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

3.1 Conformance with NRC General Design Criteria

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

3.1.1.5 Criterion 5 - Sharing of Structures, Systems, and Components

VCS SUP 3.1-1

Add the following paragraph at the end of this section.

VCS is a dual unit plant. No structures, systems, or components important to safety are shared between Units 1 and 2. The requirements of Criterion 5 are met.

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.

Table 3.2-1 Classification Summary

Replace the note for System P73 with the following.

STD CDI

The site-specific plant design includes the Hydrogen Water Chemistry System (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.

VCS SUP 3.5-3 Delete the entire second sentence beginning with: “The site proximity missile has. . .”

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 the following departures and/or supplements.

3.6.2.5 Pipe Break Analysis Results and Protection Methods

Replace the first sentence with the following.

STD COL 3.6.5-1-A The pipe break evaluation report will be completed in conjunction with closure of ITAAC 3.1-1, Item 3. This information will be included in the FSAR as part of a subsequent FSAR update. The pipe break evaluation report includes the following.

3.6.5 COL Information

3.6.5-1-H Pipe Break Analysis Results and Protection Methods

STD COL 3.6.5-1-A This COL item is addressed in Subsection 3.6.2.5.

3.7 Seismic Design

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

3.7.1.1 Design Ground Motion

Add the following sections following Subsection 3.7.1.1.3.

3.7.1.1.4 Site-Specific Seismic Design Ground Motion Response Spectra

VCS SUP 3.7-1

The site-specific ground motion response spectra (GMRS) are described in Subsection 2.5.2.6. The development of the Foundation Input Response Spectra (FIRS) is described below. In addition, the Certified Seismic Design Response Spectra (CSDRS) (horizontal and vertical) are compared with the FIRS, as well as with the GMRS and the RG 1.60 criteria anchored to 0.24g, for all three seismic Category I structures (reactor building/fuel building (RB/FB), control building (CB) and the fire water service complex (FWSC), in Table 2.0-201.

3.7.1.1.4.1 Development of Amplification Factors at FIRS Horizons

The uniform hazard response spectra (UHRS) described in Subsection 2.5.2.4 are defined on hard rock, defined as rock with a shear wave velocity of V_s = 9200 feet/second (2.8 kilometers/second), which is located at more than 20,000 feet (6096 meters) below the ground surface. Subsection 2.5.2.5 describes the development of the site-specific amplification factors at the GMRS horizon that result from the transmission of the seismic waves through the thick soil column. The effect is modeled by a truncated soil column, extending from the finished ground surface (including top 15 feet (4.5 meters) of fill) to a depth of about 8115 feet (2473 meters), and including an adjustment to the soil damping within the truncated soil column to represent the anelastic attenuation of ground motion by the entire soil column (the κ [“kappa”] value). In addition, to obtain site amplification factors at the GMRS horizon, the top soil layers down to the GMRS horizon, at a depth of about 100 feet (30 meters) below finished ground surface (top of fill), are not included in the soil column model.

The soil model used for computation of FIRS amplification factors is the same model used for GMRS analysis except the soil layers above the GMRS horizon are added to the soil column extending the column to the

finished grade at the top of the fill. The best estimate shear wave velocity and the strain dependent soil properties for the full soil column are randomized and a suite of 60 randomized profiles are used for soil amplification analysis. Similar to GMRS analysis, computation of soil amplification for FIRS is performed for VCS Units 1 and 2 separately and resulting amplifications are enveloped over the two units to develop one common FIRS for both units for each horizon. Figures 3.7-201 and 3.7-202 illustrate the 60 V_s profiles generated for VCS Units 1 and 2, respectively. The same figures compare the log-mean of these 60 V_s profiles to the base V_s profile described in Subsection 2.5.2.5.1. The randomization procedure is described in detail in Subsection 2.5.2.5.2. The procedure described in Subsection 2.5.2.5 was used to adjust the soil damping to maintain the total kappa applicable to the site.

Using the randomized profiles, the soil column analysis is performed with the de-aggregated low frequency (LF) and high frequency (HF) spectra of hard rock motion at 10^{-4} and 10^{-5} annual-frequency-of-exceedance following the same methodology described in Subsection 2.5.2.5. The resulting site-specific FIRS amplification factors are used with the hard rock spectra of Subsection 2.5.2.4 to develop FIRS in Subsection 3.7.1.1.4.3.

3.7.1.1.4.2 Site Response Analysis

The FIRS horizons for the three seismic Category I structures: FWSC, CB and RB/FB, defined in Table 3.7-201 are computed. The amplification factors represent the amplification of input motion at the input hard rock level to the response motion as outcrop motion at each of the three horizons and for both of the two units. Envelope amplification factors for the two units are used to develop FIRS.

Figures 3.7-203, 3.7-204 and 3.7-205 show the log-mean amplification factors from analyses of the 60 randomized profiles along with the 10^{-4} LF and HF input motions of VCS Units 1 and 2 at the three considered FIRS horizons. As would be expected due to the large thickness of sediments at the site, amplifications are largest at low frequencies (below about 4.0 Hz) and small de-amplification occurs at high frequencies because of soil damping. Figures 3.7-206, 3.7-207, and 3.7-208 show the log-mean amplification factors from analyses of the 60 randomized profiles with the 10^{-5} LF and HF input motions of VCS Units 1 and 2 at the three considered FIRS horizons. The same trend is observed in the site

response to the input motions with the 10^{-5} annual frequency of exceedance as with the 10^{-4} annual frequency of exceedance.

The log-mean of maximum strains versus depth from analyses of the 60 randomized profiles for LF and HF, 10^{-4} and 10^{-5} input motions, are presented in Figures 3.7-209 and 3.7-210 for VCS Units 1 and 2, respectively. As shown in these figures, the log-mean of maximum strains is less than 0.10% for VCS Unit 1 and 0.12% for VCS Unit 2 over the total soil column depth. The log-mean of maximum strains in the deep soil layers at depths below 615 feet (187 meters) are very small and do not exceed 0.035%. These results confirm the adequacy of linear-elastic (strain-independent) soil properties used for the deep soil layers, (see Subsection 2.5.2.5.1.)

As stated above, the envelope amplification factors are used to develop VCS site FIRS. Comparisons of the envelope of the VCS Units 1 and 2 log-mean soil amplification factors for LF and HF, 10^{-4} and 10^{-5} input motions are presented in Figures 3.7-211, 3.7-212, and 3.7-213 at the three FIRS horizons, respectively. As shown in these figures, the amplifications for the LF input motions are generally larger than for HF input motions, at a specific annual frequency of exceedance, especially at frequencies greater than about 10 Hz. De-amplification at higher frequencies is small particularly for the LF input motion, followed by amplification of the peak ground acceleration at high frequencies (above 50 Hz for LF 10^{-4} and above 70 Hz for LF 10^{-5} input motion).

Using the developed amplification factors, recommended FIRS are calculated in Subsection 3.7.1.1.4.3.

3.7.1.1.4.3 Foundation Input Response Spectra

The recommended horizontal and vertical FIRS for elevations 30, 46, and 84 feet horizons are calculated. These horizons correspond to the RB/FB, CB, and FWSC horizons, respectively. Discussion of soil column analysis for computation of FIRS and the soil amplification factors are presented above in Subsections 3.7.1.1.4.1 and 3.7.1.1.4.2. The same methodology used to develop the GMRS in FSAR Subsection 2.5.2.6 is used for the recommended FIRS design response spectra. Similar to the GMRS, the recommended FIRS design response spectra are for 5% spectral damping. It should be noted that the FIRS are developed considering the in-situ soil to the bottom of the RB/FB foundation at elevation 30 feet. To provide a core competent bearing stratum for the

foundation, the soil material between elevations 95 feet (29 meters) and 8 feet (2.4 meters) may be replaced with structural fill. The effects of structural fill on soil amplification will be evaluated and if warranted the FIRS will be revised. This evaluation will be made after properties of the structural fill have been developed, and is expected to be provided in Revision 1 of the COLA.

The computation of horizontal FIRS given the 10^{-4} and 10^{-5} uniform hazard spectra is defined in ASCE/SEI 43-05 (Reference 3.7-201) and RG 1.208.

The procedure for computing the horizontal FIRS is as follows:

For each spectral frequency at which the UHRS is defined, a slope factor AR is determined from:

$$AR=SA(10^{-5})/SA(10^{-4}) \qquad \text{Equation 3.7-201}$$

where $SA(10^{-4})$ is the spectral acceleration at a mean UHRS exceedance frequency of 10^{-4}/yr (and similarly for $SA(10^{-5})$). A Design Factor "DF" is defined based on AR, which reflects the slope of the mean hazard curve between 10^{-4} and 10^{-5} mean annual frequencies of exceedance. The DF at each spectral frequency is given by:

$$DF= 0.6(AR)^{0.80} \qquad \text{Equation 3.7-202}$$

and

$$FIRS = \max[SA(10^{-4}) \times \max(1, DF), 0.45 \times SA(10^{-5})] \qquad \text{Equation 3.7-203}$$

The derivation of DF is described in detail in the Commentary to ASCE/SEI Standard 43-05 and in RG 1.208.

The same recommended V:H factors that were applied to the GMRS are applicable to the horizontal FIRS and are also used to develop the recommended vertical FIRS. That is, the V:H ratios were obtained using the standard horizontal and vertical spectra recommended in RG 1.60, as discussed in Subsection 2.5.2.6.

Development of soil amplification factors for the three FIRS horizons (elevations 30, 46 and 84 feet horizons) is discussed in Subsection 3.7.1.1.4.1 and Subsection 3.7.1.1.4.2. These site specific amplification factors are computed at a suite of 301 frequency values between 0.1 and 100 Hz for both the HF and LF cases at the 10^{-4}, 10^{-5}, and 10^{-6} levels.

The resulting horizontal and vertical FIRS are plotted for the following structures:

- Reactor/fuel buildings at elevation 30 feet are plotted in Figure 3.7-214.
- Control building at elevation 46 feet is plotted in Figure 3.7-215.
- Fire water service complex at elevation 84 feet is plotted in Figure 3.7-216.

3.7.1.1.4.4 Comparison of FIRS with CSDRS and Input Motion for Site Specific SSI Analysis

Site-specific SSI analysis is performed, and the results are compared with the enveloping design values in Subsection 3.7.2.4. For the SSI analysis, site-specific soil profiles are used to develop the best estimate, upper bound, and lower bound profiles. The input motion used is RG 1.60 anchored to 0.24g for all three structures, RB/FB, CB, and FWSC as documented in Subsection 3.7.2.4.1. This motion is less than the CSDRS used for the standard design as presented in Subsection 3.7.1.1.

The FIRS, CSDRS, and the RG 1.60 spectra scaled to 0.24g are compared in Figures 3.7-217 and 3.7-218 for horizontal and vertical spectra, respectively. For the FWSC structures, the design motion is 1.35 times the CSDRS.

These Figures show that the CSDRS, and RG 1.60 scaled to 0.24g envelop the FIRS for the RB/FB, CB and FWSC and confirm the conservatism of RG 1.60 motion scaled to 0.24g for site specific SSI analysis.

A subsample of 38 frequencies that span the range of 0.1 to 100 Hz for the final horizontal and vertical FIRS for elevations 30, 46, and 84 feet is listed in Tables 3.7-202, 3.7-203 and 3.7-204.

3.7.1.1.5 **Site-Specific Design Ground Motion Time History**

The site-specific earthquake ground motion time history is addressed in Subsection 2.5.2.

3.7.1.3 **Supporting Media for Seismic Category I Structures**

Add the following at the end of the first paragraph.

VCS SUP 3.7-2

Subsection 2.5.4 provides site-specific properties of subsurface materials.

3.7.2.4 Soil-Structure Interaction

Add the following at the end of the first paragraph.

VCS SUP 3.7-3

Subsection 2.5.4 describes the site-specific properties of subsurface materials.

3.7.2.4.1 Site-Specific Analysis

VCS DEP 2.5.4-1

This section presents the soil-structure interaction (SSI) analysis performed for VCS Units 1 and 2 site conditions for the ESBWR seismic Category I reactor building (RB), fuel building (FB), control building (CB), and fire water service complex (FWSC) using RG 1.60 spectra scaled to 0.24g to envelope the site-specific safe shutdown earthquake (SSE). The results of the SSI analysis are considered preliminary since estimated soil properties and profiles were used, and RG 1.60 spectra anchored to 0.24g were used to construct the input motion to the structures. The final SSI analysis will use the soil profiles and soil properties described in Subsection 2.5.4, and will use the final site-specific FIRS described in this subsection. The final results will be presented in Revision 1 to the COLA. This analysis is performed to confirm applicability of the ESBWR design to the site addressing the departure of the minimum shear wave velocity parameter specified in the referenced DCD. The analysis follows the DCD methodology for SSI analysis using the SASSI2000 computer program. The SSI analysis model is developed from the DCD building stick model coupled with a site-specific foundation model. The analysis results are compared with the DCD seismic design envelopes to confirm the applicability of the ESBWR design.

3.7.2.4.1.1 Soil Profiles

The soil properties of the subsurface layers considered in the SSI analysis are shown in Table 3.7-205 and are based on the in situ soil profile for VCS Unit 1 with 15 feet of fill added to the top. The soil profiles for VCS Units 1 and 2 are similar. The soil profile corresponding to VCS Unit 1 was selected for the SSI analyses. The best estimate (BE) low strain shear wave velocity values (V_{BE}), provided in Table 2.5.4-251, are adjusted to become strain compatible by applying a reduction of 10% to the V_{BE} values. The strain-compatible lower bound (LB) and upper bound (UB) velocities (V_{LB} and V_{UB}) are obtained from the strain-compatible V_{BE} profile as follows.

$$V_{LB} = V_{BE} / \sqrt{1.5}$$

$$V_{UB} = V_{BE} \times \sqrt{1.5}$$

Damping values in Table 3.7-205 are associated with low strain (1.0 x 10^{-4} %) and used conservatively as strain-compatible values as well.

3.7.2.4.1.2 Structural Backfill

To obtain acceptable parameters for dynamic bearing capacity and settlement approximately 21 feet of additional material is required to be over-excavated underneath the reactor/fuel building foundations (elevation 29.4 – elevation 8 ≈ 21 feet additional excavation underneath the foundation). The addition of structural fill to provide satisfactory static and dynamic bearing capacity may not have strictly the same characteristics as the materials (sand and clays) that are removed and for which the site-specific SSI analysis is based upon. Therefore, upon installation of the structural fill (granular material/lean concrete (flowable fill)/mass concrete) that is placed below the foundation, the material will be evaluated to determine its suitability. A subsequent SSI reanalysis may be required based on whether the installed material properties are suitably bounded by the range of values used in this SSI analysis.

3.7.2.4.1.3 Input Motion

The input ground motion considered in this analysis follows RG 1.60 anchored to 0.24g for all three structures, RB/FB, CB, and FWSC. The spectrum compatible artificial time histories delineated in DCD Subsection 3.7.1.1.1 are scaled to yield 0.24g peak ground acceleration in each of the 3 directions (H1, H2 and vertical) for use as free-field outcrop input motion at the foundation level of each of the buildings in the SHAKE analyses using strain-compatible BE, LB and UB profiles without further iterations. The SHAKE analysis is performed for the RB/FB and CB following the DCD method in which the soil layers above the foundation level are included in the soil column. The resulting surface motion along with the corresponding soil profile are used in the SASSI analysis. The FWSC is essentially a surface founded structure for which the foundation input motion is applied directly in the SASSI analysis without embedment.

3.7.2.4.1.4 Analysis Method

The method of analysis follows DCD Subsection 3A.5.2 methodology for SSI analysis using the SASSI2000 computer program.

3.7.2.4.1.5 Analysis Models

The SSI model for site-specific SASSI analysis is constructed from the building stick model coupled with the foundation finite element model in the same manner as described in DCD Subsection 3A.7.3. The building stick models are shown in DCD Figures 3A.7-4, 3A.7-6 and 3A.7-7 for the RB/FB, CB, and FWSC, respectively. The overall site-specific SASSI models are shown in Figures 3.7-219 through 3.7-221 for the RB/FB, and Figures 3.7-222 through 3.7-224 for the CB. They are the same as DCD Figures 3A.7-8 through 3A.7-10 for the RB/FB and Figures 3A.7-11 through 3A.7-13 for the CB, except that the vertical spacing of the wall nodes are adjusted for a closer match with the site-specific soil layers. The SASSI model for the FWSC is the same as the DCD and is shown in DCD Figures 3A.7-14 and 3A.7-15.

3.7.2.4.1.6 Analysis Cases

The site-specific SSI analysis cases are summarized in Tables 3.7-206 through 3.7-208 for the RB/FB, CB, and FWSC, respectively.

Each analysis case consists of three SASSI runs for three directions of excitation (two horizontal and vertical) separately. The resulting co-directional responses from each run of the analysis case are combined by the SRSS method to obtain the total response.

3.7.2.4.1.7 Analysis Results

The results of site-specific SSI analyses for BE, LB and UB cases are enveloped and compared with the seismic design envelopes specified in DCD Section 3A.9 for maximum seismic structural loads and floor response spectra at key locations.

The RB/FB results are presented in Tables 3.7-209 through 3.7-213 for maximum seismic structural loads, and in Tables 3.7-217 through 3.7-222 for maximum acceleration (zero period acceleration). The floor response spectra at 5% damping are shown in Figures 3.7-225 through 3.7-230 for the X direction, in Figures 3.7-231 through 3.7-236 for the Y direction, and in Figures 3.7-237 through 3.7-242 for the vertical direction.

The CB results are presented in Table 3.7-214 for maximum seismic structural loads, and in Table 3.7-223 for maximum acceleration (zero period acceleration). The floor response spectra at 5% damping are shown in Figures 3.7-243 and 3.7-244 for the X direction, in

Figures 3.7-245 and 3.7-246 for the Y direction, and in Figures 3.7-247 and 3.7-248 for the vertical direction.

The FWSC results are presented in Tables 3.7-215 and 3.7-216 for maximum seismic structural loads, and in Tables 3.7-224 and 3.7-225 for maximum acceleration (zero period acceleration). The floor response spectra at 5% damping are shown in Figures 3.7-249 through 3.7-252 for the X direction, in Figures 3.7-253 through 3.7-256 for the Y direction, and in Figures 3.7-257 through 3.7-260 for the vertical direction.

3.7.2.4.1.8 Conclusions

From the analysis results presented above, it can be concluded that the Victoria County Station site-specific SSE responses are bounded by the ESBWR design envelopes. The applicability of the ESBWR design is therefore confirmed.

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

Add the following second paragraph.

VCS SUP 3.7-4 The locations of structures are provided in Figure 1.1-201.

3.7.4 Seismic Instrumentation

Add the following at the end of the first paragraph.

VCS SUP 3.7-5 The seismic monitoring program described in this subsection, including the necessary test and operating procedures, will be implemented prior to receipt of fuel on site.

3.7.5 References

3.7-201 ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities*, American Society of Civil Engineers, 2005.

3.7-202 ESBWR Design Control Document Tier 2, *Chapter 2 Site Characteristics*, 26A6642AH, Rev. 4, September, 2007.

Table 3.7-201
Elevations and Depths of FIRS Horizons

Structure	Elevation [feet (meters)]	Depth [feet (meters)]
Fire Water Service Complex (FWSC)	84 (26)	11 (3)
Control Building (CB)	46 (14)	49 (15)
Reactor Building/Fuel Building (RB/FB)	30 (9)	65 (20)

Table 3.7-202
Recommended Horizontal and Vertical FIRS for the Elevation 30 Feet Horizon

Frequency (Hz)	Horizontal FIRS (Elevation 30 feet), SA(g)	Vertical FIRS (Elevation 30 feet), SA(g)
100	7.50×10^{-2}	7.50×10^{-2}
90	8.05×10^{-2}	8.05×10^{-2}
80	8.60×10^{-2}	$8.60 \times 10^{-2}2$
70	8.93×10^{-2}	8.93×10^{-2}
60	9.08×10^{-2}	9.08×10^{-2}
50	9.13×10^{-2}	9.13×10^{-2}
45	9.15×10^{-2}	9.15×10^{-2}
40	9.19×10^{-2}	9.19×10^{-2}
35	9.27×10^{-2}	9.27×10^{-2}
30	9.37×10^{-2}	9.37×10^{-2}
25	9.58×10^{-2}	9.58×10^{-2}
20	1.02×10^{-1}	1.02×10^{-1}
15	1.12×10^{-1}	1.12×10^{-1}
12.5	1.18×10^{-1}	1.18×10^{-1}
10	1.27×10^{-1}	1.27×10^{-1}
9	1.33×10^{-1}	1.33×10^{-1}
8	1.39×10^{-1}	1.39×10^{-1}
7	1.47×10^{-1}	1.46×10^{-1}
6	1.57×10^{-1}	1.57×10^{-1}
5	1.65×10^{-1}	1.65×10^{-1}
4	1.63×10^{-1}	1.63×10^{-1}
3	1.64×10^{-1}	1.40×10^{-1}
2.5	1.72×10^{-1}	1.23×10^{-1}
2	1.87×10^{-1}	1.33×10^{-1}
1.5	1.83×10^{-1}	1.29×10^{-1}
1.25	1.60×10^{-1}	1.12×10^{-1}
1	1.41×10^{-1}	9.82×10^{-2}
0.9	1.44×10^{-1}	1.00×10^{-1}
0.8	1.52×10^{-1}	1.05×10^{-1}
0.7	1.63×10^{-1}	1.13×10^{-1}
0.6	1.76×10^{-1}	1.20×10^{-1}
0.5	1.67×10^{-1}	1.14×10^{-1}
0.4	1.10×10^{-1}	7.48×10^{-2}
0.3	8.08×10^{-2}	5.43×10^{-2}
0.2	2.74×10^{-2}	1.83×10^{-2}
0.15	1.67×10^{-2}	1.11×10^{-2}
0.125	1.17×10^{-2}	$7.82E \times 10^{-3}$
0.1	5.83×10^{-3}	$3.89E \times 10^{-3}$

Table 3.7-203
Recommended Horizontal and Vertical FIRS for the Elevation 46 Feet Horizon

Frequency (Hz)	Horizontal FIRS (Elevation 46 feet), SA(g)	Vertical FIRS (Elevation 46 feet), SA(g)
100	7.73×10^{-2}	7.73×10^{-2}
90	8.29×10^{-2}	8.29×10^{-2}
80	8.86×10^{-2}	8.86×10^{-2}
70	9.20×10^{-2}	9.20×10^{-2}
60	9.35×10^{-2}	9.35×10^{-2}
50	9.40×10^{-2}	9.40×10^{-2}
45	9.41×10^{-2}	9.41×10^{-2}
40	9.46×10^{-2}	9.46×10^{-2}
35	9.53×10^{-2}	9.53×10^{-2}
30	9.63×10^{-2}	9.63×10^{-2}
25	9.83×10^{-2}	9.83×10^{-2}
20	1.04×10^{-1}	1.04×10^{-1}
15	1.14×10^{-1}	1.14×10^{-1}
12.5	1.21×10^{-1}	1.21×10^{-1}
10	1.32×10^{-1}	1.32×10^{-1}
9	1.38×10^{-1}	1.38×10^{-1}
8	1.45×10^{-1}	1.45×10^{-1}
7	1.53×10^{-1}	1.53×10^{-1}
6	1.62×10^{-1}	1.62×10^{-1}
5	1.67×10^{-1}	1.66×10^{-1}
4	1.68×10^{-1}	1.68×10^{-1}
3	1.75×10^{-1}	1.50×10^{-1}
2.5	1.86×10^{-1}	1.33×10^{-1}
2	1.97×10^{-1}	1.40×10^{-1}
1.5	1.91×10^{-1}	1.34×10^{-1}
1.25	1.65×10^{-1}	1.15×10^{-1}
1	1.44×10^{-1}	1.00×10^{-1}
0.9	1.47×10^{-1}	1.02×10^{-1}
0.8	1.54×10^{-1}	1.07×10^{-1}
0.7	1.65×10^{-1}	1.14×10^{-1}
0.6	1.78×10^{-1}	1.22×10^{-1}
0.5	1.68×10^{-1}	1.15×10^{-1}
0.4	1.12×10^{-1}	7.56×10^{-2}
0.3	8.11×10^{-2}	5.45×10^{-2}
0.2	2.75×10^{-2}	1.84×10^{-2}
0.15	1.67×10^{-2}	1.12×10^{-2}
0.125	1.17×10^{-2}	7.84×10^{-3}
0.1	5.85×10^{-3}	3.91×10^{-3}

Table 3.7-204
Recommended Horizontal and Vertical FIRS for the Elevation 84 Feet Horizon

Frequency (Hz)	Horizontal FIRS (Elevation 84 feet), SA(g)	Vertical FIRS (Elevation 84 feet), SA(g)
100	8.35×10^{-2}	8.35×10^{-2}
90	8.95×10^{-2}	8.95×10^{-2}
80	9.57×10^{-2}	9.57×10^{-2}
70	9.93×10^{-2}	9.93×10^{-2}
60	1.01×10^{-1}	1.01×10^{-1}
50	1.01×10^{-1}	1.01×10^{-1}
45	1.01×10^{-1}	1.01×10^{-1}
40	1.02×10^{-1}	1.02×10^{-1}
35	1.02×10^{-1}	1.02×10^{-1}
30	1.03×10^{-1}	1.03×10^{-1}
25	1.04×10^{-1}	1.04×10^{-1}
20	1.09×10^{-1}	1.09×10^{-1}
15	1.17×10^{-1}	1.17×10^{-1}
12.5	1.25×10^{-1}	1.25×10^{-1}
10	1.38×10^{-1}	1.38×10^{-1}
9	1.46×10^{-1}	1.46×10^{-1}
8	1.54×10^{-1}	1.54×10^{-1}
7	1.64×10^{-1}	1.64×10^{-1}
6	1.76×10^{-1}	1.76×10^{-1}
5	1.85×10^{-1}	1.84×10^{-1}
4	2.03×10^{-1}	2.02×10^{-1}
3	2.21×10^{-1}	1.89×10^{-1}
2.5	2.22×10^{-1}	1.59×10^{-1}
2	2.30×10^{-1}	1.63×10^{-1}
1.5	2.17×10^{-1}	1.53×10^{-1}
1.25	1.80×10^{-1}	1.26×10^{-1}
1	1.53×10^{-1}	1.06×10^{-1}
0.9	1.54×10^{-1}	1.07×10^{-1}
0.8	1.59×10^{-1}	1.10×10^{-1}
0.7	1.69×10^{-1}	1.16×10^{-1}
0.6	1.81×10^{-1}	1.24×10^{-1}
0.5	1.70×10^{-1}	1.16×10^{-1}
0.4	1.13×10^{-1}	7.66×10^{-2}
0.3	8.16×10^{-2}	5.48×10^{-2}
0.2	2.76×10^{-2}	1.85×10^{-2}
0.15	1.67×10^{-2}	1.12×10^{-2}
0.125	1.18×10^{-2}	7.86×10^{-3}
0.1	5.88×10^{-3}	3.93×10^{-3}

Table 3.7-205
Site Specific Soil Properties

Layer No.	Soil Layer	Top EL. (ft)	Bottm EL. (ft)	Top EL. (m)	Bottm EL. (m)	Top DCD EL. (m)	Bottom DCD EL. (m)	Thickness (m)	Unit Weight (N/m^3)	BE Vs (m/s)	LB Vs (m/s)	UB Vs (m/s)	Damping Ratio h (%)	Poisson's Ratio ν	Note
1	FILL I	95	87	28.96	26.52	4.50	2.06	2.44	20400	192	157	235	1.40	0.35	FWSC bottom of mat DCD EL. 2.15m
2	FILL II	87	80	26.52	24.39	2.06	-0.07	2.13	20400	233	190	285	1.40	0.35	
3	CLAY 1 - Top	80	50	24.39	15.25	-0.07	-9.21	9.14	19600	192	157	235	2.60	0.41	CB bottom of mat DCD EL. -10.4m
4	CLAY 1-Bottom	50	33.5	15.25	10.22	-9.21	-14.24	5.03	19600	230	188	282	2.60	0.46	
5	SAND 2	33.5	19	10.22	5.80	-14.24	-18.66	4.42	20400	269	220	329	0.50	0.47	RB/FB bottom of mat DCD EL. -15.5m
6	CLAY 3	19	-4	5.80	-1.21	-18.66	-25.67	7.01	18900	272	222	333	1.10	0.48	
7	SAND 4	-4	-28.5	-1.21	-8.68	-25.67	-33.14	7.47	20400	486	397	595	0.50	0.45	
8	CLAY 5 - Top	-28.5	-49.5	-8.68	-15.08	-33.14	-39.54	6.40	20100	288	235	353	0.90	0.48	
9	SAND 5	-49.5	-60	-15.08	-18.28	-39.54	-42.74	3.20	20400	291	238	356	0.50	0.48	
10	CLAY 5 - Bottom	-60	-75	-18.28	-22.85	-42.74	-47.31	4.57	20100	304	248	372	0.90	0.48	
11	SAND 6	-75	-127	-22.85	-38.70	-47.31	-63.16	15.85	20400	411	336	503	0.50	0.47	
12	CLAY 7	-127	-172	-38.70	-52.42	-63.16	-76.88	13.72	19600	390	318	478	0.90	0.47	
13	SAND 8	-172	-206	-52.42	-62.78	-76.88	-87.24	10.36	20400	414	338	507	0.50	0.47	
14	CLAY 9	-206	-252	-62.78	-76.80	-87.24	-101.26	14.02	19600	337	275	413	0.90	0.48	
15	SAND 10	-252	-268	-76.80	-81.68	-101.26	-106.14	4.88	20400	447	365	547	0.50	0.46	
16	CLAY 11	-268	-328	-81.68	-99.97	-106.14	-124.43	18.29	19500	315	257	386	0.90	0.48	
17	SAND 12	-328	-346	-99.97	-105.45	-124.43	-129.91	5.48	20400	491	401	601	0.50	0.46	
18	CLAY 13	-346	-422	-105.45	-128.62	-129.91	-153.08	23.17	19500	379	309	464	0.90	0.47	
19	SAND 14	-422	-454	-128.62	-138.37	-153.08	-162.83	9.75	20400	480	392	588	0.50	0.45	
20	CLAY 15	-454	-465	-138.37	-141.73	-162.83	-166.19	3.36	19600	411	336	503	0.90	0.47	
21	SAND 16	-465	-480	-141.73	-146.30	-166.19	-170.76	4.57	20400	488	398	598	0.50	0.45	
22	CLAY 17	-480	-507	-146.30	-154.53	-170.76	-178.99	8.23	19600	439	358	538	0.90	0.47	
23	SAND 18	-507	-520	-154.53	-158.49	-178.99	-182.95	3.96	20400	546	446	669	0.50	0.45	
24	Half space	-520		-158.49		-182.95			20400	543	443	665		0.46	

