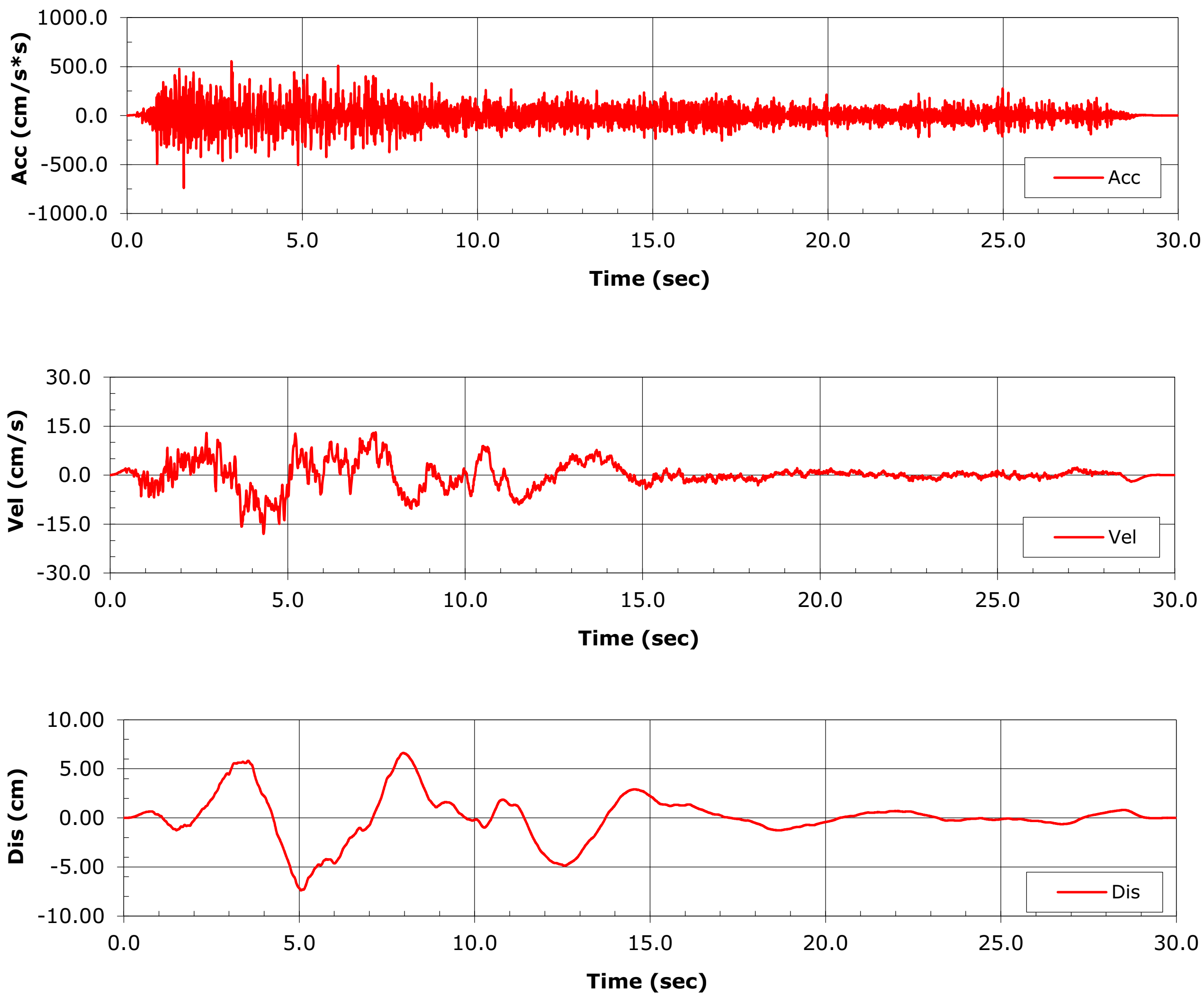
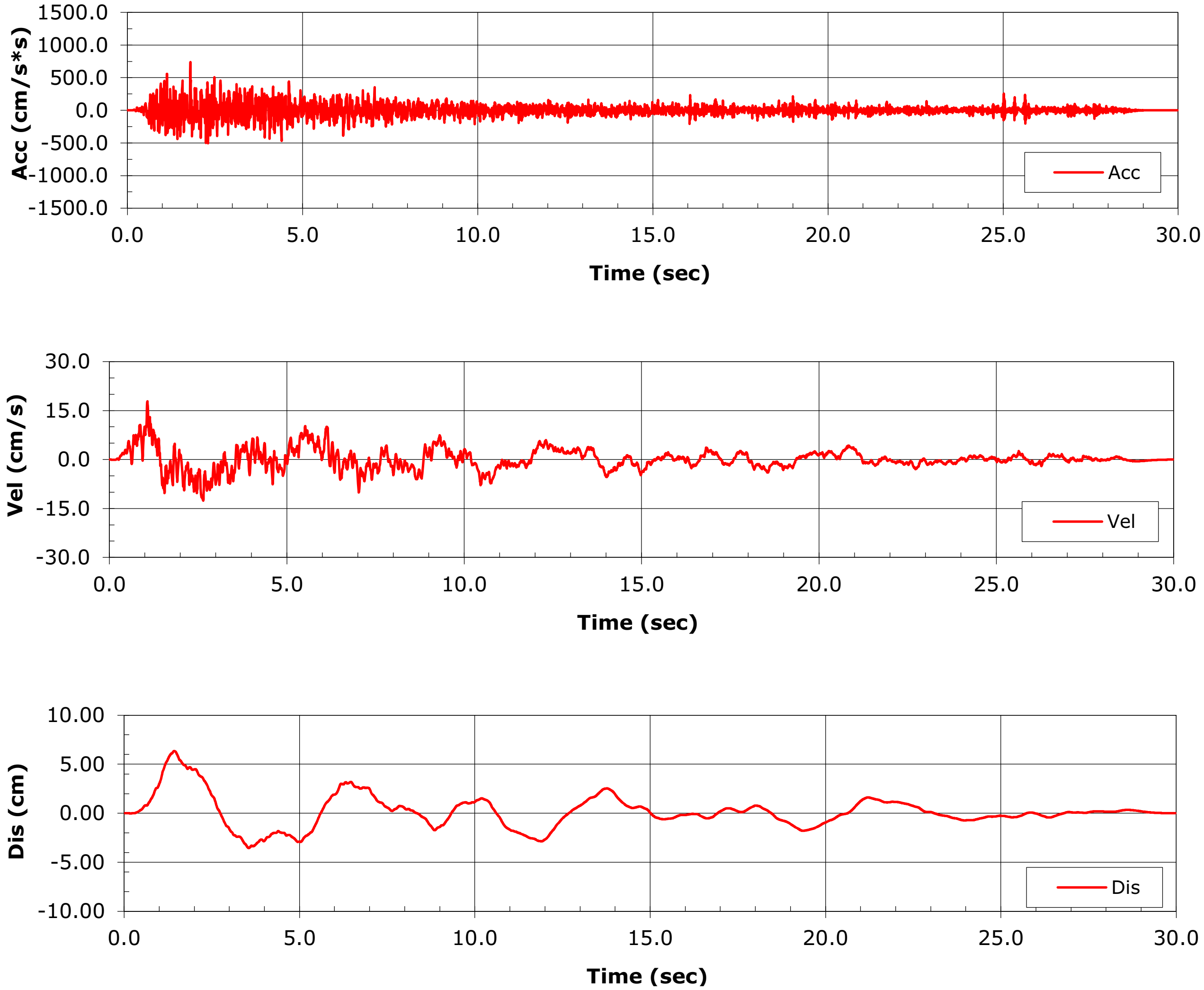
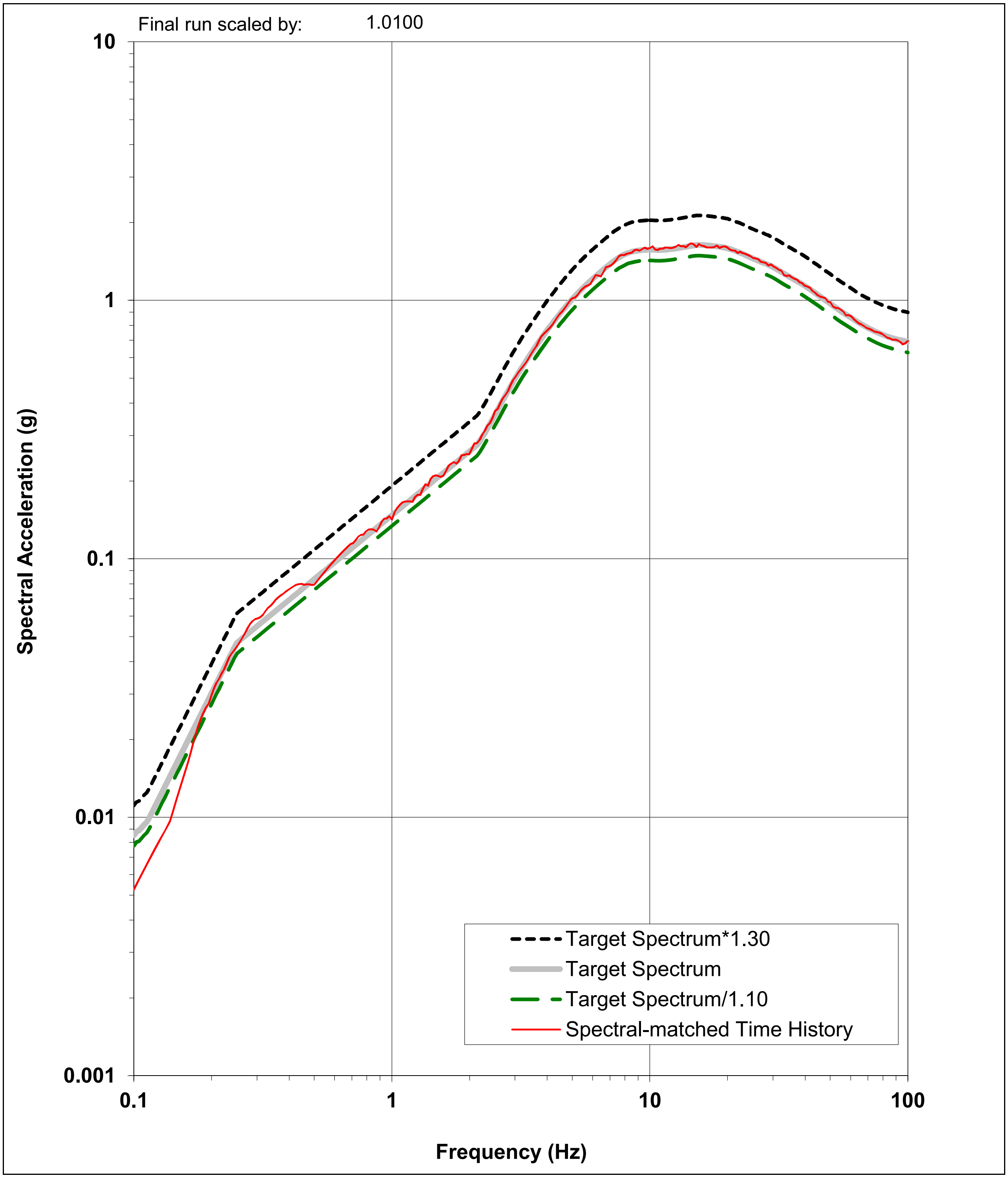


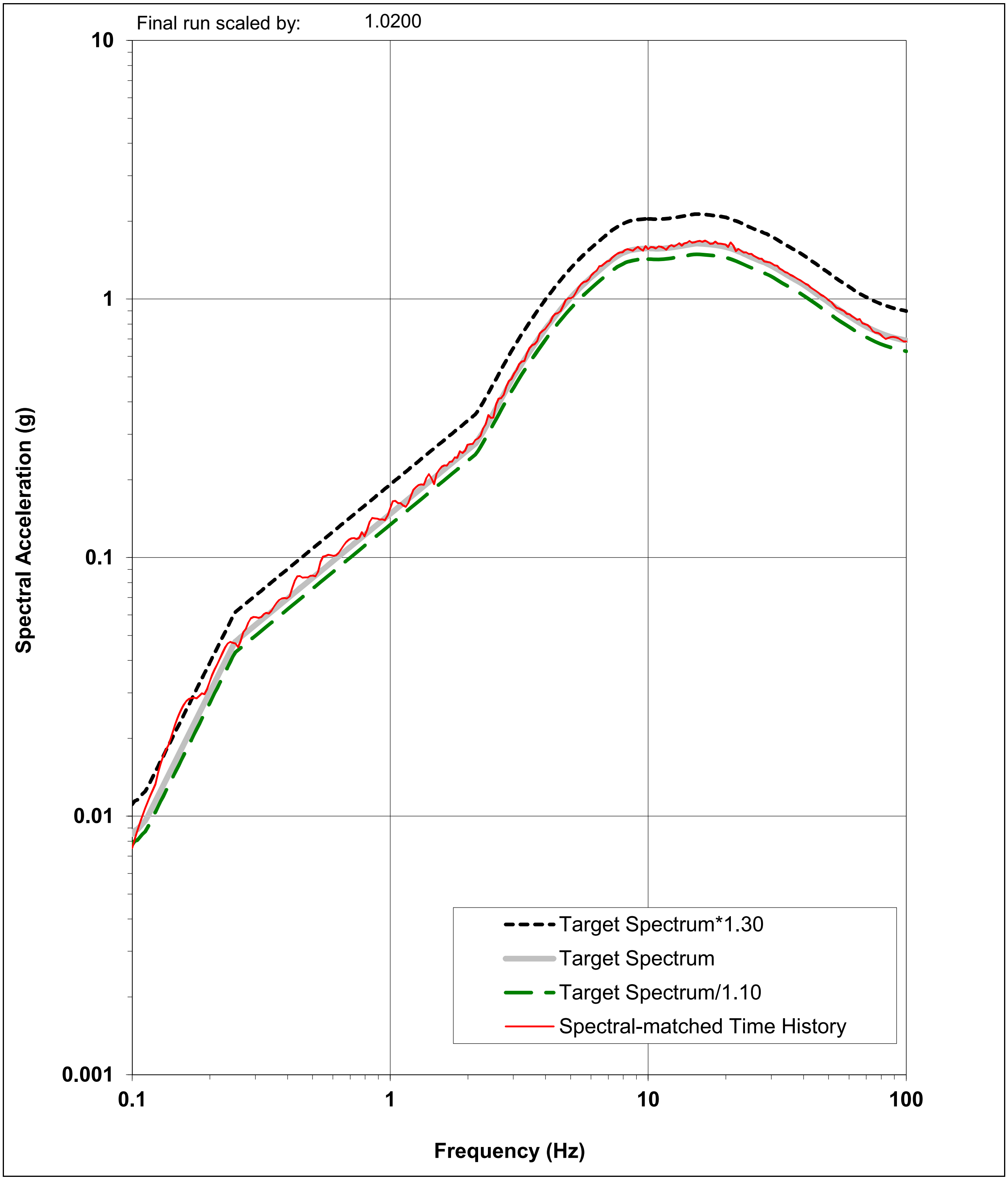
Figure 3.7.1-258 **Acceleration, Velocity, and Displacement Spectrally Matched Full Column Outcrop Time-Histories for CB, UP Component**



NAPS SUP 3.7-2 Figure 3.7.1-259 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, H1 Component at Elevation 282 ft**



NAPS SUP 3.7-2 Figure 3.7.1-260 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, H2 Component at Elevation 282 ft**



NAPS SUP 3.7-2 Figure 3.7.1-261 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, UP Component at Elevation 282 ft**

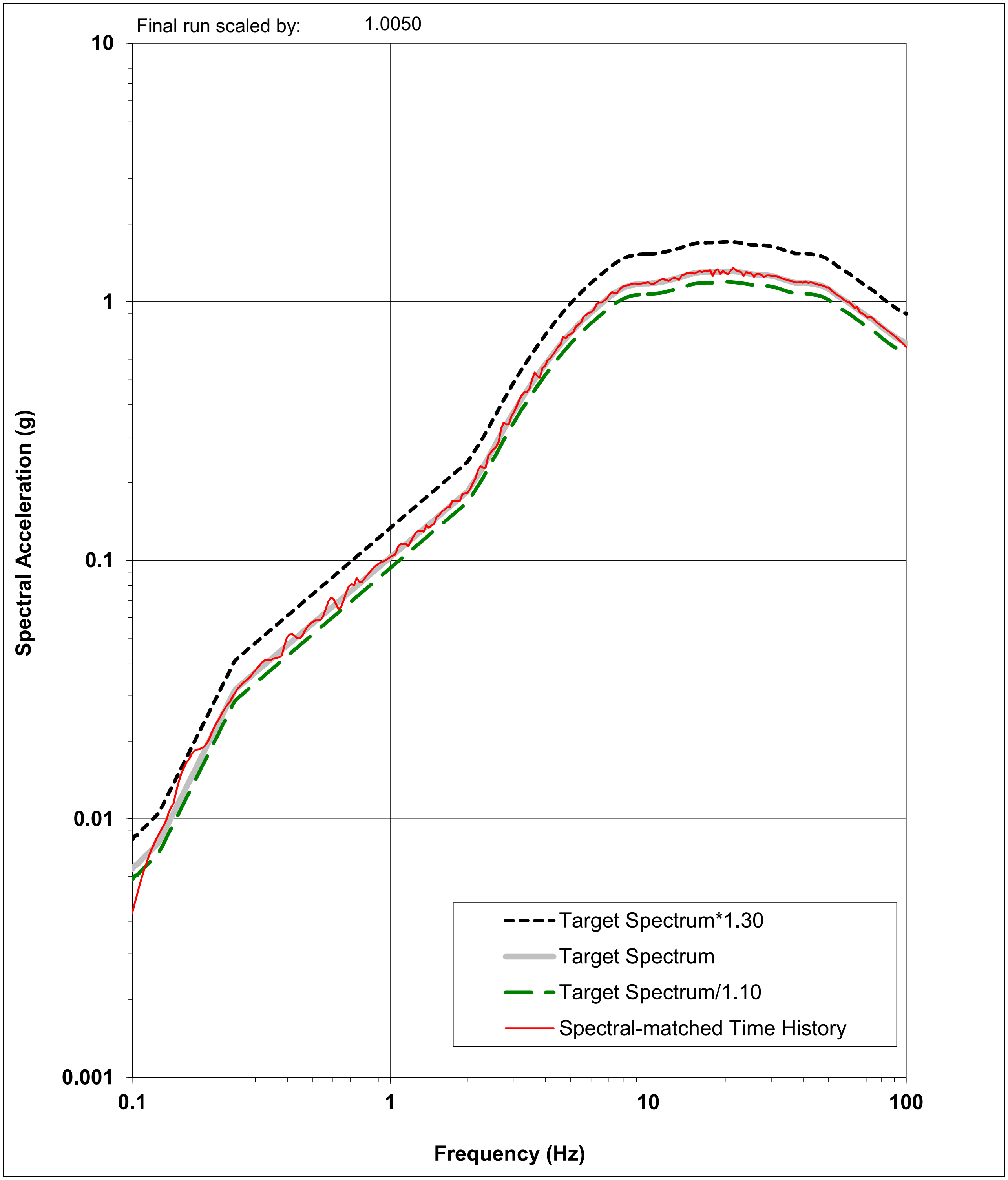


Figure 3.7.1-262 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, H1 Component at Elevation 282 ft**

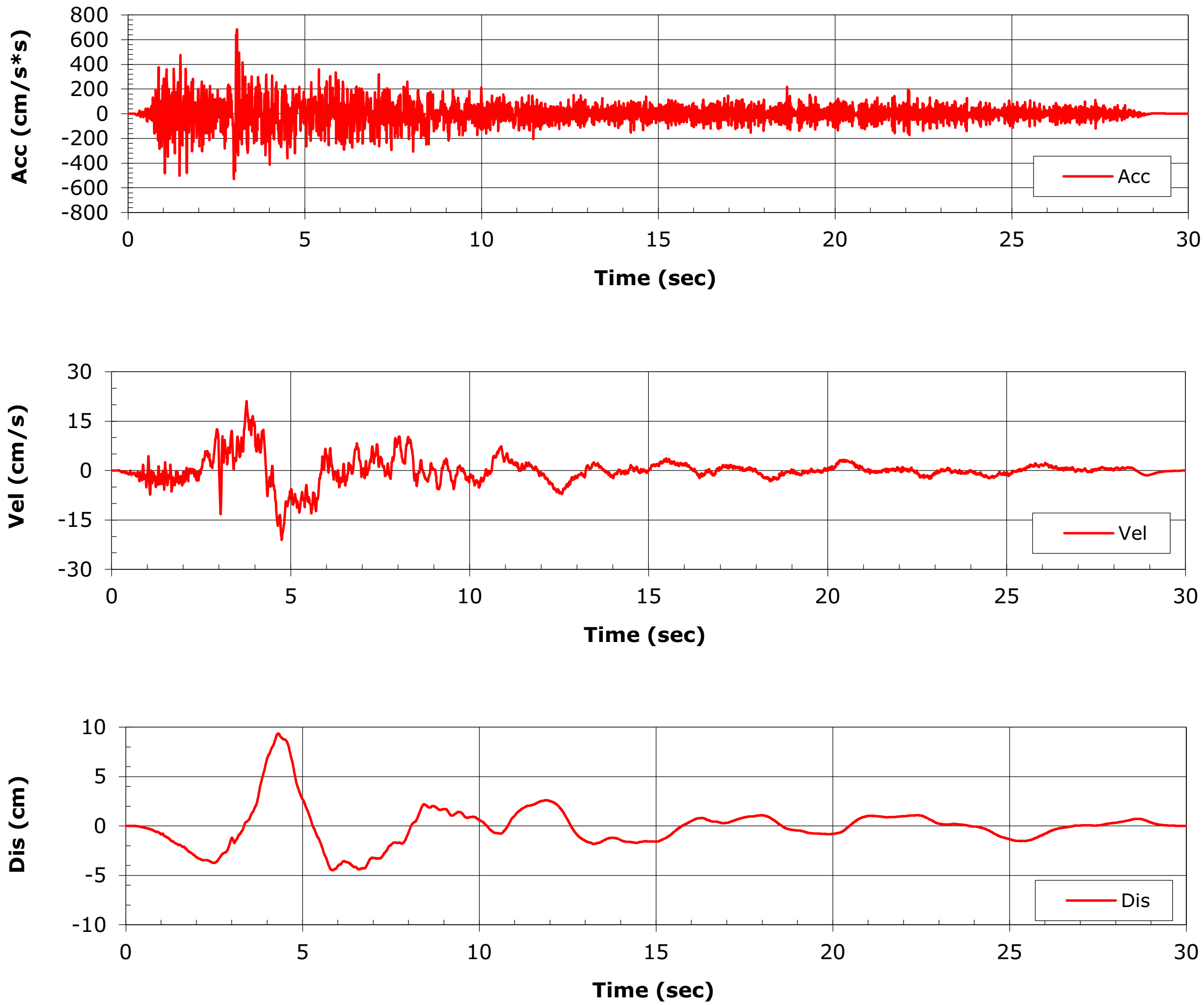


Figure 3.7.1-263 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, H2 Component at Elevation 282 ft**

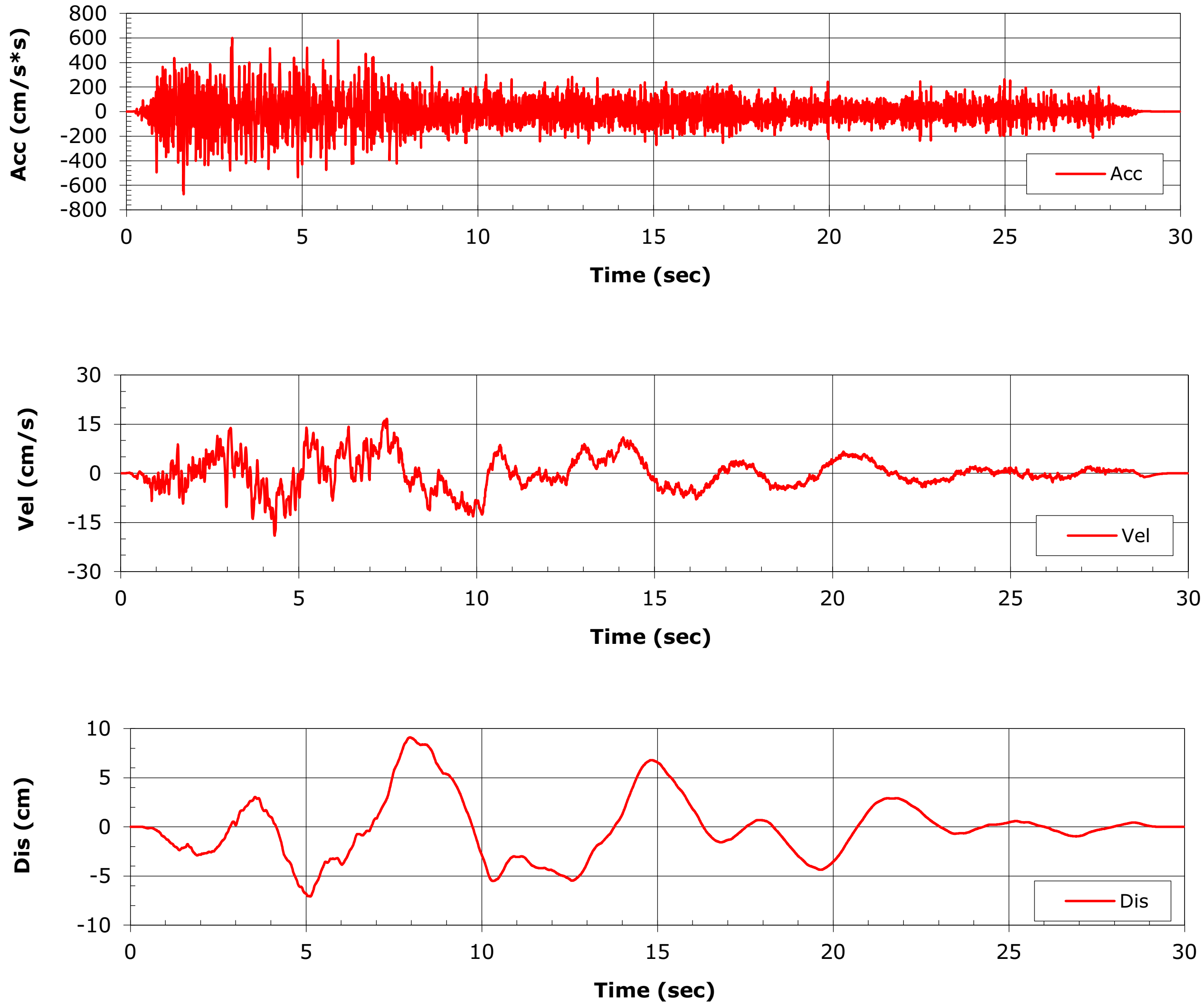


Figure 3.7.1-264 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, UP Component at Elevation 282 ft**

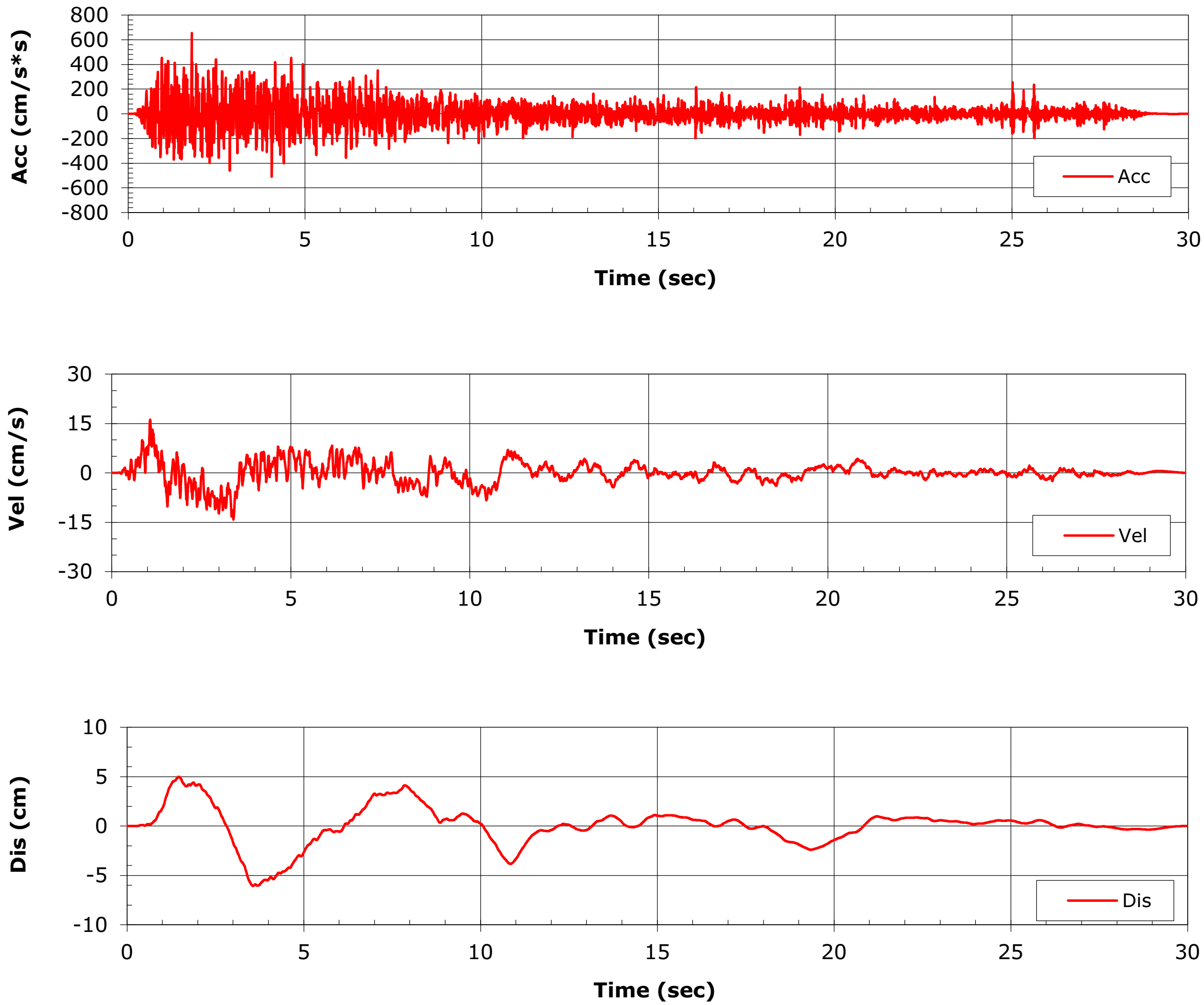


Figure 3.7.1-265 **Development of Horizontal Site-Dependent SSE Manifestation at Grade and OBE at Grade**

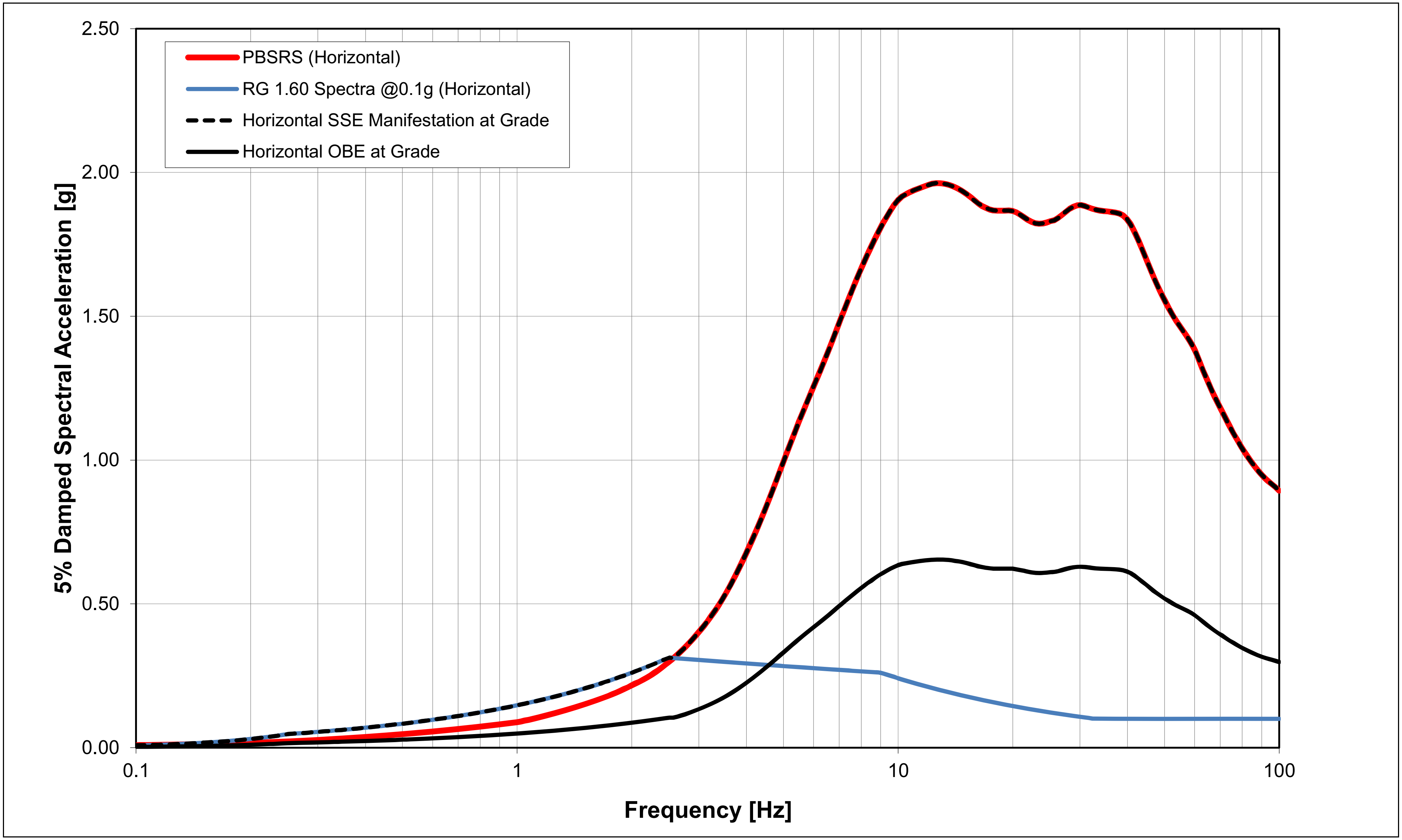


Figure 3.7.1-266 **Development of Vertical Site-Dependent SSE Manifestation at Grade and OBE at Grade**

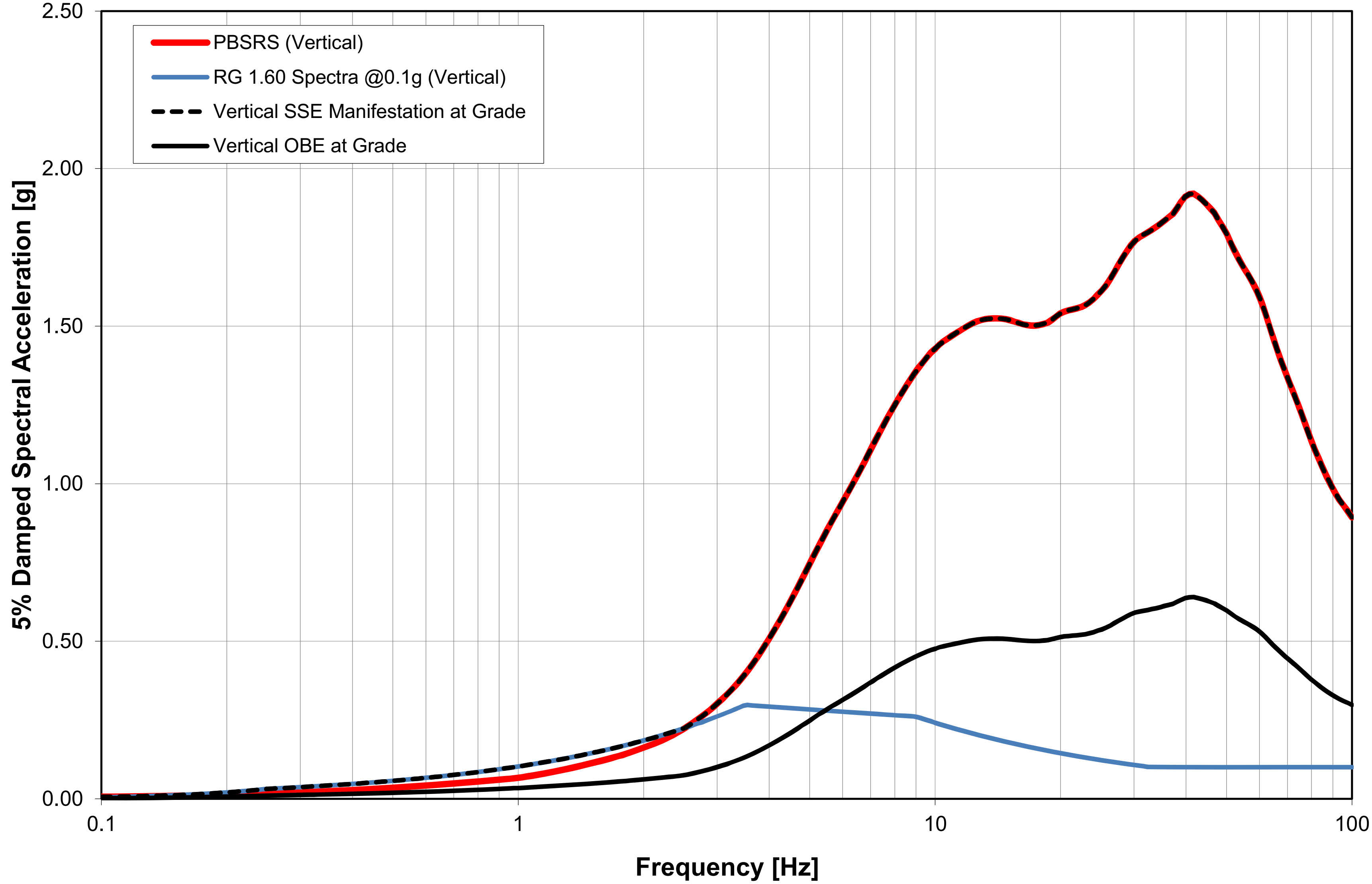
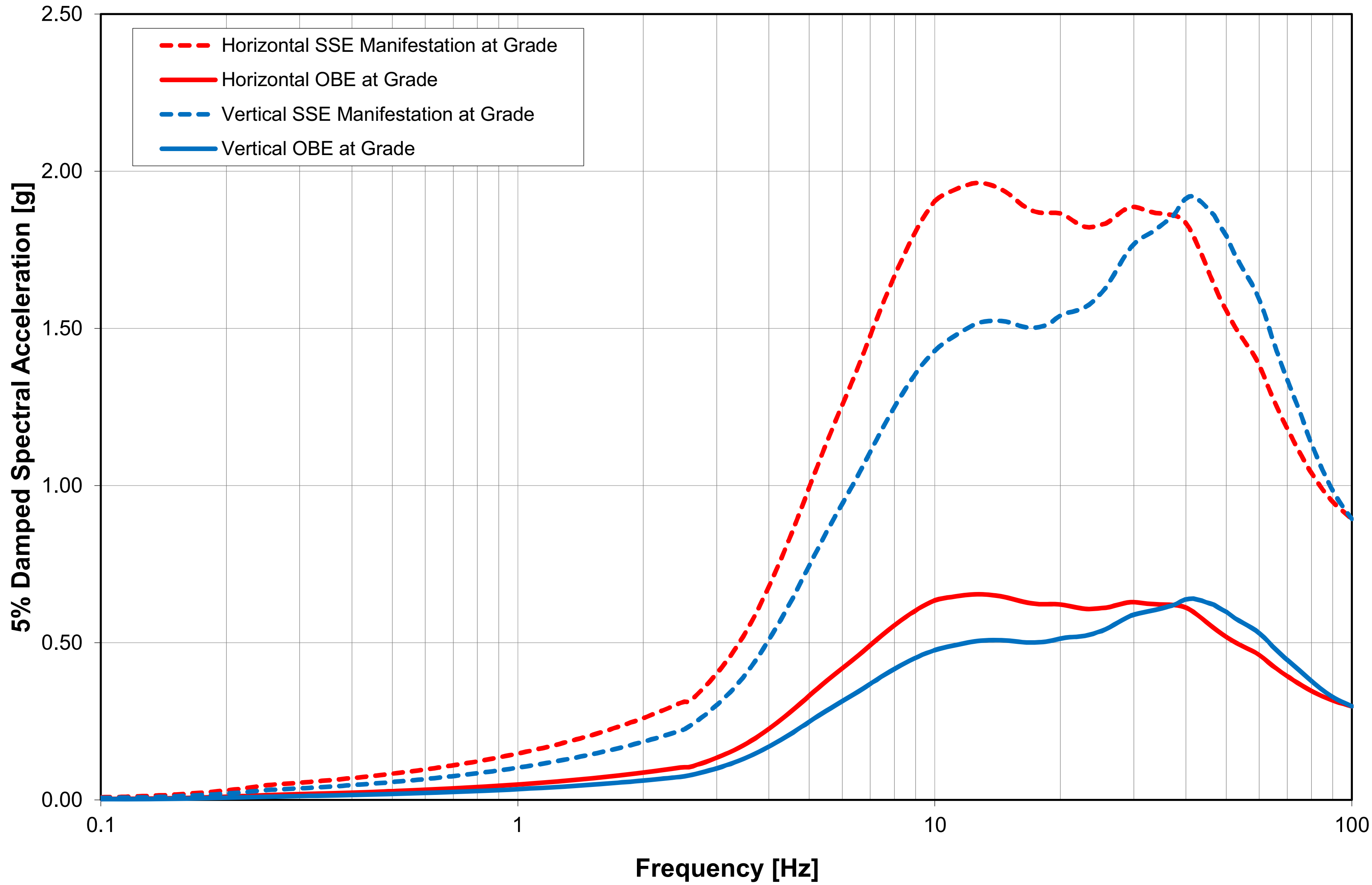


Figure 3.7.1-267 **Site-Dependent SSE Manifestation at Grade and OBE at Grade**



NAPS SUP 3.7-2 Figure 3.7.1-268 **PSD for the H1 Component of the RB/FB Partial Profile Spectrum Compatible Acceleration Time History**

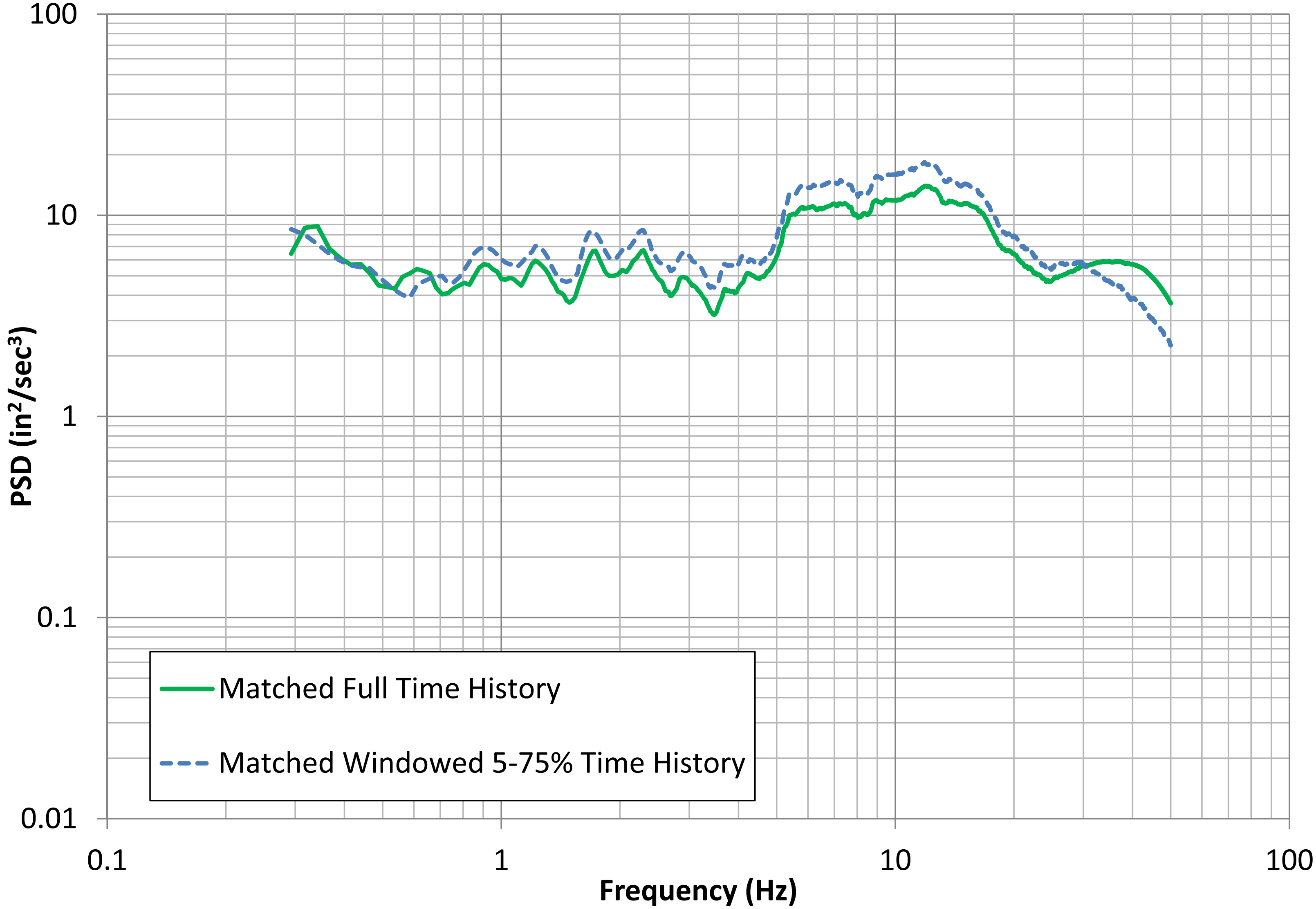


Figure 3.7.1-269 **PSD for the H2 Component of the RB/FB Partial Profile Spectrum Compatible Acceleration Time History**

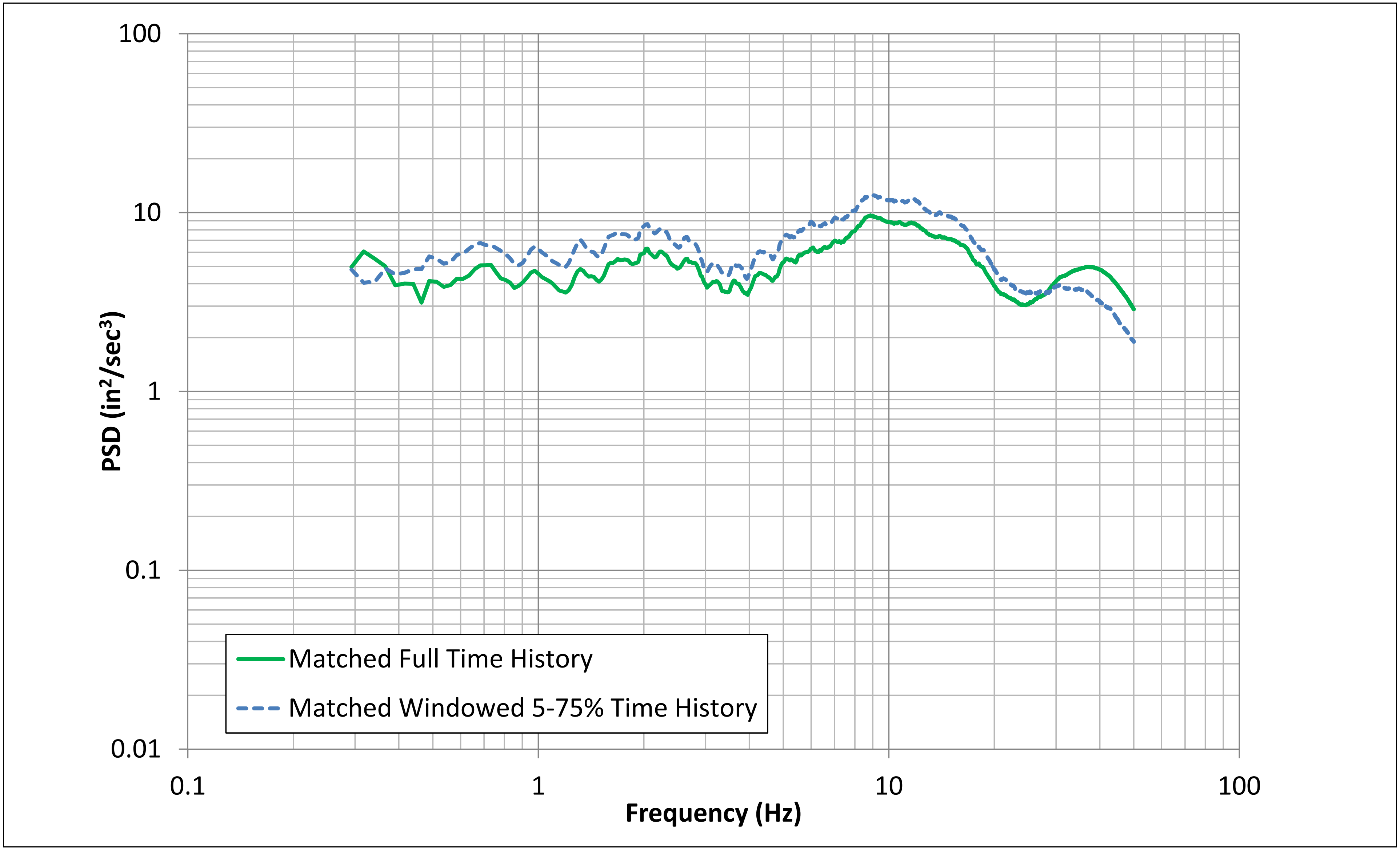


Figure 3.7.1-270 **PSD for the UP Component of the RB/FB Partial Profile Spectrum Compatible Acceleration Time History**

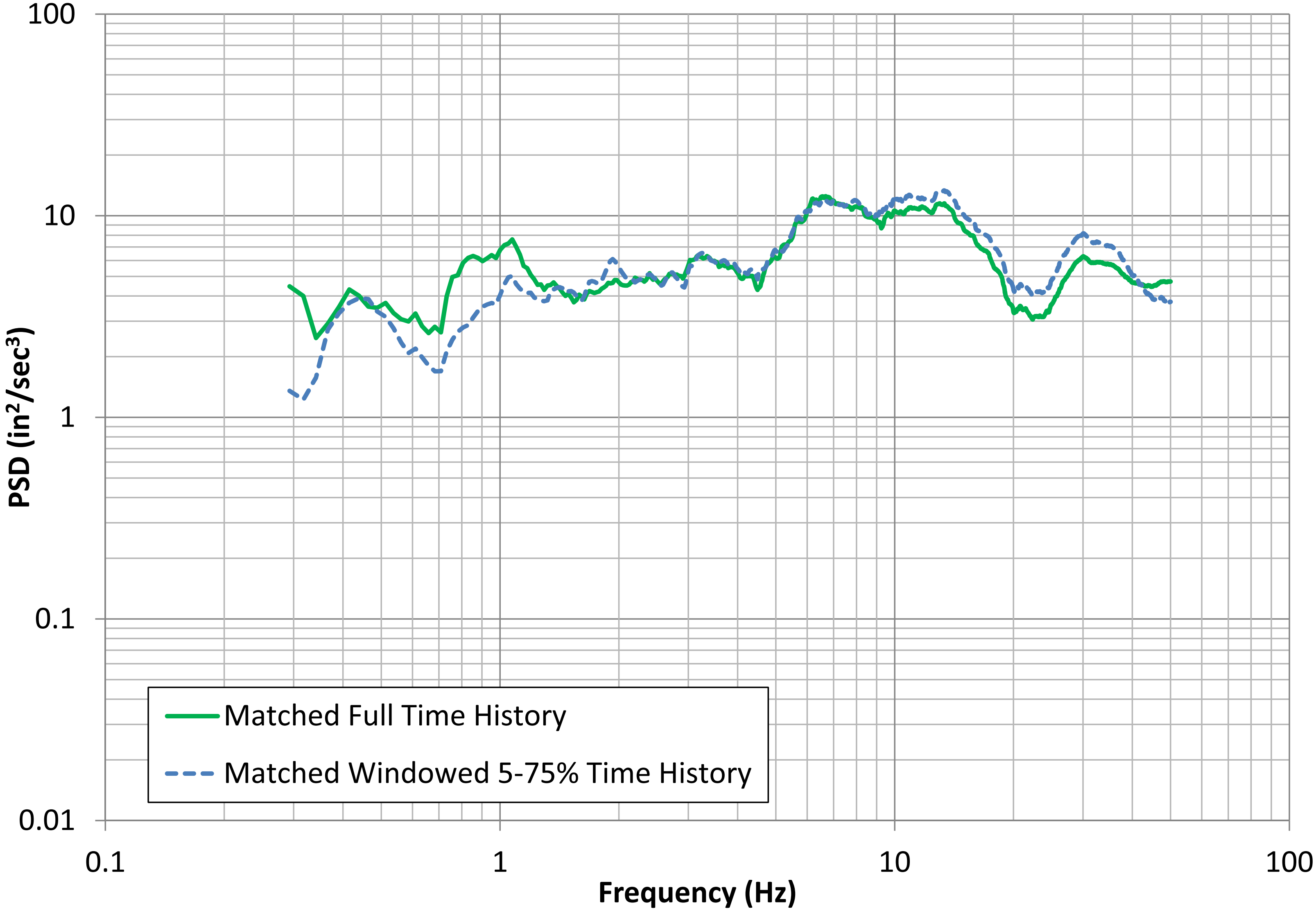
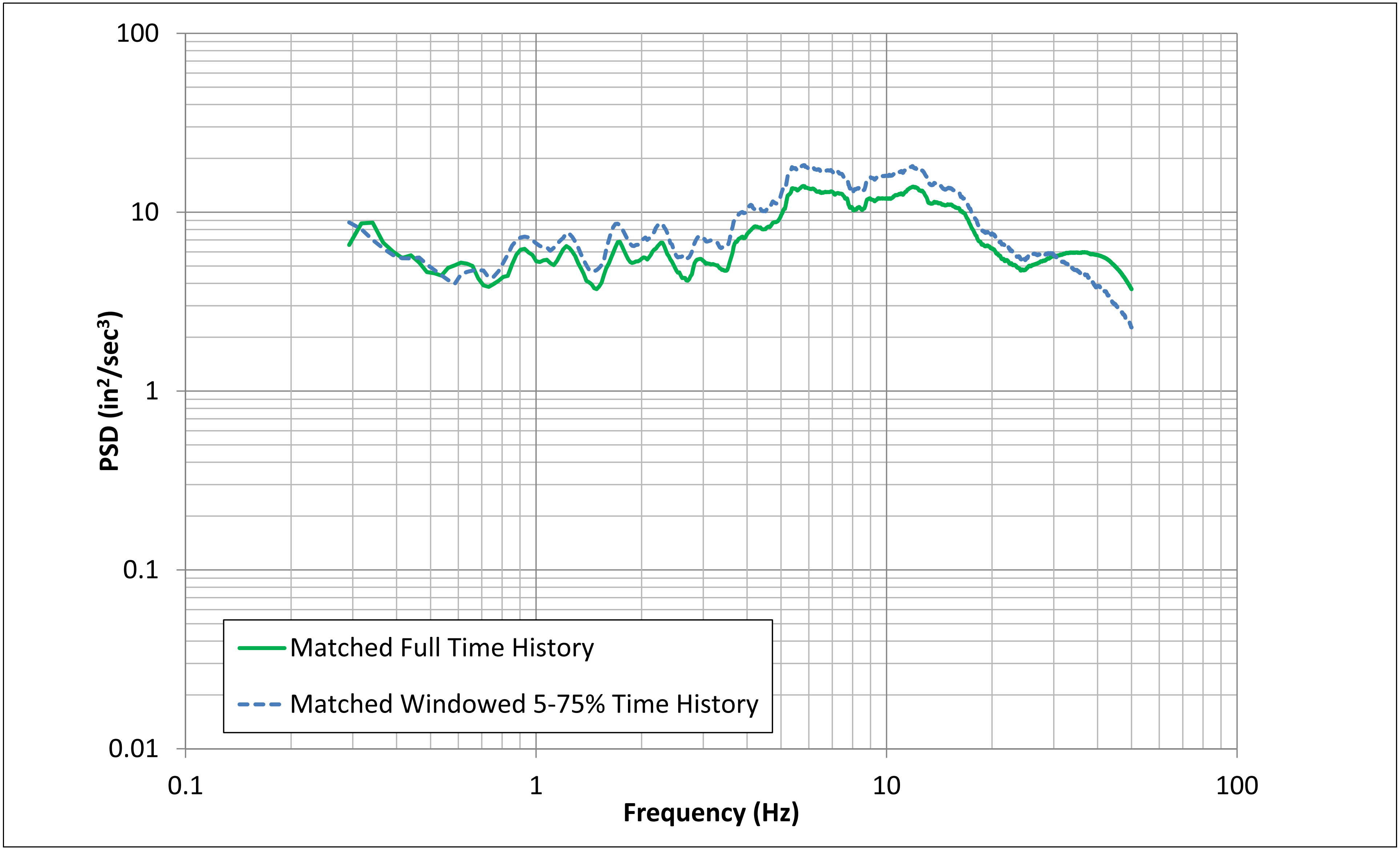


Figure 3.7.1-271 **PSD for the H1 Component of the RB/FB Full Profile Spectrum Compatible Acceleration Time History**



NAPS SUP 3.7-2 Figure 3.7.1-272 **PSD for the H2 Component of the RB/FB Full Profile Spectrum Compatible Acceleration Time History**

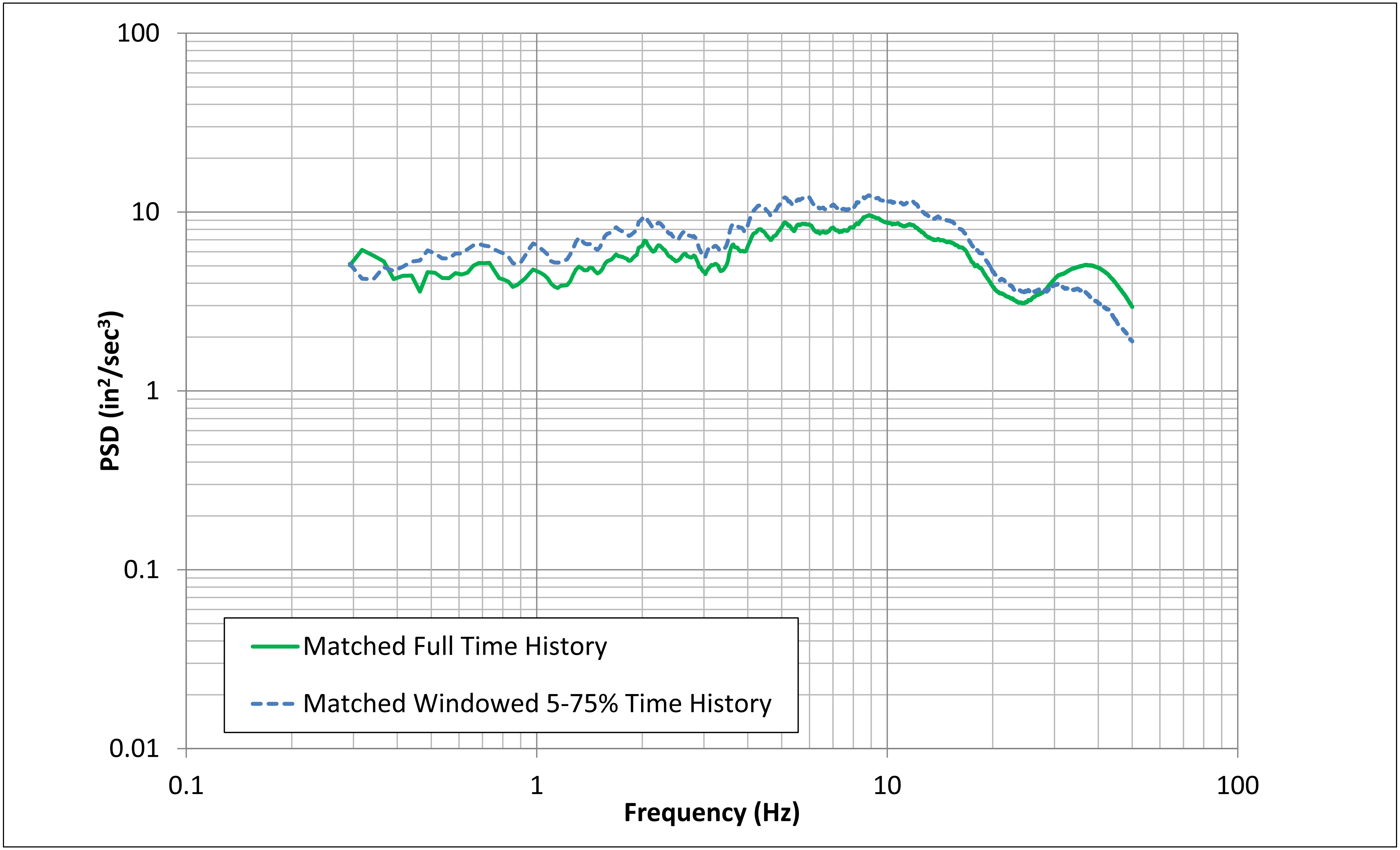
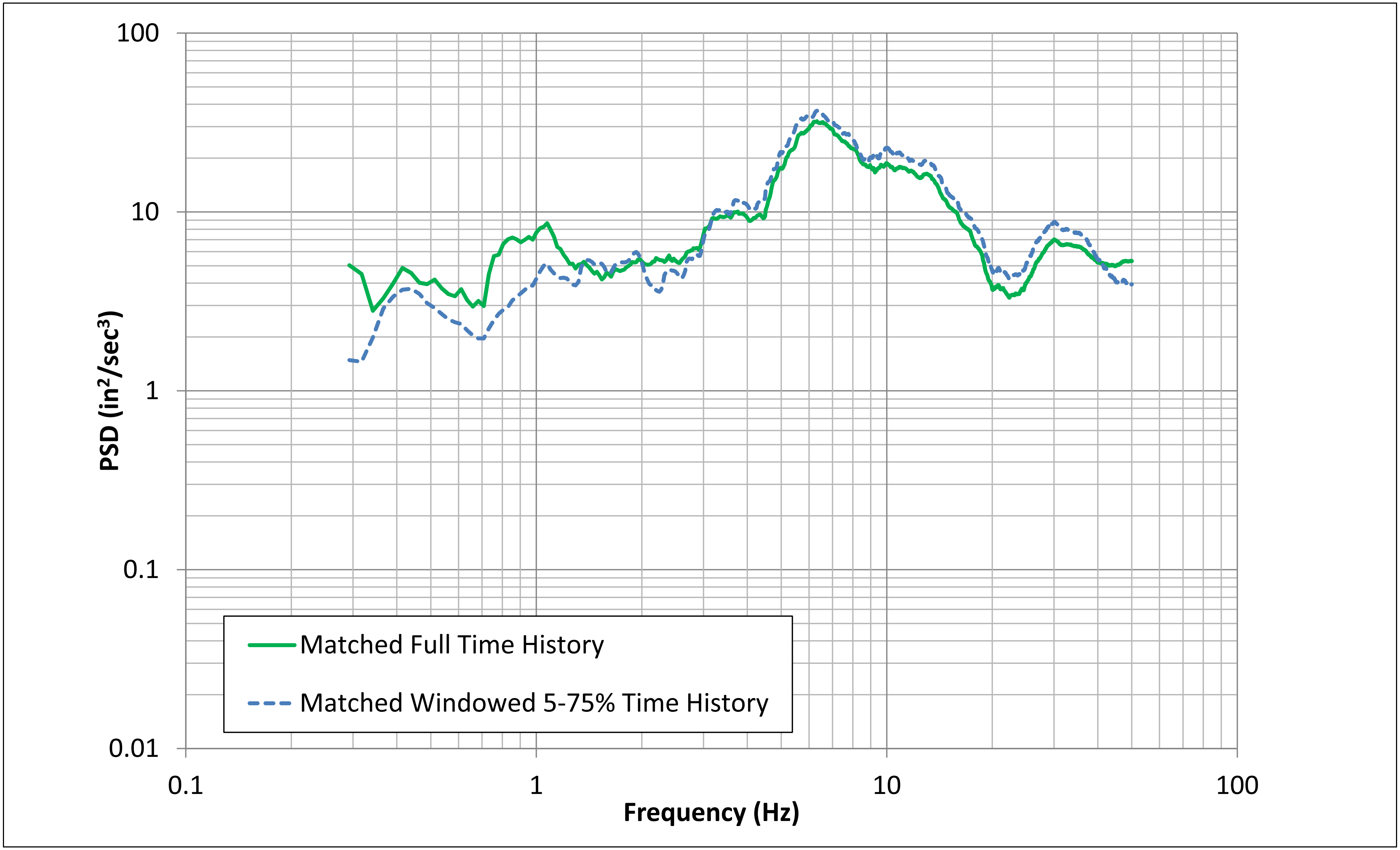


Figure 3.7.1-273 **PSD for the UP Component of the RB/FB Full Profile Spectrum Compatible Acceleration Time History**



NAPS SUP 3.7-2 Figure 3.7.1-274 **PSD for the H1 Component of the CB Partial Profile Spectrum Compatible Acceleration Time History**

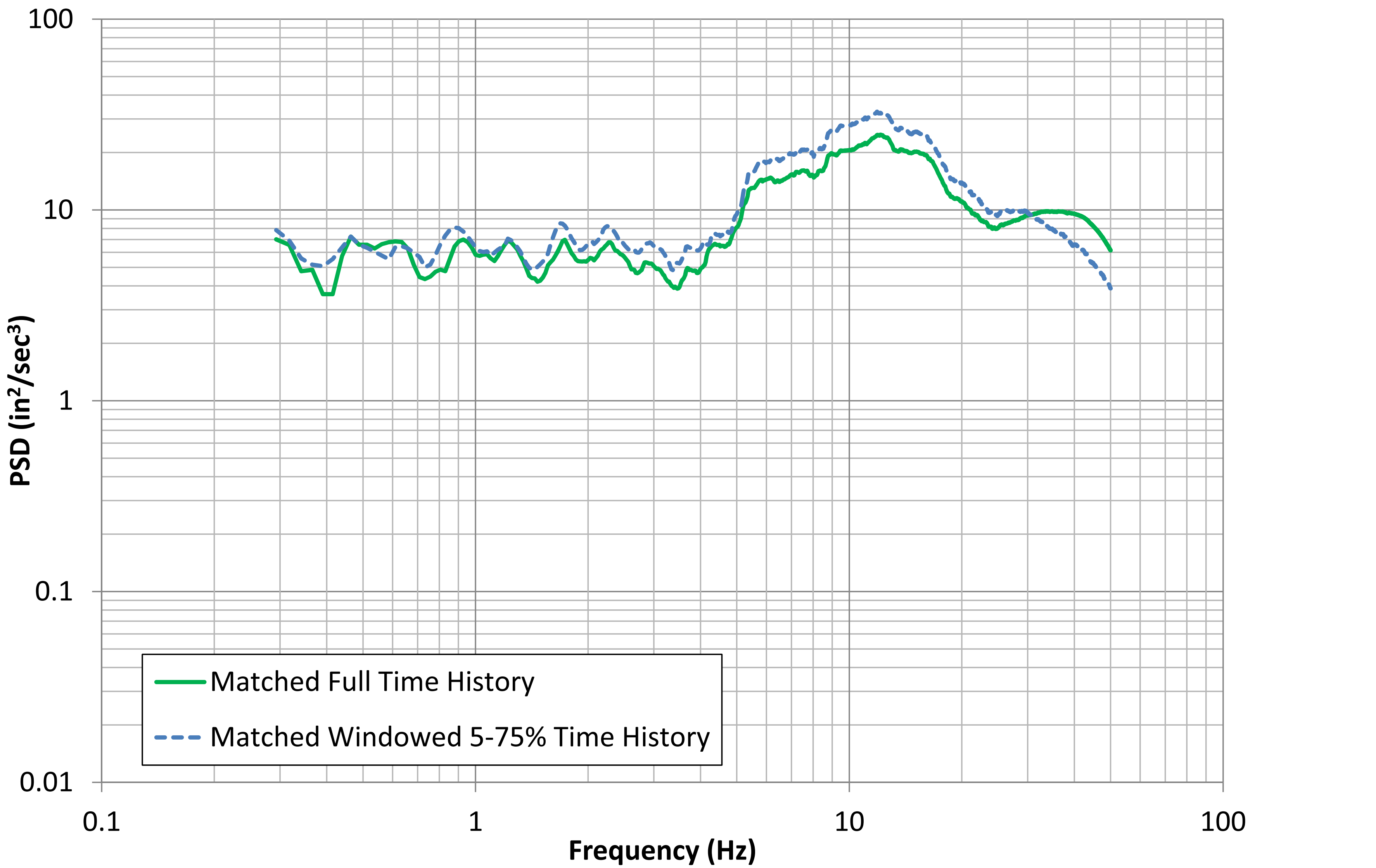


Figure 3.7.1-275 **PSD for the H2 Component of the CB Partial Profile Spectrum Compatible Acceleration Time History**

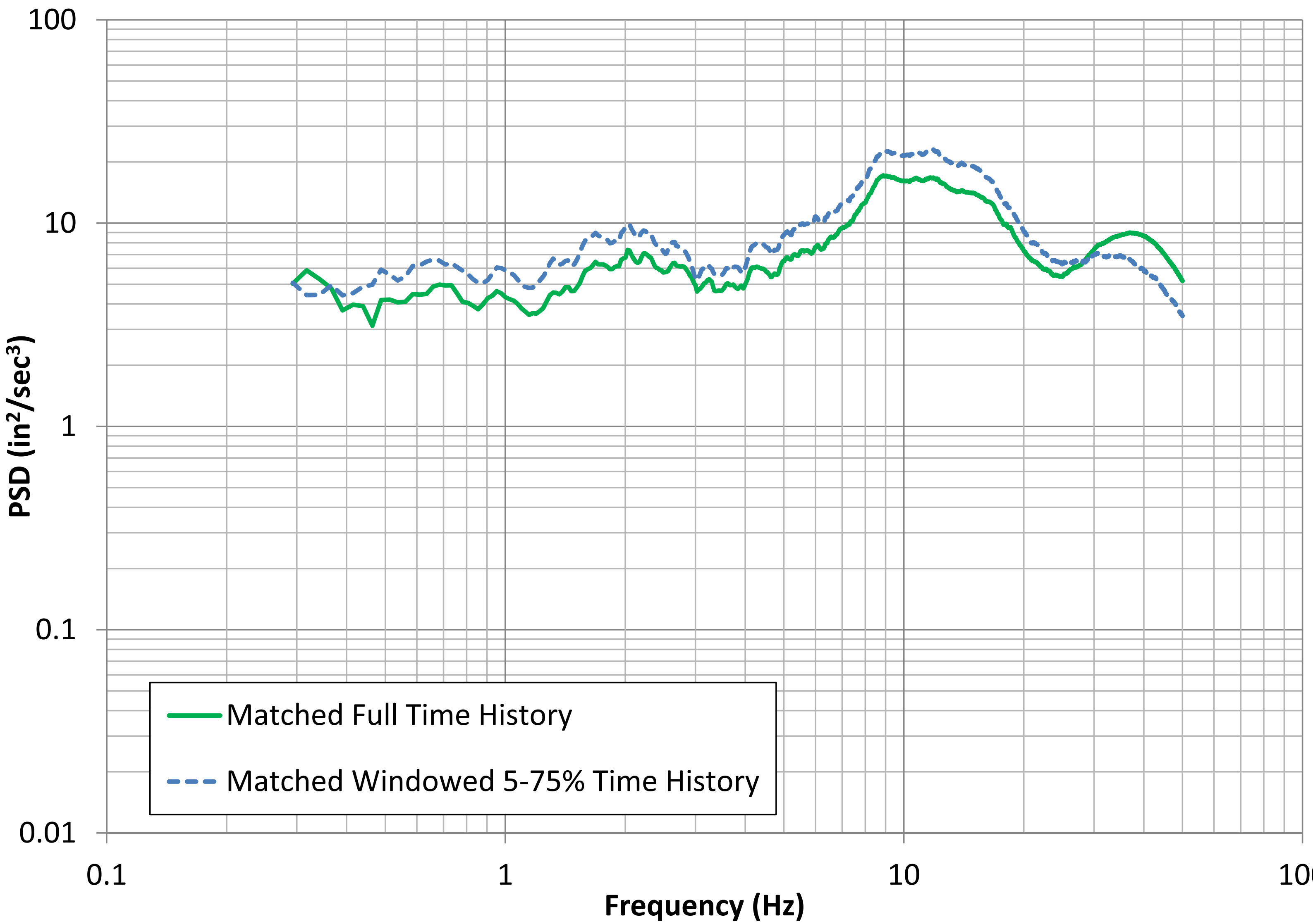


Figure 3.7.1-276 **PSD for the UP Component of the CB Partial Profile Spectrum Compatible Acceleration Time History**

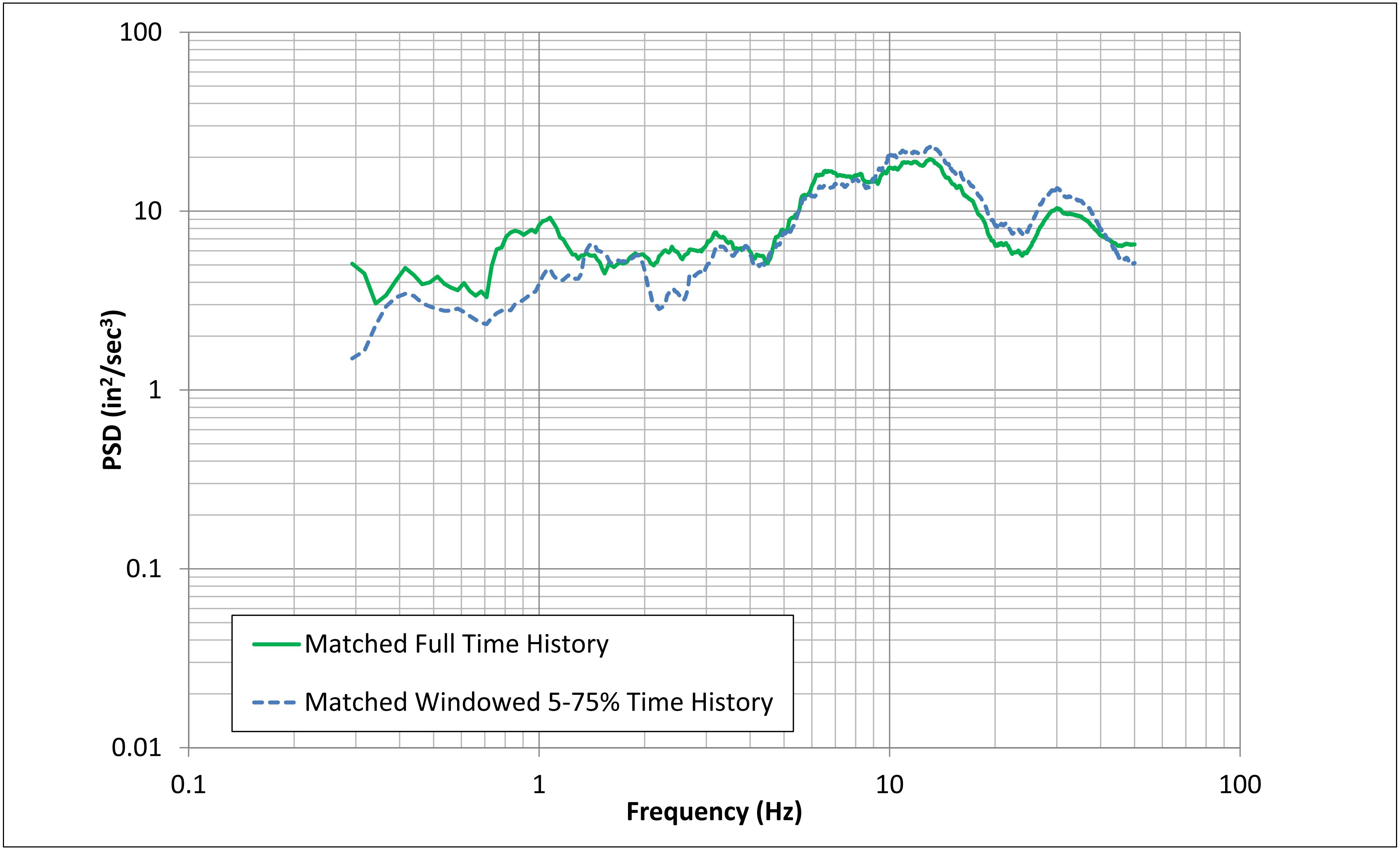


Figure 3.7.1-277 **PSD for the H1 Component of the CB Full Profile Spectrum Compatible Acceleration Time History**

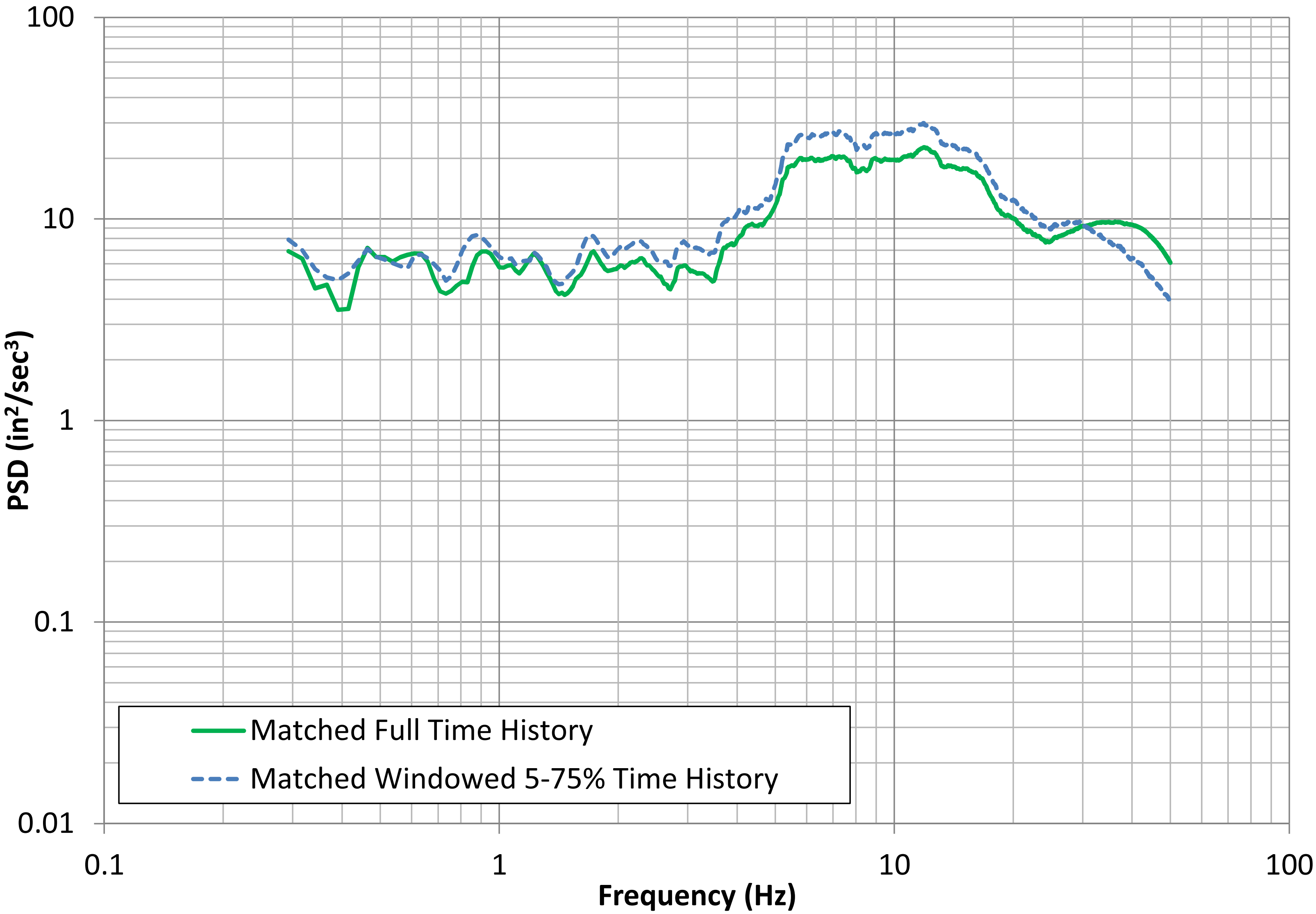


Figure 3.7.1-278 **PSD for the H2 Component of the CB Full Profile Spectrum Compatible Acceleration Time History**

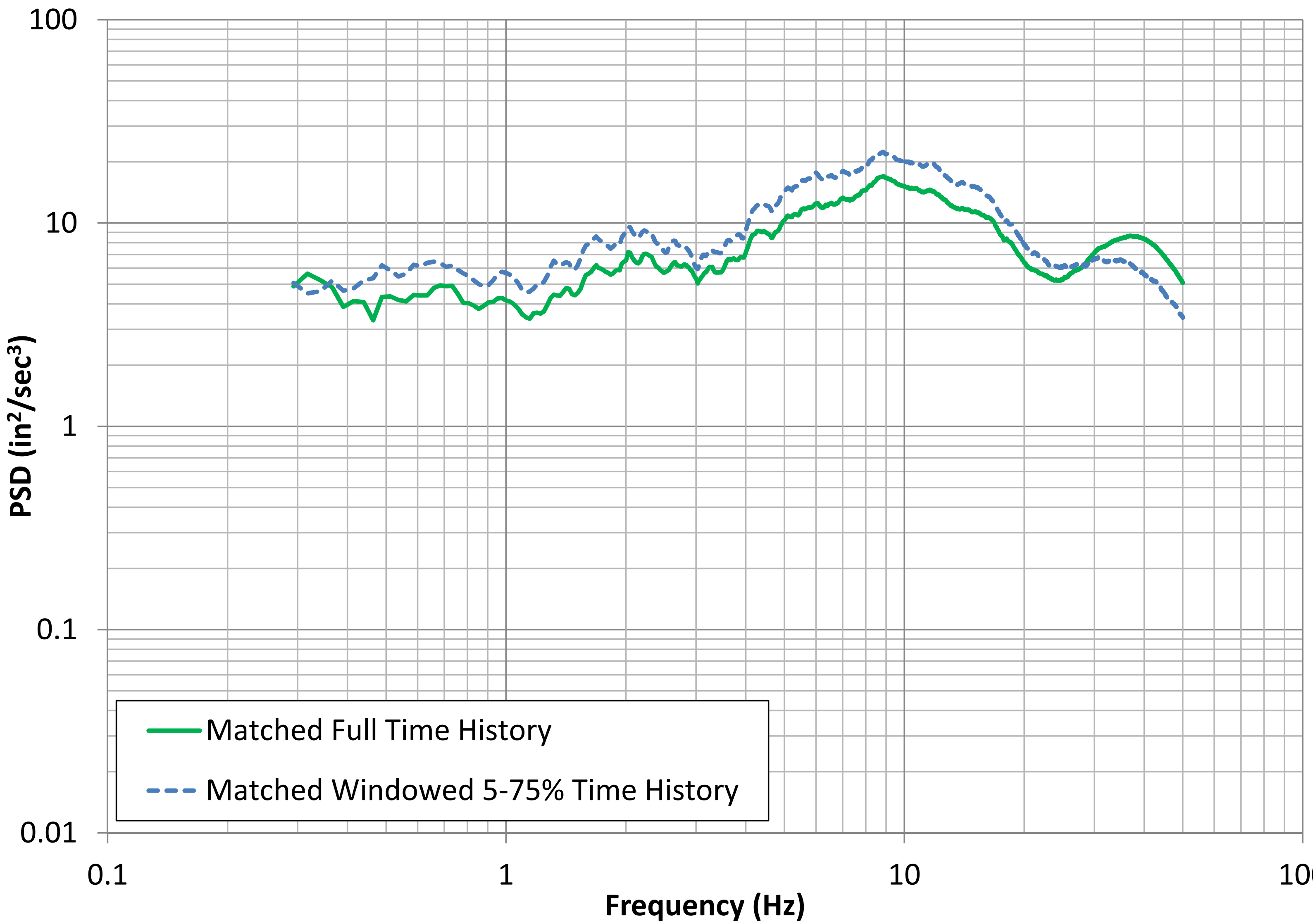
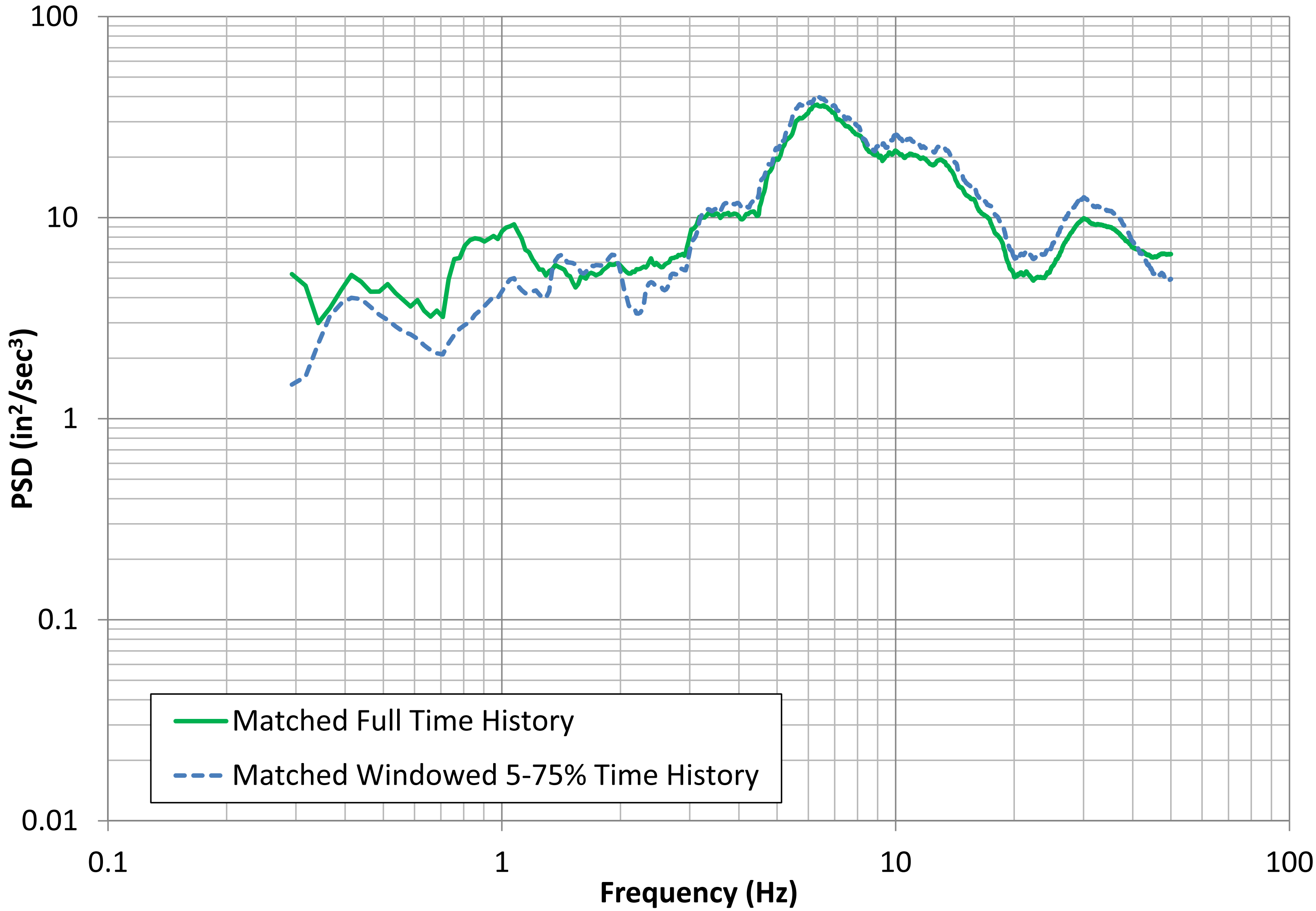


Figure 3.7.1-279 **PSD for the UP Component of the CB Full Profile Spectrum Compatible Acceleration Time History**



NAPS SUP 3.7-2 Figure 3.7.1-280 **PSD for the H1 Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 282 ft**

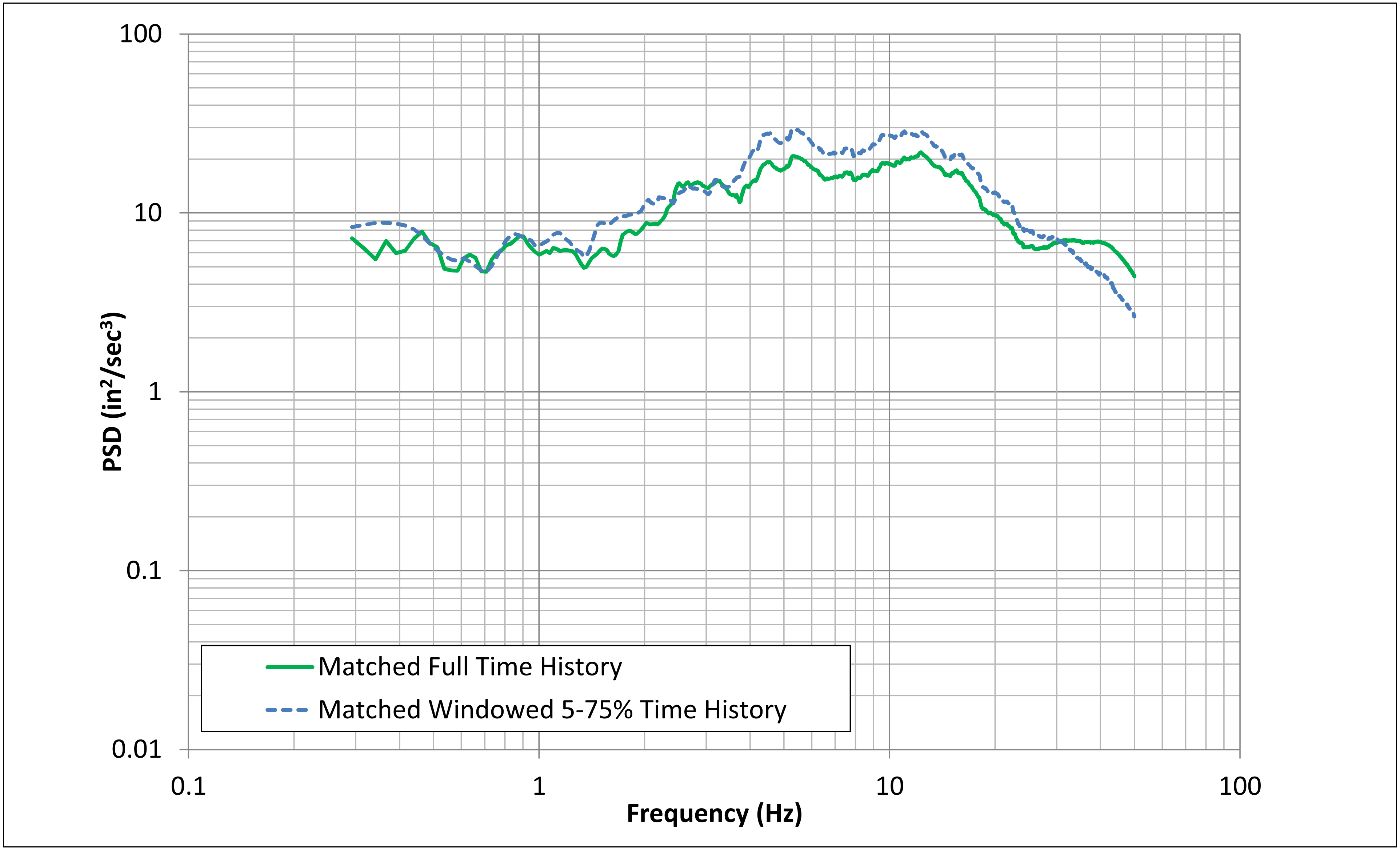


Figure 3.7.1-281 **PSD for the H2 Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 282 ft**

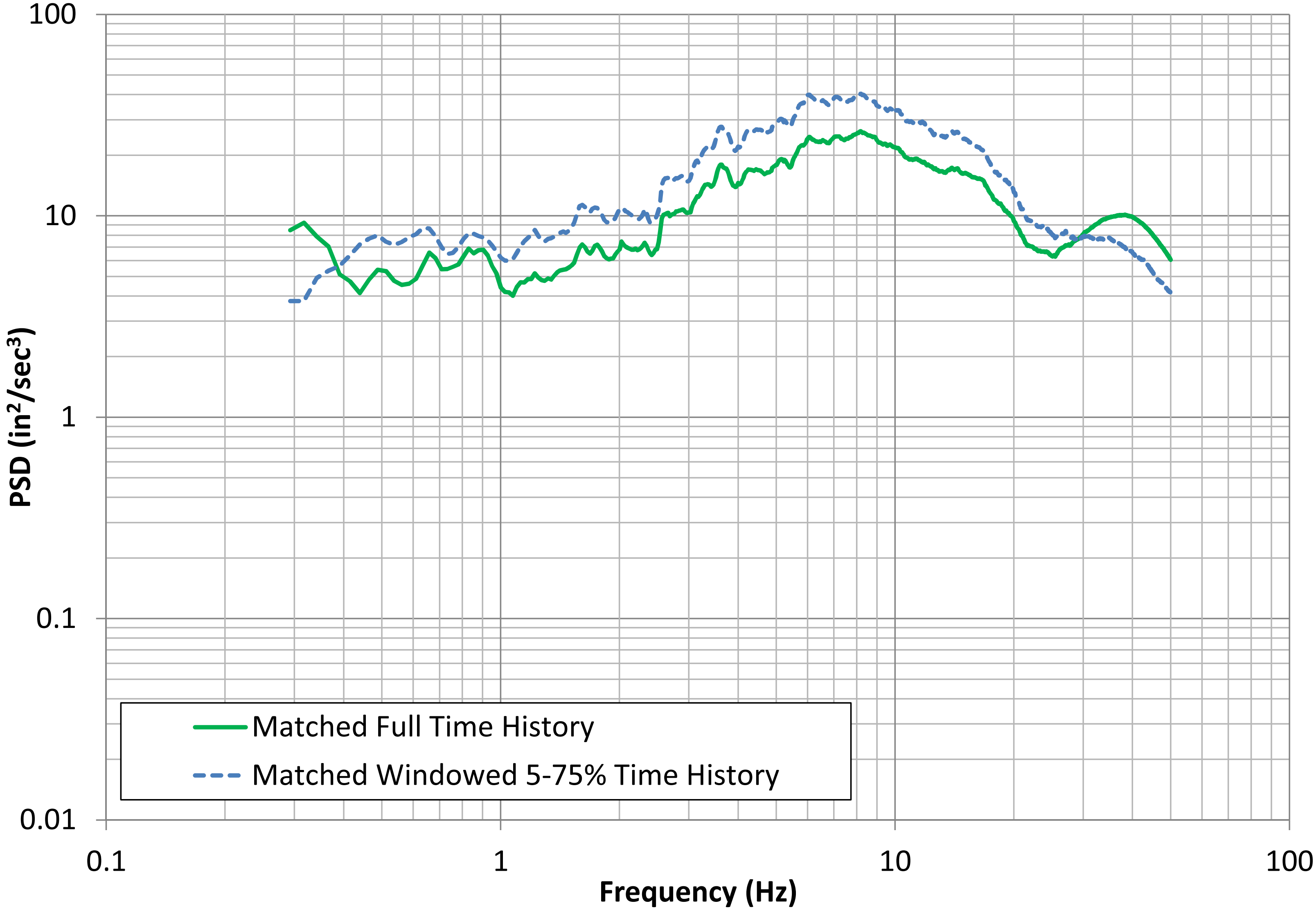
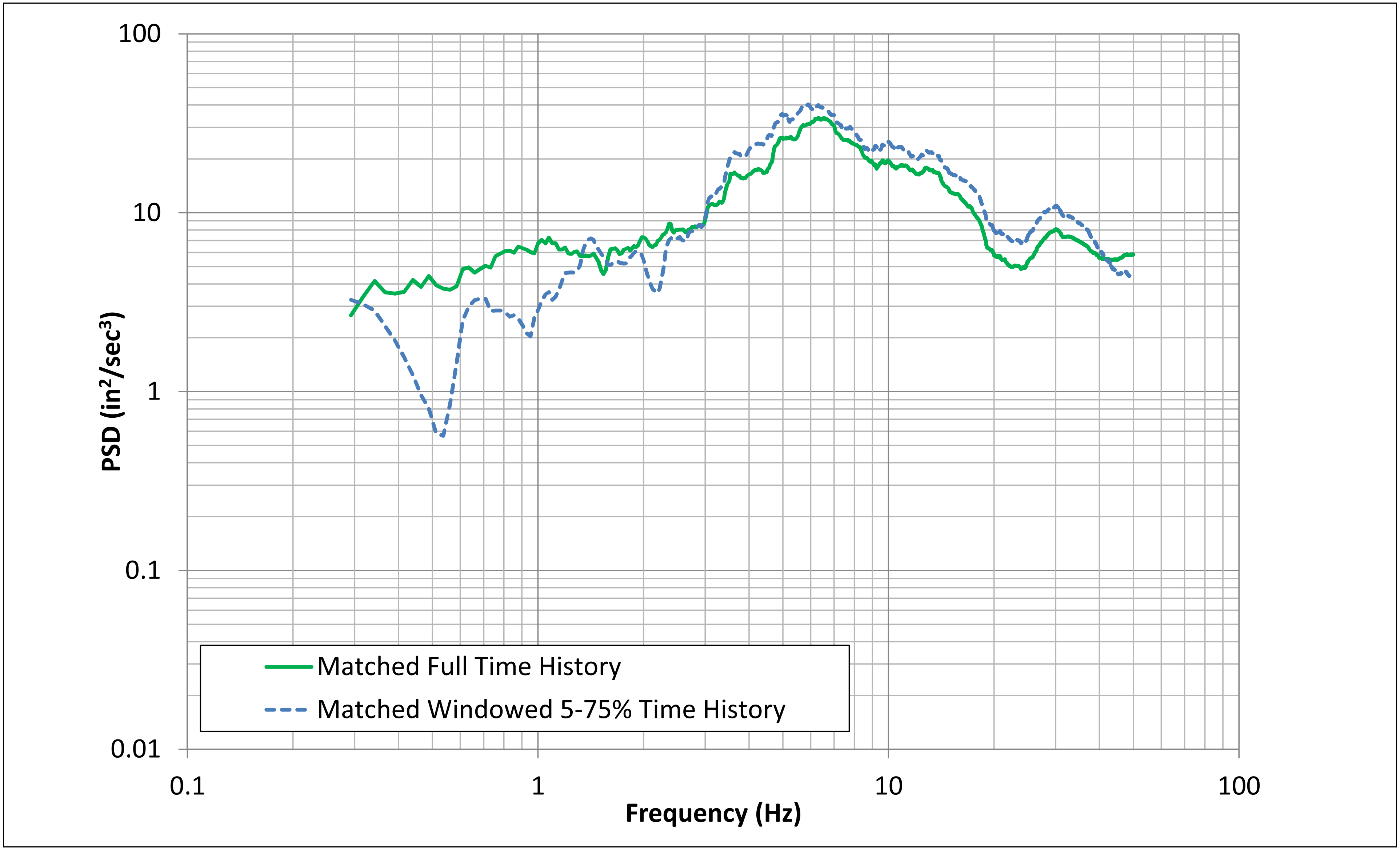


Figure 3.7.1-282 **PSD for the UP Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 282 ft**



NAPS SUP 3.7-1 Figure 3.7.1-283 **Development of 5% Damped Final Horizontal SSI Input Response Spectrum at Elevation 220 ft for FWSC**

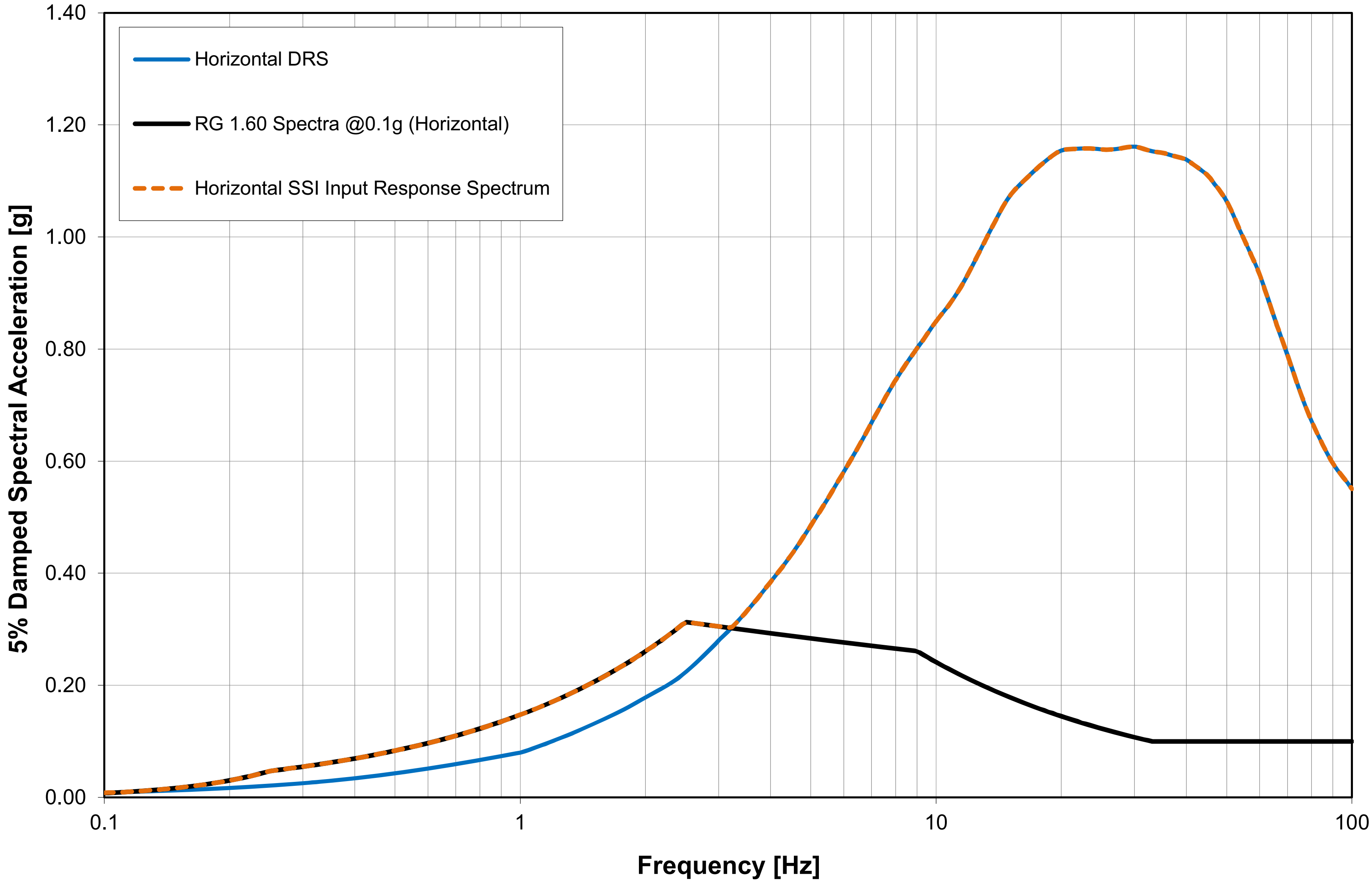
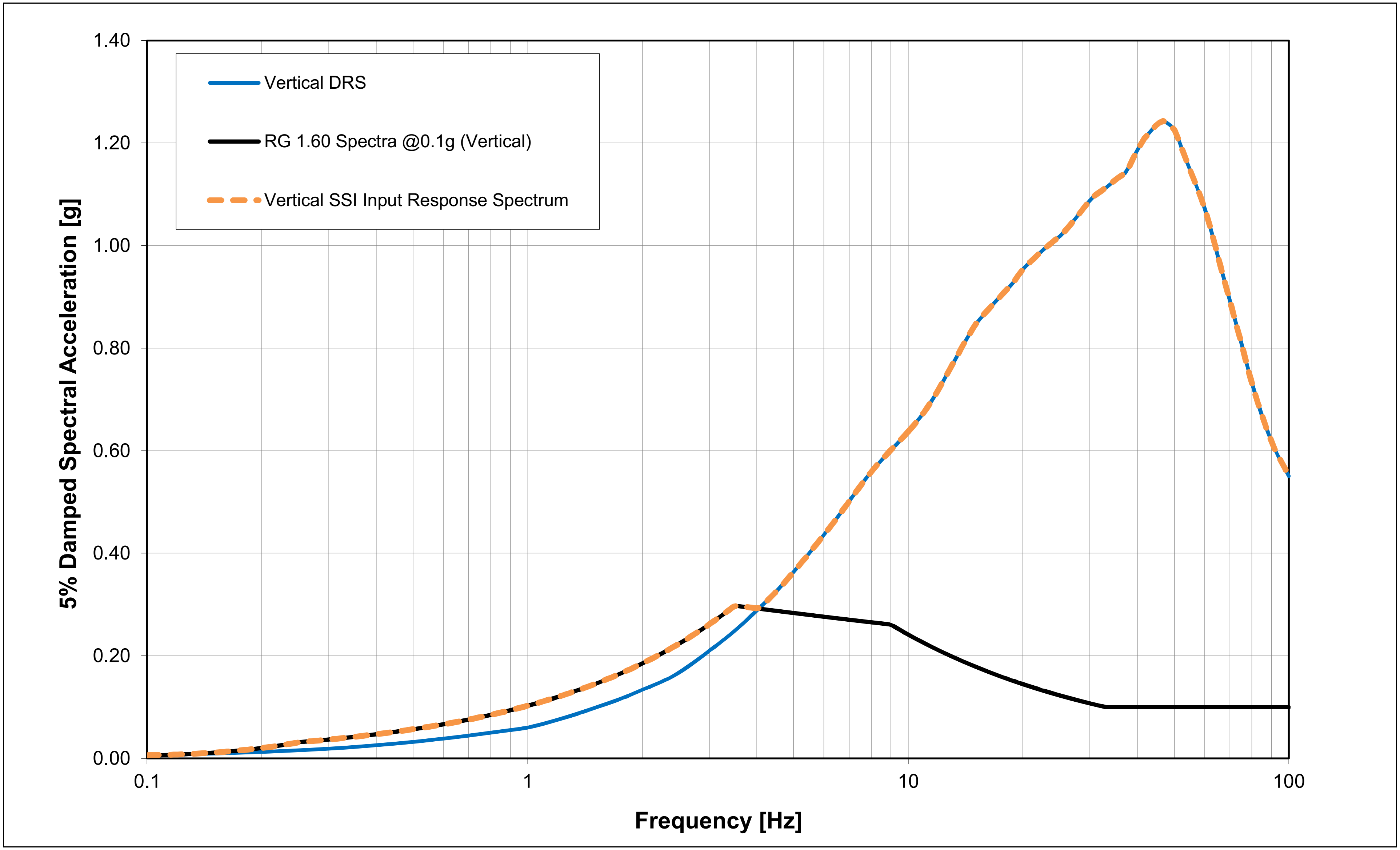
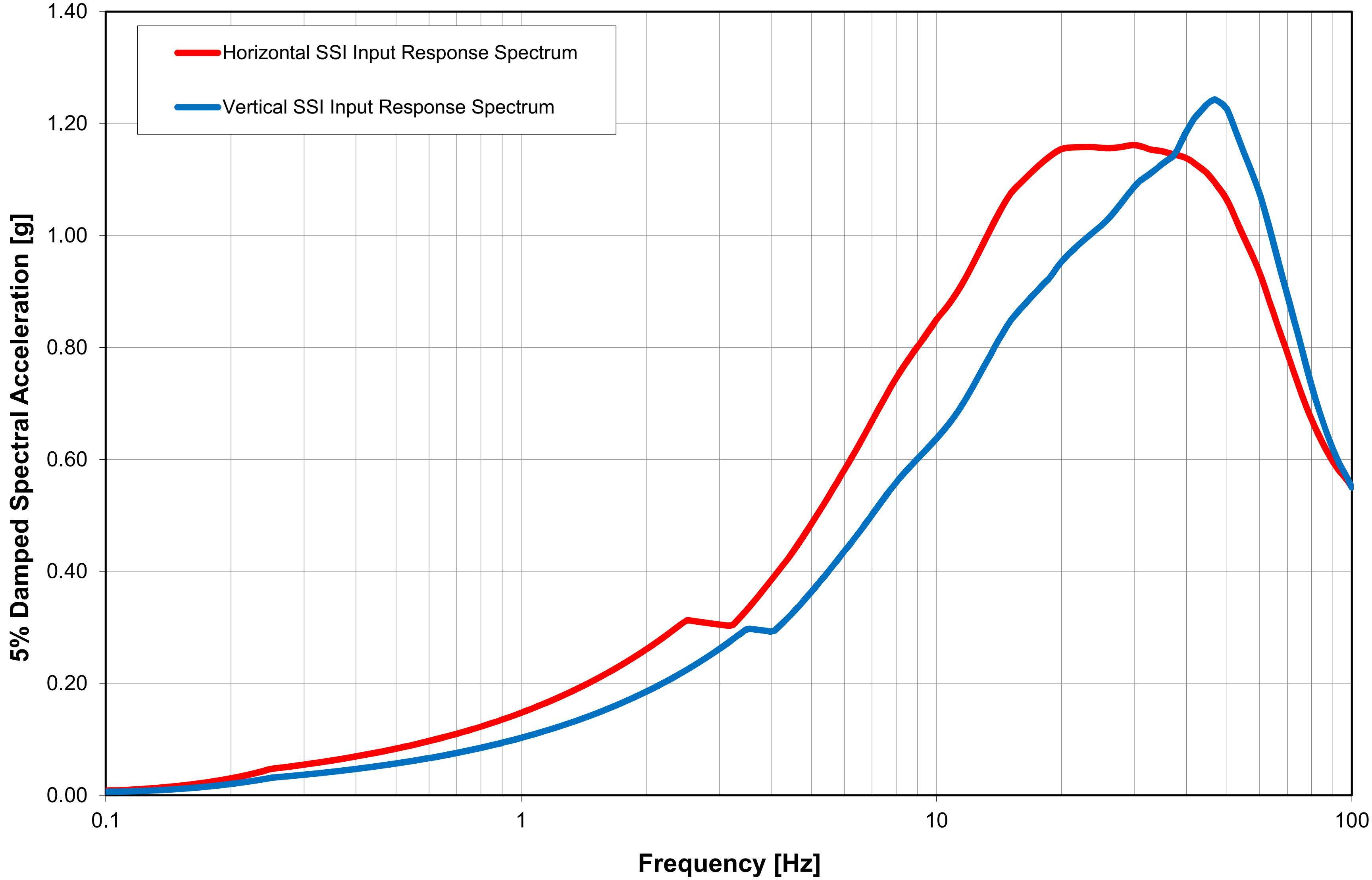


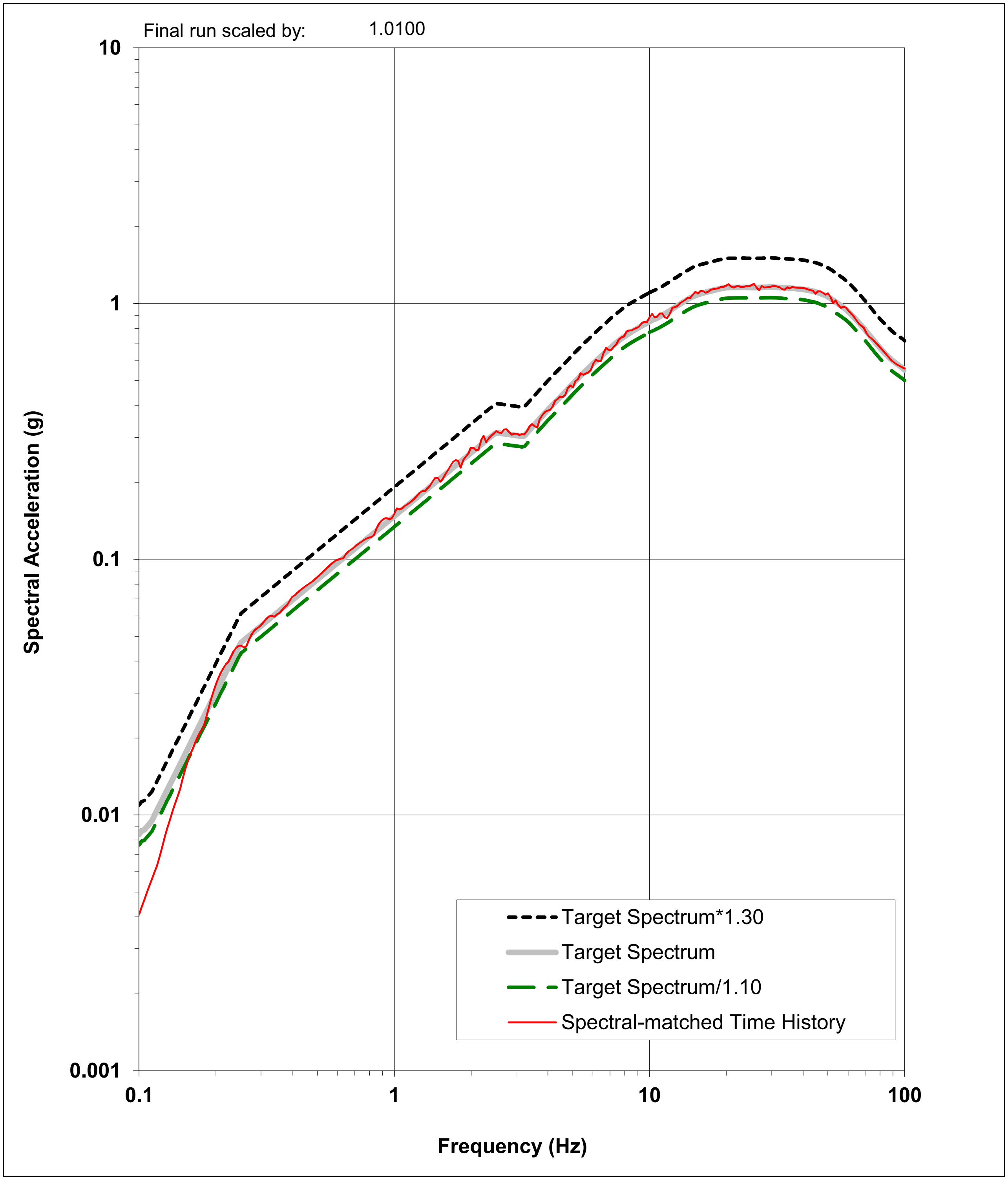
Figure 3.7.1-284 **Development of 5% Damped Final Vertical SSI Input Response Spectrum at Elevation 220 ft for FWSC**



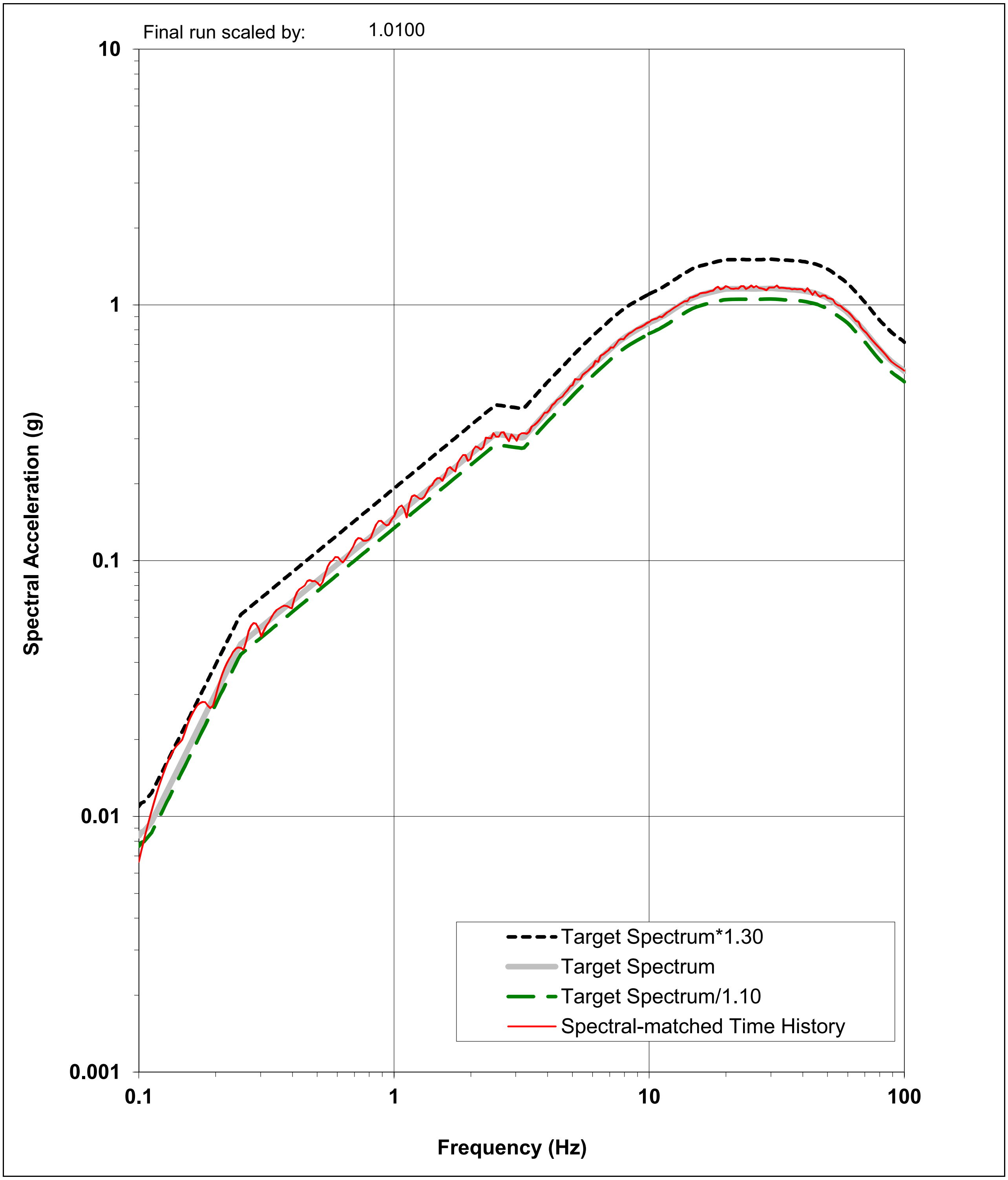
NAPS SUP 3.7-1 Figure 3.7.1-285 **5% Damped Final SSI Input Response Spectra at Elevation 220 ft for FWSC**



NAPS SUP 3.7-2 Figure 3.7.1-286 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, H1 Component at Elevation 220 ft**



NAPS SUP 3.7-2 Figure 3.7.1-287 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, H2 Component at Elevation 220 ft**



NAPS SUP 3.7-2 Figure 3.7.1-288 **Comparison between the Final Scaled Spectrum Compatible Response Spectrum, the Target Spectrum, and Upper and Lower Target Spectrum Bounds for the FWSC, UP Component at Elevation 220 ft**

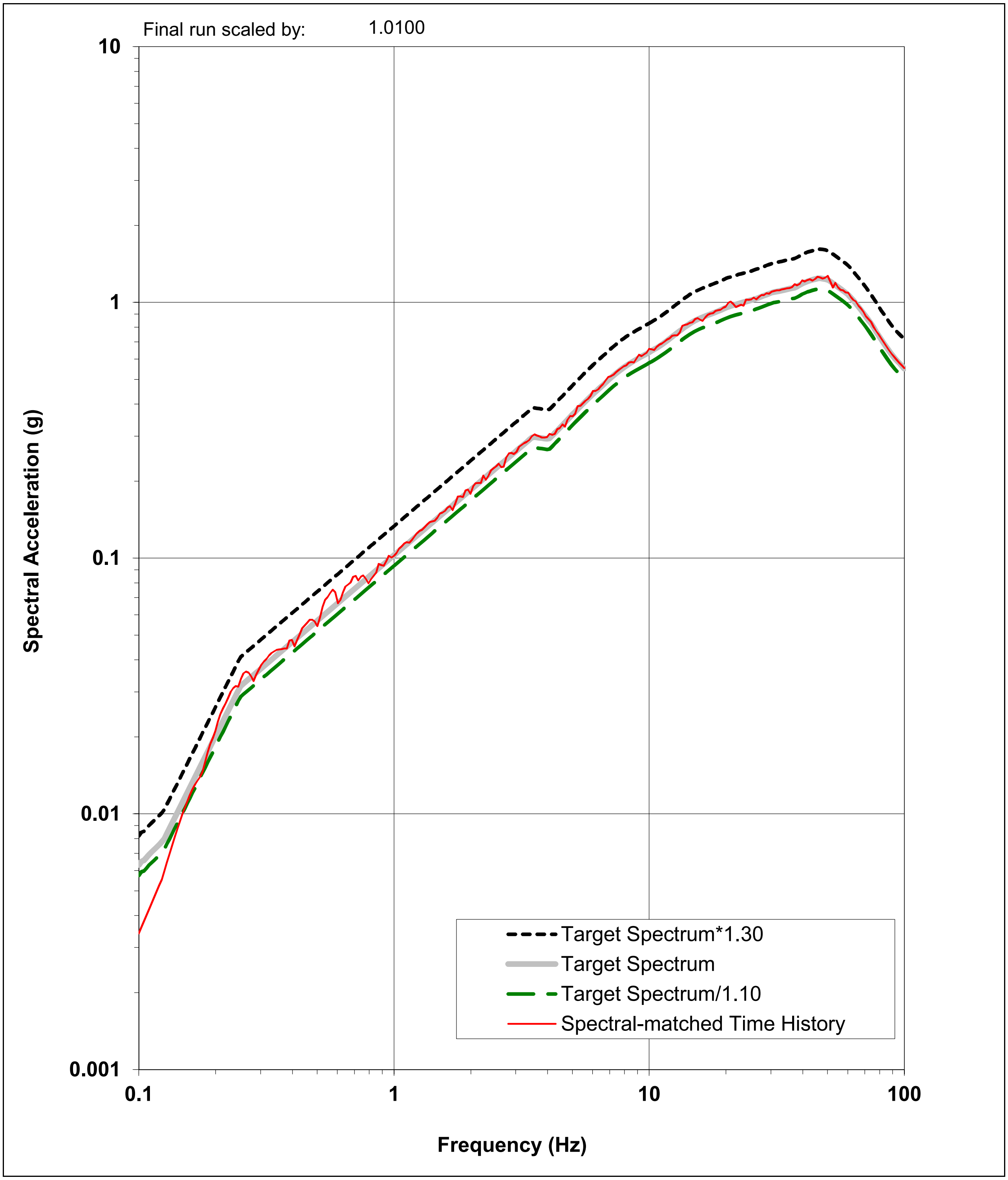
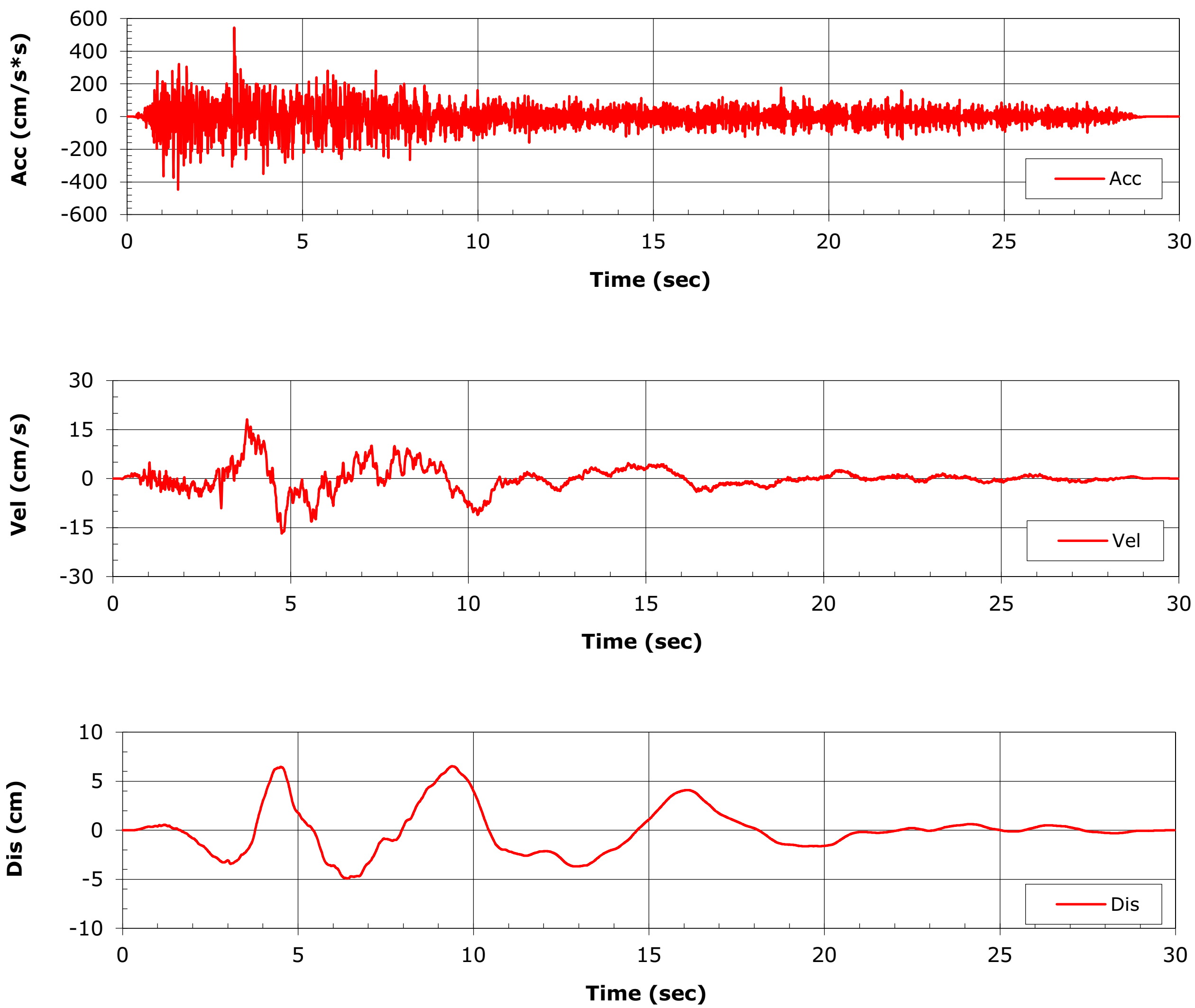


Figure 3.7.1-289 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, H1 Component at Elevation 220 ft**



NAPS SUP 3.7-2 Figure 3.7.1-290 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, H2 Component at Elevation 220 ft**

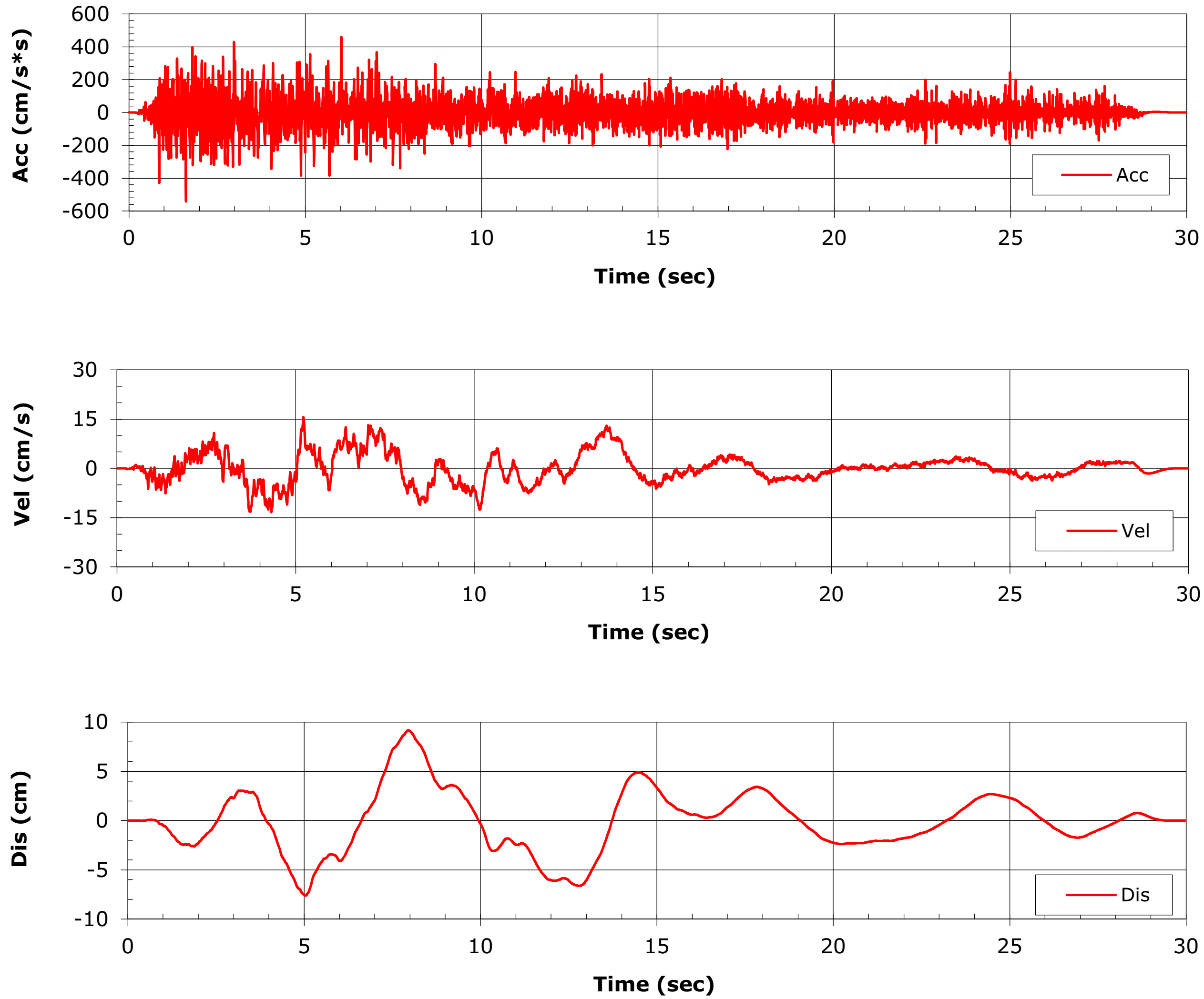


Figure 3.7.1-291 **Acceleration, Velocity, and Displacement Spectrally Matched Partial Column Outcrop Time Histories for the FWSC, UP Component at Elevation 220 ft**

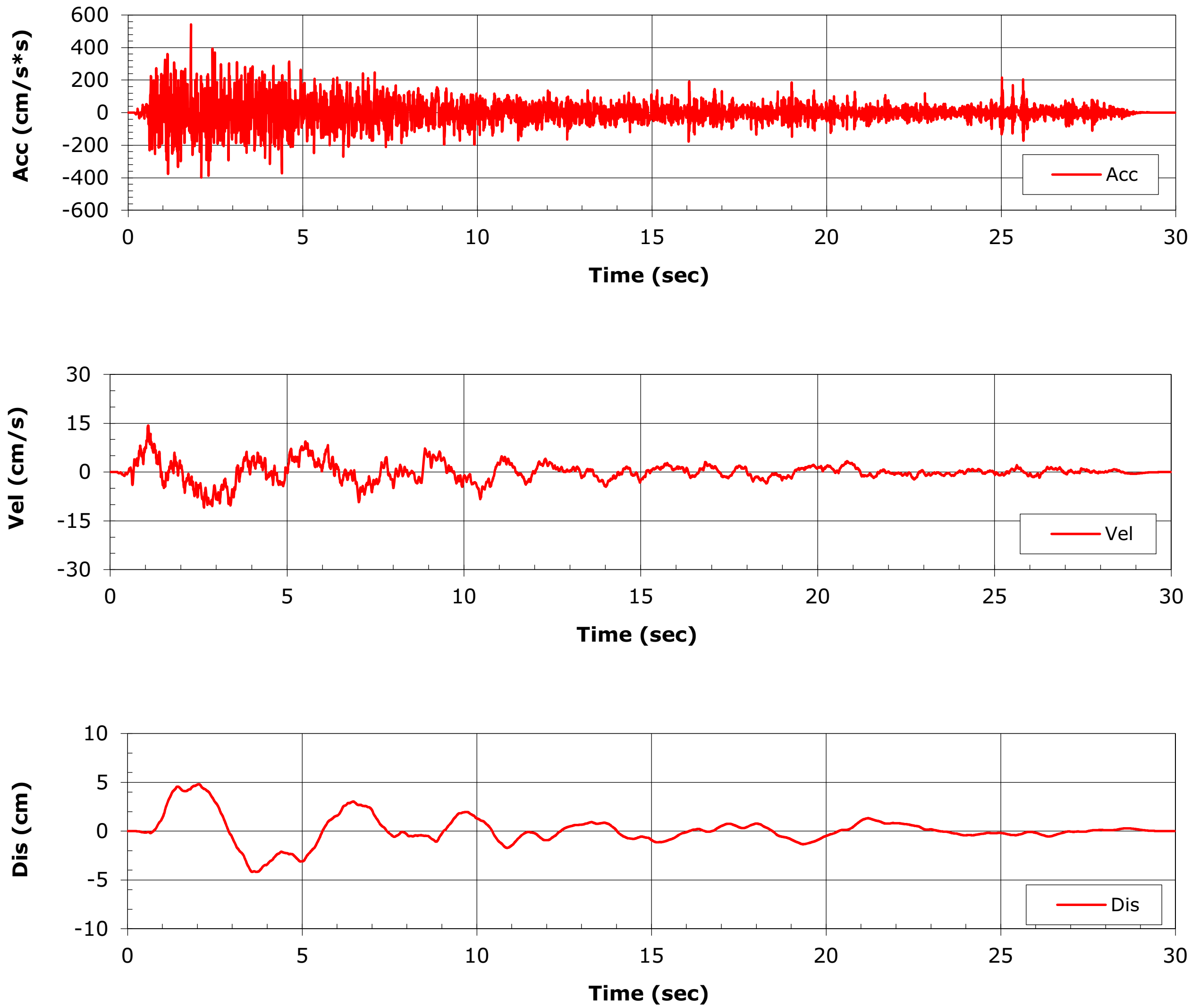


Figure 3.7.1-292 **PSD for the H1 Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 220 ft**

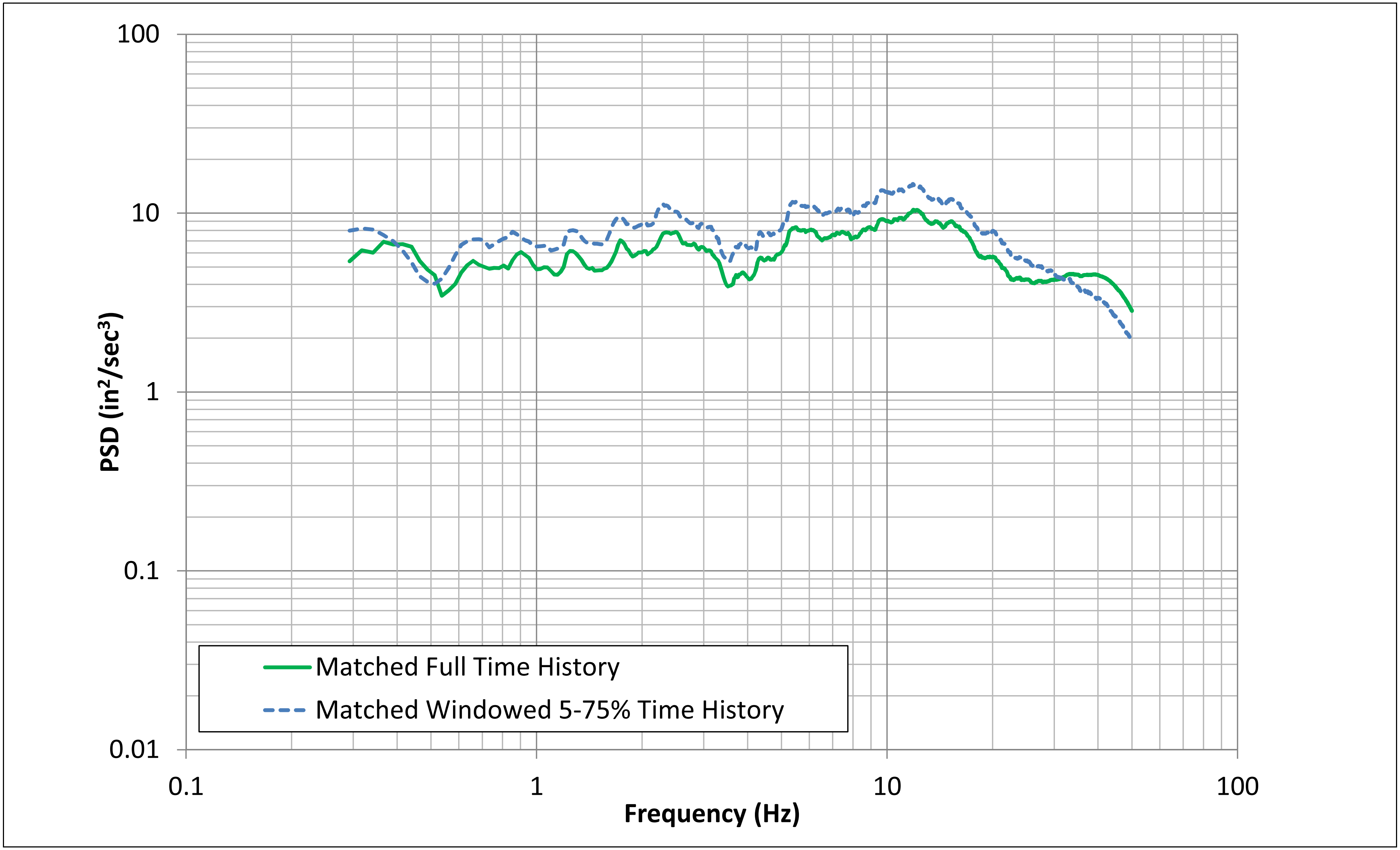


Figure 3.7.1-293 **PSD for the H2 Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 220 ft**

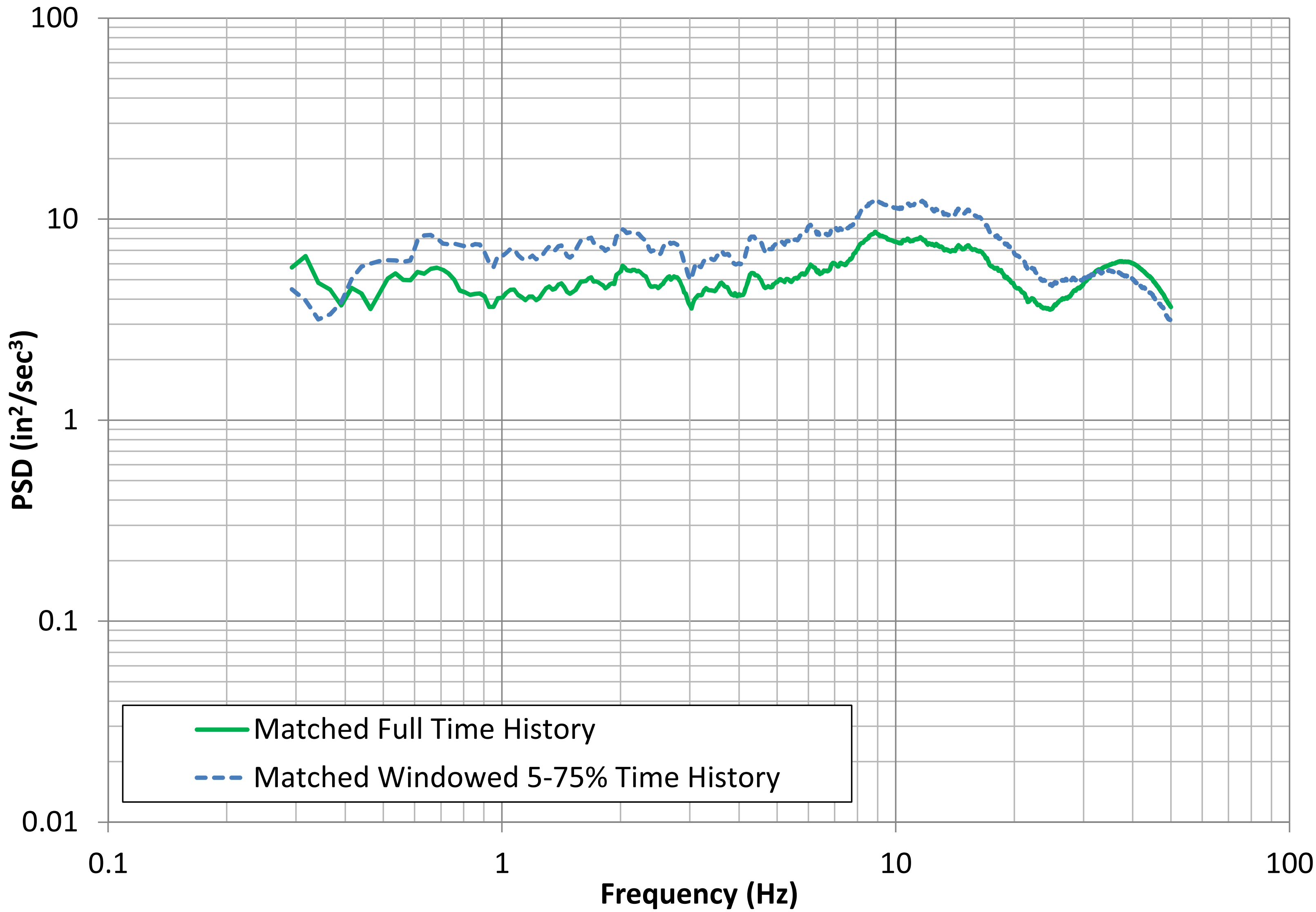


Figure 3.7.1-294 **PSD for the UP Component of the FWSC Spectrum Compatible Acceleration Time History at Elevation 220 ft**

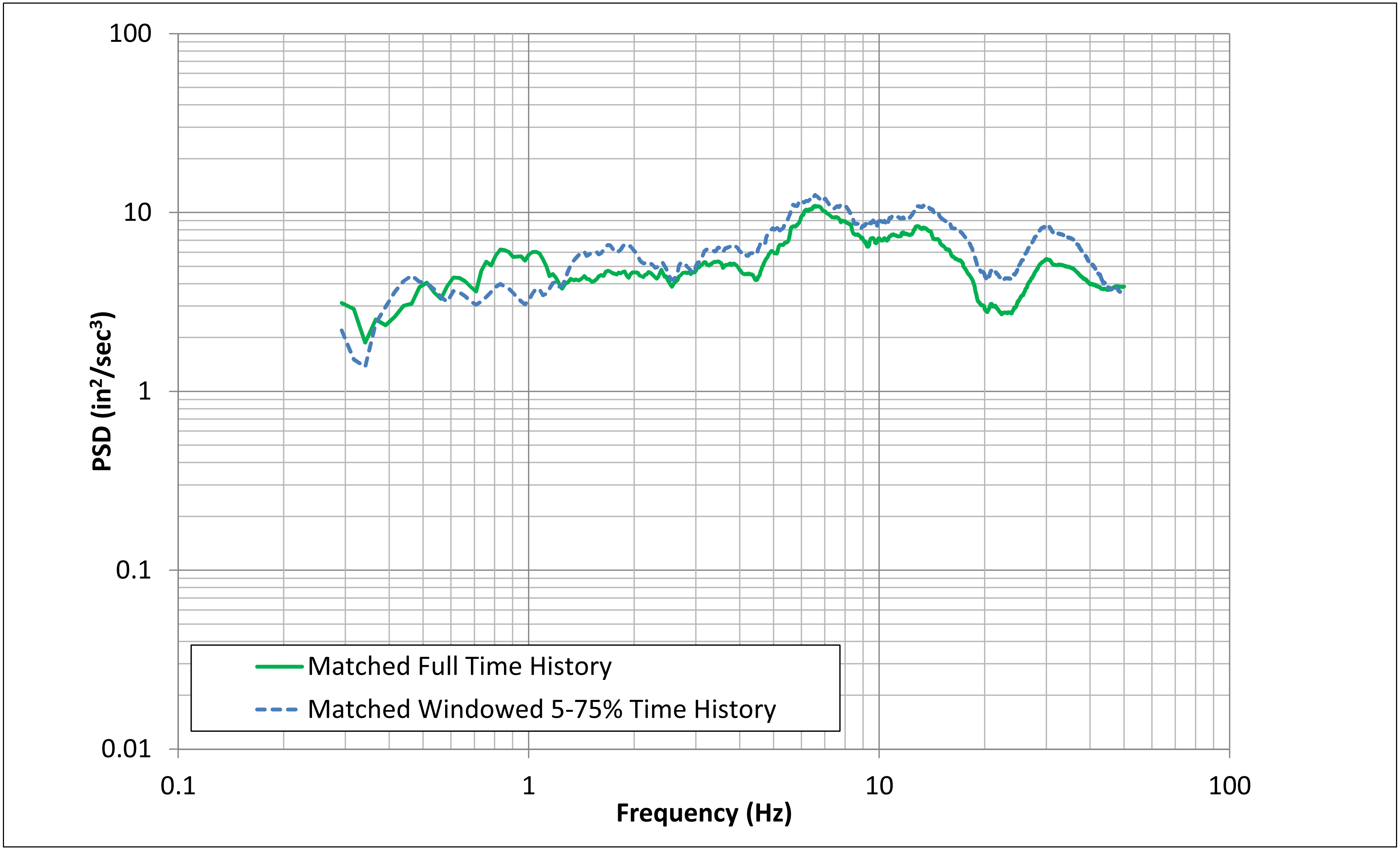


Figure 3.7.1-295 **Confirmatory NEI Check for Fully Embedded RB/FB, H1**

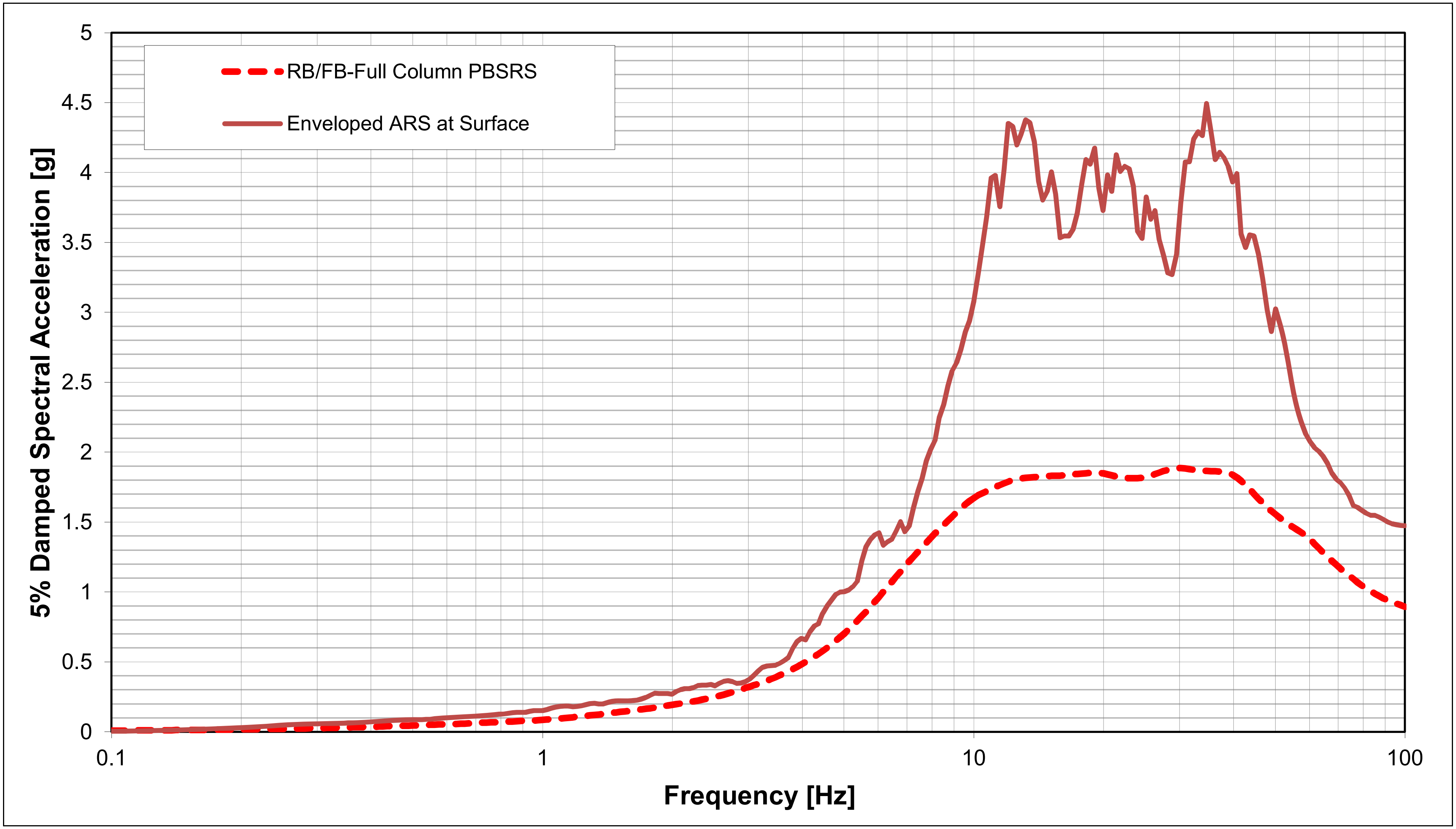


Figure 3.7.1-296 **Confirmatory NEI Check for Fully Embedded RB/FB, H2**

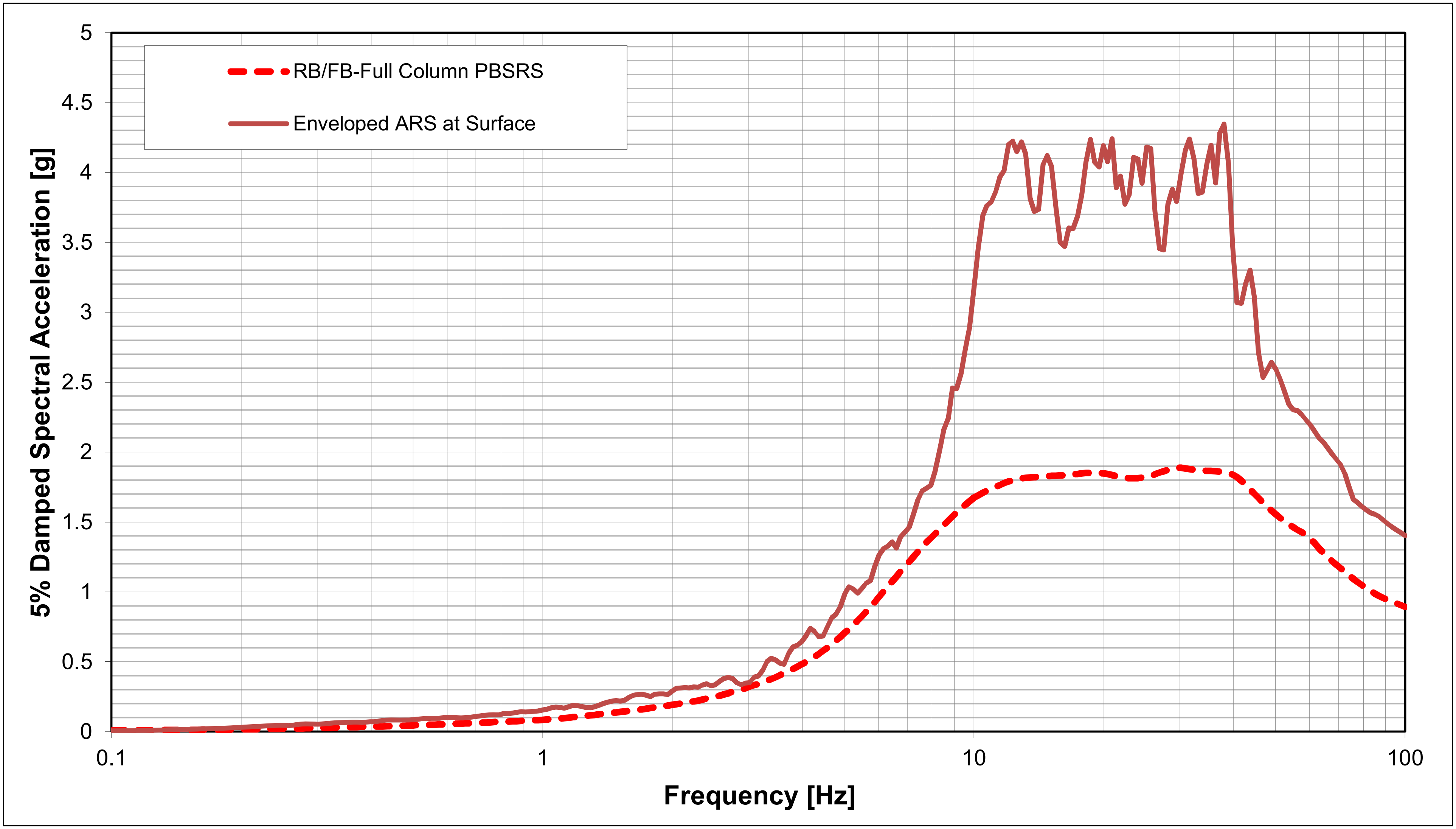


Figure 3.7.1-297 **Confirmatory NEI Check for Fully Embedded RB/FB, UP**

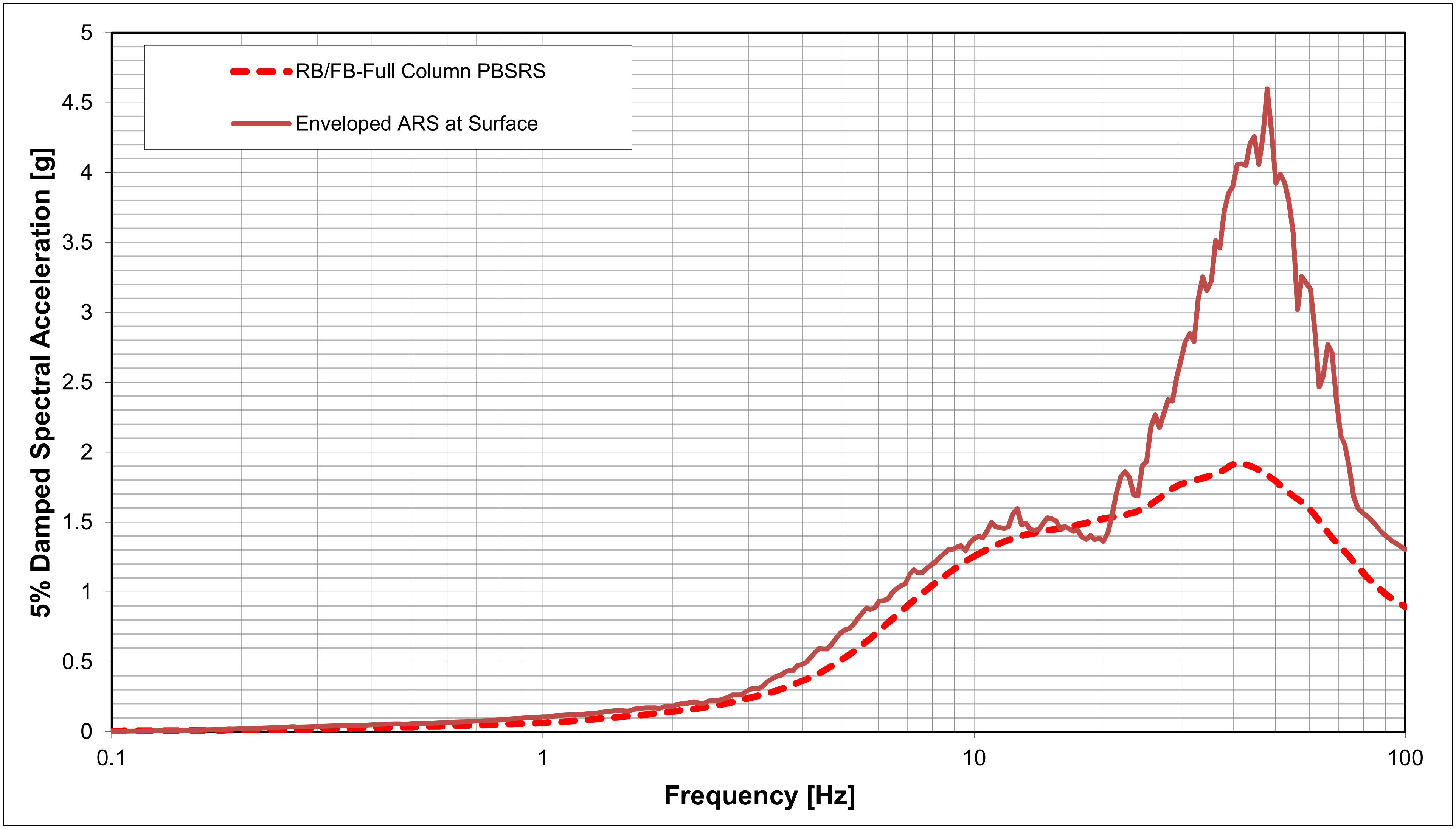


Figure 3.7.1-298 **Confirmatory NEI Check for Partially Embedded RB/FB, H1**

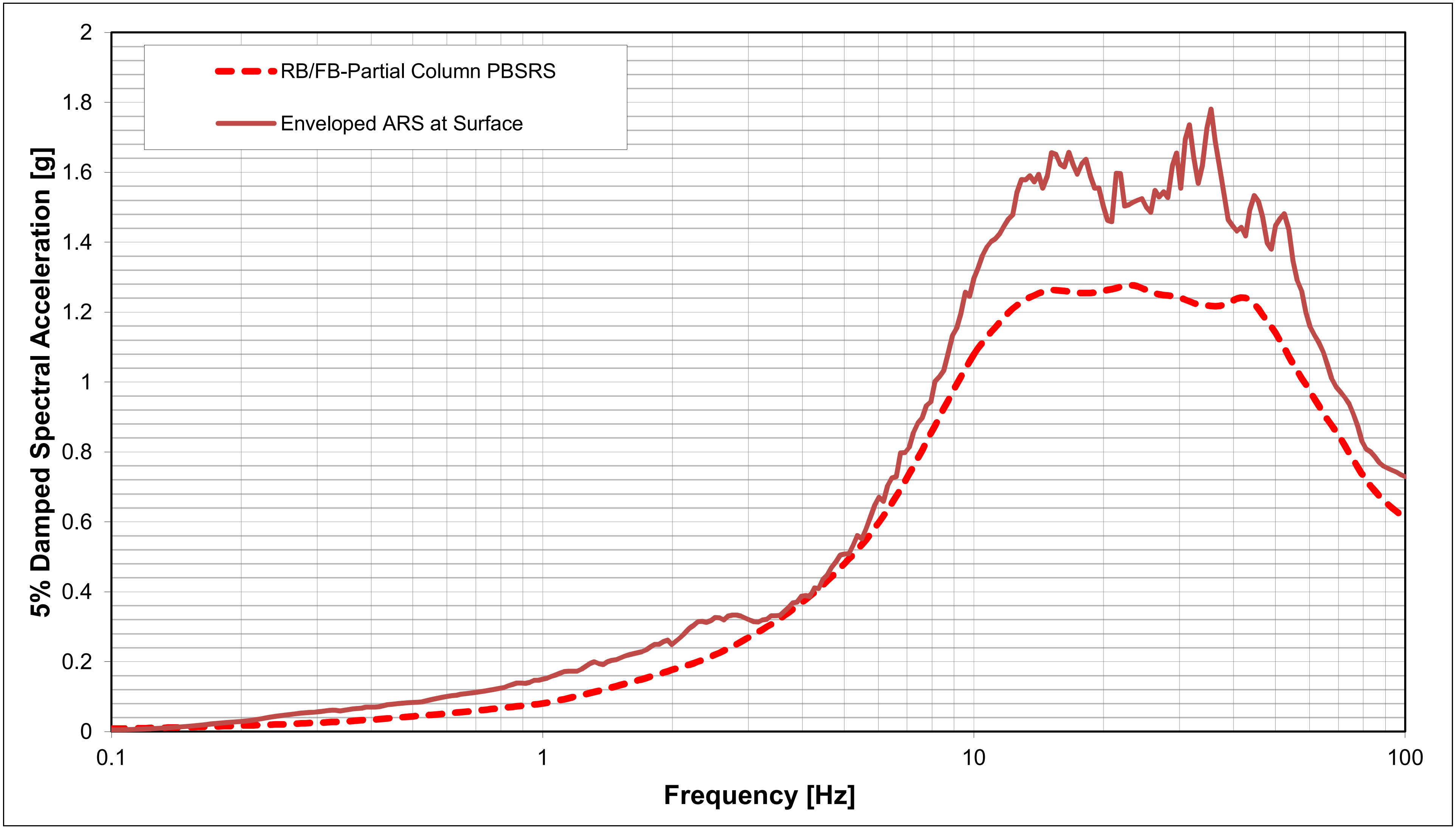


Figure 3.7.1-299 **Confirmatory NEI Check for Partially Embedded RB/FB, H2**

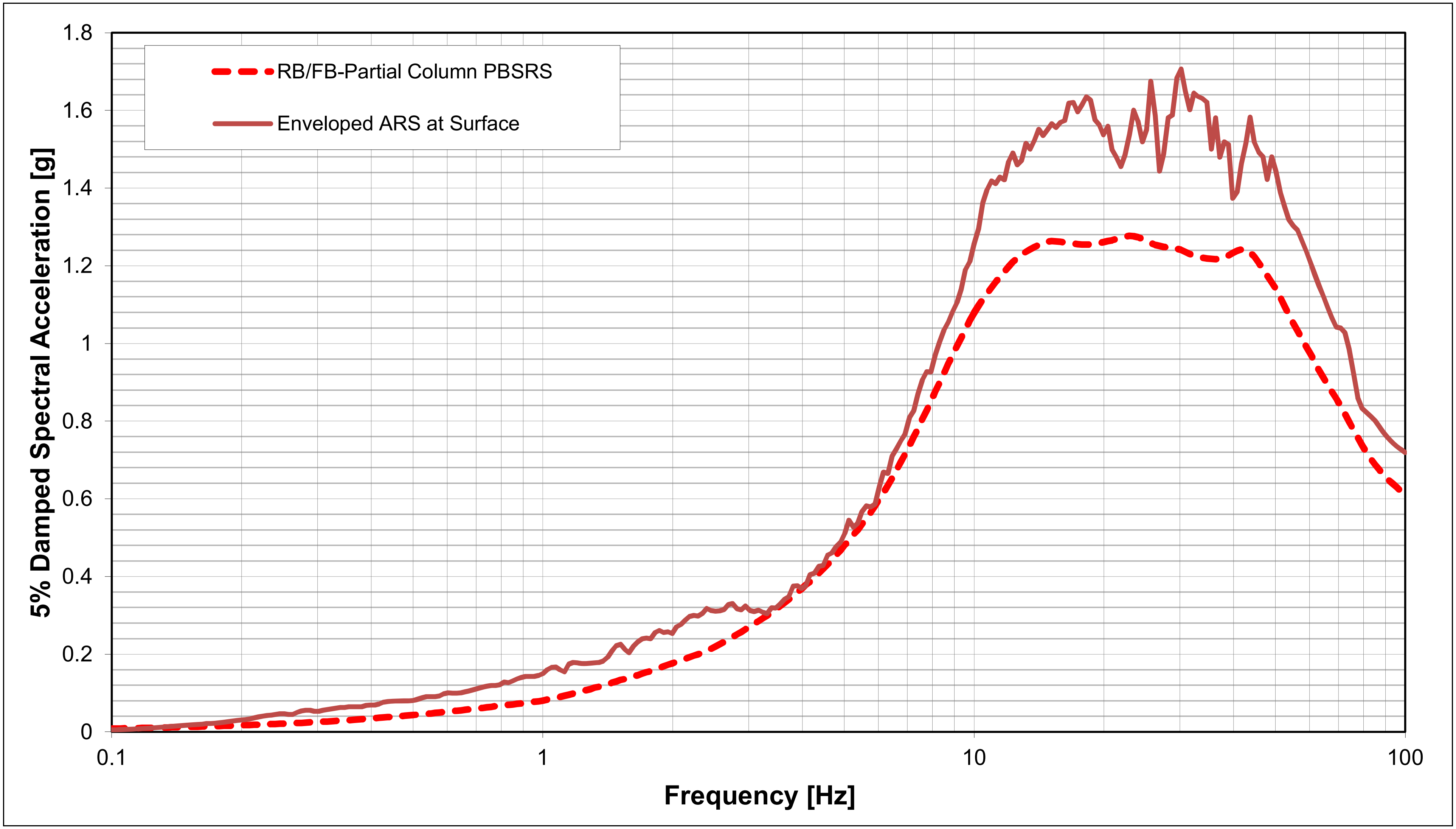
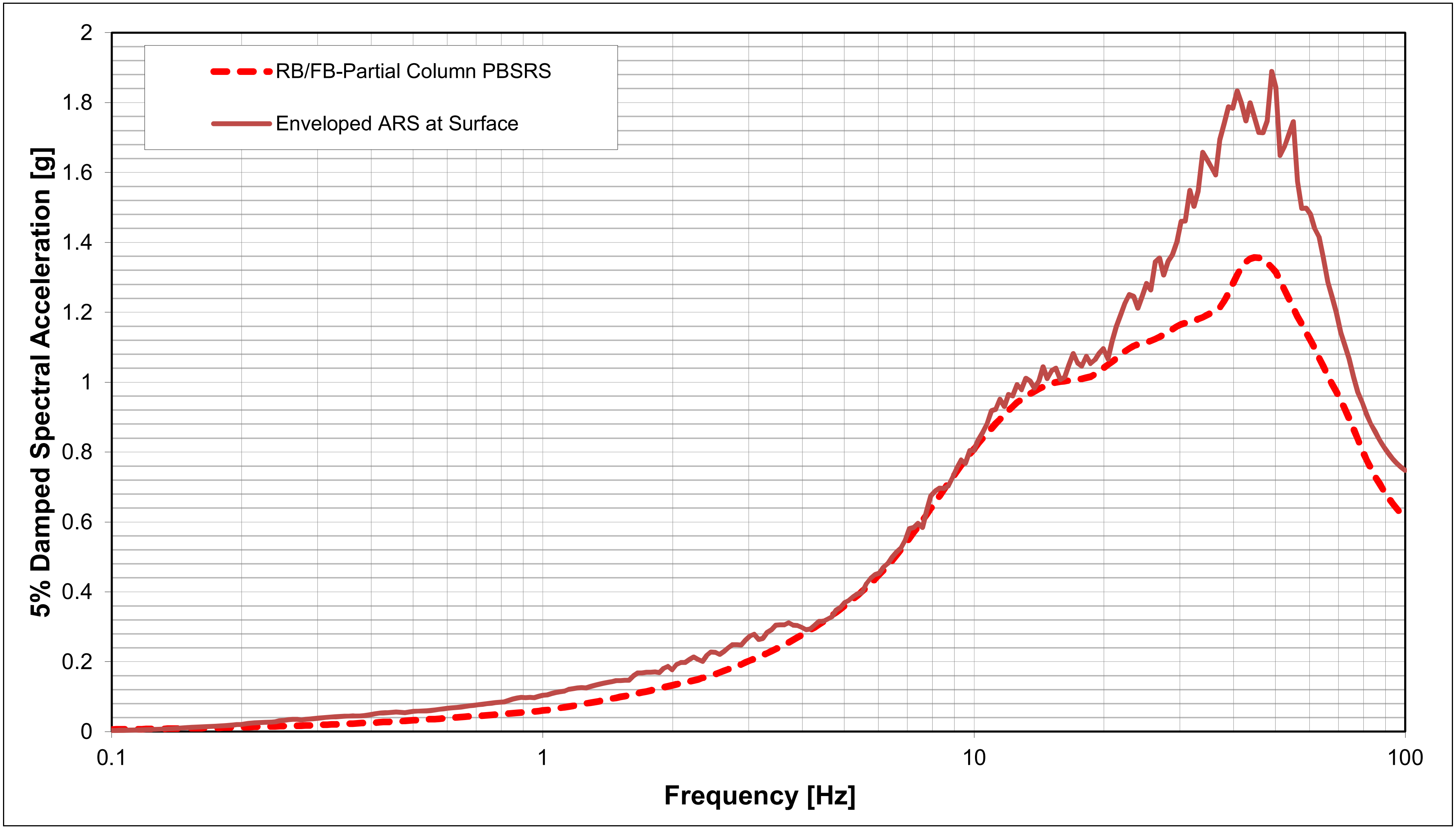


Figure 3.7.1-300 **Confirmatory NEI Check for Partially Embedded RB/FB, UP**



NAPS SUP 3.7-2 Figure 3.7.1-301 **Confirmatory NEI Check for Fully Embedded CB, H1**

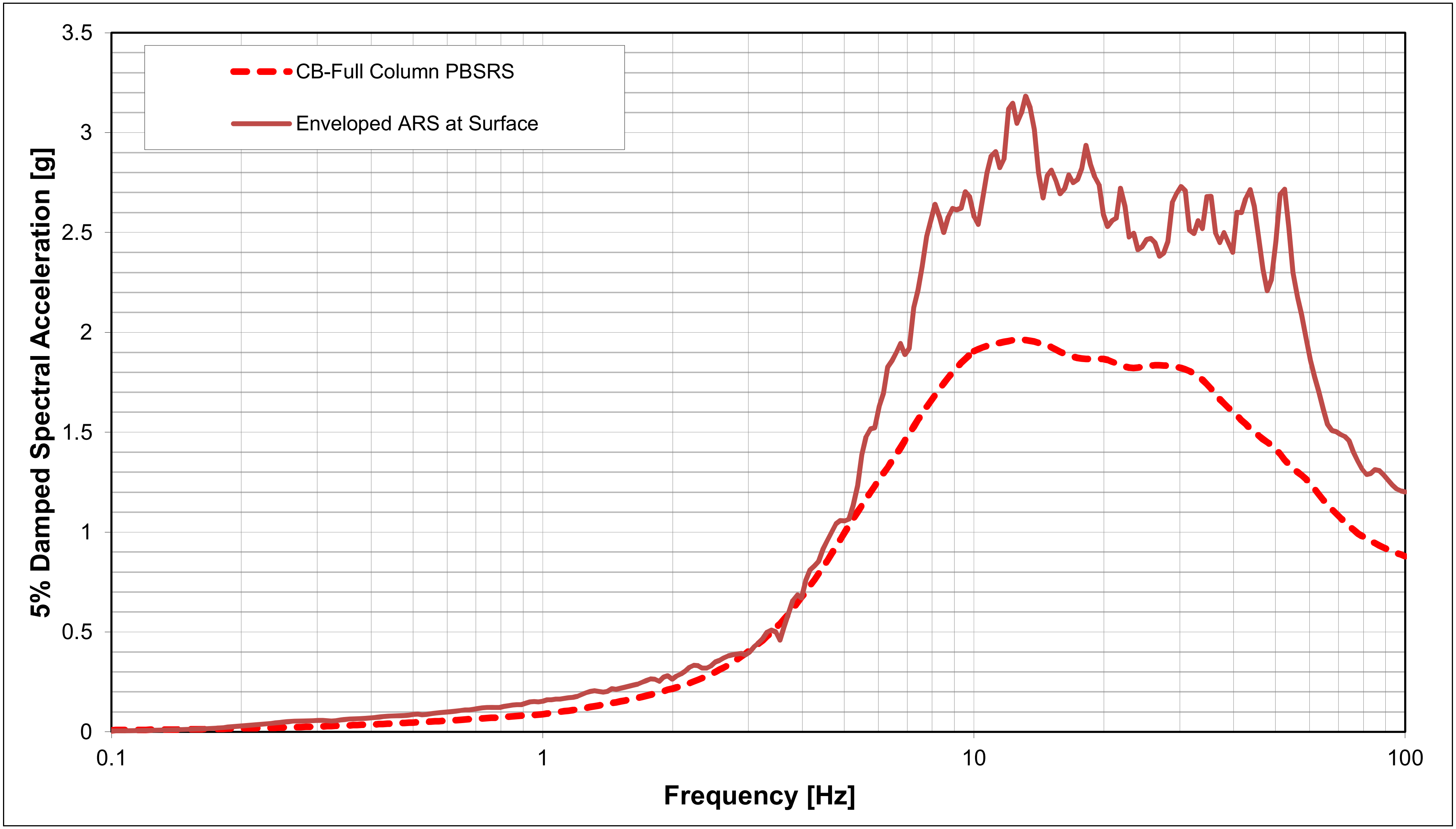


Figure 3.7.1-302 **Confirmatory NEI Check for Fully Embedded CB, H2**

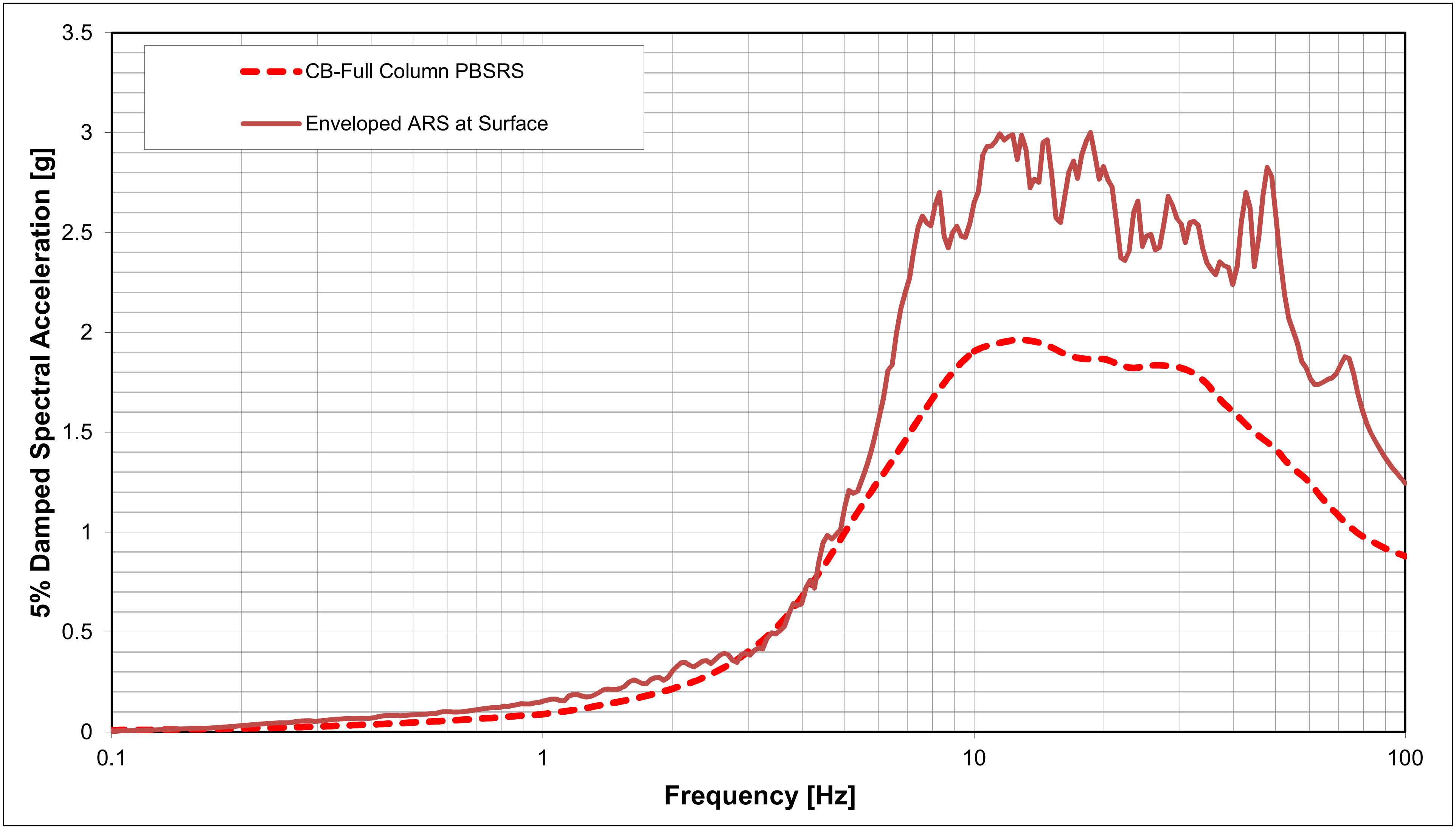
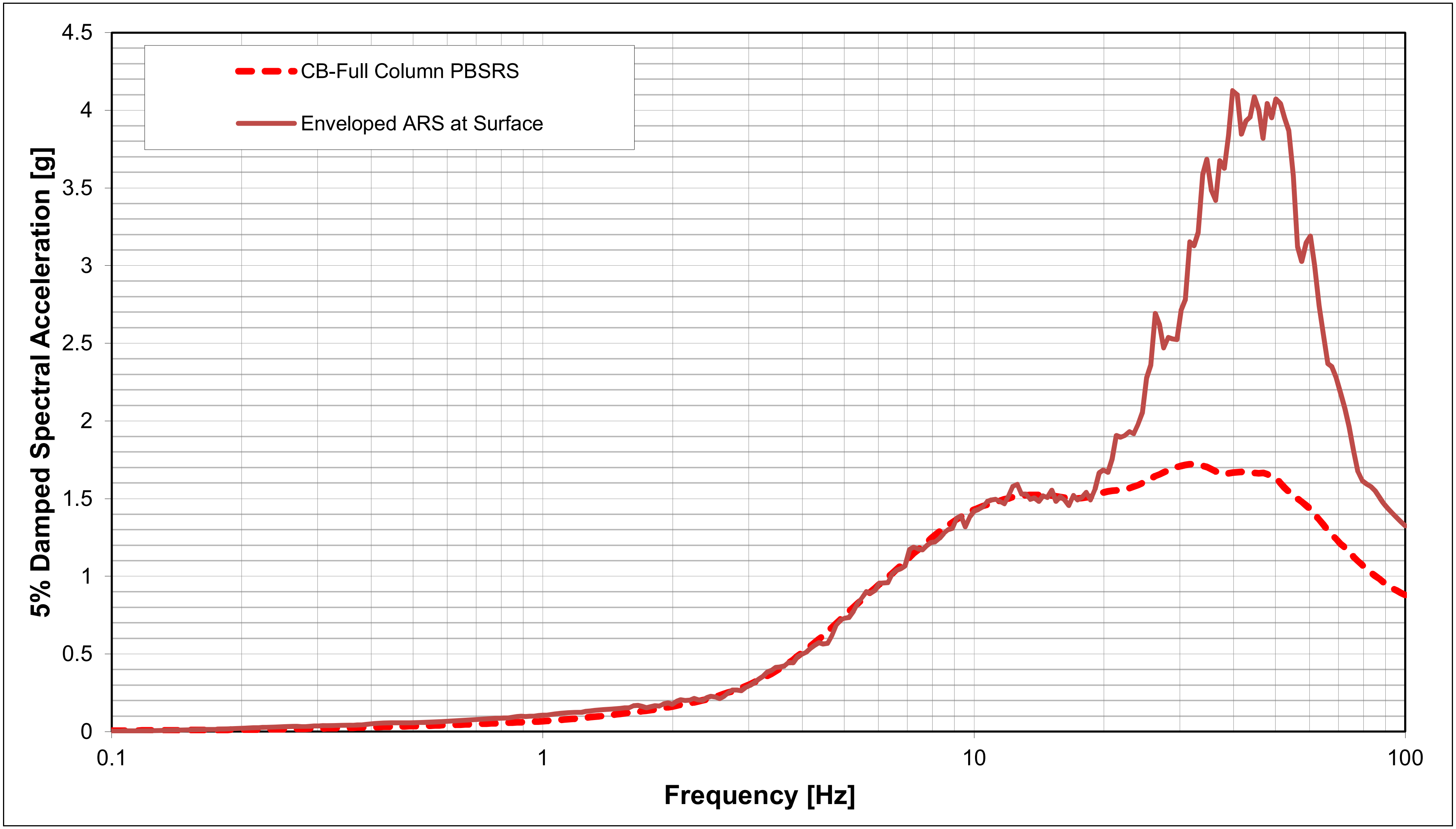


Figure 3.7.1-303 **Confirmatory NEI Check for Fully Embedded CB, UP**



NAPS SUP 3.7-2 Figure 3.7.1-304 **Confirmatory NEI Check for Partially Embedded CB, H1**

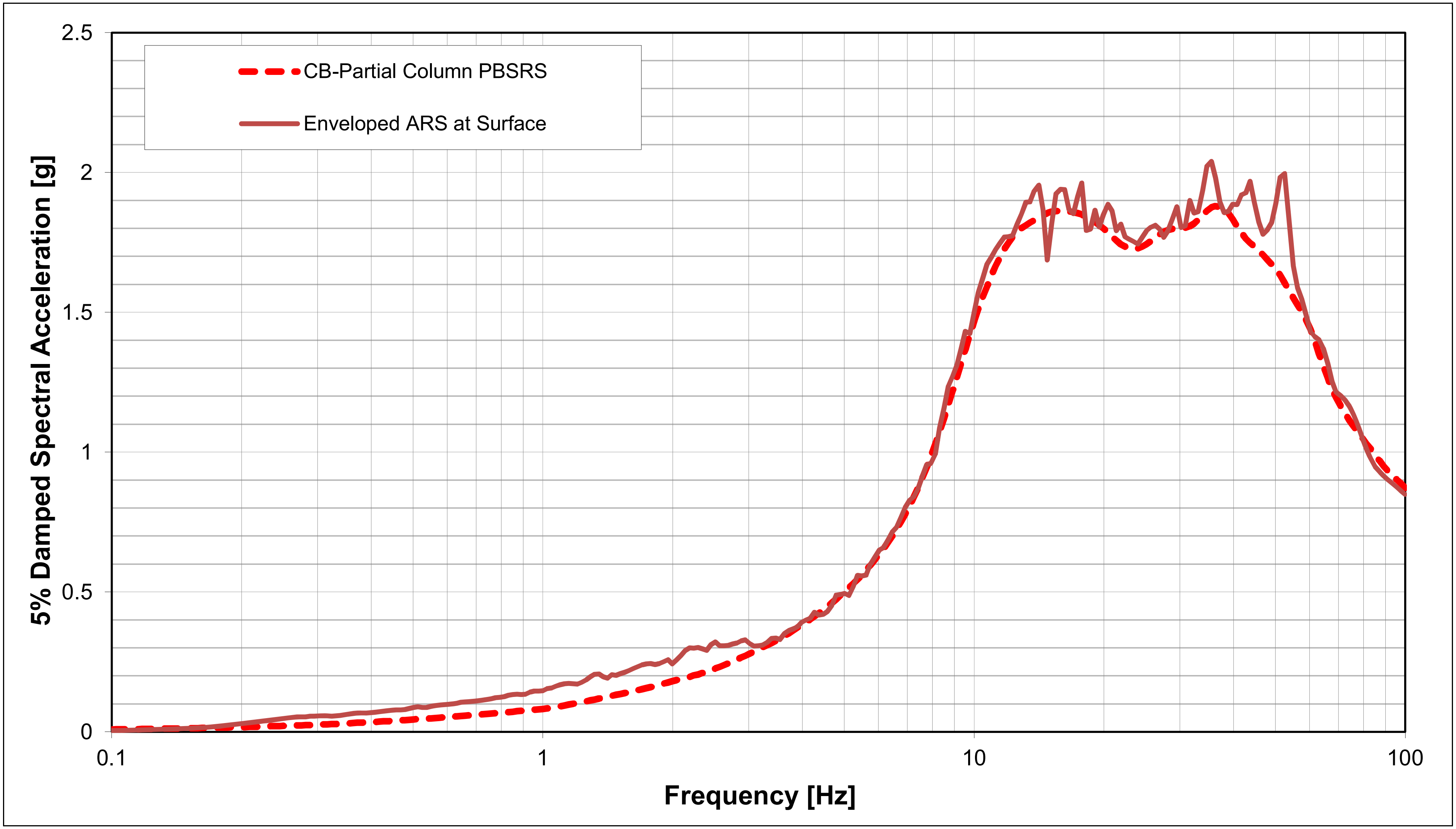


Figure 3.7.1-305 **Confirmatory NEI Check for Partially Embedded CB, H2**

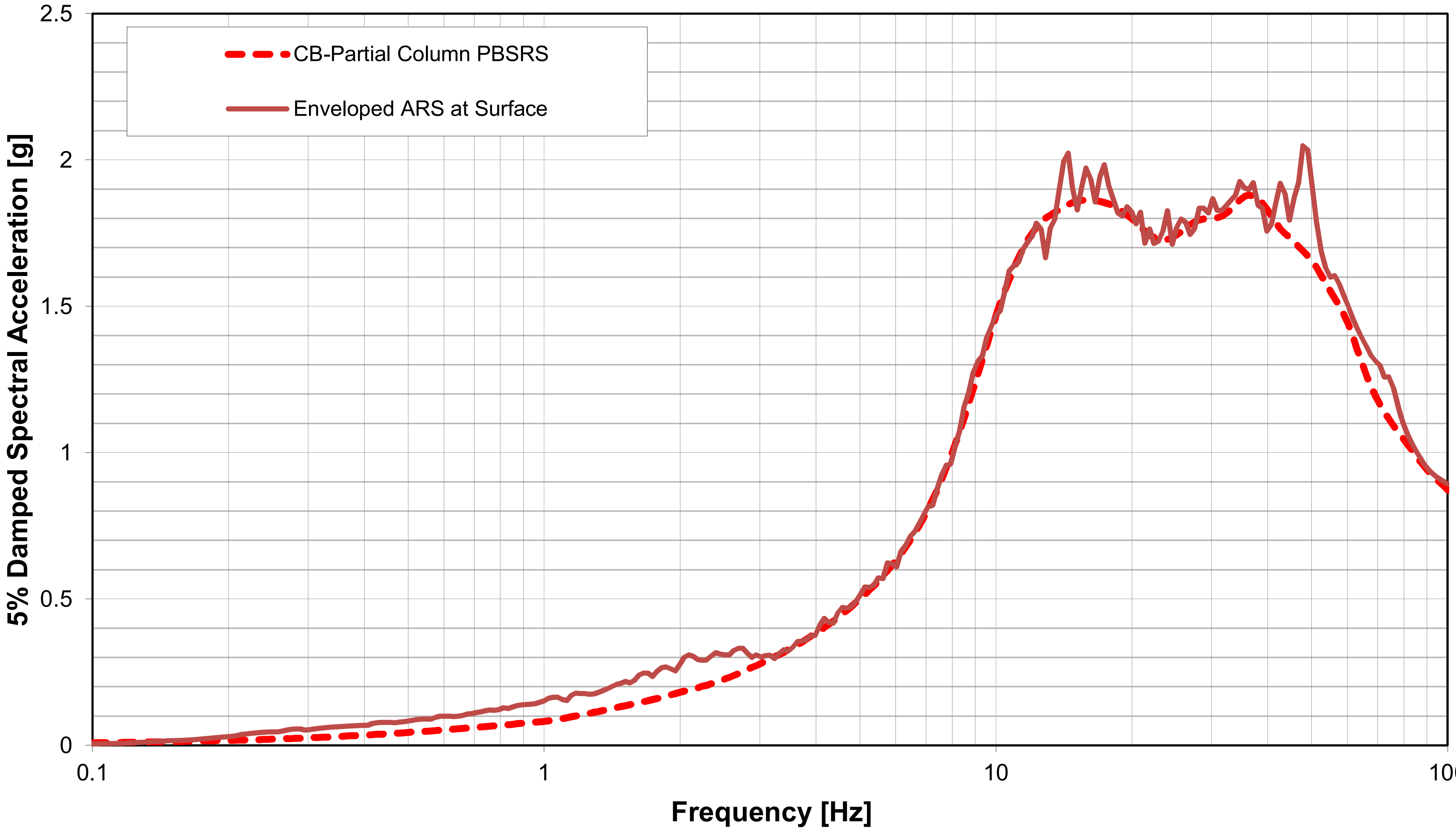
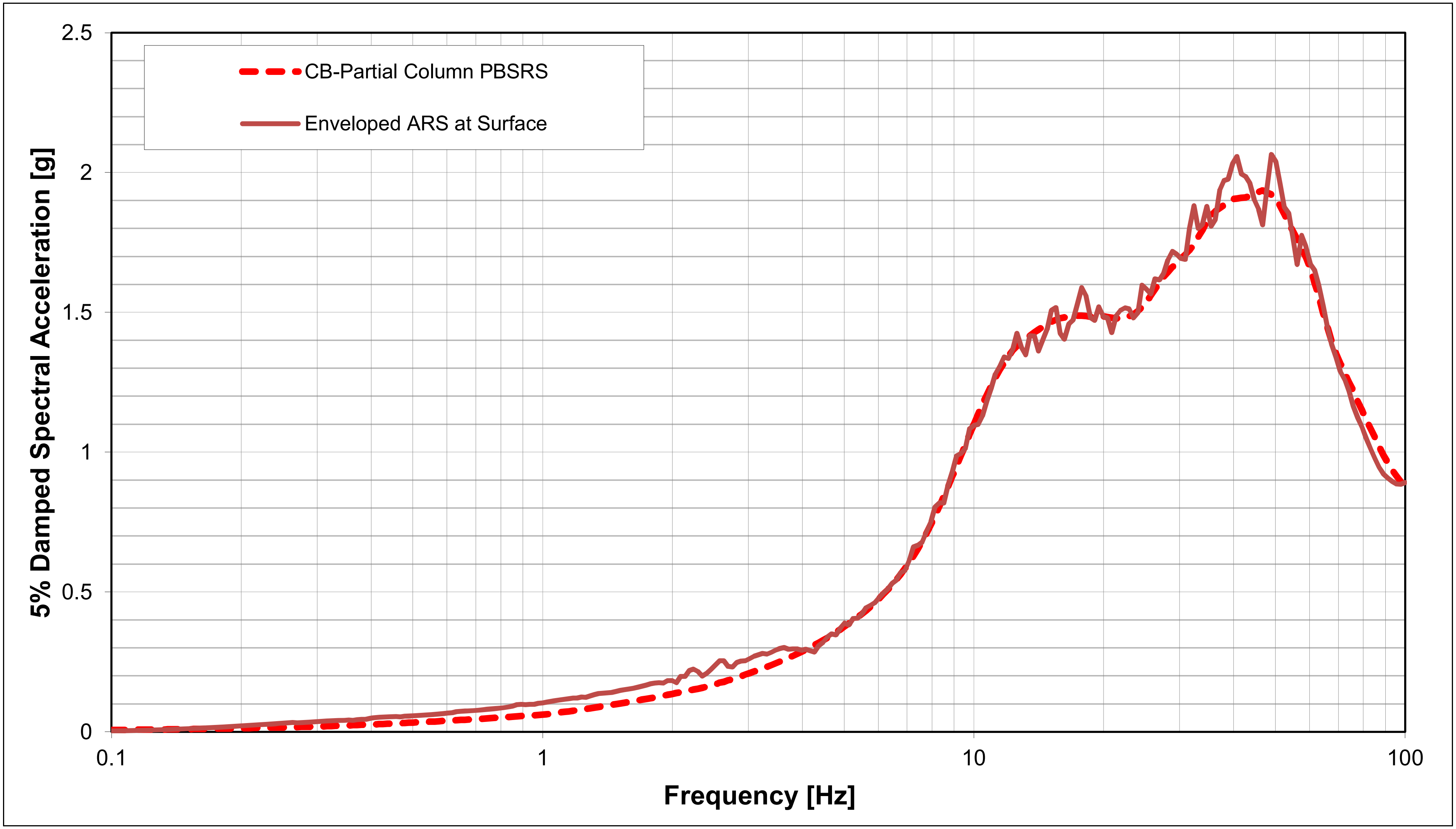


Figure 3.7.1-306 **Confirmatory NEI Check for Partially Embedded CB, UP**



3.7.2 Seismic System Analysis

Replace the last sentence of the first paragraph with the following.

NAPS DEP 3.7-1

[*DCD Table 3.7-3 provides a summary of the standard design seismic analysis methods for primary building structures using generic site conditions.*]* Sections 3.7.2.4 and 3A.10 through 3A.19 describe the supplemental SSI analyses for the site-specific conditions using SASSI2010. SASSI2010 is described in Section 3C.7.4. ACS SASSI, which is used for site-specific sensitivity analyses, is described in Section 3C.7.6.

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

3.7.2.2 Natural Frequencies and Responses

Replace the first sentence in this paragraph with the following.

NAPS DEP 3.7-1

[*Natural frequencies and SSI responses of Seismic Category I buildings obtained from the seismic response analyses forming the basis for seismic design of ESBWR Standard Plant are presented in DCD Sections 3A.1 through 3A.9. The SSI responses for site-specific conditions are provided in Sections 3.7.2.4 and 3A.10 through 3A.19.*]*

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

3.7.2.4 Soil-Structure Interaction

Add the following at the end of the first paragraph.

NAPS DEP 3.7-1

This section of the DCD, including associated DCD Appendix 3A in its entirety, is incorporated by reference with the following supplemental information for the site-specific soil-structure interaction (SSI) analyses for the RB/FB, CB, and FWSC. DCD Appendix 3A provides the SSI analysis approach and results for the standard design based on the CSDRS and generic soil conditions described in Section 3.7.1.

The site-specific SSI analysis considers SSI effects by following an approach that is consistent with those used for standard design. The structural models used for the site-specific SSI analyses have the same configuration, stiffness, and mass inertia properties as the standard design basis structural models presented in DCD Appendix 3A. Only the

meshing of the below-grade portions of the buildings is adjusted for site-specific conditions.

As described in Section 2.0, the site-specific horizontal and vertical FIRS have been compared to the corresponding CSDRS used for design of ESBWR standard plant. These comparisons show that there are ranges of frequencies where both the horizontal and vertical site-specific FIRS exceed the CSDRS. In accordance with the requirements of DCD Tier 1, Section 5.1, to address these exceedances, site-specific SSI analyses are performed for Seismic Category I RB/FB, CB, and FWSC structures using the site-specific ground motion and strain compatible soil properties.

The results of these analyses serve to demonstrate the applicability of the seismic design of the ESBWR Standard Plant for the site-specific conditions. The responses obtained from the site-specific SSI analyses serve as basis for development of site-specific design ISRS for all locations in the Seismic Category I buildings.

Sections 3A.10 through 3A.19 present the approach and methodology used for the site-specific SSI analyses. Appendix 3G presents the reconciliation of the ESBWR standard plant design for the site-specific conditions. Site-specific design ISRS are presented in Section 3A.18.2 for representative locations.

3.7.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures

Add the following at the end of this section.

NAPS SUP 3.7-5 The locations of structures are provided in Figure 2.1-201 and DCD Figure 1.1-1.

NAPS DEP 3.7-1 The locations of structures around the Unit 3 power block area are depicted in the plant layout provided in Figure 2.1-201 and DCD Figure 1.1-1. All Non-Seismic Category I structures that are within the scope of the standard design are addressed in this section. Each other Non-Seismic Category structure that is outside the scope of the DCD is at least a distance of its height above grade from Seismic Category I structures. Thus, the collapse of any site-specific non-Seismic Category I

SSC will not cause the non-Seismic Category I SSC to compromise the structural integrity and/or the functions of any Seismic Category I SSC.

Two sets of site-specific seismic response analyses are performed using the site-specific design ground motion and subgrade dynamic properties to demonstrate the adequacy of the standard plant:

- Site-specific SSI analyses of the stand alone TB, RW, SB, and Ancillary Diesel Building (ADB) structures following methodology consistent with the site-specific seismic SSI analyses of the Seismic Category I structures presented in Section 3.7.2.4.
- Site-specific seismic structure-soil-structure interaction (SSSI) analyses to evaluate any adverse effects of seismic interaction between the TB, RW, SB, and ADB structures and adjacent Seismic Category I structures, to ensure that the design precludes adverse interactions.

Results of these site-specific seismic SSI and SSSI analyses will be discussed as part of the ITAAC completion package for the TB, RW, SB, and ADB structures to demonstrate that acceptance criteria in ITAAC Tables 2.4.15-1, 2.4.16-1, 2.4.17-1, and 2.4.18-1, respectively, are met.

3.7.2.8.1 Turbine Building

Add the following at the end of this section.

NAPS DEP 3.7-1

The site-specific SSI analysis and seismic evaluation of the Turbine Building are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4. A seismic design motion is used that is compatible with site-specific FIRS that are developed considering the site-specific subgrade conditions under the Turbine Building. The development of these FIRS follows the same methodology as the one used for the FIRS for Seismic Category I buildings in Section 2.5.2. The site-specific SSI analysis uses subgrade dynamic properties that are compatible with the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3. To ensure the site-specific design precludes adverse interactions, an approach consistent with the approach used for the Seismic Category I structures is used to evaluate the effects of seismic SSSI with adjacent Seismic Category I structures.

The Turbine Building location is shown in Figure 2.1-201 and DCD Figure 1.1-1. The seismic gaps between the Turbine Building and the

Reactor Building are no less than the calculated maximum relative displacements between the two buildings during an SSE event, considering out-of phase response of the two buildings.

3.7.2.8.2 Radwaste Building

Add the following at the end of this section.

NAPS DEP 3.7-1

The site-specific SSI analysis and seismic evaluation of the Radwaste Building (RW) are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4. A seismic design motion is used that is compatible with site-specific FIRS that are developed considering the site-specific subgrade conditions under the RW foundation. The development of these FIRS follows the same methodology as the one used for the development of the FIRS for Seismic Category I buildings in Section 2.5.2. The site-specific SSI analysis of RW uses subgrade dynamic properties that are compatible to the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3. To ensure the site-specific design precludes adverse interactions, an approach consistent with the approach used for the Seismic Category I structures is used to evaluate the effects of seismic SSSI with adjacent Seismic Category I structures.

The RW location is shown in Figure 2.1-201 and DCD Figure 1.1-1. It is at least 10 meters from the RB. The building height is shown in DCD Figure 1.2-25.

Add the following at the end of this section.

NAPS SUP 3.7-8

To meet the requirements for safe separation distance from the liquid hydrogen storage tanks, the RW exterior walls have a static wall pressure capacity of at least 3 psi. based on analysis using the exterior wall thickness, wall span, and wall reinforcement ratio as defined by ACI 349, as referenced in RG 1.143 (see DCD Sections 3.8.4.4.2 and 3.8.4.5.4).

3.7.2.8.3 Service Building

Add the following at the end of this section.

The site-specific SSI analysis and seismic evaluation of the Service Building are performed following the same methodology as the one used

for the Seismic Category I buildings in Section 3.7.2.4. A seismic design motion is used that is compatible with site-specific FIRS that are developed considering the site-specific subgrade conditions under the Service Building. The development of these FIRS follows the same methodology as the one used for the FIRS for Seismic Category I buildings in Section 2.5.2. The site-specific SSI analysis uses subgrade dynamic properties that are compatible to the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3.

To ensure the site-specific design precludes adverse interactions, an approach consistent with the approach used for the Seismic Category I structures is used to evaluate the effects of seismic SSSI with adjacent Seismic Category I structures.

The Service Building location is shown in Figure 2.1-201 and DCD Figure 1.1-1. The seismic gaps between the Service Building and the Reactor Building/Fuel Building are no less than the calculated maximum relative displacements between the two buildings during an SSE event, considering out-of phase response of the two buildings.

3.7.2.8.4 Ancillary Diesel Building

Add the following at the end of this section.

NAPS DEP 3.7-1

The site-specific SSI analysis and seismic evaluation of the Ancillary Diesel Building are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4. A seismic design motion is used that is compatible with site-specific FIRS that are developed considering the site-specific subgrade conditions under the Ancillary Diesel Building. The development of these FIRS follows the same methodology as the one used for the FIRS for Category I buildings in Section 2.5.2. The site-specific SSI analysis uses subgrade dynamic properties that are compatible to the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3. To ensure the site-specific design precludes adverse interactions, an approach consistent with the approach used for the Seismic Category I structures is used to evaluate the effects of seismic SSSI with adjacent Seismic Category I structures.

The Ancillary Diesel Building location is shown in Figure 2.1-201 and DCD Figure 1.1-1. It is at least 15.2 meters from the Fuel Building.

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3.7.3.13 Seismic Category I Buried Piping, Conduits and Tunnels

Replace the sixth paragraph sixth bullet as follows.

NAPS DEP 3.7-1

- [*Seismic input motions are based on the single envelope design response spectra as defined in DCD Table 3.7-2, using the applicable scale factor, and site-specific SSE FIRS.*]*

Replace the seventh paragraph as follows.

[*Seismic Category I utilities and Safety Class RW-IIa radwaste piping installed in trenches or tunnels are analyzed in accordance with the standard requirements of DCD Section 3.7.3. Seismic input motions for the portions located below ground are based on the single envelope design response spectra as defined in DCD Table 3.7-2, using applicable scale factors, and site-specific SSE FIRS.*]*

Site-specific SSE FIRS define the design input ground motion at the bottom elevations of Seismic Category I trenches, tunnels and duct bank structures that contain piping and conduits following the same methodology as used for the development of full column FIRS for the design of Seismic Category I buildings as described in Sections 2.5.2 and 3.7.1. These FIRS consider, as applicable, the variations of subgrade conditions and the strain-compatible dynamic properties of in-situ subgrade and/or backfill materials under and above these structures and components. The site-specific SSE FIRS are amplified as necessary to include the effects of the adjacent heavy foundations on the free field motion and address the effects of structure-soil-structure interaction on the seismic response of these buried piping, conduits and tunnels.

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

3.7.4 Seismic Instrumentation

Add the following at the end of the first paragraph.

NAPS SUP 3.7-6

The seismic monitoring program described in this subsection, including the necessary test and operating procedures, will be implemented prior to receipt of fuel on site.

3.7.4.2 Location and Description of Instrumentation

Add the following after the second paragraph.

NAPS SUP 3.7-6

The subsurface geologic structure (layering) of the site is considered in determination of the location of the free-field seismic instrument at the site. Appropriate spectral ratios are applied to the acceleration response spectra and velocity response spectra of the recorded motion to account for potential differences between the subsurface geologic conditions at the location of the free-field instrument and the power block area.

3.7.4.4 Comparison of Measured and Predicted Responses

Replace the last sentence (including the bulletized list) of the first paragraph as follows:

NAPS DEP 3.7-1

The plant is shut down if the walkdown inspections discover damage to equipment that would affect the safe operation of the plant, or the recorded motion in the free-field in any of the three directions (two horizontal and one vertical) exceeds both the certified design and site-specific response spectrum limits and the cumulative absolute velocity limit as follows:

- Certified design response spectrum limit is exceeded if:
    - at frequencies between 2 and 10 Hz, the recorded response spectral accelerations of 5 percent damping exceed one-third of the corresponding CSDRS values or 0.2g, whichever is greater; or
    - at frequencies between 1 and 2 Hz, the recorded response spectral velocities of 5 percent damping exceed one-third of the corresponding CSDRS values or 6 in/sec (152.4 mm/sec), whichever is greater.
- Site-specific response spectrum limit is exceeded if:
    - at frequencies between 2 and 10 Hz, the recorded response spectral accelerations of 5 percent damping exceed the corresponding site dependent OBE at grade presented in Table 3.7.1-216 or 0.2g, whichever is greater; or
    - at frequencies between 1 and 2 Hz, the recorded response spectral velocities of 5 percent damping exceed the corresponding OBE values presented in Table 3.7.1-217 or 6 in/sec (152.4 mm/sec), whichever is greater

- Cumulative absolute velocity limit is exceeded if the cumulative absolute velocity value calculated according to the procedures in EPRI TR-100082, December 1991 (DCD Reference 3.7-12), is greater than 0.16g/sec.

3.7.5 Site-Specific Information

Replace DCD Section 3.7.5 with the following.

NAPS DEP 3.7-1

(1) [*See Table 2.0-201 and Section 3.7.1 for seismology requirements of site-specific SSE ground response spectra.*

(2) *See Table 2.0-201 for soil properties requirements of site-specific foundation bearing capacities, minimum shear wave velocity and liquefaction potential. For sites not meeting the soil property requirements, a site-specific analysis is required to demonstrate the adequacy of the standard plant design. Site-specific SSI analyses for the Seismic Category I RB/FB, CB, and FWSC structures are described in Section 3.7.2 to demonstrate the adequacy of the standard plant design of these buildings.*]*

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

3.7.6 References

3.7-201 Kramer, Steven L. (1996), Geotechnical Earthquake Engineering, Prentice-Hall, ISBN 0-13-374943-6.

3.7-202 U.S. Nuclear Regulatory Commission (2010), Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses, DC/COL-ISG-17, March 2010.

3.7-203 NEI White Paper, "Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation," NEI, June 2009.

3.7-204 McGuire, R. K., W. J. Silva, and C. J. Costantino (2001), "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions, Hazard- and Risk-consistent Ground Motion Spectra Guidelines," prepared for Nuclear Regulatory Commission, NUREG/CR-6728.

3.7-205 American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities."

3.7-206 DC/COL-ISG-017, "Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses," March 24, 2010.

3.7-207 Philippacopoulos, A. J., "Recommendations for Resolution of Public Comments on USI A-40, "Seismic Design Criteria"," Brookhaven National Laboratory, NUREG/CR-5347, May 1989.

3.8 Seismic Category I Structures

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following at the end of this section.

NAPS DEP 3.7-1

This section describes these Seismic Category I structures and identifies the design features, applicable codes and standards, loads and load combinations, design and analysis procedures, and structural acceptance criteria. The structural evaluations of the Seismic Category I structures are described in DCD Sections 3G.1 through 3G.6 for evaluations using the seismic demands based on the CSDRS defined ground motion and generic site subgrade conditions. Sections 3G.7 through 3G.10 present the structural evaluations using the seismic demands based on the site-specific design ground motion and site-specific subgrade conditions.

3.8.1 Concrete Containment

3.8.1.1 Description of the Containment

3.8.1.1.1 Concrete Containment

Replace the first paragraph with the following.

NAPS DEP 3.7-1

The structural design and analysis of the containment structure are described in DCD Section 3G.1 and Section 3G.7. These sections provide a more detailed description of the containment and the analytical models, inputs, analytical procedures, figures, results from controlling load combinations, components with controlling concrete stresses, reinforcement stresses, and liner strains for the concrete containment vessel. DCD Section 3G.1 provides results of structural evaluations using the CSDRS seismic loads, and Section 3G.7 provides results of structural evaluations using the site-specific seismic demands.

3.8.1.1.2 Containment Liner Plate

Replace the first sentence of the second paragraph with the following.

NAPS DEP 3.7-1

The liner plate is stiffened by use of structural sections and plates to carry the design loads and to anchor the liner plate to the concrete. DCD Section 3G.1.5.4 and Section 3G.7.5.4, describe the results of the structural evaluation of the containment liner plate.

3.8.1.4 Design and Analysis Procedures

3.8.1.4.1 Containment Cylindrical Wall, Top Slab, and Foundation Mat

3.8.1.4.1.1 Analytical Methods

Replace the second sentence of the second paragraph with the following.

NAPS DEP 3.7-1

The details of the global FEA model are described in DCD Section 3G.1.4.1 and Section 3G.7.4.1.

3.8.1.4.1.2 Design Methods

Replace the first two paragraphs with the following.

NAPS DEP 3.7-1

The design of the containment structure is based on the membrane forces, shear forces and bending moments for the load combinations defined in DCD Subsection 3.8.1.3.6. The membrane forces, shear forces and bending moments in selected sections are obtained from the analysis performed using the computer program NASTRAN, as described in DCD Subsection 3.8.1.4.1.1. The global analysis considers the major structural configurations, including RCCV with the internal steel components, the RB with floor connections to the RCCV, and the basemat, using plate element modeling and linear material assumptions. The selected elements from the global model used for the section sizing design calculations are described in DCD Section 3G.1.5.4 and Section 3G.7.5.4. The site-specific structural design evaluations are performed using the same selected elements as used in the standard design structural evaluations.

For the standard design structural evaluations, the SSDP-2D program module, described in DCD Appendix 3C, is used to determine the extent of concrete cracking at these sections and the resulting concrete and rebar stresses. The SSDP-2D program models a single element of unit height, unit width, and depth equal to the thickness of the wall or slab. The calculations used in SSDP-2D assume that the concrete is isotropic and linearly elastic but with zero tensile strength. The methods used in SSDP-2D can also account for the reduced thermal forces and moments due to concrete cracking when the option of thermal cracking is selected. However, the redistribution of section forces and moments that occurs due to concrete cracking under thermal loads is not calculated by the SSDP-2D procedure. For the standard design structural evaluations, to

account for the concrete cracking effects and redistribution of forces and moments from thermal loads, the procedure described in DCD Section 3.8.1.4.1.3 is used and the option of thermal cracking in SSDP-2D is not selected.

For the site-specific structural evaluations, the SSDP-2D program with the option of thermal cracking is selected to account for the reduced thermal forces and moments due to concrete cracking (rather than the procedure described in DCD Section 3.8.1.4.1.3, which uses thermal ratios to account for concrete cracking and redistribution of forces and moments from thermal loads).

The site-specific structural evaluations address the thermal transient profiles calculated by TRACG in the global model directly using SSDP-2D (rather than through a separate evaluation) as described in DCD Section 3G.5. The SSDP-2D program does not redistribute the section forces and is a more conservative approach than the 3D nonlinear method (thermal ratios) used for the standard design to redistribute the LOCA thermal forces due to cracking. Using SSDP-2D for the site-specific structural evaluations is possible because the design changes described in DCD Section 3G.5.3 for the RB upper pools provides increased strength in the structures such that the thermal forces did not need to be redistributed through the 3D nonlinear program. The site-specific structural evaluations demonstrate containment structural adequacy using the same structural acceptance criteria described in DCD Section 3.8.1.5.

3.8.1.4.1.3 Concrete Cracking Considerations

Add the following paragraph at the end of this section.

NAPS DEP 3.7-1

As explained in Section 3.8.1.4.1.2, the site-specific structural evaluations use the SSDP-2D program to address concrete cracking considerations.

3.8.1.6 Material, Quality Control and Special Construction Techniques

3.8.1.6.1 Concrete

Add the following paragraph at the end of Section (2) Aggregates.

NAPS SUP 3.8-1 ASTM Standards C1260 and C1293 are used in testing aggregates for potential alkali-silica reactivity (ASR).

3.8.2 Steel Components of the Reinforced Concrete Containment

3.8.2.4 Design and Analysis Procedures

3.8.2.4.1 Description

3.8.2.4.1.5 PCCS Condenser

Replace the last paragraph with the following.

NAPS DEP 3.7-1 A finite element analysis model supplemented with hand calculation is used to determine the stresses in the different components of the PCCS condenser and supports. Details of this analysis, including relevant drawings and results, can be found in DCD Reference 3.8-1, and details of the site specific analysis, which uses the same approach as the DCD but with site-specific seismic loads, can be found in Reference 3.8-201. The PCCS condenser parts conform to the design requirements of the ASME BPVC, Section III, Subsection NE (Class MC), Subarticles NE-3200 and NE-3300. The PCCS condenser support is evaluated in accordance with the ASME BPVC, Section III, Subsection NF.

3.8.3 Concrete and Steel Internal Structures of the Concrete Containment

3.8.3.1 Description of the Internal Structures

Replace the last sentence of this section with the following.

NAPS DEP 3.7-1 DCD Section 3G.1 and Section 3G.7 present the detailed design and analysis information for these internal structures.

3.8.3.1.2 RPV Support Bracket

Replace the last sentence of this section with the following.

NAPS DEP 3.7-1 See DCD Section 3G.1.5.4.2.4 and Section 3G.7.5.4.2.4.

3.8.4 Other Seismic Category I Structures

Add the following at the end of this section.

NAPS DEP 3.7-1

Site-specific structural evaluations for the RB, FB, CB, and FWSC are described in Sections 3G.7 through 3G.10.

3.8.4.1 Description of the Structures

3.8.4.1.1 Reactor Building Structure

Replace the first sentence of the last paragraph with the following.

NAPS DEP 3.7-1

The summary stress reports for the RB are in DCD Section 3G.1 and Section 3G.7.

3.8.4.1.2 Control Building

Replace the first sentence of the last paragraph with the following.

NAPS DEP 3.7-1

The summary stress reports for the CB are in DCD Section 3G.2 and Section 3G.8.

3.8.4.1.3 Fuel Building

Replace the first sentence of the last paragraph with the following.

NAPS DEP 3.7-1

The summary stress reports for the FB are in DCD Section 3G.3 and Section 3G.9.

3.8.4.1.4 Firewater Service Complex

Replace the first sentence of the last paragraph with the following.

NAPS DEP 3.7-1

The summary stress reports for the FWSC are in DCD Section 3G.4 and Section 3G.10.

3.8.4.4 Design and Analysis Procedures

3.8.4.4.1 Reactor Building, Control Building and Fuel Building

Replace the last sentence of the second paragraph with the following.

NAPS DEP 3.7-1

The model is described in DCD Section 3G.1.4.1 and Section 3G.7.4.1.

Replace the third paragraph with the following.

NAPS DEP 3.7-1

The FEA model of the CB includes the entire structure. The details of the FEA model of the CB are described in DCD Section 3G.2.4.1 and Section 3G.8.4.1.

3.8.4.4.3 Firewater Service Complex

Replace the last sentence of the first paragraph with the following.

NAPS DEP 3.7-1

The model is described in DCD Section 3G.4.4.1 and Section 3G.10.4.1.

3.8.4.5 Structural Acceptance Criteria

Add the following paragraph at the beginning of this section.

The structural acceptance criteria for the site-specific structural evaluations of the RB and FB, which are described in Sections 3G.7 and 3G.9, are the same as the acceptance criteria for the standard design provided in this section, with the exception that the site-specific structural evaluations may use a refined evaluation to demonstrate that the acceptance criteria of the more limiting of the ASME Code and ACI 349-01 are met. The SSDP-2D computer program uses a simplified approach for meeting ASME Code requirements for factored loads based on the linear concrete stress-strain relationship and principal stress for concrete stress. This approach is more conservative than the parabolic or nonlinear stress distribution accepted by ASME BPVC, Section III, Division 2, CC-3511.1(e).

In the site-specific stress evaluations for the RB and FB, for cases where an element exceeds ASME acceptance criteria using the conservative SSDP-2D analysis, additional reinforcing steel is added or the element is re-evaluated using axial load-moment interaction curves that meet ACI 349-01 and ASME acceptance criteria. The ASME acceptance criteria are based on a parabolic concrete stress-strain relationship and applicable ASME allowable stresses for a cross section subjected to membrane loads and moments due to factored loads. This approach ensures that the more limiting acceptance criteria of the ASME Code and the ACI 349-01 Code are met.

In summary, the site-specific structural evaluations for the RB and FB may use: 1) SSDP-2D; or 2) an axial load-moment interaction curve

confirming allowable stresses for factored loads, to demonstrate that the more limiting acceptance criteria of the ASME Code and ACI 349-01 are met.

The structural acceptance criteria for the site-specific structural evaluations of the CB and FWSC, which are described in Sections 3G.8 and 3G.10, are the same as the acceptance criteria used for the standard design. The site-specific structural evaluations of the CB and FWSC use the SSDP-2D program to demonstrate the structural adequacy of the structural members in the CB and FWSC structures.

3.8.5 Foundations

Add the following at the end of this section.

NAPS DEP 3.7-1 Site-specific structural evaluations for the RB/FB, CB, and FWSC foundations are described in Sections 3G.7 through 3G.10.

3.8.5.1 Description of the Foundations

Replace the second sentence of the fourth paragraph with the following.

NAPS DEP 3.7-1 The RB foundation summary stress reports are described in DCD Section 3G.1 and Section 3G.7. The CB foundation summary stress reports are described in DCD Section 3G.2 and Section 3G.8. The FB foundation summary stress reports are described in DCD Section 3G.3 and Section 3G.9.

Replace the last sentence of the fifth paragraph with the following.

NAPS DEP 3.7-1 Details of the foundation design and analysis for the FWSC, including foundation stability evaluations, are contained in DCD Section 3G.4 and Section 3G.10.

3.8.5.4 Design and Analysis Procedures

Replace the last sentence of the seventh paragraph with the following.

NAPS DEP 3.7-1 Details are provided in DCD Section 3G.1.5.5.1, and site-specific evaluation results for foundation stability are described in Section 3G.7.5.5.

3.8.5.5 Structural Acceptance Criteria

Add the following at the end of this section.

The site-specific evaluations of the seismic stability of RB/FB, CB, and FWSC foundations are described in Sections 3G.7.5.5, 3G.8.5.5, and 3G.10.5.5, respectively. These sections also present the calculated maximum dynamic bearing pressure demands on the basemats of the RB/FB, CB, and FWSC.

Table 3.8.5-201 **Deleted**

Table 3.8.5-202 **Deleted**

Table 3.8.5-203 **Deleted**

Table 3.8.5-204 **Deleted**

Table 3.8.5-205 **Deleted**

Figure 3.8.4-201 **Deleted**

Figure 3.8.4-202 **Deleted**

Figure 3.8.4-203 **Deleted**

Figure 3.8.4-204 **Deleted**

Figure 3.8.4-205 **Deleted**

Figure 3.8.4-206 **Deleted**

Figure 3.8.4-207 **Deleted**

Figure 3.8.4-208 **Deleted**

3.8.7 References

Add the following at the end of the section.

3.8-201 GE Hitachi Nuclear Energy, “North Anna 3 PCCS Condenser Seismic Analysis,” 002N8530, Class I (Nonproprietary), Revision 4, April 2016.

3.9 Mechanical Systems and Components

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.9.2.4 Initial Startup Flow-Induced Vibration Testing of Reactor Internals

Replace the last paragraph with the following.

CWR COL 3.9.9-1-A

1. For reactor internals other than the steam dryer, the vibration assessment program, as specified in Regulatory Guide (RG) 1.20, is provided in DCD Appendix 3L and the following referenced GEH Report:

   - NEDE-33259P-A, "Reactor Internals Flow Induced Vibration Program"

   The classification of the Unit 3 reactor internals in accordance with RG 1.20 is dependent on ESBWR status; i.e., if Unit 3 is the initial ESBWR to perform testing of the reactor internals or if testing is performed at another reactor prior to Unit 3 testing. There are two different scenarios:

   a. A valid prototype for the Unit 3 reactor internals does not exist. Under this scenario, Unit 3 reactor internals classification is a prototype per RG 1.20.

   b. A valid prototype for Unit 3 reactor internals does exist. If the prototype testing is performed outside the United States, the guidance in RG 1.20, Revision 3, Regulatory Position 1.2, would need to be satisfied in order for this reactor to be considered a "valid prototype." Assuming that Unit 3 reactor internals are substantially similar to the valid prototype and that the valid prototype does not experience inservice problems that result in component or operational modifications, Unit 3 reactor internals will be classified as non-prototype Category I. If a change to the classification for Unit 3 reactor internals is later determined to be necessary, the classification change will be addressed at the time the change is proposed with proper evaluation/justification and documented in a revision to the FSAR.

2. Specific to the steam dryer, the comprehensive vibration assessment program, as specified in RG 1.20, is provided in DCD Appendix 3L and the following referenced GEH Reports:

   - NEDE-33312P, “ESBWR Steam Dryer Acoustic Load Definition”
   - NEDE-33313P, “ESBWR Steam Dryer Structural Evaluation”
   - NEDE-33408P, “ESBWR Steam Dryer – Plant Based Load Evaluation Methodology – PBLE01 Model Description”

   The steam dryer is classified as a prototype according to RG 1.20, Revision 3. Section 10.2 of NEDE-33313P provides four elements of a steam dryer Comprehensive Vibration Assessment Program that must be addressed. The following describes the approach for the steam dryer Comprehensive Vibration Assessment Program elements, consistent with RG 1.20 and Section 10.2 of NEDE-33313P:

   a. The ESBWR steam dryer Comprehensive Vibration Assessment Program is described in DCD Section 3.9, DCD Appendix 3L, and NEDE-33313P, Section 10.0, which includes a description for preparing and submitting to the NRC a Steam Dryer Monitoring Plan no later than 90 days before initial fuel load.

   b. The detailed design of the steam dryer will follow the methodology described in DCD Appendix 3L and the incorporated engineering reports. As described in NEDE-33313P, Section 10.2(b), an example of a steam dryer predictive analysis that concludes the steam dryer will not exceed stress limits with applicable bias and uncertainties and the minimum alternating stress ratio of 2.0 is provided in NEDE-33408P. The final detailed design of the ESBWR steam dryer has not yet been completed. Therefore, the example of an as-designed steam dryer that has been subjected to the predictive analysis process and successful startup testing described in NEDE-33408P serves as the design analysis report for the steam dryer and provides sufficient information for licensing. The post-licensing commitments in ITAAC and license conditions confirm the acceptability of the ESBWR steam dryer design.

c. The startup program and associated steam dryer license conditions that include appropriate notification points during power ascension, providing data to the NRC at certain hold points and at full power, and providing to the NRC a full stress analysis report and evaluation within 90 days of reaching the full power level, are established in accordance with NEDE-33313P, Section 10.2(c).

d. Periodic steam dryer inspection during refueling outages is as described in NEDE-33313P, Section 10.2(d), and associated license conditions.

