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

3.1 Conformance with NRC General Design Criteria

This section of the referenced 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.

STD CDI Add the following sentence at the end of Section 3.2

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 Subsection 9.3.9 for further details.

Replace the note for System P74 with the following.

STD CDI The site-specific plant design does not include the Zinc Injection System.

3.3 Wind and Tornado Loadings

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

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.

3.5.1.5 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.

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

3.7.1.1 Design Ground Motion

Add the following at the end of this section.

EF3 SUP 3.7-7 Figure 2.0-201 and Figure 2.0-202 provide the Certified Seismic Design Response Spectra (CSDRS), which envelopes the site-specific design ground motions (FIRS) developed in Subsection 2.5.2 for the Reactor Building/Fuel Building (RB/FB) and Control Building (CB) and is used for design of the ESBWR RB/FB and CB. Figure 2.0-203 and Figure 2.0-204 provide the Fire Water Service Complex (FWSC) CSDRS, which envelopes the site-specific design ground motions (FIRS) for the FWSC and is used for design of the FWSC.

For the Fermi 3 RB/FB and CB, site-specific soil-structure interaction (SSI) analyses were performed to address the following conditions:

- Partial embedment in the Bass Islands Group bedrock of the RB/FB and CB Seismic Category I structures, as shown on Figure 2.5.4-202 and Figure 2.5.4-203, to confirm that the Referenced DCD design is applicable for this case.
- To demonstrate that the Referenced DCD requirements for the backfill surrounding Seismic Category I structures above the top of bedrock can be neglected for RB/FB and CB with the RB/FB and CB partially embedded in the bedrock at the Fermi 3 site.

Figure 2.0-201, Figure 2.0-202, Figure 2.0-203, and Figure 2.0-204 show that the FIRS developed in Subsection 2.5.2 are enveloped by the CSDRS in both horizontal and vertical directions for the RB/FB, CB, and FWSC. Therefore, the Fermi 3 site-specific SSI analyses were not performed to address any exceedance of the CSDRS; rather, the Fermi 3 site-specific SSI analyses were performed to address the two Fermi 3 site-specific conditions outlined above.

The site-specific SSI analyses developed hazard-consistent seismic input for site response and SSI analyses consistent with Interim Staff Guidance DC/COL-ISG-017 and an NEI developed white paper (Reference 3.7.1-206). The design ground motion for the SSI analyses (herein called SSI FIRS) is based on an enveloped combination of the FIRS developed in Subsection 2.5.2 for a subsurface profile truncated at the foundation level (Truncated Soil Column Response [TSCR]) and outcrop response FIRS developed for the full soil column (Soil Column Outcrop Response [SCOR]) to finished ground level grade (Subsection 3.7.1.1.4). Due to the site-specific SSI analyses completed for Fermi 3, the site-specific Safe Shutdown Earthquake (SSE) applicable for plant shut down purposes is the lower of the two SSI FIRS for the RB/FB or CB.

The operating basis earthquake (OBE) is one-third of the SSE. These SSE and OBE definitions are used in conjunction with the criteria specified in DCD Section 3.7.4.4 to determine whether a plant shutdown is required following a seismic event.

EF3 SUP 3.7-1

3.7.1.1.4 Fermi 3 Site-Specific SSI Ground Motion

In the SASSI2000 model for the Fermi 3 site-specific SSI analyses, the RB/FB and CB are modeled as partially embedded structures that penetrate into the Bass Islands Group bedrock. The elevation of the top of the Bass Islands Group bedrock is 168.2 m (552.0 ft) NAVD 88. The

engineered granular backfill surrounding the RB/FB and CB above the Bass Islands Group bedrock is not included in the model.

The RB/FB and CB FIRS presented in Subsection 2.5.2 were developed as Truncated Soil Column Response (TSCR) outcropping motions with all material above the foundation levels removed (herein called TSCR FIRS). In order to consider the potential influence of material above the foundation levels in the SSI analyses, a second set of FIRS were developed for the Fermi 3 site as a Soil Column Outcrop Response (SCOR) at the RB/FB and CB foundation levels (herein called SCOR FIRS). The SCOR FIRS at the RB/FB and CB foundation levels were developed based on the full soil column to the finished ground level grade at Elevation 179.6 m (589.3 ft) NAVD 88 using the procedure described in Section 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017 and Section 3.2.3 of the NEI developed white paper (Reference 3.7.1-206). This approach was developed to ensure hazard-consistent seismic input for the site-specific SSI analyses. The Fermi 3 site-specific SSI FIRS was then developed by enveloping the site-specific hazard-consistent FIRS computed as a TSCR FIRS, presented in Subsection 2.5.2, and the SCOR FIRS, presented in Subsection 3.7.1.1.4.1, to capture the maximum site response effects of both soil columns. The enveloping Fermi 3 site-specific SSI FIRS are used as seismic inputs for Fermi 3 site-specific SSI analyses for the RB/FB and CB.

Development of the SSI FIRS and ground motion time histories in three directions (two horizontal and one vertical) compatible with the SSI FIRS are discussed in the following subsections.

3.7.1.1.4.1 **Full Soil Column Ground Motions**

The process described in Section 3.2.3 of the NEI developed white paper (Reference 3.7.1-206) for development of a SCOR FIRS requires the development of the Performance-Based Surface Response Spectra (PBSRS) at the finished ground level grade. The SCOR FIRS at the RB/FB and CB foundation levels are then computed as outcropping motions from within this full soil column site response analysis. The method used to develop the site-specific PBSRS at the finished ground level grade for the Fermi 3 site is exactly the same as that used in Subsection 2.5.2.5 to develop the TSCR FIRS with the exception that the soil column is extended to the finished ground level grade instead of

being truncated at the foundation level. The method in Subsection 2.5.2 employs Approach 2B outlined in NUREG/CR-6728 (Reference 2.5.2-270) to develop hazard-consistent surface spectra at the ground surface and foundation levels from the generic hard rock Uniform Hazard Response Spectrum (UHRS) presented in Subsection 2.5.2.4. As described in Subsection 2.5.2.5, the following steps are involved in this approach:

1. Characterize the dynamic properties of the subsurface materials.
2. Randomize these properties to represent their uncertainty and variability across the site.
3. Based on the deaggregation of the rock hazard, define the distribution of magnitudes contributing to the controlling earthquakes for high-frequency (HF) and low-frequency (LF) ground motions and define the response spectra appropriate for each of the deaggregation earthquakes (DE).
4. Obtain appropriate rock site time histories to weakly match the response spectra for the DEs to be used as input at the base of the subsurfce profiles.
5. Compute mean site amplification functions for the HF and LF controlling earthquakes based on the weighted average of the amplification function for the DEs.
6. Scale the response spectra for the controlling earthquakes (defined in the same manner as the reference earthquake [RE]) by the mean amplification function to obtain surface motions.
7. Envelop these scaled spectra to obtain surface motions at the finished ground level grade that are hazard-consistent with the generic CEUS hard rock hazard levels.

The Fermi 3 site-specific PBSRS at the finished ground level grade and the SCOR FIRS were developed by repeating the analysis steps presented above using the full soil column. Analysis steps 1 and 2 are described below in Subsection 3.7.1.1.4.1.1. Analysis steps 3 and 4 are based on the rock hazard for the Fermi 3 site and are the same as those performed for the TSCR analyses presented in Subsection 2.5.2.4 and Subsection 2.5.2.5. The input rock motions for the site response analyses presented in Subsection 2.5.2.5 are used in the full soil column analysis without modification. Step 5 is described in

Subsection 3.7.1.1.4.1.2. Steps 6 and 7 are described in Subsection 3.7.1.1.4.2.

3.7.1.1.4.1.1 Dynamic Properties for the Full Soil Column Profile

The PBSRS surface at the finished ground level grade for the Fermi 3 site is Elevation 179.6 m (589.3 ft) NAVD 88. This elevation will be achieved by excavating and removing the existing overburden to the top of the Bass Islands Group bedrock unit at Elevation 168.2 m (552.0 ft) NAVD 88, and backfilling with engineered granular backfill to the finished ground level grade. This process results in an average engineered granular backfill thickness of approximately 11.2 m (37 ft). Below the engineered granular backfill is bedrock and the fill concrete between the foundation walls and the bedrock. Subsection 2.5.2.5.1 discusses the development of the dynamic engineering properties for the in-situ bedrock material. The dynamic engineering properties for the in-situ bedrock material used in the site response analysis for computing the PBSRS at the finished ground level grade and SCOR FIRS are provided in Table 3.7.1-201, Table 3.7.1-202, and Table 3.7.1-203 below layer number 9. The finished ground level grade reported in Table 3.7.1-201 through Table 3.7.1-203 is rounded to the nearest foot (e.g., 589 ft). This difference is not considered significant for the site response since, as discussed in Subsection 3.7.1.1.4.1.1.3, the layer boundaries of the soil profiles are randomized.

Above the bedrock, the shear-wave velocity (V_S) for the engineered granular backfill is estimated based on empirical relationships for angular-grained material from Richart et al (Reference 3.7.1-201):

$$V_S = [159 - (53.5)e](\overline{\sigma_0})^{0.25}$$

Where:

V_S is the shear wave velocity in ft/sec

e is the void ratio

$\overline{\sigma_0}$ is the average effective confining pressure $\mathrm{lb/ft^2}$ defined as

$$\overline{\sigma_0} = \frac{1}{3}(\sigma'_V + 2\sigma'_H)$$

σ'_V is the effective vertical stress in $\mathrm{lb/ft^2}$

σ'_H is the effective horizontal stress in $\mathrm{lb/ft^2}$ with $\sigma'_H = k_0\sigma'_V$

k_0 is the at-rest earth pressure coefficient

Figure 3.7.1-201 shows the estimated three shear wave velocity profiles (the lower-range [LR], intermediate-range [IR], and upper-range [UR] site

response analysis profiles) for the engineered granular backfill used as input to the site response analysis for computing the PBSRS at the finished ground level grade and SCOR FIRS. A range of values for the engineered granular backfill is used to assess the potential variability of the fill shear-wave velocities in the full soil column site response analyses. The three shear wave velocity profiles for the engineered granular backfill are provided in layers 1 through 9 in Table 3.7.1-201, Table 3.7.1-202, and Table 3.7.1-203 for the LR, IR, and UR profiles, respectively. As stated in Subsection 2.5.2.5.1, a single velocity profile is appropriate for the in-situ material at the Fermi 3 site; therefore, the velocity profile does not change below the engineered granular backfill. The groundwater table is assumed to be at the maximum historical groundwater elevation of 175.6 m (576.11 ft) NAVD 88 (Subsection 2.4.12) for estimating the shear wave velocities of the engineered granular backfill.

3.7.1.1.4.1.1.1 **Density**

Unit weights for the LR, IR, and UR site response analysis profiles are provided in Table 3.7.1-201, Table 3.7.1-202, and Table 3.7.1-203, respectively, for engineered granular backfill and bedrock. A range of values for the engineered granular backfill is used to assess the potential variability of density in the full soil column site response analyses.

3.7.1.1.4.1.1.2 **Shear Modulus Reduction and Damping**

The upper 11.3 m (37 ft) of the Fermi 3 full soil column site response analysis profile consists of engineered granular backfill. The modulus reduction and damping relationships for the engineered granular backfill used in the site response analyses are chosen from EPRI generic sand curves (Reference 2.5.4-229). Figure 3.7.1-202 presents the modulus reduction and damping relationships for the 0 to 6.1 m (20 ft) and 6.1 m to 15.2 m (20 to 50 ft) depth ranges. The damping ratio curves were limited to a maximum of 15 percent damping for site response analyses as recommended in Appendix E of Regulatory Guide 1.208. The type of modulus reduction and damping relationship for engineered granular backfill in the LR, IR, and UR site response analysis profiles are provided in Table 3.7.1-201, Table 3.7.1-202, and Table 3.7.1-203.

Below 11.3 m (37 ft), the remaining portion of the full soil column site response analysis profile consists of dolomite and claystone bedrock as discussed in Subsection 2.5.2.5.1.2. The bedrock is expected to remain

essentially linear at low to moderate levels of shaking. Damping within the in-situ dolomite and claystone bedrock is characterized by a high-frequency attenuation parameter (κ) that ranges from 0.001 and 0.003 seconds (Subsection 2.5.2.5.1). The values of κ established in Subsection 2.5.2.5.1 are used to develop the full soil column site response analysis for the Fermi 3 site.

3.7.1.1.4.1.1.3 Randomization of Dynamic Properties

Site response analyses for the full soil column profile were conducted using randomized dynamic soil properties following the methods described in Subsection 2.5.2.5.1.3. The randomized dynamic soil properties included shear wave velocity, modulus reduction, and damping. Additionally, the locations of velocity layer boundaries were randomized to vary uniformly within the range of layer thickness observed in the site borings.

Sixty randomized V_S profiles were generated for each of the LR, IR, and UR site response analysis profiles (a total of 180 randomized V_S profiles for all three site response analysis profiles). The statistics of the randomized profiles are summarized by comparing to the input target values for median velocity and standard deviation (sigma) of $\ln(V_s)$ for the LR, IR, and UR profiles. As an example of this process, Figure 3.7.1-203 to Figure 3.7.1-205 show the 60 randomized velocity profiles and the statistics of the randomized shear wave velocity profiles for the IR site response analysis profile.

The modulus reduction and damping relationships were also randomized as shown on Figure 3.7.1-206 and Figure 3.7.1-207. The standard deviation in the modulus reduction and damping were set so that the randomized relationships fell within recommended bounds provided by Silva (Reference 2.5.2-287).

The damping in the sedimentary bedrock beneath the engineered granular backfill was computed using the randomized sedimentary bedrock layer velocities and thicknesses, and the selected values of κ described in Subsection 2.5.2.5.1.

3.7.1.1.4.1.2 Site Ampflication Functions

A process similar to the description for developing the GMRS and FIRS site amplification functions in Subsection 2.5.2.5.3 was repeated to produce mean site amplification functions for the PBSRS at the finished

ground level grade and the SCOR FIRS at the RB/FB and CB foundation levels.

Figure 3.7.1-208 shows the site response logic tree used to compute the controlling earthquake or RE mean amplification function and the weights assigned to the bedrock damping values and the subsurface profiles. This logic tree is similar to Figure 2.5.2-266; however, instead of including uncertainty in the shear modulus and damping curves for the glacial till that will be excavated during construction, the logic tree includes the three LR, IR, and UR site response analysis profiles to assess uncertainty in the dynamic properties of the engineered granular backfill. For each DE, mean amplification functions were computed using three bedrock damping values (κ) and the LR, IR, and UR profiles. The results from the three DEs are then combined to produce a weighted mean amplification function for the RE. The weights assigned to the DEs are given in Table 2.5.2-222.

The mean amplification functions were then smoothed to remove small dips and peaks considered an artifact of the finite number of analyses. Linear interpolation in logarithmic space (log-log interpolation) smoothed the HF and LF amplification function above 1 Hz and below 10 Hz, respectively.

Figure 3.7.1-209 shows the mean PBSRS site amplification functions at the finished ground level grade for the 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} exceedence levels of input ground motion. Both the original and smoothed PBSRS site amplification functions are presented. Because of the non-linear behavior of the engineered granular backfill, the site amplification is sensitive to the level of input motion for most frequencies.

The SCOR site amplification functions at the RB/FB and CB foundation levels were obtained from the results of the site response analyses for the full soil column profile. Again, the mean amplification functions were smoothed to remove small features considered artifacts of the analyses. Figure 3.7.1-210 and Figure 3.7.1-211 show both the mean and smoothed SCOR site amplification functions for 10^{-4} and 10^{-5} exceedence levels of input ground motions at the RB/FB and CB foundation levels, respectively. These amplification functions show little sensitivity to the two different levels of motions because both foundations are founded in the same bedrock unit that has a relatively high and uniform shear-wave velocity.

3.7.1.1.4.2 Surface Hazard Spectra for PBSRS and SCOR FIRS

The surface UHRS at the finished ground level grade and at the RB/FB and CB foundation levels were constructed following the procedures described in Subsection 2.5.2.6 for the GMRS at the top of competent material. The appropriate site amplification functions were used to scale the generic hard rock UHRS and the LF and HF RE to obtain the surface UHRS at the finished ground level grade and for the RB/FB and CB SCOR foundation levels. For the generic hard rock UHRS, the HF amplification function is used for frequencies above 5 Hz and the LF amplification function is used for frequencies below 2.5 Hz. Frequencies between 2.5 and 5 Hz use a weighted combination of the HF and LF amplifications.

Figure 3.7.1-212 shows the surface spectra, for the scaled LF and HF RE and the scaled hard rock UHRS, and the envelop spectrum for the 10^{-4} exceedance level ground motions at the finished ground level grade. The amplification functions and the corresponding surface spectrum show a slight dip in the frequency range of 6 to 25 Hz. The dip was conservatively removed in constructing the enveloped surface UHRS for the 10^{-4} exceedance level ground motions. As a result, the final spectra will be conservative in the frequency range of approximately 6 to 25 Hz.

Figure 3.7.1-213 shows the SCOR spectra, for the scaled LF and HF RE and the scaled hard rock UHRS, and the envelop spectrum for the 10^{-4} exceedance level ground motions at the RB/FB foundation level developed using the full soil column. The SCOR UHRS at the RB/FB foundation level was developed using the same process described for the finished ground level grade surface UHRS, including smoothing through the dip in the spectrum between approximately 6 and 25 Hz.

Similar operations were performed to develop the SCOR UHRS for the 10^{-4} exceedance level ground motions at the CB foundation level, and the 10^{-5} exceedance level motions at both the finished ground level grade surface, and the RB/FB and CB foundation levels.

3.7.1.1.4.3 Incorporation of Cumulative Absolute Velocity (CAV)

The EPRI CAV model was implemented in a second set of PSHA calculations for the full soil column at the Fermi 3 site following the procedures described in Subsection 2.5.2.6.2. Again, two sets of calculations were performed. The first set incorporated the CAV filter and

site amplification, and the second set was performed using only site amplification. The purpose of performing these two sets of calculations is to provide ratios of CAV/no-CAV spectral values at the seven spectral frequencies used in the PSHA calculations. These spectral ratios are then used to adjust the smooth surface UHRS discussed in Subsection 3.7.1.1.4.2 to produce the final hazard-consistent surface UHRS.

Figure 3.7.1-214 through Figure 3.7.1-220 compare the surface mean hazard curves computed with and without CAV at the finished ground level grade for the seven spectral frequencies of 0.5, 1, 2.5, 5, 10, 25, and 100 Hz, respectively. Also shown on these figures is the corresponding generic CEUS hard rock hazard curve from Subsection 2.5.2.4.4.

The surface mean hazard results shown on Figure 3.7.1-214 through Figure 3.7.1-220 are interpolated to obtain the spectral accelerations corresponding to mean annual frequencies of exceedance of 10^{-4} and 10^{-5}. The ratio of the spectral accelerations computed with CAV to those computed without CAV for the seven spectral frequencies are then used to scale the smooth surface spectra described in Subsection 3.7.1.1.4.2 to produce hazard-consistent surface UHRS that are based on the use of the CAV filter. The CAV/no-CAV spectral ratios at intermediate periods are obtained by log-log interpolation. Figure 3.7.1-221 shows the resulting mean 10^{-4} and 10^{-5} surface UHRS, with and without CAV, at the finished ground level grade.

3.7.1.1.4.4 PBSRS at the Finished Ground Level Grade

3.7.1.1.4.4.1 Horizontal PBSRS

Development of the horizontal PBSRS at the finished ground level follows the same processes for development of the GMRS provided in Regulatory Guide 1.208 and Subsection 2.5.2.6.3. Figure 3.7.1-222 shows the horizontal PBSRS at the finished ground level grade calculated using a design factor (DF) (10^{-4} UHRS x DF) and the minimum value (10^{-5} UHRS x 0.45) when the DF exceeds 4.2. The final PBSRS is the envelope of the two horizontal PBSRS curves. Figure 3.7.1-222 also shows the 10^{-4} and 10^{-5} surface UHRS at the finished ground level grade. Table 3.7.1-204 presents the resulting horizontal PBSRS values.

3.7.1.1.4.4.2 Vertical PBSRS

The vertical GMRS developed in Subsection 2.5.2.6.3 used vertical to horizontal (V/H) spectral ratios recommended by NUREG/CR-6728 (Reference 2.5.2-270) for CEUS bedrock sites. The vertical PBSRS at the finished ground level grade was also constructed using V/H spectral ratios; however, the full soil column profile consists of a thin layer of soil over bedrock. This profile is somewhat different than the generic rock conditions for which the V/H ratios shown on Figure 2.5.2-287 were developed. At present, there are no published V/H ratios for ground motions in the CEUS for the conditions represented by the full soil column profile, a profile with a thin soil layer over bedrock. Therefore, the V/H ratios for the vertical PBSRS were developed by examining differences between bedrock and shallow soil site V/H ratios for western US (WUS) data and using the differences to adjust the CEUS hard rock V/H values.

The WUS V/H ratios recommended in NUREG/CR-6728 (Reference 2.5.2-270) were based on ground motion relationships for a generic bedrock site classification. More recently, Campbell and Bozorgnia (Reference 3.7.1-203) developed empirical ground motion prediction equations for bedrock sites that contained explicit categorization for firm bedrock (V_{S30} 830 m/s ± 339 m/s [2723 ft/s ± 1112 ft/s]) and soft rock (V_{S30} 421 m/s ± 109 m/s [1381 ft/s ± 358 ft/s]) sites, where V_{S30} is the average shear wave velocity in the upper 30 m (100 ft). The soft bedrock V/H ratios are used to indicate the potential behavior of a shallow stiff soil site. The results obtained using Campbell and Bozorgnia (2003) suggest that the peak in the V/H ratios for soft bedrock shifts slightly towards lower frequencies compared to the peak for firm bedrock sites. The V/H ratios are also lower on soft bedrock for frequencies less than about 3 Hz.

The Pacific Earthquake Engineering Research (PEER) Center’s Next Generation Attenuation (NGA) Project (Reference 3.7.1-207) developed an extensive database of strong motion records from active tectonic environments. The records from Reference 3.7.1-207 were analyzed by Gülerce and Abrahamson (Reference 3.7.1-208) to develop a model for V/H ratios based on V_{S30} values (the average velocity in the upper 30 meters). In order to compare the model of Gülerce and Abrahamson (Reference 3.7.1-208) to the site categories of Campbell and Bozorgnia (Reference 3.7.1-203), V/H ratios were computed using the Gülerce and Abrahamson (Reference 3.7.1-208) model for V_{S30} values of 830 m/s

(2,723 ft/s) and 421 m/s (1,381 ft/s). These V_{S30} values corresponded to the firm rock and soft rock categories of Campbell and Bozorgnia (Reference 3.7.1-203). The result suggests a trend similar to the Campbell and Bozorgnia (Reference 3.7.1-203) result.

Figure 3.7.1-223 shows V/H spectral ratios as a function of frequency used for generating the vertical PBSRS at the finished ground level grade, and the V/H spectral ratios recommended by NUREG/CR- 6728 (Reference 2.5.2-270) for CEUS bedrock sites with a PGA between 0.2 g and 0.5 g. The V/H spectral ratios used for generating the vertical PBSRS are based on the V/H spectral ratios recommended by NUREG/CR-6728 (Reference 2.5.2-270) for CEUS bedrock sites with a shift in the frequencies above 10 Hz to represent the shift in the peak V/H spectral ratios towards lower frequencies in the Campbell and Bozorgnia (Reference 3.7.1-203) and Gülerce and Abrahamson (Reference 3.7.1-208) comparisons. Additionally, at frequencies below 5 Hz the V/H spectral ratio is reduced slightly to reflect the differences observed in the Campbell and Bozorgnia (Reference 3.7.1-203) and Gülerce and Abrahamson (Reference 3.7.1-208) comparisons. The resulting vertical PBSRS is listed in Table 3.7.1-204 along with the values of V/H. Figure 3.7.1-224 shows the horizontal and vertical PBSRS (5 percent damping) at the finished ground level grade.

3.7.1.1.4.4.3 **Deterministic Profiles for the Full Soil Column**

Three deterministic profiles, the best estimate (BE), lower bound (LB), and upper bound (UB), were developed from the PBSRS site response analysis following the requirements of SRP 3.7.2 and guidance from the Interim Staff Guidance DC/COL-ISG-017. These profiles were based on the statistics of the iterated soil properties for the randomized full soil column profile described in Subsection 3.7.1.1.4.1.1.3.

The full soil column BE profile was set equal to values interpolated between the median iterated soil properties for the 10^{-4} and 10^{-5} exceedance level ground motions. The resulting subsurface layers and the corresponding strain compatible dynamic engineering properties for the full soil column BE profile are listed in Table 3.7.1-205.

The full soil column LB profile was set equal to the 16th percentile of the distribution of randomized soil properties, and the full soil column UB profile was set equal to the 84th percentile of the distribution of randomized soil properties. The range in the full soil column UB and LB

shear wave velocities was increased where necessary to maintain the minimum variation from the shear modulus for the BE profile (G_{best}), more than 1.5 x G_{best} or G_{best} / 1.5, to define the range as required in SRP 3.7.2. Table 3.7.1-206 and Table 3.7.1-207 list the resulting subsurface layers and the corresponding strain compatible dynamic engineering properties for the full soil column LB and UB profiles, respectively.

Figure 3.7.1-225 shows the full soil column LB, BE, and UB subsurface shear wave velocity profiles for the Fermi 3 site near the RB/FB and CB. The corresponding damping ratios were obtained from the statistics of the iterated profiles assuming negative correlation between shear wave velocity (V_S) and damping: that is the 16th percentile damping was used for the full soil column UB profile and the 84th percentile damping was used for the full soil column LB profile. The compression wave velocities were based on the measured shear wave velocities for the in-situ materials, the recommend Poisson's ratios in Table 2.5.4-202, and the relationship from Kramer (Reference 2.5.4-232) presented as follows:

$$\frac{V_P}{V_S} = \sqrt{\frac{2-2\nu}{1-2\nu}}$$

Where:

V_P is the compression wave velocity

V_S is the shear wave velocity

ν is the Poisson's ratio

Although the bedrock is below the groundwater table at the site, compression wave velocities exceeded the 1,524 m/s (5,000 ft/sec) (velocity in water); therefore, a minimum value of 1,524 m/s (5,000 ft/sec) for the bedrock compression wave velocity below the water table was not imposed.

3.7.1.1.4.5 **SCOR FIRS**

The process described in Subsection 3.7.1.1.4.4 was used to develop the SCOR FIRS at the RB/FB and CB foundation levels. The SCOR FIRS are shown on Figure 3.7.1-226 and Figure 3.7.1-227 for the RB/FB and CB, respectively. The spectral accelerations for the RB/FB and CB SCOR FIRS are provided in Table 3.7.1-208 and Table 3.7.1-209, respectively. Also shown on Figure 3.7.1-226 and Figure 3.7.1-227 are the ESBWR CSDRS (Reference 2.5.2-291). The SCOR FIRS for the RB/FB and CB are enveloped by the ESBWR CSDRS

Since the RB/FB and CB foundation levels are within the bedrock units, the vertical SCOR FIRS were generated using the V/H spectral ratios for hard rock recommended by NUREG/CR-6728 (Reference 2.5.2-270) for CEUS bedrock sites. The recommended CEUS hard rock V/H spectral ratios for 0.2 g ≤ PGA ≤ 0.5 g are shown on Figure 3.7.1-223 (red curve). Although the PGA for the horizontal SCOR FIRS is slightly less than 0.2 g, the V/H spectral ratios for a PGA between 0.2 g and 0.5 g were used. Because the vertical PBSRS was based on modified V/H spectral ratios for a PGA between 0.2 g and 0.5 g, use of the rock V/H spectral ratios for this PGA range to develop the vertical SCOR FIRS maintains consistent vertical to horizontal spectral ratios between the PBSRS and SCOR FIRS.

Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206) state that time histories matched to the outcrop FIRS should be convolved from the foundation level up to the finished ground level grade using the full soil column LB, BE, and UB subsurface profiles, and that the resulting envelope of the three surface spectra from the time histories should envelop the PBSRS at the finished ground level grade. This comparison was made by matching the seed time history using the methods discussed in Subsection 3.7.1.1.5 to the SCOR FIRS. The matched time histories compatible with the SCOR FIRS were then input at the appropriate foundation level into the three deterministic soil column profiles (LB, BE, and UB) for the full soil column, shown on Figure 3.7.1-225, and convolved to the PBSRS level at finished ground level grade with SHAKE analyses. Comparison of the resulting envelope of the three surface spectra from the horizontal time histories and the horizontal PBSRS showed that the resulting envelope did not envelop the PBSRS at frequencies below 0.5 Hz and at a location near 2 Hz. Comparison of the resulting envelope of the three surface spectra from the vertical time histories and the vertical PBSRS showed that the envelope did not envelop the PBSRS at frequencies below 0.5 Hz or at frequencies between about 1.5 Hz and 10 Hz.

The horizontal SCOR FIRS were then enhanced by increasing the overall level of ground motion in the frequency ranges identified during the comparison of the resulting envelope of the three surface spectra from the time histories and the PBSRS. Figure 3.7.1-228 and Figure 3.7.1-229 show the horizontal SCOR FIRS and the horizontal enhanced SCOR FIRS for the RB/FB and CB, respectively. Also shown on Figure

3.7.1-228 and Figure 3.7.1-229 are the horizontal ESBWR CSDRS (Reference 2.5.2-291). The enhanced horizontal SCOR FIRS for the RB/FB and CB are enveloped by the horizontal ESBWR CSDRS. Time histories matched to the enhanced SCOR FIRS were then convolved from the foundation level up to the finished ground level grade using the full soil column LB, BE, and UB subsurface profiles for comparison to the PBSRS at the finished ground level grade. Figure 3.7.1-230 and Figure 3.7.1-231 show the comparison of the PBSRS at the finished ground level grade with the envelope of the surface response spectra obtained from SHAKE analyses using the LB, BE, and UB full soil column profiles and the matched time histories compatible with the RB/FB and CB enhanced SCOR FIRS, respectively. The envelope of the three response spectra at the ground surface exceeds the PBSRS at the finished ground level grade for each component of motion, satisfying the Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206). The RB/FB and CB enhanced horizontal SCOR FIRS values are provided in Table 3.7.1-210 and Table 3.7.1-211, respectively.

The vertical SCOR FIRS was also enhanced in the identified frequency ranges. Figure 3.7.1-232 and Figure 3.7.1-233 show the vertical SCOR FIRS and the vertical enhanced SCOR FIRS for the RB/FB and CB, respectively. Also shown on Figure 3.7.1-232 and Figure 3.7.1-233 are the vertical ESBWR CSDRS (Reference 2.5.2-291). The enhanced vertical SCOR FIRS for the RB/FB and CB are enveloped by the vertical ESBWR CSDRS. Vertical component time histories matched to the enhanced SCOR FIRS were then convolved from the foundation level up to the finished ground level grade using the full soil column LB, BE, and UB subsurface profiles for comparison to the PBSRS at the finished ground level grade. Figure 3.7.1-234 and Figure 3.7.1-235 show the comparison of the PBSRS at the finished ground level grade with the envelope of the surface response spectra obtained from SHAKE analyses using the LB, BE, and UB full soil column profiles and the matched time histories compatible with the RB/FB and CB enhanced SCOR FIRS. The envelope of the three response spectra at the ground surface exceeds the PBSRS at the finished ground level grade for each component of motion, satisfying the Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206). The RB/FB and CB enhanced vertical SCOR FIRS values are provided in Table 3.7.1-210 and Table 3.7.1-211, respectively.

3.7.1.1.4.6 SSI FIRS

The horizontal SSI FIRS was developed by enveloping the horizontal TSCR FIRS from Subsection 2.5.2 and the enhanced horizontal SCOR FIRS developed in Subsection 3.7.1.1.4.5 to capture the maximum site response effects from full and truncated subsurface profiles. The final horizontal SSI FIRS was smoothed by log-log interpolation. Figure 3.7.1-236 and Figure 3.7.1-237 show the TSCR FIRS, the enhanced SCOR FIRS, the enveloped FIRS, and the final smoothed horizontal SSI FIRS at the RB/FB and CB foundation levels (herein called horizontal SSI FIRS), respectively. The RB/FB and CB horizontal SSI FIRS values are provided in Table 3.7.1-212.

A similar procedure was used to construct the vertical SSI FIRS as was used for the horizontal SSI FIRS. Figure 3.7.1-238 and Figure 3.7.1-239 show the TSCR FIRS, the enhanced SCOR FIRS, the enveloped FIRS, and the final smoothed vertical SSI FIRS at the RB/FB and CB foundation levels (herein called vertical SSI FIRS), respectively. The RB/FB and CB vertical SSI FIRS values are also provided in Table 3.7.1-212.

The final smoothed horizontal and vertical SSI FIRS for the RB/FB and CB used for development of the ground motion time histories are shown on Figure 3.7.1-240 and Figure 3.7.1-241, respectively. Table 3.7.1-212 provides the PGA – listed as the 100 Hz value – for the RB/FB and CB horizontal SSI FIRS. As shown on the footnote in Table 3.7.1-212, the PGA for RB/FB and CB horizontal SSI FIRS are higher than the 0.1 g requirement of SRP 3.7.1 Section II (Acceptance Criteria), Revision 3.

Appendix S of 10 CFR Part 50 requires that safety related structures be designed for a minimum PGA of 0.1g. SRP 3.7.1 further indicates that the minimum ground motion level represents a suitable smooth broad-banded response spectral shape scaled to the minimum PGA of 0.1g. As discussed in NUREG/CR-6926 (Reference 3.7.1-209), the process used to develop the site-specific ground motions for the Fermi 3 site produces a broad-band response spectrum without valleys at localized frequencies. As shown in FSAR Table 2.5.2-219, the GMRS and associated FIRS represent the contributions of ground motion from a wide range of magnitudes. Because the PGA values for the site-specific SSI FIRS exceed 0.1g, these spectra meet the minimum PGA requirement specified in Appendix S of 10 CFR Part 50 and SRP 3.7.1.

The site-specific SSI FIRS are compared to appropriate site-independent spectral shapes scaled to the minimum PGA of 0.1g. The RB/FB and CB are to be founded on relatively hard rock. The median rock spectral shape defined in NUREG/CR-0098 (Reference 3.7.1-210) has been used in NUREG-1407 (Reference 3.7.1-211) to specify ground motions for safety evaluations of CEUS nuclear power plants. Figure 3.7.1-259 shows that the SSI FIRS envelop the median rock site spectral shape from NUREG/CR-0098 (Reference 3.7.1-210) scaled to 0.1g PGA and meet the requirements specified in Appendix S of 10 CFR Part 50 and SRP 3.7.1. Alternatively, as discussed in NUREG/CR-6926 (Reference 3.7.1-209), NUREG/CR-6728 (Reference 2.5.2-255) developed appropriate spectral shapes for ground motions on CEUS rock sites. The CEUS rock site spectral relationships presented in NUREG/CR-6728 were used to develop rock spectral shapes for the DEs presented in Table 2.5.2-219. A single enveloping spectral shape was constructed. Figure 3.7.1-259 shows that the SSI FIRS also envelop this spectral shape scaled to the minimum PGA of 0.1g.

EF3 SUP 3.7-2

3.7.1.1.5 Site-Specific Design Ground Motion Time History

Two sets of three orthogonal time histories (two horizontal and one vertical component) were generated to match the horizontal and vertical SSI FIRS (Subsection 3.7.1.1.4.6) for the RB/FB and CB, respectively, in accordance with the criteria of NUREG/CR-6728 (Reference 2.5.2-270). The selected seed time history is the 1999 Chi-Chi Taiwan Earthquake, TAP078 recording, chosen from the CEUS record library provided in NUREG/CR-6728 (Reference 2.5.2-270). This time history represents a distant recording of a large magnitude (moment magnitude 7.6) earthquake, consistent with the large contribution of the New Madrid source to the hazard at the Fermi 3 site. Details of this record are provided in Table 3.7.1-213.

A single set of time histories (two horizontal and one vertical component) was developed for both the RB/FB and CB foundation levels to satisfy the enveloping requirements of Option 1, Approach 2 of SRP 3.7.1 Section II (Acceptance Criteria), Revision 3. Per paragraph 2(d) of Approach 2, in lieu of the power spectrum density requirement, the requirement that the computed 5 percent damped response spectrum of the time history does not exceed the target response spectrum at any frequency by more than 30 percent was

met at frequencies between 0.1 and 50 Hz. A few frequencies above 50 Hz do exceed the target spectrum by more than 30 percent; however, a check of the power spectral density for frequencies above 50 Hz is not required for CEUS sites by Appendix B of SRP 3.7.1. Table 3.7.1-214 and Table 3.7.1-215 present the correlation coefficients between each combination of time history components (two horizontal and one vertical). The correlation coefficients all fall below the criteria of 0.16 in SRP 3.7.1 Section II (Acceptance Criteria), Revision 3.

Spectral matching was performed using the time-domain spectral matching procedure proposed by Lilhanand and Tseng (Reference 3.7.1-204) and later modified by Abrahamson (Reference 3.7.1-205). Figure 3.7.1-242 through Figure 3.7.1-247 show the comparison of the response spectrum in the two horizontal and one vertical direction for the following:

- The SSI FIRS.
- 1.3 times (30 percent greater) the SSI FIRS.
- 0.9 times (10 percent less) the SSI FIRS at the RB/FB and CB levels.
- Response spectrum for the spectrally matched time history

The response spectra for the spectrally-matched time histories were calculated for comparison with the SSI FIRS at 301 spectral frequency points (or 100 frequencies per spectral frequency decade). As shown in Figure 3.7.1-242 through Figure 3.7.1-247, the 5 percent damped response spectra of the spectrally-matched time histories are within the range of 0.9 to 1.3 times the SSI FIRS at any frequency. Therefore, the criteria of Option 1, Approach 2 of SRP 3.7.1 Section II (Acceptance Criteria), Revision 3, are satisfied.

The time step and duration of the matched time histories are 0.005 seconds and 80 seconds, respectively. The duration of the time histories for Arias Intensity to rise from 5 percent to 75 percent is greater than the minimum 6 second duration identified in SRP 3.7.1, Section II (Acceptance Criteria), Revision 3, and consistent with the characteristic earthquake duration of NUREG/CR-6728 (Reference 2.5.2-270). Details of the matched time histories including the PGA, peak ground velocity (PGV), and peak ground displacement (PGD) are presented in Table 3.7.1-216. Figure 3.7.1-248 to Figure 3.7.1-253 present the matched time histories (outcropping motions) compatible with the RB/FB and CB SSI

FIRS at the foundation levels. The duration, and the values of PGV/PGA and PGA*PGD/PGV^2 are generally consistent with the characteristic values reported in NUREG/CR-6728 (Reference 2.5.2-270). The hard rock UHRS for the Fermi 3 site represents a combination of hazard from large, distant earthquakes and smaller, closer earthquakes. Thus, it is expected that the PGV/PGA values would be lower than those for large, distant earthquakes as the PGA is enriched to represent smaller magnitude, closer earthquakes. Spectral matching of the time histories to response spectra extended to a period of 10 seconds also enriches the PGD values, leading to an increase in the values of PGA*PGD/PGV^2.

