FINAL SAFETY ANALYSIS REPORT

CHAPTER 3

DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

This chapter of the U.S. EPR FSAR is incorporated by reference, with the departures and supplements described in the following sections.

3.1 COMPLIANCE WITH NUCLEAR REGULATORY COMMISSION GENERAL DESIGN CRITERIA

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

3.1.1 Overall Requirements

3.1.1.1 Criterion 1 – Quality Standards and Records

No departures or supplements.

3.1.1.1.1 U.S. EPR Compliance

The U.S. EPR FSAR includes the following COL Item in Section 3.1.1.1.1:

> A COL applicant that references the U.S. EPR design certification will identify the site-specific QA Program Plan that demonstrates compliance with GDC 1.

This COL Item is addressed as follows:

{The QA Program is provided in the Quality Assurance Program Description, (QAPD) as described in Chapter 17.}

The QAPD is applicable to the siting, design, fabrication, construction (including pre-operational testing), operation (including testing), maintenance and modification of the facility. The QAPD demonstrates compliance with GDC 1.

3.1.1.2 Criterion 2 – Design Bases for Protection Against Natural Phenomena

No departures or supplements.

3.1.1.3 Criterion 3 – Fire Protection

No departures or supplements.

3.1.1.4 Criterion 4 – Environmental and Missile Design Bases

No departures or supplements.

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

No departures or supplements.

3.1.1.5.1 U.S. EPR Compliance

{CCNPP Unit 3 shares the following structures, systems, and components with CCNPP Units 1 and 2:

- ♦ Offsite transmission system – The CCNPP Unit 3 substation is electrically integrated with the existing CCNPP Units 1 and 2, 500 kV substation. While the offsite transmission system is shared between CCNPP Unit 3 and CCNPP Units 1 and 2, CCNPP Unit 3 has onsite AC and DC systems that are dedicated to its use. The offsite AC power sources are described in more detail in Section 8.2, and the onsite power sources are described in Section 8.3.

- Existing Chesapeake Bay intake channel and embayment consists of the:
  - Existing CCNPP Units 1 and 2 intake channel that extends 4,500 ft (1,380 m) offshore.
  - Existing embayment that is defined by a deep curtain wall.
  - CCNPP Unit 3 intake inlet area.
  - Non-safety-related CWS Makeup Water Intake Structure.
  - Safety-related Ultimate Heat Sink (UHS) Makeup Water Intake Structure.

  CCNPP Units 1 and 2 and CCNPP Unit 3 share the CCNPP Units 1 and 2 intake channel and embayment. While the CCNPP Unit 3 CWS Makeup Water Intake Structure, UHS Makeup Water Intake Structure, and the inlet area are located within the embayment, they are structurally independent of the CCNPP Units 1 and 2 intake structures, and are located in a different part of the embayment. The UHS is described in more detail in Section 9.2.5. The CWS System is described in more detail in Section 10.4.5.

- Meteorological tower – The meteorological tower provides meteorological data to CCNPP Units 1 and 2 and CCNPP Unit 3 to support operational and emergency response purposes. It is described in more detail in Section 2.3.3.
- Emergency Operations Facility (EOF) – The EOF is described in more detail in Part 5 of the COL application.

The structures, systems, and components are designed such that an accident in one unit would not impair their ability to perform their function for any other unit.}

3.1.2 Protection by Multiple Fission Product Barriers

No departures or supplements.

3.1.3 Protection and Reactivity Control Systems

No departures or supplements.

3.1.4 Fluid Systems

No departures or supplements.

3.1.5 Reactor Containment

No departures or supplements.

3.1.6 Fuel and Reactivity Control

No departures or supplements.

3.1.7 References

{No departures or supplements.}

3.2 CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS

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

3.2.1 Seismic Classification

The U.S. EPR FSAR includes the following COL Item in Section 3.2.1:

> A COL applicant that references the U.S. EPR design certification will identify the seismic classification of applicable site-specific SSCs that are not identified in U.S. EPR FSAR Table 3.2.2-1.

This COL Item is addressed as follows:

The seismic classifications for applicable site-specific structures, systems, and components (SSCs) are provided in Table 3.2-1.

{U.S. EPR FSAR Section 3.2.1 states: "The seismic classification of the U.S. EPR SSCs uses the following categories: Seismic Category I, Seismic Category II, radwaste seismic, conventional seismic, and non-seismic." As described in Section 3.2.1.4, CCNPP Unit 3 the Conventional Seismic classification is supplemented with the Conventional Seismic-I designation to address the portions of the site-specific Fire Protection SSCs that support equipment required to achieve safe shutdown following a seismic event.}

3.2.1.1 Seismic Category I

No departures or supplements.

3.2.1.2 Seismic Category II

{Some SSCs that perform no safety-related function could, if they failed under seismic loading, prevent or reduce the functional capability of a Seismic Category I SSC, Conventional Seismic SSC required to be functional during and following an SSE (designated as CS-I), or cause incapacitating injury to main control room occupants during or following an SSE. These non-safety-related SSCs are classified as Seismic Category II.

SSCs classified as Seismic Category II are designed to withstand SSE seismic loads without incurring a structural failure that permits deleterious interaction with any Seismic Category I SSC, Conventional Seismic SSC required to be functional during and following an SSE (designated as CS-I), or that could result in injury to main control room occupants. The seismic design criteria that apply to Seismic Category II SSCs are addressed in Section 3.7.}

3.2.1.3 Radwaste Seismic

No departures or supplements.

3.2.1.4 Conventional Seismic

{This section of the U.S. EPR FSAR is incorporated by reference, with the supplements described in the following sections. In addition to the Conventional Seismic classification defined in the U.S. EPR FSAR Section 3.2.1, CCNPP Unit 3 Fire Protection System requires that some portions of the system and support system(s) to remain functional during and following a seismic event to support equipment required to achieve safe shutdown in accordance with Regulatory Guide 1.189 (NRC, 2007). This requirement for the portions of the Fire Protection and supporting systems is designated as CS-I in Table 3.2-1, Table 3.10-1, Table 3.11-1, Figures 9.5-2, 9.5-3 and other Sections of COLA FSAR. Sections 3.7 and 3.8 discuss the seismic methods for analysis and design of these components.}

3.2.1.5 Non-Seismic

No departures or supplements.

3.2.2 System Quality Group Classification

The U.S. EPR FSAR includes the following COL Item in Section 3.2.2:

> A COL applicant that references the U.S. EPR design certification will identify the quality group classification of site-specific pressure-retaining components that are not identified in Table 3.2.2-1.

This COL Item is addressed as follows:

The quality group classification of site-specific pressure-retaining components is provided in Table 3.2-1.

3.2.3 References

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

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
(Page 1 of 11)

KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
PEB Essential Service Water System							
30PEB 15/25/35/45	ESW Basin External Access Piping	NS-AQ	D	CS-1	Yes	URB/UZT	ASME B31.1
30PEB 15/25/35/45 AA001	ESW Basin External Access Piping Isolation Valve	NS-AQ	D	CS-1	Yes	UZT	ASME B31.1
30PEB 15/25/35/45 AA501	ESW Basin External Access Piping Vent Valve	NS-AQ	D	CS-1	Yes	URB	ASME B31.1
30PEB 15/25/35/45 AA401	ESW Basin External Access Piping Drain Valve	NS-AQ	D	CS-1	Yes	UZT	ASME B31.1
PED UHS Makeup Water System							
30PED 10/20/30/40/ AP001	UHS Makeup Water Pumps	S	C	I	Yes	UPF	ASME III ANSI/HI 2.3
30PED 10/20/30/40/ AH001	UHS Makeup Water Pump Motors (30 PED 10/20/30/40/ AH001)	S	N/A	I	Yes	UPF	(Note 8)
PED	Piping (30PED 10/20/30/40) to Cooling Tower	S	C	I	Yes	UPF/UZT	ASME III
30PED 10/20/30/40 AT001	Pump Discharge Strainer	S	C	I	Yes	UPF	ASME III
30PED 10/20/30/40	UHS Makeup Water Isolation Valves	S	C	I	Yes	UPF/UZT	ASME III (Note 8)
PED	Ventilation Equipment Piping	S	C	I	Yes	UPF	ASME III
PED	Air Conditioning Unit	S	C	I	Yes	UPF	ASME III / ASME AG-1
PED	Air Cooled Condenser	S	C	I	Yes	UPF	ASME III / ASME AG-1
30PED 10/20/30/40	UHS Makeup Water Traveling Screen Room Vane Axial Fan	S	N/A	I	Yes	UPF	ASME AG-1
30PED 10/20/30/40	UHS Makeup Water Traveling Screen Room Unit Heater	S	N/A	I	Yes	UPF	ASME AG-1
30PED 10/20/30/40	Piping and valves of traveling screen wash system	S	C	I	Yes	UPF	ASME III
PED	Ventilation Equipment Including Ventilation Louvers and Tornado Dampers	S	N/A	I	Yes	UPF	ASME AG-1
PED	Ventilation Equipment	NS-AQ	D	II	Yes	UPF	(Notes 5 & 6)

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
30 PED 11/21/31/41/ AC001	Isolation Valves for Equipment	S	C	I	Yes	UPF	ASME III
30UFB10 01/02/03/04	UHS Makeup Water Intake Structure	S	N/A	I	Yes	UPF	ANSI/HI 9.8/ACI 349/ ANSI/AISC N690
PED	Instrumentation and Controls in the UHS Makeup Water Intake Structure	S	N/A	I	Yes	UPF	(Note 8)
PED	Instrumentation and Controls in the UHS Makeup Water Intake Structure	NS-AQ	N/A	II	Yes	UPF	(Notes 5 & 6)
PED	UHS Makeup Water System Electrical Distribution System Equipment	S	N/A	I	Yes	UPF	(Note 8)
UPF	UHS Makeup Water System Electrical Distribution System Equipment	NS-AQ	N/A	II	Yes	UPF	(Notes 5 & 8)
PED	Miscellaneous piping and valves	S	C	I	Yes		ASME III
PED	Traveling Screens	S	N/A	I	Yes	UPF	(Note 6)
PED	Bar Screens	S	N/A	I	Yes	UPE/UPF	AISC N690
PED	Buried Intake Pipes	S	C	I	Yes	UPE/ UPF	ASME III
PED	Forebay	S	N/A	I	No	UPE/ UPF	ACI 349
PED	Sheet Pile Wall	NS-AQ	N/A	CS	No		IBC / AISC N690
PED	Electrical Duct Banks traversing from each Essential Service Water Building to the UHS Makeup Water Intake Structure	S	N/A	I	Yes	UPF/ UQB/ UZT	ACI 349 (Note 8)
PA, PAA, PAB, PAC Circulating Water System							
URA	Circulating Water Cooling Tower and Basin	NS	N/A	CS	No	URA	IBC
UPE	Circulating Water System Makeup Intake Structure	NS-AQ	N/A	II	Yes	UPE	IBC / ACI 349 (Note 5)
30 PAC10/20/30 AP 001	Circ Water Pumps	NS	E	NSC	No	UQA	ASME B31.1/ANSI/ HI 2.3
PAC	Circ Water Pump Fans	NS	N/A	NSC	No	UQA	(Note 8)
30 PAC10/20/30 AH 001	Circ Water Pump Motors	NS	N/A	NSC	No	UQA	(Note 8)
30PAA10/20/30 AT001	Removable Screens	NS	N/A	NSC	No	UQA	(Note 6)
PAB	Circ Water Piping	NS	E	NSC	No	UQA	ASME B31.1/AWWA

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
PAB	Circ Water Valves	NS	E	NSC	No	UQA	ASME B31.1/AWWA
PAB	Instrumentation and Controls in Circ Water Piping	NS	N/A	NSC	No	UQA/ UZT	AWWA/ASME B31.1
30 PAC10/20/30 AP 001	Circ Water Makeup Pumps	NS	E	NSC	No	UPE	ASME B31.1/ANSI/HI 2.3
UQA	Circ Water Pump Bldg	NS	N/A	CS	No	UQA	IBC
30 PAC10/20/30 AH 001	Circ Water Makeup Pump Motors	NS	N/A	NSC	No	UPE	(Note 8)
PAB	Circ Water Makeup Piping	NS	E	NSC	No	UPE/UZT	AWWA/ASME B31.1
PAB	Circ Water Chemical Treatment Piping	NS	E	NSC	No	UZT/ UPE/ UQA	ASME B31.1
PAB	Circ Water Cooling Tower Blowdown Piping	NS	E	NSC	No	UQA/ UZT	AWWA/ ASME B31.1
PAB	Circ Water Bypass Piping	NS	E	NSC	No	UQA/ UZT	AWWA/ASME B31.1
PAA	Traveling Screens	NS	9	NSC	No	UPE	
PAB	Makeup piping Valves	NS	E	NSC	No	UPE	AWWA/ASME B31.1
PAB	Instrumentation and Controls in Makeup Piping	NS	N/A	NSC	No	UQA/ UZT	AWWA/ASME B31.1
PAA	Removable Trash Screen / Drive	NS	N/A	NSC	No	UPE	(Note 6)
PA	Circ Water System Electrical Distribution Equipment	NS	N/A	NSC	No	UQA	(Note 8)
GW Raw Water System, includes Essential Service Water Normal Makeup Supply							
GW	Desalination Transfer Pumps	NS	E	NSC	No	UPQ	ASME B31.1/ANSI (Note 8)
GW	Desalination Transfer Pump Motors	NS	N/A	NSC	No	UPQ	(Note 8)
GW	Desalination Water Storage Tanks	NS	E	CS	No	UPQ	AWWA D100/IBC
GW	Recirculation Valves	NS	E	NSC	No	UPQ	ASME B31.1
GW	Raw Water System Piping	NS	E	NSC	No	UPQ	ASME B31.1
GW	Water Heaters	NS	E	NSC	No	UPQ	ASME Section VIII
UPQ	Desalination/Water Treatment Building	NS	N/A	CS	No	UPQ	IBC
GW	Piping	NS	E	NSC	No	UPQ/ UZT	ASME B31.1
GW	Valves	NS	E	NSC	No	UPQ	ASME B31.1 (Note 8)

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
GW	RO Equipment	NS	E	NSC	No	UPQ	ASME B31.1
GW	Tanks	NS	E	CS	No	UPQ	AWWA D100/IBC
GW	Filters	NS	E	NSC	No	UPQ	ASME B31.1
GW	Pumps	NS	E	NSC	No	UPQ	ASME B31.1/ANSI/ NEMA
GW	Motors	NS	N/A	NSC	No	UPQ	(Note 8)
GW	Blowers	NS	N/A	NSC	No	UPQ	ASME B31.1
GW	System Electrical Distribution Equipment	NS	N/A	NSC	No	UPQ	(Note 8)
GR Sewage Water Treatment System							
GR	Waste Water Treatment Facility	NS	N/A	CS	No	UGU/ UZT	IBC
GR	Debris Tank	NS	E	CS	No	UGU/ UZT	AWWA D100/IBC
GR	Macerating Pumps	NS	E	NSC	No	UGU/ UZT	ASME B31.1/ANSI/ NEMA
GR	Macerating Pump Motors	NS	N/A	NSC	No	UZT	(Note 8)
GR	Aeration Chamber	NS	E	NSC	No	UGU/ UZT	(Note 6)
GR	Aeration Blower	NS	N/A	NSC	No	UGU/ UZT	(Note 6)
GR	Underground Piping	NS	E	NSC	No	UGU/ UZT	ASME B31.1
GR	Sewage Treatment System Piping	NS	E	NSC	No	UGU/ UZT	ASME B31.1
GR	Sewage System Electrical Distribution Equipment	NS	N/A	NSC	No	UGU/ UZT	(Note 8)
UYF, USU Security Access Facility, including Warehouse							
USU	Storage / Warehouse	NS	N/A	CS	No	USU	IBC
UYF	Security Access Facility	NS	N/A	CS	No	UYF	IBC
UYF	Security Access Electrical Distribution Equipment	NS	N/A	NSC	No	UYF	(Note 8)
QJ Central Gas Distribution System							
UTG	Central Gas Supply Bldg	NS	N/A	CS	No	UTG	IBC
QJ	Piping	NS	E	NSC	No	UTG	ASME B31.1
QJ	Valves	NS	E	NSC	No	UTG	ASME B31.1
QJ	Compressed Gas Tanks	NS	E	NSC	No	UTG	DOT Standards
QJ	Central Gas Supply Electrical Distribution Equipment	NS	N/A	NSC	No	UTG	(Note 8)

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}

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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
GK, Potable and Sanitary Water Systems							
GK	Piping	NS	E	NSC	No		ASME B31.1
GK	Valves	NS	E	NSC	No		ASME B31.1
GK	Tanks	NS	E	CS	No		AWWA D100/ASME VIII/IBC
GK	Pump	NS	E	NSC	No		ASME B31.1/ANSI (Note 8)
GK	Motors	NS	N/A	NSC	No		(Note 8)
GK	Potable Water System Electrical Distribution Equipment	NS	N/A	NSC	No		(Note 8)
SG, SGA, SGAO, SGM Fire Water Supply System							
SGA	Fire Water Distribution System, Conventional Area (Safe Shutdown Equipment Protection) Underground Loop	NA-AQ	D	CS-I	Yes	UZT	NFPA 24 NFPA 25 NFPA 804 ANSI ASME B31.1 ASME III (seismic qualification methodology only) ASCE 4-98 (Notes 5 & 8)
SGA	Fire Water Distribution System Underground Piping, including valves and hydrants, Turbine Island Loop and Cooling Tower Loop (Not providing Safe Shutdown Equipment Protection following an SSE)	NS-AQ	D	NSC	No	UZT	NFPA 24 NFPA 25 NFPA 214 NFPA 804 (Note 8)
SGA	Fire Water Distribution System Underground Piping, Including valves and hydrants, to UHS Makeup Water Intake Structure (Protecting Shutdown Equipment Protection following an SSE)	NS-AQ	D	CS-I	Yes	UZT	NFPA 24 NFPA 25 NFPA 804 ANSI/ASME B31.1 ASME III (seismic qualification methodology only) ASCE 4-98 (Notes 5 & 8)
SGA, SG	Fire Water Distribution System Aboveground Piping, including valves and suppression system inside the Fire Protection Building	NS-AQ	D	CS-I	Yes	USG	NFPA 13 NFPA 25 NFPA 804 ANSI/ASME B31.1 ASME III (seismic qualification methodology only) (Notes 5 & 8)

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
USG	Fire Water Storage Tanks	NS-AQ	D	CS-I	Yes	USG/ UZT	NFPA 20 NFPA 22 NFPA 25 AWWA D100 ACI 349/ANSI/AISC N690/ASCE 4-98 ANSI/ASME B31.1 (Notes 5 & 8)
USQ	Fire Protection Building	NS-AQ	N/A	CS-I	Yes	USG/ UZT	ACI 349 (Note 5) ANSI/AISC N690
SGM	Diesel Engine Driven Fire Pumps and Drivers, subsystems, including diesel fuel oil supply piping	NS-AQ	D	CS-I	Yes	USG	NFPA 20 NFPA 25 NFPA 804 ANSI/ASME B31.1 ASME III (seismic qualification methodology only) IEEE 344 (Notes 5 & 8)
SGM	Standby Diesel Generator for Fire Protection Building Ventilation System and subsystems including diesel fuel oil supply	NS-AQ	D	CS-I	Yes	USG	NFPA 110 NFPA 804 NEMA NG-1-2003 (Note 8)
SGM	Electric Motor Driven Fire Pump and Driver	NS-AQ	D	NSC	No	USG	NFPA 20 NFPA 25 NFPA 804 IBC (Note 8)
SA	Ventilation Equipment and Ductwork, Supporting Diesel Driven Fire Pumps	NS-AQ	D	CS-I	Yes	USG	NFPA 20 NFPA 90A ASME AG-1 ASME N-509 (Notes 5 & 8)
SA	Ventilation Equipment and Ductwork, Not Supporting Diesel Driven Fire Pumps	NS-AQ	D	NSC	No	USG	NFPA 20 NFPA 90A IBC (Notes 5 & 8)
SGM	Electric Motor Driven Fire Jockey Pump and driver	NS-AQ	D	NSC	No	USG	NFPA 20 NFPA 25 NFPA 804 IBC (Note 8)
SG	Fire Water Storage Tanks Makeup Piping and Valves From Raw (Desalinated) Water Supply System	NS	D	NSC	No	UZT	NFPA 22 NFPA 25 (Note 8)

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
SG	Fire Protection Electrical Distribution System for normal power operation	NS	N/A	NSC	No	USG	IBC
SG	Fire Protection Electrical Distribution System supporting Fire Protection distribution system components designated as Conventional Seismic-I	NS-AQ	N/A	CS-I	Yes	USG	IEEE-344
SG	Instrumentation and Controls in the Fire Protection Building Supporting the Fire Protection System designated as Conventional Seismic-I	NS-AQ	N/A	CS-I	Yes	USG	IEEE-344
Fire Suppression Systems							
	Fire Water Aboveground Piping and Valves of Suppression Systems Standpipes and Hose Stations for Site Specific Buildings other than UHS Makeup Water Intake Structure and Fire Protection Building	NS-AQ	D	NSC	No	UST UTG UYF UPQ	NFPA 13 NFPA 14 NFPA 25 NFPA 804 IBC (Note 8)
	Fire Water Aboveground Piping and Valves of Standpipes and Hose Stations for UHS makeup Water Intake Structure	NS-AQ	D	CS-1	Yes	UPF	NFPA 14 NFPA 25 NFPA 804 ANSI/ASME B31.1 ASME III (seismic qualification methodology only) (Notes 5 & 8)
Other Site-Specific Structures							
UMA, UBA	Turbine Building, Switchgear Building	NS-AQ	NA	II	Yes	UMA, UBA	Steel - AISC N690 Concrete - ACI 349 (Note 5)
UKE	Access Building	NS-AQ	NA	II	Yes	UKE	Steel - AISC N690 Concrete - ACI 349 (Note 5)
UAC	Grid Systems Control Building	NS	N/A	CS	No	UAC	IBC
UQZ	Electrical Duct Banks traversing from the Safeguards Buildings to the Four Essential Service Water Buildings and Both Emergency Power Generating Buildings	S	N/A	I	Yes	UJK/ UZT/ UQB/ UBP	ACI-349