3. Summary of Reactor Internals Vibration Assessment Program

For reactor internals other than the steam dryer, the comprehensive vibration assessment program will be developed and implemented as described in DCD Appendix 3L with no departures. The vibration measurement and inspection programs will comply with the guidance specified in RG 1.20, Revision 3, consistent with the Unit 3 reactor internals classification. A summary of the vibration analysis program and description of the vibration measurement (including measurement locations and analysis predictions) and inspection phases of the comprehensive vibration inspection program will be submitted to the NRC six months prior to implementation.

For reactor internals other than the steam dryer, the preliminary and final reports (as necessary), which together summarize the results of the vibration analysis, measurement and inspection programs will be submitted to the NRC within 60 and 180 days, respectively, following the completion of the programs.

3.9.3.1 Loading Combinations, Design Transients and Stress Limits

Replace the fifth paragraph with the following.

STD COL 3.9.9-2-A

The equipment stress reports identified in this DCD section will be completed within six months of completion of DCD ITAAC Table 3.1-1. The FSAR will be revised as necessary in a subsequent update to address the results of this analysis.

3.9.3.7.1(3)e Snubber Preservice and Inservice Examination and Testing

Preservice Examination and Testing

Add the following at the end of this section.

STD COL 3.9.9-4-A

A preservice thermal movement examination is also performed; during initial system heatup and cooldown, for systems whose design operating temperature exceeds 121°C (250°F), snubber thermal movement is verified.

Additionally, preservice operational readiness testing is performed on all snubbers. The operational readiness test is performed to verify the parameters of ISTD-5120. Snubbers that fail the preservice operational readiness test are evaluated to determine the cause of failure, and are retested following completion of corrective action(s).

Snubbers that are installed incorrectly or otherwise fail preservice testing requirements are re-installed correctly, adjusted, modified, repaired or replaced, as required. Preservice examination and testing is re-performed on installation-corrected, adjusted, modified, repaired or replaced snubbers as required.

The preservice inspection and testing programs for snubbers will be completed in accordance with milestones described in Section 13.4.

Inservice Examination and Testing

Add the following at the beginning of this section.

STD COL 3.9.9-4-A

Inservice examination and testing of all safety-related snubbers is conducted in accordance with the requirements of the ASME OM Code, Subsection ISTD. Inservice examination is initially performed not less than two months after attaining 5 percent reactor power operation and will be completed within 12 calendar months after attaining 5 percent reactor power. Subsequent examinations are performed at intervals defined by ISTD-4252 and Table ISTD-4252-1. Examination intervals, subsequent to the third interval, are adjusted based on the number of unacceptable snubbers identified in the then current interval.

An inservice visual examination is performed on all snubbers to identify physical damage, leakage, corrosion, degradation, indication of binding, misalignment or deformation and potential defects generic to a particular

design. Snubbers that do not meet visual examination requirements are evaluated to determine the root cause of the unacceptability, and appropriate corrective actions (e.g., snubber is adjusted, repaired, modified, or replaced) are taken. Snubbers evaluated as unacceptable during visual examination may be accepted for continued service by successful completion of an operational readiness test.

Snubbers are tested inservice to determine operational readiness during each fuel cycle, beginning no sooner than 60 days before the scheduled start of the applicable refueling outage. Snubber operational readiness tests are conducted with the snubber in the as-found condition, to the extent practical, either in place or on a test bench, to verify the test parameters of ISTD-5210. When an in-place test or bench test cannot be performed, snubber subcomponents that control the parameters to be verified are examined and tested. Preservice examinations are performed on snubbers after reinstallation when bench testing is used (ISTD-5224), or on snubbers where individual subcomponents are reinstalled after examination (ISTD-5225).

Defined test plan groups (DTPG) are established and the snubbers of each DTPG are tested according to an established sampling plan each fuel cycle. Sample plan size and composition are determined as required for the selected sample plan, with additional sampling as may be required for that sample plan based on test failures and failure modes identified. Snubbers that do not meet test requirements are evaluated to determine root cause of the failure, and are assigned to failure mode groups (FMG) based on the evaluation, unless the failure is considered unexplained or isolated. The number of unexplained snubber failures not assigned to an FMG determines the additional testing sample. Isolated failures do not require additional testing. For unacceptable snubbers, additional testing is conducted for the DTPG or FMG until the appropriate sample plan completion criteria are satisfied.

Unacceptable snubbers are adjusted, repaired, modified, or replaced. Replacement snubbers meet the requirements of ISTD-1600. Post-maintenance examination and testing, and examination and testing of repaired snubbers, is done to ensure that test parameters that may have been affected by the repair or maintenance activity are verified acceptable.

Service life for snubbers is established, monitored and adjusted as required by ISTD-6000 and the guidance of ASME OM Code Nonmandatory Appendix F.

The inservice inspection and testing programs for snubbers will be completed in accordance with milestones described in Section 13.4.

Delete the last two sentences of the last paragraph.

3.9.3.7.1(3)e Snubber Support Data

Replace the first sentence with the following.

STD COL 3.9.9-4-A For the ASME Class 1, 2, and 3 systems listed in DCD Tier 1, Section 3.1, that contain snubbers, a plant-specific table will be prepared in conjunction with the closure of the system-specific ITAAC for piping and component design and will include the following specific snubber information.

Add the following at the end of this section.

STD COL 3.9.9-4-A This information will be included in the FSAR as part of a subsequent FSAR update.

3.9.6 Inservice Testing of Pumps and Valves

Replace the last sentence of the last paragraph with the following.

STD COL 3.9.9-3-A Milestones for implementation of the ASME OM Code preservice and inservice testing programs are defined in Section 13.4.

3.9.6.1 Inservice Testing of Valves

Add the following before the last paragraph.

STD COL 3.9.9-3-A Each valve subject to inservice testing is also tested during the preservice test (PST) period. Preservice tests are conducted under conditions as near as practicable to those expected during subsequent inservice testing. Valves (or the control system) that have undergone maintenance that could affect performance, or valves that are repaired or replaced, are re-tested to verify performance parameters that could have been affected are within acceptable limits. Safety and relief valves and nonreclosing pressure relief devices are preservice tested in accordance with the requirements of the ASME OM Code, Mandatory Appendix I.

3.9.6.1.4 Valve Testing

Add the following at the end of the introduction to this section.

STD COL 3.9.9-3-A

Other specific testing requirements for power-operated valves include stroke-time testing and, as applicable, diagnostic testing to evaluate valve condition and to verify the valve will continue to function under design-basis conditions.

(1) Valve Exercise Tests

Add the following after the second sentence of the first paragraph.

NAPS COL 3.9.9-3-A

Valves are tested by full-stroke exercising, during operation at power, to the positions required to fulfill their functions.

Add the following after the third sentence of the first paragraph.

STD COL 3.9.9-3-A

If full-stroke exercising is not practicable, part-stroke exercising is performed during operation at power or during cold shutdown.

Add the following new paragraph after the first paragraph.

STD COL 3.9.9-3-A

During extended shutdowns, valves that are required to be operable must remain capable of performing their intended safety function. Exercising valves during cold shutdown commences within 48 hours of achieving cold shutdown and continues until testing is complete or the plant is ready to return to operation at power. Valve testing required to be performed during a refueling outage is completed before returning the plant to operation at power.

Add the following after the first sentence of the second paragraph.

STD COL 3.9.9-3-A

Valve testing uses reference values determined from the results of PST or IST. These tests that establish reference values are performed under conditions as near as practicable to those expected during the IST. Stroke time is measured and compared to the reference value, except for valves classified as fast-acting (e.g., solenoid-operated valves (SOVs) with stroke time less than 2 seconds), for which a stroke time limit of 2 seconds is assigned.

Add the following after the third paragraph.

STD COL 3.9.9-3-A

SOVs are tested to confirm the valves move to their energized positions and are maintained in those positions, and to confirm that the valves move to the appropriate failure mode positions when de-energized.

Pre-conditioning of valves or their associated actuators or controls prior to IST undermines the purpose of IST and is prohibited. Pre-conditioning includes manipulation, pre-testing, maintenance, lubrication, cleaning, exercising, stroking, operating, or disturbing the valve to be tested in any way, except as may occur in an unscheduled, unplanned, and unanticipated manner during normal operation.

(4) Special Tests

Add the following after the second paragraph under the second bullet.

STD COL 3.9.9-3-A

Industry and regulatory guidance is considered in development of IST program for explosively actuated valves. In addition, the IST program for explosively actuated valves incorporates lessons learned from the design and qualification process for these valves such that surveillance activities provide reasonable assurance of the operational readiness of explosively actuated valves to perform their safety functions.

3.9.6.1.5 Specific Valve Test Requirements

(1) Power-Operated Valve Tests

Replace the last paragraph with the following.

STD COL 3.9.9-3-A

Section 3.9.6.8 describes additional (non-Code) testing of power-operated valves as discussed in Regulatory Issue Summary 2000-03.

(3) Check Valve Exercise Tests

Add the following as the first sentence of the second paragraph.

STD COL 3.9.9-3-A

Check valve testing requires verification that obturator movement is in the direction required for the valve to perform its safety function.

Add the following before the last paragraph.

STD COL 3.9.9-3-A

Acceptance criteria for this testing consider the specific system design and valve application. For example, a valve's safety function may require obturator movement in both open and closed directions. A mechanical exerciser may be used to operate a check valve for testing. Where a mechanical exerciser is used, acceptance criteria are provided for the force or torque required to move the check valve's obturator. Exercise tests also detect missing, sticking, or binding obturators.

If these test methods are impractical for certain check valves, or if sufficient flow cannot be achieved or verified, a sample disassembly examination program verifies valve obturator movement. The sample disassembly examination program groups check valves by category of similar design, application, and service condition.

During the disassembly process, the full-stroke motion of the obturator is verified. Nondestructive examination is performed on the hinge pin to assess wear, and seat contact surfaces are examined to verify adequate contact. Full-stroke motion of the obturator is re-verified immediately prior to completing reassembly. At least one valve from each group is disassembled and examined at each refueling outage, and all the valves in each group are disassembled and examined at least once every eight years. Before being returned to service, valves disassembled for examination or valves that received maintenance that could affect their performance are exercised with a full- or part-stroke. Details and bases of the sampling program are documented and recorded in the test plan.

When operating conditions, valve design, valve location, or other considerations prevent direct observation or measurements by use of conventional methods to determine adequate check valve function, diagnostic equipment and nonintrusive techniques are used to monitor internal conditions. Nonintrusive tests used are dependent on system and valve configuration, valve design and materials, and include methods such as ultrasonic (acoustic), magnetic, radiography, and use of

accelerometers to measure system and valve operating parameters (e.g., fluid flow, disk position, disk movement, disk impact, and the presence or absence of cavitation and back-tapping). Nonintrusive techniques also detect valve degradation. Diagnostic equipment and techniques used for valve operability determinations are verified as effective and accurate under the PST program.

Testing is performed, to the extent practical, under normal operation, cold shutdown, or refueling conditions applicable to each check valve. Testing includes effects created by sudden starting and stopping of pumps, if applicable, or other conditions, such as flow reversal. When maintenance that could affect valve performance is performed on a valve in the IST program, post-maintenance testing is conducted prior to returning the valve to service.

Preoperational testing is performed during the initial test program (refer to Section 14.2) to verify that valves are installed in a configuration that allows correct operation, testing, and maintenance. Preoperational testing verifies that piping design features accommodate check valve testing requirements. Tests also verify disk movement to and from the seat and determine, without disassembly, that the valve disk positions correctly, fully opens or fully closes as expected, and remains stable in the open position under the full spectrum of system design-basis fluid flow conditions.

Data acquired during check valve testing and inspections, and the maintenance history of a valve or group of valves is collected and maintained in order to establish the basis for specifying inservice testing, examination, and preventive maintenance activities that will identify and/or mitigate the failure of the check valves or groups of check valves tested. This data is also used to determine if certain check valve condition monitoring tests, such as nonintrusive tests, are feasible and effective in monitoring for these identified failure mechanisms, whether periodic disassembly and examination activities would be effective in monitoring for these failure mechanisms, as well as to determine possible valve groupings to implement in a future check valve condition monitoring program as allowed by ISTC-5222, the requirements of which are described in ASME OM Code, Appendix II.

3.9.6.5 Valve Replacement, Repair and Maintenance

Add the following to the end of the paragraph.

STD COL 3.9.9-3-A

When a valve or its control system has been replaced, repaired, or has undergone maintenance that could affect valve performance, a new reference value is determined, or the previous value is reconfirmed by an inservice test. This test is performed before the valve is returned to service, or immediately if the valve is not removed from service. Deviations between the previous and new reference values are identified and analyzed. Verification that the new values represent acceptable operation is documented.

3.9.6.6 10 CFR 50.55a Relief Requests and Code Cases

Add the following at the end of the first paragraph.

STD SUP 3.9-1

No relief from or alternative to the ASME OM Code is being requested.

3.9.6.7 Inservice Testing Program Implementation

Delete the last paragraph.

3.9.6.8 Non-Code Testing of Power-Operated Valves

Replace the second sentence of the first paragraph with the following.

STD COL 3.9.9-3-A

These tests, which are typically performed under static (no flow or pressure) conditions, also document the “baseline” performance of the valves to support maintenance and trending programs.

Replace the fifth sentence of the first paragraph with the following.

STD COL 3.9.9-3-A

Uncertainties associated with performance of these tests and use of the test results (including those associated with measurement equipment and potential degradation mechanisms) are addressed appropriately.

Replace the last sentence of the first paragraph with the following.

STD COL 3.9.9-3-A

Uncertainties affecting both valve function and structural limits are addressed.

Replace the second paragraph with the following.

STD COL 3.9.9-3-A

Additional testing is performed as part of the air-operated valve (AOV) program, which includes the key elements for an AOV Program as identified in the JOG AOV program document, Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000 (References 3.9.201 and 3.9.202). The AOV program incorporates the attributes for a successful power-operated valve long-term periodic verification program, as discussed in RIS 2000-03, Resolution of Generic Safety Issue 158: Performance of Safety-related Power-Operated Valves Under Design Basis Conditions, (Reference 3.9.203) by incorporating lessons learned from previous nuclear power plant operations and research programs as they apply to the periodic testing of air- and other power-operated valves included in the IST program. For example, key lessons learned addressed in the AOV program include:

- Valves are categorized according to their safety significance and risk ranking.
- Setpoints for AOVs are defined based on current vendor information or valve qualification diagnostic testing, such that the valve is capable of performing its design-basis function(s).
- Periodic static testing is performed, at a minimum on high risk (high safety significance) valves, to identify potential degradation, unless those valves are periodically cycled during normal plant operation under conditions that meet or exceed the worst case operating conditions within the licensing basis of the plant for the valve, which would provide adequate periodic demonstration of AOV capability. If required based on valve qualification or operating experience, periodic dynamic testing is performed to re-verify the capability of the valve to perform its required functions.
- Sufficient diagnostics are used to collect relevant data (e.g., valve stem thrust and torque, fluid pressure and temperature, stroke time, operating and/or control air pressure, etc.) to verify the valve meets the functional requirements of the qualification specification.
- Test frequency is specified, and is evaluated each refueling outage based on data trends as a result of testing. Frequency for periodic testing is in accordance with References 3.9.201 and 3.9.202, with a minimum of 5 years (or 3 refueling cycles) of data collected and evaluated before extending test intervals.

- Post-maintenance procedures include appropriate instructions and criteria to ensure baseline testing is re-performed as necessary when maintenance on the valve, valve repair or replacement, have the potential to affect valve functional performance.
- Guidance is included to address lessons learned from other valve programs in procedures and training specific to the AOV program.
- Documentation from AOV testing, including maintenance records and records from the corrective action program are retained and periodically evaluated as a part of the AOV program.

The attributes of the AOV testing program described above, to the extent that they apply to and can be implemented on other safety-related power-operated valves, such as electro-hydraulic valves, are applied to those other power-operated valves.

3.9.7 Risk-Informed Inservice Testing

Replace this section with the following.

STD SUP 3.9-2 Risk informed inservice testing is not being utilized.

3.9.8 Risk-Informed Inservice Inspection of Piping

Replace this section with the following.

STD SUP 3.9-3 Risk informed inservice inspection is not being utilized.

3.9.9 COL Information

3.9.9-1-A Reactor Internals Vibration Analysis, Measurement and Inspection Program

CWR COL 3.9.9-1-A This COL item is addressed in Section 3.9.2.4.

3.9.9-2-A ASME Class 2 or 3 or Quality Group D Components with 60 Year Design Life

STD COL 3.9.9-2-A This COL item is addressed in Section 3.9.3.1.

3.9.9-3-A Inservice Testing Programs

STD COL 3.9.9-3-A
NAPS COL 3.9.9-3-A This COL item is addressed in Section 3.9.6.

3.9.9-4-A Snubber Inspection and Test Program

STD COL 3.9.9-4-A This COL item is addressed in Section 3.9.3.7.1(3)e and Section 3.9.3.7.1(3)e.

3.9.10 References

3.9.201 Joint Owners Group Air Operated Valve Program Document, Revision 1, December 13, 2000.

3.9.202 USNRC, Eugene V. Imbro, letter to Mr. David J. Modeen, Nuclear Energy Institute, Comments On Joint Owners' Group Air Operated Valve Program Document, October 8, 1999.

3.9.203 Regulatory Issue Summary 2000-03, Resolution of Generic Safety Issue 158: Performance of Safety-related Power-Operated Valves Under Design Basis Conditions, March 15, 2000.

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.10.1.4 Dynamic Qualification Report

Replace the last paragraph with the following.

STD COL 3.10.4-1-A

An implementation schedule for completing ITAAC will be provided to the NRC no later than 1 year after issuance of the combined license or at the start of construction as defined in 10 CFR 50.10(a), whichever is later. Dominion shall submit updates to the ITAAC schedules every 6 months thereafter and, within 1 year of its scheduled date for initial loading of fuel, and shall submit updates to the ITAAC schedules every 30 days until the final notification is provided to the NRC under paragraph 10 CFR 52.99(c)(1).

The Dynamic Qualification Report and documentation that describe the seismic and dynamic qualification methods will be made available for NRC staff review, inspection, and audit. Information that verifies the seismic and dynamic qualification will be made available to the NRC to facilitate reviews, inspections, and audits throughout the process. FSAR information will be revised, as necessary, as part of a subsequent FSAR update.

STD SUP 3.10-1

Section 17.5 defines the Quality Assurance Program requirements that are applied to equipment qualification files, including requirements for handling safety-related quality records, control of purchased material, equipment and services, test control, and other quality related processes.

3.10.4 COL Information

3.10.4-1-A **Dynamic Qualification Report**

STD COL 3.10.4-1-A This COL item is addressed in Section 3.10.1.4.

3.11 Environmental Qualification of Mechanical and Electrical Equipment

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3.11.4.4 Environmental Qualification Documentation

Replace the last paragraph with the following.

STD COL 3.11-1-A The documentation necessary to support the continued qualification of the equipment installed in the plant that is within the Environmental Qualification (EQ) Program scope is available in accordance with 10 CFR 50 Appendix A, General Design Criterion 1. EQ files are maintained for equipment and certain post-accident monitoring devices that are subject to a harsh environment. The files are maintained for the operational life of the plant.

Central to the EQ Program is the EQ Master Equipment List (EQMEL). The EQMEL identifies the electrical and mechanical equipment or components that must be environmentally qualified for use in a harsh environment. The EQMEL consists of equipment that is essential to emergency reactor shutdown, containment isolation, reactor core cooling, or containment and reactor heat removal, or that is otherwise essential in preventing a significant release of radioactive material to the environment. This list is developed from the equipment list provided in DCD Table 3.11-1. The EQMEL and a summary of equipment qualification results are maintained as part of the equipment qualification file for the operational life of the plant.

Administrative programs are in place to control revision to the EQ files and the EQMEL. When adding or modifying components in the EQ Program, EQ files are generated or revised to support qualification. The EQMEL is revised to reflect these new components. To delete a component from the EQ Program requires a deletion justification to be prepared that demonstrates why the component can be deleted. This justification consists of an analysis of the component, an associated

circuit review if appropriate, and a safety evaluation. The justification is released and/or referenced on an appropriate change document.

For changes to the EQMEL, supporting documentation is completed and approved prior to issuing the changes. This documentation includes safety reviews and new or revised EQ files. Plant modifications and design basis changes are subject to change process reviews, e.g., reviews in accordance with 10 CFR 50.59 or the change control requirements of the ESBWR-specific appendix to 10 CFR Part 52, in accordance with appropriate plant procedures. These reviews address EQ issues associated with the activity. Any changes to the EQMEL that are not the result of a modification or design basis change are subject to a separate review that is accomplished and documented in accordance with plant procedures.

Engineering change documents or maintenance documents generated to document work performed on an EQ component are reviewed against the current revision of the EQ files for potential impact. Changes to EQ documentation may be due to, but not limited to, plant modifications, calculations, corrective maintenance, or other EQ concerns.

The operational aspects of the EQ program include:

- Evaluation of EQ results for design life to establish activities to support continued EQ
- Determination of surveillance and preventive maintenance activities based on EQ results
- Consideration of EQ maintenance recommendations from equipment vendors
- Evaluation of operating experience in developing surveillance and preventive maintenance activities for specific equipment
- Development of plant procedures that specify individual equipment identification, appropriate references, installation requirements, surveillance and maintenance requirements, post-maintenance testing requirements, condition monitoring requirements, replacement part identification, and applicable design changes and modifications
- Development of plant procedures for reviewing equipment performance and EQ operational activities, and for trending the results to incorporate lessons learned through appropriate modifications to the operational EQ program

- Development of plant procedures for the control and maintenance of EQ records

Implementation of the environmental qualification program, including development of the plant specific Environmental Qualification Document (EQD), will be in accordance with the milestone defined in Section 13.4.

3.11.7 COL Information

3.11-1-A Environmental Qualification Document

STD COL 3.11-1-A This COL item is addressed in Section 3.11.4.4.

CWR SUP 3.12-1

3.12 Piping Design Review

Information on seismic Category I and II, and nonseismic piping analysis and their associated supports is presented in Sections 3.7, 3.9, 3D, 3K, 5.2 and 5.4.

STD SUP 3.13-1

3.13 Threaded Fasteners - ASME Code Class 1, 2, and 3

Criteria applied to the selection of materials, design, inspection and testing of threaded fasteners (i.e., threaded bolts, studs, etc.) are presented in DCD Section 3.9.3.9, with supporting information in DCD Sections 4.5.1, 5.2.3, and 6.1.1.

Appendix 3A Seismic Soil-Structure Interaction Analysis

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

3A.1 Introduction

Add at the beginning of this section.

NAPS DEP 3.7-1

DCD Sections 3A.1 through 3A.9 provide information related to the ESBWR standard design SSI analyses for generic site conditions and analysis cases. This information provides the basis and results for the ESBWR Standard Plant SSI analyses that were performed using the CSDRS vibratory ground motion. The North Anna 3 Early Site Permit site-specific information that is discussed in DCD Sections 3A.1 through 3A.9 is also used as input to the ESBWR standard design SSI analyses.

Sections 3A.10 through 3A.19 provide information related to the site-specific SSI analyses performed using the site-specific design motion and subgrade conditions. The site-specific SSI analyses are described, and the results are provided, in Sections 3.7.2, 3.8.4, 3.8.5, and 3A.10 through 3A.19. Sections 3A.10 through 3A.18 correspond to DCD Sections 3A.1 through 3A.9, and Section 3A.19 summarizes the site-specific analyses results.

The results of both the ESBWR standard design SSI analyses and the Unit 3 site-specific SSI analyses are used as input for the seismic design, analyses, and qualification of plant structures, systems, and components.

3A.2 Deleted

3A.9 Site Envelope Seismic Responses

Add the following at the end of this section.

NAPS DEP 3.7-1

3A.10 Site-Specific Seismic Soil-Structure Interaction Analysis Introduction

Sections 3A.10 through 3A.19 present the SSI analysis to establish the site-specific seismic design basis for the RB, FB, CB, and FWSC for the ESBWR Standard Plant Seismic Category I structures. The RB and FB are integrated and founded on a common basemat and termed RB/FB.

The FWSC is composed of two Firewater Storage Tanks (FWS) and a Fire Pump Enclosure (FPE), which are founded on a common basemat.

As described in Section 2.0, the site-specific horizontal and vertical FIRS have been compared to the corresponding CSDRS used for the design of the ESBWR standard plant. These comparisons show that there are ranges of frequencies where both the horizontal and vertical site-specific FIRS exceed the CSDRS. In accordance with the requirements of DCD Tier 1, Section 5.1, to address these exceedances, site-specific SSI analyses are performed for Seismic Category I RB/FB, CB, and FWSC structures using the site-specific ground motion and strain compatible soil properties. These analyses are supplemental to the CSDRS standard design analyses.

The ESBWR standard design based on the CSDRS remains applicable and the site-specific analyses are performed to address the site-specific conditions. The site-specific SSE design ground motion at the foundation level and the dynamic properties of subgrade materials are described in Section 3.7.1. The site-specific SSI analysis results are presented in the form of seismic responses at key locations in the RB/FB, CB, and FWSC. Both the standard design analyses and the site-specific analyses results are used in the seismic design, analyses, and qualification of SSCs for Unit 3. The evaluations for the RB/FB, CB, and FWSC structures are described in Appendix 3G.

The site-specific SSI analyses for the RB/FB, CB, and FWSC follow the standard design methodology described in DCD Section 3A.5.2 using the SASSI2010 computer program. For the RB/FB, the ACS SASSI computer program is also used. The SASSI2010 and ACS SASSI computer programs use exactly the same methodology as the SASSI2000 computer program used for the standard design SSI analyses to provide the solution for the seismic response of the structure-subgrade interaction system based on the frequency domain complex response method. Section 3A.10.1 demonstrates the adequacy of ACS SASSI computer program solutions for the site-specific seismic response of the RB/FB. As described in Section 3A.16, the SASSI structural (HOUSE) models are developed from the standard design SASSI model coupled with site-specific strain compatible dynamic subsurface properties.

The site-specific design basis SSI analyses use structural models with upper bound stiffness properties that provide conservative seismic

responses for the rock site with high frequency design ground motion. The results of the site-specific structural stiffness variation sensitivity analyses, presented in Section 3A.17.9, confirm that the site-specific design basis analyses that are based on the model with upper bound stiffness properties adequately address the effects of structural stiffness variations with the exception of limited instances of local exceedances. These exceedances are included in the site-specific design basis as described in Section 3A.18.

The far-field models used for the site-specific SSI analyses are assigned dynamic properties of the in-situ subgrade materials that are compatible to the strains generated by the site-specific design motion. The SSI models also include near-field solid elements representing the strain compatible dynamic properties of the concrete and structural fill materials backfilled below and around the buildings. The site-specific SSI analyses consider BE, LB, and UB properties of the subgrade materials to account for the effects of the potential variability in the properties of the subgrade materials at the site.

The site-specific SSI analyses for the RB/FB and CB consider two different embedment configurations representing:

1. the buildings being partially embedded (PE) up to the Zone III rock nominal top elevation, and

2. the buildings being fully embedded (FE) up to the finished ground level grade elevation.

The envelope of responses obtained from the RB/FB and CB analyses of the BE, LB and UB partial and full column profiles provides the site-specific seismic demands used for site-specific design and evaluation of the RB/FB and CB.

The results of site-specific evaluations in Section 3A.17.11 show that the SSI analyses of the stand-alone CB model bound the SSSI effects of the RB/FB and FWSC on the CB seismic response with the exception of limited instances of local exceedances. The CB site-specific design ISRS are enhanced as described in Section 3A.18.2 to bound these exceedances.

The FWSC site-specific design basis is developed based on the envelope of the results obtained from site-specific SSI analyses of FWSC

stand-alone model and SSSI analyses of FWSC-CB combined model performed with the input control motion applied:

1. as a surface input motion compatible to the spectra defining the site-specific design motion at the bottom of the FWSC foundation at Elevation 282 ft NAVD88 (standard design Elevation 2.15 m), and
2. as an in-column motion compatible to the spectra defining the site-specific design motion at the bottom of the concrete fill at nominal Elevation 220 ft NAVD88 (standard design Elevation -16.8 m).

Consideration of two different control motion elevations captures the effects of seismic wave propagation through concrete fill supporting the FWSC basemat and thus addresses potential deamplification of the high frequency input motion as the seismic waves propagate through the in-situ saprolite. The FWSC site-specific design basis that is developed based on the envelope of results obtained from the analyses that use these two sets of input control motions meets the intent of DC/COL-ISG-017, which specifies that the spectra defining the design motion at the surface be enveloped by deterministic seismic response analyses at the top of the considered soil columns. In accordance with SRP 3.7.2, three subsurface profiles are considered for each input control motion, namely, a BE profile, a LB profile, and a UB profile to account for the effects of the potential variability in the subgrade properties at the FWSC location. The effects of separation between the concrete fill and surrounding soil on the FWSC seismic response are evaluated in Section 3A.17.14.5. The exceedances due to these soil separation effects are included in the FWSC site-specific design basis as described in Section 3A.18.

The results of site-specific SSI analyses are compared with the envelopes presented in DCD Section 3A.9 to determine exceedances relative to the standard design. The results of SSI analyses are also used as the basis for the site-specific seismic design evaluations of the RB/FB, CB, and FWSC, which are described in Appendix 3G.

3A.10.1 Comparison of SASSI2010 and ACS SASSI Results

To demonstrate the adequacy of the ACS SASSI computer program solutions for the site-specific seismic response of the RB/FB, a verification analysis is performed using the ACS SASSI computer

program and results are compared to results using SASSI2010. The verification is performed using the RB/FB model with upper bound structural stiffness properties and OBE damping values for the UB full column profile (corresponding to analysis Case 6 in Table 3A.15-201). This ACS SASSI model consists of all the 3-D elements that the SASSI family of programs uses to model the SSI system, including brick elements, beam elements, shell elements, soft and rigid spring elements, mass/stiffness matrix, and mass elements. The analysis of this case uses the same inputs and the same set of frequencies of analyses as those used for the corresponding SASSI2010 analysis.

The following results from the ACS SASSI verification analysis are compared to the corresponding results of the SASSI2010 licensing basis analysis (analysis Case 6 in Table 3A.15-201):

- Acceleration Transfer Functions at selected key lumped mass floor locations
- Maximum accelerations at lumped mass locations
- Maximum forces and moments for the stick members
- Maximum floor displacements relative to the free-field motion
- 5 percent damped ISRS for the responses at the key floor locations

The close agreement of the ACS SASSI computer program results with those obtained using the SASSI2010 computer program demonstrates the adequacy of the ACS SASSI computer program solutions for the site-specific seismic response of the RB/FB.

3A.11 Plant Site Plan

The site plan is shown in Figure 2.1-201. Table 2.5.2-209 lists the size, depth, and loading of the Seismic Category I structures. The model axes in the X-direction and Y-direction represent the north-south (NS) direction and the east-west (EW) direction, respectively. These directions are referenced to plant north. Plant north is oriented 23.54 degrees east of true north. The Z-axis represents the vertical direction.

Elevations in Sections 3A.10 through 3A.19 are given in feet NAVD88 and may include the elevation in meters for comparison to specific DCD elevations. As specified in Table 2.0-201, the design plant grade elevation identified in DCD Table 3.4-1 is 4650 mm, which corresponds to 88.4 m (Elevation 290.0 ft NAVD88) for the site as shown in Figure 2.1-201.

3A.12 Site-Specific Subgrade Conditions

This section describes the site subgrade conditions used in the site-specific SSI analyses.

3A.12.1 Generic Site Conditions

Generic site conditions are not considered in the site-specific SSI analyses.

3A.12.2 Site-Specific Conditions

The site subgrade conditions used in the site-specific SSI analyses are described in Section 3.7.1 and discussed below.

The geology of the site is discussed in detail in Section 2.5.1. The subsurface materials encountered at the site and the engineering properties of these subsurface materials are discussed in detail in Section 2.5.4. To account for the variability of the subgrade properties, SSI analyses are performed for three sets (BE, UB and LB) of dynamic properties of subgrade materials. Development of the BE, LB, and UB site-specific strain compatible dynamic subsurface material properties is discussed in Section 3.7.1.1.4. The strain compatible dynamic properties used to develop the BE, LB, and UB subsurface profiles used in the site-specific SSI analyses are provided in Tables 3.7.1-201 and 3.7.1-202 for the RB/FB, Tables 3.7.1-203 and 3.7.1-204 for the CB, and Tables 3.7.1-205 and 3.7.1-206 for the FWSC. The site-specific SSI inputs are described below for each structure.

The RB/FB and CB site-specific SSI analyses are performed for two embedment configurations representing two limiting SSI stiffness conditions:

- LB stiffness represented by partial column profiles that neglect stiffness of softer soil materials above the rock top elevation
- UB stiffness represented by full column profiles simulating full contact of embedment with below-grade exterior walls (no soil separation) and fully saturated stiffness properties of soil below the nominal groundwater level

To address the variability of the subgrade properties, the RB/FB and CB SSI analyses are performed for partial and full column profiles representing BE, LB, and UB dynamic properties of in-situ materials

compatible to the strains generated by the site-specific design ground motion.

The RB/FB and CB SSI analyses also consider BE, LB, and UB dynamic properties for the structural and concrete fill materials placed around the RB/FB and CB. The structural fill dynamic properties are compatible to the strains generated by the site-specific design ground motion. The dynamic properties used for the concrete fill are independent of strain, reflecting the linear elastic behavior of the concrete under the small earthquake-induced strains.

The site-specific seismic response analyses of the FWSC consider BE, LB, and UB dynamic properties of the in-situ subgrade materials at the FWSC location that are compatible with the strains generated by the site-specific design ground motion. The site-specific strain-compatible dynamic properties of the in-situ rock and saprolite subgrade materials are assigned to the far-field models and the excavated volume elements of the FWSC models. The BE, LB and BE properties assigned to the near-field elements modeling the concrete fill placed below the FWSC foundation are independent of strain, reflecting the linear elastic behavior of the concrete under the small earthquake-induced strains. The near-field elements in the FWSC-CB combined model representing the structural fill placed in the gap between the CB and FWSC and around the concrete fill below the FWSC foundation are assigned BE, LB and UB properties that are compatible to the strains generated by the input design motion.

The P-wave velocity of the saprolite and structural fill materials below the groundwater level is set equal to or close to that of the water to capture the effect of groundwater on P-wave velocity of saturated soil. A maximum value of 0.48 is used for the Poisson’s ratio of subgrade materials to ensure the numerical stability of the analyses results.

The partial and full embedment configurations considered in the RB/FB and CB SSI analyses provide responses that bound the effects of subgrade stiffness variations related to the soil separation, backfill horizontal extent, and groundwater level variations, and minimize the effects of dissipation of energy in the SSI system due to damping of the embedment materials. The partially embedded models provide an LB representation of the stiffness of the RB/FB and CB embedment because they do not consider the stiffness of the subgrade materials (saprolite and the structural fill) above the Zone III rock surface. The partially embedded

models also neglect the dissipation of energy in the SSI system that is due to the material damping of the saprolite and the structural fill.

The RB/FB and CB fully embedded models consider a minimum horizontal extent of the structural fill to provide a UB representation of the stiffness of the embedment because the structural fill has a lower shear wave velocity (and thus lower shear modulus and stiffness) than the surrounding in-situ saprolite. Comparisons between the shear wave velocity and damping ratio of the structural fill and in-situ saprolite, provided in Figures 3A.12.2-201 and 3A.12.2-202, show that the structural fill has lower stiffness and higher damping properties than the surrounding in-situ saprolite. The same relationships are also shown in comparisons of the average strain-compatible shear wave velocities (Vs_{ave}) and shear column frequencies (f_{sc}) of the concrete fill, structural fill and in-situ materials presented in Tables 3A.12.2-201 and 3A.12.2-202. Therefore, the consideration of the minimum horizontal extent of the structural fill reduces the dissipation of energy in the SSI system because the material damping of the structural fill is higher than that of the in-situ saprolite.

The site-specific SSI analyses of the FWSC neglect the effects of the structural fill placed around the FWSC basemat and the concrete fill because the strain-compatible dynamic properties of the structural fill are similar to those of the surrounding in-situ saprolite. The comparisons presented in Figure 3A.12.2-203 show that the structural fill and the in-situ saprolite have similar shear wave velocities, compression wave velocities and damping. The comparisons presented in Table 3A.12.2-203 also show that the values of the average strain-compatible shear wave velocities (Vs_{ave}) and shear column frequencies (f_{sc}) of the structural and concrete fill are very close to those of the in-situ saprolite and rock. The FWSC-CB combined model used for the FWSC-CB SSSI analyses presented in Section 3A.17.11 includes the structural fill placed in the gap between the CB and FWSC and around the concrete fill below the FWSC foundation. The inclusion of the structural fill in the combined model addresses the effects of the structural fill on the FWSC seismic response.

The SSI analyses for the FWSC are performed on models representing fully-bonded conditions between the concrete fill supporting the FWSC foundation and the surrounding soil. Sensitivity analyses are performed on models simulating conditions of maximum separation between the

concrete fill under the FWSC foundation and the surrounding soil. The effects of separation between the concrete fill and surrounding soil on the seismic response of the FWSC structures and the Unit 3 site-specific design basis are addressed based on the results of these sensitivity analyses as described in Section 3A.17.14.5.

NAPS DEP 3.7-1

Table 3A.12.2-201 **RB/FB Comparisons of the Average Strain-Compatible Shear Wave Velocities and Shear Column Frequencies of the Fill and In-Situ Materials**

	Concrete Fill/ Zone III Rock Embedment					Structural Fill/Saprolite Embedment				
		Backfill		In-Situ			Backfill		In-Situ	
Soil Case	**Depth m**	**$V_{S\ ave}$ m/s**	**f_{sc} Hz**	**$V_{S\ ave}$ m/s**	**f_{sc} Hz**	**Depth m**	**$V_{S\ ave}$ m/s**	**f_{sc} Hz**	**$V_{S\ ave}$ m/s**	**f_{sc} Hz**
LB	14.8	1829	30.9	979	16.5	5.2	137	6.6	228	11.0
BE		2134	36.0	1318	22.3		213	10.3	360	17.4
UB		2438	41.2	1774	30.0		331	16.0	566	27.3

NAPS DEP 3.7-1

Table 3A.12.2-202 **CB Comparisons of the Average Strain-Compatible Shear Wave Velocities and Shear Column Frequencies of the Fill and In-Situ Materials**

	Concrete Fill/ Zone III Rock Embedment					Structural Fill/Saprolite Embedment				
		Backfill		In-Situ			Backfill		In-Situ	
Soil Case	**Depth m**	**V_{s-ave} m/s**	**f_{sc} Hz**	**V_{s-ave} m/s**	**f_{sc} Hz**	**Depth m**	**V_{s-ave} m/s**	**f_{sc} Hz**	**V_{s-ave} m/s**	**f_{sc} Hz**
LB	7.3	1829	62.6	519	17.8	7.6	147	4.8	218	7.2
BE		2134	73.1	690	23.6		226	7.4	336	11.0
UB		2438	83.5	916	31.4		347	11.4	515	16.9

NAPS DEP 3.7-1

Table 3A.12.2-203 **FWSC Comparisons of the Average Strain-Compatible Shear Wave Velocities and Shear Column Frequencies of the Fill and In-Situ Materials**

	Zone III Rock			Structural Fill/Saprolite					Full Column				
					Backfill		In-Situ			Backfill		In-Situ	
Soil Case	Depth m	$V_{S\ ave}$ m/s	f_{sc} Hz	Depth m	$V_{S\ ave}$ m/s	f_{sc} Hz	$V_{S\ ave}$ m/s	f_{sc} Hz	Depth m	$V_{S\ ave}$ m/s	f_{sc} Hz	$V_{S\ ave}$ m/s	f_{sc} Hz
LB		604	20.6		157	3.4	192	4.1		243	3.2	261	3.5
BE	7.3	781	26.7	11.7	252	5.4	298	6.4	19.0	383	5.1	391	5.2
UB		1010	34.5		405	8.7	461	9.9		598	7.9	584	7.7

Figure 3A.12.2-201 **RB/FB Comparisons Between Shear Wave Velocity and Damping Ratio of Structural Fill and In-Situ Saprolite**

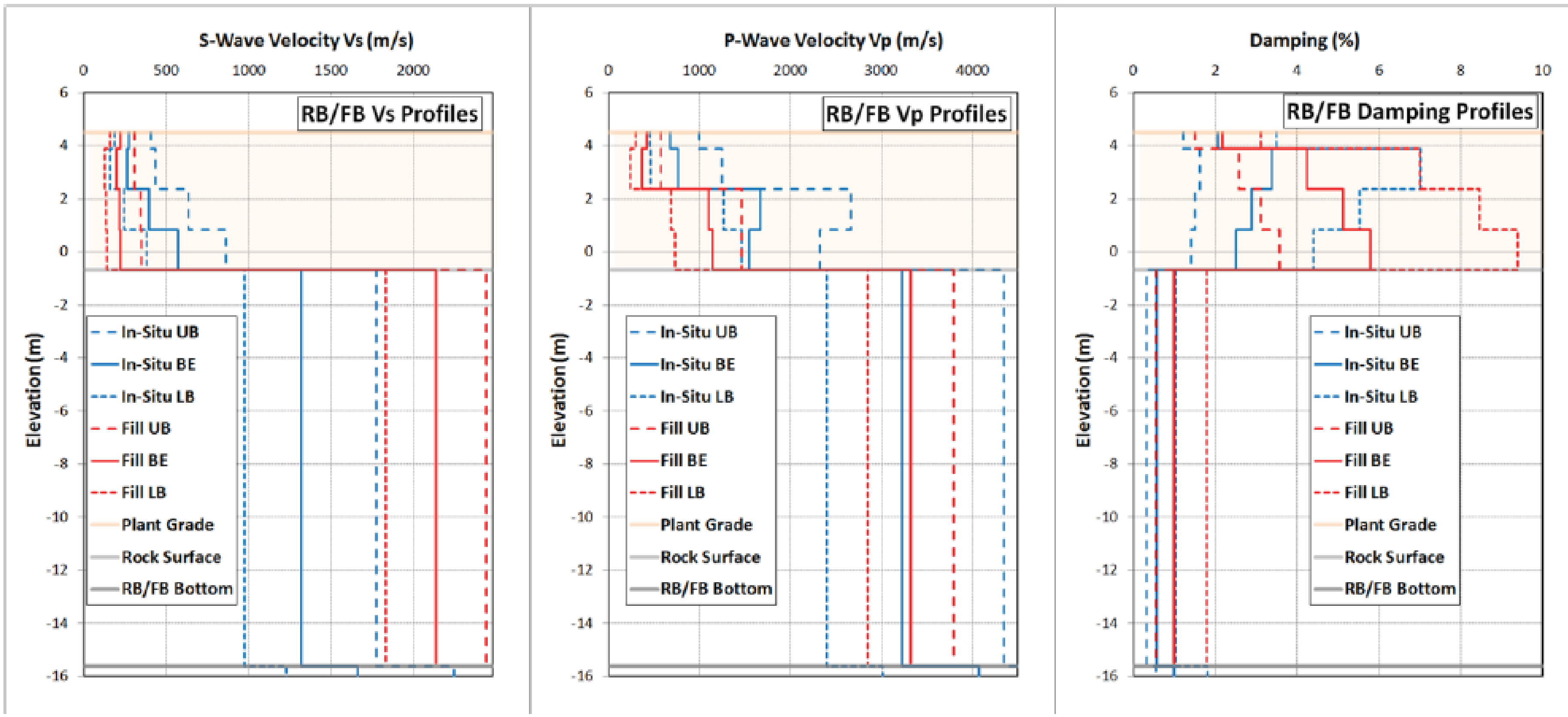


Figure 3A.12.2-202 **CB Comparisons Between Shear Wave Velocity and Damping Ratio of Structural Fill and In-Situ Saprolite**

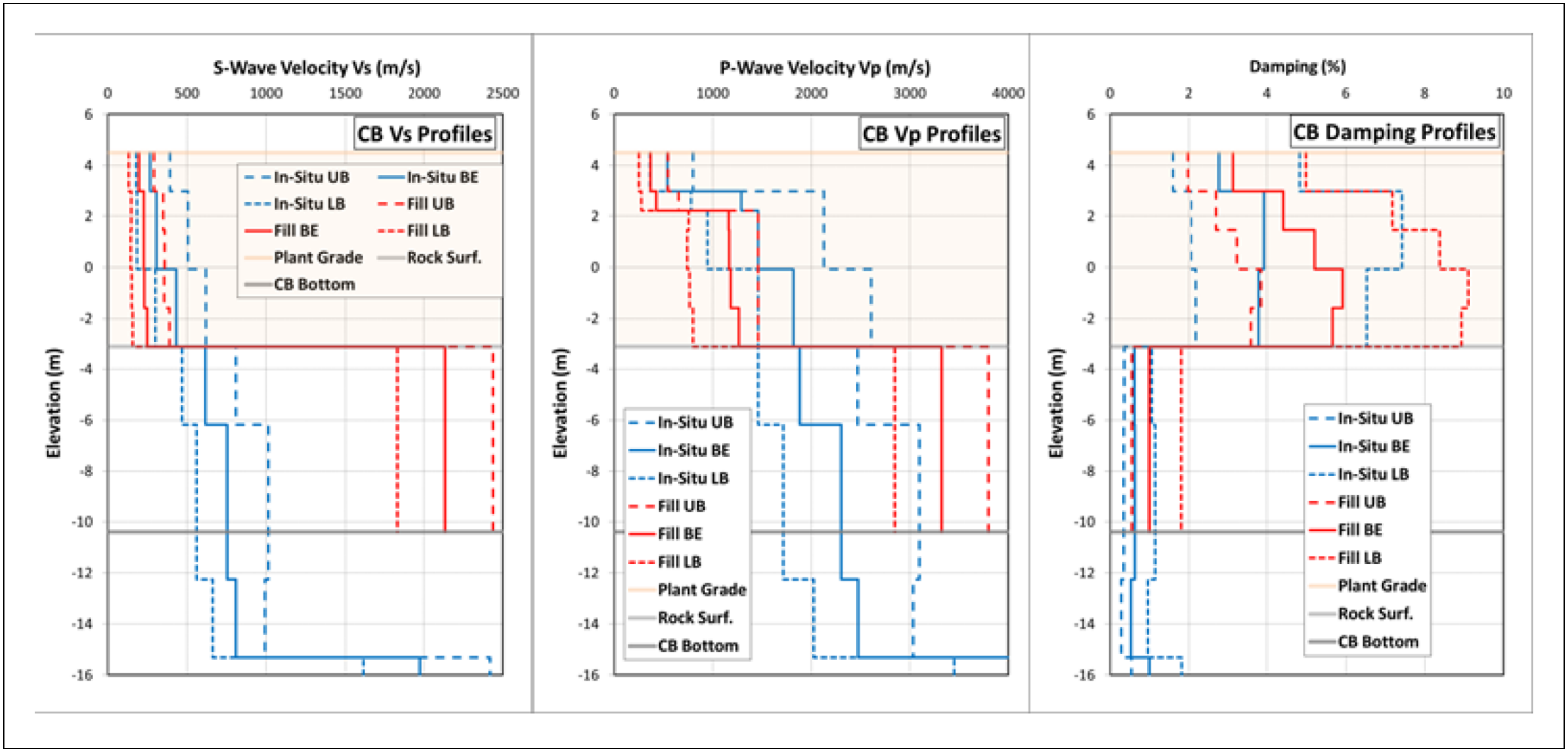
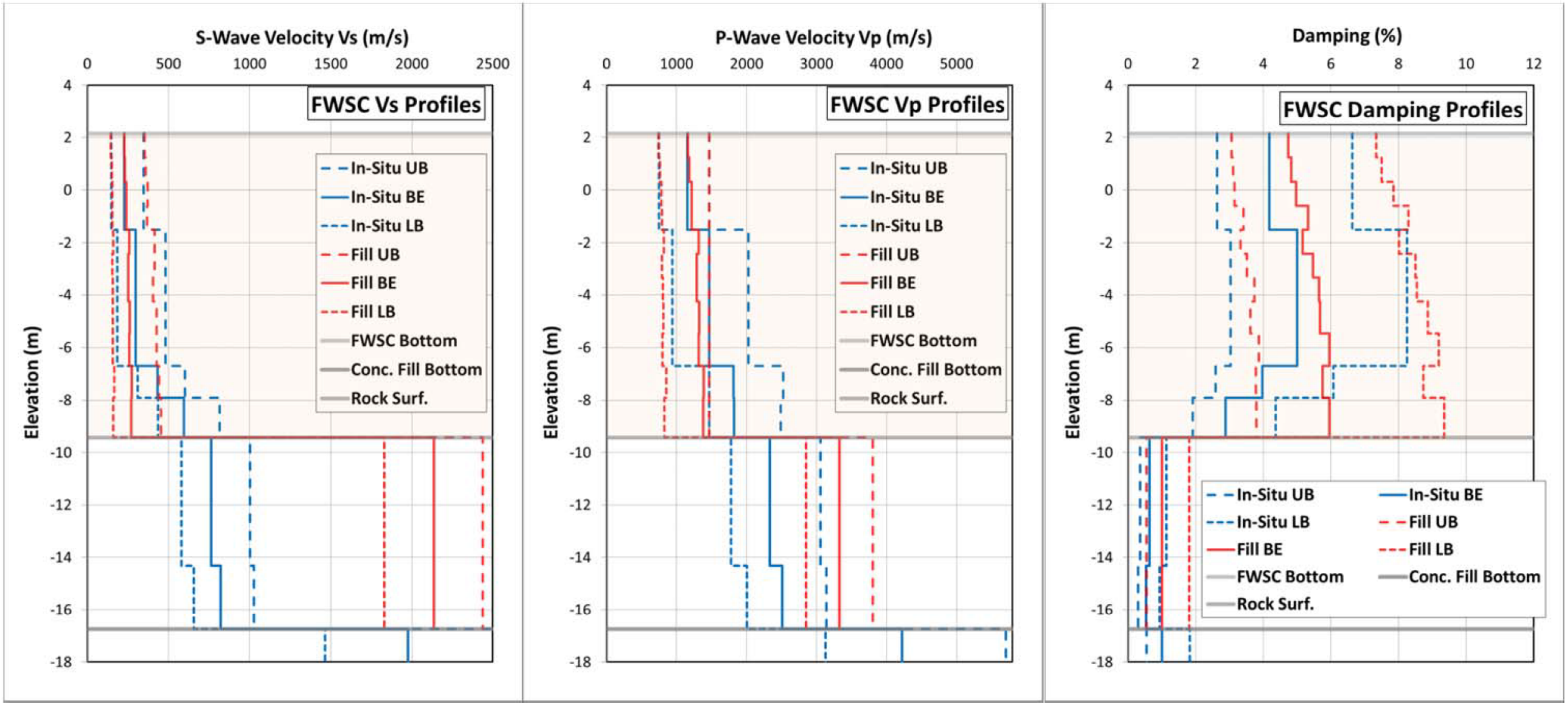


Figure 3A.12.2-203 **FWSC Comparisons Between Shear and Compression Wave Velocity and Damping Ratio of Structural Fill and In-Situ Saprolite**



NAPS DEP 3.7-1

3A.13 Site-Specific Input Motion and Damping Values

3A.13.1 Site-Specific Input Motion

The time history method is used to perform site-specific seismic response analyses. Section 3.7.1.1.5 describes development of the site-specific ground motion time histories used as input control motion in the site-specific SSI analyses.

Six sets of ground motion time histories are used as input control motion in three orthogonal directions for the SSI analyses of the RB/FB and CB for the BE, LB, and UB partial and full column profiles. These acceleration time histories represent the in-column free-field motion at the RB/FB and CB foundation bottom elevation. The time histories are developed from the outcrop motion time histories that are compatible with the envelope of the RB/FB FIRS and CB FIRS and the broadband spectra specified in RG 1.60 anchored at 0.1g. The in-column ground motion time histories are checked using the NEI method described in DC/COL-ISG-017. The duration of time histories is 29.98 seconds and the time step is 0.005 seconds.

The SSI input control motion for the CB is defined at its basemat bottom elevation (Elevation 241 ft NAVD88), consistent with the standard design approach. This is consistent with the CB FIRS that is also defined at the bottom of the CB basemat following the recommendations of DC/COL-ISG-017. The input motion control point is approximately 5.0 m higher than the bottom of the SASSI2010 structural (HOUSE) model established at the bottom of the concrete fill placed below the CB basemat at Elevation -15.31 m (Elevation 225.0 ft NAVD88). Differences in elevations between the basemat bottom elevation and the bottom of the concrete fill have only a small effect on the seismic response of the CB because the propagation of the seismic waves through the 5.0 m thick Zone III rock, in which the concrete fill block is embedded, would not affect the energy content of the motion due to the dissipation of energy in the rock column material.

The comparison of the DRS developed in Section 2.5.2.5.3 from the results of probabilistic site response analyses of partial and full column profiles representing subgrade conditions at the CB location show that upward propagation of the seismic waves through the rock from the bottom of the concrete fill to the bottom of the CB foundation does not result in shifts of the frequency content of the input motions towards lower frequencies or reduction of the high frequency amplitudes. This can be

seen by comparing the DRS defining the horizontal ground motion at the following two horizons:

- RB/FB basemat bottom elevation of 224 ft NAVD88, which is 1 foot below the bottom elevation of the concrete fill block below the CB foundation (the horizontal full column DRS and partial column DRS at this elevation that are presented in Figures 2.5.2-300 and 2.5.2-303, respectively).
- CB basemat bottom elevation of 241 ft NAVD88 (the horizontal full column DRS and partial column DRS that were adopted as CB Horizontal FIRS that are presented in Figures 2.5.2-301 and 2.5.2-304, respectively).

Therefore, the input control motion used for the site-specific SSI analyses of the CB defined at the basemat bottom elevation is acceptable and does not affect the results of the site-specific seismic evaluation or the design of the CB.

Four sets of ground motion time histories are used as input control motion in three orthogonal directions for the FWSC site-specific seismic response analyses:

- One set of surface input motion time histories compatible to the spectra defining the site-specific design motion at the bottom of the FWSC foundation at Elevation 282 ft NAVD88 (standard design Elevation 2.15 m), and
- Three sets of in-column motion time histories compatible to the spectra defining the site-specific design motion at the bottom of the concrete fill at nominal Elevation 220 ft NAVD88 (standard design Elevation -16.8 m) for analyses of BE, LB and UB subgrade profiles.

The envelope of results obtained from the FWSC analyses that use these two sets of input control motions meets the intent of DC/COL-ISG-017, which specifies that the spectra defining the design motion at the surface be enveloped by deterministic seismic response analyses at the top of the considered soil columns.

3A.13.2 Damping Values Used for Site-Specific Analyses

The site-specific SSI analyses use structural models with full stiffness properties and OBE damping values to ensure conformance with guidance in SRP 3.7.2 and RG 1.61 for calculations of site-specific in-structure response spectra (ISRS). The OBE damping values are also

used for calculation of the site-specific SSE load demands on the RB/FB structures. Results obtained from the analyses of models with full (uncracked concrete) stiffness and SSE damping are used for calculations of the site-specific seismic load demands on the CB and FWSC reinforced concrete structures. The use of SSE damping for development of structural loads is adequate because the stresses obtained from models with SSE damping will remain lower than the stress limits considered by the applicable structural design codes. Responses from models with full (uncracked concrete) stiffness and SSE damping are also used for the foundation uplift and seismic stability evaluations because these analyses also consider limiting conditions that are associated with high dissipation of energy in the SSI dynamic system.

SSE damping is assigned to the models with reduced (cracked concrete) stiffness properties used for the sensitivity SSI analyses described in Section 3A.17.9 to represent the higher dissipation of energy in the structures when subjected to high stresses corresponding to the fully cracked concrete condition. SSE damping is also assigned to the models used for the sensitivity analyses for the evaluation of the effects of separation between the concrete fill placed under the FWSC foundation and surrounding soil that are described in Section 3A.17.14.5. The SSE damping provides a realistic representation of the higher dissipation of energy in the SSI system reflecting larger seismic response displacements associated with the condition of maximum separation between the concrete fill block and the surrounding soil.

Table 3A.13.2-201 provides the damping values used for the site-specific SSI analyses. The damping values are based on RG 1.61, DCD Table 3.7-1, and the standard design model. Section 3A.15 and Tables 3A.15-201 through 3A.15-206 provide details on the use of SSE damping values used in specific analysis cases.

NAPS DEP 3.7-1

Table 3A.13.2-201 **Damping Values for Site-Specific Seismic Response Analyses**

	Percent of Critical Damping	
Components	**SSE Damping**	**OBE Damping**
Reinforced concrete structures	7.0	4.0
Vent Wall/Diaphragm Floor		
• 0% Concrete Stiffness Contribution	4.0	
• 50% Concrete Stiffness Contribution	5.0	
• 100% Concrete Stiffness Contribution		3.0
Reactor Shield Wall	4.0	3.0
Reactor Pressure Vessel (RPV)	4.0	2.0
Separator/Chimney/Shroud	4.0	2.0
Fuel		
• Horizontal	6.0	6.0
• Vertical	6.0	4.0
Control Rod Drive Housing (CRDH)	2.0	1.0
RPV and Shroud Support	4.0	2.0
CRDH Support (CRD restraint)	4.0	2.0
Shroud Support	4.0	2.0

NAPS DEP 3.7-1

3A.14 Site-Specific Soil-Structure Interaction Analysis Method

Site-specific SSI analyses are performed using the SASSI methodology used for the DCD seismic analysis of uniform and layered sites.

3A.14.1 DAC3N Analysis Method

The DAC3N analysis method is not used for site-specific SSI analyses.

3A.14.2 SASSI Analysis Method

The same SASSI methodology is used for the site-specific SSI analyses as the one presented in DCD Section 3A.5.2 to provide the solution for the seismic response of the structure-subgrade interaction system based on the frequency domain complex response method. The site-specific SASSI analyses use both the flexible volume (direct) method (DM) and the modified subtraction method (MSM) simplification. Benchmarking evaluations are used to demonstrate the accuracy of the MSM solutions relative to the corresponding solutions for the DM.

Finite elements with complex moduli are used for modeling the dynamic properties of the structures, foundations, near-field backfill materials and the excavated in-situ soil. Model details are described in Section 3A.16.

The site-specific SSI analyses are performed using a frequency step of 0.0244 Hz and a Fast Fourier Transformation (FFT) number of 8192. The computations are performed for a selected set of frequencies that are equal to or lower than the passing frequency of the analyzed SSI model, i.e., the highest frequency of seismic waves that can be transmitted through the SSI model. The seismic response of the SSI system at other frequencies is obtained by interpolation. Interpolated acceleration transfer function results are reviewed to identify numerical anomalies (e.g., sharp narrow spikes) that can potentially impact the accuracy of the frequency domain SSI analyses results. To ensure that the used set of frequencies of analysis provides sufficiently numerically accurate results, additional frequencies of analysis are used to demonstrate that the identified anomalies in the transfer function interpolation do not affect the accuracy of the results.

Analyses are performed separately for each one of the three directional components of input ground motion. The maximum co-directional seismic forces, moments, accelerations and displacements for each of the three ground motion time history components are combined with the corresponding cross-directional responses using the SRSS method. The

co-directional soil/rock reactions are combined using the algebraic sum method in the time domain for sliding, soil bearing, and base contact area evaluations. Absolute sum method in time domain is used for lateral soil pressure evaluations. The absolute sum method is a conservative alternative to performing algebraic sum for all possible combinations of the input directions.

The ISRS are developed using the SRSS method. As described in Section 3A.16, the ISRS are developed for responses at the edges of the structures by taking into account coupling effects between vertical and rocking and between lateral and torsional motions. The site-specific SSI analyses use cut-off-frequencies that ensure the calculated site-specific design ISRS are adequate for design and qualification of components and equipment for frequencies up to 50 Hz, per the guidelines of NRC DC/COL-ISG-01.

3A.14.2.1 SASSI Analysis Method for RB/FB

The site-specific SSI analyses of the RB/FB are performed using the SASSI2010 computer program with the exception of the sensitivity analyses of the fully embedded RB/FB models with reduced stiffness properties described in Section 3A.17.9, which use the ACS SASSI computer program. The verification study described in Section 3A.10.1 demonstrates that the two programs provide virtually identical numerical results for the site-specific SSI response of the RB/FB.

Analyses of the partially embedded RB/FB model use the flexible volume (direct) method (DM) where all nodes of the excavated volume are specified as interaction nodes to calculate the SSI system impedance matrix. Analyses of the larger fully embedded RB/FB model use the modified subtraction method (MSM) simplification where the impedance calculations are performed for a selected set of nodes within the excavated volume.

3A.14.2.2 SASSI Analysis Method for CB

The site-specific SSI analyses of the CB are performed using the SASSI2010 computer program. The analyses of the partially embedded CB model use the flexible volume DM where all nodes of the excavated volume are specified as interaction nodes to calculate the SSI system impedance matrix. The analyses of the larger fully embedded CB model use the MSM simplification where the impedance calculations are performed for a selected set of nodes within the excavated volume.

3A.14.2.3 SASSI Analysis Method for FWSC

The site-specific SSI analyses of the FWSC half-models with symmetry and asymmetry boundary conditions are performed using the SASSI2010 computer program. However, unlike the SSI analysis performed for the standard design that considers the FWSC basemat resting on the surface of the supporting subgrade with infinite horizontal layering, the site-specific SSI analysis uses the structural model that explicitly includes the concrete fill below the FWSC foundation as a block embedded in the in-situ soil and rock. For the site-specific SSI analysis, a refined mesh is used for the excavated volume portion of the model to ensure it can pass high frequency waves. Because this results in a total number of interaction nodes that can exceed the program limitation for impedance calculations if the DM is used, the simplified MSM is employed instead where only selected nodes of the excavated volume are specified as interaction nodes. Specifically, interaction nodes are defined at the five exterior sides of the excavated volume (excluding the plane of symmetry), and two additional horizontal planes within the excavated volume.

3A.14.2.4 SASSI Analysis Method for Structure-Soil-Structure Interaction Analyses

The SSSI analyses of the CB-RB/FB, CB-FWSC, and FWSC-CB combined models are performed using the SASSI2010 computer program with the MSM where only selected nodes of the excavated volume are specified as interaction nodes. Section 3A.17.11 describes the site-specific evaluations for assessing the effects of SSSI on the site-specific seismic response of Seismic Category I structures.

3A.15 Site-Specific Soil-Structure Interaction Analysis Cases

The site-specific SSI analyses cases for the RB/FB, CB, and FWSC are summarized below.

The RB/FB site-specific cases listed in Table 3A.15-201 are as follows:

- Design bases analyses Cases 1 through 6 use the SASSI2010 computer program and the structural models with full stiffness properties and OBE damping.
- Sensitivity analyses Cases S1 through S12 use the SASSI2010 and ACS SASSI computer programs and the structural models with reduced stiffness properties and SSE damping to evaluate the effects of structural stiffness variations as described in Section 3A.17.9.

RB/FB acceleration transfer function results obtained from each analysis case are reviewed to ensure that selected frequencies of analysis provide sufficient numerically accurate results. Values of cut-off frequencies of analysis are used that are equal to or lower than the passing frequency of the SSI model (the highest frequency of seismic waves that can be transmitted through the SSI model). The selected values of cut-off-frequencies of analysis ensure that the SSI analyses provide RB/FB site-specific design ISRS that, per the guidelines of NRC DC/COL-ISG-01, are adequate for design and qualification of components and equipment for frequencies up to 50 Hz. The cut-off frequencies of analysis for the RB/FB are equal to or higher than 50 Hz for all analyses cases with the exception of the analysis of the fully embedded RB/FB model for the LB full column profile for which a cut-off frequency of 33 Hz is used.

Results of the RB/FB SSI analyses provided in Section 3A.17 show that the site-specific SSI analyses adequately capture the response of the RB/FB structures at high frequencies. SSI analyses results show that the analyses of UB subgrade profiles typically govern the maximum responses of the RB/FB structures. Results also show that UB subgrade profiles typically yield bounding results for the out-of-plane response of flexible slabs and walls. ISRS results show that the analyses of UB subgrade profiles typically govern the responses of the RB/FB at high frequencies. The analyses of the LB full column profile only provide bounding results for the ISRS envelopes at frequencies below 9 Hz. This is at least 24 Hz lower than the lowest cut-off frequency value of 33 Hz used for the analyses of LB full column profile. The cut-off frequencies used for the analyses of the UB partial and full column profiles that typically govern the design at high frequencies capture approximately 99 percent of the input motion energy. The other analysis cases use cut-off frequencies that enable the capture of at least 82 percent of the input motion energy.

The CB site-specific cases listed in Table 3A.15-202 are as follows:

- Design bases analyses Cases 1 through 6 are analyzed utilizing the structural models with full (uncracked concrete) stiffness properties and OBE damping to develop the site-specific seismic design basis ISRS

- Design bases analyses Cases 7 through 12 are analyzed utilizing the structural models with full (uncracked concrete) stiffness properties and SSE damping to develop the site-specific seismic design basis load demands on the CB structure and calculate base reactions for the CB stability evaluations
- Sensitivity Cases S1 through S6 are analyzed utilizing the CB structural models with reduced (cracked) stiffness properties and SSE damping to provide responses for the concrete cracking effects sensitivity evaluation described in Section 3A.17.9.

Acceleration transfer function results obtained from each analysis case are inspected to ensure that selected frequencies of analyses provide numerically accurate results. Values of cut-off frequencies of analyses are used that are equal to or lower than the passing frequency of the SSI model (the highest frequency of seismic waves that can be transmitted through the SSI model). The selected values of cut-off-frequencies of analysis ensure that the SSI analysis provide CB site-specific design ISRS that, per requirements of DC/COL-ISG-01, are adequate for design and qualification of components and equipment for frequencies up to 50 Hz. The cut-off frequencies of analyses are equal to or higher than 50 Hz for all analysis cases with the exception of the analysis of the LB full column profile for which cut-off frequency of 34 Hz is used.

Results of the CB SSI analyses presented in Section 3A.17 show that the analysis of the UB subgrade profiles govern the responses of the CB at high frequencies. The cut-off frequencies used for the analyses of the UB partial and full column profiles capture virtually all (approximately 99 percent) of the input motion energy. The other analysis cases use cut-off frequencies that enable capturing of at least 82 percent of the input motion energy. The UB partial column profile also provides bounding ISRS results for frequencies higher than 31 Hz. The LB and BE full column profiles can only affect the enveloping ISRS for the response at the CB basemat top at frequencies below 18 Hz, which is at least 16 Hz lower than the lowest value of 34 Hz used as cut-off frequency for the CB site-specific SSI analyses of the LB full column profile.

The FWSC site-specific cases listed in Table 3A.15-203 are as follows:

- Design basis Cases 1 through 6 use the FWSC structural model with full (uncracked concrete) stiffness properties and OBE damping to develop the site-specific seismic design basis ISRS and to calculate

maximum displacements of the FWSC structures relative to free-field ground motion. Cases 1 through 3 are performed using the surface control motion input at the bottom of the FWSC basemat Elevation 282 ft NAVD88. Cases 4 through 6 are performed using the in-column control motions input at the bottom of the concrete fill Elevation 220 ft NAVD88.

- Design basis Cases 7 through 9 are analyzed utilizing the FWSC structural model with full (uncracked concrete) stiffness properties and SSE damping and in-column control motions input at the bottom of the concrete fill Elevation 220 ft NAVD88 to develop the site-specific seismic design basis load demands on the FWSC structures and to calculate base reactions for the FWSC stability and bearing pressure evaluations.
- Sensitivity Cases S1 through S6 are analyzed utilizing the FWSC structural model with reduced (cracked) stiffness properties and SSE damping supported on the LB, UB, and BE subgrade profiles to provide responses to the concrete cracking sensitivity evaluation described in Section 3A.17.9. Cases S1 through S6 are performed using in-column control motion inputs at the bottom of the FWSC basemat or at the bottom of the concrete fill.
- Sensitivity Cases SF1 through SF3 are performed on the FWSC stand-alone model representing conditions of maximum separation between the FWSC concrete fill and the surrounding soil.

FWSC acceleration transfer function results obtained from each analysis case are inspected to ensure that selected frequencies of analyses provide numerically accurate results. Values of cut-off frequencies of analyses are used that are equal to or lower than the passing frequency of the SSI model (the highest frequency of seismic waves that can be transmitted through the SSI model). The selected values of cut-off-frequencies of analysis ensure that the SSI analysis provides FWSC site-specific design ISRS that, per requirements of DC/COL-ISG-01, is adequate for the design and qualification of components and equipment for frequencies up to 50 Hz. The cut-off frequencies of analyses are equal to or higher than 50 Hz for all analysis cases with the exception of the analysis of the LB subgrade profile (analysis Cases 1, 4, 7, S1, S2, and SF1) for which a cut-off frequency of 36 Hz is used.

Results of the FWSC SSI analyses presented in Section 3A.17 show that the analyses of the UB subgrade profile govern the FWSC responses at high frequencies. The cut-off frequencies used for the analyses of the UB subgrade profiles capture virtually all (approximately 99 percent) of the input motion energy. The analyses of the BE and LB subgrade profiles use cut-off frequencies that enable the capture of at least 95 percent and 81 percent of the input motion energy, respectively. The comparisons in Section 3A.17 of the results obtained from the set of six analysis of the FWSC model with full stiffness properties and OBE damping for the different subgrade profiles show that the analyses of the UB and BE profiles provide results for maximum accelerations, member forces, and base reactions that bound the results obtained from the analyses of the LB subgrade profile. The UB and BE profiles also provide bounding ISRS results for frequencies higher than 25 Hz, which is at least 10 Hz lower than the lowest value of 36 Hz used as the cut-off frequency for the FWSC site-specific SSI analyses of the LB subgrade profile.

The SSSI analysis cases for the RB/FB effects on the CB are listed in Table 3A.15-204. Section 3A.17.11 describes the site-specific SSSI analyses performed to address effects of structure to structure interaction of the RB/FB on the CB seismic response. Values of cut-off frequencies of analysis are equal to or close to the passing frequency of the CB-RB/FB model (the highest frequency of seismic waves that can be transmitted through the model). The SSSI analyses of the CB-RB/FB combined models that are performed for the three cases listed in Table 3A.15-204 use cut-off frequencies of analysis that are identical to those used for the corresponding SSI analyses to ensure that the energy content of the input motion captured by the SSSI analyses and the reference SSI analyses is the same and does not affect the SSSI evaluations.

Section 3A.17.11 describes the site-specific SSSI analyses performed to address effects of structure to structure interaction on the seismic response of the CB and FWSC. Table 3A.15-205 presents the two analysis cases considered for the site-specific evaluation of the SSSI effects of the FWSC on the CB (CB-FWSC) seismic response. Table 3A.15-206 presents the twelve analysis cases performed to include the SSSI effects of the CB on the FWSC (FWSC-CB) seismic response in the FWSC site-specific design basis.

The SSSI analyses of the CB-FWSC combined model that are performed for the two bounding subgrade stiffness conditions use cut-off frequencies of analysis that are identical to those used for the corresponding SSI analyses. This ensures that the energy content of the input motion captured by the SSSI analyses and the reference SSI analyses is the same and does not affect the SSSI evaluations.

The SSSI analyses of the FWSC-CB combined model are performed for the same set of input subgrade properties and ground motion time histories as those used for the SSI analyses of the FWSC stand-alone model. This ensures that the results of the FWSC-CB analyses that are used to develop the FWSC site-specific design basis completely capture the effects of the subgrade properties variations. The cut-off frequency used for the FWSC-CB SSSI analysis of the UB subgrade profile is 70 Hz, which is identical to the cut-off frequency used for the corresponding SSI analyses of the FWSC stand-alone model for the UB soil profile. As shown in Table 3A.15-206, the analyses of the UB profiles capture virtually all (approximately 99 percent) of the input motion energy.

The FWSC-CB SSSI analyses of the BE and LB profiles use cut-off frequencies of 47 Hz and 30 Hz, respectively, and can capture at least 72 percent of the input motion energy. These cut-off frequencies are slightly lower than the cut-off frequencies of 36 Hz and 55 Hz used for the corresponding SSI analyses of the FWSC stand-alone model for the LB and BE soil profiles. The use of these lower cut-off frequencies of the BE and LB profiles is acceptable because SSSI analysis Cases FC1 through FC6 in Table 3A.15-206 show that the analysis of the UB subgrade profile with deep control motion governs the maximum responses of the FWSC structures.

Three sensitivity SSSI analysis Cases (SF4 through SF6) are performed on the FWSC-CB combined model representing separated conditions at the interfaces between the FWSC concrete fill and the surrounding soil, using the same cut-off frequencies as the corresponding SSSI analyses of the FWSC-CB combined model representing the fully bonded conditions between concrete fill and surrounding soil (Cases FC7 through FC9 in Table 3A.15-206).

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Table 3A.15-201 **Site-Specific SSI Cases – RB/FB**

Case No.	Computer Program	Structural Model Properties*	Subgrade Profile		Method	Control Motion El.	Frequency (Hz)		Captured Motion Energy		
							Passing	Cut-off	X(N-S)	Y(E-W)	Z(Vert.)
1	SASSI 2010	UC100	Partial Column	LB	DM	224 ft	62	62	99%	98%	96%
2				BE			83	70	100%	100%	100%
3				UB			112	70	99%	99%	100%
4			Full Column	LB	MSM		33	33	82%	82%	88%
5				BE			50	50	96%	96%	94%
6				UB			78	70	99%	99%	100%
Sensitivity Analyses for Evaluations of Stiffness Variation Effects											
S1	SASSI 2010	CR50	Partial Column	LB	DM	224 ft	62	62	99%	98%	96%
S2				BE			83	70	100%	100%	100%
S3				UB			112	70	99%	99%	100%
S4			Full Column	LB	MSM		33	33	82%	82%	88%
S5	ACS SASSI			BE			50	50	96%	96%	94%
S6				UB			78	70	99%	99%	100%
S7	SASSI 2010	CR00	Partial Column	LB	DM	224 ft	62	62	99%	98%	96%
S8				BE			83	70	100%	100%	100%
S9				UB			112	70	99%	99%	100%
S10			Full Column	LB	MSM		33	33	82%	82%	88%
S11	ACS SASSI			BE			50	50	96%	96%	94%
S12				UB			78	70	99%	99%	100%

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Table 3A.15-201 **Site-Specific SSI Cases – RB/FB** *(continued)*

*Structural Properties:

UC100 – Uncracked reinforced concrete and 100% in-fill concrete contribution to the stiffness of concrete-filled steel structures and OBE damping values

CR50 – Cracked reinforced concrete and 50% in-fill concrete contribution to the stiffness of concrete-filled steel structures and SSE damping values

CR00 – Cracked reinforced concrete and 0% in-fill concrete contribution to stiffness of concrete-filled steel structures and SSE damping values

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Table 3A.15-202 **Site-Specific SSI Analysis Cases – CB**

Case No.	Structural Model Properties*)	Subgrade Profile		Method	Control Motion El.	Frequency (Hz)		Captured Motion Energy		
						Passing	Cut-off	X (NS)	Y (EW)	Z (Vert.)
1	UC_{OBE}	Partial Column	LB	DM	241 ft	50	50	97%	96%	99%
2			BE			66	66	100%	99%	100%
3			UB			86	70	99%	99%	99%
4		Full Column	LB	MSM		34	34	83%	82%	86%
5			BE			51	50	96%	95%	92%
6			UB			77	70	99%	99%	99%
7	UC_{SSE}	Partial Column	LB	DM	241 ft	50	50	97%	96%	99%
8			BE			66	66	100%	99%	100%
9			UB			86	70	99%	99%	99%
10		Full Column	LB	MSM		34	34	83%	82%	86%
11			BE			51	50	96%	95%	92%
12			UB			77	70	99%	99%	99%
Sensitivity Analyses for Evaluations of Stiffness Variation Effects										
S1	CR_{SSE}	Partial Column	LB	DM	241 ft	50	50	97%	96%	99%
S2			BE			66	66	100%	99%	100%
S3			UB			86	70	99%	99%	99%
S4		Full Column	LB	MSM		34	34	83%	82%	86%
S5			BE			51	50	96%	95%	92%
S6			UB			77	70	99%	99%	99%

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Table 3A.15-202 **Site-Specific SSI Analysis Cases – CB** *(continued)*

*) Structural Properties:

UC_{OBE} – Uncracked reinforced concrete and OBE damping values

UC_{SSE} – Uncracked reinforced concrete and SSE damping values

CR_{SSE} – Cracked reinforced concrete with 50% reduced shear and bending stiffness and SSE damping values

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Table 3A.15-203 **Site-Specific SSI Cases – FWSC**

Case No.	Structural Model Properties[a]	Subgrade Profile	Method	Control Motion El.	Frequency (Hz)		Captured Motion Energy		
					Passing	Cut-off	X (NS)	Y (EW)	Z (Vert.)
1	UC_{OBE}	LB	MSM	282 ft	36	36	89%	87%	83%
2		BE			55	55	97%	97%	95%
3		UB			84	70	100%	100%	99%
4		LB	MSM	220 ft	36	36	87%	81%	84%
5		BE			55	55	98%	96%	95%
6		UB			84	70	100%	99%	99%
7	UC_{SSE}	LB	MSM	220 ft	36	36	87%	81%	84%
8		BE			55	55	98%	96%	95%
9		UB			84	70	100%	99%	99%
Sensitivity Analyses for Evaluations of Concrete Cracking Effects									
S1	CR_{SSE}	LB	MSM	282 ft	36	36	89%	87%	83%
S2		LB	MSM	220 ft	36	36	87%	81%	84%
S3		UB	MSM	282 ft	84	70	100%	100%	99%
S4		UB	MSM	220 ft	84	70	100%	99%	99%
S5		BE	MSM	282 ft	55	55	97%	97%	95%
S6		BE	MSM	220 ft	55	55	98%	96%	95%
Sensitivity Analyses for Evaluations of Potential Soil Separation Effects									
SF1	SUC_{SSE}	LB	MSM	220 ft	36	36	87%	81%	84%
SF2		BE			55	55	98%	96%	95%
SF3		UB			84	70	100%	99%	99%

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Table 3A.15-203 **Site-Specific SSI Cases – FWSC** *(continued)*

a. Structural Properties:
UC_{OBE} – Uncracked reinforced concrete and OBE damping values
UC_{SSE} – Uncracked reinforced concrete and SSE damping values
CR_{SSE} – Cracked reinforced concrete with 50% reduced shear and bending stiffness and SSE damping values
SUC_{SSE} – Uncracked reinforced concrete and SSE damping values with FWSC concrete fill separated

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Table 3A.15-204 **Site-Specific SSSI Cases – CB-RB/FB**

Case No.	Structural Model Properties[a]	Subgrade Profile		Method	Control Motion El.	Passing Freq. (Hz)	Cut-off Freq. (Hz)	Captured Motion Energy		
								X (NS)	Y (EW)	Z (Vert.)
CR1	UC_{OBE}	Partial Column	LB	MSM	241 ft	55	50	97%	97%	99%
CR2			UB			85	70	100%	100%	99%
CR3		Full Column	UB			65	70[b]	96%	95%	98%

a. Structural Model Properties:
UC_{OBE} – Uncracked reinforced concrete and OBE damping values.

b. The cut-off frequency is taken as 70 Hz in order to use the same cut-off frequency as the SSI analysis of the stand-alone model for comparison.

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Table 3A.15-205 **Site-Specific SSSI Cases – CB-FWSC**

Case No.	Structural Model Properties[a]	Subgrade Profile		Method	Control Motion El.	Passing Freq. (Hz)	Cut-off Freq. (Hz)	Captured Motion Energy		
								X (NS)	Y (EW)	Z (Vert.)
CF1	UC_{OBE}	Full Column	LB	MSM	241 ft	34	34	83%	82%	86%
CF2			UB			74	70	99%	99%	99%

a. Structural Model Properties:
UC_{OBE} – Uncracked reinforced concrete and OBE damping values.

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Table 3A.15-206 **Site-Specific SSSI Cases – FWSC-CB**

Case No.	Structural Model Properties[a]		Subgrade Profile	Method	Control Motion El.	Passing Freq. (Hz)	Cut-off Freq. (Hz)	Captured Motion Energy X (NS)	Captured Motion Energy Y (EW)	Captured Motion Energy Z (Vert.)
FC1	UC_{OBE}	Full Column	LB	MSM	282 ft	30	30	84%	81%	75%
FC2			BE			47	47	98%	97%	95%
FC3			UB			72	70	99%	99%	99%
FC4			LB		220 ft	30	30	80%	72%	72%
FC5			BE			47	47	98%	96%	95%
FC6			UB			72	70	99%	99%	99%
FC7	UC_{SSE}	Full Column	LB	MSM	220 ft	30	30	80%	72%	72%
FC8			BE			47	47	98%	96%	95%
FC9			UB			72	70	99%	99%	99%
SF4	SUC_{SSE}	Full Column	LB	MSM	220 ft.	30	30	80%	72%	72%
SF5			BE			47	47	98%	96%	95%
SF6			UB			72	70	99%	99%	99%

a. Structural Model Properties:

UC_{OBE} – Uncracked reinforced concrete and OBE damping values.

UC_{SSE} – Uncracked reinforced concrete and SSE damping values.

SUC_{SSE} – Uncracked reinforced concrete and SSE damping values with FWSC concrete fill separated (for soil separation sensitivity studies in Section 3A.17.14.5).

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3A.16 Site-Specific SSI Analysis Models

Following the standard design methodology described in DCD Section 3A.7, models used for the site-specific seismic response analyses are based on three-dimensional lumped mass-beam models that consider shear, bending, torsion, and axial deformations. Single-Degree-of-Freedom (SDOF) oscillators are attached to lumped-mass beam models to capture local out-of-plane responses of slabs and walls for the flexible modes of vibration with frequencies up to 50 Hz.

The models used for the site-specific design basis SSI analyses differ from the models used for the standard design SASSI analyses in that:

- The lower OBE damping value is assigned to the models to calculate ISRS
- The meshing of the below-grade portion of the models is modified to fit the layering and stiffness properties of the site-specific subgrade
- Rigid outriggers are installed at each floor elevation to facilitate calculation of ISRS and displacements at floor edges
- Near-field subgrade elements are included in the models to represent the fill materials

The site-specific evaluations of the structural stiffness variation effects in Section 3A.17.9 are based on the results of sensitivity analyses performed on models with reduced stiffness properties and SSE damping values representative of the dynamic properties of the reinforced concrete structures under fully cracked concrete conditions. In addition to the 50 percent reduced stiffness being applied to all SDOF oscillators in the models used for the design basis analyses, the reduced stiffness models used for the sensitivity analyses also include additional SDOF oscillators that are necessary to adequately capture all modes of out-of-plane vibrations of walls and slabs with frequencies up to 50 Hz under fully cracked conditions.

The site-specific evaluations of effects of SSSI are based on seismic response analyses of combined models that adequately capture the site-specific conditions between the Category I buildings. The descriptions of the CB-FWSC, FWSC-CB and CB-RB/FB combined models used for the site-specific SSSI analyses are provided in Section 3A.17.11.

3A.16.1 Method of Dynamic Structural Model Development

The site-specific models are based on the models used for the DCD analyses, as described in DCD Section 3A.7, including the method of dynamic structural model development discussed in DCD Section 3A.7.1.

Site-specific seismic sensitivity studies are performed using models that capture the effect of concrete cracking on out-of-plane vibrations of flexible walls and slabs. Additional SDOF oscillators are included in the reduced stiffness models used for the RB/FB, CB, and FWSC structural stiffness variation effects sensitivity studies to capture local out-of-plane response of cracked slabs and walls.

The properties of the additional SDOF oscillators are developed based on the results of eigenvalue analyses using the same methodology and local finite element models that were used for the standard design, except for:

- Additional constraints added to the RB/FB models used for extraction of additional modes of out-of-plane vibration of walls in order to decouple higher modes that represent coupled in-plane and out-of-plane vibration of walls.
- The eigenvalues extracted for all modes with frequencies up to 71 Hz. Under 50 percent reduced stiffness conditions, this corresponds to a modal frequency of (71 ÷ √2) = 50 Hz.
- The stiffness of the SDOF oscillators calculated from the results of the eigenvalue analyses of the standard design local finite element models with full (uncracked) stiffness are reduced by 50 percent.

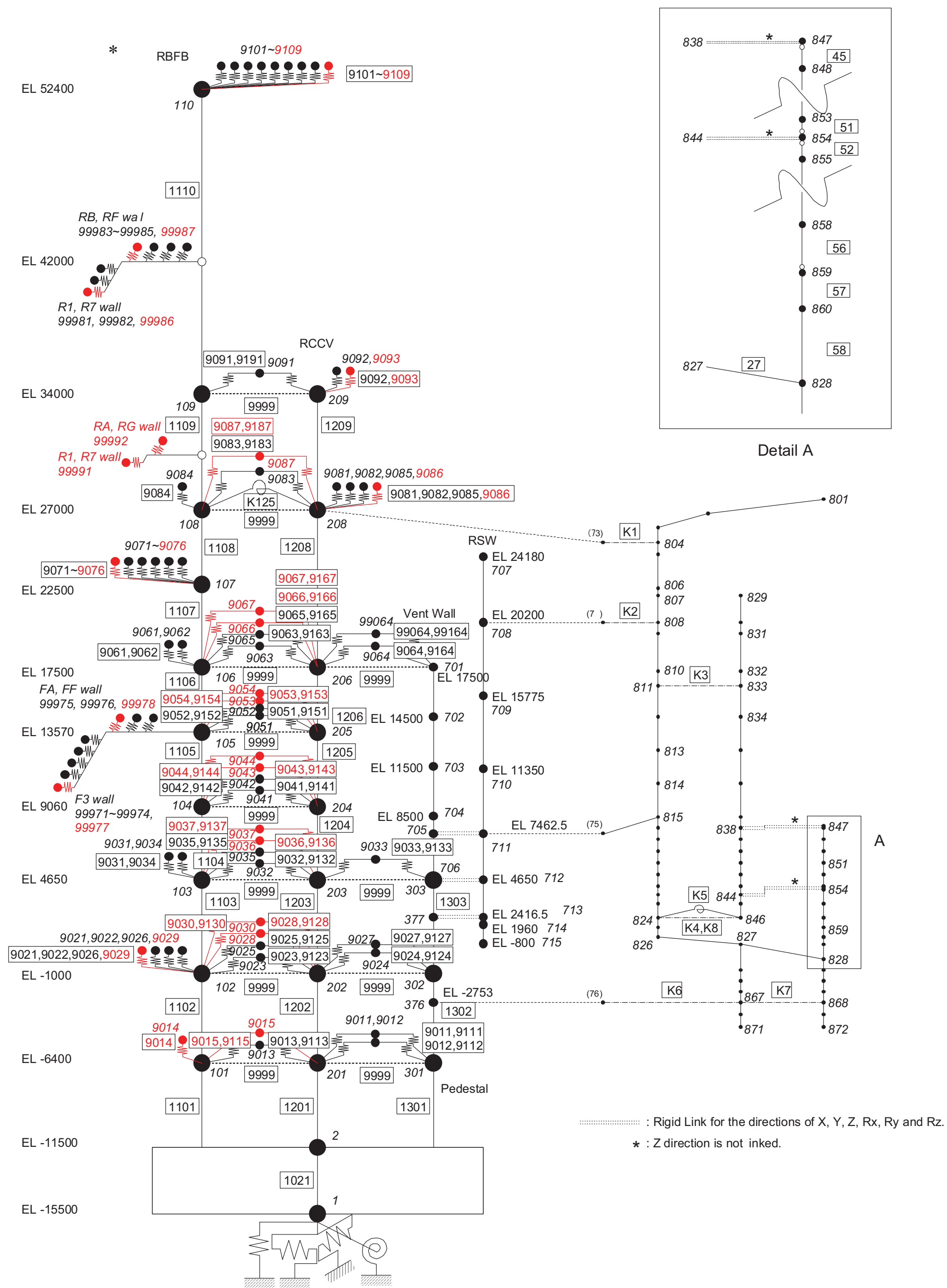
3A.16.2 Lumped Mass-Beam Stick Model for SSI Analysis

As described further below, the site-specific models are based on the standard design lumped mass-beam stick models described in DCD Section 3A.7.2.

The configuration of the site-specific models representing the above grade portion of the RB/FB, CB, and FWSC structures is identical to the configuration of the models used for the standard design that are shown in DCD Figures 3A.7-4, 3A.7-6, and 3A.7-7, respectively. The only exceptions are the models used for the site-specific evaluations of structural stiffness variation effects, which include additional SDOF oscillators to adequately capture all modes of vibration with frequencies up to 50 Hz under fully cracked conditions. The meshing of the

below-grade portion of the models is modified to fit the layering and stiffness properties of the subgrade. Figures 3A.16.2-201 through 3A.16.2-203 present the configuration of the RB/FB, CB, and FWSC models with reduced stiffness properties used for the site-specific sensitivity analyses of structural stiffness variation effects. In these figures, the SDOF oscillators added to the standard design models to capture all of the modes of out-of-plane vibrations of fully cracked slabs and walls for frequencies up to 50 Hz are shown in red.

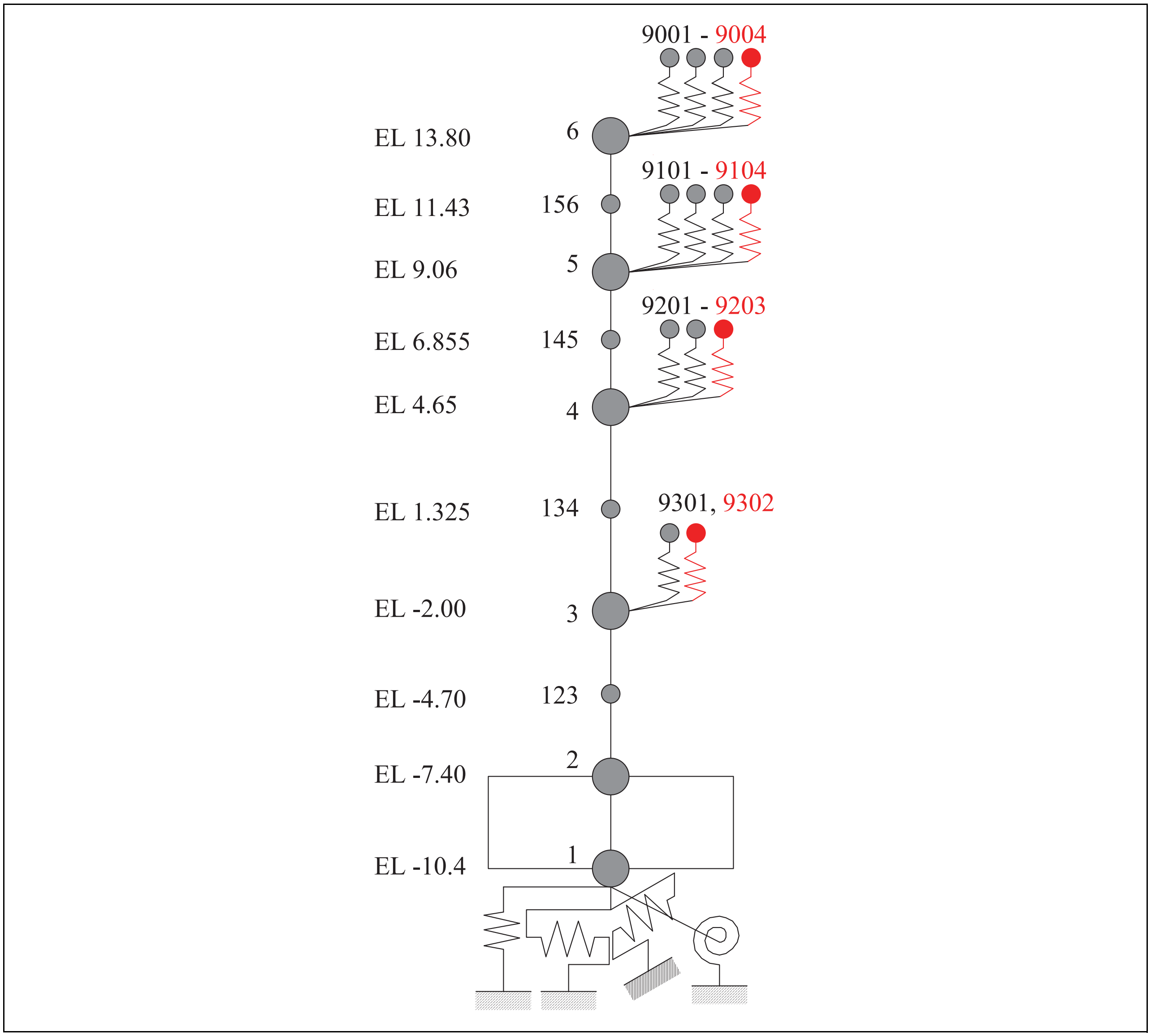
NAPS DEP 3.7-1 Figure 3A.16.2-201 **RB/FB Seismic Analysis Stick Model with Additional SDOF Oscillators**



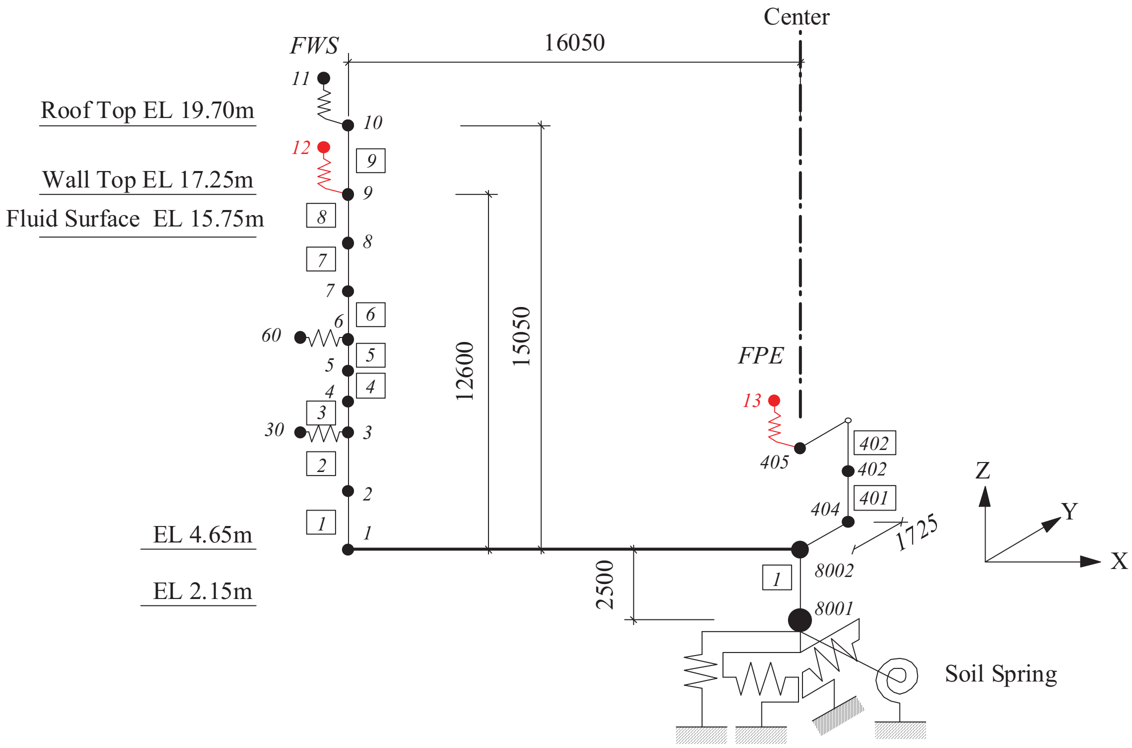
*: The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Note: Slab oscillator node 99064 is only for the model considering 0% of infill concrete stiffness of the vent wall and diaphragm floor.

NAPS DEP 3.7-1 Figure 3A.16.2-202 **CB Seismic Analysis Stick Model with Additional SDOF Oscillators**



NAPS DEP 3.7-1 Figure 3A.16.2-203 **FWSC Seismic Analysis Stick Model with Additional SDOF Oscillators**



Mass at Node 30 represents the impulsive mode.
Mass at Node 60 represents the fundamental sloshing (convective) mode.
The model is assumed to be symmetric about YZ-plane including the center line.

3A.16.3 SSI Model for SASSI2010 Analysis

The site-specific SSI structural models for the RB/FB, CB, and FWSC are constructed from the lumped mass-stick beam models coupled with the foundation finite element model following the methodology described in DCD Section 3A.7.3. The RB/FB, CB, and FWSC lumped mass-stick models (LMSMs) are described in Section 3A.16.2. Details of the models for the RB/FB, CB, and FWSC are described in the following sections.

3A.16.3.1 SSI Model for SASSI2010 Analysis – RB/FB

The model used for the site-specific SSI analysis of the RB/FB is based on the LMSMs shown in DCD Figure 3A.7-4 and designated in DCD Table 3A.6-1 as the base model including wall oscillators. This model was considered for RU-7 and RL-6 standard design SSI analyses.

Stand-alone RB/FB SSI models are developed for the site-specific RB/FB SSI analyses for the following two embedment configurations:

- Partially embedded RB/FB model used for analyses of BE, LB, and UB partial column subgrade profiles
- Fully embedded RB/FB model used for analyses of BE, LB, and UB full column profiles

A minimum value of 10.27 ft (3.13 m) is used for the lateral extent of the near-field concrete and structural fill elements at all four sides of the RB/FB model. This value represents the smaller of one-half of the distance between RB/FB and adjacent buildings and the gap between the building and the inside face of sheet piling at the sides without adjacent buildings, as described in Section 2.5.4.5.1.

The models used for RB/FB site-specific SSI analyses are shown in Figures 3A.16.3-201 through 3A.16.3-204b for the partially embedded model and in Figures 3A.16.3-205 through 3A.16.3-208b for the fully embedded model. The model axes are as described in Section 3A.11.

Exterior walls below grade and the foundation basemat are modeled using plate (flat shell) elements the same as the SASSI model used for the standard design RB/FB SSI analyses. The basemat plate elements are shown in Figures 3A.16.3-201 and 3A.16.3-205.

The damping values for seismic response analyses, which are assigned to the RB/FB models, are provided in Table 3A.13.2-201. The models

used for the design basis SSI analyses of the RB/FB are representative of:

- Full (uncracked) stiffness of the reinforced concrete structures
- Full (100 percent) stiffness contribution of the in-fill concrete to the concrete-filled steel structures

The OBE damping values reflect the lower dissipation of energy in the structures experiencing lower stress levels associated with the uncracked concrete condition.

The use of UB stiffness properties and OBE damping values ensure conformance with SRP 3.7.2 and RG 1.61 for calculations of site-specific ISRS. The use of UB stiffness properties and OBE damping values provides conservative results for the site-specific SSE load demands on the RB/FB structures for the Unit 3 rock site and high frequency design motion. As described in Section 3A.17.9, sensitivity analyses are performed to evaluate the effects of structural stiffness variations on the site-specific SSI response of the RB/FB using the CR 50 and CR 100 models with reduced stiffness properties and SSE damping values. These models are representative of dynamic properties of RB/FB reinforced concrete structures under the fully cracked condition (i.e., the condition when all of the concrete structural members are cracked). Consistent with the approach used for the standard design to address the effects of in-fill concrete on the stiffness of the Vent Wall (VW) and Diaphragm Floor (D/F), the site-specific sensitivity analyses consider a 50 percent and 0 percent stiffness contribution of the in-fill concrete to the concrete-filled steel structures. The model, shown in Figure 3A.16.2-201, used for the sensitivity study on the structural stiffness variation effects also has SDOF oscillators that capture all the modes of the local out-of-plane vibrations of the RB/FB slabs and walls for frequencies up to 50 Hz under cracked concrete conditions.

For the partially embedded model, the excavated volume is modeled from the top of the Zone III rock at Elevation -0.68 m (Elevation 273.0 ft NAVD88) to the bottom of the excavation at Elevation -15.5 m (Elevation 224.4 ft NAVD88). For the fully embedded model, the excavated volume is extended upward to the finished ground level grade at Elevation 4.5 m (Elevation 290.0 ft NAVD88). The mesh size of the excavated volume elements is set to ensure conformance with SASSI2010 criteria that the maximum element size in all three directions

does not exceed 20 percent of the shear wave length of the excavated soil at the highest (cut-off) frequency of analysis. The mesh of the near-field solid elements of the backfill surrounding the RB/FB is consistent with the mesh of the excavated volume and the mesh of the plate elements of the basemat and exterior walls.

In the partially embedded model, the excavated volume is modeled using a uniform and regular mesh. However, the top layers of the soft soil medium and the structural fill added to the fully embedded model between the Zone III rock and the finished ground level grade elevation require a more refined mesh in order to pass seismic waves with high frequencies. The fully embedded model also requires a coarser mesh of the rock and concrete fill below the Zone III rock level to ensure the overall model size does not exceed the program limitations. Therefore, in the transitional layers below the rock surface elevation, the fully embedded models use non-uniform mesh with triangular shell elements, prism, tetrahedral, and pyramid solid elements. An adequate value for the point-load radius used as input in the computation of the site impedance matrix is determined based on the results of a benchmarking study.

The passing and cut-off frequencies of analysis for the models used for the SSI analysis of the RB/FB are provided in Table 3A.15-201. The passing frequencies are calculated based on both the maximum horizontal and vertical dimensions of the excavated volume mesh and the near-field mesh. The model maximum passing frequencies for all subsurface profiles are no smaller than the cut-off frequency of analysis.

The maximum aspect ratios of the regular 3-D thin shell elements in the RB/FB partially and fully embedded models are 1:1.6 and 1:1.8, respectively. The maximum aspect ratios of the regular 3-D solid brick elements in the partially and fully embedded models are 1:1.6 and 1:3.5, respectively. Accuracy of the SASSI2010 program has been verified and validated for models with a maximum aspect ratio of 1:4 for both the 3-D thin shell and 3-D solid brick finite elements. Additionally, the accuracy of using non-uniform irregular elements is also demonstrated by results of a comparative study.

The analyses of the partially embedded RB/FB model use the flexible volume (direct) method (DM) where all nodes of the excavated volume are specified as interaction nodes to calculate the SSI system impedance matrix. The analyses of the fully embedded RB/FB model use the

modified subtraction method (MSM) simplification, where only a selected set of nodes of the excavated volume are specified as interaction nodes. For the fully embedded RB/FB model, all the nodes at the six exterior sides and the one horizontal plane at Elevation 0.08 m of the excavated volume are specified as interaction nodes.

The site profiles used for the site-specific SSI analyses of the RB/FB (Tables 3A.16.3-201 through 3A.16.3-206) consist of 38 and 41 layers on top of the half-space for the partial and full columns, respectively. The maximum value of Poisson's ratio of all materials in the RB/FB model is 0.48, which is within the range to which the accuracy of the SASSI2010 program has been verified and validated. The shear and compression wave velocities are adjusted using the equivalent wave travel time procedure as shown below.

$$Vs_{ave} = \frac{H}{\sum_i d_i / Vs_i} \quad Vp_{ave} = \frac{H}{\sum_i d_i / Vp_i}$$

where H is the thickness of the adjusted layer and d_i, V_{si} and V_{pi} are the thickness, shear wave and compression wave velocities of the layers in the original site profiles, respectively (see "Original data" in the note on Tables 3A.16.3.201 through 3A.16.3-206). The unit weight and damping ratios of the adjusted layers are determined as weighted averages with respect to the layer thickness.

The top of the half-space in the RB/FB models is established at Elevation -168.0 m (125 ft NAVD88). The half-space simulation consists of an additional ten layers with viscous dashpots added at the base of the site finite element model to account for the dissipation of energy at the model lower boundary. The total depth of the site model used for the SSI analyses of the RB/FB is more than 223 m, which exceeds two times the footprint dimension of the RB/FB. Results of a sensitivity study demonstrate that the depth of the lower boundary of the site model does not affect the results of SSI analysis.

As indicated in Figure 3A.16.3-209, the RB/FB stick model is connected to the side walls at floor Elevations -11.5 m, -6.4 m, -0.68 m, and 4.5 m by a set of rigid beams. At the base of the model at Elevation -15.5 m, a rigid beam is used to connect all the stick models to the center of the basemat. Figure 3A.16.3-209 also shows the connection between the RB/FB stick model and foundation.

Three-dimensional (3-D) spring elements are established at the RB/FB exterior wall/backfill interfaces as shown in Figures 3A.16.3-202 and 3A.16.3-206 for the partially embedded and fully embedded models, respectively. Springs are also established at the bottom of the structural model to calculate reactions at the basemat interface with the underlying Zone III-IV rock. These spring elements are assigned global stiffness properties high enough to ensure they do not affect the dynamic response of the analyzed SSI system, but not so high that they cause numerical sensitivity resulting from significant digit saturation truncation. The interface spring elements provide spring force results that serve as input for calculation of the site-specific wall lateral pressure and foundation bearing pressure demands. The spring force results also serve as input for calculation of seismic driving forces for the site-specific stability evaluations.

3A.16.3.2 SSI Model for SASSI2010 Analysis – CB

The model used for the site-specific SSI analysis of the CB is based on the three-dimensional LMSM shown in DCD Figure 3A.7-6 and designated in DCD Table 3A.6-1 as the base model.

Stand-alone CB SSI models are developed for the site-specific CB SSI analyses for the following two embedment configurations:

- Partially embedded CB model used for analyses of LB, BE and UB partial column subgrade profiles
- Fully embedded CB model used for analyses of LB, BE and UB full column subgrade profiles

A minimum value of 12.24 ft (3.73 m) is used for the lateral extent of near-field concrete and structural fill elements at all four sides of the CB model. This value is the smaller of one-half of the distance between CB and adjacent buildings and the actual width of the gap between the building and the inside face of sheet piling at the sides without adjacent buildings, as described in Section 2.5.4.5.1.

The models used for CB site-specific SSI analyses are shown in Figures 3A.16.3-210 through 3A.16.3-213b for the partially embedded model and in Figures 3A.16.3-214 through 3A.16.3-217b for the fully embedded model. The model axes are as described in Section 3A.11.

Exterior walls below grade and the foundation basemat are modeled using plate elements the same as the SASSI model used for standard

design CB SSI analyses. However, because the soil medium between the top elevation of the finished ground level grade or Zone III rock and the foundation basemat are modeled in the Unit 3 site-specific SSI analysis, the vertical spacing of the wall nodes is adjusted to match the site-specific subsurface layers. The sizes of the plate elements are adjusted to satisfy the SASSI2010 requirement for the mesh size that limits the size of the elements to not more than 20 percent of the length of the shear wave passing through the soil material. The basemat plate elements are shown in Figures 3A.16.3-210 and 3A.16.3-214.

The full (uncracked concrete) stiffness is assigned to the structural members in the CB structural model to ensure that the design basis SSI analysis yields conservative results for Unit 3 rock site and high frequency design motion. In accordance with the RG 1.61 and SRP 3.7.2 guidance, the UC_{OBE} models used for the development of the CB site-specific ISRS are assigned OBE structural damping. The use of lower OBE structural damping values ensures that the ISRS peaks envelope the condition when the stresses and the dissipation of energy in the structures are low (RG 1.61, Section C.1.2).

The development of site-specific seismic structural load demands, foundation uplift, and stability evaluations are based on responses obtained from the design basis SSI analyses of the CB UC_{SSE} model with upper bound (uncracked concrete) stiffness properties in conjunction with 7 percent SSE structural damping, consistent with DCD Section 3A.4.2. Per RG 1.61, Section C.1.2, the use of SSE damping for development of structural loads is adequate because the stresses obtained from models with SSE damping will remain lower than the stress limits considered by the applicable structural design codes. The use of SSE damping for the foundation uplift and stability evaluations is adequate because these analyses also consider limiting conditions that are associated with high dissipation of energy in the SSI dynamic system.

Section 3A.17.9 discusses evaluation of the effects of concrete cracking on the SSI response of the CB that is based on the results of the sensitivity analyses of the CB CR_{SSE} model with reduced structural stiffness properties representing the fully cracked concrete condition, i.e., conditions where all of the concrete structural members are cracked. The model, shown in Figure 3A.16.2-202, used for the sensitivity study on the concrete cracking effects also has SDOF oscillators that capture all

modes of the local out-of-plane vibrations of the CB slabs for frequencies up to 50 Hz under cracked concrete conditions.

For the partially embedded model, the excavated volume is modeled from the top of the Zone III rock at Elevation -3.12 m (Elevation 265.0 ft NAVD88) to the bottom of the excavation at Elevation -15.31 m (Elevation 225.0 ft NAVD88). For the fully embedded model, the excavated volume is further extended upward to the finished ground level grade at Elevation 4.5 m (Elevation 290.0 ft NAVD88). The mesh size of the excavated volume elements is set to ensure that per SASSI2010 criteria, the maximum element size in all three directions does not exceed 20 percent of the shear wave length of the excavated soil at the highest (cut-off) frequency of analysis. The mesh of the near-field soil solid elements of the backfill surrounding the CB is consistent with the mesh of the excavated volume and the mesh of the plate elements of the basemat and exterior walls.

In the partially embedded model, the excavated volume is modeled using a uniform and regular mesh. However, the top layers of soft soil medium and structural fill added to the fully embedded model between the Zone III rock and the finished ground level grade require a refined mesh in order to capture sufficient input motion energy. The fully embedded model also requires a coarser mesh of the rock and concrete fill below the Zone III rock level to ensure the overall model size does not exceed the program limitations. Therefore, in the transitional layers below the rock surface elevation, the fully embedded models use non-uniform mesh with irregular triangular shell elements, prism, tetrahedral and pyramid solid elements. A benchmarking study determines an adequate value for the point radius used as input in the SASSI2010 computation of the site impedance matrix.

The passing and cut-off frequencies of analysis for the models used for SSI analysis of CB are shown in Table 3A.15-202. The passing frequencies are calculated on the basis of both the maximum horizontal and vertical dimensions of the excavated volume mesh and near-field mesh. The table shows that the model maximum passing frequencies for all subsurface profiles are no smaller than the cut-off frequency of analysis.

The maximum aspect ratios of the regular 3-D thin shell elements in the CB partially and fully embedded models are 1:1.7 and 1:1.6, respectively. The maximum aspect ratios of the regular 3-D solid brick elements in the

partially and fully embedded models are 1:1.5 and 1:1.9, respectively. The accuracy of SASSI2010 program has been verified and validated for models with a maximum aspect ratio of 1:4 for both the 3-D thin shell and 3-D solid brick finite elements. Additionally, the accuracy of using non-uniform irregular elements is also demonstrated by the results of a comparative study.

Site profiles used for the site-specific SSI analysis of the CB are presented in Tables 3A.16.3-207 through 3A.16.3-209 for the partial column profiles, and in Tables 3A.16.3-210 through 3A.16.3-212 for the full column profiles. They consist of 32 and 43 layers on top of half space for the partial and full columns, respectively. The maximum value of Poisson's ratio of all materials in the CB model is 0.48, which is within the range to which the accuracy of SASSI2010 program has been verified and validated. Layering and strain compatible properties of site profiles that were developed from the results of the site response analysis are adjusted using the procedure described in Section 3A.16.3.1.

The top of the half-space in the CB models is established at DCD Elevation -90.8 m (125 ft NAVD88). Consistent with SASSI manual recommendations, the half-space simulation consists of an additional ten layers with viscous dashpots added at the base of the site finite element model to account for the dissipation of energy at the model lower boundary. The total depth of the site model used for the SSI analyses of CB is more than 88 m, which exceeds two times the CB maximum footprint dimension of 30.3 m. Results of a sensitivity study demonstrate that the depth of the lower boundary of the site model used for the site-specific SSI analyses does not affect the results of the analysis.

As indicated in Figure 3A.16.3-218, the CB stick model is connected to the side walls at floor Elevation -10.4 m, -7.4 m, -2.0 m, and 4.5 m by a set of rigid beams. At the base of the model at Elevation -10.4 m, a rigid beam is used to connect the stick model to the center of the basemat.

Three-dimensional (3-D) spring elements are established at the CB exterior wall/backfill interfaces and concrete fill under the CB basemat as shown in Figures 3A.16.3-211, and 3A.16.3-215a and 3A.16.3-215b for the partially embedded and fully embedded models, respectively. Springs are also established at the bottom of the CB structural model to calculate reactions at the concrete fill interface with the underlying Zone III/IV rock. These spring elements are assigned global stiffness properties high enough to ensure they do not affect the dynamic response of the

analyzed SSI system. The interface spring elements provide spring force results that serve as input for calculation of the site-specific wall lateral pressure and foundation bearing pressure demands. The spring forces results also serve as input for calculation of seismic driving forces for the site-specific stability evaluations.

3A.16.3.3 SSI Model for SASSI2010 Analysis – FWSC

The model used for the site-specific SSI analysis of the FWSC is a half model with symmetry (asymmetry) boundary conditions. This model is based on the three-dimensional LMSM shown in DCD Figure 3A.7-7 and is designated in DCD Table 3A.6-1 as the base model. The stiffness of the structural elements of the FWSC is represented by a single set of stick elements that consider the vertical and horizontal eccentricity.

In addition to the differences in the SSI models identified in Section 3A.16, the site-specific FWSC SSI model also differs from the standard design base model in that a block of near-field solid elements embedded in the in-situ soil and rock is used to model the concrete fill placed below the FWSC basemat

The foundation basemat is modeled using plate elements in the same manner as the DCD SASSI analysis model. The size of the plate elements does not exceed 20 percent of the length of the shear wave passing through the soil material.

Full (uncracked concrete) stiffness properties are assigned to the FWSC structural model used for the design basis SSI analyses, which yields conservative results for the rock site and high frequency design motion. In accordance with RG 1.61 and SRP 3.7.2 guidance, the dynamic UC_{OBE} model used for the development of the FWSC site-specific ISRS is assigned OBE structural damping. The use of lower OBE structural damping values ensures that the ISRS peaks envelope the condition when the stresses and dissipation of energy in the structures are low (RG 1.61, Section C.1.2).

The development of site-specific seismic structural load demands, foundation uplift, and stability evaluations are based on responses obtained from the design basis SSI analyses of the FWSC UC_{SSE} model with upper bound (uncracked concrete) stiffness properties in conjunction with SSE structural damping. Per RG 1.61, Section C.1.2, the use of SSE damping for the development of structural loads is adequate because the stresses obtained from models with SSE damping will remain lower than

the stress limits considered by the applicable structural design codes. The use of SSE damping for the foundation uplift and stability evaluations is adequate because these analyses generate foundation reaction forces and moments at the bottom of basemat that are consistent with the seismic structural load demands generated from the FWSC UC_{SSE} model.

Evaluation of the effects of concrete cracking on the FWSC site-specific SSI response is based on the results of the sensitivity analyses of the FWSC CR_{SSE} dynamic model with reduced structural stiffness properties representing the fully cracked concrete condition, i.e., conditions where all of the concrete structural members are cracked. The CR_{SSE} model, shown in Figure 3A.16.2-203, used for the sensitivity study on the concrete cracking effects also has SDOF oscillators that capture all modes of the local out-of-plane vibrations of the FWS and FPE roofs for frequencies up to 50 Hz under cracked concrete conditions.

The models used for FWSC site-specific SSI analyses are shown on Figures 3A.16.3-219 through 3A.16.3-221b. The model axes are as described in Section 3A.11.

The structural model also includes the concrete fill block resting on top of the Zone III-IV rock that supports the FWSC foundation. The concrete fill that is embedded in the in-situ saprolite and Zone III rock is modeled using brick solid elements. As shown in Figures 3A.16.3-219 through 3A.16.3-221b, the concrete fill block, as well as the excavated volume, are modeled from the top of the Zone III-IV rock at Elevation -16.84 m (Elevation 220.0 ft NAVD88) to the bottom of the basemat foundation at Elevation 2.15 m (Elevation 282.3 ft NAVD88). The size of the elements in all directions for the excavated volume is determined, in accordance with SASSI2010 requirements, not to exceed 20 percent of the length of the shear wave passing through the soil material. The passing and cut-off frequencies of analysis are shown in Table 3A.15-203. The passing frequencies are calculated on the basis of both the maximum horizontal and vertical dimensions of the excavated volume and backfill mesh. The table shows that the model maximum passing frequencies for all subsurface profiles are no smaller than the cut-off frequency of analysis.

The excavated volume in the FWSC site-specific SSI model has a uniform mesh. The maximum aspect ratio of the 3-D thin shell elements for the basemat is 1:1.4. The maximum aspect ratio of the 3-D solid brick

elements is 1:2.9. Accuracy of the SASSI2010 program is verified and validated for models with a maximum aspect ratio of 1:4 for both the 3-D thin shell and 3-D solid brick finite elements.

The soil properties used for the site-specific FWSC SSI analysis shown in Tables 3A.16.3-213 through 3A.16.3-215 consist of 50 layers on top of the half-space. The maximum value of soil Poisson's ratio considered in the site models is 0.48, which is within the range of accuracy that the SASSI2010 program has been verified and validated. The shear and compression wave velocities, unit weights, and damping ratios are not adjusted from the original strain iterated soil profiles. Instead, layering of the profiles of strain-compatible properties that are developed from the results of the site response analysis is used and some layers are either combined or divided so that the site models used for site-specific SSI analyses can meet passing frequency requirements.

The top of the half-space in the FWSC models is established at the DCD Elevation -120.8 m (126 ft NAVD88). Consistent with SASSI manual recommendations, the half-space simulation consists of an additional ten layers with viscous dashpots added at the base of the site finite element model to account for the dissipation of energy at the model lower boundary. The total depth of the site model used for SSI analyses of FWSC is more than 123 m, which exceeds two times the maximum footprint dimension of the FWSC basemat of 52 m. Results of a sensitivity study demonstrate that the depth of the lower boundary of the site model used for the site-specific SSI analyses does not affect the results of the analysis.

The FWSC stick models are connected to the basemat at Elevation 2.15 m (282.3 ft NAVD88) by a set of rigid beams without mass along the footprint of walls of the FWS and the FPE.

The 3-D spring elements are established at the interface between the concrete fill solid elements and the FWSC basemat shell elements as well as the interface between the concrete fill elements and the surrounding in-situ soil. These spring elements are assigned global stiffness properties high enough to ensure that they do not affect the dynamic properties of the analyzed SSI system. The spring elements at the FWSC basemat and concrete fill interface provide spring force results that serve as input for the calculation of base contact pressures and foundation bearing pressure demands. The spring forces results also

serve as input for the calculation of seismic driving forces for the site-specific stability evaluations.

Table 3A.16.3-201 **Subsurface Properties for SSI Analysis of RB/FB PE (BE profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-0.68 -3.54	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-3.54 -6.40	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-6.40 -8.95	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-8.95 -11.50	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-11.50 -13.50	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-13.50 -15.50	2.32	1318	3229	0.58	82.8	0.400	2.32	2134	3325	1.00	134.2	0.150
-15.50 -18.45	2.60	1644	4025	0.98	111.4	0.400	← See Note on the next page					
-18.45 -21.41	2.61	1661	4068	1.00	112.2	0.400						
-21.41 -24.61	2.61	1578	3865	1.00	98.6	0.400						
-24.61 -27.81	2.61	1578	3865	1.00	98.6	0.400						

Table 3A.16.3-201 **Subsurface Properties for SSI Analysis of RB/FB PE (BE profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-27.81 -32.78	2.63	2682	4779	1.00	107.9	0.270						
-32.78 -37.76	2.63	2682	4779	1.00	107.7	0.270						
-37.76 -42.74	2.63	2682	4779	1.00	107.7	0.270						
-42.74 -	2.63	2804	4996	1.00		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

-15.50 -15.62	2.32	1318	3229	0.58		0.400						
-15.62 -18.45	2.61	1661	4068	1.00		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.

Example: 1644=(18.45-15.5)/(0.12/1318+2.83/1661)

Damping ratio is determined using the thickness weighted average procedure.

Example: 0.98=(0.58x(15.62-15.50)+1.00x(18.45-15.62))/(0.12+2.83)

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Table 3A.16.3-202 **Subsurface Properties for SSI Analysis of RB/FB PE (LB profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-0.68 / -3.54	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-3.54 / -6.40	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-6.40 / -8.95	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-8.95 / -11.50	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-11.50 / -13.50	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-13.50 / -15.50	2.32	979	2398	1.02	61.5	0.400	2.32	1829	2850	1.80	115.0	0.150
-15.50 / -18.45	2.60	1217	2983	1.79	82.5	0.400	← See Note on the next page					
-18.45 / -21.41	2.61	1230	3014	1.82	83.1	0.400						
-21.41 / -24.61	2.61	1058	2591	1.82	66.1	0.400						
-24.61 / -27.81	2.61	1058	2591	1.82	66.1	0.400						

Table 3A.16.3-202 **Subsurface Properties for SSI Analysis of RB/FB PE (LB profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-27.81 -32.78	2.63	2190	3902	1.82	88.1	0.270						
-32.78 -37.76	2.63	2190	3902	1.82	87.9	0.270						
-37.76 -42.74	2.63	2190	3902	1.82	87.9	0.270						
-42.74 -	2.63	2290	4079	1.82		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

-15.50 -15.62	2.32	979	2398	1.02		0.400						
-15.62 -18.45	2.61	1230	3014	1.82		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.

Example: 1217=(18.45-15.5)/(0.12/979+2.83/1230)

Damping ratio is determined using the thickness weighted average procedure.

Example: 1.79=(1.02x(15.62-15.50)+1.82x(18.45-15.62))/(0.12+2.83)

Table 3A.16.3-203 **Subsurface Properties for SSI Analysis of RB/FB PE (UB profile)**

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-0.68 -3.54	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-3.54 -6.40	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-6.40 -8.95	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-8.95 -11.50	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-11.50 -13.50	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-13.50 -15.50	2.32	1774	4346	0.33	111.5	0.400	2.32	2438	3800	0.55	153.3	0.150
-15.50 -18.45	2.60	2218	5434	0.54	150.3	0.400	← See Note on the next page					
-18.45 -21.41	2.61	2242	5492	0.55	151.4	0.400						
-21.41 -24.61	2.61	2354	5767	0.55	147.1	0.400						
-24.61 -27.81	2.61	2354	5767	0.55	147.1	0.400						

Table 3A.16.3-203 **Subsurface Properties for SSI Analysis of RB/FB PE (UB profile)** *(continued)*

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-27.81 / -32.78	2.63	3285	5852	0.55	132.1	0.270						
-32.78 / -37.76	2.63	3285	5852	0.55	131.9	0.270						
-37.76 / -42.74	2.63	3285	5852	0.55	131.9	0.270						
-42.74 / -	2.63	3434	6119	0.55		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-15.50 / -15.62	2.32	1774	4346	0.33		0.400						
-15.62 / -18.45	2.61	2242	5492	0.55		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.

Example: 2218=(18.45-15.5)/(0.12/1774+2.83/2242)

Damping ratio is determined using the thickness weighted average procedure.

Example: 0.54=(0.33x(15.62-15.50)+0.55x(18.45-15.62))/(0.12+2.83)

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Table 3A.16.3-204 **Subsurface Properties for SSI Analysis of RB/FB FE (BE profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
4.50 / 3.89	2.00	277	678	2.07	56.9	0.400	2.08	224	418	2.18	56.9	0.299
3.89 / 3.13	2.00	267	761	3.38	54.9	0.430	2.08	198	370	4.24	50.3	0.299
3.13 / 2.37	2.00	267	761	3.38	54.9	0.430	2.08	198	370	4.24	50.3	0.299
2.37 / 1.61	2.08	397	1668	2.89	81.6	0.470	2.08	216	1103	5.13	54.9	0.480
1.61 / 0.84	2.08	397	1668	2.89	81.6	0.470	2.08	216	1103	5.13	54.9	0.480
0.84 / 0.08	2.08	575	1549	2.50	118.2	0.420	2.08	224	1144	5.80	56.9	0.480
0.08 / -0.68	2.08	575	1549	2.50	118.2	0.420	2.08	224	1144	5.80	56.9	0.480
-0.68 / -2.00	2.32	1318	3229	0.58	135.5	0.400	2.32	2134	3325	1.00	272.7	0.150
-2.00 / -4.50	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-4.50 / -6.40	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150

Table 3A.16.3-204 **Subsurface Properties for SSI Analysis of RB/FB FE (BE profile)** *(continued)*

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-6.40 / -8.40	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-8.40 / -10.40	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-10.40 / -11.50	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-11.50 / -13.50	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-13.50 / -15.50	2.32	1318	3229	0.58	67.7	0.400	2.32	2134	3325	1.00	136.3	0.150
-15.50 / -18.45	2.60	1644	4025	0.98	84.5	0.400	← See Note on the next page					
-18.45 / -21.41	2.61	1661	4068	1.00	85.4	0.400						
-21.41 / -23.41	2.61	1578	3865	1.00	81.1	0.400						
-23.41 / -25.61	2.61	1578	3865	1.00	81.1	0.400						
-25.61 / -27.81	2.61	1578	3865	1.00	81.1	0.400						

Table 3A.16.3-204 **Subsurface Properties for SSI Analysis of RB/FB FE (BE profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-27.81 / -32.78	2.63	2682	4779	1.00	107.9	0.270						
-32.78 / -37.76	2.63	2682	4779	1.00	107.7	0.270						
-37.76 / -42.74	2.63	2682	4779	1.00	107.7	0.270						
-42.74 / -	2.63	2804	4996	1.00		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-15.50 / -15.62	2.32	1318	3229	0.58		0.400						
-15.62 / -18.45	2.61	1661	4068	1.00		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.
Example: 1644=(18.45-15.5)/(0.12/1318+2.83/1661)
Damping ratio is determined using the thickness weighted average procedure.
Example: 0.98=(0.58x(15.62-15.50)+1.00x(18.45-15.62))/(0.12+2.83)

Table 3A.16.3-205 **Subsurface Properties for SSI Analysis of RB/FB FE (LB profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
4.50 / 3.89	2.00	188	460	3.50	38.6	0.400	2.08	162	303	3.12	41.1	0.300
3.89 / 3.13	2.00	163	464	7.02	33.5	0.430	2.08	127	238	7.00	32.2	0.301
3.13 / 2.37	2.00	163	464	7.02	33.5	0.430	2.08	127	238	7.00	32.2	0.301
2.37 / 1.61	2.08	248	1266	5.52	51.0	0.480	2.08	135	689	8.45	34.3	0.480
1.61 / 0.84	2.08	248	1266	5.52	51.0	0.480	2.08	135	689	8.45	34.3	0.480
0.84 / 0.08	2.08	384	1463	4.40	78.9	0.463	2.08	143	729	9.40	36.3	0.480
0.08 / -0.68	2.08	384	1463	4.40	78.9	0.463	2.08	143	729	9.40	36.3	0.480
-0.68 / -2.00	2.32	979	2398	1.02	100.6	0.400	2.32	1829	2850	1.80	233.7	0.150
-2.00 / -4.50	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-4.50 / -6.40	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150

Table 3A.16.3-205 **Subsurface Properties for SSI Analysis of RB/FB FE (LB profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-6.40 -8.40	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-8.40 -10.40	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-10.40 -11.50	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-11.50 -13.50	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-13.50 -15.50	2.32	979	2398	1.02	50.3	0.400	2.32	1829	2850	1.80	116.8	0.150
-15.50 -18.45	2.60	1217	2983	1.79	62.6	0.400	← See Note on the next page					
-18.45 -21.41	2.61	1230	3014	1.82	63.2	0.400						
-21.41 -23.41	2.61	1058	2591	1.82	54.4	0.400						
-23.41 -25.61	2.61	1058	2591	1.82	54.4	0.400						
-25.61 -27.81	2.61	1058	2591	1.82	54.4	0.400						

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Table 3A.16.3-205 **Subsurface Properties for SSI Analysis of RB/FB FE (LB profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-27.81 -32.78	2.63	2190	3902	1.82	88.1	0.270						
-32.78 -37.76	2.63	2190	3902	1.82	87.9	0.270						
-37.76 -42.74	2.63	2190	3902	1.82	87.9	0.270						
-42.74 -	2.63	2290	4079	1.82		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

-15.50 -15.62	2.32	979	2398	1.02		0.400						
-15.62 -18.45	2.61	1230	3014	1.82		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.

Example: 1217=(18.45-15.5)/(0.12/979+2.83/1230)

Damping ratio is determined using the thickness weighted average procedure.

Example: 1.79=(1.02x(15.62-15.50)+1.82x(18.45-15.62))/(0.12+2.83)

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Table 3A.16.3-206 **Subsurface Properties for SSI Analysis of RB/FB FE (UB profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
4.50 3.89	2.00	408	999	1.22	83.9	0.400	2.08	309	578	1.52	78.5	0.300
3.89 3.13	2.00	437	1248	1.63	89.8	0.430	2.08	307	574	2.57	78.0	0.300
3.13 2.37	2.00	437	1248	1.63	89.8	0.430	2.08	307	574	2.57	78.0	0.300
2.37 1.61	2.08	634	2665	1.52	130.4	0.470	2.08	346	1463	3.11	87.9	0.470
1.61 0.84	2.08	634	2665	1.52	130.4	0.470	2.08	346	1463	3.11	87.9	0.470
0.84 0.08	2.08	862	2321	1.42	177.3	0.420	2.08	352	1463	3.58	89.5	0.469
0.08 -0.68	2.08	862	2321	1.42	177.3	0.420	2.08	352	1463	3.58	89.5	0.469
-0.68 -2.00	2.32	1774	4346	0.33	182.4	0.400	2.32	2438	3800	0.55	311.5	0.150
-2.00 -4.50	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-4.50 -6.40	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150

Table 3A.16.3-206 **Subsurface Properties for SSI Analysis of RB/FB FE (UB profile)** *(continued)*

EL (m)	Soil Unit Weight (t/m^3)	Soil Vs (m/sec)	Soil Vp (m/sec)	Soil Damping (%)	Soil Highest Frequency (Hz)	Soil Poisson's ratio	Backfill Unit Weight (t/m^3)	Backfill Vs (m/sec)	Backfill Vp (m/sec)	Backfill Damping (%)	Backfill Highest Frequency (Hz)	Backfill Poisson's ratio
-6.40 / -8.40	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-8.40 / -10.40	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-10.40 / -11.50	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-11.50 / -13.50	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-13.50 / -15.50	2.32	1774	4346	0.33	91.2	0.400	2.32	2438	3800	0.55	155.7	0.150
-15.50 / -18.45	2.60	2218	5434	0.54	114.0	0.400	← See Note on the next page					
-18.45 / -21.41	2.61	2242	5492	0.55	115.2	0.400						
-21.41 / -23.41	2.61	2354	5767	0.55	121.0	0.400						
-23.41 / -25.61	2.61	2354	5767	0.55	121.0	0.400						
-25.61 / -27.81	2.61	2354	5767	0.55	121.0	0.400						

Table 3A.16.3-206 **Subsurface Properties for SSI Analysis of RB/FB FE (UB profile)** *(continued)*

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-27.81 -32.78	2.63	3285	5852	0.55	132.1	0.270						
-32.78 -37.76	2.63	3285	5852	0.55	131.9	0.270						
-37.76 -42.74	2.63	3285	5852	0.55	131.9	0.270						
-42.74 -	2.63	3434	6119	0.55		0.270						

Note: The soil properties of the adjusted layer, shown in the red box on the previous page, are evaluated from the original properties shown below.

Original data

-15.50 -15.62	2.32	1774	4346	0.33		0.400						
-15.62 -18.45	2.61	2242	5492	0.55		0.400						

Vs and Vp are determined using the equivalent wave travel time procedure.

Example: 2218=(18.45-15.5)/(0.12/1774+2.83/2242)

Damping ratio is determined using the thickness weighted average procedure.

Example: 0.54=(0.33x(15.62-15.50)+0.55x(18.45-15.62))/(0.12+2.83)

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Table 3A.16.3-207 **Subsurface Properties for SSI Analysis of CB PE (BE Profile)**

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-3.120 -4.645	2.32	617	1885	0.62	72.5	0.440	2.32	2134	3325	1.00	251.0	0.150
-4.645 -6.170	2.32	617	1885	0.62	72.5	0.440	2.32	2134	3325	1.00	251.0	0.150
-6.170 -7.400	2.32	754	2305	0.63	88.7	0.440	2.32	2134	3325	1.00	251.0	0.150
-7.400 -8.900	2.32	754	2305	0.63	88.7	0.440	2.32	2134	3325	1.00	251.0	0.150
-8.900 -10.400	2.32	754	2305	0.63	88.7	0.440	2.32	2134	3325	1.00	251.0	0.150
-10.400 -12.260	2.32	754	2305	0.63	81.0	0.440	2.32	2134	3325	1.00	229.4	0.150
-12.260 -13.785	2.32	811	2477	0.53	95.4	0.440	2.32	2134	3325	1.00	251.0	0.150
-13.785 -15.310	2.32	811	2477	0.53	95.4	0.440	2.32	2134	3325	1.00	251.0	0.150

Table 3A.16.3-207 **Subsurface Properties for SSI Analysis of CB PE (BE Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-15.310 / -18.360	2.61	1976	4225	1.00	129.5	0.360						
-18.360 / -24.460	2.61	2128	4273	1.00	69.7	0.335						
-24.460 / -27.500	2.61	2421	4613	1.00	159.2	0.310						
-27.500 / -30.550	2.63	2638	4772	1.00	172.9	0.280						
-30.550 / -33.600	2.63	2512	4787	1.00	164.7	0.310						
-33.600 / -36.650	2.63	2639	4937	1.00	173.0	0.300						
-36.650 / -39.700	2.63	2689	4722	1.00	176.3	0.260						
-39.700 / -42.740	2.63	2847	5150	1.00	187.3	0.280						
-42.740 / -45.790	2.63	2804	5245	1.00	183.8	0.300						
-45.790 / -	2.63	2804	4794	1.00		0.240						

Table 3A.16.3-208 **Subsurface Properties for SSI Analysis of CB PE (LB Profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-3.120 / -4.645	2.32	471	1463	1.06	55.4	0.442	2.32	1829	2850	1.80	215.1	0.150
-4.645 / -6.170	2.32	471	1463	1.06	55.4	0.442	2.32	1829	2850	1.80	215.1	0.150
-6.170 / -7.400	2.32	561	1715	1.14	66.0	0.440	2.32	1829	2850	1.80	215.1	0.150
-7.400 / -8.900	2.32	561	1715	1.14	66.0	0.440	2.32	1829	2850	1.80	215.1	0.150
-8.900 / -10.400	2.32	561	1715	1.14	66.0	0.440	2.32	1829	2850	1.80	215.1	0.150
-10.400 / -12.260	2.32	561	1715	1.14	60.3	0.440	2.32	1829	2850	1.80	196.6	0.150
-12.260 / -13.785	2.32	662	2022	0.96	77.8	0.440	2.32	1829	2850	1.80	215.1	0.150
-13.785 / -15.310	2.32	662	2022	0.96	77.8	0.440	2.32	1829	2850	1.80	215.1	0.150

Table 3A.16.3-208 **Subsurface Properties for SSI Analysis of CB PE (LB Profile)** *(continued)*

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-15.310 / -18.360	2.61	1613	3450	1.82	105.7	0.360						
-18.360 / -24.460	2.61	1738	3488	1.82	56.9	0.335						
-24.460 / -27.500	2.61	1977	3767	1.82	130.0	0.310						
-27.500 / -30.550	2.63	2154	3897	1.82	141.2	0.280						
-30.550 / -33.600	2.63	2051	3909	1.82	134.4	0.310						
-33.600 / -36.650	2.63	2155	4031	1.82	141.3	0.300						
-36.650 / -39.700	2.63	2195	3855	1.82	143.9	0.260						
-39.700 / -42.740	2.63	2324	4205	1.82	152.8	0.280						
-42.740 / -45.790	2.63	2289	4282	1.82	150.0	0.300						
-45.790 / -	2.63	2290	3915	1.82		0.240						

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Table 3A.16.3-209 **Subsurface Properties for SSI Analysis of CB PE (UB Profile)**

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-3.120 / -4.645	2.32	808	2469	0.36	95.0	0.440	2.32	2438	3800	0.55	286.8	0.150
-4.645 / -6.170	2.32	808	2469	0.36	95.0	0.440	2.32	2438	3800	0.55	286.8	0.150
-6.170 / -7.400	2.32	1014	3098	0.35	119.2	0.440	2.32	2438	3800	0.55	286.8	0.150
-7.400 / -8.900	2.32	1014	3098	0.35	119.2	0.440	2.32	2438	3800	0.55	286.8	0.150
-8.900 / -10.400	2.32	1014	3098	0.35	119.2	0.440	2.32	2438	3800	0.55	286.8	0.150
-10.400 / -12.260	2.32	1014	3098	0.35	109.0	0.440	2.32	2438	3800	0.55	262.1	0.150
-12.260 / -13.785	2.32	993	3034	0.29	116.8	0.440	2.32	2438	3800	0.55	286.8	0.150
-13.785 / -15.310	2.32	993	3034	0.29	116.8	0.440	2.32	2438	3800	0.55	286.8	0.150

Table 3A.16.3-209 **Subsurface Properties for SSI Analysis of CB PE (UB Profile)** *(continued)*

EL (m)	Soil: Unit Weight (t/m^3)	Soil: Vs (m/sec)	Soil: Vp (m/sec)	Soil: Damping (%)	Soil: Highest Frequency (Hz)	Soil: Poisson's ratio	Backfill: Unit Weight (t/m^3)	Backfill: Vs (m/sec)	Backfill: Vp (m/sec)	Backfill: Damping (%)	Backfill: Highest Frequency (Hz)	Backfill: Poisson's ratio
-15.310 -18.360	2.61	2420	5174	0.55	158.6	0.360						
-18.360 -24.460	2.61	2607	5233	0.55	85.4	0.335						
-24.460 -27.500	2.61	2965	5650	0.55	195.0	0.310						
-27.500 -30.550	2.63	3231	5845	0.55	211.8	0.280						
-30.550 -33.600	2.63	3077	5863	0.55	201.7	0.310						
-33.600 -36.650	2.63	3232	6047	0.55	211.9	0.300						
-36.650 -39.700	2.63	3293	5783	0.55	215.9	0.260						
-39.700 -42.740	2.63	3487	6308	0.55	229.4	0.280						
-42.740 -45.790	2.63	3434	6424	0.55	225.1	0.300						
-45.790 -	2.63	3434	5872	0.55		0.240						

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Table 3A.16.3-210 **Subsurface Properties for SSI Analysis of CB FE (BE Profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
4.500 3.740	2.00	266	540	2.78	53.6	0.340	2.08	198	370	3.14	49.9	0.299
3.740 2.980	2.00	266	540	2.78	53.6	0.340	2.08	198	370	3.14	49.9	0.299
2.980 2.215	2.00	307	1290	3.93	61.8	0.470	2.08	228	426	4.41	57.5	0.299
2.215 1.450	2.00	307	1463	3.93	61.8	0.477	2.08	228	1161	4.41	57.5	0.480
1.450 0.690	2.00	307	1463	3.93	61.8	0.477	2.08	229	1168	5.21	57.7	0.480
0.690 -0.070	2.00	307	1463	3.93	61.8	0.477	2.08	229	1168	5.21	57.7	0.480
-0.070 -0.720	2.08	433	1818	3.78	87.2	0.470	2.08	231	1180	5.92	58.2	0.480
-0.720 -1.370	2.08	433	1818	3.78	87.2	0.470	2.08	231	1180	5.92	58.2	0.480
See Note below→ -1.370 -2.000	2.08	433	1818	3.78	87.2	0.470	2.08	242	1232	5.76	60.9	0.480
-2.000 -2.560	2.08	433	1818	3.78	87.2	0.470	2.08	248	1264	5.67	62.5	0.480

Table 3A.16.3-210 **Subsurface Properties for SSI Analysis of CB FE (BE Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-2.560 / -3.120	2.08	433	1818	3.78	87.2	0.470	2.08	248	1264	5.67	62.5	0.480
-3.120 / -4.645	2.32	617	1885	0.62	62.2	0.440	2.32	2134	3325	1.00	215.2	0.150
-4.645 / -6.170	2.32	617	1885	0.62	62.2	0.440	2.32	2134	3325	1.00	215.2	0.150
-6.170 / -7.400	2.32	754	2305	0.63	76.0	0.440	2.32	2134	3325	1.00	215.2	0.150
-7.400 / -8.900	2.32	754	2305	0.63	76.0	0.440	2.32	2134	3325	1.00	215.2	0.150
-8.900 / -10.400	2.32	754	2305	0.63	76.0	0.440	2.32	2134	3325	1.00	215.2	0.150
-10.400 / -12.260	2.32	754	2305	0.63	76.0	0.440	2.32	2134	3325	1.00	215.2	0.150
-12.260 / -13.785	2.32	811	2477	0.53	81.7	0.440	2.32	2134	3325	1.00	215.2	0.150
-13.785 / -15.310	2.32	811	2477	0.53	81.7	0.440	2.32	2134	3325	1.00	215.2	0.150

Table 3A.16.3-210 **Subsurface Properties for SSI Analysis of CB FE (BE Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-15.310 -18.360	2.61	1976	4225	1.00	129.5	0.360						
-18.360 -24.460	2.61	2128	4273	1.00	69.7	0.335						
-24.460 -27.500	2.61	2421	4613	1.00	159.2	0.310						
-27.500 -30.550	2.63	2638	4772	1.00	172.9	0.280						
-30.550 -33.600	2.63	2512	4787	1.00	164.7	0.310						
-33.600 -36.650	2.63	2639	4937	1.00	173.0	0.300						
-36.650 -39.700	2.63	2689	4722	1.00	176.3	0.260						
-39.700 -42.740	2.63	2847	5150	1.00	187.3	0.280						
-42.740 -45.790	2.63	2804	5245	1.00	183.8	0.300						
-45.790 -	2.63	2804	4794	1.00		0.240						

Table 3A.16.3-210 **Subsurface Properties for SSI Analysis of CB FE (BE Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
Note: The soil properties of adjusted layer, shown in the red box above, are evaluated from original properties shown below.												
Original data												
-1.370 -1.600	2.08	433	1818	3.78		0.470	2.08	231	1180	5.92		0.480
-1.600 -2.000	2.08	433	1818	3.78		0.470	2.08	248	1264	5.67		0.480

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Table 3A.16.3-211 **Subsurface Properties for SSI Analysis of CB FE (LB Profile)**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
4.500 / 3.740	2.00	180	365	4.83	36.2	0.339	2.08	134	251	4.98	33.7	0.301
3.740 / 2.980	2.00	180	365	4.83	36.2	0.339	2.08	134	251	4.98	33.7	0.301
2.980 / 2.215	2.00	186	782	7.42	37.5	0.470	2.08	148	277	7.17	37.3	0.300
2.215 / 1.450	2.00	186	949	7.42	37.5	0.480	2.08	148	755	7.17	37.3	0.480
1.450 / 0.690	2.00	186	949	7.42	37.5	0.480	2.08	146	742	8.38	36.8	0.480
0.690 / -0.070	2.00	186	949	7.42	37.5	0.480	2.08	146	742	8.38	36.8	0.480
-0.070 / -0.720	2.08	302	1463	6.53	60.8	0.478	2.08	150	764	9.11	37.8	0.480
-0.720 / -1.370	2.08	302	1463	6.53	60.8	0.478	2.08	150	764	9.11	37.8	0.480
See Note below→ -1.370 / -2.000	2.08	302	1463	6.53	60.8	0.478	2.08	154	786	9.00	38.9	0.480
-2.000 / -2.560	2.08	302	1463	6.53	60.8	0.478	2.08	157	800	8.93	39.5	0.480

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Table 3A.16.3-211 **Subsurface Properties for SSI Analysis of CB FE (LB Profile)** *(continued)*

EL (m)	Soil						Backfill					
	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-2.560 / -3.120	2.08	302	1463	6.53	60.8	0.478	2.08	157	800	8.93	39.5	0.480
-3.120 / -4.645	2.32	471	1463	1.06	47.5	0.442	2.32	1829	2850	1.80	184.4	0.150
-4.645 / -6.170	2.32	471	1463	1.06	47.5	0.442	2.32	1829	2850	1.80	184.4	0.150
-6.170 / -7.400	2.32	561	1715	1.14	56.5	0.440	2.32	1829	2850	1.80	184.4	0.150
-7.400 / -8.900	2.32	561	1715	1.14	56.5	0.440	2.32	1829	2850	1.80	184.4	0.150
-8.900 / -10.400	2.32	561	1715	1.14	56.5	0.440	2.32	1829	2850	1.80	184.4	0.150
-10.400 / -12.260	2.32	561	1715	1.14	56.5	0.440	2.32	1829	2850	1.80	184.4	0.150
-12.260 / -13.785	2.32	662	2022	0.96	66.7	0.440	2.32	1829	2850	1.80	184.4	0.150
-13.785 / -15.310	2.32	662	2022	0.96	66.7	0.440	2.32	1829	2850	1.80	184.4	0.150

Table 3A.16.3-211 **Subsurface Properties for SSI Analysis of CB FE (LB Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-15.310 -18.360	2.61	1613	3450	1.82	105.7	0.360						
-18.360 -24.460	2.61	1738	3488	1.82	56.9	0.335						
-24.460 -27.500	2.61	1977	3767	1.82	130.0	0.310						
-27.500 -30.550	2.63	2154	3897	1.82	141.2	0.280						
-30.550 -33.600	2.63	2051	3909	1.82	134.4	0.310						
-33.600 -36.650	2.63	2155	4031	1.82	141.3	0.300						
-36.650 -39.700	2.63	2195	3855	1.82	143.9	0.260						
-39.700 -42.740	2.63	2324	4205	1.82	152.8	0.280						
-42.740 -45.790	2.63	2289	4282	1.82	150.0	0.300						
-45.790 -	2.63	2290	3915	1.82		0.240						

Table 3A.16.3-211 **Subsurface Properties for SSI Analysis of CB FE (LB Profile)** *(continued)*

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
Note: The soil properties of adjusted layer, shown in the red box above, are evaluated from original properties shown below. Original data												
-1.370 -1.600	2.08	302	1463	6.53		0.478	2.08	150	764	9.11		0.480
-1.600	2.08	302	1463	6.53		0.478	2.08	157	800	8.93		0.480

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Table 3A.16.3-212 Subsurface Properties for SSI Analysis of CB FE (UB Profile)

		Soil						Backfill					
	EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
	4.500 / 3.740	2.00	394	800	1.60	79.4	0.340	2.08	292	546	1.98	73.6	0.300
	3.740 / 2.980	2.00	394	800	1.60	79.4	0.340	2.08	292	546	1.98	73.6	0.300
	2.980 / 2.215	2.00	506	2126	2.08	102.0	0.470	2.08	350	655	2.72	88.2	0.300
	2.215 / 1.450	2.00	506	2126	2.08	102.0	0.470	2.08	350	1463	2.72	88.2	0.470
	1.450 / 0.690	2.00	506	2126	2.08	102.0	0.470	2.08	360	1463	3.24	90.7	0.468
	0.690 / -0.070	2.00	506	2126	2.08	102.0	0.470	2.08	360	1463	3.24	90.7	0.468
	-0.070 / -0.720	2.08	621	2608	2.19	125.2	0.470	2.08	358	1463	3.84	90.2	0.468
	-0.720 / -1.370	2.08	621	2608	2.19	125.2	0.470	2.08	358	1463	3.84	90.2	0.468
See Note below→	-1.370 / -2.000	2.08	621	2608	2.19	125.2	0.470	2.08	378	1463	3.69	95.4	0.464
	-2.000 / -2.560	2.08	621	2608	2.19	125.2	0.470	2.08	391	1463	3.60	98.6	0.462

Table 3A.16.3-212 **Subsurface Properties for SSI Analysis of CB FE (UB Profile)** *(continued)*

EL (m)	Soil Unit Weight (t/m^3)	Soil Vs (m/sec)	Soil Vp (m/sec)	Soil Damping (%)	Soil Highest Frequency (Hz)	Soil Poisson's ratio	Backfill Unit Weight (t/m^3)	Backfill Vs (m/sec)	Backfill Vp (m/sec)	Backfill Damping (%)	Backfill Highest Frequency (Hz)	Backfill Poisson's ratio
-2.560 / -3.120	2.08	621	2608	2.19	125.2	0.470	2.08	391	1463	3.60	98.6	0.462
-3.120 / -4.645	2.32	808	2469	0.36	81.4	0.440	2.32	2438	3800	0.55	245.8	0.150
-4.645 / -6.170	2.32	808	2469	0.36	81.4	0.440	2.32	2438	3800	0.55	245.8	0.150
-6.170 / -7.400	2.32	1014	3098	0.35	102.2	0.440	2.32	2438	3800	0.55	245.8	0.150
-7.400 / -8.900	2.32	1014	3098	0.35	102.2	0.440	2.32	2438	3800	0.55	245.8	0.150
-8.900 / -10.400	2.32	1014	3098	0.35	102.2	0.440	2.32	2438	3800	0.55	245.8	0.150
-10.400 / -12.260	2.32	1014	3098	0.35	102.2	0.440	2.32	2438	3800	0.55	245.8	0.150
-12.260 / -13.785	2.32	993	3034	0.29	100.1	0.440	2.32	2438	3800	0.55	245.8	0.150
-13.785 / -15.310	2.32	993	3034	0.29	100.1	0.440	2.32	2438	3800	0.55	245.8	0.150

Table 3A.16.3-212 **Subsurface Properties for SSI Analysis of CB FE (UB Profile)** *(continued)*

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-15.310 / -18.360	2.61	2420	5174	0.55	158.6	0.360						
-18.360 / -24.460	2.61	2607	5233	0.55	85.4	0.335						
-24.460 / -27.500	2.61	2965	5650	0.55	195.0	0.310						
-27.500 / -30.550	2.63	3231	5845	0.55	211.8	0.280						
-30.550 / -33.600	2.63	3077	5863	0.55	201.7	0.310						
-33.600 / -36.650	2.63	3232	6047	0.55	211.9	0.300						
-36.650 / -39.700	2.63	3293	5783	0.55	215.9	0.260						
-39.700 / -42.740	2.63	3487	6308	0.55	229.4	0.280						
-42.740 / -45.790	2.63	3434	6424	0.55	225.1	0.300						
-45.790 / -	2.63	3434	5872	0.55		0.240						

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Table 3A.16.3-212 **Subsurface Properties for SSI Analysis of CB FE (UB Profile)** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
Note: The soil properties of adjusted layer, shown in the red box above, are evaluated from original properties shown below. Original data												
-1.370 / -1.600	2.08	621	2608	2.19		0.470	2.08	358	1463	3.84		0.468
-1.600 / -2.000	2.08	621	2608	2.19		0.470	2.08	391	1463	3.60		0.462

Table 3A.16.3-213 **Site Model Properties for SSI Analysis of BE Profile - FWSC**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
2.15 / 1.40	2.00	226	1153	4.18	54.7	0.480	2.32	2134	3325	1.00	517.3	0.150
1.40 / 0.65	2.00	226	1153	4.18	54.7	0.480	2.32	2134	3325	1.00	517.3	0.150
0.65 / -0.10	2.00	226	1153	4.18	54.7	0.480	2.32	2134	3325	1.00	517.3	0.150
-0.10 / -0.85	2.00	226	1153	4.18	54.7	0.480	2.32	2134	3325	1.00	517.3	0.150
-0.85 / -1.60	2.00	226	1153	4.18	54.7	0.480	2.32	2134	3325	1.00	517.3	0.150
-1.60 / -2.46	2.00	298	1463	5.00	69.3	0.478	2.32	2134	3325	1.00	496.2	0.150
-2.46 / -3.32	2.00	298	1463	5.00	69.3	0.478	2.32	2134	3325	1.00	496.2	0.150
-3.32 / -4.18	2.00	298	1463	5.00	69.3	0.478	2.32	2134	3325	1.00	496.2	0.150

Table 3A.16.3-213 **Site Model Properties for SSI Analysis of BE Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-4.18 / -5.04	2.00	298	1463	5.00	69.3	0.478	2.32	2134	3325	1.00	496.2	0.150
-5.04 / -5.91	2.00	298	1463	5.00	68.5	0.478	2.32	2134	3325	1.00	490.5	0.150
-5.91 / -6.78	2.00	298	1463	5.00	68.5	0.478	2.32	2134	3325	1.00	490.5	0.150
-6.78 / -8.000	2.08	432	1814	3.97	70.8	0.470	2.32	2134	3325	1.00	349.8	0.150
-8.000 / -9.520	2.08	596	1821	2.89	78.4	0.440	2.32	2134	3325	1.00	280.7	0.150
-9.520 / -11.140	2.32	763	2331	0.64	94.1	0.440	2.32	2134	3325	1.00	263.4	0.150
-11.140 / -12.770	2.32	763	2331	0.64	93.6	0.440	2.32	2134	3325	1.00	261.8	0.150
-12.770 / -14.400	2.32	763	2331	0.64	93.6	0.440	2.32	2134	3325	1.00	261.8	0.150

Table 3A.16.3-213 **Site Model Properties for SSI Analysis of BE Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-14.400 -15.620	2.32	821	2508	0.53	134.5	0.440	2.32	2134	3325	1.00	349.8	0.150
-15.620 -16.840	2.32	821	2508	0.53	134.5	0.440	2.32	2134	3325	1.00	349.8	0.150

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Table 3A.16.3-213 **Site Model Properties for SSI Analysis of BE Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-16.840 -18.670	2.61	1976	4225	1.00	215.9	0.360						
-18.670 -22.020	2.61	2128	4273	1.00	127.0	0.335						
-22.020 -25.37	2.63	2421	4613	1.00	144.5	0.310						
-25.37 -28.72	2.63	2638	4772	1.00	157.4	0.280						
-28.72 -32.08	2.63	2512	4787	1.00	149.5	0.310						
-32.08 -35.43	2.63	2639	4937	1.00	157.5	0.300						
-35.43 -38.78	2.63	2689	4722	1.00	160.5	0.260						
-38.78 -42.14	2.63	2847	5150	1.00	169.4	0.280						
-42.14 -45.49	2.63	2804	5245	1.00	167.4	0.300						
-45.49 -	2.63	2804	4794	1.00	-	0.240						

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Table 3A.16.3-214 **Site Model Properties for SSI Analysis of LB Profile - FWSC**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
2.15 / 1.40	2.00	147	750	6.63	35.6	0.480	2.32	1829	2850	1.82	443.3	0.150
1.40 / 0.65	2.00	147	750	6.63	35.6	0.480	2.32	1829	2850	1.82	443.3	0.150
0.65 / -0.10	2.00	147	750	6.63	35.6	0.480	2.32	1829	2850	1.82	443.3	0.150
-0.10 / -0.85	2.00	147	750	6.63	35.6	0.480	2.32	1829	2850	1.82	443.3	0.150
-0.85 / -1.60	2.00	147	750	6.63	35.6	0.480	2.32	1829	2850	1.82	443.3	0.150
-1.60 / -2.46	2.00	184	940	8.25	42.7	0.480	2.32	1829	2850	1.82	425.3	0.150
-2.46 / -3.32	2.00	184	940	8.25	42.7	0.480	2.32	1829	2850	1.82	425.3	0.150
-3.32 / -4.18	2.00	184	940	8.25	42.7	0.480	2.32	1829	2850	1.82	425.3	0.150

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Table 3A.16.3-214 **Site Model Properties for SSI Analysis of LB Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-4.18 / -5.04	2.00	184	940	8.25	42.7	0.480	2.32	1829	2850	1.82	425.3	0.150
-5.04 / -5.91	2.00	184	940	8.25	42.2	0.480	2.32	1829	2850	1.82	420.4	0.150
-5.91 / -6.78	2.00	184	940	8.25	42.2	0.480	2.32	1829	2850	1.82	420.4	0.150
-6.78 / -8.000	2.08	310	1463	6.08	50.8	0.476	2.32	1829	2850	1.82	299.8	0.150
-8.000 / -9.520	2.08	436	1463	4.37	57.3	0.451	2.32	1829	2850	1.82	240.6	0.150
-9.520 / -11.140	2.32	581	1775	1.14	71.7	0.440	2.32	1829	2850	1.82	225.8	0.150
-11.140 / -12.770	2.32	581	1775	1.14	71.2	0.440	2.32	1829	2850	1.82	224.4	0.150
-12.770 / -14.400	2.32	581	1775	1.14	71.2	0.440	2.32	1829	2850	1.82	224.4	0.150

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Table 3A.16.3-214 **Site Model Properties for SSI Analysis of LB Profile - FWSC** *(continued)*

	Soil						**Backfill**					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-14.400 -15.620	2.32	655	2002	0.94	107.3	0.440	2.32	1829	2850	1.82	299.8	0.150
-15.620 -16.840	2.32	655	2002	0.94	107.3	0.440	2.32	1829	2850	1.82	299.8	0.150

Table 3A.16.3-214 **Site Model Properties for SSI Analysis of LB Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-16.840 -18.670	2.61	1464	3130	1.82	160.0	0.360						
-18.670 -22.020	2.61	1738	3488	1.82	103.7	0.335						
-22.020 -25.37	2.63	1977	3767	1.82	118.0	0.310						
-25.37 -28.72	2.63	2154	3897	1.82	128.5	0.280						
-28.72 -32.08	2.63	2051	3909	1.82	122.0	0.310						
-32.08 -35.43	2.63	2155	4031	1.82	128.6	0.300						
-35.43 -38.78	2.63	2195	3855	1.82	131.0	0.260						
-38.78 -42.14	2.63	2324	4205	1.82	138.3	0.280						
-42.14 -45.49	2.63	2289	4282	1.82	136.6	0.300						
-45.49 -	2.63	2290	3915	1.82	-	0.240						

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Table 3A.16.3-215 **Site Model Properties for SSI Analysis of UB Profile - FWSC**

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
2.15 / 1.40	2.00	348	1463	2.64	84.3	0.470	2.32	2438	3800	0.55	591.0	0.150
1.40 / 0.65	2.00	348	1463	2.64	84.3	0.470	2.32	2438	3800	0.55	591.0	0.150
0.65 / -0.10	2.00	348	1463	2.64	84.3	0.470	2.32	2438	3800	0.55	591.0	0.150
-0.10 / -0.85	2.00	348	1463	2.64	84.3	0.470	2.32	2438	3800	0.55	591.0	0.150
-0.85 / -1.60	2.00	348	1463	2.64	84.3	0.470	2.32	2438	3800	0.55	591.0	0.150
-1.60 / -2.46	2.00	483	2030	3.03	112.3	0.470	2.32	2438	3800	0.55	566.9	0.150
-2.46 / -3.32	2.00	483	2030	3.03	112.3	0.470	2.32	2438	3800	0.55	566.9	0.150
-3.32 / -4.18	2.00	483	2030	3.03	112.3	0.470	2.32	2438	3800	0.55	566.9	0.150

Table 3A.16.3-215 **Site Model Properties for SSI Analysis of UB Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-4.18 -5.04	2.00	483	2030	3.03	112.3	0.470	2.32	2438	3800	0.55	566.9	0.150
-5.04 -5.91	2.00	483	2030	3.03	111.0	0.470	2.32	2438	3800	0.55	560.4	0.150
-5.91 -6.78	2.00	483	2030	3.03	111.0	0.470	2.32	2438	3800	0.55	560.4	0.150
-6.78 -8.000	2.08	600	2524	2.60	98.3	0.470	2.32	2438	3800	0.55	399.6	0.150
-8.000 -9.520	2.08	814	2488	1.92	107.1	0.440	2.32	2438	3800	0.55	320.7	0.150
-9.520 -11.140	2.32	1002	3060	0.36	123.7	0.440	2.32	2438	3800	0.55	300.9	0.150
-11.140 -12.770	2.32	1002	3060	0.36	122.9	0.440	2.32	2438	3800	0.55	299.1	0.150
-12.770 -14.400	2.32	1002	3060	0.36	122.9	0.440	2.32	2438	3800	0.55	299.1	0.150

Table 3A.16.3-215 **Site Model Properties for SSI Analysis of UB Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**	**Unit Weight (t/m^3)**	**Vs (m/sec)**	**Vp (m/sec)**	**Damping (%)**	**Highest Frequency (Hz)**	**Poisson's ratio**
-14.400 -15.620	2.32	1028	3141	0.30	168.5	0.440	2.32	2438	3800	0.55	399.6	0.150
-15.620 -16.840	2.32	1028	3141	0.30	168.5	0.440	2.32	2438	3800	0.55	399.6	0.150

Table 3A.16.3-215 **Site Model Properties for SSI Analysis of UB Profile - FWSC** *(continued)*

	Soil						Backfill					
EL (m)	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio	Unit Weight (t/m^3)	Vs (m/sec)	Vp (m/sec)	Damping (%)	Highest Frequency (Hz)	Poisson's ratio
-16.840 -18.670	2.61	2667	5703	0.55	291.4	0.360						
-18.670 -22.020	2.61	2607	5233	0.55	155.6	0.335						
-22.020 -25.37	2.63	2965	5650	0.55	177.0	0.310						
-25.37 -28.72	2.63	3231	5845	0.55	192.8	0.280						
-28.72 -32.08	2.63	3077	5863	0.55	183.1	0.310						
-32.08 -35.43	2.63	3232	6047	0.55	192.9	0.300						
-35.43 -38.78	2.63	3293	5783	0.55	196.5	0.260						
-38.78 -42.14	2.63	3487	6308	0.55	207.5	0.280						
-42.14 -45.49	2.63	3434	6424	0.55	205.0	0.300						
-45.49 -	2.63	3434	5872	0.55	-	0.240						

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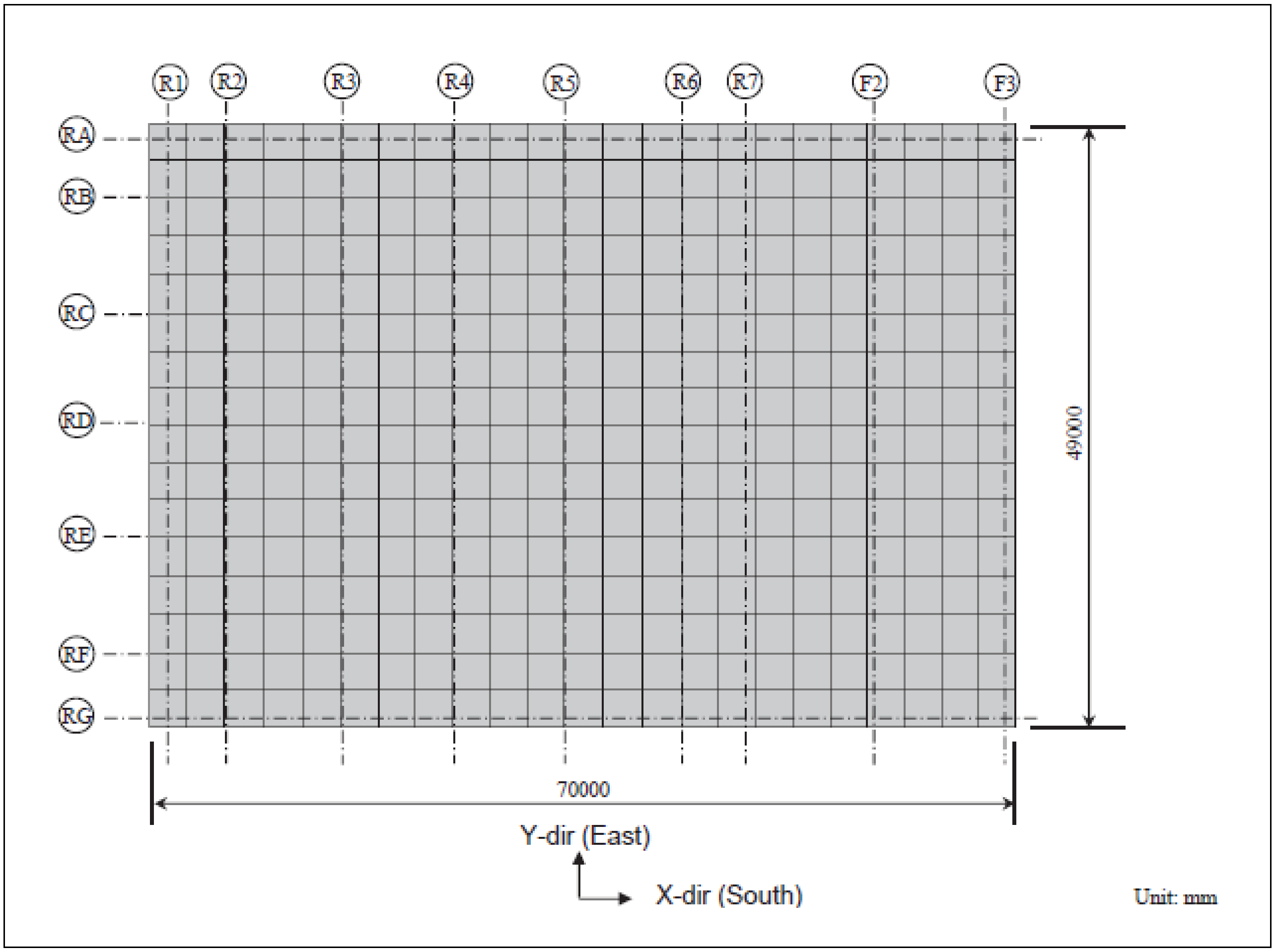
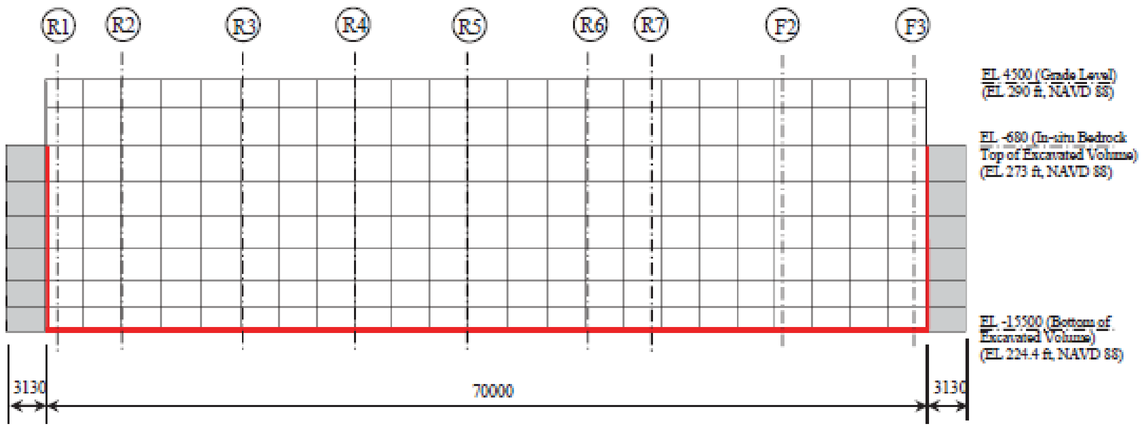
Figure 3A.16.3-201 **SASSI2010 Plate Elements for RB/FB Basemat in Partially Embedded Model**



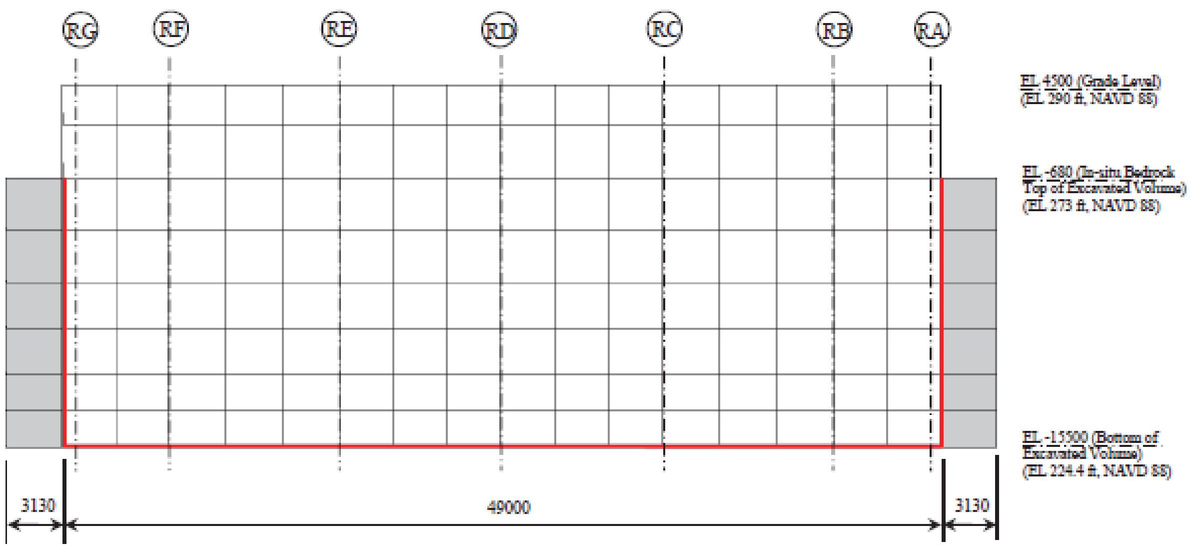
NAPS DEP 3.7-1 Figure 3A.16.3-202 **SASSI2010 Plate Elements for RB/FB Exterior Walls in the Partially Embedded Model**



(a) Walls on Column Rows RA and RG

Unit: mm

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.



(b) Walls on Column Rows R1 and F3

Unit: mm

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

NAPS DEP 3.7-1 Figure 3A.16.3-203 **SASSI2010 Excavated Volume Solid Elements for the RB/FB Partially Embedded Model**

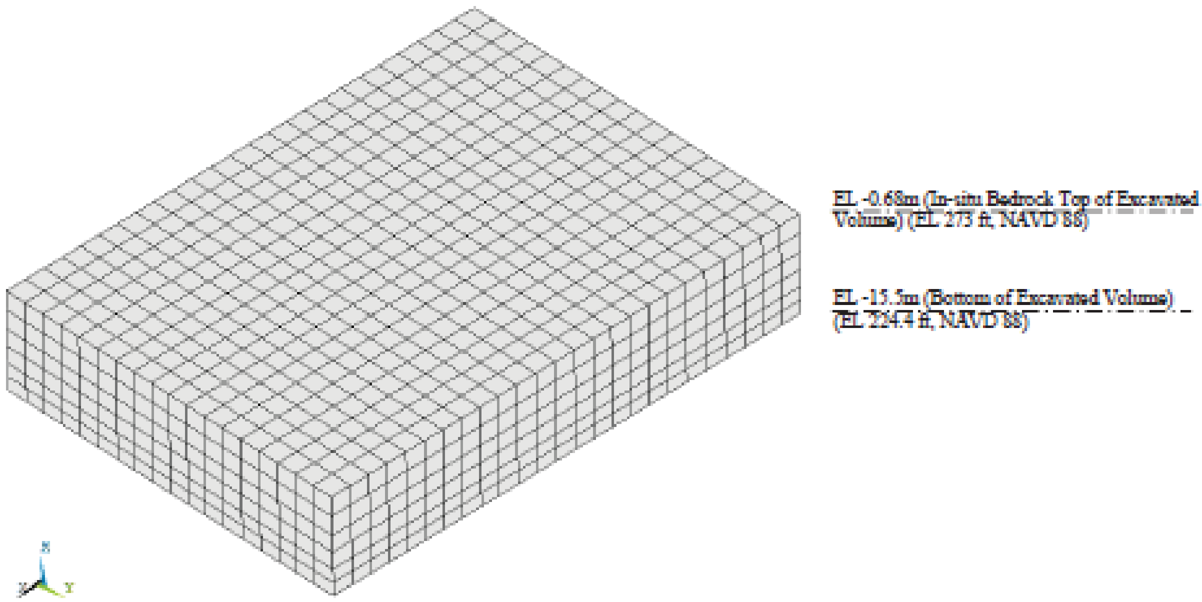
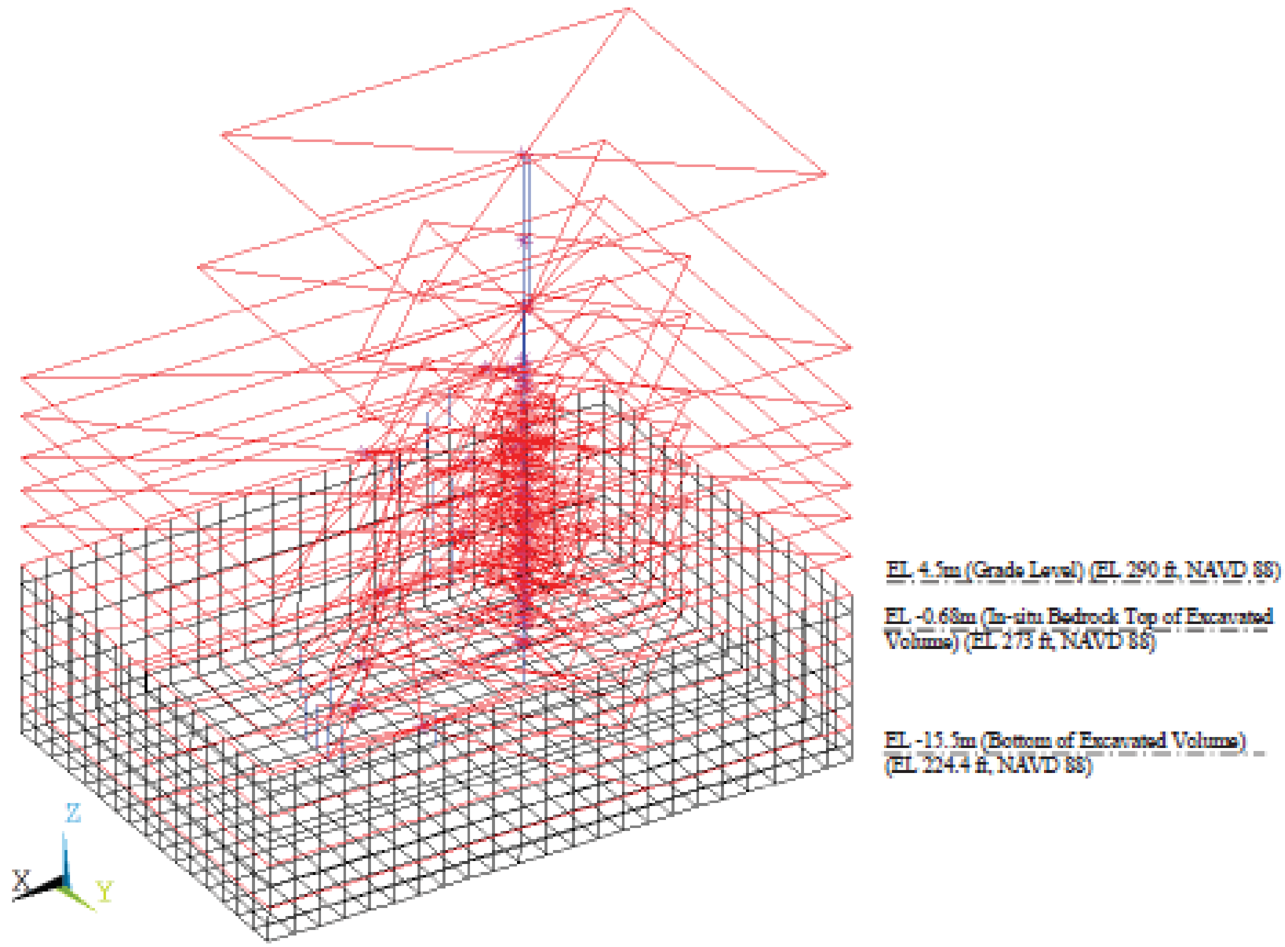


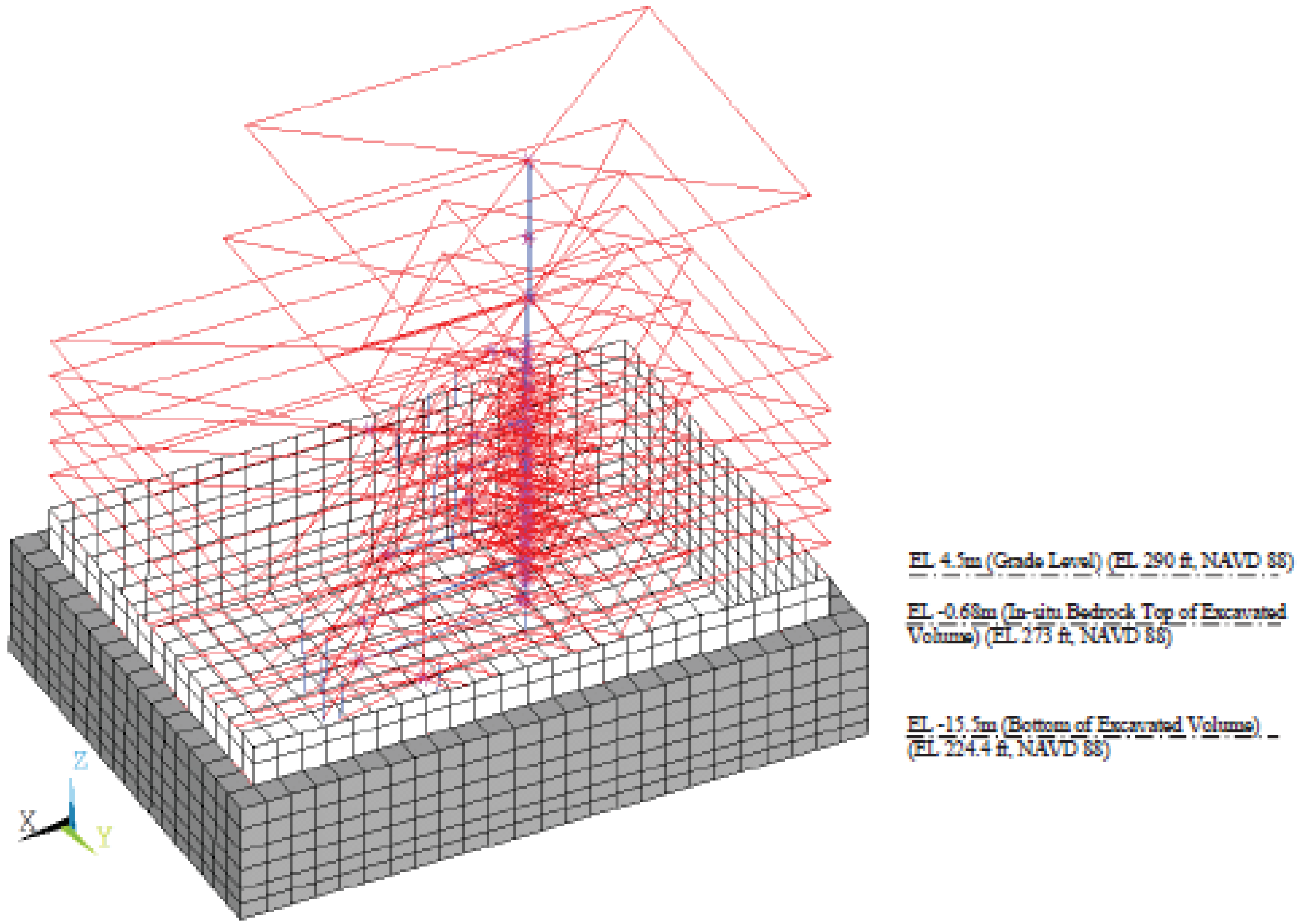
Figure 3A.16.3-204a **Overview of SASSI2010 SSI RB/FB Partially Embedded Model**



(a) Overview without Concrete Fill and Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams indicated in red are installed at the floor levels.

Figure 3A.16.3-204b **Overview of SASSI2010 SSI RB/FB Partially Embedded Model**



(b) Overview with Concrete Fill and without Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams indicated in red are installed at the floor levels.

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Figure 3A.16.3-205 **SASSI2010 Plate Elements for RB/FB Basemat in the Fully Embedded Model**

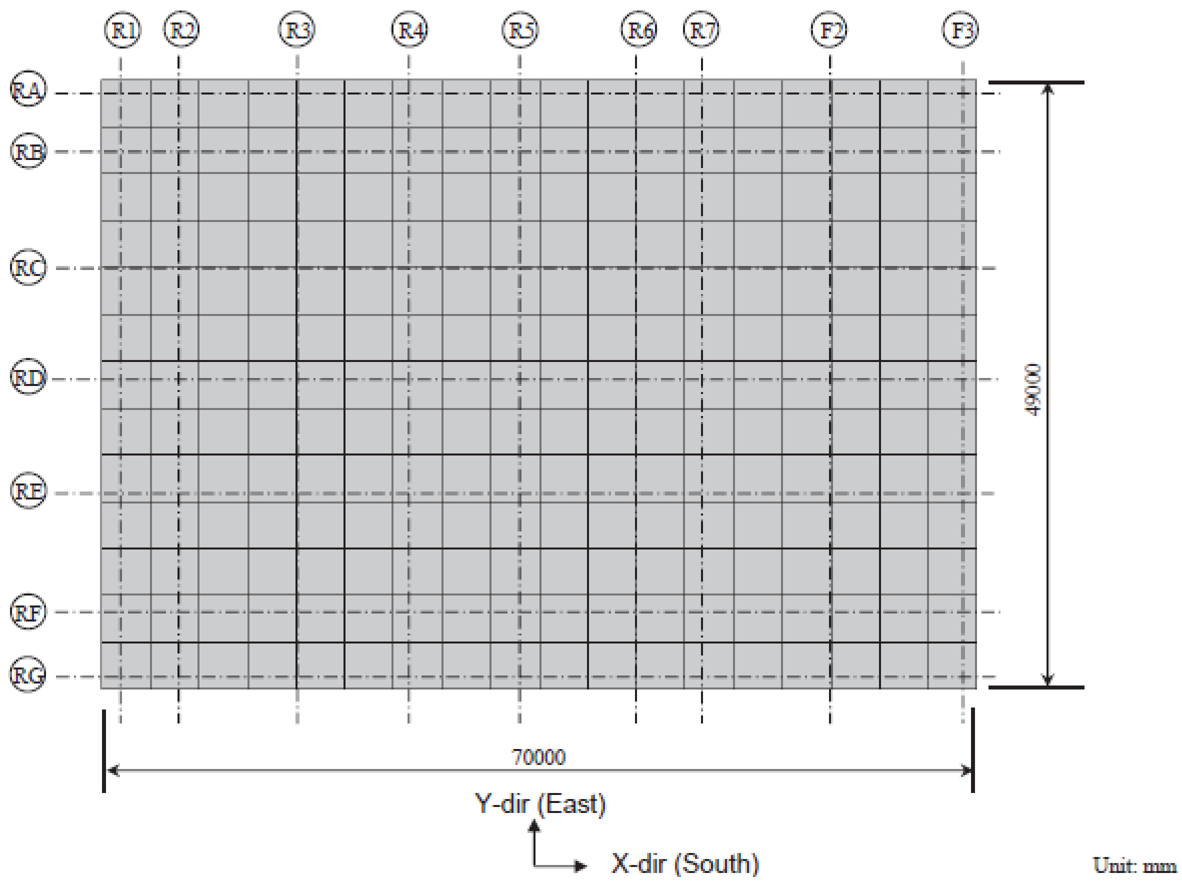
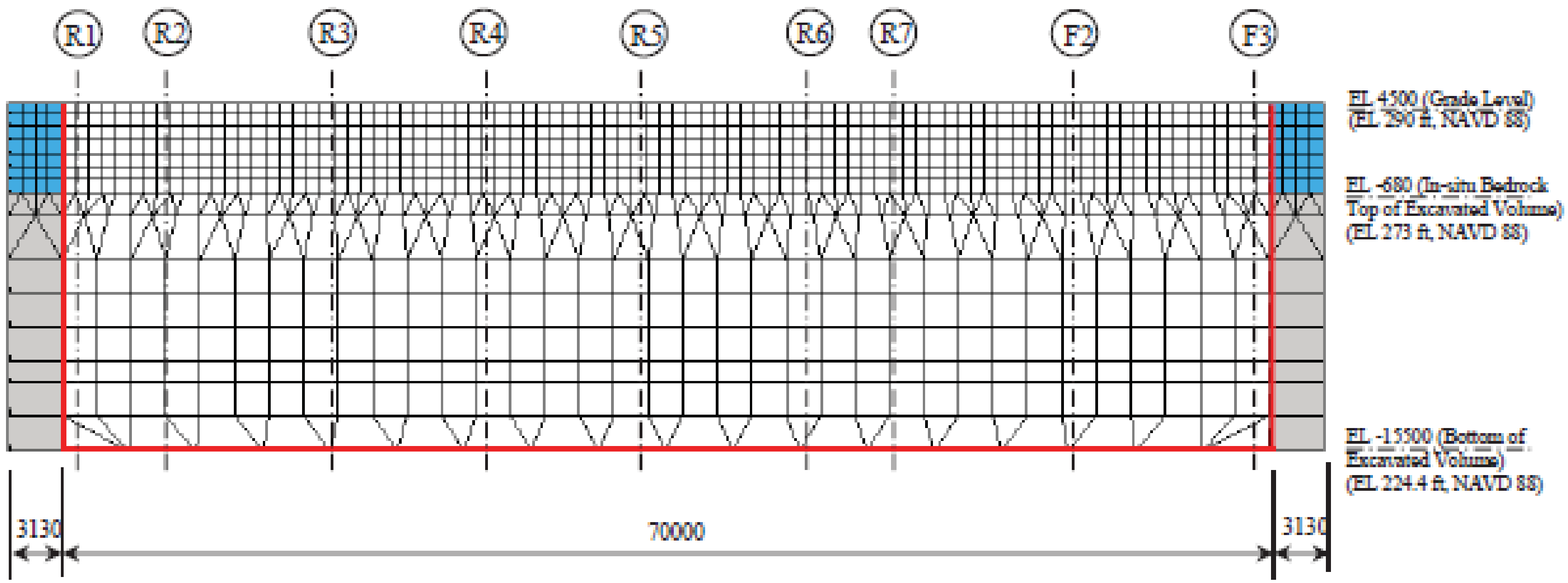


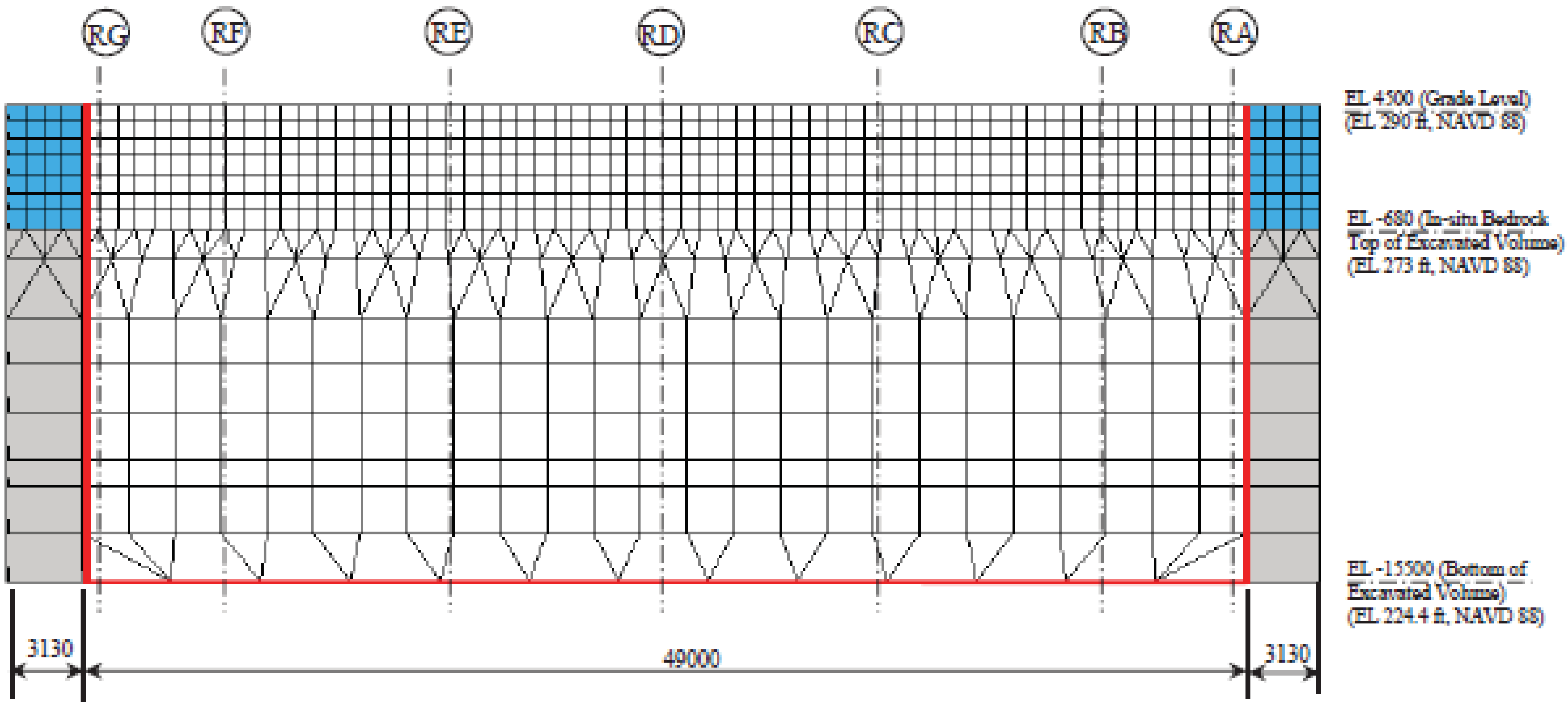
Figure 3A.16.3-206a **SASSI2010 Plate Elements for RB/FB Exterior Walls in the Fully Embedded Model**



(a) Walls on Column Rows RA and RG

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

Figure 3A.16.3-206b **SASSI2010 Plate Elements for RB/FB Exterior Walls in the Fully Embedded Model**



(b) Walls on Column Rows R1 and F3

Unit: mm

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

Figure 3A.16.3-207 **SASSI2010 Excavated Volume Solid Elements for the RB/FB Fully Embedded Model**

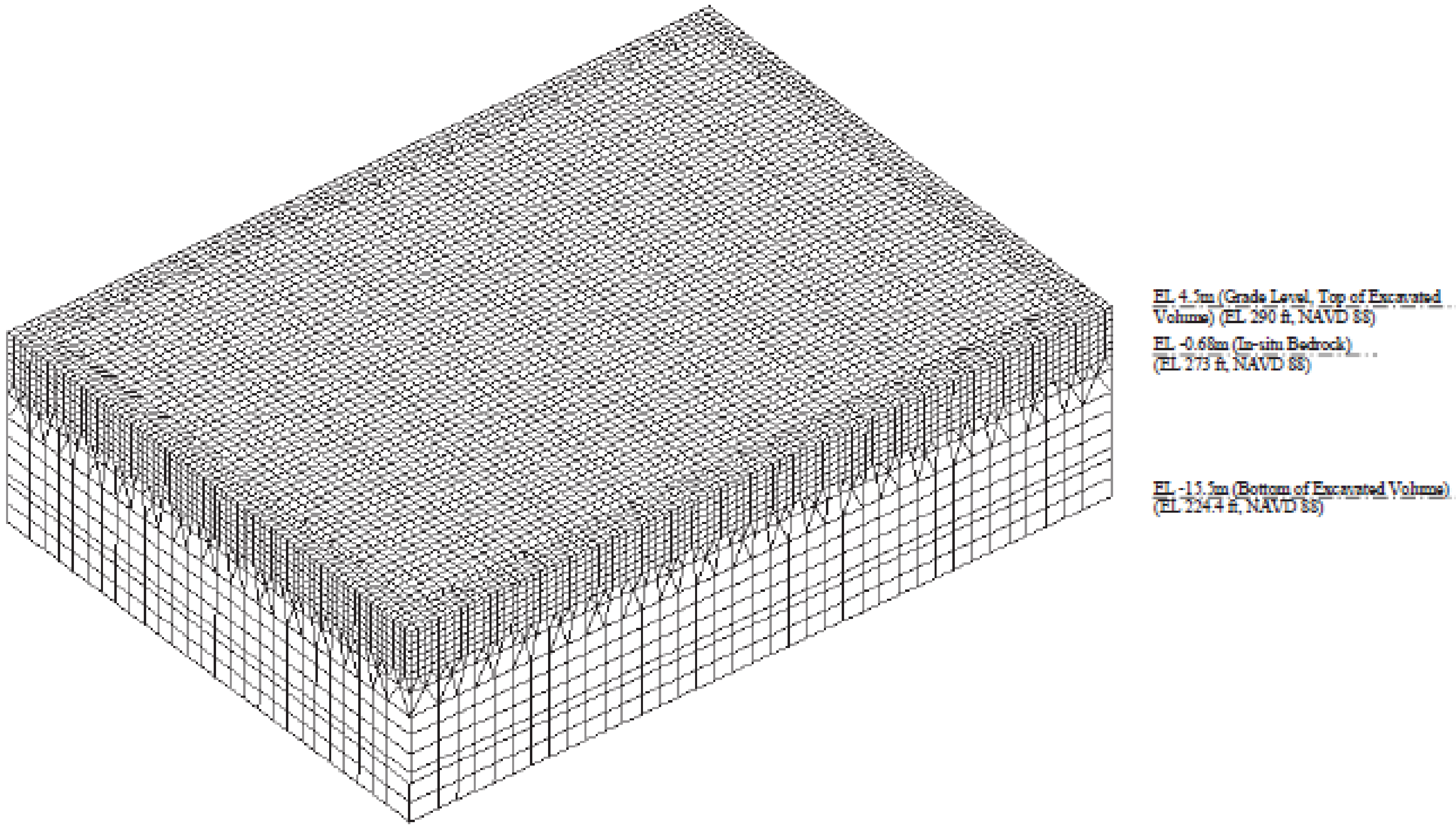
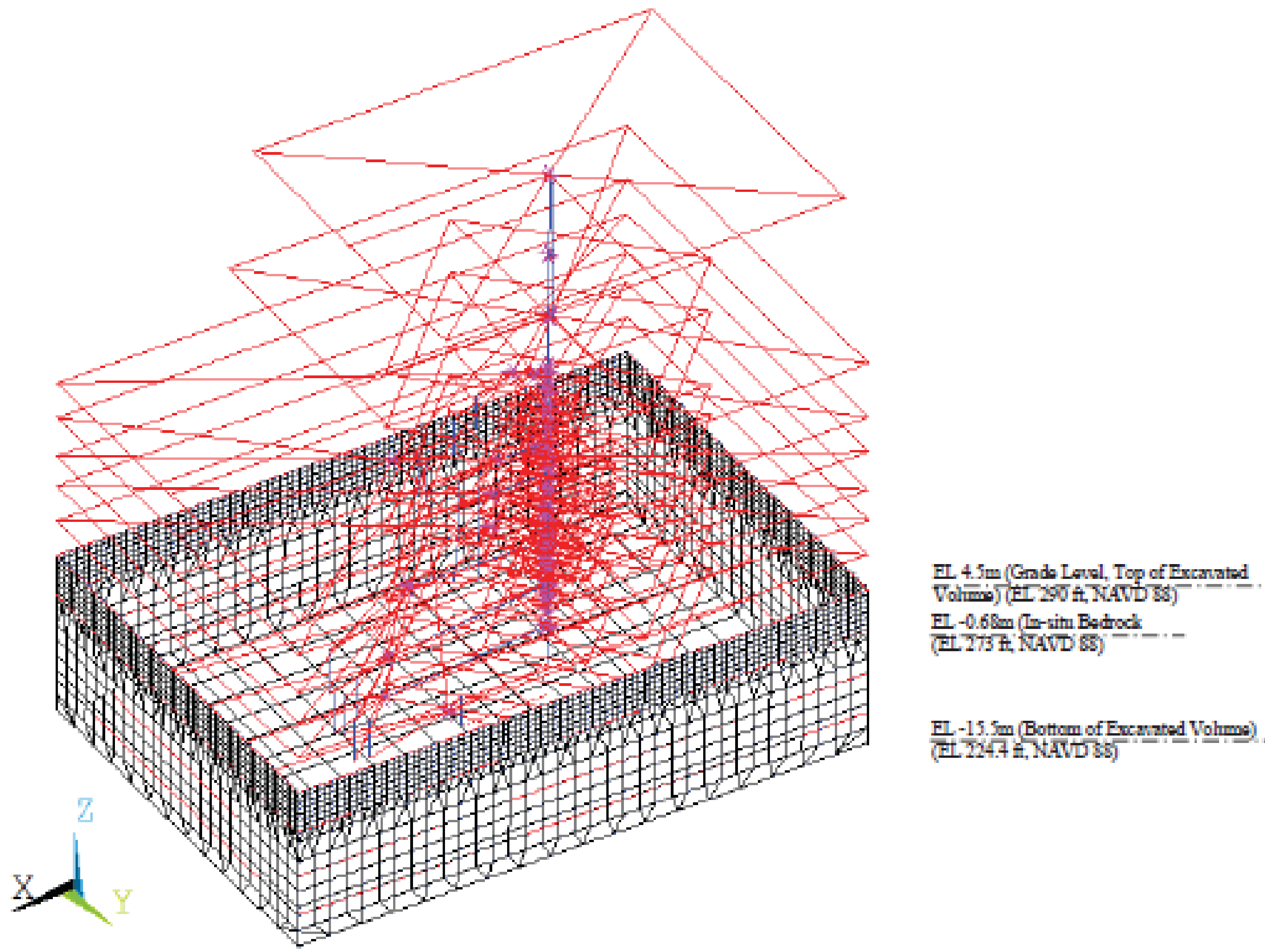


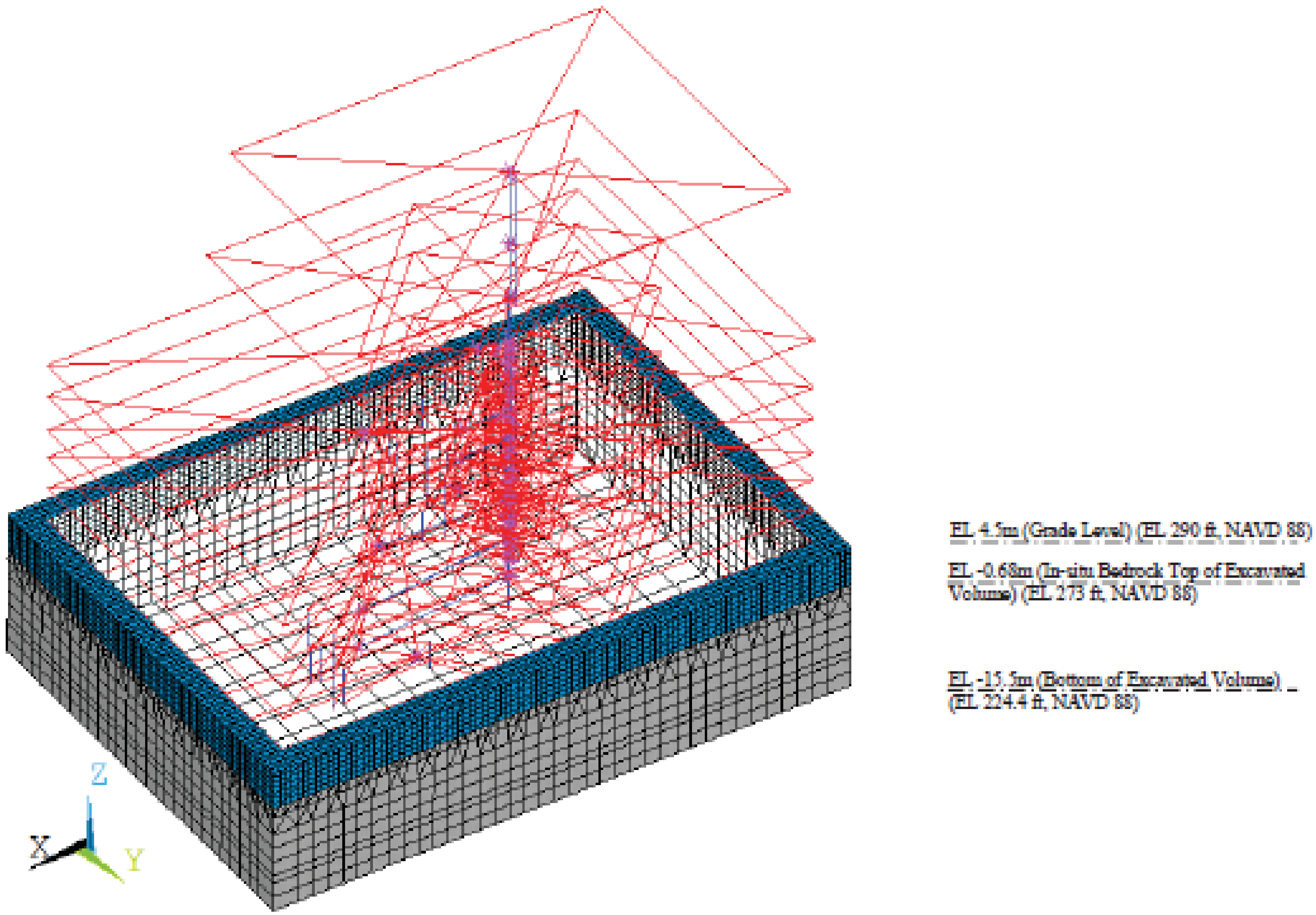
Figure 3A.16.3-208a **Overview of SASSI2010 SSI RB/FB Fully Embedded Model**



(a) Overview without Concrete Fill and Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams indicated in red are installed at the floor levels.

Figure 3A.16.3-208b **Overview of SASSI2010 SSI RB/FB Fully Embedded Model**



(b) Overview with Concrete Fill and without Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams indicated in red are installed at the floor levels.

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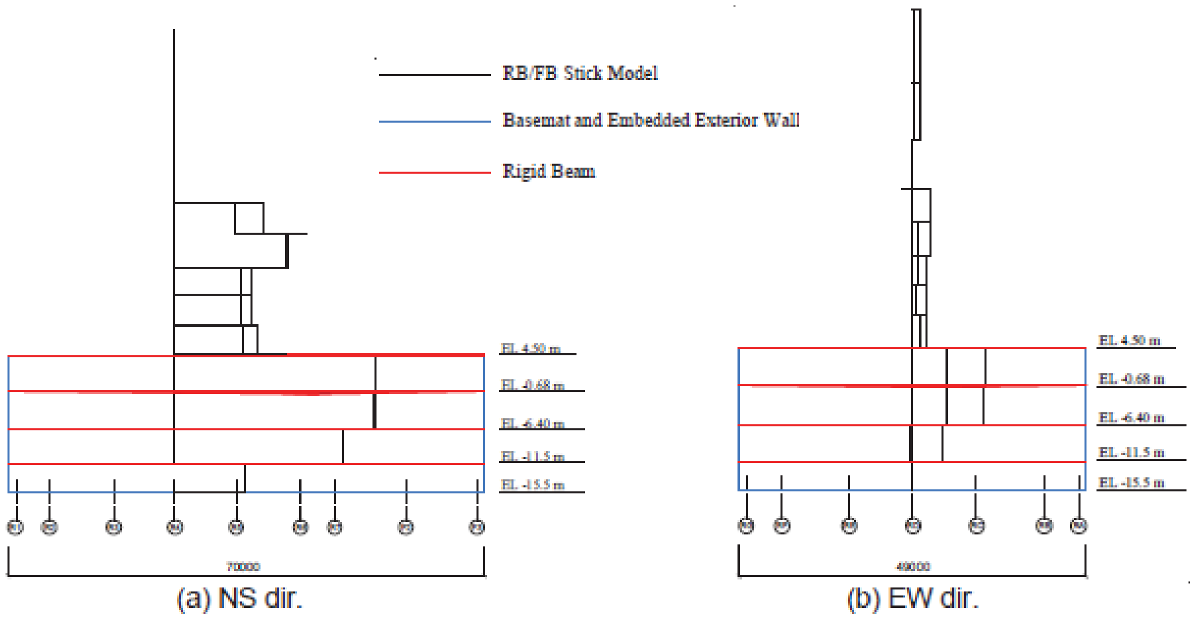
Figure 3A.16.3-209 **Connection Between RB/FB Stick Model and Foundation**



Note: Outriggers installed to the RB/FB stick are not shown in the figures.

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Figure 3A.16.3-210 **SASSI2010 Plate Elements for CB Basemat in the Partially Embedded Model**

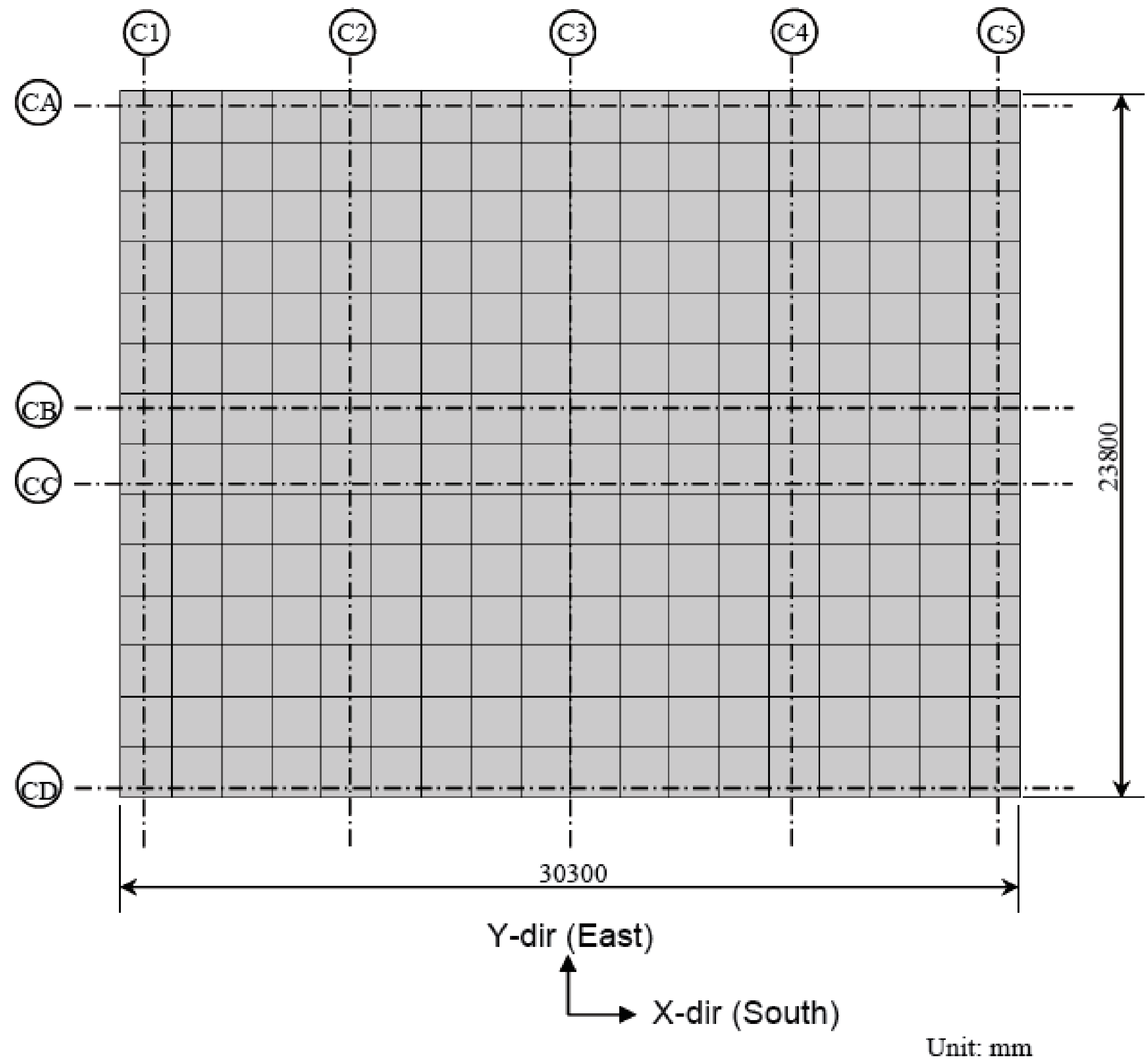
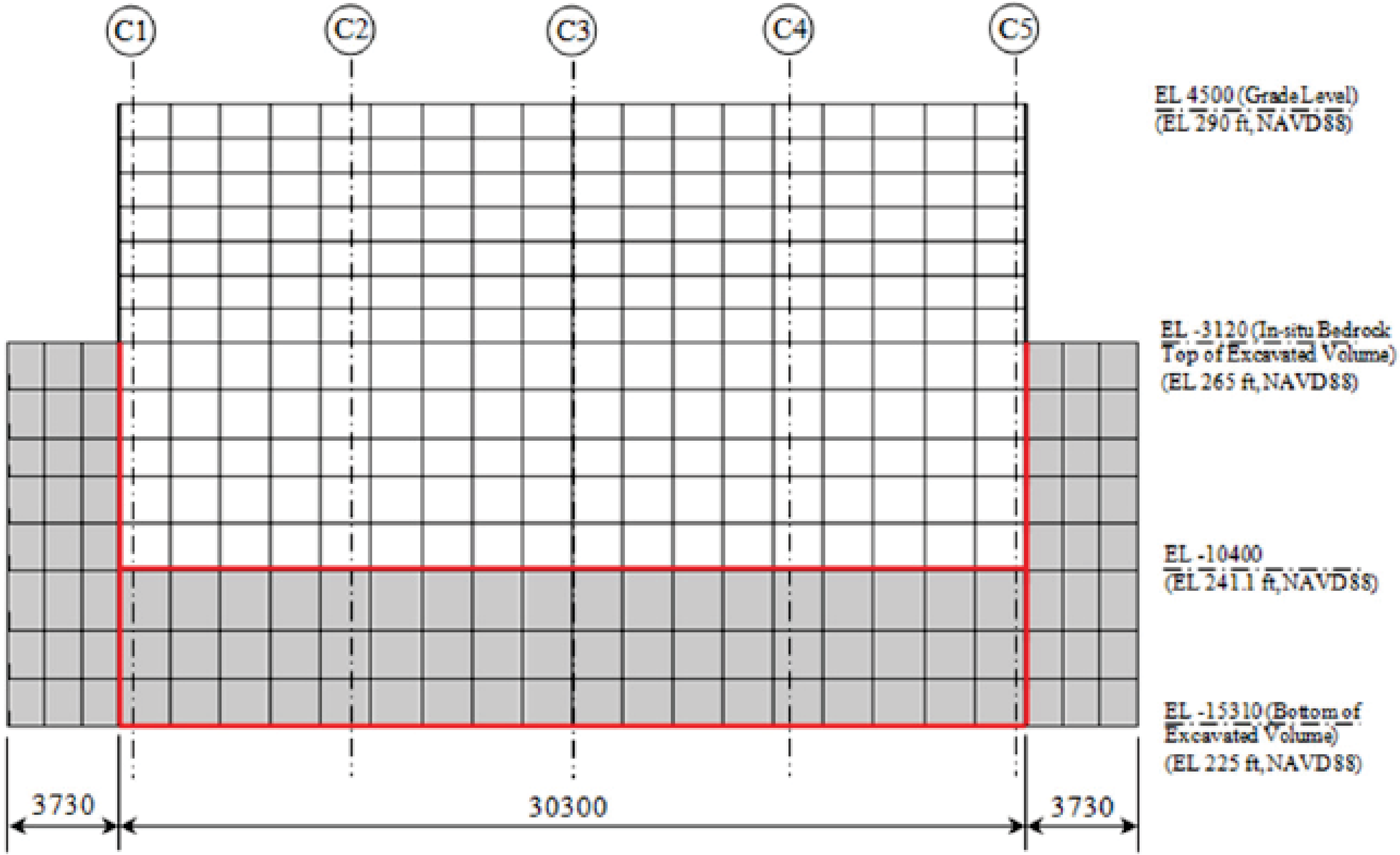


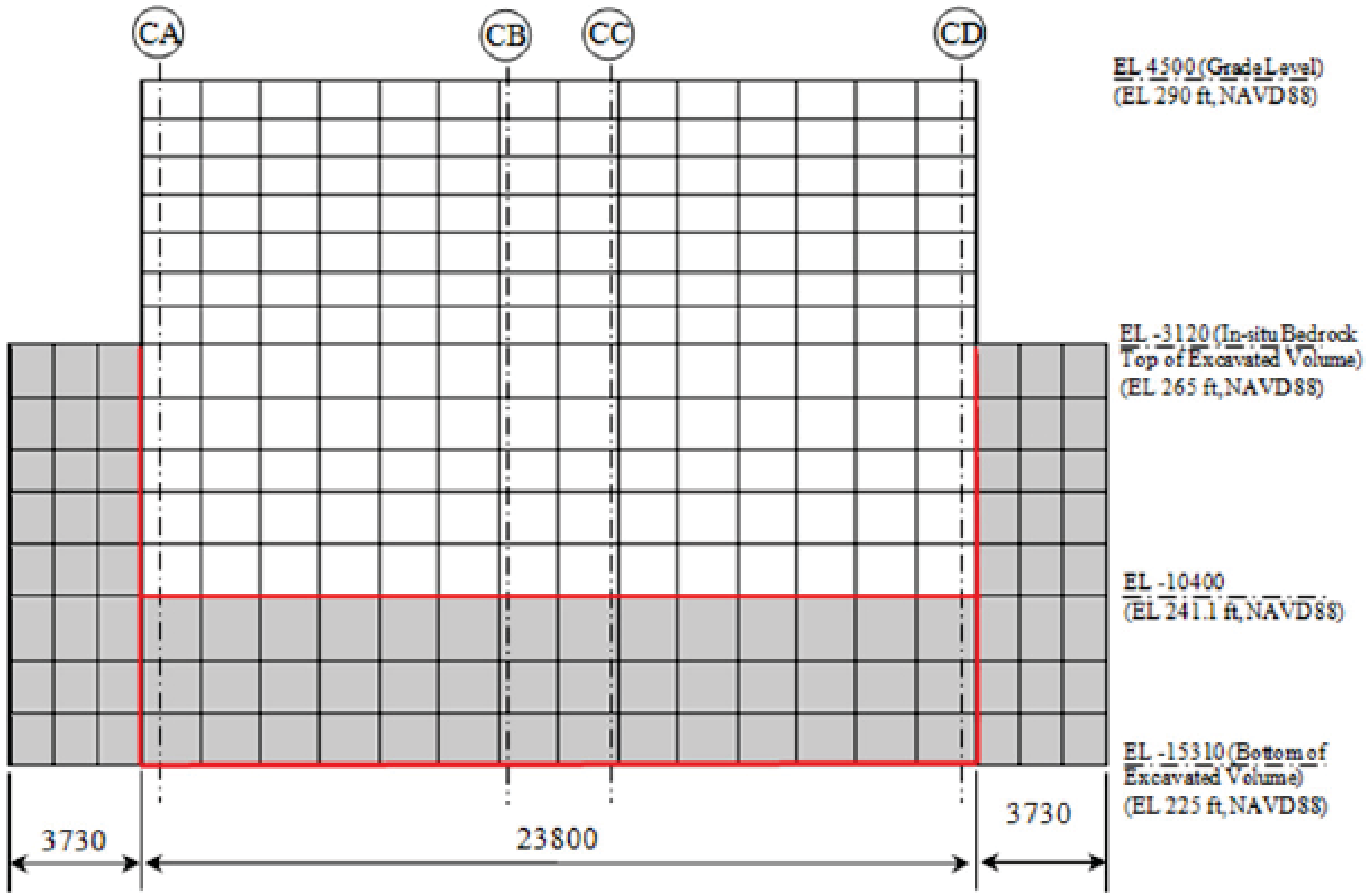
Figure 3A.16.3-211 **SASSI2010 Plate Elements for CB Exterior Walls in the Partially Embedded Model**



(a) Walls on Column Rows CA and CD (Unit: mm)

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

Figure 3A.16.3-211 **SASSI2010 Plate Elements for CB Exterior Walls in the Partially Embedded Model** *(continued)*



(b) Walls on Column Rows C1 and C5 (Unit: mm)

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

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Figure 3A.16.3-212 **SASSI2010 Excavated Volume Solid Elements for the CB Partially Embedded Model**

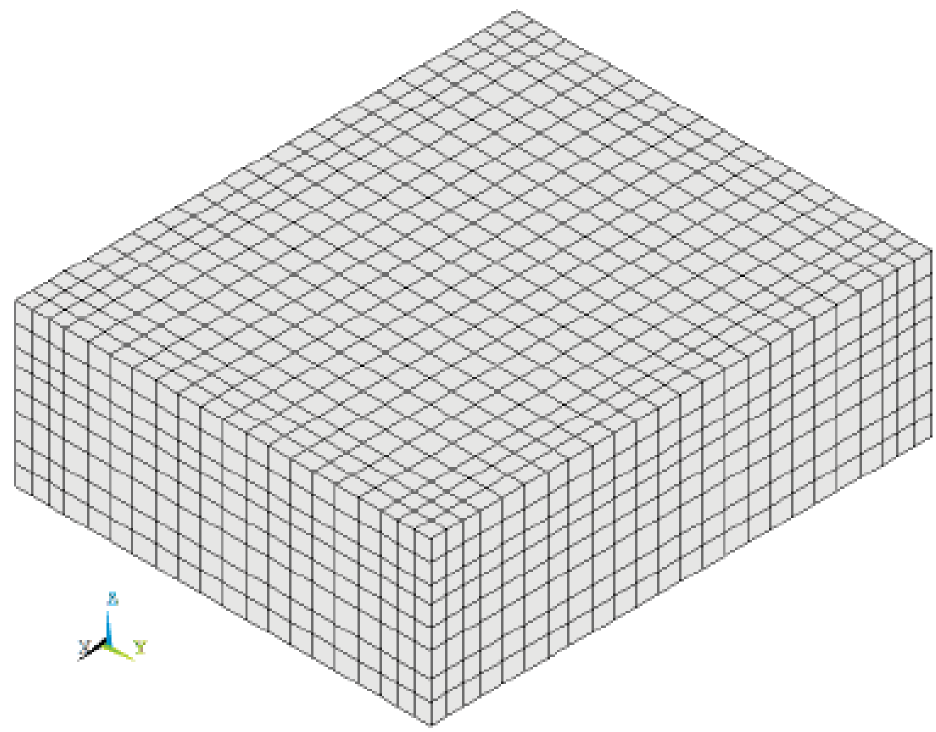
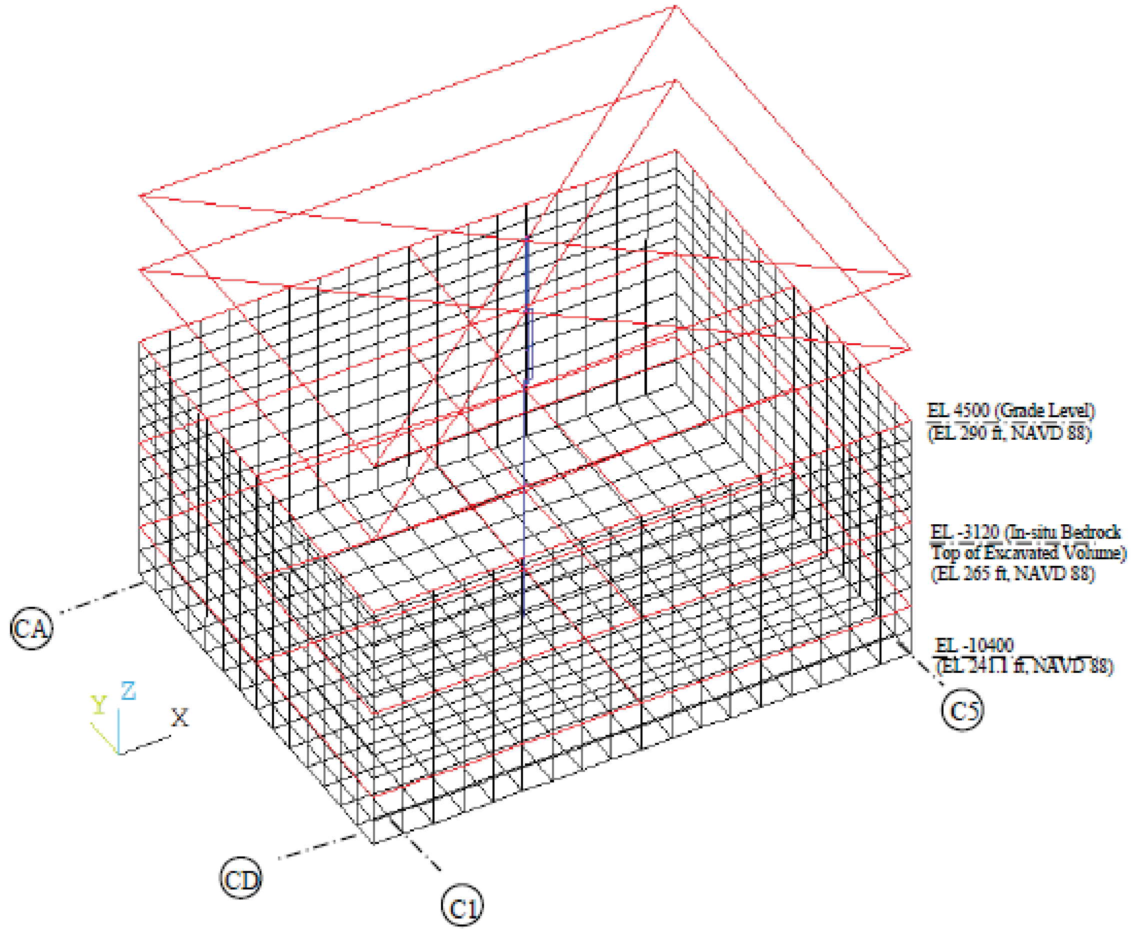


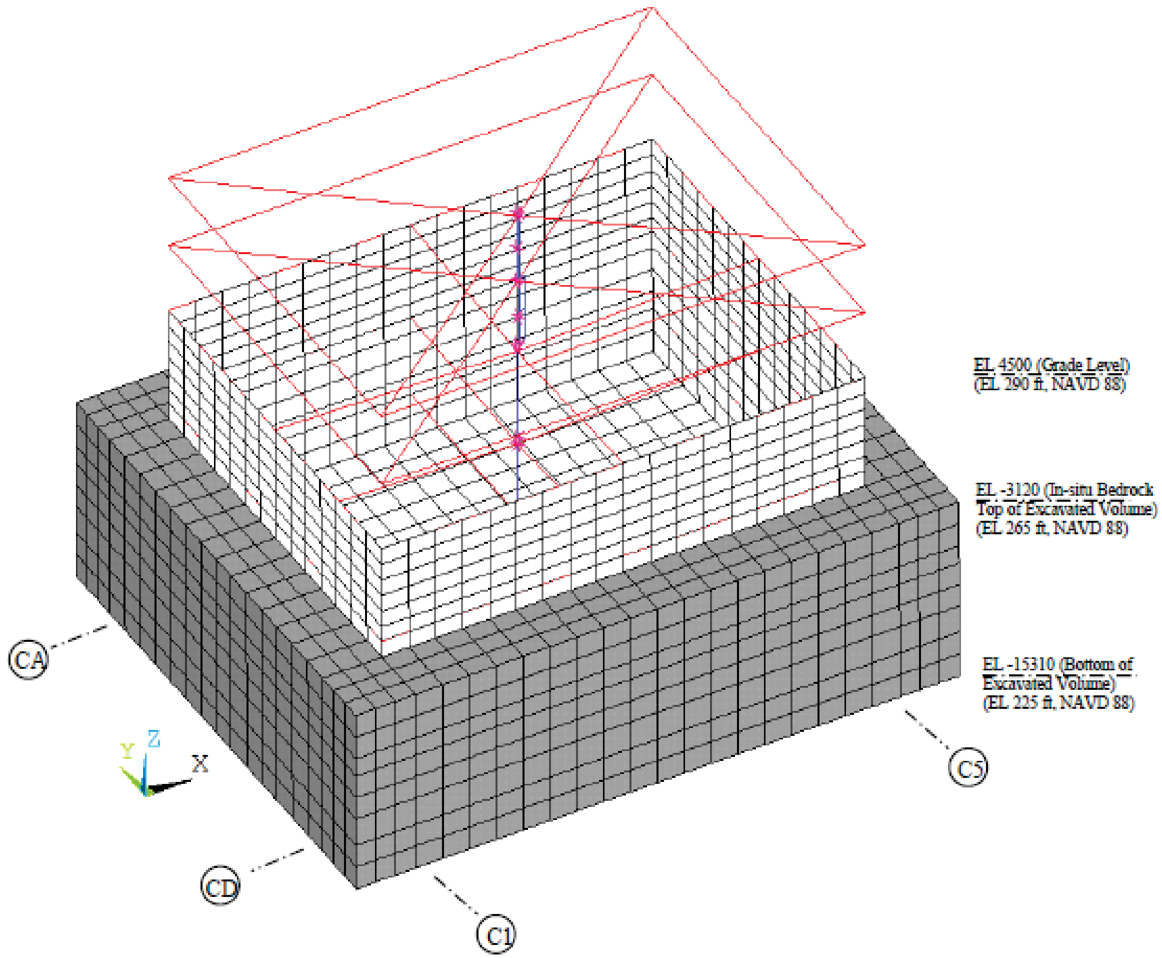
Figure 3A.16.3-213a **Overview of SASSI2010 SSI CB Partially Embedded Model**



(a) Overview without Concrete Fill and Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams or outriggers indicated in red are installed at the floor levels.