In accordance with Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206), the spectrally-matched time histories compatible with the RB/FB and CB SSI FIRS were then input as outcropping motions at the foundation level into the three deterministic LB, BE, and UB SSI profiles shown on Figure 3.7.1-258 (see Subsection 3.7.1.3) to compute the resulting in-column motions at the RB/FB and CB foundation levels using the program SHAKE (Reference 2.5.2-282). A total of 18 SHAKE analyses were performed using combinations of the three SSI profiles (LB, BE, UB), the three time history components (two horizontal [H1, H2] and one vertical [V] components) and the two foundation levels (RB/FB and CB). The SHAKE analyses were performed using SSI profiles shown on Figure 3.7.1-258 (see Subsection 3.7.1.3) without iteration of soil properties to generate in-column motions at the foundation levels for input into the SASSI2000 computer program for the Fermi 3 sitespecific SSI analysis.

Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206) state that time histories matched to the outcrop FIRS should be convolved from the foundation level up to the finished ground level grade using the full soil column LB, BE, and UB subsurface profiles, and that the resulting envelope of the three surface spectra from the time histories should envelop the PBSRS at the finished ground level grade. Both documents address cases where the SSI analyses consider surface structures, embedded structures modeled as surface structure, and fully embedded structures. The Fermi 3 SSI analyses consider partial embedment in the Bass Islands Group bedrock with the backfill above the bedrock removed. To make the comparison with the PBSRS at the finished ground level grade for the partially embedded case, the matched time histories compatible with the SSI

FIRS were input into the three deterministic soil column profiles (LB, BE, and UB) for the SSI soil column, shown on Figure 3.7.1-258 (see Subsection 3.7.1.3), and convolved to the top of the in situ bedrock with SHAKE analyses. The freefield surface motions at the top of the in situ bedrock were then input as outcrop motions at the base of the engineered granular backfill (Elevation 552 NAVD 88) into the corresponding deterministic soil column profiles (LB, BE, and UB) for the full soil column, shown on Figure 3.7.1-225, and convolved to the PBSRS level at finished ground level grade with SHAKE analyses. This two step method results in the matched time histories compatible with the SSI FIRS being convolved from the foundation level to the PBSRS level at finished ground level grade for direct comparison of the two spectra. As previously stated, the SSI FIRS was developed by enveloping the TSCR FIRS and the enhanced SCOR FIRS, which are both compliant with the procedures outlined in Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper, to capture the maximum site response effect from the full and truncated subsurface profiles. Figure 3.7.1-254 to Figure 3.7.1-257 show the comparison of the PBSRS at the finished ground level grade with the envelope of the surface response spectra obtained from SHAKE analyses using the LB, BE, and UB SSI profiles and the full soil column profiles, and the matched time histories compatible with the RB/FB and CB SSI FIRS. The envelope of the three response spectra at the ground surface exceeds the PBSRS at the finished ground level grade for each component of motion, satisfying the requirement specified in Interim Staff Guidance DC/COL-ISG-017 and the NEI developed white paper (Reference 3.7.1-206).

3.7.1.2 Percentage of Critical Damping Values

Add the following at the end of Subsection 3.7.1.2.

Table 3.7.1-217 through Table 3.7.1-219 provide the damping ratio for subsurface material properties used in Fermi 3 site-specific SSI analyses for the RB/FB and CB.

3.7.1.3 Supporting Media for Seismic Category I Structures

Add the following at the end of the first paragraph.

EF3 SUP 3.7-3

Subsection 2.5.4 provides site-specific properties of subsurface materials.

Subsection 2.5.4 provides engineering properties of subsurface materials at the Fermi 3 site. The design groundwater elevation assumed for development of the LB, BE, and UB subsurface profiles is provided in Subsection 3.7.1.1.4.1.1. Table 3.7.1-217 through Table 3.7.1-219 provide the strain compatible dynamic engineering properties of subsurface material for the LB, BE, and UB subsurface profiles, respectively, used for the Fermi 3 site-specific SSI analyses for the RB/FB and CB. The three profiles are identical to the full soil column profiles developed in Subsection 3.7.1.1.4.4.3 with the approximately 11.2 m (37 ft) engineered granular fill material removed above the top of the Bass Islands Group bedrock. Figure 3.7.1-258 shows the LB, BE, and UB subsurface shear wave velocity profiles for the Fermi 3 site-specific SSI analysis.

A difference of about 0.1 m (0.4 ft) is observed between the elevation of the closest layer boundary to the RB/FB and CB foundation levels (Elevation 524.0 ft and 540.0 ft NAVD 88) and the actual elevation of the RB/FB and CB foundations (Elevation 523.7 ft and 540.4 ft NAVD 88). This difference is due to randomization of the dynamic properties in Subsection 3.7.1.1.4.1.1.3 which included randomization of the layer elevations. This difference is negligible and, therefore, the bottom of the RB/FB and CB foundation levels are set at Elevation 524.0 and 540.0 ft NAVD 88, respectively, for the Fermi 3 site-specific SSI analyses.

3.7.1.4 References

3.7.1-201 Richart, F.E., Woods, R.D., and J.R. Hall, “Vibration of Soils and Foundations,” Prentice-Hall, 1970.

3.7.1-202 Bowles, J.E., “Foundation Analysis and Design,” McGraw-Hill, 1996.

3.7.1-203 Campbell, K.W., and Y. Bozorgnia, ”Updated Near-Source Ground-Motion (Attenuation) Relations for the Horizontal and Vertical Components of Peak Ground Acceleration and

Acceleration Response Spectra," Bulletin of the Seismological Society of America, Vol. 93, No. 1, 2003.

3.7.1-204 Lilhanand, K., and W.S. Tseng, "Development and application of realistic earthquake time histories compatible with multiple-damping response spectra," Proceedings of the 9th World Conference on Earthquake Engineering, Tokyo-Kyoto, Japan, v. II, 1988.

3.7.1-205 Abrahamson, N., "Non-stationary spectral matching," Seismological Research Letters, Vol. 63, No. 1, 1992.

3.7.1-206 Nuclear Energy Institute (NEI) White Paper, "Consistent site response/soil-structure interaction analysis and evaluation," NEI, June 12, 2009.

3.7.1-207 Power, M., B. Chiou, N. Abrahamson, Y. Bozorgnia, T. Shantz, and C. Robless, "An Overview of the NGA Project," Earthquake Spectra, Vol. 24, pp. 3-21, 2008.

3.7.1-208 Gülerce, Z., and N. Abrahamson, "Site-specific spectra for vertical ground motion," Earthquake Spectra, Vol. 27, pp. 997-1021, 2011.

3.7.1-209 Braverman, J.I., J. Xu, B.R. Ellingwood, C.J. Costantino, R.J. Morante, and C.H. Hofmayer, 2007, Evaluation of the Seismic Design Criteria in ASCE/SEI Standard 43-05 for Application to Nuclear Power Plants, Brookhaven National Laboratory, NUREG/CR-6926.

3.7.1-210 Newmark, N.M. and W.J. Hall, 1978, Development of criteria for seismic review of selected nuclear power plants, NUREG/CR-0098, U.S. Nuclear Regulatory Commission: Washington D.C.

3.7.1-211 Chen, J.T., N.C. Chokshi, R.M. Kenneally, G.B. Kelly, W.D. Beckner, C. McCracken, A.J. Murphy, L. Reiter, and D. Jeng, 1991, Procedural and submittal guidance for the individual plant examination of external events (IPEEE) for severe accident vulnerabilities, NUREG-1407, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research.

Table 3.7.1-201 Full Soil Column Site Response Analysis Profile: Lower Range [EF3 SUP 3.7-1]

Layer Number	Thickness (ft.)	Shear wave Velocity (fps)	Unit Weight (kips/ft.^{3})	Material Curves	Soil/Rock Type
Finished Ground Level Grade, Top of Profile Elevation 589 ft.					
1	2.9	418	0.119	EPRI 0 – 20 feet	Backfill
2	2.9	550	0.119	EPRI 0 – 20 feet	Backfill
3	4.2	638	0.119	EPRI 0 – 20 feet	Backfill
4	3.2	702	0.119	EPRI 0 – 20 feet	Backfill
5	2.5	733	0.119	EPRI 0 – 20 feet	Backfill
6	4.3	754	0.119	EPRI 0 – 20 feet	Backfill
7	5.0	780	0.119	EPRI 20 – 50 feet	Backfill
8	5.0	805	0.119	EPRI 20 – 50 feet	Backfill
9	7.0	834	0.119	EPRI 20 – 50 feet	Backfill
10	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
11	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
12	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
13	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
14	11.0	6650	0.150	Linear, κ layer 1	Bass Islands
15	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
16	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
17	15.0	4600	0.150	Linear, κ layer 2	Bass Islands
18	20.0	3350	0.150	Linear, κ layer 3	Salina F
19	20.0	3350	0.150	Linear, κ layer 3	Salina F
20	20.0	3350	0.150	Linear, κ layer 3	Salina F
21	21.0	3350	0.150	Linear, κ layer 3	Salina F
22	21.0	4050	0.150	Linear, κ layer 3	Salina F
23	21.0	4050	0.150	Linear, κ layer 3	Salina F
24	10.0	5600	0.150	Linear, κ layer 4	Salina E
25	20.0	9450	0.150	Linear, κ layer 4	Salina E
26	21.0	9450	0.150	Linear, κ layer 4	Salina E
27	21.0	9450	0.150	Linear, κ layer 4	Salina E
28	21.0	9450	0.150	Linear, κ layer 4	Salina E
29	45.0	9000	0.160	Linear, κ layer 4	Salina C
30	45.0	9000	0.160	Linear, κ layer 4	Salina C
Halfspace		9300	0.169	0.1% Damping	Salina B

Table 3.7.1-202 Full Soil Column Site Response Analysis Profile: Intermediate Range [EF3 SUP 3.7-1]

Layer Number	Thickness (ft.)	Shear wave Velocity (fps)	Unit Weight (kips/ft.^{3})	Material Curves	Soil/Rock Type
Finished Ground Level Grade, Top of Profile Elevation 589 ft.					
1	2.9	549	0.133	EPRI 0 – 20 feet	Backfill
2	2.9	613	0.133	EPRI 0 – 20 feet	Backfill
3	4.2	690	0.133	EPRI 0 – 20 feet	Backfill
4	3.2	760	0.133	EPRI 0 – 20 feet	Backfill
5	2.5	794	0.133	EPRI 0 – 20 feet	Backfill
6	4.3	819	0.133	EPRI 0 – 20 feet	Backfill
7	5.0	850	0.133	EPRI 20 – 50 feet	Backfill
8	5.0	879	0.133	EPRI 20 – 50 feet	Backfill
9	7.0	913	0.133	EPRI 20 – 50 feet	Backfill
10	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
11	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
12	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
13	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
14	11.0	6650	0.150	Linear, κ layer 1	Bass Islands
15	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
16	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
17	15.0	4600	0.150	Linear, κ layer 2	Bass Islands
18	20.0	3350	0.150	Linear, κ layer 3	Salina F
19	20.0	3350	0.150	Linear, κ layer 3	Salina F
20	20.0	3350	0.150	Linear, κ layer 3	Salina F
21	21.0	3350	0.150	Linear, κ layer 3	Salina F
22	21.0	4050	0.150	Linear, κ layer 3	Salina F
23	21.0	4050	0.150	Linear, κ layer 3	Salina F
24	10.0	5600	0.150	Linear, κ layer 4	Salina E
25	20.0	9450	0.150	Linear, κ layer 4	Salina E
26	21.0	9450	0.150	Linear, κ layer 4	Salina E
27	21.0	9450	0.150	Linear, κ layer 4	Salina E
28	21.0	9450	0.150	Linear, κ layer 4	Salina E
29	45.0	9000	0.160	Linear, κ layer 4	Salina C
30	45.0	9000	0.160	Linear, κ layer 4	Salina C
Halfspace		9300	0.169	0.1% Damping	Salina B

Table 3.7.1-203 Full Soil Column Site Response Analysis Profile: Upper Range [EF3 SUP 3.7-1]

Layer Number	Thickness (ft.)	Shear wave Velocity (fps)	Unit Weight (kips/ft.^{3})	Material Curves	Soil/Rock Type
Finished Ground Level Grade, Top of Profile Elevation 589 ft.					
1	2.9	670	0.146	EPRI 0 – 20 feet	Backfill
2	2.9	722	0.146	EPRI 0 – 20 feet	Backfill
3	4.2	773	0.146	EPRI 0 – 20 feet	Backfill
4	3.2	818	0.146	EPRI 0 – 20 feet	Backfill
5	2.5	842	0.146	EPRI 0 – 20 feet	Backfill
6	4.3	867	0.146	EPRI 0 – 20 feet	Backfill
7	5.0	901	0.146	EPRI 20 – 50 feet	Backfill
8	5.0	934	0.146	EPRI 20 – 50 feet	Backfill
9	7.0	972	0.146	EPRI 20 – 50 feet	Backfill
10	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
11	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
12	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
13	10.0	6650	0.150	Linear, κ layer 1	Bass Islands
14	11.0	6650	0.150	Linear, κ layer 1	Bass Islands
15	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
16	12.0	6650	0.150	Linear, κ layer 1	Bass Islands
17	15.0	4600	0.150	Linear, κ layer 2	Bass Islands
18	20.0	3350	0.150	Linear, κ layer 3	Salina F
19	20.0	3350	0.150	Linear, κ layer 3	Salina F
20	20.0	3350	0.150	Linear, κ layer 3	Salina F
21	21.0	3350	0.150	Linear, κ layer 3	Salina F
22	21.0	4050	0.150	Linear, κ layer 3	Salina F
23	21.0	4050	0.150	Linear, κ layer 3	Salina F
24	10.0	5600	0.150	Linear, κ layer 4	Salina E
25	20.0	9450	0.150	Linear, κ layer 4	Salina E
26	21.0	9450	0.150	Linear, κ layer 4	Salina E
27	21.0	9450	0.150	Linear, κ layer 4	Salina E
28	21.0	9450	0.150	Linear, κ layer 4	Salina E
29	45.0	9000	0.160	Linear, κ layer 4	Salina C
30	45.0	9000	0.160	Linear, κ layer 4	Salina C
Halfspace		9300	0.169	0.1% Damping	Salina B

Table 3.7.1-204 Horizontal and Vertical PBSRS at the Finished Ground Level Grade with Associated V/H Ratios(Sheet 1 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
0.0100	100.0000	0.2604	1.000	0.2604
0.0166	60.2410	0.3197	1.088	0.3479
0.0200	50.0000	0.3605	1.133	0.4084
0.0250	40.0000	0.4229	1.129	0.4775
0.0300	33.3333	0.4618	1.097	0.5066
0.0330	30.3030	0.4714	1.049	0.4945
0.0400	25.0000	0.5085	0.967	0.4920
0.0420	23.8095	0.5066	0.954	0.4834
0.0440	22.7273	0.5059	0.940	0.4756
0.0460	21.7391	0.5124	0.926	0.4744
0.0480	20.8333	0.5161	0.912	0.4709
0.0500	20.0000	0.5212	0.900	0.4689
0.0550	18.1818	0.5286	0.873	0.4612
0.0600	16.6667	0.5354	0.852	0.4560
0.0650	15.3846	0.5447	0.832	0.4531
0.0700	14.2857	0.5534	0.814	0.4504
0.0750	13.3333	0.5617	0.802	0.4506
0.0800	12.5000	0.5695	0.793	0.4516
0.0850	11.7647	0.5770	0.784	0.4525
0.0900	11.1111	0.5841	0.776	0.4534
0.0950	10.5263	0.5909	0.769	0.4542
0.1000	10.0000	0.5975	0.762	0.4550
0.1100	9.0909	0.6093	0.748	0.4560
0.1200	8.3333	0.6203	0.737	0.4570
0.1300	7.6923	0.6305	0.726	0.4579
0.1400	7.1429	0.6402	0.717	0.4587
0.1500	6.6667	0.6493	0.708	0.4595
0.1600	6.2500	0.6580	0.699	0.4602
0.1700	5.8824	0.6662	0.692	0.4609
0.1800	5.5556	0.6741	0.685	0.4615
0.1900	5.2632	0.6797	0.678	0.4608
0.2000	5.0000	0.6852	0.672	0.4602
0.2200	4.5455	0.6897	0.660	0.4554
0.2400	4.1667	0.6820	0.650	0.4433
0.2600	3.8462	0.6677	0.650	0.4340

Table 3.7.1-204 Horizontal and Vertical PBSRS at the Finished Ground Level Grade with Associated V/H Ratios(Sheet 2 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
0.2800	3.5714	0.6559	0.650	0.4264
0.3000	3.3333	0.6393	0.650	0.4155
0.3200	3.1250	0.6109	0.650	0.3971
0.3400	2.9412	0.5728	0.650	0.3723
0.3600	2.7778	0.5333	0.650	0.3467
0.3800	2.6316	0.4897	0.650	0.3183
0.4000	2.5000	0.4491	0.650	0.2919
0.4200	2.3810	0.4093	0.650	0.2660
0.4400	2.2727	0.3710	0.650	0.2411
0.4600	2.1739	0.3358	0.650	0.2182
0.4800	2.0833	0.3094	0.650	0.2011
0.5000	2.0000	0.2850	0.650	0.1852
0.5500	1.8182	0.2291	0.650	0.1489
0.6000	1.6667	0.1890	0.650	0.1228
0.6500	1.5385	0.1613	0.650	0.1048
0.7000	1.4286	0.1410	0.650	0.0916
0.7500	1.3333	0.1257	0.650	0.0817
0.8000	1.2500	0.1143	0.650	0.0743
0.8500	1.1765	0.1058	0.650	0.0688
0.9000	1.1111	0.0998	0.650	0.0648
0.9500	1.0526	0.0946	0.650	0.0615
1.0000	1.0000	0.0889	0.650	0.0578
1.1000	0.9091	0.0833	0.650	0.0542
1.2000	0.8333	0.0794	0.650	0.0516
1.3000	0.7692	0.0754	0.650	0.0490
1.4000	0.7143	0.0730	0.650	0.0474
1.5000	0.6667	0.0711	0.650	0.0462
1.6000	0.6250	0.0694	0.650	0.0451
1.7000	0.5882	0.0679	0.650	0.0441
1.8000	0.5556	0.0671	0.650	0.0436
1.9000	0.5263	0.0653	0.650	0.0425
2.0000	0.5000	0.0640	0.650	0.0416
2.2000	0.4545	0.0592	0.650	0.0385
2.4000	0.4167	0.0557	0.650	0.0362
2.6000	0.3846	0.0529	0.650	0.0344

Table 3.7.1-204 Horizontal and Vertical PBSRS at the Finished Ground Level Grade with Associated V/H Ratios(Sheet 3 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
2.8000	0.3571	0.0510	0.650	0.0331
3.0000	0.3333	0.0494	0.650	0.0321
3.2000	0.3125	0.0474	0.650	0.0308
3.4000	0.2941	0.0454	0.650	0.0295
3.6000	0.2778	0.0436	0.650	0.0283
3.8000	0.2632	0.0420	0.650	0.0273
4.0000	0.2500	0.0404	0.650	0.0263
4.2000	0.2381	0.0391	0.650	0.0254
4.4000	0.2273	0.0378	0.650	0.0246
4.6000	0.2174	0.0366	0.650	0.0238
4.8000	0.2083	0.0355	0.650	0.0231
5.0000	0.2000	0.0345	0.650	0.0224
5.5000	0.1818	0.0322	0.650	0.0209
6.0000	0.1667	0.0303	0.650	0.0197
6.5000	0.1538	0.0286	0.650	0.0186
7.0000	0.1429	0.0271	0.650	0.0176
7.5000	0.1333	0.0258	0.650	0.0168
8.0000	0.1250	0.0246	0.650	0.0160
8.5000	0.1176	0.0236	0.650	0.0153
9.0000	0.1111	0.0226	0.650	0.0147
10.0000	0.1000	0.0210	0.650	0.0136

Table 3.7.1-205 Full Soil Column Deterministic Profile: Best Estimate [EF3 SUP 3.7-1]

Layer	Thickness (ft)	Total Depth (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation of Layer Base (ft)
1	2.9	2.9	132.5	557	2.73	1028	586.1
2	2.9	5.8	132.5	588	4.19	1148	583.2
3	4.2	10.0	132.5	622	5.09	1291	579.0
4	3.2	13.2	132.5	663	5.49	1422	575.8
5	2.6	15.8	132.5	680	5.87	5000	573.2
6	4.3	20.1	132.5	702	6.08	5000	568.9
7	5.0	25.1	132.5	750	4.39	5000	563.9
8	4.9	30.0	132.5	772	4.54	5000	559.0
9	7.0	37.0	132.5	795	4.56	5000	552.0
10	10.0	47.0	150	6689	0.95	13202	542.0
11	2.0	49.0	150	6592	0.95	13202	540.0
12	8.0	57.0	150	6592	0.95	13202	532.0
13	8.0	65.0	150	6745	0.95	13202	524.0
14	2.0	67.0	150	6745	0.95	13202	522.0
15	10.2	77.2	150	6825	0.95	13202	511.8
16	11.0	88.2	150	6790	0.95	13202	500.8
17	11.9	100.1	150	6853	0.95	13202	488.9
18	11.7	111.8	150	6609	0.95	13202	477.2
19	15.0	126.8	150	4752	1.37	9835	462.2
20	20.0	146.8	150	3309	1.91	7889	442.2
21	19.9	166.7	150	3252	1.91	7889	422.3
22	19.9	186.6	150	3235	1.91	7889	402.4
23	21.3	207.9	150	3218	1.91	7889	381.1
24	21.1	229.0	150	4072	1.91	9537	360.0
25	21.1	250.1	150	4132	1.91	9537	338.9
26	9.9	260.0	150	5650	0.73	10477	329.0
27	19.7	279.7	150	9523	0.73	17679	309.3
28	21.0	300.7	150	9439	0.73	17679	288.3
29	20.5	321.2	150	9525	0.73	17679	267.8
30	22.1	343.3	150	9491	0.73	17679	245.7
31	45.0	388.3	160	8943	0.73	16282	200.7
32	44.6	432.9	160	9049	0.73	16282	156.1
33	Half Space		169	9494	0.10	17100	

Table 3.7.1-206 Full Soil Column Deterministic Profile: Lower Bound [EF3 SUP 3.7-1]

Layer	Thickness (ft)	Total Depth (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation of Layer Base (ft)
1	2.9	2.9	119	408	4.07	781	586.1
2	2.9	5.8	119	426	6.55	937	583.2
3	4.2	10.0	119	432	7.84	1054	579.0
4	3.2	13.2	119	485	8.23	1161	575.8
5	2.6	15.8	119	501	8.50	5000	573.2
6	4.3	20.1	119	513	8.65	5000	568.9
7	5.0	25.1	119	574	6.45	5000	563.9
8	4.9	30.0	119	610	6.59	5000	559.0
9	7.0	37.0	119	608	6.90	5000	552.0
10	10.0	47.0	150	5462	1.51	10779	542.0
11	2.0	49.0	150	5383	1.51	10779	540.0
12	8.0	57.0	150	5383	1.51	10779	532.0
13	8.0	65.0	150	5507	1.51	10779	524.0
14	2.0	67.0	150	5507	1.51	10779	522.0
15	10.2	77.2	150	5573	1.51	10779	511.8
16	11.0	88.2	150	5544	1.51	10779	500.8
17	11.9	100.1	150	5596	1.51	10779	488.9
18	11.7	111.8	150	5396	1.51	10779	477.2
19	15.0	126.8	150	3880	2.18	8030	462.2
20	20.0	146.8	150	2616	2.88	6441	442.2
21	19.9	166.7	150	2529	2.88	6441	422.3
22	19.9	186.6	150	2611	2.88	6441	402.4
23	21.3	207.9	150	2478	2.88	6441	381.1
24	21.1	229.0	150	3111	2.88	7787	360.0
25	21.1	250.1	150	3189	2.88	7787	338.9
26	9.9	260.0	150	4613	1.12	8554	329.0
27	19.7	279.7	150	7776	1.12	14435	309.3
28	21.0	300.7	150	7707	1.12	14435	288.3
29	20.5	321.2	150	7777	1.12	14435	267.8
30	22.1	343.3	150	7750	1.12	14435	245.7
31	45.0	388.3	160	7302	1.12	13294	200.7
32	44.6	432.9	160	7388	1.12	13294	156.1
33	Half Space		169	7752	0.1	13962	

Table 3.7.1-207 Full Soil Column Deterministic Profile: Upper Bound [EF3 SUP 3.7-1]

Layer	Thickness (ft.)	Total Depth (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation of Layer Base (ft)
1	2.9	2.9	146	734	1.79	1259	586.1
2	2.9	5.8	146	751	2.84	1406	583.2
3	4.2	10.0	146	816	3.39	1581	579.0
4	3.2	13.2	146	891	3.48	1742	575.8
5	2.6	15.8	146	939	3.61	5000	573.2
6	4.3	20.1	146	930	3.85	5000	568.9
7	5.0	25.1	146	1021	2.81	5000	563.9
8	4.9	30.0	146	1032	2.86	5000	559.0
9	7.0	37.0	146	1041	2.97	5000	552.0
10	10.0	47.0	150	8192	0.48	16169	542.0
11	2.0	49.0	150	8074	0.48	16169	540.0
12	8.0	57.0	150	8074	0.48	16169	532.0
13	8.0	65.0	150	8261	0.48	16169	524.0
14	2.0	67.0	150	8261	0.48	16169	522.0
15	10.2	77.2	150	8359	0.48	16169	511.8
16	11.0	88.2	150	8316	0.48	16169	500.8
17	11.9	100.1	150	8393	0.48	16169	488.9
18	11.7	111.8	150	8094	0.48	16169	477.2
19	15.0	126.8	150	5820	0.68	12046	462.2
20	20.0	146.8	150	4221	0.95	9662	442.2
21	19.9	166.7	150	4042	0.95	9662	422.3
22	19.9	186.6	150	4041	0.95	9662	402.4
23	21.3	207.9	150	4033	0.95	9662	381.1
24	21.1	229.0	150	4987	0.95	11681	360.0
25	21.1	250.1	150	5061	0.95	11681	338.9
26	9.9	260.0	150	6920	0.36	12831	329.0
27	19.7	279.7	150	11664	0.36	21653	309.3
28	21.0	300.7	150	11560	0.36	21653	288.3
29	20.5	321.2	150	11666	0.36	21653	267.8
30	22.1	343.3	150	11625	0.36	21653	245.7
31	45.0	388.3	160	10953	0.36	19941	200.7
32	44.6	432.9	160	11082	0.36	19941	156.1
33	Half Space		169	11628	0.1	20943	

Table 3.7.1-208 Horizontal and Vertical RB/FB SCOR FIRS with Associated V/H Ratios (Sheet 1 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
0.0100	100.0000	0.1882	1.0000	0.1882
0.0166	60.2410	0.3517	1.1374	0.4000
0.0200	50.0000	0.4174	1.1244	0.4694
0.0250	40.0000	0.4663	1.0426	0.4862
0.0300	33.3333	0.4867	0.9675	0.4709
0.0330	30.3030	0.4894	0.9400	0.4600
0.0400	25.0000	0.4948	0.8800	0.4354
0.0420	23.8095	0.4881	0.8681	0.4237
0.0440	22.7273	0.4817	0.8569	0.4128
0.0460	21.7391	0.4757	0.8461	0.4025
0.0480	20.8333	0.4701	0.8355	0.3928
0.0500	20.0000	0.4647	0.8255	0.3836
0.0550	18.1818	0.4468	0.8069	0.3605
0.0600	16.6667	0.4311	0.7984	0.3441
0.0650	15.3846	0.4126	0.7906	0.3262
0.0700	14.2857	0.4047	0.7834	0.3170
0.0750	13.3333	0.3974	0.7769	0.3087
0.0800	12.5000	0.3906	0.7708	0.3011
0.0850	11.7647	0.3849	0.7651	0.2945
0.0900	11.1111	0.3801	0.7597	0.2887
0.0950	10.5263	0.3756	0.7547	0.2834
0.1000	10.0000	0.3713	0.7500	0.2785
0.1100	9.0909	0.3633	0.7500	0.2725
0.1200	8.3333	0.3561	0.7500	0.2671
0.1300	7.6923	0.3496	0.7500	0.2622
0.1400	7.1429	0.3437	0.7500	0.2578
0.1500	6.6667	0.3383	0.7500	0.2537
0.1600	6.2500	0.3333	0.7500	0.2500
0.1700	5.8824	0.3287	0.7500	0.2465
0.1800	5.5556	0.3244	0.7500	0.2433
0.1900	5.2632	0.3204	0.7500	0.2403
0.2000	5.0000	0.3166	0.7500	0.2375
0.2200	4.5455	0.3106	0.7500	0.2329
0.2400	4.1667	0.3064	0.7500	0.2298
0.2600	3.8462	0.3022	0.7500	0.2266

Table 3.7.1-208 Horizontal and Vertical RB/FB SCOR FIRS with Associated V/H Ratios (Sheet 2 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
0.2800	3.5714	0.2970	0.7500	0.2228
0.3000	3.3333	0.2947	0.7500	0.2210
0.3200	3.1250	0.2896	0.7500	0.2172
0.3400	2.9412	0.2789	0.7500	0.2092
0.3600	2.7778	0.2647	0.7500	0.1985
0.3800	2.6316	0.2517	0.7500	0.1888
0.4000	2.5000	0.2361	0.7500	0.1771
0.4200	2.3810	0.2210	0.7500	0.1657
0.4400	2.2727	0.2069	0.7500	0.1552
0.4600	2.1739	0.1927	0.7500	0.1445
0.4800	2.0833	0.1817	0.7500	0.1363
0.5000	2.0000	0.1706	0.7500	0.1279
0.5500	1.8182	0.1467	0.7500	0.1101
0.6000	1.6667	0.1290	0.7500	0.0968
0.6500	1.5385	0.1148	0.7500	0.0861
0.7000	1.4286	0.1035	0.7500	0.0777
0.7500	1.3333	0.0953	0.7500	0.0715
0.8000	1.2500	0.0898	0.7500	0.0673
0.8500	1.1765	0.0850	0.7500	0.0638
0.9000	1.1111	0.0813	0.7500	0.0610
0.9500	1.0526	0.0777	0.7500	0.0583
1.0000	1.0000	0.0744	0.7500	0.0558
1.1000	0.9091	0.0713	0.7500	0.0535
1.2000	0.8333	0.0687	0.7500	0.0515
1.3000	0.7692	0.0665	0.7500	0.0499
1.4000	0.7143	0.0648	0.7500	0.0486
1.5000	0.6667	0.0634	0.7500	0.0476
1.6000	0.6250	0.0621	0.7500	0.0466
1.7000	0.5882	0.0607	0.7500	0.0455
1.8000	0.5556	0.0598	0.7500	0.0448
1.9000	0.5263	0.0587	0.7500	0.0440
2.0000	0.5000	0.0578	0.7500	0.0433
2.2000	0.4545	0.0536	0.7500	0.0402
2.4000	0.4167	0.0502	0.7500	0.0377
2.6000	0.3846	0.0473	0.7500	0.0355

Table 3.7.1-208 Horizontal and Vertical RB/FB SCOR FIRS with Associated V/H Ratios (Sheet 3 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal PBSRS (g)	V/H	Vertical PBSRS (g)
2.8000	0.3571	0.0448	0.7500	0.0336
3.0000	0.3333	0.0426	0.7500	0.0320
3.2000	0.3125	0.0406	0.7500	0.0305
3.4000	0.2941	0.0389	0.7500	0.0292
3.6000	0.2778	0.0373	0.7500	0.0280
3.8000	0.2632	0.0358	0.7500	0.0269
4.0000	0.2500	0.0345	0.7500	0.0259
4.2000	0.2381	0.0333	0.7500	0.0250
4.4000	0.2273	0.0322	0.7500	0.0241
4.6000	0.2174	0.0312	0.7500	0.0234
4.8000	0.2083	0.0302	0.7500	0.0227
5.0000	0.2000	0.0294	0.7500	0.0220
5.5000	0.1818	0.0274	0.7500	0.0206
6.0000	0.1667	0.0258	0.7500	0.0193
6.5000	0.1538	0.0243	0.7500	0.0182
7.0000	0.1429	0.0231	0.7500	0.0173
7.5000	0.1333	0.0220	0.7500	0.0165
8.0000	0.1250	0.0210	0.7500	0.0157
8.5000	0.1176	0.0201	0.7500	0.0151
9.0000	0.1111	0.0193	0.7500	0.0145
10.0000	0.1000	0.0179	0.7500	0.0134

Table 3.7.1-209 Horizontal and Vertical CB SCOR FIRS with Associated V/H Ratios (Sheet 1 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	V/H	Vertical CB FIRS (g)
0.0100	100.0000	0.1878	1.0000	0.1878
0.0166	60.2410	0.3511	1.1374	0.3994
0.0200	50.0000	0.4167	1.1244	0.4686
0.0250	40.0000	0.4655	1.0426	0.4854
0.0300	33.3333	0.4859	0.9675	0.4702
0.0330	30.3030	0.4886	0.9400	0.4593
0.0400	25.0000	0.4940	0.8800	0.4347
0.0420	23.8095	0.4869	0.8681	0.4227
0.0440	22.7273	0.4803	0.8569	0.4116
0.0460	21.7391	0.4741	0.8461	0.4012
0.0480	20.8333	0.4682	0.8355	0.3912
0.0500	20.0000	0.4626	0.8255	0.3819
0.0550	18.1818	0.4499	0.8069	0.3630
0.0600	16.6667	0.4385	0.7984	0.3501
0.0650	15.3846	0.4283	0.7906	0.3386
0.0700	14.2857	0.4191	0.7834	0.3283
0.0750	13.3333	0.4107	0.7769	0.3190
0.0800	12.5000	0.4030	0.7708	0.3106
0.0850	11.7647	0.3959	0.7651	0.3029
0.0900	11.1111	0.3893	0.7597	0.2957
0.0950	10.5263	0.3833	0.7547	0.2893
0.1000	10.0000	0.3785	0.7500	0.2839
0.1100	9.0909	0.3695	0.7500	0.2771
0.1200	8.3333	0.3614	0.7500	0.2710
0.1300	7.6923	0.3541	0.7500	0.2656
0.1400	7.1429	0.3475	0.7500	0.2606
0.1500	6.6667	0.3415	0.7500	0.2561
0.1600	6.2500	0.3359	0.7500	0.2520
0.1700	5.8824	0.3308	0.7500	0.2481
0.1800	5.5556	0.3260	0.7500	0.2445
0.1900	5.2632	0.3216	0.7500	0.2412
0.2000	5.0000	0.3174	0.7500	0.2381
0.2200	4.5455	0.3107	0.7500	0.2330
0.2400	4.1667	0.3066	0.7500	0.2300
0.2600	3.8462	0.3024	0.7500	0.2268

Table 3.7.1-209 Horizontal and Vertical CB SCOR FIRS with Associated V/H Ratios (Sheet 2 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	V/H	Vertical CB FIRS (g)
0.2800	3.5714	0.2972	0.7500	0.2229
0.3000	3.3333	0.2949	0.7500	0.2212
0.3200	3.1250	0.2900	0.7500	0.2175
0.3400	2.9412	0.2793	0.7500	0.2094
0.3600	2.7778	0.2650	0.7500	0.1987
0.3800	2.6316	0.2520	0.7500	0.1890
0.4000	2.5000	0.2363	0.7500	0.1772
0.4200	2.3810	0.2212	0.7500	0.1659
0.4400	2.2727	0.2070	0.7500	0.1553
0.4600	2.1739	0.1928	0.7500	0.1446
0.4800	2.0833	0.1818	0.7500	0.1364
0.5000	2.0000	0.1707	0.7500	0.1280
0.5500	1.8182	0.1468	0.7500	0.1101
0.6000	1.6667	0.1291	0.7500	0.0968
0.6500	1.5385	0.1148	0.7500	0.0861
0.7000	1.4286	0.1036	0.7500	0.0777
0.7500	1.3333	0.0953	0.7500	0.0715
0.8000	1.2500	0.0898	0.7500	0.0673
0.8500	1.1765	0.0850	0.7500	0.0638
0.9000	1.1111	0.0813	0.7500	0.0610
0.9500	1.0526	0.0777	0.7500	0.0583
1.0000	1.0000	0.0744	0.7500	0.0558
1.1000	0.9091	0.0713	0.7500	0.0535
1.2000	0.8333	0.0687	0.7500	0.0515
1.3000	0.7692	0.0665	0.7500	0.0499
1.4000	0.7143	0.0648	0.7500	0.0486
1.5000	0.6667	0.0634	0.7500	0.0476
1.6000	0.6250	0.0621	0.7500	0.0465
1.7000	0.5882	0.0607	0.7500	0.0455
1.8000	0.5556	0.0598	0.7500	0.0448
1.9000	0.5263	0.0587	0.7500	0.0440
2.0000	0.5000	0.0578	0.7500	0.0433
2.2000	0.4545	0.0536	0.7500	0.0402
2.4000	0.4167	0.0502	0.7500	0.0377
2.6000	0.3846	0.0473	0.7500	0.0355

Table 3.7.1-209 Horizontal and Vertical CB SCOR FIRS with Associated V/H Ratios (Sheet 3 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	V/H	Vertical CB FIRS (g)
2.8000	0.3571	0.0448	0.7500	0.0336
3.0000	0.3333	0.0426	0.7500	0.0320
3.2000	0.3125	0.0406	0.7500	0.0305
3.4000	0.2941	0.0389	0.7500	0.0292
3.6000	0.2778	0.0373	0.7500	0.0280
3.8000	0.2632	0.0358	0.7500	0.0269
4.0000	0.2500	0.0345	0.7500	0.0259
4.2000	0.2381	0.0333	0.7500	0.0250
4.4000	0.2273	0.0322	0.7500	0.0241
4.6000	0.2174	0.0312	0.7500	0.0234
4.8000	0.2083	0.0302	0.7500	0.0227
5.0000	0.2000	0.0294	0.7500	0.0220
5.5000	0.1818	0.0274	0.7500	0.0206
6.0000	0.1667	0.0258	0.7500	0.0193
6.5000	0.1538	0.0243	0.7500	0.0182
7.0000	0.1429	0.0231	0.7500	0.0173
7.5000	0.1333	0.0220	0.7500	0.0165
8.0000	0.1250	0.0210	0.7500	0.0157
8.5000	0.1176	0.0201	0.7500	0.0151
9.0000	0.1111	0.0193	0.7500	0.0145
10.0000	0.1000	0.0179	0.7500	0.0134