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)
UQZ	Electrical Duct Banks traversing from the Safeguards Buildings to the Switchgear Building	NS	N/A	CS	No	UJK/ UZT/ UBA	IBC
	Electrical Duct Banks traversing from the Emergency Auxiliary Transformers to the Safeguard Buildings	NS	N/A	CS	No	UBE/ UZT/ UJK	IBC
UBZ	Electrical Duct Banks traversing from the Switchgear Building to the Desalination Plant, Circulating Water Pump Building, Cooling Tower, Switchyard Control House, Site Specific Auxiliary Transformer, Sewage Treatment Plant, and CW Makeup Water Intake Structure	NS	N/A	CS	No	UBA/ UZT/ UPQ/ UQA/ URA/ UAC/ UAA/ UGV/ UPE	IBC
	Electrical Duct Banks traversing between miscellaneous conventional seismic category buildings	NS	N/A	CS	No	UZT	IBC

Notes:

1. As defined in U.S. EPR FSAR Section 3.2.1, the U.S. EPR safety classifications, as supplemented by the UniStar Quality Assurance Program Description (QAPD) classifications, are:
   S- Safety-related (UniStar QAPD classification - QA Level 1)
   NS- Non-safety-related
   NS-AQ- Supplemented Grade (UniStar QAPD classification - QA Level 2)
2. As defined in Section 3.2.1 and U.S. EPR FSAR Section 3.2.1, the Seismic Classifications are:
   I – Seismic Category I
   II – Seismic Category II
   CS – Conventional Seismic, Conventional Seismic SSCs required to remain functional during and following an SSE are designated as Conventional Seismic-I (CS-I)
   NSC – Non-seismic

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)

3. Locations are defined in the table that follows:

KKS Designator	Location
UAA	Switchyard
UAC	Grid System Control Building
UBA	Switchgear Building
UBE	Auxiliary Power Transformers
UBP	Emergency Power Generating Building
UGV	Sewage Treatment Plant Building
UJK	Safeguard Building Electrical
UMA	Turbine Building
UPF	UHS Makeup Water Intake Structure
UPE	Circulating Water Makeup Intake Structure
UQB	Essential Service Water Pump Building
UQA	Circulating Water Pump Building
URA	Cooling Tower Structure
URB	Essential Service Water Cooling Tower Structure
USG	Fire Water Storage Tanks and Fire Protection Building
UST	Workshop & Warehouse Building
USU	Storage/Warehouse
UTG	Central Gas Supply Building
UYF	Security Access Building
UZT	Outdoor Area
UPQ	Water Treatment Building
UQZ	Buried piping and pipe ducts for service water systems and cables
UBZ	Buried conduit duct bank from Switchgear building to transformers
UGU	Wastewater discharge structure

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)

4. Acronyms are defined below:

KKS	Code Description
GW	Raw water supply system
GK	Potable and sanitary water systems
GKB	Potable and sanitary water distribution system
GR	Sewage water treatment system
PA	Circulating water supply system
PAA	Circulating water screening plant
PAB	Circulating water piping system
PAC	Circulating water pump system
PEB	Essential service water system
PED	Essential service water recirculation cooling system
QJ	Central gas distribution system
SG	Stationary fire protection systems
SGA	Fire water distribution system, conventional area
SGA0	Fire water distribution system outside of buildings
SGM	Fire protection equipment

5. Those SSCs classified as NS-AQ (for Safety Class) and classified as "Yes" for 10 CFR Appendix B will be subject only to those quality assurance requirements of Appendix B that are pertinent to that SSC based on the potential affect of the SSC on safety-related functions.
6. These components will be designed to the Manufacturer's Standard of design.
7. Quality group classification is applicable for pressure retaining and radioactive containing SSC's. This does not apply to electrical equipment, or component structures. The quality group classification of those components will be N/A.
8. Applicable codes and standards for the electrical components in Table 3.2-1 are provided in U.S. EPR Section 8.1.4.3.

Table 3.2-1 — {Classification Summary for Site-Specific SSCs}
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KKS System or Component Code	SSC Description	Safety Classification (Note 1)	Quality Group Classification	Seismic Category (Note 2)	10CFR50 Appendix B Program (Note 5)	Location (Note 3)	Comments/ Commercial Code (Note 9)

9. Applicable Code Editions

Commercial Code	Edition
ASME III	2004
ANSI/HI 2.3	2000
ANSI/HI 9.8	1998
ACI 349	ACI 349/349R-01, 2001
ANSI/AISC N690	1994 (R2004)s2
IBC	2006 (w/ 2007 supplements)
ASME B31.1	2004
ASME Section VIII	2004
DOT Standard	Latest editions endorsed by DOT regulations in 10 CFR Title 49
NFPA 13	2007
NFPA 14	2007
NFPA 20	2007
NFPA 22	2003
NFPA 24	2007
NFPA 25	2002
NFPA 90A	2002 (with 2003 & 2005 errata)
NFPA 214	2005
NFPA 804	2006
ASME/ANSI N509	2002 (w/ 2003, 2005 errata)
ASME AG-1a	2003 w/ 2004 addenda
ASCE 4	1998, reprinted in 2000
AWWA D100	2005
AWWA	Latest editions issued as of detailed design
ANSI/AISC 341	2005
AISC 360	2005
ACI 318-05/318R-05	2005

3.3 WIND, HURRICANE AND TORNADO LOADINGS

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

The U.S. EPR FSAR includes the following COL Item in Section 3.3:

> A COL applicant that references the U.S. EPR design certification will determine site-specific wind, hurricane, and tornado characteristics and compare these to the standard plant criteria. If the site-specific wind, hurricane, and tornado characteristics are not bounded by the site parameters, postulated for the certified design, then the COL applicant will evaluate the design for site-specific wind, hurricane, and tornado events and demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.

This COL Item is addressed as follows:

Table 2.0-1 provides a comparison of the wind, hurricane, and tornado parameters for the U.S. EPR FSAR design and the site-specific values.

{The U.S. EPR FSAR design wind, hurricane, and tornado parameters bound the site-specific wind, hurricane, and tornado characteristics. Additional discussion regarding the derivation of the site-specific wind, hurricane, and tornado characteristics is provided in Section 2.3.1. Seismic Category I structures are designed to withstand the effects of wind, hurricane, and tornado loadings. Wind, hurricane, and tornado parameters in U.S. EPR FSAR Table 2.1-1 are used for design of Seismic Category I structures for CCNPP Unit 3.}

3.3.1 Wind Loadings

The U.S. EPR FSAR includes the following COL Item in Section 3.3.1:

> A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for wind loads, will not affect the ability of other structures to perform their intended safety functions.

This COL Item is addressed as follows:

{Site-specific non safety-related structures not included in the U.S. EPR standard plant design are designed for CCNPP Unit 3 site-specific wind loads.}

3.3.1.1 Design Wind Velocity

{As described in Subsection 2.3.1.2.2.15, the basic wind speed for CCNPP Unit 3 site is 95 mph. The basic wind speed is increased by a factor of 1.07, which accounts for the 100-year mean recurrence interval, for the design of site-specific non safety-related structures. The 100-year recurrence interval wind speed for CCNPP Unit 3 site is 101.65 mph.}

3.3.1.2 Determination of Applied Wind Forces

{Design wind pressures for site-specific non safety-related structures are determined in accordance with guidelines provided in ASCE 7-05 (ASCE, 2005) and described in U.S. EPR FSAR

Subsection 3.3.1.2, using the site-specific 100-year recurrence interval wind speed. The velocity pressure exposure coefficient (K_z), topographic factor (K_{zt}), and wind directionality factor (K_d) are determined in conformance with ASCE 7-05 (ASCE, 2005) for the site-specific conditions, and an importance factor of 1.15 is used.}

3.3.2 Extreme Wind Loads (Hurricanes and Tornadoes)

The U.S. EPR FSAR includes the following COL Item in Section 3.3.2:

> A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for hurricane and tornado loads, will not affect the ability of other structures to perform their intended safety functions.

This COL Item is addressed as follows:

{A discussion of site-specific structures not designed for hurricane and tornado loadings is provided in Section 3.3.2.3.}

3.3.2.1 Applicable Hurricane and Tornado Design Parameters

{No departures or supplements.}

3.3.2.2 Determination of Hurricane and Tornado Forces on Structures

No departures or supplements.

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

{Non-safety-related structures located on the site and not included in U.S. EPR FSAR Section 3.3.2.3 include:

- Fire Protection Water Tanks
- Fire Protection Building
- Storage / Warehouse
- Central Gas Supply Building
- Security Access Facility
- Switchgear Building
- Grid Systems Control Building
- Circulating Water System Cooling Tower
- Circulating Water System Pump Building
- Circulating Water System Makeup Water Intake Structure

- Circulating Water System Retention Basin
- Desalinization/Water Treatment Plant
- Waste Water Treatment Facility
- Sheet Pile Wall
- Demineralized Water Tanks

Except for the Switchgear Building, Sheet Pile Wall, and Circulating Water System (CWS) Makeup Water Intake Structure (MWIS), the non-safety-related buildings are miscellaneous steel and concrete structures, which are not designed for hurricane and tornado loadings. These structures are distant enough from safety-related structures that their collapse due to hurricane and tornado loadings would not result in adverse interaction with any safety-related structure. During detailed design of such structures, their heights and separation distances from safety-related structures will be maintained such that the failure of these structures due to hurricane and tornado loadings will not affect the ability of safety-related structures to perform their intended safety functions. Missiles generated by the collapse of these structures during hurricane and tornado loadings are enveloped by the design basis hurricane and tornado missile loads described in U.S. EPR FSAR Section 3.5.1.4.

The TI Structure, Sheet Pile Wall, and CWS MWIS have the potential for interaction with safety-related structures and are designed to withstand the effects of hurricane and tornado loadings as described below:

The TI Structure employs engineered pressure relief sliding panels to mitigate the effects of hurricane and tornado loadings. Potential missiles generated by detachment of these siding panels are addressed in Subsection 3.5.1.4.

The layout of the Sheet Pile Wall and the separation distance between the Sheet Pile Wall and the nearest Seismic Category (SC) I structure, system, and component (SSC) will preclude any interaction between the Sheet Pile Wall and the SC I SSC for hurricane and tornado loads.

The reinforced concrete portion of the CWS MWIS is designed for hurricane and tornado loadings. Should collapse of the aboveground steel structure occur, it cannot directly impact any SC I SSC. Since the reinforced concrete portion supporting the steel structure is integrally connected to SC I Forebay Structure, the reinforced concrete portion is analyzed to demonstrate that the collapse of the steel structure due to hurricane and tornado loads does not impair the integrity of SC I SSCs.

3.3.3 References

{**ASCE, 2005.** Minimum Design Loads for Buildings and Other Structures, ASCE 7-05, American Society of Civil Engineers, 2005.}

3.4 WATER LEVEL (FLOOD) DESIGN

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

Seismic Category I structures, systems and components (SSCs) can withstand the effects of flooding due to natural phenomena or onsite equipment failures without losing the capability to perform their safety-related functions. The maximum flood and ground water elevations for the U.S. EPR are shown in U.S. EPR FSAR Table 2.1-1 and Table 2.0-1.

{The U.S. EPR FSAR flood and ground water design elevations bound the Calvert Cliffs site-specific elevations or otherwise calculations have been performed to demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.}

3.4.1 Internal Flood Protection

The U.S. EPR FSAR includes the following COL Item in Section 3.4.1:

> A COL applicant that references the U.S. EPR design certification will include in its maintenance program appropriate watertight door preventive maintenance in accordance with manufacturer recommendations so that each Safeguards Building and Fuel Building watertight door above elevation +0 feet remains capable of performing its intended function.

The COL Item is addressed as follows:

The maintenance program will include preventive maintenance for Safeguards Building and Fuel Building watertight doors above elevation +0 feet in the maintenance program in accordance with the manufacturer's recommendations.

3.4.2 External Flood Protection

The U.S. EPR FSAR includes the following COL Item in Section 3.4.2:

> A COL applicant that references the U.S. EPR design certification will design the watertight seal between the Access Building and the adjacent Category I access path to the Reactor Building Tendon Gallery. Watertight seal design will account for hydrostatic loads, lateral earth pressure loads, and other applicable loads.

This COL Item is addressed as follows:

The seal between the Access Building and the adjacent Category I access path to the Reactor Building Tendon Gallery will be designed to be watertight. The watertight seal design will account for hydrostatic loads, lateral earth pressure loads, and other applicable loads.

{This section of the U.S. EPR FSAR is incorporated by reference with the supplements as described below:

The maximum groundwater elevation in the U.S. EPR FSAR generic design is 3.3 ft (1 m) below finished grade. The maximum groundwater level at the CCNPP Unit 3 Powerblock is approximately 30 ft (9.1 m) below finished grade as discussed in Section 2.4.12.5.

The U.S. EPR FSAR requires the Probable Maximum Flood (PMF) elevation to be 1 ft (0.3 m) below finished yard grade. This requirement envelopes the CCNPP Unit 3 maximum flood level for all safety-related structures, except the Ultimate Heat Sink (UHS) Makeup Water Intake Structure. The UHS Makeup Water Intake Structure is located at the shoreline. Since the UHS Makeup Water Intake Structure is classified as a safety-related building, it will be designed to meet the requirements of Regulatory Guide 1.27 (NRC, 1976). The UHS Makeup Water Intake Structure is designed to be watertight to prevent internal flooding of the buildings. The UHS Makeup Water Intake Structure is discussed in Section 2.4.10, Section 3.4.3.10, Section 3.8.5 and Section 9.2.5.}

3.4.3 Analysis of Flooding Events

3.4.3.1 Internal Flooding Events

{No departures or supplements.}

3.4.3.2 External Flooding Events

The U.S. EPR FSAR includes the following COL Item in Section 3.4.3.2:

> A COL applicant that references the U.S. EPR design certification will confirm the potential site-specific external flooding events are bounded by the U.S. EPR design basis flood values or otherwise demonstrate that the design is acceptable.

This COL Item is addressed as follows:

{U.S. EPR FSAR Section 3.4.3.2 states: "The Seismic Category I structures are not designed for dynamic effects associated with external flooding (e.g., wind, waves, currents) because the design basis flood level is below the finished yard grade." The design of the CCNPP Unit 3 safety-related structures is consistent with this statement, except the UHS Makeup Water Intake Structure. Flooding of this structure is addressed in Section 3.4.3.10.}

3.4.3.3 Reactor Building Flooding Analysis

No departures or supplements.

3.4.3.4 Safeguard Buildings Flooding Analysis

No departures or supplements.

3.4.3.5 Fuel Building Flooding Analysis

No departures or supplements.

3.4.3.6 Nuclear Auxiliary Building Flooding Analysis

No departures or supplements.

3.4.3.7 Radioactive Waste Building Flooding Analysis

No departures or supplements.

3.4.3.8 Emergency Power Generating Buildings Flooding Analysis

No departures or supplements.

3.4.3.9 Essential Service Water Pump Buildings and Essential Service Water Cooling Tower Structures Flooding Analysis

No departures or supplements.

3.4.3.10 Ultimate Heat Sink Makeup Water Intake Structure Flooding Analysis

The U.S. EPR FSAR includes the following COL Item in Section 3.4.3.10:

> A COL applicant that references the U.S. EPR design certification will perform a flooding analysis for the ultimate heat sink makeup water intake structure based on the site-specific design of the structure and the flood protection concepts provided herein.

This COL Item is addressed as follows:

{The maximum flood level at the UHS Makeup Water Intake Structure location is elevation 33.2 ft (10.11 m) as a result of the surge, wave heights, and wave run-up associated with the PMH as discussed in Section 2.4.5. The UHS Makeup Water Intake Structure would experience flooding during a PMH. This structure is designed to withstand the static and dynamic flooding forces, and the UHS Makeup Water pump room and transformer rooms are designed to be watertight. The UHS Makeup Water Intake Structure traveling screen rooms are designed with water tight structural walls and roof. The traveling screen room floor is elevated above the probable maximum storm surge (PMSS). The flood protection measures for the UHS Makeup Water Intake Structure are described in Section 2.4.10.

In the event of flooding due to equipment or piping failure within a UHS Makeup Water pump room, the affected division of the UHS Makeup Water System is assumed to be lost. The flood protection measures for the UHS Makeup Water Intake Structure ensure that a flood in one division will not impact another division. Thus, there would be two divisions of the UHS Makeup Water System available for fulfillment of the safety function, if one division is assumed to be unavailable due to maintenance.}

3.4.3.11 Permanent Dewatering System

The U.S. EPR FSAR includes the following COL Item in Section 3.4.3.11:

> A COL applicant that references the U.S. EPR design certification will define the need for a site-specific permanent dewatering system.

This COL Item is addressed as follows:

{As described in Section 2.4.12.5, based on ground water modelling of post-construction water table elevations, a permanent ground water dewatering system is not anticipated to be a design feature for the CCNPP Unit 3 facility.

3.4.3.12 Turbine Building Flooding Analysis

Potential flooding of the yard area north of the Turbine Building due to CWS pipe failure inside the building is addressed in Section 10.4.5.3}

3.4.4 Analysis Procedures

No departures or supplements.

3.4.5 References

{**NRC, 1976.** Ultimate Heat Sink for Nuclear Power Plants, Regulatory Guide 1.27, Revision 2, U.S. Nuclear Regulatory Commission, January, 1976.}

3.5 MISSILE PROTECTION

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

3.5.1 Missile Selection and Description

No departures or supplements.

3.5.1.1 Internally Generated Missiles Outside Containment

No departures or supplements.

3.5.1.1.1 Credible Internally Generated Missile Sources Outside Containment

No departures or supplements.

3.5.1.1.2 Non-Credible Internally Generated Missile Sources Outside Containment

No departures or supplements.

3.5.1.1.3 Missile Prevention and Protection Outside Containment

The U.S. EPR FSAR includes the following COL item in Section 3.5.1.1.3:

> A COL applicant that references the U.S. EPR design certification will describe controls to confirm that unsecured compressed gas cylinders will be either removed or seismically supported when not in use to prevent them from becoming missiles.

This COL item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC shall, prior to initial fuel load, have plant procedures in place that specify that unsecured equipment, including portable pressurized gas cylinders, located inside or outside containment and required for maintenance or undergoing maintenance, is to be removed from containment prior to operation, moved to a location where the equipment is not a potential hazard to SSCs important to safety, or seismically restrained to prevent the equipment from becoming a missile.}

The U.S. EPR FSAR includes the following COL item in Section 3.5.1.1.3:

> A COL applicant that references the U.S. EPR design certification will describe controls to confirm that unsecured maintenance equipment, including that required for maintenance and that are undergoing maintenance, will be either removed or seismically supported when not in use to prevent it from becoming a missile.

This COL item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC shall, prior to initial fuel load, establish plant procedural controls to ensure that unsecured maintenance equipment, including that required for maintenance and that are undergoing maintenance, will be removed from containment prior to operation, moved to a location where it is not a potential hazard to safety-related SSCs, or restrained to prevent it from becoming a missile.}

3.5.1.2 Internally Generated Missiles Inside Containment

No departures or supplements.

3.5.1.2.1 Credible Internally Generated Missile Sources Inside Containment

No departures or supplements.

3.5.1.2.2 Non-Credible Internally Generated Missile Sources Inside Containment

No departures or supplements.

3.5.1.2.3 Missile Prevention and Protection Inside Containment

The U.S. EPR FSAR includes the following COL Item in Section 3.5.1.2.3:

> A COL applicant that references the U.S. EPR design certification will describe essential elements of a program to confirm that unsecured maintenance equipment, including that required for maintenance and that are undergoing maintenance, will be removed from containment prior to operation, moved to a location where it is not a potential hazard to safety-related SSC, or seismically restrained to prevent it from becoming a missile.

This COL Item is addressed as follows:

The Maintenance Rule Program includes the essential elements of a program to ensure that unsecured maintenance equipment, including that required for maintenance and that are undergoing maintenance, will be removed from containment prior to operation, moved to a location where it is not a potential hazard to safety-related SSCs, or restrained to prevent it from becoming a missile.

The Maintenance Rule Program is described in Section 17.6 and Section 17.7 and incorporates the guidance of NEI 07-02A. The schedule for implementation of the Maintenance Rule Program is provided in Table 13.4-1.

3.5.1.3 Turbine Missiles

The U.S. EPR FSAR includes the following COL Item in Section 3.5.1.3:

> A COL applicant that references the U.S. EPR design certification will confirm the evaluation of the probability of turbine missile generation for the selected turbine generator, P_1, is less than 1E-5 for turbine generators unfavorably oriented.

This COL Item is addressed as follows:

The turbine-generator design consists of a HP/IP turbine stage with three LP turbines as described in U.S. EPR FSAR Section 10.2. A turbine missile analysis has been developed for the selected turbine design (Alstom, 2007, Alstom, 2010a, Alstom, 2010b). The analysis considers stress corrosion cracking (SCC), brittle fracture and destructive overspeed as potential failure mechanisms. The analysis also addresses inspection intervals in regard to the probability of failure. The turbine missile analysis calculates the probability of turbine rotor failure consistent with the guidance in Regulatory Guide 1.115 (NRC, 1977) and in NUREG-0800 Section 3.5.1.3 (NRC, 2007b). The analysis includes charts on missile generation probabilities versus service time for the HP/IP and LP turbine rotors.

The probability of reaching destructive overspeed is largely dictated by the probability of failure of the governing and overspeed protection system. Turbine overspeed protection is described in U.S. EPR FSAR Section 10.2. The steam turbine has two independent valves in series on each steam inlet with failsafe hydraulic actuators. These valves are tripped by the redundant overspeed protection system.

The inspection requirements for the turbine rotors during major overhauls ensure that indications of SCC will be detected. The turbine rotor inspection program is described in U.S. EPR FSAR Section 10.2 and is consistent with the turbine manufacturer's recommended inspection intervals required to meet the calculated failure probability of the turbine rotor.