Figure 3A.16.3-213b **Overview of SASSI2010 SSI CB Partially Embedded Model**



(b) Overview with Concrete Fill without Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams or outriggers indicated in red are installed at the floor levels.

Figure 3A.16.3-214 **SASSI2010 Plate Elements for CB Basemat in the Fully Embedded Model**

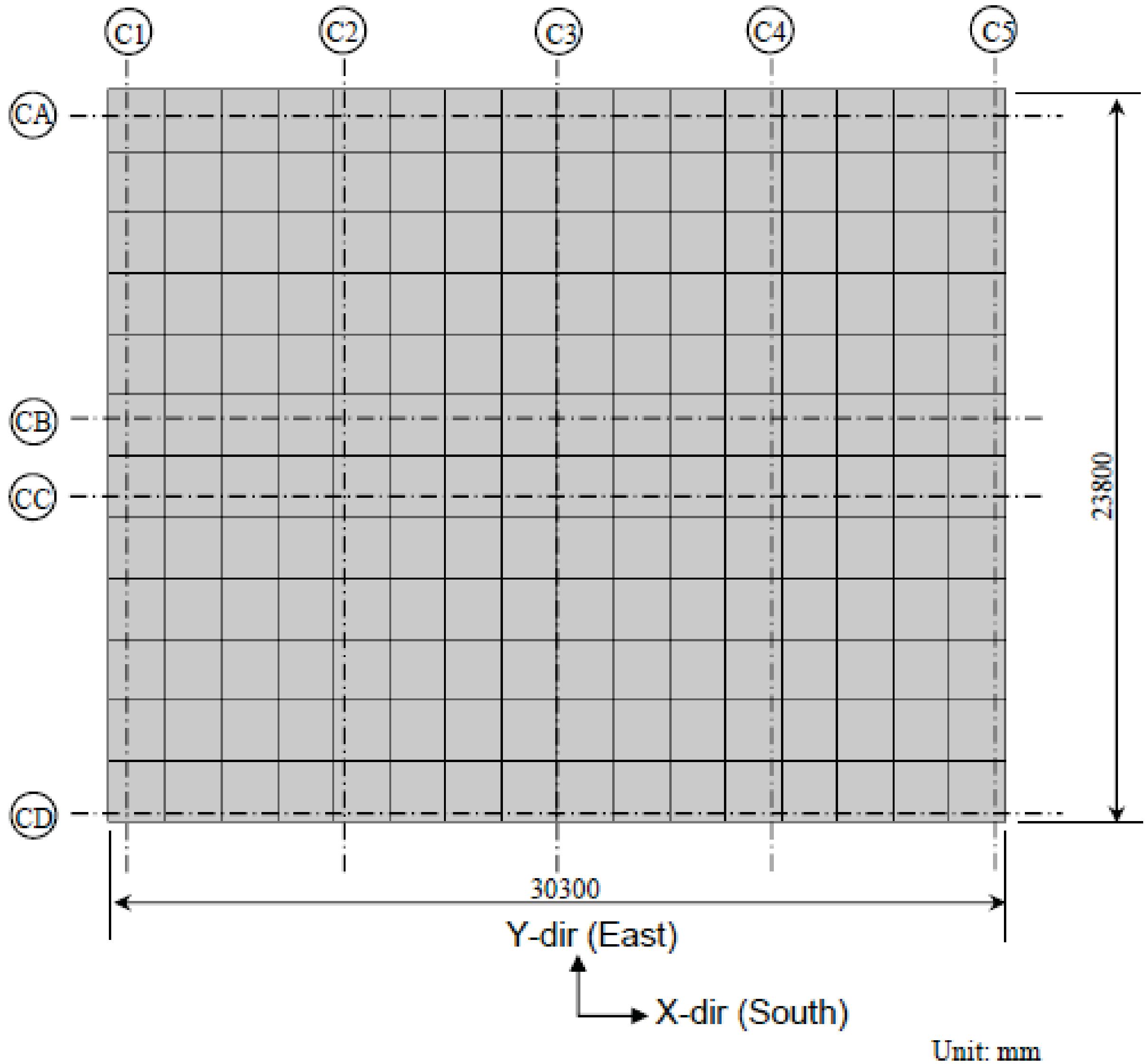
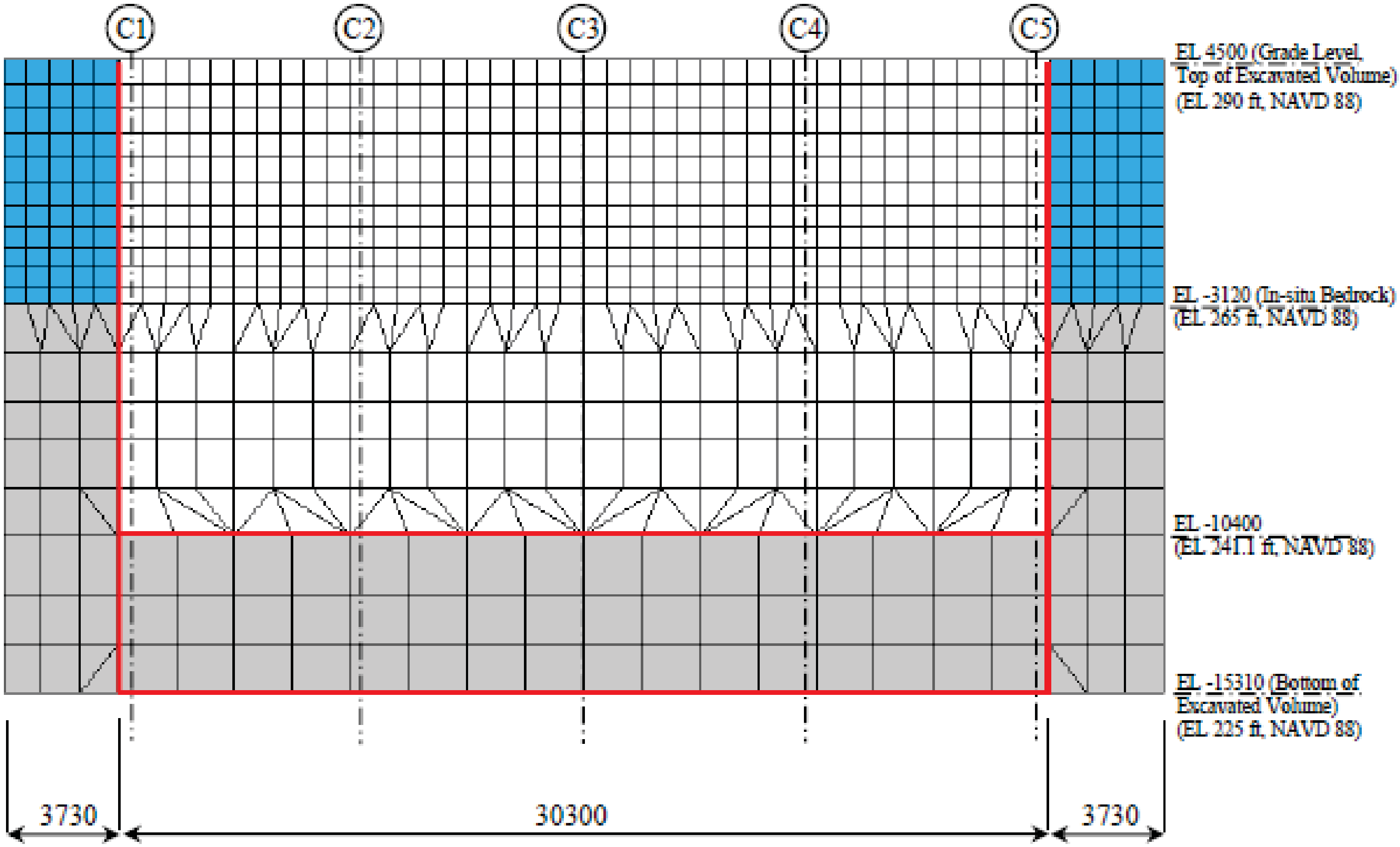


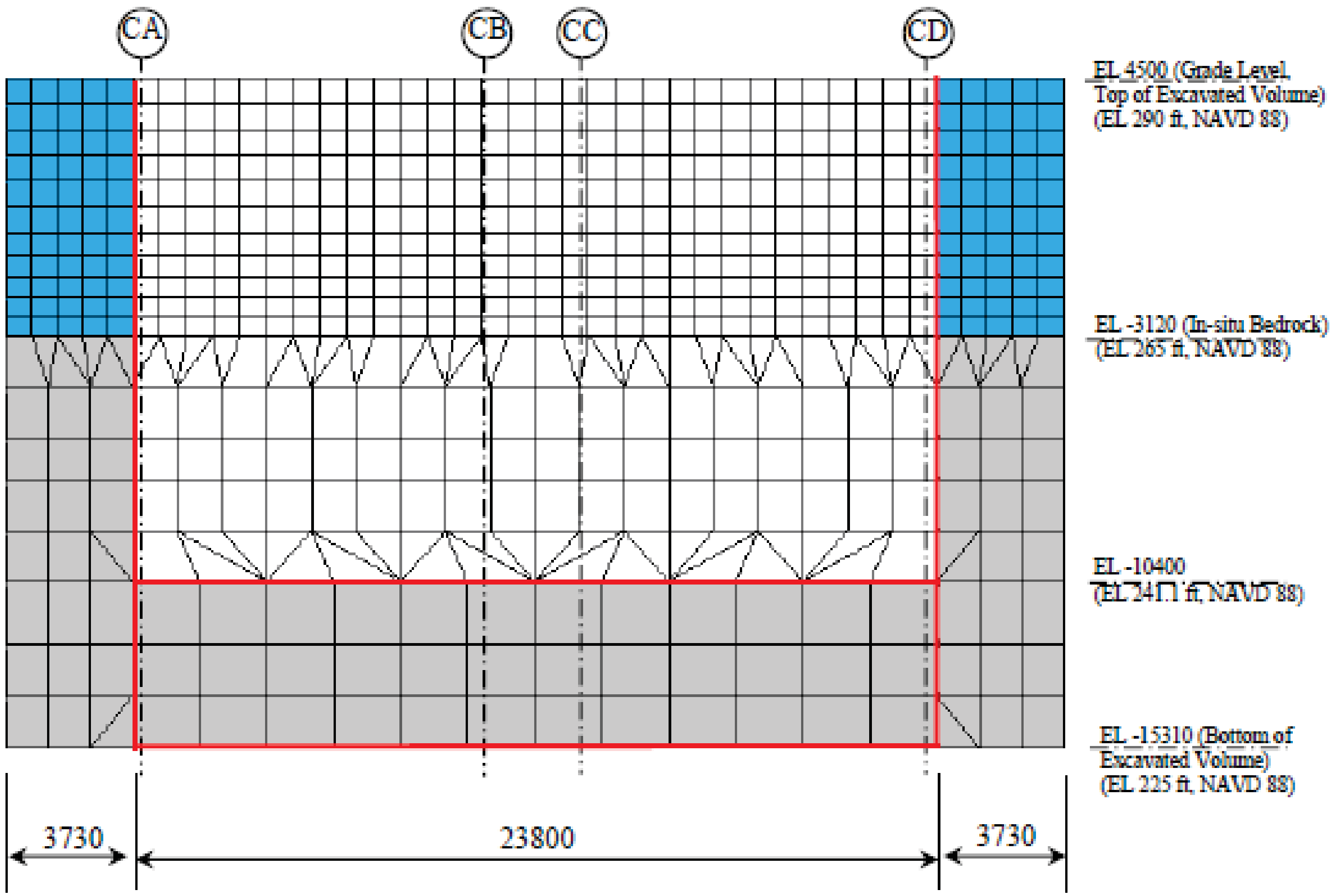
Figure 3A.16.3-215a **SASSI2010 Plate Elements for CB Exterior Walls in the Fully Embedded Model**



(a) Walls on Column Rows CA and CD (Unit: mm)

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

Figure 3A.16.3-215b **SASSI2010 Plate Elements for CB Exterior Walls in the Fully Embedded Model**



(b) Walls on Column Rows C1 and C5 (Unit: mm)

Note: The extent of double nodes used at the structural/soil interfaces is shown in red lines.

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Figure 3A.16.3-216 **SASSI2010 Excavated Volume Solid Elements for the CB Fully Embedded Model**

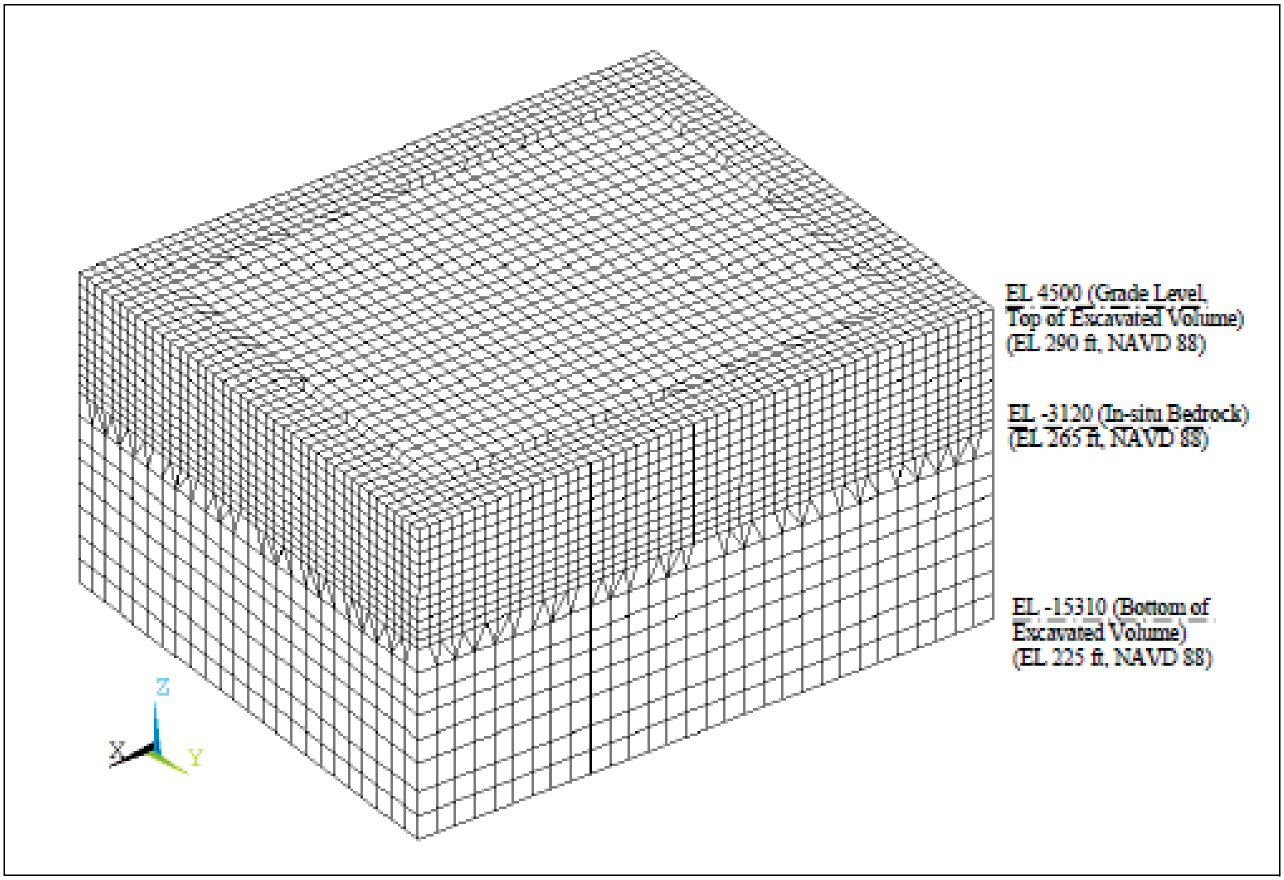
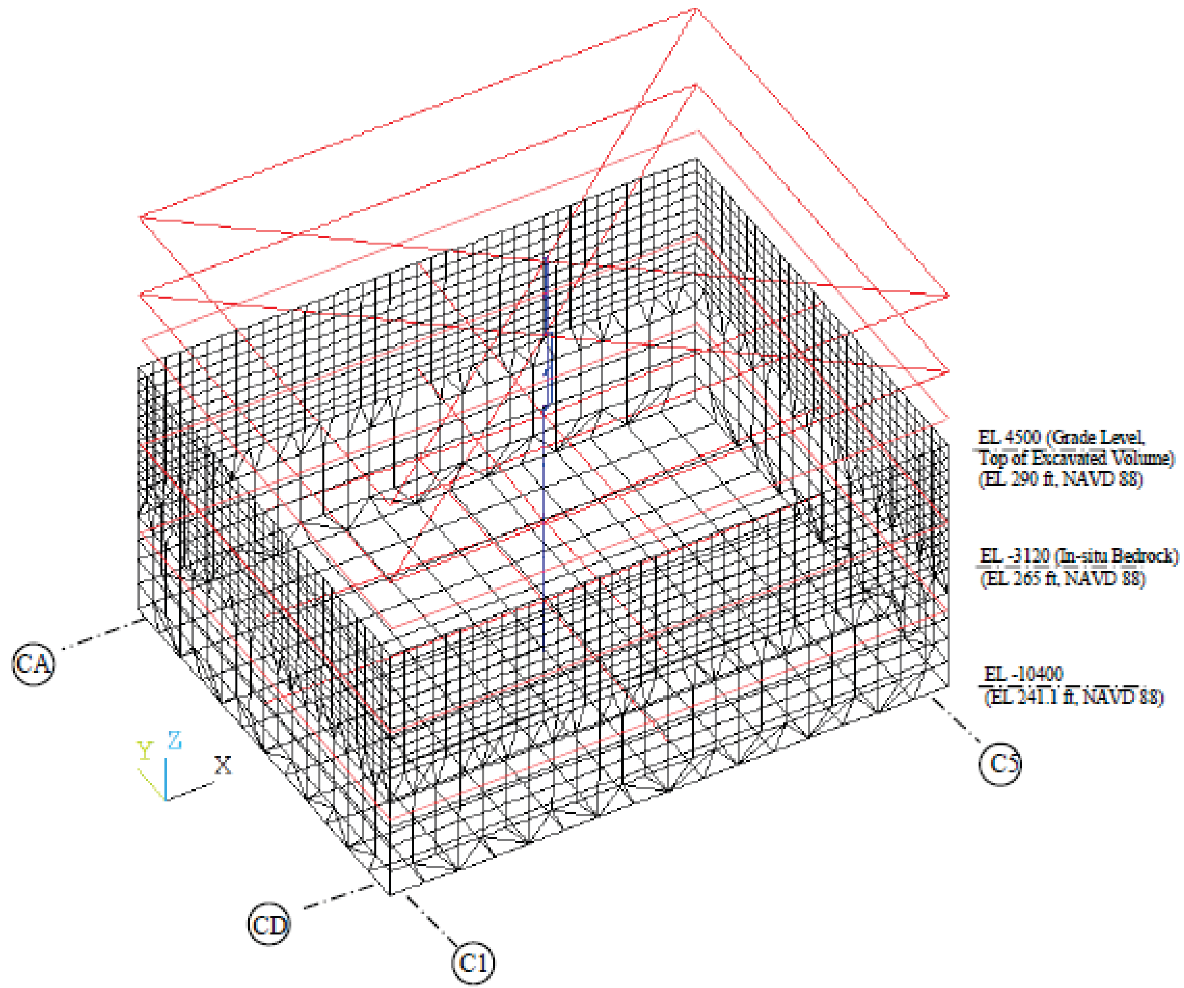


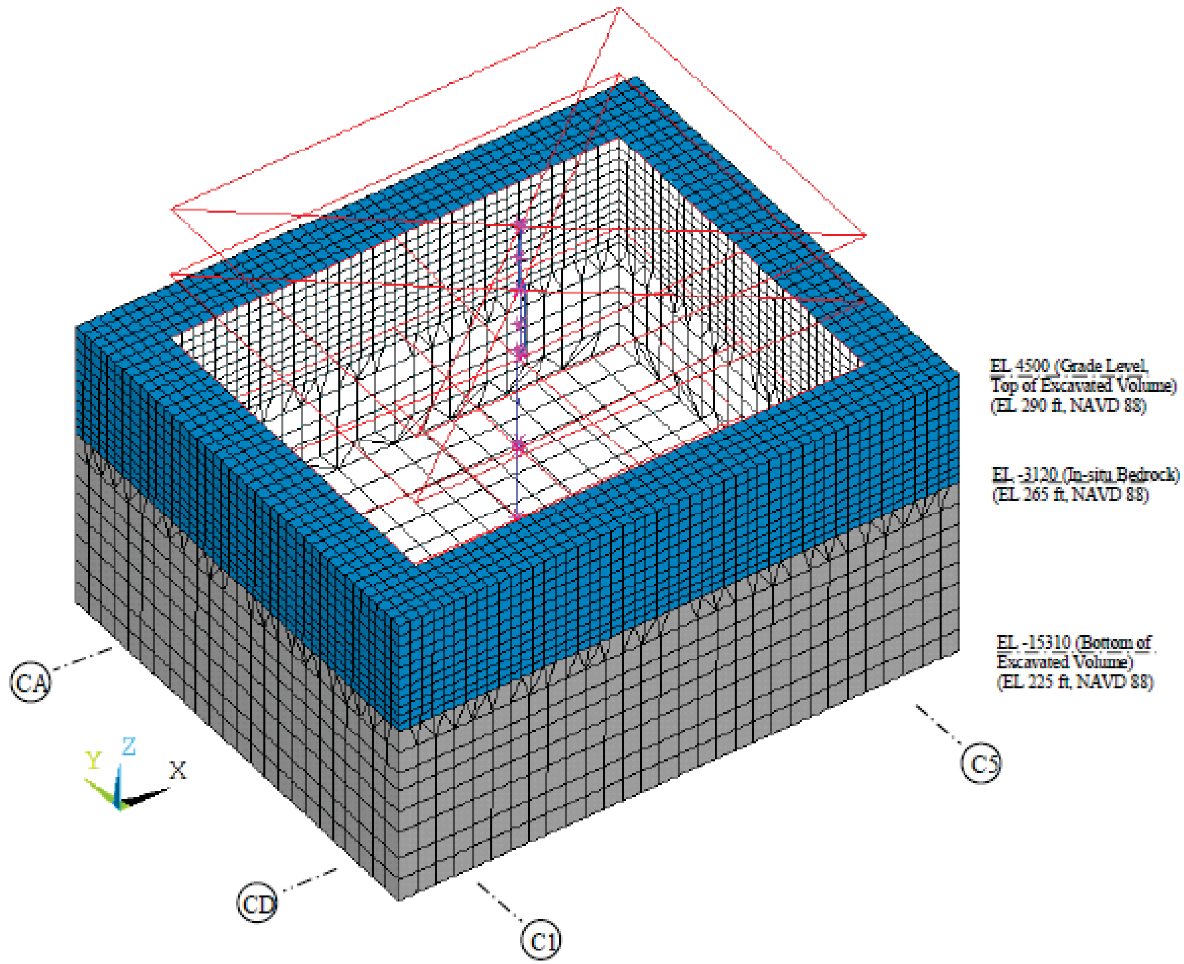
Figure 3A.16.3-217a **Overview of SASSI2010 SSI CB Fully Embedded Model**



(a) Overview without Concrete Fill and Excavated Volume

Note: 1) Wall and basemat are modeled with shell elements.
2) Rigid beams or outriggers indicated in red are installed at the floor levels.

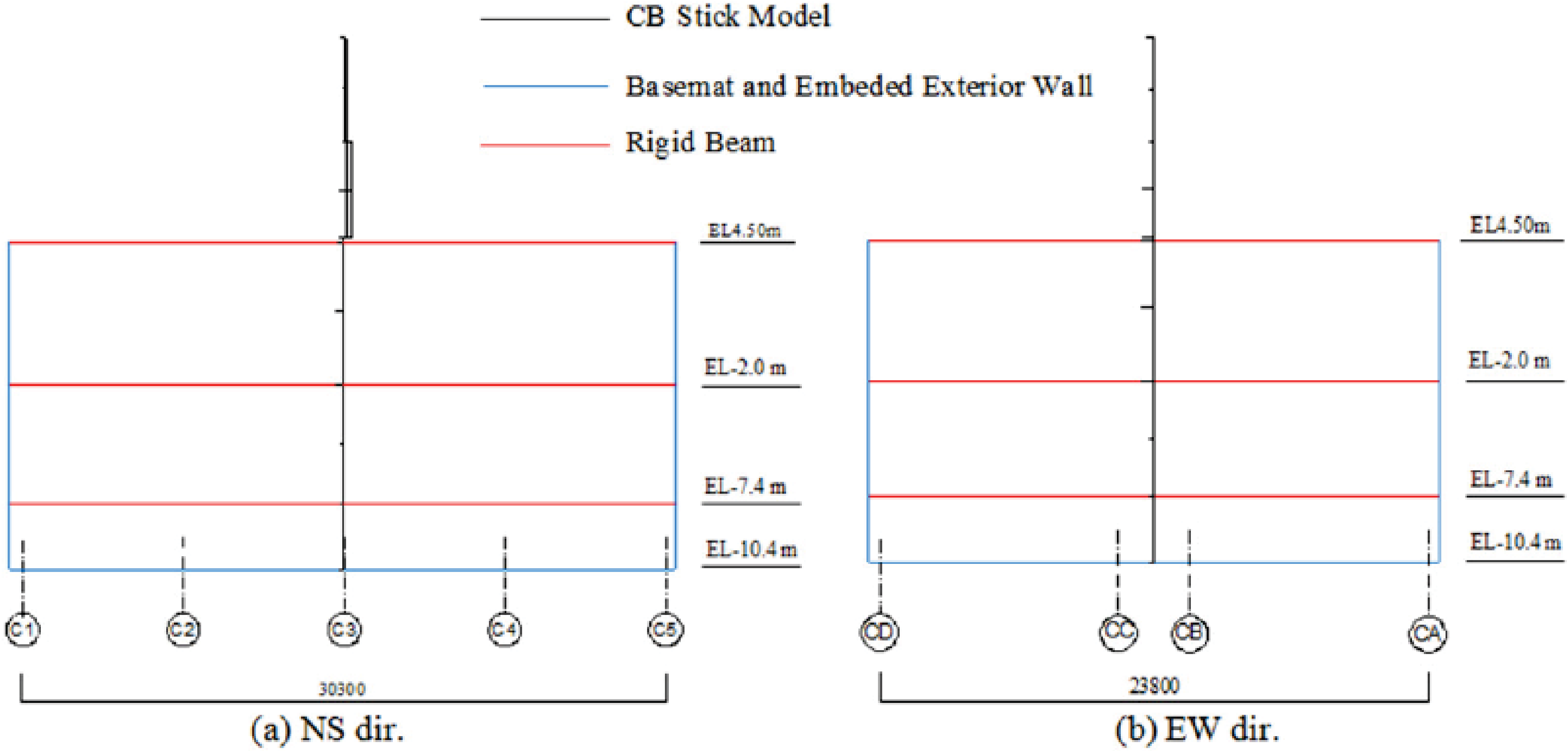
Figure 3A.16.3-217b **Overview of SASSI2010 SSI CB Fully Embedded Model**



(b) Overview with Concrete Fill without Excavated Volume

Note:
1) Wall and basemat are modeled with shell elements.
2) Rigid beams or outriggers indicated in red are installed at the floor levels.

Figure 3A.16.3-218 **Connection between CB Stick Model and Foundation**



Note: Outriggers installed to the CB stick are not shown in the figures.

Figure 3A.16.3-219 **SASSI2010 Plate Elements for FWSC Basemat**

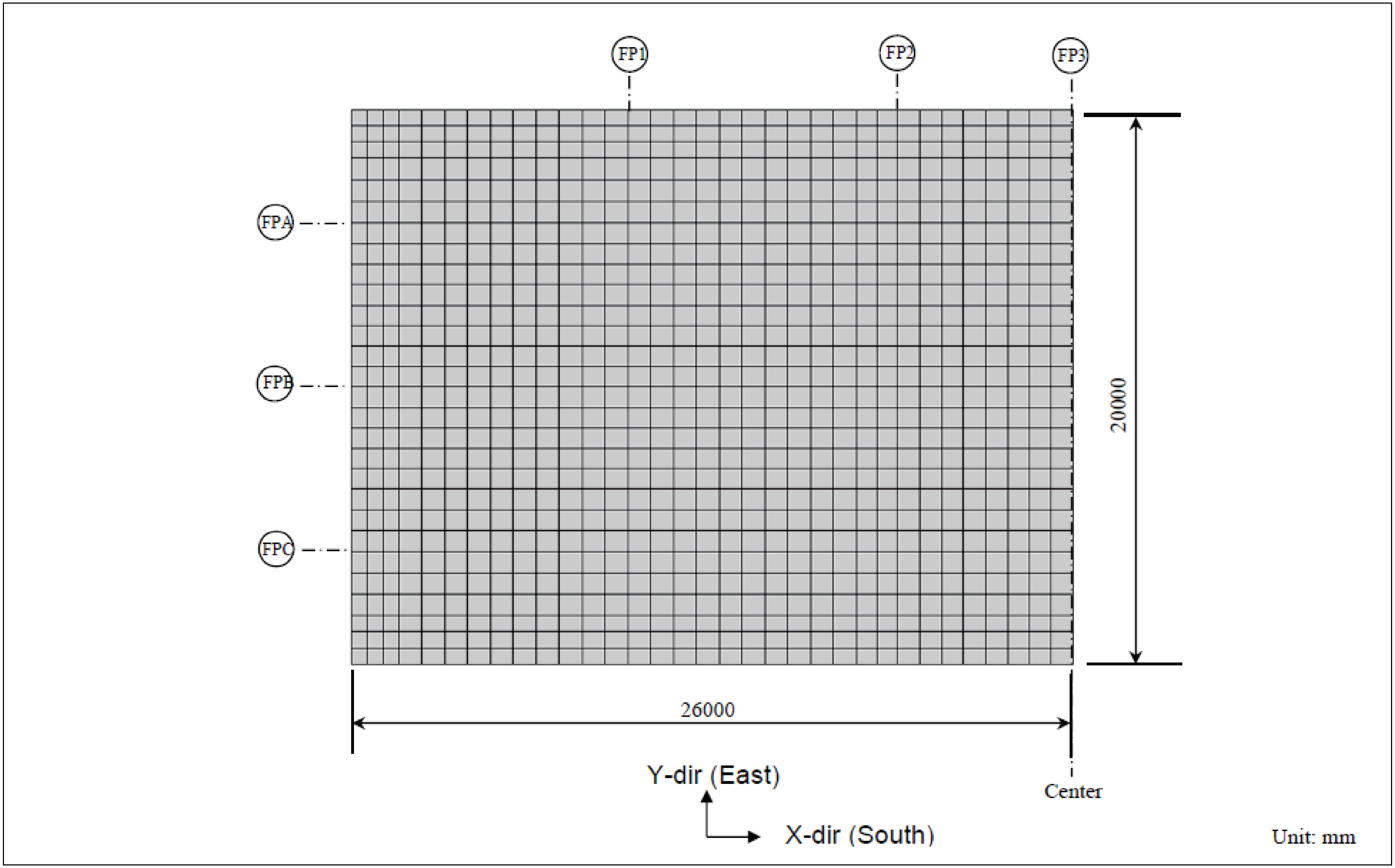


Figure 3A.16.3-220 **SASSI2010 Solid Elements for FWSC Concrete Fill and or Excavated Volume**

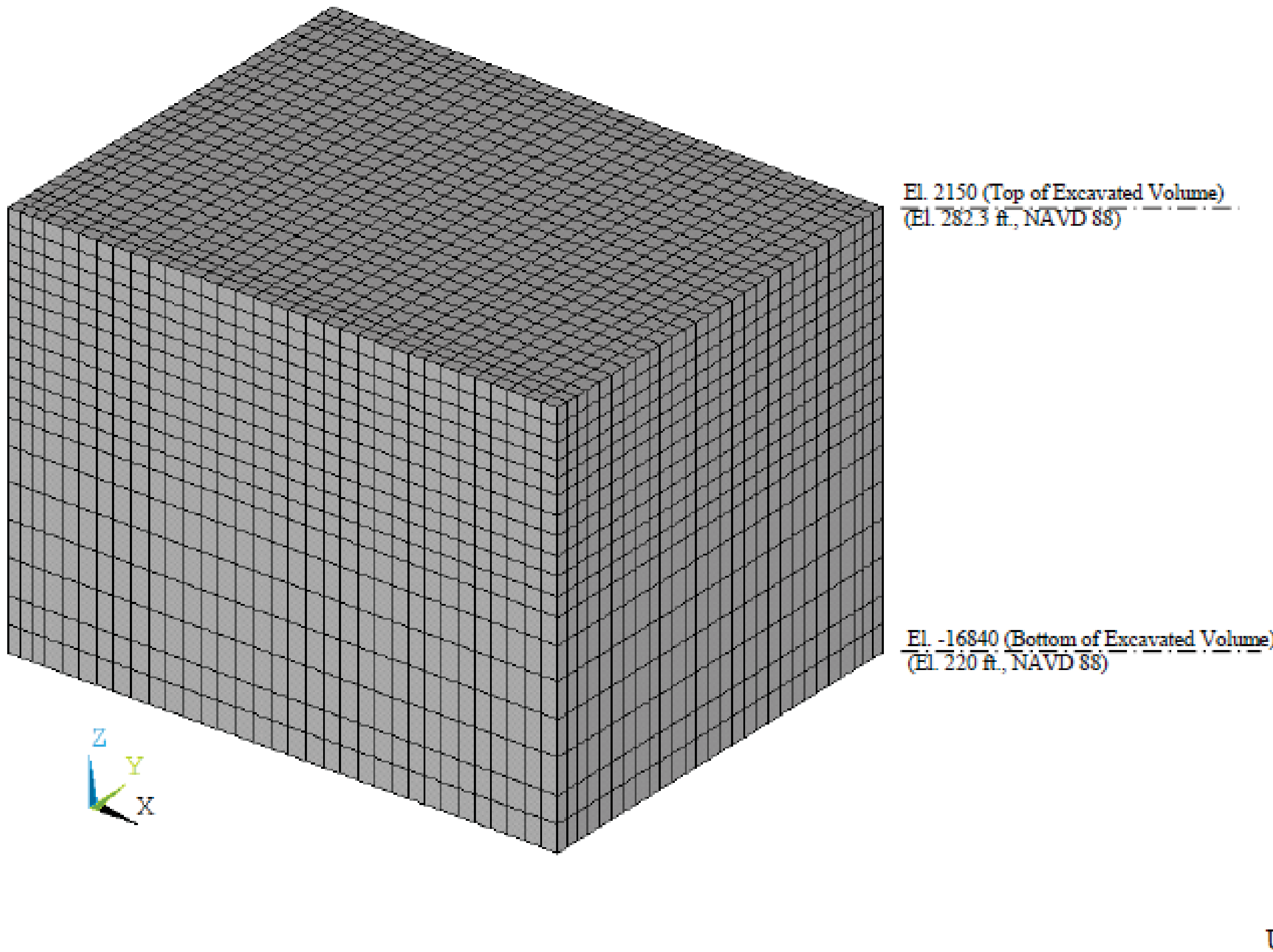
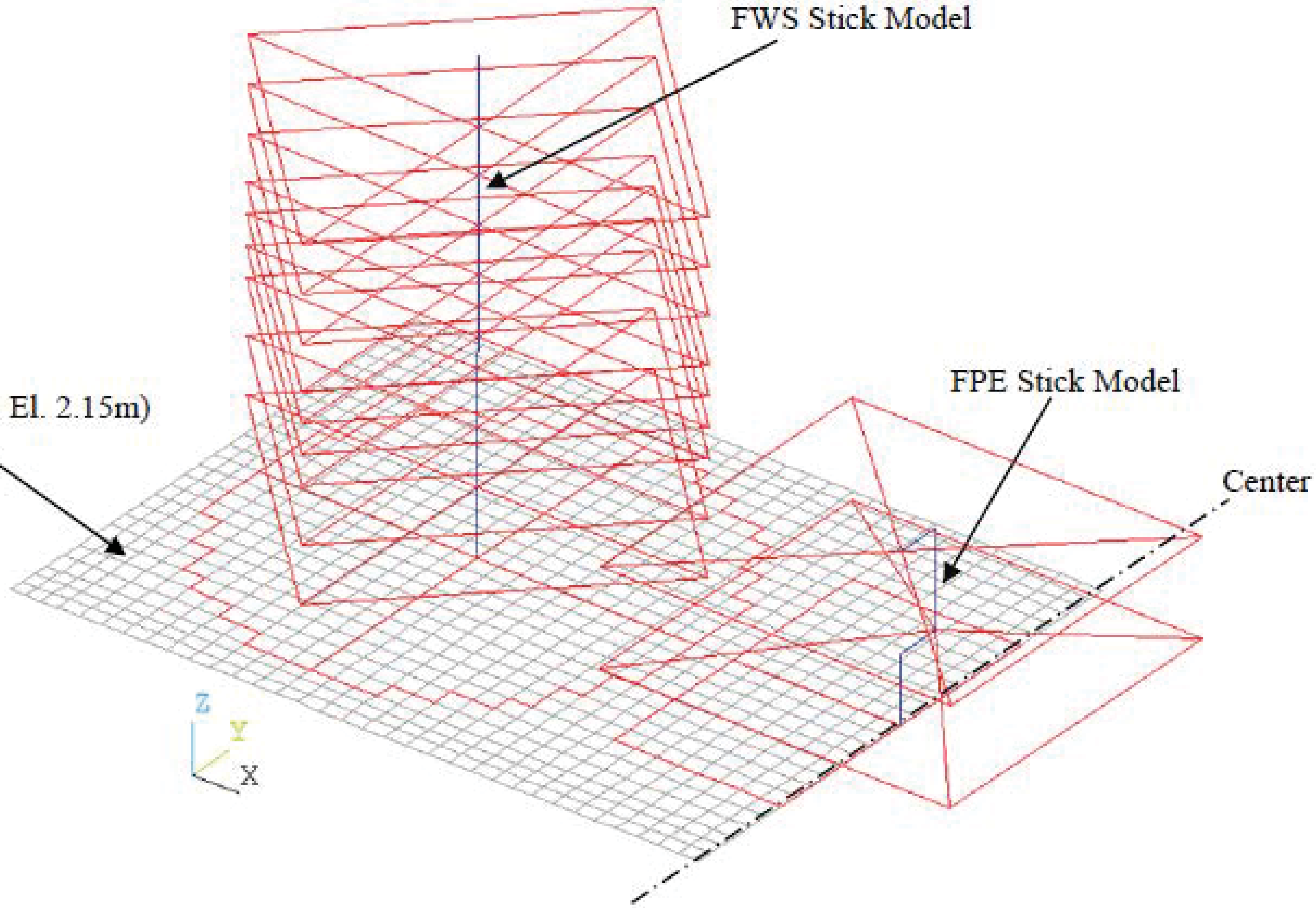


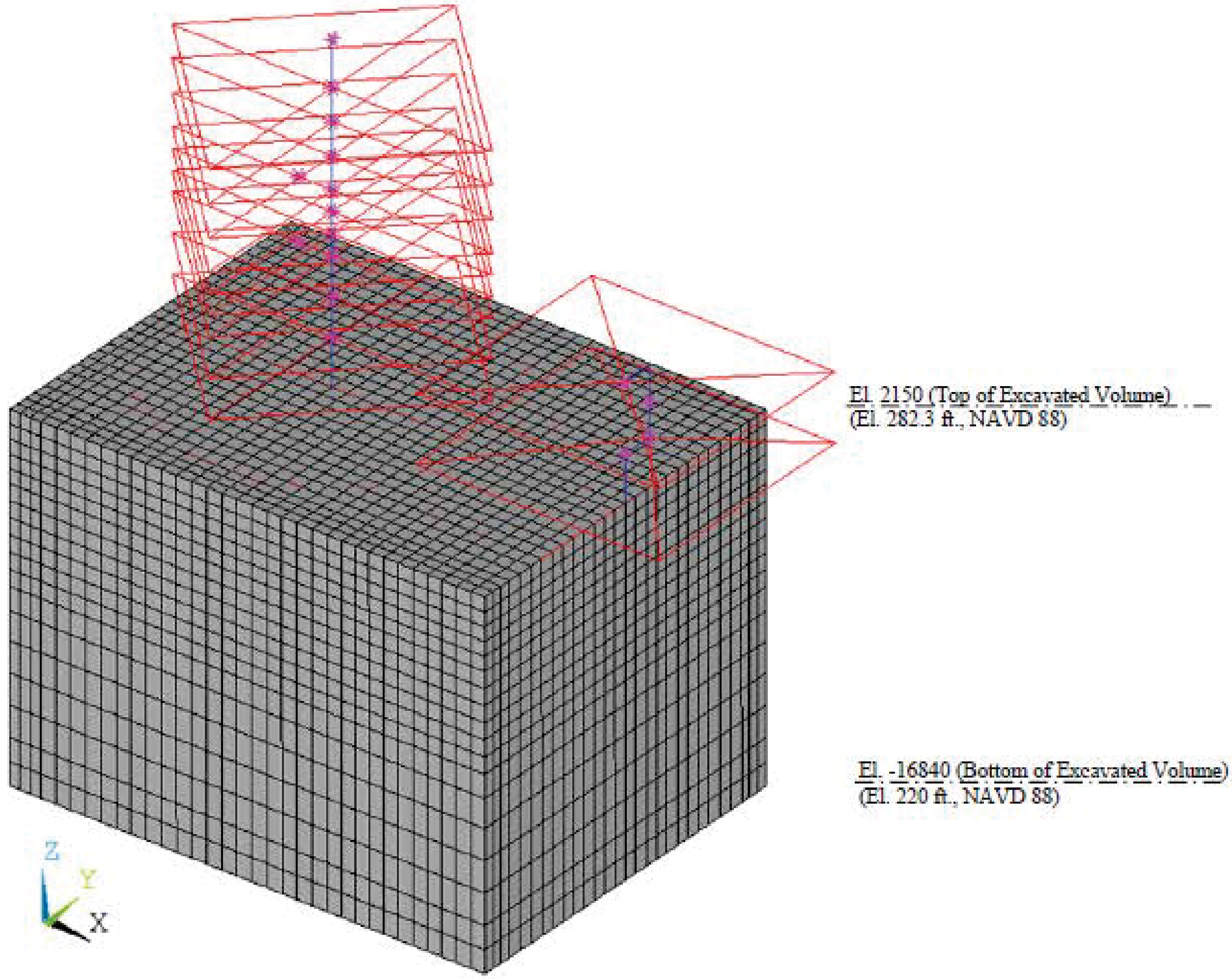
Figure 3A.16.3-221a **Overview of SASSI2010 SSI FWSC Half Model**



(a) Overview without Concrete Fill

Note: Basemat is modeled with shell elements.

Figure 3A.16.3-221b **Overview of SASSI2010 SSI FWSC Half Model**



(b) Overview with Concrete Fill

Note: Basemat is modeled with shell elements.

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3A.17 Unit 3 SSI Analysis Results

The following sections present the results of the site-specific SSI analyses. The site-specific SSI analyses results are compared with the standard design seismic envelopes presented in DCD Sections 3A.8 and 3A.9. Comparisons are provided for maximum seismic structural loads and ISRS.

Sections 3A.17.12, 3A.17.13 and 3A.17.14, respectively, present the results of the design basis SSI analyses of the RB/FB, CB and FWSC stand-alone models. The site-specific structural load demands and design ISRS are based on the envelope of the results from these analyses. The results of the site-specific SSSI analyses of the FWSC-CB combined model, described in Section 3A.17.11, are also enveloped with the results of the site-specific SSI analyses of the FWSC stand-alone model to include the SSSI effects of the CB on the FWSC seismic response. The enveloping structural loads and ISRS that are obtained from analyses of models with UB structural stiffness properties are enhanced to bound the local exceedances due to the effects of structural stiffness variation described in Section 3A.17.9. The enveloping ISRS for the CB are also enhanced to bound the SSSI effects of the RB/FB and FWSC on the CB seismic response, which are described in Section 3A.17.11. The enveloping loads and ISRS for the site-specific evaluation of the FWSC SSCs are also enhanced to bound the effects of separation between the concrete fill under the FWSC basemat and the surrounding soil as discussed in Section 3A.17.14.5.Section 3A.18 presents the site-specific seismic structural load demands and broadened design ISRS that are enhanced based on results of the sensitivity analyses described in Sections 3A.17.9, 3A.17.11, and 3A.17.14.5 to bound the effects of structural stiffness variation, SSSI and soil separation.

DCD Section 3A.8, which provides the standard design SSI analysis results, presents a number of typical SSI results to show the effect of different soil properties on seismic responses at selected locations in terms of acceleration response spectra and seismic forces. Certain effects that are discussed in DCD Section 3A.8, including soil stiffness, single envelope ground motion, layered sites, embedment, and lateral soil pressures, are evaluated in the site-specific SSI analyses using the site-specific conditions and, therefore, are not discussed separately in

Section 3A.17. This section discusses the site-specific SSI analysis results for the RB/FB, CB, and FWSC.

3A.17.1 Effect of Soil Stiffness

Site-specific SSI analyses consider BE, UB, and LB properties to address the effects of variation of dynamic properties of subsurface materials. The partial and full embedment configurations considered in the RB/FB and CB SSI analyses provide responses that bound the effects of subgrade stiffness variations related to the soil separation, backfill horizontal extent, and groundwater level variations.

Results of site-specific SSI analyses presented in Section 3A.17.12 show that the response of RB/FB structures is insensitive to the subgrade stiffness variations.

The results of CB SSI analysis show that the saprolite and structural fill above the top of Zone III rock affect the response of the light and deeply embedded CB, resulting in shifts of the CB peak responses to higher frequencies. The effects of rock subgrade properties variations on the CB response are smaller. The SSI analysis of UB partial column profile provides bounding site-specific seismic demands on CB structure. The CB analysis of the partial column profiles yield bounding results with few exceptions in the ISRS results at lower (< 20 Hz) frequencies that are bounded by responses obtained from analyses of full column profiles.

The FWSC site-specific design basis is developed as envelope of responses obtained from the SSI analyses of FWSC stand-alone model and SSSI analyses of FWSC-CB combined model for LB, BE, and UB profiles representing the stiffness variation of subgrade below the FWSC basemat bottom elevation. These analyses consider the FWSC as a surface mounted structure and neglect the effect of engineered fill and in-situ soil located above FWSC basemat elevation. The models used for the analyses explicitly model the concrete fill placed below the FWSC foundation. The FWSC stand-alone model neglects the structural fill placed around the concrete fill supporting the FWSC basemat. The FWSC-CB combined model includes the structural fill placed in the gap between the CB and FWSC and around the concrete fill below the FWSC foundation. The envelope of SSI and SSSI analyses results addresses the effects of the structural fill horizontal extent variations on the FWSC seismic response. The variation of subgrade properties affects the

response of the FWSC by shifting the peak responses to higher frequencies as the stiffness of the subgrade increases.

The effects of separation between the concrete fill under the FWSC basemat and the surrounding soil are discussed in Section 3A.17.14.5.

The site-specific analyses for the SSSI effects described in Section 3A.17.11 consider variations of subgrade stiffness properties.

3A.17.2 Effect of Single Enveloping Ground Motion

Site-specific SSI analyses are performed using the site-specific ground motion, as described in Section 3.7.1.1 for each of the Seismic Category I structures.

3A.17.3 Effect of Updated Design of Reactor Shield Wall and Vent Wall

As explained in Section 3A.16.3, the dynamic models used for the site-specific SSI analyses of RB/FB are based on the standard design structural model used for the Case RU-4 that reflects the updated design of the reactor shield wall (RSW) and VW.

3A.17.4 Effect of In-fill Concrete Stiffness of Vent Wall and Diaphragm Floor

As described in Section 3A.16.3.1, site-specific SSI analyses of RB/FB use dynamic models with upper bound stiffness properties representing full (100 percent) stiffness contribution of the in-fill concrete to the stiffness of the concrete-filled steel structures to provide conservative seismic responses for the rock site with high frequency design ground motion. Consistent with the approach used for the standard design to address the effects of variations of the in-fill concrete stiffness on the stiffness of the VW and D/F, site-specific sensitivity analyses are performed on two RB/FB dynamic models with reduced stiffness properties that consider a 50 percent and 0 percent stiffness contribution of the in-fill concrete to the concrete-filled steel structures. See Section 3A.17.9 for the results of the evaluation of the effects of structural stiffness variations on the site-specific seismic response of the RB/FB.

3A.17.5 Effect of Loss-of-Coolant Accident (LOCA) Flooding

The responses obtained from the site-specific SSI analyses using the models representing the plant normal operation conditions envelope the effects of LOCA flooding inside the containment. The additional water

mass due to LOCA flooding increases the dynamic mass of the RB/FB, shifting the structural frequencies and the peak responses of the building away from the amplified region of the Unit 3 ground motion at high frequencies.

3A.17.6 Effect of Layered Sites

Site-specific SSI analyses use Unit 3 layered subgrade properties.

3A.17.7 Effect of Embedment

The RB/FB and CB SSI analyses consider partial and full embedment configurations. The results of the SSI analyses indicate that the site-specific responses of the RB/FB are generally insensitive to the embedment. The differences between the responses obtained from the RB/FB SSI analyses of the partially and fully embedded models are mainly due to the differences in the energy content of the input motions used for the SSI analyses of the partial and full column profiles at structural frequencies. The results of SSI analysis show that the saprolite and structural fill above the top of the Zone III rock affect the response of the light and deeply embedded CB resulting in shifts of the CB peak responses to higher frequencies. The dissipation of energy in the engineered fill material also reduces the CB response. Sections 3A.17.12 and 3A.17.13 discuss how these two different embedment configurations affect the RB/FB and CB seismic response. The lower SSI damping of the partial rock column subgrade profiles and the higher energy of the partial column ground motion at frequencies close to the CB structure natural frequencies resulted in higher responses of the CB.

The site-specific SSI analyses consider the FWSC as a surface mounted structure and neglect the effects of the in-situ saprolite and structural fill placed around the FWSC.

3A.17.8 Effect of Lateral Soil Pressures

Section 3A.17.12.4 presents the results of the site-specific SSI analyses of the RB/FB for the maximum seismic lateral pressures on the RB/FB below-grade exterior walls. Comparison of the results from analysis Cases 1 through 6 in Table 3A.15-201 show that the variation of the soil properties has a small effect on the calculated dynamic pressures on the exterior walls. Section 3A.17.13.4 presents the results of the site-specific SSI analyses of the CB for the maximum seismic lateral pressures on the CB below-grade exterior walls. Comparisons of the results from analysis

Cases 7 through 12 in Table 3A.15-202 show that the variation of the soil properties has a small effect on the calculated dynamic pressures on the exterior walls.

3A.17.9 Effect of Concrete Cracking

Site-specific sensitivity evaluations are performed of the effects of concrete cracking on the response of the reinforced concrete members and the out-of-plane vibrations of flexible slabs and walls. These evaluations are based on the results of site-specific sensitivity analyses of models representing dynamic properties of reinforced concrete structures under fully cracked conditions when all of the concrete structural members are considered fully cracked. SSE damping values are assigned to the concrete and steel structural members in the models used for these sensitivity SSI analyses in conjunction with reduced (cracked concrete) stiffness properties to represent the higher dissipation of energy in the structures when subjected to high stresses corresponding to the fully cracked concrete condition.

The shear and bending stiffness properties of the reinforced concrete members in the models used for the concrete cracking evaluations, shown on Figures 3A.16.2-201 through 3A.16.2-203, are reduced by 50 percent in accordance with ASCE 43-05. Since the 50 percent reduced flexural stiffness of the walls and slabs also lowers their natural frequencies of out-of-plane vibrations by $\sqrt{2}$, additional SDOF oscillators are added to the lumped mass stick models to adequately capture all modes of out-of-plane vibration with frequencies ranging from 35 Hz ($\frac{50}{\sqrt{2}}$ Hz) to 50 Hz under fully cracked conditions.

The results of the site-specific analyses of models with reduced stiffness properties indicate that variations of the structural stiffness can amplify some local responses, resulting in exceedances relative to the structural load demands and the broadened ISRS obtained as an envelope of the results of design basis SSI analyses of models with full (uncracked concrete) stiffness properties. For the site-specific evaluations of the RB/FB, CB, and FWSC structures, the structural load demands are enhanced, as described in Section 3A.18.1, to bound all exceedances that are due to variations in structural stiffness. The approach used for enhancing the ISRS to bound effects of structural stiffness variations is described in Section 3A.18.2. The exceedances are considered significant for the purposes of site-specific design and qualification of

equipment if any of the sensitivity analysis cases yield 5 percent damped ISRS that exceed the enveloped and broadened ISRS results from the design basis SSI analyses of models with upper bound stiffness by more than 10 percent for any frequency up to 50 Hz. The 10 percent exceedance criterion that is used for addressing the effects of concrete cracking is reasonable because the sensitivity analyses for evaluation of concrete cracking effects on the seismic response of the RB/FB, CB, and FWSC consider that the stiffness of all concrete elements throughout their length is reduced by 50 percent. Due to the impracticality of performing an analysis that accurately considers the variations of concrete stiffness as a function of the member stresses, this approach is used to address the effects of concrete cracking. The approach is conservative because, during an SSE event, many concrete elements will not crack and, for most cracked elements, cracking will be limited to the vicinity of the highly-stressed portions of the element length. In accordance with the guidance in DC/COL-ISG-01, the design ISRS are required to accurately represent the response of the structures up to 50 Hz. Therefore, exceedances occurring at frequencies higher than 50 Hz have no impact on the design or evaluations of the equipment.

3A.17.9.1 Effect of Structural Stiffness Variation on RB/FB

Specifically for the RB/FB, a sensitivity study is performed to evaluate effects of structural stiffness variations on the seismic response of the RB/FB at Unit 3 site including the effects of:

- Reduced stiffness of the reinforced concrete members due to concrete cracking, and
- Contribution of in-fill concrete stiffness on the dynamic properties of the concrete-filled steel structures discussed in Section 3A.17.4.

The study is based on the results of a set of twelve sensitivity SSI analyses (Cases S1 to S12 in Table 3A.15-201) of the following two structural models with reduced stiffness and SSE damping:

CR00 Model representing:

- Fully cracked reinforced concrete structures with 50 percent reduced shear and bending stiffness
- No (0 percent) in-fill concrete contribution to the stiffness of the concrete-filled VW and D/F steel structures

CR50 Model representing:

- Fully cracked reinforced concrete structures with 50 percent reduced shear and bending stiffness
- 50 percent in-fill concrete contribution to the stiffness of the concrete-filled VW and D/F steel structures

These evaluations of the effects of structural stiffness variations on the seismic response of RB/FB show that the site-specific design basis SSI analyses of the UC100 Model with full (uncracked concrete) stiffness and OBE damping (analyses Cases 1 to 6 in Table 3A.15-201) provide demands on the RB/FB reinforced concrete structures and ISRS that envelope concrete cracking effects with a few exceedances that are small and have a local effect.

Comparisons of the results from the analyses of the CR00, CR50, and UC100 models for the seismic horizontal forces and overturning moments on the top of the basemat together with the vertical accelerations are also used to evaluate the effects of the structural stiffness variations on the results of the RB/FB stability and foundation dynamic bearing pressure calculations, presented in Section 3G.7.5.5. Based on these comparisons, the analyses of the UC100 model provide seismic demands for the evaluations of the RB/FB foundation stability and dynamic bearing pressures and the calculations of the lateral dynamic pressures on the below ground exterior walls that bound the effects of the structural stiffness variations.

Based on the results of the sensitivity SSI analyses on the RB/FB models with reduced stiffness properties (analysis Cases S1 to S12 in Table 3A.15-201), the site-specific seismic load demands and ISRS, obtained as an envelope of the results of design basis SSI analysis Cases 1 through 6 in Table 3A.15-201, are adjusted to bound effects of structural stiffness variations. Section 3A.18.1.1 presents the amplified seismic loads used for the site-specific evaluation of the RB/FB structures that bound the small local exceedances of:

- Seismic loads on the RSW, VW, and pedestal structures (an example is shown in Figure 3A.17.9.1-201)
- Out-of-plane seismic loads on the RB/FB slabs and walls presented in Tables 3A.17.9.1-201 and 3A.17.9.1-202

The envelope of the 5 percent damped ISRS results obtained from the analyses of the CR00 and CR50 models for partial and full column

profiles for the responses of the RB/FB at the selected locations are compared to the ±15 percent broadened and valley-filled ISRS obtained from the site-specific SSI analysis of the UC100 model with upper bound stiffness and OBE damping and the standard design spectra. The comparisons show that the site-specific SSI analyses of the RB/FB model with upper bound structural stiffness properties and OBE damping values provide enveloped and broadened ISRS that, in general, envelope the effects of structural stiffness variations on the design and qualification of equipment and components. The exceptions are the small sharp peak exceedances noted below and the exceedances observed in some of the SDOF oscillator ISRS.

- Peaks in the ISRS for the horizontal response of the RSW and RPV that exceed the site-specific broadened enveloping spectra at the 10 Hz to 15 Hz frequency range but are enveloped by the standard design ISRS as shown in Figures 3A.17.9.1-203 and 3A.17.9.1-204
- Peaks in the RPV vertical ISRS that exceed the site-specific broadened enveloping spectra at the 20 Hz to 30 Hz frequency range as shown in Figure 3A.17.9.1-204
- Peaks in the RB/FB basemat horizontal ISRS that exceed the site-specific broadened enveloping spectra above 30 Hz but are enveloped by the standard design ISRS as shown in Figure 3A.17.9.1-205
- Peaks in the VW vertical ISRS that exceed the site-specific broadened enveloping spectra above 25 Hz but are enveloped by the standard design ISRS as shown in Figure 3A.17.9.1-202

The comparisons in Figures 3A.17.9.1-206 and 3A.17.9.1-207 indicate that shifts of the ISRS peaks to lower frequencies can sometimes lead to resonance effects that can amplify the response of the cracked slab or wall and result in ISRS that exceed both the site-specific broadened enveloping ISRS and standard design ISRS. To address these exceedances, the Unit 3 site-specific design and qualification of equipment and components use enhanced ISRS that bound the effects of structural stiffness variation, as described in Section 3A.18.2.

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Table 3A.17.9.1-201 **Exceedances of Out-of-Plane Loads on RB/FB Flexible Slabs Due to Structural Stiffness Variations**

		Equivalent Average Vertical Acceleration (g)					
Elev. (m)	**Location**	**PE CR50**	**PE CR00**	**FE CR50**	**FE CR00**	**UC100 Enveloping**	**Standard Design**
-6.4	RCCV-Pedestal	0.46	0.46	0.59	**0.61**	0.60	0.63
	RB-RCCV	0.59	0.59	**0.66**	0.65	0.57	0.71
	FB	0.55	0.55	0.57	**0.58**	-	-
17.5	RCCV-Pedestal	0.65	0.64	0.70	0.72	0.70	0.71
	D/F	0.87	1.64	1.23	**2.38**	1.53	1.84

Note: The shaded values are exceedances from the site-specific enveloping out-of-plane loads obtained from the design basis analyses of the RB/CB UC100 model.
Maximum values presented in bold.

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Table 3A.17.9.1-202 **Exceedances of Out-of-Plane Loads on RB/FB Flexible Walls Due to Structural Stiffness Variations**

			Equivalent Horizontal Acceleration (g)					
Elev. (m)	**Column Line Location**	**Direction**	**PE CR50**	**PE CR00**	**FE CR50**	**FE CR00**	**UC100 Enveloping**	**Standard Design**
30.5	R1 and R7s	NS	0.50	0.51	0.57	0.58	-	-
	RA and RGs	EW	0.54	0.54	0.51	0.51	-	-

Note: The shaded values are exceedances from the site-specific enveloping out-of-plane loads due to additional oscillators added to models representing reduced stiffness (cracked concrete) conditions.

Figure 3A.17.9.1-201 **Exceedances of RSW Seismic Loads Due to Structural Stiffness Variations**

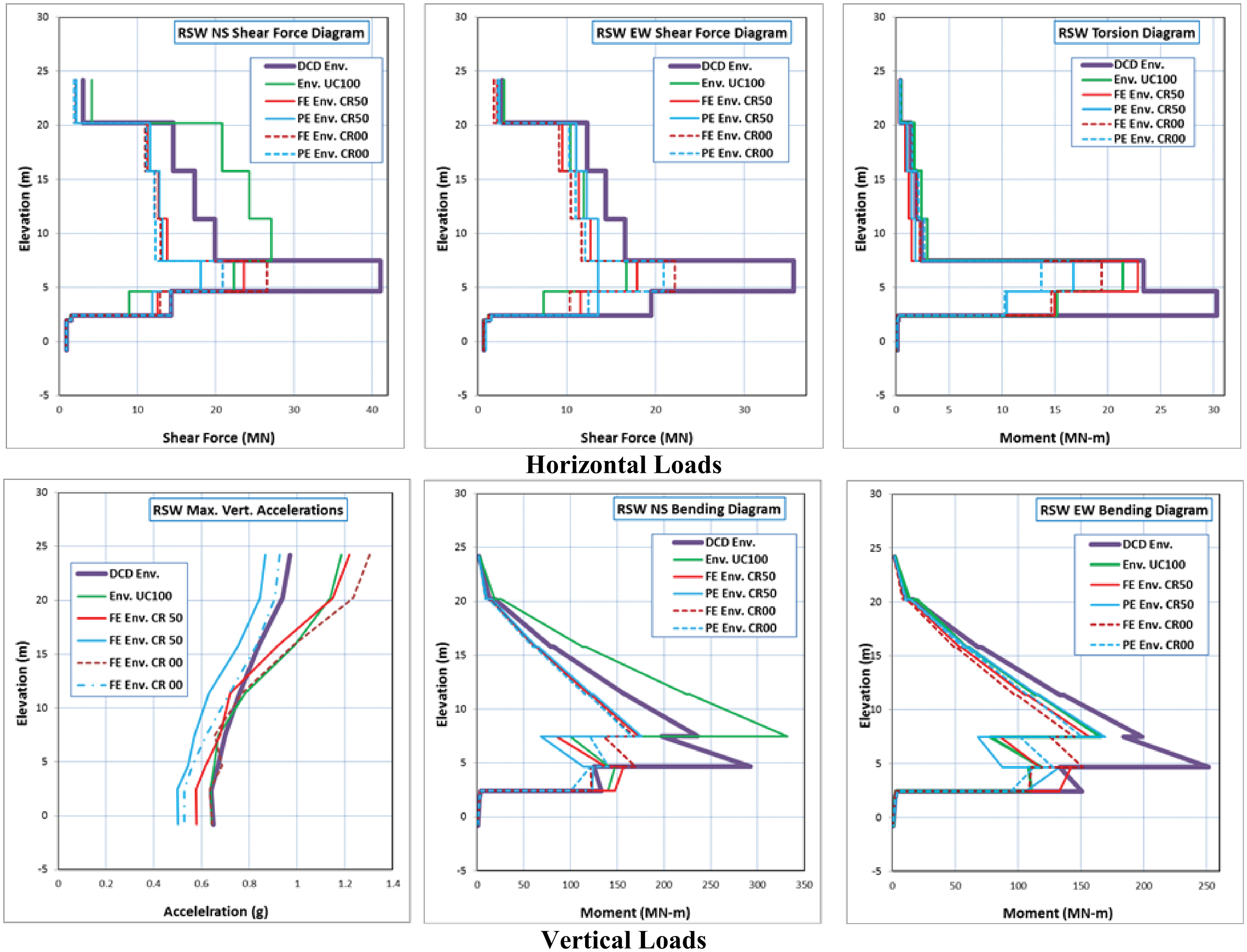

Figure 3A.17.9.1-202 **Structural Stiffness Variation Effects on ISRS – VW Top**

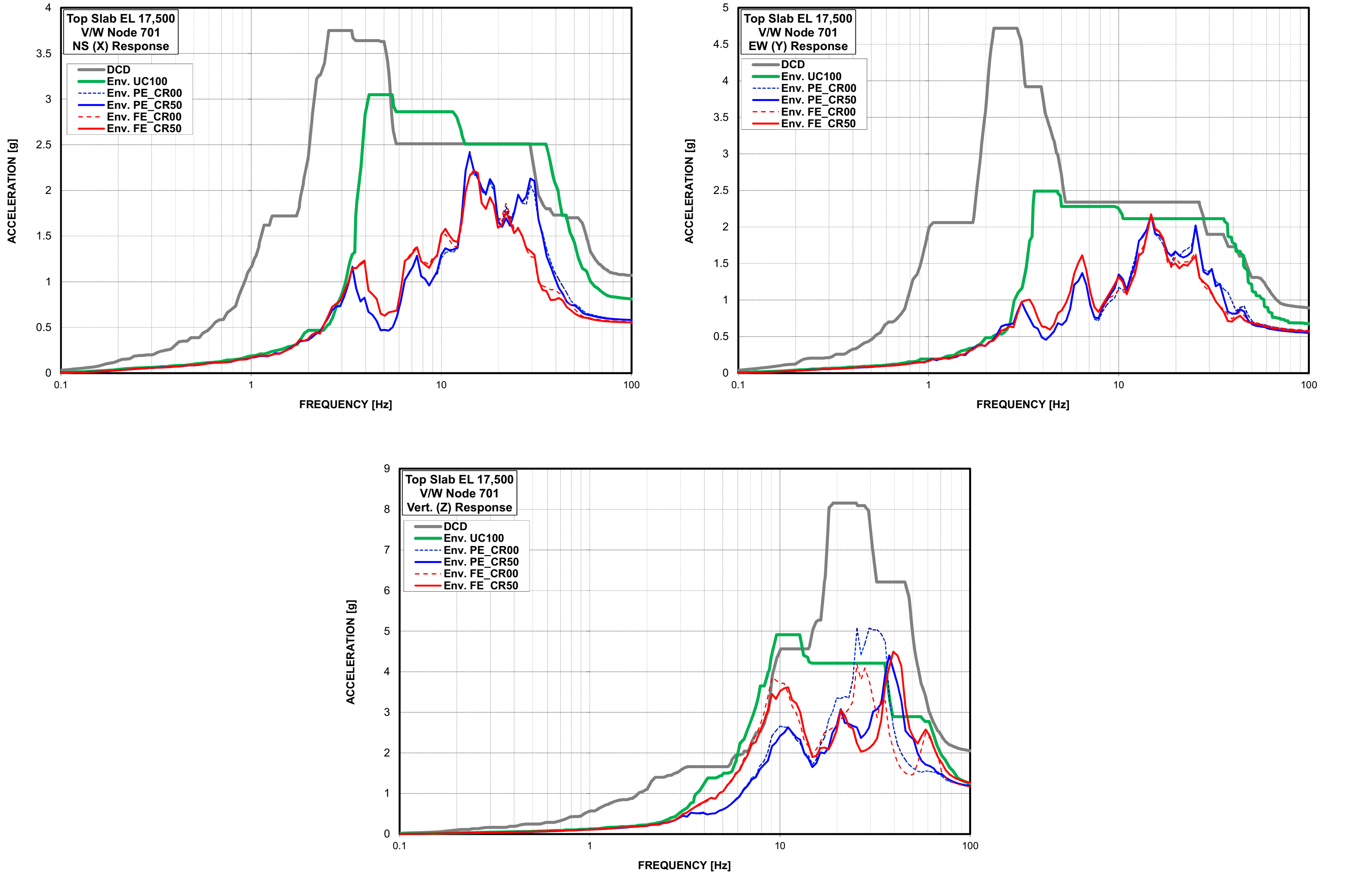

Figure 3A.17.9.1-203 **Structural Stiffness Variation Effects on ISRS – RSW Top**

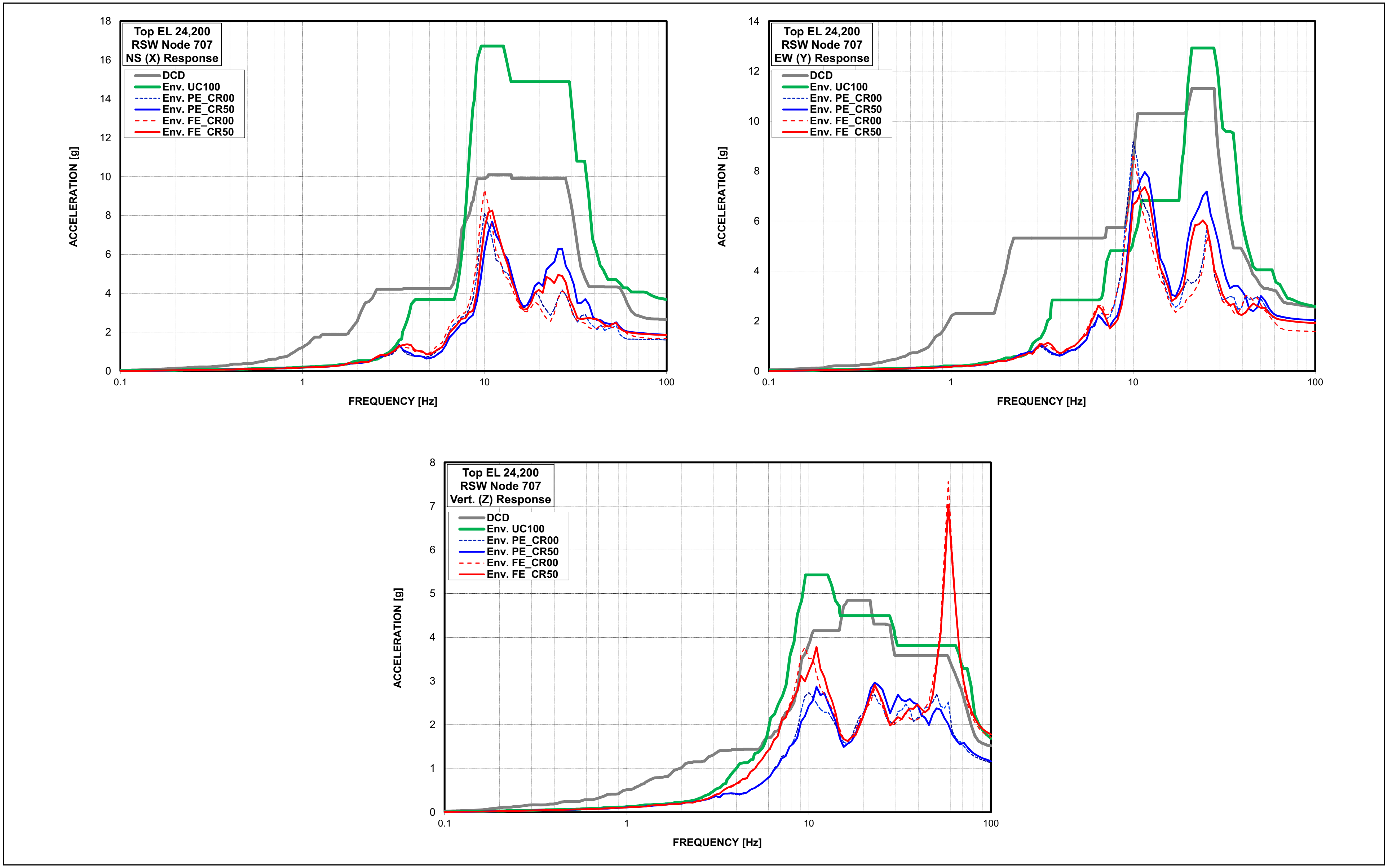

Figure 3A.17.9.1-204 **Structural Stiffness Variation Effects on ISRS – RPV Top**

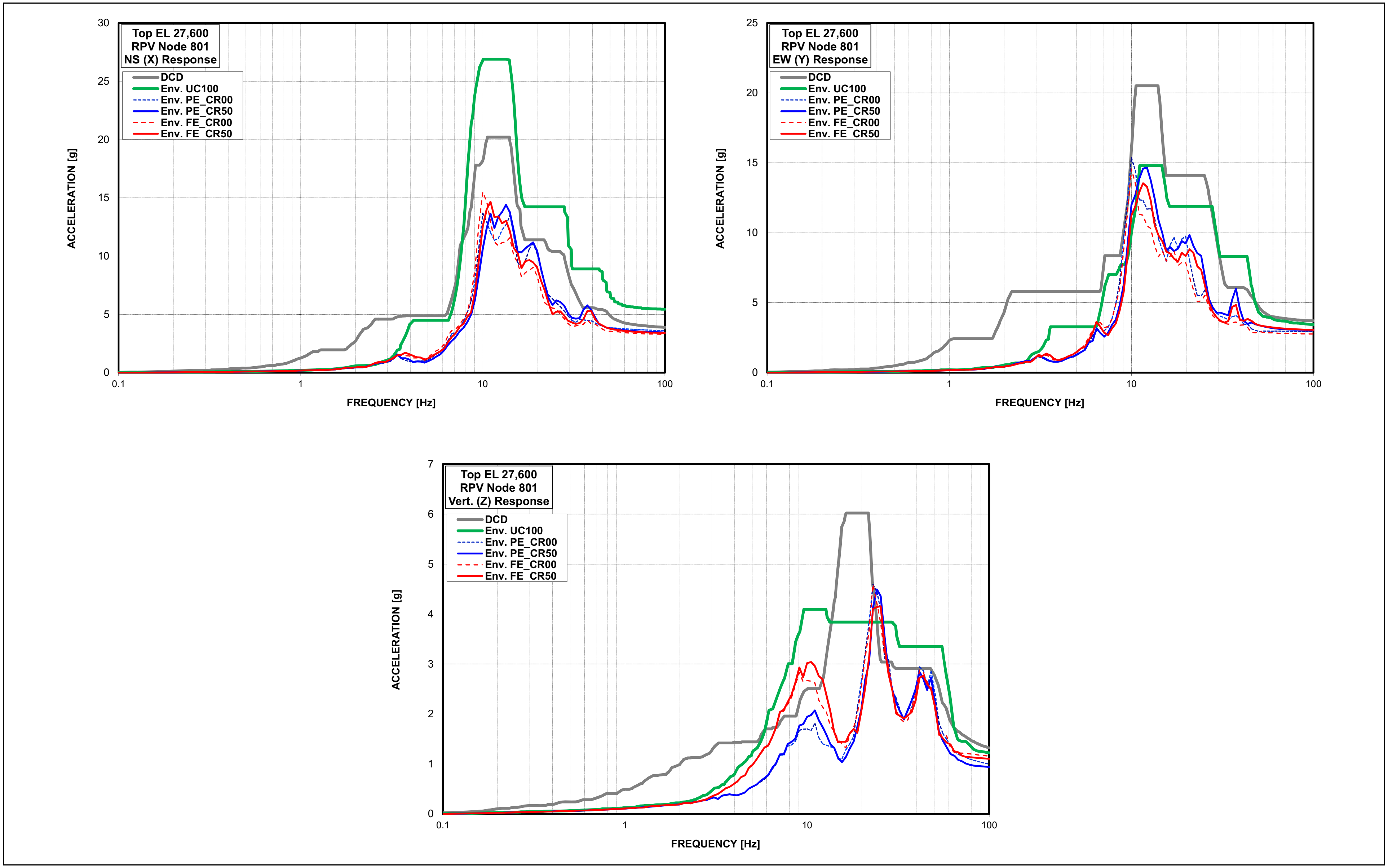

Figure 3A.17.9.1-205 **Structural Stiffness Variation Effects on ISRS – RB/FB Basemat**

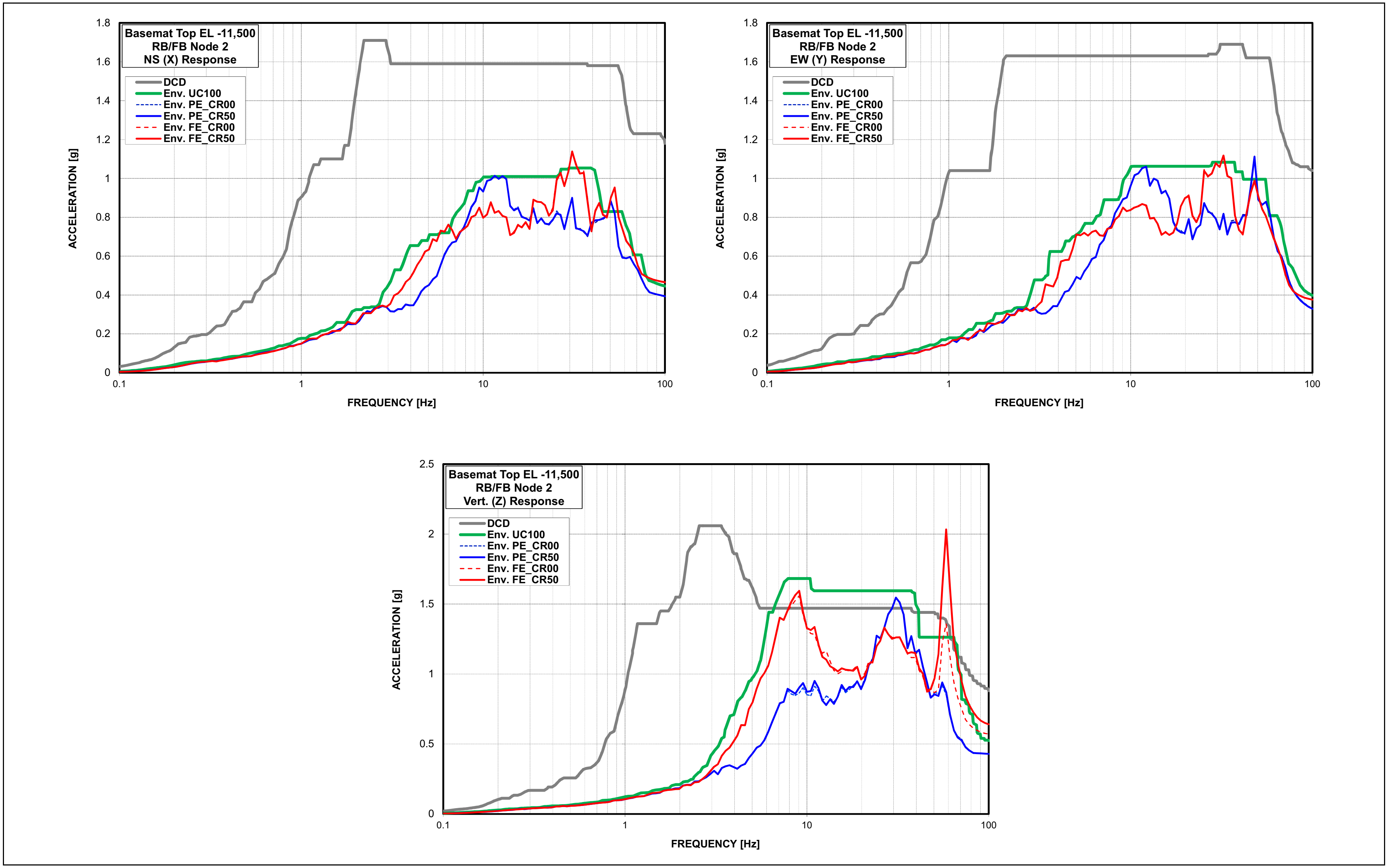

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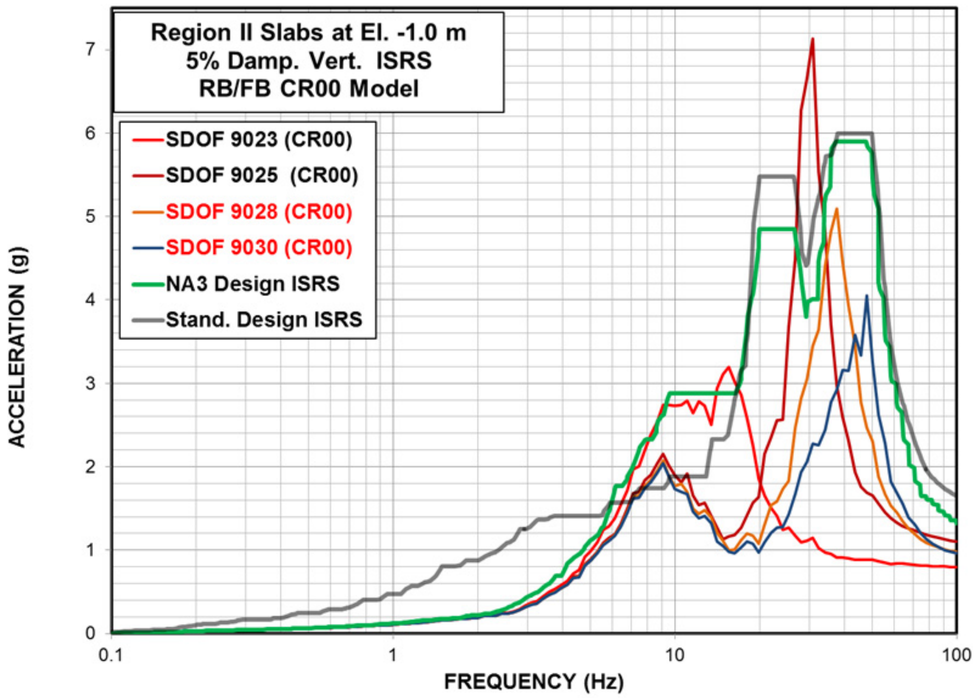
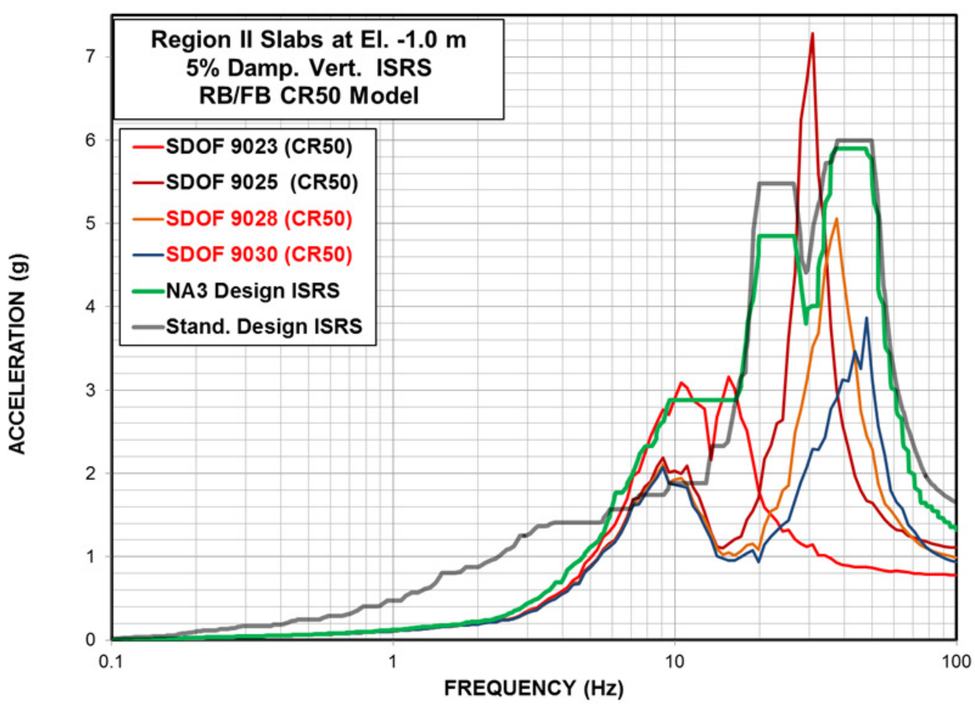
Figure 3A.17.9.1-206 **Structural Stiffness Variation Effects on Out-of-Plane ISRS For Region II Slabs at El. -1.0m**



CR00 Model Results



CR50 Model Results

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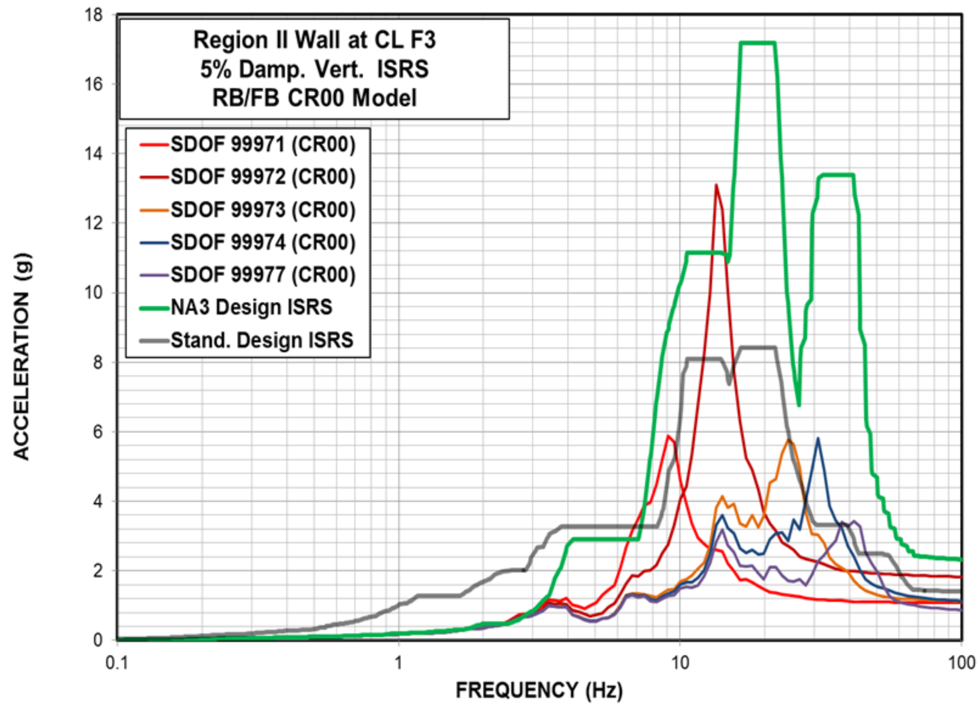
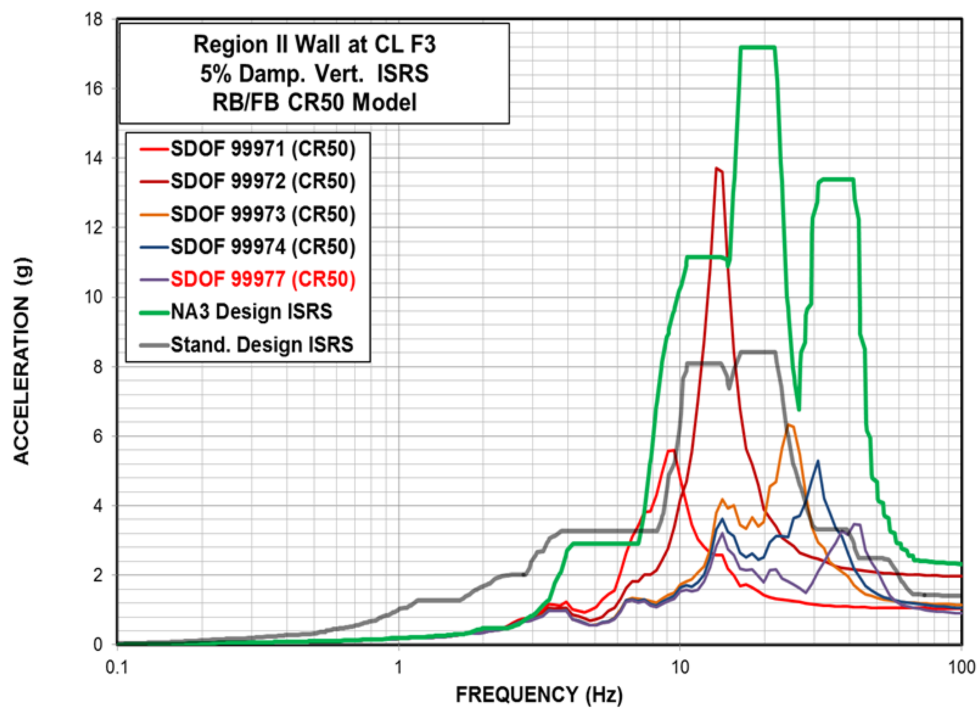
Figure 3A.17.9.1-207 **Structural Stiffness Variation Effects of Out-of-Plane ISRS For Region II Walls at CL F3**



CR00 Model Results



CR50 Model Results

3A.17.9.2 Effect of Structural Stiffness Variations on CB

Site-specific sensitivity studies are performed to evaluate the effects of structural stiffness variations on the seismic response of the CB based on comparisons of responses obtained from:

- Models UC_{OBE} and UC_{SSE} with full stiffness when all members of the CB are uncracked (analysis Cases 1 through 12 in Table 3A.15-202)
- Model CR_{SSE} with 50 percent reduced shear and bending stiffness of the reinforced concrete members due to concrete cracking (analysis Cases S1 through S6 in Table 3A.15-202)

These evaluations consider the effects of concrete cracking on the response of the CB reinforced concrete structure and the out-of-plane vibrations of the flexible slabs. The effects of the concrete cracking on the site-specific seismic demands on the CB structure are evaluated by comparing the enveloping maximum member forces and acceleration results from the analyses of the UC_{SSE} models with full stiffness properties and SSE damping (analysis Cases 7 through 12 in Table 3A.15-202) with the corresponding results obtained from the sensitivity analyses of the CR_{SSE} models with reduced (cracked concrete) stiffness properties (analyses Cases S1 through S6 in Table 3A.15-202). The effect of concrete cracking on the CB site-specific ISRS is evaluated by comparing the 5 percent damped enveloped and broadened ISRS from the analyses of the UC_{OBE} models with full stiffness properties and OBE damping (analysis Cases 1 through 6 in Table 3A.15-202) with the ISRS obtained from the sensitivity analysis cases S1 to S6 that are performed on the CR_{SSE} models.

The comparisons show that the site-specific CB SSI analyses of the models with full (uncracked concrete) stiffness and SSE damping provide site-specific seismic demands on the CB structure that envelope the effects of concrete cracking. Only the local out-of-plane loads on some of the CB slabs exceed the loads obtained from the analyses of the CB model with full stiffness and SSE damping, as shown on Table 3A.17.9.2-201.

Comparisons of the results from the analyses of the CR_{SSE} and UC_{SSE} models for the seismic horizontal forces and overturning moments on the top of the basemat together with the vertical accelerations are also used to evaluate the concrete cracking effects on the CB stability and dynamic bearing pressure calculations, presented in Section 3G.8.5.5. Based on

these comparisons, the analyses of the UC_{SSE} model provide seismic demands for the evaluation of the CB foundation stability and dynamic bearing pressures that bound effects of concrete cracking.

The site-specific SSI analyses of the CB model with full (uncracked concrete) stiffness properties and OBE damping values provide site-specific design ISRS that in general envelope the concrete cracking effects on the design and qualification of CB equipment and components. The largest peak exceedances are observed in some of the SDOF oscillator ISRS.

As an example, Figure 3A.17.9.2-201 compares the envelope of 5 percent damped SDOF ISRS results from the sensitivity SSI analyses of the CR_{SSE} models with the ±15 percent broadened and valley-filled ISRS obtained from the standard and site-specific design basis SSI analyses of the UC_{OBE} models representing the out-of-plane response of the CB roof under uncracked concrete conditions. The figure shows that as a result of the concrete cracking, the peak of the response spectra calculated from the SDOF oscillators in the CR_{SSE} model shifted to lower frequencies resulting in exceedances at frequencies below 12.5 Hz and frequencies between 31 and 34 Hz. These and other similar exceedances are addressed in the site-specific design and evaluation of components and equipment as discussed in Section 3A.18.2.

NAPS DEP 3.7-1 Table 3A.17.9.2-201 **Concrete Cracking Effects on Vertical Out-of-Plane Loads on Flexible Slabs – CB**

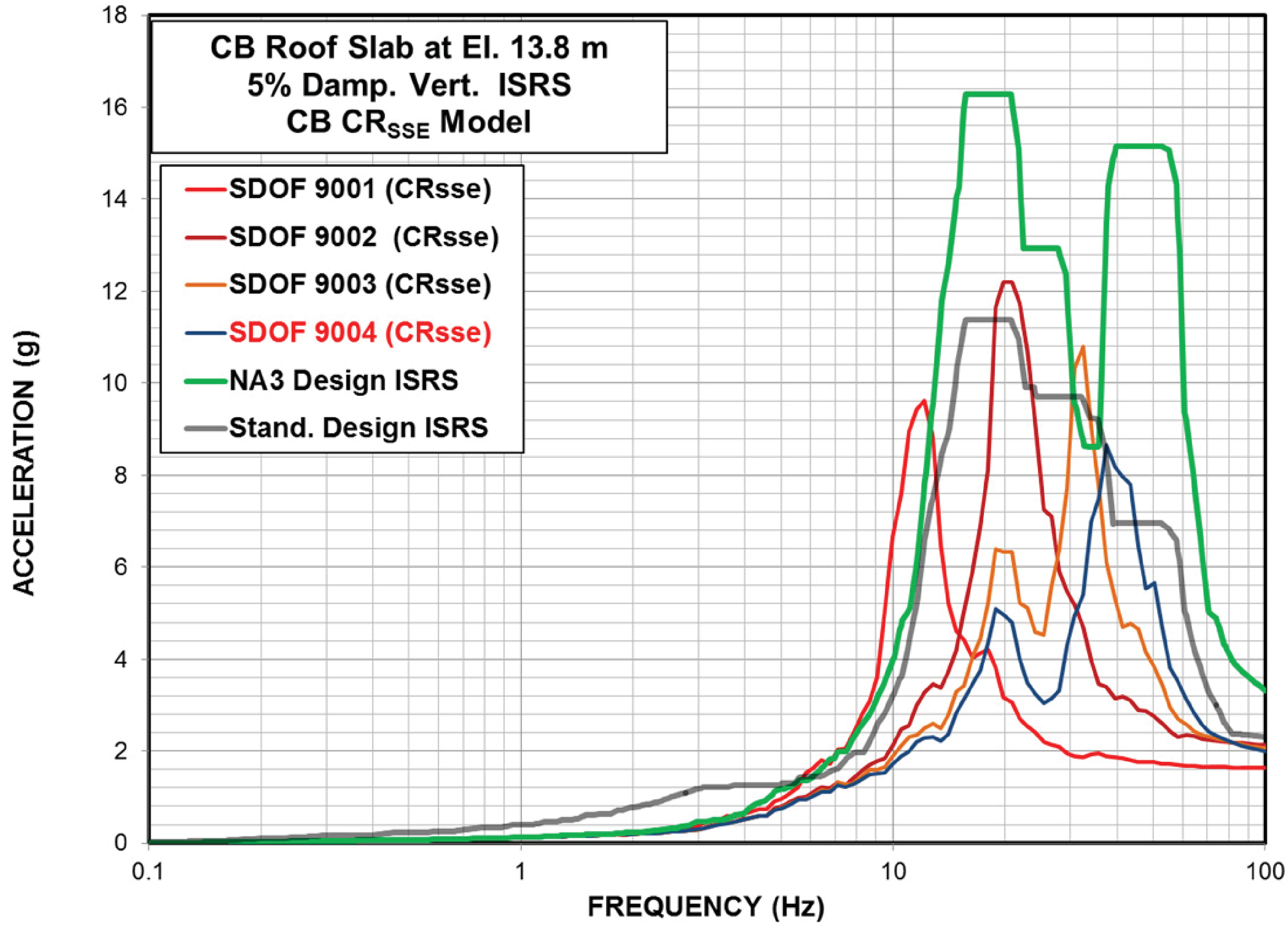
		Slab Equivalent Out-of-Plane Acceleration Load (g)							
		Reduced Stiffness CR_{SSE} Model							
		Partial Column			Full Column				
EL (m)	**Location**	**BE**	**UB**	**LB**	**BE**	**UB**	**LB**	**UC_{SSE} Envelope**	**Max. Exceedance**
13.80	Roof	1.37	*1.53*	1.19	1.02	1.17	0.87	1.52	0%
9.06*)	CA-CD	1.07	*1.19*	0.94	0.85	0.97	0.73	1.21	-
4.65	CA-CD	0.91	*1.03*	0.80	0.72	0.82	0.60	0.91	13%
-2.00	CA-CD	0.64	*0.69*	0.60	0.54	0.62	0.47	0.66	5%

Note: *) An enveloping load is used for all of the slabs regions at EL 9.06 m

The shaded values are exceedances from the UC_{SSE} model enveloping results.

Values in italic are the maximum values obtained from the analyses of the CR_{SSE} model

Figure 3A.17.9.2-201 **Concrete Cracking Effects on CB Roof Out-of-Plane ISRS**



3A.17.9.3 Effect of Structural Stiffness Variations on FWSC

Site-specific sensitivity evaluations of the effects of concrete cracking on the SSI response of the FWSC are performed based on the comparisons of the results obtained from:

- Models UC_{OBE} and UC_{SSE} with full structural stiffness properties representing the condition when all members of the FWSC reinforced concrete structures are assigned full (uncracked concrete) stiffness properties (analysis Cases 1 through 9 in Table 3A.15-203)
- Model CR_{SSE} with 50 percent reduced shear and bending stiffness properties representing the condition when all members of the FWSC reinforced concrete structures are fully cracked (analyses Cases S1 to S6 in Table 3A.15-203)

These evaluations consider the effects of concrete cracking on the response of the FWSC reinforced concrete structures and the out-of-plane vibrations of the FWS and FPE roofs. The effects of the concrete cracking on the site-specific seismic demands on the FWSC structures are evaluated by comparing the results from the sensitivity analyses of the CR_{SSE} model with reduced (cracked concrete) stiffness properties to the enveloped maximum member forces and accelerations results from the site-specific design basis SSI analyses of the FWSC UC_{SSE} model with full stiffness properties and SSE damping (analysis Cases 7 to 9 in Table 3A.15-203). The effects of concrete cracking on the FWSC site-specific ISRS are evaluated by comparing the 5 percent ISRS obtained from the sensitivity analysis cases performed on the CR_{SSE} models with the 5 percent damped broadened and valley-filled ISRS obtained as an envelope of results from the SSI analyses of the FWSC UC_{OBE} models with full stiffness properties and OBE damping (analysis Cases 1 to 6 in Table 3A.15-203).

To evaluate the effects of concrete cracking on the FWSC stability and dynamic bearing pressures, results from the analyses of the CR_{SSE} model and SSI envelope UC_{SSE} model for the seismic horizontal and vertical driving forces and overturning moments are compared.

Results of these evaluations show that the site-specific SSI analyses of the models with full (uncracked concrete) stiffness and SSE damping provide site-specific seismic demands on the FWS structures that envelope the effects of concrete cracking. The evaluations also show that cracking of the concrete amplifies the horizontal load demands on the

FPE structure and the local vertical out-of-plane load on the FPE roof. The site-specific evaluations of the FWSC structures address the effects of concrete cracking by using amplified input seismic loads that bound the exceedances of:

- Horizontal hydrodynamic load from the water contained in the FWSC tanks (Table 3A.17.9.3-201)
- Horizontal loads on the FPE structure (Figures 3A.17.9.3-201 and 3A.17.9.3-202)
- Out-of-plane vertical load on the FPE roof (Table 3A.17.9.3-202)

The site-specific evaluation also shows that the site-specific analyses of the models with full (uncracked concrete) stiffness and SSE damping provide seismic demands for the evaluation of the FWSC foundation stability and dynamic bearing pressures, including lateral load demands on shear keys, that bound the effects of concrete cracking.

The site-specific analyses of the FWSC model with full (uncracked concrete) stiffness properties and OBE damping values provide ISRS that envelope the concrete cracking effects with the only significant exceedances in the ISRS representing the response of the FPE top that are otherwise enveloped by the standard design ISRS.

Figure 3A.17.9.3-203 presents the 5 percent damped ISRS for the vertical response of the SDOF oscillator representing the flexible mode of out-of-plane vibration of the FPE roof under cracked concrete conditions obtained from the results of sensitivity analysis Cases S2, S4, and S6 in Table 3A.15-203. The comparisons of these spectra with the ±15 percent broadened ISRS and the standard design ISRS representing the vertical response of the FPE roof, which is rigid under full (uncracked concrete) stiffness conditions, show that the cracking of the concrete amplifies the out-of-plane response of the FPE roof resulting in ISRS peak exceedances both of the broadened enveloping site-specific ISRS and the standard design ISRS. Section 3A.18.2 presents the approach used for enhancing the site-specific ISRS to bound effects of concrete cracking for the purposes of design and qualification of equipment and components.

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Table 3A.17.9.3-201 **Exceedance of FWS Water Hydrodynamic Loads Due To Concrete Cracking Effects**

SDOF Oscillator				Acceleration (g)		
Elev. (m)	**Node No.**	**Description**	**Direction**	**CR_{SSE} SSI Envelope[a]**	**UC_{SSE} SSI Envelope**	**Standard Design**
8.81	30	FWS Water Impulsive Mode	NS (X)	0.76	0.87	1.10
			EW (Y)	1.10	1.01	1.40

Note: a. From analysis of UB profile with deep Input Motion (Case S4)
Shaded cell identifies exceedance due to concrete cracking effects.

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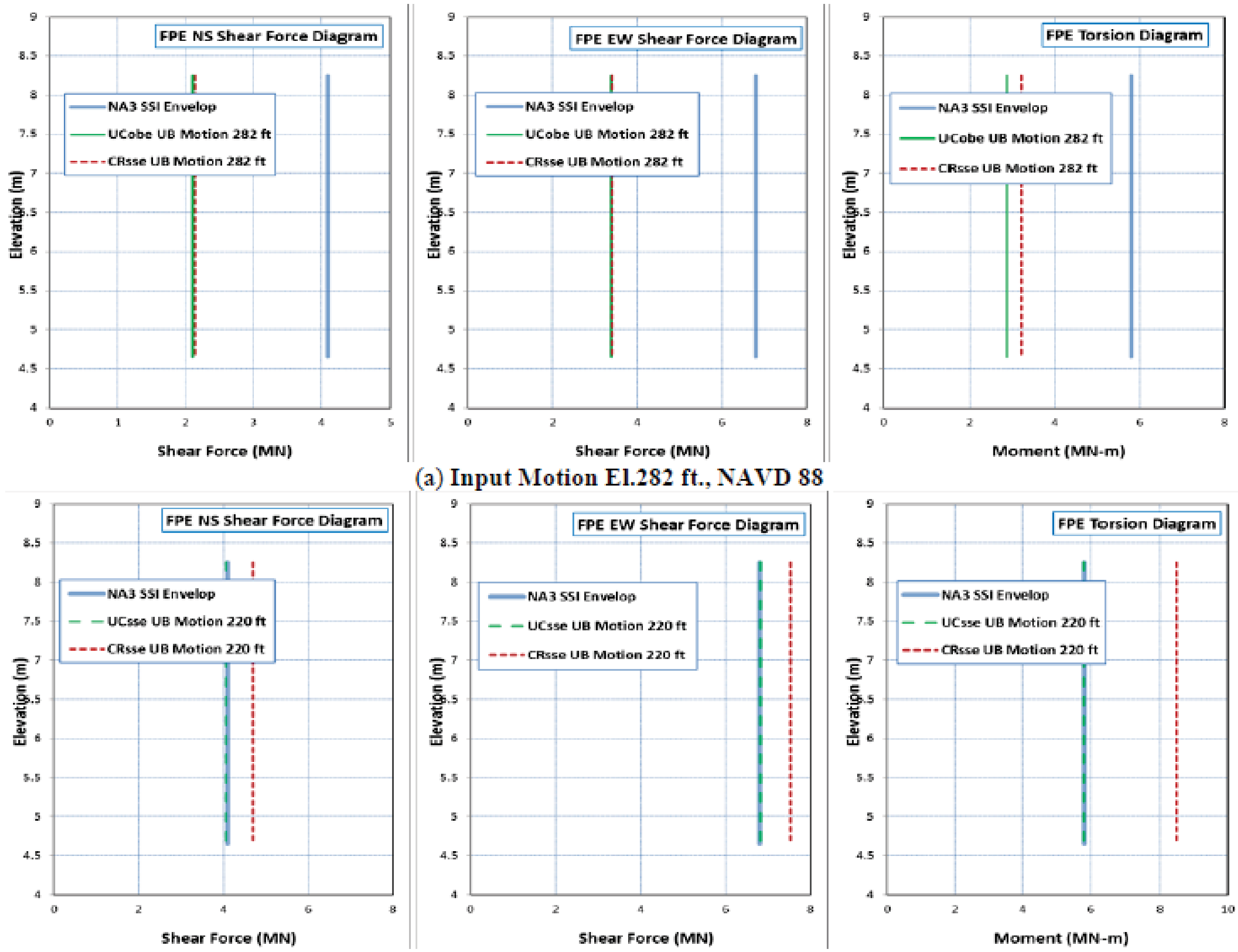
Table 3A.17.9.3-202 **Exceedance of Vertical Out-of-Plane Loads on FPE Roof Due To Concrete Cracking Effects**

Slab		Equivalent Average Acceleration (g)		
Elev. (m)	**Location**	**CR_{SSE} SSI Envelope[a]**	**UC_{SSE} SSI Envelope**	**Standard Design**
8.25	FPE Roof	1.10	0.72	1.12

Note: a. From analysis of UB profile with deep Input Motion (Case S4)
Shaded cell identifies exceedance due to concrete cracking effects.

Table 3A.17.9.3-203 **Deleted**

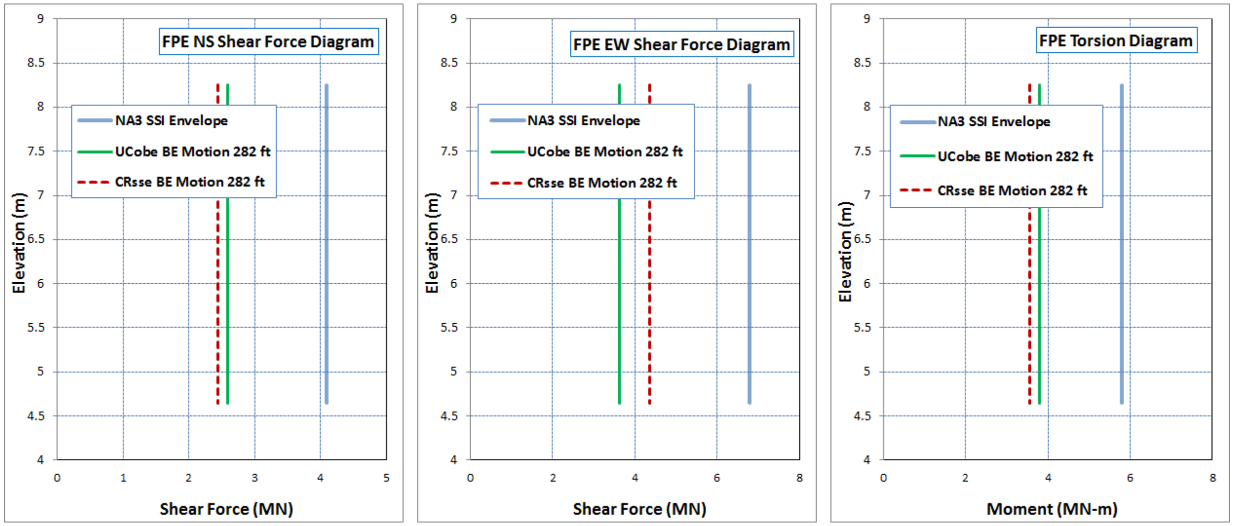
Figure 3A.17.9.3-201 **Concrete Cracking Effects on Horizontal Seismic Load Demands on FPE Structure - UB Profile Analyses**



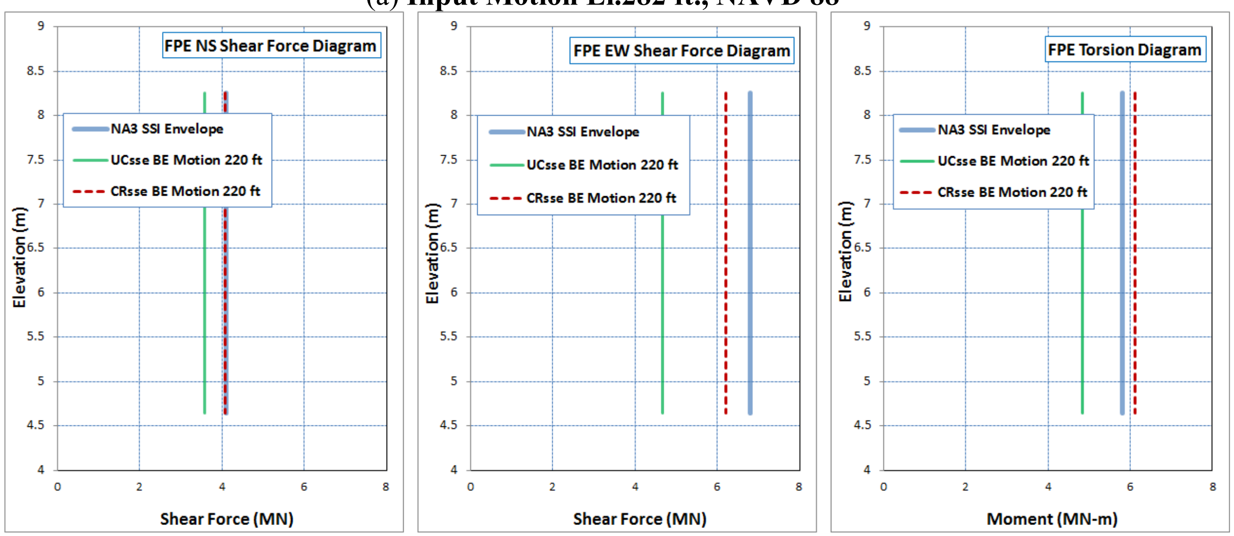
(a) Input Motion El.282 ft., NAVD 88

(b) Input Motion El.220 ft., NAVD 88

Figure 3A.17.9.3-202 **Concrete Cracking Effects on Horizontal Seismic Load Demands on FPE Structure - BE Profile Analyses**

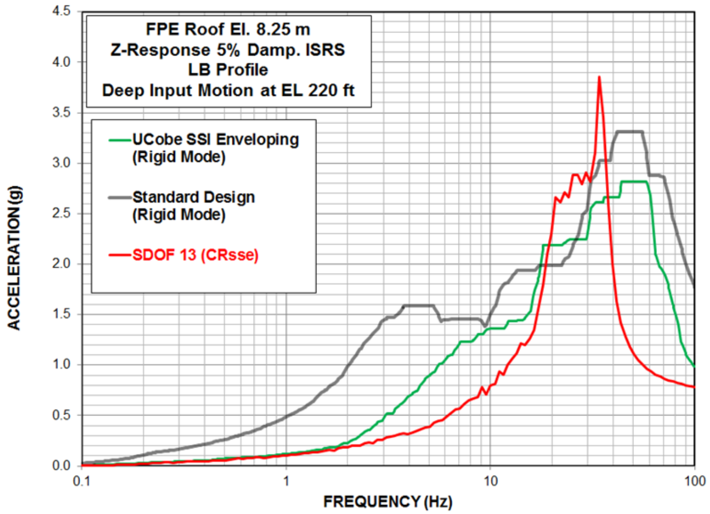


(a) **Input Motion El.282 ft., NAVD 88**

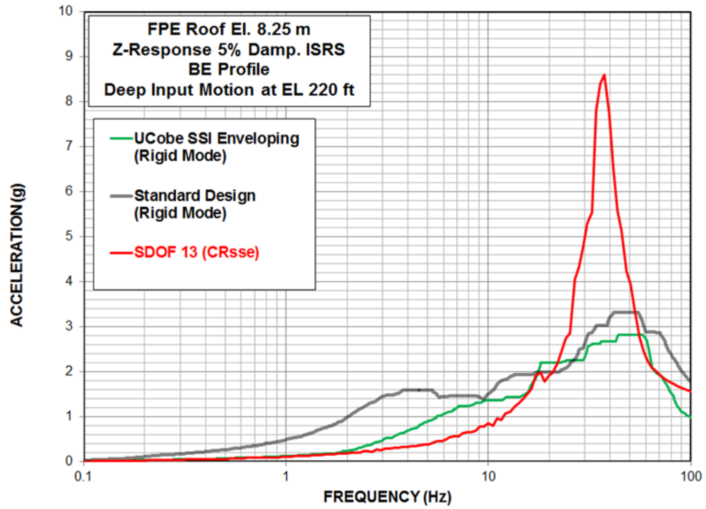


(b) **Input Motion El.220 ft., NAVD 88**

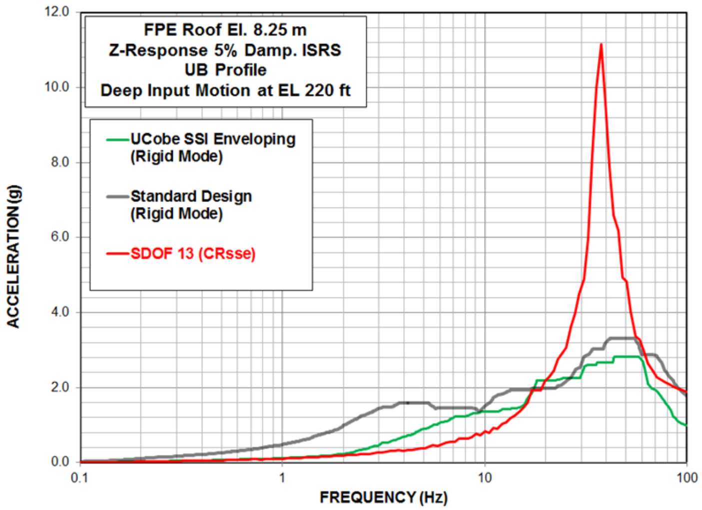
Figure 3A.17.9.3-203 **Concrete Cracking Effects on FPE Roof Out-of-Plane ISRS**



Analysis of LB Profile with Deep Input Motion at El 220 ft, NAVD 88



Analysis of BE Profile with Deep Input Motion at El.220 ft., NAVD 88



Analysis of UB Profile with Deep Input Motion at El.220 ft., NAVD 88

3A.17.10 Effect of Wall Out-of-Plane Vibration

As explained in DCD Section 3A.8.10, to obtain design loads and ISRS for flexible walls, site-specific seismic analyses of the RB/FB are performed on LMSM with SDOF oscillators representing the out-of-plane responses of flexible walls shown in the RB/FB complex seismic analysis model in DCD Figure 3A.7-4. As shown in Figure 3A.16.2-201, additional SDOF oscillators are added to the RB/FB complex dynamic model to capture all flexible modes (modes with frequencies up to 50 Hz) of out-of-plane vibration of walls under fully cracked conditions. Sections 3A.17.12 and 3A.17.9.1 describe the calculated results of the RB/FB out-of-plane oscillators and Section 3A.18.1.1 describes the site-specific enveloping out-of-plane loads on the RB/FB flexible walls.The out-of-plane response of CB and FWSC walls under both uncracked and cracked conditions are characterized with modes of vibrations for which frequencies are higher than 50 Hz.

3A.17.11 Effect of Structure-Structure Interaction

Site-specific evaluations of the effects of SSSI between the FWSC and the adjacent CB, which are of similar size and weight, follow a methodology consistent with the one used in the standard design to determine:

- SSSI effects of the FWSC on the CB seismic response based on results of site-specific SSSI analyses of the CB-FWSC combined model presented in Figure 3A.17.11-202
- SSSI effects of the CB on the FWSC seismic response based on results of site-specific SSSI analyses of the FWSC-CB combined model presented in Figure 3A.17.11-203.

The site-specific evaluations of the SSSI effects of the large and heavy RB/FB on the seismic response of the small and light CB are also based on the results of site-specific SSSI analyses using the CB-RB/FB combined model presented in Figure 3A.17.11-201. This explicit approach that captures the site-specific effects of dynamic coupling between the RB/FB and CB is different from the approximate approach used for the standard design SSSI evaluation in DCD Section 3A.8.11, which considers only the effect of the RB/FB on the seismic ground motion at the CB location. The standard design approach to evaluate the SSSI effects of the RB/FB on the CB is not directly implemented for the site-specific evaluations because it cannot explicitly capture the

conditions between the two buildings and address the effect of subgrade property variations across the site.

Table 3A.15-204 lists the cases used in the site-specific analyses for the SSSI effect of the RB/FB on the CB. Table 3A.15-205 and 3A.15-206 list the cases used in analyses for the SSSI effects of the FWSC on the CB and CB on the FWSC, respectively.

The site-specific SSSI analyses are performed on combined models using the MSM and the SASSI2010 computer program.

The CB-FWSC and FWSC-CB combined SSSI models representing the dynamic properties of the CB and FWSC structures also include near-field subgrade elements providing an explicit representation of the subgrade conditions existing between the FWSC and the CB. The near-field solid elements model the concrete fill and structural fill backfilled into the gap between the buildings. The concrete fill is backfilled up to the top of the Zone III rock elevation, and the structural fill is backfilled above the Zone III rock elevation up to the finished ground level grade.

The site-specific SSSI effects of the FWSC on the CB seismic response are evaluated using the results of the SSSI analyses of the CB-FWSC combined model for the full column subgrade profiles representing strain-compatible dynamic soil/rock properties at the CB location. The SSSI analyses are performed on full column profiles to accurately capture the effects of concrete fill placed below the FWSC foundation on the CB seismic response. To account for the effects of the potential variability in the properties of the soil and rock, the CB-FWSC SSSI analyses are performed for the two bounding subgrade stiffness conditions using the UB and LB CB full column profiles and corresponding in-layer input motions defined by the CB SSI design spectra applied at the bottom of the CB foundation. The subgrade dynamic properties and input motions used for the CB-FWSC SSSI analyses are identical to those used for the SSI analyses of the CB stand-alone model. The use of identical inputs enables the SSSI effect of the FWSC on the CB seismic response to be directly evaluated by comparing the results obtained from the SSSI analyses of the CB-FWSC combined model with the results of the SSI analyses of the CB stand-alone model.

The site-specific SSSI effects of the FWSC on the CB are evaluated by comparing the site-specific CB-FWSC SSSI analyses results with the corresponding CB seismic structural loads and ISRS that are developed as the envelope of the results of the design basis SSI analyses of the CB stand-alone models with full (uncracked concrete) stiffness properties. Comparisons are also made with the corresponding seismic loads and ISRS used for the standard design of the CB.

The site-specific SSSI effects of the CB on the FWSC seismic response are evaluated using the results of the SSSI analyses of the FWSC-CB combined model for the subgrade profiles representing strain-compatible dynamic soil/rock properties at the FWSC location. The subgrade dynamic properties and the input motions used for the site-specific FWSC-CB SSSI analyses are identical to those used for the site-specific FWSC stand-alone model SSI analyses. The only difference between the FWSC-CB combined model and the FWSC stand-alone model is that the structural fill placed in the gap between the two buildings and around the concrete fill below the FWSC foundation is explicitly included in the FWSC-CB combined model and is neglected in the FWSC stand-alone model. Inclusion of the structural fill in the combined model is intended to address the effects of the structural fill on the FWSC seismic response, in particular the structural fill placed between the two buildings. Consideration of the site conditions at the FWSC location enables the SSSI effect of the CB on the FWSC seismic response to be directly evaluated by comparing the results obtained from the SSSI analyses of the FWSC-CB combined model with the results of the SSI analyses of the FWSC stand-alone model.

The SSSI effects of the CB on the FWSC site-specific seismic design are evaluated by comparing the site-specific FWSC-CB SSSI analyses results with the corresponding FWSC seismic load demands and broadened ISRS developed as the envelope of the results of the design basis SSI analyses of the FWSC stand-alone model with full (uncracked concrete) stiffness properties. Comparisons are also made with the corresponding structural seismic loads and ISRS used for the standard design of the FWSC.

The following SSSI analyses cases are performed on the FWSC-CB combined model with OBE damping values to obtain the SSSI responses needed for the development of the FWSC site-specific design ISRS:

- LB, BE, and UB full column profiles using the surface outcrop input motion compatible with the FWSC FIRS that governs the FWSC ISRS at lower frequencies
- LB, BE, and UB full column profiles using the corresponding in-column input motion compatible with the SSI design spectra at the bottom of the concrete fill placed below the FWSC foundation that governs the FWSC ISRS at high frequencies

The following SSSI analyses cases are performed on the FWSC-CB combined model with SSE damping values to obtain the SSSI responses for the development of the site-specific seismic load demands on the FWSC:

- LB, BE, and UB full column profiles using the corresponding in-column input motion compatible to the SSI design spectra at the bottom of the concrete fill placed below the FWSC foundation that governs the FWSC maximum site-specific seismic load demand

The SSSI analyses of the FWSC-CB combined model are performed for the same set of inputs as the ones used for the SSI analyses of the FWSC stand-alone model.

To provide explicit representation of the subgrade conditions that exist between the RB/FB and the CB, the CB-RB/FB combined model includes the Access Tunnel, which is structurally isolated from the RB/FB and CB, and the near-field elements representing the concrete fill and structural fill below the Access Tunnel and surrounding the CB. The concrete fill is backfilled up to the top of the Zone III rock elevation, and the structural fill is backfilled above the Zone III rock elevation up to the finished ground level grade.

The site-specific SSSI effects of the RB/FB on the CB seismic response are evaluated using the results of the SSSI analyses of the CB-RB/FB combined model for the full column and partial column subgrade profiles representing strain-compatible dynamic soil/rock properties at the CB location. To account for the effects of the potential variability in the properties of the soil and rock, two different embedment conditions and

two sets of bounding subgrade strain-compatible dynamic properties are considered. The CB-RB/FB SSSI analyses are performed using:

- The LB partial column profile, which is representative of the lower bound subgrade stiffness conditions at the CB location, with the in-column input control motion applied at the CB basemat bottom elevation
- The UB full column profile, which is representative of the upper bound subgrade stiffness conditions at the CB location, with the in-column input control motion applied at the CB basemat bottom elevation
- The UB partial column profile, which is the analysis case that governs the overall seismic response of the CB stand-alone model with the in-column input control motion applied at the CB basemat bottom elevation

The subgrade dynamic properties and input motions used for the CB-RB/FB SSSI analysis are identical to those used for the SSI analysis of the CB stand-alone model. Using identical inputs enables the SSSI effects of the RB/FB on the CB seismic response to be directly evaluated by comparing the results obtained from the SSSI analyses of the CB-RB/FB combined model with the results of the SSI analyses of the CB stand-alone model.

The site-specific design basis developed from the results of SSI analyses of CB stand-alone models envelopes the SSSI effects of the FWSC and RB/FB on the CB seismic response. Exceptions are the peaks of some of the CB ISRS that can be amplified by the SSSI effects. Section 3A.18.2 describes the approach used to enhance the CB ISRS to bound SSSI effects of the FWSC and RB/FB on the CB seismic response at the Unit 3 site.

The site-specific structural loads presented in Section 3A.17.13.2 that are based on maximum responses obtained from the design basis SSI analyses of the CB stand-alone models provide demands that bound all of the SSSI-induced amplifications of the CB maximum responses with exception of the CB torsional moment demands that are induced by the eccentricity of the FWSC and RB/FB. Comparisons of total shear demands on the CB exterior walls include the contribution of the shear load demand, the calculated torsion, and the accidental torsion demonstrate that the contribution of the SSSI-induced torsional moment amplification on the total shear demand on the CB exterior walls is small

and is enveloped by the site-specific loads in Section 3A.17.13.2, that are obtained from the design basis SSI analyses of the CB stand-alone models.

The site-specific evaluations also show that the site-specific SSI analyses of CB stand-alone models provide dynamic lateral pressures that envelope the SSSI effects of the FWSC and RB/FB. Exceptions are the lateral dynamic pressures on the CB west wall facing the RB/FB that are amplified due to SSSI effects of the RB/FB resulting in lateral pressure exceedances at the top level of in-situ rock and at the basemat level. The larger exceedance at the basemat level (about Elevation -10.4 m) has no effect on the CB below-grade wall design. The CB west exterior wall is supported at the floor level at Elevation -2.0 m, so the relatively small exceedance of the dynamic lateral pressure demand at the rock Elevation -3.12 m has a negligibly small effect on the out-of-plane flexural and shear stress demands on the CB west exterior wall.

The CB-FWSC and the CB-RB/FB SSSI analyses results for the seismic horizontal force and overturning moment demands on top of the basemat along with the vertical accelerations are also enveloped by the results of the SSI analyses of the CB stand-alone models. The seismic driving forces used for the evaluation of the CB stability are proportional to the shear force, vertical force, and bending moment demands on the top of the CB basemat. The dynamic bearing pressure demands on the CB basemat are proportional to the overturning moment and vertical seismic force demands. Therefore, for evaluation of the CB foundation stability and dynamic bearing pressures, SSI analyses of the CB stand-alone models provide seismic demands that bound the SSSI effects of the FWSC and RB/FB on the CB foundation stability and dynamic bearing pressures.

The evaluations show that the site-specific design basis SSI analyses of the CB stand-alone model (analysis Cases 1 through 6 in Table 3A.15-202) provide ±15 percent broadened enveloping ISRS that bound the SSSI effects of the FWSC and RB/FB on the CB seismic response with small sharp peak exceedances at frequencies greater than 10 Hz. These exceedances of the ISRS for the CB response in EW and vertical direction are otherwise bound by the standard design ISRS. Exceptions are the ISRS for the vertical response of the CB presented in Figure 3A.17.11-204 that exceed both the site-specific enveloping ISRS

and the standard design ISRS. The CB site-specific ISRS are enhanced as described in Section 3A.18.2, if any of the sensitivity SSSI analyses of the CB-RB/FB and the CB-FWSC combined models yield 5 percent damped ISRS that exceed the corresponding broadened ISRS for frequencies up to 50 Hz, the cut-off frequency of importance for design as specified in DC/COL-ISG-01.

The results of the FWSC-CB SSSI evaluations show that the results obtained from the SSSI analyses of the FWSC-CB combined model need to be included in the FWSC site-specific design. As shown in Figure 3A.17.11-205, the SSSI with the CB amplifies the horizontal loads on the FWS structure resulting in small exceedances of the site-specific shear load demands with respect to the loads used for the standard design. The SSSI-induced amplifications of the FWS torsion are larger, resulting in site-specific demands that are four times the torsion load considered in the standard design. Figure 3A.17.11-205 shows that the site-specific CB SSSI effects on the FWS vertical loads are small. As shown in Figure 3A.17.11-206, the CB SSSI effects result in small exceedances of the load demands on the FPE structure that are otherwise enveloped by the standard design loads. The SSSI between the CB and FWSC also amplifies the out-of-plane load demand on the FWS roof as shown in Table 3A.17.11-201.

The results of the FWSC-CB SSSI analyses indicate that the CB SSSI effects also amplify the peak responses of the FWSC resulting in exceedances of the ±15 percent broadened and valley filled enveloping ISRS obtained from the site-specific design basis SSI analyses of the FWSC stand-alone model (analysis Cases 1 through 6 in Table 3A.15-203). Significant exceedances in the ISRS can be observed for:

- The EW response of the FWS roof between frequencies of 12 and 18 Hz (shown in Figure 3A.17.11-207).
- The vertical response of the FWS roof and basemat between frequencies of 30 and 40 Hz (shown in Figures 3A.17.11-207 and 3A.17.11-208).
- The vertical response of the FPE basemat between frequencies of 30 and 50 Hz (shown in Figure 3A.17.11-209).

The FWSC-CB SSSI analyses results for the vertical response of the FWSC basemat also exceed the corresponding standard design ISRS.

The results obtained from the FWSC-CB SSSI analyses are used to develop the FWSC site-specific seismic design basis to envelope the small amplifications of the FWSC response that are due to the SSSI with the CB.

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Table 3A.17.11-201 **Exceedances of FWS Roof Out-of-Plane Load Due to CB SSSI Effects**

Slab		Flexible Mode (SDOF Oscillator)				Rigid Mode (LMSM)				Equivalent Average Acceleration (g)		
				Acceleration (g) [a]				Acceleration (g) [a]		Site-Specific [a]		
Elev. (m)	Location	Weight (kN)	Mass Node	SSSI	SSI	Weight (kN)	Mass Node	SSSI	SSI	SSSI	SSI	Stand. Design
19.70	FWS Roof	1339	11	3.98	3.36	2480	10	1.40	1.43	2.30	2.11	1.74

Note: a. Results of the SSSI and SSI analyses of the FWSC-CB combined and FWSC stand-alone models with full stiffness properties and SSE damping values.

The shaded values are exceedance from the SSI models.

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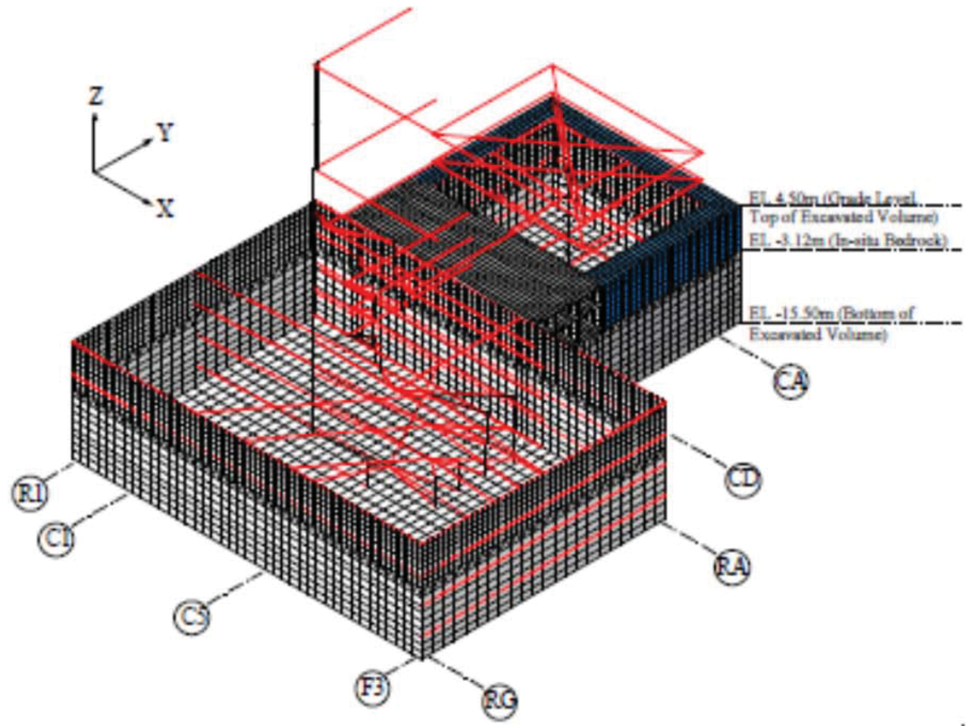
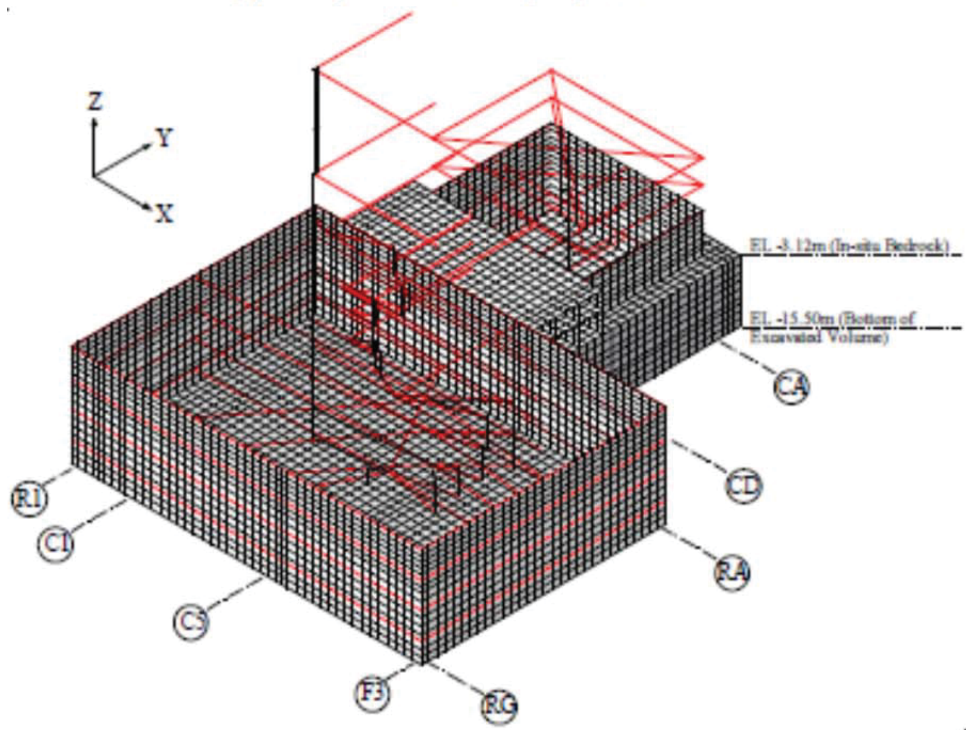
Figure 3A.17.11-201 **CB-RB/FB Combined Model**



(a) Fully Embedded (FE) Model



(b) Partially Embedded (PE) Model

Figure 3A.17.11-202 **CB-FWSC Combined Model**

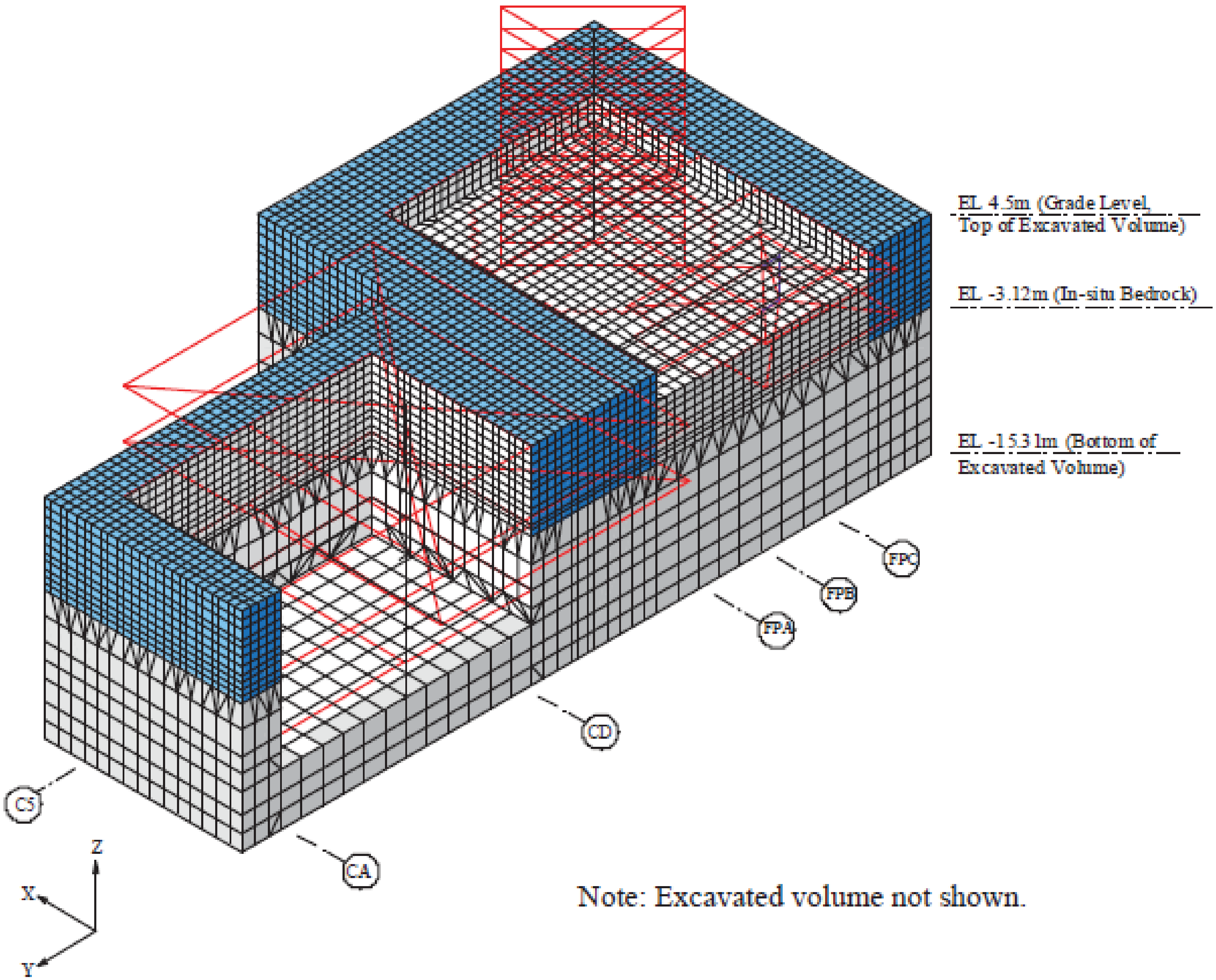


Figure 3A.17.11-203 **FWSC-CB Combined Model**

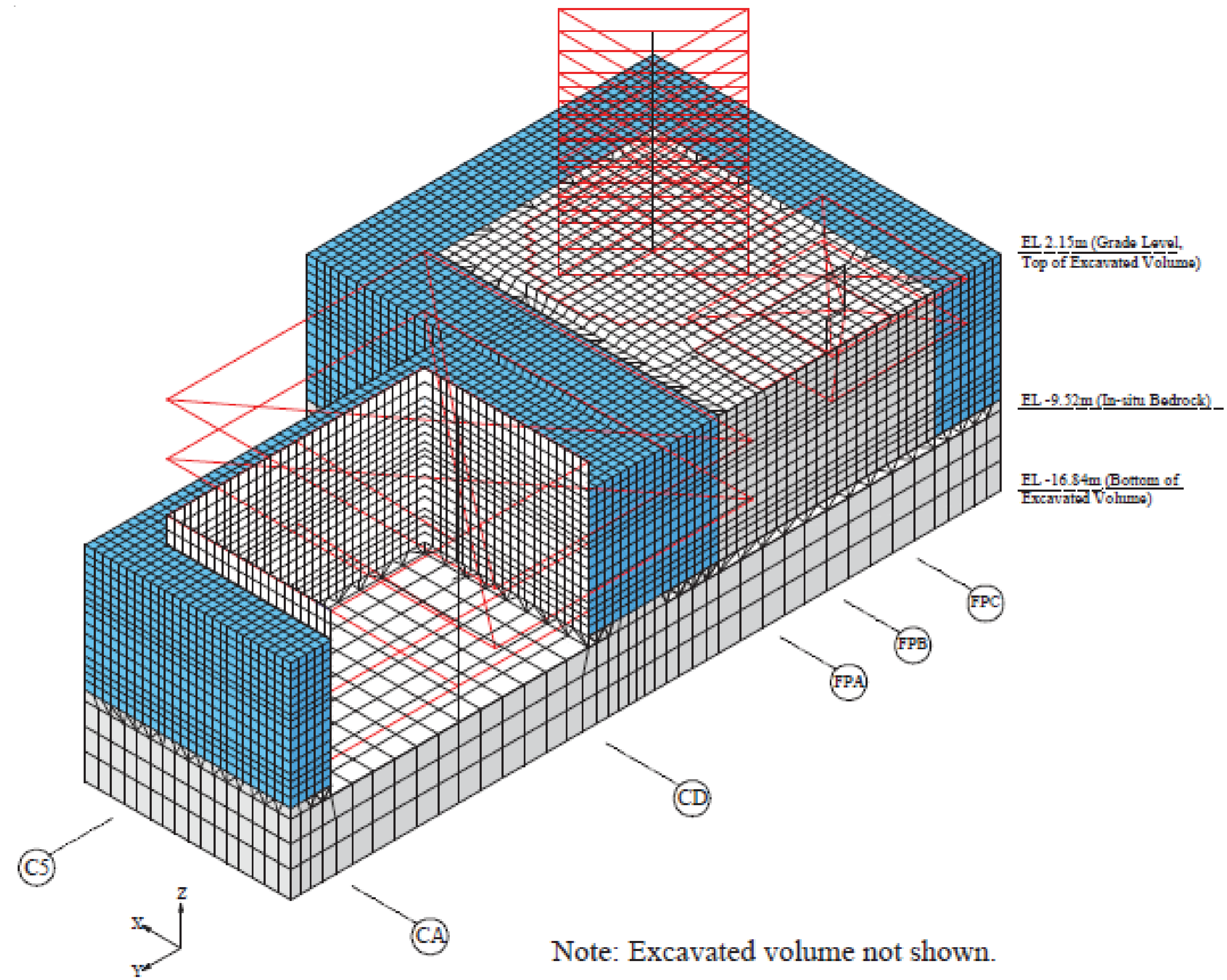
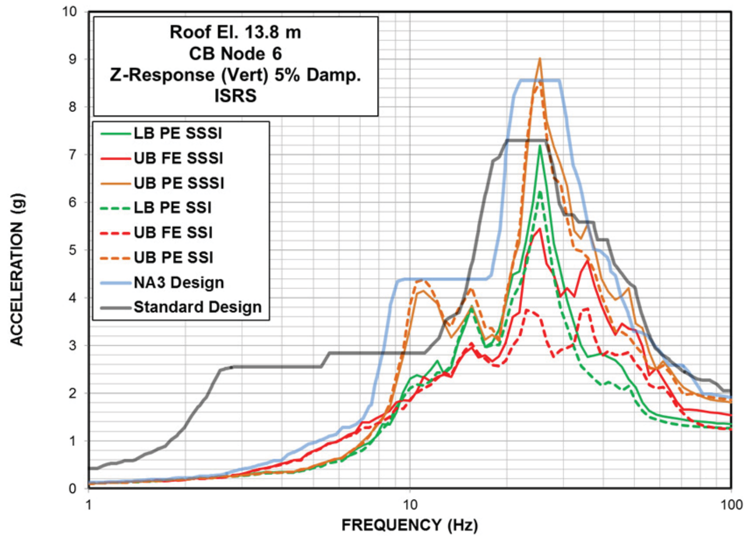
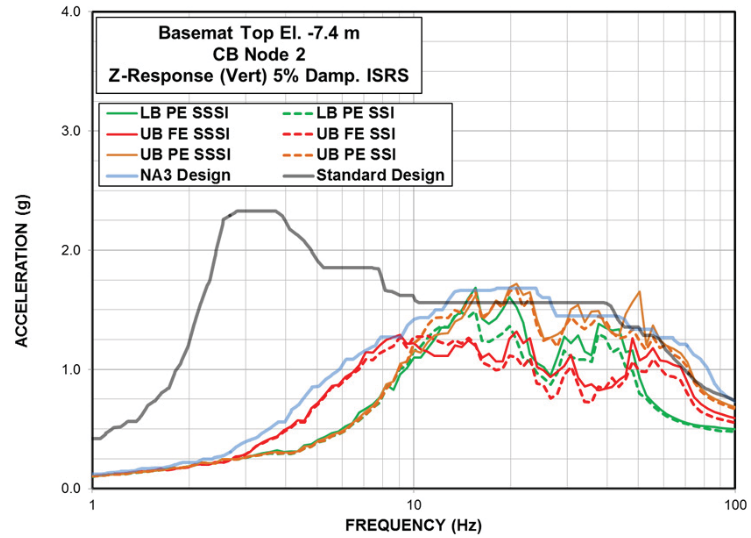


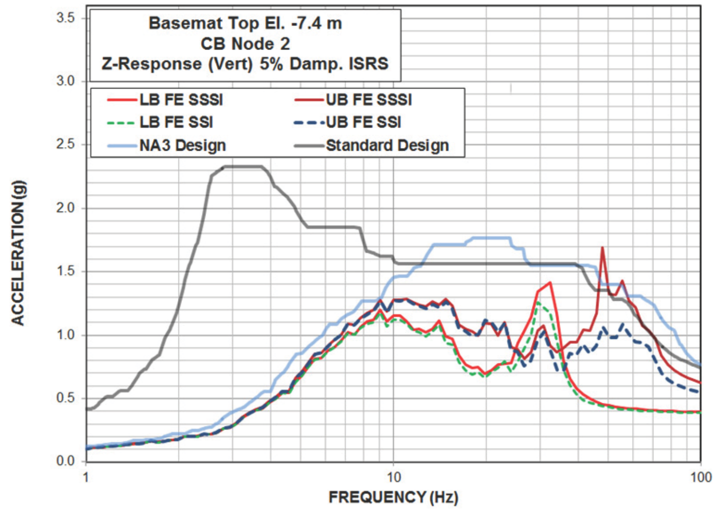
Figure 3A.17.11-204 **Exceedances of CB ISRS due to RB/FB and FWSC SSSI Effects**



RB/FB SSSI Effects on ISRS for Response at CB Roof Elevation 13.8 m



RB/FB SSSI Effects on ISRS for Response at CB Basemat Top Elevation - 7.40 m



FWSC SSSI Effects on ISRS for Response at CB Basemat Top Elevation - 7.40 m

Figure 3A.17.11-205 **Exceedances of FWS Loads due to CB SSSI Effects**

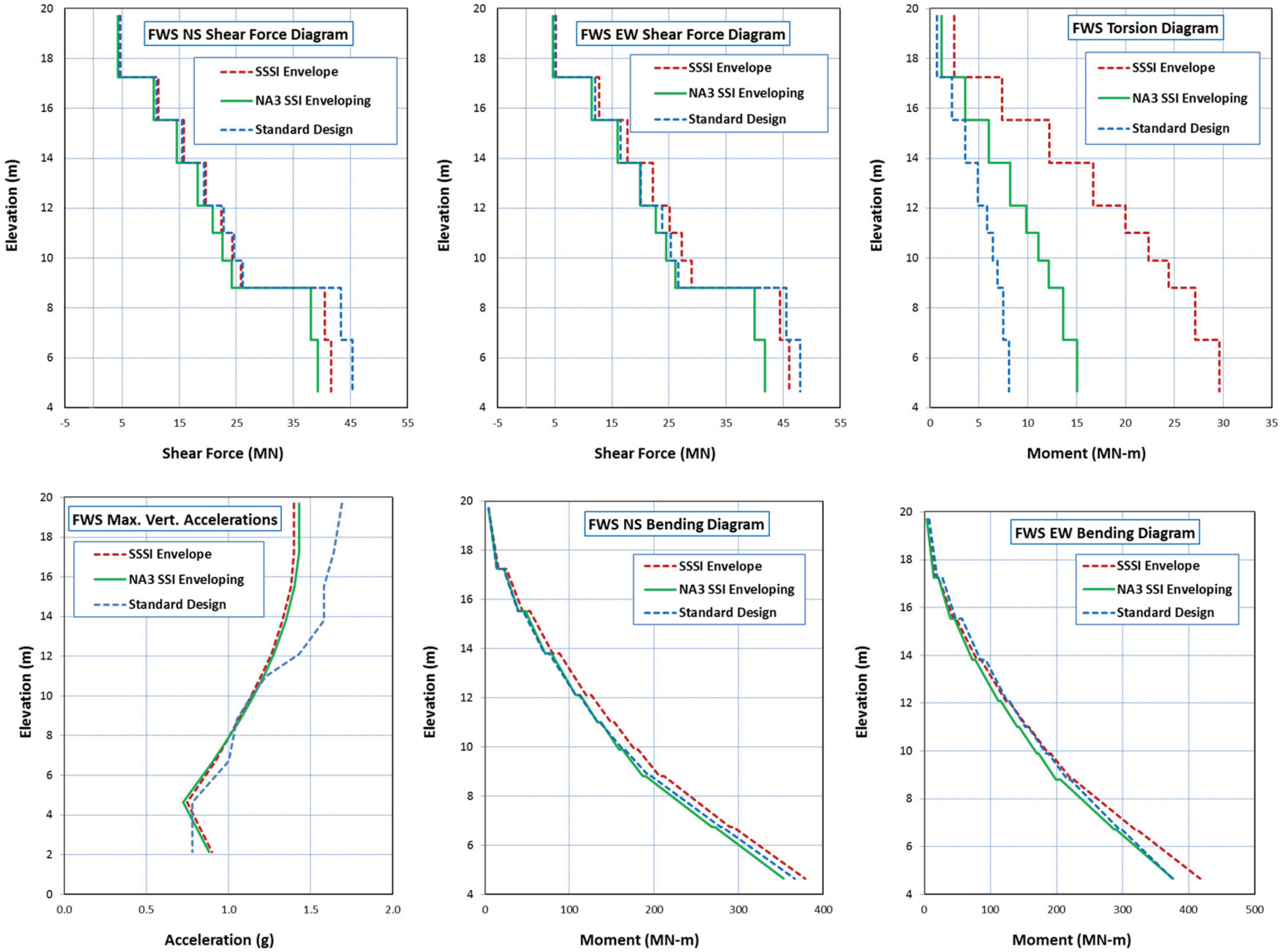


Figure 3A.17.11-206 **Exceedances of FPE Loads due to CB SSSI Effects**

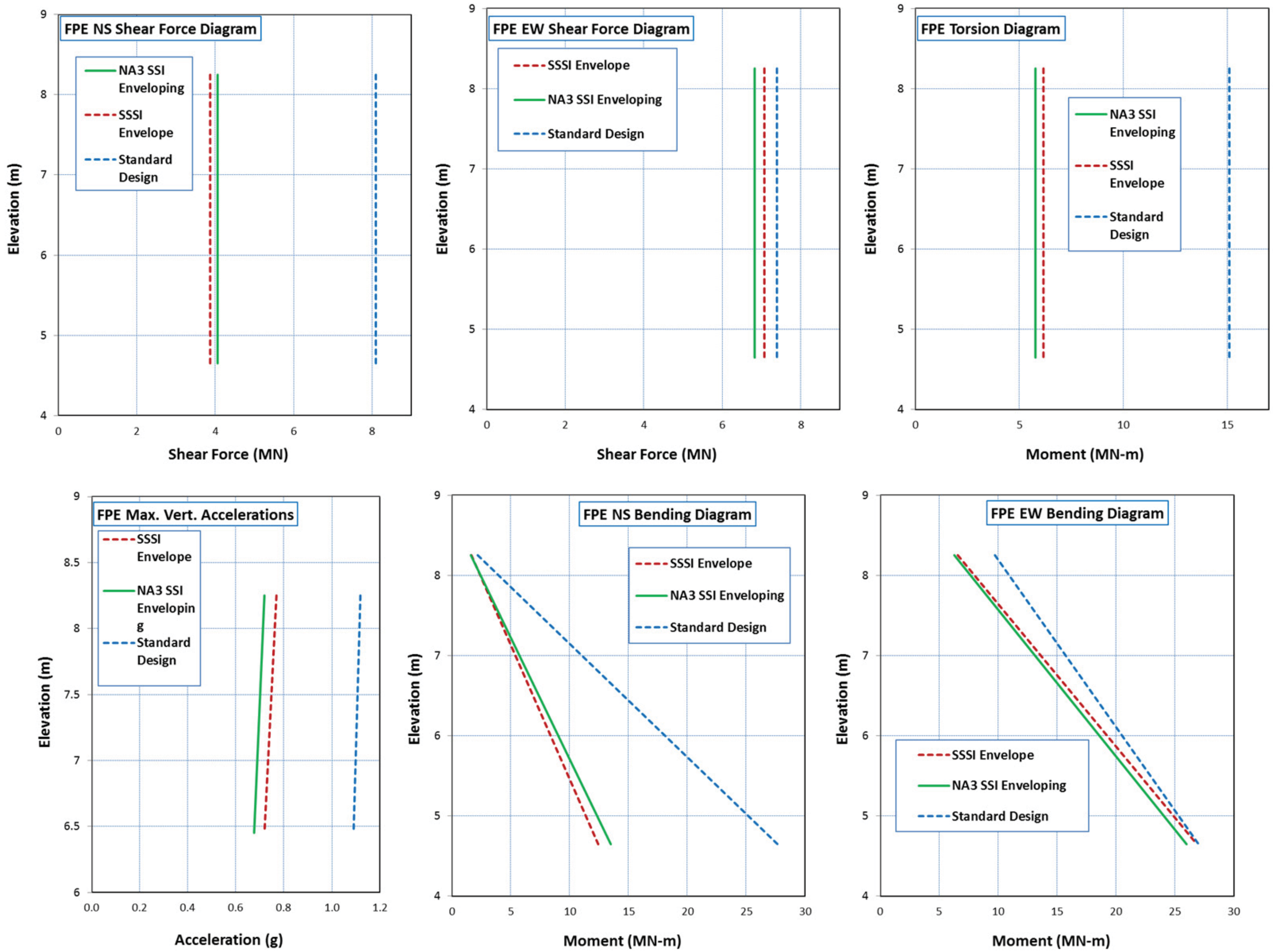


Figure 3A.17.11-207 **Exceedances of FWS Roof ISRS due to CB SSSI Effects**

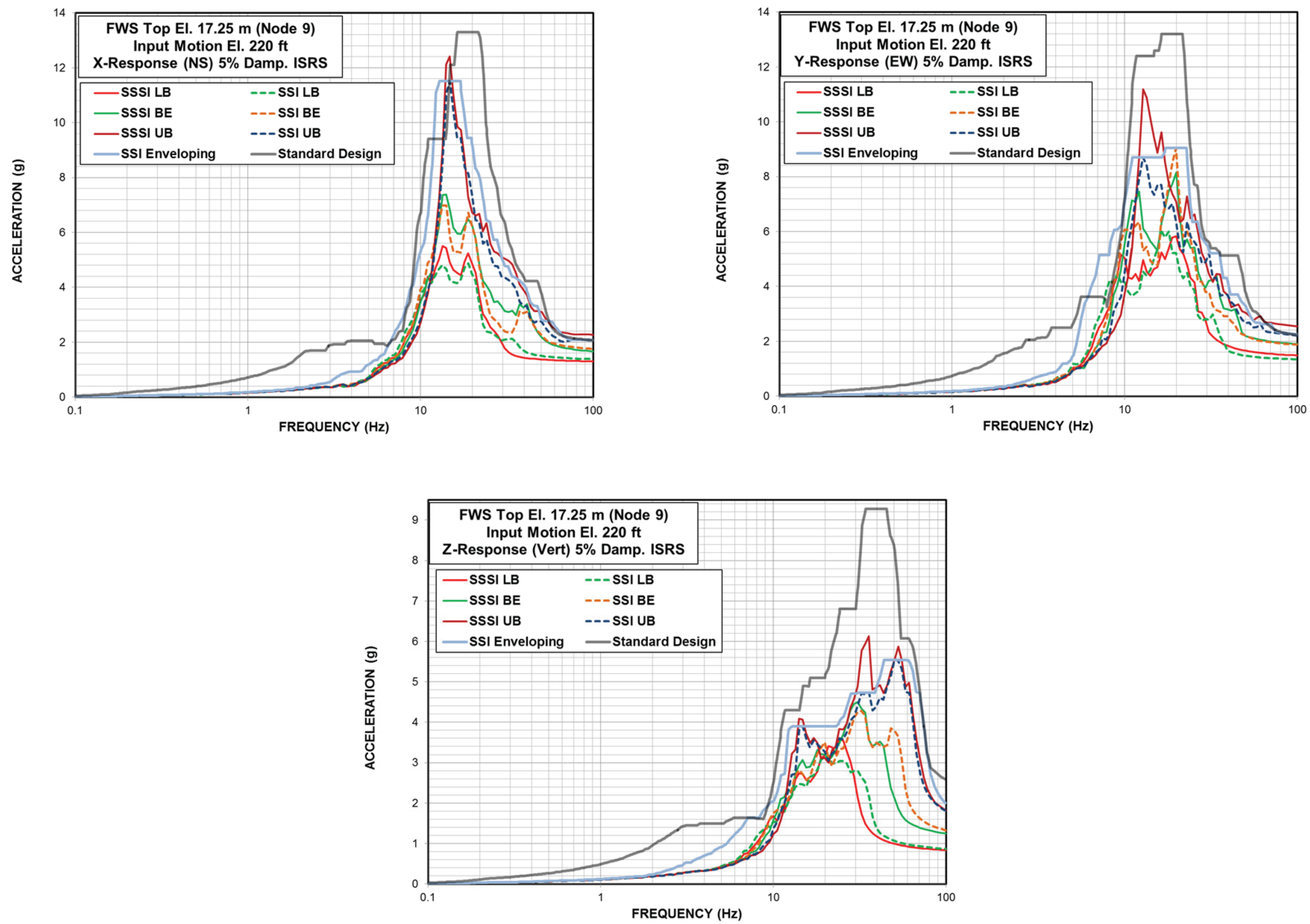


Figure 3A.17.11-208 **Exceedances of FWS Basemat ISRS due to CB SSSI Effects**

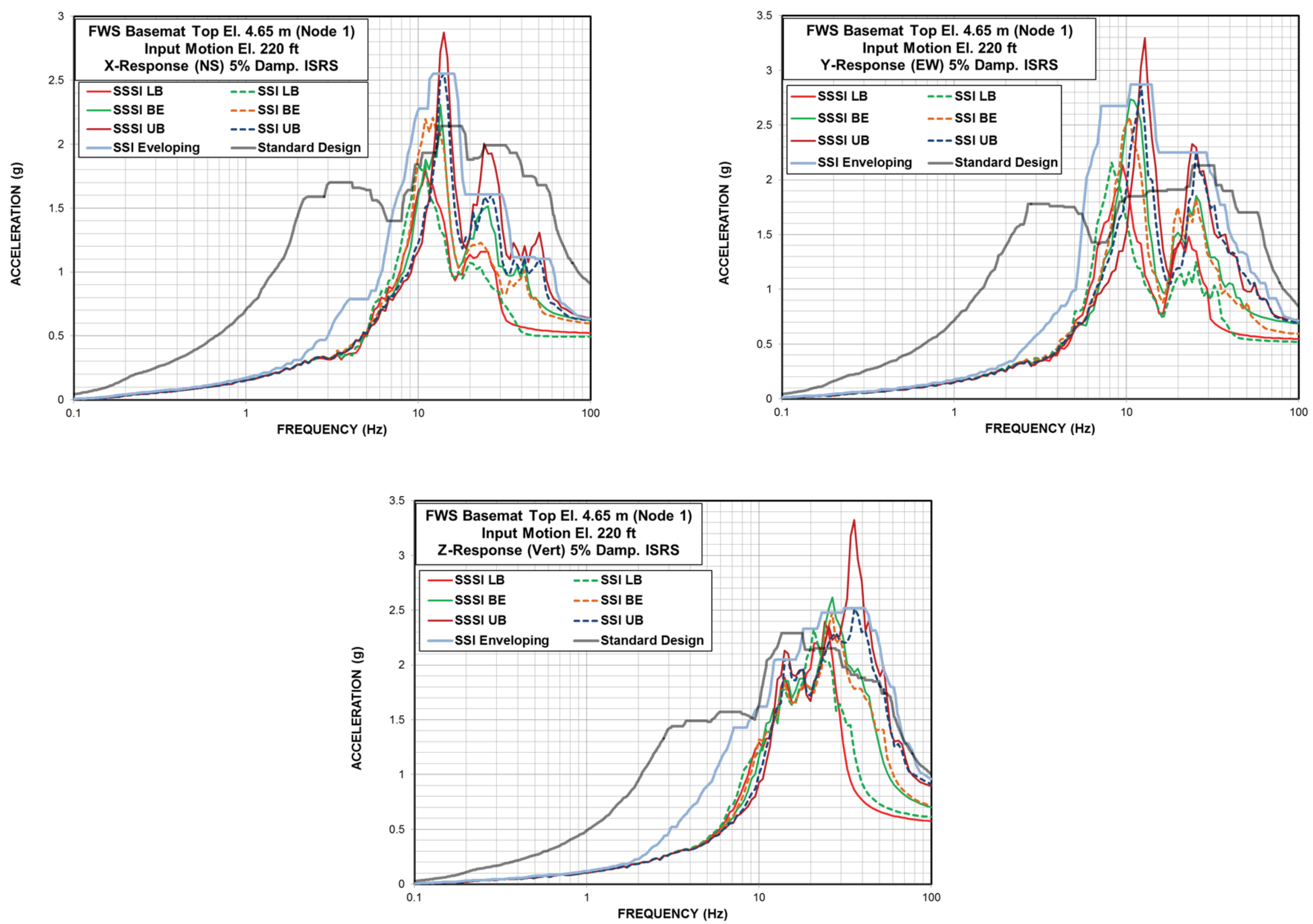
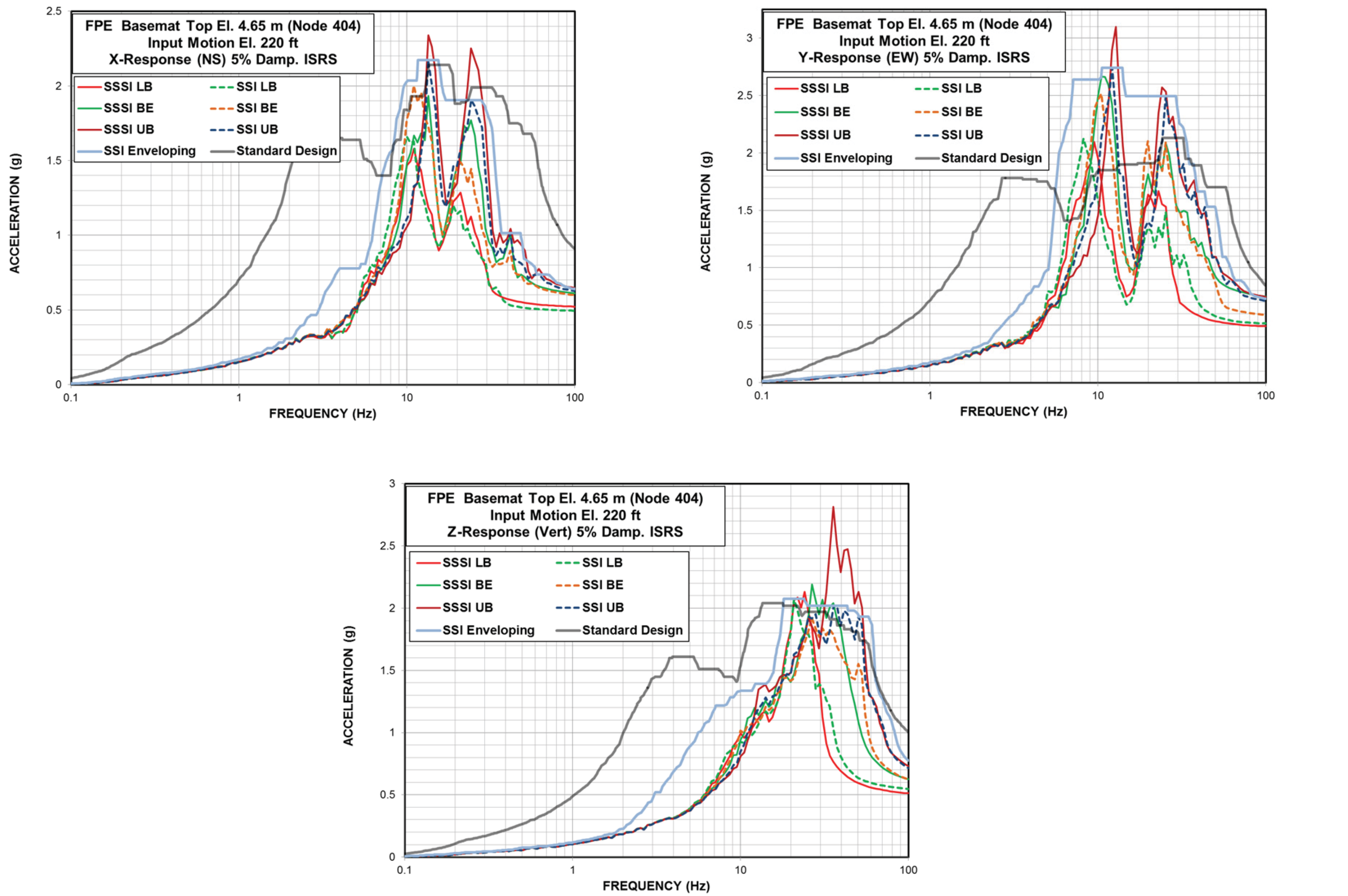


Figure 3A.17.11-209 **Exceedances of FPE Basemat ISRS due to CB SSSI Effects**



3A.17.12 Site-Specific SSI Analysis Results for RB/FB

This section presents the results of the site-specific design basis SSI analyses of the RB/FB models with upper bound stiffness properties and OBE damping values (Cases 1 through 6 in Table 3A.15-201).

3A.17.12.1 RB/FB SSI Response

The results of the site-specific SSI analysis of the RB/FB indicate that the co-directional responses (the responses in the direction of the applied earthquake) govern the site-specific seismic response of the RB/FB. The most pronounced cross-directional responses of the RB/FB basemat are observed in the results obtained from the analyses of the LB profile, thus indicating that the softer subgrade amplifies the torsional and rocking response of the RB/FB basemat. The rocking of the RB/FB basemat in the NS direction is the most significant cross directional response.

Comparisons of SSI analyses results for different embedment configurations and subgrade material properties show that the peak site-specific responses of the RB/FB are at frequencies close to the natural frequencies of structures. Variations of subgrade properties affect only the amplitudes of peak responses, with the analyses of the UB subgrade profiles yielding the largest peak response as a result of the lower damping of subgrade materials. The peak horizontal responses of the RB/FB, RCCV, and VW are at lower frequencies where the full column input motion spectra exceed the partial column spectra.

Comparisons of results obtained from the analyses of the six subgrade profiles indicate that the rock subgrade has a very small effect on the seismic response of the RB/FB. The differences in responses obtained from the analyses of different subgrade profiles are due to the differences in the subgrade material damping and the different energy content of the input motion at natural frequencies of the RB/FB structures. The analyses of the UB full column profile mostly yields bounding horizontal responses of the RB/FB, RCCV, and VW.

3A.17.12.2 Maximum Accelerations and Member Forces

Figures 3A.17.12.2-201a through 3A.17.12.2-202e present comparisons of the results for maximum absolute accelerations at the RB/FB mass locations from the site-specific design basis SSI analyses of the RB/FB model with UB stiffness and OBE damping (analyses Cases 1 through 6 in Table 3A.15-201). Table 3A.17.12.2-201 compares the maximum vertical acceleration results for the RB/FB slab SDOF oscillators obtained

from the design basis SSI analyses of the six subgrade profiles. Table 3A.17.12.2-202 compares the maximum accelerations of wall SDOF oscillators obtained from the design basis SSI analyses.

Figures 3A.17.12.2-203a through 3A.17.12.2-204e present comparisons of the maximum shear forces and torsion results obtained from the design basis SSI analyses of the RB/FB partially embedded and RB/FB fully embedded models. Comparisons of the maximum member force and acceleration results show that the analyses of the UB subgrade profiles typically govern the RB/FB maximum responses.

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Table 3A.17.12.2-201 **Maximum Accelerations of Slab SDOF Oscillators – RB/FB**

SDOF Oscillator		Vertical Acceleration (g)							
		Full Column			Partial Column			Enve-lope	Stan-dard Design
Elev. (m)	Node No.	LB	BE	UB	LB	BE	UB		
52.40	9101	*0.33*	0.33	0.32	0.30	0.30	0.30	0.33	1.20
	9102	*1.33*	1.29	1.28	0.80	0.79	0.77	1.33	1.82
	9103	3.90	5.58	*6.27*	2.91	4.11	4.79	6.27	3.14
	9104	2.02	2.38	*2.62*	1.89	2.01	2.26	2.62	2.45
	9105	1.60	2.27	*2.42*	1.62	2.10	2.17	2.42	2.32
	9106	2.44	3.09	3.52	2.11	3.06	*3.74*	3.74	2.99
	9107	1.42	2.31	*3.22*	1.59	2.08	3.08	3.22	2.80
	9108	1.12	1.69	*2.50*	1.24	1.49	2.09	2.50	2.61
34.00	9091	0.94	1.42	*1.61*	0.79	1.03	1.29	1.61	1.29
	9092	0.88	1.11	*1.61*	0.85	1.07	1.34	1.61	1.08
27.00	9081	1.15	1.36	*1.60*	1.00	1.10	1.26	1.60	1.16
	9082	0.89	1.17	*1.52*	0.76	0.93	1.26	1.52	0.99
	9083	0.78	1.06	*1.30*	0.74	0.84	1.06	1.30	1.09
	9084	0.73	1.25	*1.67*	0.90	0.99	1.42	1.67	1.32
	9085	0.86	1.14	*1.46*	0.72	0.89	1.19	1.46	0.97
22.50	9071	*1.15*	1.15	1.15	0.64	0.65	0.67	1.15	1.60
	9072	*1.79*	1.70	1.64	1.12	1.07	1.03	1.79	1.31
	9073	2.37	3.56	*4.47*	1.84	2.57	3.13	4.47	2.03
	9074	0.93	1.24	*1.53*	0.87	1.07	1.25	1.53	1.31
	9075	1.04	1.29	*1.51*	0.98	1.08	1.32	1.51	1.16
17.50	9061	1.97	3.00	*3.65*	1.61	2.30	2.90	3.65	1.79
	9062	1.15	1.57	2.40	1.37	1.68	*2.62*	2.62	1.49
	9063	0.77	0.96	*1.13*	0.64	0.82	0.98	1.13	0.82
	9064	1.14	1.38	*1.53*	0.93	1.07	1.17	1.53	1.84
	9065	0.59	1.00	*1.28*	0.80	0.93	1.24	1.28	1.42

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Table 3A.17.12.2-201 **Maximum Accelerations of Slab SDOF Oscillators – RB/FB** *(continued)*

SDOF Oscillator		Vertical Acceleration (g)							
		Full Column			Partial Column			Enve-lope	Stan-dard Design
Elev. (m)	Node No.	LB	BE	UB	LB	BE	UB		
13.57	9051	0.74	0.95	*1.11*	0.64	0.82	0.96	1.11	0.81
	9052	0.59	0.94	*1.25*	0.75	0.89	1.22	1.25	1.46
9.06	9041	0.83	0.84	*0.95*	0.69	0.76	0.82	0.95	0.88
	9042	0.61	0.94	*1.26*	0.70	0.85	1.19	1.26	1.42
4.65	9031	0.84	1.42	*1.62*	0.98	1.41	1.59	1.62	1.17
	9032	0.79	0.86	*0.89*	0.69	0.74	0.84	0.89	0.97
	9033	0.78	0.93	*1.12*	0.78	0.85	0.98	1.12	1.02
	9034	0.60	1.20	*1.73*	1.10	1.16	1.81	1.81	1.51
	9035	0.57	0.87	*1.07*	0.69	0.77	1.05	1.07	1.38
-1.00	9021	0.92	0.86	*0.97*	0.88	0.84	0.92	0.97	1.12
	9022	1.26	1.60	1.90	0.99	1.64	*2.07*	2.07	1.45
	9023	0.80	0.92	*0.98*	0.75	0.79	0.89	0.98	1.01
	9024	0.72	0.98	*1.12*	0.67	0.94	1.03	1.12	0.89
	9025	0.55	1.00	1.14	0.75	0.85	*1.21*	1.21	1.34
	9026	0.54	1.06	1.38	1.06	1.22	*1.63*	1.63	1.57
	9027	0.55	0.65	0.67	0.54	0.57	*0.68*	0.68	0.88
-6.40	9011	0.77	0.76	*0.84*	0.73	0.76	0.84	0.84	0.92
	9012	0.68	1.03	*1.17*	0.76	1.05	1.13	1.17	0.92
	9013	0.71	0.88	1.35	0.68	0.93	1.52	1.52	1.35

Note: The shaded values in the table show exceedances from the standard design.
The values shown in Italics are the governing case.

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Table 3A.17.12.2-202 **Maximum Accelerations of Wall SDOF Oscillators – RB/FB**

SDOF Oscillator			Horizontal Acceleration (g)							
			Full Column			Partial Column			Envelope	Standard Design
Elev. (m)	Node No.	Dir.	LB	BE	UB	LB	BE	UB		
42.00	99981	NS (X)	1.73	2.32	*2.66*	1.45	1.93	2.20	2.66	1.54
	99982		1.07	1.46	*1.54*	0.93	1.22	1.53	1.54	1.00
13.57	99971		1.19	1.66	*2.11*	1.21	1.51	1.81	2.11	1.38
	99972		1.57	1.46	2.00	1.84	1.90	*2.29*	2.29	1.37
	99973		0.73	1.19	1.35	0.91	1.26	*1.88*	1.88	1.15
	99974		0.64	0.74	1.04	0.59	0.81	*1.10*	1.10	1.00
42.00	99983	EW (Y)	1.27	1.45	*1.86*	1.09	1.26	1.59	1.86	1.71
	99984		0.98	0.89	*1.02*	0.75	0.99	1.00	1.02	1.56
	99985		0.88	0.89	*1.00*	0.68	0.75	0.85	1.00	1.25
13.57	99975		1.10	1.50	1.66	1.38	1.74	*2.16*	2.16	1.28
	99976		0.43	0.64	0.78	0.53	0.69	*0.92*	0.92	1.00

Note: The shaded values in the table show exceedances from the standard design.
The values shown in Italics are the governing case.

Figure 3A.17.12.2-201a **Fuel Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**

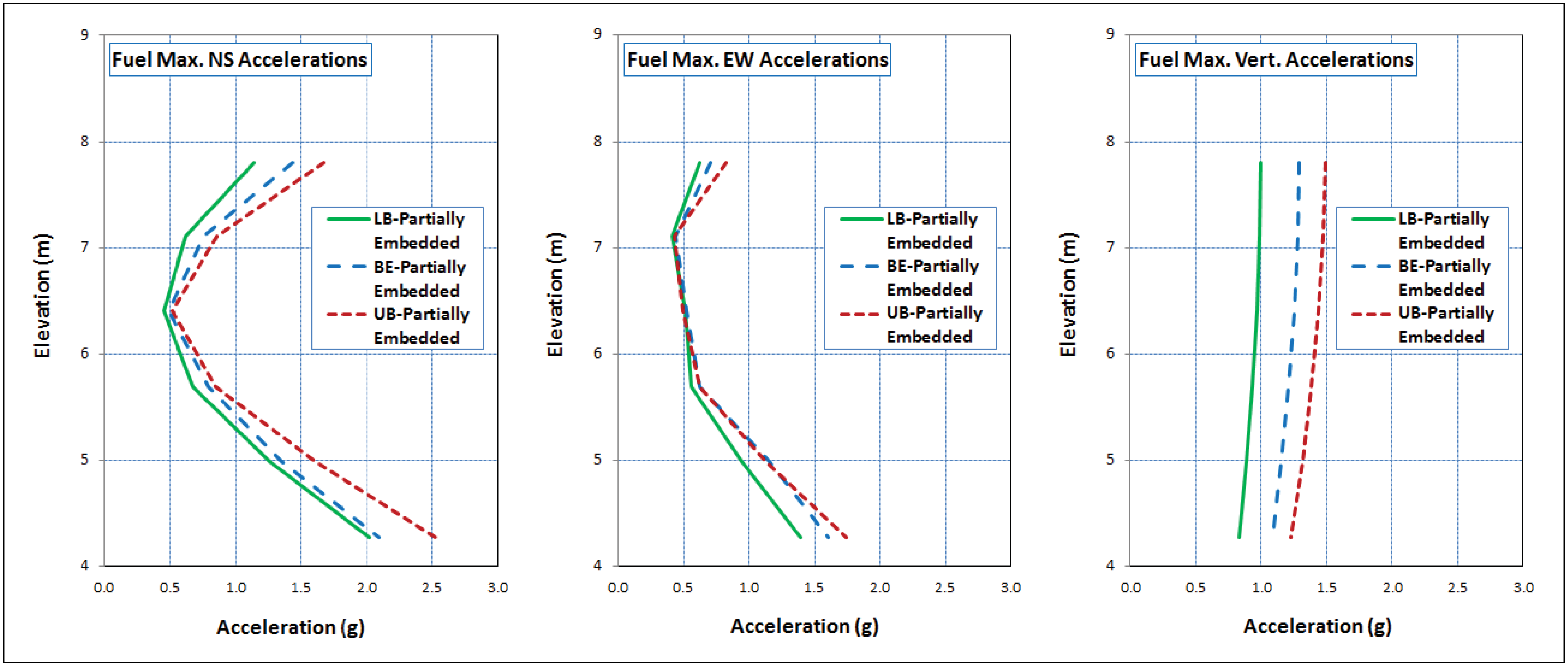


Figure 3A.17.12.2-201b **RB/FB Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**

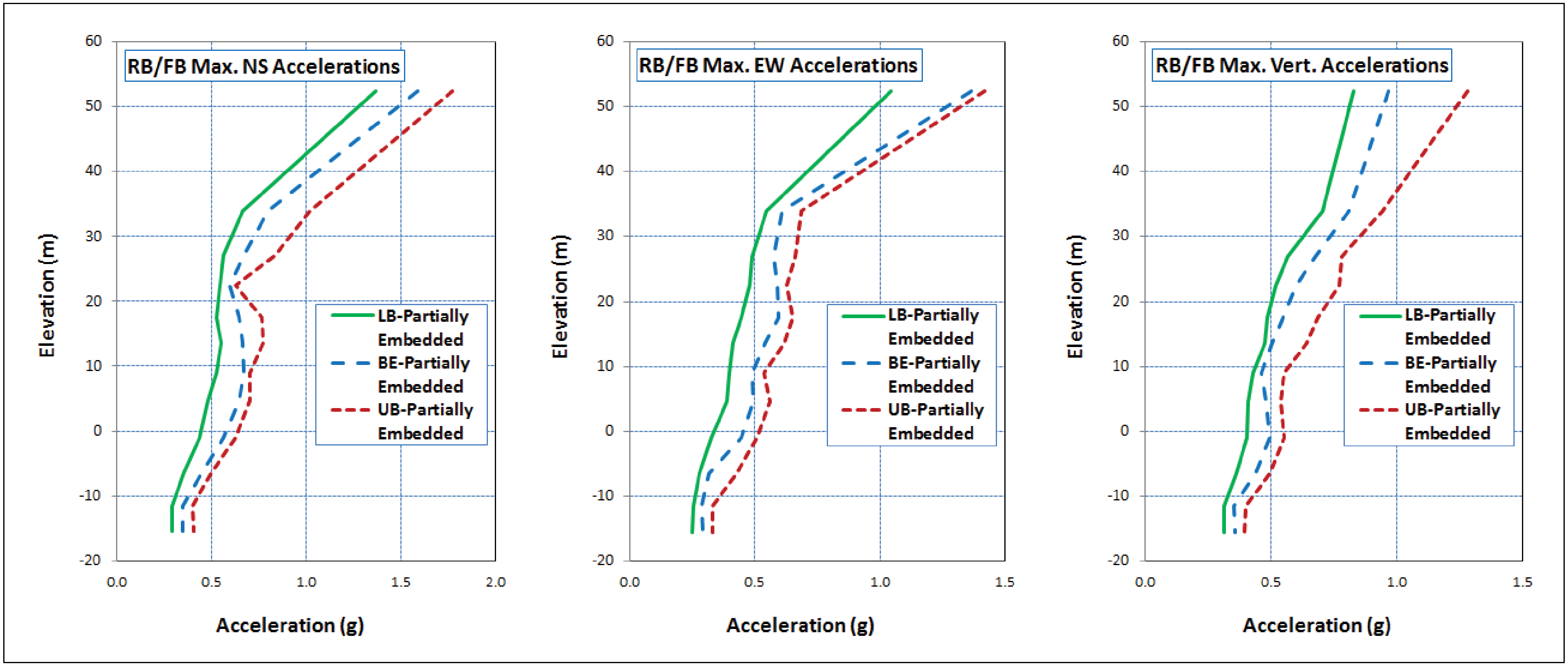


Figure 3A.17.12.2-201c **RCCV Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**

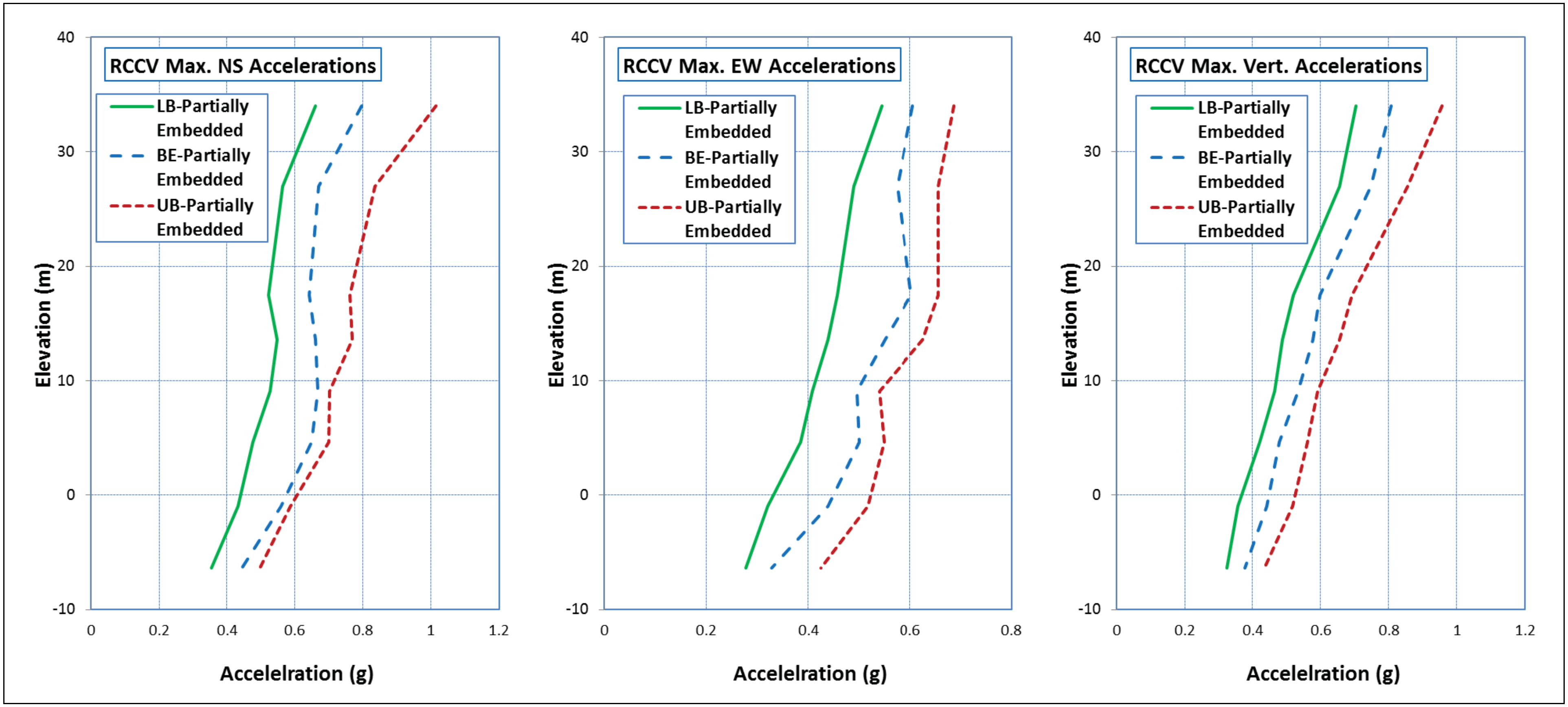


Figure 3A.17.12.2-201d **VW/Pedestal Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**

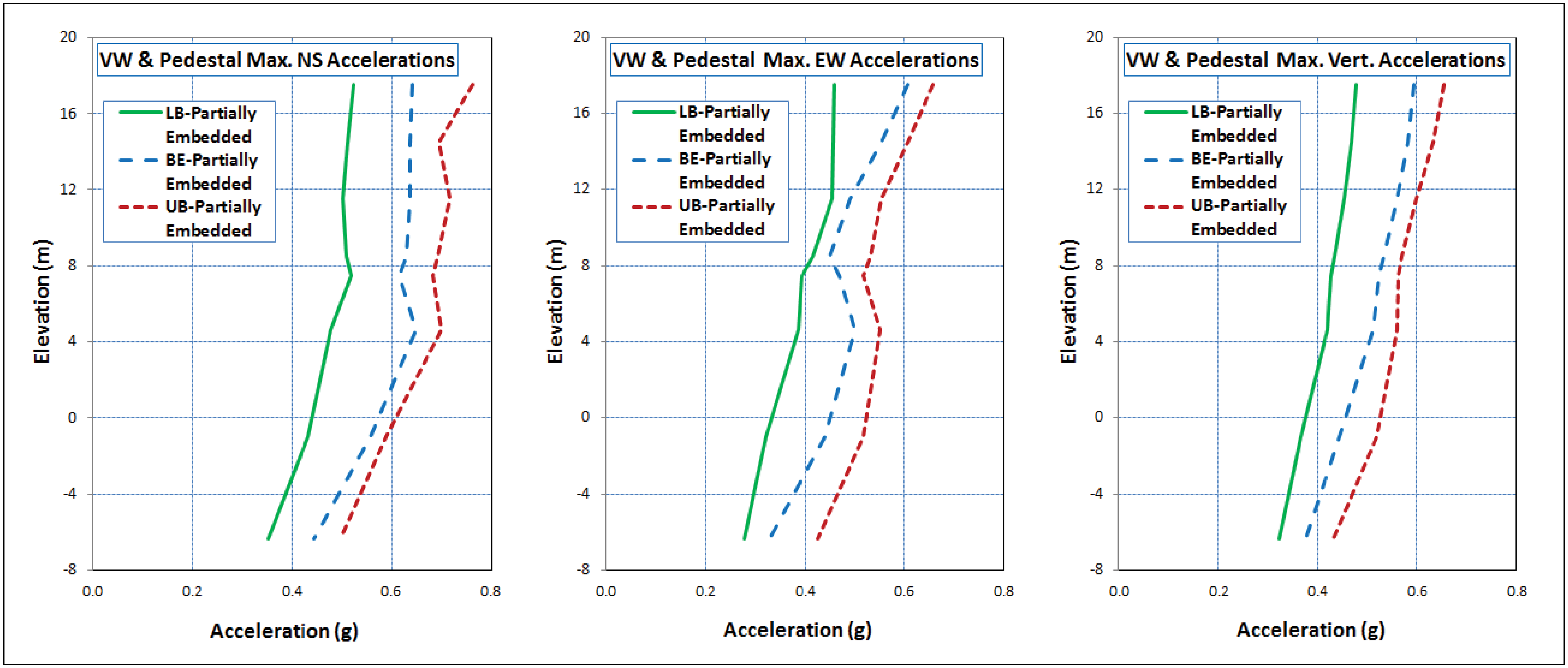


Figure 3A.17.12.2-201e **RSW Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**

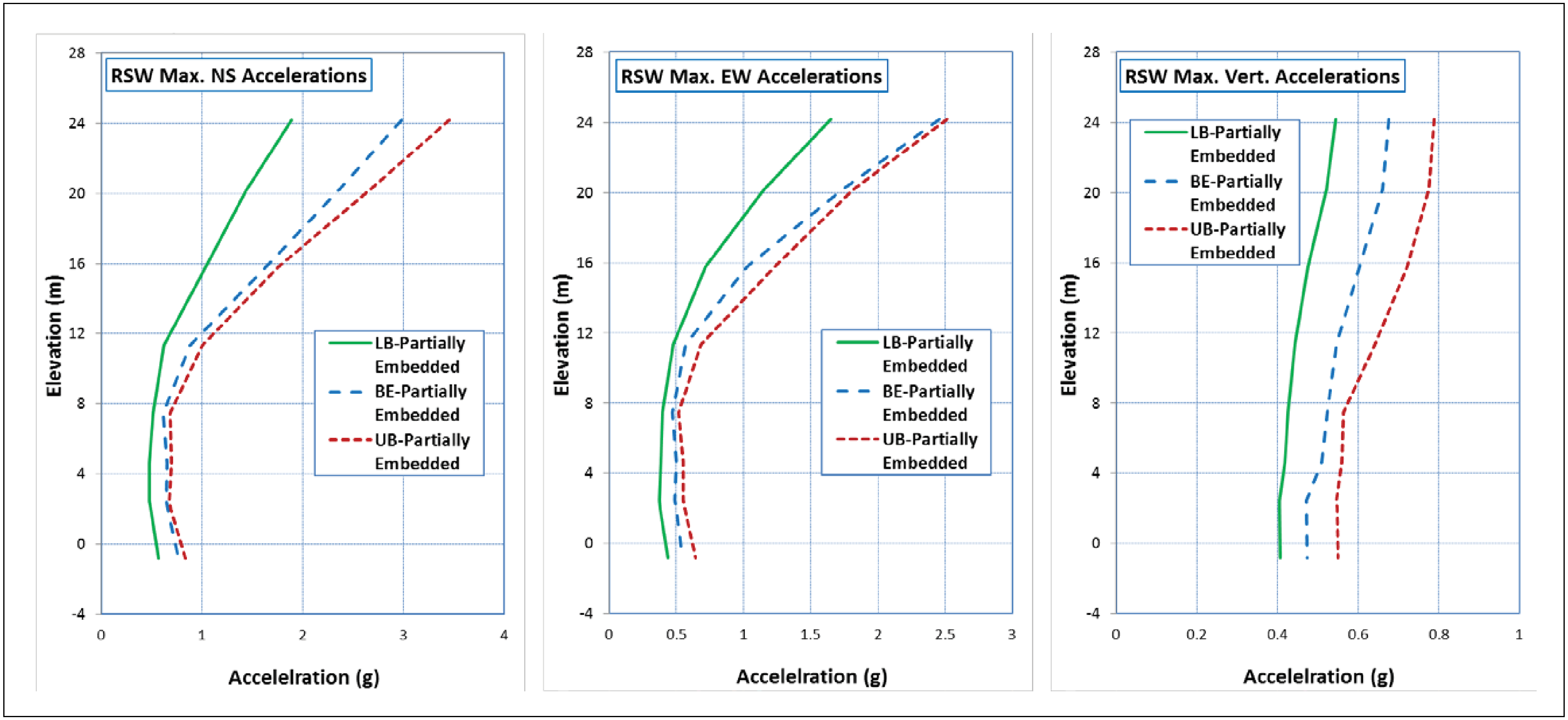


Figure 3A.17.12.2-202a **Fuel Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**

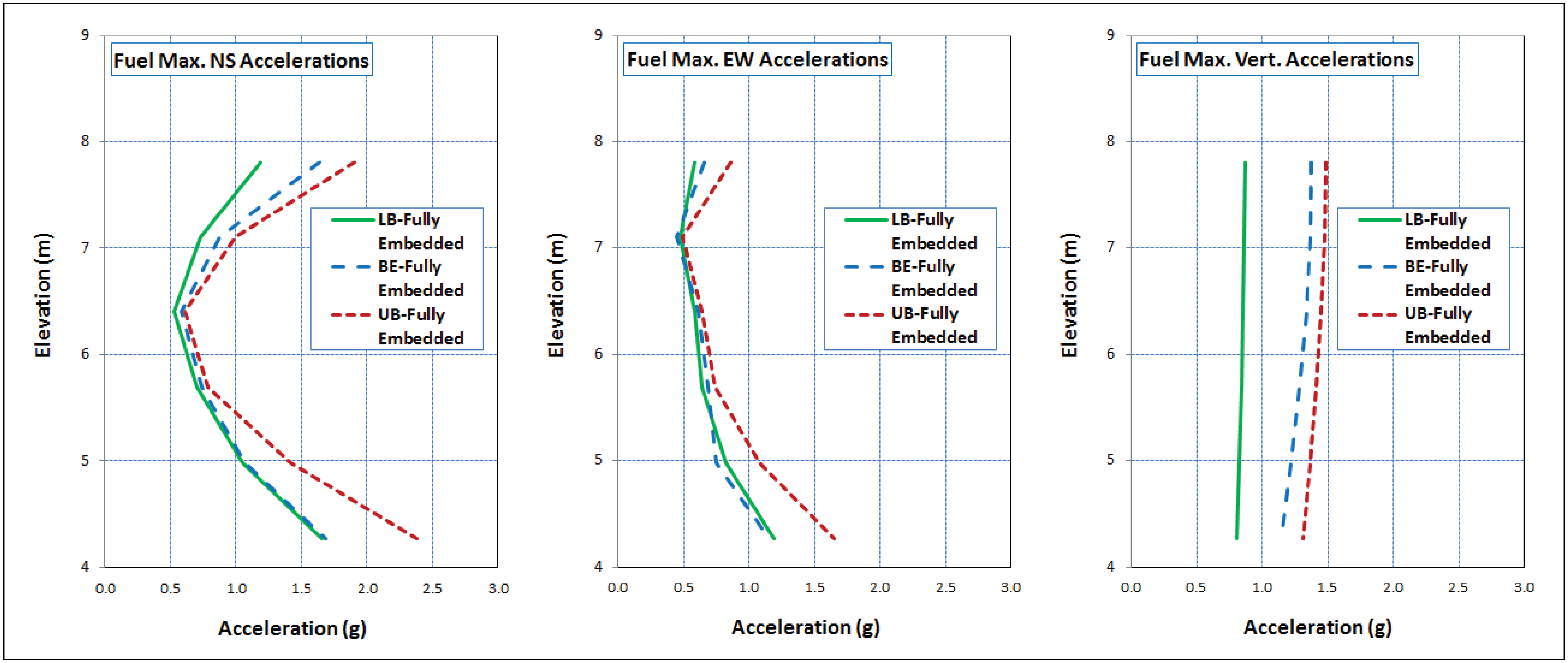


Figure 3A.17.12.2-202b **RB/FB Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**

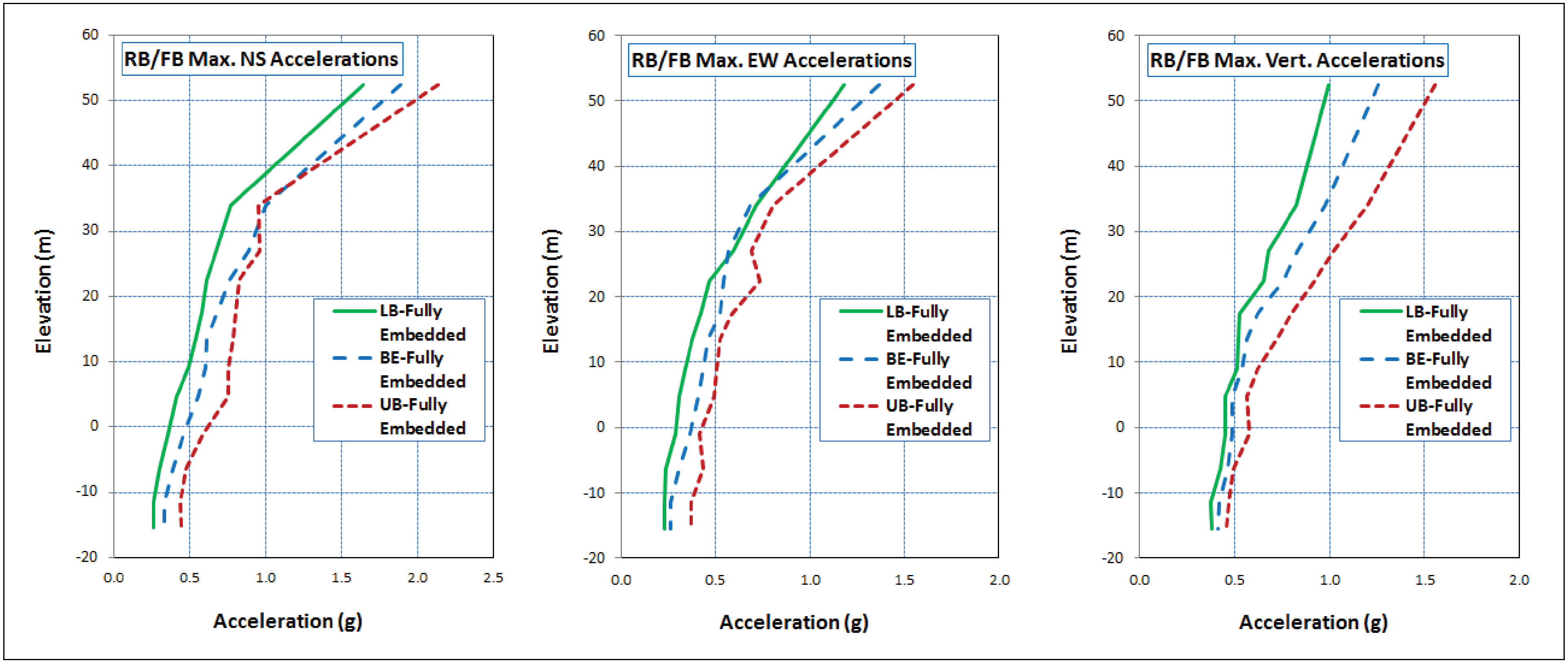


Figure 3A.17.12.2-202c **RCCV Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**

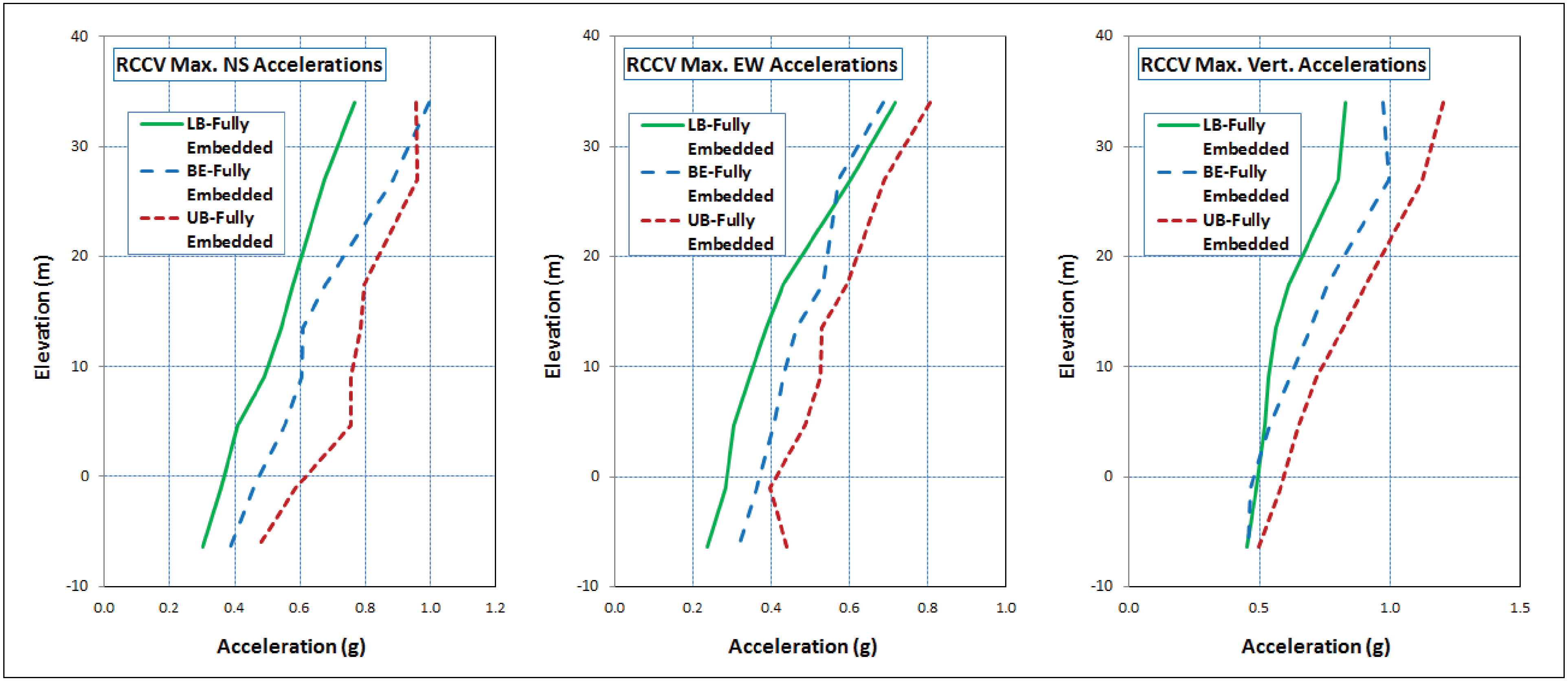
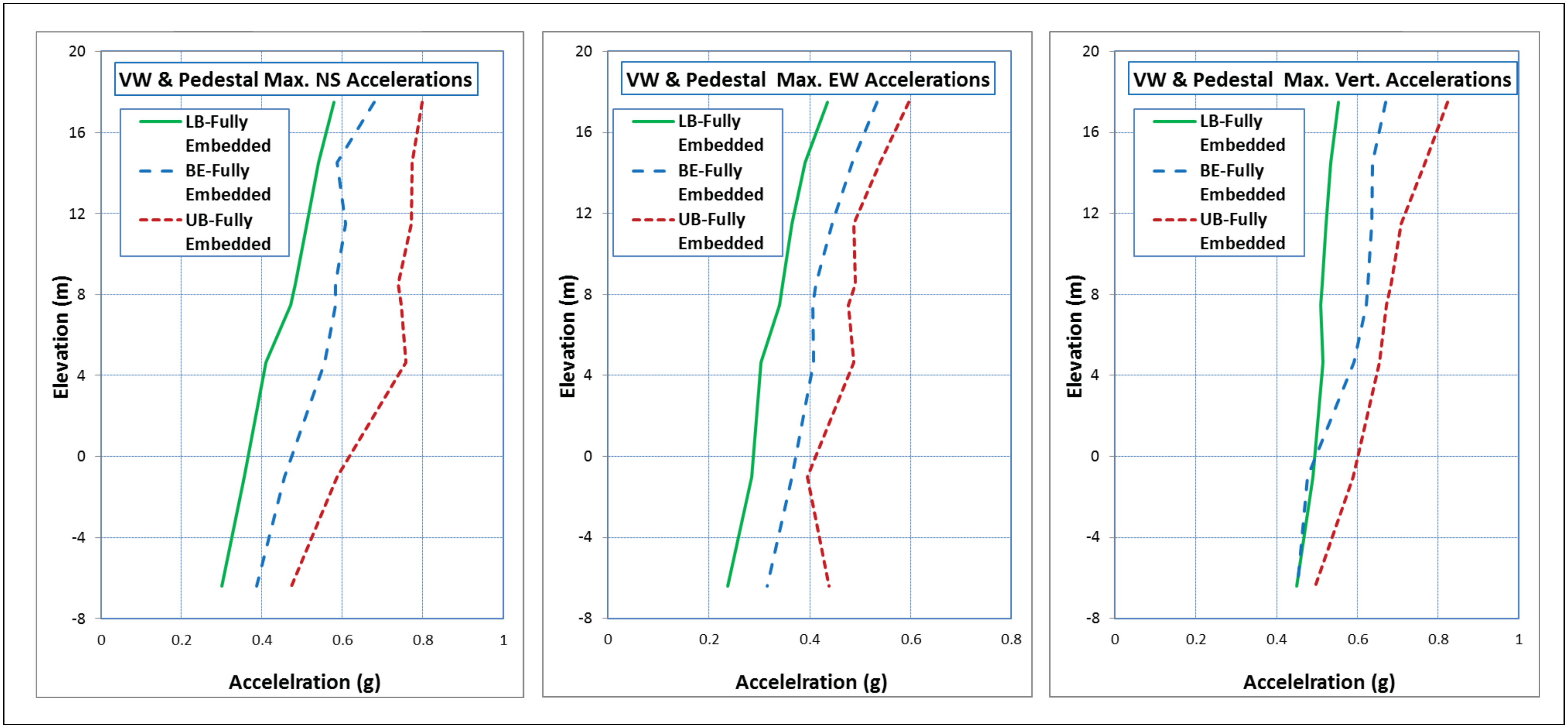


Figure 3A.17.12.2-202d **VW/Pedestal Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**



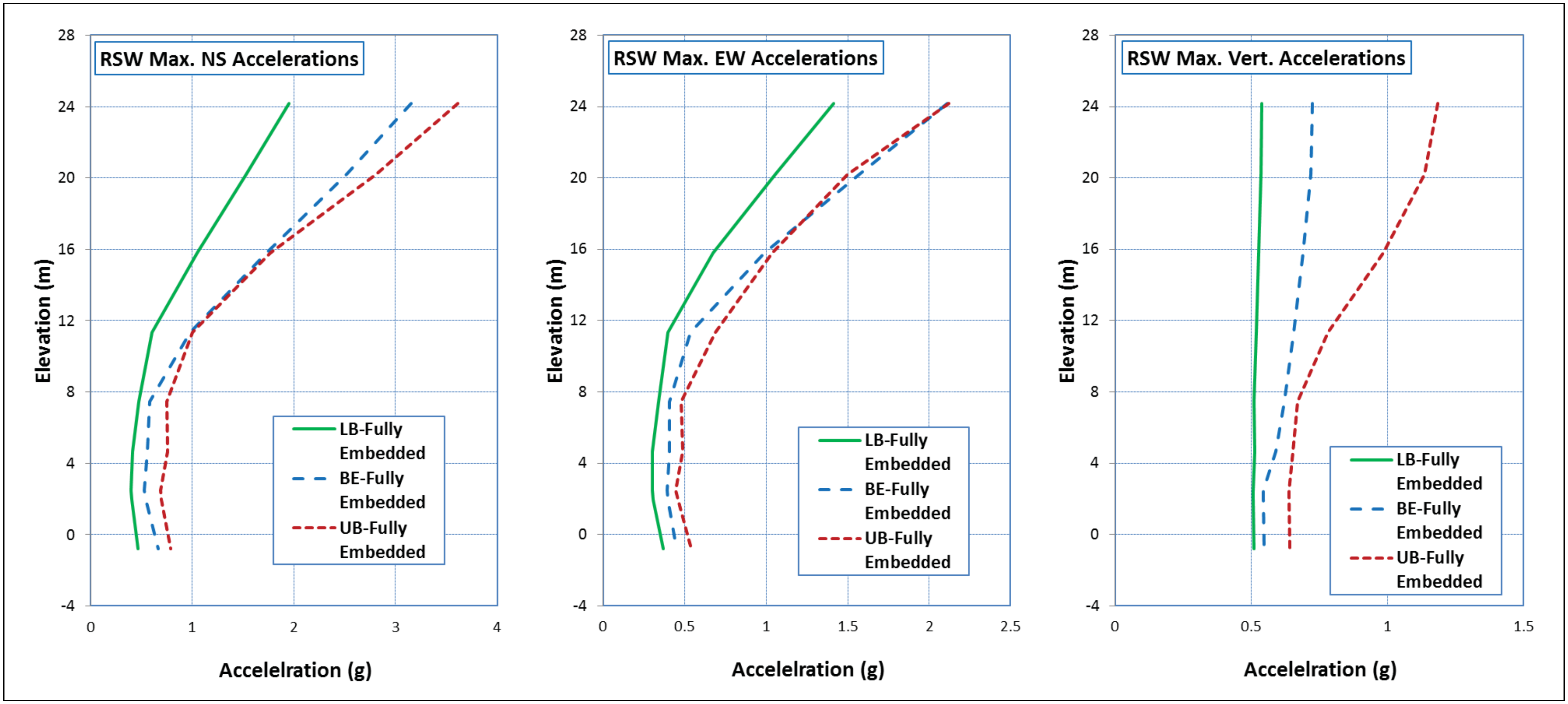


Figure 3A.17.12.2-202e **RSW Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**

Figure 3A.17.12.2-203a **RB/FB Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

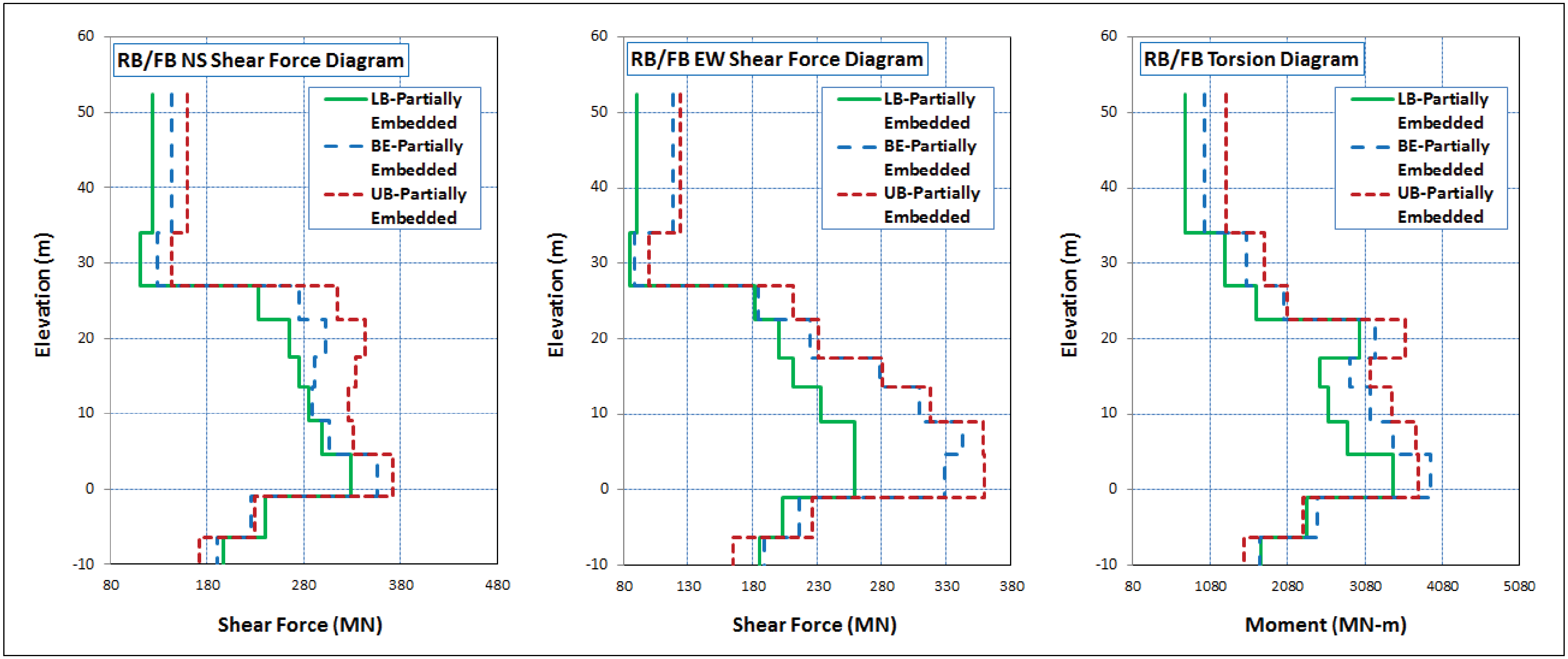


Figure 3A.17.12.2-203b **RCCV Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

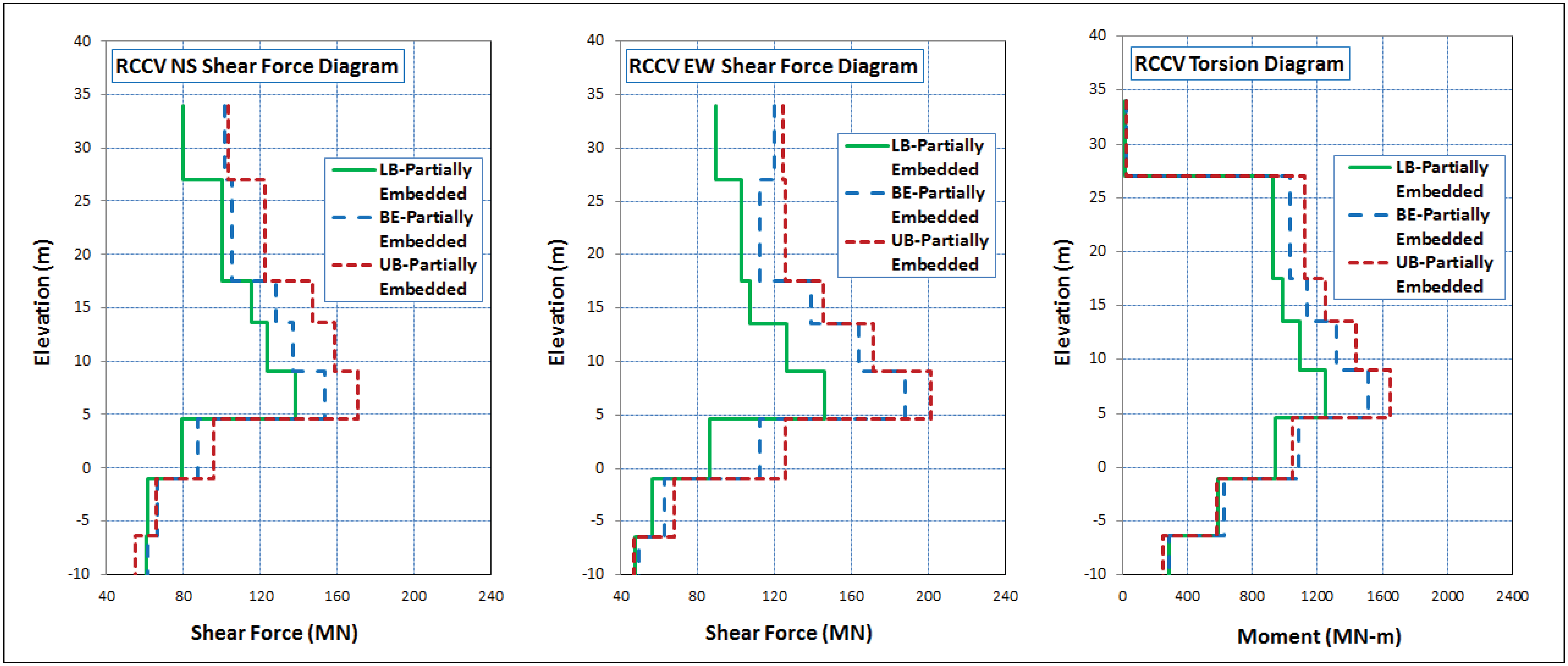


Figure 3A.17.12.2-203c **VW Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

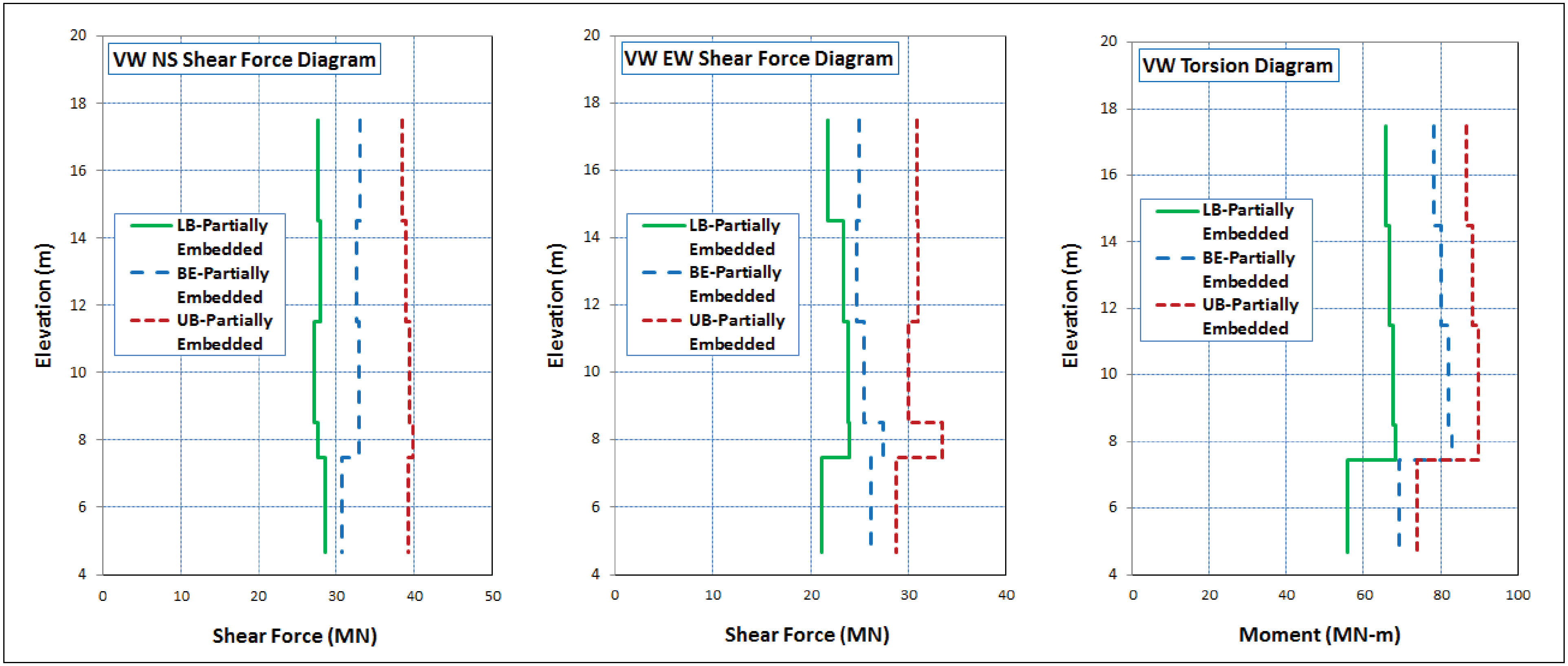


Figure 3A.17.12.2-203d **Pedestal Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

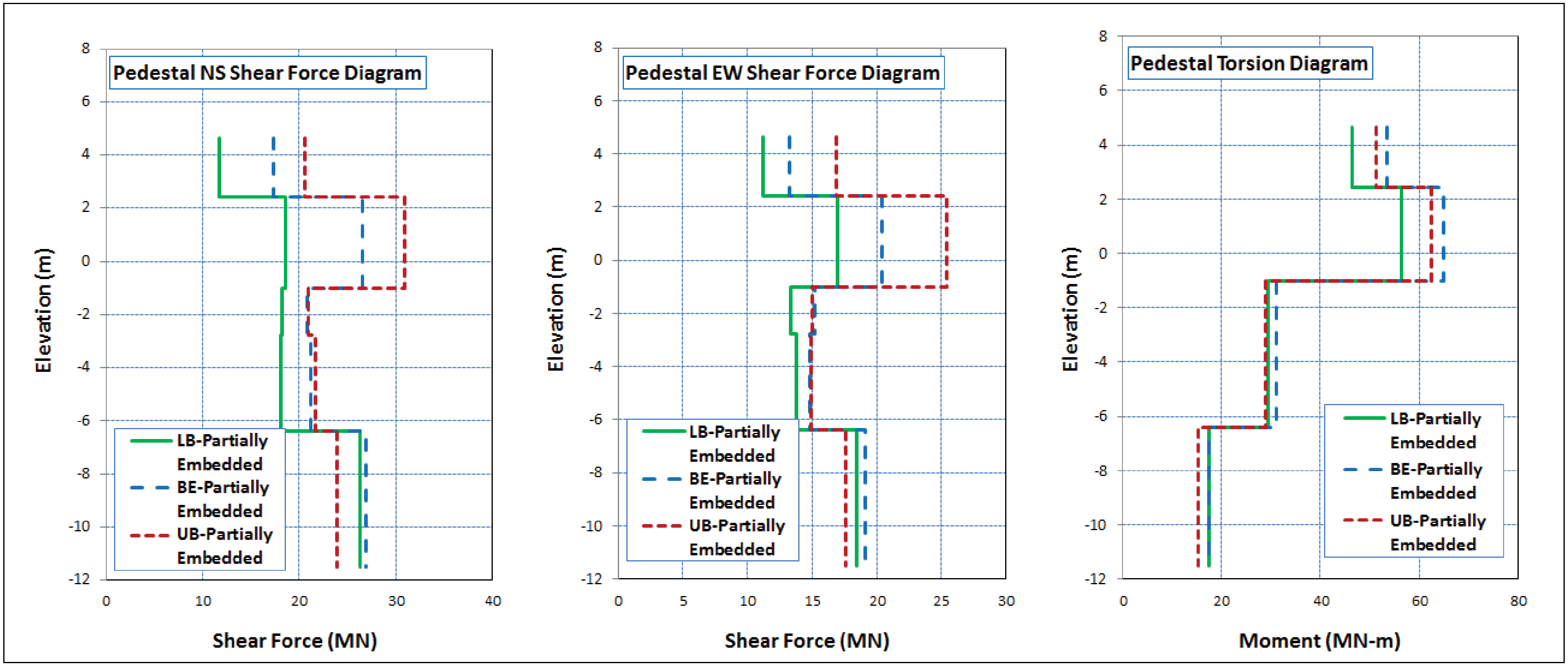


Figure 3A.17.12.2-203e **RSW Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

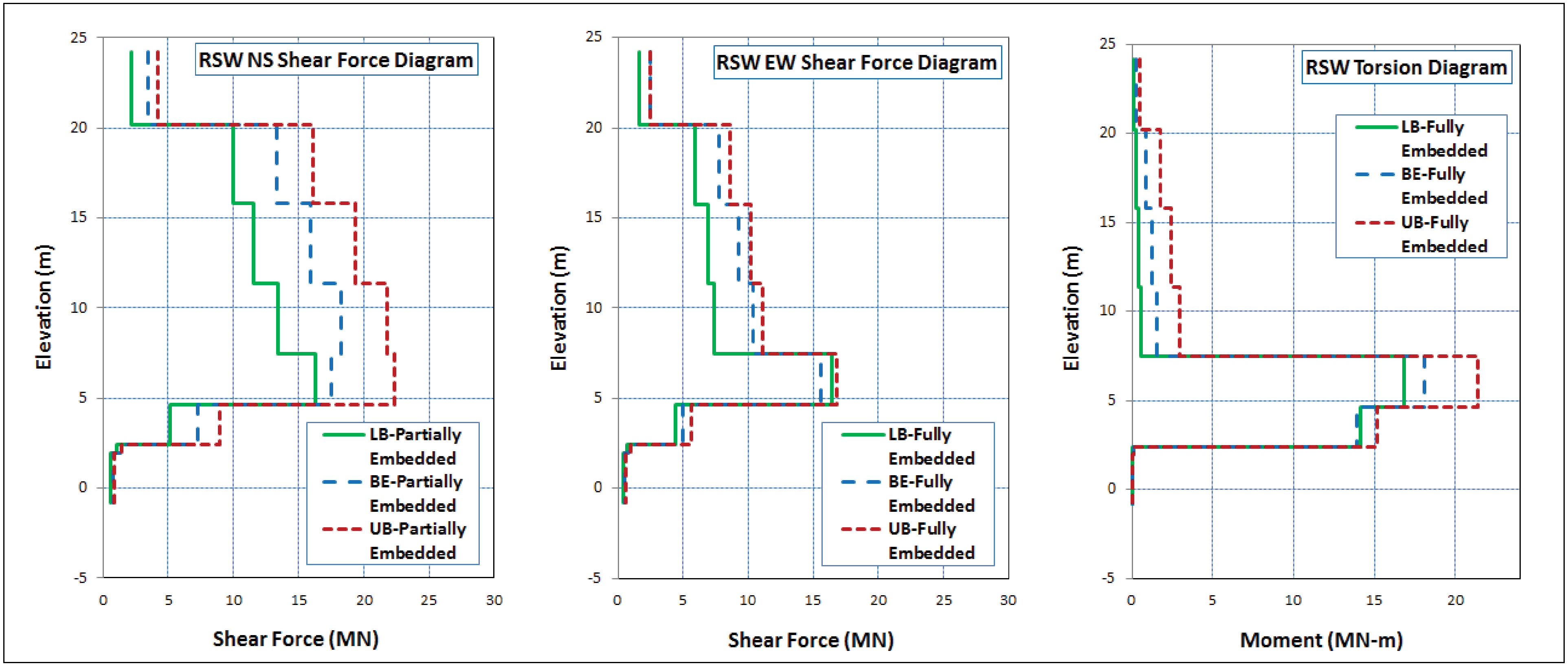


Figure 3A.17.12.2-204a **RB/FB Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**

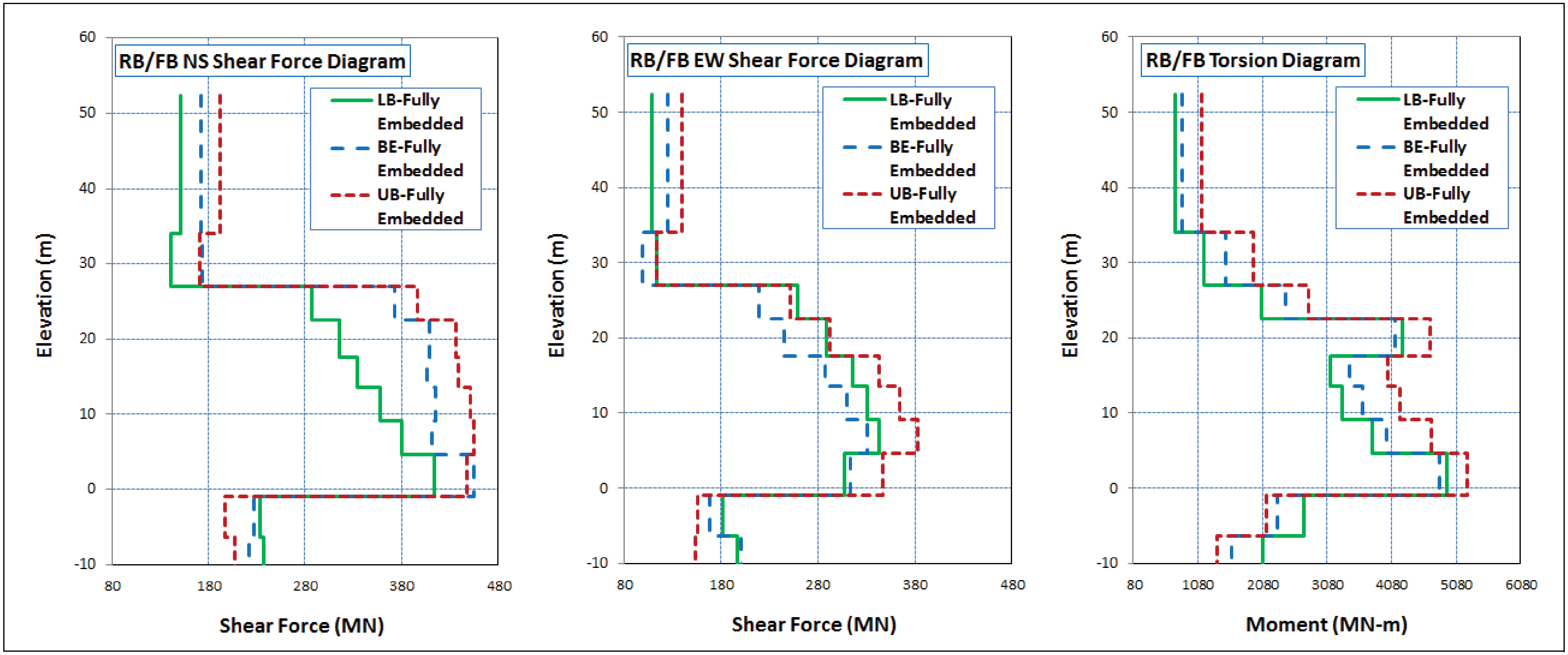


Figure 3A.17.12.2-204b **RCCV Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**

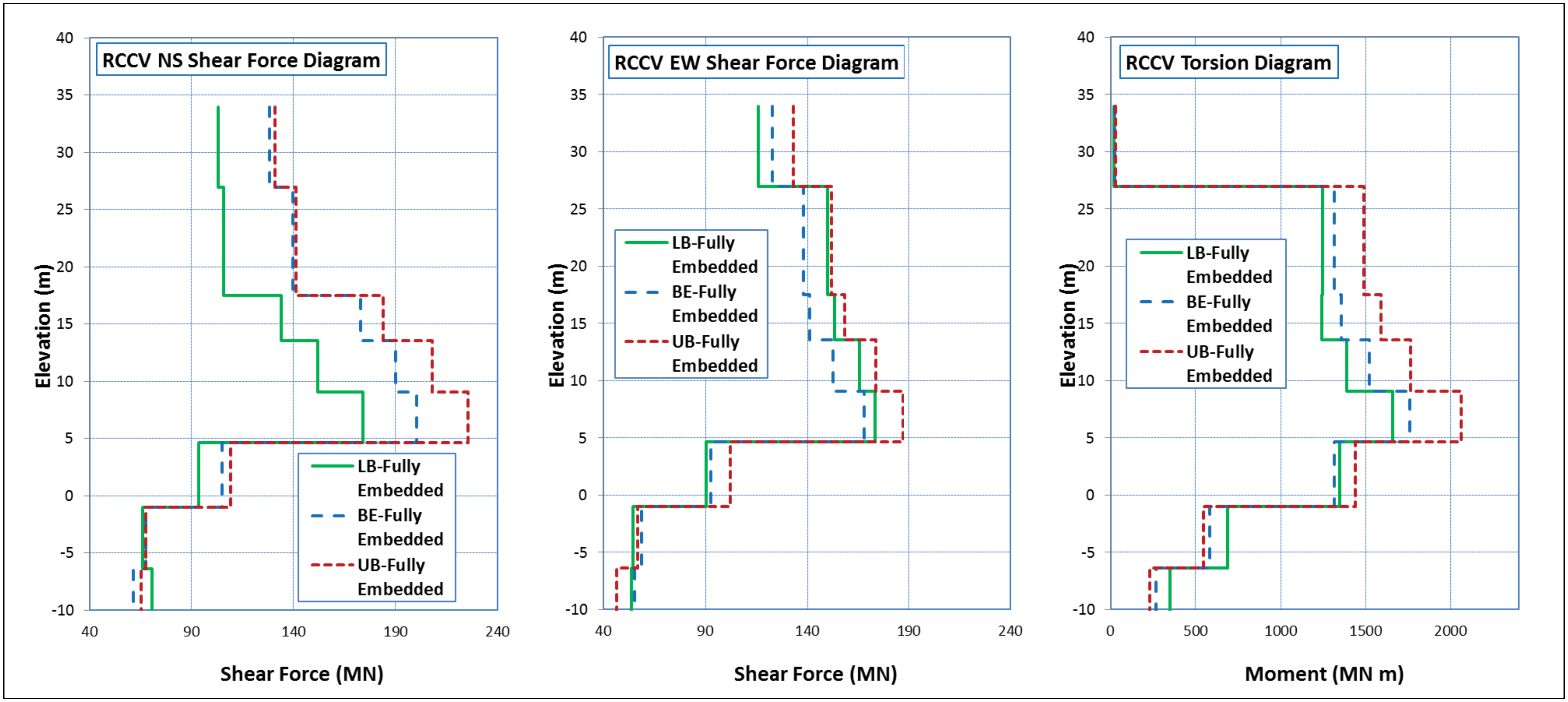


Figure 3A.17.12.2-204c **VW Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**

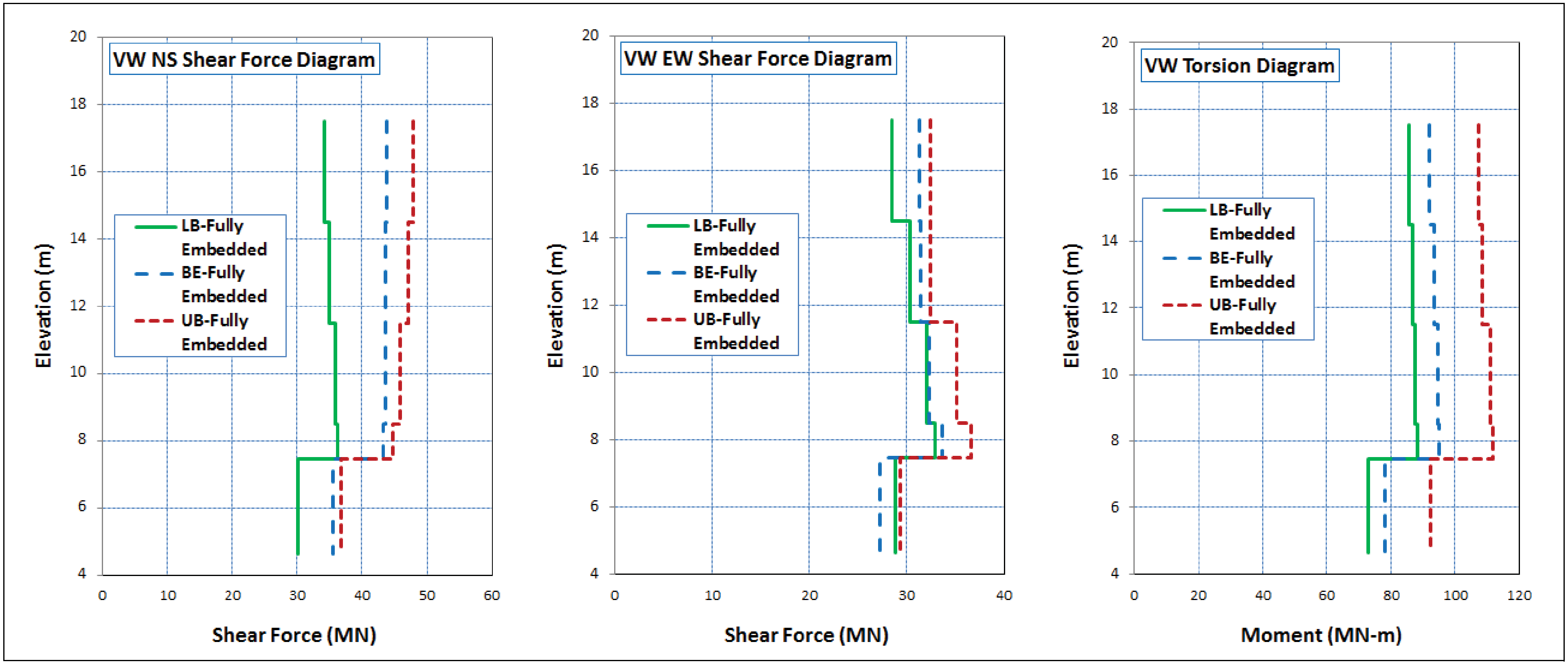


Figure 3A.17.12.2-204d **Pedestal Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**

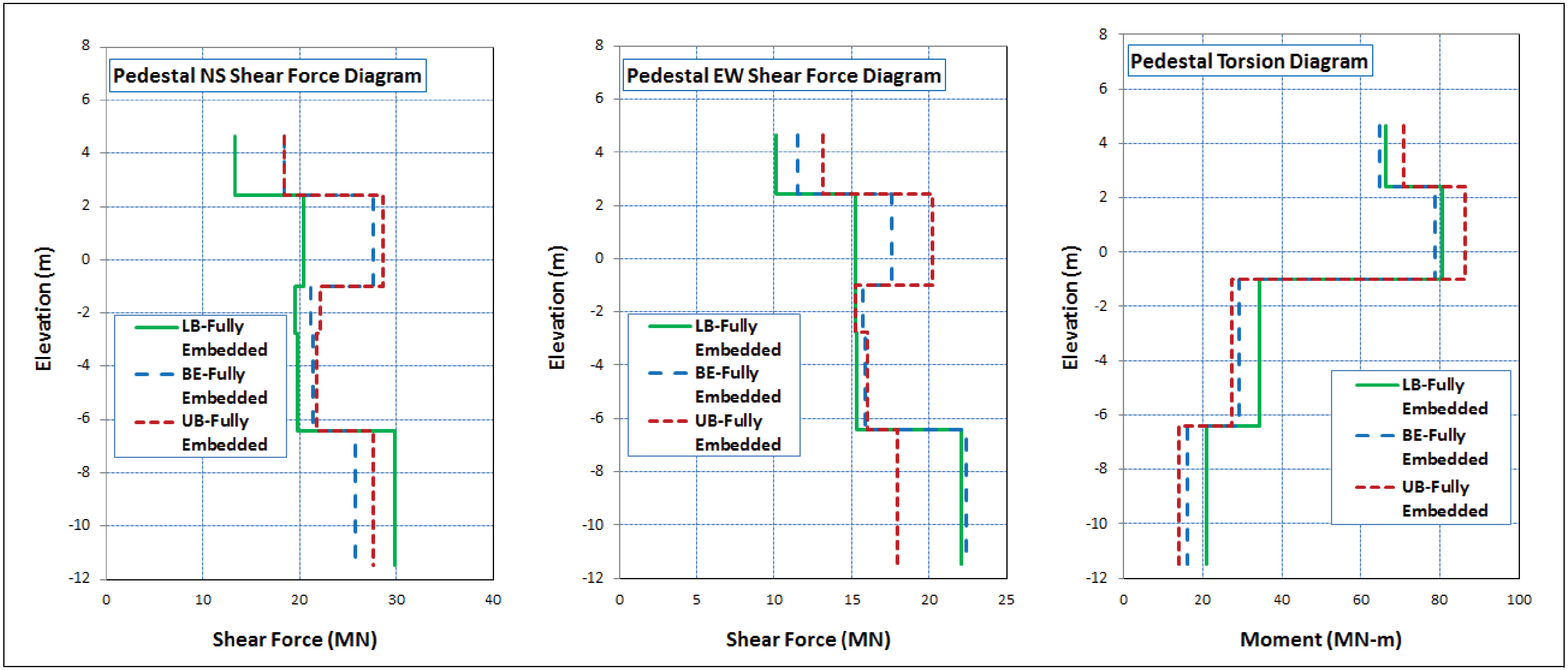
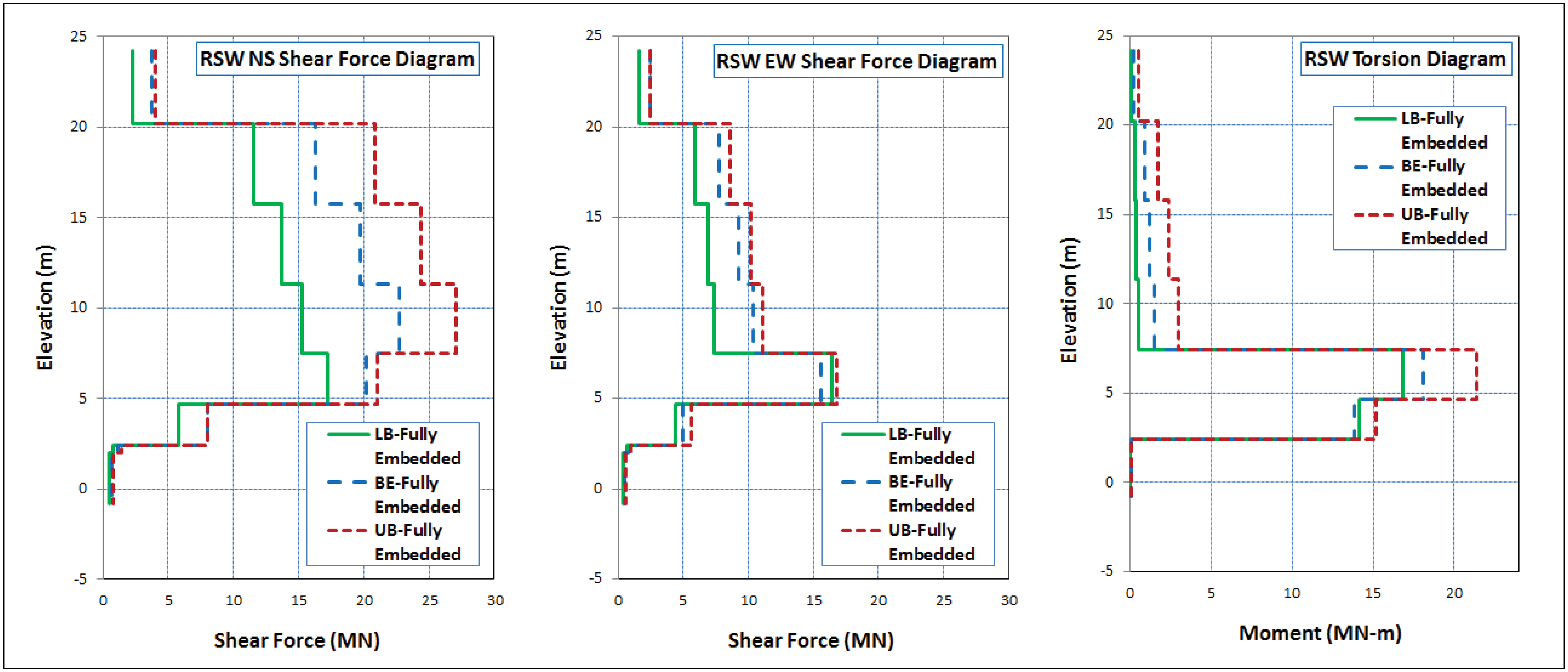


Figure 3A.17.12.2-204e **RSW Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**



3A.17.12.3 Acceleration Response Spectra

Comparisons of the 5 percent damped ARS, referred herein as ISRS, results of the design basis analysis Cases 1 through 6 in Table 3A.15-201 are presented for selected locations within the RB/FB and selected slab and wall oscillators at different elevations. Floor ISRS are obtained for particular floor elevations as the envelope of responses at the four outrigger locations. The ISRS for the out-of-plane response of flexible slabs and walls are obtained from the seismic response calculated for SDOF oscillator mass nodes. The ISRS obtained from the analyses of the three orthogonal components of the earthquake motion are combined using the SRSS method.

