Enclosure 1
Responses to NRC Request for Additional Information, RAI No. 253

Questions 03.07.02-42, 43, 44, 47, 48, 52, and 53

Calvert Cliffs Nuclear Power Plant, Unit 3

Question 03.07.02-42

Follow Up to Question 03.07.02-5

The response provided by the applicant to address SRP 3.7.2, Acceptance Criteria 3.C.ii regarding whether a structural model is sufficiently detailed such that further refinement will have a negligible response on the solution results, does not provide a basis for concluding that the mesh size is suitably refined to accurately capture the global and local dynamic response. The applicant is requested to demonstrate that the mesh size used in the SASSI finite element model of the Common Basemat Intake Structures (CBIS) is sufficiently detailed such that further refinement will not significantly change the response of the structure or the analysis results.

In addition, per SRP 3.7.1, Structural Acceptance Criteria 4.A.vii, the SSI model for the CBIS needs to be evaluated to confirm that the dynamic model is of sufficient refinement to capture the response of the structure throughout the frequency range of interest including the high frequency responses. For soft soil case(s), the transmission characteristics are limited by the transmission capability of the site soils, which have a much lower stiffness than the concrete structural elements. As a result, insufficient modeling of the soil layers may limit the frequency content of the earthquake time history input to the structural model. The applicant is requested to present the results of any sensitivity studies that were performed to assure that the seismic models meet the above SRP criterion, and include this information in the FSAR. If sensitivity studies were not performed, the applicant is requested to provide the technical basis for how it meets the criterion of the SRP, or justify an alternative.

The information requested above is needed for the staff to conclude that the seismic models are providing the complete response of the structure to the seismic input and that an under-prediction of seismic results has not occurred due to the assumptions of mesh size used in the analysis.

The last sentence in the first paragraph of page 3-38 refers to Figure 3.7.2.3-1 as providing the finite element mesh for the half model of the CBIS. It appears the figure number should be 3.7-26. The applicant is requested to identify the correct figure number and change the reference in the FSAR.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

In the SSI analysis of the CBIS, the response to seismic wave excitation is governed by the lower bound soil criteria, which has a much lower stiffness than the concrete structural elements. The allowable soil layer thickness for SASSI analysis is determined using the simple rule that the layer thickness must not exceed one-fifth of the wave length at the highest frequency of analysis. SASSI requires that the interaction nodes below ground level be located at the location of the soil layer interfaces. Hence, the mesh size in the vertical direction for the structural elements is equal to the neighboring soil layer thickness. The mesh size for the soil profile was dominated by the minimum shear wave velocity. The minimum shear wave velocity for the intake structure site is 373.1 ft/s from the Lower Bound soil properties (Table 3F-7, layer 6).

Therefore, the minimum mesh size for a 50 Hz cut off frequency provided in the SASSI model is:

$$H_{max} = \frac{V_s}{5f_{CF}} = \frac{373.1 \text{ ft/s}}{5 * 50 \text{ Hz}} = 1.5 \text{ ft}$$

The figure referenced in Section 3.7.2.3.2 has been corrected to identify Figure 3.7-26.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Question 03.07.02-43

Follow Up to Question 03.07.02-8

In FSAR Section 3.7.2.3.2, the applicant states that the only walls that will crack are the east and west forebay walls. As the assumption of whether walls or slabs are cracked can affect the seismic response of the structure and change the frequency response characteristics of in-structure response spectra (ISRS), the applicant is requested to provide the results of an analysis that demonstrates that only the east and west forebay walls will crack and that the other walls and slabs remain uncracked under the applicable loading conditions. The staff requests this information to enable it to conclude that the calculated design loads used for the structure and the ISRS used for the design of supported equipment and suspended systems are conservative and accurately reflect the building response to the seismic input. The applicant is requested to provide this information for both the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) and the UHS Electrical Building (EB).

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

For the updated analysis of the CBIS, cracked elements in critical locations of the Forebay walls, common basemat, UHS MWIS Water Basin sidewall and UHS MWIS Pump House sidewall are shown in figures 1 through 4 below (cracked elements are magenta and uncracked elements are blue).

Cracking was investigated by combining the SASSI accelerations with the Normal loads in the STAAD model. An iterative process was followed to identify the extent of cracked elements as recommended by ASCE-4-98: A first analysis was carried out in SASSI, assuming no cracked elements. The results indicated a number of cracked elements and the SASSI model was updated by reducing the stiffness of these elements. The results of the second analysis indicated that cracking had extended to neighboring elements, and the SASSI model was updated again. The results of the third and final SASSI analysis showed close agreement between cracked elements and those assumed to be cracked prior to the analysis.

The stiffness of the cracked element was considered as half of the uncracked stiffness which is consistent with ASCE 43-05 (Section 3.4.1). ASCE 4-98 (Section C3.1.3.1) recognizes the complexity of an analysis that considers cracking but provides no guidance on cracked concrete stiffness.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Figure 1
Cracked elements for SSE analysis – Basemat

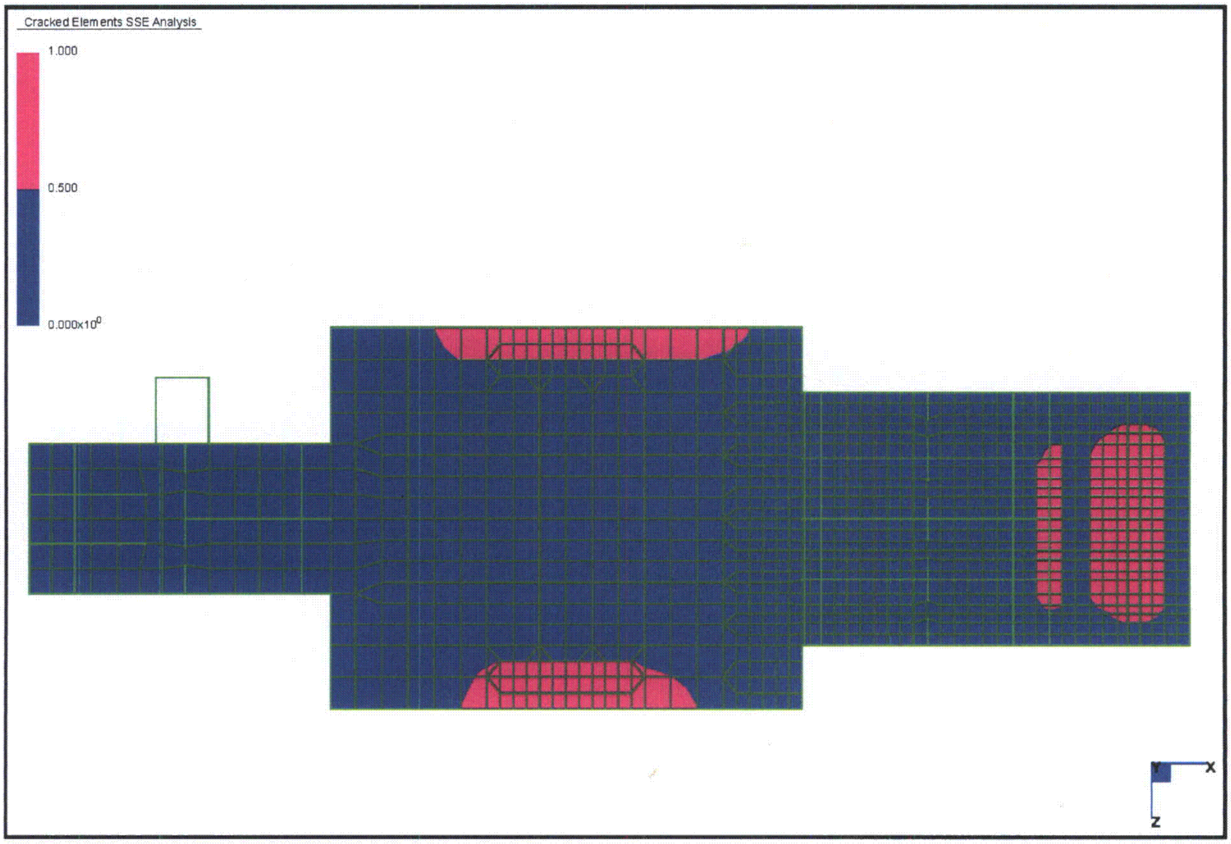


Figure 2
Cracked elements for SSE analysis – Forebay Walls

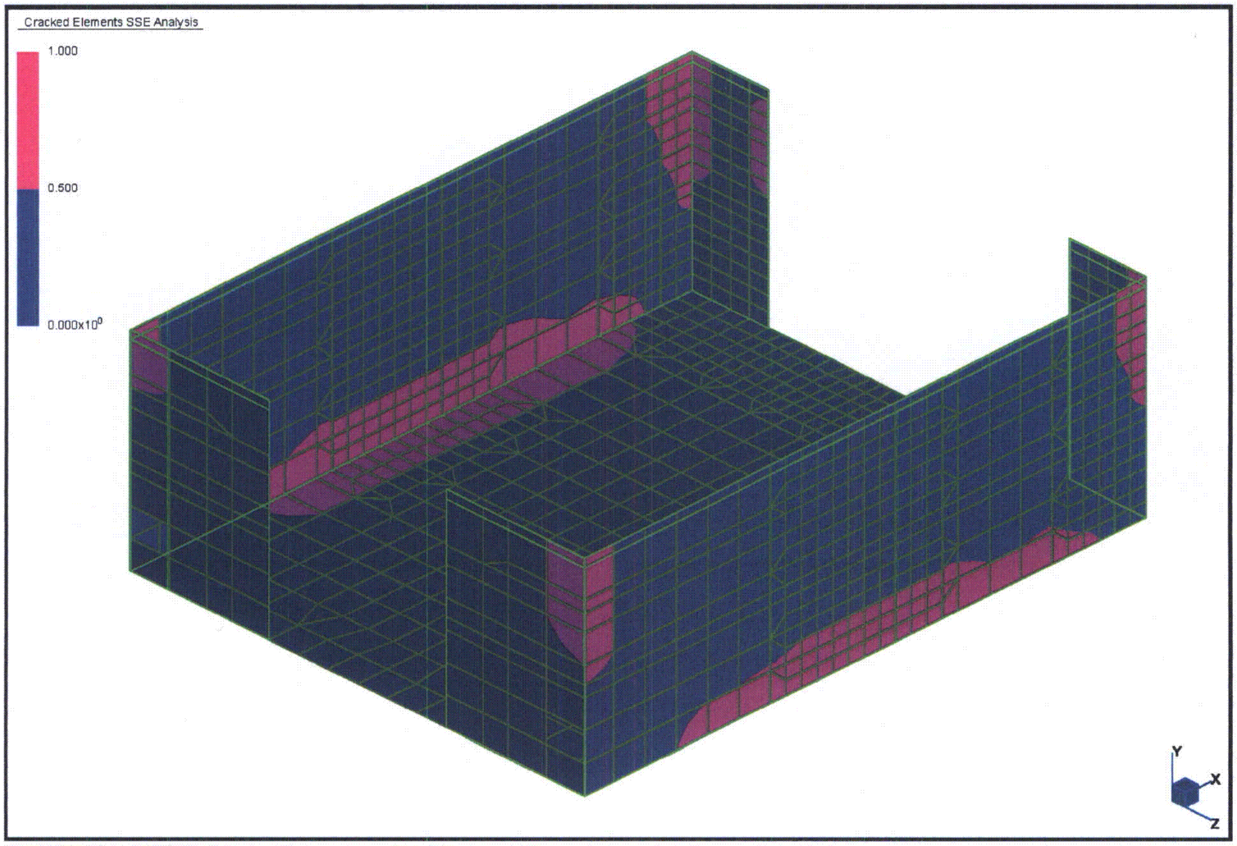


Figure 3
Cracked elements for SSE analysis – Pump House North-South Walls

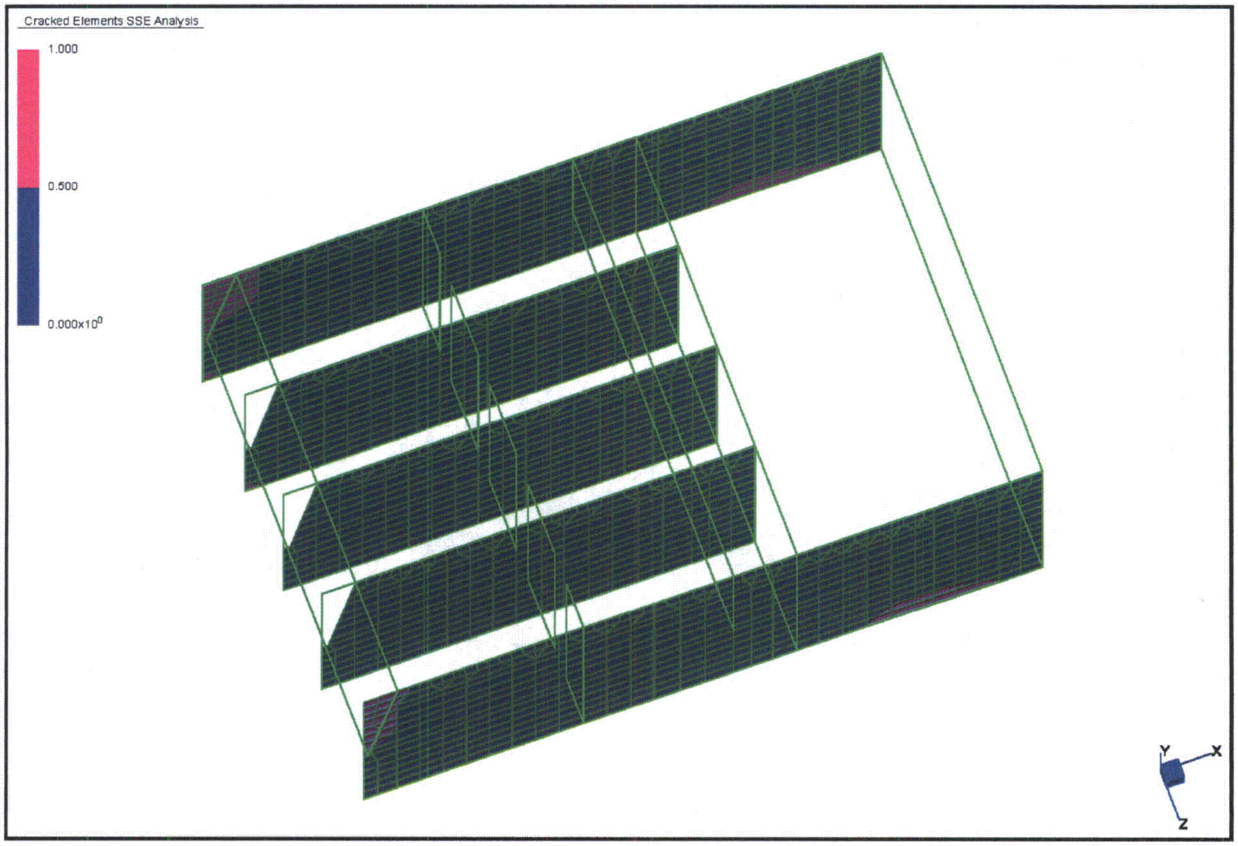
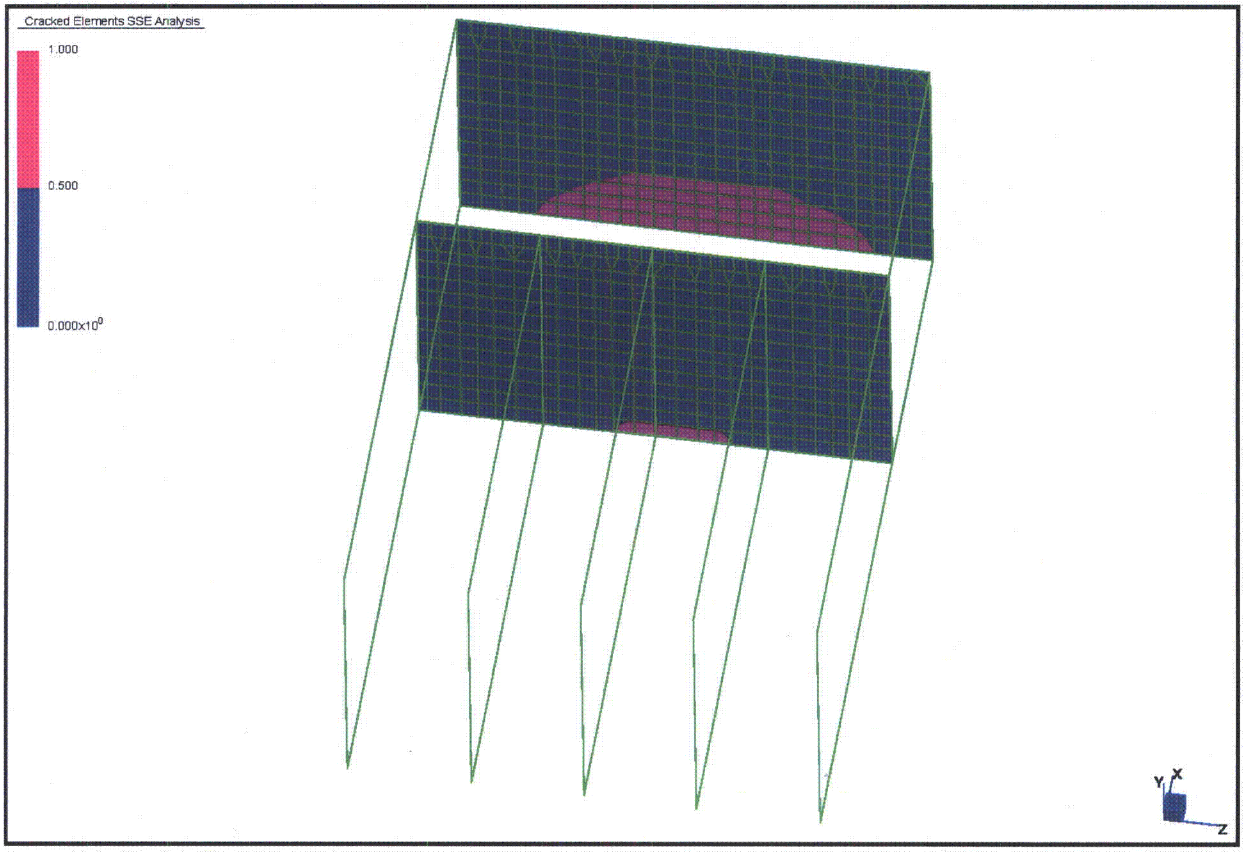


Figure 4
Cracked elements for SSE analysis – Pump House East- West Walls



Question 03.07.02-44

Follow Up to Updated Response to Question 03.07.02-11

Regarding the calculation of the convective water mass, the applicant stated that the methodology of ACI 350.3-06 (Seismic Design of Liquid Containing Concrete Structures and Commentary) has been used. However, the applicant stated that because the convective frequencies are very low, it has concluded that the corresponding accelerations are insignificant and therefore the convective loads are ignored in the analysis of the structure. The applicant is requested to provide an analysis using the methods of ACI 350.3-06 to determine the convective seismic loads on the structure and demonstrate that these loads are insignificant and have no effect on the structure's design.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

The latest analysis includes a SASSI model that implements the impulsive and convective seismic load according to ACI 350.3-06. The convective hydrodynamic loads are considered in the SASSI model.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Question 03.07.02-47

Follow Up to Question 03.07.02-21

The seismic model of the UHS EB assumes that the building is symmetric along the North South plane of the structure. However, the internal walls are not symmetric about this plane (See Figure 3E.4-5 in Revision 6 of the FSAR). For a seismic excitation in the North-South direction, there will be a torsional response of the structure which the existing model locks out due to the assumed boundary conditions. The applicant is requested to address why this non symmetry was ignored in the model development and what affect the modeling assumptions have on the building's seismic response and the computed torsional loads for which the structure must be designed. The staff requests this information to enable it to determine whether or not the response of the structure to a seismic event and the loads used in structure's design have been under-predicted by the assumption of building symmetry.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

A sensitivity analysis was performed to analyze the effect of the non-symmetric features in the UHS MWIS. The non-symmetric features in the UHS MWIS arise from the location of the wall openings, floor openings, and masses from the electrical and mechanical equipment. The sensitivity analysis included the CBIS at CCNPP Unit 3.

The effect of the non-symmetric feature is analyzed by creating a SASSI model which contains the non-symmetric wall and floor openings and mass of intake pumps and electrical equipment. The finite element model also includes masses corresponding to 25 percent of floor design live load and 75 percent of roof design snow load, and 50 pounds per square feet of miscellaneous dead load, in addition to the self-weight of the structure. The sensitivity analysis considered the upper bound soil condition of the CBIS site.

The sensitivity analysis considered three models:

1. Complete Structure (CS) as shown in Figure 5.
2. Half Model- East Side (HM-ES) as shown in Figure 6.
3. Half Model- West Side (HM-WS) as shown in Figure 7.

Figure 5
Complete Structure (CS) of CBIS

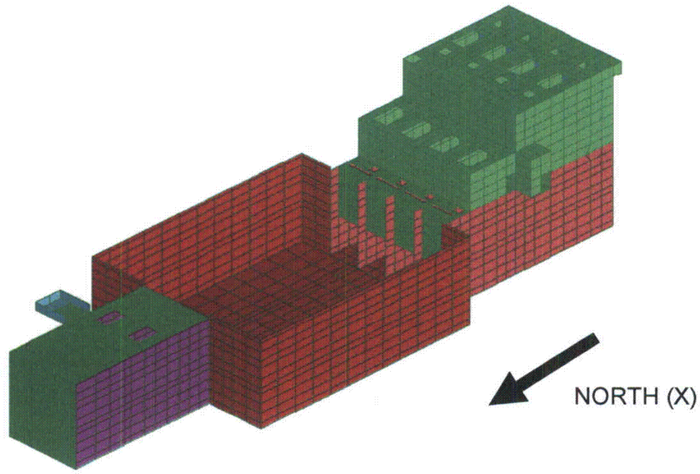


Figure 6
Half Model at the East Side (HM-ES) of CBIS

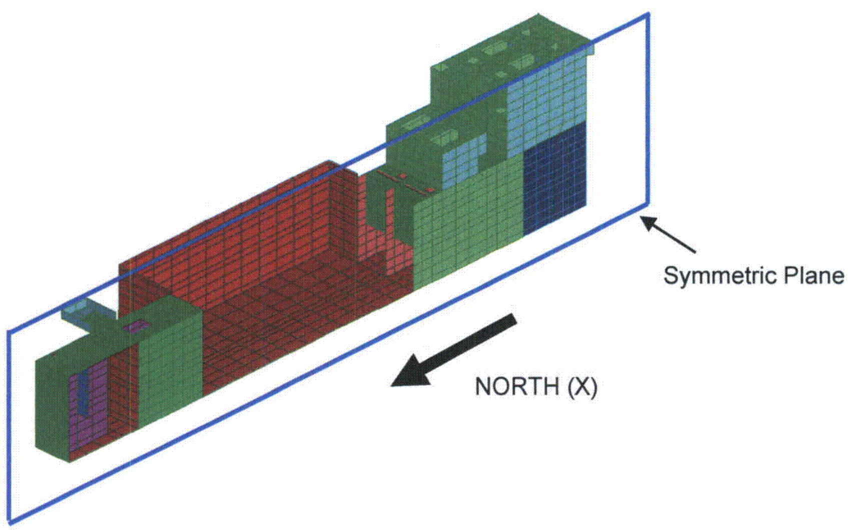
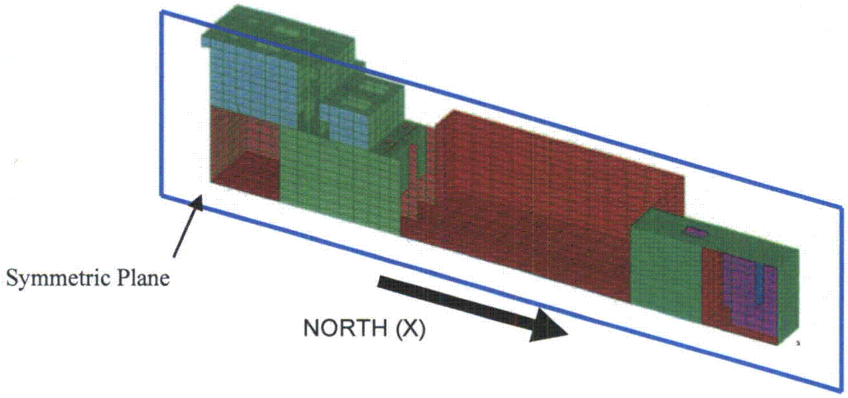


Figure 7
Half Model at the West Side (HM-WS) of CBIS



A total of nine SASSI simulations were conducted to evaluate the effect of non-symmetric feature inside the CBIS. The nine simulations include:

1. Three simulations for the complete structure (CS) shown in Figure 5 using X (N-S), Y (E-W) and Z (Vertical) direction input motion
2. Three simulations for the half model on the east side (HM-ES) shown in Figure 6 using input motion in X (N-S), Y (E-W) and Z (Vertical) direction and
3. Three simulations for the half model on the west side (HM-WS) shown in Figure 7 using input motion in X (N-S), Y (E-W) and Z (Vertical) direction

The amplification functions for the analyzed nine models are shown in Figures 8 through 13 for the point coordinate locations shown in Table 1. These points are selected at the UHS MWIS floors located at Elevations. 11.5' and 26.5' NGVD 29. Four points (D, E, F, and G) are selected inside the Complete structure (CS) where two of them (D and F) are located in the eastern part of the structure and the other two (E and G) are located in the western part of the structure. For result comparison purpose two points (D' and F') are selected on the Half Model at the East Side (HM-ES) at the same coordinate locations to points D and F in the complete structure (CS) respectively. Similarly, two points (E' and G') are selected on the Half Model at the West Side (HM-WS) with similar coordinate locations as E and G points in the complete structure respectively. The coordinate locations of the selected points are shown in Table 1. The results from points D' and F' in the HM-ES are compared with the results at D and F points in the complete structure (CS) respectively. Similarly, the results from points E' and G' in the HM-WS are compared with the results at E and G points in the complete structure respectively.

Figures 8 and 9 show the comparison of the amplification function in the X (N-S) direction. Figures 10 and 11 show the comparison of the amplification function in the Y (E-W) direction. Figures 12 and 13 show the comparison of the amplification function in the Z (vert.) direction.

Table 1
Location of nodes used to develop amplification function output for Effect of Non-symmetric features analysis

Nodes	Location	Point Name	Elevation NGVD 29 (ft)	Coordinates*		
				X (ft)	Y (ft)	Z (ft)
Location of comparison points in the complete structure(CS)						
9126	Ground Floor	D	11.5	103.237	7	0
9128	Ground Floor	E	11.5	103.237	-7	0
8507	Second Floor	F	26.5	113.77	5.499	15.5
8509	Second Floor	G	26.5	113.77	-5.499	15.5
Location of comparison points in the Half Model on the East Side (HM-ES)						
3984	Ground Floor	D'	11.5	103.237	7	0
4625	Second floor	F'	26.5	113.77	5.499	15.5
Location of comparison points in the Half Model on the West Side (HM-WS)						
3964	Ground Floor	E'	11.5	103.237	-7	0
4610	Second Floor	G'	26.5	113.77	-5.499	15.5

*The origin of the coordinate system is located at the ground level, at the top of the Center of the Forebay.

Figure 8
North-South (X) direction amplification functions for points located on a floor at Elevation. 11.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location D, complete structure west side (CS-WS) at location E, half Model on West Side (HM-WS) at location E' and Half Model on the East Side (HM-ES) at location D'.

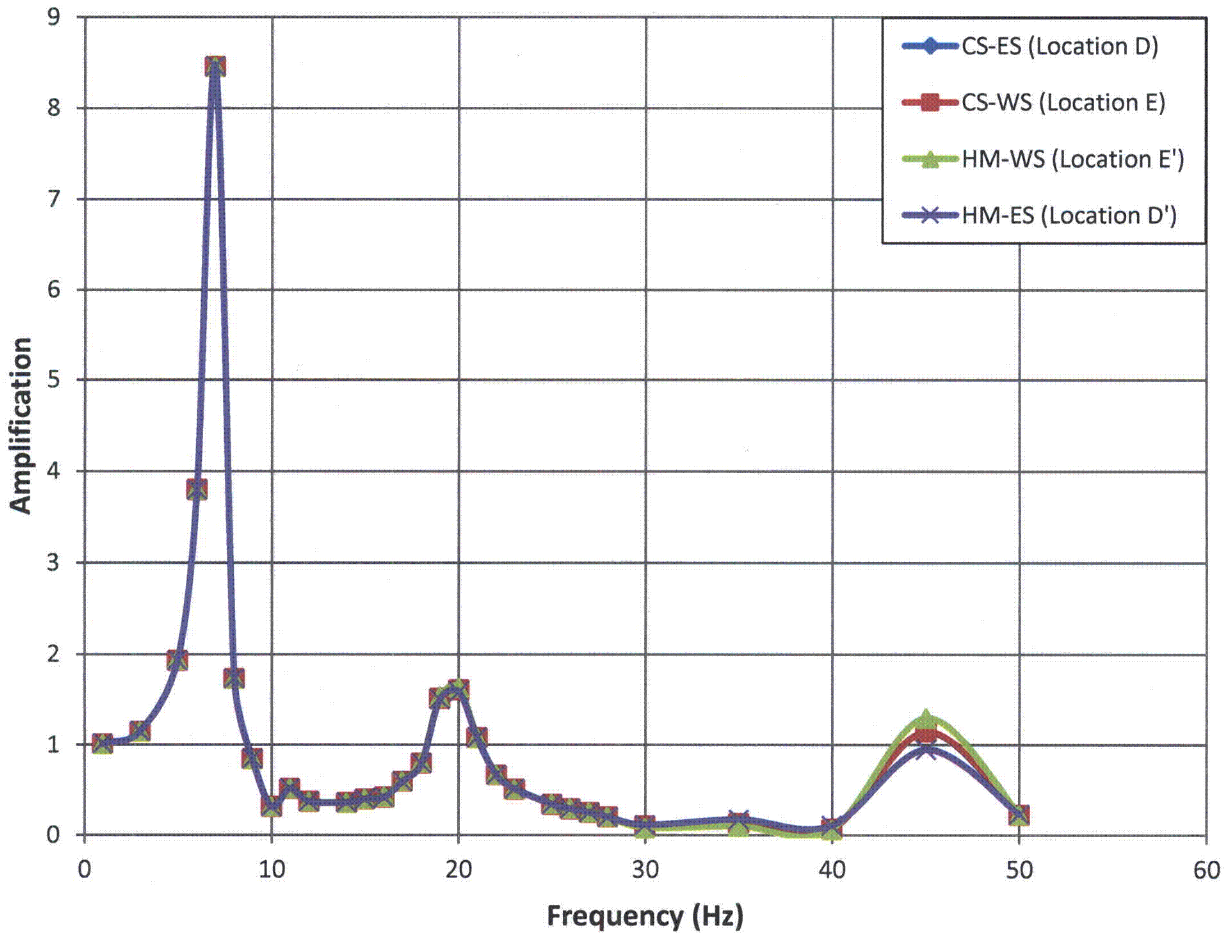


Figure 9
North-South (X) direction amplification functions for points located on a floor at Elevation. 26.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location F, complete structure west side (CS-WS) at location G, half Model on West Side (HM-WS) at location G' and Half Model on the East Side (HM-ES) at location F'.

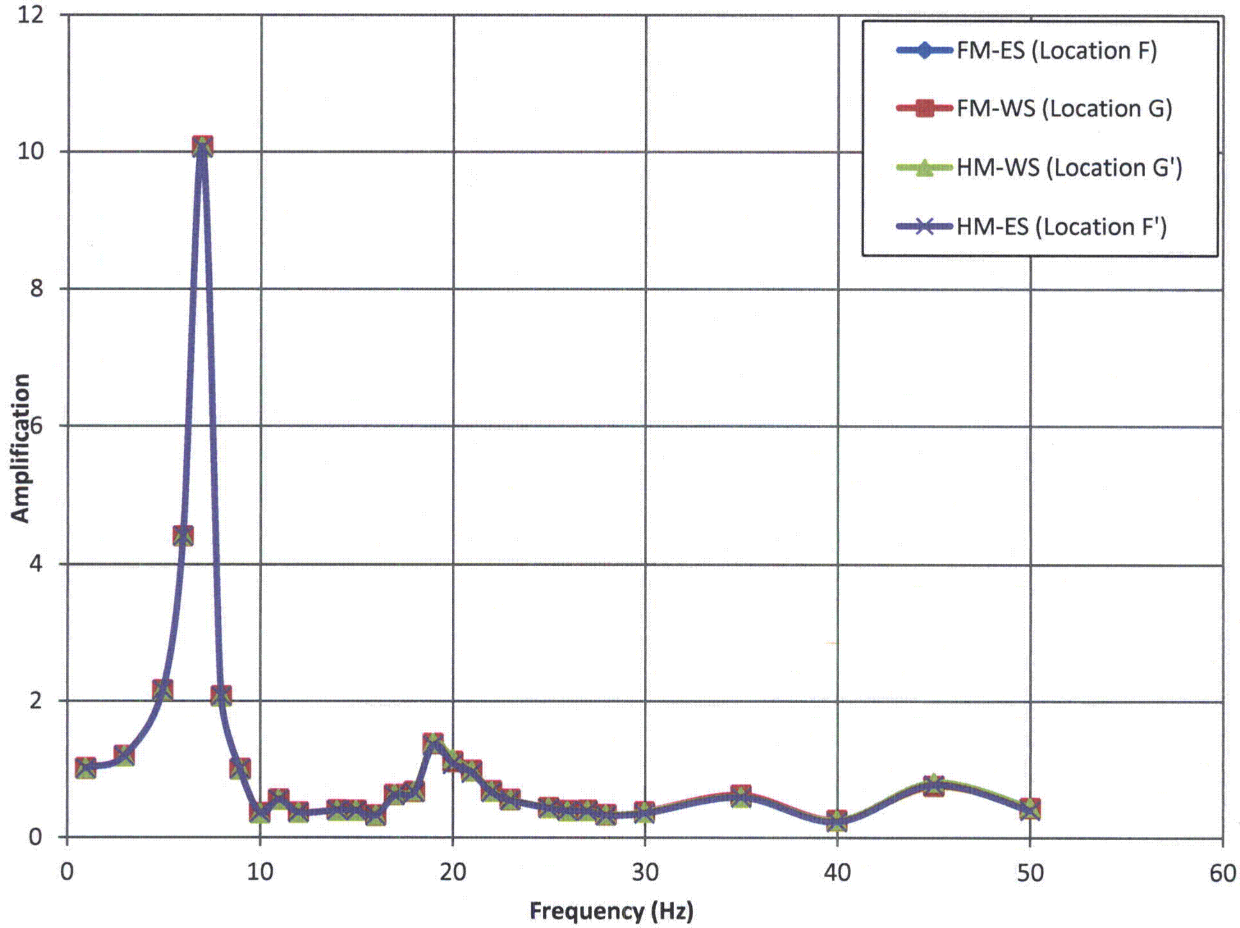


Figure 10
East-West (Y) direction amplification functions for points located on a floor at Elevation. 11.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location D, complete structure west side (CS-WS) at location E, half Model on West Side (HM-WS) at location E' and Half Model on the East Side (HM-ES) at location D'.

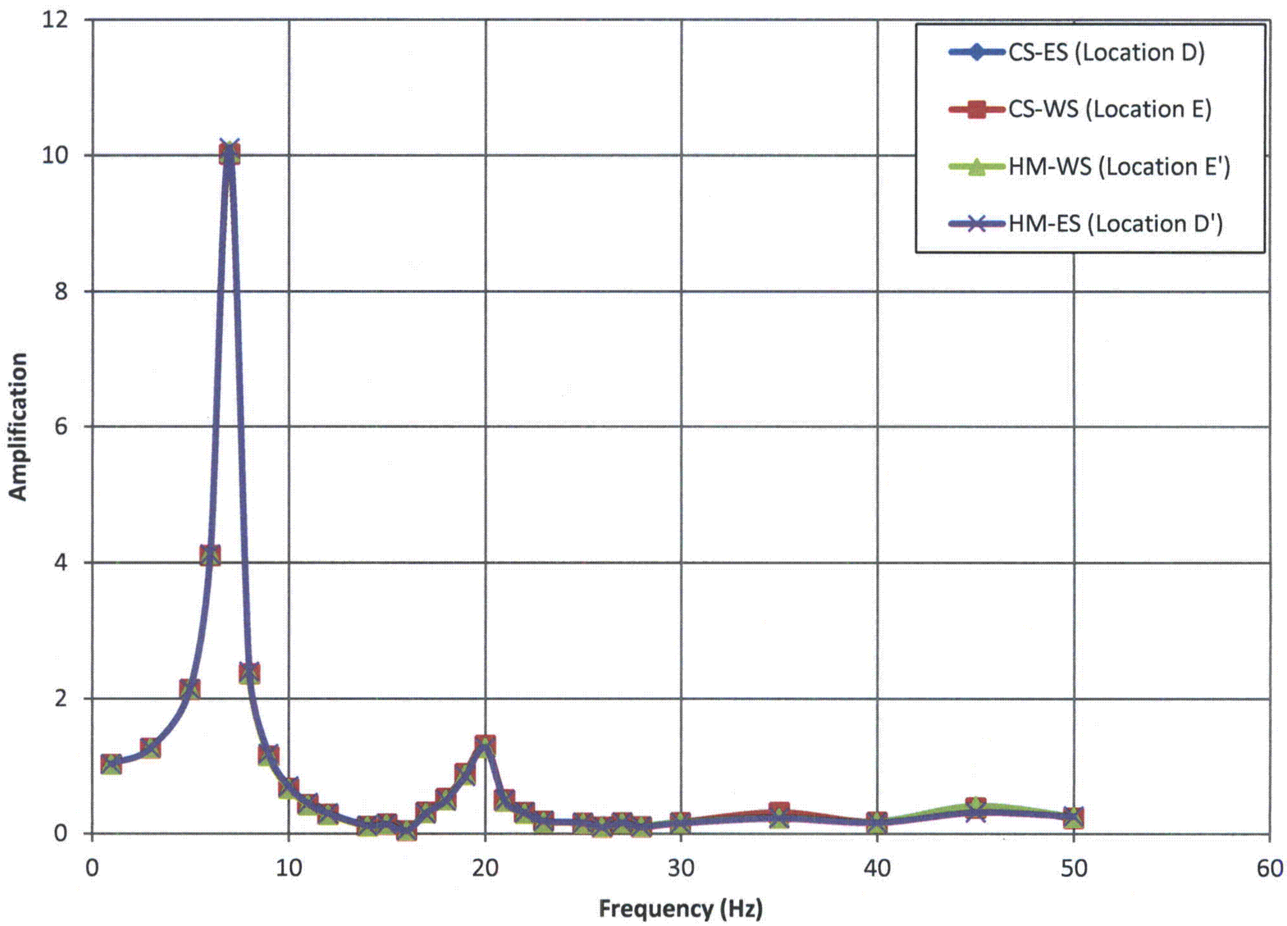


Figure 11
East-West(Y) direction amplification functions for points located on a floor at Elevation 26.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location F, complete structure west side (CS-WS) at location G, half Model on West Side (HM-WS) at location G' and Half Model on the East Side (HM-ES) at location F'.

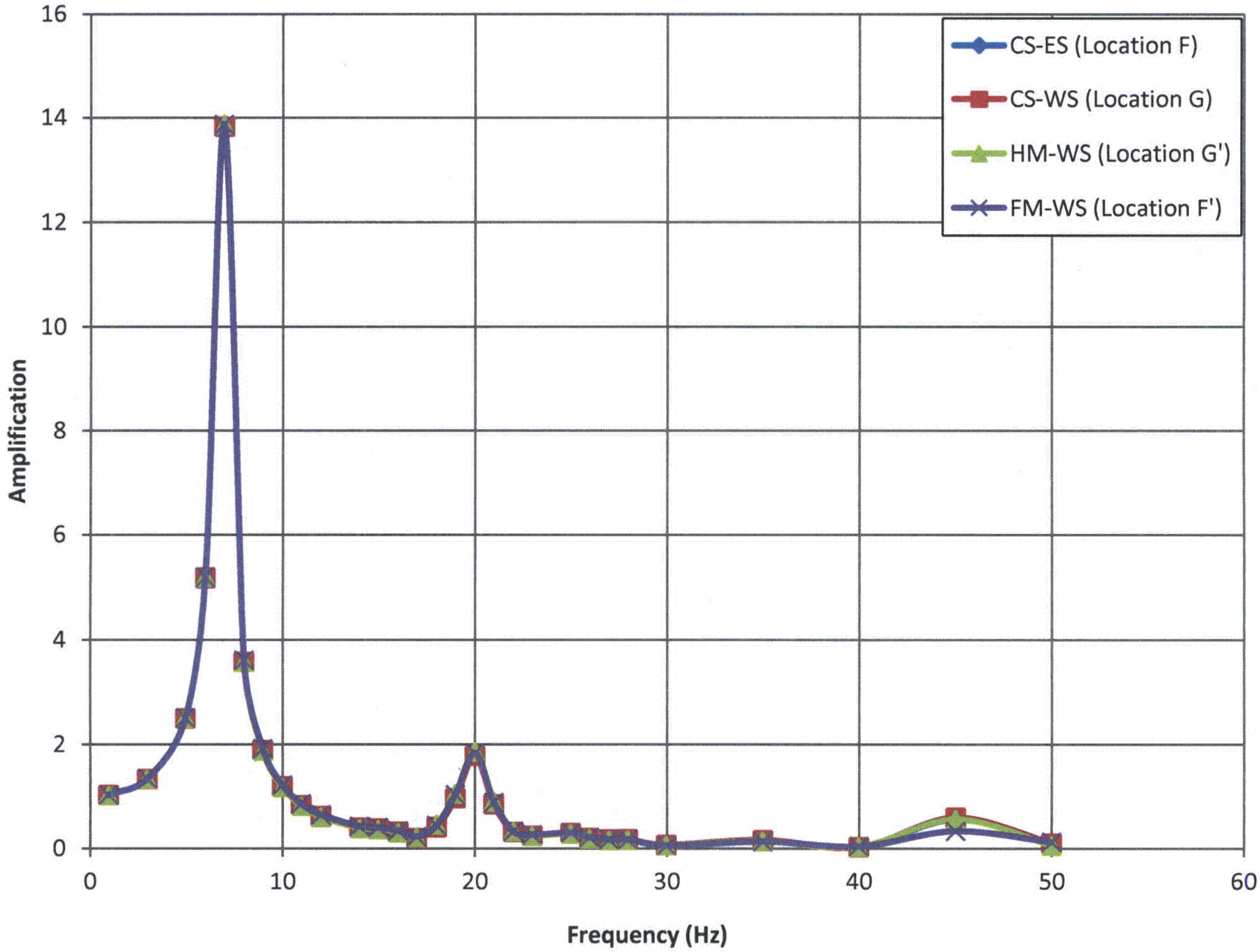


Figure 12
Vertical (Z) direction amplification functions for points located on a floor at Elevation 11.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location D, complete structure west side (CS-WS) at location E, half Model on West Side (HM-WS) at location E' and Half Model on the East Side (HM-ES) at location D'.

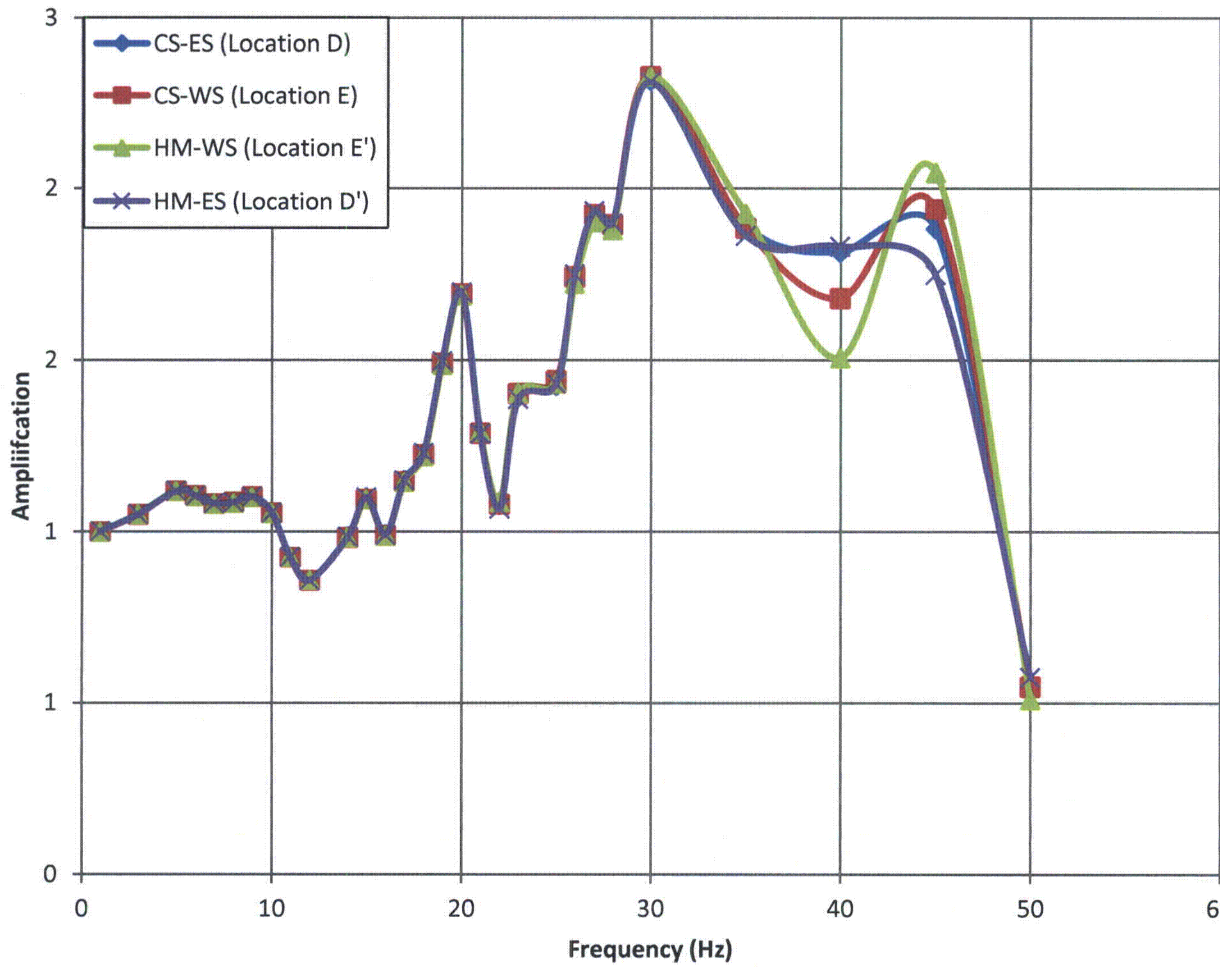
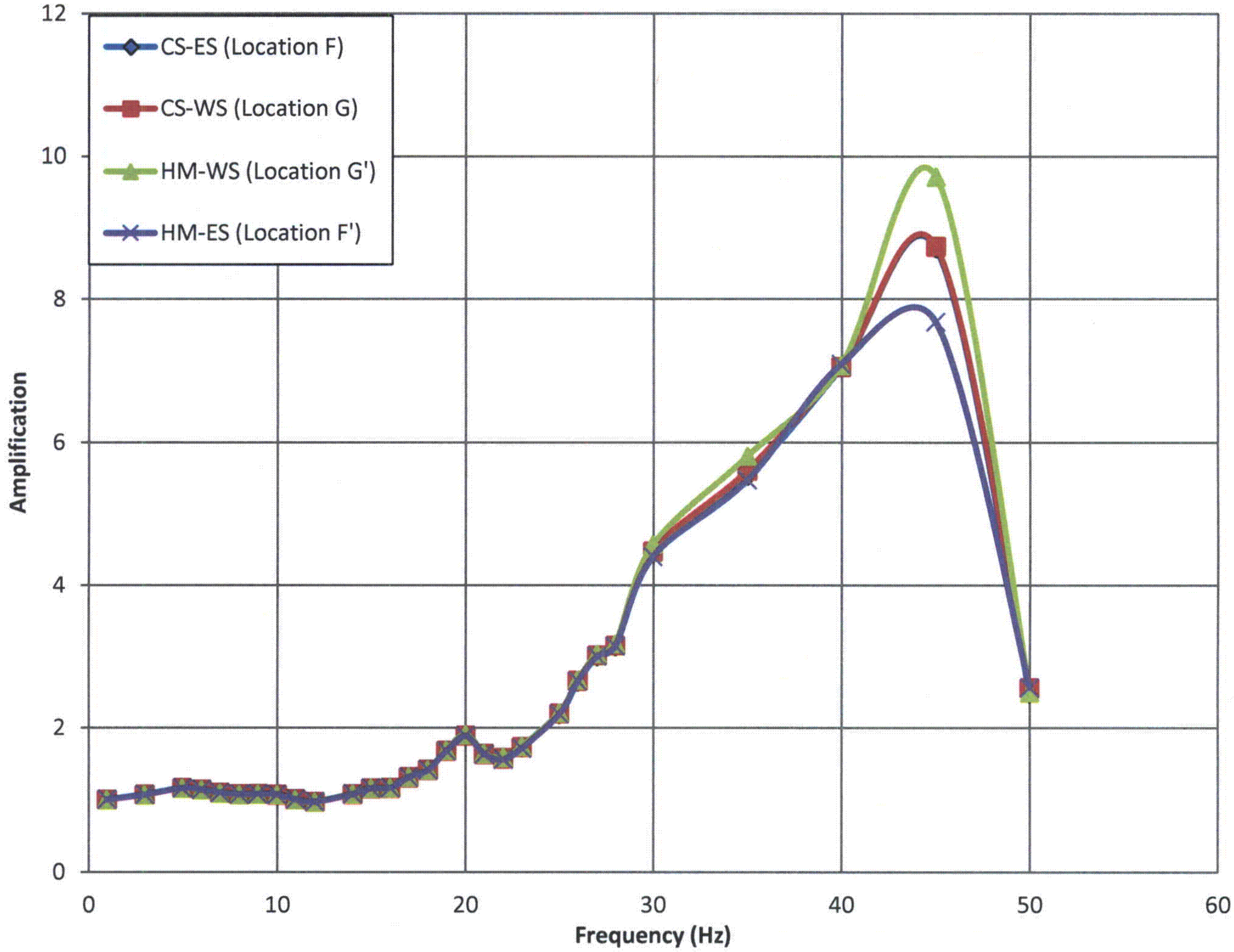


Figure 13
Vertical (Z) direction amplification functions for points located on a floor at Elevation 26.5 ft in the UHS MWIS for complete structure East Side(CS-ES) at location F, complete structure west side (CS-WS) at location G, half Model on West Side (HM-WS) at location G' and Half Model on the East Side (HM-ES) at location F'.



Based on the amplification function results, the complete structure (CS), the half model on the east side (HM-ES), and the half model on the west side (HM-WS) show agreement for both X(N-S) and Y(E-W) direction input motions. No significant difference was observed and the effect of non-symmetric features looks negligible for N-S and E-W directions of motion. However, the comparison of the three models for the vertical (Z) input motion shows some differences as shown in Figures 12 and 13. The differences are the result of the non-symmetric features in the UHS MWIS. Both the complete structure (CS) and the half model on the west side (HM-WS) show larger amplification response compared to the eastern side (HM-ES) of the CBIS for frequencies approximately higher than 30 Hz. To account for the effect of this symmetry effect in the UHS MWIS, the western half of the CBIS is selected for further detailed SSI analysis of the CBIS.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Question 03.07.02-48

Follow Up to Question 03.07.02-25

In its response to Question 03.07.02-25 which requested that the applicant confirm that only the guidance provided in RG 1.122 was used for peak broadening of in-structure response spectra (ISRS), the applicant responded by incorporating by reference Section 3.7.2.9 of US EPR FSAR. Section 3.7.2.9 of the U.S. EPR FSAR does not provide the Regulatory Guide used for peak broadening of ISRS. That basis is provided in U.S. EPR FSAR Section 3.7.2.5 which references RG 1.122. The applicant is requested to revise the CCNPP FSAR to indicate the basis for the peak broadening of ISRS by providing the appropriate reference.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

The broadening and smoothing of the floor response spectrum were performed according to RG 1.122. FSAR Section 3.7.2.9 has been revised.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Question 03.07.02-52

Follow-Up to RAI 03.07.02-35

In its response to Question 03.07.02-35, the applicant stated that the analysis and design results for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) will be updated in a future submittal of FSAR Sections 3.8.4, 3.8.5, and Appendix 3E. In order for the staff to be able evaluate the design basis and the design loads used for this structure and to be able to conclude that the structure meets the requirements of General Design Criteria 2, the applicant is requested to provide the analysis and design results for the UHS MWIS including updated FSAR Sections for staff review. In addition, the applicant is also requested to respond to the issues raised in Question 03.07.02-35, as appropriate, in the revised Table 3E.4-2.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.8 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

Table 3E.4-2, as reviewed by the NRC for RAI No. 167 Question 03.07.02-35, was removed from the FSAR. Therefore correcting the issues associated with information as presented in that table is no longer necessary.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Question 03.07.02-53

Follow Up to Question to 03.07.02-40

In its response to RAI No. 65, Question 03.07.02-15, the applicant described a systematic method for using the accelerations determined in the dynamic analysis of the UHS MWIS and applying these to a static model of the building to obtain forces and moments for structural design. This method involved the use of a weighted average of accelerations which were obtained from the building dynamic analysis. In Question 03.07.02-40, the applicant was requested to clarify if the absolute or signed acceleration values were used in the weighted average calculation. If the signed acceleration values were used, the applicant was requested to explain why it was acceptable to apply this methodology to out-of-plane slab accelerations caused by a building rotation about a horizontal axis. The applicant's response to Question 03.07.02-40 states that the time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4. This does not provide a response to the follow-up question, and Section 3.7.2.4 does not describe how the results of the SASSI analysis are used to determine forces and moments for building design. If the weighted average method is used to determine the forces and moments for building design then Question 03.07.02-40 is still applicable and the applicant is requested to provide a response. If this method is not used, the applicant should describe the methods used to determine the design forces and moments in the static models of the UHS MWIS and UHS EB using the analysis results from the SASSI seismic model. This information will assist in assessing how the three directions of earthquake motion were considered in the design and whether the method used to convert seismic accelerations into design loads was done in a conservative manner.

Response

The UHS MWIS has been modified to include the electrical equipment, eliminating the need for a separate Electrical Building. FSAR Section 3.7 (included in Enclosure 2) has been updated to reflect the analysis of the new configuration.

The updated design and analysis of the UHS MWIS was prepared using absolute accelerations.

COLA Impact

The CCNPP Unit 3 COLA has been updated to incorporate the change to the UHS MWIS and elimination of the UHS Electrical Building as shown in Enclosures 2 through 12.

Enclosure 2

Complete FSAR Sections 3.7, 3.8, Appendix 3E and Appendix 3F with changes

Calvert Cliffs Nuclear Power Plant, Unit 3

3.7 SEISMIC DESIGN

This section of the U.S. EPR FSAR is incorporated by reference with the supplements as described in the following sections.

3.7.1 SEISMIC DESIGN PARAMETERS

{Section 3.7.1 and Appendix 3F describe the site-specific seismic design parameters for CCNPP Unit 3. Section 3.7.2 demonstrates, through confirmatory site-specific Soil-Structure Interaction (SSI) analysis, that the U.S. EPR design is applicable. In addition, the SSI analysis of the site-specific Seismic Category I structures, listed below, is presented in Section 3.7.2.

Throughout this section, three groups of structures are considered:

- Nuclear Island (NI) Common Basemat Structures
- Emergency Power Generating Buildings (EPGB) and Essential Service Water Buildings (ESWB) located in the NI area
- Site-specific Seismic Category I structures

The site-specific Seismic Category I structures at CCNPP Unit 3 are:

- Ultimate Heat Sink (UHS) Makeup Water Intake Structure
- Forebay
- ~~UHS Electrical Building~~
- Buried Electrical Duct Banks and Pipes

Two site-specific Seismic Category I structures: the UHS Makeup Water Intake Structure and the UHS Forebay, as well as the Seismic Category II Circulating Water Makeup Water Intake Structure share the same basemat; they are referred to as Common Basemat Intake Structures (CBIS). The CBIS ~~and UHS Electrical Building~~ are situated at the CCNPP Unit 3 site along the west bank of the Chesapeake Bay. Figures 9.2-4, 9.2-5 and 9.2-6 provide plan views of the Seismic Category I UHS structures, along with associated sections. Figures 10.4-4 and 10.4-5 provide the plan and section views of the Seismic Category II Circulating Water Makeup Intake Structure. The bottom of the CBIS basemat is situated approximately 37.5 ft (11.4 m) below a nominal grade elevation of 10 ft (3.0 m) NGVD 29~~, while the bottom of the UHS Electrical Building basemat foundation is situated approximately 20.5 ft (6.2 m) below grade~~. The layout of the Seismic Category I buried electrical duct banks and Seismic Category I buried piping is defined in Figures 3.8-1 and 3.8-2, and Figures 3.8-3 and 3.8-4, respectively.

3.7.1.1 Design Ground Motion

The site-specific Foundation Input Response Spectra (FIRS) for CCNPP Unit 3 are developed using Regulatory Guide 1.208 (NRC, 2007a). The FIRS are developed for the NI common basemat structures and the Seismic Category I ESWB and EPGB in the NI area, as well as for the site-specific Seismic Category I ~~UHS Electrical Building and~~ CBIS in the Intake area. The development of the Site Safe Shutdown Earthquake (Site SSE) is discussed in Section 3.7.1.1.1. All FIRS are shown to be enveloped by the Site SSE. Therefore, the Site SSE is used as the input motion for the analysis of the structures in Section 3.7.2.

3.7.1.1.1 Design Ground Motion Response Spectra

3.7.1.1.1.1 Design Ground Motion Response Spectra for Nuclear Island Common Basemat Structures

Development of FIRS

As described, in the US EPR FSAR Section 3.7.2.4, the NI Common Basemat Structures are analyzed as surface-founded structures and structural embedment is ignored in the Soil-Structure Interaction (SSI) analysis. The Foundation Input Response Spectra (FIRS) for the NI Common Basemat Structures is defined at the bottom of the basemat at approximately 40 ft (12 m) below grade. The GMRS are also defined at this depth. The FIRS for the NI common basemat is therefore taken as the GMRS for CCNPP Unit 3. The GMRS are developed, in Section 2.5.2.6, using Regulatory Guide 1.208 (NRC, 2007a). Computer programs SOILSIM (version 1.3) and RVTSITE (version 1.2) were used to perform site response analysis for the NI Common Basemat Structures and develop GMRS.

Development of Site SSE

Appendix S of 10 CFR Part 50 (CFR, 2008) requires that the horizontal component of the SSE ground motion in the free-field at the foundation level of the structures must be an appropriate response spectrum with a peak ground acceleration of at least 0.1 g. The FIRS for the horizontal direction in the free-field at the foundation level of the NI Common Basemat Structures has a peak ground acceleration of 0.076 g. Therefore an appropriate Site SSE for CCNPP Unit 3 is defined as follows.

The Site SSE ground motion for CCNPP Unit 3 is the envelope of the U.S. EPR FSAR European Utility Requirements (EUR) Soft Soil spectrum anchored at 0.15 g and the horizontal RG 1.60 spectrum anchored at 0.1 g, therefore satisfying the requirements of Appendix S of 10 CFR Part 50. The Site SSE ground motion, which is specified for both horizontal and vertical directions, is presented in Figure 3.7-1 and Table 3.7-1.

Comparison of FIRS, CSDRS and Site SSE

A comparison of the horizontal and vertical GMRS (or FIRS for NI Common Basemat Structures) versus the Site SSE is shown in Figures 3.7-2 and 3.7-3, respectively. The horizontal and vertical GMRS are enveloped by the Site SSE. A comparison of the GMRS and Site SSE to the CSDRS is outlined below:

1. The PGA for the GMRS (FIRS for the NI Common Basemat Structures) and Site SSE are less than 0.3 g, the PGA for the CSDRS.

2. A comparison of the FIRS for the NI Common Basemat Structures (i.e., GMRS) with the CSDRS is shown in Figures 3.7-4 and 3.7-5 for the horizontal and vertical directions, respectively. This comparison shows that the CSDRS envelops the GMRS (FIRS for the NI Common Basemat Structures).

3. A comparison of the Site SSE with the CSDRS is shown in Figure 3.7-6. This comparison shows that the CSDRS does not envelop the Site SSE in the low frequency range.

In conclusion, while the CCNPP Unit 3 GMRS are enveloped by the CSDRS, the Site SSE is not enveloped by the CSDRS. Therefore, a confirmatory SSI analysis is conducted, as described in Section 3.7.2.

Development of Site OBE

RG 1.166 states that the operating basis earthquake (OBE) response spectrum check is performed using the lower of: 1) The spectrum used in the certified design, or 2) A spectrum other than (1) used in the design of any Seismic Category I structure.

Section 3.7.4.4 of the U.S. EPR FSAR states that the application of OBE Exceedance Criteria is based on the following:

i. For the certified design portion of the plant, the OBE ground motion is one-third of the certified seismic design response spectra (CSDRS).

ii. For the safety-related noncertified design portion of the plant, the OBE ground motion is one-third of the site-specific SSE design motion response spectra, as described in Section 3.7.1.

iii. The threshold response spectrum ordinate criterion to be used in conjunction with RG 1.166 is the lowest of (i) and (ii).

The EUR soft soil spectrum is lower than the Site SSE below approximately 0.36 Hz. Therefore, the Site OBE for CCNPP Unit 3 is the composite earthquake which consists of one-third of the site SSE (i.e. the Site SSE anchored at 0.05g vs. 0.15g) in the high frequency, and one-third of the EUR Soft Soil spectrum (i.e. the EUR Soft Soil Spectrum anchored at 0.10g vs. 0.30g) in the low frequency (approximately 0.36Hz and below). The Site OBE is shown in Figure 3.7-6.

3.7.1.1.1.2 Design Ground Motion Response Spectra for EPGB and ESWB

Development of FIRS

The FIRS for Seismic Category I Emergency Power Generating Buildings (EPGB) and the Seismic Category I Essential Service Water Buildings (ESWB) are developed in accordance with Regulatory Guide 1.208 (NRC, 2007a). The FIRS are developed through seismic site response analysis using the rock motion spectra, presented in Section 2.5.2.5.1.4, and the soil profile properties representing the NI area site conditions, presented in Section 2.5.4.2 (including properties for structural backfill that supports both the EPGB and ESWB). Appendix 3F discusses in detail the development of FIRS as well as the site response analysis methodology and the computer codes.

Comparison of FIRS, CSDRS and Site SSE

The FIRS are checked for adequacy as SSI input according to the applicable requirements (NEI, 2009 and NRC, 2009), and amplified to account for the structure-soil-structure Interaction (SSSI) effects at the NI area (see Appendix 3F for details). The modified and amplified FIRS are referred to as Adjusted FIRS in the following discussion. Figure 3.7-7 compares the Site SSE with the following spectra:

- Site-specific horizontal and vertical Adjusted FIRS for the EPGB and ESWB. The FIRS for the EPGB and ESWB are calculated as the envelope of the FIRS at ground surface (the EPGB in the SSI analysis is surface founded) and the FIRS at 22 ft (6.7 m) below grade (corresponding to the bottom of foundation elevation of the ESWB).

- Regulatory Guide 1.60 (NRC, 1973) horizontal spectrum scaled to a PGA of 0.10 g.

- The CSDRS based on the EUR soft, medium and hard soil spectra.

The comparison shows that the CSDRS envelops the Adjusted FIRS at all frequencies except for small exceedance at the low frequency range (around 0.2 Hz). The comparison also shows, as presented more clearly in Figure 3.7-8, that in addition to satisfying the requirements of Appendix S of 10 CFR Part 50 (CFR, 2008), the Site SSE envelops the Adjusted FIRS. As such, confirmatory SSI analyses are performed for the EPGB and ESWB using the Site SSE as the design response spectrum and a set of site-specific LB, BE and UB soil profiles strain-compatible with Site SSE, presented in Section 3.7.1.3.2.