Table 3.7-206
RB/FB SSI Analysis Cases

Building	No.	Model * (DCD)	Input Motion	Site Condition		
				BE	LB	UB
RB/FB	RVI-A1	Wall out-of-plane	RG1.60 0.24g Motion	✓		
	RVI-A2				✓	
	RVI-A3					✓

Note *: Refer to DCD Table 3A.6-1

Table 3.7-207
CB SSI Analysis Cases

Building	No.	Model * (DCD)	Input Motion	Site Condition		
				BE	LB	UB
CB	CVI-A1	Base	RG1.60 0.24g Motion	✓		
	CVI-A2				✓	
	CVI-A3					✓

Note *: Refer to DCD Table 3A.6-1

Table 3.7-208
FWSC SSI Analysis Cases

Building	No.	Model * (DCD)	Input Motion	Site Condition		
				BE	LB	UB
FWSC	FVI-A1	Base	RG1.60 0.24g Motion	✓		
	FVI-A2				✓	
	FVI-A3					✓

Note *: Refer to DCD Table 3A.6-1

Table 3.7-209
Enveloping Seismic Loads: RB/FB Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
52.40	110				271	285	
		1110	34.3	43.1	788	1026	138
34.00	109				1069	1392	
		1109	51.5	46.8	1345	1704	296
27.00	108				1915	1986	
		1108	125.2	118.4	2152	2480	826
22.50	107				2567	2679	
		1107	143.3	135.8	2901	3315	1569
17.50	106				2971	3514	
		1106	159.9	162.8	3361	4098	1245
13.57	105				3483	4270	
		1105	173.8	176.8	4136	4966	1260
9.06	104				4227	5142	
		1104	189.3	193.9	4997	5881	1394
4.65	103				2989	2943	
		1103	229.2	154.7	3988	3581	2021
-1.00	102				2976	3004	
		1102	254.5	164.6	4077	3620	1770
-6.40	101				2806	2849	
-11.50	2	1101	276.2	185.2	3904	3434	1880

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.	Torsion
52.40	110				16%	16%	
		1110	23%	27%	18%	23%	10%
34.00	109				19%	25%	
		1109	27%	31%	21%	27%	12%
27.00	108				25%	28%	
		1108	29%	30%	24%	29%	25%
22.50	107				26%	29%	
		1107	30%	29%	25%	29%	26%
17.50	106				24%	29%	
		1106	30%	29%	24%	30%	25%
13.57	105				24%	30%	
		1105	31%	29%	25%	30%	24%
9.06	104				25%	30%	
		1104	31%	30%	26%	30%	23%
4.65	103				16%	15%	
		1103	27%	18%	17%	15%	18%
-1.00	102				13%	12%	
		1102	29%	18%	15%	12%	15%
-6.40	101				10%	9%	
-11.50	2	1101	30%	18%	12%	10%	16%

Table 3.7-210
Enveloping Seismic Loads: RCCV Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
34.00	209				38	73	
		1209	31.8	46.9	214	385	4
27.00	208				282	576	
		1208	47.2	65.9	609	1177	455
17.50	206				670	1291	
		1206	69.3	76.7	885	1558	489
13.57	205				913	1624	
		1205	79.9	86.0	1213	1957	527
9.06	204				1227	2050	
		1204	92.8	97.5	1644	2404	612
4.65	203				1671	2501	
		1203	54.0	44.8	1923	2660	587
-1.00	202				1974	2747	
		1202	73.7	50.9	2360	2927	449
-6.40	201				2456	2970	
-11.50	2	1201	76.0	51.4	2782	3138	314

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.	Torsion
34.00	209				19%	13%	
		1209	23%	26%	20%	26%	12%
27.00	208				17%	23%	
		1208	29%	27%	21%	27%	25%
17.50	206				20%	27%	
		1206	30%	26%	21%	27%	25%
13.57	205				21%	27%	
		1205	30%	26%	22%	27%	24%
9.06	204				22%	27%	
		1204	31%	27%	24%	27%	23%
4.65	203				24%	27%	
		1203	24%	15%	24%	25%	20%
-1.00	202				24%	26%	
		1202	27%	15%	25%	23%	15%
-6.40	201				26%	23%	
-11.50	2	1201	29%	17%	26%	22%	16%

Table 3.7-211
Enveloping Seismic Loads: VW/Pedestal Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
17.50	701				18	6	
		701	3.1	4.3	14	13	9
14.50	702				13	14	
		702	4.4	5.4	15	30	9
11.50	703				15	31	
		703	5.7	6.7	27	51	9
8.50	704				27	51	
		704	6.7	7.7	33	58	9
7.4625	705				48	57	
		705	5.3	5.0	59	72	5
4.65	706,303				118	134	
		1303	7.2	7.1	135	149	29
2.4165	377				165	183	
		1377	10.9	10.8	200	217	35
-1.00	302				164	190	
		1302	19.0	13.4	197	208	22
-2.75	376				198	208	
		1376	19.1	13.4	263	244	22
-6.40	301				235	239	
-11.50	2	1301	30.8	21.4	392	337	19

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.	Torsion
17.50	701				24%	7%	
		701	11%	15%	14%	11%	12%
14.50	702				11%	10%	
		702	15%	18%	8%	14%	11%
11.50	703				8%	14%	
		703	19%	20%	10%	16%	12%
8.50	704				10%	16%	
		704	22%	22%	11%	17%	12%
7.4625	705				17%	17%	
		705	17%	17%	17%	18%	8%
4.65	706,303				22%	24%	
		1303	22%	16%	24%	25%	20%
2.4165	377				24%	25%	
		1377	23%	16%	27%	25%	20%
-1.00	302				20%	21%	
		1302	29%	16%	22%	20%	15%
-2.75	376				22%	20%	
		1376	29%	16%	24%	18%	15%
-6.40	301				21%	18%	
-11.50	2	1301	29%	18%	24%	17%	16%

Table 3.7-212
Enveloping Seismic Loads: RSW Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
24.18	707				0.2	0.1	
		707	0.5	0.3	1.8	1.4	0.0
20.20	708				2.2	1.6	
		708	3.0	2.1	13.6	10.8	0.1
15.775	709				12.4	10.9	
		709	3.7	2.6	32.9	22.6	0.1
11.35	710				35.1	22.7	
		710	4.4	3.3	50.0	35.6	0.2
7.4625	711				36.5	45.4	
		711	12.3	11.6	72.0	76.7	4.5
4.65	712				23.8	27.6	
		712	3.1	3.1	31.2	34.4	6.2
2.4165	713				0.7	0.7	
		713	0.4	0.4	0.6	0.5	0.0
1.96	714				0.6	0.5	
-0.80	715	714	0.2	0.2	0.0	0.1	0.0

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.	Torsion
24.18	707				8%	6%	
		707	18%	12%	14%	11%	6%
20.20	708				12%	10%	
		708	21%	18%	17%	17%	7%
15.775	709				15%	16%	
		709	21%	19%	21%	18%	7%
11.35	710				22%	18%	
		710	22%	21%	21%	19%	9%
7.4625	711				19%	25%	
		711	30%	32%	25%	31%	21%
4.65	712				20%	23%	
		712	22%	16%	25%	25%	20%
2.4165	713				22%	22%	
		713	28%	30%	21%	21%	11%
1.96	714				23%	23%	
-0.80	715	714	26%	28%	9%	12%	11%

Table 3.7-213
Enveloping Seismic Loads: RPV Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)
Shroud	845				3.4	1.8
Bottom	846	844	1.2	0.9	4.3	2.5
RPV	815				19.7	11.7
Support	711	871	5.4	4.3	21.9	14.7

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.
Shroud	845				21%	12%
Bottom	846	844	17%	13%	20%	14%
RPV	815				14%	9%
Support	711	871	29%	24%	16%	11%

Table 3.7-214
Enveloping Seismic Loads: CB Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Torsion (MN-m)
13.80	6				17	14	
		6	6.7	6.8	40	40	13.7
9.06	5				51	48	
		5	12.9	13.6	105	99	29.5
4.65	4				46	40	
		4	26.9	23.8	200	146	45.7
-2.00	3				68	71	
-7.40	2	3	51.8	48.5	295	280	83.2

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-Dir.	Shear Y-Dir.	Moment X-Dir.	Moment Y-Dir.	Torsion
13.80	6				11%	11%	
		6	20%	23%	16%	20%	19%
9.06	5				14%	18%	
		5	24%	25%	18%	22%	23%
4.65	4				6%	7%	
		4	36%	30%	18%	15%	26%
-2.00	3				5%	7%	
-7.40	2	3	42%	49%	19%	18%	34%

Table 3.7-215
Enveloping Seismic Loads: FWS Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear X-dir. (MN)	Shear Y-dir. (MN)	Moment X-dir. (MN-m)	Moment Y-dir. (MN-m)	Torsion (MN-m)
19.70	10				0.6	0.7	
		9	0.8	1.0	2.4	2.9	0.1
17.25	9				3.3	4.3	
		8	2.0	2.4	6.7	7.9	0.2
15.53	8				7.6	9.4	
		7	2.8	3.4	12.5	14.5	0.4
13.81	7				13.3	15.9	
		6	3.7	4.4	19.5	22.8	0.6
12.10	6				20.2	23.5	
		5	4.6	5.9	24.2	29.1	0.7
11.00	5				24.7	29.6	
		4	5.1	6.5	29.4	35.8	0.8
9.90	4				30.0	36.4	
		3	5.6	7.0	35.4	43.8	0.8
8.81	3				36.2	44.6	
		2	10.8	12.0	57.7	69.1	0.9
6.73	2				58.1	70.2	
4.65	1	1	11.7	12.9	82.3	96.7	1.1

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear X-dir.	Shear Y-dir.	Moment X-dir.	Moment Y-dir.	Torsion
19.70		10			13%	11%	
	9		18%	19%	17%	15%	11%
17.25		9			15%	16%	
	8		18%	20%	17%	17%	11%
15.53		8			17%	16%	
	7		18%	21%	18%	17%	11%
13.81		7			18%	17%	
	6		19%	22%	18%	18%	12%
12.10		6			18%	18%	
	5		20%	25%	18%	19%	12%
11.00		5			18%	19%	
	4		21%	26%	18%	19%	12%
9.90		4			18%	19%	
	3		21%	26%	18%	20%	12%
8.81		3			18%	20%	
	2		25%	26%	21%	23%	12%
6.73		2			21%	23%	
4.65	1	1	26%	27%	22%	26%	13%

Table 3.7-216
Enveloping Seismic Loads: FPE Stick

(a) Seismic Loads

Elev. (m)	Node No.	Elem No.	Shear		Moment		Torsion
			X-dir. (MN)	Y-dir. (MN)	X-dir. (MN-m)	Y-dir. (MN-m)	(MN-m)
8.25	405	402			0.8	2.1	
4.65	404	401	1.6	1.7	5.5	6.2	2.1

(b) Ratio with DCD Rev.4 ((a)/DCD Design Loads)

Elev. (m)	Node No.	Elem No.	Shear		Moment		Torsion
			X-dir.	Y-dir.	X-dir.	Y-dir.	
8.25	405	402			37%	22%	
4.65	404	401	20%	23%	20%	23%	14%

Table 3.7-217
Enveloping Maximum Vertical Acceleration: RB/FB

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.40	110	RBFB	0.30
34.00	109	RBFB	0.30
27.00	108	RBFB	0.29
22.50	107	RBFB	0.27
17.50	106	RBFB	0.27
13.57	105	RBFB	0.26
9.06	104	RBFB	0.26
4.65	103	RBFB	0.26
-1.00	102	RBFB	0.25
-6.40	101	RBFB	0.25
-11.50	2	RBFB	0.25
-15.50	1	RBFB	0.25

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
52.40	110	RBFB	24%
34.00	109	RBFB	37%
27.00	108	RBFB	40%
22.50	107	RBFB	38%
17.50	106	RBFB	37%
13.57	105	RBFB	35%
9.06	104	RBFB	36%
4.65	103	RBFB	33%
-1.00	102	RBFB	33%
-6.40	101	RBFB	37%
-11.50	2	RBFB	40%
-15.50	1	RBFB	49%

Table 3.7-218
Enveloping Maximum Vertical Acceleration: RCCV

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
34.00	209	RCCV	0.30
27.00	208	RCCV	0.28
17.50	206	RCCV	0.28
13.57	205	RCCV	0.28
9.06	204	RCCV	0.28
4.65	203	RCCV	0.27
-1.00	202	RCCV	0.27
-6.40	201	RCCV	0.26

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
34.00	209	RCCV	34%
27.00	208	RCCV	32%
17.50	206	RCCV	39%
13.57	205	RCCV	36%
9.06	204	RCCV	44%
4.65	203	RCCV	39%
-1.00	202	RCCV	46%
-6.40	201	RCCV	45%

Table 3.7-219
Enveloping Maximum Vertical Acceleration: VW/Pedestal

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
17.50	701	VW	0.29
14.50	702	VW	0.28
11.50	703	VW	0.28
8.50	704	VW	0.28
7.4625	705	VW	0.28
4.65	706, 303	Pedestal	0.28
-1.00	302	Pedestal	0.28
-6.40	301	Pedestal	0.28

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
17.50	701	VW	27%
14.50	702	VW	27%
11.50	703	VW	30%
8.50	704	VW	37%
7.4625	705	VW	40%
4.65	706, 303	Pedestal	42%
-1.00	302	Pedestal	44%
-6.40	301	Pedestal	48%

Table 3.7-220
Enveloping Maximum Vertical Acceleration: RSW

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
24.18	707	RSW	0.28
20.20	708	RSW	0.28
15.775	709	RSW	0.28
11.35	710	RSW	0.28
7.4625	711	RSW	0.28
4.65	712	RSW	0.28
2.4615	713	RSW	0.27
1.96	714	RSW	0.27
-0.80	715	RSW	0.27

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
24.18	707	RSW	29%
20.20	708	RSW	30%
15.775	709	RSW	34%
11.35	710	RSW	37%
7.4625	711	RSW	40%
4.65	712	RSW	42%
2.4615	713	RSW	43%
1.96	714	RSW	43%
-0.80	715	RSW	42%

Table 3.7-221 (Sheet 1 of 2)
Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab Oscillators

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.40	9101	Oscillator	0.66
	9102	Oscillator	0.82
	9103	Oscillator	0.49
	9104	Oscillator	0.33
	9105	Oscillator	0.32
	9106	Oscillator	0.31
	9107	Oscillator	0.31
	9108	Oscillator	0.31
34.00	9091	Oscillator	0.30
	9092	Oscillator	0.30
27.00	9081	Oscillator	0.30
	9082	Oscillator	0.29
	9083	Oscillator	0.29
	9084	Oscillator	0.29
	9085	Oscillator	0.28
22.50	9071	Oscillator	0.76
	9072	Oscillator	0.72
	9073	Oscillator	0.41
	9074	Oscillator	0.27
	9075	Oscillator	0.28
17.50	9061	Oscillator	0.38
	9062	Oscillator	0.27
	9063	Oscillator	0.28
	9064	Oscillator	0.38
	9065	Oscillator	0.28
	99064	Oscillator	0.29

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
52.40	9101	Oscillator	55%
	9102	Oscillator	45%
	9103	Oscillator	16%
	9104	Oscillator	14%
	9105	Oscillator	14%
	9106	Oscillator	10%
	9107	Oscillator	11%
	9108	Oscillator	12%
34.00	9091	Oscillator	24%
	9092	Oscillator	29%
27.00	9081	Oscillator	26%
	9082	Oscillator	29%
	9083	Oscillator	27%
	9084	Oscillator	22%
	9085	Oscillator	29%
22.50	9071	Oscillator	48%
	9072	Oscillator	55%
	9073	Oscillator	20%
	9074	Oscillator	21%
	9075	Oscillator	25%
17.50	9061	Oscillator	21%
	9062	Oscillator	18%
	9063	Oscillator	34%
	9064	Oscillator	21%
	9065	Oscillator	20%
	99064	Oscillator	27%

Table 3.7-221 (Sheet 2 of 2)
Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab Oscillators

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
13.57	9051	Oscillator	0.27
	9052	Oscillator	0.28
9.06	9041	Oscillator	0.28
	9042	Oscillator	0.27
4.65	9031	Oscillator	0.26
	9032	Oscillator	0.27
	9033	Oscillator	0.29
	9034	Oscillator	0.26
	9035	Oscillator	0.27
-1.00	9021	Oscillator	0.26
	9022	Oscillator	0.26
	9023	Oscillator	0.27
	9024	Oscillator	0.28
	9025	Oscillator	0.26
	9026	Oscillator	0.26
	9027	Oscillator	0.27
-6.40	9011	Oscillator	0.27
	9012	Oscillator	0.27
	9013	Oscillator	0.26

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
13.57	9051	Oscillator	33%
	9052	Oscillator	19%
9.06	9041	Oscillator	32%
	9042	Oscillator	19%
4.65	9031	Oscillator	22%
	9032	Oscillator	28%
	9033	Oscillator	28%
	9034	Oscillator	17%
	9035	Oscillator	20%
-1.00	9021	Oscillator	24%
	9022	Oscillator	18%
	9023	Oscillator	27%
	9024	Oscillator	32%
	9025	Oscillator	19%
	9026	Oscillator	17%
	9027	Oscillator	31%
-6.40	9011	Oscillator	29%
	9012	Oscillator	30%
	9013	Oscillator	19%

Table 3.7-222
Enveloping Maximum Horizontal Acceleration: RB/FB Wall Out-of-plane Oscillators

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
42.00	99981	Oscillator	0.39
(X-dir)	99982	Oscillator	0.32
42.00	99983	Oscillator	0.39
(Y-dir)	99984	Oscillator	0.38
	99985	Oscillator	0.38
13.57	99971	Oscillator	0.28
(X-dir)	99972	Oscillator	0.32
	99973	Oscillator	0.25
	99974	Oscillator	0.25
13.57	99975	Oscillator	0.24
(Y-dir)	99976	Oscillator	0.23

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
42.00	99981	Oscillator	25%
(X-dir)	99982	Oscillator	25%
42.00	99983	Oscillator	23%
(Y-dir)	99984	Oscillator	24%
	99985	Oscillator	30%
13.57	99971	Oscillator	20%
(X-dir)	99972	Oscillator	23%
	99973	Oscillator	22%
	99974	Oscillator	25%
13.57	99975	Oscillator	19%
(Y-dir)	99976	Oscillator	24%

Table 3.7-223
Enveloping Maximum Vertical Acceleration: CB

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
13.80	6	CB	0.25
9.06	5	CB	0.25
4.65	4	CB	0.25
-2.00	3	CB	0.24
-7.40	2	CB	0.24
-10.40	1	CB	0.24
13.50	9001	Oscillator	0.37
	9002	Oscillator	0.28
	9003	Oscillator	0.26
9.06	9101	Oscillator	0.35
	9102	Oscillator	0.27
	9103	Oscillator	0.26
4.65	9201	Oscillator	0.26
	9202	Oscillator	0.25
-2.00	9301	Oscillator	0.25

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration
13.80	6	CB	25%
9.06	5	CB	29%
4.65	4	CB	34%
-2.00	3	CB	43%
-7.40	2	CB	47%
-10.40	1	CB	47%
13.50	9001	Oscillator	17%
	9002	Oscillator	21%
	9003	Oscillator	18%
9.06	9101	Oscillator	18%
	9102	Oscillator	21%
	9103	Oscillator	18%
4.65	9201	Oscillator	20%
	9202	Oscillator	17%
-2.00	9301	Oscillator	18%

Table 3.7-224
Enveloping Maximum Vertical Acceleration: FWS

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
19.70	10	FWS	0.28
17.25	9	FWS	0.28
15.53	8	FWS	0.28
13.81	7	FWS	0.28
12.10	6	FWS	0.28
11.00	5	FWS	0.28
9.90	4	FWS	0.28
8.81	3	FWS	0.28
6.73	2	FWS	0.28
4.65	8002	FWSC	0.28
2.15	8001	FWSC	0.32
19.70	11	Oscillator	0.32

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
19.70	10	FWS	17%
17.25	9	FWS	17%
15.53	8	FWS	18%
13.81	7	FWS	18%
12.10	6	FWS	20%
11.00	5	FWS	23%
9.90	4	FWS	25%
8.81	3	FWS	27%
6.73	2	FWS	28%
4.65	8002	FWSC	36%
2.15	8001	FWSC	41%
19.70	11	Oscillator	10%

Table 3.7-225
Enveloping Maximum Vertical Acceleration: FPE

(a) Maximum Vertical Acceleration

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
8.25	405	FPE	0.29
6.45	402	FPE	0.29

(b) Ratio with DCD Rev.4 ((a)/DCD Design Acceleration)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
8.25	405	FPE	26%
6.45	402	FPE	27%

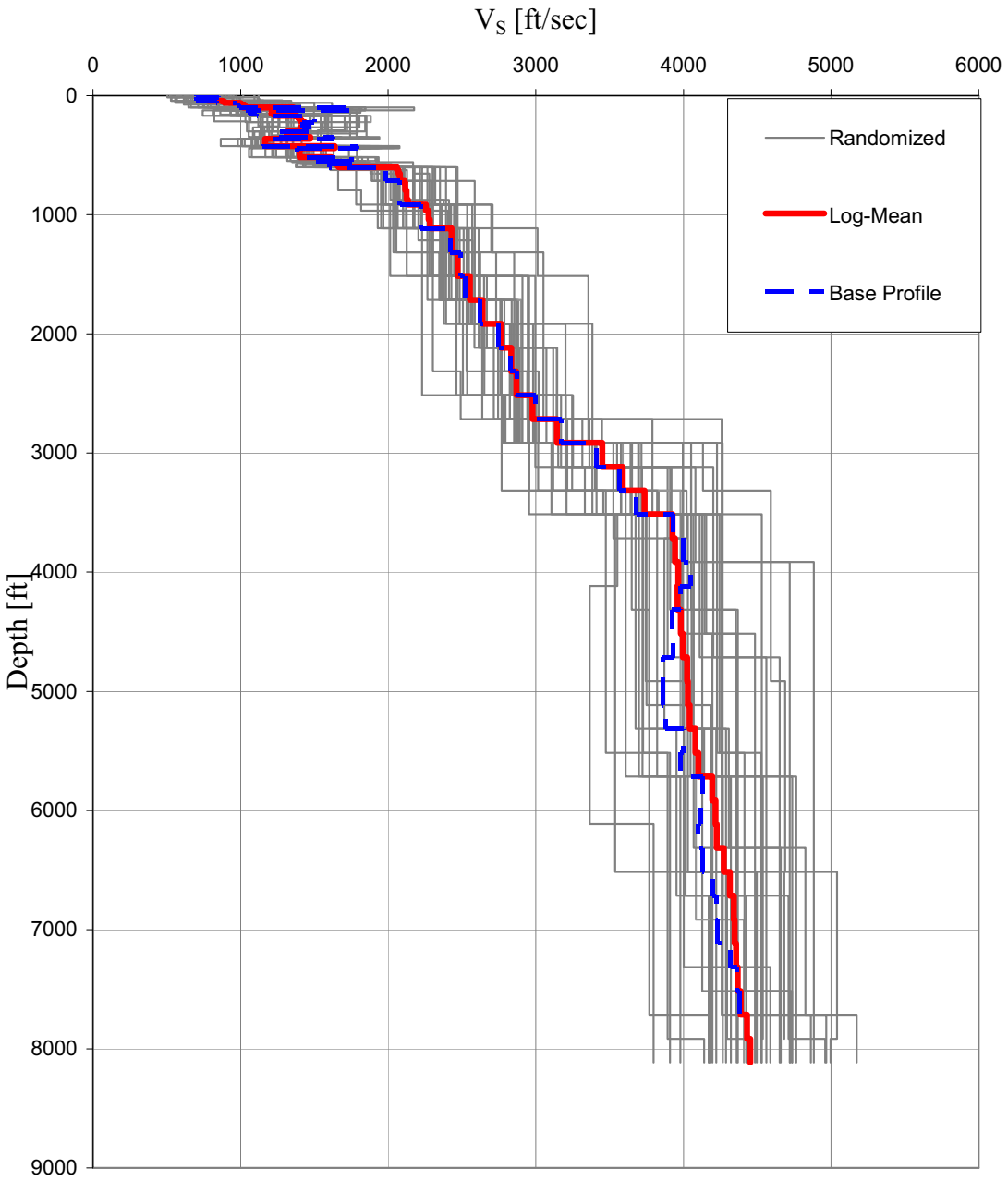


Figure 3.7-201 Randomized Shear Wave Velocity Profiles, Log-Mean Shear Wave Velocity Profile and the Base Profile Used For Randomization — Unit 1

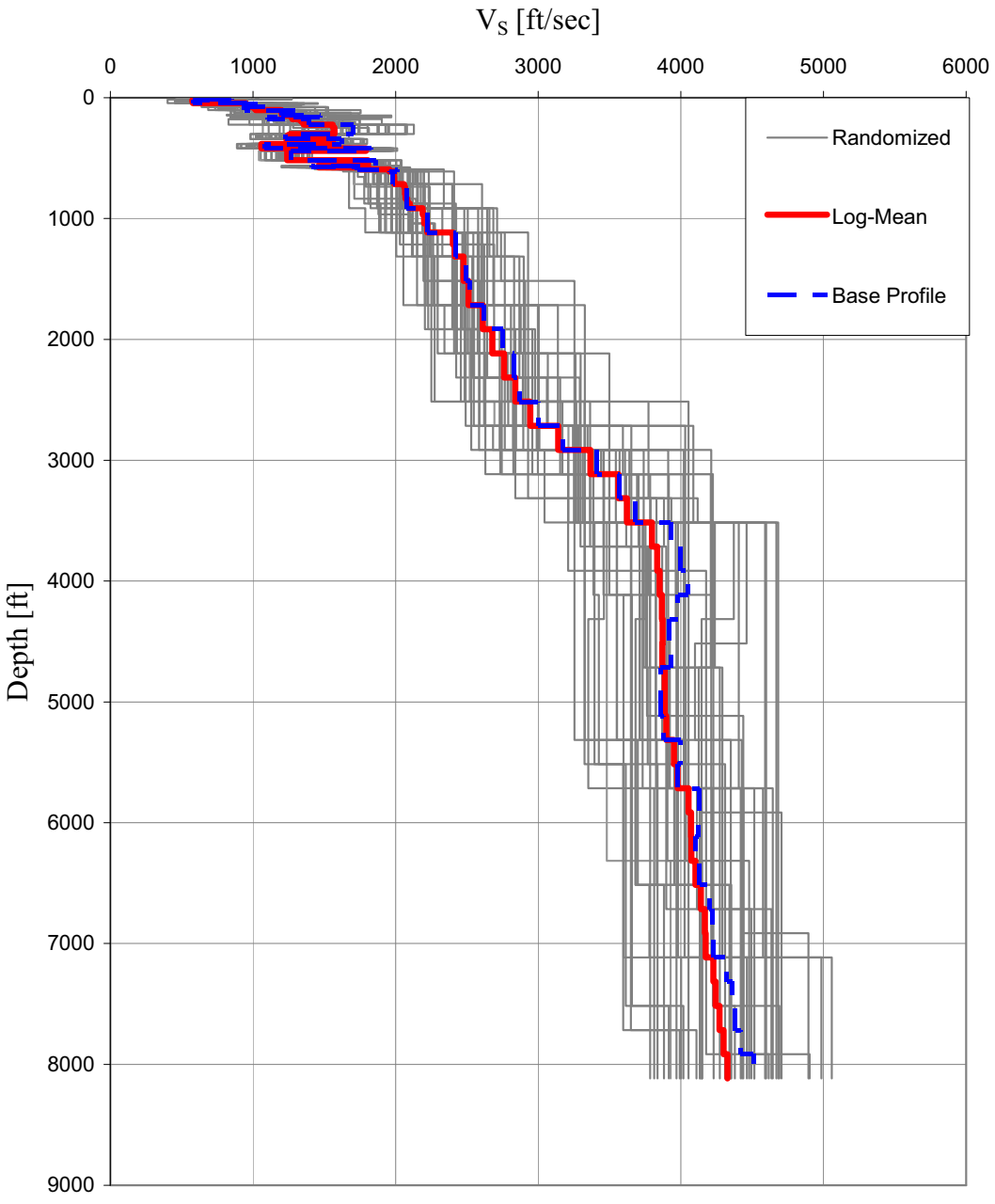


Figure 3.7-202 Randomized Shear Wave Velocity Profiles, Log-Mean Shear Wave Velocity Profile and the Base Profile Used For Randomization — Unit 2