Table 3.7.1-210 Enhanced Horizontal and Vertical RB/FB SCOR FIRS (Sheet 1 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal RB/FB FIRS (g)	Vertical RB/FB FIRS (g)
0.0100	100.0000	0.1882	0.1882
0.0166	60.2410	0.3517	0.4000
0.0200	50.0000	0.4174	0.4694
0.0250	40.0000	0.4663	0.4862
0.0300	33.3333	0.4867	0.4709
0.0330	30.3030	0.4894	0.4600
0.0400	25.0000	0.4948	0.4500
0.0420	23.8095	0.4881	0.4497
0.0440	22.7273	0.4817	0.4494
0.0460	21.7391	0.4757	0.4491
0.0480	20.8333	0.4701	0.4489
0.0500	20.0000	0.4647	0.4486
0.0550	18.1818	0.4468	0.4480
0.0600	16.6667	0.4311	0.4475
0.0650	15.3846	0.4126	0.4470
0.0700	14.2857	0.4047	0.4465
0.0750	13.3333	0.3974	0.4461
0.0800	12.5000	0.3906	0.4457
0.0850	11.7647	0.3849	0.4453
0.0900	11.1111	0.3801	0.4450
0.0950	10.5263	0.3756	0.4446
0.1000	10.0000	0.3713	0.4443
0.1100	9.0909	0.3633	0.4437
0.1200	8.3333	0.3561	0.4432
0.1300	7.6923	0.3496	0.4427
0.1400	7.1429	0.3437	0.4423
0.1500	6.6667	0.3383	0.4418
0.1600	6.2500	0.3333	0.4414
0.1700	5.8824	0.3287	0.4411
0.1800	5.5556	0.3244	0.4407
0.1900	5.2632	0.3204	0.4404
0.2000	5.0000	0.3166	0.4401
0.2200	4.5455	0.3106	0.4395

Table 3.7.1-210 Enhanced Horizontal and Vertical RB/FB SCOR FIRS (Sheet 2 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal RB/FB FIRS (g)	Vertical RB/FB FIRS (g)
0.2400	4.1667	0.3064	0.4336
0.2600	3.8462	0.3022	0.4276
0.2800	3.5714	0.2970	0.4203
0.3000	3.3333	0.2947	0.4170
0.3200	3.1250	0.2896	0.4098
0.3400	2.9412	0.2789	0.3767
0.3600	2.7778	0.2674	0.3480
0.3800	2.6316	0.2570	0.3228
0.4000	2.5000	0.2475	0.3006
0.4200	2.3810	0.2387	0.2809
0.4400	2.2727	0.2307	0.2633
0.4600	2.1739	0.2233	0.2476
0.4800	2.0833	0.2164	0.2334
0.5000	2.0000	0.2100	0.2205
0.5500	1.8182	0.1946	0.1932
0.6000	1.6667	0.1815	0.1712
0.6500	1.5385	0.1703	0.1532
0.7000	1.4286	0.1605	0.1382
0.7500	1.3333	0.1519	0.1256
0.8000	1.2500	0.1442	0.1148
0.8500	1.1765	0.1374	0.1055
0.9000	1.1111	0.1313	0.0975
0.9500	1.0526	0.1257	0.0904
1.0000	1.0000	0.1206	0.0842
1.1000	0.9091	0.1118	0.0779
1.2000	0.8333	0.1043	0.0725
1.3000	0.7692	0.0978	0.0679
1.4000	0.7143	0.0922	0.0639
1.5000	0.6667	0.0872	0.0604
1.6000	0.6250	0.0829	0.0572
1.7000	0.5882	0.0789	0.0545
1.8000	0.5556	0.0754	0.0520
1.9000	0.5263	0.0722	0.0497

Table 3.7.1-210 Enhanced Horizontal and Vertical RB/FB SCOR FIRS (Sheet 3 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal RB/FB FIRS (g)	Vertical RB/FB FIRS (g)
2.0000	0.5000	0.0693	0.0477
2.2000	0.4545	0.0643	0.0442
2.4000	0.4167	0.0603	0.0414
2.6000	0.3846	0.0568	0.0390
2.8000	0.3571	0.0538	0.0370
3.0000	0.3333	0.0511	0.0352
3.2000	0.3125	0.0488	0.0335
3.4000	0.2941	0.0466	0.0321
3.6000	0.2778	0.0447	0.0308
3.8000	0.2632	0.0430	0.0296
4.0000	0.2500	0.0414	0.0285
4.2000	0.2381	0.0400	0.0275
4.4000	0.2273	0.0386	0.0266
4.6000	0.2174	0.0374	0.0257
4.8000	0.2083	0.0363	0.0249
5.0000	0.2000	0.0352	0.0242
5.5000	0.1818	0.0329	0.0226
6.0000	0.1667	0.0309	0.0213
6.5000	0.1538	0.0292	0.0201
7.0000	0.1429	0.0277	0.0190
7.5000	0.1333	0.0264	0.0181
8.0000	0.1250	0.0252	0.0173
8.5000	0.1176	0.0241	0.0166
9.0000	0.1111	0.0231	0.0159
10.0000	0.1000	0.0215	0.0147

Table 3.7.1-211 Enhanced Horizontal and Vertical CB SCOR FIRS (Sheet 1 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	Vertical CB FIRS (g)
0.0100	100.0000	0.1878	0.1878
0.0166	60.2410	0.3511	0.3994
0.0200	50.0000	0.4167	0.4686
0.0250	40.0000	0.4655	0.4854
0.0300	33.3333	0.4859	0.4702
0.0330	30.3030	0.4886	0.4593
0.0400	25.0000	0.4940	0.4500
0.0420	23.8095	0.4869	0.4492
0.0440	22.7273	0.4803	0.4485
0.0460	21.7391	0.4741	0.4478
0.0480	20.8333	0.4682	0.4471
0.0500	20.0000	0.4626	0.4465
0.0550	18.1818	0.4499	0.4450
0.0600	16.6667	0.4385	0.4436
0.0650	15.3846	0.4283	0.4423
0.0700	14.2857	0.4191	0.4412
0.0750	13.3333	0.4107	0.4401
0.0800	12.5000	0.4030	0.4391
0.0850	11.7647	0.3959	0.4382
0.0900	11.1111	0.3893	0.4373
0.0950	10.5263	0.3833	0.4364
0.1000	10.0000	0.3785	0.4356
0.1100	9.0909	0.3695	0.4342
0.1200	8.3333	0.3614	0.4328
0.1300	7.6923	0.3541	0.4316
0.1400	7.1429	0.3475	0.4305
0.1500	6.6667	0.3415	0.4294
0.1600	6.2500	0.3359	0.4285
0.1700	5.8824	0.3308	0.4275
0.1800	5.5556	0.3260	0.4267
0.1900	5.2632	0.3216	0.4259
0.2000	5.0000	0.3174	0.4251
0.2200	4.5455	0.3107	0.4237
0.2400	4.1667	0.3066	0.4181

Table 3.7.1-211 Enhanced Horizontal and Vertical CB SCOR FIRS (Sheet 2 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	Vertical CB FIRS (g)
0.2600	3.8462	0.3024	0.4124
0.2800	3.5714	0.2972	0.4053
0.3000	3.3333	0.2949	0.4022
0.3200	3.1250	0.2900	0.3955
0.3400	2.9412	0.2793	0.3643
0.3600	2.7778	0.2677	0.3371
0.3800	2.6316	0.2572	0.3132
0.4000	2.5000	0.2477	0.2922
0.4200	2.3810	0.2389	0.2734
0.4400	2.2727	0.2308	0.2567
0.4600	2.1739	0.2233	0.2417
0.4800	2.0833	0.2164	0.2281
0.5000	2.0000	0.2100	0.2158
0.5500	1.8182	0.1946	0.1896
0.6000	1.6667	0.1815	0.1685
0.6500	1.5385	0.1703	0.1512
0.7000	1.4286	0.1605	0.1367
0.7500	1.3333	0.1519	0.1245
0.8000	1.2500	0.1442	0.1141
0.8500	1.1765	0.1374	0.1050
0.9000	1.1111	0.1313	0.0972
0.9500	1.0526	0.1257	0.0903
1.0000	1.0000	0.1206	0.0843
1.1000	0.9091	0.1118	0.0779
1.2000	0.8333	0.1043	0.0725
1.3000	0.7692	0.0978	0.0679
1.4000	0.7143	0.0922	0.0639
1.5000	0.6667	0.0872	0.0604
1.6000	0.6250	0.0829	0.0572
1.7000	0.5882	0.0789	0.0545
1.8000	0.5556	0.0754	0.0520
1.9000	0.5263	0.0722	0.0497
2.0000	0.5000	0.0693	0.0477
2.2000	0.4545	0.0643	0.0442

Table 3.7.1-211 Enhanced Horizontal and Vertical CB SCOR FIRS (Sheet 3 of 3) [EF3 SUP 3.7-1]

T (sec)	F (Hz)	Horizontal CB FIRS (g)	Vertical CB FIRS (g)
2.4000	0.4167	0.0603	0.0414
2.6000	0.3846	0.0568	0.0390
2.8000	0.3571	0.0538	0.0370
3.0000	0.3333	0.0511	0.0352
3.2000	0.3125	0.0488	0.0335
3.4000	0.2941	0.0467	0.0321
3.6000	0.2778	0.0447	0.0308
3.8000	0.2632	0.0430	0.0296
4.0000	0.2500	0.0414	0.0285
4.2000	0.2381	0.0400	0.0275
4.4000	0.2273	0.0386	0.0266
4.6000	0.2174	0.0374	0.0257
4.8000	0.2083	0.0363	0.0249
5.0000	0.2000	0.0352	0.0242
5.5000	0.1818	0.0329	0.0226
6.0000	0.1667	0.0309	0.0213
6.5000	0.1538	0.0292	0.0201
7.0000	0.1429	0.0277	0.0190
7.5000	0.1333	0.0264	0.0181
8.0000	0.1250	0.0252	0.0173
8.5000	0.1176	0.0241	0.0166
9.0000	0.1111	0.0231	0.0159
10.0000	0.1000	0.0215	0.0147

Table 3.7.1-212 Horizontal and Vertical SSI FIRS for RB/FB and CB (Sheet 1 of 3) [EF3 SUP 3.7-1]

Period (sec)	Frequency (Hz)	Horizontal FIRS for RB/FB (g)	Vertical FIRS for RB/FB (g)	Horizontal FIRS for CB (g)	Vertical FIRS for CB (g)
0.010	100.000	0.2185(1)	0.2185	0.2125(2)	0.2125
0.017	60.241	0.3656	0.4158	0.3601	0.4096
0.020	50.000	0.4318	0.4855	0.4410	0.4959
0.025	40.000	0.4663	0.4862	0.5093	0.5310
0.030	33.333	0.4867	0.4709	0.5034	0.4871
0.033	30.303	0.4894	0.4600	0.4981	0.4682
0.040	25.000	0.4948	0.4500	0.4940	0.4500
0.042	23.810	0.4881	0.4497	0.4869	0.4492
0.044	22.727	0.4895	0.4494	0.4829	0.4485
0.046	21.739	0.4922	0.4491	0.4808	0.4478
0.048	20.833	0.4948	0.4489	0.4787	0.4471
0.050	20.000	0.4974	0.4486	0.4768	0.4465
0.055	18.182	0.5033	0.4480	0.4724	0.4450
0.060	16.667	0.5088	0.4475	0.4684	0.4436
0.065	15.385	0.4968	0.4470	0.4647	0.4423
0.070	14.286	0.4922	0.4465	0.4563	0.4412
0.075	13.333	0.4879	0.4461	0.4529	0.4401
0.080	12.500	0.4839	0.4457	0.4497	0.4391
0.085	11.765	0.4801	0.4453	0.4468	0.4382
0.090	11.111	0.4766	0.4450	0.4440	0.4373
0.095	10.526	0.4734	0.4446	0.4414	0.4364
0.100	10.000	0.4703	0.4443	0.4389	0.4356
0.110	9.091	0.4606	0.4437	0.4307	0.4342
0.120	8.333	0.4520	0.4432	0.4233	0.4328
0.130	7.692	0.4442	0.4427	0.4166	0.4316
0.140	7.143	0.4371	0.4423	0.4105	0.4305
0.150	6.667	0.4306	0.4418	0.4049	0.4294
0.160	6.250	0.4246	0.4414	0.3997	0.4285
0.170	5.882	0.4190	0.4411	0.3949	0.4275
0.180	5.556	0.4138	0.4407	0.3913	0.4267
0.190	5.263	0.4090	0.4404	0.3888	0.4259
0.200	5.000	0.4062	0.4401	0.3864	0.4251
0.220	4.545	0.3946	0.4395	0.3832	0.4237

Table 3.7.1-212 Horizontal and Vertical SSI FIRS for RB/FB and CB (Sheet 2 of 3) [EF3 SUP 3.7-1]

Period (sec)	Frequency (Hz)	Horizontal FIRS for RB/FB (g)	Vertical FIRS for RB/FB (g)	Horizontal FIRS for CB (g)	Vertical FIRS for CB (g)
0.240	4.167	0.3777	0.4336	0.3781	0.4181
0.260	3.846	0.3524	0.4276	0.3589	0.4124
0.280	3.571	0.3309	0.4203	0.3358	0.4053
0.300	3.333	0.3121	0.4170	0.3155	0.4022
0.320	3.125	0.2955	0.4098	0.2977	0.3955
0.340	2.941	0.2807	0.3767	0.2819	0.3643
0.360	2.778	0.2674	0.3480	0.2677	0.3371
0.380	2.632	0.2570	0.3228	0.2572	0.3132
0.400	2.500	0.2475	0.3006	0.2477	0.2922
0.420	2.381	0.2387	0.2809	0.2389	0.2734
0.440	2.273	0.2307	0.2633	0.2308	0.2567
0.460	2.174	0.2233	0.2476	0.2233	0.2417
0.480	2.083	0.2164	0.2334	0.2164	0.2281
0.500	2.000	0.2100	0.2205	0.2100	0.2158
0.550	1.818	0.1946	0.1932	0.1946	0.1896
0.600	1.667	0.1815	0.1712	0.1815	0.1685
0.650	1.538	0.1703	0.1532	0.1703	0.1512
0.700	1.429	0.1605	0.1382	0.1605	0.1367
0.750	1.333	0.1519	0.1256	0.1519	0.1245
0.800	1.250	0.1442	0.1148	0.1442	0.1141
0.850	1.176	0.1374	0.1055	0.1374	0.1050
0.900	1.111	0.1313	0.0975	0.1313	0.0972
0.950	1.053	0.1257	0.0904	0.1257	0.0903
1.000	1.000	0.1206	0.0842	0.1206	0.0843
1.100	0.909	0.1118	0.0779	0.1118	0.0779
1.200	0.833	0.1043	0.0725	0.1043	0.0725
1.300	0.769	0.0978	0.0679	0.0978	0.0679
1.400	0.714	0.0922	0.0639	0.0922	0.0639
1.500	0.667	0.0872	0.0604	0.0872	0.0604
1.600	0.625	0.0829	0.0572	0.0829	0.0572
1.700	0.588	0.0789	0.0545	0.0789	0.0545
1.800	0.556	0.0754	0.0520	0.0754	0.0520
1.900	0.526	0.0722	0.0497	0.0722	0.0497

Table 3.7.1-212 Horizontal and Vertical SSI FIRS for RB/FB and CB (Sheet 3 of 3) [EF3 SUP 3.7-1]

Period (sec)	Frequency (Hz)	Horizontal FIRS for RB/FB (g)	Vertical FIRS for RB/FB (g)	Horizontal FIRS for CB (g)	Vertical FIRS for CB (g)
2.000	0.500	0.0693	0.0477	0.0693	0.0477
2.200	0.455	0.0643	0.0442	0.0643	0.0442
2.400	0.417	0.0603	0.0414	0.0603	0.0414
2.600	0.385	0.0568	0.0390	0.0568	0.0390
2.800	0.357	0.0538	0.0370	0.0538	0.0370
3.000	0.333	0.0511	0.0352	0.0511	0.0352
3.200	0.313	0.0488	0.0335	0.0488	0.0335
3.400	0.294	0.0466	0.0321	0.0467	0.0321
3.600	0.278	0.0447	0.0308	0.0447	0.0308
3.800	0.263	0.0430	0.0296	0.0430	0.0296
4.000	0.250	0.0414	0.0285	0.0414	0.0285
4.200	0.238	0.0400	0.0275	0.0400	0.0275
4.400	0.227	0.0386	0.0266	0.0386	0.0266
4.600	0.217	0.0374	0.0257	0.0374	0.0257
4.800	0.208	0.0363	0.0249	0.0363	0.0249
5.000	0.200	0.0352	0.0242	0.0352	0.0242
5.500	0.182	0.0329	0.0226	0.0329	0.0226
6.000	0.167	0.0309	0.0213	0.0309	0.0213
6.500	0.154	0.0292	0.0201	0.0292	0.0201
7.000	0.143	0.0277	0.0190	0.0277	0.0190
7.500	0.133	0.0264	0.0181	0.0264	0.0181
8.000	0.125	0.0252	0.0173	0.0252	0.0173
8.500	0.118	0.0241	0.0166	0.0241	0.0166
9.000	0.111	0.0231	0.0159	0.0231	0.0159
10.000	0.100	0.0215	0.0147	0.0215	0.0147

Notes:

(1) Value indicates the peak ground acceleration for RB/FB horizontal SSI FIRS (greater than 0.1 g).

(2) Value indicates the peak ground acceleration for CB horizontal SSI FIRS (greater than 0.1 g).

Table 3.7.1-213 Seed Time History Recording Details [EF3 SUP 3.7-2]

Earthquake Event	Station	Component	Record Parameters: PGA (g)	PGV (cm/s)	PGD (cm)	Duration (sec)
1999 Chi-Chi, Taiwan M 7.6	TAP078 R = 131 km	TAP078-North	0.88	13.0	5.55	25.8
		TAP078-West	0.094	10.7	4.98	30.1
		TAP078-Vertical	0.063	8.6	8.3	30.5

Note:

Duration is defined as the time interval between the time history points at which 5% and 75% of the normalized Arias intensity (total energy measure) has been recorded.

Table 3.7.1-214 Cross Correlation Coefficients for the Matched Time Histories Corresponding to the SSI FIRS at the RB/FB Level
[EF3 SUP 3.7-2]

Correlated Components	Cross Correlation Coefficient
Horizontal (H1) – Horizontal (H2)	-0.02
Horizontal (H1) – Vertical (V)	0.02
Horizontal (H2) – Vertical (V)	-0.02

Table 3.7.1-215 Cross Correlation Coefficients for the Matched Time Histories Corresponding to the SSI FIRS at the CB Level [EF3 SUP 3.7-2]

Correlated Components	Cross Correlation Coefficient
Horizontal (H1) – Horizontal (H2)	-0.01
Horizontal (H1) – Vertical (V)	0.02
Horizontal (H2) – Vertical (V)	-0.02

Table 3.7.1-216 Matched Time History (Outcrop) Parameters [EF3 SUP 3.7-2]

Response Spectrum	Component	Record Parameters					
		PGA (g)	PGV (cm/s)	PGD (cm)	Duration (sec)	PGV/PGA (cm/s/g)	PGA*PGD/ $(PGV)^2$
RB/FB SSI FIRS	Horizontal 1	0.23	15.24	11.81	25.44	65.71	11.57
	Horizontal 2	0.22	15.40	11.62	29.47	68.84	10.75
	Vertical	0.22	9.51	10.20	31.66	42.72	24.62
CB SSI FIRS	Horizontal 1	0.23	15.18	11.96	25.41	67.17	11.51
	Horizontal 2	0.21	13.16	11.74	29.68	61.37	14.26
	Vertical	0.22	10.46	9.70	31.33	47.85	19.02

Note:

Duration is defined as the time interval between the time history points at which 5% and 75% of the normalized Arias intensity (total energy measure) has been recorded.

Table 3.7.1-217 Best Estimate Properties for Fermi 3 SSI Analyses Based on the Soil Column Truncated at the Top of In Situ Bedrock [EF3 SUP 3.7-2]

Layer	Thickness (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation at Top of Layer (ft)
SSI Profile, Top of Profile Elevation 552.0 ft.						
1	10.0	150	6689	0.95	13202	552.0
2	2.0	150	6592	0.95	13202	542.0
3	8.0	150	6592	0.95	13202	540.0
4	8.0	150	6745	0.95	13202	532.0
5	2.0	150	6745	0.95	13202	524.0
6	10.2	150	6825	0.95	13202	522.0
7	11.0	150	6790	0.95	13202	511.8
8	11.9	150	6853	0.95	13202	500.8
9	11.7	150	6609	0.95	13202	488.9
10	15.0	150	4752	1.37	9835	477.2
11	20.0	150	3309	1.91	7889	462.2
12	19.9	150	3252	1.91	7889	442.2
13	19.9	150	3235	1.91	7889	422.3
14	21.3	150	3218	1.91	7889	402.4
15	21.1	150	4072	1.91	9537	381.1
16	21.1	150	4132	1.91	9537	360.0
17	9.9	150	5650	0.73	10477	338.9
18	19.7	150	9523	0.73	17679	329.0
19	21.0	150	9439	0.73	17679	309.3
20	20.5	150	9525	0.73	17679	288.3
21	22.1	150	9491	0.73	17679	267.8
22	45.0	160	8943	0.73	16282	245.7
23	44.6	160	9049	0.73	16282	200.7
24	Half Space	169	9494	0.10	17100	156.1

Notes:
1. The top of in situ (Bass Islands Group) bedrock is at EL. 552 ft NAVD 88 (top of layer No.1).
2. The bottom of CB basemat is at EL. 540 ft NAVD 88 (top of layer No. 3).
3. The bottom of RB/FB basemat is at EL. 524 ft NAVD 88 (within layer No. 5).
4. For SSI analyses presented in Subsection 3.7.2, the following elevation references are used in the SASSI2000 model:
   - EL. -6770 mm is the top of in-situ (Bass Islands Group) bedrock which is equivalent to EL. 552 ft NAVD 88.
   - EL. -10400 mm is at the bottom of CB basemat which is equivalent to EL. 540 ft NAVD 88.
   - EL. -15500 mm is at the bottom of RB/FB basemat which is equivalent to EL. 524 ft NAVD 88.

Table 3.7.1-218 Lower Bound Properties for Fermi 3 SSI Analyses Based on the Soil Column Truncated at the Top of In Situ Bedrock [EF3 SUP 3.7-2]

Layer	Thickness (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation at Top of Layer (ft)
SSI Profile, Top of Profile Elevation 552.0 ft.						
1	10.0	150	5462	1.51	10779	552.0
2	2.0	150	5383	1.51	10779	542.0
3	8.0	150	5383	1.51	10779	540.0
4	8.0	150	5507	1.51	10779	532.0
5	2.0	150	5507	1.51	10779	524.0
6	10.2	150	5573	1.51	10779	522.0
7	11.0	150	5544	1.51	10779	511.8
8	11.9	150	5596	1.51	10779	500.8
9	11.7	150	5396	1.51	10779	488.9
10	15.0	150	3880	2.18	8030	477.2
11	20.0	150	2616	2.88	6441	462.2
12	19.9	150	2529	2.88	6441	442.2
13	19.9	150	2611	2.88	6441	422.3
14	21.3	150	2478	2.88	6441	402.4
15	21.1	150	3111	2.88	7787	381.1
16	21.1	150	3189	2.88	7787	360.0
17	9.9	150	4613	1.12	8554	338.9
18	19.7	150	7776	1.12	14435	329.0
19	21.0	150	7707	1.12	14435	309.3
20	20.5	150	7777	1.12	14435	288.3
21	22.1	150	7750	1.12	14435	267.8
22	45.0	160	7302	1.12	13294	245.7
23	44.6	160	7388	1.12	13294	200.7
24	Half Space	169	7752	0.1	13962	156.1

Notes:
1. The top of in situ (Bass Islands Group) bedrock is at EL. 552 ft NAVD 88 (top of layer No.1).
2. The bottom of CB basemat is at EL. 540 ft NAVD 88 (top of layer No. 3).
3. The bottom of RB/FB basemat is at EL. 524 ft NAVD 88 (within layer No. 5).
4. For SSI analyses presented in Subsection 3.7.2, the following elevation references are used in the SASSI2000 model:
   - EL. -6770 mm is the top of in-situ (Bass Islands Group) bedrock which is equivalent to EL. 552 ft NAVD 88.
   - EL. -10400 mm is at the bottom of CB basemat which is equivalent to EL. 540 ft NAVD 88.
   - EL. -15500 mm is at the bottom of RB/FB basemat which is equivalent to EL. 524 ft NAVD 88

Table 3.7.1-219 Upper Bound Properties for Fermi 3 SSI Analyses Based on the Soil Column Truncated at the Top of In Situ Bedrock [EF3 SUP 3.7-2]

Layer	Thickness (ft)	Unit Weight (pcf)	Shear Wave Velocity (ft/sec)	Damping Ratio (%)	Compression Wave Velocity (ft/sec)	Elevation at Top of Layer (ft)
SSI Profile, Top of Profile Elevation 552.0 ft.						
1	10.0	150	8192	0.48	16169	552.0
2	2.0	150	8074	0.48	16169	542.0
3	8.0	150	8074	0.48	16169	540.0
4	8.0	150	8261	0.48	16169	532.0
5	2.0	150	8261	0.48	16169	524.0
6	10.2	150	8359	0.48	16169	522.0
7	11.0	150	8316	0.48	16169	511.8
8	11.9	150	8393	0.48	16169	500.8
9	11.7	150	8094	0.48	16169	488.9
10	15.0	150	5820	0.68	12046	477.2
11	20.0	150	4221	0.95	9662	462.2
12	19.9	150	4042	0.95	9662	442.2
13	19.9	150	4041	0.95	9662	422.3
14	21.3	150	4033	0.95	9662	402.4
15	21.1	150	4987	0.95	11681	381.1
16	21.1	150	5061	0.95	11681	360.0
17	9.9	150	6920	0.36	12831	338.9
18	19.7	150	11664	0.36	21653	329.0
19	21.0	150	11560	0.36	21653	309.3
20	20.5	150	11666	0.36	21653	288.3
21	22.1	150	11625	0.36	21653	267.8
22	45.0	160	10953	0.36	19941	245.7
23	44.6	160	11082	0.36	19941	200.7
24	Half Space	169	11628	0.1	20943	156.1

Notes:
1. The top of in situ (Bass Islands Group) bedrock is at EL. 552 ft NAVD 88 (top of layer No.1).
2. The bottom of CB basemat is at EL. 540 ft NAVD 88 (top of layer No. 3).
3. The bottom of RB/FB basemat is at EL. 524 ft NAVD 88 (within layer No. 5).
4. For SSI analyses presented in Subsection 3.7.2, the following elevation references are used in the SASSI2000 model:
   - EL. -6770 mm is the top of in-situ (Bass Islands Group) bedrock which is equivalent to EL. 552 ft NAVD 88.
   - EL. -10400 mm is at the bottom of CB basemat which is equivalent to EL. 540 ft NAVD 88.
   - EL. -15500 mm is at the bottom of RB/FB basemat which is equivalent to EL. 524 ft NAVD 88.

Figure 3.7.1-201 Shear Wave Velocity Profiles for Site Response Analysis Representing the Intermediate and Bounding Estimates [EF3 SUP 3.7-1]

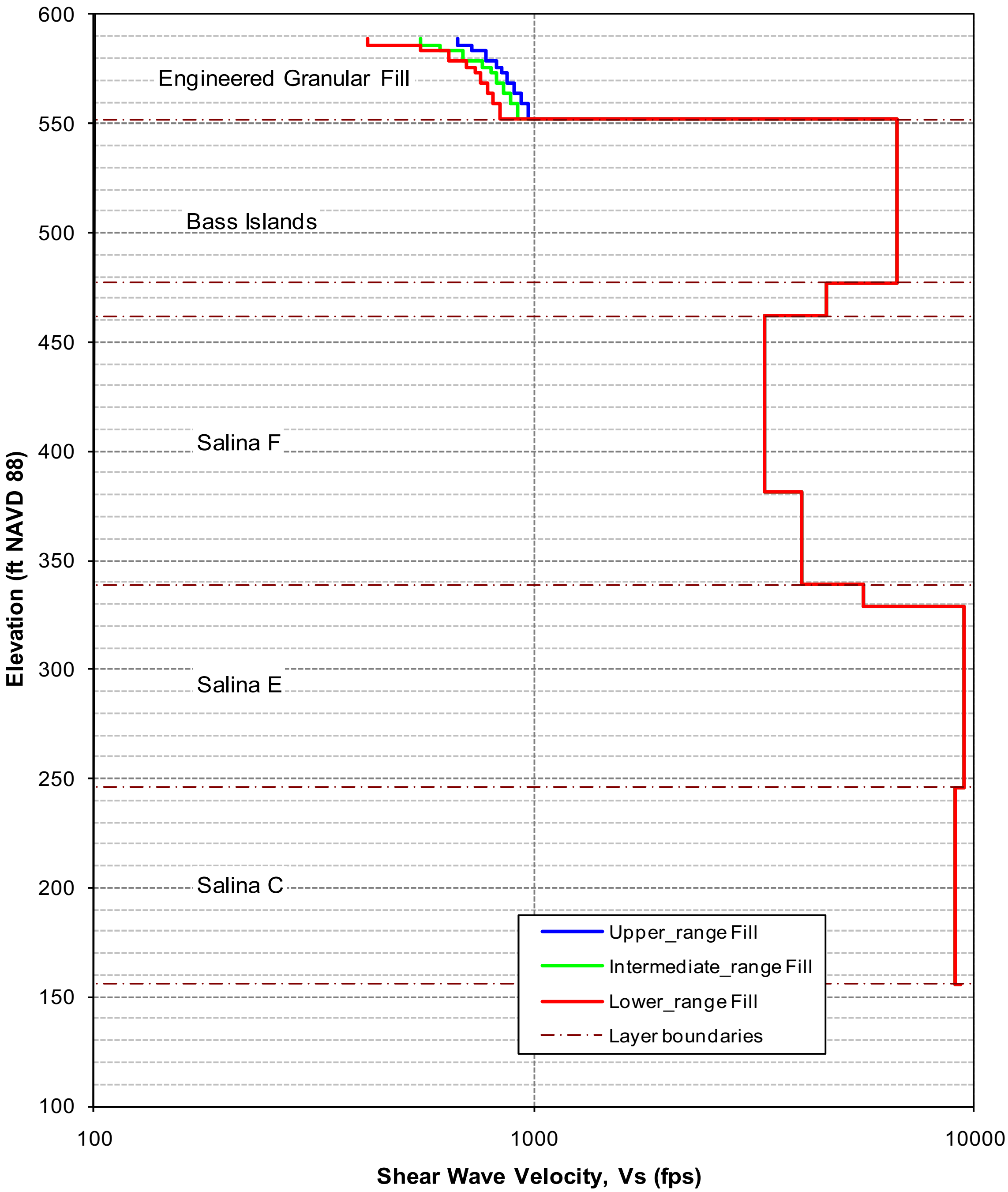


Figure 3.7.1-202 Modulus Reduction and Damping Relationships Used for the Engineered Granular Backfill Material [EF3 SUP 3.7-1]

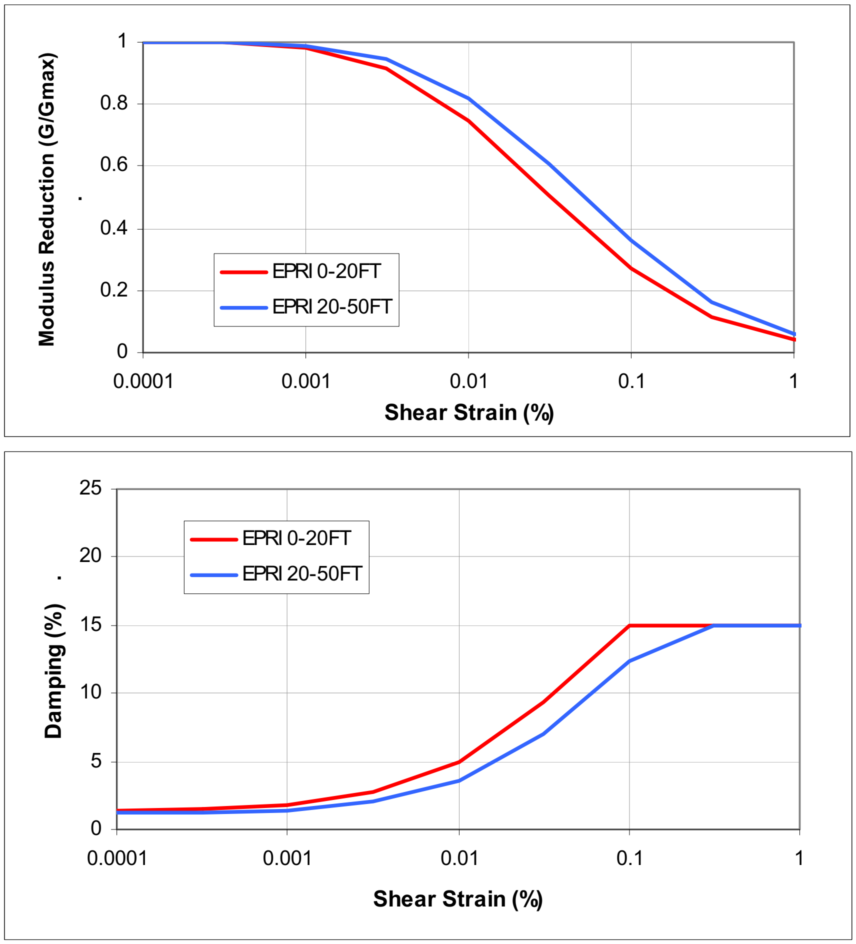


Figure 3.7.1-203 Randomized Shear Wave Velocity Profiles 1-30 for the Intermediate Range Site Response Analysis Profile
[EF3 SUP 3.7-1]

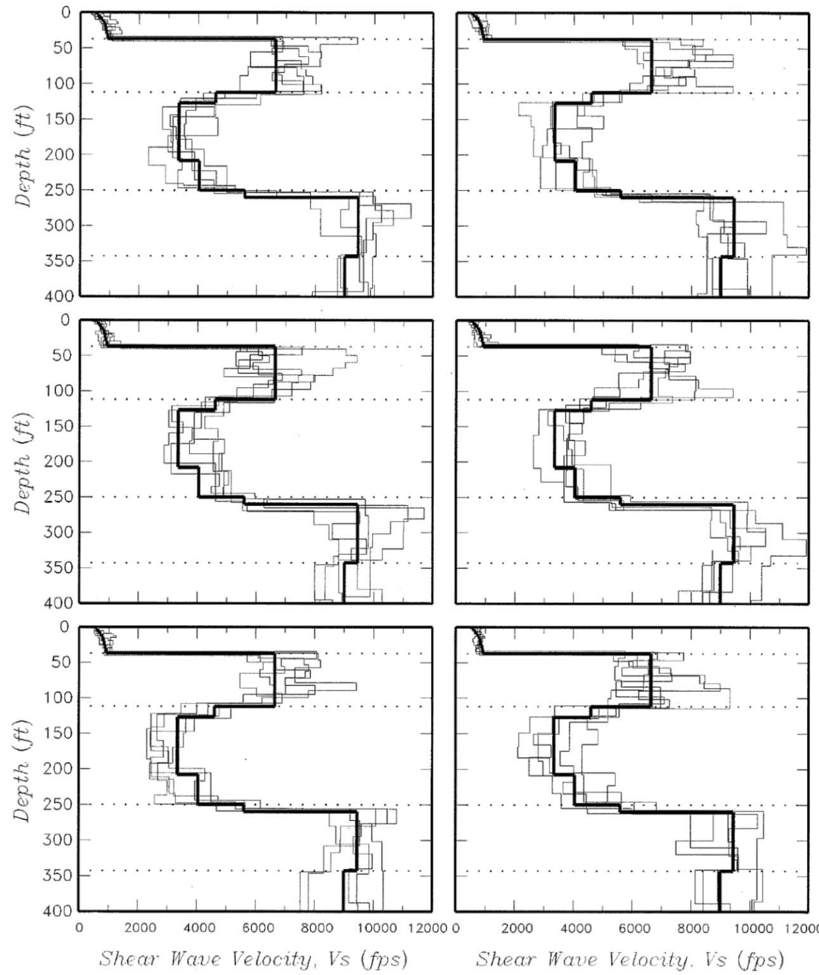


Figure 3.7.1-204 Randomized Shear Wave Velocity Profiles 31-60 for the Intermediate Range Site Response Analysis Profile [EF3 SUP 3.7-1]

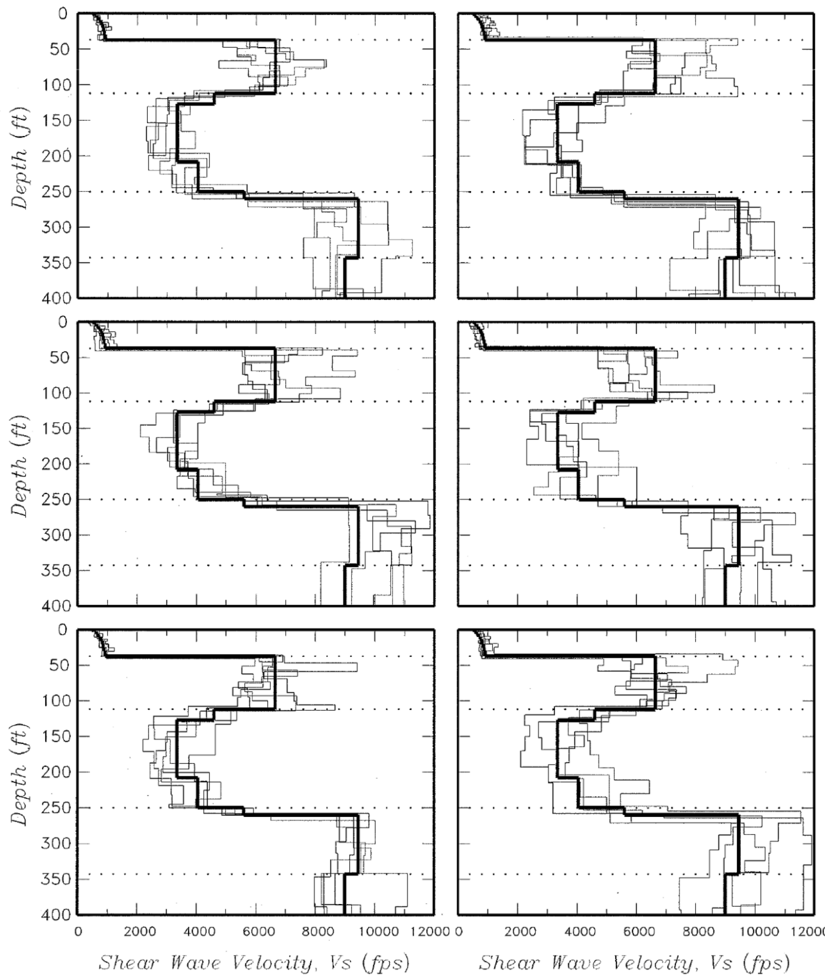


Figure 3.7.1-205 Statistics of Randomized Shear Wave Velocity Profiles for the Intermediate Range Site Response Analysis Profile [EF3 SUP 3.7-1]