The site-specific confirmatory SSI analysis is presented in Section 3.7.2 and demonstrates that the U.S. EPR design is applicable to the EPGB and ESWB.

3.7.1.1.1.3 Design Ground Motion Response Spectra for Common Basemat Intake Structures ~~and UHS Electrical Building~~

Development of FIRS

The FIRS for the site-specific structures (CBIS ~~and UHS Electrical Building~~) are developed in accordance with Regulatory Guide 1.208 (NRC, 2007a). The FIRS are developed through seismic site response analysis using the rock motion spectra, presented in Section 2.5.2.5.1.4, and the soil profile properties representing the Intake area site conditions, presented in Section 2.5.4.2 (including properties for structural backfill surrounding ~~both~~ the CBIS ~~and UHS Electrical Building~~). Appendix 3F discusses in detail the development of FIRS as well as the site response analysis methodology and the computer codes used.

Comparison of FIRS and Site SSE

The FIRS are checked for adequacy as SSI input according to the applicable requirements (NEI, 2009 and NRC, 2009), see Appendix 3F for details. The modified FIRS are referred to as Adjusted FIRS in the following discussion. Figure 3.7-9 compares the Site SSE with the following spectra:

- Site-specific horizontal and vertical Adjusted FIRS for the Intake area at 37.5 ft (11.4 m) below grade (corresponding to the bottom of foundation elevation of the CBIS).
- ~~Site-specific horizontal and vertical Adjusted FIRS for the Intake area, that is the envelope of the Adjusted FIRS at ground surface and at 20.5 ft (6.2 m) below grade (corresponding to the bottom of foundation elevation of the UHS Electrical Building).~~
- Regulatory Guide 1.60 (NRC, 1973) horizontal spectrum scaled to a PGA of 0.10 g.

Figure 3.7-9 demonstrates that, in addition to satisfying the requirements of Appendix S of 10 CFR Part 50 (CFR, 2008), there is significant margin between the Site SSE and the horizontal and vertical Adjusted FIRS.

The SSI analysis for the CBIS is ~~and UHS Electrical Building are~~ described in detail in Section 3.7.2.4. The analysis uses the Site SSE as the design response spectrum and a set of site-specific LB, BE and UB profiles (presented in Section 3.7.1.3.3) that are strain-compatible with the Site SSE.

3.7.1.1.1.4 Design Ground Motion Response Spectra for Seismic Category I Buried Utilities

A separate site response analysis can not be performed for the utility corridor between the NI and Intake areas until detailed design. However, the FIRS developed for the NI area (Section 3.7.1.1.1.1 and Section 3.7.1.1.1.2) and Intake area (Section 3.7.1.1.1.3) are shown to be comfortably enveloped by the Site SSE. The Site SSE is therefore considered as the design ground motion for the seismic analysis of the buried utilities.

3.7.1.1.2 Design Ground Motion Time History

A three component set of spectrum compatible acceleration time histories is developed for use as input time histories for SSI analysis. The two horizontal and one vertical components are modified to be spectrum compatible with the Site SSE. The spectral matching criteria given in NUREG CR-6728 (McGuire et al., 2001) and NUREG-0800, Section 3.7.1, Approach 2, Option 1 (NRC, 2007b) are followed for the spectral matching procedure, including the cross-correlation between the three components of less than 0.16. The starting seed input time histories are selected as the EUR soft soil three component acceleration time histories, presented in U.S. EPR FSAR Section 3.7.1.1.2. These time histories are spectrum compatible with the EUR soft target spectra scaled to a PGA of 0.3g. Figure 3.7-10 presents the acceleration, velocity and displacement time histories for the first horizontal component (S1) spectrally matched to Site SSE. Figure 3.7-11 presents the time histories for the second horizontal component (S2) and Figure 3.7-12 presents the time histories for the vertical component (S3). Bechtel proprietary computer programs RSPM (version 1.0) and SETARGET (version 1.0) were used to develop these spectrally matched time histories.

3.7.1.1.2.1 Design Ground Motion Time History for Nuclear Island Common Basemat

As described in the US EPR FSAR Section 3.7.2.4, the NI Common Basemat Structures are analyzed as surface-founded structures and structural embedment is ignored in the SSI analysis. The three component set of Site SSE spectrum compatible acceleration time histories presented in Figure 3.7-10 through Figure 3.7-12 are used as the input ground motion for the confirmatory SSI analysis of the NI Common Basemat Structures.

3.7.1.1.2.2 Design Ground Motion Time History for EPGB and ESWB

As described in the US EPR FSAR Section 3.7.2.4, the EPGB is analyzed as a surface-founded structure. The three component set of Site SSE spectrum compatible acceleration time histories presented in Figure 3.7-10 through Figure 3.7-12 are used as the input ground motion for the confirmatory SSI analysis of the EPGB.

In the case of the ESWB, which is analyzed as an embedded structure, the "within" acceleration time histories at the FIRS horizon are calculated using the computer program SHAKE2000 (described in Appendix 3F). In this analysis, the Site SSE spectrally matched time histories are used as input "outcrop" motions at the foundation level in conjunction with the strain-compatible profiles for the NI area, presented in Section 3.7.1.3.2. No further iterations on soil properties are performed as the acceleration time history is converted from "outcrop" to "within." The analysis results in a set of three "within" motions (two horizontal and one vertical) at the same FIRS horizon. Three sets are developed corresponding to the LB, BE and UB profiles for the ESWB, as presented in Figure 3.7-13 through Figure 3.7-15. The development of the "within" acceleration time histories is discussed in detail in Appendix 3F. In the SSI analysis, the time histories are applied at the FIRS horizon as "within" motions and are used in conjunction with the respective SSI soil profiles, described in Section 3.7.1.3.2.

3.7.1.1.2.3 Design Ground Motion Time History for Common Basemat Intake Structures~~ and UHS Electrical Building~~

In the case of the CBIS~~ and UHS Electrical Building~~, which are analyzed as embedded structures, the "within" acceleration time histories at each FIRS horizon are calculated using the computer program SHAKE2000 (described in Appendix 3F). In this analysis, the Site SSE spectrally matched time histories are used as input "outcrop" motions at the foundation level in conjunction with the strain-compatible profiles for the Intake area, presented in Section 3.7.1.3.3. No further iterations on soil properties are performed as the acceleration time history is converted from "outcrop" to "within." The analysis results in a set of three "within" motions (two horizontal and one vertical) at the same FIRS horizon. ~~Six~~Three sets are developed corresponding to the LB, BE and UB profiles for the ~~UHS Electrical Building and~~ CBIS, as presented in Figure 3.7-~~16~~19 through 3.7-21. The development of the within acceleration time histories is discussed in detail in Appendix 3F. The time histories are applied at the FIRS horizon as "within" motions and are used in conjunction with the corresponding SSI soil profiles, described in Section 3.7.1.3.3.

3.7.1.2 Percentage of Critical Damping Values

Operating Basis Earthquake (OBE) structural damping values, defined in Table 2 of RG 1.61, Rev 1 (NRC, 2007c), are used for the dynamic analysis of site-specific Seismic Category I SSCs and confirmatory SSI analysis of the NI Common Basemat Structures as well as for the EPGB and ESWB. In-structure response spectra (ISRS) for site-specific Seismic Category I structures are also based on OBE structural damping values.

The damping values for site-specific Seismic Category II-SSE and Seismic Category II structures are in accordance with RG 1.61, Rev. 1 (NRC, 2007c).

3.7.1.3 Supporting Media for Seismic Category I Structures

3.7.1.3.1 Nuclear Island Common Basemat

The supporting media for the seismic analysis of the NI Common Basemat Structures is shown in Figure 3.7-22 and Table 3.7-2 through Table 3.7-4. The presented soil profiles are site-specific and are strain-compatible with the Site SSE. Lower bound and upper bound profiles are calculated maintaining a minimum variation of 0.5 on the shear modulus. An evaluation of the CCNPP Unit 3 site-specific soil profiles with respect to the criteria provided in U.S. EPR FSAR Section 2.5.2.6 is described below:

1. The NI Common basemat is founded on top of Chesapeake Cemented Sand with a low-strain, best-estimate shear wave velocity of approximately 1,450 ft/s (440 m/s) (see Figure 2.5-167). Since this shear wave velocity is greater than 1,000 ft/s (300 m/s), the CCNPP Unit 3 NI is founded on competent material as defined in NUREG-0800 Section 3.7.1 (NRC, 2007b).

2. The lateral uniformity of site-specific profile (using the criterion of a soil layer with an angle of dip less than 20 degrees) is addressed in Section 2.5.4.10.3.

3. The range of shear wave velocities of the CCNPP Unit 3 strain-compatible soil profiles is shown in Figure 3.7-22, and is bounded by that of the generic strain-compatible soil profiles used in the U.S. EPR FSAR as shown in Figure 3.7-23. However, there are variations in the soil layering and shear wave velocities from the generic soil profiles considered in the U.S. EPR FSAR.

In view of such variations, confirmatory site-specific SSI analyses are performed, as described in Section 3.7.2. The resulting in-structure response spectra (ISRS) at representative locations of the NI structures, as reported in Section 3.7.2.5.1, are found to be bounded by the corresponding U.S. EPR FSAR ISRS. Therefore, the U.S. EPR design is applicable to CCNPP Unit 3 NI Common Basemat Structures.

3.7.1.3.2 EPGB and ESWB

The supporting media for the seismic analysis of the EPGB and ESWB in the NI area are presented in Figure 3.7-24. The presented soil profiles are site-specific and are strain-compatible with the Site SSE. The development of the Site SSE strain-compatible soil profiles is described in detail in Appendix 3F.

Note that in contrast to Figure 3.7-22, where the top layer is located at the bottom of the NI common basemat foundation at approximately 40 ft (12 m) below grade, Figure 3.7-24 presents the profiles for the upper 656 ft (200m) with the top layer at grade, including the structural backfill layers, therefore consistent with the confirmatory SSI analyses of the EPGB and ESWB, described in Section 3.7.2.

3.7.1.3.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

The supporting media for the seismic analysis of the ~~UHS Electrical Building and~~ CBIS in the Intake area are presented in Figure 3.7-25 for the upper 656 ft (200m). The presented soil profiles are site-specific and are strain-compatible with the Site SSE. The development of the Site SSE strain-compatible soil profiles is described in detail in Appendix 3F. The dimensions of ~~the UHS Electrical Building and~~ CBIS, including the structural height, are~~is~~ described in Section 3.7.2.3.2.

3.7.1.4 References

CFR, 2008. Domestic Licensing of Production and Utilization Facilities, 10 CFR Part 50, U.S. Nuclear Regulatory Commission, February 2008.

McGuire, R.K., W.J. Silva, and C.J. Costantino, 2001. Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard and Risk-Consistent Ground Motion Spectra Guidelines, NUREG CR-6728, October, 2001.

Nuclear Energy Institute [NEI], 2009. Consistent Site-Response/Soil Structure Interaction Analysis and Evaluation. NEI White Paper, June 12, 2009 (ADAMS Accession No. ML091680715).

NRC, 1973. Design Response Spectra for Seismic Design of Nuclear Power Plants, Regulatory Guide 1.60, Revision 1, U.S. Nuclear Regulatory Commission, December 1973.

NRC, 2007a. A Performance-Based Approach to Define the Site Specific Earthquake Ground Motion, Regulatory Guide 1.208, Revision 0, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007b. Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, Revision 3, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007c. Damping Values for Seismic Design of Nuclear Power Plants, Regulatory Guide 1.61, Revision 1, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2009. Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses, DC/COL-ISG-017 Draft Issued for Comments.}

3.7.2 SEISMIC SYSTEM ANALYSIS

The U.S. EPR FSAR includes the following COL Item in Section 3.7.2:

A COL applicant that references the U.S. EPR design certification will confirm that the site-specific seismic response is within the parameters of Section 3.7 of the U.S. EPR standard design.

This COL Item is addressed as follows:

{The confirmatory soil-structure interaction (SSI) analysis of Nuclear Island (NI) Common Basemat Structures, Emergency Power Generating Buildings (EPGBs) and Essential Service Water Buildings (ESWBs) for Site SSE and site-specific strain-compatible soil properties is addressed in Section 3.7.2.4. The confirmatory SSI analysis is performed since:

- the U.S. EPR FSAR certified seismic design response spectra (CSDRS) does not envelop the Site SSE in the low frequency range, as shown in Figure 3.7-6, and
- the site-specific strain-compatible best estimate (BE), lower bound (LB) and upper bound (UB) soil profiles are bounded, but exhibit variations in the upper layers when compared with the ten generic soil profiles used in U.S. EPR FSAR, as described in FSAR Section 3.7.1.3.1.

Site-specific Seismic Category I structures at CCNPP Unit 3 include:

- Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS)
- ~~UHS Electrical Building~~
- Forebay

The Seismic Category I UHS Makeup Water Intake Structure~~, Seismic Category I UHS Electrical Building,~~ and Seismic Category I Forebay are situated at the CCNPP Unit 3 site along the west bank of the Chesapeake Bay. These structures are part of the UHS Makeup Water System, which provides makeup water to the Essential Service Water Buildings for maintaining the safe shutdown of the plant 72 hours after a design basis accident. The UHS Makeup Water Intake Structure and Forebay are supported on a common basemat, which also supports the Seismic Category II Circulating Water Makeup Intake Structure. The UHS Makeup Water Intake Structure, Forebay, and Circulating Water Makeup Intake Structure, henceforth referred to as the Common Basemat Intake Structures (CBIS) in Section 3.7.2, are integrally connected. The Circulating Water Makeup Intake Structure and the UHS Makeup Water Intake Structure, respectively, are located on the north and south end of the Forebay. ~~The UHS Electrical Building is founded on a separate basemat and is situated approximately 20.5 ft (6.2 m) south of UHS Makeup Water Intake Structure.~~ Figure 2.1-1 depicts the CCNPP Unit 3 site plan, which shows the position of the UHS Makeup Water Intake Structure~~, UHS Electrical Building,~~ and Forebay relative to the NI.

The bottom of the CBIS common basemat is situated approximately 37.5 ft (11.4 m) below a nominal grade elevation of 10 ft (3.0 m)~~, while the bottom of the UHS Electrical Building basemat is situated approximately 20.5 ft (6.2 m) below grade~~. Figures 9.2-4, 9.2-5, and 9.2-6 provide plan views of the Seismic Category I structures, along with associated sections and details. Figures 10.4-4 and 10.4-5 provide the plan and section views of the Seismic Category II Circulating Water Makeup Intake Structure.

3.7.2.1 Seismic Analysis Methods

No departures or supplements.

3.7.2.1.1 Time History Analysis Method

No departures or supplements.

3.7.2.1.2 Response Spectrum Method

No departures or supplements.

3.7.2.1.3 Complex Frequency Response Analysis Method

As described in Section 3.7.2.3.2, an integrated finite element model is developed for the CBIS ~~and UHS Electrical Building~~. The complex frequency response analysis method is used for the seismic SSI analysis of these structures, with earthquake motion considered in three orthogonal directions (two horizontal and one vertical) as described in Section 3.7.2.6. The SSI analysis of site-specific structures is performed, as described in Section 3.7.2.4, using RIZZO computer code SASSI, Version 1.3a~~Bechtel computer code SASSI2000, Version 3.1~~. The hydrodynamic load effects are considered as described in Section 3.7.2.3.2. ~~The model used for SSI analysis inherently includes the effect of multiple support excitations at the common basemat and the pump room floor slab of the UHS Makeup Water Intake Structure.~~

3.7.2.1.4 Equivalent Static Load Method of Analysis

No departures or supplements.

3.7.2.2 Natural Frequencies and Response Loads

3.7.2.2.1 Nuclear Island Common Basemat Structures

Section 3.7.2.5.1 provides the in-structure response spectra (ISRS) for NI Common Basemat Structures for site-specific strain-compatible soil properties and Site SSE.

3.7.2.2.2 EPGB and ESWB

Section 3.7.2.5.2 provides the ISRS for EPGB and ESWB at the locations defined in U.S. EPR FSAR Section 3.7.2.5 for site-specific strain-compatible soil properties and Site SSE. Section 3.7.2.4.6.2 provides the combined average maximum nodal accelerations for the site-specific confirmatory SSI analysis.

3.7.2.2.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

The SSI analysis of site-specific Seismic Category I structures is performed using the complex frequency response analysis method described in Section 3.7.2.1.3, where the equation of motion is solved in the frequency domain. The natural frequencies and associated modal analysis results are not obtained from this analysis. However, fixed base undamped eigenvalue analyses have been performed separately for the Common Basemat Intake Structures ~~and the UHS Electrical Building~~. The analysis results are tabulated in Tables 3.7-5 and 3.7-6 ~~through 3.7-8~~ for reference purposes only.

Section 3.7.2.5.3 provides the ISRS at the locations of safety-related UHS Makeup Water pumps and facilities in the UHS Makeup Water Intake Structure at El. 11.5 ft and El. -22.5 ft, and at the location of safety-related electrical equipment ~~situated in the UHS Electrical Building~~at El. 26.5 ft. Section 3.7.2.4.6.3 provides the combined ~~average~~ maximum nodal accelerations for the CBIS ~~and the UHS Electrical Building~~.

3.7.2.3 Procedures Used for Analytical Modeling

No departures or supplements.

3.7.2.3.1 Seismic Category I Structures – Nuclear Island Common Basemat

No departures or supplements.

3.7.2.3.2 Seismic Category I Structures – Not on Nuclear Island Common Basemat

As described in Section 3.7.2.4.2.2, the confirmatory SSI analysis of EPGB and ESWB is performed using the same structural model defined in U.S. EPR FSAR.

The UHS Makeup Water Intake Structure~~, UHS Electrical Building,~~ and Forebay are the site-specific Seismic Category I structures situated away from the NI in the intake area.

The CBIS, i.e., the UHS Makeup Water Intake Structure, Forebay, and Circulating Water Makeup Intake Structure are reinforced concrete shear wall structures, and are supported on a 5 ft (1.5 m) thick reinforced concrete basemat. The Common Basemat Intake Structures extend approximately 260~~227~~ ft (79.3~~69.3~~ m) along the North-South direction and ~~109~~89 ft (27.1~~33.2~~ m) along the East-West direction, with respect to CCNPP Unit 3 coordinate system. The maximum height of the structures from the bottom of common basemat to the top of the UHS Makeup Water Intake Structure roof is approximately 69~~54~~ ft (21.0~~16.5~~ m).

~~The UHS Electrical Building is a reinforced concrete shear wall structure, situated approximately 20.5 ft (6.2 m) south of the UHS Makeup Water Intake Structure, and is supported on a separate 5 ft (1.5 m) thick reinforced concrete basemat. The UHS Electrical Building is approximately 33 ft (10.1 m) along the North-South direction and 74 ft (22.6 m) along the East-West direction, and has a height of approximately 21 ft (6.4 m) from the bottom of basemat.~~

Figures 9.2-4 through 9.2-6 and Figures 10.4-4 and 10.4-5 are used as the bases for the development of the analytical model of the aforementioned structures.

A~~n integrated~~ 3D finite element model of the CBIS~~ and the UHS Electrical Building~~ is developed in ~~GTSTRUDL, Version 29.1~~STAAD Pro, Version 8i, as shown in Figures 3.7-26 and 3.7-27. The ~~integrated~~ model is used to generate the finite element model for seismic SSI analysis using ~~Bechtel~~RIZZO computer code SASSI, Version 1.3a~~ computer code SASSI2000, Version 3.1~~, and to perform static analysis for non-seismic loads. ~~The structure-soil-structure interaction effects between the Common Basemat Intake Structures and the UHS Electrical Building are incorporated by performing the SSI analysis using the integrated finite element model.~~

The CBIS are~~and the UHS Electrical Building are both~~ symmetric about ~~their~~the North-South ~~axes~~axis, as depicted in Figures 9.2-4 through 9.2-6 and Figures 10.4-4 and 10.4-5. A sensitivity analysis was performed to consider the effects of the non-symmetric features such as door openings and equipment masses. Based on the sensitivity analysis, only one-half (western half) of the CBIS is modeled for the SSI analysis. Figure 3.7-26 depicts the finite element mesh for the half model.

The reinforced concrete basemat, floor slabs, and walls of the Common Basemat Intake Structures are modeled using plate/shell elements to accurately represent the structural geometry and to capture both in-plane and out-of-plane effects from applied loads. The finite element mesh is sufficiently refined to accurately represent the global and local modes of vibration. The skimmer walls, at the entrance of the UHS Makeup Water Intake Structure and Circulating Water Makeup Intake Structure into the Forebay Structure, have an inclination of approximately 10 degrees with the vertical, which is neglected in the finite element model. This simplification has an insignificant effect on the global mass and stiffness distribution, and is conservative for the local response of structural panels. The finite element model in SASSI uses a thin shell element formulation that represents the in-plane and out-of-plane bending effects. In-plane shear deformation are accurately reproduced by the finite element mesh, while out-of-plane shear deformations are considered negligible due to the low thickness/height ratio of these walls.

The reinforced concrete basemat, floor slabs, and walls of the CBIS are modeled using thin shell elements in RIZZO computer code SASSI, Version 1.3a, to accurately represent the structural geometry and to capture in-plane membrane and out-of-plane bending. The average mesh size used in the finite element model below ground level and along the vertical direction is approximately 1.6 ft (0.5 m), based on one-fifth of the wave length at the highest frequency of the SASSI analysis. The average mesh size in the plan direction is approximately 5 ft (1.5 m), abased on an aspect ratio of approximately 3.0).

~~The centerline of UHS Electrical Building is offset approximately 7 ft (2.1 m) towards east of the centerline of the CBIS. Within the integrated SSI model, the 7 ft offset of UHS Electrical Building is ignored and the centerline of UHS Electrical Building is modeled collinear with the centerline of the CBIS such that both structures have the same plane of symmetry. Therefore, only one-half (eastern half) of the CBIS and UHS Electrical Building is modeled. Figure 3.7-26 depicts the finite element mesh for the integrated half model. Since both structures are essentially fully embedded and each structure is symmetrical about its North-South axis, the alignment of both structures along the plane of symmetry is considered acceptable for modeling and analysis. An evaluation of SSI results confirms that the coupling responses due to rocking and torsional motions are very small. Therefore, ignoring the actual offset of the UHS Electrical Building from the plane of symmetry in the SSI half model has negligible effects on the SSI responses.~~

~~The reinforced concrete basemat, floor slabs, and walls of the Common Basemat Intake Structures and the UHS Electrical Building are modeled using plate elements, GT STRUDL element types SBHQ6 and SBHT6, to accurately represent the structural geometry and to capture both in-plane and out-of-plane effects from applied loads. The finite element mesh is sufficiently refined to accurately represent the global and local modes of vibration. The skimmer walls, at the entrance of the UHS Makeup Water Intake Structure and Circulating Water Makeup Intake Structure into the Forebay Structure, have an inclination of approximately 10 degrees with the vertical, which is neglected in the finite element model. This simplification has an insignificant effect on the global mass and stiffness distribution, and is conservative for the local response of structural panels. The finite element model in SASSI 2000 uses a thick shell element formulation (element type SHL17) that represents the in-plane and out-of-plane effects, along with the transverse shear deformations Figure 3.7.2.3-1depicts the finite element mesh for the integrated half model for the site-specific structures.~~

~~The reinforced concrete basemat, floor slabs, and walls of the CBIS and the UHS Electrical Building are modeled using thick shell element (element type SHL17) in Bechtel computer code SASSI2000, Version 3.1, to accurately represent the structural geometry and to capture in-plane membrane, out-of-plane bending, and transverse shear deformation effects. The average mesh size used in the finite element model is approximately 5 ft (1.5 m). Further mesh refinement has negligible effect on the results of fixed-base modal analysis.~~

The skimmer walls, at the entrance of the UHS Makeup Water Intake Structure and the Circulating Water Makeup Intake Structure into the Forebay, have an inclination of approximately 10 degrees with the vertical. However, these walls are modeled vertically for simplification of the finite element model. This simplification has an insignificant effect on the global mass and stiffness distribution, and on the local responses of the structural panels.

The east and west bottom walls of the Forebay, to the top portion of the forebay wall corners, and the basemat below the backfill inside the UHS MWIS are the only structural panels that will crack during any of the applicable loading conditions. These walls crack since they retain approximately ~~32.5 ft (9.9 m)~~37.5 ft (11.5 m) of soil and exhibit cantilever behavior. The out-of-plane bending stiffness of these walls is reduced by one-half to simulate cracked behavior in accordance with ASCE 43-05 (ASCE, 2005). For the walls located in the plane of symmetry, the modulus of elasticity and density are reduced by one-half to accurately represent mass and stiffness in the half model.

As shown in Figures 10.4-4 and 10.4-5, the pump house enclosure and the electrical room for the Circulating Water Makeup Intake Structure are steel enclosures founded on grade slabs. The grade slabs are separated from the CBIS by providing an expansion joint, and are not included in the finite element model. The south end of the pump house enclosure is partially supported on the operating deck slab of the Circulating Water Makeup Intake Structure. The masses corresponding to the applicable dead loads and snow loads for the pump house enclosure are appropriately included in the finite element model.

The finite element model used for the seismic SSI analysis includes masses corresponding to 25 percent of floor design live load and 75 percent of roof design snow load, as applicable, and 50 pounds per square feet of miscellaneous dead load in addition to the self weight of the structure. The weights of ~~major~~ equipment are included in the dynamic analysis.

The hydrodynamic effects of water contained in the CBIS are considered in accordance with ACI 350.3-06 (ACI, 2006). The impulsive and convective water masses due to horizontal earthquake excitation are calculated using the clear dimensions between the walls perpendicular to the direction of motion and the minimum height of water during a hurricane (Elev. -4.0 ft NGVD 29). The impulsive water masses are rigidly attached to the walls, and the convective water masses are connected to the walls using springs with appropriate stiffness. The entire water mass is lumped at the basemat nodes for earthquake ground motion in the vertical direction. The hydrodynamic loads are included for walls both in the Forebay and basement of the UHS Makeup Water Intake Structure.

~~The hydrodynamic effects of water contained in the CBIS are considered in accordance with ACI 350.3-06 (ACI, 2006). The impulsive water masses due to horizontal earthquake excitation are calculated using the clear dimensions between the walls perpendicular to the direction of motion and the maximum height of water during normal operation (Elev. +0.0 ft based on NGVD 29). The entire water mass is lumped at the basemat for earthquake ground motion in the vertical direction. The impulsive water masses are rigidly attached to the walls and basemat, and are included in the SSI model.~~

~~The maximum convective frequencies for the water mass contained in the UHS Makeup Water Intake Structure are approximately 0.51 Hz and 0.74 Hz in the East-West and North-South directions, respectively. The convective frequencies for the water mass in the Forebay are approximately 0.13 Hz and 0.15 Hz in the North-South and East-West directions, respectively. For the Circulating Water Makeup Intake Structure, the maximum convective frequency is approximately 0.59 Hz in both directions. Since the convective frequencies for water masses in the CBIS are very low, the convective masses are not included in the SSI model.~~ The maximum sloshing heights in both directions for the UHS Makeup Water Intake Structure and the Forebay are approximately ~~1.2~~ 0.6 ft (~~0.4~~0.2 m) and ~~1.1~~0.5 ft (~~0.3~~0.15 m), respectively. The minimum available freeboard for the UHS Makeup Water Intake Structure and the minimum clearance for the Forebay are significantly higher than the maximum sloshing heights.

The earthquake excitation along the North-South and vertical directions cause symmetric loading on the structure, whereas the earthquake excitation along the East-West direction causes anti-symmetric loading on the structure. The seismic SSI analysis is performed by applying appropriate symmetric and anti-symmetric boundary conditions in the plane of symmetry of the ~~integrated~~ half model shown in Figure 3.7-26, as indicated in Table 3.7-9.

3.7.2.3.3 Seismic Category II Structures

Site-specific Seismic Category II-SSE structures, systems, and components (SSCs) are analyzed and designed to meet the same requirements as the Seismic Category I SSCs. Seismic Category II Circulating Water Makeup Intake Structure is analyzed along-with the Seismic Category I Forebay and Seismic Category I UHS Makeup Water Intake Structure, as described in Section 3.7.2.3.2. Other site-specific Seismic Category II structures are designed using conventional codes and standards, but are also analyzed for Site SSE.

3.7.2.3.4 Conventional Seismic (CS) Structures

No departures or supplements.

3.7.2.4 Soil-Structure Interaction

This section describes the confirmatory soil-structure interaction (SSI) analyses for the Nuclear Island Common Basemat Structures, EPGB, and ESWB. In addition the SSI analysis of the CBIS ~~and the UHS Electrical Building~~ are also described. ~~The site-specific Seismic Category I CBIS and UHS Electrical Building are analyzed together in one SSI model, using an integrated SSI model which automatically accounts for structure-soil-structure interaction (SSSI) effects between the two structures.~~

The complex frequency response analysis method is used for the SSI analyses, in accordance with the requirements of NUREG-0800 Section 3.7.2, Acceptance Criteria 1.A and 4 and Section 3.7.1, Acceptance Criteria 4.A.vii (NRC, 2007a). During the SSI analyses, the effects of foundation embedment (for ESWB~~,~~ and CBIS ~~and UHS Electrical Building~~), soil layering, soil nonlinearity, ground water table, and variability of soil and rock properties on the seismic response of the structures are accounted for, as described in the following sections. In particular, Sections 3.7.2.4.1 through 3.7.2.4.6 provide the steps followed to perform the SSI analyses. Section 3.7.2.4.7 describes the computer codes used in the analyses.

3.7.2.4.1 Step 1 – SSE Strain Compatible Soil Properties

3.7.2.4.1.1 Nuclear Island Common Basemat Structures

For the Nuclear Island Common Basemat Structures, confirmatory SSI analyses are performed for the lower bound, best estimate and upper bound soil profiles established in Section 3.7.1.3.1 and shown in Tables 3.7-2, 3.7-3 and 3.7-4. Soil properties used in the SSI analysis are strain-compatible with the Site SSE, and account for the range of variation of shear-wave velocity, damping ratio, and P-wave velocity.

3.7.2.4.1.2 EPGB and ESWB

For the EPGB and ESWB, confirmatory SSI analyses are performed for the lower bound, best estimate and upper bound soil profiles established in Section 3.7.1.3.2. Tables 3F-3, 3F-4, and 3F-5 show the properties for the top fifty layers of each soil profile (approximately 300 ft), while

Figures 3F-29, 3F-30 and 3F-31, respectively, show the shear wave velocity, damping ratio and P-wave velocity for the top six hundred feet in this area. Soil properties used in the SSI analysis are strain-compatible with the Site SSE, and account for the range of variation of shear-wave velocity, damping ratio, and P-wave velocity.

3.7.2.4.1.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

SSI analyses for the CBIS ~~and UHS Electrical Building~~ are performed for the lower bound, best estimate and upper bound soil profiles established in Section 3.7.1.3.3. Tables 3F-6, 3F-7 and 3F-8 show the properties for the top fifty layers of each soil profile (approximately 380 ft), while Figures 3F-32, 3F-33 and 3F-34, respectively, show the shear wave velocity, damping ratio and P-wave velocity for the top six hundred feet in the intake area. Soil properties used in the SSI analysis are strain-compatible with the Site SSE, and account for the range of variation of shear-wave velocity, damping ratio, and P-wave velocity.

3.7.2.4.2 Step 2 – Development of Structural Model

3.7.2.4.2.1 Nuclear Island Common Basemat Structures

Confirmatory SSI analyses of the Nuclear Island Common Basemat Structures use the same structural model as used in U.S. EPR FSAR, except that 4 percent structural damping for reinforced concrete and 3 percent structural damping for pre-stressed concrete, NSSS components and vent stack is applied. In particular, the NI Common Basemat Structures are analyzed as surface-founded structures on a rigid foundation.

3.7.2.4.2.2 EPGB and ESWB

Confirmatory SSI analyses for the EPGB and ESWB use the same structural model and structural damping (i.e., 4 percent structural damping) as described in U.S. EPR FSAR Sections 3.7.2.3.2 and 3.7.2.4.2 for these structures.

3.7.2.4.2.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

Section 3.7.2.3.2 describes the development of the integrated finite element model of the CBIS in STAAD Pro ~~and UHS Electrical Building in GTSTRUDL~~, and translation of the model into SASSI~~2000~~. The ~~thick plate element in SASSI2000 (i.e., SHL17)~~thin plate element in SASSI is used to model all the structural panels.

The Common Basemat Intake Structures ~~and the UHS Electrical Building~~ are reinforced concrete structures. A structural damping of 4 percent is used in the SSI analysis to obtain the ISRS, while 5 percent is used to obtain internal forces for the design of the CBIS using STAAD Pro.

3.7.2.4.3 Step 3 – Development of Soil Model

3.7.2.4.3.1 Nuclear Island Common Basemat Structures

SSI analyses are conducted for the three soil profiles discussed in Section 3.7.2.4.1.1, namely CCNPP Unit 3 strain-compatible BE, CCNPP Unit 3 strain-compatible LB and CCNPP Unit 3 strain-compatible UB. Each soil profile is discretized in a sufficient number of horizontal sub-layers, followed by a uniform half space beneath the lowest sub-layer.

The effect of ground water table on the seismic soil-structure-interaction (SSI) analysis of NI Common Basemat Structures is considered through modification of the P-Wave velocity profiles and by using the saturated weight for the soil below the ground water table.

3.7.2.4.3.2 EPGB and ESWB

The soil model is developed using the SSE strain-compatible lower bound, best estimate and upper bound soil profiles discussed in Section 3.7.2.4.1.2. Each soil profile is discretized in a sufficient number of horizontal sub-layers, followed by a uniform half space beneath the lowest sub-layer, which is located at a depth of 435 ft. The material soil or rock damping does not exceed 15 percent. P-wave damping is set to be equal to S-wave damping for all soil layers.

The effect of ground water table on the seismic soil-structure-interaction (SSI) analysis of the structure is considered through modification of the P-Wave velocity profiles as discussed in Section 3.7.1.3.2 and by using the saturated weight for the soil below the ground water table.

3.7.2.4.3.3 Common Basemat Intake Structures~~and UHS Electrical Building~~

The soil model is developed using the SSE strain-compatible lower bound, best estimate and upper bound soil profiles discussed in Section 3.7.2.4.1.3. Each soil profile is discretized in a ~~sufficient~~ number of horizontal sub-layers based on shear propagation requirement, and a uniform half space is introduced beneath the lowest sub-layer, which is located at a depth of 350 ft.~~, followed by a uniform half space beneath the lowest sub-layer, which is located at a depth of 400 ft.~~ The material soil or rock damping does not exceed 15 percent. P-wave damping is set to be equal to S-wave damping for all soil layers.

The effect of ground water table on the seismic SSI analysis of the integrated CBIS~~and UHS Electrical Building~~ is considered through modification of the P-Wave velocity profiles as discussed in Section 3.7.1.3.3, and by using the saturated weight for the soil below the ground water table.

3.7.2.4.4 Step 4 – Development of SSI Analysis Soil Model

3.7.2.4.4.1 Nuclear Island Common Basemat Structures

The same SSI model and methodology used in U.S. EPR FSAR for the Nuclear Island Common Basemat Structures is used for the confirmatory SSI analyses, with the following exceptions:

- Site-specific soil profiles strain-compatible with the Site SSE are used, as described in Section 3.7.2.4.1.1.

- The free-field control input motion to the SSI analysis of the NI Common Basemat Structures is the Site SSE previously described in Section 3.7.1.1.2.1. The Site SSE is applied at NI foundation level, which is the horizon used for development of the NI FIRS (i.e., CCNPP Unit 3 GMRS described in Section 2.5.2.6). In particular, the surface outcrop motions (acceleration time histories) shown in Figures 3.7-10, 3.7-11 and 3.7-12 are used for the SSI analysis.

- Four percent structural damping is applied.

3.7.2.4.4.2 EPGB and ESWB

The same SSI model and methodology used in U.S. EPR FSAR for the EPGB and ESWB is used for the confirmatory SSI analyses, with the following exceptions:

- Interaction forces are obtained at the basemat nodes at the soil-structure interface, and subsequently used in the stability analyses described in Section 3.7.2.14.2.

- Site-specific soil profiles strain-compatible with the Site SSE are used, as described in Section 3.7.2.4.1.2.

- The control input motion for the SSI analysis of the EPGB and ESWB is the Site SSE described in Section 3.7.1.1.2.2. The control motion is applied at the foundation level (i.e., at the same horizon used for development of FIRS). In particular, for the EPGB, the surface outcrop motions (acceleration time histories) shown in Figures 3.7-10, 3.7-11 and 3.7-12 are used, while for the ESWB the within soil-column motions (acceleration time histories) shown in Figures 3.7-13, 3.7-14 and 3.7-15 are used.

3.7.2.4.4.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

~~The CBIS and the UHS Electrical Building are approximately 20.5 ft (6.1 m) apart. Structure-soil-structure interaction (SSSI) effects between these structures are intrinsically accounted for during the seismic analyses since both structures are included in the integrated SSI model.~~

The SSI model includes the CBIS~~, UHS Electrical Building~~, the surrounding layers of structural fill and the existing soil media as shown in Figure 3.7-27. Interaction forces are obtained at the basemat nodes at the soil-structure interface, and subsequently used in the stability analyses described in Section 3.7.2.14.2.

The control input motion for the SSI analysis of the CBIS ~~and UHS Electrical Building~~ is the within soil-column motion corresponding to the outcrop Site SSE for each soil profile, shown in Figures 3.7-19, 3.7-20 and 3.7-21 and described in Section 3.7.1.1.2.3. Consistent with the development of the within soil-column motion, the control motion is applied at the foundation level of the CBIS (i.e., at the same horizon used for development of FIRS for the CBIS).

3.7.2.4.5 Step 5 – Performing SSI Analysis

3.7.2.4.5.1 Nuclear Island Common Basemat Structures

Confirmatory SSI analyses for the Nuclear Island Common Basemat Structures are performed following the same methodology used in U.S. EPR FSAR for this structure.

3.7.2.4.5.2 EPGB and ESWB

Confirmatory SSI analyses for the EPGB and ESWB are performed following the same methodology used in U.S. EPR FSAR for these structures.

3.7.2.4.5.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

The SSI analysis of the ~~integrated~~ model for the CBIS ~~and UHS Electrical Building~~ is performed using ~~Bechtel computer code SASSI2000~~RIZZO computer code SASSI. SSI analysis is performed for each direction of the Site SSE (i.e., X (N-S), Y (E-W), Z (Vertical)) and for each of the three soil profiles described in Section 3.7.2.4.1.3.

3.7.2.4.6 Step 6 – Extracting Seismic SSI Responses

3.7.2.4.6.1 Nuclear Island Common Basemat Structures

SSI analysis outputs are generated for each soil profile (i.e., LB, BE, and UB) and direction of the input motion. In particular in-structure response spectra for 5 percent damping are generated at the key locations as described in Section 3.7.2.5.1.

3.7.2.4.6.2 EPGB and ESWB

SSI analysis outputs are generated for each soil profile (i.e., LB, BE, and UB) and direction of the input motion. Accelerations, in-structure response spectra, and interaction forces at the soil-basemat interface are calculated.

Tables 3.7-10 and 3.7-11 provide the combined average maximum nodal accelerations at various elevations of EPGB and ESWB, respectively. These accelerations have been obtained using the same methodology outlined in U.S. EPR FSAR Section 3.7.2.4.6. Comparison of the structural accelerations provided in Tables 3.7-10 and 3.7-11 with the corresponding structural accelerations reported in U.S. EPR FSAR Tables 3.7.2-27 and 3.7.2-28, respectively, show that the site-specific accelerations for EPGB and ESWB are bounded by the certified design.

Output response time histories of nodal interaction forces for each of the basemat nodes of the EPGB and ESWB are used to calculate response time histories of resultant sliding forces and overturning moments, which are used to evaluate the overall stability of each structure as described in Section 3.7.2.14.2.

In-structure response spectra are reported at selected locations of the EPGB and ESWB as detailed in Section 3.7.2.5.2.

3.7.2.4.6.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

SSI analysis outputs are generated for each soil profile (i.e., LB, BE, and UB) and direction of the input motion. Accelerations, relative displacements, element forces, in-structure response spectra, resultant sliding force and total overturning moments are calculated.

Tables 3.7-12 ~~and 3.7-13~~ provides the combined ~~average~~ maximum nodal accelerations at various elevations of UHS Makeup Water Intake Structure ~~and UHS Electrical Building, respectively~~. These accelerations have been obtained using the methodology outlined in U.S. EPR FSAR Section 3.7.2.4.6.

Absolute peak element forces and moments (i.e., membrane and out-of-plane bending and shear resultants) are calculated for each soil profile and direction of the input motion. These forces and moments are used for the design of critical walls and slabs, as detailed in Appendix 3E.

~~Response time histories of nodal interaction forces are calculated for each of the basemat nodes of the CBIS and UHS Electrical Building. These nodal interaction forces are used to calculate response time histories of resultant sliding forces and overturning moments, which are used to evaluate the overall stability of each structure as described in Section 3.7.2.14.2.~~ For determination of seismic stability of the CBIS, the seismically induced normal and shear stresses at the base of the CBIS foundation are computed and compared with the restoring stresses from the self weight of the structure as described in Section 3.7.2.14.3.

In-structure response spectra (ISRS) are reported at selected locations of the CBIS ~~and the UHS Electrical Building~~ as detailed in Section 3.7.2.5.3.

~~For the design of Seismic Category I buried commodities, the response time histories of relative displacements between the UHS Makeup Water Intake Structure and UHS Electrical Building at the building interface locations are used.~~

3.7.2.4.7 Computer Codes

The confirmatory SSI analysis of the NI Common Basemat Structures is performed using AREVA computer code SASSI, Version 4.2; which has been verified and validated in accordance with the AREVA 10 CFR 50 Appendix B QA program.

Bechtel computer code SASSI2000, Version 3.1, is used to perform the seismic confirmatory SSI analysis of the EPGB and ESWB~~, and the SSI analysis of the CBIS and UHS Electrical Building~~. This program is developed and maintained in accordance with Bechtel's engineering department and QA procedures. Validation manuals are maintained in the Bechtel Computer Services Library. The program is in compliance with the requirements of ASME NQA-1-1994.

RIZZO computer code SASSI, Version 1.3a, is used to perform the seismic confirmatory SSI analysis of the CBIS. This program is developed and maintained in accordance with RIZZO's engineering department and QA procedures. Validation manuals are maintained in the RIZZO Computer Services Library. The program is in compliance with the requirements of ASME NQA-1-1994.

3.7.2.5 Development of Floor Response Spectra

A structural damping of 4 percent is used for the development of ISRS for the site-specific reconciliation of NI Common Basemat Structures, EPGB and ESWB; this is in compliance with RG 1.61, Revision 1 (NRC, 2007b). This damping value is also used for the development of ISRS for the Common Basemat Intake Structures~~ and UHS Electrical Building~~.

As described in Sections 3.7.2.5.1 and 3.7.2.5.2, the ISRS for NI Common Basemat Structures, EPGB and ESWB are bounded by the corresponding U.S. EPR FSAR ISRS. Therefore, the U.S. EPR FSAR ISRS are applicable to CCNPP Unit 3 NI Common Basemat Structures, EPGB and ESWB.

3.7.2.5.1 Nuclear Island Common Basemat Structures

U.S. EPR FSAR Section 3.7.2.5 describes the development of floor response spectra for the NI Common Basemat Structures. The soil cases are described in U.S. EPR FSAR Table 3.7.1-6 and the ground design response spectra are shown in U.S. EPR FSAR Figure 3.7.1-1 for the NI. The ISRS used to design the piping, cable trays and commodity supports for the NI are the spectrum envelopes shown in U.S. EPR FSAR, Tier 2, Figures 3.7.2-74 through 3.7.2-100 and Figures 3.7.2-110 through 3.7.2-112.

For site-specific confirmatory analysis, response spectra for 5 percent damping in the three directions are generated, using methodology consistent with the U.S. EPR FSAR Section 3.7.2.5, at the following key locations:

- Reactor Building Internal Structure at Elev. 16.9 ft (5.15 m) and 64.0 ft (19.5 m).
- Safeguard Building 1 at Elev. 27 ft (8.1 m) and 69.9 ft (21.0 m).
- Safeguard Building 2/3 at Elev. 27 ft (8.1 m) and 50.5 ft (15.4 m).
- Safeguard Building 4 at Elev. 69.9 ft (21.0 m).
- Containment Building at Elev. 123 ft (37.6 m) and 190 ft (58.0 m).

A comparison of the 5 percent damped ISRS for the CCNPP Unit 3 BE, LB and UB soil profiles with the corresponding peak-broadened Design Certification ISRS show that the certified design bounds the CCNPP Unit 3 seismic demands by a large margin (Figures 3.7-28 through 3.7-54). Therefore, the CCNPP Unit 3 site-specific seismic responses are bounded by the U.S. EPR FSAR results. The Seismic Category II vent stack structure is part of the NI common basemat structures. Consequently, the site-specific seismic response of the vent stack is confirmed as well.

The site-specific seismic responses for the Nuclear Auxiliary Building (NAB) and Radioactive Waste Processing Building (RWPB) are within the parameters of Section 3.7 of the U.S. EPR standard design. The seismic responses at the center of basemats of the NAB and RWPB structures were computed from the site-specific SSI analysis for the Nuclear Island common basemat structures described in Section 3.7.2.4. The site-specific response for the NAB is enveloped by U.S. EPR standard design response as shown by comparing the site-specific ISRS (Figures 3.7-55 through 3.7-57) at the basemat for NAB to the corresponding U.S. EPR standard design ISRS (Figures 3.7-58 through 3.7-60). Similarly, the site-specific response for the RWPB is enveloped by U.S. EPR standard design response as shown by comparing the site-specific ISRS (Figures 3.7-61 through 3.7-63) at the basemat for RWPB to the corresponding U.S. EPR standard design ISRS (Figures 3.7-64 through 3.7-66).

3.7.2.5.2 EPGB and ESWB

U.S. EPR FSAR Section 3.7.2.5 describes the development of floor response spectra for the EPGB and ESWB. The soil cases are described in U.S. EPR FSAR Table 3.7.1-6 and the ground design response spectra are shown in U.S. EPR FSAR Figures 3.7.1-33 and 3.7.1-34 for the EPGB and ESWB.

For site-specific confirmatory analysis, ISRS are generated for EPGB and ESWB at locations identified in U.S. EPR FSAR Section 3.7.2.5, using the guidelines described in U.S. EPR FSAR Section 3.7.2.5. The ISRS are however, calculated from 0.2 to 100 Hz, and correspond to the envelope of the ISRS for the site-specific strain-compatible BE, LB and UB soil profiles. For the purposes of confirmatory analyses, Figures 3.7-67 to 3.7-75 show the comparison of 5 percent damped ISRS, which are representative of the response at all damping values, with the corresponding ISRS from U.S. EPR FSAR. The site-specific ISRS for these structures are enveloped by the corresponding design certification ISRS by a large margin, except for frequencies less than approximately 0.3 Hz. Though the maximum site-specific spectral acceleration in this frequency range is 0.07g, the ISRS exceed the certified design ISRS by more than 10 percent in this frequency range. This represents a departure from the U.S. EPR FSAR based on the guidelines specified in U.S. EPR FSAR Section 2.5.2.6. The effects of the low frequency exceedances on EPGB and ESWB are addressed as follows:

- The structural reconciliation is addressed in Sections 3.8.4 and 3.8.5.
- The ISRS used to design the systems and components housed within these structures are the envelop of the ISRS shown in U.S. EPR FSAR Figures 3.7.2-101 through 3.7.2-109 and the corresponding site-specific ISRS shown in Figures 3.7-67 through 3.7-75.

3.7.2.5.3 Common Basemat Intake Structures ~~and UHS Electrical Building~~

ISRS at the location of safety-related equipment within the UHS Makeup Water Intake Structure are generated using the SSI model described in Section 3.7.2.4. The ISRS are calculated from 0.1 to 50 Hz, which meets the guidelines provided in RG 1.122, Revision 1 (NRC, 1978). For the UHS Makeup Water Intake Structure, the ISRS are calculated at 0.5 percent, 2 percent, 3 percent, 4 percent, 5 percent, 7 percent and 10 percent damping. The ISRS are enveloped for the site-specific strain-compatible BE, LB and UB soil profiles.

For the UHS Makeup Water Intake Structure, the ISRS are developed at the location of safety-related makeup pumps and facilities, as shown in Figures 3.7-76 through 3.7-81 and at the location of safety-related electrical equipment supported at EL +26.5 ft in the CBIS, and are shown in Figures 3.7-82 through 3.7-84. ISRS will be generated at the support locations of additional safety-related equipment, as required.

~~ISRS at the location of safety-related equipment within the UHS Makeup Water Intake Structure and UHS Electrical Building are generated using the SSI model described in Section 3.7.2.4. The ISRS are calculated from 0.2 to 100 Hz following the guidelines described in U.S. EPR FSAR Section 3.7.2.5 for EPGB and ESWB, which meets the guidelines provided in RG 1.122, Revision 1 (NRC, 1978). The ISRS are calculated at 2 percent, 3 percent, 4 percent, 5 percent, 7 percent and 10 percent damping. For the UHS Makeup Water Intake Structure, ISRS are also generated at 0.5 percent damping. The ISRS are enveloped for the site-specific strain-compatible BE, LB and UB soil profiles.~~

~~For the UHS Makeup Water Intake Structure, the ISRS are developed at the location of safety-related makeup pumps, as shown in Figures 3.7-76 through 3.7-78. ISRS for the UHS Electrical Building are generated at the location of safety-related electrical equipment supported at the basemat, and are shown in Figures 3.7-79 through 3.7-81. ISRS will be generated at the support locations of additional safety-related equipment, as required.~~

3.7.2.6 Three Components of Earthquake Motion

As indicated in Section 3.7.2.4, the SSI analysis of the site-specific Seismic Category I structures is performed using the integrated finite element model, with the input ground motion applied separately in the three directions. Following the methodology described in U.S. EPR FSAR Section 3.7.2.5 for EPGB and ESWB, the ISRS in the UHS Makeup Water Intake Structure ~~and UHS Electrical Building~~ are determined by using the Square Root of Sum of Squares (SRSS) of the calculated response spectra in a given direction, due to earthquake motion in the three directions.

The maximum member forces and moments due to the three earthquake motion components are combined using the ASCE 4-98 (ASCE, 2000) "100-40-40" combination rule to obtain the maximum total member forces and moments. The 100-40-40 rule used is consistent with the requirements of RG 1.92, Revision 2 (NRC, 2006).

3.7.2.7 Combination of Modal Responses

No departures or supplements.}

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

The U.S. EPR FSAR includes the following COL Item and conceptual design information in Section 3.7.2.8:

> A COL applicant that references the U.S. EPR design certification will provide the site-specific separation distances for the Access Building and Turbine Building:
>
> [[The separation gaps between the AB and SBs 3 and 4 are 0.98 ft and 1.31 ft, respectively (see Figure 3B-1).]]
>
> [[The separation between the TB and NI Common Basemat Structures is approximately 30 ft (see Figure 3B-1).]]

The COL Item and the conceptual design information are addressed as follows:

The conceptual design information identified above is incorporated by reference.

The U.S. EPR FSAR includes the following COL Item in Section 3.7.2.8:

> A COL applicant that references the U.S. EPR design certification will provide the seismic design basis for the sources of fire protection water supply for safe plant shutdown in the event of a SSE.

The COL Item is addressed as follows:

The U.S EPR FSAR Section 3.7.2.8 states that the Fire Protection Storage Tanks and Buildings are classified as Conventional Seismic Structures and that RG 1.189 (NRC, 2007) requires that a water supply be provided for manual firefighting in areas containing equipment for safe plant shutdown in the event of a SSE. The U.S. EPR FSAR Section 3.7.2.8 also states the fire protection storage tanks and building are designed to provide system pressure integrity under SSE loading conditions.

In addition to the Seismic Classifications defined in U.S. EPR FSAR Section 3.2.1, a seismic classification of Seismic Category II-SSE is utilized. This designation is utilized to ensure the design basis requirement that Fire Protection SSC are required to remain functional during and following a seismic event to support equipment required to achieve safe shutdown.

Refer to Section 3.2.1 and U.S. EPR FSAR Section 3.2.1 for further discussion of seismic classifications. In addition, Section 3.2.1 categorizes Fire Protection SSC into two categories:

1. SSC that must remain functional during and after an SSE (i.e., Seismic Category II-SSE); and

2. SSC that must remain intact after an SSE without deleterious interaction with Seismic Category I or Seismic Category II-SSE (i.e., Seismic Category II).

Fire Protection SSC required to remain functional during and following a safe shutdown earthquake to support safe shutdown of the plant following a design basis seismic event are designated as Seismic Category II-SSE. The following Fire Protection structures, systems, and components are required to remain functional during and after a seismic event:

1. Fire Water Storage Tanks;

2. Fire Protection Building;

3. Diesel driven fire pumps and their associated sub systems and components, including the diesel fuel oil system;

4. Critical support systems for the Fire Protection Building, i.e., ventilation; and

5. The portions of the fire water piping system and components (including isolation valves) which supply water to the stand pipes in buildings that house the equipment required for safe shutdown of the plant following an SSE.

Manual actions may be required to isolate the portion of the Fire Protection piping system that is not qualified as Seismic Category II-SSE.

U.S. EPR FSAR Section 3.7.2.8 addresses the interaction of the following Non-Seismic Category I structures with Seismic Category I structures:

- Vent Stack
- Nuclear Auxiliary Building
- Access Building
- Turbine Building
- Radioactive Waste Processing Building

{The following CCNPP Unit 3 Non-Seismic Category I structures identified in Table 3.2-1 could also potentially interact with Seismic Category I SSC:

- Buried and above ground Seismic Category II and Seismic Category II-SSE Fire Protection SSC, including Fire Water Storage Tanks and Fire Protection Building.
- Seismic Category II Turbine Building (U.S. EPR FSAR Section 3.7.2.8 also provides conceptual information to address seismic interaction of Turbine Building with the Seismic Category I SSCs)
- Seismic Category II Switchgear Building
- Conventional Seismic Grid Systems Control Building
- Seismic Category II Circulating Water Makeup Intake Structure
- Conventional Seismic Sheet Pile Wall
- Existing Baffle Wall

The buried Seismic Category II-SSE Fire Protection SSC identified in Table 3.2-1 are seismically analyzed using the design response spectra identified in Section 3.7.1.1.1.4 for use in the analysis of the Seismic Category I site-specific buried utilities. The analysis of the buried Seismic Category II-SSE fire protection SSC will confirm they remain functional during and following an SSE in accordance with NRC Regulatory Guide 1.189 (NRC, 2007). Section 3.7.3.12 further defines the methodology for the analysis of buried Fire Protection piping. Seismic Category II-SSE buried piping is an embedded commodity that by its nature does not significantly interact with above ground Seismic Category I SSC. The buried Seismic Category II-SSE Fire Protection SSCs are designed to the same requirements as the buried Seismic Category I SSCs.

The above ground Seismic Category II and Seismic Category II-SSE Fire Protection SSC, including Fire Water Storage Tanks and Fire Protection Building, identified in Table 3.2-1 are seismically analyzed utilizing the appropriate design response spectra. Seismic load combinations are developed in accordance with the requirements of ASCE 43-05 (ASCE, 2005) using a limiting acceptance condition for the structure characterized as essentially elastic behavior with no damage (i.e., Limit State D) as specified in the Standard. The analysis of the above ground Seismic Category II-SSE fire protection SSC will confirm they remain functional during and following an SSE in accordance with NRC Regulatory Guide 1.189 (NRC, 2007). The analysis of the above ground Seismic Category II fire protection SSCs will confirm they maintain a pressure boundary after an SSE event.

Table 3.7-14 provides the criteria used to prevent seismic interaction of Turbine Building, Switchgear Building, Circulating Water Makeup Intake Structure and Grid Systems Control Building with other Seismic Category I structures, systems and components (SSCs).

The Seismic Category II Turbine Building and Seismic Category II Switchgear Building together comprise a common Turbine Island (TI) structure and are situated approximately 30 ft (9.1 m) from the NI Common Basemat structures. The Switchgear Building is a steel framed structure. The Turbine Building and Switchgear Building are designed using conventional seismic codes and standards presented in Table 3.7-14, but are also analyzed and designed using Site SSE to prevent seismic interaction with the Seismic Category I SSCs. An evaluation of the site-specific SSE responses will confirm that the separation distance between the TI structure and the Seismic Category I SSCs exceeds the sum of the maximum relative seismic displacement between the structures, construction tolerances and settlement effects by an appropriate factor of safety.

The Conventional Seismic Grid Systems Control Building is located in the Switchyard area, and has a minimum separation distance of approximately 700 ft (213.4 m) from the nearest Seismic Category I SSCs (see Figure 2.1-5). Therefore, potential collapse of this building has no adverse impact on the function of Seismic Category I SSCs. This meets NUREG-0800 Section 3.7.2, Acceptance Criterion 8.A (NRC, 2007a).

The Seismic Category II Circulating Water Makeup Intake Structure is situated between the Seismic Category I Buried Intake Pipes and is comprised of a reinforced concrete embedded structure and an above ground steel structure. The reinforced concrete embedded structure is integrally connected to the Seismic Category I Forebay and is designed to the same requirements as a Seismic Category I structure. The Seismic Category I Buried Intake Pipes are approximately 15 ft (4.6 m) away from the embedded walls of the Circulating Water Makeup Intake Structure. Therefore, there is no possibility of any seismic interaction between the Buried Intake Pipes and the Circulating Water Makeup Intake Structure. Therefore, the design methodology for the reinforced concrete embedded structure meets NUREG-0800 Section 3.7.2, Acceptance Criterion 8.C (NRC, 2007a).

The above ground steel structure is located such that it cannot directly strike any Seismic Category I SSCs. Since the reinforced concrete embedded structure supporting the steel structure is integrally connected to the Seismic Category I Forebay, the reinforced concrete embedded structure is analyzed to demonstrate that the collapse of the steel superstructure does not impair the integrity of Seismic Category I SSCs, nor result in incapacitating injury to control room occupants.

The Conventional Seismic Unit 3 Sheet Pile Wall is located approximately 30 ft (9.1 m) from the north end of the Seismic Category I Buried Intake Pipes. The Sheet Pile Wall will be analyzed and designed using conventional seismic codes and standards but will also be analyzed using Site SSE to prevent any adverse interaction with the Seismic Category I Buried Intake Pipes. The existing Baffle Wall is approximately 46 ft (14.0 m) above the bed of the intake area and is located approximately 50 ft (15.2 m) from the north end of the Seismic Category I Buried Intake Pipes. Therefore, the interaction of the Baffle Wall with the Buried Intake Pipes is not possible.

3.7.2.9 Effects of Parameter Variations on Floor Response Spectra

~~No departures or supplements.~~ In-structure response spectra are smoothed and the peaks associated with each of the structural frequencies are broadened according to procedure described in RG 1.122 (NRC, 1978). This accounts for uncertainties in the structural frequencies owing to uncertainties in the material properties of the structure and soil, approximation in the modeling techniques used in the seismic analysis and the effect of potential concrete cracking.

3.7.2.10 Use of Constant Vertical Static Factors

No departures or supplements.

3.7.2.11 Method Used to Account for Torsional Effects

For the CBIS~~ and UHS Electrical Building~~, both inherent and accidental torsional effects are accounted for in the seismic design. The inherent torsion effects are built into the 3D ~~integrated~~ finite element model used for the SSI analysis.

The ~~accidental torsion is considered separately for the CBIS and the UHS Electrical Building. For each structure, the~~ seismic inertia force at each story level is calculated using the maximum absolute structural accelerations in each horizontal direction, provided in ~~Tables~~Table 3.7-12 ~~and 3.7-13~~, and the horizontal mass at that level. The accidental torsional moment is determined as the story inertia force times a moment arm equal to ±5 percent of the building plan dimension in the perpendicular direction, in accordance with NUREG-0800 Section 3.7.2, Acceptance Criterion 11 (NRC, 2007a). These moments are then used to calculate the in-plane shear forces in the walls, which are used for structural design. The responses from earthquakes in three orthogonal directions are combined in accordance with the co-directional response combination provisions of FSAR Section 3.7.2.6.

3.7.2.12 Comparison of Responses

As multiple seismic analysis methods are not employed for the site-specific Seismic Category I structures, a comparison of responses is not applicable.

3.7.2.13 Methods for Seismic Analysis of Category I Dams

No departures or supplements.

3.7.2.14 Determination of Dynamic Stability of Seismic Category I Structures

3.7.2.14.1 Nuclear Island Common Basemat Structures

The methodology to perform dynamic stability evaluation of the Nuclear Island Common Basemat Structures is incorporated by reference to U.S. EPR Section 3.7.2.14.

3.7.2.14.2 ~~EPGB, ESWB~~EPGB and ESWB~~, Common Basemat Intake Structures and UHS Electrical Building~~

The stability of the EPGB~~,~~ and ESWB~~, CBIS and the UHS Electrical Building~~ for seismic loading is determined using the stability load combinations provided in NUREG-0800 Section 3.8.5, Acceptance Criteria 3 (NRC, 2007a).

For determination of seismic stability, the overturning moments about each of the four edges of the basemat and sliding forces at the bottom of the basemat are computed by using the response time histories of reactions at the basemat nodes. These responses include the effects of seismic forces, static and dynamic lateral earth pressures, and hydrostatic and hydrodynamic forces. The following steps are used to assess the seismic stability:

i. The response time histories of reaction forces for each basemat node are obtained for each Site SSE direction and soil profile (i.e., BE, LB and UB as described in section 3.7.2.4.3). Three reaction forces are obtained for each earthquake direction; therefore nine response time histories of reaction forces are reported per soil profile at each basemat node.

ii. The response time histories of total force are calculated in the vertical and two horizontal directions for each soil profile. The total force in a particular direction is calculated by algebraic addition of nodal reactions in that direction due to earthquake in each direction.

iii. The response time history of total sliding force is calculated for each soil profile. The sliding force is calculated as the magnitude of the vector sum of the total forces in the two horizontal directions.

iv. The response time histories of seismic overturning moment are calculated about each of the four edges of the basemat for each soil profile. The overturning moment about a particular edge is calculated by algebraic sum of the overturning moments about that edge from each nodal reaction due to earthquake in each direction.

v. Evaluation of the sliding, overturning and bearing seismic stability of each structure is performed for each soil profile and each point in time.

The loads considered in the calculation of structural mass in the seismic SSI analysis, which includes the self weight of the structure, weight of the permanent equipment and contained water during normal operation, 25% of the design live load and 75% of the design snow load are consistently used to determine the restoring moments. The vertical force calculated in Step ii is accounted for during the calculation of sliding resistance. Results of dynamic stability are reported in Appendix 3E.

3.7.2.14.3 Seismic Stability of Common Basemat Intake Structures (CBIS)

The stability of the CBIS Building for seismic loading is determined using the stability load combinations provided in NUREG-0800 Section 3.8.5, Acceptance Criteria 3 (NRC, 2007a), listed as Load Combination 7 in FSAR Table 3E.4-1.

For determination of seismic stability of the CBIS, the seismically induced normal and shear stresses at the base of the CBIS foundation are computed and compared with the restoring stresses from the self weight of the structure.

The seismic reaction stresses at the CBIS foundation-soil interface are computed at selected locations using 3D brick elements modeled at the base of the CBIS foundation. The seismic normal and shear stresses at the bottom of the basemat are computed by using the response time histories of reaction stresses at the selected basemat locations. These responses include the effects of seismic forces, dynamic lateral earth pressures, and hydrodynamic forces.

The stabilizing forces for the CBIS are considered from the self weight of the intake structure and static earth pressure. The resultant stabilizing stresses are obtained from PLAXIS 3D analysis of the CBIS. PLAXIS 3D analysis considered the self weight of the intake structure, static earth pressures, and the uplift effect of the ground water at the base of the basemat. The effective shear resistance of the soil is computed using PLAXIS 3D output and the vertical seismic load on the CBIS basemat.