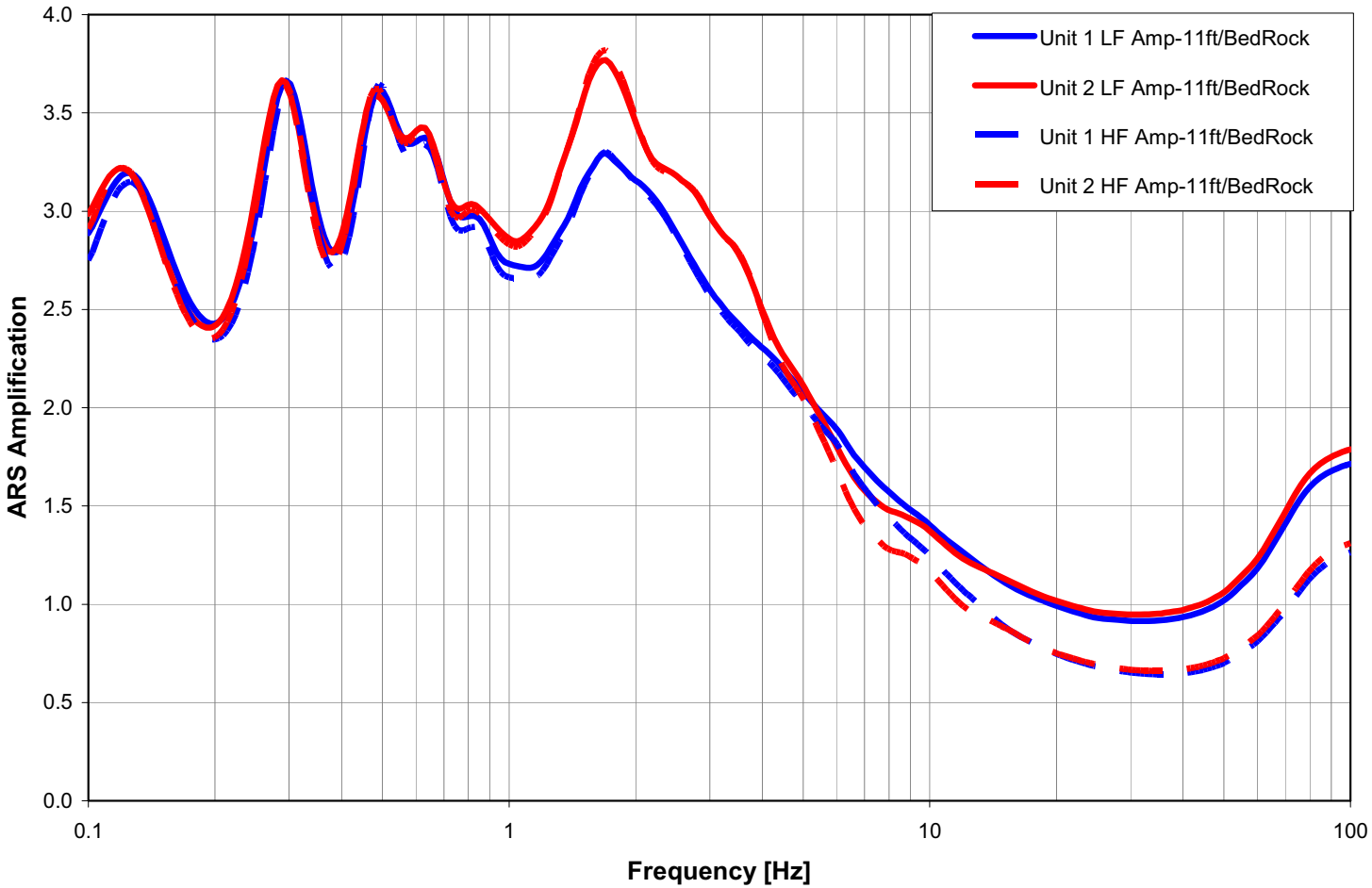


Figure 3.7-203 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of FWSC (at 11 foot depth) for 10^{-4} LF and HF Input Motions

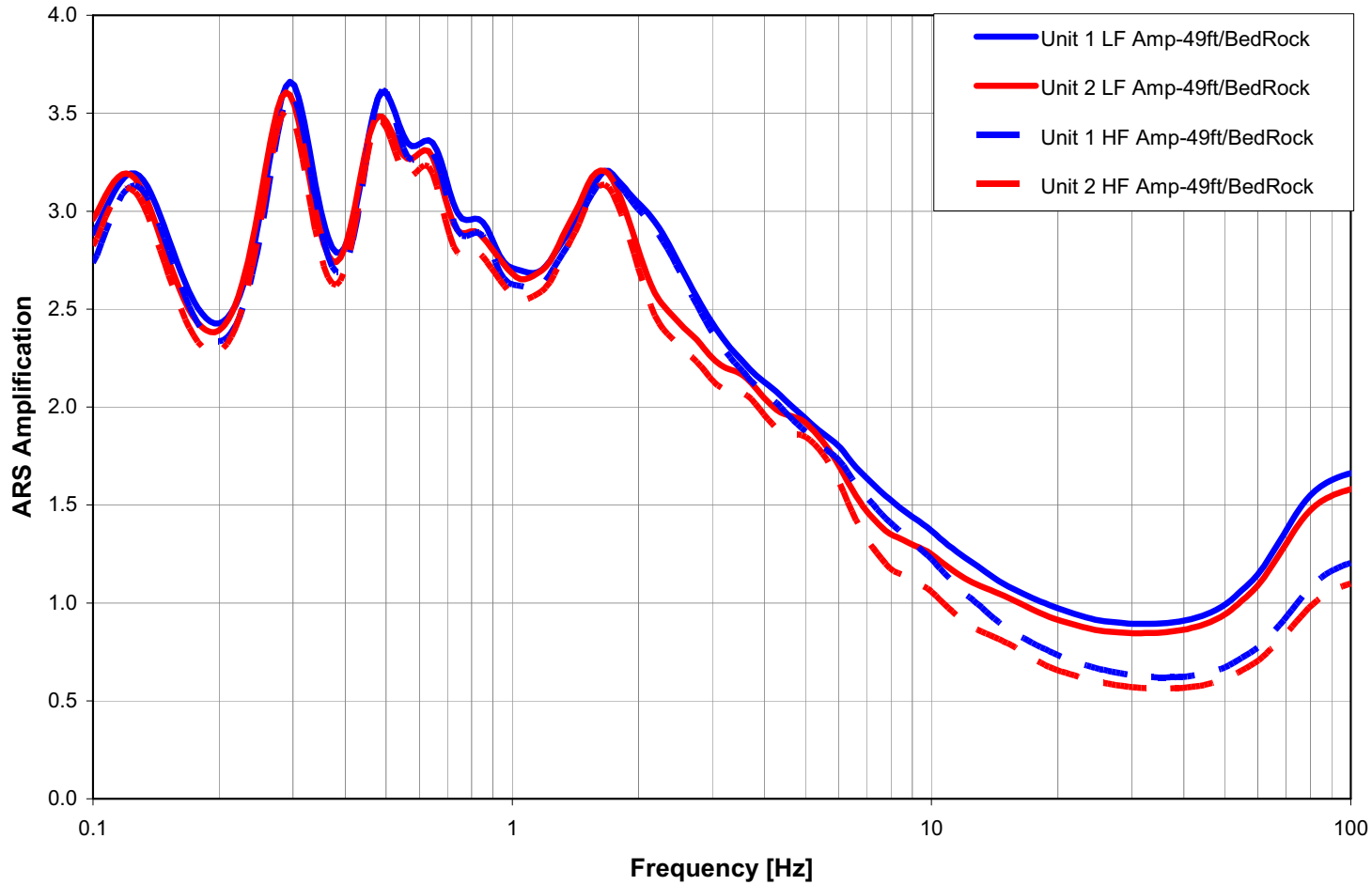


Figure 3.7-204 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of CB (at 49 foot depth) for 10^{-4} LF and HF Input Motion

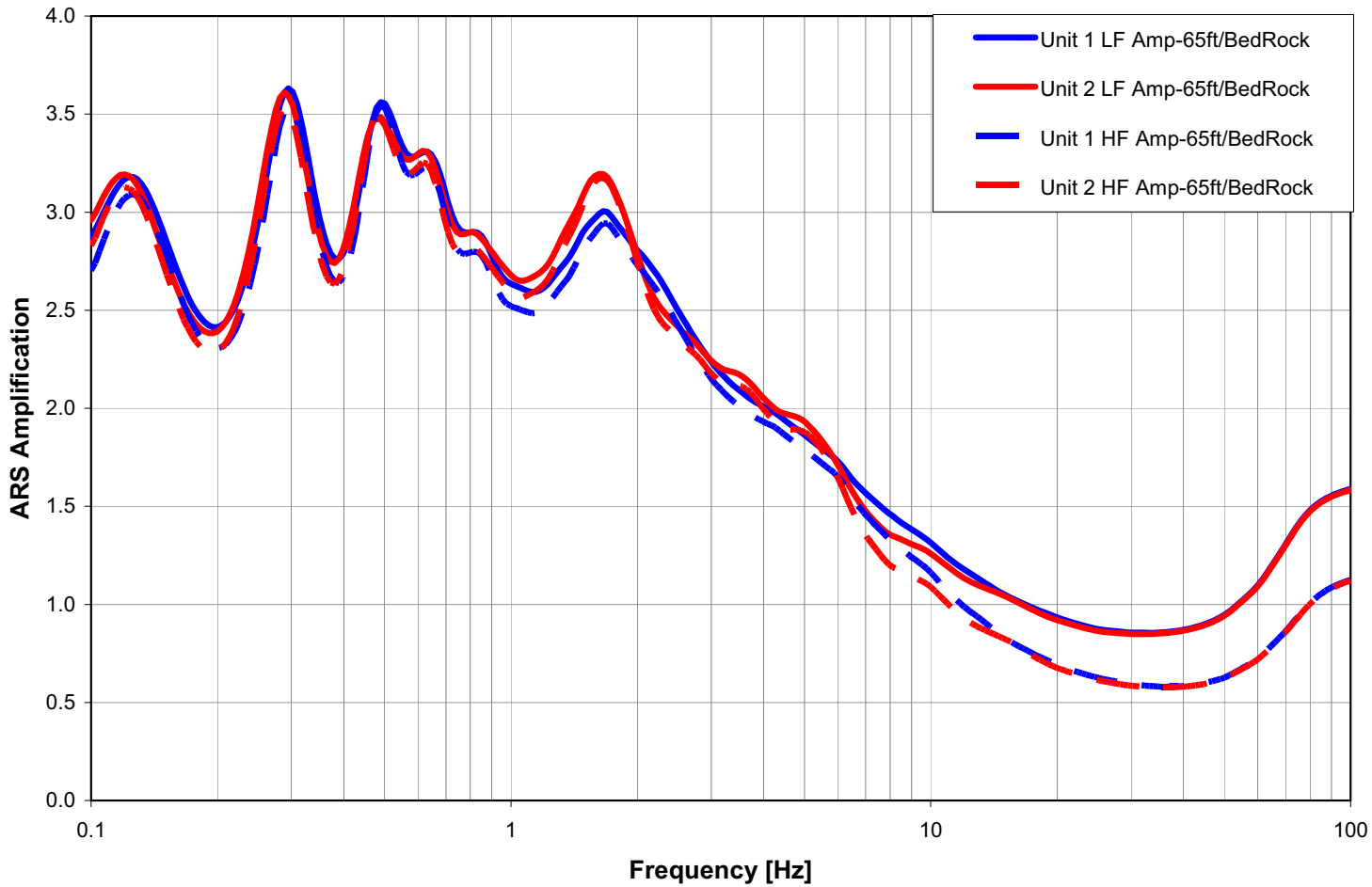


Figure 3.7-205 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of RB/FB (at 65 foot depth) for 10^{-4} LF and HF Input Motions

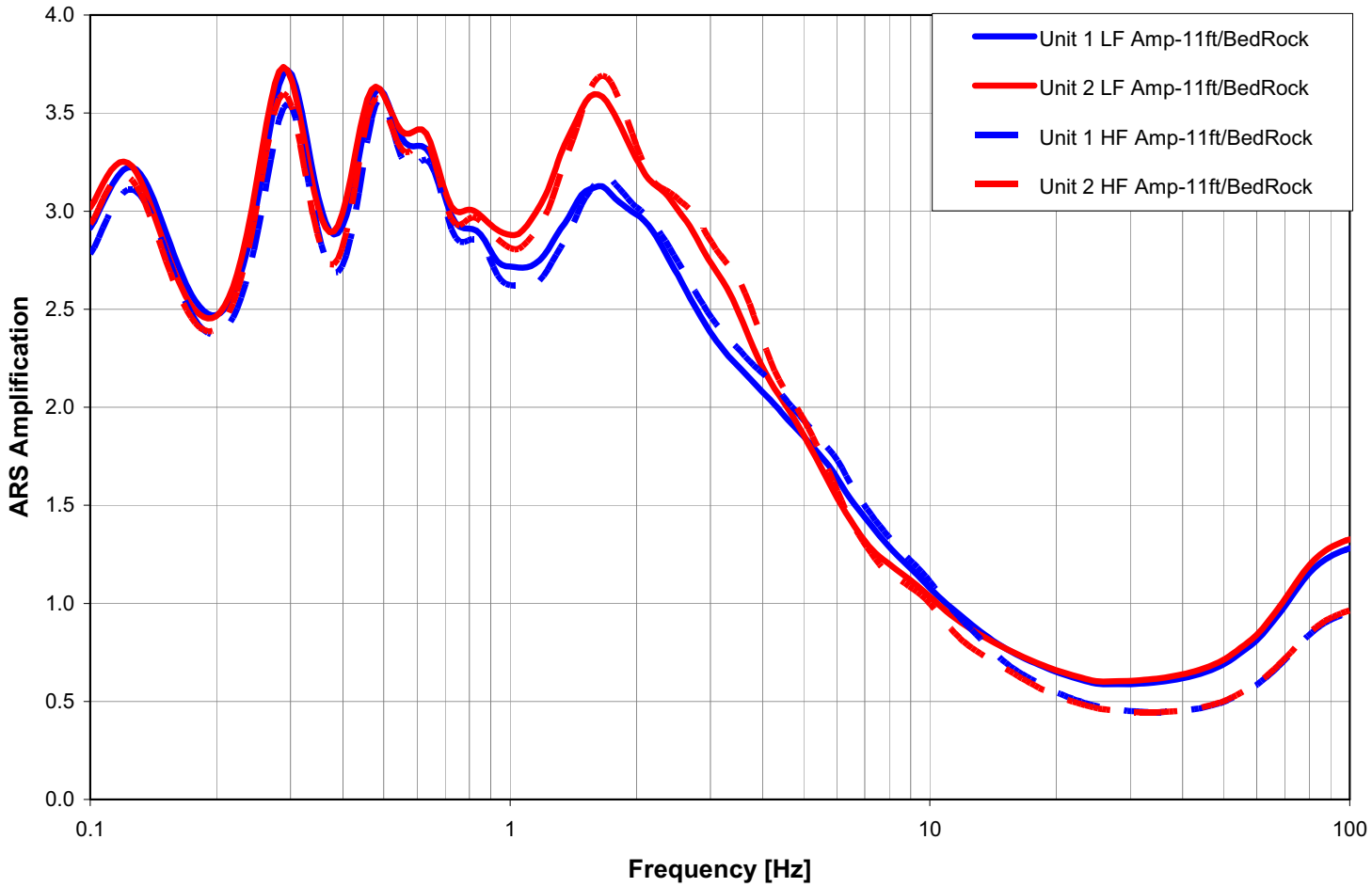


Figure 3.7-206 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of FWSC (at 11 foot depth) for 10^{-5} LF and HF Input Motions

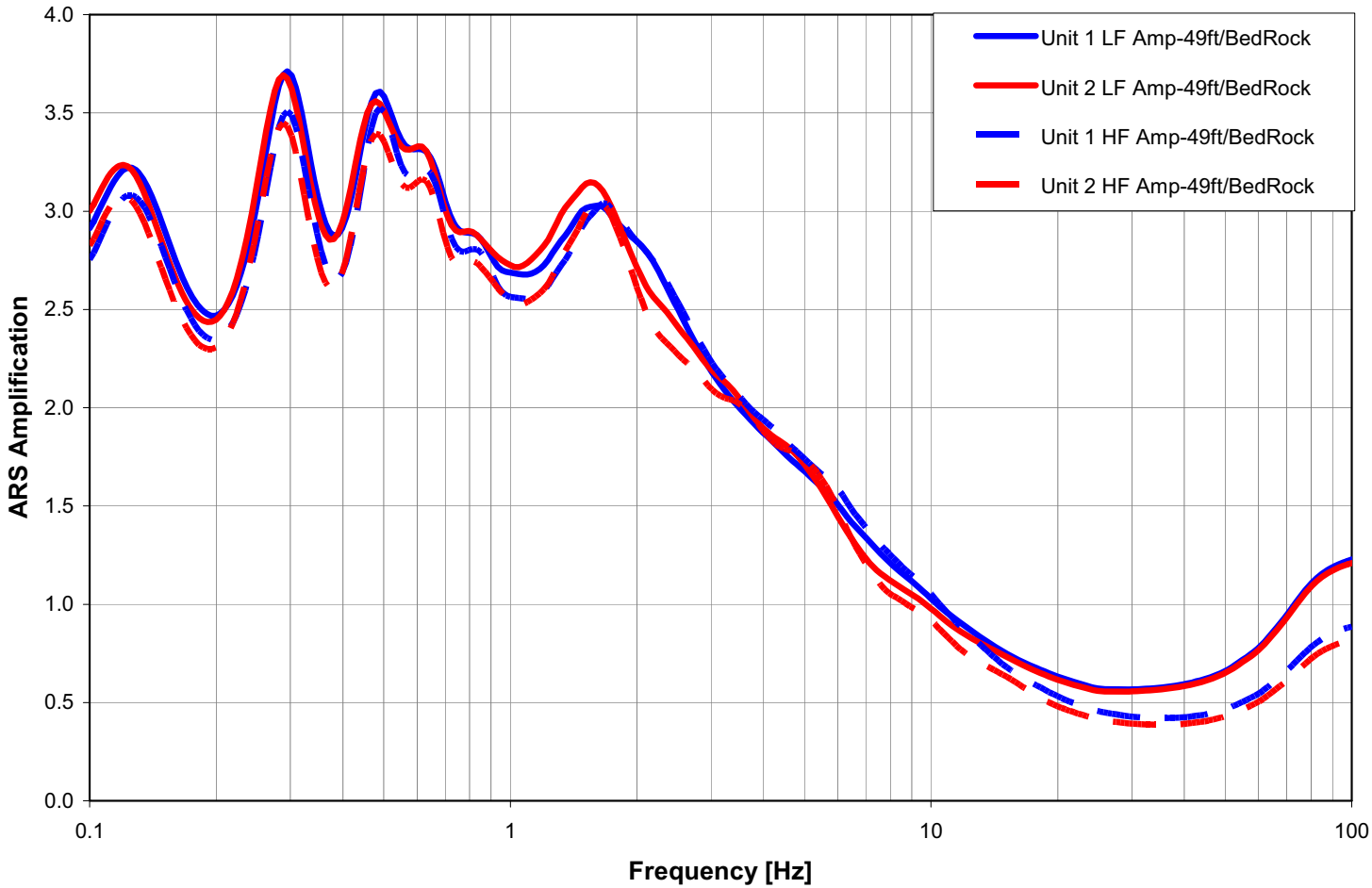


Figure 3.7-207 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of CB (at 49 foot depth) for 10^{-5} LF and HF Input Motions

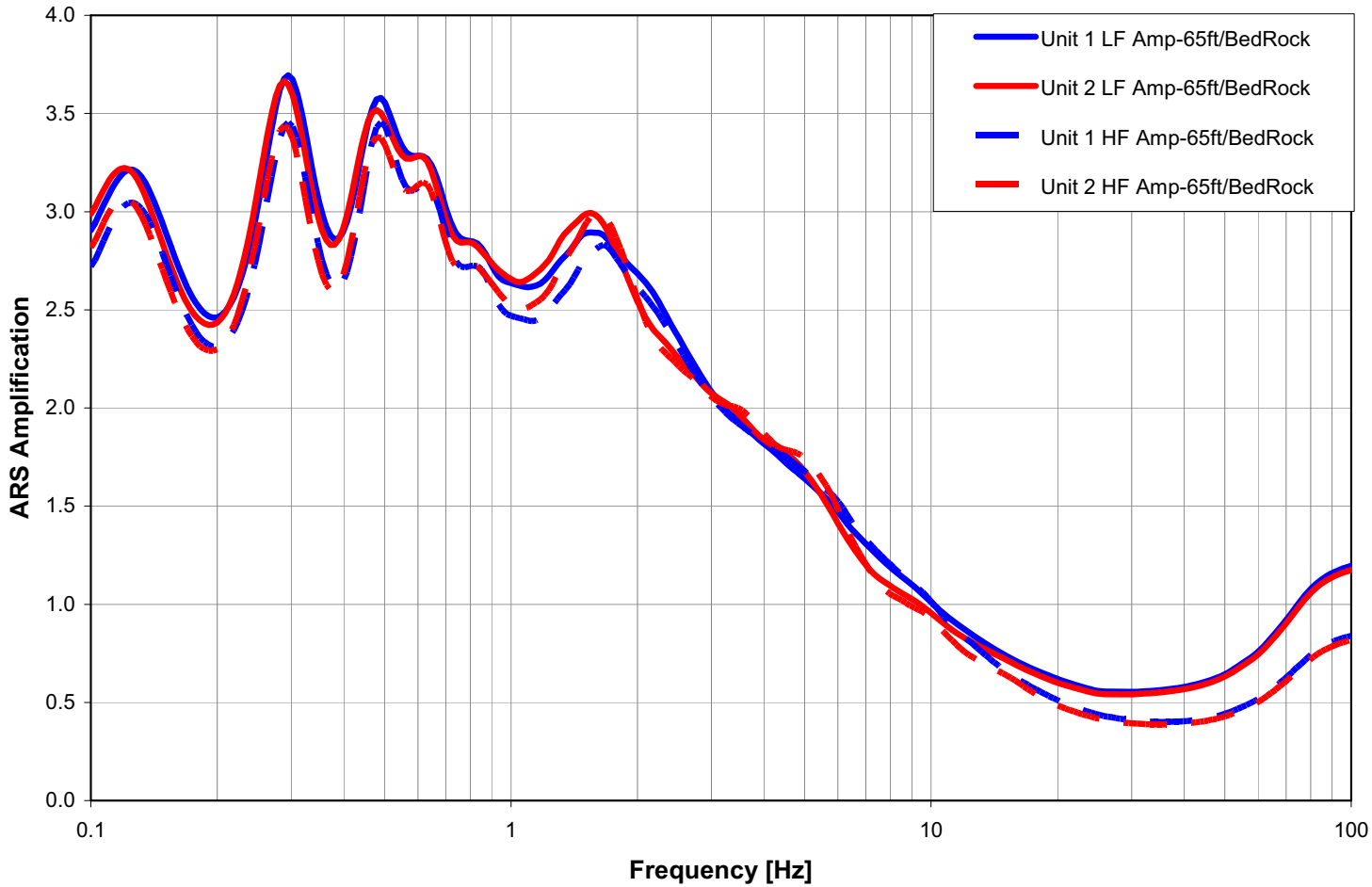


Figure 3.7-208 Logarithmic Mean of Site Amplification Factor at FIRS Horizon of RB/FB (at 65 foot depth) for 10^{-5} LF and HF Input Motions