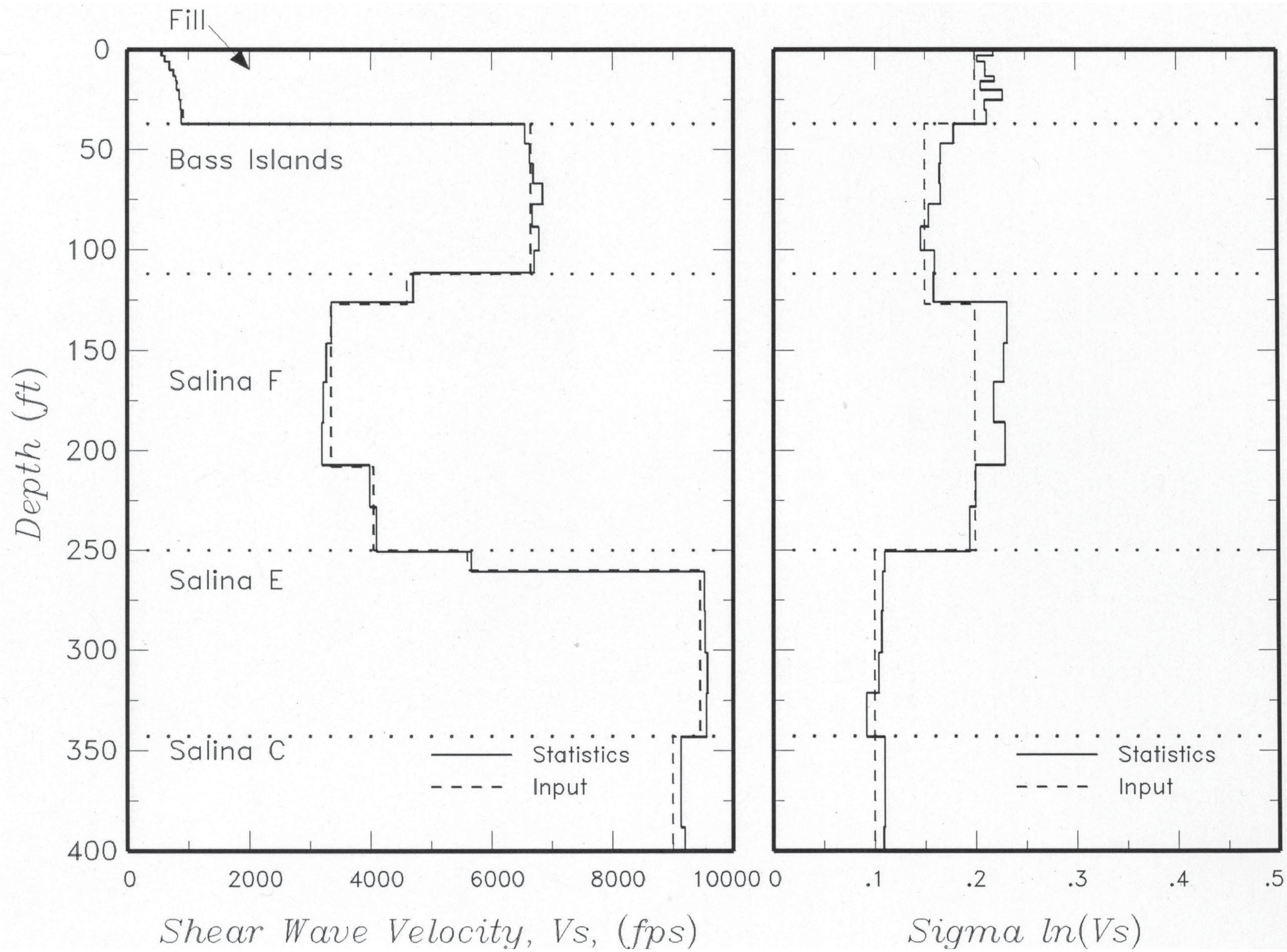


Figure 3.7.1-206 Randomized Shear Modulus Reduction and Damping Relationships Used for 0 to 20 Feet Depth Engineered Granular Backfill Material [EF3 SUP 3.7-1]

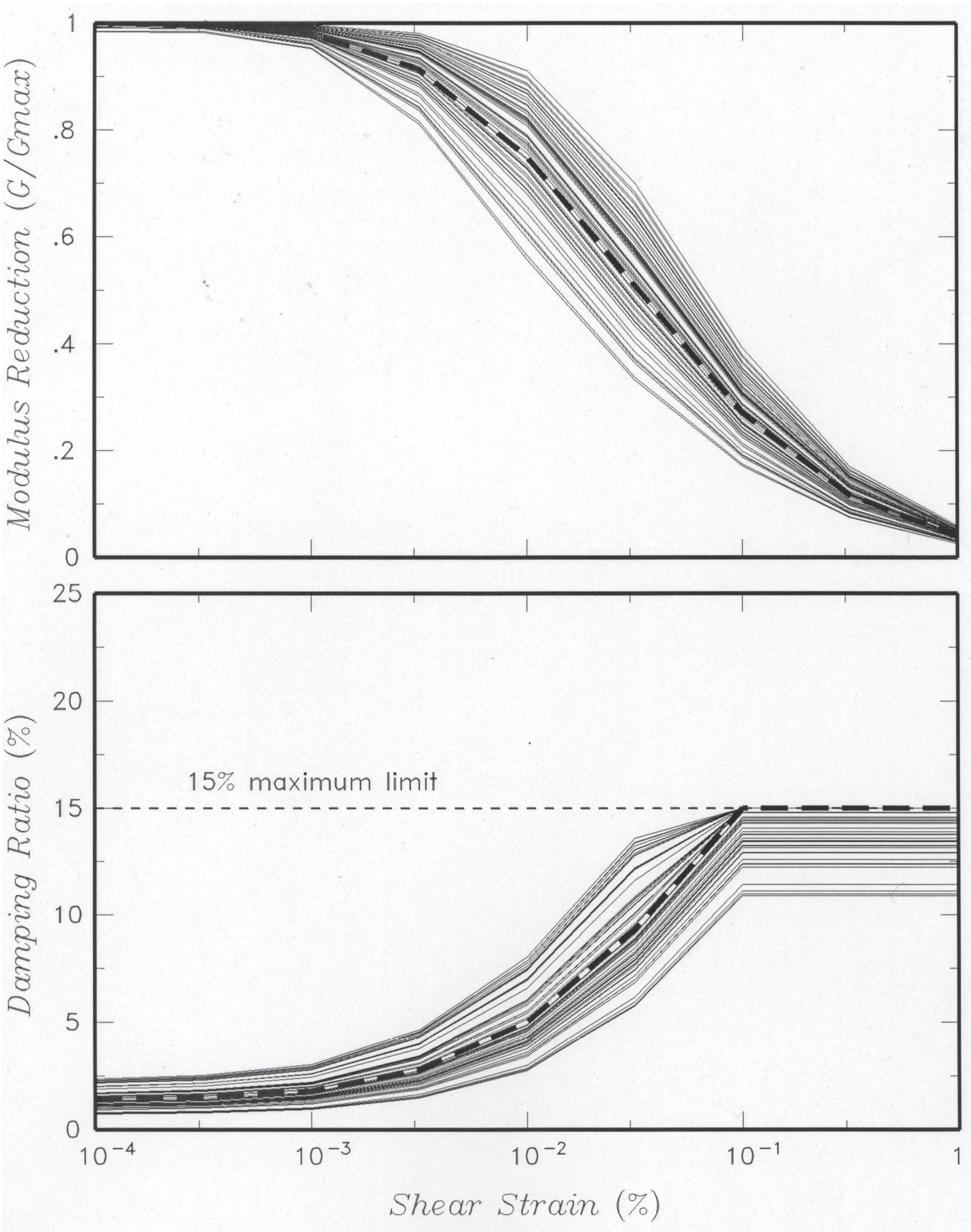


Figure 3.7.1-207 Randomized Shear Modulus Reduction and Damping Relationships Used for 20 to 50 Feet Depth Engineered Granular Backfill Material [EF3 SUP 3.7-1]

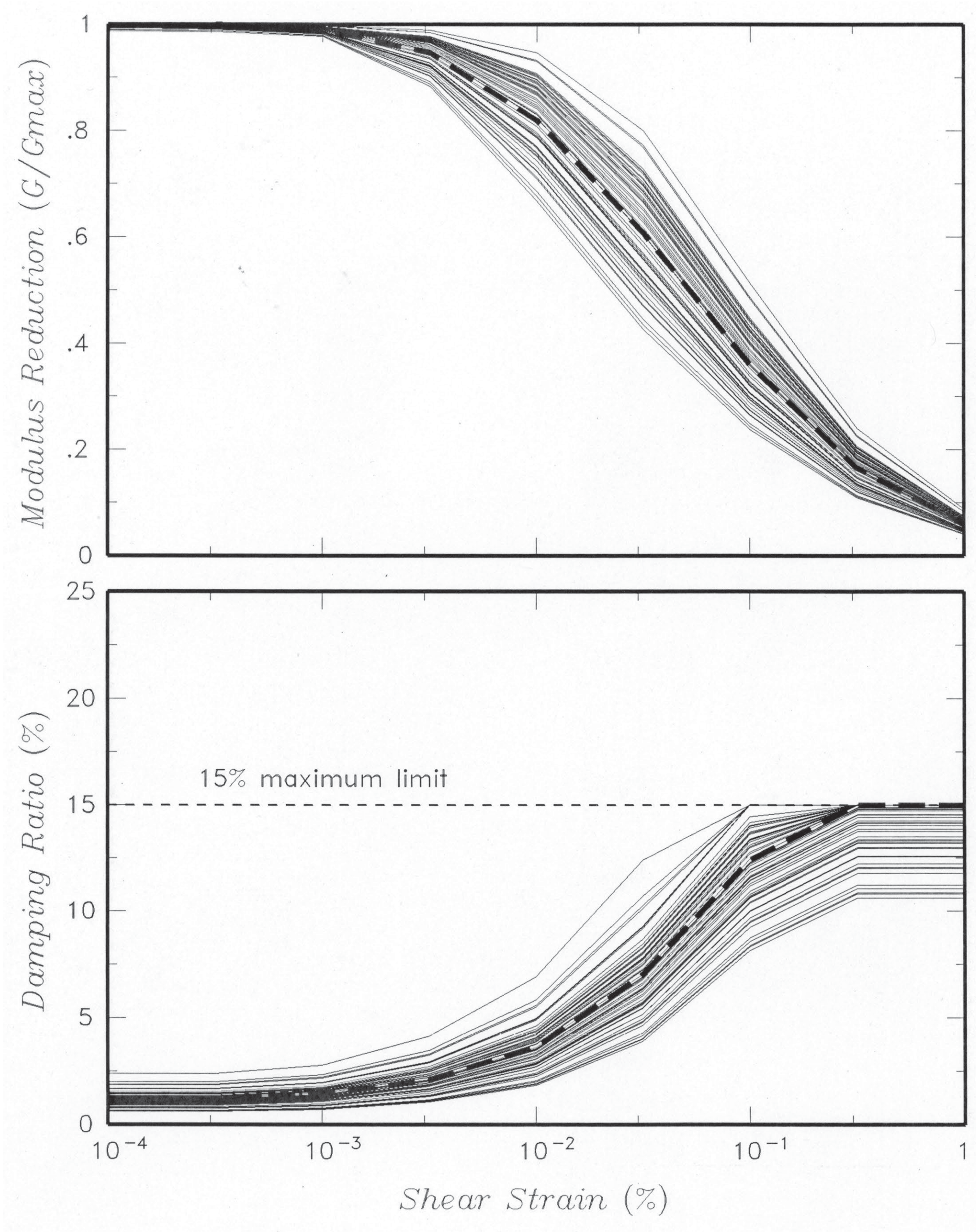


Figure 3.7.1-208 Site Response Logic Tree for Full Soil Column Profile [EF3 SUP 3.7-1]

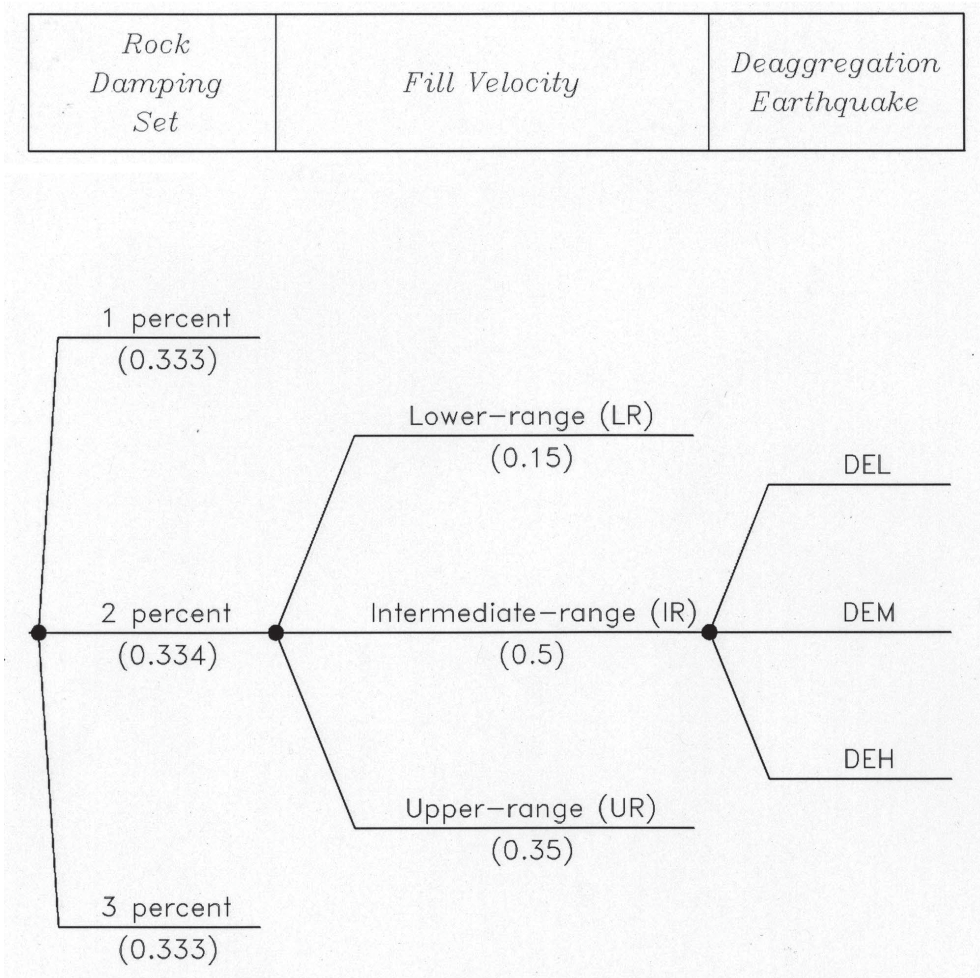
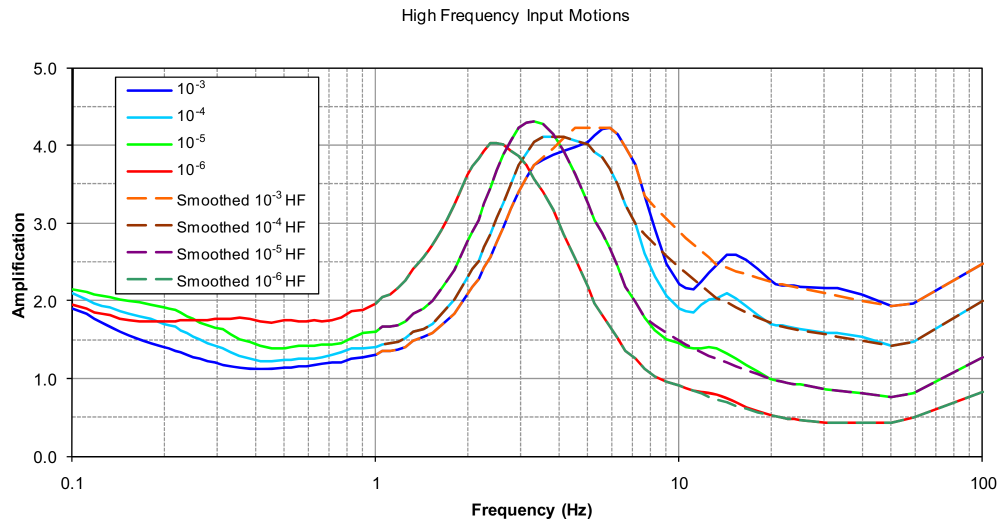


Figure 3.7.1-209 PBSRS Amplification Functions for the Fermi 3 Site [EF3 SUP 3.7-1]



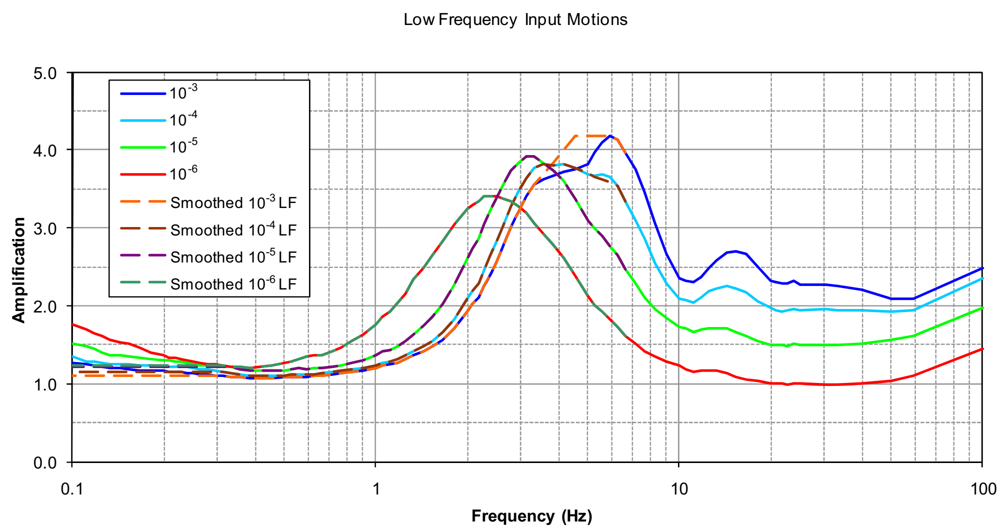
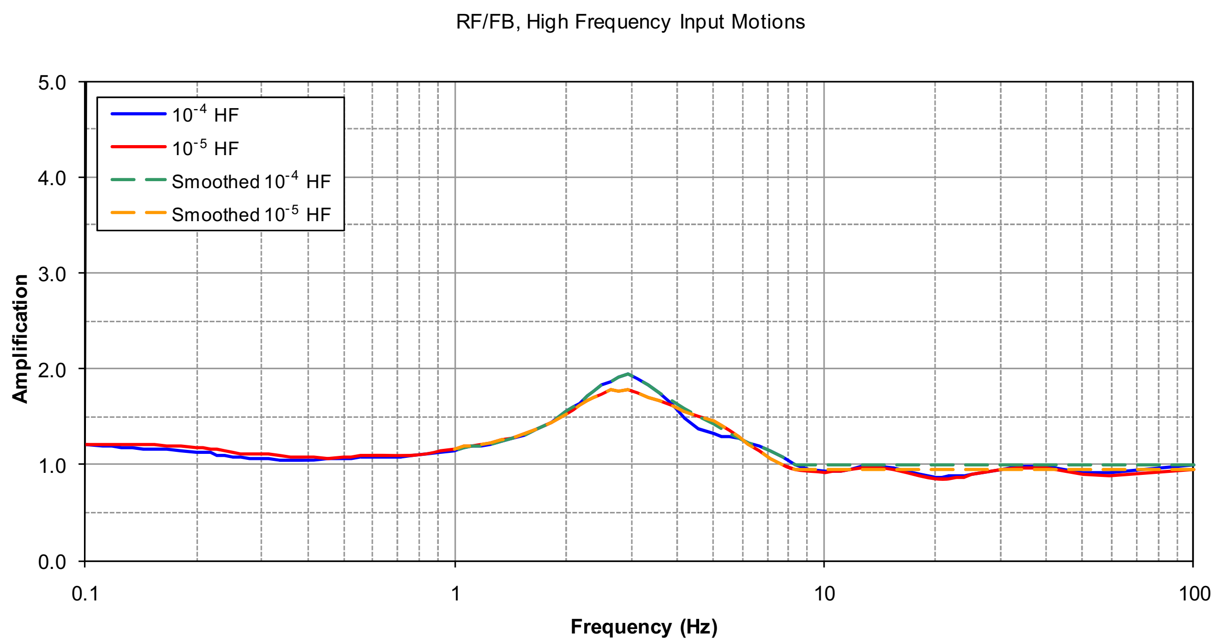


Figure 3.7.1-210 RB/FB SCOR Amplification Functions for the Fermi 3 Site [EF3 SUP 3.7-1]



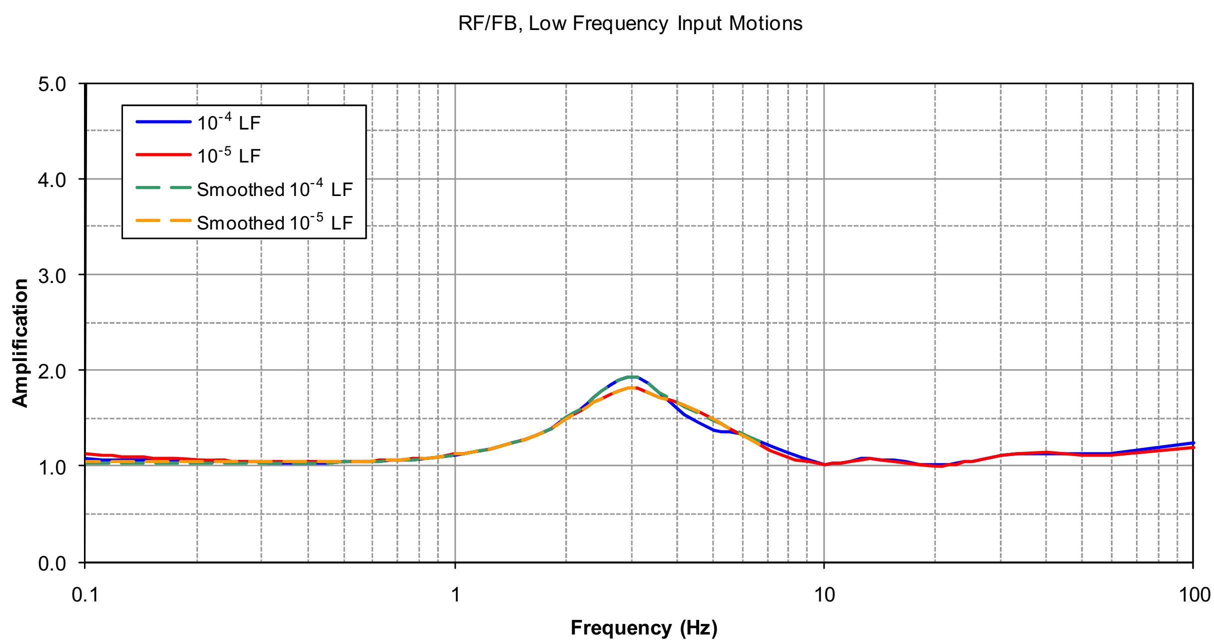
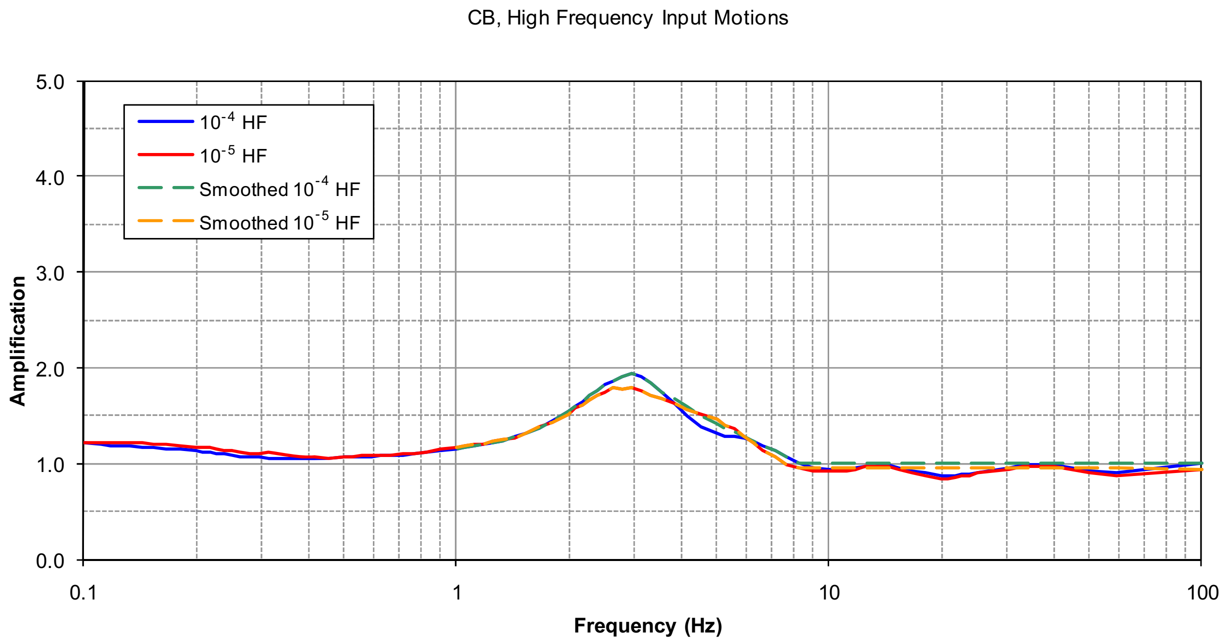


Figure 3.7.1-211 CB SCOR Amplification Function for the Fermi 3 Site [EF3 SUP 3.7-1]



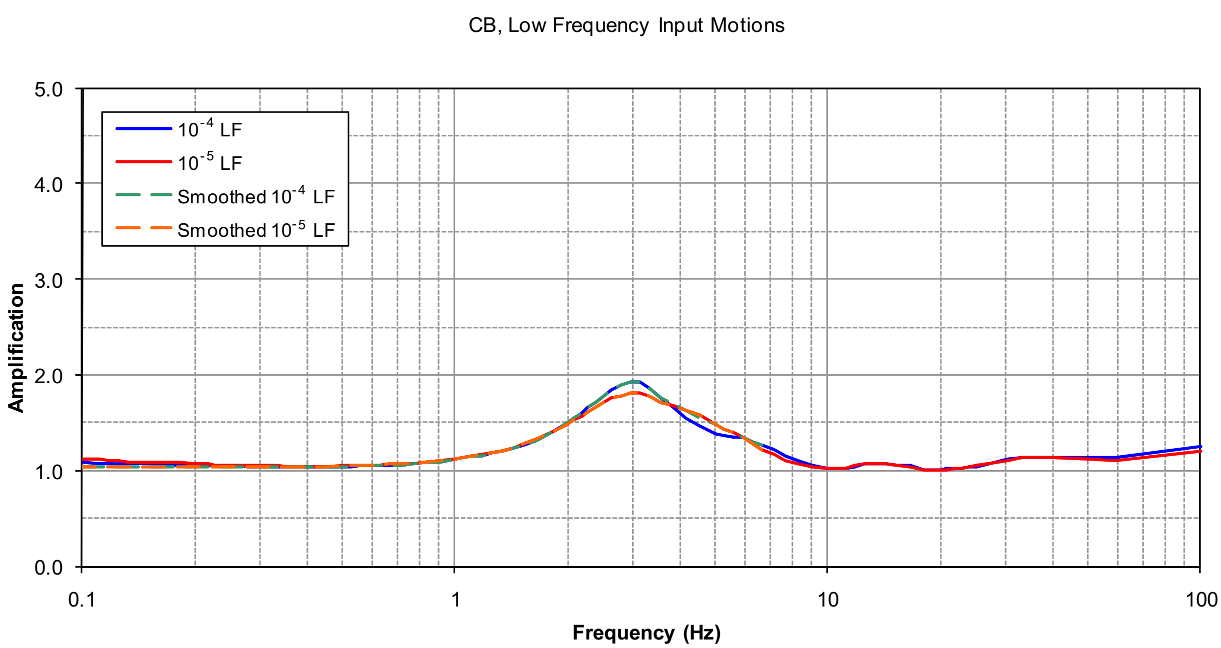


Figure 3.7.1-212 Development of 10^{-4} Surface UHRS at the Finished Ground Level Grade for the Full Soil Column Profile [EF3 SUP 3.7-1]

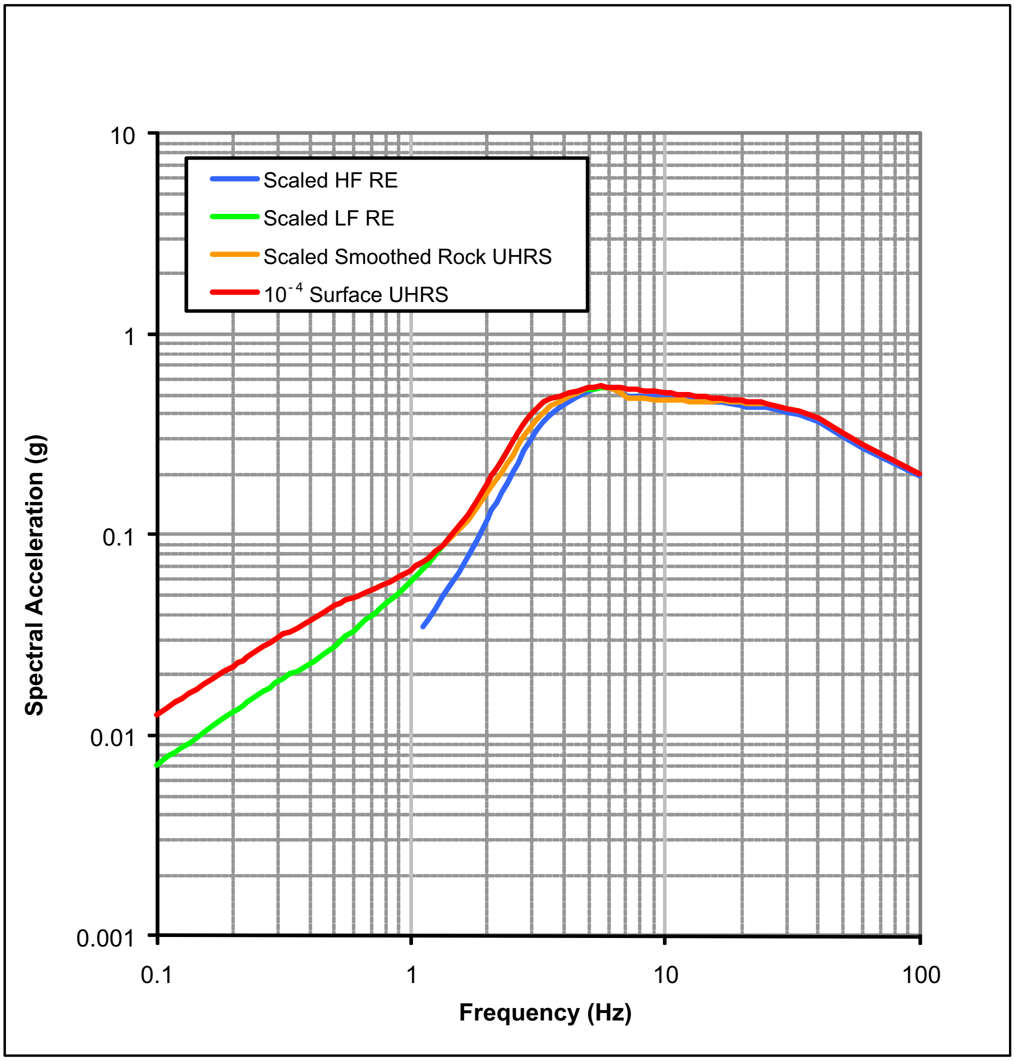


Figure 3.7.1-213 Development of 10^{-4} SCOR UHRS at the RB/FB Foundation Level for the Full Soil Column Profile [EF3 SUP 3.7-1]

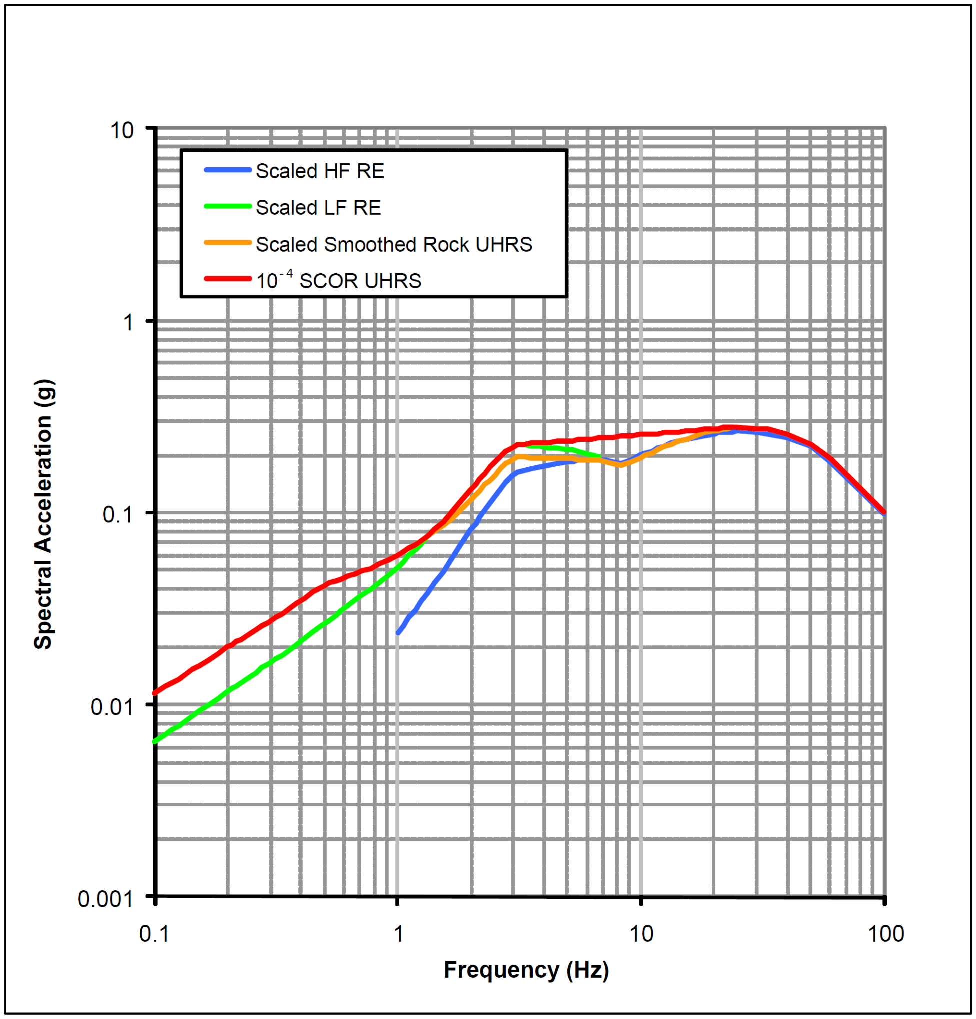


Figure 3.7.1-214 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 0.5 Hz Spectral Acceleration [EF3 SUP 3.7-1]

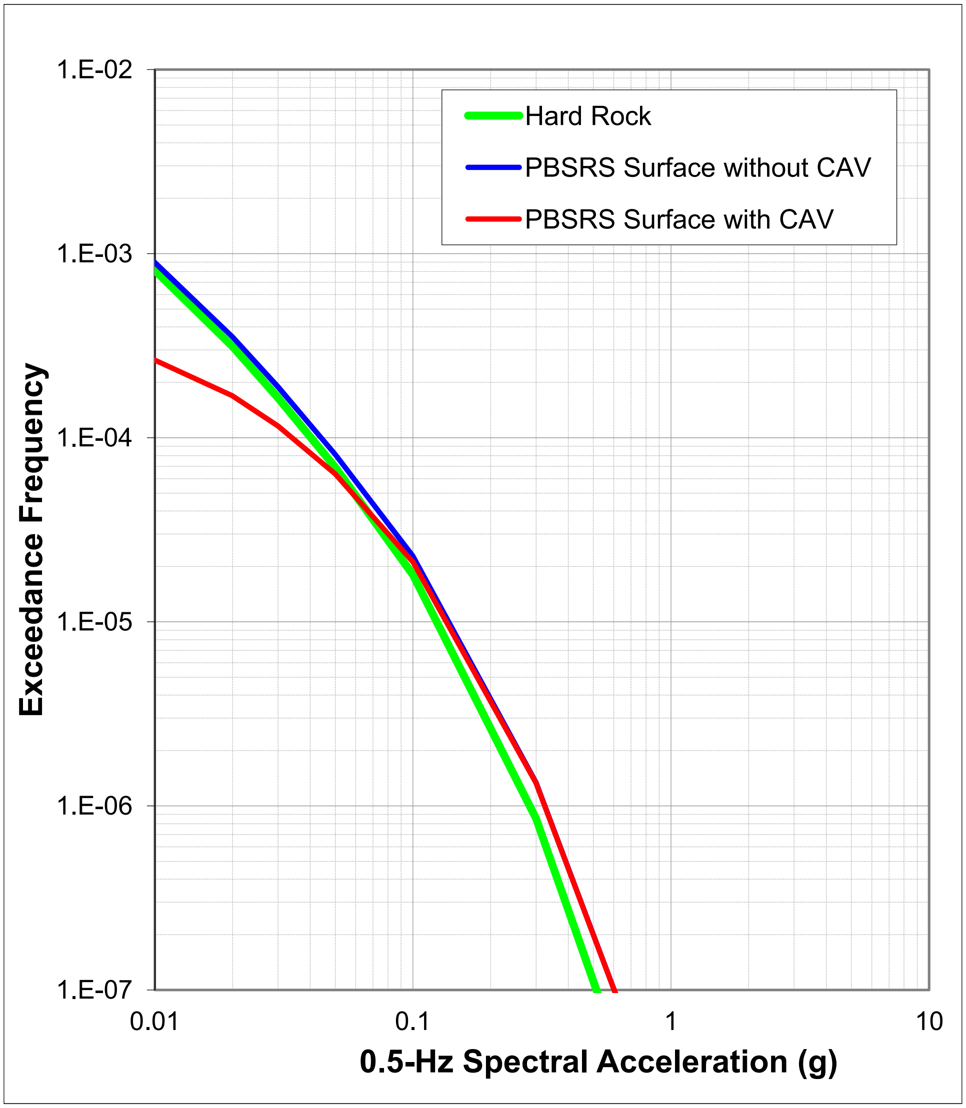


Figure 3.7.1-215 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 1 Hz Spectral Acceleration [EF3 SUP 3.7-1]