The following steps are used to assess the seismic stability of the CBIS:

i. iThe response time histories of stresses at selected locations of the basemat are obtained for each site SSE direction and soil profile (i.e., BE, LB and UB) from the seismic SSI analysis. Three reaction stresses are obtained for each earthquake direction; therefore nine response time histories of reaction stresses are reported per soil profile.

ii. The response time histories of normal and shear stresses are calculated in the vertical and two horizontal directions for each soil profile. The total stress in a particular direction is calculated by algebraic addition of the stresses in that direction due to earthquake in each direction.

iii. The response time history of total sliding shear stress is calculated for each soil profile. The sliding shear stress is calculated as the magnitude of the vector sum of the shear stresses in the two horizontal directions.

iv. Evaluation of the seismic stability for sliding and uplifting/overturning of the CBIS is performed for each soil profile (BE, LB and UB) at each point in time by computing the factors of safety as the ratio of the restoring stresses of the CBIS to the corresponding seismically induced stresses.

The factors of safety evaluated for the seismic stability are compared with the minimum required factors of safety specified in U.S. EPR FSAR Table 3.8-11. According to this reference, the minimum required factors of safety for sliding and overturning associated with Safe Shutdown Earthquake (E', Seismic Category I foundations) loading combination is 1.1. As a result the CBIS are evaluated to be safe against sliding and overturning due to seismic loads. Results of dynamic stability are reported in Appendix 3E.

3.7.2.15 Analysis Procedure for Damping

The structure and soil damping used in SSI analyses of site-specific Seismic Category I structures are described in Sections 3.7.2.4.2.3 and 3.7.2.4.3.3.

3.7.2.16 References

ACI, 2006. Seismic Design of Liquid-Containing Concrete Structures, ACI 350.3-06, American Concrete Institute, 2006.

ASCE, 2000. Seismic Analysis of Safety-Related Nuclear Structures and Commentary, ASCE Standard 4-98, American Society of Civil Engineers, 2000.

ASCE, 2005. Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities, ASCE 43-05, American Society of Civil Engineers, January 2005.

NRC, 1973. Design Response Spectra for Seismic Design of Nuclear Power Plants, Regulatory Guide 1.60, U.S. Nuclear Regulatory Commission, December 1973.

NRC, 1978. Development of Floor Design Response Spectra for Seismic Design of Floor-Supported equipment or Components, Regulatory Guide 1.122, U.S. Nuclear Regulatory commission, February, 1978.

NRC, 2006. Combining Modal Responses and Spatial Components in Seismic Response Analysis, Regulatory Guide 1.92 Revision 2, U.S. Nuclear Regulatory Commission, July 2006.

NRC, 2007. Fire Protection for Nuclear Power Plants, Regulatory Guide 1.189, Revision 1, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007a. Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2008. Earthquake Engineering Criteria for Nuclear Power Plants, Title 10, Code of Federal Regulations, Part 50, Appendix S, U. S. Nuclear Regulatory Commission, February 2008.}

3.7.3 SEISMIC SUBSYSTEM ANALYSIS

No departures or supplements.

3.7.3.1 Seismic Analysis Methods

No departures or supplements.

3.7.3.2 Determination of Number of Earthquake Cycles

No departures or supplements.

3.7.3.3 Procedures Used for Analytical Modeling

{No departures or supplements.}

3.7.3.4 Basis for Selection of Frequencies

{No departures or supplements.}

3.7.3.5 Analysis Procedure for Damping

{No departures or supplements.}

3.7.3.6 Three Components of Earthquake Motion

No departures or supplements.

3.7.3.7 Combination of Modal Responses

No departures or supplements.

3.7.3.8 Interaction of Other Systems with Seismic Category I Systems

No departures or supplements.

3.7.3.9 Multiply-Supported Equipment and Components with Distinct Inputs

No departures or supplements.

3.7.3.10 Use of Equivalent Vertical Static Factors

No departures or supplements.

3.7.3.11 Torsional Effects of Eccentric Masses

No departures or supplements.

3.7.3.12 Buried Seismic Category I Piping, Conduits, and Tunnels

{For CCNPP Unit 3, a buried duct bank refers to multiple PVC electrical conduits encased in reinforced concrete.

The seismic analysis and design of Seismic Category I buried reinforced concrete electrical duct banks is in accordance with IEEE 628-2001 (R2006) (IEEE, 2001), ASCE 4-98 (ASCE, 2000) and ACI 349-01(ACI, 2001), including supplemental guidance of Regulatory Guide 1.142 (NRC, 2001).

Side walls of electrical manholes are analyzed for seismic waves traveling through the surrounding soil in accordance with the requirements of ASCE 4-98 (ASCE, 2000), including dynamic soil pressures.

Seismic Category I buried Essential Service Water Pipes, Seismic Category I buried Intake Pipes and Seismic Category II and Seismic Category II-SSE buried Fire Protection pipe are analyzed for the effects of seismic waves traveling through the surrounding soil in accordance with the specific requirements of ASCE 4-98 (ASCE, 2000):

- Long, straight buried pipe sections, remote from bends or anchor points, are designed assuming no relative motion between the flexible structure and the ground (i.e. the structure conforms to the ground motion).

- The effects of bends and differential displacement at connections to buildings are evaluated using equations for beams on elastic foundations, and subsequently combined with the buried pipe axial stress.

For long straight sections of buried pipe, maximum axial strain and curvature are calculated per equations contained in ASCE 4-98 (ASCE, 2000). These equations reflect seismic wave propagation and incorporate the material's modulus of elasticity to determine the corresponding maximum axial and bending stresses. The procedure combines stresses from compression, shear and surface waves by the square root of the sum of the squares (SRSS) method. Maximum stresses for each wave type are then combined using the SRSS method. Subsequently, seismic stresses are combined with stresses from other loading conditions, e.g., long-term surcharge loading.

For straight sections of buried pipe, the transfer of axial strain from the soil to the buried structure is limited by the frictional resistance developed. Consequently, axial stresses may be reduced by consideration of such slippage effects, as appropriate.

The seismic analysis of bends of buried pipe is based on the equations developed for beams on elastic foundations. Specifically, the transverse leg is assumed to deform as a beam on an elastic foundation due to the axial force in the longitudinal leg. The spring constant at the bend depends on the stiffness of the longitudinal and transverse legs as well as the degree of fixity at the bend and ends of the legs.

Seismic analysis of restrained segments of buried pipe utilizes guidance provided in Appendix VII, Procedures for the Design of Restrained Underground Piping, of ASME B31.1-2004 (ASME, 2004).}

3.7.3.13 Methods for Seismic Analysis of Category I Concrete Dams

The U.S. EPR FSAR includes the following COL Item in Section 3.7.3.13:

> A COL applicant that references the U.S. EPR design certification will provide a description of methods for seismic analysis of site-specific Category I concrete dams, if applicable.

This COL Item is addressed as follows:

{No Seismic Category I dams will be used at CCNPP Unit 3.}

3.7.3.14 Methods for Seismic Analysis of Aboveground Tanks

No departures or supplements.

3.7.3.15 References

{**ACI, 2001.** Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary on Code Requirements for Nuclear Safety-Related Concrete Structures, ACI 349-01/349-R01, American Concrete Institute, 2001.

ASCE, 2000. Seismic Analysis of Safety-Related Nuclear Structures and Commentary, ASCE 4-98, American Society of Civil Engineers, 2000.

ASME, 2004. Procedures for the Design of Restrained Underground Piping, Appendix VII, Power Piping, ASME B31.1-2004, American Society of Mechanical Engineers, 2004.

IEEE, 2001. IEEE Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations, IEEE 628-2001, IEEE, 2001.

NRC, 2001. Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments), Regulatory Guide 1.142, U.S. Nuclear Regulatory Commission, November 2001.}

3.7.4 SEISMIC INSTRUMENTATION

No departures or supplements.

3.7.4.1 Comparison with NRC Regulatory Guide 1.12

No departures or supplements.

3.7.4.2 Location and Description of Instrumentation

The U.S. EPR FSAR includes the following COL Item in Section 3.7.4.2:

> A COL applicant that references the U.S. EPR design certification will determine whether essentially the same seismic response from a given earthquake is expected at each of the units in a multi-unit site or instrument each unit. In the event that only one unit is instrumented, annunciation shall be provided to each control room.

This COL Item is addressed as follows:

{CCNPP Unit 3 is a single unit, U.S. EPR facility. Annunciation of the seismic instrumentation for CCNPP Unit 3 will be provided in the CCNPP Unit 3 main control room.}

3.7.4.2.1 Field Mounted Sensors

The U.S. EPR FSAR includes the following COL Item in Section 3.7.4.2.1:

> A COL applicant that references the U.S. EPR design certification will determine if a suitable location exists for the free-field acceleration sensor. The mounting location must be such that the effects associated with surface features, buildings, and components on the recordings of ground motion are insignificant. The acceleration sensor must be based on material representative of that upon which the Nuclear Island (NI) and other Seismic Category I structures are founded.

This COL Item is addressed as follows:

{The free-field acceleration sensor is located on the base mat of the Fire Protection Building, which is a small rectangular structure, located within the protected area and situated on plant grade. The centerline of the Radioactive Waste Processing Building, the nearest significant structure, is approximately two of its plan dimensions from the Fire Protection Building. The centerline of the NI Common base mat is approximately two of its equivalent diameters from the Fire Protection Building. This location is sufficiently distant from nearby structures that they have no significant influence on the recorded free-field seismic motion.

In addition, the plan dimensions of the Fire Protection Building are small enough that its base mat will not have a significant filtering effect on the free-field motion. This area of the plant is also a quiet zone in that turbine-induced ground vibration will not significantly affect the free-field sensor

The Fire Protection Building design is such that the free-field acceleration sensor is protected from damage and adverse interaction during a seismic event. Seismic load combinations for the Fire Protection Building are developed in accordance with requirements of ASCE 43-05 (ASCE, 2005) using a limiting acceptance condition for the structure characterized as essentially elastic behavior with no damage (i.e., Limit State D, as specified in the Standard). The Fire Protection Building is supported on material representative of that upon which the NI Common base mat Structures and other Seismic Category I structures are founded.

The sensor location is protected from accidental impact but is readily accessible for surveillance, maintenance, and repair activities. The sensor is rigidly mounted in alignment with the orthogonal axes assumed for seismic analysis. The free-field acceleration sensor location is sufficiently distant from radiation sources that there is no occupational exposure expected during normal operating modes, which is consistent with ALARA.

A soil-structure-interaction (SSI) analysis will be conducted during final design of the Fire Protection Building and fire protection storage tanks to determine if the Fire Protection Building and/or fire protection storage tanks significantly influence the ability of the free-field acceleration sensor to accurately measure ground surface motion during a seismic event. Should the SSI analysis determine that the Fire Protection Building or fire protection storage tanks significantly influence free-field acceleration sensor ability to accurately measure ground surface motion during a seismic event the sensor will be moved to a suitable location. The location for the free-field acceleration sensor will be determined in accordance with the guidance provided in Regulatory Guide 1.12. The location will be sufficiently distant from nearby structures that may have significant influence on the recorded free-field seismic motion. The free-field acceleration sensor will be located on a base mat that is founded on material that is representative of that upon which the NI and other Seismic Category I structures are founded. The sensor will be protected from accidental impact, and will be readily accessible for surveillance, maintenance, and repair activities. The sensor will be rigidly mounted in alignment with the orthogonal axes assumed for seismic analysis. To maintain occupational radiation exposures ALARA, the free-field acceleration sensor location will be sufficiently distant from radiation sources such that there is minimal occupational exposure expected during normal operating modes.}

3.7.4.2.2 System Equipment Cabinet

No departures or supplements.

3.7.4.2.3 Seismic Recorder(s)

No departures or supplements.

3.7.4.2.4 Central Controller

No departures or supplements.

3.7.4.2.5 Power Supplies

No departures of supplements.

3.7.4.3 Control Room Operator Notification

No departures or supplements.

3.7.4.4 Comparison with Regulatory Guide 1.166

Post-earthquake actions and an assessment of the damage potential of the event using the EPRI-developed OBE Exceedance Criteria follow the guidance of EPRI reports NP-5930 (EPRI, 1988) and NP-6695 (EPRI, 1989), as endorsed by the U.S. Nuclear Regulatory Commission in Regulatory Guide 1.166 (NRC, 1997a) and Regulatory Guide 1.167 (NRC, 1997b). OBE Exceedance Criteria is based on a threshold response spectrum ordinate check and a CAV check using recorded motions from the free-field acceleration sensor. If the respective OBE ground motion is exceeded in a potentially damaging frequency range or significant plant damage occurs, the plant must be shutdown following plant procedures. The shutdown OBE for CCNPP Unit 3, which is described in Section 3.7.1.1, is the composite earthquake which consists of one-third site-specific SSE (anchored at 0.05g) and EUR Soft Soil spectrum anchored at 0.10g in the low frequency (approximately 0.36Hz and below).

3.7.4.5 Instrument Surveillance

No departures or supplements.

3.7.4.6 Program Implementation

No departures or supplements.

3.7.4.7 References

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

EPRI, 1988. A Criterion for Determining Exceedance of the Operating Basis Earthquake, NP-5930, Electric Power Research Institute, July 1988.

EPRI, 1989. Guidelines for Nuclear Plant Response to an Earthquake, NP-6695, Electric Power Research Institute, December 1989.

NRC, 1997a. Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions, Regulatory Guide 1.166, Revision 0, U. S. Nuclear Regulatory Commission, March 1997.

NRC, 1997b. Restart of a Nuclear Power Plant Shut Down by a Seismic Event, Regulatory Guide 1.167, Revision 0, U. S. Nuclear Regulatory Commission, March 1997.}

Table 3.7-1— {Site SSE (Horizontal and Vertical) Spectral Accelerations at 5% Damping}

Freq (Hz)	Spectral Acceleration (g)
0.1	7.53E-03
0.125	1.18E-02
0.15	1.69E-02
0.2	3.01E-02
0.3	5.47E-02
0.4	6.93E-02
0.5	8.33E-02
0.6	9.67E-02
0.7	1.21E-01
0.8	1.43E-01
0.9	1.61E-01
1	1.79E-01
1.25	2.23E-01
1.5	2.68E-01
2	3.57E-01
2.5	4.46E-01
3	4.50E-01
4	4.50E-01
5	4.50E-01
6	4.50E-01
7	4.50E-01
8	4.48E-01
9	4.11E-01
10	3.79E-01
12.5	3.18E-01
15	2.76E-01
20	2.21E-01
25	1.86E-01
30	1.62E-01
35	1.50E-01
40	1.50E-01
45	1.50E-01
50	1.50E-01
60	1.50E-01
70	1.50E-01
80	1.50E-01
90	1.50E-01
100	1.50E-01

Table 3.7-2—CCNPP Unit 3 Best Estimate Soil for SSI Analysis of NI Common Basemat Structure}

(Page 1 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m³)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
1	1.22	18.85	451.9	1524.0	0.0147	0.0147	74	1.22
2	1.52	18.85	451.4	1524.0	0.0148	0.0148	59	2.74
3	1.52	18.85	450.6	1524.0	0.0150	0.0150	59	4.27
4	2.29	18.85	516.3	1712.5	0.0147	0.0147	45	6.55
5	2.29	18.85	515.6	1709.9	0.0148	0.0148	45	8.84
6	1.14	18.85	333.0	1697.9	0.0172	0.0172	58	9.98
7	1.14	18.85	333.0	1697.9	0.0172	0.0172	58	11.13
8	1.14	18.85	331.9	1692.5	0.0174	0.0174	58	12.27
9	1.14	18.85	331.9	1692.5	0.0174	0.0174	58	13.41
10	2.29	18.85	497.4	1649.8	0.0151	0.0151	44	15.70
11	2.29	18.85	497.0	1648.3	0.0152	0.0152	43	17.98
12	1.07	17.28	364.8	1533.5	0.0171	0.0171	68	19.05
13	1.07	17.28	364.8	1533.5	0.0171	0.0171	68	20.12
14	1.07	17.28	363.6	1528.4	0.0173	0.0173	68	21.18
15	1.07	17.28	363.6	1528.4	0.0173	0.0173	68	22.25
16	1.07	17.28	363.0	1525.8	0.0174	0.0174	68	23.32
17	1.07	17.28	363.0	1525.8	0.0174	0.0174	68	24.38
18	1.07	17.28	362.6	1524.0	0.0175	0.0175	68	25.45
19	1.07	17.28	362.6	1524.0	0.0175	0.0175	68	26.52
20	1.07	17.28	361.9	1524.0	0.0176	0.0176	68	27.58
21	1.07	17.28	361.9	1524.0	0.0176	0.0176	68	28.65
22	1.52	17.28	374.8	1575.1	0.0118	0.0118	49	30.18
23	1.52	17.28	374.8	1575.1	0.0118	0.0118	49	31.70
24	1.52	17.28	374.3	1573.2	0.0118	0.0118	49	33.22
25	1.52	17.28	374.3	1573.2	0.0118	0.0118	49	34.75
26	1.52	17.28	372.0	1563.6	0.0118	0.0118	49	36.27
27	1.52	17.28	372.0	1563.6	0.0118	0.0118	49	37.80
28	1.52	17.28	371.7	1562.3	0.0118	0.0118	49	39.32
29	1.52	17.28	371.7	1562.3	0.0118	0.0118	49	40.84
30	1.52	17.28	371.5	1561.7	0.0118	0.0118	49	42.37
31	1.52	17.28	371.5	1561.7	0.0118	0.0118	49	43.89
32	1.52	17.28	371.4	1561.0	0.0118	0.0118	49	45.42
33	1.52	17.28	371.4	1561.0	0.0118	0.0118	49	46.94
34	1.52	17.28	371.2	1560.4	0.0119	0.0119	49	48.46
35	1.52	17.28	371.2	1560.4	0.0119	0.0119	49	49.99
36	1.52	17.28	371.1	1559.8	0.0119	0.0119	49	51.51
37	1.52	17.28	371.1	1559.8	0.0119	0.0119	49	53.04
38	1.52	17.28	370.9	1559.1	0.0119	0.0119	49	54.56
39	1.52	17.28	370.9	1559.1	0.0119	0.0119	49	56.08
40	1.52	17.28	370.8	1558.5	0.0119	0.0119	49	57.61
41	1.52	17.28	370.8	1558.5	0.0119	0.0119	49	59.13
42	1.52	17.28	370.6	1557.8	0.0119	0.0119	49	60.66
43	1.52	17.28	370.6	1557.8	0.0119	0.0119	49	62.18
44	1.52	17.28	370.6	1557.8	0.0119	0.0119	49	63.70
45	1.52	17.28	370.6	1557.8	0.0119	0.0119	49	65.23
46	1.52	17.28	370.3	1556.6	0.0119	0.0119	49	66.75

Table 3.7-2—CCNPP Unit 3 Best Estimate Soil for SSI Analysis of NI Common Basemat Structure}
(Page 2 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
47	1.52	17.28	370.3	1556.6	0.0119	0.0119	49	68.28
48	1.52	17.28	370.0	1555.3	0.0119	0.0119	49	69.80
49	1.52	17.28	370.0	1555.3	0.0119	0.0119	49	71.32
50	1.52	17.28	370.0	1555.3	0.0119	0.0119	49	72.85
51	1.52	17.28	370.0	1555.3	0.0119	0.0119	49	74.37
52	1.52	18.85	533.9	1770.6	0.0157	0.0157	70	75.90
53	1.52	18.85	533.9	1770.6	0.0157	0.0157	70	77.42
54	1.52	18.85	533.7	1770.1	0.0157	0.0157	70	78.94
55	1.52	18.85	533.7	1770.1	0.0157	0.0157	70	80.47
56	3.05	18.85	651.2	1753.4	0.0150	0.0150	43	83.52
57	3.05	18.85	622.4	1776.1	0.0152	0.0152	41	86.56
58	3.05	18.85	622.2	1775.6	0.0152	0.0152	41	89.61
59	3.05	18.85	621.9	1774.7	0.0153	0.0153	41	92.66
60	3.05	18.85	621.6	1773.9	0.0153	0.0153	41	95.71
61	2.74	18.85	630.6	1926.6	0.0153	0.0153	46	98.45
62	2.74	18.85	630.6	1926.6	0.0153	0.0153	46	101.19
63	2.74	18.85	630.3	1925.7	0.0153	0.0153	46	103.94
64	2.74	18.85	630.9	1927.5	0.0153	0.0153	46	106.68
65	2.74	18.85	630.8	1927.1	0.0153	0.0153	46	109.42
66	3.05	18.85	673.8	2058.4	0.0151	0.0151	44	112.47
67	3.05	18.85	673.8	2058.4	0.0151	0.0151	44	115.52
68	3.05	18.85	673.6	1813.7	0.0151	0.0151	44	118.57
69	3.05	18.85	674.5	1652.2	0.0151	0.0151	44	121.62
70	3.05	18.85	674.2	1651.5	0.0151	0.0151	44	124.66
71	3.05	18.85	674.2	1651.5	0.0152	0.0152	44	127.71
72	3.05	18.85	674.1	1651.1	0.0152	0.0152	44	130.76
73	3.05	18.85	673.8	1650.4	0.0152	0.0152	44	133.81
	Halfspace	18.07	673.7	1650.1	0.0155	0.0155		

Table 3.7-3—{CCNPP Unit 3 Lower Bound Soil for SSI Analysis of NI Common Basemat Structure}

(Page 1 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m³)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
1	1.22	18.85	343.0	1524.0	0.0211	0.0211	56	1.22
2	1.52	18.85	342.4	1524.0	0.0212	0.0212	45	2.74
3	1.52	18.85	341.6	1524.0	0.0214	0.0214	45	4.27
4	1.14	18.85	383.6	1524.0	0.0207	0.0207	67	5.41
5	1.14	18.85	383.6	1524.0	0.0207	0.0207	67	6.55
6	1.14	18.85	382.6	1524.0	0.0209	0.0209	67	7.70
7	1.14	18.85	382.6	1524.0	0.0209	0.0209	67	8.84
8	1.14	18.85	243.9	1243.6	0.0243	0.0243	43	9.98
9	1.14	18.85	243.9	1243.6	0.0243	0.0243	43	11.13
10	1.14	18.85	242.8	1238.1	0.0246	0.0246	42	12.27
11	1.14	18.85	242.8	1238.1	0.0246	0.0246	42	13.41
12	1.14	18.85	402.5	1524.0	0.0215	0.0215	70	14.55
13	1.14	18.85	402.5	1524.0	0.0215	0.0215	70	15.70
14	1.14	18.85	402.0	1524.0	0.0217	0.0217	70	16.84
15	1.14	18.85	402.0	1524.0	0.0217	0.0217	70	17.98
16	1.07	17.28	297.9	1519.0	0.0240	0.0240	56	19.05
17	1.07	17.28	297.9	1519.0	0.0240	0.0240	56	20.12
18	1.07	17.28	296.9	1513.9	0.0242	0.0242	56	21.18
19	1.07	17.28	296.9	1513.9	0.0242	0.0242	56	22.25
20	1.07	17.28	296.4	1511.3	0.0244	0.0244	56	23.32
21	1.07	17.28	296.4	1511.3	0.0244	0.0244	56	24.38
22	1.07	17.28	296.0	1509.4	0.0245	0.0245	55	25.45
23	1.07	17.28	296.0	1509.4	0.0245	0.0245	55	26.52
24	1.07	17.28	295.5	1506.9	0.0247	0.0247	55	27.58
25	1.07	17.28	295.5	1506.9	0.0247	0.0247	55	28.65
26	1.52	17.28	306.0	1524.0	0.0174	0.0174	40	30.18
27	1.52	17.28	306.0	1524.0	0.0174	0.0174	40	31.70
28	1.52	17.28	305.6	1524.0	0.0174	0.0174	40	33.22
29	1.52	17.28	305.6	1524.0	0.0174	0.0174	40	34.75
30	1.52	17.28	303.7	1524.0	0.0174	0.0174	40	36.27
31	1.52	17.28	303.7	1524.0	0.0174	0.0174	40	37.80
32	1.52	17.28	303.5	1524.0	0.0174	0.0174	40	39.32
33	1.52	17.28	303.5	1524.0	0.0174	0.0174	40	40.84
34	1.52	17.28	303.4	1524.0	0.0175	0.0175	40	42.37
35	1.52	17.28	303.4	1524.0	0.0175	0.0175	40	43.89
36	1.52	17.28	303.2	1524.0	0.0175	0.0175	40	45.42
37	1.52	17.28	303.2	1524.0	0.0175	0.0175	40	46.94
38	1.52	17.28	303.1	1524.0	0.0175	0.0175	40	48.46
39	1.52	17.28	303.1	1524.0	0.0175	0.0175	40	49.99
40	1.52	17.28	303.0	1524.0	0.0175	0.0175	40	51.51
41	1.52	17.28	303.0	1524.0	0.0175	0.0175	40	53.04
42	1.52	17.28	302.9	1524.0	0.0175	0.0175	40	54.56
43	1.52	17.28	302.9	1524.0	0.0175	0.0175	40	56.08
44	1.52	17.28	302.7	1524.0	0.0175	0.0175	40	57.61
45	1.52	17.28	302.7	1524.0	0.0175	0.0175	40	59.13
46	1.52	17.28	302.6	1524.0	0.0175	0.0175	40	60.66

Table 3.7-3—{CCNPP Unit 3 Lower Bound Soil for SSI Analysis of NI Common Basemat Structure}

(Page 2 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m³)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
47	1.52	17.28	302.6	1524.0	0.0175	0.0175	40	62.18
48	1.52	17.28	302.6	1524.0	0.0175	0.0175	40	63.70
49	1.52	17.28	302.6	1524.0	0.0175	0.0175	40	65.23
50	1.52	17.28	302.4	1524.0	0.0176	0.0176	40	66.75
51	1.52	17.28	302.4	1524.0	0.0176	0.0176	40	68.28
52	1.52	17.28	302.1	1524.0	0.0176	0.0176	40	69.80
53	1.52	17.28	302.1	1524.0	0.0176	0.0176	40	71.32
54	1.52	17.28	302.1	1524.0	0.0176	0.0176	40	72.85
55	1.52	17.28	302.1	1524.0	0.0176	0.0176	40	74.37
56	1.52	18.85	435.9	1524.0	0.0221	0.0221	57	75.90
57	1.52	18.85	435.9	1524.0	0.0221	0.0221	57	77.42
58	1.52	18.85	435.8	1524.0	0.0221	0.0221	57	78.94
59	1.52	18.85	435.8	1524.0	0.0221	0.0221	57	80.47
60	1.52	18.85	531.7	1524.0	0.0212	0.0212	70	81.99
61	1.52	18.85	531.7	1524.0	0.0212	0.0212	70	83.52
62	1.52	18.85	508.2	1524.0	0.0212	0.0212	67	85.04
63	1.52	18.85	508.2	1524.0	0.0212	0.0212	67	86.56
64	1.52	18.85	508.1	1524.0	0.0212	0.0212	67	88.09
65	1.52	18.85	508.1	1524.0	0.0212	0.0212	67	89.61
66	1.52	18.85	507.8	1524.0	0.0213	0.0213	67	91.14
67	1.52	18.85	507.8	1524.0	0.0213	0.0213	67	92.66
68	1.52	18.85	507.6	1524.0	0.0213	0.0213	67	94.18
69	1.52	18.85	507.6	1524.0	0.0213	0.0213	67	95.71
70	2.74	18.85	514.9	1573.1	0.0213	0.0213	38	98.45
71	2.74	18.85	514.9	1573.1	0.0213	0.0213	38	101.19
72	2.74	18.85	514.7	1572.3	0.0214	0.0214	38	103.94
73	2.74	18.85	515.2	1573.8	0.0214	0.0214	38	106.68
74	2.74	18.85	515.0	1573.4	0.0214	0.0214	38	109.42
75	3.05	18.85	550.1	1680.6	0.0213	0.0213	36	112.47
76	3.05	18.85	550.1	1680.6	0.0213	0.0213	36	115.52
77	3.05	18.85	550.0	1524.0	0.0213	0.0213	36	118.57
78	3.05	18.85	550.7	1524.0	0.0213	0.0213	36	121.62
79	3.05	18.85	550.5	1524.0	0.0213	0.0213	36	124.66
80	3.05	18.85	550.5	1524.0	0.0214	0.0214	36	127.71
81	3.05	18.85	550.4	1524.0	0.0214	0.0214	36	130.76
82	3.05	18.85	550.1	1524.0	0.0214	0.0214	36	133.81
	Halfspace	18.07	550.0	1524.0	0.0218	0.0218		

Table 3.7-4—{CCNPP Unit 3 Upper Bound Soil for SSI Analysis of NI Common Basemat Structure}

(Page 1 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m³)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
1	1.22	18.85	595.3	1698.7	0.0103	0.0103	98	1.22
2	1.52	18.85	595.1	1698.1	0.0104	0.0104	78	2.74
3	1.52	18.85	594.5	1696.5	0.0105	0.0105	78	4.27
4	2.29	18.85	695.0	2305.0	0.0104	0.0104	61	6.55
5	2.29	18.85	694.7	2304.2	0.0105	0.0105	61	8.84
6	1.14	18.85	454.7	2318.3	0.0121	0.0121	80	9.98
7	1.14	18.85	454.7	2318.3	0.0121	0.0121	80	11.13
8	1.14	18.85	453.7	2313.6	0.0123	0.0123	79	12.27
9	1.14	18.85	453.7	2313.6	0.0123	0.0123	79	13.41
10	2.29	18.85	614.8	2039.0	0.0106	0.0106	54	15.70
11	2.29	18.85	614.5	2037.9	0.0106	0.0106	54	17.98
12	1.07	17.28	446.8	1878.1	0.0122	0.0122	84	19.05
13	1.07	17.28	446.8	1878.1	0.0122	0.0122	84	20.12
14	1.07	17.28	445.3	1871.9	0.0123	0.0123	83	21.18
15	1.07	17.28	445.3	1871.9	0.0123	0.0123	83	22.25
16	1.07	17.28	444.6	1868.7	0.0124	0.0124	83	23.32
17	1.07	17.28	444.6	1868.7	0.0124	0.0124	83	24.38
18	1.07	17.28	444.0	1866.4	0.0125	0.0125	83	25.45
19	1.07	17.28	444.0	1866.4	0.0125	0.0125	83	26.52
20	1.07	17.28	443.3	1863.2	0.0126	0.0126	83	27.58
21	1.07	17.28	443.3	1863.2	0.0126	0.0126	83	28.65
22	1.52	17.28	459.0	1929.1	0.0080	0.0080	60	30.18
23	1.52	17.28	459.0	1929.1	0.0080	0.0080	60	31.70
24	1.52	17.28	458.4	1926.8	0.0080	0.0080	60	33.22
25	1.52	17.28	458.4	1926.8	0.0080	0.0080	60	34.75
26	1.52	17.28	455.6	1915.0	0.0080	0.0080	60	36.27
27	1.52	17.28	455.6	1915.0	0.0080	0.0080	60	37.80
28	1.52	17.28	455.2	1913.5	0.0080	0.0080	60	39.32
29	1.52	17.28	455.2	1913.5	0.0080	0.0080	60	40.84
30	1.52	17.28	455.1	1912.7	0.0080	0.0080	60	42.37
31	1.52	17.28	455.1	1912.7	0.0080	0.0080	60	43.89
32	1.52	17.28	454.9	1911.9	0.0080	0.0080	60	45.42
33	1.52	17.28	454.9	1911.9	0.0080	0.0080	60	46.94
34	1.52	17.28	454.7	1911.1	0.0080	0.0080	60	48.46
35	1.52	17.28	454.7	1911.1	0.0080	0.0080	60	49.99
36	1.52	17.28	454.5	1910.3	0.0081	0.0081	60	51.51
37	1.52	17.28	454.5	1910.3	0.0081	0.0081	60	53.04
38	1.52	17.28	454.3	1909.5	0.0081	0.0081	60	54.56
39	1.52	17.28	454.3	1909.5	0.0081	0.0081	60	56.08
40	1.52	17.28	454.1	1908.7	0.0081	0.0081	60	57.61
41	1.52	17.28	454.1	1908.7	0.0081	0.0081	60	59.13
42	1.52	17.28	453.9	1908.0	0.0081	0.0081	60	60.66
43	1.52	17.28	453.9	1908.0	0.0081	0.0081	60	62.18
44	1.52	17.28	453.9	1908.0	0.0081	0.0081	60	63.70
45	1.52	17.28	453.9	1908.0	0.0081	0.0081	60	65.23
46	1.52	17.28	453.6	1906.4	0.0081	0.0081	60	66.75

Table 3.7-4—{CCNPP Unit 3 Upper Bound Soil for SSI Analysis of NI Common Basemat Structure}

(Page 2 of 2)

Layer No.	Layer Thickness (m)	Weight Density (kN/m³)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-Damp Ratio	P-Damp Ratio	Passing Frequency (Hz)	Depth (m)
47	1.52	17.28	453.6	1906.4	0.0081	0.0081	60	68.28
48	1.52	17.28	453.2	1904.8	0.0081	0.0081	59	69.80
49	1.52	17.28	453.2	1904.8	0.0081	0.0081	59	71.32
50	1.52	17.28	453.2	1904.8	0.0081	0.0081	59	72.85
51	1.52	17.28	453.2	1904.8	0.0081	0.0081	59	74.37
52	1.52	18.85	653.8	2168.5	0.0112	0.0112	86	75.90
53	1.52	18.85	653.8	2168.5	0.0112	0.0112	86	77.42
54	1.52	18.85	653.6	2167.9	0.0112	0.0112	86	78.94
55	1.52	18.85	653.6	2167.9	0.0112	0.0112	86	80.47
56	3.05	18.85	797.6	2147.5	0.0106	0.0106	52	83.52
57	3.05	18.85	762.3	2175.2	0.0109	0.0109	50	86.56
58	3.05	18.85	762.1	2174.7	0.0109	0.0109	50	89.61
59	3.05	18.85	761.7	2173.6	0.0109	0.0109	50	92.66
60	3.05	18.85	761.3	2172.5	0.0110	0.0110	50	95.71
61	2.74	18.85	772.4	2359.6	0.0109	0.0109	56	98.45
62	2.74	18.85	772.4	2359.6	0.0109	0.0109	56	101.19
63	2.74	18.85	772.0	2358.4	0.0110	0.0110	56	103.94
64	2.74	18.85	772.7	2360.7	0.0110	0.0110	56	106.68
65	2.74	18.85	772.5	2360.2	0.0110	0.0110	56	109.42
66	3.05	18.85	825.2	2521.0	0.0107	0.0107	54	112.47
67	3.05	18.85	825.2	2521.0	0.0107	0.0107	54	115.52
68	3.05	18.85	825.0	2221.4	0.0107	0.0107	54	118.57
69	3.05	18.85	826.1	2023.5	0.0107	0.0107	54	121.62
70	3.05	18.85	825.7	2022.6	0.0107	0.0107	54	124.66
71	3.05	18.85	825.7	2022.6	0.0107	0.0107	54	127.71
72	3.05	18.85	825.5	2022.2	0.0108	0.0108	54	130.76
73	3.05	18.85	825.2	2021.3	0.0108	0.0108	54	133.81
	Halfspace	18.07	825.1	2021.0	0.0110	0.0110		

Table 3.7-5—{Frequencies and Mass Participation Factors for Common Basemat Intake Structures with Symmetric Boundary Conditions – Fixed Base Analysis}

(Coordinates based on CCNPP Unit 3)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
1	6.517	0.00	0.00	12.03	51	67.673	0.14	0.37	0.54
2	11.410	0.04	0.00	0.00	52	68.109	0.26	0.42	0.10
3	18.026	17.16	1.54	0.25	53	69.468	0.11	0.00	0.64
4	18.616	2.51	0.24	2.72	54	69.792	0.11	0.18	0.63
5	25.368	0.01	0.00	4.89	55	69.928	0.01	0.05	1.21
6	26.087	27.41	0.01	0.01	56	70.312	0.01	0.01	0.15
7	26.612	12.79	3.74	0.00	57	70.348	0.03	0.01	0.14
8	27.747	4.52	0.15	0.01	58	71.180	0.23	0.00	1.74
9	30.323	0.00	0.00	0.00	59	73.317	0.01	2.00	0.03
10	32.783	0.05	0.03	10.23	60	73.894	0.00	0.22	0.27
11	34.094	0.00	0.01	17.22	61	74.154	0.01	0.11	0.39
12	35.262	0.02	0.01	0.19	62	74.527	0.04	0.67	0.00
13	36.473	0.45	0.00	1.44	63	75.382	0.00	1.10	0.04
14	37.360	0.98	0.00	0.18	64	75.665	0.01	0.00	0.00
15	37.778	0.07	0.01	0.31	65	76.080	0.00	0.28	0.20
16	39.505	0.72	0.00	0.93	66	76.298	0.00	1.32	1.11
17	41.163	2.23	0.00	0.37	67	76.820	0.00	0.04	0.03
18	42.762	0.51	0.03	0.00	68	77.390	0.00	0.02	0.21
19	43.830	0.00	0.04	0.78	69	77.518	0.00	0.26	0.00
20	46.256	2.30	14.84	0.00	70	78.004	0.00	0.05	0.09
21	46.839	2.56	0.37	0.25	71	78.066	0.01	0.02	0.00
22	47.419	0.45	0.08	0.07	72	78.754	0.03	0.23	0.00
23	47.893	0.27	0.43	0.04	73	79.321	0.02	0.57	0.21
24	49.662	0.12	0.00	0.06	74	79.385	0.05	0.01	0.34
25	50.827	1.22	1.51	0.25	75	79.623	0.19	0.46	0.14
26	51.157	1.09	14.10	0.19	76	79.926	0.15	0.63	0.03
27	51.783	3.41	0.00	0.39	77	80.561	0.87	1.13	0.03
28	53.028	0.00	0.07	0.12	78	81.749	0.03	0.18	0.00
29	53.982	0.05	0.05	1.16	79	82.311	0.05	1.76	1.04
30	54.739	0.00	0.24	0.30	80	82.526	0.09	0.51	0.08
31	55.221	0.02	0.49	0.01	81	82.827	0.31	3.11	0.00
32	55.658	2.22	0.14	0.57	82	83.473	0.01	6.85	0.01
33	56.481	0.00	0.00	0.46	83	83.995	0.06	0.02	0.06
34	56.741	0.08	1.32	1.19	84	84.495	0.00	0.48	0.02
35	57.057	1.12	3.24	0.02	85	84.761	0.23	0.00	0.19
36	58.240	0.09	0.26	0.37	86	85.201	0.23	0.03	0.05
37	58.958	0.67	0.20	1.17	87	85.534	0.00	1.17	0.47
38	60.173	0.01	5.83	0.79	88	86.130	0.18	0.18	0.02
39	60.272	0.04	4.46	0.03	89	86.675	0.01	0.03	0.05
40	61.264	0.05	1.19	0.92	90	86.904	0.03	0.01	0.01
41	61.814	0.00	0.13	0.05	91	87.257	0.29	0.12	0.30
42	62.094	0.04	0.00	0.21	92	87.658	0.30	0.28	0.01
43	62.885	0.32	0.00	0.96	93	88.147	0.04	0.00	0.02
44	63.843	0.07	2.29	0.16	94	88.768	0.00	0.15	0.00
45	64.098	0.00	0.00	0.20	95	88.860	0.01	0.00	0.00
46	64.826	0.05	0.77	0.22	96	90.489	0.00	0.24	0.09
47	65.519	0.11	0.00	0.23	97	91.238	0.00	0.28	0.15
48	65.908	1.01	1.21	0.51	98	91.970	0.27	0.42	0.03
49	65.936	0.01	0.01	2.27	99	92.579	0.05	0.10	0.64
50	67.239	0.04	0.40	0.04	100	92.822	0.05	0.13	0.37

Table 3.7-5—{Frequencies and Mass Participation Factors for Common Basemat Intake Structures with Symmetric Boundary Conditions – Fixed Base Analysis}
(Coordinates based on CCNPP Unit 3)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
1	8.32	0	6.16	0	51	46.48	0	0.24	0.36
2	11.72	21.29	0.07	1.30	52	47.31	0.01	0.01	0.81
3	11.97	1.30	0.02	7.85	53	47.94	0.01	0.43	0.11
4	13.30	1.34	0.01	0.08	54	49.39	1.11	0.14	0.50
5	13.62	0.50	0.01	4.06	55	49.64	1.55	0	0.02
6	13.70	4.45	0.74	0.25	56	49.68	2.11	0	0.06
7	13.95	1.38	7.63	0.03	57	50.24	0.25	0.07	0.28
8	15.56	2.94	0	0.02	58	50.35	0.46	0.15	0.66
9	15.83	6.10	0	0.06	59	52.34	0.28	0.64	0.11
10	16.09	6.87	0	0.07	60	53.49	0	0.49	0
11	17.59	1.11	0.02	0.25	61	53.63	0.01	0.69	0
12	17.83	0.23	0	1.68	62	56.38	0.04	0.65	0.06
13	17.99	0	0.06	0.33	63	56.60	0.02	0.64	1.00
14	18.22	1.33	1.17	0.18	64	56.75	0.01	0.03	0.55
15	18.40	0.59	2.33	0.02	65	57.03	0.03	0.04	1.31
16	18.69	0.21	0.04	0.18	66	57.11	0.06	0	1.36
17	19.24	0	0.69	0	67	57.13	0.01	0	1.36
18	25.12	0.59	1.79	0	68	57.31	0.00	0.08	0.46
19	27.23	13.33	0.07	0	69	57.75	0.18	1.21	0.42
20	29.26	0.60	0	1.53	70	58.87	0.10	0.27	0.19
21	29.31	0.12	0	0.28	71	58.94	0.01	0.69	0.67
22	29.35	0.51	0	0.79	72	58.99	0.09	0.20	0.56
23	29.42	0.23	0	0.29	73	59.32	0.03	1.09	0.89
24	29.92	0.06	0	0.69	74	59.96	0	0.52	0
25	30.06	0.02	0	0.47	75	60.48	0	0.37	0.16
26	30.12	0	0	0.39	76	61.40	0.03	0.16	0.29
27	31.13	0.02	0	1.13	77	61.65	0.39	0	0.50
28	32.85	0	0.02	0.38	78	64.02	0.01	0.65	0.02
29	33.00	0.02	0	0.70	79	67.40	0.08	0	0.72
30	33.08	0.16	0	0.41	80	68.03	0.09	0	0.30
31	33.92	0	3.41	0.03	81	68.49	0	0.32	0.15
32	34.37	0.03	0.02	0.40	82	68.68	0.21	0.06	0.25
33	34.40	0.07	0.02	0.66	83	69.07	0.54	0.19	0.05
34	34.44	0.02	0	0.67	84	70.75	0.03	0.36	0.04
35	34.82	0.06	0.01	0.43	85	71.90	0.18	0	0.57
36	34.84	0.03	0.02	0.40	86	71.98	0.03	0.02	0.35
37	35.72	1.27	0	0	87	73.69	0.01	0.29	0.15
38	36.64	0	2.05	0	88	75.11	0.27	0.58	0.67
39	36.84	0.05	4.11	0.01	89	75.50	0.06	0.25	0.14
40	37.86	0.74	0.97	0	90	76.64	0.01	0.02	3.80
41	39.27	0.01	0.40	0	91	76.96	0	0.26	0.41
42	42.89	0.53	1.68	0.09	92	77.93	0.09	0.33	6.55
43	42.93	0.25	0.69	0.01	93	78.64	0.05	0.59	0.53
44	44.11	0.77	0.11	0.06	94	79.46	0.20	0.08	0.15
45	44.36	0.01	1.01	0.30	95	80.21	0.12	0.75	0.02
46	44.61	0	0.13	0.30	96	80.44	0.02	1.52	0.03
47	44.95	0.01	0.26	0.95	97	81.36	0.03	0.50	0.20
48	45.32	0.01	0.04	0.45	98	84.48	0.01	0.14	0.36
49	45.62	0.20	0.02	0.18	99	84.95	0.04	0	0.48
50	45.72	0	0.05	0.56	100	87.70	0.07	0.26	0.18

Table 3.7-6—{Frequencies and Mass Participation Factors for Common Basemat Intake Structures with Anti-Symmetric Boundary Conditions – Fixed Base Analysis}

(Coordinates based on CCNPP Unit 3)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
1	6.503	0.00	0.00	12.18	51	64.231	0.01	0.02	0.05
2	11.262	0.02	0.00	0.68	52	64.983	0.11	0.01	0.07
3	13.771	0.47	0.22	40.32	53	65.465	0.06	1.20	0.00
4	16.293	0.00	0.03	18.66	54	65.935	0.00	0.00	1.85
5	18.546	0.25	0.06	0.42	55	66.162	0.40	1.22	0.02
6	20.484	9.35	0.13	0.39	56	66.395	0.20	0.04	0.00
7	25.098	0.84	0.01	0.67	57	67.135	0.03	2.54	0.04
8	25.370	0.00	0.00	4.68	58	67.414	0.03	3.68	0.16
9	28.123	2.89	0.05	0.14	59	67.520	0.11	0.23	0.00
10	30.325	0.00	0.00	0.00	60	68.059	0.00	4.85	0.14
11	31.348	0.50	0.00	0.05	61	68.587	0.54	0.05	0.13
12	32.441	3.25	5.69	2.83	62	69.415	0.00	2.07	0.01
13	34.002	6.84	0.00	0.17	63	70.075	0.01	1.29	0.07
14	34.553	0.04	0.03	0.00	64	70.328	0.00	0.00	0.00
15	34.792	1.08	0.30	0.05	65	71.090	0.15	0.70	0.12
16	35.745	0.01	0.30	0.00	66	71.406	0.06	2.24	0.00
17	37.248	5.69	0.35	0.12	67	72.862	0.07	0.53	0.00
18	37.612	5.49	0.00	0.00	68	73.164	0.06	0.01	0.01
19	37.764	0.04	0.00	0.50	69	73.983	0.00	0.06	0.02
20	39.060	1.97	0.77	0.16	70	74.084	0.88	0.00	0.00
21	40.208	0.06	0.06	0.74	71	75.326	0.04	0.10	0.01
22	40.820	2.18	0.00	0.18	72	75.403	0.19	0.54	0.06
23	42.710	0.09	0.03	0.95	73	75.569	0.23	0.04	0.06
24	44.789	5.97	0.00	0.00	74	76.485	0.02	0.72	0.01
25	45.121	0.01	0.01	0.00	75	76.615	0.00	0.24	0.01
26	45.528	6.03	0.02	1.02	76	77.050	0.00	0.62	0.00
27	46.153	3.96	0.02	0.01	77	77.398	0.00	0.00	0.16
28	47.203	0.02	0.00	0.01	78	78.396	0.10	0.25	0.01
29	48.583	0.65	0.10	0.02	79	79.472	0.00	0.59	0.07
30	50.072	3.16	0.21	0.03	80	79.844	0.03	0.88	0.03
31	51.061	0.00	0.02	0.00	81	80.116	0.02	0.36	0.01
32	51.999	2.21	2.39	0.01	82	81.164	0.00	2.38	0.00
33	52.401	0.29	1.86	0.89	83	81.601	0.01	3.36	0.02
34	53.369	12.62	0.19	0.00	84	82.463	0.05	0.68	0.24
35	54.423	2.50	0.18	0.00	85	82.712	0.41	0.04	0.03
36	54.526	0.04	6.21	0.16	86	83.041	0.00	5.41	0.00
37	54.963	0.59	1.15	0.00	87	83.435	0.26	3.79	0.01
38	55.593	0.00	0.34	0.00	88	83.703	0.31	0.15	0.01
39	55.872	0.00	1.01	0.01	89	83.994	0.00	0.02	0.00
40	56.734	0.04	0.46	0.14	90	84.224	0.00	0.04	0.24
41	57.044	0.15	0.04	0.01	91	84.830	0.03	0.11	0.08
42	57.678	0.01	2.36	0.34	92	85.151	0.36	0.95	0.46
43	58.758	0.17	0.09	0.13	93	85.431	0.00	0.00	0.06
44	59.366	0.04	6.23	0.07	94	86.005	0.02	0.90	0.02
45	60.843	0.57	0.56	0.08	95	86.143	0.11	0.00	0.02
46	61.093	0.00	0.01	0.01	96	86.618	0.02	0.01	0.01
47	61.608	0.44	0.25	0.42	97	87.048	0.04	0.03	0.00
48	62.226	0.25	0.10	0.07	98	87.253	0.24	0.69	0.01
49	62.848	0.17	0.78	0.01	99	87.298	0.07	0.14	0.00
50	63.762	0.75	0.00	0.17	100	88.264	0.00	0.00	0.01

Table 3.7-6—{Frequencies and Mass Participation Factors for Common Basemat Intake Structures with Anti-Symmetric Boundary Conditions – Fixed Base Analysis}

(Coordinates based on CCNPP Unit 3)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
1	8.27	0.01	9.83	0	51	36.89	1.34	0	0.20
2	9.61	0.02	33.28	0.12	52	36.90	0.47	0	0.20
3	11.31	0.58	12.13	2.20	53	36.93	0.49	0	0
4	12.17	1.47	4.12	4.01	54	37.13	0.40	0.01	0.27
5	12.43	6.38	1.27	0.29	55	37.50	0.81	0.06	0.01
6	14.13	0.17	7.14	0.26	56	37.58	0.74	0.11	0
7	14.26	0.06	4.54	1.66	57	37.71	0.14	0.04	0.35
8	14.33	0.01	1.18	0.85	58	37.73	0.33	0.08	0.03
9	14.49	2.29	0.02	0.02	59	38.79	0.03	0.00	0.39
10	15.03	0.29	0.88	0.11	60	38.87	0.93	0.05	0.16
11	15.53	0.55	0.07	0	61	39.13	0.01	0	0.39
12	15.70	0.07	0.01	1.07	62	39.35	0.22	0.01	0.30
13	15.80	2.53	0.04	0.05	63	40.43	0.03	0	0.81
14	16.63	1.62	0.16	0.09	64	41.00	0.07	0	0.46
15	17.21	1.59	0.07	0.06	65	42.68	1.14	0	0.27
16	17.28	0.28	0.11	0.05	66	42.71	0.43	0.01	0.08
17	17.80	0.93	0.61	0.13	67	42.73	0.75	0.01	0.15
18	18.16	0.05	0.02	1.17	68	43.96	0.61	0	0.10
19	18.21	0.42	0.10	0.01	69	46.69	0.34	0.01	0.04
20	19.08	0.60	0.07	0.02	70	46.72	1.60	0.02	0.03
21	19.37	0.43	0.02	0	71	46.74	2.55	0.02	0.04
22	19.38	0	0	0.76	72	46.79	0.40	0	0.02
23	19.67	0.99	0.03	0.01	73	47.76	0.29	0.04	0.33
24	19.83	0	0.01	0.77	74	50.32	0.64	0.01	0.09
25	22.78	0.32	0.12	0	75	50.94	0.01	0.33	0.19
26	22.79	0.36	0.27	0.01	76	51.33	0.43	0.01	0.95
27	22.82	0.24	0.18	00	77	52.44	1.81	0.19	0.02
28	22.94	0.33	0.19	0.01	78	53.43	0.72	0.04	0.15
29	23.02	0.29	0.17	0.01	79	53.87	0.16	0.01	0.47
30	23.11	0.32	0.18	0.01	80	54.72	0.43	0.05	0.14
31	24.44	0.35	0.16	0	81	54.87	0.24	0.06	0.43
32	26.93	1.23	0.28	0.13	82	55.20	0.09	0.03	0.95
33	26.94	0.53	0.02	0.03	83	56.80	0	0.01	0.76
34	28.33	0.13	0.32	0.07	84	60.46	0.29	0.04	0.23
35	28.81	0.13	0.16	0.13	85	61.85	0.19	0.12	1.87
36	29.15	0.89	0.19	0.10	86	62.91	0.02	0	0.38
37	29.24	0.14	0.17	0.29	87	64.85	0.06	0.01	0.40
38	29.44	0.28	0.11	0.13	88	65.73	0.11	0.19	0.29
39	31.60	0.12	0.19	0.11	89	66.02	0.04	0.01	0.97
40	31.63	0.37	0.48	0	90	66.63	0.04	0.08	1.05
41	31.66	0.30	0.22	0.13	91	67.86	0.04	0.22	0.27
42	34.07	0.50	0.02	0.02	92	68.46	0.13	0	0.32
43	34.09	0.38	0.02	0	93	70.72	0.01	0.01	0.41
44	34.33	0.55	0.03	0	94	72.15	0	0.03	1.12
45	35.17	0.46	0.01	0.05	95	72.34	0.03	0.01	0.47
46	35.48	1.80	0.10	0.17	96	75.13	0	0.01	0.40
47	36.43	0.44	0.04	0	97	75.15	0.06	0.14	3.74
48	36.51	0.64	0.13	0	98	76.09	0.03	0.01	0.74
49	36.66	0	0.63	0.02	99	76.69	0.27	0.03	1.94
50	36.67	0.01	0.91	0	100	77.32	0.03	0	0.65

Table 3.7-7—{Not Used~~Frequencies and Mass Participation Factors for UHS Electrical Building with Symmetric Boundary Conditions – Fixed Base Analysis~~}

~~(Coordinates based on CCNPP Unit 3)~~

Mode #	Frequency (Hz)	Mass Participation Factors (%) N-S	Vertical	E-W	Mode #	Frequency (Hz)	Mass Participation Factors (%) N-S	Vertical	E-W
1	29.494	51.79	0.00	0.09	51	177.140	0.20	0.26	0.08
2	41.828	22.89	0.58	0.00	52	178.396	0.00	0.08	0.03
3	44.781	4.56	0.08	0.02	53	181.045	0.14	0.00	0.57
4	55.498	0.00	3.70	0.53	54	184.760	0.03	0.22	1.06
5	59.936	2.71	0.00	16.30	55	188.129	0.01	0.02	1.29
6	61.351	0.18	5.08	12.23	56	188.951	0.00	0.46	0.03
7	62.963	0.02	5.94	17.70	57	189.413	0.01	0.02	0.20
8	68.779	0.98	10.90	0.02	58	191.541	0.00	0.46	0.00
9	70.085	0.00	2.08	1.19	59	192.333	0.13	0.27	0.29
10	71.985	0.06	7.32	2.21	60	194.479	0.00	0.05	0.08
11	74.403	0.00	0.02	4.66	61	194.997	0.03	0.01	0.01
12	79.007	0.04	0.01	0.29	62	200.297	0.06	0.01	0.24
13	82.810	1.06	0.02	1.73	63	203.053	0.05	0.01	0.20
14	87.440	0.30	0.00	2.35	64	205.726	0.00	0.05	0.03
15	89.156	0.61	0.24	0.07	65	207.780	0.00	0.08	2.22
16	90.334	0.14	0.12	0.01	66	210.104	0.02	0.16	1.41
17	92.178	0.01	2.50	0.01	67	212.399	0.00	0.03	0.25
18	95.983	0.00	0.38	1.04	68	214.877	0.00	0.10	0.01
19	98.318	0.16	1.69	0.00	69	216.628	0.01	0.00	0.01
20	99.230	0.61	3.74	0.02	70	218.147	0.10	0.02	0.28
21	101.380	0.37	0.15	0.66	71	219.351	0.00	0.16	0.09
22	104.441	0.37	0.34	0.45	72	222.118	0.39	0.01	0.36
23	106.348	0.02	1.70	0.32	73	222.484	0.02	0.07	0.24
24	107.397	1.86	0.00	0.04	74	225.122	0.04	0.01	0.56
25	112.371	0.00	6.94	0.38	75	226.188	0.00	0.16	0.53
26	115.701	0.11	8.69	0.03	76	229.278	0.22	0.00	0.14
27	120.595	0.00	0.03	3.43	77	229.585	0.03	0.10	0.01
28	129.854	0.06	1.37	0.01	78	231.427	0.05	0.00	0.40
29	131.168	0.01	0.44	3.04	79	232.889	0.02	0.00	0.03
30	133.006	0.01	5.10	1.41	80	234.734	0.02	0.07	0.24
31	134.436	0.12	0.30	0.02	81	235.610	0.18	0.05	0.14
32	135.036	0.04	0.43	0.25	82	238.650	0.13	0.12	0.15
33	137.814	0.00	0.22	0.01	83	241.851	0.08	0.02	0.03
34	140.035	0.66	0.12	0.71	84	242.078	0.01	0.00	0.13
35	142.311	0.19	0.72	0.05	85	243.192	0.00	0.09	0.21
36	145.681	0.01	0.01	0.47	86	246.868	0.04	0.02	0.02
37	146.146	0.09	9.83	0.00	87	248.849	0.39	0.01	0.07
38	148.513	0.00	2.33	0.04	88	250.894	0.07	0.01	0.06
39	149.976	0.00	0.00	0.33	89	251.967	0.02	0.00	0.30
40	151.015	0.15	0.79	0.18	90	253.290	0.14	0.07	0.04
41	154.590	0.00	0.90	0.70	91	256.174	0.19	0.00	0.13
42	155.876	0.00	0.01	0.23	92	257.454	0.13	0.00	0.02
43	158.936	0.13	0.85	0.02	93	259.937	0.00	0.03	0.09
44	162.092	0.76	0.14	0.01	94	262.667	0.04	0.05	0.09
45	162.594	0.09	0.02	0.02	95	263.342	0.00	0.01	0.14
46	164.673	0.56	0.70	0.58	96	264.593	0.03	0.00	0.06
47	166.577	0.08	0.27	0.14	97	267.597	0.02	0.09	0.19
48	168.004	0.03	0.05	0.00	98	269.866	0.06	0.00	0.01
49	171.534	0.21	0.17	0.01	99	270.774	0.00	0.00	0.02
50	173.780	1.19	0.00	0.00	100	272.784	0.00	0.01	0.11

Table 3.7-8—{Not Used~~Frequencies and Mass Participation Factors for UHS Electrical Building with Anti-Symmetric Boundary Conditions – Fixed Base Analysis}~~

~~(Coordinates based on CCNPP Unit 3)~~

Mode #	Frequency (Hz)	Mass Participation Factors (%) N-S	Vertical	E-W	Mode #	Frequency (Hz)	Mass Participation Factors (%) N-S	Vertical	E-W
1	42.326	72.06	0.02	3.32	51	181.572	0.08	0.00	0.41
2	45.659	3.31	0.81	77.74	52	183.888	0.37	0.70	0.02
3	55.028	0.00	0.78	0.08	53	187.719	0.15	0.19	0.00
4	58.363	0.07	9.48	0.02	54	188.597	0.00	0.50	0.03
5	60.138	0.38	10.22	0.15	55	190.522	0.04	0.00	0.00
6	66.039	0.17	0.49	1.09	56	192.747	0.37	0.15	0.04
7	68.557	0.00	0.05	0.12	57	194.362	0.07	0.03	0.21
8	69.500	0.01	0.04	0.11	58	195.039	0.54	0.24	0.32
9	72.045	0.10	0.37	0.00	59	196.376	0.01	0.37	0.13
10	73.747	0.08	4.97	0.21	60	198.176	0.00	0.01	0.05
11	75.077	0.07	0.38	0.14	61	200.373	0.10	0.68	0.16
12	77.555	0.27	0.00	0.02	62	202.469	0.22	0.11	0.00
13	81.691	0.21	0.08	0.12	63	204.591	0.01	0.02	0.00
14	83.226	0.07	1.40	0.79	64	208.998	0.00	0.03	0.05
15	88.363	0.13	0.02	0.01	65	210.269	0.04	0.00	0.06
16	91.112	0.94	0.64	0.16	66	211.977	0.04	0.67	0.06
17	95.481	0.31	0.05	0.02	67	213.790	0.03	0.09	0.00
18	98.733	0.00	0.74	0.02	68	215.040	0.00	0.90	0.07
19	99.131	0.23	1.80	0.02	69	216.310	0.07	0.12	0.30
20	101.927	3.52	0.83	0.06	70	218.187	0.07	0.10	0.30
21	102.893	0.62	0.00	0.01	71	219.311	1.19	0.16	0.03
22	104.268	0.01	1.51	0.11	72	220.727	0.17	0.04	0.07
23	106.312	0.66	0.50	0.52	73	223.243	0.00	0.17	0.03
24	110.573	0.30	0.70	0.47	74	223.729	0.00	0.00	0.24
25	114.507	0.17	20.06	0.05	75	226.584	0.00	0.02	0.09
26	118.730	0.00	0.35	2.21	76	227.961	0.07	0.02	0.11
27	120.439	0.05	0.00	0.00	77	229.417	0.43	0.31	0.18
28	127.149	0.43	0.05	0.41	78	230.068	0.03	0.24	0.25
29	131.849	0.00	0.03	0.10	79	234.733	0.00	0.02	0.01
30	134.167	0.00	3.28	0.45	80	236.128	0.11	0.02	0.05
31	135.706	0.02	1.49	0.06	81	237.500	0.04	0.48	0.16
32	137.115	0.00	3.56	0.80	82	239.057	0.44	0.06	0.13
33	138.801	0.07	0.80	0.71	83	241.129	0.43	0.19	0.05
34	140.416	0.13	0.01	0.03	84	242.754	0.10	0.02	0.02
35	141.503	0.68	0.00	0.15	85	243.295	0.00	0.23	0.02
36	144.582	0.07	0.27	0.00	86	244.126	0.13	0.12	0.00
37	146.156	1.50	1.40	0.01	87	244.828	1.02	0.31	0.01
38	146.764	0.08	6.74	0.01	88	248.582	0.01	0.00	0.06
39	151.577	0.31	0.53	0.19	89	249.529	0.03	0.07	0.01
40	153.445	0.00	0.92	0.08	90	251.594	0.00	0.03	0.00
41	157.292	0.01	2.25	0.00	91	251.900	0.01	0.03	0.05
42	158.058	0.01	0.00	0.10	92	253.361	0.00	0.02	0.07
43	160.875	0.00	0.36	0.40	93	258.664	0.04	0.11	0.04
44	162.196	0.20	0.63	0.00	94	259.071	0.03	0.02	0.03
45	164.932	0.05	0.00	0.04	95	262.615	0.06	0.02	0.03
46	165.701	0.13	0.11	0.01	96	264.417	0.00	0.01	0.07
47	168.816	0.12	0.00	0.17	97	265.846	0.01	0.00	0.01
48	172.712	0.50	0.00	0.07	98	266.983	0.18	0.00	0.00
49	175.586	0.10	0.04	0.00	99	270.771	0.00	0.10	0.15
50	178.036	0.14	1.40	0.21	100	273.425	0.06	0.00	0.01

Table 3.7-9—~~{Boundary Conditions for Nodes in Plane of Symmetry for Integrated Finite Element Model}~~

~~Seismic Loading~~	~~Ux~~	~~Uy~~	~~Uz~~	~~ϕx~~	~~ϕy~~	~~ϕz~~
~~Symmetric~~	~~Free~~	~~Free~~	~~Fix~~	~~Fix~~	~~Fix~~	~~Free~~
~~Anti-symmetric~~	~~Fix~~	~~Fix~~	~~Free~~	~~Free~~	~~Free~~	~~Fix~~

~~Notes:~~
- ~~Coordinate Axes correspond to GTSTRUDL model axes shown in Figure 3.7-26~~
- ~~Ux, Uy and Uz are the displacements, and ϕx, ϕy and ϕz are the rotations.~~

Table 3.7-9—{Boundary Conditions for Nodes in Plane of Symmetry of the CBIS Finite Element Model}

Direction of Seismic Loading	Condition of Plane of symmetry	Degree of Freedom of nodes on symmetric plane					
		Ux	Uy	Uz	ϕx	ϕy	ϕz
North-South	Symmetric	Free	Fix	Free	Fix	Free	Fix
East-West	Anti-symmetric	Fix	Free	Fix	Free	Fix	Free
Vertical	Symmetric	Free	Fix	Free	Fix	Free	Fix

Notes:
- Ux, Uy and Uz are the displacements, and ϕx, ϕy and ϕz are the rotations.