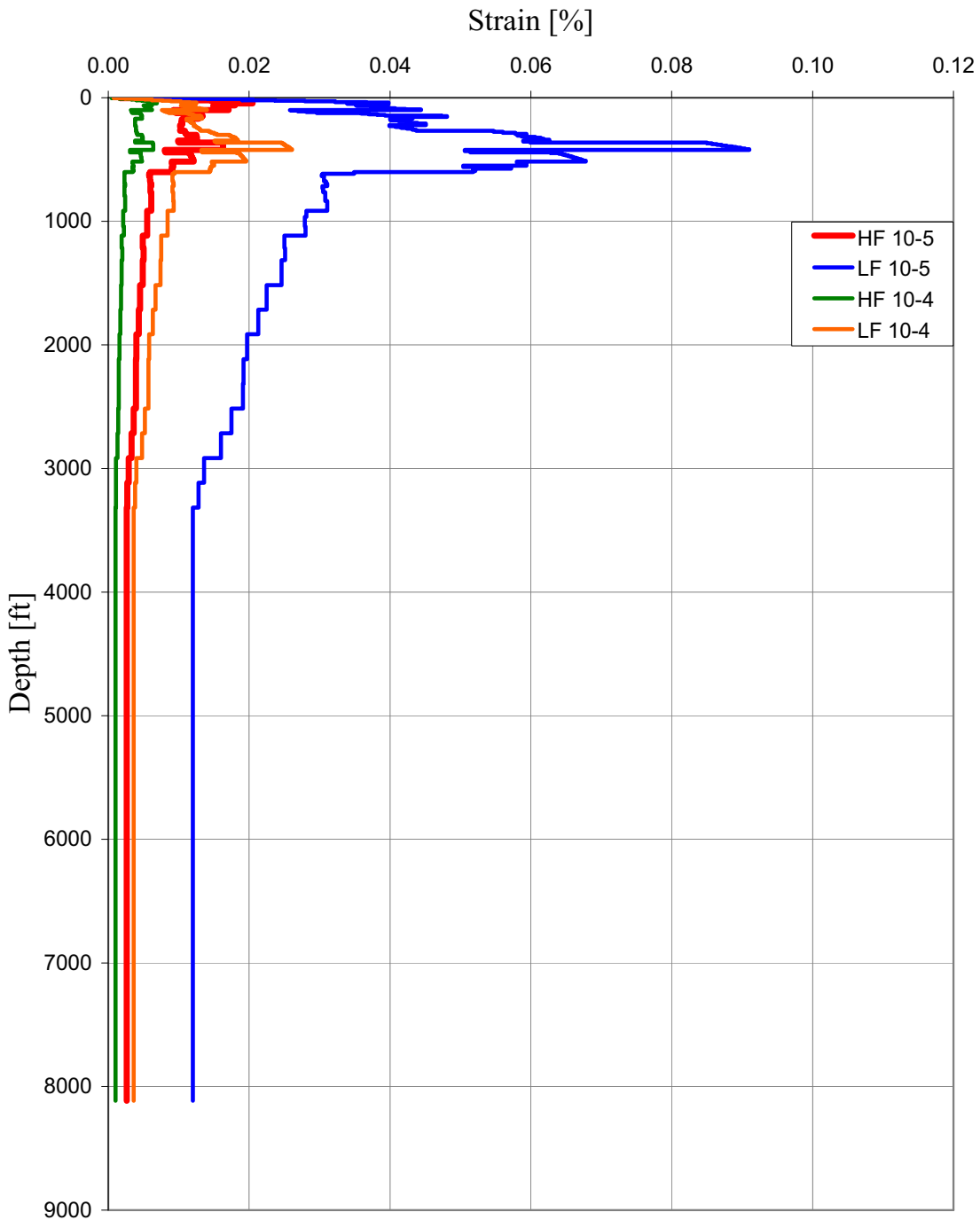


Figure 3.7-209 Logarithmic Mean Maximum Strain Profiles — Unit 1

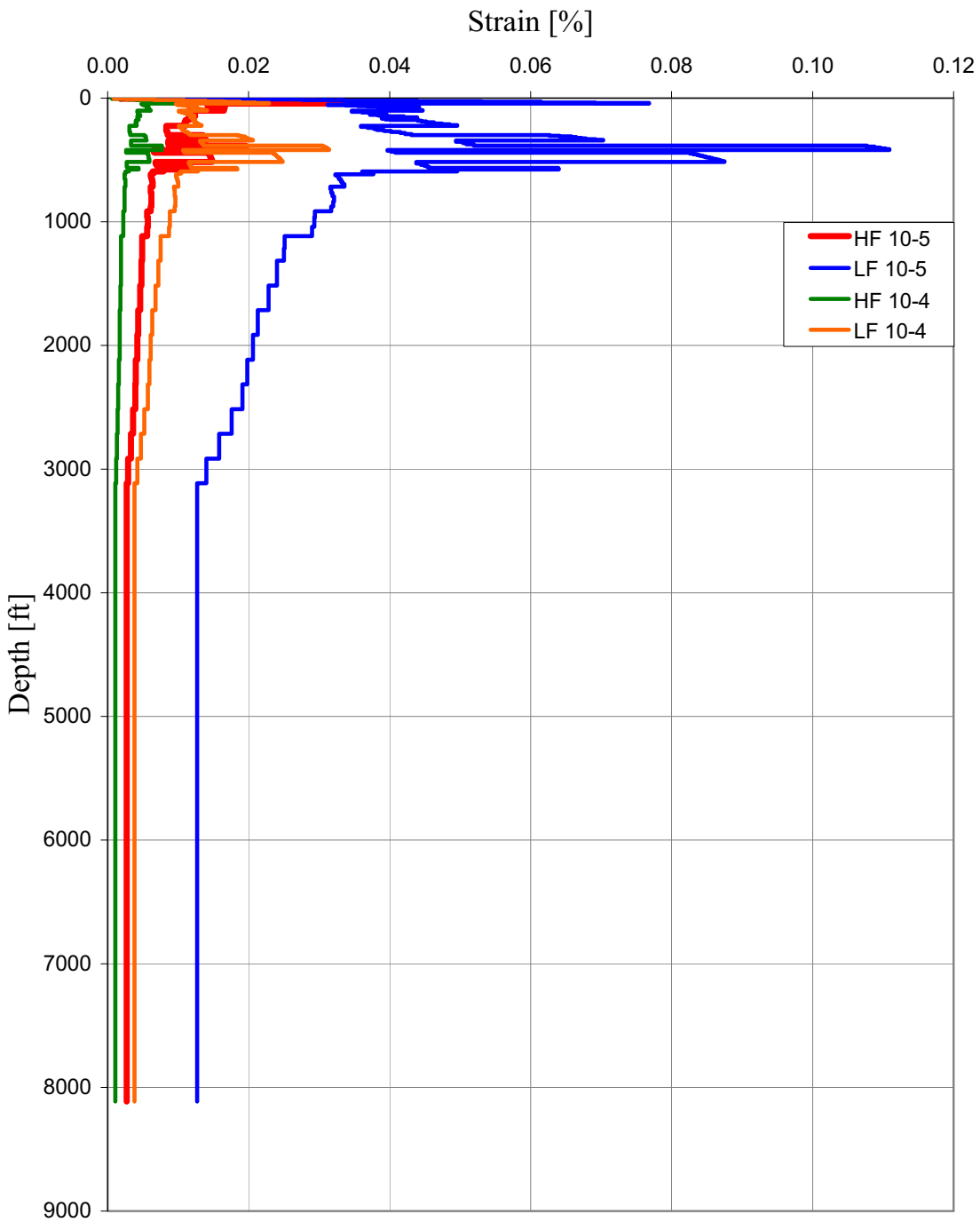


Figure 3.7-210 Logarithmic Mean Maximum Strain Profiles — Unit 2

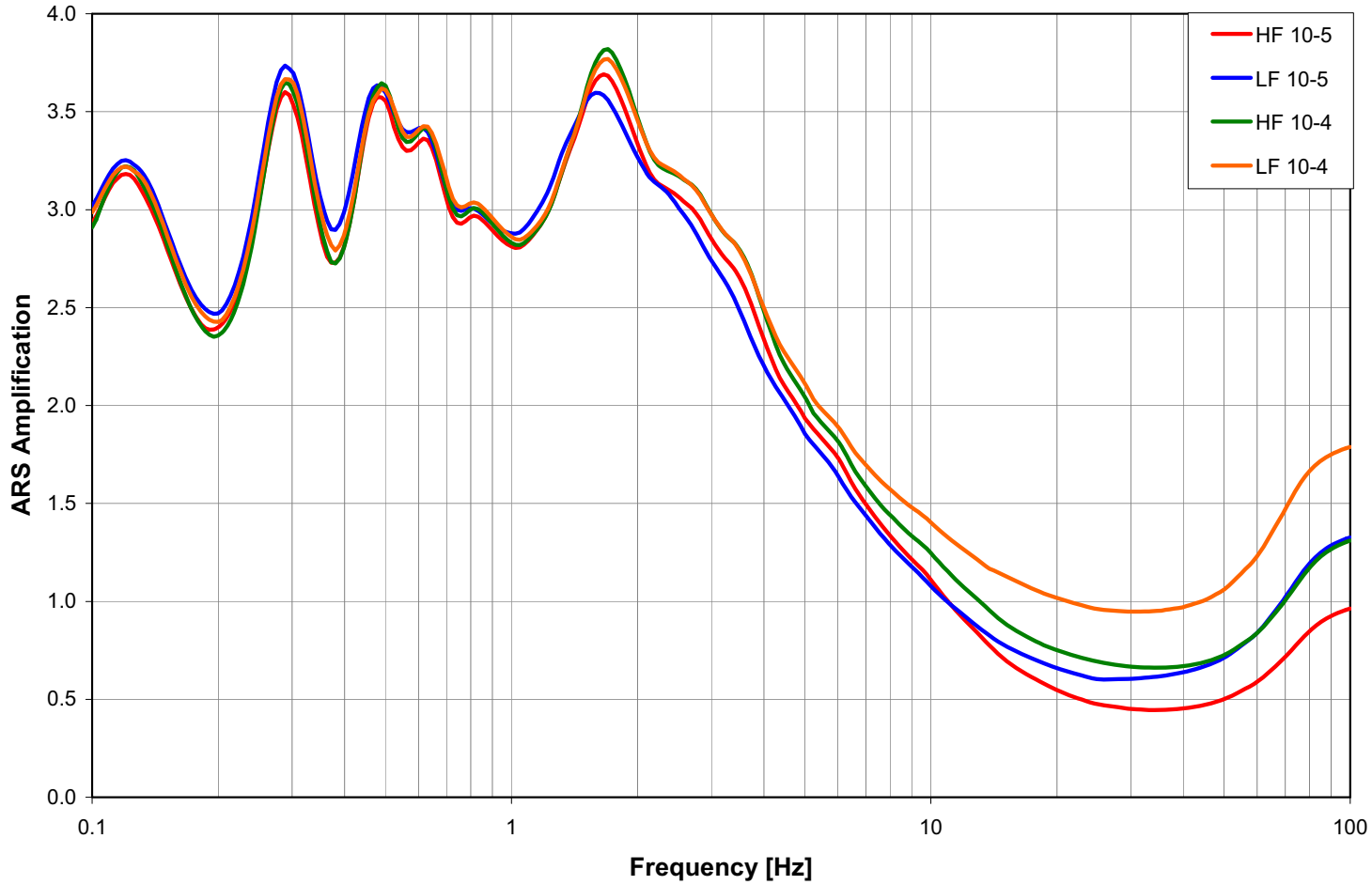


Figure 3.7-211 Comparison of Log-Mean Soil Amplification Factors at FIRS Horizon of FWSC (at 11 foot depth) for LF and HF 10^{-4} and 10^{-5} Input Motions

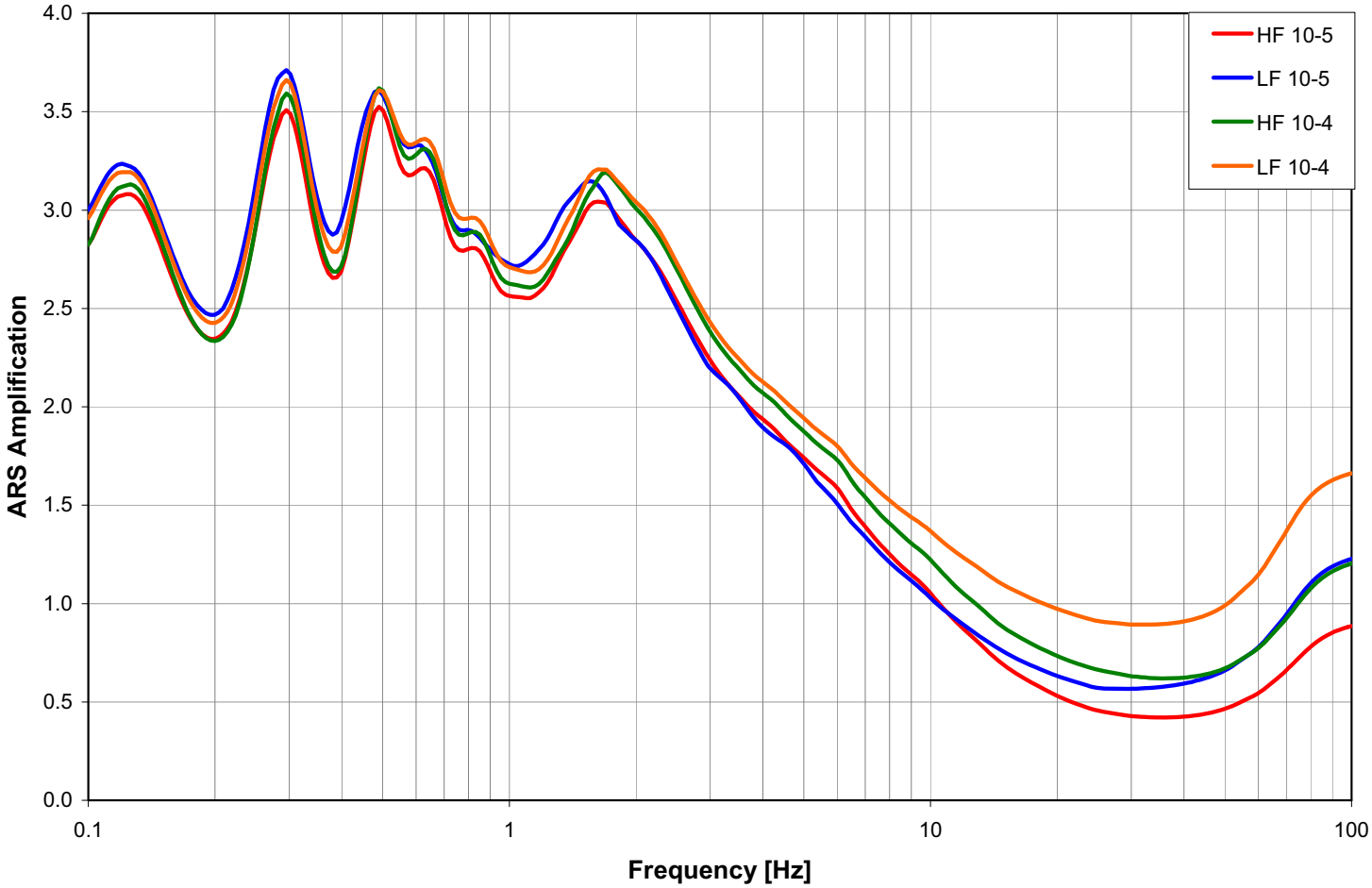


Figure 3.7-212 Comparison of Log-Mean Soil Amplification Factors at FIRS Horizon of CB (at 49 foot depth) for LF and HF 10^{-4} and 10^{-5} Input Motions

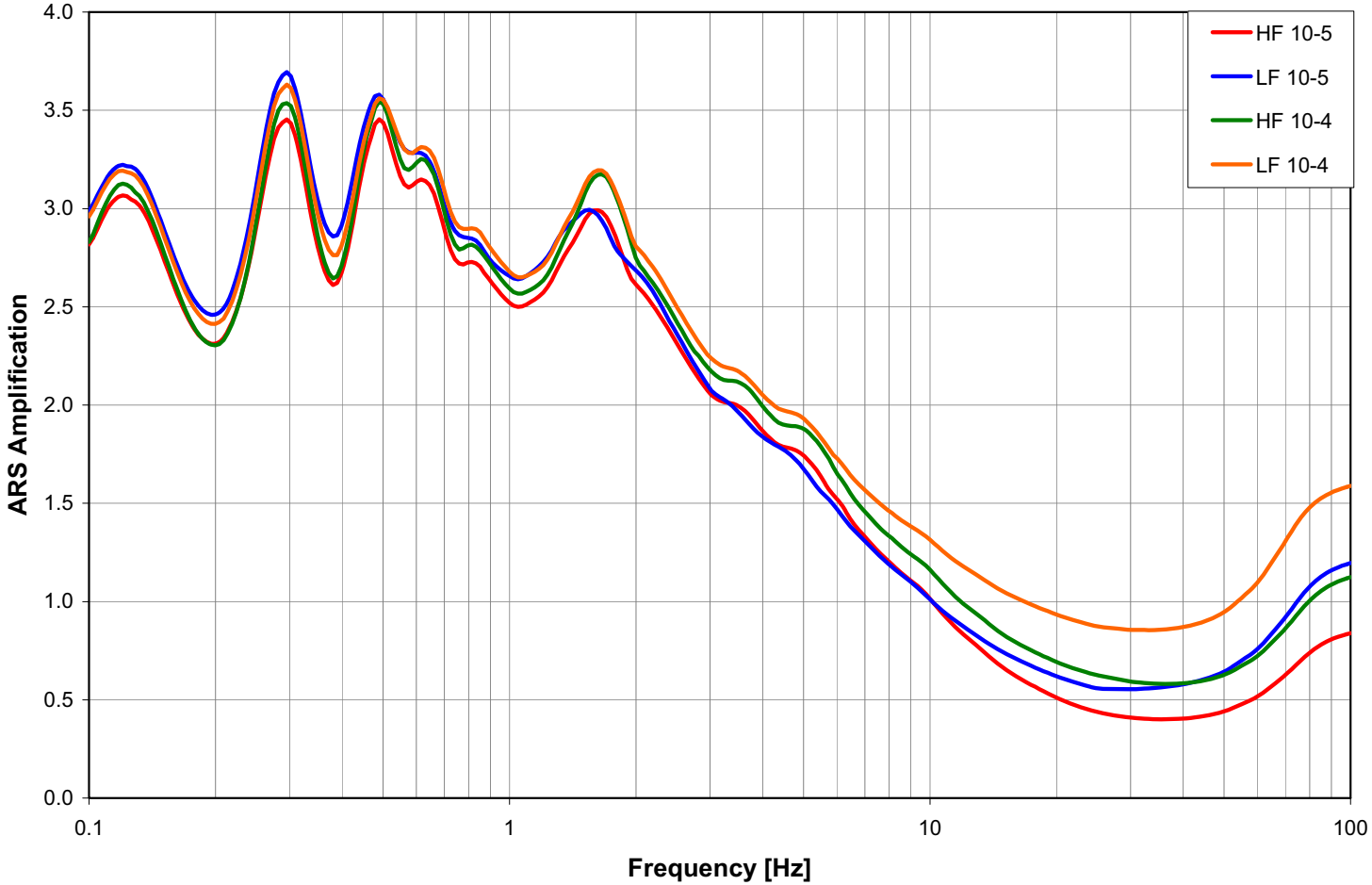


Figure 3.7-213 Comparison of Log-Mean Soil Amplification Factors at FIRS Horizon of RB/FB (at 65 foot depth) for LF and HF 10^{-4} and 10^{-5} Input Motions

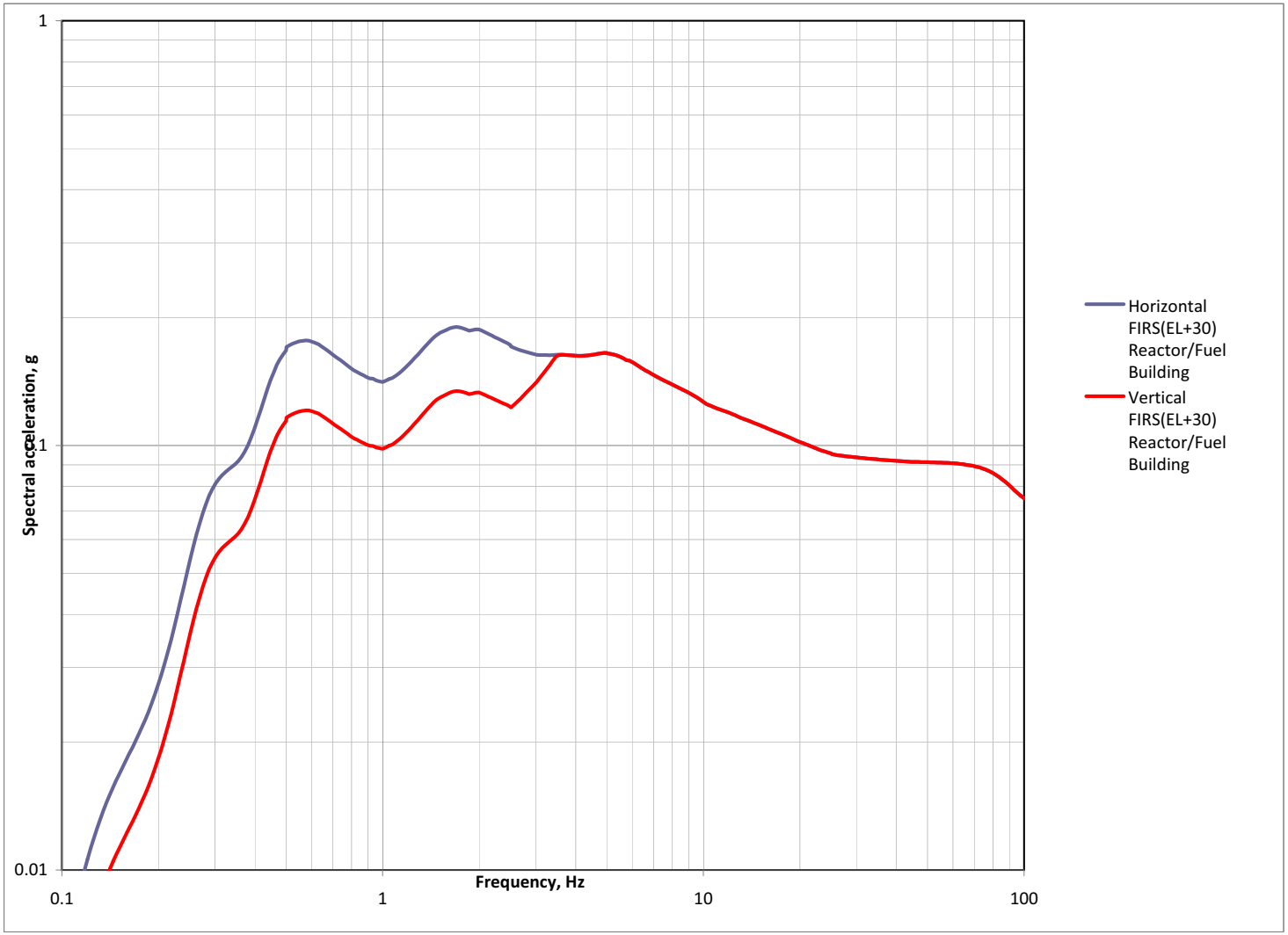


Figure 3.7-214 FIRS (Horizontal and Vertical) for Reactor/Fuel Building at Elevation 30 Feet

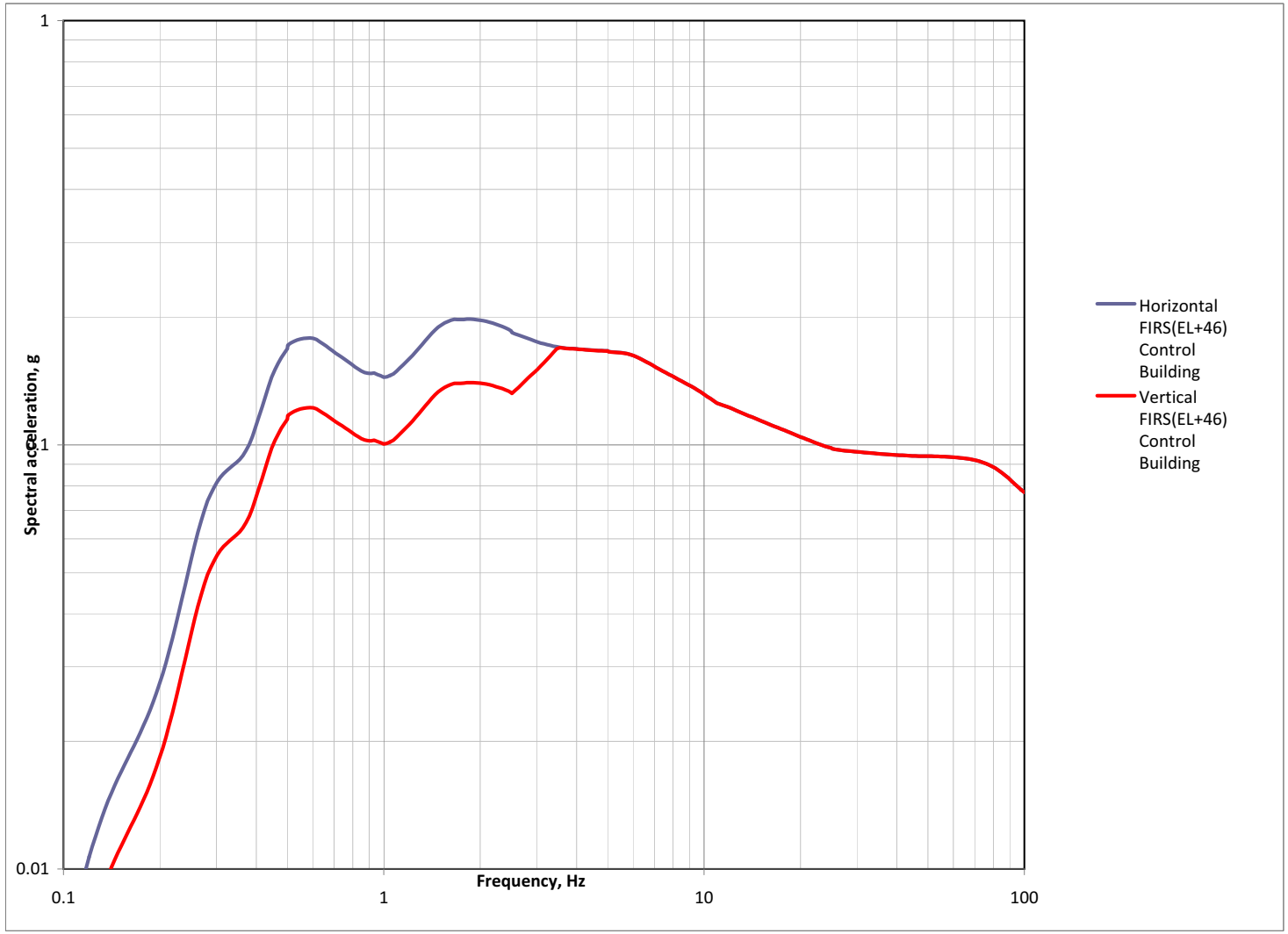


Figure 3.7-215 FIRS (Horizontal and Vertical) for Control Building at Elevation 46 Feet

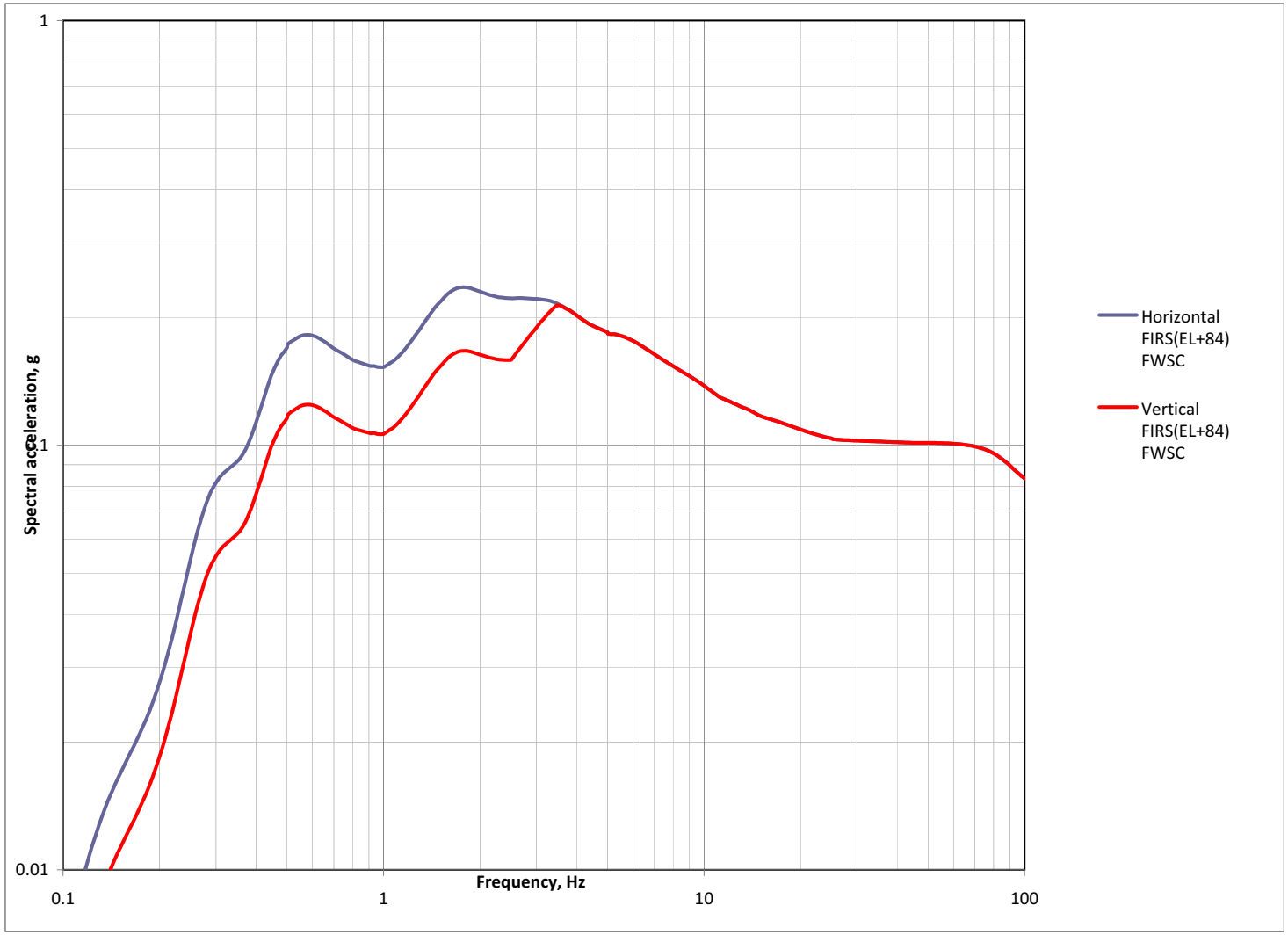


Figure 3.7-216 FIRS (Horizontal and Vertical) for Fire Water Service Complex at Elevation 84 Feet

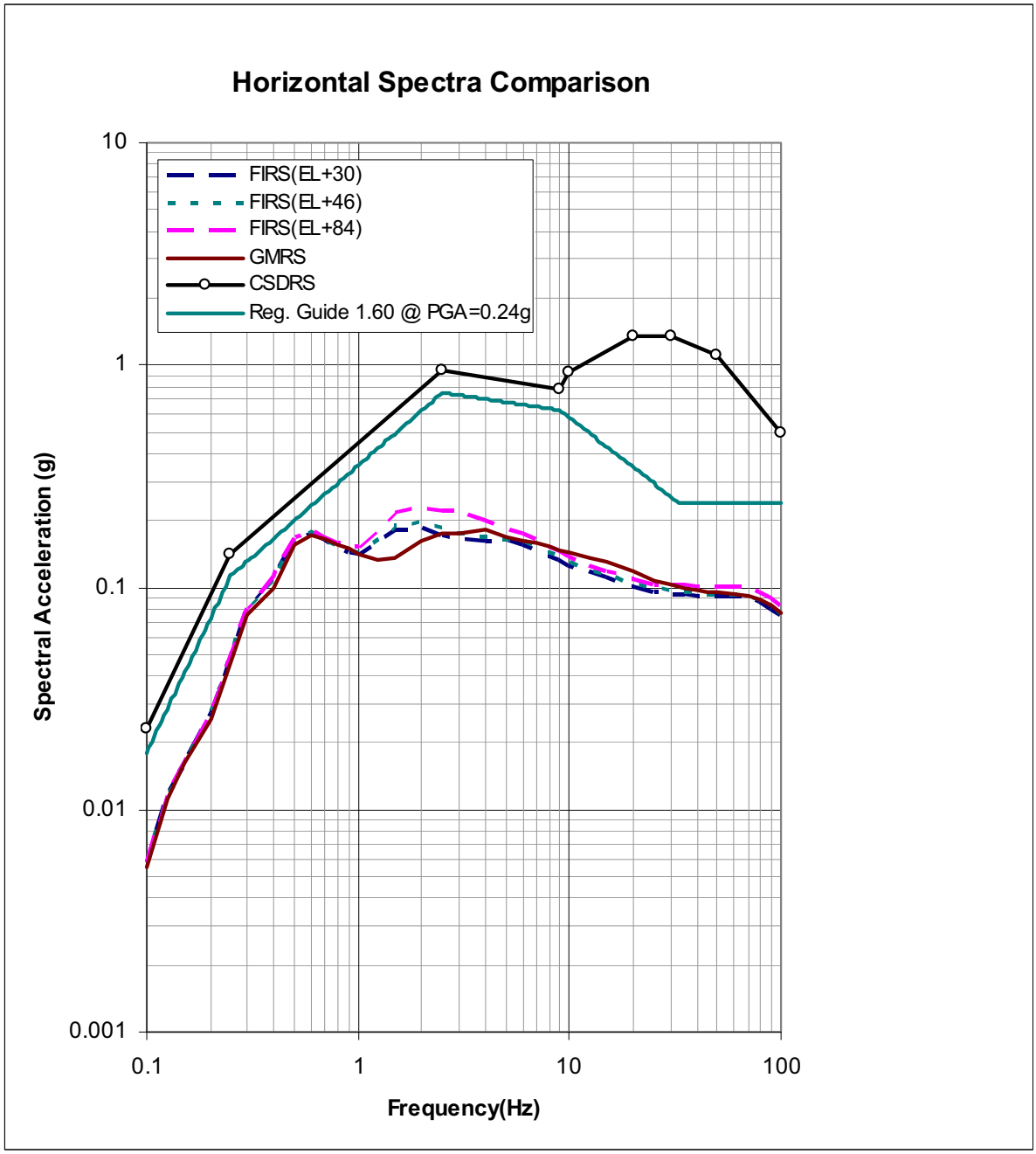


Figure 3.7-217 Comparison of the Recommended Horizontal FIRS for Elevations 30, 46, and 84 Feet, GMRS Horizons with the Horizontal CSDRS, and Regulatory Guide 1.60 @ PGA = 0.24g