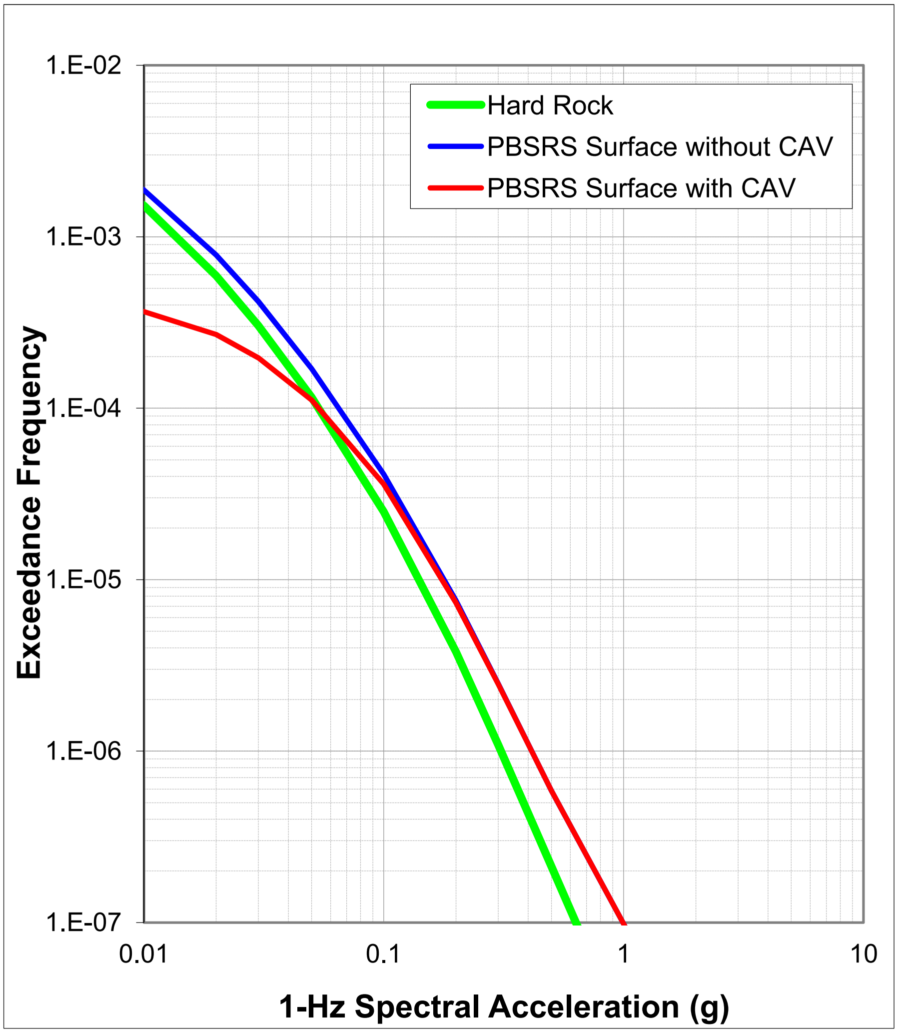


Figure 3.7.1-216 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 2.5 Hz Spectral Acceleration [EF3 SUP 3.7-1]

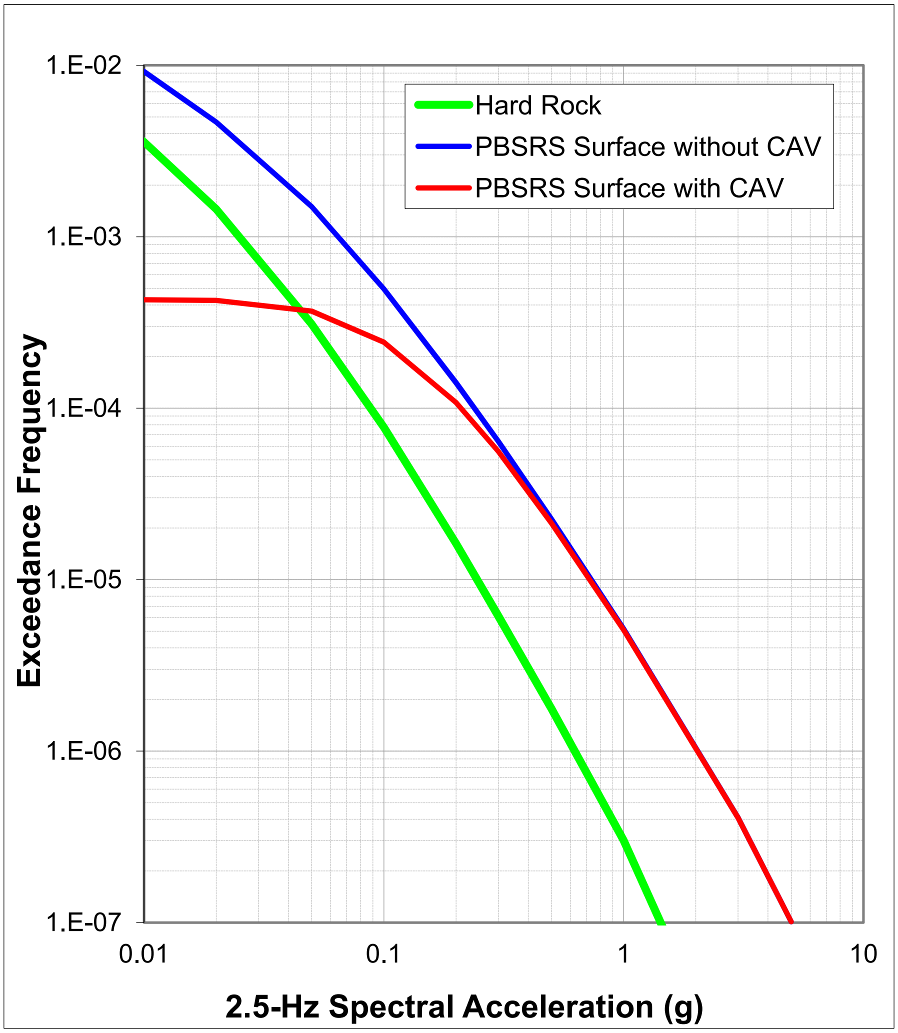


Figure 3.7.1-217 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 5 Hz Spectral Acceleration [EF3 SUP 3.7-1]

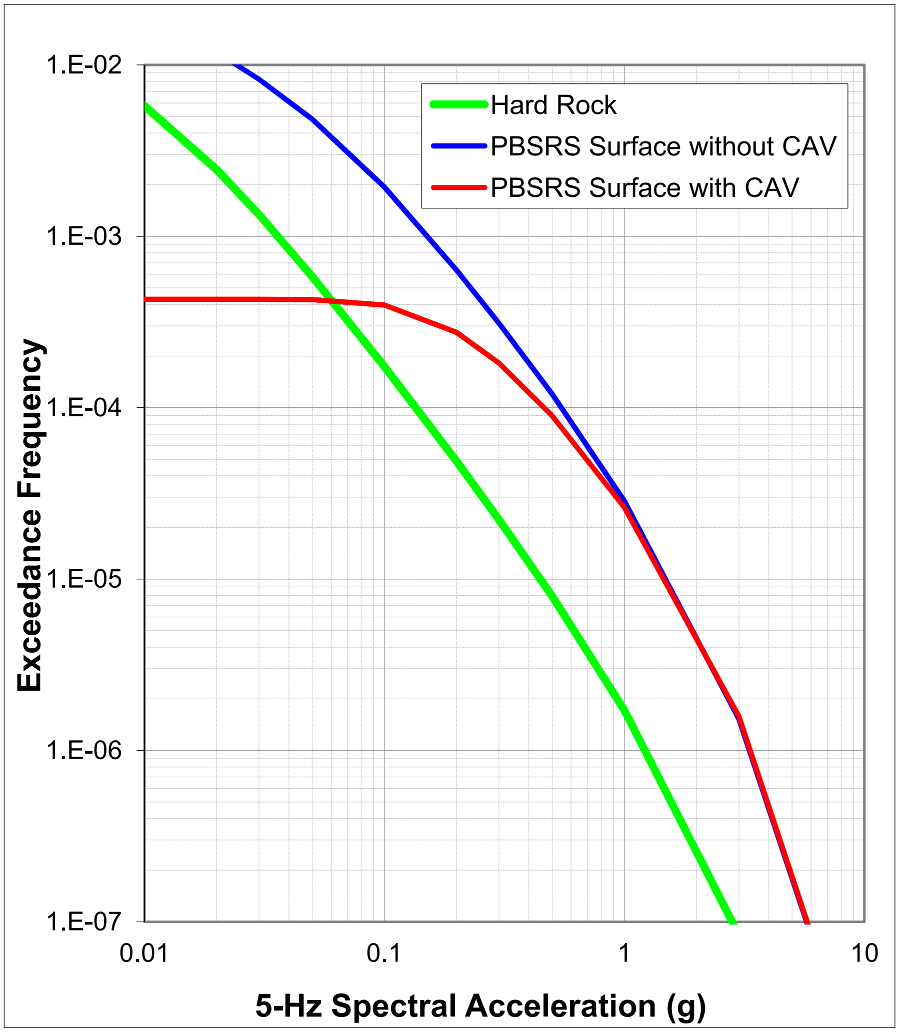


Figure 3.7.1-218 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 10 Hz Spectral Acceleration [EF3 SUP 3.7-1]

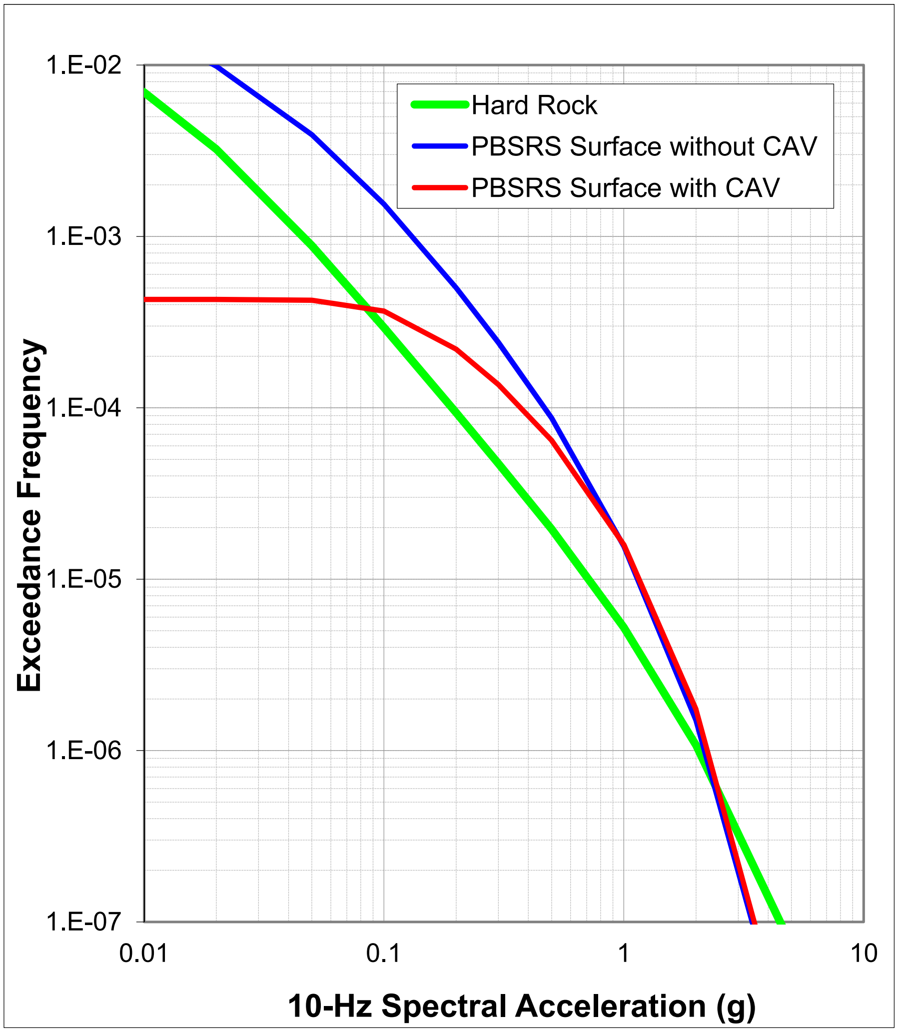


Figure 3.7.1-219 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 25 Hz Spectral Acceleration [EF3 SUP 3.7-1]

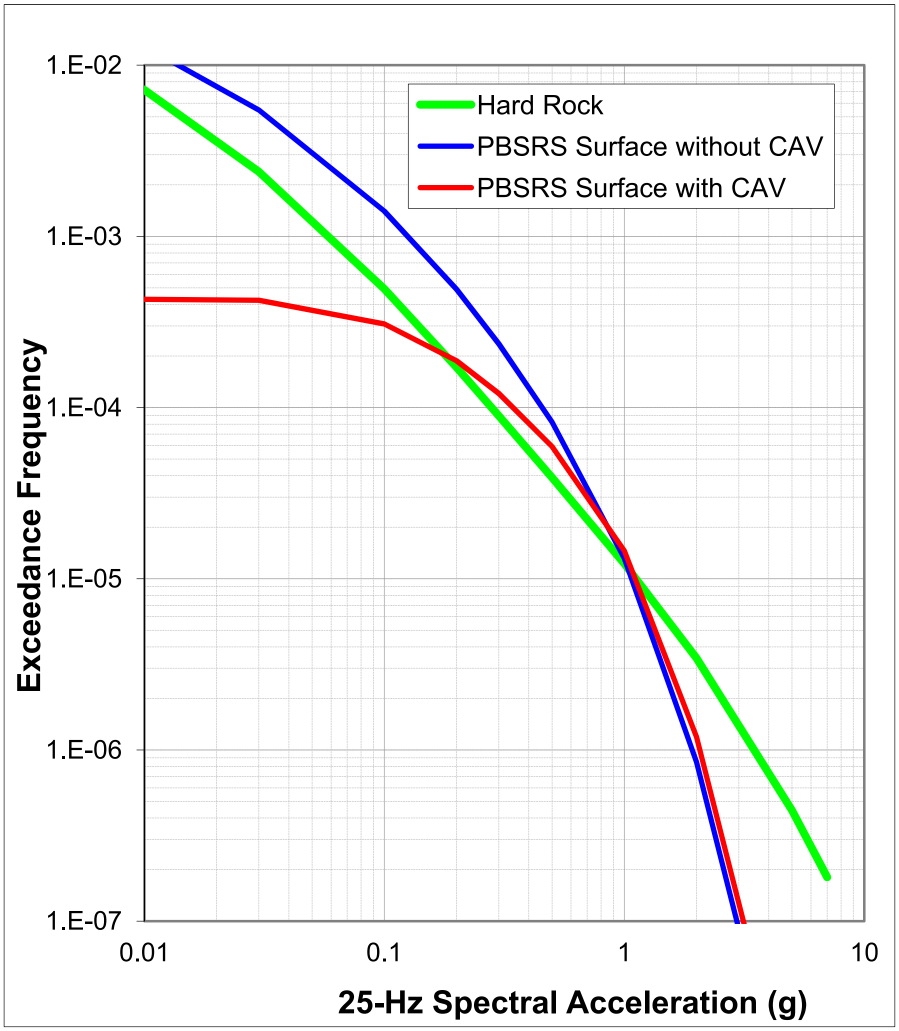


Figure 3.7.1-220 Surface Hazard Curves at Finished Ground Level Grade for the Full Soil Column Profile Computed With and Without CAV for 100 Hz Spectral Acceleration [EF3 SUP 3.7-1]

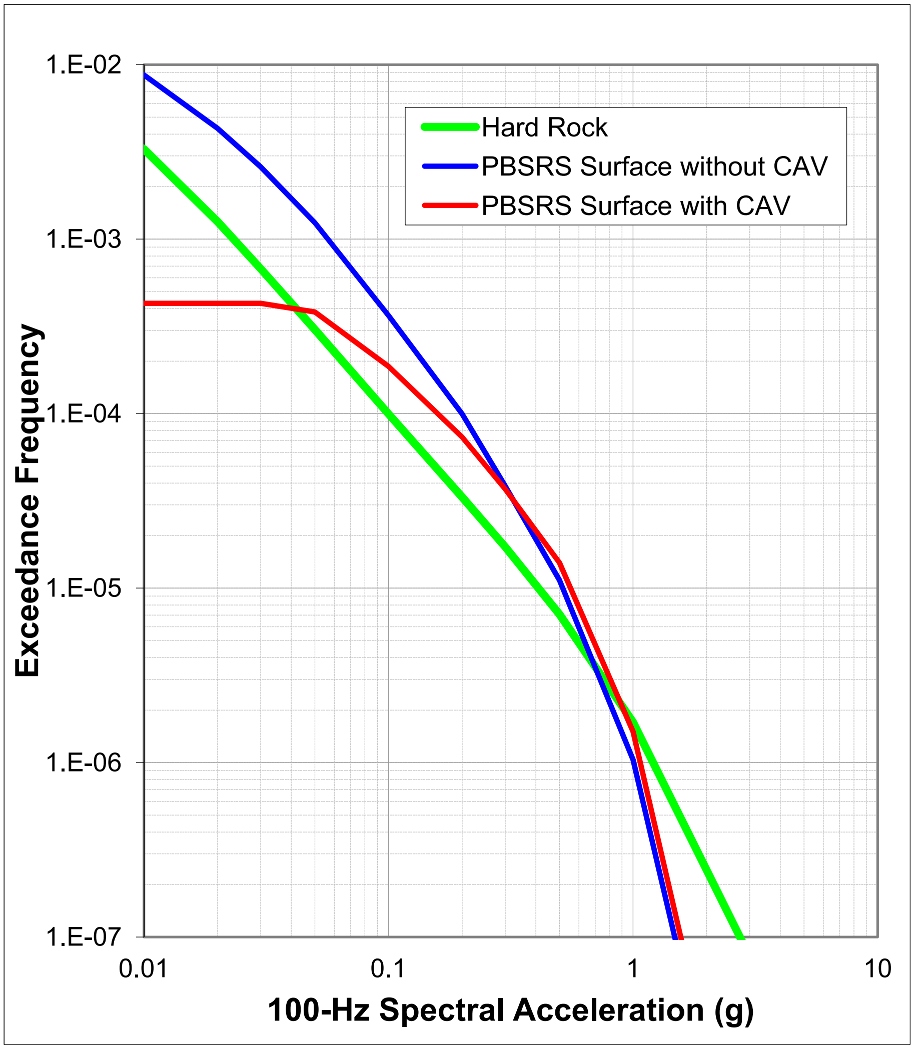


Figure 3.7.1-221 Surface UHRS at the Finished Ground Level Grade Computed With and Without CAV [EF3 SUP 3.7-1]

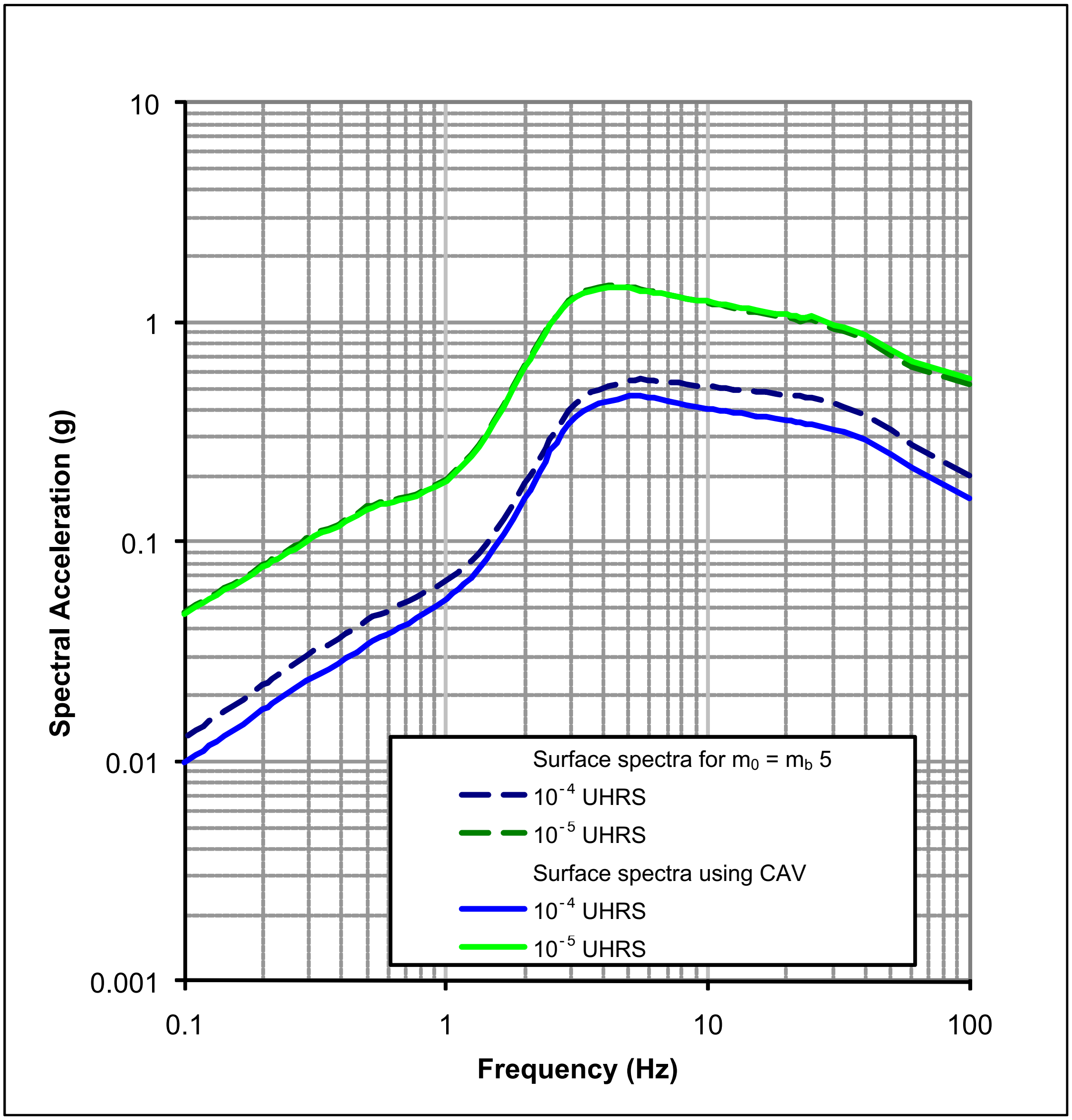


Figure 3.7.1-222 Horizontal PBSRS for the Fermi 3 Site [EF3 SUP 3.7-1]

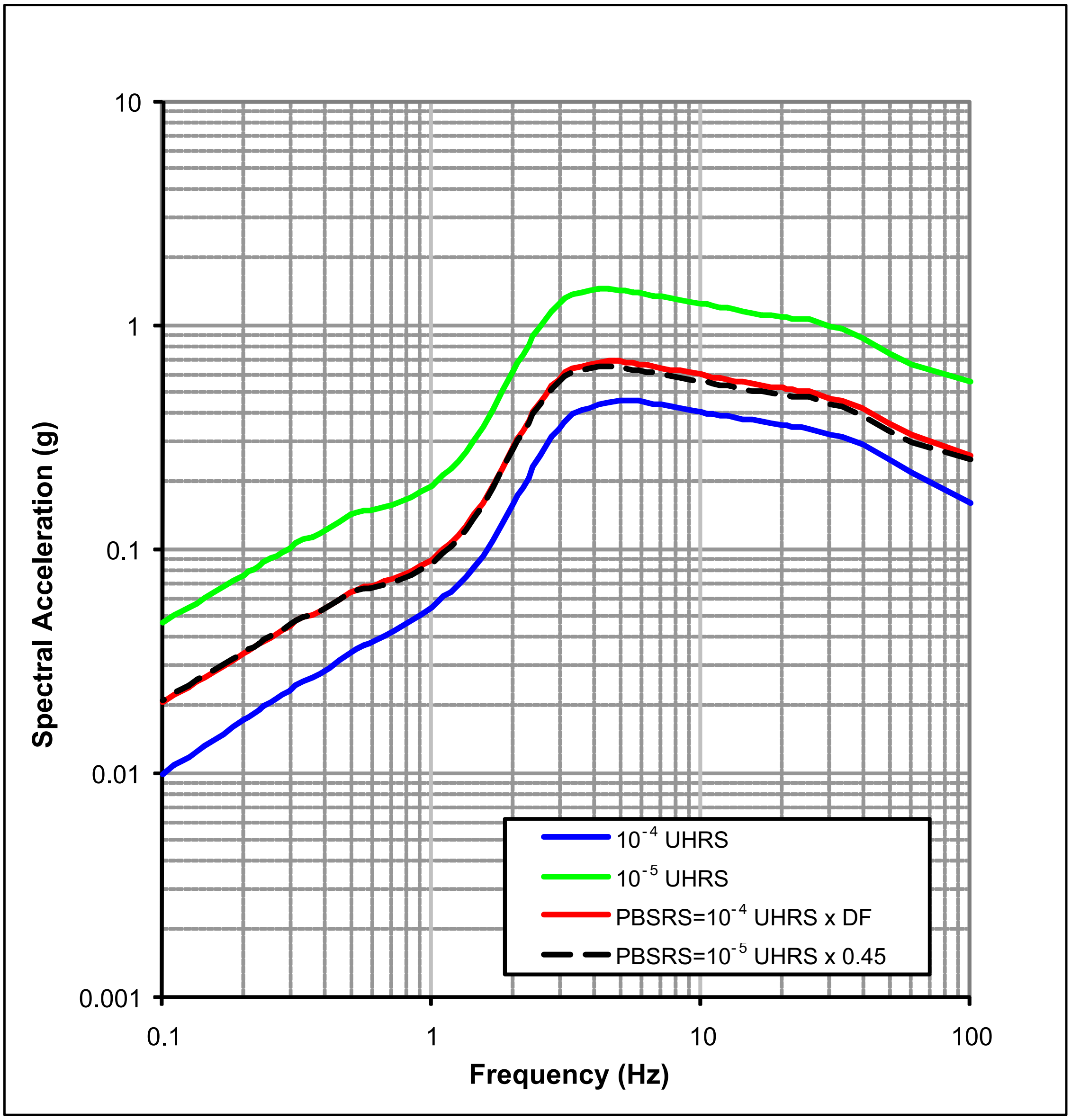


Figure 3.7.1-223 Vertical to Horizontal Spectral Ratios Developed for Fermi 3 Full Soil Column Profile [EF3 SUP 3.7-1]

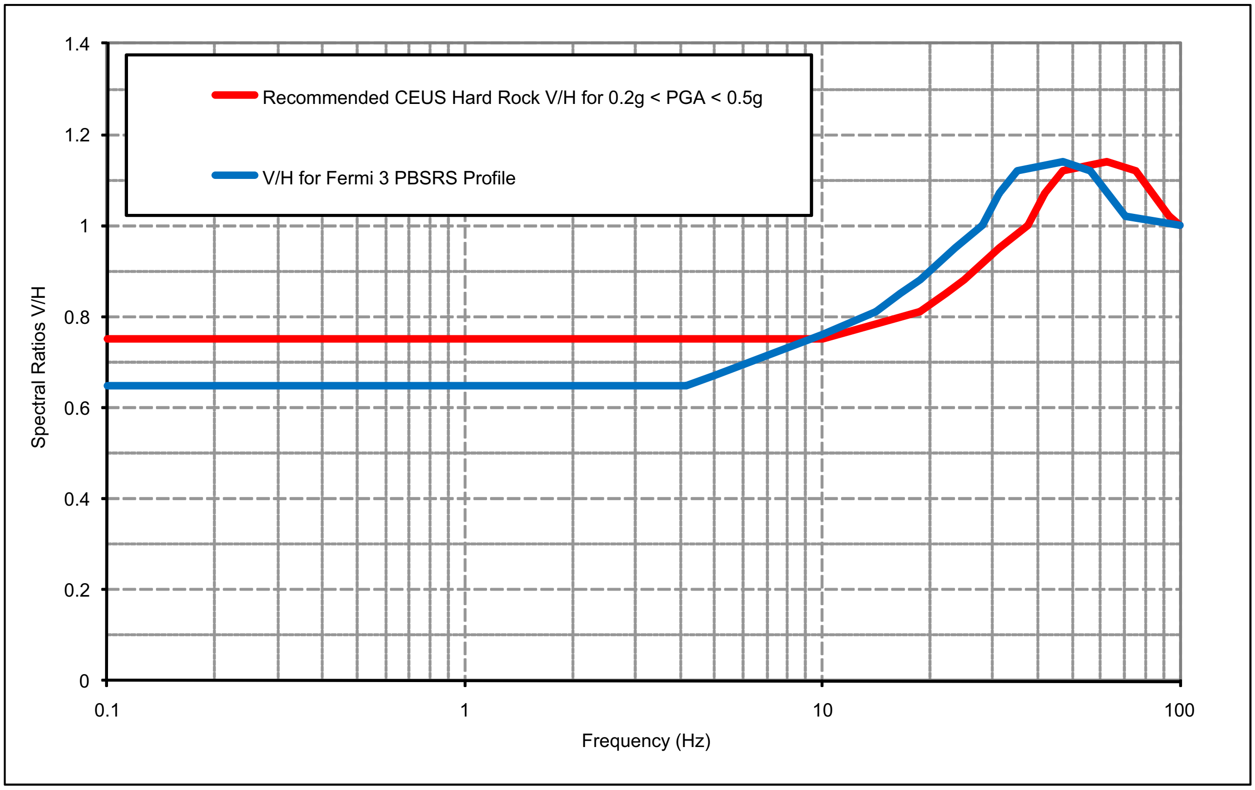


Figure 3.7.1-224 Fermi 3 PBSRS at Finished Ground Level Grade (5% Damping) [EF3 SUP 3.7-1]

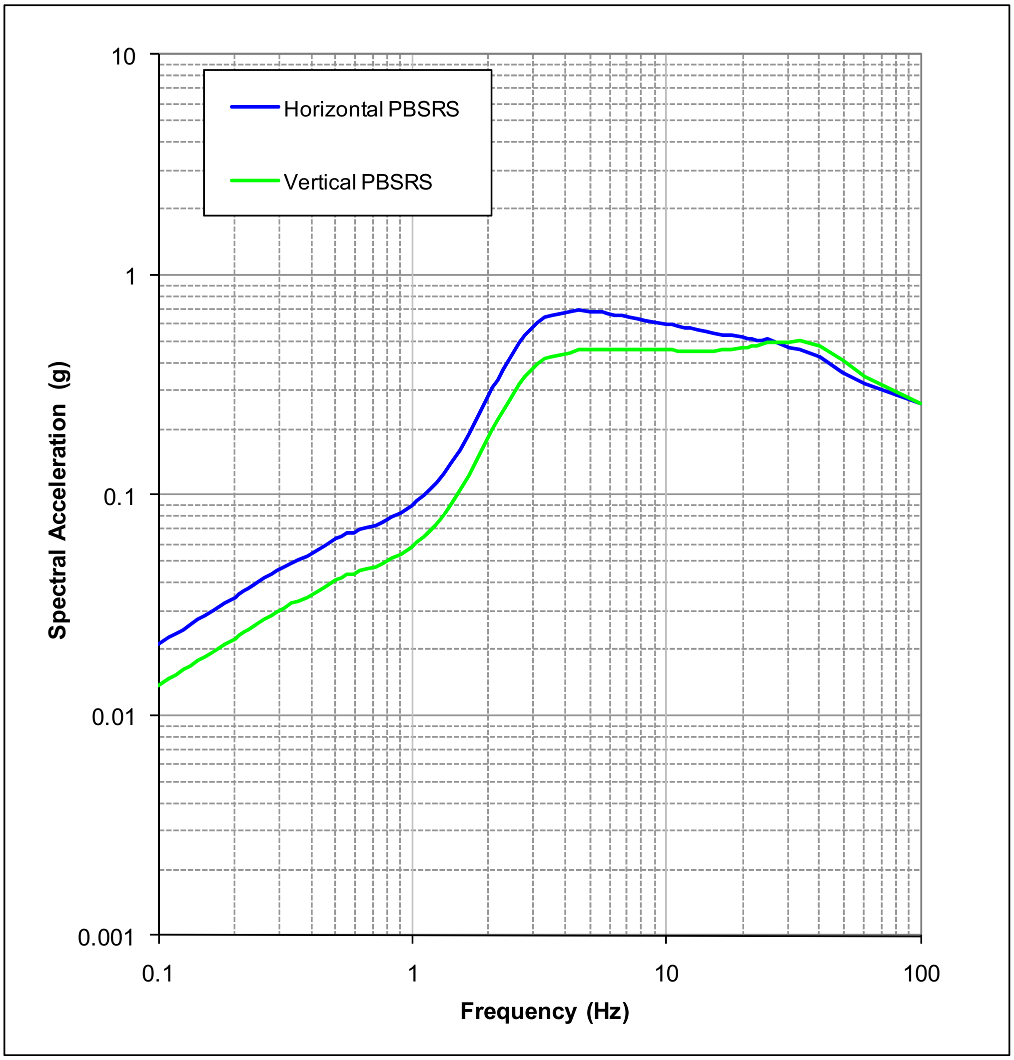


Figure 3.7.1-225 Lower Bound, Best Estimate, and Upper Bound Shear Wave Velocity Profiles for the Full Soil Column [EF3 SUP 3.7-1]

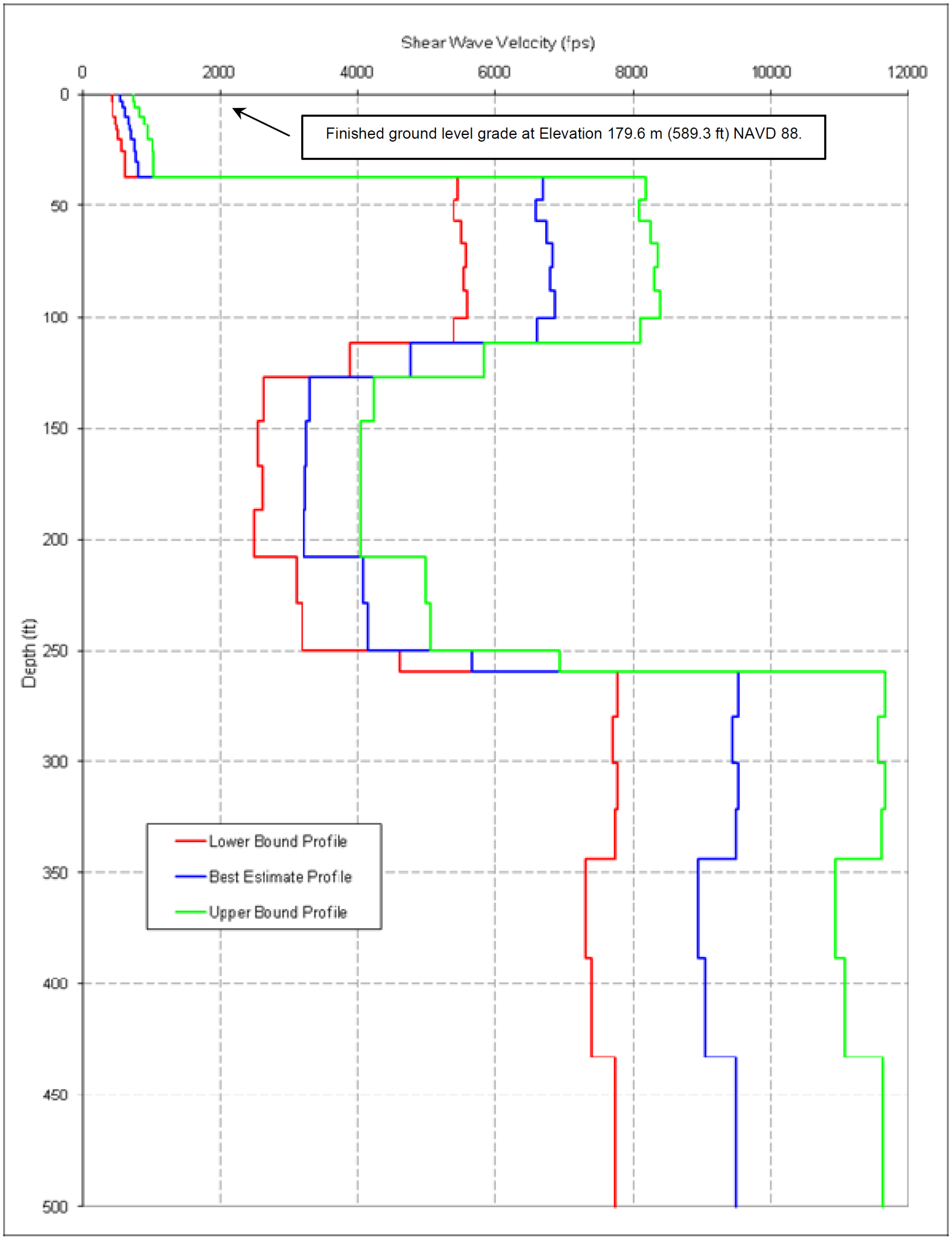


Figure 3.7.1-226 Fermi 3 RB/FB SCOR FIRS (5% Damping) [EF3 SUP 3.7-1]