Table 3.7-10—{Worst Case Accelerations in mergency Power Generating Building}

Slab Elevation	X (E-W) Direction	Y (N-S) Direction	Z (Vert) Direction
+68'-0"	0.31g	0.30g	0.29g
+51'-6"	0.27g	0.29g	0.29g
+19'-3"	0.22g	0.24g	0.23g
0'-0"	0.20g	0.21g	0.24g

Note:
Elevations and plant coordinate system refer to U.S EPR FSAR.

Table 3.7-11—{Worst Case Accelerations in Essential Services Water Building}

Slab Elevation	X (N-S) Direction	Y (E-W) Direction	Z (Vert) Direction
+114'-0"	0.28g	0.28g	0.32g
+80'-9"	0.24g	0.22g	0.33g
+61'-10"	0.22g	0.26g	0.22g
+33'-0"	0.20g	0.18g	0.21g
0'-0"	0.16g	0.16g	0.20g

Note:
Elevations and plant coordinate system refer to U.S EPR FSAR.

Table 3.7-12—{Worst Case Accelerations in Common Basemat Intake Structures}

UHS Makeup Water Intake Structure			
~~Slab~~Floor Elevation	X (N-S) Direction	Y (E-W) Direction	Z (Vert) Direction
~~+26'-6"~~-22.5	~~0.18g~~0.225g	~~0.21g~~0.147g	~~0.20g~~0.233g
~~+11'-6"~~11.5	~~0.16g~~0.315g	~~0.19g~~0.199g	~~0.20g~~0.238g
~~-22'-6"~~26.5	~~0.15g~~0.342g	~~0.12g~~0.236g	~~0.19g~~0.240g

Forebay			
~~Slab~~Floor Elevation	X (N-S) Direction	Y (E-W) Direction	Z (Vert) Direction
~~-22'-6"~~-22.5	~~0.14g~~0.227g	~~0.13g~~0.153g	~~0.20g~~0.215g

~~Circulating Water Makeup Intake Structure~~			
~~Slab Elevation~~	~~X (N-S) Direction~~	~~Y (E-W) Direction~~	~~Z (Vert) Direction~~
~~+11'-6"~~	~~0.17g~~	~~0.19g~~	~~0.19g~~
~~-22'-6"~~	~~0.15g~~	~~0.12g~~	~~0.19g~~

Note:
Elevations and plant coordinate system refer to U.S EPR FSAR.

Table 3.7-13—{Not Used~~Worst Case Accelerations in UHS Electrical Building~~}

~~Slab Elevation~~	~~X (N-S) Direction~~	~~Y (E-W) Direction~~	~~Z (Vert) Direction~~
~~+10'-6"~~	~~0.20g~~	~~0.18g~~	~~0.20g~~
~~-5'-6"~~	~~0.17g~~	~~0.17g~~	~~0.19g~~

~~Note:~~
~~Elevations and plant coordinate system refer to U.S EPR FSAR.~~

Table 3.7-14—{Criteria for Seismic Interaction of Site-Specific Non-Seismic Category I Structures with Seismic Category I Structures}

Basis: Control Interaction through Prevention of Structure-to-Structure Impact1				
Structure	**Seismic Category**	**Design Code**	**Seismic Interaction Criteria**	**Seismic Interaction Evaluation**
Turbine Building and Switchgear Building	SC-II2b	IBC Steel – AISC 341, AISC 360 & AISC N6903 Concrete – ACI 318 & ACI 3493	SSE	No Interaction
Grid Systems Control Building	CS2a	IBC Steel – AISC 360 Concrete – ACI 318	None	No Interaction
Circulating Water Intake Structure	SC-II2b	IBC Steel – AISC 341 & ACI 360 Concrete – ACI 349	SSE	No Interaction

Notes:

1. This table is not applicable to equipment and subsystems qualification criteria.
2. Seismic Classification
   a. Conventional Seismic
   b. Seismic Category II
3. AISC N690 and ACI 349, as applicable, will be used for SSE and tornado load combinations in the design of the Lateral Force Resisting System (LFRS).

Figure 3.7-1—{CCNPP Unit 3 Site SSE Spectrum (0.15g PGA), 5% damping}

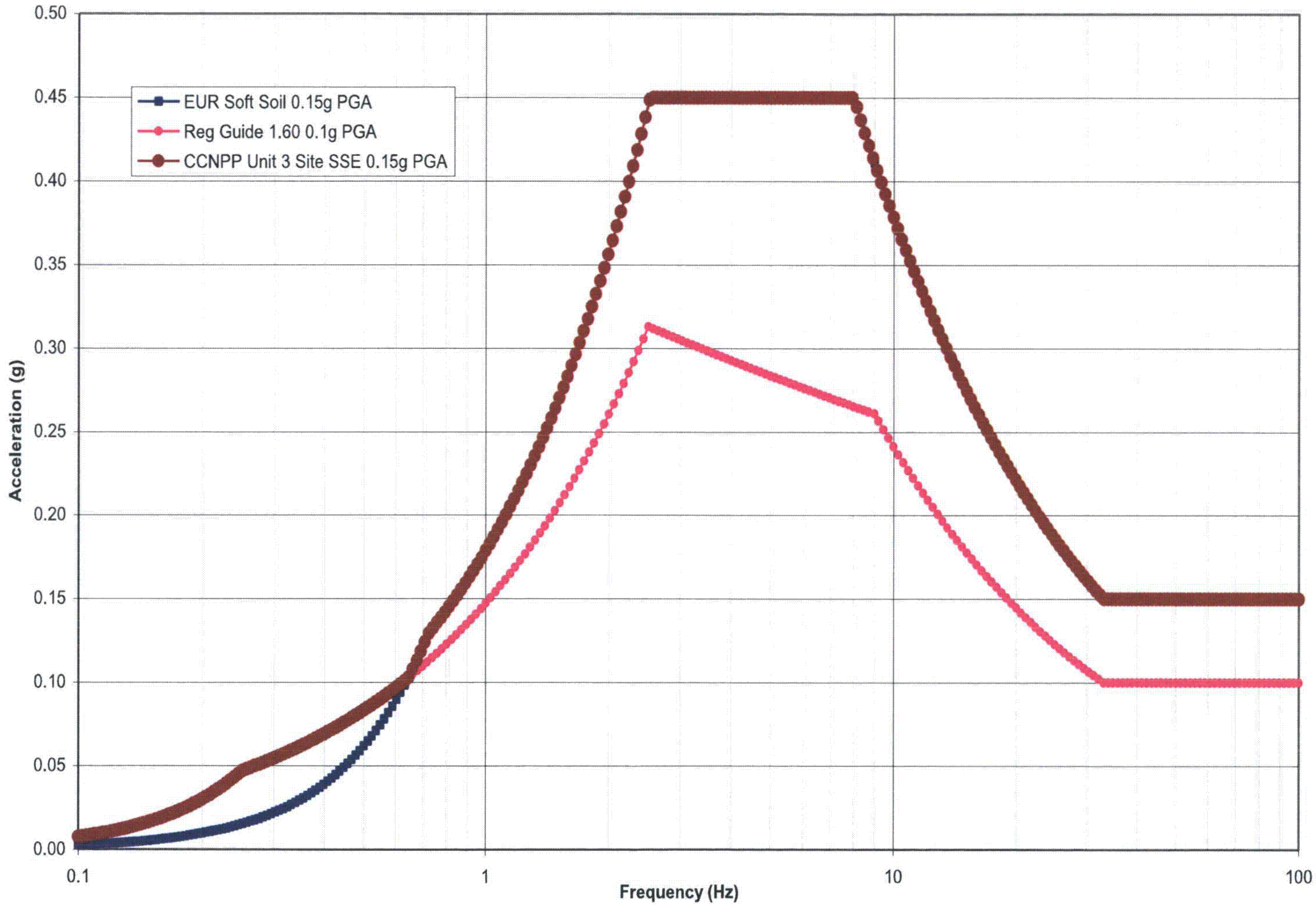


Figure 3.7-2—{CCNPP Unit 3 GMRS (Horizontal) and CCNPP Unit 3 Site SSE Spectrum, 5% damping}

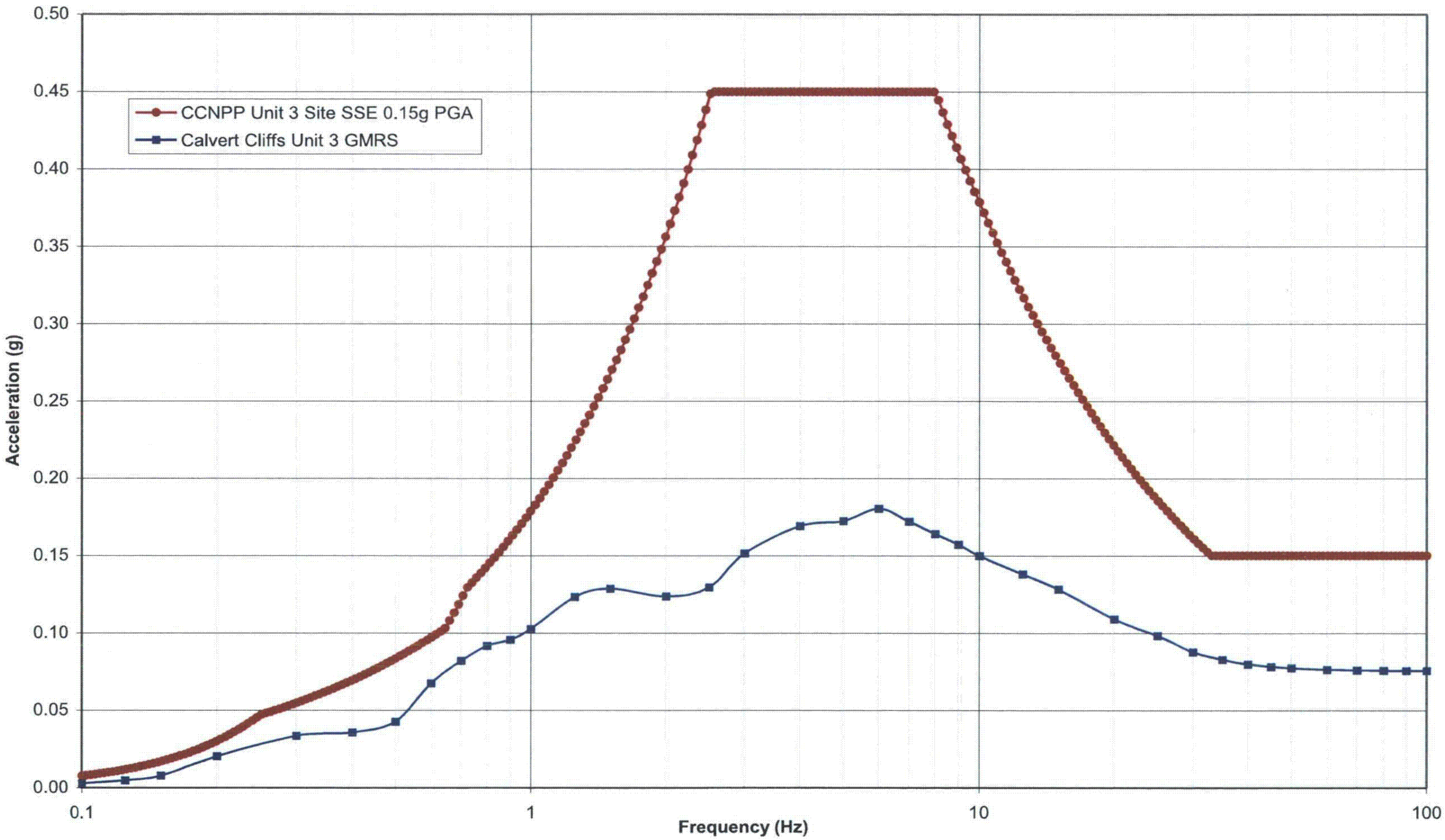


Figure 3.7-3—{CCNPP Unit 3 GMRS (Vertical) and CCNPP Unit 3 Site SSE Spectrum, 5% damping}

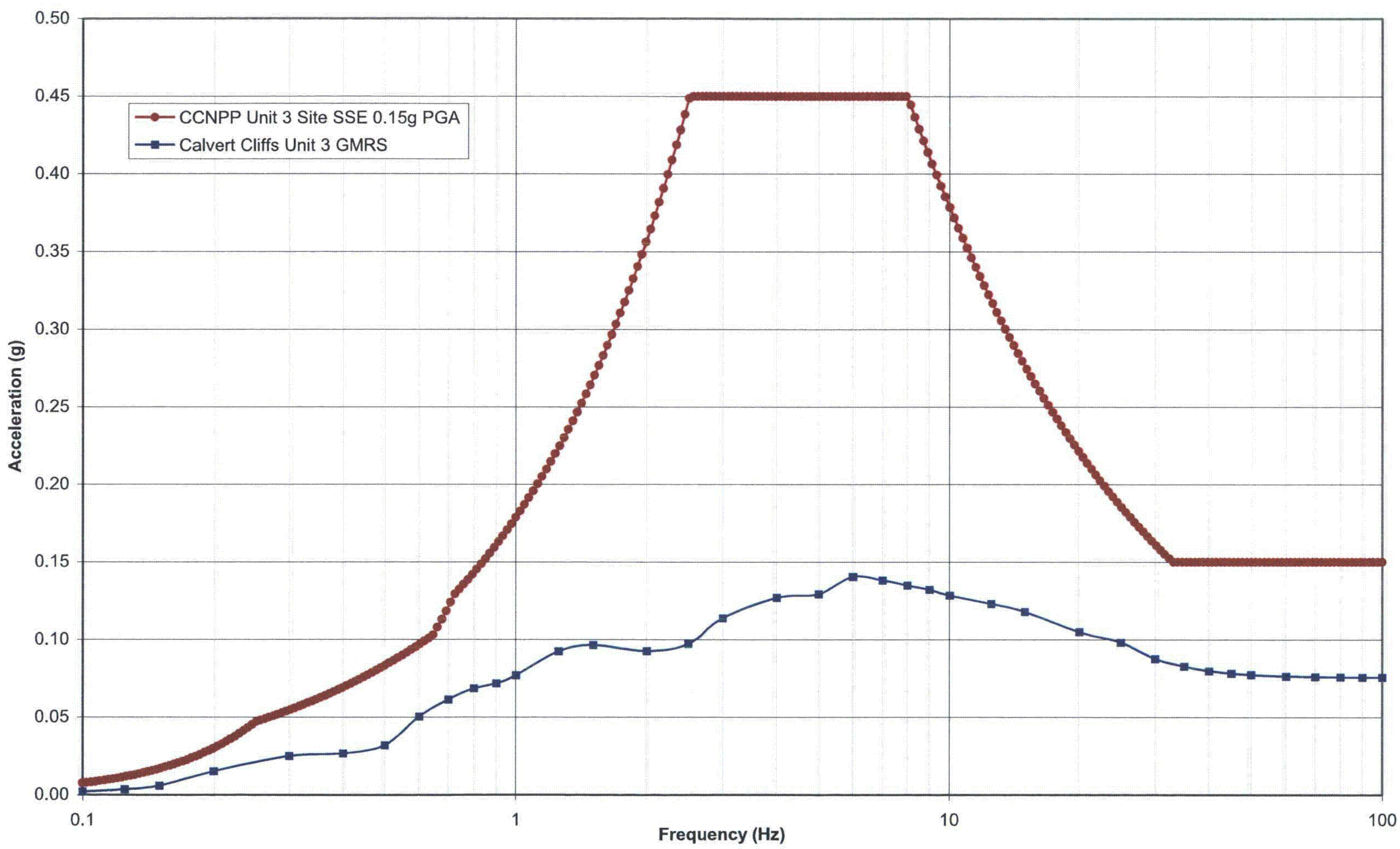


Figure 3.7-4—{CCNPP Unit 3 GMRS and EUR CSDRS (Horizontal) for the Nuclear Island Common Basemat Structures}

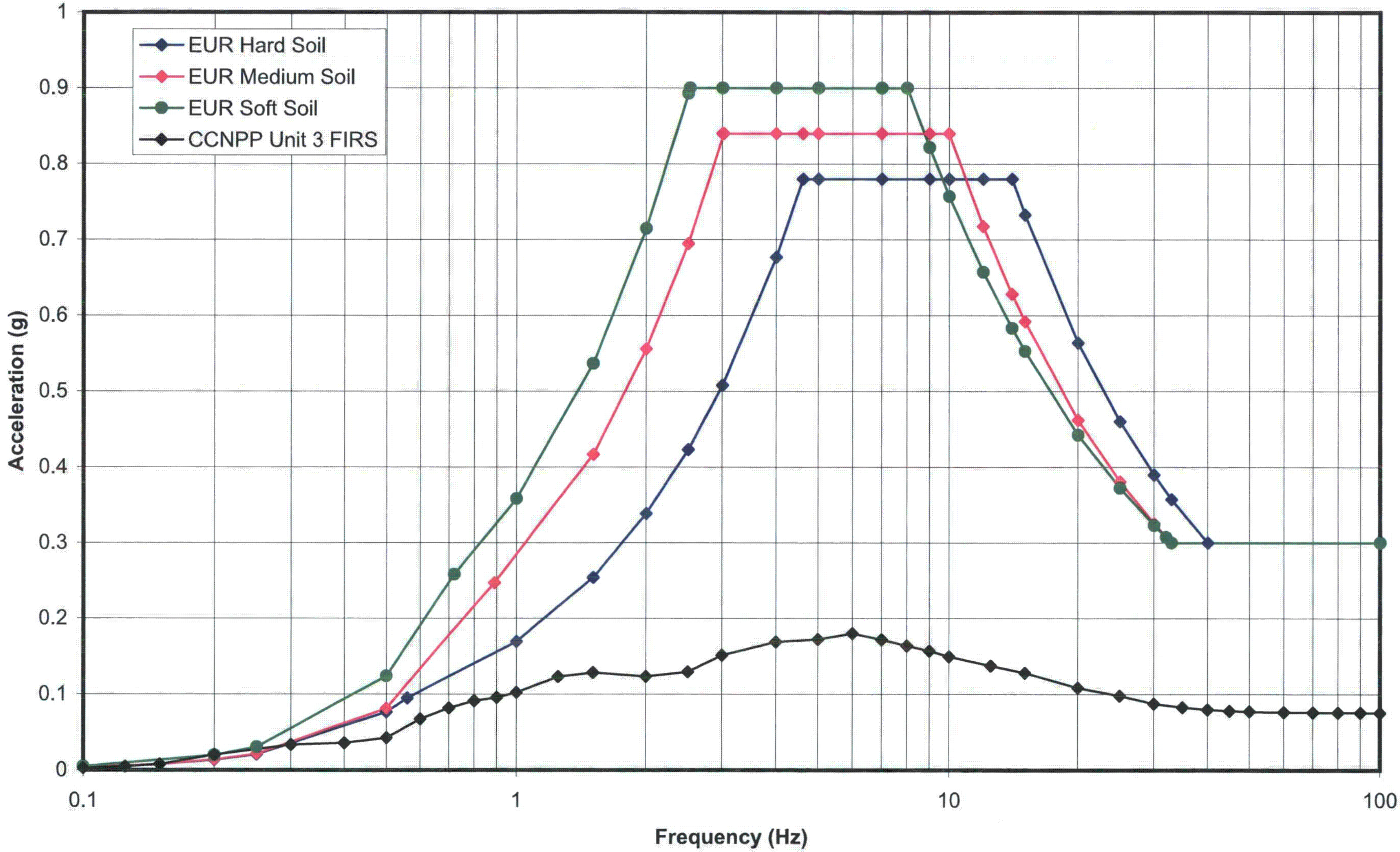


Figure 3.7-5—{CCNPP Unit 3 GMRS and EUR CSDRS (Vertical) for the Nuclear Island Common Basemat Structures}

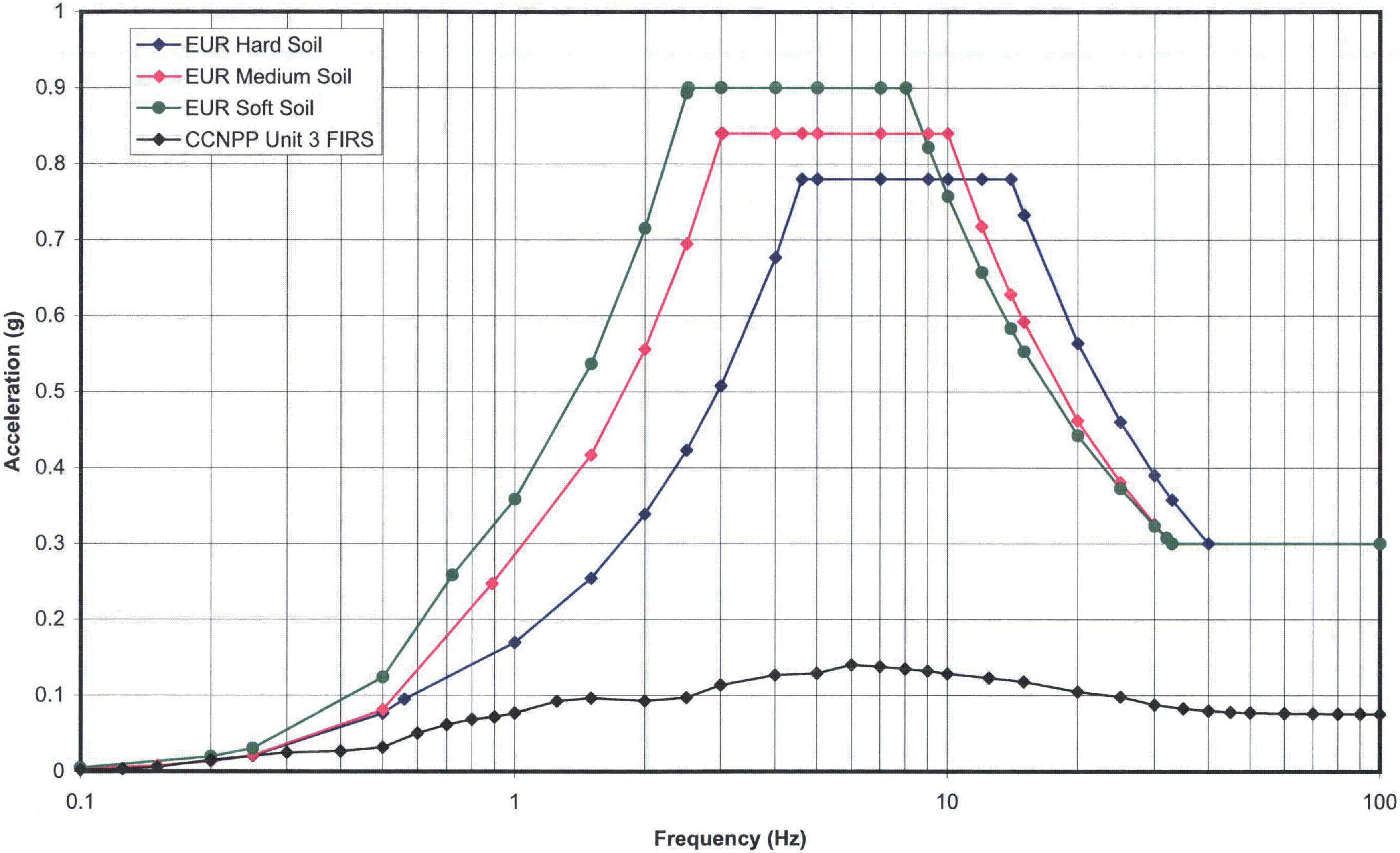


Figure 3.7-6—{CCNPP Unit 3 Site SSE, Site OBE and EUR CSDRS}

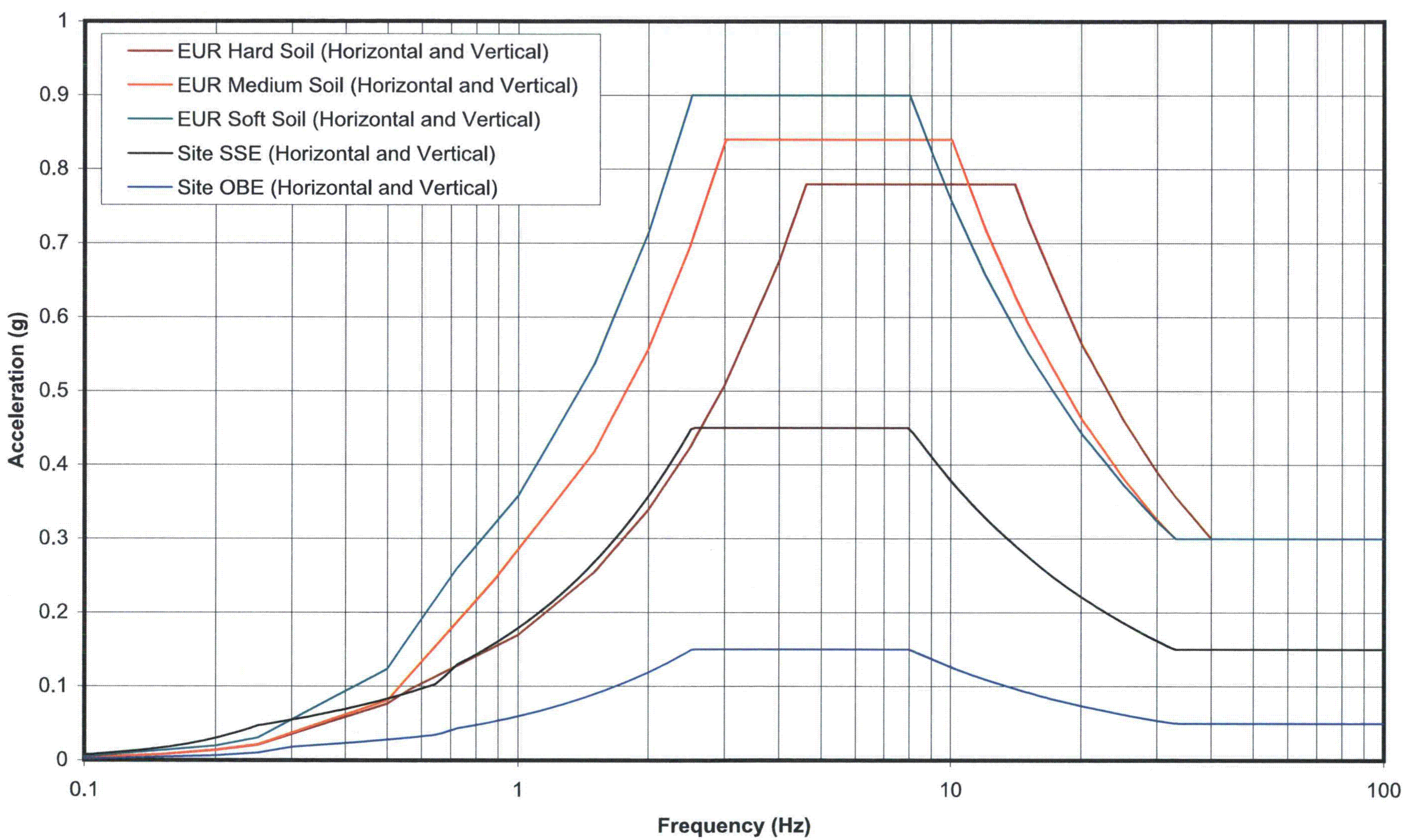


Figure 3.7-7—{Comparison of CSDRS, Site SSE and Horizontal RG 1.60 scaled to 0.10 g to Adjusted FIRS for ESWB and EPGB}

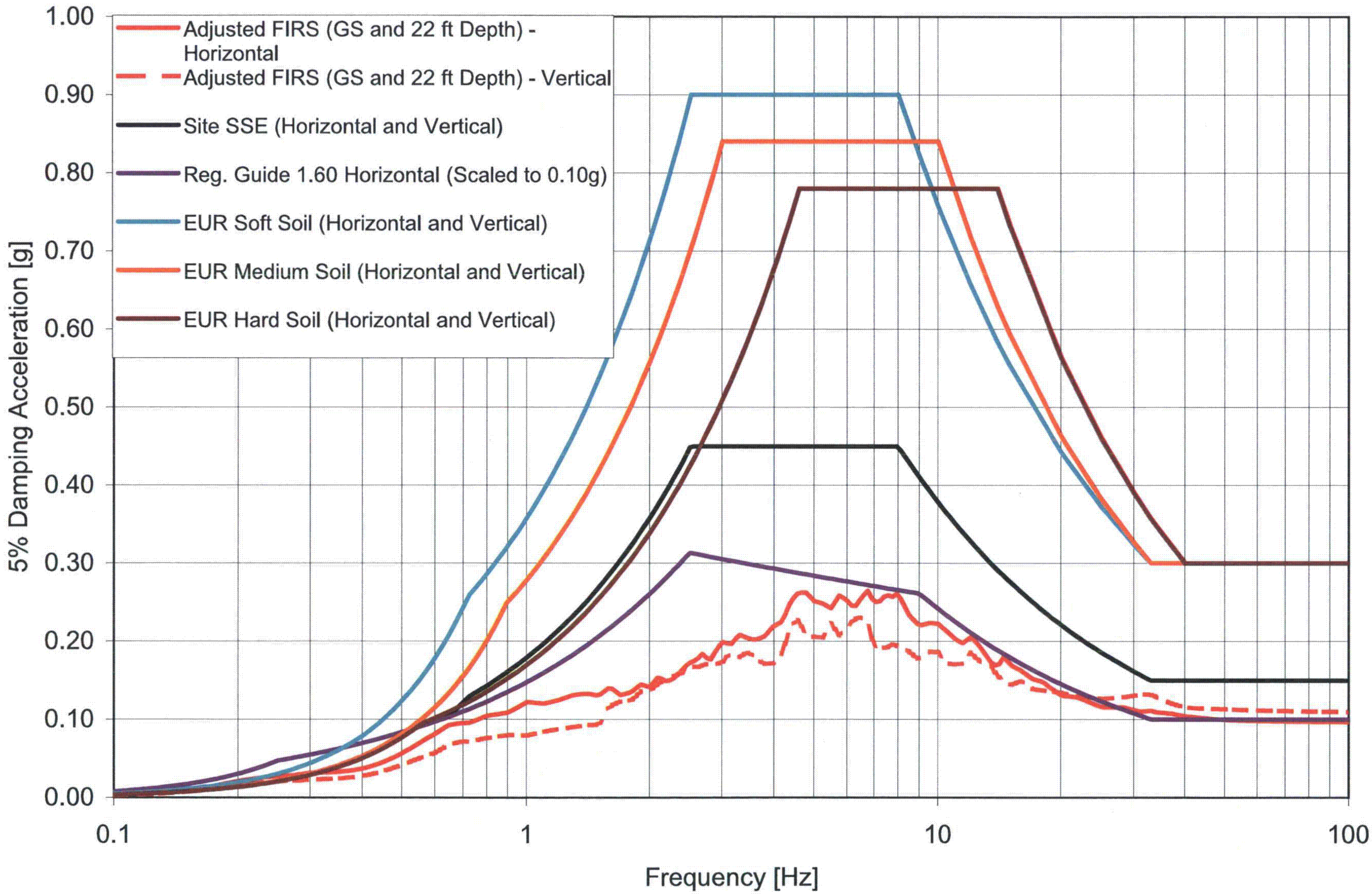


Figure 3.7-8—{Comparison of Site SSE and Horizontal RG 1.60 scaled to 0.10 g to Adjusted FIRS for ESWB and EPGB}

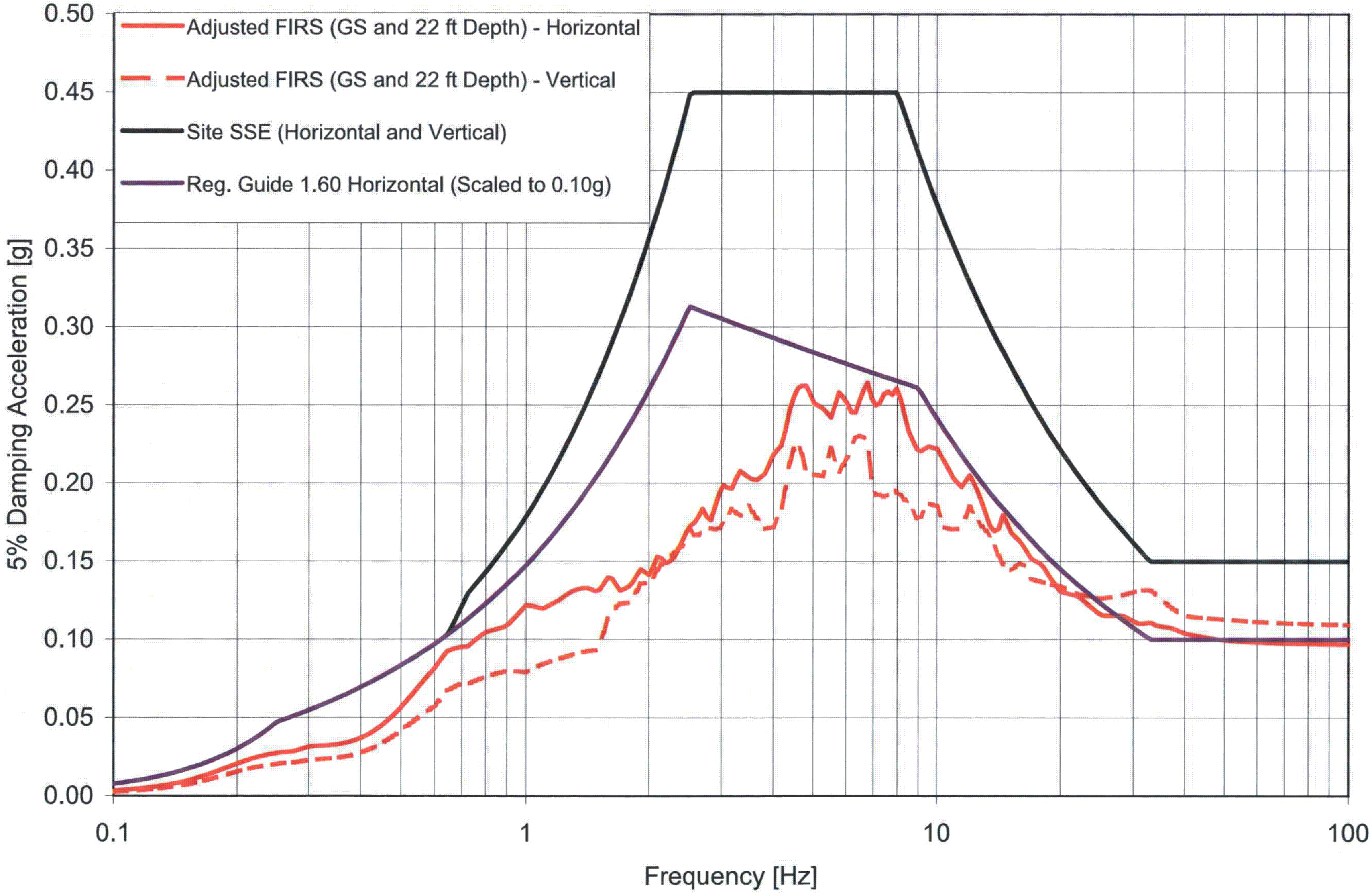


Figure Replaced

Figure 3.7-9—{Comparison of Site SSE and Horizontal RG 1.60 scaled to 0.10 g to Adjusted FIRS for ~~UHS Electrical Building and~~ CBIS}

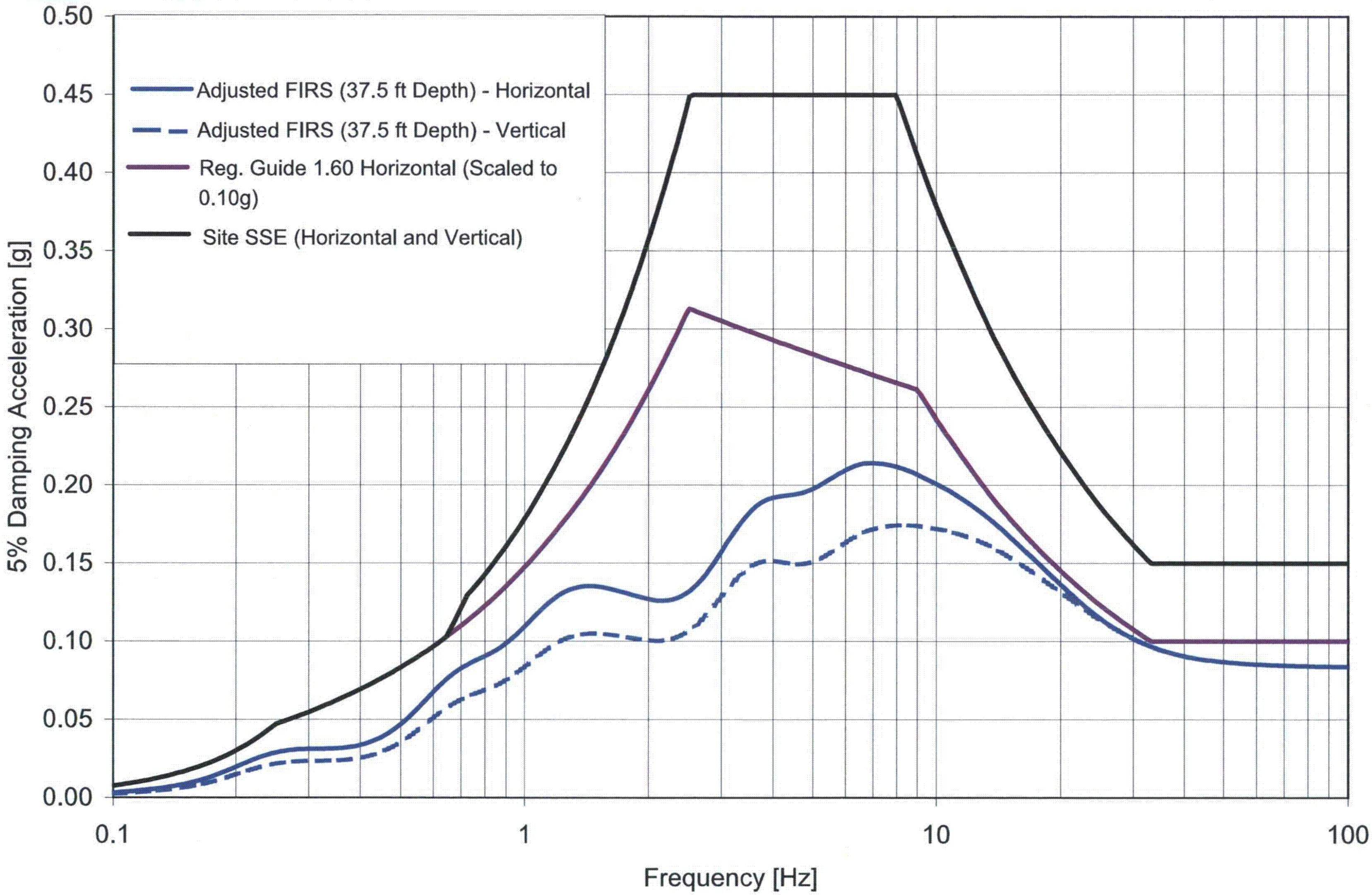


Figure 3.7-10—{Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal Component S1}

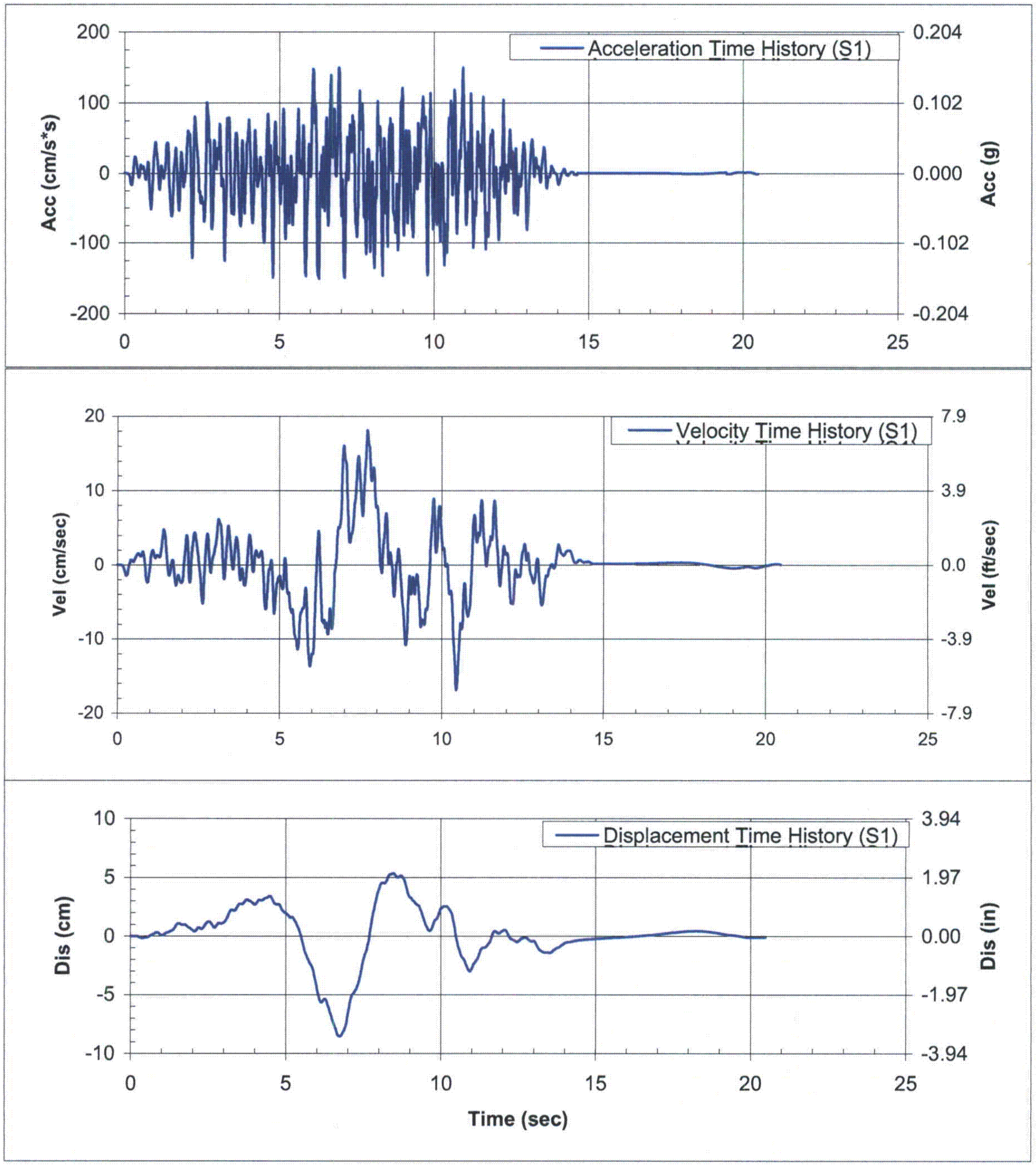


Figure 3.7-11—{Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal Component S2}

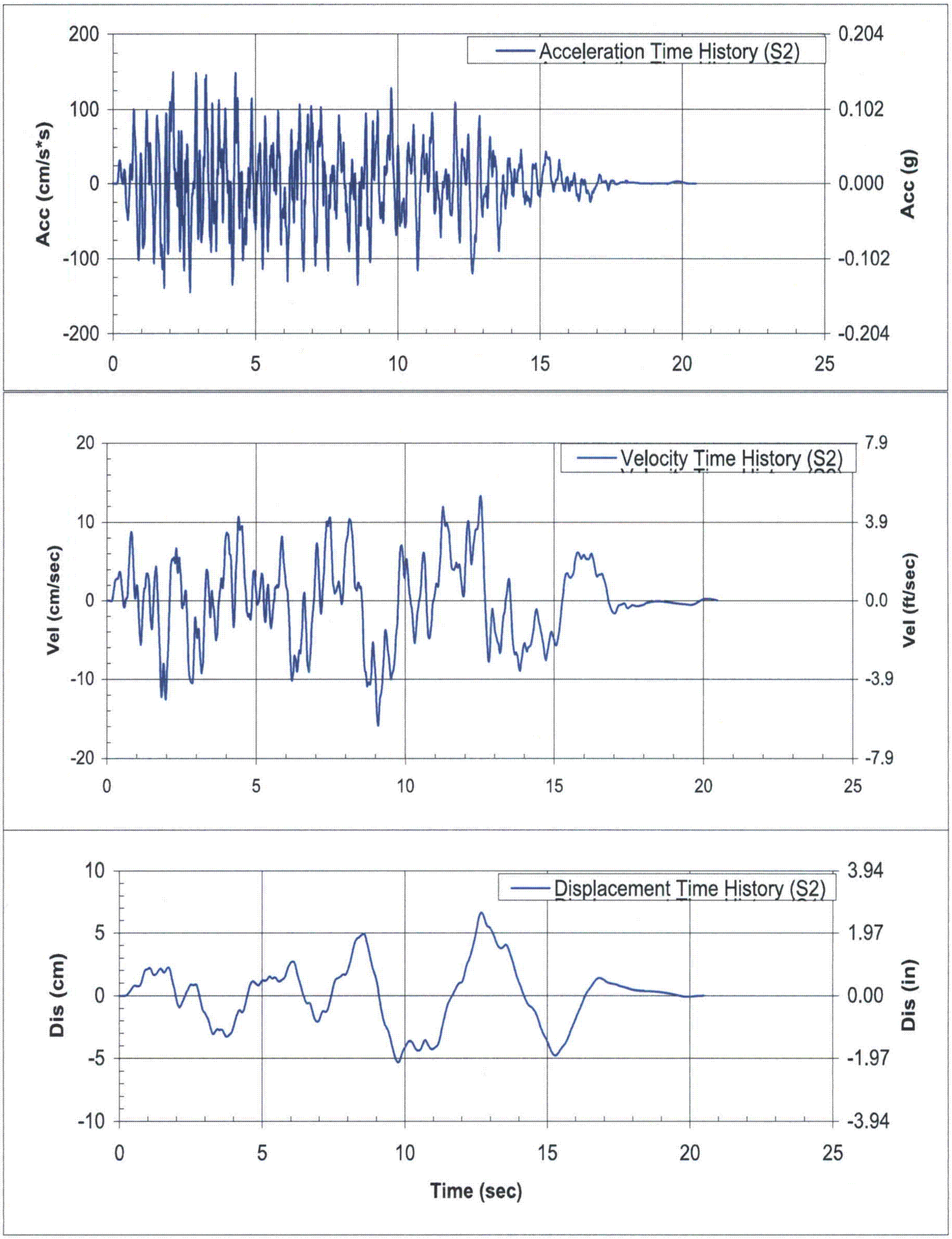


Figure 3.7-12—{Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Vertical Component S3}

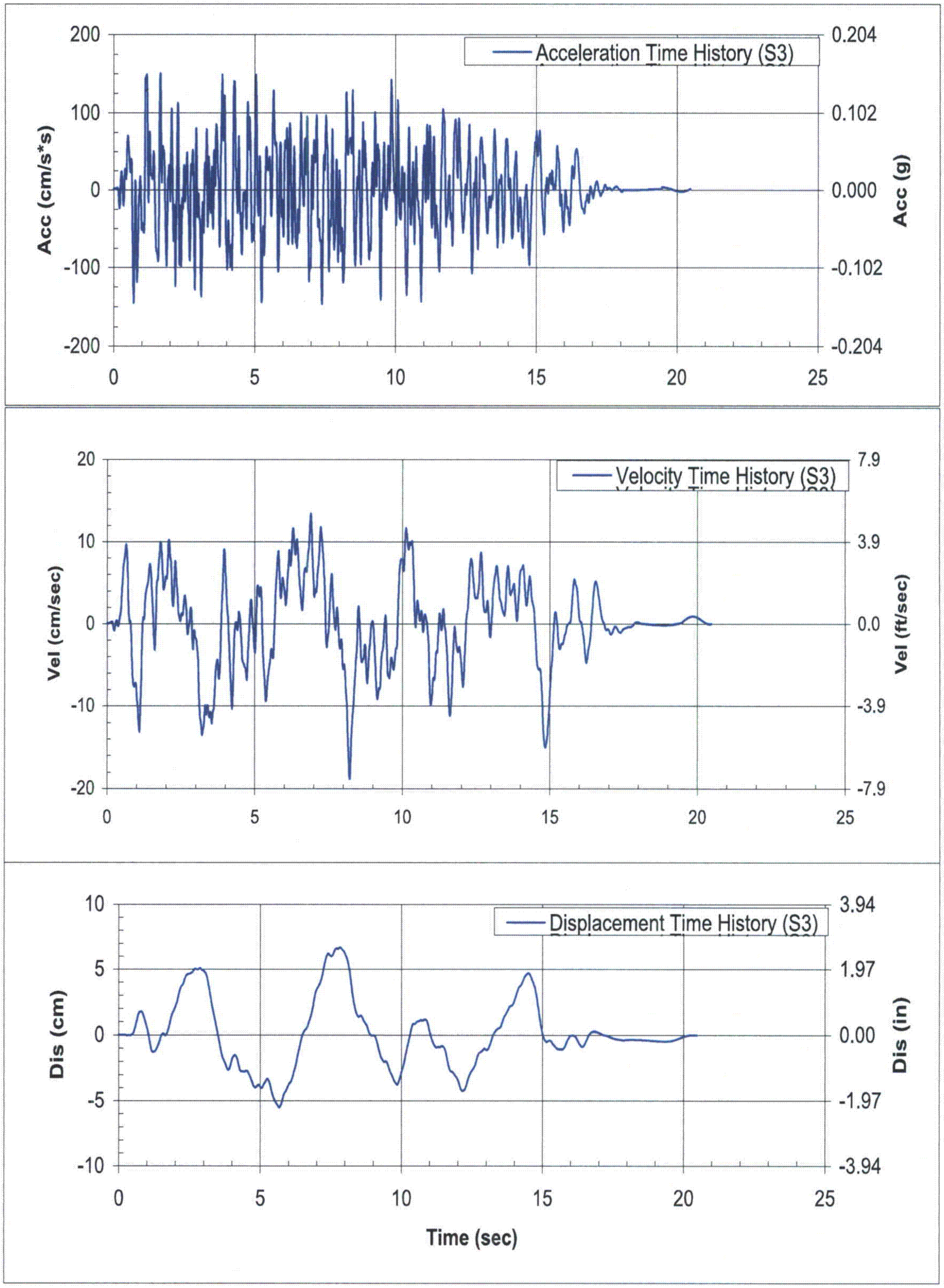
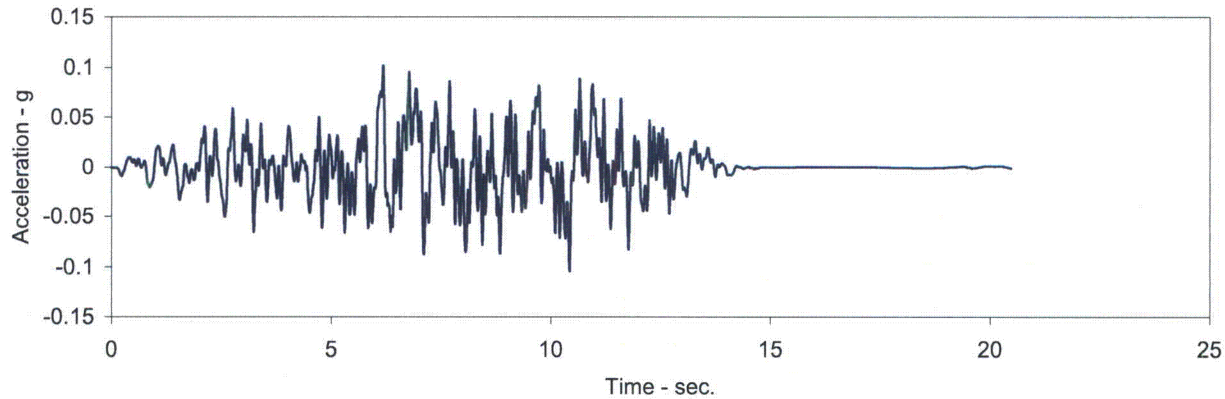
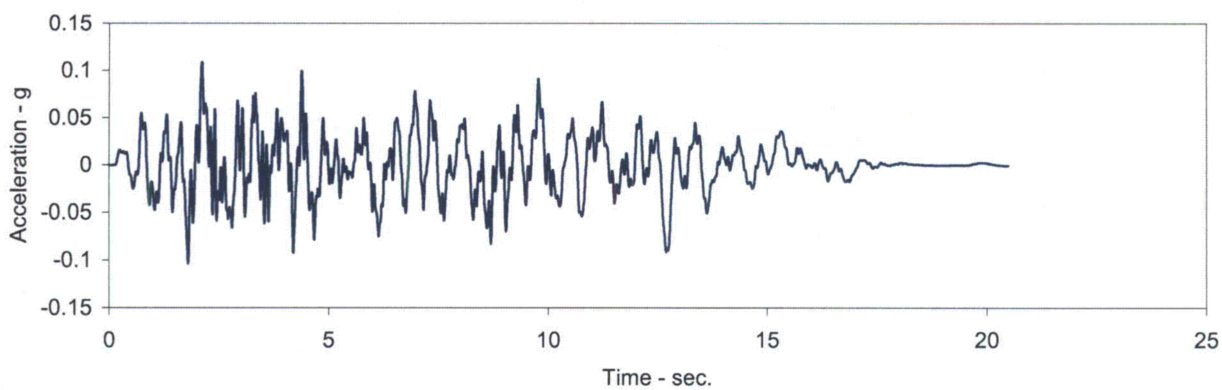


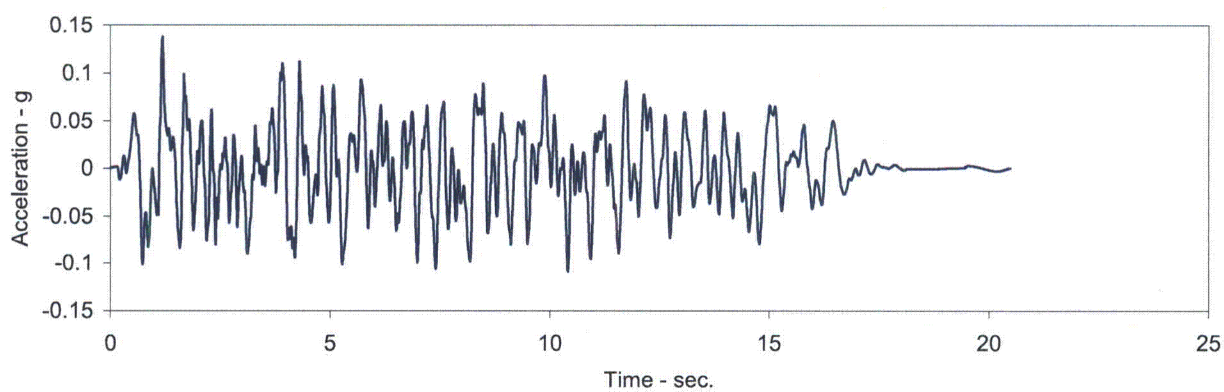
Figure 3.7-13—{SSI "Within" Acceleration Time Histories for Input at ESWB Foundation (LB Soil Case)– NI Area (22 ft Depth)}



a) Horizontal Direction S1

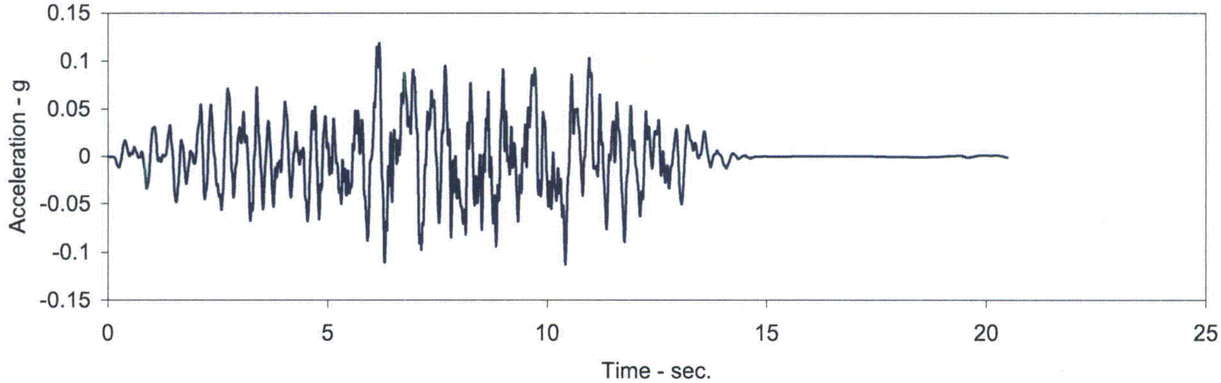


b) Horizontal Direction S2

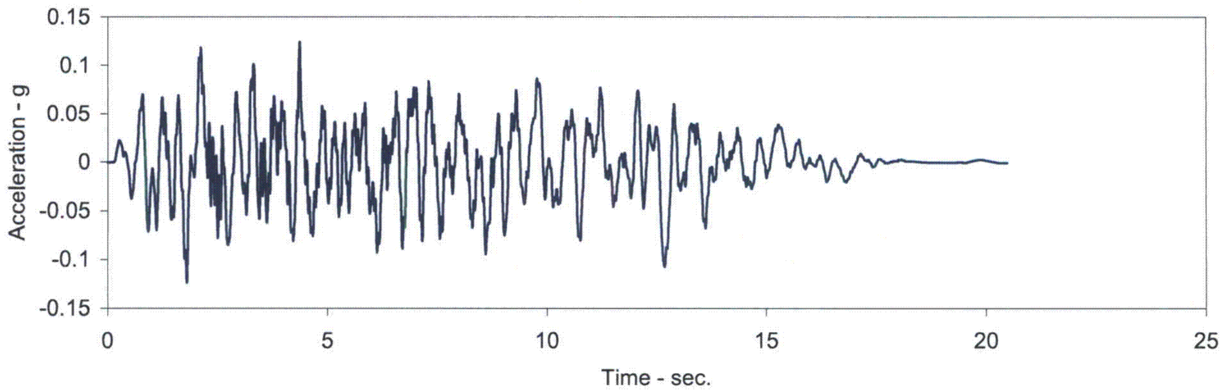


c) Vertical Direction S3

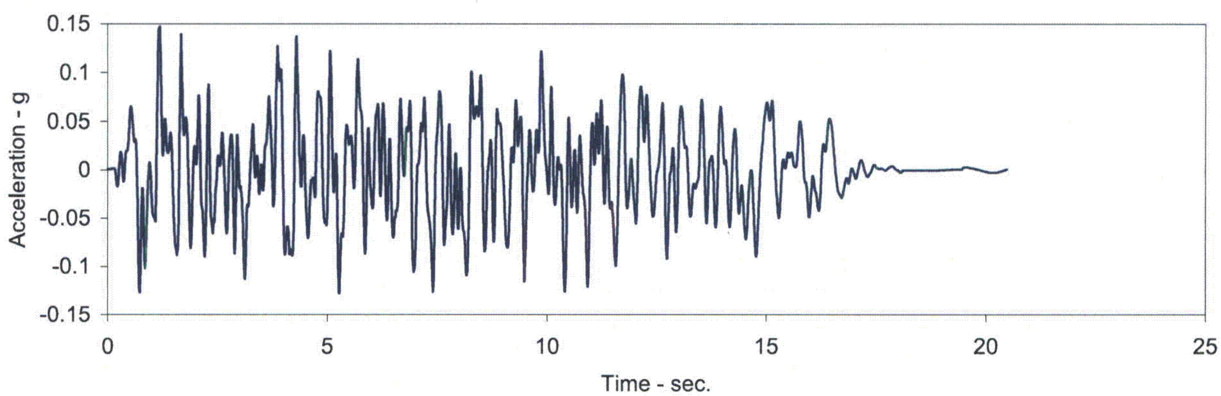
Figure 3.7-14—{SSI "Within" Acceleration Time Histories for Input at ESWB Foundation (BE Soil Case)– NI Area (22 ft Depth)}



a) Horizontal Direction S1

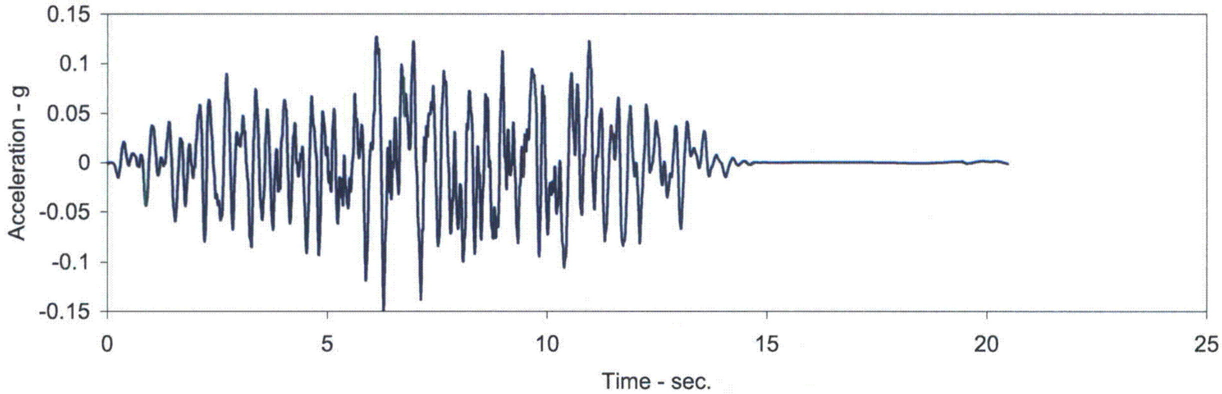


b) Horizontal Direction S2

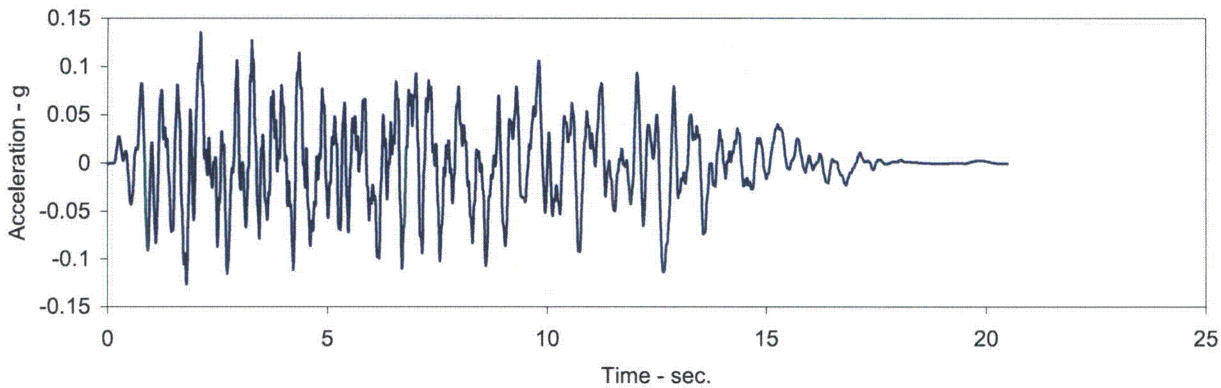


c) Vertical Direction S3

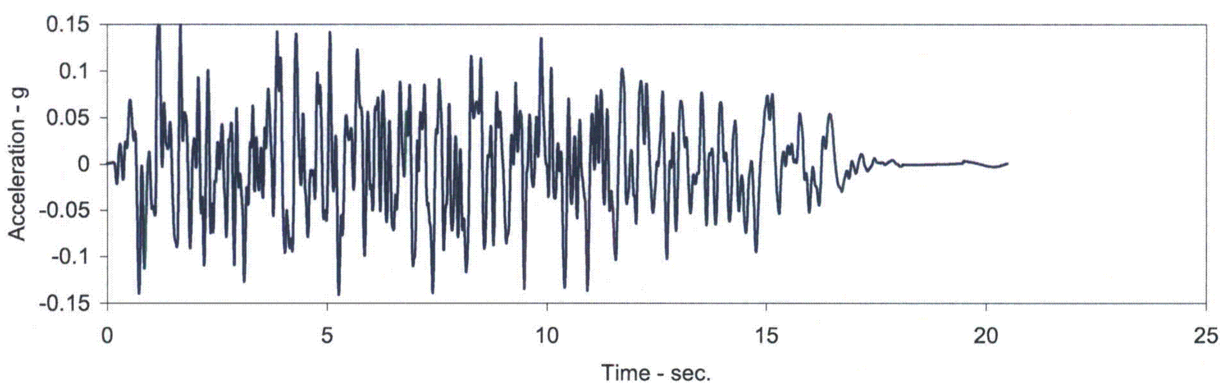
Figure 3.7-15—{SSI "Within" Acceleration Time Histories for Input at ESWB Foundation (UB Soil Case)– NI Area (22 ft Depth)}



a) Horizontal Direction S1



b) Horizontal Direction S2



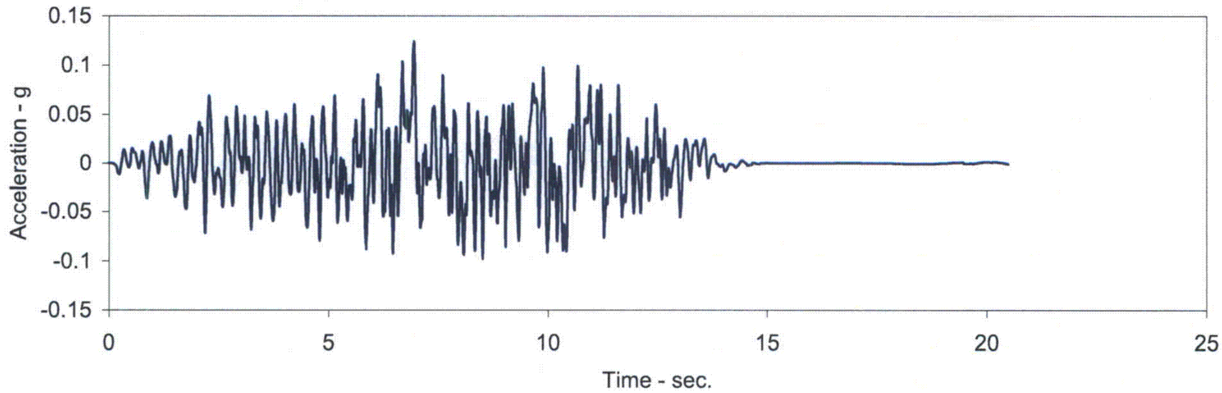
c) Vertical Direction S3

Figure 3.7-16—{Not Used~~SSI "Within" Acceleration Time Histories for Input at UHS Electrical Building Foundation (LB Soil Case) - Intake Area (20.5 ft Depth)~~}