Figures 3A.17.12.3-201a through 3A.17.12.3-201f, 3A.17.12.3-202a through 3A.17.12.3-202f, and 3A.17.12.3-203a through 3A.17.12.3-203f compare the 5 percent damped ISRS for the response in NS(X), EW(Y) and vertical (Z) directions at key locations within the RB/FB, obtained from the SSI analyses of the RB/FB partially embedded (PE) and fully embedded (FE) models, with UB stiffness properties and OBE damping values (Cases 1 to 6 in Table 3A.15-201) with the corresponding 5 percent damped standard design enveloping ISRS in DCD Section 3A.9.

The comparison of the ISRS results obtained from the different site-specific SSI analysis cases shows that the responses obtained from the analyses of the UB subgrade profiles govern with the exception of narrow frequency intervals (< 25 Hz) where the analyses of the BE and LB profiles can be bounding. The results from the analyses of the full column profiles bound the horizontal ISRS for frequencies between 3 Hz and 8 Hz and, in general, bound the vertical ISRS for frequencies between 3 Hz and 15 Hz, reflecting the higher energy content of the full column input motion at lower frequencies.

The comparisons in Figures 3A.17.12.3-201a through 3A.17.12.3-203f indicate that the site-specific ISRS exceed the corresponding standard design ISRS, mainly above 10 Hz where the site-specific FIRS exceed the CSDRS. The peak exceedances occur in the site-specific horizontal ISRS close to the natural frequencies of the containment internal structures (10 Hz to 30 Hz). The site-specific vertical ISRS exceed the standard design ISRS at frequencies above 10 Hz.

Additionally, a review of site-specific SSI analyses results indicates that there are exceedances in SDOF oscillator ISRS representing the

out-of-plane response of RB/FB flexible slabs and walls that occur mainly at frequencies corresponding to the frequencies of the oscillators. Figures 3A.17.12.3-204a through 3A.17.12.3-204c show selected examples of slab and wall oscillator ISRS.

The site-specific ISRS exceed the standard design enveloping ISRS due to the lower OBE structural damping values used for the site-specific SSI analyses versus the SSE damping values used for standard design SSI analyses. The fact that the site-specific design motion has higher energy content than the standard design CSDRS at frequencies close to the SSI frequencies of the RB/FB structure also explains the exceedances in ISRS.

Figure 3A.17.12.3-201a **Comparison of ISRS – RB/FB Refueling Floor in NS (X)-Direction**

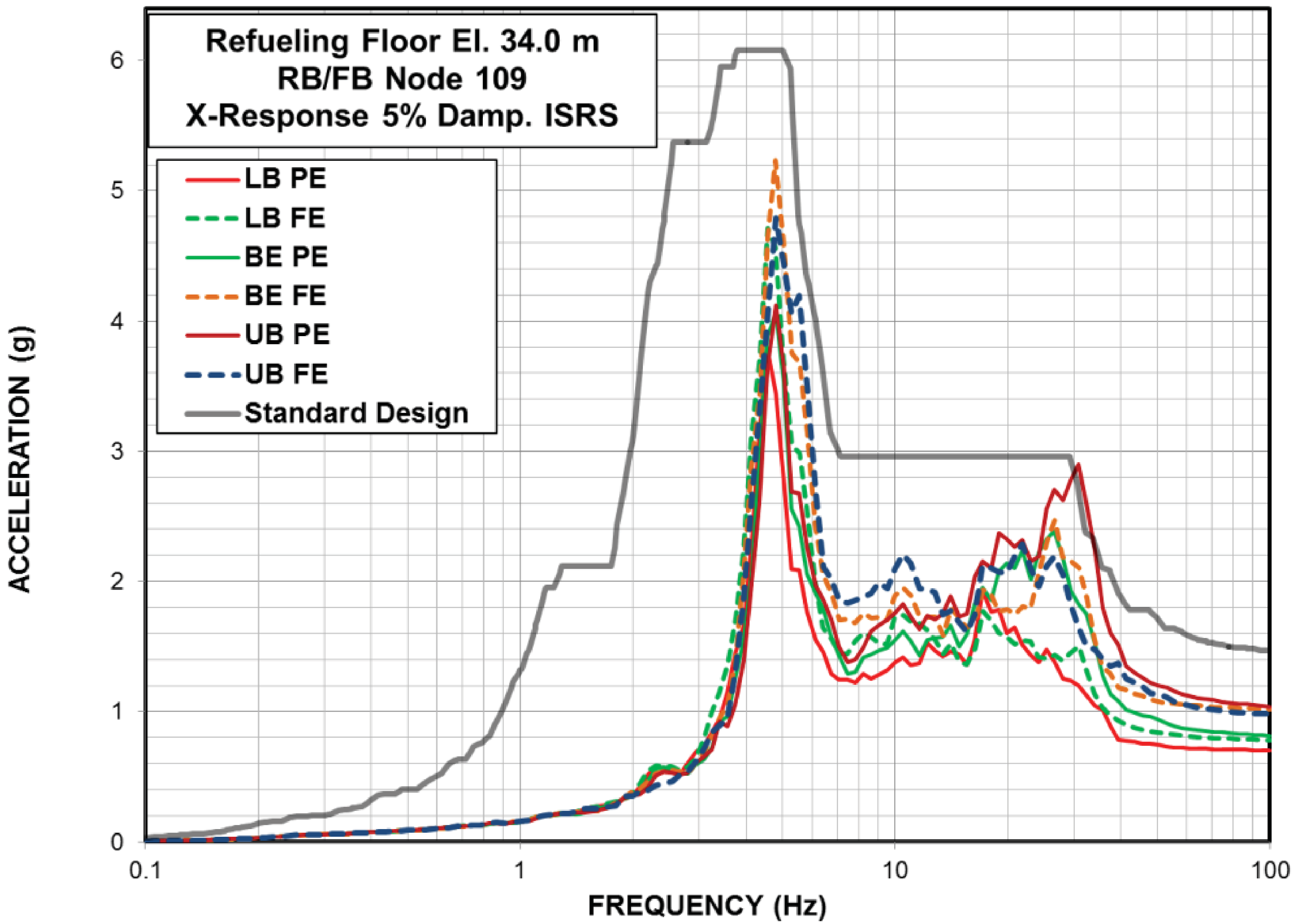


Figure 3A.17.12.3-201b **Comparison of ISRS - RCCV Top Slab in NS (X)-Direction**

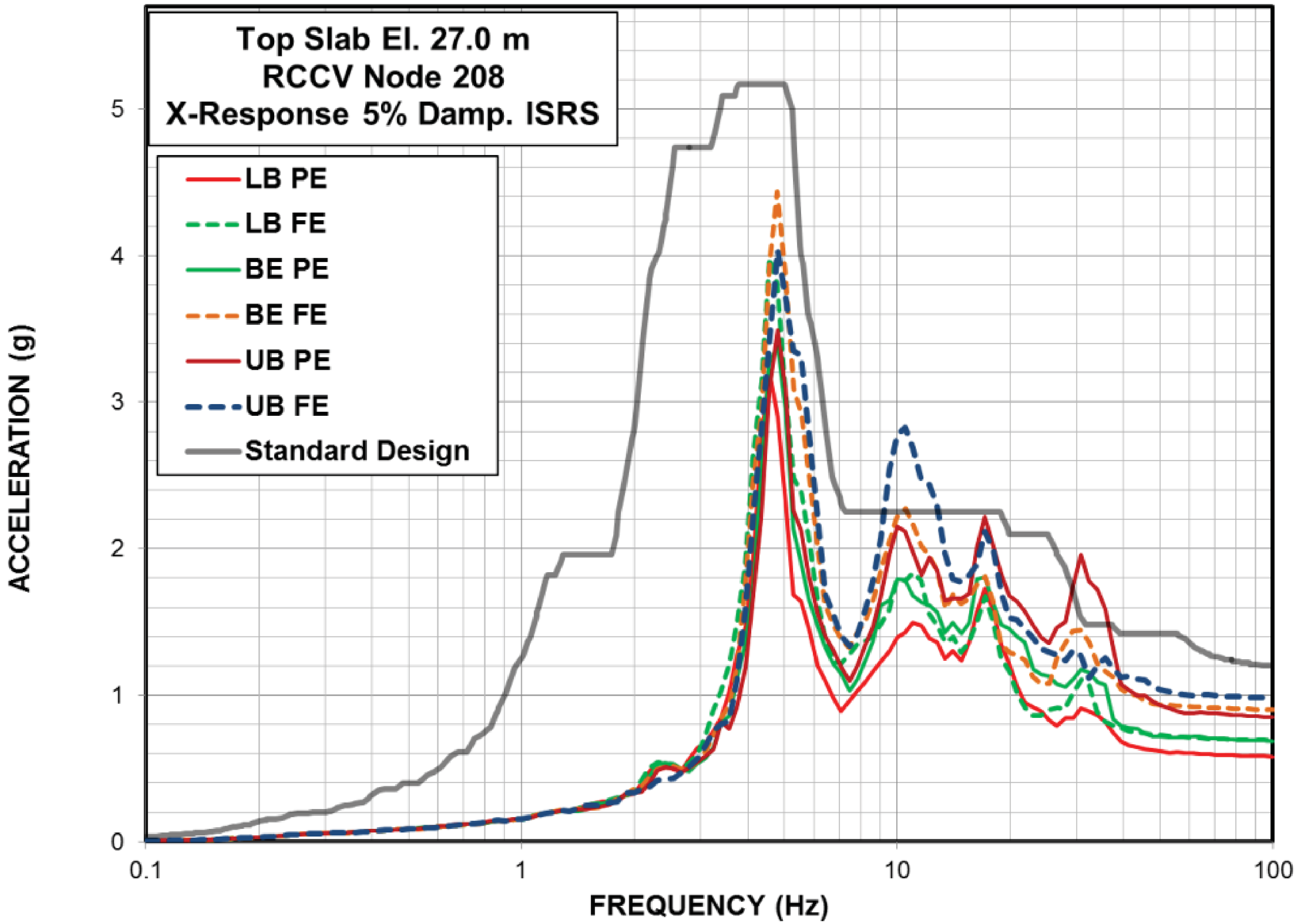


Figure 3A.17.12.3-201c **Comparison of ISRS - Vent Wall Top in NS (X)-Direction**

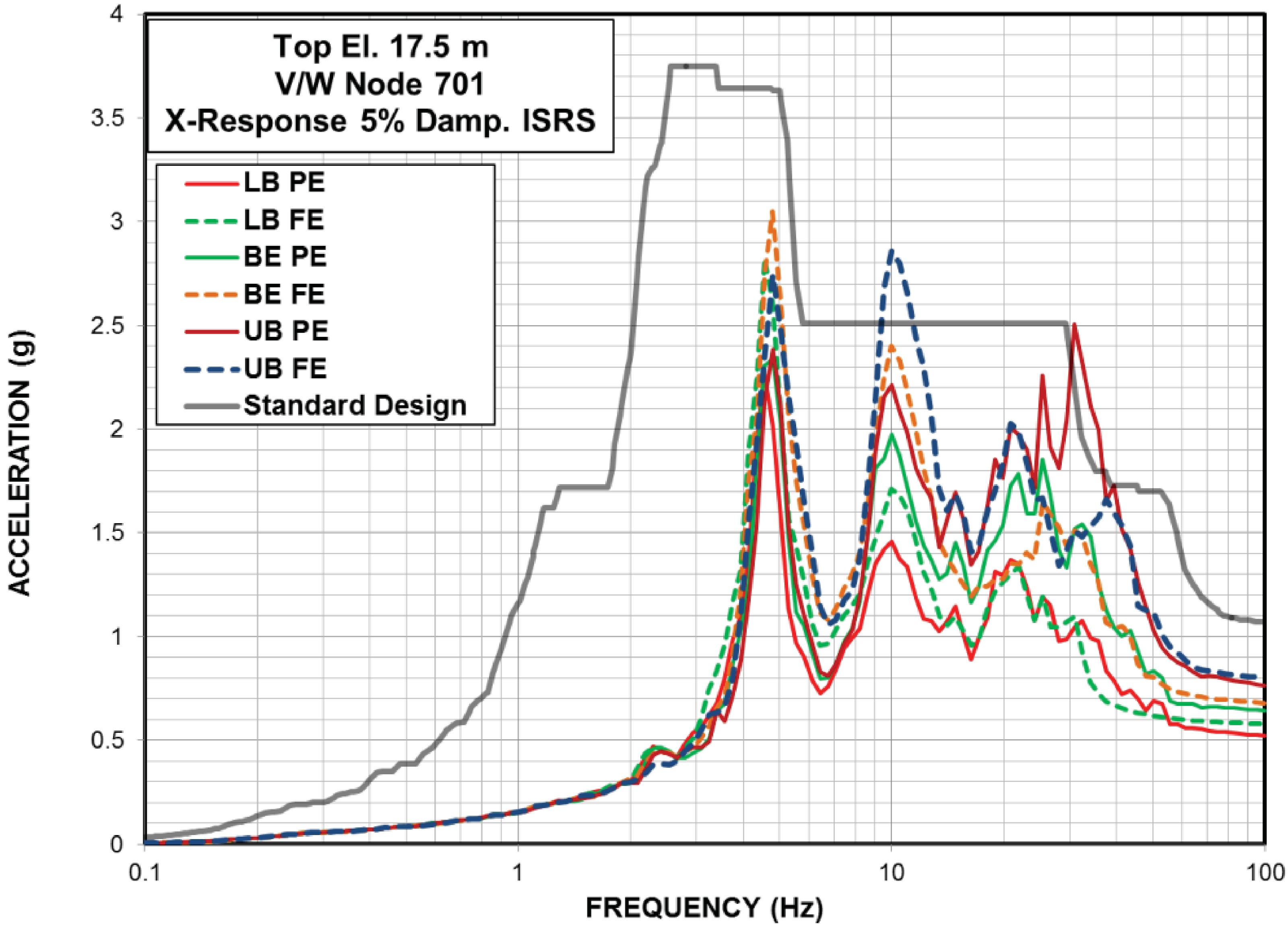


Figure 3A.17.12.3-201d **Comparison of ISRS - RSW Top in NS (X)-Direction**

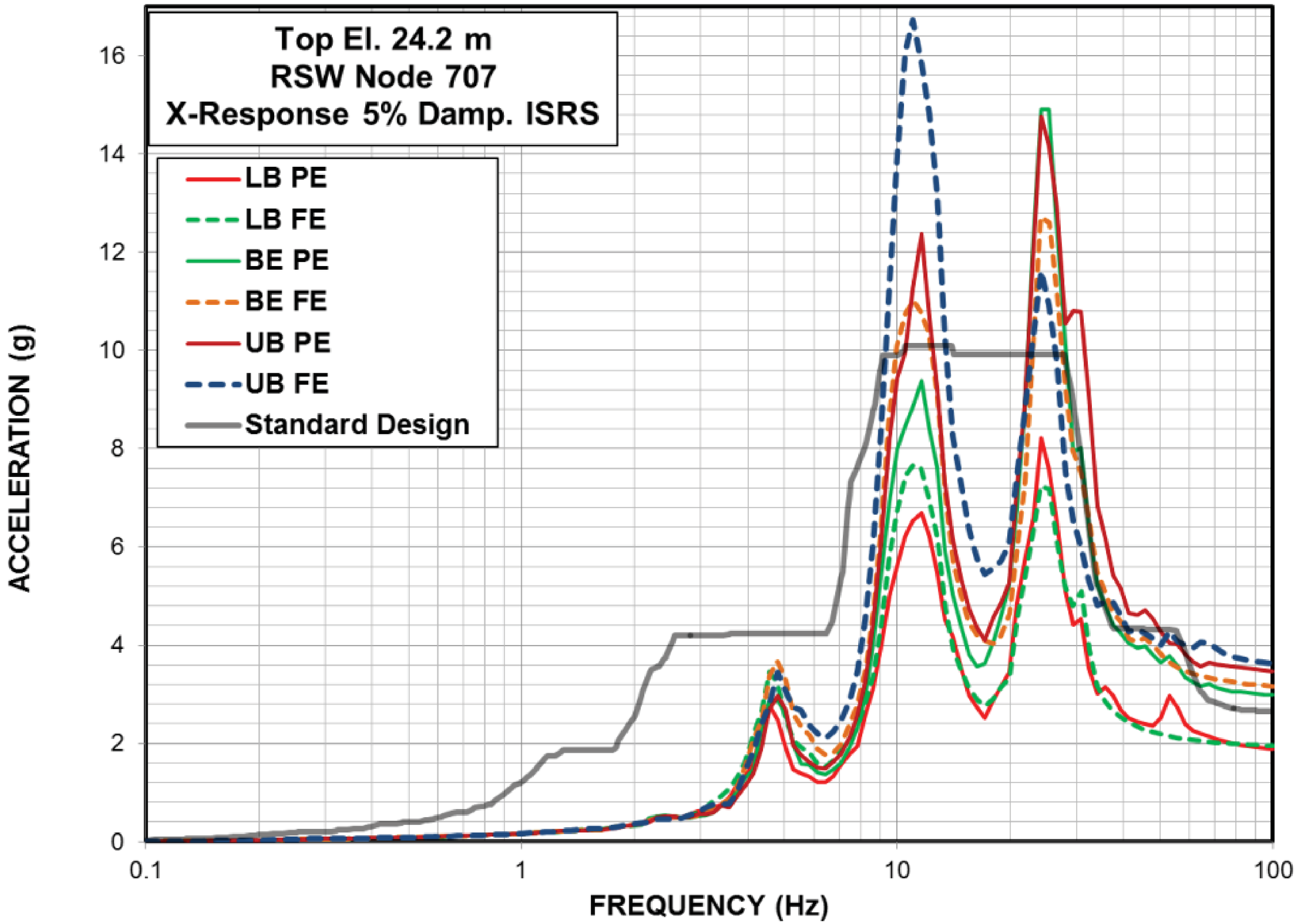


Figure 3A.17.12.3-201e **Comparison of ISRS - RPV Top in NS (X)-Direction**

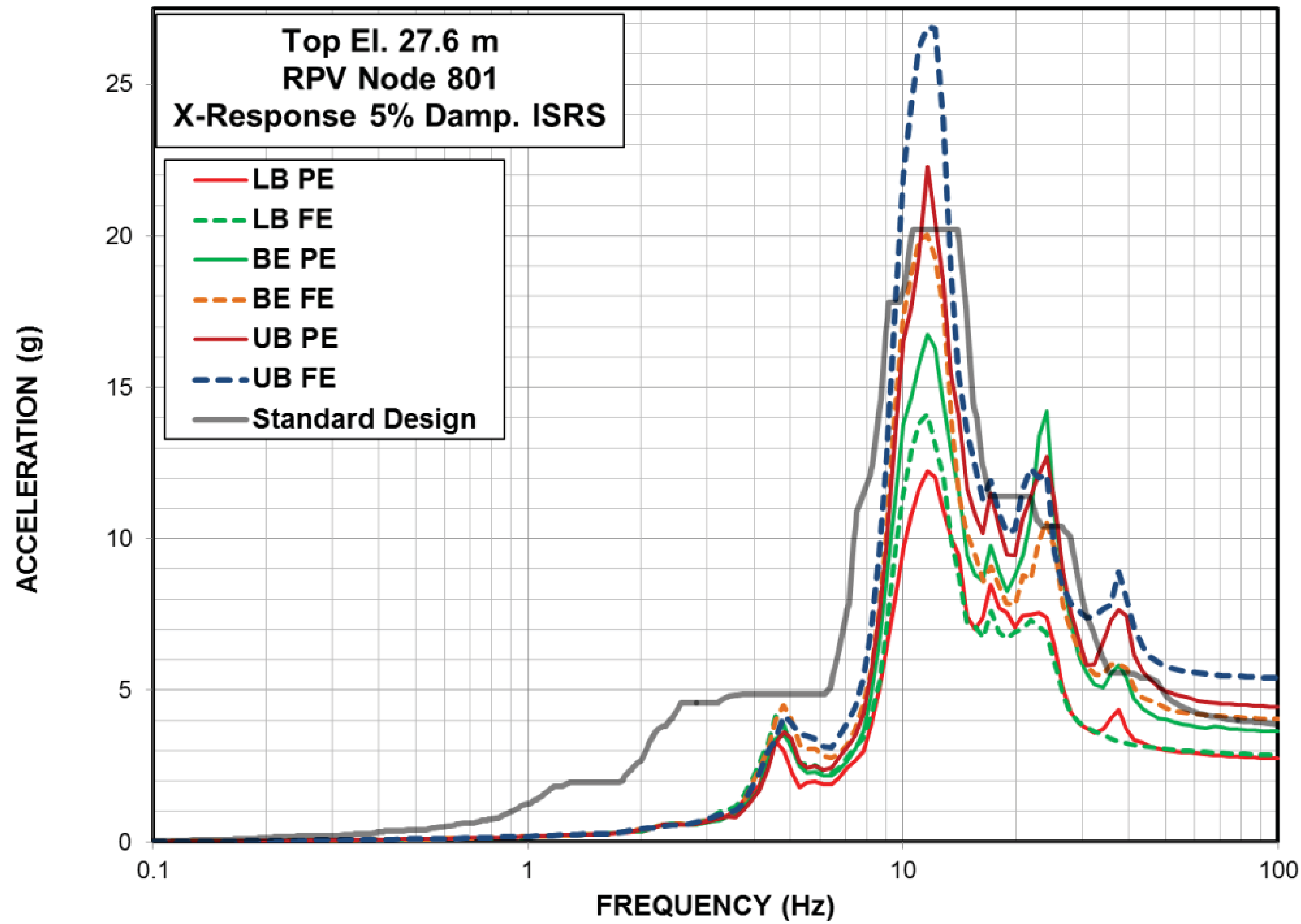


Figure 3A.17.12.3-201f **Comparison of ISRS - RB/FB Basemat in NS (X)-Direction**

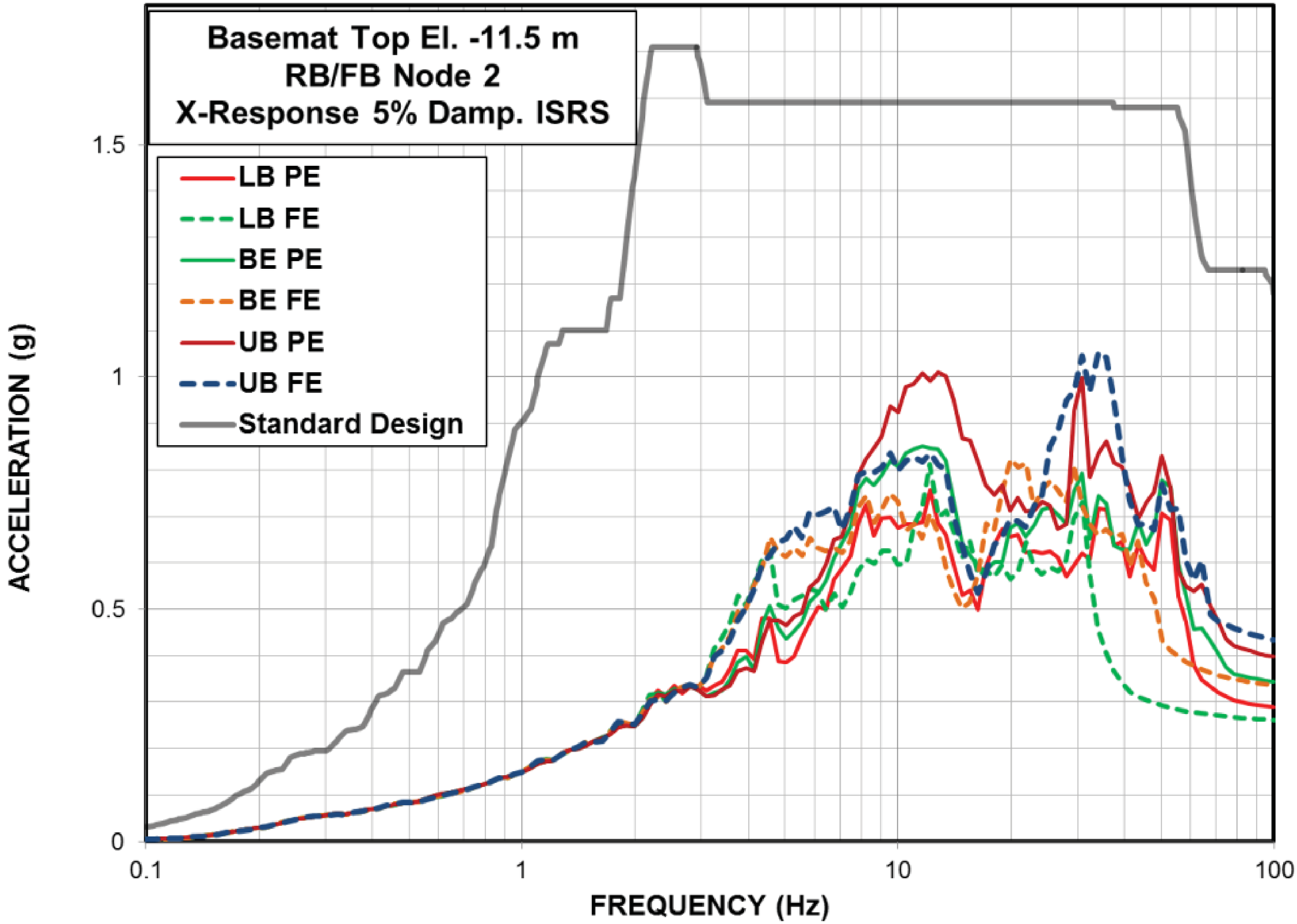


Figure 3A.17.12.3-202a **Comparison of ISRS - RB/FB Refueling Floor in EW (Y)-Direction**

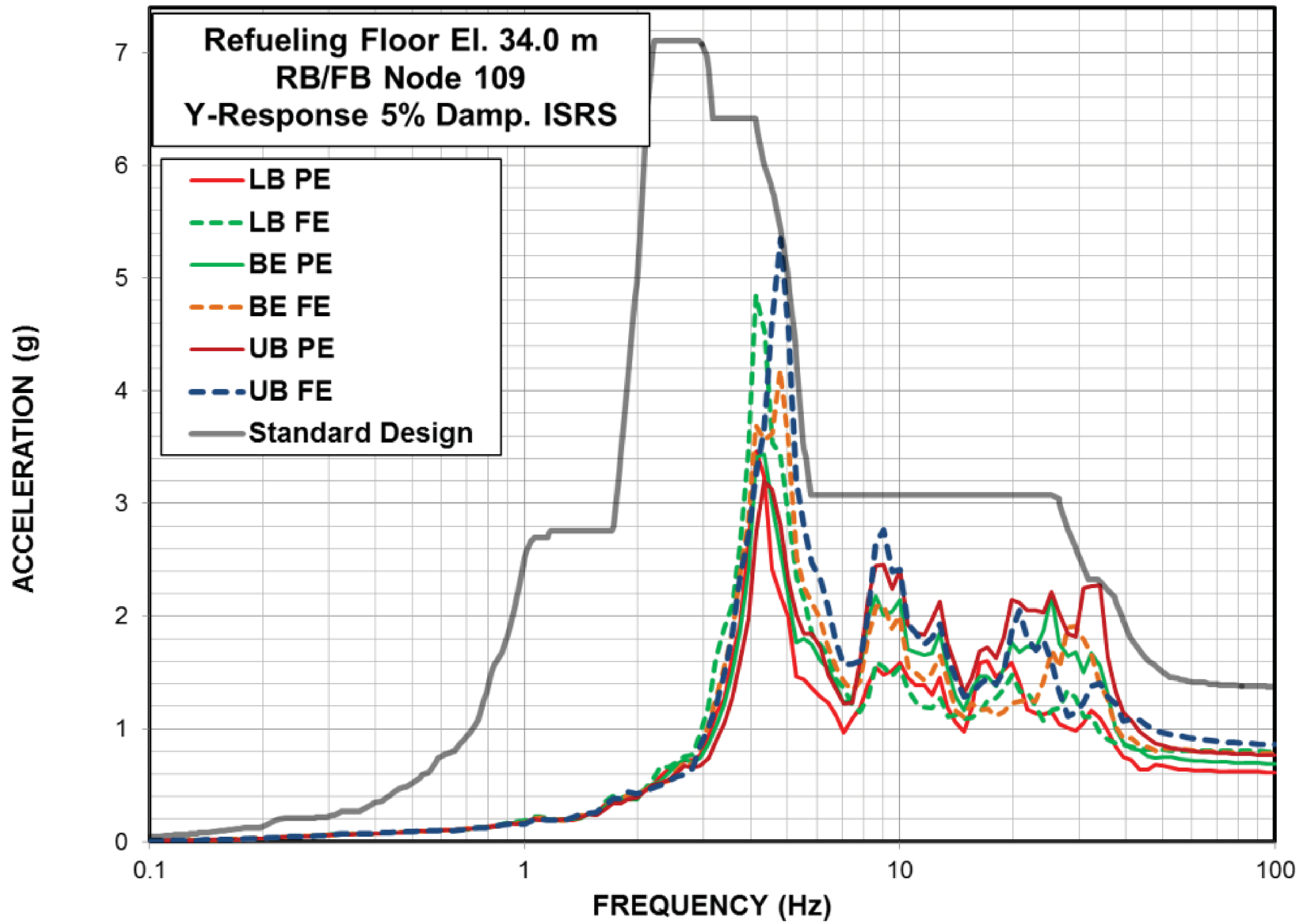


Figure 3A.17.12.3-202b **Comparison of ISRS - RCCV Top Slab in EW (Y)-Direction**

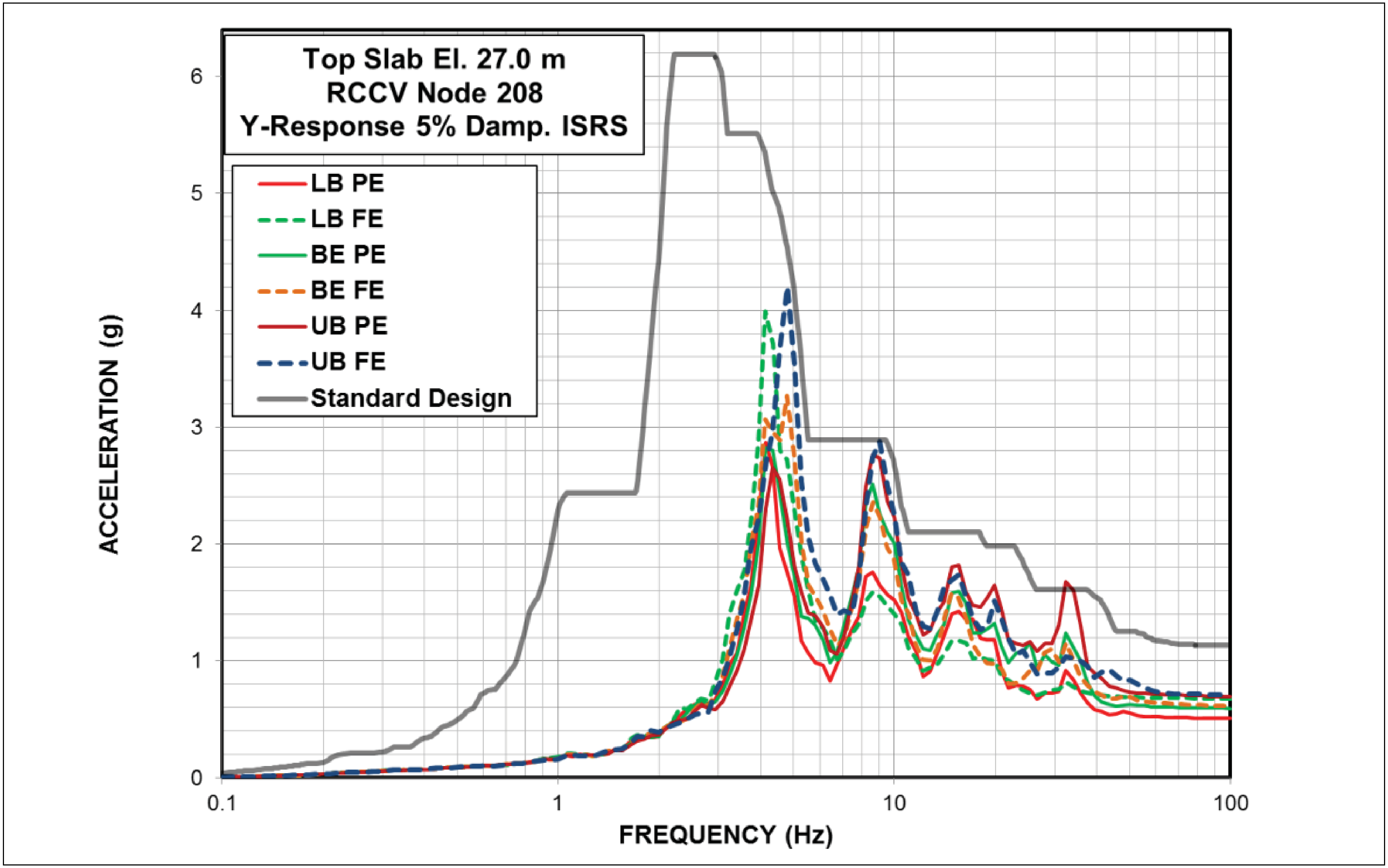


Figure 3A.17.12.3-202c **Comparison of ISRS - Vent Wall Top in EW (Y)-Direction**

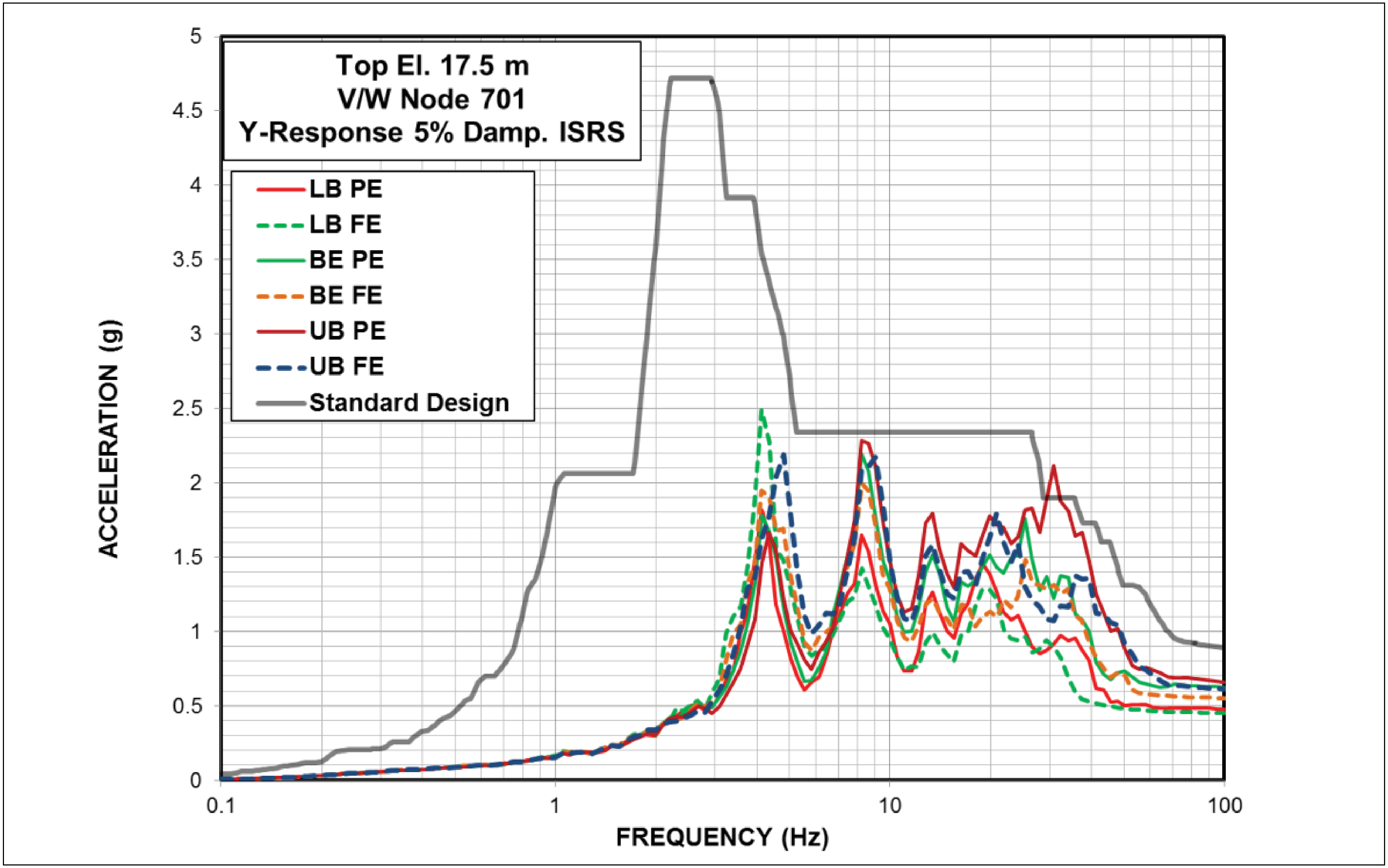


Figure 3A.17.12.3-202d **Comparison of ISRS - RSW Top in EW (Y)-Direction**

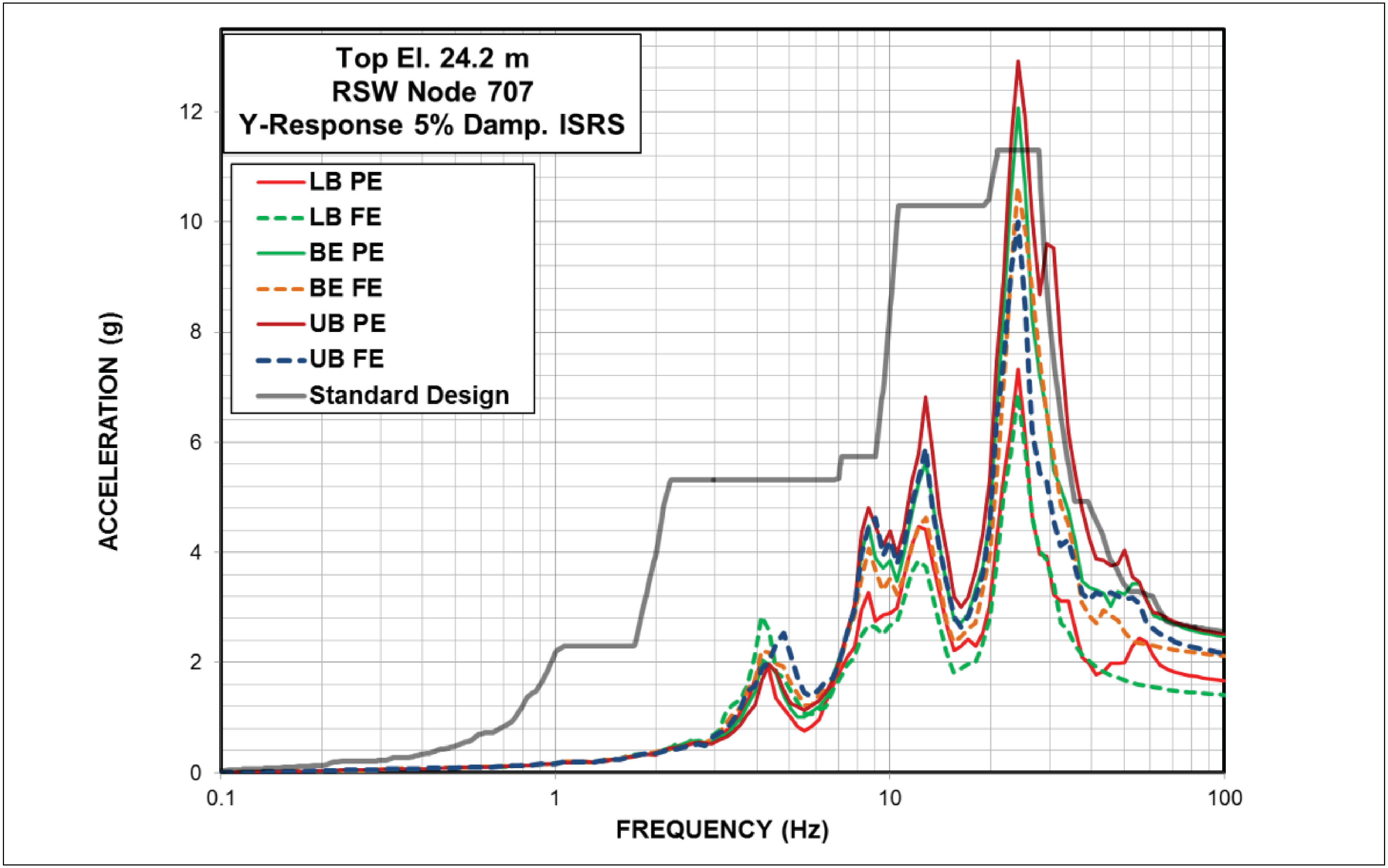


Figure 3A.17.12.3-202e **Comparison of ISRS - RPV Top in EW (Y)-Direction**

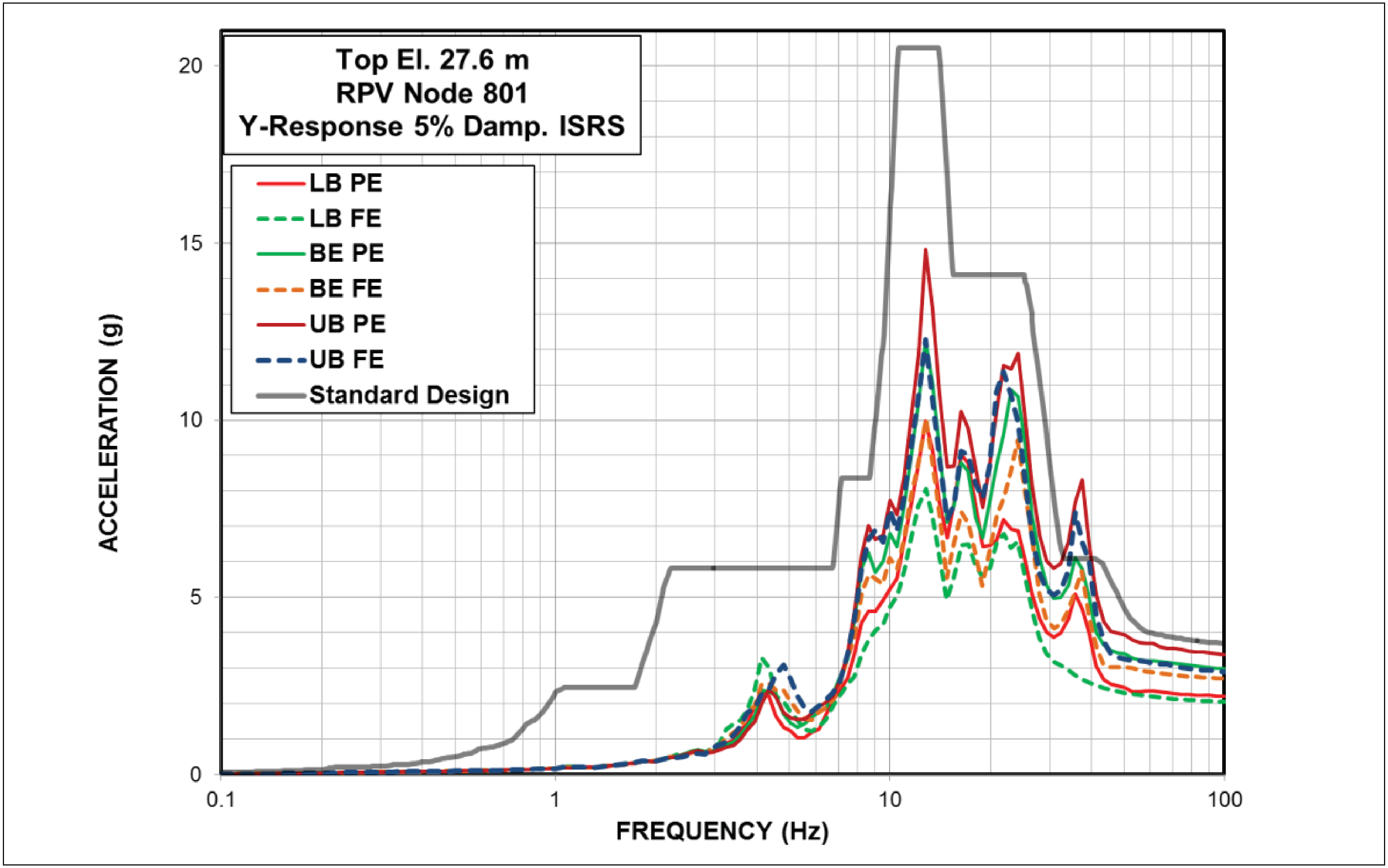


Figure 3A.17.12.3-202f **Comparison of ISRS - RB/FB Basemat in EW (Y)-Direction**

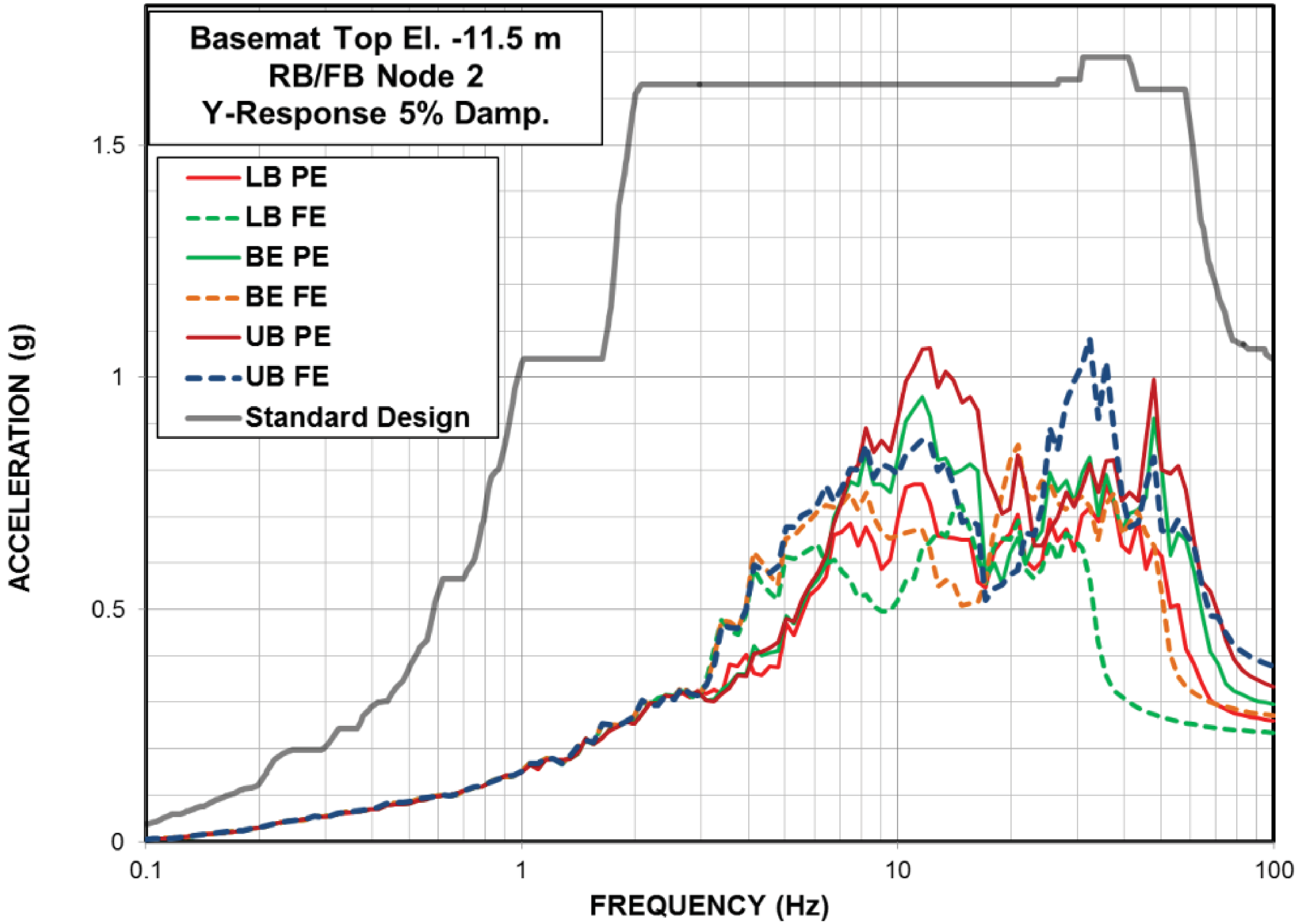


Figure 3A.17.12.3-203a **Comparison of ISRS - RB/FB Refueling Floor in Vertical (Z)-Direction**

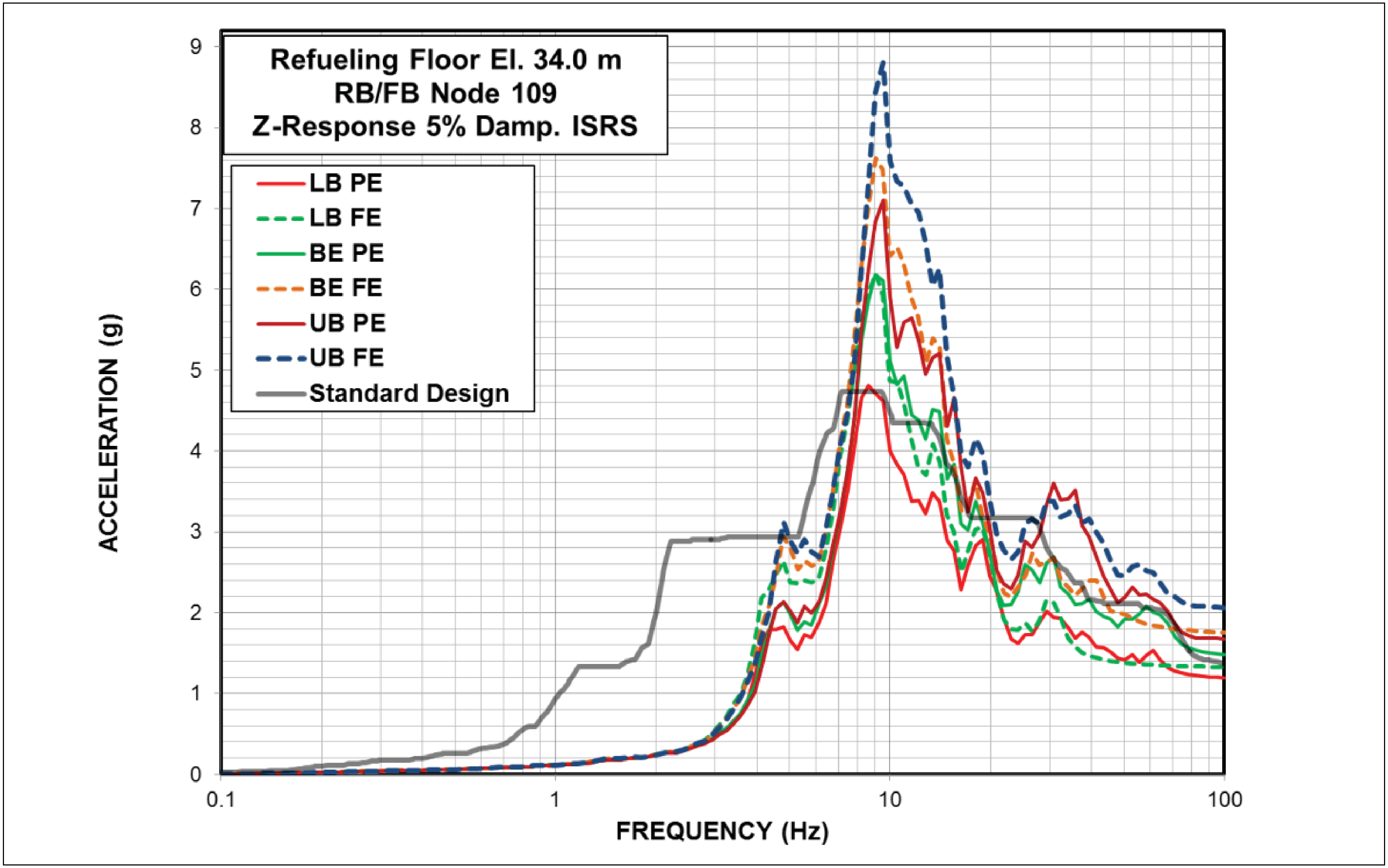


Figure 3A.17.12.3-203b **Comparison of ISRS - RCCV Top Slab in Vertical (Z)-Direction**

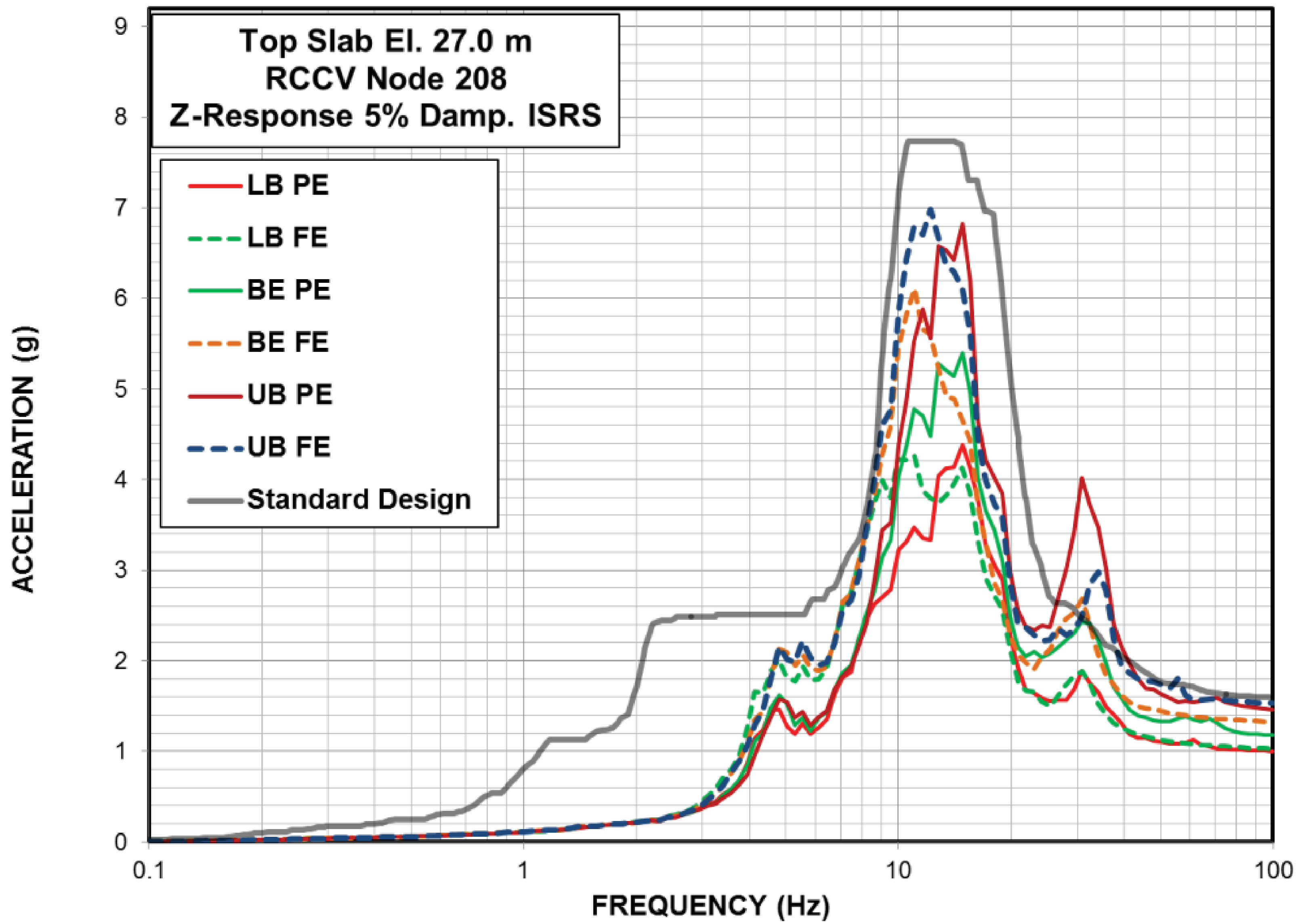


Figure 3A.17.12.3-203c **Comparison of ISRS - Vent Wall Top in Vertical (Z)-Direction**

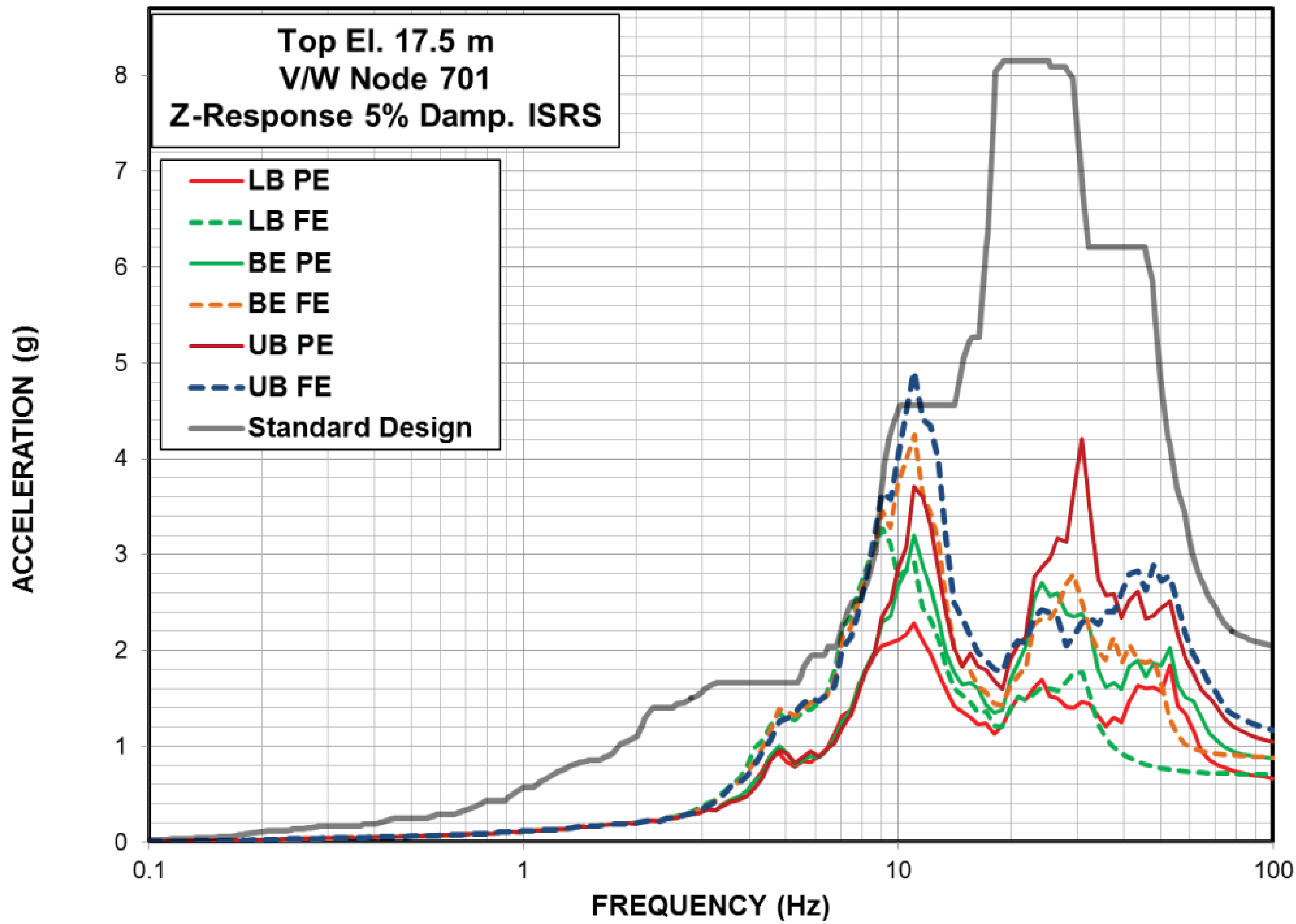


Figure 3A.17.12.3-203d **Comparison of ISRS - RSW Top in Vertical (Z)-Direction**

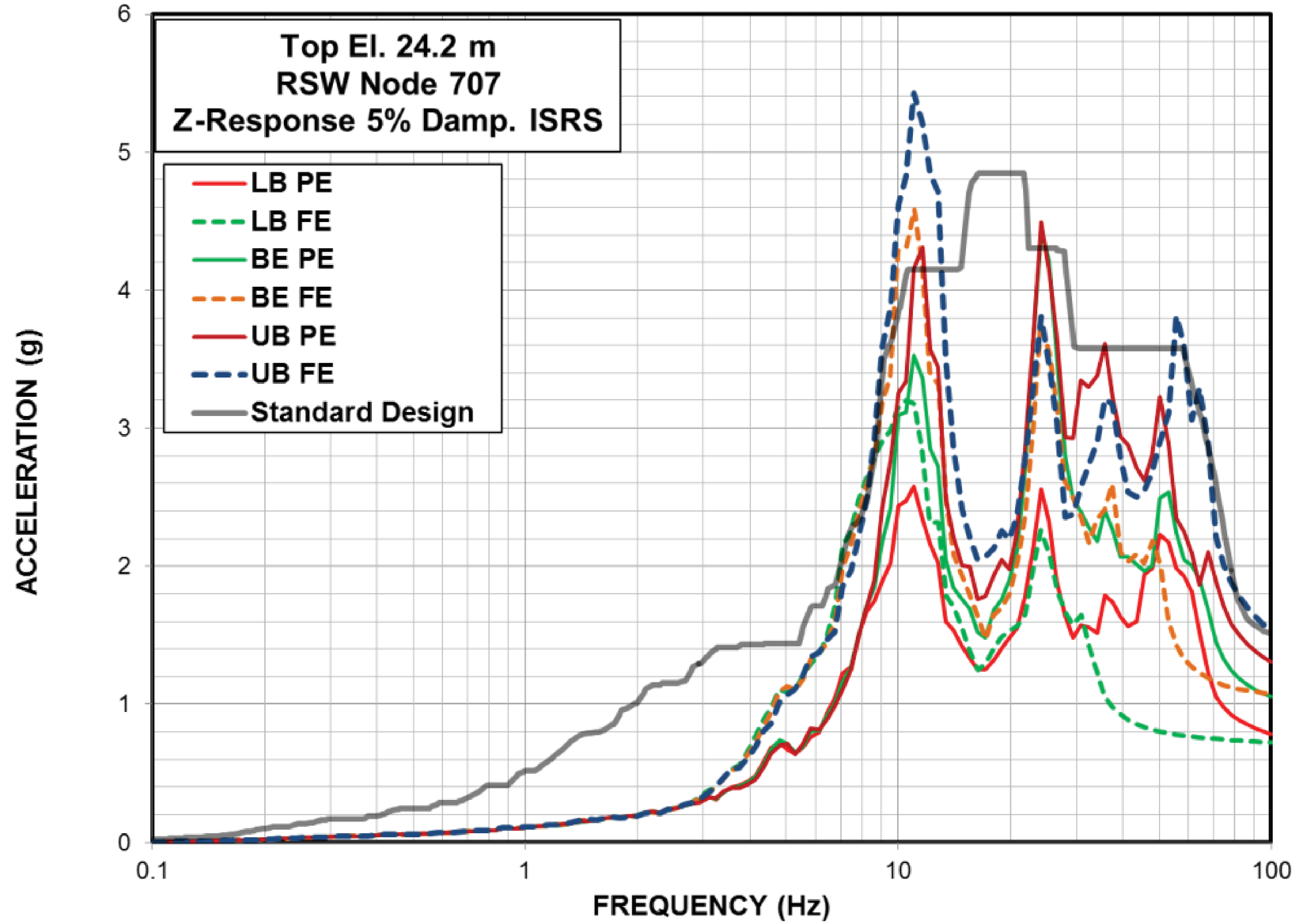


Figure 3A.17.12.3-203e **Comparison of ISRS - RPV Top in Vertical (Z)-Direction**

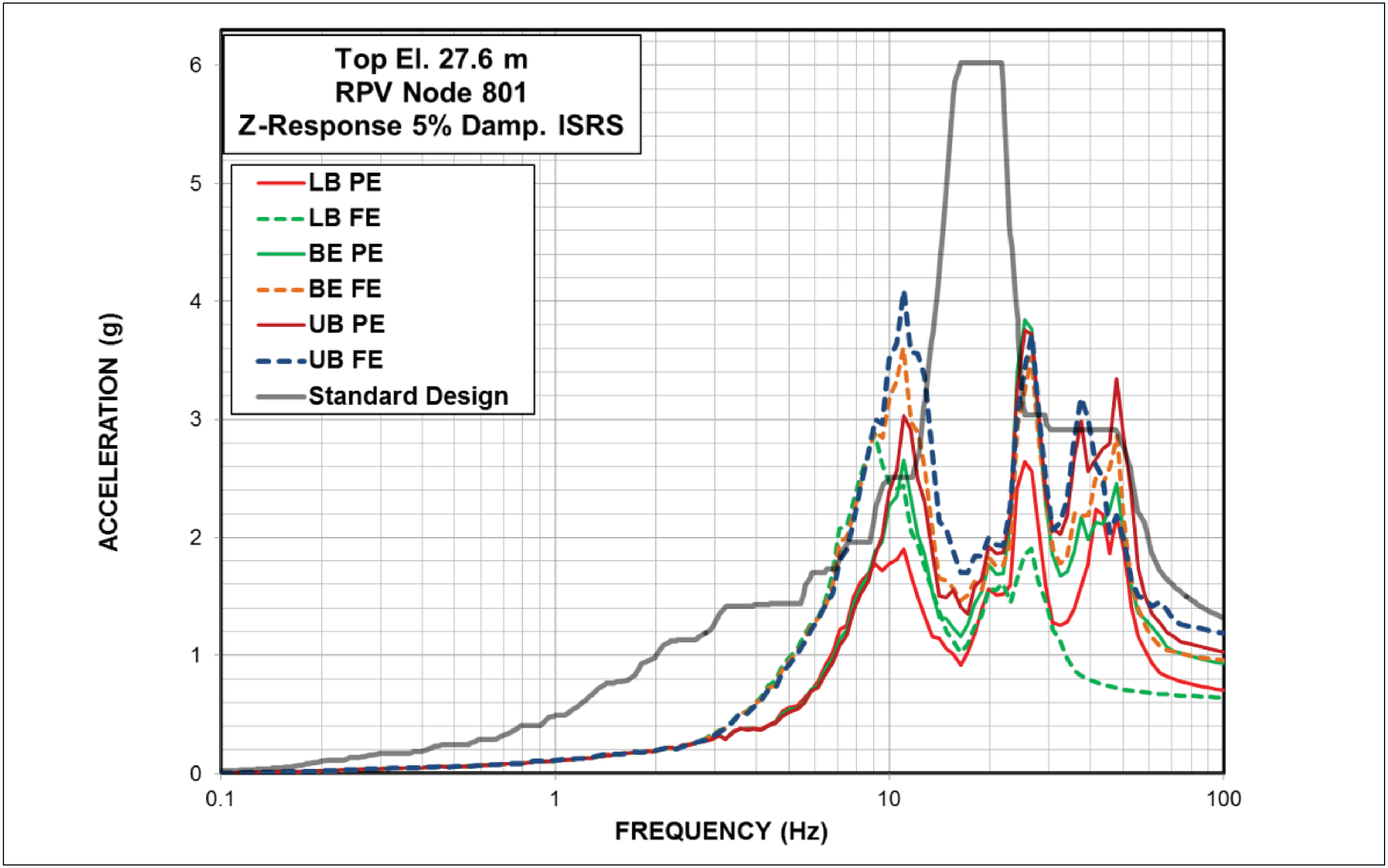


Figure 3A.17.12.3-203f **Comparison of ISRS - RB/FB Basemat in Vertical (Z)-Direction**

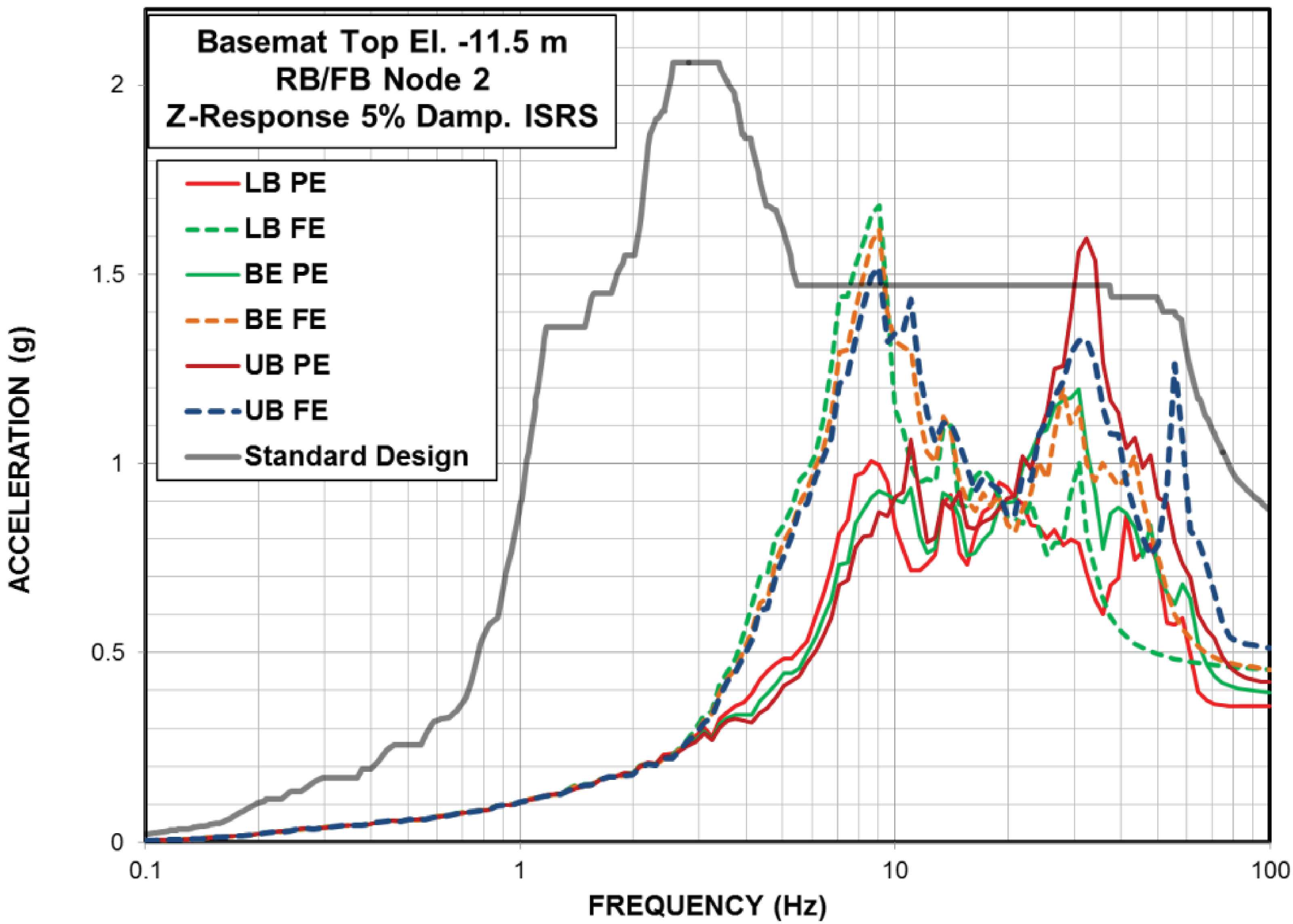


Figure 3A.17.12.3-204a **Comparison of ISRS - Oscillator Node RB/FB 99982X**

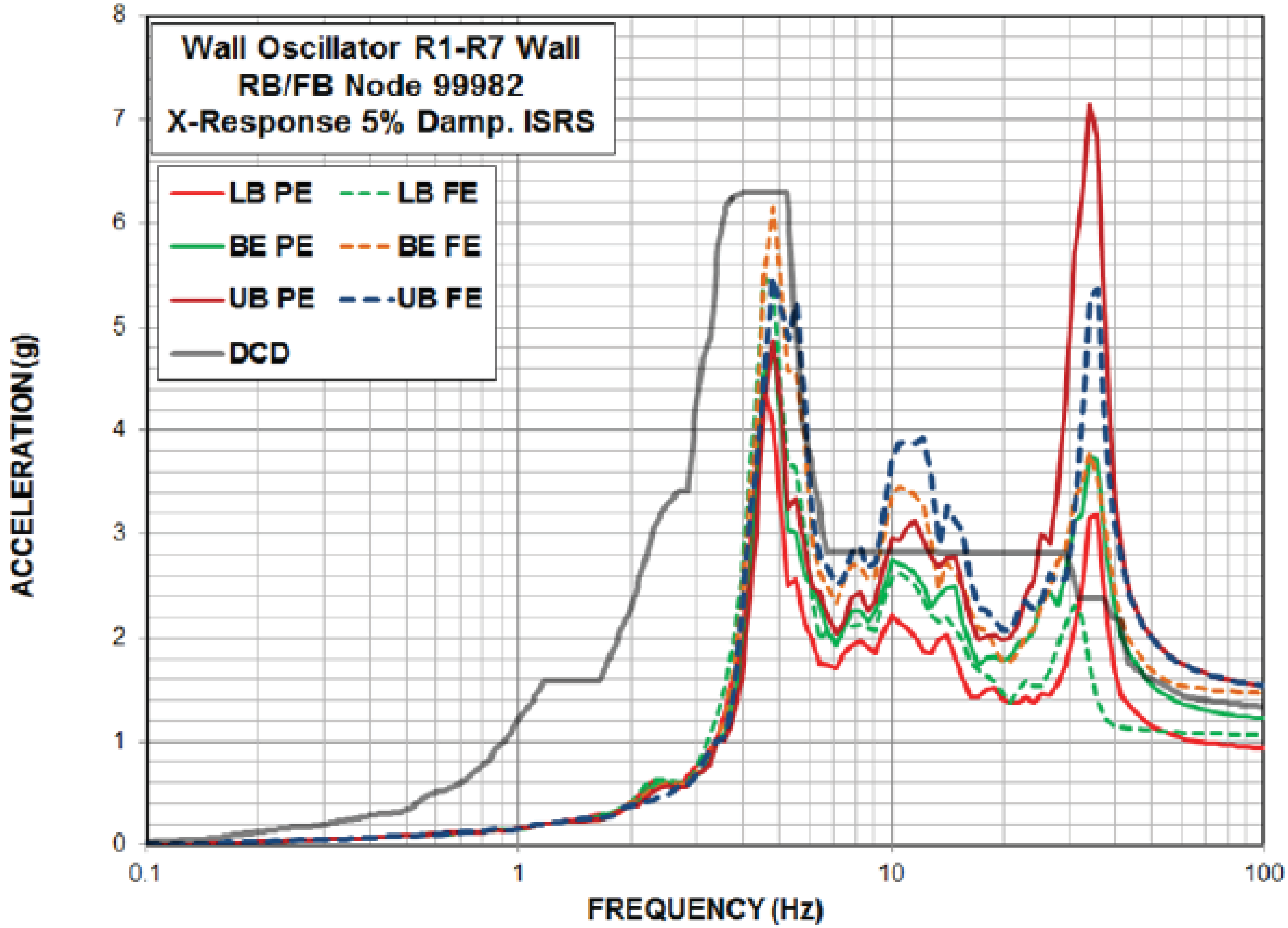


Figure 3A.17.12.3-204b **Comparison of ISRS - Oscillator Node RB/FB 99975Y**

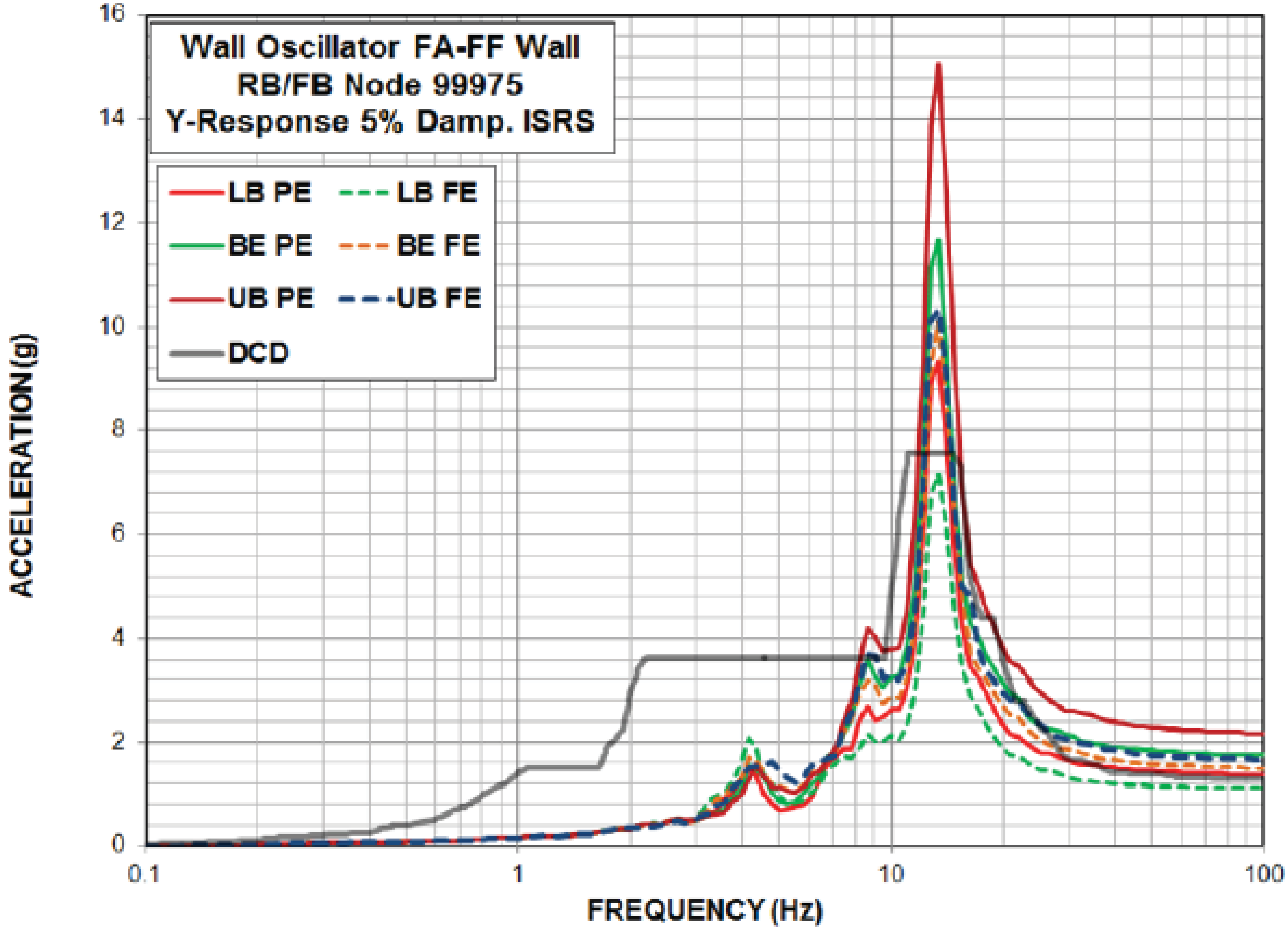
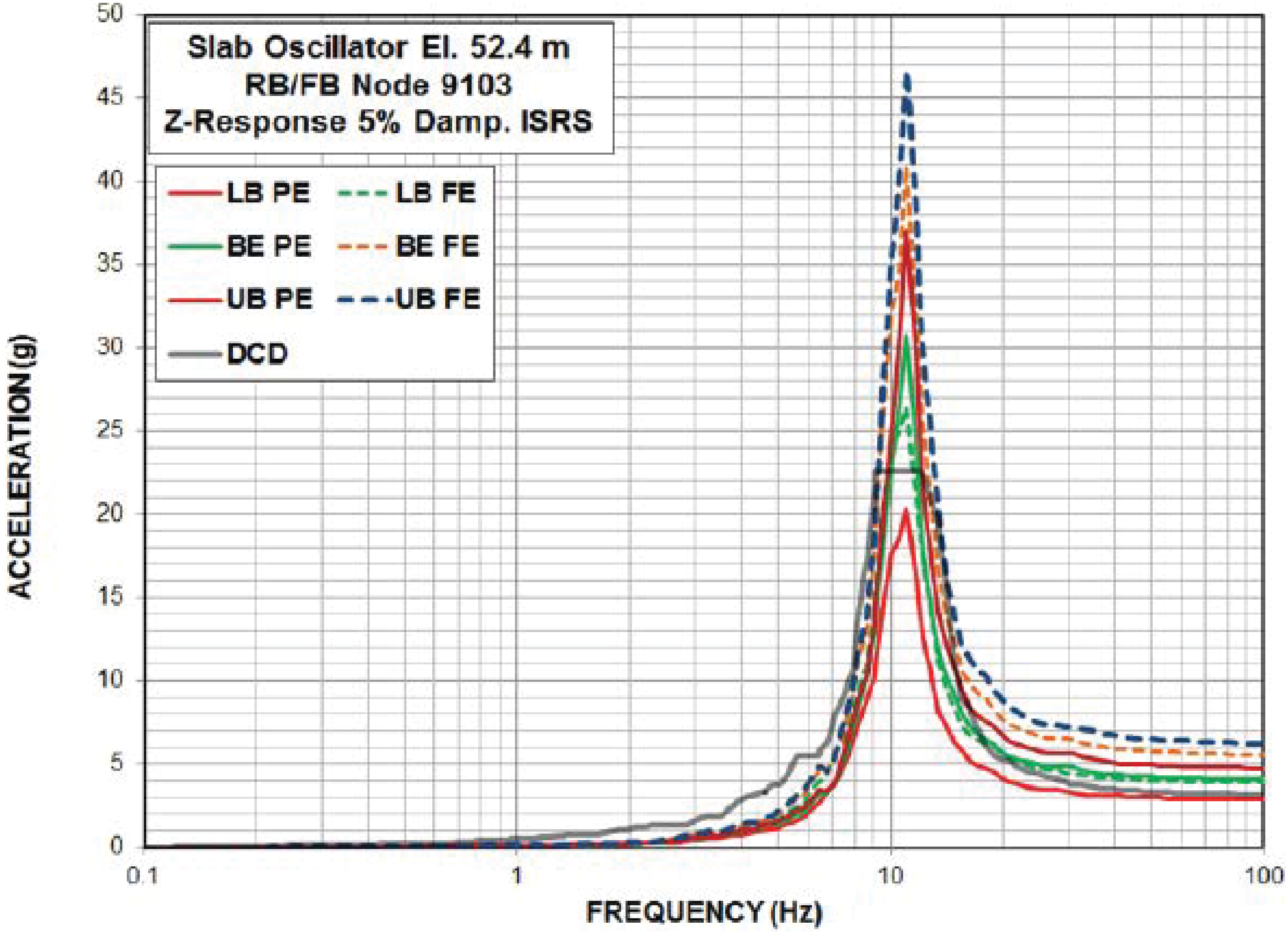


Figure 3A.17.12.3-204c **Comparison of ISRS - Oscillator Node RB/FB 9103Z**



3A.17.12.4 Maximum Lateral Pressures on Below-Grade Exterior Walls

As discussed in Section 3A.16.3, spring elements between double nodes are installed on the foundation and soil/rock interfaces to calculate the SSI contact reactions. The lateral seismic pressures on the RB/FB below-grade walls are calculated from the SASSI analyses results for the force time histories from the springs installed between the shells on the sides of the embedded portion of RB/FB model and the surrounding near-field elements.

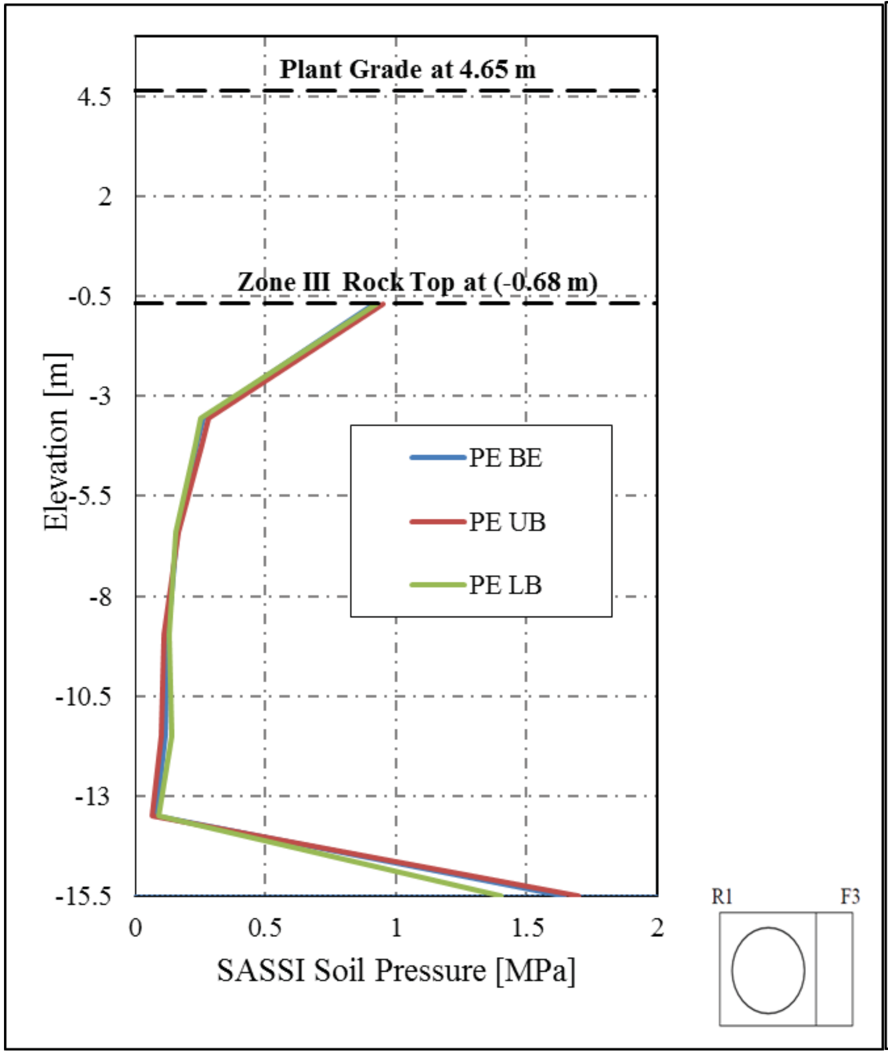
The absolute value of the co-directional spring force magnitudes obtained from the analyses of the three orthogonal input earthquake motion components are summed in the time domain. The absolute values of the maximum lateral forces for all spring elements at the same elevations are summed up to obtain the total maximum lateral forces at the respective elevations for the four RB/FB below-grade exterior walls separately.

Figures 3A.17.12.4-201a through 3A.17.12.4-201d provide plots of the results of the site-specific design basis SSI analyses of the RB/FB partially embedded (PE) and fully embedded (FE) models with upper bound stiffness properties and OBE damping values (Cases 1 through 6 in Table 3A.15-201) for the maximum seismic lateral pressures on the RB/FB below-grade exterior walls. The comparison of the results obtained from different analyses shows that the variation of the soil properties has a very small effect on the calculated dynamic pressures on the exterior walls. Very small differences can be observed between the lateral pressures calculated from the analyses of BE, LB, and UB profiles. The results obtained from the analyses of full column profiles show that the pressures on the RB/FB exterior walls from the structural fill or saprolite are small relative to those from the concrete fill/Zone III rock. The analyses of both embedment configurations yield maximum lateral pressures at the top of Zone III rock (Elevation -0.68 m) and at the bottom of RB/FB basemat (Elevation -15.5 m).

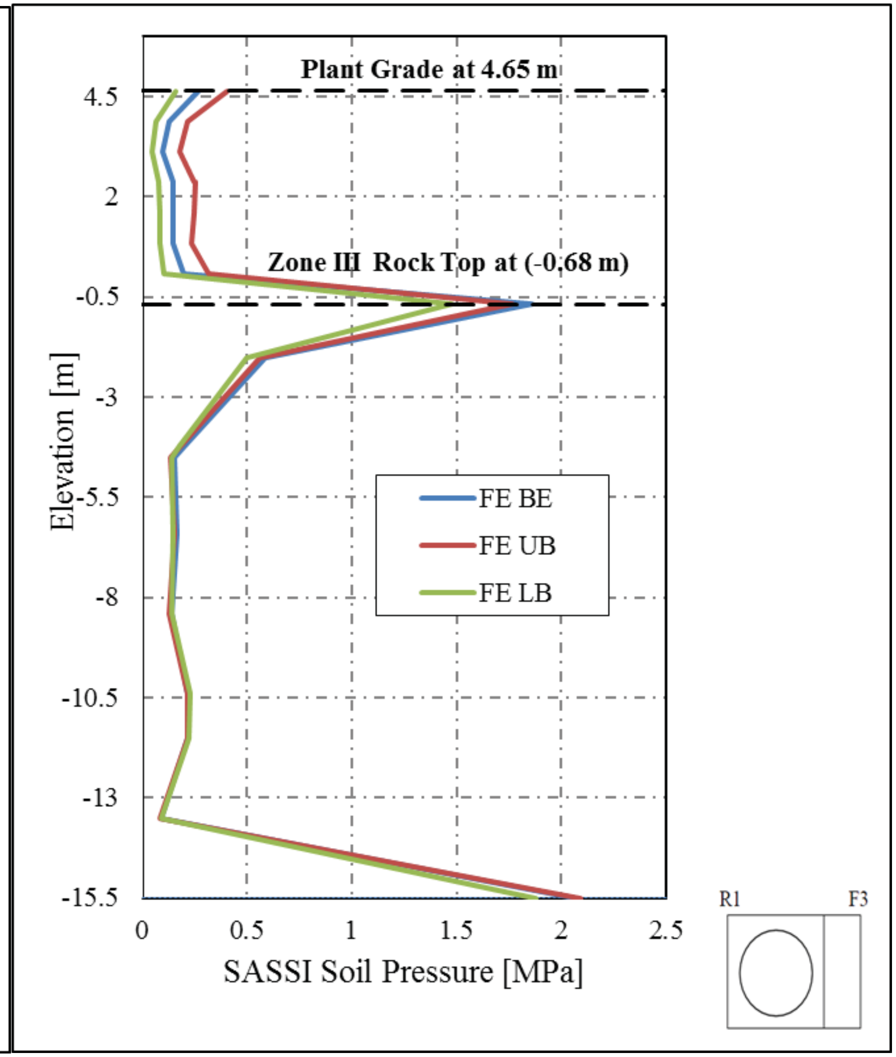
In Section 3G.7.5.6, the dynamic lateral pressure results obtained from the site-specific SSI analyses are combined with site-specific static pressures to develop the total site-specific lateral load demands on RB/FB below-grade exterior walls. These total site-specific lateral loads are compared with the corresponding standard design loads in order to

determine exceedances of the site-specific lateral loads demands relative to the standard design.

Figure 3A.17.12.4-201a **Dynamic Lateral Pressures on Below-Grade Exterior Walls: RB/FB Wall at Column Line R1**

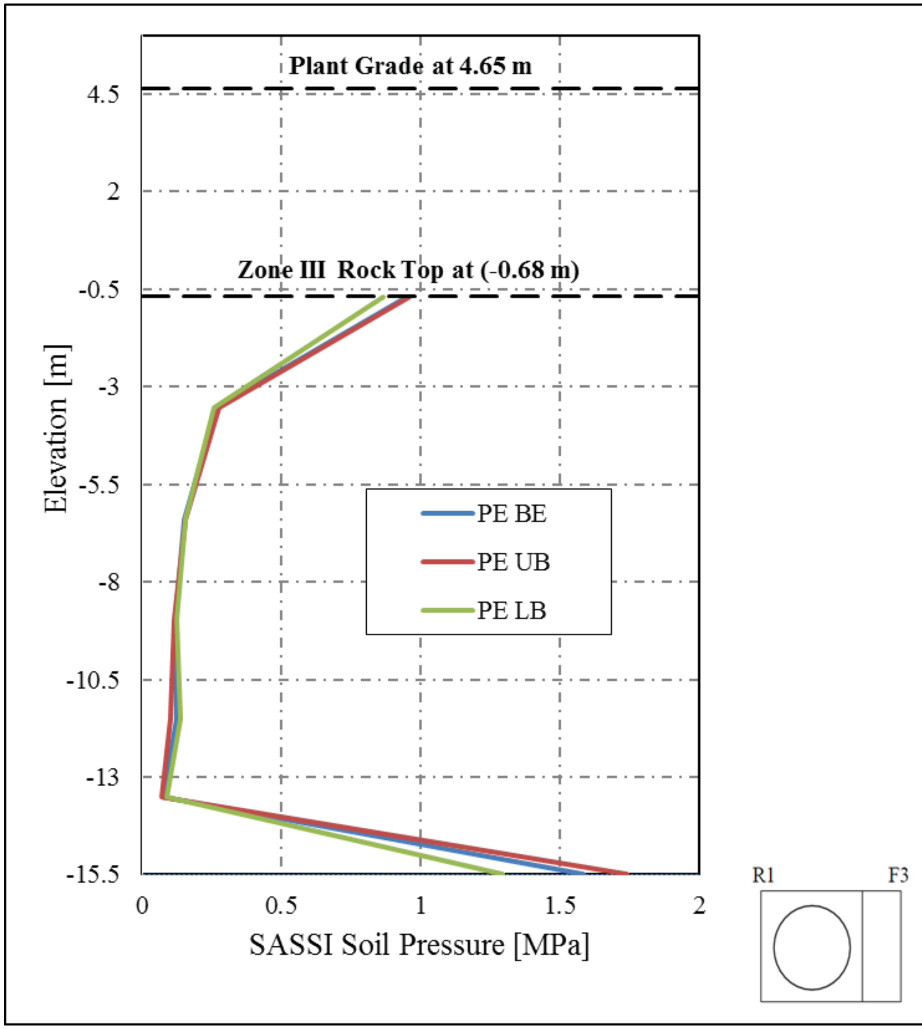


Partially Embedded Model

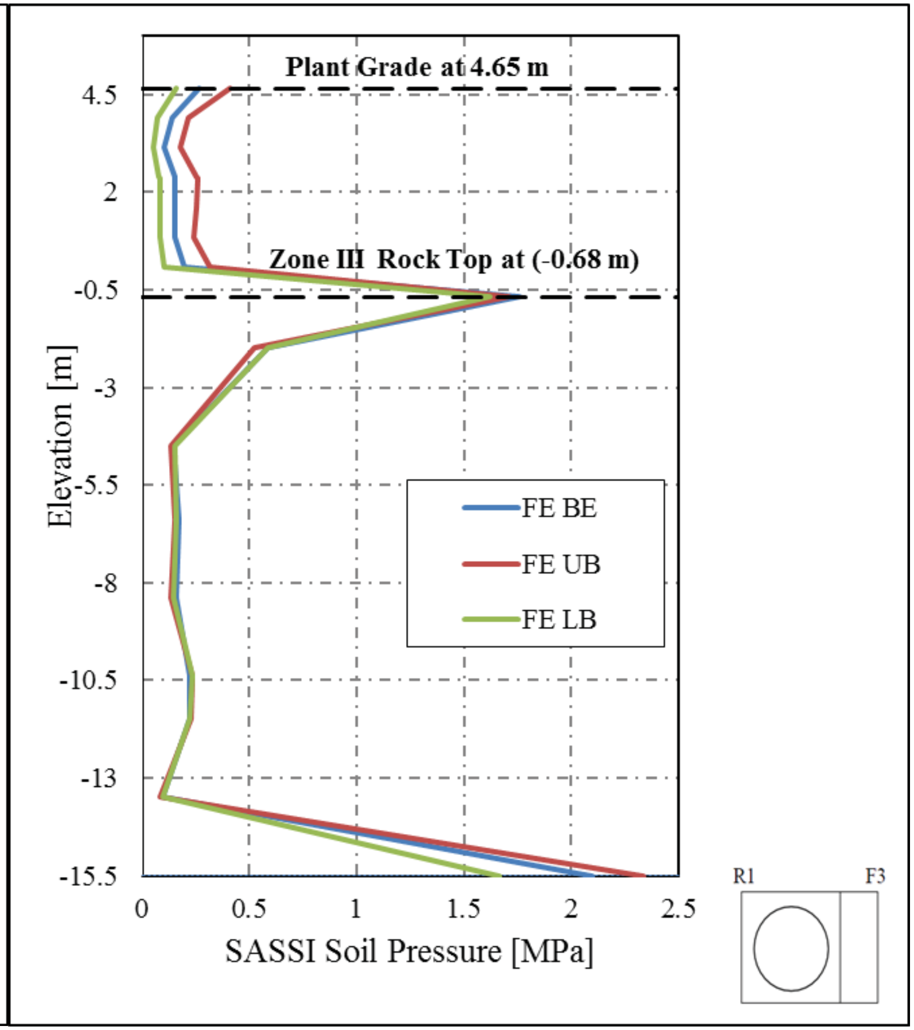


Fully Embedded Model

Figure 3A.17.12.4-201b **Dynamic Lateral Pressures on Below-Grade Exterior Walls: RB/FB Wall at Column Line F3**

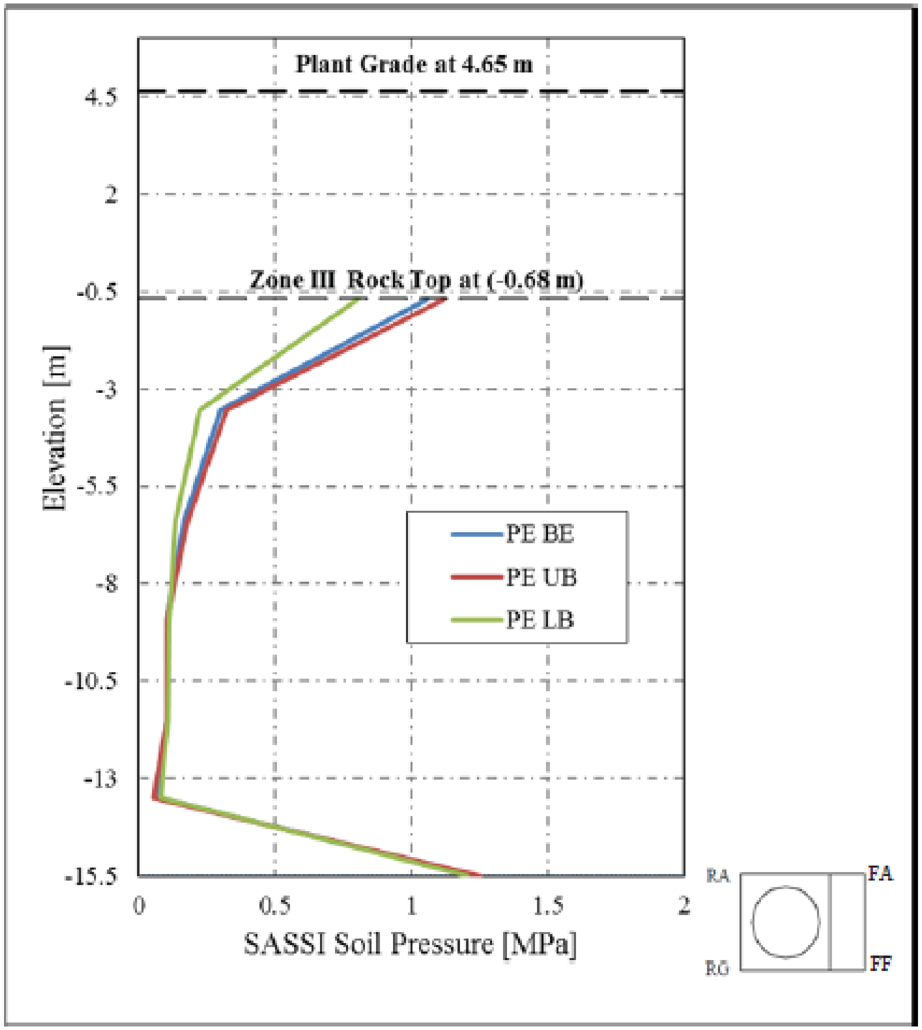


Partially Embedded Model

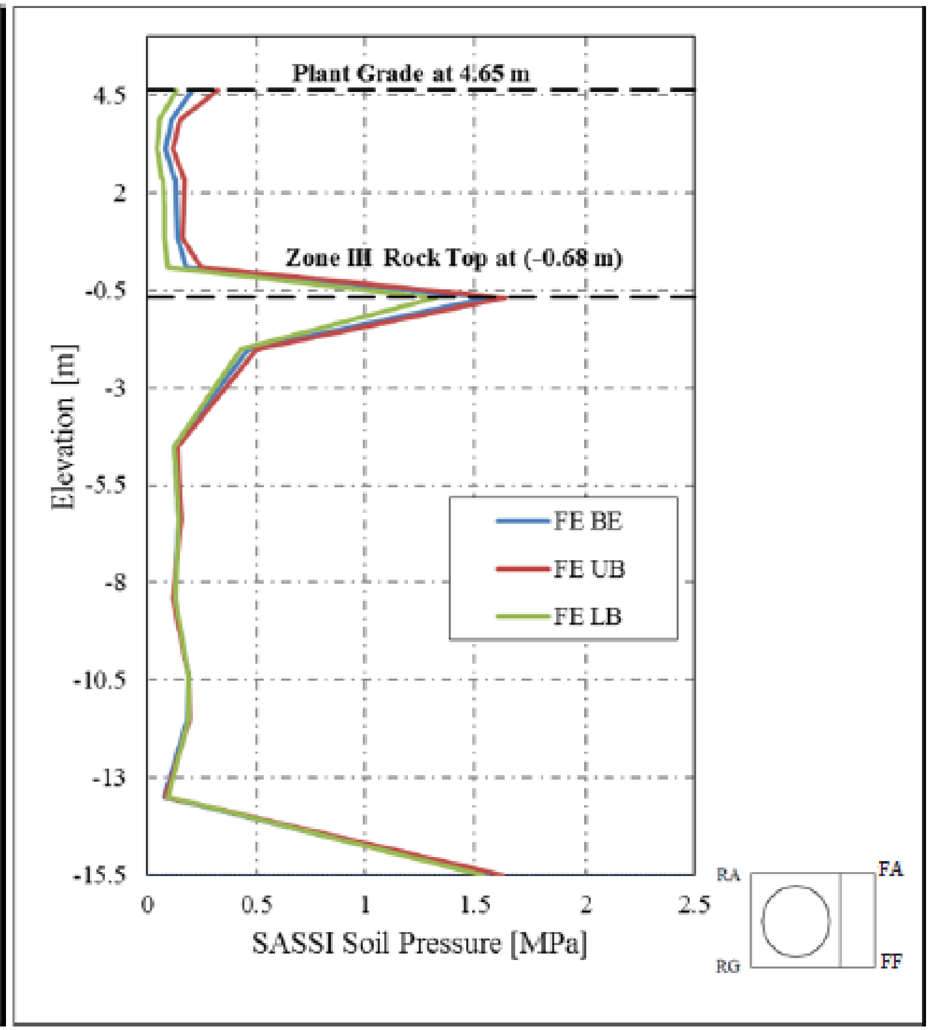


Fully Embedded Model

Figure 3A.17.12.4-201c **Dynamic Lateral Pressures on Below-Grade Exterior Walls: RB/FB Wall at Column Lines RA and FA**

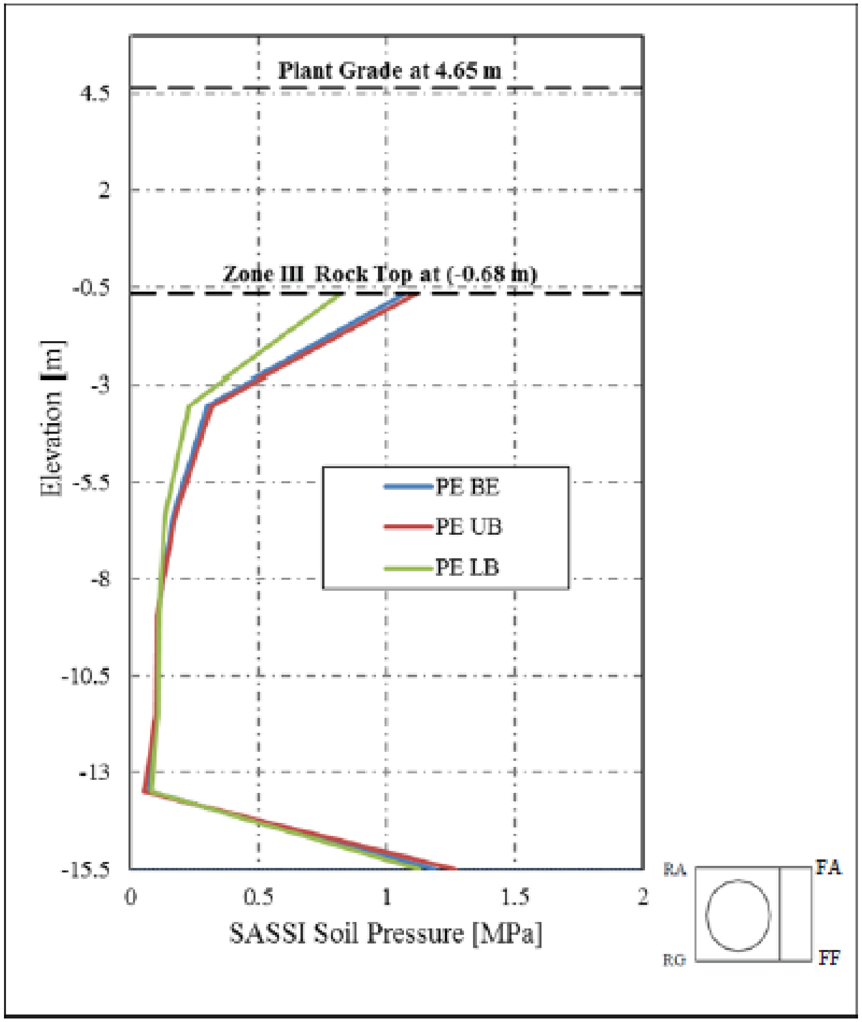


Partially Embedded Model

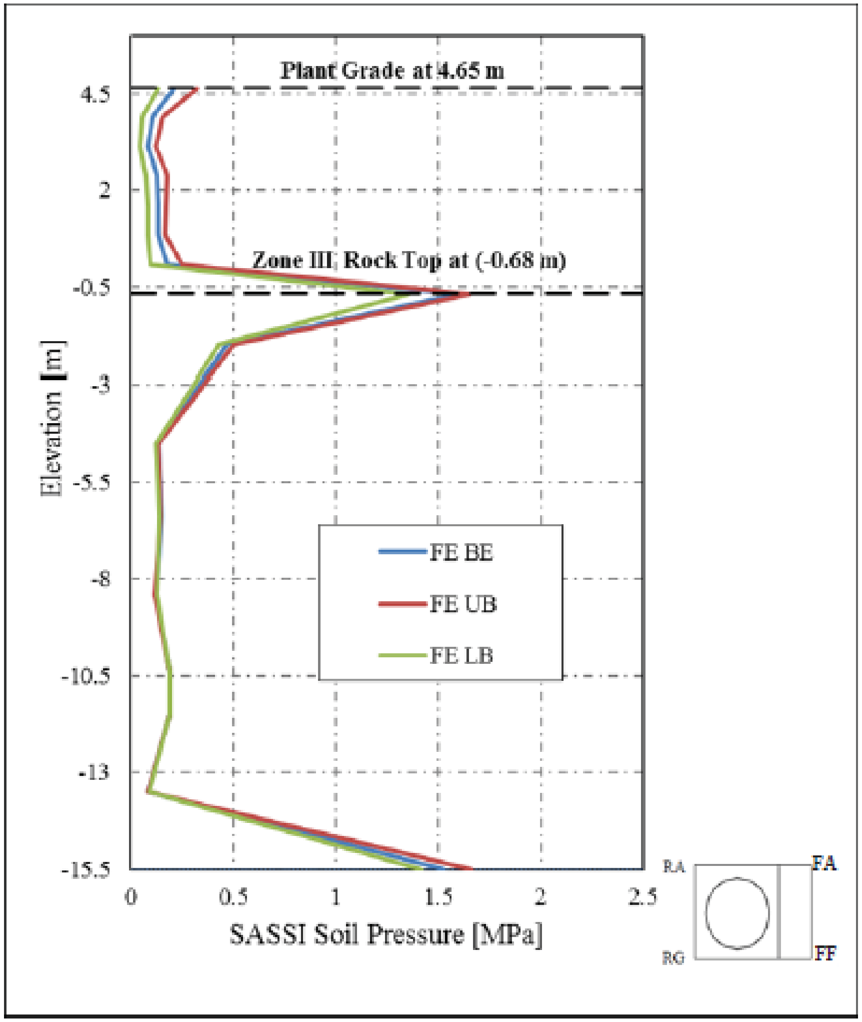


Fully Embedded Model

Figure 3A.17.12.4-201d **Dynamic Lateral Pressures on Below-Grade Exterior Walls: RB/FB Wall at Column Line RG and FF**



Partially Embedded Model



Fully Embedded Model

3A.17.12.5 Base Reactions and Contact Pressures

The results of the SSI analyses for contact spring forces are also used to calculate time histories of the seismic driving forces used as input for the sliding stability evaluations and dynamic bearing pressure calculations. The time histories of the horizontal and vertical driving seismic forces in the three orthogonal directions are calculated as the algebraic sum of the spring forces in the three directions at each time step from all contact spring elements at the interfaces between the RB/FB and the surrounding soil.

The contact spring elements at the bottom of the RB/FB basemat provide the input needed for the calculation of the dynamic bearing pressures.

The calculations of the dynamic bearing pressures are based on the time histories of:

- The overturning base moments calculated for both the horizontal directions by summing algebraically the moments generated by each contact spring reaction at the bottom of the RB/FB basemat
- The vertical driving seismic forces calculated as the algebraic sum of the vertical spring forces at each time step from all contact spring elements at the interface between the bottom of the RB/FB basemat and the rock

The results of the SSI analyses for the time histories of the vertical spring forces obtained from the contact springs at the bottom of the RB/FB basemat are used to develop base contact pressures for determining the minimum base contact area. These calculations are performed in the following steps:

1. Time histories of the vertical base reactions are calculated as the sum of the spring forces obtained from the contact spring elements at the bottom of the RB/FB basemat.
2. Time histories of upward base reactions $R_V(t)$ are calculated by subtracting the vertical seismic force calculated in Step 1 and the groundwater buoyancy force from the building seismic weight (total weight assigned to the RB/FB dynamic model).

3. Time histories of the overturning base moments $M_{NS}(t)$ and $M_{EW}(t)$ are calculated for the rotation about NS and EW axes by summing the moments generated by each contact spring reaction at the bottom of basemat.

4. The time history of base reaction eccentricity *Ecc(t)* is calculated as follows:

$$Ecc(t) = \frac{1}{R_V(t)}\sqrt{M_{NS}(t)^2 + M_{EW}(t)^2}$$

5. The critical time step when the maximum uplift of the RB/FB basemat occurs is determined as the time instance when the value of the base reaction eccentricity Ecc(t) is the largest.

6. The plot of the base contact area is developed using the base spring force results at the critical time step obtained from the analysis of soil case that yields maximum value for base vertical reaction eccentricity.

7. The base contact pressures are calculated by dividing the base spring forces by their tributary area and then adding the uniform static pressure due to the effective weight of the building (the RB/FB seismic weight minus the groundwater buoyancy).

8. The uplifted area of the foundation is determined as the area where the value of the contact pressure is negative.

The uplift of the non-symmetric RB/FB may be affected by the phasing between the three directions of input motions. Since the RB/FB is symmetrical with respect to the NS (X) direction vertical plane, the direction of the input motion in the EW (Y) direction has a negligible phasing effect on the calculated uplift area. The only significant eccentricity of the building is with respect to the EW direction vertical plane. Therefore, the following four combinations of input motion directions are considered for the contact ratio evaluation:

1. $R_D + R_B + E_x + E_y + E_z$
2. $R_D + R_B + E_x - E_y - E_z$
3. $R_D + R_B - E_x + E_y + E_z$
4. $R_D + R_B - E_x - E_y - E_z$

where: $\pm E_j$ represents the seismic base contact pressures due to the earthquake component in positive or negative j =X, Y and Z direction.

R_D and R_B are static base contact pressures due to dead weight and groundwater buoyancy.

Table 3A.17.12.5-201 summarizes the calculations of maximum base reaction eccentricities and shows that the design basis analyses of the UB full column subgrade profile yields the minimum base contact ratios. The results show that the contact area between the RB/FB basemat and the underlying subgrade remains larger than 80 percent which, according to the guidance of SRP 3.7.2, ensures that the potential uplift of the RB/FB basemat has negligible effects on the RB/FB seismic response and on the results of site-specific RB/FB SSI analyses which are performed on linear elastic models.

As described in Section 3A.16.3, the dynamic model uses shell elements to represent the RB/FB basemat and the below-grade exterior walls and stick elements to represent the stiffness of the interior walls below grade elevations and all above grade walls. The stick elements do not capture the contribution of the inner walls and the RPV pedestal to the overall stiffness of the RB/FB complex basemat. Therefore, the RB/FB dynamic model underestimates the stiffness of the basemat, which, in turn, affects the distribution of base pressures used for the calculations of the minimum foundation contact area presented in Table 3A.17.12.5-201.

To address the effect of basemat stiffness on the RB/FB foundation uplift calculations, additional calculations are performed that consider the bounding case of an absolutely rigid foundation. Under the assumption of an absolutely rigid foundation, the minimum contact pressures below the RB/FB basemat are calculated based on a closed-form solution from the theory of elasticity using the SSI analyses results for the vertical base reaction and overturning moments. These additional calculations of RB/FB rigid foundation uplift are performed for the two critical SSI analyses of UB partial column and UB full column profiles for the critical

instance of time identified in Table 3A.17.12.5-201. The additional calculations show that consideration of a rigid foundation yields a minimum base contact ratio of 97.2 percent, which is larger than the minimum contact ratios calculated from the flexible foundation models that are presented in Table 3A.17.12.5-201. This confirms that the possible uplift of the RB/FB basemat has a negligible effect on the RB/FB seismic response and results of the site-specific RB/FB SSI analyses.

NAPS DEP 3.7-1

Table 3A.17.12.5-201 **Summary of Maximum Base Reaction Eccentricity and Minimum Contact Ratio Results – RB/FB**

Combination of Input Direction	Analysis	Full Column			Partial Column		
		BE	UB	LB	BE	UB	LB
+Ex+Ey+Ez	Max. Eccentricity (m)	9.24	8.58	7.47	9.03	9.07	8.25
	Min. Contact Ratio	93.1%	93.1%	95.3%	94.7%	94.1%	95.5%
	at Time (s)	3.645	3.625	4.320	4.310	4.070	4.315
+Ex-Ey-Ez	Max. Eccentricity (m)	8.37	8.51	7.51	8.44	9.44	7.23
	Min. Contact Ratio	92.0%	89.2%	95.7%	92.8%	90.4%	96.1%
	at Time (s)	3.235	3.225	3.465	3.225	3.225	3.460
-Ex+Ey+Ez	Max. Eccentricity (m)	7.22	6.63	7.53	7.17	7.53	6.86
	Min. Contact Ratio	95.9%	92.2%	93.5%	94.1%	93.7%	94.5%
	at Time (s)	3.460	3.625	3.470	4.425	3.350	4.430
-Ex-Ey-Ez	Max. Eccentricity (m)	9.99	9.24	9.37	9.12	10.65	7.86
	Min. Contact Ratio	91.4%	90.9%	92.5%	93.5%	91.3%	93.6%
	at Time (s)	3.150	3.145	3.155	7.080	7.075	3.155

Note: The shaded values in the table show the governing case for full column and partial column.

3A.17.13 Site-Specific SSI Analysis Results for CB

This section presents results of the site-specific SSI design basis analyses of the CB stand-alone models with full stiffness properties (analysis Cases 1 through 12 in Table 3A.15-202).

3A.17.13.1 CB SSI Response

Results of the CB SSI analysis show that the saprolite and structural fill above the top of Unit 3 rock can affect the response of the light and deeply embedded CB resulting in shifts of the CB peak responses to higher frequencies and also reduction of responses due to higher dissipation of energy. The effects of rock subgrade properties variations on the CB response are smaller. The SSI analysis of UB partial column profile provides bounding site-specific seismic demands on the CB structure. The CB analysis of the partial column profiles yield bounding results with few exceptions in the ISRS results at lower (< 20 Hz) frequencies that are bounded by responses obtained from analyses of full column profiles.

3A.17.13.2 Maximum Accelerations and Member Forces

Figures 3A.17.13.2-201 and 3A.17.13.2-202 compare results for maximum absolute accelerations at CB floor mass locations from the design basis SSI analyses of CB models with full stiffness and SSE damping for the partial column profiles and full column profiles, respectively. Table 3A.17.13.2-201 compares the maximum vertical accelerations results for CB slab SDOF oscillators obtained from the design basis analysis Cases 7 through 12 in Table 3A.15-202. Figures 3A.17.13.2-203 and 3A.17.13.2-204 compare the maximum shear forces and torsion results obtained from the analyses of CB models with full stiffness properties and SSE damping for the partial column profiles and full column profiles, respectively. Comparisons of the maximum response results show that the analysis of the UB partial column profile (analysis Case 9) govern the CB maximum responses with the exception of the maximum shear forces between Elevations -2.5 m and 4.7 m obtained from the analyses of the CB fully embedded model where the softer soil embedment amplified the CB shears.

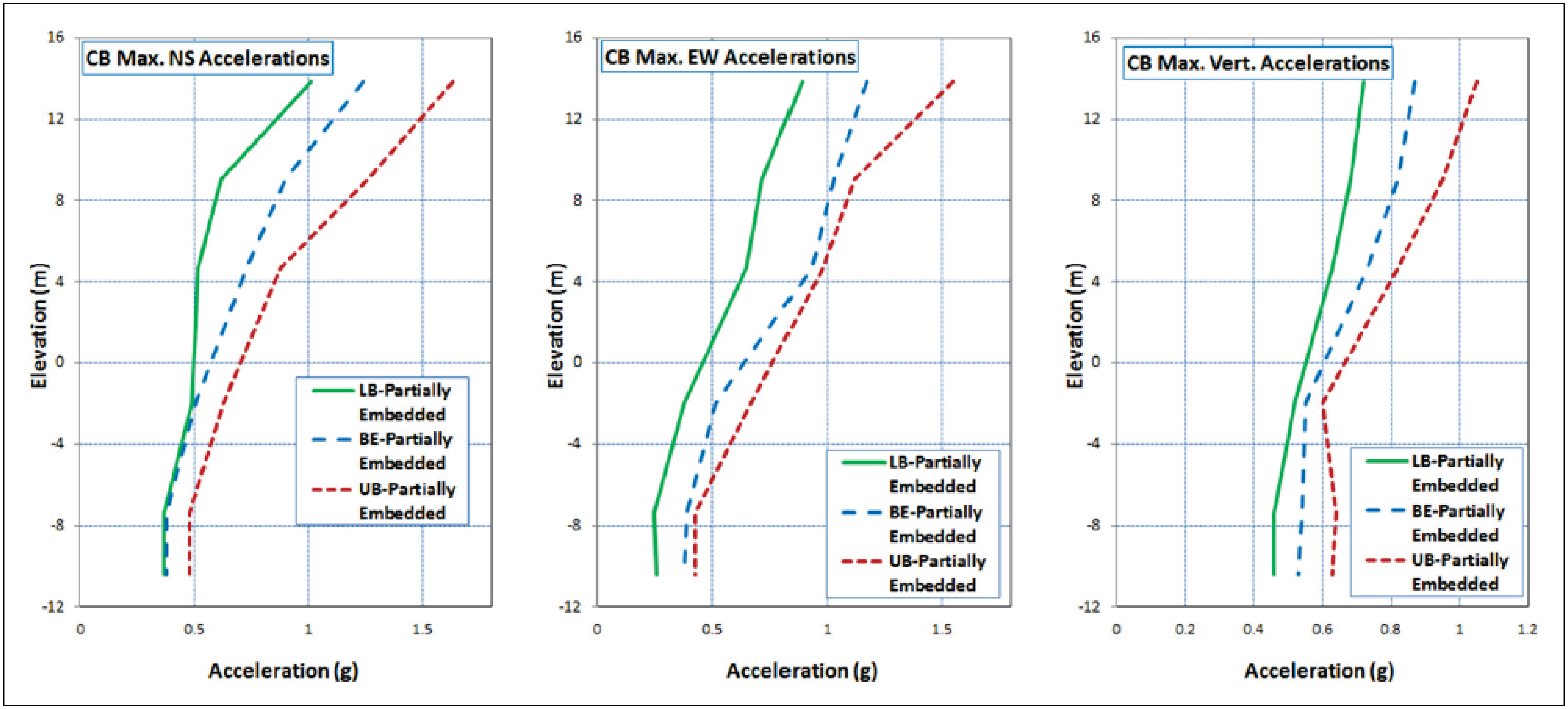
NAPS DEP 3.7-1

Table 3A.17.13.2-201 **Maximum Accelerations of Slab SDOF Oscillators - CB**

Elev. (m)	Node No.	Vertical Acceleration (g) Full Column LB	BE	UB	Partial Column LB	BE	UB	NA3 Envelope	Standard Design
13.80	9001	0.92	1.13	1.45	1.80	2.08	*2.20*	2.20	2.19
	9002	1.15	1.16	1.28	1.18	1.44	*1.69*	1.69	1.34
	9003	0.73	1.41	1.98	1.30	1.80	*1.99*	1.99	1.43
9.06	9101	1.00	1.31	1.49	1.86	2.00	*2.08*	2.08	2.00
	9102	0.77	1.11	1.30	1.16	1.33	*1.53*	1.53	1.26
	9103	0.67	1.41	*2.00*	1.28	1.77	1.91	2.00	1.43
4.65	9201	0.76	0.99	1.03	0.96	1.10	*1.24*	1.24	1.30
	9202	0.62	1.17	*1.53*	1.09	1.33	1.46	1.53	1.43
-2.00	9301	0.53	1.08	0.97	1.12	*1.16*	1.12	1.16	1.39

Note: The shaded values in the table show exceedance from standard design.
The values shown in Italic are governing case

Figure 3A.17.13.2-201 **CB Maximum Acceleration Results from Design Basis Analyses of Partial Column Profiles**



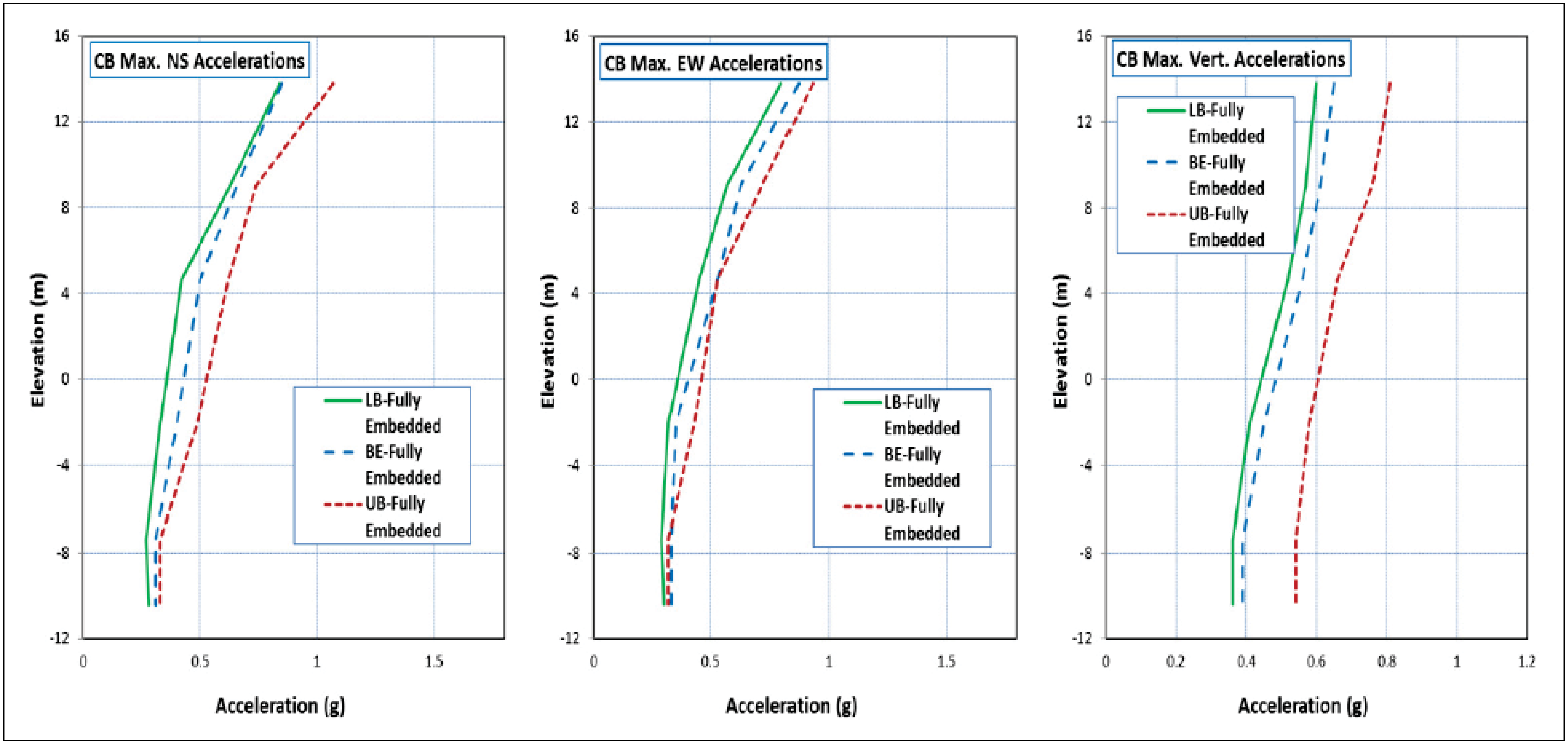


Figure 3A.17.13.2-202 **CB Maximum Acceleration Results from Design Basis Analyses of Full Column Profiles**

Figure 3A.17.13.2-203 **CB Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Partial Column Profiles**

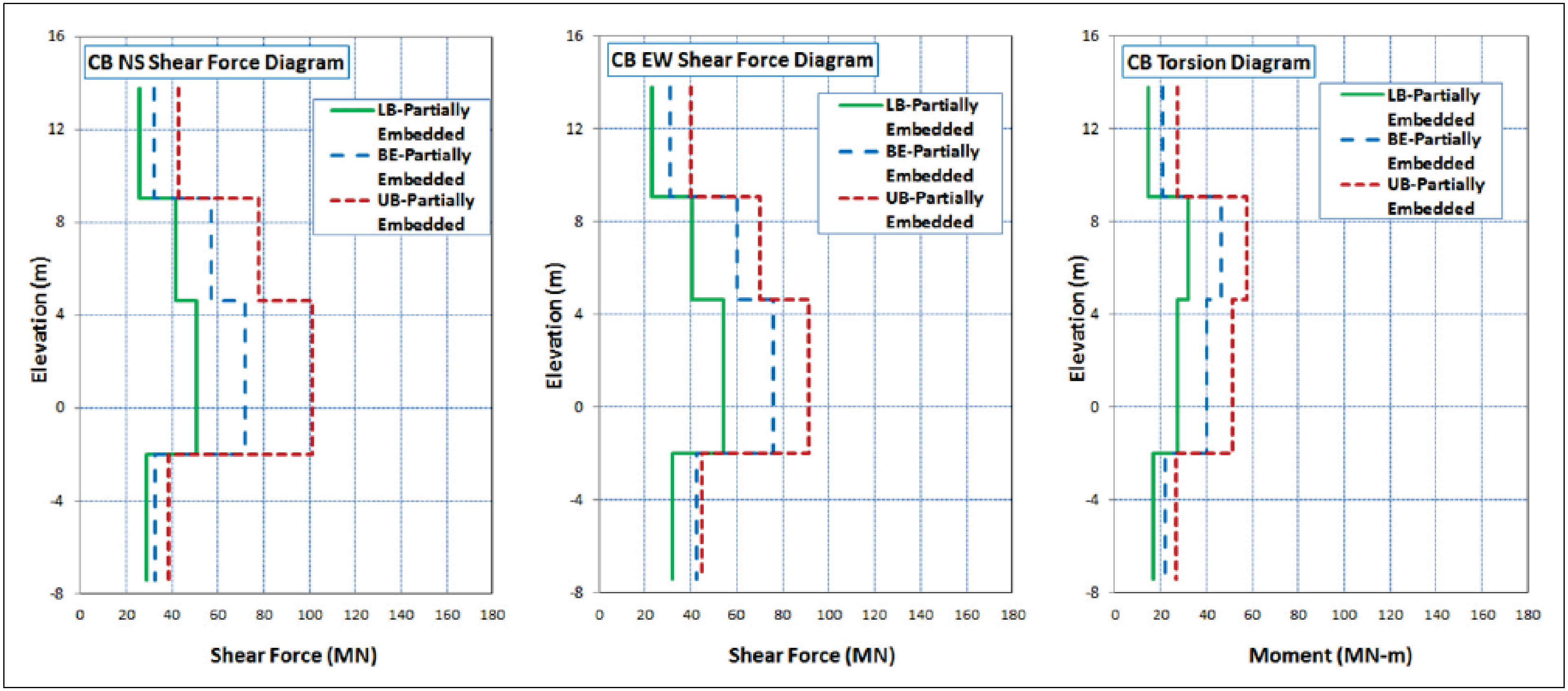
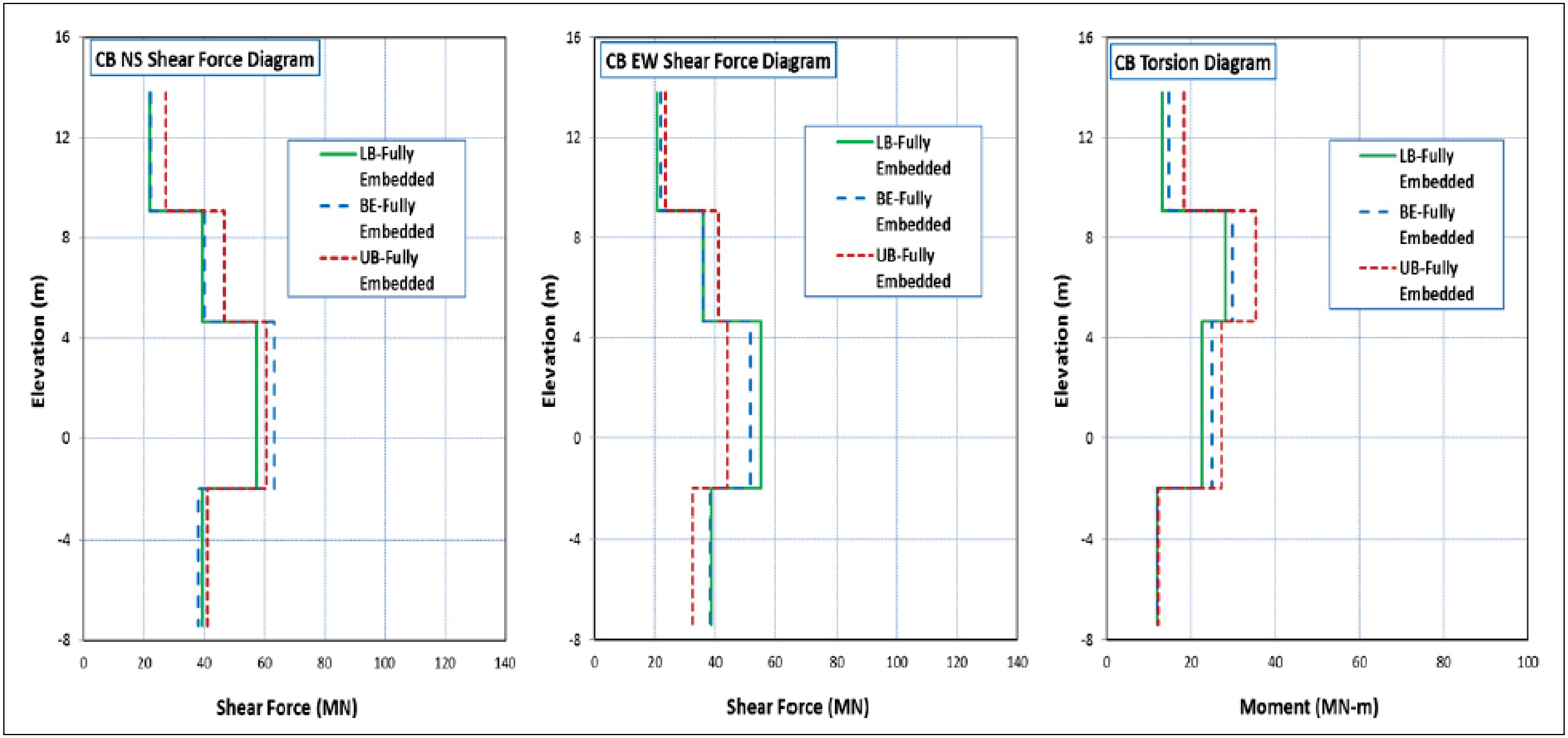


Figure 3A.17.13.2-204 **CB Maximum Shear Forces and Torsional Moment Results from Design Basis Analyses of Full Column Profiles**



3A.17.13.3 Acceleration Response Spectra

Comparisons of the 5 percent damped ARS, referred herein as the ISRS, results are presented for selected locations within the CB. The ISRS are obtained from the analyses of the CB model with full (uncracked concrete) stiffness properties and OBE damping for the six subgrade profiles (analysis Cases 1 through 6 in Table 3A.15-202).

Figures 3A.17.13.3-201a and 3A.17.13.3-201b, Figures 3A.17.13.3-202a and 3A.17.13.3-202b, and Figures 3A.17.13.3-203a and 3A.17.13.3-203b, respectively, present the 5 percent damped ISRS for the response in NS(X), EW(Y) and vertical (Z) directions at two key locations within the CB obtained from the SSI analyses of the CB partially embedded (PE) and fully embedded (FE) models. These site-specific ISRS are compared with the corresponding 5 percent damped standard design ISRS in DCD Section 3A.9.

Comparisons of the ISRS results obtained from the different site-specific SSI analyses show that the responses obtained from the analyses of the partial column subgrade profiles govern the horizontal and vertical ISRS for frequencies higher than 7 Hz and 10 Hz, respectively. The exception is the ISRS for the CB basemat response in the NS direction, where the analyses of the UB full column profile are bounding at frequencies between 15 and 20 Hz. The UB partial column profile also provides bounding ISRS results for frequencies higher than 31 Hz. The LB and BE full column profiles can only affect the enveloping ISRS for the response at the CB basemat top at frequencies below 18 Hz.

Comparisons in Figures 3A.17.13.3-201a through 3A.17.13.3-203b indicate that the CB site-specific ISRS exceed the corresponding standard design spectra. Large peak exceedances occur in the site-specific ISRS for the horizontal response of the CB roof at a relatively narrow frequency range between 10 and 15 Hz. The site-specific vertical ISRS also exceeds the corresponding standard design ISRS at frequencies from 10 to 15 Hz and 22 to 30 Hz. Certain exceedances in the SDOF oscillator ISRS occur mainly at frequencies corresponding to the frequencies of the oscillators.

The ISRS exceedances are due: 1) to the lower OBE structural damping values used for the site-specific SSI analysis versus the SSE damping values used for standard design SSI analyses and 2) the fact that the Unit 3 site-specific design motion has higher energy content than the

standard design CSDRS at frequencies close to the natural frequencies of the CB structure.

Figure 3A.17.13.3-201a **Comparison of ISRS - CB Top in NS (X)-Direction**

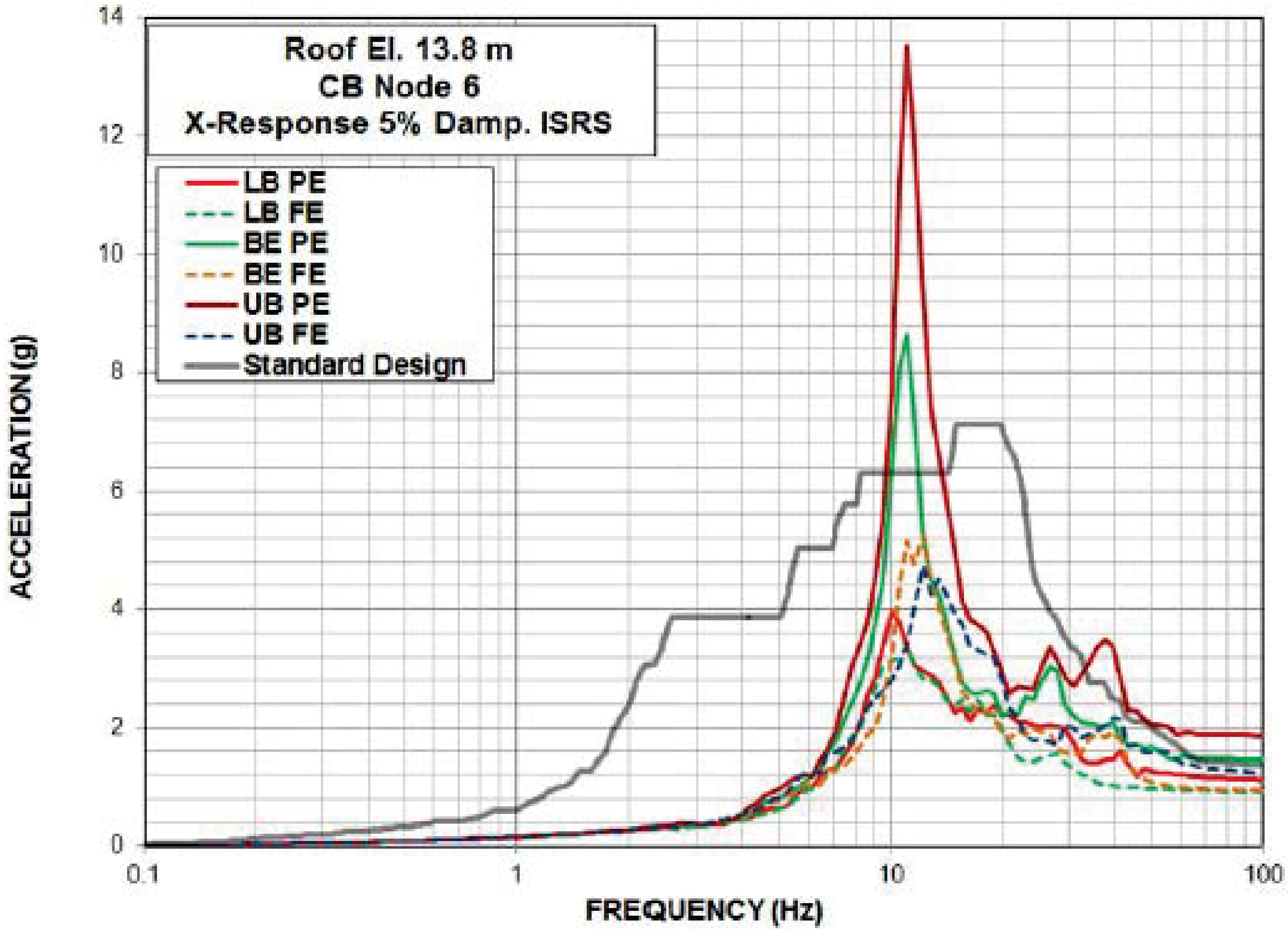


Figure 3A.17.13.3-201b **Comparison of ISRS - CB Basemat in NS (X)-Direction**

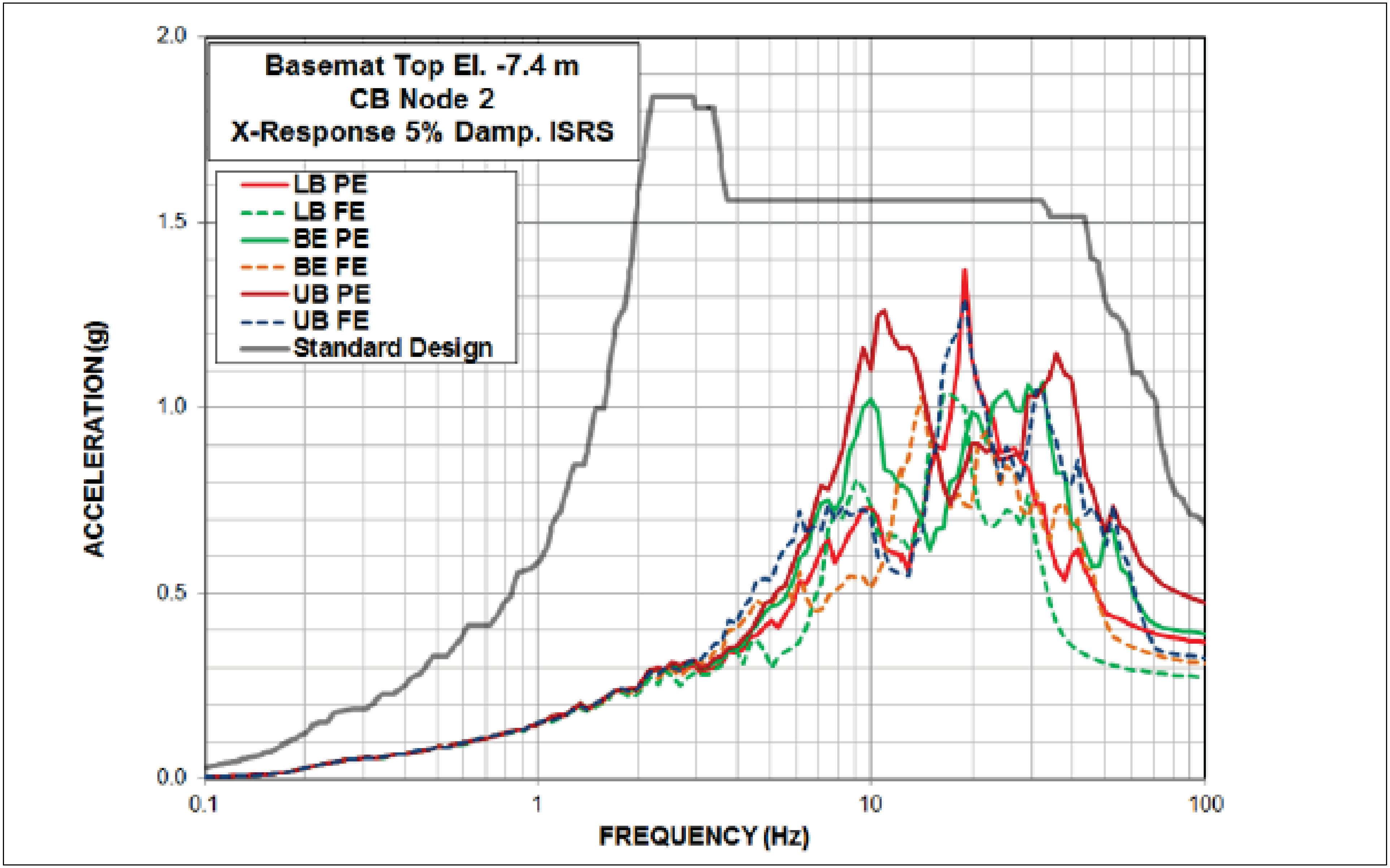


Figure 3A.17.13.3-202a **Comparison of ISRS - CB Top in EW (Y)-Direction**

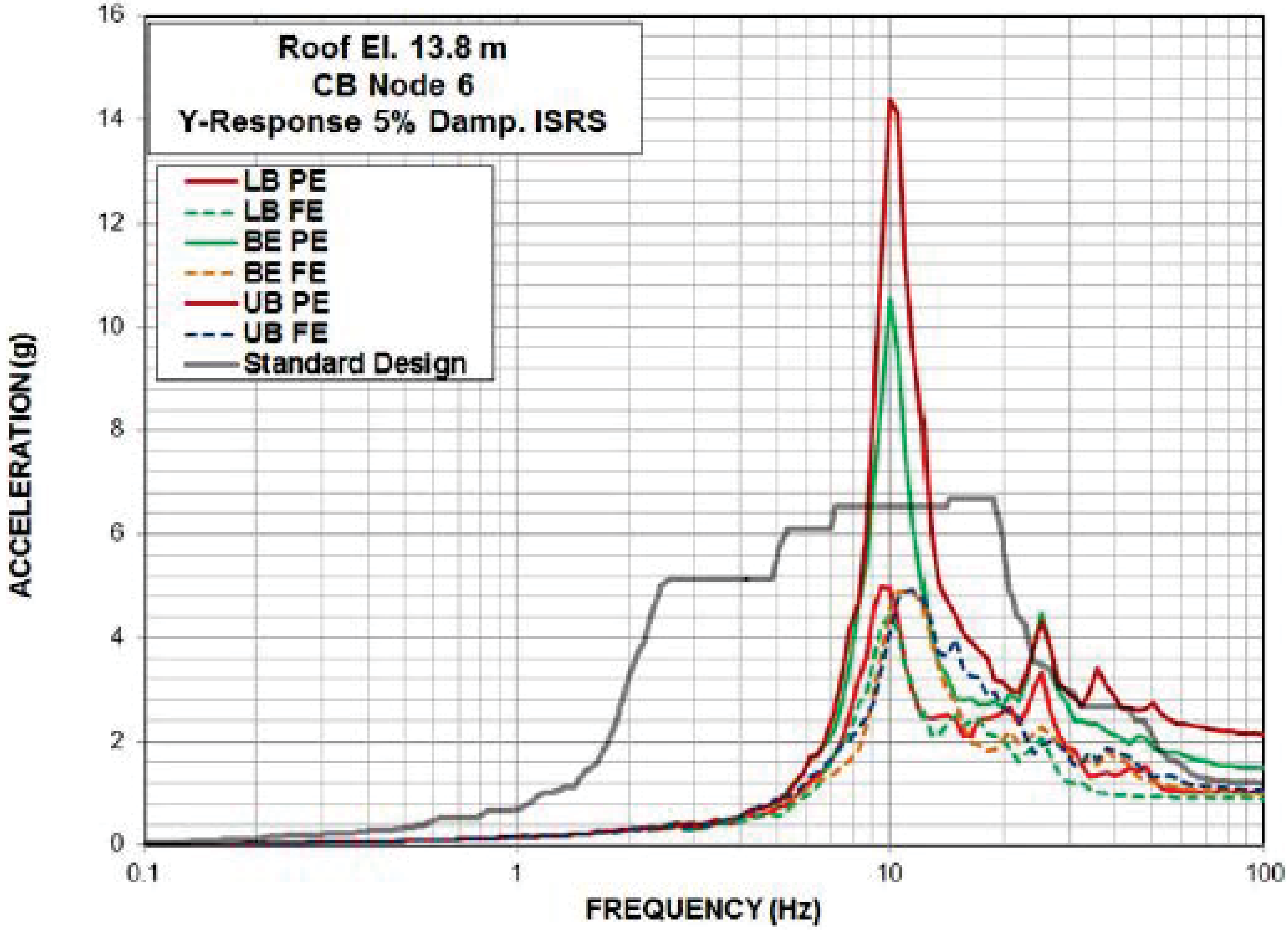


Figure 3A.17.13.3-202b **Comparison of ISRS - CB Basemat in EW (Y)-Direction**

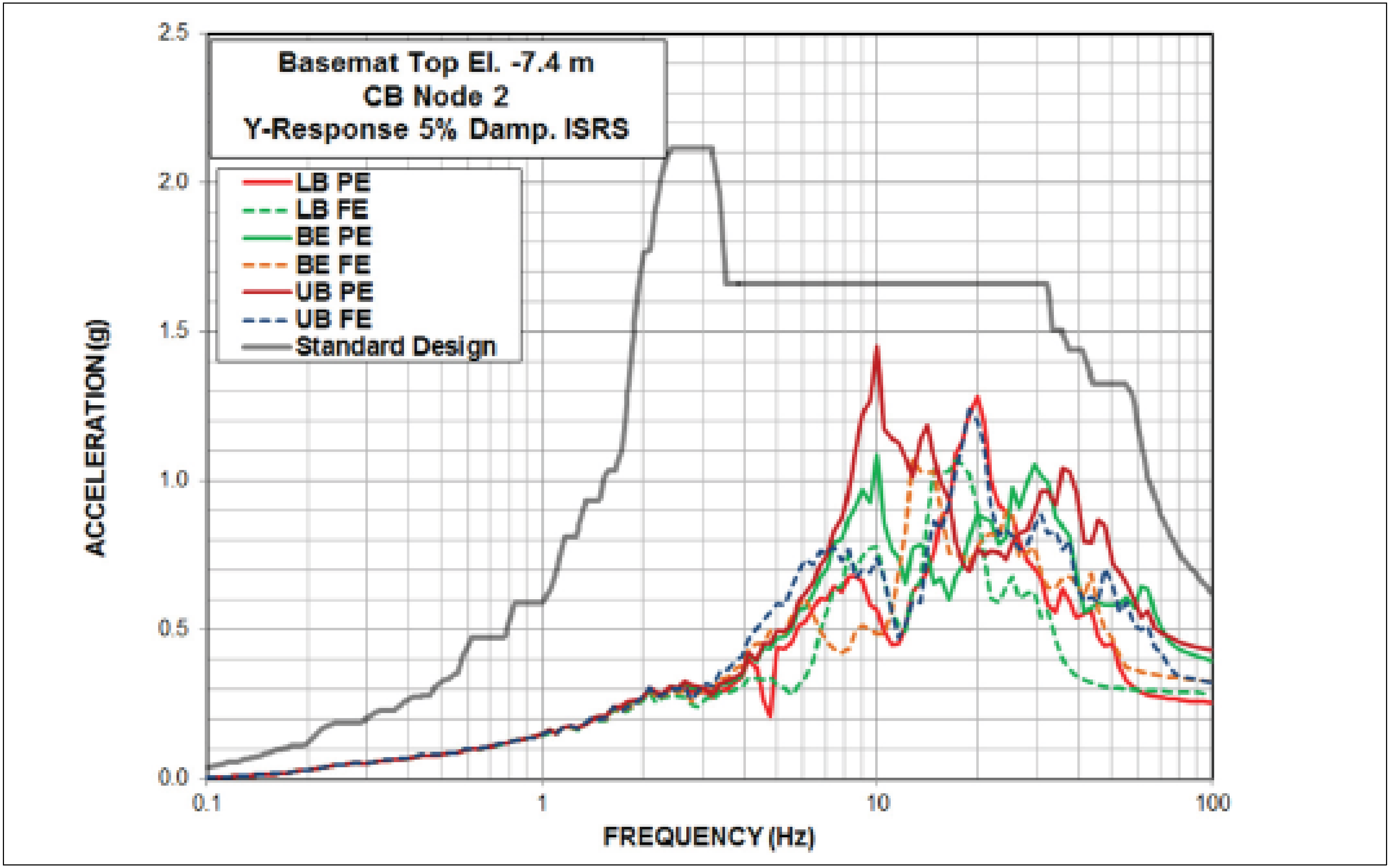


Figure 3A.17.13.3-203a **Comparison of ISRS - CB Top in Vertical (Z)-Direction**

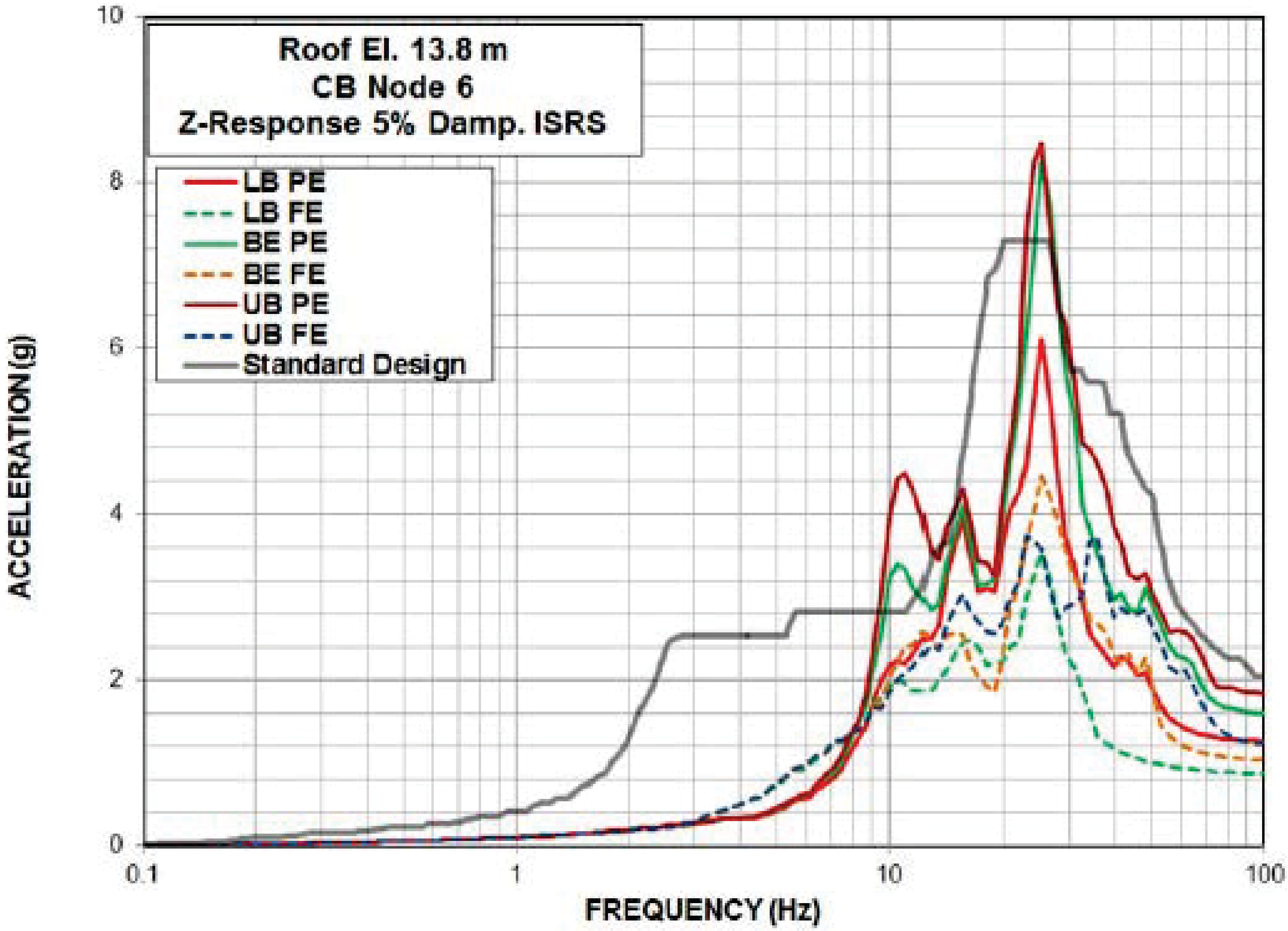
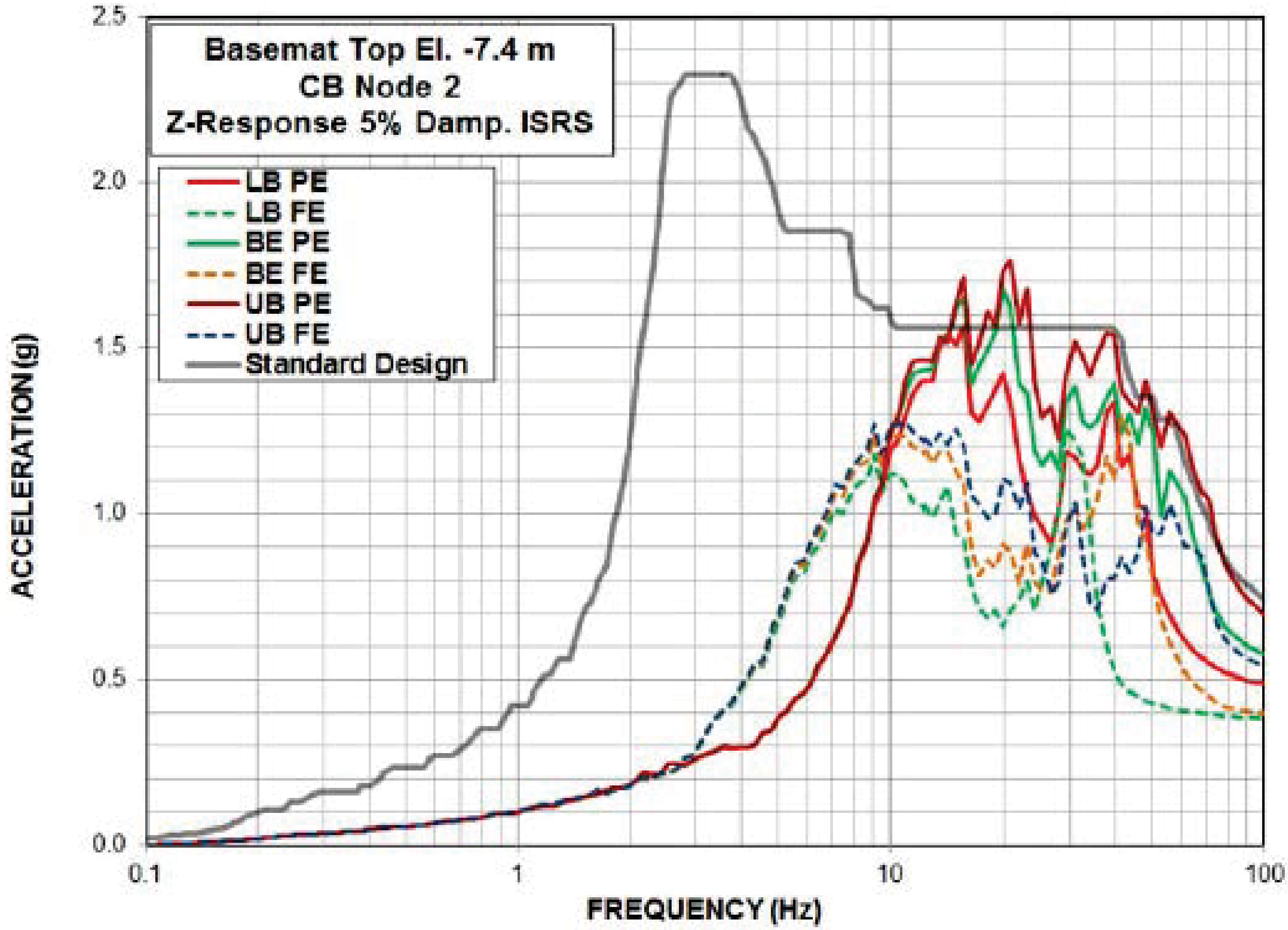


Figure 3A.17.13.3-203b **Comparison of ISRS - CB Basemat in Vertical (Z)-Direction**



3A.17.13.4 Maximum Lateral Pressures on Below-Grade Exterior Walls

As discussed in Section 3A.16.3, spring elements between “double nodes” are installed on the foundation and soil/rock interfaces to calculate the SSI forces. The lateral seismic pressures on the CB below-grade walls are calculated from the SASSI analysis results for the spring forces installed between the shells on the sides of the embedded portion of the CB model and the surrounding near-field elements.

Figures 3A.17.13.4-201 through 3A.17.13.4-204 provide plots of the results from the site-specific design basis SSI analysis of the CB partially embedded (PE) and fully embedded (FE) models with upper bound stiffness properties and SSE damping values (Cases 7 through 12 in Table 3A.15-202) for the maximum seismic lateral pressures on the CB below-grade exterior walls.

The comparison of the results obtained from different analyses show that the variation of the soil properties has a very small effect on the calculated dynamic pressures on the exterior walls. Very small differences can be observed between the lateral pressures calculated from the analysis of LB, BE and UB profiles. Results obtained from the analyses of full column profiles show that the pressures on the CB exterior walls from the structural fill/saprolite are small relative to those from the concrete fill/Zone III rock. The analyses of both embedment configurations yield maximum lateral pressures at the top of Zone III rock (Elevation -0.68 m; Elevation 273.0 ft NAVD88) and at the bottom of CB basemat (Elevation -10.4 m; Elevation 241.1 ft NAVD88).

In Section 3G.8.5.6, the dynamic lateral pressure results obtained from the site-specific SSI analysis are combined with site-specific static pressures to develop the total site-specific lateral load demands on the CB below-grade exterior walls. These total site-specific lateral loads are compared with the corresponding enveloping standard design loads in order to determine exceedances of the site-specific lateral loads demands relative to the standard design.

Figure 3A.17.13.4-201 **CB Dynamic Lateral Pressures on Below-Grade Exterior Wall at Column Line C1**

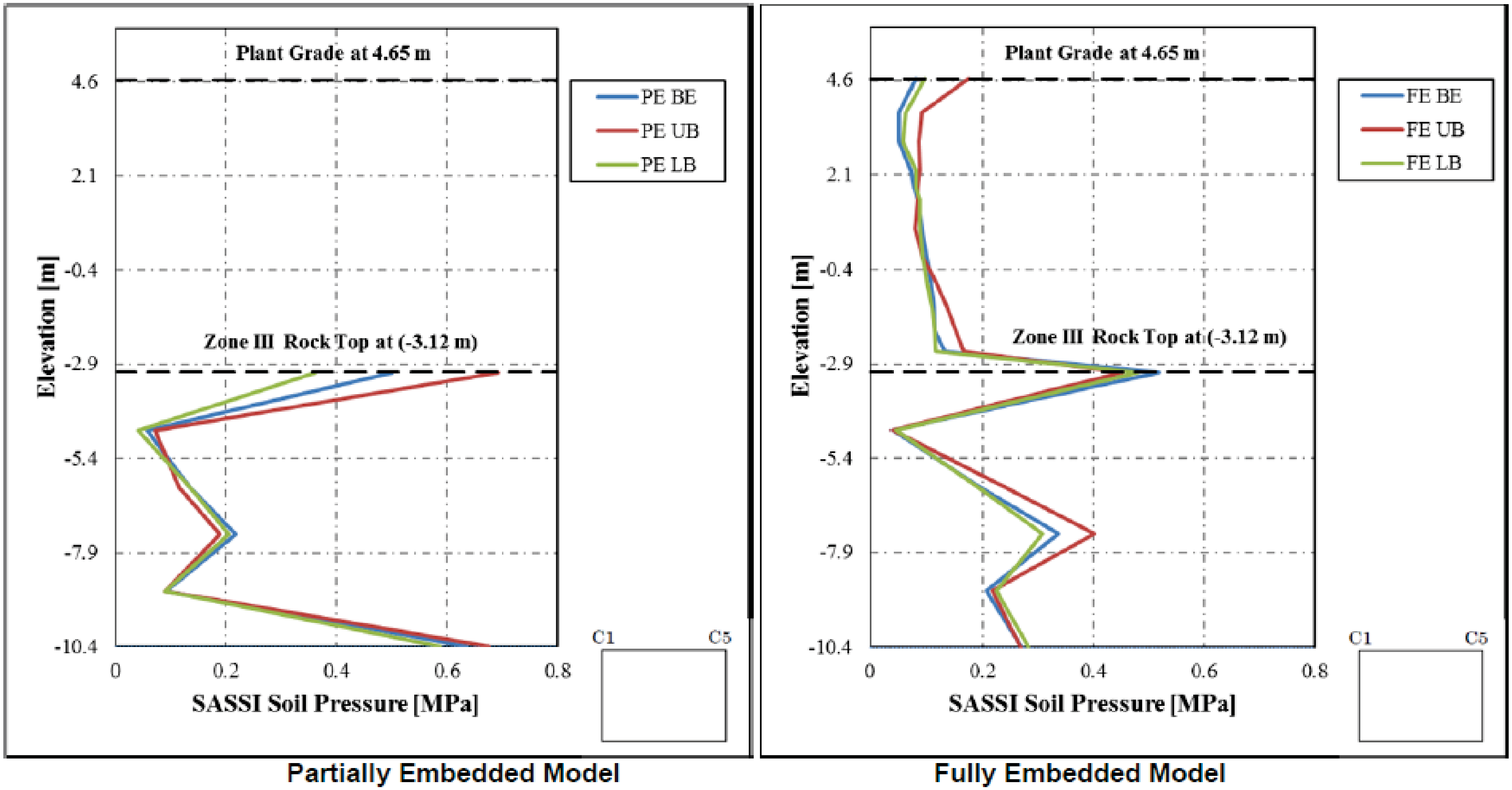


Figure 3A.17.13.4-202 **CB Dynamic Lateral Pressures on Below-Grade Exterior Wall at Column Line C5**

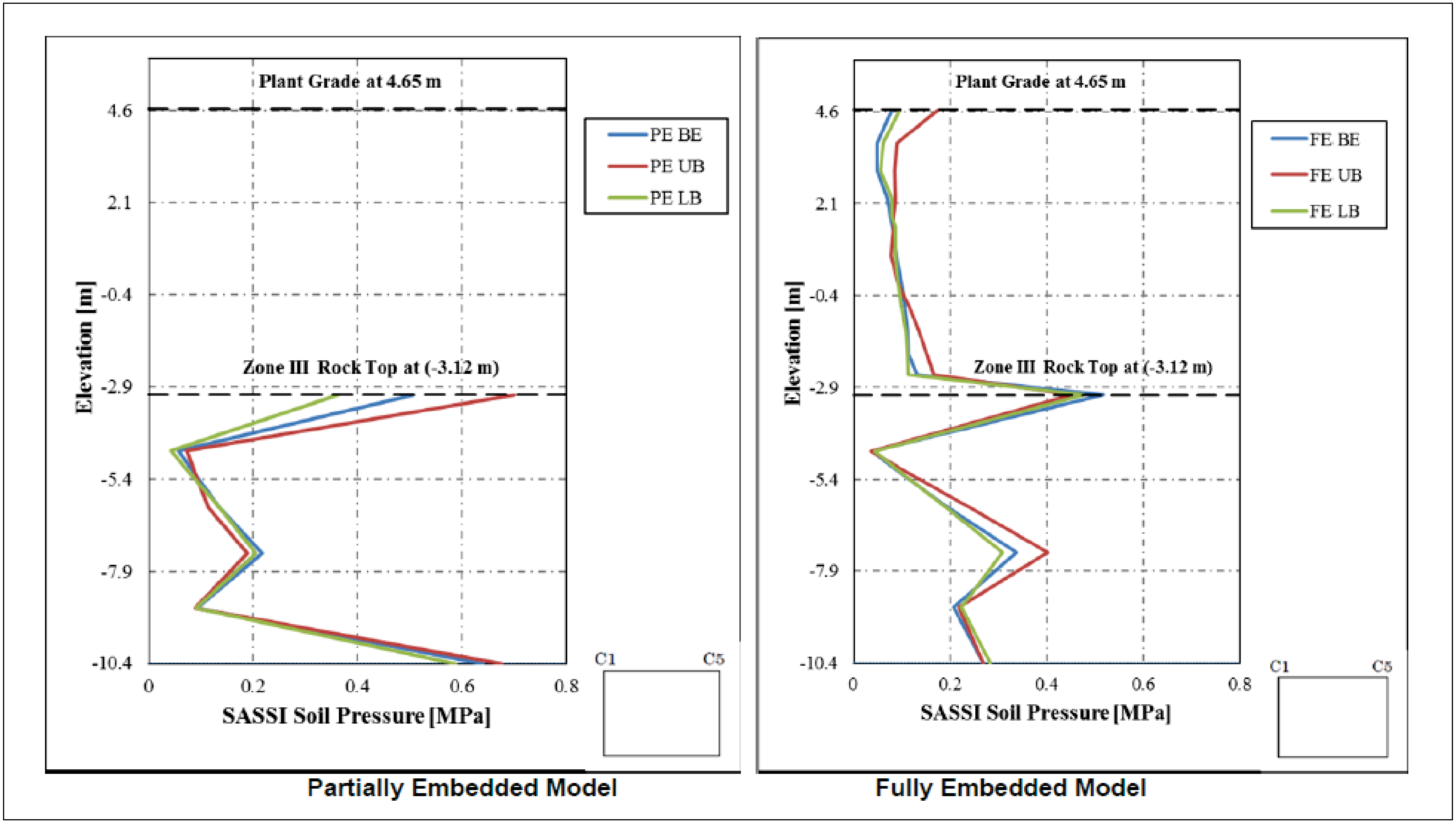
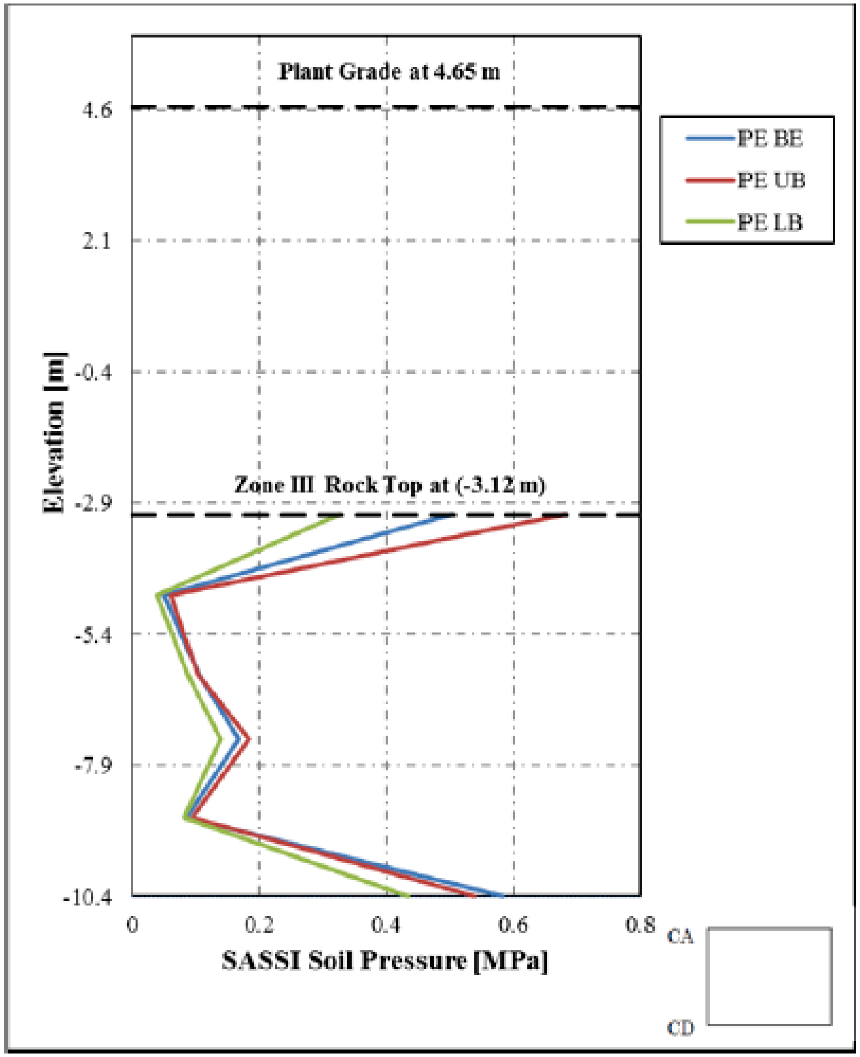
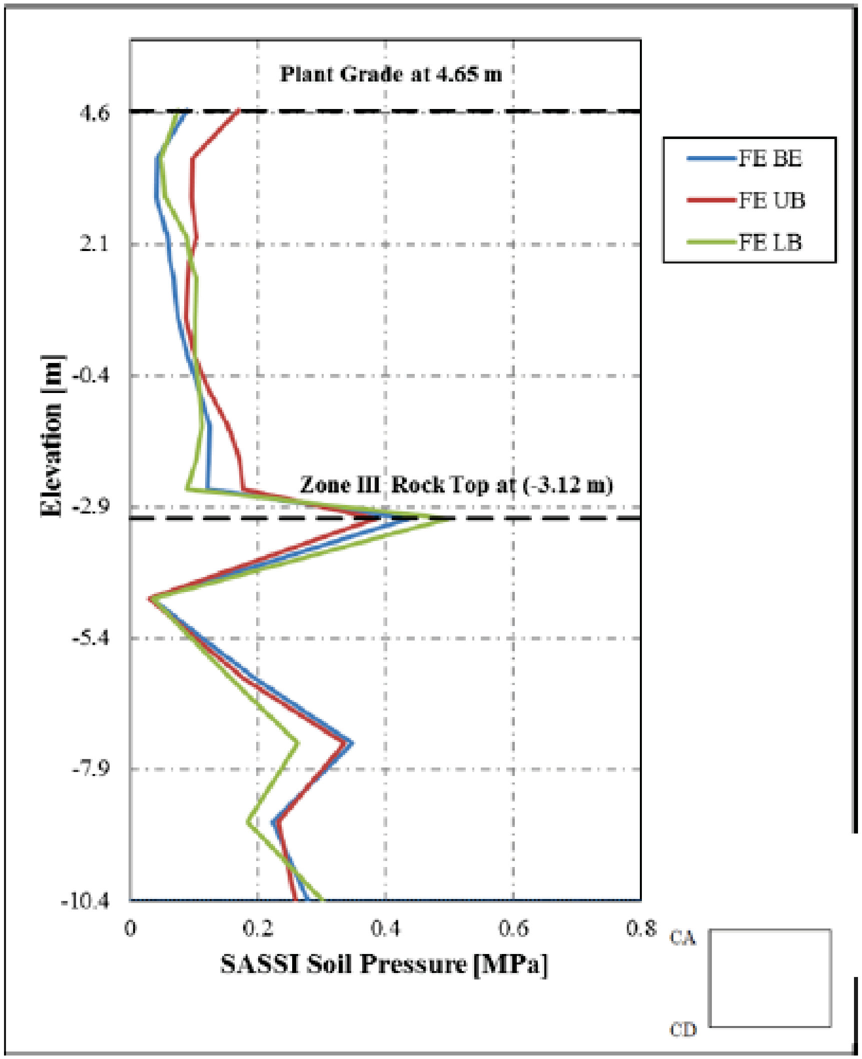


Figure 3A.17.13.4-203 **CB Dynamic Lateral Pressures on Below-Grade Exterior Wall Column Line CA**

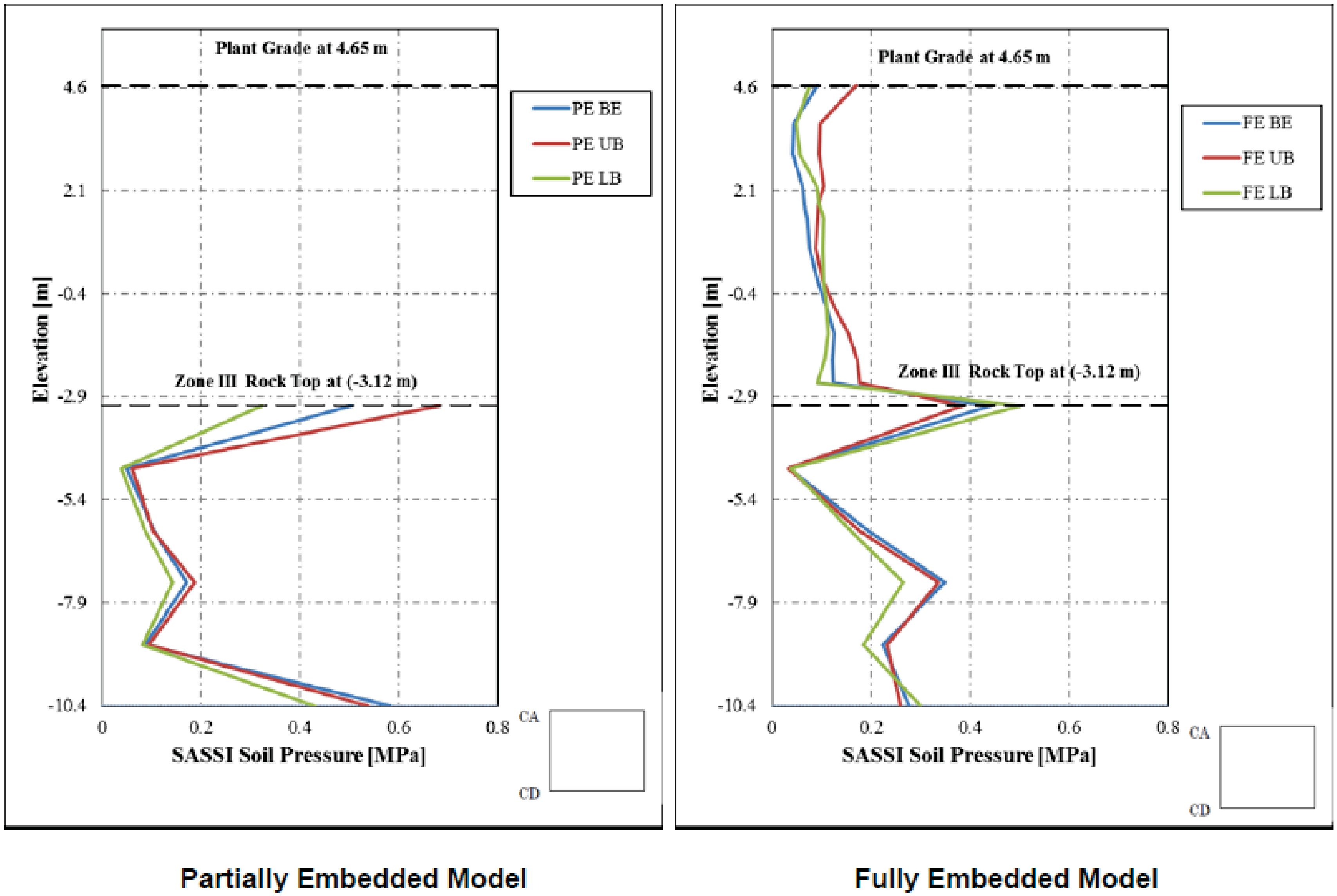


Partially Embedded Model



Fully Embedded Model

Figure 3A.17.13.4-204 **CB Dynamic Lateral Pressures on Below-Grade Exterior Wall at Column Line CD**



3A.17.13.5 Base Reactions and Contact Pressures

Results of the SSI analyses for contact spring forces are also used to calculate the time histories of the seismic driving forces used as input for the sliding stability evaluations and dynamic bearing pressure calculations. The time histories of the horizontal and vertical driving seismic forces and overturning base moments are calculated as described in Section 3A.17.12.5.

The time histories of the vertical spring forces obtained from the contact springs at the bottom of the CB basemat are also used to develop the base contact pressure plots that are used to calculate the minimum base contact area. The CB foundation uplift calculations are performed using the results of the three design basis SSI analyses of the CB model with upper bound stiffness properties and SSE damping for the LB, BE, and UB partial column profiles (analysis Cases 7 to 9 in Table 3A.15-202). These are the analyses cases that provide bounding seismic loads on the CB structure. The calculations are performed for each of the three critical soil cases as described in Section 3A.17.12.5.

However, the CB structure and model are nearly symmetrical with respect to both the NS (X) and EW(Y) direction vertical planes, so the effect of different phasing of the X and Y input motions in the calculation of the contact area is insignificant. Therefore, the contact ratio calculations are performed considering the following two combinations of input motion directions:

- R_D+R_B +E_x + E_y + E_z
- R_D+R_B -E_x - E_y - E_z

Table 3A.17.13.5-201 summarizes, for each soil case, the results of the calculations of maximum base reaction eccentricities and minimum contact areas. It shows that, as expected, the analysis of the UB partial column subgrade profile yields the maximum value for the vertical base reaction eccentricity and the minimum value for the foundation contact area. The results presented in Table 3A.17.13.5-201 show that the base contact area remains larger than 80 percent, which, per the guidance of SRP 3.7.2, ensures that the possible uplift of the CB basemat has a negligible effect on the results of site-specific CB SSI analyses.

As shown in Figures 3A.16.3-213a and 3A.16.3-213b, which present the CB dynamic model used for the SSI analyses of partial column profiles, shell elements are used to model the basemat and the below-grade

exterior walls. Stick elements are used to represent the stiffness of the interior walls below grade elevations and all above grade walls. These stick elements represent the overall stiffness of the walls only for the purpose of calculating floor responses and, unlike the shells modeling the in-plane stiffness of exterior walls, do not capture the contribution of the inner wall oriented in the EW direction and located at the middle of the CB basemat (Column Line C3 in Figure 3A.16.3-210) to the overall stiffness of the CB basemat. Therefore, the CB dynamic model underestimates the stiffness of the basemat, which, in turn, can affect the distribution of base pressures that are calculated from the SSI analysis model and used for calculations of the minimum foundation contact area.

Alternative uplift calculations are performed to further address the effect of basemat stiffness on the CB foundation uplift calculations that consider:

- the case where the in-plane stiffness of CB interior wall in the dynamic model is accounted for by adding rigid beams in the middle of the CB basemat
- the bounding case of an absolutely rigid foundation

The results of alternative calculations performed on the model with CB interior wall for the case identified in Table 3A.17.13.5-201 as critical for the uplift of the CB foundation predict a minimum base contact area of 73 percent. Further evaluations performed considering an absolutely rigid foundation show that the uplift of the CB foundation is grossly overestimated by the conservative approach used to account for the effects of the groundwater buoyancy and embedment. The uplift calculations conservatively consider the groundwater buoyancy pressure applied uniformly at the bottom of the CB foundation. Because the actual permeability of the concrete fill supporting the CB foundation is very small and insufficient for this buoyancy pressure to be generated, the actual uplift of the foundation will be considerably lower than the calculated values. Additional calculations are performed to illustrate the effect of groundwater buoyancy and show that, without the buoyancy pressure, the uplift of the CB rigid basemat is reduced by more than 40 percent.

The foundation uplift calculations are all based on responses obtained from the analyses of the CB partially embedded model that neglects the stiffness of the subgrade located above Zone III rock. As explained in Section 3A.12.2, the purpose of SSI analyses of partially embedded

models is to address in a conservative manner the possible effects of soil separation and groundwater table variations on the CB response. Unlike the fully embedded models that include the subgrade materials above the Zone III rock, and thus provide a more realistic representation of the CB embedment conditions, the partially embedded models considered for the uplift calculations represent a hypothetical embedment condition. To illustrate how the full embedment can affect the uplift of the CB foundation, additional foundation uplift calculations are performed using the results from the CB SSI analysis of the LB, BE and UB full column profiles (analysis Cases 10 through 12 in Table 3A.15-202) and are used to illustrate the effect of full embedment on the CB base contact area. The results of these calculations show that, under fully embedded conditions, the CB rigid foundation remains in full (100 percent) contact with the underlying subgrade for the entire duration of the design ground motion.

Further evaluations also show that, under the site-specific high frequency design ground motion, the larger uplifts of the CB basemat are infrequent (uplift larger than 20 percent occurs only once) with too short a duration (less than 0.02 seconds) to have an effect on the seismic response of the CB structure. Therefore, considering the duration and the frequency of occurrence of the larger uplifts and the conservatism introduced in the uplift calculations, it is confirmed that the uncertainties in the base contact pressure calculations related to the overall stiffness of the CB foundation do not affect the results of the CB SSI analyses that are performed on linear elastic SSI models.

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Table 3A.17.13.5-201 **Summary of Maximum Base Reaction Eccentricity Results - CB**

Combination	Analysis	UC_{SSE} Model Partial Column BE	UB	LB
+Ex+Ey+Ez	Max. Eccentricity (m)	5.2	5.9	5.5
	at Time (s)	3.085	1.910	3.085
	Minimum Contact Ratio	91.4%	92.3%	92.1%
-Ex-Ey-Ez	Max. Eccentricity (m)	7.7	10.2	4.0
	at Time (s)	1.815	1.810	1.810
	Minimum Contact Ratio	82.9%	82.7%	85.2%

Note: The shaded values are the governing case.

3A.17.14 Site-Specific SSI Analysis Results for FWSC

This section presents the results of the site-specific design basis SSI analyses of the FWSC (analysis Cases 1 through 9 in Table 3A.15-203).

3A.17.14.1 FWSC SSI Response

Comparisons of the results of the design basis SSI analyses of the FWSC model with full stiffness and OBE damping for all subgrade profiles and the two different elevations of the input control motion show that the analyses performed using input control motion at the bottom of the concrete fill Elevation 220 ft NAVD88 provide bounding results for the maximum responses of the FWSC structures. The analysis of the UB profile using deep input control motion at the bottom of the concrete fill provides bounding site-specific seismic demands on the FWSC structures. The only exception is the torsional moment demand on the FWS tank structure that is governed by the results of the analysis of the BE profile with deep input control motion at the bottom of the concrete fill.

The site-specific seismic load demands on the FWSC are developed using the maximum force and acceleration results obtained from the FWSC UC_{SSE} model with full (uncracked concrete) properties and SSE damping. These analyses are performed using only the in-column control motion that is input at the bottom of the concrete fill Elevation 220 ft NAVD88 (analysis Cases 7 through 9 in Table 3A.15-203) that, as shown in Section 3A.17.14.2, are governing for the maximum site-specific responses of FWSC structures. The results from the set of six analyses performed on the FWSC UC_{OBE} model with full (uncracked concrete) stiffness properties and OBE damping (analysis Cases 1 through 6 in Table 3A.15-203) are used for development of the FWSC site-specific ISRS as described in Section 3A.17.14.3. In addition, the effects of potential separation between the concrete fill below the foundation and the surrounding soil on the seismic response of the FWSC structures are evaluated, as described in Section 3A.17.14.5.

3A.17.14.2 Maximum Accelerations and Member Forces

Figures 3A.17.14.2-201a through 3A.17.14.2-202b present comparisons of the results of the design basis SSI analyses of FWSC UC_{OBE} model with full stiffness and OBE damping for the LB, BE, and UB subgrade profiles for maximum absolute accelerations at FWS and FPE lumped mass locations, respectively. Figures 3A.17.14.2-201a and 3A.17.14.2-202a compare the results obtained from the analyses

with surface input motion at Elevation 282 ft NAVD88 (analysis Cases 1 through 3 in Table 3A.15-203). Figures 3A.17.14.2-201b and 3A.17.14.2-202b compare the results obtained from the analyses with deep input motion at Elevation 220 ft NAVD88 (analysis Cases 4 through 6 in Table 3A.15-203). Table 3A.17.14.2-201 compares the maximum accelerations results for the FWSC SDOF oscillators representing the out-of-plane response of the FWS roof and the horizontal responses of the sloshing and impulsive hydrodynamic modes of vibration of the water in the FWS tank.

Figures 3A.17.14.2-203a through 3A.17.14.2-204b present comparisons of the maximum shear forces and torsional moments on the FWS and FPE structures obtained from the analyses of the FWSC model for LB, BE and UB subgrade profiles. Figures 3A.17.14.2-203a and 3A.17.14.2-204a compare the results obtained from the analyses with surface input motion at Elevation 282 ft NAVD88 (analysis Cases 1 through 3 in Table 3A.15-203). Figures 3A.17.14.2-203b and 3A.17.14.2-204b compare the results obtained from the analyses with deep input motion at Elevation 220 ft NAVD88 (analysis Cases 4 through 6 in Table 3A.15-203).

Figures 3A.17.14.2-201a through 3A.17.14.2-204b show the analysis of UB subgrade profile with deep input control motion (analysis Case 6 in Table 3A.15-203) governs the maximum responses of the FWSC structures with the exception of torsional moment demand on the FWS that are governed by the analysis of the BE profile with deep input motion at Elevation 220 ft NAVD88 (analysis Case 5 in Table 3A.15-203). Comparisons in Table 3A.17.14.2-201 show that analysis Case 6 also governs the maximum responses of the FWSC SDOF oscillators.

The comparisons of the results obtained from the analysis with surface and deep input motions show that the high frequency content of the input motion transmitted through the concrete fill block resulted in significantly higher results for the FWS and FPE maximum accelerations and forces.