The turbine missile analysis demonstrates that the probability of turbine rotor failure resulting in an ejection of the turbine rotor (or internal structure) fragments through the turbine casing, P_1, is less than 1E-5 for an unfavorably oriented turbine.

The turbine missile analysis is available for review.

The U.S. EPR FSAR also includes the following COL Item in Section 3.5.1.3:

> A COL applicant that references the U.S. EPR design certification will assess the effect of potential turbine missiles from turbine generators within other nearby or co-located facilities.

This COL Item is addressed as follows:

{CCNPP Units 1 and 2 FSAR Section 5.3.1.2, indicates that the probability of turbine missile generation P_1 for the CCNPP Units 1 and 2 turbines is less than 1E-5 per year, which is below the threshold value of 1E-5 described in CCNPP Units 1 and 2 UFSAR Section 5.3.1.1. The orientation of CCNPP Unit 1 and Unit 2 turbines has been evaluated and the SSCs important to safety of CCNPP Unit 3 are located outside the low trajectory strike zones as described in Regulatory Guide 1.115. Therefore, CCNPP Unit 3 safety-related SSC are adequately protected from potential CCNPP Unit 1 and Unit 2 turbine missiles.}

3.5.1.4 Missiles Generated by Extreme Winds

The U.S. EPR FSAR includes the following COL Item in Section 3.5.1.4:

> A COL applicant that references the U.S. EPR design certification will evaluate the potential for other missiles generated by natural phenomena, such as hurricane and tornado winds, and their potential impact on the missile protection design features of the U.S. EPR.

This COL Item is addressed as follows:

All Seismic Category I structures that make up the U.S. EPR standard design meet the most stringent Region I missile spectrum presented in Table 2 of Regulatory Guide 1.76 (NRC, 2007a) and Table 1 of Regulatory Guide 1.221 (NRC, 2011). The associated hurricane and tornado wind speeds (230 mph (103 m/s) maximum) represent an exceedance frequency of 1E-07 per year. Region I hurricane and tornado missile parameters are reflected in U.S. EPR FSAR Table 3.5-1 and are used in the standard design of all Seismic Category I structures.

{The CCNPP Unit 3 site is located off the Chesapeake Bay near Lusby, Maryland. Using Regulatory Guide 1.76, Figure 1, this site lies in tornado intensity Region II. The associated wind speeds (200 mph (89 m/s) maximum) represent an exceedance frequency of 1E-07 per year. The

CCNPP Unit 3 site is located in Region II. As such, the Region I wind speed and resulting missile spectrum used for the U.S. EPR standard is conservative with respect to the Regulatory Guide 1.76 acceptance criteria.

Regulatory Guide 1.76 (NRC, 2007a) does not address extreme winds such as hurricane winds or the missiles associated with such winds. However, Regulatory Guide 1.221 addresses design basis hurricane and associated missiles. The design basis hurricane missile spectrum given in Table 1 of Regulatory Guide 1.221 is the same as the design-basis tornado missile spectrum presented in Regulatory Guide 1.76. Therefore, additional site-specific wind conditions were considered as follows:

Summarizing from Section 2.3.1, the following meteorological data is specific to the CCNPP site and provides a site-specific comparative justification for the use of the tornado design-basis missile spectrum for other potentially extreme high wind conditions:

- Annually, Maryland has a relatively low number of tornados compared to much of the contiguous United States. From 1950 to 1995, the annual average number of tornados is four, with an annual average of strong-violent tornados (F2 - F5) of one. Based on National Weather Service meteorological data from January 1, 1950 to December 31, 2006, there were 12 tornados reported in Calvert County with estimated minimum and maximum Fujita damage scales ranging from F0 to F2, respectively. This equates to estimated wind speeds ranging from 73 mph (117 km/hr) to a maximum of 157 mph (253 km/hr).

- A review of the National Hurricane Center statistics from 1851 to 2004 found only 2 direct hits on Maryland, with neither classified greater than a category 2 on the Saffir-Simpson scale, representing estimated wind speeds ranging from 74 mph (119 km/hr) to 110 mph (177 km/hr).

- In addition, a review of all recorded cases of high winds (winds greater than 58 mph (93 km/hr)) from meteorological data from June 2, 1980 to December 31, 2006 for Calvert County, Maryland, found 17 events with wind speeds ranging from 58 mph (93 km/hr) to 104 mph (167 km/hr).

For a general comparison, the strongest of tornadoes are classified as F4 and F5 in the Fujita damage scale and have estimated winds speeds of 207 mph (333 km/hr) and higher. Likewise, the strongest of hurricanes are those classified as 4 and 5 in the Saffir-Simpson scale with estimated winds speeds of 131 mph (211 km/hr) and higher. By comparison of the site-specific meteorological data, and the estimated strongest wind speed classifications for both tornado and hurricane conditions, it is reasonable to conclude that the Region I tornado missile spectrum from Regulatory Guide 1.76 is a conservative representation of those that could be generated by the less intense extreme wind conditions anticipated at the CCNPP Unit 3 site.}

The U.S. EPR FSAR also includes the following COL Item in Section 3.5.1.4:

> For sites with surrounding ground elevations that are higher than plant grade, a COL applicant that references the U.S. EPR design certification will confirm that automobile missiles cannot be generated within a 0.5 miles radius of safety-related SSC that would lead to impact higher than 30 ft above plant grade.

This COL Item is addressed as follows:

The tornado missile spectrum requirements provided in Regulatory Guide 1.76 (NRC, 2007a) describe three design-basis missiles; a pipe, sphere, and automobile. The pipe and sphere missiles are assumed to impact applicable structures at all elevations. The automobile missile is to be considered at all altitudes less than 30 ft (9.1 m) above all grade levels within 0.5 miles (0.8 km) of the plant structures.

Category I structures within the Nuclear Island (NI) base mat which include the Reactor, Fuel, and Safeguard Buildings (SB) 2 and 3 are protected by being housed in independent hardened structures. Walls and roof slabs of the hardened structures are designed of heavily reinforced concrete that envelopes the Region I tornado missile spectrum requirements. SB 1 and 4 are not enclosed in hardened structures, due to the system redundancy provided by SB 2 and 3. Although SB 1 and 4 are not housed in an independent hardened structure, they are constructed of heavily reinforced concrete and all wall and roof slab sections meet the minimum acceptable tornado missile barrier guidance identified in NUREG-0800, Section 3.5.3 (NRC, 2007b).

Likewise, the U.S. EPR standard design of all Category I structures outside the NI base mat are constructed of reinforced concrete and all wall and roof slabs meet the Region I design-basis missile spectrum, including the automobile missile guidance of Regulatory Guide 1.76 (NRC, 2007a) for all structural elevations. An exception to the previous statement is that for the Essential Service Water Cooling Tower, the automobile missile impact is considered on all wall elements at all elevations, but not the roof slab. The highest elevation within the 0.5 mile (0.8 km) radius at CCNPP Unit 3 is at an approximate elevation of 130 ft (39.6 m). Adding the 30 ft (9.1 m) requirement, all elements below elevation 160 ft (48.8 m) require evaluation of the automobile missile. Normal grade elevation at the Essential Service Water Cooling Tower and pump structures is approximately 82 ft (25 m). Therefore, structural elements less than 78 ft (23.8 m) high require automobile missile evaluation. The height of the Essential Service Water Cooling Tower is approximately 96 ft (29 m) and the adjoining pumphouse roof slab is at approximately 63 ft (19 m) elevation. Automobile missile impact is considered in pumphouse structure roof slab design but is not postulated for the Essential Service Water Cooling Tower roof slab design because the elevation of this roof slab is above the maximum height at which evaluation of the automobile missile must be evaluated.

The site-specific Seismic Category I Ultimate Heat Sink (UHS) Makeup Water Intake Structure is constructed of reinforced concrete, and the missile barrier walls and roof slabs meet Region 1 design-basis missile spectrum, including the automobile missile guidance of Regulatory Guide 1.76 (NRC, 2007a). On this basis, the site-specific conditions are conservatively enveloped for all required elevations.

Potential missiles generated by detachment of the siding panels of the Switchgear Building at the CCNPP Unit 3 site during a Region I tornado event were evaluated. For Seismic Category I structures at the CCNPP Unit 3 Site, the target response ductilities and required minimum wall thickness for these postulated panel missiles were found to be enveloped by those for the Regulatory Guide 1.76 Region I missile spectrum.

Thus, by the standard U.S. EPR meeting the Region I tornado missile spectrum requirements and the hurricane missile spectrum requirements for all Category I structures, the site-specific conditions at CCNPP Unit 3 are in compliance with all Regulatory Guide 1.76 (NRC, 2007a) and Regulatory Guide 1.221 (NRC, 2011) missile requirements.}

3.5.1.5 Site Proximity Missiles (Except Aircraft)

The U.S. EPR FSAR includes the following COL Item in Section 3.5.1.5:

> A COL applicant that references the U.S. EPR design certification will evaluate the potential for site proximity explosions and missiles generated by these explosions for their potential impact on missile protection design features.

This COL Item is addressed as follows:

In accordance with Regulatory Guide 1.206 (NRC, 2007c), the following missile sources have been considered and are discussed in Section 2.2:

- Train explosions
- Truck explosions
- Ship or barge explosions
- Industrial facilities
- Pipeline explosions
- Military facilities

Section 2.2 evaluates the effects of potential accidents in the vicinity of the site from present and projected industrial, transportation, and military facilities and operations. Each transportation mode and facility was evaluated with regard to the effects from potential accidents relating to explosions, flammable vapor clouds (delayed ignition), and toxic chemicals (vapors or gases), including liquid spills. Evaluation acceptance criteria for these hazards are in accordance with Regulatory Guides 1.91 and 1.78 (NRC, 1978a and NRC, 2001, respectively).

{From Section 2.2 and 3.5.1.3 (turbine missile generation of CCNPP Units 1 and 2), none of the potential site-specific external event hazards evaluated (except aircraft hazards which are discussed below) resulted in an unacceptable effect important to the safe operation of CCNPP Unit 3. This conclusion is substantiated by each potential external hazard either being screened based on: (1) applicable regulatory guidance; or (2) the hazard contribution to core damage frequency (CDF) being less than 1E-6 per year.}

3.5.1.6 Aircraft Hazards

The U.S. EPR FSAR includes the following COL Item in Section 3.5.1.6:

> A COL applicant that references the U.S. EPR design certification will evaluate site-specific aircraft hazards and their potential impact on plant SSC.

This COL Item is addressed as follows:

In accordance with Regulatory Guide 1.70 (NRC, 1978b), Regulatory Guide 1.206 (NRC, 2007c), and NUREG-0800, Section 3.5.1.6 (NRC, 2007b), the risks due to aircraft hazards should be sufficiently low. Furthermore, aircraft accidents that could lead to radiological consequences in excess of the exposure guidelines of 10 CFR 50.34(a)(1) (CFR, 2008) with a probability of occurrence greater than an order of magnitude of 1E-7 per year should be considered in the design of the plant.

Section 2.2 describes the site-specific aircraft and airway hazard evaluations. {Due to the number of annual aircraft operations at two airports and close proximity of airways V31 and V93, a probabilistic risk assessment (PRA) was performed to assess the core damage frequency (CDF) effect from these hazards. Results of the PRA show the total CDF from the site airplane crash scenarios; and the resulting containment release frequency meet the NUREG-0800 Section 3.5.1.6 acceptance criteria (refer to Section 19.1.5.4.4).

Thus, by compliance with the NUREG-0800 acceptance criteria, no additional design-basis criteria for the standard U.S EPR design is required as a result of the site-specific aircraft hazard for CCNPP Unit 3.}

3.5.2 Structures, Systems, and Components to Be Protected From Externally Generated Missiles

{The UHS makeup water system buried components, including underground piping, cables, and instrumentation from the UHS makeup water intake structure to the essential service water pump building are buried at a sufficient depth to withstand the effects of postulated missile hazards.}

3.5.3 Barrier Design Procedures

No departures or supplements.

3.5.4 References

{**Alstom, 2007.** Alstom Report TSDMF 07-018 D, Unistar Project Turbine Missile Analysis, dated May 30, 2007.

Alstom, 2010a. Alstom Report TNUD-EI 10-011, Unistar Project Turbine Missile Analysis, Fracture Mechanics Applied to the LP Rotor, dated June 30, 2010.

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NRC, 1978b. Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition), Regulatory Guide 1.70, Revision 3, U.S. Nuclear Regulatory Commission, November 1978.

NRC, 2001. Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release, Regulatory Guide 1.78, Revision 1, U.S. Nuclear Regulatory Commission, December 2001.

NRC, 2007a. Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants, Regulatory Guide 1.76, Revision 1, 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, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007c. Combined License Applications for Nuclear Power Plants (LWR Edition), Regulatory Guide 1.206, Revision 0, U.S. Nuclear Regulatory Commission, June 2007.

NRC, 2011. Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants Regulatory Guide 1.221, Revision 0, U.S. Nuclear Regulatory Commission, October 2011.}

3.6 PROTECTION AGAINST DYNAMIC EFFECTS ASSOCIATED WITH POSTULATED RUPTURE OF PIPING

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

3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside of Containment

No departures or supplements.

3.6.2 Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

No departures or supplements.

3.6.2.1 Criteria Used to Define Break and Crack Location and Configuration

No departures or supplements.

3.6.2.2 Guard Pipe Assembly Design Criteria

No departures or supplements.

3.6.2.3 Analytical Methods to Define Forcing Functions and Response Models

No departures or supplements.

3.6.2.4 Dynamic Analysis Methods to Verify Integrity and Operability

No departures or supplements.

3.6.2.5 Implementation of Criteria Dealing with Special Features

3.6.2.5.1 Pipe Whip Restraints

The U.S. EPR FSAR includes the following COL Item in Section 3.6.2.5.1:

> A COL applicant that references the U.S. design certification will provide diagrams showing the configurations, locations, and orientations of the pipe whip restraints in relation to break locations in each piping system.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall provide the diagrams showing the configurations, locations, and orientations of the pipe whip restraints in relation to break locations in each piping system prior to fabrication and installation of the piping system.

3.6.2.5.2 Structural Barrier Design

No departures or supplements.

3.6.2.5.3 Evaluation of Pipe Rupture Environmental Effects

No departures or supplements.

3.6.2.6 References

No departures or supplements.

3.6.3 Leak-Before-Break Evaluation Procedures

The U.S. EPR FSAR includes the following COL Item in Section 3.6.3.3.4.1:

> A COL applicant that references the U.S. EPR design certification will implement the ISI program as augmented with NRC approved ASME Code cases that are developed and approved for augmented inspections of Alloy 690/152/52 material to address PWSCC concerns.

The COL Item is addressed as follows:

An ISI program will be implemented and will include NRC approved ASME Code cases that are developed and approved for augmented inspections of Alloy 690/152/52 material to address PWSCC concerns.

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 characteristics for CCNPP Unit 3. Section 3.7.2 provides the methodology and results of the confirmatory site-specific Soil-Structure Interaction (SSI) analysis. The confirmatory analysis of the Nuclear Island (NI) is based on:

- A Finite Element Method (FEM) that considers embedment of the below grade portion of the NI
- A Shear Wave Velocity (SWV) that accounts for the presence of engineered backfill below and around the NI, and
- The site-specific SSE response spectra.

The results of this confirmatory analysis are not used for design because the U.S. EPR Design of the NI, EPGB, and ESWB are adopted for CCNPP3. 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 (NICBM) 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
- Buried Electrical Duct Banks and Pipes

The generic design Seismic Category II structure Nuclear Auxiliary Building (NAB), is analyzed and designed to a seismic design criteria equivalent of a Seismic Category I structure.

The site-specific Seismic Category II structures, analyzed and designed to a seismic design criteria equivalent of a Seismic Category I structure are:

- Turbine Island (TI) Structure (i.e., combined Turbine Building and Switchgear Building)
- Access Building (AB)

The Turbine Building and Switchgear Building share the same basemat; they are referred to as the TI Structure. Although the TI Structure is a Seismic Category II structure, it is analyzed and designed as a Seismic Category I structure to preclude any interaction during failure with other safety-related Seismic Category I Structures (ESWB, EPGB and Safeguard Building) in the vicinity of the TI. Figure 3.8-1 shows the location of the TI Structure. The top of the TI basemat is situated approximately 19'-1" (5.81 m) below a nominal grade elevation of 85'-0".

The CCNPP Unit 3 site specific AB is classified as a nonsafety-related Augmented Quality (NS-AQ) structure in COLA FSAR Table 3.2. It is a reinforced concrete structure that is analyzed and designed as a Seismic Category I structure. The closest Seismic Category I structure to the AB is the Safeguards Buildings (SB) of the NI. The NAB and AB are located adjacent to the NI Common Basemat Structures. They are included as lumped mass stick models within the FEM of the NI in the MTR/SASSI analysis as described in Section 3.7.2. The FEM of the NI with the NAB and AB is referred to as the NI/NAB/AB model. The buildings are on the same soil supporting media and subject to the same initial input motion. The stability analyses for these structures use an input motion derived from the SSI analysis in order to account for structure-soil-structure interaction (SSSI) effects. Figure 3.7-86 shows the NI/NAB/AB SSI model, with a representation of the NI full FEM model and the NAB and AB lumped mass stick models.

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 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. 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.

The NAB and AB are located adjacent to the NI Common Basemat Structures. They are included as lump mass stick models with the finite element model of the Nuclear Island in the MTR/SASSI analysis as described in Section 3.7.2. They are on the same supporting media as the NI common Basemat Structures and subjected to the same initial input motion. The stability analysis of these structures use an input motion derived from the SSI analysis in order to account for structure soil structure interaction (SSSI) effects. Figure 3.7-86 shows the NI/NAB/AB SSI model, with a representation of the NI full FEM model and the NAB and AB lumped mass stick models

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 for confirmatory analysis purposes are developed for the NI common basemat structures and the Seismic Category I ESWB and EPGB in the NI area. The FIRS used for the NI is shared by the adjacent NAB and AB structures. The SSI of the NAB and AB is performed with the use of an integrated model that includes the NI. The model is referred to as the NI/NAB/AB SSI model. Other FIRS for design purposes are developed for the site-specific Seismic Category I CBIS in the Intake area. Other FIRS, for analysis purposes, are developed for the Seismic Category II TI Structure. 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 conservatively used as the input motion for both the confirmatory analysis of the U.S. EPR FSAR structures; the NI/NAB/AB, EPGB, and ESWB; and the analysis and design of the site-specific structures.

3.7.1.1.1 Design Ground Motion Response Spectra

3.7.1.1.1.1 Design Ground Motion Response Spectra for the NI/NAB/AB

Development of FIRS

For confirmatory analysis purposes, the NI/NAB/AB are analyzed as embedded structures in the Soil Structure Interaction (SSI) analysis. The FIRS for the NI/NAB/AB is defined at the bottom of the NI basemat at approximately 39 ft (11.9 m) below grade as a full-column outcrop motion. 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 the structures). The site conditions under the NI/NAB/AB structures are represented by two soil columns (RB26 and RB36, refer to Appendix 3F for detail), and the FIRS for the NI are calculated as the envelope response from the two soil columns. The FIRS are checked for adequacy as SSI input according to the applicable requirements (NEI, 2009 and NRC, 2010). The development of the site-specific FIRS for the NI structures is described in detail in Appendix 3F, Section 3F.1.

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 has a peak ground acceleration of 0.135 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 site specific FIRS and the U.S. EPR FSAR European Utility Requirements (EUR) Soft Soil spectrum anchored at a Peak Ground Acceleration (PGA) of 0.15 g, therefore satisfying the requirements of Appendix S of 10 CFR Part 50. The FIRS for the NI and the Site SSE are shown in Figure 3.7-1 and Figure 3.7-2, for the horizontal and vertical directions, respectively. The horizontal and vertical FIRS are enveloped by the Site SSE. The horizontal and vertical Site SSE ground motion is presented in Figure 3.7-3 and Table 3.7-1.

Comparison of FIRS, CSDRS and Site SSE

A comparison of the FIRS 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 the PGA for the CSDRS (0.3 g).

2. A comparison of the FIRS for the NI with the CSDRS is shown in Figure 3.7-4 and Figure 3.7-5 for the horizontal and vertical directions, respectively. This comparison shows that the CSDRS does not envelop the FIRS for the NI in the low frequency range.

3. A comparison of the Site SSE with the CSDRS is shown in Figure 3.7-4 and Figure 3.7-5, respectively. This comparison shows that the CSDRS does not envelop the Site SSE in the low frequency range below 0.67 Hz in the horizontal direction, and below 0.31 Hz in the vertical direction.

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 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).

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, as full-column outcrop motions, 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.

Development of the Site SSE

The FIRS are checked for adequacy as SSI input according to the applicable requirements (NEI, 2009 and NRC, 2010). The modified FIRS are referred to as Adjusted FIRS in the following discussion.

As described in Section 3F.1 of Appendix 3F, the SSE motion of the EPGB and ESWB (Modified SSE or SSE_{NI} - for influence of NI) is developed to envelop the site-specific FIRS, as well as the Site SSE (Section 3.7.1.1.1.1), and to take into account the difference in elevations between the NI structures and the EPGB and ESWB. In addition, the SSE motion is amplified using an idealized frequency dependent function, presented in Figure 3.7-7a, to account for the Structure-Soil-Structure Interaction (SSSI) effects at the NI area due to the proximity to the NICBM structures. As part of the site-specific SSI analysis of the NI/NAB/AB, the site specific SSSI amplification effects are computed and compared to the idealized SSSI function to verify the adequacy of the latter. Figure 3.7b and Figure 3.7c verify the adequacy by comparing the assumed set of SSSI functions and the actual computed results, for the horizontal and vertical directions. The actual computed functions shown in the figures correspond to the highest recorded at the ESWB and EPGB locations. Figure 3.7-8a and Figure 3.7-8b compare the

Modified SSE (SSE_{NI}) for the EPGB and ESWB in the horizontal and vertical directions, respectively, with the site specific horizontal and vertical Adjusted FIRS for the EPGB and ESWB.