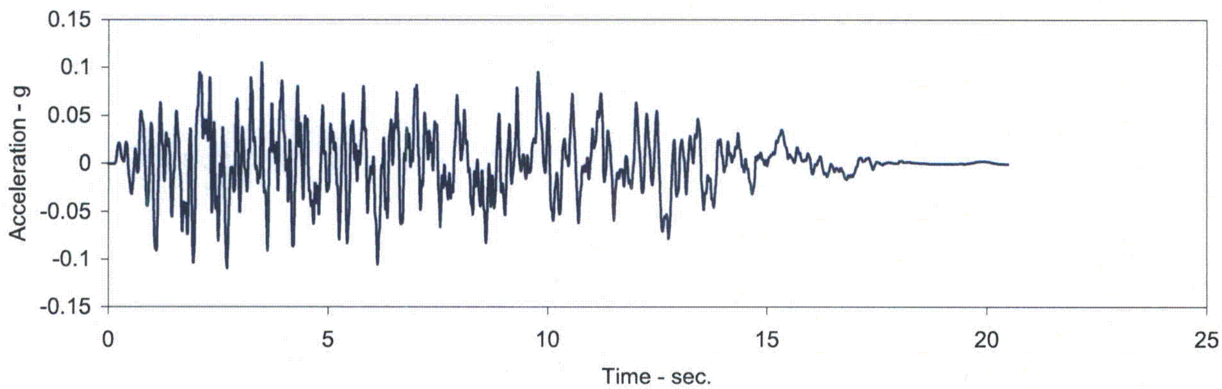
Figure 3.7-17—{Not Used~~SSI "Within" Acceleration Time Histories for Input at UHS Electrical Building Foundation (BE Soil Case) - Intake Area (20.5 ft Depth)~~}

Figure 3.7-18—{Not Used~~SSI "Within" Acceleration Time Histories for Input at UHS Electrical Building Foundation (UB Soil Case) - Intake Area (20.5 ft Depth)~~}

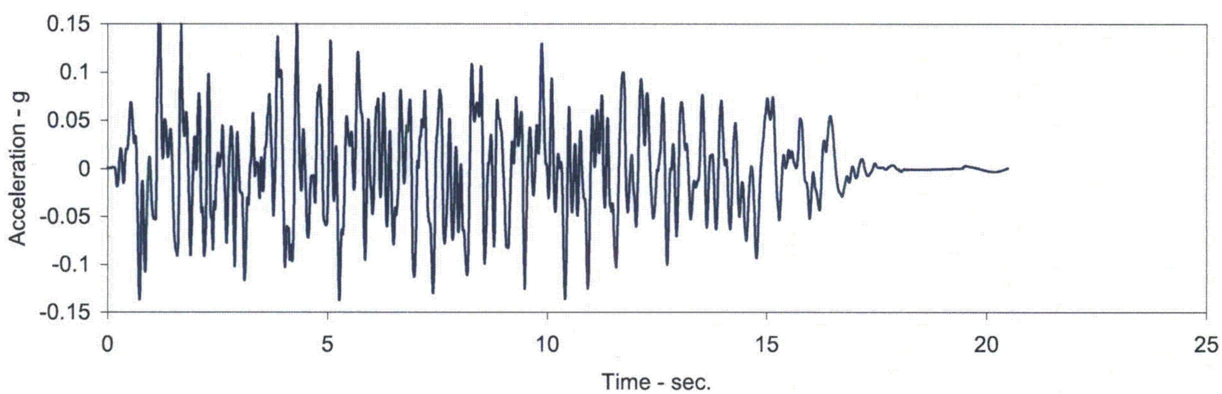
Figure 3.7-19—{SSI "Within" Acceleration Time Histories for Input at CBIS Foundation (LB Soil Case)– Intake Area (37.5 ft Depth)}



a) Horizontal Direction S1

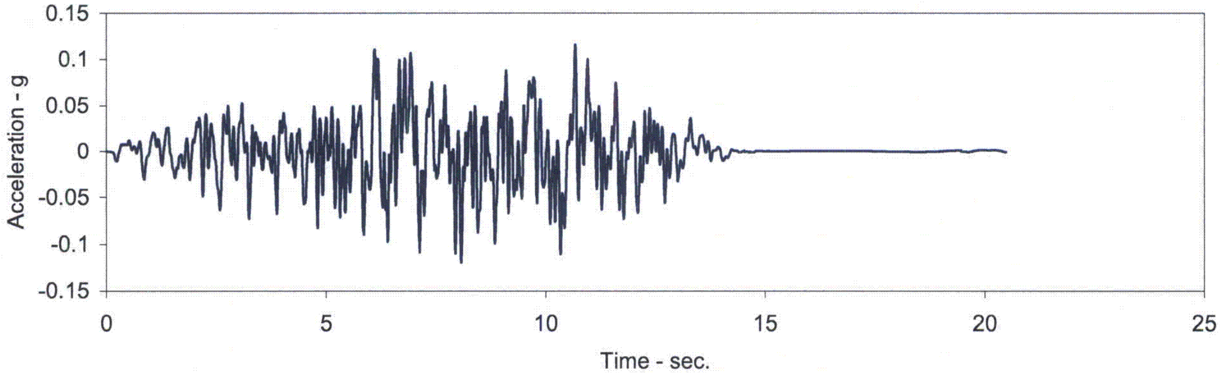


b) Horizontal Direction S2

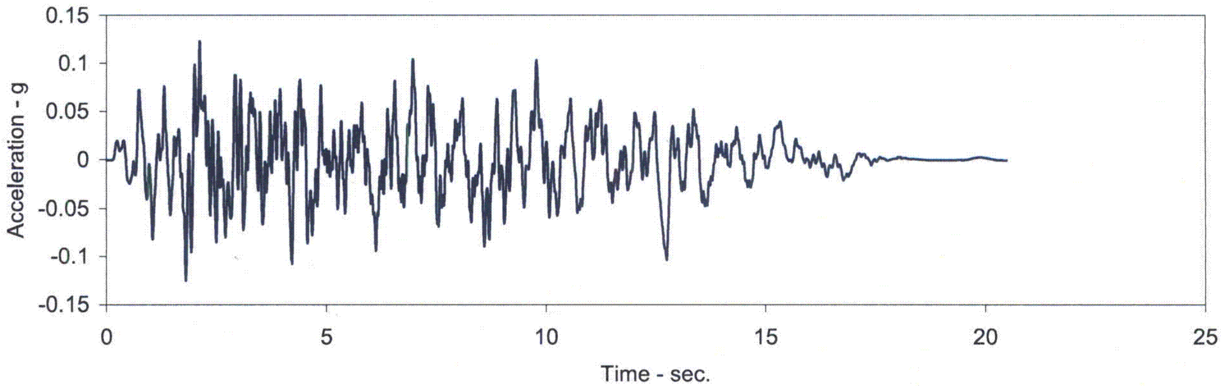


c) Vertical Direction S3

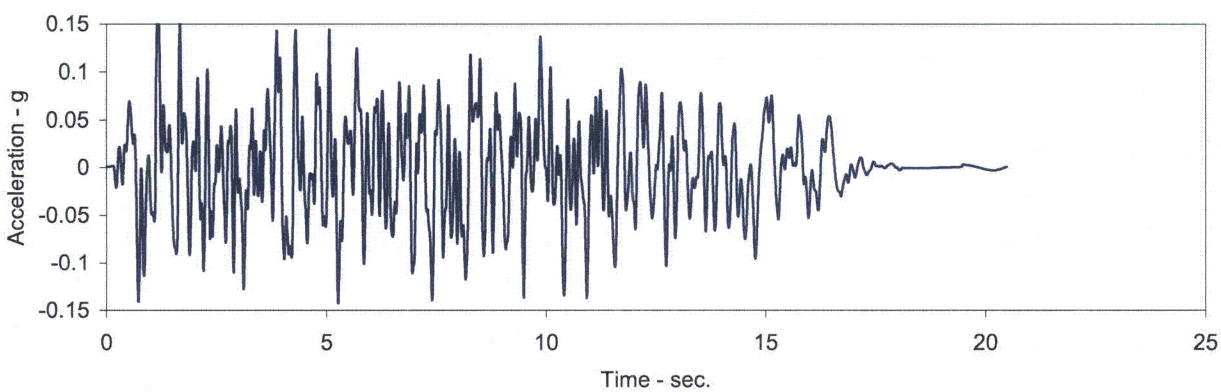
Figure 3.7-20—{SSI "Within" Acceleration Time Histories for Input at CBIS Foundation (BE Soil Case)– Intake Area (37.5 ft Depth)}



a) Horizontal Direction S1

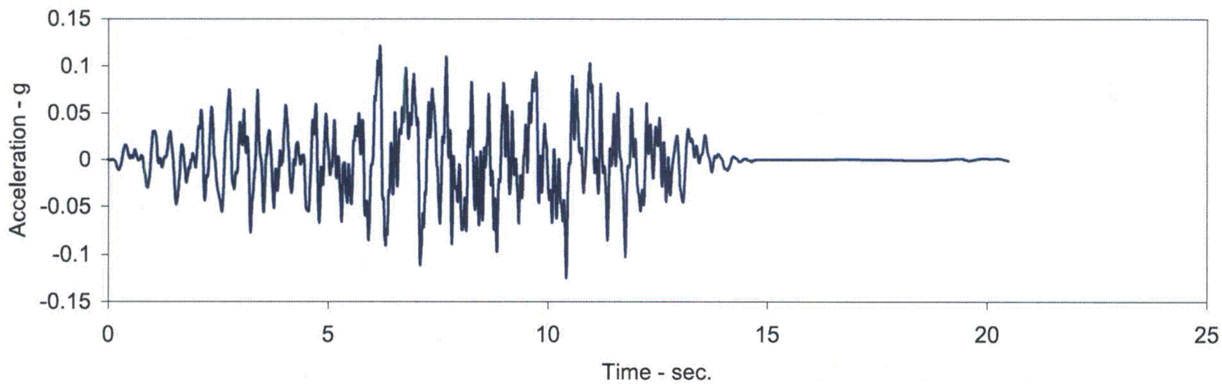


b) Horizontal Direction S2

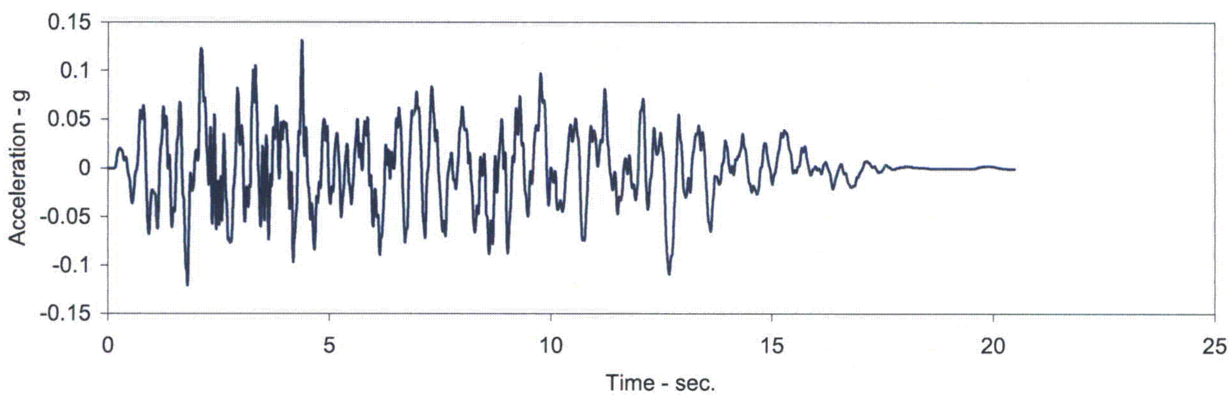


c) Vertical Direction S3

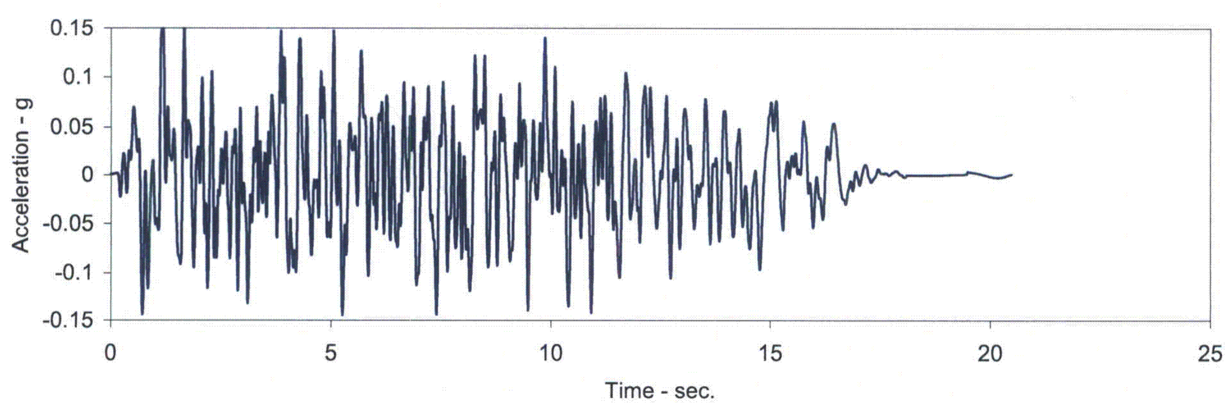
Figure 3.7-21—{SSI "Within" Acceleration Time Histories for Input at CBIS Foundation (UB Soil Case)– Intake Area (37.5 ft Depth)}



a) Horizontal Direction S1



b) Horizontal Direction S2



c) Vertical Direction S3

Figure 3.7-22—{CCNPP Unit 3 Strain-Compatible Soil Profiles for NI Common Basemat Structures}

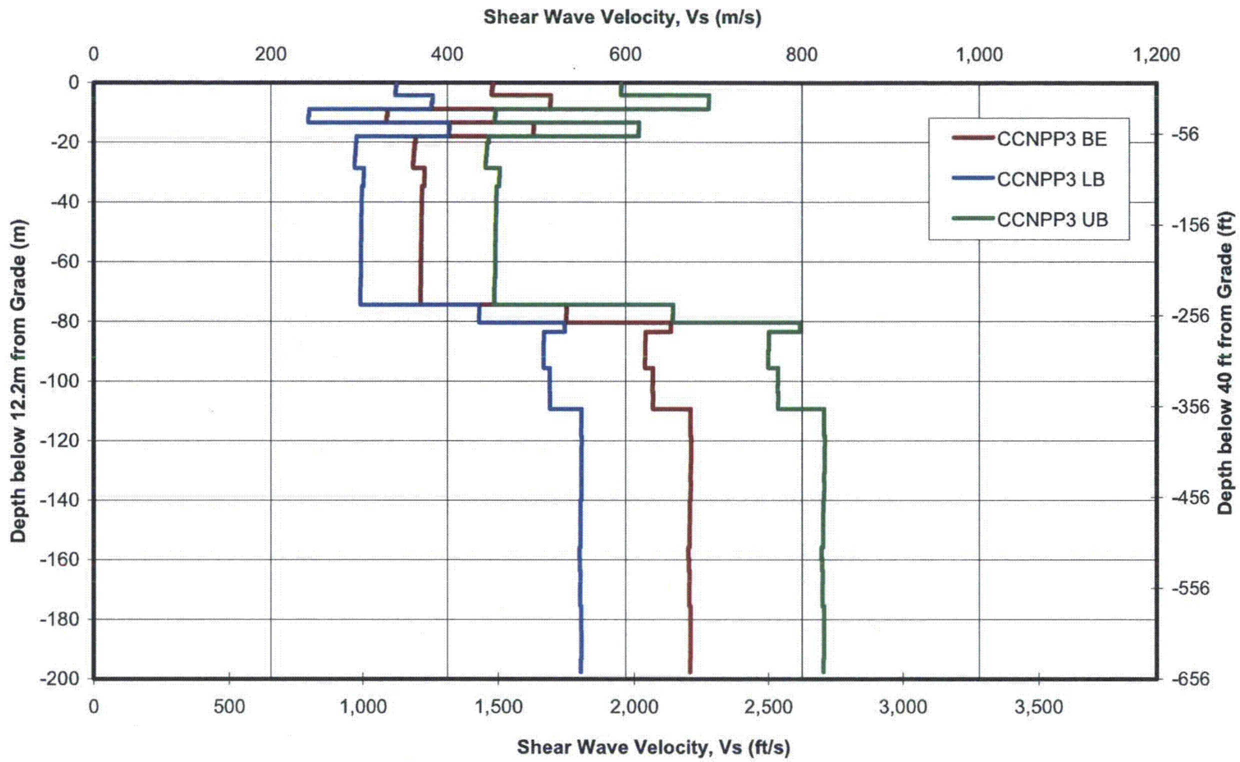


Figure 3.7-23—{EPR DC Soil Cases vs. CCNPP Unit 3 Soil Cases for SSI Analysis}

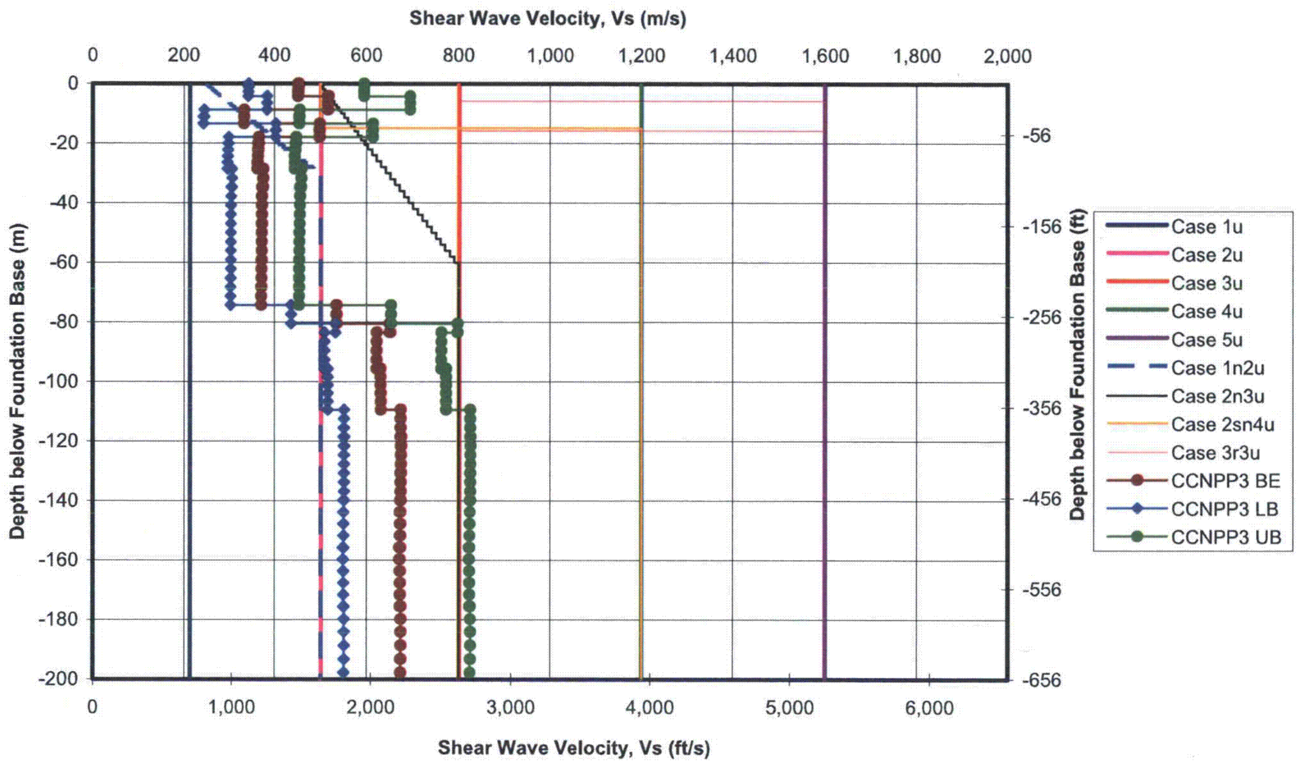


Figure 3.7-24—{CCNPP Unit 3 Strain-Compatible profiles at the NI Area for EPGB and ESWB}

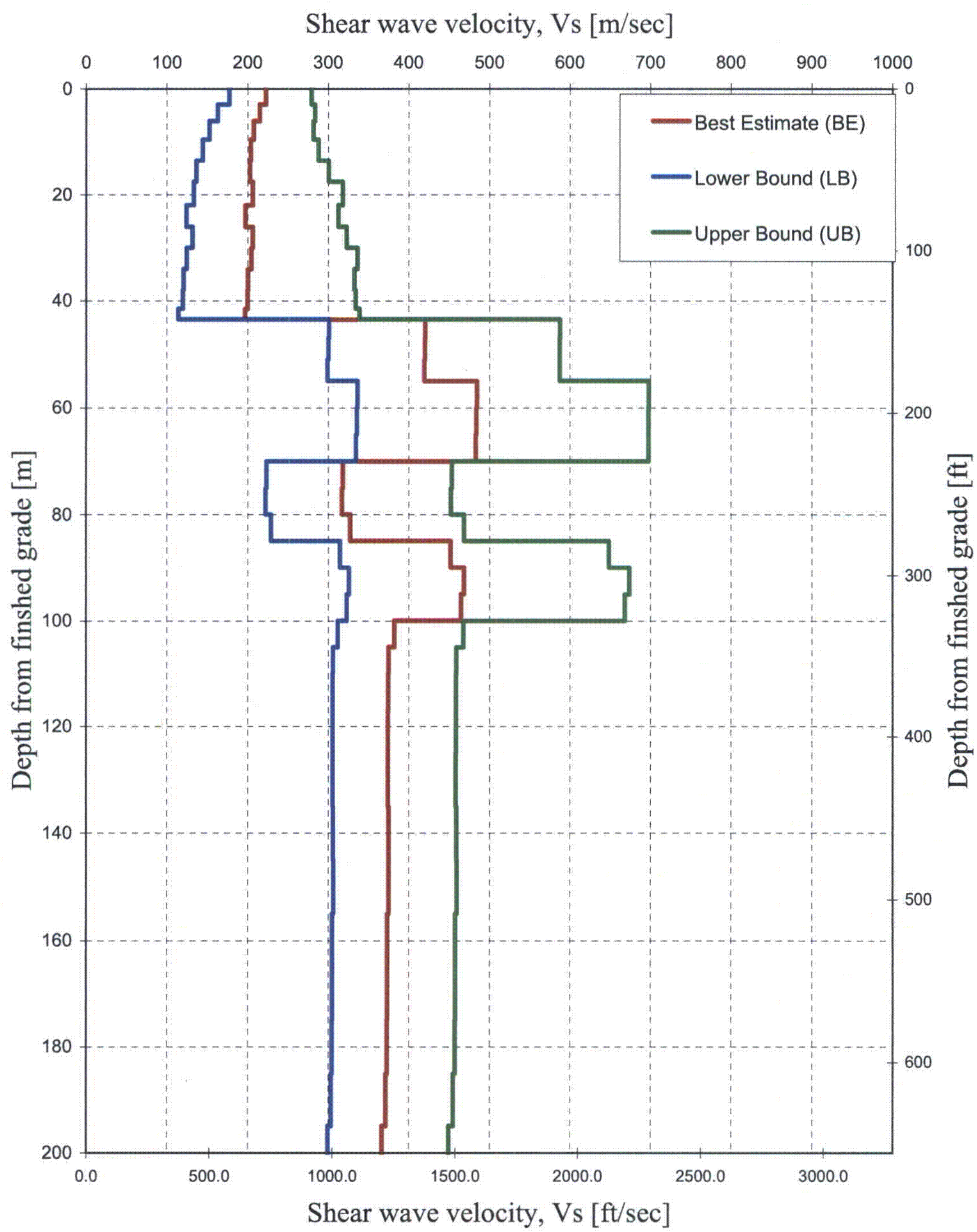


Figure 3.7-25—{CCNPP Unit 3 Strain-Compatible profiles at the Intake Area for CBIS ~~and UHS Electrical Building~~}

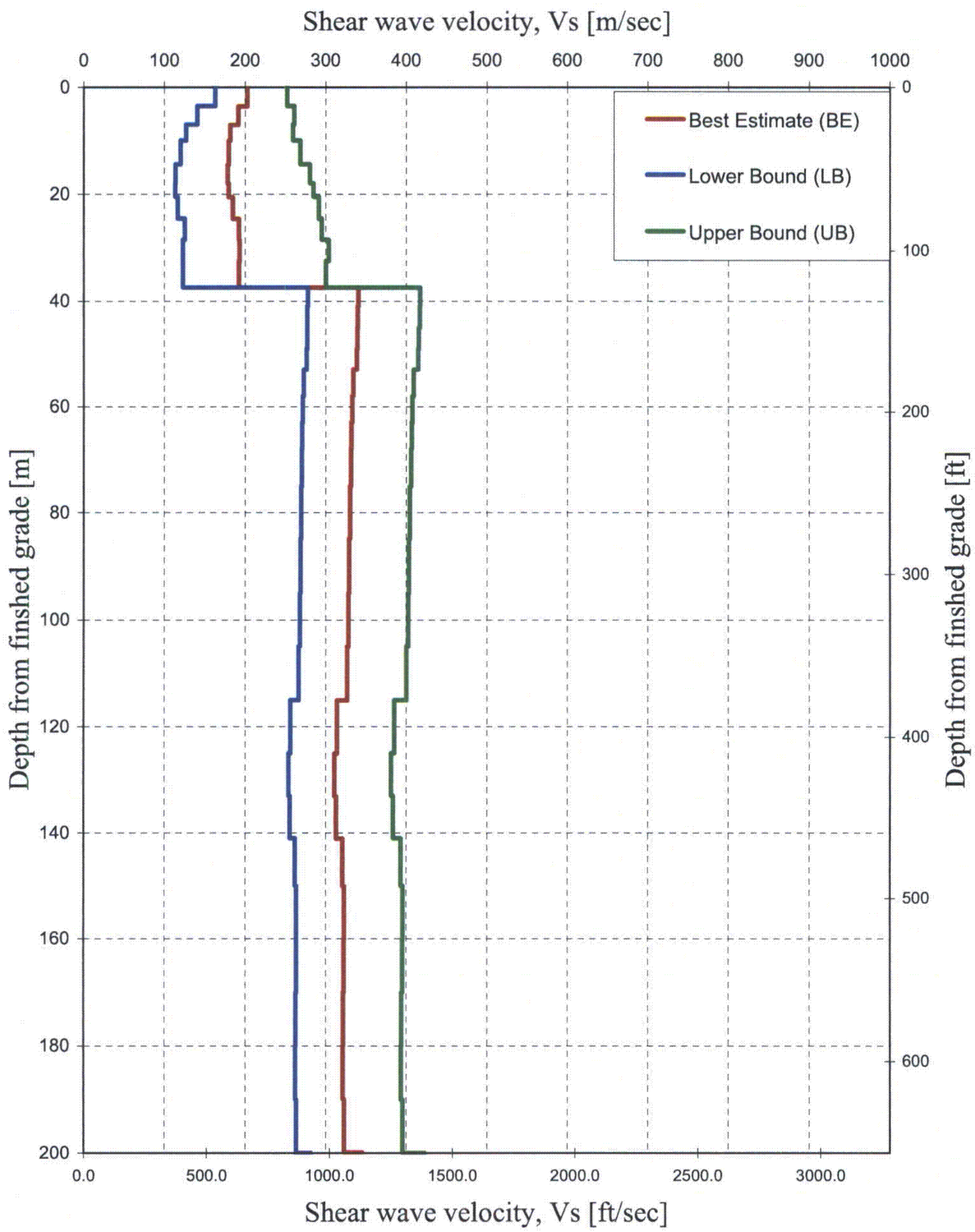


Figure Replaced

Figure 3.7-26—{Isometric View of the Common Basemat Intake Structures ~~and UHS Electrical Building GTSTRUDL Model~~}

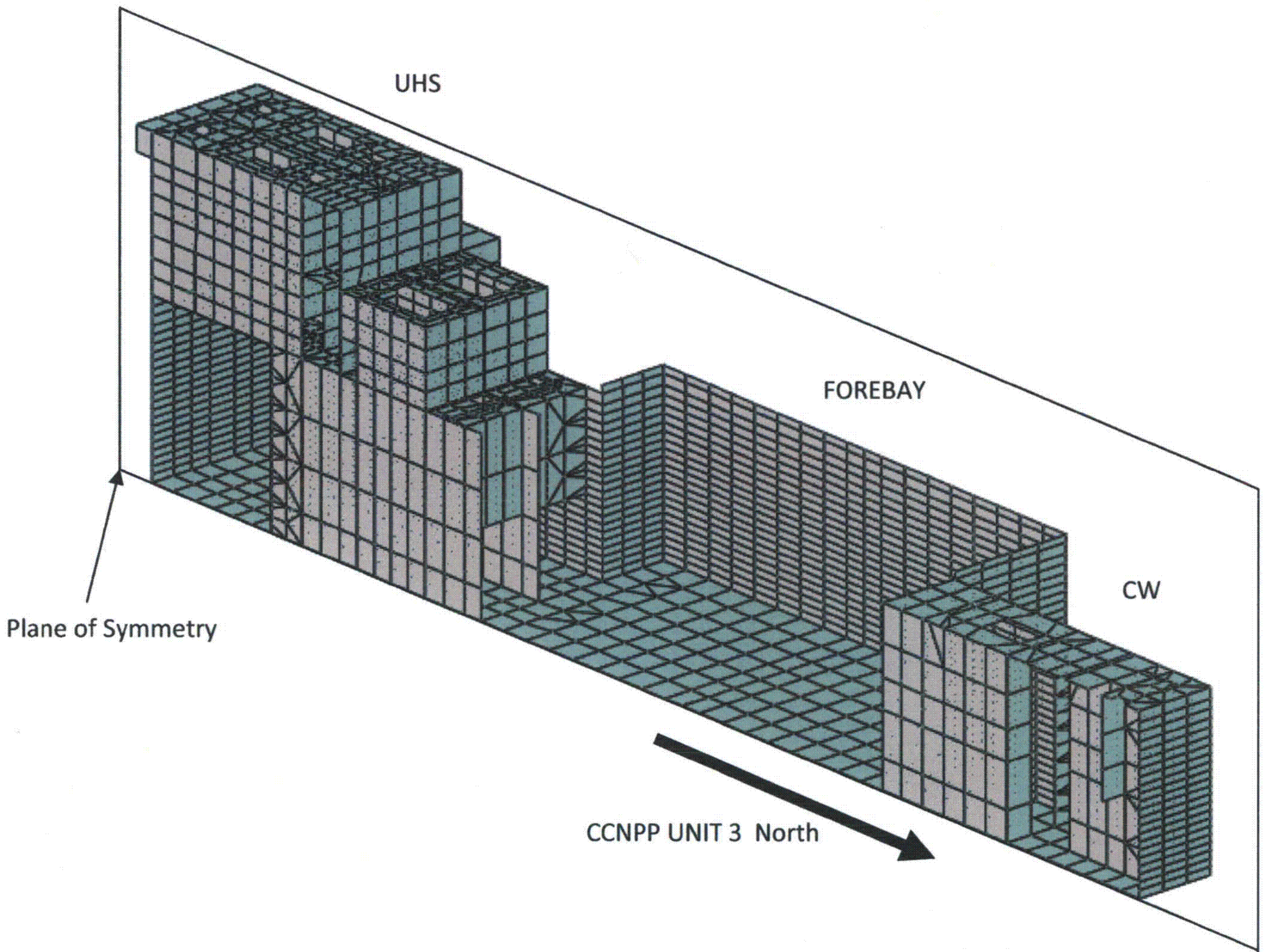
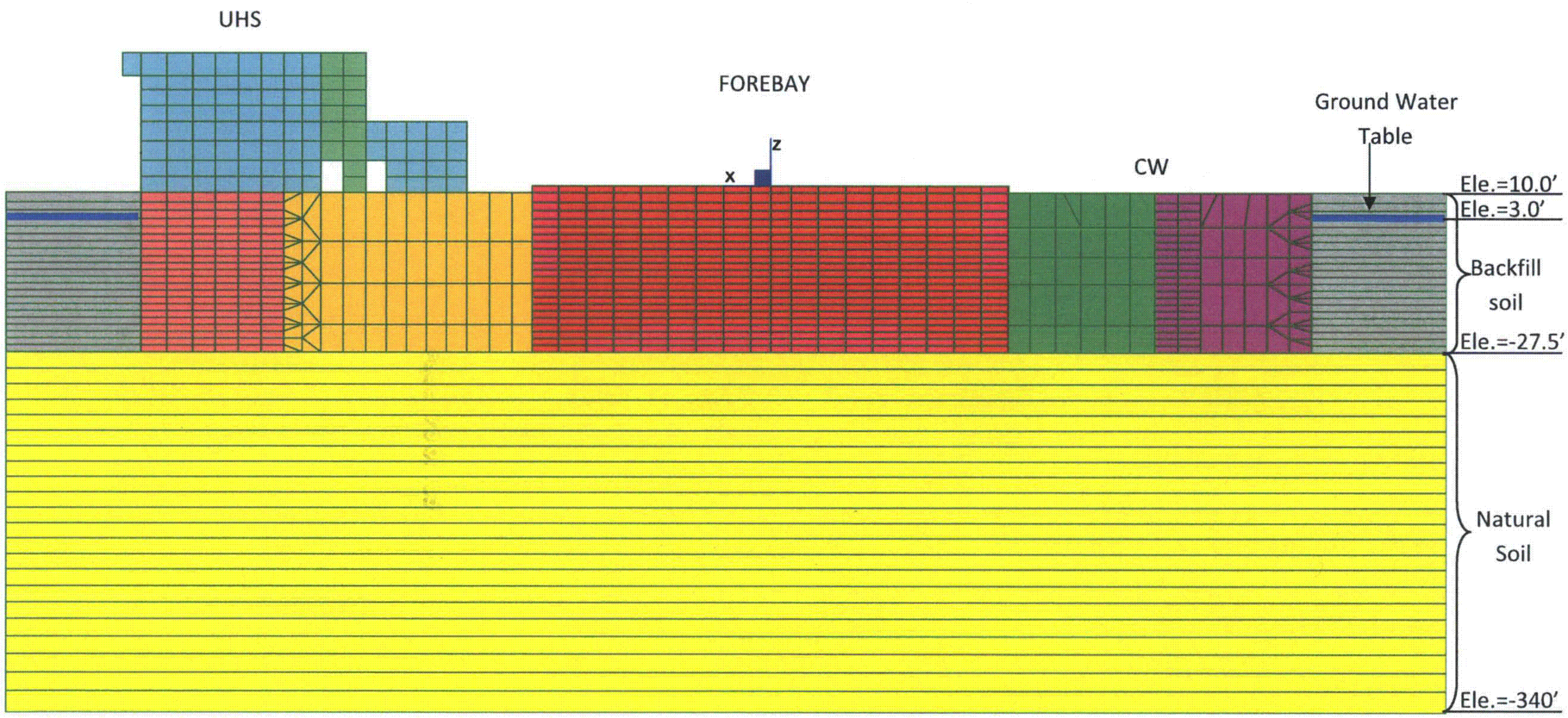


Figure Replaced

Figure 3.7-27—{Soil-Structure Interaction (SSI) model for the Common Basemat Intake Structures ~~and UHS Electrical Building looking East~~ (Elevations and plant coordinate system refer to CCNPP Unit 3] }



The soil layering system shown is schematic.

The soil layering system shown is schematic. ~~The soil descretization used in SASSI is consistent with site response analysis model.~~

Figure 3.7-28—{Reactor Bldg Internal Structure, Elev. 5.15 m, X(E-W) Direction, 5% Damping}

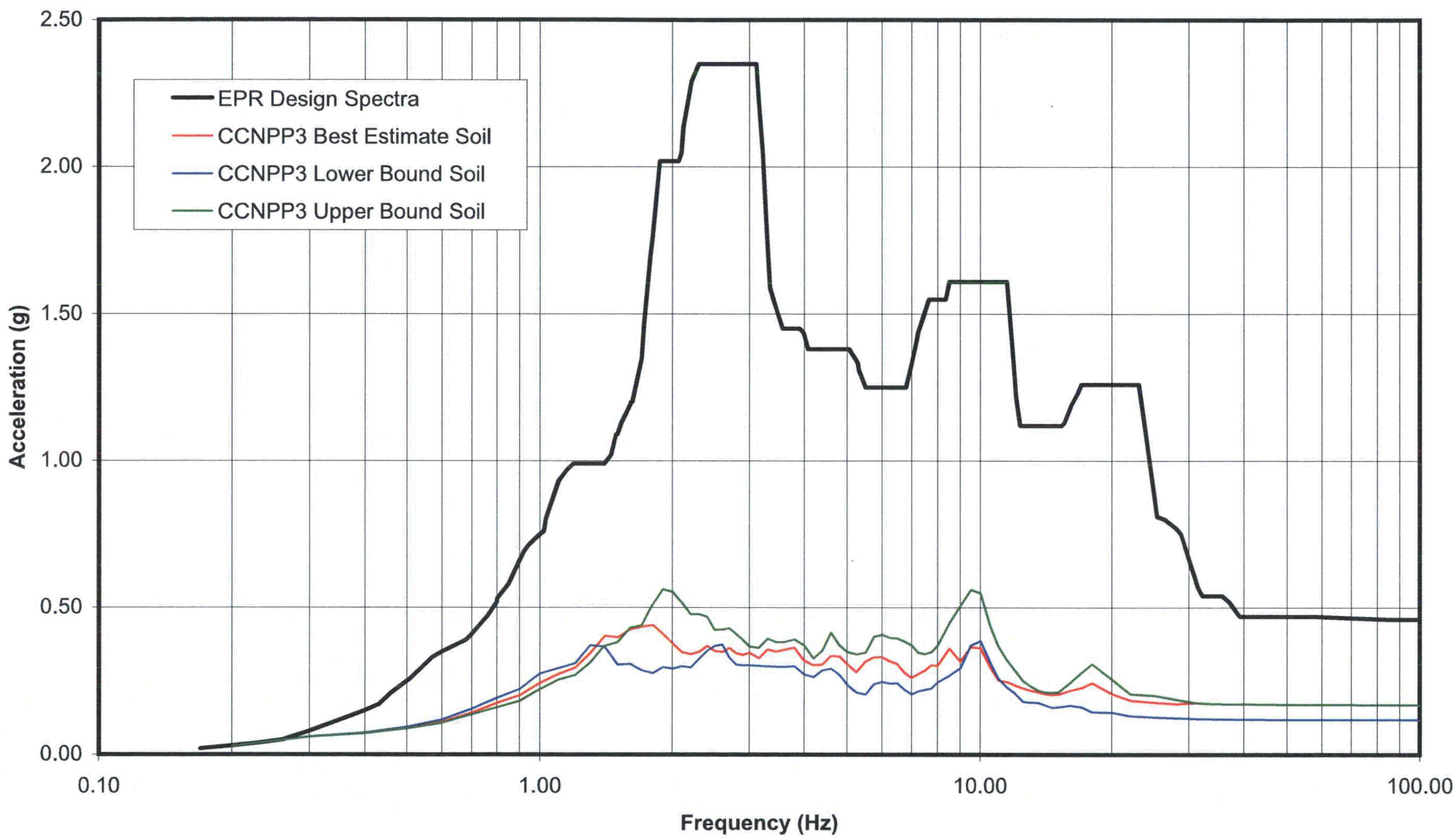


Figure 3.7-29—{Reactor Bldg Internal Structure, Elev. 5.15 m, Y(N-S) Direction, 5% Damping}

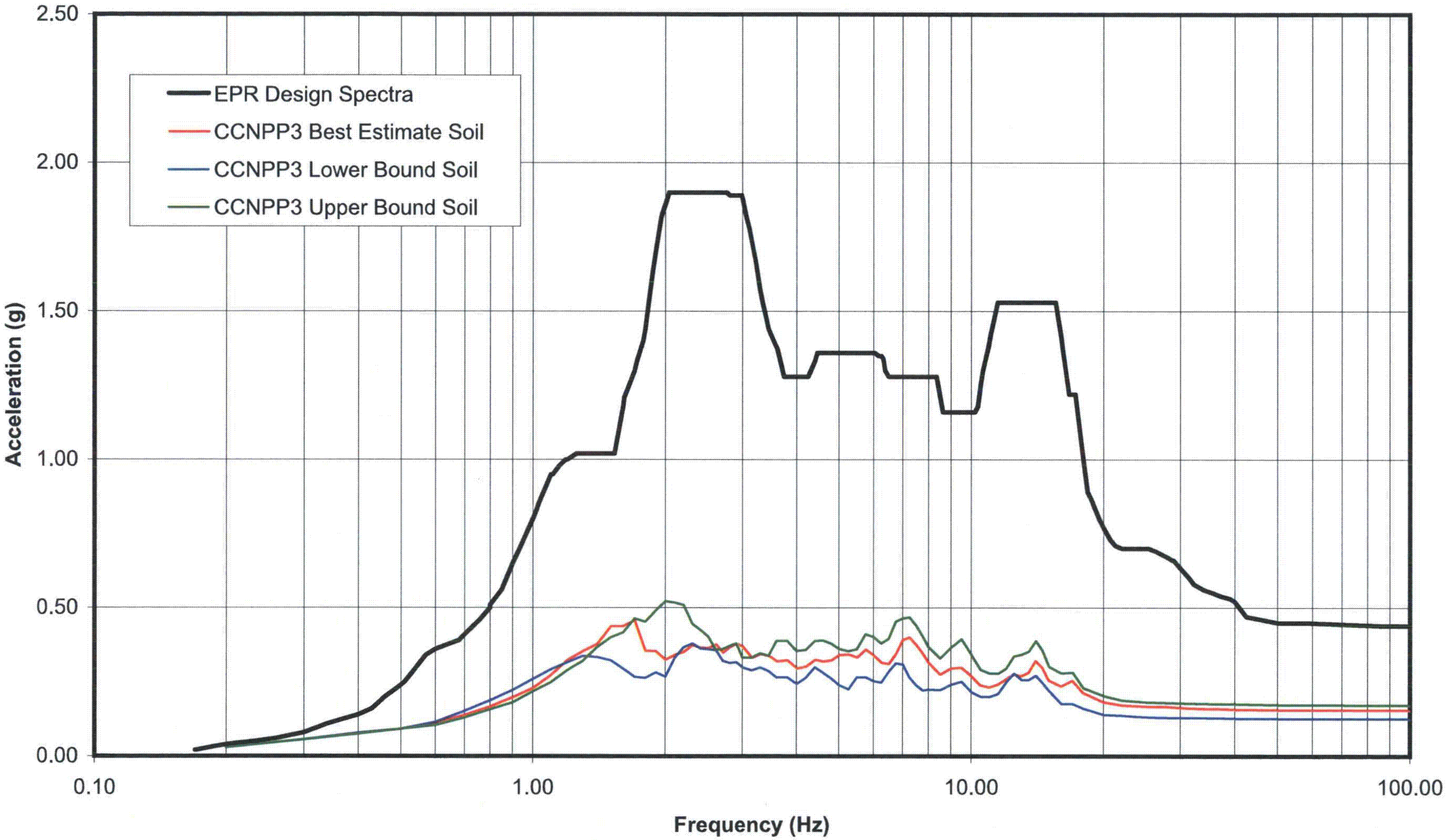


Figure 3.7-30—{Reactor Bldg Internal Structure, Elev. 5.15 m, Z(Vert) Direction, 5% Damping}

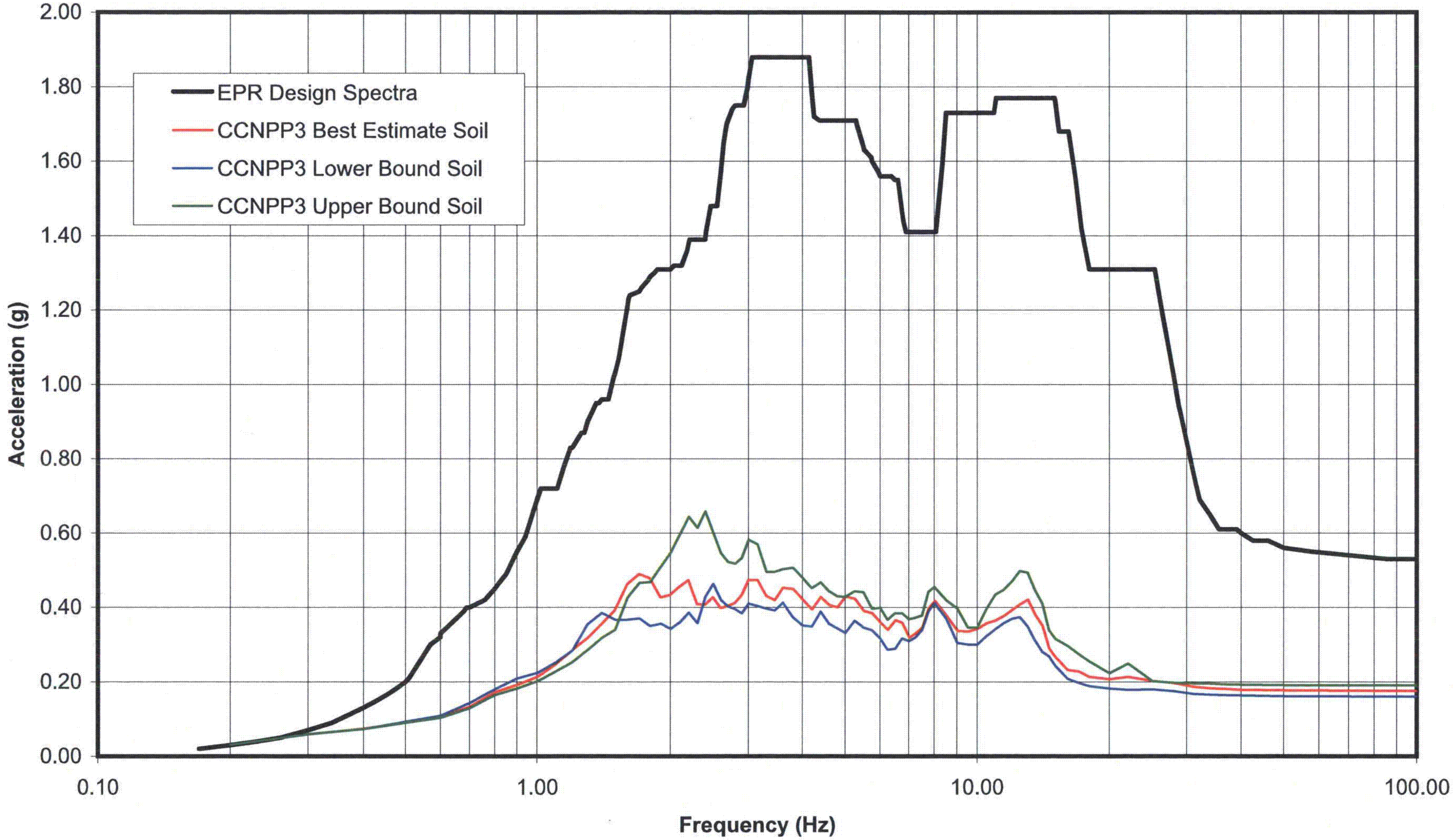


Figure 3.7-31—{Reactor Bldg Internal Structure, Elev. 19.5 m, X(E-W) Direction, 5% Damping}

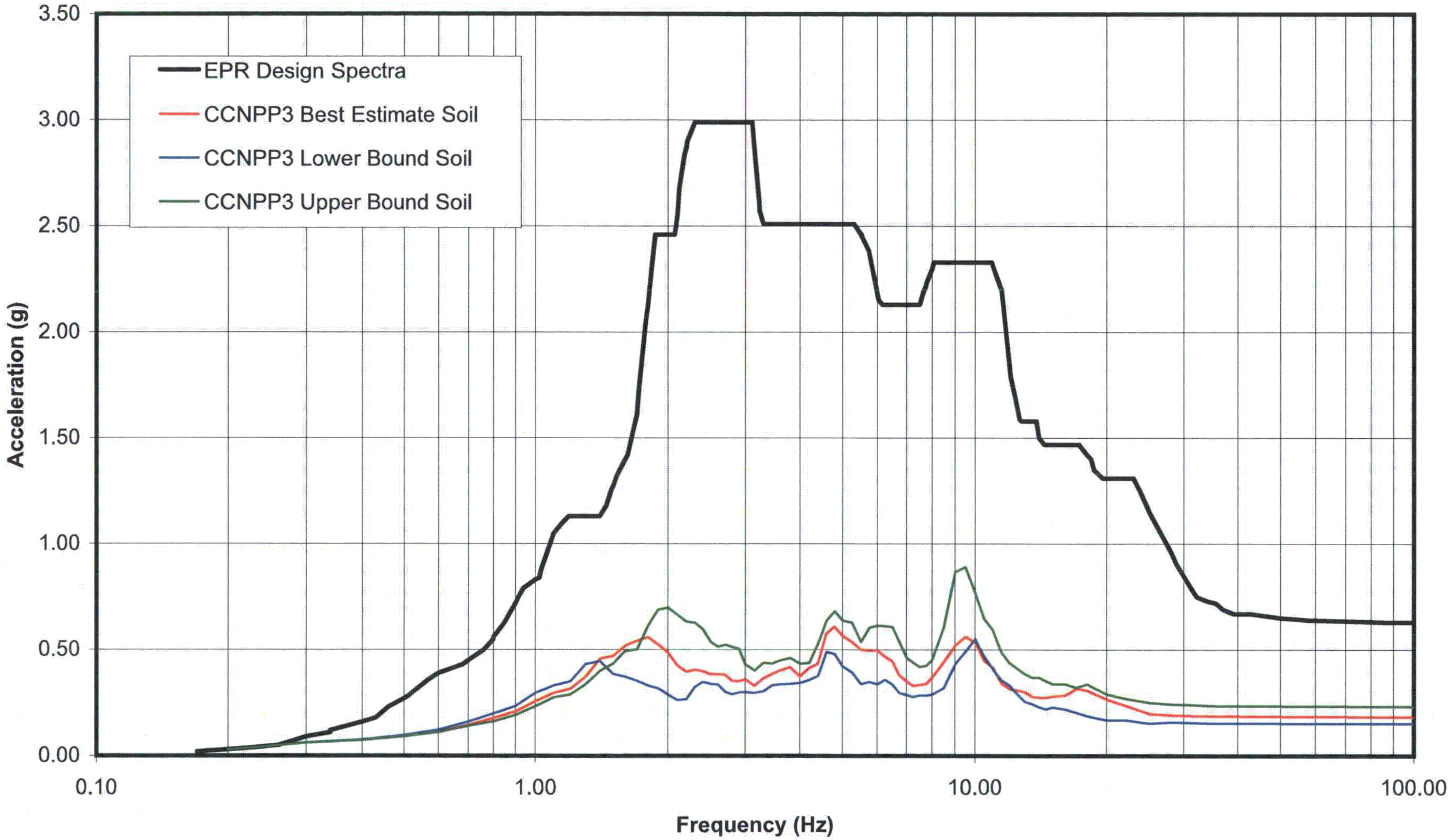


Figure 3.7-32—{Reactor Bldg Internal Structure, Elev. 19.5 m, Y(N-S) Direction, 5% Damping}

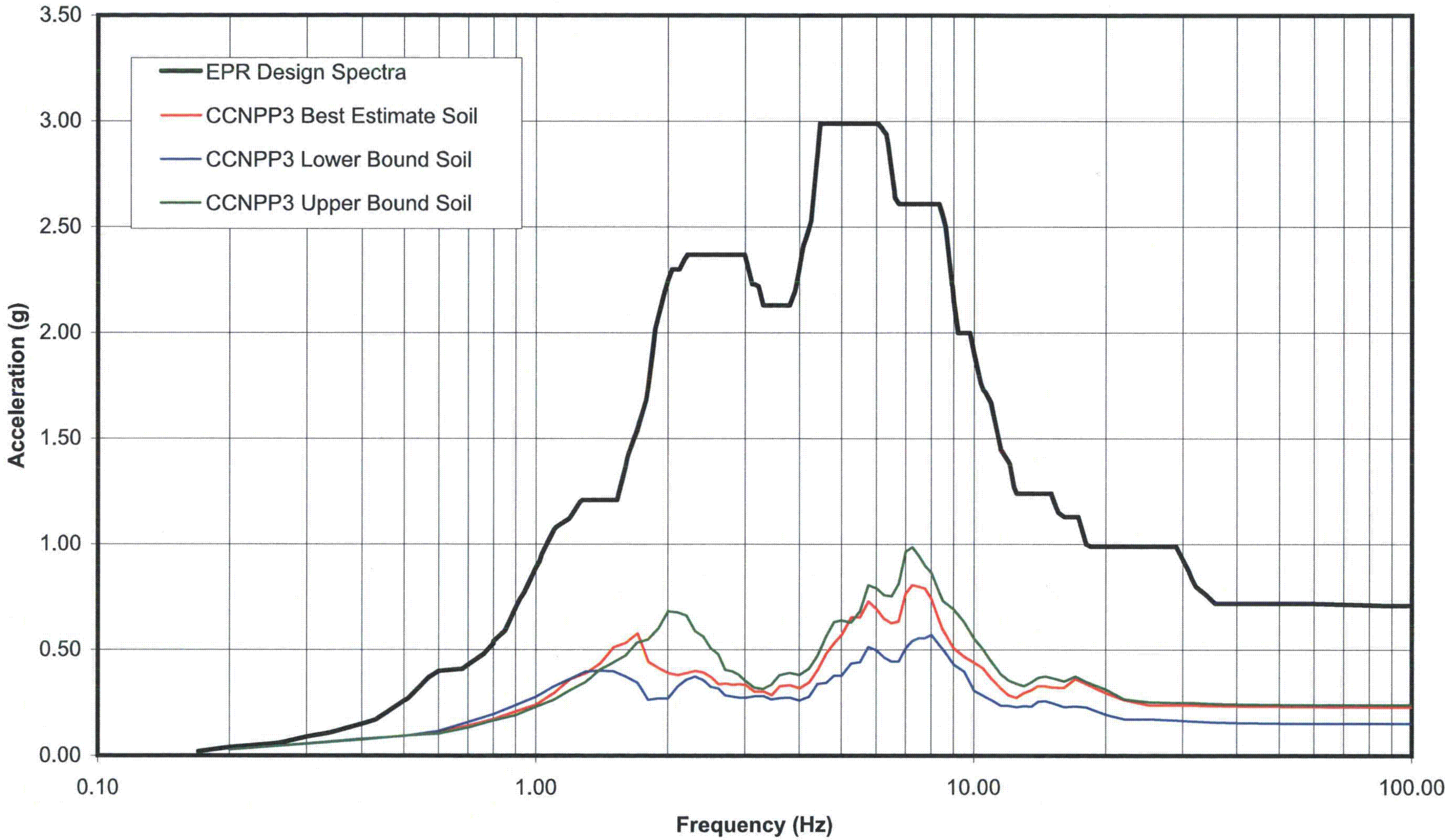


Figure 3.7-33—Reactor Bldg Internal Structure, Elev. 19.5 m, Z(Vert) Direction, 5%Damping}

