Greg Gibson
Vice President, Regulatory Affairs

750 East Pratt Street, Suite 1600
Baltimore, Maryland 21202

UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

September 15, 2009

UN#09-388

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3
RAI No. 58, Seismic Design Parameters, Questions 03.07.01-1 and 03.07.01-10
RAI No. 65, Seismic System Analysis, Questions 03.07.02-18 and 03.07.02-24
RAI No. 112, Seismic Design Parameters; Question 03.07.01-11

References:

1) John Rycyna (NRC) to Robert Poche (UniStar Nuclear Energy), "RAI No 58 SEB2 1966.doc (PUBLIC)" email dated February 17, 2009

2) John Rycyna (NRC) to Robert Poche (UniStar Nuclear Energy), "RAI No 65 SEB2 1971.doc (PUBLIC)" email dated February 18, 2009

3) John Rycyna (NRC) to Robert Poche (UniStar Nuclear Energy), "RAI No 112 SEB 2574.doc (PUBLIC)" email dated April 30, 2009

4) UniStar Nuclear Energy Letter UN#09-364, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI No. 58, Seismic Design Parameters, Questions 03.07.01-3 and 03.07.01-5, dated August 27, 2009

D096
NRO

The purpose of this letter is to respond to the requests for additional information (RAIs) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated February 17, 2009 (Reference 1), February 18, 2009 (Reference 2), and April 30, 2009 (Reference 3). These RAIs address Seismic Design and Analysis, as discussed in Section 3.7 of the Final Safety Analysis Report, as submitted in Part 2 of the CCNPP Unit 3 Combined License Application (COLA), Revision 5.

Enclosure 1 provides the current status of responses to the RAI questions for Seismic Analysis RAI Nos. 58, 65, and 112.

Enclosure 2 provides our responses to RAI No. 58, Questions 03.07.01-1 and 03.07.01-10; RAI No. 65, Questions 03.07.02-18 and 03.07.02-24; and RAI No. 112, Question 03.07.01-11, as committed in Reference 4.

Several of the responses include revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

The responses do not include any new regulatory commitments.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Michael J. Yox at (410) 495-2436.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 15, 2009

for ~~Greg~~ Greg Gibson

Enclosures:

1) Response Summary for Requests for Additional Information, RAI No. 58, Seismic Design Parameters; RAI No. 65, Seismic System Analysis; and RAI No. 112, Seismic Design Parameters; Calvert Cliffs Nuclear Power Plant Unit 3

2) Response to NRC Request for Additional Information, RAI No. 58, Seismic Design Parameters, Questions 03.07.01-1 and 03.07.01-10; RAI No. 65, Seismic System Analysis, Questions 03.07.02-18 and 03.07.02-24; and RAI No. 112, Seismic Design Parameters, Question 03.07.01-11; Calvert Cliffs Nuclear Power Plant, Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

GTG/TD/mdf

Enclosure 1

Response Summary for Requests for Additional Information,
RAI No. 58, Seismic Design Parameters,
RAI No. 65, Seismic System Analysis, and
RAI No. 112, Seismic Design Parameters;
Calvert Cliffs Nuclear Power Plant Unit 3

Response Summary for Requests for Additional Information

RAI Set 58 Question	Description of RAI Item	Response Date
03.07.01-1	Justify assumptions of rigid basemat in SSI analysis of Nuclear Island including lower bound soil properties (where shear wave velocity is less than 1000 fps)	This Letter – See Enclosure 2
	Identify impact on the SSI analysis results and on the design of the foundation mat and supported superstructure.	This Letter – See Enclosure 2
03.07.01-2	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.01-3	For EPGB and ESWB, provide methodology to calculate FIRS at grade elevation computed from the GMRS which were determined at an applicable elevation 41 ft below grade. See UniStar Nuclear Energy letter UN#09-364, dated August 27, 2009	Response submitted
	Describe computer codes, soil column model, and the basis for the shear wave velocity of the structural backfill that supports both the EPGB and ESWB and the impact of this backfill on the development of the FIRS.	December 29, 2009
	Provide in the FSAR the spectra at the foundation level of each structure meeting Appendix S requirements.	December 29, 2009
	Provide in the FSAR a comparison of the FIRS at the foundation level of each structure meeting the requirements of Appendix S to the CSDRS provided in the U.S. EPR FSAR.	December 29, 2009
	Provide the basis for not performing confirmatory analysis for the EPGB and ESWB similar to that for NI. See UniStar Nuclear Energy letter UN#09-329, dated July 29, 2009.	Response submitted
03.07.01-4	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.01-5	For Ultimate Heat Sink Electrical Building, provide and include in the FSAR the horizontal and vertical spectra depicting design spectra and applicable envelope. See UniStar Nuclear Energy letter UN#09-364, dated August 27, 2009	Response submitted

Response Summary for Requests for Additional Information

RAI Set 58 Question	Description of RAI Item	Response Date
	Provide in the FSAR a reconciliation of the design response spectrum with the horizontal foundation input response spectra (FIRS) for this structure which meets the minimum requirements of 10 CFR Part 50, Appendix S.	December 29, 2009
	Include a description of how the FIRS are developed including the soil model, soil properties, backfill properties, computer programs and analysis assumptions.	December 29, 2009
03.07.01-6	Provide in the FSAR how the design response spectrum and assumed soil properties used in the analysis of the UHS MWIS will be reconciled with the FIRS that meets the requirements of Appendix S and the final soil properties determined from the site final geotechnical studies. See UniStar Nuclear Energy letter UN#09-371, dated September 14, 2009	Response submitted
	Include in the FSAR a comparison of the FIRS with the design response spectra used in the analysis.	December 29, 2009
	Include a description of how the FIRS are developed including the soil model, soil properties, computer programs, and analysis assumptions.	December 29, 2009
03.07.01-7	Provide in the FSAR a discussion of the site-specific spectra that were considered for buried utilities.	December 29, 2009
	Provide justification for the use of the EUR soft soil spectrum including possible displacement and velocity differences that may exist with the use of this spectrum as opposed to using a site specific spectrum.	December 29, 2009
	Provide a comparison of the EUR soft soil spectrum with appropriate site specific spectra that are applicable to buried utilities.	December 29, 2009
03.07.01-8	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.01-9	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.01-10	State explicitly or by reference design ground motion time histories for Nuclear Island, EPGB and ESWB structures.	This Letter – See Enclosure 2

Response Summary for Requests for Additional Information

RAI Set 58 Question	Description of RAI Item	Response Date
	What are the site specific design ground motions and their bases that apply to these structures? Provide this information in Section 3.7.1.1.2 of the FSAR.	December 29, 2009

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-1	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-2	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-3	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-4	Provide results of SSI analysis for Ultimate Heat Sink Electrical Building that meet the acceptance criteria 4.A.vii of SRP 3.7.1 and acceptance criteria 4 of SRP 3.7.2 using subgrade model of final soil and backfill properties or justify alternative.	December 29, 2009
	Include SSSI effects from UHS MWIS.	December 29, 2009
	Reconcile with the results of assumed seismic response and ISRS.	December 29, 2009
03.07.02-5	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-6	Describe how the SSI analysis performed for Ultimate Heat Sink Makeup Water Intake Structure (UHS MWIS) meets the acceptance criteria and 4.A.vii of SRP 3.7.1 or justify alternative.	December 29, 2009
	Provide a figure depicting the soil-structure model used for the seismic analysis.	December 29, 2009

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
	Provide the basis for the assumed soil properties and profile used to calculate the frequency independent impedance functions. See UniStar Nuclear Energy letter UN#09-339, dated August 13, 2009	Response submitted
	Provide the method and formulas used to calculate the values of the soil springs under the foundation as well as the lateral soil springs that represent the embedment effects. See UniStar Nuclear Energy letter UN#09-339, dated August 13, 2009	Response submitted
	State whether the soil properties used in the analysis are strain dependent or simply the low strain values. If these are low strain values, justify their use and quantify the impact of not using strain dependent properties on the results of the analysis. If the soil properties are strain dependent, describe how the final soil properties are determined in the analysis. See UniStar Nuclear Energy letter UN#09-339, dated August 13, 2009	Response submitted
	For large values of Poisson's ratio, the dynamic stiffness and damping are frequency dependent. Provide justification for assuming that the impedance functions of the supporting foundation are frequency independent. See UniStar Nuclear Energy letter UN#09-339, dated August 13, 2009	Response submitted
	Confirm that the control motion is applied at the base of the soil structure analysis model. See UniStar Nuclear Energy letter UN#09-339, dated August 13, 2009	Response submitted
	Provide a reconciliation of the final soil properties and the foundation input response spectra (FIRS) that are based on these properties with the seismic analysis results described in the FSAR.	December 29, 2009
03.07.02-7	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-8	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-9	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-10	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-11	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-12	Provide results of a structure-to-structure interaction analysis between UHS MWIS and EB.	December 29, 2009
03.07.02-13	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-14	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-15	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.02-16	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-17	The interaction of non-seismic Category I structures with Seismic Category I systems is described in FSAR Section 3.7.2.8. In this section on page 3.0-41, it states that fire protection SSCs are categorized as either Seismic Category II-SSE, meaning the SSC must remain functional during and after a Safe Shutdown Earthquake (SSE), or Seismic Category II, meaning the SSC must remain intact after an SSE without deleterious interaction with a Seismic Category I or Seismic Category II-SSE SSC. In the U.S. EPR FSAR on page 3.7-95, it states that Seismic Category II is designed to the same criteria as Seismic Category I structures. In SRP 3.7.2, SRP Acceptance Criteria 8, which addresses the interaction of non-Category I structures with Category I SSCs, it states that when non-Category I structures are designed to prevent failure under SSE conditions; the margin of safety shall be equivalent to that of the Seismic Category I structure. • Describe how this margin of safety is achieved for the Seismic Category II-SSE and Seismic Category II portions of the fire protection system. Include in your response the seismic inputs, loading combinations, codes and acceptance criteria. What are the differences in the method of design for these two seismic categories? • Describe the basis and provide figures in the FSAR of the design response spectra used to analyze above ground seismic Category II and seismic Category II-SSE fire protection SSCs including the fire protection tanks. • What are the methods of analysis and acceptance criteria for both the buried and above ground portions of the fire protection system that are Seismic Category II-SSE that will ensure that these portions of the system will remain functional following an SSE event? • What are the modeling and analysis methods used for the fire protection tanks and to what extent do the fire protection tanks meet the acceptance criteria of SRP 3.7.3, SRP Acceptance Criteria 14.A. thru J? When the tank analysis does not meet the acceptance criteria, provide the technical justification for not doing so.	October 16, 2009
03.07.02-18	Clarify the seismic classification of fire protection tank and building. See UniStar Nuclear Energy letter UN#09-329, dated July 29, 2009.	Response submitted
	Reconcile the U.S. EPR seismic analysis for NAB with the site-specific soil properties and foundation input response spectra (FIRS)	This Letter – See Enclosure 2

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
	Demonstrate in the FSAR that the displacement of this structure relative to the nuclear island common basemat structure is enveloped by the results of the U.S. EPR analysis.	This Letter – See Enclosure 2
03.07.02-19	In FSAR Section 3.7.2.8 on page 3.0-42 it states that the conventional seismic switchgear building, conventional seismic grids systems control building, the conventional seismic circulating water intake structure and the Seismic Category II retaining wall surrounding the CCNPP Unit 3 intake channel could potentially interact with Seismic Category I SSCs. For each of the above structures, describe in the FSAR how the seismic interaction acceptance criteria of SRP 3.7.2, SRP Acceptance Criteria 8 are met, or justify an alternative. If they are intended to meet criterion B, provide the technical basis for the determination that the collapse of the non-Category I structure is acceptable. For criterion C, confirm that the structure will be analyzed and designed to have a margin of safety equivalent to that of a Category I structure and state how this will be accomplished.	October 16, 2009
03.07.02-20	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-21	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-22	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted
03.07.02-23	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-24	Per COLA item 3.7-1, address that the seismic response of the nuclear island common base mat structures, seismic Category II structures, the Nuclear Auxiliary Building and the Radioactive Waste Processing Building is within the parameters of Section 3.7 of U.S. EPR FSAR.	This Letter – See Enclosure 2
	Provide a summary for each structure, either directly or by reference, which describes how the COL item is met.	This Letter – See Enclosure 2
03.07.02-25	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-26	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted

Response Summary for Requests for Additional Information

RAI Set 112 Question	Description of RAI Item	Response Date
03.07.01-11	Provide a definition of site SSE and explain how it meets regulation requirements.	This Letter – See Enclosure 2
	Consistent with the site SSE, provide the FIRS in the free field at the foundation level of each structure meeting the requirements of Appendix S, and describe how each is determined.	This Letter – See Enclosure 2 (NI) December 15, 2009 (EPGB, ESWB)
	For the U.S. EPR Certified Design structures, provide a comparison of the results of the site seismic analyses using the FIRS input motion defined at the foundation level of each structure, with the analyses results documented in the U.S. EPR FSAR.	This Letter – See Enclosure 2 (NI) December 15, 2009 (EPGB, ESWB)
	For the EPGS and ESWS, describe how the effect of structure-soil-structure interaction has been accounted for in the analysis of these buildings.	December 29, 2009 (EPGB, ESWB)

Enclosure 2

Response to NRC Request for Additional Information,
RAI No. 58, Seismic Design Parameters, Questions 03.07.01-1 and 03.07.01-10,
RAI No. 65, Seismic System Analysis, Questions 03.07.02-18 and 03.07.02-24, and
RAI No. 112, Seismic Design Parameters; Question 03.07.01-11
Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No. 58

Question 03.07.01-1

FSAR Section 3.7.1.1.1 (Design Ground Motion Response Spectra), on page 3.0-30, describes the best estimate soil profiles for CCNPP Unit 3. The comparison of the generic site soil columns with the site-specific information shown in FSAR Figure 3.7-7 is based on low-strain best-estimate shear wave velocities. The lower bound shear wave velocities are provided in Table 3.7-2. In this table, layers 4 and 5 have a shear wave velocity of 243.5 m/sec (799 ft/sec), while layers 7 through 25 have a shear wave velocity of 269.4 m/sec (883.9 ft/sec). In both instances, the lower bound shear wave velocity is less than 1000 ft/sec the minimum shear wave velocity for the subgrade to be classified as competent material. In addition, the calculated strain dependent properties under seismic load will lower the shear wave velocities from those shown in Table 3.7-2. SRP 3.7.1, SRP Acceptance Criteria 3, states that if the minimum shear wave velocity is less than 1000 ft/sec, additional studies need to be performed addressing potential impact on soil-structure-interaction (SSI), potential settlements and design of foundation elements. Lower subgrade properties may invalidate the assumption that the mat is rigid in the SSI analysis thus affecting the analysis results, as well as the nuclear island (NI) design loads for seismic and accident design conditions. As the assumption of a non-rigid mat may produce additional seismic bending loads into the mat and NI superstructure, what is the technical justification for using a rigid mat in the SSI analysis with the lower bound soil properties? What is the possible impact on the SSI analysis results and on the design of the foundation mat and supported superstructure?

Response

Soil Structure Interaction (SSI) analyses for the Nuclear Island (NI) common basemat structures are revised using site-specific Safe Shutdown Earthquake (SSE) input motion and corresponding strain-compatible soil properties. FSAR Figure 3.7-1 and Figure 3.7-2 are revised to show a comparison of the Certified Seismic Design Response Spectra (CSDRS) with the horizontal and vertical Foundation Input Response Spectra (FIRS), respectively. FSAR Table 3.7-1, Table 3.7-2, and Table 3.7-3 are revised to show the updated Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 best estimate, lower bound, and upper bound soil profiles used for SSI analyses, respectively. Accordingly, FSAR Figure 3.7-6 and Figure 3.7-7 are now based on the shear wave velocities for the site-specific strain-compatible soil profiles, instead of site-specific low-strain shear wave velocities. Based on the updated Figure 3.7-7, the range of shear wave velocities of the CCNPP Unit 3 strain-compatible soil profiles are bounded by the generic strain-compatible soil cases used in the U.S. EPR design certification. However, there are variations in the soil layering from the generic soil profiles considered in design certification. In view of such variations, confirmatory site-specific SSI analyses were performed. The resulting In-Structure Response Spectra (ISRS) at representative locations of the NI common basemat structures are bounded by the corresponding design certification ISRS by a large margin. FSAR Figures 3.7-8 through 3.7-34 will be revised to show the updated ISRS comparisons. The margin available for the site-specific responses is deemed more than adequate to cover any potential increases in loads caused by a non-rigid mat. Since the foundation mat and supported superstructure are designed for design-certification-enveloped loads which bound the site-specific loads by a considerable margin, the impact of any potential increases in the loads due to a non-rigid mat would still be bounded by the design loads.

COLA Impact

The following changes will be made in a future revision of the COLA:

- CCNPP Unit 3 FSAR Section 3.7.1.1.1 will be revised as indicated below.
- CCNPP Unit 3 FSAR Table 3.7-1, Table 3.7-2, and Table 3.7-3 will be replaced with the revised tables.
- CCNPP Unit 3 FSAR Figure 3.7-1, Figure 3.7-2, Figure 3.7-6, Figure 3.7-7 and Figure 3.7-8 through Figure 3.7-34 will be revised as described in the response and indicated on the enclosed markup.

3.7.1.1.1 Design Ground Motion Response Spectra

Seismic Reconciliation of CSDRS and GMRS for the Nuclear Island Common Basemat

5. ~~The idealized low strain Best Estimate site soil profile consists of soil layers that range from a shear wave velocity of about 1,130 ft/s (344.4 m/s) to about 2,330 ft/s (710 m/s). This range of shear wave velocity falls within the bounds of the uniform soil profiles used in the certified design. The CCNPP Unit 3 profile shown in Figure 3.7-6 indicates that there are layers of softer soils underlying stiffer layers. The layered sites considered in the certified design do not correspond directly to that of CCNPP Unit 3 in terms of layer thickness and shear wave velocity, although the certified profiles generally cover a wider range of impedance (stiffness) mismatch. Confirmatory soil-structure interaction analyses are performed to demonstrate that the site-specific in-structure response spectra (ISRS) at representative locations of the NI Common basemat Structures resulting from the combination of input ground motion with the site-specific soil profile are bounded by the corresponding ISRS for the certified design.~~The range of shear wave velocities of the CCNPP Unit 3 strain-compatible soil profiles is shown in Figure 3.7-6, and is bounded by that of the generic strain-compatible soil profiles used in the U.S. EPR FSAR as shown in Figure 3.7-7. However, there are variations in the soil layering from the generic soil profiles considered in the U.S. EPR FSAR. In view of such variations, confirmatory site-specific SSI analyses were performed. The resulting in-structure response spectra (ISRS) at representative locations of the NI structures are bounded by the corresponding U.S. EPR FSAR ISRS.
6. A comparison of the FIRS (or GMRS) for the NI Common basemat structures with the CSDRS is shown in Figure 3.7-1 and Figure 3.7-2 for the horizontal and vertical directions, respectively. This comparison shows that the CSDRS is significantly greater than the FIRS. A comparison of the CCNPP soil profiles with those considered in the ~~certified design~~ U.S. EPR FSAR is shown in Figure 3.7-7. From this comparison, it is less clear that the ~~certified design~~ U.S. EPR FSAR soil profiles ~~is~~ are bounding. Although it is apparent that the CCNPP Unit 3 shear wave velocities are bounded by the ~~certified design~~ U.S. EPR FSAR, the soil layer thicknesses and variations in shear wave velocities are different. Confirmatory site-specific SSI analyses ~~are~~ were performed to demonstrate that the site-specific ~~ground motion~~ SSE coupled with the site-specific soil profiles are bounded by the ~~certified design~~ U.S. EPR FSAR.
7. The confirmatory site-specific SSI analyses ~~are~~ were performed using methodology consistent with that presented in the U.S. EPR FSAR. A brief description of the analyses is provided below:

Confirmatory Analyses

Soil Profiles

Table 3.7-1, Table 3.7-2, and Table 3.7-3 shows~~s~~ the ~~low~~-strain-compatible Best Estimate (BE), Lower Bound (LB), and Upper Bound (UB) soil profiles that ~~was~~were used in the site-specific Soil Structure Interaction (SSI) analysis.

~~Estimates for the low-strain Upper Bound (UB) and Lower Bound (LB) case soil properties for the SSI analysis were obtained by varying the soil shear modulus, G_{BE} of the low-strain BE case. The damping and Poisson's ratio remain unchanged from the BE values. The estimates for the low-strain shear modulus, G_{UB}, for the UB soil case are obtained by multiplying G_{BE} by $(1+C_v)$, where C_v is a factor that accounts for uncertainties in SSI analysis and soil properties. The value of C_v is conservatively assumed as 1.0. The estimates for the low-strain shear modulus, G_{LB}, are obtained by dividing G_{BE} by $(1+C_v)$. Thus the estimates for the low-strain shear moduli of LB and UB soil cases are $0.5*G_{BE}$ and $2.0*G_{BE}$, respectively.~~

~~Table A-2 and Table A-3 show the estimated soil profiles for the low-strain LB and UB soil cases used in the site-specific SSI analysis.~~

SSI Analysis

The same SSI model and methodology used for the U.S. EPR FSAR ~~is~~ was used for the confirmatory SSI analyses, except that OBE structural damping is used since it is unlikely that the ~~0.1 g~~0.15 g PGA motion will result in high enough stress levels to justify SSE damping levels.

SSI analyses for three soil cases, namely CCNPP Unit 3 ~~low~~-strain-compatible BE, CCNPP Unit 3 ~~low~~-strain-compatible LB and CCNPP Unit 3 ~~low~~-strain-compatible UB, were performed using ~~EUR Soft Soil~~ site-specific SSE input motion~~with 0.1g PGA as seismic input~~.