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Table 3A.17.14.2-201 **Maximum Accelerations of SDOF Oscillators - FWSC**

SDOF Oscillator				Acceleration (g)						
				Motion Elevation 282 ft.			Motion Elevation 220 ft.			
Elev. (m)	**Node No.**	**Description**	**Direction**	**LB**	**BE**	**UB**	**LB**	**BE**	**UB**	**Envelope**
19.70	11	FWS Roof	Vert. (Z)	1.34	1.62	1.58	2.10	3.26	*4.22*	4.22
12.10	60	FWS Water Sloshing Mode	NS (X)	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	0.10
			EW (Y)	0.07	0.07	0.07	*0.09*	*0.09*	*0.09*	0.09
8.81	30	FWS Water Impulsive Mode	NS (X)	0.77	0.85	0.72	0.80	0.85	1.02	1.02
			EW (Y)	0.68	0.73	0.64	0.74	0.81	1.08	1.08

Note: The shaded values are the governing case(s)

Figure 3A.17.14.2-201a **FWS Maximum Accelerations from Analyses of FWSC UC_{OBE} Model with Surface Input Motion at Elevation 282 ft**

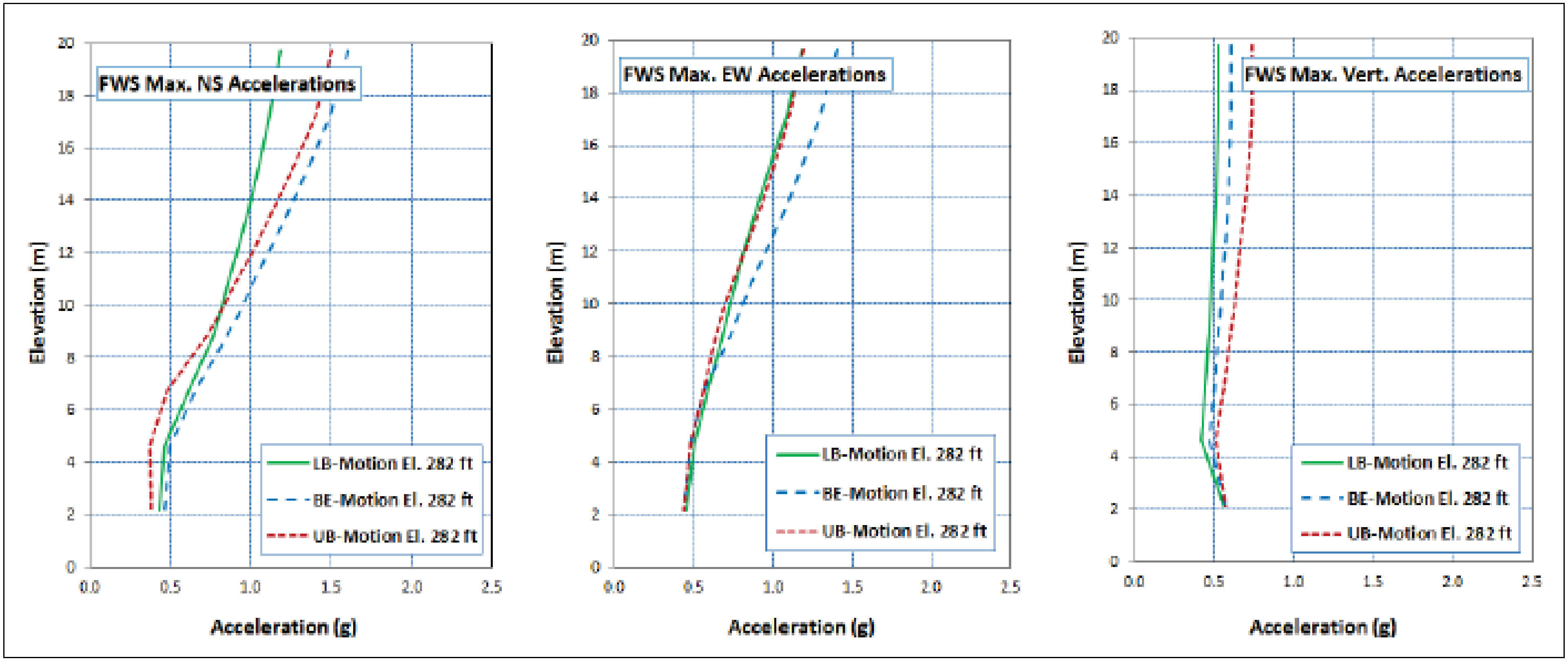

Figure 3A.17.14.2-201b **FWS Maximum Accelerations from Analyses of FWSC UC_{OBE} Model with Deep Input Motion at Elevation 220 ft**

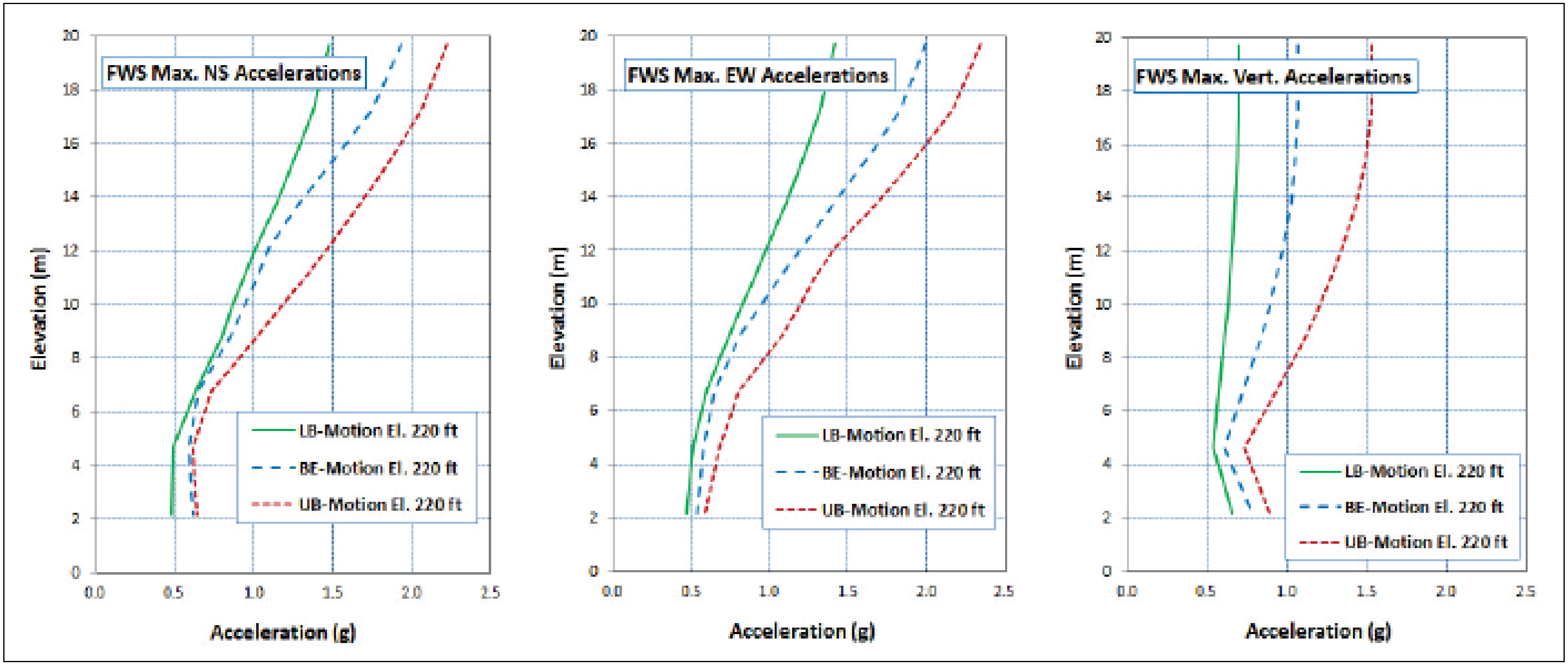

Figure 3A.17.14.2-202a **FPE Maximum Accelerations from Analyses of FWSC UC_{OBE} Model with Surface Input Motion at Elevation 282 ft**

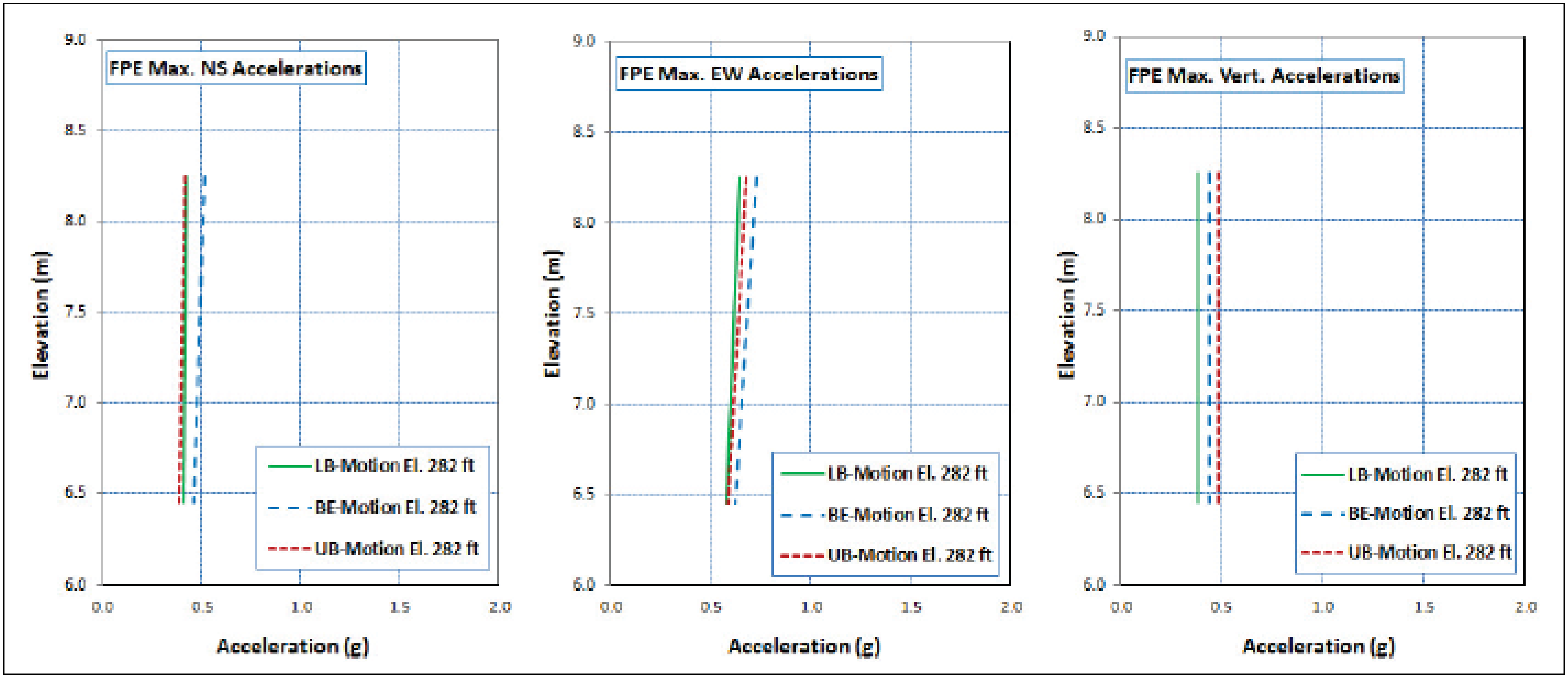

Figure 3A.17.14.2-202b **FPE Maximum Accelerations from Analyses of FWSC UC_{OBE} Model with Deep Input Motion at Elevation 220 ft**

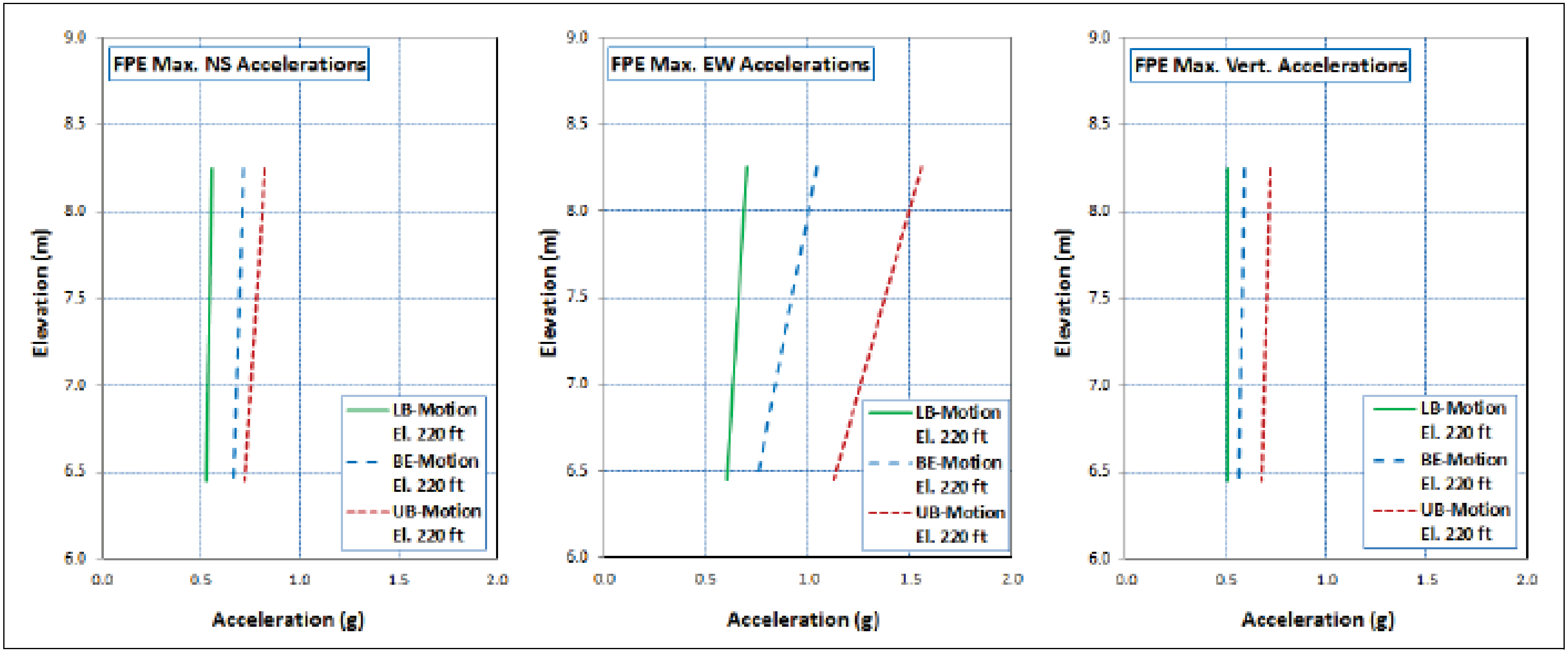

Figure 3A.17.14.2-203a **FWS Maximum Shear Forces and Torsion from Analyses of FWSC UC_{OBE} Model with Surface Input Motion at Elevation 282 ft**

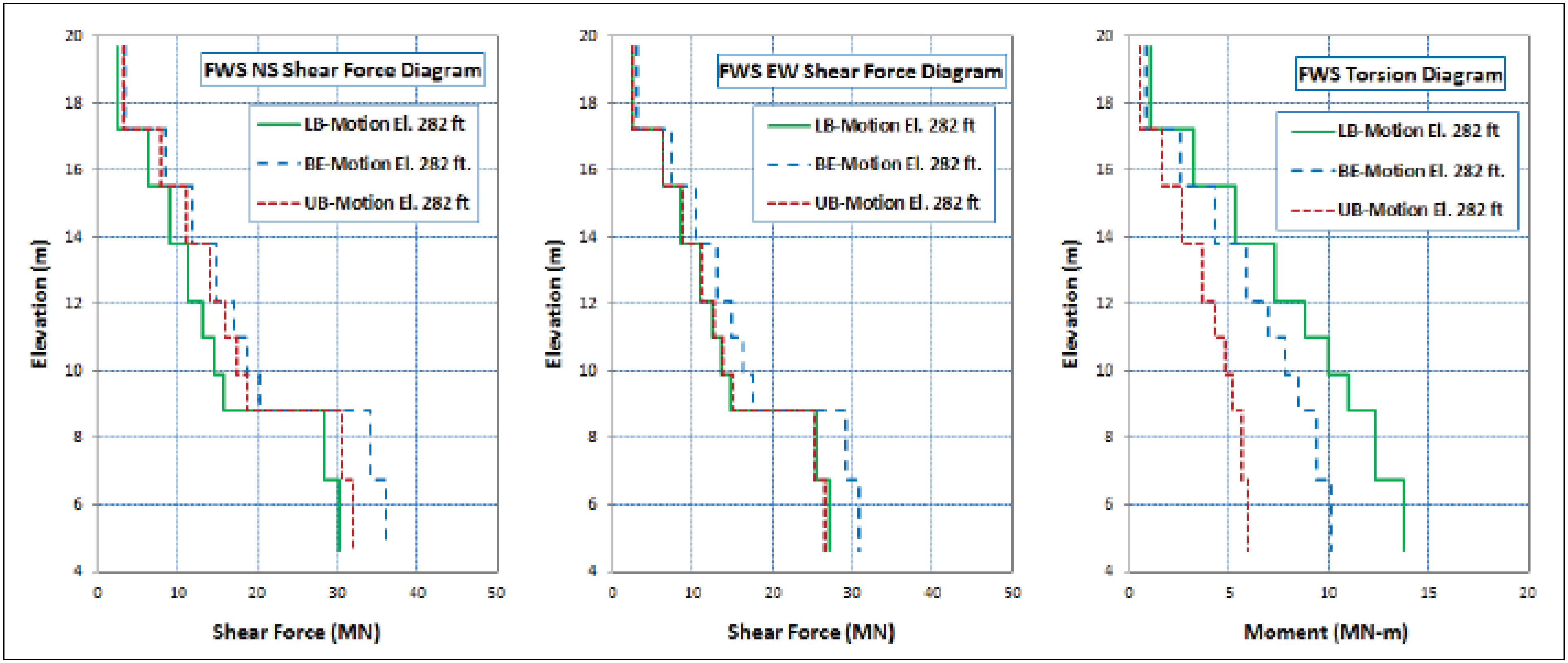

Figure 3A.17.14.2-203b **FWS Maximum Shear Forces and Torsion from Analyses of FWSC UC_{OBE} Model with Deep Input Motion at Elevation 220 ft**

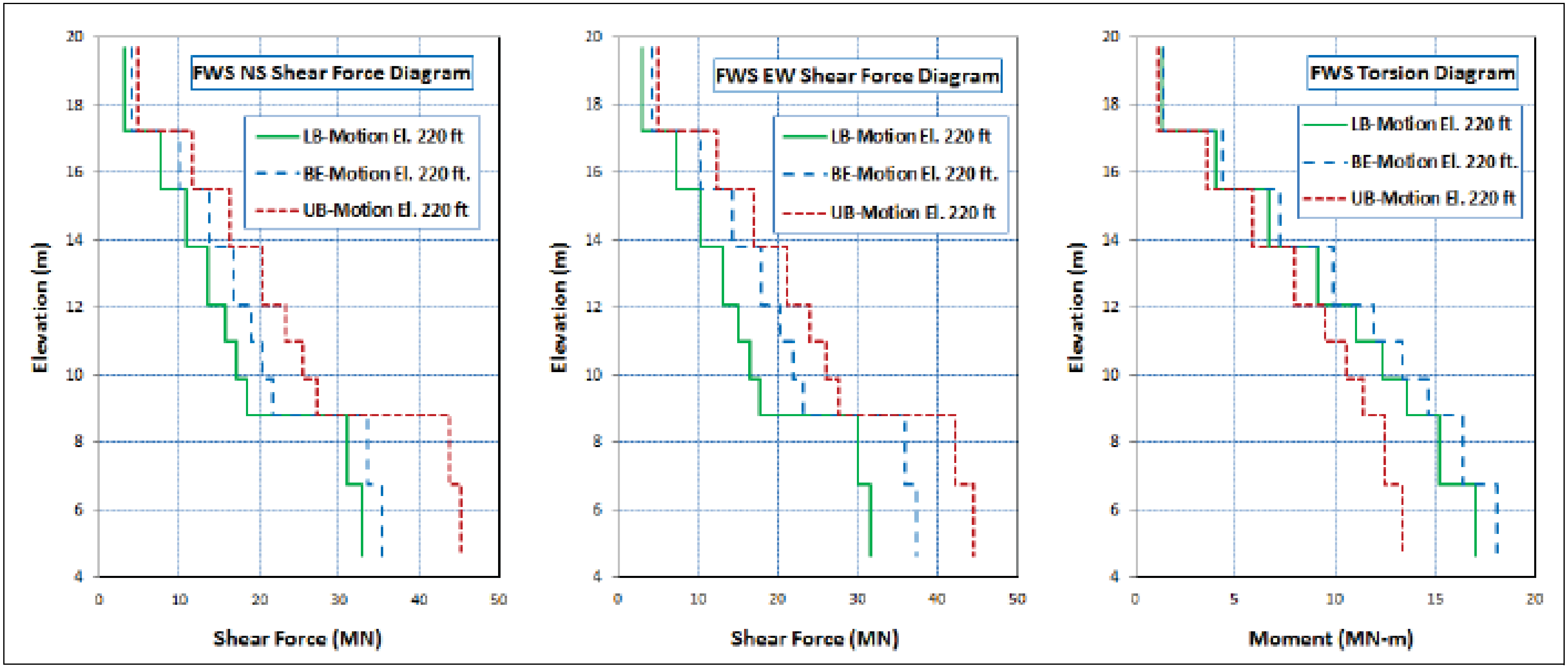

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Figure 3A.17.14.2-204a **FPE Maximum Shear Forces and Torsion from Analyses of FWSC UC_{OBE} Model with Surface Input Motion at Elevation 282 ft**

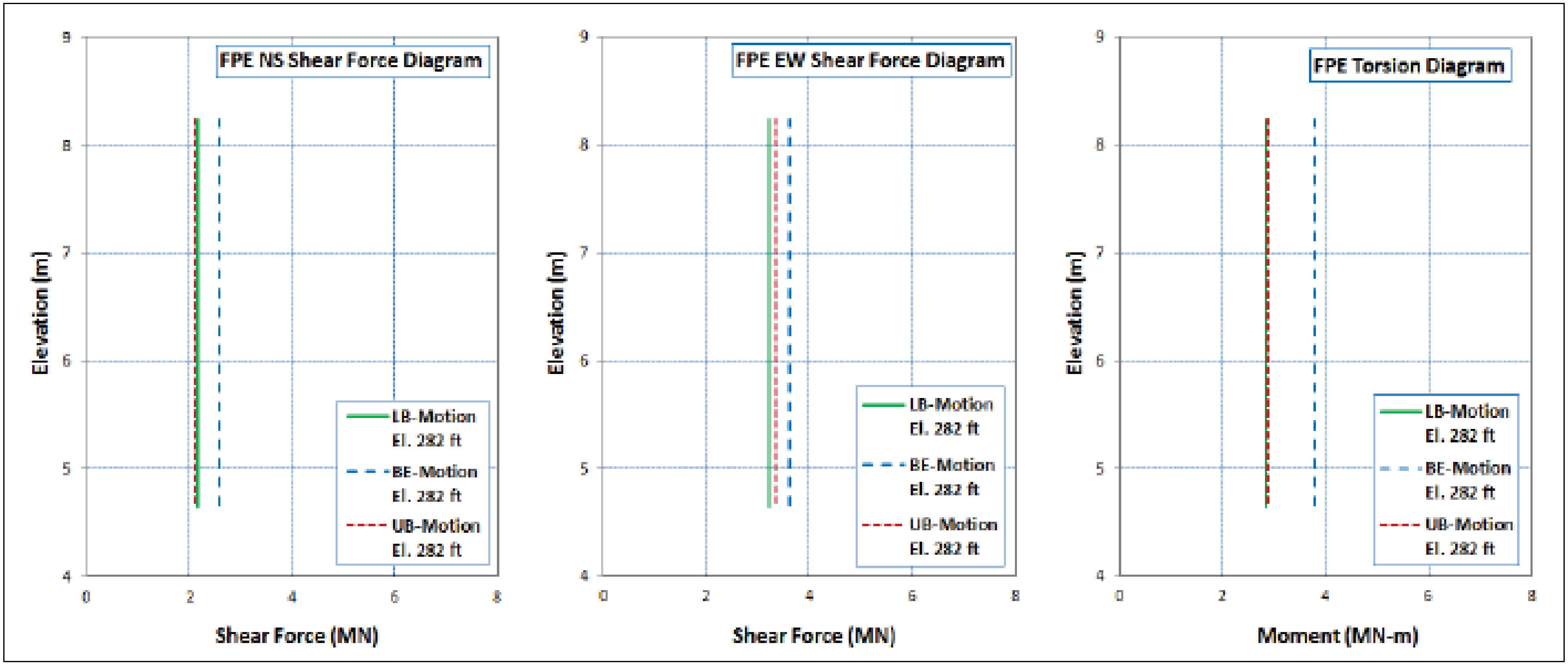
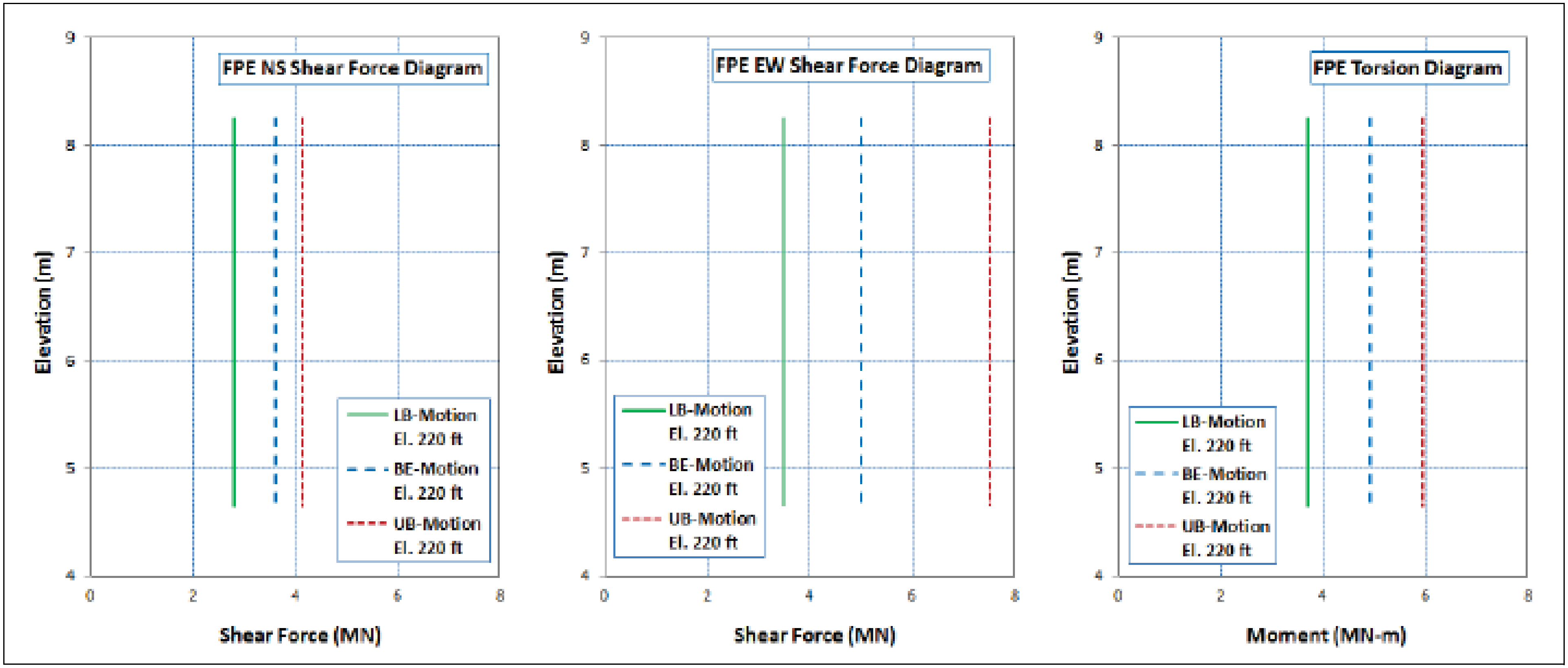


Figure 3A.17.14.2-204b **FPE Maximum Shear Forces and Torsion from Analyses of FWSC UC_{OBE} Model with Deep Input Motion at Elevation 220 ft**



3A.17.14.3 Acceleration Response Spectra

Figures 3A.17.14.3-201a through 3A.17.14.3-201d, Figures 3A.17.14.3-202a through 3A.17.14.3-202d, and Figures 3A.17.14.3-203a through 3A.17.14.3-203d, respectively, compare the 5 percent damped ARS, referred herein as the ISRS, for the response in NS(X), EW(Y), and vertical (Z) directions at the four key locations within the FWSC with the corresponding 5 percent damped standard design ISRS in DCD Section 3A.9. These spectra are obtained from the design basis SSI analyses of the UC_{OBE} model with full stiffness properties and OBE damping, for the LB, BE, and UB subgrade profiles using surface and deep input control motions at Elevation 282 ft NAVD88 and Elevation 220 ft NAVD88.

Comparison of the ISRS results obtained from the different site-specific SSI analyses show that the responses obtained from the analyses with deep input motion at Elevation 220 ft NAVD88 govern the horizontal and vertical ISRS for frequencies higher than 10 Hz and 18 Hz, respectively. The analyses with surface input motion at Elevation 282 ft NAVD88 (analysis Case 1 in Table 3A.15-203) govern the response at frequencies lower than 9 Hz.

Comparisons in Figures 3A.17.14.3-201a through 3A.17.14.3-203d indicate that the FWSC site-specific ISRS can exceed the corresponding standard design spectra. Large exceedances can be observed in the site-specific ISRS for the EW response of the FWSC basemat and the FPE at frequencies between 5 and 15 Hz. An exceedance in the FWS roof SDOF oscillator ISRS occurs at frequencies corresponding to the frequencies of the oscillator.

The ISRS exceedances are due: 1) to the higher energy content of the site-specific design motion as compared to the standard design CSDRS at mid-range frequencies and 2) to the lower OBE structural damping values used for the site-specific SSI analyses versus the SSE damping values used for the standard design SSI analyses.

Figure 3A.17.14.3-201a **Comparison of ISRS for Response of FWS Wall Top in NS (X) Direction**

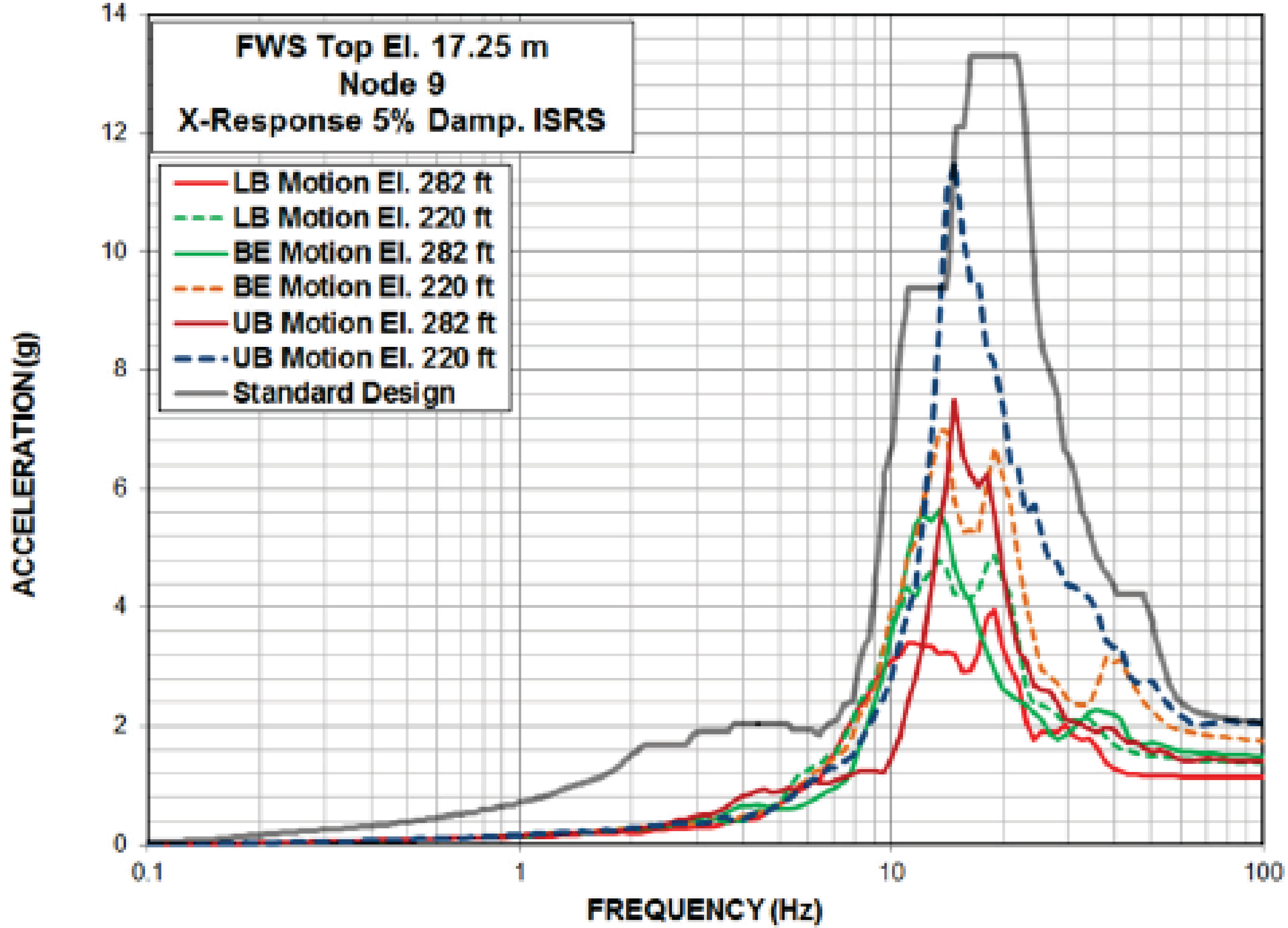


Figure 3A.17.14.3-201b **Comparison of ISRS for Response of FWS Basemat in NS (X) Direction**

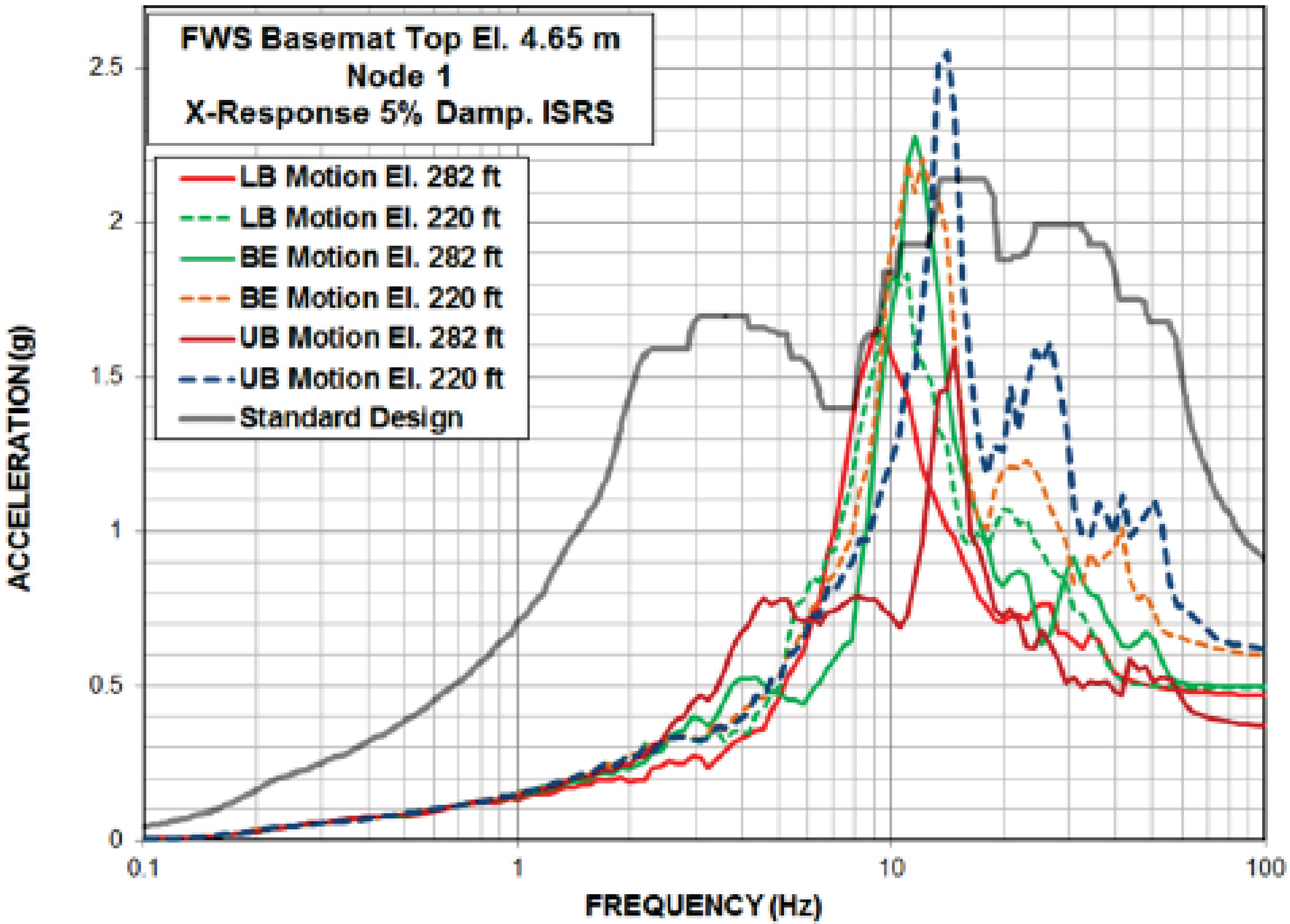


Figure 3A.17.14.3-201c **Comparison of ISRS for Response of FPE Top in NS (X) Direction**

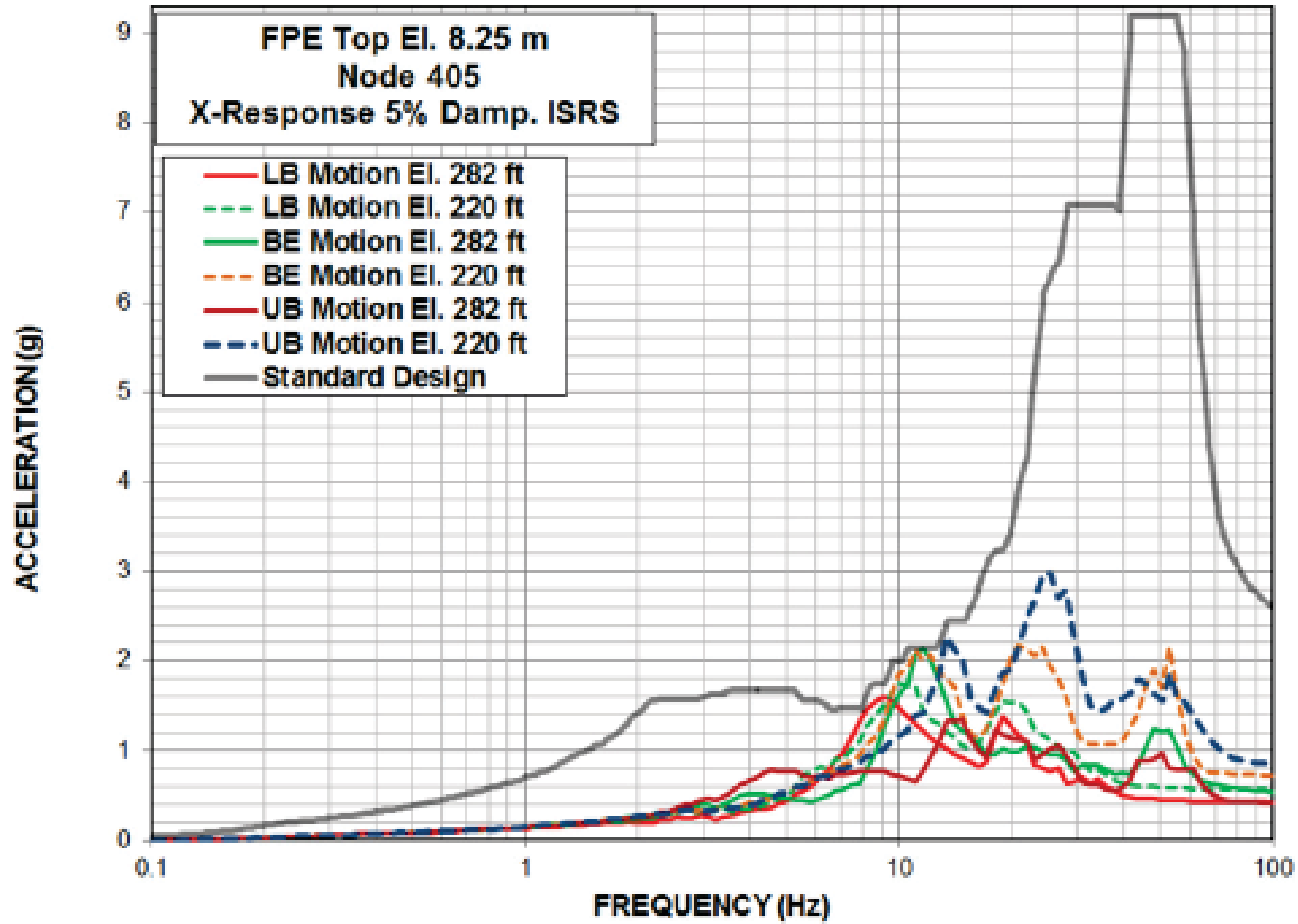


Figure 3A.17.14.3-201d **Comparison of ISRS for Response of FPE Basemat in NS (X) Direction**

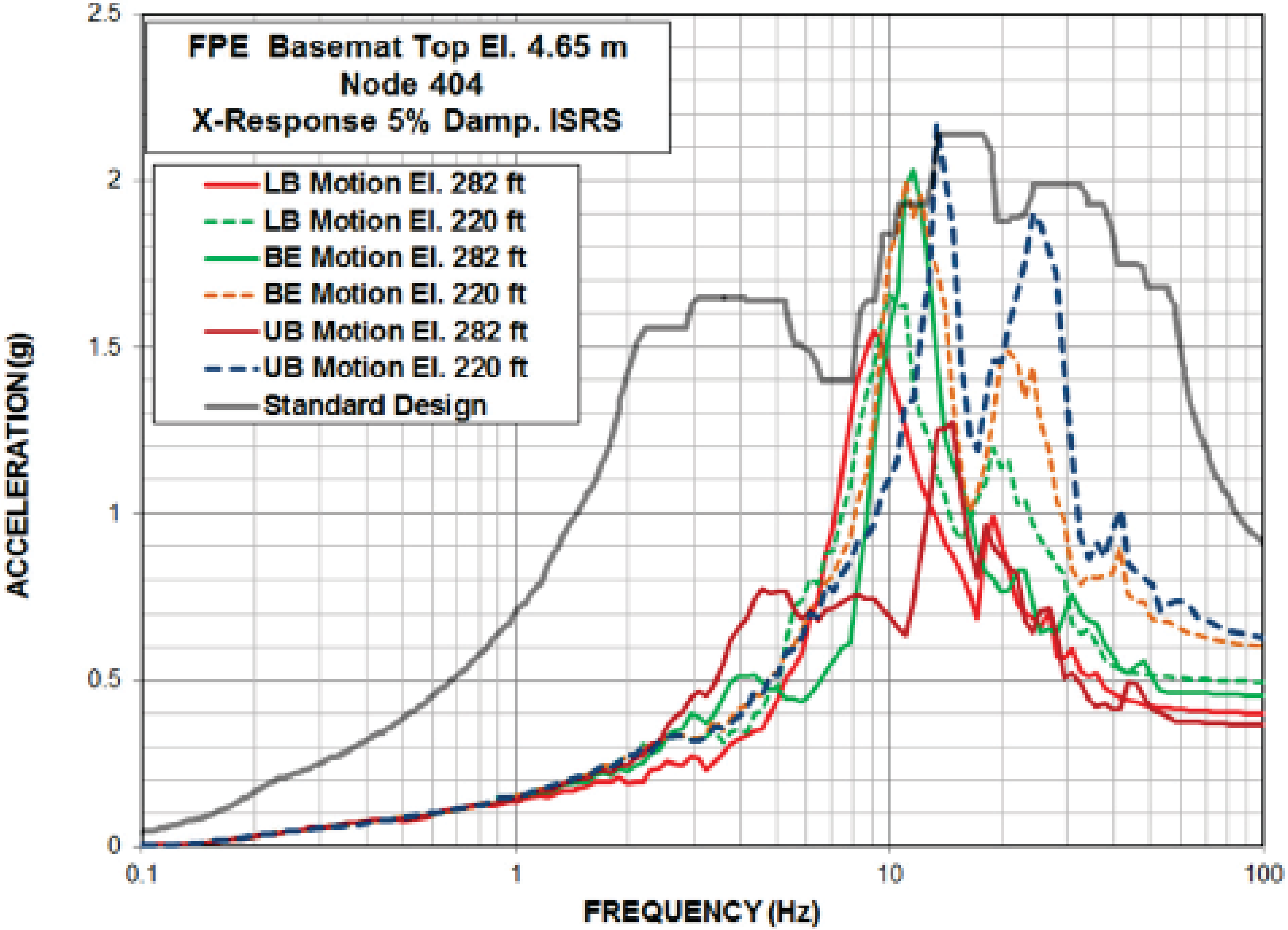


Figure 3A.17.14.3-202a **Comparison of ISRS for Response of FWS Wall Top in EW (Y) Direction**

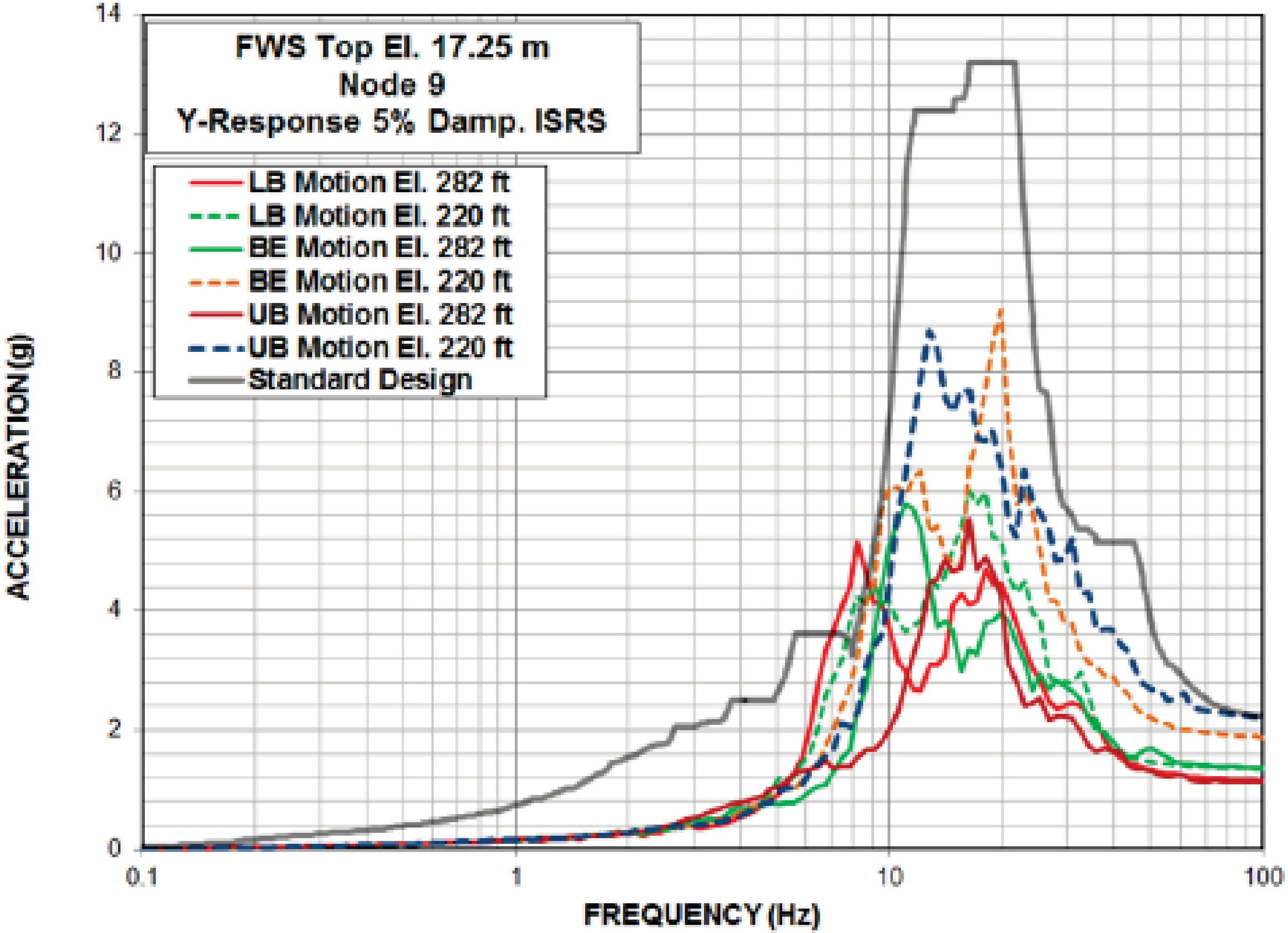


Figure 3A.17.14.3-202b **Comparison of ISRS for Response of FWS Basemat in EW (Y) Direction**

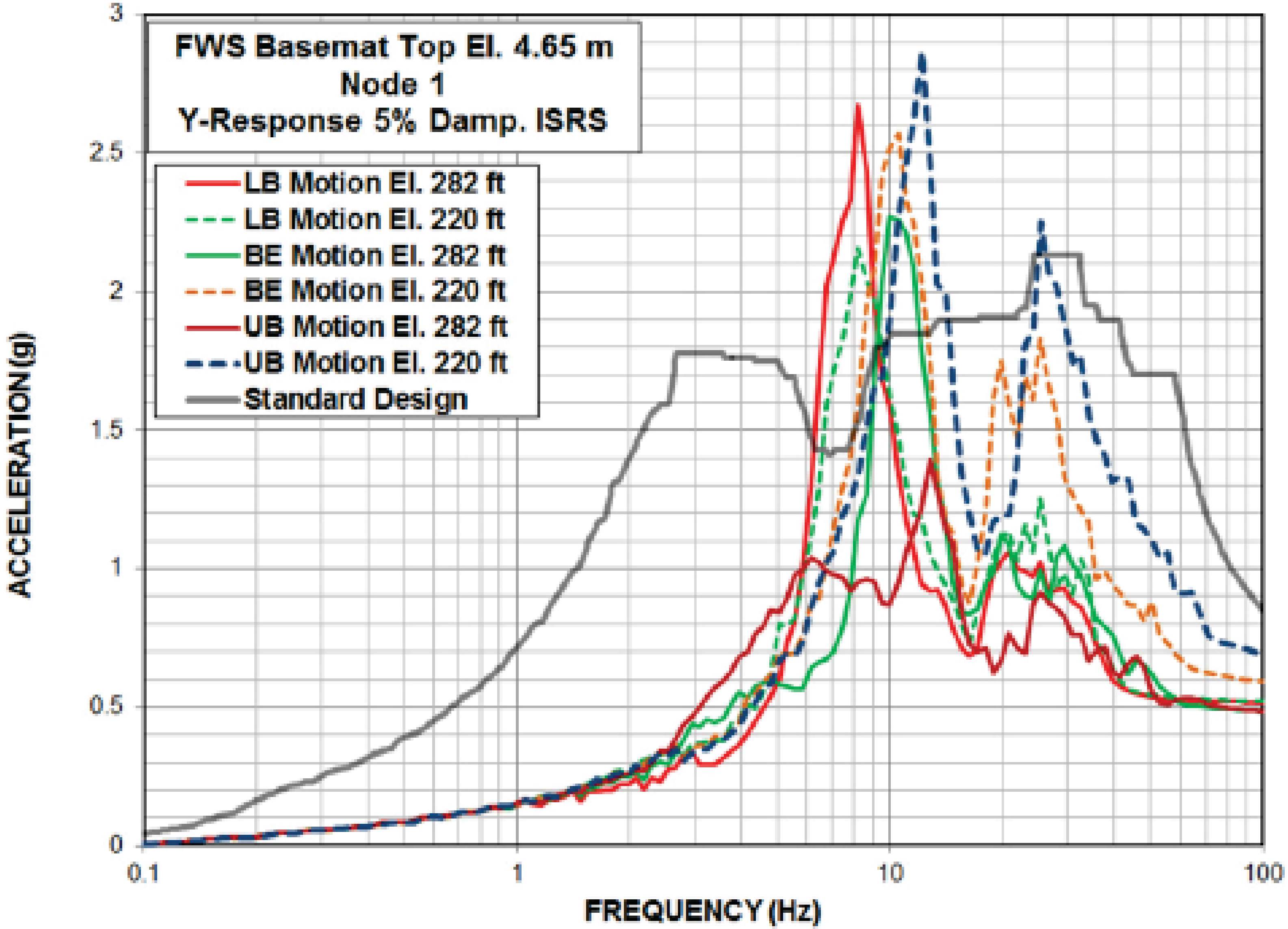


Figure 3A.17.14.3-202c **Comparison of ISRS for Response of FPE Top in EW (Y) Direction**

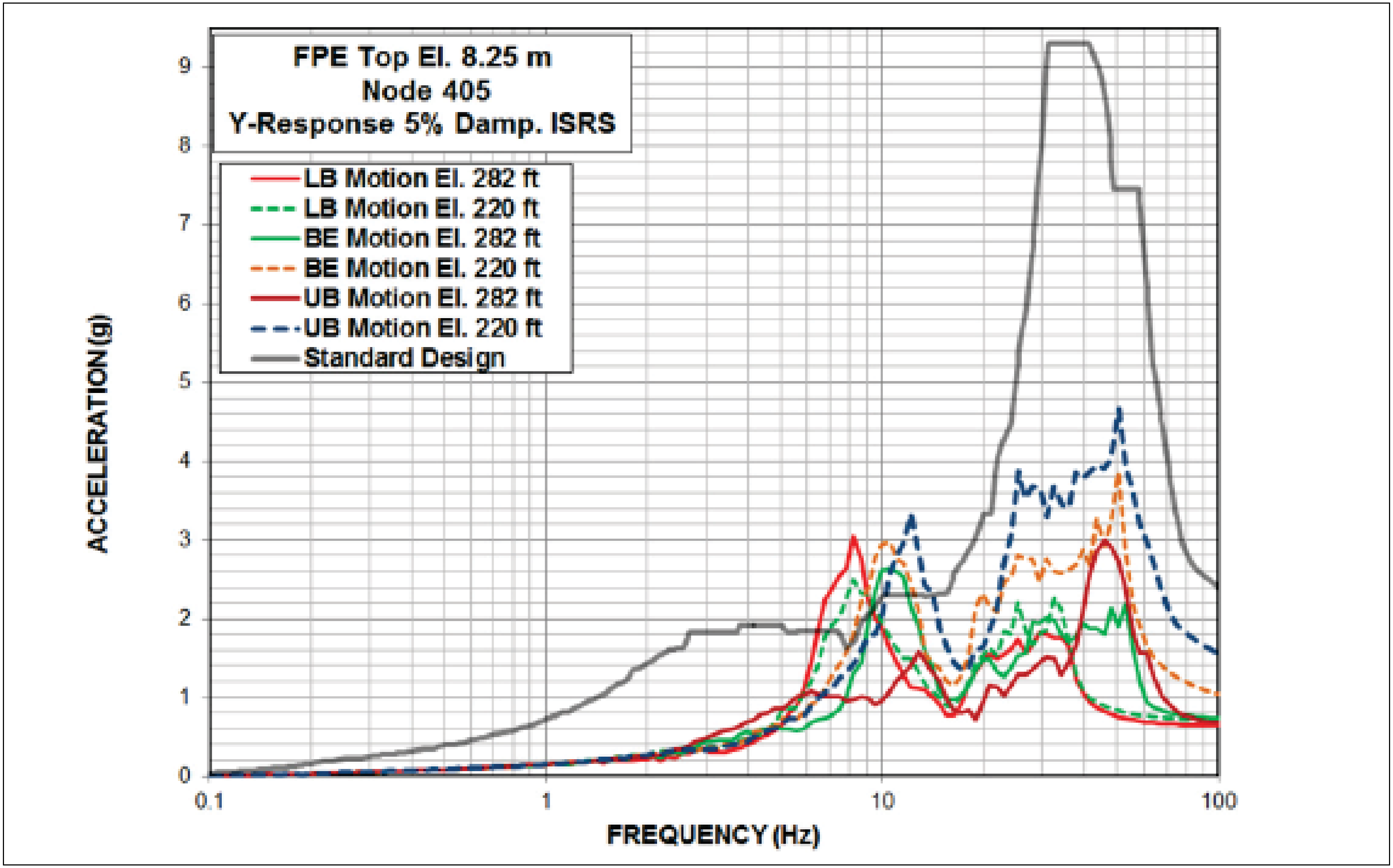


Figure 3A.17.14.3-202d **Comparison of ISRS for Response of FPE Basemat in EW (Y) Direction**

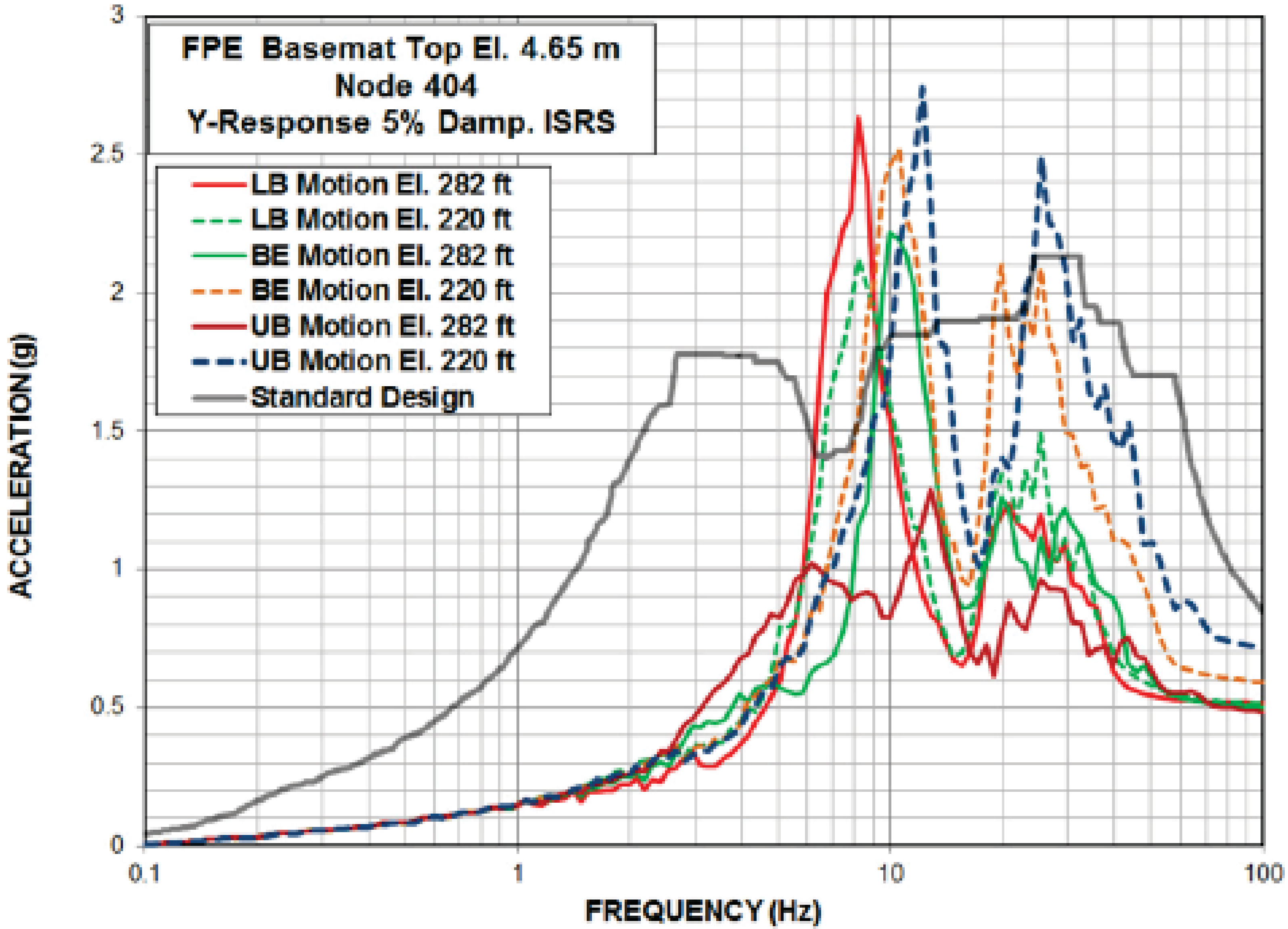


Figure 3A.17.14.3-203a **Comparison of ISRS for Response of FWS Wall Top in Vert. (Z) Direction**

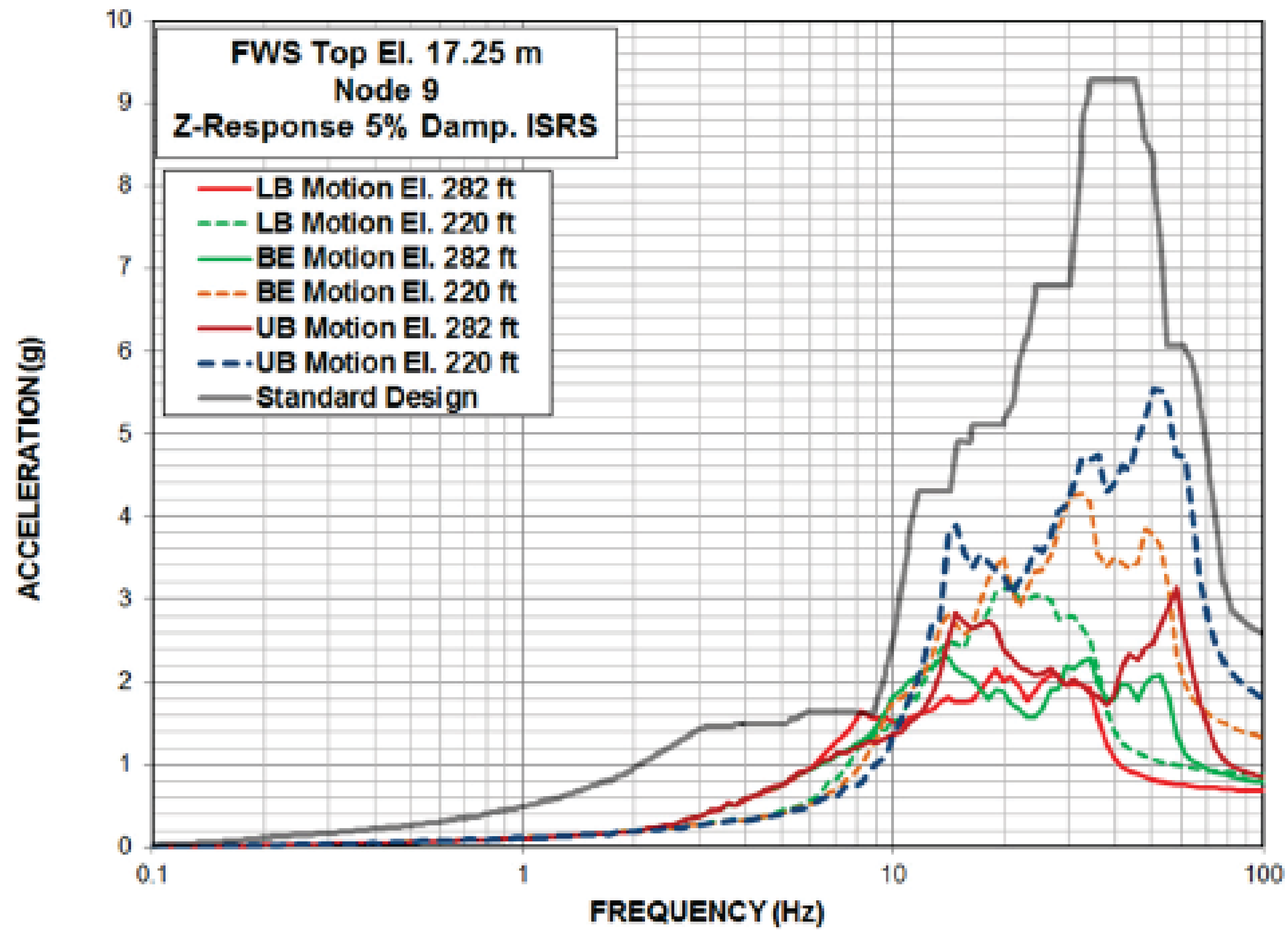


Figure 3A.17.14.3-203b **Comparison of ISRS for Response of FWS Basemat in Vert. (Z) Direction**

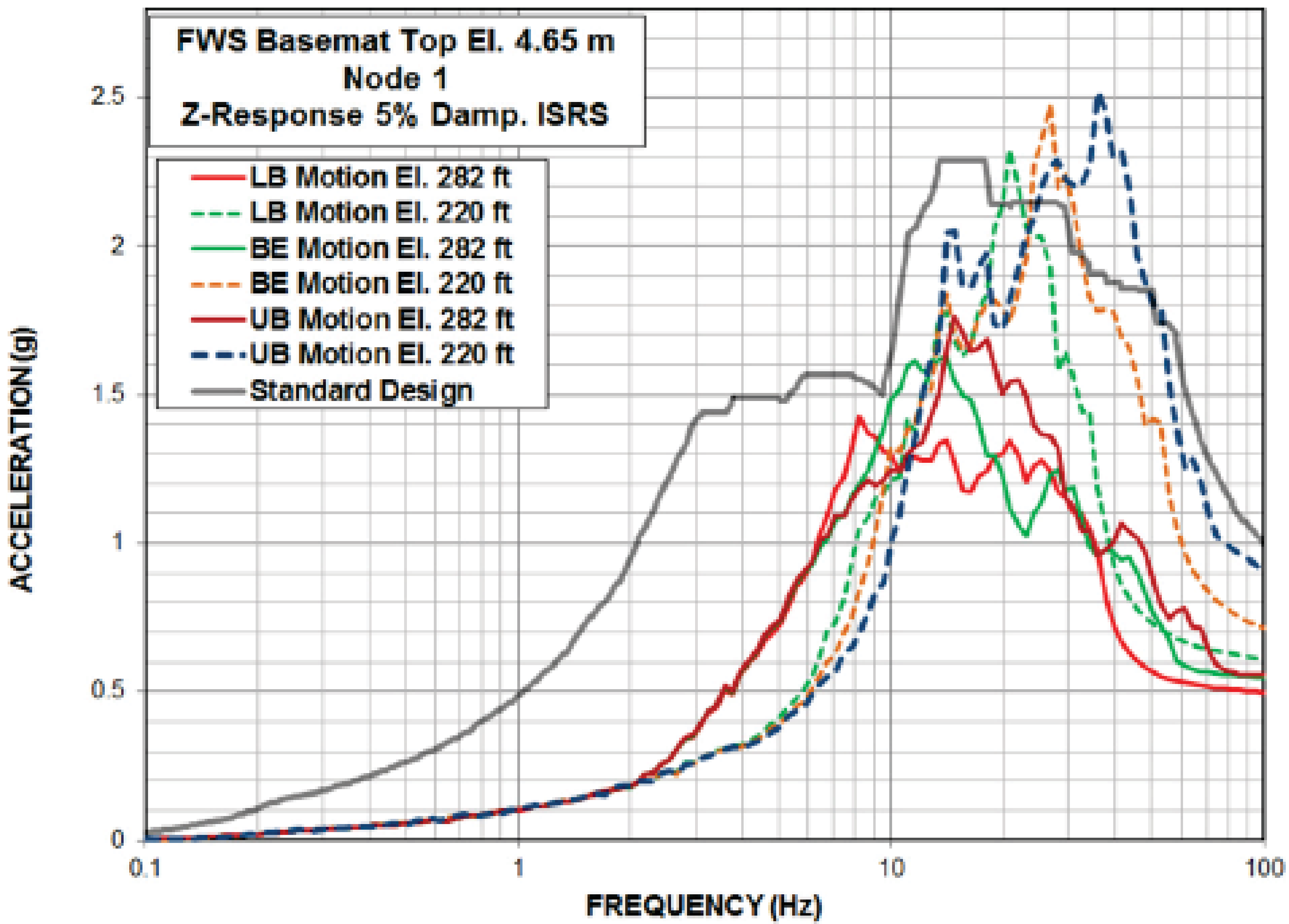


Figure 3A.17.14.3-203c **Comparison of ISRS for Response of FPE Top in Vert. (Z) Direction**

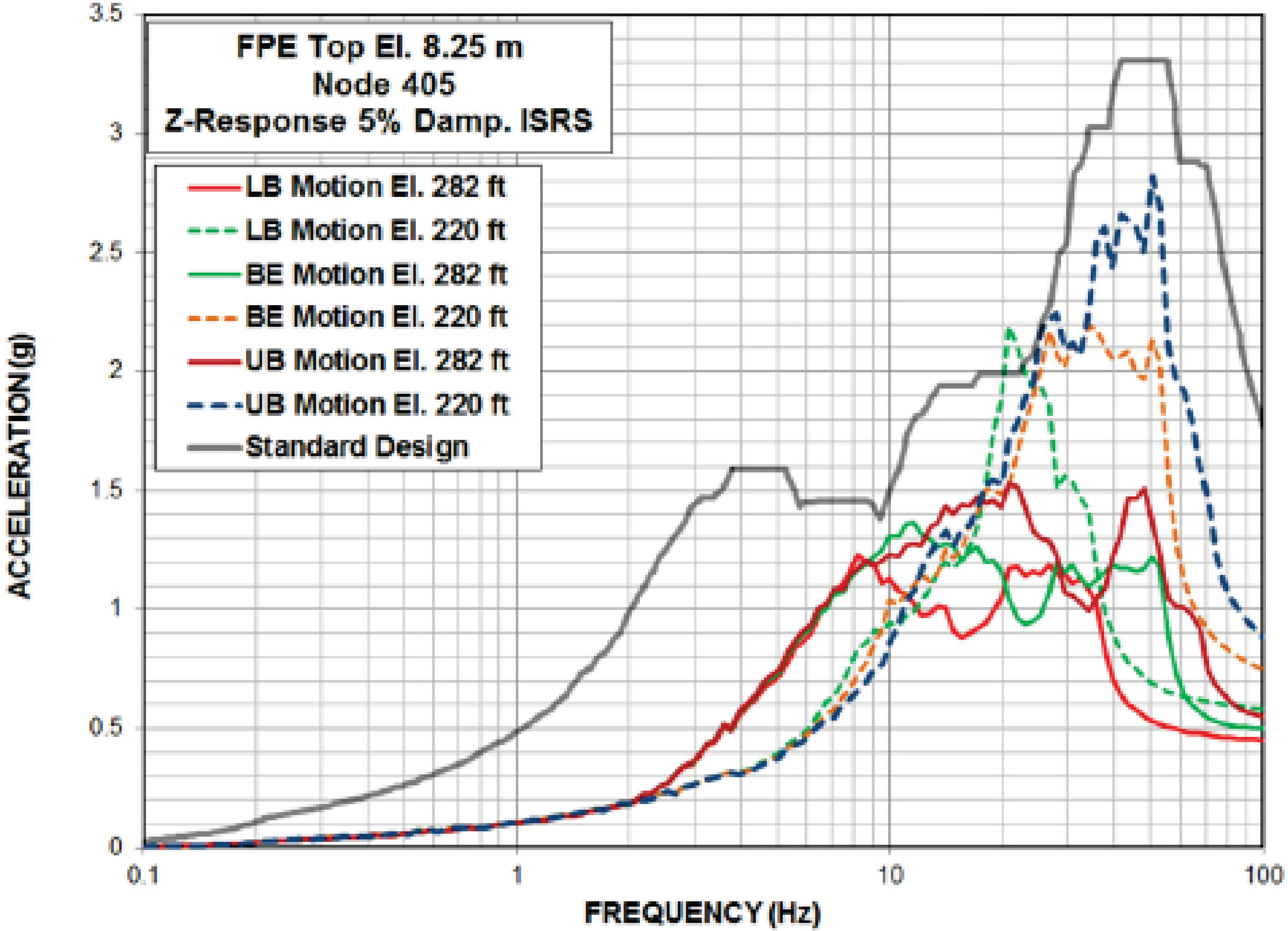
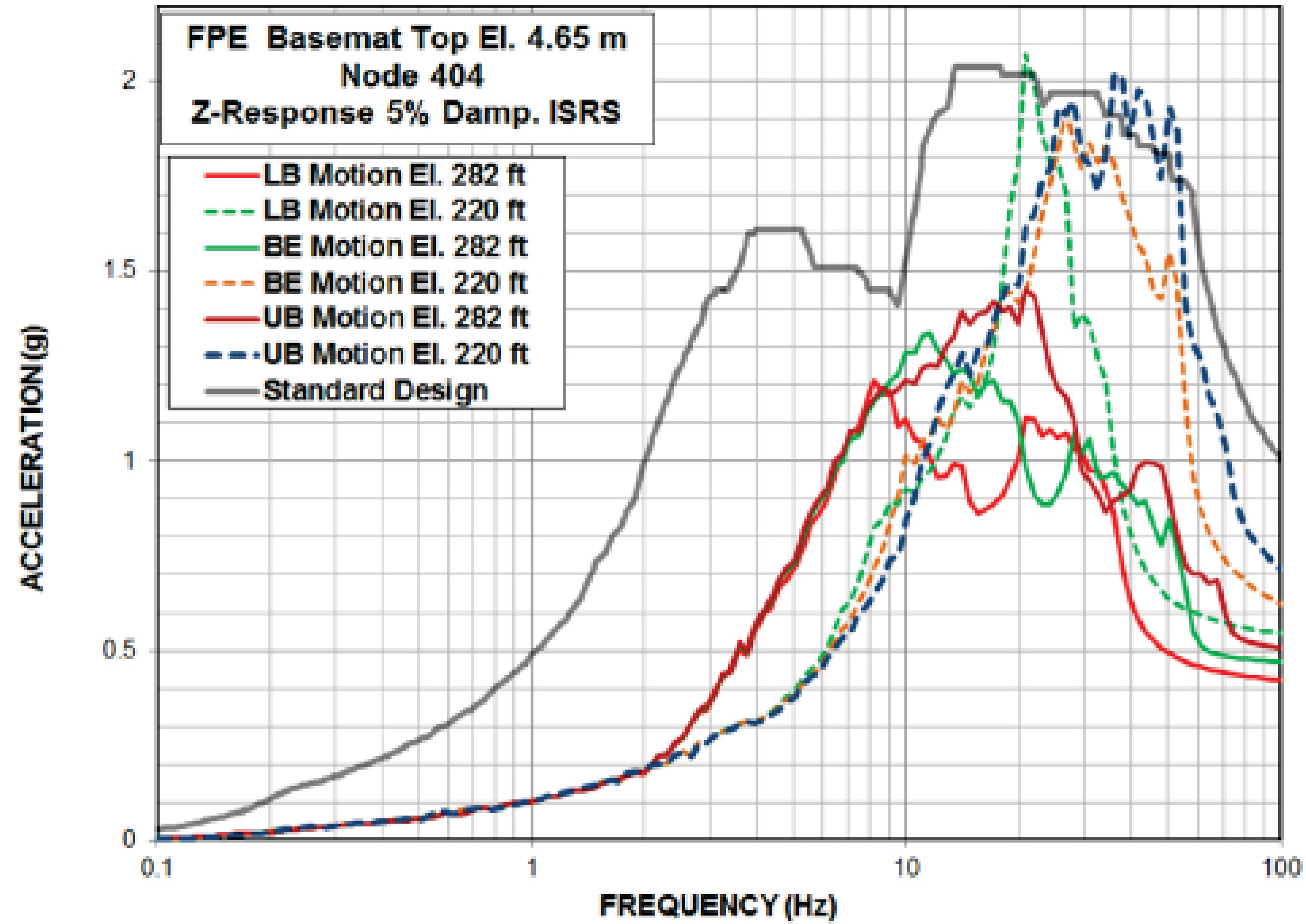


Figure 3A.17.14.3-203d **Comparison of ISRS for Response of FPE Basemat in Vert. (Z) Direction**



3A.17.14.4 Base Reactions and Contact Pressures

Results of the FWSC site-specific SSI analyses for contact spring forces are also used to calculate the time histories of the seismic driving forces used as input for the sliding stability evaluations and dynamic bearing pressure calculations. The time histories of the horizontal and vertical driving seismic forces and overturning base moments are calculated as described in Section 3A.17.12.5.

The time histories of the vertical spring forces obtained from the contact springs at the bottom of the FWSC basemat are also used to develop the base contact pressure plots that are used to calculate the minimum base contact area.

The FWSC foundation uplift calculations are performed using the results of the three design basis SSI analyses of the FWSC UC_{SSE} model with full (uncracked concrete) stiffness properties and SSE damping for the LB, BE, and UB partial column profiles using input motion applied at the bottom of concrete fill at Elevation 220 ft (analysis Cases 7 to 9 in Table 3A.15-203). These are the analyses cases that, as discussed in Section 3A.17.14.1, are governing for the maximum seismic response of the FWSC structures. The calculations are performed for each of the three critical soil cases following the steps as described in Section 3A.17.12.5.

However, the configuration of the FWSC structures and model are nearly symmetrical with respect to both the NS (X) and EW(Y) direction vertical planes, so the effect of different phasing of the X and Y input motions in the calculation of the contact area is insignificant. Therefore, the contact ratio calculations are performed considering the following two combinations of input motion directions:

- $R_D+R_B +E_x + E_y + E_z$
- $R_D+R_B -E_x - E_y – E_z$

As shown in Figure 3A.16.3-221a, rigid beams connect the nodes of the FWSC basemat located around the base of the FWS and FPE structures. These rigid beams ensure that the FWSC dynamic model adequately represents the in-plane stiffness contribution of the FWS and FPE walls on the overall stiffness of the basemat. Therefore, the SASSI2010 results provide an adequate distribution of the base contact pressures used for calculations of the uplift area.

Table 3A.17.14.4-201 summarizes, for each critical analysis case, the calculations of maximum base reaction eccentricities and minimum contact area. It shows that the analysis of the BE profile (analysis Case 8 in Table 3A.15-203) yields the minimum value for the foundation contact area.

Results of the FWSC foundation uplift calculations presented in Table 3A.17.14.4-201 show that the contact area between the FWSC basemat and the underlying concrete fill remains greater than 85 percent. Therefore, the minimum base contact area is greater than 80 percent, which, per the guidance of SRP 3.7.2, ensures that the possible uplift of the FWSC basemat has negligible effects on the results of site-specific FWSC SSI analyses.

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Table 3A.17.14.4-201 **Summary of Maximum Base Reaction Eccentricity Results - FWSC**

Combination	Analysis	UC_{SSE} Model Deep Input Motion at Elevation 220 ft NAVD88 BE	UB	LB
+Ex+Ey+Ez	Max. Eccentricity (m)	19.7	12.0	8.8
	at Time (s)	1.155	1.485	1.160
	Minimum Contact Ratio	85.8	91.7	97.4
-Ex-Ey-Ez	Max. Eccentricity (m)	9.2	12.9	7.2
	at Time (s)	1.140	1.140	3.095
	Minimum Contact Ratio	89.7	86.3	95.9

Note: The shaded values are the governing case.

3A.17.14.5 Effects of Soil Separation

Effects of possible separation between the concrete fill and surrounding soil on the site-specific seismic response of the FWSC structures are evaluated. This evaluation is based on the results of sensitivity SSI analyses (Cases SF1 through SF3 in Table 3A.15-203) and sensitivity SSSI analyses (Cases SF4 through SF6 in Table 3A.15-206) performed on FWSC stand-alone and FWSC-CB combined models simulating conditions of maximum separation between the concrete fill and the surrounding soil. These analyses are performed using a deep input control motion at Elevation -16.84 m (Elevation 220 ft NAVD88) on models with full (uncracked concrete) stiffness properties and SSE damping values. The SSE damping provides a realistic representation of the higher dissipation of energy in the SSI system reflecting larger seismic response displacements associated with the condition of maximum separation between the concrete fill block and the surrounding soil. The maximum depth of possible separation between the concrete fill and the surrounding soil is assessed using the seismic lateral pressure results from the corresponding design basis SSI and SSSI analyses of fully bonded models (analysis Cases 7 through 9 in Table 3A.15-203 and analysis Cases FC7 through FC9 in Table 3A.15-206). In the SASSI2010 models, the soil separation is simulated by disconnecting the nodes of the concrete fill near-field elements from the far-field elements at elevations above the calculated soil separation depths.

To identify possible exceedances in the maximum load demands on FWSC structures due to soil separation, the envelope of maximum member forces and accelerations results from the analyses of soil separated models are compared with the corresponding enveloping results from the design basis SSI and SSSI analyses of the fully bonded models. The 5 percent damped ISRS results from the SSI and SSSI analyses of FWSC models simulating soil separation are also compared with the corresponding 5 percent damped, broadened ISRS, developed as the envelope of results from the site-specific design basis SSI and SSSI analyses of fully bonded models, to determine exceedances due to separation between the concrete fill and the surrounding soil.

Results of the evaluations indicate that the effects of separation between the FWSC concrete fill block and surrounding soil on the seismic load demands on the FWSC structures are relatively small. The soil separation effects can amplify the horizontal load demands on the FWS

structure in the NS direction, the torsional demands on the FWS structure, and the hydrodynamic loads from the water contained in the FWS tank. As shown in Figure 3A.17.14.5-201 and Table 3A.17.14.5-201, the overall effect of these amplifications is small, with load demand exceedances that are less than 7 percent.

The last plot in Figure 3A.17.14.5-201 also shows that the analyses of FWSC models representing soil separated conditions provide vertical seismic acceleration at the top of the FWS basemat that is approximately 14 percent higher than the enveloping vertical acceleration obtained from the design basis analyses of fully bonded models.

Using the methodology described in Section 3G.10.5.5, calculations are performed for the sliding stability of the FWSC foundation using the results of the sensitivity analyses of the FWSC and FWSC-CB models, representing fully separated soil conditions (analysis Cases SF1 through SF3 in Table 3A.15-203 and SF4 through SF6 in Table 3A.15-206). Table 3A.17.14.5-202 presents a summary of the stability analyses of the FWSC foundation against sliding at the basemat-concrete fill interface. The table also compares the results for lateral load demands on the FWSC shear keys obtained from these calculations with the results obtained from the design basis analyses of the fully bonded models. The comparison shows that the separation between the concrete fill and surrounding soil can amplify the lateral load demand on the FWSC shear keys by 47 percent in the NS direction and 13 percent in the EW direction. The site-specific evaluations of FWSC structures, basemat, and shear keys use the input seismic loads presented in Section 3A.18.1.3, which incorporate enhancements to bound all exceedances due to separation between the concrete fill and surrounding soil.

As shown in Figures 3A.17.14.5-202 through 3A.17.14.5-204, ISRS peak exceedances as large as 30 percent are observed in the results obtained from the soil separation sensitivity analyses of the UB and BE profiles (analysis Cases SF2 and SF3 in Table 3A.15-203 and SF5 and SF6 in Table 3A.15-206). Results of the sensitivity analyses are used to enhance the site-specific ISRS obtained from analyses of fully bonded models to bound the effects of separation between the concrete fill and the surrounding soil. Specifically, the FWSC site-specific ISRS are enhanced if any of the sensitivity analyses of the models representing fully separated soil conditions yield 5 percent damped ARS that exceed

the corresponding broadened ISRS obtained as an envelope of the design basis SSI and SSSI analyses (Cases 1 through 6 in Table 3A.15-203 and FC1 through FC6 in Table 3A.15-206) by more than 10 percent at frequencies up to 50 Hz. The FWSC site-specific ISRS are amplified as described in Section 3A.18.2.

The 10 percent exceedance criterion that is used for the enhancement of the site-specific ISRS is reasonable considering the conservatisms introduced in this evaluation of soil separation effects. The sensitivity analyses are representative of bounding fully separated conditions, in which, at the same instance of time, all four sides of the concrete fill lose contact with the surrounding soil resulting in maximum separation depths. During an actual SSE event, this is an unlikely condition because not all sides of the concrete fill will experience separation from the surrounding soil at the same instance of time and throughout the duration of the earthquake. For example, during an SSE event in the North-South (or East-West) direction, the South (or West) side of the concrete fill would be in contact with the soil, at the same instance when the North (or East) side is separated from the soil, and vice versa. In the models used for the seismic response analyses of the FWSC, the concrete fill below the FWSC foundation is considered as a part of the subgrade. In order to account for variations of the subgrade properties, three sets of dynamic properties (LB, BE, and UB) are used for the concrete fill together with LB, BE, and UB properties of the other subgrade materials. Under fully separated conditions that are accompanied by higher stress levels in the soil, the LB profile, which represents lower stiffness and higher damping properties of the subgrade materials, provides a more realistic representation of the dynamic properties of the near-field soil surrounding the concrete fill than the BE and UB profiles.

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Table 3A.17.14.5-201 **Soil Separation Effects on SDOF Oscillators Maximum Accelerations**

SDOF Oscillator				Acceleration (g)			
Elev. (m)	**Node No.**	**Description**	**Direction**	**Soil Separated*)**	**Fully Bonded**)**	**% Diff**	**Standard Design**
19.70	11	FWS Roof	Vert. (Z)	3.81	3.98	-4.3%	3.26
12.10	60	FWS Water Sloshing Mode	NS (X)	0.10	0.10	0.0%	0.30
			EW (Y)	0.09	0.09	-0.1%	0.40
8.81	30	FWS Water Impulsive Mode	NS (X)	1.00	0.94	6.9%	1.10
			EW (Y)	1.03	1.01	1.9%	1.40

Note: The shaded values are exceedances due to soil separation.

*) Envelope of results from SSI and SSSI sensitivity analyses of soil separated models (Cases SF1 through SF3 in Table 3A.15-203 and SF4 through SF6 in Table 3A.15-206)

**) Enveloping results from design basis analyses (Cases 7 through 9 in Table 3A.15-203 and FC7 through FC9 in Table 3A.15-206)

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Table 3A.17.14.5-202 **Soil Separation Effects on FWSC Shear Keys Lateral Resistance Pressure**

Basemat width in NS Dir.	52.0	m
Basemat width in EW Dir.	20.0	m
Depth of Shear Key	3.6	m
Total Weight	169	MN
Buoyancy	6	MN

Subgrade Condition		FWSC SSI Analyses						FWSC-CB SSSI Analyses					
		LB (Case SF1)		BE (Case SF2)		UB (Case SF3)		LB (Case SF4)		BE (Case SF5)		UB (Case SF6)	
Sliding Direction		NS	EW	NS	EW	NS	EW	NS	EW	NS	EW	NS	EW
Time (sec)		3.135	5.075	1.155	1.805	1.060	1.645	3.130	1.810	1.110	1.650	1.140	1.640
Vertical Seismic Load (MN)		21	23	104	79	72	74	32	79	49	58	91	59
Minimum Vertical Load (MN)		142	140	59	84	91	89	131	84	114	94	72	104
F_v: Horizontal Seismic Force (MN)		96	99	107	110	96	98	94	67	103	76	80	120
F_{ub}: Bottom Friction Force (MN)		85	84	35	50	55	53	79	50	68	56	43	62
F_r': Lateral Resistance Force at Shear Key (MN)	Soil Separated	20	24	82	71	51	55	25	24	45	27	45	70
	Fully Bonded *)	18	12	56	37	46	52	19	15	38	25	53	63
FS (=(F_{ub}+F_r')/F_v)		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{max}: Maximum Stress (MPa) Associated with Lateral Resistance F_r'	Soil Separated	0.31	0.28	1.26	0.82	0.79	0.64	0.38	0.28	0.69	0.31	0.69	0.81
	Fully Bonded *)	0.28	0.14	0.87	0.43	0.71	0.60	0.30	0.17	0.59	0.29	0.82	0.73

Note: The red numbers are the maximum lateral load demand on shear keys in NS and EW direction.
Shaded areas indicate exceedances due to soil separation effects
*) Results from Table 3G.10-214(b).

Figure 3A.17.14.5-201 **Soil Separation Induced Exceedances of FWSC Structural Loads**

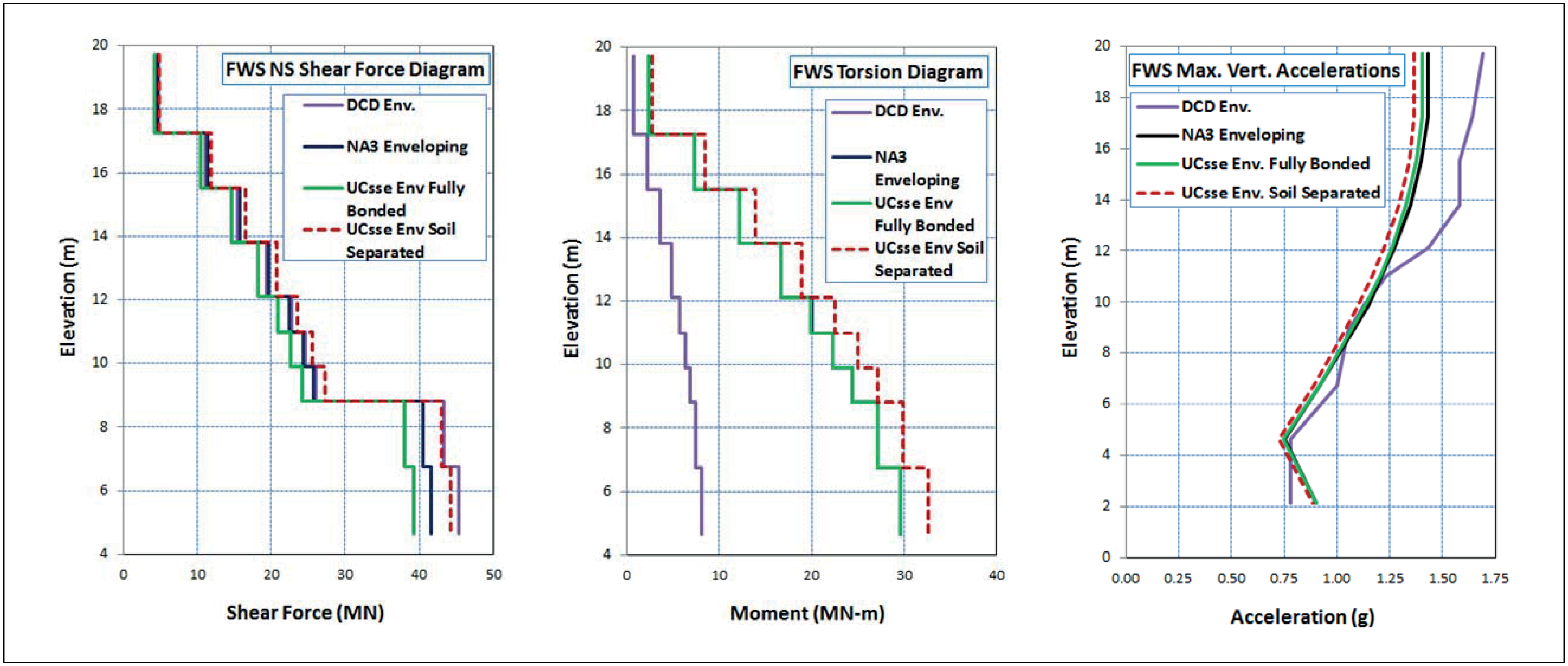


Figure 3A.17.14.5-202 **Soil Separation Induced Exceedances of FWSC ISRS for Response of FPE Top El. 8.25 m**

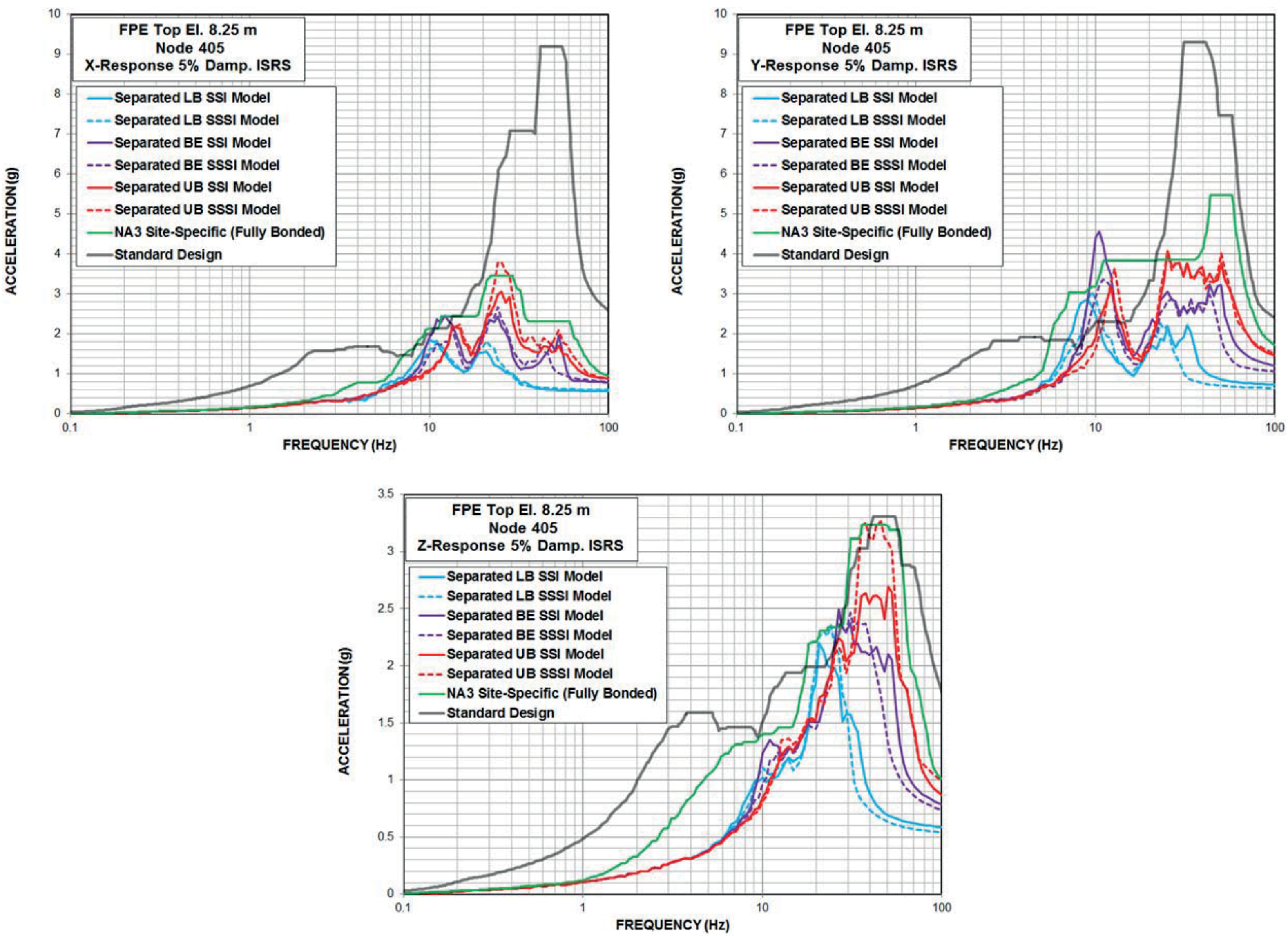


Figure 3A.17.14.5-203 **Soil Separation Induced Exceedances of FWSC ISRS for Response of FWS Basemat El. 4.65 m**

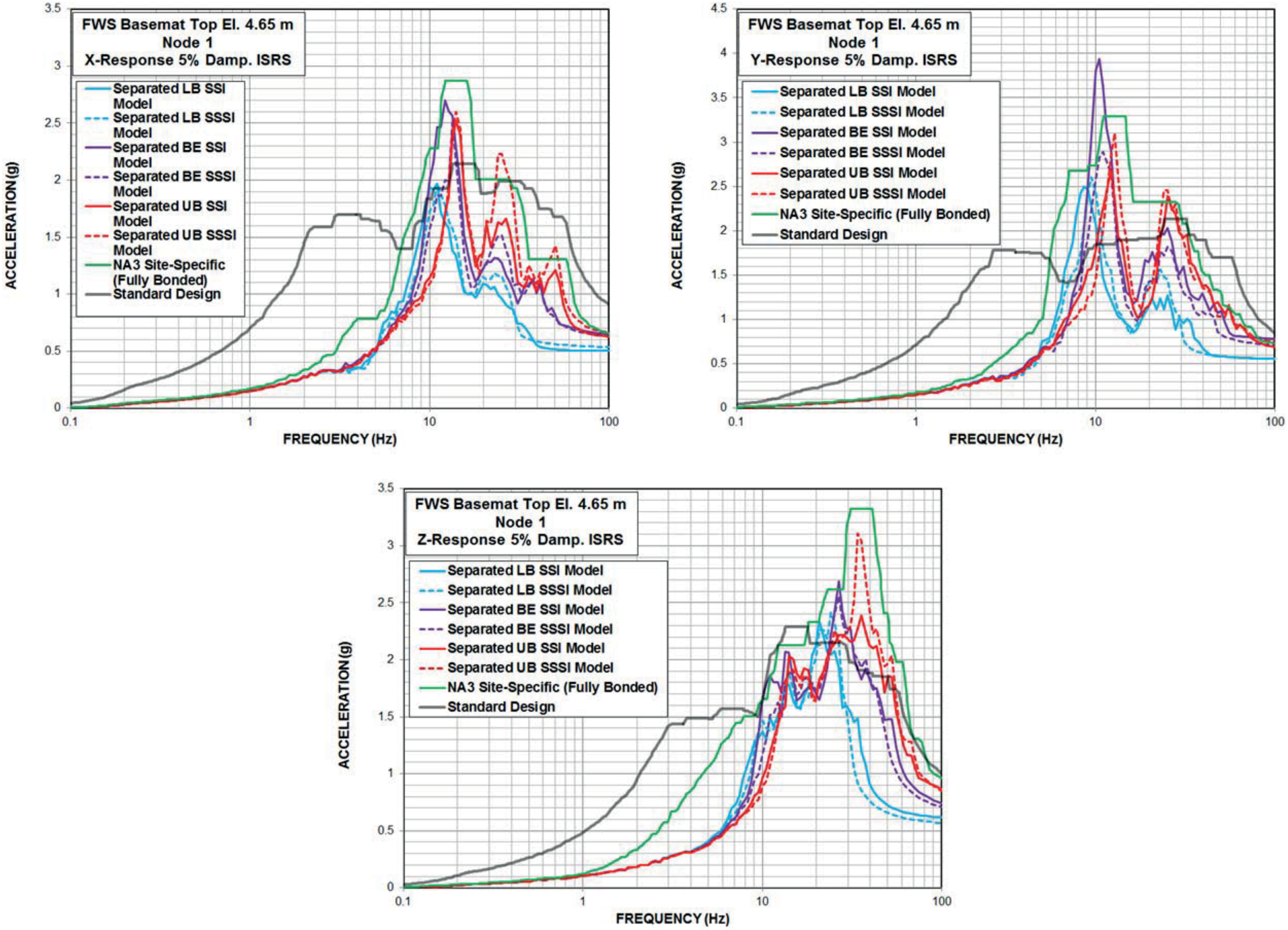
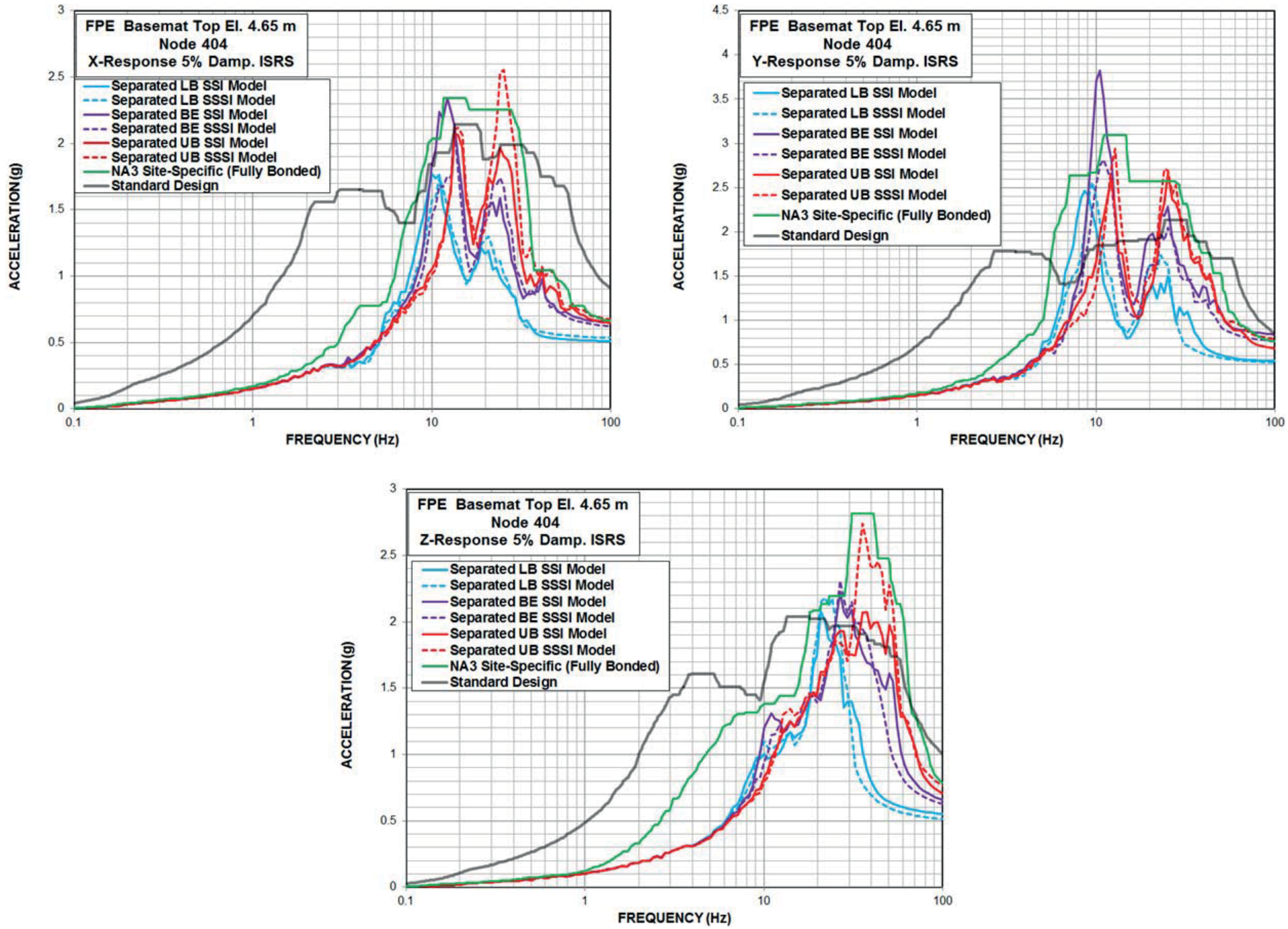


Figure 3A.17.14.5-204 **Soil Separation Induced Exceedances of FWSC ISRS for Response of FPE Basemat El. 4.65 m**



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3A.18 Unit 3 Site Envelope Seismic Responses

Site-specific evaluations and design of Seismic Category I structures, systems and components are based on the envelope of results obtained from the design basis SSI analyses of the RB/FB, CB, and FWSC stand-alone models with the upper bound stiffness properties listed in Tables 3A.15-201 through 3A.15-203, and the design basis SSSI analyses of the FWSC-CB combined model summarized in Table 3A.15-206. As described in this section, these enveloping site-specific demands are enhanced using the results of the sensitivity analyses described in Sections 3A.17.9, 3A.17.11, and 3A.17.14.5 to bound the effects of structural stiffness variations, SSSI, and soil separation. Section 3A.18.1 presents the comparisons of the enhanced site-specific load demands on the Seismic Category I structures with the corresponding seismic loads used for the standard design that are presented in DCD Section 3A.9.1. Section 3A.18.2 presents the enhanced site-specific design ISRS for the responses at key locations within the RB/FB, CB and FWSC.

3A.18.1 Site-Specific Seismic Structural Loads

Results from site-specific SSI analyses of the RB/FB, CB, and FWSC are enveloped, enhanced to bound the effects from sensitivity analyses, and compared with the corresponding standard design envelopes in DCD Section 3A.9.1 to determine the exceedances relative to the seismic loads used for the standard design of Seismic Category I structures. These bounding results are also used to develop the site-specific seismic load demands for use in site-specific structural evaluations presented in Appendix 3G.

Site-specific seismic load demands are developed for the site-specific structural evaluations of Seismic Category I structures following the methodology used to develop the standard design seismic structural loads. Horizontal load demands on the structures are developed from diagrams of the maximum shear forces and maximum torsional moments. Vertical site-specific seismic load demands are developed from the diagrams of the maximum vertical floor mass accelerations. The maximum bending moments are also used for the structural evaluations to account for the effects of floor rocking on the wall axial forces.

The results for maximum accelerations of the SDOF oscillator masses are used to develop the local out-of-plane load demands on flexible slabs

and walls. The methodology used to calculate the site-specific out-of-plane loads on the flexible slabs and walls is identical to the methodology used for the standard design. Weighted average out-of-plane accelerations are calculated to represent the total site-specific seismic load demands on the flexible slabs and walls that include the contribution of both:

- The flexible modes of vibration represented by the maximum accelerations of the SDOF oscillators
- The rigid modes of vibration represented by the maximum accelerations of the floor lumped masses

3A.18.1.1 Reactor Building/Fuel Building Site-Specific Seismic Structural Load Demands

The site-specific seismic load demands on the RB/FB structures that are based on the envelope of results from analysis Cases 1 through 6 in Table 3A.15-201 bound the effects from variations in subgrade conditions and the effects of soil separation on the RB/FB seismic response. These design basis analyses results are adjusted to bound the effects of structural stiffness variations described in Section 3A.17.9.1 by enveloping them with the results of the sensitivity SSI analyses of the reduced stiffness CR00 and CR50 models (analyses Cases S1 through S12 in Table 3A.15-201). This section presents the enhanced structural loads used as input for the site-specific evaluations of the RB/FB. These loads are compared with the seismic loads used for the standard design in DCD Section 3A.9.1 to identify site-specific exceedances.

Tables 3A.18.1.1-201a through 3A.18.1.1-201f present the site-specific seismic shear forces and moments and compare them with the corresponding standard design loads. Tables 3A.18.1.1-202a through 3A.18.1.1-202e present the comparison of site-specific maximum accelerations at floor lumped mass locations with the corresponding standard design accelerations. Comparisons of the diagrams of the site-specific horizontal and vertical load demands with the corresponding seismic loads used for the standard design are illustrated in Figures 3A.18.1.1-201a through 3A.18.1.1-202e. Figures 3A.18.1.1-201a through 3A.18.1.1-201e compare the shear force and torsion diagrams, which define the horizontal seismic load demands on the RB/FB structures. The torsional moments in Tables 3A.18.1.1-201a through

3A.18.1.1-201f and Figures 3A.18.1.1-201a through 3A.18.1.1-202e are values calculated directly from the SSI analyses results. These torsional moments are combined with the accidental torsion for the site-specific evaluations of the RB/FB structures in Appendix 3G. Figures 3A.18.1.1-202a through 3A.18.1.1-202e compare the maximum vertical accelerations and bending moment diagrams that define the vertical seismic load demands on the RB/FB structures.

Table 3A.18.1.1-203 presents the site-specific out-of-plane load demands on the RB/FB flexible slabs. Table 3A.18.1.1-204 presents the site-specific out-of-plane load demands on the RB/FB flexible walls. Tables 3A.18.1.1-203 and 3A.18.1.1-204 compare these site-specific out-of-plane load demands on the RB/FB flexible slabs and walls with the magnitudes of the corresponding loads used for the standard design of RB/FB structures.

Table 3A.18.1.1-205 presents the site-specific relative displacements and spring reactions for the RPV stabilizer. Table 3A.18.1.1-205 compares the site-specific relative displacements and spring reactions demands on the RPV stabilizer to the corresponding demands of the standard design values. The comparison in Table 3A.18.1.1-205 indicates that the site-specific seismic load demands can exceed the standard design values in the NS direction of the RPV Stabilizer by as much as 54 percent.

The comparisons presented in Figures 3A.18.1.1-201a through 3A.18.1.1-202e and Tables 3A.18.1.1-201a through 3A.18.1.1-204 indicate that the site-specific load demands can exceed the corresponding loads used for the standard design of the RB/FB structures. The comparisons in Figures 3A.18.1.1-201a through 3A.18.1.1-202e and Tables 3A.18.1.1-201a through 3A.18.1.1-201f indicate that the site-specific horizontal load demands on the RB/FB walls are enveloped by the standard design with the exception of the NS shear load demands that exceed the corresponding standard design loads at elevations mainly above 7.5 m. Comparisons in Figures 3A.18.1.1-202a through 3A.18.1.1-202e indicate larger exceedances in vertical loads at higher elevations above 8.0 m that can increase the axial stress demands and reduce the capacity of the reinforced concrete members. The highest exceedances of the local out-of-plane loads can be observed at the flexible walls and slabs located at elevations of 17.5 m and above. The maximum exceedance of

58 percent is calculated for the out-of-plane vertical load on the main steam tunnel slab.

Site-specific evaluations of the RB/FB structures described in Appendix 3G are performed to address these exceedances in the site-specific load demands and calculate the available site-specific margins of RB/FB structures.

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Table 3A.18.1.1-201a **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on RB/FB**

Element		Standard Design					Site-Specific Demands					Difference				
		Shear (MN)		Bending (MN-m)		Torsion	Shear (MN)		Bending (MN-m)		Torsion	Shear		Bending		
Elev. (m)	Node No.	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	Torsion
52.40	110	151.9	158.2	1642	1808	1379	192.2	140.0	2724	2143	1284	27%	-11%	66%	19%	-7%
	109			4303	4465				5838	4488				36%	1%	
34.00	109	191.7	153.0	5585	5522	2405	173.2	113.9	8196	5821	1938	-10%	-26%	47%	5%	-19%
	108			6477	6317				8719	6389				35%	1%	
27.00	108	425.4	400.7	7685	7106	3333	396.0	259.4	9400	7162	2799	-7%	-35%	22%	1%	-16%
	107			8964	8596				9599	7958				7%	-7%	
22.50	107	483.7	464.0	9905	9193	6093	436.4	291.8	11216	8328	4678	-10%	-37%	13%	-9%	-23%
	106			11464	11297				11424	9227				0%	-18%	
17.5	106	532.9	555.4	12386	11935	5068	438.4	343.5	12105	9408	4023	-18%	-38%	-2%	-21%	-21%
	105			13778	13867				12349	10195				-10%	-26%	
13.57	105	569.2	599.9	14298	14377	5245	450.7	363.7	12839	10255	4211	-21%	-39%	-10%	-29%	-20%
	104			16593	16740				13651	11216				-18%	-33%	
9.06	104	610.1	654.3	16966	17191	5985	454.6	383.4	13904	11338	4694	-25%	-41%	-18%	-34%	-22%
	103			19378	19672				15231	12506				-21%	-36%	
4.65	103	839.8	872.2	19064	20192	11425	454.7	360.1	9392	6302	5248	-46%	-59%	-51%	-69%	-54%
	102			23163	24272				10952	7759				-53%	-68%	
-1.00	102	871.4	938.5	23673	24948	11523	240.0	226.6	6545	4819	2718	-72%	-76%	-72%	-81%	-76%
	101			27655	29263				7303	5358				-74%	-82%	
-6.40	101	933.6	1029.7	28126	30038	11690	237.7	200.4	4748	3351	2079	-75%	-81%	-83%	-89%	-82%
-11.5	2			32235	35275				5053	3356				-84%	-90%	

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-201b Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on RCCV

Element		Standard Design					Site-Specific Demands					Difference				
		Shear (MN)		Bending (MN-m)		Torsion	Shear (MN)		Bending (MN-m)		Torsion	Shear		Bending		
Elev. (m)	Node No.	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	Torsion
34.00	209	137.0	183.2	195	581	36	130.9	133.2	230	510	29	-4%	-27%	18%	-12%	-19%
	208			1057	1496				1029	1160				-3%	-22%	
27.00	208	164.9	248.5	1708	2532	1814	141.1	151.9	2162	2303	1489	-14%	-39%	27%	-9%	-18%
	207			2959	4368				2938	3071				-1%	-30%	
17.50	206	230.2	290.2	3315	4715	1982	184.1	158.4	3259	3667	1591	-20%	-45%	-2%	-22%	-20%
	205			4147	5761				3691	3904				-11%	-32%	
13.57	205	263.4	326.2	4327	5949	2186	207.9	173.4	3817	4203	1762	-21%	-47%	-12%	-29%	-19%
	204			5404	7264				4389	4491				-19%	-38%	
9.06	204	304.2	365.8	5628	7519	2616	225.4	201.2	4481	4853	2062	-26%	-45%	-20%	-35%	-21%
	203			6785	8909				5190	5203				-24%	-42%	
4.65	203	227.3	289.4	6992	9171	2870	109.2	125.7	5523	5470	1439	-52%	-57%	-21%	-40%	-50%
	202			7958	10581				5740	5824				-28%	-45%	
-1.00	202	272.4	330.6	8076	10738	2926	67.6	68.1	6008	6066	690	-75%	-79%	-26%	-44%	-76%
	201			9417	12523				5924	6035				-37%	-52%	
-6.40	201	261.7	303.5	9534	12651	1962	70.7	55.1	6053	6141	349	-73%	-82%	-37%	-51%	-82%
-11.50	2			10836	14200				5961	6127				-45%	-57%	

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-201c **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on Vent Wall**

Element		Standard Design					Site-Specific Demands					Difference				
		Shear (MN)		Bending (MN-m)		Torsion	Shear (MN)		Bending (MN-m)		Torsion	Shear		Bending		
Elev. (m)	Node No.	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	(MN-m)	NS	EW	NS*)	EW*)	Torsion
17.50	701	35.0	37.0	78	85	116	47.9	32.4	107	62	107	37%	-12%	37%	-27%	-8%
	702			114	136				139	107				22%	-21%	
14.50	702	36.4	39.3	119	148	118	47.1	32.4	139	113	108	29%	-17%	17%	-24%	-8%
	703			226	260				279	204				24%	-22%	
11.50	703	37.0	41.8	229	269	120	45.8	35.1	280	207	111	24%	-16%	22%	-23%	-8%
	704			340	390				411	301				21%	-23%	
8.50	704	37.8	44.7	341	396	122	44.7	36.5	411	302	112	18%	-18%	20%	-24%	-8%
	705			379	438				458	338				21%	-23%	
7.4625	705	40.7	40.5	359	438	101	39.1	29.4	440	352	92	-4%	28%	23%	-20%	-9%
4.65	706, 303			456	525				513	427				13%	-19%	

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-201d **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on Pedestal**

Element		Standard Design					Site-Specific Demands					Difference				
		Shear (MN)		Bending (MN-m)			Shear (MN)		Bending (MN-m)			Shear		Bending		
Elev. (m)	Node No.	NS	EW	NS*)	EW*)	Torsion (MN-m)	NS	EW	NS*)	EW*)	Torsion (MN-m)	NS	EW	NS*)	EW*)	Torsion
4.65	303	32.8	44.8	581	621	142	20.5	16.9	667	496	71	-37%	-62%	15%	-20%	-50%
	377			599	667				651	502				9%	-25%	
2.4165	377	48.1	66.3	732	817	172	32.1	31.4	793	614	86	-33%	-53%	8%	-25%	-50%
	302			778	922				754	631				-3%	-32%	
-1.00	302	65.6	81.4	839	959	146	22.1	15.7	691	571	34	-66%	-81%	-18%	-41%	-76%
	376			928	1050				658	555				-29%	-47%	
-2.75	376	66.0	81.7	928	1050	146	21.8	16.1	658	555	34	-67%	-80%	-29%	-47%	-76%
	301			1116	1330				594	524				-47%	-61%	
-6.40	301	104.4	121.2	1149	1346	118	29.8	22.4	555	518	21	-71%	-82%	-52%	-61%	-82%
-11.50	2			1655	1963				553	514				-67%	-74%	

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-201e **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on Reactor Shield Wall**

Element		Standard Design					Site-Specific Demands					Difference				
Elev. (m)	Node No.	Shear (MN) NS	Shear (MN) EW	Bending (MN-m) NS*)	Bending (MN-m) EW*)	Torsion (MN-m)	Shear (MN) NS	Shear (MN) EW	Bending (MN-m) NS*)	Bending (MN-m) EW*)	Torsion (MN-m)	Shear NS	Shear EW	Bending NS*)	Bending EW*)	Torsion
24.18	707	3.0	2.7	2.1	1.7	0.4	4.2	3.0	2.5	2.2	0.5	44%	9%	19%	29%	24%
	708			13.2	12.4				18.9	13.8				43%	11%	
20.20	708	14.6	12.3	18.4	16.8	1.4	20.8	11.1	25.8	19.8	1.7	43%	-5%	40%	18%	23%
	709			79.0	68.4				113.5	59.3				44%	-13%	
15.775	709	17.3	14.4	81.9	71.0	1.9	24.4	12.3	116.7	61.3	2.4	41%	-10%	42%	-14%	26%
	710			158.4	133.6				224.1	115.5				41%	-14%	
11.35	710	19.9	16.6	159.1	136.4	2.4	27.1	13.5	227.6	116.9	3.0	36%	-15%	43%	-14%	23%
	711			236.2	198.7				331.9	169.3				41%	-15%	
7.4625	711	41.1	35.6	197.0	183.6	23.4	26.6	22.2	135.4	125.5	22.9	-35%	-38%	-31%	-32%	-2%
	712			292.4	251.3				169.6	151.7				-42%	-40%	
4.65	712	14.3	19.5	125.1	133.0	30.3	14.3	13.5	156.8	142.3	15.2	0%	-31%	25%	7%	-50%
	713			133.0	150.9				147.3	132.8				11%	-12%	
2.4615	713	1.5	1.3	3.6	3.2	0.2	1.6	1.6	4.0	4.0	0.2	3%	29%	11%	25%	-22%
	714			2.9	2.7				3.3	3.3				14%	22%	
1.96	714	0.9	0.7	2.7	2.4	0.1	0.9	0.9	3.0	3.0	0.1	15%	31%	11%	25%	-15%
-0.8	715			0.5	0.5				0.7	0.6				40%	20%	

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-201f **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on RPV**

Component	Node No.	Elem. No.	Standard Design Axial (MN)	Standard Design Shear (MN) NS	Standard Design Shear (MN) EW	Standard Design Moment (MN-m) NS*)	Standard Design Moment (MN-m) EW*)	Site-Specific Demands Axial (MN)	Site-Specific Demands Shear (MN) NS	Site-Specific Demands Shear (MN) EW	Site-Specific Demands Moment (MN-m) NS*)	Site-Specific Demands Moment (MN-m) EW*)	Difference Axial	Difference Shear NS	Difference Shear EW	Difference Moment NS*)	Difference Moment EW*)
Shroud Bottom	845	844	8.58	7.2	7.0	16.2	14.3	9.10	18.6	7.9	29.9	15.6	6%	158%	13%	85%	9%
	846					21.3	17.3				44.5	18.9				109%	9%
Fuel Top	847	845	0.05	1.2	1.1	0.0	0.0	0.05	0.9	1.0	0.0	0.0	9%	-22%	-7%	-	-
	848					0.1	0.1				0.1	0.1				-22%	-7%
Fuel Middle	848	846	0.44	1.0	1.0	0.1	0.1	0.48	1.0	1.0	0.1	0.1	9%	-1%	-4%	-22%	-7%
	849					0.8	0.8				0.8	0.8				-3%	-6%
Fuel Middle	849	847	1.15	0.6	0.6	0.8	0.8	1.25	0.6	0.7	0.8	0.8	8%	11%	9%	-3%	-6%
	850					1.2	1.3				1.2	1.3				-1%	0%
Fuel Middle	850	848	1.86	0.2	0.2	1.2	1.3	2.01	0.4	0.3	1.2	1.3	8%	50%	18%	-1%	0%
	851					1.2	1.3				1.1	1.3				-7%	3%
Fuel Middle	851	849	2.56	0.6	0.6	1.2	1.3	2.75	0.7	0.6	1.1	1.3	8%	24%	-1%	-7%	3%
	852					0.8	0.8				0.8	0.9				-2%	4%
Fuel Middle	852	850	3.24	1.0	1.0	0.8	0.8	3.46	1.0	1.1	0.8	0.9	7%	-1%	5%	-2%	4%
	853					0.1	0.1				0.1	0.1				-1%	-6%
Fuel Bottom	853	851	3.56	1.1	1.1	0.1	0.1	3.80	1.0	1.1	0.1	0.1	7%	-1%	-6%	-1%	-6%
	854					0.0	0.0				0.0	0.0				-	-
RPV Support	815	871	25.26	18.6	17.9	143.8	135.8	24.75	29.8	18.8	182.7	151.9	-2%	60%	5%	27%	12%
	711					141.3	136.8				176.6	147.4				25%	8%

Note: Shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending in NS or EW direction, respectively.

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Table 3A.18.1.1-202a **Comparison of Site-Specific and Standard Design Maximum Accelerations for RB/FB**

Acceleration (g)

Elev. (m)	Node No.	Standard Design			Site-Specific Demands			Difference		
		NS	EW	Vert.	NS	EW	Vert.	NS	EW	Vert.
52.40	110	1.68	1.78	1.27	2.13	1.55	1.56	27%	-13%	23%
34.00	109	1.18	1.15	0.83	1.02	0.81	1.20	-14%	-30%	44%
27.00	108	0.99	1.02	0.73	0.96	0.69	1.02	-3%	-33%	40%
22.50	107	0.98	0.91	0.73	0.83	0.73	0.92	-16%	-20%	26%
17.50	106	0.98	0.84	0.73	0.80	0.65	0.80	-19%	-23%	9%
13.57	105	0.97	0.77	0.74	0.79	0.64	0.72	-19%	-17%	-3%
9.06	104	0.84	0.73	0.73	0.76	0.70	0.62	-10%	-4%	-15%
4.65	103	0.73	0.68	0.78	0.76	0.77	0.56	4%	13%	-28%
-1.00	102	0.68	0.63	0.76	0.63	0.63	0.57	-8%	0%	-24%
-6.40	101	0.61	0.62	0.68	0.53	0.55	0.53	-14%	-12%	-23%
-11.50	2	0.60	0.55	0.63	0.43	0.37	0.51	-28%	-33%	-18%
-15.50	1	0.51	0.51	0.51	0.44	0.37	0.52	-14%	-28%	2%

Note: The presented values are the maximum accelerations at floor lumped mass locations.
Shaded values in the table show an exceedance from standard design.

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Table 3A.18.1.1-202b **Comparison of Site-Specific and Standard Design Maximum Accelerations for RCCV**

Acceleration (g)

Elev. (m)	Node No.	Standard Design			Site-Specific Demands			Difference		
		NS	EW	Vert.	NS	EW	Vert.	NS	EW	Vert.
34.00	209	1.18	1.15	0.90	1.02	0.81	1.20	-14%	-30%	34%
27.00	208	0.98	1.02	0.88	0.96	0.69	1.12	-2%	-33%	28%
17.50	206	0.98	0.85	0.73	0.80	0.66	0.91	-19%	-23%	24%
13.57	205	0.97	0.78	0.78	0.79	0.64	0.82	-19%	-18%	5%
9.06	204	0.84	0.74	0.65	0.76	0.68	0.72	-10%	-9%	11%
4.65	203	0.73	0.69	0.70	0.76	0.73	0.65	4%	6%	-7%
-1.00	202	0.68	0.63	0.59	0.63	0.62	0.58	-8%	-2%	-1%
-6.40	201	0.61	0.60	0.59	0.53	0.56	0.55	-14%	-7%	-6%

Note: The presented values are the maximum accelerations at lumped mass locations.
Shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-202c **Comparison of Site-Specific and Standard Design Maximum Accelerations for Vent Wall and Pedestal**

Acceleration (g)

Elev. (m)	Node No.	Standard Design			Site-Specific Demands			Difference		
		NS	EW	Vert.	NS	EW	Vert.	NS	EW	Vert.
17.50	701	0.98	0.85	1.10	0.80	0.66	0.82	-19%	-23%	-25%
14.50	702	1.40	1.06	1.04	0.80	0.70	0.86	-43%	-34%	-17%
11.50	703	1.42	1.14	0.92	0.84	0.74	0.81	-41%	-35%	-12%
8.50	704	0.98	0.86	0.77	0.74	0.72	0.72	-25%	-17%	-6%
7.46	705	0.85	0.77	0.70	0.75	0.67	0.67	-12%	-13%	-4%
4.65	706, 303	0.73	0.69	0.67	0.76	0.73	0.69	4%	6%	3%
-1.00	302	0.68	0.63	0.59	0.63	0.62	0.59	-8%	-2%	0%
-6.40	301	0.61	0.60	0.50	0.53	0.56	0.56	-14%	-7%	11%

Note: The presented values are the maximum accelerations at lumped mass locations.
Shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-202d **Comparison of Site-Specific and Standard Design Maximum Accelerations for Reactor Shield Wall**

Acceleration (g)

Elev. (m)	Node No.	Standard Design			Site-Specific Demands			Difference		
		NS	EW	Vert.	NS	EW	Vert.	NS	EW	Vert.
24.18	707	2.51	2.38	0.97	3.61	2.51	1.30	44%	6%	34%
20.20	708	2.13	1.90	0.94	2.81	1.82	1.23	32%	-4%	31%
15.78	709	1.74	1.39	0.84	1.77	1.23	0.99	2%	-11%	17%
11.35	710	1.29	0.95	0.76	1.01	0.81	0.78	-22%	-15%	3%
7.46	711	0.85	0.77	0.70	0.75	0.67	0.68	-12%	-13%	-3%
4.65	712	0.73	0.69	0.67	0.76	0.73	0.69	4%	6%	2%
2.46	713	0.74	0.66	0.64	0.73	0.70	0.64	-2%	7%	0%
1.96	714	0.75	0.66	0.64	0.75	0.73	0.64	-1%	11%	0%
-0.80	715	0.86	0.72	0.65	0.88	0.88	0.64	3%	23%	-1%

Note: The presented values are the maximum accelerations at lumped mass locations.
Shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-202e **Comparison of Site-Specific and Standard Design Maximum Accelerations for Fuel**

		Standard Design			Site-Specific Demands			Difference		
Elev. (m)	**Node No.**	**NS (g)**	**EW (g)**	**Vert. (g)**	**NS (g)**	**EW (g)**	**Vert. (g)**	**NS**	**EW**	**Vert.**
7.90	847	1.09	1.00	1.41	2.06	1.03	1.54	89%	3%	9%
7.81	848	1.06	0.98	1.41	1.91	0.98	1.54	80%	0%	9%
7.11	849	0.91	0.92	1.41	1.00	0.73	1.53	10%	-21%	8%
6.40	850	0.98	0.91	1.39	0.69	0.82	1.50	-30%	-9%	8%
5.69	851	0.91	0.98	1.36	0.85	0.86	1.45	-6%	-12%	7%
4.98	852	1.20	1.12	1.33	1.61	1.15	1.39	34%	3%	5%
4.27	853	1.65	1.42	1.28	2.52	1.74	1.32	53%	22%	3%
4.18	854	1.73	1.52	1.27	2.63	1.81	1.31	52%	19%	3%

Note: The presented values are the maximum accelerations at lumped mass locations.
Shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-203 **Comparison of Site-Specific and Standard Design Maximum Out-of-Plane Loads on RB/FB Flexible Slabs**

		Slab Equivalent Out-of-Plane Acceleration Load (sAave) (g)					
Elev. (m)	**Location**	**UC100 Env.**	**CR00 Env.**	**CR50 Env.**	**Site-Specific**	**Standard Design[a]**	**Difference/ Exceedance**
52.40	RB Roof	1.51	0.75	0.74	1.51	1.64	-8%
34.00	RB-RCCV	1.23	0.88	0.93	1.23	0.90	37%
	RCCV	1.30	0.95	1.00	1.30	0.93	40%
27.00	Top Slab	1.37	1.09	1.19	1.37	0.98	40%
	RB-RCCV	1.06	0.81	0.90	1.06	0.77	37%
	M/S tunnel roof	1.13	0.80	0.88	1.13	0.82	38%
22.50	FB Roof	1.31	0.74	0.77	1.31	1.47	-11%
17.50	M/S tunnel slab	1.74	1.15	1.14	1.74	1.10	58%
	RB-RCCV	0.94	0.79	0.84	0.94	0.78	20%
	DF	1.53	2.38	1.23	2.38	1.84	29%
13.57	RB-RCCV	0.89	0.79	0.84	0.89	0.84	6%
9.06	RB-RCCV	0.79	0.76	0.78	0.79	0.82	-4%
4.65	FB	1.11	0.82	0.81	1.11	1.03	8%
	RB-RCCV	0.87	0.84	0.86	0.87	0.95	-9%
	RCCV-Pedestal	0.82	0.77	0.77	0.82	0.80	2%

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Table 3A.18.1.1-203 **Comparison of Site-Specific and Standard Design Maximum Out-of-Plane Loads on RB/FB Flexible Slabs** *(continued)*

		Slab Equivalent Out-of-Plane Acceleration Load (sAave) (g)					
Elev. (m)	**Location**	**UC100 Env.**	**CR00 Env.**	**CR50 Env.**	**Site-Specific**	**Standard Design[a]**	**Difference/ Exceedance**
-1.00	FB	0.71	0.70	0.69	0.71	0.88	-19%
	RB-RCCV	0.73	0.70	0.69	0.73	0.85	-14%
	RCCV-Pedestal	0.70	0.72	0.70	0.72	0.71	1%
-6.40	RCCV-Pedestal	0.60	0.61	0.59	0.61	0.63	-3%
	RB-RCCV	0.57	0.65	0.66	0.66	0.71	-7%
	FB	-	0.58	0.57	0.58	-	Add Load[b]

a. ESBWR standard design values.

b. Additional load due to concrete cracking.

The shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-204 **Comparison of Site-Specific and Standard Design Maximum Out-of-Plane Loads on RB/FB Flexible Walls**

Elev. (m)	Location	Wall Equivalent Out-of-Plane Acceleration Load (wAave) (g)					Difference
		UC100 Env.	CR00 Env.	CR50 Env.	Site-Specific	Standard Design[a]	
42.00	R1 and R7 walls	2.10	1.77	1.88	2.10	1.48	42%
	RB and RF walls	1.27	0.87	0.91	1.27	1.52	-16%
30.50	R1 and R7 walls (Additional Oscillator)	-	0.58	0.57	0.58	-	Add Load[b]
	RA and RG walls (Additional Oscillator)	-	0.54	0.54	0.54	-	Add Load[b]
13.57	F3 wall	1.48	0.94	0.95	1.48	1.19	25%
	FA and FF walls	1.55	0.89	0.95	1.55	1.09	42%

a. ESBWR standard design values.

b. Additional Load due to concrete cracking.

The shaded values in the table show exceedance from standard design.

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Table 3A.18.1.1-205 **Comparison of RPV Stabilizer Bounding Spring Reactions and Displacements vs. Standard Design**

	Node No.		Standard Design		Site-Specific Demands		Difference	
Dir.	**i**	**j**	**Rel. Displ. (cm)**	**Reaction (MN)**	**Rel. Displ. (cm)**	**Reaction (MN)**	**Relative Displacement**	**Reaction**
NS	808	708	0.13	7.85	0.20	12.12	51%	54%
EW	808	708	0.14	8.48	0.12	7.64	-12%	-10%

Note: The shaded values in the table show exceedance from standard design.

Figure 3A.18.1.1-201a **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on RB/FB**

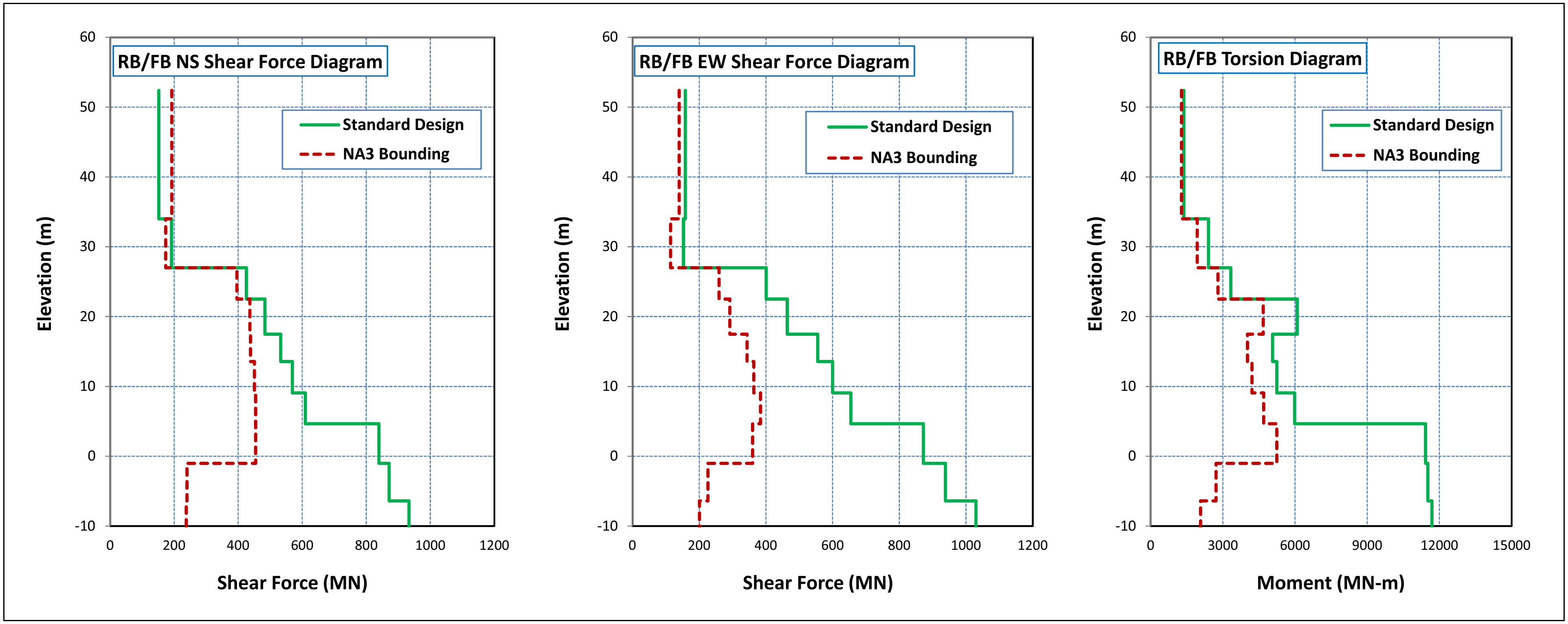

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Figure 3A.18.1.1-201b **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on RCCV**

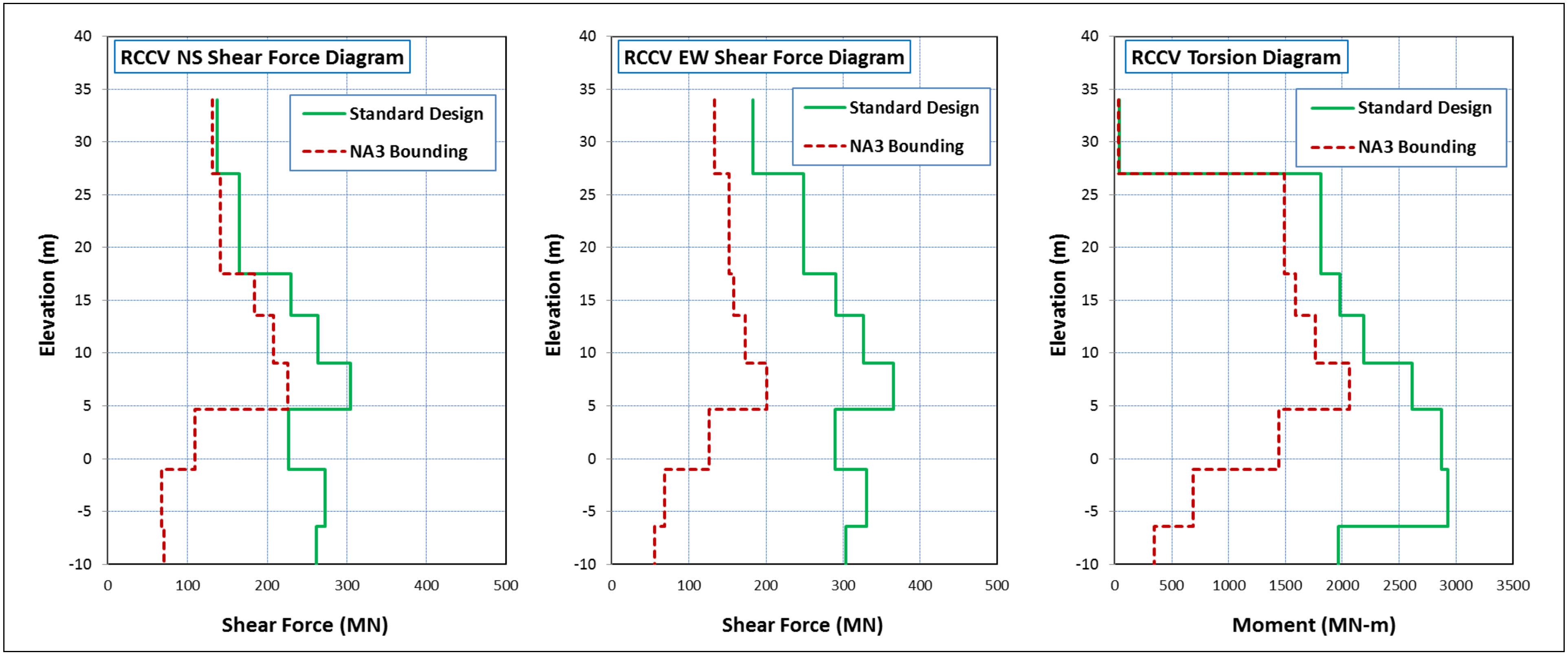

Figure 3A.18.1.1-201c **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on Vent Wall**

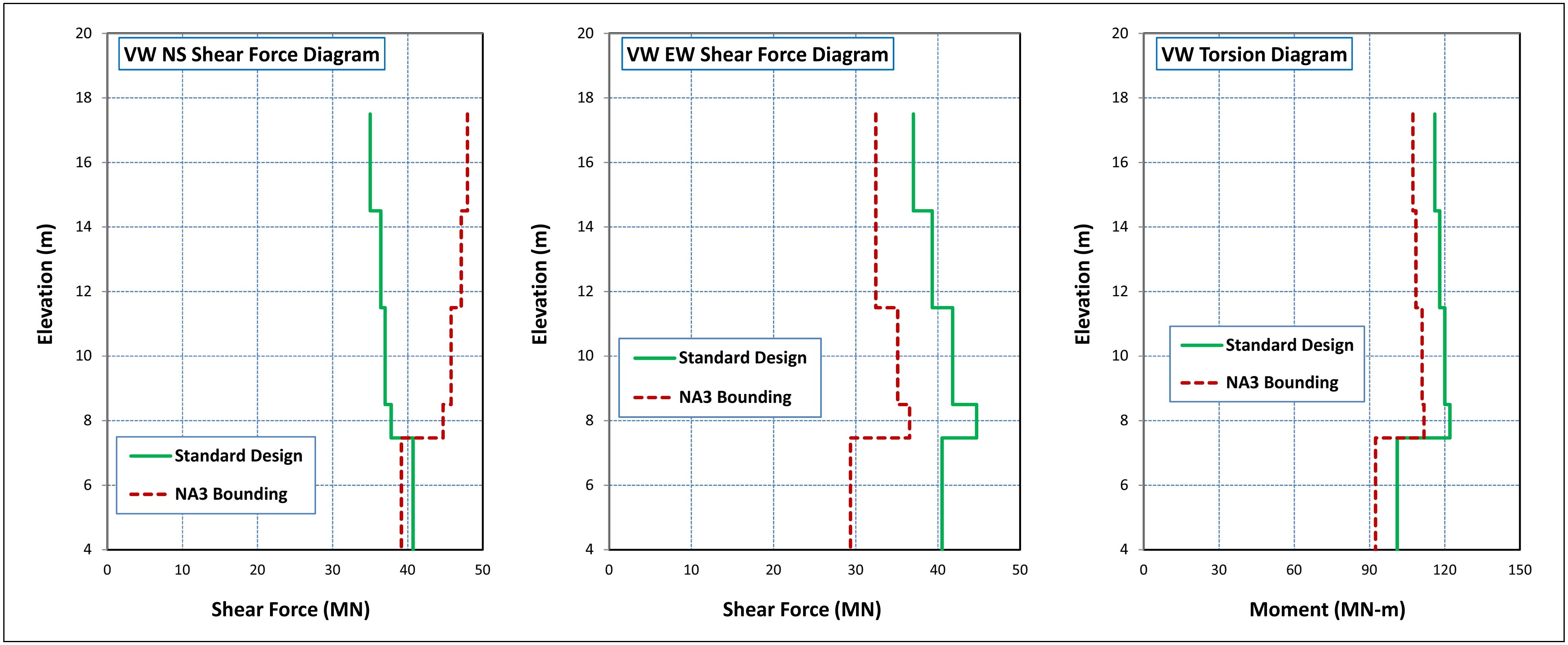

Figure 3A.18.1.1-201d **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on Pedestal**

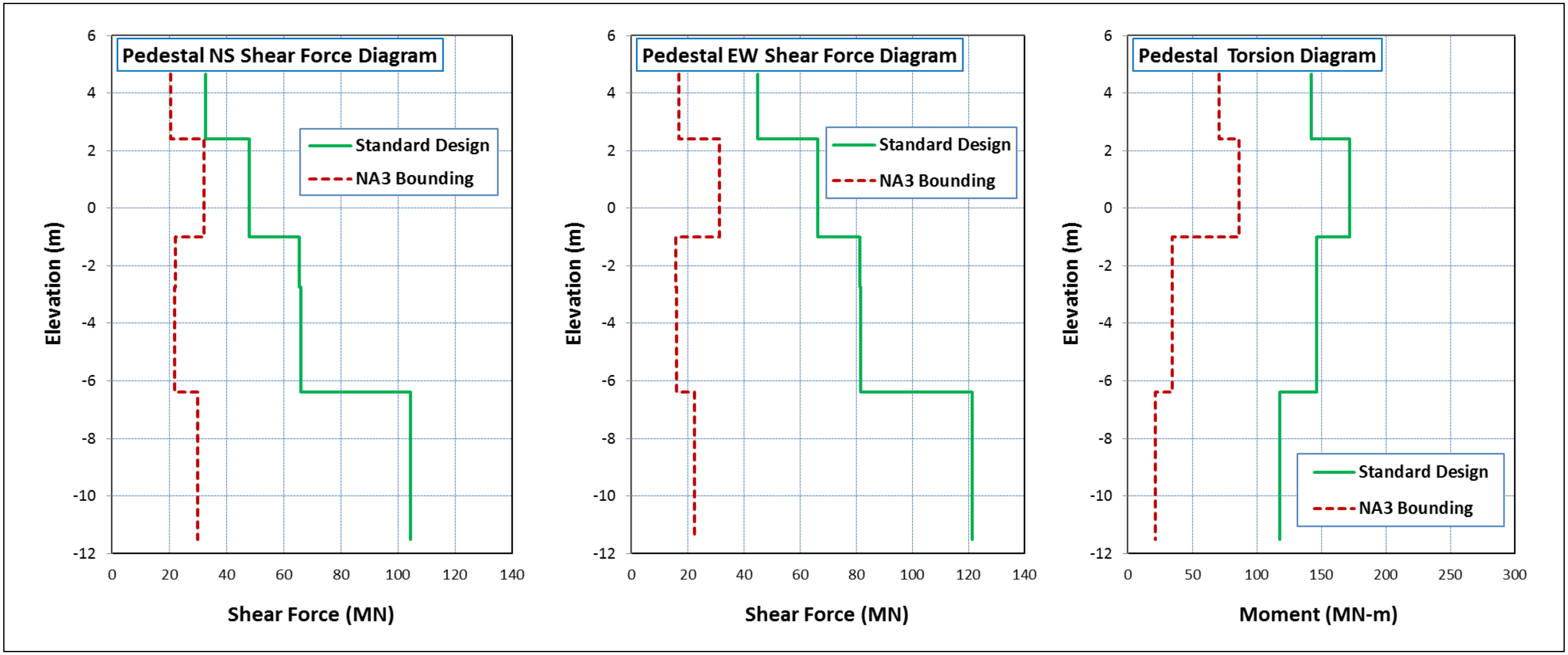

Figure 3A.18.1.1-201e **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on Reactor Shield Wall**

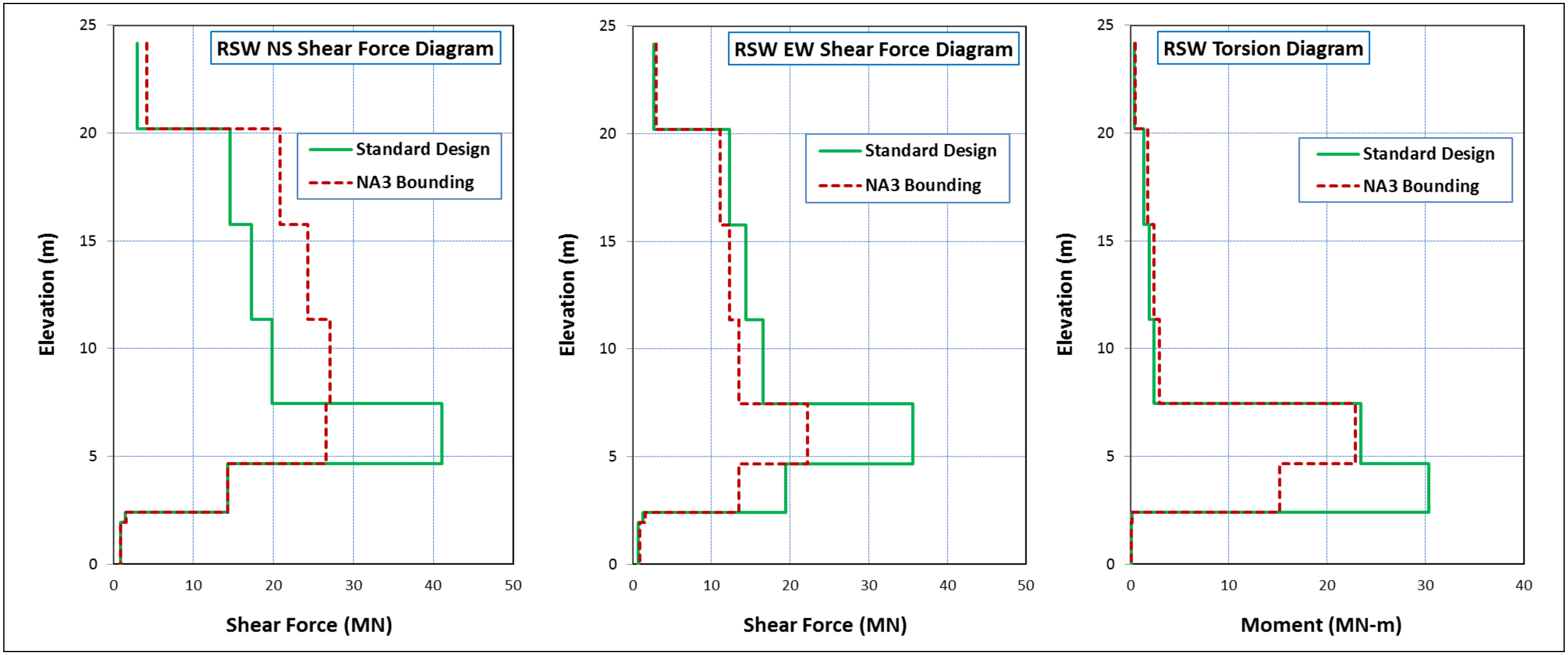

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Figure 3A.18.1.1-202a **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on RB/FB**

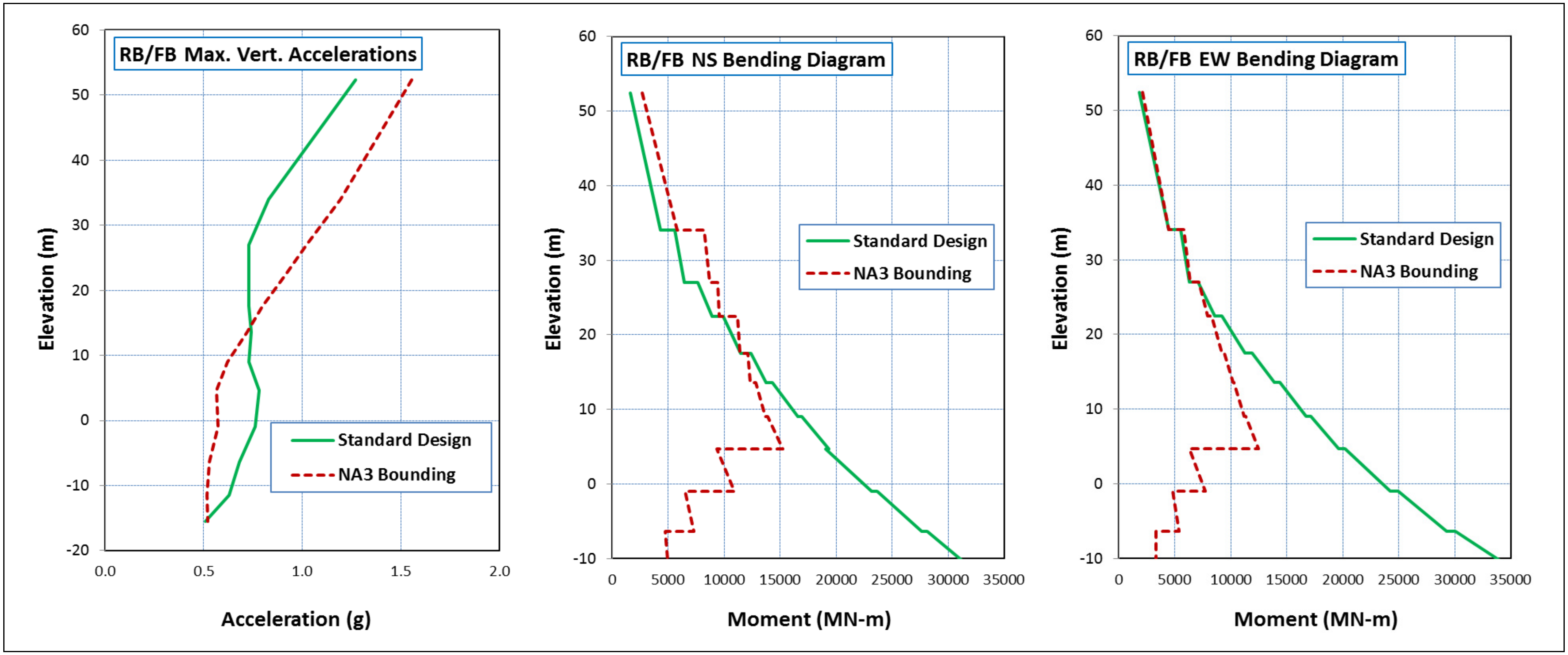
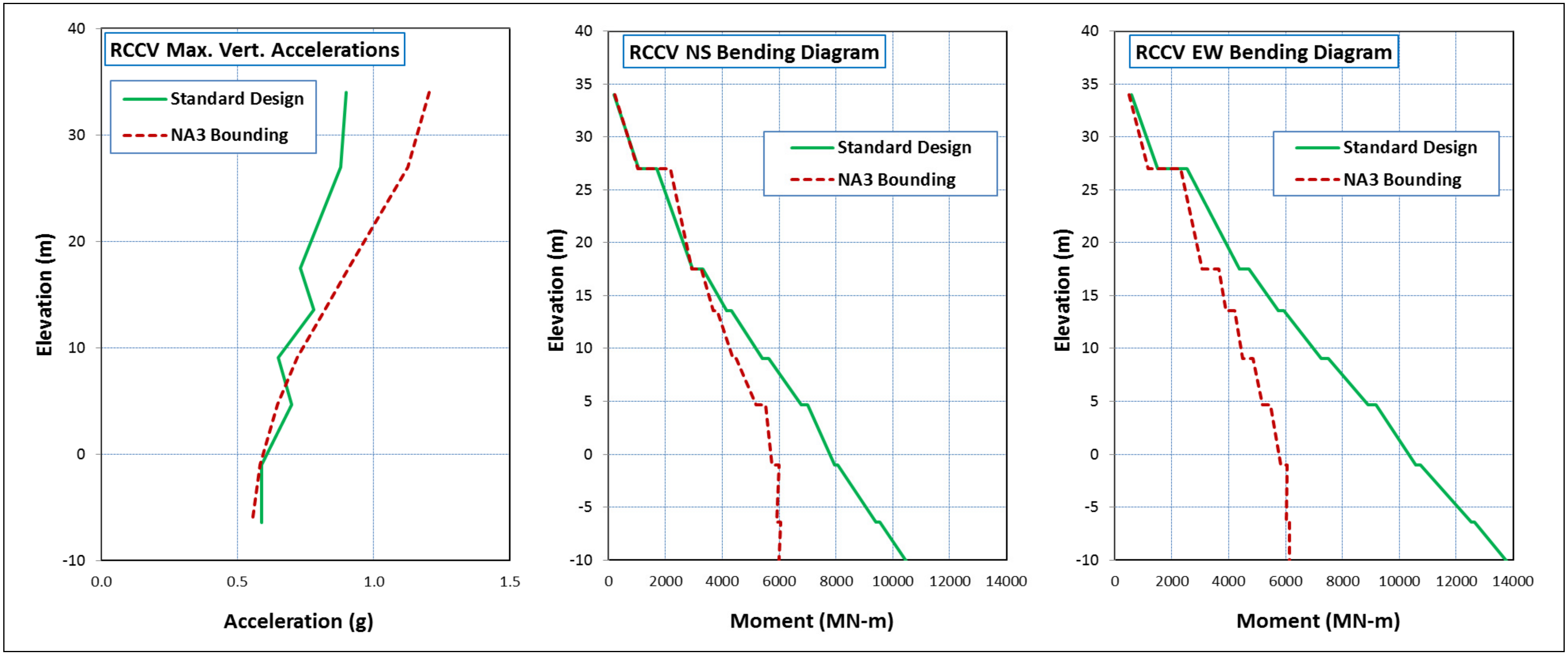


Figure 3A.18.1.1-202b **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on RCCV**



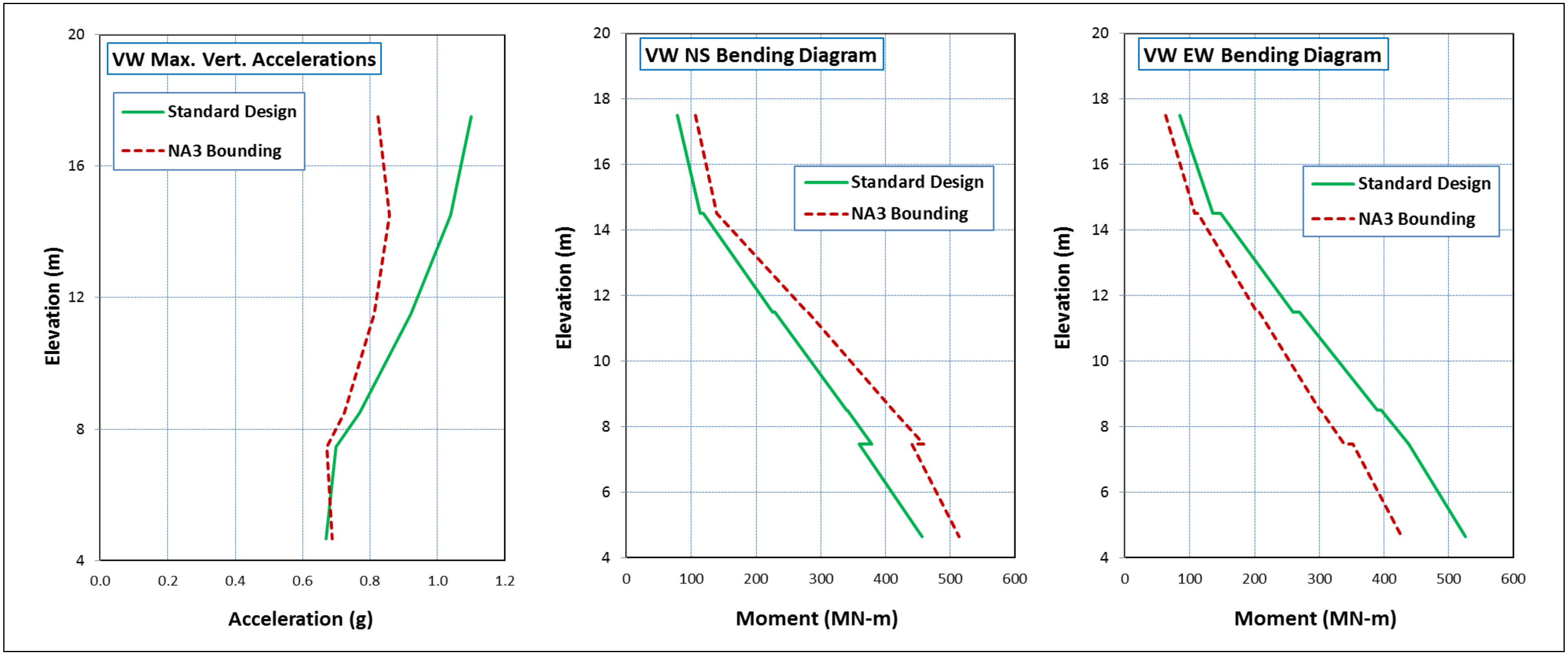


Figure 3A.18.1.1-202c **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on Vent Wall**

Figure 3A.18.1.1-202d **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on Pedestal**

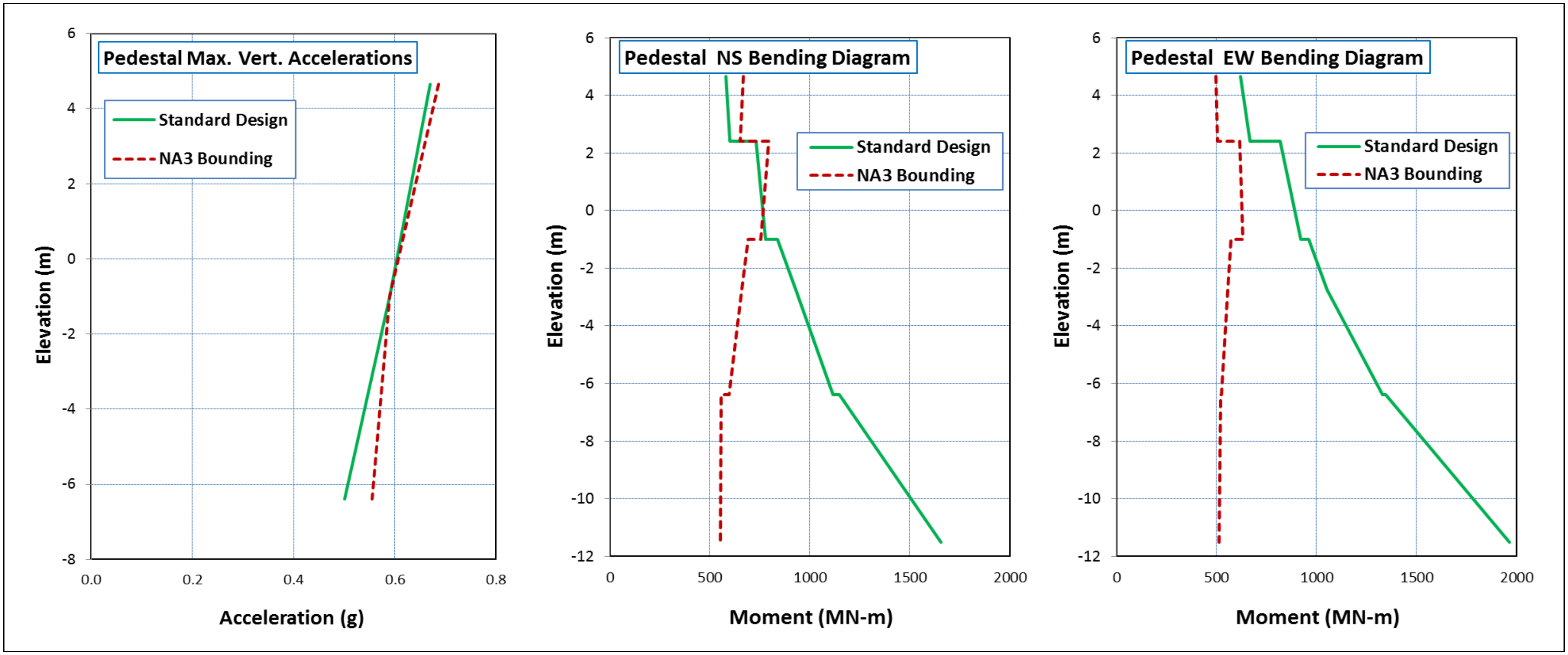
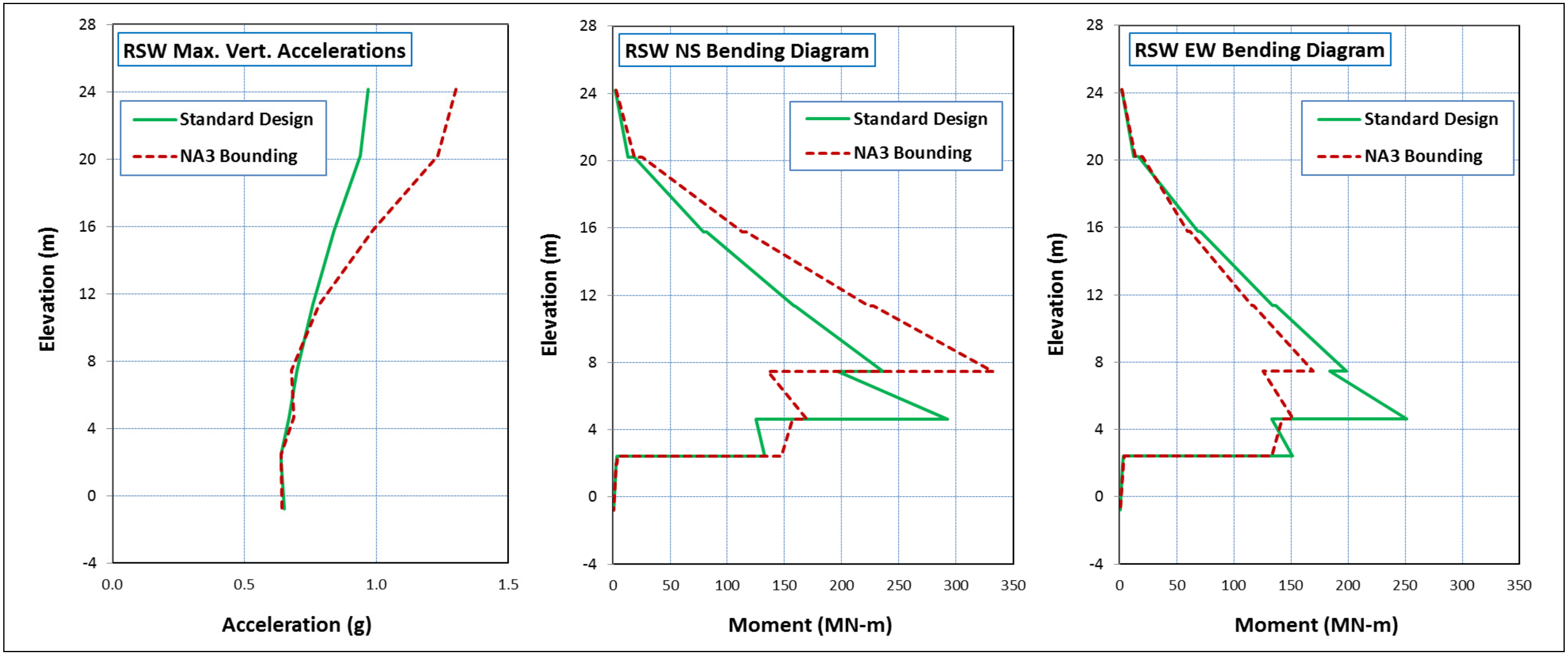


Figure 3A.18.1.1-202e **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on Reactor Shield Wall**



3A.18.1.2 CB Site-Specific Seismic Structural Load Demands

The load demands on the CB structure, which are obtained as the envelope of results from the design basis SSI analyses of the CB partially and fully embedded models (Cases 7 through 12 in Table 3A.15-202), bound the effects from variations in subgrade conditions and the effects of soil separation on the CB site-specific seismic response.

The evaluation of concrete cracking effects, described in Section 3A.17.9.2, shows that cracking of the concrete amplifies the out-of-plane load demands on some of the CB slabs. To address the site-specific effects of concrete cracking on the seismic load demands on the CB structure, the enveloping structural loads are enhanced by enveloping the maximum member force and lumped mass acceleration results from the following analyses:

- Design basis SSI analyses of CB UC_{SSE} stand-alone models with full (uncracked concrete) stiffness and SSE damping values (Cases 7 through 12 in Table 3A.15-202)
- SSI sensitivity analyses of CB CR_{SSE} stand-alone models with reduced (cracked concrete) stiffness and SSE damping values (Cases S1 through S6 in Table 3A.15-202)

The site-specific evaluations of SSSI effects of the FWSC and RB/FB on the seismic response of CB in Section 3A.17.11 show that the CB enveloping load demands bound the SSSI effects of the FWSC and RB/FB with a few small exceedances in some of the local load demands. As discussed in Section 3A.17.11, these exceedances have a negligible effect on the CB structure and are not included in the site-specific evaluation of the CB structure. This section presents the seismic loads used as input for the site-specific evaluations of the CB structure that are enhanced to bound concrete cracking effects.

Table 3A.18.1.2-201 presents the comparison of the site-specific seismic shear forces and moments with the corresponding standard design loads. Table 3A.18.1.2-202 compares the site-specific maximum accelerations at floor lumped mass locations with the corresponding standard design enveloping accelerations. Site-specific horizontal and vertical load demands are compared to the corresponding seismic loads used for standard design in Figures 3A.18.1.2-201 and 3A.18.1.2-202. The torsional moments in Table 3A.18.1.2-201 and Figure 3A.18.1.2-201 are values calculated directly from the SSI analyses results. These

torsional moments are combined with the accidental torsion for the site-specific evaluation of CB structure in Section 3G.9. Figure 3A.18.1.2-201 compares the shear force and torsion diagrams that define the horizontal seismic load demands on the CB structure. Figure 3A.18.1.2-202 compares the maximum vertical accelerations and bending moment diagrams that define the vertical seismic load demands on the CB structure.

Table 3A.18.1.2-203 presents the site-specific out-of-plane load demands on the CB flexible slabs and compares them with the magnitudes of the corresponding loads used for the standard design of CB structures.

Comparisons presented in Figures 3A.18.1.2-201 and 3A.18.1.2-202 and Tables 3A.18.1.2-201 through 3A.18.1.2-203 indicate that the site-specific load demands exceed the corresponding loads used for the standard design of the CB structure. The comparisons in Figure 3A.18.1.2-201 and Table 3A.18.1.2-201 indicate that the site-specific horizontal load demands on the CB walls can exceed the seismic loads used for standard design by as much as 50 percent. Comparisons in Figure 3A.18.1.2-202 and Table 3A.18.1.2-202 show the exceedances in vertical loads to be smaller (< 30 percent). Exceedances of the local out-of-plane loads on flexible slabs are no more than 20 percent. Site-specific evaluations of the CB structure, described in Appendix 3G, are performed to address these exceedances in the site-specific load demands and calculate the available site-specific margins of CB structure.

Table 3A.18.1.2-201 **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on CB**

Element		Standard Design					Site-Specific Demands					Difference/Exceedance				
		Shear (MN)		Bending (MN-m)			Shear (MN)		Bending (MN-m)			Shear		Bending		
Elev. (m)	Node No.	NS	EW	NS*)	EW*)	Torsion (MN-m)	NS	EW	NS*)	EW*)	Torsion (MN-m)	NS	EW	NS	EW	Torsion
13.80	6	33.1	29.1	160	124	23.1	42.7	40.2	110	86	27.5	29%	38%	-31%	-31%	19%
	5			250	197				276	226				10%	15%	
9.06	5	53.4	54.8	360	275	44.9	77.9	70.1	360	293	57.7	46%	28%	0%	6%	29%
	4			573	443				685	562				20%	27%	
4.65	4	75.6	80.1	723	540	56.9	101.0	91.2	382	204	51.2	34%	14%	-47%	-62%	-10%
	3			1136	988				1053	736				-7%	-25%	
-2.00	3	124.4	99.4	1232	1036	59.9	41.0	44.8	567	511	26.9	-67%	-55%	-54%	-51%	-55%
-7.40	2			1570	1525				771	693				-51%	-55%	

Note: The shaded values in the table show exceedance from standard design.

*) NS and EW represent moments for bending the NS and EW direction, respectively.

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Table 3A.18.1.2-202 **Comparison of Site-Specific and Standard Design Maximum Accelerations on CB**

		Acceleration (g)								
		Standard Design			**Site-Specific**			**Difference**		
Elev. (m)	**Node No.**	**NS**	**EW**	**Vert.**	**NS**	**EW**	**Vert.**	**NS**	**EW**	**Vert.**
13.80	6	1.26	1.11	1.00	1.63	1.55	1.05	30%	39%	5%
9.06	5	0.88	0.90	0.86	1.26	1.12	0.95	42%	25%	11%
4.65	4	0.86	0.82	0.74	0.88	0.98	0.82	2%	20%	10%
-2.00	3	0.79	0.71	0.56	0.68	0.83	0.60	-13%	17%	6%
-7.40	2	0.54	0.54	0.51	0.48	0.43	0.64	-11%	-21%	26%
-10.40	1	0.54	0.53	0.51	0.48	0.43	0.63	-11%	-18%	25%

Notes: The presented values are the maximum accelerations at floor lumped mass locations.
The shaded values in the table show exceedance from standard design.

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Table 3A.18.1.2-203 **Comparison of Site-Specific and Standard Design Maximum Out-of-Plane Loads on CB Flexible Slabs**

El. (m)	Location	Slab Equivalent Out-of-Plane Acceleration Load (g) Standard Design	Site-Specific	Difference
13.80	Roof	1.39	1.53	10%
9.06	CA-CD	1.08	1.21	12%
4.65	CA-CD	0.87	1.03	18%
-2.00	CA-CD	0.66	0.69	5%

Note: The shaded values in the table show exceedance from standard design.

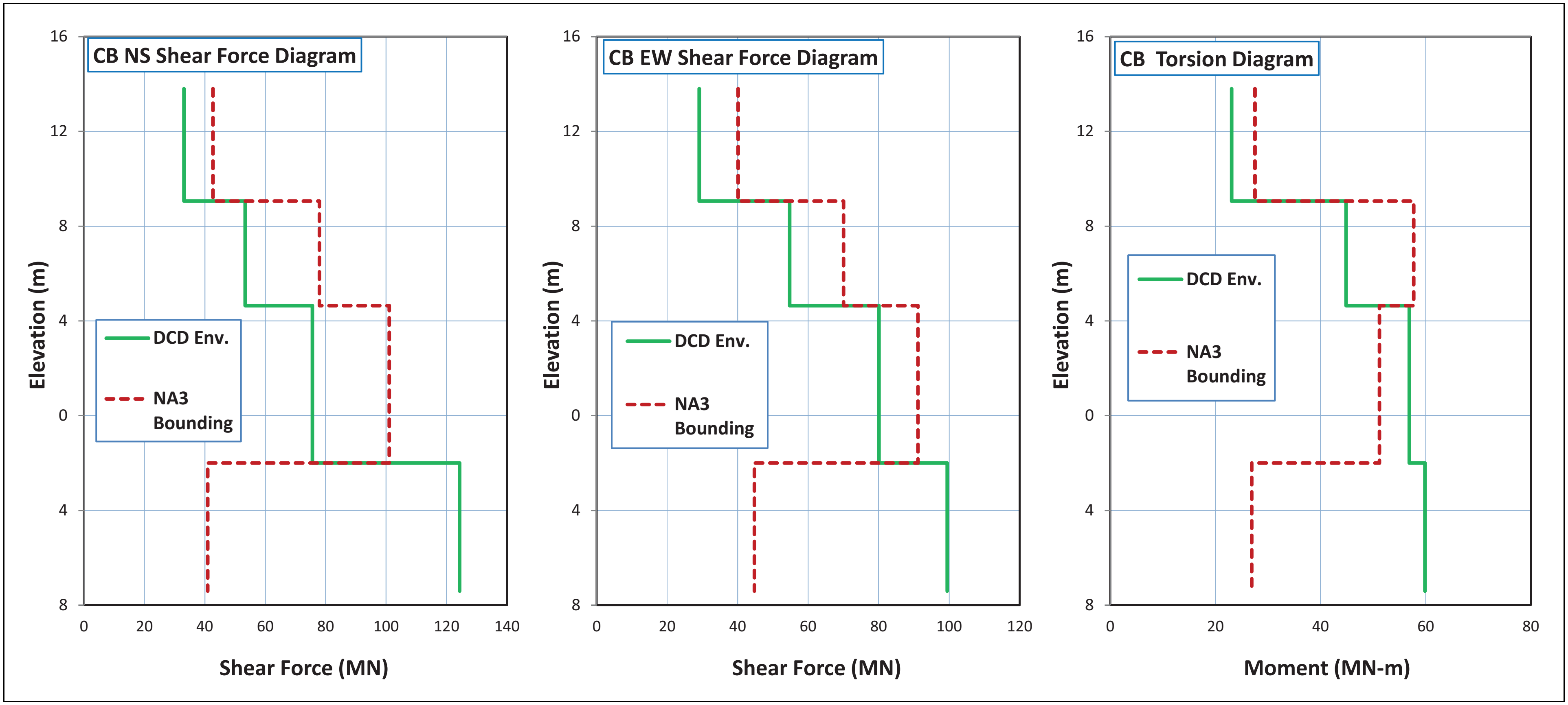
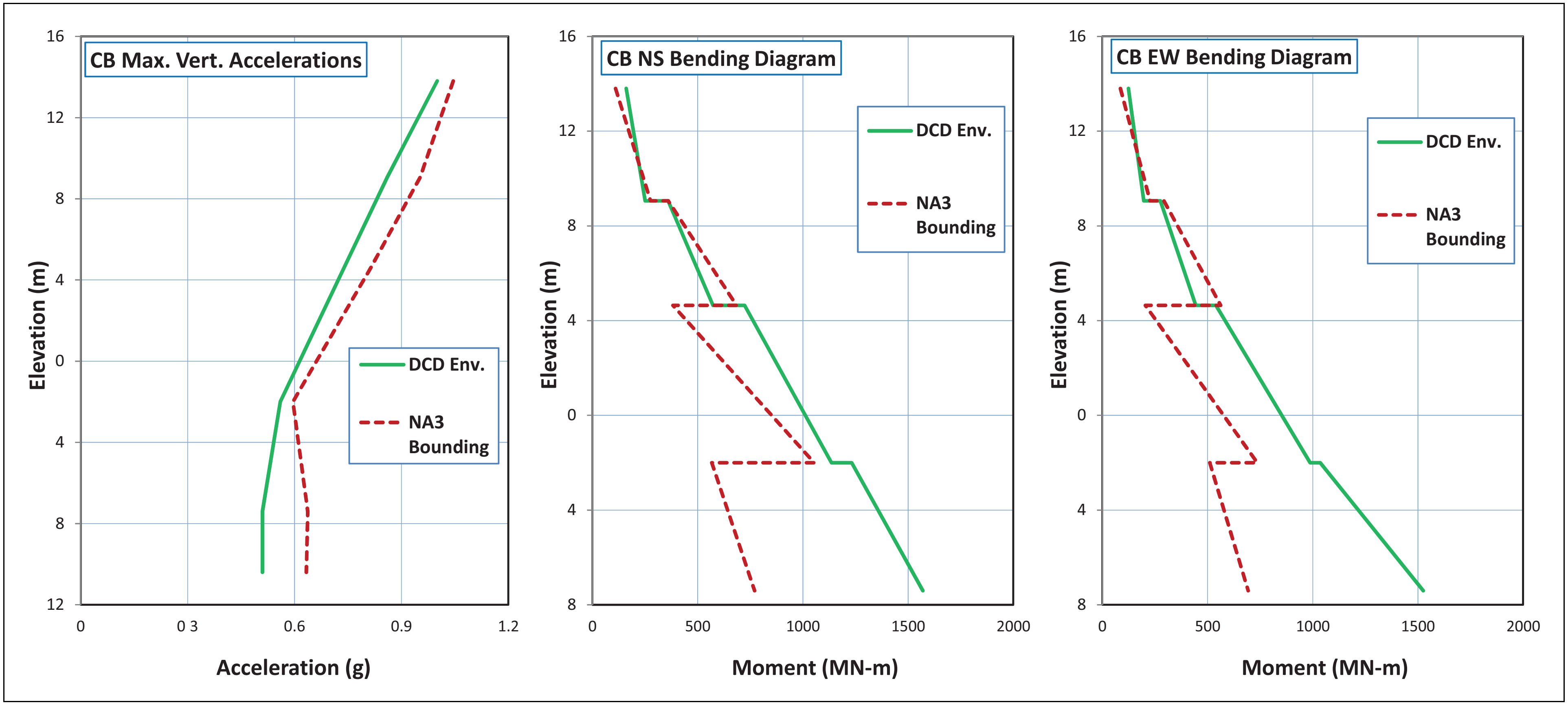


Figure 3A.18.1.2-201 **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on CB**

Figure 3A.18.1.2-202 **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on CB**



3A.18.1.3 FWSC Site-Specific Seismic Structural Load Demands

The site-specific seismic load demands presented in this section form the basis for seismic design and evaluation of the FWSC structures. The site-specific SSSI evaluation in Section 3A.17.11 shows that responses obtained from the SSI analyses of the stand-alone FWSC models do not envelope the SSSI effects of the CB on the FWSC seismic response. Therefore, results of the site-specific SSI analyses of the FWSC stand-alone models are used, together with the corresponding results of the site-specific SSSI analyses of the FWSC-CB combined model, to develop the seismic load demands for the site-specific evaluation of the Unit 3 FWSC structures. Site-specific seismic load demands on the FWSC structures are based on the envelope of results for maximum member forces and vertical accelerations obtained from the SSI and SSSI analyses of the FWSC stand-alone and the FWSC-CB combined models with full (uncracked concrete) stiffness properties and SSE damping using deep input control motion applied at the bottom of the concrete fill at Elevation 220 ft NAVD88.

The FWSC structural loads, which are obtained as the envelope of results from the design basis SSI analyses of the FWSC stand-alone model (Cases 7 through 9 in Table 3A.15-203) and design basis SSSI analyses of the FWSC-CB combined model (Cases FC7 through FC9 in Table 3A.15-206), bound the effects of variations in subgrade conditions and the SSSI effects of the CB on the site-specific seismic response of the FWSC.

The evaluation in Section 3A.17.14.5 indicates that the separation between the concrete fill (placed below the FWSC basemat) and the surrounding soil affects the FWSC seismic response and amplifies:

- the horizontal and torsional load demands on the FWS structure
- the hydrodynamic loads from the water contained in the FWS tank
- the lateral force demands on the FWSC shear keys.

The FWSC seismic loads are enhanced to bound these exceedances by enveloping the maximum member force and lumped mass acceleration results from the following analyses:

- Design basis SSI and SSSI analyses of FWSC stand-alone and FWSC-CB combined models representing fully bonded conditions (Cases 7 through 9 in Table 3A.15-203 and Cases FC7 through FC9 in Table 3A.15-206)

- SSI and SSSI sensitivity analyses of FWSC stand-alone and FWSC-CB combined models representing conditions of maximum separation between the concrete fill and surrounding soil (Cases SF1 through SF3 in Table 3A.15-203 and Cases SF4 through SF6 in Table 3A.15-206).

To address the effects of separation between the concrete fill and surrounding soil, the site-specific structural evaluation of the FWSC shear keys uses lateral force demands that are enveloped from the results of the design basis SSI and SSSI analyses of fully bonded models (Cases 7 through 9 in Table 3A.15-203 and Cases FC7 through FC9 in Table 3A.15-206) and sensitivity analyses of models representing maximum separation (Cases SF1 through SF3 in Table 3A.15-203 and Cases SF4 through SF6 in Table 3A.15-206).

The evaluation of concrete cracking effects on the seismic response of FWSC structures in Section 3A.17.9.3 shows that cracking of the concrete amplifies:

- The horizontal hydrodynamic load from the water contained in the FWS tank
- The horizontal loads on the FPE structure
- The out-of-plane vertical load on the FPE roof

These seismic loads are enhanced to bound the exceedances due to the concrete cracking effects by using concrete cracking amplification factors greater than or equal to 1.0 ($CR_{amp} \geq 1.0$). These amplification factors are calculated as the ratios of:

- the enveloped results of the SSI sensitivity analyses of FWSC CR_{SSE} stand-alone model with reduced (cracked concrete) stiffness and SSE damping (analysis Cases S1 through S6 in Table 3A.15-203) over
- the enveloped results of the design basis SSI analyses of FWSC UC_{SSE} stand-alone model with full (uncracked concrete) stiffness and SSE damping (analysis Cases 7 through 9 in Table 3A.15-203)

To capture the combined effects of concrete cracking, soil separation and SSSI effects of the CB on the seismic response of the FWSC, these concrete cracking amplification factors ($CR_{amp} \geq 1.0$) are applied to the FWSC seismic loads after being enhanced to bound the effects of separation between the concrete fill and the surrounding soil.

The site-specific evaluation presented in Section 3A.17.9.3 shows that the sliding analyses of models with full (uncracked concrete) stiffness and SSE damping, which are presented in Section 3G.10.5.5, provide seismic demands on the FSWC shear keys that bound the effects of concrete cracking.

Table 3A.18.1.3-201 presents the FWSC site-specific maximum member forces and moments and compares them with the corresponding standard design values.

Table 3A.18.1.3-202 presents the maximum accelerations at FWSC lumped mass locations. This table compares these site-specific maximum accelerations to the corresponding standard design enveloping accelerations.

Table 3A.18.1.3-203 presents the site-specific maximum accelerations of the FWSC SDOF oscillators used for the calculation of the site-specific out-of-plane seismic loads on the FWS roof and the site-specific hydrodynamic seismic loads from the water contained in the FWS tank. Table 3A.18.1.3-203 also presents a comparison of the site-specific maximum accelerations of the FWSC SDOF oscillators with the corresponding standard design values.

Table 3A.18.1.3-204 presents the equivalent average acceleration representing the out-of-plane seismic load demand on the FWS roofs. In Table 3A.18.1.3-204, the site-specific out-of-plane seismic load demands on the FWS roof are compared with the corresponding loads used for the standard design of the FWSC structures. Table 3A.18.1.3-204 also includes an additional out-of-plane load applied to the FPE roof due to the consideration of cracked concrete conditions.

Table 3A.18.1.3-205 presents the site-specific lateral loads on the FWSC shear keys as well as a comparison of these loads with the corresponding standard design values.

Figures 3A.18.1.3-201 and 3A.18.1.3-202 present diagrams of the site-specific horizontal load demands on the FWS and FPE structures, respectively. The torsional moments in Table 3A.18.1.3-201 and Figures 3A.18.1.3-201 and 3A.18.1.3-202 are values calculated directly from the SSI and SSSI analyses results. These torsional moments are combined with the accidental torsion for the site-specific evaluation of FWSC structures in Section 3G.8. Vertical load demands on these two FWSC structures are shown in Figures 3A.18.1.3-203

and 3A.18.1.3-204. Figures 3A.18.1.3-201 through 3A.18.1.3-204 compare the site-specific load demands with the corresponding loads used for the standard design.

The comparisons presented in Figures 3A.18.1.3-201 through 3A.18.1.3-204 and Tables 3A.18.1.3-201 through 3A.18.1.3-205 indicate that the site-specific load demands exceed the corresponding loads used for the standard design of the FWSC structures. The comparisons in Table 3A.18.1.3-201, along with Figures 3A.18.1.3-201 and 3A.18.1.2-202, indicate that the site-specific horizontal shear load demands on the FWSC structures exceed the seismic loads used for standard design by no more than 11 percent. Large exceedances are observed in the torsional load demands on the FWS structure, but the effect of these exceedances on the design of the FWSC wall is small. Comparisons in Tables 3A.18.1.3-201 and 3A.18.1.3-202 and Figures 3A.18.1.3-203 and 3A.18.1.3-204 show exceedances of the vertical loads on FWS and FPE walls to be no more than 20 percent. The comparisons of vertical accelerations in Table 3A.18.1.3-202 also indicate an exceedance of 27 percent in vertical load demands on FWSC basemat. As shown in Table 3A.18.1.3-203, the site-specific accelerations of the FWS water response SDOF oscillators do not exceed the corresponding standard design values. Table 3A.18.1.3-204 shows the exceedance of the local out-of-plane loads on FWSC roofs to be 32 percent. The site-specific lateral loads on FWSC shear keys exceed the corresponding standard design loads by as much as 41 percent, as shown in Table 3A.18.1.3-205.

Site-specific evaluations of the FWSC structures described in Appendix 3G are performed to address these exceedances in the site-specific load demands and to calculate the available site-specific design margins.

Table 3A.18.1.3-201 **Comparison of Site-Specific and Standard Design Maximum Structural Forces and Moments on FWSC**

Structure	Element: Elev. (m)	Element: No.	Element: Node No.	Standard Design: Shear (MN) NS	Standard Design: Shear (MN) EW	Standard Design: Bending (MN-m) NS[a]	Standard Design: Bending (MN-m) EW[a]	Standard Design: Torsion (MN-m)	Site-Specific: Shear (MN) NS	Site-Specific: Shear (MN) EW	Site-Specific: Bending (MN-m) NS[a]	Site-Specific: Bending (MN-m) EW[a]	Site-Specific: Torsion (MN-m)	Difference: Shear NS	Difference: Shear EW	Difference: Bending NS[a]	Difference: Bending EW[a]	Difference: Torsion
FWS	19.70	9	10	4.6	5.1	4	7	0.7	5.0	5.2	5	5	4.5	8%	3%	13%	-26%	522%
			9			14	19				16	17				14%	-11%	
	17.25	8	9	11.1	12.1	22	27	2.2	12.1	12.9	26	26	13.6	9%	7%	17%	-1%	523%
			8			39	47				45	48				15%	2%	
	15.53	7	8	15.5	16.5	45	57	3.6	16.8	17.9	54	57	22.3	9%	9%	20%	1%	522%
			7			71	84				80	84				13%	0%	
	13.81	6	7	19.3	20.1	76	92	4.9	20.9	22.3	89	95	30.1	8%	11%	17%	3%	519%
			6			107	124				121	125				12%	0%	
	12.10	5	6	22.8	23.8	111	128	5.8	23.7	25.3	126	133	35.4	4%	6%	14%	3%	515%
			5			134	153				152	157				13%	3%	
	11.00	4	5	24.6	25.3	136	157	6.4	25.7	27.3	155	160	39.0	4%	8%	14%	2%	512%
			4			163	184				184	190				12%	3%	
	9.90	3	4	26.1	26.6	166	187	6.9	27.3	29.1	187	193	41.9	5%	9%	13%	3%	508%
			3			194	216				216	225				11%	4%	
	8.81	2	3	43.3	45.5	197	221	7.5	42.9	44.5	221	229	45.1	-1%	-2%	12%	4%	502%
			2			279	295				306	320				10%	9%	
FWS	6.73	1	2	45.3	48.0	281	299	8.1	44.3	46.1	310	324	47.7	-2%	-4%	10%	8%	487%
	4.65		8002			366	375				401	419				9%	12%	
FPE	8.25	402	405	8.1	7.4	2	10	15.1	4.9	8.1	2	8	9.6	-39%	10%	7%	-20%	-36%
	4.65	401	404			28	27				18	31				-35%	14%	

Note: Shaded values are exceedances of site-specific loads with respect to standard design.

a. NS and EW represent moments for bending in NS and EW direction, respectively.

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Table 3A.18.1.3-202 **Comparison of Site-Specific and Standard Design Maximum Accelerations for FWSC**

			Standard Design			Site-Specific			Difference		
Elev. (m)	**Node No.**	**Location**	**NS (g)**	**EW (g)**	**Vert. (g)**	**NS (g)**	**EW (g)**	**Vert. (g)**	**NS**	**EW**	**Vert.**
19.70	10	FWS	2.16	2.40	1.69	2.31	2.45	1.43	7%	2%	-15%
17.25	9	FWS	1.99	2.09	1.64	2.12	2.27	1.43	7%	9%	-13%
15.53	8	FWS	1.80	1.81	1.58	1.91	2.04	1.40	6%	13%	-11%
13.81	7	FWS	1.60	1.63	1.58	1.68	1.78	1.35	5%	9%	-15%
12.10	6	FWS	1.43	1.59	1.43	1.44	1.50	1.27	1%	-5%	-11%
11.00	5	FWS	1.33	1.52	1.23	1.28	1.32	1.21	-4%	-13%	-1%
9.90	4	FWS	1.24	1.44	1.13	1.12	1.18	1.15	-9%	-18%	2%
8.81	3	FWS	1.15	1.37	1.05	1.00	1.12	1.07	-13%	-18%	2%
6.73	2	FWS	0.77	0.88	1.00	0.76	0.86	0.92	-1%	-3%	-9%
4.65	8002	Basemat Top	0.71	0.77	0.78	0.71	0.74	0.95	0%	-4%	22%
2.15	8001	Basemat Bottom	0.70	0.76	0.78	0.76	0.77	1.00	7%	2%	27%
8.25	405	FPE	1.72	1.60	1.12	1.03	1.70	0.78	-40%	7%	-30%
6.45	402	FPE	1.19	1.19	1.09	0.83	1.17	0.72	-30%	-2%	-34%

Shaded values are exceedances of site-specific loads with respect to standard design.

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Table 3A.18.1.3-203 **Comparison of Site-Specific and Standard Design Maximum Accelerations of FWS Water Response SDOF Oscillators**

SDOF Oscillator				Acceleration (g)		
Elev. (m)	**Node No.**	**Description**	**Direction**	**Standard Design**	**Site-Specific**	**Difference**
12.10	60	FWS Water Sloshing Mode	NS (X)	0.30	0.10	-66%
			EW (Y)	0.40	0.09	-78%
8.81	30	FWS Water Impulsive Mode	NS (X)	1.10	1.00	-9%
			EW (Y)	1.40	1.12	-20%

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Table 3A.18.1.3-204 **Comparison of Site-Specific and Standard Design Maximum Out-of-Plane Loads on FWS and FPE Roofs**

Slab		Equivalent Average Acceleration (g)		
Elev. (m)	**Location**	**Standard Design**	**Site-Specific**	**Difference**
19.70	FWS Roof	1.74	2.30	32%
8.25	FPE Roof	-	1.10	Addition Load due to Concrete Cracking

Note: The shading shows exceedances of standard design loads.

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Table 3A.18.1.3-205 **Comparison of Site-Specific and Standard Design Maximum Lateral Loads on FWSC Shear Keys**

Load Direction	Load Magnitude (MN) Standard Design	Load Magnitude (MN) Site-Specific	Difference
NS	58	82	41%
EW	58	71	23%

Note: The shading shows exceedances of standard design loads.

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Figure 3A.18.1.3-201 **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on FWS Structure**

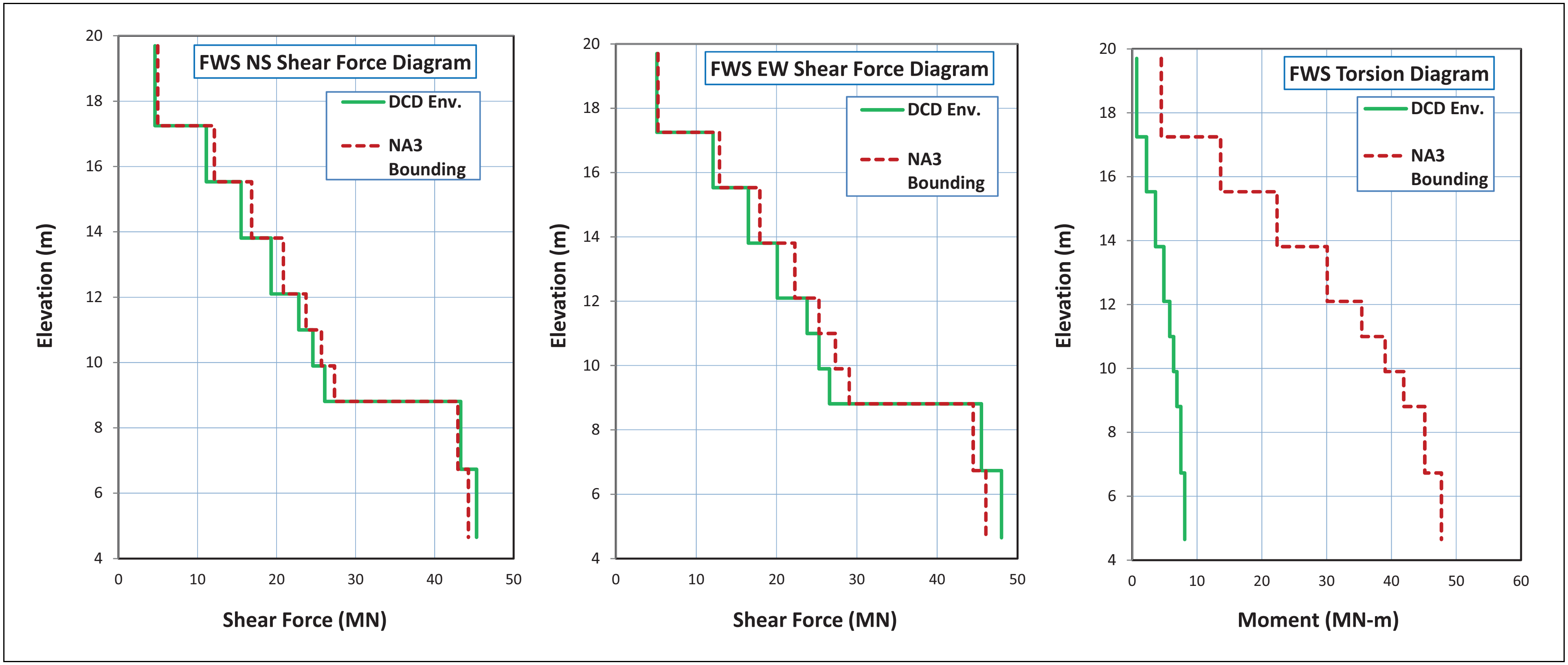


Figure 3A.18.1.3-202 **Comparison of Site-Specific and Standard Design Horizontal Seismic Load Demands on FPE Structure**

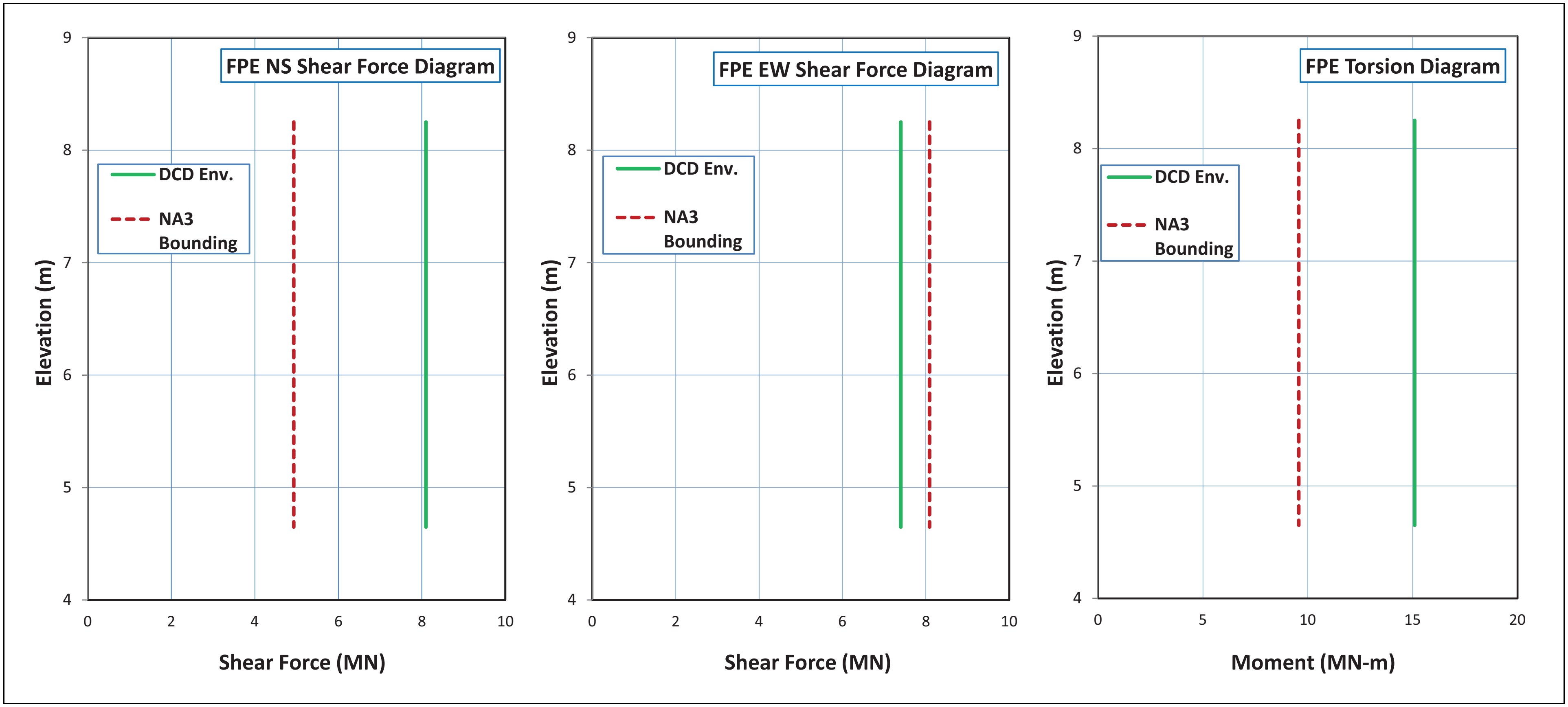


Figure 3A.18.1.3-203 **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on FWS Structure**

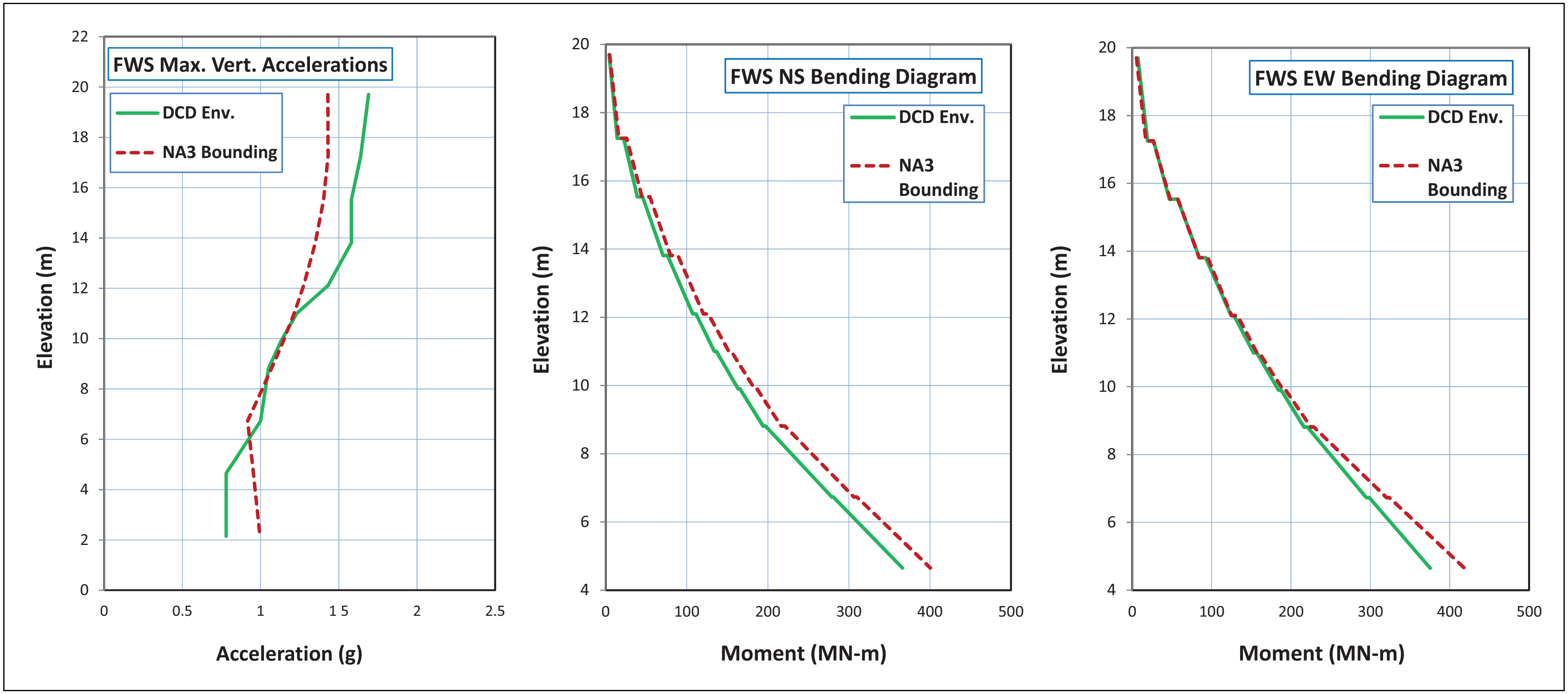
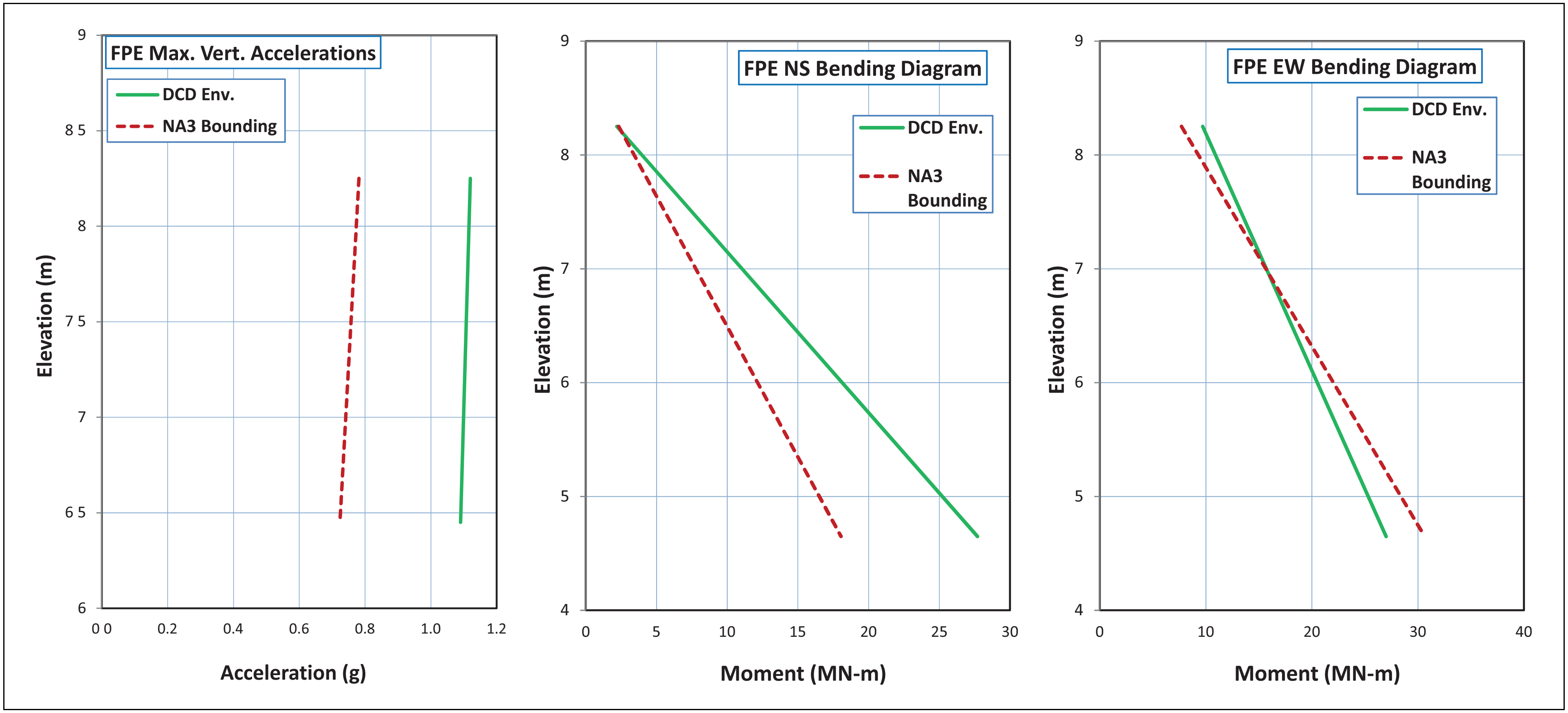


Figure 3A.18.1.3-204 **Comparison of Site-Specific and Standard Design Vertical Seismic Load Demands on FPE Structure**



3A.18.2 Site-Specific Design In-Structure Response Spectra

The RB/FB, CB, and FWSC, site-specific ISRS are developed based on the envelope of the results from the design basis analyses of models with UB stiffness properties and OBE damping. These site-specific ISRS at 5 percent damping are peak broadened by ±15 percent and valley-filled and then compared with the corresponding 5 percent damped ARS results of sensitivity analyses to determine possible exceedances that can affect the design and qualification of equipment and components located within these structures. Criteria are established to determine significant exceedances, which require enhancement of the site-specific design ISRS. Sections 3A.17.9 and 3A.17.14.5 describe the criteria for exceedances due to concrete cracking effects and soil separation, respectively. Exceedances due to concrete cracking effects and soil separation are considered significant for the purposes of site-specific design and qualification of equipment if any of the sensitivity analysis cases yields 5 percent damped ARS exceed the site-specific design ISRS by more than 10 percent for any frequency less than or equal to 50 Hz. Section 3A.17.11 describes the criteria for exceedances due to SSSI effects. Exceedances due to SSSI effects are considered significant for the purposes of site-specific design and qualification of equipment if any of the sensitivity analysis cases yields 5 percent damped ARS exceed the site-specific design ISRS for any frequency less than or equal to 50 Hz.

This section presents the site-specific design ISRS for critical damping ratios 2, 3, 4, 5, 7, 10, and 20 percent representing the horizontal and vertical responses of the RB/FB, CB, and FWSC at key floor locations. Before these ISRS are peak broadened by ±15 percent and valley-filled, these ISRS are enhanced as described below to bound all significant effects of structural stiffness variations, SSSI, and soil separation.

The RB/FB ISRS are based on the envelope of ISRS results from the site-specific SSI analyses of RB/FB model with UB stiffness properties and OBE damping (analysis Cases 1 through 6 in Table 3A.15-201).These ISRS are enhanced to bound all significant exceedances (>10 percent) due to structural stiffness variation effects. The horizontal and vertical ISRS are enhanced by enveloping the results from the design basis analysis Cases 1 through 6 and sensitivity analysis Cases S1 through S12 in Table 3A.15-201. These bounding ISRS are then peak broadened by ±15 percent and valley-filled.

Table 3A.18.2-201 provides a summary of the RB/FB site-specific design ISRS for the responses at key floor locations that are enhanced to bound significant exceedances due to concrete cracking. A “Yes” in the Enhanced column of the table indicates that the ISRS had a significant exceedance due to concrete cracking and are enhanced as described above.

The vertical ISRS used for the site-specific design and qualification of equipment and components supported by flexible slabs are developed as follows:

1. The ISRS for out-of-plane slab response obtained as the envelope of results from the design basis analysis Cases 1 through 6 in Table 3A.15-201 are grouped and enveloped based on the SDOF oscillator slab region grouping.

2. The ±15 percent broadened and valley-filled ISRS developed in Step 1 are compared to the envelope of the ISRS representing the out-of-plane responses of the slab under fully cracked conditions, which are obtained from the results of sensitivity analysis Cases S1 through S12 in Table 3A.15-201.

3. If the comparisons in Step 2 show that the cracked slab ISRS exceed the design ISRS at frequencies up to 50 Hz by more than 10 percent, the design ISRS are adjusted by enveloping the results from the design basis analysis Cases 1 through 6 and sensitivity analysis Cases S1 through S12 in Table 3A.15-201.

4. Broaden the peaks of the amplified ARS obtained in Step 3 by ±15 percent and then fill the valleys to obtain the enhanced design ISRS that bounds the effects of structural stiffness variations.

The CB ISRS are based on the envelope of ISRS results from the site-specific SSI analyses of the CB model with upper bound stiffness properties and OBE damping (analysis Cases 1 through 6 in Table 3A.15-202).To address significant exceedances (>10 percent) due to concrete cracking effects, the horizontal and vertical ISRS for CB floor responses are enhanced by enveloping the results from the design basis analysis Cases 1 through 6 and S1 through S6 in Table 3A.15-202. These bounding ISRS are then peak broadened by ±15 percent and valley-filled. The vertical ISRS used for site-specific design and

qualification of equipment and components supported by CB flexible slabs are developed as follows:

1. The ISRS for out-of-plane slab response obtained as the envelope of results from the design basis analysis Cases 1 through 6 in Table 3A.15-202 are grouped and enveloped based on the SDOF oscillator slab region grouping.

2. The ±15 percent broadened ISRS developed in Step 1 are compared to the envelope of the ISRS representing the out-of-plane responses of the slab under fully cracked conditions, which are obtained from the results of sensitivity analysis Cases S1 through S6 in Table 3A.15-202.

3. If comparisons in Step 2 above show that the cracked slab ISRS exceed the design ISRS at frequencies up to 50 Hz by more than 10 percent, the design ISRS for each required damping value is enhanced by enveloping the results obtained from the set of twelve SSI analyses (Cases 1 through 6 and S1 through S6 in Table 3A.15-202) for the ARS of SDOF oscillators representing the out-of-plane response of the particular slab under uncracked and cracked conditions. The enveloped ARS is then broadened by ±15 percent and the valleys are filled.

After being enhanced to bound effects of concrete cracking, the CB ISRS are further enhanced to bound exceedances due to SSSI effects of the RB/FB and FWSC on the CB seismic response as follows:

1. For those SSSI analysis cases (Cases CR1, CR2, and CR3 in Table 3A.15-204 and Cases CF1 and CF2 in Table 3A.15-205) that produce 5 percent damped ARS results that exceed the corresponding broadened ISRS for frequencies up to 50 Hz, calculate the ratios between the unbroadened ARS results obtained from the SSSI analysis of the CB-RB/FB and the CB-FWSC combined models over the unbroadened ARS results from the SSI analysis of the CB stand-alone model for the corresponding subgrade profile.

2. Develop SSSI amplification factors $SSSI_{amp} \geq 1.0$ for all frequencies up to 100 Hz using the ARS ratio results calculated in Step 1 to capture the SSSI effects from the CB-FWSC and CB-RB/FB SSSI analyses.

3. Apply the SSSI amplification factors ($SSSI_{amp}$) calculated in Step 2 to the unbroadened enveloping ARS results from the analyses of CB stand-alone models enhanced to bound effects of concrete cracking.

4. Broaden the peaks of the amplified ARS obtained in Step 3 by ±15 percent and then fill the valleys to obtain the enhanced design ISRS that bounds the effects of both concrete cracking and SSSI on the CB response.

The calculations in Steps 1 through 4 above are performed for each ISRS damping ratio required.

Table 3A.18.2-202 provides a summary of the site-specific design ISRS representing responses at CB key floor locations that are enhanced to bound significant exceedances due to concrete cracking and SSSI effects. A "Yes" in the table indicates that the ISRS had a significant exceedance due to the respective sensitivity analysis shown in the table and is enhanced as described above.

The site-specific design ISRS for the FWSC are based on the envelope of results from:

- Site-specific SSI analyses of the FWSC stand-alone model with full (uncracked concrete) stiffness properties and OBE damping (analysis Cases 1 through 6 in Table 3A.15-203)
- Site-specific SSSI analyses of the FWSC-CB combined model with full stiffness properties and OBE damping (analysis Cases FC1 through FC6 in Table 3A.15-206)

For significant exceedances (>10 percent) up to 50 Hz due to soil separation, the FWSC site-specific enveloping ISRS are enhanced to bound effects of separation between the concrete fill and surrounding soil by enveloping the ARS results from the SSI and SSSI sensitivity analyses of models representing separated soil conditions (analysis Cases SF1 through SF3 in Table 3A.15-203 and Cases SF4 through SF6 in Table 3A.15-206) with the results of the SSI and SSSI design basis analyses of the models representing fully bonded conditions (analysis Cases 1 through 6 in Table 3A.15-203 and analysis Cases FC1 through

FC6 in Table 3A.15-206). The enveloped ARS is then peak broadened by ±15 percent and the valleys are filled.

If any of the SSI sensitivity analyses of the FWSC model with reduced stiffness (Cases S1 through S6 in Table 3A.15-203) yields a 5 percent damped ARS that exceeds the corresponding broadened ISRS obtained as the envelope of results from the design basis SSI analysis Cases 1 through 6 in Table 3A.15-203 by more than 10 percent for any frequency less than or equal to 50 Hz, that ISRS is enhanced to bound the effects of concrete cracking for the purposes of design and qualification of equipment and components.

To combine the effects of concrete cracking, separation between concrete fill and surrounding soil, and the SSSI effects of the CB on the FWSC response, the ISRS is enhanced as follows for each required damping ratio:

1. Develop an uncracked SSI ARS as the envelope of the results from the design basis SSI analyses of the FWSC UC_{OBE} stand-alone model with full stiffness and OBE damping representing fully bonded conditions at concrete fill-to-soil interfaces (analysis Cases 1 through 6 in Table 3A.15-203).

2. Develop an uncracked response ARS as the envelope of the results from:
   - Design basis SSI analyses of the FWSC UC_{OBE} stand-alone model (Step 1).
   - Design basis SSSI analyses of the FWSC-CB UC_{OBE} combined model representing fully bonded conditions at concrete fill-to-soil interfaces (analysis Cases FC1 through FC6 in Table 3A.15-206).
   - SSI sensitivity analyses of the FWSC SUC_{SSE} stand-alone model representing maximum separation between concrete fill and surrounding soil (analysis Cases SF1 through SF3 in Table 3A.15-203).
   - SSSI sensitivity analyses of the FWSC-CB SUC_{SSE} combined model representing maximum separation between concrete fill and surrounding soil (analysis Cases SF4 through SF6 in Table 3A.15-206).

3. Develop a cracked SSI ARS as the envelope of the results from the SSI analyses of the FWSC model with reduced stiffness and SSE damping (analysis Cases S1 through S6 in Table 3A.15-203).

4. Determine the concrete cracking amplification factors $CR_{amp} \geq 1.0$ for frequencies up to 100 Hz based on the ratio of the unbroadened cracked SSI ARS from Step 3 over the unbroadened SSI ARS from the design basis SSI analyses developed in Step 1.

5. Apply the concrete cracking amplification factor determined in Step 4 to the unbroadened ARS developed in Step 2, representing the enveloping response of FWSC structures with full (uncracked concrete) stiffness properties.

6. Broaden the peaks of the amplified ISRS obtained in Step 5 by ±15 percent and then fill the valleys to obtain the site-specific design ISRS that bounds the effects of concrete cracking, soil separation and CB SSSI effects on the FWSC response.

ISRS results for the response of the additional SDOF Oscillator (described in Section 3A.17.14.3) obtained from the SSI analyses of the FWSC model with reduced stiffness and SSE damping (analysis Cases S1 through S6 in Table 3A.15-203) are enveloped and broadened by ±15 percent. This ISRS serves as input for the site-specific design and qualification of equipment or components supported by the FPE roof.

Table 3A.18.2-203 provides a summary of the site-specific design ISRS representing responses at FWSC key locations that are enhanced to bound significant exceedances due to soil separation and concrete cracking effects. A “Yes” in the table indicates that the ISRS had a significant exceedance due to the respective sensitivity analysis shown in the table and is enhanced as described above.

For key locations in the RB/FB, CB, and FWSC, Figures 3A.18.2-201a through 3A.18.2-203l present the site-specific design ISRS in NS(x), EW(y), and vertical (z) directions.