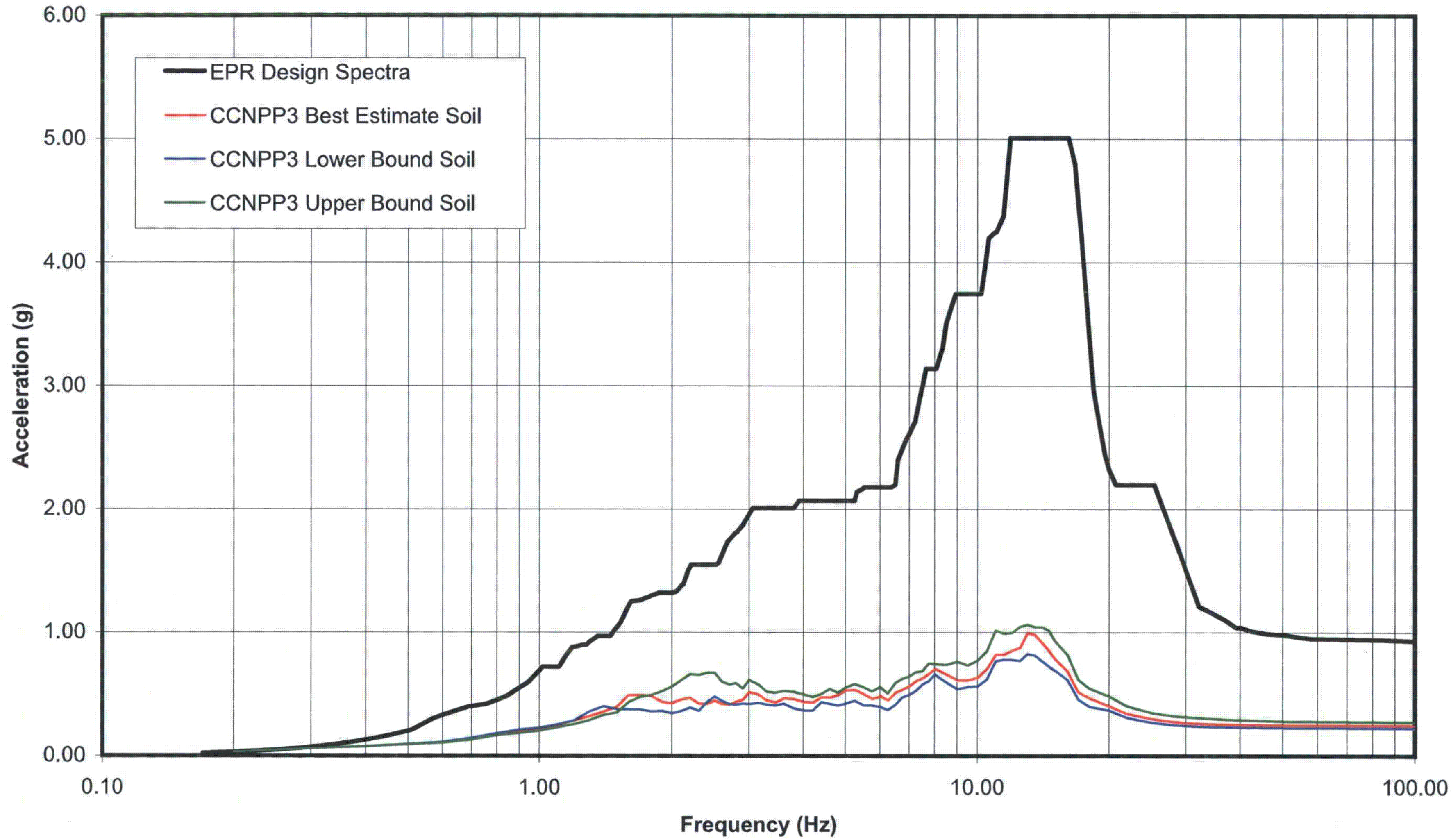


Figure 3.7-34—{Safeguard Building 1, Elev. 8.1 m, X(E-W) Direction, 5% Damping}

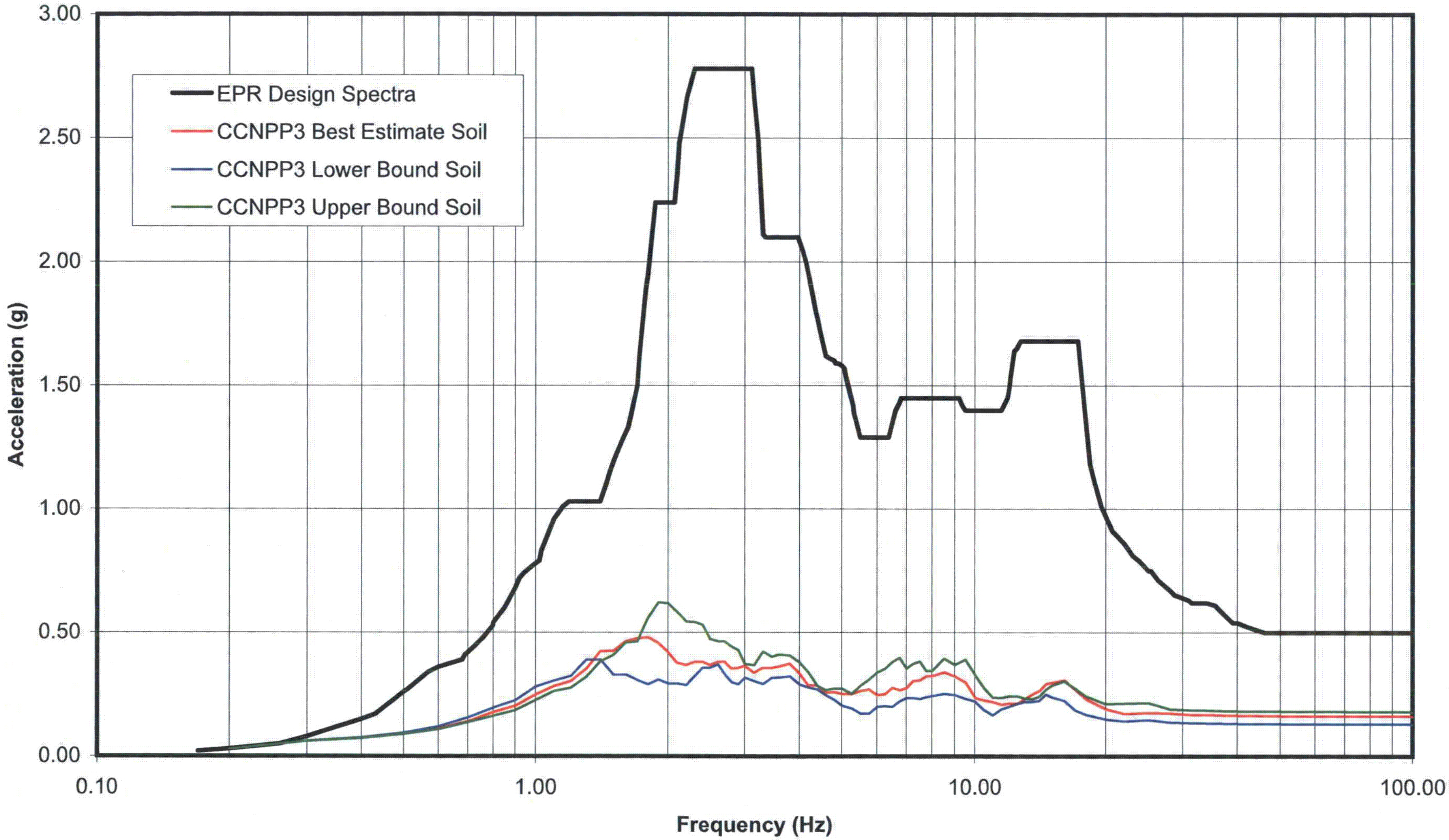


Figure 3.7-35—{Safeguard Building 1, Elev. 8.1 m, Y(N-S) Direction, 5% Damping}

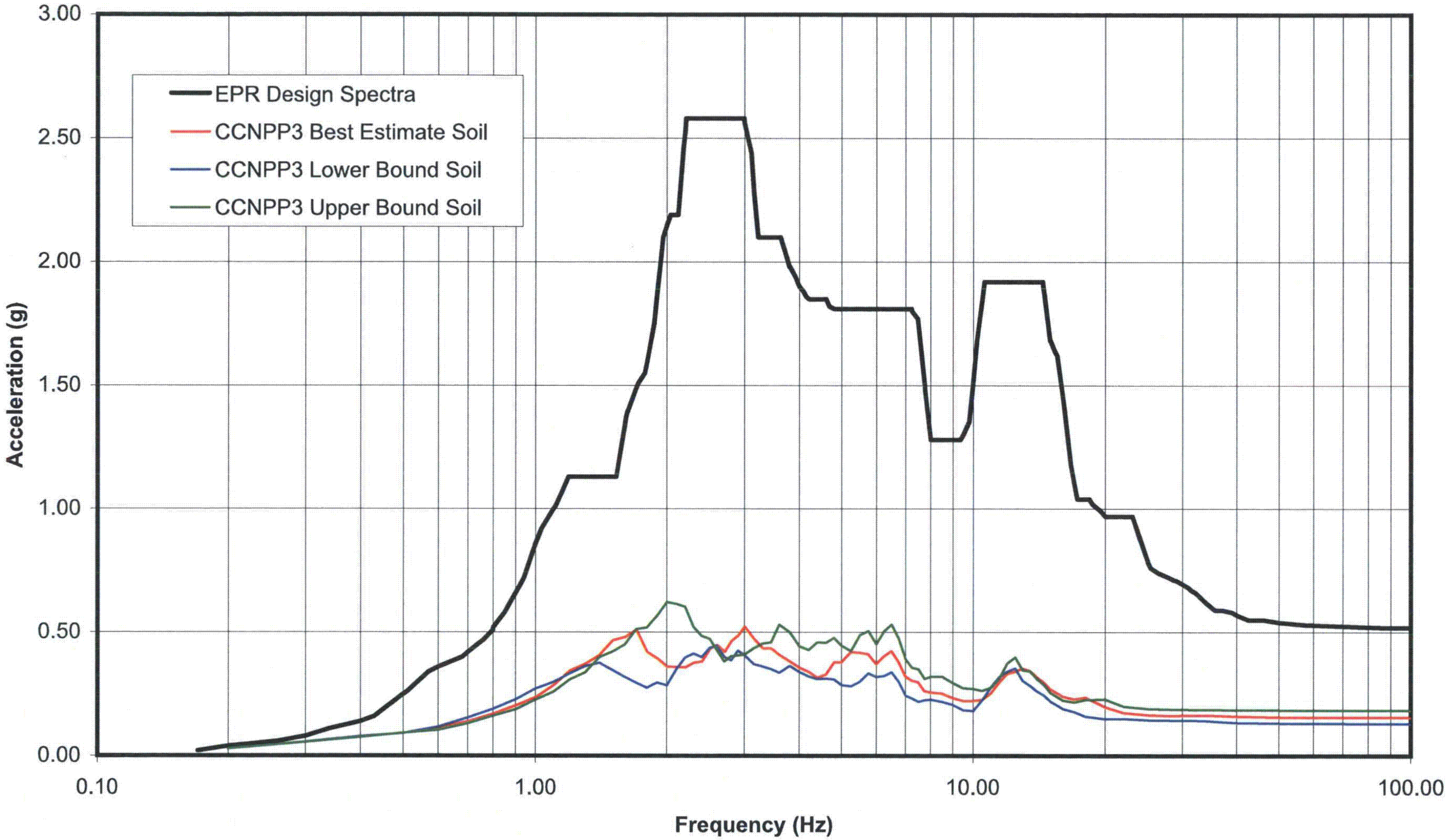


Figure 3.7-36—{Safeguard Building 1, Elev. 8.1 m, Z(Vert) Direction, 5% Damping}

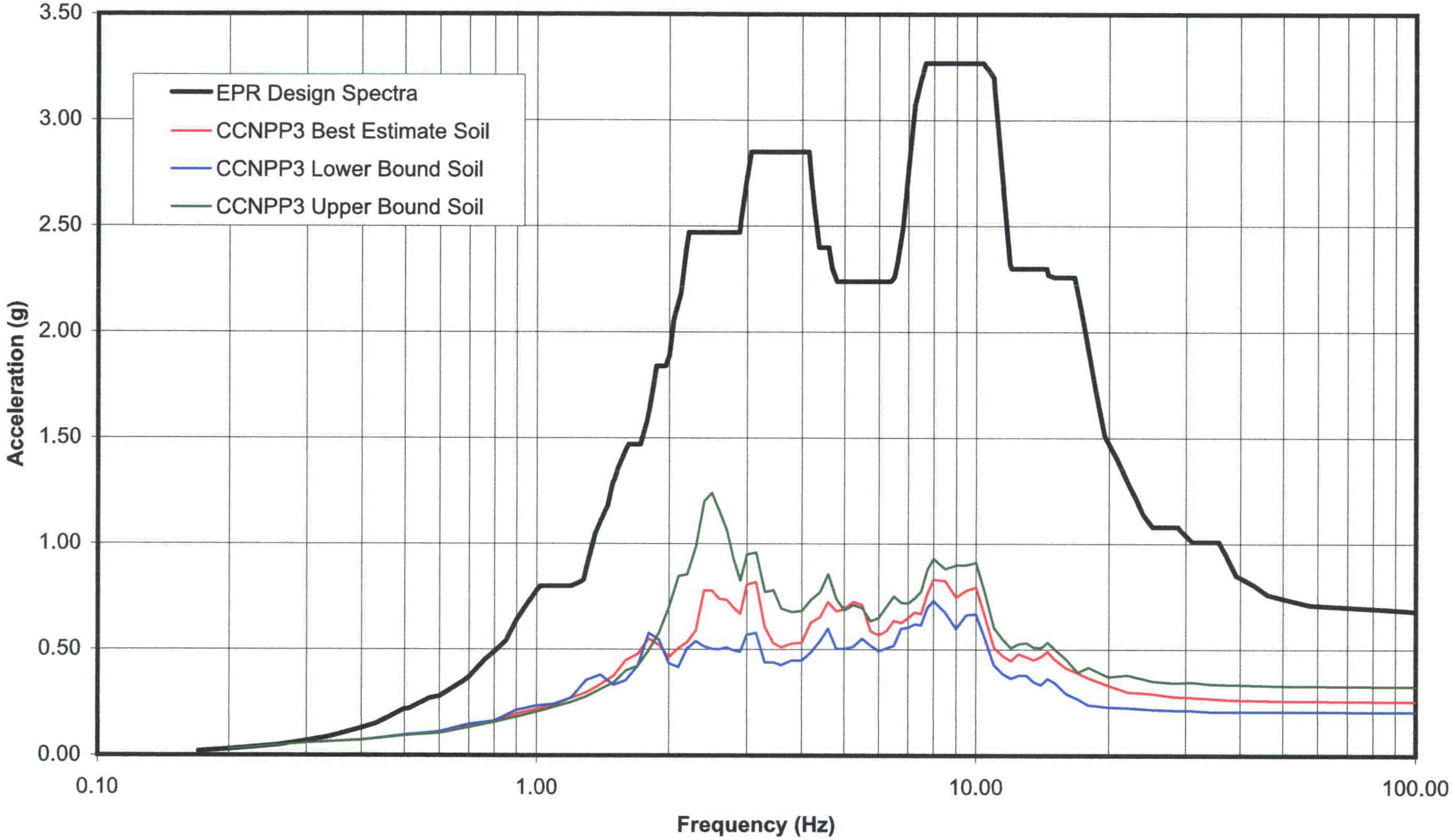


Figure 3.7-37—{Safeguard Building 1, Elev. 21.0 m, X(E-W) Direction, 5% Damping}

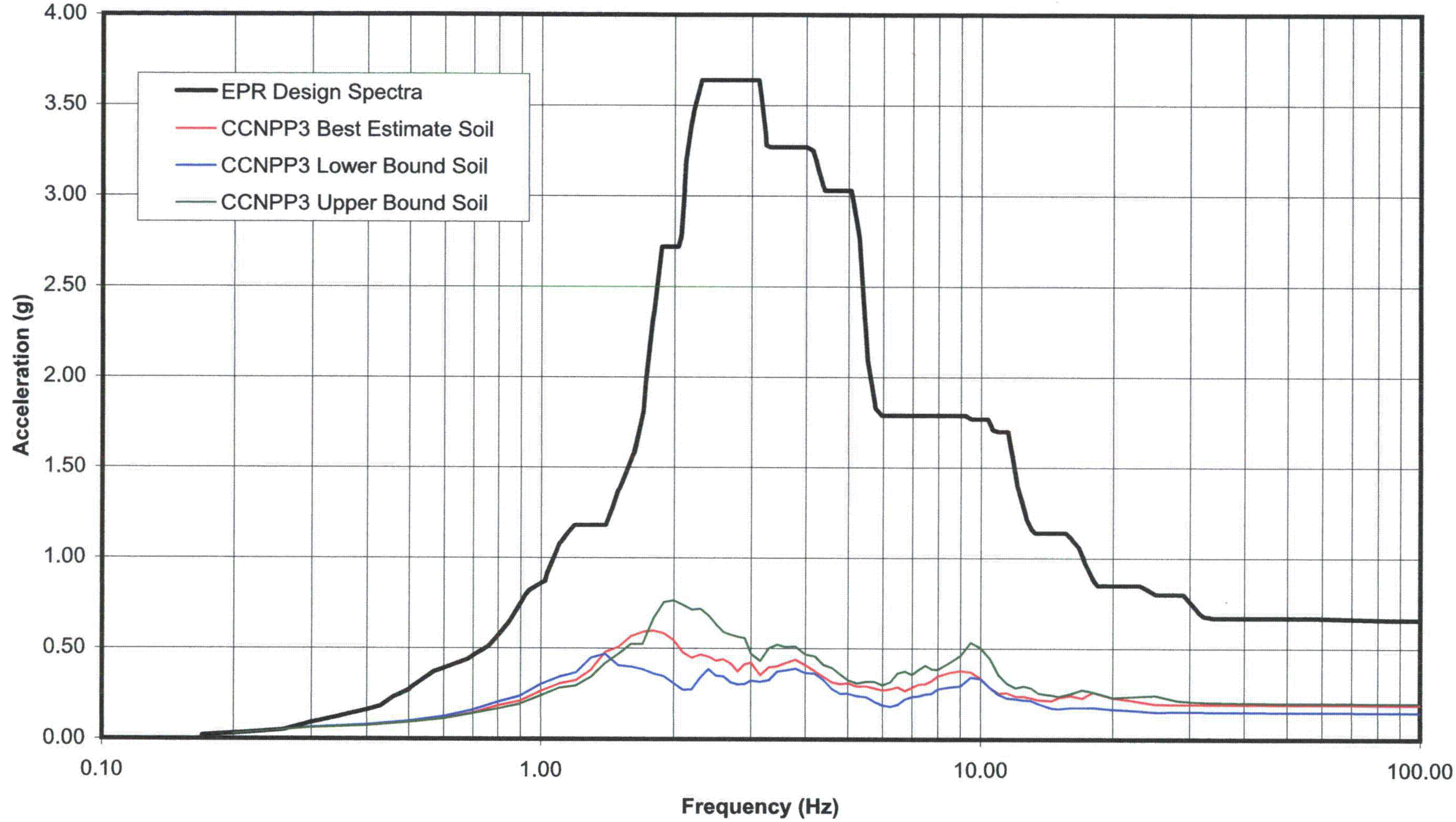


Figure 3.7-38—{Safeguard Building 1, Elev. 21.0 m, Y(N-S) Direction, 5% Damping}

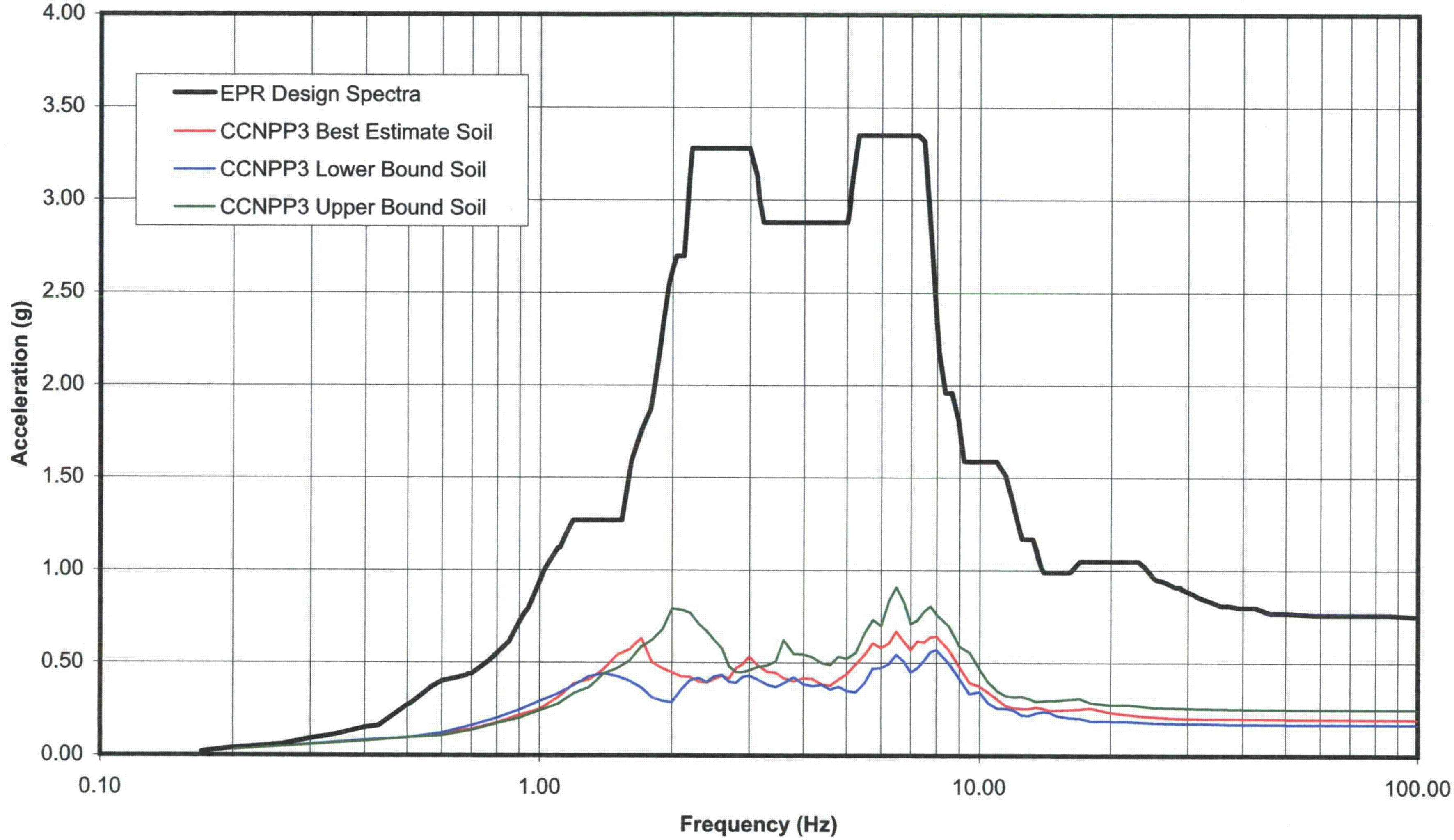


Figure 3.7-39—{Safeguard Building 1, Elev. 21.0 m, Z(Vert) Direction, 5% Damping}

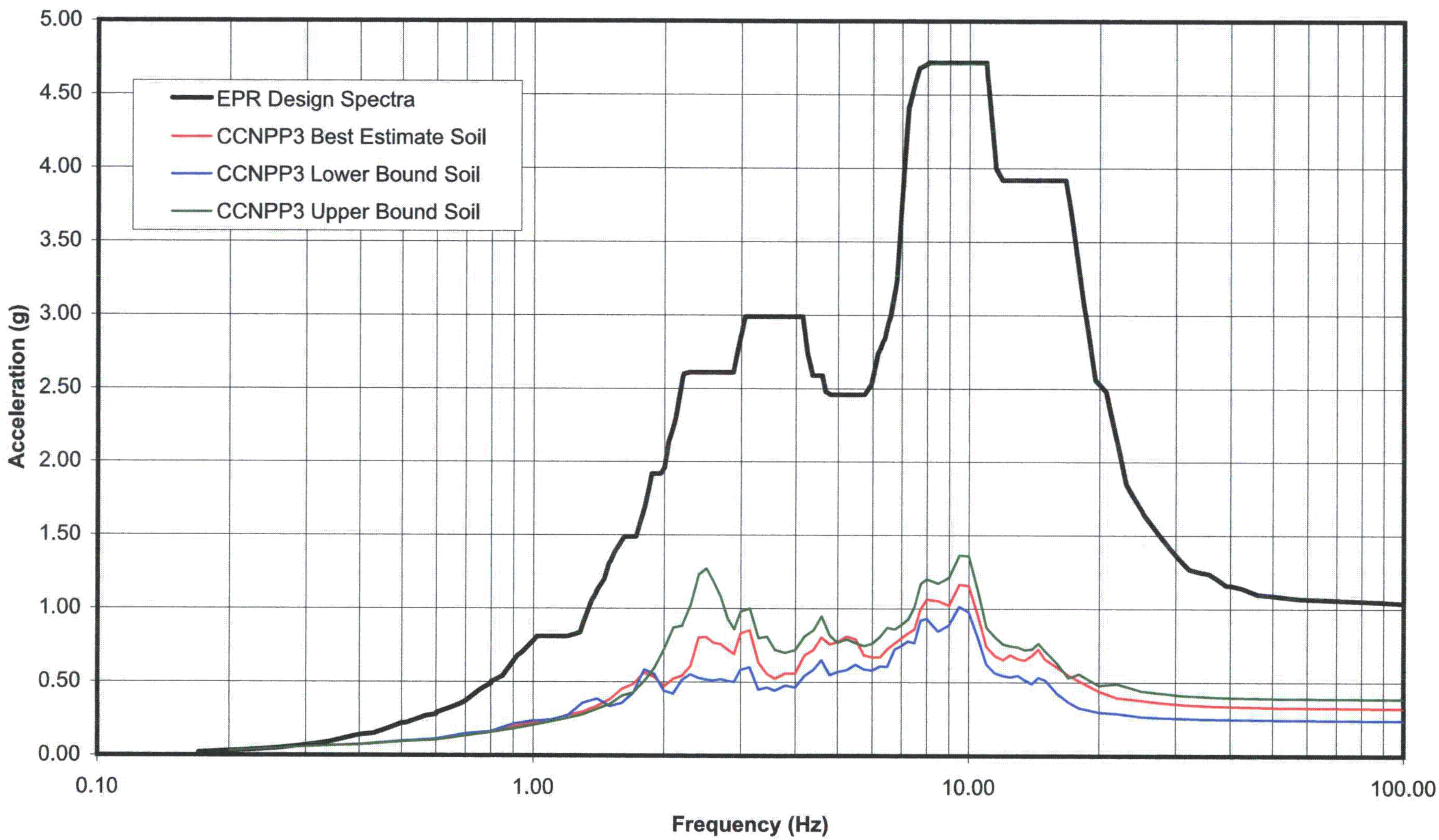


Figure 3.7-40—{Safeguard Building 2/3, Elev. 8.1m, X(E-W) Direction, 5% Damping}

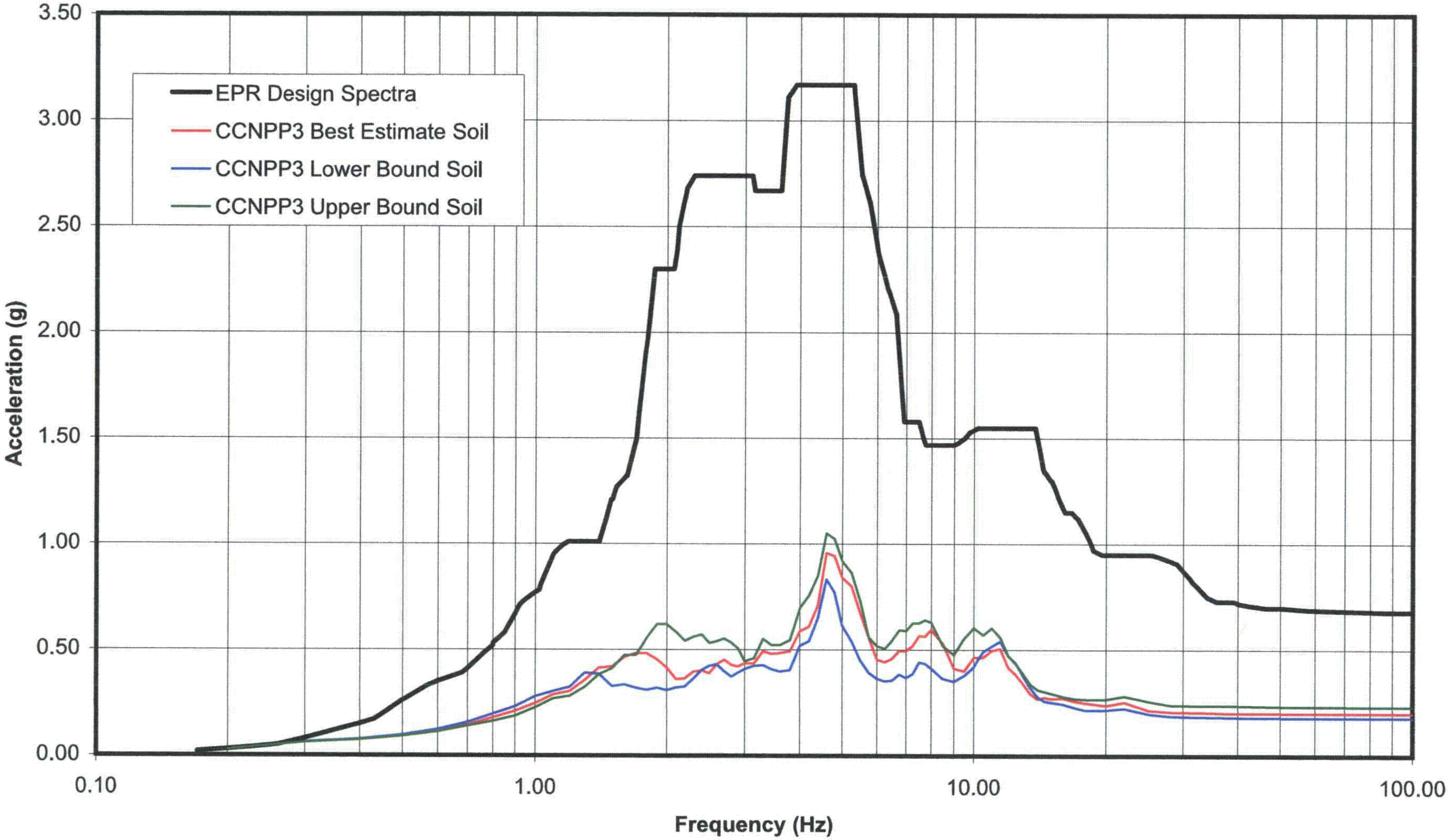


Figure 3.7-41—{Safegurd Building 2/3, Elev. 8.1 m, Y(N-S) Direction, 5% Damping}

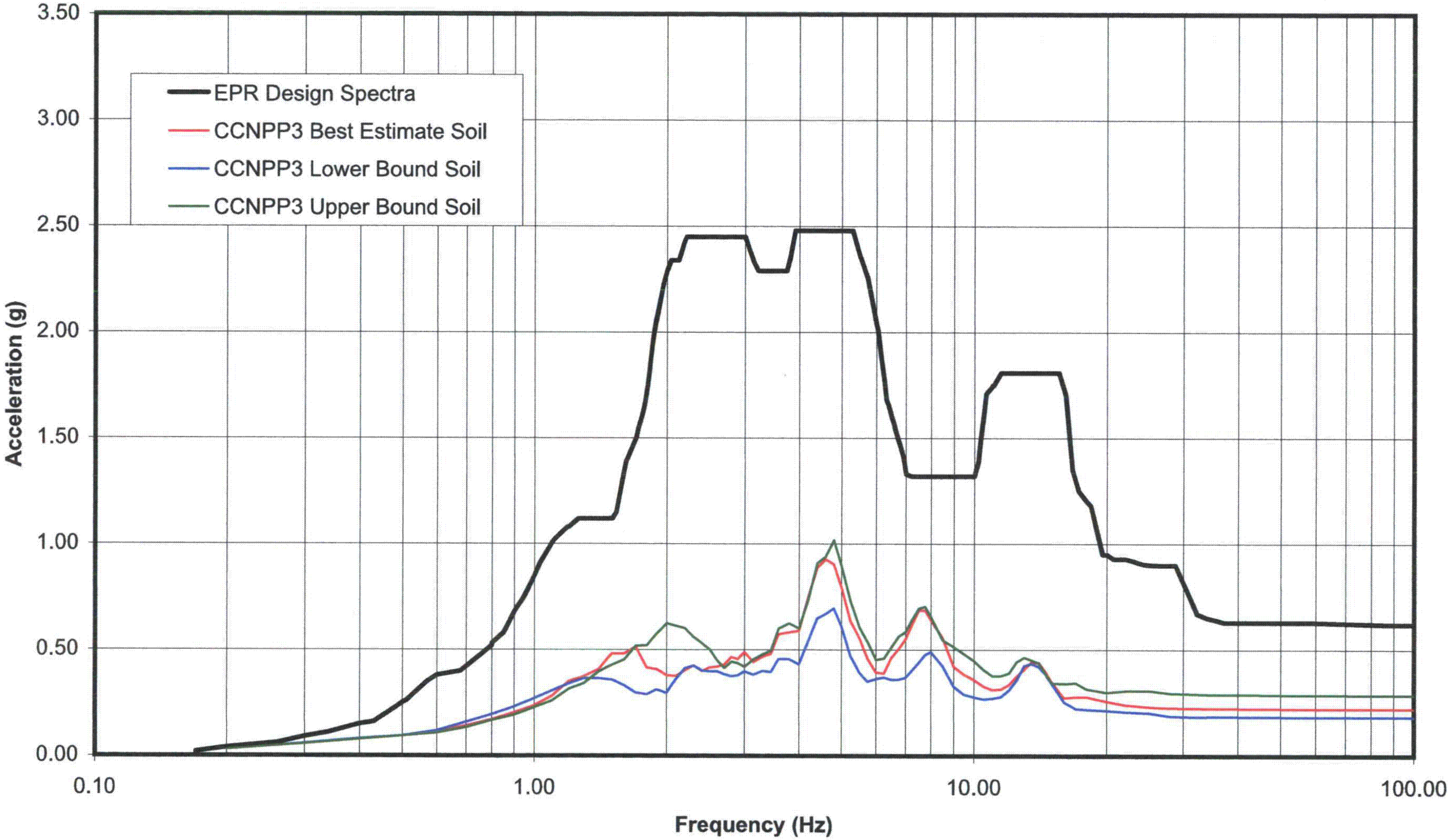


Figure 3.7-42—{Safeguard Building 2/3, Elev. 8.1 m, Z(Vert) Direction, 5% Damping}

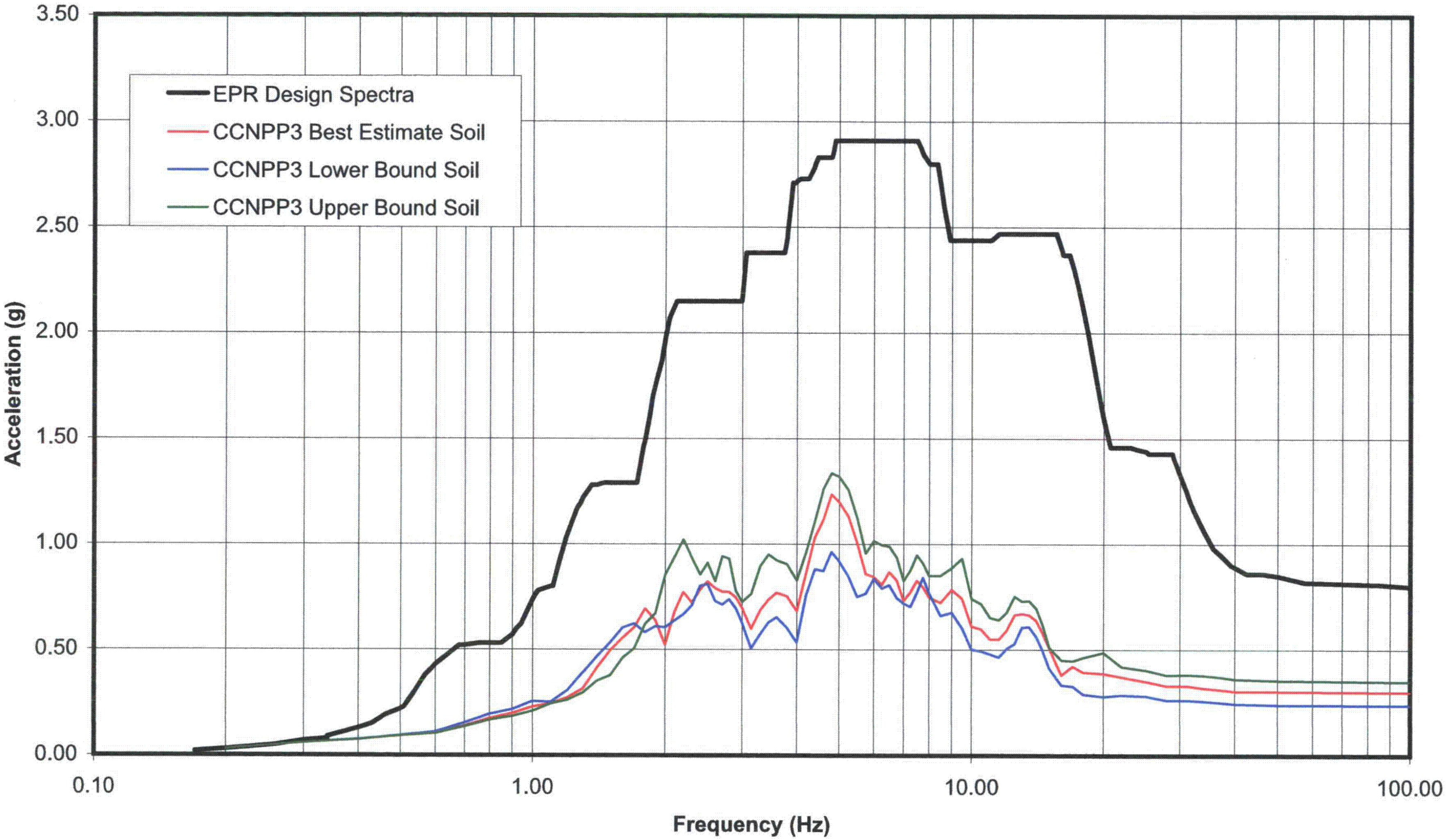


Figure 3.7-43—{Safeguard Building 2/3, Elev. 15.4 m, X(E-W) Direction, 5% Damping}

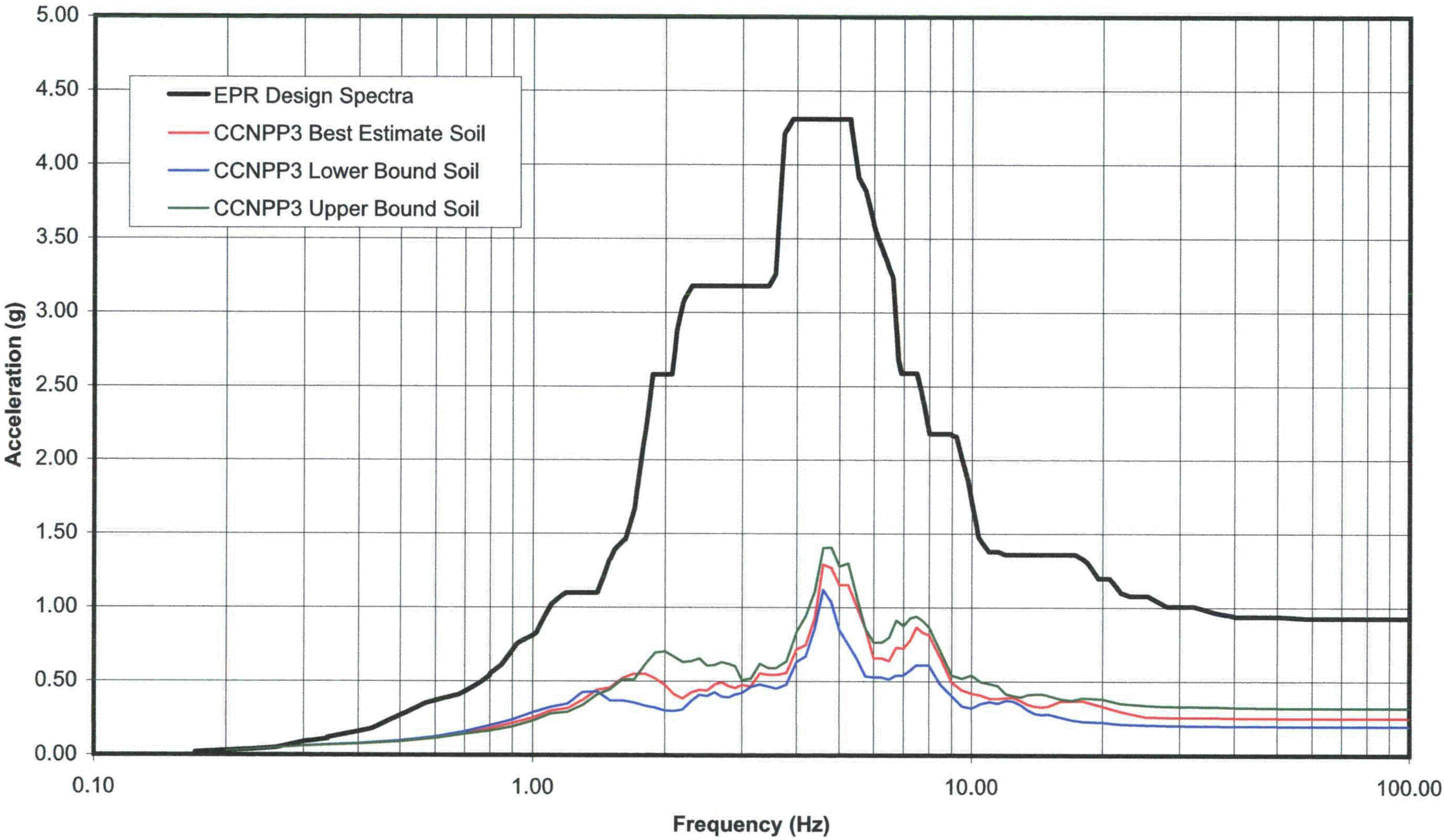


Figure 3.7-44—{Safeguard Building 2/3, Elev. 15.4 m, Y(N-S) Direction, 5% Damping}

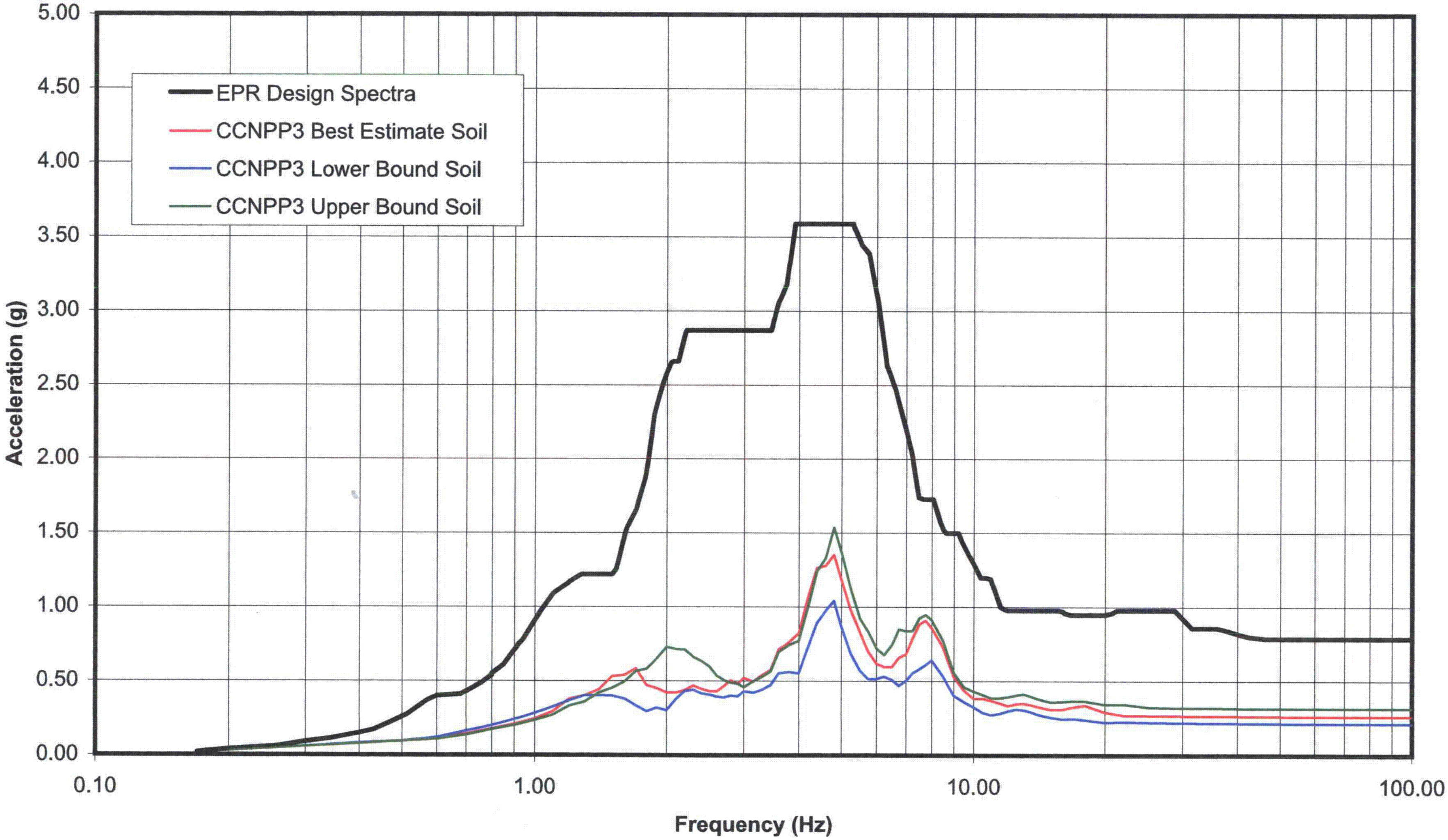


Figure 3.7-45—{Safeguard Buvilding 2/3, Elev. 15.4 m, Z(Vert) Direction5% Damping}

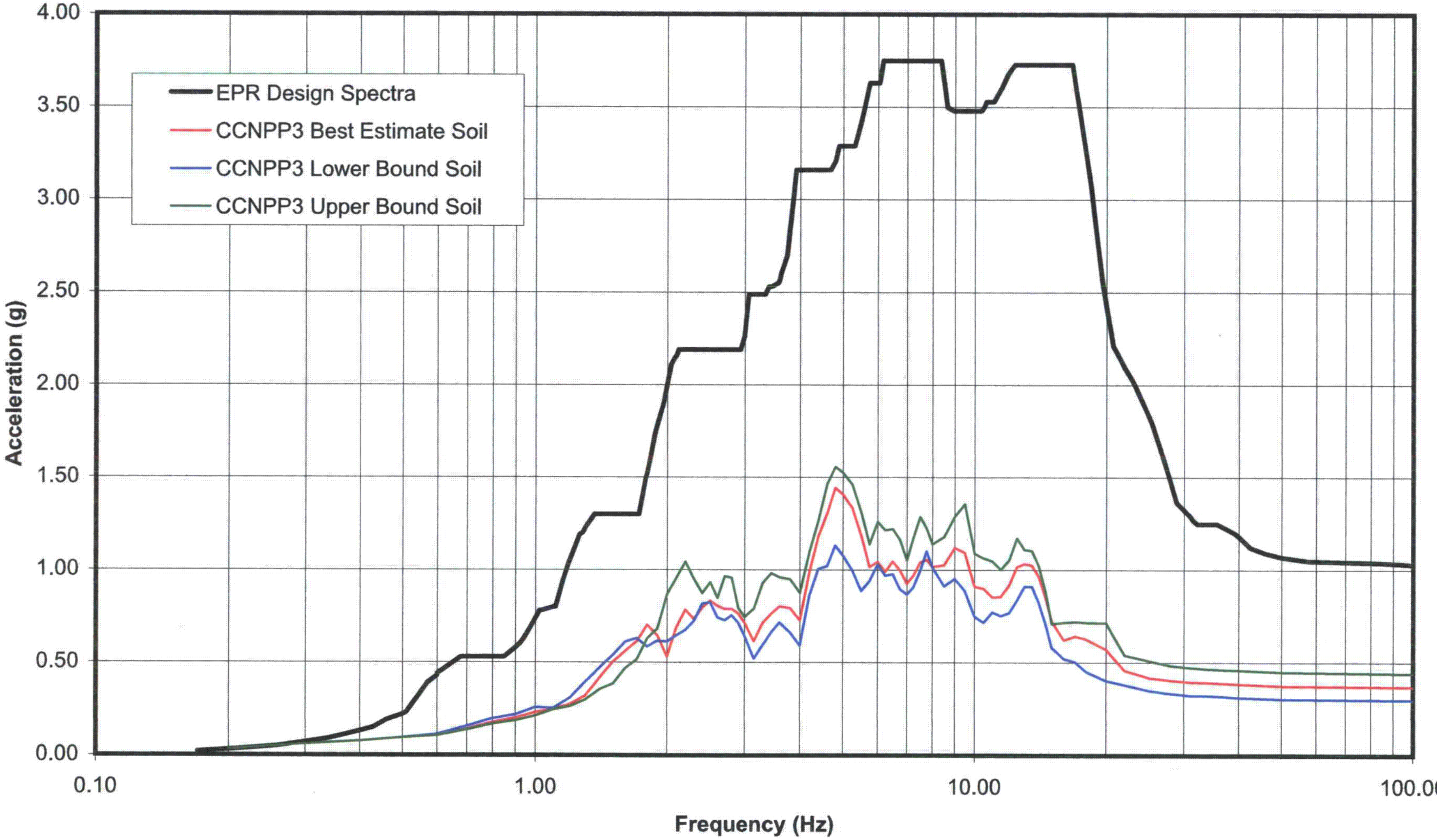


Figure 3.7-46—{Safeguard Building 4, Elev. 21.0 m, X(E-W) Direction, 5% Damping}

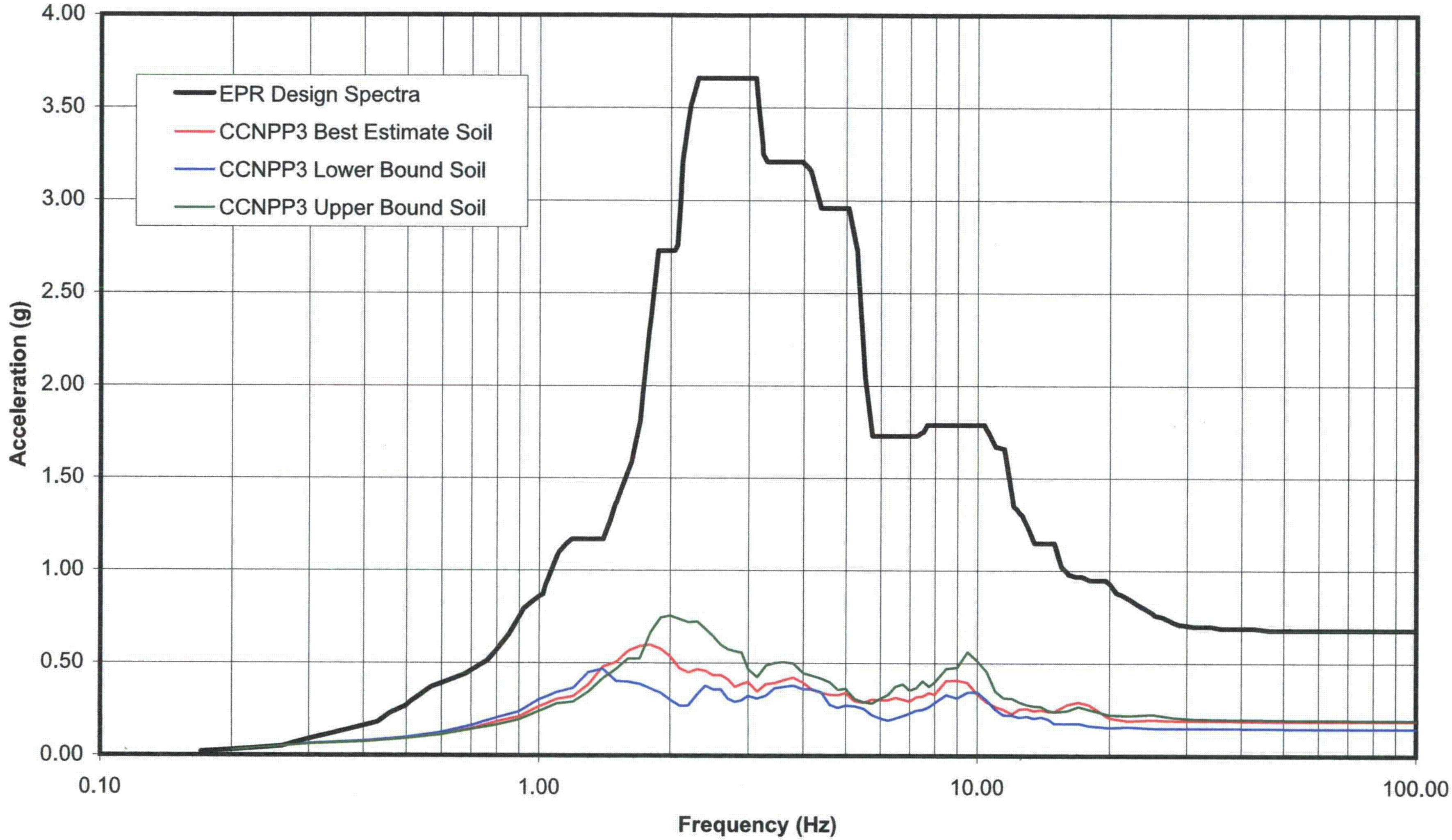


Figure 3.7-47—{Safeguard Building 4, Elev. 21.0 m, Y(N-S) Direction,5% Damping}

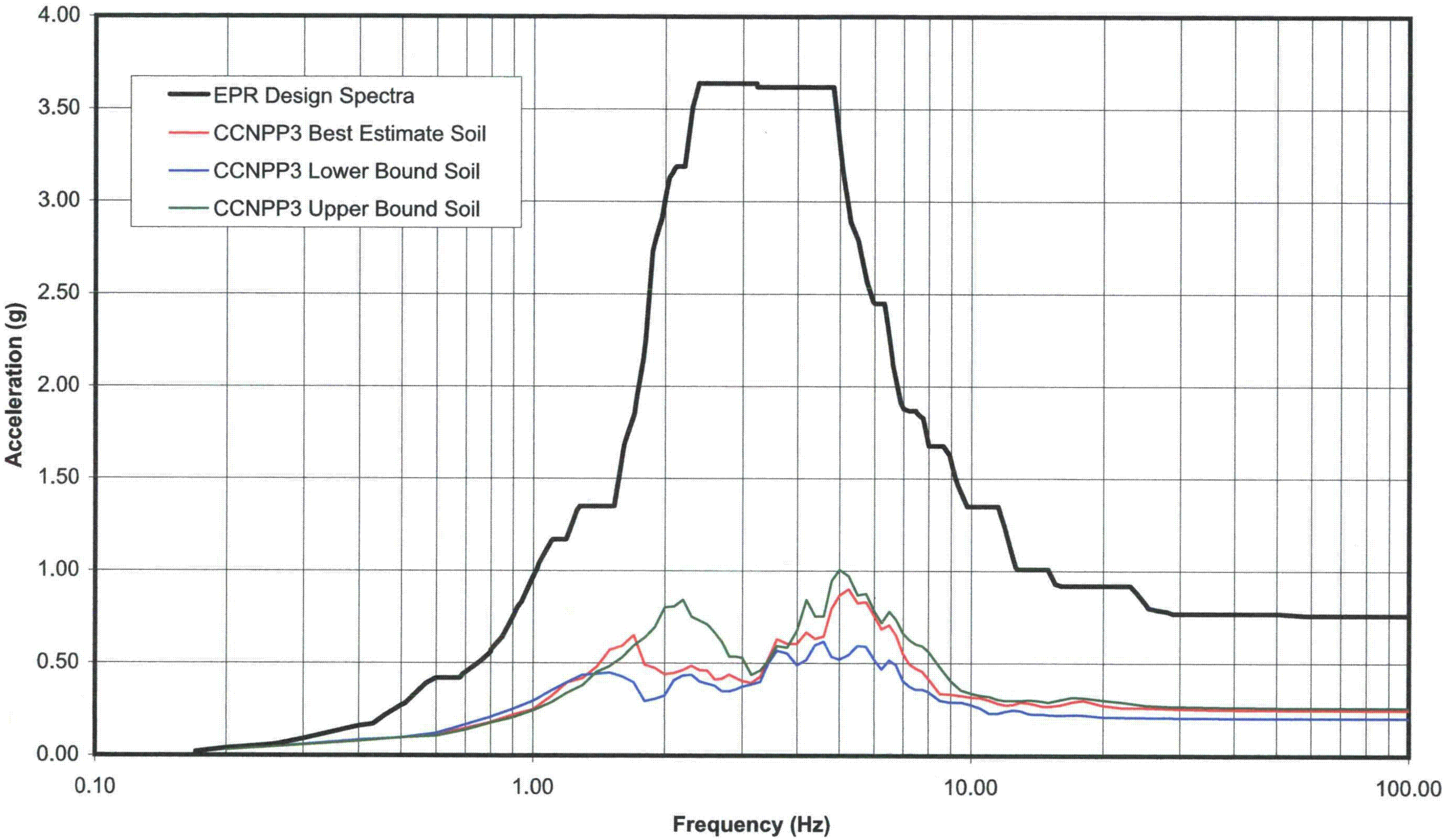


Figure 3.7-48—{Safeguard Building 4, Elev. 21.0 m, Z(Vert) Direction, 5% Damping}

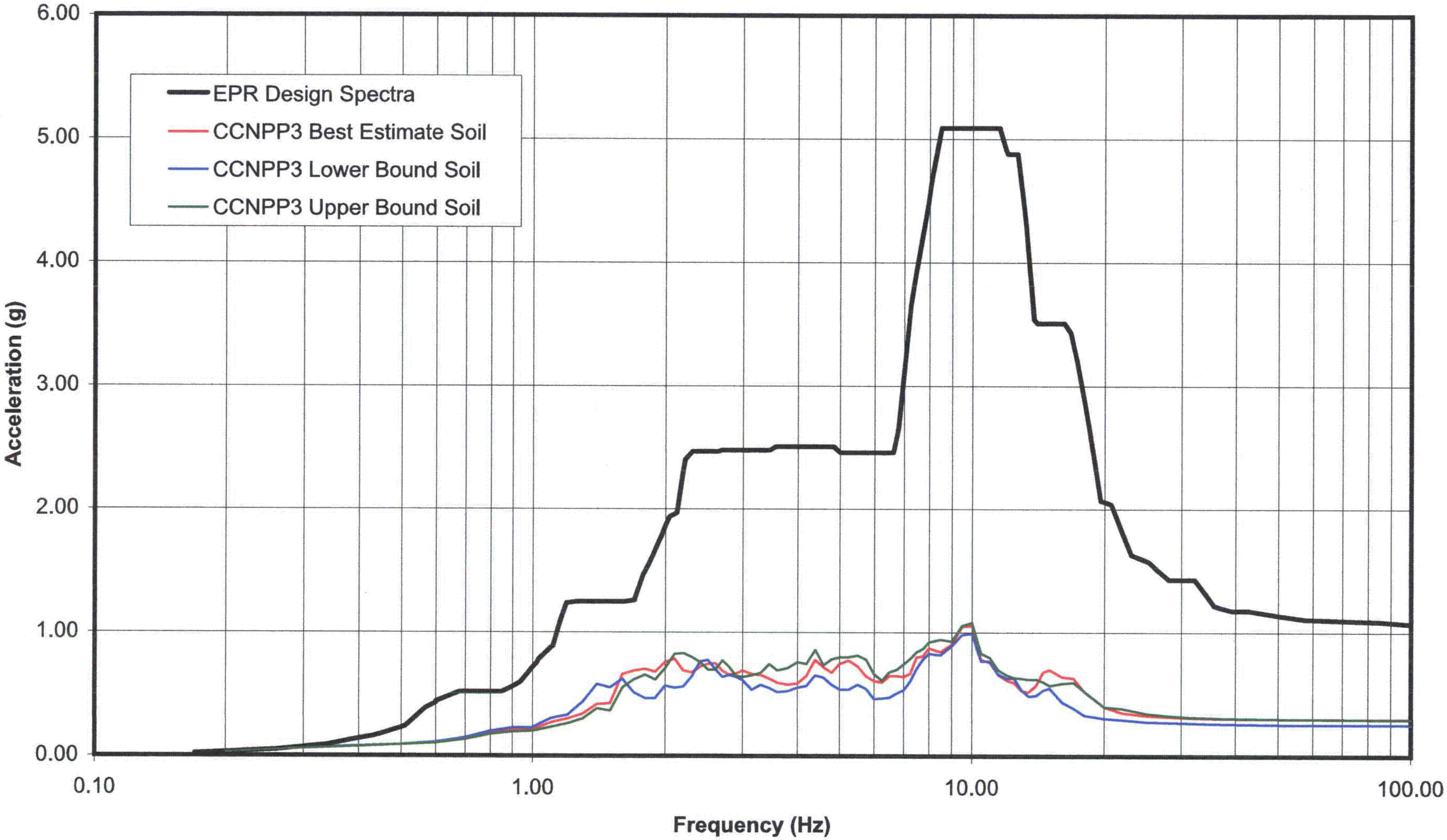


Figure 3.7-49—{Containment Building, Elev. 37.6 m, X(E-W) Direction, 5% Damping}

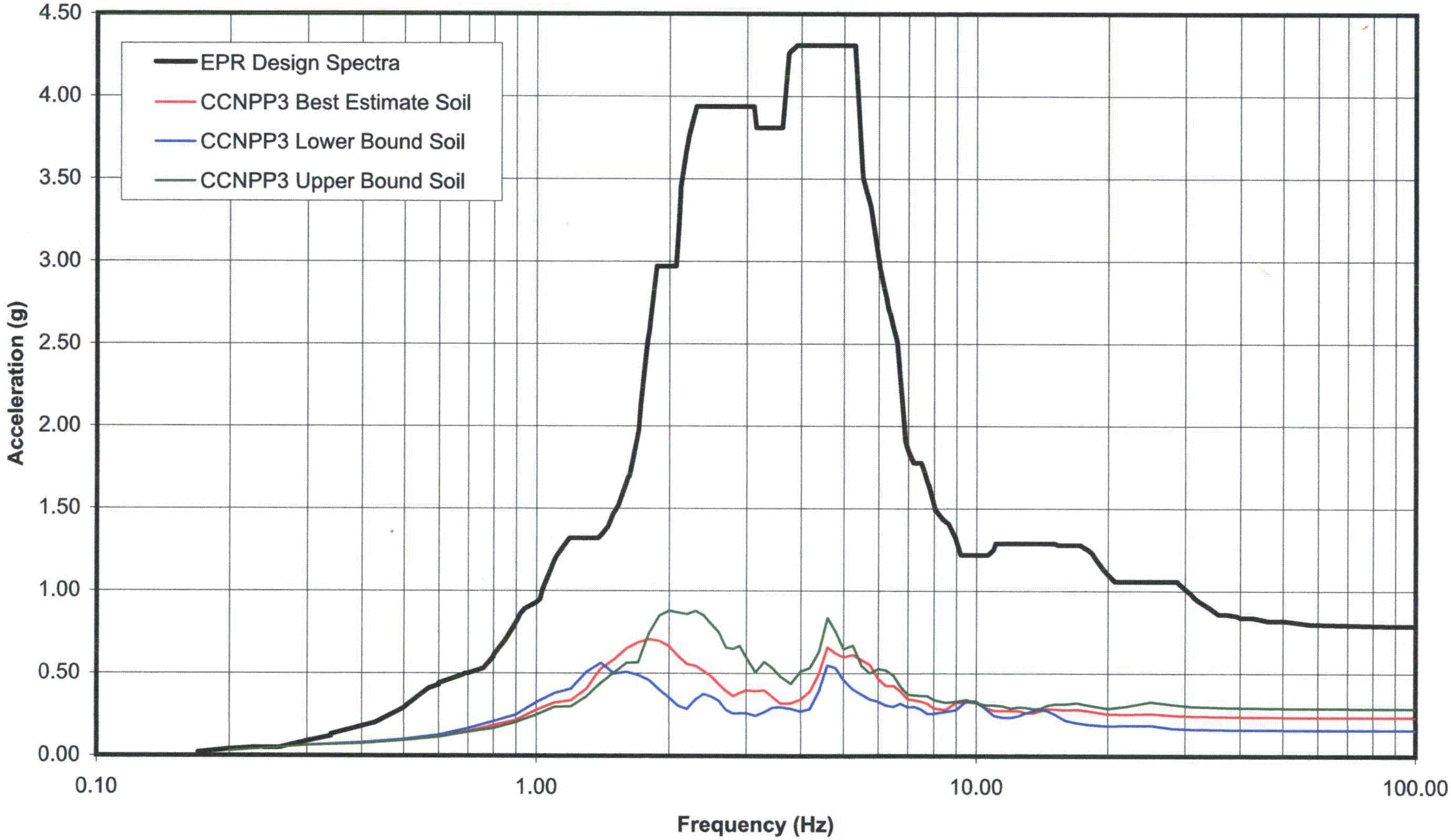


Figure 3.7-50—{Containmvent Building, Elev. 37.6 m, Y(N-S) Direction, 5% Damping}

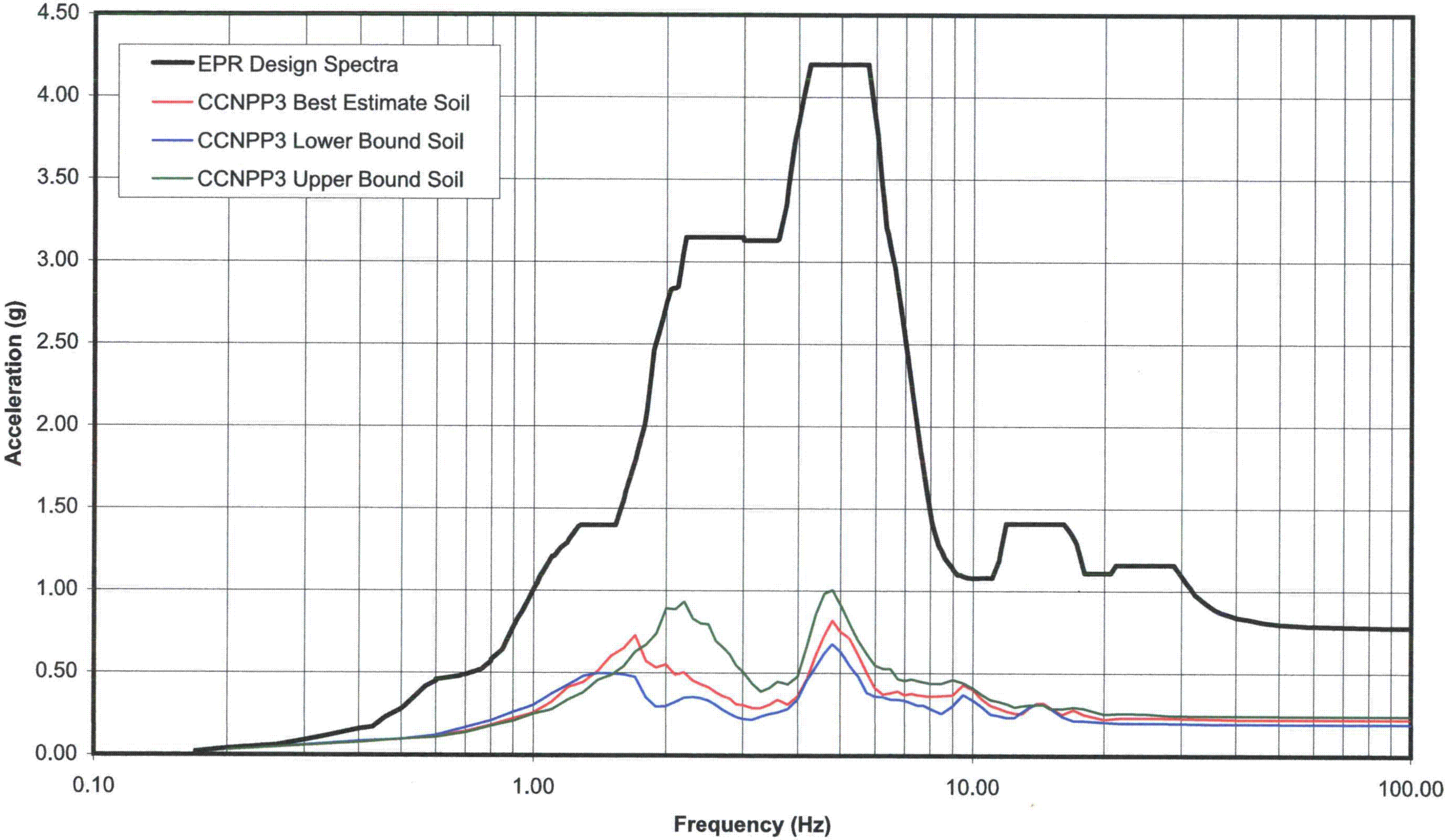


Figure 3.7-51—{Containment Building, Elev. 37.6 m, Z(Vert) Direction, 5% Damping}