**Table 3.7-1-{CCNPP Unit 3 Best Estimate Soil for SSI Analysis}
(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 Freqency (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
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

Table 3.7-1-{CCNPP Unit 3 Best Estimate Soil for SSI Analysis}
(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 Freqency (Hz)	Depth (m)
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 3.7-2-{CCNPP Unit 3 Lower Bound Soil for SSI Analysis}
(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 Freqency (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
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

Table 3.7-2-{CCNPP Unit 3 Lower Bound Soil for SSI Analysis} (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 Freqency (Hz)	Depth (m)
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 3.7-3-{CCNPP Unit 3 Upper Bound Soil for SSI Analysis} (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 Freqency (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
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

**Table 3.7-3-{CCNPP Unit 3 Upper Bound Soil for SSI Analysis}
(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 Freqency (Hz)	Depth (m)
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		

Figure 3.7-1—{CCNPP Unit 3 GMRS and EUR CSDRS (Horizontal) for the Nuclear Island Common Base Mat Structures}

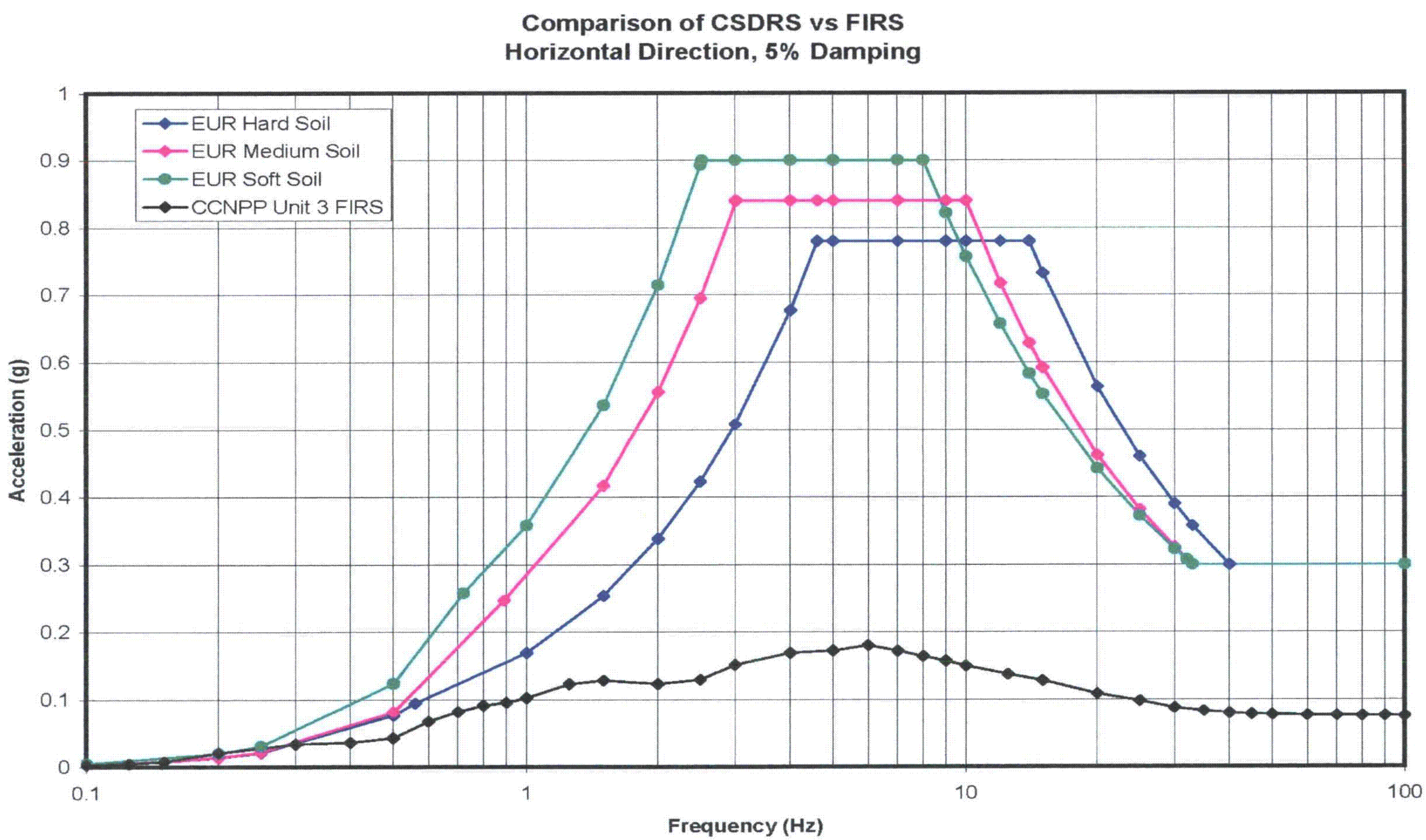


Figure 3.7-2—{CCNPP Unit 3 GMRS and EUR CSDRS (Vertical) for the Nuclear Island Common Base Mat Structures}

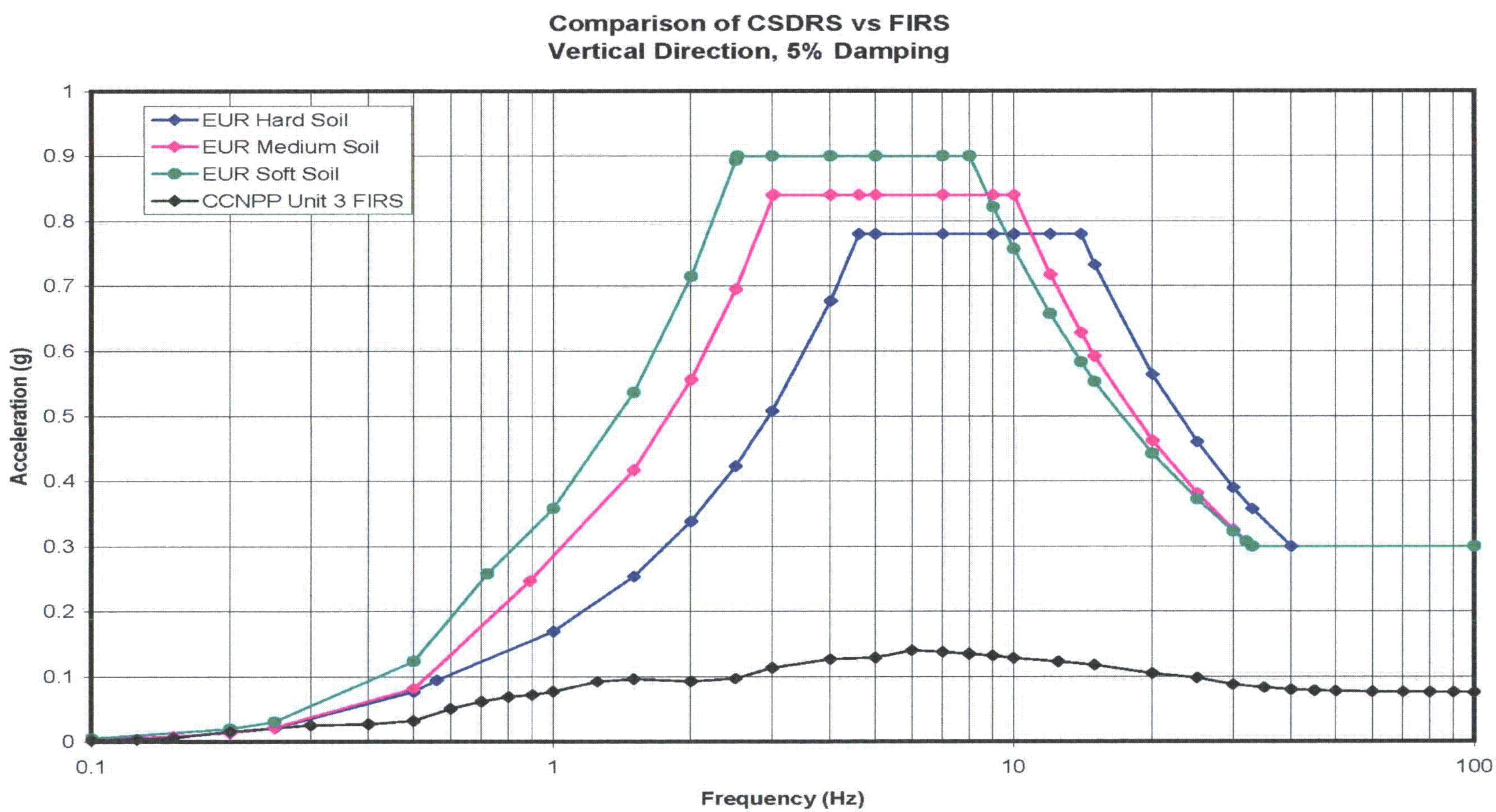


Figure 3.7-6—{CCNPP Unit 3 Strain-Compatible Soil Profiles}

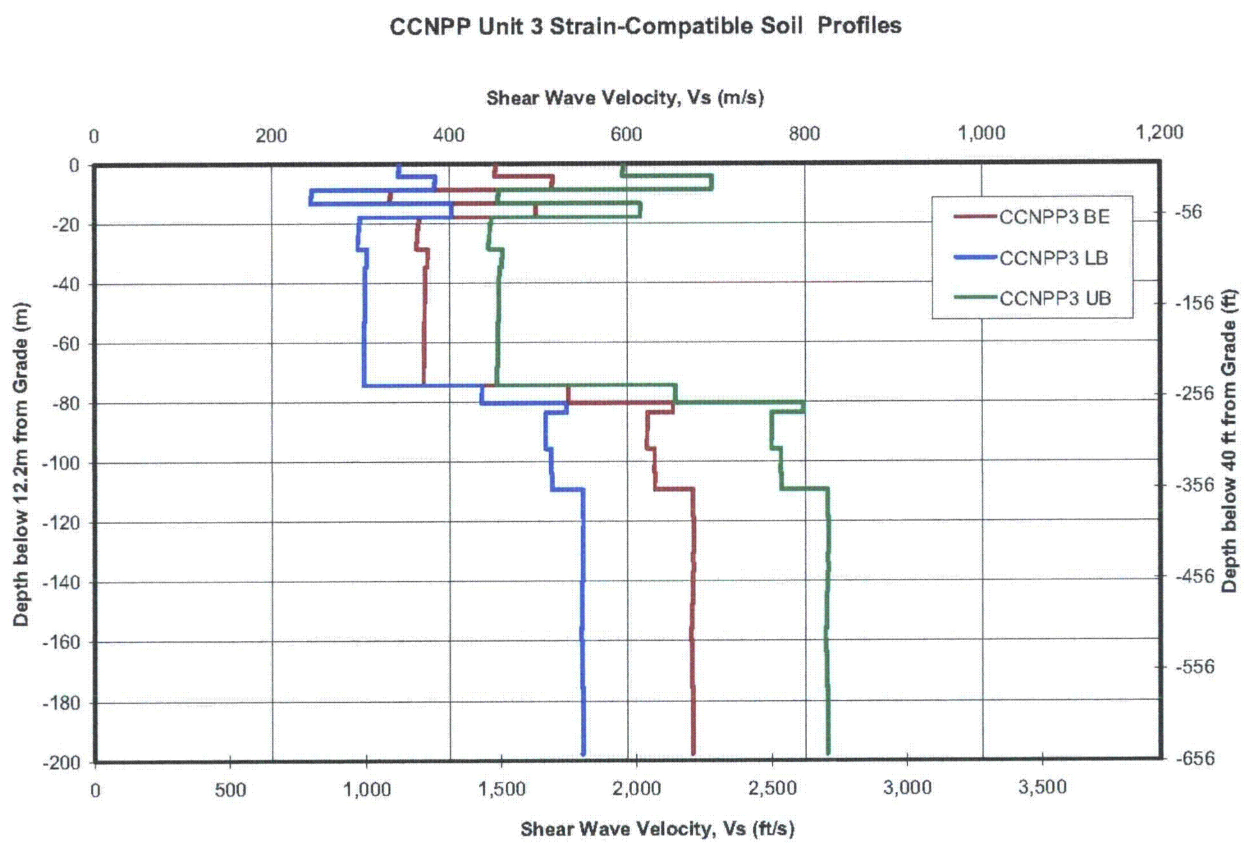


Figure 3.7-7—{EPR DC Soil Cases vs. CCNPP Unit 3 Soil Cases for SSI Analysis}

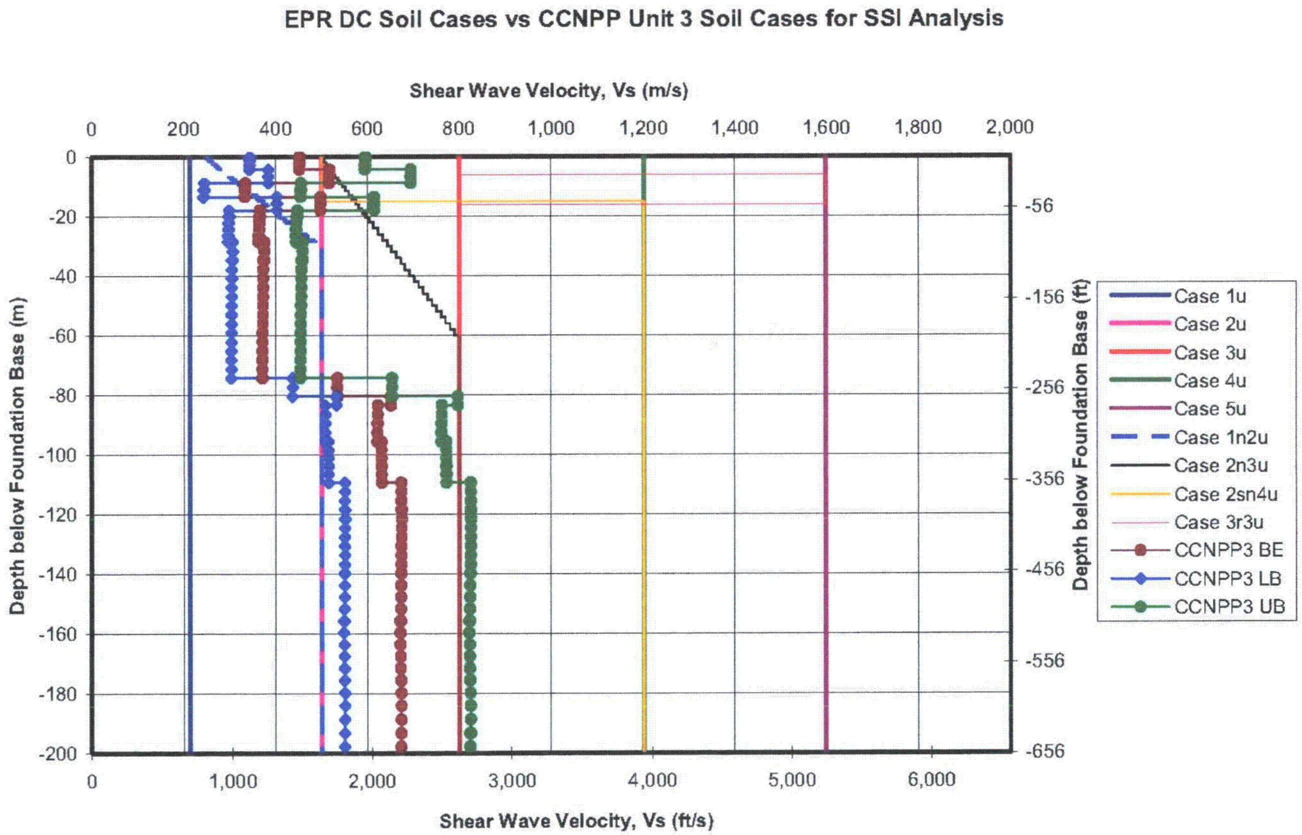


Figure 3.7-8—{Reactor Bldg Internal Structure, Elev. 5.15 m, X (E-W) Direction, 5% Damping}

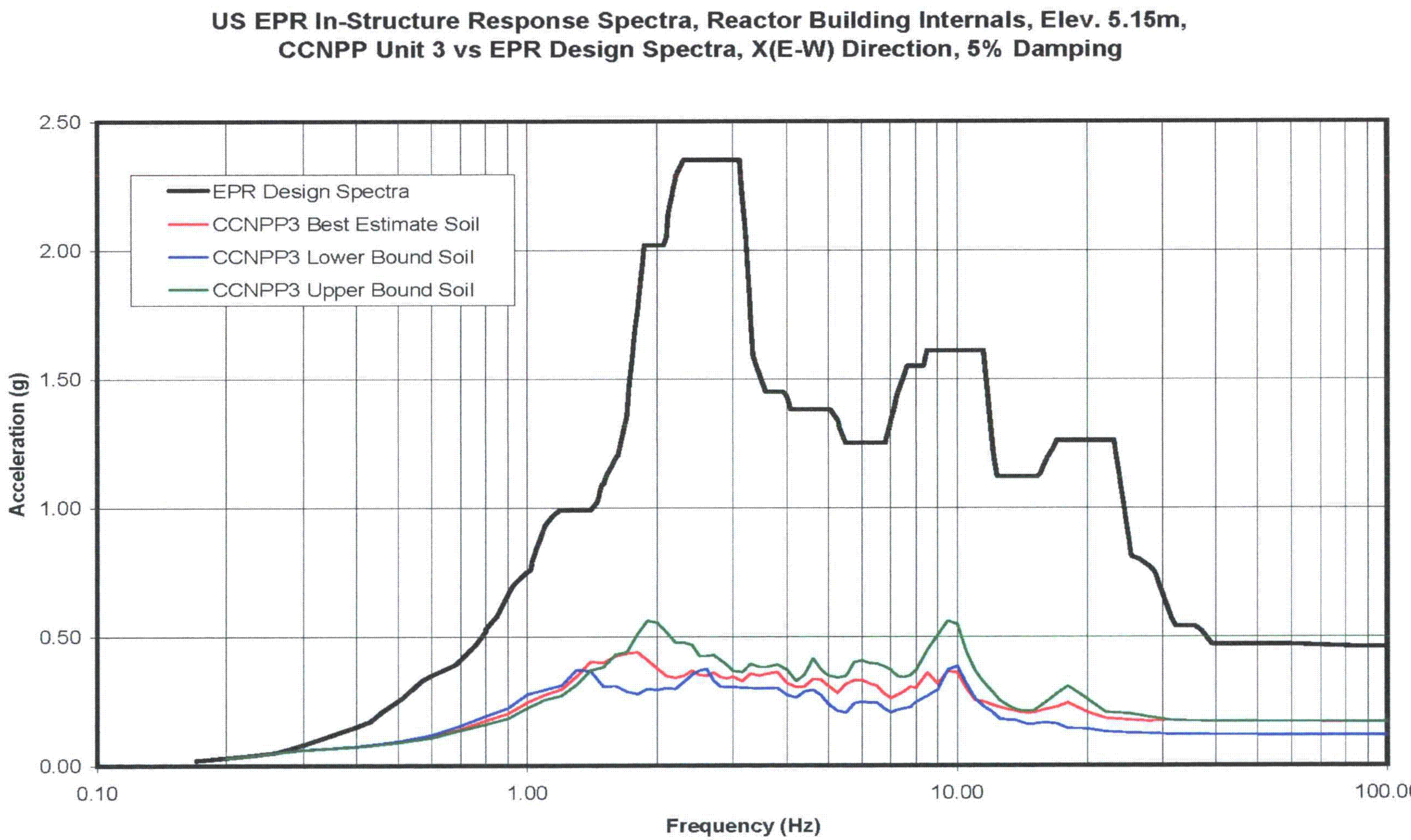


Figure 3.7-9—{Reactor Bldg Internal Structure, Elev. 5.15m, Y (N-S) Direction, 5% Damping}

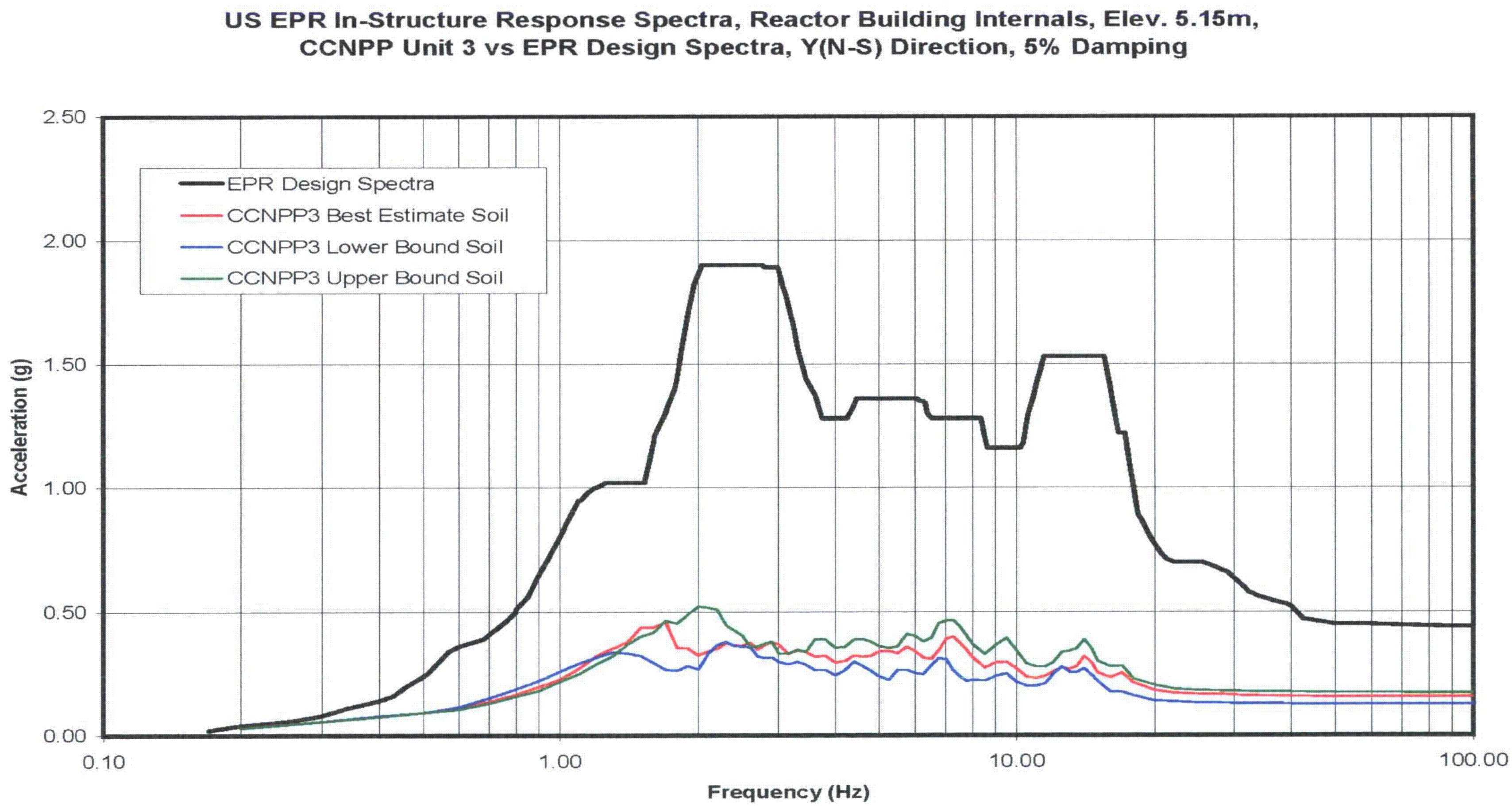


Figure 3.7-10—{Reactor Bldg Internal Structure, Elev. 5.15 m, Z (Vert) Direction, 5% Damping}