The Modified SSE (SSE_{NI}) is shown to envelop both the Site SSE and the site-specific FIRS. As such, confirmatory SSI analyses are performed for the EPGB and ESWB using the Modified SSE (SSE_{NI}) motion as the design response spectrum and a set of site-specific Lower Bound (LB), Best Estimate (BE) and Upper Bound (UB) soil profiles strain-compatible with the SSE_{NI}, 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

Development of FIRS

The FIRS for the site-specific structures (CBIS) are developed in accordance with Regulatory Guide 1.208 (NRC, 2007a). The FIRS are developed, as full-column outcrop motions, 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 the CBIS). Appendix 3F discusses in detail the development of FIRS as well as the site response analysis methodology and the computer codes used.

Development of the SSE_{CBIS}

The FIRS are checked for adequacy as SSI input according to the applicable requirements (NEI, 2009 and NRC, 2010), see Appendix 3F for details. The modified FIRS are referred to as Adjusted FIRS in the following discussion.

As described in Section 3F.1 of Appendix 3F, the SSE motion of the CBIS (SSE_{CBIS}) is developed to envelop the site-specific FIRS, as well as the Site SSE (Section 3.7.1.1.1.1), and to take into account the difference in elevations and site conditions between the NI structures and the CBIS. Figure 3.7-9a and Figure 3.7-9b compare the SSE_{CBIS}, in the horizontal and vertical directions, respectively, to the 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).

The SSE_{CBIS} is shown to envelop both the Site SSE and the site-specific FIRS. The SSI analysis for the CBIS is described in detail in Section 3.7.2.4. The analysis uses the SSE_{CBIS} 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 SSE_{CBIS}.

3.7.1.1.1.4 Foundation Input 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.

3.7.1.1.1.5 Foundation Input Response Spectra for the Turbine Island Structure

The Turbine Island (TI) Structure lies in the NI area, with the same site conditions as those for the EPGB and ESWB, and in proximity to the NI structures. The FIRS for the Seismic Category II TI Structure are developed in accordance with Regulatory Guide 1.208 (NRC, 2007a). The FIRS are developed, as full-column outcrop motions, 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 support the TI Structure). Appendix 3F discusses in detail the development of FIRS as well as the site response analysis methodology and the computer codes. Given that the FIRS for the TI Structure are enveloped by the FIRS for the EPGB and ESWB, the Modified SSE (SSENI) for EPGB and ESWB (see Section 3.7.1.1.1.2), which accounts for the SSSI effects due to the proximity to the NICBM structures, is adopted as the design ground motion for the TI Structure.

3.7.1.1.2 Design Ground Motion Time History

Three component sets of spectrum compatible acceleration time histories, each composed of two horizontal and one vertical, are developed for use as input time histories for SSI analysis. The three sets are modified to be spectrum compatible with the three design ground motions corresponding to different structures, namely: Site SSE for the NI structures, Modified SSE (SSE_{NI}) for the EPGB, ESWB, and TI structures, and SSE_{CBIS} for the CBIS in the intake area. The spectral matching criteria given in NUREG CR-6728 (McGuire et al., 2001) and NUREG-0800, Section 3.7.1, (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 from the database of candidate time histories provided with NUREG/CR-6728 (McGuire et al., 2001) from the Central and Eastern United States (CEUS) soil cases for an earthquake with magnitude (Mw) between 6-7 and distances between 10 km and 50 km. The magnitude and distance range were selected based on the available magnitude and distance bins provided in the NUREG/CR-6728 (McGuire et al., 2001) database of time histories and the deaggregation results for the project site. The selection of a seed time history from the soil database bins rather than the rock database bins was driven by the target spectrum used in the spectral matching procedure being more typical of a soil site condition than a CEUS hard rock site condition.

Figure 3.7-10 presents the acceleration, velocity and displacement time histories for the first horizontal component (H1) spectrally matched to Site SSE. Figure 3.7-11 presents the time histories for the second horizontal component (H2) and Figure 3.7-12 presents the time histories for the vertical component (UP). All three sets of spectrally matched time histories are provided in Appendix 3F, Section 3F.1.6. Bechtel proprietary computer program RSPM (version 1.1) was used to develop these spectrally matched time histories and is described in Section 3F.4.

In SSI analysis, the NI/NAB/AB, as well as the EPGB, ESWB and TI Structure are analyzed as embedded structures, where the "within" acceleration time histories calculated at the FIRS horizon for each building serve as the input motion. The "within" acceleration time histories at each FIRS horizon are calculated using the computer program SHAKE2000 (described in Appendix 3F, Section 3F.4). In this analysis, the time histories spectrally matched to the design ground motion for each structure (Site SSE, SSE_{NI} and SSE_{CBIS}) are used as input "outcrop" motions at the foundation level in conjunction with the strain-compatible profiles for the structure, presented in Section 3.7.1.3. No further iterations on soil properties are performed as the acceleration time history is converted from "outcrop" to "within." The analysis results in "within" motions at the same FIRS horizon. Three sets (two horizontal and one vertical) are developed for each structure, corresponding to the LB, BE and UB profiles.

The "within" acceleration time histories calculated at the foundation horizon of the NICBM structures, at a depth of 39 ft, are presented in Figure 3.7-13 for the LB soil case, and in Figure 3.7-14 and Figure 3.7-15 for the BE and UB case, respectively. Other "within" motions, that relate to the SSI analysis of the EPGB, ESWB, TI structure and the CBIS, are calculated and presented in Appendix 3F. Corresponding surface input motion acceleration spectra are used for the SSI analyses.

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/NAB/AB, as well as for the EPGB and ESWB.

The damping values for site-specific Conventional Seismic-I and Seismic Category II structures are in accordance with RG 1.61, Rev. 1 (NRC, 2007c). For the Turbine Island Structure, the SSE damping value for bolted steel structures from Table 1 of RG 1.61, Rev 1 (NRC, 2007c) is used.

3.7.1.3 Supporting Media for Seismic Category I Structures

3.7.1.3.1 Nuclear Island Common Basemat with Nuclear Auxiliary Building (NAB) and Access Building (AB) (NI/NAB/AB)

The supporting media for the seismic analysis of the NI/NAB/AB is shown in Figure 3.7-19 and Table 3.7-2a, Table 3.7-2b, and Table 3.7-2c. The presented soil profiles are site-specific and are strain-compatible with the Site SSE. The development of the SSE strain compatible soil profiles is described in Appendix 3F. The Appendix 3F profiles are close to 200 layers. MTR/SASSI can accommodate up to 100 soil layers + halfspace. The Appendix 3F soil profiles were truncated to <100 layers + halfspace. The top layers (shown in Figure 3.7-19a) are approximately the same as Appendix 3F, but modified to align with the embedded structure mesh or subdivided to pass the required frequency. Figure 3.7-19b shows a comparison of the truncated profiles versus the Appendix 3F profiles.

3.7.1.3.2 EPGB and ESWB

The supporting media for the seismic analysis of the EPGB is presented in Figure 3.7-20 and Table 3.7-3a, Table 3.7-3b, and Table 3.7-3c. The supporting media for the seismic analysis of the ESWB is presented in Figure 3.7-21 and Table 3.7-4a, Table 3.7-4b, and Table 3.7-4c. The presented soil profiles are site-specific and are strain-compatible with the Modified SSE (SSE_{NI}). The development of the SSE strain-compatible soil profiles is described in detail in Appendix 3F. The Appendix 3F profiles are close to 200 layers. MTR/SASSI can accommodate up to 100 soil layers + halfspace.The Appendix 3F soil profiles were truncated to <100 layers + halfspace. The top layers (shown in Figure 3.7-20a and Figure 3.7-21a) are approximately the same as Appendix 3F, but modified to align with the embedded structure mesh or subdivided to pass the required frequency. Figure 3.7 20b and Figure 3.7-21b show a comparison of the truncated profiles versus the Appendix 3F profiles.

3.7.1.3.3 Common Basemat Intake Structures

The supporting media for the seismic analysis of the CBIS in the Intake area are presented in Figure 3.7-22 for the upper 1000 ft (305 m). The presented soil profiles are site-specific and are strain-compatible with the SSE_{CBIS}. The development of the SSE strain-compatible soil profiles is described in detail in Appendix 3F. The dimensions of the CBIS, including the structural height, are described in Section 3.7.2.3.2.

3.7.1.3.4 Turbine Island Structure

The subsurface conditions under the TI Structure are equivalent to those used for the EPGB and ESWB. Therefore the soil property profiles, strain-compatible with Site SSE, presented in Section 3.7.1.3.2, are used in the SSI analysis of the TI Structure.

3.7.1.4 Supporting Media for CS-I Structures (Fire Protection Building (FPB) and Fire Water Storage Tanks (FWSTs))

Terrace sands will be removed so that controlled fill is placed directly over the Chesapeake cemented sands. Since more than 40 ft of controlled engineered fill will be placed beneath the foundations and geotechnical information is available from surrounding borings, the subsurface conditions are well defined for the FPB and FWSTs. The engineered fill in the area of the FPB and FWSTs will be placed with the same materials and specifications as for Category I structures. The shear wave velocity and compaction Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) used for Category I structures will also be enforced for the FPB and FWSTs. In conclusion, a well-defined and competent foundation soil will be in place for these structures.

3.7.1.5 References

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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, 2010. Interim Staff Guidance on Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses, DC/COL-ISG.}

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 soil-structure interaction (SSI) analyses of the Nuclear Island (NI) with the Nuclear Auxiliary Building and the Access Building (NI/NAB/AB), the Emergency Power Generating Buildings (EPGBs), and the Essential Service Water Buildings (ESWBs) for the SSE and site-specific strain-compatible soil properties are addressed in Section 3.7.2.4.

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

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

The Seismic Category I UHS Makeup Water Intake Structure 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. Figure 2.1-1 depicts the CCNPP Unit 3 site plan, which shows the position of the UHS Makeup Water Intake Structure 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). 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

3.7.2.1.3.1 Nuclear Island Common Basemat Structures

No departures or supplements.

3.7.2.1.3.2 EPGB and ESWB

No departures or supplements.

3.7.2.1.3.3 Common Basemat Intake Structures

As described in Section 3.7.2.3.2, an integrated FEM is developed for the CBIS. 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 ACS SASSI, Version 2.3.0. The hydrodynamic load effects are considered as described in Section 3.7.2.3.2.

3.7.2.1.3.4 Turbine Island (TI) Structure

As described in Section 3.7.2.3.3, an integrated FEM is developed for the TI Structure. The complex frequency response analysis method is used for the seismic Soil Structure Interaction (SSI) analysis of the structure, 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 Bechtel computer code SASSI2010, Version 1.1.

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

No departures or supplements.

3.7.2.2.2 EPGB and ESWB

No departures or supplements.

3.7.2.2.3 Common Basemat Intake Structures

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. The analysis results are tabulated in Table 3.7-5 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 at El. 26.5 ft. Section 3.7.2.4.6.3 provides the combined maximum nodal accelerations for the CBIS.

3.7.2.2.4 Turbine Island Structure

Section 3.7.2.8 presents the evaluation of the TI structure for seismic stability (i.e., overturning and sliding) based on results from the SSI dynamic analysis when subjected to the SSE motion, and using the corresponding strain-compatible profiles as supporting media.

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

3.7.2.3.2.1 EPGB and ESWB

No departures or supplements.

3.7.2.3.2.2 Common Basemat Intake Structures

The UHS Makeup Water Intake Structure 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 ft (79.3 m) along the North-South direction and 89 ft (27.1 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 ft (21.0 m).

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

A 3D FEM of the CBIS is developed in STAAD Pro, Version 8i, as shown in Figures 3.7-23 and 3.7-24. The model is used to generate the FEM for seismic SSI analysis using ACS SASSI, Version 2.3.0, and to perform static analysis for non-seismic loads.

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 in all three directions of motion except for one local mode of vibration of the slabs in the UHS along the vertical direction, with a frequency of around 30 Hz (secondary peak). The maximum difference observed, when comparing the response to a very refined model, is limited to 15 percent around the peak. This small difference is accounted for by increasing the peaks around 30 Hz of the vertical ISRS at the center of slabs of the UHS, by a factor of 1.2 after performing the smoothing and broadening per RG. 1.122.

The FEM in SASSI uses a thin shell element formulation that represents the in-plane and out-of-plane bending effects. In-plane shear deformation is accurately reproduced by the finite element mesh, while out-of-plane shear deformations are considered negligible in the X (north-south) and Z (vertical) directions. In the Y (east-west) direction, a small shift in the main frequencies (less than 1 Hz, or 6%), is observed when comparing the fixed base SASSI model with a fixed base STAAD model that includes a thick shell element formulation. There is also a maximum difference of 10% for the amplitudes of the main and secondary peaks. These differences are accounted for by increasing the peaks of ISRS in the Y (east-west) direction by a factor of 1.15 after performing the smoothing and broadening. Per RG 1.122, ISRS main frequencies are broadened by a factor of 15%, which covers the differences on the frequency shift observed in Y (east-west) direction.

The reinforced concrete basemat, floor slabs, and walls of the CBIS are modeled using thin shell elements in ACS SASSI, Version 2.3.0, to accurately represent the structural geometry and to capture in-plane membrane and out-of-plane bending. The average mesh size used in the FEM below ground level and along the vertical direction is approximately 1.9 ft (0.6 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 5.3 ft (1.6 m), based on an aspect ratio of approximately 2.8.

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 FEM. This simplification has an insignificant effect on the global mass and stiffness distribution, and on the local responses of the structural panels.

Two sets of models of the CBIS are considered to represent the effect of cracking in the concrete: one fully uncracked with OBE damping (RG 1.92) and the other one fully cracked with SSE damping. The cracked model considers that the out-of-plane bending of the walls and floors as 50 percent of the gross bending stiffness ASCE 43-05 (ASCE, 2005).The envelope of the response of both models is used for the calculation of stresses in the soil for stability analysis, ISRS and accelerations on the structure.

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 included in the FEM. The south end of the pump house enclosure is partially supported on the operating deck slab of the Circulating Water Makeup Intake Structure. Therefore, the stiffness and masses corresponding to the applicable dead loads and snow loads for the pump house enclosure are appropriately included in the FEM.

The FEM 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 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 for normal water level, corresponding to MSL, at El. 0.64 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 in the CW, Forebay, and basement of the UHS Makeup Water Intake Structure.

The maximum sloshing heights in both directions for the Forebay are approximately 0.82 ft (0.25 m) and 0.95 ft (0.29 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.

3.7.2.3.3 Seismic Category II Structures

3.7.2.3.3.1 Nuclear Auxiliary Building

The NAB is included as a lumped mass stick model in the SSI analysis of the NI. The stability analysis used an FEM to confirm that no interaction occurs (see Section 3.7.2.8).

3.7.2.3.3.2 Access Building

The AB is included as a lumped mass stick model in the SSI analysis of the NI. The stability analysis used an FEM to confirm that no interaction occurs (see Section 3.7.2.8.2).

3.7.2.3.3.3 Circulating Water Makeup Intake Structure

The Seismic Category II Circulating Water Makeup Intake Structure (CWIS) 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.

3.7.2.3.3.4 Turbine Island Structure

As described in Section 3.7.2.4.2.4, the SSI analysis of the Turbine Island Structure is performed using a FEM.

The TI Structure is a site-specific structure and is classified as a nonsafety-related, Augmented Quality (NS-AQ) Seismic Category II structure according to COLA FSAR Table 3.2-1.

The sub-structure of TI Structure is comprised of a reinforced concrete basemat, below grade reinforced concrete walls and integral reinforced concrete pilasters supporting steel columns.

The super-structure of the TI Structure is primarily structural steel. However for the direction parallel to the Turbine Generator (TG), concrete shear walls are used below the operating deck.

For the direction parallel to the TG, above the operating deck, the Lateral Force Resisting System (LFRS) is a steel braced frame. For the direction perpendicular to the TG, the LFRS is steel braced frame below the operating deck with moment resisting frames above the operating deck.

Key floor levels of the TI Structure and their structural floor systems include:

- Grade Level: concrete slab supported by composite steel beams and either composite or non-composite girders.

- Mezzanine Level: for Turbine Building, structural steel framing supporting steel grating typically, with select areas of concrete slabs supported by structural steel beams and girders. For Switchgear Building, concrete slab supported by composite steel beams and either composite or non-composite girders.

- Battery Level: concrete slab supported by composite steel beams and either composite or non-composite girders.
- Operating Deck Level: concrete slab supported by composite or noncomposite steel beams and girders depending on the location.
- Roof: for Turbine Building, structural steel beams and roof purlins supported by long-span structural steel roof trusses at main column lines. For Switchgear Building low roof, concrete slab supported by composite steel beams and either composite or non-composite girders. For Switchgear Building high roof, steel plate supported by beams and girders.

The Turbine Generator (TG) is supported by a reinforced concrete TG deck. The deck is supported by spring isolators. The spring isolators, grouped at primary column locations, are supported by structural steel box columns which are integral with the overall structural steel frame of the TI Structure.

The 3D finite element (FE) model of the TI Structure is developed in GTSTRUDL, Version 31, as shown in Figures 3.7-82 to 3.7-84. The FE model is used to generate the FE model for seismic SSI analysis using the Bechtel computer code SASSI2010, Version 1.1.

The FEM in SASSI uses a thick shell element formulation that represents the in-plane and out-of-plane bending effects, as well as the in-plane and out-of-plane shear.

For the SSI analysis, the shear walls and end walls are considered to be cracked. In accordance with ASCE 43-05 (ASCE, 2005), the modulus of elasticity (E) and the shear modulus (G) are reduced to one-half of their values. Conservatively, the axial rigidity is also reduced by one-half. Considering the vertical load distribution system of the TI Structure, the reduction in axial rigidity of the shear walls and end walls will have insignificant effect on the global mass and stiffness distribution of the TI Structure.

The FEM used for the seismic SSI analysis includes masses corresponding to 25 percent of the floor design live load and 75 percent of the roof design snow load. Major equipment (including Turbine Generator, Feedwater Tank, Moisture Separator Reheater, and Feedwater Heaters), is included explicitly in the dynamic analysis. An allowance is provided for piping, miscellaneous commodities, and minor equipment.

3.7.2.3.4 Conventional Seismic (CS) Structures

{This section of U.S. EPR is incorporated by reference with the following supplement:

The FPB and FWSTs are structures that must remain functional during and following an SSE and are therefore designated as Conventional Seismic-I (CS-I). The design of the FPB and FWSTs will be consistent with the methodology used for Category II structures described in Section 3.7.2.3.3 of the U.S. EPR FSAR. These structures are analyzed to SSE load conditions and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure.

Seismic input, methods of analysis, design methodology, and acceptance criteria of Fire Protection buried piping designated as CS-I will be same as for SC I buried piping described in Sections 3.7.3.12, 3.8.4.1.9, 3.8.4.4.5, 3.8.4.5, and 3.8.6.}

3.7.2.4 Soil-Structure Interaction

This section describes the soil-structure interaction (SSI) analyses for the NI/NAB/AB, the EPGB, and the ESWB. In addition, the SSI analysis of the CBIS, as well as the Seismic Category II TI Structure is also described.

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), 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.

Similarly, the SSI analysis of the TI Structure is performed using the complex frequency response analysis method described in detail in Sections 3.7.2.4.1 through 3.7.2.4.7.

3.7.2.4.1 Step 1 – SSE Strain Compatible Soil Properties

3.7.2.4.1.1 Nuclear Island Common Basemat Structures with NAB and AB (NI/NAB/AB)

For the NI/NAB/AB, 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 Table 3.7-2a, Table 3.7-2b, Table 3.7-2c, and Figure 3.7-19. Soil properties used in the SSI analysis are strain-compatible with the 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, and shown in Table 3.7-3a, Table 3.7-3b and Table 3.7-3c and Figure 3.7-20a for the EPGB and Table 3.7-4a, Table 3.7-4b and Table 3.7-4c and Figure 3.7-20b for the ESWB. Soil properties used in the SSI analysis are strain-compatible with the Modified SSE (SSE_{NI}), 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

SSI analyses for the CBIS are performed for the lower bound, best estimate and upper bound soil profiles established in Section 3.7.1.3.3. Table 3F-6, Table 3F-7 and Table 3F-8 show the properties for the top fifty layers of each soil profile (approximately 380 ft), while Figure 3F-32, Figure 3F-33 and Figure 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 SSE_{CBIS}, and account for the range of variation of shear-wave velocity, damping ratio, and P-wave velocity.

3.7.2.4.1.4 Turbine Island Structure

As described in Section 3.7.1.3.4, the TI Structure shares the same supporting media with both the EPGB and ESWB. Soil properties used in the SSI analysis are strain compatible with the Modified SSE (SSE_{NI}), 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 with NAB and AB (NI/NAB/AB)

The model described in the U.S. EPR FSAR is used for CCNPP Unit 3. An embedded stick model representing the AB is included with this model for the CCNPP Unit 3 analysis.

3.7.2.4.2.2 EPGB and ESWB

No departures or supplements.

3.7.2.4.2.3 Common Basemat Intake Structures

Section 3.7.2.3.2 describes the development of the integrated FEM of the CBIS in STAAD Pro, and translation of the model into SASSI. Thin plate elements are used in SASSI to model all of the structural panels.

The Common Basemat Intake Structures are primarily reinforced concrete structures with steel structures in the Steel Enclosure building and in the Forebay area. Structural damping corresponding to the OBE case (4 percent for concrete and 3 percent for steel) is used for the fully uncracked concrete model; and SSE damping (7 percent for concrete and 4 percent for steel) is used for the fully cracked concrete model.

3.7.2.4.2.4 Turbine Island Structure

Section 3.7.2.3.3 describes the development of the FEM of the TI structure in GTSTRUDL. The model is translated into SASSI2010 Version 1.1 and the SSI analysis is performed to evaluate the seismic stability (overturning and sliding) of the TI.

With part of the TI Structure embedded in soil, excavated soil elements are modeled into the SASSI2010 model using eight-node brick elements. Since the direct method is used for the computation of the impedance matrix when performing SSI analysis, the nodes used to model the excavated soil elements are considered as interaction nodes.

To evaluate for overturning and sliding of the structure during a seismic event, translational spring elements are added to the building nodes below grade in contact with soil. These include the nodes for the basemat and the exterior walls adjacent to soil. The spring elements are modeled with very stiff spring properties. One end of the spring is attached to the structural shell element node, while the other end is attached to an interaction node in the soil.