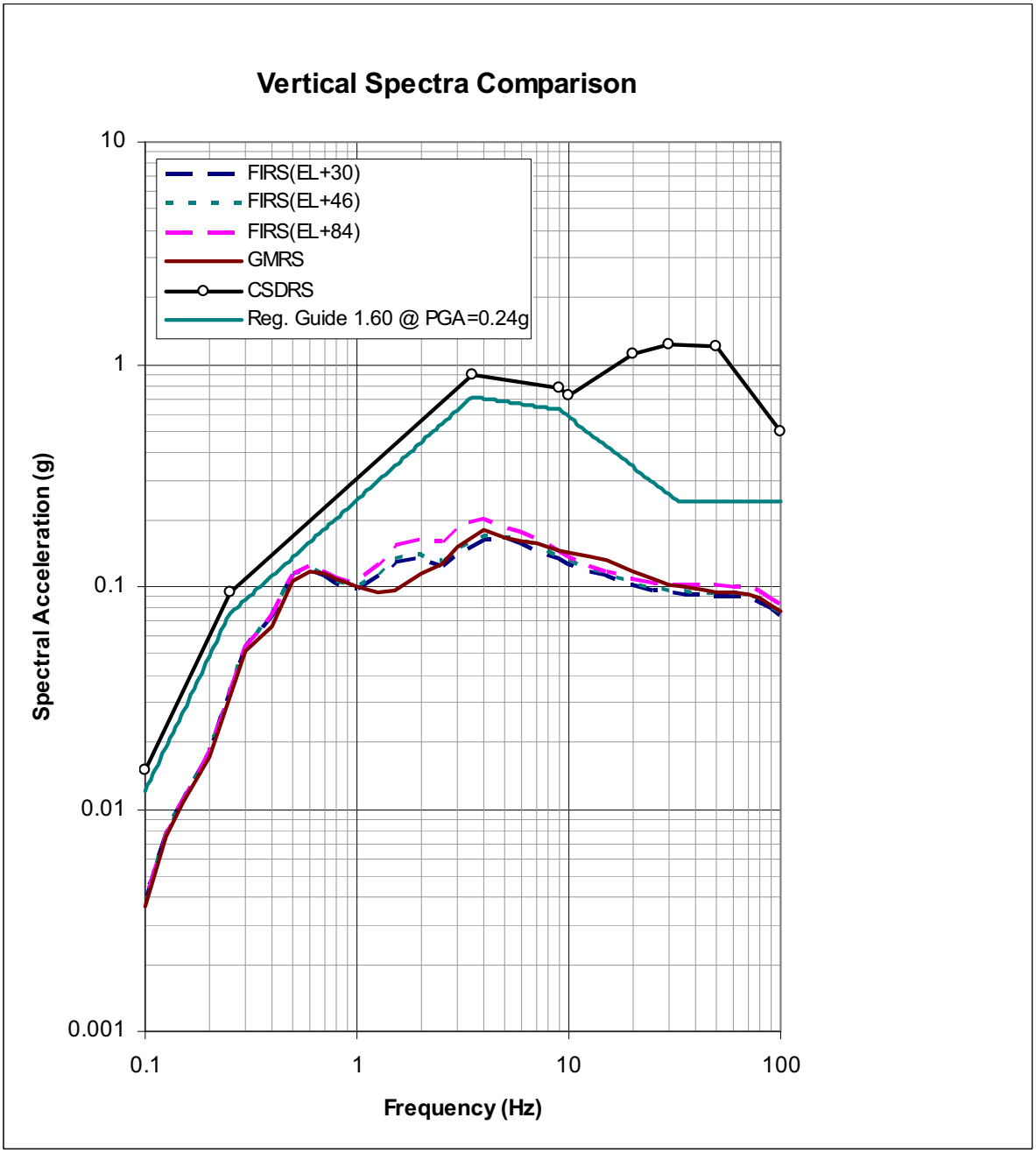


Figure 3.7-218 Comparison of the Recommended Vertical FIRS for Elevations 30, 46, and 84 Feet, GMRS Horizons with the Vertical CSDRS, and Regulatory Guide 1.60 @ PGA = 0.24g

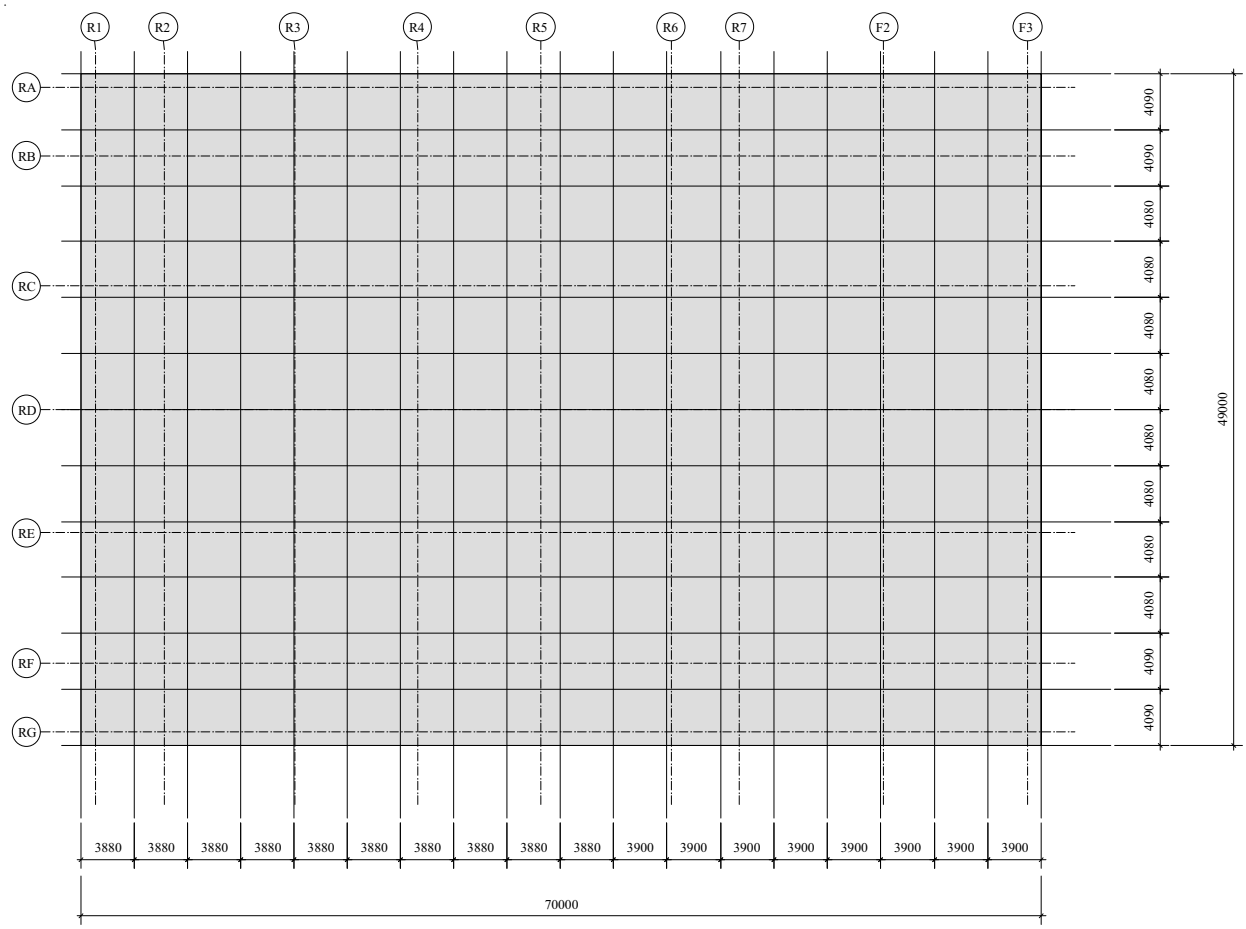
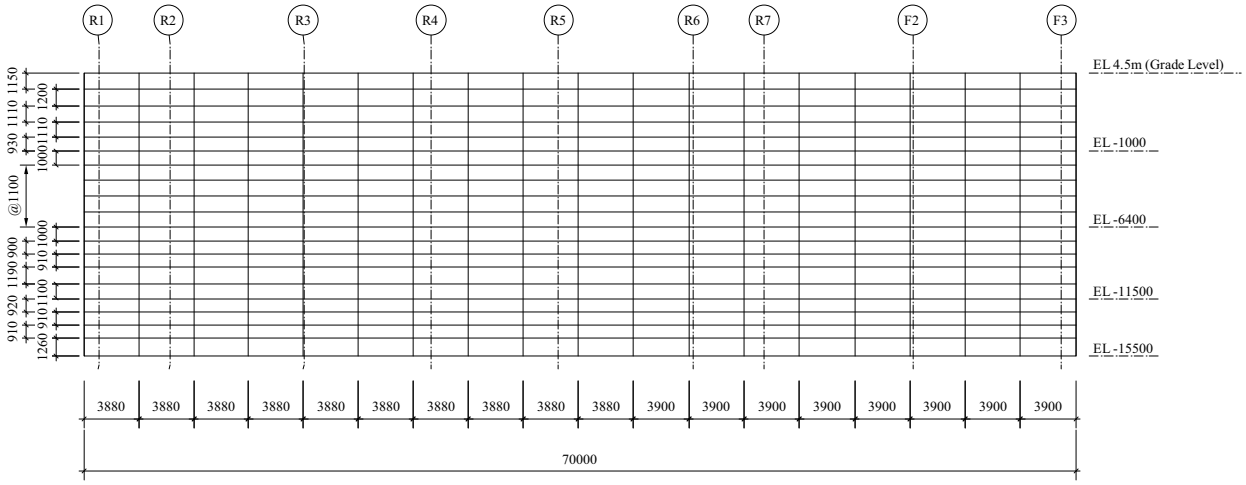
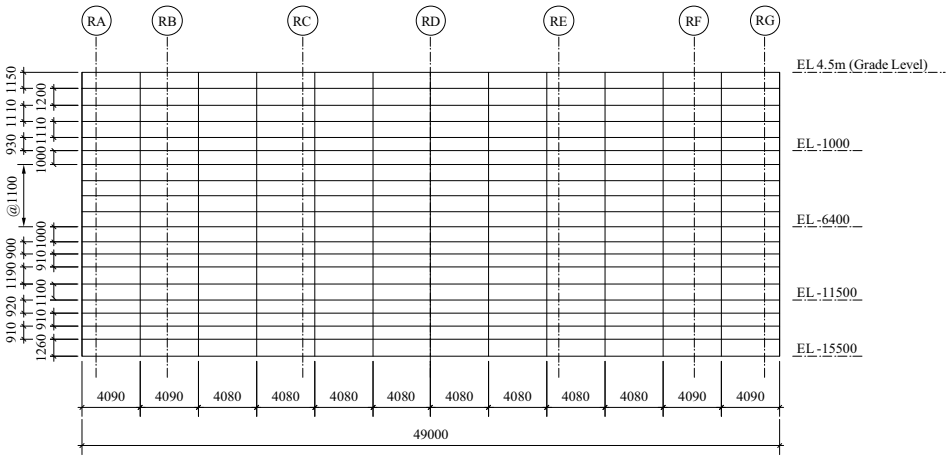


Figure 3.7-219 SASSI2000 Plate Elements for RB/FB Basemat



(a) Walls on Column Rows RA and RG



(b) Walls on Column Rows R1 and F3

Figure 3.7-220 SASSI2000 Plate Elements for RB/FB Exterior Walls

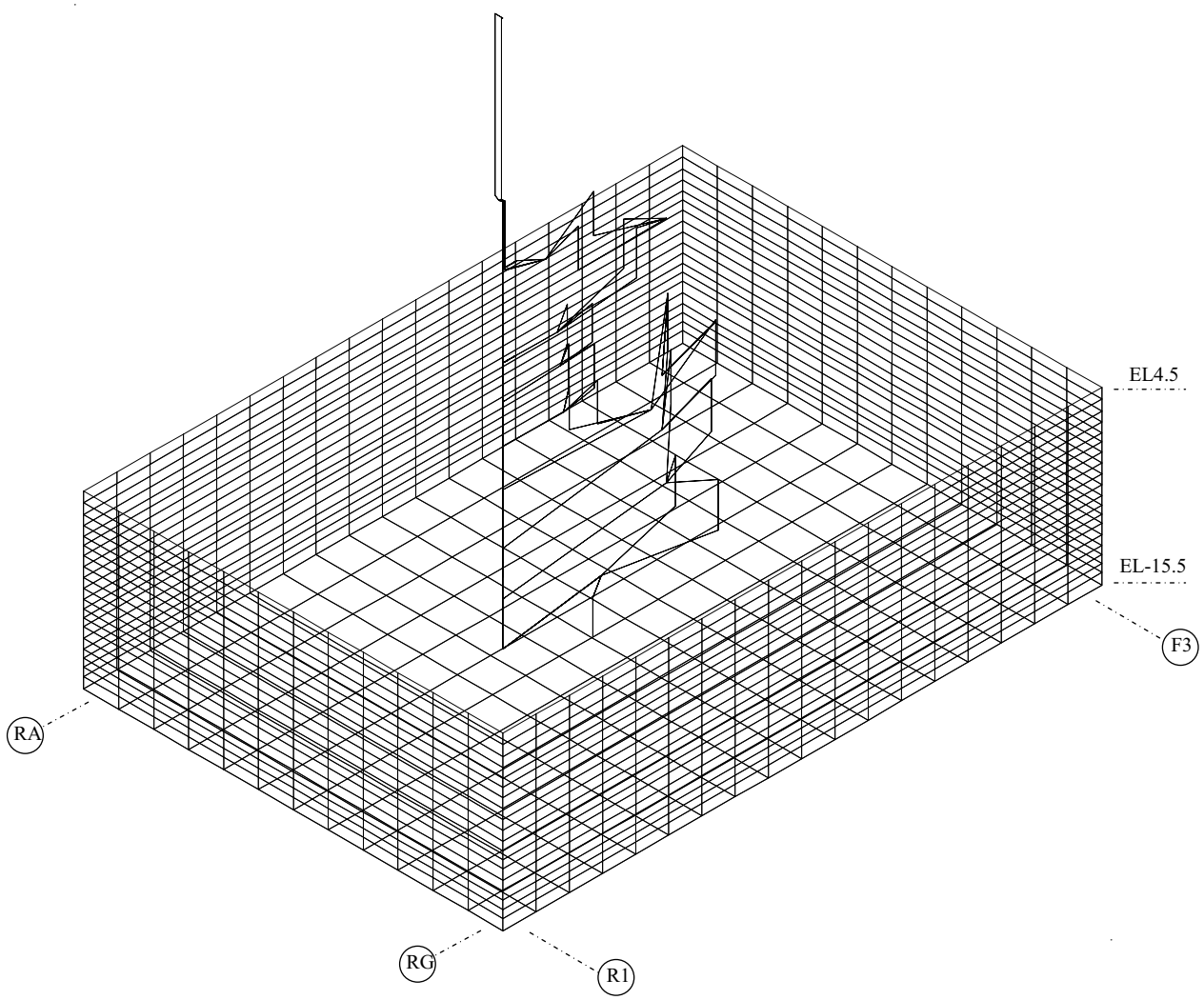


Figure 3.7-221 Overview of RB/FB SASSI2000 Model

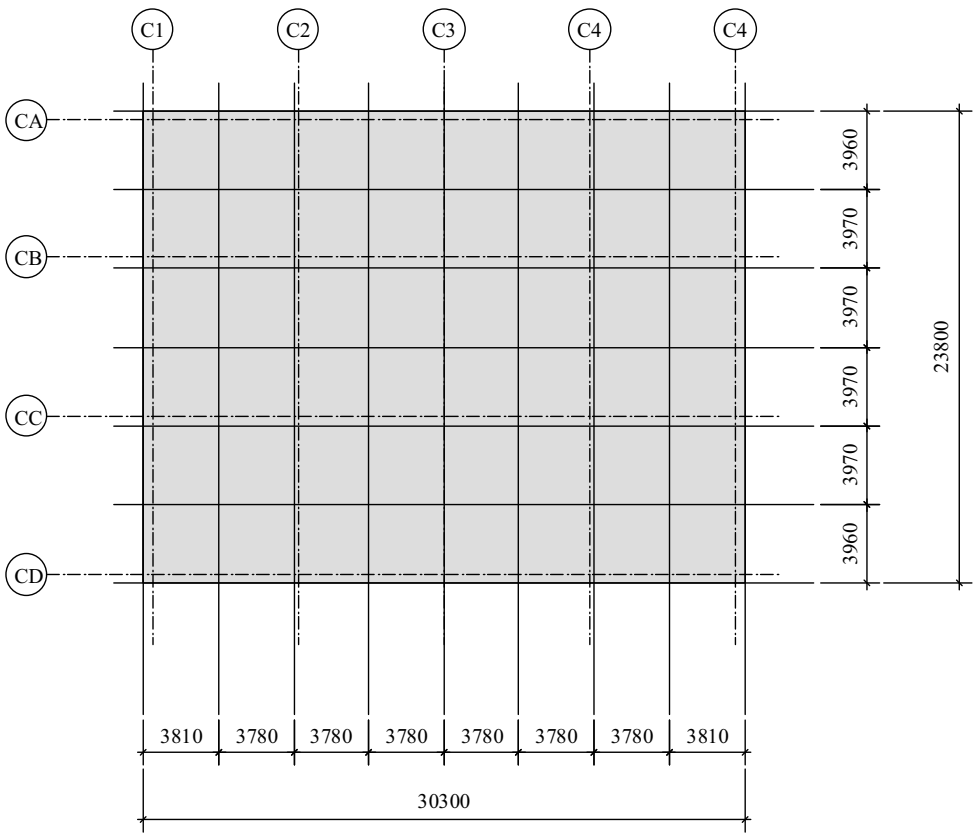
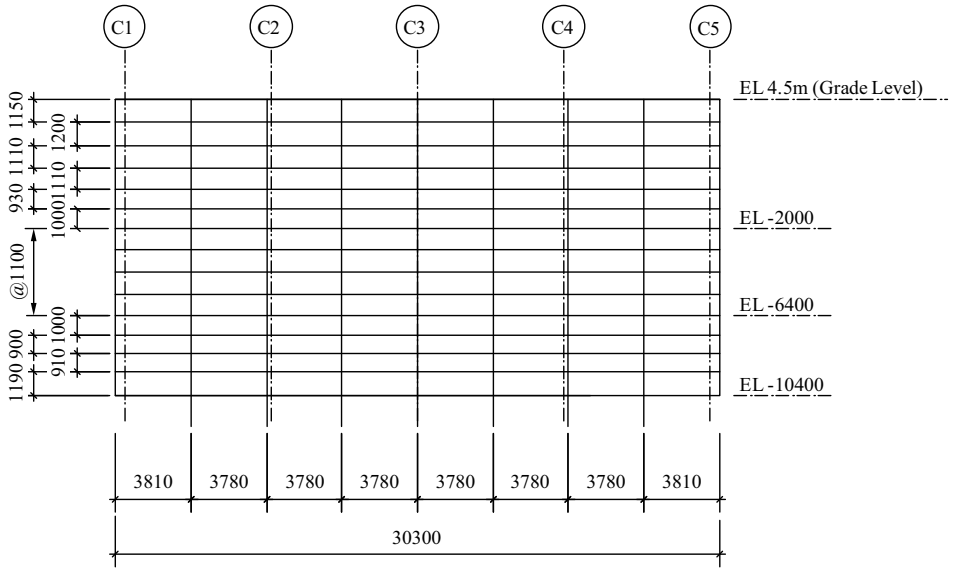
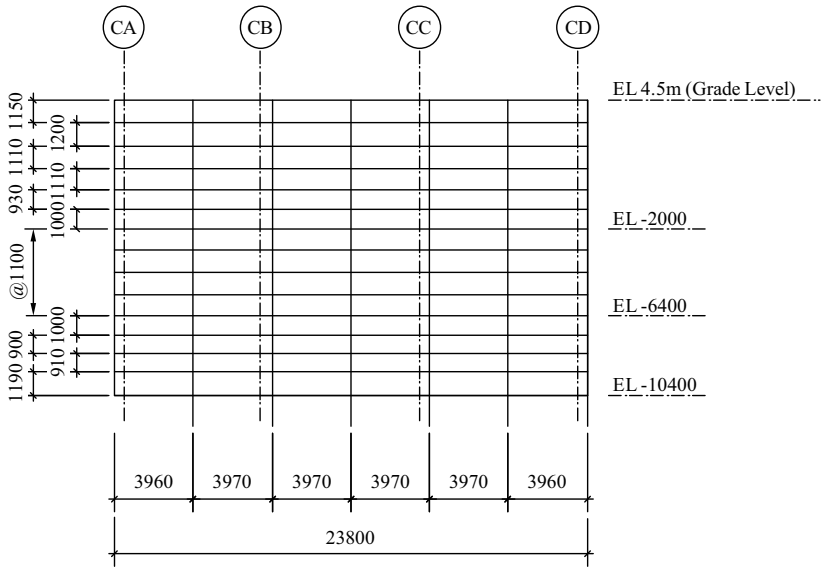