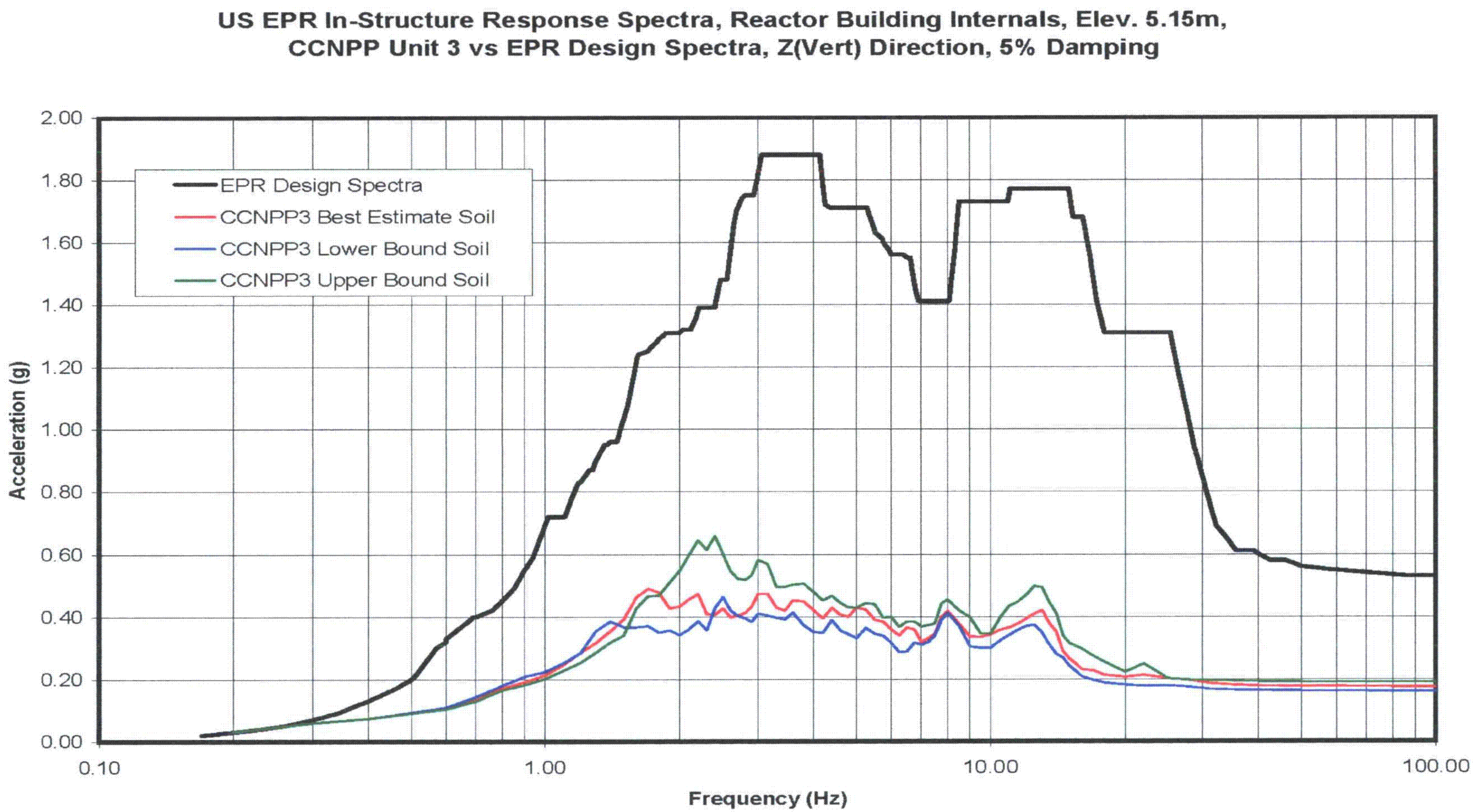


Figure 3.7-11—{Reactor Bldg Internal Structure, Elev. 19.5 m, X (E-W) Direction, 5% Damping}

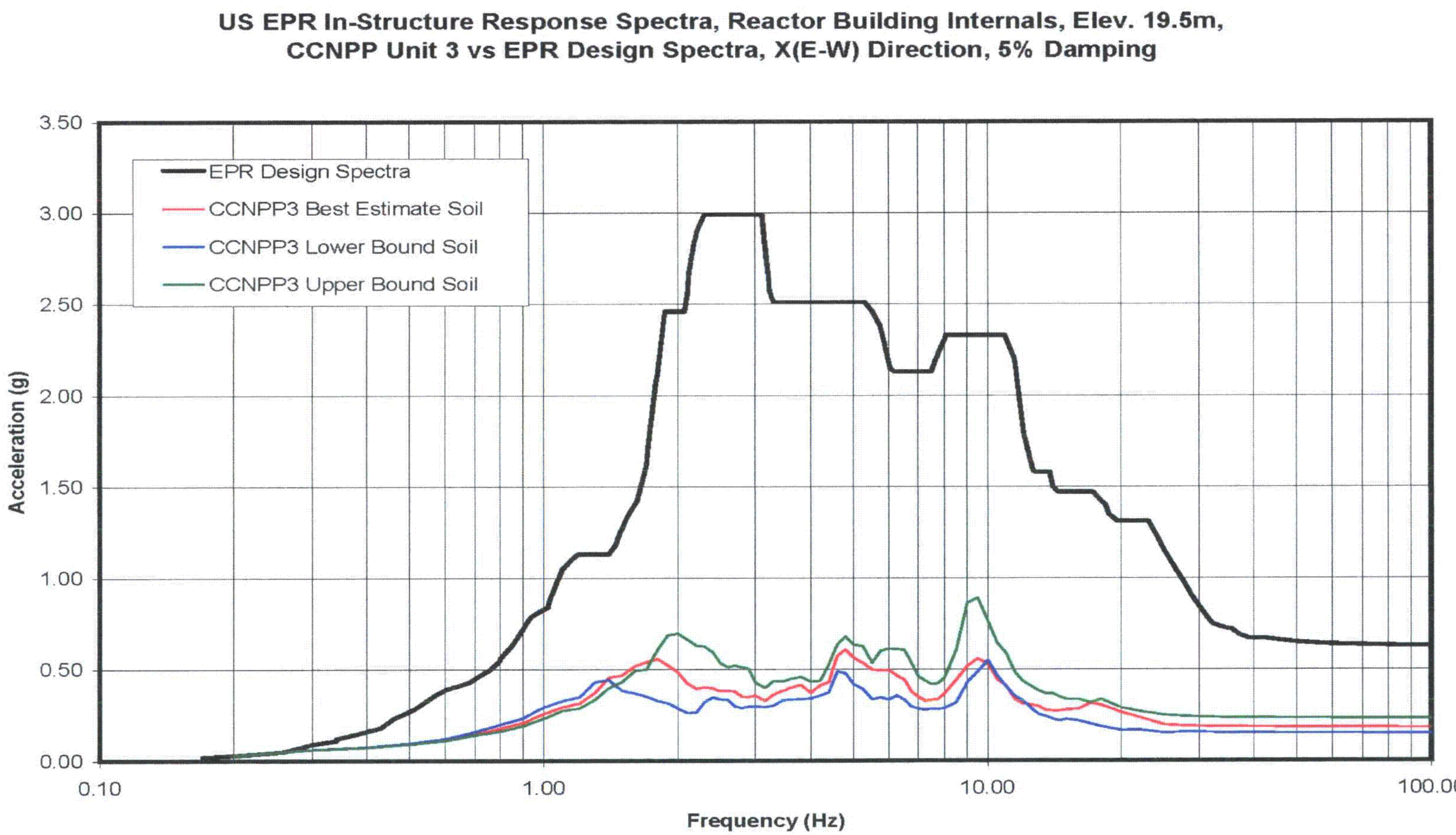


Figure 3.7-12—{Reactor Bldg Internal Structure, Elev. 19.5m, Y (N-S) Direction, 5% Damping}

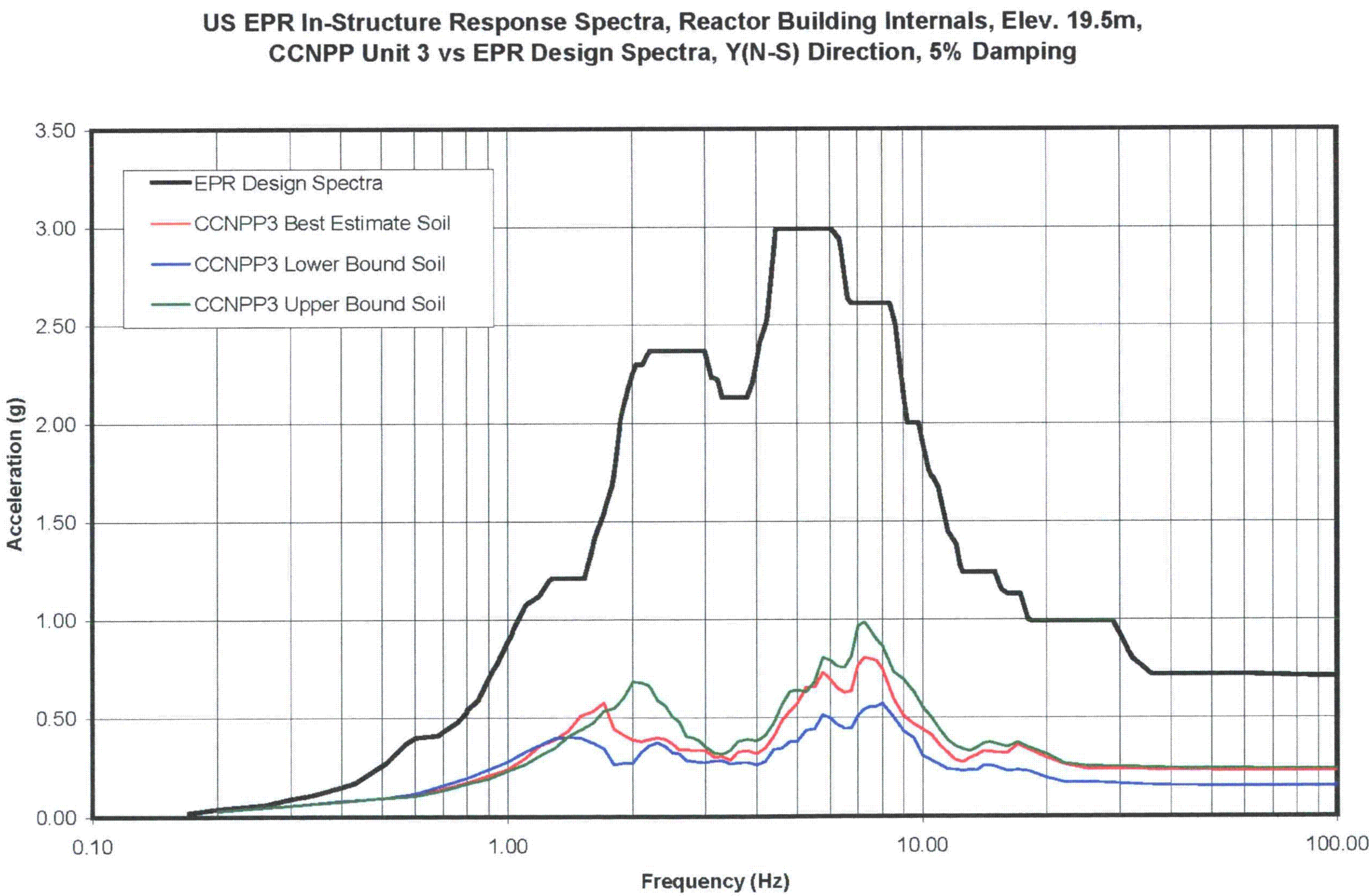


Figure 3.7-13—{Reactor Bldg Internal Structure, Elev. 19.5m, Z (Vert) Direction, 5% Damping}

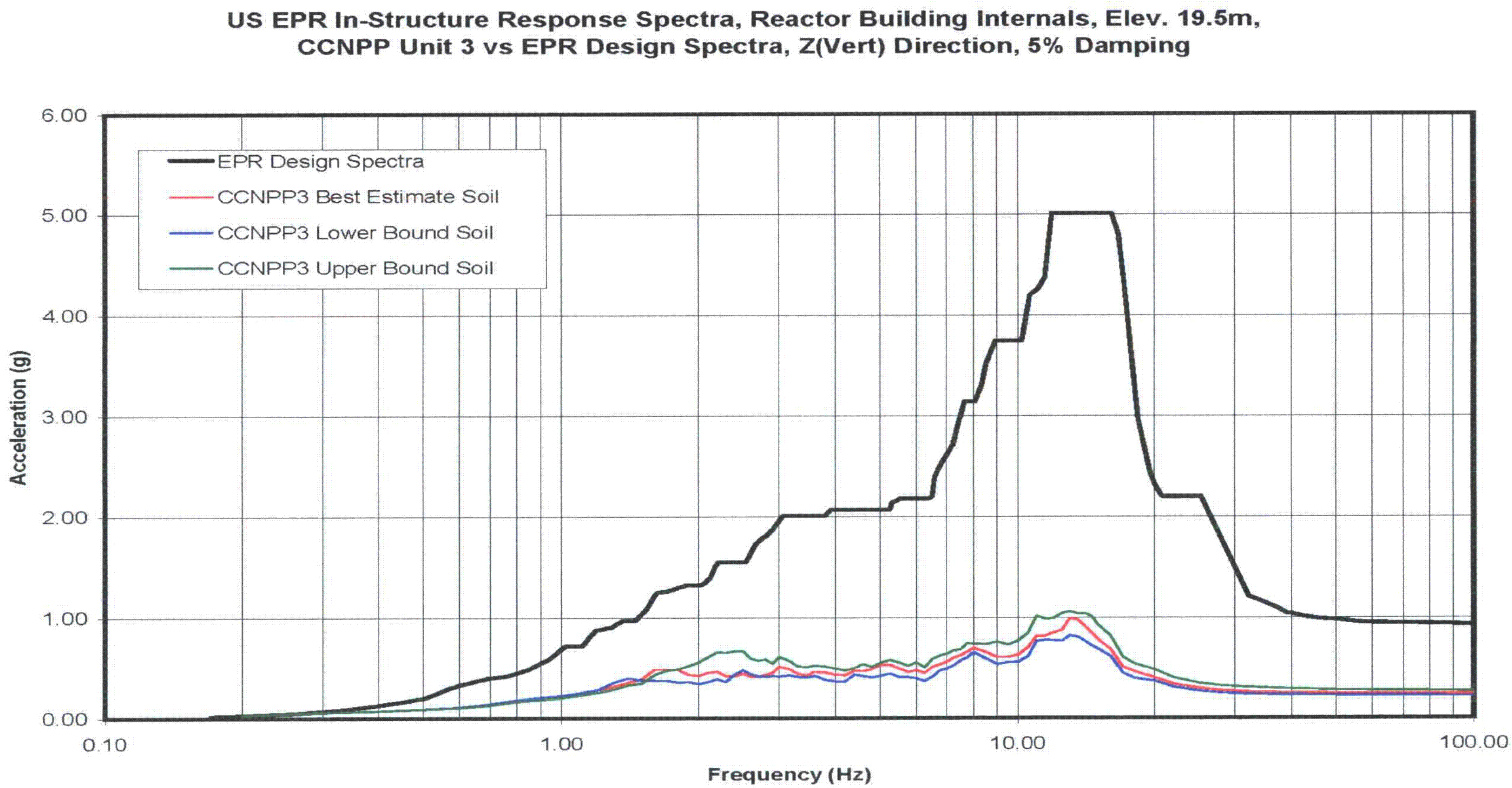


Figure 3.7-14—{Safeguard Building 1, Elev. 8.1m, X (E-W) Direction, 5%Damping}

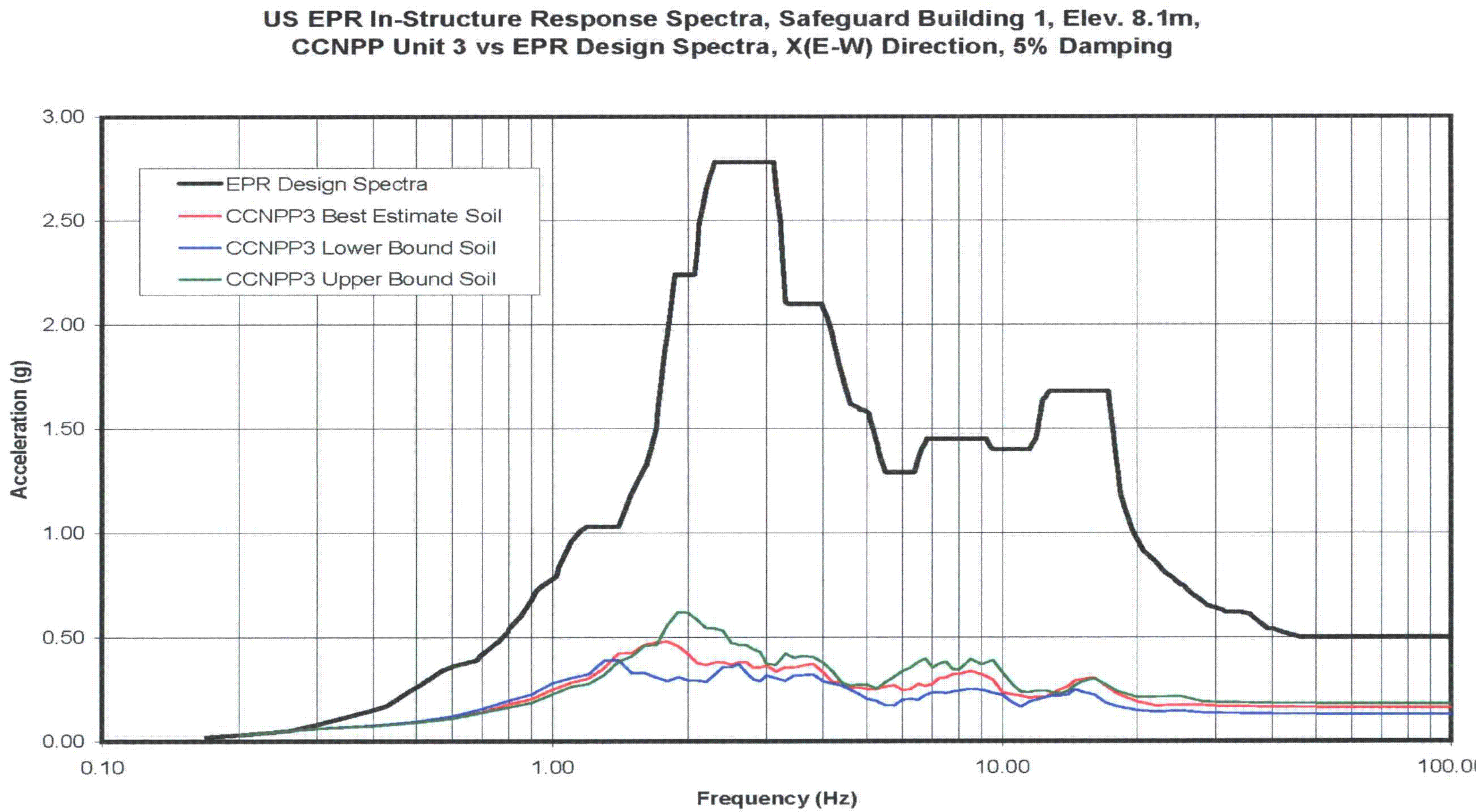


Figure 3.7-15—{Safeguard Building 1, Elev. 8.1m, Y (N-S) Direction, 5%Damping}

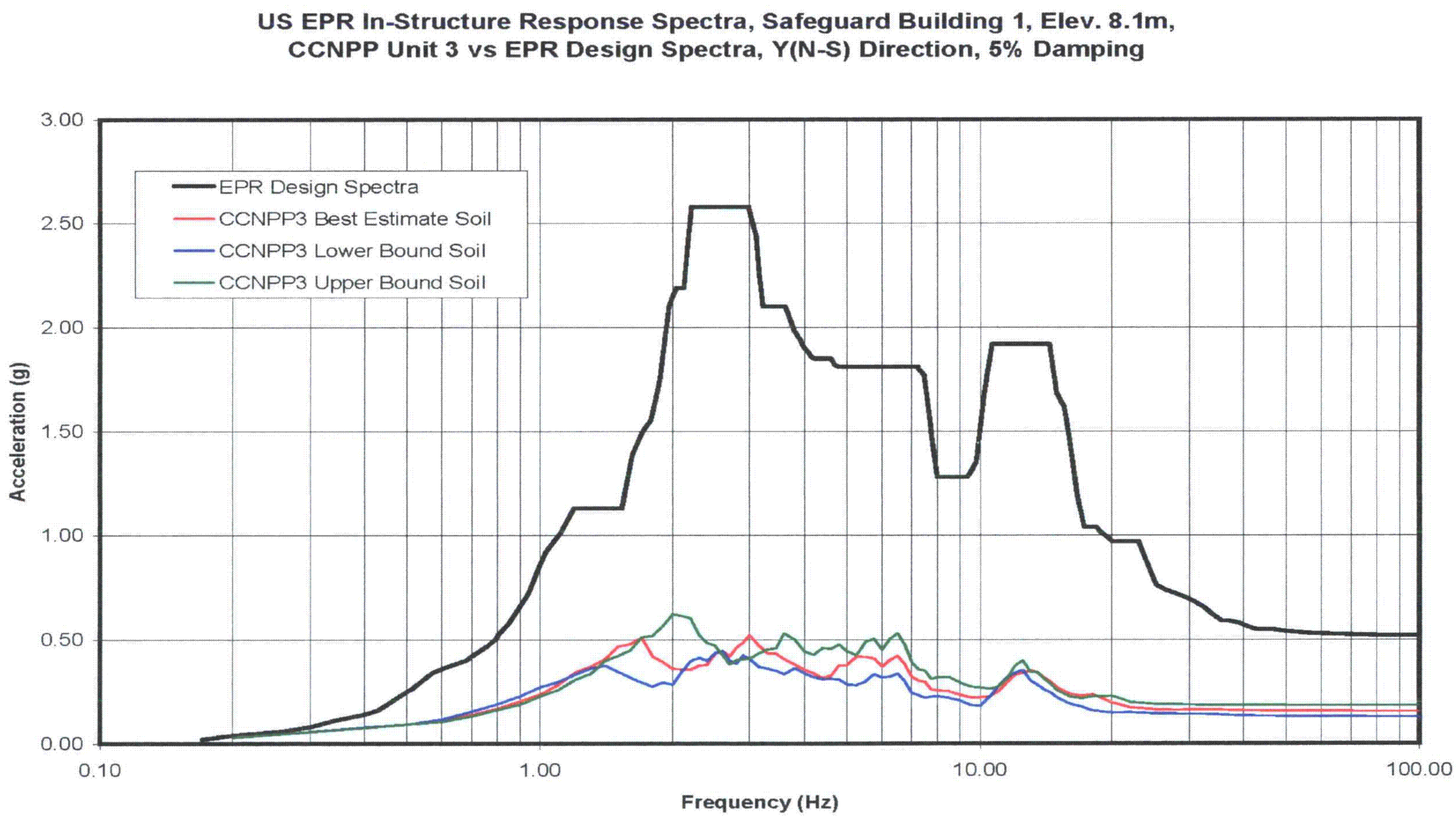


Figure 3.7-16—{Safeguard Building 1, Elev. 8.1m, Z (Vert) Direction, 5% Damping}

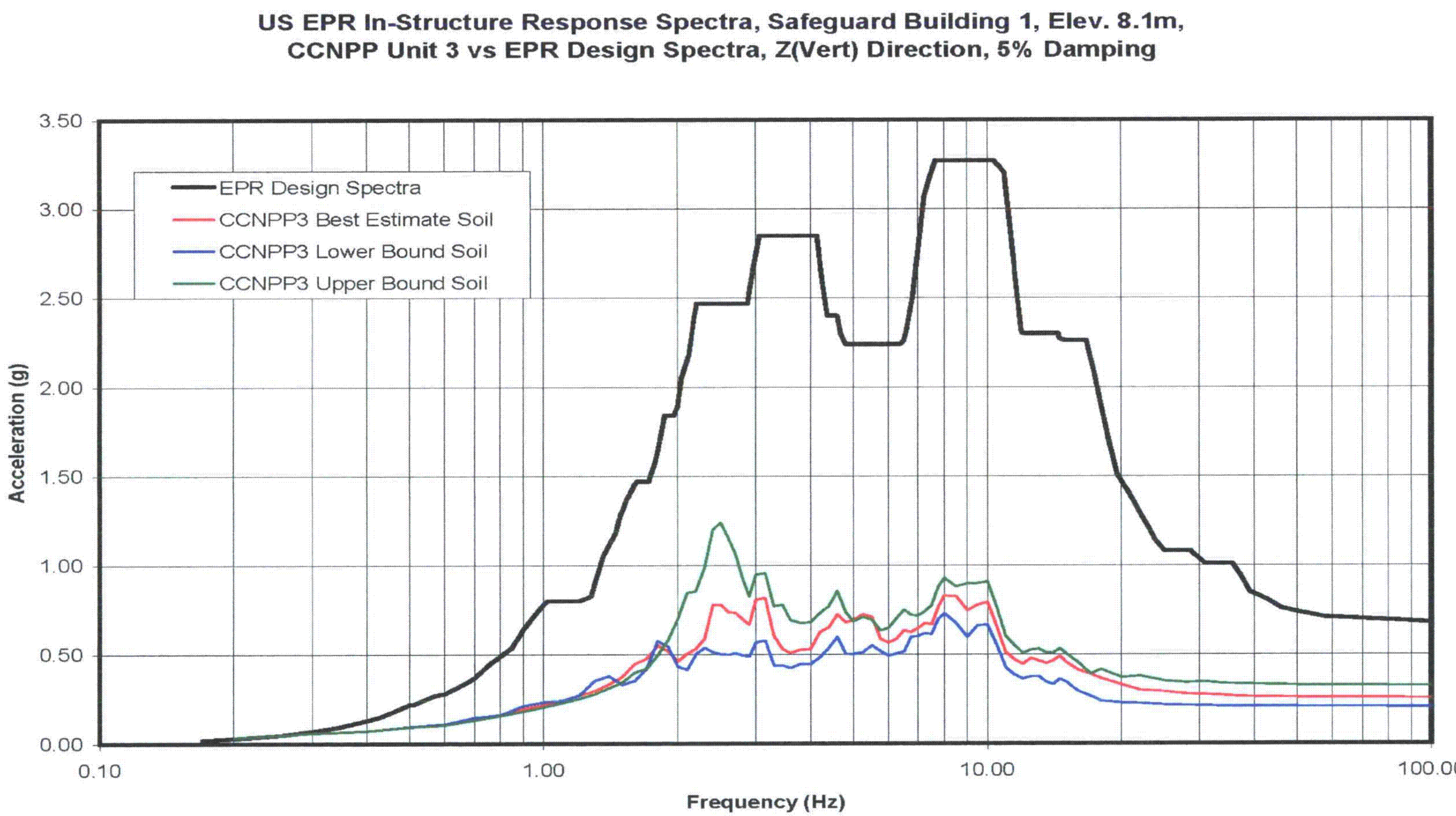


Figure 3.7-17—{Safeguard Building 1, Elev. 21.0 m, X (E-W) Direction, 5% Damping}