NAPS DEP 3.7-1

Table 3A.18.2-201 RB/FB ISRS Exceedance Checks for Structural Stiffness Variation Effects

Location	Elevation	Direction	Enhanced
RB/FB Refueling Floor	34 m	X	Yes
		Y	Yes
		Z	No
RCCV Top Slab	27 m	X	Yes
		Y	Yes
		Z	No
VW Top Slab	17.5 m	X	Yes
		Y	Yes
		Z	Yes
RSW Top	24.2 m	X	Yes
		Y	Yes
		Z	No
RPV Top	27.6 m	X	Yes
		Y	Yes
		Z	Yes
RB/FB Basemat	-11.5 m	X	No
		Y	Yes
		Z	No

NAPS DEP 3.7-1

Table 3A.18.2-202 **CB ISRS Exceedance Checks**

Location	Elevation	Dir.	Cracking	SSSI				
				CB-FWSC LB Full Column	CB-FWSC UB Full Column	CB-RB/FB LB Partial Column	CB-RB/FB UB Partial Column	CB-RB/FB UB Full Column
CB Roof (Node 6)	13.80 m	X	Yes	No	Yes	No	No	No
		Y	No	No	No	No	No	No
		Z	Yes	No	Yes	No	Yes	No
CB Basemat (Node 2)	-7.40 m	X	No	No	No	No	No	No
		Y	Yes	No	Yes	Yes	Yes	Yes
		Z	No	No	Yes	Yes	Yes	Yes

NAPS DEP 3.7-1

Table 3A.18.2-203 **FWSC ISRS Exceedances Checks**

Location	Elevation	Dir.	Soil Separation	Cracking
FWS Wall Top (Node 9)	17.25 m	X	No	Yes
		Y	Yes	Yes
		Z	Yes	Yes
FWS Basemat (Node 1)	4.65 m	X	Yes	Yes
		Y	Yes	No
		Z	No	No
FPE Top (Node 405)	8.25 m	X	Yes	Yes
		Y	Yes	Yes
		Z	No	Yes
FPE Basemat (Node 404)	4.65 m	X	Yes	No
		Y	Yes	No
		Z	No	No

Figure 3A.18.2-201a **Site-Specific In-Structure Response Spectra - RB/FB Node 109X**

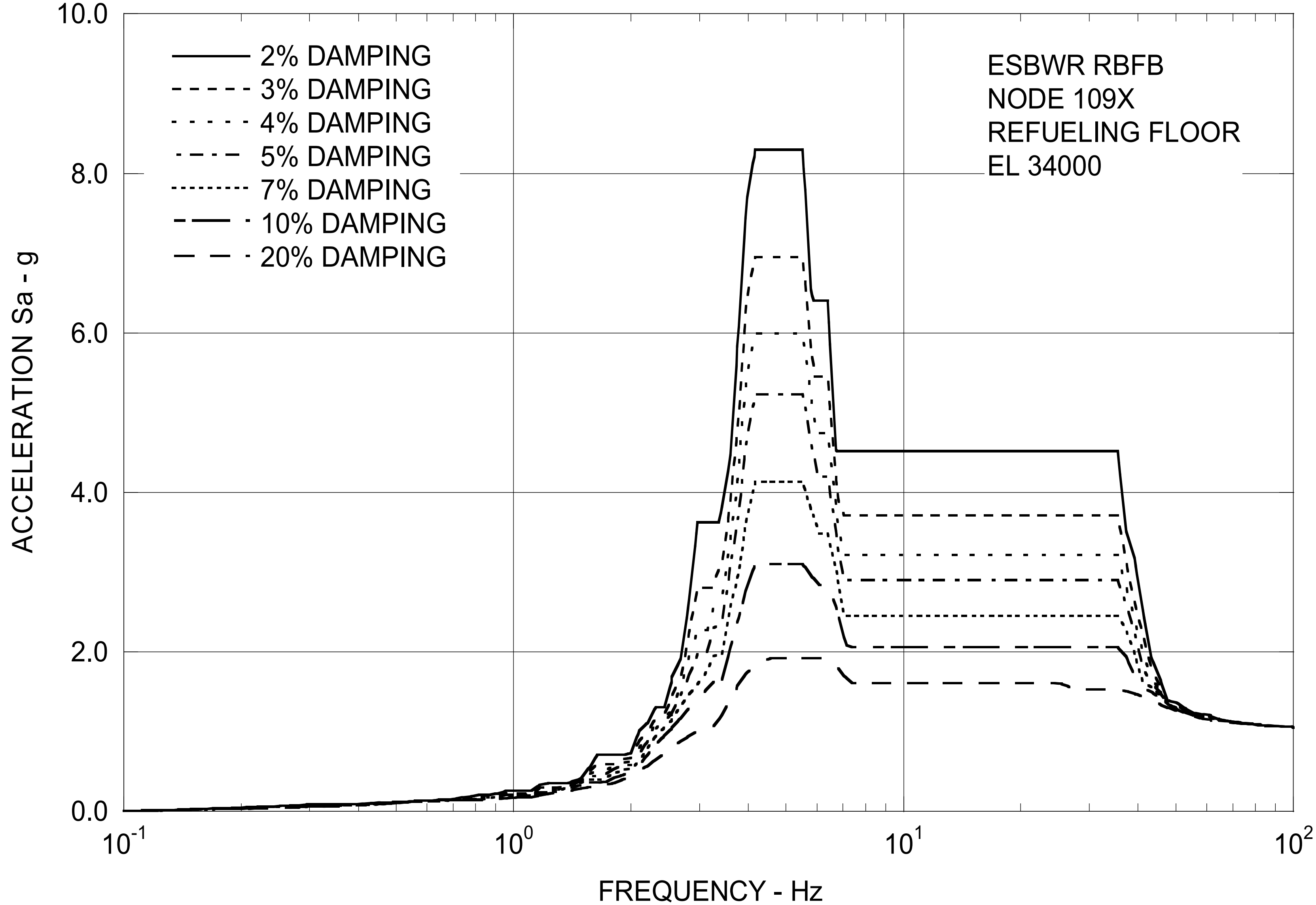


Figure 3A.18.2-201b **Site-Specific In-Structure Response Spectra - RCCV Node 208X**

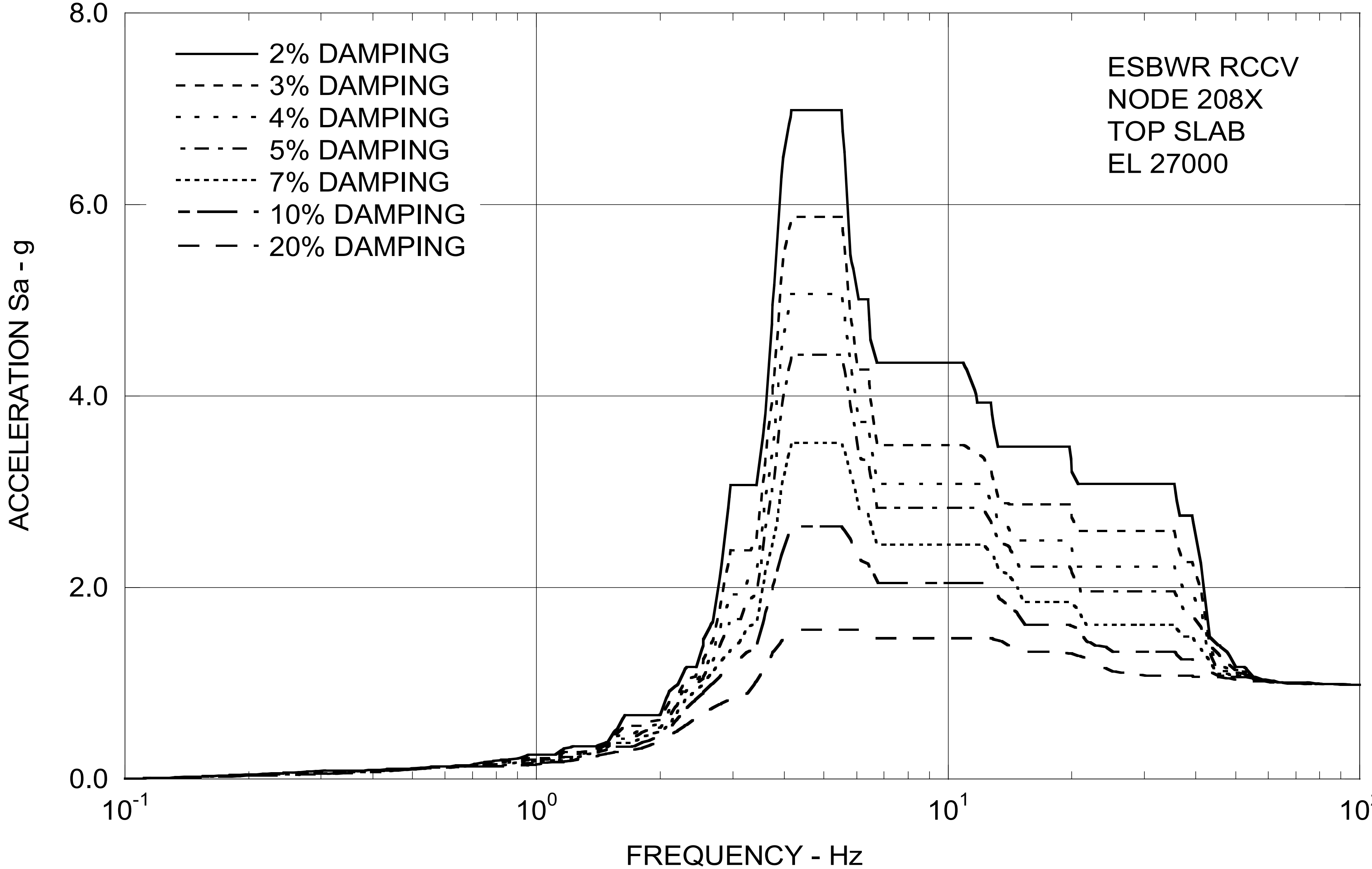


Figure 3A.18.2-201c **Site-Specific In-Structure Response Spectra - Vent Wall Node 701X**

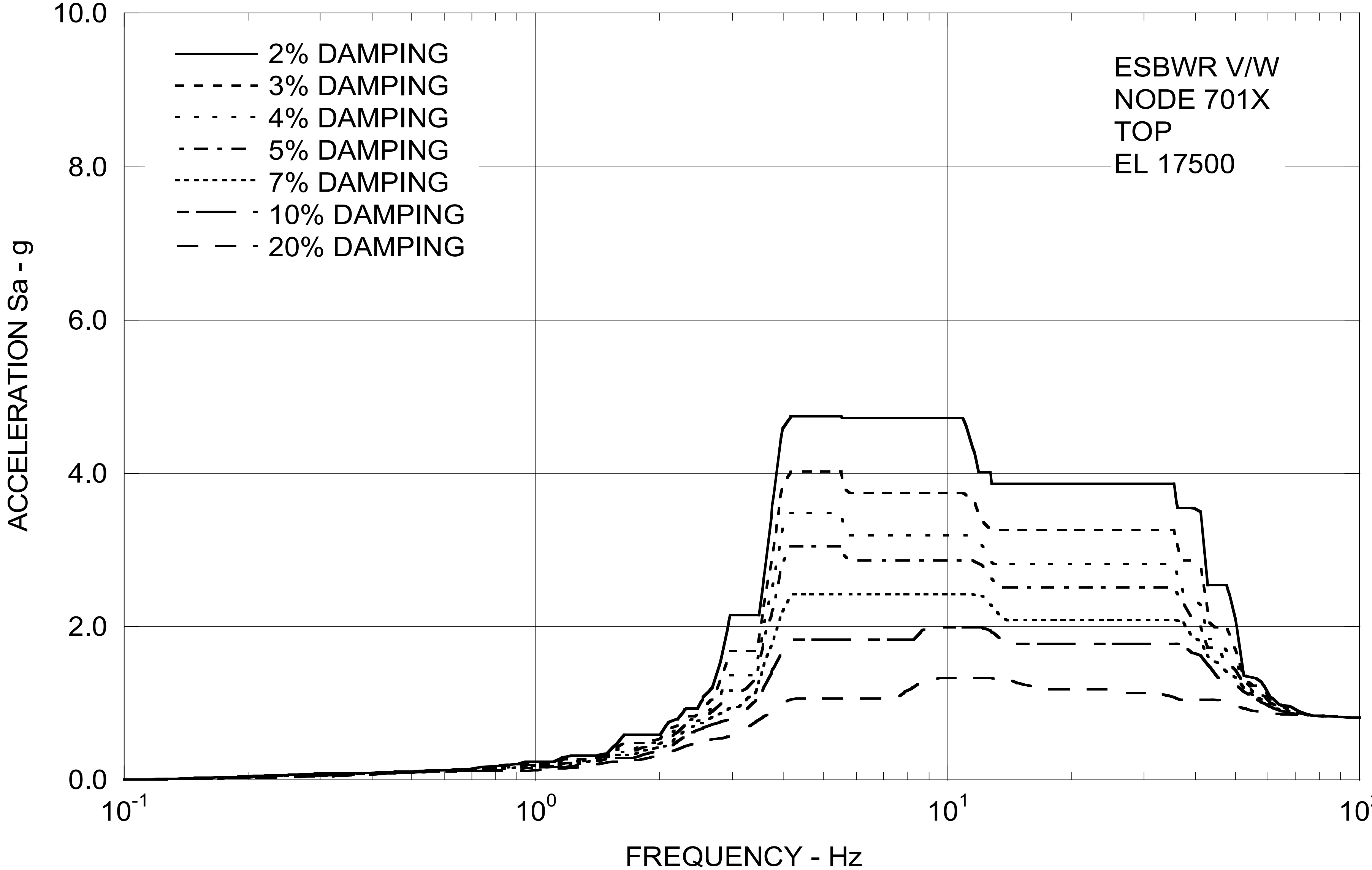


Figure 3A.18.2-201d **Site-Specific In-Structure Response Spectra - RSW Node 707X**

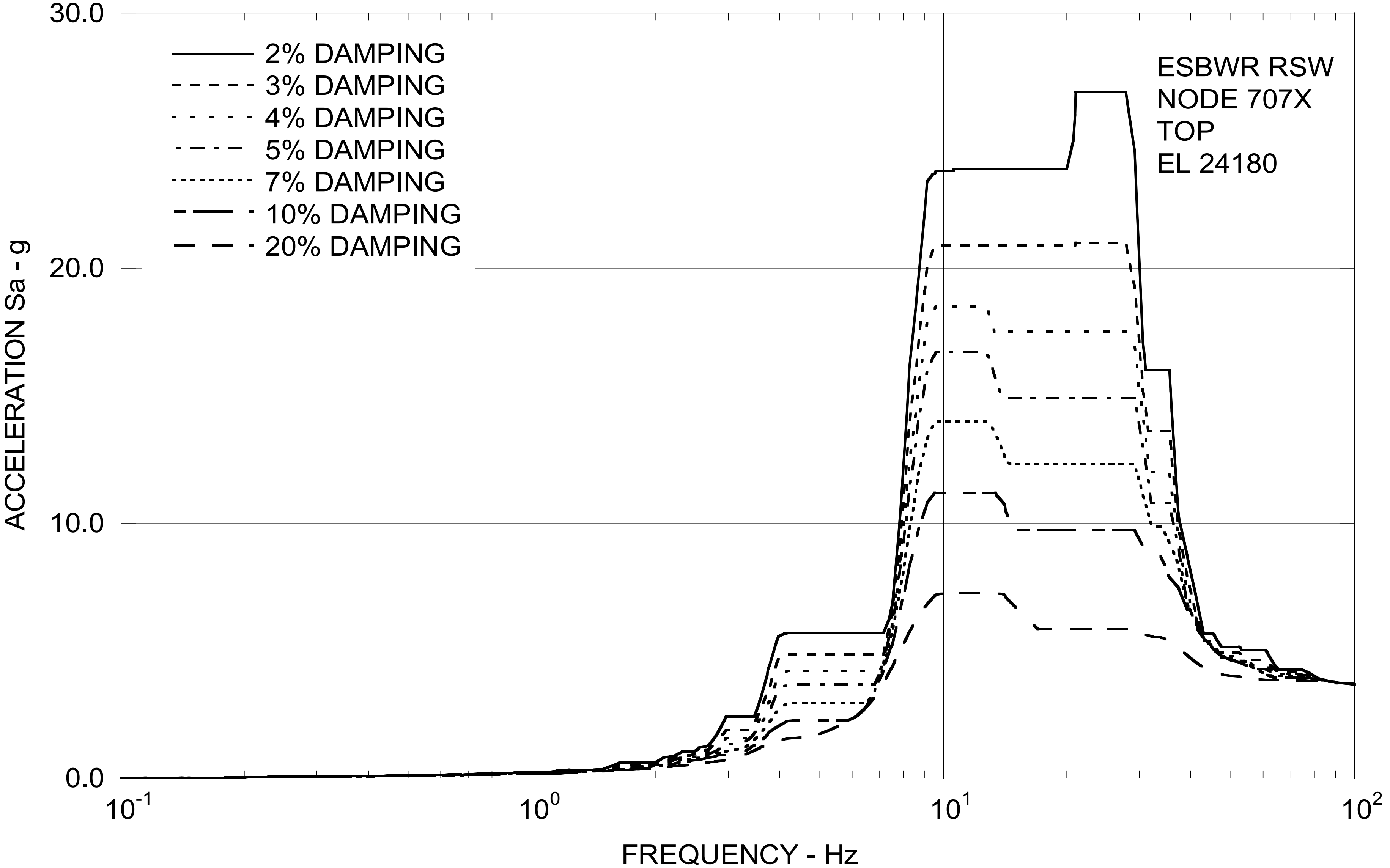


Figure 3A.18.2-201e **Site-Specific In-Structure Response Spectra - RPV Node 801X**

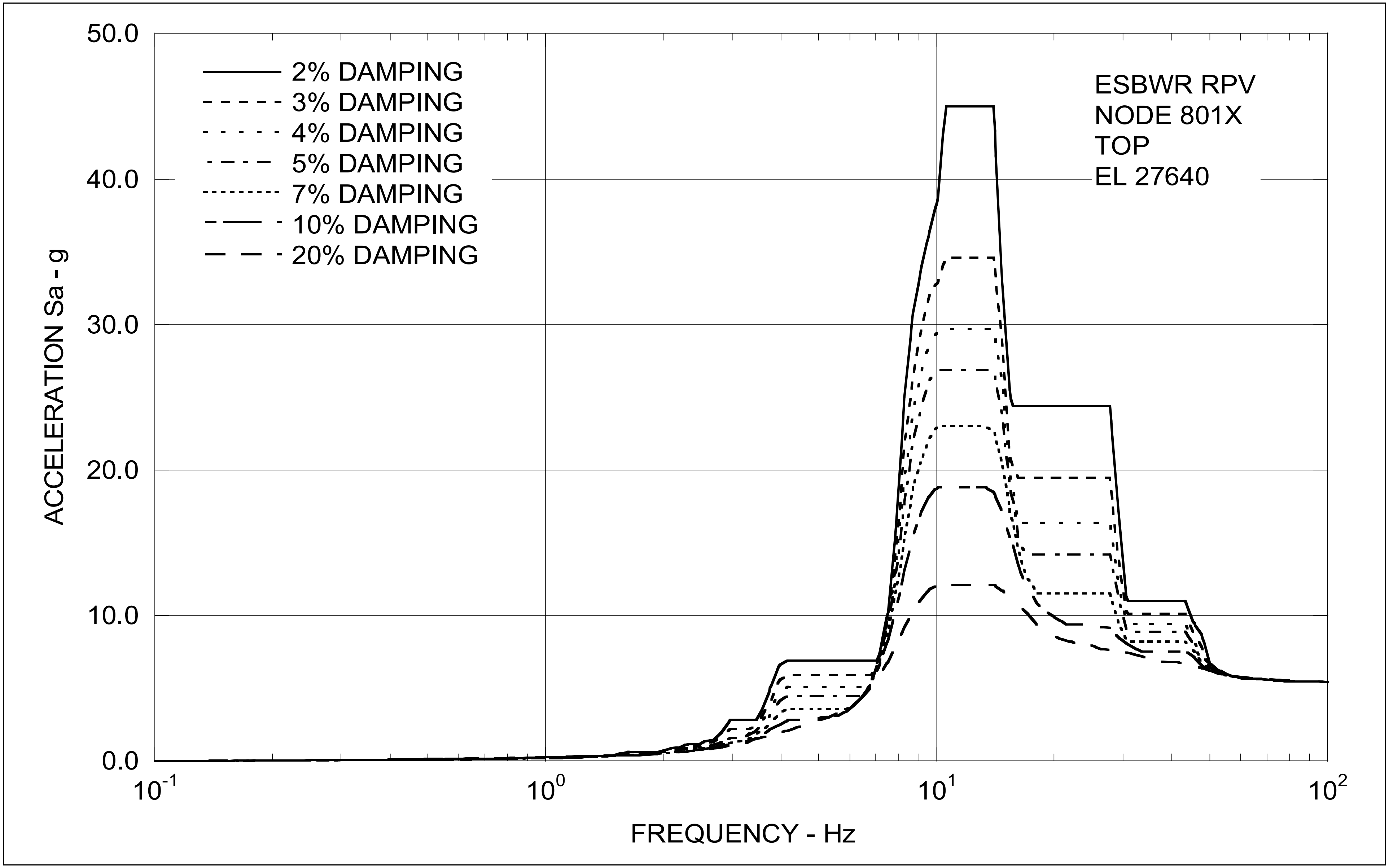


Figure 3A.18.2-201f **Site-Specific In-Structure Response Spectra - RB/FB Node 2X**

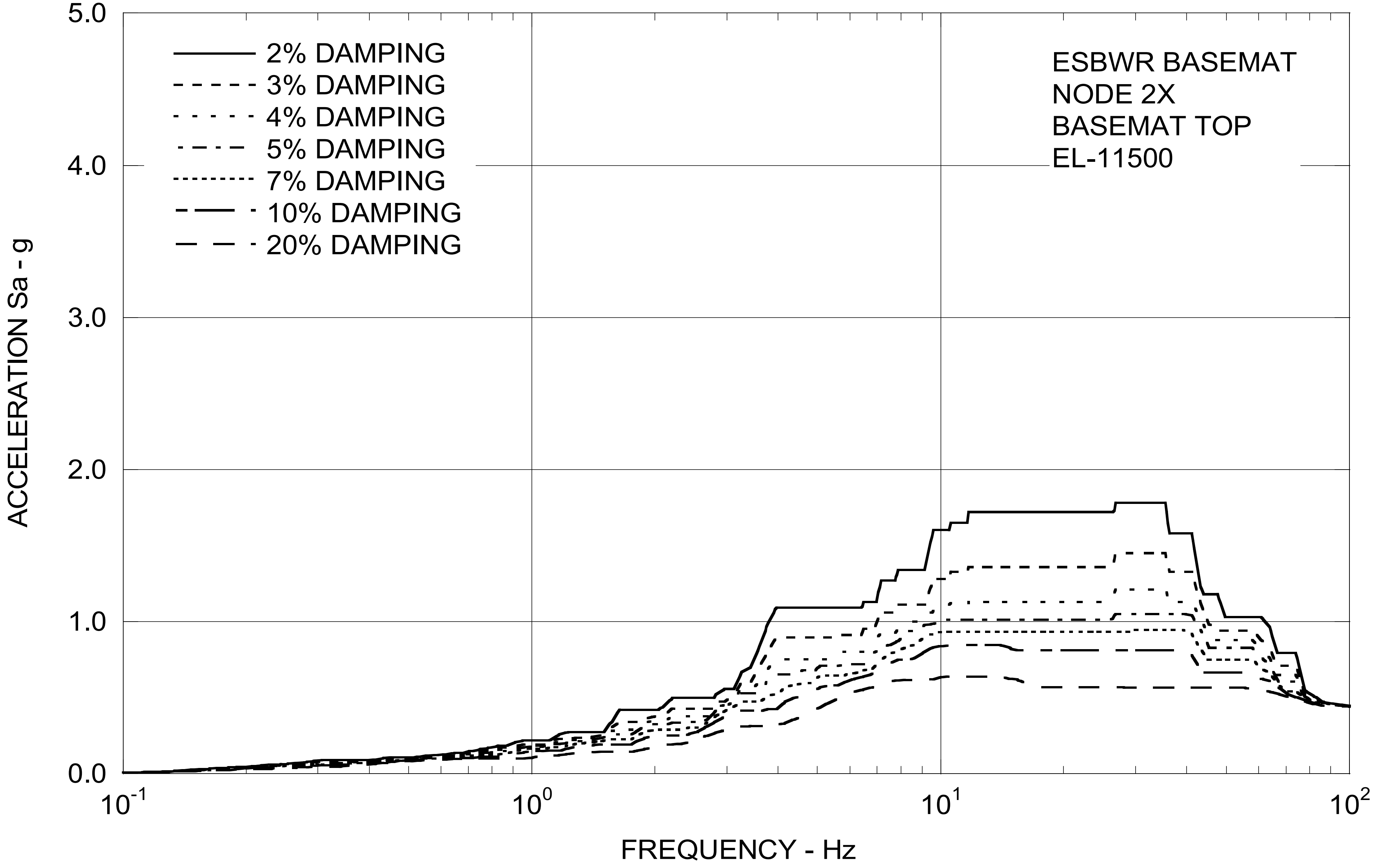


Figure 3A.18.2-201g **Site-Specific In-Structure Response Spectra - CB Node 6 X**

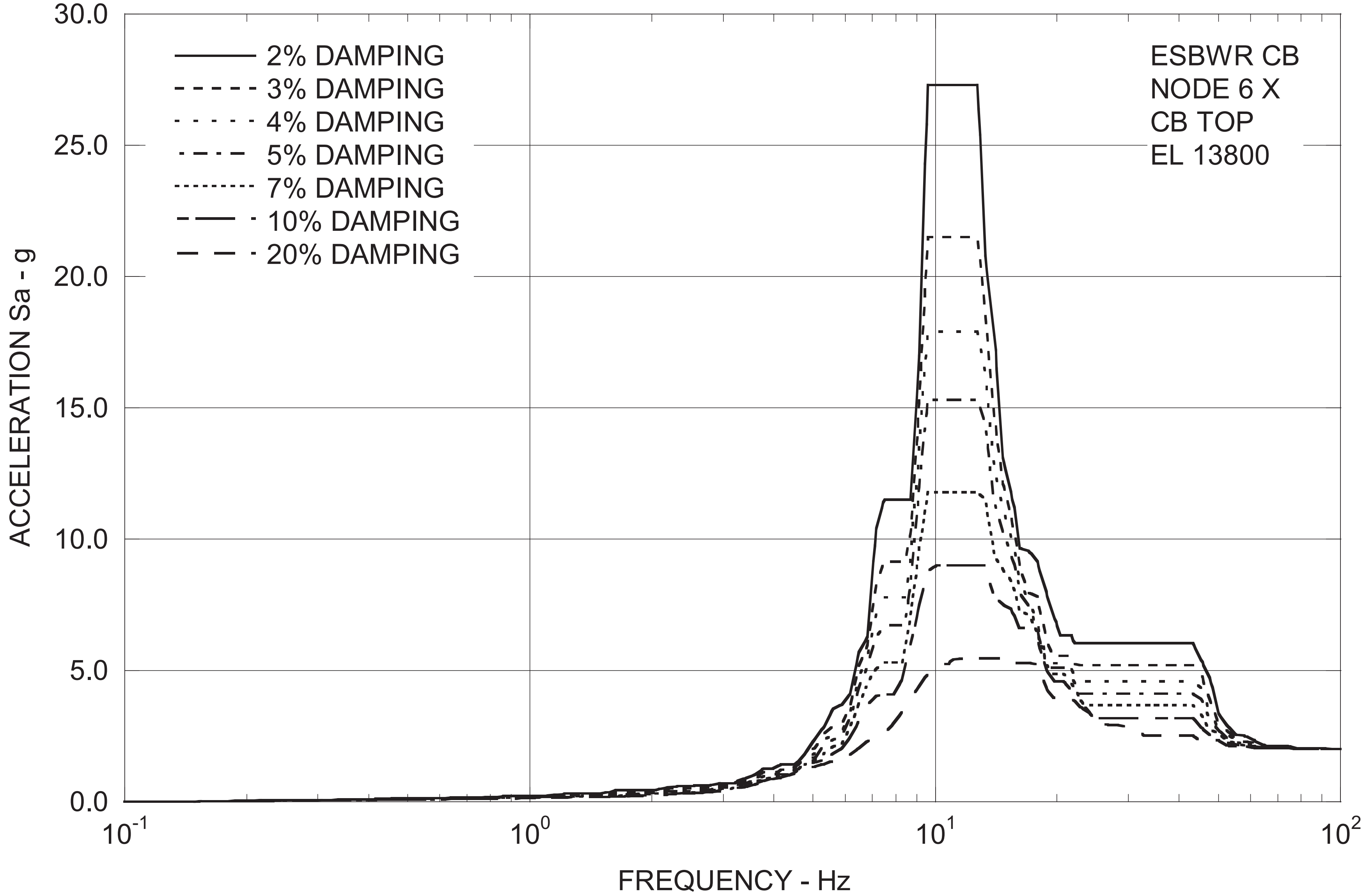


Figure 3A.18.2-201h **Site-Specific In-Structure Response Spectra - CB Node 2 X**

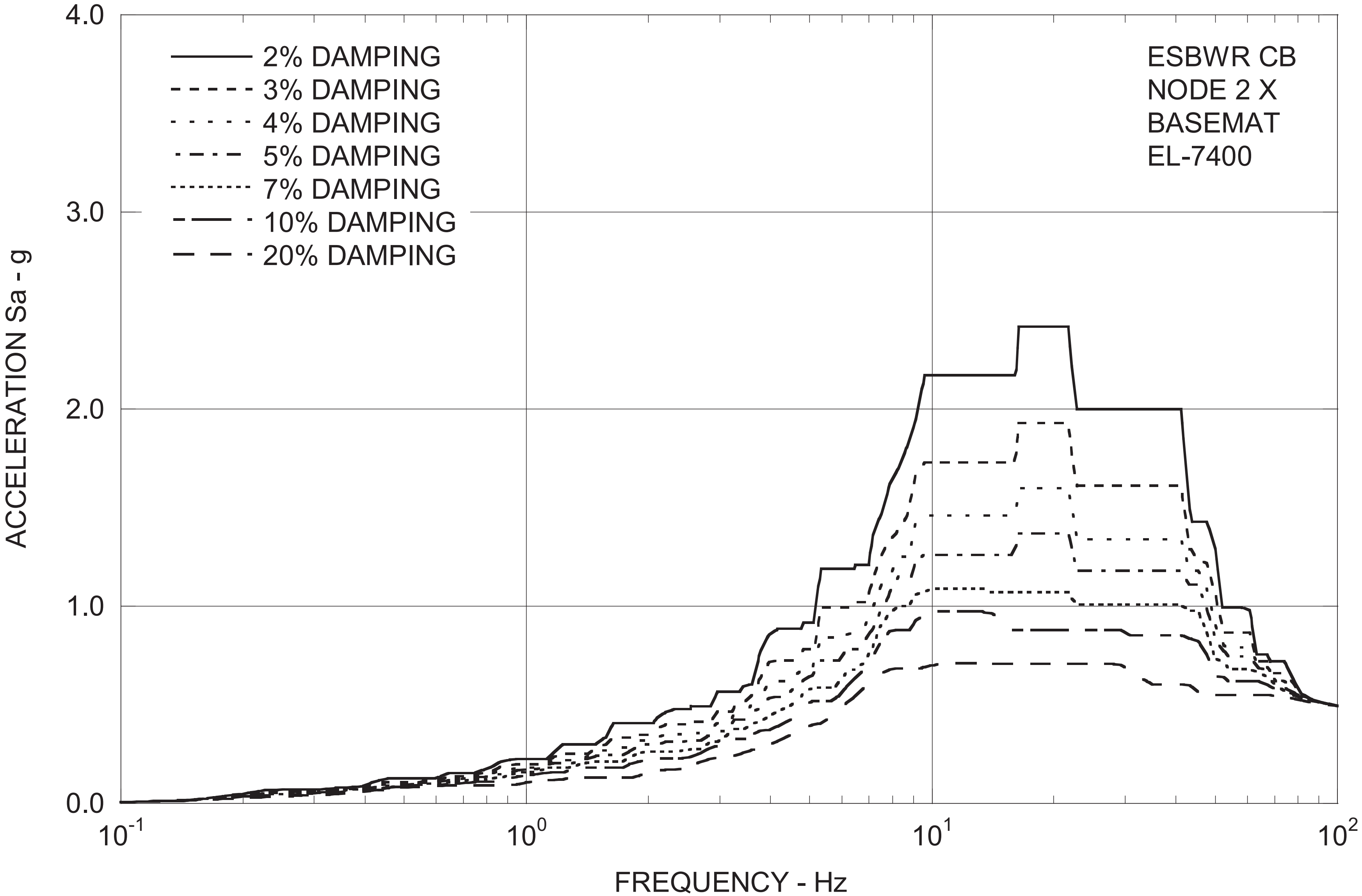


Figure 3A.18.2-201i **Site-Specific In-Structure Response Spectra - FWS Node 9 X**

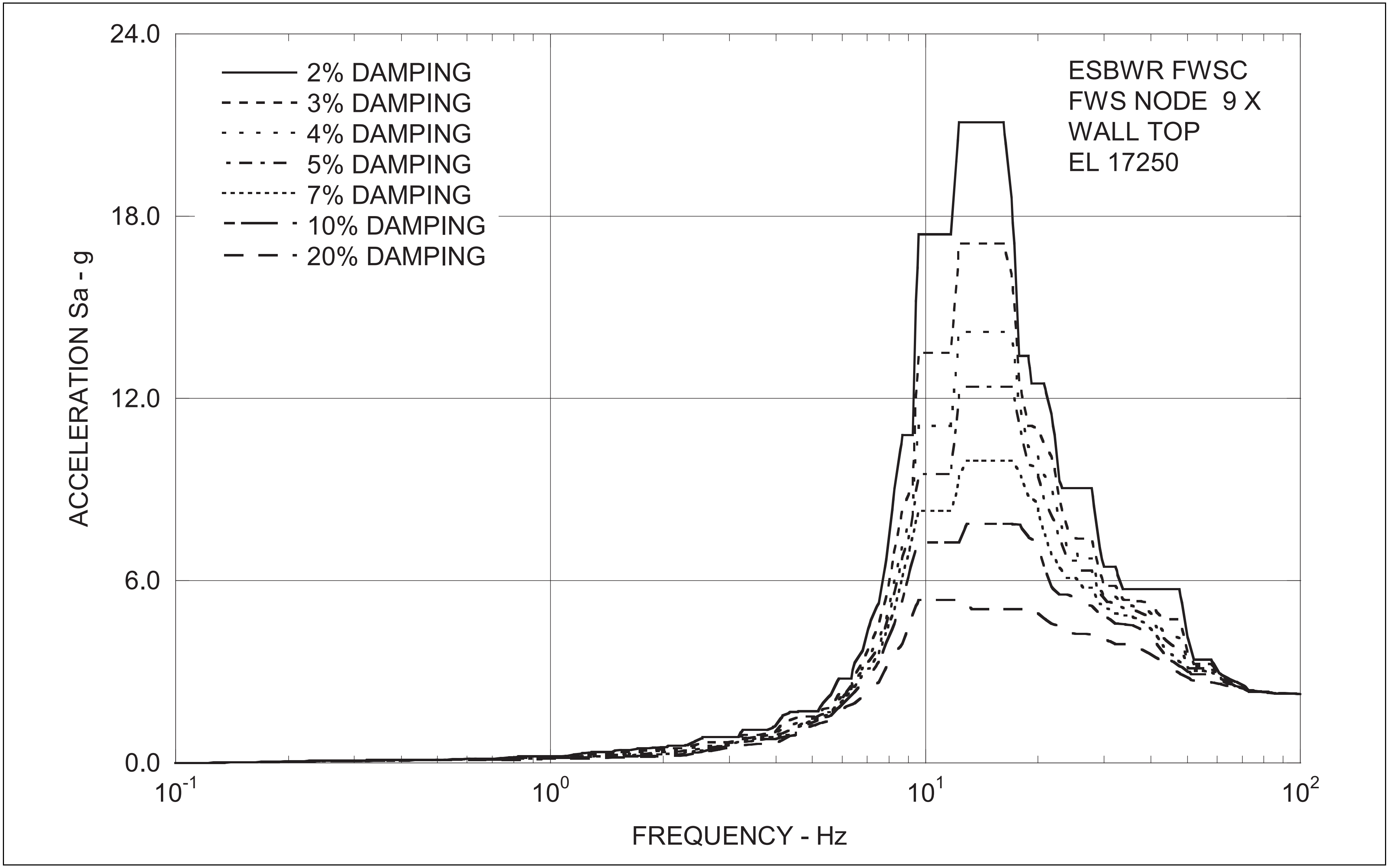


Figure 3A.18.2-201j **Site-Specific In-Structure Response Spectra - FWS Node 1 X**

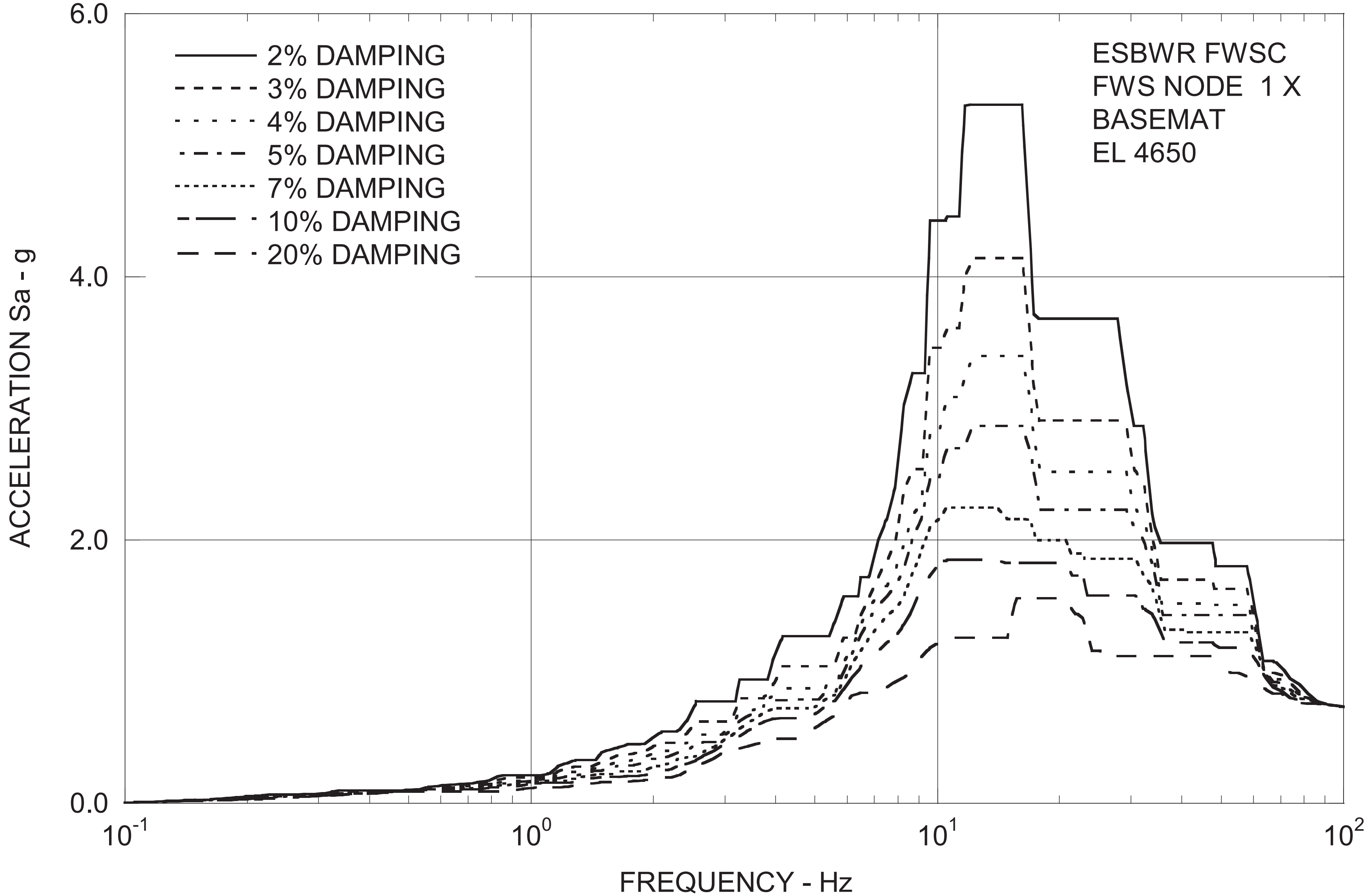


Figure 3A.18.2-201k **Site-Specific In-Structure Response Spectra - FPE Node 405 X**

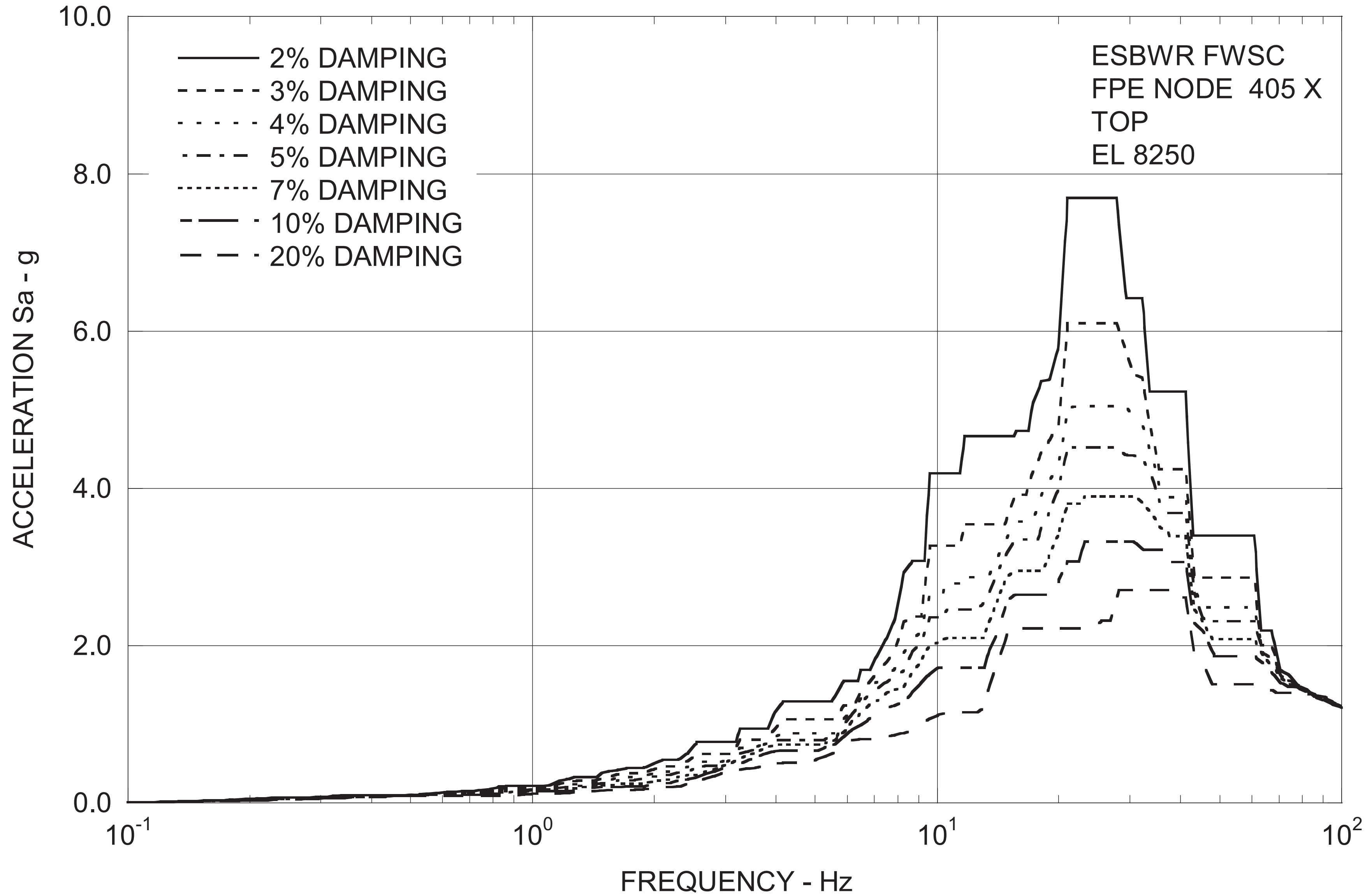


Figure 3A.18.2-201I **Site-Specific In-Structure Response Spectra - FPE Node 404 X**

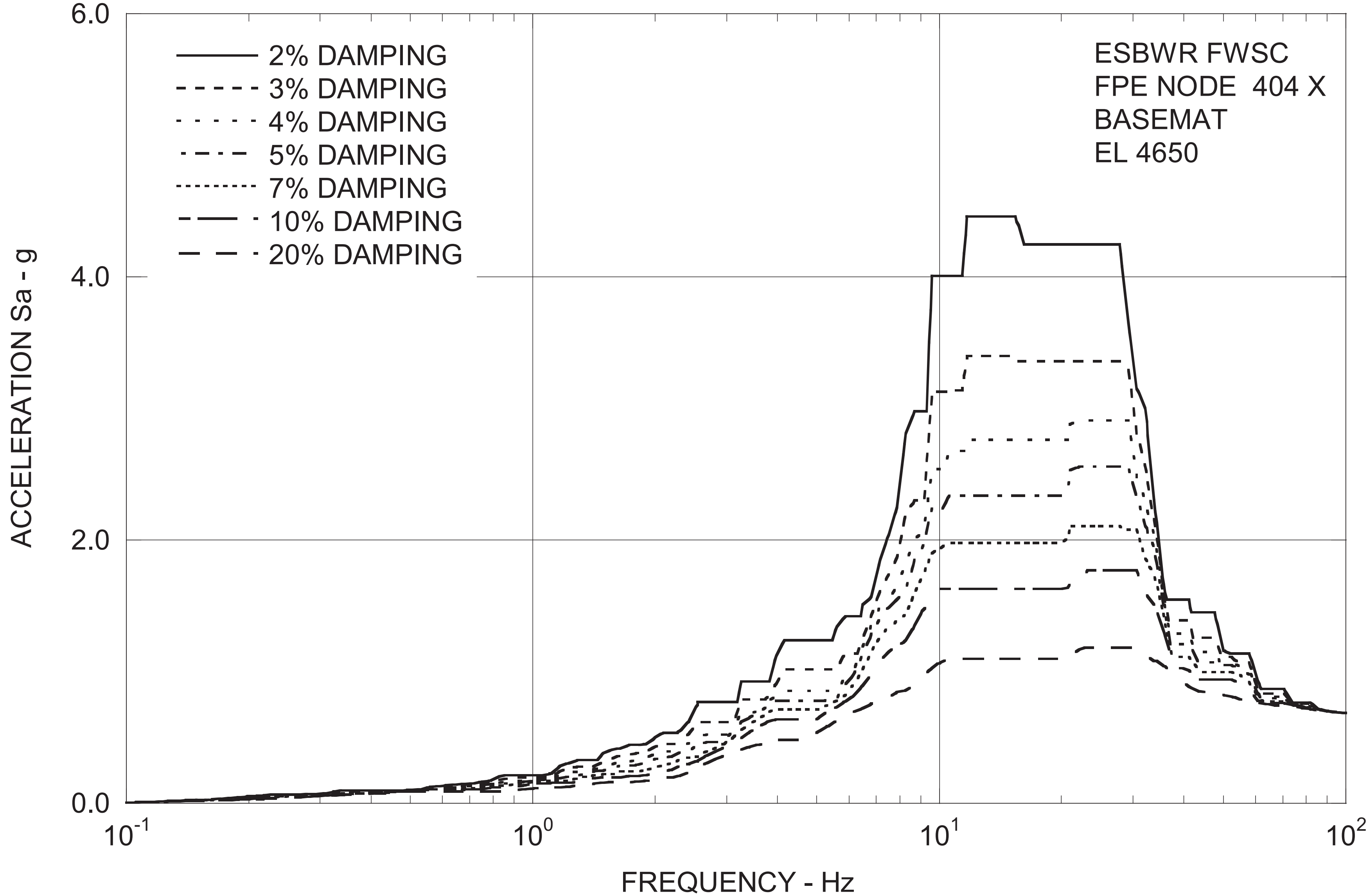


Figure 3A.18.2-202a **Site-Specific In-Structure Response Spectra - RB/FB Node 109Y**

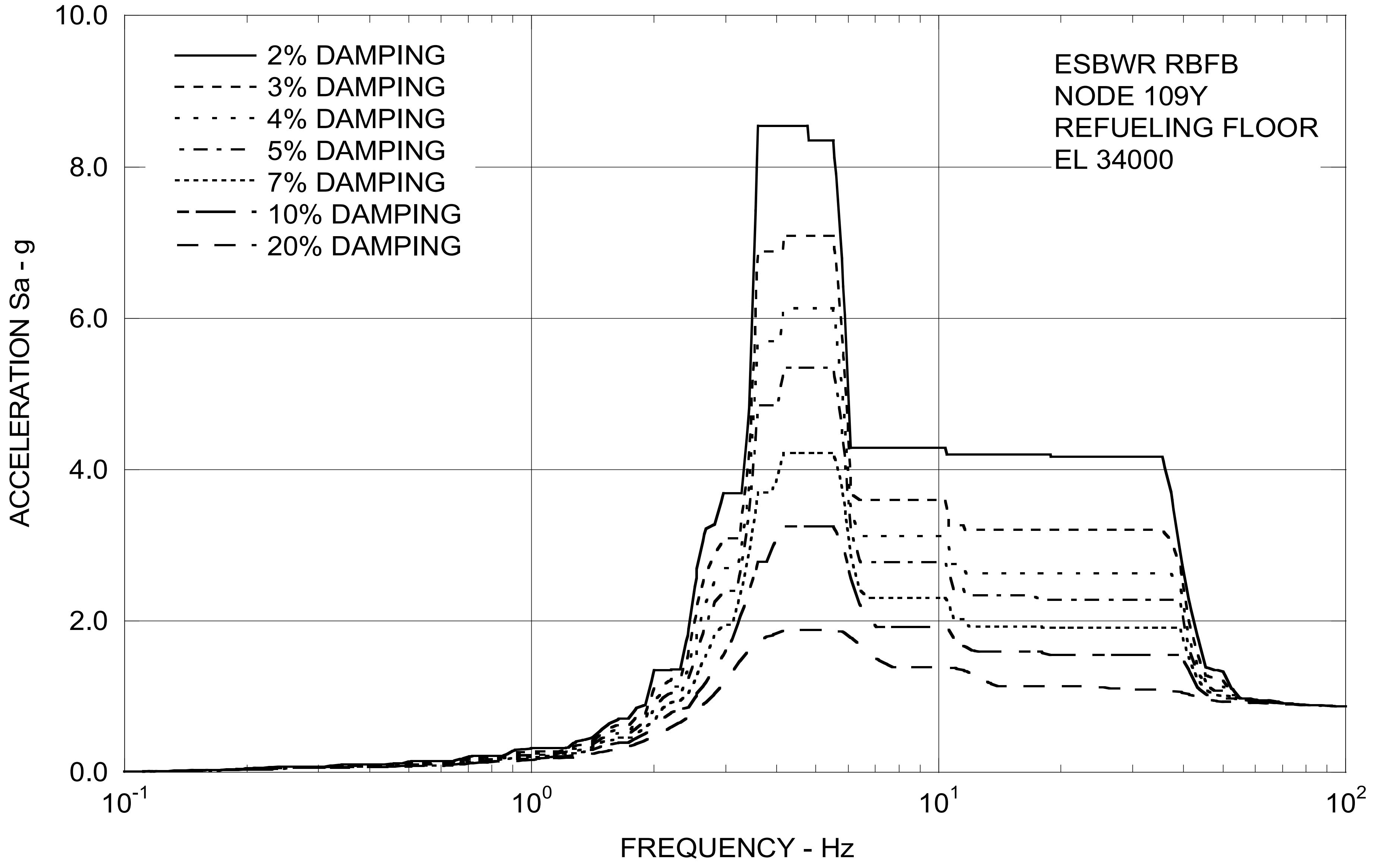


Figure 3A.18.2-202b **Site-Specific In-Structure Response Spectra - RCCV Node 208Y**

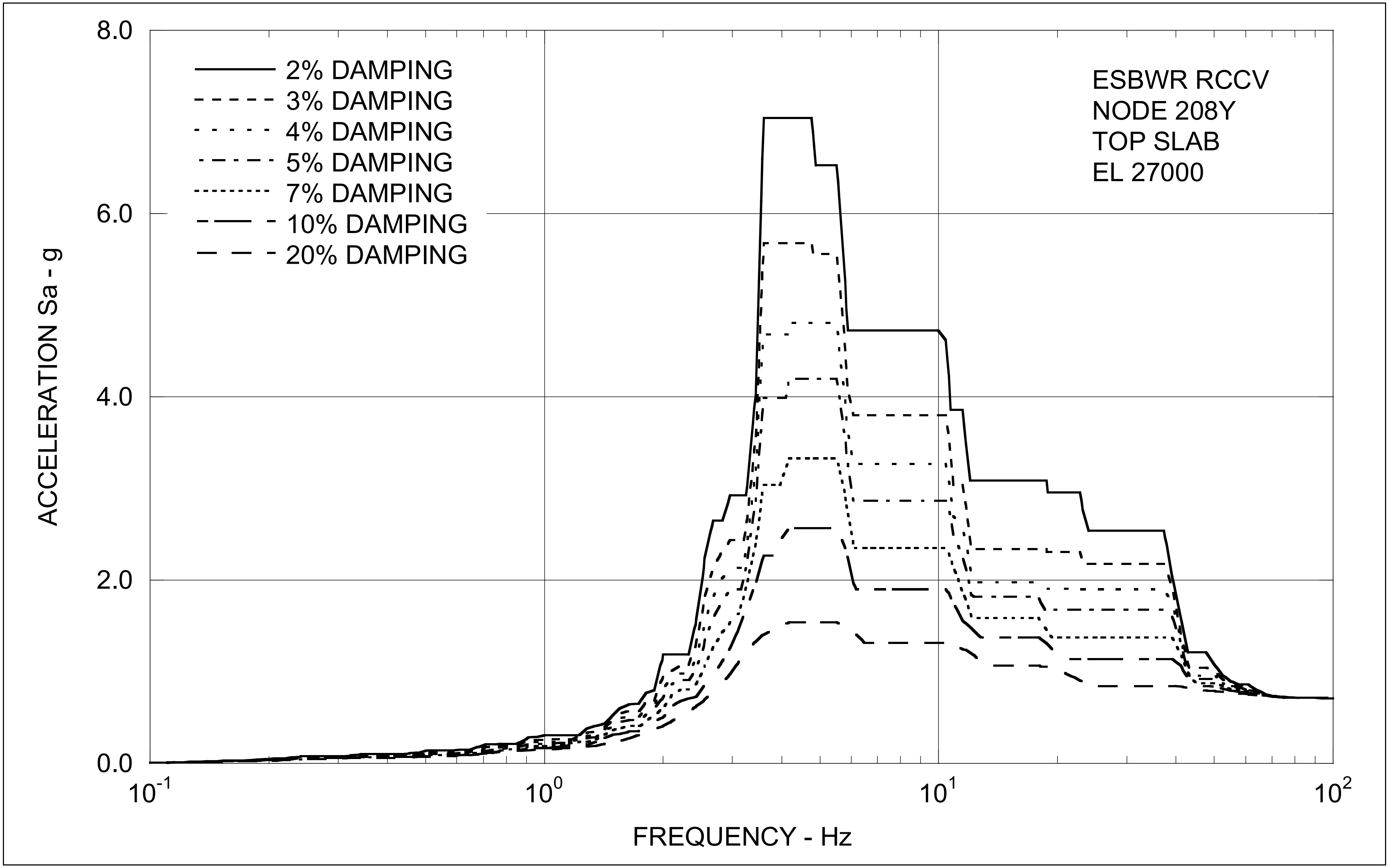


Figure 3A.18.2-202c **Site-Specific In-Structure Response Spectra - Vent Wall Node 701Y**

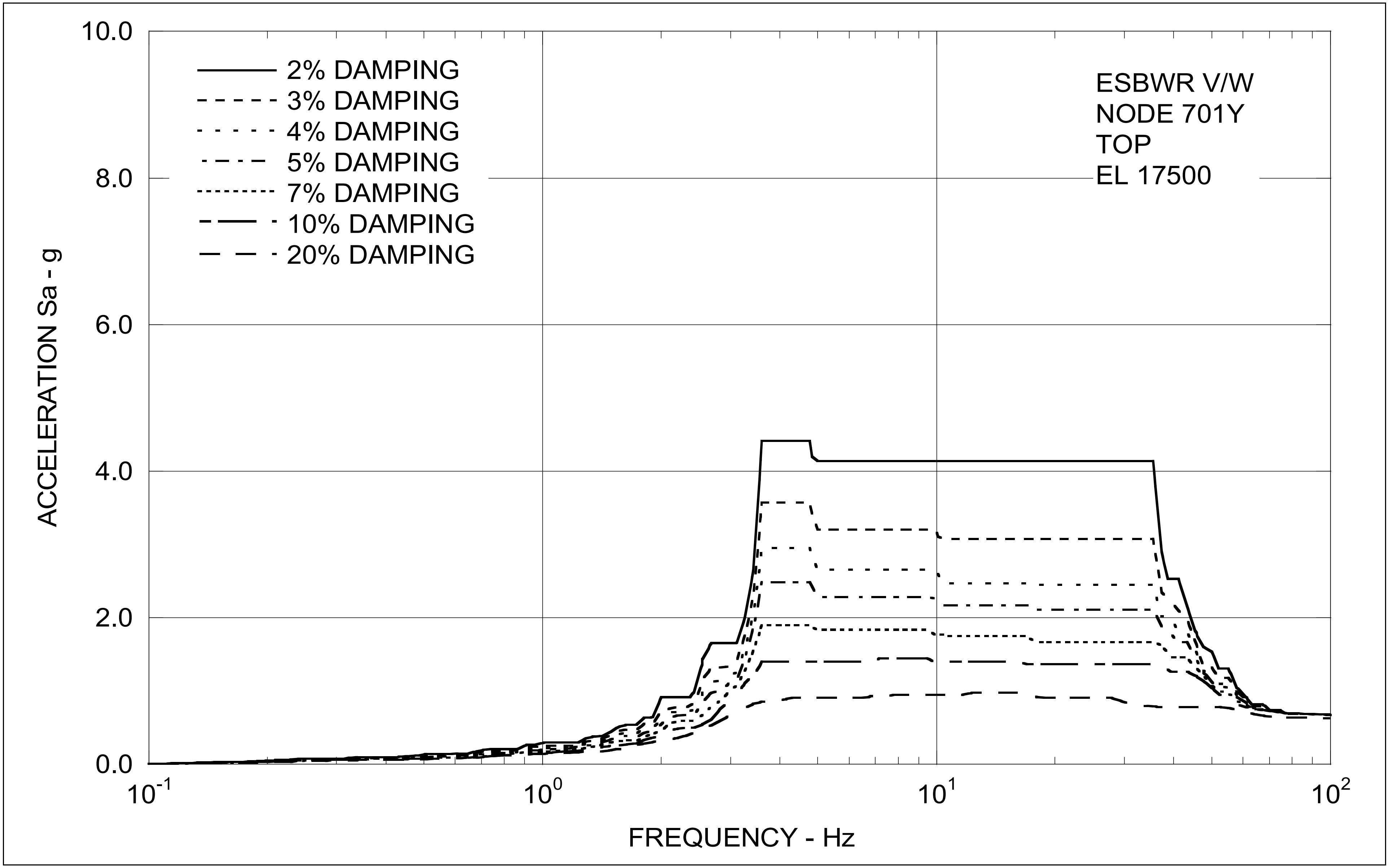


Figure 3A.18.2-202d **Site-Specific In-Structure Response Spectra - RSW Node 707Y**

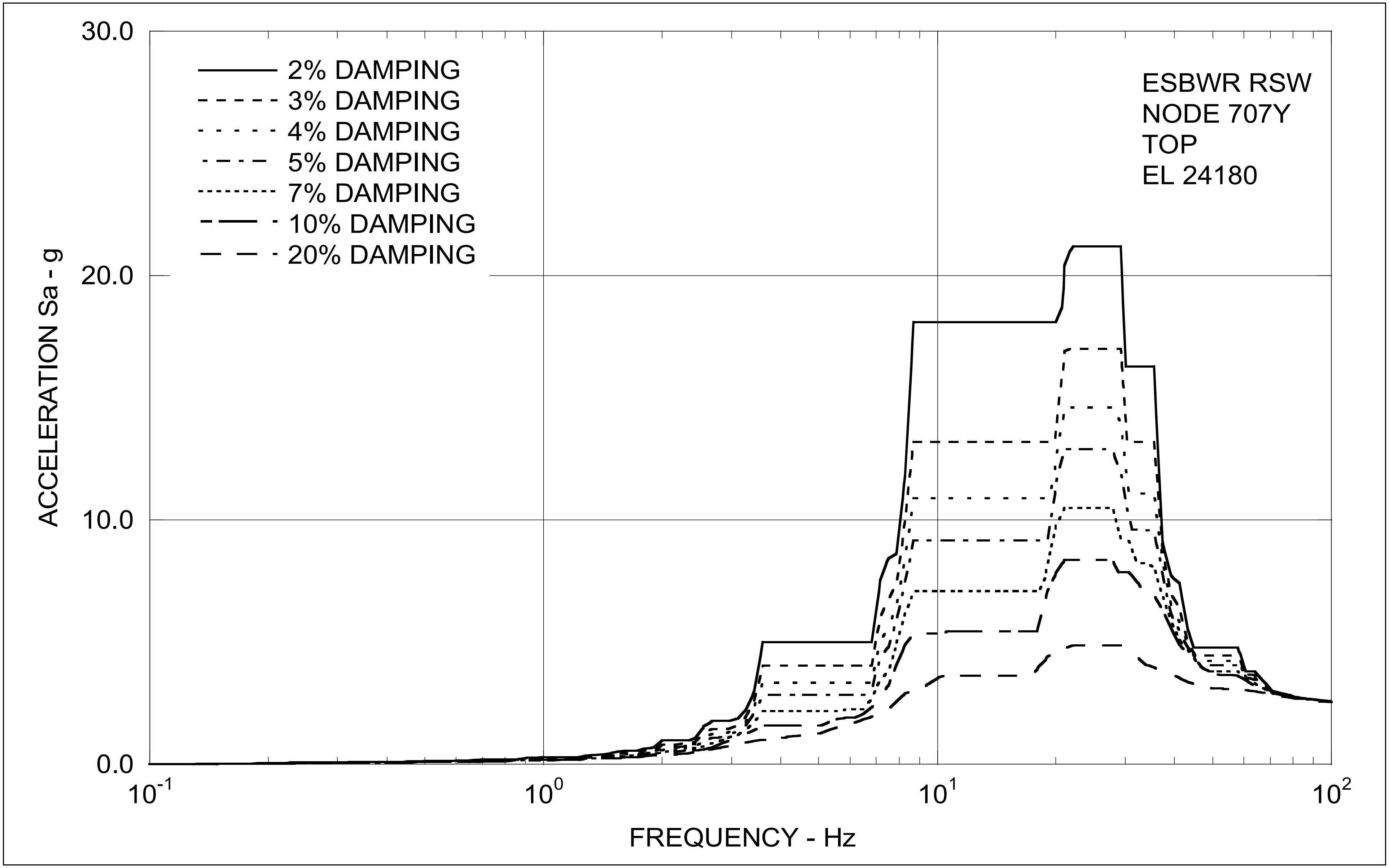


Figure 3A.18.2-202e **Site-Specific In-Structure Response Spectra - RPV Node 801Y**

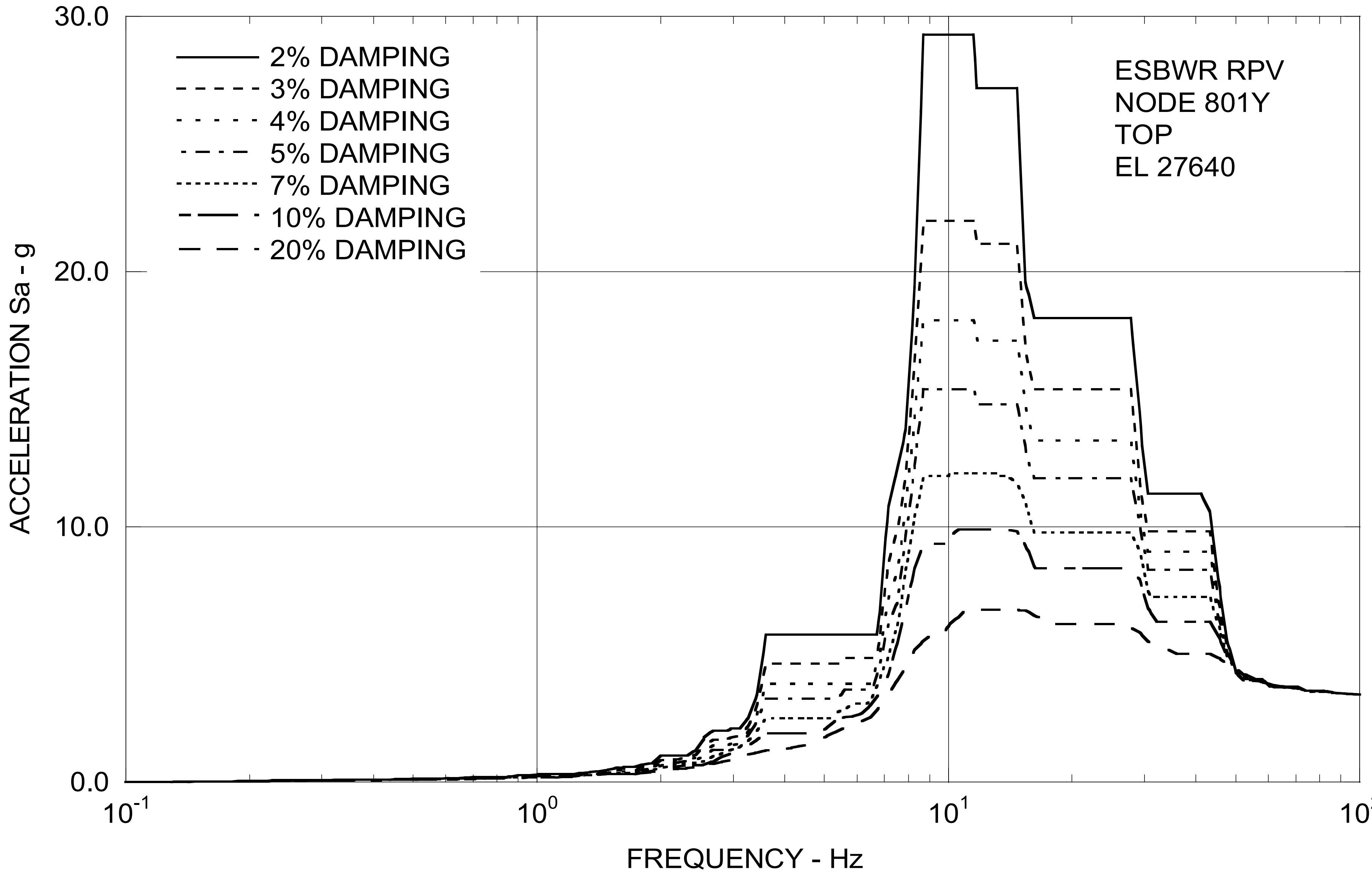


Figure 3A.18.2-202f **Site-Specific In-Structure Response Spectra - RB/FB Node 2Y**

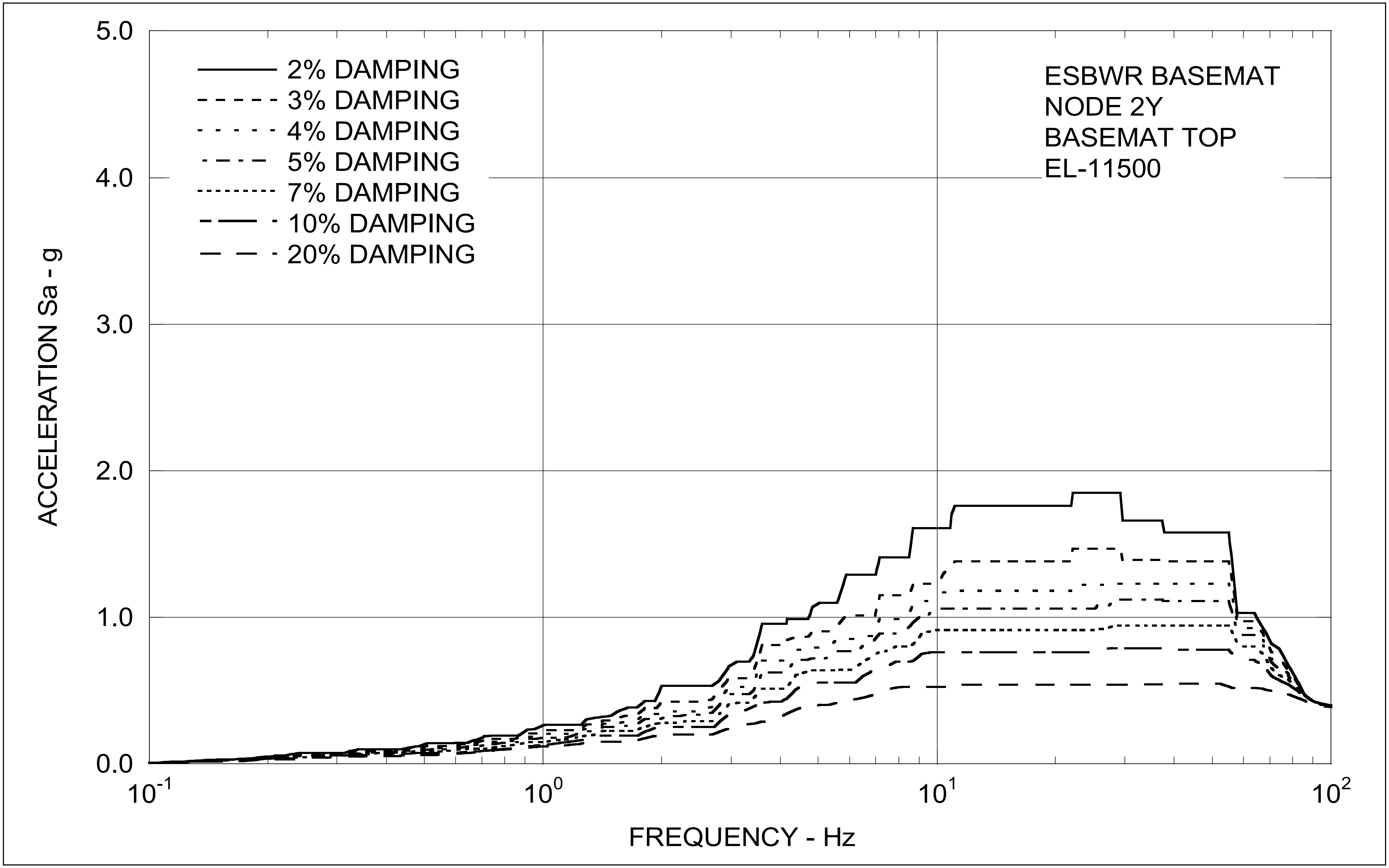


Figure 3A.18.2-202g **Site-Specific In-Structure Response Spectra - CB Node 6 Y**

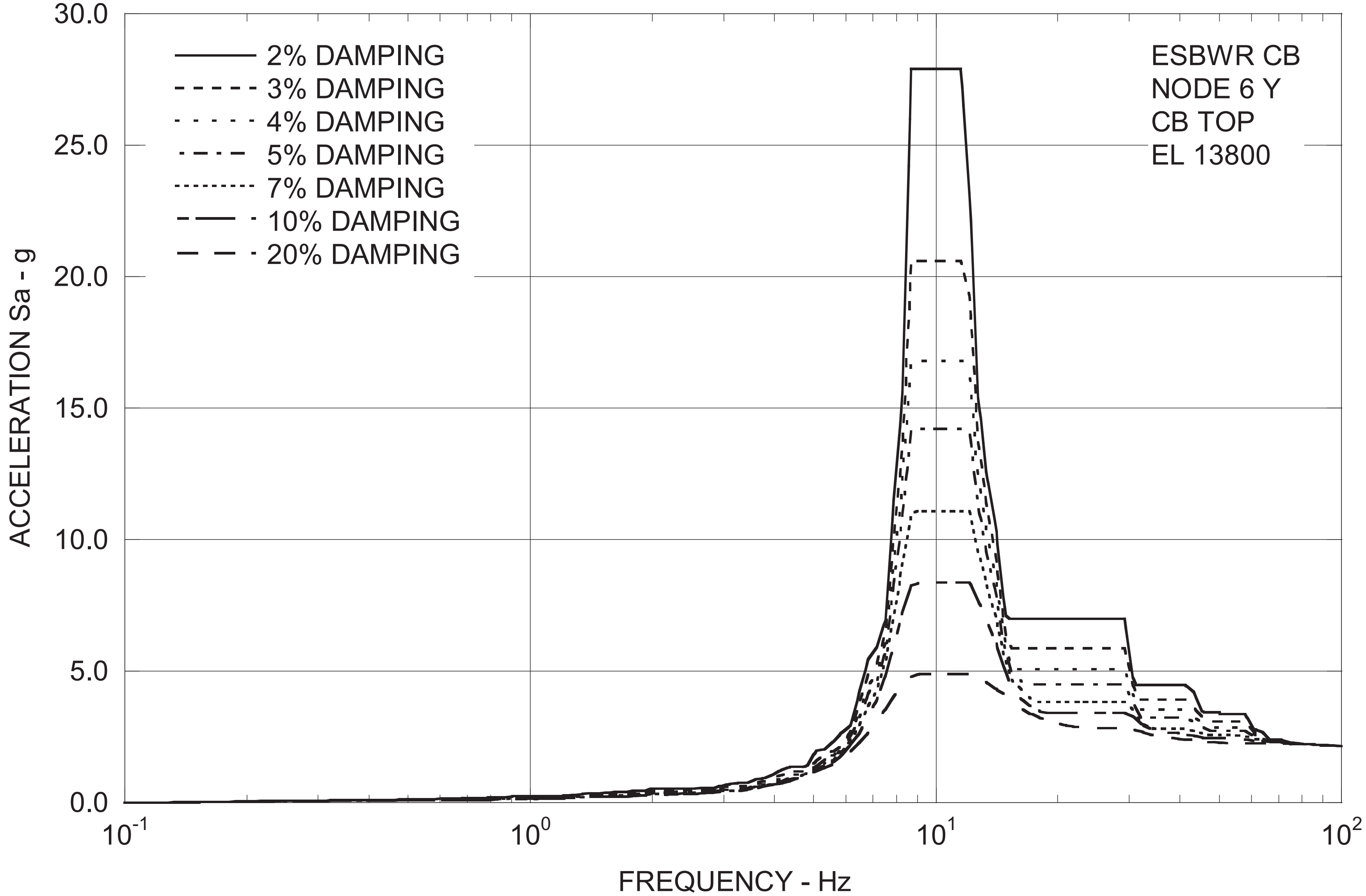


Figure 3A.18.2-202h **Site-Specific In-Structure Response Spectra - CB Node 2 Y**

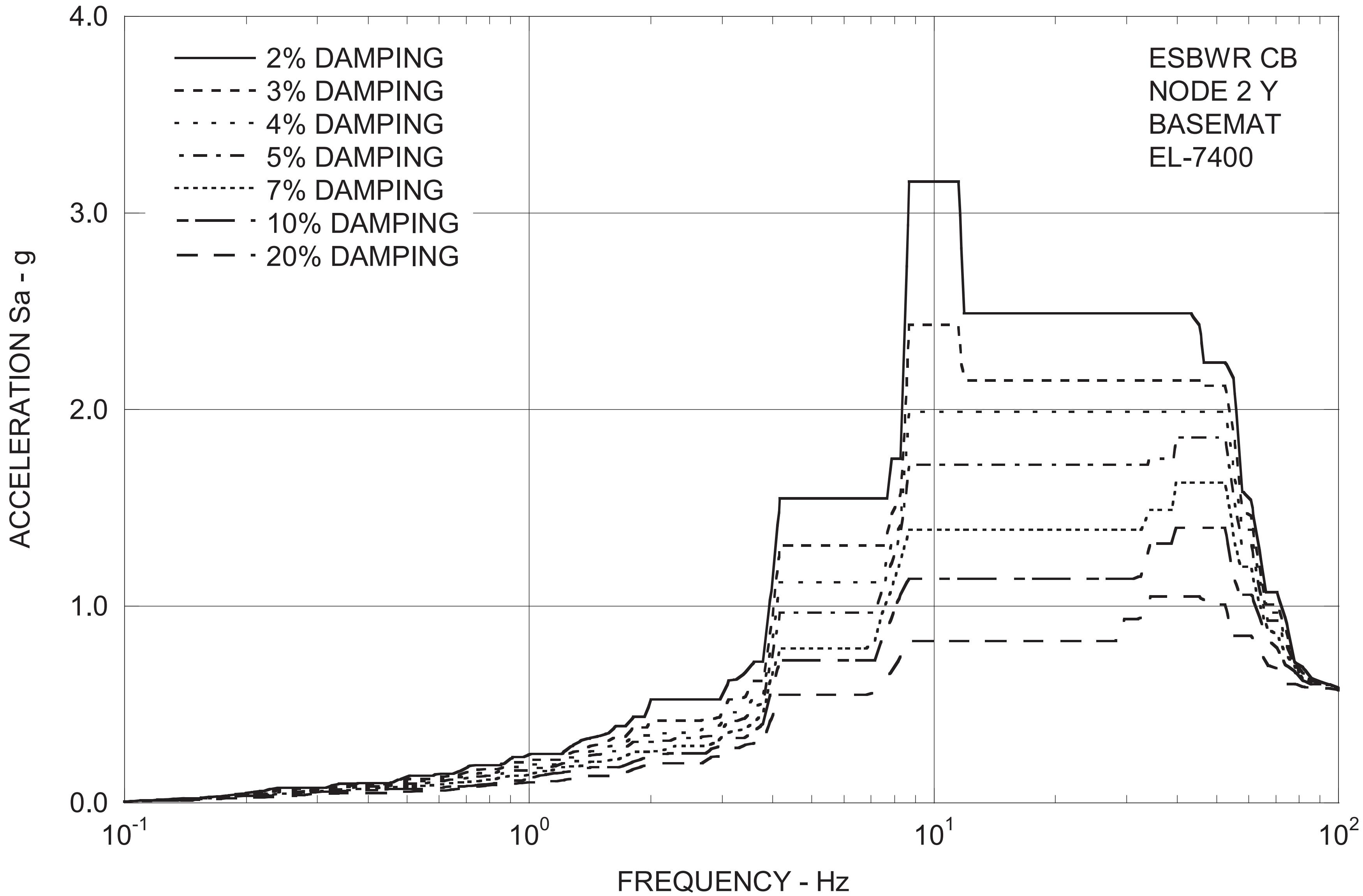


Figure 3A.18.2-202i **Site-Specific In-Structure Response Spectra - FWS Node 9 Y**

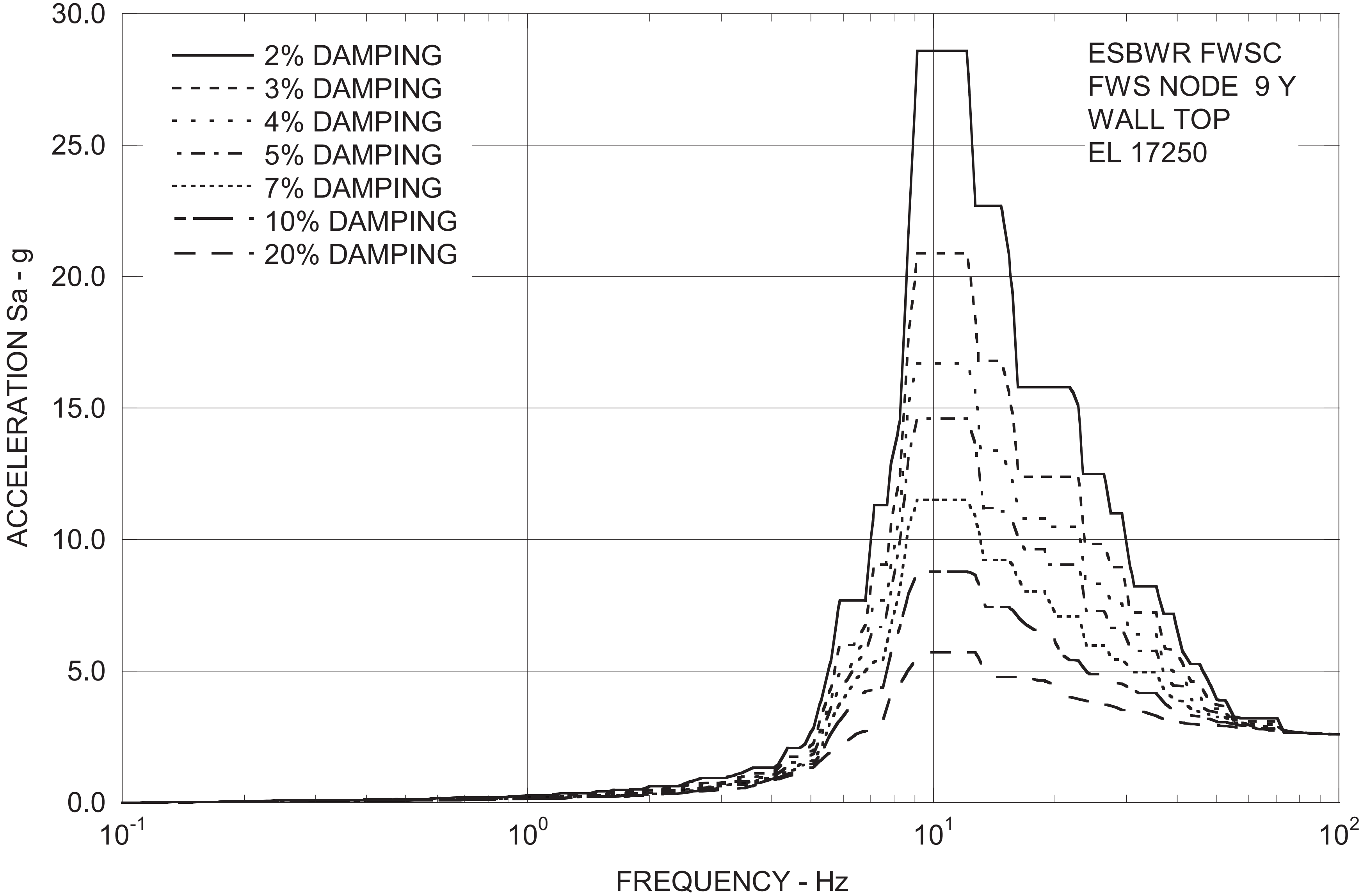


Figure 3A.18.2-202j **Site-Specific In-Structure Response Spectra - FWS Node 1 Y**

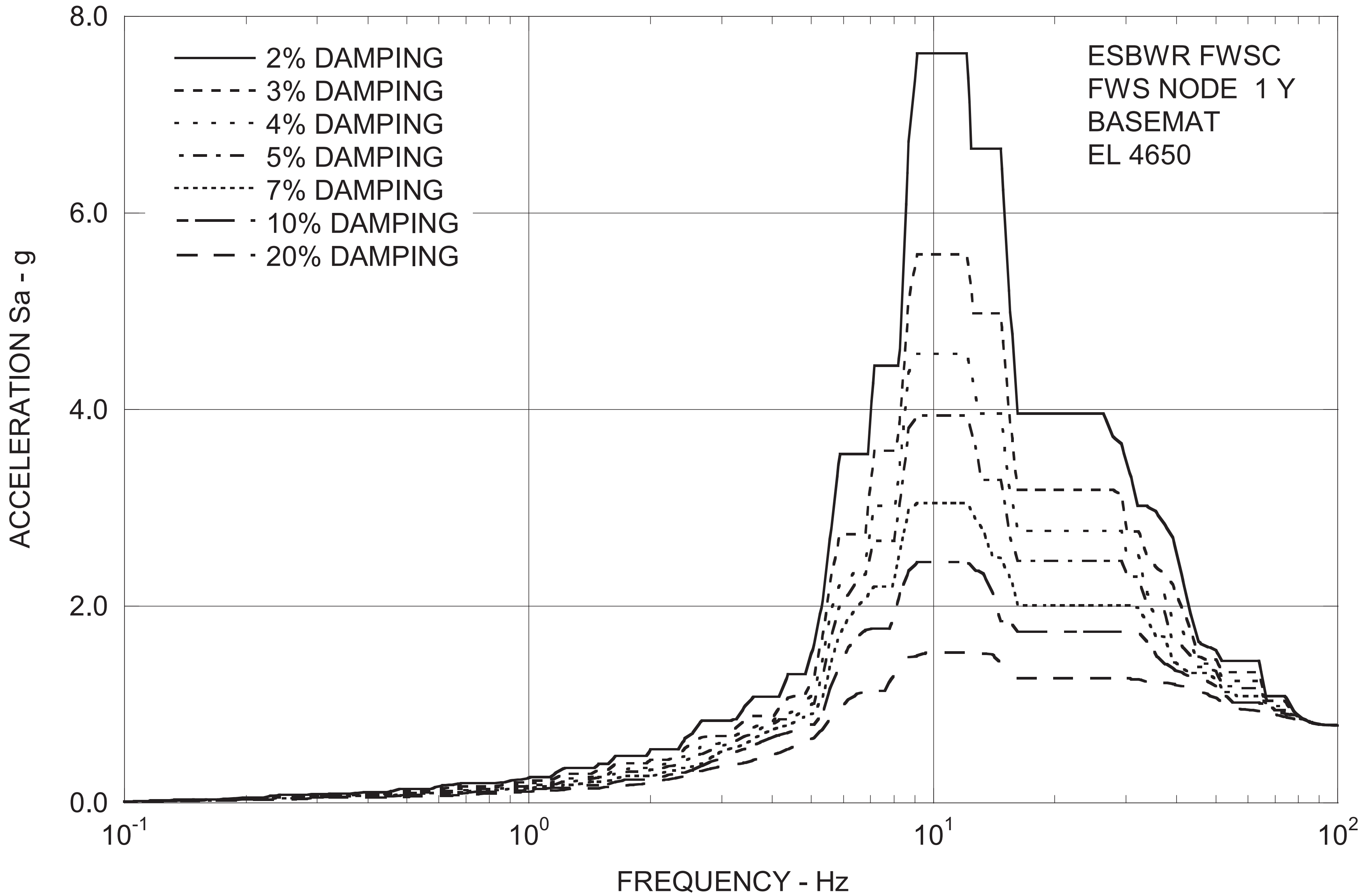


Figure 3A.18.2-202k **Site-Specific In-Structure Response Spectra - FPE Node 405 Y**

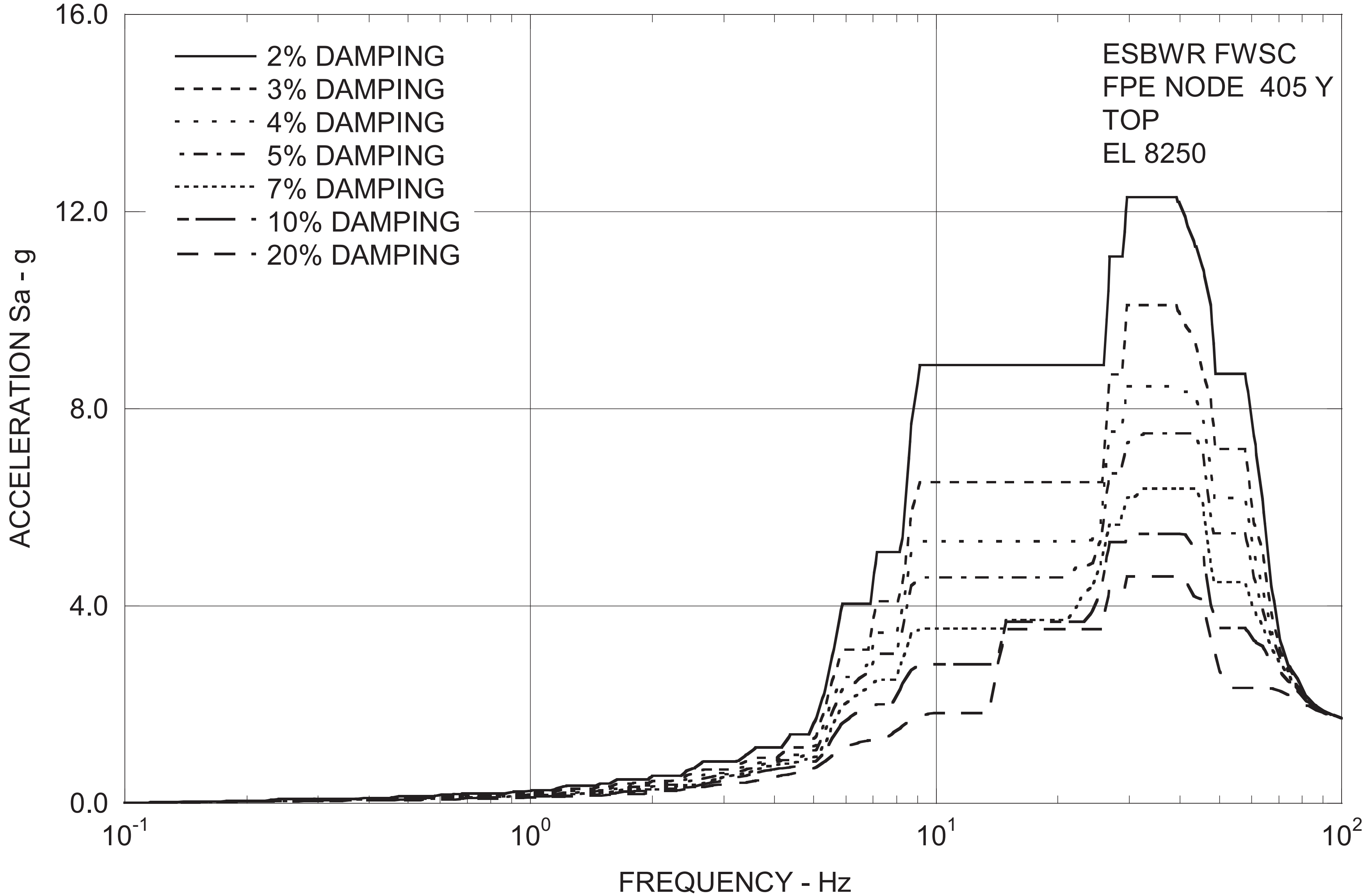


Figure 3A.18.2-202I **Site-Specific In-Structure Response Spectra - FPE Node 404 Y**

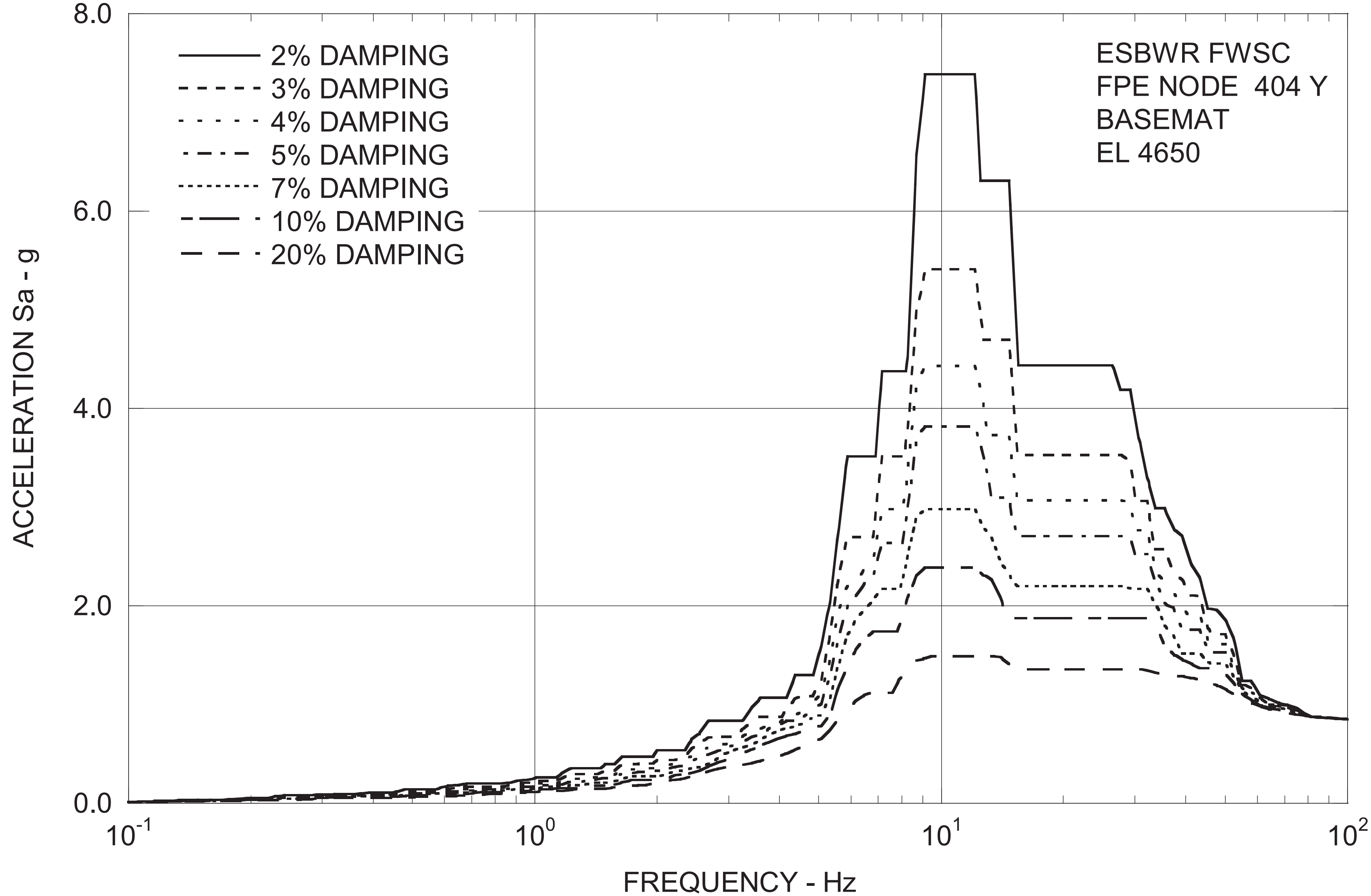


Figure 3A.18.2-203a **Site-Specific In-Structure Response Spectra - RB/FB Node 109 Z**

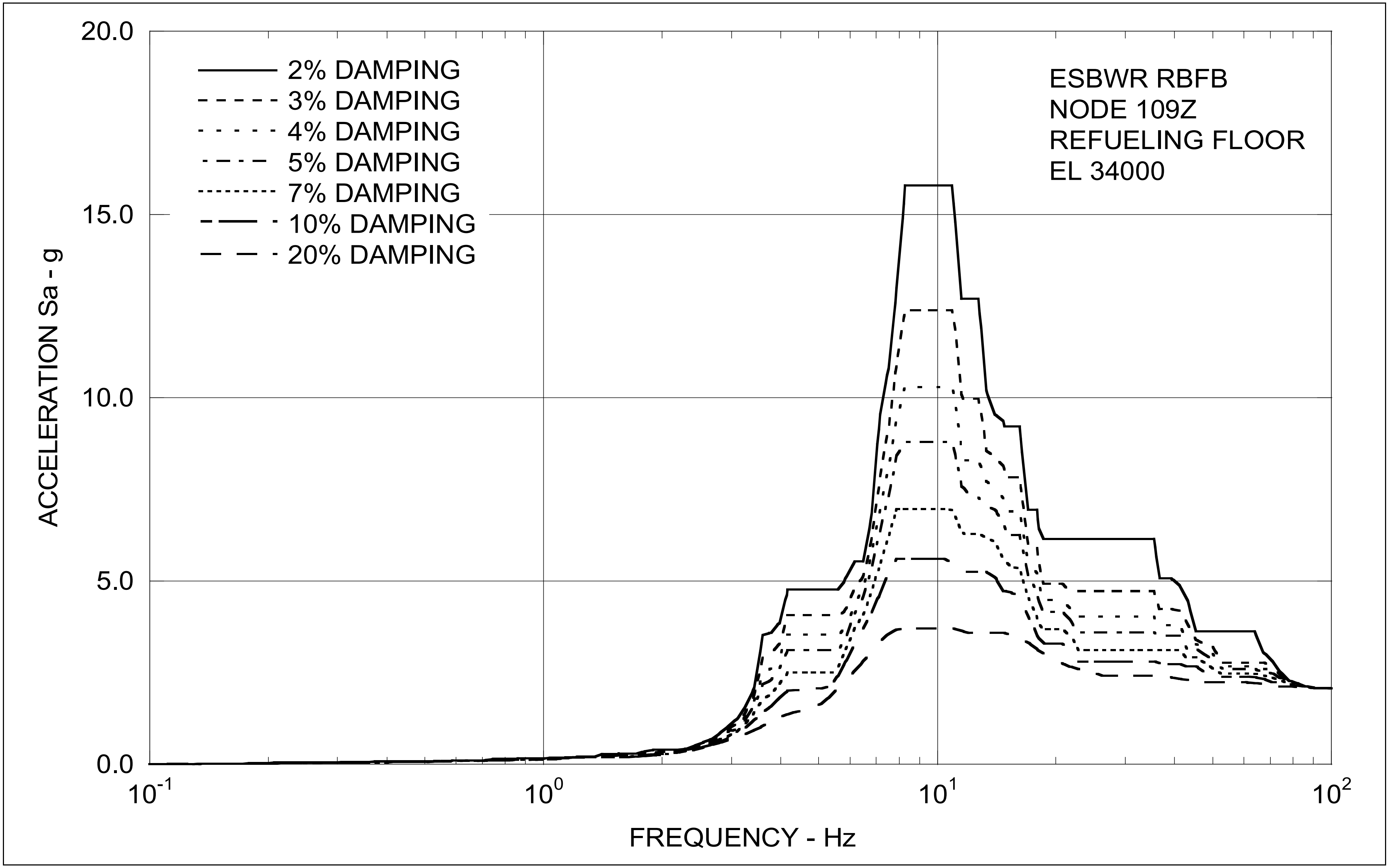


Figure 3A.18.2-203b **Site-Specific In-Structure Response Spectra - RCCV Node 208Z**

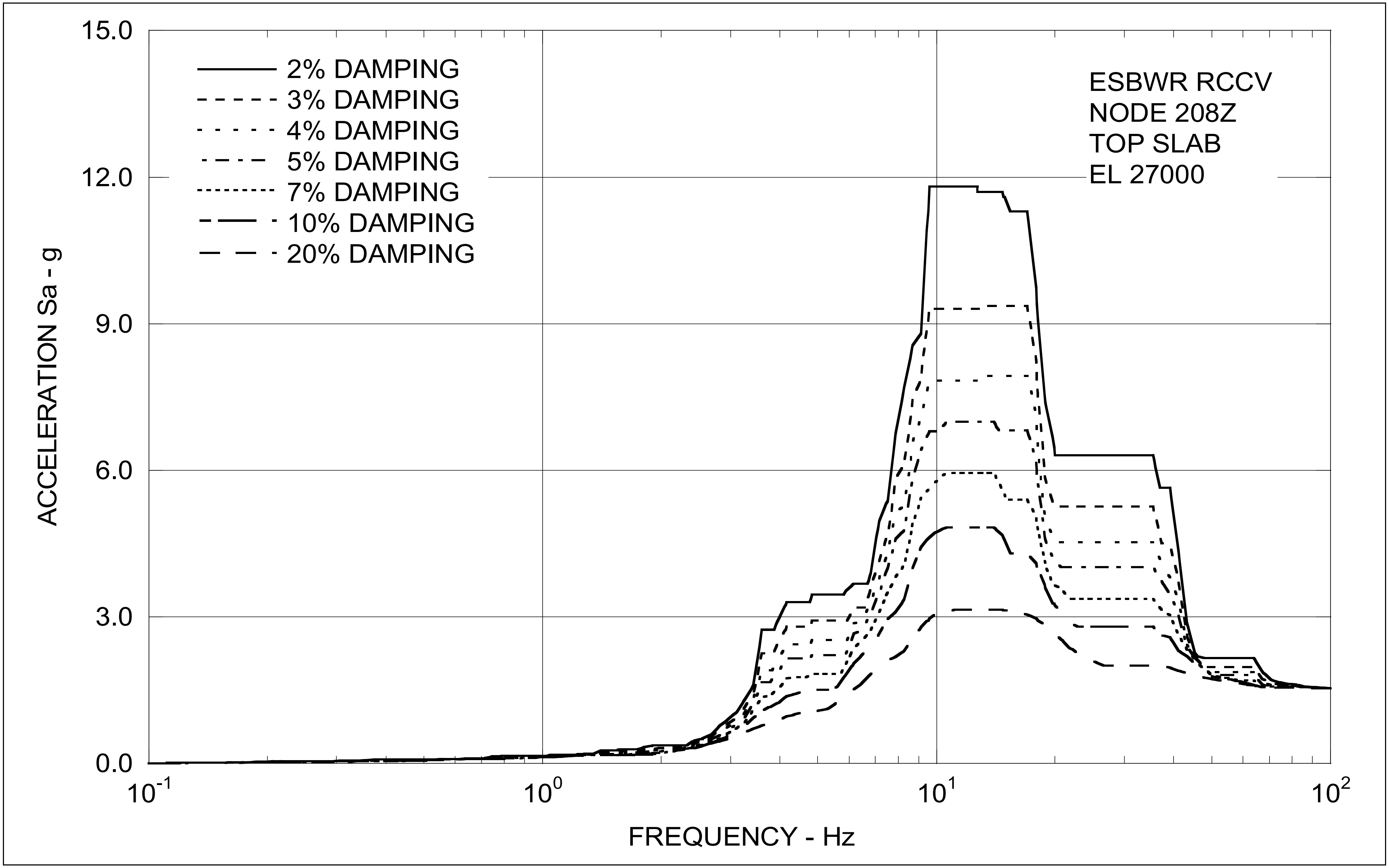


Figure 3A.18.2-203c **Site-Specific In-Structure Response Spectra - Vent Wall Node 701Z**

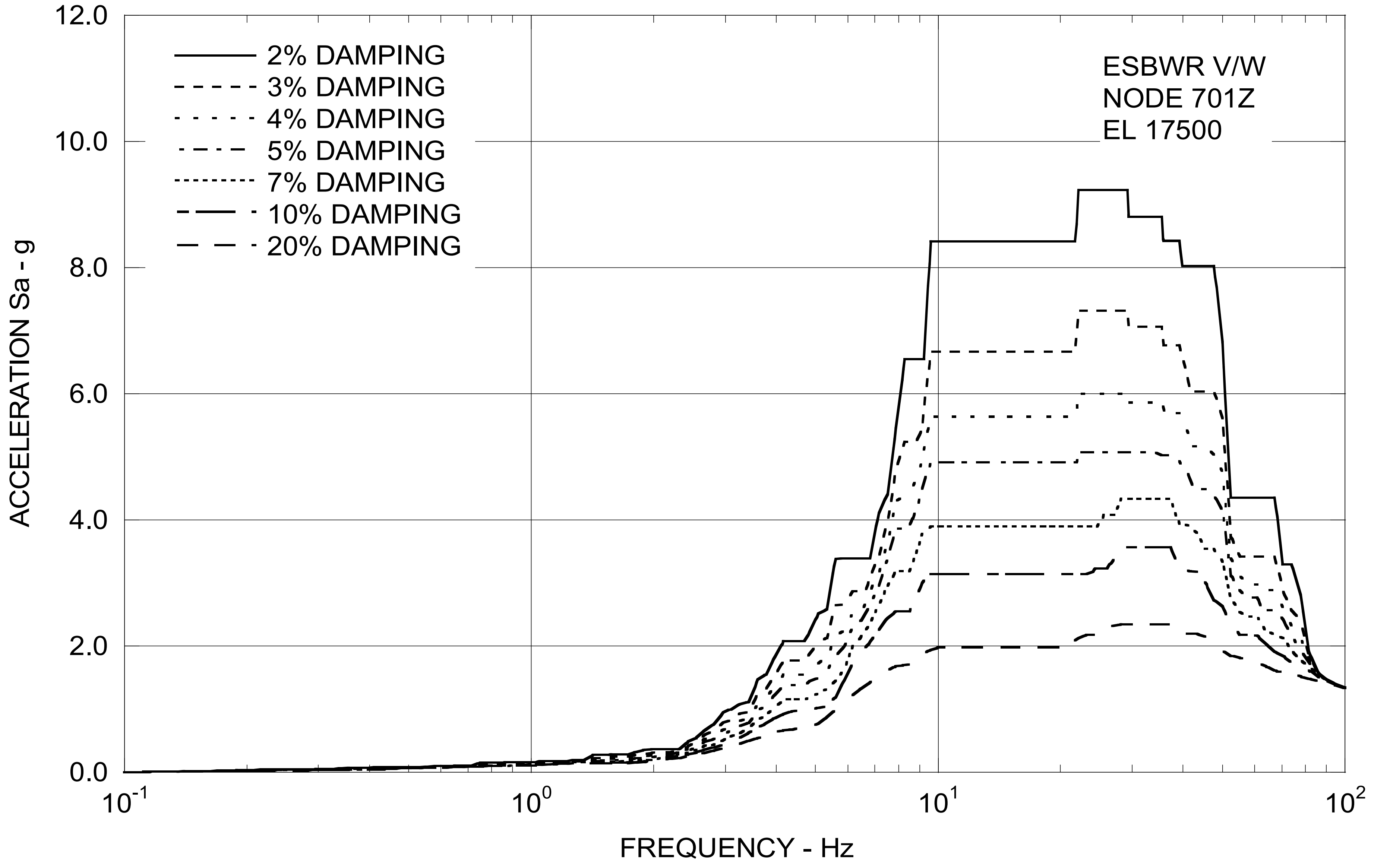


Figure 3A.18.2-203d **Site-Specific In-Structure Response Spectra - RSW Node 707Z**

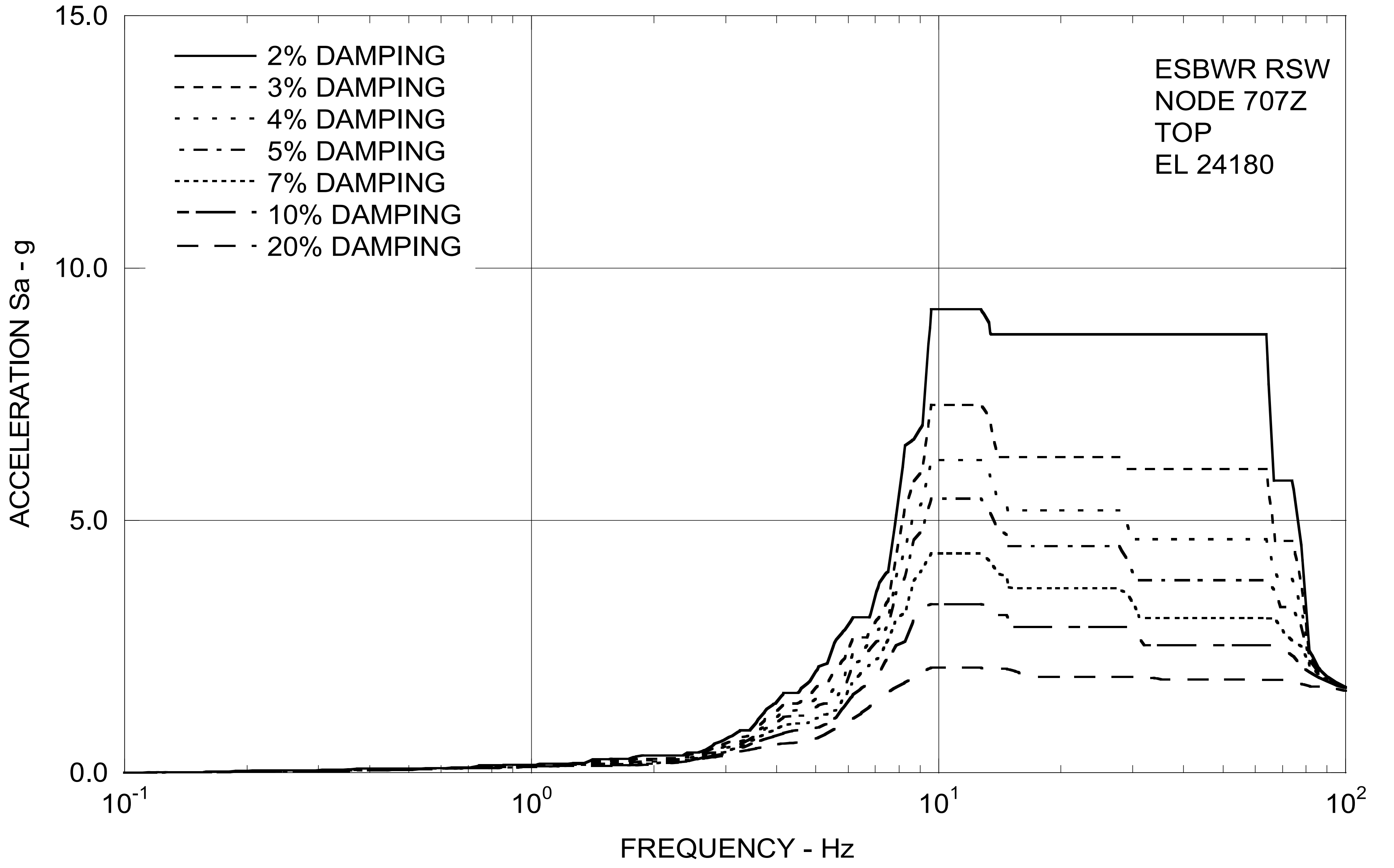


Figure 3A.18.2-203e **Site-Specific In-Structure Response Spectra - RPV Node 801Z**

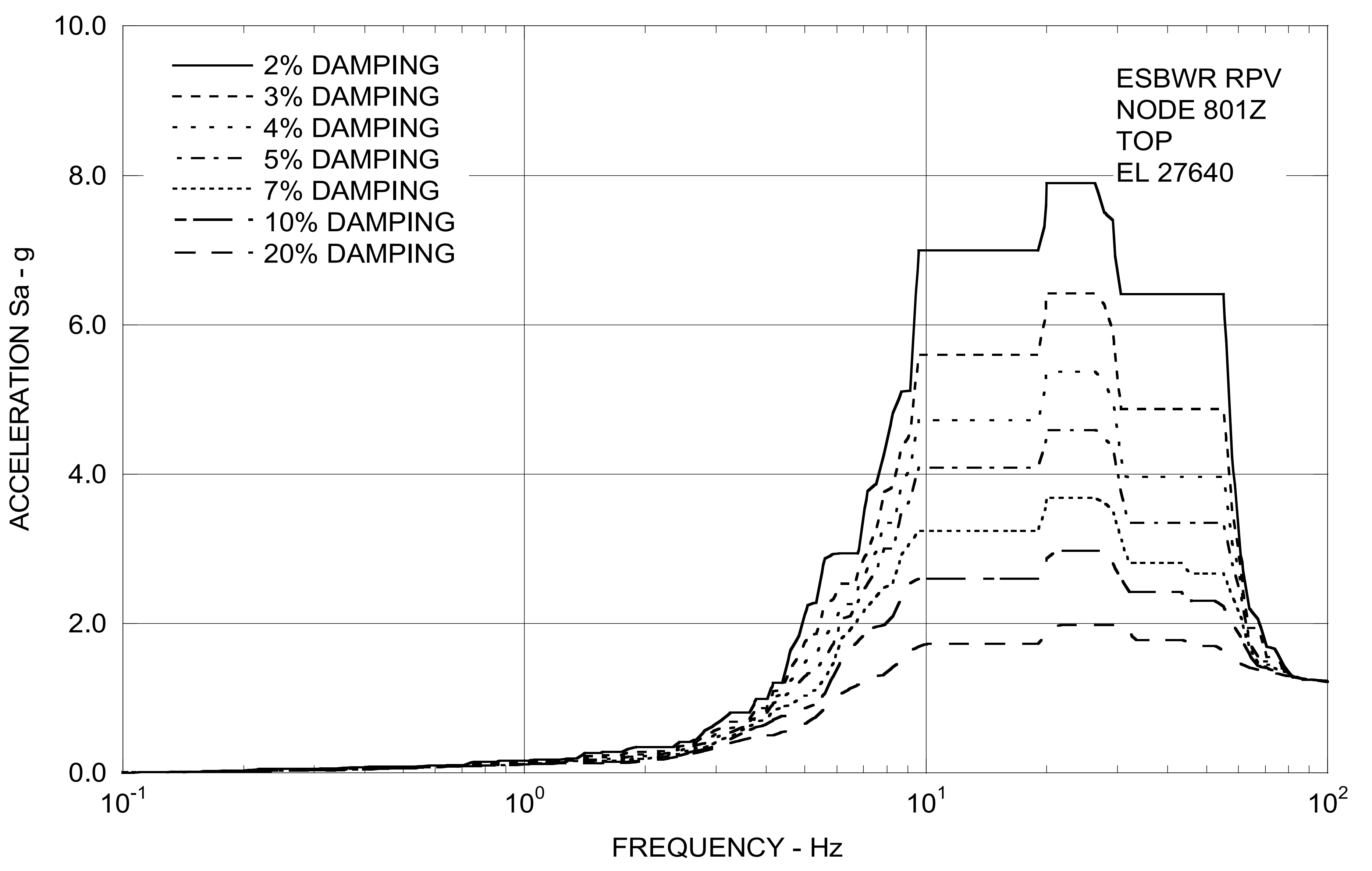


Figure 3A.18.2-203f **Site-Specific In-Structure Response Spectra - RB/FB Node 2Z**

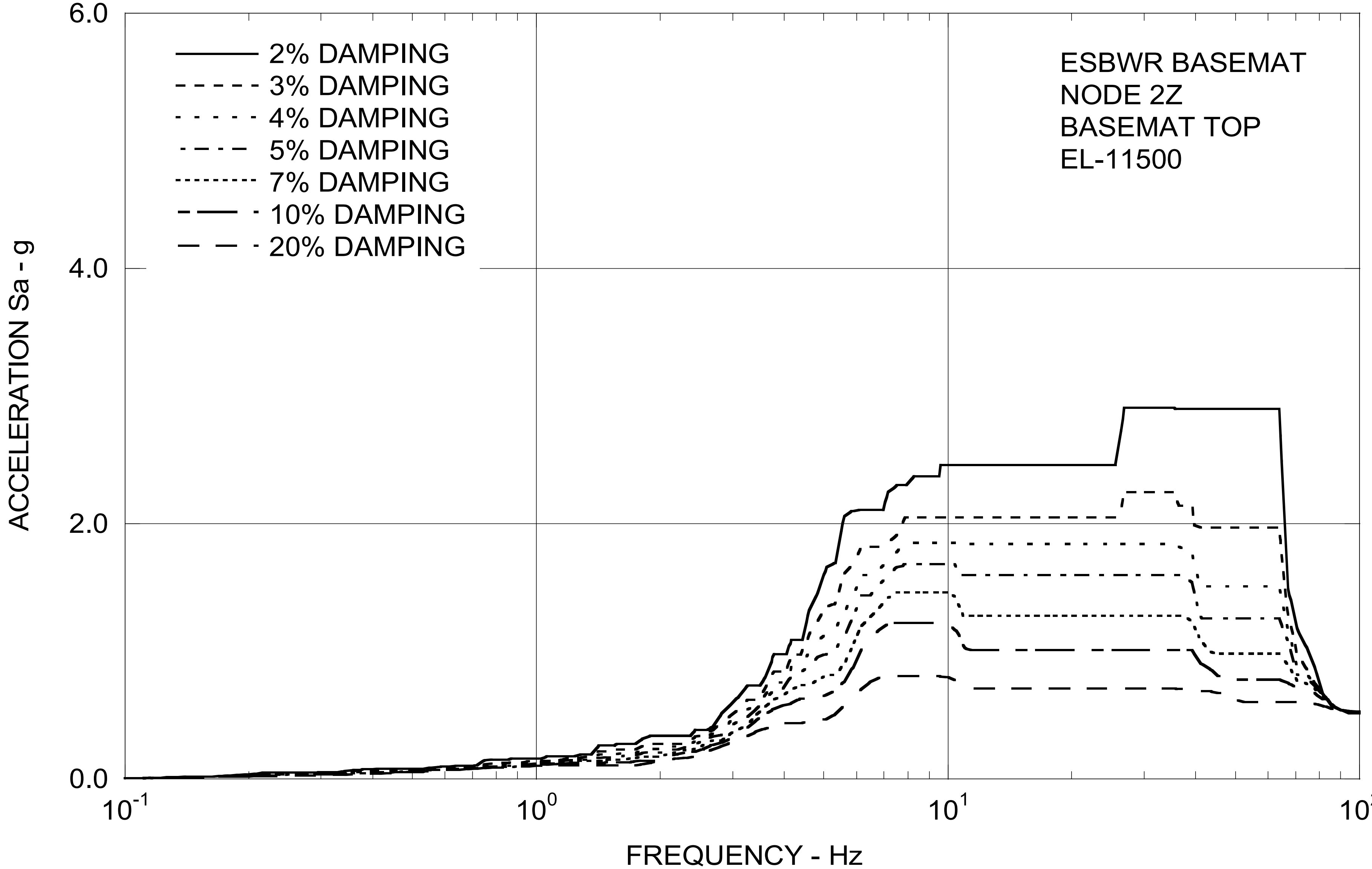


Figure 3A.18.2-203g **Site-Specific In-Structure Response Spectra - CB Node 6 Z**

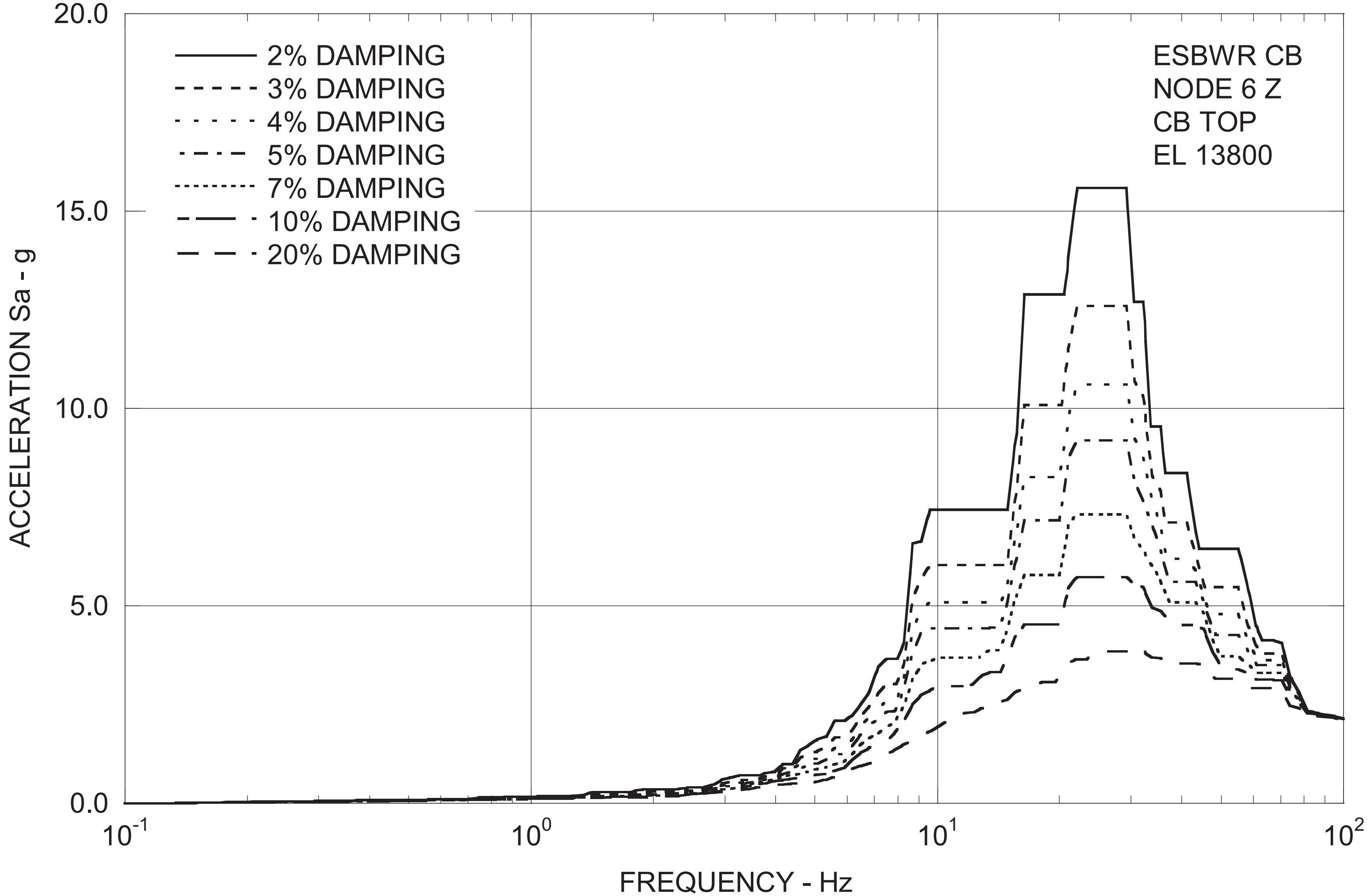


Figure 3A.18.2-203h **Site-Specific In-Structure Response Spectra - CB Node 2 Z**

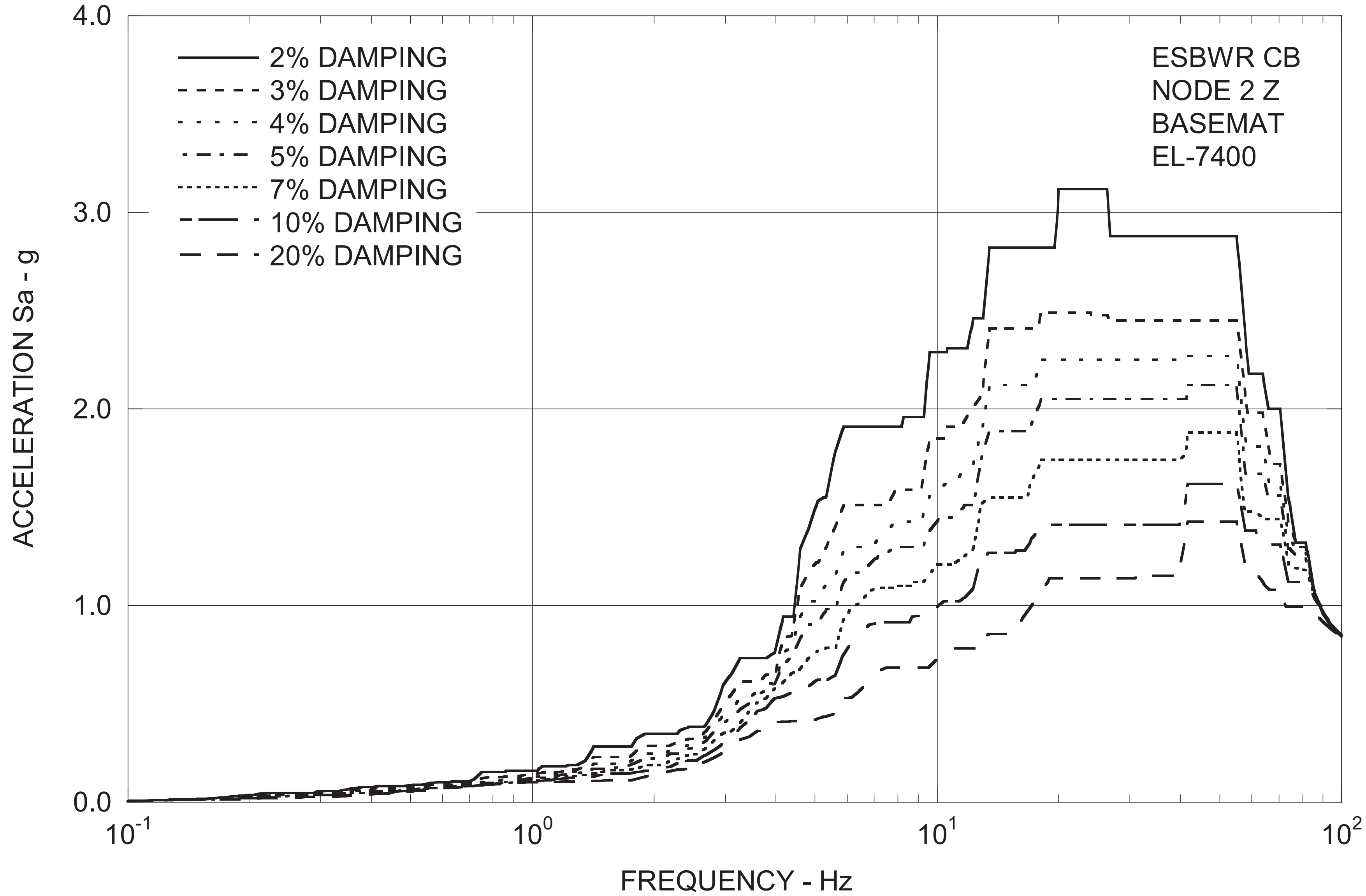


Figure 3A.18.2-203i **Site-Specific In-Structure Response Spectra - FWS Node 9 Z**

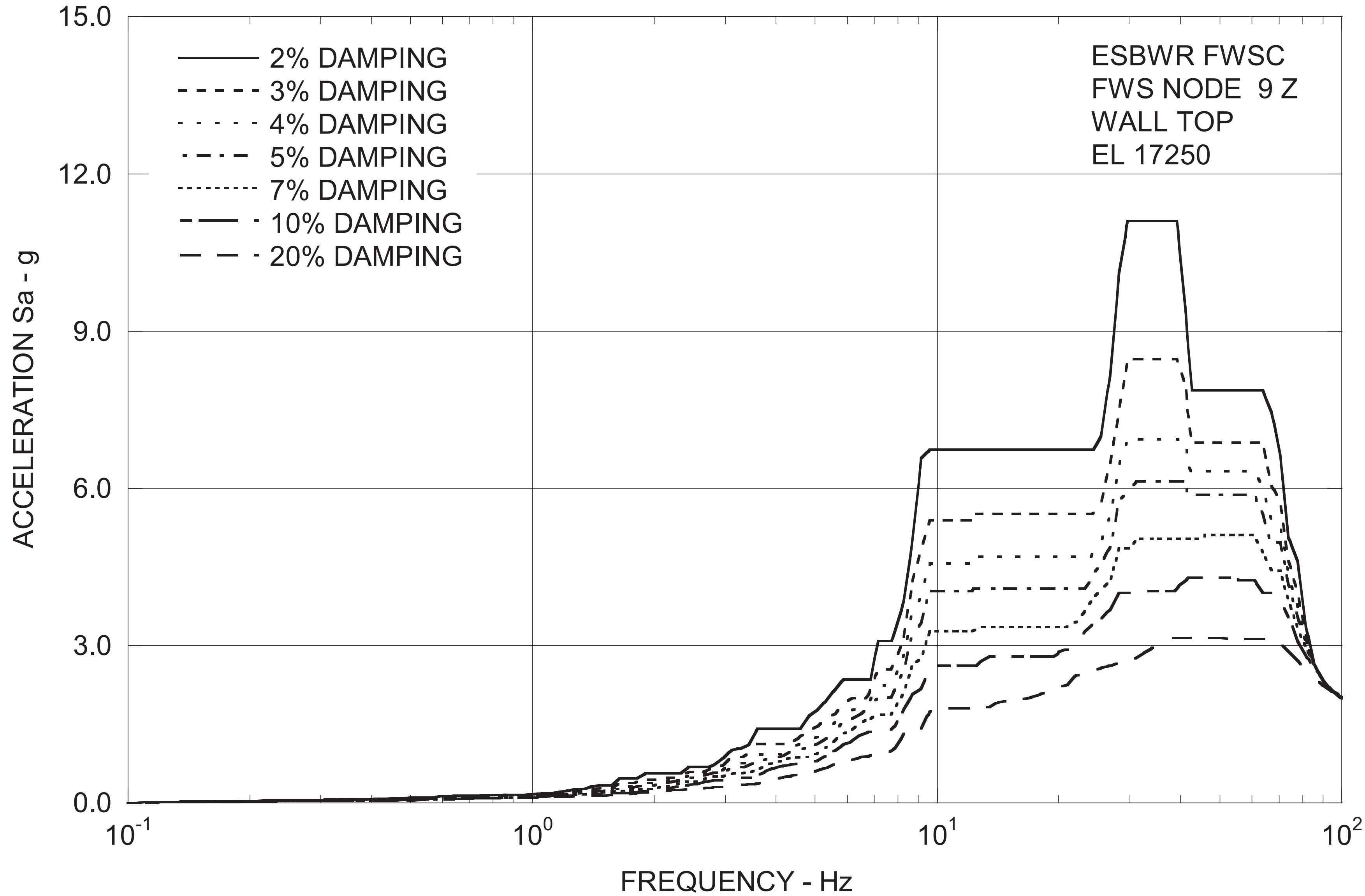


Figure 3A.18.2-203j **Site-Specific In-Structure Response Spectra - FWS Node 1 Z**

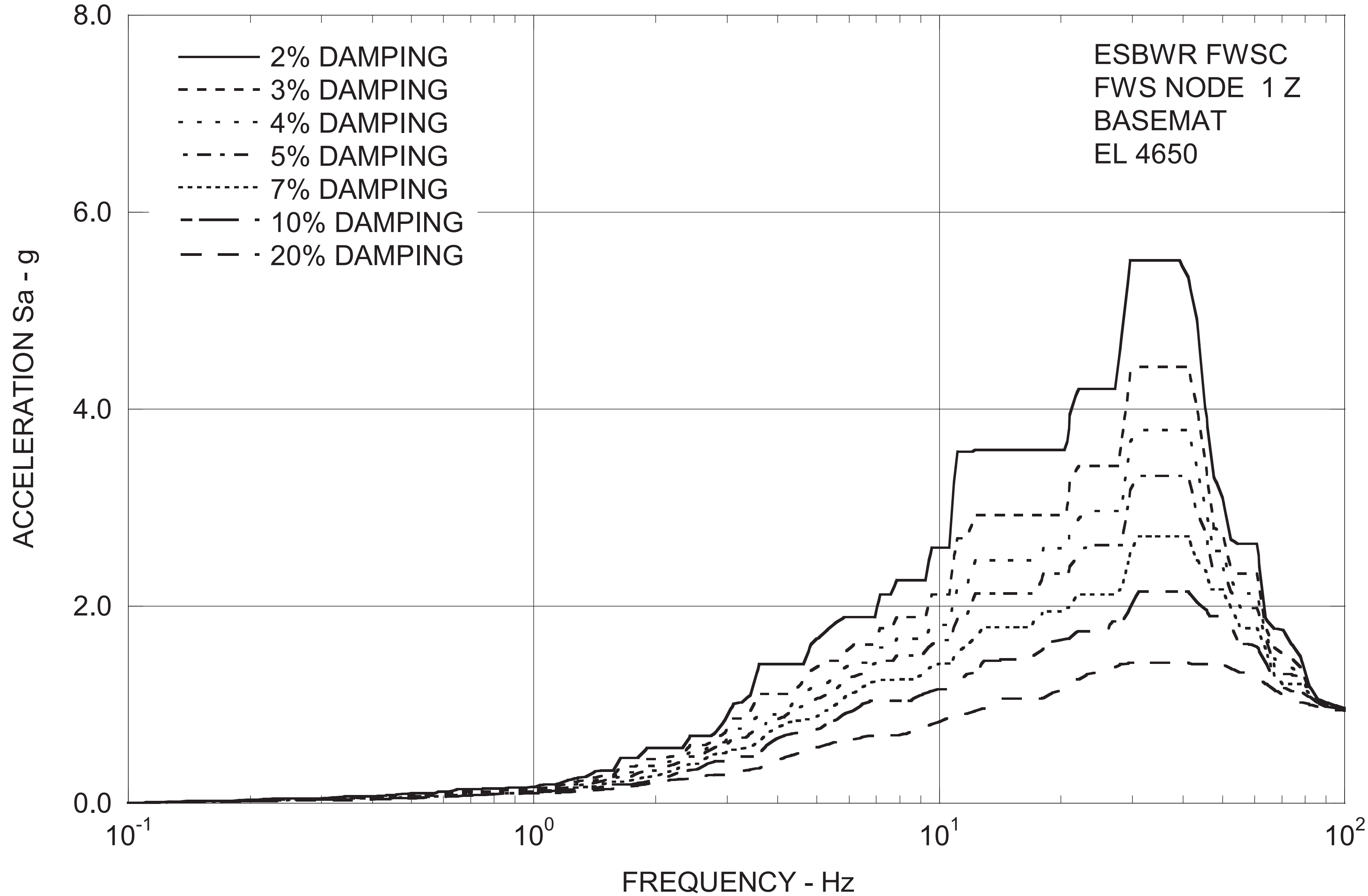


Figure 3A.18.2-203k **Site-Specific In-Structure Response Spectra - FPE Node 405 Z**

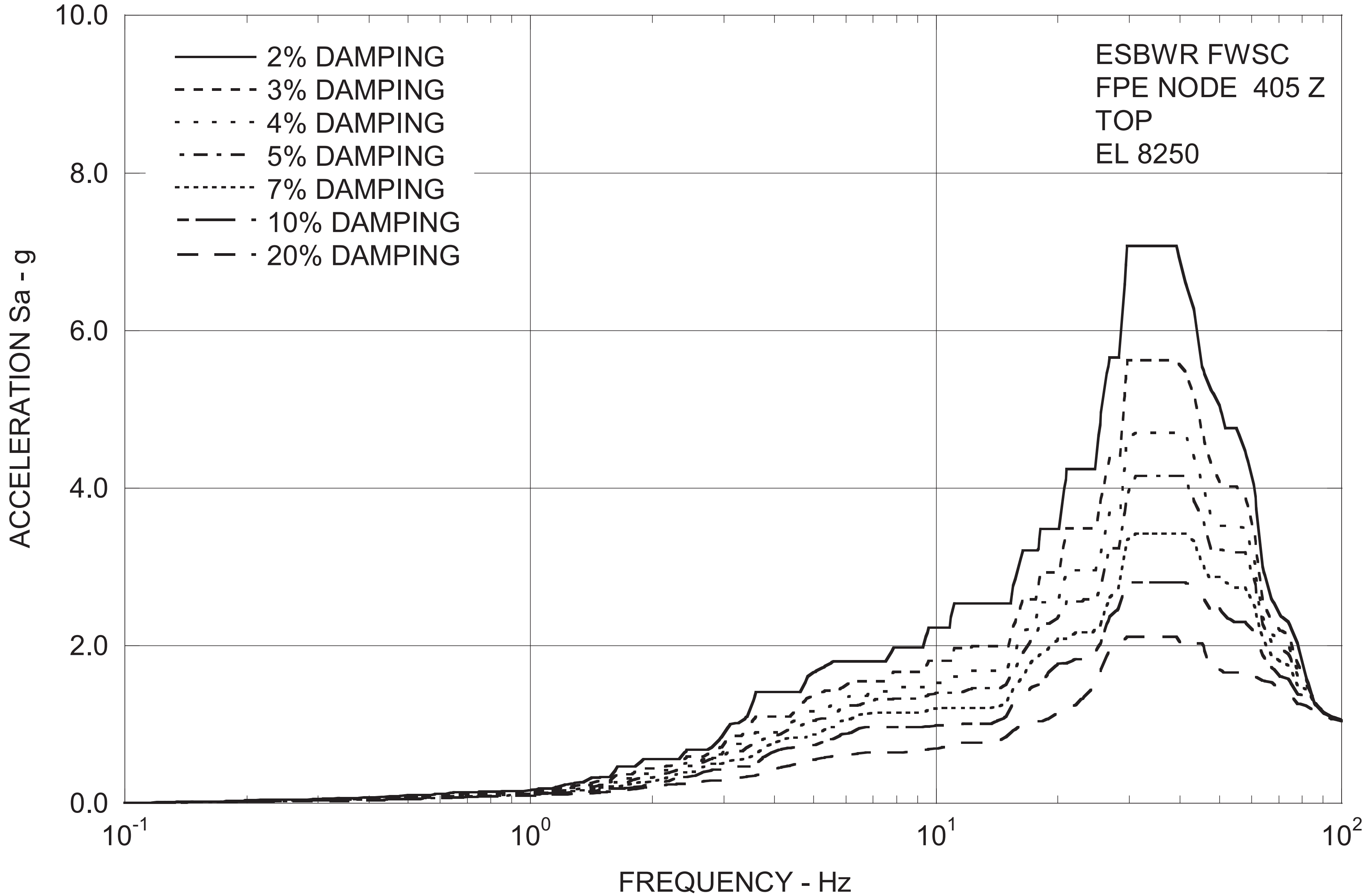
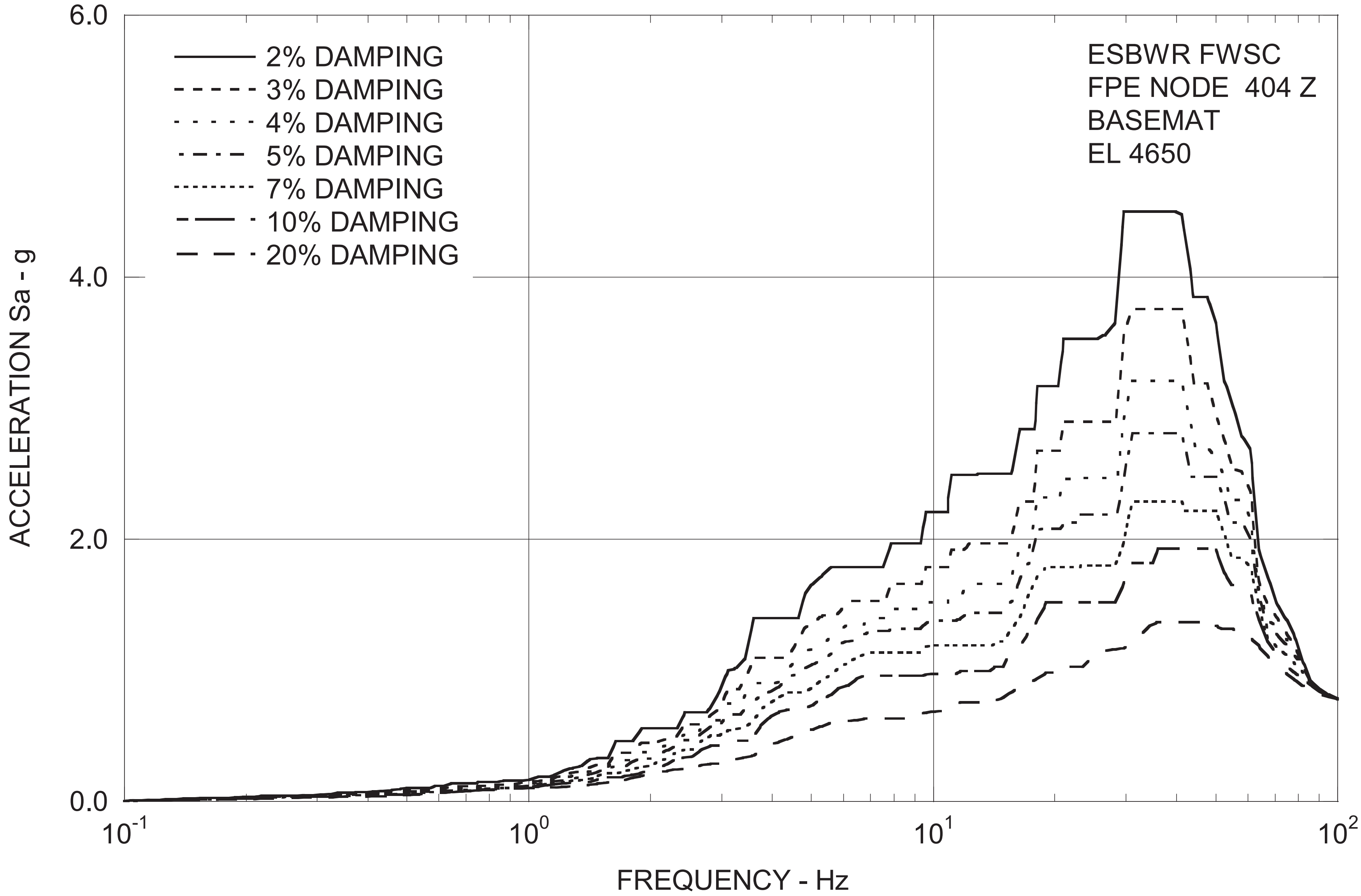


Figure 3A.18.2-203I **Site-Specific In-Structure Response Spectra - FPE Node 404 Z**



3A.18.3 Basemat Interface Loads with Foundation Medium for Foundation Stability Evaluation

Site-specific foundation stability evaluations presented in Section 3.8.5 use the results of the SSI analyses for contact spring forces to calculate time histories of the seismic driving forces. These seismic driving forces are used as input for the sliding stability evaluations and dynamic bearing pressure calculations. The time histories of the horizontal and vertical driving seismic forces in the three orthogonal directions are calculated as the algebraic sum of the spring forces in the three directions at each time step from all contact spring elements at the interfaces between the structure and the surrounding soil.

The contact spring elements at the bottom of the RB/FB basemat provide the input needed for the calculation of the dynamic bearing pressures. Contact spring elements at the bottom of the CB basemat and at the bottom of the concrete fill supporting the CB provide the input needed for calculating the dynamic bearing pressures from the CB on the concrete fill and the Zone III/IV rock. Contact spring elements at the bottom of the FWSC basemat and at the bottom of the concrete fill supporting the FWSC basemat provide the input needed for calculating the dynamic bearing pressures from the FWSC on the concrete fill and the Zone III/IV rock. The calculations of the dynamic bearing pressures are based on the time histories of:

- The overturning base moments calculated for both the horizontal directions by summing algebraically the moments generated by each contact spring reaction at the bottom of the basemat
- The vertical driving seismic forces calculated as the algebraic sum of the vertical spring forces at each time step from all contact spring elements at the interface between the bottom of the basemat and the rock

NAPS DEP 3.7-1

3A.19 Unit 3 Site-Specific Seismic Analyses Conclusions

The site-specific seismic analyses of Seismic Category I buildings provide site-specific seismic demands that are compared to the corresponding enveloping loads used for the standard design of SSCs. The comparisons serve to determine exceedances resulting from the site-specific GMRS that exceed the standard design CSDRS. The results of the site-specific analyses also form the basis for the site-specific evaluations of Seismic Category I SSCs presented in Appendix 3G.

3A.19.1 Reactor Building/Fuel Building

Site-specific RB/FB SSI analyses indicate the following:

- Site-specific seismic demands exceed the seismic demands used for the standard design of the RB/FB structures and components.
- Site-specific evaluations of the RB/FB structures and components use input seismic loads that are based on the site-specific loads presented in Section 3A.18.1.1. These seismic structural loads that bound amplifications due to structural stiffness variations are used as inputs for the site-specific evaluations of the RB/FB structures.
- Site-specific ISRS are developed for all damping values and locations of the RB/FB based on the analyses of the RB/FB models with upper bound stiffness properties and OBE damping. To address the effects of structural stiffness variations described in Section 3A.17.9.1, the site-specific evaluations and design of the equipment and components use site-specific design ISRS that are enhanced as described in Section 3A.18.2.

3A.19.2 Control Building

Site-specific CB SSI analyses indicate the following:

- Site-specific seismic demands exceed the seismic demands used for the standard design of the CB structure.
- The site-specific evaluation of the CB structure uses input seismic loads that are based on the site-specific loads presented in Section 3A.18.1.2. These seismic structural loads that bound amplifications due to concrete cracking effects are used as input for the site-specific evaluation of the CB structure.
- Site-specific ISRS are developed for all damping values and locations of the CB based on the analyses of the CB models with full (uncracked concrete) stiffness properties and OBE damping, as described in Section 3A.18.2. The site-specific evaluations of the equipment and components use enhanced ISRS that bound effects of concrete cracking and the SSSI of the RB/FB and FWSC.

3A.19.3 Firewater Service Complex

Site-specific FWSC SSI analyses indicate the following:

- Site-specific seismic demands exceed the seismic demands used for the standard design of the FWSC structures.

- Site-specific evaluations of the FWSC structures use input seismic loads that are based on the site-specific loads presented in Section 3A.18.1.3. These loads that bound amplifications due to CB SSSI, concrete cracking and separation between the concrete fill and surrounding soil, are used as input for site-specific evaluations of FWSC structures.
- Site-specific ISRS described in Section 3A.18.2 are developed for all damping values and locations within the FWSC based on the envelope of the results of the SSI and SSSI analyses of the FWSC stand-alone and FWSC combined models with full (uncracked concrete) stiffness properties and OBE damping. These ISRS envelop the site-specific SSSI effects of the CB on the FWSC seismic response, as described in Section 3A.17.11. The site-specific ISRS are enhanced as described in Section 3A.18.2 to address the effects of separation between the concrete fill and surrounding soil described in Section 3A.17.14.5 and the effects of concrete cracking described in Section 3A.17.9.3.

3A.19.4 SSSI Effects

Results of the site-specific evaluations of the effects of SSSI, which are described in Section 3A.17.11, show that the SSSI between the FWSC, CB, and RB/FB have small effects on the site-specific seismic responses of these Seismic Category I structures. The site-specific analyses of CB stand-alone models provided the structural load demands presented in Section 3A.18.1.2 that bound the effects of SSSI with a few small exceedances that have a negligible effect on the CB structural design. The ISRS used for design and evaluation of CB equipment and components are enhanced as described in Section 3A.18.2 to bound the SSSI effect of RB/FB and FWSC on the CB site-specific seismic response. The site-specific structural load demands and ISRS presented in Section 3A.18 that are used for the FWSC site-specific evaluations in Appendix 3G are developed by enveloping the results of SSI analysis of the FWSC stand-alone model and the SSSI analyses of the FWSC-CB combined model.

Appendix 3B Containment Hydrodynamic Load Definitions

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3C Computer Programs Used in the Design and Analysis of Seismic Category I Structures

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following at the end of Appendix 3C.

NAPS DEP 3.7-1

3C.7.4 Site-Specific Dynamic Soil-Structure Interaction Analysis Program – SASSI2010

3C.7.4.1 Description

SASSI2010 is used to solve a wide range of dynamic SSI problems in two or three dimensions.

3C.7.4.2 Validation

SASSI version 2010 was obtained from Isatis LLC under the contract with the Regents of the University of California and implemented by Shimizu Corporation of Tokyo, Japan on HP Z420 Workstation computer using Windows 7 OS. Program validation documentation is available at Shimizu Corporation.

The validation test report documents details of the SASSI2010 verification and validation of all of the SASSI2010 program modules used in the Unit 3 SSI analyses with passing frequencies up to 70 Hz. The verification and validation are performed in accordance with the Shimizu Quality Assurance Program. The report describes the methodology used to perform the verification and validation; provides the acceptance criteria; lists the capabilities, options, and limitations that are verified and validated; and provides the details and results of the validation problems. Verification methods include comparison with classical solutions, analytical results or experimental test data; comparisons with results from other software; and comparisons of results of various analysis problems. Acceptance criteria include numerical accuracy, good numerical agreement, and expected behavior. The process confirms that the SASSI2010 computer program is adequate for the 3D seismic response analyses of the Unit 3 SSI systems.

3C.7.5 Free-Field Site Response Analysis – P-SHAKE

A model comparable to the free-field site response analysis SHAKE method described in the DCD Section 3C.7.3 is the PSHAKE method described in Section 2.5.2 (Reference 2.5-222) and Section 3.7.1. P-SHAKE is a Bechtel proprietary modified version of SHAKE.

3C.7.5.1 Description

P-SHAKE is a Bechtel proprietary modified version of SHAKE. P-SHAKE generates the same design earthquake-induced strain-compatible soil properties and site response motions as generated by SHAKE and the input files of the two programs for the most part are compatible. P-SHAKE is, however, built on a different program logic that allows the site response analysis to be performed with acceleration response spectrum as input instead of acceleration time histories used by SHAKE.

3C.7.5.2 Validation

The P-SHAKE program validation documents are located in Bechtel's Computation Service Library.

3C.7.5.3 Extent of Application

P-SHAKE is used to provide the site-specific earthquake-induced design ground motions and the associated strain-compatible soil properties for the Seismic Category I structures (RB/FB, CB, and FWSC).

3C.7.6 Site-Specific Dynamic Soil-Structure Interaction Analysis Program – ACS SASSI

3C.7.6.1 Description

ACS SASSI is a finite element computer code for performing 3D dynamic SSI analyses for shallow, embedded, deeply embedded, and buried structures under external vibratory or impulsive forces or earthquake ground motions. ACS SASSI is based on the SASSI code developed by the University of California at Berkeley.

3C.7.6.2 Validation

ACS SASSI was obtained from Ghiocel Predictive (GP) Technologies, Inc. under a 10 CFR 50, Appendix B, quality purchase order. Program validation documentation is available at GP Technologies, Inc., 6 South Main Street, 2nd Floor, Pittsford, NY 14534. Specific to the Unit 3 site conditions, GEH and Shimizu performed analyses to validate the results for ACS SASSI for use in performing sensitivity analyses for Unit 3.

3C.7.6.3 Extent of Application

This program is used to perform sensitivity analyses for Unit 3 site-specific SSI analysis for Seismic Category I structures.

3C.7.7 Soil Column Amplification/Attenuation Analysis – SHAKE2000

3C.7.7.1 Description

The original SHAKE computer program for earthquake response analysis of horizontally layered sites was developed at the University of California, Berkeley, by B. Schnabel, John Lysmer, and H. B. Seed in 1972. SHAKE2000 (Version 1.1 / 2006) is a Bechtel proprietary modified version of SHAKE, and is a separate program. SHAKE2000 generates the design earthquake-induced strain-compatible soil properties and site response motions.

3C.7.7.2 Verification

The SHAKE2000 program verification documents are in Bechtel's Computation Service Library.

3C.7.7.3 Extent of Application

SHAKE2000 is used to calculate the site response motions in SSI input soil profiles consistent with the SSI input time-histories as described in Section 3.7.1.

Appendix 3D Computer Programs Used in the Design of Components, Equipment, and Structures

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3E Deleted

Appendix 3F Response of Structures to Containment Loads

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3G Design Details and Evaluation Results of Seismic Category I Structures

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following paragraphs at the beginning of this section.

NAPS DEP 3.7-1

DCD Sections 3G.1 through 3G.6 provide the standard design details and evaluation results for the Seismic Category I structures based on the CSDRS and the standard design analyses. Sections 3G.7 through 3G.10 provide the site-specific design details and evaluation results for the Seismic Category I structures based on the Unit 3 ground motion response spectra, which is not bounded by the CSDRS at all frequencies.

The structural evaluations follow the standard design methodologies, use the standard design load combinations and selected elements, and use the standard design loads, which bound the site-specific characteristics (other than the CSDRS), except that the standard design seismic loads are replaced with the site-specific seismic loads.

The standard design structural evaluations continue to apply and remain valid for the CSDRS seismic response. The site-specific structural evaluations using the standard design loads, load combinations, and selected elements, but replacing the seismic loads with the site-specific seismic loads, supplement the standard design evaluations to address site-specific conditions. The standard design of the Seismic Category I structures is maintained, except where the design is adjusted by providing additional reinforcement, as described in Sections 3G.7 through 3G.10, to ensure seismic adequacy as part of the selected elements evaluation.

These site-specific evaluations use seismic loads presented in Section 3A.18, which incorporate the effects of stiffness variation, SSSI, and soil separation, as applicable.

The site-specific evaluations are based on the results of static analyses performed on NASTRAN finite element models which are identical to those used for the standard design described in DCD Section 3G.1.4. These models consider the stiffness of the subgrade by using the same linear elastic spring elements and subgrade stiffness properties as the ones used for the standard design described in DCD Section 3G.1.4.2. These spring elements that represent the generic soft soil subgrade

stiffness provide design demands that envelope the effects of the stiffer site-specific rock subgrade and foundation uplift with a few exceptions that do not affect the conclusions of the site-specific evaluations. The results of sensitivity evaluations showed that amplifications due to the higher site-specific subgrade stiffness and foundation uplift are small. The site-specific design margins envelope any possible amplifications due to the higher site-specific subgrade stiffness or foundation uplift.

The adequacy of the Seismic Category I structures for site-specific conditions is demonstrated by comparing the site-specific demands with the structural members section capacities at the same set of selected elements as those considered for the standard design.

In addition to the site-specific structural evaluations using the DCD selected elements, a sensitivity study has been performed to further demonstrate the structural adequacy of the concrete members in Seismic Category I structures at Unit 3. The study first identified specific regions experiencing seismic demands that exceed the standard design seismic demands. The study reviewed the regions in each of the structures and identified a total of 96 additional elements located in the seismic load path for additional site-specific structural evaluation (62 in the RB, 27 in the FB, and 7 in the CB). The additional site-specific structural evaluation results from the study indicate that no changes to the standard design concrete member properties (e.g., wall and slab thicknesses, beam and column sizes) are necessary to meet the standard design structural acceptance criteria. The results of this sensitivity study indicate that localized reinforcement may need to be added to some of these structural members as part of detailed design.

The final design details of the SSCs will meet the structural acceptance criteria, as presented in Section 3.8, and will be verified through ITAAC. The methods used in the standard design to complete final site-specific structural design details are modified as described in Section 3.8 and Appendix 3G.

Add the following at the end of this section.

NAPS DEP 3.7-1

3G.7 Site-Specific Structural Evaluation of Reactor Building/Fuel Building Complex

The site-specific structural evaluations of the RB and FB, which are founded on a common basemat, are performed as the RB/FB complex. This section describes the structural evaluation of containment structure,

containment internal structures, and RB structures, and Section 3G.9 describes the separate structural evaluations of the FB. The stability evaluation of the RB/FB complex foundation is described in Section 3G.7.5.5.

3G.7.1 Objective and Scope

The objective of this section is to document the site-specific structural evaluations based on the site-specific seismic analyses performed to address exceedances of the CSDRS. DCD Section 3G.1 remains applicable for the analysis and design of the RB, containment, and containment internal structures with the seismic loads based on the CSDRS. Results of site-specific SSI analyses indicate that seismic load demands, in some cases, exceed the seismic load demands used in the standard design. The site-specific structural evaluations of the RB, containment, and containment internal structures use the input site-specific seismic loads from Section 3A.18.1.1.

3G.7.2 Conclusions

For the RB, the concrete containment, and the containment internal structures, site-specific finite element analyses performed, as described in Sections 3G.7.3, 3G.7.4, and 3G.7.5, demonstrate that the stresses or strains in concrete, reinforcement, liner, and containment internal structures, with the exception of a change for the RB and an overstress condition for the containment internal structures (listed below), are less than the allowable stresses or strains per the applicable regulations, codes, or standards listed in DCD Section 3.8.

- For the RB, a change is made in the arrangement of shear ties for Element 24211 (Section 3G.7.5.4.3)
- For the containment internal structures, no change is made to the diaphragm floor radial web plates (upper and lower), for which the structural evaluation shows that there is an overstress condition (see Section 3G.7.5.4.2.1 for the justification)

The factors of safety against sliding and overturning of the structure are higher than the required minimum, as described in Section 3G.7.5.5. The lateral passive resistance pressures required for the site-specific stability of the RB/FB foundation are enveloped by the lateral passive pressure loads used in DCD Section 3G.1.5.5 for the standard design capacity check of the RB/FB below-grade exterior walls.

For the PCCS condenser supports, a change is made to ensure that the support saddle bolts and their embedment are designed to withstand the increased tension load due to the site-specific seismic loads, as described in Section 3G.7.5.4.1.5.

3G.7.3 Structural Description

The RB/FB structures are described in DCD Sections 3G.1.3 and 3G.3.3.

3G.7.4 Analytical Models

3G.7.4.1 Structural Models

Site-specific structural models are based on the standard design structural models described in DCD Sections 3G.1.4.1 for the RB and 3G.3.4 for the FB. The RB/FB, containment, and containment internal structures are analyzed using the finite element computer program NASTRAN, which is described in DCD Section 3C.2.

3G.7.4.2 Foundation Models

Site-specific foundation models are based on the standard design foundation models described in DCD Section 3G.1.4.2.

3G.7.5 Structural Analysis and Design

3G.7.5.1 Site Design Parameters

Key site design parameters used in the structural evaluation are those identified in DCD Section 3G.1.5.1, based on soft site subgrade stiffness conditions, which are conservative for the Unit 3 hard rock site.

Key site-specific parameters used as inputs for the site-specific stability and bearing pressure calculations are identified in Table 3G.7-201.

3G.7.5.2 Site Design Loads, Load Combinations, and Material Properties

Site-specific structural evaluations use the loads (except for the seismic loads), load combinations, and acceptance criteria that are used to perform the standard design structural evaluations. The standard design structural evaluation process is described in DCD Section 3G.1.5.4. The seismic loads are obtained from the site-specific SSI analyses results described in Section 3A.18.1.1.

The following loads are the same as those used in the standard design:

• Dead Load and Live Load	DCD Section 3G.1.5.2.1.1
• Snow and Rain Load	DCD Section 3G.1.5.2.1.2
• Lateral Soil Pressure at Rest	DCD Section 3G.1.5.2.1.3
• Wind Load	DCD Section 3G.1.5.2.1.4
• Tornado Load	DCD Section 3G.1.5.2.1.5
• Pressure Loads	DCD Section 3G.1.5.2.1.7
• Condensation Oscillation and Chugging Loads	DCD Section 3G.1.5.2.1.8
• Safety Relief Valve Loads	DCD Section 3G.1.5.2.1.9
• Steam Tunnel Subcompartment Pressure	DCD Section 3G.1.5.2.1.10
• Subcompartment Pressure in Other Compartments	DCD Section 3G.1.5.2.1.11
• Annulus Pressurization Loads	DCD Section 3G.1.5.2.1.12

For the thermal loads, DCD Section 3G.1.5.2.1.6 explains that the structural evaluation for TRACG calculated-LOCA temperatures is described in DCD Section 3G.5. The structural evaluations of the RB upper pools in DCD Section 3G.5 used updated temperatures to demonstrate that the thermal transient profiles calculated by TRACG do not invalidate the structural design analysis using thermal loads presented in DCD Section 3G.1.5.2.1.6. The standard design model with the updates to address the TRACG loads also included standard design changes in the pool gate and upper pools. The updated global finite element model is used for site-specific structural evaluations that include the dead load, the pressure loads (at the drywell, IC/PCCS pools, and the HELB in the MS tunnel and wetwell), the temperature loads in the RB upper pools, and the site-specific seismic loads. Other site-specific load cases are used with the original global finite element model, as these cases are not influenced by design changes in the pools and are the same as those considered in the standard design, DCD Section 3G.1.5.2.1.6.

For the RCCV thermal loads, a method using 3D nonlinear analyses applied in the standard design is not used for the site-specific structural evaluation. The effects of concrete cracking due to the thermal load are

considered by reducing the thermal section forces using the SSDP-2D method described in DCD Section 3G.1.5.4. Because the method using SSDP-2D is more conservative than the 3D nonlinear method, and because the SSDP-2D method is used for the normal operation loads, it is acceptable to use the SSDP-2D method for the reduction of thermal section forces in the RCCV structural evaluation.

Site-specific seismic loads are substituting the standard design seismic loads. Four components (two horizontal, one vertical, and one torsional) of the seismic loads are considered. Overturning moment loads applied at each floor elevation are also considered to account for the effects of floor rocking on the wall axial forces. The soil pressure due to an earthquake is considered a seismic load. The dynamic soil pressure loads due to earthquakes are calculated from the SSI analyses results as described in Section 3A.17.12.4. The structural evaluation also considers the lateral passive resistance pressures required for the stability of the RB/FB foundation that are obtained from the results of the sliding stability analyses in Section 3G.7.5.5. The lateral soil pressures at rest used in the site-specific structural evaluation are the same as those used for the standard design structural evaluations. The site-specific lateral pressure loads on the walls are shown on Figures 3G.7-205 through 3G.7-212.

Load combinations and acceptance criteria are the same as the standard design, as described in DCD Section 3G.1.5.2.2.

Material properties used in the Unit 3 analyses for concrete, reinforcing steel, and structural steel are the same as those used in the standard design, as described in DCD Section 3G.1.5.2.3.

3G.7.5.3 Stability Requirements

The stability requirements for the RB/FB are given in DCD Section 3G.1.5.3. A factor of safety of 1.1 is required for both overturning and sliding. Analyses demonstrate that the RB/FB meets the required factors of safety for overturning stability and for stability against sliding, as described in Section 3G.7.5.5. The seismic stability of the RB/FB is demonstrated without reliance on the shear keys, which are credited in the standard design stability evaluation. However, the design for the RB/FB is not changed.

3G.7.5.4 Structural Design Evaluation

This section provides a description of the structural design evaluations of the containment structure, the containment internal structures, and the RB structures, considering site-specific seismic load demands. Except as noted otherwise, site-specific evaluations use the standard design models, analysis methods, loads (as described in Section 3G.7.5.2), load combinations, and acceptance criteria, but the standard design seismic loads are replaced with the seismic loads determined by the site-specific analyses described in Sections 3A.10 through 3A.19.

The site-specific evaluations of these structures are performed using the seismic design loads described in Section 3G.7.5.2, which, in some instances, exceed the seismic design loads of the standard design as shown in Section 3A.18.1.1. These loads are included in the site-specific structural evaluation to demonstrate the adequacy of the standard design or to identify changes that are necessary for the site-specific Seismic Category I structures.

Figures 3G.7-213 through 3G.7-215 illustrate deformations of the overall RB structure obtained by NASTRAN analyses for the seismic loads corresponding to Tables 3G.7-202 through 3G.7-204, which present the RCCV and RB seismic load results. These figures correspond to DCD Figures 3G.1-36 through 3G.1-38. Tables 3G.7-202 through 3G.7-204 present the internal membrane forces and moments in the RCCV and RB due to the site-specific seismic loads.

For the site-specific RB/FB stress evaluations, the computer program SSDP-2D is used to evaluate rebar and concrete stresses consistent with the standard design as described in DCD Section 3G.1.5.4, except as described in Section 3G.7.5.2 and below. Figure 3G.7-201 is a flowchart showing the structural analysis and design process used in the site-specific stress evaluations, which is comparable to DCD Figure 3G.1-39 for the standard design process.

The SSDP-2D computer program uses a simplified approach for meeting ASME Code requirements for factored loads. Specifically, the concrete compressive stress distribution in SSDP-2D is based on a linear distribution, which is more conservative than the parabolic or nonlinear stress distribution permitted in ASME BPVC, Section III, Division 2, Section CC-3511.1(e).

For cases where an element exceeds ASME acceptance criteria using the conservative SSDP-2D analysis, additional reinforcing steel is added or the element is evaluated using axial load-moment interaction curves that meet ACI 349-01 and ASME acceptance criteria. The ASME acceptance criteria are based on a parabolic concrete stress-strain relationship and applicable ASME allowable stresses for a cross section subjected to membrane loads and moments due to factored loads. This approach ensures that the more limiting acceptance criteria of the ASME Code and the ACI 349-01 Code are met, as described in Section 3.8.4.5.

3G.7.5.4.1 Containment Structure

The site-specific evaluations demonstrate that the RCCV standard design is adequate to resist the site-specific seismic loads presented in Section 3A.18.1.1 in combination with non-seismic standard design loads. A change in the PCCS condenser support design for the support saddle bolts and their embedment is described in Section 3G.7.5.4.1.5. Conclusions from the site-specific stress checks are summarized as follows:

- Stresses of the concrete and rebar are less than the allowable stresses specified in the code.
- Areas of the primary and shear reinforcement, which have been provided, satisfy the required values.

Tables 3G.7-202 through 3G.7-204 provide the results of the NASTRAN analysis for the seismic loads for the RCCV (Sections 1 through 17, as shown on DCD Figure 3G.1-28). Combined forces and moments for the RCCV are shown in Tables 3G.7-205a through 3G.7-205e. Tables 3G.7-206a through 3G.7-206e compare the rebar and concrete stresses determined from the RCCV selected load combinations CV-1, CV-7a, CV-7b, CV-11a, and CV-11b to the code allowable stresses, respectively. Table 3G.7-207 presents the RCCV transverse shear results and Table 3G.7-208 presents the RCCV tangential shear results. Table 3G.7-211 shows the stress summary of the Drywell Head. Section 3G.7.5.4.1.5 provides results of the site-specific stress analysis of the PCCS condenser and support with site-specific seismic loads.

The site-specific evaluation of the containment liner plate is performed to evaluate the structural integrity of the liner plate following the same methodology and acceptance criteria as that used for the standard design. The strain of the liner plate is obtained from the NASTRAN model

analysis for the site-specific seismic loads combined with the non-seismic standard design loads. As shown on Table 3G.7-210, the maximum strains of the containment liner plate are less than the allowable limits.

3G.7.5.4.1.1 Containment Wall Including RPV Pedestal

Sections 1 through 9, which are shown on DCD Figure 3G.1-28, are selected sections for the containment wall, including the RPV pedestal. Maximum stress in the vertical rebar is 224.7 MPa (32.58 ksi) at Section 7 near the bottom of the RCCV Drywell due to load combination CV-11b, as shown in Table 3G.7-206e. The maximum stress in the hoop rebar is 209.7 MPa (30.41 ksi), which occurs at Section 8, the Drywell mid-height due to load combination CV-11b, as shown in Table 3G.7-206e. The maximum concrete compressive stress is -21.0 MPa (-3.05 ksi), which occurs at Sections 7, 8, and 9 due to load combination CV-11b, as shown in Table 3G.7-206e.

The maximum transverse shear stress is 4.38 MPa (0.64 ksi) at Section 1 for the load combination CV-7b. The amounts of shear ties provided satisfy the required values at all sections, as indicated in Table 3G.7-207.

The maximum tangential shear stress of 1.80 MPa (0.26 ksi) is found at Section 7, the bottom of the Drywell, due to load combinations CV-11a and CV-11b. The value is less than the allowable tangential shear stress provided by orthogonal reinforcement. The amounts of reinforcement provided satisfy the required values at all sections as shown in Table 3G.7-208.

3G.7.5.4.1.2 Containment Top Slab and Suppression Pool Slab

For the Containment Top Slab and Suppression Pool Slab, Sections 12 through 17 in DCD Figure 3G.1-28 are examined. The maximum rebar stresses are 241.2 MPa (34.98 ksi) at Section 16 due to the load combination CV-11b in the Top Slab, and 238.2 MPa (34.55 ksi) at Section 13 due to load combination CV-11b in the Suppression Pool Slab. The maximum concrete compressive stress in the Top Slab is -24.4 MPa (-3.54 ksi), which occurs at Section 15 due to load combination CV-11b, as shown in Table 3G.7-206e, and in the Suppression Pool Slab is -26.1 MPa (-3.78 ksi), which occurs at Section 13 due to load combination CV-7b, as shown in Table 3G.7-206c.

For the Containment Top Slab and Suppression Pool Slab, the maximum transverse shear stresses are 1.79 MPa (0.26 ksi) at Section 15 for the

load combination CV-7b in the Top Slab, and 3.18 MPa (0.46 ksi) at Section 14 for load combination CV-7a in the Suppression Pool Slab. The amounts of shear ties provided satisfy the required values at all sections, as indicated in Table 3G.7-207.

3G.7.5.4.1.3 Containment Foundation Mat

For the Containment Foundation Mat, Sections 10 and 11 in DCD Figure 3G.1-28 are evaluated for the part of the concrete containment in the foundation mat. The maximum rebar stress is calculated as 69.5 MPa (10.08 ksi) at Section 11 due to load combination CV-7b as shown in Table 3G.7-206c.

For the Containment Foundation Mat, the maximum transverse shear stress of 0.95 MPa (0.14 ksi) is found also at the Section 11 for load combination CV-11b, as shown on Table 3G.7-207. The maximum concrete compressive stress is -7.7 MPa (-1.12 ksi) at Section 11 due to load combination CV-11a as shown in Table 3G.7-206d.

3G.7.5.4.1.4 Drywell Head

The Drywell Head is analyzed using the NASTRAN finite element analysis computer program. The stresses, including discontinuity stresses induced by the combination of external pressure or internal pressure, dead load, live load, thermal effects, and seismic loads, are evaluated. The Drywell Head design details are shown in DCD Figure 3G.1-51. This figure includes a value for the initial bolt stress (preload) of the SA-437 Gr. B4B, M80 drywell head flange bolts as 166 MPa based on the nominal 80 mm bolt diameter. This corresponds to 198 MPa based on the diameter of the bolt at the root of thread, or section of least diameter under stress.

The highest stresses calculated in the site-specific structural evaluation are summarized in Table 3G.7-211, which shows the stress summary of the Drywell Head with the site-specific seismic loads. As in the standard design, as documented in DCD Table 3G.1-36, the stresses (except $P_L + P_b + Q$ at service Level A and B) are well within the allowable stress limits. $P_L + P_b + Q$ at service Level A and B exceeds the allowable stresses, as in the standard design. However, as for the standard design, it is shown to be acceptable for meeting all requirements for the simplified elastic-plastic analysis stipulated in NE-3228.3 of the ASME BPVC, Section III, using the standard design process as described in DCD Section 3G.1.5.4.1.4.

3G.7.5.4.1.5 PCCS Condenser

A site-specific structural evaluation is performed for the PCCS condenser and its RCCV support, using the standard design methodologies and models described in DCD Reference 3G.1-3 and the site-specific seismic ISRS. Results of the site-specific analyses indicate that certain of the site-specific loads are not bounded by the corresponding loads considered in the standard design evaluation, but the PCCS condenser component stresses remain bounded by the standard design stresses or are below the allowable stress values, as described in Reference 3G.7-201. Specific to the PCCS condenser support design, the support saddle bolts and their embedment are designed to withstand the increased tension load due to the site-specific seismic load demands.

3G.7.5.4.2 Containment Internal Structures

Site-specific evaluations of the containment internal structures are performed following the same methodology used for the standard design and using the applicable load combinations for the particular structure, but with the site-specific seismic loads presented in Section 3A.18.1.1. As in the standard design evaluations described in DCD Section 3G.1.5.4.2, the SRSS method is used to combine the stresses due to dynamic loads, such as seismic, hydrodynamic, and annulus pressurization loads, for the steel structures. No design changes from the standard design are necessary. DCD Figures 3G.1-55 through 3G.1-59 show the design of these structures. Except for the diaphragm floor, the containment internal structures are within the acceptance criteria of the standard design. As discussed in Section 3G.7.5.4.2.1, the standard design of the diaphragm floor is acceptable. A refined calculation for the diaphragm floor, consistent with the calculation used for the development of out-of-plane loads on slabs, uses equivalent average acceleration to demonstrate that the site-specific stress demands for the upper and lower radial plates remain within the allowable limits.

3G.7.5.4.2.1 Diaphragm Floor

Design of Structural Components: The design of the diaphragm floor is based on the elastic analysis results obtained from the model described in DCD Section 3G.1.4. Table 3G.7-212 summarizes the stresses in various structural elements of the diaphragm floor slab obtained using an out-of-plane acceleration load of 2.38g representing the flexible mode of vibration. This acceleration, when applied on the total weight of the slab,

results in an overly conservative load demand causing the site-specific stress demands calculated in this manner for the upper and lower radial plates to exceed code allowable stresses by approximately 6 percent. All other stresses are within the allowable limits. To demonstrate that the site-specific stress demands for the upper and lower radial plates will remain within allowable limits, an additional calculation has been performed applying the same methodology as the one used for development of the out-of-plane loads on other slabs (equivalent average acceleration), which yields a significantly lower demand (1.53g) on the slab and reduces the stress demands below the code allowable values.

Design of Anchorage: Anchorage requirements for various loading combinations and the capacities of the anchorage provided are shown in Table 3G.7-213. Design loads are within the capacity of the anchorage.

3G.7.5.4.2.2 Vent Wall Structure

Design of Structural Components: Stresses in the inner cylinder, the outer cylinder, and the web plate are summarized in Table 3G.7-214. The stresses are shown to be within allowable limits.

Design of Anchorage: The most severe case of the vent wall anchorage reaction load is summarized in Table 3G.7-217. The design loads are within the capacity of the anchorage.

3G.7.5.4.2.3 Reactor Shield Wall

The stresses are summarized in Table 3G.7-215 and are within the allowable limits.

3G.7.5.4.2.4 RPV Support Bracket

Design of Structural Components: The stresses in the support bracket are summarized in Table 3G.7-216 and are within allowable limits.

Design of Anchorage: DCD Figure 3G.1-57 shows the RPV support bracket anchorage into the RCCV wall. The most severe case of the RPV support bracket anchorage reaction load is summarized in Table 3G.7-217. The design loads are within the capacities of the anchorage.

3G.7.5.4.2.5 Gravity-Driven Cooling System Pool

Design of Structural Components: DCD Figure 3G.1-59 shows the design details. The stresses are summarized in Table 3G.7-218. Taking into account the deformation limit evaluation for the horizontal beam member, stresses and stress ratios are within the allowable limits.

Design of Anchorage: Threaded mechanical couplers with anchor bars are used as shown in DCD Figure 3G.1-59. Table 3G.7-219 shows the anchorage requirements and the capacities of the anchorage provided. The design loads are within the capacities.

3G.7.5.4.3 Reactor Building

Site-specific analyses indicate that the standard design RB structures meet the structural acceptance criteria to withstand the site-specific seismic loads presented in Section 3A.18.1.1 in combination with non-seismic standard design loads on the structures, with the exception of a change in the arrangement of shear ties for a single wall. This section summarizes the results of the analyses of the RB structure with the change in the arrangement of shear ties.

Stress check calculations of the RB structures are performed to evaluate the structural integrity of the RB following the standard design methodology. The stress checks are based on results of the global model analyses for the site-specific seismic loads combined with the non-seismic load results from the standard design. The conclusions are summarized as follows.

- Reinforced concrete structures
  - The stresses of the concrete and rebar are less than the allowable stresses specified in the code, with the change in the arrangement of shear ties for the exterior wall at column line R7/F1 (Element 24211), as described below.
  - The sections have sufficient strength to withstand transverse shear forces generated by design loads.
- Steel structures
  - The stresses of steel members are less than the allowable stresses specified in the code.

Sections 18 through 31, which are shown on DCD Figure 3G.1-28, and Section 32, which is the IC/PCCS pool wall in the N-S direction, are considered for the site-specific evaluations of the RB. Tables 3G.7-220a and 3G.7-220b show the combined forces and moments for the RB selected load combinations 9a and 9b (see DCD Table 3G.1-11 for the load combinations). Table 3G.7-221 shows the sectional thicknesses and rebar ratios of the RB used in the evaluation. In evaluating the sectional thicknesses and rebar ratios, it was identified that a change in the

arrangement of the shear ties is needed to withstand site-specific seismic loads. A change from the standard plant is made in the arrangement of shear ties for Element 24211 in Section 23 at the exterior wall of the RB, Elevation 22.50 m to Elevation 24.60 m, column line R7/F1, from #7@400x200 (DCD Table 3G.1-50) to #7@200x200.

The stresses of the concrete and reinforcing steel are calculated for flexure and membrane forces using the SSDP-2D computer code, as described in DCD Section 3G.1.5.4. The calculations are performed for selected design load combinations and confirm that values are less than their allowable stresses. Calculated stresses and allowable stresses are compared in Tables 3G.7-222a, 3G.7-222b, and 3G.7-222c for the RB selected load combinations 9a, 9b, and 8b. Table 3G.7-223 presents the RB transverse shear results for the DCD load combinations.

The foundation stability of the integrated RB and FB common foundation is described in Section 3G.7.5.5. Section 3G.7.5.6 describes the lateral pressures on exterior embedded walls that are used as input for the structural evaluation.

3G.7.5.4.3.1 RB Shear Walls

For the RB shear walls, the maximum rebar stress of 319.7 MPa (46.36 ksi) is found in the vertical rebar at Section 23 due to the load combination RB-9b, as shown in Table 3G.7-222b. The maximum horizontal rebar stress is 246.0 MPa (35.67 ksi) at Section 22 due to the load combination RB-9b, as shown in Table 3G.7-222b. The maximum transverse shear force is 4.95 MN/m (28.26 kips/in) against the shear strength of 6.61 MN/m (37.73 kips/in) at Section 20, the top of the cylindrical wall below the RCCV wall, as shown in Table 3G.7-223.

3G.7.5.4.3.2 RB Foundation Mat Outside Containment

Section 24, as shown on DCD Figure 3G.1-28, is selected for the RB foundation mat outside the containment at the junction with the cylindrical wall below the RCCV wall. The maximum rebar stress of 152.3 MPa (22.08 ksi) is found in the top rebar, as shown in Table 3G.7-222a. The maximum bottom rebar stress is 59.4 MPa (8.61 ksi), as shown in Table 3G.7-222a. The maximum transverse shear force is 6.34 MN/m (36.19 kips/in) against the shear strength of 15.69 MN/m (89.57 kips/in), as shown in Table 3G.7-223.

3G.7.5.4.3.3 RB Floor Slabs

For floor slabs, Sections 25 to 27, as shown on DCD Figure 3G.1-28, are selected at their junction with the RCCV. The maximum rebar stress of 273.0 MPa (39.59 ksi) is found at Section 26, as shown in Table 3G.7-222c for selected load combination RB-8b. A maximum transverse shear force is 8.30 MN/m (47.38 kips/in) against the shear strength of 10.65 MN/m (60.81 kips/in), as shown in Table 3G.7-223.

3G.7.5.4.3.4 Pool Girders

Sections 28 to 30, as shown on DCD Figure 3G.1-28, are selected for evaluation for pool girders. The maximum rebar stress of 271.6 MPa (39.38 ksi) is found in the horizontal rebar at Section 29, as shown in Table 3G.7-222b, whereas the maximum vertical rebar stress is 252.9 MPa (24.61 ksi) at Section 28, as shown in Table 3G.7-222b. The maximum transverse shear force is 1.02 MN/m (5.82 kips/in) against the shear strength of 5.58 MN/m (31.85 kips/in), as shown in Table 3G.7-223.

3G.7.5.4.3.5 Main Steam Tunnel Floors and Walls

Section 31 is selected for the MS tunnel wall and slabs. The maximum rebar stress is 230.6 MPa (33.44 ksi), as shown in Table 3G.7-222b. The maximum transverse shear force is 0.57 MN/m (3.26 kips/in) against the shear strength of 5.74 MN/m (32.78 kips/in), as shown in Table 3G.7-223.

3G.7.5.4.3.6 IC/PCCS Pool

Section 32, described in DCD Section 3G.5.3, is selected for the pool wall in NS direction. The maximum stress of the vertical rebar is found be 98.5 MPa (14.28 ksi) due to the load combination RB-9a as shown in Table 3G.7-222a. The maximum stress of the horizontal rebar is found to be 82.6 MPa (11.98 ksi) due to the load combination RB-8b also as shown in Table 3G.7-222c. The maximum transverse shear force is 0.23 MN/m (1.31 kips/in) against the shear strength of 2.42 MN/m (13.81 kips/in), as shown in Table 3G.7-223.

3G.7.5.5 Foundation Stability

The methodology used for the site-specific stability calculations is consistent with the methodology used for the standard design stability evaluations presented in the DCD Section 3.8.5.5. The seismic stability of the RB/FB is evaluated against overturning and sliding.

Site-specific evaluations of the foundation seismic stability and dynamic bearing pressures are performed using the results obtained from the set

of six site-specific design basis SSI analyses of the RB/FB model with for BE, LB, and UB partial and full column profiles. These analyses of models with UB structural stiffness properties and OBE damping values provide seismic demands that bound the effects of structural stiffness variations on the stability, foundation dynamic bearing pressures and the lateral passive resistance pressure demands on the below-grade exterior walls required for the seismic stability of the RB/FB.

The factors of safety against overturning due to earthquake loading for the RB/FB, using the SSI seismic analysis results presented in Appendix 3A, are determined by using the energy approach described in DCD Section 3.7.2.14. The sliding evaluation is performed for two orthogonal horizontal directions separately using a linear time history analysis approach. In each direction, the phasing between the horizontal and vertical seismic forces is considered at each time step to compute the sliding factor of safety in the time domain.

Table 3G.7-225 presents the calculated overturning and sliding stability factors of safety for the SSI analyses Cases 1 through 6, which are described in Table 3A.15-201. The calculated overturning and sliding stability factors of safety are equal to or greater than the acceptance criteria in DCD Section 3G.1.5.3 and DCD Table 3.8-14 for a factor of safety acceptance criteria of 1.1. Therefore, the calculations demonstrate the adequate stability of the RB/FB.

The results of the sliding stability evaluations in Table 3G.7-225(b) show that the base friction and the lateral resistance provided by the concrete fill and Zone III rock embedment alone are sufficient to ensure that the RB/FB foundation maintains a factor of safety against sliding that is greater than the required acceptance criteria of 1.1. The maximum lateral pressures required to maintain a sliding factor of safety greater than 1.1 are less than the allowable lateral bearing capacity of the subgrade surrounding the RB/FB in Table 3G.7-201. Lateral passive pressures required to ensure the sliding stability of the RB/FB at the site are calculated assuming triangular distribution. In Section 3G.7.5.6, these pressures are compared with the corresponding lateral pressures used for the standard design of the RB/FB structures.

The calculations of the RB/FB foundation maximum soil dynamic bearing pressure demands follow the same Energy Balance (EB)/Modified Energy Balance (MEB) method that was used for the standard design calculations, as described in DCD Section 3G.1.5.5 (DCD

Reference 3G.1-2). These dynamic bearing pressure demands are compared with the allowable dynamic bearing capacity provided in Table 2.5.4-211 to ensure the capacity of the subgrade is sufficient to resist the dynamic bearing pressures from the RB/FB foundation.

Specifically, the basemat uplift rotation, moment, and foundation bearing pressures are calculated in accordance with the MEB method using the results for spring forces at the bottom of the RB/FB basemat from the SSI analyses of the RB/FB as described in Section 3A.17.12.5. The evaluation of the dynamic bearing pressure considers the seismic weight of the RB/FB that includes the building self-weight and 25 percent of the design live loads. The bearing pressure evaluations are performed considering both the upward and downward direction of the vertical seismic base reactions. To capture the effect of the groundwater on the dynamic pressure calculations, the buoyancy force is subtracted from the gravity force for the calculations that consider upward seismic force reaction. The time histories of the overturning moments about the X and Y axes at the center of the RB/FB foundation are calculated by summing the moments generated by each vertical nodal spring reaction at the bottom of the basemat.

The calculated maximum dynamic soil bearing pressures for the RB/FB foundation for the SSI analyses Cases 1 through 6, which are listed in Table 3A.15-201, are shown in Table 3G.7-231. The site-specific dynamic foundation bearing pressure calculations show that the site-specific demands are lower than the dynamic bearing pressures considered in the standard design of the RB/FB foundation (DCD Table 3G.1-58). The calculated maximum dynamic bearing pressure is also lower than the allowable dynamic bearing pressure of the Zone III-IV rock and concrete fill underlying the RB/FB foundation provided in Table 2.5.4-211.

3G.7.5.6 Lateral Pressures on Exterior Embedded Walls

Figures 3G.7-205 through 3G.7-212 provide plots of the site-specific total lateral soil pressure acting on the below grade exterior walls of the RB/FB. Two plots are presented in each figure comparing the site-specific lateral pressure demands on each wall segment with the corresponding lateral pressure loads used for the standard design of RB/FB structures in DCD Section 3G.1. The first plot presents the comparison of the at-rest static and the dynamic components of the lateral pressures acting on the walls. The seismic lateral pressure

demands represent the envelope of the results obtained from the site-specific SSI analyses described in Section 3A.17.12.4. The second plot compares the site-specific total pressures (static plus dynamic) and the maximum passive pressures required for sliding stability of the RB/FB with the corresponding standard design loads. Figures 3G.7-205 through 3G.7-212 show that, near the slab at Elevation 270.3 ft NAVD88 (standard design Elevation -1.50 m), the site-specific total lateral pressures exceed the lateral pressures used for the standard design of RB/FB structures. The maximum total site-specific lateral pressures presented in this section are used as input for the site-specific evaluations of the RB/FB structures to demonstrate that the capacities of the RB/FB below-grade exterior walls are sufficient to resist the site-specific lateral pressure demands.

Table 3G.7-232 presents the magnitudes of the site-specific dynamic lateral pressure loads applied on the below grade exterior walls of the finite element model used for the site-specific evaluation of RB/FB structures. These loads envelope the results of the RB/FB site-specific SSI analyses for dynamic pressure loads that are presented in Figures 3G.7-205 through 3G.7-212.

As shown in Figures 3G.7-205 through 3G.7-212, the lateral passive resistance demands required for the site-specific stability of the RB/FB foundation are enveloped by the corresponding lateral passive pressure loads used in the standard design to check the capacity of the RB/FB below-grade walls in DCD Section 3G.1.5.5. Therefore, the site-specific capacity check of the RB/FB walls is not performed because the results of the standard design capacity check that are presented in DCD Tables 3G.1-57a through 3G.1-57e bound the corresponding site-specific demands.

3G.7.5.7 Tornado Missile Evaluation

DCD Section 3G.1.5.6 is applicable to the Unit 3 RB with no changes.

3G.7.5.8 References

3G.7-201 GE Hitachi Nuclear Energy, “North Anna 3 PCCS Condenser Seismic Analysis,” 002N8530, Class I (Nonproprietary), Revision 4, April 2016.

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Table 3G.7-201 **RB/FB Site-Specific Parameters**

Parameters	Values
Building Width:	
X-direction (NS-direction)	229.7 ft (70 m)
Y-direction (EW-direction)	160.8 ft (49 m)
Zone III Rock Embedment Depth:	
Nominal Zone III Rock Elevation	El. 273 ft, NAVD88 (standard design El. -0.68 m)
Depth to bottom of RB/FB basemat	48.6 ft (14.82 m)
At-Rest Lateral Pressure Coefficient K_0	
Structural fill	0.36
Concrete fill (calculated per Eq. 7-2)	0.176 (Poisson ratio ν_c = 0.15)
Unit weight (dry and submerged)	
Structural fill	2.08 t/m^3 (dry) 1.295 t/m^3 (submerged)
Concrete fill	2.32 t/m^3(dry) 1.445 t/m^3 (submerged)
Water Level:	
Nominal Groundwater Elevation	El. 282.6 ft, NAVD88 (standard design El. 2.24 m)
Depth below finished ground level grade	7.4 ft (2.26 m)
Friction Coefficient, μ:	
Foundation/Zone III/IV Rock Interface	0.6 [a]
Allowable Lateral Dynamic Bearing Pressure:	
Zone III rock at El. 224.4 ft., NAVD88 (standard design El. -15.5 m)	32.8 ksf (1.57 MPa)

a. A value of 0.6 is used for the friction coefficient, which is the lowest value for concrete fill and Zone III-IV rock and the foundation structural concrete.

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Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	-0.146	-0.876	0.260	0.078	0.710	0.030	-0.034	0.223
	5013	0.148	0.459	0.492	0.096	0.550	-0.016	0.022	0.176
	5024	0.131	1.672	0.060	0.028	0.231	-0.003	0.002	0.051
2 RPV Pedestal Mid-Height	6006	-0.404	-2.737	0.365	0.017	0.415	0.085	0.120	-0.192
	6013	-0.279	0.626	0.464	-0.243	-0.120	0.020	-0.001	0.033
	6024	0.561	3.319	0.285	0.105	-0.422	-0.023	-0.019	0.174
3 RPV Pedestal Top	6606	-0.797	-3.344	0.116	0.040	-0.474	-0.119	0.441	0.035
	6613	-0.955	0.703	-0.536	-0.241	-0.445	0.240	-0.229	-0.041
	6624	1.043	4.876	-0.014	0.123	-0.120	0.048	-0.095	0.061
4 RCCV Wetwell Bottom	1806	-1.602	-2.000	-2.302	0.159	1.121	-0.052	0.035	0.471
	1813	-0.258	1.400	-2.584	-0.013	0.119	-0.024	0.015	0.077
	1824	1.276	3.896	-0.186	-0.152	-0.977	-0.005	0.001	-0.454
5 RCCV Wetwell Mid-Height	2606	-0.493	-1.845	-2.724	-0.044	-0.044	-0.098	-0.015	0.121
	2613	-0.637	1.330	-3.008	-0.063	-0.070	-0.038	-0.008	0.002
	2624	0.229	3.133	-0.220	0.071	0.152	0.000	-0.003	-0.210
6 RCCV Wetwell Top	3406	-0.230	-1.478	-2.608	-0.026	0.000	-0.026	-0.006	0.019
	3413	-0.569	1.163	-3.124	-0.021	0.049	-0.058	0.034	-0.063
	3424	-0.533	2.591	-0.092	0.120	0.880	0.030	0.006	-0.317

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Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	-0.191	-1.455	-2.773	0.064	0.520	0.005	0.015	0.169
	3613	-0.525	1.117	-3.091	-0.012	0.080	-0.048	0.036	0.072
	3624	-0.358	3.598	-0.139	-0.194	-0.823	0.047	0.024	-0.183
8 RCCV Drywell Mid-Height	4006	0.525	-1.153	-2.613	-0.066	-0.133	-0.055	0.018	0.217
	4013	-0.283	1.096	-3.011	-0.027	-0.094	-0.086	0.001	0.015
	4976	-0.299	2.887	-0.152	-0.120	-0.196	-0.024	0.020	-0.120
9 RCCV Drywell Top	4406	0.783	-0.848	-2.172	-0.204	-0.968	0.008	0.033	0.295
	4413	0.051	1.162	-2.839	0.044	-0.012	-0.024	-0.053	-0.045
	4424	-0.678	2.369	-0.122	-0.037	-0.103	-0.025	-0.011	-0.082
10 Basemat @ Center	80003	1.808	0.981	-0.103	-2.461	-1.800	0.043	0.054	0.027
	80007	1.767	0.946	-0.129	-2.342	-1.789	0.053	0.090	0.031
	80012	1.683	0.886	-0.072	-2.248	-1.790	0.033	0.107	0.003
11 Basemat Inside RPV Pedestal	80206	2.156	1.176	-0.252	-2.992	-1.539	0.250	0.277	0.095
	80213	1.824	0.867	-0.285	-2.073	-1.294	0.650	0.507	0.198
	80224	1.343	0.769	-0.070	-0.779	-1.267	0.057	0.479	0.019
12 S/P Slab @ RPV	83306	-0.211	-0.855	-0.980	-0.891	-0.493	-0.123	-0.330	0.048
	83313	-0.266	-1.018	0.678	-0.436	-0.283	-0.165	-0.146	0.066
	83324	-0.568	0.380	0.135	0.128	0.028	-0.013	0.082	0.007

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Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	-0.203	-1.174	-0.786	0.159	-0.256	-0.085	-0.230	-0.010
	83413	-0.144	-0.771	0.616	0.050	-0.182	-0.104	-0.108	0.002
	83424	-0.672	0.469	0.092	-0.064	-0.061	-0.008	0.046	0.000
14 S/P Slab @ RCCV	83506	-0.131	-1.313	-0.537	0.802	0.039	0.000	-0.177	-0.022
	83513	-0.084	-0.558	0.601	0.351	-0.037	-0.006	-0.085	-0.020
	83524	-0.634	0.504	0.072	-0.203	-0.124	-0.002	0.041	-0.002
15 Top Slab @ Drywell Head Opening	98120	-0.029	-0.053	-0.040	-0.078	-0.066	-0.063	0.008	0.016
	98135	0.536	0.065	-0.132	-0.091	0.006	-0.011	-0.024	0.009
	98104	-0.059	-1.429	0.077	-0.019	-0.187	0.018	-0.008	0.026
16 Top Slab @ Center	98149	0.034	0.416	0.158	-0.067	0.029	-0.087	-0.004	-0.017
	98170	-0.072	-0.265	0.073	-0.065	-0.096	-0.047	-0.015	-0.018
	98109	0.117	-1.213	-0.056	-0.156	-0.248	-0.020	-0.063	0.042
17 Top Slab @ RCCV	98174	-0.283	0.965	0.110	0.005	-0.015	-0.163	-0.021	0.007
	98197	-0.328	-0.331	0.424	0.008	-0.002	-0.107	0.035	0.082
	98103	-0.122	-1.346	0.058	-1.101	-0.457	0.014	-0.254	0.016
18 Wall Below RCCV Bottom	6	-0.783	-1.624	-0.038	0.162	1.122	0.025	-0.037	0.414
	13	0.522	1.176	-0.115	0.157	0.785	-0.009	0.013	0.205
	24	0.758	3.600	0.062	0.072	0.397	0.000	0.000	0.021

Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
19 Wall Below RCCV Mid-Height	806	-1.220	-2.023	-0.301	-0.030	0.015	0.051	0.010	-0.010
	813	0.027	1.363	-0.375	-0.005	-0.018	0.029	0.005	0.063
	824	0.969	3.912	0.024	-0.007	-0.032	0.000	0.002	0.062
20 Wall Below RCCV Top	1606	-1.574	-2.018	-1.434	-0.048	-0.075	-0.033	0.025	-0.069
	1613	-0.179	1.334	-1.602	-0.080	-0.300	-0.016	0.010	0.059
	1624	1.266	3.651	-0.082	-0.034	-0.254	-0.003	-0.002	0.089
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	0.092	-0.658	0.266	0.593	2.400	0.008	-0.008	0.889
	20023	-0.024	-0.479	-0.045	-0.317	0.400	0.065	0.427	0.293
	30010	1.085	0.430	-0.564	0.100	0.568	-0.002	-0.008	-0.153
	30020	-0.001	0.896	0.105	-0.014	0.299	0.011	-0.100	-0.091
	40001	0.008	0.890	-0.267	-0.048	0.225	-0.020	0.056	-0.080
	40011	0.684	0.478	0.028	-0.005	0.031	0.001	-0.002	0.036
22 Exterior Wall @ EL4.65 ~6.60 m	22011	-0.409	-4.278	1.316	0.110	0.748	0.071	-0.043	0.598
	22023	-0.129	-3.435	0.177	-0.124	0.208	-0.115	0.282	0.131
	32010	-0.477	0.875	-2.847	-0.010	-0.020	-0.002	-0.004	-0.012
	32020	0.107	4.483	-1.209	0.109	0.014	-0.005	0.092	0.008
	42001	0.154	4.717	-0.785	0.135	-0.066	-0.001	-0.073	0.027
	42011	1.001	2.927	0.147	-0.032	-0.207	0.008	0.000	0.181

NAPS DEP 3.7-1

Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-0.878	-4.111	0.148	-0.125	-0.314	-0.029	-0.002	0.740
	24224	-0.319	-7.118	0.933	0.671	1.055	-0.249	0.228	1.171
	34210	-0.945	0.276	-3.286	-0.016	-0.078	0.000	0.023	-0.028
	34220	-0.087	2.292	-0.946	-0.075	0.037	0.018	-0.060	-0.016
	44201	-0.140	2.787	-0.468	-0.044	0.034	-0.013	0.086	-0.006
24 Basemat @ Wall Below RCCV	90140	2.760	0.669	-0.723	-2.536	-1.105	0.361	-0.675	0.793
	90182	1.990	0.248	-0.604	-0.522	0.386	0.127	0.010	-0.090
	90111	0.282	1.008	-0.031	1.675	0.096	0.154	-1.230	-0.110
25 Slab EL4.65 m @ RCCV	93140	-1.696	0.303	-0.213	-0.204	-0.125	0.095	-0.046	0.062
	93182	-0.251	-0.090	0.093	-0.006	-0.003	0.010	0.005	0.012
	93111	-0.141	0.204	-0.030	0.349	0.060	0.012	-0.248	0.001
26 Slab EL17.5 m @ RCCV	96144	-0.554	0.255	0.093	-0.173	-0.143	0.099	-0.037	0.042
	96186	-0.427	-0.127	0.132	-0.003	-0.012	0.010	0.010	0.008
	96113	0.046	-0.904	-0.097	1.094	0.112	0.012	-0.905	-0.108
27 Slab EL27.0 m @ RCCV	98472	0.655	-0.206	-0.040	-0.206	-0.213	0.071	-0.021	0.039
	98514	-0.509	-0.071	0.098	-0.027	0.040	0.057	0.035	-0.006
	98424	0.940	-1.110	0.070	-0.825	-0.252	0.087	0.954	0.076
28 Pool Girder @ Storage Pool	123054	0.078	1.309	-0.293	-0.042	-0.015	0.028	0.013	0.002
	123154	-0.864	0.481	-0.105	-0.056	-0.017	0.005	-0.009	0.001

Table 3G.7-202 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
29 Pool Girder @ Cavity	123062	-0.152	-0.096	0.234	-0.001	0.004	-0.008	0.001	0.005
	123162	-0.462	-0.123	0.274	-0.007	0.003	-0.007	-0.010	-0.001
30 Pool Girder @ Fuel Pool	123067	-0.535	0.362	0.423	0.065	0.049	0.012	0.020	0.033
	123167	-0.479	-0.107	0.751	0.025	0.023	0.001	0.004	0.005
31 MS Tunnel Wall and Slab	150122	-0.029	0.276	-0.061	-0.060	-0.205	-0.009	0.011	-0.032
	96611	-0.002	-0.057	0.005	-0.169	-0.550	-0.047	0.067	0.024
	98614	0.048	-0.362	0.037	0.174	0.743	0.063	-0.058	-0.025
32 IC/PCCS Pool Wall in NS Direction	125051	0.017	0.133	0.376	0.004	0.004	0.000	0.004	-0.010
	125151	-0.110	0.133	0.414	0.009	0.006	0.000	0.006	-0.003
	125055	-0.115	-0.023	0.460	-0.005	-0.006	0.003	-0.003	-0.003
	125155	-0.221	-0.004	0.470	0.000	0.005	0.003	0.005	-0.004

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):
1 MN/m = 6.852 × 10^4 lbf/ft
1 MNm/m = 2.248 × 10^5 lbf-ft/ft

NAPS DEP 3.7-1

Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	-0.776	-1.841	-0.090	0.065	0.689	0.013	-0.048	0.305
	5013	-0.768	-2.776	-0.020	0.216	1.052	0.011	-0.034	0.455
	5024	-0.071	-0.270	-0.166	0.018	0.080	-0.001	0.053	0.034
2 RPV Pedestal Mid-Height	6006	-0.091	-2.233	0.135	0.040	0.284	0.030	-0.017	-0.098
	6013	-0.174	-3.410	-0.125	0.032	0.440	0.030	-0.001	-0.131
	6024	-0.012	-0.314	-0.419	-0.003	0.021	-0.053	0.016	-0.011
3 RPV Pedestal Top	6606	0.013	-2.249	0.593	-0.042	-0.397	-0.083	0.042	0.165
	6613	-0.177	-3.441	-0.071	-0.121	-0.612	0.046	0.059	0.261
	6624	-0.025	-0.251	-1.014	-0.015	-0.020	0.117	-0.140	0.012
4 RCCV Wetwell Bottom	1806	-0.416	-2.735	1.954	0.116	0.545	0.023	-0.002	0.211
	1813	-0.919	-3.805	-0.510	0.181	1.064	0.020	-0.001	0.474
	1824	-0.113	-0.330	-3.252	0.010	0.063	-0.054	0.023	0.025
5 RCCV Wetwell Mid-Height	2606	-0.039	-2.221	1.963	-0.005	-0.014	0.037	0.010	0.069
	2613	-0.202	-3.215	-0.517	-0.025	-0.061	0.018	0.005	0.211
	2624	-0.037	-0.208	-3.193	-0.007	-0.019	-0.072	-0.018	0.009
6 RCCV Wetwell Top	3406	0.182	-1.740	1.953	-0.015	-0.098	0.048	-0.028	0.074
	3413	-0.020	-2.735	-0.584	-0.057	-0.319	-0.015	0.038	0.218
	3424	0.121	-0.150	-2.874	-0.016	-0.041	-0.007	-0.012	0.011

Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	0.210	-1.633	1.740	0.033	0.187	0.035	-0.026	0.011
	3613	-0.068	-2.987	-0.696	0.100	0.605	0.015	0.036	0.212
	3624	0.088	-0.215	-3.064	0.023	0.064	-0.003	-0.009	0.031
8 RCCV Drywell Mid-Height	4006	0.420	-1.205	1.674	-0.007	0.015	0.045	0.011	0.090
	4013	0.378	-2.370	-0.617	-0.054	-0.182	-0.012	-0.001	0.234
	4976	-0.063	-0.127	-3.147	-0.020	-0.019	-0.010	-0.018	0.008
9 RCCV Drywell Top	4406	0.658	-0.814	1.537	-0.080	-0.327	0.016	0.025	0.155
	4413	0.406	-1.837	-0.474	-0.193	-0.965	0.018	-0.018	0.250
	4424	-0.149	-0.100	-3.329	-0.023	0.008	0.004	-0.017	-0.018
10 Basemat @ Center	80003	0.066	-0.095	-0.953	0.035	-0.035	0.256	-0.012	-0.253
	80007	0.017	-0.020	-0.852	-0.051	-0.107	0.188	-0.006	-0.238
	80012	0.068	-0.103	-0.806	0.072	0.073	0.095	-0.002	-0.250
11 Basemat Inside RPV Pedestal	80206	0.047	0.121	-1.148	-0.483	-1.319	0.919	0.065	-0.654
	80213	-0.191	0.100	-0.773	-0.934	-2.066	0.274	0.046	-0.628
	80224	0.013	-0.092	-0.227	-0.057	-0.045	-0.362	-0.038	-0.333
12 S/P Slab @ RPV	83306	0.220	0.115	-0.281	-0.443	-0.205	0.143	-0.176	-0.065
	83313	0.476	-0.011	-0.086	-0.681	-0.331	-0.023	-0.269	0.000
	83324	0.029	-0.005	0.626	-0.029	-0.010	-0.191	-0.014	0.093

Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	0.112	0.028	-0.125	0.086	-0.075	0.097	-0.116	-0.001
	83413	0.436	-0.154	-0.087	0.122	-0.126	-0.018	-0.177	0.001
	83424	0.025	-0.006	0.327	0.009	0.001	-0.125	-0.008	-0.004
14 S/P Slab @ RCCV	83506	-0.021	0.038	-0.095	0.425	0.074	0.006	-0.095	0.022
	83513	0.363	-0.196	-0.079	0.614	0.109	-0.015	-0.138	-0.001
	83524	0.015	-0.013	0.223	0.036	0.012	0.009	-0.008	-0.034
15 Top Slab @ Drywell Head Opening	98120	0.841	0.713	0.603	0.037	0.284	0.104	0.049	0.071
	98135	-0.092	-0.257	0.422	0.094	0.113	-0.059	-0.030	0.051
	98104	-0.301	-0.430	0.441	-0.026	0.155	0.021	-0.034	0.127
16 Top Slab @ Center	98149	0.638	0.271	0.354	0.053	0.209	0.017	-0.027	-0.067
	98170	0.634	-0.078	0.637	-0.016	-0.045	0.004	-0.007	-0.025
	98109	-0.071	-0.002	0.590	0.037	0.126	0.032	0.012	0.063
17 Top Slab @ RCCV	98174	0.878	0.240	0.431	0.185	0.132	-0.056	-0.090	0.066
	98197	0.866	-0.055	0.566	-0.033	-0.203	0.047	0.035	-0.076
	98103	0.102	-0.091	0.817	0.035	0.026	0.122	-0.026	0.022
18 Wall Below RCCV Bottom	6	-1.362	-3.188	0.325	0.163	0.904	0.007	-0.033	0.385
	13	-1.290	-3.599	-0.300	0.128	0.707	0.012	-0.016	0.334
	24	-0.156	-0.336	-1.107	-0.013	-0.020	-0.009	0.014	0.008

Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
19 Wall Below RCCV Mid-Height	806	-0.523	-3.092	0.837	0.029	0.036	0.035	0.007	-0.032
	813	-1.029	-3.722	-0.421	0.023	0.025	0.019	0.000	0.063
	824	-0.085	-0.368	-1.651	-0.003	-0.002	-0.008	-0.004	-0.011
20 Wall Below RCCV Top	1606	-0.366	-2.610	1.656	-0.001	-0.153	0.019	0.006	0.059
	1613	-0.805	-3.269	-0.482	-0.059	-0.366	0.017	-0.003	0.113
	1624	-0.112	-0.330	-2.605	0.003	0.020	-0.038	0.016	-0.004
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	0.104	0.367	1.984	0.001	-0.207	-0.018	-0.021	-0.055
	20023	-0.016	-1.243	0.171	-0.115	0.079	0.040	0.153	0.095
	30010	-0.635	-0.216	-0.743	0.163	0.762	0.015	0.012	-0.232
	30020	-0.102	-0.927	-0.550	0.040	-0.084	-0.006	-0.008	0.045
	40001	0.061	-1.082	-0.238	-0.107	-0.318	-0.001	-0.133	0.070
	40011	0.009	-0.030	-1.125	-0.020	-0.069	-0.006	-0.016	0.027
22 Exterior Wall @ EL4.65 ~6.60 m	22011	-0.104	-1.029	3.564	-0.014	-0.010	-0.004	-0.011	-0.017
	22023	-0.323	-3.988	2.727	0.085	0.080	-0.032	0.027	0.047
	32010	-0.595	-2.880	-0.678	0.023	0.132	0.013	0.000	-0.202
	32020	-0.093	-3.812	-1.603	-0.041	0.074	0.007	-0.048	-0.040
	42001	-0.085	-3.676	-2.018	-0.062	-0.030	0.010	0.029	0.012
	42011	-0.066	0.437	-3.545	-0.002	-0.007	-0.012	-0.004	0.000

Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-0.012	0.063	3.573	0.006	0.015	-0.008	0.000	0.002
	24224	-0.371	-5.221	3.445	0.319	0.211	-0.015	-0.223	0.158
	34210	-0.182	-1.740	-0.569	-0.107	-0.609	0.007	0.004	-0.191
	34220	0.115	-2.079	-1.749	-0.050	-0.100	0.006	0.013	0.009
	44201	-0.059	-2.191	-2.196	-0.016	-0.007	-0.033	0.026	-0.017
24 Basemat @ Wall Below RCCV	90140	0.090	-0.409	-1.411	-1.245	-1.547	1.181	-1.254	1.198
	90182	-0.890	-0.003	-0.539	-0.538	-1.570	0.223	-0.026	1.660
	90111	0.044	-0.185	0.345	0.059	-0.084	-0.381	0.065	0.451
25 Slab EL4.65 m @ RCCV	93140	-0.082	-0.051	0.108	-0.132	-0.116	0.077	-0.040	0.028
	93182	-0.099	0.065	0.096	-0.093	-0.469	-0.016	0.020	0.392
	93111	0.094	0.021	-0.148	-0.007	0.004	0.000	-0.001	-0.003
26 Slab EL17.5 m @ RCCV	96144	0.080	0.194	0.113	-0.112	-0.112	0.074	-0.039	0.016
	96186	0.192	-0.068	0.160	-0.105	-0.544	-0.020	0.026	0.445
	96113	-0.018	0.110	-0.595	-0.069	-0.017	-0.045	0.043	-0.033
27 Slab EL27.0 m @ RCCV	98472	0.062	0.772	0.239	-0.053	-0.060	0.025	0.055	-0.076
	98514	0.363	-0.183	0.348	-0.167	-1.101	0.002	0.020	0.701
	98424	-0.202	0.194	3.448	-0.001	-0.023	0.123	-0.042	-0.040
28 Pool Girder @ Storage Pool	123054	-0.250	-0.289	-0.162	-0.197	-0.091	0.054	-0.023	-0.061
	123154	0.240	-0.389	-0.563	-0.156	-0.010	0.067	-0.017	-0.004

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Table 3G.7-203 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
29 Pool Girder @ Cavity	123062	0.197	-0.814	-0.044	-0.038	-0.026	0.009	0.028	-0.001
	123162	0.256	-0.817	-0.052	-0.027	0.002	-0.008	0.028	-0.021
30 Pool Girder @ Fuel Pool	123067	-0.049	-0.123	-0.097	-0.090	-0.092	-0.051	-0.014	-0.075
	123167	0.276	-0.388	0.341	-0.065	0.017	-0.041	0.013	-0.008
31 MS Tunnel Wall and Slab	150122	0.005	-0.093	0.022	0.024	0.074	0.029	-0.005	-0.158
	96611	-0.017	0.048	0.029	0.012	0.055	-0.047	0.000	0.054
	98614	-0.008	-0.006	0.003	-0.023	-0.092	-0.262	0.023	0.011
32 IC/PCCS Pool Wall in NS Direction	125051	0.083	-0.069	0.125	0.009	0.008	0.004	0.003	-0.002
	125151	0.042	-0.061	0.009	0.008	0.000	0.005	0.004	0.004
	125055	0.221	-0.010	-0.058	-0.001	0.007	0.001	0.000	-0.001
	125155	0.194	-0.013	-0.059	-0.002	0.000	-0.001	-0.004	0.007

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):
1 MN/m = 6.852×10^4 lbf/ft
1 MNm/m = 2.248×10^5 lbf-ft/ft

NAPS DEP 3.7-1

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	1.587	-2.124	0.189	-0.477	-2.741	0.009	-0.021	-1.153
	5013	1.264	-2.852	0.274	-0.402	-2.398	0.000	-0.016	-0.980
	5024	0.884	-3.230	0.019	-0.361	-2.133	0.009	0.003	-0.864
2 RPV Pedestal Mid-Height	6006	-0.178	-2.240	0.282	0.016	0.073	0.030	0.025	-0.016
	6013	-0.186	-2.446	0.415	-0.024	0.026	0.013	-0.016	0.030
	6024	-0.040	-1.884	-0.192	0.006	-0.036	0.008	0.016	0.063
3 RPV Pedestal Top	6606	-0.395	-1.898	0.399	0.433	2.895	0.105	0.103	-0.971
	6613	-0.393	-1.931	0.239	0.375	2.773	-0.126	-0.068	-0.923
	6624	-0.245	-1.889	0.065	0.397	2.768	0.135	0.057	-0.897
4 RCCV Wetwell Bottom	1806	-0.512	-5.207	0.202	-0.096	-0.639	0.008	0.001	-0.122
	1813	-0.642	-5.112	0.208	-0.101	-0.545	0.005	0.000	-0.079
	1824	-0.554	-5.759	-0.036	-0.097	-0.572	0.003	-0.004	-0.095
5 RCCV Wetwell Mid-Height	2606	-0.236	-4.884	0.236	0.010	-0.021	0.002	0.000	-0.083
	2613	-0.337	-4.787	0.198	-0.033	-0.065	0.003	-0.002	-0.051
	2624	-0.353	-5.307	0.018	-0.006	-0.009	0.001	-0.002	-0.092
6 RCCV Wetwell Top	3406	-0.275	-4.370	0.324	0.116	0.661	-0.078	0.104	-0.222
	3413	-0.182	-4.504	0.165	0.023	0.237	0.037	-0.048	-0.091
	3424	-0.176	-4.612	0.031	0.029	0.224	-0.080	0.086	-0.050
7 RCCV Drywell Bottom	3606	-0.092	-4.201	0.197	-0.001	0.056	-0.087	0.076	0.131
	3613	-0.032	-4.449	0.180	-0.011	0.002	0.050	-0.029	0.095
	3624	-0.132	-4.935	0.096	0.022	0.187	-0.083	0.045	0.145

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
8 RCCV Drywell Mid-Height	4006	0.585	-3.805	0.098	-0.171	-0.641	-0.043	-0.008	0.277
	4013	0.484	-4.470	0.228	-0.065	-0.457	-0.001	-0.007	0.154
	4976	0.021	-4.097	0.252	-0.038	-0.319	-0.006	-0.011	0.108
9 RCCV Drywell Top	4406	0.366	-3.280	-0.269	-0.332	-1.923	-0.013	0.008	0.393
	4413	-0.258	-4.428	0.120	-0.203	-1.250	-0.003	0.002	0.249
	4424	-0.063	-3.278	0.204	-0.074	-0.614	0.006	0.000	0.085
10 Basemat @ Center	80003	-1.125	-1.390	0.065	8.634	8.865	-0.033	0.261	-0.210
	80007	-1.152	-1.418	0.051	8.641	8.862	-0.033	-0.045	-0.340
	80012	-1.148	-1.468	0.052	8.634	8.855	-0.030	-0.335	-0.048
11 Basemat Inside RPV Pedestal	80206	-1.062	-1.220	0.106	5.665	6.166	0.969	1.133	-0.998
	80213	-1.159	-1.466	0.159	6.623	4.831	-0.108	-0.049	-1.566
	80224	-1.268	-1.689	0.057	4.779	6.676	-0.173	-1.527	-0.123
12 S/P Slab @ RPV	83306	0.137	0.402	-0.250	2.170	1.502	-0.007	1.187	-0.029
	83313	0.335	0.300	-0.062	2.167	1.495	0.012	1.185	0.025
	83324	0.328	0.466	-0.025	2.153	1.488	-0.016	1.179	-0.026
13 S/P Slab @ Center	83406	0.207	0.378	-0.176	-0.960	0.696	0.001	0.552	0.000
	83413	0.442	0.229	-0.011	-0.946	0.679	0.000	0.551	0.002
	83424	0.407	0.409	-0.008	-0.947	0.675	-0.002	0.549	-0.001
14 S/P Slab @ RCCV	83506	0.207	0.335	-0.162	-1.732	0.004	-0.008	0.105	0.005
	83513	0.461	0.211	0.023	-1.728	-0.009	-0.004	0.109	0.004
	83524	0.406	0.404	-0.003	-1.725	-0.008	-0.002	0.106	-0.001

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
15 Top Slab @ Drywell Head Opening	98120	1.352	0.331	0.495	-0.699	-0.196	-0.487	0.105	0.592
	98135	3.422	0.257	-0.220	-0.935	0.350	0.198	-0.083	0.500
	98104	0.064	0.747	-0.032	-0.364	-2.248	0.431	-0.004	0.310
16 Top Slab @ Center	98149	2.131	-0.495	0.697	-1.021	-0.219	0.050	0.006	-0.410
	98170	1.784	-0.103	0.129	-0.947	-1.003	0.101	0.003	0.080
	98109	0.140	0.533	0.069	-0.939	-1.360	0.241	0.150	0.137
17 Top Slab @ RCCV	98174	0.967	-0.193	0.237	-0.997	-0.753	-0.377	-0.221	0.055
	98197	0.563	-0.132	-0.190	-0.366	1.547	0.214	0.085	0.939
	98103	-0.238	0.328	0.096	2.430	0.330	0.277	1.234	0.156
18 Wall Below RCCV Bottom	6	0.390	-6.640	0.527	-0.361	-2.351	0.013	-0.038	-0.756
	13	0.501	-5.422	0.409	-0.612	-3.320	0.005	-0.006	-1.021
	24	0.458	-6.058	-0.161	-0.651	-3.531	0.006	-0.002	-1.060
19 Wall Below RCCV Mid-Height	806	-0.001	-5.924	0.178	0.011	-0.049	-0.022	0.007	-0.115
	813	-0.174	-5.442	0.360	-0.026	-0.047	-0.010	-0.019	-0.214
	824	-0.129	-6.106	-0.147	-0.033	-0.002	-0.007	0.001	-0.232
20 Wall Below RCCV Top	1606	-0.709	-5.409	0.135	0.187	1.012	0.008	-0.003	-0.344
	1613	-0.841	-5.281	0.271	0.181	1.101	0.007	0.000	-0.395
	1624	-0.755	-5.937	-0.093	0.184	1.094	0.000	-0.006	-0.384

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	-0.571	-3.328	-0.340	-0.035	0.005	0.004	0.048	0.042
	20023	0.005	-1.108	-0.390	0.106	-0.219	-0.007	-0.084	-0.134
	30010	-0.160	-1.781	0.051	-0.371	-1.965	0.016	0.003	0.460
	30020	-0.053	-0.988	-0.201	0.187	-0.567	-0.058	0.127	0.191
	40001	-0.049	-1.028	0.164	0.191	-0.576	0.058	-0.127	0.186
	40011	-0.323	-2.306	0.001	-0.423	-2.233	-0.011	-0.001	0.530
22 Exterior Wall @ EL4.65 ~6.60 m	22011	0.185	-3.014	0.654	-0.007	0.056	0.001	-0.021	0.061
	22023	0.005	-1.557	-0.255	-0.117	0.001	-0.014	0.078	0.015
	32010	-0.033	-1.772	0.059	0.000	0.039	0.003	0.000	-0.025
	32020	-0.049	-1.973	-0.093	-0.063	-0.004	-0.006	-0.056	-0.009
	42001	-0.058	-2.061	-0.089	-0.081	-0.005	0.003	0.041	-0.002
	42011	-0.319	-2.366	-0.078	-0.002	0.037	-0.004	0.003	-0.020
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-0.245	-1.884	0.122	-0.082	-0.546	0.006	-0.002	-0.047
	24224	-0.060	-1.302	0.460	0.055	-0.028	-0.055	-0.067	-0.007
	34210	-0.054	-0.868	0.063	-0.009	-0.116	0.001	0.006	-0.015
	34220	0.040	-0.964	-0.213	0.053	-0.040	0.001	0.044	0.001
	44201	0.026	-1.163	-0.393	0.046	-0.021	0.010	-0.047	-0.002
24 Basemat @ Wall Below RCCV	90140	0.292	-0.734	-0.477	-2.136	-1.628	3.174	-1.481	1.751
	90182	-0.623	-0.317	-0.066	0.837	-2.260	-0.383	0.221	0.666
	90111	-0.387	-0.896	0.058	-2.068	1.015	-0.489	0.713	0.115

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
25 Slab EL4.65 m @ RCCV	93140	-0.089	0.124	0.064	0.052	0.072	-0.045	0.102	-0.083
	93182	0.115	0.099	0.018	0.025	0.072	0.006	-0.007	-0.132
	93111	0.070	0.144	-0.026	0.101	0.028	0.004	-0.130	-0.003
26 Slab EL17.5 m @ RCCV	96144	-0.171	0.227	0.164	0.028	0.034	-0.026	0.094	-0.070
	96186	0.258	-0.093	-0.035	-0.007	-0.053	0.003	-0.004	-0.007
	96113	-0.076	0.554	-0.083	-0.296	0.011	0.011	0.337	0.034
27 Slab EL27.0 m @ RCCV	98472	0.381	-0.046	0.256	0.418	0.684	-0.574	0.444	-0.521
	98514	0.135	0.039	0.068	0.061	0.301	0.046	-0.023	-0.205
	98424	-0.230	0.416	-0.030	2.488	0.577	0.020	-1.510	-0.116
28 Pool Girder @ Storage Pool	123054	0.490	-3.033	-1.047	0.034	0.033	0.088	0.014	0.035
	123154	1.605	-0.550	-0.833	0.044	-0.004	0.122	0.057	-0.009
29 Pool Girder @ Cavity	123062	0.502	0.763	0.407	-0.053	-0.286	0.025	0.018	-0.128
	123162	-1.839	0.280	0.213	-0.096	-0.088	0.019	0.106	0.032
30 Pool Girder @ Fuel Pool	123067	0.459	-2.959	1.895	0.005	-0.068	-0.104	-0.129	-0.023
	123167	0.647	-0.692	1.644	0.019	-0.002	0.013	-0.045	-0.010
31 MS Tunnel Wall and Slab	150122	-0.029	0.142	0.341	0.021	0.007	0.026	-0.015	-0.074
	96611	-0.017	0.396	-0.019	0.065	-0.289	-0.103	-0.109	0.035
	98614	-0.024	-0.249	-0.021	0.016	-0.565	-0.065	-0.057	0.036

Table 3G.7-204 **RCCV & RB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
32 IC/PCCS Pool Wall in NS Direction	125051	-0.140	-1.646	-1.201	0.006	-0.074	-0.003	0.006	-0.055
	125151	-0.160	-0.650	-0.995	0.001	-0.011	-0.006	0.015	-0.003
	125055	0.057	-0.200	-0.105	-0.024	-0.137	0.004	-0.045	-0.088
	125155	-0.704	-0.139	-0.088	0.006	0.034	0.007	0.046	-0.051

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):
1 MN/m = 6.852×10^4 lbf/ft
1 MNm/m = 2.248×10^5 lbf-ft/ft

Table 3G.7-205a **Combined Forces and Moments: RCCV, Selected Load Combination CV-1**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	OTHR	-2.160	-7.673	-0.041	0.367	2.150	0.033	-0.011	1.247
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5013	OTHR	-2.686	-8.084	0.051	0.306	2.352	-0.003	-0.005	1.435
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5024	OTHR	-2.531	-7.503	0.051	0.479	2.105	-0.010	0.011	1.231
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2 RPV Pedestal Mid-Height	6006	OTHR	1.177	-7.414	0.012	-0.050	-0.209	0.024	0.075	-0.347
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6013	OTHR	0.888	-7.385	0.193	-0.206	-0.269	0.004	-0.002	-0.328
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6024	OTHR	1.234	-5.442	-0.516	0.296	0.070	0.015	-0.008	-0.264
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3 RPV Pedestal Top	6606	OTHR	0.577	-6.197	0.796	0.434	2.820	0.036	0.233	-0.999
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6613	OTHR	0.260	-6.383	-0.095	0.294	2.846	-0.106	-0.092	-1.053
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	6624	OTHR	0.814	-6.035	0.318	0.410	2.506	0.145	0.061	-0.809
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4 RCCV Wetwell Bottom	1806	OTHR	0.295	-2.016	-0.054	0.369	2.198	0.018	0.011	0.782
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1813	OTHR	0.093	-2.409	0.195	0.362	2.322	-0.001	-0.003	0.893
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1824	OTHR	0.527	-2.331	0.001	0.362	2.107	0.008	-0.005	0.825
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3G.7-205a **Combined Forces and Moments: RCCV, Selected Load Combination CV-1** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 RCCV Wetwell Mid-Height	2606	OTHR	2.629	-1.556	-0.108	-0.166	-0.663	-0.002	0.008	-0.046
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2613	OTHR	2.279	-2.166	0.178	-0.194	-0.684	0.000	-0.007	0.011
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2624	OTHR	2.607	-1.849	-0.015	-0.122	-0.697	-0.003	0.004	-0.081
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6 RCCV Wetwell Top	3406	OTHR	2.448	-0.900	0.085	-0.068	-0.229	0.067	-0.031	-0.013
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3413	OTHR	2.089	-1.959	0.113	-0.109	-0.249	-0.096	0.048	0.012
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3424	OTHR	2.082	-1.171	0.049	0.021	0.078	0.058	-0.018	-0.057
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7 RCCV Drywell Bottom	3606	OTHR	2.395	-0.361	-0.019	-0.019	0.079	0.095	0.002	0.487
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3613	OTHR	2.099	-1.462	0.188	-0.008	0.357	-0.084	-0.001	0.712
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	3624	OTHR	2.064	-0.777	0.039	0.110	0.556	0.059	0.011	0.565
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8 RCCV Drywell Mid-Height	4006	OTHR	1.551	0.065	0.050	-0.071	-0.240	0.018	0.032	-0.300
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4013	OTHR	1.592	-1.630	0.318	-0.151	-0.453	0.009	-0.011	-0.261
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4976	OTHR	1.587	-0.337	-0.012	0.034	-0.017	0.001	-0.013	-0.379
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3G.7-205a **Combined Forces and Moments: RCCV, Selected Load Combination CV-1** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
9 RCCV Drywell Top	4406	OTHR	0.504	0.467	0.159	0.362	2.110	0.002	-0.001	-0.675
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4413	OTHR	-0.037	-1.799	0.252	0.253	2.072	0.037	0.009	-0.787
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4424	OTHR	1.163	-0.073	-0.032	0.428	2.331	0.023	0.002	-0.725
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10 Basemat @ Center	80003	OTHR	-2.863	-1.599	0.149	-0.569	0.018	-0.045	0.165	-0.112
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	80007	OTHR	-2.890	-1.607	0.134	-0.493	0.040	-0.027	0.004	-0.181
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	80012	OTHR	-2.942	-1.596	0.135	-0.487	0.043	-0.031	-0.154	-0.018
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11 Basemat Inside RPV Pedestal	80206	OTHR	-2.529	-1.750	0.231	-2.485	-2.262	0.712	0.971	-1.148
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	80213	OTHR	-2.632	-1.602	0.090	-1.593	-3.038	-0.112	-0.079	-1.534
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	80224	OTHR	-3.117	-2.017	0.060	-2.699	-1.674	-0.162	-1.224	-0.144
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12 S/P Slab @ RPV	83306	OTHR	0.001	1.185	-0.425	-0.250	0.620	-0.066	1.940	-0.038
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83313	OTHR	0.202	0.928	-0.092	-0.191	0.635	0.041	1.953	0.051
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83324	OTHR	0.233	1.419	0.053	-0.286	0.586	-0.038	1.901	-0.055
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3G.7-205a **Combined Forces and Moments: RCCV, Selected Load Combination CV-1** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	OTHR	0.250	0.885	-0.316	-2.855	-0.665	-0.030	-0.129	0.003
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83413	OTHR	0.582	0.670	-0.019	-2.827	-0.672	-0.005	-0.119	0.002
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83424	OTHR	0.422	1.104	0.029	-2.796	-0.663	0.005	-0.150	0.000
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14 S/P Slab @ RCCV	83506	OTHR	0.379	0.731	-0.242	1.265	-0.177	-0.026	-1.740	0.000
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83513	OTHR	0.751	0.610	0.004	1.249	-0.184	-0.005	-1.730	0.002
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	83524	OTHR	0.488	0.997	0.030	1.374	-0.131	-0.001	-1.759	0.001
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15 Top Slab @ Drywell Head Opening	98120	OTHR	0.108	1.013	1.166	1.063	0.649	0.502	0.321	-0.987
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98135	OTHR	-0.703	-0.422	-0.496	0.741	-0.293	0.189	0.187	-1.273
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98104	OTHR	-0.244	2.463	-0.780	0.955	3.198	-0.384	-0.415	-0.725
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16 Top Slab @ Center	98149	OTHR	-0.126	1.468	-0.434	0.340	-0.094	0.389	0.016	0.409
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98170	OTHR	-0.063	0.913	-0.363	0.526	0.280	-0.036	-0.043	-0.224
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98109	OTHR	0.348	1.588	-0.183	0.977	2.009	-0.295	-0.107	-0.383
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Table 3G.7-205a **Combined Forces and Moments: RCCV, Selected Load Combination CV-1** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
17 Top Slab @ RCCV	98174	OTHR	0.659	1.205	-0.087	0.182	0.228	0.484	0.133	-0.169
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98197	OTHR	0.336	1.260	-0.207	-0.156	-1.637	-0.112	-0.072	-1.045
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	98103	OTHR	0.668	1.772	-0.090	-1.030	0.462	-0.341	-0.899	-0.217
		TEMP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

OTHR: Loads other than thermal loads
TEMP: Thermal loads

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Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	OTHR	-2.269	-7.811	-0.043	0.405	2.376	0.034	-0.011	1.347
		TEMP	-3.476	1.649	-0.329	-6.696	-6.462	-0.046	0.105	1.012
		HYDR	1.879	5.303	0.129	0.382	2.323	0.017	0.024	1.086
	5013	OTHR	-2.798	-8.211	0.045	0.343	2.575	-0.003	-0.005	1.536
		TEMP	-3.121	1.796	-0.097	-6.854	-6.851	-0.006	0.027	0.925
		HYDR	2.099	5.570	0.515	0.426	2.519	0.001	0.018	1.220
	5024	OTHR	-2.639	-7.607	0.052	0.518	2.316	-0.011	0.012	1.322
		TEMP	-3.419	1.892	-0.003	-6.894	-6.129	-0.026	-0.036	1.045
		HYDR	2.282	5.413	0.243	0.434	2.450	0.013	0.024	1.195
2 RPV Pedestal Mid-Height	6006	OTHR	1.305	-7.546	-0.001	-0.055	-0.227	0.024	0.076	-0.362
		TEMP	0.080	1.775	0.154	-6.175	-4.043	0.264	0.065	-1.515
		HYDR	0.446	5.872	0.309	0.056	0.390	0.033	0.047	0.082
	6013	OTHR	1.015	-7.511	0.186	-0.210	-0.288	0.004	-0.002	-0.343
		TEMP	-0.061	1.444	-0.177	-6.419	-3.904	-0.057	-0.026	-1.669
		HYDR	0.466	5.457	0.487	0.105	0.375	0.012	0.016	0.079
	6024	OTHR	1.380	-5.524	-0.526	0.300	0.059	0.015	-0.010	-0.270
		TEMP	-0.245	2.050	0.059	-7.408	-2.297	-0.304	-0.003	-1.547
		HYDR	0.457	4.341	0.599	0.078	0.360	0.027	0.026	0.028

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Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
3 RPV Pedestal Top	6606	OTHR	0.646	-6.328	0.797	0.430	2.792	0.028	0.239	-0.976
		TEMP	20.997	2.192	0.564	-6.643	-5.510	-0.035	-1.941	0.870
		HYDR	0.816	5.248	0.908	0.710	4.278	0.198	0.644	1.214
	6613	OTHR	0.317	-6.528	-0.104	0.290	2.832	-0.099	-0.098	-1.035
		TEMP	21.088	1.964	-0.425	-6.702	-5.546	0.139	2.063	0.862
		HYDR	0.797	4.919	0.398	0.627	4.016	0.173	0.420	1.197
	6624	OTHR	0.878	-6.173	0.319	0.405	2.474	0.138	0.067	-0.784
		TEMP	21.900	2.601	0.228	-6.671	-5.665	0.005	-2.338	1.055
		HYDR	0.728	5.071	0.435	0.617	3.907	0.196	0.555	1.147
4 RCCV Wetwell Bottom	1806	OTHR	0.322	-1.893	-0.072	0.381	2.269	0.018	0.011	0.797
		TEMP	2.533	0.468	-0.194	-4.438	-8.138	0.077	0.083	-1.750
		HYDR	0.961	1.171	0.676	0.558	3.366	0.014	0.008	1.396
	1813	OTHR	0.120	-2.310	0.197	0.374	2.394	-0.001	-0.003	0.910
		TEMP	1.866	-2.167	-0.420	-4.274	-7.773	-0.025	-0.007	-1.523
		HYDR	0.921	1.191	0.607	0.561	3.342	0.011	0.005	1.422
	1824	OTHR	0.554	-2.179	0.002	0.374	2.176	0.008	-0.005	0.841
		TEMP	2.926	-2.481	0.046	-4.432	-8.134	0.020	-0.085	-1.667
		HYDR	1.036	0.822	0.573	0.563	3.392	0.013	0.010	1.440

Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 RCCV Wetwell Mid-Height	2606	OTHR	2.704	-1.438	-0.131	-0.167	-0.659	-0.001	0.008	-0.041
		TEMP	1.379	0.586	-0.171	-3.308	-1.033	0.018	0.039	0.074
		HYDR	1.233	0.863	0.779	0.072	0.415	0.034	0.005	0.255
	2613	OTHR	2.344	-2.077	0.181	-0.196	-0.683	0.000	-0.007	0.017
		TEMP	0.111	-2.544	-0.109	-3.090	-1.052	0.009	-0.075	0.370
		HYDR	1.197	0.898	0.639	0.061	0.325	0.032	0.014	0.207
	2624	OTHR	2.676	-1.697	-0.016	-0.121	-0.697	-0.003	0.004	-0.079
		TEMP	0.965	-2.909	-0.087	-3.293	-0.935	-0.026	0.067	0.189
		HYDR	1.396	0.751	0.518	0.094	0.326	0.008	0.009	0.195
6 RCCV Wetwell Top	3406	OTHR	2.592	-0.791	0.071	-0.092	-0.369	0.099	-0.057	0.035
		TEMP	11.723	1.461	0.327	-4.151	-8.468	-0.227	0.461	3.349
		HYDR	0.925	0.689	0.833	0.140	0.541	0.198	0.231	0.288
	3413	OTHR	2.192	-1.875	0.104	-0.124	-0.327	-0.126	0.066	0.041
		TEMP	8.032	-3.439	0.044	-4.382	-9.151	-0.402	0.538	3.335
		HYDR	0.721	0.752	0.525	0.073	0.374	0.097	0.102	0.243
	3424	OTHR	2.180	-1.017	0.068	0.006	-0.015	0.094	-0.040	-0.024
		TEMP	10.292	-4.166	0.471	-3.681	-5.045	-0.039	-0.006	2.165
		HYDR	0.751	0.626	0.408	0.032	0.340	0.055	0.081	0.216

Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	OTHR	2.542	-0.167	-0.030	-0.012	0.108	0.128	-0.010	0.525
		TEMP	8.504	1.377	0.674	-5.342	-9.036	0.607	0.534	-1.980
		HYDR	0.961	0.714	0.535	0.125	0.496	0.056	0.221	0.186
	3613	OTHR	2.209	-1.284	0.178	0.004	0.439	-0.116	0.003	0.778
		TEMP	4.607	-4.161	1.005	-4.955	-6.227	-0.363	0.317	-0.820
		HYDR	0.665	0.611	0.213	0.107	0.486	0.119	0.106	0.166
	3624	OTHR	2.177	-0.488	0.054	0.124	0.630	0.096	0.007	0.615
		TEMP	-4.291	-6.043	0.252	-0.934	-2.498	0.068	0.000	0.351
		HYDR	0.597	0.407	0.433	0.100	0.456	0.040	0.074	0.135
8 RCCV Drywell Mid-Height	4006	OTHR	1.632	0.236	0.038	-0.054	-0.194	0.021	0.034	-0.348
		TEMP	5.952	2.178	0.212	-5.110	-5.057	0.011	-0.126	-0.683
		HYDR	0.956	0.591	0.256	0.050	0.486	0.032	0.165	0.156
	4013	OTHR	1.687	-1.435	0.322	-0.162	-0.464	0.011	-0.011	-0.274
		TEMP	4.287	-5.850	1.041	-4.672	-4.289	0.014	-0.132	-0.308
		HYDR	0.706	0.748	0.111	0.058	0.105	0.052	0.061	0.119
	4976	OTHR	1.699	-0.079	-0.030	0.039	0.001	0.001	-0.013	-0.411
		TEMP	-2.660	-5.335	0.580	-0.954	-1.780	0.003	0.013	-0.584
		HYDR	0.283	0.329	0.312	0.043	0.045	0.019	0.008	0.096