Figure 3.7-222 SASSI2000 Plate Elements for CB Basemat



(a) Walls on Column Rows CA and CD



(b) Walls on Column Rows C1 and C5

Figure 3.7-223 SASSI2000 Plate Elements for CB Exterior Walls

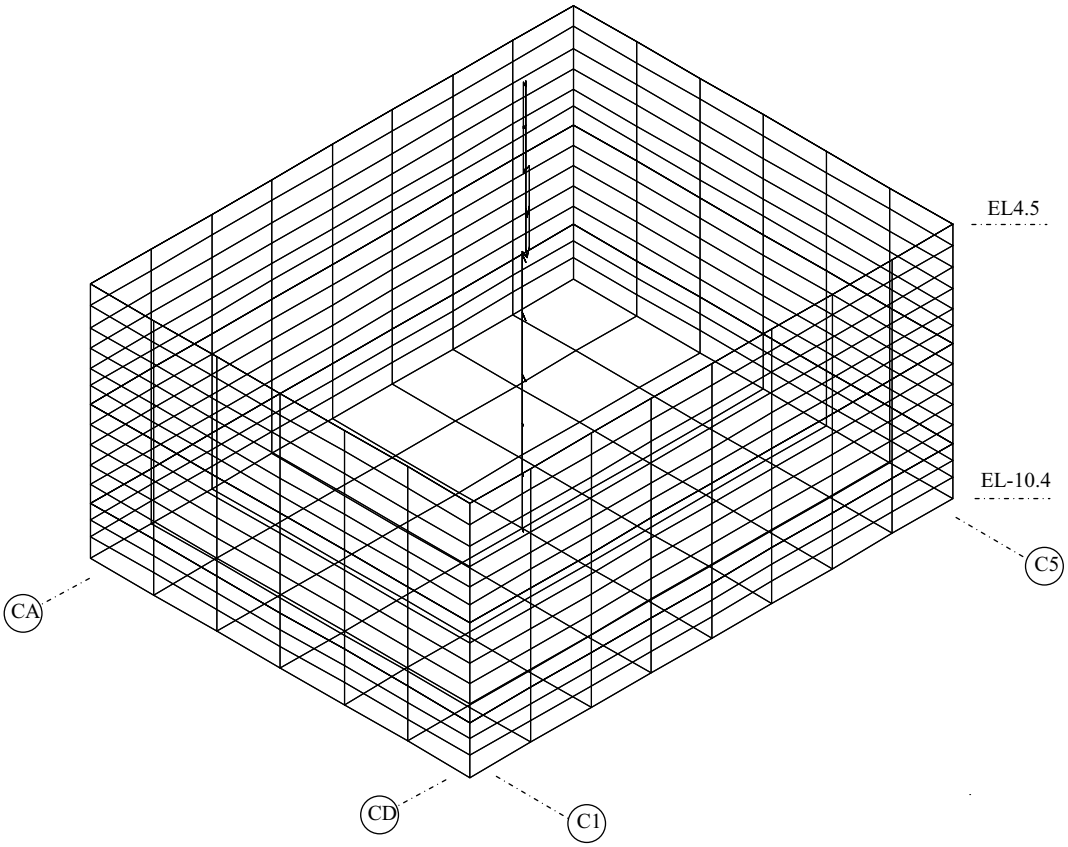


Figure 3.7-224 Overview of CB SASSI2000 Model

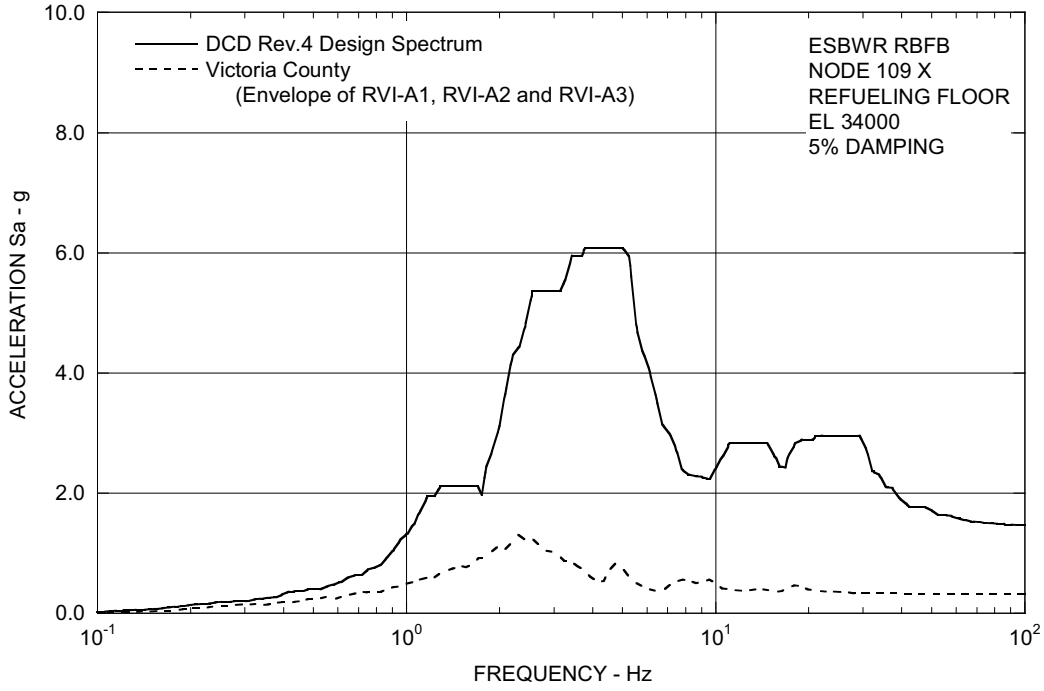


Figure 3.7-225 Comparison of Floor Response Spectra — RB/FB Refueling Floor X

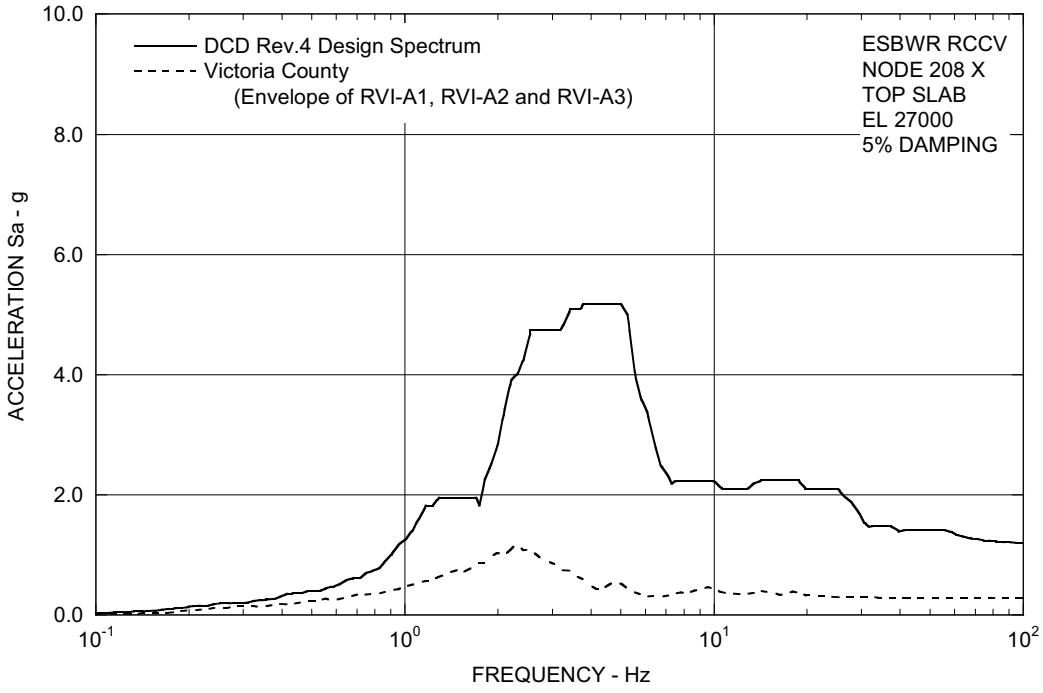


Figure 3.7-226 Comparison of Floor Response Spectra — RCCV Top Slab X

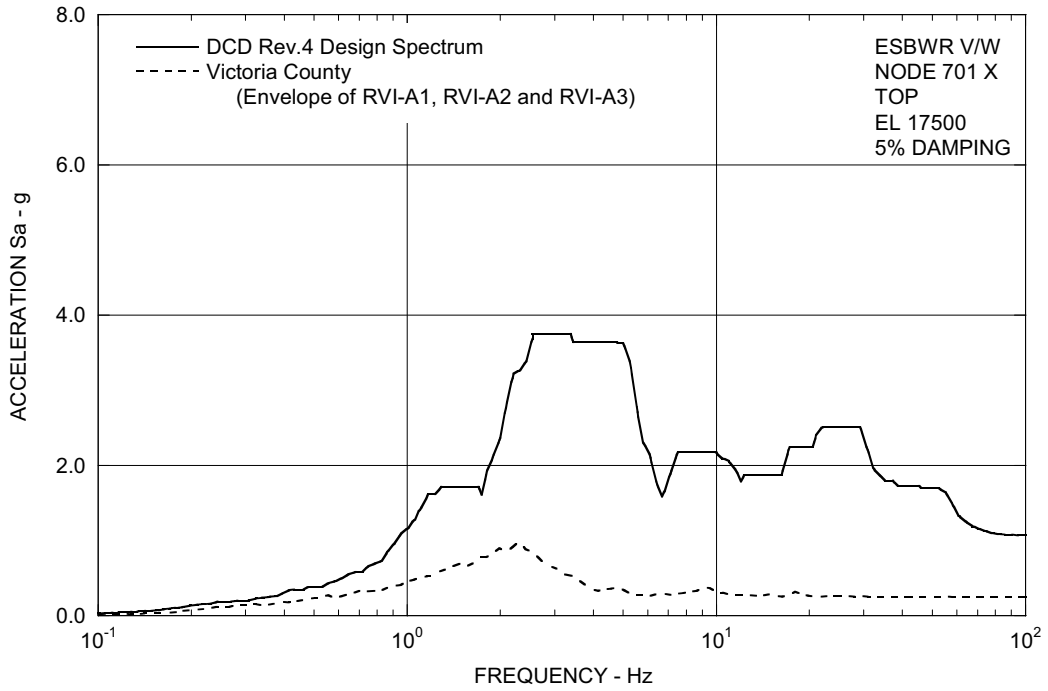


Figure 3.7-227 Comparison of Floor Response Spectra — Vent Wall Top X

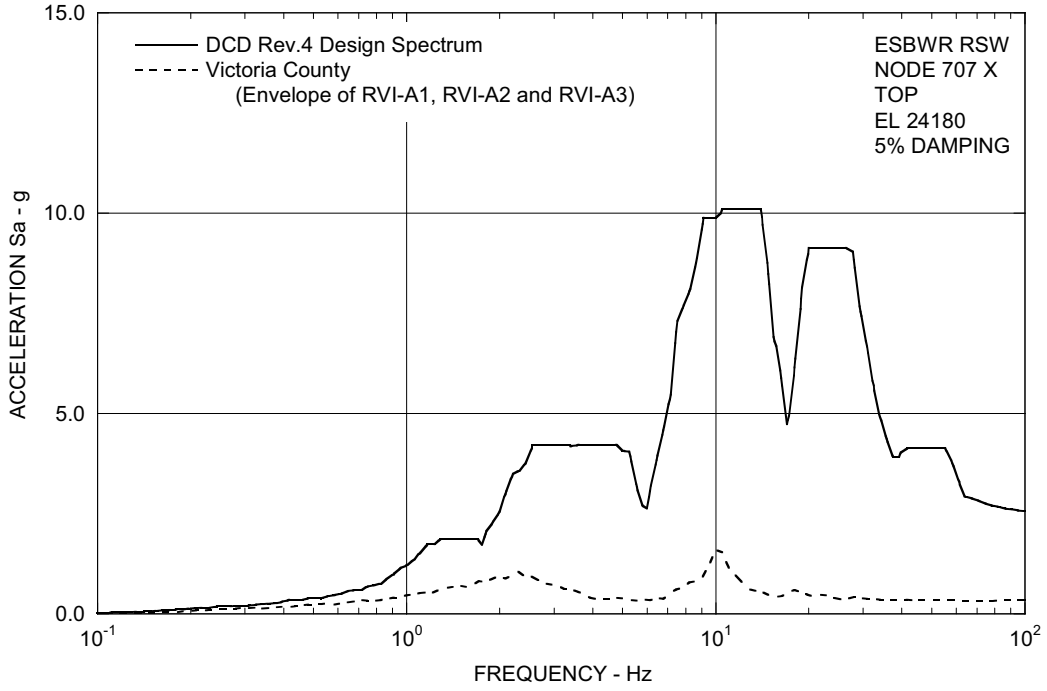


Figure 3.7-228 Comparison of Floor Response Spectra — RSW Top X

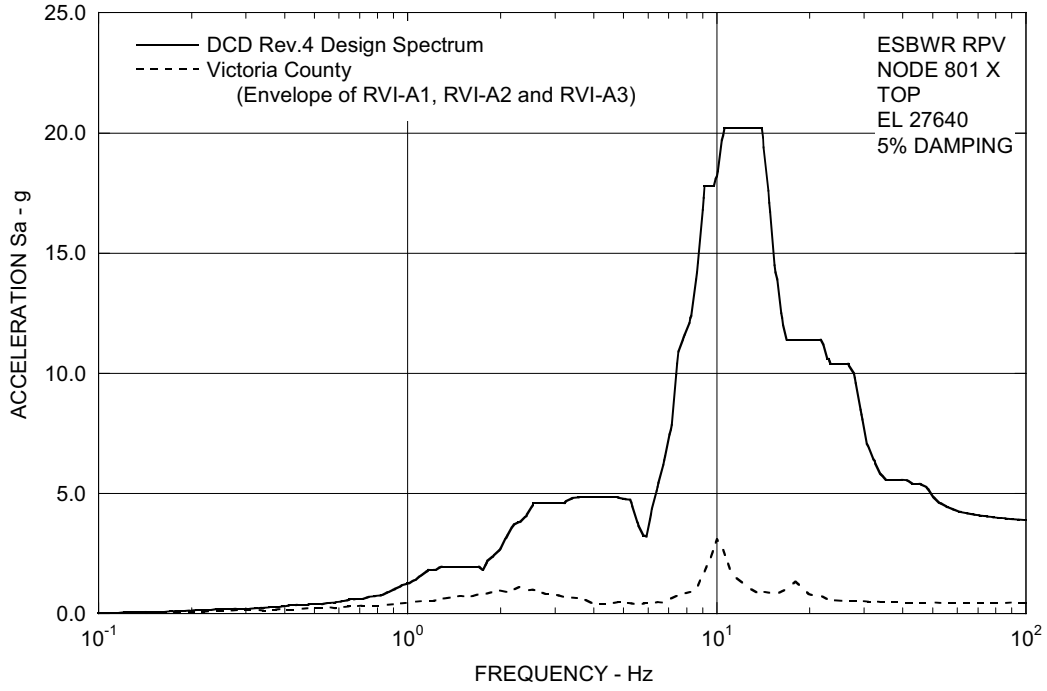


Figure 3.7-229 Comparison of Floor Response Spectra — RPV Top X

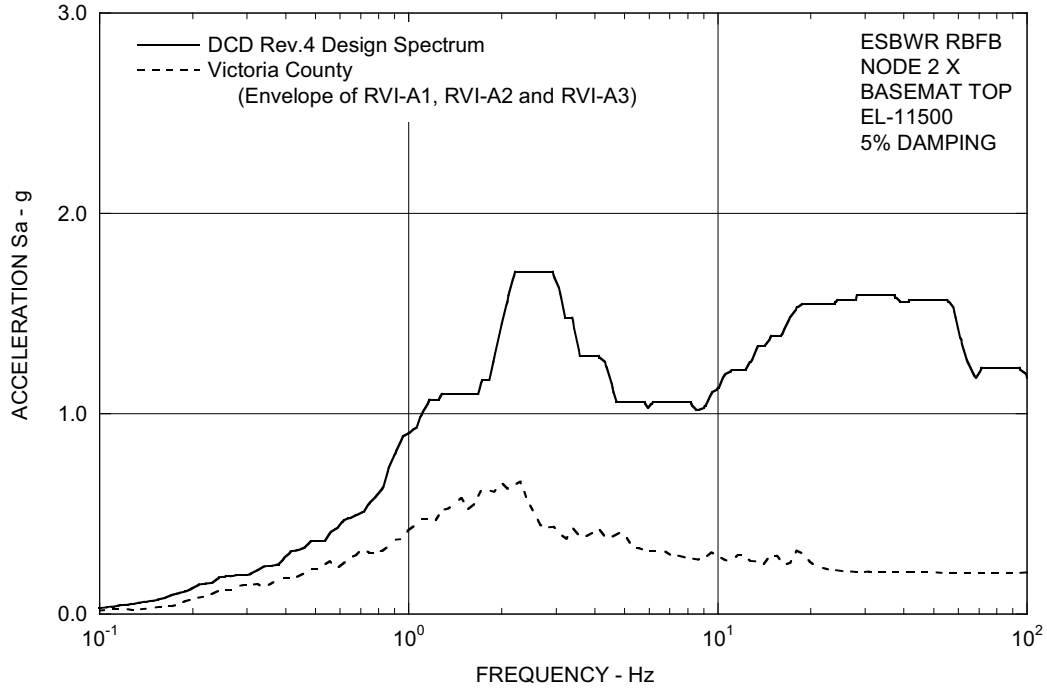


Figure 3.7-230 Comparison of Floor Response Spectra — RB/FB Basemat X

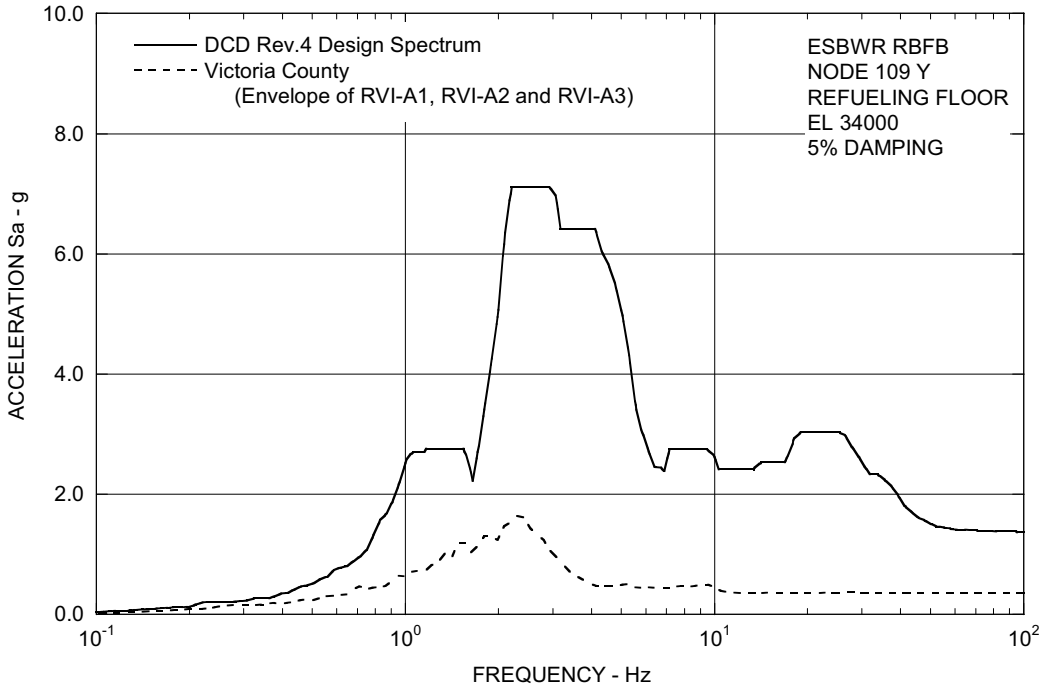


Figure 3.7-231 Comparison of Floor Response Spectra — RB/FB Refueling Floor Y

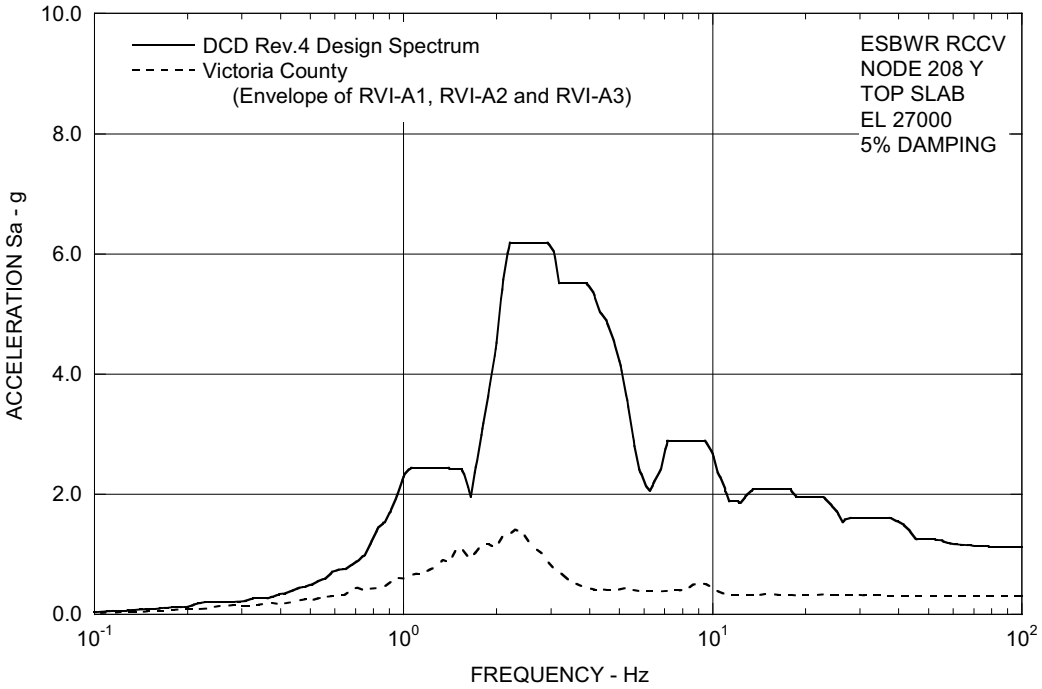


Figure 3.7-232 Comparison of Floor Response Spectra — RCCV Top Slab Y

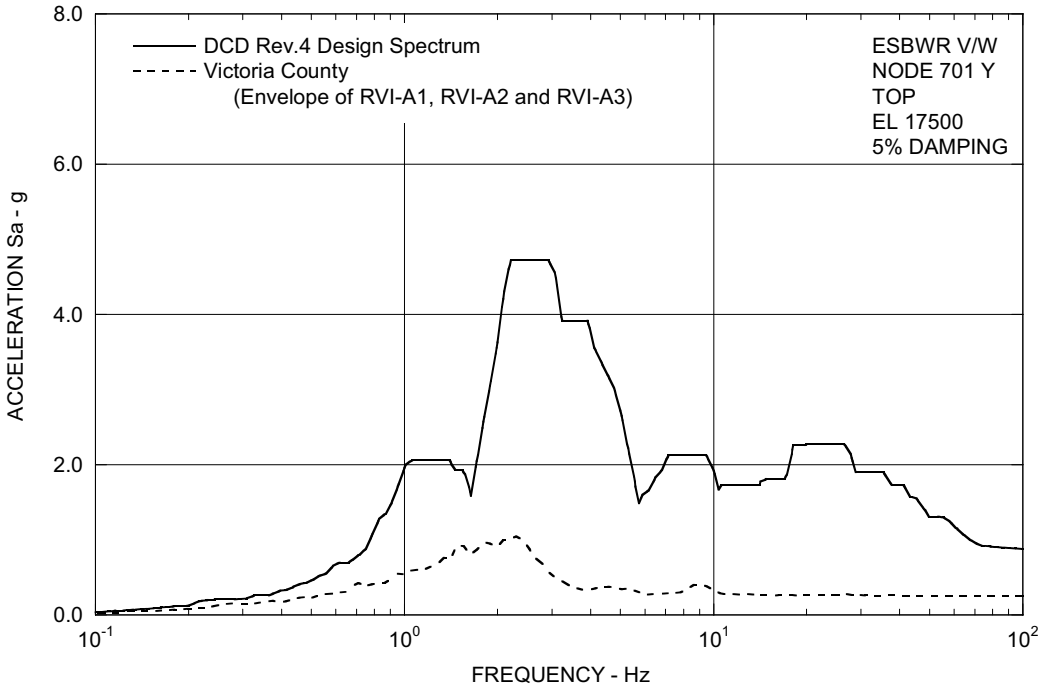


Figure 3.7-233 Comparison of Floor Response Spectra — Vent Wall Top Y

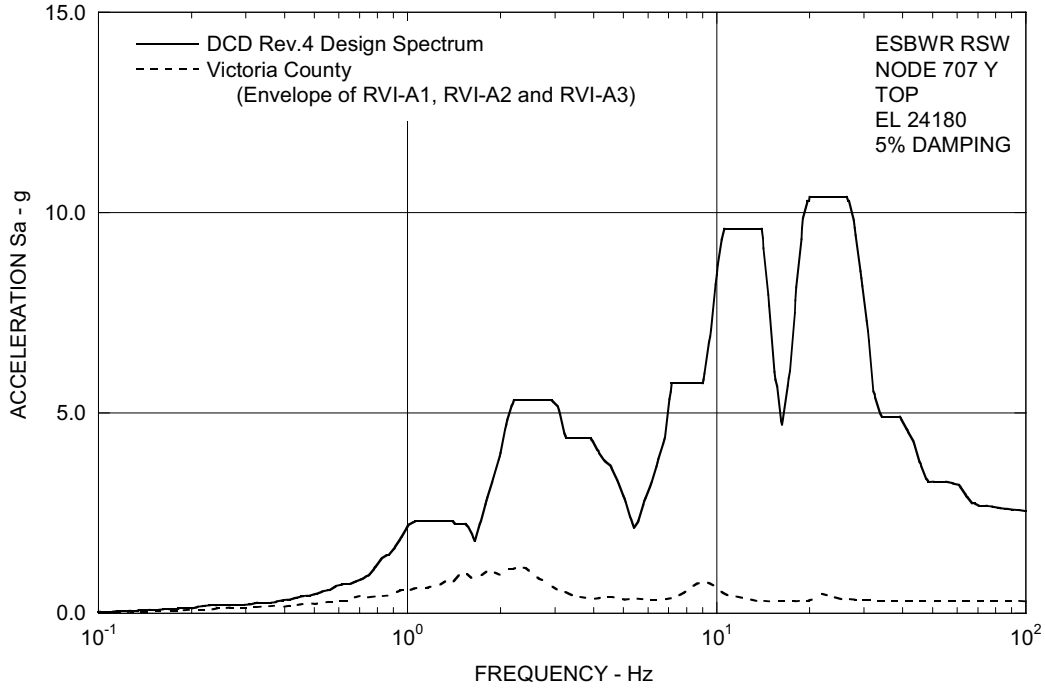


Figure 3.7-234 Comparison of Floor Response Spectra — RSW Top Y

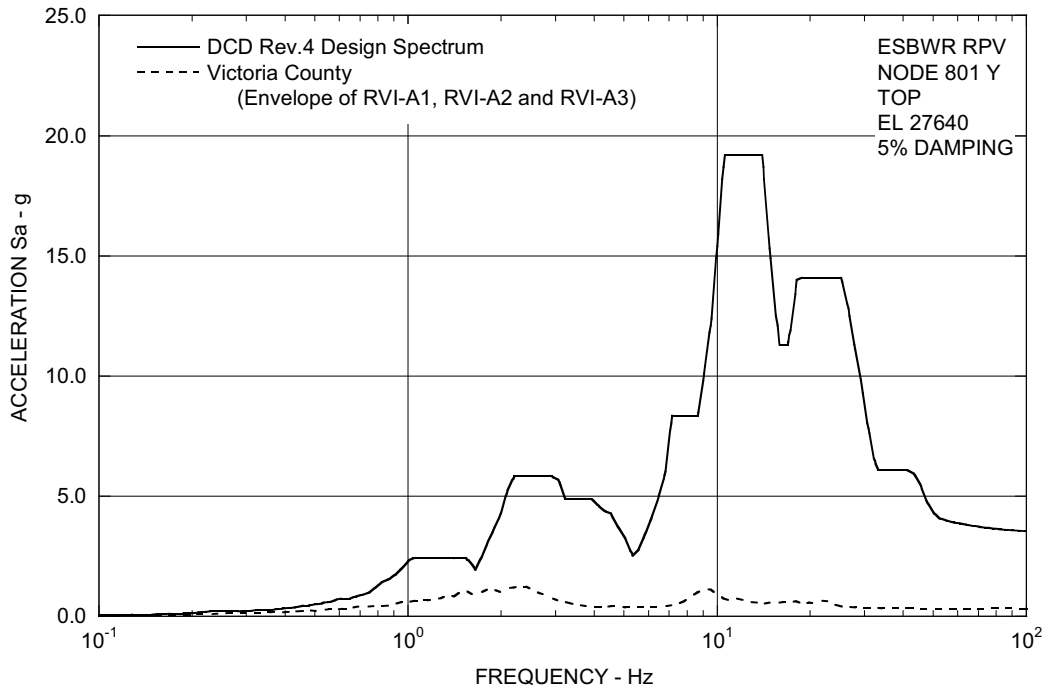


Figure 3.7-235 Comparison of Floor Response Spectra — RPV Top Y

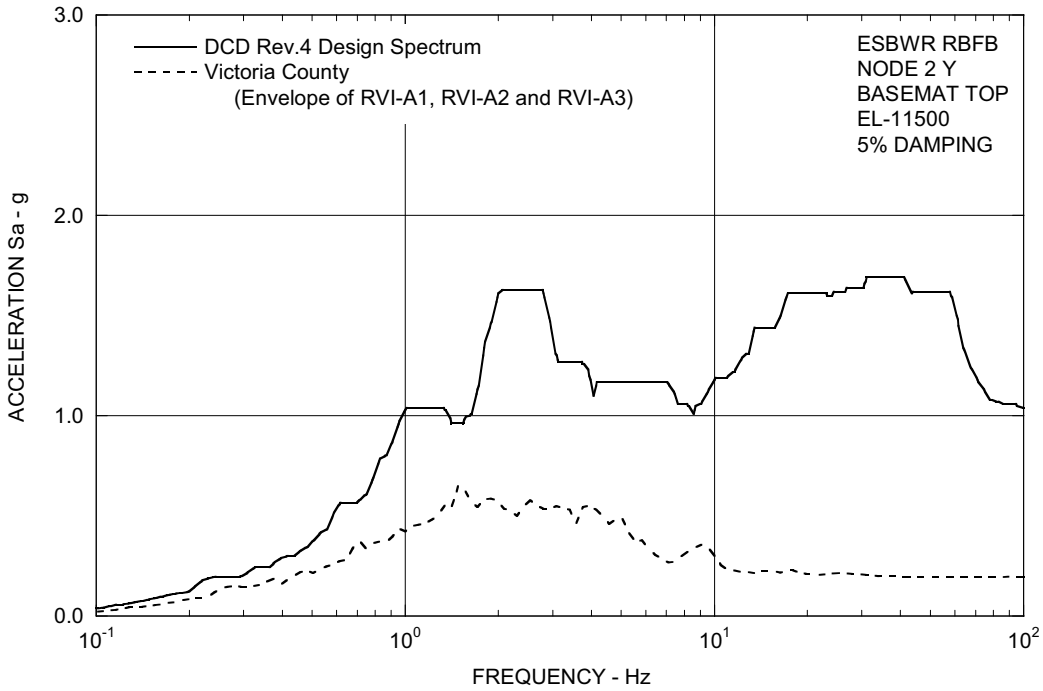


Figure 3.7-236 Comparison of Floor Response Spectra — RB/FB Basemat Y

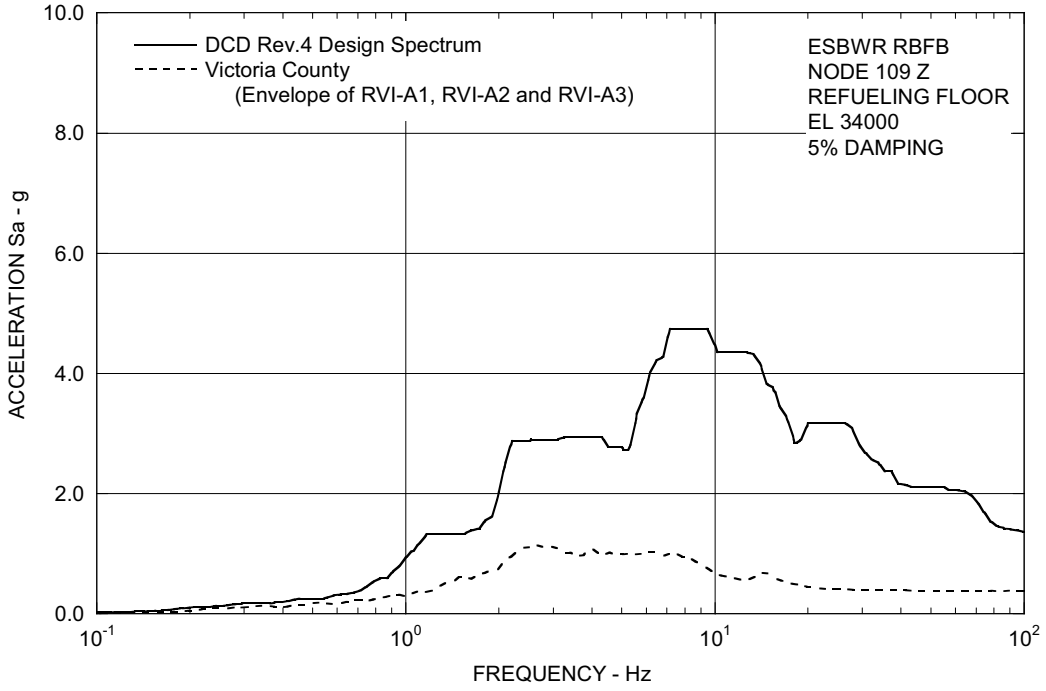


Figure 3.7-237 Comparison of Floor Response Spectra - RB/FB Refueling Floor Z

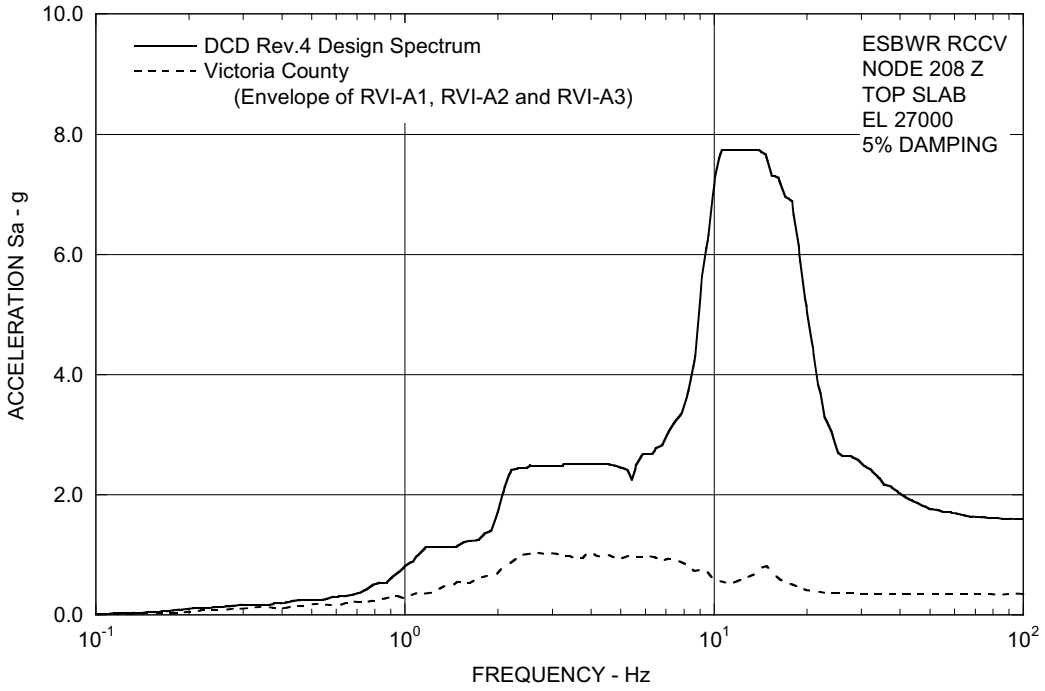


Figure 3.7-238 Comparison of Floor Response Spectra — RCCV Top Slab Z

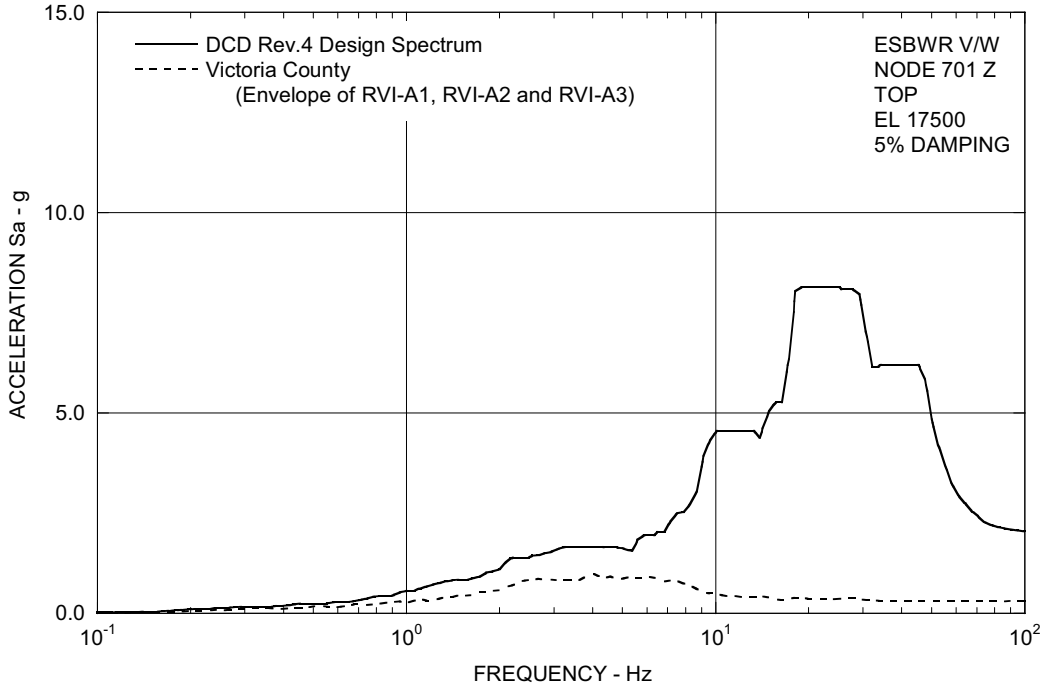


Figure 3.7-239 Comparison of Floor Response Spectra — Vent Wall Top Z

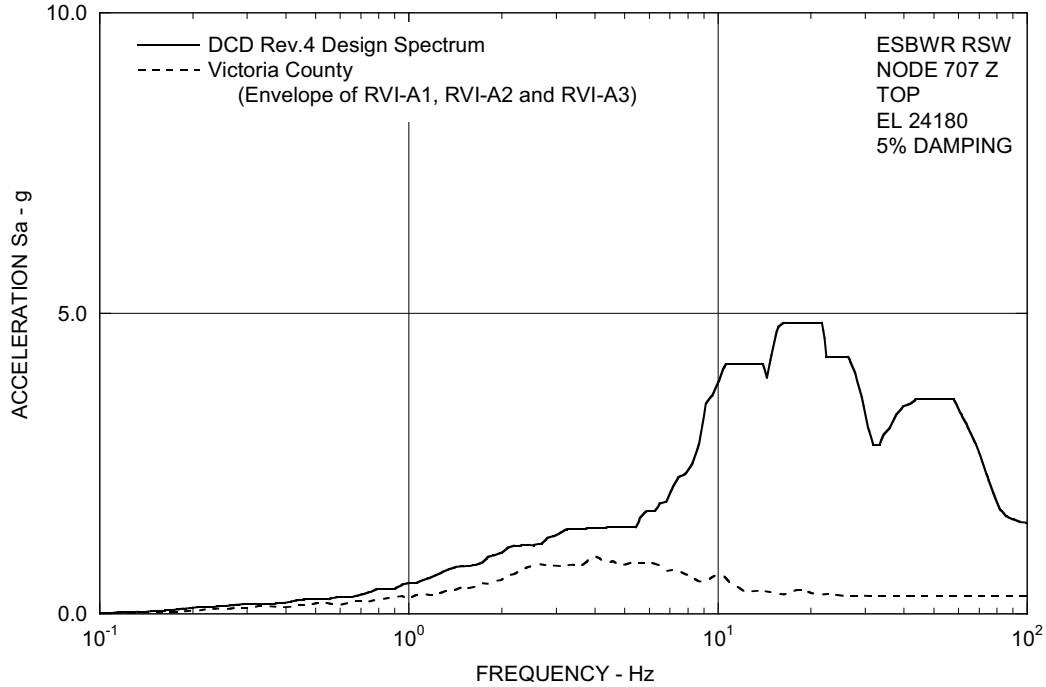


Figure 3.7-240 Comparison of Floor Response Spectra — RSW Top Z

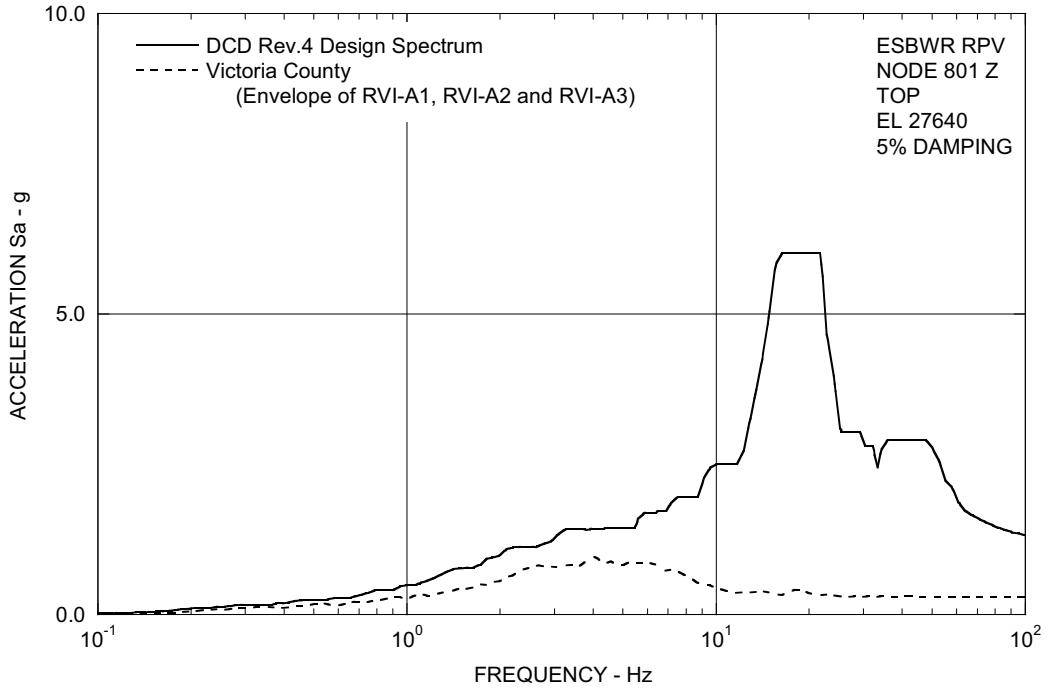


Figure 3.7-241 Comparison of Floor Response Spectra — RPV Top Z

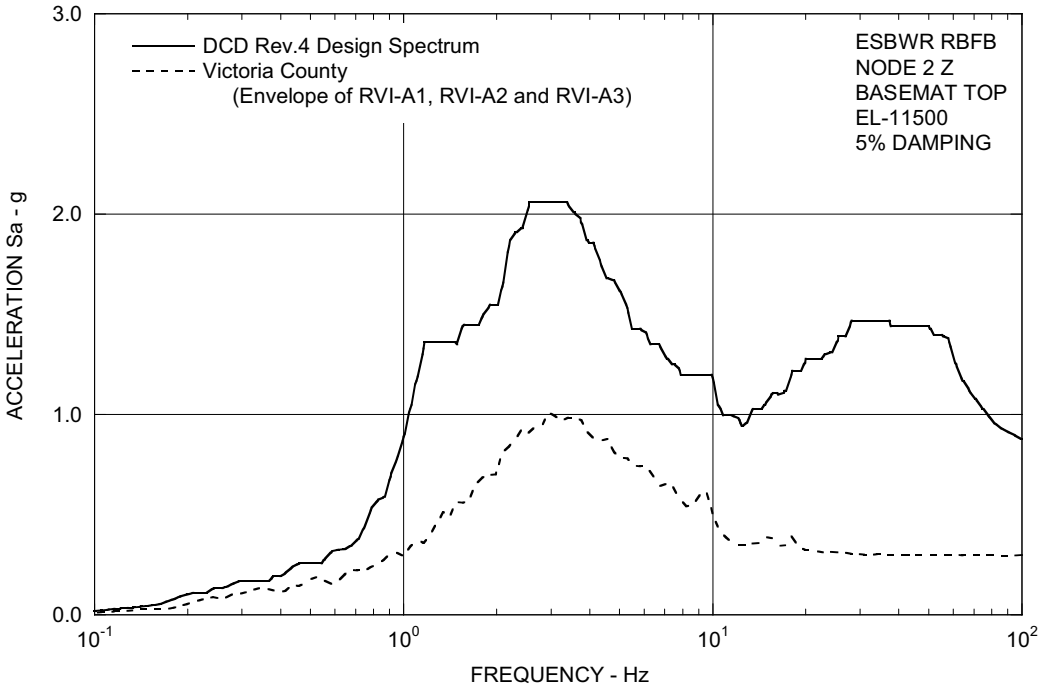


Figure 3.7-242 Comparison of Floor Response Spectra — RB/FB Basemat Z

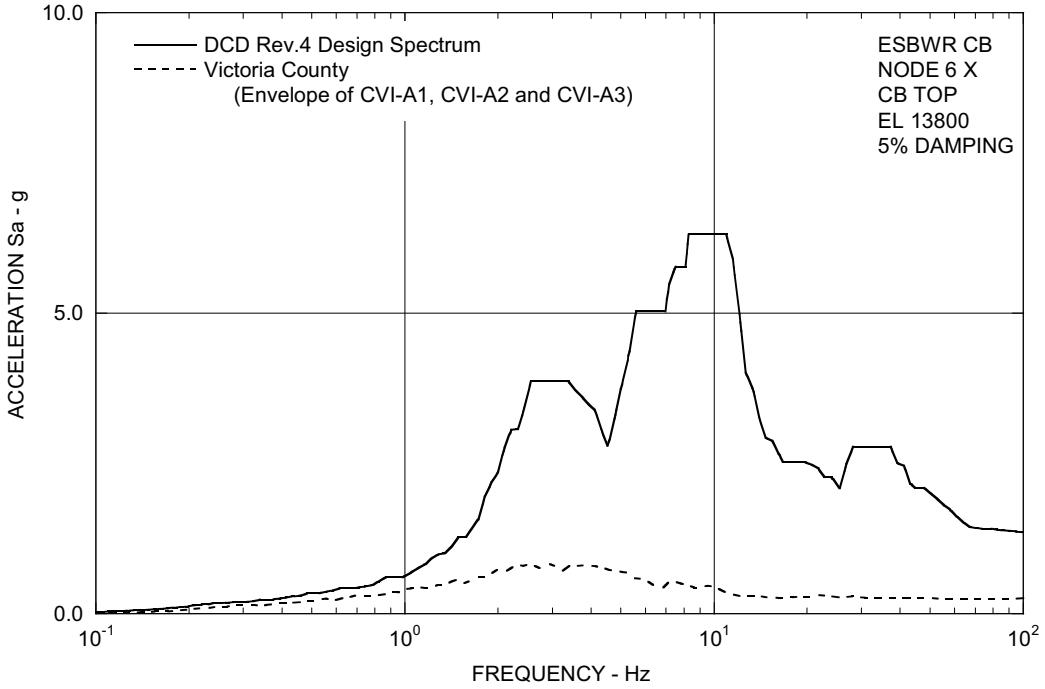


Figure 3.7-243 Comparison of Floor Response Spectra — CB Top X

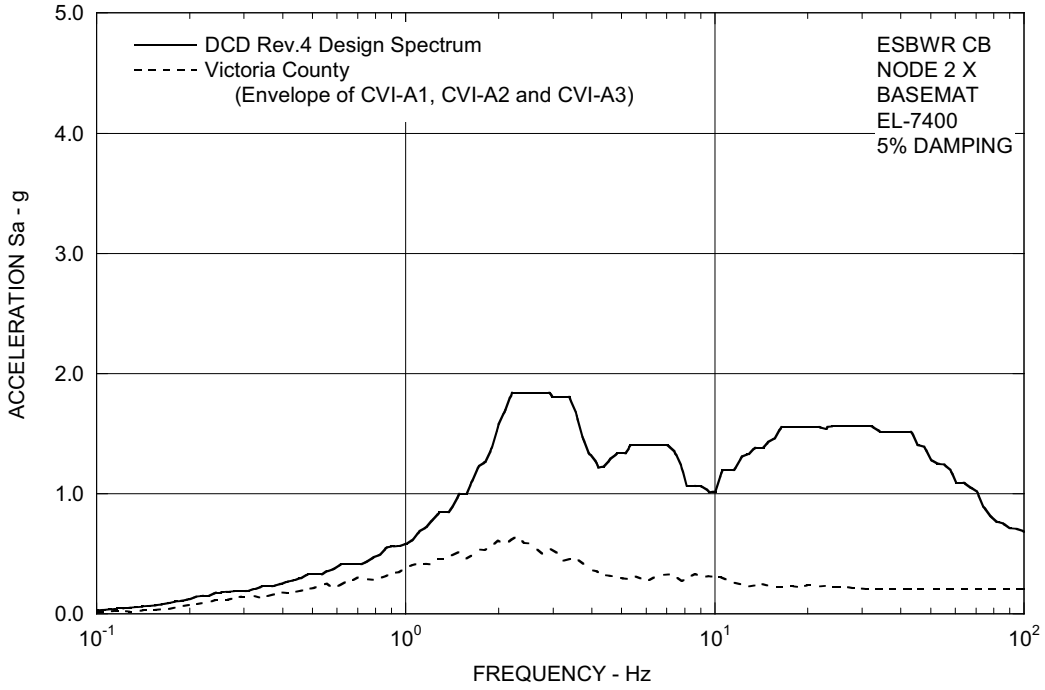


Figure 3.7-244 Comparison of Floor Response Spectra — CB Basemat X

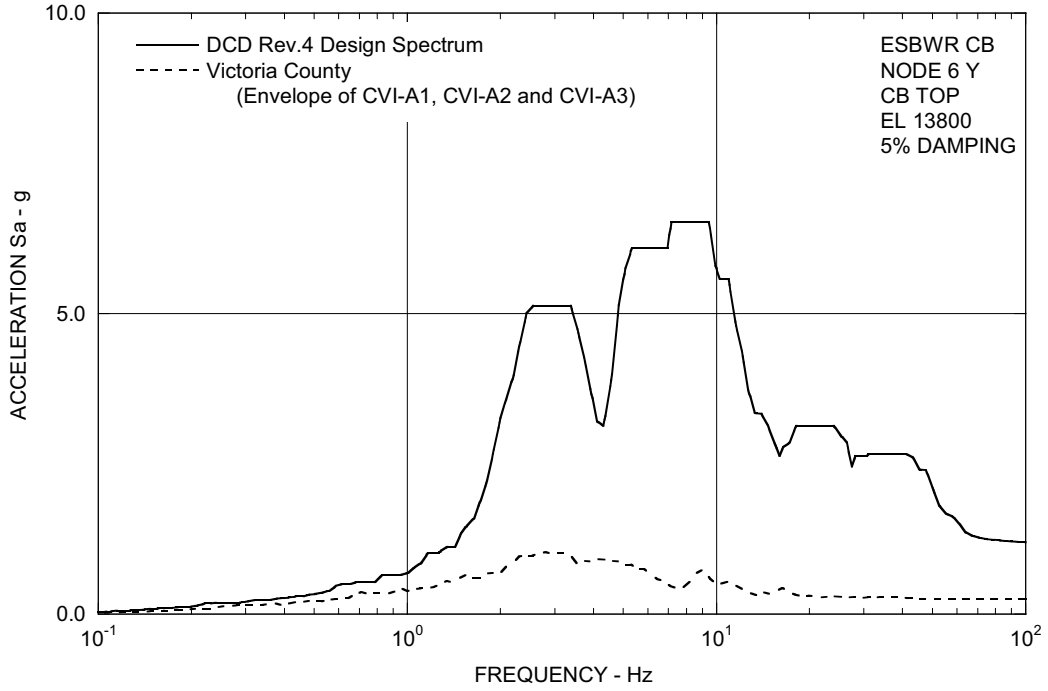


Figure 3.7-245 Comparison of Floor Response Spectra — CB Top Y

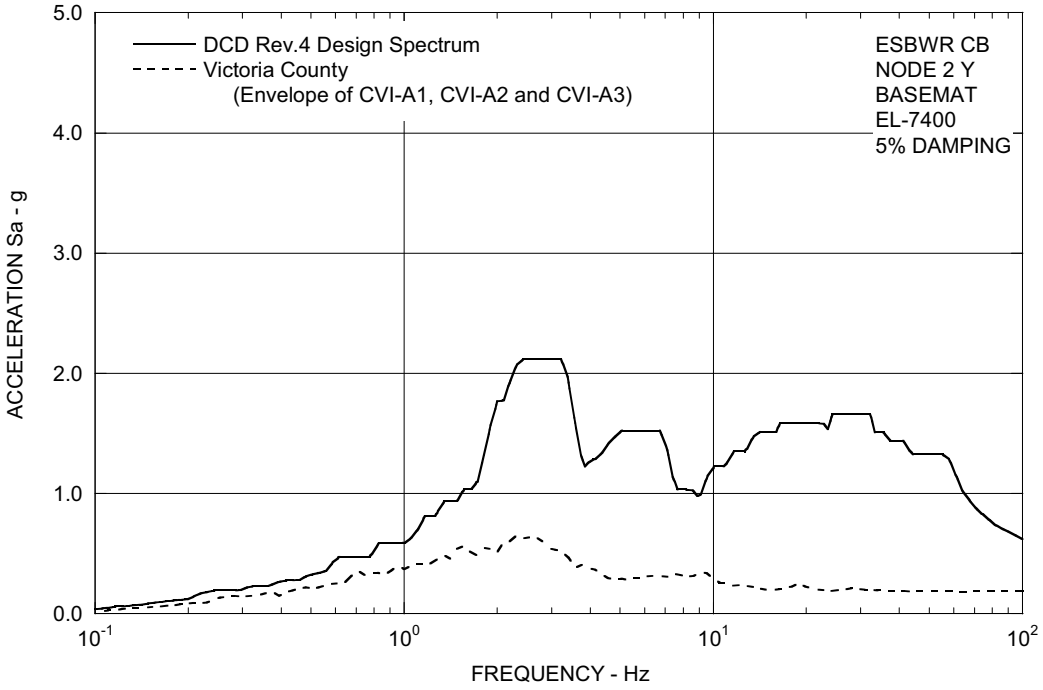


Figure 3.7-246 Comparison of Floor Response Spectra — CB Basemat Y

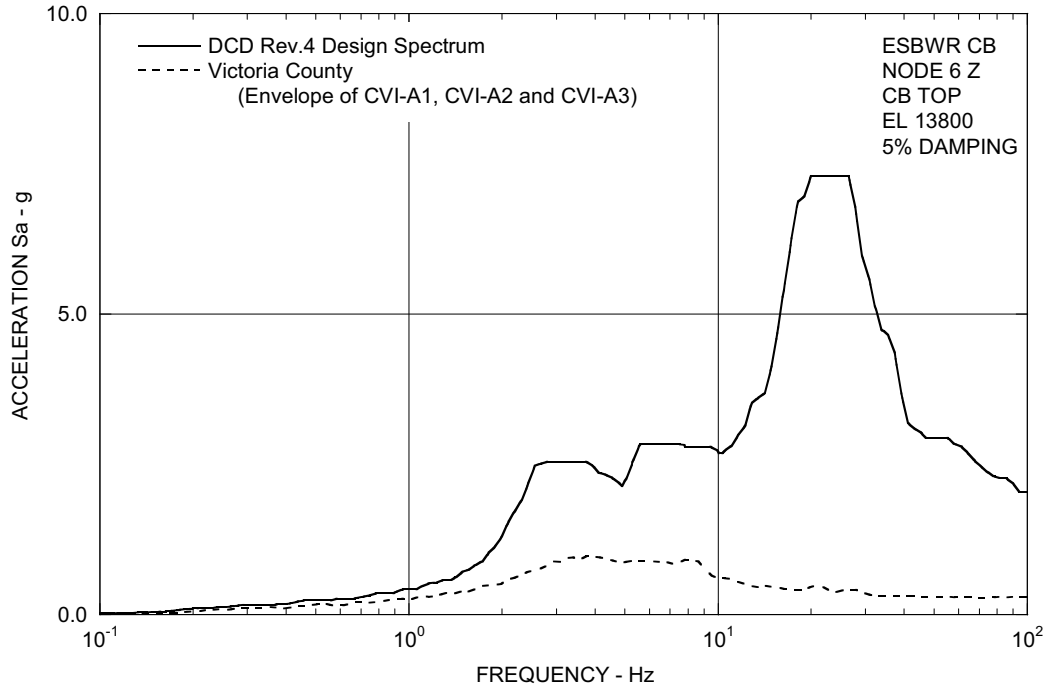


Figure 3.7-247 Comparison of Floor Response Spectra — CB Top Z

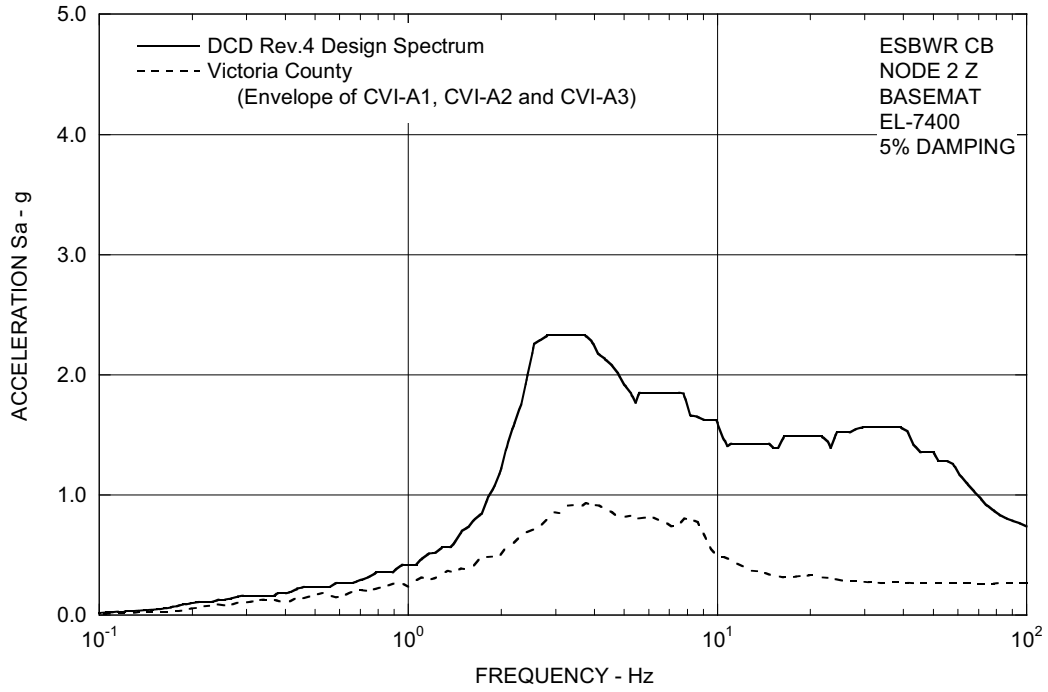


Figure 3.7-248 Comparison of Floor Response Spectra — CB Basemat Z

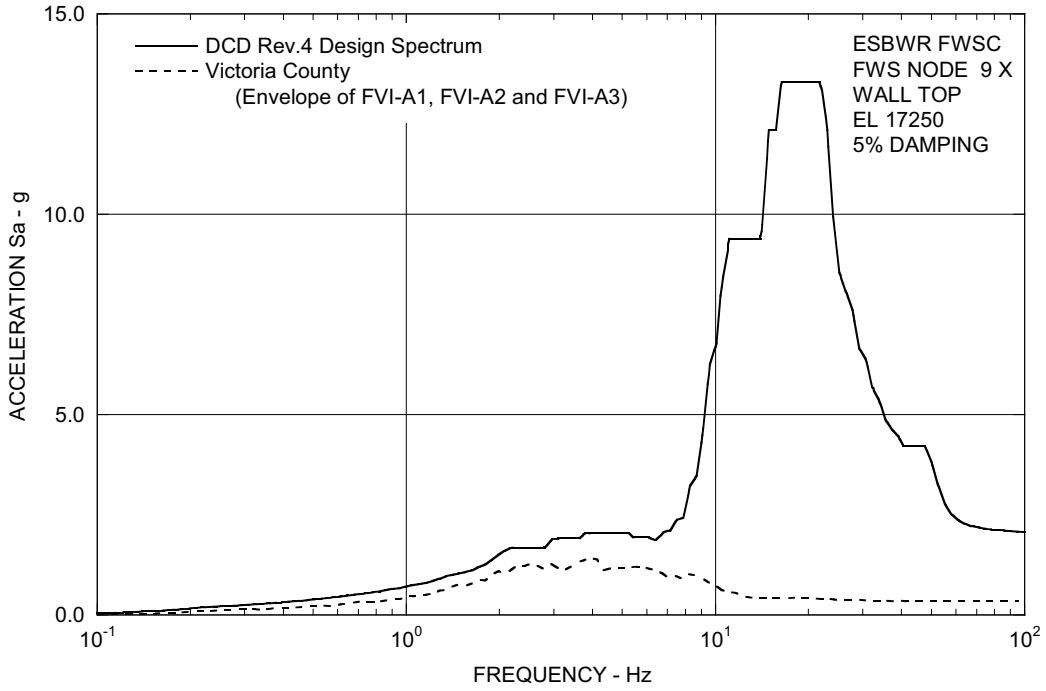


Figure 3.7-249 Comparison of Floor Response Spectra — FWS Wall Top X

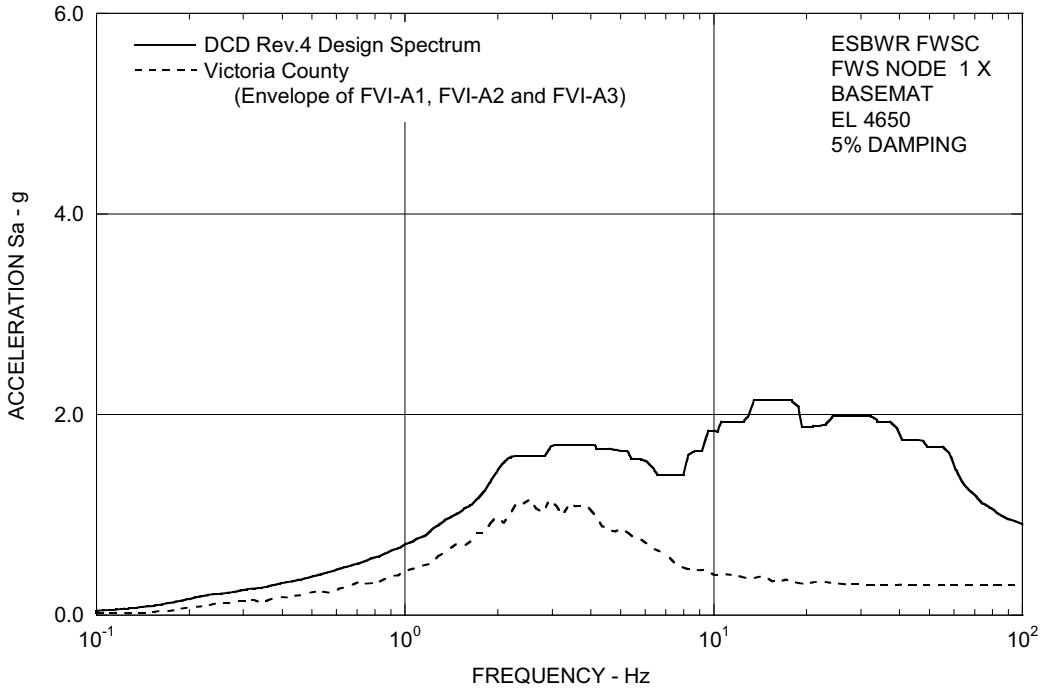


Figure 3.7-250 Comparison of Floor Response Spectra — FWS Basemat X

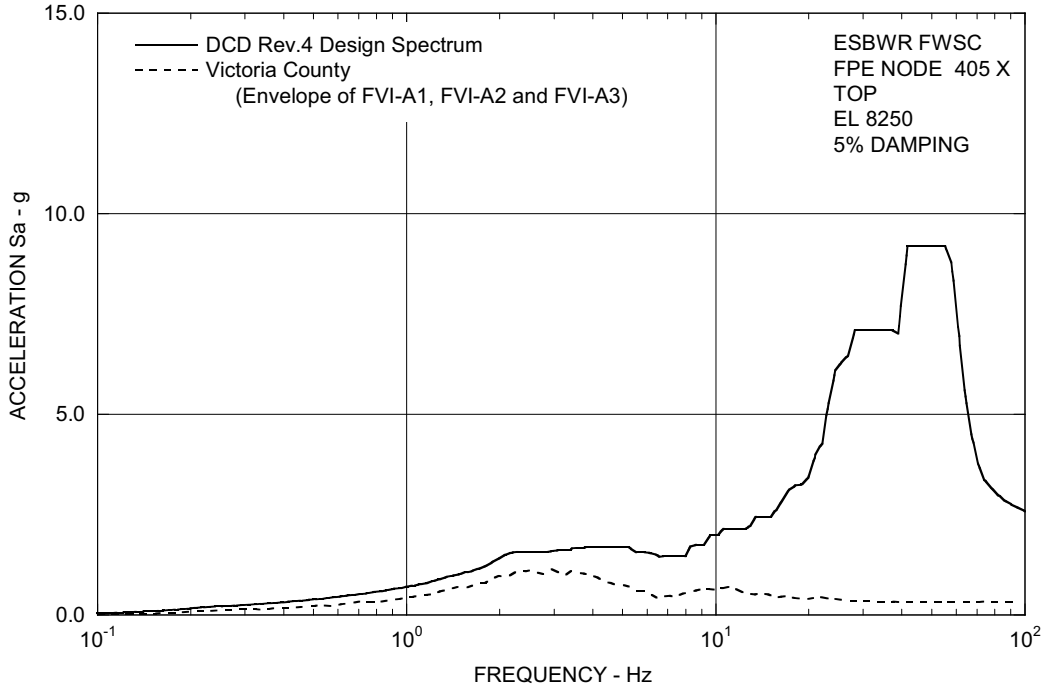


Figure 3.7-251 Comparison of Floor Response Spectra — FPE Top X

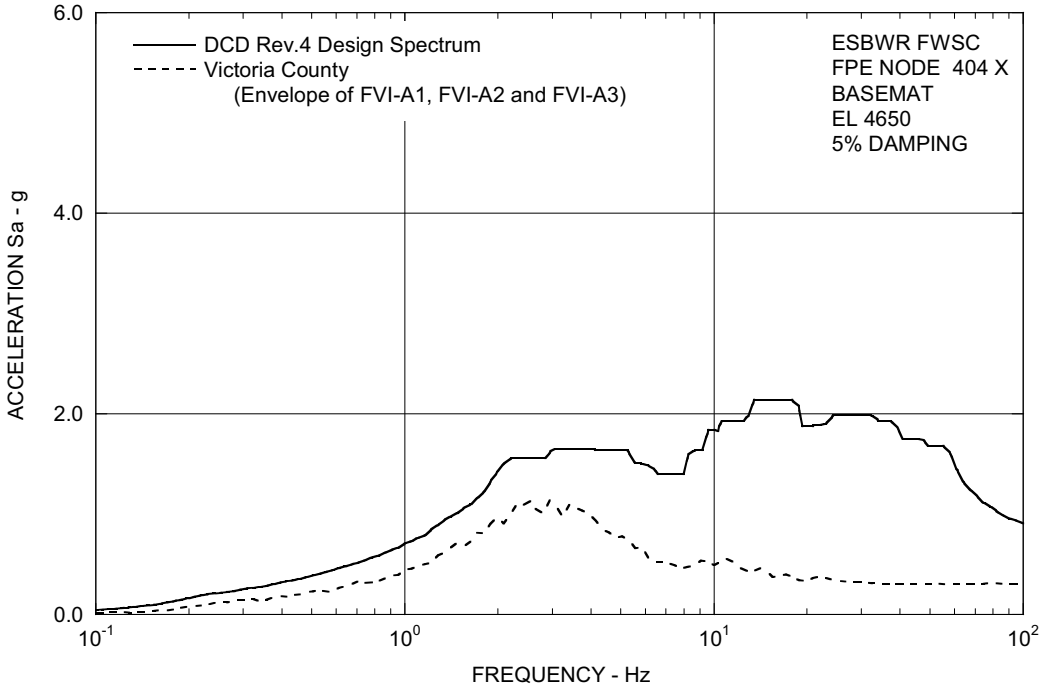


Figure 3.7-252 Comparison of Floor Response Spectra — FPE Basemat X

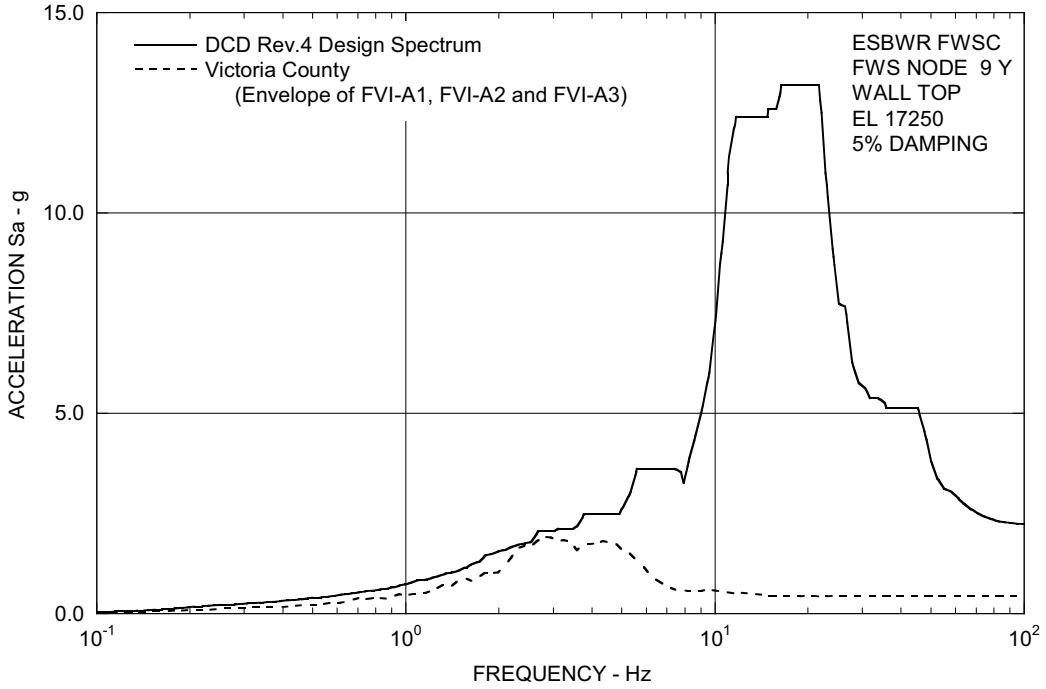


Figure 3.7-253 Comparison of Floor Response Spectra — FWS Wall Top Y

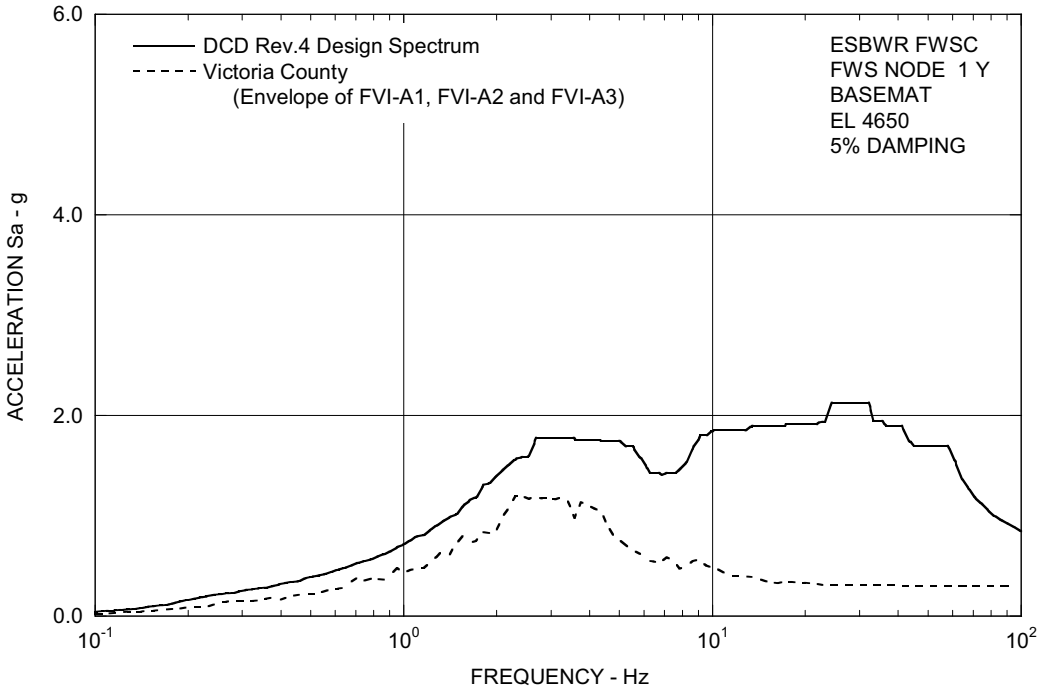


Figure 3.7-254 Comparison of Floor Response Spectra — FWS Basemat Y

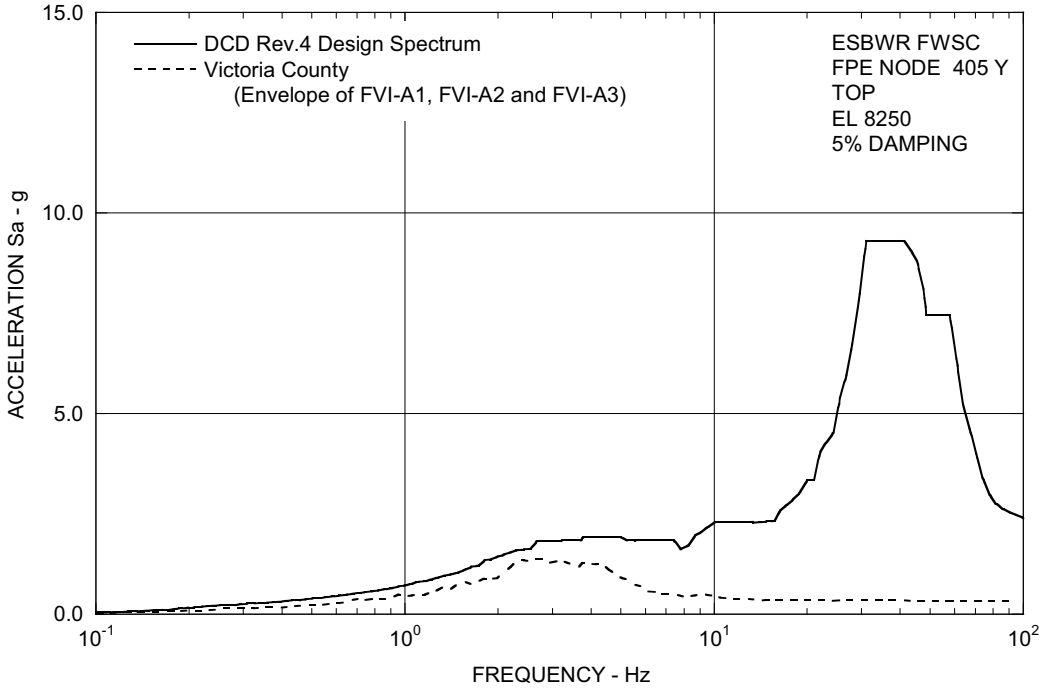