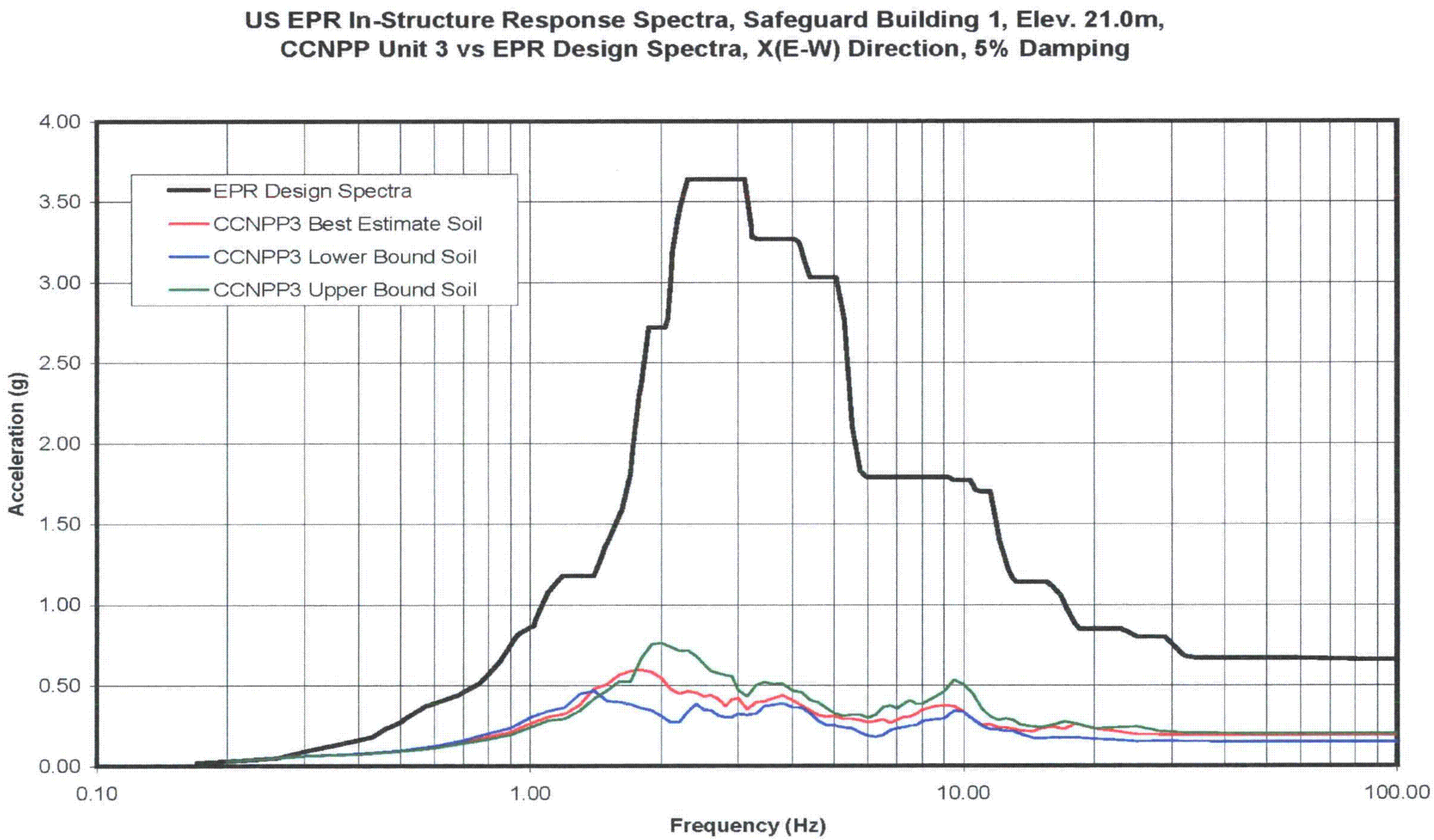


Figure 3.7-18—{Safeguard Building 1, Elev. 21.0m, Y (N-S) Direction, 5% Damping}

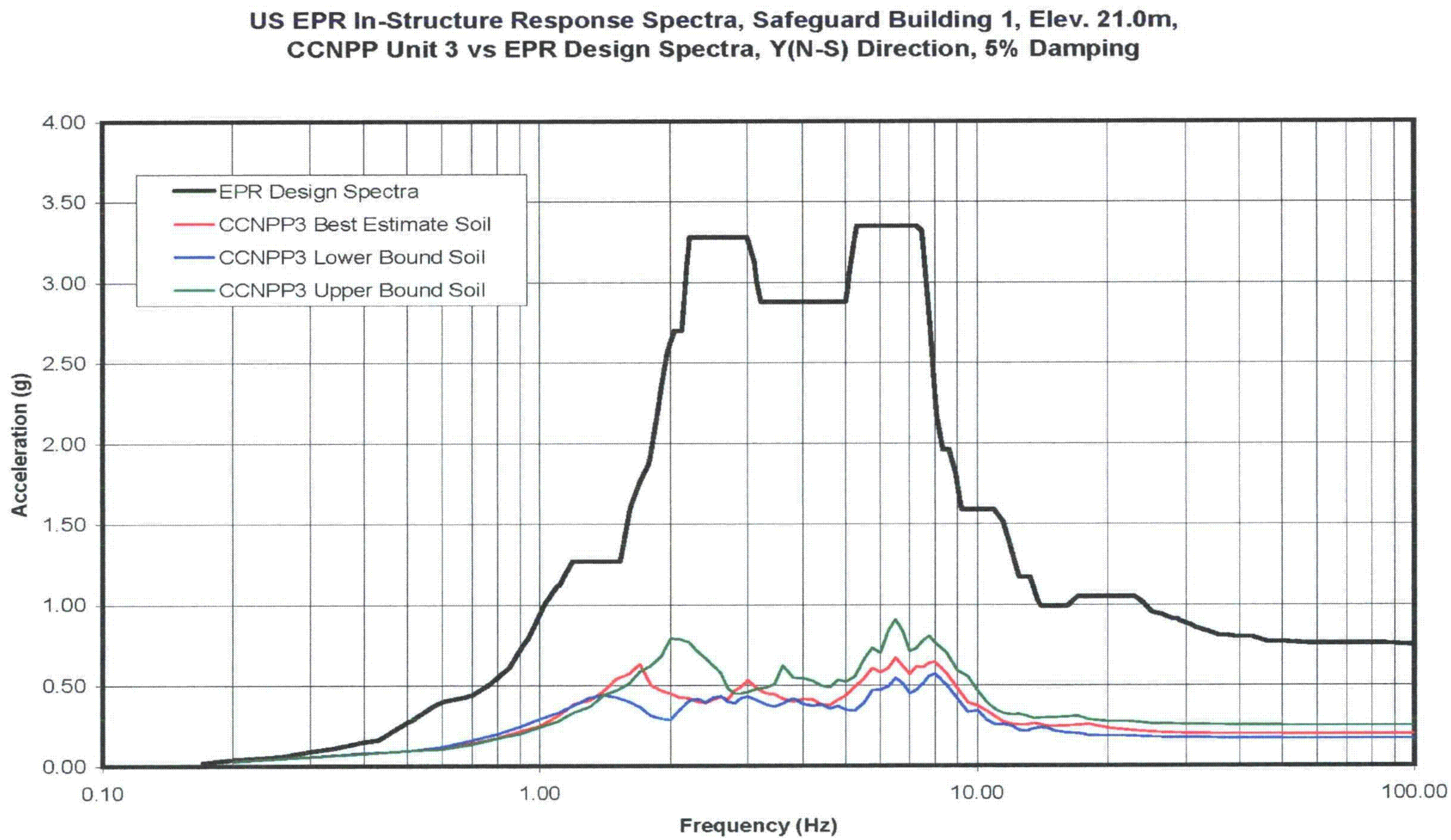


Figure 3.7-19—{Safeguard Building 1, Elev. 21.0m, Z (Vert) Direction, 5% Damping}

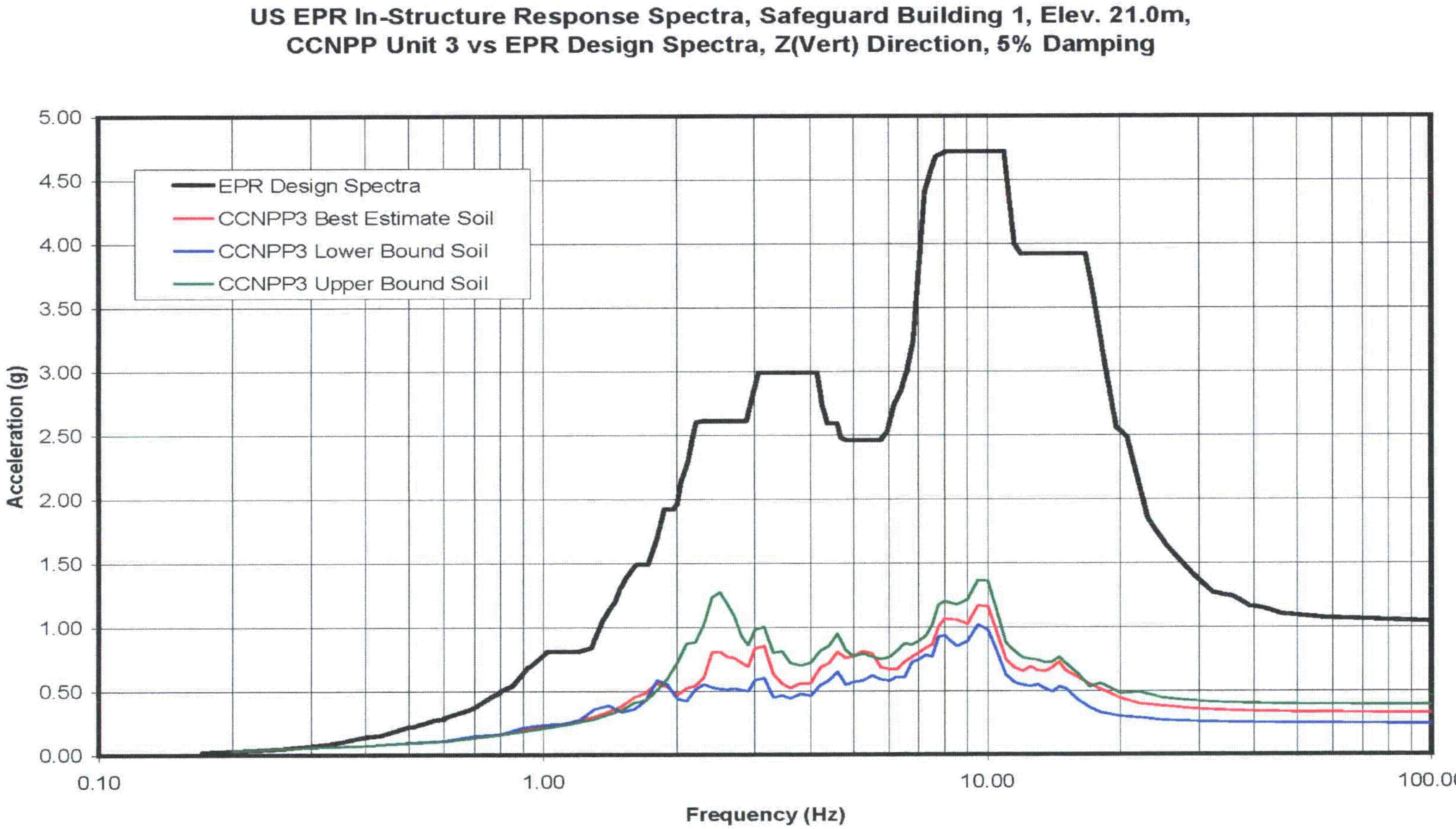


Figure 3.7-20—{Safeguard Building 2/3, Elev. 8.1m, X (E-W) Direction, 5%Damping}

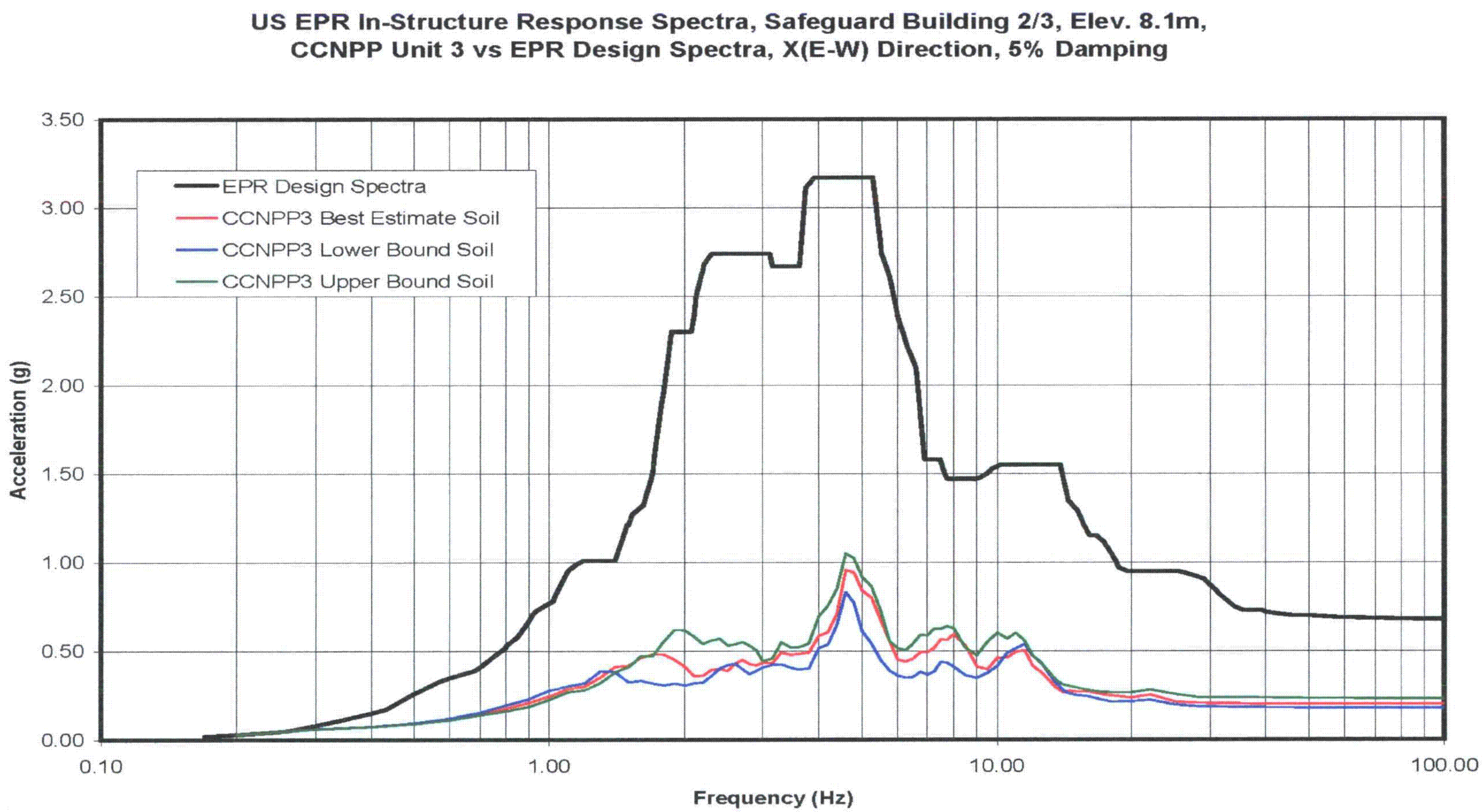


Figure 3.7-21—{Safeguard Building 2/3, Elev. 8.1m, Y (N-S) Direction, 5% Damping}

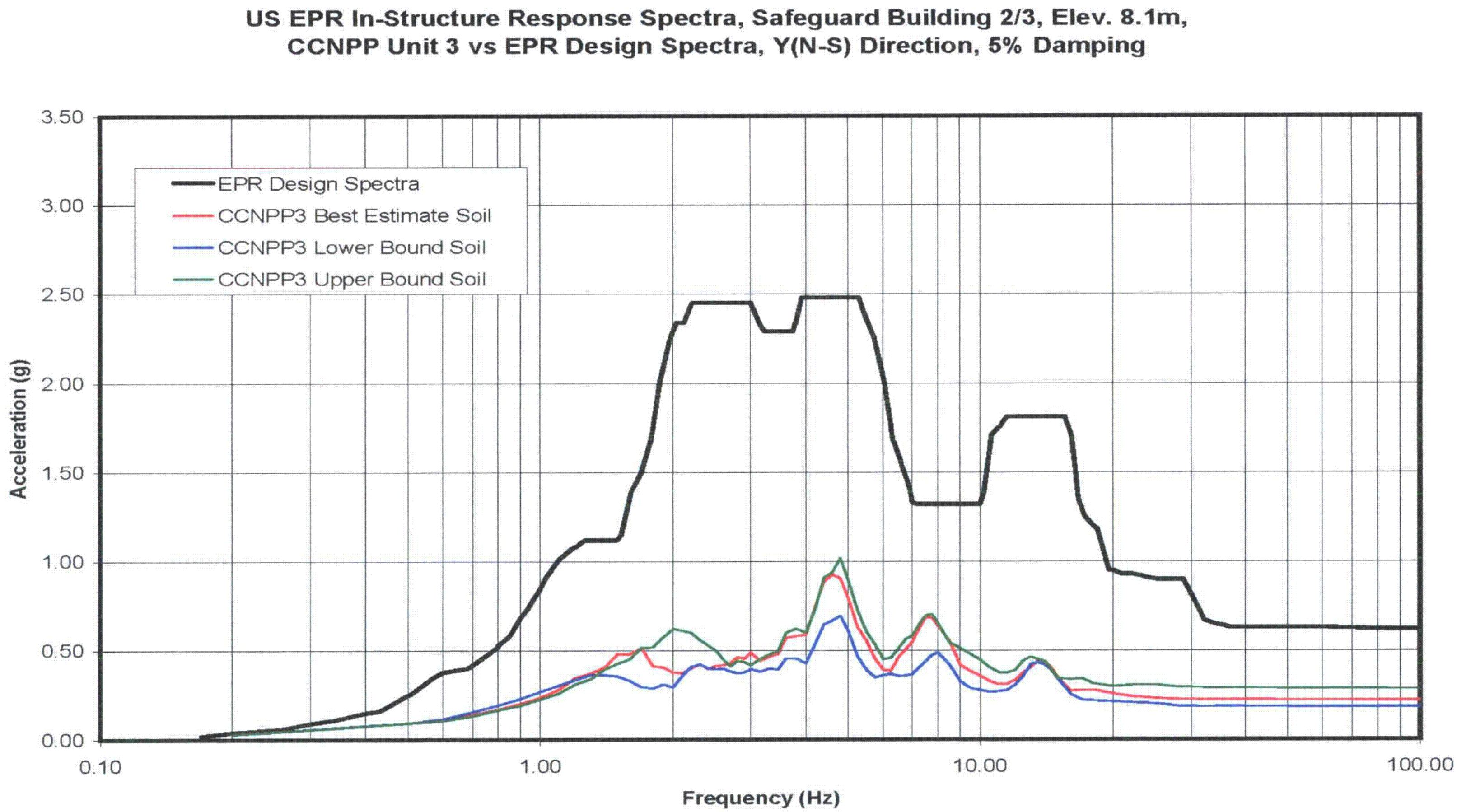


Figure 3.7-22—{Safeguard Building 2/3, Elev. 8.1m, Z (Vert) Direction, 5%Damping}