3.7.2.4.3 Step 3 – Development of Soil Model

3.7.2.4.3.1 Nuclear Island Common Basemat Structures with NAB and AB (NI/NAB/AB)

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 the NI/NAB/AB is considered through modification of the P-Wave velocity profiles and by using the saturated weight for the soil below the ground water table. 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.

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. 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

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 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 365 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 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.

3.7.2.4.3.4 Turbine Island Structure

The soil model is developed using the SSE strain-compatible lower bound, best estimate and upper bound soil profiles, which are identical to the soil profiles for the EPGB and ESWB. 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 391 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.

3.7.2.4.4 Step 4 – Development of SSI Analysis Soil Model

3.7.2.4.4.1 Nuclear Island Common Basemat Structures with NAB and AB (NI/NAB/AB)

The model described in the U.S. EPR FSAR is used for CCNPP Unit 3. The CCNPP Unit 3 model is complemented with an embedded stick model representing the AB. Figure 3.7-86 shows the

NI/NAB/AB SSI model, with a representation of the NI full FEM model and the NAB and AB lumped mass stick models. The CCNPP Unit 3 analysis uses the following inputs:

- ♦ Site-specific soil profiles strain-compatible with the Site SSE are used, as described in Section 3.7.2.4.1.1.
- ♦ The Site SSE is defined as a SHAKE outcrop at the bottom of the NI foundation. The control input motion to the SSI analysis of the NI common basemat structures is a surface motion corresponding to the Site SSE applied as a SHAKE outcrop at the bottom of the NI foundation for each of the 3 soil profiles (LB, BE and UB). The surface input motion acceleration spectra of the time histories used for the SSI analysis are shown in Figure 3.7-67a, Figure 3.7-67b and Figure 3.7-67c.
- ♦ Four percent structural damping is applied.

3.7.2.4.4.2 EPGB and ESWB

The model described in the U.S. EPR FSAR is used for CCNPP Unit 3. The CCNPP Unit 3 analysis uses the following inputs:

- ♦ 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 to the SSI analysis of the EPGB is a surface motion corresponding to the Modified Site SSE applied as a SHAKE outcrop at the bottom of the EPGB foundation shear keys (11 ft below grade) for each of the 3 soil profiles (LB, BE and UB). The surface input motion acceleration spectra of the time histories used for the SSI analysis are shown in Figure 3.7-68a, Figure 3.7-68b and Figure 3.7-68c.
- ♦ The control input motion to the SSI analysis of the ESWB is a surface motion corresponding to the Modified Site SSE applied as a SHAKE outcrop at the bottom of the ESWB foundation (33 ft below grade) for each of the 3 soil profiles (LB, BE and UB). The surface input motion acceleration spectra of the time histories used for the SSI analysis shown in Figure 3.7-69a, Figure 3.7-69b and Figure 3.7-69c.

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.

3.7.2.4.4.3 Common Basemat Intake Structures

The SSI model includes the CBIS, the Steel Enclosure Building, the surrounding layers of structural fill, and the existing soil media as shown in Figure 3.7-24. Three-dimensional brick elements are used for the entire basemat area in order to obtain seismic stresses for the stability analyses described in Section 3.7.2.14.3.

The control input motion for the SSI analysis of the CBIS is the within soil-column motion corresponding to the outcrop Site SSE for each soil profile. Acceleration, velocity and displacement time histories spectrally matched to SSE_{CBIS} for CBIS are shown in Figures 3F-28d,e,f. 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).

3.7.2.4.4.4 Turbine Island Structures

The SSI model includes the TI Structure, the surrounding layers of structural fill, and the existing soil media. At each interaction node on the side walls and at the basemat, three orthogonal zero-length stiff spring elements link the structure to the soil. The spring forces due to dynamic loading are subsequently used in the stability analyses described in Section 3.7.2.8.

The control input motion for the SSI analysis of the TI Structure is the within the soil column motion corresponding to the outcrop Site SSE for each soil profile described in Section 3.7.1.3.4. Consistent with the development of the soil column motion, the control motion is applied at the foundation level of the TI Structure (i.e., at the same horizon used for development of FIRS for the TI Structure).

3.7.2.4.5 Step 5 - Performing SSI Analysis

3.7.2.4.5.1 Nuclear Island Common Basemat Structures with NAB and AB (NI/NAB/AB)

The SSI analysis for the NI/NAB/AB is performed using the same methodologies as the U.S. EPR. The analysis includes the presence of the AB, which is represented as a lumped mass stick model. Figure 3.7-86 shows the NI/NAB/AB SSI model, with a representation of the NI full FEM model and the NAB and AB lumped mass stick models.

3.7.2.4.5.2 EPGB and ESWB

.No departures or supplements.

3.7.2.4.5.3 Common Basemat Intake Structures

The SSI analysis of the model for the CBIS is performed using ACS SASSI Version 2.3.0. 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 and for two sets of properties for the concrete: one considering all the elements uncracked with OBE damping (4 percent for concrete and 3 percent for steel) and the other with all the elements cracked with SSE damping (7 percent for concrete and 4 percent for steel).

3.7.2.4.5.4 Turbine Island Structure

The SSI analysis of the model for the TI Structure is performed using Bechtel computer code SASSI2010, following the previously described methodology.

3.7.2.4.6 Step 6 - Extracting Seismic SSI Responses

3.7.2.4.6.1 Nuclear Island Common Basemat Structures with NAB and AB (NI/NAB/AB)

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.

Table 3.7-6 provides the combined average maximum nodal accelerations at various elevations of the Nuclear Island Common Basemat Structures. Comparison of the structural accelerations provided in Table 3.7-6 with the corresponding structural accelerations reported in U.S. EPR FSAR Tables 3.7.2-10, show that the site-specific accelerations for the Nuclear Island Common Basemat Structures are bounded by the certified design.

Acceleration response is extracted at the base and floor levels of the AB in order to perform the stability analysis. The stability analysis of the AB is discussed in Section 3.7.2.8.2

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.

Table 3.7-7 provides the combined average maximum nodal accelerations at various elevations of the EPGB and ESWB. Comparison of the structural accelerations provided in Table 3.7-7 with the corresponding structural accelerations reported in U.S. EPR FSAR Tables 3.7.2-27 and 3.7.2-28, (for the EPGB and ESWB respectively), show that the site-specific accelerations for the EPGB and ESWB are bounded by the certified design.

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

SSI analysis outputs are generated for each soil profile (i.e., LB, BE, and UB) and direction of the input motion. Accelerations, soil stresses, in-structure response spectra, resultant sliding force and total overturning moments are calculated using the CBIS model in ACS SASSI.

Table 3.7-8 provides the combined maximum nodal accelerations at various elevations of UHS Makeup Water Intake Structure. 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 using the CBIS model in STAAD Pro. These forces and moments are used for the design of critical walls and slabs, as detailed in Appendix 3E.

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 as detailed in Section 3.7.2.5.3.

3.7.2.4.6.4 Turbine Island Structure

SSI analysis outputs are generated for each soil profile (i.e., LB, BE, and UB) and direction of the input motion. In particular, spring element forces, located at the soil-structure interface, are calculated.

Time-history responses are calculated by SASSI at a uniform time step of 0.005 seconds. For the spring elements at the bottom of the basemat and at the exterior walls adjacent to soil, the responses are spring forces in the three orthogonal translation directions. Two sets of results can be extracted from the SASSI analyses. The first set consists of only the maximum positive or negative forces for each spring. The second set consists of the actual resultant force for each spring at each time step, including the directional sign.

For the building stability evaluation of the Turbine Island Structure, only the maximum positive or negative forces for each spring are considered. An additional conservatism is to assume the spring forces are acting in the same direction (i.e. in-phase), using the absolute value of the output responses. Peak forces at each spring, in each response direction, due to seismic input in each of the 3 directions, and for each of the soil cases evaluated, are then combined. Within each soil case, since maximum responses are used in each response direction (X, Y, and Z), the responses due to X, Y, Z seismic inputs are combined using square-root-of-sum-of-squares (SRSS) method. The spring forces are similar to support reactions of the building and are used to calculate the total shear (sliding), total vertical uplift force, and overall overturning moment at the bottom of the basemat slab.

For stability evaluation using time-step methodology, resultant seismic inputs in each direction are combined algebraically at each time step for all nodes, while accounting for the directional sign (positive or negative). The sum of forces of all nodes, in each of the two horizontal directions, are then combined by the square-root-of-sum-of-squares (SRSS) to yield the total sliding demand force.

The determination of seismic stability of the TI Structure is presented in Section 3.7.2.8.

3.7.2.4.7 Computer Codes

The SSI analysis of the NI/NAB/AB, EPGB, and ESWB is performed using AREVA computer code MTR/SASSI, Version 9.6HPC, 9.6 and 9.6.1; which has been verified and validated in accordance with the AREVA 10 CFR 50 Appendix B QA program.

ACS SASSI, Version 2.3.0, is used to perform the seismic confirmatory SSI analysis of the CBIS. This program is verified and validated in accordance with the RIZZO 10 CFR 50 Appendix B QA program.

Bechtel computer code SASSI2010, Version 1.1, is used to perform the seismic SSI analysis of the TI structure. 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.

3.7.2.5 Development of Floor Response Spectra

A structural damping of 4 percent is used for the development of ISRS for the 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.

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 for all frequencies above 0.7 Hz. Reconciliation for frequencies below 0.7 Hz are addressed in Section 2.5.2.6.

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 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 Vessel Support at elevation +16 ft, 10-3/4 in.
- Steam generator supports at elevation +63 ft, 11-3/4 in.
- Safeguard Building 1 at elevation +26 ft, 7 in. and elevation+68 ft, 11 in.
- Safeguard Buildings 2/3 at elevation +26 ft, 7 in. and elevation +53 ft, 6 in
- Safeguard Building 4 at elevation+68 ft, 11 in
- Reactor Containment Building
- Polar crane support at elevation+123 ft, 4-1/4 in.
- Top-of-dome at elevation+190 ft, 3-1/2 in
- Fuel Building at elevation+12 ft, 1-3/4 in. and elevation +48 ft, 6-3/4 in.

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 (Figure 3.7-25 through Figure 3.7-57) for frequencies above 0.7 Hz. Reconciliation for frequencies below 0.7 Hz are addressed in Section 2.5.2.6.

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 analyses, ISRS are generated for EPGB and ESWB at these key 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:

- EPGB at center of basemat and elevation +50 ft, 6 in.
- ESWB at elevation +14 ft, 0 in.

Figure 3.7-58 to Figure 3.7-66 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 0.7 Hz. Reconciliation of the accelerations at these low frequencies is discussed in Section 2.5.2.6.

3.7.2.5.3 Common Basemat Intake Structures

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 0.01 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 Figure 3.7-73 through Figure 3.7-78 and at the location of safety-related electrical equipment supported at EL +26.5 ft in the CBIS, and are shown in Figure 3.7-79 through Figure 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

3.7.2.6.1 Nuclear Island Common Basemat Structures

No departures or supplements.

3.7.2.6.2 EPGB and ESWB

No departures or supplements.

3.7.2.6.3 Common Basemat Intake Structures

As indicated in Section 3.7.2.4, the SSI analysis of the site-specific Seismic Category I structures is performed using the integrated FEM, with the input ground motion applied separately in the three directions. The ISRS in the UHS Makeup Water Intake Structure are determined using the time history equal to the algebraic summation of the earthquake motion in the three directions.

The maximum member forces and moments due to the three earthquake motion components are combined using the Square Root of the Sum of the Squares (SRSS) combination rule to obtain the maximum total member forces and moments. The SRSS method 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 Structures

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 (AB) and Turbine Building.

The COL Item is addressed as follows:

> The conceptual design information in U.S. EPR FSAR, Tier 2, Figure 3B-1 provides the separation gaps between the AB and SBs 3 and 4 and between the TB and the NI Common Basemat Structures. This information is incorporated by reference.

{Additional section sub numbering that is not in the U.S. EPR FSAR has been added.

3.7.2.8.1 Nuclear Auxiliary Building

A site specific stability analysis of the Nuclear Auxiliary Building (NAB) has been performed using essentially the same model and methodology as used for the standard plant and described in Section 3.7.2.8.1 of the U.S. EPR FSAR. This analysis has two main steps. First, translational and rotational acceleration time histories at the center of the NAB basemat were obtained from the Nuclear Island SASSI model. Then, those time histories were used as input to a NAB FEM model to determine the bearing pressure and peak displacement. The FEM model is evaluated in ANSYS 13.0 SP2. This evaluation satisfies the COL Item in Section 2.5.4.10.1 which states:

> A COL applicant that references the U.S. EPR design certification will perform a site-specific analysis to determine the bearing pressure demand and peak displacement of the NAB. The foundation soils beneath the NAB foundation basemat shall have the capacity to support the bearing pressure with a factor of safety of 3.0 under static conditions, or 2.0 under combined static and dynamic conditions, whichever is greater. The minimum required separation distance is a factor of two times the calculated absolute sum of the maximum combined site specific NAB and U.S. EPR NI design displacements, but not less than 30 inches.

The CCNPP Unit 3 analysis uses the following site specific changes:

- The NI SASSI model for CCNPP Unit 3 also includes a stick model of the AB (AB).
- The CCNPP Unit 3 SSE and associated time histories are used instead of the CSDRS.
- The OBE damping values are used.
- The CCNPP Unit 3 soil properties are used, such as active, passive and at rest earth pressure coefficients, and soil translational spring distributions for dynamic vertical and horizontal springs for NAB superstructure.
- The Upper Bound (UB), Best Estimate (BE), and Lower Bound (LB) soil profiles are used.
- Coefficients of friction of $\mu = 0.47$ static, and $\mu = 0.35$ dynamic, are analyzed.

The CCNPP Unit 3 SSE and some of the CCNPP Unit 3 soil properties (angle of internal friction, soil density and coefficient of friction) do not satisfy the U.S. EPR design parameters specified in U.S. EPR FSAR Table 2.1-1. These departures have no safety significance. This is demonstrated by the following discussion.

Bearing Pressure

Peak bearing pressure is necessary to confirm that the soil in the vicinity of the NI common basemat structures is capable of supporting the structures.

The maximum static bearing pressure for the NAB is 13.2 ksf, and the maximum dynamic bearing pressure is 35.5 ksf.

Table 2.5-67 establishes the allowable bearing capacities of 35.3 ksf static and 52.9 ksf dynamic for CCNPP Unit 3 NAB. Therefore the site specific bearing pressures are within the allowable bearing pressure capacities beneath the NAB.

Displacement between Structures

An analysis has been performed to confirm that a seismic event would not result in interaction between the NAB and the Fuel Building or the NAB and Safeguard Building 4. This analysis considers the maximum movement due to sliding and seismic displacement (top movement), and settlement induced tilt for both the NAB and the NI.

The NAB is predicted to slide. The analysis predicts maximum movement of 0.76 inches in the X-direction (between the NAB and the Fuel Building), 1.83 inches in the Y direction (between the NAB and Safeguards Building 4) and 0.36 inches of uplift. In addition to sliding the, NAB experience, elastic displacement during the earthquake. The total seismic displacement at the top of the structures is 3.67 inches in the X-direction and 4.62 inches in the Y-direction. The NAB is predicted to tilt up to 1.13 inches per 50 feet during settlement. This tilt adds an additional movement of 3.16 inches in the X direction and 3.11 inches in the Y-direction.

For conservatism, the seismic displacement of the NI is the maximum displacement from the U.S. EPR Design Certification, and settlement tilt is calculated at the 0.5 in per 50 feet design parameter. The NI maximum seismic displacement is 0.92 inches in the X direction and 0.89 in the Y direction. The maximum tilt is 1.40 and 1.37 inches in the X-and Y-directions, respectively.

The contribution of the four factors to total displacement is summarized in Table 3.7-11. The values are the maximum values obtained regardless of soil type (UB, BE, and LB). For the NAB, the maximum seismic displacement (top movement) occurred with the LB soil. Settlement induced tilt is independent of the soil case.

For conservatism, the maximum displacements are added absolutely, even though the buildings are more likely to move in phase.

Factor of Safety

The standard design includes a 30-inch gap between the NAB and the NI common basemat structures. At the CCNPP Unit 3 site, this distance provides a factor of safety of 3.28 in the X-direction and 3.0 in the Y-direction. Therefore although the Seismic Category II NAB will slide, it does not interact with the Seismic Category I NI common basemat structures.}

3.7.2.8.2 Access Building

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

A COL applicant that references the U.S. EPR design certification will demonstrate that the response of the Access Building to an SSE event will not impair the ability of Seismic Category I systems, structures, or components to perform their design basis safety functions.

[[The Access Building is analyzed to site-specific SSE load conditions and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure with the exception of sliding and overturning criteria. Because the Access Building does not have a safety function, it may slide or uplift provided that the gap between the Access Building and any Category I structure is adequate to prevent interaction. The effects of sliding, overturning, and any other calculated building displacements (e.g., building deflections, settlement) must be considered when demonstrating the gap adequacy between the Access Building and adjacent Category I structures. The separation gaps between the Access Building and SBs 3 and 4 are 0.98 ft and 1.31 ft, respectively (U.S. EPR FSAR, Tier 2, Figure 3B-1).]]

For COL applicants that incorporate the conceptual design for the Access Building presented in the U.S. EPR FSAR (i.e., [[the Access Building is analyzed to site-specific SSE load conditions and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure with the exception of sliding and overturning criteria]]), this COL item is addressed by demonstrating that the gap between the Access Building and adjacent Category I structures is sufficient to prevent interaction. The effects of sliding, overturning, and any other calculated building displacements (e.g., building deflections, settlement) must be considered when demonstrating the gap adequacy between the Access Building and adjacent Category I structures.

This COL Item and conceptual design information is addressed as follows:

{The conceptual design for the Access Building (AB) presented in the U.S. EPR FSAR will be used for the CCNPP Unit 3 AB.

1. Building Layout/Details

   The AB is a site-specific structure and is classified as a nonsafety-related Augmented Quality (NS-AQ) Seismic Category II structure according to Table 3.2-1.

   The multi-story AB is comprised of reinforced concrete. Reinforced concrete components include below grade walls, partial height shear, structural columns, and a basemat.

2. Acceptable Codes and Standards

   The AB is analyzed and designed to the same requirements as the site-specific Seismic Category I structures. The applicable design codes and standards for the reinforced concrete and structural steel components of the AB are listed in Tables 3.2-1 and Table 3.7-10. The reinforced concrete components of the AB are designed in accordance with ACI 349 and the structural steel components of the AB designed in accordance with ANSI/AISC N690.

3. Loads and Load Combinations

The design loads and load combinations for the AB are consistent with those used for the design of site-specific Seismic Category I structures.

a. Dead Loads

Dead loads for the AB are in accordance with Section 3.8.4.3.1, which incorporates the U.S. EPR FSAR Section 3.8.4.3.1 by reference.

b. Live Loads

Live loads for the AB are in accordance with Section 3.8.4.3.1. The live loads include loads due to rain, snow and ice and are based on the site-specific conditions. The live loads of the AB further include loads consistent with the equipment layout within the structure.

c. Seismic Loads

Seismic loads are calculated using the CCNPP Unit 3 Site SSE spectrum, which is depicted in Figure 3.7-1.

d. Wind Loads

The AB is a site-specific structure and is designed for site-specific wind loads. The site-specific wind parameters (i.e., basic wind speed, 100-year recurrence interval wind speed) and applicable codes and guidelines (e.g., importance factor of 1.15) for the determination of site-specific wind loads are included in Section 3.3.1.

e. Extreme Wind Loads (Hurricanes and Tornadoes)

Hurricane and tornado loads for the analysis and design of AB are in accordance with Section 3.3.2. Design basis tornado characteristics and tornado missile parameters are in accordance with Tornado Region I of NRC RG 1.76, Revision 1. Design basis hurricane characteristics and hurricane missile parameters are in accordance with NRC RG 1.221, Revision 0. Hurricane and tornado wind loads will be converted to wind pressure loads according to SEI/ASCE 7-05 guidelines. Pressure relief siding panels are utilized, as necessary, to mitigate hurricane and tornado wind pressures.

f. Load Combinations

Load combinations for analysis and design of the AB are consistent with those used for the analysis and design of Seismic Category I structures, as described in Section 3.8.4.3.2, which incorporates the U.S. EPR FSAR Section 3.8.4.3.2 by reference.

4. Analysis Procedures

Finite element methods are utilized to analyze the AB for applicable loads and load combinations described above. For seismic loads, the AB is designed to maintain a margin of safety equivalent to that of Seismic Category I structures. The margin of safety equivalent to that of Seismic Category I structures is achieved by analyzing and designing the AB to the same requirements as a Seismic Category I structure.

5. Materials

   Concrete and reinforcing steel materials for the AB conform to those for site specific Category I structures, which are discussed in Section 3E.4.2.

   The concrete used for the AB has a minimum design compressive strength of 5000 psi (with ASTM A615, Grade 60 or 75 reinforcing steel).

6. Acceptance Criteria

   Since the AB will be designed to the same requirements as the Seismic Category I structures, the structural acceptance criteria for the AB are identical to those for Seismic Category I structures, which are outlined in Section 3.8.4.5, that incorporate the U.S. EPR FSAR Section 3.8.4.5 by reference.

   The AB is designed to remain elastic under an SSE event. Therefore, in regard to seismic interaction considerations, the design methodology for the AB meets NUREG-0800, Standard Review Plan 3.7.2, Acceptance Criterion 8.C.

   The elastic displacements of the AB are computed using finite element analysis methods. The finite element analyses report confirms that the elastic displacements of AB combined with those of nearest Seismic Category I structures are less than the provided separation distances.

Bearing Pressure

Peak bearing pressure is necessary to confirm that the soil in the vicinity of the NI common basemat structures is capable of supporting the structures.

The maximum static bearing pressure for the AB is 9.2 ksf, and the maximum dynamic bearing pressure is 18.4 ksf.

Bearing capacities for the AB are 43.5 ksf static and 58.0 ksf dynamic. Therefore, the site specific bearing pressures are within the allowable bearing pressure capacities beneath the AB.