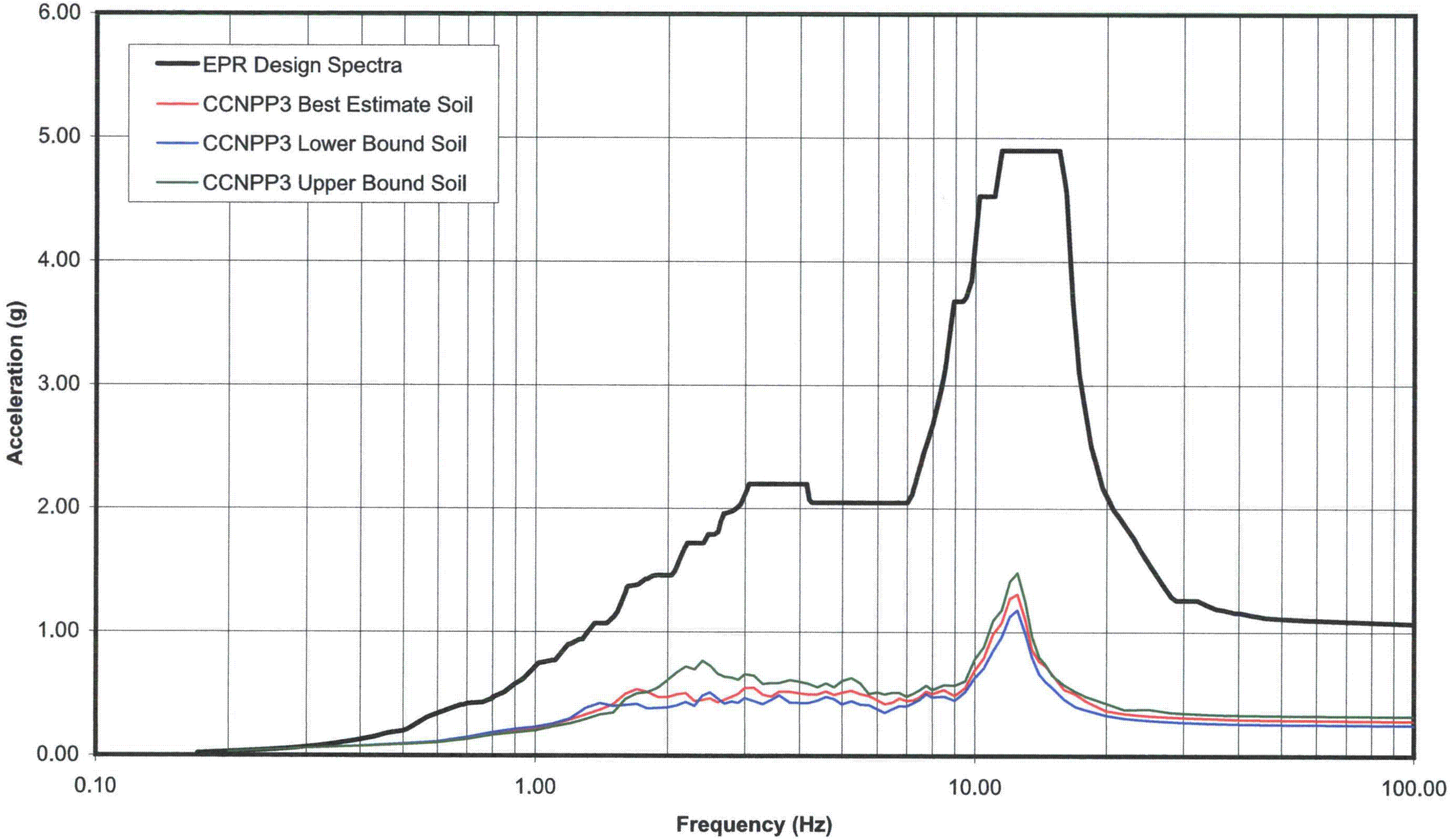


Figure 3.7-52—{Containment Building, Elev. 58.0 m, X(E-W) Direction, 5% Damping}

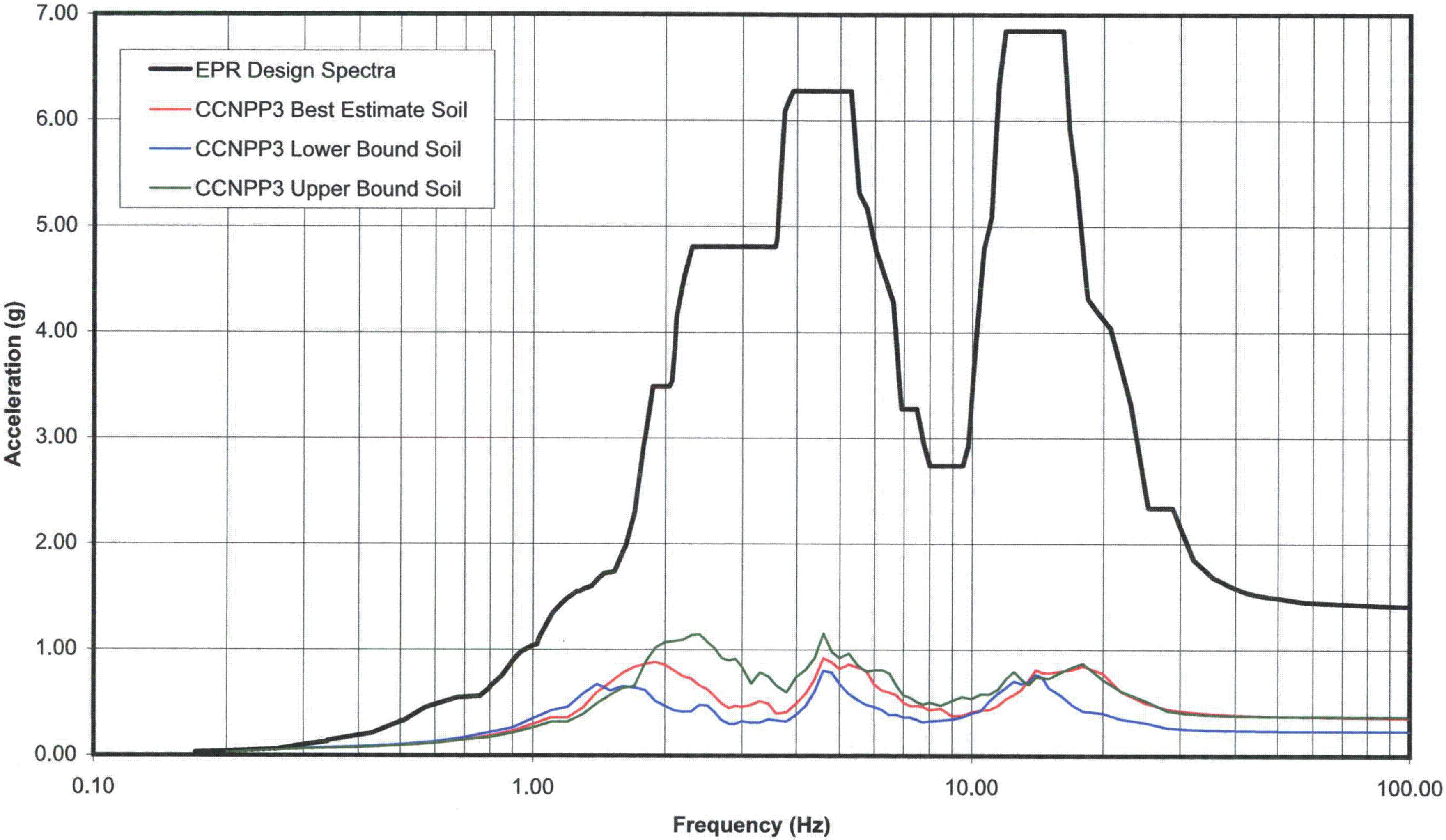


Figure 3.7-53—{Containment Building, Elev. 58.0 m, Y(N-S) Direction, 5% Damping}

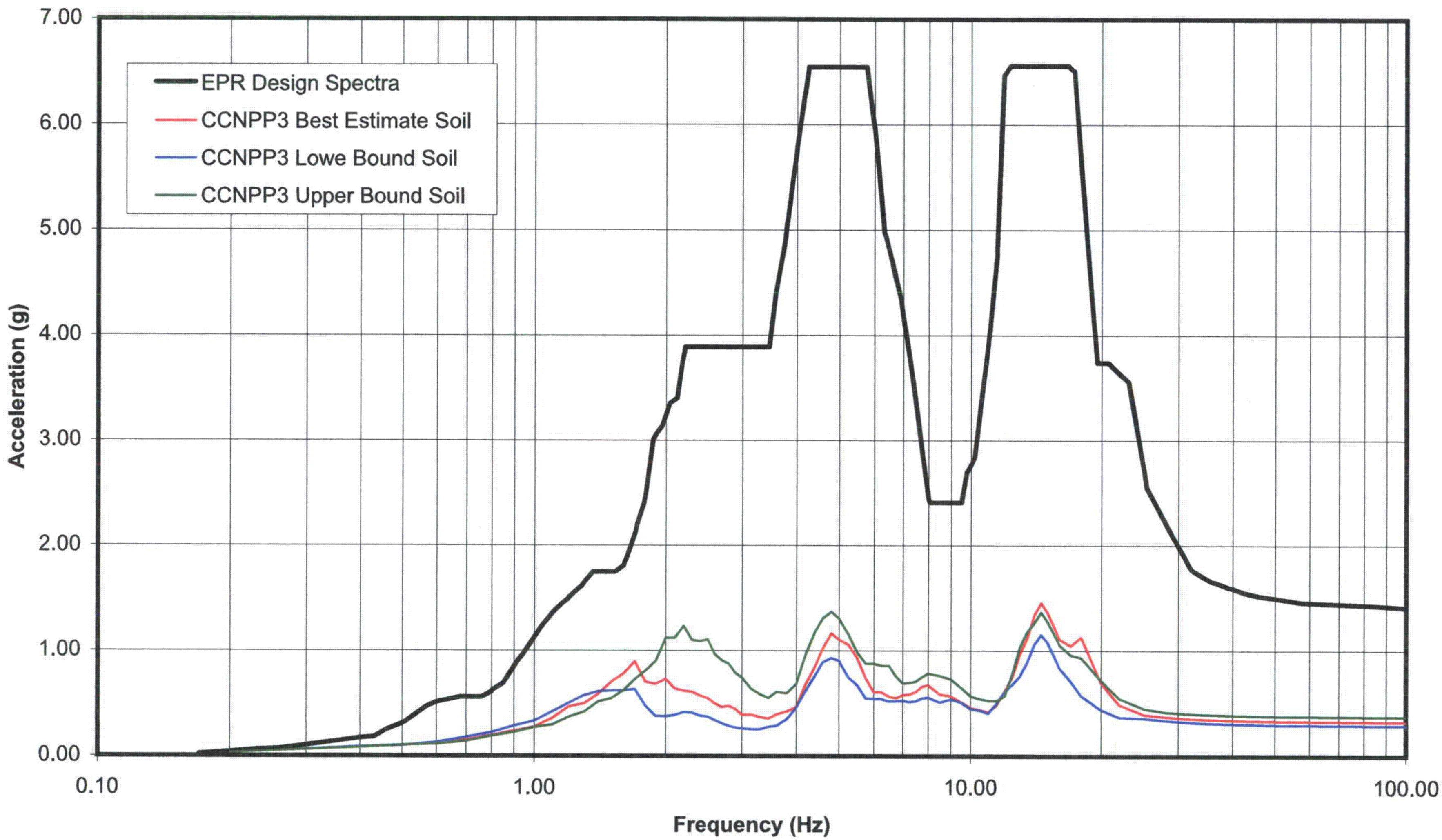


Figure 3.7-54—{Containment Building, Elev. 58.0 m, Z(Vert) Direction, 5% Damping}

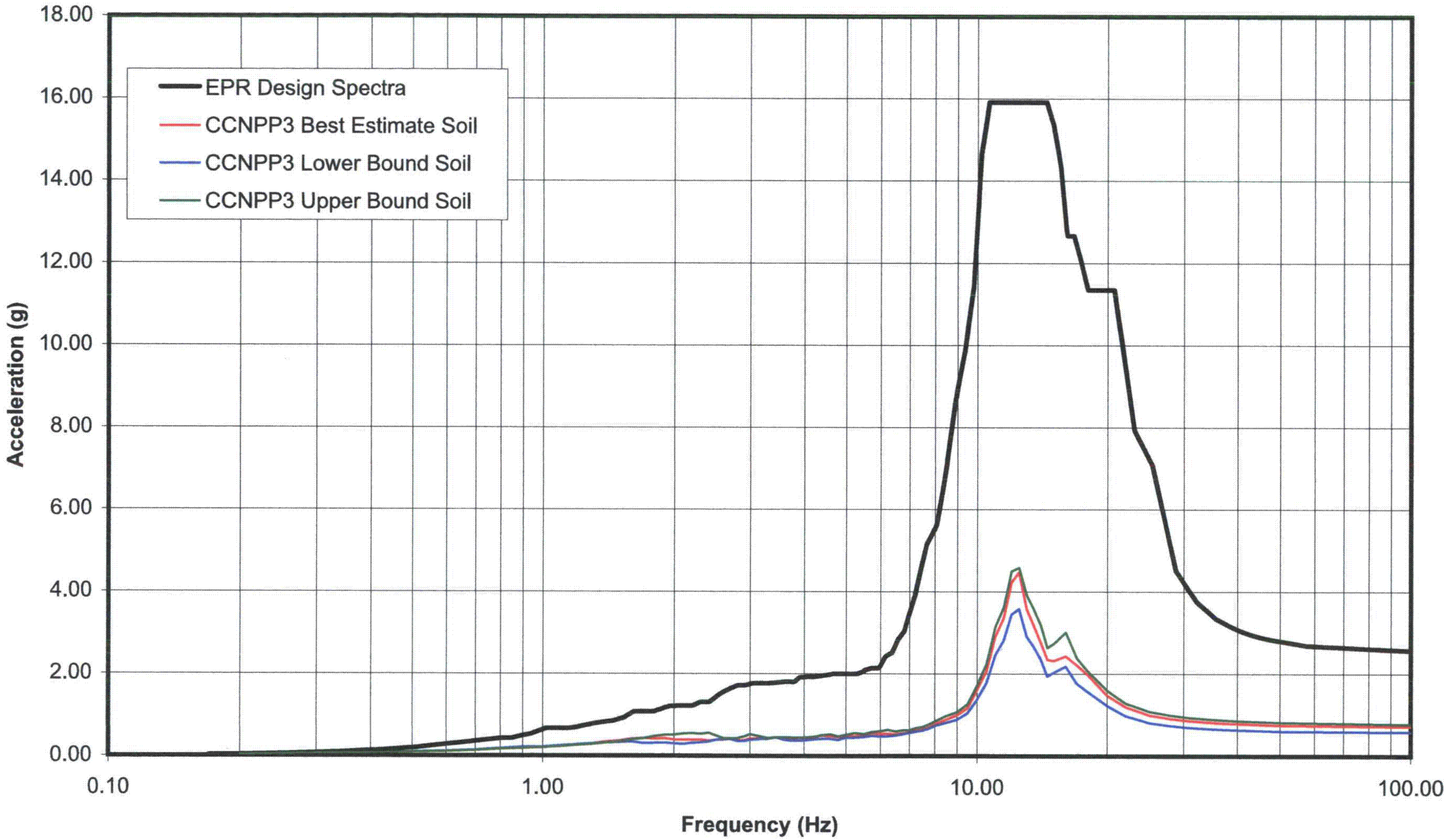


Figure 3.7-55—{CCNPP Unit 3 NAB Basemat X(E-W) Direction Spectra (5% Damping)}

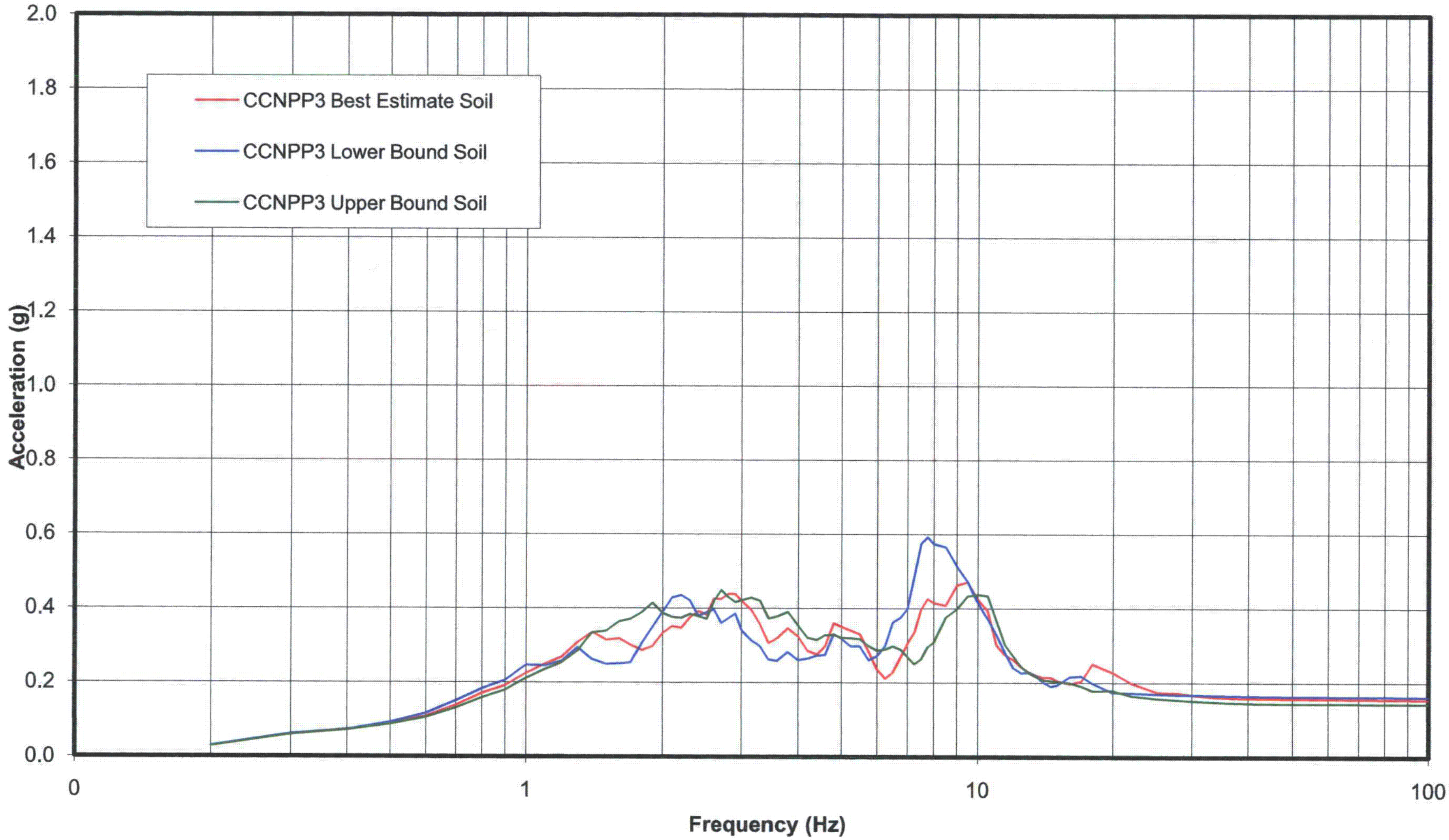


Figure 3.7-56—{CCNPP Unit 3 NAB Basemat Y(N-S) Direction Spectra (5% Damping)}

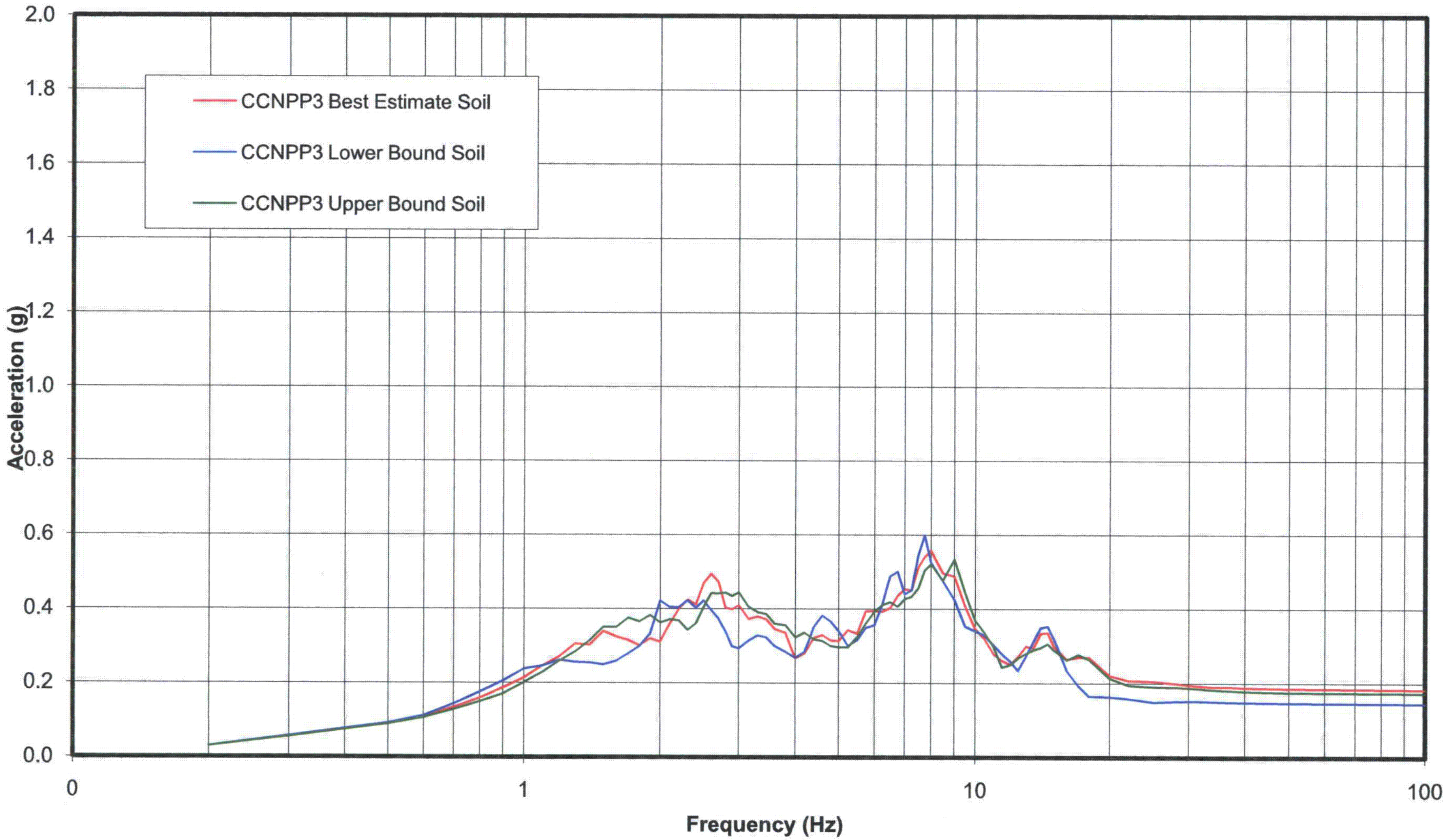


Figure 3.7-57—{CCNPP Unit 3 NAB Basemat Z(Vert) Direction Spectra (5% Damping)}

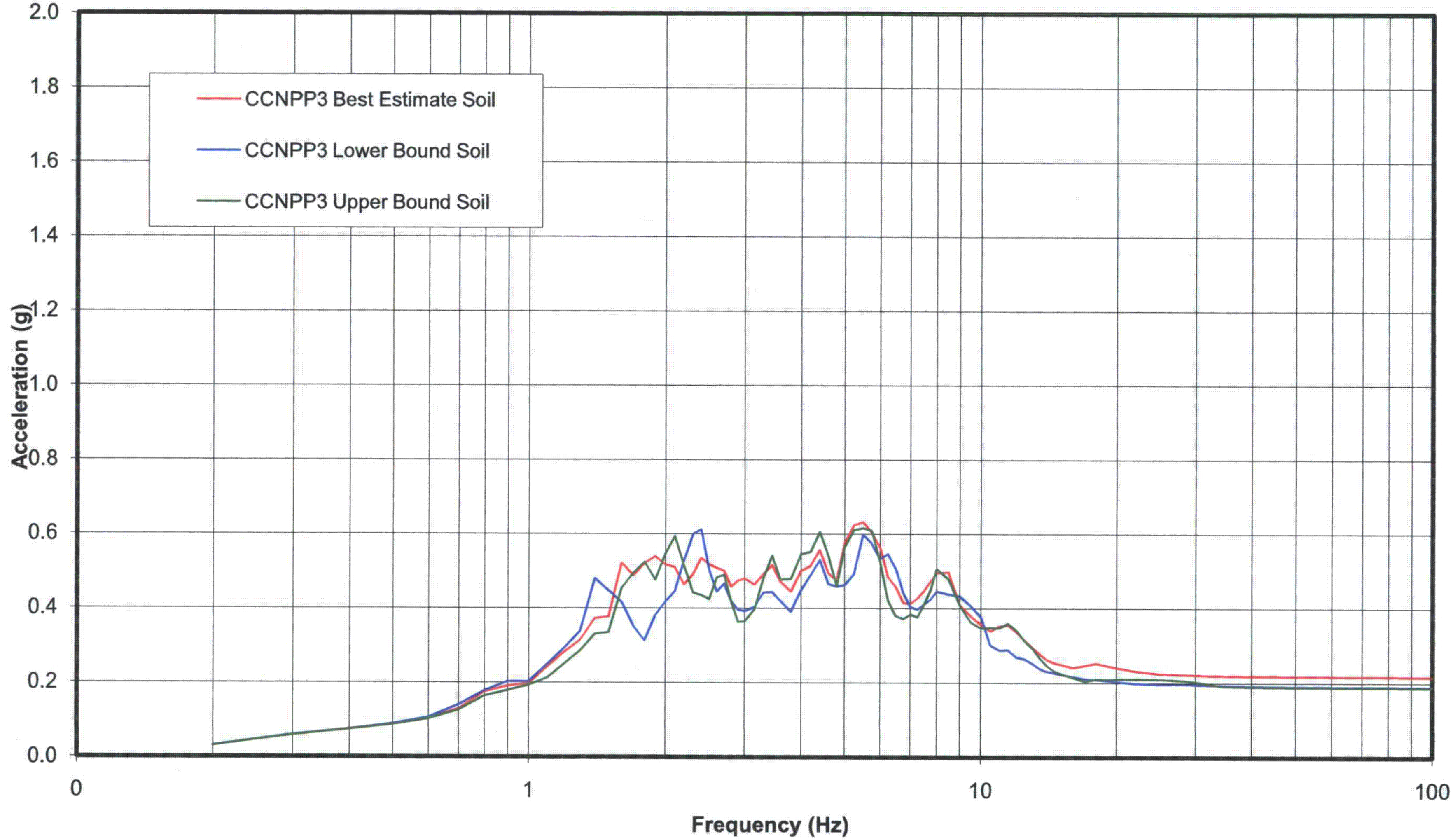


Figure 3.7-58—{Desig Certification NAB Basemat X(E-W) Direction Spectra (5% Damping)}

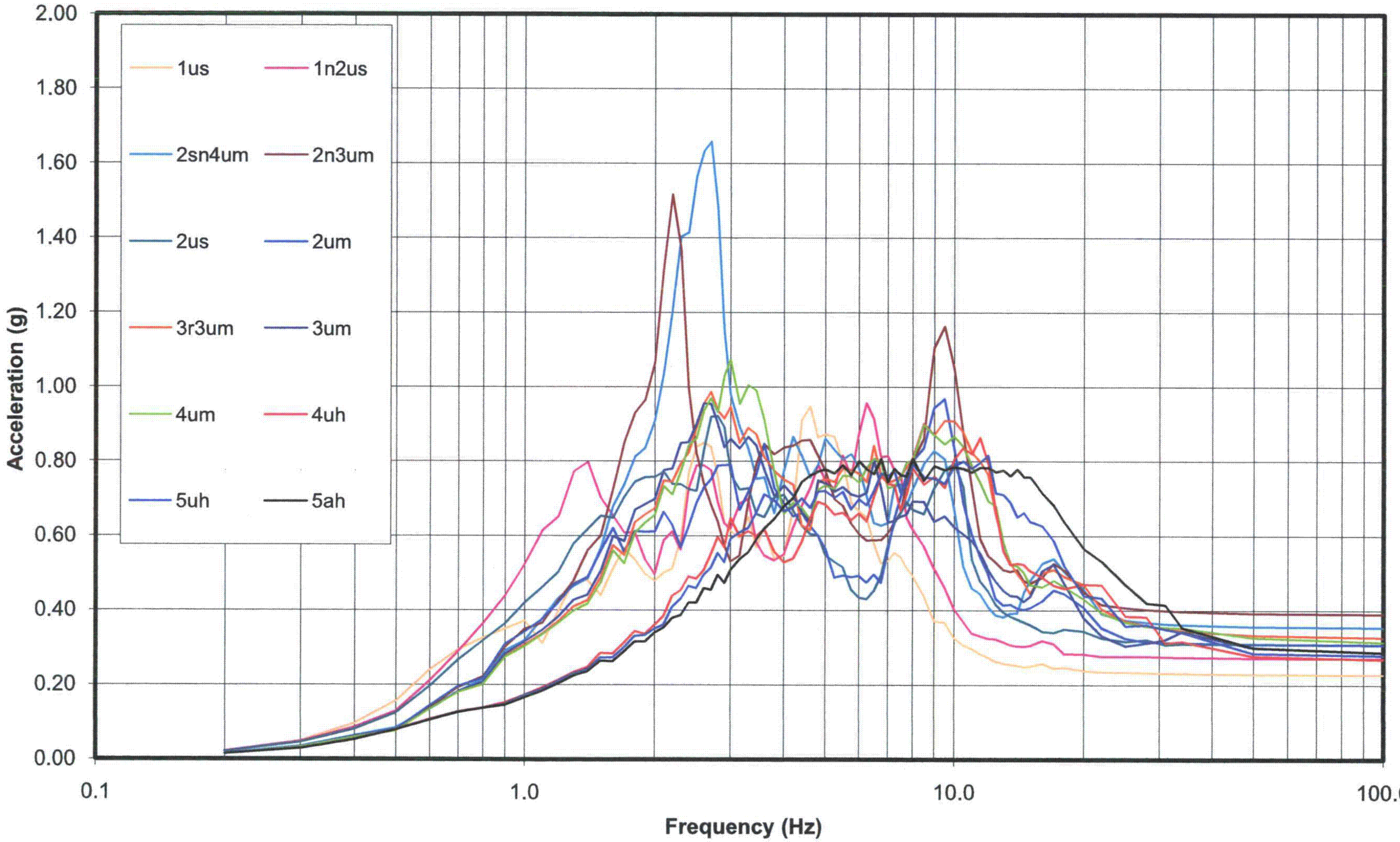


Figure 3.7-59—{Design Certification NAB Basemat Y(N-S) Direction Spectra (5% Damping)}

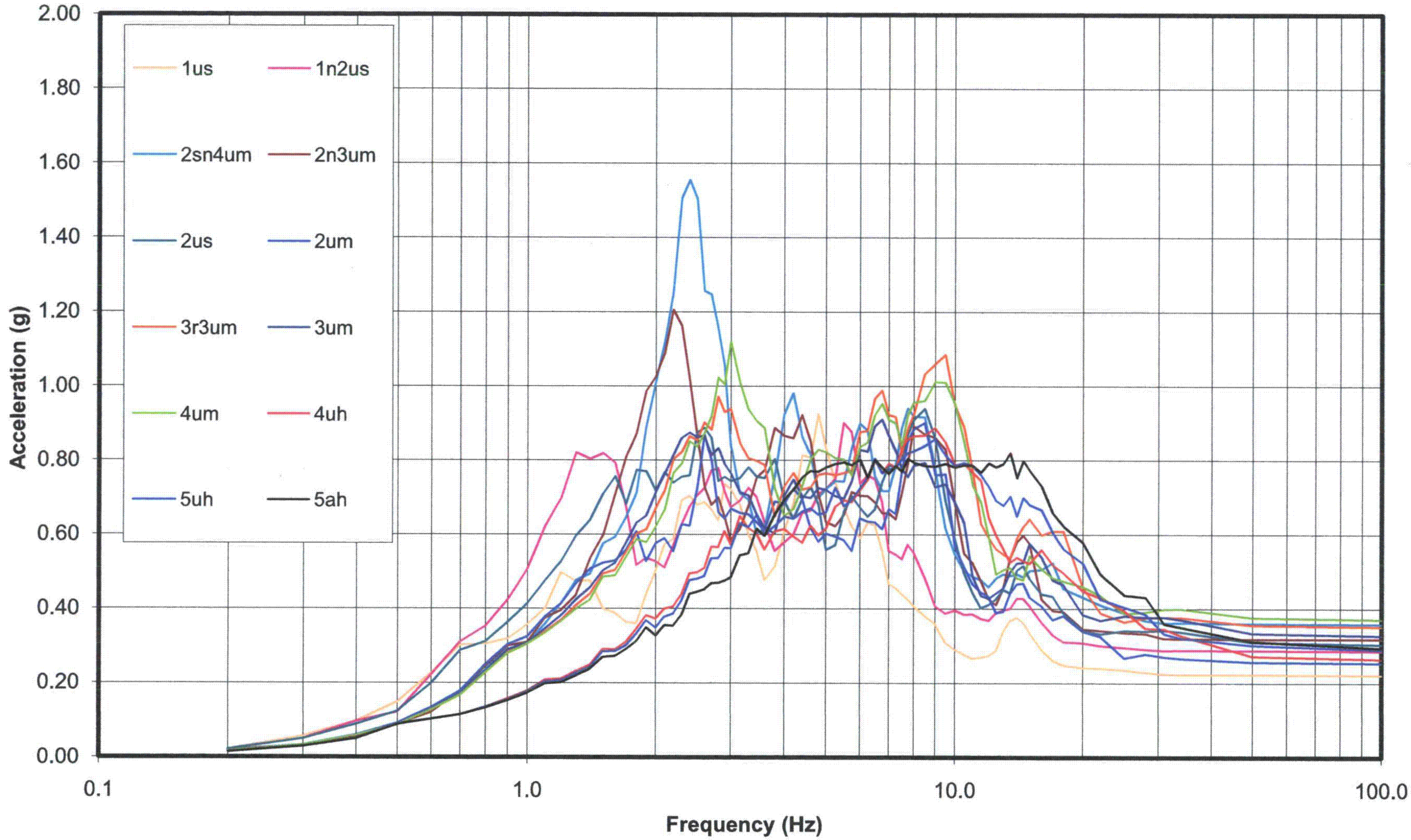


Figure 3.7-60—{Design Certification NAB Basemat Z(Vert) Direction Spectra (5% Damping)}

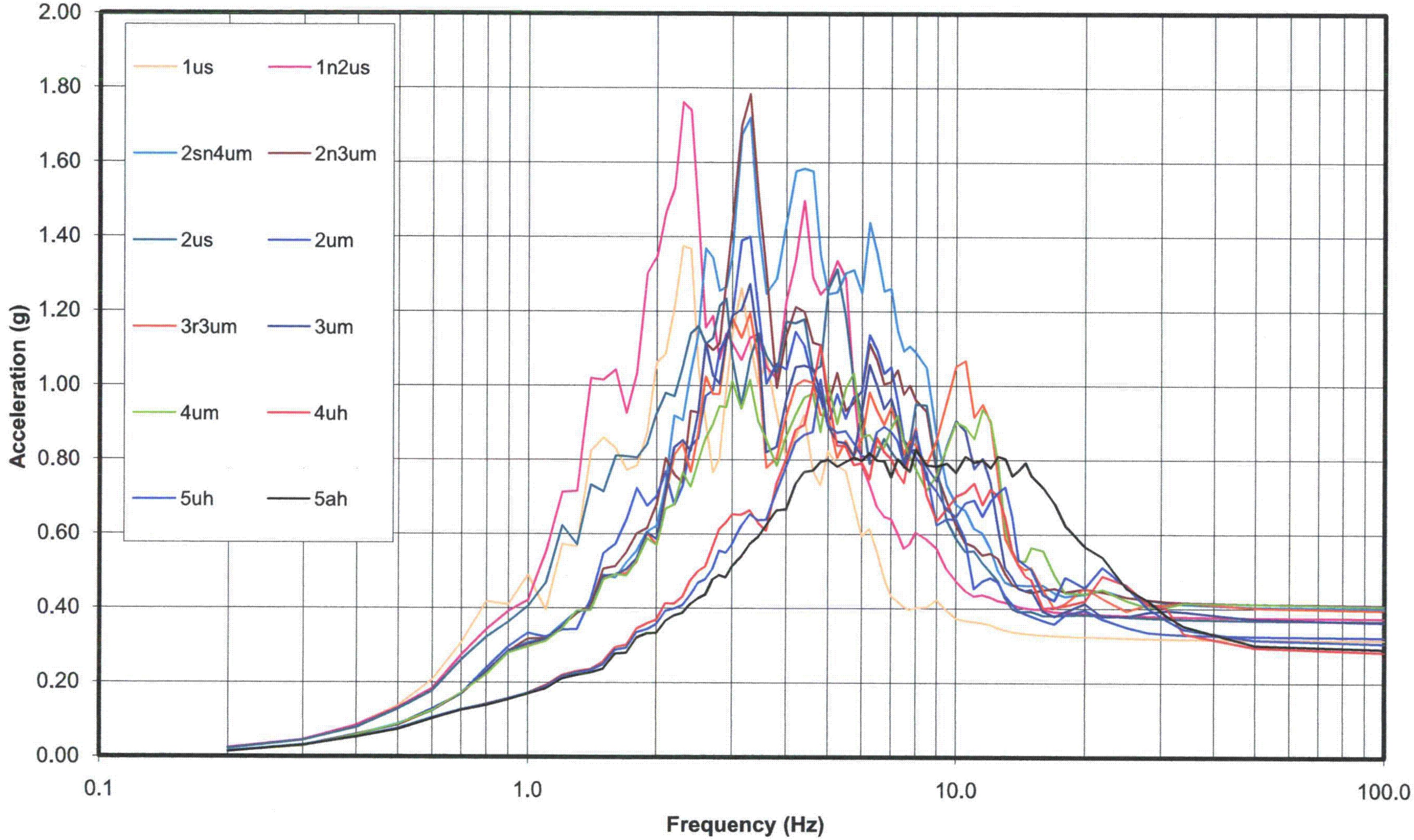


Figure 3.7-61—{CCNPP Unit 3 Radioactive Waste Processing Building Basemat X-Direction Spectra (5% Damping)}

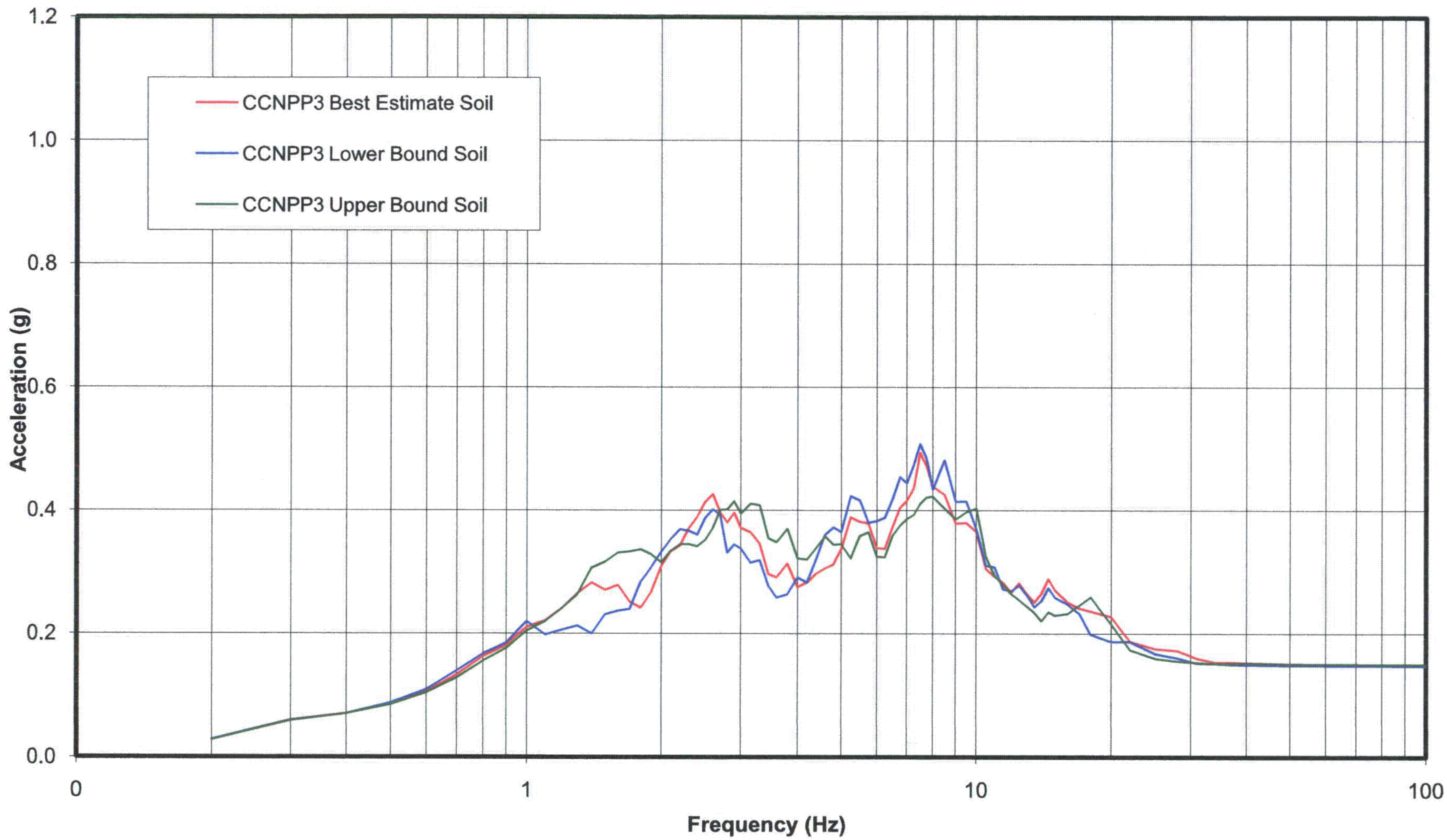


Figure 3.7-62—{CCNPP Unit 3 Radioactive Waste Processing Building Basemat Y-Direction Spectra (5% Damping)}

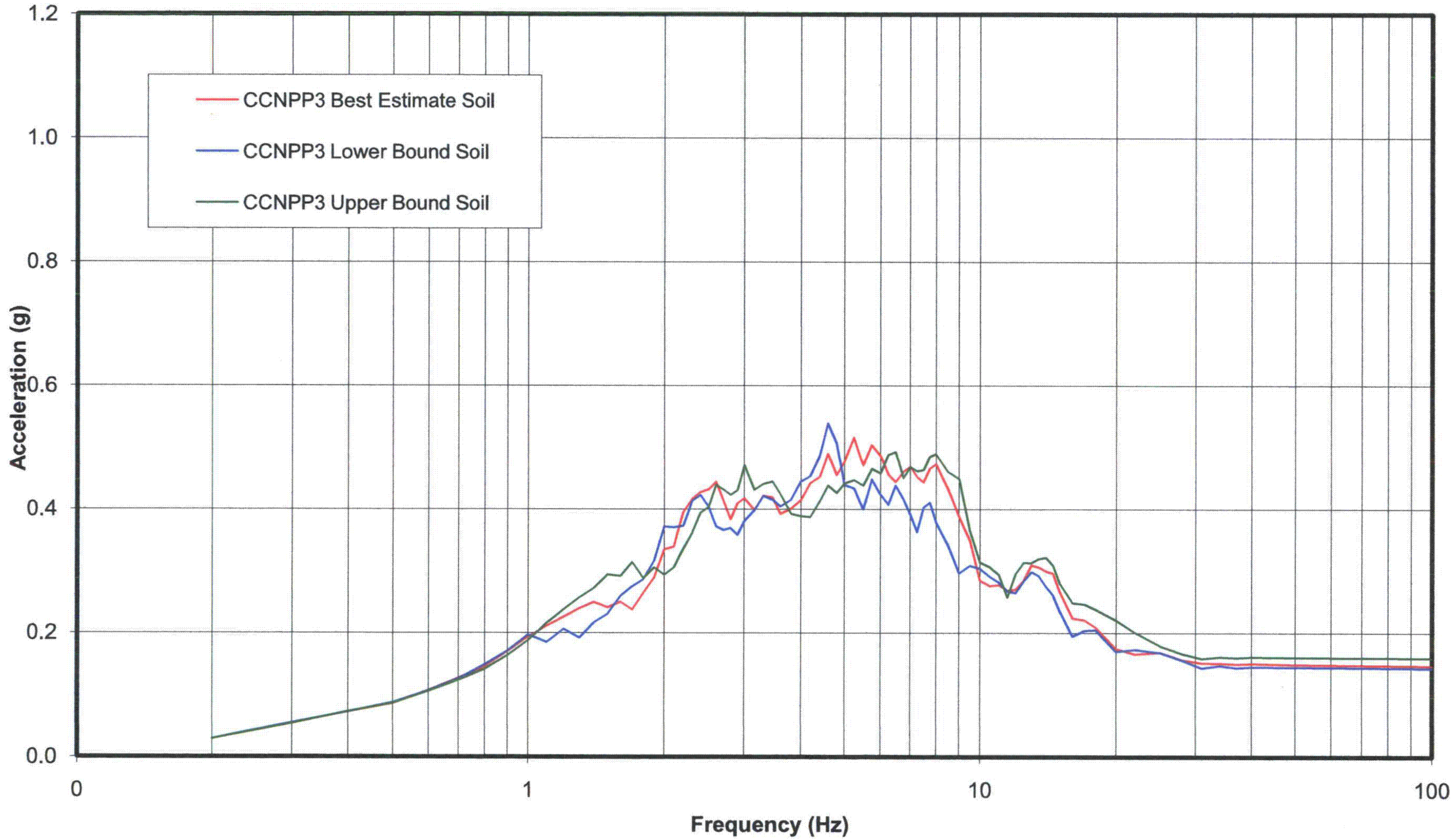


Figure 3.7-63—{CCNPP Unit 3 Radioactive Waste Processing Building Basemat Z-Direction Spectra (5% Damping)}

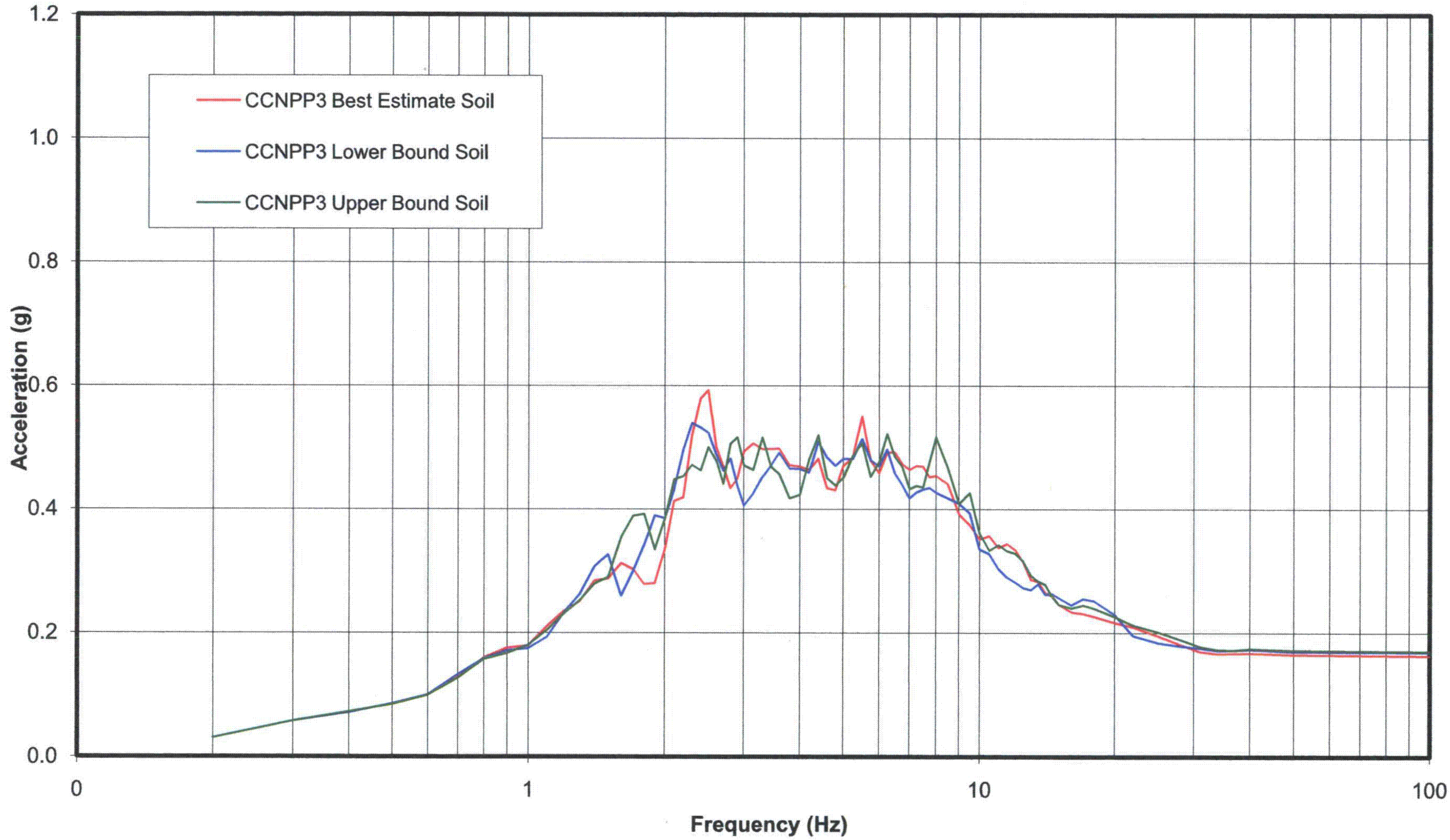


Figure 3.7-64—{Design Certification Radioactive Waste Processing Building Basemat X-Direction Spectra (5% Damping)}

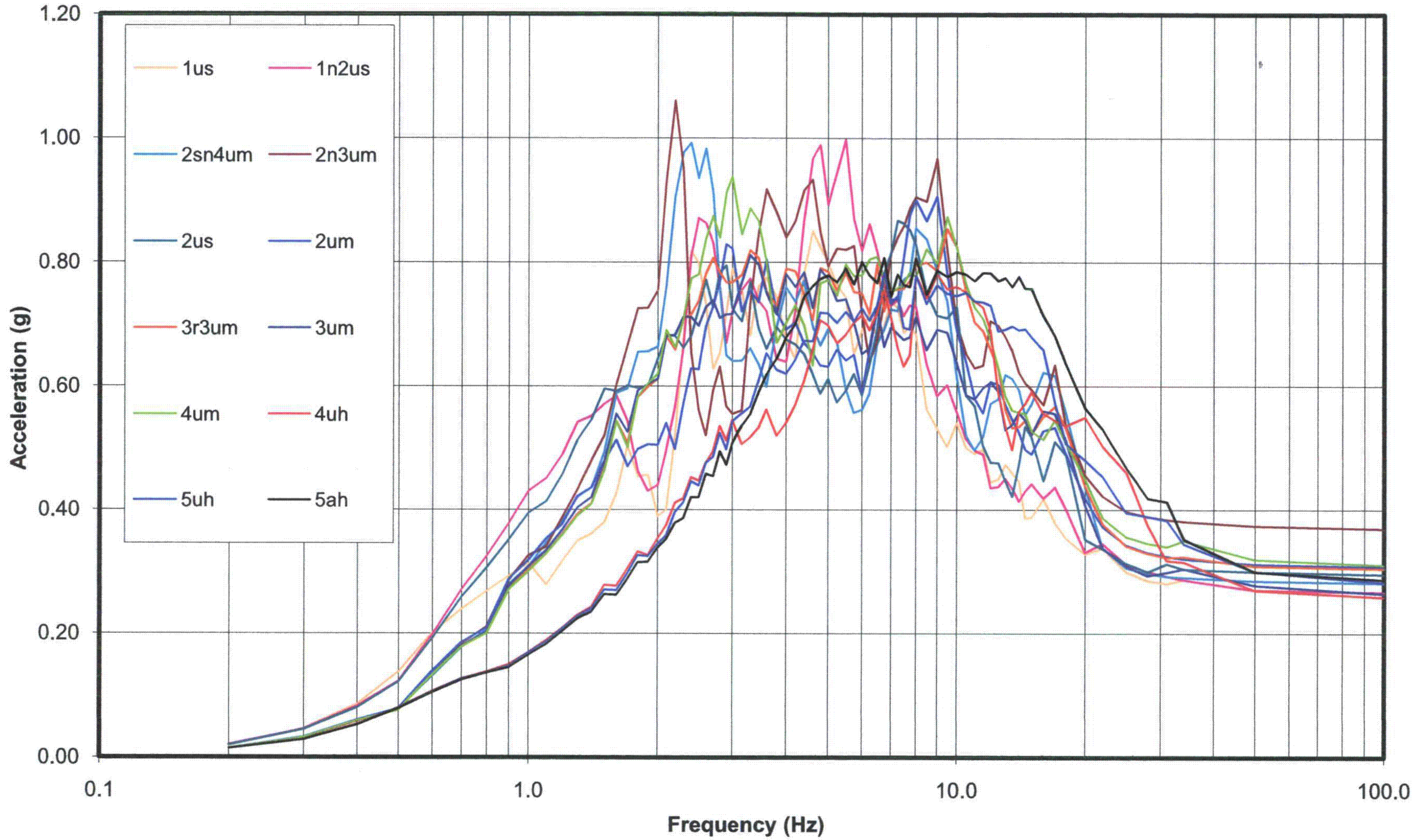


Figure 3.7-65—{Design Certification Radioactive Waste Processing Building Basemat Y-Direction Spectra (5% Damping)}

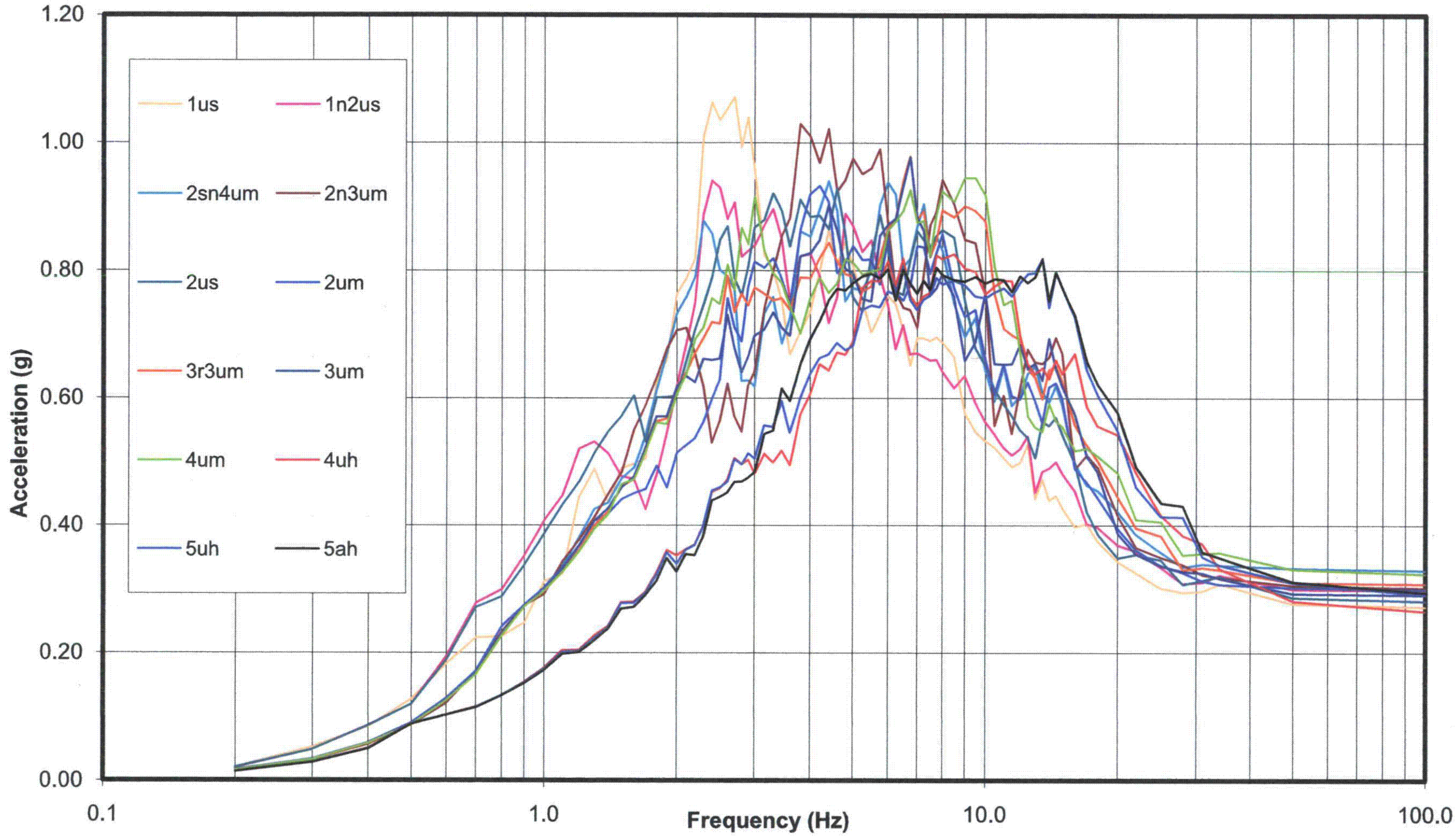


Figure 3.7-66—{Design Certification Radioactive Waste Processing Building Basemat Z-Direction Spectra (5% Damping)}

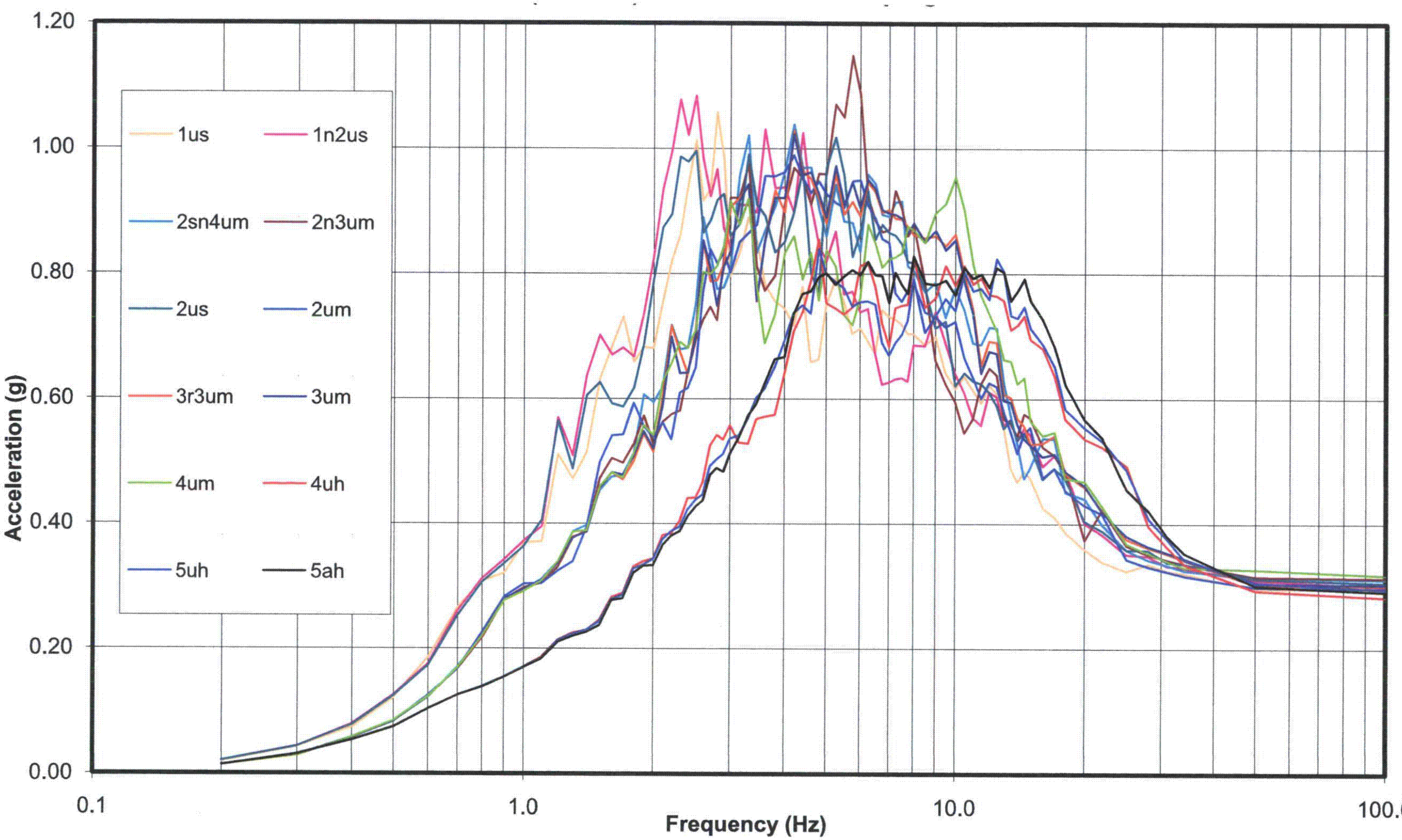


Figure 3.7-67—{Emergency Power Generating Building (EPGB), Elev. 0.0 ft (0.0 m), X (E-W) Direction ISRS, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

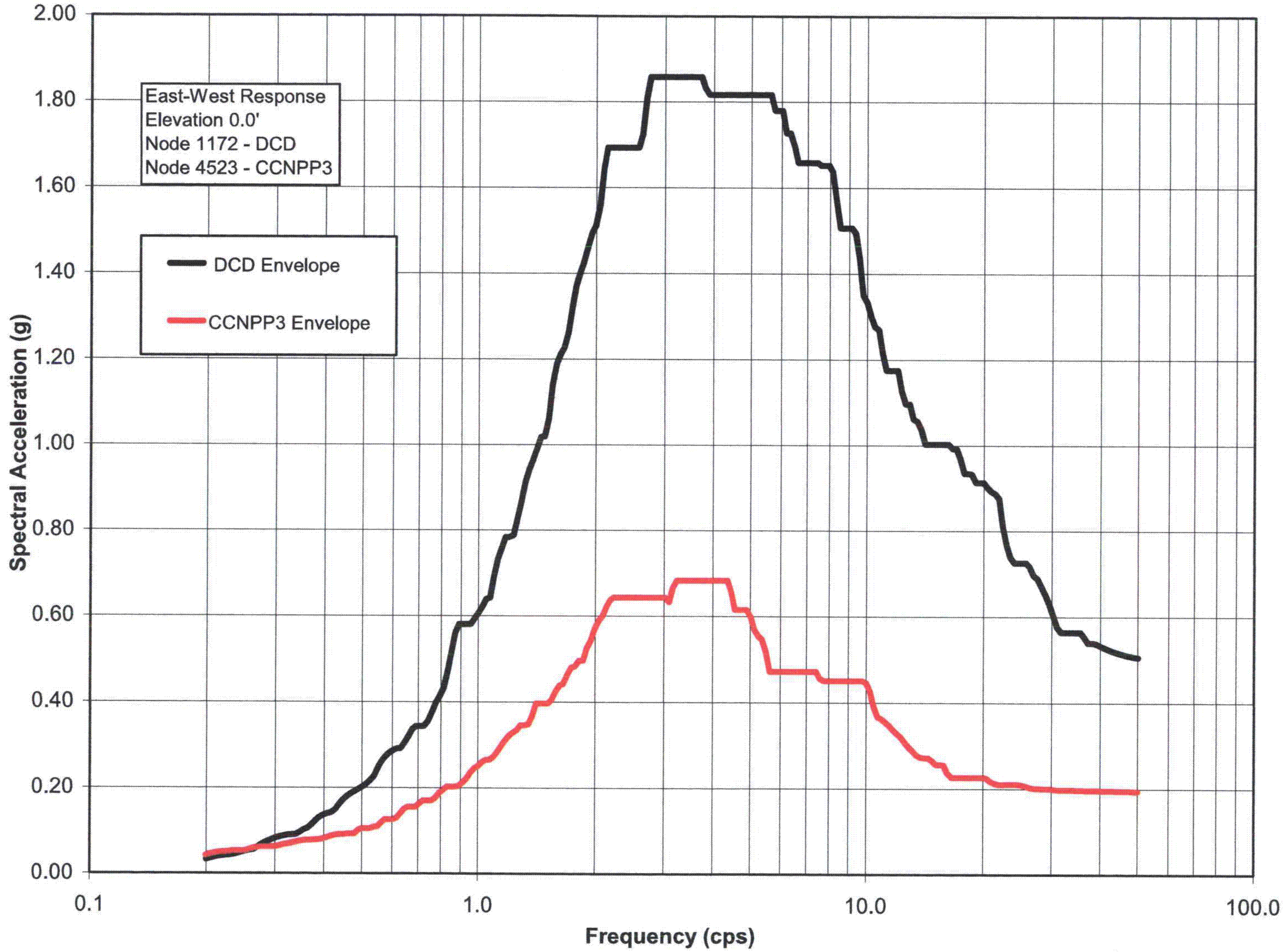


Figure 3.7-68—{Emergency Power Generating Building (EPGB), Elev. 0.0 ft (0.0 m), Y (N-S) Direction ISRS, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