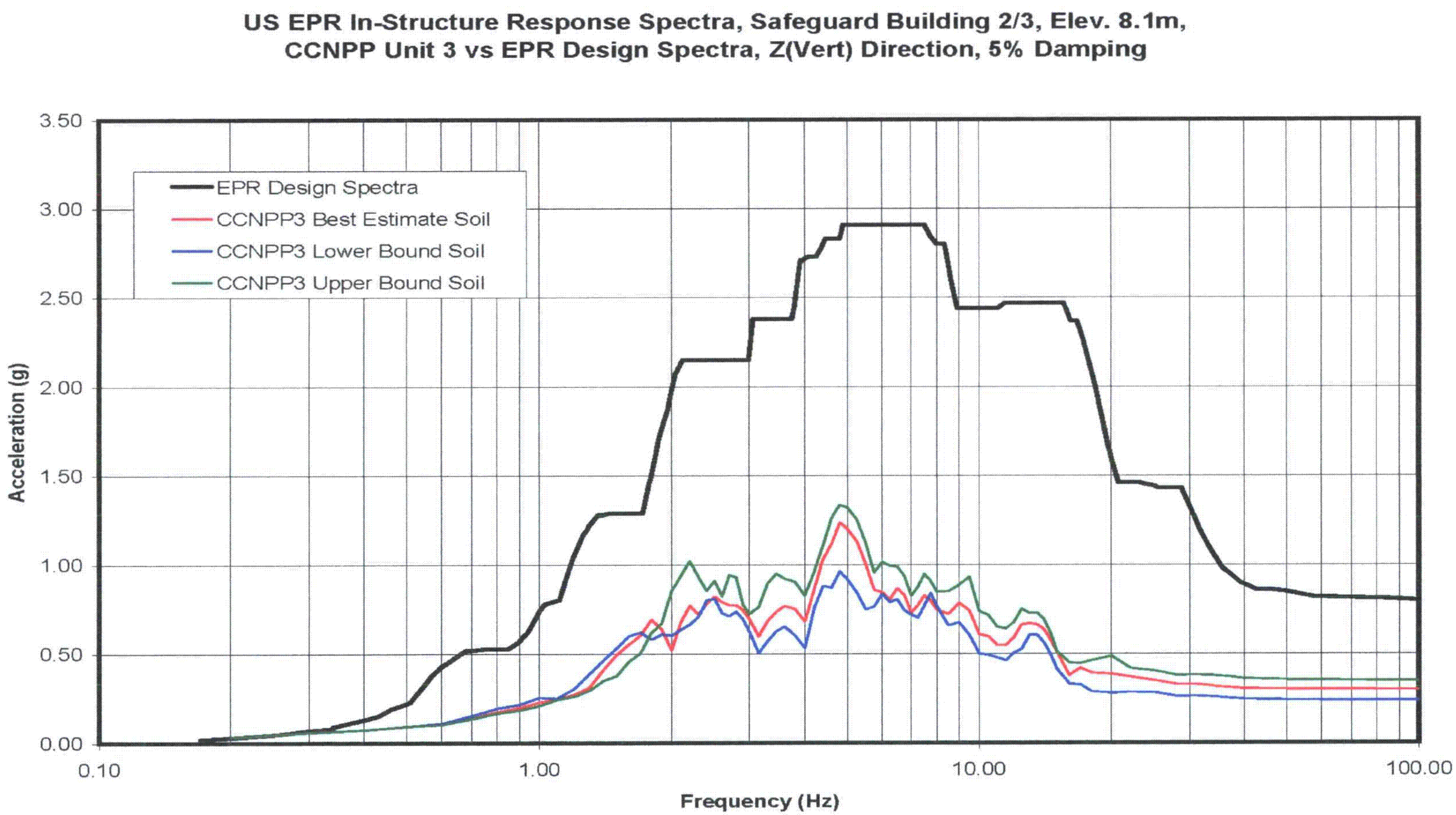


Figure 3.7-23—{Safeguard Building 2/3, Elev. 15.4 m, X (E-W) Direction, 5% Damping}

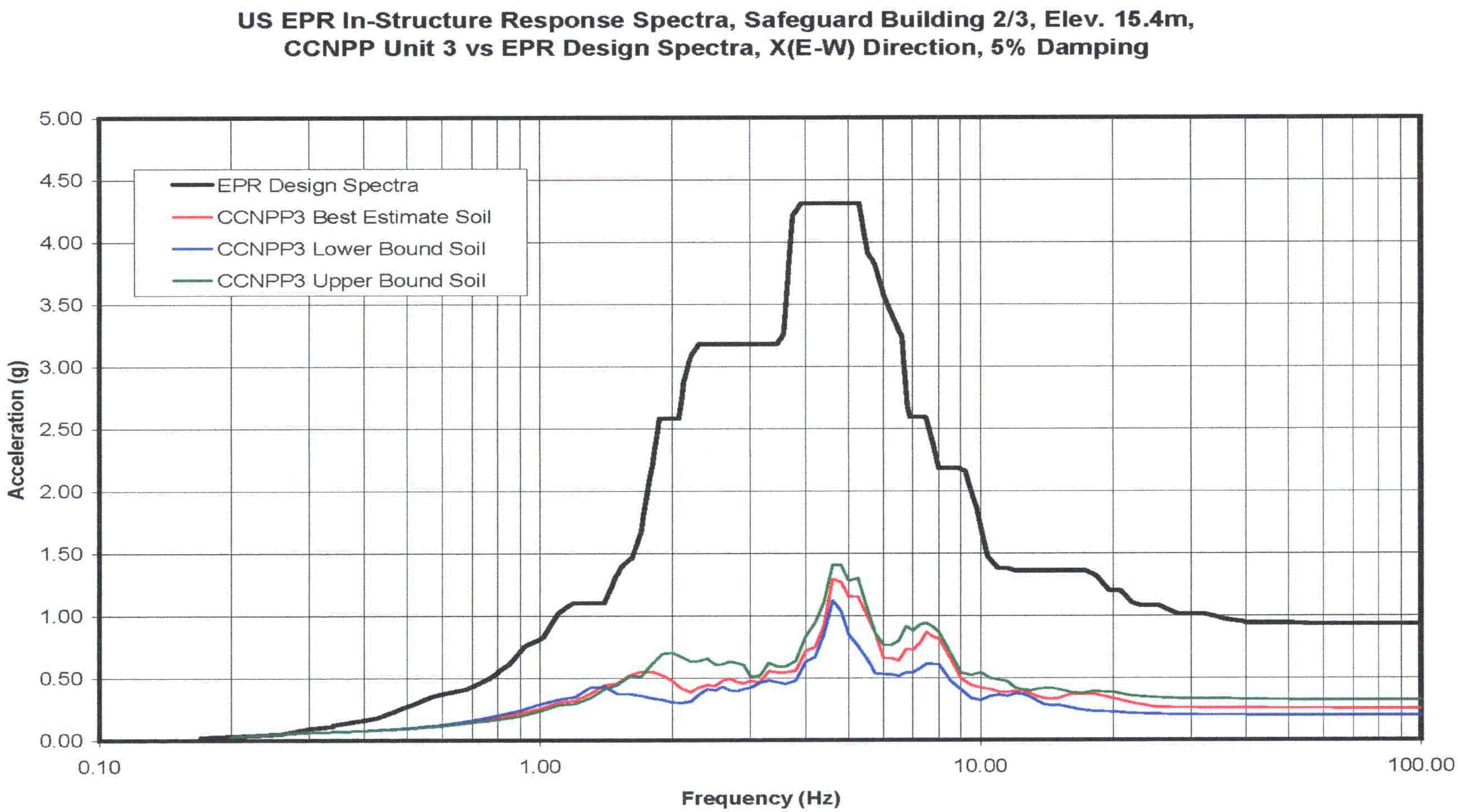


Figure 3.7-24—{Safeguard Building 2/3, Elev. 15.4 m, Y (N-S) Direction, 5% Damping}

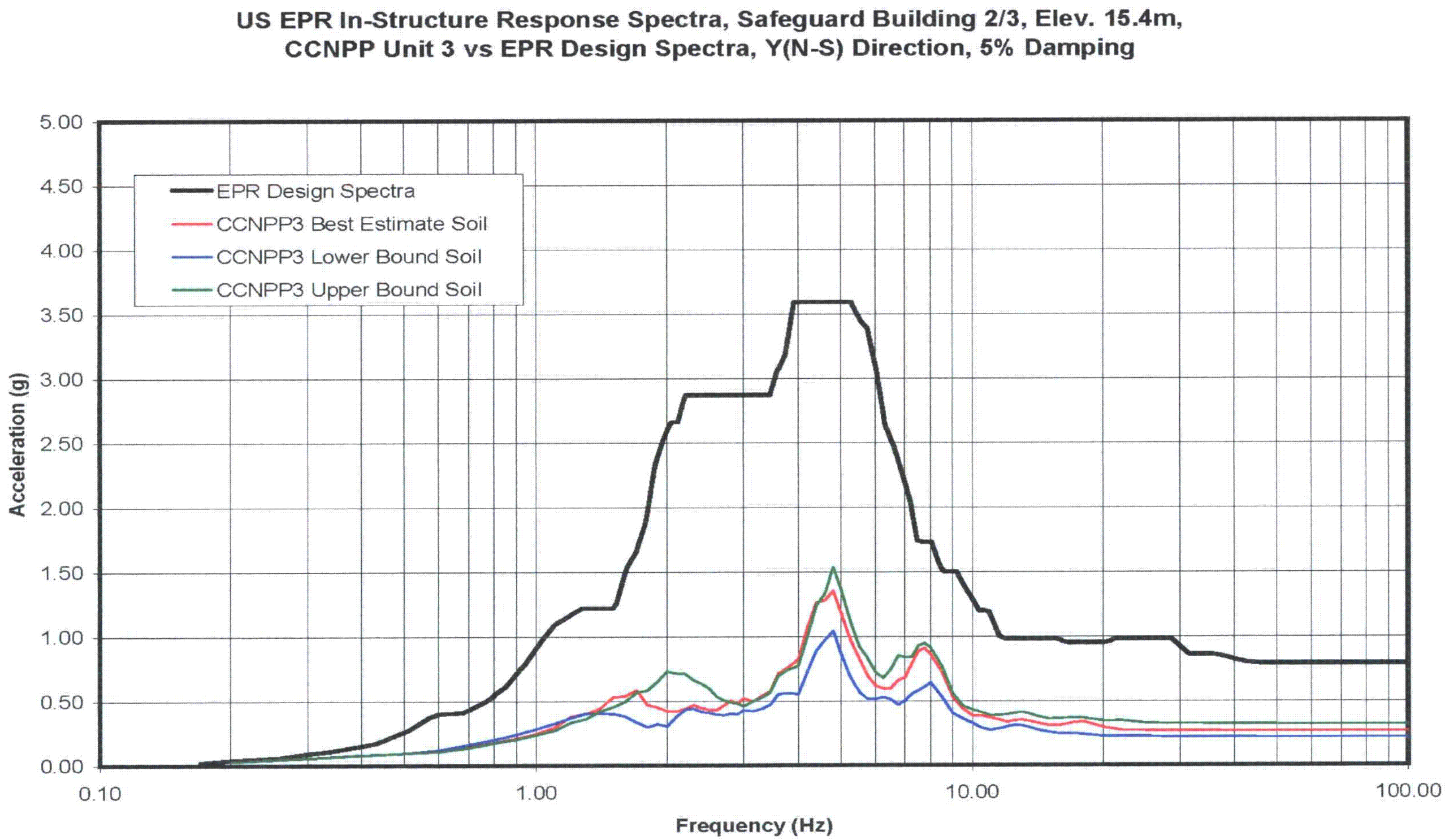


Figure 3.7-25—{Safeguard Building 2/3, Elev. 15.4 m, Z (Vert) Direction, 5% Damping}

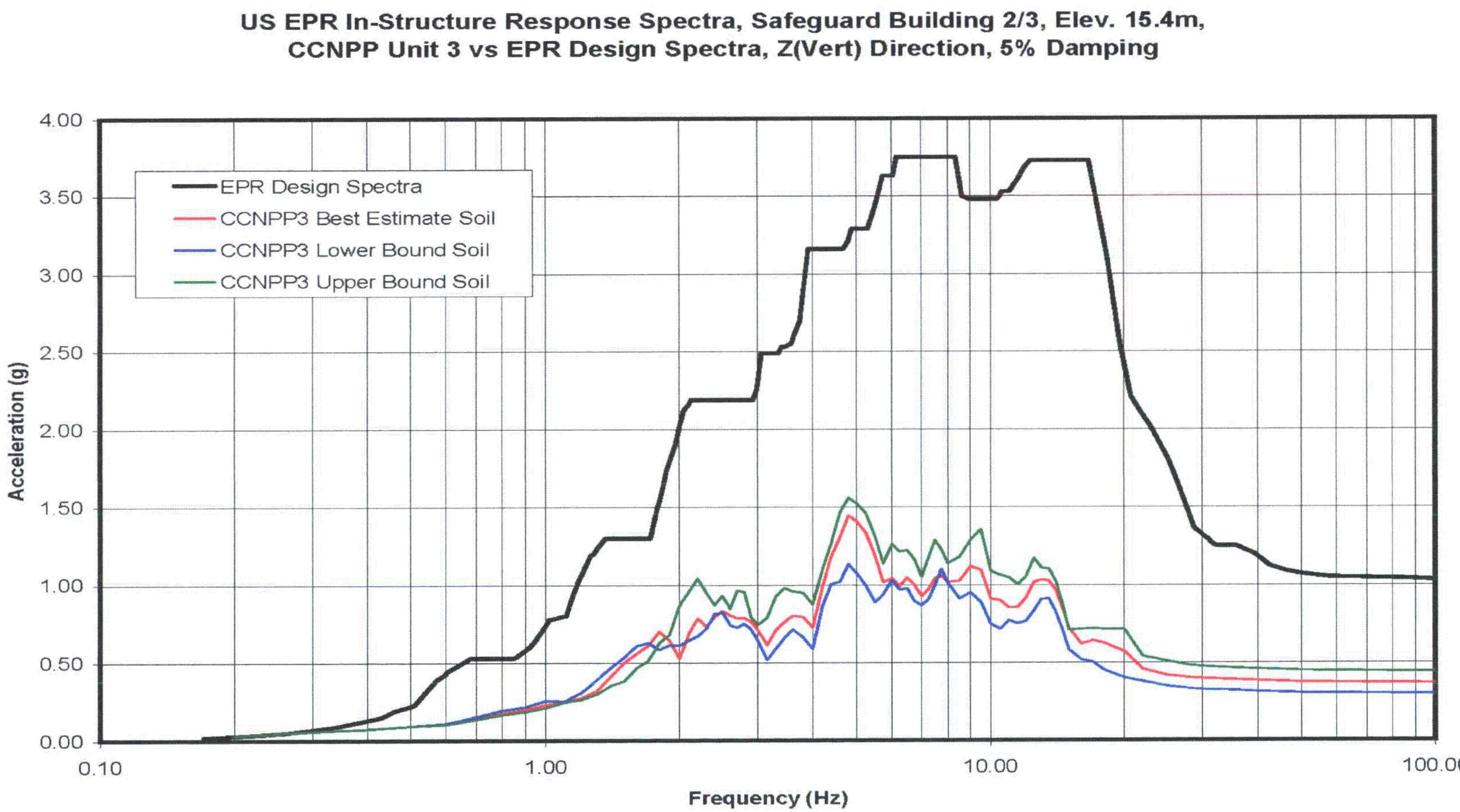


Figure 3.7-26—{Safeguard Building 4, Elev. 21.0 m, X (E-W) Direction, 5% Damping}

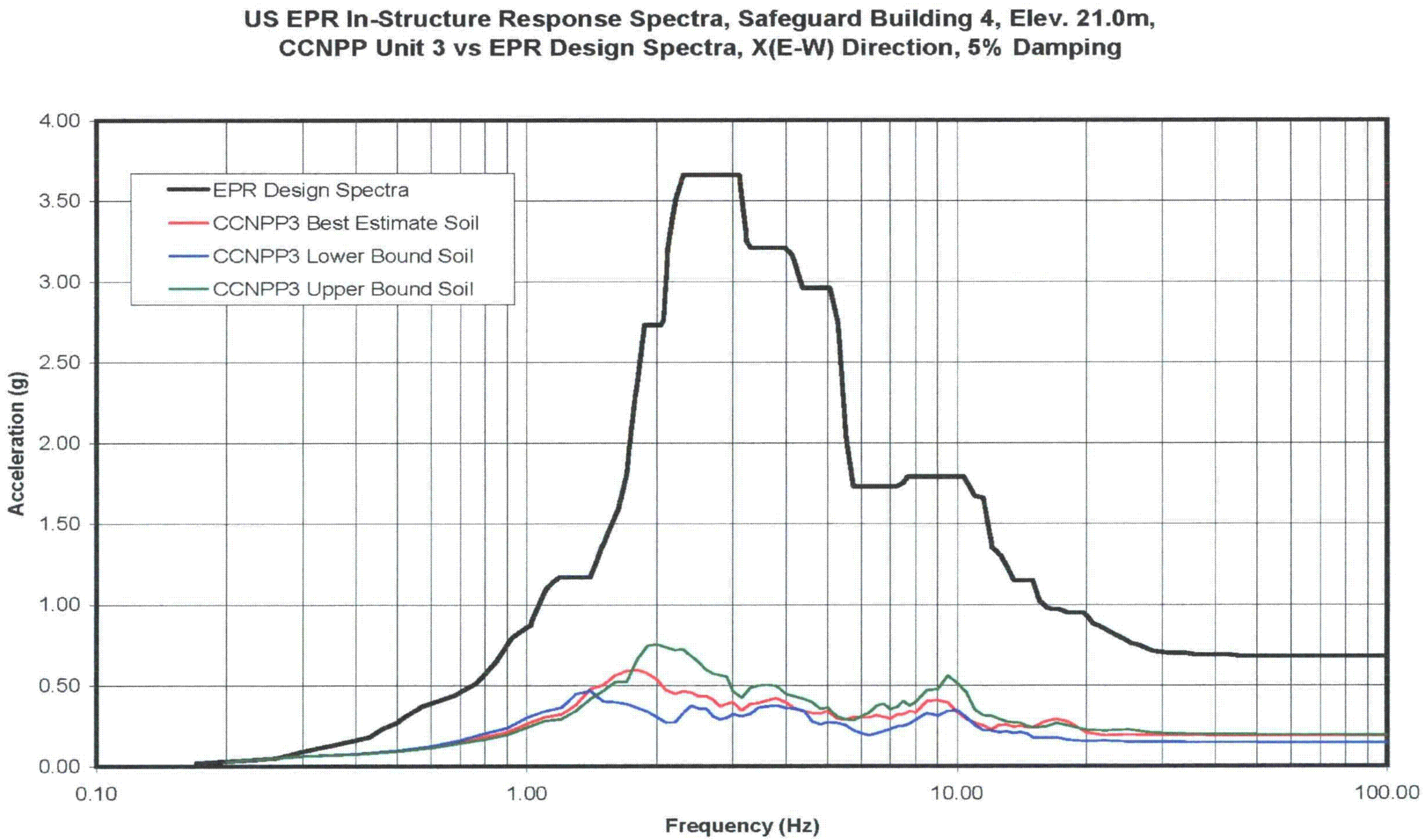


Figure 3.7-27—{Safeguard Building 4, Elev. 21.0m, Y (N-S) Direction, 5% Damping}

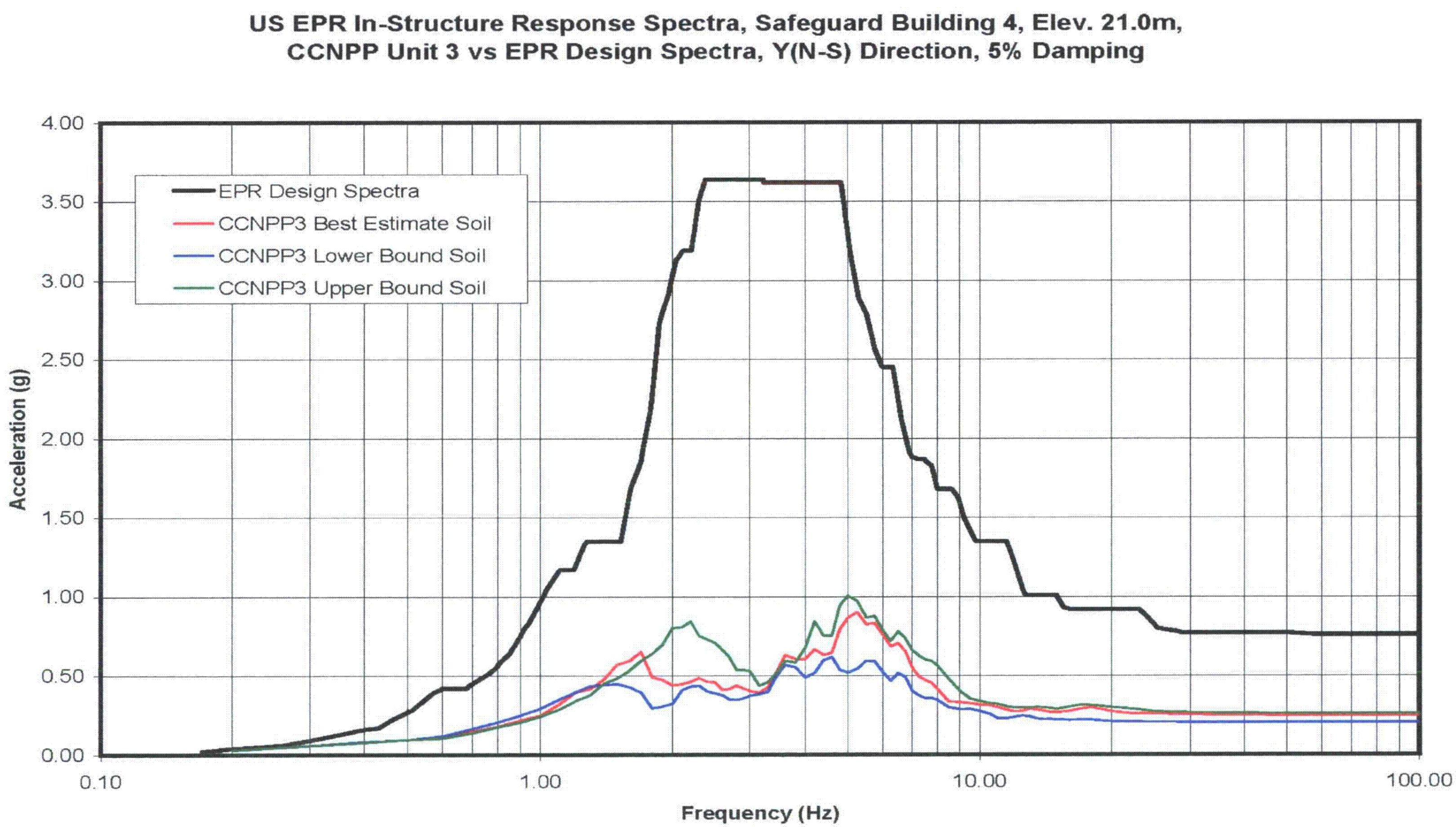


Figure 3.7-28—{Safeguard Building 4, Elev. 21.0 m, Z (Vert) Direction, 5% Damping}