Sliding and Overturning

The seismic stability of the AB is analyzed for the Lower Bound (LB), Best Estimate (BE), and Upper Bound (UB) soil cases, as well as for variation in concrete stiffness using uncracked (UNCR) and cracked (CR) concrete properties. An FEM model is used to perform the stability analysis. Figure 3.7-87 shows a representation of the AB FEM model. Features of the AB FEM stability model are:

- The model includes 100% dead loads, 25% live loads, and 75% precipitation loads.
- The shell basemat of the AB is replaced with 4 layers of solid elements; the interface between the shell and solid elements are then connected with multipoint constraints.
- Translational soil springs and compression-only soil springs are implemented at the base of the model.

- ♦ Buoyancy loads are placed acting upward and their magnitude is consistent with the groundwater level.
- ♦ Active earth pressures are calculated and applied along the embedded portion of the North and East sides of the AB FEM model.

The stability analysis is conservatively conducted with a pseudo-static approach as follows:

a. A static analysis of the AB is calculated under static loading conditions, to obtain the initial spring reaction forces and bearing pressure at the foundation base. The bearing pressure of the basemat is determined from the reaction force and the contributory area of each node at the bottom of the basemat.

b. For each direction of analysis (X, Y and Z), seismic forces are applied independently to the AB structure as inertia forces that result from the ZPAs. ZPAs at each level of the AB structure are obtained from the embedded NI/NAB/AB SSI simulation. For each direction of analyses, the spring reaction forces, settlement and bearing pressures at the foundation base are determined.

c. The three directional driving forces (two horizontals and one vertical) are considered to act simultaneously and then are combined with an algebraic summation.

d. For the sliding stability analysis, the resisting forces are obtained by taking the product of the coefficient of friction and the normal component of the foundation contact vertical force; the horizontal driving forces at the basemat are combined using the Square Root of the Sum of the Squares (SRSS) average.

e. The driving forces are obtained from the horizontal forces at the points in which there is contact between foundation and soil.

f. Uplift is reported for areas at which no contact between the foundation basemat and underlying soil takes place; the ground contact ratio (ratio of the area of the foundation in contact with soil to the total area of the foundation) is calculated for each analysis case; the percentage uplift is the percent foundation not in contact with the soil.

g. The FOS to resist overturning is determined with respect to the edges contiguous to the NI.

h. Vertical inertia forces are placed acting upward at all times.

The results of the stability analysis are summarized in Table 3.7-12. The minimum FOS to resist sliding is 1.38 and corresponds to the uncracked, upper bound (UNCR-UB) case. The minimum FOS against overturning is 1.73 for the CR-UB case. Both cracked and uncracked cases yield similar values and the upper bound soil conditions control the stability of the AB. The stability analysis of the AB indicates that there is no potential for sliding and overturning. Sliding does not impact the gap between the AB and the NI Safeguards Buildings.

Displacement between Structures

An analysis has been performed to confirm that a seismic event would not result in interaction between the AB and Safeguards Building 2/3 or the AB and Safeguard Building 4. This analysis considers the relative movement due to seismic displacement, and settlement induced tilt for both the AB and the NI.

The minimum separation gap between the NI and the AB is approximately 1 ft (12"). Since neither the NI nor the AB slide during an SSE event, the sources of elastic deformation that will reduce the gap are:

- Displacement due to building tilt caused by static settlement,
- Dynamic displacement

The tilt at the basemat of the AB is slightly higher than for other buildings in the Powerblock area since its static settlement is heavily influenced by the NI. The tilt for the AB is toward the NI and has a value of 1.13" in 50' (or 1/530). The height of the AB measured from the foundation base is 88.9 ft. The displacement at the top of the AB is therefore:

$$\Delta_{TILT\_AB} = \frac{1}{530}(88.9\text{ ft})\left(\frac{12\text{ in}}{1\text{ ft}}\right) = 2.01''$$

The NI tilt is 0.32"/50' (or 1/1875). Using the AB height, measured from the foundation base, the displacement of the NI at the elevation of the top of the AB is:

$$\Delta_{TILT\_NI} = \frac{1}{1875}(88.9\text{ ft})\left(\frac{12\text{ in}}{1\text{ ft}}\right) = 0.57''$$

Dynamic relative displacements are calculated for the nodes at the base and top of the structures. The displacements are calculated from the double integration of the acceleration time history responses of the SASSI SSI simulation. The displacements are relative, but the gap analysis is also performed in relative terms.

Two approaches are used to calculate the maximum relative displacement between the top nodes of the AB and the SB structures:

1. At each time-step, the relative displacement at the top of the AB is subtracted from the relative displacement at the top of the Safeguards Buildings. The maximum dynamic displacement corresponds to the maximum difference recorded throughout the time history. This operation is repeated for each of the nodes in the Safeguards Buildings.

$$\Delta_{DYN} = \max(\Delta_{SG} - \Delta_{AB})$$

2. A more conservative approach: (a) calculate the difference in displacement between the base of the AB and the SB (Δ_{BASE}), (b) calculate the maximum displacement between the top of the AB and the base of the AB (capture AB rotation: $\Delta_{AB\text{-}ROT}$); (c) calculate the maximum displacement between the top of the SB and the base of the SB (capture SB rotation: $\Delta_{SB\text{-}ROT}$); (d) add the maximum base relative displacement to the maximum rotation displacements from each building (Δ_{DYN}) assuming that both buildings displace out of phase.

Using Approach 1 the estimated GAP reduction between the AB and NI is:

GAP REDUCTION = $\Delta_{TILT\_NI} + \Delta_{TILT\_AB} + \Delta_{DYN}$ = 0.57 + 2.01 + 0.34 = 2.92"

Using Approach 2 the estimated GAP reduction between the AB and NI is:

$$\text{GAP REDUCTION} = \Delta_{TILT\_NI} + \Delta_{TILT\_AB} + \Delta_{DYN} = 0.57 + 2.01 + 0.56 = 3.14"$$

Factor of Safety

The existing separation gap between the NI and the AB is adequate since there will be no interaction between the buildings. A Factor of Safety of 3.82 results from dividing the 12" gap over the estimated gap reduction.}

3.7.2.8.3 Turbine Building

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

> A COL applicant that references the U.S. EPR design certification will demonstrate that the response of the TB (including Switchgear Building on the common basemat) to an SSE event will not impair the ability of Seismic Category I systems, structures, or components to perform their design basis safety functions.
>
> [[The TI Structure is analyzed to site-specific SSE load conditions and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure. The separation between the TI Structure and NI Common Basemat Structures is approximately 30 ft (U.S. EPR FSAR, Tier 2, Figure 3B-1).]]

This COL Item is addressed as follows:

{The Turbine Building and Switchgear Building (also referred to as the Turbine Island (TI) Structure) are classified as Seismic Category II structures. These structures were analyzed and designed to the same requirements as other Seismic Category I structures for site-specific SSE loads. This design methodology meets the NUREG 0800 SRP 3.7.2 Acceptance Criterion 8.C.

Table 3.7-9 summarizes the results for the stability evaluation of the Turbine Island Structure. For sliding assessment, the maximum required coefficient of friction against sliding of the structure is shown for each soil case. Shear resistance against sliding is provided by the weight of the structure minus the net uplift force from vertical seismic, multiplied by the coefficient of friction factor.

In the Upper Bound case, following the time step methodology described in Section 3.7.2.4.6.4, the actual sliding effects are calculated at each time step of 0.005 seconds. As a result of this evaluation, the required coefficient of friction for the Upper Bound soil case is 0.19 (see Table 3.7-9 and Figure 3.7-85). The calculated factor of safety (FOS) is therefore 2.68 for the Upper Bound case.

Table 3.7-9 indicates that the maximum required coefficients of friction for the Lower Bound and Best Estimate soil cases are 0.33 and 0.45, respectively. These coefficients of friction are calculated using maximum absolute demand forces as described in Section 3.7.2.4.6.4. The resulting FOS are 1.16 and 1.58 for the Lower Bound and Best Estimate soil cases, respectively. All factors of safety are larger than the required FOS of 1.1 for SSE per NUREG 0800 Standard Review Plan (SRP) 3.8.5. However it is important to note that in the two latter cases, conservatism is included in the analysis, and it is expected that if, similar to the Upper Bound case, time-step methodology were used, the calculated factors of safety would be larger than reported.

The table also summarizes the results for the uplift and overturning evaluations of the TI Structure. Demands, capacities, and factors of safety against uplifting and overturning of the structure are shown. For the structural overturning stability assessment, overturning moment effects about the four sides of the basemat slab are considered individually. Capacity against uplift is provided by the static weight of the structure. The resulting minimum FOS for uplift is 1.98 in the Upper Bound soil case, which is larger than the required FOS of 1.1 for SSE per NUREG 0800 SRP 3.8.5.

Capacities against overturning are the resisting moments provided by the structure weight, separately bending about the four sides of the basemat. The summary table indicates the minimum computed Factor of Safety (FOS) for overturning in all three soil cases is 1.82, which is more than the required 1.1 for SSE per SRP 3.8.5. Since the computed factor of safety for overturning is more than required, further evaluation using the time-step methodology is not needed.

In addition to determining the structural stability of the TI, an evaluation is performed to establish whether separation occurs between the concrete basemat and the soil. The evaluation consists of identifying the locations of the various springs where a net uplift force occurs. This is done by conservatively assuming the maximum seismic vertical force for all springs are applied in the upward direction at the same time. For each spring, a net uplift occurs when the seismic vertical force exceeds the static weight tributary for that spring. The results are shown in Figure 3.7-88 for the most critical Upper Bound soil case. The figure shows the locations of the springs at the basemat, along with the locations of the springs where net uplift force results. As expected, uplift occurs for the springs along the perimeter of the basemat. This is reasonable since the seismic overturning effects will be maximized at the edge of the slab. However, this localized separation between the concrete basemat and the soil is not expected to be critical, due to the fact that the springs in the areas adjacent to the perimeter are experiencing net compressive forces. The local uplift will only occur for a short time interval, and then weight from the adjacent concrete area will force the slab back down. Figure 3.7-88 also shows that net uplift occurs within some localized interior regions of the basemat. Similar to the reasoning for the perimeter uplift, it is expected that weight from the adjoining areas will offset these uplift effects. It should be noted that the separation evaluation is performed using the maximum seismic uplift spring forces occurring at the same time. If time-step methodology is used, then the number of springs with net uplift is expected to be reduced, along with the possibility that these springs will be scattered randomly throughout the slab, instead of concentrated within one area.

3.7.2.8.4 Radioactive Waste Building

No departures or supplements.

3.7.2.8.5 [[Fire Protection Storage Tanks and Buildings]]

The U.S. EPR FSAR includes the following COL Item and conceptual design information in Section 3.7.2.8 - Fire Protection Storage Tanks and Buildings:

> 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 Fire Protection Storage Tanks and Buildings are classified as Conventional Seismic Structures.]] RG 1.189 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 fire protection storage tanks and building are designed to provide system pressure integrity under SSE loading conditions. Seismic load combinations are developed in accordance with the requirements of ASCE 7-10.]]

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 definition of Conventional Seismic Classification as defined in the U.S. EPR FSAR Section 3.2.1, a designation of Conventional Seismic-I is utilized. The Conventional Seismic-I designation is utilized to ensure the design basis requirement that some portions of the Fire Protection System SSCs 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 site-specific Fire Protection SSCs into two categories:

1. SSC that must remain functional during and after an SSE; and
2. SSC classified as non-seismic for support of equipment that is not required during or following an SSE to achieve safe shutdown.

The Fire Protection Storage Tanks and Buildings are structures that must remain functional during and following an SSE and are therefore designated as Conventional Seismic-I (CS-I).

The Fire Storage Tanks and Building will remain elastic under an SSE event. Therefore, in regards to seismic interaction considerations, the design methodology for the Fire Storage Tanks and Building meets NUREG-0800, Standard Review Plan 3.7.2, Acceptance Criterion 8.C Fire Storage Tanks and Building.

1. Building Layout/Details

   The Fire Protection Building (FPB) is projected as a one-story steel structure founded over a reinforced concrete basemat. The dimensions of the building are approximately 90 x 36 ft (plan) by 21 ft (height). The Fire Water Storage Tanks (FWSTs) are projected as two 40 ft diameter steel tanks approximately 35 ft high.

   Concrete and steel materials for the FPB and FWSTs will conform to those for site-specific Seismic Category I structures, which are discussed in COLA FSAR Section 3E.4.2. The concrete has a minimum design compressive strength of 5000 psi (with ASTM A615, Grade 60 or 75 reinforcing steel). The structural steel W-shape members are ASTM A992, and the structural steel channels, angles, and plates conform to ASTM A36 (except angles of cased seats for modular composite floor panels, which conform to ASTM A572 Grade 50).

   As shown in Figure 2.5-93 the FPB and FWSTs are located at the Northeast corner of the Powerblock Area. The current topography at the location of the buildings has a surface elevation of about 43 ft. Plant grade is set at El 85.0. Therefore at least 42 ft of engineered fill will be placed between the building foundation and the native soils. Terrace sands will be removed so that controlled fill is placed directly over the Chesapeake cemented sands. Since more than 40 ft of controlled engineered fill will be placed beneath the foundations and geotechnical information is available from surrounding borings, the subsurface conditions are well defined for the FPB and FWSTs. The engineered fill in the area of the FPB and FWSTs will be placed with the same materials and specifications as for Category I structures. The shear wave velocity and compaction Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) used for Category I structures will also be enforced for the FPB and FWSTs. In conclusion, a well-defined and competent foundation soil will be in place for these structures.

2. Design Criteria

   The design of the FPB and FWSTs will be consistent with the methodology used for Category II structures described in Section 3.7.2.3.3 of the U.S. EPR FSAR, with the exception of sliding and overturning, which will be analyzed more conservatively. These structures are analyzed to SSE load conditions and designed to the codes and standards associated with Seismic Category I structures, so that the margin of safety is equivalent to that of a Category I structure. Sliding and overturning analysis of the FPB and FWSTs will be performed under SSE load conditions and Factors of Safety will be equivalent to those required for Category I structures.

   Procurement, quality control, and Quality Assurance requirements for the FPB and the FWSTs will be performed equivalent to Category II structures, according to the guidance provided in the U.S. EPR FSAR Section 3.2.1.2.

3. Analysis and Design of the FPB

   A fixed-based equivalent lateral force methodology will be used to analyze the one-story FPB. The total seismic base shear will be imposed at the roof level of the building and seismic forces will be distributed along the lateral force resisting elements according to location and stiffness. Additional accidental torsion will be incorporated by using an eccentricity of +/- 5% of the maximum building dimension and analyzing the structure in both horizontal directions. Since the structure is a one-story building, the incorporation of the total base shear in the first mode of oscillation will result in a conservative approach. The structure will be placed over a common basemat that will provide a fixed support.

   The total seismic base shear will be calculated by multiplying the superstructure total weight times the maximum spectral acceleration of the CCNPP Unit 3 SSE times a factor of 1.5.

   The FPB houses equipment that must remain functional during and after an SSE event. In-Structure Response Spectra (ISRS) for equipment at the basemat will be equivalent to the envelope of the CCNPP Unit 3 SSE and a Foundation Input Response Spectra (FIRS) developed at the location of the building. ISRS for SSCs that are attached to the columns or the roof of the structure, and that must remain functional during and after an SSE, will be determined by performing an elastic single degree of freedom response time history analysis or by scaling the base ISRS by a ratio of maximum acceleration response obtained with a modal analysis.

The FPB will be designed to the codes and standards associated with Seismic Category I structures. The design of the reinforced concrete foundation of the FPB will be performed in compliance with American Concrete Institute (ACI) 349, "Code Requirements for Nuclear Safety-Related Concrete Structures." The steel structure will be designed using American National Standards Institute (ANSI) and American Institute of Steel Construction (AISC) ANSI/AISC N690-1994 including Supplement 2 (2004), "Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities."

4. Analysis and Design of the FWSTs

   The FWSTs are above ground steel tanks, fixed to their foundation, and will be founded on competent engineered fill that will be subject to ITAAC equivalent to those of the CCNPP3 Category I structures. The methodologies to determine seismic forces for the FWSTs will be as described in American Water Works Association (AWWA) D-100, "Welded Steel Tanks for Water Storage" and TID-7024, "Nuclear Reactors and Earthquakes."

   The seismic forces for the design of the FWSTs will include convective and impulsive components consistent with the SSE elastic design with maximum spectral accelerations of 0.45 g. The methodologies to establish the magnitude of these forces are based on the Housner method as described in AWWA D-100 and TID-7024. No reduction for ductility will be incorporated (Ri=1.0; Rc=1.0). No reduction of base shear or overturning moment to account for Soil Structure Interaction (SSI) effects will be incorporated. The design overturning moments and shears will be established with a bounding approach of AWWA D-100 Sections 13.5.2 and 13.5.3, and TID-7024 Chapter 6. AWWA D-100 Section 13.5.4 will be used to evaluate overall stability. The impulsive acceleration used for the computation of moments and forces will correspond to the maximum spectral acceleration of the CCNPP Unit 3 SSE. For the convective mode, the natural frequency of sloshing water is determined, and the corresponding acceleration is based on 0.5 percent damping. Stability analyses of the tanks and their foundation will be performed to accommodate maximum overturning moments and shear forces.

   Codes for the design of steel tanks are AWWA D-100 and the National Fire Protection Association (NFPA) 22, "Standard for Water Tanks for Private Fire Protection."

5. Acceptance Criteria

   The Fire Storage Tanks and Building will remain elastic under an SSE event. Therefore, in regards to seismic interaction considerations, the design methodology for the Fire Storage Tanks and Building meets NUREG-0800, Standard Review Plan 3.7.2, Acceptance Criterion 8.C.

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

   1. Diesel driven fire pumps and their associated subsystems and components, including the diesel fuel oil system;

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

3. The portions of the fire water piping system and components (including isolation valves) which supply water to the standpipes 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 Conventional Seismic-I.

3.7.2.8.6 Site Specific Structures

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 Fire Protection SSC designated as Conventional Seismic-I.
- Seismic Category II TI Structure (i.e., combined Turbine Building and Switchgear Building)
- Conventional Seismic Grid Systems Control Building
- Seismic Category II Circulating Water Makeup Intake Structure
- Conventional Seismic Sheet Pile Wall
- Existing Baffle Wall.

3.7.2.8.6.1 Buried and above ground Fire Protection SSC Designated as Conventional Seismic

The buried Fire Protection SSC designated as Conventional Seismic-I as identified in Table 3.2-1 are seismically analyzed using the design response spectra identified in Section 3.7.1.1.1.4. These piping mains will be designed according to ASCE 4-98, 1983 ASCE Report "Seismic Response of Buried Pipes and Structural Components," and the U.S. EPR FSAR Appendix 3F.

The above ground Fire Protection SSC, designated as Conventional Seismic-I as identified in Table 3.2-1 are seismically analyzed utilizing the appropriate design response spectra per Table 3.8-6. The analysis of the above ground fire protection SSC designated as Conventional Seismic-I will confirm they remain functional during and following an SSE in accordance with NRC Regulatory Guide 1.189 (NRC, 2007).}

3.7.2.8.6.2 Turbine Island (TI) Structure (Turbine Building and Switchgear Building)

1. Building Layout/Details

   The combined TI Structure is described in Section 3.7.2.3.3

2. Acceptable Codes and Standards

   The TI Structure is analyzed and designed to the same requirements as the site-specific Seismic Category I structures. The applicable design codes and standards for the reinforced concrete and structural steel components of the TI Structure are listed in COLA FSAR Tables 3.2-1 and 3.7-11. The reinforced concrete components of the TI

Structure are designed in accordance with ACI 349 and the structural steel components of the TI Structure designed in accordance with ANSI/AISC N690.

3. Loads and Load Combinations

The design loads and load combinations for the TI Structure are consistent with those used for the design of site-specific Seismic Category I structures.

a. Dead Loads

Dead loads for the TI Structure are in accordance with Section 3.8.4.3.1, which incorporates the U.S. EPR FSAR Section 3.8.4.3.1 by reference.

b. Live Loads

Live loads for the TI Structure are in accordance with Section 3.8.4.3.1. The live loads include the loads due to rain, snow and ice and are based on the site-specific conditions. The live loads of the TI Structure further include loads consistent with the equipment layout within the structure.

c. Seismic Loads

Seismic loads are calculated using the CCNPP Unit 3 Site SSE Spectrum, which is depicted in COLA FSAR Figure 3.7-1.

d. Wind Loads

The TI structure is a site-specific structure and is designed for site-specific wind loads. The site-specific wind parameters (i.e. basic wind speed, 100-year recurrence interval wind speed) and applicable codes and guidelines for the determination of site-specific wind loads were included in Section 3.3.1.

e. Extreme Wind Loads (Hurricanes and Tornadoes)

Hurricane and tornado loads for the analysis and design of TI Structure are in accordance with COLA FSAR Section 3.3.2. Design basis tornado characteristics and tornado missile parameters are in accordance with Tornado Region I of NRC RG 1.76, Revision 1. Design basis hurricane characteristics and hurricane missile parameters are in accordance with NRC RG 1.221, Revision 0. Hurricane and tornado wind loads will be converted to wind pressure loads according to SEI/ASCE 7-05 guidelines. Hurricane and tornado wind pressures are mitigated through the use of pressure relief siding panels.

f. Load Combinations

Load combinations for the analysis and design of the TI Structure are consistent with those used for the analysis and design of Seismic Category I structures, as described in Section 3.8.4.3.2, which incorporates the U.S. EPR FSAR Section 3.8.4.3.2 by reference.

4. Analysis Procedures

Finite element methods are utilized to analyze the TI Structure for applicable loads and load combinations. For seismic loads, the TI Structure is designed to maintain a margin of safety equivalent to that of Seismic Category I structures. The margin of safety equivalent to that of Seismic Category I structures is achieved by analyzing and designing the TI Structure to the same requirements as a Seismic Category I structure.