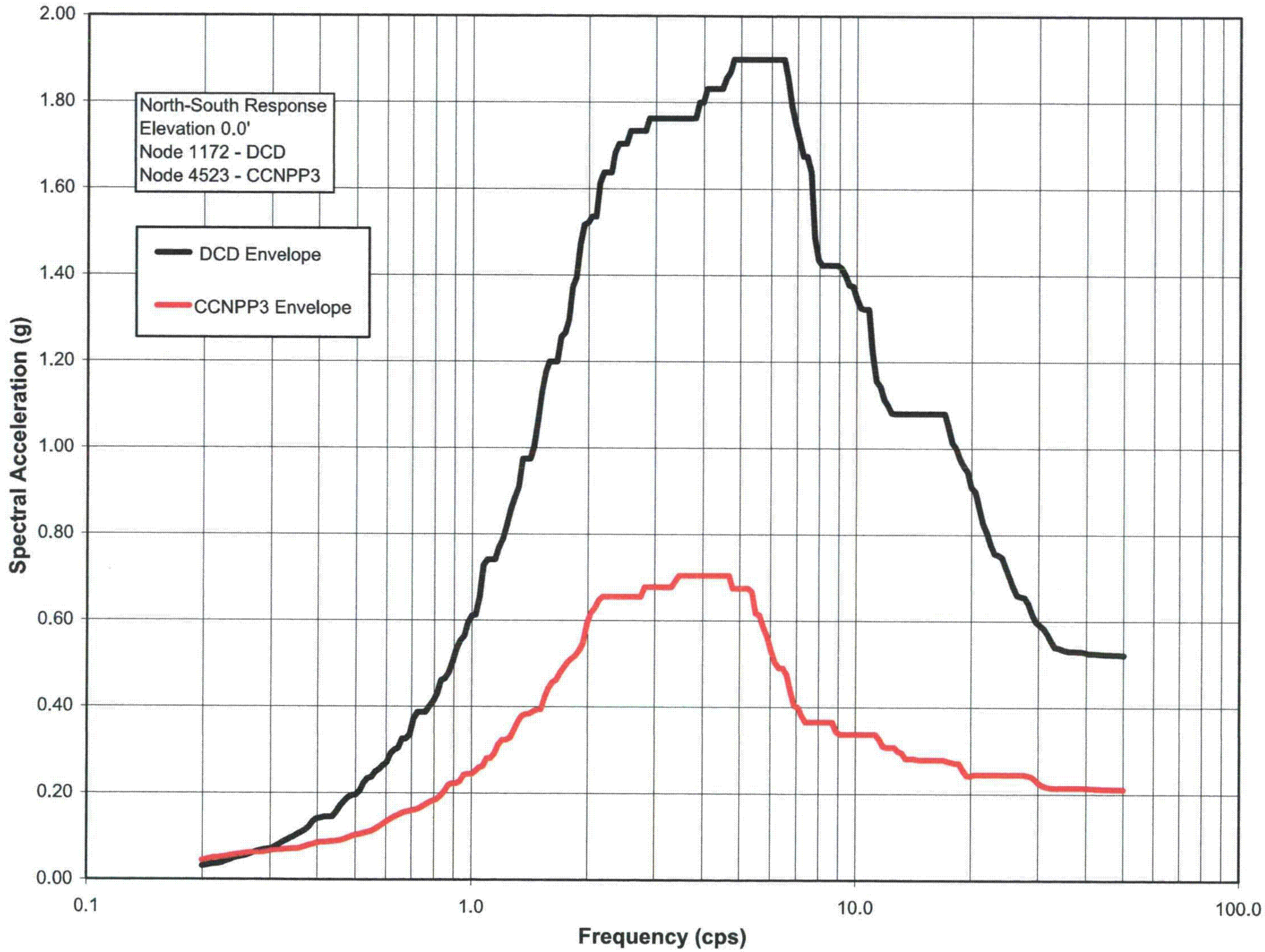


Figure 3.7-69—{Emergency Power Generating Building (EPGB), Elev. 0.0 ft (0.0 m), Z (Vert) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

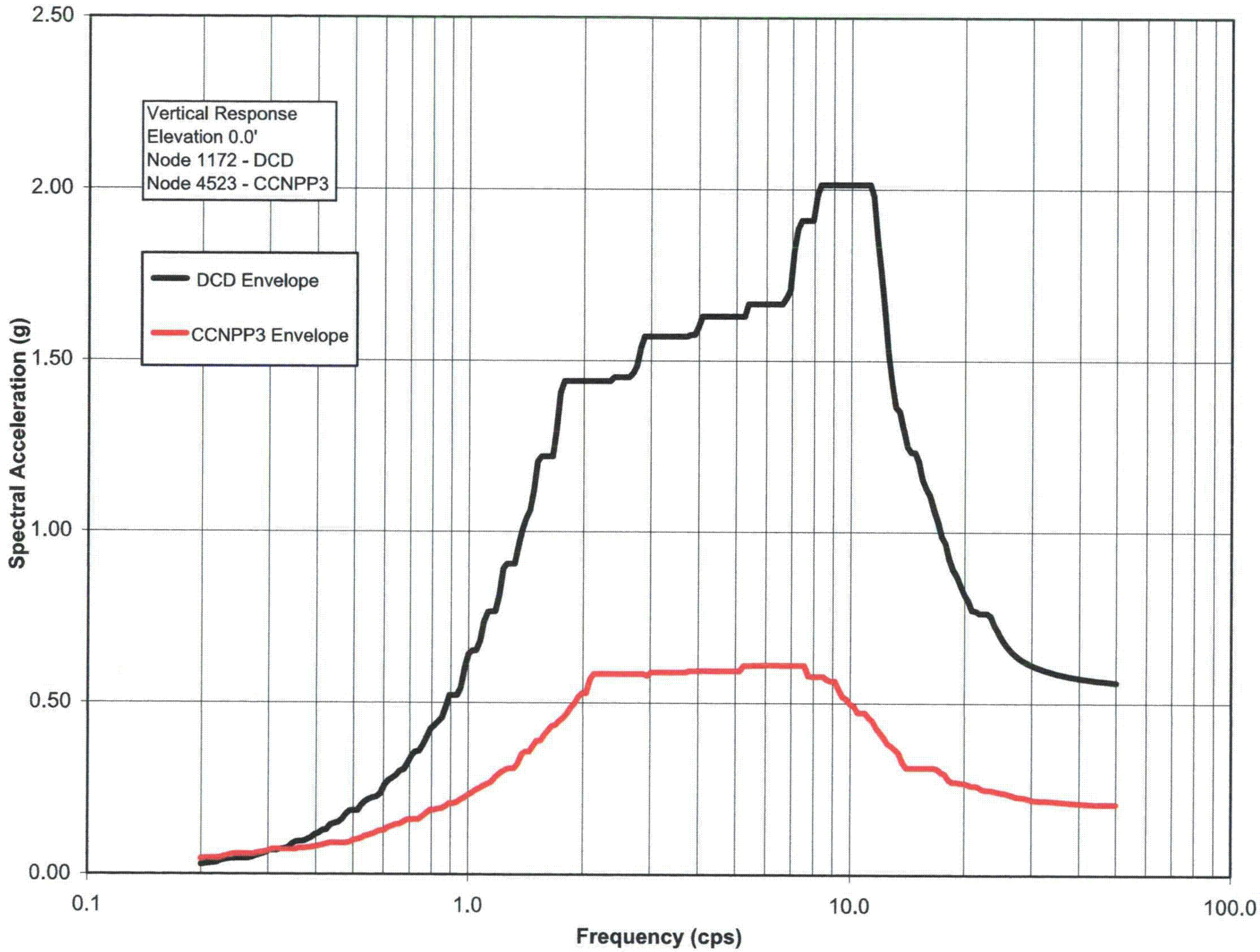


Figure 3.7-70—{Essential Service Water Building (ESWB), Elev. 63.0 ft (19.2 m), X (N-S) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

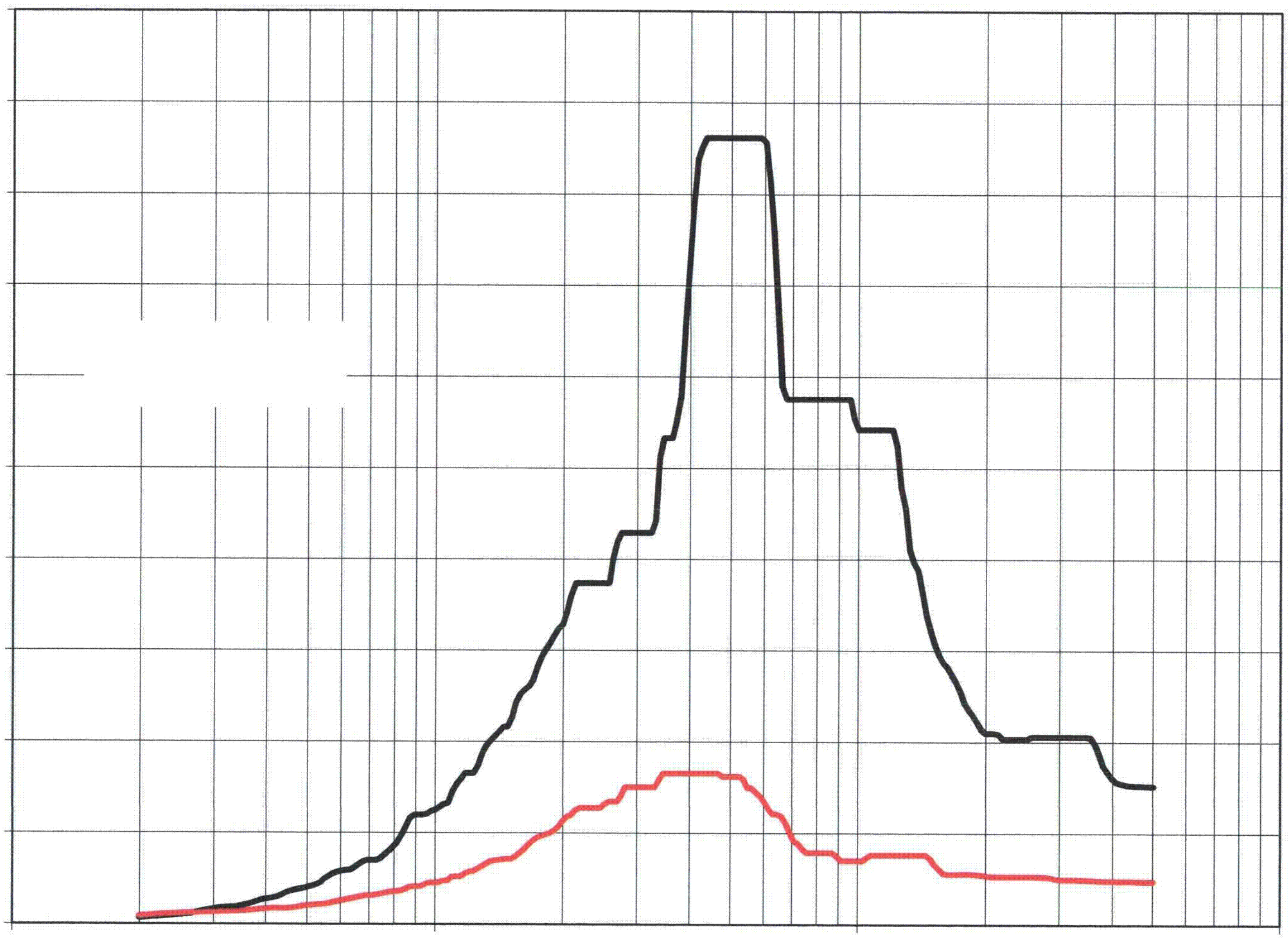


Figure 3.7-71—{Essential Service Water Building (ESWB), Elev. 63.0 ft (19.2 m), Y (E-W) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

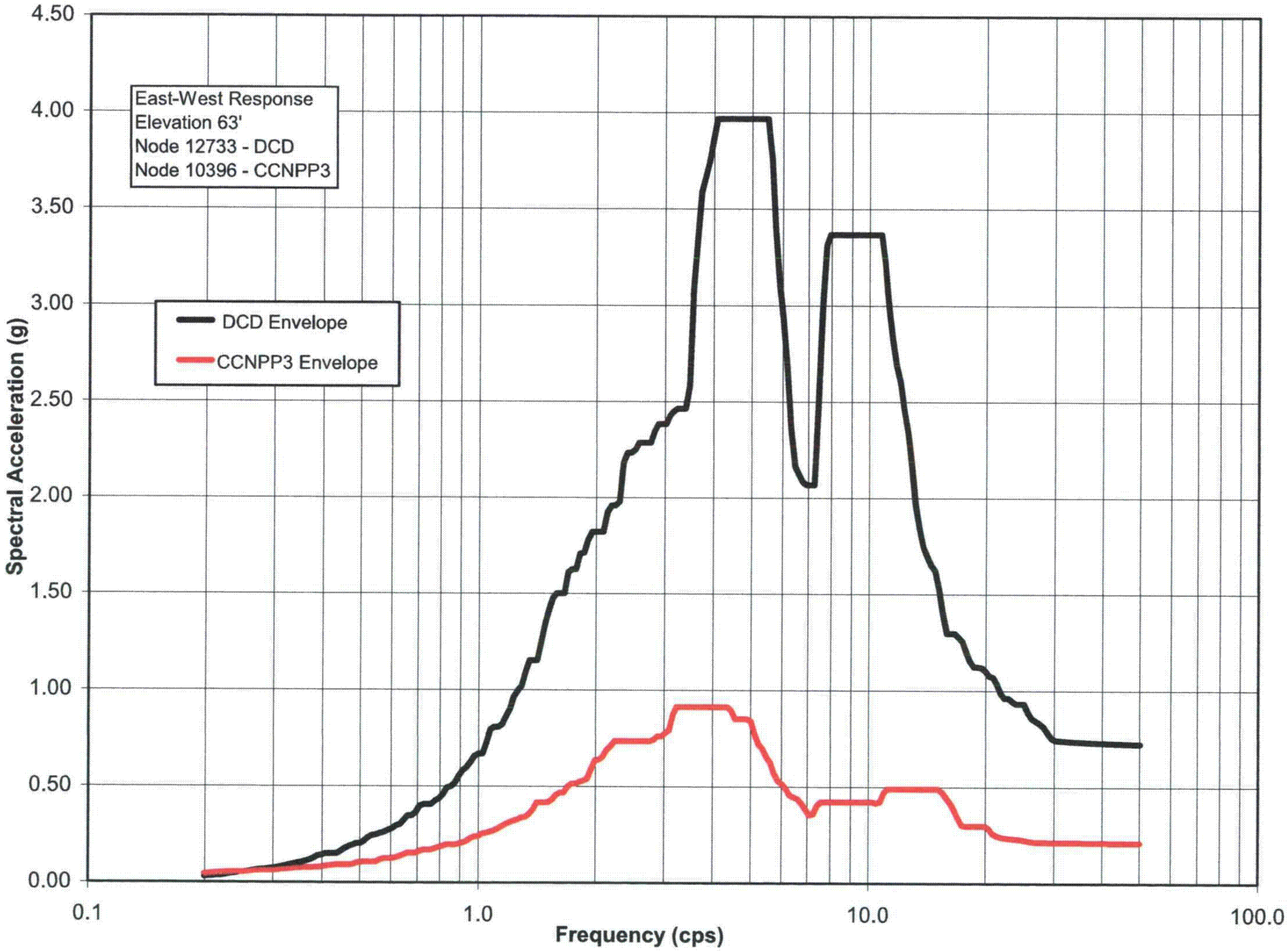


Figure 3.7-72—{Essential Service Water Building (ESWB), Elev. 63.0 ft (19.2 m), Z (Vert) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

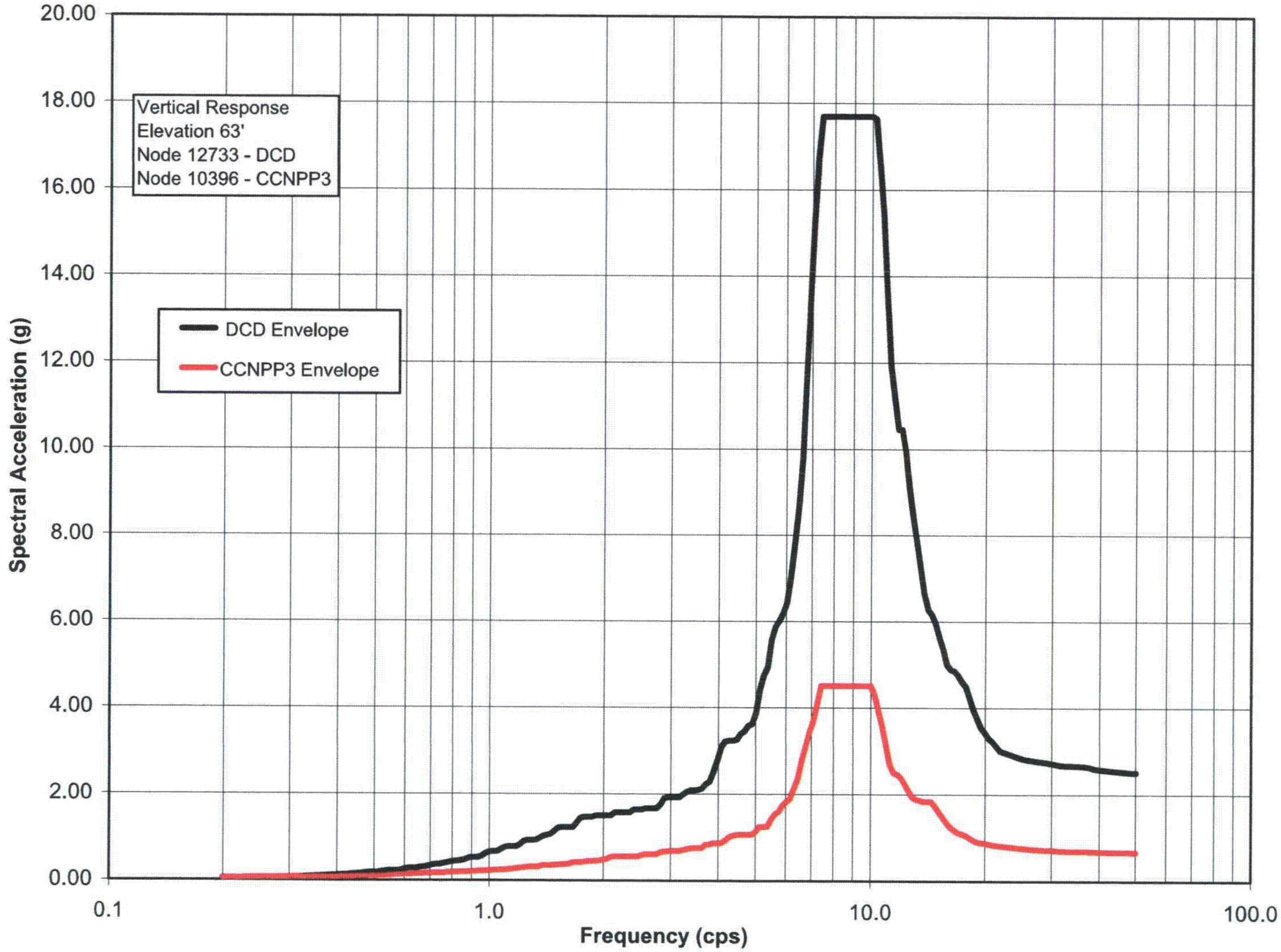


Figure 3.7-73—{Essential Service Water Building (ESWB), Elev. 14.0 ft (4.3 m), X (N-S) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

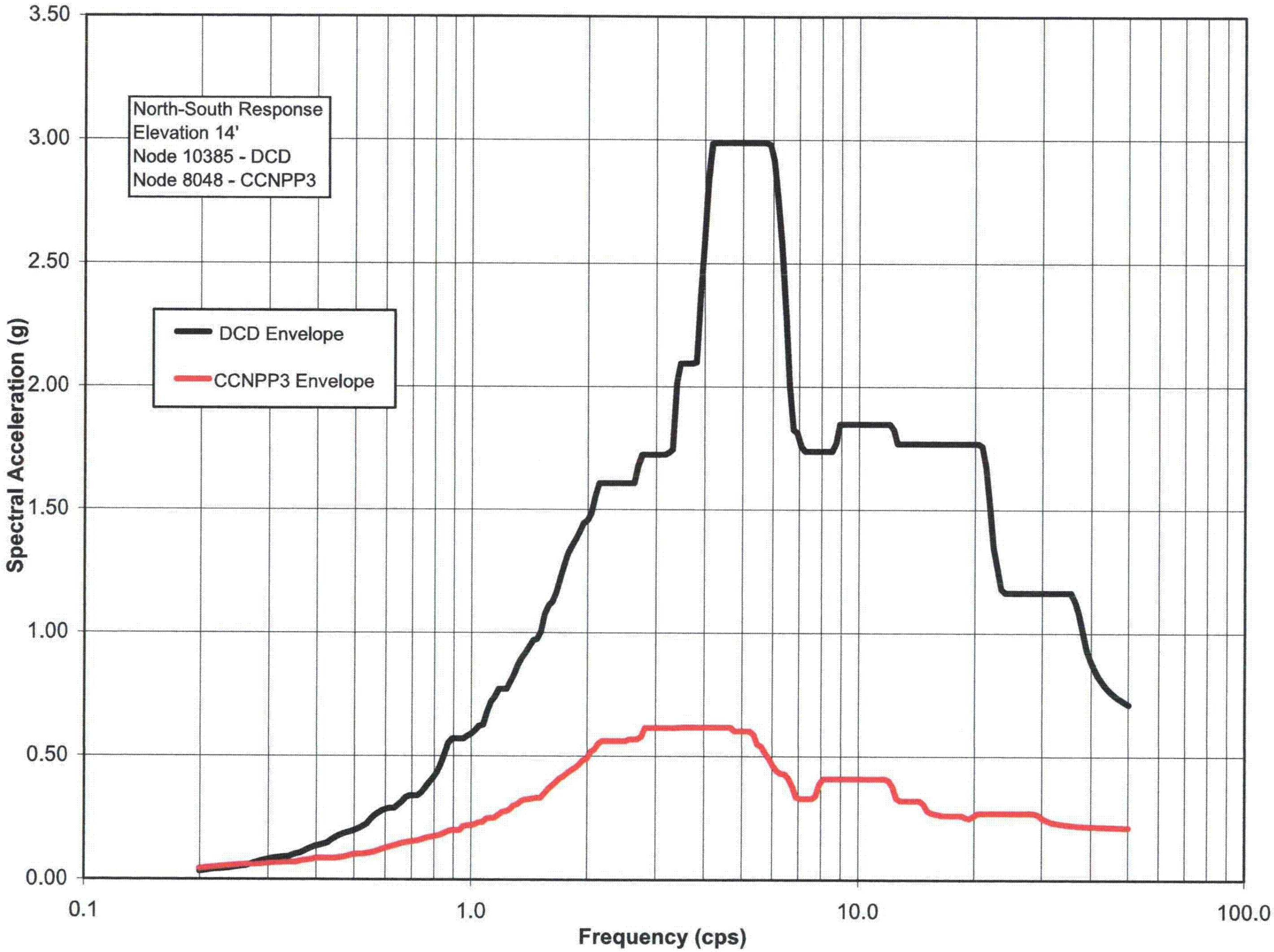


Figure 3.7-74—{EssentialService Water Building (ESWB), Elev. 14.0 ft (4.3 m), Y (E-W) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

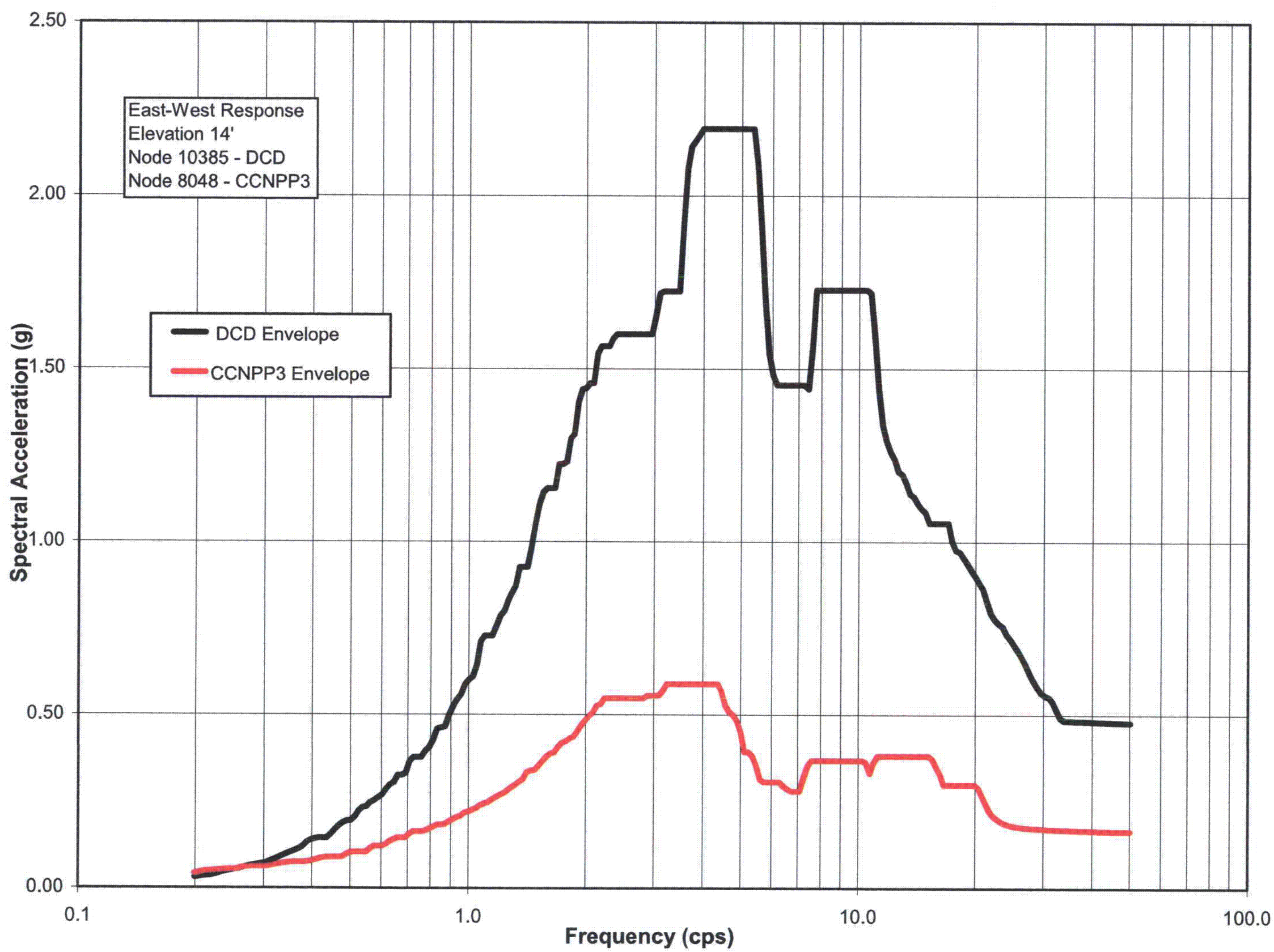


Figure 3.7-75—{Essential Service Water Building (ESWB), Elev. 14.0 ft (4.3 m), Z (Vert) Direction Spectra, 5% Damping. Elevations and plant coordinate system refer to U.S EPR FSAR.}

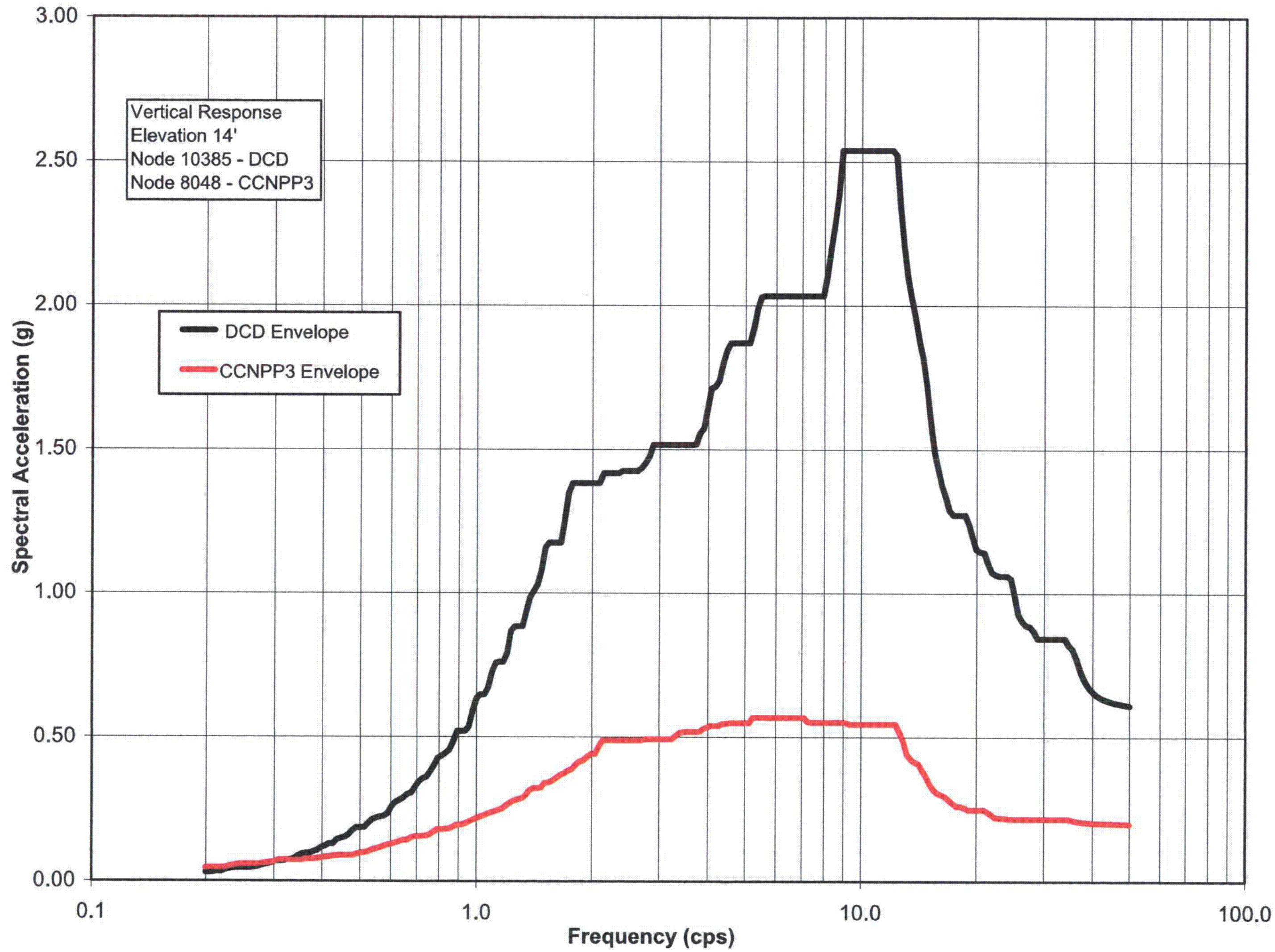


Figure Replaced

Figure 3.7-76—{ISRS for UHS Makeup Water Intake Structure at location at Elev. -22.5 ft (-6.86 m)~~of Makeup Pumps, Elev. 11.5 ft (3.5 m)~~, North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

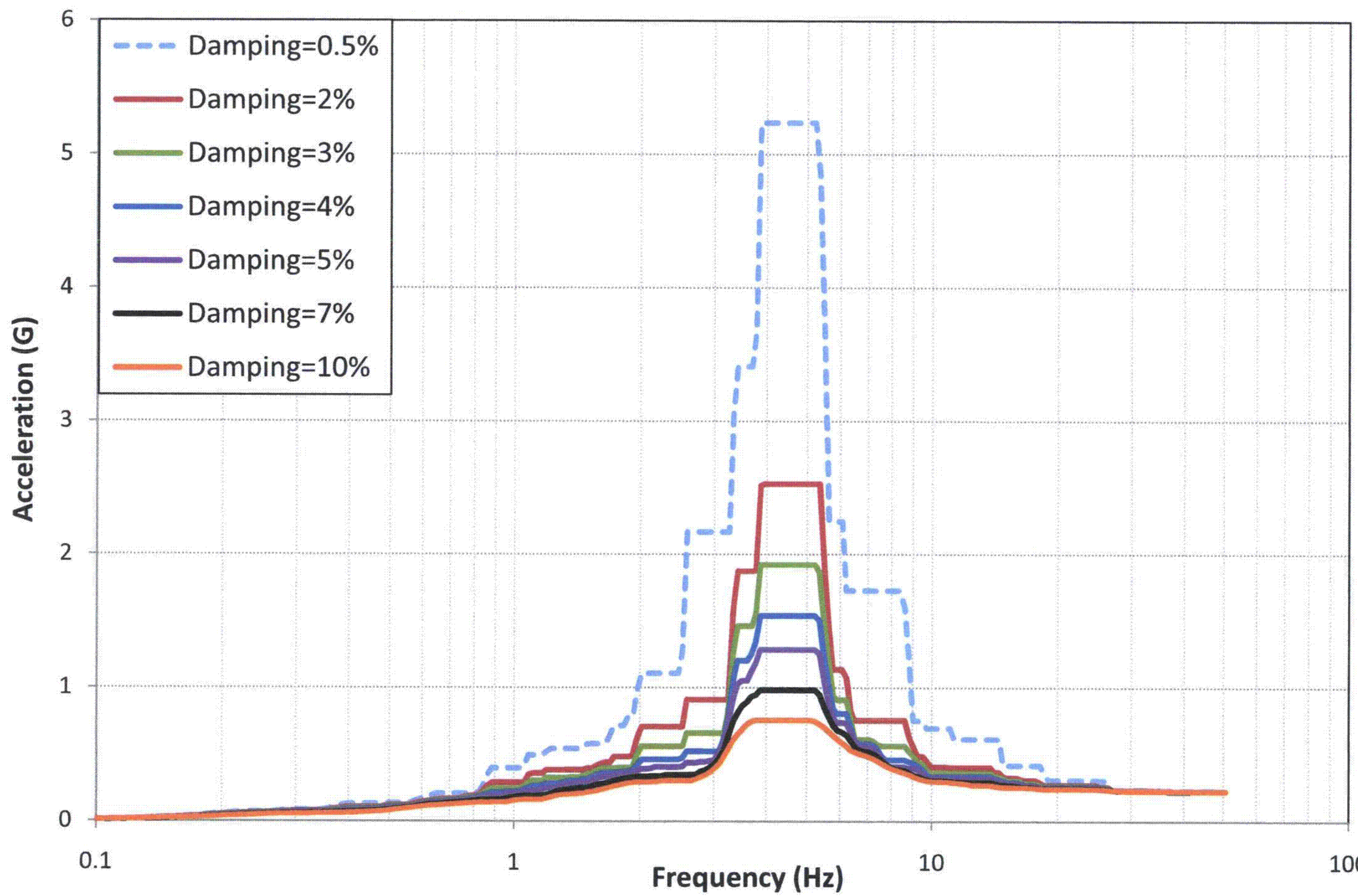


Figure Replaced

Figure 3.7-77—{ISRS for UHS Makeup Water Intake Structure at ~~location of Makeup Pumps,~~ Elev. ~~11.5 ft (3.5 m)~~ -22.5 ft (-6.86 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3.}

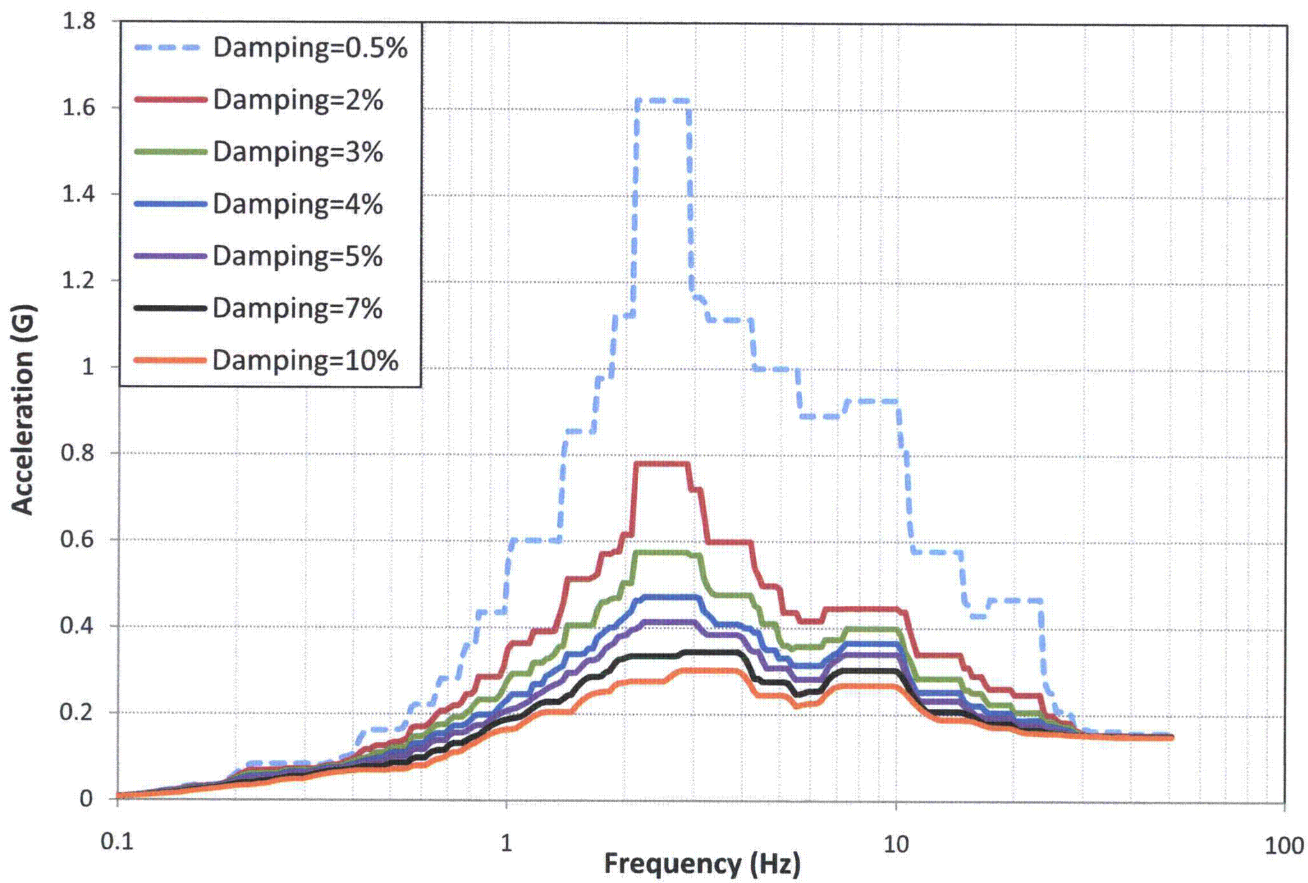


Figure Replaced

Figure 3.7-78—{ISRS for UHS Makeup Water Intake Structure at ~~location of Makeup Pumps,~~ Elev. ~~11.5 ft (3.5 m)~~-22.5 ft (-6.86 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

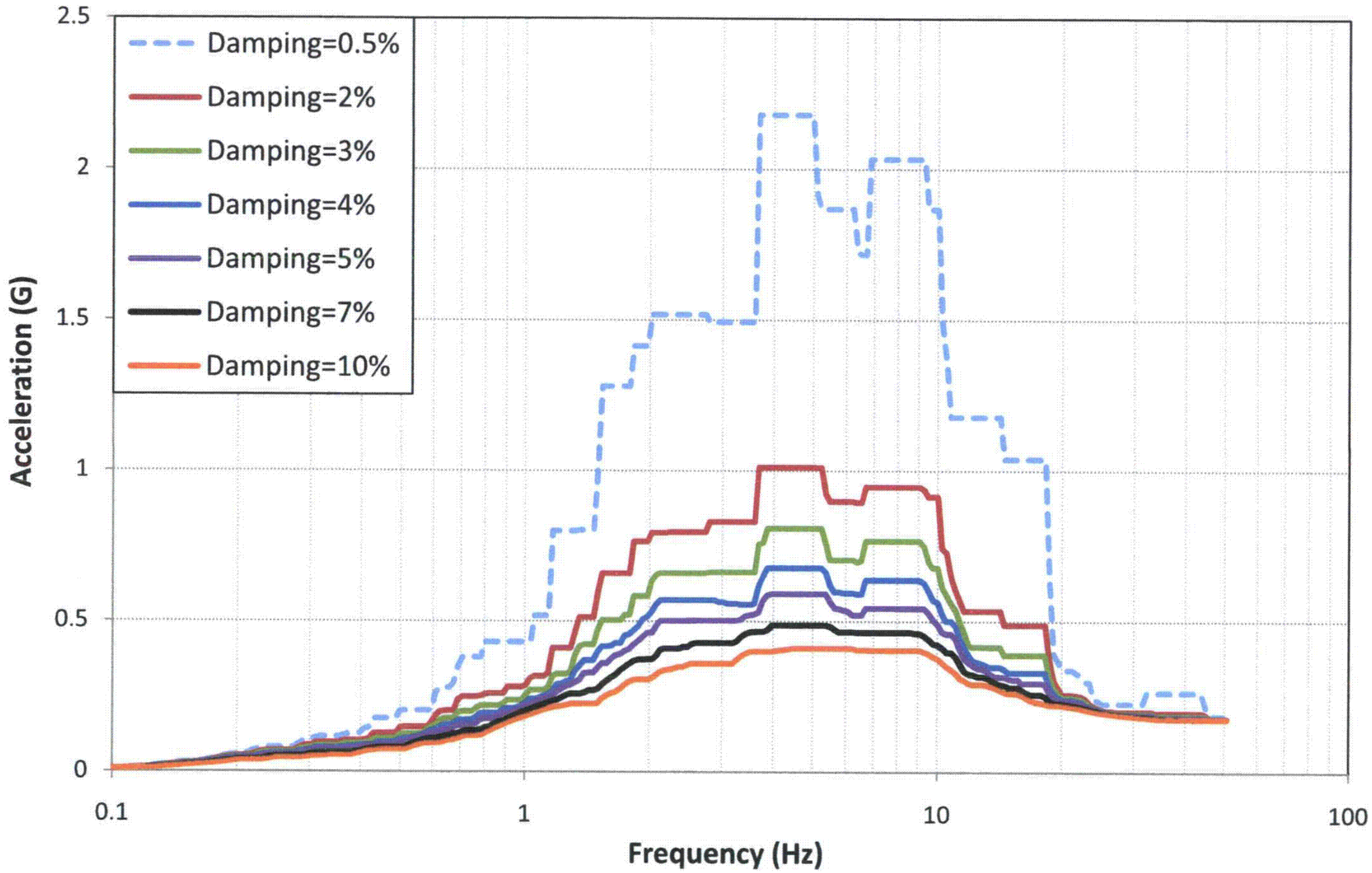


Figure Replaced

Figure 3.7-79—{ISRS for ~~UHS Electrical Building, Elev. -5.5 ft (-1.7 m)~~Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3.}

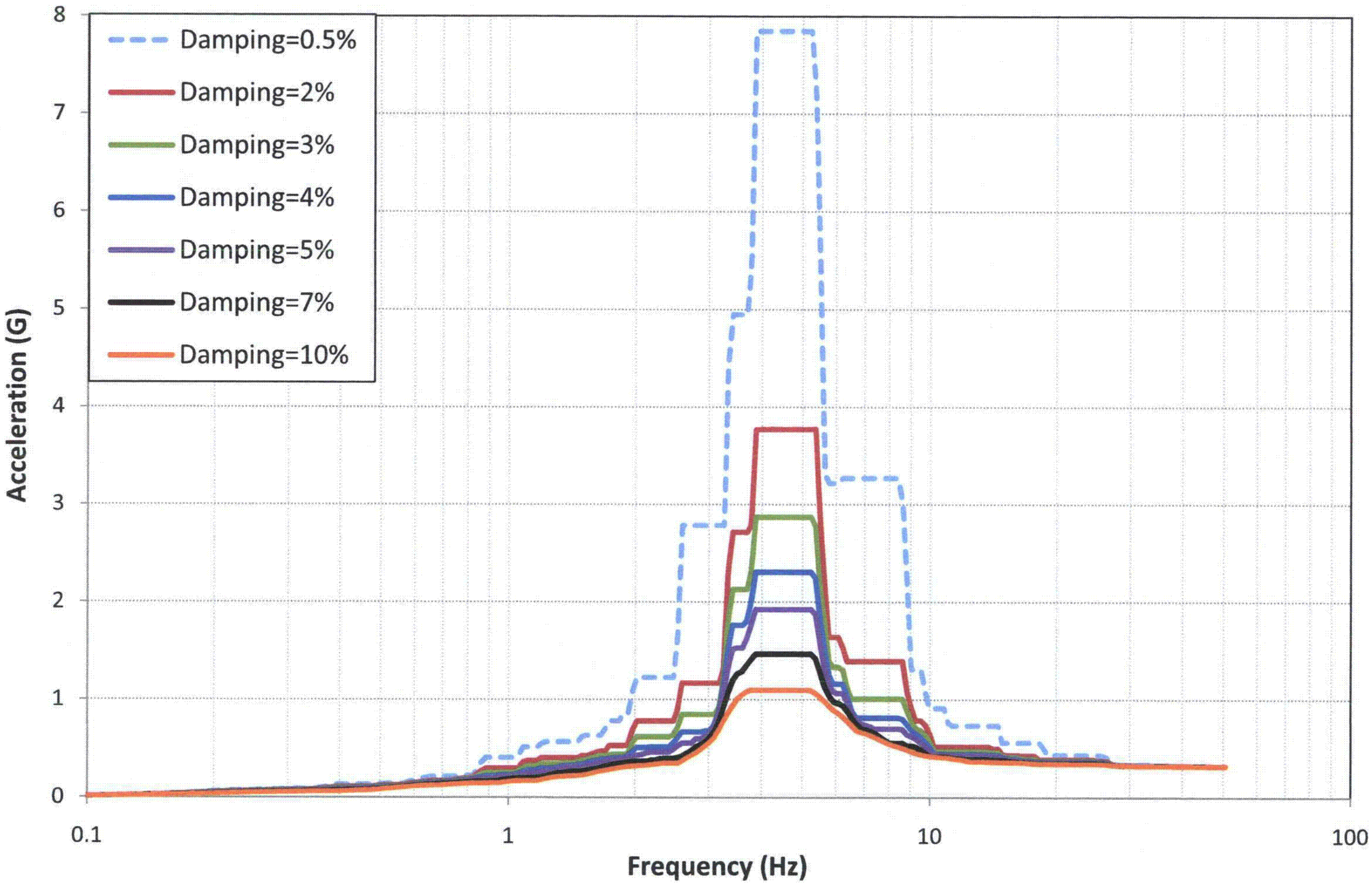


Figure Replaced

Figure 3.7-80—{ISRS for UHS ~~Electrical Building, Elev. -5.5 ft (-1.7 m)~~Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

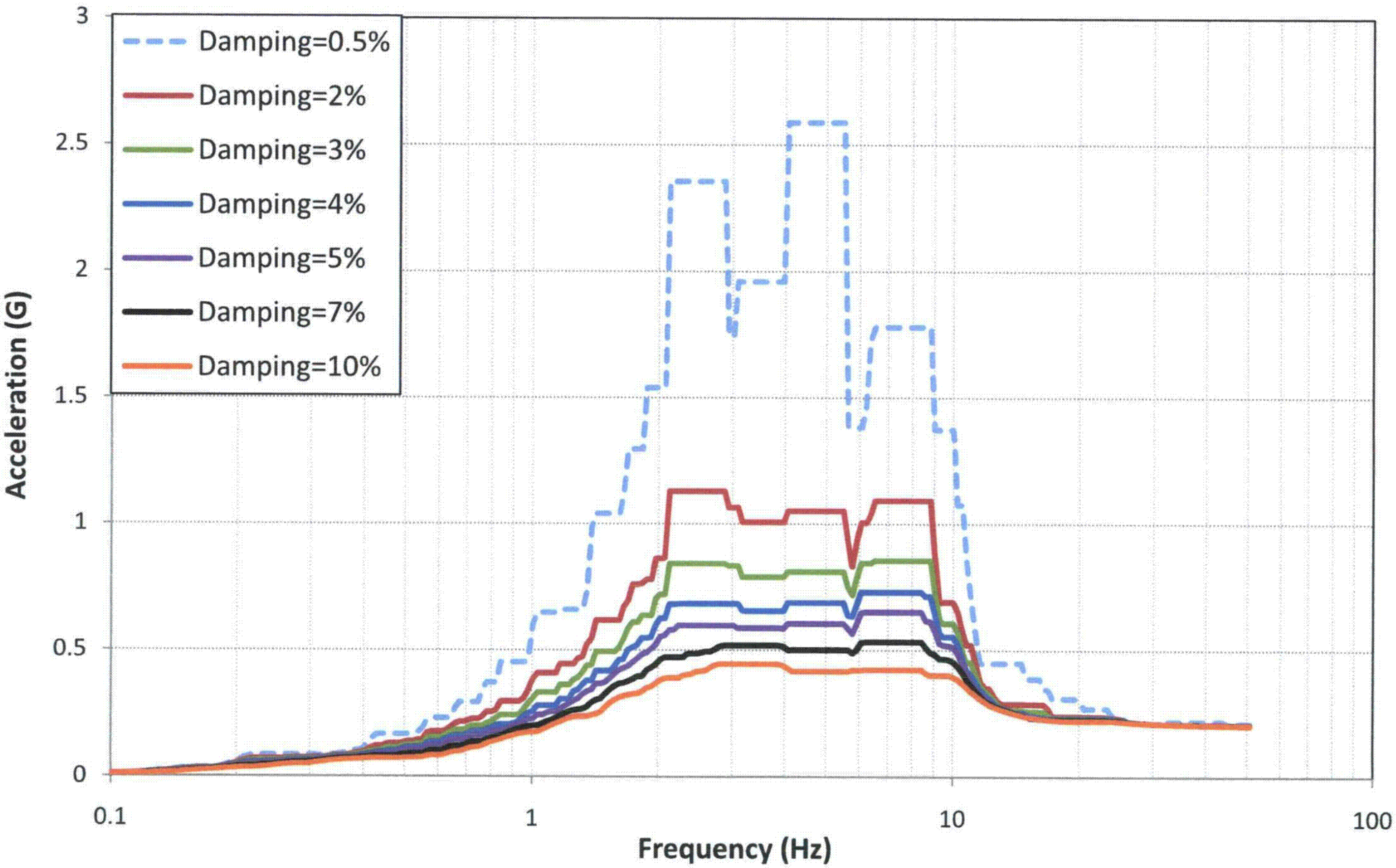
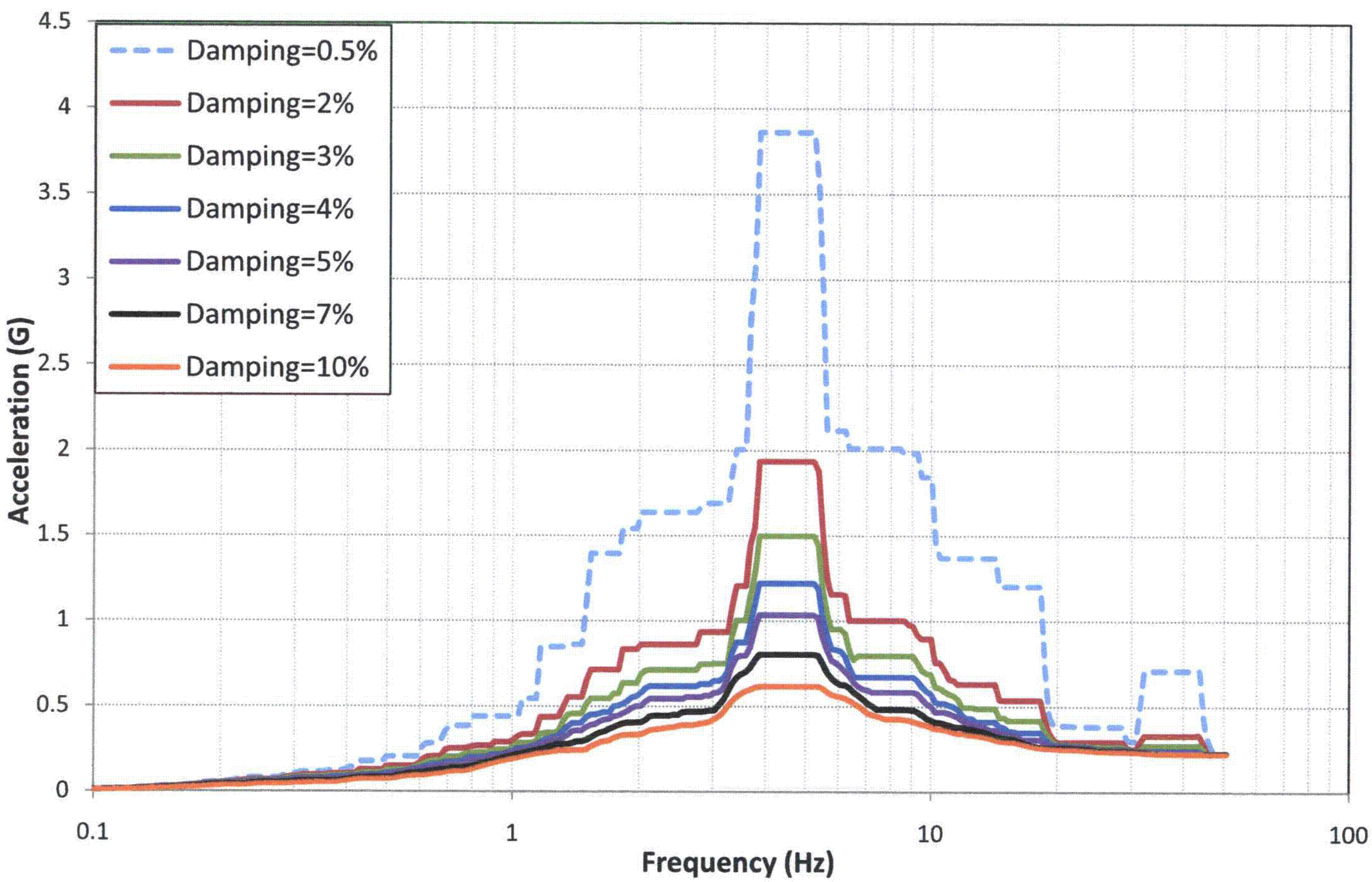


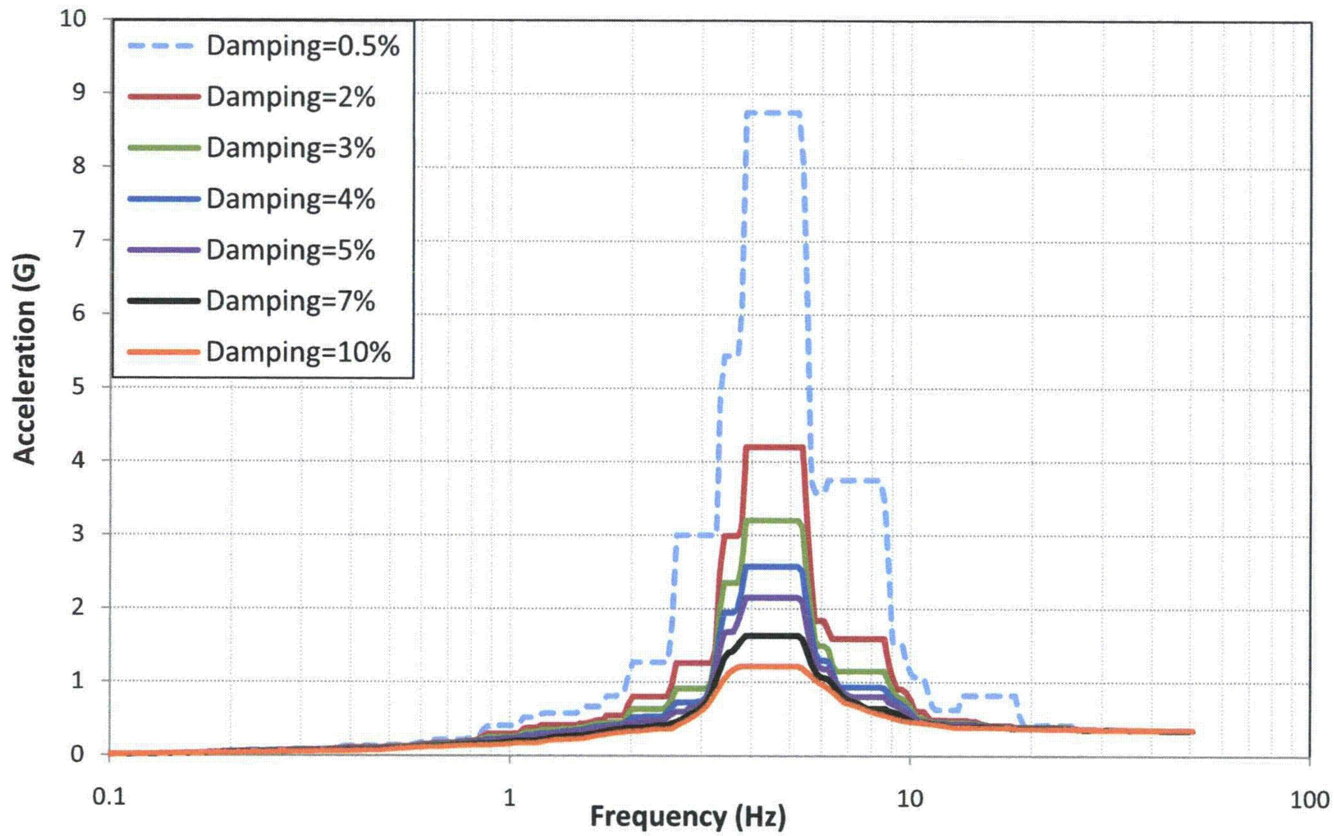
Figure Replaced

Figure 3.7-81—{ISRS for ~~UHS Electrical Building, Elev. -5.5 ft (-1.7 m)~~Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}



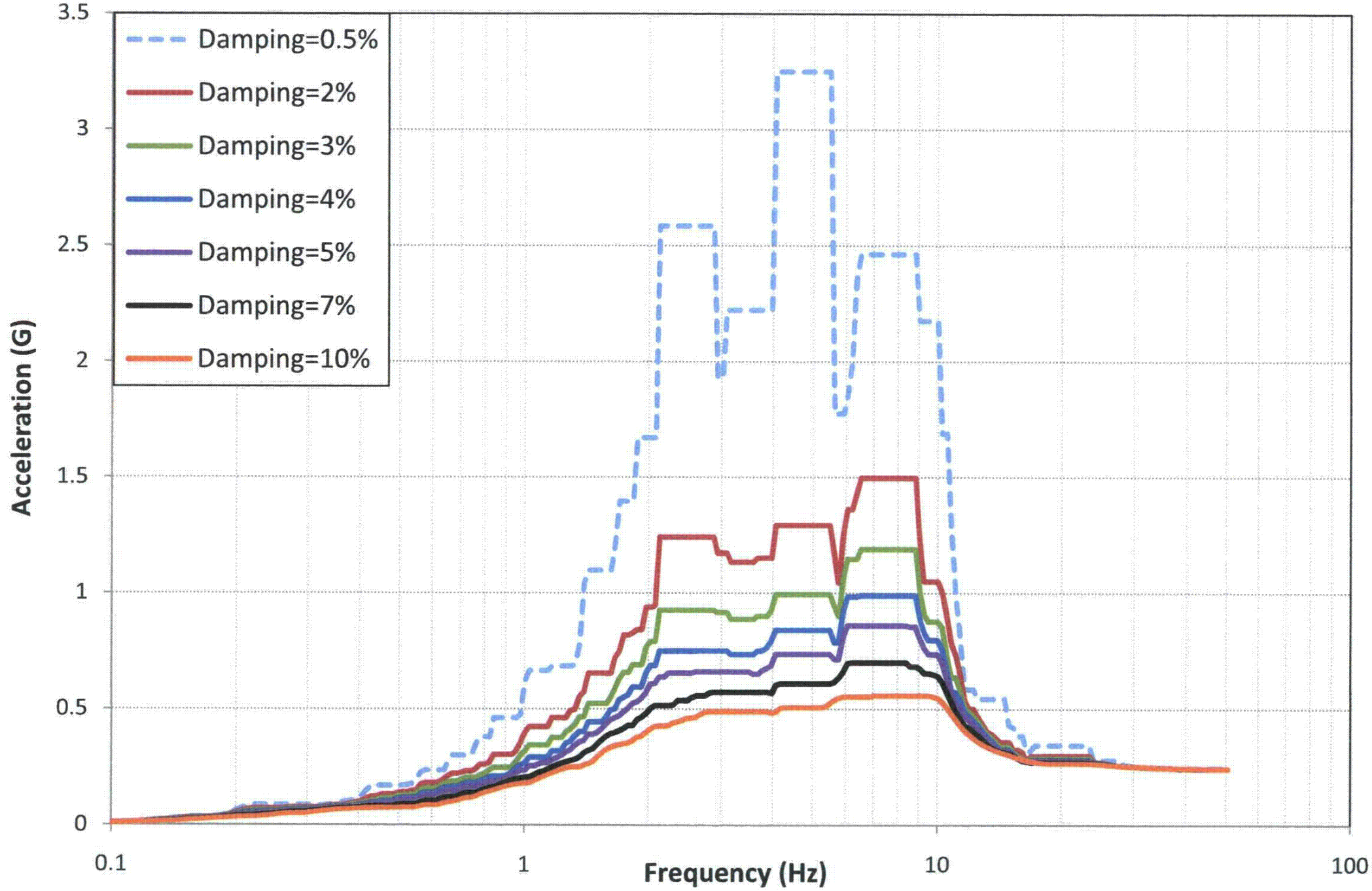
New Figure

Figure 3.7-82—{ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}



New Figure

Figure 3.7-83—{ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}



New Figure

Figure 3.7-84—{ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}