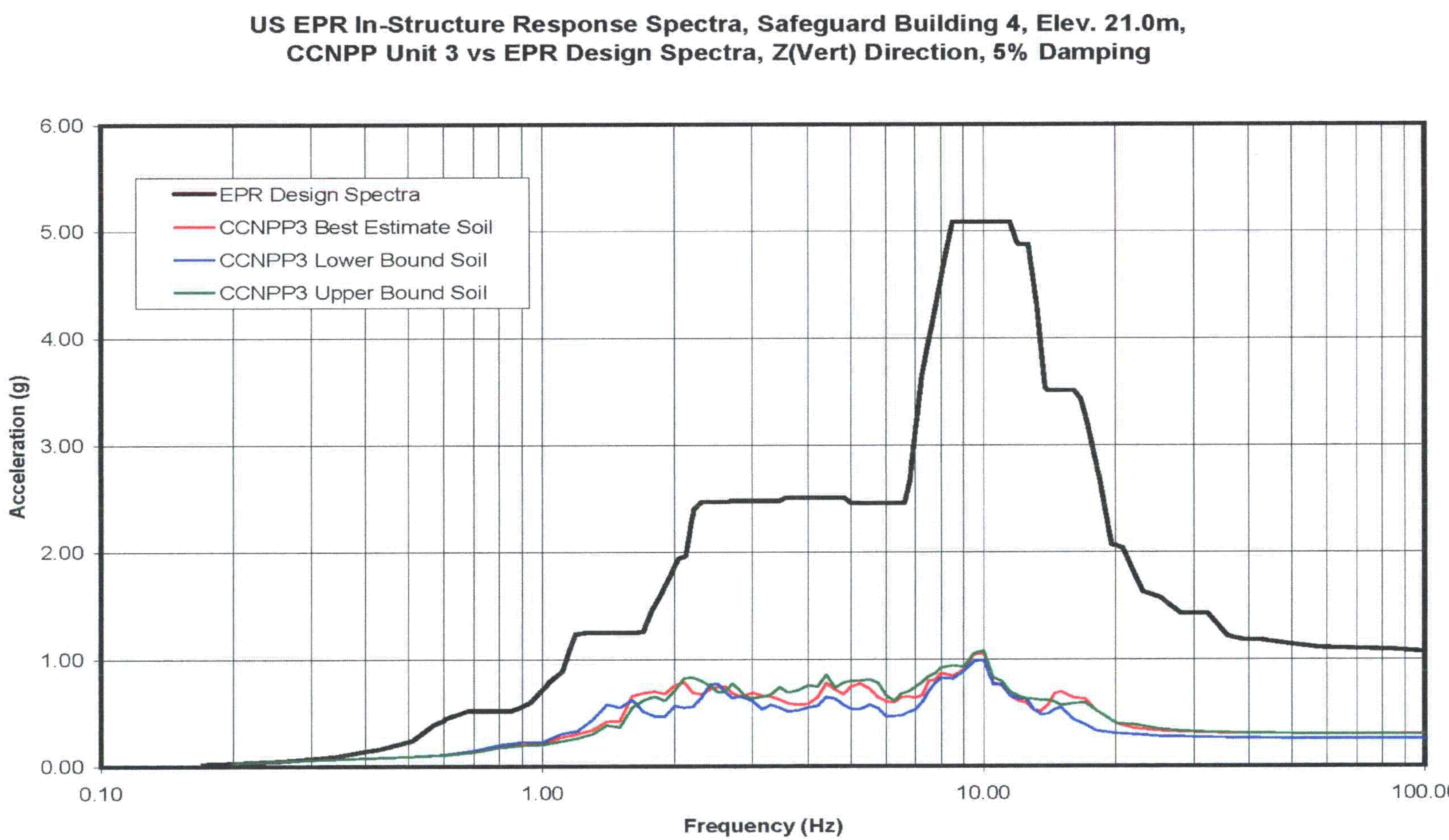


Figure 3.7-29—{Containment Building, Elev. 37.6 m, X (E-W) Direction, 5% Damping}

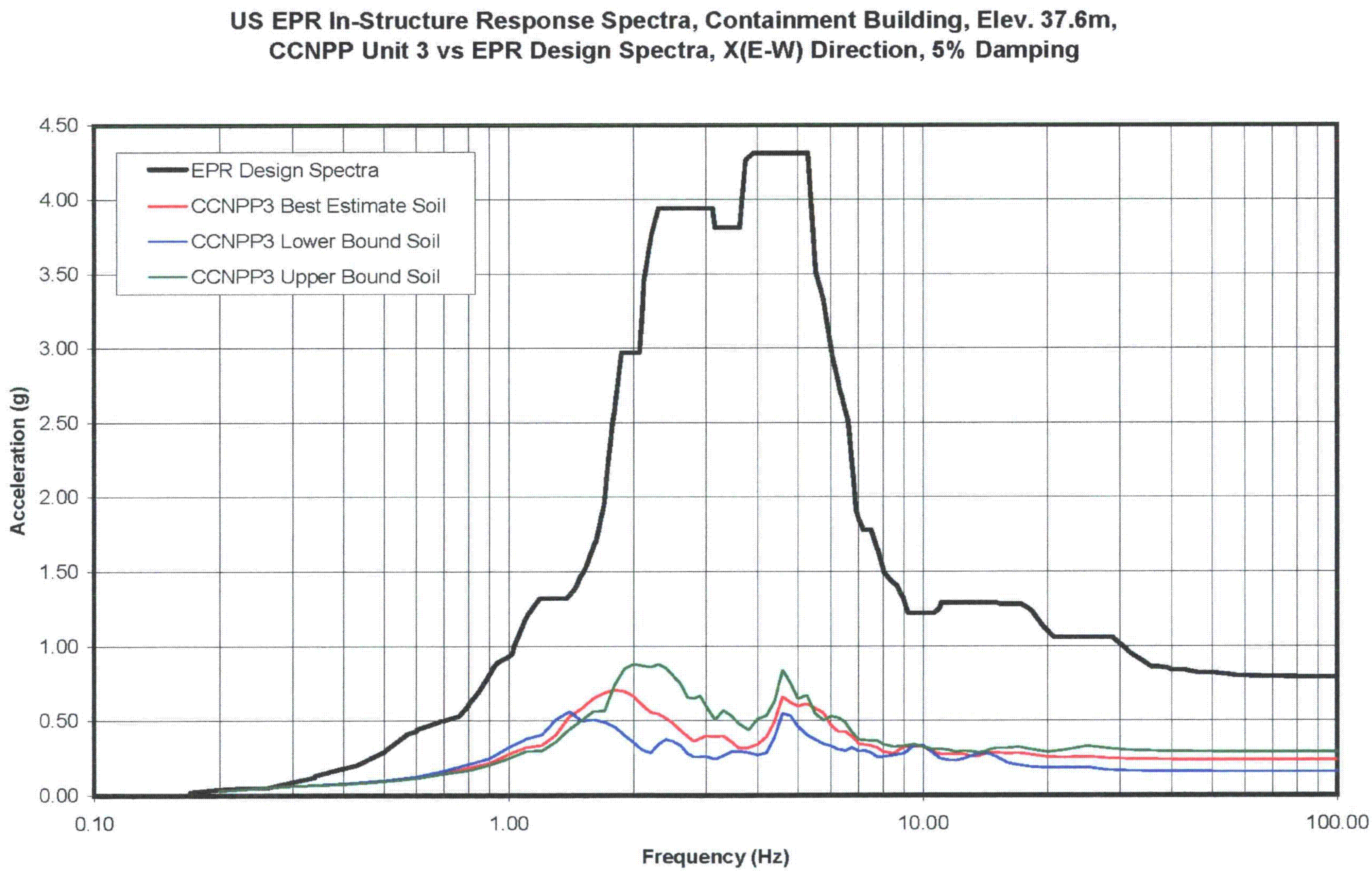


Figure 3.7-30—{Containment Building, Elev. 37.6 m, Y (N-S) Direction, 5% Damping}

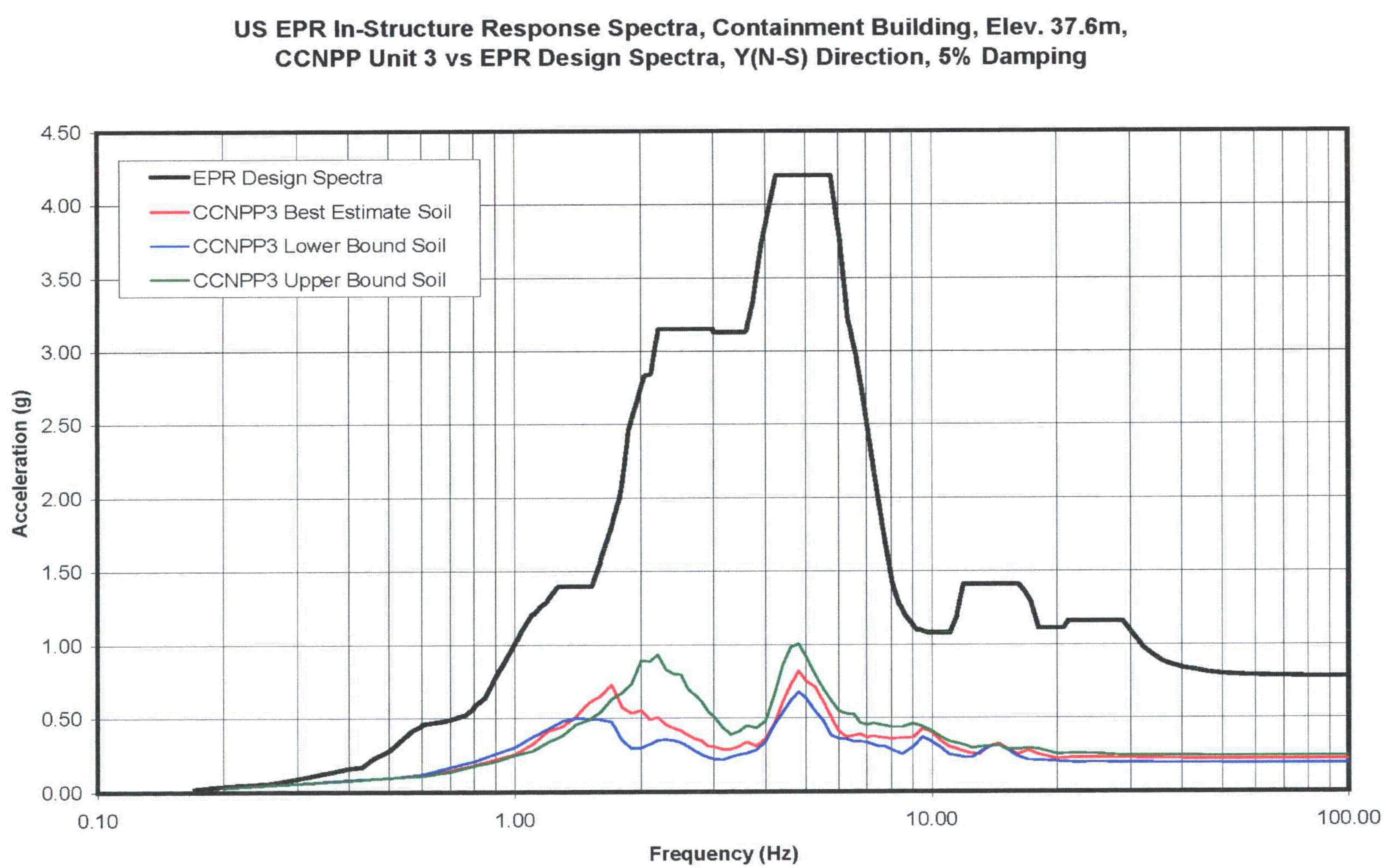


Figure 3.7-31—{Containment Building, Elev. 37.6m, Z (Vert) Direction, 5% Damping}

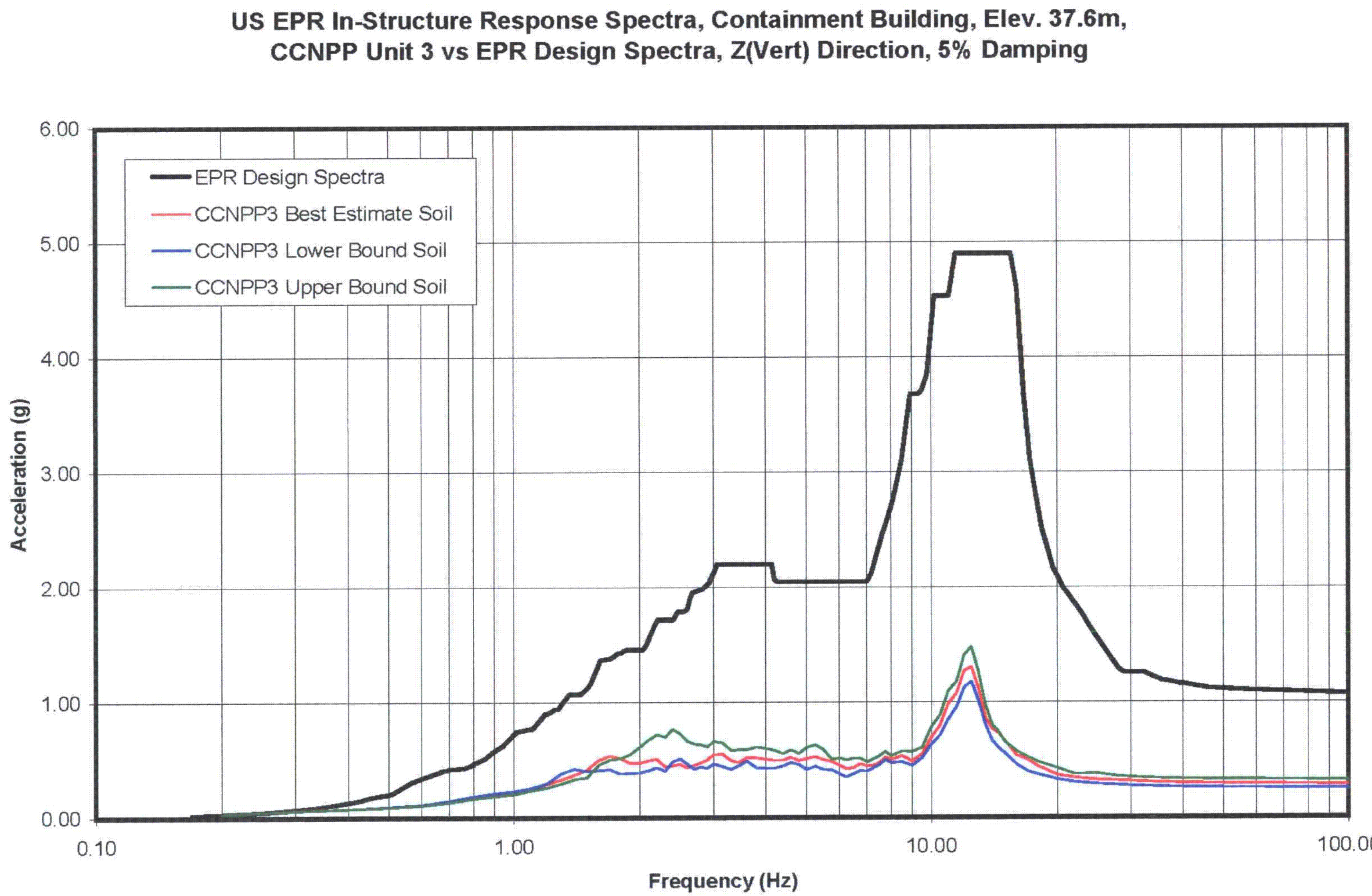


Figure 3.7-32—{Containment Building, Elev. 58.0 m, X (E-W) Direction, 5% Damping}

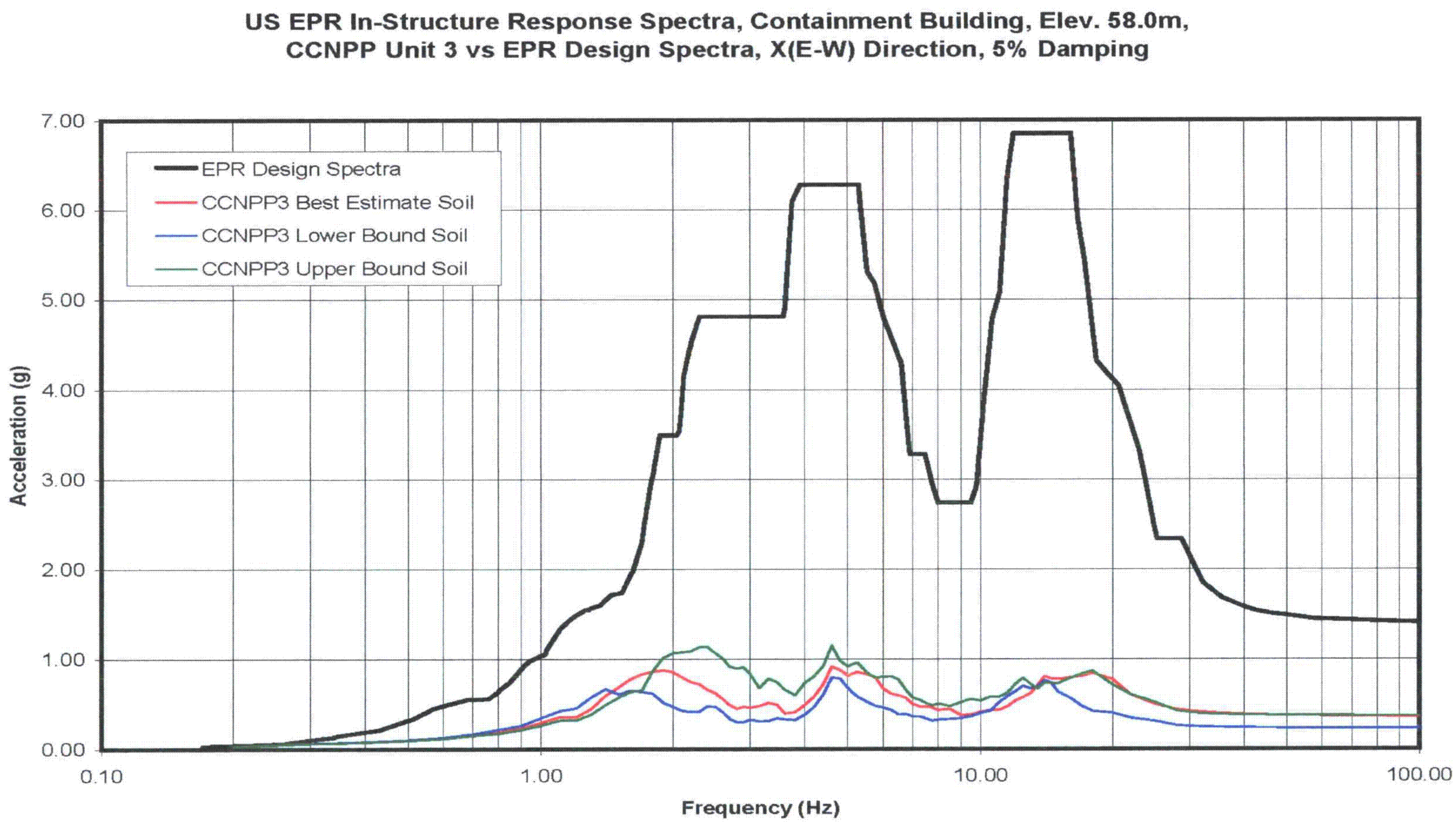


Figure 3.7-33—{Containment Building, Elev. 58.0 m, Y (N-S) Direction, 5% Damping}

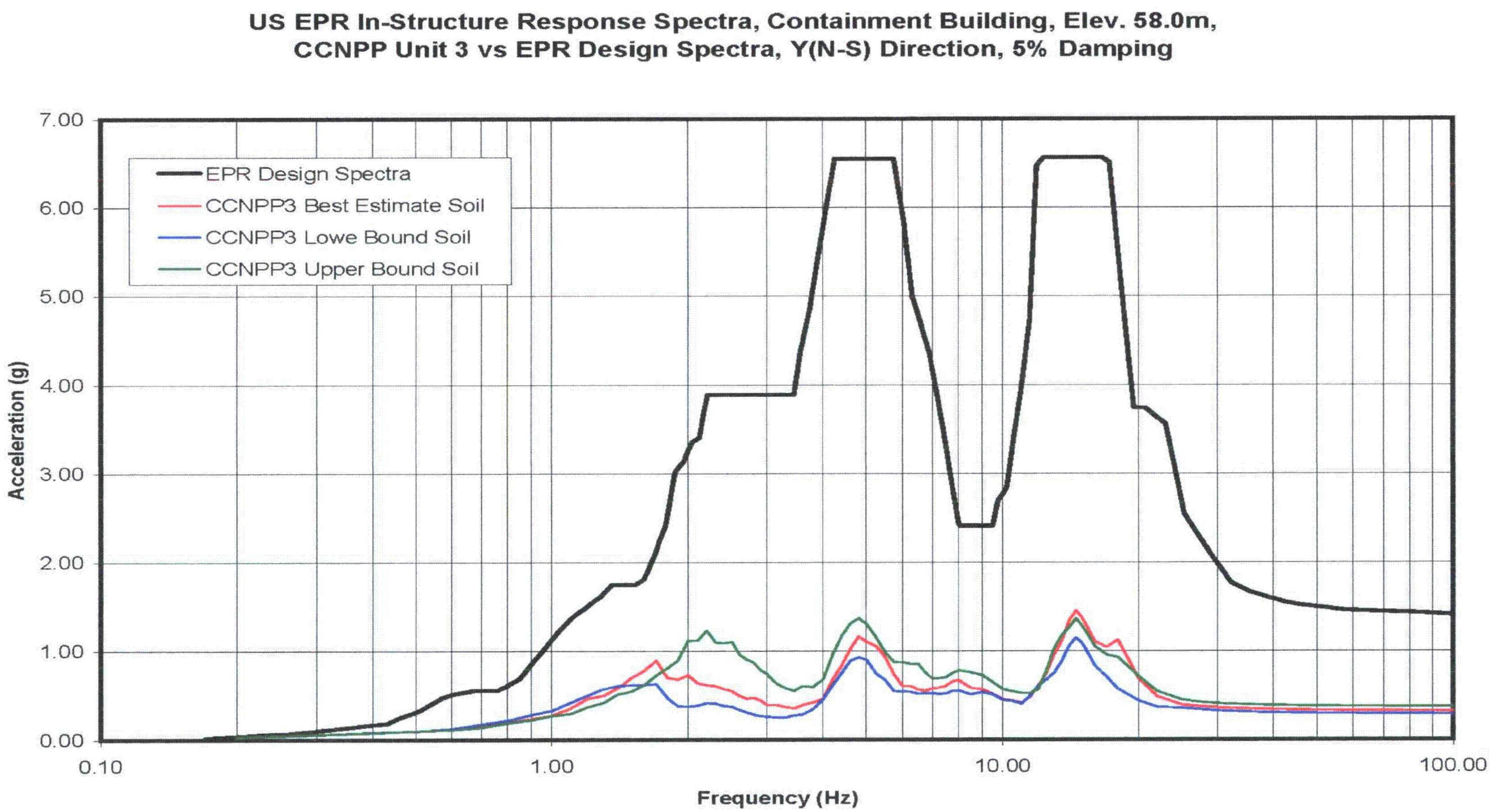
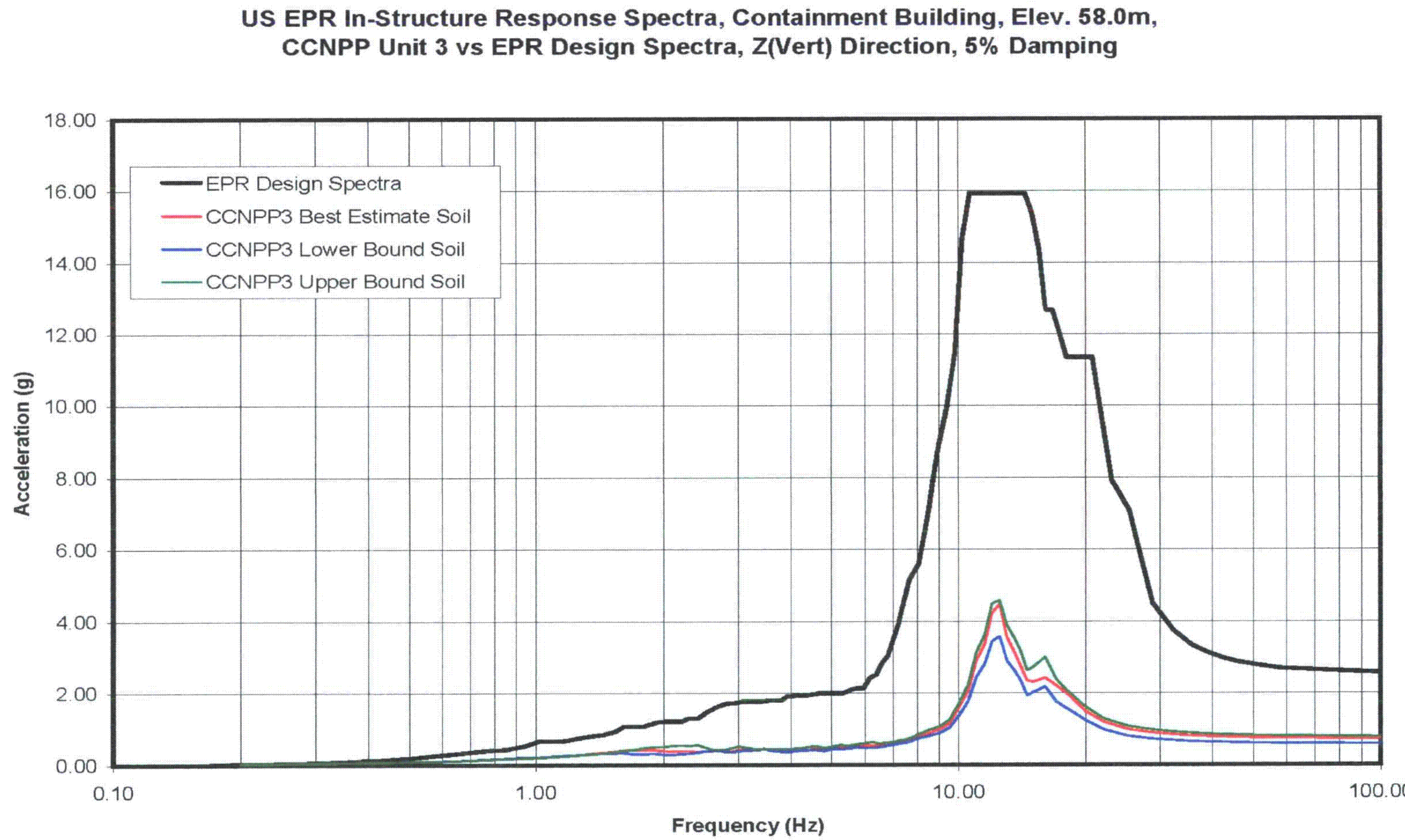