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Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
9 RCCV Drywell Top	4406	OTHR	0.565	0.574	0.186	0.425	2.455	0.013	-0.002	-0.757
		TEMP	6.433	1.711	-0.232	-4.475	-3.816	0.299	0.087	-0.150
		HYDR	0.301	0.362	0.066	0.108	0.442	0.083	0.088	0.339
	4413	OTHR	0.070	-1.593	0.264	0.271	2.235	0.039	0.011	-0.842
		TEMP	0.711	-6.632	-0.292	-4.753	-4.467	0.253	-0.243	0.643
		HYDR	0.754	0.888	0.339	0.335	0.363	0.254	0.118	0.389
	4424	OTHR	1.278	0.144	-0.048	0.465	2.539	0.024	0.001	-0.783
		TEMP	-5.846	-4.171	0.767	-0.363	1.129	-0.024	-0.022	-1.462
		HYDR	0.183	0.262	0.219	0.052	0.309	0.004	0.007	0.128
10 Basemat @ Center	80003	OTHR	-2.788	-1.513	0.148	-1.074	-0.468	-0.044	0.152	-0.102
		TEMP	-4.270	-5.140	0.021	-8.130	-8.102	-0.039	0.029	-0.008
		HYDR	1.283	1.173	0.112	4.575	4.159	0.065	0.277	0.266
	80007	OTHR	-2.813	-1.521	0.133	-0.998	-0.446	-0.026	0.006	-0.165
		TEMP	-4.296	-5.104	0.056	-8.096	-8.099	-0.037	0.028	-0.009
		HYDR	1.280	1.155	0.094	4.490	4.145	0.068	0.228	0.317
	80012	OTHR	-2.866	-1.509	0.134	-0.992	-0.442	-0.030	-0.138	-0.016
		TEMP	-4.302	-5.040	0.042	-8.079	-8.109	-0.032	0.024	-0.001
		HYDR	1.250	1.127	0.072	4.442	4.108	0.058	0.351	0.201

Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
11 Basemat Inside RPV Pedestal	80206	OTHR	-2.450	-1.668	0.231	-2.841	-2.619	0.668	0.936	-1.123
		TEMP	-4.260	-5.523	0.137	-8.575	-8.460	0.003	0.005	-0.035
		HYDR	1.472	1.255	0.219	6.569	5.991	0.976	0.802	0.838
	80213	OTHR	-2.552	-1.514	0.086	-1.999	-3.346	-0.109	-0.079	-1.490
		TEMP	-4.445	-5.127	0.161	-8.289	-8.565	-0.151	-0.018	-0.103
		HYDR	1.362	1.183	0.128	5.525	6.846	0.593	0.475	1.091
	80224	OTHR	-3.037	-1.937	0.059	-3.018	-2.067	-0.158	-1.175	-0.143
		TEMP	-4.372	-4.948	0.081	-8.177	-8.193	-0.045	-0.038	0.010
		HYDR	1.226	0.902	0.114	6.560	5.212	0.461	1.049	0.380
12 S/P Slab @ RPV	83306	OTHR	-0.024	1.222	-0.426	-0.361	0.565	-0.067	1.922	-0.037
		TEMP	-10.607	10.981	0.454	-4.700	-2.770	0.032	-0.288	0.000
		HYDR	1.543	1.102	0.524	1.382	0.906	0.093	2.882	0.066
	83313	OTHR	0.171	0.963	-0.092	-0.302	0.578	0.042	1.935	0.051
		TEMP	-10.822	11.242	-0.850	-4.737	-2.848	-0.039	-0.302	-0.028
		HYDR	1.473	1.129	0.322	1.340	0.825	0.152	2.839	0.054
	83324	OTHR	0.209	1.453	0.052	-0.399	0.528	-0.038	1.881	-0.056
		TEMP	-10.702	11.862	1.279	-4.487	-2.654	0.006	-0.156	0.046
		HYDR	1.528	1.190	0.345	1.265	0.729	0.108	2.762	0.063

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Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	OTHR	0.240	0.904	-0.315	-2.869	-0.710	-0.032	-0.157	0.003
		TEMP	-6.490	4.881	-0.530	-3.815	-3.181	-0.001	-0.306	0.016
		HYDR	1.511	1.103	0.306	4.347	1.357	0.069	0.408	0.004
	83413	OTHR	0.571	0.691	-0.020	-2.841	-0.717	-0.004	-0.147	0.002
		TEMP	-6.986	5.307	0.315	-3.900	-3.257	-0.015	-0.278	-0.011
		HYDR	1.444	1.138	0.180	4.326	1.324	0.080	0.394	0.004
	83424	OTHR	0.414	1.120	0.030	-2.810	-0.708	0.005	-0.179	0.000
		TEMP	-6.630	5.823	0.078	-3.895	-3.148	-0.003	-0.210	0.009
		HYDR	1.507	1.226	0.182	4.294	1.302	0.068	0.386	0.004
14 S/P Slab @ RCCV	83506	OTHR	0.375	0.744	-0.240	1.364	-0.182	-0.026	-1.778	-0.001
		TEMP	-3.948	2.320	-0.446	-2.906	-3.131	-0.038	-0.275	0.016
		HYDR	1.408	1.094	0.225	2.419	0.376	0.023	2.689	0.014
	83513	OTHR	0.747	0.626	0.002	1.348	-0.190	-0.005	-1.767	0.002
		TEMP	-4.567	2.419	0.440	-3.190	-3.174	-0.008	-0.192	-0.001
		HYDR	1.347	1.138	0.178	2.366	0.364	0.023	2.683	0.010
	83524	OTHR	0.485	1.006	0.031	1.476	-0.134	-0.001	-1.797	0.001
		TEMP	-4.038	3.201	-0.017	-3.278	-3.153	0.013	-0.168	-0.005
		HYDR	1.417	1.245	0.172	2.365	0.340	0.020	2.677	0.010

Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
15 Top Slab @ Drywell Head Opening	98120	OTHR	0.091	1.055	1.249	1.198	0.705	0.574	0.344	-1.096
		TEMP	-7.068	-4.258	-0.770	0.956	0.732	2.765	-0.161	-0.002
		HYDR	0.343	0.110	0.142	0.073	0.106	0.053	0.013	0.028
	98135	OTHR	-0.800	-0.457	-0.538	0.860	-0.338	0.193	0.208	-1.406
		TEMP	-8.729	-5.283	0.235	3.147	-2.057	-1.132	0.380	-0.267
		HYDR	0.547	0.079	0.114	0.098	0.030	0.024	0.007	0.012
	98104	OTHR	-0.267	2.476	-0.841	1.049	3.560	-0.434	-0.447	-0.805
		TEMP	-4.999	-1.752	0.585	-1.461	3.712	-1.500	0.185	-0.214
		HYDR	0.101	0.422	0.164	0.030	0.178	0.039	0.008	0.065
16 Top Slab @ Center	98149	OTHR	-0.159	1.774	-0.514	0.485	0.010	0.423	0.010	0.369
		TEMP	-6.075	-2.540	-1.137	2.229	2.310	0.496	0.037	0.048
		HYDR	0.506	0.266	0.055	0.068	0.053	0.037	0.023	0.029
	98170	OTHR	-0.061	1.251	-0.419	0.638	0.436	-0.043	-0.021	-0.159
		TEMP	-5.510	-3.566	-1.042	2.141	2.864	-0.042	0.030	0.389
		HYDR	0.367	0.263	0.176	0.052	0.074	0.017	0.007	0.007
	98109	OTHR	0.392	1.659	-0.204	1.122	2.234	-0.329	-0.121	-0.419
		TEMP	-6.256	-0.887	0.773	1.219	2.564	-0.119	0.329	-0.005
		HYDR	0.065	0.222	0.272	0.041	0.120	0.037	0.007	0.019

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Table 3G.7-205b **Combined Forces and Moments: RCCV, Selected Load Combination CV-7a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
17 Top Slab @ RCCV	98174	OTHR	0.766	1.501	-0.104	0.350	0.385	0.526	0.153	-0.110
		TEMP	-4.871	-2.689	-0.476	2.352	3.211	0.255	-0.023	0.434
		HYDR	0.430	0.275	0.097	0.162	0.179	0.117	0.059	0.053
	98197	OTHR	0.478	1.656	-0.206	-0.162	-1.986	-0.133	-0.076	-1.114
		TEMP	-7.584	-2.926	-1.360	1.917	3.110	0.130	0.154	-0.447
		HYDR	0.602	0.383	0.154	0.104	0.187	0.049	0.023	0.052
	98103	OTHR	0.747	1.921	-0.097	-1.258	0.473	-0.382	-1.047	-0.244
		TEMP	-6.577	-2.458	-0.070	3.431	3.308	0.118	0.450	0.084
		HYDR	0.085	0.251	0.323	0.127	0.113	0.021	0.033	0.002

OTHR: Loads other than thermal loads
TEMP: Thermal loads
HYDR: Hydrodynamic loads

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Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	OTHR	-2.625	-8.295	-0.047	0.522	3.081	0.037	-0.012	1.659
		TEMP	-12.849	0.250	-0.523	-16.011	-12.625	-0.093	0.227	4.158
		HYDR	1.386	3.966	0.120	0.281	1.716	0.012	0.017	0.800
	5013	OTHR	-3.162	-8.649	0.036	0.458	3.272	-0.003	-0.005	1.852
		TEMP	-12.356	0.343	-0.104	-16.288	-13.239	-0.007	0.021	4.062
		HYDR	1.546	4.064	0.486	0.313	1.855	0.001	0.012	0.897
	5024	OTHR	-2.994	-7.963	0.058	0.639	2.977	-0.015	0.014	1.612
		TEMP	-12.862	0.231	0.003	-16.285	-11.829	-0.073	-0.054	4.265
		HYDR	1.685	3.975	0.243	0.322	1.818	0.009	0.017	0.885
2 RPV Pedestal Mid-Height	6006	OTHR	1.628	-8.021	-0.032	-0.070	-0.292	0.023	0.080	-0.407
		TEMP	-2.408	0.615	0.443	-16.093	-14.923	0.436	0.146	-1.774
		HYDR	0.355	4.530	0.223	0.040	0.318	0.025	0.036	0.059
	6013	OTHR	1.325	-7.951	0.177	-0.226	-0.355	0.003	-0.002	-0.389
		TEMP	-2.624	0.212	-0.206	-16.582	-14.795	-0.048	-0.033	-2.015
		HYDR	0.348	4.059	0.457	0.077	0.290	0.008	0.011	0.058
	6024	OTHR	1.739	-5.793	-0.556	0.309	0.016	0.015	-0.013	-0.291
		TEMP	-2.728	0.667	0.076	-18.533	-11.361	-0.661	0.020	-1.697
		HYDR	0.347	3.315	0.485	0.055	0.280	0.022	0.018	0.024

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
3 RPV Pedestal Top	6606	OTHR	0.857	-6.862	0.814	0.485	3.145	0.015	0.278	-1.027
		TEMP	8.837	0.682	0.577	-16.163	-12.297	0.057	-1.395	-2.012
		HYDR	0.734	3.973	0.751	0.565	3.241	0.197	0.624	0.881
	6613	OTHR	0.502	-7.076	-0.120	0.341	3.201	-0.088	-0.131	-1.095
		TEMP	9.213	0.732	-0.359	-16.199	-12.536	0.030	1.518	-1.952
		HYDR	0.698	3.604	0.413	0.487	2.967	0.148	0.400	0.865
	6624	OTHR	1.089	-6.661	0.319	0.461	2.814	0.128	0.098	-0.831
		TEMP	9.545	0.848	0.253	-16.174	-12.377	0.066	-1.768	-1.800
		HYDR	0.656	3.799	0.358	0.487	2.933	0.184	0.530	0.838
4 RCCV Wetwell Bottom	1806	OTHR	0.592	-1.140	-0.113	0.492	2.935	0.018	0.011	1.016
		TEMP	-1.533	-1.021	-0.228	-10.248	-14.646	0.090	0.096	-1.555
		HYDR	0.744	0.794	0.484	0.391	2.348	0.010	0.006	0.984
	1813	OTHR	0.382	-1.663	0.190	0.484	3.061	-0.002	-0.003	1.136
		TEMP	-2.037	-4.249	-0.394	-10.039	-14.121	-0.043	-0.006	-1.254
		HYDR	0.721	0.812	0.419	0.394	2.340	0.009	0.005	0.997
	1824	OTHR	0.849	-1.425	0.005	0.481	2.820	0.009	-0.005	1.062
		TEMP	-1.011	-4.103	0.136	-10.224	-14.384	0.028	-0.105	-1.321
		HYDR	0.813	0.553	0.410	0.403	2.410	0.011	0.009	1.025

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 RCCV Wetwell Mid-Height	2606	OTHR	3.476	-0.674	-0.184	-0.213	-0.854	0.000	0.009	-0.036
		TEMP	-4.269	-1.249	-0.234	-9.962	-7.559	0.001	0.044	0.117
		HYDR	0.909	0.588	0.546	0.055	0.314	0.023	0.003	0.189
	2613	OTHR	3.054	-1.472	0.177	-0.241	-0.865	-0.001	-0.008	0.026
		TEMP	-5.197	-5.323	-0.038	-9.725	-7.432	-0.015	-0.093	0.418
		HYDR	0.872	0.617	0.438	0.046	0.247	0.021	0.010	0.154
	2624	OTHR	3.429	-0.971	-0.022	-0.155	-0.886	-0.004	0.005	-0.090
		TEMP	-4.923	-4.754	-0.111	-10.020	-7.637	-0.043	0.078	0.194
		HYDR	1.010	0.508	0.363	0.067	0.252	0.006	0.007	0.149
6 RCCV Wetwell Top	3406	OTHR	3.225	-0.006	0.021	-0.092	-0.340	0.078	-0.041	0.007
		TEMP	5.196	-0.343	0.501	-10.839	-14.129	0.028	0.144	2.477
		HYDR	0.656	0.480	0.585	0.102	0.399	0.139	0.162	0.204
	3413	OTHR	2.746	-1.299	0.122	-0.130	-0.264	-0.101	0.054	0.003
		TEMP	3.430	-7.154	0.362	-10.781	-14.124	-0.109	0.133	2.640
		HYDR	0.505	0.527	0.365	0.052	0.272	0.071	0.073	0.167
	3424	OTHR	2.713	-0.285	0.050	0.036	0.163	0.069	-0.026	-0.097
		TEMP	2.843	-6.398	0.484	-9.990	-9.736	0.045	-0.108	0.896
		HYDR	0.515	0.430	0.287	0.022	0.227	0.039	0.057	0.148

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	OTHR	3.121	0.547	-0.089	-0.022	0.061	0.114	-0.003	0.590
		TEMP	0.851	-0.258	0.079	-12.665	-14.960	0.282	0.179	-0.838
		HYDR	0.686	0.499	0.370	0.087	0.343	0.037	0.156	0.129
	3613	OTHR	2.726	-0.779	0.218	-0.024	0.383	-0.086	0.004	0.858
		TEMP	-0.941	-8.499	1.390	-12.337	-13.241	-0.243	0.024	-0.345
		HYDR	0.472	0.428	0.150	0.074	0.339	0.084	0.076	0.116
	3624	OTHR	2.695	0.220	0.017	0.118	0.594	0.069	0.009	0.684
		TEMP	-10.577	-8.035	0.298	-7.210	-6.858	0.089	-0.061	1.477
		HYDR	0.410	0.275	0.305	0.071	0.324	0.028	0.052	0.095
8 RCCV Drywell Mid-Height	4006	OTHR	1.939	0.939	0.024	-0.033	-0.180	0.030	0.033	-0.460
		TEMP	1.893	0.841	-0.323	-12.242	-12.219	0.193	-0.154	-0.810
		HYDR	0.681	0.411	0.172	0.035	0.337	0.023	0.117	0.109
	4013	OTHR	1.995	-0.995	0.350	-0.186	-0.494	0.010	-0.010	-0.372
		TEMP	1.197	-10.529	1.292	-12.197	-11.585	0.046	-0.165	-0.457
		HYDR	0.500	0.530	0.072	0.039	0.071	0.037	0.044	0.082
	4976	OTHR	2.092	0.563	-0.071	0.044	0.033	0.002	-0.014	-0.532
		TEMP	-7.092	-6.953	0.638	-7.681	-8.655	0.012	0.039	-0.305
		HYDR	0.194	0.228	0.217	0.029	0.033	0.013	0.006	0.069

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
9 RCCV Drywell Top	4406	OTHR	0.640	1.242	0.262	0.583	3.265	0.021	-0.002	-1.007
		TEMP	6.726	0.270	-1.390	-11.635	-9.864	0.510	0.460	-0.602
		HYDR	0.216	0.252	0.050	0.075	0.309	0.059	0.062	0.235
	4413	OTHR	0.106	-1.217	0.291	0.374	2.930	0.040	0.012	-1.071
		TEMP	-0.989	-11.897	-0.372	-12.126	-10.994	0.411	-0.180	0.175
		HYDR	0.515	0.626	0.245	0.237	0.250	0.181	0.084	0.270
	4424	OTHR	1.539	0.694	-0.085	0.575	3.189	0.028	0.001	-0.974
		TEMP	-10.172	-5.565	0.973	-7.107	-5.872	-0.070	-0.009	-1.761
		HYDR	0.128	0.188	0.151	0.037	0.220	0.003	0.005	0.087
10 Basemat @ Center	80003	OTHR	-2.535	-1.233	0.146	-2.661	-1.992	-0.041	0.119	-0.076
		TEMP	-1.587	-2.420	-0.001	-8.464	-8.777	-0.040	0.022	-0.010
		HYDR	0.927	0.853	0.083	3.426	3.125	0.057	0.241	0.224
	80007	OTHR	-2.558	-1.239	0.131	-2.582	-1.969	-0.023	0.014	-0.123
		TEMP	-1.600	-2.375	0.039	-8.444	-8.779	-0.040	0.014	-0.014
		HYDR	0.925	0.836	0.072	3.359	3.115	0.061	0.210	0.259
	80012	OTHR	-2.612	-1.226	0.133	-2.577	-1.965	-0.027	-0.093	-0.010
		TEMP	-1.607	-2.298	0.028	-8.433	-8.799	-0.031	0.005	0.001
		HYDR	0.901	0.812	0.055	3.323	3.083	0.048	0.293	0.182

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
11 Basemat Inside RPV Pedestal	80206	OTHR	-2.187	-1.400	0.233	-4.032	-3.796	0.554	0.847	-1.058
		TEMP	-1.604	-2.924	0.120	-8.962	-9.256	0.034	-0.007	-0.049
		HYDR	1.081	0.938	0.151	4.965	4.512	0.804	0.639	0.640
	80213	OTHR	-2.285	-1.228	0.077	-3.312	-4.389	-0.093	-0.072	-1.372
		TEMP	-1.721	-2.346	0.088	-8.685	-9.343	-0.166	-0.026	-0.164
		HYDR	0.989	0.860	0.085	4.109	5.137	0.558	0.450	0.810
	80224	OTHR	-2.770	-1.678	0.055	-4.079	-3.336	-0.147	-1.039	-0.140
		TEMP	-1.574	-2.175	0.061	-8.644	-8.932	-0.052	-0.105	0.019
		HYDR	0.883	0.637	0.082	4.962	3.893	0.423	0.799	0.352
12 S/P Slab @ RPV	83306	OTHR	0.066	1.480	-0.446	-0.735	0.519	-0.071	2.248	-0.042
		TEMP	-11.672	3.835	0.218	-9.639	-8.194	0.035	-0.073	-0.040
		HYDR	1.298	0.806	0.476	1.029	0.690	0.081	2.027	0.049
	83313	OTHR	0.264	1.205	-0.084	-0.667	0.534	0.042	2.263	0.058
		TEMP	-11.910	4.316	-0.426	-9.668	-8.271	-0.025	-0.075	0.011
		HYDR	1.213	0.820	0.328	1.005	0.623	0.139	1.996	0.041
	83324	OTHR	0.296	1.717	0.050	-0.770	0.483	-0.038	2.207	-0.062
		TEMP	-11.696	4.693	0.966	-9.530	-8.130	-0.002	0.004	0.007
		HYDR	1.256	0.871	0.342	0.951	0.560	0.098	1.945	0.048

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	OTHR	0.383	1.114	-0.324	-3.471	-0.968	-0.036	-0.263	0.003
		TEMP	-8.140	-0.574	-0.507	-9.101	-8.502	0.000	-0.107	0.016
		HYDR	1.234	0.820	0.265	3.030	0.974	0.060	0.303	0.004
	83413	OTHR	0.727	0.894	-0.020	-3.440	-0.976	-0.005	-0.252	0.002
		TEMP	-8.751	0.109	0.485	-9.199	-8.591	-0.012	-0.069	-0.008
		HYDR	1.150	0.845	0.178	3.015	0.946	0.074	0.292	0.004
	83424	OTHR	0.554	1.339	0.033	-3.411	-0.964	0.006	-0.285	0.000
		TEMP	-8.209	0.422	0.013	-9.166	-8.499	0.001	-0.043	0.006
		HYDR	1.203	0.917	0.178	2.995	0.931	0.063	0.287	0.004
14 S/P Slab @ RCCV	83506	OTHR	0.534	0.932	-0.243	1.894	-0.229	-0.028	-2.224	-0.002
		TEMP	-6.270	-2.431	-0.382	-8.852	-8.637	-0.050	-0.135	0.021
		HYDR	1.115	0.816	0.196	1.745	0.260	0.020	1.878	0.011
	83513	OTHR	0.923	0.821	0.002	1.878	-0.238	-0.005	-2.213	0.002
		TEMP	-7.033	-2.078	0.612	-9.208	-8.687	-0.011	-0.022	0.001
		HYDR	1.042	0.850	0.169	1.702	0.249	0.023	1.873	0.009
	83524	OTHR	0.643	1.210	0.032	2.007	-0.178	0.000	-2.244	0.002
		TEMP	-6.237	-1.445	-0.080	-9.171	-8.643	0.017	-0.039	-0.005
		HYDR	1.097	0.937	0.164	1.708	0.232	0.020	1.870	0.009

Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
15 Top Slab @ Drywell Head Opening	98120	OTHR	-0.116	1.220	1.421	1.549	0.876	0.764	0.398	-1.412
		TEMP	-11.465	-10.588	-5.034	7.058	5.009	5.155	-1.417	-1.082
		HYDR	0.239	0.081	0.101	0.050	0.074	0.036	0.009	0.019
	98135	OTHR	-1.528	-0.597	-0.608	1.179	-0.461	0.203	0.263	-1.771
		TEMP	-16.071	-6.982	2.437	10.528	-0.434	-1.821	1.058	-1.141
		HYDR	0.374	0.055	0.078	0.068	0.021	0.017	0.005	0.009
	98104	OTHR	-0.337	2.874	-1.003	1.321	4.626	-0.589	-0.539	-1.018
		TEMP	-6.701	-12.118	2.879	2.391	11.786	-3.140	0.876	-0.611
		HYDR	0.069	0.289	0.113	0.021	0.123	0.026	0.005	0.047
16 Top Slab @ Center	98149	OTHR	-0.546	2.189	-0.729	0.733	0.035	0.500	0.014	0.527
		TEMP	-11.277	-3.014	-1.862	5.796	8.885	0.958	0.550	-1.906
		HYDR	0.350	0.186	0.040	0.047	0.037	0.026	0.016	0.020
	98170	OTHR	-0.368	1.466	-0.516	0.916	0.680	-0.069	-0.031	-0.221
		TEMP	-9.611	-4.561	-0.870	4.301	5.407	-0.101	-0.114	0.048
		HYDR	0.252	0.185	0.120	0.035	0.051	0.012	0.005	0.005
	98109	OTHR	0.445	1.908	-0.252	1.490	2.892	-0.434	-0.170	-0.525
		TEMP	-7.853	-1.643	0.877	9.057	11.508	-0.324	0.767	0.077
		HYDR	0.042	0.153	0.192	0.028	0.083	0.027	0.005	0.013

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Table 3G.7-205c **Combined Forces and Moments: RCCV, Selected Load Combination CV-7b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
17 Top Slab @ RCCV	98174	OTHR	0.746	1.816	-0.160	0.551	0.562	0.702	0.224	-0.159
		TEMP	-9.261	-3.967	-1.472	5.055	6.597	0.112	-0.062	0.291
		HYDR	0.298	0.192	0.069	0.113	0.126	0.079	0.041	0.038
	98197	OTHR	0.452	1.949	-0.214	-0.141	-2.616	-0.196	-0.109	-1.508
		TEMP	-11.733	-4.685	-1.499	4.215	6.202	0.220	0.358	-0.438
		HYDR	0.414	0.266	0.108	0.072	0.133	0.034	0.017	0.035
	98103	OTHR	0.937	2.239	-0.127	-1.911	0.510	-0.503	-1.454	-0.318
		TEMP	-7.870	-5.563	-0.327	12.878	12.662	0.251	0.583	0.155
		HYDR	0.056	0.174	0.229	0.090	0.079	0.016	0.023	0.001

OTHR: Loads other than thermal loads
TEMP: Thermal loads
HYDR: Hydrodynamic loads

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	OTHR	-1.721	-7.080	-0.037	0.221	1.277	0.029	-0.010	0.861
		TEMP	-3.476	1.649	-0.329	-6.696	-6.462	-0.046	0.105	1.012
		SEIS	2.142	2.953	0.758	0.503	2.930	0.088	0.072	1.275
		HYDR	1.333	3.785	0.094	0.270	1.646	0.012	0.017	0.770
	5013	OTHR	-2.238	-7.547	0.064	0.164	1.489	-0.002	-0.005	1.043
		TEMP	-3.121	1.796	-0.097	-6.854	-6.851	-0.006	0.027	0.925
		SEIS	2.267	4.399	0.665	0.679	2.926	0.030	0.054	1.264
		HYDR	1.490	3.953	0.386	0.302	1.787	0.001	0.012	0.866
	5024	OTHR	-2.095	-7.067	0.044	0.328	1.288	-0.006	0.008	0.873
		TEMP	-3.419	1.892	-0.003	-6.894	-6.129	-0.026	-0.036	1.045
		SEIS	1.619	3.950	0.225	0.506	2.294	0.012	0.056	0.960
		HYDR	1.625	3.854	0.189	0.309	1.745	0.009	0.017	0.851
2 RPV Pedestal Mid-Height	6006	OTHR	0.767	-6.834	0.052	-0.032	-0.130	0.024	0.070	-0.291
		TEMP	0.080	1.775	0.154	-6.175	-4.043	0.264	0.065	-1.515
		SEIS	0.998	4.294	0.936	0.123	0.554	0.191	0.396	0.349
		HYDR	0.321	4.221	0.218	0.039	0.284	0.023	0.033	0.059
	6013	OTHR	0.494	-6.846	0.206	-0.186	-0.186	0.005	-0.003	-0.272
		TEMP	-0.061	1.444	-0.177	-6.419	-3.904	-0.057	-0.026	-1.669
		SEIS	1.250	4.275	0.811	1.159	0.874	0.069	0.070	0.403
		HYDR	0.331	3.890	0.369	0.074	0.270	0.008	0.011	0.057
	6024	OTHR	0.775	-5.113	-0.478	0.284	0.121	0.016	-0.003	-0.239
		TEMP	-0.245	2.050	0.059	-7.408	-2.297	-0.304	-0.003	-1.547
		SEIS	1.065	4.010	0.662	1.124	0.972	0.065	0.078	0.486
		HYDR	0.328	3.114	0.438	0.055	0.261	0.019	0.019	0.021

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
3 RPV Pedestal Top	6606	OTHR	0.315	-5.553	0.777	0.375	2.444	0.055	0.186	-0.953
		TEMP	20.997	2.192	0.564	-6.643	-5.510	-0.035	-1.941	0.870
		SEIS	1.630	4.534	1.370	0.480	2.986	0.635	1.412	1.063
		HYDR	0.601	3.767	0.658	0.515	3.067	0.157	0.498	0.865
	6613	OTHR	0.036	-5.718	-0.072	0.241	2.446	-0.122	-0.054	-0.994
		TEMP	21.088	1.964	-0.425	-6.702	-5.546	0.139	2.063	0.862
		SEIS	2.808	4.079	0.671	0.852	2.909	0.361	0.380	1.057
		HYDR	0.579	3.509	0.305	0.452	2.863	0.129	0.324	0.851
	6624	OTHR	0.552	-5.439	0.318	0.350	2.145	0.159	0.025	-0.769
		TEMP	21.900	2.601	0.228	-6.671	-5.665	0.005	-2.338	1.055
		SEIS	2.451	5.382	1.109	0.760	2.776	0.235	0.259	0.966
		HYDR	0.534	3.632	0.319	0.447	2.797	0.153	0.426	0.817
4 RCCV Wetwell Bottom	1806	OTHR	-0.012	-2.905	-0.005	0.242	1.435	0.017	0.011	0.534
		TEMP	2.533	0.468	-0.194	-4.438	-8.138	0.077	0.083	-1.750
		SEIS	2.179	6.277	3.312	0.270	1.493	0.128	0.035	0.581
		HYDR	0.703	0.817	0.455	0.397	2.392	0.010	0.005	0.996
	1813	OTHR	-0.204	-3.168	0.205	0.237	1.557	0.000	-0.002	0.636
		TEMP	1.866	-2.167	-0.420	-4.274	-7.773	-0.025	-0.007	-1.523
		SEIS	1.545	6.550	2.983	0.262	1.242	0.044	0.024	0.545
		HYDR	0.673	0.829	0.413	0.399	2.377	0.008	0.004	1.013
	1824	OTHR	0.188	-3.215	-0.001	0.239	1.372	0.008	-0.006	0.577
		TEMP	2.926	-2.481	0.046	-4.432	-8.134	0.020	-0.085	-1.667
		SEIS	1.768	6.994	3.460	0.274	1.171	0.058	0.038	0.552
		HYDR	0.756	0.570	0.387	0.403	2.421	0.009	0.007	1.029

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 RCCV Wetwell Mid-Height	2606	OTHR	1.751	-2.464	-0.048	-0.114	-0.452	-0.003	0.007	-0.054
		TEMP	1.379	0.586	-0.171	-3.308	-1.033	0.018	0.039	0.074
		SEIS	0.699	5.697	3.529	0.070	0.088	0.136	0.023	0.160
		HYDR	0.888	0.605	0.524	0.052	0.296	0.023	0.004	0.184
	2613	OTHR	1.472	-2.874	0.184	-0.144	-0.486	0.000	-0.006	0.000
		TEMP	0.111	-2.544	-0.109	-3.090	-1.052	0.009	-0.075	0.370
		SEIS	1.262	6.011	3.383	0.139	0.173	0.054	0.014	0.230
		HYDR	0.859	0.630	0.432	0.044	0.234	0.021	0.010	0.149
	2624	OTHR	1.745	-2.695	-0.006	-0.086	-0.489	-0.002	0.003	-0.071
		TEMP	0.965	-2.909	-0.087	-3.293	-0.935	-0.026	0.067	0.189
		SEIS	0.738	6.218	3.359	0.129	0.236	0.080	0.025	0.270
		HYDR	0.999	0.525	0.348	0.067	0.237	0.006	0.006	0.142
6 RCCV Wetwell Top	3406	OTHR	1.696	-1.843	0.133	-0.056	-0.200	0.076	-0.040	-0.003
		TEMP	11.723	1.461	0.327	-4.151	-8.468	-0.227	0.461	3.349
		SEIS	0.447	4.938	3.456	0.113	0.667	0.203	0.177	0.230
		HYDR	0.630	0.484	0.561	0.095	0.369	0.133	0.156	0.196
	3413	OTHR	1.426	-2.624	0.098	-0.093	-0.262	-0.111	0.053	0.033
		TEMP	8.032	-3.439	0.044	-4.382	-9.151	-0.402	0.538	3.335
		SEIS	0.861	5.510	3.417	0.079	0.438	0.116	0.116	0.271
		HYDR	0.491	0.532	0.354	0.050	0.255	0.066	0.069	0.166
	3424	OTHR	1.452	-2.017	0.061	-0.004	-0.072	0.071	-0.024	0.007
		TEMP	10.292	-4.166	0.471	-3.681	-5.045	-0.039	-0.006	2.165
		SEIS	0.849	5.373	2.995	0.130	1.059	0.090	0.088	0.375
		HYDR	0.520	0.441	0.274	0.022	0.234	0.037	0.056	0.151

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	OTHR	1.704	-1.271	0.041	-0.007	0.121	0.093	-0.002	0.391
		TEMP	8.504	1.377	0.674	-5.342	-9.036	0.607	0.534	-1.980
		SEIS	0.323	4.755	3.582	0.115	0.737	0.097	0.167	0.403
		HYDR	0.652	0.500	0.361	0.085	0.342	0.038	0.149	0.126
	3613	OTHR	1.477	-2.084	0.146	0.022	0.413	-0.104	-0.003	0.604
		TEMP	4.607	-4.161	1.005	-4.955	-6.227	-0.363	0.317	-0.820
		SEIS	0.756	5.564	3.380	0.137	0.701	0.052	0.107	0.379
		HYDR	0.450	0.433	0.143	0.075	0.341	0.080	0.072	0.114
	3624	OTHR	1.448	-1.655	0.073	0.111	0.567	0.072	0.011	0.467
		TEMP	-4.291	-6.043	0.252	-0.934	-2.498	0.068	0.000	0.351
		SEIS	0.615	6.166	3.204	0.219	0.861	0.100	0.055	0.234
		HYDR	0.411	0.284	0.291	0.071	0.323	0.027	0.050	0.094
8 RCCV Drywell Mid-Height	4006	OTHR	1.214	-0.863	0.055	-0.085	-0.248	0.006	0.028	-0.165
		TEMP	5.952	2.178	0.212	-5.110	-5.057	0.011	-0.126	-0.683
		SEIS	1.109	4.148	3.283	0.174	0.735	0.103	0.094	0.349
		HYDR	0.646	0.410	0.173	0.035	0.329	0.021	0.111	0.106
	4013	OTHR	1.248	-2.158	0.278	-0.125	-0.420	0.008	-0.012	-0.135
		TEMP	4.287	-5.850	1.041	-4.672	-4.289	0.014	-0.132	-0.308
		SEIS	0.926	5.260	3.257	0.119	0.629	0.088	0.042	0.289
		HYDR	0.476	0.531	0.075	0.039	0.073	0.035	0.041	0.083
	4976	OTHR	1.129	-1.133	0.038	0.029	-0.054	0.000	-0.012	-0.233
		TEMP	-2.660	-5.335	0.580	-0.954	-1.780	0.003	0.013	-0.584
		SEIS	0.398	5.070	3.298	0.138	0.389	0.035	0.029	0.176
		HYDR	0.193	0.232	0.209	0.030	0.031	0.013	0.005	0.069

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
9 RCCV Drywell Top	4406	OTHR	0.462	-0.470	0.060	0.184	1.145	0.001	0.000	-0.376
		TEMP	6.433	1.711	-0.232	-4.475	-3.816	0.299	0.087	-0.150
		SEIS	1.163	3.470	2.775	0.368	2.106	0.071	0.091	0.443
		HYDR	0.203	0.252	0.046	0.073	0.300	0.056	0.059	0.229
	4413	OTHR	-0.011	-2.231	0.217	0.116	1.168	0.035	0.008	-0.486
		TEMP	0.711	-6.632	-0.292	-4.753	-4.467	0.253	-0.243	0.643
		SEIS	0.636	5.001	2.883	0.239	1.502	0.148	0.018	0.269
		HYDR	0.516	0.629	0.230	0.226	0.253	0.171	0.080	0.264
	4424	OTHR	0.866	-0.757	0.013	0.293	1.525	0.019	0.002	-0.486
		TEMP	-5.846	-4.171	0.767	-0.363	1.129	-0.024	-0.022	-1.462
		SEIS	0.708	4.101	3.512	0.102	0.660	0.030	0.024	0.142
		HYDR	0.123	0.187	0.147	0.037	0.220	0.003	0.005	0.090
10 Basemat @ Center	80003	OTHR	-3.175	-1.946	0.153	1.397	1.904	-0.049	0.206	-0.145
		TEMP	-4.270	-5.140	0.021	-8.130	-8.102	-0.039	0.029	-0.008
		SEIS	2.115	1.714	1.074	9.349	9.265	0.289	0.274	0.336
		HYDR	0.908	0.831	0.076	3.250	2.955	0.047	0.202	0.192
	80007	OTHR	-3.205	-1.955	0.136	1.469	1.925	-0.032	-0.005	-0.235
		TEMP	-4.296	-5.104	0.056	-8.096	-8.099	-0.037	0.028	-0.009
		SEIS	2.096	1.715	0.945	9.322	9.269	0.226	0.114	0.420
		HYDR	0.906	0.817	0.065	3.190	2.945	0.049	0.168	0.228
	80012	OTHR	-3.256	-1.946	0.137	1.475	1.927	-0.035	-0.209	-0.025
		TEMP	-4.302	-5.040	0.042	-8.079	-8.109	-0.032	0.024	-0.001
		SEIS	2.025	1.725	0.877	9.282	9.261	0.139	0.356	0.258
		HYDR	0.885	0.797	0.050	3.157	2.919	0.041	0.254	0.145

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Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
11 Basemat Inside RPV Pedestal	80206	OTHR	-2.854	-2.080	0.229	-1.020	-0.813	0.857	1.084	-1.231
		TEMP	-4.260	-5.523	0.137	-8.575	-8.460	0.003	0.005	-0.035
		SEIS	2.387	1.714	1.373	7.475	7.088	1.409	1.372	1.504
		HYDR	1.044	0.895	0.149	4.683	4.269	0.707	0.579	0.597
	80213	OTHR	-2.961	-1.956	0.101	0.027	-1.759	-0.131	-0.087	-1.683
		TEMP	-4.445	-5.127	0.161	-8.289	-8.565	-0.151	-0.018	-0.103
		SEIS	2.167	1.715	0.967	7.791	6.098	0.775	0.532	1.811
		HYDR	0.965	0.838	0.086	3.929	4.879	0.437	0.351	0.777
	80224	OTHR	-3.447	-2.337	0.065	-1.395	-0.110	-0.176	-1.396	-0.147
		TEMP	-4.372	-4.948	0.081	-8.177	-8.193	-0.045	-0.038	0.010
		SEIS	1.838	1.861	0.338	5.314	6.997	0.454	1.698	0.407
		HYDR	0.869	0.635	0.079	4.696	3.714	0.336	0.750	0.279
12 S/P Slab @ RPV	83306	OTHR	-0.087	0.887	-0.398	0.209	0.695	-0.060	1.589	-0.033
		TEMP	-10.607	10.981	0.454	-4.700	-2.770	0.032	-0.288	0.000
		SEIS	0.341	0.981	1.083	2.394	1.598	0.197	1.249	0.097
		HYDR	1.136	0.794	0.394	0.982	0.646	0.066	2.051	0.046
	83313	OTHR	0.112	0.650	-0.101	0.259	0.709	0.040	1.601	0.044
		TEMP	-10.822	11.242	-0.850	-4.737	-2.848	-0.039	-0.302	-0.028
		SEIS	0.645	1.083	0.731	2.325	1.562	0.169	1.238	0.076
		HYDR	1.082	0.810	0.252	0.956	0.588	0.111	2.021	0.039
	83324	OTHR	0.148	1.112	0.055	0.170	0.661	-0.038	1.550	-0.048
		TEMP	-10.702	11.862	1.279	-4.487	-2.654	0.006	-0.156	0.046
		SEIS	0.657	0.611	0.701	2.158	1.488	0.194	1.187	0.103
		HYDR	1.121	0.856	0.266	0.907	0.523	0.078	1.968	0.045

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	OTHR	0.098	0.648	-0.304	-2.188	-0.362	-0.026	0.001	0.003
		TEMP	-6.490	4.881	-0.530	-3.815	-3.181	-0.001	-0.306	0.016
		SEIS	0.317	1.270	0.838	0.985	0.747	0.153	0.614	0.023
		HYDR	1.106	0.797	0.225	3.093	0.966	0.049	0.290	0.003
	83413	OTHR	0.414	0.442	-0.019	-2.163	-0.368	-0.004	0.009	0.002
		TEMP	-6.986	5.307	0.315	-3.900	-3.257	-0.015	-0.278	-0.011
		SEIS	0.638	0.839	0.651	0.985	0.723	0.112	0.602	0.005
		HYDR	1.054	0.819	0.140	3.078	0.943	0.058	0.281	0.003
	83424	OTHR	0.273	0.853	0.026	-2.129	-0.363	0.004	-0.021	0.000
		TEMP	-6.630	5.823	0.078	-3.895	-3.148	-0.003	-0.210	0.009
		SEIS	0.790	0.631	0.380	0.971	0.683	0.128	0.555	0.006
		HYDR	1.100	0.884	0.137	3.056	0.928	0.049	0.276	0.003
14 S/P Slab @ RCCV	83506	OTHR	0.207	0.520	-0.237	0.638	-0.124	-0.024	-1.233	0.001
		TEMP	-3.948	2.320	-0.446	-2.906	-3.131	-0.038	-0.275	0.016
		SEIS	0.260	1.392	0.583	1.985	0.119	0.059	0.235	0.044
		HYDR	1.024	0.791	0.166	1.721	0.267	0.017	1.913	0.010
	83513	OTHR	0.558	0.392	0.005	0.623	-0.129	-0.005	-1.223	0.002
		TEMP	-4.567	2.419	0.440	-3.190	-3.174	-0.008	-0.192	-0.001
		SEIS	0.592	0.654	0.631	1.978	0.198	0.024	0.221	0.020
		HYDR	0.978	0.820	0.137	1.684	0.258	0.017	1.909	0.008
	83524	OTHR	0.318	0.765	0.028	0.748	-0.081	-0.001	-1.251	0.001
		TEMP	-4.038	3.201	-0.017	-3.278	-3.153	0.013	-0.168	-0.005
		SEIS	0.759	0.654	0.269	1.792	0.218	0.014	0.132	0.035
		HYDR	1.028	0.899	0.128	1.687	0.241	0.015	1.906	0.007

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
15 Top Slab @ Drywell Head Opening	98120	OTHR	0.421	0.816	0.977	0.627	0.430	0.266	0.254	-0.587
		TEMP	-7.068	-4.258	-0.770	0.956	0.732	2.765	-0.161	-0.002
		SEIS	1.607	0.813	0.799	0.700	0.353	0.496	0.146	0.603
		HYDR	0.234	0.076	0.098	0.050	0.072	0.037	0.009	0.019
	98135	OTHR	0.349	-0.229	-0.427	0.341	-0.139	0.176	0.119	-0.815
		TEMP	-8.729	-5.283	0.235	3.147	-2.057	-1.132	0.380	-0.267
		SEIS	3.466	0.367	0.494	0.943	0.391	0.204	0.095	0.513
		HYDR	0.372	0.053	0.077	0.068	0.020	0.017	0.005	0.008
	98104	OTHR	-0.148	1.917	-0.586	0.611	1.842	-0.186	-0.300	-0.460
		TEMP	-4.999	-1.752	0.585	-1.461	3.712	-1.500	0.185	-0.214
		SEIS	0.309	1.677	0.439	0.369	2.260	0.434	0.051	0.327
		HYDR	0.068	0.287	0.110	0.021	0.123	0.027	0.005	0.044
16 Top Slab @ Center	98149	OTHR	0.450	1.078	-0.165	0.065	-0.064	0.297	0.006	0.146
		TEMP	-6.075	-2.540	-1.137	2.229	2.310	0.496	0.037	0.048
		SEIS	2.231	0.717	0.804	1.033	0.301	0.080	0.064	0.404
		HYDR	0.345	0.181	0.037	0.047	0.036	0.026	0.016	0.020
	98170	OTHR	0.423	0.828	-0.255	0.184	0.016	-0.003	-0.013	-0.090
		TEMP	-5.510	-3.566	-1.042	2.141	2.864	-0.042	0.030	0.389
		SEIS	1.905	0.288	0.656	0.950	1.003	0.111	0.024	0.090
		HYDR	0.250	0.178	0.120	0.036	0.051	0.012	0.005	0.005
	98109	OTHR	0.313	1.292	-0.126	0.521	1.173	-0.161	-0.042	-0.247
		TEMP	-6.256	-0.887	0.773	1.219	2.564	-0.119	0.329	-0.005
		SEIS	0.210	1.333	0.569	0.967	1.400	0.244	0.165	0.160
		HYDR	0.044	0.151	0.182	0.029	0.084	0.025	0.005	0.013

Table 3G.7-205d **Combined Forces and Moments: RCCV, Selected Load Combination CV-11a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
17 Top Slab @ RCCV	98174	OTHR	0.779	0.960	-0.010	-0.014	0.058	0.254	0.042	-0.058
		TEMP	-4.871	-2.689	-0.476	2.352	3.211	0.255	-0.023	0.434
		SEIS	1.356	1.025	0.528	1.016	0.770	0.408	0.240	0.098
		HYDR	0.293	0.187	0.067	0.110	0.121	0.081	0.040	0.036
	98197	OTHR	0.484	1.096	-0.194	-0.198	-0.931	-0.033	-0.028	-0.502
		TEMP	-7.584	-2.926	-1.360	1.917	3.110	0.130	0.154	-0.447
		SEIS	1.120	0.360	0.727	0.383	1.561	0.243	0.095	0.941
		HYDR	0.411	0.261	0.107	0.072	0.127	0.034	0.016	0.036
	98103	OTHR	0.450	1.419	-0.048	-0.213	0.412	-0.189	-0.391	-0.124
		TEMP	-6.577	-2.458	-0.070	3.431	3.308	0.118	0.450	0.084
		SEIS	0.268	1.393	0.788	2.654	0.600	0.298	1.252	0.160
		HYDR	0.058	0.171	0.217	0.090	0.080	0.014	0.023	0.002

OTHR: Loads other than thermal loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 RPV Pedestal Bottom	5006	OTHR	-1.959	-7.403	-0.039	0.300	1.747	0.031	-0.011	1.069
		TEMP	-12.849	0.250	-0.523	-16.011	-12.625	-0.093	0.227	4.158
		SEIS	2.142	2.953	0.758	0.503	2.930	0.088	0.072	1.275
		HYDR	1.030	2.969	0.088	0.208	1.273	0.009	0.012	0.595
	5013	OTHR	-2.481	-7.839	0.058	0.240	1.953	-0.002	-0.005	1.254
		TEMP	-12.356	0.343	-0.104	-16.288	-13.239	-0.007	0.021	4.062
		SEIS	2.267	4.399	0.665	0.679	2.926	0.030	0.054	1.264
		HYDR	1.150	3.029	0.369	0.232	1.379	0.001	0.009	0.668
	5024	OTHR	-2.332	-7.305	0.048	0.409	1.729	-0.008	0.009	1.066
		TEMP	-12.862	0.231	0.003	-16.285	-11.829	-0.073	-0.054	4.265
		SEIS	1.619	3.950	0.225	0.506	2.294	0.012	0.056	0.960
		HYDR	1.260	2.975	0.188	0.241	1.360	0.007	0.012	0.662
2 RPV Pedestal Mid-Height	6006	OTHR	0.981	-7.151	0.031	-0.042	-0.173	0.024	0.072	-0.321
		TEMP	-2.408	0.615	0.443	-16.093	-14.923	0.436	0.146	-1.774
		SEIS	0.998	4.294	0.936	0.123	0.554	0.191	0.396	0.349
		HYDR	0.266	3.408	0.166	0.030	0.241	0.019	0.027	0.044
	6013	OTHR	0.700	-7.139	0.200	-0.196	-0.231	0.005	-0.003	-0.302
		TEMP	-2.624	0.212	-0.206	-16.582	-14.795	-0.048	-0.033	-2.015
		SEIS	1.250	4.275	0.811	1.159	0.874	0.069	0.070	0.403
		HYDR	0.259	3.036	0.351	0.057	0.219	0.006	0.009	0.045
	6024	OTHR	1.014	-5.292	-0.498	0.290	0.093	0.016	-0.006	-0.253
		TEMP	-2.728	0.667	0.076	-18.533	-11.361	-0.661	0.020	-1.697
		SEIS	1.065	4.010	0.662	1.124	0.972	0.065	0.078	0.486
		HYDR	0.261	2.491	0.369	0.041	0.212	0.016	0.014	0.019

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
3 RPV Pedestal Top	6606	OTHR	0.456	-5.909	0.788	0.412	2.680	0.046	0.212	-0.987
		TEMP	8.837	0.682	0.577	-16.163	-12.297	0.057	-1.395	-2.012
		SEIS	1.630	4.534	1.370	0.480	2.986	0.635	1.412	1.063
		HYDR	0.552	2.994	0.564	0.428	2.438	0.156	0.487	0.661
	6613	OTHR	0.159	-6.083	-0.083	0.275	2.692	-0.114	-0.076	-1.034
		TEMP	9.213	0.732	-0.359	-16.199	-12.536	0.030	1.518	-1.952
		SEIS	2.808	4.079	0.671	0.852	2.909	0.361	0.380	1.057
		HYDR	0.519	2.708	0.314	0.367	2.223	0.114	0.313	0.649
	6624	OTHR	0.692	-5.765	0.318	0.387	2.372	0.152	0.045	-0.800
		TEMP	9.545	0.848	0.253	-16.174	-12.377	0.066	-1.768	-1.800
		SEIS	2.451	5.382	1.109	0.760	2.776	0.235	0.259	0.966
		HYDR	0.491	2.860	0.273	0.368	2.206	0.145	0.411	0.629
4 RCCV Wetwell Bottom	1806	OTHR	0.168	-2.403	-0.032	0.316	1.878	0.017	0.011	0.680
		TEMP	-1.533	-1.021	-0.228	-10.248	-14.646	0.090	0.096	-1.555
		SEIS	2.179	6.277	3.312	0.270	1.493	0.128	0.035	0.581
		HYDR	0.574	0.582	0.330	0.296	1.771	0.007	0.004	0.746
	1813	OTHR	-0.030	-2.736	0.201	0.310	2.002	-0.001	-0.003	0.787
		TEMP	-2.037	-4.249	-0.394	-10.039	-14.121	-0.043	-0.006	-1.254
		SEIS	1.545	6.550	2.983	0.262	1.242	0.044	0.024	0.545
		HYDR	0.555	0.592	0.291	0.298	1.767	0.007	0.004	0.755
	1824	OTHR	0.385	-2.712	0.001	0.310	1.802	0.008	-0.005	0.724
		TEMP	-1.011	-4.103	0.136	-10.224	-14.384	0.028	-0.105	-1.321
		SEIS	1.768	6.994	3.460	0.274	1.171	0.058	0.038	0.552
		HYDR	0.623	0.400	0.281	0.305	1.826	0.008	0.007	0.778

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 RCCV Wetwell Mid-Height	2606	OTHR	2.266	-1.954	-0.083	-0.145	-0.581	-0.003	0.007	-0.051
		TEMP	-4.269	-1.249	-0.234	-9.962	-7.559	0.001	0.044	0.117
		SEIS	0.699	5.697	3.529	0.070	0.088	0.136	0.023	0.160
		HYDR	0.693	0.434	0.372	0.042	0.234	0.016	0.002	0.144
	2613	OTHR	1.945	-2.471	0.182	-0.174	-0.607	0.000	-0.007	0.006
		TEMP	-5.197	-5.323	-0.038	-9.725	-7.432	-0.015	-0.093	0.418
		SEIS	1.262	6.011	3.383	0.139	0.173	0.054	0.014	0.230
		HYDR	0.662	0.456	0.300	0.035	0.187	0.014	0.008	0.117
	2624	OTHR	2.247	-2.211	-0.011	-0.109	-0.615	-0.002	0.003	-0.078
		TEMP	-4.923	-4.754	-0.111	-10.020	-7.637	-0.043	0.078	0.194
		SEIS	0.738	6.218	3.359	0.129	0.236	0.080	0.025	0.270
		HYDR	0.765	0.373	0.246	0.051	0.193	0.005	0.005	0.115
6 RCCV Wetwell Top	3406	OTHR	2.118	-1.320	0.100	-0.056	-0.180	0.062	-0.029	-0.022
		TEMP	5.196	-0.343	0.501	-10.839	-14.129	0.028	0.144	2.477
		SEIS	0.447	4.938	3.456	0.113	0.667	0.203	0.177	0.230
		HYDR	0.457	0.355	0.398	0.070	0.277	0.095	0.111	0.142
	3413	OTHR	1.796	-2.240	0.110	-0.097	-0.220	-0.094	0.045	0.008
		TEMP	3.430	-7.154	0.362	-10.781	-14.124	-0.109	0.133	2.640
		SEIS	0.861	5.510	3.417	0.079	0.438	0.116	0.116	0.271
		HYDR	0.351	0.394	0.249	0.037	0.189	0.049	0.050	0.117
	3424	OTHR	1.807	-1.530	0.049	0.015	0.047	0.054	-0.015	-0.042
		TEMP	2.843	-6.398	0.484	-9.990	-9.736	0.045	-0.108	0.896
		SEIS	0.849	5.373	2.995	0.130	1.059	0.090	0.088	0.375
		HYDR	0.371	0.320	0.194	0.016	0.163	0.027	0.040	0.108

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
7 RCCV Drywell Bottom	3606	OTHR	2.090	-0.794	0.001	-0.014	0.090	0.084	0.002	0.435
		TEMP	0.851	-0.258	0.079	-12.665	-14.960	0.282	0.179	-0.838
		SEIS	0.323	4.755	3.582	0.115	0.737	0.097	0.167	0.403
		HYDR	0.472	0.366	0.253	0.061	0.246	0.025	0.107	0.089
	3613	OTHR	1.822	-1.747	0.172	0.003	0.376	-0.084	-0.003	0.658
		TEMP	-0.941	-8.499	1.390	-12.337	-13.241	-0.243	0.024	-0.345
		SEIS	0.756	5.564	3.380	0.137	0.701	0.052	0.107	0.379
		HYDR	0.324	0.321	0.101	0.054	0.250	0.057	0.052	0.082
	3624	OTHR	1.793	-1.183	0.048	0.107	0.543	0.054	0.012	0.513
		TEMP	-10.577	-8.035	0.298	-7.210	-6.858	0.089	-0.061	1.477
		SEIS	0.615	6.166	3.204	0.219	0.861	0.100	0.055	0.234
		HYDR	0.292	0.201	0.206	0.053	0.242	0.019	0.036	0.069
8 RCCV Drywell Mid-Height	4006	OTHR	1.419	-0.394	0.046	-0.072	-0.239	0.012	0.027	-0.239
		TEMP	1.893	0.841	-0.323	-12.242	-12.219	0.193	-0.154	-0.810
		SEIS	1.109	4.148	3.283	0.174	0.735	0.103	0.094	0.349
		HYDR	0.466	0.297	0.118	0.025	0.231	0.015	0.079	0.076
	4013	OTHR	1.453	-1.865	0.296	-0.141	-0.440	0.008	-0.011	-0.201
		TEMP	1.197	-10.529	1.292	-12.197	-11.585	0.046	-0.165	-0.457
		SEIS	0.926	5.260	3.257	0.119	0.629	0.088	0.042	0.289
		HYDR	0.341	0.398	0.050	0.027	0.051	0.025	0.030	0.059
	4976	OTHR	1.391	-0.705	0.011	0.032	-0.033	0.001	-0.013	-0.313
		TEMP	-7.092	-6.953	0.638	-7.681	-8.655	0.012	0.039	-0.305
		SEIS	0.398	5.070	3.298	0.138	0.389	0.035	0.029	0.176
		HYDR	0.135	0.170	0.146	0.021	0.023	0.009	0.004	0.052

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
9 RCCV Drywell Top	4406	OTHR	0.512	-0.025	0.111	0.289	1.684	0.007	0.000	-0.543
		TEMP	6.726	0.270	-1.390	-11.635	-9.864	0.510	0.460	-0.602
		SEIS	1.163	3.470	2.775	0.368	2.106	0.071	0.091	0.443
		HYDR	0.148	0.182	0.036	0.052	0.214	0.040	0.043	0.162
	4413	OTHR	0.013	-1.981	0.235	0.185	1.632	0.036	0.008	-0.639
		TEMP	-0.989	-11.897	-0.372	-12.126	-10.994	0.411	-0.180	0.175
		SEIS	0.636	5.001	2.883	0.239	1.502	0.148	0.018	0.269
		HYDR	0.363	0.469	0.168	0.162	0.182	0.123	0.057	0.187
	4424	OTHR	1.040	-0.391	-0.012	0.367	1.959	0.021	0.002	-0.613
		TEMP	-10.172	-5.565	0.973	-7.107	-5.872	-0.070	-0.009	-1.761
		SEIS	0.708	4.101	3.512	0.102	0.660	0.030	0.024	0.142
		HYDR	0.087	0.142	0.101	0.028	0.166	0.002	0.003	0.064
10 Basemat @ Center	80003	OTHR	-3.007	-1.759	0.151	0.338	0.888	-0.047	0.184	-0.127
		TEMP	-1.587	-2.420	-0.001	-8.464	-8.777	-0.040	0.022	-0.010
		SEIS	2.115	1.714	1.074	9.349	9.265	0.289	0.274	0.336
		HYDR	0.689	0.634	0.057	2.545	2.321	0.042	0.180	0.166
	80007	OTHR	-3.035	-1.767	0.135	0.412	0.909	-0.029	0.000	-0.206
		TEMP	-1.600	-2.375	0.039	-8.444	-8.779	-0.040	0.014	-0.014
		SEIS	2.096	1.715	0.945	9.322	9.269	0.226	0.114	0.420
		HYDR	0.688	0.622	0.051	2.496	2.314	0.045	0.157	0.193
	80012	OTHR	-3.087	-1.757	0.136	0.418	0.912	-0.033	-0.180	-0.021
		TEMP	-1.607	-2.298	0.028	-8.433	-8.799	-0.031	0.005	0.001
		SEIS	2.025	1.725	0.877	9.282	9.261	0.139	0.356	0.258
		HYDR	0.671	0.603	0.038	2.471	2.290	0.035	0.219	0.134

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
11 Basemat Inside RPV Pedestal	80206	OTHR	-2.678	-1.902	0.230	-1.814	-1.598	0.781	1.025	-1.187
		TEMP	-1.604	-2.924	0.120	-8.962	-9.256	0.034	-0.007	-0.049
		SEIS	2.387	1.714	1.373	7.475	7.088	1.409	1.372	1.504
		HYDR	0.804	0.702	0.105	3.702	3.366	0.602	0.480	0.476
	80213	OTHR	-2.784	-1.765	0.095	-0.848	-2.454	-0.120	-0.083	-1.605
		TEMP	-1.721	-2.346	0.088	-8.685	-9.343	-0.166	-0.026	-0.164
		SEIS	2.167	1.715	0.967	7.791	6.098	0.775	0.532	1.811
		HYDR	0.736	0.640	0.058	3.062	3.834	0.416	0.337	0.605
	80224	OTHR	-3.269	-2.165	0.062	-2.102	-0.956	-0.169	-1.305	-0.146
		TEMP	-1.574	-2.175	0.061	-8.644	-8.932	-0.052	-0.105	0.019
		SEIS	1.838	1.861	0.338	5.314	6.997	0.454	1.698	0.407
		HYDR	0.659	0.470	0.058	3.723	2.907	0.313	0.598	0.262
12 S/P Slab @ RPV	83306	OTHR	-0.026	1.059	-0.412	-0.040	0.665	-0.063	1.807	-0.036
		TEMP	-11.672	3.835	0.218	-9.639	-8.194	0.035	-0.073	-0.040
		SEIS	0.341	0.981	1.083	2.394	1.598	0.197	1.249	0.097
		HYDR	0.990	0.616	0.366	0.765	0.514	0.058	1.530	0.036
	83313	OTHR	0.175	0.812	-0.096	0.015	0.679	0.041	1.819	0.048
		TEMP	-11.910	4.316	-0.426	-9.668	-8.271	-0.025	-0.075	0.011
		SEIS	0.645	1.083	0.731	2.325	1.562	0.169	1.238	0.076
		HYDR	0.927	0.623	0.255	0.751	0.465	0.104	1.507	0.030
	83324	OTHR	0.206	1.287	0.054	-0.078	0.631	-0.038	1.767	-0.052
		TEMP	-11.696	4.693	0.966	-9.530	-8.130	-0.002	0.004	0.007
		SEIS	0.657	0.611	0.701	2.158	1.488	0.194	1.187	0.103
		HYDR	0.959	0.664	0.265	0.716	0.420	0.072	1.470	0.036

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
13 S/P Slab @ Center	83406	OTHR	0.193	0.787	-0.310	-2.589	-0.534	-0.028	-0.070	0.003
		TEMP	-8.140	-0.574	-0.507	-9.101	-8.502	0.000	-0.107	0.016
		SEIS	0.317	1.270	0.838	0.985	0.747	0.153	0.614	0.023
		HYDR	0.941	0.627	0.200	2.291	0.733	0.043	0.226	0.003
	83413	OTHR	0.519	0.577	-0.019	-2.562	-0.540	-0.004	-0.061	0.002
		TEMP	-8.751	0.109	0.485	-9.199	-8.591	-0.012	-0.069	-0.008
		SEIS	0.638	0.839	0.651	0.985	0.723	0.112	0.602	0.005
		HYDR	0.879	0.643	0.139	2.280	0.712	0.055	0.218	0.003
	83424	OTHR	0.367	0.999	0.028	-2.529	-0.533	0.005	-0.092	0.000
		TEMP	-8.209	0.422	0.013	-9.166	-8.499	0.001	-0.043	0.006
		SEIS	0.790	0.631	0.380	0.971	0.683	0.128	0.555	0.006
		HYDR	0.919	0.699	0.135	2.265	0.703	0.046	0.216	0.003
14 S/P Slab @ RCCV	83506	OTHR	0.313	0.645	-0.239	0.991	-0.155	-0.025	-1.531	0.000
		TEMP	-6.270	-2.431	-0.382	-8.852	-8.637	-0.050	-0.135	0.021
		SEIS	0.260	1.392	0.583	1.985	0.119	0.059	0.235	0.044
		HYDR	0.849	0.624	0.149	1.309	0.196	0.015	1.419	0.008
	83513	OTHR	0.675	0.522	0.004	0.976	-0.161	-0.005	-1.521	0.002
		TEMP	-7.033	-2.078	0.612	-9.208	-8.687	-0.011	-0.022	0.001
		SEIS	0.592	0.654	0.631	1.978	0.198	0.024	0.221	0.020
		HYDR	0.795	0.647	0.132	1.278	0.187	0.017	1.416	0.007
	83524	OTHR	0.424	0.901	0.029	1.102	-0.110	-0.001	-1.549	0.001
		TEMP	-6.237	-1.445	-0.080	-9.171	-8.643	0.017	-0.039	-0.005
		SEIS	0.759	0.654	0.269	1.792	0.218	0.014	0.132	0.035
		HYDR	0.836	0.714	0.124	1.287	0.175	0.015	1.415	0.006

Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
15 Top Slab @ Drywell Head Opening	98120	OTHR	0.283	0.926	1.091	0.861	0.544	0.392	0.290	-0.798
		TEMP	-11.465	-10.588	-5.034	7.058	5.009	5.155	-1.417	-1.082
		SEIS	1.607	0.813	0.799	0.700	0.353	0.496	0.146	0.603
		HYDR	0.167	0.057	0.071	0.036	0.052	0.026	0.006	0.014
	98135	OTHR	-0.136	-0.322	-0.474	0.554	-0.221	0.183	0.155	-1.059
		TEMP	-16.071	-6.982	2.437	10.528	-0.434	-1.821	1.058	-1.141
		SEIS	3.466	0.367	0.494	0.943	0.391	0.204	0.095	0.513
		HYDR	0.259	0.037	0.053	0.049	0.015	0.012	0.004	0.006
	98104	OTHR	-0.195	2.182	-0.694	0.792	2.553	-0.289	-0.361	-0.602
		TEMP	-6.701	-12.118	2.879	2.391	11.786	-3.140	0.876	-0.611
		SEIS	0.309	1.677	0.439	0.369	2.260	0.434	0.051	0.327
		HYDR	0.047	0.201	0.077	0.015	0.089	0.019	0.004	0.032
16 Top Slab @ Center	98149	OTHR	0.191	1.354	-0.308	0.230	-0.048	0.349	0.009	0.251
		TEMP	-11.277	-3.014	-1.862	5.796	8.885	0.958	0.550	-1.906
		SEIS	2.231	0.717	0.804	1.033	0.301	0.080	0.064	0.404
		HYDR	0.245	0.130	0.028	0.034	0.026	0.019	0.012	0.014
	98170	OTHR	0.218	0.971	-0.319	0.369	0.178	-0.020	-0.020	-0.131
		TEMP	-9.611	-4.561	-0.870	4.301	5.407	-0.101	-0.114	0.048
		SEIS	1.905	0.288	0.656	0.950	1.003	0.111	0.024	0.090
		HYDR	0.176	0.127	0.084	0.025	0.036	0.009	0.003	0.004
	98109	OTHR	0.348	1.457	-0.158	0.767	1.612	-0.231	-0.076	-0.318
		TEMP	-7.853	-1.643	0.877	9.057	11.508	-0.324	0.767	0.077
		SEIS	0.210	1.333	0.569	0.967	1.400	0.244	0.165	0.160
		HYDR	0.030	0.106	0.129	0.021	0.060	0.018	0.004	0.009

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Table 3G.7-205e **Combined Forces and Moments: RCCV, Selected Load Combination CV-11b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
17 Top Slab @ RCCV	98174	OTHR	0.766	1.170	-0.048	0.120	0.176	0.371	0.089	-0.091
		TEMP	-9.261	-3.967	-1.472	5.055	6.597	0.112	-0.062	0.291
		SEIS	1.356	1.025	0.528	1.016	0.770	0.408	0.240	0.098
		HYDR	0.208	0.134	0.049	0.078	0.086	0.057	0.028	0.026
	98197	OTHR	0.467	1.292	-0.199	-0.183	-1.351	-0.075	-0.049	-0.764
		TEMP	-11.733	-4.685	-1.499	4.215	6.202	0.220	0.358	-0.438
		SEIS	1.120	0.360	0.727	0.383	1.561	0.243	0.095	0.941
		HYDR	0.290	0.186	0.078	0.051	0.091	0.024	0.011	0.026
	98103	OTHR	0.576	1.630	-0.068	-0.649	0.436	-0.269	-0.662	-0.174
		TEMP	-7.870	-5.563	-0.327	12.878	12.662	0.251	0.583	0.155
		SEIS	0.268	1.393	0.788	2.654	0.600	0.298	1.252	0.160
		HYDR	0.039	0.121	0.155	0.068	0.059	0.011	0.018	0.001

OTHR: Loads other than thermal loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

Table 3G.7-206a **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-1**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
1 RPV Pedestal Bottom	5006	-4.3	-15.5	-2.6	-3.2	-11.3	-23.8	310.2
	5013	-4.6	-15.5	-4.3	-4.0	-11.3	-25.2	310.2
	5024	-4.2	-15.5	-3.2	-4.7	-10.9	-23.1	310.2
2 RPV Pedestal Mid-Height	6006	-3.1	-15.5	33.4	23.2	-21.0	-17.4	310.2
	6013	-3.1	-15.5	19.3	21.6	-21.2	-17.1	310.2
	6024	-2.1	-15.5	49.0	17.1	-13.8	-12.9	310.2
3 RPV Pedestal Top	6606	-4.7	-15.5	25.8	6.3	-0.7	-25.3	310.2
	6613	-4.6	-15.5	12.1	3.8	-5.1	-26.0	310.2
	6624	-4.4	-15.5	27.5	7.1	-4.6	-24.0	310.2
4 RCCV Wetwell Bottom	1806	-5.2	-15.5	20.2	3.3	25.2	-14.9	310.2
	1813	-5.4	-15.5	15.8	2.5	23.9	-16.2	310.2
	1824	-4.9	-15.5	26.1	5.0	18.6	-16.0	310.2
5 RCCV Wetwell Mid-Height	2606	-1.4	-15.5	56.7	46.6	-13.1	0.8	310.2
	2613	-1.7	-15.5	47.2	42.1	-16.4	0.3	310.2
	2624	-1.7	-15.5	57.9	44.7	-10.3	-2.7	310.2
6 RCCV Wetwell Top	3406	-0.9	-15.5	37.0	30.4	1.1	-4.6	310.2
	3413	-0.9	-15.5	28.9	28.4	-16.9	0.9	310.2
	3424	-0.5	-15.5	34.2	23.3	0.8	-6.0	310.2

Table 3G.7-206a **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-1** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
7 RCCV Drywell Bottom	3606	-0.6	-15.5	40.6	27.1	-6.3	2.6	310.2
	3613	-1.3	-15.5	36.1	24.0	-6.5	-2.1	310.2
	3624	-2.1	-15.5	41.5	19.1	8.1	-4.7	310.2
8 RCCV Drywell Mid-Height	4006	-0.2	-15.5	35.0	26.8	-3.6	7.7	310.2
	4013	-1.3	-15.5	33.3	30.6	-7.0	-1.3	310.2
	4976	-0.2	-15.5	39.8	24.0	-1.2	-0.8	310.2
9 RCCV Drywell Top	4406	-5.8	-15.5	30.1	7.5	93.7	6.3	310.2
	4413	-5.2	-15.5	11.9	3.2	38.9	-9.7	310.2
	4424	-5.7	-15.5	54.2	12.1	74.9	-6.4	310.2
10 Basemat @ Center	80003	-0.7	-12.4	-4.2	-2.9	-1.6	-1.8	310.2
	80007	-0.7	-12.4	-4.2	-3.0	-1.6	-1.8	310.2
	80012	-0.7	-12.4	-4.3	-3.1	-1.6	-1.8	310.2
11 Basemat Inside RPV Pedestal	80206	-1.2	-12.4	-4.4	0.2	-2.9	1.7	310.2
	80213	-1.2	-12.4	-2.6	-1.7	-4.2	6.0	310.2
	80224	-1.2	-12.4	-5.4	-0.5	-3.0	-0.4	310.2
12 S/P Slab @ RPV	83306	-0.7	-15.5	14.9	19.9	73.6	11.6	310.2
	83313	-0.2	-15.5	1.8	17.8	56.5	0.4	310.2
	83324	-0.2	-15.5	-2.2	21.4	68.4	15.3	310.2

Table 3G.7-206a **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-1** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
13 S/P Slab @ Center	83406	-6.0	-15.5	-7.0	81.9	13.3	60.5	310.2
	83413	-5.6	-15.5	-4.9	83.3	5.6	46.1	310.2
	83424	-5.8	-15.5	-7.3	79.4	11.0	59.5	310.2
14 S/P Slab @ RCCV	83506	-3.7	-15.5	66.6	-12.8	25.8	18.4	310.2
	83513	-3.1	-15.5	69.3	-8.3	13.5	10.9	310.2
	83524	-3.9	-15.5	65.7	-14.3	28.6	19.2	310.2
15 Top Slab @ Drywell Head Opening	98120	-4.9	-18.6	114.9	22.4	115.9	24.1	310.2
	98135	-1.1	-18.6	10.1	-4.8	-10.9	9.9	310.2
	98104	-8.3	-18.6	87.8	13.9	151.5	20.7	310.2
16 Top Slab @ Center	98149	-1.9	-18.6	7.1	28.5	33.8	69.5	310.2
	98170	-2.4	-18.6	40.9	-2.0	55.8	21.5	310.2
	98109	-5.1	-18.6	61.2	7.3	108.8	6.2	310.2
17 Top Slab @ RCCV	98174	-3.2	-18.6	24.6	57.3	57.5	26.9	310.2
	98197	-3.4	-18.6	10.2	24.2	15.0	104.8	310.2
	98103	-3.7	-18.6	32.3	57.8	61.9	39.6	310.2

Note: Negative value means compression.

a.	RCCV, Pedestal:	Direction 1: Hoop	Direction 2: Vertical
	S/P Slab:	Direction 1: Radial	Direction 2: Circumferential
	Top Slab:	Direction 1: N-S	Direction 2: E-W
	Basemat @center:	Direction 1: N-S	Direction 2: E-W
	Basemat Inside RPV Pedestal:	Direction 1: Top: Radial	Bottom: N-S
		Direction 2: Top: Circumferential	Bottom: E-W

Table 3G.7-206b **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7a**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
1 RPV Pedestal Bottom	5006	-9.5	-28.7	-29.7	23.5	-44.8	-8.4	367.9
	5013	-10.0	-28.7	-31.4	26.7	-47.1	-8.3	367.9
	5024	-9.3	-28.7	-32.6	24.6	-43.1	-7.7	367.9
2 RPV Pedestal Mid-Height	6006	-8.0	-28.7	8.6	84.5	-45.3	48.2	367.9
	6013	-8.0	-28.7	4.9	86.2	-44.8	38.7	367.9
	6024	-5.3	-28.7	5.4	92.5	-27.7	37.3	367.9
3 RPV Pedestal Top	6606	-10.2	-28.7	54.3	119.9	-60.1	-26.8	367.9
	6613	-10.4	-28.7	51.5	106.7	-58.1	-34.7	367.9
	6624	-10.6	-28.7	67.6	113.2	-58.2	-16.0	367.9
4 RCCV Wetwell Bottom	1806	-11.6	-29.0	23.6	80.8	49.1	78.8	369.7
	1813	-13.6	-29.0	20.1	74.2	-42.2	64.2	369.7
	1824	-14.7	-29.0	28.6	64.3	-46.6	70.9	369.7
5 RCCV Wetwell Mid-Height	2606	-7.1	-29.1	59.7	107.4	-29.7	32.6	370.2
	2613	-4.7	-29.1	33.0	101.3	-27.1	-5.9	370.2
	2624	-4.2	-29.1	73.7	92.8	-25.0	-8.6	370.2
6 RCCV Wetwell Top	3406	-14.1	-29.1	79.1	105.8	-57.1	77.9	370.2
	3413	-10.9	-29.1	56.7	84.8	-63.9	42.2	370.2
	3424	-7.2	-29.1	74.0	86.1	-70.3	17.2	370.2

Table 3G.7-206b **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
7 RCCV Drywell Bottom	3606	-12.7	-28.7	67.2	95.0	-50.5	84.4	367.8
	3613	-10.3	-28.7	40.3	89.0	-45.9	19.5	367.8
	3624	-6.2	-27.7	-7.0	-2.6	-34.1	-12.4	360.2
8 RCCV Drywell Mid-Height	4006	-5.4	-28.7	41.8	95.3	-13.0	73.9	367.8
	4013	-9.6	-28.7	34.4	104.7	-51.2	10.6	367.8
	4976	-5.2	-27.7	10.3	39.5	-29.0	-7.9	360.2
9 RCCV Drywell Top	4406	-8.1	-28.7	42.8	54.7	131.4	9.4	367.8
	4413	-7.8	-28.7	8.3	67.2	-42.4	-17.8	367.8
	4424	-9.5	-27.7	-12.8	-10.7	83.9	-21.8	360.2
10 Basemat @ Center	80003	-4.9	-23.2	-16.7	13.8	-14.7	13.3	370.2
	80007	-4.8	-23.2	-16.8	12.9	-14.6	13.2	370.2
	80012	-4.8	-23.2	-16.9	12.5	-14.3	13.5	370.2
11 Basemat Inside RPV Pedestal	80206	-7.3	-23.2	-8.1	37.1	-13.0	37.2	370.2
	80213	-7.2	-23.2	-5.1	25.3	-13.3	56.0	370.2
	80224	-6.5	-23.2	-11.5	34.1	-11.2	29.9	370.2
12 S/P Slab @ RPV	83306	-14.5	-29.0	-72.7	21.8	170.5	77.9	369.8
	83313	-14.0	-29.0	-75.7	29.5	157.3	67.0	369.8
	83324	-13.6	-29.0	-73.5	26.5	170.5	85.1	369.8

Table 3G.7-206b **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
13 S/P Slab @ Center	83406	-21.9	-29.0	-60.3	172.0	38.5	198.8	369.8
	83413	-22.2	-29.0	-62.5	176.6	32.8	188.0	369.8
	83424	-21.7	-29.0	-62.4	174.0	40.7	200.3	369.8
14 S/P Slab @ RCCV	83506	-8.7	-29.0	-31.9	40.3	27.8	124.1	369.8
	83513	-9.3	-29.0	-34.9	37.5	27.7	122.0	369.8
	83524	-8.1	-29.0	-35.3	29.4	42.1	117.0	369.8
15 Top Slab @ Drywell Head Opening	98120	-9.3	-33.5	36.6	-10.5	88.2	4.6	361.7
	98135	-7.8	-33.5	-6.6	-35.1	-22.9	1.9	361.7
	98104	-12.1	-33.5	2.9	-7.2	186.8	16.3	361.7
16 Top Slab @ Center	98149	-5.9	-33.6	-7.3	-13.3	56.7	56.0	362.7
	98170	-5.9	-33.6	12.4	-21.4	88.9	3.6	362.7
	98109	-7.1	-33.6	-8.2	-21.2	139.2	3.5	362.7
17 Top Slab @ RCCV	98174	-7.5	-33.6	29.6	-15.3	79.9	4.2	362.7
	98197	-4.6	-33.6	-11.8	-20.8	18.5	118.0	362.7
	98103	-5.2	-33.6	-8.8	-22.2	96.3	8.8	362.7

Table 3G.7-206b **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7a** *(continued)*

Note: Negative value means compression.

a.	RCCV, Pedestal:	Direction 1: Hoop	Direction 2: Vertical
		S/P Slab:	Direction 1: RadialDirection 2: Circumferential
	Top Slab:	Direction 1: N-S	Direction 2: E-W
	Basemat @center:	Direction 1: N-S	Direction 2: E-W
	Basemat Inside RPV Pedestal:	Direction 1: Top: Radial Direction 2: Top	Bottom: N-S CircumferentialBottom: E-W

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Table 3G.7-206c **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7b**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
1 RPV Pedestal Bottom	5006	-16.7	-27.9	-77.2	48.7	-46.0	7.8	361.6
	5013	-17.0	-27.9	-78.6	48.7	-47.7	7.2	361.6
	5024	-17.1	-27.9	-80.7	48.3	-43.7	4.9	361.6
2 RPV Pedestal Mid-Height	6006	-12.1	-27.9	-15.8	153.6	-59.2	64.4	361.6
	6013	-12.7	-27.9	-18.9	156.6	-59.8	61.0	361.6
	6024	-10.8	-27.9	-20.9	173.9	-40.6	49.1	361.6
3 RPV Pedestal Top	6606	-13.1	-27.9	23.0	163.1	-61.0	25.3	361.6
	6613	-12.4	-27.9	19.9	155.0	-60.7	11.5	361.6
	6624	-12.3	-27.9	23.9	160.9	-60.0	12.0	361.6
4 RCCV Wetwell Bottom	1806	-12.9	-28.3	-5.7	92.5	-22.9	87.4	364.4
	1813	-14.6	-28.3	-9.5	85.6	-41.7	62.7	364.4
	1824	-14.9	-28.3	7.5	123.4	-41.6	73.8	364.4
5 RCCV Wetwell Mid-Height	2606	-12.9	-28.2	10.4	170.2	-27.6	84.9	363.8
	2613	-13.7	-28.2	-12.3	148.8	-45.8	39.2	363.8
	2624	-12.8	-28.2	-8.3	160.5	-44.5	49.1	363.8
6 RCCV Wetwell Top	3406	-14.4	-28.2	52.4	149.4	-43.0	123.8	363.8
	3413	-18.5	-28.2	43.6	139.0	-71.8	72.7	363.8
	3424	-12.3	-28.2	38.7	129.3	-51.9	40.3	363.8

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Table 3G.7-206c **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
7 RCCV Drywell Bottom	3606	-15.9	-27.7	33.9	144.6	-30.8	152.5	360.2
	3613	-19.7	-27.7	25.9	134.2	-70.6	65.5	360.2
	3624	-12.6	-26.7	-24.2	45.3	-41.5	18.5	352.9
8 RCCV Drywell Mid-Height	4006	-12.4	-27.7	16.0	164.4	-19.6	135.0	360.2
	4013	-18.7	-27.7	18.7	172.3	-81.2	51.5	360.2
	4976	-13.0	-26.7	-15.8	81.5	-43.9	54.9	352.9
9 RCCV Drywell Top	4406	-6.0	-27.7	12.2	134.0	11.0	40.7	360.2
	4413	-15.7	-27.7	-8.2	112.2	-79.5	-12.6	360.2
	4424	-11.0	-26.7	-39.7	48.9	-23.3	7.1	352.9
10 Basemat @ Center	80003	-4.2	-23.2	-9.1	25.7	-5.9	30.0	370.2
	80007	-4.2	-23.2	-9.3	24.7	-5.8	30.0	370.2
	80012	-4.2	-23.2	-9.6	24.0	-5.6	30.2	370.2
11 Basemat Inside RPV Pedestal	80206	-6.4	-23.2	-3.6	46.4	-6.6	52.9	370.2
	80213	-6.4	-23.2	5.3	36.6	-6.0	69.5	370.2
	80224	-5.9	-23.2	-4.8	46.1	-3.8	47.1	370.2
12 S/P Slab @ RPV	83306	-18.6	-28.3	-68.9	92.5	39.5	166.2	364.4
	83313	-19.2	-28.3	-68.8	93.8	37.8	158.0	364.4
	83324	-17.2	-28.3	-76.1	93.7	51.7	148.6	364.4

Table 3G.7-206c **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-7b** *(continued)*

Location	Element ID	Concrete Stress (MPa) Calculated	Concrete Stress (MPa) Allowable	Primary Reinforcement Stress (MPa) Calculated Direction 1[a] In/Top	Direction 1[a] Out/Bottom	Direction 2[a] In/Top	Direction 2[a] Out/Bottom	Allowable
13 S/P Slab @ Center	83406	-25.9	-28.3	-61.8	219.1	15.4	235.2	364.4
	83413	-26.1	-28.3	-65.1	220.2	13.8	222.8	364.4
	83424	-25.3	-28.3	-64.3	218.6	19.8	237.5	364.4
14 S/P Slab @ RCCV	83506	-12.2	-28.3	-34.8	66.8	-13.6	164.3	364.4
	83513	-12.9	-28.3	-36.7	70.4	-13.1	162.3	364.4
	83524	-11.3	-28.3	-35.9	58.4	9.6	172.1	364.4
15 Top Slab @ Drywell Head Opening	98120	-19.3	-31.4	141.5	-1.9	159.8	-5.4	349.2
	98135	-16.6	-31.4	29.8	-59.6	-20.7	-2.3	349.2
	98104	-24.2	-31.4	28.9	-10.1	231.5	-16.3	349.2
16 Top Slab @ Center	98149	-11.8	-31.9	-5.5	-47.6	123.0	9.4	352.0
	98170	-9.7	-31.9	3.8	-40.8	129.8	3.6	352.0
	98109	-16.7	-32.6	86.6	-24.7	216.9	-6.5	356.6
17 Top Slab @ RCCV	98174	-10.1	-31.9	25.4	-31.4	108.0	-1.3	352.0
	98197	-7.9	-31.9	-16.8	-40.8	17.8	124.8	352.0
	98103	-11.6	-32.6	39.1	-23.6	155.2	-8.9	356.6

Note: Negative value means compression.

a. RCCV, Pedestal: Direction 1: Hoop; Direction 2: Vertical
S/P Slab: Direction 1: Radial; Direction 2: Circumferential
Top Slab: Direction 1: N-S; Direction 2: E-W
Basemat @center: Direction 1: N-S; Direction 2: E-W
Basemat Inside RPV Pedestal: Direction 1: Top: Radial; Bottom: N-S
Direction 2: Top: Circumferential; Bottom: E-W

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Table 3G.7-206d **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11a**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
1 RPV Pedestal Bottom	5006	-10.6	-28.7	-29.4	39.3	-46.9	3.3	367.9
	5013	-11.1	-28.7	-31.5	40.0	-50.4	6.2	367.9
	5024	-9.8	-28.7	-31.1	30.8	-44.5	4.8	367.9
2 RPV Pedestal Mid-Height	6006	-7.8	-28.7	9.1	88.8	-43.5	59.4	367.9
	6013	-8.4	-28.7	-4.2	115.9	-44.5	44.8	367.9
	6024	-6.2	-28.7	-22.7	117.1	35.8	40.4	367.9
3 RPV Pedestal Top	6606	-10.8	-28.7	67.6	130.7	118.6	-22.1	367.9
	6613	-10.5	-28.7	73.9	139.7	72.2	-4.8	367.9
	6624	-10.8	-28.7	86.7	141.7	104.4	2.1	367.9
4 RCCV Wetwell Bottom	1806	-12.8	-29.0	51.1	132.4	137.6	81.0	369.7
	1813	-14.5	-29.0	37.4	108.2	-60.6	79.3	369.7
	1824	-15.1	-29.0	64.1	124.0	-65.2	92.1	369.7
5 RCCV Wetwell Mid-Height	2606	-6.0	-29.1	80.0	115.0	127.7	130.5	370.2
	2613	-7.4	-29.1	39.5	114.5	-39.9	83.9	370.2
	2624	-7.5	-29.1	63.9	111.9	53.9	81.9	370.2
6 RCCV Wetwell Top	3406	-8.6	-29.1	109.3	108.5	-40.1	167.4	370.2
	3413	-15.1	-29.1	58.6	100.1	-74.3	157.6	370.2
	3424	-11.3	-29.1	71.0	97.2	-71.4	107.1	370.2

Table 3G.7-206d **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				Allowable
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	
7 RCCV Drywell Bottom	3606	-7.9	-28.7	102.6	97.5	-44.9	171.8	367.8
	3613	-13.0	-28.7	47.6	104.4	-63.3	112.0	367.8
	3624	-10.5	-27.7	-6.8	27.7	-58.5	43.8	360.2
8 RCCV Drywell Mid-Height	4006	-5.6	-28.7	81.1	139.5	122.1	136.8	367.8
	4013	-13.7	-28.7	51.4	130.5	-72.0	65.0	367.8
	4976	-9.1	-27.7	19.8	64.3	-48.5	59.4	360.2
9 RCCV Drywell Top	4406	-3.8	-28.7	97.7	130.1	78.2	169.6	367.8
	4413	-13.1	-28.7	16.2	85.2	-70.1	28.3	367.8
	4424	-9.3	-27.7	22.9	-9.6	101.4	-40.6	360.2
10 Basemat @ Center	80003	-7.0	-23.2	-19.5	27.7	-18.2	28.8	370.2
	80007	-6.9	-23.2	-19.7	25.7	-18.3	27.7	370.2
	80012	-6.8	-23.2	-19.8	24.7	-18.4	27.4	370.2
11 Basemat Inside RPV Pedestal	80206	-7.6	-23.2	-19.4	27.0	-13.1	27.8	370.2
	80213	-7.7	-23.2	-8.5	31.6	-16.4	43.6	370.2
	80224	-6.7	-23.2	-16.1	20.9	-16.8	23.4	370.2
12 S/P Slab @ RPV	83306	-15.4	-29.0	-75.4	41.9	211.4	91.0	369.8
	83313	-14.5	-29.0	-82.6	54.2	197.2	76.5	369.8
	83324	-13.6	-29.0	-81.6	53.8	196.5	98.7	369.8

Table 3G.7-206d **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
13 S/P Slab @ Center	83406	-18.4	-29.0	-52.6	135.3	43.3	192.1	369.8
	83413	-19.0	-29.0	-54.5	134.4	32.3	166.3	369.8
	83424	-18.2	-29.0	-57.6	126.8	48.1	170.0	369.8
14 S/P Slab @ RCCV	83506	-11.1	-29.0	-34.3	69.2	40.4	132.7	369.8
	83513	-10.9	-29.0	-35.4	62.1	27.9	112.8	369.8
	83524	-9.3	-29.0	-38.5	46.5	34.4	104.3	369.8
15 Top Slab @ Drywell Head Opening	98120	-9.8	-33.5	34.1	-13.4	71.9	-2.2	361.7
	98135	-8.7	-33.5	-9.8	-40.5	-23.2	3.3	361.7
	98104	-12.9	-33.5	-12.9	-9.6	212.3	20.9	361.7
16 Top Slab @ Center	98149	-7.1	-33.6	-3.7	-29.6	72.2	9.4	362.7
	98170	-7.2	-33.6	15.6	-25.0	87.8	-5.3	362.7
	98109	-7.2	-33.6	-12.5	-23.1	162.4	8.2	362.7
17 Top Slab @ RCCV	98174	-7.3	-33.6	4.0	-22.9	92.4	3.8	362.7
	98197	-5.4	-33.6	-10.7	-17.6	37.8	132.6	362.7
	98103	-12.0	-33.6	47.9	-33.6	132.8	17.6	362.7

Note: Negative value means compression.

a.

RCCV, Pedestal:	Direction 1: Hoop	Direction 2: Vertical
S/P Slab:	Direction 1: Radial	Direction 2: Circumferential
Top Slab:	Direction 1: N-S	Direction 2: E-W
Basemat @center:	Direction 1: N-S	Direction 2: E-W
Basemat Inside RPV Pedestal:	Direction 1: Top: Radial	Bottom: N-S
	Direction 2: Top: Circumferential	Bottom: E-W

Table 3G.7-206e **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11b**

Location	Element ID	Concrete Stress (MPa) Calculated	Concrete Stress (MPa) Allowable	Primary Reinforcement Stress (MPa) Calculated Direction 1[a] In/Top	Calculated Direction 1[a] Out/Bottom	Calculated Direction 2[a] In/Top	Calculated Direction 2[a] Out/Bottom	Allowable
1 RPV Pedestal Bottom	5006	-16.8	-27.9	-75.9	66.5	-49.7	11.4	361.6
	5013	-17.4	-27.9	-77.9	63.7	-55.9	14.7	361.6
	5024	-17.2	-27.9	-78.2	57.5	-49.3	9.7	361.6
2 RPV Pedestal Mid-Height	6006	-12.9	-27.9	-19.7	157.8	-61.2	94.7	361.6
	6013	-13.9	-27.9	-28.0	141.0	-60.0	77.0	361.6
	6024	-12.7	-27.9	-30.1	156.9	-43.2	65.4	361.6
3 RPV Pedestal Top	6606	-13.6	-27.9	28.4	176.6	-63.2	30.9	361.6
	6613	-13.3	-27.9	32.0	192.8	-64.3	15.7	361.6
	6624	-13.0	-27.9	35.0	193.6	-64.2	30.9	361.6
4 RCCV Wetwell Bottom	1806	-15.5	-28.3	20.6	187.0	59.0	153.9	364.4
	1813	-17.1	-28.3	17.4	154.1	-63.6	133.5	364.4
	1824	-16.9	-28.3	22.6	168.5	-62.7	143.4	364.4
5 RCCV Wetwell Mid-Height	2606	-11.4	-28.2	5.2	169.3	-38.8	177.4	363.8
	2613	-14.2	-28.2	-14.1	183.0	-62.2	158.1	363.8
	2624	-13.6	-28.2	15.0	189.7	-59.3	171.4	363.8
6 RCCV Wetwell Top	3406	-13.7	-28.2	54.3	159.6	-50.0	214.9	363.8
	3413	-19.3	-28.2	50.7	156.1	-84.2	174.8	363.8
	3424	-15.4	-28.2	43.7	141.5	-70.9	132.2	363.8

Table 3G.7-206e **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
7 RCCV Drywell Bottom	3606	-14.7	-27.7	36.4	160.2	-45.0	224.7	360.2
	3613	-21.0	-27.7	32.8	153.7	-88.5	126.1	360.2
	3624	-15.0	-26.7	-26.3	66.3	-69.8	101.2	352.9
8 RCCV Drywell Mid-Height	4006	-12.9	-27.7	28.3	209.7	-35.0	207.1	360.2
	4013	-21.0	-27.7	28.9	199.8	-97.2	103.9	360.2
	4976	-15.3	-26.7	-13.2	115.1	-64.0	140.2	352.9
9 RCCV Drywell Top	4406	-12.3	-27.7	38.4	196.8	131.5	115.6	360.2
	4413	-21.0	-27.7	-4.3	138.0	-105.8	36.7	360.2
	4424	-13.0	-26.7	-39.8	85.5	-40.3	77.2	352.9
10 Basemat @ Center	80003	-7.4	-23.2	17.9	52.5	26.1	57.6	370.2
	80007	-7.2	-23.2	13.6	49.9	23.7	55.6	370.2
	80012	-7.1	-23.2	-10.8	48.6	25.0	54.3	370.2
11 Basemat Inside RPV Pedestal	80206	-6.9	-23.2	18.8	40.3	-3.7	45.2	370.2
	80213	-7.4	-23.2	2.3	50.0	-7.6	62.7	370.2
	80224	-6.4	-23.2	-7.9	33.5	-8.4	41.3	370.2
12 S/P Slab @ RPV	83306	-20.9	-28.3	-69.7	122.0	58.4	205.7	364.4
	83313	-22.1	-28.3	-71.5	118.6	46.9	210.5	364.4
	83324	-21.8	-28.3	-72.0	113.9	74.8	191.3	364.4

Table 3G.7-206e **Rebar and Concrete Stresses of RCCV: Selected Load Combination CV-11b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
13 S/P Slab @ Center	83406	-23.1	-28.3	-54.4	191.2	21.2	238.2	364.4
	83413	-23.7	-28.3	-55.6	190.1	16.2	215.5	364.4
	83424	-22.5	-28.3	-61.1	178.8	17.4	214.2	364.4
14 S/P Slab @ RCCV	83506	-14.8	-28.3	-35.1	117.6	-10.3	150.0	364.4
	83513	-16.1	-28.3	-37.1	124.8	-5.9	128.6	364.4
	83524	-13.9	-28.3	-37.6	98.2	-10.9	162.8	364.4
15 Top Slab @ Drywell Head Opening	98120	-20.0	-31.4	128.9	-8.3	128.1	-14.9	349.2
	98135	-16.6	-31.4	65.6	-62.9	-21.0	-6.2	349.2
	98104	-24.4	-31.4	30.2	-11.9	187.9	-30.7	349.2
16 Top Slab @ Center	98149	-12.5	-31.9	-7.9	-53.1	123.2	6.7	352.0
	98170	-10.8	-31.9	-6.3	-45.0	114.9	-5.4	352.0
	98109	-17.4	-32.6	89.9	-22.4	241.2	-8.1	356.6
17 Top Slab @ RCCV	98174	-10.1	-31.9	7.0	-39.8	78.7	-11.1	352.0
	98197	-9.5	-31.9	-15.1	-43.5	64.1	-9.4	352.0
	98103	-17.3	-32.6	143.3	-22.8	146.1	-10.6	356.6

Note: Negative value means compression.

a.

RCCV, Pedestal:	Direction 1: Hoop	Direction 2: Vertical
S/P Slab:	Direction 1: Radial	Direction 2: Circumferential
Top Slab:	Direction 1: N-S	Direction 2: E-W
Basemat @center:	Direction 1: N-S	Direction 2: E-W
Basemat Inside RPV Pedestal:	Direction 1: Top: Radial	Bottom: N-S
	Direction 2: Top: Circumferential	Bottom: E-W

Table 3G.7-207 **Transverse Shear of RCCV for DCD Load Combinations**

Location		Element ID	LOAD ID	Shear Force Q (MN/m)	d (m)	Shear Stress (MPa)			Shear Tie Ratio (%)	
						Vu	Vc	Vs	required	provided
1	RPV Pedestal Bottom	5006	CV-11b	6.64	1.83	4.27	2.63	1.63	0.395	1.010
		5013	CV-7b	6.81	1.83	4.38	2.63	1.75	0.436	1.010
		5024	CV-7b	6.76	1.83	4.35	2.65	1.70	0.410	1.010
2	RPV Pedestal Mid-Height	6006	CV-7a	1.77	1.94	1.08	0.97	0.11	0.027	0.252
		6013	CV-7b	2.35	1.94	1.43	1.37	0.06	0.014	0.252
		6024	CV-7a	1.79	1.94	1.09	0.87	0.21	0.052	0.252
3	RPV Pedestal Top	6606	CV-11b	2.85	1.93	1.74	1.37	0.37	0.090	1.010
		6613	CV-7a	0.22	1.92	0.14	0.14	0.00	0.000	1.010
		6624	CV-7b	0.03	1.93	0.02	0.02	0.00	0.000	1.010
4	RCCV Wetwell Bottom	1806	CV-11a	1.00	1.54	0.77	0.48	0.29	0.070	0.540
		1813	CV-11a	0.29	1.48	0.23	0.23	0.00	0.000	0.540
		1824	CV-7a	2.25	1.48	1.79	1.64	0.15	0.035	0.540
5	RCCV Wetwell Mid-Height	2606	CV-11a	0.24	1.43	0.20	0.20	0.00	0.000	0.270
		2613	CV-11a	0.12	1.47	0.09	0.09	0.00	0.000	0.270
		2624	CV-11a	0.19	1.43	0.15	0.15	0.00	0.000	0.270
6	RCCV Wetwell Top	3406	CV-11b	2.18	1.43	1.80	0.44	1.36	0.329	0.721
		3413	CV-11a	2.97	1.43	2.45	1.38	1.07	0.259	0.721
		3424	CV-11a	1.77	1.43	1.46	1.55	0.00	0.000	0.721
7	RCCV Drywell Bottom	3606	CV-11b	0.41	1.43	0.34	0.21	0.14	0.034	0.721
		3613	CV-11b	0.12	1.40	0.10	0.10	0.00	0.000	0.721
		3624	CV-11b	1.45	1.43	1.19	1.26	0.00	0.000	0.721

Table 3G.7-207 **Transverse Shear of RCCV for DCD Load Combinations** *(continued)*

Location	Element ID	LOAD ID	Shear Force Q (MN/m)	d (m)	Shear Stress (MPa)			Shear Tie Ratio (%)	
					Vu	Vc	Vs	required	provided
8 RCCV Drywell Mid-Height	4006	CV-11a	0.14	1.57	0.11	0.11	0.00	0.000	0.270
	4013	CV-7b	0.66	1.43	0.54	1.86	0.00	0.000	0.270
	4976	CV-7b	0.80	1.43	0.66	1.23	0.00	0.000	0.270
9 RCCV Drywell Top	4406	CV-7b	1.26	1.43	1.04	0.74	0.30	0.075	0.540
	4413	CV-1	0.79	1.68	0.47	0.87	0.00	0.000	0.540
	4424	CV-11a	1.48	1.61	1.08	0.94	0.14	0.035	0.540
10 Basemat @ Center	80003	CV-7b	0.48	4.63	0.12	1.02	0.00	0.000	0.179
	80007	CV-11b	0.71	4.61	0.18	0.98	0.00	0.000	0.179
	80012	CV-11b	0.67	4.64	0.17	0.94	0.00	0.000	0.179
11 Basemat Inside RPV Pedestal	80206	CV-11b	3.73	4.63	0.95	1.62	0.00	0.000	1.290
	80213	CV-11b	3.68	4.61	0.94	1.13	0.00	0.000	1.290
	80224	CV-7b	1.96	4.65	0.50	1.04	0.00	0.000	1.290
12 S/P Slab @ RPV	83306	CV-11b	3.73	1.76	2.50	1.68	0.82	0.199	1.140
	83313	CV-11b	3.71	1.76	2.49	1.91	0.58	0.144	1.140
	83324	CV-11b	3.66	1.76	2.46	2.22	0.24	0.057	1.140
13 S/P Slab @ Center	83406	CV-1	0.13	1.76	0.07	0.07	0.00	0.000	0.263
	83413	CV-1	0.12	1.76	0.07	0.07	0.00	0.000	0.263
	83424	CV-1	0.15	1.76	0.09	0.09	0.00	0.000	0.263
14 S/P Slab @ RCCV	83506	CV-7a	4.74	1.76	3.18	2.24	0.94	0.227	1.010
	83513	CV-7a	4.64	1.76	3.11	2.25	0.87	0.211	1.010
	83524	CV-7a	4.64	1.76	3.11	2.24	0.87	0.211	1.010

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Table 3G.7-207 **Transverse Shear of RCCV for DCD Load Combinations** *(continued)*

Location	Element ID	LOAD ID	Shear Force Q (MN/m)	d (m)	Shear Stress (MPa)			Shear Tie Ratio (%)	
					Vu	Vc	Vs	required	provided
15 Top Slab @ Drywell Head Opening	98120	CV-7b	1.87	1.95	1.13	1.33	0.00	0.000	0.358
	98135	CV-7b	2.96	1.95	1.79	2.63	0.00	0.000	0.358
	98104	CV-7b	1.32	1.73	0.90	1.08	0.00	0.000	0.358
16 Top Slab @ Center	98149	CV-7a	0.35	1.82	0.23	0.23	0.00	0.000	0.179
	98170	CV-1	0.23	1.95	0.12	0.12	0.00	0.000	0.179
	98109	CV-7b	0.55	1.81	0.36	0.89	0.00	0.000	0.179
17 Top Slab @ RCCV	98174	CV-1	0.22	1.97	0.11	0.11	0.00	0.000	0.179
	98197	CV-7b	1.66	2.00	0.98	0.88	0.10	0.023	0.717
	98103	CV-11b	1.66	1.79	1.09	1.20	0.00	0.000	0.717

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Table 3G.7-208 **Tangential Shear of RCCV for DCD Load Combinations**

Location	Element ID	Load ID	Section Forces Nx/Ny (MN/m)	Section Forces NxI/NyI (MN/m)	Section Forces V (MN/m)	Thickness t (m)	Rebar Area (cm^2/m) Required rAs	Rebar Area (cm^2/m) Provided pAs	rAs/pAs	v_{so} (MPa) Calculated	v_{so} (MPa) Allowable	v_u (MPa) Calculated	v_u (MPa) Allowable $0.4f_c'-v_{so}$
1 RPV Pedestal Bottom	5006	CV-11a	-4.296	-2.523	-0.764	2.40	-45.1	431.3	-0.105	0.32	4.83	0.32	13.20
		CV-11a	-5.498	-4.800	-0.764	2.40	-17.3	724.8	-0.024	0.32	4.83	0.32	13.20
	5013	CV-11a	-4.646	2.713	0.769	2.40	-49.6	431.3	-0.115	0.32	4.83	0.32	13.20
		CV-11a	-5.787	-5.914	-0.769	2.40	4.8	724.8	0.007	0.32	4.83	0.32	13.20
	5024	CV-11a	-4.772	-2.294	0.293	2.40	-66.8	431.3	-0.155	0.12	4.83	0.12	13.39
		CV-11a	-5.217	-5.518	0.293	2.40	8.4	724.8	0.012	0.12	4.83	0.12	13.39
2 RPV Pedestal Mid-Height	6006	CV-11a	0.767	1.048	0.961	2.40	59.5	431.3	0.138	0.40	4.83	0.40	13.12
		CV-11a	-5.109	6.021	-0.961	2.40	26.9	543.6	0.049	0.40	4.83	0.40	13.12
	6013	CV-11a	0.441	-1.294	-0.891	2.40	54.7	431.3	0.127	0.37	4.83	0.37	13.15
		CV-11a	-5.415	-5.780	0.891	2.40	11.8	543.6	0.022	0.37	4.83	0.37	13.15
	6024	CV-7a	1.268	0.457	-0.599	2.40	55.0	431.3	0.127	0.25	4.83	0.25	13.27
		CV-11a	-3.063	5.077	0.793	2.40	56.4	543.6	0.104	0.33	4.83	0.33	13.19
3 RPV Pedestal Top	6606	CV-11a	4.066	-1.737	-1.520	2.40	173.3	602.4	0.288	0.63	4.83	0.63	12.88
		CV-11a	-5.553	-5.895	1.520	2.40	14.5	543.6	0.027	0.63	4.83	0.63	12.88
	6613	CV-11a	3.790	-2.867	0.737	2.40	183.5	602.4	0.305	0.31	4.83	0.31	13.21
		CV-11a	-5.718	5.381	0.737	2.40	-7.8	543.6	-0.014	0.31	4.83	0.31	13.21
	6624	CV-11a	4.435	-2.509	-1.154	2.40	195.6	602.4	0.325	0.48	4.83	0.48	13.04
		CV-11a	-5.439	-6.493	1.154	2.40	31.4	543.6	0.058	0.48	4.83	0.48	13.04
4 RCCV Wetwell Bottom	1806	CV-11a	0.859	2.290	-3.343	2.00	132.8	474.0	0.280	1.67	4.85	1.67	11.97
		CV-11a	-2.803	6.330	3.343	2.00	117.8	584.0	0.202	1.67	4.85	1.67	11.97
	1813	CV-11a	0.589	1.685	3.011	2.00	109.3	474.0	0.230	1.51	4.85	1.51	12.13
		CV-11a	-5.295	-6.602	3.011	2.00	53.0	584.0	0.091	1.51	4.85	1.51	12.13
	1824	CV-11a	1.199	1.923	3.481	2.00	140.0	474.0	0.295	1.74	4.85	1.74	11.90
		CV-11a	-5.691	7.017	-3.481	2.00	57.9	584.0	0.099	1.74	4.85	1.74	11.90

Table 3G.7-208 **Tangential Shear of RCCV for DCD Load Combinations** *(continued)*

Location	Element ID	Load ID	Section Forces Nx/Ny (MN/m)	Section Forces Nxl/Nyl (MN/m)	Section Forces V (MN/m)	Thickness t (m)	Rebar Area (cm^2/m) Required rAs	Rebar Area (cm^2/m) Provided pAs	rAs/pAs	v_{so} (MPa) Calculated	v_{so} (MPa) Allowable	v_u (MPa) Calculated	v_u (MPa) Allowable $0.4f_c'-v_{so}$
5 RCCV Wetwell Mid-Height	2606	CV-11a	2.146	1.130	-3.568	2.00	159.1	518.0	0.307	1.78	4.85	1.78	11.88
		CV-11a	-2.078	5.729	3.568	2.00	126.2	519.0	0.243	1.78	4.85	1.78	11.88
	2613	CV-11a	1.583	-1.527	-3.410	2.00	143.7	518.0	0.277	1.71	4.85	1.71	11.96
		CV-11a	-5.418	-6.044	3.410	2.00	41.1	519.0	0.079	1.71	4.85	1.71	11.96
	2624	CV-11a	2.137	1.242	-3.377	2.00	154.9	518.0	0.299	1.69	4.85	1.69	11.98
		CV-11b	-5.248	-6.229	-3.368	2.00	50.4	519.0	0.097	1.68	4.78	1.68	11.57
6 RCCV Wetwell Top	3406	CV-11a	4.780	0.773	3.501	2.00	226.0	732.0	0.309	1.75	4.85	1.75	11.92
		CV-11b	-1.662	4.951	-3.479	2.00	120.6	519.0	0.232	1.74	4.78	1.74	11.51
	3413	CV-11b	3.745	0.930	3.426	2.00	200.5	732.0	0.274	1.71	4.78	1.71	11.54
		CV-11a	-5.982	-5.535	3.436	2.00	14.4	519.0	0.028	1.72	4.85	1.72	11.95
	3424	CV-11a	4.349	0.996	3.007	2.00	203.0	732.0	0.277	1.50	4.85	1.50	12.16
		CV-11a	-6.183	5.391	-3.007	2.00	-0.3	519.0	-0.001	1.50	4.85	1.50	12.16
7 RCCV Drywell Bottom	3606	CV-11a	3.888	-0.728	-3.600	2.00	205.6	732.0	0.281	1.80	4.82	1.80	11.71
		CV-11b	-0.932	-4.769	3.591	2.00	139.9	519.0	0.270	1.80	4.74	1.80	11.22
	3613	CV-11a	3.334	0.880	3.383	2.00	185.7	732.0	0.254	1.69	4.82	1.69	11.82
		CV-11a	-6.245	5.581	-3.383	2.00	7.7	519.0	0.015	1.69	4.82	1.69	11.82
	3624	CV-1	2.064	0.000	0.000	2.00	66.5	732.0	0.091	0.00	4.88	0.00	13.80
		CV-11b	-7.608	-6.169	3.211	2.00	-18.5	519.0	-0.036	1.61	4.65	1.61	10.94
8 RCCV Drywell Mid-Height	4006	CV-11a	2.755	-1.283	-3.288	2.00	170.9	518.0	0.330	1.64	4.82	1.64	11.87
		CV-11b	-0.081	-4.158	-3.286	2.00	144.9	519.0	0.279	1.64	4.74	1.64	11.37
	4013	CV-11a	2.614	-1.041	-3.258	2.00	164.1	518.0	0.317	1.63	4.82	1.63	11.88
		CV-11a	-8.008	-5.287	3.258	2.00	-48.9	519.0	-0.094	1.63	4.82	1.63	11.88
	4976	CV-11a	-0.357	-0.442	3.305	2.00	82.7	518.0	0.160	1.65	4.74	1.65	11.37
		CV-11b	-5.670	-5.073	3.302	2.00	10.9	519.0	0.021	1.65	4.65	1.65	10.89

Table 3G.7-208 **Tangential Shear of RCCV for DCD Load Combinations** *(continued)*

Location	Element ID	Load ID	Section Forces: Nx/Ny (MN/m)	Section Forces: Nxl/Nyl (MN/m)	Section Forces: V (MN/m)	Thickness t (m)	Rebar Area (cm^2/m): Required rAs	Rebar Area (cm^2/m): Provided pAs	rAs/pAs	v_{so} (MPa): Calculated	v_{so} (MPa): Allowable	v_u (MPa): Calculated	v_u (MPa): Allowable $0.4f_c'-v_{so}$
9 RCCV Drywell Top	4406	CV-11b	2.910	1.173	-2.776	2.00	164.4	518.0	0.317	1.39	4.74	1.39	11.63
		CV-11a	0.150	-3.479	-2.776	2.00	125.1	519.0	0.241	1.39	4.82	1.39	12.13
	4413	CV-11a	0.524	0.819	2.892	2.00	96.0	518.0	0.185	1.45	4.82	1.45	12.07
		CV-1	-1.799	0.000	0.000	2.00	-58.0	519.0	-0.112	0.00	4.88	0.00	13.80
	4424	CV-1	1.163	0.000	0.000	2.00	37.5	430.0	0.087	0.00	4.88	0.00	13.80
		CV-11a	-4.086	4.105	-3.515	2.00	36.6	476.0	0.077	1.76	4.74	1.76	11.26

Note: Top and bottom lines for each element indicate evaluation results for hoop and vertical rebar, respectively.

Nomenclature:

Nx, Ny: axial forces in the hoop and vertical directions due to pressure and dead loads, respectively

Nxl, Nyl: axial forces in the hoop and vertical directions due to lateral loads, respectively

V: tangential shear due to lateral loads

v_{so}: tangential shear stress borne by orthogonal rebar

Table 3G.7-209 **Not Used**

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Table 3G.7-210 **Containment Liner Plate Strains (Max)**

Category	Calculated Strain: Cylinder	Pedestal	DW Bottom	WW Bottom	Top Slab	D/F Thick Plate	Pedestal Thick Plate	Allowable Tension Allowable Compression
Test	0.0004 -0.0012	0.0004 -0.0006	0.0000 -0.0001	0.0002 -0.0002	0.0003 -0.0001	0.0005 -0.0002	0.0002 -0.0002	0.002 -0.002
Normal Operation	0.0005 -0.0008	0.0005 -0.0010	0.0001 -0.0003	0.0004 -0.0006	0.0002 -0.0005	0.0002 -0.0005	0.0002 -0.0007	0.002 -0.002
Severe Environment	0.0005 -0.0008	0.0005 -0.0010	0.0001 -0.0003	0.0004 -0.0006	0.0002 -0.0005	0.0002 -0.0005	0.0002 -0.0007	0.003 -0.005
Extreme Environment	0.0005 -0.0008	0.0005 -0.0010	0.0001 -0.0003	0.0004 -0.0006	0.0002 -0.0005	0.0002 -0.0005	0.0002 -0.0007	0.003 -0.005
Abnormal: LOCA	0.0007 -0.0035	0.0005 -0.0028	0.0001 -0.0003	0.0004 -0.0022	0.0006 -0.0019	0.0008 -0.0017	0.0003 -0.0021	0.003 -0.005
Abnormal/Extreme Environment	0.0012 -0.0040	0.0007 -0.0030	0.0002 -0.0004	0.0007 -0.0024	0.0006 -0.0020	0.0009 -0.0017	0.0004 -0.0021	0.003 -0.005

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Table 3G.7-211 **Drywell Head Elements Stress**

Service Level	P_L Calculated Stress (MPa)	P_L Allowable Stress (MPa)	$P_L + P_b$ Calculated Stress (MPa)	$P_L + P_b$ Allowable Stress (MPa)	$P_L + P_b + Q$ Calculated Stress (MPa)	$P_L + P_b + Q$ Allowable Stress (MPa)
Test Condition	77	262	77	262	-	-
Design Condition	66	227	66	227	-	-
A, B	78	227	78	227	797[a]	456
C	138	342	138	342	-	-
D	138	430	138	430	-	-

a. Acceptable by meeting all requirements for simplified elastic-plastic analysis stipulated in NE-3228.3 of ASME BPVC, Sec. III

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Table 3G.7-212 **Diaphragm Floor (D/F) Slab Elements Stress Summary**

Structural Elements	Member Size	Governing Load Combination	Stress	Allowable Stress	Acceptance Criteria[b]
Top Plate[a]	25mm	Normal Normal	σ_{min} = -214 MPa τ_{max} = 107 MPa	σ = 261 MPa τ = 174 MPa	1.0S 1.0S
Bottom Plate	25mm	Normal Normal	σ_{max} = 202 MPa τ_{max} = 101 MPa	σ = 272 MPa τ = 181 MPa	1.0S 1.0S
Radial Web Plate (Upper Web)[c]	25mm	Abnormal Abnormal/Extreme	σ_{min} = -343 MPa τ_{max} = 268 MPa	σ = 391 MPa τ = 253 MPa	1.5S 1.4S
Radial Web Plate (Lower Web)[c]	25mm	Severe Abnormal/Extreme	σ_{min} = -236 MPa τ_{max} = 257 MPa	σ = 261 MPa τ = 253 MPa	1.0S 1.4S
Tangential Web Plate	25mm	Abnormal Abnormal/Extreme	σ_{min} = -334 MPa τ_{max} = 202 MPa	σ = 391 MPa τ = 243 MPa	1.5S 1.4S
Bottom Flange[a]	38mm	Normal Normal	σ_{min} = -186 MPa τ_{max} = 93 MPa	σ = 269 MPa τ = 181 MPa	1.0S 1.0S

a. Thermal stress associated with extreme and abnormal load conditions meets deformation limits of AISC N690, Section Q1.5.7.2. The total stress excluding thermal stress satisfies the allowable stress limit in AISC N690, Table Q1.5.7.1.

b. S = Allowable stress limit specified in AISC N690, Part 1.

c. Thermal stress associated with extreme and abnormal load conditions (values in red) meets deformation limits of AISC N690, Section Q1.5.7.2. The total stress excluding thermal stress does not satisfy the allowable stress limit in AISC N690, Table Q1.5.7.1. See Section 3G.7.5.4.2.1 for justification of acceptability.

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Table 3G.7-213 **Diaphragm Floor (D/F) Slab Anchorage Structural Capacity**

Anchor Locations	Governing Load Combination	Design Load (kN)	No. of Anchor Bars Provided	Total Capacity (kN)	Acceptance Criteria[a]
Top Plate	Abnormal/Extreme	1007/deg	1-#18 @0.9 deg	1066/deg	$0.9F_y$
Bottom Plate	Normal	151/deg	1-#18 @0.9 deg	592/deg	$0.5F_y$
Girder Radial Web Plate	Abnormal/Extreme	3501	5-#18	4804	$0.9F_y$
Girder Bottom Flange	Abnormal/Extreme	1270	5-#18	4804	$0.9F_y$

a. F_y = Specified minimum yield stress

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Table 3G.7-214 **Vent Wall Structural Elements Stress Summary**

Structural Elements	Member Size	Governing Load Combination	Calculated Stress	Allowable Stress	Acceptance Criteria[a]
Inner Cylinder	25mm	Severe Severe	σ_{min} = -190 MPa τ_{max} = 111 MPa	σ = 261 MPa τ = 174 MPa	1.0S 1.0S
Outer Cylinder	25mm	Abnormal/Extreme Abnormal/Extreme	σ_{min} = -241 MPa τ_{max} = 139 MPa	σ = 435 MPa τ = 253 MPa	1.6S 1.4S
Radial Web Plate	25mm	Abnormal/Extreme Abnormal/Extreme	σ_{min} = -283 MPa τ_{max} = 171 MPa	σ = 417 MPa τ = 243 MPa	1.6S 1.4S

a. S = Allowable stress limit specified in AISC N690, Part 1

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Table 3G.7-215 Reactor Shield Wall (RSW) Structural Elements Stress Summary

Structural Elements	Member Size	Governing Load Combination	Calculated Stress	Allowable Stress	Acceptance Criteria[a]
RSW Cylindrical Shell	210mm	Abnormal	σ_{min} = -277 MPa	σ = 391 MPa	1.5S
	100mm	Abnormal/Extreme	τ_{max} = 95 MPa	τ = 131 MPa	1.4S

a. S = Allowable stress limit specified in AISC N690, Part 1

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Table 3G.7-216 RPV Support Bracket Structural Elements Stress Summary

Structural Elements	Member Size	Governing Load Combination	Calculated Stress	Allowable Stress	Acceptance Criteria[a]
Horizontal Plate	150mm	Severe	σ_{max} = 66 MPa	σ = 141 MPa	1.0S
	150mm	Severe	τ_{max} = 56 MPa	τ = 94 MPa	1.0S
Vertical Plate	150mm	Severe	σ_{min} = -106 MPa	σ = 141 MPa	1.0S
	150mm	Abnormal/Extreme	τ_{max} = 96 MPa	τ = 131 MPa	1.4S

a. S = Allowable stress limit specified in AISC N690, Part 1

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Table 3G.7-217 Vent Wall and RPV Support Bracket Anchorage Structural Capacity

Anchor Locations	Governing Load Combination	Design Load (kN)	No. of Anchor Bars Provided	Total Capacity (kN)	Acceptance Criteria[a]
Vent Wall	Abnormal/Extreme	1333/deg	4-#18 @1.8 deg	2112/deg	$0.9F_y$
RPV Support Bracket	Abnormal/Extreme	36695	72-#18	69178	$0.9F_y$

a. F_y = Specified minimum yield stress

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Table 3G.7-218 **GDCS Pool Structural Elements Stress Summary**

Structural Elements	Member Size	Governing Load Combination	Calculated Stress or Stress Ration	Allowable Stress or Stress Ratio	Acceptance Criteria[b]
Wall Plate	16mm	Abnormal Abnormal/Extreme	σ_{min} = -371 MPa τ_{max} = 203 MPa	σ = 391 MPa τ = 243 MPa	1.5S 1.4S
Vertical Column	550x550x25	Abnormal Abnormal/Extreme	Ratio = 0.64 τ = 75 MPa	Ratio = 1.0 τ = 243 MPa	1.5S 1.4S
Vertical Column	800x800x65	Severe Severe	Ratio = 0.78 τ = 51 MPa	Ratio = 1.0 τ = 174 MPa	S S
Horizontal Member[a]	450x450x25	Severe Severe	Ratio = 0.76 τ = 40 MPa	Ratio = 1.0 τ = 174 MPa	S S
Bracing Member	350x350x35	Severe Abnormal/Extreme	Ratio = 0.78 τ = 34 MPa	Ratio = 1.0 τ = 243 MPa	S 1.4S

a. Thermal stress associated with extreme and abnormal load conditions meets deformation limits of AISC N690, Section Q1.5.7.2. The total stress excluding thermal stress satisfies the allowable stress limit in AISC N690, Table Q1.5.7.1.

b. S = Allowable stress limit specified in AISC N690, Part 1

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Table 3G.7-219 **GDCS Pool Anchorage Structural Capacity**

Anchor Locations	Governing Load Combination	Design Load/ Anchor Bar (kN)	Capacity/ Anchor Bar (kN)	Acceptance Criteria[a]
Bracing Members @RCCV Wall	Abnormal/Extreme	652	960	$0.9F_y$
Horizontal Members @RCCV Wall	Abnormal/Extreme	709	960	$0.9F_y$

a. F_y = Specified minimum yield stress

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Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
18 Wall Below RCCV Bottom	6	OTHR	-1.400	-6.451	-0.191	-0.048	-0.575	-0.004	0.000	-0.074
		TEMP	1.177	-0.473	-0.669	0.101	1.063	-0.040	0.024	0.044
		SEIS	2.942	7.596	0.819	0.455	2.879	0.060	0.114	1.022
		HYDR	0.730	1.683	0.349	0.209	1.193	0.003	0.010	0.417
	13	OTHR	-1.324	-4.936	0.021	-0.357	-1.820	0.006	-0.005	-0.486
		TEMP	0.307	-3.027	-0.689	0.408	2.284	-0.002	0.019	0.475
		SEIS	2.990	6.667	0.680	0.657	3.767	0.017	0.025	1.312
		HYDR	0.582	1.701	0.362	0.158	0.930	0.004	0.008	0.321
	24	OTHR	-1.138	-5.397	-0.165	-0.401	-2.405	-0.001	0.002	-0.807
		TEMP	0.412	-3.041	0.146	0.425	2.350	-0.005	-0.002	0.516
		SEIS	2.106	7.069	1.196	0.659	3.721	0.015	0.022	1.154
		HYDR	0.638	1.871	0.334	0.114	0.717	0.003	0.007	0.254
19 Wall Below RCCV Mid-Height	806	OTHR	-1.128	-5.265	-0.171	0.007	0.032	-0.023	-0.013	-0.078
		TEMP	1.601	-1.332	0.182	0.235	1.292	0.083	-0.053	-0.063
		SEIS	2.715	7.082	1.180	0.103	0.122	0.103	0.064	0.143
		HYDR	0.209	1.673	0.467	0.016	0.090	0.022	0.003	0.026
	813	OTHR	-1.535	-4.861	0.161	-0.021	0.106	-0.007	0.001	-0.051
		TEMP	1.036	-2.990	-0.508	0.175	1.290	-0.027	0.006	0.450
		SEIS	2.309	6.799	0.796	0.203	0.487	0.049	0.027	0.250
		HYDR	0.162	1.735	0.485	0.023	0.089	0.007	0.002	0.076
	824	OTHR	-1.804	-5.285	-0.062	0.101	0.391	0.009	-0.001	0.084
		TEMP	0.890	-3.046	0.126	0.176	1.306	0.019	0.010	0.396
		SEIS	2.360	7.372	1.689	0.244	0.499	0.027	0.013	0.267
		HYDR	0.180	1.909	0.438	0.013	0.095	0.010	0.001	0.048

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Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
20 Wall Below RCCV Top	1606	OTHR	-0.318	-4.636	-0.041	-0.130	-0.762	0.024	0.005	0.138
		TEMP	11.606	-2.042	0.301	-0.668	-3.250	0.099	0.085	2.306
		SEIS	2.278	6.409	2.761	0.223	1.075	0.123	0.028	0.360
		HYDR	0.573	1.710	0.449	0.335	1.886	0.009	0.005	0.547
	1613	OTHR	-0.509	-4.748	0.254	-0.155	-0.762	-0.002	-0.003	0.151
		TEMP	11.229	-3.474	-0.425	-0.785	-4.386	-0.008	-0.014	2.714
		SEIS	1.605	6.417	1.899	0.240	1.485	0.033	0.018	0.592
		HYDR	0.570	1.738	0.465	0.336	1.944	0.004	0.006	0.592
	1624	OTHR	-0.137	-4.829	-0.014	-0.189	-1.171	0.006	-0.007	0.324
		TEMP	12.187	-3.970	-0.124	-0.867	-4.480	-0.001	-0.082	2.817
		SEIS	1.940	6.999	2.725	0.198	1.333	0.043	0.033	0.536
		HYDR	0.624	1.887	0.447	0.331	1.880	0.003	0.008	0.581

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	OTHR	-1.819	-3.469	-0.717	0.141	0.804	0.015	0.039	0.262
		TEMP	3.023	3.384	0.790	0.274	1.136	0.041	-0.173	0.330
		SEIS	2.212	3.459	2.195	0.719	2.803	0.032	0.055	1.107
		HYDR	0.134	0.191	0.521	0.270	1.101	0.010	0.028	0.406
	20023	OTHR	-1.161	-1.469	-0.585	-0.008	-0.247	0.013	-0.057	-0.141
		TEMP	-1.459	-1.215	1.590	1.936	3.930	0.184	0.310	0.647
		SEIS	1.327	1.953	0.794	0.532	0.597	0.101	0.629	0.404
		HYDR	0.014	0.456	0.106	0.070	0.102	0.010	0.083	0.063
	30010	OTHR	-1.224	-2.354	-0.170	-0.234	-1.284	0.011	0.002	0.895
		TEMP	0.421	2.641	-0.135	1.081	3.585	-0.018	-0.024	-0.601
		SEIS	3.058	1.953	1.026	0.436	2.379	0.029	0.027	0.869
		HYDR	0.411	0.177	0.226	0.129	0.686	0.002	0.005	0.174
	30020	OTHR	-0.970	-1.615	-0.225	-0.535	-0.786	0.017	-0.153	0.330
		TEMP	-0.090	-1.196	-0.238	0.081	1.104	0.123	-0.022	-0.270
		SEIS	0.847	1.721	1.415	0.490	0.912	0.160	0.406	0.430
		HYDR	0.030	0.605	0.155	0.026	0.126	0.006	0.044	0.039
	40001	OTHR	-0.763	-1.785	0.353	-0.320	-1.095	-0.197	0.070	0.629
		TEMP	-0.154	-0.831	0.014	0.123	1.237	-0.081	0.114	-0.310
		SEIS	0.790	1.806	1.368	0.537	1.002	0.216	0.330	0.403
		HYDR	0.030	0.624	0.134	0.044	0.114	0.006	0.045	0.032
	40011	OTHR	-1.371	-3.077	-0.028	-0.278	-1.648	-0.002	0.005	1.572
		TEMP	0.865	2.785	0.044	1.075	3.674	0.007	0.012	-0.638
		SEIS	1.584	2.452	1.304	0.425	2.280	0.016	0.021	0.762
		HYDR	0.301	0.346	0.268	0.087	0.448	0.005	0.007	0.108

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
22 Exterior Wall @ EL4.65 ~6.60 m	22011	OTHR	0.107	-2.850	0.649	-0.005	0.094	0.012	-0.024	0.133
		TEMP	3.577	2.789	-0.075	-0.128	-0.161	0.049	0.032	-0.031
		SEIS	1.226	5.546	4.092	0.153	0.818	0.090	0.050	0.715
		HYDR	0.217	0.746	0.584	0.012	0.084	0.019	0.003	0.159
	22023	OTHR	-0.068	-1.637	-0.059	0.049	0.031	-0.067	0.053	0.011
		TEMP	1.984	-3.558	-1.991	0.092	0.423	-0.047	0.570	0.405
		SEIS	0.750	5.668	3.527	0.299	0.222	0.141	0.357	0.148
		HYDR	0.049	0.415	0.288	0.097	0.032	0.026	0.029	0.010
	32010	OTHR	0.037	-1.940	0.038	-0.019	-0.007	0.005	0.000	-0.068
		TEMP	14.408	6.124	0.009	-2.798	-2.759	0.004	-0.008	0.040
		SEIS	1.206	3.569	3.077	0.057	0.356	0.022	0.004	0.219
		HYDR	0.256	0.299	0.303	0.016	0.039	0.004	0.001	0.099
	32020	OTHR	-0.012	-1.900	0.169	-0.028	-0.038	-0.040	-0.009	0.023
		TEMP	0.445	4.720	2.524	-0.285	-1.833	-0.377	0.922	0.167
		SEIS	0.525	6.282	2.371	0.441	0.184	0.173	0.243	0.069
		HYDR	0.028	0.390	0.200	0.064	0.007	0.011	0.048	0.005
	42001	OTHR	-0.017	-1.953	0.081	-0.012	-0.070	0.055	0.004	0.046
		TEMP	2.451	3.607	2.534	-0.371	-1.611	-0.058	-0.794	-0.254
		SEIS	0.379	6.366	2.517	0.289	0.162	0.239	0.354	0.049
		HYDR	0.048	0.408	0.224	0.083	0.007	0.008	0.033	0.002
	42011	OTHR	-0.245	-2.297	-0.043	-0.036	-0.101	-0.003	0.004	-0.040
		TEMP	12.432	4.405	0.143	-2.975	-2.774	0.081	0.081	0.172
		SEIS	1.202	3.902	3.709	0.069	0.408	0.038	0.048	0.184
		HYDR	0.159	0.532	0.361	0.031	0.033	0.008	0.004	0.093

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
23 Exterior Wall @ EL22.50 ~24.60 m	24211	OTHR	0.150	-1.585	0.081	-0.023	-0.200	0.012	0.003	-0.207
		TEMP	4.177	2.901	-0.313	0.092	0.628	0.014	-0.122	1.431
		SEIS	0.931	4.603	3.707	0.152	0.641	0.042	0.007	0.711
		HYDR	0.142	0.484	0.283	0.030	0.133	0.015	0.002	0.151
	24224	OTHR	-0.026	-1.353	0.185	0.028	-0.018	-0.022	-0.043	-0.022
		TEMP	0.340	4.642	-3.562	0.871	-0.344	-0.446	-0.824	-0.417
		SEIS	0.511	8.980	3.791	0.769	1.137	0.261	0.367	1.272
		HYDR	0.024	0.485	0.236	0.095	0.064	0.024	0.047	0.068
	34210	OTHR	0.361	-0.815	0.071	0.004	0.075	0.000	0.003	0.033
		TEMP	15.323	4.794	-0.317	-2.778	-2.409	0.015	-0.011	0.104
		SEIS	1.058	1.986	3.456	0.103	0.608	0.012	0.025	0.194
		HYDR	0.202	0.102	0.171	0.015	0.077	0.009	0.001	0.041
	34220	OTHR	0.058	-1.197	-0.027	0.047	0.006	0.000	0.033	-0.001
		TEMP	1.721	4.437	2.297	0.980	-1.464	-0.240	1.609	0.013
		SEIS	0.159	3.297	2.210	0.111	0.114	0.027	0.079	0.025
		HYDR	0.028	0.231	0.098	0.036	0.015	0.017	0.023	0.007
	44201	OTHR	0.024	-1.285	-0.109	0.049	0.012	0.004	-0.035	-0.006
		TEMP	1.001	5.209	0.300	0.668	-1.698	0.337	-1.911	0.044
		SEIS	0.167	3.795	2.479	0.068	0.041	0.040	0.109	0.024
		HYDR	0.026	0.280	0.164	0.033	0.005	0.003	0.024	0.004

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
24 Basemat @ Wall Below RCCV	90140	OTHR	-3.142	-2.669	0.148	-1.147	-0.481	1.613	-1.900	1.694
		TEMP	1.052	1.448	1.374	0.756	-0.217	-0.971	-0.682	-0.069
		SEIS	2.801	1.113	1.986	3.720	2.589	3.423	2.095	2.337
		HYDR	0.511	0.359	0.401	0.987	0.702	0.218	0.702	0.721
	90182	OTHR	-2.479	-2.537	-0.046	0.232	-1.054	-0.033	0.049	0.446
		TEMP	1.619	0.481	0.610	-0.246	-3.861	0.184	-0.141	2.769
		SEIS	2.544	0.415	1.472	1.264	3.140	0.509	0.312	2.146
		HYDR	0.940	0.180	0.184	0.566	0.378	0.154	0.197	0.791
	90111	OTHR	-3.922	-2.463	-0.021	-1.672	0.197	-0.220	0.145	0.119
		TEMP	0.567	2.209	-0.001	-4.129	-0.522	0.050	2.860	0.127
		SEIS	0.479	1.371	1.951	3.034	1.044	0.680	1.765	0.565
		HYDR	0.141	0.811	0.051	0.274	0.454	0.121	0.736	0.189
25 Slab EL4.65 m @ RCCV	93140	OTHR	-0.355	0.056	0.234	0.095	0.110	-0.088	0.129	-0.109
		TEMP	-0.669	2.312	4.286	-0.515	-0.395	0.287	-0.135	0.111
		SEIS	1.713	0.333	0.267	0.269	0.210	0.146	0.126	0.111
		HYDR	0.182	0.196	0.238	0.036	0.027	0.036	0.010	0.012
	93182	OTHR	0.125	-0.144	0.022	0.009	0.070	0.006	-0.004	-0.055
		TEMP	4.229	-4.036	-1.098	-0.354	-1.829	-0.083	0.075	1.370
		SEIS	0.313	0.148	0.131	0.128	0.637	0.030	0.030	0.587
		HYDR	0.290	0.073	0.082	0.025	0.042	0.004	0.005	0.108
	93111	OTHR	-0.185	0.248	-0.015	0.018	-0.002	-0.001	-0.010	-0.005
		TEMP	-3.602	4.956	-0.257	-1.768	-0.316	-0.047	1.178	0.000
		SEIS	0.185	0.254	0.154	0.537	0.097	0.022	0.434	0.005
		HYDR	0.073	0.316	0.068	0.013	0.021	0.002	0.066	0.002

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
26 Slab EL17.5 m @ RCCV	96144	OTHR	-0.003	0.471	0.581	0.117	0.124	-0.097	0.133	-0.113
		TEMP	-0.269	4.712	6.965	-0.230	-0.125	0.167	-0.073	0.023
		SEIS	0.611	0.374	0.224	0.221	0.196	0.136	0.109	0.086
		HYDR	0.056	0.021	0.228	0.068	0.057	0.034	0.013	0.015
	96186	OTHR	0.748	-0.307	-0.071	0.006	0.060	0.000	-0.004	-0.086
		TEMP	6.688	-4.125	-1.418	-0.091	-0.316	-0.048	0.016	0.347
		SEIS	0.532	0.188	0.210	0.115	0.599	0.026	0.031	0.481
		HYDR	0.176	0.097	0.118	0.035	0.162	0.006	0.008	0.130
	96113	OTHR	-0.374	1.228	-0.107	0.112	0.048	-0.008	0.047	0.016
		TEMP	-8.342	2.574	-1.682	-4.481	-2.783	-0.199	1.240	-0.059
		SEIS	0.090	1.066	0.667	1.234	0.140	0.053	1.033	0.124
		HYDR	0.054	0.335	0.192	0.246	0.059	0.009	0.189	0.020
27 Slab EL27.0 m @ RCCV	98472	OTHR	0.538	0.462	-0.046	0.176	0.270	-0.145	0.331	-0.357
		TEMP	-0.778	-0.772	5.392	-0.313	0.031	-0.311	0.451	-0.561
		SEIS	0.794	0.877	0.373	0.464	0.714	0.577	0.448	0.527
		HYDR	0.100	0.049	0.146	0.061	0.079	0.039	0.048	0.051
	98514	OTHR	0.298	0.383	0.033	-0.004	-0.213	0.008	-0.011	-0.055
		TEMP	0.397	-2.323	-1.289	-0.515	0.047	-0.042	0.045	-0.511
		SEIS	0.669	0.096	0.371	0.189	1.155	0.076	0.047	0.772
		HYDR	0.170	0.075	0.161	0.027	0.127	0.001	0.002	0.100
	98424	OTHR	-0.221	1.168	-0.045	0.656	0.262	-0.086	-0.778	-0.060
		TEMP	-9.063	-6.855	-1.452	1.316	-0.418	0.194	-5.559	-0.101
		SEIS	1.057	1.196	3.487	2.644	0.649	0.155	1.814	0.149
		HYDR	0.047	0.148	0.092	0.231	0.096	0.014	0.157	0.010

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
28 Pool Girder @ Storage Pool	123054	OTHR	0.281	-0.342	0.594	0.061	0.034	-0.072	-0.036	-0.044
		TEMP	1.314	-2.832	1.430	2.281	2.120	0.027	-0.232	0.482
		SEIS	0.569	3.326	1.105	0.205	0.094	0.091	0.049	0.123
		HYDR	0.118	0.151	0.128	0.010	0.008	0.005	0.012	0.012
	123154	OTHR	0.616	-0.173	0.550	0.073	0.032	-0.064	-0.050	0.021
		TEMP	1.031	0.747	-0.407	1.925	1.145	-0.338	-0.086	0.247
		SEIS	1.837	0.841	1.008	0.167	0.070	0.158	0.061	0.020
		HYDR	0.215	0.029	0.123	0.014	0.009	0.016	0.006	0.001
29 Pool Girder @ Cavity	123062	OTHR	0.376	-0.508	-0.685	-0.003	0.071	0.008	0.031	0.052
		TEMP	-1.254	-0.148	-0.719	0.101	0.323	0.027	0.057	0.172
		SEIS	0.576	1.124	0.540	0.154	0.283	0.046	0.080	0.160
		HYDR	0.126	0.015	0.096	0.008	0.011	0.004	0.005	0.003
	123162	OTHR	0.829	-0.194	-0.510	0.013	-0.014	0.007	0.005	-0.006
		TEMP	-1.691	-0.032	-0.470	0.128	-0.117	-0.003	-0.151	0.085
		SEIS	1.895	0.871	0.309	0.277	0.119	0.030	0.166	0.037
		HYDR	0.318	0.014	0.091	0.016	0.010	0.003	0.011	0.003
30 Pool Girder @ Fuel Pool	123067	OTHR	0.292	-0.040	-0.373	-0.019	-0.061	-0.010	-0.071	-0.038
		TEMP	-2.405	-6.001	-1.842	0.639	0.439	-0.117	-0.150	0.470
		SEIS	0.766	2.994	1.977	0.106	0.097	0.102	0.127	0.170
		HYDR	0.124	0.755	0.287	0.021	0.020	0.008	0.017	0.021
	123167	OTHR	0.054	-0.040	-0.424	0.007	-0.031	0.027	-0.064	0.001
		TEMP	-2.204	-2.669	-2.246	0.268	-0.449	-0.228	-0.011	0.180
		SEIS	0.932	0.809	1.827	0.065	0.104	0.067	0.074	0.028
		HYDR	0.336	0.219	0.315	0.014	0.006	0.005	0.008	0.003

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Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
31 MS Tunnel Wall and Slab	150122	OTHR	0.016	-0.187	0.341	0.022	0.085	0.015	-0.008	-0.058
		TEMP	0.224	-0.515	1.901	1.053	3.140	-0.007	-0.584	0.364
		SEIS	0.043	0.340	0.351	0.069	0.221	0.044	0.020	0.189
		HYDR	0.013	0.039	0.004	0.006	0.024	0.004	0.002	0.014
	96611	OTHR	-0.038	0.587	-0.035	0.059	-0.079	-0.053	-0.071	0.018
		TEMP	-0.447	4.103	-0.332	-1.287	-7.109	-0.423	0.426	0.209
		SEIS	0.034	0.440	0.046	0.183	0.626	0.129	0.128	0.071
		HYDR	0.007	0.053	0.008	0.031	0.072	0.013	0.011	0.006
	98614	OTHR	-0.019	-0.246	-0.018	-0.132	-0.854	-0.114	-0.011	0.046
		TEMP	-0.187	1.989	-0.145	-0.861	-10.477	-0.011	0.470	0.303
		SEIS	0.049	0.404	0.040	0.188	0.962	0.293	0.087	0.053
		HYDR	0.004	0.081	0.005	0.004	0.040	0.006	0.001	0.007

Table 3G.7-220a **Combined Forces and Moments: RB, Selected Load Combination RB-9a** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
32 IC/PCCS Pool Wall in NS Dir.	125051	OTHR	0.114	0.016	0.234	-0.029	-0.007	0.000	-0.022	0.009
		TEMP	-0.257	-0.976	-0.150	-0.013	-0.016	-0.001	-0.024	-0.015
		SEIS	0.163	1.653	1.292	0.010	0.076	0.004	0.016	0.059
		HYDR	0.011	0.066	0.042	0.002	0.001	0.000	0.002	0.001
	125151	OTHR	0.184	-0.043	0.179	-0.038	-0.011	-0.001	-0.034	0.001
		TEMP	-0.404	-0.680	0.529	0.018	0.055	0.012	-0.030	-0.051
		SEIS	0.200	0.661	1.067	0.003	0.014	0.012	0.022	0.013
		HYDR	0.027	0.037	0.047	0.003	0.001	0.000	0.003	0.000
	125055	OTHR	0.172	-0.068	-0.087	0.010	0.031	0.002	0.015	0.024
		TEMP	-0.601	0.281	0.050	0.008	0.023	0.001	0.007	0.002
		SEIS	0.266	0.203	0.532	0.033	0.140	0.006	0.051	0.096
		HYDR	0.032	0.031	0.064	0.001	0.001	0.000	0.001	0.000
	125155	OTHR	0.311	-0.003	-0.068	0.001	-0.016	-0.001	-0.009	0.013
		TEMP	-1.201	-0.035	0.047	0.008	0.037	-0.005	-0.061	0.002
		SEIS	0.766	0.139	0.461	0.019	0.042	0.009	0.051	0.058
		HYDR	0.052	0.012	0.069	0.001	0.000	0.000	0.001	0.001

OTHR: Loads other than thermal loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):

1 MN/m = 6.852×10^4 lbf/ft

1 MNm/m = 2.248×10^5 lbf-ft/ft

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
18 Wall Below RCCV Bottom	6	OTHR	-1.459	-6.276	-0.223	-0.012	-0.366	-0.005	0.001	-0.005
		TEMP	0.745	-0.977	-0.895	0.238	1.920	-0.053	0.044	0.293
		SEIS	2.942	7.596	0.819	0.455	2.879	0.060	0.114	1.022
		HYDR	0.564	1.225	0.276	0.162	0.924	0.002	0.008	0.323
	13	OTHR	-1.372	-4.789	0.011	-0.318	-1.598	0.006	-0.005	-0.417
		TEMP	-0.174	-4.065	-0.782	0.604	3.357	-0.002	0.023	0.785
		SEIS	2.990	6.667	0.680	0.657	3.767	0.017	0.025	1.312
		HYDR	0.446	1.240	0.285	0.124	0.725	0.003	0.006	0.250
	24	OTHR	-1.209	-5.232	-0.159	-0.360	-2.171	-0.001	0.003	-0.735
		TEMP	0.101	-3.765	0.212	0.594	3.314	-0.007	-0.003	0.779
		SEIS	2.106	7.069	1.196	0.659	3.721	0.015	0.022	1.154
		HYDR	0.491	1.370	0.273	0.092	0.573	0.003	0.005	0.203
19 Wall Below RCCV Mid-Height	806	OTHR	-1.110	-5.086	-0.192	0.010	0.050	-0.021	-0.013	-0.074
		TEMP	1.907	-2.149	0.225	0.307	1.688	0.090	-0.068	-0.082
		SEIS	2.715	7.082	1.180	0.103	0.122	0.103	0.064	0.143
		HYDR	0.151	1.212	0.367	0.012	0.070	0.018	0.002	0.020
	813	OTHR	-1.511	-4.728	0.153	-0.017	0.125	-0.006	0.002	-0.040
		TEMP	1.360	-3.986	-0.566	0.221	1.702	-0.034	0.006	0.602
		SEIS	2.309	6.799	0.796	0.203	0.487	0.049	0.027	0.250
		HYDR	0.116	1.258	0.385	0.017	0.068	0.007	0.002	0.059
	824	OTHR	-1.789	-5.114	-0.055	0.106	0.407	0.009	-0.001	0.095
		TEMP	1.151	-3.732	0.198	0.224	1.729	0.027	0.015	0.502
		SEIS	2.360	7.372	1.689	0.244	0.499	0.027	0.013	0.267
		HYDR	0.127	1.390	0.359	0.009	0.073	0.009	0.001	0.038

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Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
20 Wall Below RCCV Top	1606	OTHR	-0.166	-4.464	-0.065	-0.178	-1.038	0.024	0.005	0.223
		TEMP	15.858	-3.114	0.381	-0.839	-4.009	0.124	0.101	3.042
		SEIS	2.278	6.409	2.761	0.223	1.075	0.123	0.028	0.360
		HYDR	0.485	1.233	0.351	0.259	1.447	0.006	0.005	0.427
	1613	OTHR	-0.359	-4.640	0.249	-0.204	-1.042	-0.003	-0.003	0.243
		TEMP	15.713	-4.649	-0.420	-1.005	-5.538	-0.011	-0.016	3.612
		SEIS	1.605	6.417	1.899	0.240	1.485	0.033	0.018	0.592
		HYDR	0.476	1.260	0.360	0.256	1.476	0.003	0.006	0.454
	1624	OTHR	0.030	-4.654	-0.010	-0.239	-1.464	0.006	-0.007	0.420
		TEMP	16.688	-4.842	-0.107	-1.115	-5.549	0.001	-0.106	3.698
		SEIS	1.940	6.999	2.725	0.198	1.333	0.043	0.033	0.536
		HYDR	0.524	1.371	0.354	0.254	1.436	0.003	0.008	0.449

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	OTHR	-1.805	-3.402	-0.714	0.158	0.865	0.016	0.037	0.280
		TEMP	3.314	4.817	0.922	0.447	1.837	0.052	-0.225	0.576
		SEIS	2.212	3.459	2.195	0.719	2.803	0.032	0.055	1.107
		HYDR	0.099	0.152	0.412	0.204	0.828	0.007	0.021	0.305
	20023	OTHR	-1.160	-1.474	-0.591	-0.013	-0.242	0.012	-0.056	-0.139
		TEMP	-1.453	-1.169	1.549	1.890	4.020	0.180	0.322	0.683
		SEIS	1.327	1.953	0.794	0.532	0.597	0.101	0.629	0.404
		HYDR	0.011	0.336	0.082	0.053	0.078	0.008	0.064	0.048
	30010	OTHR	-1.196	-2.341	-0.172	-0.212	-1.176	0.010	0.001	0.872
		TEMP	0.688	3.733	-0.258	1.289	4.763	-0.022	-0.031	-0.865
		SEIS	3.058	1.953	1.026	0.436	2.379	0.029	0.027	0.869
		HYDR	0.304	0.132	0.184	0.100	0.526	0.002	0.004	0.133
	30020	OTHR	-0.963	-1.641	-0.229	-0.543	-0.782	0.019	-0.151	0.330
		TEMP	-0.058	-1.477	-0.392	0.021	1.209	0.144	-0.026	-0.282
		SEIS	0.847	1.721	1.415	0.490	0.912	0.160	0.406	0.430
		HYDR	0.024	0.444	0.117	0.021	0.092	0.004	0.033	0.028
	40001	OTHR	-0.760	-1.807	0.367	-0.327	-1.086	-0.198	0.069	0.628
		TEMP	-0.090	-1.141	0.056	0.039	1.330	-0.097	0.105	-0.322
		SEIS	0.790	1.806	1.368	0.537	1.002	0.216	0.330	0.403
		HYDR	0.024	0.458	0.102	0.034	0.083	0.005	0.034	0.022
	40011	OTHR	-1.371	-3.050	-0.027	-0.253	-1.527	-0.001	0.005	1.546
		TEMP	1.295	3.630	0.051	1.243	4.654	0.011	0.015	-0.844
		SEIS	1.584	2.452	1.304	0.425	2.280	0.016	0.021	0.762
		HYDR	0.232	0.250	0.214	0.069	0.354	0.003	0.006	0.085

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
22 Exterior Wall @ EL4.65 ~6.60 m	22011	OTHR	0.178	-2.796	0.636	-0.005	0.104	0.012	-0.025	0.147
		TEMP	5.080	4.474	-0.209	-0.175	-0.228	0.067	0.045	0.074
		SEIS	1.226	5.546	4.092	0.153	0.818	0.090	0.050	0.715
		HYDR	0.173	0.555	0.436	0.009	0.057	0.014	0.002	0.115
	22023	OTHR	-0.060	-1.627	-0.051	0.070	0.037	-0.071	0.046	0.010
		TEMP	2.211	-3.114	-2.141	0.528	0.492	-0.052	0.386	0.393
		SEIS	0.750	5.668	3.527	0.299	0.222	0.141	0.357	0.148
		HYDR	0.037	0.295	0.213	0.080	0.023	0.019	0.022	0.008
	32010	OTHR	0.125	-1.926	0.034	-0.019	0.005	0.006	0.000	-0.086
		TEMP	16.739	7.724	-0.075	-2.893	-3.003	-0.001	-0.014	0.022
		SEIS	1.206	3.569	3.077	0.057	0.356	0.022	0.004	0.219
		HYDR	0.201	0.217	0.231	0.014	0.033	0.003	0.001	0.076
	32020	OTHR	-0.004	-1.883	0.207	-0.013	-0.034	-0.047	0.001	0.025
		TEMP	0.653	4.869	2.518	0.104	-1.860	-0.395	1.226	0.199
		SEIS	0.525	6.282	2.371	0.441	0.184	0.173	0.243	0.069
		HYDR	0.023	0.275	0.154	0.054	0.005	0.010	0.040	0.004
	42001	OTHR	-0.007	-1.928	0.099	0.009	-0.065	0.058	-0.003	0.048
		TEMP	2.720	3.801	2.644	0.130	-1.563	-0.051	-0.998	-0.239
		SEIS	0.379	6.366	2.517	0.289	0.162	0.239	0.354	0.049
		HYDR	0.039	0.291	0.171	0.069	0.005	0.006	0.028	0.002
	42011	OTHR	-0.172	-2.235	-0.036	-0.039	-0.095	-0.004	0.004	-0.056
		TEMP	14.110	5.515	0.234	-3.164	-3.046	0.073	0.090	0.169
		SEIS	1.202	3.902	3.709	0.069	0.408	0.038	0.048	0.184
		HYDR	0.134	0.389	0.271	0.027	0.032	0.007	0.004	0.077

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
23 Exterior Wall @ EL22.50 ~24.60 m	24211	OTHR	0.226	-1.528	0.079	-0.012	-0.136	0.013	0.004	-0.237
		TEMP	6.073	5.669	-0.239	0.176	0.982	0.008	-0.147	1.336
		SEIS	0.931	4.603	3.707	0.152	0.641	0.042	0.007	0.711
		HYDR	0.102	0.359	0.211	0.022	0.100	0.011	0.002	0.109
	24224	OTHR	-0.023	-1.406	0.156	0.025	-0.013	-0.017	-0.037	-0.021
		TEMP	1.011	5.349	-3.664	1.966	0.071	-0.637	-1.563	-0.323
		SEIS	0.511	8.980	3.791	0.769	1.137	0.261	0.367	1.272
		HYDR	0.017	0.354	0.169	0.068	0.046	0.018	0.034	0.049
	34210	OTHR	0.440	-0.801	0.073	0.005	0.103	0.000	0.002	0.042
		TEMP	21.813	5.545	-0.581	-2.903	-2.819	0.035	-0.002	-0.128
		SEIS	1.058	1.986	3.456	0.103	0.608	0.012	0.025	0.194
		HYDR	0.147	0.074	0.125	0.010	0.055	0.006	0.001	0.030
	34220	OTHR	0.061	-1.255	-0.002	0.046	0.014	0.002	0.032	-0.002
		TEMP	2.794	5.432	4.414	2.629	-1.178	-0.711	2.571	0.094
		SEIS	0.159	3.297	2.210	0.111	0.114	0.027	0.079	0.025
		HYDR	0.020	0.170	0.072	0.025	0.010	0.012	0.016	0.005
	44201	OTHR	0.024	-1.326	-0.064	0.050	0.018	0.002	-0.032	-0.007
		TEMP	1.793	6.586	0.562	2.230	-1.491	0.539	-2.967	0.044
		SEIS	0.167	3.795	2.479	0.068	0.041	0.040	0.109	0.024
		HYDR	0.018	0.206	0.118	0.023	0.004	0.003	0.017	0.003

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
24 Basemat @ Wall Below RCCV	90140	OTHR	-3.147	-2.640	0.202	-0.982	-0.349	1.403	-1.887	1.660
		TEMP	0.838	1.691	1.751	-0.171	-1.046	-1.095	-1.135	0.139
		SEIS	2.801	1.113	1.986	3.720	2.589	3.423	2.095	2.337
		HYDR	0.384	0.272	0.318	0.741	0.524	0.189	0.522	0.533
	90182	OTHR	-2.369	-2.527	-0.049	0.166	-0.817	-0.005	0.044	0.431
		TEMP	1.908	0.687	0.488	-0.873	-5.527	0.260	-0.110	3.825
		SEIS	2.544	0.415	1.472	1.264	3.140	0.509	0.312	2.146
		HYDR	0.703	0.135	0.141	0.425	0.324	0.130	0.153	0.588
	90111	OTHR	-3.909	-2.406	-0.028	-1.440	0.138	-0.188	0.132	0.116
		TEMP	0.733	2.908	-0.011	-5.322	-1.147	0.107	3.687	0.151
		SEIS	0.479	1.371	1.951	3.034	1.044	0.680	1.765	0.565
		HYDR	0.099	0.619	0.041	0.248	0.342	0.104	0.550	0.150
25 Slab EL4.65 m @ RCCV	93140	OTHR	-0.338	0.086	0.260	0.104	0.116	-0.095	0.130	-0.110
		TEMP	-0.383	3.018	5.804	-0.739	-0.564	0.413	-0.192	0.163
		SEIS	1.713	0.333	0.267	0.269	0.210	0.146	0.126	0.111
		HYDR	0.141	0.153	0.201	0.027	0.019	0.026	0.008	0.009
	93182	OTHR	0.178	-0.133	0.020	0.009	0.081	0.007	-0.004	-0.051
		TEMP	6.161	-5.154	-1.518	-0.481	-2.508	-0.114	0.105	1.903
		SEIS	0.313	0.148	0.131	0.128	0.637	0.030	0.030	0.587
		HYDR	0.232	0.069	0.068	0.019	0.031	0.003	0.004	0.080
	93111	OTHR	-0.173	0.295	-0.024	0.030	-0.003	-0.001	-0.008	-0.005
		TEMP	-4.494	6.820	-0.448	-2.369	-0.414	-0.066	1.594	0.001
		SEIS	0.185	0.254	0.154	0.537	0.097	0.022	0.434	0.005
		HYDR	0.073	0.256	0.054	0.010	0.016	0.001	0.051	0.002

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
26 Slab EL17.5 m @ RCCV	96144	OTHR	0.012	0.551	0.669	0.131	0.133	-0.104	0.136	-0.116
		TEMP	0.733	5.839	8.138	-0.232	-0.178	0.174	-0.043	0.066
		SEIS	0.611	0.374	0.224	0.221	0.196	0.136	0.109	0.086
		HYDR	0.042	0.018	0.169	0.049	0.040	0.024	0.009	0.010
	96186	OTHR	0.866	-0.359	-0.094	0.009	0.079	0.002	-0.005	-0.103
		TEMP	9.999	-4.559	-2.165	-0.150	-0.675	-0.057	0.023	0.638
		SEIS	0.532	0.188	0.210	0.115	0.599	0.026	0.031	0.481
		HYDR	0.127	0.072	0.088	0.025	0.116	0.004	0.006	0.093
	96113	OTHR	-0.447	1.387	-0.140	0.168	0.057	0.000	0.002	0.013
		TEMP	-9.165	5.149	-1.811	-4.378	-2.755	-0.237	1.010	-0.100
		SEIS	0.090	1.066	0.667	1.234	0.140	0.053	1.033	0.124
		HYDR	0.043	0.239	0.139	0.179	0.044	0.006	0.138	0.015
27 Slab EL27.0 m @ RCCV	98472	OTHR	0.541	0.521	-0.068	0.159	0.239	-0.092	0.321	-0.342
		TEMP	-3.645	-3.148	5.906	-1.729	-1.315	-0.297	0.534	-0.685
		SEIS	0.794	0.877	0.373	0.464	0.714	0.577	0.448	0.527
		HYDR	0.075	0.036	0.103	0.045	0.059	0.029	0.035	0.038
	98514	OTHR	0.312	0.396	0.031	-0.011	-0.282	0.003	-0.010	-0.043
		TEMP	-2.902	-2.765	-1.440	-1.895	-1.503	-0.079	0.078	-0.381
		SEIS	0.669	0.096	0.371	0.189	1.155	0.076	0.047	0.772
		HYDR	0.121	0.054	0.118	0.020	0.094	0.001	0.001	0.074
	98424	OTHR	-0.248	1.315	-0.050	0.415	0.227	-0.104	-0.703	-0.054
		TEMP	-8.825	-1.775	-2.345	3.485	0.429	0.374	-5.774	-0.156
		SEIS	1.057	1.196	3.487	2.644	0.649	0.155	1.814	0.149
		HYDR	0.033	0.106	0.068	0.172	0.073	0.010	0.118	0.007

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
28 Pool Girder @ Storage Pool	123054	OTHR	0.254	0.062	0.883	0.063	0.032	-0.096	-0.040	-0.052
		TEMP	3.583	1.298	2.382	3.613	2.453	-0.343	0.113	0.317
		SEIS	0.569	3.326	1.105	0.205	0.094	0.091	0.049	0.123
		HYDR	0.085	0.112	0.096	0.007	0.006	0.004	0.008	0.009
	123154	OTHR	0.469	-0.118	0.803	0.073	0.035	-0.096	-0.061	0.024
		TEMP	3.638	3.575	-2.911	3.372	1.303	-0.374	-0.255	0.413
		SEIS	1.837	0.841	1.008	0.167	0.070	0.158	0.061	0.020
		HYDR	0.157	0.021	0.091	0.010	0.007	0.011	0.004	0.001
29 Pool Girder @ Cavity	123062	OTHR	0.359	-0.748	-0.884	0.004	0.130	0.007	0.034	0.079
		TEMP	0.505	0.115	-1.385	3.836	3.893	0.008	0.034	0.188
		SEIS	0.576	1.124	0.540	0.154	0.283	0.046	0.080	0.160
		HYDR	0.088	0.010	0.070	0.006	0.008	0.003	0.003	0.002
	123162	OTHR	1.266	-0.294	-0.641	0.030	-0.001	0.004	-0.012	-0.011
		TEMP	1.929	0.409	-1.840	3.803	2.820	0.092	-0.288	0.644
		SEIS	1.895	0.871	0.309	0.277	0.119	0.030	0.166	0.037
		HYDR	0.233	0.010	0.066	0.012	0.008	0.002	0.008	0.002
30 Pool Girder @ Fuel Pool	123067	OTHR	0.253	0.356	-0.750	-0.024	-0.063	0.006	-0.059	-0.044
		TEMP	-2.101	-7.271	-3.005	3.592	3.540	-0.636	0.317	0.815
		SEIS	0.766	2.994	1.977	0.106	0.097	0.102	0.127	0.170
		HYDR	0.090	0.556	0.209	0.015	0.014	0.006	0.012	0.015
	123167	OTHR	-0.044	0.041	-0.769	0.005	-0.035	0.028	-0.062	0.004
		TEMP	-0.679	-2.776	-3.132	2.749	1.834	-0.242	-0.176	0.616
		SEIS	0.932	0.809	1.827	0.065	0.104	0.067	0.074	0.028
		HYDR	0.249	0.161	0.229	0.010	0.004	0.004	0.006	0.002

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Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
31 MS Tunnel Wall and Slab	150122	OTHR	0.024	-0.229	0.352	0.021	0.090	0.015	-0.007	-0.062
		TEMP	0.316	-0.711	1.797	0.940	3.101	0.011	-0.551	0.426
		SEIS	0.043	0.340	0.351	0.069	0.221	0.044	0.020	0.189
		HYDR	0.009	0.029	0.003	0.004	0.018	0.003	0.001	0.010
	96611	OTHR	-0.044	0.652	-0.040	0.056	-0.087	-0.054	-0.070	0.018
		TEMP	-0.557	4.662	-0.414	-1.254	-7.116	-0.406	0.420	0.206
		SEIS	0.034	0.440	0.046	0.183	0.626	0.129	0.128	0.071
		HYDR	0.005	0.039	0.006	0.023	0.054	0.009	0.008	0.004
	98614	OTHR	-0.019	-0.264	-0.018	-0.160	-0.915	-0.124	-0.002	0.049
		TEMP	-0.043	0.725	-0.043	-0.850	-9.922	-0.018	0.459	0.307
		SEIS	0.049	0.404	0.040	0.188	0.962	0.293	0.087	0.053
		HYDR	0.003	0.061	0.003	0.003	0.030	0.004	0.001	0.005

Table 3G.7-220b **Combined Forces and Moments: RB, Selected Load Combination RB-9b** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
32 IC/PCCS Pool Wall in NS Dir.	125051	OTHR	0.151	0.243	0.465	-0.034	0.004	0.001	-0.026	0.018
		TEMP	-2.425	-2.173	-0.782	0.093	0.096	-0.014	0.023	0.036
		SEIS	0.163	1.653	1.292	0.010	0.076	0.004	0.016	0.059
		HYDR	0.008	0.048	0.031	0.001	0.001	0.000	0.002	0.001
	125151	OTHR	0.235	0.020	0.367	-0.043	-0.010	0.000	-0.042	0.002
		TEMP	-2.083	-1.572	1.896	0.131	0.140	0.029	0.019	-0.082
		SEIS	0.200	0.661	1.067	0.003	0.014	0.012	0.022	0.013
		HYDR	0.020	0.027	0.035	0.002	0.001	0.000	0.002	0.000
	125055	OTHR	0.188	-0.090	-0.086	0.016	0.058	0.002	0.024	0.041
		TEMP	-4.971	-0.309	0.162	0.019	0.097	0.004	-0.047	-0.011
		SEIS	0.266	0.203	0.532	0.033	0.140	0.006	0.051	0.096
		HYDR	0.023	0.022	0.047	0.000	0.000	0.000	0.000	0.000
	125155	OTHR	0.472	-0.022	-0.065	0.001	-0.024	-0.002	-0.020	0.024
		TEMP	-4.973	-0.680	0.046	0.014	0.094	-0.011	-0.133	0.027
		SEIS	0.766	0.139	0.461	0.019	0.042	0.009	0.051	0.058
		HYDR	0.039	0.008	0.050	0.000	0.000	0.000	0.001	0.000

OTHR: Loads other than thermal loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):

1 MN/m = 6.852×10^4 lbf/ft

1 MNm/m = 2.248×10^5 lbf-ft/ft

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Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation**

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
18 Wall Below RCCV Bottom	6 13 24	2.0	Inside	2-#18@300	0.860	3-#18@0.9°	1.297	#9@0.9°x300	0.721
			Outside	3-#18@300	1.290	3-#18@0.9° +1-#18@0.9°	1.729		
19 Wall Below RCCV Mid-Height	806 813 824	2.0	Inside	2-#18@300	0.860	3-#18@0.9°	1.297	#9@1.2°x600	0.270
			Outside	3-#18@300	1.290	3-#18@0.9°	1.297		
20 Wall Below RCCV Top	1606 1613 1624	2.0	Inside	2-#18@300	0.860	3-#18@0.9°	1.297	#9@1.2°x300	0.540
			Outside	3-#18@300	1.290	3-#18@0.9° +1-#18@1.8°	1.513		

Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Position	Primary Reinforcement – Direction 1[a] Arrangement[b]	Direction 1[a] Ratio (%)	Direction 2[a] Arrangement[b]	Direction 2[a] Ratio (%)	Shear Tie Arrangement	Shear Tie Ratio (%)
21 Exterior Wall @ EL-11.50 to -10.50 m	20011	2.0	Inside	4-#11@200 +1-#11@400	1.132	5-#11@200 (+1-#11@200)	1.510	#7@400x200	0.484
			Outside	4-#11@200 +1-#11@400	1.132	5-#11@200 (+2-#11@200)	1.761		
	20023	2.0	Inside	4-#11@200 +1-#11@400	1.132	5-#11@200 (+1-#11@200)	1.510	#7@400x200	0.484
			Outside	4-#11@200 +1-#11@400	1.132	5-#11@200	1.258		
	30010 30020	2.0	Inside	1-#11@100 +3-#11@200	1.258	2-#11@100 +2-#11@200	1.510	6@200x200	0.710
			Outside	2-#11@100 +2-#11@200	1.510	3-#11@100 +1-#11@200	1.761		
	40001 40011	2.0	Inside	1-#11@100 +3-#11@200	1.258	2-#11@100 +2-#11@200	1.510	6@200x200	0.710
			Outside	2-#11@100 +2-#11@200	1.510	2-#11@100 +2-#11@200	1.510		

Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Position	Primary Reinforcement: Direction 1[a] Arrangement[b]	Direction 1[a] Ratio (%)	Direction 2[a] Arrangement[b]	Direction 2[a] Ratio (%)	Shear Tie Arrangement	Shear Tie Ratio (%)
22 Exterior Wall @ EL4.65 to 6.60 m	22011	1.5	Inside	3-#11@200 +1-#11@400	1.174	4-#11@200 (+1-#11@200)	1.677	#7@400x200	0.484
			Outside	3-#11@200 +1-#11@400	1.174	4-#11@200 (+1-#11@200)	1.677		
	22023	1.5	Inside	3-#11@200 +1-#11@400	1.174	4-#11@200	1.342	#7@400x200	0.484
			Outside	3-#11@200 +1-#11@400	1.174	4-#11@200	1.342		
	32010	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#6@400x400	0.177
			Outside	3-#11@200 (+2-#11@200)	1.677	3-#11@200 (+2-#11@200)	1.677		
	32020	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#6@400x400	0.177
			Outside	3-#11@200	1.006	3-#11@200	1.006		
	42001	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#7@400x400	0.242
			Outside	4-#11@200	1.342	4-#11@200	1.342		
	42011	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#7@400x400	0.242
			Outside	4-#11@200 (+1-#11@200)	1.677	4-#11@200 (+1-#11@200)	1.677		

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Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Position	Primary Reinforcement: Direction 1[a] Arrangement[b]	Direction 1[a] Ratio (%)	Direction 2[a] Arrangement[b]	Direction 2[a] Ratio (%)	Shear Tie Arrangement	Shear Tie Ratio (%)
23 Exterior Wall @ EL22.50 to 24.60m	24211	1.5	Inside	3-#11@200 +1-#11@400	1.174	4-#11@200 (+1-#11@200)	1.677	#7@200x200	0.968
			Outside	3-#11@200 +1-#11@400	1.174	4-#11@200	1.342		
	24224	1.5	Inside	3-#11@200 +1-#11@400	1.174	4-#11@200 (+1-#11@200)	1.677	#7@200x200	0.968
			Outside	3-#11@200 +1-#11@400	1.174	4-#11@200 (+1-#11@200)	1.677		
	34210	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#6@400x400	0.177
			Outside	3-#11@200 (+2-#11@200)	1.677	3-#11@200 (+2-#11@200)	1.677		
	34220	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#6@200x200	0.710
			Outside	3-#11@200	1.006	3-#11@200	1.006		
	44201	1.5	Inside	3-#11@200	1.006	3-#11@200	1.006	#7@200x200	0.968
			Outside	4-#11@200	1.342	4-#11@200	1.342		
Note: Updated reinforcement arrangement from standard design is shown in red.									
24 Basemat @ Wall Below RCCV	90140 90182 90111	4.0	Top	5-#11@0.9°	0.401	4-#11@200 +1-#11@400	0.566	#11@0.9x400	0.801
			Bottom	5-#11@200	0.629	5-#11@200	0.629		

Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
25 Slab EL4.65 m @ RCCV	93140 93182 93111	1.0	Top	2-#11@200	1.006	2-#11@200	1.006	#5@200x200	0.500
			Bottom	2-#11@200	1.006	2-#11@200	1.006		
26 Slab EL17.5 m @ RCCV	96144 96186	1.0	Top	2-#11@200	1.006	2-#11@200	1.006	#5@200x200	0.500
			Bottom	2-#11@200	1.006	2-#11@200	1.006		
	96113	1.6	Top	2-#11@200	0.629	2-#11@200	0.629	#5@200x200	0.500
			Bottom	3-#11@200	0.944	3-#11@200	0.944		
27 Slab EL27.0 m @ RCCV	98472 98514	1.5	Top	3-#11@200 (+2-#11@200)	1.677	3-#11@200 (+2-#11@200)	1.677	#7@200x200	0.968
			Bottom	3-#11@200 (+3-#11@200)	2.013	3-#11@200 (+3-#11@200)	2.013		
	98424	2.4	Top	4-#11@200 (+2-#11@200)	1.258	4-#11@200 (+2-#11@200)	1.258	#7@200x200	0.968
			Bottom	4-#11@200 (+1-#11@200)	1.048	4-#11@200 (+1-#11@200)	1.048		
28 Pool Girder @ Storage Pool	123054 123154	1.6	Inside	3-#11@200	0.944	3-#11@200	0.944	#7@400x200	0.484
			Outside	3-#11@200 (+1-#11@200)	1.258	3-#11@200	0.944		
29 Pool Girder @ Well	123062 123162	1.6	Inside	3-#11@200	0.944	3-#11@200	0.944	#7@400x400	0.242
			Outside	3-#11@200	0.944	3-#11@200	0.944		

Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Position	Primary Reinforcement: Direction 1[a] Arrangement[b]	Direction 1[a] Ratio (%)	Direction 2[a] Arrangement[b]	Direction 2[a] Ratio (%)	Shear Tie Arrangement	Shear Tie Ratio (%)
30 Pool Girder @ Buffer Pool	123067 123167	1.6	Inside	3-#11@200 (+1-#11@200)	1.258	3-#11@200 (+1-#11@200)	1.258	#7@400x200	0.484
			Outside	3-#11@200	0.944	3-#11@200	0.944		
31 MS Tunnel Wall and Slab	150122	1.3	Inside	2-#11@200	0.774	2-#11@200	0.774	#6@400x400	0.177
			Outside	2-#11@200 +1-#11@400	0.968	2-#11@200 +1-#11@400	0.968		
	96611	1.6	Top	2-#11@200	0.629	2-#11@200	0.629	#5@200x200	0.500
			Bottom	3-#11@200	0.944	3-#11@200	0.944		
	98614	2.4	Top	4-#11@200	0.839	4-#11@200	0.839	#5@200x200	0.500
			Bottom	3-#11@200	0.629	3-#11@200	0.629		
32 IC/PCCS Pool Wall in NS Dir.	125051 125151 125055 125155	1.0	Inside	1-#11@200 +1-#11@400	0.755	1-#11@200 +1-#11@400	0.755	#5@400x200	0.250
			Outside	2-#11@200	1.006	2-#11@200 (+1-#11@400)	1.258		

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Table 3G.7-221 **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

a. Wall Below RCCV Direction 1: Hoop Direction 2: Vertical
Exterior Wall Direction 1: Horizontal Direction 2: Vertical
Slab/MS Tunnel Slab Direction 1: N-S Direction 2: E-W
Pool Girder Direction 1: Horizontal Direction 2: Vertical
MS Tunnel Wall Direction 1: Horizontal Direction 2: Vertical
Basemat Direction 1: Top: Radial; Bottom: N-SDirection 2: Top: Circumferential; Bottom: E-W

b. Rebar in parenthesis indicates additional bars locally required.

SI to U.S. Customary units conversion (SI units are the controlling units and U.S. Customary units are for reference only):
1 m = 3.28 ft

Table 3G.7-222a **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9a**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
18 Wall Below RCCV Bottom	6	-10.3	-29.3	51.7	65.3	-22.1	69.4	372.2
	13	-11.3	-29.3	25.6	57.2	-26.5	-62.3	372.2
	24	-10.8	-29.3	39.4	40.6	85.5	-30.0	372.2
19 Wall Below RCCV Mid-Height	806	-7.8	-29.3	95.6	47.8	58.6	-50.2	372.2
	813	-8.8	-29.3	59.3	40.6	38.0	-53.0	372.2
	824	-9.8	-29.3	79.6	48.0	71.2	-57.5	372.2
20 Wall Below RCCV Top	1606	-12.3	-29.3	87.4	117.0	-80.6	80.1	372.2
	1613	-14.7	-29.3	56.4	93.8	-92.2	50.8	372.2
	1624	-15.5	-29.3	83.9	115.7	-98.4	84.9	372.2
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	-8.6	-29.3	67.5	109.8	53.1	113.7	372.2
	20023	-6.3	-28.9	12.8	-19.5	20.4	-25.3	368.9
	30010	-5.6	-29.3	55.6	46.2	34.2	76.5	372.2
	30020	-3.9	-29.3	-11.7	10.7	-7.6	-18.6	372.2
	40001	-4.1	-29.3	21.0	8.4	-6.3	23.2	372.2
	40011	-5.7	-29.3	42.4	42.6	26.6	92.9	372.2

Table 3G.7-222a **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
22 Exterior Wall @ EL4.65 ~6.60 m	22011	-8.6	-29.3	152.6	142.2	255.4	135.4	372.2
	22023	-8.9	-29.3	124.6	56.7	70.0	47.0	372.2
	32010	-4.3	-29.3	175.1	199.8	158.3	236.9	372.2
	32020	-7.4	-29.3	112.0	91.6	190.9	270.6	372.2
	42001	-7.4	-29.3	120.2	68.4	209.2	219.0	372.2
	42011	-6.5	-29.3	111.8	150.8	182.2	160.9	372.2
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-5.6	-29.3	188.4	126.0	227.1	119.9	372.2
	24224	-10.8	-29.3	137.2	135.3	298.7	155.4	372.2
	34210	-4.8	-29.3	168.4	213.0	107.6	188.6	372.2
	34220	-3.7	-29.3	108.0	73.6	138.0	172.5	372.2
	44201	-4.0	-29.3	129.3	91.1	151.8	196.1	372.2
24 Basemat @ Wall Below RCCV	90140	-4.8	-23.5	152.3	-2.9	25.1	9.7	372.2
	90182	-3.8	-23.5	25.2	59.4	45.5	33.0	372.2
	90111	-4.3	-23.5	-21.8	27.9	44.1	54.2	372.2
25 Slab EL4.65 m @ RCCV	93140	-10.5	-29.3	114.3	142.3	103.9	156.3	372.2
	93182	-17.5	-29.3	42.2	84.3	-73.2	91.6	372.2
	93111	-16.2	-29.3	-67.4	85.8	55.9	90.2	372.2

Table 3G.7-222a **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9a** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
26 Slab EL17.5 m @ RCCV	96144	-10.8	-29.3	204.2	192.4	217.6	230.0	372.2
	96186	-9.0	-29.3	103.8	149.1	-41.3	-35.7	372.2
	96113	-15.6	-28.8	-107.0	75.4	94.9	135.1	368.2
27 Slab EL27.0 m @ RCCV	98472	-9.6	-29.1	77.7	61.6	61.5	60.3	370.3
	98514	-4.9	-29.1	18.4	45.4	-18.7	36.9	370.3
	98424	-8.8	-28.1	-23.4	-46.4	-20.3	-11.3	363.0
28 Pool Girder @ Storage Pool	123054	-8.9	-29.0	23.8	112.9	-30.5	123.2	369.8
	123154	-3.2	-29.0	92.4	134.7	75.3	99.2	369.8
29 Pool Girder @ Cavity	123062	-3.4	-28.4	34.2	35.9	45.7	38.8	365.0
	123162	-2.1	-28.4	96.8	63.2	40.7	53.8	365.0
30 Pool Girder @ Fuel Pool	123067	-7.4	-28.4	-4.1	28.9	-35.3	-12.2	365.0
	123167	-6.7	-28.4	28.4	41.4	48.2	17.9	365.0
31 MS Tunnel Wall and Slab	150122	-12.5	-29.3	17.6	164.2	-22.6	195.8	372.2
	96611	-8.9	-29.3	-2.0	23.4	-13.7	226.8	372.2
	98614	-7.9	-29.3	4.0	27.6	-6.0	178.5	372.2
32 IC/PCCS Pool Wall in NS Dir.	125051	-3.8	-28.3	79.5	47.4	98.5	74.8	364.7
	125151	-3.8	-28.3	75.9	46.0	47.2	30.6	364.7
	125055	-1.6	-28.3	27.2	17.8	37.0	47.8	364.7
	125155	-1.8	-28.3	22.9	14.4	39.4	15.3	364.7

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Table 3G.7-222a **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Note: Negative value means compression.

a.	Wall Below RCCV	Direction 1: Hoop	Direction 2: Vertical
	Exterior Wall	Direction 1: Horizontal	Direction 2: Vertical
	Slab/MS Tunnel Slab	Direction 1: N-S	Direction 2: E-W
	Pool Girder	Direction 1: Horizontal	Direction 2: Vertical
	MS Tunnel Wall	Direction 1: Horizontal	Direction 2: Vertical
	Basemat	Direction 1: Top: Radial; Bottom: N-S	Direction 2: Top: Circumferential; Bottom: E-W

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Table 3G.7-222b **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9b**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
18 Wall Below RCCV Bottom	6	-11.6	-29.3	37.8	57.6	-17.6	-64.0	372.2
	13	-13.1	-29.3	24.3	40.2	-18.1	-70.5	372.2
	24	-12.5	-29.3	20.3	50.6	-19.8	-69.2	372.2
19 Wall Below RCCV Mid-Height	806	-8.5	-29.3	96.4	47.3	54.7	-54.1	372.2
	813	-9.7	-29.3	61.3	46.4	-34.0	-57.6	372.2
	824	-10.5	-29.3	82.1	45.6	74.1	-60.9	372.2
20 Wall Below RCCV Top	1606	-13.4	-29.3	107.1	134.1	-85.0	95.2	372.2
	1613	-16.2	-29.3	76.8	111.6	-98.5	61.3	372.2
	1624	-16.7	-29.3	104.2	134.0	-103.6	101.6	372.2
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	-8.2	-29.3	116.6	40.7	65.7	104.4	372.2
	20023	-6.2	-28.9	11.6	-19.4	20.8	-25.1	368.9
	30010	-5.6	-29.3	58.2	48.0	38.5	76.7	372.2
	30020	-4.2	-29.3	-12.0	11.1	-7.5	-18.0	372.2
	40001	-4.3	-29.3	18.0	11.1	-6.8	-17.8	372.2
	40011	-5.9	-29.3	43.2	47.8	31.6	91.4	372.2

Table 3G.7-222b **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
22 Exterior Wall @ EL4.65 ~6.60 m	22011	-7.0	-29.3	246.0	202.2	235.8	303.4	372.2
	22023	-8.7	-29.3	131.6	56.8	85.0	54.4	372.2
	32010	-4.6	-29.3	186.7	231.6	135.2	221.2	372.2
	32020	-5.3	-29.3	56.2	122.7	198.5	280.1	372.2
	42001	-7.4	-29.3	102.2	85.9	206.6	216.1	372.2
	42011	-6.3	-29.3	124.3	160.9	196.0	163.9	372.2
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-5.7	-29.3	244.4	148.0	259.4	123.7	372.2
	24224	-10.2	-29.3	146.8	106.0	319.7	132.2	372.2
	34210	-4.8	-29.3	191.9	237.1	106.8	232.9	372.2
	34220	-5.3	-29.3	133.5	21.5	146.4	139.7	372.2
	44201	-3.9	-29.3	185.3	57.8	193.6	194.8	372.2
24 Basemat @ Wall Below RCCV	90140	-5.2	-23.5	115.0	3.2	4.8	-8.3	372.2
	90182	-3.9	-23.5	23.0	32.9	87.2	39.5	372.2
	90111	-4.5	-23.5	24.6	37.0	74.5	27.4	372.2
25 Slab EL4.65 m @ RCCV	93140	-13.1	-29.3	144.1	195.2	147.9	204.7	372.2
	93182	-21.4	-29.3	60.4	100.5	-89.1	108.2	372.2
	93111	-19.4	-29.3	-80.8	101.4	70.8	104.6	372.2

Table 3G.7-222b **Rebar and Concrete Stresses of RB: Selected Load Combination RB-9b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
26 Slab EL17.5 m @ RCCV	96144	-10.9	-29.3	211.9	245.0	256.7	266.9	372.2
	96186	-11.0	-29.3	130.2	187.1	-52.3	40.1	372.2
	96113	-16.4	-28.8	-110.3	63.4	115.2	151.9	368.2
27 Slab EL27.0 m @ RCCV	98472	-9.7	-27.6	57.0	84.3	77.8	85.8	359.4
	98514	-9.8	-27.6	-21.9	34.9	-31.4	64.2	359.4
	98424	-9.3	-28.1	106.9	-73.3	175.0	64.4	363.0
28 Pool Girder @ Storage Pool	123054	-7.1	-29.0	53.2	171.9	119.9	252.9	369.8
	123154	-3.7	-29.0	76.1	161.8	84.3	114.3	369.8
29 Pool Girder @ Cavity	123062	-13.3	-27.4	35.8	222.8	7.5	187.8	358.3
	123162	-10.0	-27.4	59.2	271.6	9.0	158.0	358.3
30 Pool Girder @ Fuel Pool	123067	-13.7	-27.4	3.8	103.3	-47.5	58.6	358.3
	123167	-7.7	-27.4	21.0	136.4	9.6	111.1	358.3
31 MS Tunnel Wall and Slab	150122	-12.8	-29.3	19.2	156.0	-26.7	187.4	372.2
	96611	-8.7	-29.3	-2.3	21.2	-11.6	230.6	372.2
	98614	-8.1	-29.3	4.1	11.2	-13.4	144.4	372.2
32 IC/PCCS Pool Wall in NS Dir.	125051	-5.2	-25.4	-13.3	-11.0	-24.4	-16.3	343.4
	125151	-6.7	-25.4	75.9	59.2	68.2	51.8	343.4
	125055	-5.1	-25.4	-32.5	-30.2	7.1	21.4	343.4
	125155	-5.0	-25.4	-33.3	-32.2	-2.5	2.1	343.4

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Table 3G.7-222b **Sectional Thicknesses and Rebar Ratios of RB Used in the Evaluation** *(continued)*

Note: Negative value means compression.

a.	Wall Below RCCV	Direction 1: Hoop	Direction 2: Vertical
	Exterior Wall	Direction 1: Horizontal	Direction 2: Vertical
	Slab/MS Tunnel Slab	Direction 1: N-S	Direction 2: E-W
	Pool Girder	Direction 1: Horizontal	Direction 2: Vertical
	MS Tunnel Wall	Direction 1: Horizontal	Direction 2: Vertical
	Basemat	Direction 1: Top: Radial; Bottom: N-S	Direction 2: Top: Circumferential; Bottom: E-W

Table 3G.7-222c Rebar and Concrete Stresses of RB: Selected Load Combination RB-8b

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
18 Wall Below RCCV Bottom	6	-7.7	-29.3	-0.5	2.7	-9.8	-40.6	372.2
	13	-8.2	-29.3	-2.0	-3.0	-11.7	-44.6	372.2
	24	-7.3	-29.3	1.3	-2.3	-15.7	-41.5	372.2
19 Wall Below RCCV Mid-Height	806	-6.1	-29.3	12.4	6.6	-14.4	-34.6	372.2
	813	-6.8	-29.3	2.5	4.6	-19.9	-39.9	372.2
	824	-7.3	-29.3	1.6	2.7	-18.7	-41.6	372.2
20 Wall Below RCCV Top	1606	-14.1	-29.3	52.6	97.2	-68.0	47.9	372.2
	1613	-16.7	-29.3	46.4	94.3	-81.0	51.5	372.2
	1624	-17.9	-29.3	62.2	107.8	-82.3	54.7	372.2
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	-4.7	-29.3	37.8	8.3	54.8	-13.1	372.2
	20023	-4.7	-28.9	8.4	-13.4	14.3	-18.8	368.9
	30010	-2.8	-29.3	6.3	-5.6	29.2	-9.2	372.2
	30020	-2.4	-29.3	-5.8	4.0	-7.2	-13.5	372.2
	40001	-2.2	-29.3	-3.8	2.4	-7.9	-12.5	372.2
	40011	-2.2	-29.3	7.0	-2.7	14.1	-9.4	372.2

Table 3G.7-222c **Rebar and Concrete Stresses of RB: Selected Load Combination RB-8b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
22 Exterior Wall @ EL4.65 ~6.60 m	22011	-1.9	-29.3	110.3	93.1	68.3	65.9	372.2
	22023	-4.6	-29.3	45.5	9.7	-6.2	-22.3	372.2
	32010	-0.6	-29.3	77.9	137.7	-2.9	63.7	372.2
	32020	-4.1	-29.3	18.4	18.7	-14.6	42.4	372.2
	42001	-1.9	-29.3	32.8	12.3	-4.2	22.6	372.2
	42011	-3.6	-29.3	37.6	96.0	-8.6	40.5	372.2
23 Exterior Wall @ EL22.50 ~24.60 m	24211	-0.6	-29.3	90.1	59.1	71.0	15.2	372.2
	24224	-3.2	-29.3	60.7	-10.1	23.0	19.0	372.2
	34210	-0.3	-29.3	121.8	219.3	31.2	157.0	372.2
	34220	-2.4	-29.3	75.3	-20.3	-16.2	38.7	372.2
	44201	-0.4	-29.3	84.8	2.1	21.1	49.5	372.2
24 Basemat @ Wall Below RCCV	90140	-1.8	-23.5	-11.9	4.5	1.1	7.5	372.2
	90182	-1.8	-23.5	-9.0	6.7	18.9	5.9	372.2
	90111	-2.4	-23.5	-13.8	4.7	18.5	9.8	372.2
25 Slab EL4.65 m @ RCCV	93140	-11.1	-29.3	115.0	175.0	150.3	198.1	372.2
	93182	-15.5	-29.3	76.2	85.5	-73.2	41.7	372.2
	93111	-14.1	-29.3	-65.5	43.1	87.0	95.9	372.2

Table 3G.7-222c **Rebar and Concrete Stresses of RB: Selected Load Combination RB-8b** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
26 Slab EL17.5 m @ RCCV	96144	-9.8	-29.3	206.7	216.9	273.0	269.0	372.2
	96186	-8.8	-29.3	143.8	164.4	-33.5	14.9	372.2
	96113	-13.9	-28.8	-88.5	19.9	103.1	128.6	368.2
27 Slab EL27.0 m @ RCCV	98472	-7.1	-27.6	6.8	58.5	18.4	56.7	359.4
	98514	-7.1	-27.6	-21.0	34.8	-22.1	43.8	359.4
	98424	-6.4	-28.1	6.2	-43.6	64.9	31.9	363.0
28 Pool Girder @ Storage Pool	123054	-7.6	-29.0	19.7	167.8	41.1	197.0	369.8
	123154	-3.9	-29.0	63.7	73.4	73.4	62.6	369.8
29 Pool Girder @ Cavity	123062	-13.6	-27.4	34.8	207.5	-3.8	190.6	358.3
	123162	-9.5	-27.4	60.8	255.4	11.2	180.2	358.3
30 Pool Girder @ Fuel Pool	123067	-11.3	-27.4	13.1	126.5	-24.0	114.1	358.3
	123167	-6.8	-27.4	22.9	138.3	16.3	113.9	358.3
31 MS Tunnel Wall and Slab	150122	-11.7	-29.3	16.4	133.9	-25.6	166.0	372.2
	96611	-6.4	-29.3	-2.2	3.3	-6.8	192.5	372.2
	98614	-6.7	-29.3	2.3	5.7	-10.0	127.0	372.2
32 IC/PCCS Pool Wall in NS Dir.	125051	-2.6	-25.4	-13.4	-11.9	-8.5	-3.0	343.4
	125151	-5.7	-25.4	82.6	60.7	85.1	61.8	343.4
	125055	-4.7	-25.4	-30.6	-29.2	-0.8	23.5	343.4
	125155	-3.7	-25.4	-25.3	-25.0	-1.1	0.8	343.4

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Table 3G.7-222c **Rebar and Concrete Stresses of RB: Selected Load Combination RB-8b** *(continued)*

Note: Negative value means compression.

a.	Wall Below RCCV	Direction 1: Hoop	Direction 2: Vertical
	Exterior Wall	Direction 1: Horizontal	Direction 2: Vertical
	Slab/MS Tunnel Slab	Direction 1: N-S	Direction 2: E-W
	Pool Girder	Direction 1: Horizontal	Direction 2: Vertical
	MS Tunnel Wall	Direction 1: Horizontal	Direction 2: Vertical
	Basemat	Direction 1: Top: Radial; Bottom: N-S	Direction 2: Top: Circumferential; Bottom: E-W

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Table 3G.7-223 **Transverse Shear of RB for DCD Load Combinations**

Location	Element ID	Load ID	Load ID	d (m)	ρv (%)	Shear Force (MN/m) Vu	Vc	Vs	φVn	Vu/φVn
18 Wall Below RCCV Bottom	6	7741	RB-9a	1.59	0.721	1.08	1.35	4.73	5.17	0.209
	13	7741	RB-9a	1.59	0.721	1.34	1.97	4.73	5.70	0.235
	24	7941	RB-9b	1.59	0.721	1.13	2.35	4.73	6.02	0.187
19 Wall Below RCCV Mid-Height	806	7441	RB-9b	1.57	0.270	0.32	4.56	1.75	5.37	0.060
	813	7441	RB-9b	1.57	0.270	0.82	4.85	1.75	5.62	0.146
	824	7441	RB-9b	1.57	0.270	0.87	4.91	1.75	5.66	0.153
20 Wall Below RCCV Top	1606	6441	RB-8b	1.57	0.540	4.04	4.02	3.50	6.39	0.632
	1613	6441	RB-8b	1.57	0.540	4.68	4.26	3.50	6.59	0.710
	1624	6441	RB-8b	1.57	0.540	4.95	4.28	3.50	6.61	0.749
21 Exterior Wall @ EL-11.50 ~-10.50 m	20011	7441	RB-9b	1.63	0.484	1.79	2.74	3.27	5.11	0.351
	20023	7441	RB-9b	1.58	0.484	1.31	3.15	3.16	5.37	0.243
	30010	7241	RB-9a	1.69	0.710	1.37	2.78	4.97	6.59	0.208
	30020	7241	RB-9a	1.71	0.710	0.76	3.16	5.02	6.95	0.109
	40001	7241	RB-9a	1.71	0.710	0.89	3.29	5.01	7.05	0.126
	40011	7241	RB-9a	1.69	0.710	1.81	3.50	4.97	7.20	0.252
22 Exterior Wall @ EL4.65 ~6.60 m	22011	7441	RB-9b	1.15	0.484	0.93	0.00	2.31	1.96	0.475
	22023	7241	RB-9a	1.18	0.484	0.73	3.55	2.36	5.02	0.146
	32010	7241	RB-9a	1.09	0.177	0.29	0.05	0.80	0.72	0.401
	32020	7941	RB-9b	1.26	0.177	0.25	0.29	0.92	1.03	0.239
	42001	7241	RB-9a	1.19	0.242	0.52	0.80	1.19	1.69	0.310
	42011	7941	RB-9b	1.09	0.242	0.20	0.23	1.09	1.13	0.177

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Table 3G.7-223 **Transverse Shear of RB for DCD Load Combinations** *(continued)*

Location	Element ID	Load ID	Load ID	d (m)	ρv (%)	Shear Force (MN/m)				Vu/φVn
						Vu	Vc	Vs	φVn	
23 Exterior Wall @ EL22.50 ~24.60 m	24211	7241	RB-9a	1.05	0.968	1.34	0.06	4.10	3.53	0.379
	24224	7941	RB-9b	1.05	0.484	1.21	0.00	2.11	1.79	0.677
	34210	7241	RB-9a	1.09	0.177	0.27	0.57	0.80	1.16	0.234
	34220	4021	RB-4	1.26	0.710	0.46	1.11	3.69	4.08	0.113
	44201	4021	RB-4	1.26	0.968	2.40	0.95	4.89	4.96	0.483
24 Basemat @ Wall Below RCCV	90140	7441	RB-9b	3.53	0.801	6.34	6.75	11.70	15.69	0.404
	90182	7441	RB-9b	3.51	0.801	5.22	5.88	11.63	14.88	0.351
	90111	7441	RB-9b	3.55	0.801	4.42	6.25	11.76	15.31	0.289
25 Slab EL4.65 m @ RCCV	93140	7441	RB-9b	0.80	0.500	0.29	0.17	1.65	1.55	0.188
	93182	7441	RB-9b	0.80	0.500	2.25	1.60	1.65	2.76	0.815
	93111	7441	RB-9b	0.80	0.500	1.86	1.45	1.65	2.63	0.707
26 Slab EL17.5 m @ RCCV	96144	7441	RB-9b	0.80	0.500	0.32	1.91	1.65	3.03	0.105
	96186	7441	RB-9b	0.80	0.500	1.03	2.13	1.65	3.21	0.319
	96113	7241	RB-9a	1.34	0.500	2.29	3.65	2.76	5.45	0.420
27 Slab EL27.0 m @ RCCV	98472	7441	RB-9b	1.21	0.968	2.03	3.30	4.73	6.83	0.297
	98514	7441	RB-9b	1.21	0.968	1.21	1.63	4.73	5.41	0.223
	98424	7441	RB-9b	1.95	0.968	8.30	4.91	7.62	10.65	0.779
28 Pool Girder @ Storage Pool	123054	4021	RB-4	1.25	0.484	0.71	3.00	2.50	4.68	0.151
	123154	7441	RB-9b	1.25	0.484	0.25	0.30	2.50	2.38	0.107
29 Pool Girder @ Cavity	123062	7241	RB-9a	1.24	0.242	0.41	2.60	1.25	3.27	0.127
	123162	7441	RB-9b	1.21	0.242	0.19	0.22	1.21	1.22	0.154
30 Pool Girder @ Fuel Pool	123067	7441	RB-9b	1.28	0.484	1.02	4.00	2.57	5.58	0.182
	123167	7441	RB-9b	1.28	0.484	0.72	1.05	2.56	3.07	0.234

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Table 3G.7-223 **Transverse Shear of RB for DCD Load Combinations** *(continued)*

Location	Element ID	Load ID	Load ID	d (m)	ρv (%)	Shear Force (MN/m)				Vu/φVn
						Vu	Vc	Vs	φVn	
31 MS Tunnel Wall and Slab	150122	7441	RB-9b	1.04	0.177	0.55	1.10	0.76	1.58	0.351
	96611	7241	RB-9a	1.34	0.500	0.50	1.66	2.76	3.75	0.134
	98614	7241	RB-9a	2.14	0.500	0.57	2.34	4.42	5.74	0.100
32 IC/PCCS Pool Wall in NS Dir.	125051	7741	RB-9a	0.79	0.250	0.06	0.07	0.81	0.75	0.075
	125151	7441	RB-9b	0.79	0.250	0.10	0.12	0.82	0.80	0.130
	125055	7741	RB-9a	0.80	0.250	0.08	0.09	0.83	0.78	0.100
	125155	7441	RB-9b	0.81	0.250	0.23	2.01	0.83	2.42	0.096

Table 3G.7-224 **Not Used**

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Table 3G.7-225 **Factors of Safety for RB/FB Foundation Stability**

(a) RB/FB Overturning Stability Evaluation

Subgrade Condition	**Partial Column Profiles**						**Full Column Profiles**					
	LB (Case 1)		**BE (Case 2)**		**UB (Case 3)**		**LB (Case 4)**		**BE (Case 5)**		**UB (Case 6)**	
Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
m_0gh (MN·m)	43,403	24,215	43,403	24,215	43,403	24,215	43,403	24,215	43,403	24,215	43,403	24,215
W_b (MN·m)	1,122	1,202	1,122	1,202	1,122	1,202	1,122	1,202	1,122	1,202	1,122	1,202
E_s (MN·m)	26.86	18.28	33.21	21.33	39.58	24.90	30.09	21.01	37.93	23.90	45.78	29.16
$FS=(m_0gh-W_b)/E_s$	1,574	1,259	1,273	1,079	1,068	**924**	1,405	1,095	1,115	963	**924**	789

Notes:

m_0 = total mass of structure and basemat
g = acceleration due to gravity
h = height of the center of structure mass at the overturning position

W_b = potential energy caused by the effect of buoyancy
E_s = maximum kinetic energy
FS = Factor of Safety

The effect of shear key is neglected conservatively.
The bold red number is the minimum Factor of Safety against overturning.

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Table 3G.7-225 **Factors of Safety for RB/FB Foundation Stability** *(continued)*

(b) Evaluation of RB/FB Stability for Sliding at Bottom of Basemat (El. 224.4 ft NAVD88)

Basemat width in NS Dir.	70.0	m
Basemat width in EW Dir.	49.0	m
Depth of Zone III rock embedment	14.81	m
Total Weight	2360	MN
Buoyancy	597	MN

Subgrade Condition	Partial Column Profiles						Full Column Profiles					
	LB (Case 1)		**BE (Case 2)**		**UB (Case 3)**		**LB (Case 4)**		**BE (Case 5)**		**UB (Case 6)**	
Sliding Direction	NS	EW	NS	EW	NS	EW	NS	EW	NS	EW	NS	EW
Time (sec)	6.330	3.695	4.410	3.200	4.410	3.195	3.150	3.695	1.820	3.200	3.320	3.195
Vertical Seismic Load (MN)	738	489	841	609	977	648	888	604	1125	830	371	861
Minimum Vertical Load (MN)	1025	1274	922	1154	786	1115	875	1159	638	933	1392	902
F_v: Horizontal Seismic Force (MN)	477	651	535	687	443	773	494	631	443	634	1009	682
F_o: Soil Force due to Turbine Building (MN)	127	0	127	0	127	0	127	0	127	0	127	0
F_{ub}: Bottom Friction Force (MN)	615	765	553	693	472	669	525	695	383	560	835	541
F_r: Lateral Resistance Force (MN)	50	0	176	64	156	181	159	0	244	137	415	209
FS $(=(F_{ub}+F_r)/(F_v+F_o))$	1.10	1.17	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{max}: Maximum Stress (MPa) Associated with Lateral Resistance F_r	0.14	0.00	0.48	0.12	0.43	0.35	0.44	0.00	0.67	0.26	**1.14**	0.40

Note:
The bold red number (1.14) is the maximum lateral pressure demand on the Zone III rock.

Table 3G.7-226 **Not Used**

Table 3G.7-227 **Not Used**

Table 3G.7-228 **Not Used**

Table 3G.7-229 **Not Used**

Table 3G.7-230 **Not Used**

Table 3G.7-231 **Maximum Soil Dynamic Bearing Pressure Demand for RB/FB**

Basemat width in NS (X) Dir.	70.0	m
Basemat width in EW (Y) Dir.	49.0	m
Gravity Load (D)	2360	MN
Buoyancy (B)	597	MN

(Buoyancy is considered only in combination with upward vertical seismic load (V_z))

		Subgrade Condition	Partial Column Analyses						Full Column Analyses					
			LB (Case 1)		BE (Case 2)		UB (Case 3)		LB (Case 4)		BE (Case 5)		UB (Case 6)	
Direction Vertical Seismic Load			**downward**		**downward**		**downward**		**downward**		**downward**		**downward**	
SASSI	Time	(sec)	3.905		7.080		7.075		3.565		3.640		3.625	
	Vertical seismic load (V_z)	(MN)	244.3		510.0		611.7		440.7		447.5		414.7	
	Total vertical load	(MN)	2,604		2,870		2,972		2,801		2,808		2,775	
	Moment in NS-dir (Mx)	(MN-m)	10,855		8,433		9,948		10,422		9,381		8,299	
	Moment in EW-dir (My)	(MN-m)	4,046		7,704		7,178		4,574		7,618		8,058	
Simplified Method**			**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**
NS dir. ↓ EW dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.015	-0.015	-0.001	-0.001	-0.001	-0.001	0.004	0.004	0.010	0.010	0.002	0.002
	Max. basemat moment (Mx)	(MN-m)	10,855	10,855	8,433	8,433	9,948	9,948	10,422	10,422	9,381	9,381	8,299	8,299
	Max. bearing pressure 1 (Px)	(MPa)	1.03	1.03	1.05	1.05	1.12	1.12	1.08	1.08	1.05	1.05	1.02	1.02
	Max. bearing pressure 2 (Py)	(MPa)	---	0.14	---	0.28	---	0.26	---	0.16	---	0.27	---	0.29
	Max. Bearing pressure (Pxy=Px+Py)	(MPa)	---	1.18	---	1.32	---	1.37	---	1.24	---	1.32	---	1.30
EW dir. ↓ NS dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.020	-0.020	-0.002	-0.002	-0.002	-0.002	0.006	0.006	0.014	0.014	0.003	0.003
	Max. basemat moment (My)	(MN-m)	4,046	4,046	7,704	7,704	7,178	7,178	4,574	4,574	7,618	7,618	8,058	8,058
	Max. bearing pressure 1(Py)	(MPa)	0.90	0.90	1.11	1.11	1.12	1.12	0.98	0.98	1.09	1.09	1.10	1.10
	Max. bearing pressure 2 (Px)	(MPa)	---	0.27	---	0.21	---	0.25	---	0.26	---	0.23	---	0.21
	Max. Bearing Pressure (Pyx=Py+Px)	(MPa)	---	1.18	---	1.32	---	1.37	---	1.24	---	1.32	---	1.30
	Envelope of Pxy and Pyx	(MPa)	---	1.18	---	1.32	---	**1.37**	---	1.24	---	1.32	---	1.30

Notes: * SASSI2010 analysis is a linear time history analysis with the 3D excitation.

** EB and MEB stand for energy balance (EB) and modified energy balance (MEB) methods.

The bold red number (1.37) is the maximum dynamic bearing pressure demand on the Zone III-IV rock.

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Table 3G.7-232 **Dynamic Lateral Pressure Loads on RB/FB Below-Grade Walls**

Elevation (m)	Soil Pressure (MPa) R1 and F3 Wall	Soil Pressure (MPa) RA and RG Wall	Note
4.65			Grade
	0.56	0.45	
-1.00			
	0.28	0.29	
-6.40			
	0.24	0.22	
-11.50			
	0.94	0.76	
-15.50			

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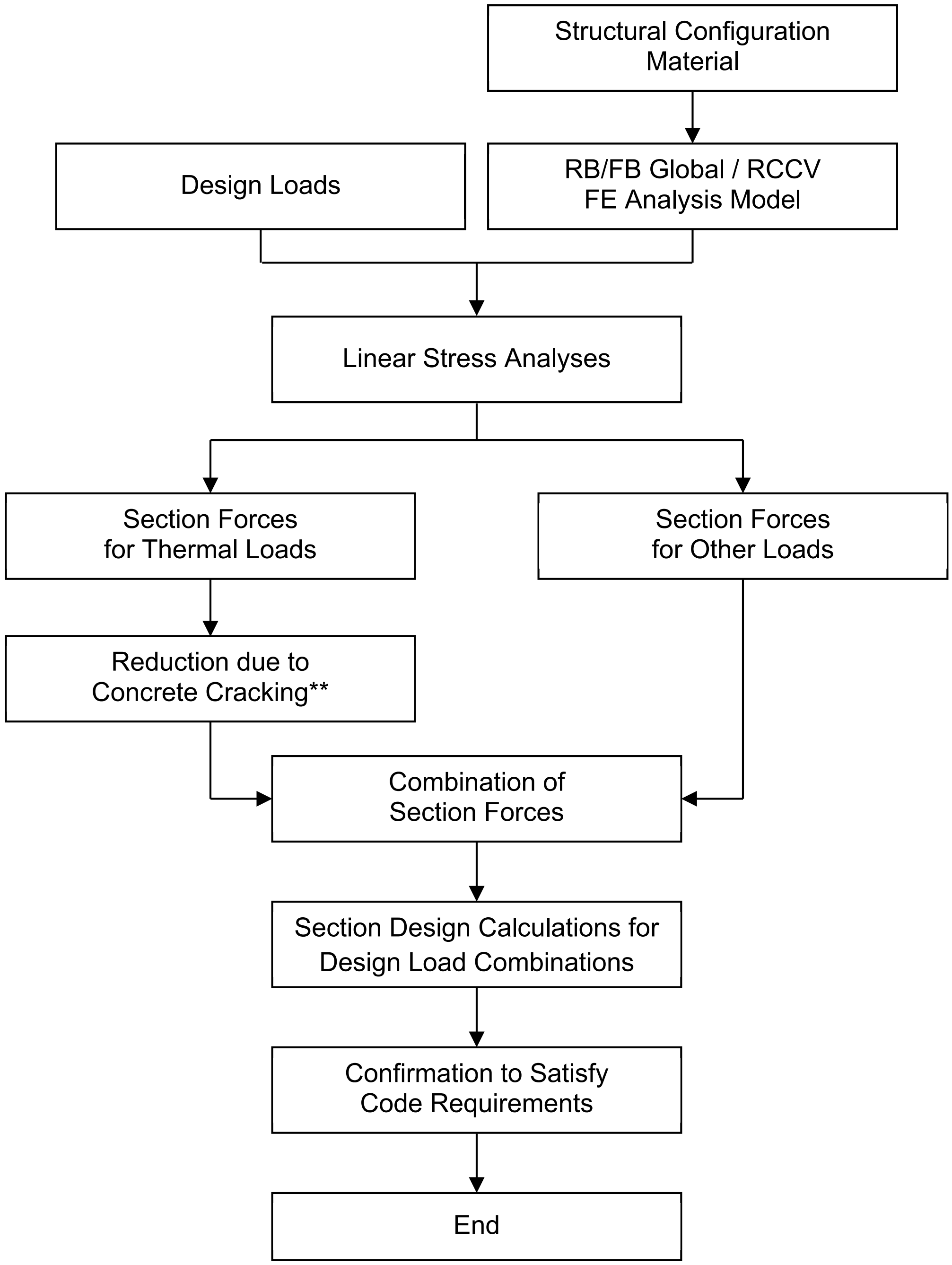
Figure 3G.7-201 **Flowchart for Unit 3 Structural Analysis and Design Process***



***See DCD Figure 3G.1-39 for comparable figure.**

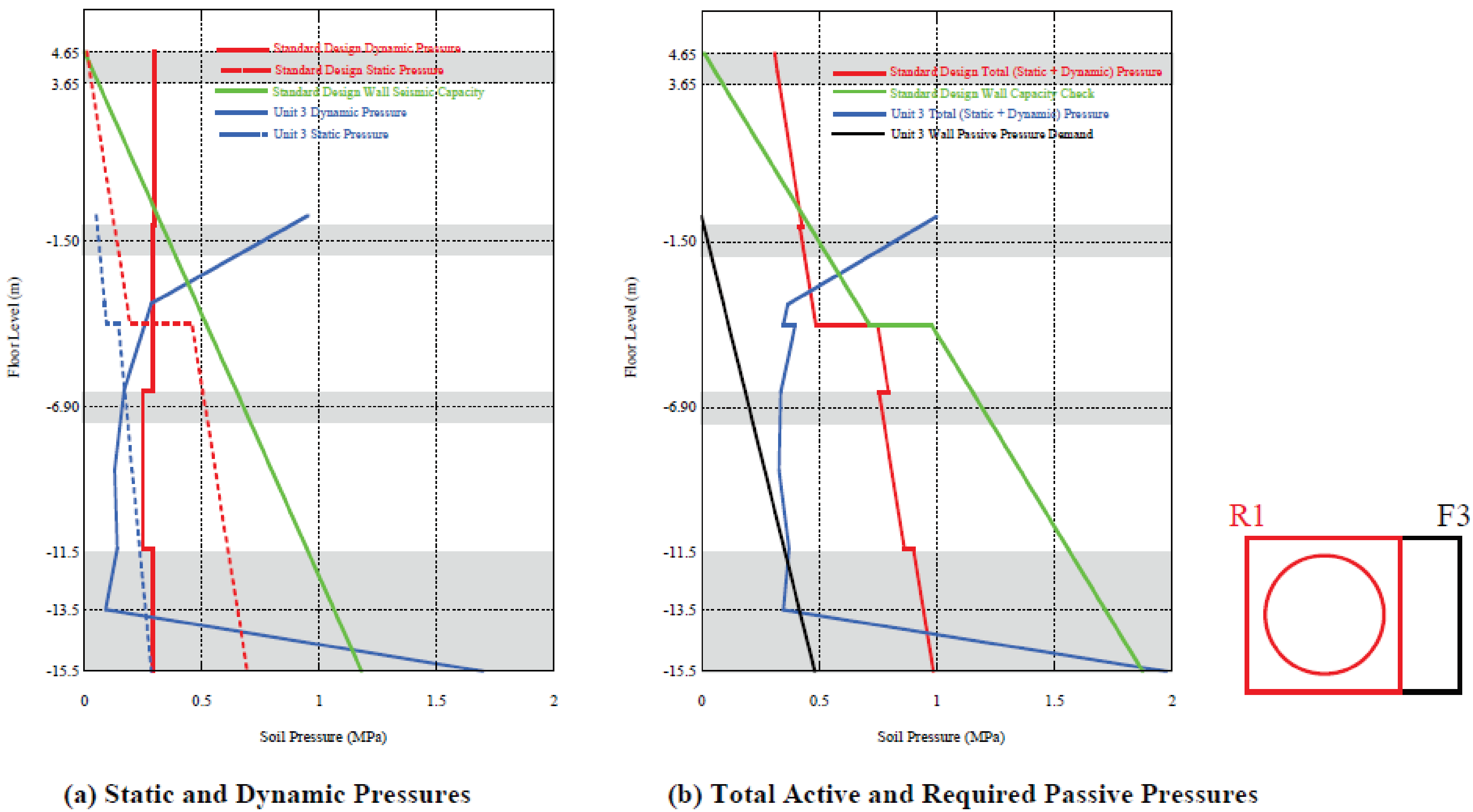
****Thermal section forces are reduced using the section design calculation program, SSDP-2D, with the thermal cracking operation selected.**

Figure 3G.7-202 **Not Used**

Figure 3G.7-203 **Not Used**

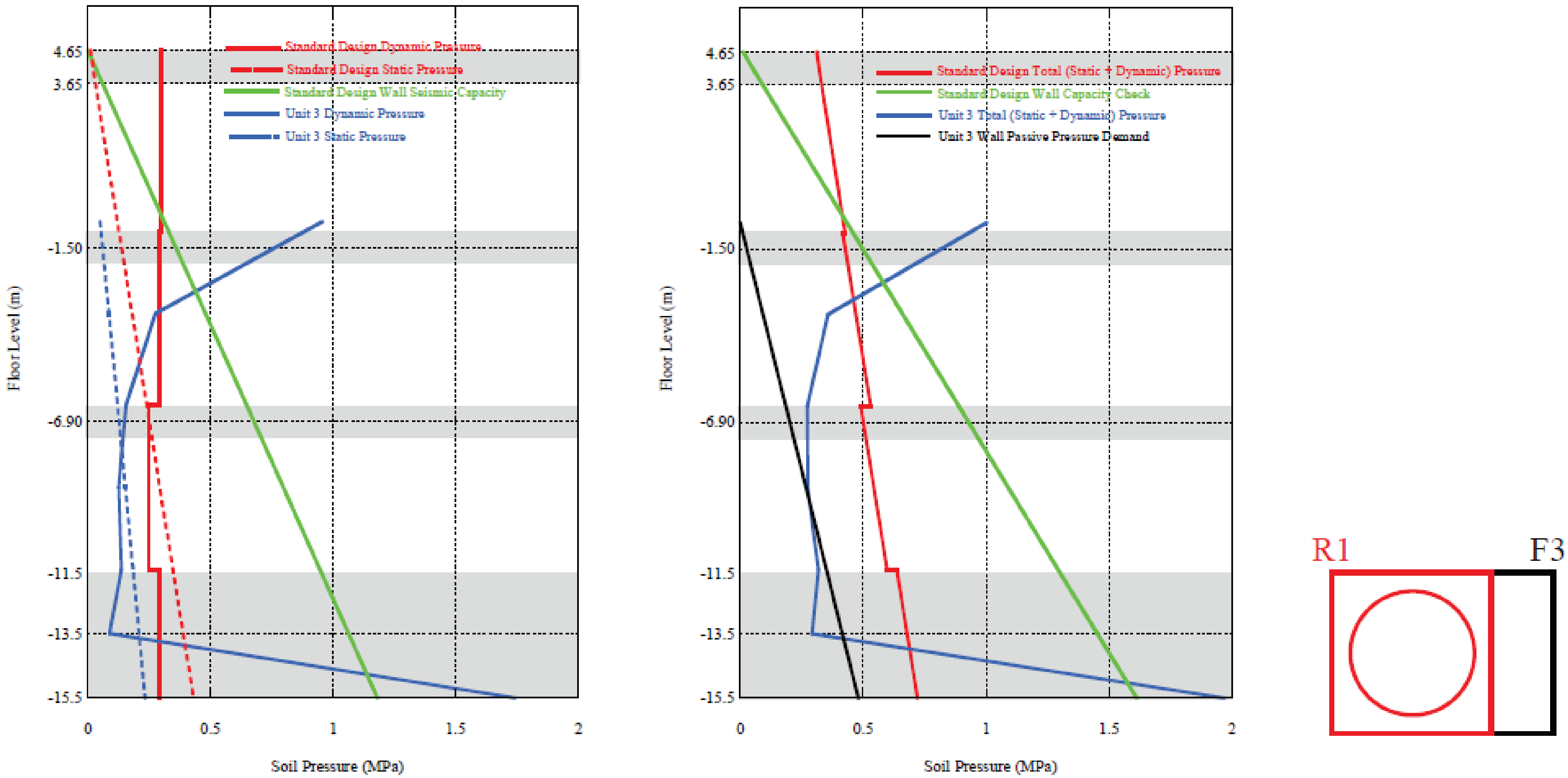
Figure 3G.7-204 **Not Used**

Figure 3G.7-205 **Lateral Pressures on R1 Wall – Envelope of LB, BE and UB Partial Column Profiles Analyses**



Note: The shaded area shows thickness of the floor slabs and basemat.