5. Materials

Concrete and reinforcing steel materials for the TI Structure conform to those for site-specific Seismic Category I structures which are discussed in COLA FSAR Section 3E.4.2. The concrete used for the TI Structure has a minimum design compressive strength of 4000 psi (with ASTM A615, Grade 60 or 75 reinforcing steel). The structural steel W-shape members are ASTM A992, and the structural steel channels, angles, and plates conform to ASTM A36 (except angles of cased seats for modular composite floor panels which conform to ASTM A572 Grade 50).

6. Acceptance Criteria

Since the TI Structure is designed to the same requirements as the Seismic Category I structures, the structural acceptance criteria for the TI Structure is identical to those for Seismic Category I structures, which are outlined in COLA FSAR Section 3.8.4.5, which incorporates the U.S. EPR FSAR Section 3.8.4.5 by reference.

The TI Structure is designed to remain elastic under an SSE. Therefore, in regards to seismic interaction considerations, the design methodology for the TI Structure meets NUREG-0800, Standard Review Plan 3.7.2, Acceptance Criterion 8.C. The elastic displacements of the TI Structure are computed using finite element analysis methods. Upon closure of COLA Part 10 Appendix B ITAAC, Revision 8, in Tables 2.4-10 and 2.4-11, the finite element analyses report will confirm that the elastic displacements of the TI structure combined with those of adjacent Seismic Category I structures are less than the provided separation distances.

3.7.2.8.6.3 Conventional Seismic Grid Systems Control Building

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). Table 3.7-10 identifies the design codes used for the Grid Systems Control Building.

3.7.2.8.6.4 Circulating Water System Makeup Water Intake Structure

1. Building Layout/Details

The Circulating Water System (CWS) Makeup Water Intake Structure (MWIS) is integrally connected to the Forebay and, together with the UHS Makeup Water Intake Structure, share a common Basemat. The CWS MWIS, Forebay and UHS are also referred to as the Common Basemat Intake Structures (CBIS). The CWS MWIS is a site-specific structure and is classified as a Nonsafety-Related Augmented Quality (NS-AQ) Seismic Category II structure according to COLA FSAR Table 3.2-1.

The CWS MWIS sub-structure is comprised of a reinforced concrete basemat, below grade reinforced concrete walls and a reinforced concrete slab at grade. The super-structure for the pump house enclosure and electrical room is a cladded steel structure, braced in both directions.

Key floor levels of the CWS MWIS structure and its structural floor systems include:

- Basemat Level: Reinforced concrete basemat shared by the CWS MWIS, Forebay and UHS MWIS.
- Grade level: Reinforced concrete floor serving as the Operating Deck Level for the CWS.
- Roof level: Structural steel pump house enclosure and electrical room.

The pump house enclosure is primarily founded on a grade slab on the Northern end while a smaller portion at the Southern end is supported by the operating deck of the CWS MWIS.

2. Acceptable Codes and Standards

The CWS MWIS structure is analyzed and designed to the same requirements as the site-specific Seismic Category I structures. The applicable design codes and standards for the reinforced concrete and structural steel components of the CWS MWIS are listed in COLA FSAR Table 3.2-1 and Table 3.7-10. The reinforced concrete components of the CWS MWIS are designed in accordance with ACI 349 and the structural steel components of the CWS MWIS designed in accordance with ANSI/AISC N690.

3. Loads and Load Combinations

The design loads and load combinations for the CWS MWIS are consistent with those used for the design of site-specific Seismic Category I structures.

a. Dead Loads

Dead loads for the CWS MWIS are in accordance with COLA FSAR Section 3.8.4.3.1, which incorporates the U.S. EPR FSAR Section 3.8.4.3.1 by reference.

b. Live Loads

Live loads for the CWS MWIS are in accordance with COLA FSAR Section 3.8.4.3.1. The live loads include the loads due to rain, snow and ice and are based on the site-specific conditions. The live loads of the CWS MWIS further include loads consistent with the equipment layout within the structure.

c. Seismic Loads

The CWS MWIS, including the pump house enclosure, is included in the SSI model for the UHS MWIS and Forebay. The CWS MWIS is analyzed and designed to meet the same design requirements as a Seismic Category I Structure. Hence, the CWS MWIS is designed to prevent failure under SSE conditions with a margin of safety equivalent to that of a Category I structure. This meets Acceptance Criteria 8.C of SRP 3.7.2.

d. Wind Loads

The CWS MWIS structure is a site-specific structure and is designed for site-specific wind loads. The site-specific wind parameters (i.e. basic wind speed, 100-year recurrence interval wind speed) and applicable codes and guidelines (e.g., importance factor of 1.15) for the determination of site specific wind loads were included in COLA FSAR Section 3.3.1.

e. Extreme Wind Loads (Hurricanes and Tornadoes)

Hurricane and tornado loads for the analysis and design of CWS MWIS are in accordance with COLA FSAR Section 3.3.2. Design basis tornado characteristics and tornado missile parameters are in accordance with NRC RG 1.76, Revision 1. Design basis hurricane characteristics and hurricane missile parameters are in accordance with NRC RG 1.221, Revision 0 (NRC, 2011). Hurricane and tornado wind loads are converted to wind pressure loads according to SEI/ASCE 7-05 guidelines.

f. Load Combinations

Load combinations for the analysis and design of the CWS MWIS are consistent with those used for the analysis and design of Seismic Category I structures, as described in COLA FSAR Section 3.8.4.3.2, which incorporates the U.S. EPR FSAR Section 3.8.4.3.2 by reference.

4. Analysis Procedures

Finite element methods are utilized to analyze the CWS MWIS for applicable loads and load combinations. For seismic loads, the CWS MWIS structure is designed to maintain a margin of safety equivalent to that of Seismic Category I structures. The margin of safety equivalent to that of Seismic Category I structures is achieved by analyzing and designing the CWS MWIS to the same requirements as a Seismic Category I structure.

5. Materials

Concrete and reinforcing steel materials for the CWS MWIS conform to those for site-specific Seismic Category I structures which are discussed in COLA FSAR Section 3E.4.2. The concrete used for the CWS MWIS has a minimum design compressive strength of 5000 psi.

6. Acceptance Criteria

Since the CWS MWIS is designed to the same requirements as the Seismic Category I structures, the structural acceptance criteria for the CWS MWIS is identical to those for Seismic Category I structures, which are outlined in COLA FSAR Section 3.8.4.5, which incorporates the U.S. EPR FSAR Section 3.8.4.5 by reference.

The elastic displacements of the CWS MWIS are computed using finite element analysis methods.

The Seismic Category II Circulating Water Makeup Intake Structure is situated between the Seismic Category I Buried Intake Pipes. 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. 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 Circulating Water Makeup Intake Structure above ground steel structure is designed to the same requirements as a Seismic Category I structure. Therefore, its design methodology meets SRP Section 3.7.2 Acceptance Criterion 8.C.

3.7.2.8.6.5 Conventional Seismic Sheet Pile Wall and Existing Baffle Wall

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 layout of the Sheet Pile Wall and the separation distance between the Sheet Pile Wall and the Seismic Category I Buried Intake Pipes precludes any potential interaction between the Sheet Pile Wall and 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. The Conventional Seismic Unit 3 Sheet Pile Wall and the Baffle Wall are both Conventional Seismic structures which meet SRP Section 3.7.2 Acceptance Criterion 8.A. SRP Section 3.7.2 Acceptance Criterion 8.A is only applicable to Conventional Seismic structures. The SRP Section 3.7.2 Acceptance Criterion 8.A is not applicable to a Conventional Seismic-I (CS-I) structure. CS-I is the designation of Conventional Seismic for an SSC which must remain functional during and after an SSE.

3.7.2.9 Effects of Parameter Variations on Floor Response Spectra

No departures or supplements.

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

3.7.2.11.1 Nuclear Island Common Basemat Structures

No departures or supplements.

3.7.2.11.2 EPGB and ESWB

No departures or supplements.

3.7.2.11.3 Common Basemat Intake Structures

For the CBIS, both inherent and accidental torsional effects are accounted for in the seismic design. The inherent torsion effects are built into the 3D FEM used for the SSI analysis.

The seismic inertia force at each story level is calculated using the maximum absolute structural accelerations in each horizontal direction, provided in Table 3.7-8, 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

The methodology for CCNPP Unit 3 structures is discussed in the following sections

3.7.2.14.1 Nuclear Island Common Basemat Structures

The seismic stability of the embedded NI foundation was analyzed using linear static analysis procedures, where foundation demand was compared to the foundation capacity to determine the factors of safety (FOS) against overturning, flotation, and sliding. Factors of safety are determined based on the ratio between capacity and demand; In addition, the percentage foundation uplift and maximum foundation bearing pressures were also determined. Bearing pressures were compared to both the established design parameters and the CCNPP unit 3 site specific bearing capacity.

Peak structural inertia force and moment demands are obtained from the site specific SASSI SSI analysis described in FSAR Section 3.7.2. Resistance (capacity) is obtained from the static soil forces acting on the embedded sidewalls and basemat. While the SSI calculations are time-dependent, stability calculations are done in ANSYS using time history methods. Analysis is done of the equilibrium of dynamic demand and static capacity boundary forces on the structure.

The SSI analysis is done for the lower bound (LB), best estimate (BE) and upper bound (UB) soil cases with both cracked and uncracked concrete properties. A comparison of the seismic inertia demands on the structure from the SSI analysis show that the UB soil cases govern. Therefore, the stability analysis only considered the UB cases.

The percentage of basemat area uplift and maximum bearing pressure are determined using linear elastic relationships.

The buildings and mathematical models used for the CCNPP Unit 3 stability analysis are the NI standard design described in the U.S. EPR FSAR. Because the engineering and stability characteristics of the NI are known from the U.S. EPR Design Certification analyses, a simplified conservative approach was used to evaluate and verify the site specific foundation stability.

The coefficient of friction used for the validation was μ=0.47.This is the lowest coefficient of friction beneath the structures and occurs between the Structural Fill and the Stratum IIb soil (See FSAR Table 3.8-1).

Static Bearing Pressure is obtained from dividing the dead load of the structure by the area of the foundation.

The foundation dynamic bearing pressures are assumed to have a linear distribution since they are well conformed in rectangular shape and relatively rigid, thick slabs. At each time step, the maximum (pmax) and minimum (pmin) foundation soil pressures are calculated by satisfying the equilibrium of resultant vertical forces and overturning and stabilizing moments acting on the foundation through an iterative procedure. The net vertical force is the sum of dead and live loads and downward inertia forces. The calculated foundation bearing pressures consider the effects of biaxial bending moments.

The maximum bearing pressure is calculated using equation:

$$P/A \pm M\ C/I$$

where:

P= Net vertical load

A= Bearing area of the basemat

M= Net bending moment at the center of gravity of the basemat

C= Distance from the basemat center of gravity to the basemat edge

I= Moment of inertia about the basemat center of gravity

The resulting factors of safety for overturning, sliding, and flotation are greater than 1.1. Static and dynamic bearing pressures are less than the established CCNPP Unit 3 soil capacity. The results of these evaluations are discussed in Section 3.8.5.5.1.

3.7.2.14.2 EPGB and ESWB

The same approach as described for the Nuclear Island Common Basemat Structures is used for the EPGB and ESWB, with two notable exceptions:

- Both high and low water levels in the ESWB pools are considered.
- Horizontal friction forces are applied to the EPGB shear keys for the sliding stability analysis

The resulting factors of safety for overturning, sliding, and flotation are greater than 1.1. Static and dynamic bearing pressures are less than the established CCNPP Unit 3 soil capacity. The results of these evaluations are discussed in Section 3.8.5.5.2.

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-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 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. These responses include the effects of seismic forces, dynamic lateral earth pressures, and hydrodynamic forces.

The resultant stabilizing stresses are obtained from PLAXIS 3D analysis of the CBIS. PLAXIS 3D analysis considers the self weight of the intake structure, static backfill loads within the structure, 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. The 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 summation of the stresses in that direction due to earthquake in each direction.

iii. The response time history of total sliding shear stress is calculated at all nodes for each soil profile for both horizontal (X and Y) directions. The sliding shear stress in each horizontal direction is multiplied by the nodal tributary area to get the nodal sliding shear force. The sliding shear forces from all nodes are summed to get the total sliding shear in the X and Y directions. The total sliding shear force is then obtained as the square root of the sum of the squares of the sliding shear forces in the X and Y directions.

iv. Evaluation of the seismic stability for sliding/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 forces/moments of the CBIS to the corresponding seismically induced forces/moments.

v. For each soil profile, seismic stability is assessed for two set of properties for the concrete: one considering all the elements uncracked with OBE damping (4 percent for concrete and 3 percent for steel) and the other with all the elements cracked with SSE damping (7 percent for concrete and 4 percent for steel).

vi. Two sets of friction coefficients are checked during the stability analysis. Basemat-Mudmat Interface: $\tan\varphi = 0.6$ and adhesion = 0; Mudmat-Chesapeake Clay/Silt Layer Interface: $\tan\varphi = 0.21$ and adhesion = 1.2 ksf.

vii. The resisting shear stress τ at each node at each time step is obtained by calculating the net restoring vertical stress σ_v (total vertical stress including water weight inside the structure and buoyancy under the CBIS) at each node at each time step and using $\tau = \sigma_v \tan\varphi + c$, where φ = friction angle, and c = adhesion component. The resisting shear stress at each node is multiplied with the nodal tributary area to get the resisting nodal shear force. Finally, all resisting shear forces from all nodes are summed across the CBIS basemat. If the vertical stress at a given node is tensile, no contribution is considered to the resisting shear force from that node.

Only seismic active earth pressures are considered in the seismic stability analysis. Seismic active earth pressures are calculated according to the Mononobe-Okabe method (Kramer, 1996). Not considering the passive earth pressures is conservative in the seismic stability analysis. Also not considered is the side friction for all cases except for the maintenance condition stability check. The stability analysis of the maintenance condition is conducted assuming no water within the CBIS. This is somehow conservative, since even during such maintenance condition, there will be water in some portions of the CBIS that still contribute to the weight and the overall sliding stability. To avoid the incorporation of excessive conservatism, a minor fraction of the side friction is introduced into the stability analysis for the maintenance condition. Static active earth pressures are considered as the normal forces and the friction coefficient is considered as 0.58 to calculate the side friction. Only 5% of the overall side friction is considered in the seismic sliding analysis of the CBIS for maintenance condition.

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

3.7.2.15.1 Nuclear Island Common Basemat Structures

No departures or supplements.

3.7.2.15.2 EPGB and ESWB

No departures or supplements.

3.7.2.15.3 Common Basemat Intake Structures

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.

The structure and soil damping used in the SSI analysis of site specific Turbine Island Structure is described in Section 3.7.1.2.

3.7.2.16 References

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

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

ANSI/AISC, 2004. Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities, 1994 including Supplement 2, ANSI/AISC N690, American National Standards Institute, 2004.

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.

Kramer, S.L., (1996). Geotechnical Earthquake Engineering, Prentice Hall, Upper Saddle River, New Jersey.

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.

NRC, 2011. Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants Regulatory Guide 1.221, Revision 0, U.S. Nuclear Regulatory Commission, October 2011.}

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 Non-Seismic Category I Subsystems

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 and Conduits

{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)/ Seismic Response of Buried Pipes and Structural Components Report, (ASCE, 1983) and ACI 349/ 349R-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, Seismic Category II buried pipes and Conventional Seismic, designated as CS-I 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) and Seismic Response of Buried Pipes and Structural Components Report, (ASCE, 1983):

- ♦ 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) and Seismic Response of Buried Pipes and Structural Components Report, (ASCE, 1983). These equations reflect seismic wave propagation and are used to determine the corresponding maximum axial and bending strains. The procedure combines strains from compression, shear and surface waves by the square root of the sum of the squares (SRSS) method. Axial and bending stresses are calculated from strains using the material's modulus of elasticity. 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) and Seismic Response of Buried Pipes and Structural Components Report, (ASCE, 1983).}

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 349/349-R01, American Concrete Institute, 2001.

ASCE, 1983. Seismic Response of Buried Pipes and Structural Components Report by the Seismic Analysis Committee of the ASCE Nuclear Structures and Materials, 1983.

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 a location for the free-field acceleration sensor 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:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall determine the location for the free-field acceleration sensor in accordance with the guidance provided in Regulatory Guide 1.12 prior to fuel load. 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}

Frequency (Hz)	Spectral Acceleration Horizontal (g)	Spectral Acceleration Vertical (g)
0.1	7.82E-03	5.86E-03
0.125	1.31E-02	9.82E-03
0.15	2.15E-02	1.61E-02
0.2	4.85E-02	3.63E-02
0.3	6.81E-02	5.10E-02
0.4	8.33E-02	6.25E-02
0.5	1.49E-01	1.12E-01
0.6	2.06E-01	1.55E-01
0.7	2.21E-01	1.66E-01
0.8	2.17E-01	1.63E-01
0.9	2.26E-01	1.70E-01
1	2.35E-01	1.79E-01
1.25	2.54E-01	2.23E-01
1.5	2.70E-01	2.68E-01
2	3.57E-01	3.57E-01
2.5	4.46E-01	4.46E-01
3	4.50E-01	4.50E-01
4	4.50E-01	4.50E-01
5	4.50E-01	4.50E-01
6	4.50E-01	4.50E-01
7	4.50E-01	4.50E-01
8	4.48E-01	4.48E-01
9	4.11E-01	4.11E-01
10	3.79E-01	3.79E-01
12.5	3.18E-01	3.18E-01
15	2.76E-01	2.76E-01
20	2.21E-01	2.21E-01
25	1.86E-01	1.86E-01
30	1.62E-01	1.62E-01
35	1.50E-01	1.50E-01
40	1.50E-01	1.50E-01
45	1.50E-01	1.50E-01
50	1.50E-01	1.50E-01
60	1.50E-01	1.50E-01
70	1.50E-01	1.50E-01
80	1.50E-01	1.50E-01
90	1.50E-01	1.50E-01
100	1.50E-01	1.50E-01

Table 3.7-2a — {NI/NAB/AB Soil Layer Upper Bound Thicknesses and Properties}
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Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	1.675	22.79	250.41	521.26	0.0159	0.0159	0.35	1.675
2	1.675	22.79	251.35	523.23	0.0269	0.0269	0.35	3.350
3	1.400	22.79	258.29	537.67	0.0342	0.0342	0.35	4.750
4	1.400	22.79	267.59	557.03	0.0386	0.0386	0.35	6.150
5	1.600	22.79	276.60	575.78	0.0395	0.0395	0.35	7.750
6	1.600	22.79	288.06	709.31	0.0408	0.0408	0.40	9.350
7	1.125	22.79	293.72	1463.04	0.0437	0.0437	0.48	10.475
8	1.125	22.79	297.15	1463.04	0.0454	0.0454	0.48	11.600
9	1.290	22.79	304.98	1463.04	0.0467	0.0467	0.48	12.890
10	1.400	22.79	308.37	1463.04	0.0491	0.0491	0.48	14.290
11	1.500	20.55	474.38	1757.26	0.0299	0.0299	0.46	15.790
12	1.500	18.86	641.61	2127.98	0.0148	0.0148	0.45	17.290
13	0.998	18.86	724.60	2403.23	0.0145	0.0145	0.45	18.288
14	1.524	18.86	724.49	2402.85	0.0146	0.0146	0.45	19.812
15	1.524	18.86	724.36	2402.45	0.0146	0.0146	0.45	21.336
16	1.524	18.86	473.68	2415.32	0.0182	0.0182	0.48	22.860
17	1.524	18.86	472.97	2411.68	0.0183	0.0183	0.48	24.384
18	1.524	18.86	495.87	2528.43	0.0182	0.0182	0.48	25.908
19	1.524	18.86	724.17	2401.80	0.0144	0.0144	0.45	27.432
20	1.524	18.86	717.75	2380.52	0.0147	0.0147	0.45	28.956
21	1.524	18.56	698.04	2315.12	0.0139	0.0139	0.45	30.480
22	1.524	16.69	487.63	2049.60	0.0109	0.0109	0.47	32.004
23	1.524	16.50	474.29	1993.54	0.0110	0.0110	0.47	33.528
24	2.134	16.50	474.05	1992.50	0.0111	0.0111	0.47	35.662
25	2.438	16.50	473.77	1991.35	0.0111	0.0111	0.47	38.100
26	3.048	16.50	473.47	1990.06	0.0111	0.0111	0.47	41.148
27	3.048	16.50	472.63	1986.56	0.0111	0.0111	0.47	44.196
28	3.048	16.50	472.54	1986.18	0.0111	0.0111	0.47	47.244
29	3.048	16.50	471.38	1981.31	0.0112	0.0112	0.47	50.292
30	3.048	16.50	471.13	1980.24	0.0112	0.0112	0.47	53.340
31	3.048	16.50	470.75	1978.64	0.0113	0.0113	0.47	56.388
32	3.048	16.50	473.49	1990.15	0.0114	0.0114	0.47	59.436
33	3.048	16.50	471.44	1981.53	0.0115	0.0115	0.47	62.484
34	3.048	16.50	470.59	1977.98	0.0116	0.0116	0.47	65.532
35	3.048	16.50	470.20	1976.35	0.0117	0.0117	0.47	68.580