Figure 3.7-34—{Containment Building, Elev. 58.0m, Z (Vert) Direction, 5% Damping}



RAI No. 58

Question 03.07.01-10

In FSAR Section 3.7.1.1.2 on page 3.0-33 a description of the design ground motion time histories are presented for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). The design ground motion time histories for the nuclear island (NI) common basemat structures, Emergency Power Generating Buildings (EPGBs), and Essential Service Water Buildings (ESWBs) are not explicitly stated or provided by reference. What are the site specific design ground motions and their bases that apply to these structures? Provide this information in this section of the FSAR.

Response

As summarized in Enclosure 1, the following portion of this RAI question is addressed herein:

State explicitly or by reference design ground motion time histories for NI, EPGB, and ESWB structures.

NI

The Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 design ground motions for the NI Common Basemat Structures in Revision 5 of the FSAR are the Certified Seismic Design Response Spectra (CSDRS) (EUR ground motions anchored to 0.3g) as described in CCNPP Unit 3 FSAR Section 3.7.1.1 and as shown in U.S. EPR FSAR Figure 3.7.1-1. The CSDRS ground motion time histories are described in U.S. EPR FSAR Section 3.7.1.1.2. As stated in CCNPP Unit 3 FSAR Section 3.7.1, the site-specific ground motions (FIRS) for CCNPP Unit 3 are enveloped by the CSDRS.

The design ground motion for the NI Common Basemat Structure has been modified so that it is the envelope of the U.S. EPR FSAR European Utility Requirements (EUR) Soft Soil spectrum anchored at 0.15 g and the Regulatory Guide 1.60 spectrum anchored at 0.1 g. The response to RAI No. 112 Question 03.07.01-11 (this enclosure) and RAI No. 19 Question 03.07.04-1[1] provides additional detail of this spectra.

EPGBs and ESWBs

The design spectra for the EPGBs and ESWBs are generated by modifying the U.S. EPR CSDRS to account for structure-soil-structure-interaction effects, as described in U.S. EPR FSAR Section 3.7.1.1.1 and shown in U.S. EPR FSAR Figures 3.7.1-33 and 3.7.1-34. The design ground motion time histories for EPGBs and ESWBs, compatible with these spectra, are described in U.S. EPR FSAR Section 3.7.1.1.2 and are shown in U.S. EPR FSAR Figures 3.7.1-35 through 3.7.1-37. These spectra and time histories are applicable for the design of CCNPP Unit 3 EPGBs and ESWBs.

---

[1] UniStar Nuclear Energy Letter UN#09-372, from Greg Gibson (UniStar Nuclear Energy) to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Plant, Unit 3, RAI No. 19, Revision 2, Seismic Instrumentation, dated September 15, 2009.

CCNPP Unit 3 FSAR Subsection 3.7.1.1.1 provides the bases for applying the design ground motions described above to EPGBs and ESWBs. FSAR Figures 3.7-35 and 3.7-36, used for this purpose, show that the site-specific FIRS for EPGBs and ESWBs, which are conservatively defined at grade, are enveloped by CSDRS.

The FIRS shown in FSAR Figures 3.7-35 and 3.7-36 were calculated using assumed structural backfill properties. The FIRS will be recalculated using actual structural backfill properties and will be provided in response to RAI 112 Question 03.07.01-11, according to the schedule provided in Enclosure 1.

COLA Impact

The changes for the response spectra for the NI Common Basemat are discussed in the response to RAI No. 112 Question 03.07.01-11 (this enclosure) and provided in the response to RAI No. 19 Question 03.07.04-1[1]

FSAR Sections 3.7.1 and 3.7.2 will be updated once the FIRS at the location of EPGBs and ESWBs are recalculated using actual structural backfill properties, and will be provided in response to RAI 112 Question 03.07.01-11, according to the schedule provided in Enclosure 1.

RAI No. 65

Question 03.07.02-18

In FSAR Section 3.7.2.8 on page 3.0-42, it states the U.S.EPR FSAR Section 3.7.2.8 addresses the interaction of certain Non-Seismic Category I structures with Seismic Category I structures These structures are the Vent Stack, Nuclear Auxiliary Building (NAB), Access Building (AB), Turbine Building (TB), Radioactive Waste Processing Building (RWPB) and the Firewater Storage Tanks and Fire Protection Building.

- The Fire Protection Tanks and Fire Protection Building are classified as Seismic Category II-SSE in the CCNPP Unit 3 FSAR. This is an exception to the U.S. EPR FSAR which classifies them as conventional seismic. Please revise this section of the CCNPP FSAR to identify and clarify this difference.

- A seismic analysis was performed for the NAB in the U.S. EPR FSAR. Since this structure could potentially interact with Seismic Category I structures, the CCNPP FSAR needs to reconcile the U.S. EPR analysis with the site-specific soil properties and foundation input response spectra (FIRS) for the NAB. Also demonstrate in the FSAR that the displacement of this structure relative to the nuclear island common basemat structure is enveloped by the results of the U.S. EPR analysis.

Response

As summarized in Enclosure 1, the following portion of this RAI question is addressed herein:

Reconcile the U.S. EPR seismic analysis for NAB with the site-specific soil properties and foundation input response spectra (FIRS):

Based on the site-specific SSI analyses performed for the Nuclear Island (NI) common basemat structures, response spectra at the basemat of the Nuclear Auxiliary Building (NAB) were generated for lower bound, best estimate, and upper bound soil cases in the X, Y, and Z directions as shown in the attached RAI response figures (Figures 3.7-42, 3.7-43 and 3.7-44). Similarly, the response spectra generated from the supporting analyses performed for the U.S. EPR design are shown in Figures 3.7-45, 3.7-46 and 3.7-47. These figures will be added to the CCNPP Unit 3 FSAR. Comparison between the two sets of figures indicates that the site-specific response spectra at the basemat of the NAB is significantly lower than for U.S. EPR design. It can therefore be concluded that the displacement of the NAB relative to the NI common basemat structure is enveloped by the results of the U.S. EPR analysis.

COLA Impact

The following changes will be made in a future revision of the COLA:

- FSAR Figure 3.7-42 through Figure 3.7-47 will be added as described in the response.

- Modifications to FSAR Section 3.7.2 including a discussion of the new figures are provided in the response to RAI 65 Question 03.07.02-24 (this enclosure).

Figure 3.7-42-{CCNPP Unit 3 NAB Basemat X-Direction Spectra (5% Damping)}

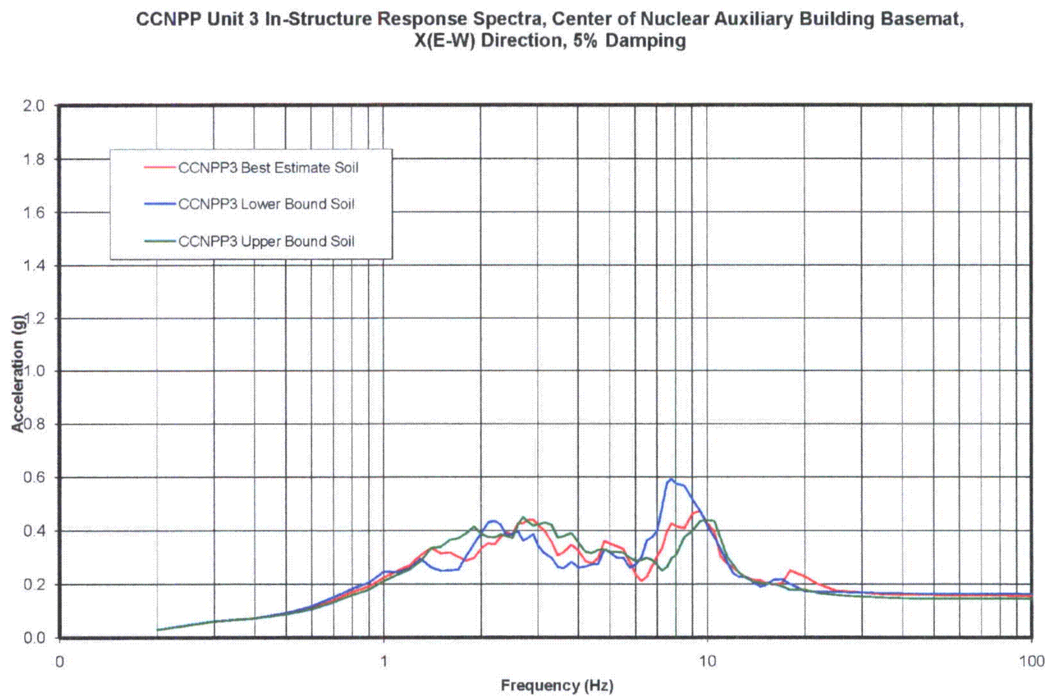


Figure 3.7-43-{CCNPP Unit 3 NAB Basemat Y-Direction Spectra (5% Damping)}

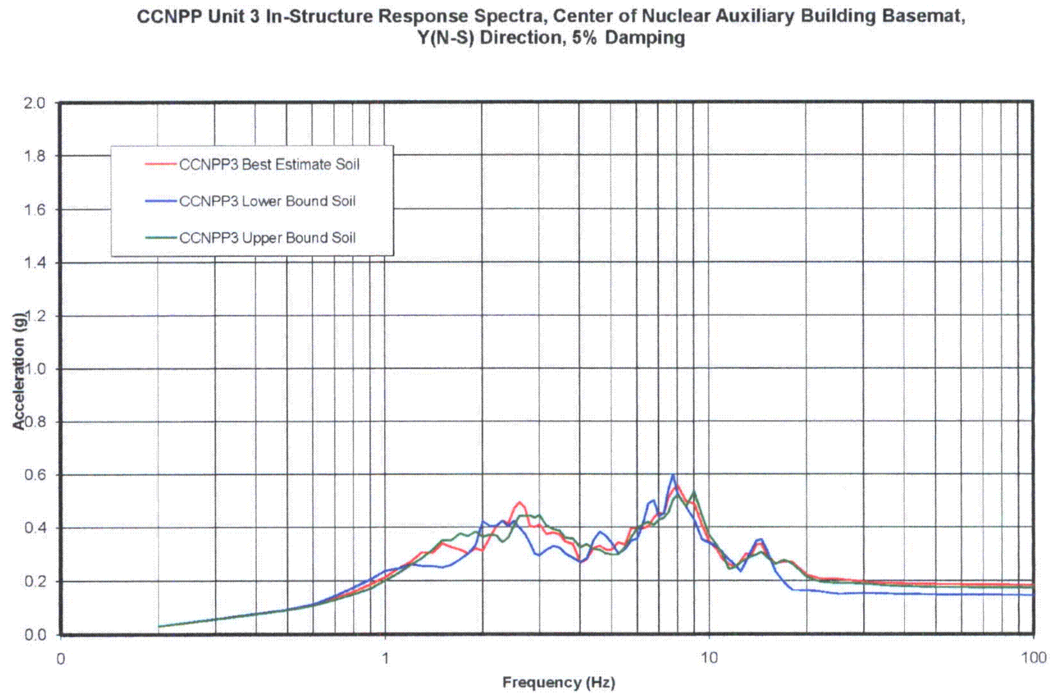


Figure 3.7-44-{CCNPP Unit 3 NAB Basemat Z-Direction Spectra (5% Damping)

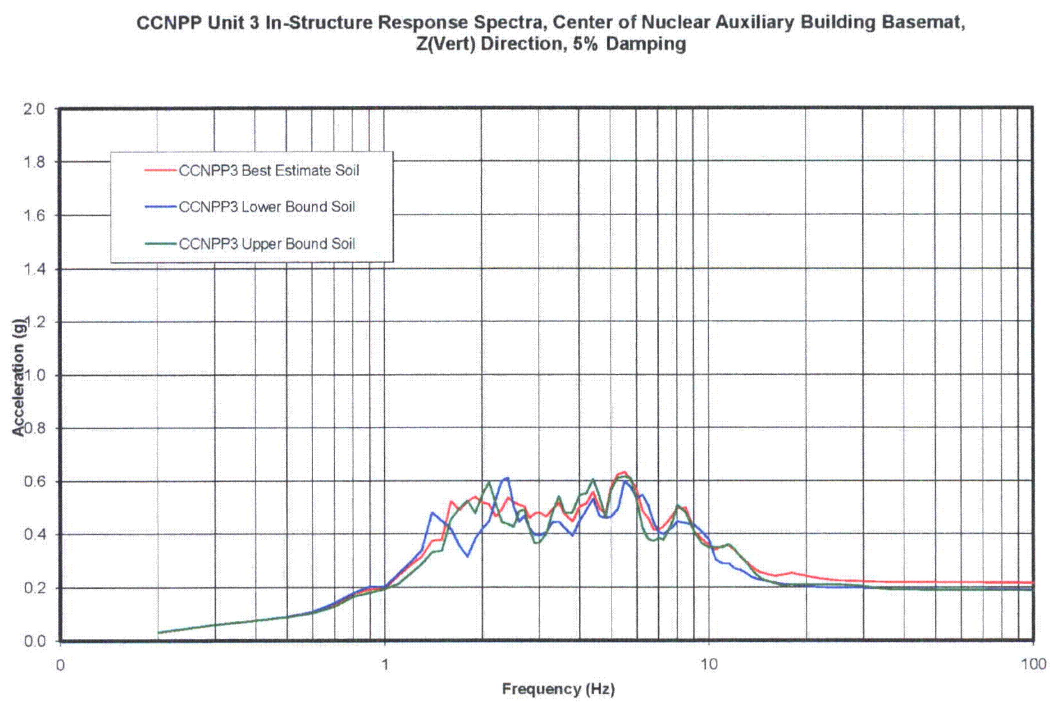


Figure 3.7-45-{Design Certification NAB Basemat X-Direction Spectra, (5% Damping)}

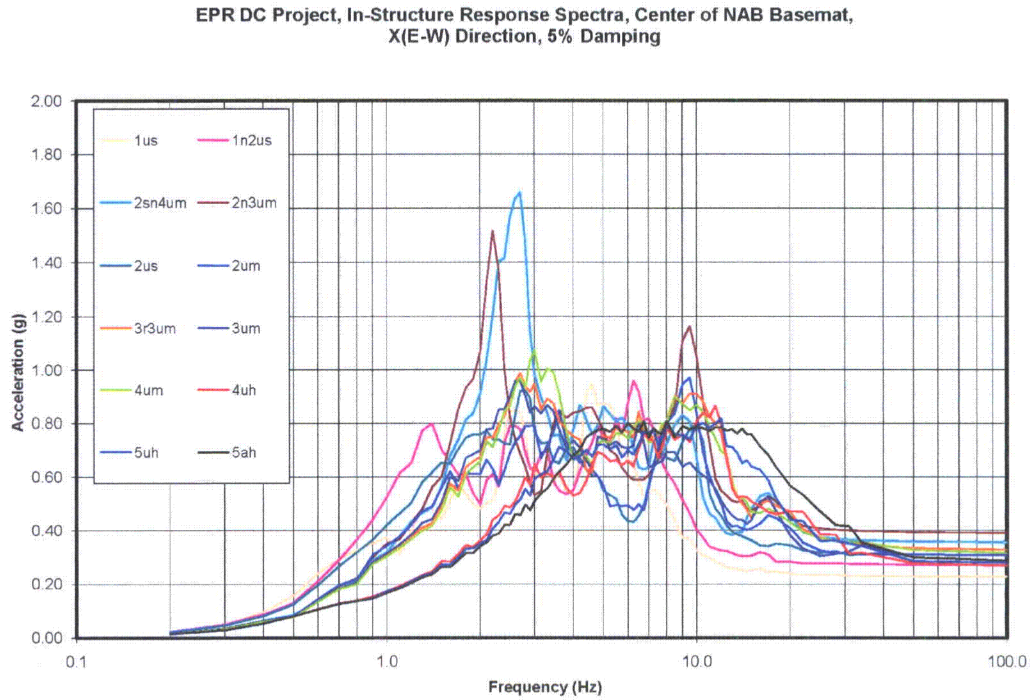


Figure 3.7-46-{Design Certification NAB Basemat Y-Direction Spectra (5% Damping)}

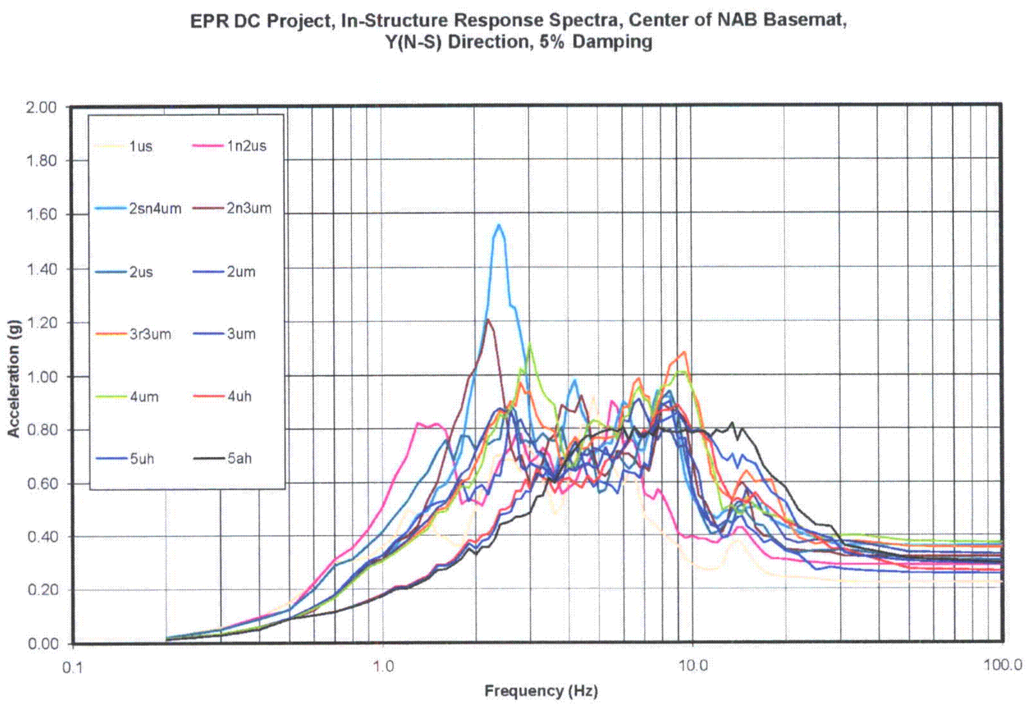
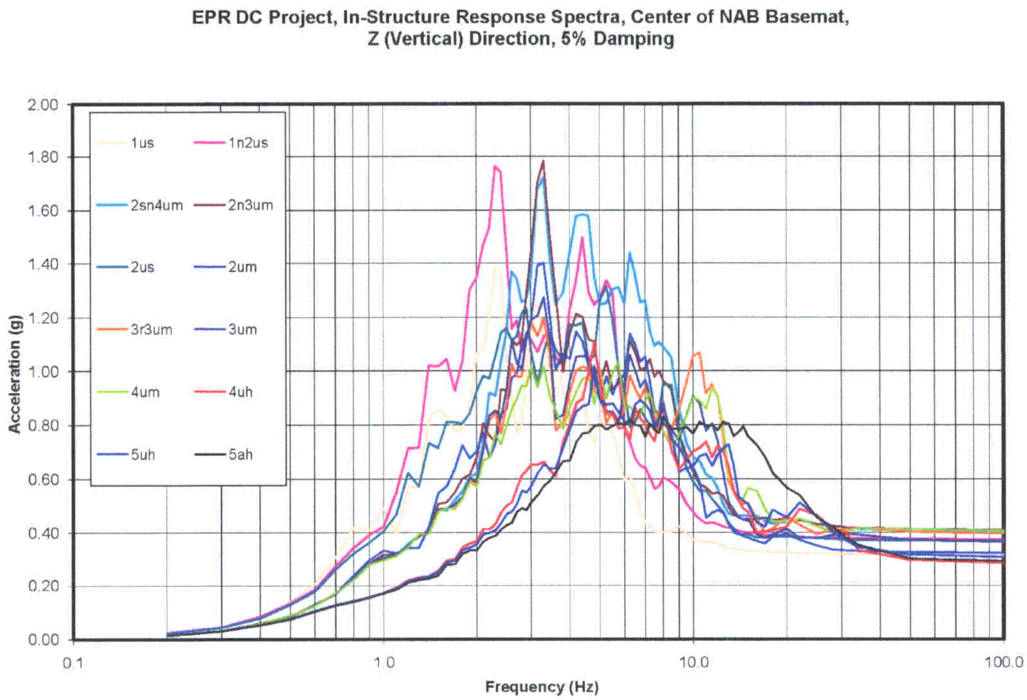


Figure 3.7-47-{Design Certification NAB Basemat Z-Direction Spectra (5% Damping)}



RAI No. 65

Question 03.07.02-24

U.S. EPR COL Information Item 3.7-1 states that 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. In its response, the applicant has not addressed, the nuclear island common basemat structures, seismic Category II structures, the Nuclear Auxiliary Building and the Radioactive Waste Processing Building, and should do so to fully respond to this information item. The applicant is requested to provide a summary for each structure, either directly or by reference, which describes how the COL item is met.