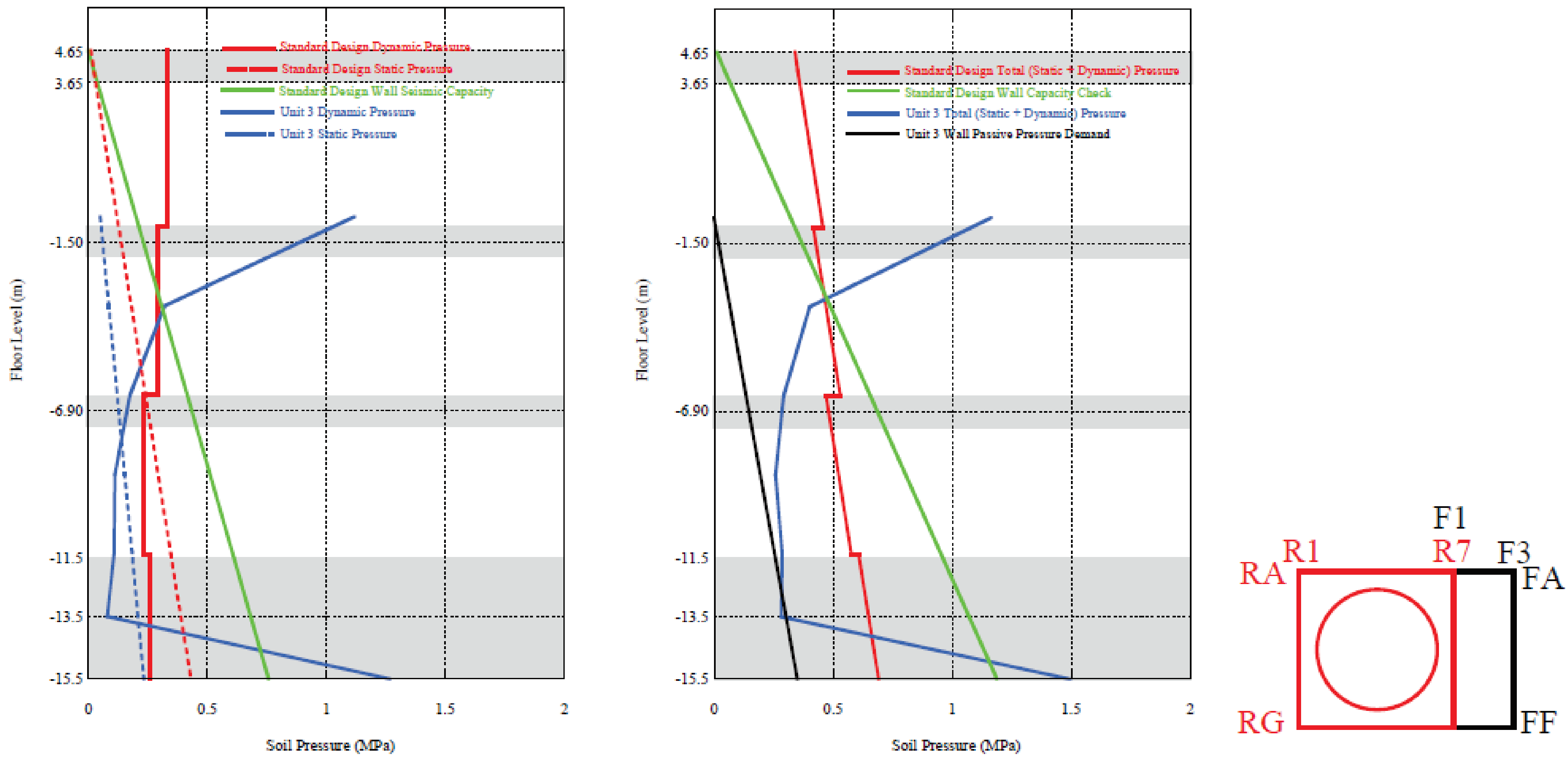
Figure 3G.7-206 **Lateral Pressures on F3 Wall – Envelope of LB, BE and UB Partial Column Profiles Analyses**



(a) Static and Dynamic Pressures **(b) Total Active and Required Passive Pressures**

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-207 **Lateral Pressures on RA, RG and FF Walls – Envelope of LB, BE and UB Partial Column Profiles Analyses**

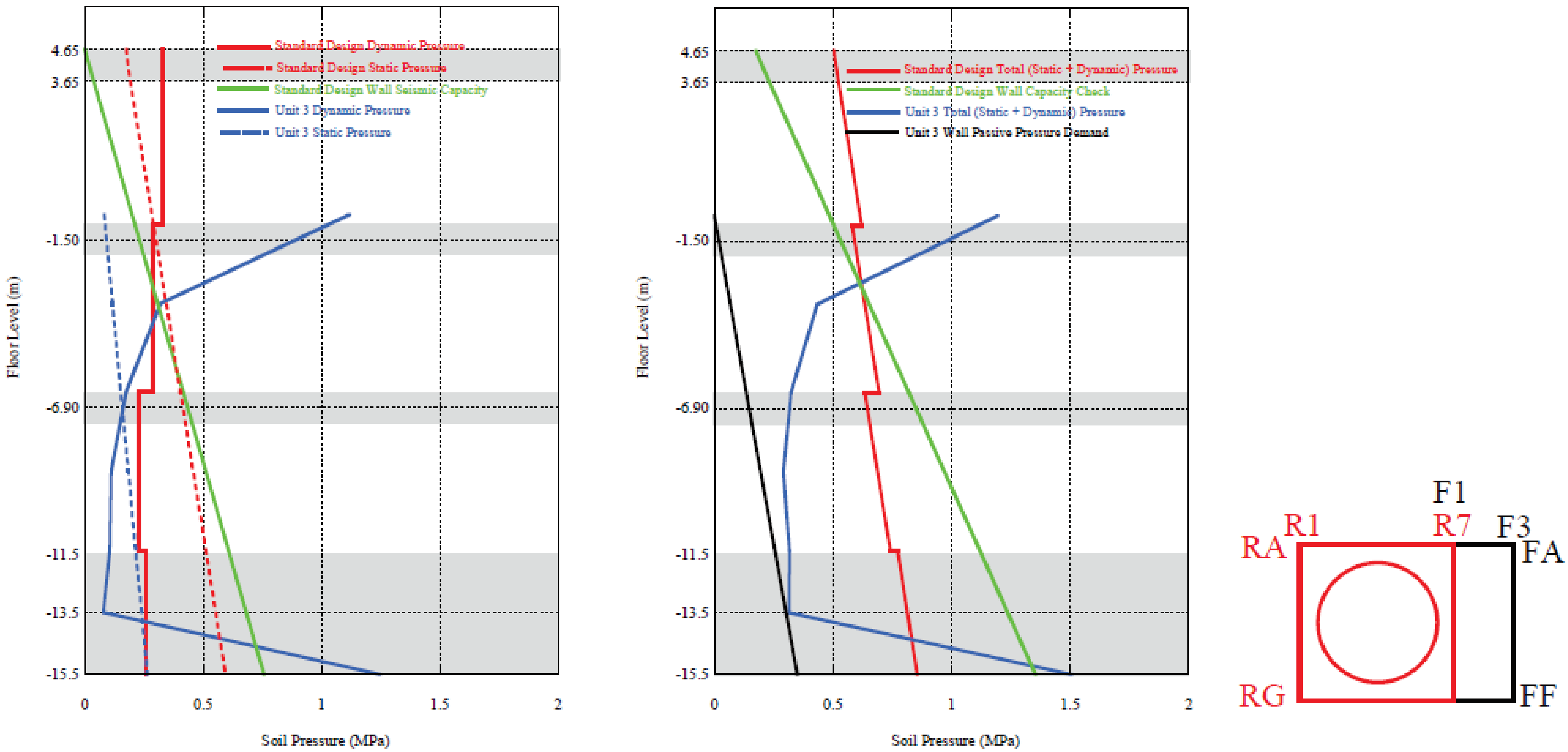


(a) Static and Dynamic Pressures

(b) Total Active and Required Passive Pressures

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-208 **Lateral Pressures on FA Wall – Envelope of LB, BE and UB Partial Column Profiles Analyses**

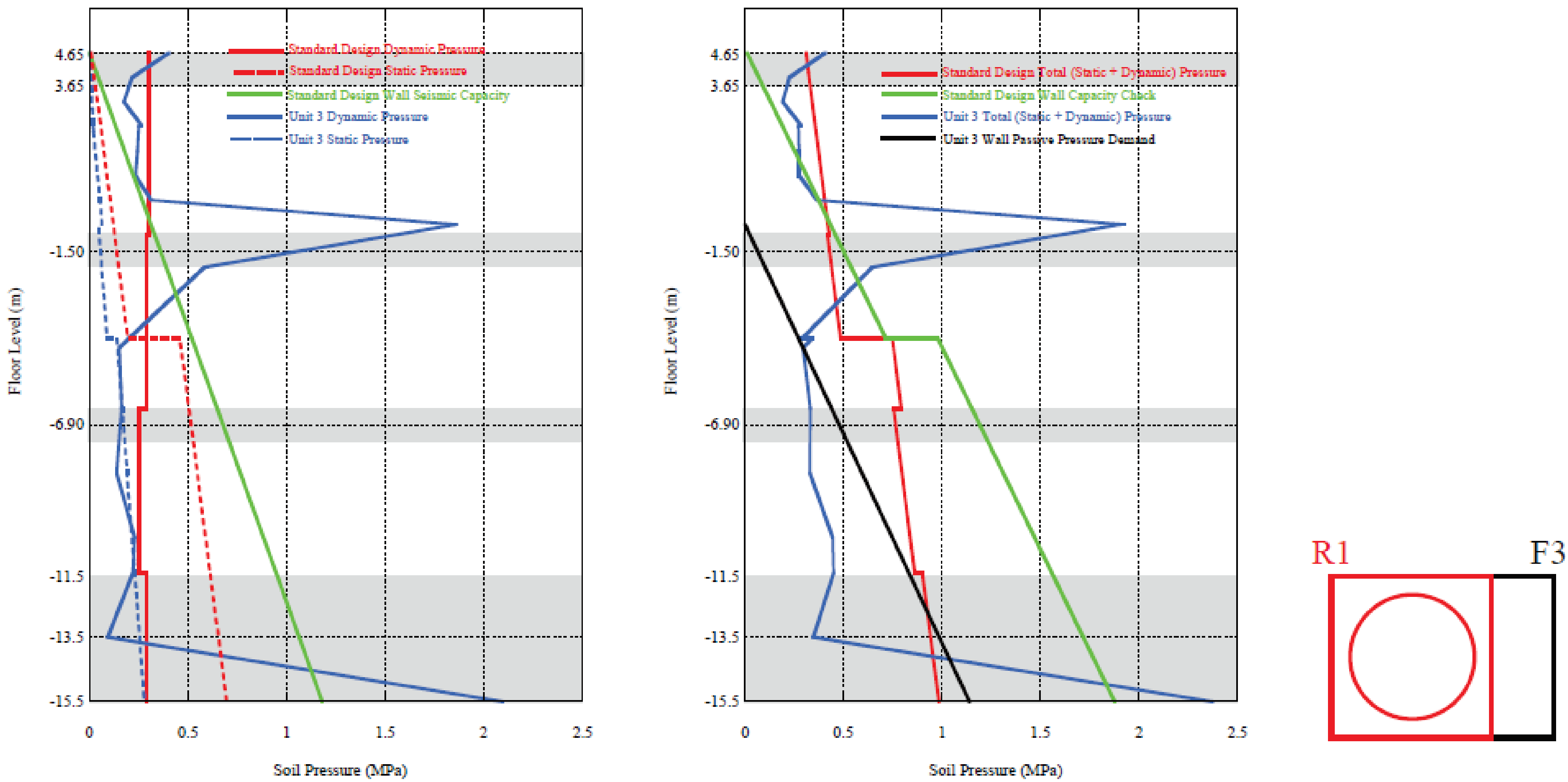


(a) Static and Dynamic Pressures

(b) Total Active and Required Passive Pressures

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-209 **Lateral Pressures on R1 Wall – Envelope of LB, BE and UB Full Column Profiles Analyses**

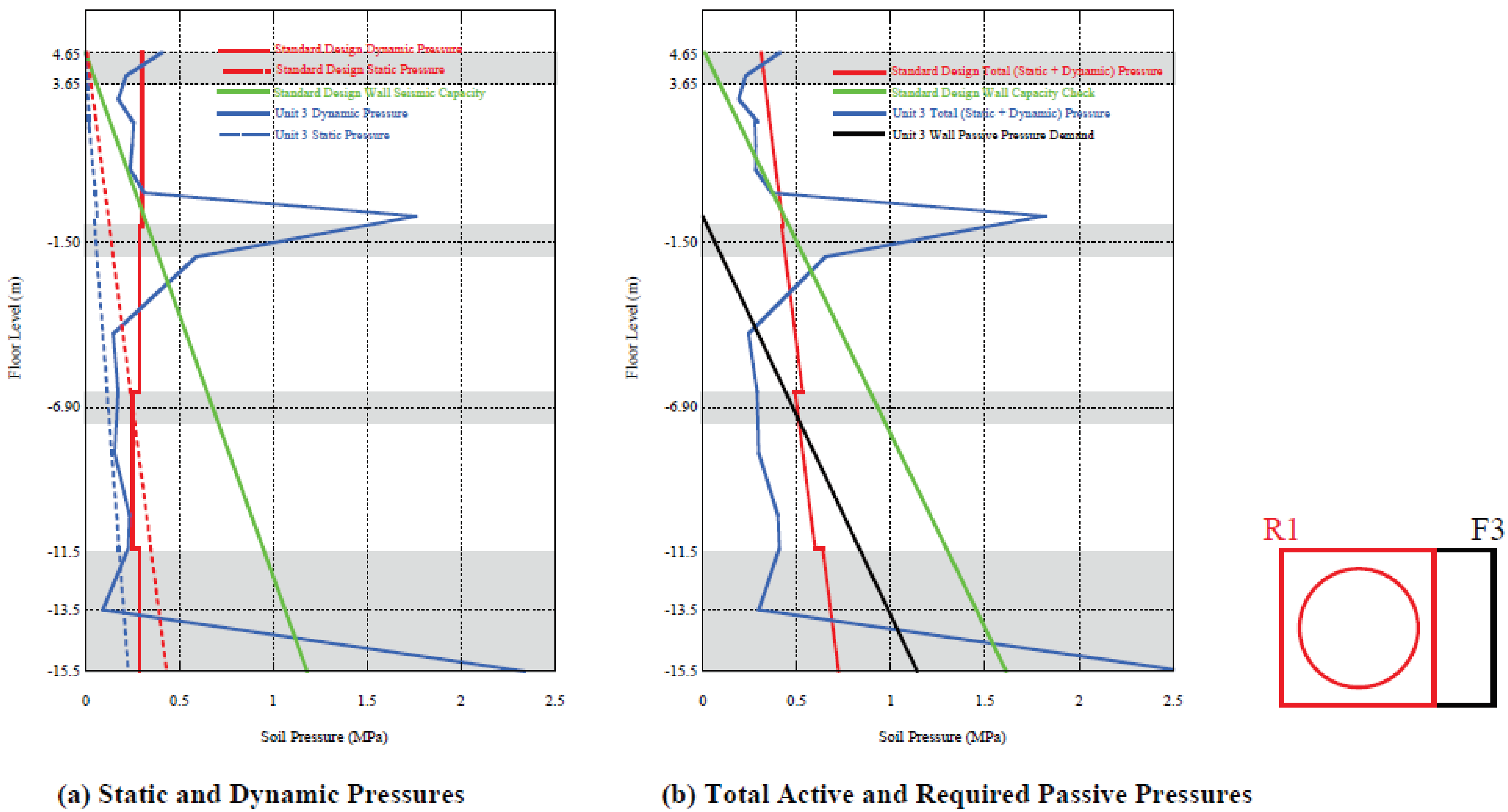


(a) Static and Dynamic Pressures

(b) Total Active and Required Passive Pressures

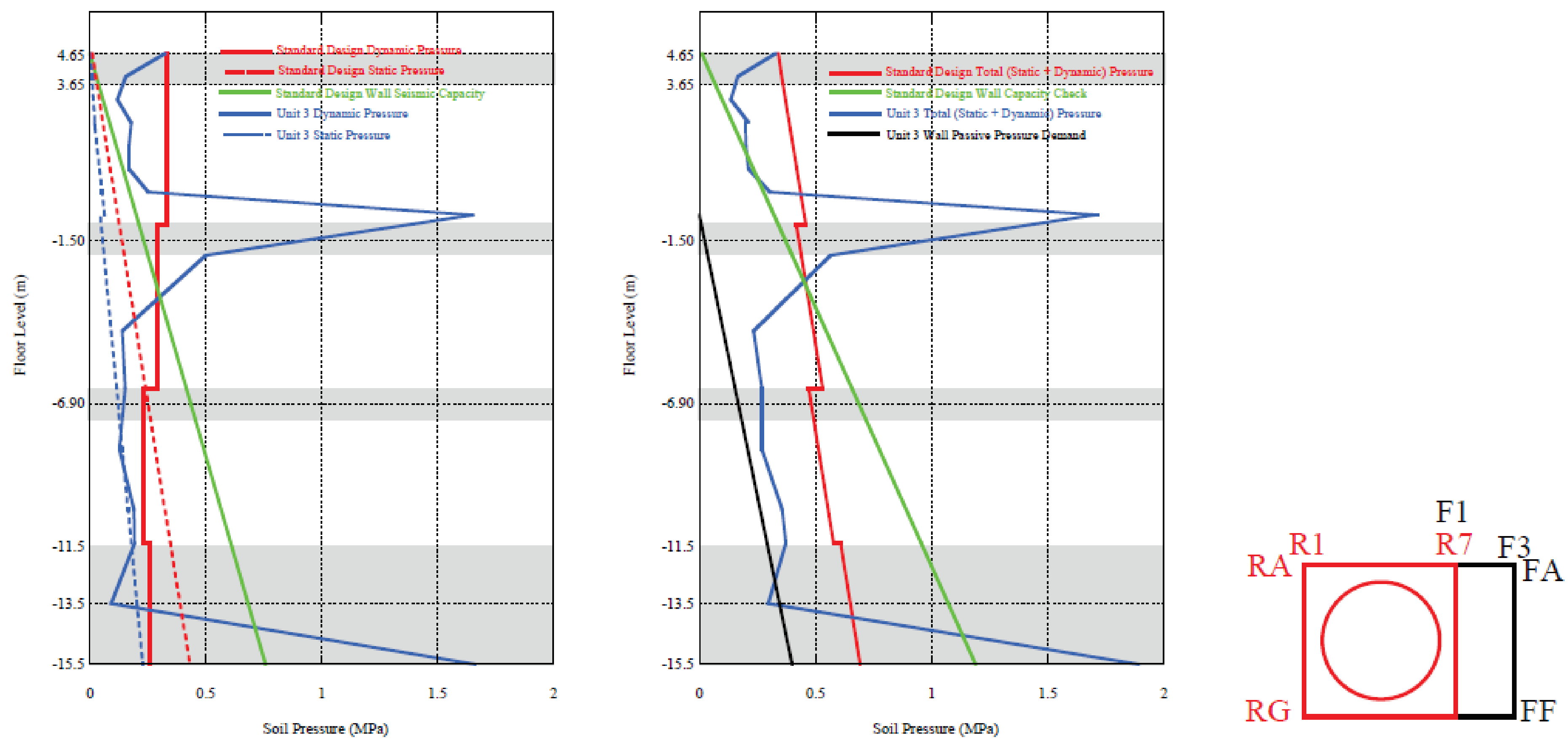
Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-210 **Lateral Pressures on F3 Wall - Envelope of LB, BE and UB Full Column Profiles Analyses**



Note: The shaded area shows thickness of the floor slabs and basemat.

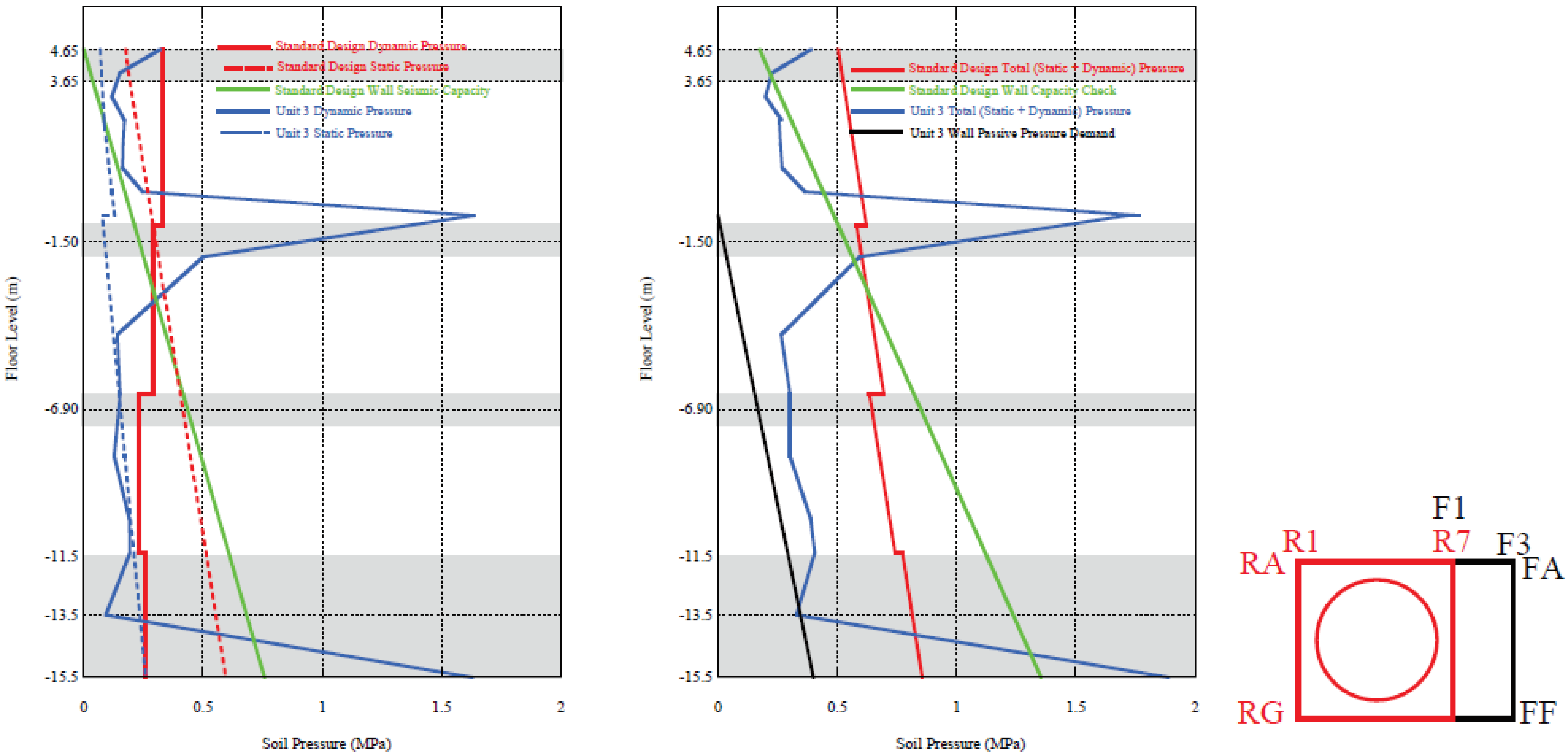
Figure 3G.7-211 **Lateral Pressures on RA, RG and FF Walls - Envelope of LB, BE and UB Full Column Profiles Analyses**



(a) Static and Dynamic Pressures **(b) Total Active and Required Passive Pressures**

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-212 **Lateral Pressures on FA Wall - Envelope of LB, BE and UB Full Column Profiles Analyses**

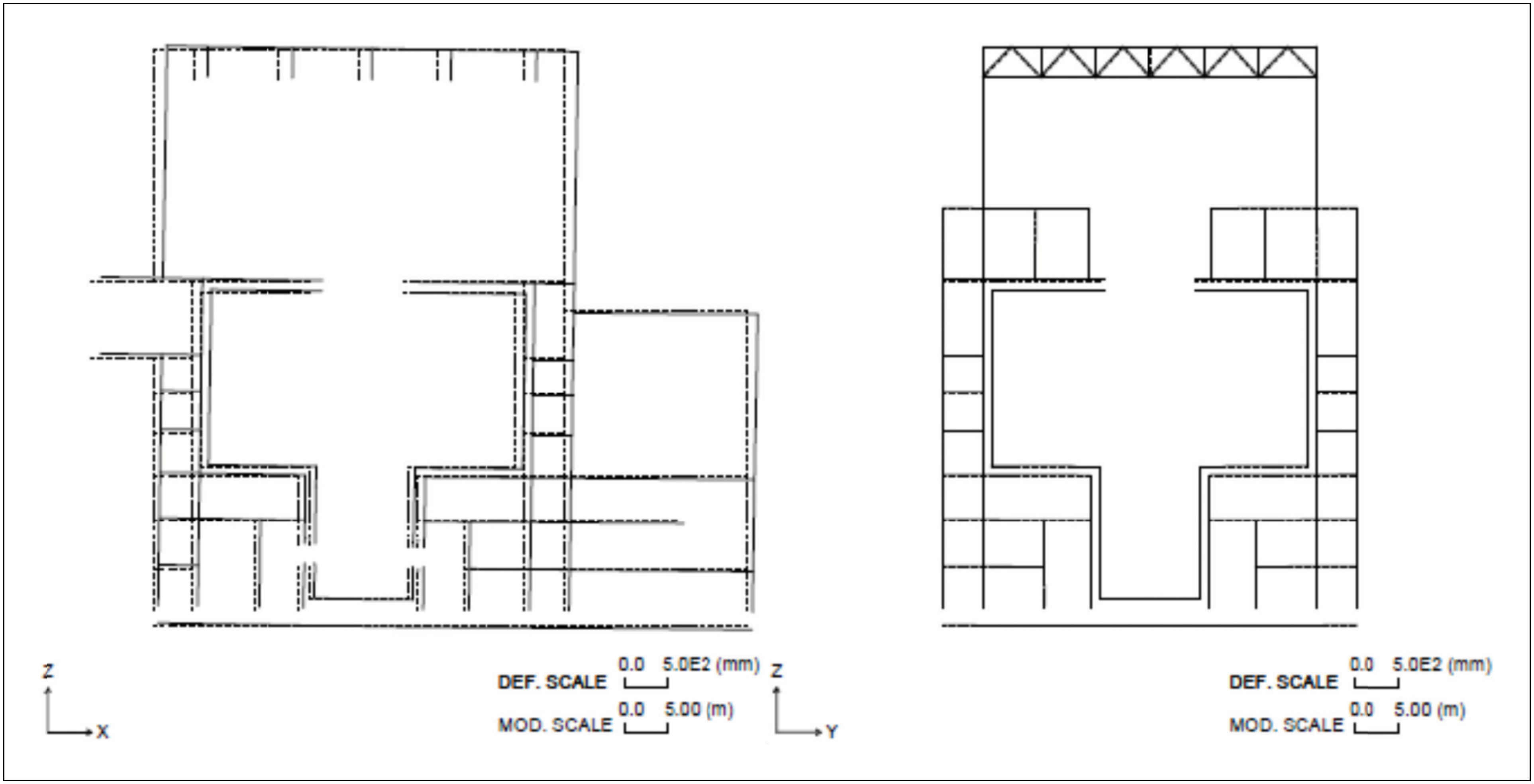


(a) Static and Dynamic Pressures

(b) Total Active and Required Passive Pressures

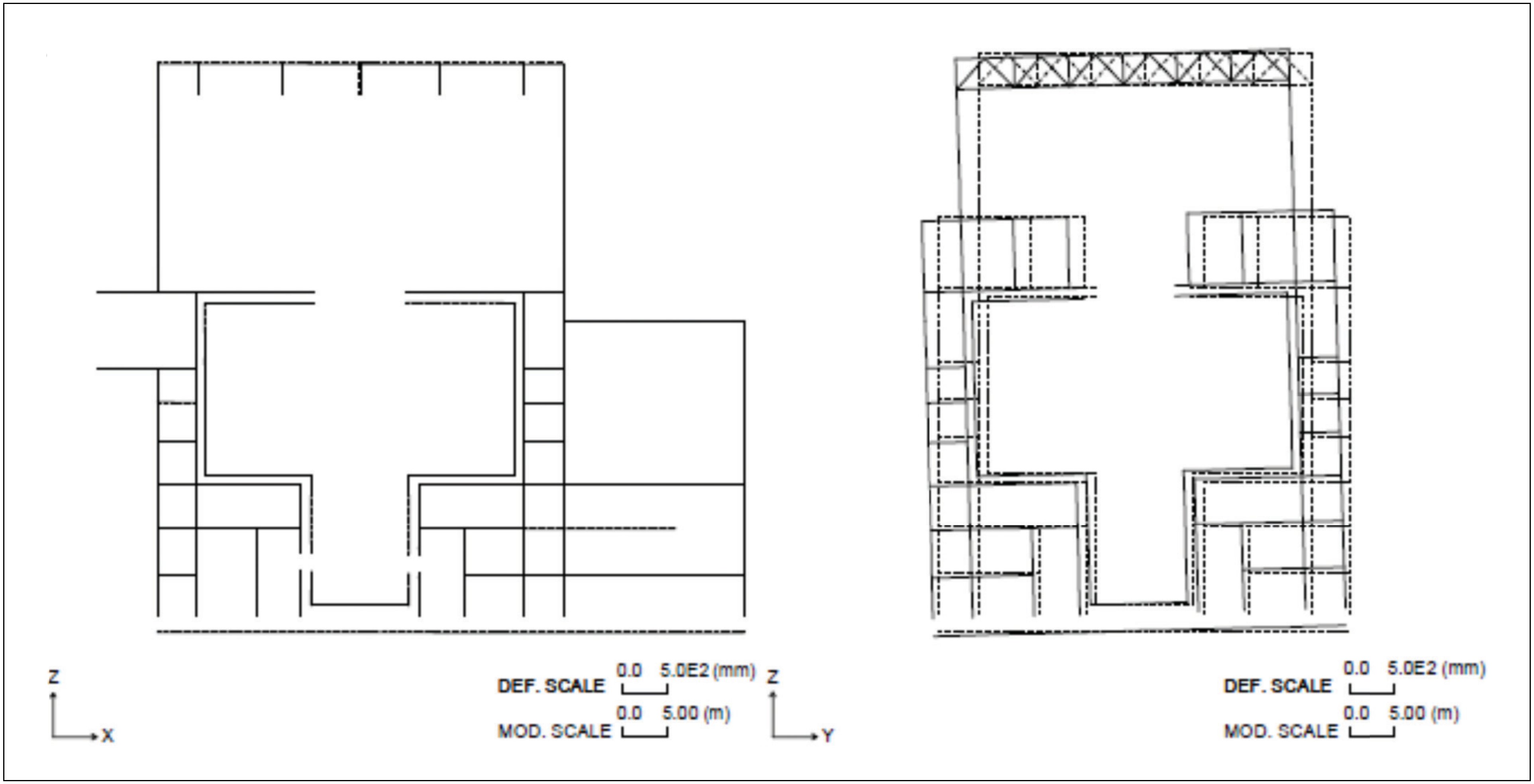
Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.7-213 **RB/FB Section Deformation for Seismic Load (Horizontal: North to South)**



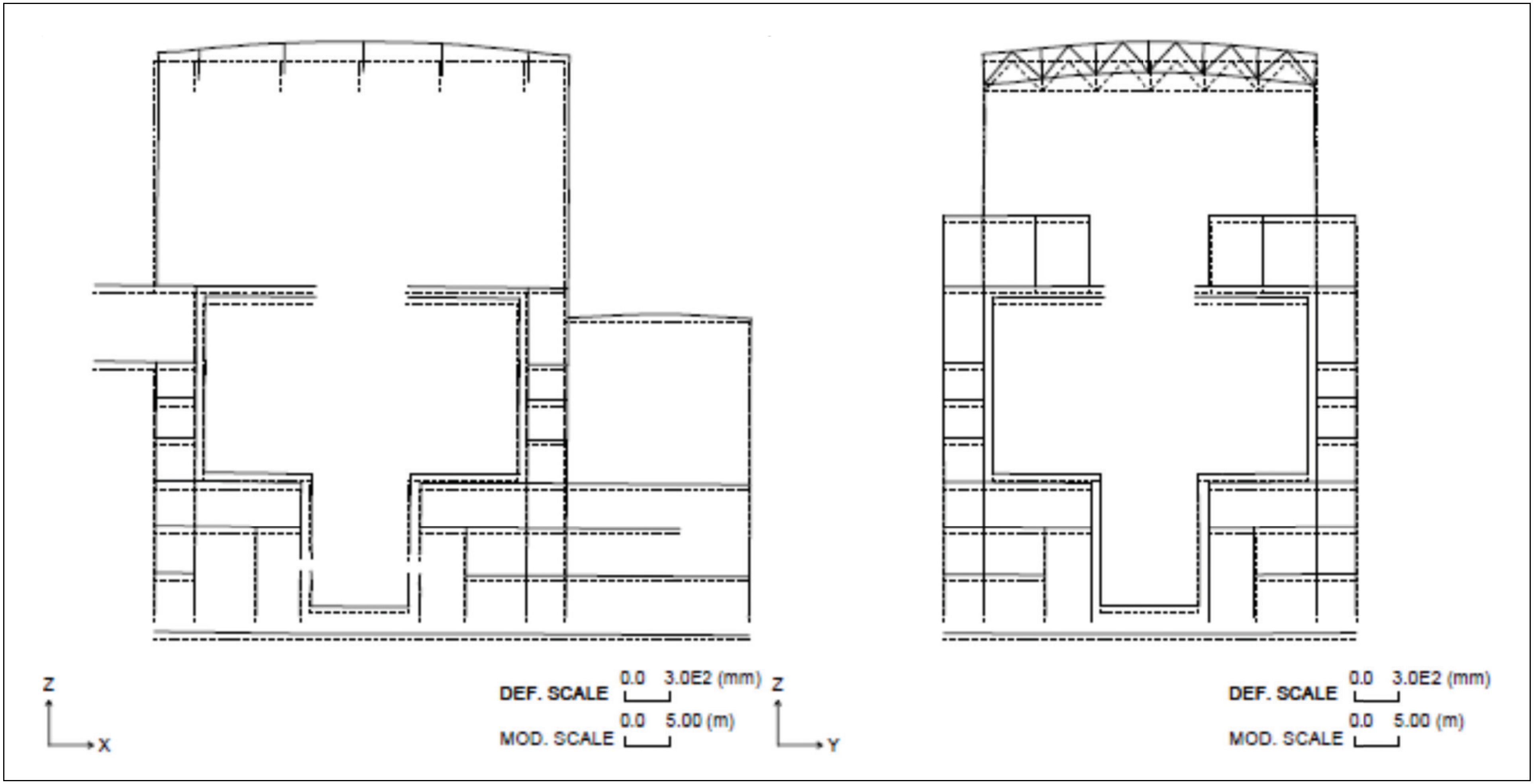
Legend: DEF. = Deformation
MOD. = Model

Figure 3G.7-214 **RB/FB Section Deformation for Seismic Load (Horizontal: East to West)**



Legend: DEF. = Deformation
MOD. = Model

Figure 3G.7-215 **RB/FB Section Deformation for Seismic Load (Vertical: Upward)**



Legend: DEF. = Deformation
MOD. = Model

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3G.8 Site-Specific Structural Evaluation of Control Building

The site-specific structural evaluations of the CB are described in this section.

3G.8.1 Objective and Scope

The objective of this section is to document the CB site-specific structural evaluations based on the analyses performed to address exceedances of the CSDRS. DCD Section 3G.2 remains applicable for the design and analysis of the CB with the seismic loads based on the CSDRS. Results of site-specific SSI analyses indicate that seismic load demands, in some cases, exceed the seismic load demands used in the standard design of the CB structure. [The site-specific evaluations of the CB structure use input seismic loads that are based on the site-specific seismic loads presented in Section 3A.18.1.2.

3G.8.2 Conclusions

The site-specific structural evaluation of the CB demonstrates that, with a steel girder (SG23) revised from the standard design, as described in Section 3G.8.5.4, the CB structure is adequate to resist the site-specific seismic loads presented in Section 3A.18.1.2 in combination with non-seismic standard plant loads. The site-specific CB sliding stability for site-specific loads is maintained and the embedded exterior walls are capable of resisting the required passive pressure, as described in Sections 3G.8.5.5 and 3G.8.5.6, respectively.

3G.8.3 Structural Description

The CB structure is described in DCD Section 3G.2.3.

3G.8.4 Analytical Models

3G.8.4.1 Structural Models

Site-Specific structural models are based on the standard design structural models described in DCD Section 3G.2.4.1. The CB is analyzed using the finite element computer program NASTRAN, which is described in DCD Section 3C.2.

3G.8.4.2 Foundation Models

Site-Specific foundation models are based on the standard design foundation models described in DCD Section 3G.2.4.2.

3G.8.5 Structural Analysis and Design

3G.8.5.1 Site Design Parameters

Key site design parameters used in the structural evaluation are those identified in DCD Section 3G.2.5.1, based on soft site subgrade stiffness conditions, which are conservative for a hard rock site.

Key site-specific parameters used as inputs for the site-specific stability and bearing pressure calculations are identified in Table 3G.8-201.

3G.8.5.2 Site Design Loads, Load Combinations, and Material Properties

Except as noted otherwise, the site-specific structural evaluation uses the loads (except seismic loads), load combinations, and acceptance criteria that are used to perform the standard design structural evaluation and which are described in DCD Section 3G.2.5.2. The site-specific evaluations of the CB structure use input seismic loads that are based on the site-specific seismic loads presented in Section 3A.18.1.2.

The following loads are the same as the standard design:

- Dead Load and Live Load — DCD Section 3G.2.5.2.1.1
- Snow and Rain Load — DCD Section 3G.2.5.2.1.2
- Lateral Soil Pressure at Rest — DCD Section 3G.2.5.2.1.3
- Wind Load — DCD Section 3G.2.5.2.1.4
- Tornado Load — DCD Section 3G.2.5.2.1.5
- Thermal Load — DCD Section 3G.2.5.2.1.6

The site-specific seismic loads are substituting the seismic loads used in the standard design. Four components (two horizontal, one vertical, and one torsional) of the seismic loads are considered. Overturning moment loads applied at each floor elevation are also considered to account for the effects of floor rocking on the wall axial forces. The site-specific evaluations of the CB structure consider the same at-rest static soil pressure loads as the ones used for the standard design that are shown in DCD Figure 3G.2-12. These standard design static soil pressure loads envelope the corresponding site-specific static soil pressures as shown in Figures 3G.8-203 through 3G.8-210. The site-specific evaluations consider the lateral dynamic pressure loads obtained from the site-specific SSI analyses described in Section 3A.17.13.4 and the

passive resistance pressures obtained from sliding stability calculations in Section 3G.8.5.6.

The load combinations and acceptance criteria are the same as the standard design, as described in DCD Section 3G.2.5.2.2.

The material properties used in the site-specific analyses for concrete, reinforcing steel, and structural steel are the same as those used in the standard design, as described in DCD Section 3G.2.5.2.3.

3G.8.5.3 Stability Requirements

The stability requirements for the CB are given in DCD Section 3G.2.5.3.

A factor of safety of 1.1 is required for both overturning and sliding. Analyses demonstrate that the CB meets the required factors of safety for overturning stability and for stability against sliding as described in Section 3G.8.5.5.

3G.8.5.4 Structural Design Evaluation

This section provides a description of the structural design evaluations of the CB, considering site-specific seismic load demands. The site-specific evaluation uses the standard design models, analysis methods, loads (other than seismic), load combinations, and acceptance criteria, but the standard design seismic loads are replaced with the site-specific seismic loads.

The site-specific CB structural evaluation is performed using the methodology used for the DCD structural evaluation, as described in DCD Section 3G.2.5. The site-specific evaluation uses the seismic design loads described in Section 3G.8.5.2, which, in some instances, exceed the seismic design loads of the standard design as shown in Section 3A.18.1.2. These loads are included in the structural evaluation to demonstrate the adequacy of the standard design to withstand these exceedances.

Site-specific stress check calculations indicate that the standard design CB is adequate to withstand the additional seismic load demands with the exception of a change for the steel girder (SG23) CBAR ID 21016 (Elevation 4.65 m on Column-Row CB, which is shown on DCD Figure 3G.2-2). This section summarizes the results of the analyses of

the CB with the change in the steel girder. With this change, the conclusions are as follows.

- Reinforced concrete structures
  - The stresses of the concrete and rebar are less than the allowable stresses specified in the code.
  - The areas of the primary and shear reinforcement satisfy the required values.
- Steel structures
  - The stresses of steel members are less than the allowable stresses specified in the code, with the change in SG23 CBAR ID 21016, as described below.

The standard design CB structure, with the change in SG23, is adequate to resist the site-specific seismic load demands in combination with the non-seismic standard plant loads.

Tables 3G.8-202 through 3G.8-204 show the forces and moments at the selected sections from the NASTRAN analyses for seismic loads. Table 3G.8-205 shows the combined forces and moments for the selected load combination CB-9 (see DCD Table 3G.2-6 for the load combinations). Tables 3G.8-206a and 3G.8-206b compare the rebar and concrete stresses for the selected load combination CB-9 at the basemat and slabs and at the walls.

Table 3G.8-207 summarizes evaluation results for transverse shear by selected load combinations. The transverse shear strength is calculated and compared with the shear forces generated by the design loads. All selected elements are examined, and it is confirmed that the section forces are less than the shear strength of the sections. The stresses of the steel members are combined and a change in a single steel girder was determined to be necessary. Specifically, it was identified that a single steel girder, SG23 CBAR ID 21016, could be overstressed and, therefore, the standard design is modified. With the changes in SG23, the stresses of the steel members are less than the code allowable stresses.

3G.8.5.4.1 Shear Walls

The maximum rebar stress in shear walls is 254.8 MPa (36.96 ksi) in the vertical rebar in the wall at Elevation 9.06 m due to the load combination CB-9, as shown in Table 3G.8-206b. The maximum horizontal rebar stress in shear walls is 239.0 MPa (34.66 ksi) in the horizontal rebar in

the wall at Elevation 9.06 m due to the load combination CB-9 as shown in Table 3G.8-206b. The maximum transverse shear force in the shear walls is 1.481 MN/m (8.46 kips/in) against the shear strength of 1.881 MN/m (10.74 kips/in) in the wall at Elevation -7.4 m, as shown in Table 3G.8-207.

3G.8.5.4.2 Floor Slabs

The maximum rebar stress in floor slabs is 198.3 MPa (28.76 ksi) in the roof slab at the Elevation 13.8 m slab due to the load combination CB-9, as shown in Table 3G.8-206a. The maximum transverse shear force in the floor slabs is 0.340 MN/m (1.94 kips/in) against the shear strength of 0.353 MN/m (2.02 kips/in) at the Elevation 4.65 m slab, as shown in Table 3G.8-207.

3G.8.5.4.3 Foundation Mat

The maximum rebar stress of 159.9 MPa (23.19 ksi) in the foundation mat is also due to the load combination CB-9, as shown on Table 3G.8-206a. The maximum transverse shear force in the foundation mat is 1.974 MN/m (11.27 kips/in) against the shear strength of 4.682 MN/m (26.73 kips/in), as shown in Table 3G.8-207.

3G.8.5.5 Foundation Stability

The methodology used for the site-specific evaluations of overturning and sliding seismic stability of the CB is consistent with the methodology used for the standard design stability evaluations presented in DCD Sections 3.7.2.14 and 3.8.5.5.

Site-specific evaluations of the foundation seismic stability, dynamic bearing pressures, and passive resistance pressures on the embedded exterior walls are performed using the results obtained from the site-specific SSI analyses of the CB stand-alone model with full (uncracked concrete) stiffness properties and SSE damping values for BE, LB, and UB partial column and full column subgrade profiles (analysis Cases 7 through 12 in Table 3A.15-202). The use of seismic responses obtained from the model with SSE damping values for the stability evaluations is adequate because these analyses consider the limiting conditions that are associated with a high dissipation of energy in the SSI dynamic system. The seismic response analyses of the models representing full (uncracked concrete) stiffness properties of the CB reinforced concrete structure provide conservative seismic load demands

for the rock site with high frequency design motion that bounds the effects of concrete cracking on the site-specific seismic load demands on the CB foundation and below grade exterior walls. SSI analyses of the CB stand-alone model with full stiffness and SSE damping properties (analysis Cases 7 through 12 in Table 3A.15-202) also provide seismic demands that bound the SSSI effects of the RB/FB and the FWSC on the CB foundation stability, foundation dynamic bearing pressures, and below-grade exterior walls lateral pressure demands.

Table 3G.8-208 presents overturning stability calculations of the CB at the site based on the results of the SSI analyses of the CB stand-alone model with full stiffness and SSE damping (Cases 7 through 12 in Table 3A.15-202). The table shows that the calculated overturning stability factor of safety is greater than the required value of 1.1.

The CB sliding evaluation is performed for two orthogonal horizontal directions separately, using a linear time history analysis approach. In each direction, the phasing between the horizontal shear and vertical seismic forces is considered at each time step to compute sliding factors of safety for different instances of time as the ratio between the base friction resistance and the horizontal driving force. The minimum value obtained during the duration of the site-specific ground motion is adopted as the factor of safety for sliding stability of the CB.

The CB sliding stability evaluations are performed considering two critical sliding planes located as follows:

- Bottom of the CB basemat at Elevation 241 ft NAVD88 (Table 3G.8-209a)
- Bottom of the underlying concrete fill at nominal Elevation 225 ft NAVD88 (Table 3G.8-209b)

The results of the sliding stability evaluations in Tables 3G.8-209a and 3G.8-209b show that the base friction and the lateral resistance provided by the concrete fill and Zone III rock embedment alone are sufficient to resist the seismic driving forces and ensure that the CB maintains a factor of safety against sliding that is greater than the required acceptance criteria of 1.1. The calculations demonstrate that the CB will maintain the stability against sliding at the two critical sliding failure planes located at the bottom of the CB basemat and the bottom of the concrete fill supporting the CB foundation. The maximum lateral pressures required to maintain a sliding factor of safety greater than 1.1

are less than the allowable lateral bearing capacity of the subgrade surrounding the CB presented in Table 3G.8-201. Lateral passive pressures required to ensure the sliding stability of the CB are calculated assuming triangular distribution. In Section 3G.8.5.6, these pressures are compared with the corresponding lateral pressures used for the standard design of the CB structure.

A stress check is performed for the embedded exterior walls of the CB for lateral passive pressures required for sliding stability, as described in Section 3G.8.5.6. The stress check results are shown in Tables 3G.8-210a and 3G.8-210b.

Tables 3G.8-211a and 3G.8-211b present a summary of calculations of the site-specific dynamic bearing pressure demands on the concrete fill under the CB basemat and the underlying Zone III/IV rock, respectively. The calculations follow the same EB/MEB method that was used for the standard design calculations. The calculations presented in Tables 3G.8-211a and 3G.8-211b show that the site-specific foundation dynamic bearing demands are lower than the dynamic bearing pressures considered in the standard design of the CB foundation (DCD Table 3G.2-27). The calculated maximum dynamic pressures are also lower than the allowable bearing capacity of the concrete fill supporting the CB basemat and the allowable bearing capacity of the underlying Zone III-IV rock subgrade provided in Table 2.5.4-211.

3G.8.5.6 Lateral Pressures on Exterior Embedded Walls

Figures 3G.8-203 through 3G.8-210 provide plots of the site-specific total lateral pressure demands on the below grade exterior walls of the CB. Two plots are presented in each figure comparing the site-specific lateral pressure demands with corresponding lateral pressure loads used for the standard design of the CB structure in DCD Section 3G.2. The first plot presents comparison of the at-rest static and the dynamic components of the lateral pressures acting on the walls. The seismic lateral pressure demands envelope the results obtained from the site-specific SSI analyses presented in Section 3A.17.13.4. The second plot compares the site-specific total pressures (static plus dynamic) and the maximum passive pressures required for sliding stability of the CB with the corresponding standard design loads.

Figures 3G.8-203 through 3G.8-210 show that near the slab at Elevation 267.9 ft NAVD88 (standard design Elevation -2.25 m) and near

the top of the CB basemat at Elevation 251.0 ft NAVD88 (standard design Elevation -7.40 m), the site-specific total lateral pressures can exceed the total lateral pressures used for the standard design of CB structure. Figures 3G.8-205 and 3G.8-206 also show that the lateral passive pressures required to ensure the stability of the CB against sliding in the EW direction can also exceed the pressures used for the standard design for the CB wall capacity check. The site-specific CB structural evaluation uses these site-specific lateral load demands as input to demonstrate that the standard design of the CB structure is adequate to withstand the site-specific lateral pressure demands on the CB below-grade exterior walls (see Section 3G.8.5.5).

Table 3G.8-212 presents the magnitudes of the site-specific dynamic lateral pressure loads applied on the below grade portion of the exterior walls of the finite element model used for the site-specific evaluation of the CB structure. These loads envelope the results of the CB site-specific SSI analyses for dynamic pressure loads that are presented in Figures 3G.8-203 through 3G.8-210 and bound the effects of concrete cracking and SSSI of FWSC and RB/FB on the CB seismic response. Exceptions are the few SSSI induced exceedances of the lateral pressure load demands on the CB wall facing the RB/FB. As explained in Section 3A.17.11, these exceedances have negligible effects on the results of the site-specific evaluations.

Table 3G.8-213 presents the magnitudes of the lateral pressure loads used as input for the check of the capacity of the CB below-grade walls to resist the passive pressure resistance loads required for the sliding stability of the CB foundation. The lateral pressure loads in Table 3G.8-213 envelope the site-specific passive pressure resistance loads presented in Figures 3G.8-203 through 3G.8-210.]

3G.8.5.7 Tornado Missile Evaluation

DCD Section 3G.2.5.6 is applicable to the CB with no changes.

NAPS DEP 3.7-1

Table 3G.8-201 **CB Site-Specific Parameters**

Parameters	Values
Building Width:	
X-direction (NS-direction)	30.3 m(99.4ft)
Y-direction (EW-direction)	23.8 m(78.1ft)
Zone III Rock Embedment Depth:	
Nominal Zone III Rock Elevation	EL 265 ft NAVD88
Depth to bottom of CB basemat	7.28 m (23.9 ft)
Depth to bottom of concrete fill	12.19 m (40 ft)
Water Level:	
Nominal Groundwater Elevation	EL 281.0 ft NAVD88 2.74 m (9 ft) below finished ground level grade
Friction Coefficient, μ	
Foundation/Concrete Fill/Rock Interfaces	0.6[a]
Allowable Lateral Dynamic Bearing Pressure:	
Zone III rock at EL 241 ft NAVD88	1.39 MPa (29.1 ksf)
Zone III rock at EL 225 ft NAVD88	1.47 MPa (30.6 ksf)

a. A value of 0.6 is used for the friction coefficient, which is the lowest value specified for site-specific concrete fill and Zone III-IV rock interfaces with the foundation structural concrete for the CB.

NAPS DEP 3.7-1

Table 3G.8-202 **CB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL-7.4 m	67	-0.075	-0.060	0.054	-0.245	-0.160	-0.095	0.339	-0.008
	72	-0.201	-1.943	-0.047	-0.427	-0.587	0.040	-0.663	-0.042
	115	-0.095	-0.041	0.946	0.024	0.021	-1.012	0.510	-0.071
	120	0.093	-0.370	-0.057	-0.249	-0.110	0.320	0.028	-0.458
Slab B1F EL-2.0 m	567	0.063	0.068	-0.052	0.019	-0.001	-0.005	0.008	-0.005
	572	-0.299	-0.162	0.093	-0.007	-0.004	-0.001	0.002	0.001
	615	0.091	0.006	0.442	0.013	0.001	0.002	0.013	0.002
	620	-0.144	0.014	0.409	-0.010	0.010	-0.001	0.011	-0.013
Slab 1F EL4.65 m	1067	0.020	-0.007	0.010	-0.003	-0.004	-0.002	0.006	-0.002
	1072	0.157	0.138	-0.042	-0.036	-0.008	-0.002	0.016	0.001
	1115	0.007	-0.010	-0.234	-0.009	-0.001	0.000	0.005	0.001
	1120	0.148	0.049	-0.072	-0.019	0.010	0.002	0.019	-0.018
Slab 2F EL9.06 m	1567	0.042	-0.048	0.007	-0.003	-0.003	-0.002	0.006	-0.001
	1572	0.280	0.336	-0.061	-0.015	-0.005	-0.001	0.009	0.000
	1615	-0.481	-0.090	0.003	-0.017	-0.003	0.002	0.010	0.003
	1620	0.166	0.082	-0.235	-0.014	0.009	0.000	0.014	-0.015
Roof EL13.8 m	1867	0.052	0.026	-0.014	-0.006	-0.005	-0.003	0.009	-0.001
	1872	0.412	0.848	0.014	0.003	-0.010	0.001	-0.008	0.001
	1915	0.152	0.025	-0.481	-0.012	-0.001	-0.004	0.007	0.002
	1920	0.182	0.189	-0.003	-0.011	0.008	-0.002	0.012	-0.014

Table 3G.8-202 **CB Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall EL-7.4 m ~EL-2.0 m	6007	0.026	-0.070	1.074	-0.033	0.019	-0.003	-0.040	0.019
	4006	-0.616	-0.860	-0.079	-0.016	-0.133	0.001	-0.001	-0.083
	4010	-0.111	-0.495	-0.534	0.008	-0.035	0.011	-0.006	-0.022
Wall EL-2.0 m ~EL4.65 m	6043	-0.030	0.060	2.181	-0.013	-0.009	-0.001	-0.003	-0.004
	4036	-0.360	-0.871	-0.029	0.039	0.168	-0.002	0.006	0.050
	4040	-0.184	-1.318	-0.723	-0.005	0.090	-0.012	0.056	0.062
Wall EL4.65 m ~EL9.06 m	6081	0.551	-0.330	1.576	0.005	0.022	-0.004	0.001	0.015
	4066	0.197	-0.677	-0.054	-0.013	-0.044	-0.003	-0.005	0.008
	4070	0.029	-0.697	-0.891	0.002	-0.006	-0.025	-0.019	-0.016
Wall EL9.06 m ~EL13.8 m	6117	-0.358	0.126	0.778	-0.002	-0.003	0.000	-0.002	0.004
	4096	0.551	-0.298	-0.069	-0.011	-0.039	0.001	-0.006	-0.014
	4100	0.132	-0.208	-0.674	-0.001	-0.019	-0.004	-0.021	-0.020

Table 3G.8-203 **CB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL-7.4 m	67	-0.134	0.064	-0.105	-0.265	-0.782	-0.049	-0.253	1.034
	72	-0.020	0.046	1.236	-0.037	-0.090	-1.297	-0.076	0.457
	115	-3.134	-0.280	-0.025	-0.343	-0.272	-0.109	0.017	-0.412
	120	-0.548	0.263	0.001	-0.132	-0.344	0.111	-0.759	0.117
Slab B1F EL-2.0 m	567	-0.012	-0.087	0.374	-0.011	-0.032	-0.008	-0.007	0.050
	572	0.004	-0.005	0.600	0.001	0.000	0.000	-0.001	-0.001
	615	-0.354	-0.068	0.227	-0.007	-0.025	-0.002	0.002	0.017
	620	0.019	-0.091	0.511	0.013	-0.017	-0.002	-0.019	0.018
Slab 1F EL4.65 m	1067	0.001	0.015	-0.016	-0.003	0.000	-0.003	-0.001	-0.001
	1072	0.001	0.004	-0.193	0.000	0.000	-0.001	-0.001	-0.002
	1115	0.244	0.109	0.003	-0.016	-0.051	0.001	-0.001	0.019
	1120	0.051	0.104	-0.108	0.012	-0.024	0.000	-0.022	0.023
Slab 2F EL9.06 m	1567	0.017	0.043	-0.044	-0.001	0.001	-0.001	0.000	-0.001
	1572	0.005	0.005	-0.424	0.000	0.000	-0.001	0.000	-0.001
	1615	0.737	0.254	0.032	-0.004	-0.023	0.001	0.004	0.009
	1620	0.092	0.147	-0.207	0.010	-0.018	-0.001	-0.017	0.018
Roof EL13.8 m	1867	0.063	0.036	-0.070	-0.003	0.000	-0.003	0.000	0.001
	1872	0.006	0.004	-0.635	0.000	0.000	-0.005	0.000	-0.003
	1915	1.315	0.362	-0.015	-0.013	-0.042	0.002	0.001	0.013
	1920	0.251	0.141	-0.099	0.006	-0.022	-0.007	-0.020	0.015

Table 3G.8-203 **CB Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall EL-7.4 m ~EL-2.0 m	6007	-1.101	-0.560	-0.141	-0.012	0.034	0.002	-0.003	0.043
	4006	0.038	-0.087	1.175	-0.005	-0.015	0.011	0.005	-0.006
	4010	0.155	-0.683	0.526	-0.039	-0.086	-0.001	-0.026	-0.038
Wall EL-2.0 m ~EL4.65 m	6043	-0.612	-0.583	-0.136	-0.074	-0.250	0.000	-0.014	-0.087
	4036	0.001	-0.058	2.069	-0.001	0.000	-0.003	-0.004	0.000
	4040	-0.156	-1.151	1.627	-0.042	0.006	0.019	0.027	0.021
Wall EL4.65 m ~EL9.06 m	6081	0.189	-0.741	-0.330	0.015	0.075	0.018	0.007	0.005
	4066	-0.002	-0.051	1.692	0.000	-0.001	0.005	0.000	-0.001
	4070	0.016	-0.601	1.263	0.016	-0.007	0.015	-0.004	-0.010
Wall EL9.06 m ~EL13.8 m	6117	0.707	-0.375	-0.393	0.006	0.002	0.002	0.004	-0.016
	4096	-0.004	-0.027	0.980	0.001	0.001	0.002	0.000	0.000
	4100	0.012	-0.254	0.691	0.014	-0.004	0.007	-0.002	-0.016

Table 3G.8-204 **CB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL-7.4 m	67	-0.027	0.640	-0.022	1.152	0.943	-0.093	-0.111	0.130
	72	0.041	-0.092	-0.013	0.432	0.127	0.044	0.535	-0.031
	115	0.676	0.259	-0.284	0.242	0.214	0.325	0.029	0.639
	120	0.053	0.027	0.137	0.099	0.174	-0.587	0.043	0.044
Slab B1F EL-2.0 m	567	-0.005	-0.662	0.039	0.048	0.018	0.006	0.060	-0.017
	572	-0.073	-0.114	0.011	0.023	0.012	-0.006	-0.077	0.004
	615	-0.164	-0.128	0.231	0.027	0.003	-0.020	0.033	0.003
	620	-0.041	-0.041	-0.056	0.017	0.017	0.021	-0.024	-0.028
Slab 1F EL4.65 m	1067	-0.086	-0.047	0.004	-0.178	-0.066	0.011	-0.032	-0.026
	1072	0.001	-0.044	-0.001	0.041	0.011	0.001	-0.085	-0.005
	1115	-0.123	-0.034	-0.014	0.019	0.171	0.009	0.000	-0.158
	1120	-0.024	-0.019	-0.056	0.019	0.017	0.017	-0.020	-0.026
Slab 2F EL9.06 m	1567	-0.039	-0.079	0.004	-0.103	-0.008	0.005	-0.020	-0.013
	1572	-0.028	-0.008	0.000	0.050	0.016	0.001	-0.088	0.000
	1615	-0.156	-0.137	0.022	0.011	0.159	0.008	-0.008	-0.167
	1620	-0.021	-0.017	-0.008	0.021	0.020	0.017	-0.022	-0.028
Roof EL13.8 m	1867	0.125	0.099	-0.004	-0.254	-0.083	0.012	-0.038	-0.007
	1872	0.051	0.125	-0.005	0.047	0.026	-0.009	-0.097	-0.001
	1915	0.135	0.166	0.002	0.008	0.200	0.013	0.007	-0.226
	1920	0.026	0.059	-0.017	0.029	0.025	0.062	-0.027	-0.032

Table 3G.8-204 **CB Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall EL-7.4 m ~EL-2.0 m	6007	0.236	0.736	0.210	0.012	-0.088	0.004	0.054	-0.066
	4006	-0.014	0.829	-0.019	0.029	0.158	-0.001	0.002	0.039
	4010	-0.062	0.221	0.102	-0.013	0.066	0.005	0.029	0.038
Wall EL-2.0 m ~EL4.65 m	6043	-0.160	1.287	0.274	-0.037	-0.024	-0.006	-0.039	0.002
	4036	-0.059	0.636	0.002	-0.018	-0.097	0.001	0.002	-0.033
	4040	0.017	0.390	-0.046	0.004	-0.023	-0.010	-0.016	-0.018
Wall EL4.65 m ~EL9.06 m	6081	-0.004	0.713	-0.006	0.021	0.133	0.005	0.001	0.073
	4066	0.007	0.408	-0.007	-0.008	-0.041	0.003	0.003	-0.029
	4070	0.017	0.297	-0.096	0.003	-0.009	-0.002	-0.007	-0.010
Wall EL9.06 m ~EL13.8 m	6117	0.018	0.434	0.043	0.013	0.089	-0.006	-0.006	0.125
	4096	0.069	0.222	0.000	-0.009	-0.048	0.001	0.003	-0.062
	4100	0.002	0.125	-0.090	-0.005	-0.012	0.003	0.003	-0.016

Table 3G.8-205 **Combined Forces and Moments: Selected Load Combination CB-9**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL-7.4 m	67	OTHR	-1.803	-2.073	-0.034	-0.908	-0.459	0.120	0.010	-0.152
		TEMP	-0.409	-1.291	0.169	6.783	6.419	-0.132	0.291	-0.113
		SEIS	0.156	0.646	0.129	1.363	1.690	0.181	0.565	1.102
	72	OTHR	-2.353	-0.545	-0.033	1.822	0.627	-0.044	-0.549	-0.012
		TEMP	-0.189	-0.279	0.059	1.916	5.868	-0.007	0.290	0.127
		SEIS	0.206	1.945	1.239	1.936	0.924	1.306	1.012	0.479
	115	OTHR	-2.411	-1.386	-0.507	-0.180	0.209	0.459	-0.382	-0.646
		TEMP	-0.198	-0.082	0.185	6.662	2.336	-0.255	0.533	0.941
		SEIS	3.207	0.383	0.992	0.532	0.814	1.151	0.527	0.774
	120	OTHR	-1.802	-0.979	-0.132	0.826	0.326	0.105	-0.334	-0.022
		TEMP	-0.949	-1.034	-0.271	3.316	3.332	1.777	1.350	1.269
		SEIS	0.559	0.455	0.148	0.839	0.819	0.916	0.852	0.576
Slab B1F EL-2.0 m	567	OTHR	-0.988	-0.058	-0.003	-0.078	-0.025	-0.005	-0.095	0.028
		TEMP	-0.720	0.380	0.045	-0.078	-0.091	0.002	-0.003	0.006
		SEIS	0.065	0.671	0.379	0.054	0.036	0.012	0.061	0.057
	572	OTHR	-1.507	-0.581	0.105	-0.012	-0.015	0.009	0.110	-0.007
		TEMP	0.331	-0.756	-0.056	-0.030	-0.063	0.003	-0.023	0.000
		SEIS	0.308	0.199	0.607	0.028	0.013	0.006	0.077	0.005
	615	OTHR	-0.478	-0.436	0.021	-0.047	-0.009	0.024	-0.054	0.006
		TEMP	-0.858	0.641	-0.723	-0.078	-0.033	0.006	-0.032	-0.073
		SEIS	0.400	0.145	0.548	0.031	0.034	0.020	0.037	0.029
	620	OTHR	-0.703	-0.345	0.932	-0.022	-0.036	-0.034	0.030	0.052
		TEMP	-0.970	-0.965	-1.402	-0.066	-0.065	0.009	0.007	0.005
		SEIS	0.151	0.101	0.657	0.027	0.028	0.021	0.035	0.038

Table 3G.8-205 **Combined Forces and Moments: Selected Load Combination CB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Slab 1F EL4.65 m	1067	OTHR	-0.319	-0.076	-0.015	0.189	0.071	-0.012	0.032	0.025
		TEMP	-1.315	-0.447	-0.012	0.062	0.026	0.001	0.003	-0.003
		SEIS	0.088	0.050	0.020	0.178	0.067	0.012	0.032	0.026
	1072	OTHR	-0.727	-0.284	0.058	-0.117	-0.022	-0.002	0.124	0.005
		TEMP	-0.170	-1.780	-0.097	0.184	0.081	0.007	-0.061	-0.001
		SEIS	0.157	0.145	0.198	0.084	0.017	0.003	0.091	0.005
	1115	OTHR	-0.187	-0.177	0.197	-0.023	-0.202	-0.008	0.001	0.179
		TEMP	-1.419	0.046	0.018	0.065	0.113	0.002	-0.008	-0.017
		SEIS	0.274	0.115	0.235	0.031	0.190	0.009	0.006	0.161
	1120	OTHR	-0.260	-0.067	0.376	-0.038	-0.020	-0.009	0.035	0.023
		TEMP	-1.987	-1.963	-2.417	0.130	0.129	-0.007	-0.033	-0.031
		SEIS	0.159	0.116	0.141	0.038	0.040	0.018	0.045	0.049
Slab 2F EL9.06 m	1567	OTHR	0.018	0.062	-0.017	0.097	0.007	-0.004	0.018	0.011
		TEMP	-2.552	-1.076	0.015	-0.027	-0.087	0.002	0.004	0.000
		SEIS	0.059	0.102	0.046	0.104	0.009	0.006	0.021	0.013
	1572	OTHR	0.081	-0.049	-0.011	-0.057	-0.016	-0.001	0.091	0.000
		TEMP	-0.679	-3.420	-0.099	0.070	-0.022	0.008	-0.099	0.006
		SEIS	0.281	0.336	0.429	0.054	0.017	0.002	0.089	0.001
	1615	OTHR	0.045	0.136	-0.034	-0.011	-0.145	-0.007	0.008	0.155
		TEMP	-2.425	0.082	-0.110	0.043	0.193	-0.031	0.036	-0.087
		SEIS	0.895	0.302	0.041	0.022	0.161	0.009	0.014	0.167
	1620	OTHR	0.033	0.014	-0.070	-0.021	-0.020	-0.018	0.021	0.026
		TEMP	-3.153	-3.133	-4.149	-0.051	-0.057	0.025	0.020	0.029
		SEIS	0.191	0.169	0.314	0.028	0.029	0.018	0.032	0.037

Table 3G.8-205 **Combined Forces and Moments: Selected Load Combination CB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Roof EL13.8 m	1867	OTHR	-0.084	-0.071	-0.003	0.173	0.074	-0.007	0.021	0.005
		TEMP	1.500	1.282	-0.012	-0.783	-1.023	0.001	0.015	-0.006
		SEIS	0.149	0.109	0.072	0.255	0.084	0.013	0.039	0.007
	1872	OTHR	-0.047	-0.113	-0.005	-0.057	-0.016	0.003	0.086	-0.001
		TEMP	1.774	1.355	0.412	-0.232	-0.745	0.032	-0.330	0.023
		SEIS	0.415	0.857	0.635	0.048	0.028	0.010	0.097	0.004
	1915	OTHR	-0.085	-0.129	-0.012	-0.009	-0.154	-0.005	-0.004	0.160
		TEMP	1.949	1.114	0.485	-0.695	-0.400	0.008	0.017	-0.146
		SEIS	1.331	0.399	0.482	0.022	0.206	0.014	0.010	0.227
	1920	OTHR	-0.011	-0.049	0.026	-0.022	-0.021	-0.046	0.015	0.021
		TEMP	-0.003	-0.164	0.493	-0.634	-0.644	-0.022	-0.011	0.005
		SEIS	0.312	0.243	0.101	0.032	0.034	0.063	0.035	0.039
Wall EL-7.4m ~EL-2.0 m	6007	OTHR	-0.856	-0.748	-0.908	0.052	0.097	0.029	0.051	0.202
		TEMP	0.521	1.371	-0.057	0.642	0.904	0.004	-0.032	0.165
		SEIS	1.228	0.934	1.128	0.076	0.119	0.037	0.115	0.208
	4006	OTHR	-0.359	-0.658	-0.024	-0.067	-0.390	0.001	-0.004	-0.712
		TEMP	0.756	-0.069	0.091	-0.688	-1.068	-0.002	-0.001	-0.194
		SEIS	0.855	1.301	1.186	0.051	0.327	0.012	0.006	0.592
	4010	OTHR	-0.278	-0.450	-0.037	-0.063	-0.156	0.077	0.074	-0.304
		TEMP	1.043	1.253	-0.324	-0.531	-0.881	-0.042	-0.156	-0.334
		SEIS	0.496	0.999	0.888	0.096	0.144	0.079	0.101	0.237

OTHR: Loads other than thermal and seismic
TEMP: Thermal loads
SEIS: Seismic loads

Table 3G.8-205 **Combined Forces and Moments: Selected Load Combination CB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall EL-2.0 m ~EL4.65 m	6043	OTHR	-0.529	-1.111	-0.549	0.044	0.037	-0.010	0.046	0.212
		TEMP	2.535	-1.168	-0.671	0.378	0.483	-0.026	0.127	0.061
		SEIS	0.877	1.448	2.282	0.101	0.277	0.023	0.058	0.362
	4036	OTHR	-0.679	-0.361	0.034	0.029	0.082	-0.004	0.021	-0.562
		TEMP	2.463	-0.411	-0.013	-0.289	-0.300	0.001	0.031	0.070
		SEIS	0.662	1.151	2.087	0.053	0.273	0.006	0.022	0.345
	4040	OTHR	-0.403	-0.880	0.399	-0.107	0.000	0.101	0.213	-0.163
		TEMP	1.381	1.392	-0.606	-0.080	-0.300	-0.047	-0.217	-0.181
		SEIS	0.465	1.967	1.906	0.112	0.133	0.046	0.144	0.171
Wall EL4.65 m ~EL9.06 m	6081	OTHR	-0.321	-0.600	0.102	0.000	-0.018	-0.001	-0.001	-0.041
		TEMP	5.519	-0.786	0.338	1.391	1.000	0.007	-0.048	-0.161
		SEIS	0.795	1.112	1.694	0.046	0.276	0.029	0.013	0.089
	4066	OTHR	-0.407	-0.280	0.056	-0.042	-0.294	-0.008	0.008	-0.055
		TEMP	6.358	-0.464	-0.042	-1.488	-1.021	0.000	-0.021	0.188
		SEIS	0.308	0.832	1.708	0.042	0.214	0.009	0.011	0.058
	4070	OTHR	-0.097	-0.419	0.271	-0.025	-0.089	-0.073	0.005	-0.047
		TEMP	3.596	1.323	-1.489	-1.232	-1.167	-0.021	-0.332	-0.163
		SEIS	0.065	0.976	1.663	0.026	0.060	0.072	0.026	0.049

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Table 3G.8-205 **Combined Forces and Moments: Selected Load Combination CB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall EL9.06 m ~EL13.8 m	6117	OTHR	-0.057	-0.362	0.001	-0.013	-0.087	0.004	0.005	-0.100
		TEMP	3.560	-0.619	-1.500	0.908	1.500	-0.022	-0.038	0.385
		SEIS	0.829	0.599	0.911	0.015	0.090	0.006	0.007	0.127
	4096	OTHR	-0.154	-0.190	0.020	0.007	0.041	-0.001	-0.005	0.055
		TEMP	3.980	-0.285	-0.182	-0.936	-1.566	-0.001	0.034	-0.463
		SEIS	0.591	0.391	0.986	0.016	0.065	0.002	0.008	0.064
	4100	OTHR	-0.005	-0.072	0.071	0.005	0.006	-0.001	-0.006	0.008
		TEMP	2.844	1.752	-1.526	-0.681	-1.227	-0.002	-0.347	-0.594
		SEIS	0.146	0.391	1.010	0.016	0.025	0.009	0.024	0.031

Table 3G.8-206a **Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-9**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				X Direction		Y Direction		
		Calculated	Allowable	Top	Bottom	Top	Bottom	Allowable
Basemat EL-7.4 m	67	-5.0	-23.5	-20.3	35.1	-30.7	28.8	372.2
	72	-8.4		-30.9	136.4	24.9	159.9	
	115	-4.9		-25.2	107.8	-11.3	12.8	
	120	-5.7		-22.8	28.9	-17.8	35.5	
Slab B1F EL-2.0 m	567	-9.7	-29.3	14.9	-33.1	136.8	35.7	372.2
	572	-6.2		-11.7	-19.7	-9.0	-23.9	
	615	-9.8		61.5	-15.9	76.4	6.7	
	620	-9.0		-13.2	-26.4	-6.4	-25.6	
Slab 1F EL4.65 m	1067	-21.0	-29.3	-27.7	143.4	-8.2	57.0	372.2
	1072	-6.4		-18.9	8.0	-30.7	-20.5	
	1115	-13.2		-16.5	-17.0	180.1	-31.0	
	1120	-9.5		-19.1	24.1	-26.4	38.3	
Slab 2F EL9.06 m	1567	-8.4	-29.3	-43.4	-31.0	1.8	-20.0	372.2
	1572	-7.9		-9.1	1.3	-39.9	-52.2	
	1615	-8.8		-43.2	-37.3	183.9	38.9	
	1620	-18.2		98.4	61.9	100.4	61.0	

Table 3G.8-206a **Rebar and Concrete Stresses (Basemat and Slabs): Selected Load Combination CB-9** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				X Direction		Y Direction		
		Calculated	Allowable	Top	Bottom	Top	Bottom	Allowable
Roof EL13.8 m	1867	-13.6	-29.3	80.0	137.3	79.3	-33.9	372.2
	1872	-4.1		159.4	64.6	196.7	54.9	
	1915	-8.6		198.3	86.2	196.6	6.8	
	1920	-15.3		138.8	20.7	153.7	-8.6	

Note: Negative value means compression.

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Table 3G.8-206b **Rebar and Concrete Stresses (Walls): Selected Load Combination CB-9**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Horizontal Direction		Vertical Direction		
		Calculated	Allowable	Inside	Outside	Inside	Outside	Allowable
Wall EL-7.4 m ~EL-2.0 m	6007	-9.8	-29.3	13.2	116.5	21.0	136.7	372.2
	4006	-14.3		68.6	121.3	-27.7	168.0	
	4010	-10.7		29.2	176.7	36.6	224.9	
Wall EL-2.0 m ~EL4.65 m	6043	-9.2	-29.3	97.1	210.5	-25.4	150.6	372.2
	4036	-5.8		103.5	113.2	130.0	102.4	
	4040	-6.5		77.0	123.9	189.7	148.4	
Wall EL4.65 m ~EL9.06 m	6081	-7.8	-29.3	76.6	198.1	32.8	101.9	372.2
	4066	-15.8		87.4	200.8	-12.5	189.2	
	4070	-7.6		119.2	188.0	77.8	227.3	
Wall EL9.06 m ~EL13.8 m	6117	-17.6	-29.3	89.1	239.0	-33.2	147.1	372.2
	4096	-15.2		73.6	182.1	-11.5	181.0	
	4100	-12.8		99.8	180.4	17.4	254.8	

Note: Negative value means compression

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Table 3G.8-207 **Calculation Results for Transverse Shear**

Location	Element ID	Load ID	d (m)	ρ_w (%)	ρ_v (%)	Shear Force (MN/m) Vu	Vc	Vs	ϕVn	Vu/ϕVn
Basemat EL-7.4 m	67	CB-9	2.745	0.366	0.177	1.537	4.798	2.011	5.788	0.266
	72	CB-9	2.720	0.370	0.177	1.477	2.483	1.993	3.805	0.388
	115	CB-9	2.743	0.366	0.177	0.905	2.370	2.010	3.723	0.243
	120	CB-9	2.734	0.368	0.177	1.974	3.505	2.003	4.682	0.422
Slab B1F EL-2.0 m	567	CB-9	0.372	1.359	0.000	0.183	0.859	0.000	0.730	0.250
	572	CB-9	0.360	1.402	0.000	0.165	0.838	0.000	0.713	0.231
	615	CB-9	0.363	1.390	0.000	0.127	0.783	0.000	0.665	0.190
	620	CB-3	0.399	1.266	0.000	0.087	0.260	0.000	0.221	0.395
Slab 1F EL4.65 m	1067	CB-9	0.378	1.336	0.000	0.082	0.370	0.000	0.314	0.262
	1072	CB-3	0.360	1.403	0.000	0.189	0.803	0.000	0.682	0.276
	1115	CB-9	0.410	1.232	0.000	0.325	0.415	0.000	0.352	0.923
	1120	CB-3	0.372	1.356	0.000	0.062	0.327	0.000	0.278	0.225
Slab 2F EL9.06 m	1567	CB-3	0.374	1.350	0.000	0.030	0.362	0.000	0.308	0.098
	1572	CB-3	0.360	1.403	0.000	0.134	0.323	0.000	0.274	0.490
	1615	CB-9	0.407	1.240	0.081	0.243	0.339	0.136	0.404	0.600
	1620	CB-3	0.390	1.295	0.000	0.048	0.406	0.000	0.345	0.139
Slab RF EL13.8 m	1867	CB-9	0.511	1.479	0.000	0.064	0.409	0.000	0.347	0.185
	1872	CB-9	0.500	1.511	0.000	0.125	0.318	0.000	0.270	0.463
	1915	CB-9	0.550	1.375	0.081	0.339	0.388	0.184	0.487	0.697
	1920	CB-9	0.537	1.408	0.000	0.076	0.524	0.000	0.445	0.171
Wall EL-7.4 m ~EL-2.0 m	6007	CB-9	0.676	1.491	0.355	0.512	1.489	0.994	2.110	0.242
	4006	CB-9	0.672	1.500	0.355	1.481	1.225	0.988	1.881	0.787
	4010	CB-9	0.673	1.498	0.355	0.702	0.479	0.989	1.247	0.563

Table 3G.8-207 **Calculation Results for Transverse Shear** *(continued)*

Location	Element ID	Load ID	d (m)	ρ_w (%)	ρ_v (%)	Shear Force (MN/m)				Vu/ϕVn
						Vu	Vc	Vs	ϕVn	
Wall EL-2.0 m ~EL4.65 m	6043	CB-9	0.675	1.494	0.355	0.649	1.847	0.992	2.413	0.269
	4036	CB-3	0.673	1.498	0.710	0.967	1.227	1.978	2.724	0.355
	4040	CB-3	0.696	1.447	0.355	0.454	1.461	1.023	2.111	0.215
Wall EL4.65 m ~EL9.06 m	6081	CB-9	0.673	1.497	0.000	0.291	1.494	0.000	1.270	0.229
	4066	CB-9	0.672	1.500	0.000	0.191	0.681	0.000	0.579	0.330
	4070	CB-9	0.694	1.452	0.000	0.117	0.300	0.000	0.255	0.458
Wall EL9.06 m ~EL13.8 m	6117	CB-9	0.493	1.533	0.000	0.412	0.562	0.000	0.478	0.863
	4096	CB-9	0.493	1.533	0.000	0.472	0.623	0.000	0.530	0.892
	4100	CB-9	0.507	1.492	0.000	0.127	0.284	0.000	0.242	0.526

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Table 3G.8-208 **Factors of Safety for CB Foundation Overturning Stability**

Subgrade Condition	Partial Column Profiles						Full Column Profiles					
	LB (Case 7)		BE (Case 8)		UB (Case 9)		LB (Case 10)		BE (Case 11)		UB (Case 12)	
Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
m_0gh (MN·m)	1,525	1,028	1,525	1,028	1,525	1,028	1,525	1,028	1,525	1,028	1,525	1,028
W_b (MN·m)	123.9	131.7	123.9	131.7	123.9	131.7	123.9	131.7	123.9	131.7	123.9	131.7
E_s (MN·m)	1.3	1.2	1.5	1.5	1.9	1.7	1.2	1.1	1.3	1.2	1.5	1.4
$FS=(m_0gh-W_b)/E_s$	1,065	763	910	605	750	**519**	1,159	783	1,065	760	909	662

Notes:

m_0 = total mass of structure and basemat

g = acceleration due to gravity

h = height of the center of structure mass at the overturning position

W_b = potential energy caused by the effect of buoyancy

E_s = maximum kinetic energy

FS = Factor of Safety

The bold red number (519) is the minimum Factor of Safety against overturning.

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Table 3G.8-209a **Factors of Safety for CB Foundation Sliding Stability, Evaluation of CB Stability for Sliding at Bottom of Basemat (Elevation 241 ft NAVD88)**

Basemat width in NS Dir.	30.3	m
Basemat width in EW Dir.	23.8	m
Depth of Zone III rock embedment	7.28	m
Total Weight	197	MN
Buoyancy (B)	86	MN

Subgrade Condition		Partial Column Profiles						Full Column Profiles					
		LB (Case 7)		BE (Case 8)		UB (Case 9)		LB (Case 10)		BE (Case 11)		UB (Case 12)	
Sliding Direction		**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
Time	(sec)	3.090	1.810	4.630	1.810	1.070	1.805	1.065	1.810	3.085	1.805	3.085	1.805
Vertical seismic load (V_z)	(MN)	49	103	77	114	70	105	55	85	42	75	49	77
Minimum vertical load	(MN)	62	8	34	0	41	6	56	26	69	36	62	34
F_v: Horizontal Seismic Force (MN)	(MN)	61	44	71	84	104	120	50	43	60	52	93	67
F_{ub}: Bottom Friction Force (MN)	(MN)	37	5	20	0	25	3	33	16	41	21	37	20
F_r: Lateral Resistance Force (MN)	(MN)	30	44	58	92	90	129	22	31	24	36	65	53
$FS = ((F_{ub}+F_r)/F_v)$		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{MAX}: Maximum Stress (MPa) Associated with Lateral Resistance F_r		0.35	0.40	0.67	0.84	1.04	**1.17**	0.25	0.28	0.28	0.33	0.75	0.48

Note:The number in bold red (1.17) is the maximum lateral pressure demand on Zone III rock.

Table 3G.8-209b **Factors of Safety for CB Foundation Sliding Stability, Evaluation of CB Stability for Sliding at Bottom of Concrete Fill (Elevation 225 ft NAVD88)**

Basemat width in NS Dir.	30.3	m
Basemat width in EW Dir.	23.8	m
Depth of Zone III rock embedment	12.38	m
Total Weight	278	MN
Buoyancy (B)	121	MN

	Partial Column Profiles						Full Column Profiles					
Subgrade Condition	**LB (Case 7)**		**BE (Case 8)**		**UB (Case 9)**		**LB (Case 10)**		**BE (Case 11)**		**UB (Case 12)**	
Sliding Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
Time (sec)	1.135	1.805	3.085	1.805	3.085	1.805	1.060	1.805	3.085	1.805	3.085	1.800
Vertical seismic load (V_z) (MN)	103	125	62	133	64	145	70	102	61	103	64	93
Minimum vertical load (MN)	54	32	95	24	93	12	87	55	96	54	93	64
F_v: Horizontal Seismic Force (MN)	65	42	113	89	146	130	60	49	68	51	110	88
F_{ub}: Bottom Friction Force (MN)	32	19	57	14	56	7	52	33	57	32	56	38
F_r: Lateral Resistance Force (MN)	39	27	68	83	105	136	14	21	17	24	66	58
$FS = ((F_{ub}+F_r)/F_v)$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{MAX}: Maximum Stress (MPa) Associated with Lateral Resistance F_r	0.27	0.15	0.47	0.45	0.72	**0.74**	0.09	0.11	0.12	0.13	0.45	0.31

Note:The number in bold red (0.74) is the maximum lateral pressure demand on Zone III rock.

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Table 3G.8-210a **Stresses of CB External Wall against Wall Capacity Passive Pressure: Selected Load Combination CB-9**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Horizontal Direction		Vertical Direction		
		Calculated	Allowable	Inside	Outside	Inside	Outside	Allowable
Wall EL-7.4 m ~EL-2.0 m	6007	-9.5	-29.3	32.7	138.0	25.5	149.9	372.2
	4006	-10.4		33.1	122.2	-23.7	132.8	
	4010	-3.3		62.4	96.4	22.0	173.7	
Wall EL-2.0 m ~EL4.65 m	6043	-9.8	-29.3	93.7	194.2	-27.7	127.4	372.2
	4036	-6.0		112.7	128.8	142.4	108.1	
	4040	-5.1		122.5	141.6	144.1	213.3	

Notes: Negative value means compression.

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Table 3G.8-210b **Transverse Shear of CB External Walls**

Location	Element ID	Load ID	d (m)	ρ_w (%)	ρ_v (%)	Shear Forces (MN/m) Vu	Vc	Vs	ϕVn	Vu/ϕVn
Wall EL-7.4 m ~EL-2.0 m	6007	CB-9	0.679	1.485	0.355	0.553	0.638	0.998	1.391	0.397
	4006	CB-9	0.672	1.500	0.355	1.160	1.488	0.988	2.104	0.551
	4010	CB-9	0.675	1.493	0.355	0.559	0.539	0.992	1.301	0.430
Wall EL-2.0 m ~EL4.65 m	6043	CB-9	0.674	1.495	0.355	0.164	0.608	0.991	1.359	0.121
	4036	CB-9	0.673	1.498	0.710	0.135	0.523	1.978	2.126	0.063
	4040	CB-9	0.677	1.489	0.355	0.279	0.532	0.995	1.298	0.215

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Table 3G.8-211a **Maximum Soil Dynamic Bearing Pressure Demand for CB, Calculations of Dynamic Bearing Pressure Demands on Concrete Fill under CB Basemat**

Basemat width in NS (X) Dir.	30.3	m	
Basemat width in EW (Y) Dir.	23.8	m	
Gravity Load (D)	197	MN	
Buoyancy (B)	86	MN	(Buoyancy is considered only in combination with upward vertical seismic load (V_z))

	Subgrade Condition		Partial Column Analyses						Full Column Analyses					
			LB (Case 7)		BE (Case 8)		UB (Case 9)		LB (Case 10)		BE (Case 11)		UB (Case 12)	
	Direction Vertical Seismic Load		downward		upward		upward		downward		downward		downward	
SASSI	Time	(sec)	3.085		1.810		1.810		1.810		1.810		1.815	
SASSI	Vertical seismic load (V_z)	(MN)	35.7		82.5		86.8		79.8		83.2		85.1	
SASSI	Total vertical load	(MN)	233		28		24		277		280		282	
SASSI	Moment in NS-dir (Mx)	(MN-m)	590		194		172		76		152		105	
SASSI	Moment in EW-dir (My)	(MN-m)	302		528		692		218		140		69	
Simplified Method**			**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**
NS dir. ↓ EW dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	15.5	18.2	17.6	21.0	0.0	0.0	0.0	0.0	0.0	0.0
NS dir. ↓ EW dir.	Max. basemat rotation (ϕ)	(10^{-4} rad)	0.004	0.004	0.002	0.002	0.001	0.001	0.010	0.010	0.009	0.009	0.005	0.005
NS dir. ↓ EW dir.	Max. basemat moment (Mx)	(MN-m)	590	590	194	196	172	173	76	76	152	152	105	105
NS dir. ↓ EW dir.	Max. bearing pressure 1 (Px)	(MPa)	0.48	0.48	0.09	0.10	0.08	0.08	0.40	0.40	0.43	0.43	0.42	0.42
NS dir. ↓ EW dir.	Max. bearing pressure 2 (Py)	(MPa)	---	0.11	---	0.23	---	0.31	---	0.08	---	0.05	---	0.02
NS dir. ↓ EW dir.	Max. Bearing pressure (Pxy=Px+Py)	(MPa)	---	0.59	---	0.32	---	0.39	---	0.48	---	0.48	---	0.44
EW dir. ↓ NS dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	67.3	83.6	77.8	92.2	0.0	0.0	0.0	0.0	0.0	0.0
EW dir. ↓ NS dir.	Max. basemat rotation (ϕ)	(10^{-4} rad)	0.008	0.008	0.014	0.057	0.020	0.156	0.011	0.011	0.015	0.015	0.009	0.009
EW dir. ↓ NS dir.	Max. basemat moment (My)	(MN-m)	302	302	528	301	692	273	218	218	140	140	69	69
EW dir. ↓ NS dir.	Max. bearing pressure 1(Py)	(MPa)	0.43	0.43	0.22	0.48	0.28	0.85	0.46	0.46	0.44	0.44	0.42	0.42
EW dir. ↓ NS dir.	Max. bearing pressure 2 (Px)	(MPa)	---	0.16	---	0.33	---	0.60	---	0.02	---	0.04	---	0.03
EW dir. ↓ NS dir.	Max. Bearing Pressure (Pyx=Py+Px)	(MPa)	---	0.59	---	0.81	---	1.46	---	0.48	---	0.48	---	0.44
	Envelope of Pxy and Pyx	(MPa)	---	0.59	---	0.81	---	**1.46**	---	0.48	---	0.48	---	0.44

Notes: * SASSI2010 analysis is a linear time history analysis with the 3D excitation.

** EB and MEB stand for energy balance (EB) and modified energy balance (MEB) methods.

The number in bold red (1.46) is the maximum dynamic bearing pressure demand on the Zone III-IV rock.

Table 3G.8-211b **Maximum Soil Dynamic Bearing Pressure Demand for CB, Calculations of Dynamic Bearing Pressure Demands on Zone III-IV Rock**

Basemat width in NS (X) Dir.	30.3	m
Basemat width in EW (Y) Dir.	23.8	m
Gravity Load (D)	197	MN
Buoyancy (B)	86	MN (Buoyancy is considered only in combination with upward vertical seismic load (V_z))

	Subgrade Condition		**Partial Column Analyses**						**Full Column Analyses**					
			LB (Case 7)		**BE (Case 8)**		**UB (Case 9)**		**LB (Case 10)**		**BE (Case 11)**		**UB (Case 12)**	
	Direction Vertical Seismic Load		**downward**		**downward**		**downward**		**downward**		**downward**		**downward**	
SASSI	Time	(sec)	1.810		1.815		1.810		3.020		1.805		1.810	
	Vertical seismic load (V_z)	(MN)	114.1		112.3		122.3		16.9		106.1		121.0	
	Total vertical load	(MN)	392		390		400		294		384		399	
	Moment in NS-dir (Mx)	(MN-m)	95		144		154		314		83		13	
	Moment in EW-dir (My)	(MN-m)	177		353		380		378		251		169	
Simplified Method**			**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**
NS dir. ↓ EW dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.004	-0.004	-0.010	-0.010	-0.006	-0.006	0.006	0.006	0.005	0.005	0.002	0.002
	Max. basemat moment (Mx)	(MN-m)	95	95	144	144	154	154	314	314	83	83	13	13
	Max. bearing pressure 1 (Px)	(MPa)	0.57	0.57	0.58	0.58	0.60	0.60	0.49	0.49	0.55	0.55	0.56	0.56
	Max. bearing pressure 2 (Py)	(MPa)	---	0.06	---	0.12	---	0.13	---	0.13	---	0.09	---	0.06
	Max. Bearing pressure (Pxy=Px+Py)	(MPa)	---	0.63	---	0.70	---	0.73	---	0.63	---	0.64	---	0.62
EW dir. ↓ NS dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.016	-0.016	-0.008	-0.008	-0.008	-0.008	0.008	0.008	0.003	0.003	0.002	0.002
	Max. basemat moment (My)	(MN-m)	177	177	353	353	380	380	378	378	251	251	169	169
	Max. bearing pressure 1(Py)	(MPa)	0.61	0.61	0.66	0.66	0.69	0.69	0.54	0.54	0.62	0.62	0.61	0.61
	Max. bearing pressure 2 (Px)	(MPa)	---	0.03	---	0.04	---	0.04	---	0.09	---	0.02	---	0.00
	Max. Bearing Pressure (Pyx=Py+Px)	(MPa)	---	0.63	---	0.70	---	0.73	---	0.63	---	0.64	---	0.62
	Envelope of Pxy and Pyx	(MPa)	---	0.63	---	0.70	---	**0.73**	---	0.63	---	0.64	---	0.62

Notes: * SASSI2010 analysis is a linear time history analysis with the 3D excitation.

** EB and MEB stand for energy balance (EB) and modified energy balance (MEB) methods.

The number in bold red (0.73) is the maximum dynamic bearing pressure demand on the Zone III-IV rock.

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Table 3G.8-212 **Dynamic Lateral Pressure Loads on CB Below-Grade Walls**

Elevation (m)	Finite-Element Mesh Height (m)	C1 and C5 Walls σ (MN/m^Z)	CA and CD Walls σ (MN/m^Z)
4.650		0.12	0.12
	0.350		
4.300			
	0.350		
3.950			
	1.830		
2.120			
	2.190		
-0.070			
	1.930		
-2.000			
	0.250		
-2.250		0.28	0.23
	0.250		
-2.500			
	1.465		
-3.965			
	1.720		
-5.685			
	1.715		
-7.400		0.31	0.28
	2.500		
-9.900			
	0.500		
-10.400			

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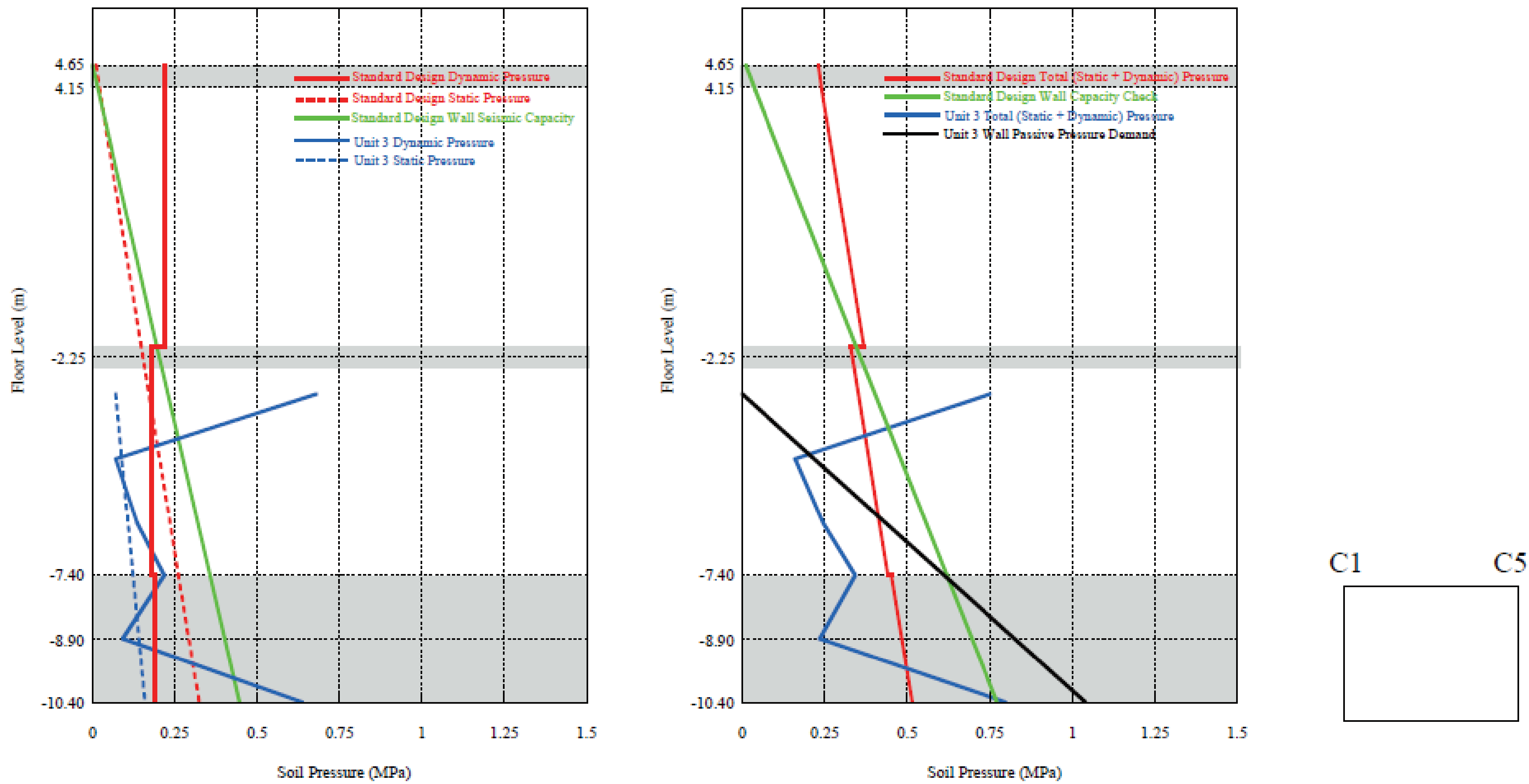
Table 3G.8-213 **Loads Used for CB Passive Resistance Pressure Checks**

Elevation (m)	Finite-Element Mesh Height (m)	C1 and C5 Walls σ (MN/m^Z)	CA and CD Walls σ (MN/m^Z)
4.650		-	-
	7.770		
-3.120			
	0.845	0.060	0.068
-3.965			
	1.720	0.244	0.274
-5.685		0.489	0.550
	1.715		
-7.400			
	3.00	-	-
-10.400			

Figure 3G.8-201 **Not Used**

Figure 3G.8-202 **Not Used**

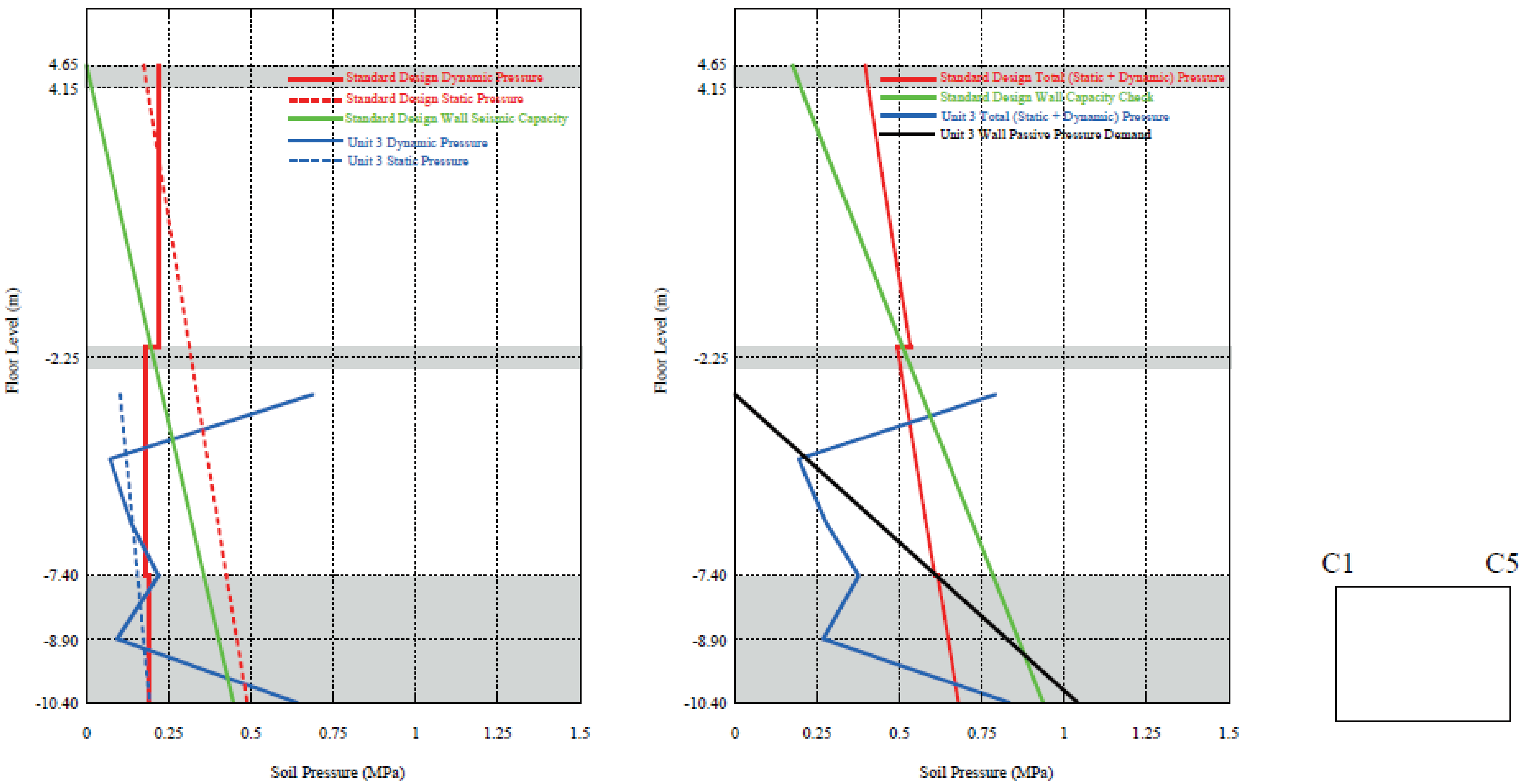
Figure 3G.8-203 **Lateral Pressure C1 Wall - Envelope of LB, BE and UB Partial Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

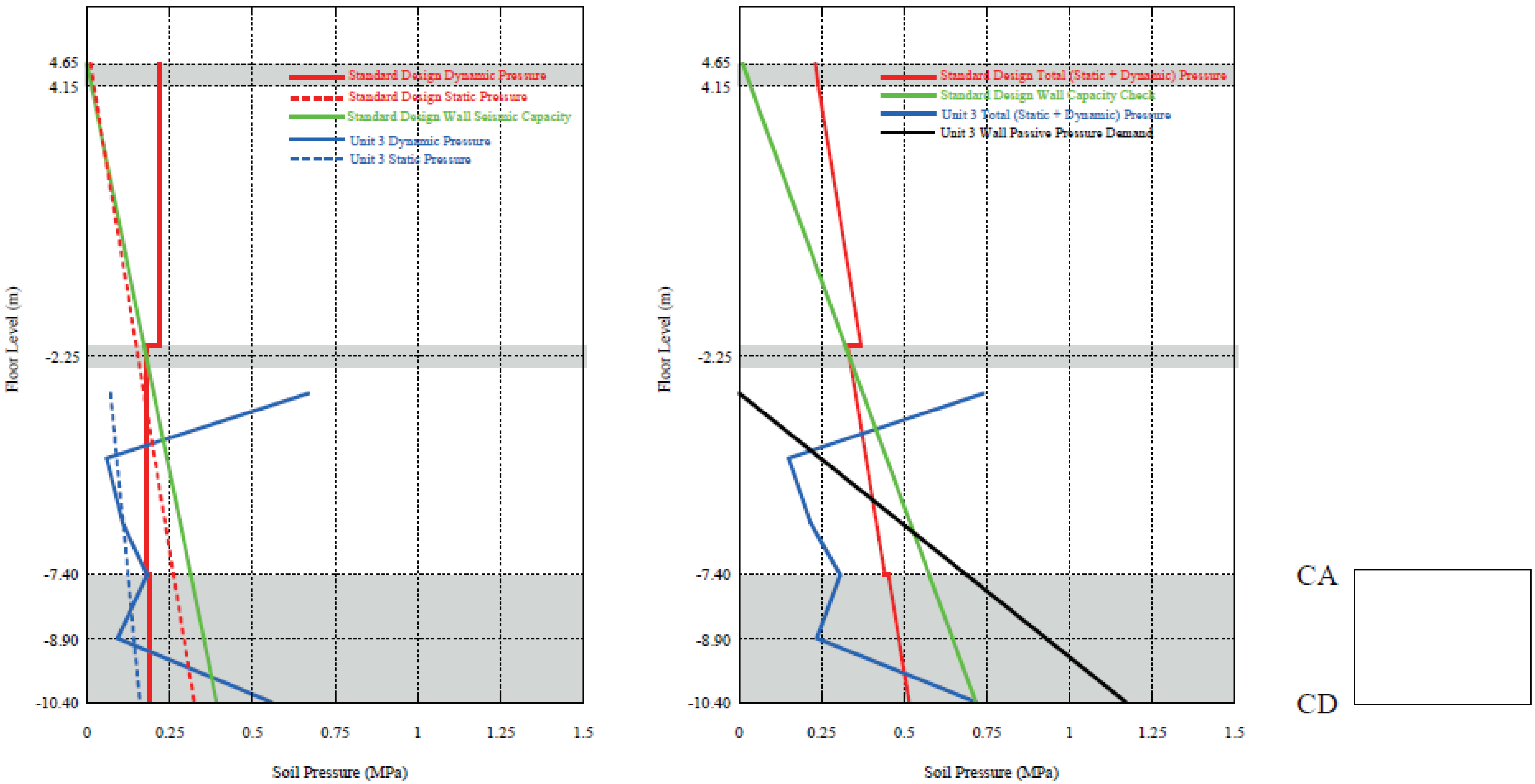
Figure 3G.8-204 **Lateral Pressure C5 Wall - Envelope of LB, BE and UB Partial Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

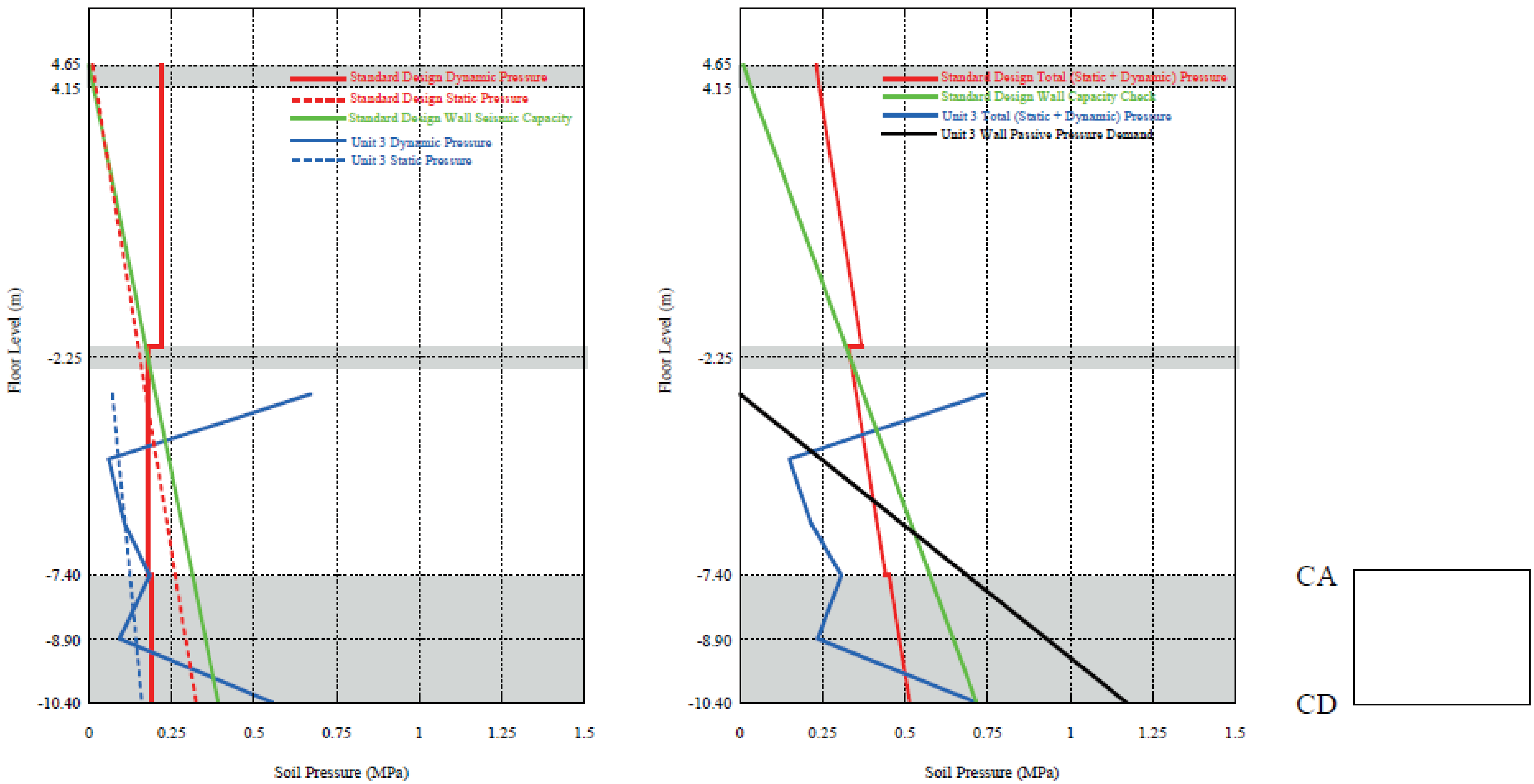
Figure 3G.8-205 **Lateral Pressure CA Wall -- Envelope of LB, BE and UB Partial Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

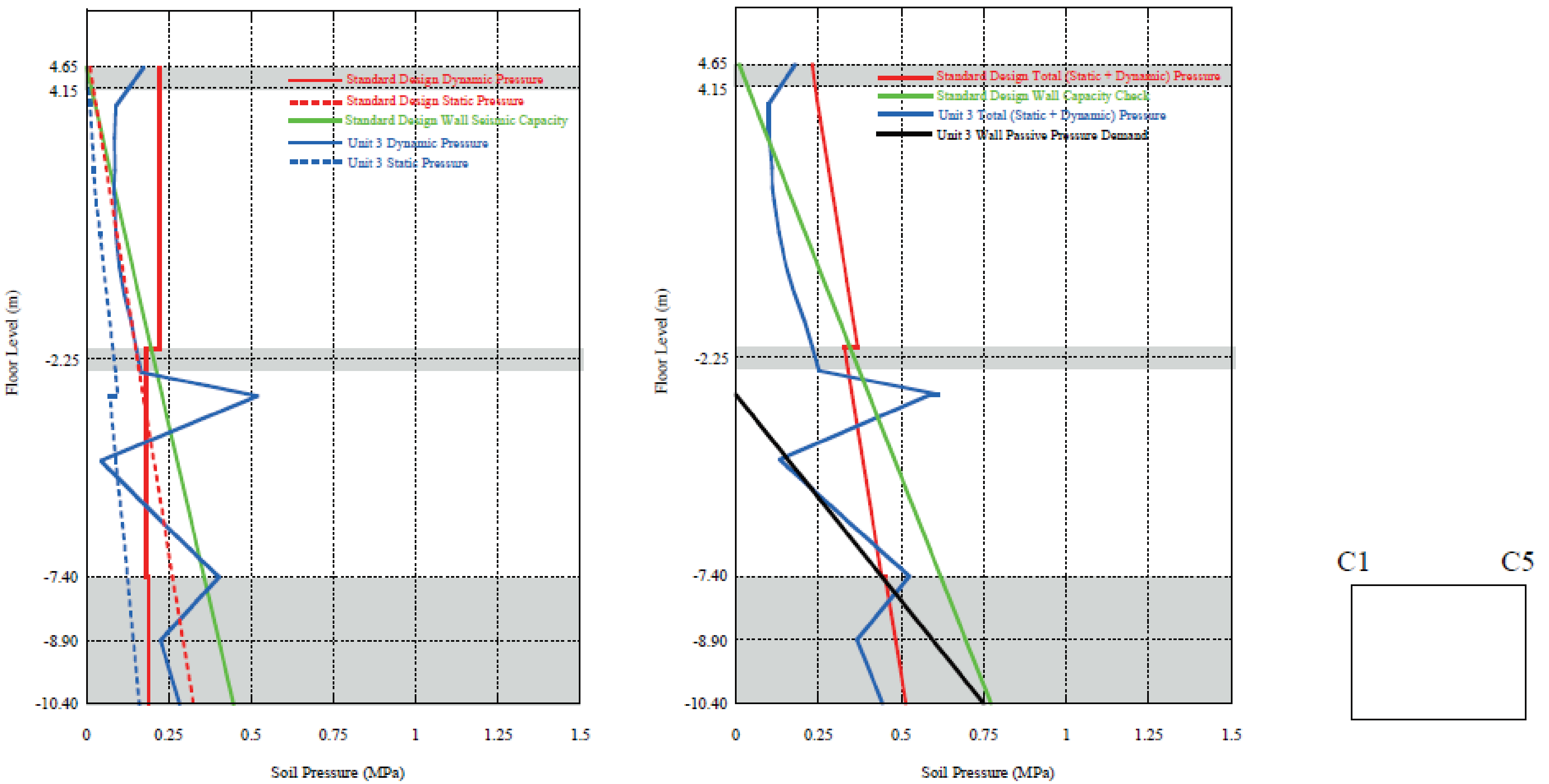
Figure 3G.8-206 **Lateral Pressure CD Wall - - Envelope of LB, BE and UB Partial Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

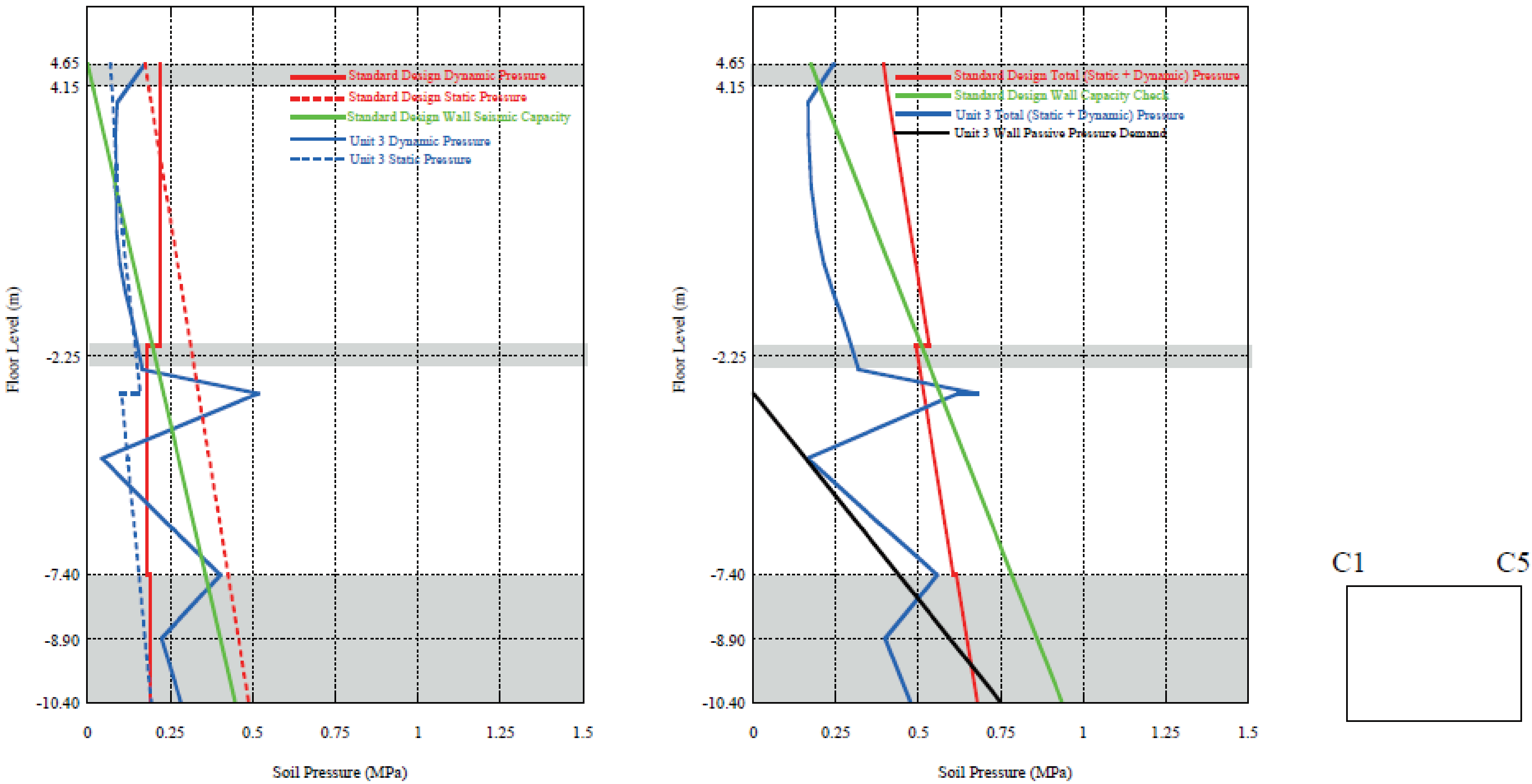
Figure 3G.8-207 **Lateral Pressure C1 Wall - Envelope of LB, BE and UB Full Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

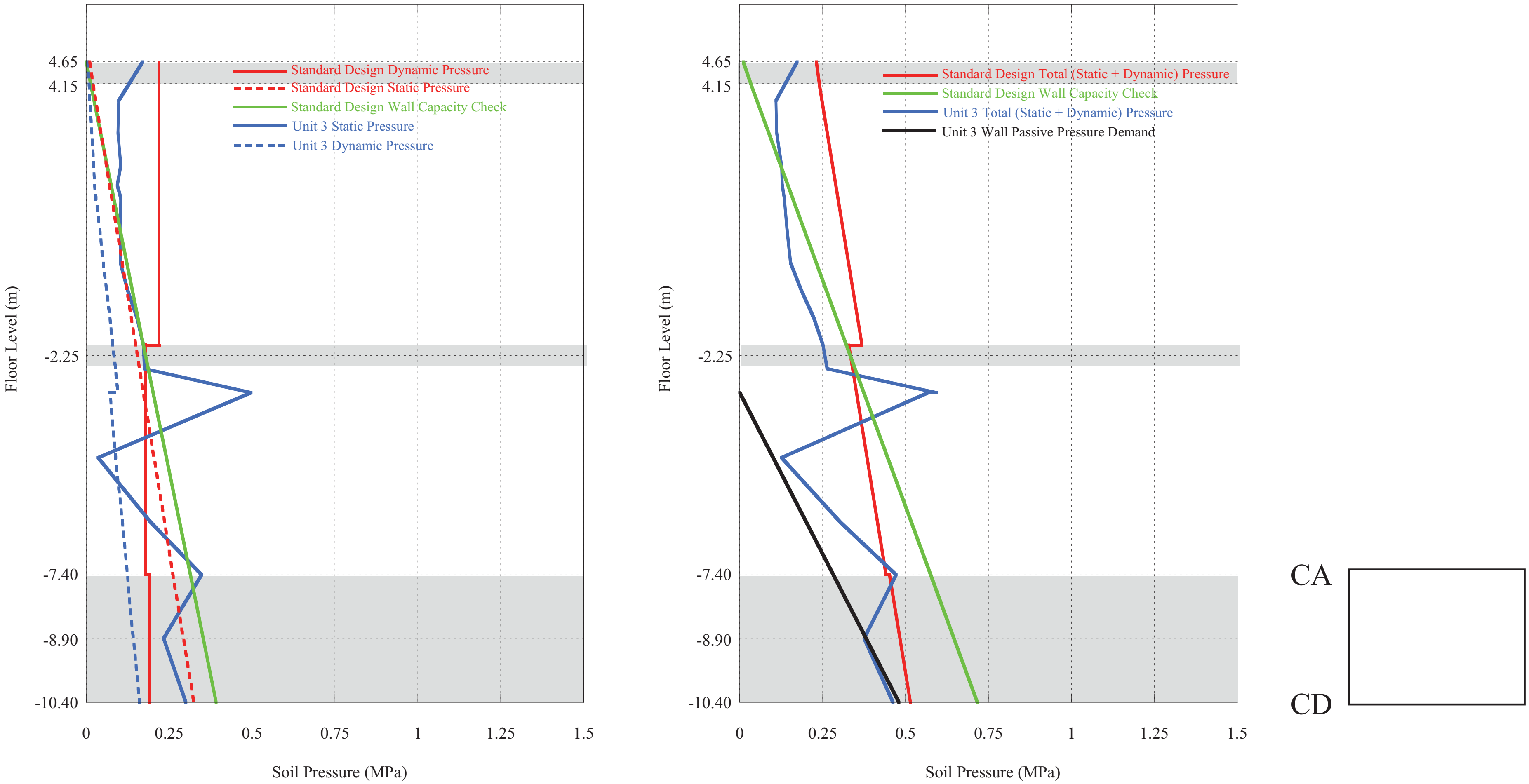
Figure 3G.8-208 **Lateral Pressure C5 Wall - Envelope of LB, BE and UB Full Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure (b) Total Pressure and Wall Passive Pressure

Note: The shaded area shows thickness of the floor slabs and basemat.

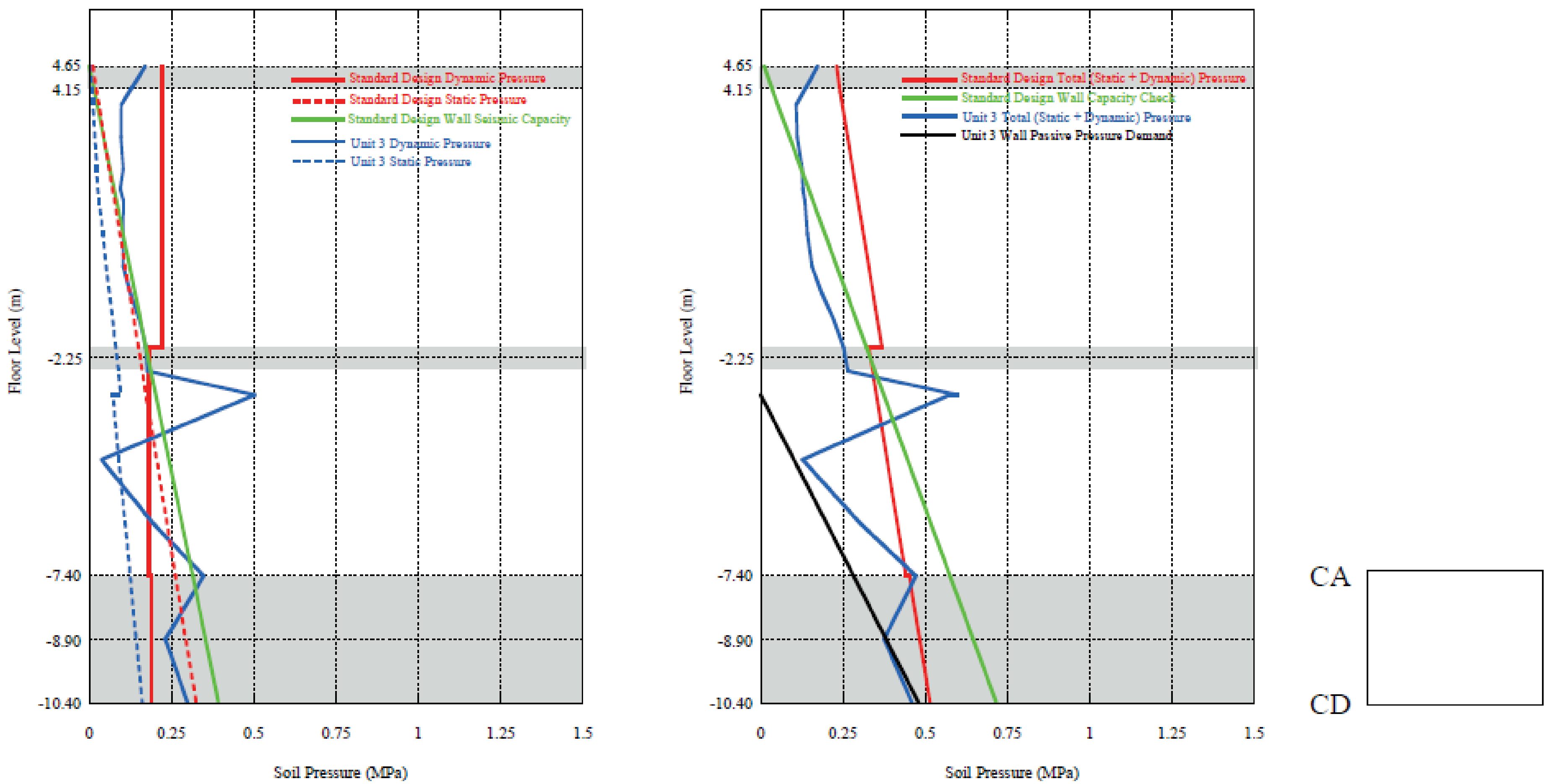
Figure 3G.8-209 **Lateral Pressure CA Wall- - Envelope of LB, BE and UB Full Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

Figure 3G.8-210 **Lateral Pressure CD Wall -- Envelope of LB, BE and UB Full Column Profiles Analyses**



(a) Static Pressure and Dynamic Pressure **(b) Total Pressure and Wall Passive Pressure**

Note: The shaded area shows thickness of the floor slabs and basemat.

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3G.9 Site-Specific Structural Evaluation of Fuel Building

The FB is integrated with the RB, including the RCCV, sharing a large common foundation mat. In the structural design of the FB, RB, and RCCV, stresses are evaluated using one finite element analysis model (RB/FB global model). Details of the analysis model and load application models are discussed with the RB/FB in Section 3G.7. This section describes the results of the finite element analyses and the structural evaluations of the FB.

3G.9.1 Objective and Scope

The objective of this section is to document the site-specific structural evaluations of the FB based on the analyses performed to address exceedances of the CSDRS. DCD Section 3G.3 remains applicable for the design and analysis of the FB with the seismic loads based on the CSDRS. Results of site-specific SSI analyses indicate that seismic load demands, in some cases, exceed the seismic load demands used for the standard design of the FB. The site-specific evaluations of the FB use input seismic loads that are based on the site-specific seismic loads presented in Section 3A.18.1.1 that bound effects of soil separation and structural stiffness variations described in Section 3A.17.9.1.

3G.9.2 Conclusions

The structural design details, inputs, and analysis results from the site-specific analysis of the FB demonstrate that the stresses in concrete and reinforcement are less than the allowable stresses per the applicable regulations, codes, or standards listed in DCD Section 3.8, with the following exceptions: 1) changes in the arrangements of reinforcements and shear ties at the exterior wall at Elevation 4.65 m to 6.60 m from the standard design, and 2) changes for the overstress condition at the exterior wall from Elevation 4.65 m to Elevation 6.60 m, which exceeds the allowable SSDP-2D stresses by 3 percent, but which is shown to meet ACI 349-01 and ASME Code limits using the alternate approach described in Sections 3.8.4.5 and 3G.7.5.4, as described below in Section 3G.9.5.4. Sliding stability for site-specific loads is maintained and the embedded exterior walls are capable of resisting passive pressure as described in Sections 3G.9.5.3 and 3G.9.5.5.

3G.9.3 Structural Description

The FB structure is described in DCD Section 3G.3.3.

3G.9.4 Analytical Models

Section 3G.7.4 provides information regarding the integrated RB/FB analysis model. The FB is analyzed using the finite element computer program NASTRAN, which is described in DCD Section 3C.2.

3G.9.5 Structural Analysis and Design

3G.9.5.1 Site Design Parameters

Key site design parameters are discussed in Section 3G.7.5.1.

3G.9.5.2 Site Design Loads, Load Combinations, and Material Properties

Loads used in the site-specific structural evaluation are discussed in Section 3G.7.5.2, as they related to the combined RB and FB structures (i.e., the RB/FB), and are the same as those used in the standard design FB structural evaluation, as described in DCD Section 3G.3.5.2, except that the seismic loads are determined from the site-specific SSI analysis results described in Section 3A.18.1.1.

The following loads are the same as those used in the standard design:

- Dead Load and Live Load — DCD Section 3G.3.5.2.1.1
- Snow and Rain Load — DCD Section 3G.3.5.2.1.2
- Lateral Soil Pressure at Rest — DCD Section 3G.3.5.2.1.3
- Wind Load — DCD Section 3G.3.5.2.1.4
- Tornado Load — DCD Section 3G.3.5.2.1.5
- Thermal Load — DCD Section 3G.3.5.2.1.6

Site-specific seismic loads replace the applicable standard design seismic loads.

Load combinations and acceptance criteria are the same as the standard design, as described in DCD Section 3G.3.5.2.2.

Material properties are as described in DCD Section 3G.3.5.2.3.

3G.9.5.3 Stability Requirements

The stability requirements are as described in DCD Sections 3G.3.5.3 and 3G.3.5.5, and Sections 3G.7.5.3 and 3G.7.5.5. The seismic stability of the RB/FB is demonstrated without reliance on the shear keys, which are credited in the standard design stability evaluation. However, the design for the RB/FB is not changed.

3G.9.5.4 Structural Design Evaluation

This section provides a description of the methodology and results of the structural evaluation of the FB structure, considering site-specific seismic load demands. Except as noted otherwise, the site-specific evaluation uses the standard design models, analysis methods, loads (as described in Section 3G.9.5.2), load combinations, and acceptance criteria, but the standard design seismic loads are replaced with the site-specific seismic loads determined in the analyses described in Sections 3A.10 through 3A.19. This section discusses the results of the finite element analyses and the structural evaluation of the FB. The evaluation includes the analysis and stress checks of the structure for site-specific seismic loads presented in Section 3A.18.1.1 in combination with other design loads in selected seismic load combinations. The site-specific seismic loads are combined with non-seismic standard plant loads following the standard design analysis methodology and acceptance criteria.

The site-specific FB structural evaluation is performed using the methodology used for the standard design structural evaluation, as described in DCD Section 3G.3.5. The site-specific evaluation uses the seismic design loads described in Section 3G.9.5.2, which, in some instances, exceed the seismic design loads of the standard design as shown in Section 3A.18.1.1. These loads are included in the site-specific structural evaluation to demonstrate the adequacy of the FB standard design.

The site-specific structural evaluation results indicate that the FB meets the structural acceptance criteria to withstand the site-specific seismic loads in combination with non-seismic standard design loads on the structure, with the exception of: 1) an overstress condition at the exterior wall, which is resolved using the alternative approach described in Sections 3.8.4.5 and 3G.7.5.4; 2) a change in the arrangements of reinforcements in two exterior wall segments; and 3) a change in the arrangement of exterior wall shear ties. This section summarizes the results of the analyses of the FB structure with the changes in the arrangement of reinforcements and shear ties. The conclusions are summarized as follows.

- Reinforced concrete walls and slabs
  - The stresses of the concrete and rebar are less than the allowable stresses specified in the code, with one exception for the overstress condition at the exterior wall from Elevation 4.65 m to

Elevation 6.60 m, which exceeds the allowable SSDP-2D stresses by 3 percent, as described below in Section 3G.9.5.4.1. Also, the arrangements of reinforcements at the exterior wall from Elevation 4.65 m to Elevation 6.60 m for Elements 72001 and 72004 are changed, as described in Section 3G.9.5.4.1.

  - The sections have enough strength to bear transverse shear forces generated by the design loads, with a change in the arrangement of shear ties at the exterior wall for Element 72004 at Elevation 4.65 m to Elevation 6.60 m, as described in Section 3G.9.5.4.1.

- Reinforced concrete columns and girders
  - The sections have sufficient strength to bear axial forces, bending moments, and shear forces generated by design loads.
- Steel structures
  - The stresses of steel members are less than the allowable stresses specified in the code.

Therefore, the FB structure is adequately designed to resist the site-specific seismic loads in combination with non-seismic standard plant loads, with the reinforcement and shear tie changes, and with the exception of the 3 percent exceedance in a localized area of one element only.

Tables 3G.9-201a through 3G.9-201c show the forces and moments at selected sections from NASTRAN analyses for seismic loads. Table 3G.9-202 shows the combined forces and moments for the selected load combination FB-9 (see DCD Table 3G.3-4 for the load combinations). Table 3G.9-203 shows the sectional thicknesses and rebar ratios of the FB used in the evaluation. Table 3G.9-204 compares the rebar and concrete stresses for the selected load combination FB-9. Table 3G.9-205 summarizes evaluation results for transverse shear for the FB.

3G.9.5.4.1 Shear Walls and Spent Fuel Pool Walls

The stresses of the concrete and reinforcing steel are calculated for flexure and membrane forces using selected design load combinations and results indicate that values are less than the code allowable stresses, with changes in the arrangements of reinforcements and shear ties, and with a single exception. As shown on Table 3G.9-203, the

arrangements of reinforcements for Elements 72001 and 72004 and shear ties for Element 72004 (at the exterior wall FB at Elevation 4.65 m to Elevation 6.60 m at the exterior wall columns FA and FF), are changed from the standard design due to the site-specific seismic loads exceeding the standard design seismic loads.

From the stress evaluation using the SSDP-2D approach, the stress demand on the FB exterior wall segment (Element 72004 from Elevation 4.65 m to Elevation 6.60 m) exceeds the SSDP-2D limits by approximately 3 percent for the axial-flexural behavior (see Table 3G.9-206).

As described in Sections 3.8.4.5 and 3G.7.5.4, when the SSDP-2D limit is exceeded, a stress check is performed using a parabolic distribution of concrete compressive stress for the section analysis. The alternate approach demonstrates that the wall section is within the ASME capacity with a parabolic concrete compressive stress distribution and the factored ACI 349-01 axial-flexural capacity curve with sufficient margin.

In addition, the site-specific seismic loads presented in Section 3A.18.1.1, applied to the NASTRAN model for structural evaluation, have been conservatively calculated using the lower OBE damping (4 percent) instead of the SSE damping (7 percent). Therefore, it is concluded that the FB exterior wall segment (Element 72004) is structurally adequate to withstand the site-specific seismic loads combined with the non-seismic loads used for the standard design (with the change in arrangements of the reinforcements and shear ties).

For shear walls and Spent Fuel Pool walls, the maximum vertical rebar stress is 257.3 MPa (37.30 ksi) in Section 2 due to the load combination FB-9 as shown in Table 3G.9-204. The maximum horizontal rebar stress is 333.3 MPa (48.33 ksi) in Section 2 for the combination FB-9, as shown in Table 3G.9-204. The maximum transverse shear force is 4.04 MN/m (23.1 kips/in) against the shear strength of 11.08 MN/m (63.25 kips/in) at Section 1, as shown in Table 3G.9-205.

3G.9.5.4.2 Floor Slabs

For floor slabs, the maximum rebar stress is 133.5 MPa (19.36 ksi) in the E-W direction due to the load combination FB-9, as shown in Table 3G.9-204. The maximum transverse shear force is 0.97 MN/m (5.54 kips/in) against the shear strength of 4.35 MN/m (24.8 kips/in) as shown in Table 3G.9-205.

3G.9.5.4.3 Foundation Mat

For foundation mat, the maximum rebar stress is 111.5 MPa (16.17 ksi) due to the load combination FB-9, as shown in Table 3G.9-204. The maximum transverse shear force is 5.35 MN/m (30.54 kips/in) against the shear strength of 16.05 MN/m (91.62 kips/in) as shown in Table 3G.9-205.

3G.9.5.5 Foundation Stability

The FB shares the foundation mat with the RB. Site-specific evaluation of foundation stability is described in Section 3G.7.5.5.

3G.9.5.6 Tornado Missile Evaluation

DCD Section 3G.3.5.6 is applicable to the FB with no changes.

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Table 3G.9-201a **Results of NASTRAN Analysis, Seismic Load FB (Horizontal: North to South Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	-2.527	-0.242	0.003	0.047	0.600	-0.044	0.182	0.250
	60219	-3.014	-0.410	-0.969	1.178	1.359	0.655	-0.168	0.104
	70201	0.104	-0.513	-2.050	-0.332	-0.161	-0.003	-0.008	-0.040
	70204	0.894	-0.953	-3.264	-0.222	-0.234	-0.136	0.010	0.024
	110718	0.541	0.223	0.570	0.024	0.004	-0.044	0.041	-0.064
2 Exterior Wall @ EL4.65 ~6.60 m	62011	0.623	-0.113	-0.372	0.013	0.227	0.003	-0.029	0.022
	62019	0.413	-0.851	-1.324	0.066	0.226	0.003	0.012	0.031
	72001	-0.541	-1.875	-3.594	-0.164	-0.068	0.013	0.015	0.044
	72004	-0.759	-1.467	-4.289	-0.040	-0.030	-0.001	0.024	0.004
3 Exterior Wall @ EL22.50 ~24.60 m	64011	2.978	-0.129	-0.106	-0.055	-0.191	0.022	0.012	0.035
	64019	2.526	0.030	-0.323	-0.057	-0.149	-0.058	-0.032	0.031
	74001	0.086	-0.118	-1.096	0.044	0.049	-0.051	0.031	-0.014
	74004	-1.294	-0.175	-1.774	0.030	0.027	-0.030	0.013	0.011
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	-1.022	0.127	-1.375	1.221	0.842	0.921	0.121	0.038
	70801	-0.358	-0.817	-3.068	-0.657	-0.131	0.005	0.054	0.014
	70804	-0.103	-0.726	-3.437	-0.274	-0.078	-0.167	0.069	0.007
	110748	0.267	0.681	0.555	0.189	0.101	-0.145	-0.026	-0.036
5 Basemat	90306	1.633	-0.406	2.341	0.219	-0.150	2.426	-1.962	0.880
	90310	0.445	-0.957	0.030	0.506	-0.204	-0.171	-0.708	1.380
	90410	0.195	-4.795	-0.653	1.554	0.524	0.164	0.151	-0.109

Table 3G.9-201a **Results of NASTRAN Analysis, Seismic Load FB (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 Basemat @ Spent Fuel Pool	90486	0.407	-1.009	-1.091	2.026	1.996	-1.743	-0.995	-0.035
	90490	-0.049	-5.644	0.507	2.336	2.835	-0.175	0.538	-0.900
	90526	2.798	-0.137	-3.221	0.443	0.361	-3.693	-1.172	-0.748
6 Slab EL4.65 m	93306	1.355	0.182	-0.860	0.288	-0.056	0.008	-0.077	-0.073
	93310	0.483	0.194	0.424	0.404	-0.225	0.053	-0.306	0.355
	93410	-0.409	0.459	1.304	0.362	0.100	0.081	-0.200	-0.005

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Table 3G.9-201b **Results of NASTRAN Analysis, Seismic Load FB (Horizontal: East to West Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	0.127	0.100	1.432	-0.003	0.182	0.017	0.004	0.053
	60219	-0.749	-0.811	0.748	0.095	-0.120	0.002	0.003	-0.021
	70201	-0.041	-0.396	-0.366	-0.035	-0.084	0.006	-0.007	0.029
	70204	-0.066	-1.134	-1.147	-0.038	-0.137	0.027	0.007	0.050
	110718	0.154	-0.450	0.179	-0.057	-0.133	-0.006	0.011	-0.070
2 Exterior Wall @ EL4.65 ~6.60 m	62011	-0.188	0.141	2.379	-0.025	-0.022	0.000	0.009	-0.009
	62019	-0.067	-1.025	1.859	0.004	0.007	0.001	-0.001	0.001
	72001	-0.092	-2.116	-0.080	-0.005	0.032	-0.001	0.033	-0.020
	72004	-0.211	-1.815	-0.919	0.026	0.082	0.012	0.006	-0.011
3 Exterior Wall @ EL22.50 ~24.60 m	64011	-0.040	0.012	1.635	0.000	0.005	-0.001	0.001	-0.001
	64019	0.503	-0.082	1.246	0.000	-0.011	0.006	0.001	0.003
	74001	0.176	-0.213	-0.277	0.054	0.003	0.004	-0.038	-0.022
	74004	0.865	-0.137	-0.920	-0.003	-0.035	-0.001	-0.002	-0.008
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	-0.330	-0.421	0.955	0.078	-0.002	-0.011	0.002	-0.010
	70801	-0.029	-0.942	-0.470	0.031	0.055	0.009	0.010	0.045
	70804	-0.138	-0.873	-1.039	0.005	0.078	0.019	0.005	0.031
	110748	0.152	-0.207	0.175	0.065	0.006	-0.029	-0.014	-0.032
5 Basemat	90306	1.386	0.424	-1.243	-0.964	-0.175	-0.848	1.116	-1.018
	90310	0.146	0.278	-0.141	-0.069	-0.051	0.230	-0.169	-0.269
	90410	0.038	0.191	-1.179	0.159	0.269	-1.639	-0.055	1.018

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Table 3G.9-201b **Results of NASTRAN Analysis, Seismic Load FB (Horizontal: East to West Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 Basemat @ Spent Fuel Pool	90486	-0.256	-0.281	-0.615	2.848	2.976	0.734	-0.251	0.291
	90490	-0.129	-1.702	-0.739	0.644	1.838	-0.546	0.905	0.419
	90526	-0.573	-0.169	-1.355	2.088	0.837	-0.745	-0.977	-1.038
6 Slab EL4.65 m	93306	-0.987	-0.072	0.755	-0.210	-0.092	-0.005	-0.050	0.040
	93310	-0.191	-0.199	0.082	-0.011	-0.082	-0.026	-0.067	-0.004
	93410	0.009	-0.598	0.036	-0.030	0.020	-0.015	0.054	0.020

Table 3G.9-201c **Results of NASTRAN Analysis, Seismic Load FB (Vertical: Upward Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	-0.394	-1.290	-0.294	-0.134	-0.824	-0.025	-0.052	-0.250
	60219	-0.106	-1.323	-0.197	-0.253	-0.663	-0.117	0.020	-0.118
	70201	0.031	-0.236	0.012	0.103	-0.108	0.000	-0.076	0.057
	70204	0.089	-0.958	-0.058	-0.078	-0.237	0.031	-0.008	0.062
	110718	0.169	-0.999	-0.239	0.000	0.035	0.008	-0.001	0.004
2 Exterior Wall @ EL4.65 ~6.60 m	62011	0.069	-0.913	0.081	0.046	0.204	0.011	0.008	0.068
	62019	0.057	-0.638	-0.092	-0.006	0.097	-0.035	0.001	0.033
	72001	0.038	-0.262	-0.010	0.045	0.006	0.001	-0.001	0.004
	72004	0.025	-0.510	0.010	0.004	0.023	0.012	-0.004	-0.004
3 Exterior Wall @ EL22.50 ~24.60 m	64011	0.075	-0.351	-0.041	-0.146	-0.706	-0.004	-0.004	0.097
	64019	-0.055	-0.438	-0.042	-0.084	-0.497	0.064	0.079	0.080
	74001	-0.011	-0.045	0.075	0.066	-0.058	-0.060	-0.029	-0.039
	74004	-0.063	-0.265	0.023	-0.103	-0.442	-0.078	0.023	-0.089
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	0.091	-1.085	-0.333	-0.280	-0.075	-0.164	-0.005	-0.055
	70801	0.090	-0.331	-0.055	0.194	0.026	-0.027	-0.048	-0.005
	70804	0.114	-0.703	-0.012	-0.023	-0.011	0.018	-0.020	0.027
	110748	0.106	-0.671	-0.295	-0.025	0.003	0.003	0.003	0.010
5 Basemat	90306	-0.712	-0.334	0.447	0.682	-0.086	0.181	-0.461	0.901
	90310	-0.084	-0.104	-0.026	-0.102	-0.113	-0.505	0.098	-0.027
	90410	-0.309	-0.785	0.302	-0.474	0.139	1.025	1.008	0.036

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Table 3G.9-201c **Results of NASTRAN Analysis, Seismic Load FB (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 Basemat @ Spent Fuel Pool	90486	-0.081	-0.369	-0.055	2.628	1.776	0.248	-0.136	0.099
	90490	-0.119	-0.339	0.155	-0.009	0.762	0.334	1.083	0.177
	90526	-0.003	-0.102	-0.124	1.279	0.419	0.034	-0.234	-0.829
6 Slab EL4.65 m	93306	0.165	-0.003	0.027	0.048	0.051	0.009	0.026	-0.126
	93310	0.034	0.044	0.206	0.046	0.020	0.041	-0.025	0.006
	93410	0.237	0.287	-0.238	0.075	0.018	-0.068	-0.046	-0.016

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Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	OTHR	-2.179	-2.004	-0.745	-0.154	-1.159	0.012	-0.076	-0.809
		TEMP	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
		SEIS	3.391	1.389	1.662	0.152	1.097	0.062	0.309	0.411
		HYDR	0.241	0.207	0.204	0.015	0.085	0.007	0.008	0.029
	60219	OTHR	-1.837	-1.809	-0.485	-0.058	-0.765	0.071	0.027	-0.605
		TEMP	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
		SEIS	4.507	1.922	1.484	2.874	5.191	1.147	0.405	2.304
		HYDR	0.224	0.415	0.145	0.059	0.141	0.008	0.005	0.024
	70201	OTHR	-0.655	-0.307	0.030	-0.935	-0.688	-0.446	0.399	-0.021
		TEMP	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
		SEIS	0.602	0.811	2.674	1.445	0.852	0.681	0.452	0.270
		HYDR	0.007	0.122	0.136	0.011	0.038	0.002	0.016	0.012
	70204	OTHR	-0.914	-1.541	-0.123	0.304	-1.512	-0.294	-0.067	1.423
		TEMP	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
		SEIS	2.332	2.155	4.012	0.621	2.107	0.487	0.097	1.544
		HYDR	0.067	0.403	0.260	0.031	0.071	0.008	0.001	0.016
	110718	OTHR	-0.526	-1.088	-0.689	-0.070	0.031	0.038	0.062	0.117
		TEMP	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
		SEIS	2.496	1.141	2.693	0.133	0.241	0.123	0.108	0.258
		HYDR	0.114	0.194	0.045	0.011	0.026	0.002	0.003	0.013

Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
2 Exterior Wall @ EL4.65 ~6.60 m	62011	OTHR	-0.162	-1.120	-0.066	0.029	0.151	0.007	0.002	0.056
		TEMP	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
		SEIS	1.284	0.962	2.571	0.199	0.891	0.038	0.042	0.348
		HYDR	0.072	0.054	0.130	0.002	0.008	0.000	0.003	0.002
	62019	OTHR	-0.256	-0.685	-0.078	0.008	0.089	-0.026	0.009	0.040
		TEMP	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
		SEIS	0.805	1.650	2.732	0.399	0.738	0.166	0.075	0.202
		HYDR	0.043	0.088	0.135	0.002	0.008	0.001	0.000	0.001
	72001	OTHR	-0.044	-0.197	-0.006	-0.199	-0.029	0.034	0.117	0.018
		TEMP	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
		SEIS	1.556	3.040	4.567	0.663	0.200	0.165	0.301	0.085
		HYDR	0.016	0.138	0.191	0.005	0.004	0.001	0.001	0.003
	72004	OTHR	-0.198	-0.588	-0.002	0.302	0.200	0.036	0.044	-0.113
		TEMP	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
		SEIS	1.884	2.616	5.021	0.622	0.871	0.106	0.117	0.460
		HYDR	0.037	0.133	0.227	0.002	0.004	0.001	0.001	0.001

Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
3 Exterior Wall @ EL22.50 ~24.60 m	64011	OTHR	0.050	-0.326	-0.059	-0.123	-0.604	0.001	-0.002	0.084
		TEMP	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
		SEIS	3.265	0.377	1.666	0.160	0.719	0.055	0.028	0.221
		HYDR	0.242	0.001	0.092	0.004	0.011	0.001	0.001	0.001
	64019	OTHR	-0.131	-0.425	-0.116	-0.068	-0.422	0.052	0.067	0.068
		TEMP	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
		SEIS	2.843	0.448	1.400	0.100	0.545	0.212	0.103	0.088
		HYDR	0.178	0.008	0.070	0.004	0.008	0.002	0.002	0.002
	74001	OTHR	-0.032	-0.046	0.146	0.046	-0.055	-0.037	-0.029	-0.028
		TEMP	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
		SEIS	0.221	0.275	1.173	0.154	0.094	0.225	0.073	0.052
		HYDR	0.014	0.013	0.064	0.006	0.003	0.003	0.003	0.002
	74004	OTHR	-0.080	-0.240	0.154	-0.085	-0.400	-0.056	0.014	-0.080
		TEMP	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
		SEIS	1.773	0.355	2.028	0.120	0.449	0.151	0.071	0.211
		HYDR	0.083	0.006	0.121	0.002	0.003	0.003	0.001	0.001

Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	OTHR	-1.497	-1.381	-0.597	0.277	0.635	0.029	0.139	-0.023
		TEMP	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
		SEIS	2.815	1.358	1.990	6.707	2.047	1.474	0.416	1.095
		HYDR	0.039	0.284	0.174	0.058	0.037	0.016	0.006	0.011
	70801	OTHR	-0.950	-0.542	-0.041	-2.508	-0.190	-0.332	1.569	-0.269
		TEMP	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
		SEIS	2.446	1.484	3.257	4.046	0.609	0.812	2.099	0.610
		HYDR	0.019	0.153	0.214	0.025	0.007	0.006	0.009	0.003
	70804	OTHR	-0.819	-0.982	-0.023	2.046	1.302	-0.251	0.231	0.205
		TEMP	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
		SEIS	2.332	1.601	3.755	3.232	1.357	0.538	0.366	0.553
		HYDR	0.036	0.267	0.261	0.023	0.011	0.012	0.002	0.007
	110748	OTHR	-0.379	-0.723	-0.443	-0.078	-0.049	-0.053	0.092	-0.050
		TEMP	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
		SEIS	1.618	1.105	2.135	0.421	0.143	0.255	0.101	0.099
		HYDR	0.043	0.066	0.049	0.007	0.007	0.011	0.001	0.004

Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 Basemat	90306	OTHR	-3.541	-2.445	0.674	0.917	-0.652	0.323	-0.542	1.429
		TEMP	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
		SEIS	2.617	0.678	2.942	1.298	0.418	2.974	2.642	1.674
		HYDR	0.266	0.117	0.292	0.253	0.065	0.246	0.234	0.289
	90310	OTHR	-1.958	-1.979	0.185	-0.542	-0.441	-0.170	0.342	0.115
		TEMP	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
		SEIS	0.583	1.065	0.300	0.726	0.502	0.939	1.193	2.000
		HYDR	0.036	0.099	0.016	0.044	0.045	0.102	0.078	0.100
	90410	OTHR	-2.630	-4.301	0.674	-1.786	0.003	1.615	1.584	-0.270
		TEMP	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
		SEIS	0.369	4.923	2.060	1.989	0.824	2.609	1.088	1.731
		HYDR	0.050	0.457	0.140	0.106	0.081	0.332	0.163	0.102
5 Basemat @ Spent Fuel Pool	90486	OTHR	-2.594	-4.374	-0.208	3.019	1.614	-0.002	-0.108	-0.148
		TEMP	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
		SEIS	0.450	1.155	1.352	6.105	4.467	2.495	1.324	0.507
		HYDR	0.113	0.145	0.089	1.198	0.875	0.148	0.090	0.061
	90490	OTHR	-2.642	-3.508	0.201	-0.804	0.810	0.377	1.391	-0.182
		TEMP	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
		SEIS	0.329	6.047	1.760	9.878	4.395	1.601	1.904	1.863
		HYDR	0.040	0.495	0.117	0.237	0.504	0.121	0.370	0.063
	90526	OTHR	-3.184	-4.999	-0.266	0.868	-3.882	-0.145	-0.188	-1.583
		TEMP	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
		SEIS	3.195	0.408	3.822	3.345	5.356	4.786	1.856	1.932
		HYDR	0.192	0.044	0.282	0.655	0.248	0.301	0.141	0.339

Table 3G.9-202 **Combined Forces and Moments: Selected Load Combination FB-9** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
6 Slab EL4.65 m	93306	OTHR	0.051	-0.186	-0.110	0.086	0.127	0.012	0.034	-0.141
		TEMP	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
		SEIS	1.696	0.171	1.135	0.408	0.395	0.029	0.104	0.175
		HYDR	0.129	0.026	0.171	0.024	0.029	0.002	0.005	0.006
	93310	OTHR	-0.034	-0.026	0.124	0.077	0.035	0.014	-0.043	0.002
		TEMP	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
		SEIS	0.577	0.275	0.548	0.580	0.327	0.108	0.431	0.423
		HYDR	0.024	0.018	0.044	0.023	0.022	0.003	0.024	0.022
	93410	OTHR	-0.010	-0.085	-0.080	0.163	0.045	-0.050	-0.072	-0.015
		TEMP	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032
		SEIS	0.606	0.801	1.358	0.813	0.172	0.209	0.392	0.027
		HYDR	0.013	0.091	0.076	0.017	0.005	0.008	0.011	0.001

OTHR: Loads other than thermal loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

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Table 3G.9-203 **Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation**

Location	Element ID	Thickness (m)	Position	Primary Reinforcement				Shear Tie	
				Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
1 Exterior Wall and Pool Wall Bottom	60011	2.0	Inside	3-#11@200	0.755	1-#11@100 +3-#11@200	1.258	#6@200x200	0.710
			Outside	1-#11@100 +3-#11@200	1.258	2-#11@100 +2-#11@200	1.510		
	60219	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258		
	70201 70204	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516		
	110718	1.5	Inside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342	#6@400x200	0.355
			Outside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342		

Table 3G.9-203 **Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
2 Exterior Wall @ EL4.65 to 6.60 m	62011 62019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	3-#11@200	1.510	3-#11@200	1.510		
	72001	1.0	Inside	3-#11@200	1.510	3-#11@200	1.510	#5@400x200	0.250
			Outside	3-#11@200	1.510	3-#11@200	1.510		
	72004	1.0	Inside	3-#11@200	1.510	2-#11@200 (+1-#11@200)	1.510	#5@400x200	0.250
			Outside	3-#11@200	1.510	3-#11@200	1.510		
Note: Revised arrangements of reinforcements and shear ties from standard design are shown in red.									
3 Exterior Wall @ EL22.50 to 24.60 m	64011	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	2-#11@200 (+1-#11@200)	1.510	2-#11@200 (+1-#11@200)	1.510		
	64019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	2-#11@200	1.006	2-#11@200	1.006		
	74001 74004	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	3-#11@200	1.510	3-#11@200	1.510		

Table 3G.9-203 **Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
4 Spent Fuel Pool Wall @ EL-5.10 to -3.30 m	60819	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258		
	70801 70804	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516		
	110748	1.5	Inside	2-#11@200	0.671	3-#11@200	1.006	#6@400x400	0.177
			Outside	2-#11@200	0.671	3-#11@200	1.006		
5 Basemat	90306 90310 90410	4.0	Top	4-#11@200	0.503	4-#11@200	0.503	#11@400x400	0.629
			Bottom	5-#11@200	0.629	5-#11@200	0.629		
5 Basemat @ Spent Fuel Pool	90486	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@600x400	0.419
			Bottom	5-#11@200	0.457	5-#11@200	0.457		
	90490 90526	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@400x400	0.629
			Bottom	5-#11@200	0.457	5-#11@200	0.457		

Table 3G.9-203 **Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement[b]	Ratio (%)	Arrangement[b]	Ratio (%)	Arrangement	Ratio (%)
6 Slab EL4.65 m	93306 93310 93410	1.3	Top	2-#11@200	0.774	2-#11@200	0.774	#5@200x200	0.500
			Bottom	2-#11@200	0.774	2-#11@200	0.774		

a. Exterior Wall, Pool Wall — Direction 1: Horizontal — Direction 2: Vertical
Basemat, Slab — Direction 1: N-S — Direction 2: E-W

b. Rebar in parenthesis indicates additional bars locally required.

Table 3G.9-204 Rebar and Concrete Stresses of FB: Selected Load Combination FB-9

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	-4.6	-29.3	57.3	-25.0	28.0	5.1	372.2
	60219	-10.4	-28.5	35.8	66.5	-39.1	78.8	366.4
	70201	-7.1	-28.3	8.2	127.5	7.5	104.2	364.6
	70204	-11.7	-28.3	72.2	84.6	-40.0	85.8	364.6
	110718	-12.1	-28.1	-10.9	115.7	-18.4	83.9	363.3
2 Exterior Wall @ EL4.65 ~6.60 m	62011	-17.3	-29.3	106.8	202.7	257.3	206.1	372.2
	62019	-20.4	-29.3	179.6	233.7	167.4	199.6	372.2
	72001	-16.2	-29.3	176.8	327.0	99.7	204.5	372.2
	72004	-15.8	-29.3	282.2	333.3	251.7	240.1	372.2
3 Exterior Wall @ EL22.50 ~24.60 m	64011	-22.1	-29.3	130.4	267.0	42.6	235.8	372.2
	64019	-7.1	-29.3	233.0	291.1	30.6	255.5	372.2
	74001	-8.7	-29.3	77.0	98.6	65.0	82.4	372.2
	74004	-9.6	-29.3	148.1	217.0	5.0	220.4	372.2
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	-8.3	-28.5	-32.5	46.4	-20.9	22.2	366.4
	70801	-14.1	-28.3	67.7	146.0	30.0	86.9	364.6
	70804	-8.6	-28.3	126.3	71.5	85.5	45.1	364.6
	110748	-9.8	-28.1	33.0	92.8	-26.6	62.1	363.3

Table 3G.9-204 **Rebar and Concrete Stresses of FB: Selected Load Combination FB-9** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				Direction 1[a]		Direction 2[a]		
		Calculated	Allowable	In/Top	Out/Bottom	In/Top	Out/Bottom	Allowable
5 Basemat	90306	-5.6	-23.5	59.9	-23.2	55.2	1.0	372.2
	90310	-1.7	-23.5	-2.5	-6.5	1.1	-7.1	372.2
	90410	-4.0	-23.5	16.1	-5.7	44.9	-22.7	372.2
5 Basemat @ Spent Fuel Pool	90486	-6.0	-22.9	-11.7	35.4	-15.6	17.4	367.2
	90490	-7.0	-22.9	15.8	89.6	99.7	60.3	367.2
	90526	-5.0	-22.9	111.5	19.0	48.6	34.4	367.2
6 Slab EL4.65 m	93306	-4.3	-29.3	82.9	90.7	133.5	38.8	372.2
	93310	-8.7	-29.3	36.4	96.6	12.7	92.0	372.2
	93410	-6.9	-29.3	83.9	90.3	20.1	-14.7	372.2

Note: Negative value means compression.

a. Exterior Wall, Pool Wall Direction 1: Horizontal, Direction 2: Vertical
Basemat, Slab Direction 1: N-S, Direction 2: E-W

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Table 3G.9-205 **Transverse Shear of FB for DCD Load Combinations**

Location	Element ID	Load ID	d (m)	ρv (%)	Shear Force (MN/m) Vu	Vc	Vs	φVn	Vu/φVn
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	FB-9	1.70	0.710	1.53	3.97	4.99	7.62	0.200
	60219	FB-9	3.05	0.710	4.04	4.08	8.96	11.08	0.364
	70201	FB-9	1.65	0.710	0.98	1.78	4.85	5.64	0.174
	70204	FB-9	1.59	0.710	3.01	2.56	4.67	6.15	0.490
	110718	FB-9	1.12	0.355	0.50	1.13	1.64	2.36	0.211
2 Exterior Wall @ EL4.65 ~6.60 m	62011	FB-9	0.72	0.125	0.38	0.75	0.37	0.95	0.400
	62019	FB-9	0.78	0.125	0.17	0.24	0.40	0.55	0.314
	72001	FB-9	0.73	0.250	0.47	0.00	0.76	0.64	0.727
	72004	FB-9	0.72	0.250	0.36	0.00	0.74	0.63	0.567
3 Exterior Wall @ EL22.50 ~24.60 m	64011	FB-9	0.72	0.125	0.31	0.71	0.37	0.92	0.334
	64019	FB-9	0.80	0.125	0.22	0.00	0.41	0.35	0.617
	74001	FB-9	0.73	0.125	0.16	0.30	0.38	0.58	0.269
	74004	FB-9	0.72	0.125	0.30	0.41	0.37	0.66	0.457
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	FB-9	3.05	0.710	2.05	6.00	8.97	12.72	0.161
	70801	FB-9	1.71	0.710	3.77	2.16	5.02	6.10	0.617
	70804	FB-9	1.62	0.710	1.02	1.36	4.75	5.19	0.197
	110748	FB-9	1.21	0.177	0.64	1.15	0.88	1.73	0.368
5 Basemat	90306	FB-9	3.53	0.629	4.66	6.92	9.18	13.68	0.341
	90310	FB-9	3.49	0.629	2.66	5.67	9.08	12.54	0.212
	90410	FB-9	3.53	0.629	3.47	6.91	9.19	13.68	0.254
5 Basemat @ Spent Fuel Pool	90486	FB-9	5.04	0.419	1.58	6.56	8.74	13.00	0.122
	90490	FB-9	5.04	0.629	5.35	5.77	13.11	16.05	0.333
	90526	FB-9	5.02	0.629	4.42	9.24	13.07	18.97	0.233

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Table 3G.9-205 **Transverse Shear of FB for DCD Load Combinations** *(continued)*

Location	Element ID	Load ID	d (m)	ρv (%)	Shear Force (MN/m)				Vu/φVn
					Vu	Vc	Vs	φVn	
6 Slab EL4.65 m	93306	FB-9	1.10	0.500	0.41	0.78	2.27	2.60	0.158
	93310	FB-9	1.10	0.500	0.97	2.85	2.27	4.35	0.223
	93410	FB-9	1.10	0.500	0.57	2.20	2.27	3.80	0.151

Table 3G.9-206 **Maximum Stress Ratios for Flexure and Membrane Forces**

Location	Element ID	Concrete		Primary Reinforcement							
				Direction 1[a]				Direction 2[a]			
				In/Top		Out/Bottom		In/Top		Out/Bottom	
		σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50 m	60011	0.246	7461	0.159	7621	0.250	8011	0.112	9013	0.164	7461
	60219	0.481	8511	0.227	7601	0.256	9011	0.168	7701	0.306	8511
	70201	0.448	6981	0.123	7751	0.467	8512	0.111	7751	0.374	8514
	70204	0.551	8511	0.212	7601	0.349	9011	0.217	7701	0.356	8514
	110718	0.719	7492	0.481	7701	0.512	8511	0.111	7751	0.377	7492
2 Exterior Wall @ EL4.65 ~6.60 m	62011	0.692	8514	0.383	9013	0.632	7492	0.729	9012	0.801	7492
	62019	0.738	8514	0.531	9014	0.638	7471	0.556	7991	0.540	7482
	72001	0.576	8511	0.766	7653	0.863	8511	0.761	7653	0.710	7491
	72004	1.033	8512	0.839	7221	0.948	8512	0.979	7632	0.946	8071
3 Exterior Wall @ EL22.50 ~24.60 m	64011	0.778	8511	0.508	7961	0.726	7521	0.451	8071	0.644	8511
	64019	0.505	7501	0.630	8513	0.798	8513	0.277	8071	0.686	7441
	74001	0.306	8511	0.217	8511	0.276	8511	0.188	7581	0.231	8511
	74004	0.460	8511	0.421	8514	0.584	7471	0.327	8061	0.593	7471
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30 m	60819	0.343	8511	0.277	7711	0.239	7601	0.086	7611	0.120	7491
	70801	0.700	7491	0.300	7601	0.534	7492	0.220	7601	0.336	7492
	70804	0.472	8513	0.434	7861	0.377	7311	0.290	7861	0.253	8513
	110748	0.547	8511	0.517	8001	0.387	8511	0.273	8001	0.278	8511

Table 3G.9-206 **Maximum Stress Ratios for Flexure and Membrane Forces** *(continued)*

Location	Element ID	Concrete		Primary Reinforcement							
				Direction 1[a]				Direction 2[a]			
				In/Top		Out/Bottom		In/Top		Out/Bottom	
		σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID
5 Basemat	90306	0.247	8512	0.181	7121	0.063	8514	0.176	7121	0.017	7911
	90310	0.150	7211	0.042	2011	0.039	7211	0.040	2011	0.044	7961
	90410	0.282	7491	0.061	8021	0.057	7461	0.128	8021	0.199	7711
5 Basemat @ Spent Fuel Pool	90486	0.347	8514	0.158	7251	0.212	7492	0.059	7251	0.165	8514
	90490	0.356	8511	0.230	7601	0.304	7492	0.273	7621	0.212	7992
	90526	0.239	7491	0.300	7921	0.088	7991	0.141	7601	0.145	8512
6 Slab EL4.65 m	93306	0.165	7211	0.517	7201	0.245	7301	0.368	8514	0.174	8001
	93310	0.303	8514	0.267	7431	0.268	8514	0.243	7411	0.257	8514
	93410	0.289	7561	0.596	7491	0.395	7701	0.275	7501	0.259	7701

Exceedance is highlighted. As described in Section 3G.9.5.4.1, the exceedance is resolved by considering the moment capacity of wall according to the specifications of ACI 349-01.

a. Exterior Wall, Pool Wall: Direction 1: Horizontal Direction 2: Vertical
Basemat, Slab: Direction 1: N-S, Direction 2: E-W

σ and σ_a = calculated and allowable stress

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3G.10 Site-Specific Structural Evaluation of Firewater Service Complex

The site-specific structural evaluations of the FWSC are described in this section.

3G.10.1 Objective and Scope

The objective of this section is to document the FWSC site-specific structural evaluations based on the analyses performed to address exceedances of the CSDRS. DCD Section 3G.4 remains applicable for the design and analysis of the FWSC with the seismic loads based on the CSDRS. Results of site-specific SSI and SSSI analyses indicate that seismic load demands, in some cases, exceed the seismic load demands used in the standard design. The site-specific evaluations of the FWSC structures use input seismic loads that are based on the site-specific seismic loads presented in Section 3A.18.1.3 that bound effects of concrete cracking, SSSI with the CB and separation between the concrete fill and surrounding soil described in Sections 3A.17.9.3, 3A.17.11, and 3A.17.14.5, respectively.

3G.10.2 Conclusions

The site-specific structural evaluation of the FWSC demonstrates that the stresses in concrete and reinforcement are less than the allowable stresses per the applicable regulations, codes, or standards listed in DCD Section 3.8 and that the areas of primary and shear reinforcement satisfy the required values. The FWSC factor of safety against sliding is met, as described in Section 3G.10.5.5. Therefore, the site-specific structural evaluations demonstrate that the standard design of the FWSC structures, with the additional primary reinforcement and shear ties shown in Table 3G.10-204, is adequate to resist the site-specific seismic loads in combination with non-seismic standard plant loads.

3G.10.3 Structural Description

The FWSC structures are described in DCD Section 3G.4.3.

3G.10.4 Analytical Models

3G.10.4.1 Structural Models

Site-specific structural models are based on the standard design structural models described in DCD Section 3G.4.4.1. The FWSC is analyzed using the finite element computer program NASTRAN, which is described in DCD Section 3C.2.

3G.10.4.2 Foundation Models

Site-specific foundation models are based on the standard design foundation models described in DCD Section 3G.4.4.2.

3G.10.5 Structural Analysis and Design

3G.10.5.1 Site Design Parameters

Key site design parameters used in the site-specific evaluation of FWSC structures are those identified in DCD Section 3G.4.5.1, based on soft site subgrade stiffness conditions, which are conservative for a hard rock site.

Key site-specific parameters used as inputs for the site-specific stability and bearing pressure calculations are identified in Table 3G.10-201.

3G.10.5.2 Site Design Loads

The site-specific structural evaluation uses the loads, load combinations, and acceptance criteria that are used to perform the standard design structural evaluation described in DCD Section 3G.4.5.2, except that the seismic loads are obtained by site-specific SSI analyses, based on the site-specific ground motion response spectra and the FWSC FIRS. The seismic loads used for the evaluations are based on the site-specific seismic loads presented in Section 3A.18.1.3.

The following loads are the same as the standard design:

- Dead Load and Live Load — DCD Section 3G.4.5.2.1.1
- Snow and Rain Load — DCD Section 3G.4.5.2.1.2
- Lateral Soil Pressure at Rest — DCD Section 3G.4.5.2.1.3
- Wind Load — DCD Section 3G.4.5.2.1.4
- Tornado Load — DCD Section 3G.4.5.2.1.5
- Thermal Load — DCD Section 3G.4.5.2.1.6

The site-specific seismic loads are substituting the seismic loads used in the standard design. Four components (two horizontal, one vertical, and one torsional) of the seismic loads are evaluated for each FWS and FPE. Overturning moment loads applied at each floor elevation are also considered to account for the effects of rocking responses on the wall axial forces. Figures 3G.10-201 and 3G.10-202 show the FWS and FPE design seismic shears and moments used as inputs to the seismic loads.

The load combinations and acceptance criteria are the same as the standard design, as described in DCD Section 3G.4.5.2.2.

The material properties used in the analyses are the same as those used in the standard design, as described in DCD Section 3G.4.5.2.3.

3G.10.5.3 Stability Requirements

The stability requirements for the FWSC are given in DCD Section 3G.4.5.3. A factor of safety of 1.1 is required for both overturning and sliding. Analyses demonstrate that the FWSC meets the required factors of safety for overturning stability and for stability against sliding.

3G.10.5.4 Structural Design Evaluation

This section provides a description of the methodology and results of the structural design evaluation of the FWSC structure, considering site-specific seismic load demands. Except as noted otherwise, the site-specific evaluation uses the standard design models, analysis methods, loads (other than seismic), load combinations, and acceptance criteria, but the standard design seismic loads are replaced with the site-specific seismic loads.

The site-specific FWSC structural evaluation is performed using the methodology used for the DCD structural evaluation, as described in DCD Section 3G.4.5. The site-specific evaluation uses the seismic design loads described in Section 3G.10.5.2, which, in some instances, exceed the seismic design loads of the standard design as shown in Section 3A.18.1.3. These loads are included in the structural evaluation to demonstrate the adequacy of the standard design to withstand these exceedances.

The site-specific stress checks demonstrate that the FWSC structures are adequate to resist site-specific seismic load demands in combination with non-seismic standard plant loads, with the addition of rebar in the basemat (Element 227) and the addition of rebar and shear ties in the shear key (Elements 72008 and 73017).

The conclusions from the site-specific stress checks are summarized as follows:

- The stresses of the concrete and rebar are less than the allowable stresses specified in the code.

- The provided area of primary and shear reinforcement, including the reinforcement changes described above satisfy the required values.

Tables 3G.10-202a through 3G.10-202c show the forces and moments at selected sections from NASTRAN analyses for site-specific seismic loads. Table 3G.10-203 shows the combined forces and moments for the selected load combination FWSC-6 (see DCD Table 3G.4-6 for the load combinations). Table 3G.10-204 shows the sectional thickness and rebar ratios used in the site-specific evaluation. Table 3G.10-205 compares the rebar and concrete stresses for the selected load combination FWSC-6. Table 3G.10-206 summarizes the site-specific evaluation results for the transverse shear by selected load combination for seismic loads.

3G.10.5.4.1 **Shear Walls**

The maximum rebar stress in the vertical rebar of FWS cylindrical walls is 236.5 MPa (34.30 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum rebar stress in the horizontal rebar of FWS cylindrical walls is 160.5 MPa (23.28 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum transverse shear force in FWS cylindrical walls is 0.551 MN/m (2.92 kips/in) against the shear strength of 1.606 MN/m (9.17 kips/in).

As for the FPE, the maximum rebar stress in the horizontal rebar of the FPE wall is 222.2 MPa (32.23 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum rebar stress in the vertical rebar of the FPE wall is 198.4 MPa (28.78 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum transverse shear force in FPE walls is 0.730 MN/m (4.17 kips/in) against the shear strength of 1.325 MN/m (7.57 kips/in).

3G.10.5.4.2 **Roof Slabs**

The maximum rebar stress in the FWS roof slab is 200.4 MPa (29.07 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum transverse shear force in the FWS roof slab is 0.118 MN/m (0.67 kips/in) against a shear strength of 0.400 MN/m (2.28 kips/in).

The maximum rebar stress in the FPE roof slab is 247.9 MPa (35.95 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum transverse shear force in the FPE roof slab is 0.237 MN/m (1.35 kips/in) against the shear strength of 0.363 MN/m (2.07 kips/in).

3G.10.5.4.3 **Foundation Mat**

Additional primary reinforcement is added to the basemat (Element 227 in Table 3G.10-204). The maximum rebar stress in the foundation mat is found to be 269.7 MPa (39.12 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum transverse shear force in the foundation mat is found to be 2.71 MN/m (15.47 kips/in) against a shear strength of 4.493 MN/m (25.66 kips/in).

3G.10.5.4.4 Shear Key

Rebar and shear ties are added to the shear key (Elements 72008 and 73017 in Table 3G.10-204). The maximum rebar stress in the horizontal rebar of the shear key is found to be 87.0 MPa (12.62 ksi) due to load combination FWSC-6, as shown in Table 3G.10-205. The maximum rebar stress in the vertical rebar of the shear key is 128.9 MPa (18.70 ksi) due to the same load combination. The maximum transverse shear force in the shear keys is found to be 1.582 MN/m (9.03 kips/in) against a shear strength of 4.163 MN/m (23.77 kips/in).

3G.10.5.5 Foundation Stability

The methodology used for the stability calculations is consistent with the methodology used for the standard design stability evaluations described in DCD Sections 3.7.2.14 and 3.8.5.5. The seismic stability of the FWSC is evaluated against overturning of the FWSC basemat and sliding for two critical sliding planes located as follows:

- Bottom of the FWSC basemat at Elevation 282 ft NAVD88
- Bottom of the underlying concrete fill at nominal Elevation 220 ft NAVD88

The stability and bearing pressure calculations are performed using the results obtained from:

- Site-specific SSI analyses of the FWSC stand-alone model with full (uncracked concrete) stiffness properties and SSE damping values for BE, LB, and UB subgrade profiles using the deep input control motion applied at the bottom of the underlying concrete fill (analysis Cases 7 through 9 in Table 3A.15-203)

- Site-specific SSSI analyses of the FWSC-CB combined model with full (uncracked concrete) stiffness properties and SSE damping values for BE, LB, and UB subgrade profiles using the deep input control motion applied at the bottom of the underlying concrete fill (analysis Cases FC7 through FC9 in Table 3A.15-206).

The seismic response analyses of the models representing full (uncracked concrete) stiffness properties of the FWSC reinforced concrete structure provide seismic load demands on the FWSC foundation that bound effects of concrete cracking on the site-specific seismic response of FWSC structure. The effects of separation between the concrete fill and surrounding soil on the sliding stability of the FWSC are discussed in Section 3A.17.14.5.

Table 3G.10-214 provides the calculated overturning and sliding stability factors of safety for the SSI analyses (Cases 7 through 9 in Table 3A.15-203) and the SSSI analyses (Cases FC7 through FC9 in Table 3A.15-206). Table 3G.10-214(a) shows that the overturning stability is greater than required.

Sliding stability is evaluated for two orthogonal horizontal directions separately using a linear time history analysis approach. In each direction, the phasing between the horizontal shear and vertical seismic forces is considered at each time step to compute the sliding factor of safety in the time domain. The lateral resistance force demands on the shear keys and subgrade surrounding the concrete fill block under the FWSC are computed if, at the particular instance of time, the friction resistance at the bottom of the FWSC basemat alone is not sufficient to achieve a minimum factor of safety of 1.1 against sliding. Table 3G.10-214(b) shows the site-specific lateral force demands on the FWSC shear keys under fully bonded conditions between the concrete fill and surrounding soil.

Sliding stability calculations performed as part of the site-specific evaluation described in Section 3A.17.14.5 show that the separation between the concrete fill and surrounding soil can amplify the lateral resistance force demands on the FWSC keys in the NS and EW directions by 47 percent and 13 percent, respectively. As shown in Table 3A.17.14.5-202, which summarizes these calculations, the maximum lateral resistance pressure demand on the concrete fill, considering the conditions of the maximum soil separation, is 1.26 MPa. The site-specific structural evaluation of the FWSC shear keys uses

amplified lateral pressure loads that bound the effects of soil separation.These site-specific pressure loads are applied in the finite element model along the FWSC shear keys normal to the direction of seismic motion.

Tables 3G.10-214(b) and 3A.17.14.5-202 show the maximum lateral resistance pressure transfer from the shear keys to the concrete fill supporting the FWSC basemat, which is below the allowable lateral bearing pressure of the concrete fill of 8.0 MPa.

Table 3G.10-214(c) presents a summary of the calculations of the FWSC global stability against sliding at the critical sliding plane at the bottom of the concrete fill, Elevation 220 ft NAVD88. For the instances of time the friction resistance at the bottom of the concrete fill alone is not sufficient, the lateral resistance force required to achieve a minimum factor of safety of 1.1 against sliding is calculated. The value of the maximum site-specific lateral passive pressure demand is below the allowable dynamic lateral bearing pressure of 1.44 MPa of Zone III rock at FWSC location specified in Table 3G.10-201.

Tables 3G.10-215(a) and (b) provide results of calculations of the maximum dynamic bearing pressure demands from the FWSC foundation to the supporting concrete fill. The calculations follow the same EB/MEB method that was used for the standard design calculations. These dynamic bearing pressure demands are compared with the allowable dynamic bearing pressure of the underlying concrete fill and Zone III-IV rock that are provided in Table 2.5.4-211, to ensure that the capacity of the subgrade is sufficient to resist the dynamic bearing pressures from the FWSC and the concrete fill supporting the FWSC basemat.

The calculations of the dynamic bearing pressure under the FWSC basemat presented in Table 3G.10-215(a) yield a site-specific demand that is lower than the maximum toe bearing pressure of 1.2 MPa considered by the standard design in DCD Table 3G.4-23 and allowable bearing capacity of concrete fill subgrade in Table 2.5.4-211. Table 3G.10-215(b) presents the calculations of the maximum dynamic bearing pressures on the surface of the underlying Zone III-IV rock. The table shows that the maximum dynamic bearing pressure demand from the FWSC and supporting concrete fill block on the Zone III/IV rock is lower than the Zone III/IV rock allowable dynamic bearing capacity specified in Table 2.5.4-211.

The capacity of the concrete fill supporting the FWSC foundation to resist the site-specific seismic demands is evaluated to ensure the stability of the FWSC. The capacity of the concrete fill to withstand seismic load demands is evaluated at the following critical horizontal planes:

- Bottom of the FWSC shear keys at Elevation -1.45 m (Elevation 270.2 ft NAVD88)
- Top of the Zone III rock located at nominal Elevation -9.52 m (Elevation 244 ft NAVD88)
- Horizontal planes at the corresponding soil separation depths (for analyses presented in Section 3A.17.14.5 of models representing soil separation)

Evaluations of the concrete fill capacity to resist the seismic demands are performed considering:

- Shear strength capacity of the monolithic concrete fill
- Frictional resistance of the construction joints in the concrete fill

Results of the evaluation of the seismic demands on the concrete fill under the FWSC foundation indicate that:

- The shear stress capacity of the concrete fill material is sufficient to withstand maximum shear stresses due to the seismic demands
- Construction joint friction resistance alone may not be sufficient to resist sliding due to seismic load demands on the concrete fill block at critical planes. As specified in detailed design, bonded construction joints constructed in accordance with ACI 207.1R are used at concrete fill horizontal lift construction joints to ensure the overall stability of the FWSC.

Section 2.5.4.2.5 describes engineering properties of concrete fill and the construction controls for preparation and placement of the concrete fill and horizontal lift joint surfaces for bonding of the joints.

3G.10.5.6 Tornado Missile Evaluation

DCD Section 3G.4.5.6 is applicable to the FWSC with no changes.

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Table 3G.10-201 **FWSC Site-Specific Parameters**

Parameters	Values
Building Width:	
X-direction (NS-direction)	52 m
Y-direction (EW-direction)	20 m
Zone III Rock Embedment Depth:	
Nominal Zone III Rock Elevation	El. 244 ft. NAVD88
Depth of Shear Key	3.6 m (11.8 ft)
Depth to bottom of concrete fill block	7.32 m (24 ft)
Water Level:	
Nominal Groundwater Elevation	El. 281.5 ft NAVD88 2.59 m (8.5 ft) below finished ground level grade
Friction Coefficient, μ:	
Foundation/Concrete Fill/Rock Interfaces	0.6[a]
Allowable Lateral Dynamic Bearing Pressure:	
Zone III rock at Elevation 220 ft, NAVD88	1.44 MPa (30.1 ksf)

a. A value of 0.6 is used for the friction coefficient, which is the lowest value specified for concrete fill and Zone III-IV rock and the foundation structural concrete.

Table 3G.10-202a **Results of NASTRAN Analysis: Seismic Load - FWSC (Horizontal: North to South Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL 4.65	18	0.226	0.071	-0.013	-1.324	-0.114	0.208	0.483	0.120
	227	2.073	0.056	-0.758	-3.212	-0.974	-0.233	2.019	-0.334
	237	1.010	-0.267	0.195	-3.733	-0.659	0.348	0.705	-0.583
	16085	1.001	0.082	-0.105	-2.164	-0.777	-0.072	-0.474	-0.596
Roof of FPE EL 8.25	51556	0.022	0.036	-0.065	0.000	-0.002	-0.002	0.001	0.000
	51558	0.047	0.341	-0.022	-0.010	-0.008	0.000	0.005	-0.001
	51576	0.018	0.014	-0.238	0.000	0.002	-0.003	-0.001	-0.001
	51578	0.011	0.091	-0.074	-0.003	0.003	-0.003	0.003	-0.007
Roof of Tank	26007	0.081	-0.074	0.006	-0.002	-0.002	0.000	-0.003	0.000
	26079	0.163	-0.102	-0.015	-0.006	-0.014	0.005	-0.001	0.009
	26082	0.077	-0.294	-0.083	0.003	0.000	-0.003	0.012	-0.007
	26085	-0.012	-0.325	0.189	0.018	0.007	0.009	0.024	0.013
South Wall of FPE	66004	0.082	-0.146	0.044	-0.009	-0.038	-0.004	-0.014	-0.009
	66006	0.144	0.096	-0.284	-0.011	-0.054	-0.010	-0.005	-0.104
	66024	0.421	-0.045	-0.015	-0.008	-0.018	-0.001	-0.003	-0.007
East Wall of FPE	67004	0.064	-0.087	0.441	0.001	0.005	-0.003	0.000	0.002
	67006	0.489	0.001	-0.045	0.001	0.021	-0.003	0.006	0.035
	67024	0.047	-0.023	0.322	0.000	-0.001	0.000	0.000	0.003

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Table 3G.10-202a **Results of NASTRAN Analysis: Seismic Load - FWSC (Horizontal: North to South Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall of South Tank	35007	0.886	-0.835	-0.719	0.008	-0.123	-0.027	-0.001	-0.147
	35010	1.141	1.336	-1.219	-0.080	-0.516	0.031	0.000	-0.448
	36507	-0.067	-0.462	-1.026	0.046	0.059	-0.005	-0.031	0.016
	36510	-0.526	0.590	-1.106	0.035	0.092	-0.016	0.025	0.033
	38507	0.164	-0.091	-0.220	0.013	0.005	0.013	0.002	0.040
	38510	-0.487	0.126	-0.388	0.013	0.028	-0.030	-0.009	0.013
	45001	1.120	3.372	0.598	-0.166	-0.669	-0.008	0.008	-0.511
	46501	-0.782	1.458	0.292	-0.053	0.061	0.006	-0.012	0.024
	48501	-0.822	0.271	0.107	-0.008	0.037	0.011	0.003	-0.025
Shear Key	72008	-0.183	-0.025	-0.345	0.132	-1.807	0.259	0.328	1.513
	73017	-4.095	1.404	1.806	-0.005	-0.005	0.003	-0.003	0.001

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Table 3G.10-202b **Results of NASTRAN Analysis: Seismic Load - FWSC (Horizontal: West to East Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL 4.65 m	18	0.754	0.106	0.453	0.827	-0.495	-0.617	0.449	0.376
	227	-0.080	-0.690	1.039	-0.188	-1.339	-1.182	0.291	0.744
	237	-0.095	-0.444	0.265	0.811	1.646	-1.059	-0.856	0.906
	16085	0.018	-0.693	-0.037	-0.497	-1.285	-0.436	-0.083	0.536
Roof of FPE EL 8.25 m	51556	0.070	0.025	-0.082	-0.009	-0.008	-0.007	-0.001	0.011
	51558	0.015	-0.116	-0.273	0.008	0.004	-0.014	-0.010	-0.009
	51576	0.710	-0.018	0.018	-0.030	-0.072	0.002	0.000	0.025
	51578	0.227	-0.102	-0.057	0.010	-0.026	0.004	-0.031	0.031
Roof of Tank	26007	-0.003	0.004	0.027	0.000	-0.001	-0.001	0.000	-0.003
	26079	0.208	0.056	0.065	0.002	-0.001	0.002	-0.003	0.015
	26082	0.122	0.065	0.116	-0.009	-0.002	0.005	-0.011	0.011
	26085	-0.097	0.055	0.073	0.004	0.000	0.001	0.002	0.004
South Wall of FPE	66004	-0.368	0.233	-0.264	-0.003	-0.013	0.005	0.002	-0.012
	66006	-0.428	0.135	0.719	-0.024	-0.065	0.002	0.001	-0.093
	66024	-0.206	0.027	0.141	0.004	0.011	-0.001	-0.006	-0.013
East Wall of FPE	67004	0.223	-0.339	-0.121	-0.036	-0.188	0.001	-0.004	-0.110
	67006	0.251	-0.257	-0.700	-0.010	-0.113	-0.002	-0.042	-0.139
	67024	0.875	-0.113	-0.078	0.010	0.042	0.004	0.004	-0.107

Table 3G.10-202b **Results of NASTRAN Analysis: Seismic Load - FWSC (Horizontal: West to East Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall of South Tank	35007	-0.931	-1.401	0.012	0.004	0.302	-0.019	-0.025	0.321
	35010	-0.399	-1.864	-1.080	0.108	0.341	-0.009	0.027	0.249
	36507	0.721	-0.617	-0.020	-0.065	-0.089	0.005	-0.012	-0.028
	36510	0.530	-0.769	-0.932	0.039	-0.031	-0.010	-0.010	-0.005
	38507	0.575	-0.135	0.052	-0.021	-0.037	0.012	0.004	-0.027
	38510	0.455	-0.142	-0.183	0.004	-0.025	0.007	0.001	0.007
	45001	0.338	0.385	-1.379	-0.016	-0.078	0.011	0.029	-0.054
	46501	-0.118	0.206	-1.358	-0.012	0.004	-0.020	0.008	0.001
	48501	-0.108	0.037	-0.324	-0.003	0.005	-0.012	-0.004	-0.004
Shear Key	72008	0.473	0.158	0.222	-0.013	-0.001	0.016	0.012	0.003
	73017	-0.020	0.010	0.025	0.197	1.493	-0.245	-0.029	-1.128

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Table 3G.10-202c **Results of NASTRAN Analysis: Seismic Load - FWSC (Vertical: Upward Direction)**

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL 4.65 m	18	-0.266	0.039	0.153	1.064	-0.193	-0.174	0.283	0.117
	227	-0.119	-0.413	-0.403	0.203	-0.307	-0.289	0.764	0.121
	237	-0.249	-0.014	0.062	-0.053	-0.495	0.289	0.673	-0.384
	16085	-0.395	-0.460	-0.417	0.358	-0.227	-0.271	0.503	-0.007
Roof of FPE EL 8.25 m	51556	0.015	-0.066	-0.010	-0.075	-0.119	0.006	-0.006	-0.017
	51558	0.012	0.431	0.012	0.019	-0.033	0.016	-0.065	0.004
	51576	-0.578	0.040	-0.085	0.014	0.104	0.011	0.006	-0.113
	51578	-0.155	0.181	-0.099	-0.002	0.030	0.035	0.016	-0.039
Roof of Tank	26007	0.456	0.408	0.013	-0.021	-0.021	0.000	0.001	0.000
	26079	-0.215	0.243	-0.058	0.002	0.054	-0.006	0.007	-0.059
	26082	0.040	-0.020	-0.254	0.031	0.027	-0.028	0.045	-0.042
	26085	0.128	-0.120	0.233	0.042	0.017	0.025	0.053	0.032
South Wall of FPE	66004	0.209	-0.058	-0.086	0.015	0.101	-0.002	-0.005	0.009
	66006	0.160	-0.309	-0.478	0.014	0.112	0.007	0.030	0.148
	66024	0.606	0.109	-0.035	0.012	0.085	-0.005	-0.004	0.009
East Wall of FPE	67004	-0.407	0.577	0.162	0.013	0.091	-0.002	0.003	0.108
	67006	-0.559	-0.036	0.837	0.015	0.049	-0.002	0.004	0.077
	67024	-0.801	0.246	0.144	-0.031	-0.150	0.001	-0.001	0.112

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Table 3G.10-202c **Results of NASTRAN Analysis: Seismic Load - FWSC (Vertical: Upward Direction)** *(continued)*

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall of South Tank	35007	-0.140	0.179	-0.122	-0.006	-0.148	0.004	0.013	-0.252
	35010	-0.251	0.750	0.010	-0.042	-0.184	-0.005	-0.013	-0.255
	36507	-0.891	0.307	-0.019	0.028	0.053	-0.002	0.005	0.048
	36510	-0.950	0.459	-0.017	-0.007	0.042	0.003	-0.003	0.040
	38507	-0.503	0.192	-0.003	0.009	0.029	-0.001	0.000	-0.083
	38510	-0.536	0.209	-0.024	0.003	0.030	-0.001	-0.001	-0.090
	45001	-0.200	0.451	-0.044	-0.007	-0.119	0.009	0.021	-0.231
	46501	-0.907	0.431	-0.008	0.018	0.044	-0.003	0.004	0.047
	48501	-0.552	0.215	0.007	0.006	0.029	-0.001	0.000	-0.091
Shear Key	72008	-0.277	-0.085	-0.287	-0.013	-0.011	0.002	0.000	0.006
	73017	1.014	-0.137	0.944	-0.009	-0.014	-0.010	-0.006	0.007

Table 3G.10-203 **Combined Forces and Moments: Selected Load Combination FWSC-6**

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Basemat EL 4.65 m	18	OTHR	0.136	-0.025	-0.082	-0.547	0.146	0.101	-0.151	-0.099
		TEMP	8.599	0.057	2.492	-8.171	-0.926	-0.375	0.060	0.553
		SEIS	0.855	0.134	0.496	1.889	0.544	0.674	0.718	0.412
	227	OTHR	0.015	0.250	0.212	-0.033	0.201	0.158	-0.382	-0.064
		TEMP	-2.901	11.308	-0.088	-3.679	-5.852	0.556	0.159	0.124
		SEIS	2.079	0.807	1.399	3.224	1.684	1.242	2.178	0.826
	237	OTHR	0.125	0.007	-0.044	0.072	0.311	-0.187	-0.371	0.229
		TEMP	3.271	4.954	2.362	-6.091	-3.626	-1.039	-0.492	-0.446
		SEIS	1.091	0.524	0.368	3.821	1.842	1.151	1.297	1.145
	16085	OTHR	0.156	0.258	0.200	-0.119	0.146	0.136	-0.186	0.007
		TEMP	-4.574	-1.873	1.031	-1.132	-0.048	0.345	-0.640	0.006
		SEIS	1.076	0.836	0.449	2.249	1.518	0.519	0.696	0.804
Roof of FPE EL 8.25 m	51556	OTHR	-0.033	0.013	0.006	0.080	0.108	-0.006	0.008	0.015
		TEMP	0.100	0.156	0.014	-0.286	-0.237	0.001	-0.006	0.007
		SEIS	0.075	0.079	0.107	0.075	0.119	0.009	0.006	0.020
	51558	OTHR	-0.036	-0.265	-0.005	-0.039	0.023	-0.015	0.073	-0.004
		TEMP	0.190	-0.460	-0.038	-0.194	-0.238	-0.008	-0.031	-0.001
		SEIS	0.051	0.562	0.275	0.023	0.034	0.022	0.066	0.010
	51576	OTHR	0.292	-0.052	0.047	-0.004	-0.088	-0.011	-0.005	0.102
		TEMP	0.794	0.118	0.100	-0.295	-0.301	0.000	-0.002	0.025
		SEIS	0.916	0.047	0.254	0.033	0.126	0.011	0.006	0.116
	51578	OTHR	0.074	-0.112	0.053	-0.008	-0.026	-0.032	-0.003	0.028
		TEMP	0.192	-0.230	0.013	-0.256	-0.299	-0.018	-0.031	0.043
		SEIS	0.275	0.227	0.137	0.011	0.040	0.035	0.035	0.050

Table 3G.10-203 **Combined Forces and Moments: Selected Load Combination FWSC-6** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Roof of Tank	26007	OTHR	-0.217	-0.194	-0.006	0.010	0.010	0.000	0.000	0.000
		TEMP	0.023	-0.036	-0.006	-0.392	-0.393	0.000	0.001	0.001
		SEIS	0.463	0.415	0.031	0.021	0.021	0.001	0.003	0.003
	26079	OTHR	0.103	-0.115	0.028	-0.001	-0.025	0.003	-0.003	0.028
		TEMP	0.417	0.111	0.038	-0.446	-0.535	0.011	-0.010	0.079
		SEIS	0.341	0.269	0.089	0.006	0.055	0.009	0.008	0.062
	26082	OTHR	-0.019	0.010	0.121	-0.015	-0.013	0.013	-0.021	0.020
		TEMP	0.322	0.147	0.076	-0.485	-0.483	0.042	-0.051	0.051
		SEIS	0.150	0.302	0.291	0.033	0.028	0.028	0.048	0.043
	26085	OTHR	-0.061	0.058	-0.111	-0.020	-0.008	-0.012	-0.025	-0.015
		TEMP	0.240	0.181	-0.005	-0.496	-0.461	-0.035	-0.056	-0.035
		SEIS	0.161	0.350	0.309	0.046	0.019	0.026	0.058	0.035
South Wall of FPE	66004	OTHR	-0.132	-0.039	0.053	-0.006	-0.040	0.001	0.003	0.023
		TEMP	2.916	-0.130	-0.123	-0.414	-0.717	0.005	-0.005	-0.184
		SEIS	0.431	0.282	0.293	0.017	0.109	0.007	0.016	0.017
	66006	OTHR	-0.109	0.109	0.291	-0.006	-0.055	-0.005	-0.016	-0.069
		TEMP	1.811	0.944	-0.412	-0.378	-0.693	-0.024	-0.203	-0.618
		SEIS	0.480	0.353	0.911	0.030	0.140	0.013	0.030	0.203
	66024	OTHR	-0.367	-0.122	0.023	-0.016	-0.095	0.004	0.002	0.025
		TEMP	-0.091	0.007	-0.037	-0.349	-0.277	0.002	0.016	-0.217
		SEIS	0.766	0.121	0.163	0.015	0.088	0.005	0.008	0.017

Table 3G.10-203 **Combined Forces and Moments: Selected Load Combination FWSC-6** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
East Wall of FPE	67004	OTHR	0.205	-0.394	-0.083	-0.009	-0.065	0.001	-0.002	-0.088
		TEMP	3.209	-0.623	-0.268	0.380	0.424	-0.001	0.002	0.026
		SEIS	0.468	0.675	0.486	0.038	0.209	0.003	0.005	0.154
	67006	OTHR	0.283	-0.042	-0.435	-0.010	-0.033	0.002	-0.002	-0.054
		TEMP	3.333	0.484	-2.062	0.317	0.398	0.006	0.135	0.170
		SEIS	0.785	0.262	1.093	0.018	0.125	0.004	0.042	0.163
	67024	OTHR	0.410	-0.200	-0.075	0.026	0.133	-0.002	0.001	-0.092
		TEMP	1.582	-0.137	-0.254	0.372	0.346	0.002	-0.007	0.044
		SEIS	1.188	0.272	0.361	0.032	0.156	0.005	0.005	0.155
Wall of South Tank	35007	OTHR	0.019	-0.186	0.072	0.000	0.070	-0.003	-0.008	0.121
		TEMP	3.012	-0.603	0.194	-1.162	-1.081	-0.009	-0.072	-0.324
		SEIS	1.294	1.641	0.757	0.011	0.358	0.034	0.028	0.434
	35010	OTHR	0.088	-0.517	-0.014	0.022	0.093	0.003	0.008	0.123
		TEMP	2.650	0.030	-0.198	-1.253	-1.254	0.033	0.015	-0.396
		SEIS	1.236	2.412	1.642	0.140	0.645	0.033	0.030	0.573
	36507	OTHR	0.401	-0.211	0.011	-0.016	-0.026	0.002	-0.003	-0.023
		TEMP	-0.295	-0.327	0.040	-1.147	-1.126	0.000	-0.011	0.082
		SEIS	1.148	0.829	1.036	0.084	0.119	0.008	0.034	0.058
	36510	OTHR	0.436	-0.296	0.006	0.005	-0.020	-0.002	0.002	-0.019
		TEMP	-0.284	-0.025	-0.256	-1.181	-1.126	-0.005	0.015	0.078
		SEIS	1.209	1.072	1.454	0.053	0.106	0.020	0.027	0.053
	38507	OTHR	0.237	-0.106	0.001	-0.005	-0.014	0.001	0.000	0.039
		TEMP	0.103	-0.062	0.007	-1.105	-0.771	0.004	0.000	-0.181
		SEIS	0.781	0.251	0.233	0.026	0.048	0.018	0.004	0.096

Table 3G.10-203 **Combined Forces and Moments: Selected Load Combination FWSC-6** *(continued)*

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
Wall of South Tank *(continued)*	38510	OTHR	0.254	-0.115	0.012	-0.001	-0.015	0.001	0.000	0.043
		TEMP	-0.050	0.003	-0.154	-1.112	-0.771	-0.018	-0.005	-0.205
		SEIS	0.855	0.282	0.434	0.014	0.048	0.031	0.009	0.091
	45001	OTHR	0.057	-0.328	0.025	0.002	0.058	-0.005	-0.011	0.111
		TEMP	3.490	0.717	-0.047	-1.173	-1.294	-0.017	0.003	-0.402
		SEIS	1.188	3.424	1.521	0.167	0.684	0.018	0.037	0.564
	46501	OTHR	0.409	-0.273	0.006	-0.010	-0.021	0.002	-0.003	-0.023
		TEMP	-0.329	0.464	0.093	-1.200	-1.154	-0.002	-0.004	0.080
		SEIS	1.204	1.534	1.397	0.057	0.075	0.021	0.015	0.053
	48501	OTHR	0.262	-0.117	-0.003	-0.003	-0.014	0.000	0.000	0.043
		TEMP	-0.195	0.079	0.049	-1.123	-0.772	0.006	0.002	-0.229
		SEIS	0.996	0.348	0.346	0.011	0.047	0.016	0.005	0.094
Shear Key	72008	OTHR	0.130	0.104	0.106	0.006	0.005	-0.001	0.000	-0.003
		TEMP	0.030	-0.442	0.322	0.098	0.107	0.033	0.018	-0.058
		SEIS	0.578	0.181	0.501	0.133	1.807	0.259	0.328	1.513
	73017	OTHR	-0.472	0.064	-0.497	0.005	0.007	0.005	0.003	-0.003
		TEMP	-6.179	-0.445	-0.899	0.020	0.028	0.034	0.011	-0.015
		SEIS	4.219	1.411	2.038	0.199	1.493	0.246	0.030	1.128

OTHR: Loads other than thermal and seismic loads.
TEMP: Thermal loads.
SEIS: Seismic loads evaluated by SRSS.

Table 3G.10-204 **Sectional Thickness and Rebar Ratios Used in the Evaluation**

Location	Element ID	Thickness (m)	Position	Primary Reinforcement: Direction 1[a] Arrangement	Primary Reinforcement: Direction 1[a] Ratio (%)	Primary Reinforcement: Direction 2[a] Arrangement	Primary Reinforcement: Direction 2[a] Ratio (%)	Shear Tie Arrangement	Shear Tie Ratio (%)
Basemat EL4.65m	18	2.50	Top	3-#11@200	0.604	3-#11@200	0.604	#7@400 × 400	0.242
			Bottom	3-#11@200	0.604	3-#11@200	0.604		
	227		Top	3-#11@200 + 1-#11@400	0.705	3-#11@200 + 1-#11@400	0.705	#7@400 × 200	0.484
			Bottom	3-#11@200	0.604	3-#11@200 + 1-#11@400	0.705		
	237		Top	3-#11@200 + 1-#11@400	0.705	3-#11@200 + 1-#11@400	0.705	#7@400 × 200	0.484
			Bottom	3-#11@200	0.604	3-#11@200	0.604		
	16085		Top	3-#11@200 + 1-#11@400	0.705	3-#11@200 + 1-#11@400	0.705	#7@400 × 400	0.242
			Bottom	3-#11@200	0.604	3-#11@200	0.604		
Roof of FPE EL8.25m	51556 51558 51576 51578	0.60	Top	1-#11@200	0.839	1-#11@200	0.839	-	-
			Bottom	1-#11@200	0.839	1-#11@200	0.839		
Roof of Tank	26007 26079 26082 26085	0.60	Top	1-#9@200	0.538	1-#9@200	0.538	-	-
			Bottom	1-#9@200	0.538	1-#9@200	0.538		

Table 3G.10-204 **Sectional Thickness and Rebar Ratios Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement	Ratio (%)	Arrangement	Ratio (%)	Arrangement	Ratio (%)
South Wall of FPE	66004	0.65	Inside	1-#11@200	0.774	1-#11@200	0.774	-	-
			Outside	2-#11@200	1.548	2-#11@200	1.548		
	66006		Inside	1-#11@200	0.774	1-#11@133	1.164	#6@200 × 200	0.710
			Outside	2-#11@200	1.548	1-#11@133 + 1-#11@200	1.938		
	66024		Inside	1-#11@200	0.774	1-#11@200	0.774	-	-
			Outside	1-#11@200 + 1-#11@400	1.161	1-#11@200 + 1-#11@400	1.161		
East Wall of FPE	67004	0.65	Inside	1-#11@200	0.774	1-#11@133	1.164	-	-
			Outside	2-#11@200	1.548	2-#11@200	1.548		
	67006		Inside	1-#11@200	0.774	1-#11@133	1.164	#6@200 × 200	0.710
			Outside	2-#11@200	1.548	1-#11@133 + 1-#11@200	1.938		
	67024		Inside	1-#11@200	0.774	1-#11@133	1.164	-	-
			Outside	1-#11@200 + 1-#11@400	1.161	1-#11@200 + 1-#11@400	1.161		

Table 3G.10-204 **Sectional Thickness and Rebar Ratios Used in the Evaluation** *(continued)*

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1[a]		Direction 2[a]			
				Arrangement	Ratio (%)	Arrangement	Ratio (%)	Arrangement	Ratio (%)
Wall of South Tank	35007 35010 45001	1.00	Inside	1-#11@150 + 1-#11@300	1.006	2-#11@150[b]	1.342	#6@150[b]×300	0.631
			Outside	2-#11@150 + 1-#11@300	1.677	2-#11@150[b] + 1-#11@300[c]	1.677		
	36507 36510 46501		Inside	1-#11@150	0.671	1-#11@150[b]	0.671	-	-
			Outside	2-#11@150	1.342	2-#11@150[b]	1.342		
	38507 38510 48501		Inside	1-#11@150	0.671	1-#11@150[b]	0.671	-	-
			Outside	1-#11@150	0.671	1-#11@150[b]	0.671		
Shear Key	72008	2.00	Inside	1-#11@200 + 1-#11@400	0.377	2-#11@200 + 1-#11@400	0.629	#7@400×200	0.484
			Outside	1-#11@200 + 1-#11@400	0.377	2-#11@200 + 1-#11@400	0.629		
	73017		Inside	3-#11@200	0.755	2-#11@200 + 1-#11@400	0.629	#7@400×200	0.484
			Outside	3-#11@200	0.755	2-#11@200 + 1-#11@400	0.629		

a. Wall: Direction 1: Horizontal Direction 2: Vertical
Basemat, Roof: Direction 2: N-S Direction 2: E-W

b. Rebar described as @150 is arranged by @1°

c. Rebar described as @300 is arranged by @2°

Note: Reinforcement revised from standard design is shown in red.

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Table 3G.10-205 **Rebar and Concrete Stresses: Selected Load Combination FWSC-6**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				X-direction*		Y-direction*		
		Calculated	Allowable	+Z side*	-Z side*	+Z side*	-+Z side*	Allowable
Basemat EL 4.65 m	18	-5.5	-23.5	224.3	21.4	54.2	12.2	372.2
	227	-11.1		50.4	74.7	144.7	109.9	
	237	-13.0		269.7	100.3	178.3	94.6	
	16085	-5.5		-13.1	-35.2	26.4	16.8	
Roof of FPE EL 8.25 m	51556	-6.5	-29.3	95.0	8.7	103.6	53.4	372.2
	51558	-4.8		58.5	4.0	48.8	-19.5	
	51576	-14.8		247.9	70.5	225.5	3.2	
	51578	-8.8		115.9	15.6	63.1	-12.3	
Roof of Tank	26007	-2.5	-29.3	78.7	-12.1	70.3	14.4	372.2
	26079	-6.8		144.4	32.3	70.1	14.2	
	26082	-4.2		186.2	24.3	200.4	45.2	
	26085	-3.0		182.2	14.9	187.1	75.0	
South Wall of FPE	66004	-11.2	-29.3	93.1	40.7	81.0	-15.9	372.2
	66006	-13.4		152.9	74.0	197.2	12.8	
	66024	-7.2		70.8	-16.0	65.5	6.7	
East Wall of FPE	67004	-12.1	-29.3	54.3	114.9	-32.6	42.2	372.2
	67006	-7.3		148.6	218.6	-11.1	198.4	
	67024	-17.0		97.7	222.2	-16.7	149.5	

Table 3G.10-205 **Rebar and Concrete Stresses: Selected Load Combination FWSC-6** *(continued)*

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				
				X-direction*		Y-direction*		
		Calculated	Allowable	+Z side*	-Z side*	+Z side*	-+Z side*	Allowable
Wall of South Tank	35007	-11.5	-29.3	120.5	59.4	59.7	-25.7	372.2
	35010	-11.3		145.8	55.0	65.2	174.4	
	36507	-6.9		141.0	33.7	84.5	18.3	
	36510	-8.3		150.5	60.9	107.0	44.2	
	38507	-3.0		142.7	31.3	43.8	7.3	
	38510	-4.2		155.1	50.3	58.1	13.1	
	45001	-11.3		134.9	86.3	69.9	236.5	
	46501	-4.3		149.1	39.4	126.3	110.4	
	48501	-3.2		160.5	42.9	55.9	13.5	
Shear Key	72008	-4.6	-23.5	83.4	87.0	88.9	107.6	372.2
	73017	-6.9		-37.1	-33.9	128.9	48.6	

Note: Negative value means compression

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Table 3G.10-205 **Rebar and Concrete Stresses: Selected Load Combination FWSC-6** *(continued)*

* For denominations of table columns, see the definition of local coordinates below:

Structure	x	y	z
Wall in N-S direction	toward South	upward	toward West
Wall in E-W direction	toward East	upward	toward South
Tank Wall	horizontal	upward	outward
Foundation Mat & Roof	toward South	toward East	upward
Shear key in N-S direction	toward South	upward	toward West
Shear key in E-W direction	toward East	upward	toward South

NAPS DEP 3.7-1

Table 3G.10-206 **Calculation Results for Transverse Shear**

Location	Element ID	Load ID	d (m)	ρ_w (%)	ρ_v (%)	Shear Force (MN/m)				Vu/φVn
						Vu	Vc	Vs	φVn	
Basemat EL 4.65	18	FWSC-6	2.240	0.674	0.242	1.001	1.391	2.244	3.090	0.324
	227	FWSC-6	2.052	0.859	0.484	2.557	2.918	4.112	5.975	0.428
	237	FWSC-6	2.044	0.862	0.484	2.195	1.275	4.096	4.565	0.481
	16085	FWSC-6	2.048	0.861	0.242	1.729	4.102	2.052	5.231	0.330
Roof of FPE EL 8.25	51556	FWSC-6	0.453	1.111	0.000	0.040	0.395	0.000	0.336	0.120
	51558	FWSC-6	0.499	1.008	0.000	0.127	0.455	0.000	0.386	0.329
	51576	FWSC-6	0.450	1.118	0.000	0.237	0.427	0.000	0.363	0.653
	51578	FWSC-6	0.457	1.102	0.000	0.121	0.667	0.000	0.567	0.213
Roof of Tank	26007	FWSC-6	0.475	0.679	0.000	0.005	0.407	0.000	0.346	0.014
	26079	FWSC-6	0.451	0.716	0.000	0.109	0.458	0.000	0.389	0.279
	26082	FWSC-6	0.476	0.678	0.000	0.117	0.459	0.000	0.390	0.299
	26085	FWSC-6	0.486	0.664	0.000	0.118	0.471	0.000	0.400	0.294
South Wall of FPE	66004	FWSC-4	0.422	2.387	0.000	0.197	0.454	0.000	0.386	0.512
	66006	FWSC-6	0.436	2.872	0.710	0.730	0.278	1.282	1.325	0.551
	66024	FWSC-4	0.443	1.701	0.000	0.192	0.491	0.000	0.418	0.460
East Wall of FPE	67004	FWSC-6	0.423	2.382	0.000	0.216	0.961	0.000	0.817	0.264
	67006	FWSC-6	0.436	2.864	0.710	0.223	0.290	1.282	1.335	0.167
	67024	FWSC-6	0.443	1.702	0.000	0.210	0.461	0.000	0.392	0.537

Table 3G.10-206 **Calculation Results for Transverse Shear** *(continued)*

Location	Element ID	Load ID	d (m)	ρ_w (%)	ρ_v (%)	Shear Force (MN/m)				Vu/ϕVn
						Vu	Vc	Vs	ϕVn	
Wall of South Tank	35007	FWSC-6	0.735	2.286	0.631	0.248	0.528	1.920	2.081	0.119
	35010	FWSC-6	0.698	1.919	0.631	0.450	0.283	1.823	1.791	0.251
	36507	FWSC-6	0.782	1.713	0.000	0.053	0.538	0.000	0.457	0.116
	36510	FWSC-4	0.772	1.735	0.000	0.084	0.753	0.000	0.640	0.132
	38507	FWSC-6	0.835	0.804	0.000	0.136	0.950	0.000	0.808	0.169
	38510	FWSC-4	0.835	0.804	0.000	0.228	0.896	0.000	0.762	0.299
	45001	FWSC-6	0.698	1.918	0.631	0.551	0.066	1.823	1.606	0.343
	46501	FWSC-6	0.775	1.730	0.000	0.040	0.316	0.000	0.269	0.150
	48501	FWSC-6	0.835	0.804	0.000	0.147	1.161	0.000	0.987	0.149
Shear Key	72008	FWSC-6	1.738	0.710	0.484	1.488	1.768	3.483	4.463	0.333
	73017	FWSC-6	1.735	0.725	0.484	1.112	1.279	3.477	4.042	0.275

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Table 3G.10-214 **Factors of Safety for FWSC Foundation Stability**

(a) FWSC Overturning Stability Evaluation

Subgrade Condition	**SSI Analyses Cases**						**SSSI Analyses Cases**					
	LB (Case 7)		**BE (Case 8)**		**UB (Case 9)**		**LB (Case FC7)**		**BE (Case FC8)**		**UB (Case FC9)**	
Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
m_0gh (MN·m)	3402	946	3402	946	3402	946	3402	946	3402	946	3402	946
W_b (MN·m)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E_s (MN·m)	0.8	0.7	0.9	0.8	1.0	1.0	0.8	0.7	0.9	0.8	1.1	1.0
$FS=(m_0gh-W_b)/E_s$	4,099	1,284	3,636	1,127	3,249	933	4,163	1,305	3,702	1,127	3,183	902

Notes:

m_0 = total mass of structure and basemat

g = acceleration due to gravity

h = height of the center of structure mass at the overturning position

W_b = potential energy caused by the effect of buoyancy

E_s = maximum kinetic energy

FS = Factor of Safety

The effect of shear key is neglected conservatively.

The bold red number is the minimum Factor of Safety against overturning.

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Table 3G.10-214 **Factors of Safety for FWSC Foundation Stability** *(continued)*

(b) Evaluation of FWSC Stability for Sliding at Bottom of Basemat (Elevation 282 ft NAVD88)

Basemat width in NS Dir.	52.0	m
Basemat width in EW Dir.	20.0	m
Depth of Zone III rock embedment	3.6	m
Total Weight	169	MN
Buoyancy	6	MN

	SSI Analyses Cases						SSSI Analyses Cases					
Subgrade Condition	**LB (Case 7)**		**BE (Case 8)**		**UB (Case 9)**		**LB (Case FC7)**		**BE (Case FC8)**		**UB (Case FC9)**	
Sliding Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
Time (sec)	3.095	4.955	1.155	1.810	1.060	1.645	1.070	4.955	1.110	1.140	1.140	1.645
Vertical Seismic Load (MN)	11	55	99	103	71	74	58	57	48	67	92	68
Minimum Vertical Load (MN)	151	107	64	60	92	89	104	106	114	95	71	95
F_v: Horizontal Seismic Force (MN)	99	70	86	66	92	96	74	71	97	75	87	109
F_{ub}: Bottom Friction Force (MN)	91	64	38	36	55	53	63	64	69	57	42	57
F_r': Lateral Resistance Force at Shear Key (MN)	18	12	**56**	37	46	52	19	15	38	25	53	**63**
FS $(=(F_{ub}+F_r')/F_v)$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{max}: Maximum Stress (MPa) Associated with Lateral Resistance F_r'	0.28	0.14	**0.87**	0.43	0.71	0.60	0.30	0.17	0.59	0.29	0.82	0.73

The bold red numbers are the maximum lateral resistance force at the shear key in the NS (56) and EW (63) directions and the maximum stress demand on the subgrade associated with the lateral resistance (0.87).

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Table 3G.10-214 **Factors of Safety for FWSC Foundation Stability** *(continued)*

(c) Evaluation of FWSC Stability for Sliding at Bottom of Concrete Fill (Elevation 220 ft NAVD88)

Basemat width in NS Dir.	52.0	m
Basemat width in EW Dir.	20.0	m
Depth of Zone III rock to bottom of concrete fill block	7.32	m
Total Weight	618	MN
Buoyancy	191	MN

	SSI Analyses Cases						SSSI Analyses Cases					
Subgrade Condition	**LB (Case 7)**		**BE (Case 8)**		**UB (Case 9)**		**LB (Case FC7)**		**BE (Case FC8)**		**UB (Case FC9)**	
Sliding Direction	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**	**NS**	**EW**
Time (sec)	3.085	1.815	1.065	1.810	1.060	1.645	3.080	1.810	1.060	1.810	1.055	1.645
Vertical Seismic Load (MN)	81	140	214	183	212	201	78	241	233	284	167	184
Minimum Vertical Load (MN)	345	187	214	144	215	226	349	186	194	183	260	243
F_v: Horizontal Seismic Force (MN)	253	118	201	213	236	183	254	135	215	184	257	202
F_{ub}: Bottom Friction Force (MN)	208	112	128	86	129	136	209	112	116	86	156	146
F_r: Lateral Resistance Force (MN)	71	17	93	147	130	66	70	37	120	117	127	77
FS $(=(F_{ub}+F_r)/F_v)$	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
σ_{max}: Maximum Stress (MPa) Associated with Lateral Resistance F_r'	0.48	0.04	0.63	0.39	**0.89**	0.17	0.48	0.10	0.82	0.31	0.86	0.20

The bold red numbers are the maximum lateral pressure demands.

Table 3G.10-215 **Maximum Soil Dynamic Bearing Pressure Demand for FWSC**

(a) Calculations of Dynamic Bearing Pressure Demands on Concrete Fill under FWSC Basemat

Basemat width in NS (x) Dir.	52.0	m
Basemat width in EW (y) Dir.	20.0	m
Gravity Load (D)	169	MN
Buoyancy (B)	6	MN (Buoyancy is considered only in combination with upward vertical seismic load (V_z))

			SSI Analyses Cases						**SSSI Analyses Cases**					
Subgrade Condition			**LB (Case 7)**		**BE (Case 8)**		**UB (Case 9)**		**LB (Case FC7)**		**BE (Case FC8)**		**UB (Case FC9)**	
Direction Vertical Seismic Load			**upward**		**upward**		**upward**		**downward**		**upward**		**upward**	
SASSI	Time	(sec)	1.115		1.145		1.140		1.115		1.140		1.140	
	Vertical seismic load (V_z)	(MN)	15		61		87		28		67		92	
	Total vertical load	(MN)	148		102		76		196		95		71	
	Moment in NS-dir (Mx)	(MN-m)	742		784		732		697		454		674	
	Moment in EW-dir (My)	(MN-m)	703		818		898		555		799		756	
Simplified Method**			**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**
NS dir. ↓ EW dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	5.3	5.7	0.0	0.0	0.0	0.0	4.8	5.1
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.04	-0.04	-0.05	-0.05	0.00	0.00	0.011	0.011	0.004	0.004	0.007	0.008
	Max. basemat moment (Mx)	(MN-m)	742	742	784	784	732	734	697	697	454	454	674	675
	Max. bearing pressure 1 (Px)	(MPa)	0.22	0.22	0.18	0.18	0.15	0.16	0.27	0.27	0.14	0.14	0.14	0.14
	Max. bearing pressure 2 (Py)	(MPa)	---	0.20	---	0.24	---	0.27	---	0.16	---	0.23	---	0.23
	Max. Bearing pressure (Pxy=Px+Py)	(MPa)	---	0.43	---	0.42	---	0.43	---	0.43	---	0.37	---	0.37
EW dir. ↓ NS dir.	Max. basemat uplift ratio α	(%)	18.0	21.9	56.5	56.1	58.4	74.5	0.0	0.0	55.0	58.6	54.9	70.5
	Max. basemat rotation (ϕ)	(10^{-4} rad)	0.28	0.31	0.00	-0.01	0.23	0.62	0.01	0.01	0.06	0.11	0.05	0.13
	Max. basemat moment (My)	(MN-m)	703	708	818	720	898	631	555	555	799	689	756	568
	Max. bearing pressure 1(Py)	(MPa)	0.34	0.36	0.33	0.45	0.33	0.57	0.35	0.35	0.32	0.44	0.29	0.46
	Max. bearing pressure 2 (Px)	(MPa)	---	0.11	---	0.20	---	0.32	---	0.08	---	0.12	---	0.25
	Max. Bearing Pressure (Pyx=Py+Px)	(MPa)	---	0.47	---	0.64	---	0.89	---	0.43	---	0.56	---	0.71
	Envelope of Pxy and Pyx	(MPa)	---	0.47	---	0.64	---	**0.89**	---	0.43	---	0.56	---	0.71

Notes: * SASSI2010 analysis is a linear time history analysis with the 3D excitation.
** EB and MEB stand for energy balance (EB) and modified energy balance (MEB) methods.
The bold red number is the maximum dynamic toe bearing pressure demand.

Table 3G.10-215 **Maximum Soil Dynamic Bearing Pressure Demand for FWSC** *(continued)*

(b) Calculations of Dynamic Bearing Pressure Demands on Zone III-IV Rock

Basemat width in NS (x) Dir.	52.0	m
Basemat width in EW (y) Dir.	20.0	m
Gravity Load (D)	618	MN
Buoyancy (B)	191	MN (Buoyancy is considered only in combination with upward vertical seismic load (V_z))

			SSI Analyses Cases						SSSI Analyses Cases					
Subgrade Condition			**LB (Case 7)**		**BE (Case 8)**		**UB (Case 9)**		**LB (Case FC7)**		**BE (Case FC8)**		**UB (Case FC9)**	
Direction Vertical Seismic Load			**upward**		**upward**		**upward**		**downward**		**downward**		**upward**	
SASSI	Time	(sec)	3.035		1.810		5.275		3.035		3.085		3.025	
	Vertical seismic load (V_z)	(MN)	39		284		45		37		65		83	
	Total vertical load	(MN)	389		143		382		655		684		344	
	Moment in NS-dir (Mx)	(MN-m)	1991		1135		1178		2886		5074		5961	
	Moment in EW-dir (My)	(MN-m)	2409		1870		2637		1637		686		1072	
Simplified Method**			**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**	**EB**	**MEB**
NS dir. ↓ EW dir.	Max. basemat uplift ratio α	(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.9	44.7
	Max. basemat rotation (ϕ)	(10^{-4} rad)	0.002	0.002	0.003	0.003	-0.003	-0.003	-0.004	-0.004	-0.004	-0.004	-0.005	-0.007
	Max. basemat moment (Mx)	(MN-m)	1991	1991	1135	1135	1178	3310	2886	2886	5074	5074	5961	5646
	Max. bearing pressure 1 (Px)	(MPa)	0.85	0.85	0.99	0.99	0.77	0.77	0.95	0.95	1.22	1.22	0.99	1.20
	Max. bearing pressure 2 (Py)	(MPa)	---	0.69	---	0.54	---	0.76	---	0.47	---	0.20	---	0.56
	Max. Bearing pressure (Pxy=Px+Py)	(MPa)	---	1.55	---	1.53	---	1.53	---	1.42	---	1.42	---	1.76
EW dir. ↓ NS dir.	Max. basemat uplift ratio α	(%)	31.5	39.9	38.0	78.3	36.5	47.0	0.0	0.0	0.0	0.0	-3.3	0.0
	Max. basemat rotation (ϕ)	(10^{-4} rad)	-0.10	-0.13	-0.21	-0.66	0.41	0.59	0.005	0.005	0.004	0.004	0.003	0.003
	Max. basemat moment (My)	(MN-m)	2409	2330	1870	1222	2637	2469	1637	1637	686	2279	1072	1074
	Max. bearing pressure 1(Py)	(MPa)	1.07	1.24	0.68	1.27	1.13	1.39	1.10	1.10	0.86	0.86	0.64	0.64
	Max. bearing pressure 2 (Px)	(MPa)	---	0.37	---	0.58	---	0.25	---	0.32	---	0.56	---	0.66
	Max. Bearing Pressure (Pyx=Py+Px)	(MPa)	---	1.61	---	1.85	---	1.63	---	1.42	---	1.42	---	1.30
	Envelope of Pxy and Pyx	(MPa)	---	1.61	---	**1.85**	---	1.63	---	1.42	---	1.42	---	1.76

Notes: * SASSI2010 analysis is a linear time history analysis with the 3D excitation.

** EB and MEB stand for energy balance (EB) and modified energy balance (MEB) methods.

The bold red number is the maximum dynamic toe bearing pressure demand.

NAPS DEP 3.7-1 Figure 3G.10-201 **Design Seismic Shear and Moments for FWSC (FWS)**

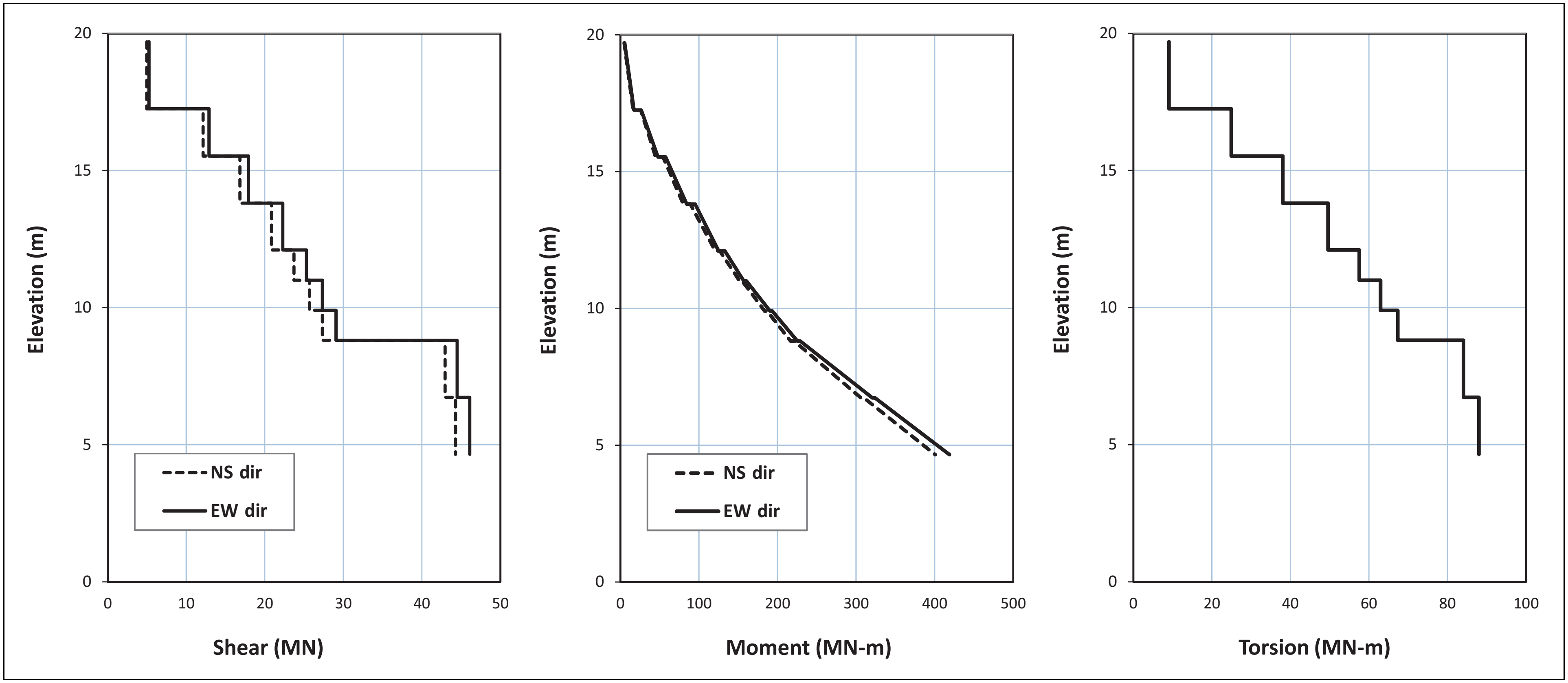

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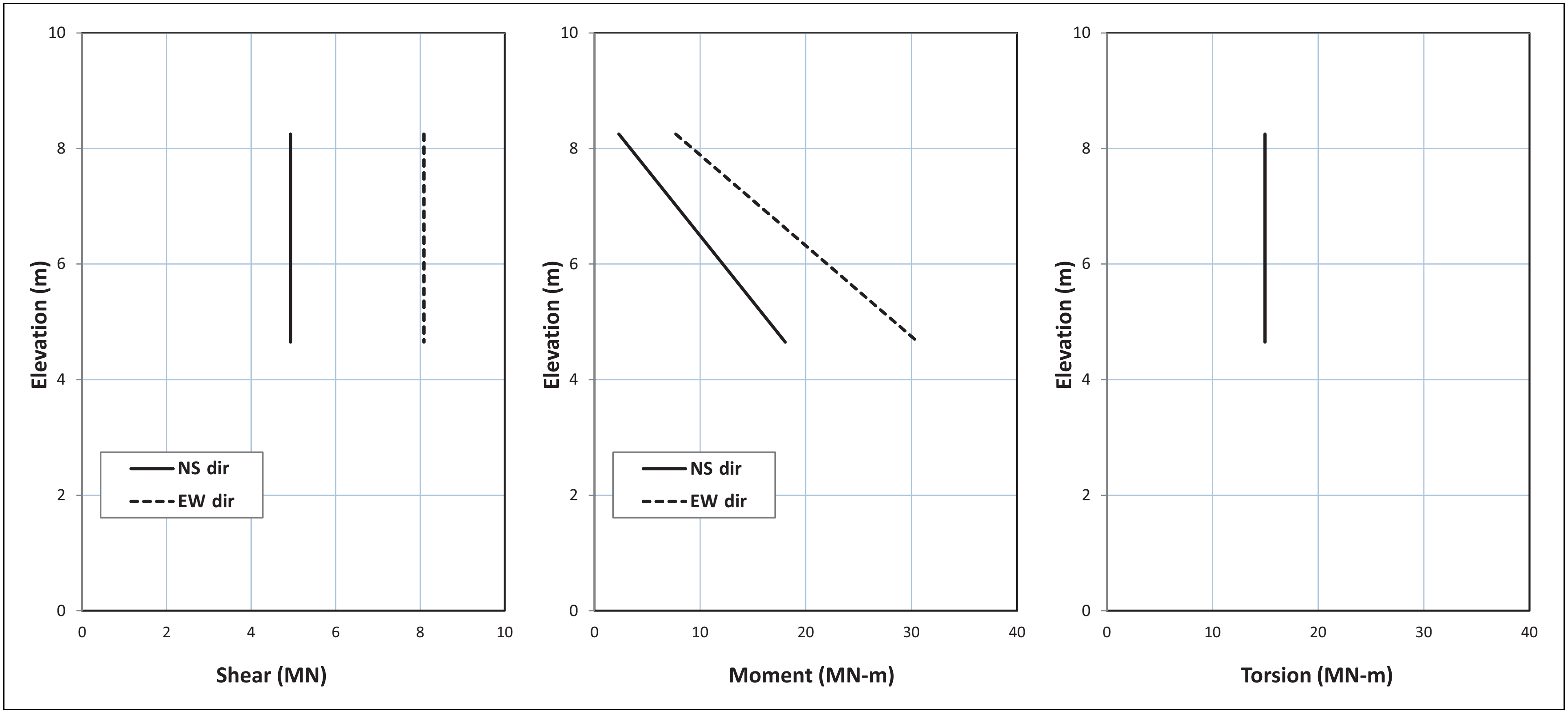
Figure 3G.10-202 **Design Seismic Shear and Moments for FWSC (FPE)**



Appendix 3H Equipment Qualification Design Environmental Conditions

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3I Designated NEDE-24326-1-P Material Which May Not Change Without Prior NRC Approval

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3J Evaluation of Postulated Ruptures in High Energy Pipes

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3K Resolution of Intersystem Loss of Coolant Accident

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 3L Reactor Internals Flow Induced Vibration Program

This section of the referenced DCD is incorporated by reference with no departures or supplements.