Figure 3.7-255 Comparison of Floor Response Spectra — FPE Top Y

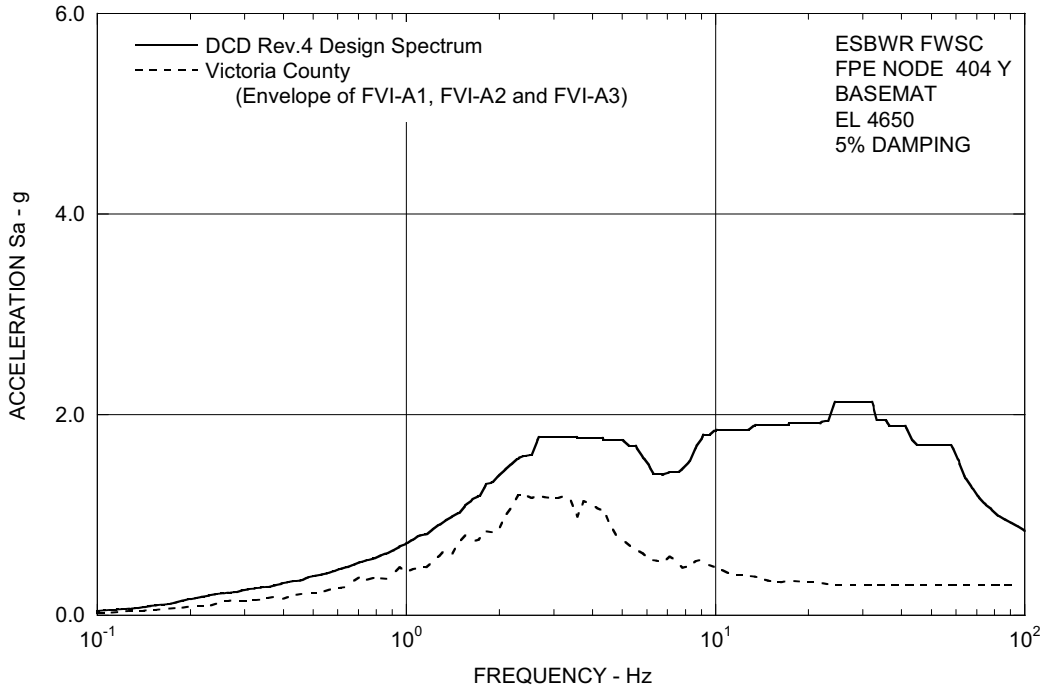


Figure 3.7-256 Comparison of Floor Response Spectra — FPE Basemat Y

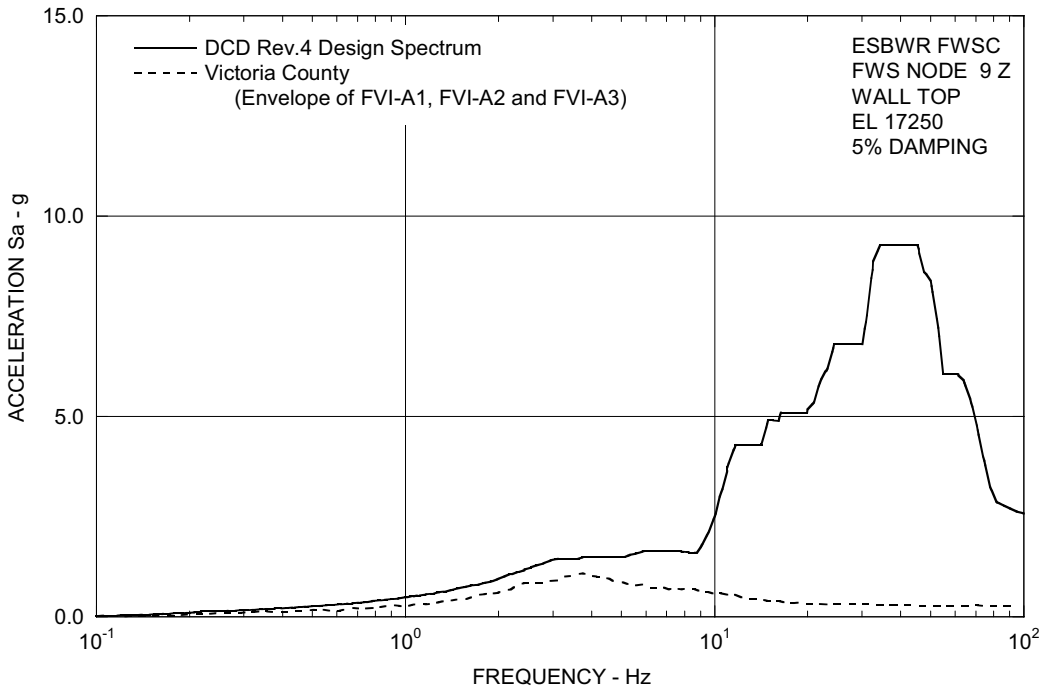


Figure 3.7-257 Comparison of Floor Response Spectra — FWS Wall Top Z

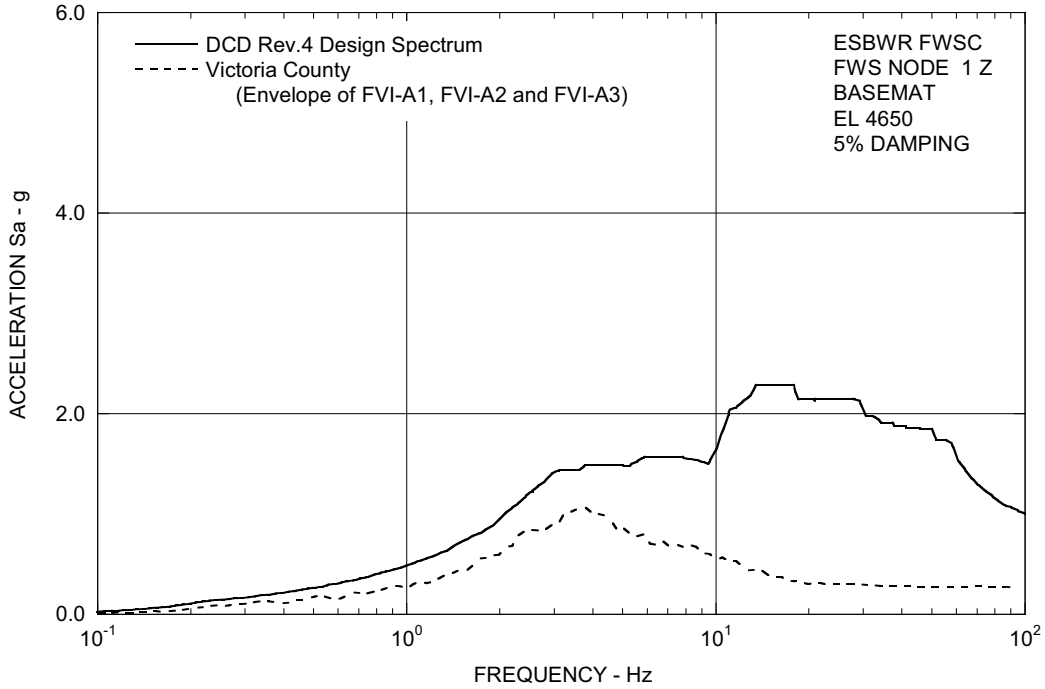


Figure 3.7-258 Comparison of Floor Response Spectra — FWS Basemat Z

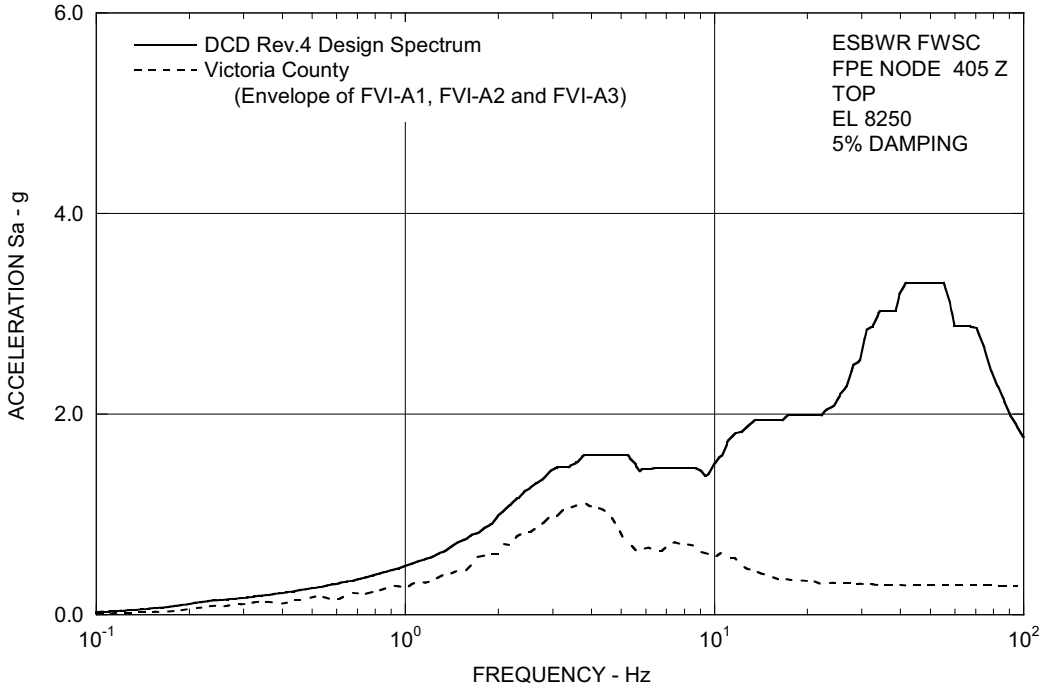


Figure 3.7-259 Comparison of Floor Response Spectra — FPE Top Z

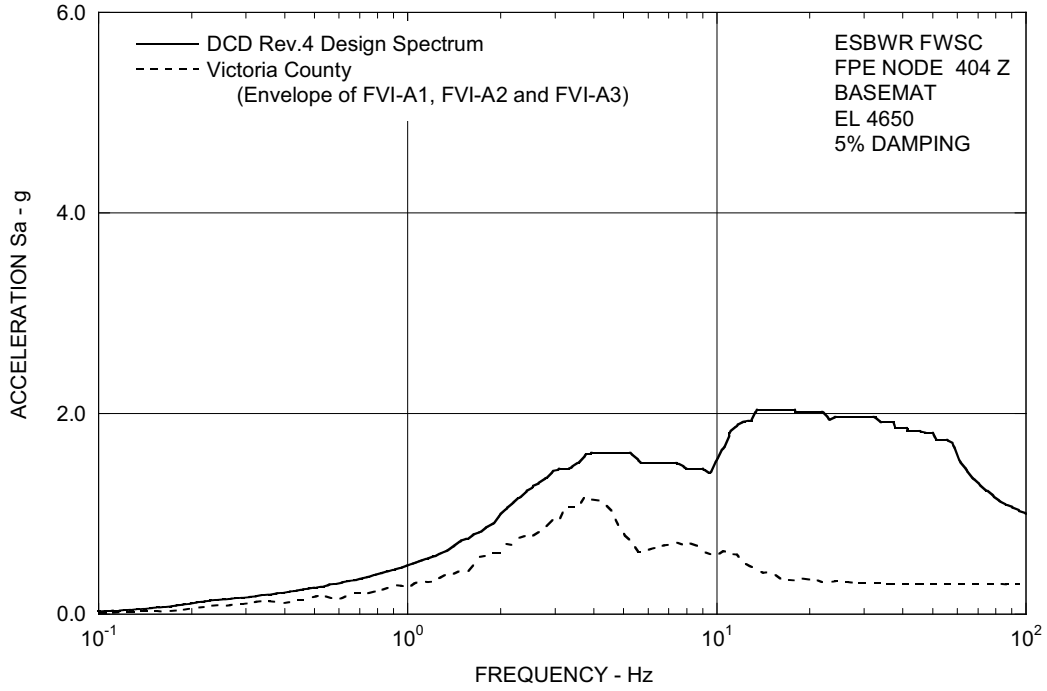


Figure 3.7-260 Comparison of Floor Response Spectra — FPE Basemat Z

3.8 Seismic Category I Structures

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

3.9 Mechanical Systems and Components

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

3.9.2.4 Initial Startup Flow-Induced Vibration Testing of Reactor Internals

Replace the last two paragraphs with the following.

VCS COL 3.9.9-1-H

A vibration assessment program as specified in RG 1.20 will be completed no later than one year after the time of application.

3.9.3.1 Loading Combinations, Design Transients and Stress Limits

Replace the last sentence with the following.

STD COL 3.9.9-2-H

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

3.9.3.7.1(3)e Snubber Pre-service and In-service Examination Testing

Replace the last two sentences at the end of this section with the following.

STD COL 3.9.9-4-A

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

3.9.3.7.1(3)f Snubber Audit Support Data

Replace the first sentence of this section with the following:

STD COL 3.9.9-4-A

A plant specific table will be prepared in conjunction with closure of ITAAC Table 3.1-1 and include the following specific snubber information:

Add the following at the end of this section.

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

3.9.6 In-Service Testing of Pumps and Valves

Replace the last sentence of this section with the following.

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

3.9.6.6 10 CFR 50.55a Relief Requests and Code Cases

Add the following at the end of the first paragraph.

STD SUP 3.9-1 No relief from or alternative to the ASME OM Code is being requested beyond what is identified in the DCD.

3.9.7 Risk-Informed Inservice Testing

Replace the text in this section with the following.

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

3.9.8 Risk-Informed Inservice Inspection of Piping

Replace the text in this section with the following.

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

3.9.9 COL Information

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

VCS COL 3.9.9-1-H This COL item is addressed in Subsection 3.9.2.4.

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

STD COL 3.9.9-2-H This COL item is addressed in Subsection 3.9.3.1.

3.9.9-3-A Inservice Testing Programs

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

3.9.9-4-A **Snubber Inspection and Test Program**

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

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

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

3.10.1.4 **Dynamic Qualification Report**

Replace the last sentence in this section with the following:

STD COL 3.10.4-1-A The Dynamic Qualification Report will be completed prior to fuel load. FSAR information will be revised, as necessary, as part of a subsequent FSAR update.

STD SUP 3.10-1 Section 17.5 defines the Quality Assurance Program requirements that are applied to equipment qualification files, including requirements for handling safety-related quality records, control of purchased material, equipment and services, test control, and other quality related processes.