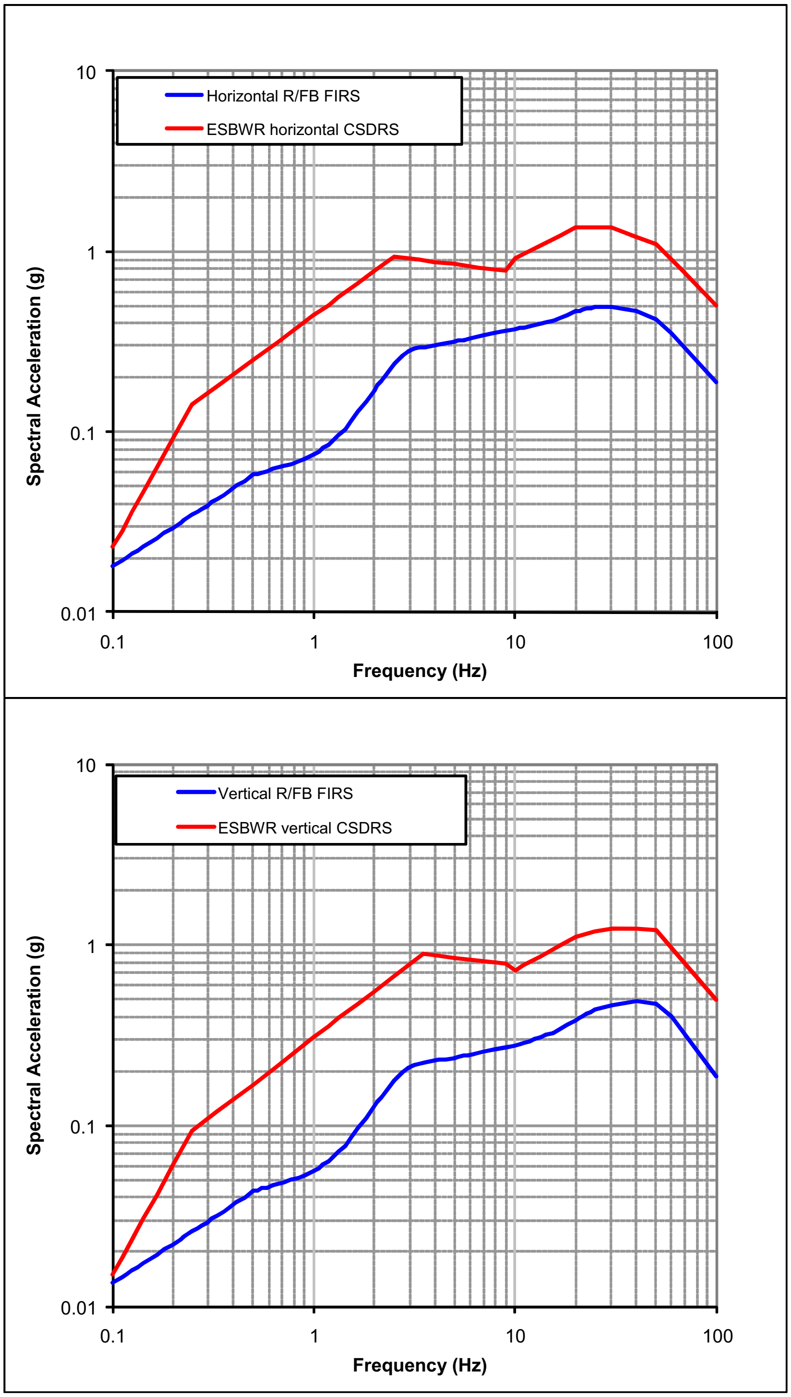


Figure 3.7.1-227 Fermi 3 CB SCOR FIRS (5% Damping) [EF3 SUP 3.7-1]

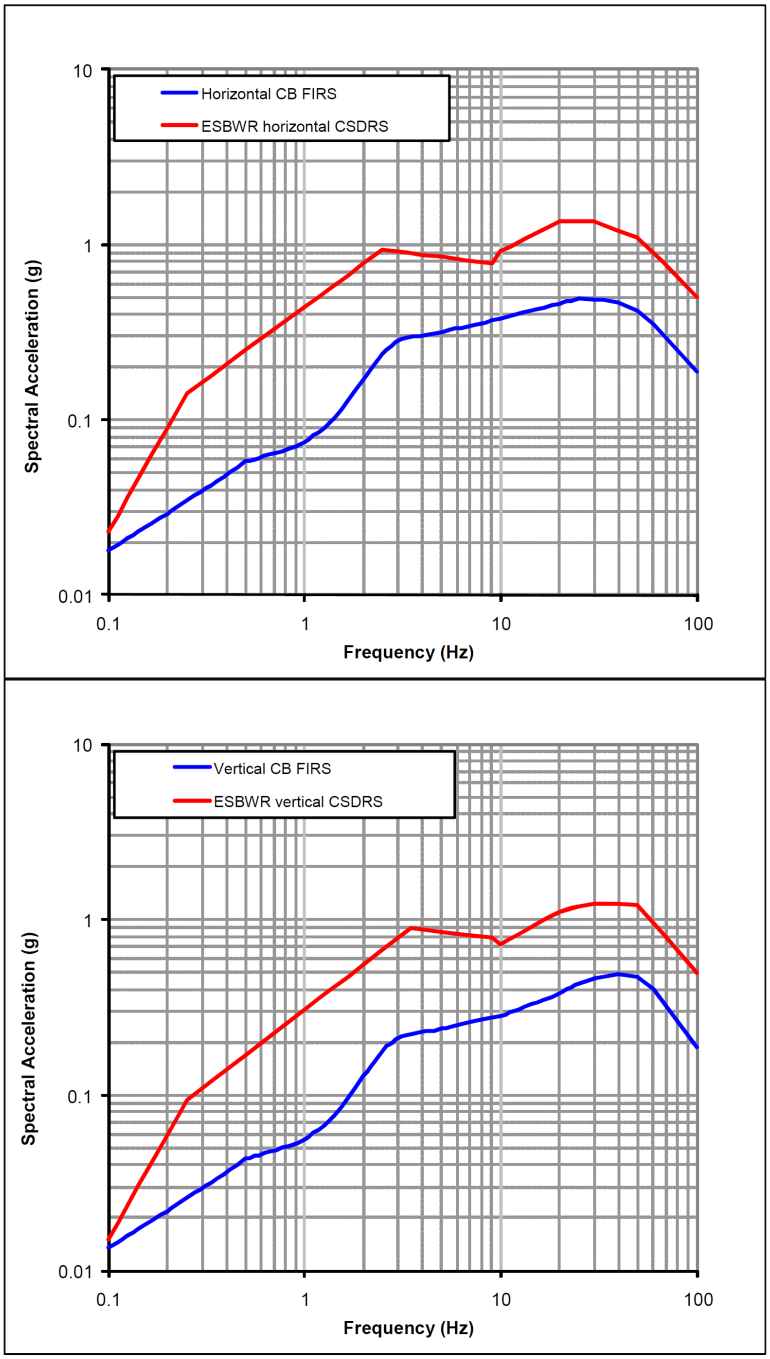


Figure 3.7.1-228 Fermi 3 Horizontal RB/FB SCOR FIRS and Enhanced SCOR FIRS (5% Damping) [EF3 SUP 3.7-1]

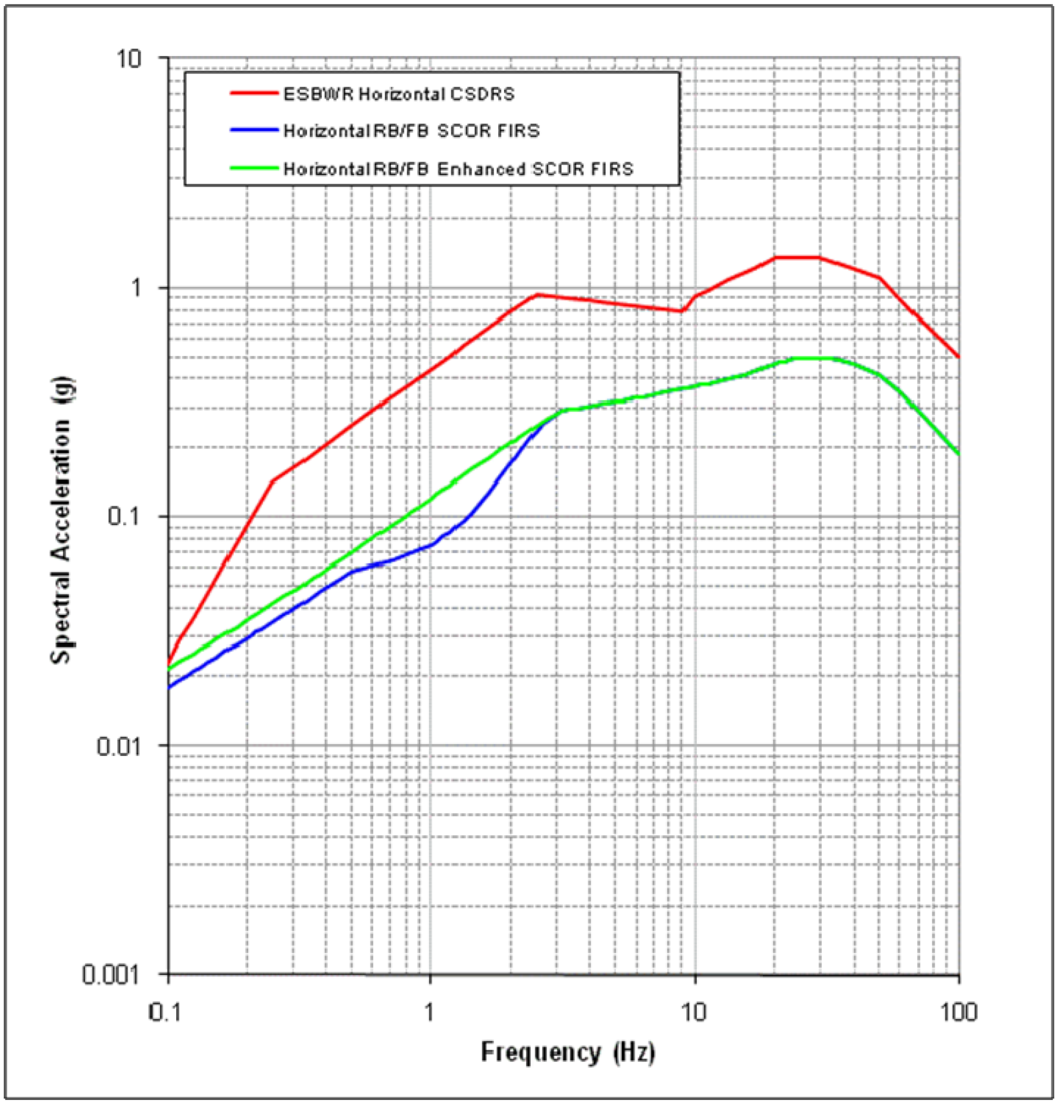


Figure 3.7.1-229 Fermi 3 Horizontal CB SCOR FIRS and Enhanced SCOR FIRS (5% damping) [EF3 SUP 3.7-1]

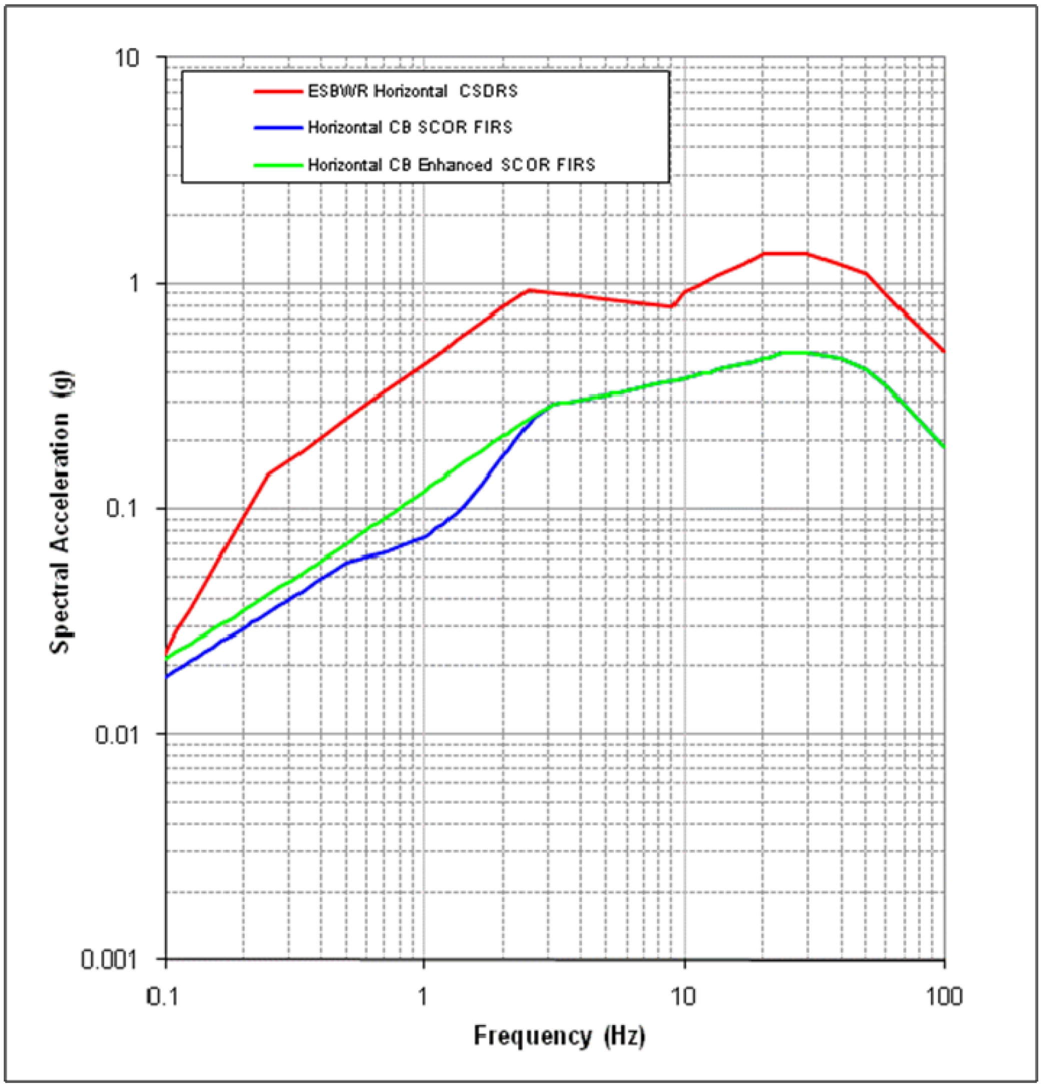


Figure 3.7.1-230 Comparison with Envelopes of the Response Spectra of Computed Horizontal Component Surface Motions for Full Soil Column Profiles Using the RB/FB Enhanced SCOR FIRS Input Motions with the Horizontal PBSRS. [EF3 SUP 3.7-1]

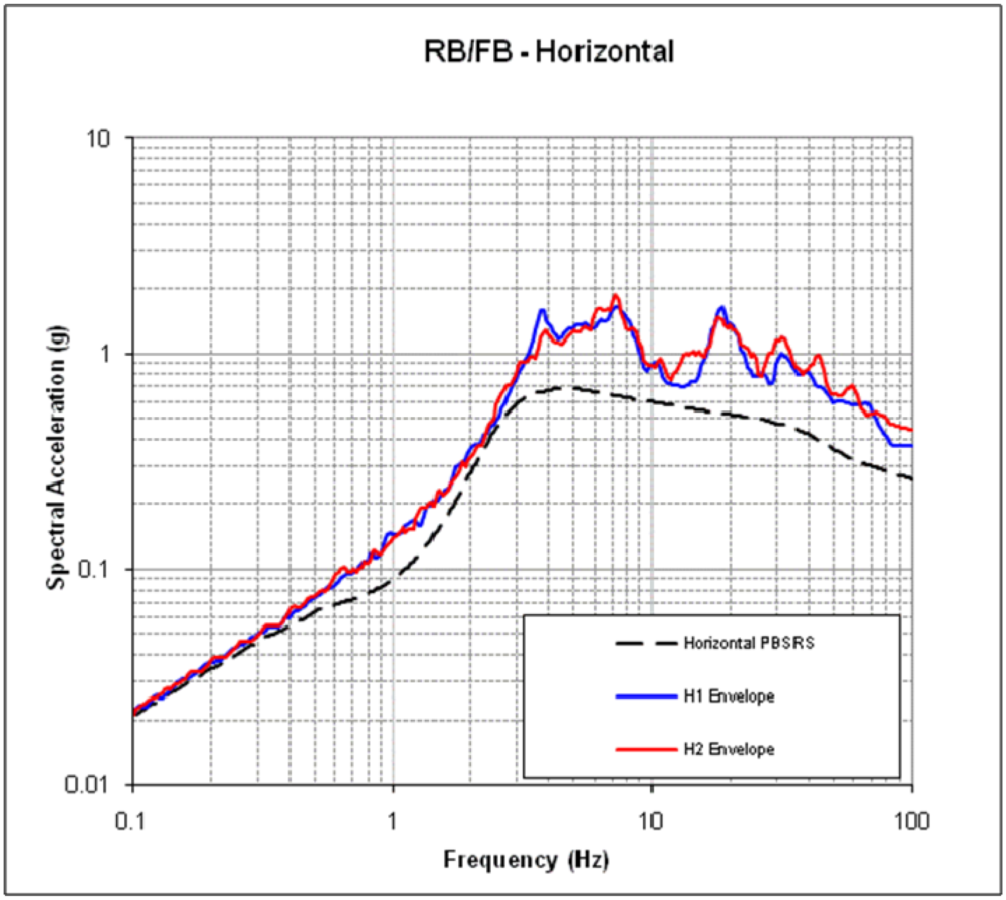


Figure 3.7.1-231 Comparison with Envelopes of the Response Spectra of Computed Horizontal Component Surface Motions for Full Soil Column Profiles Using the CB Enhanced SCOR FIRS Input Motions with the Horizontal PBSRS. [EF3 SUP 3.7-1]

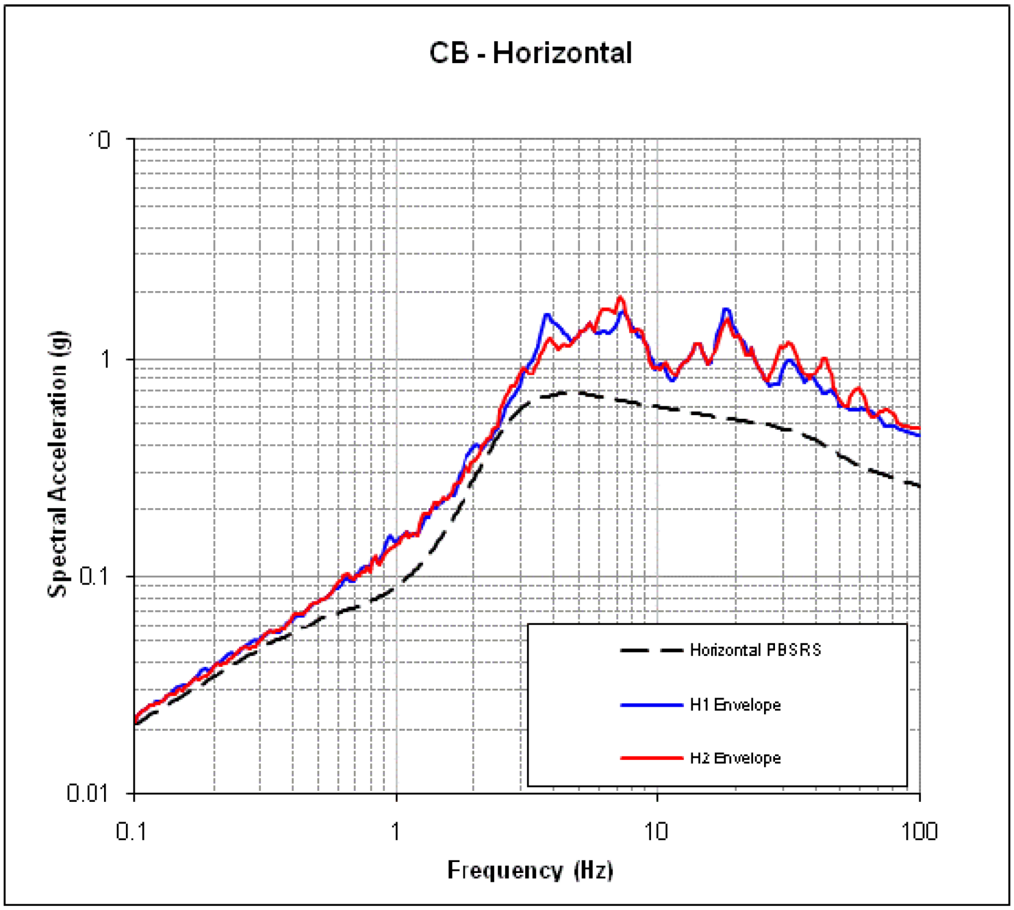


Figure 3.7.1-232 Fermi 3 Vertical RB/FB SCOR FIRS and Enhanced SCOR FIRS (5% Damping). [EF3 SUP 3.7-1]

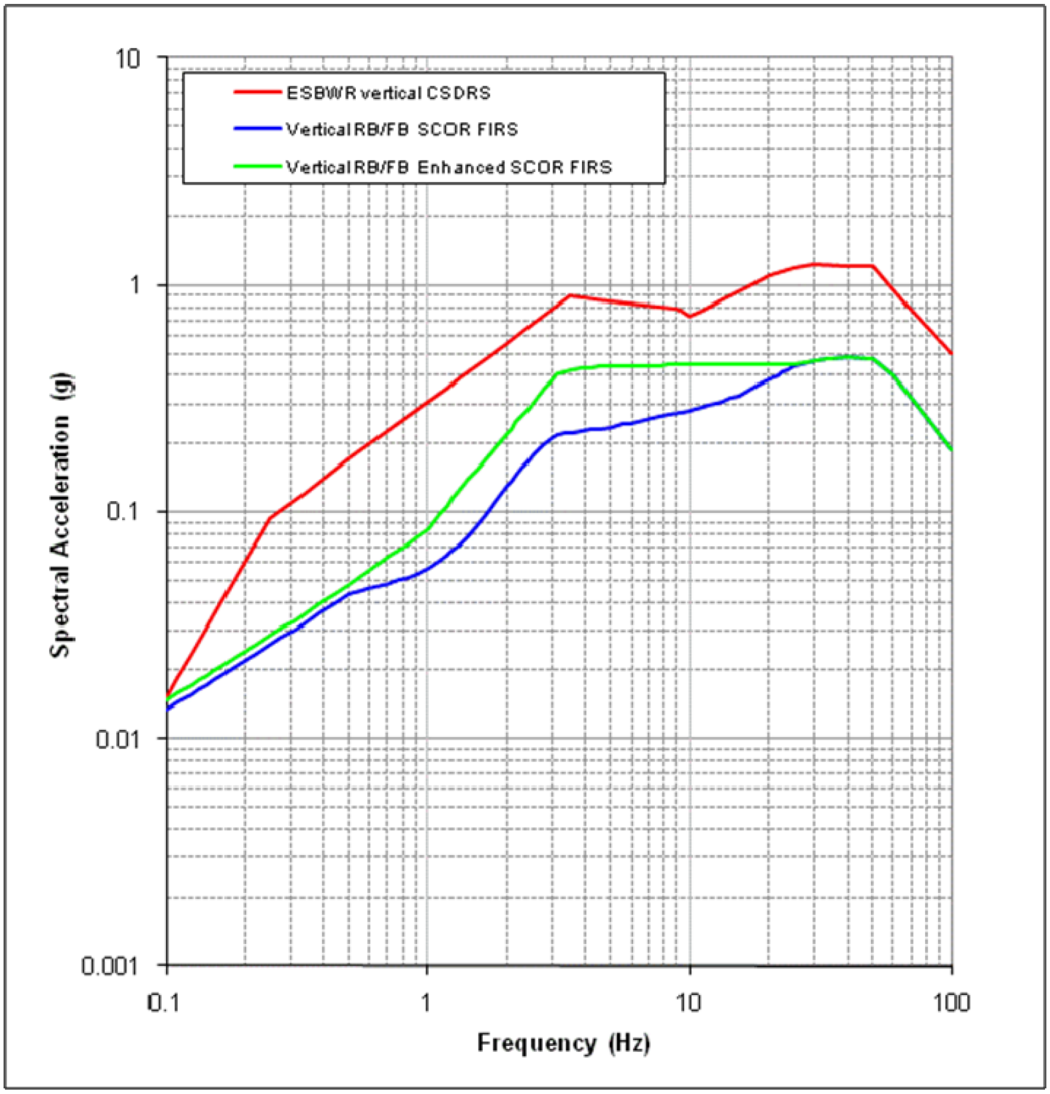


Figure 3.7.1-233 Fermi 3 Vertical CB SCOR FIRS and Enhanced SCOR FIRS (5% Damping). [EF3 SUP 3.7-1]

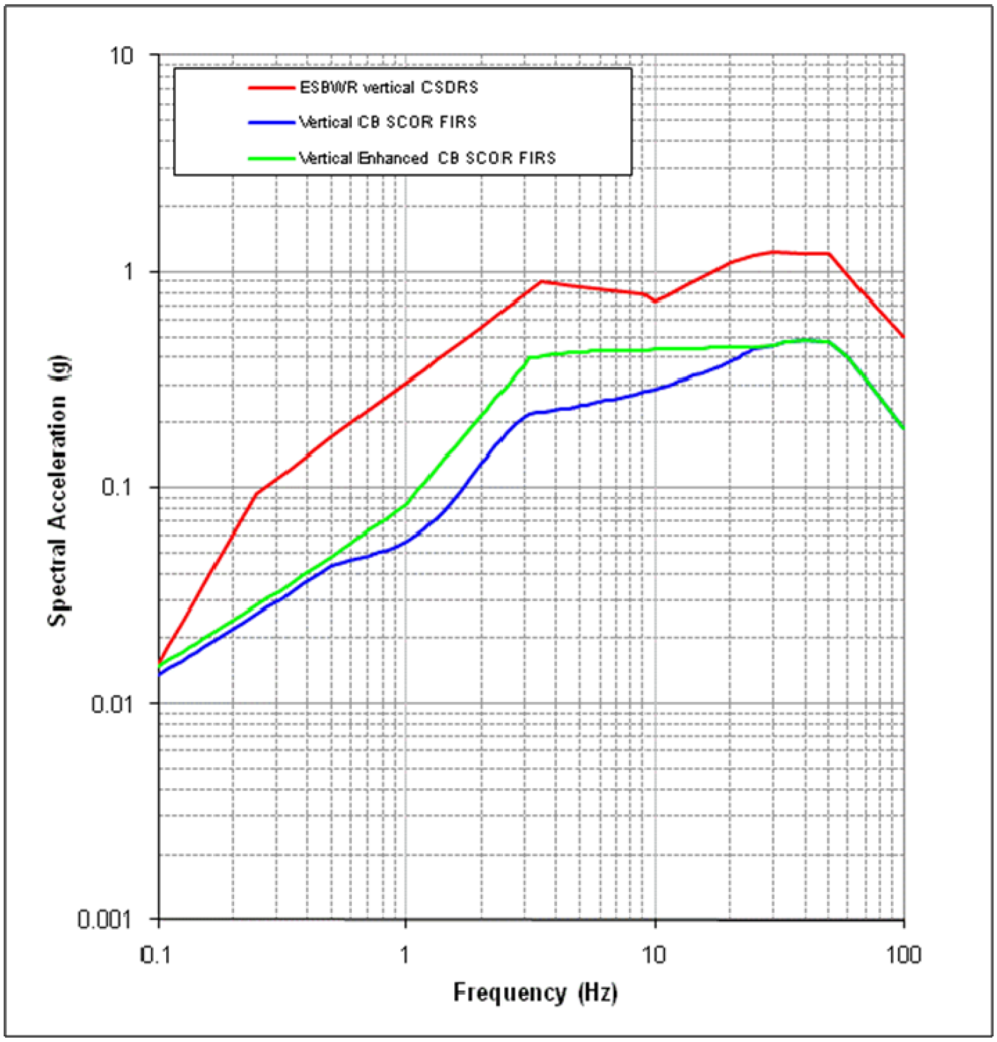


Figure 3.7.1-234 Comparison of the Envelope of the Response Spectra of Computed Vertical Component Surface Motions for Full Soil Column Profiles Using the RB/FB Enhanced SCOR FIRS Input Motions with the Vertical PBSRS. [EF3 SUP 3.7-1]

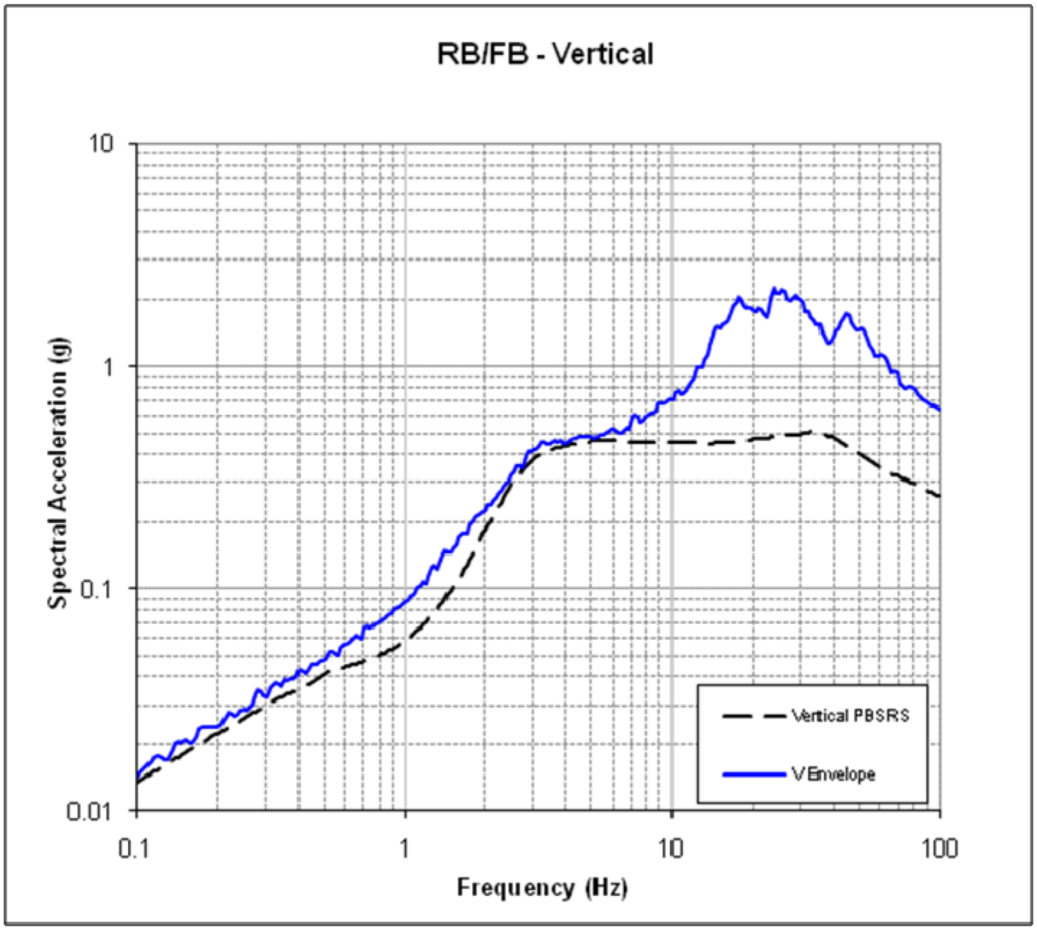


Figure 3.7.1-235 Comparison of the Envelope of the Response Spectra of Computed Vertical Component Surface Motions for Full Soil Column Profiles Using the CB Enhanced SCOR FIRS Input Motions with the Vertical PBSRS. [EF3 SUP 3.7-1]

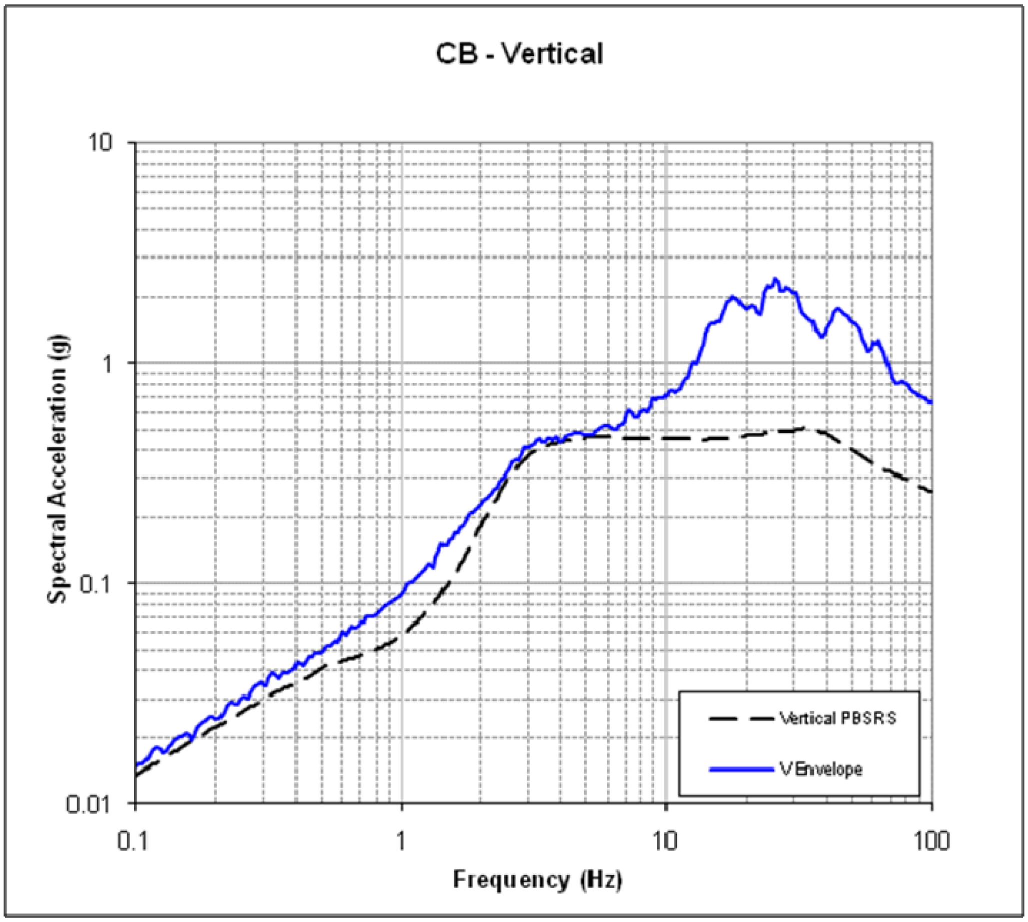


Figure 3.7.1-236 Development of Horizontal Fermi 3 SSI FIRS for the RB/FB [EF3 SUP 3.7-1]

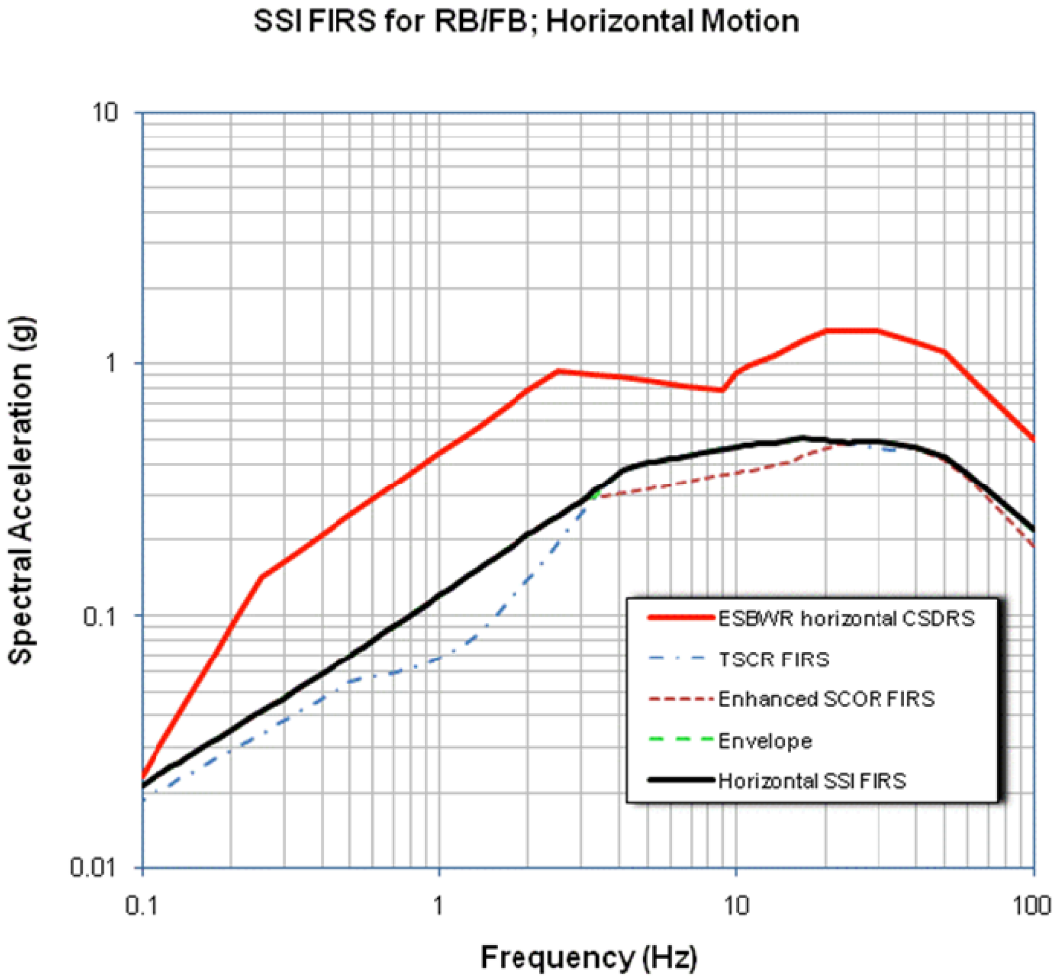


Figure 3.7.1-237 Development of Horizontal Fermi 3 SSI FIRS for the CB [EF3 SUP 3.7-1]