Response

Nuclear Island Common Basemat Structures and Seismic Category II Structures:

A site-specific confirmatory SSI analysis was performed using site-specific SSE input motion and corresponding strain-compatible soil properties. It was concluded from the In-Structure Response Spectra (ISRS) comparison at key locations of the NI (shown in FSAR Figures 3.7-8 through 3.7-34 in response to RAI 58, Question 03.07.01-1(this enclosure)), that site-specific ISRS are enveloped by the corresponding U.S. EPR design ISRS by a large margin. Therefore, it is confirmed that the site-specific seismic response for the NI common basemat structures is within the parameters of Section 3.7 of the U.S. EPR standard design. The only Seismic Category II structure, the vent stack, is part of the NI common basemat structures. Consequently, the site-specific seismic response of the vent stack is confirmed as well. FSAR Section 3.7.2 will be revised to address the NI common basemat structures and Seismic Category II structures.

Nuclear Auxiliary Building (NAB) and Radioactive Waste Processing Building (RWPB):

Responses at the center of basemats of these structures were computed from the site-specific SSI analysis of the NI mentioned above. The response to RAI 65, Question 03.07.02-18 (this enclosure), shows that site-specific response for the NAB is enveloped by U.S. EPR standard design response. The same conclusion may be drawn by comparing the site-specific responses (shown in attached Figures 3.7-48 through 3.7-50) at the basemat for RWPB to the corresponding U.S. EPR standard design responses (shown in attached Figures 3.7-51 through 3.7-53). Therefore, it is confirmed that the site-specific seismic responses for the NAB and RWPB are within the parameters of Section 3.7 of the U.S. EPR standard design. FSAR Section 3.7.2 will be revised to address the NAB and the RWPB. Also, new figures will be added to address the RWPB.

COLA Impact

FSAR Section 3.7.2 will be revised as follows and FSAR Figures 3.7-48 through 3.7-53 will be added in a future COLA revision. New Figures 3.7-42 through 3.7-47 were provided in the response to RAI 65 Question 03.07.02-18 (this enclosure).

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:

{As established in Section 3.7.1.1.1, the site-specific seismic response of the Seismic Category I Nuclear Island common basemat structures is within the parameters of Section 3.7 of the U.S. EPR FSAR standard design. A site-specific confirmatory SSI analysis was performed using site-specific SSE input motion and corresponding strain-compatible soil properties. It was concluded from the In-Structure Response Spectra (ISRS) comparison at key locations of the NI (Figures 3.7-8 through 3.7-34) that site-specific ISRS are enveloped by the corresponding design certification ISRS by a large margin. 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.

{As established in Section 3.7.1.1.1, the seismic input to the analysis of the Seismic Category I EPGBs and the Seismic Category I ESWBs is in accordance with the U.S. EPR FSAR seismic criteria. Figures 3.7-35 and 3.7-36 establish that the U.S. EPR FSAR seismic input motion is conservative relative to the site-specific input motion. The analysis of these two structures considers the ten generic soil profiles defined for the certified design in U.S. EPR FSAR Section 3.7.1.3. These ten soil profiles bound the site-specific soil profile as indicated in Section 2.5.2.6. Consequently, the site-specific seismic responses of the EPGBs and ESWBs are within the parameters of U.S. EPR FSAR Section 3.7.

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 3.7.1.1.1. The site-specific response for the NAB is enveloped by U.S. EPR standard design response as shown by comparing the site-specific responses (Figures 3.7-42 through 3.7-44) at the basemat for NAB to the corresponding U.S. EPR standard design responses (Figures 3.7-45 through 3.7-47). The site-specific response for the RWPB is enveloped by U.S. EPR standard design response as shown by comparing the site-specific responses (Figures 3.7-48 through 3.7-50) at the basemat for RWPB to the corresponding U.S. EPR standard design responses (Figures 3.7-51 through 3.7-53).

Figure 3.7-48–{CCNPP Unit 3 Radioactive Waste Processing Building Basemat X-Direction Spectra (5% Damping)}

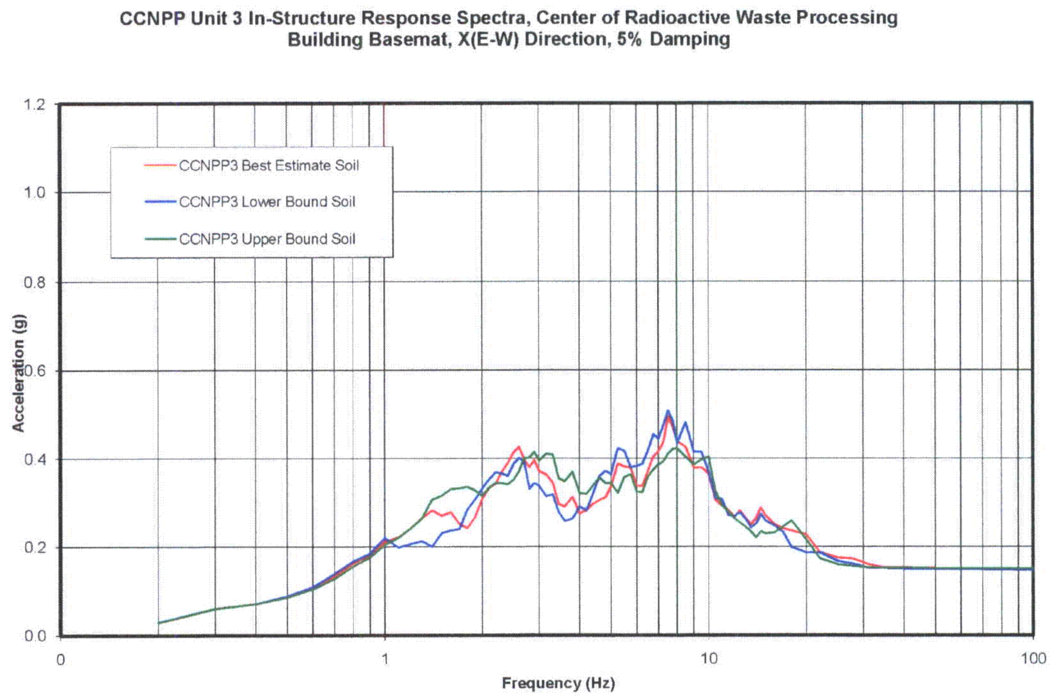


Figure 3.7-49—{CCNPP Unit 3 Radioactive Waste Processing Building Basemat Y-Direction Spectra (5% Damping)}

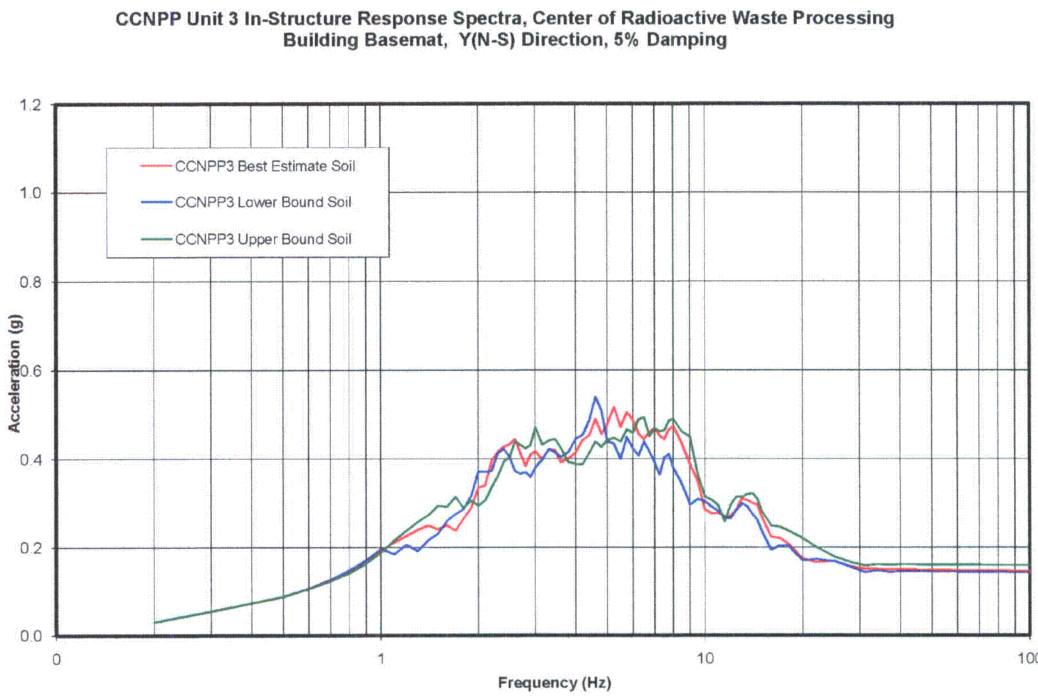


Figure 3.7-50—{CCNPP Unit 3 Radioactive Waste Processing Building Basemat Z-Direction Spectra (5% Damping)}

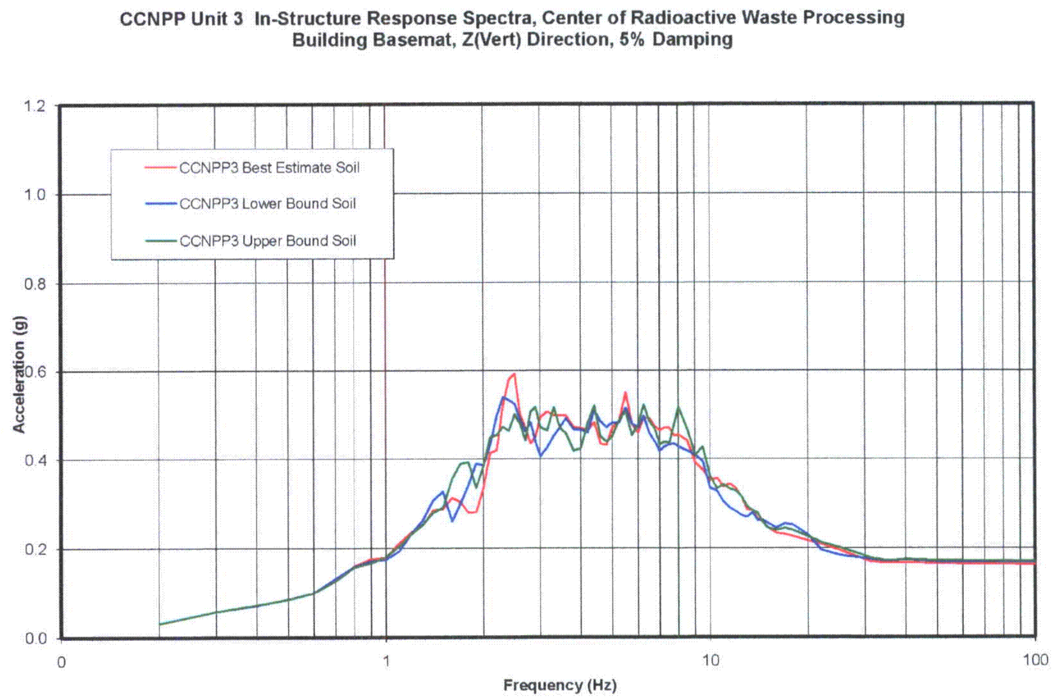


Figure 3.7-51–{Design Certification Radioactive Waste Processing Building Basemat X-Direction Spectra (5% Damping)}

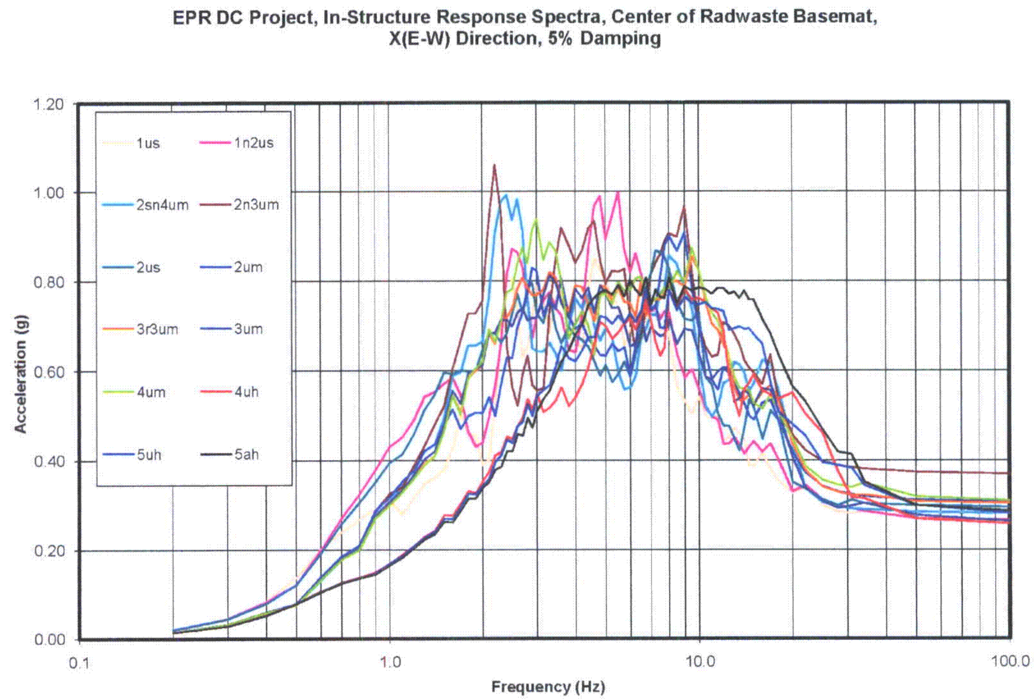


Figure 3.7-52–{Design Certification Radioactive Waste Processing Building Basemat Y-Direction Spectra (5% Damping)}

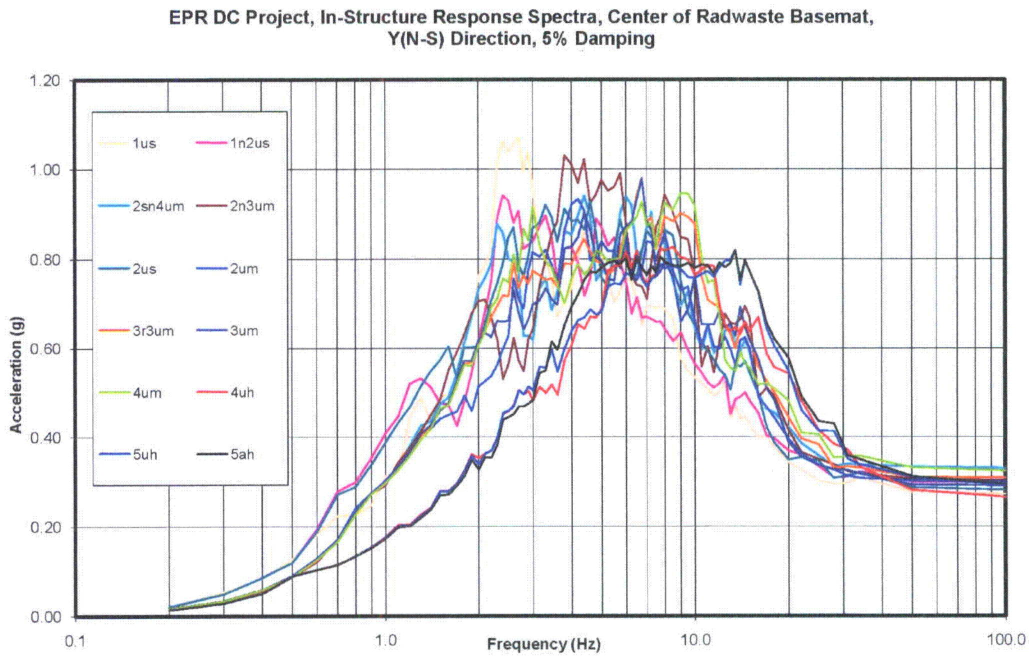
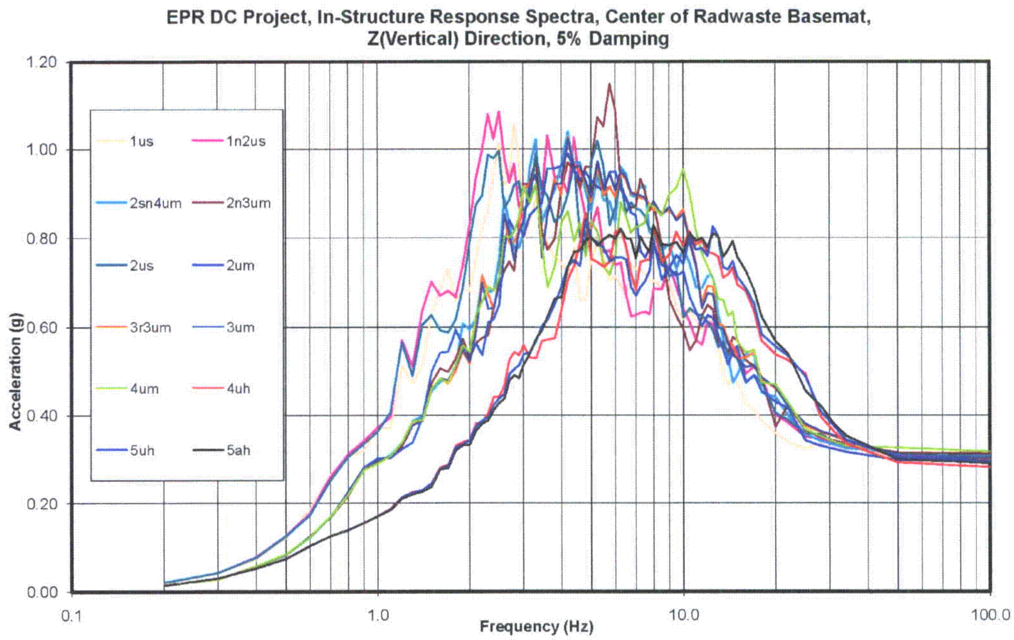


Figure 3.7-53–{Design Certification Radioactive Waste Processing Building Basemat Z-Direction Spectra (5% Damping)}



RAI No. 112

Question 03.07.01-11

In FSAR Section 3.7.1, the Ground Motion Response Spectra (GMRS) is defined at the foundation level of the nuclear island (NI) common basemat structure as having a horizontal and vertical peak ground acceleration of .067g. The FSAR further states that to meet Appendix S of 10CFR Part 50, a horizontal safe shutdown earthquake (SSE) ground motion is defined as the envelope of the GMRS and the set of certified seismic design response spectra (CSDRS) curves anchored at .10 g peak ground acceleration. However, the subsequent confirmatory analysis of the NI common basemat structures uses the European Utility Requirements (EUR) soft soil with a peak ground acceleration (PGA) of .10 g. The foundation input response spectra (FIRS) for the Emergency Power Generating Building (EPGB) and Emergency Service Water Building (ESWB) have not been defined and no confirmatory analysis has been performed. The assumed input motion of the Ultimate Heat Sink (UHS) Make-up Water Intake Structure (MWIS) is the EUR soft soil spectrum with a PGA of .15 g. The assumed input motion for the UHS Electrical Building (EB) is an envelope of EUR soft soil spectrum with a zero period acceleration (ZPA) of .15 g, and in-structure response spectra (ISRS) determined at the operating deck of the UHS MWIS. The subject was discussed in great detail during the audit held during March 17 through March 19, 2009, and it was noted that there has been a different approach to the seismic qualification of seismic Category I structures at the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 site that did not correspond to a clear definition of the SSE for the site. Therefore, the staff is requesting the applicant to provide the following information:

a) Provide a definition of the site SSE. Describe how it meets regulation requirements;

b) Consistent with the site SSE, provide the FIRS in the free field at the foundation level of each structure meeting the requirements of Appendix S, and describe how each is determined;

c) For the U.S. EPR Certified Design structures, provide a comparison of the results of the site seismic analyses using the FIRS input motion defined at the foundation level of each structure, with the analyses results documented in the U.S EPR FSAR.

d) For the EPGB and ESWB, describe how the effect of structure-soil-structure interaction has been accounted for in the analysis of these buildings.

Response

As summarized in Enclosure 1, the following portion of this RAI question is addressed herein:

Provide a definition of the site SSE. Describe how it meets regulation requirements:

The site-specific safe shutdown earthquake (SSE) spectrum for the CCNPP Unit 3 site is the envelope of EUR Soft Soil spectrum scaled to a 0.15 g PGA and the RG 1.60 horizontal spectrum scaled to a 0.1 g PGA. FSAR Figure 3.7-3 is revised to show the site-specific SSE spectrum in the revised response to RAI No.19, Question 03.07.04-1[1].

Consistent with the site SSE, provide the FIRS in the free field at the foundation level of each structure meeting the requirements of Appendix S, and describe how each is determined (This response for the Nuclear Island):

The CCNPP Unit 3 Nuclear Island FIRS, which is shown in Figure 3.7-1 (modified in response to RAI 58 Question 03.07.01-1 (this enclosure), has a horizontal peak ground acceleration (PGA) of 0.076 g and does not satisfy the 0.1 g minimum horizontal PGA requirement of 10 CFR 50, Appendix S. Consequently, in order to comply with Appendix S, the site SSE as described above is used as the free-field ground motion (for the horizontal and vertical directions) for the site-specific confirmatory SSI analysis of the NI.

For the U.S. EPR Certified Design structures, provide a comparison of the results of the site seismic analyses using the FIRS input motion defined at the foundation level of each structure, with the analyses results documented in the U.S. EPR FSAR (This response for the Nuclear Island):

For Nuclear Island Common Basemat Structures, the comparison of results of the site seismic analyses using the FIRS input motion with the analyses results documented in the U.S. EPR FSAR is described in the response to RAI 58, Question 03.07.01-1.

COLA Impact

FSAR Section 3.7.1 will be revised as described in response to RAI 19, Question 03.07.04-1[1] and RAI 58, Question 03.07.01-1 (this enclosure) in a future COLA revision.