3.10.4 **Combined Operating License Information**

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

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

3.11 Environmental Qualification of Mechanical and Electrical Equipment

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

3.11.2.2 **Qualification Program, Methods and Documentation**

Add the following paragraphs at the end of this section:

STD COL 3.11-1-A Implementation of the environmental qualification program, including development of the plant specific Environmental Qualification Document (EQD), will be in accordance with the milestone defined in Section 13.4.

Following program implementation, DCD Table 3.11-1 will be supplemented, as necessary, in a subsequent FSAR update to include

additional equipment covered by the program but not identified in the table.

3.11.3 Combined Operating License Information

3.11-1-A Environmental Qualification Document (EQD)

STD COL 3.11-1-A This COL item is addressed in Subsection 3.11.2.2.

STD SUP 3.12-1

3.12 Piping Design Review

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

STD SUP 3.12-2 The location and distance between piping systems will be established as part of the completion of ITAAC Table 3.1-1. The FSAR will be revised as necessary, in a subsequent update to include this information.

STD SUP 3.13-1

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

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

Appendix 3A Seismic Soil-Structure Interaction Analysis

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

3A.1 Introduction

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

VCS CDI Site-specific geotechnical data is described in Chapter 2. This data is compatible with the site enveloping parameters considered in the standard design, with the exception of the soil shear wave velocity, which is discussed in Subsection 3.7.2.4.

3A.2 ESBWR Standard Plant Site Plan

Replace the first two sentences of the first paragraph with the following.

VCS CDI The site plan is shown in Figure 1.1-201. The plan orientation is denoted on the figure.

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

VCS CDI

In modeling the buildings the 0°–180° (plant NS) and the 90°-270° (plant EW) directions are designated as x- and y- axes, respectively.

Appendix 3B Containment Hydrodynamic Load Definitions

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

Appendix 3C Computer Programs Used in the Design and Analysis of Seismic Category I Structures

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

Appendix 3D Computer Programs Used in the Design of Components, Equipment and Structures

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

VCS SUP 3E-1

Appendix 3E Deleted

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

Appendix 3F Response of Structures to Containment Loads

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

Appendix 3G Design Details and Evaluation Results of Seismic Category I Structures

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

Appendix 3H Equipment Qualification Design Environmental Conditions

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

Appendix 3I Designated NEDE-24326-1-P Material Which May Not Change Without Prior NRC Approval

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

Appendix 3J Evaluation of Postulated Ruptures in High Energy Pipes

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

Appendix 3K Resolution of Intersystem Loss of Coolant Accident

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

Appendix 3L Reactor Internals Flow Induced Vibration Program

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