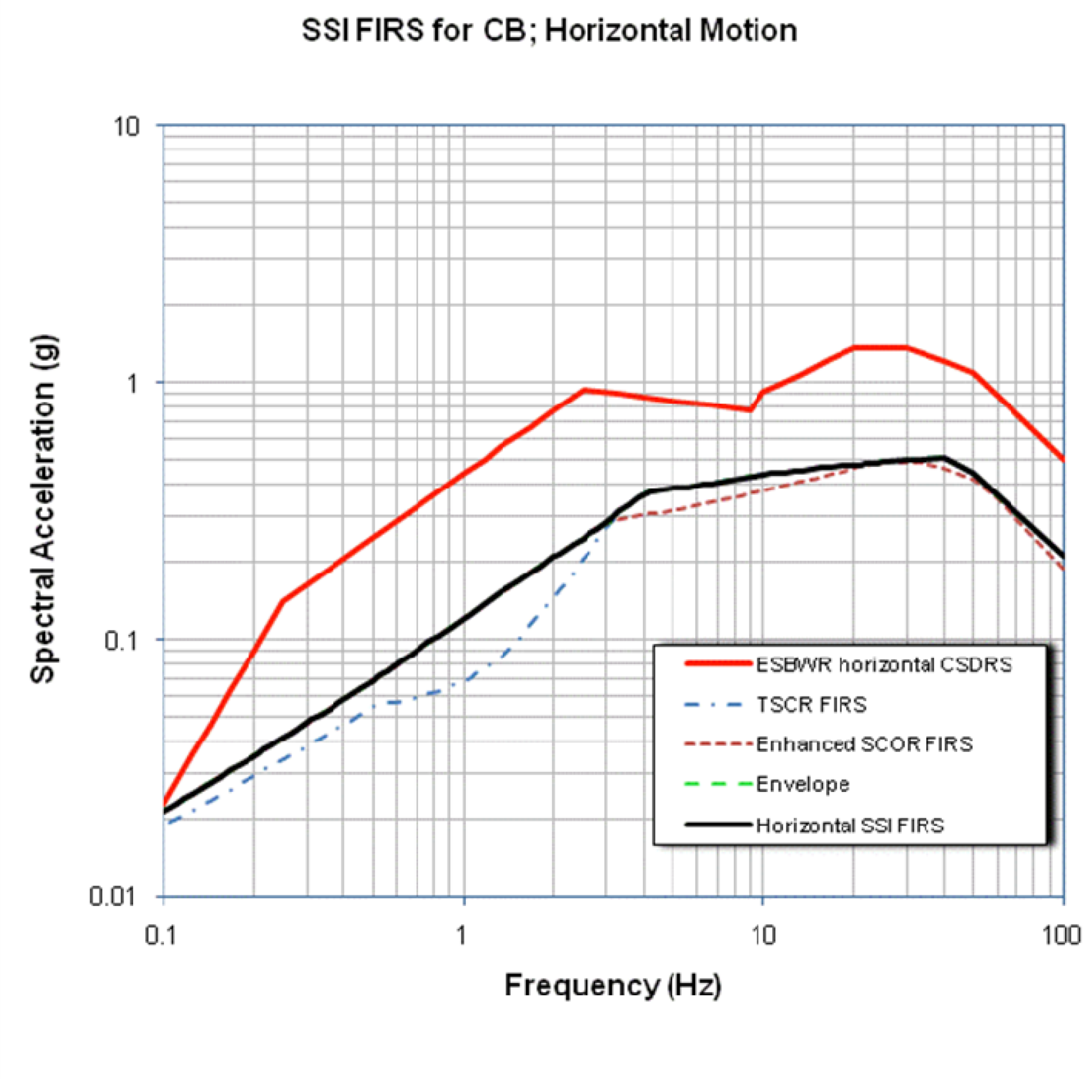


Figure 3.7.1-238 Development of Vertical Fermi 3 SSI FIRS for the RB/FB [EF3 SUP 3.7-1]

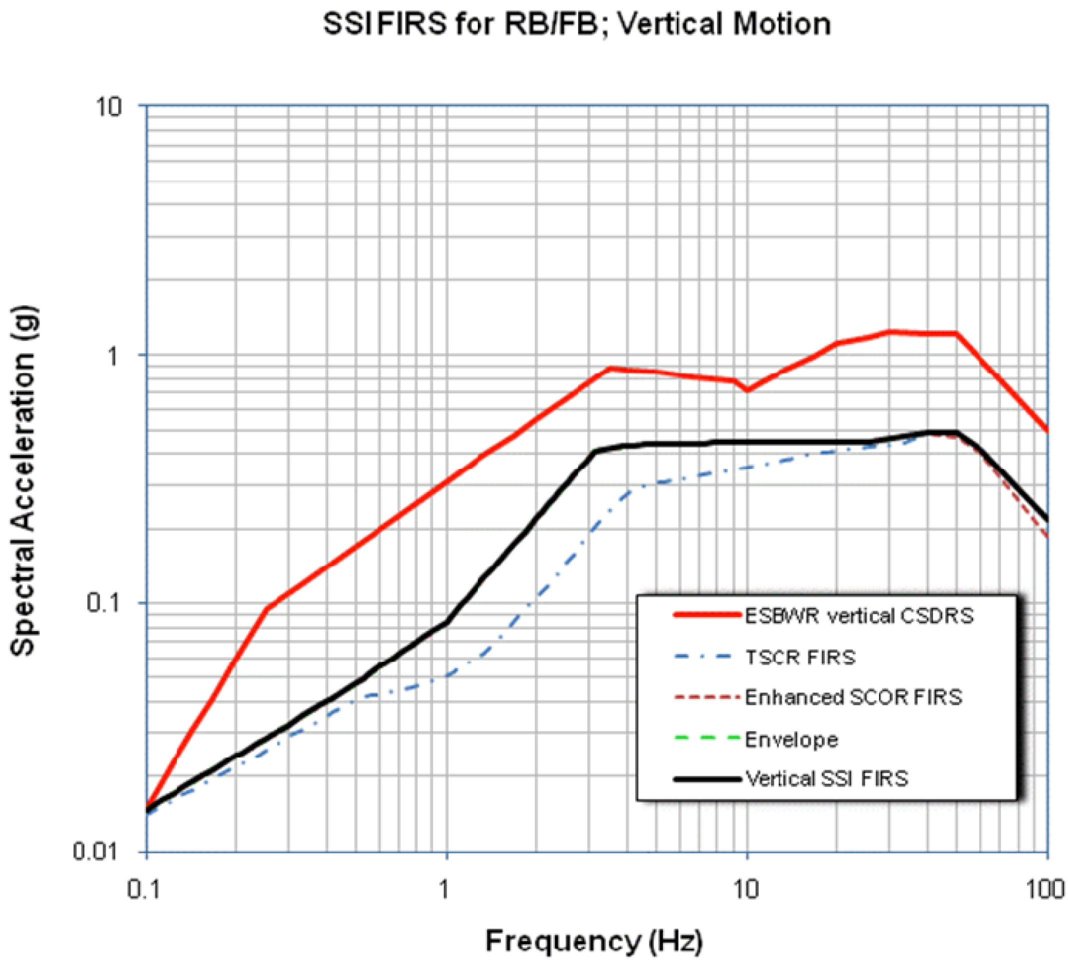


Figure 3.7.1-239 Development of Vertical Fermi 3 SSI FIRS for the CB [EF3 SUP 3.7-1]

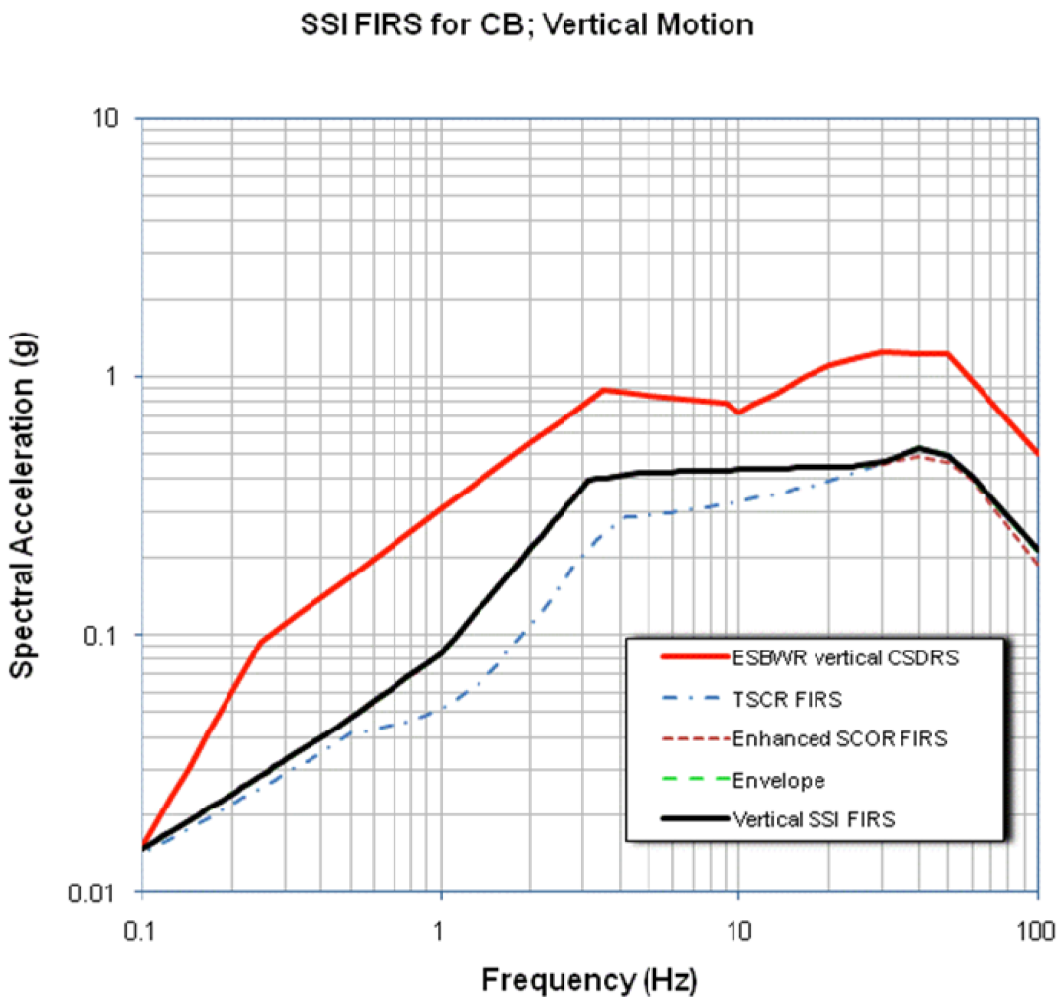


Figure 3.7.1-240 Horizontal and Vertical Fermi 3 SSI FIRS for the RB/FB [EF3 SUP 3.7-1]

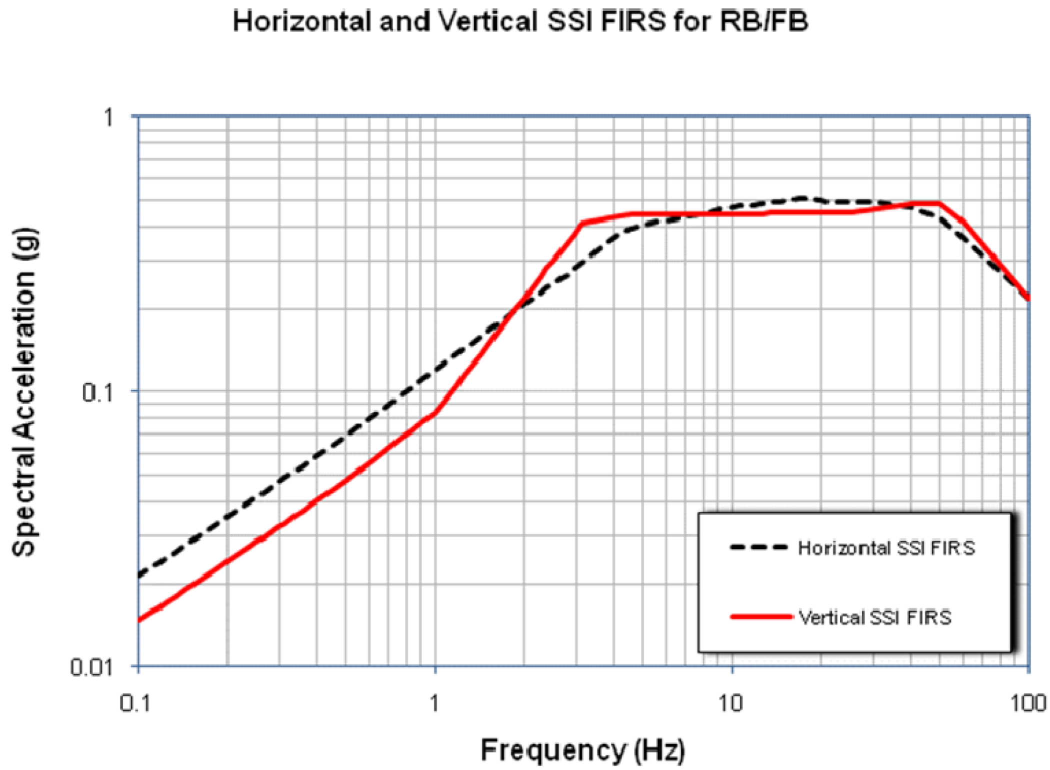


Figure 3.7.1-241 Horizontal and Vertical Fermi 3 SSI FIRS for the CB [EF3 SUP 3.7-1]

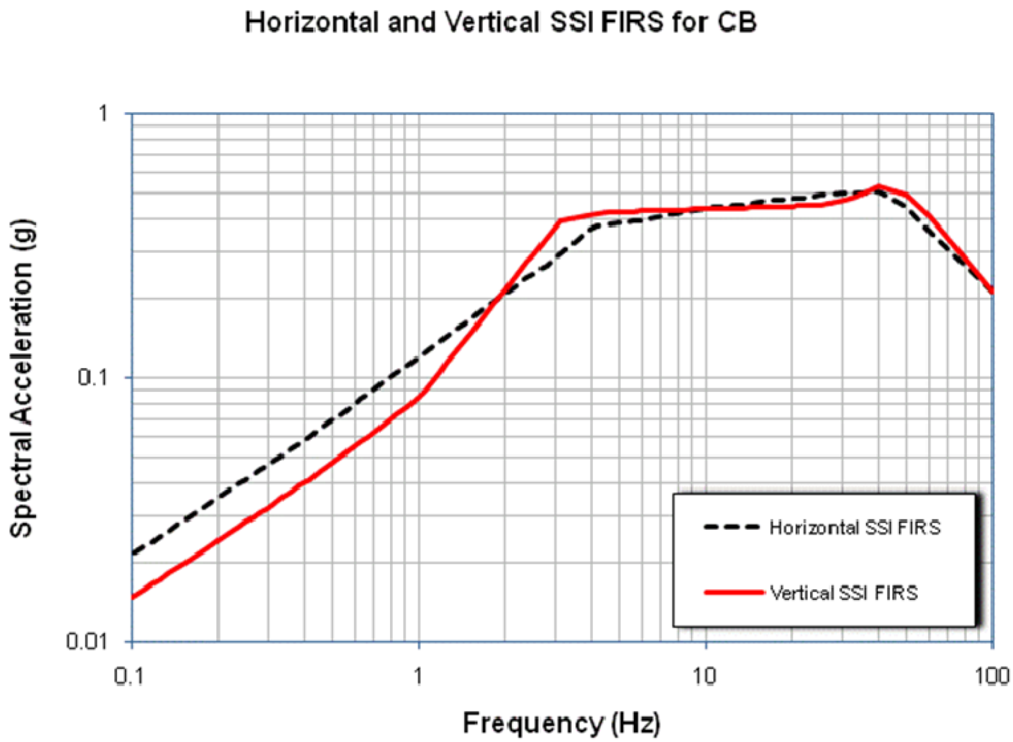


Figure 3.7.1-242 Response Spectrum for Spectrally Matched Horizontal (H1) Component for the Fermi 3 RB/FB SSI FIRS. [EF3 SUP 3.7-2]

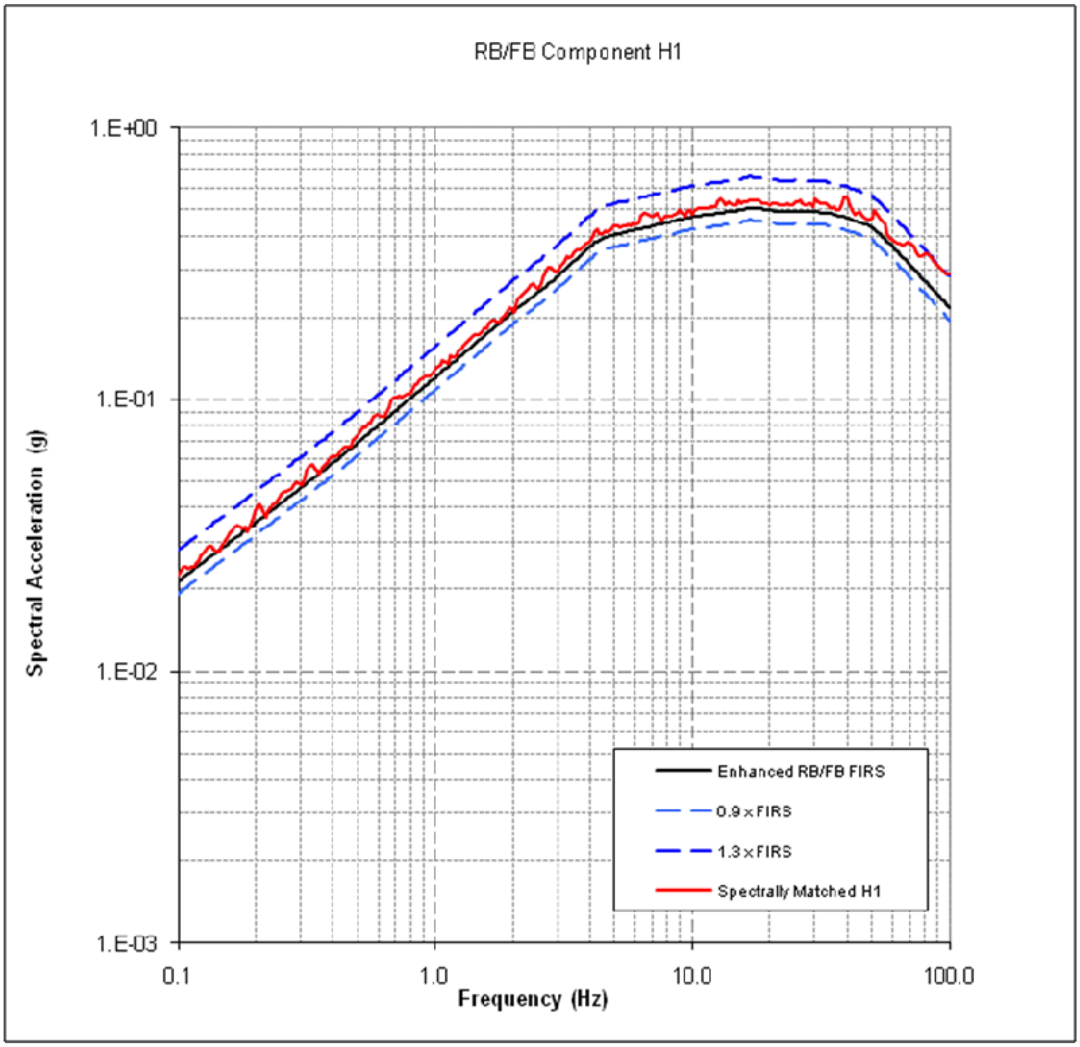


Figure 3.7.1-243 Response Spectrum for Spectrally Matched Horizontal (H2) Component for the Fermi 3 RB/FB SSI FIRS. [EF3 SUP 3.7-2]

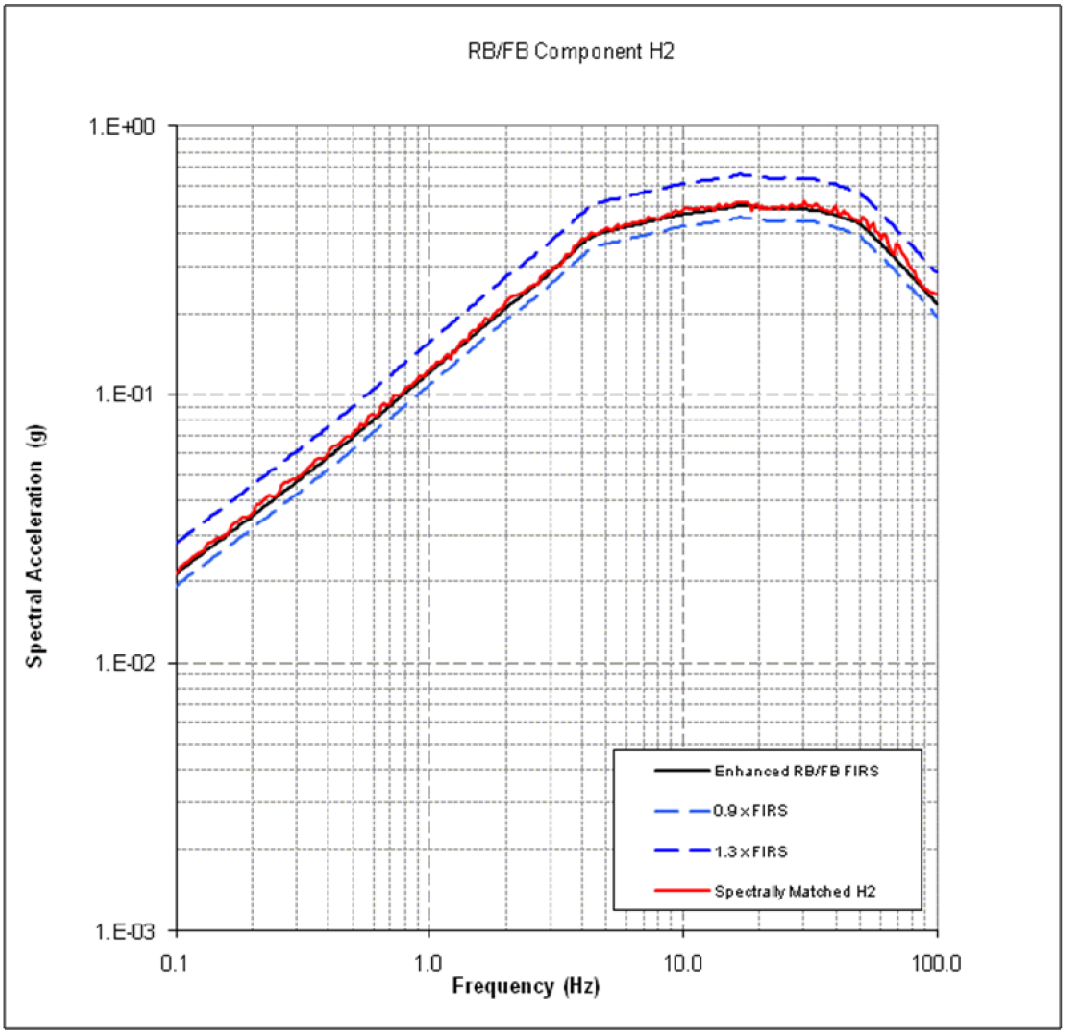


Figure 3.7.1-244 Response Spectrum for Spectrally Matched Vertical (V) Component for the Fermi 3 RB/FB SSI FIRS. [EF3 SUP 3.7-2]

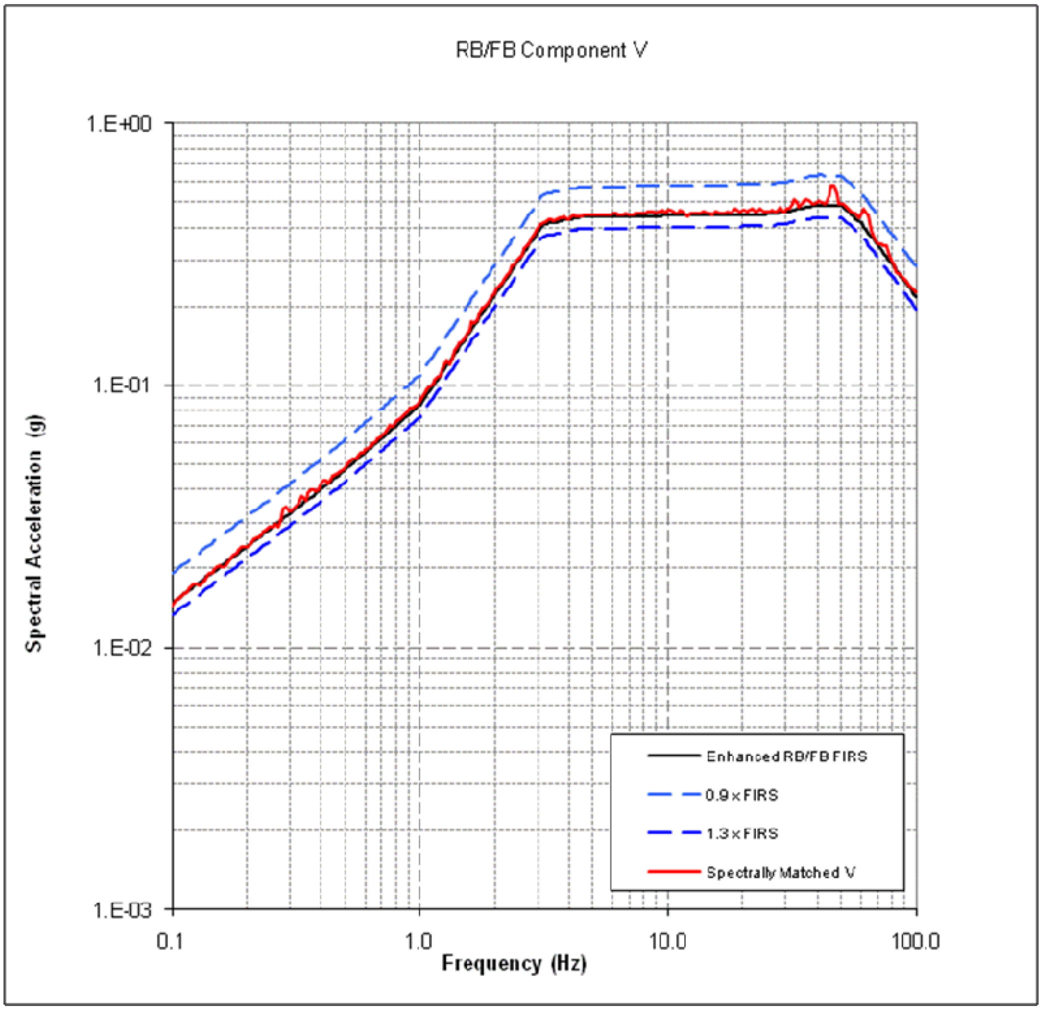


Figure 3.7.1-245 Response Spectrum for Spectrally Matched Horizontal (H1) Component for the Fermi 3 CB SSI FIRS.

[EF3 SUP 3.7-2]

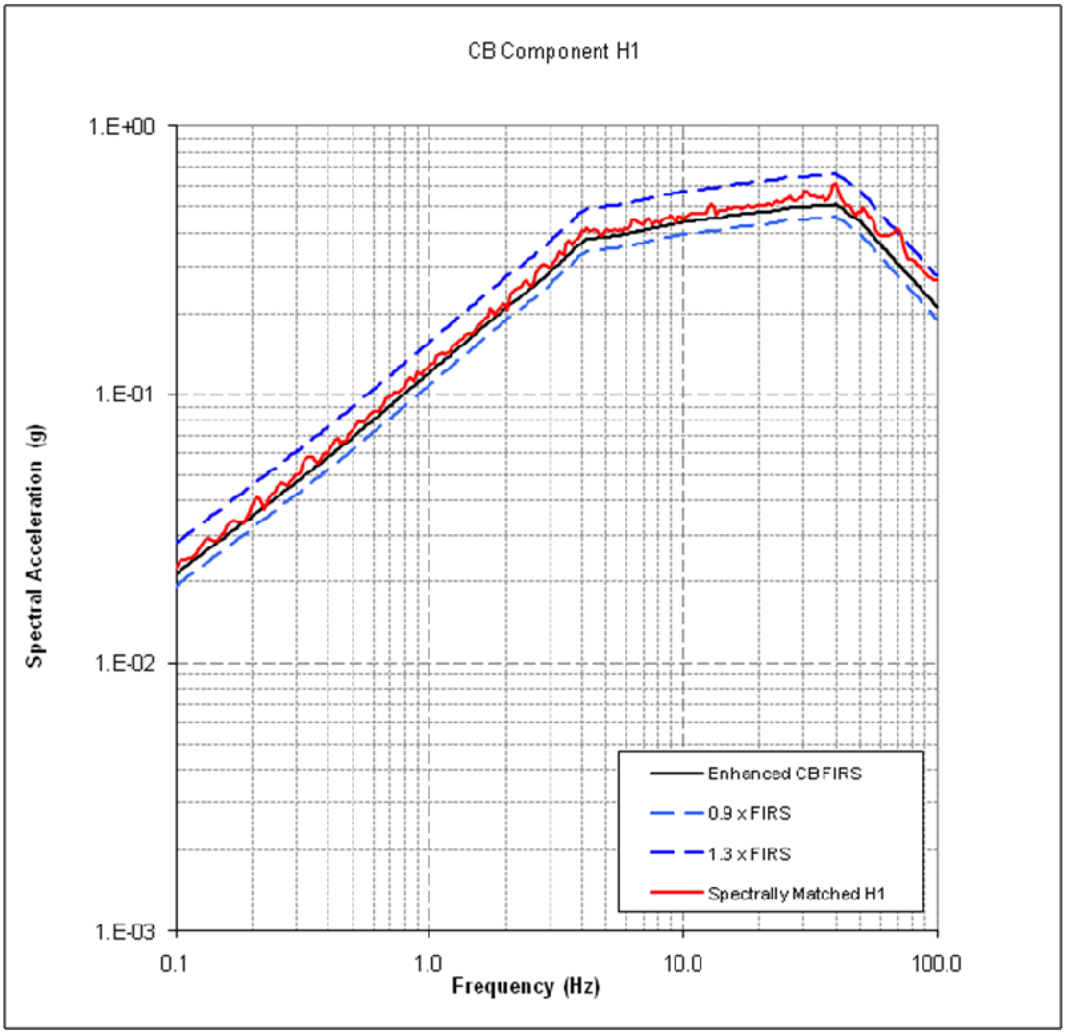


Figure 3.7.1-246 Response Spectrum for Spectrally Matched Horizontal (H2) Component for the Fermi 3 CB SSI FIRS.

[EF3 SUP 3.7-2]

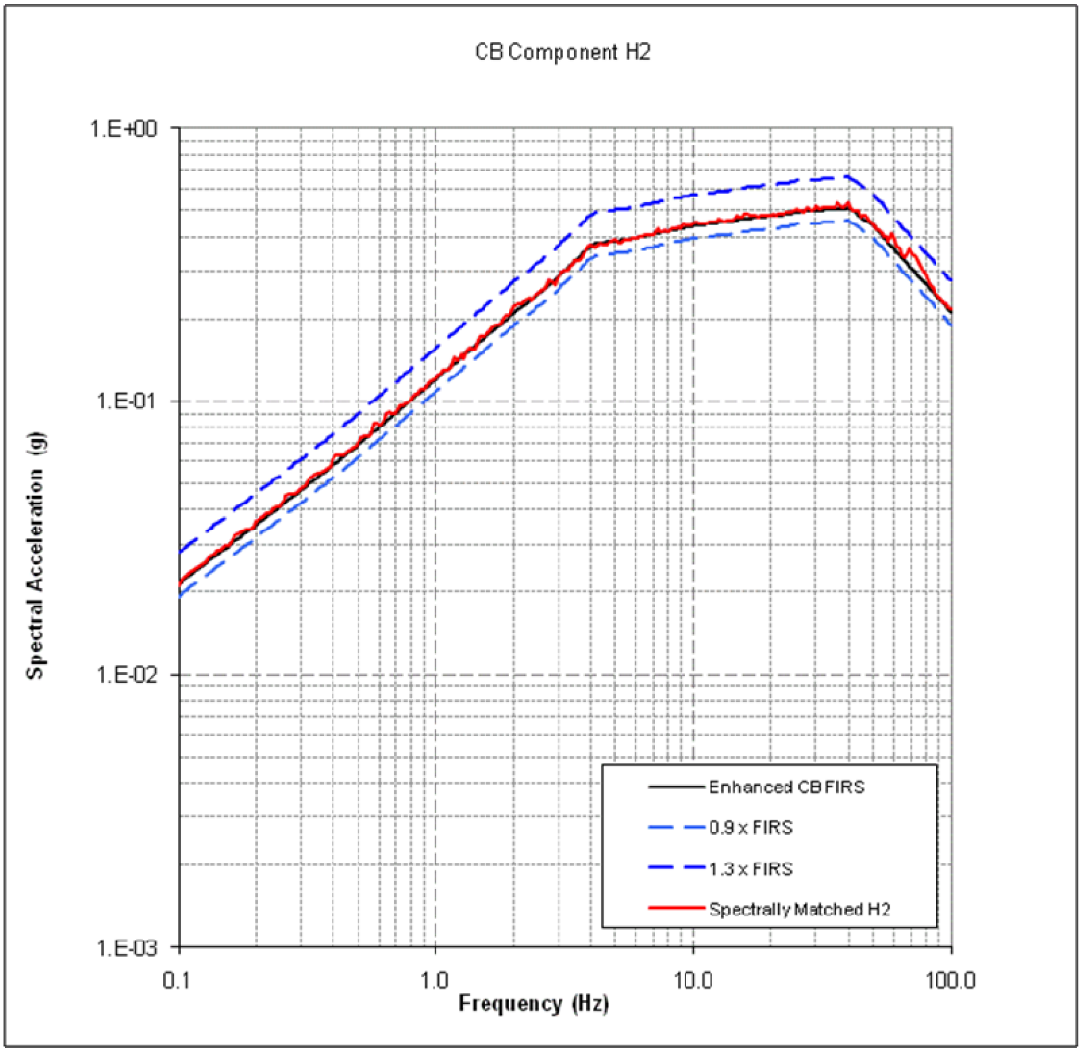


Figure 3.7.1-247 Response Spectrum for Spectrally Matched Vertical (V) Component for the Fermi 3 CB SSI FIRS.

[EF3 SUP 3.7-2]

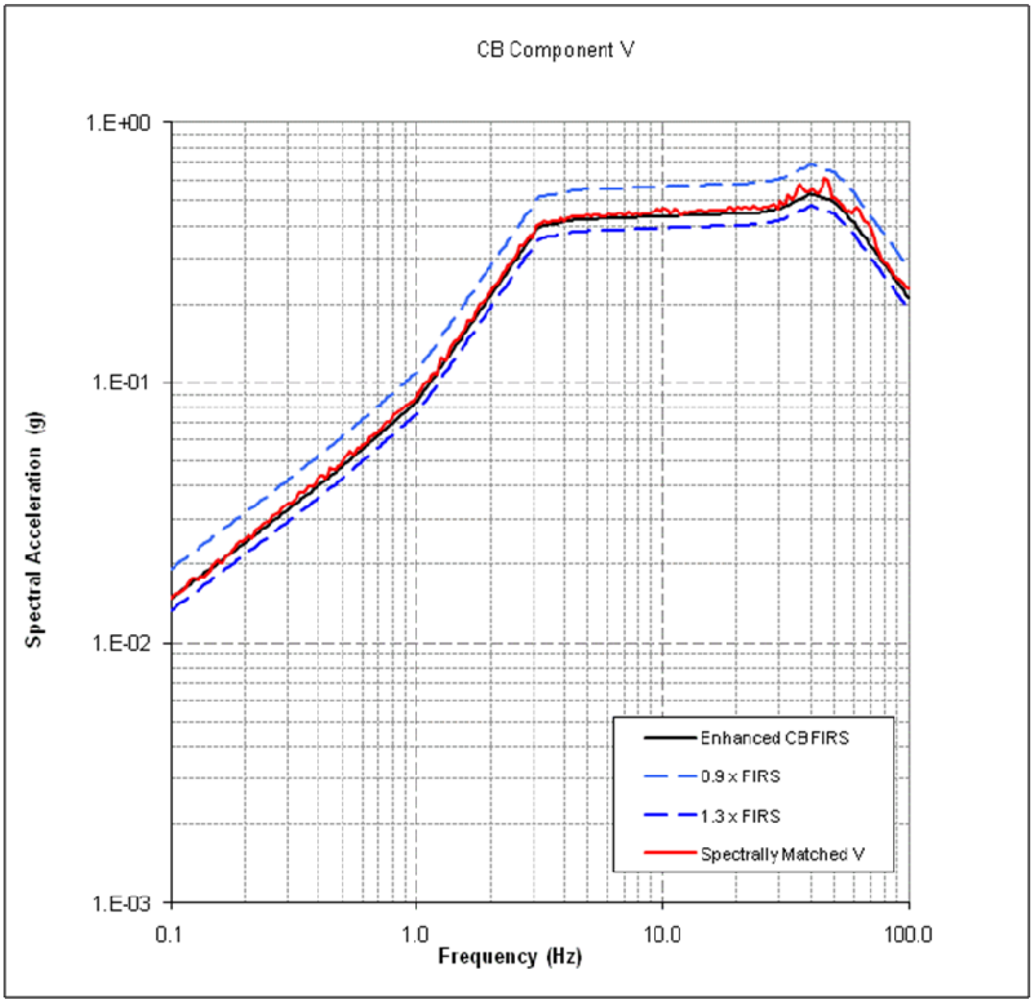


Figure 3.7.1-248 Acceleration, Velocity, and Displacement Time Histories for the SSI FIRS Horizontal (H1) Component Compatible with the RB/FB Horizontal SSI FIRS. [EF3 SUP 3.7-2]

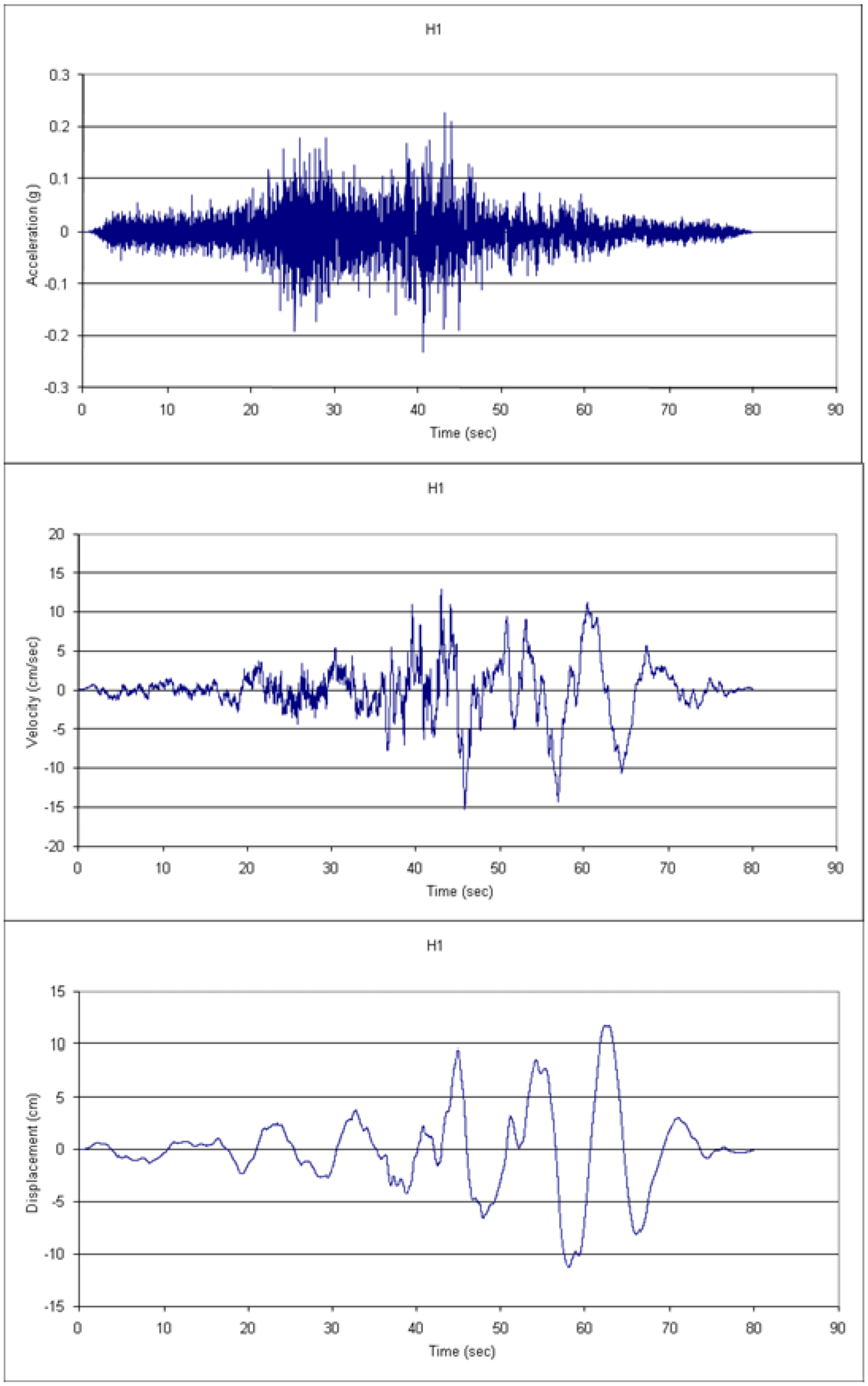


Figure 3.7.1-249 Acceleration, Velocity, and Displacement Time Histories for the SSI FIRS Horizontal (H2) Component Compatible with the RB/FB Horizontal SSI FIRS. [EF3 SUP 3.7-2]

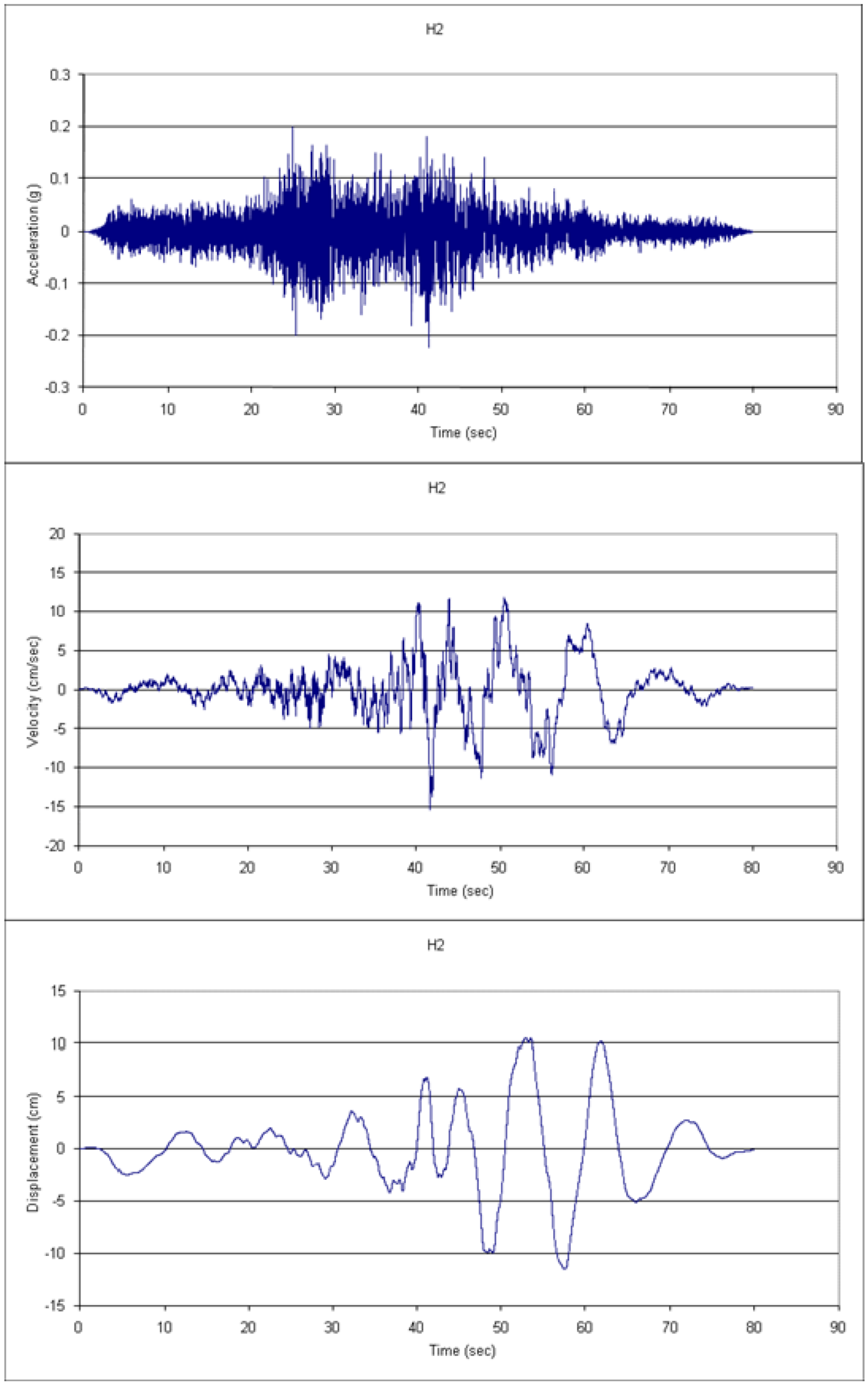


Figure 3.7.1-250 Acceleration, Velocity, and Displacement Time Histories for the SSI FIRS Vertical (V) Component Compatible with the RB/FB Vertical SSI FIRS [EF3 SUP 3.7-2]

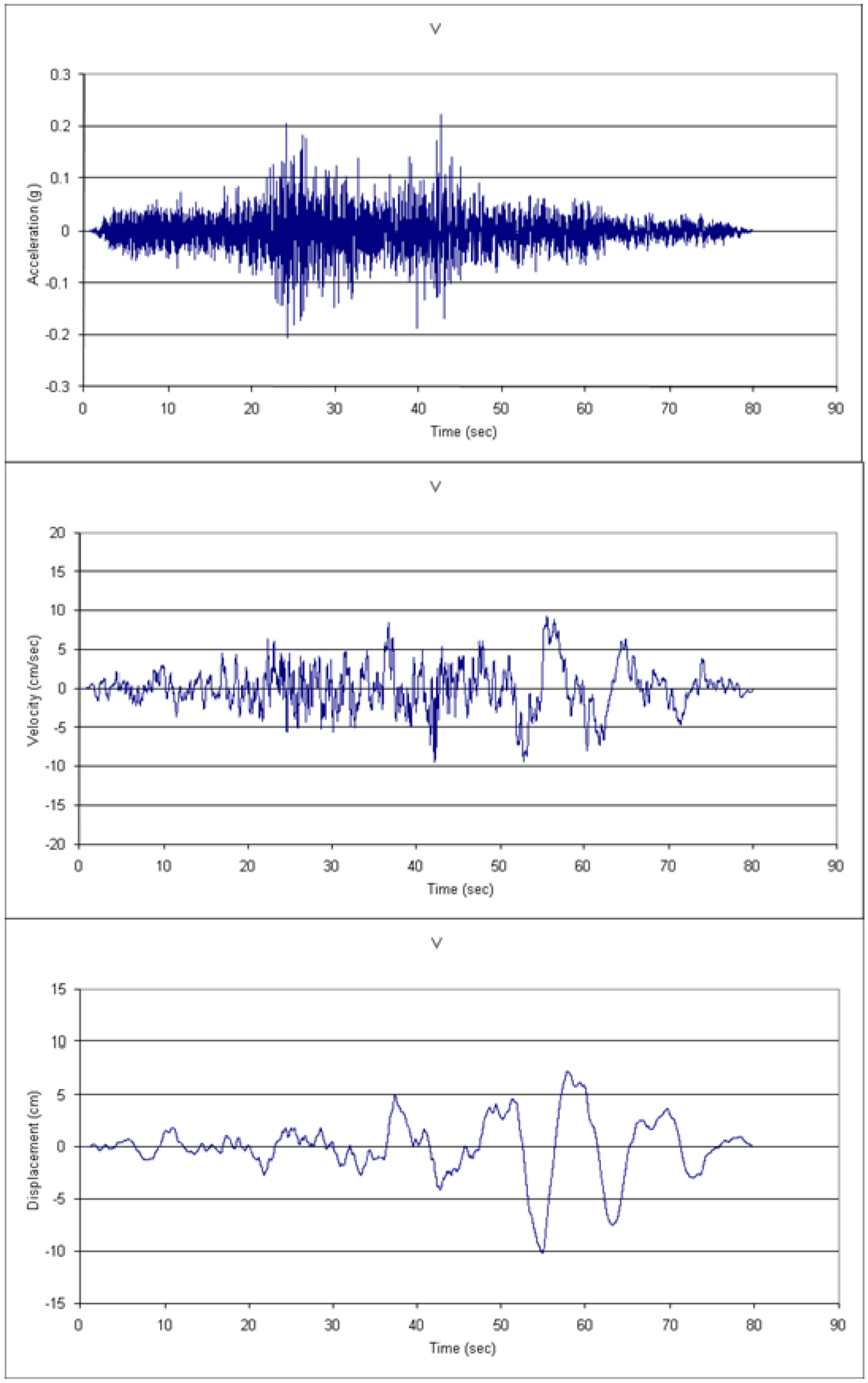


Figure 3.7.1-251 Acceleration, Velocity, and Displacement Time Histories for the SSI FIRS Horizontal (H1) Component Compatible with the CB Horizontal SSI FIRS. [EF3 SUP 3.7-2]

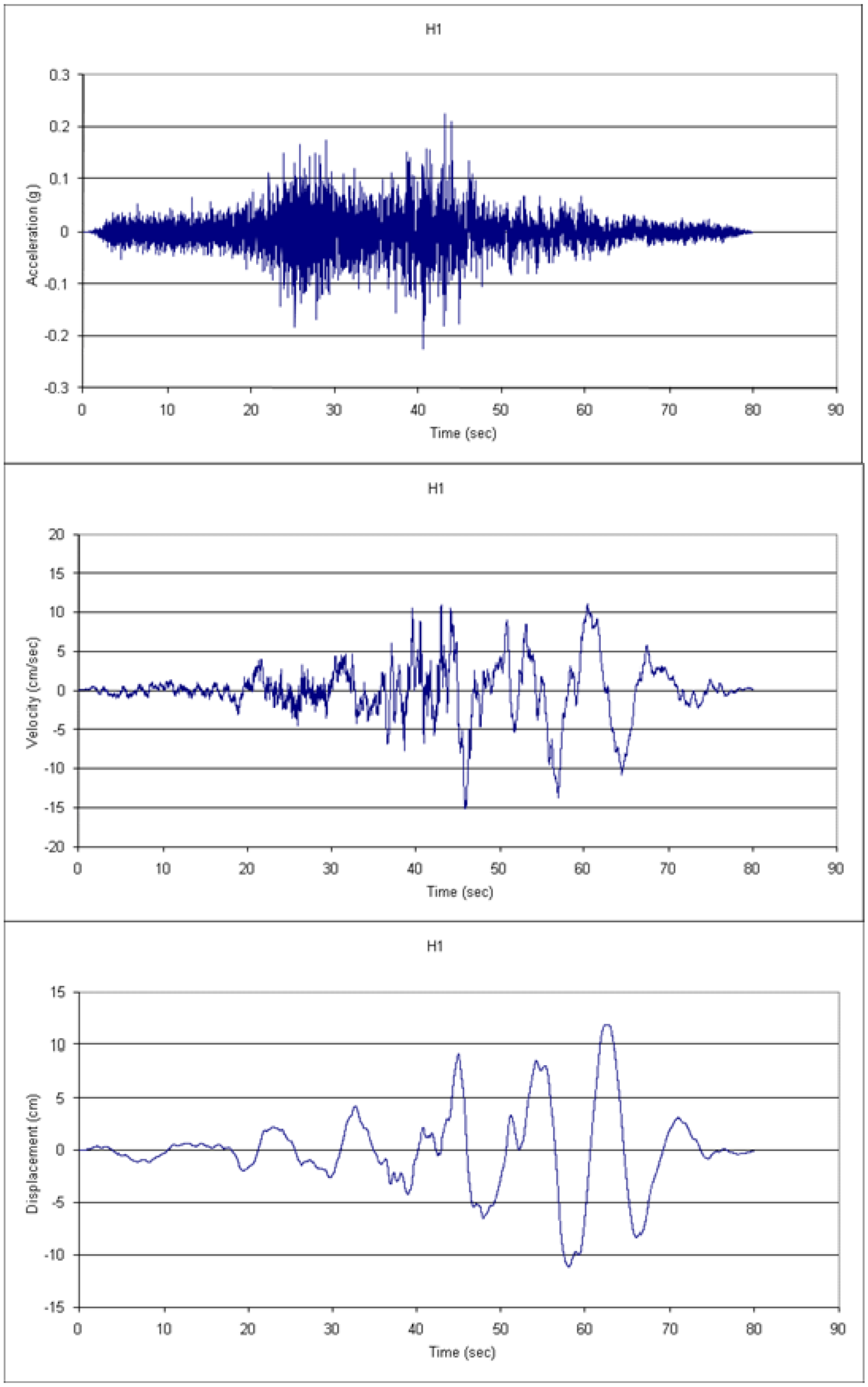


Figure 3.7.1-252 Acceleration, Velocity, and Displacement Time Histories for the SSI FIRS Horizontal (H2) Component Compatible with the CB Horizontal SSI FIRS. [EF3 SUP 3.7-2]

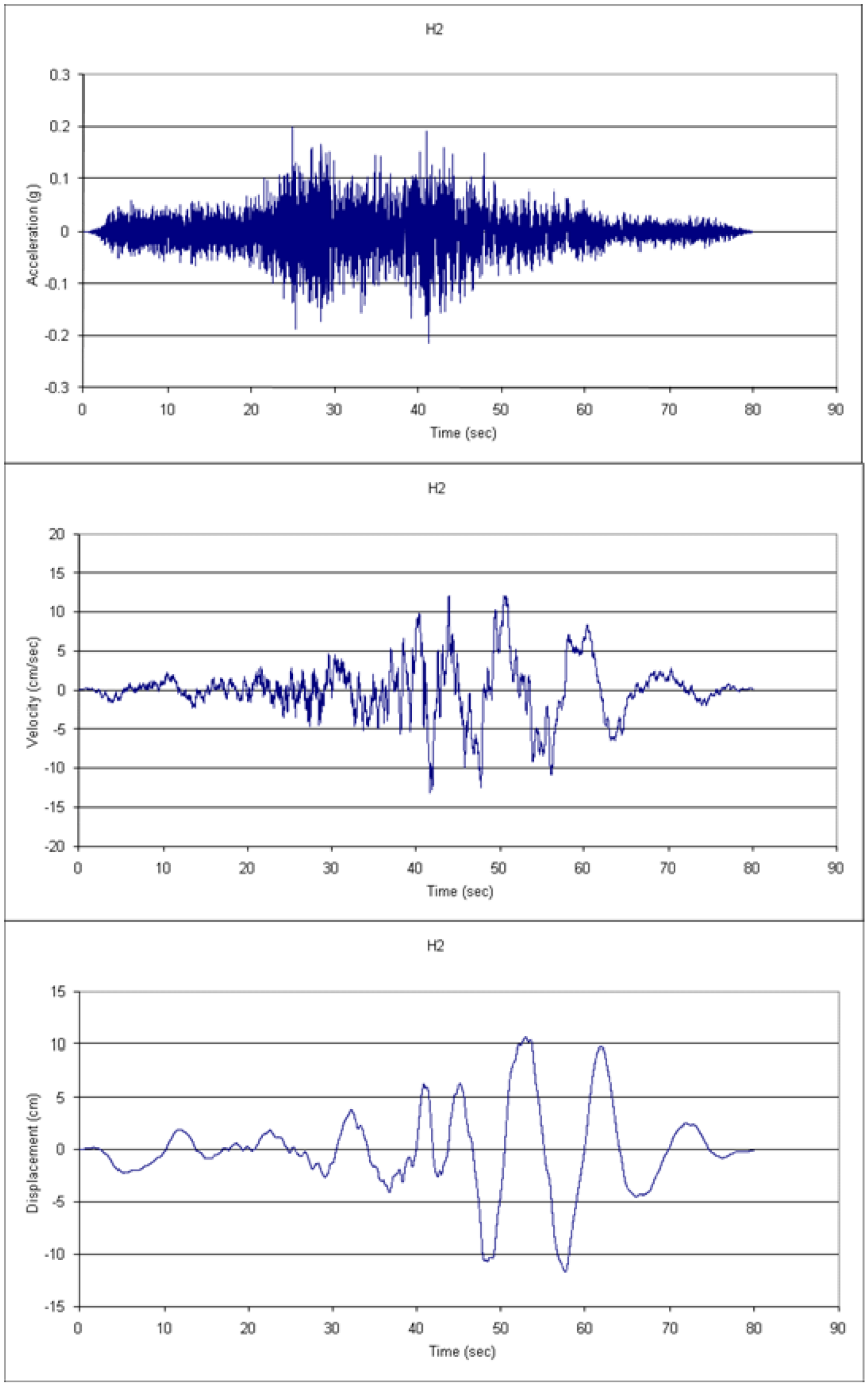


Figure 3.7.1-253 Acceleration, Velocity and Displacement Time Histories for the SSI FIRS Vertical (V) Component Compatible with the CB Vertical SSI FIRS [EF3 SUP 3.7-2]

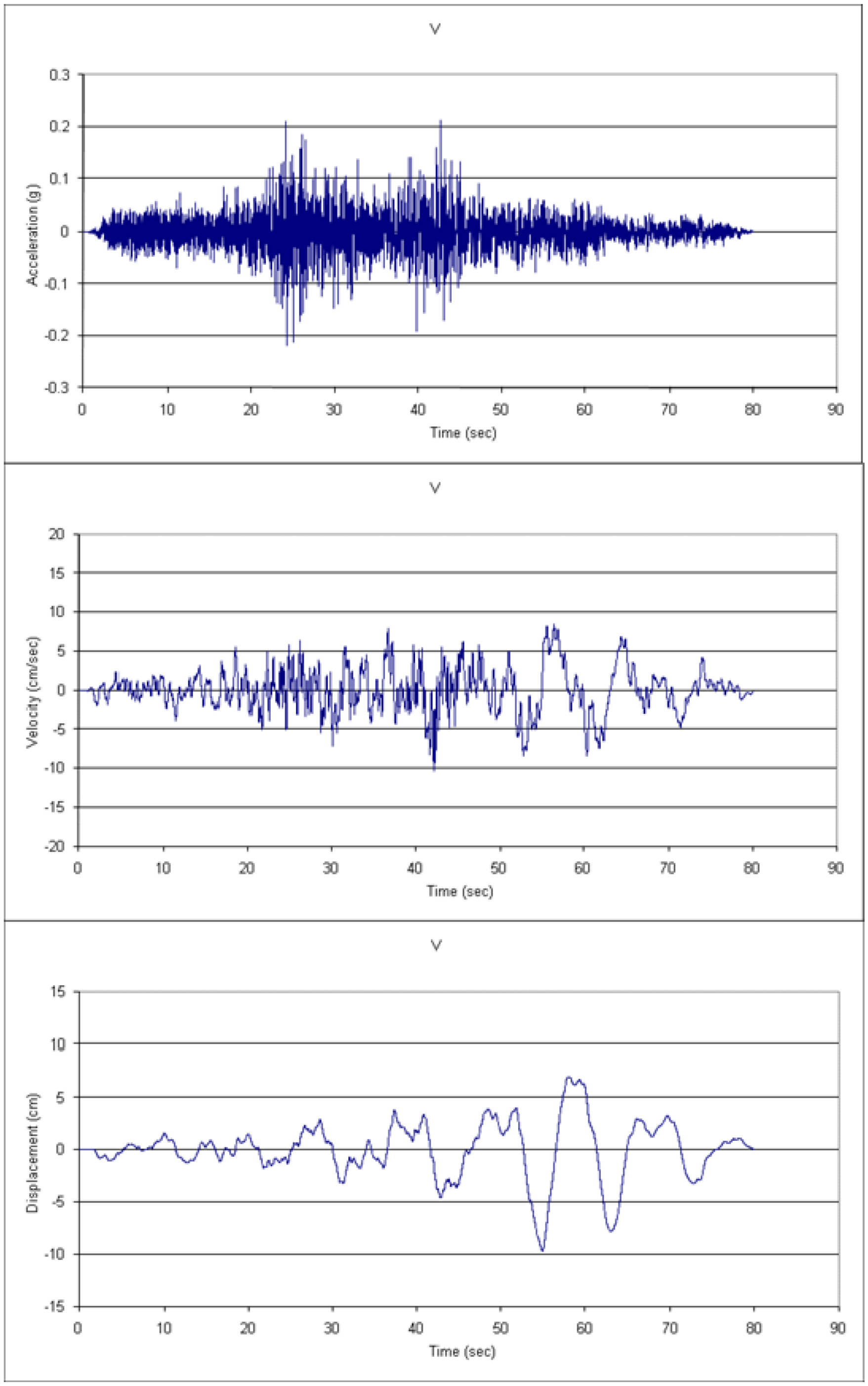


Figure 3.7.1-254 Comparison of the Envelope of the Response Spectra of Computed Horizontal (H1 and H2) Component Surface Motions Using the RB/FB SSI FIRS Input Motion with the Horizontal PBSRS [EF3 SUP 3.7-2]

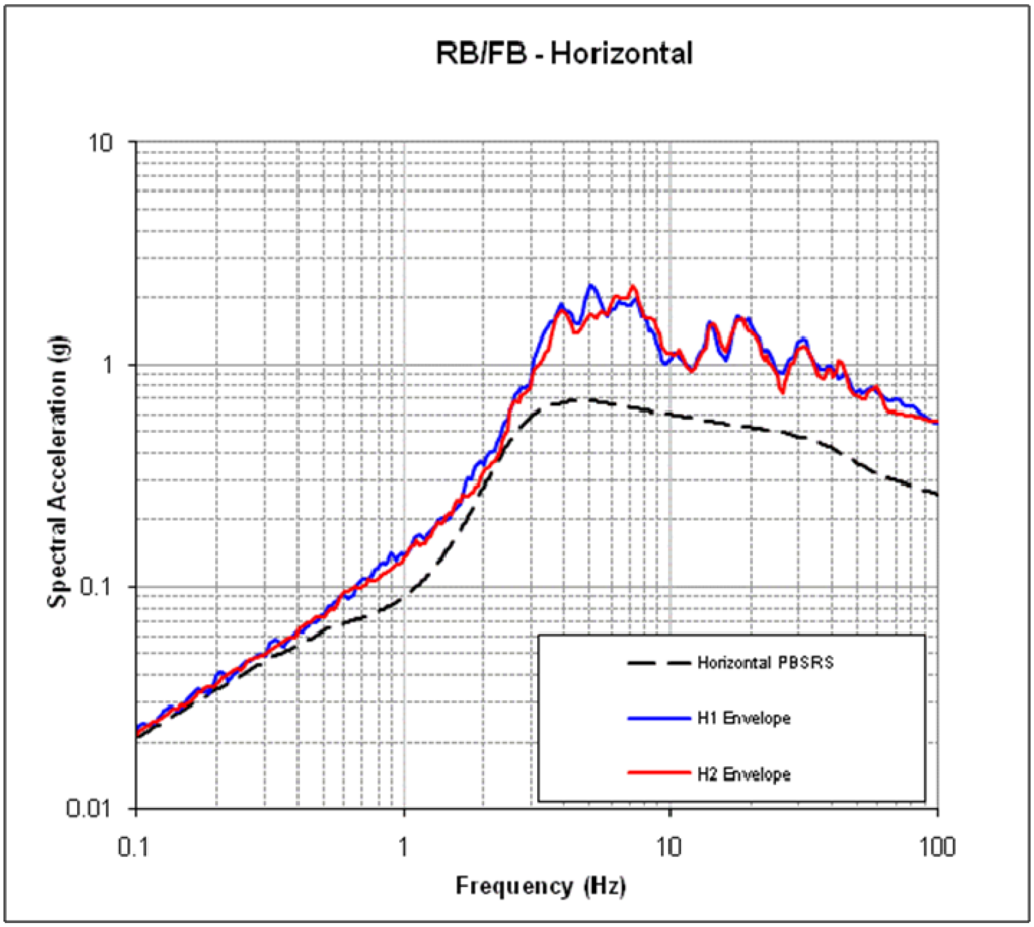


Figure 3.7.1-255 Comparison of the Envelope of the Response Spectra of Computed Vertical (V) Component Surface Motions Using the RB/FB SSI FIRS Input Motion with the Vertical PBSRS [EF3 SUP 3.7-2]

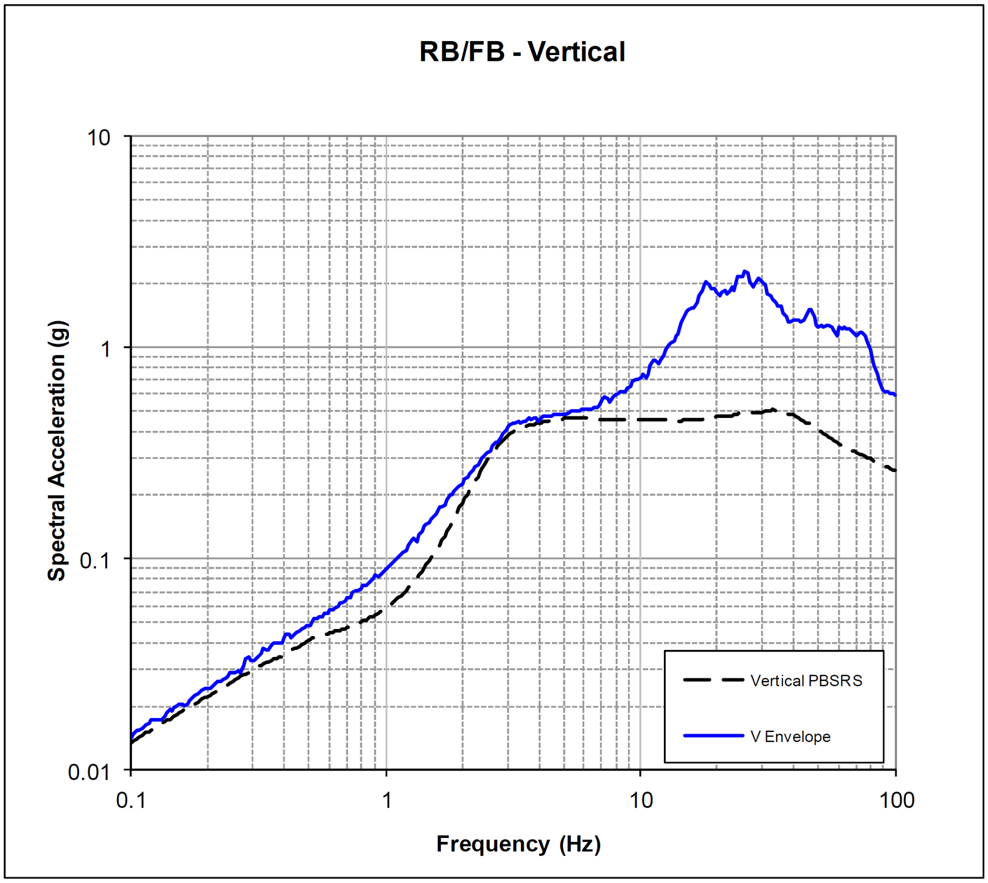


Figure 3.7.1-256 Comparison of the Envelope of the Response Spectra of Computed Horizontal (H1 and H2) Component Surface Motions Using the CB SSI FIRS Input Motion with the Horizontal PBSRS [EF3 SUP 3.7-2]

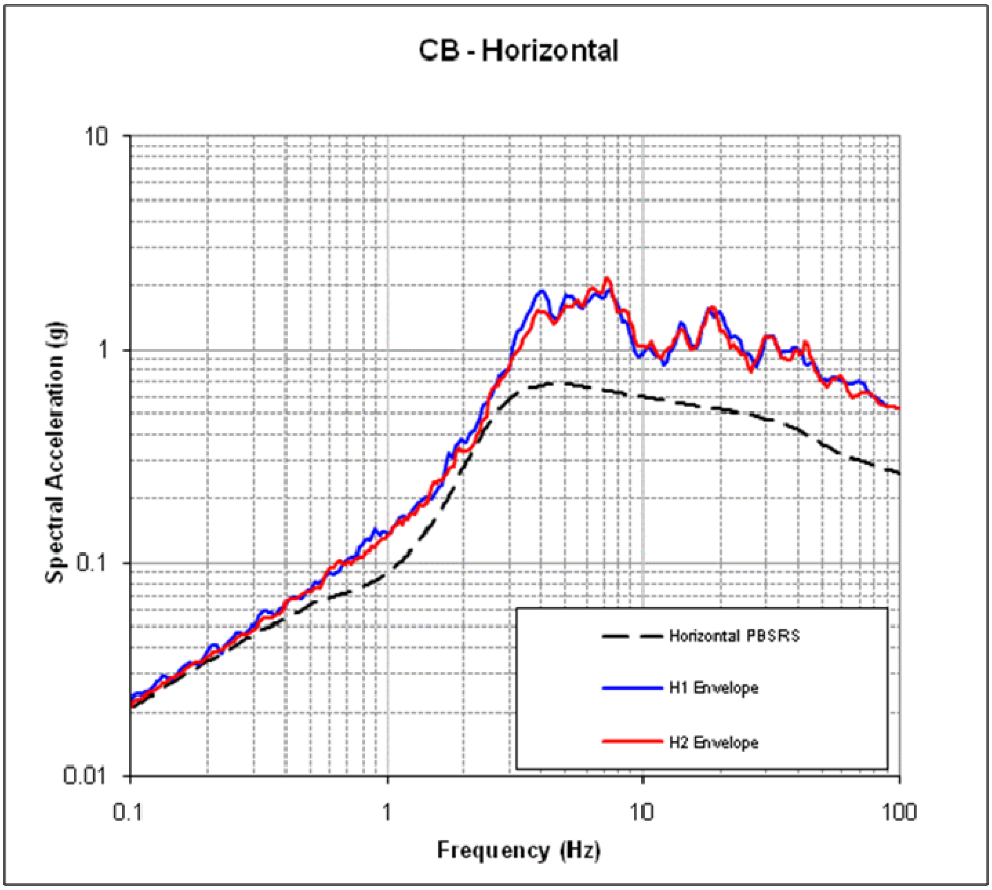


Figure 3.7.1-257 Comparison of the Envelope of the Response Spectra of Computed Vertical (V) Component Surface Motions Using the CB SSI FIRS Input Motion with the Vertical PBSRS [EF3 SUP 3.7-2]

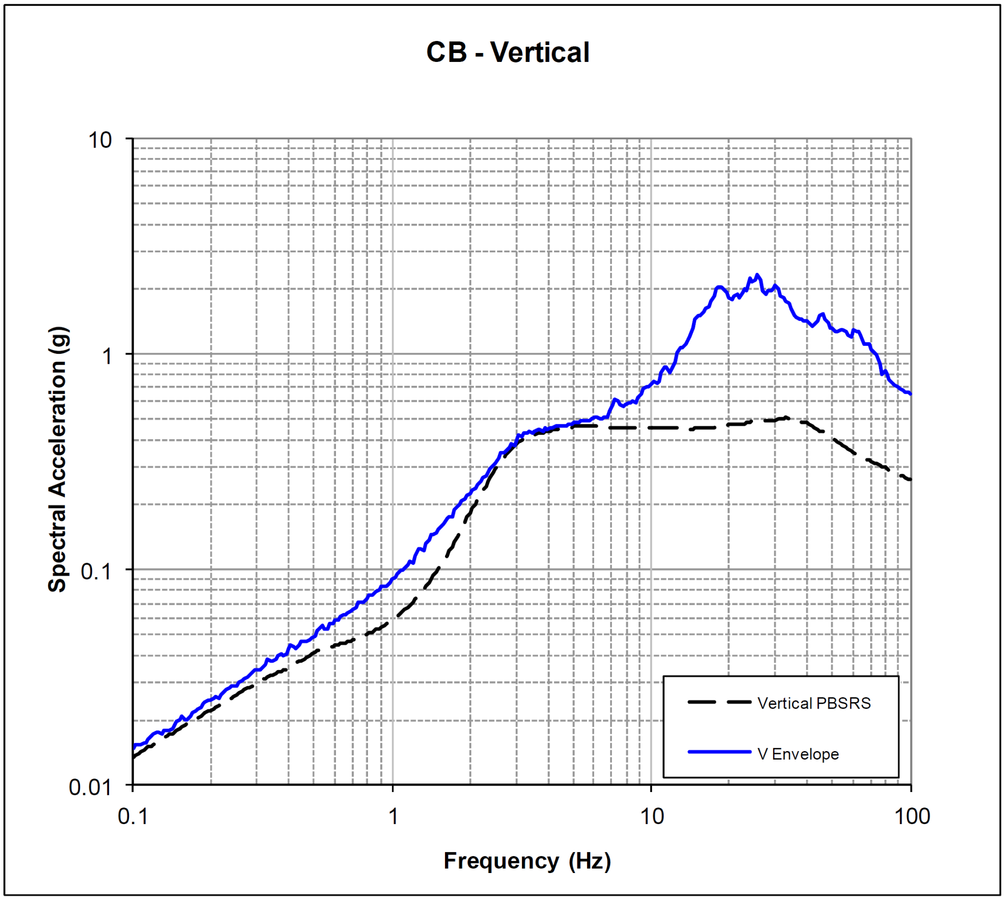


Figure 3.7.1-258 Lower Bound, Best Estimate and Upper Bound Shear Wave Velocity Profiles for the Fermi 3 Site-Specific SSI Analyses [EF3 SUP 3.7-2]

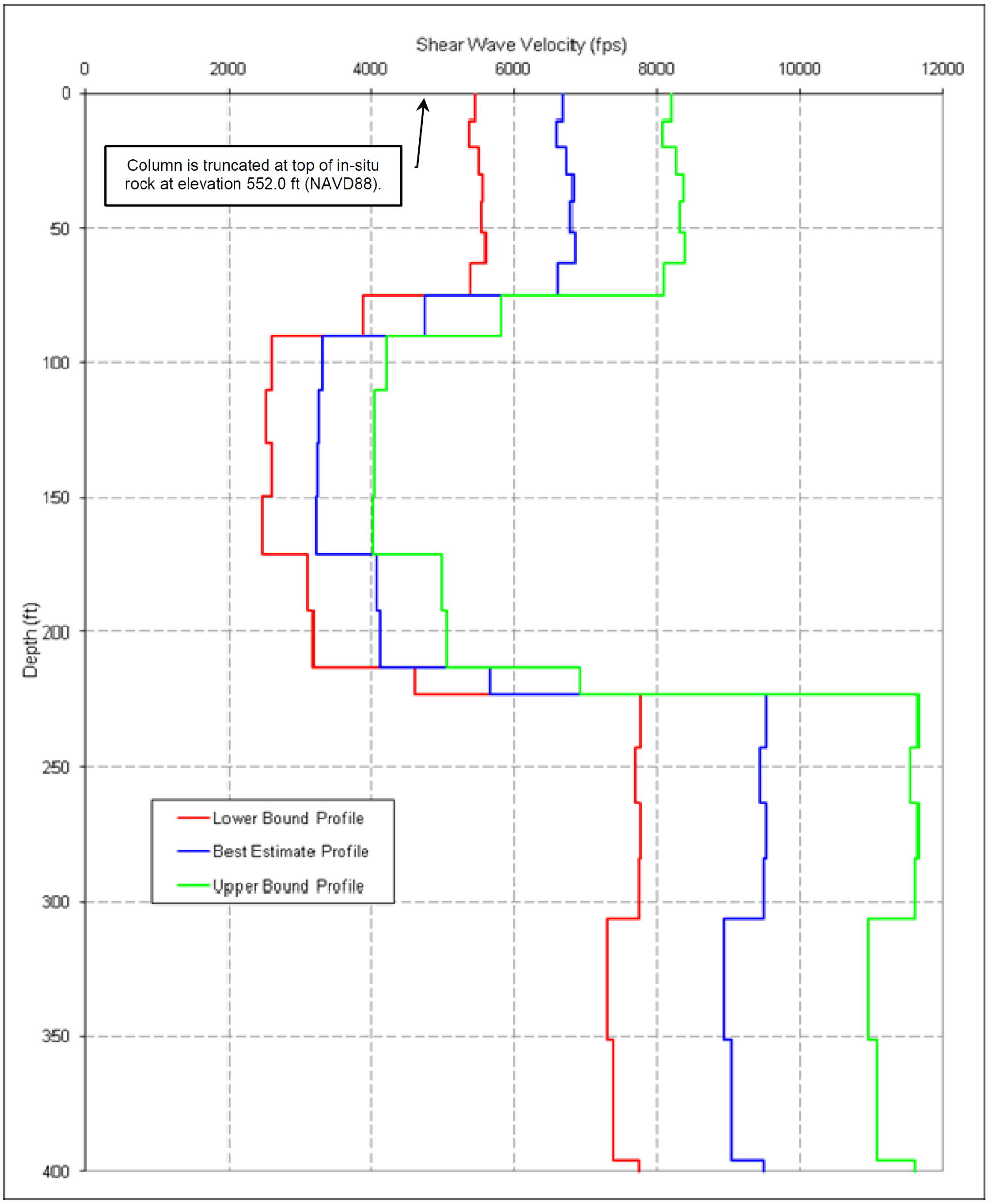


Figure 3.7.1-259 Comparison of Fermi 3 RB/FB and CB SSI FIRS with the NUREG/CR-0098 (Reference 3.7.1-210) median rock spectral shape and enveloping NUREG/CR-6728 (Reference 2.5.2-255) CEUS spectral shape, both scaled to a minimum PGA of 0.1g. All spectra are for 5% damping. [EF3 SUP 3.7-2]