Table 3.7-2a — {NI/NAB/AB Soil Layer Upper Bound Thicknesses and Properties}

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Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
36	3.048	16.50	469.88	1974.98	0.0118	0.0118	0.47	71.628
37	3.048	16.50	470.80	1978.85	0.0119	0.0119	0.47	74.676
38	2.438	16.50	469.18	1972.06	0.0118	0.0118	0.47	77.114
39	2.134	16.50	468.71	1970.09	0.0116	0.0116	0.47	79.248
40	1.524	16.50	469.70	1974.23	0.0114	0.0114	0.47	80.772
41	1.524	16.69	481.66	2024.52	0.0114	0.0114	0.47	82.296
42	1.524	16.85	489.47	2057.31	0.0114	0.0114	0.47	83.820
43	1.524	17.24	500.19	2102.37	0.0117	0.0117	0.47	85.344
44	1.524	17.90	529.60	2225.99	0.0124	0.0124	0.47	86.868
45	1.524	18.48	602.57	1998.49	0.0139	0.0139	0.45	88.392
46	1.524	18.92	624.44	2071.03	0.0149	0.0149	0.45	89.916
47	1.524	19.14	639.05	2119.48	0.0156	0.0156	0.45	91.440
48	1.524	19.36	693.56	2300.28	0.0166	0.0166	0.45	92.964
49	1.524	19.54	748.65	2015.79	0.0170	0.0170	0.42	94.488
50	1.524	19.65	745.23	2006.60	0.0175	0.0175	0.42	96.012
51	1.524	19.65	745.87	2128.40	0.0179	0.0179	0.43	97.536
52	1.524	19.65	742.62	2119.11	0.0184	0.0184	0.43	99.060
53	1.524	19.65	748.67	2136.39	0.0180	0.0180	0.43	100.584
54	1.524	19.65	746.42	2129.95	0.0182	0.0182	0.43	102.108
55	1.524	19.65	734.36	2095.55	0.0185	0.0185	0.43	103.632
56	1.524	19.65	729.17	2080.75	0.0186	0.0186	0.43	105.156
57	1.524	19.65	721.55	2058.98	0.0190	0.0190	0.43	106.680
58	1.524	19.65	716.60	2044.88	0.0191	0.0191	0.43	108.204
59	1.524	19.65	707.09	2160.18	0.0192	0.0192	0.44	109.728
60	1.524	19.65	693.34	2118.18	0.0193	0.0193	0.44	111.252
61	1.524	19.65	687.62	2100.73	0.0198	0.0198	0.44	112.776
62	1.829	19.65	683.40	2087.83	0.0202	0.0202	0.44	114.605
63	1.829	19.62	683.77	2088.96	0.0205	0.0205	0.44	116.434
64	1.524	19.51	688.70	2104.01	0.0202	0.0202	0.44	117.958
65	1.524	19.43	696.03	2126.42	0.0200	0.0200	0.44	119.482
66	1.524	19.16	712.25	2175.97	0.0196	0.0196	0.44	121.006
67	1.524	18.85	729.17	2227.65	0.0197	0.0197	0.44	122.530
68	1.524	18.66	742.63	1819.07	0.0195	0.0195	0.40	124.054
69	2.438	18.41	760.07	1861.79	0.0191	0.0191	0.40	126.492
70	3.048	18.23	775.19	1898.83	0.0193	0.0193	0.40	129.540

Table 3.7-2a — {NI/NAB/AB Soil Layer Upper Bound Thicknesses and Properties}
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Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
71	3.048	18.11	782.09	1915.73	0.0189	0.0189	0.40	132.588
72	3.048	18.08	783.60	1919.42	0.0188	0.0188	0.40	135.636
73	3.048	18.08	783.02	1918.01	0.0190	0.0190	0.40	138.684
74	3.048	18.08	783.02	1918.01	0.0190	0.0190	0.40	141.732
75	3.048	18.08	782.31	1916.26	0.0190	0.0190	0.40	144.780
76	3.048	18.08	782.31	1916.26	0.0190	0.0190	0.40	147.828
77	3.048	18.08	781.52	1914.33	0.0191	0.0191	0.40	150.876
78	3.048	18.08	781.52	1914.33	0.0191	0.0191	0.40	153.924
79	3.048	18.08	781.52	1914.33	0.0191	0.0191	0.40	156.972
80	3.048	18.08	780.65	1912.18	0.0191	0.0191	0.40	160.020
81	3.048	18.08	780.65	1912.18	0.0191	0.0191	0.40	163.068
82	3.048	18.08	780.65	1912.18	0.0191	0.0191	0.40	166.116
83	3.048	18.08	779.68	1909.83	0.0192	0.0192	0.40	169.164
84	3.048	18.08	779.68	1909.83	0.0192	0.0192	0.40	172.212
85	3.048	18.08	779.68	1909.83	0.0192	0.0192	0.40	175.260
86	3.048	18.08	779.68	1909.83	0.0192	0.0192	0.40	178.308
87	3.048	18.08	778.68	1907.36	0.0194	0.0194	0.40	181.356
88	3.048	18.08	778.68	1907.36	0.0194	0.0194	0.40	184.404
89	3.048	18.08	778.68	1907.36	0.0194	0.0194	0.40	187.452
90	3.048	18.08	778.68	1907.36	0.0194	0.0194	0.40	190.500
91	3.048	18.08	777.65	1904.86	0.0196	0.0196	0.40	193.548
92	3.048	18.08	777.65	1904.86	0.0196	0.0196	0.40	196.596
93	3.048	18.08	777.65	1904.86	0.0196	0.0196	0.40	199.644
94	3.048	18.08	777.65	1904.86	0.0196	0.0196	0.40	202.692
95	3.048	18.08	777.65	1904.86	0.0196	0.0196	0.40	205.740
Uniform Half-Space		18.08	871.60	2134.98	0.0196	0.0196	0.40	-

Table 3.7-2b — {NI/NAB/AB Soil Layer Lower Bound Thicknesses and Properties}
(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	1.675	22.79	167.30	348.26	0.0393	0.0393	0.35	1.675
2	1.675	22.79	139.68	290.77	0.0717	0.0717	0.35	3.350
3	1.400	22.79	126.83	264.02	0.0904	0.0904	0.35	4.750
4	1.400	22.79	122.84	255.71	0.1019	0.1019	0.35	6.150
5	1.600	22.79	121.19	252.28	0.1095	0.1095	0.35	7.750
6	1.600	22.79	125.11	309.35	0.1137	0.1137	0.40	9.350
7	1.125	22.79	125.10	637.90	0.1165	0.1165	0.48	10.475
8	1.125	22.79	124.45	634.60	0.1179	0.1179	0.48	11.600
9	1.290	22.79	122.31	623.66	0.1212	0.1212	0.48	12.890
10	1.400	22.79	118.85	605.99	0.1249	0.1249	0.48	14.290
11	1.500	22.79	116.18	592.41	0.1282	0.1282	0.48	15.790
12	1.500	22.79	116.80	595.57	0.1308	0.1308	0.48	17.290
13	0.693	22.79	118.24	602.92	0.1325	0.1325	0.48	17.983
14	1.524	18.86	371.33	1463.04	0.0263	0.0263	0.47	19.507
15	1.829	18.86	370.38	1463.04	0.0267	0.0267	0.47	21.336
16	1.524	18.86	211.46	1078.26	0.0412	0.0412	0.48	22.860
17	1.524	18.86	210.36	1072.65	0.0421	0.0421	0.48	24.384
18	1.524	18.86	211.12	1076.52	0.0426	0.0426	0.48	25.908
19	1.524	18.86	330.95	1463.04	0.0294	0.0294	0.47	27.432
20	1.524	18.86	348.94	1463.04	0.0283	0.0283	0.47	28.956
21	1.524	18.48	337.33	1463.04	0.0274	0.0274	0.47	30.480
22	1.524	16.54	302.74	1463.04	0.0160	0.0160	0.48	32.004
23	1.524	16.50	300.01	1463.04	0.0164	0.0164	0.48	33.528
24	2.134	16.50	299.81	1463.04	0.0166	0.0166	0.48	35.662
25	2.438	16.50	299.58	1463.04	0.0166	0.0166	0.48	38.100
26	3.048	16.50	299.34	1463.04	0.0167	0.0167	0.48	41.148
27	3.048	16.50	297.87	1463.04	0.0167	0.0167	0.48	44.196
28	3.048	16.50	297.16	1463.04	0.0159	0.0159	0.48	47.244
29	3.048	16.50	296.93	1463.04	0.0165	0.0165	0.48	50.292
30	3.048	16.50	296.67	1463.04	0.0166	0.0166	0.48	53.340
31	3.048	16.50	296.40	1463.04	0.0168	0.0168	0.48	56.388
32	3.048	16.50	295.93	1463.04	0.0170	0.0170	0.48	59.436
33	3.048	16.50	296.26	1463.04	0.0182	0.0182	0.48	62.484
34	3.048	16.50	297.26	1463.04	0.0181	0.0181	0.48	65.532
35	3.048	16.50	297.01	1463.04	0.0183	0.0183	0.48	68.580

Table 3.7-2b — {NI/NAB/AB Soil Layer Lower Bound Thicknesses and Properties}
(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
36	3.048	16.50	296.76	1463.04	0.0184	0.0184	0.48	71.628
37	3.048	16.50	297.02	1463.04	0.0183	0.0183	0.48	74.676
38	2.438	16.50	296.41	1463.04	0.0180	0.0180	0.48	77.114
39	2.134	16.50	296.78	1463.04	0.0182	0.0182	0.48	79.248
40	1.524	16.50	296.30	1463.04	0.0183	0.0183	0.48	80.772
41	1.524	16.50	296.19	1463.04	0.0185	0.0185	0.48	82.296
42	1.524	16.74	304.72	1463.04	0.0197	0.0197	0.48	83.820
43	1.524	17.09	318.26	1463.04	0.0213	0.0213	0.48	85.344
44	1.524	17.70	327.15	1463.04	0.0246	0.0246	0.47	86.868
45	1.524	18.26	342.40	1463.04	0.0265	0.0265	0.47	88.392
46	1.524	18.92	369.62	1463.04	0.0281	0.0281	0.47	89.916
47	1.524	19.36	401.79	1463.04	0.0283	0.0283	0.46	91.440
48	1.524	19.58	445.00	1475.91	0.0277	0.0277	0.45	92.964
49	1.524	19.65	471.70	1463.04	0.0271	0.0271	0.44	94.488
50	1.524	19.65	490.08	1463.04	0.0267	0.0267	0.44	96.012
51	1.524	19.65	504.05	1463.04	0.0258	0.0258	0.43	97.536
52	1.524	19.65	498.72	1463.04	0.0258	0.0258	0.43	99.060
53	1.524	19.65	491.97	1463.04	0.0263	0.0263	0.44	100.584
54	1.524	19.65	488.54	1463.04	0.0264	0.0264	0.44	102.108
55	1.524	19.65	482.68	1463.04	0.0268	0.0268	0.44	103.632
56	1.524	19.65	481.31	1463.04	0.0269	0.0269	0.44	105.156
57	1.524	19.65	481.18	1463.04	0.0264	0.0264	0.44	106.680
58	1.524	19.65	473.79	1463.04	0.0267	0.0267	0.44	108.204
59	1.524	19.65	467.66	1463.04	0.0271	0.0271	0.44	109.728
60	1.524	19.65	460.82	1463.04	0.0272	0.0272	0.44	111.252
61	1.524	19.65	457.26	1463.04	0.0274	0.0274	0.45	112.776
62	1.829	19.65	457.30	1463.04	0.0274	0.0274	0.45	114.605
63	1.829	19.65	455.88	1463.04	0.0274	0.0274	0.45	116.434
64	1.524	19.62	455.99	1463.04	0.0273	0.0273	0.45	117.958
65	1.524	19.46	463.29	1463.04	0.0271	0.0271	0.44	119.482
66	1.524	19.32	468.78	1463.04	0.0272	0.0272	0.44	121.006
67	1.524	18.96	482.64	1474.50	0.0267	0.0267	0.44	122.530
68	1.524	18.64	490.72	1463.04	0.0274	0.0274	0.44	124.054
69	2.438	18.30	505.82	1463.04	0.0272	0.0272	0.43	126.492
70	3.048	18.12	511.30	1463.04	0.0271	0.0271	0.43	129.540

Table 3.7-2b — {NI/NAB/AB Soil Layer Lower Bound Thicknesses and Properties}
(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
71	3.048	18.08	513.20	1463.04	0.0273	0.0273	0.43	132.588
72	3.048	18.08	512.94	1463.04	0.0273	0.0273	0.43	135.636
73	3.048	18.08	512.58	1463.04	0.0275	0.0275	0.43	138.684
74	3.048	18.08	512.58	1463.04	0.0275	0.0275	0.43	141.732
75	3.048	18.08	512.13	1463.04	0.0279	0.0279	0.43	144.780
76	3.048	18.08	512.13	1463.04	0.0279	0.0279	0.43	147.828
77	4.572	18.08	511.61	1463.04	0.0279	0.0279	0.43	152.400
78	4.572	18.08	511.61	1463.04	0.0279	0.0279	0.43	156.972
79	4.572	18.08	511.03	1463.04	0.0282	0.0282	0.43	161.544
80	4.572	18.08	511.03	1463.04	0.0282	0.0282	0.43	166.116
81	4.064	18.08	510.41	1463.04	0.0286	0.0286	0.43	170.180
82	4.064	18.08	510.41	1463.04	0.0286	0.0286	0.43	174.244
83	4.064	18.08	510.41	1463.04	0.0286	0.0286	0.43	178.308
84	4.064	18.08	509.76	1463.04	0.0288	0.0288	0.43	182.372
85	4.064	18.08	509.76	1463.04	0.0288	0.0288	0.43	186.436
86	4.064	18.08	509.76	1463.04	0.0288	0.0288	0.43	190.500
87	5.080	18.08	509.09	1463.04	0.0291	0.0291	0.43	195.580
88	5.080	18.08	509.09	1463.04	0.0291	0.0291	0.43	200.660
89	5.080	18.08	509.09	1463.04	0.0291	0.0291	0.43	205.740
Uniform Half-space		18.08	573.60	1495.53	0.0281	0.0281	0.41	-

Table 3.7-2c — {NI/NAB/AB Soil Layer Best Estimate Thicknesses and Properties}
(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	1.675	22.79	212.25	441.83	0.0245	0.0245	0.35	1.675
2	1.675	22.79	198.10	412.37	0.0408	0.0408	0.35	3.350
3	1.400	22.79	194.02	403.89	0.0510	0.0510	0.35	4.750
4	1.400	22.79	193.13	402.03	0.0582	0.0582	0.35	6.150
5	1.600	22.79	191.16	397.93	0.0631	0.0631	0.35	7.750
6	1.600	22.79	196.39	485.70	0.0662	0.0662	0.40	9.350
7	1.125	22.79	198.35	1011.38	0.0690	0.0690	0.48	10.475
8	1.125	22.79	199.15	1015.48	0.0709	0.0709	0.48	11.600
9	1.290	22.79	198.33	1011.31	0.0731	0.0731	0.48	12.890
10	1.400	22.79	196.98	1004.38	0.0757	0.0757	0.48	14.290
11	1.500	22.79	196.52	1002.06	0.0774	0.0774	0.48	15.790
12	1.500	20.61	375.99	1404.13	0.0459	0.0459	0.46	17.290
13	0.998	18.86	519.72	1723.71	0.0195	0.0195	0.45	18.288
14	1.524	18.86	519.09	1721.63	0.0197	0.0197	0.45	19.812
15	1.524	18.86	518.45	1719.49	0.0199	0.0199	0.45	21.336
16	1.524	18.86	330.78	1686.66	0.0266	0.0266	0.48	22.860
17	1.524	18.86	329.77	1681.52	0.0269	0.0269	0.48	24.384
18	1.524	18.86	337.36	1720.19	0.0269	0.0269	0.48	25.908
19	1.524	18.86	511.30	1695.80	0.0202	0.0202	0.45	27.432
20	1.524	18.86	517.25	1715.53	0.0202	0.0202	0.45	28.956
21	1.524	18.56	497.34	1649.50	0.0192	0.0192	0.45	30.480
22	1.524	16.69	392.03	1647.79	0.0135	0.0135	0.47	32.004
23	1.524	16.50	387.26	1627.72	0.0129	0.0129	0.47	33.528
24	2.134	16.50	387.06	1626.87	0.0131	0.0131	0.47	35.662
25	2.438	16.50	386.83	1625.93	0.0131	0.0131	0.47	38.100
26	3.048	16.50	386.58	1624.88	0.0132	0.0132	0.47	41.148
27	3.048	16.50	385.90	1622.02	0.0129	0.0129	0.47	44.196
28	3.048	16.50	385.83	1621.71	0.0132	0.0132	0.47	47.244
29	3.048	16.50	384.88	1617.73	0.0135	0.0135	0.47	50.292
30	3.048	16.50	384.68	1616.86	0.0135	0.0135	0.47	53.340
31	3.048	16.50	384.37	1615.56	0.0136	0.0136	0.47	56.388
32	3.048	16.50	386.60	1624.95	0.0139	0.0139	0.47	59.436
33	3.048	16.50	384.93	1617.92	0.0139	0.0139	0.47	62.484
34	3.048	16.50	384.24	1615.01	0.0142	0.0142	0.47	65.532
35	3.048	16.50	383.92	1613.68	0.0143	0.0143	0.47	68.580

Table 3.7-2c — {NI/NAB/AB Soil Layer Best Estimate Thicknesses and Properties}

(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
36	3.048	16.50	383.65	1612.56	0.0145	0.0145	0.47	71.628
37	3.048	16.50	384.41	1615.73	0.0143	0.0143	0.47	74.676
38	2.438	16.50	383.09	1610.18	0.0145	0.0145	0.47	77.114
39	2.134	16.50	382.70	1608.57	0.0144	0.0144	0.47	79.248
40	1.524	16.50	383.51	1611.95	0.0142	0.0142	0.47	80.772
41	1.524	16.69	393.28	1653.01	0.0147	0.0147	0.47	82.296
42	1.524	16.85	399.65	1679.78	0.0150	0.0150	0.47	83.820
43	1.524	17.24	407.78	1713.96	0.0164	0.0164	0.47	85.344
44	1.524	17.90	432.35	1817.25	0.0179	0.0179	0.47	86.868
45	1.524	18.48	469.45	1556.98	0.0195	0.0195	0.45	88.392
46	1.524	18.92	493.62	1637.16	0.0204	0.0204	0.45	89.916
47	1.524	19.14	503.83	1671.01	0.0212	0.0212	0.45	91.440
48	1.524	19.36	553.09	1834.38	0.0211	0.0211	0.45	92.964
49	1.524	19.54	598.21	1610.74	0.0207	0.0207	0.42	94.488
50	1.524	19.65	606.52	1633.11	0.0214	0.0214	0.42	96.012
51	1.524	19.65	609.00	1737.83	0.0215	0.0215	0.43	97.536
52	1.524	19.65	606.34	1730.24	0.0217	0.0217	0.43	99.060
53	1.524	19.65	611.29	1744.36	0.0215	0.0215	0.43	100.584
54	1.524	19.65	609.45	1739.10	0.0217	0.0217	0.43	102.108
55	1.524	19.65	599.60	1711.01	0.0220	0.0220	0.43	103.632
56	1.524	19.65	595.37	1698.92	0.0223	0.0223	0.43	105.156
57	1.524	19.65	589.14	1681.15	0.0227	0.0227	0.43	106.680
58	1.524	19.65	585.11	1669.64	0.0230	0.0230	0.43	108.204
59	1.524	19.65	577.33	1763.78	0.0233	0.0233	0.44	109.728
60	1.524	19.65	566.11	1729.48	0.0236	0.0236	0.44	111.252
61	1.524	19.65	561.44	1715.24	0.0240	0.0240	0.44	112.776
62	1.829	19.65	558.00	1704.71	0.0243	0.0243	0.44	114.605
63	1.829	19.62	558.30	1705.63	0.0245	0.0245	0.44	116.434
64	1.524	19.51	562.32	1717.92	0.0244	0.0244	0.44	117.958
65	1.524	19.43	568.31	1736.21	0.0242	0.0242	0.44	119.482
66	1.524	19.16	581.55	1776.67	0.0235	0.0235	0.44	121.006
67	1.524	18.85	595.37	1818.87	0.0233	0.0233	0.44	122.530
68	1.524	18.66	606.36	1485.26	0.0230	0.0230	0.40	124.054
69	2.438	18.41	620.60	1520.15	0.0226	0.0226	0.40	126.492
70	3.048	18.23	632.94	1550.39	0.0226	0.0226	0.40	129.540

Table 3.7-2c — {NI/NAB/AB Soil Layer Best Estimate Thicknesses and Properties}
(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
71	3.048	18.11	638.58	1564.19	0.0224	0.0224	0.40	132.588
72	3.048	18.08	639.81	1567.20	0.0224	0.0224	0.40	135.636
73	3.048	18.08	639.34	1566.05	0.0226	0.0226	0.40	138.684
74	3.048	18.08	639.34	1566.05	0.0226	0.0226	0.40	141.732
75	3.048	18.08	638.75	1564.62	0.0227	0.0227	0.40	144.780
76	3.048	18.08	638.75	1564.62	0.0227	0.0227	0.40	147.828
77	4.572	18.08	638.11	1563.04	0.0228	0.0228	0.40	152.400
78	4.572	18.08	638.11	1563.04	0.0228	0.0228	0.40	156.972
79	4.572	18.08	637.39	1561.29	0.0230	0.0230	0.40	161.544
80	4.572	18.08	637.39	1561.29	0.0230	0.0230	0.40	166.116
81	4.064	18.08	636.61	1559.37	0.0231	0.0231	0.40	170.180
82	4.064	18.08	636.61	1559.37	0.0231	0.0231	0.40	174.244
83	4.064	18.08	636.61	1559.37	0.0231	0.0231	0.40	178.308
84	4.064	18.08	635.79	1557.35	0.0234	0.0234	0.40	182.372
85	4.064	18.08	635.79	1557.35	0.0234	0.0234	0.40	186.436
86	4.064	18.08	635.79	1557.35	0.0234	0.0234	0.40	190.500
87	3.810	18.08	634.95	1555.31	0.0236	0.0236	0.40	194.310
88	3.810	18.08	634.95	1555.31	0.0236	0.0236	0.40	198.120
89	3.810	18.08	634.95	1555.31	0.0236	0.0236	0.40	201.930
90	3.810	18.08	634.95	1555.31	0.0236	0.0236	0.40	205.740
Uniform Half-space		18.08	710.40	1740.11	0.0234	0.0234	0.40	-

Table 3.7-3a — {EPGB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}

(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.000	0.145	916.77	1908.40	0.0126	0.0126	0.35	2.000
2	3.000	0.145	925.38	1926.34	0.0151	0.0151	0.35	5.000
3	3.000	0.145	926.66	1928.99	0.0194	0.0194	0.35	8.000
4	3.000	0.145	934.75	1945.83	0.0231	0.0231	0.35	11.000
5	2.500	0.145	944.36	1965.84	0.0252	0.0252	0.35	13.500
6	2.000	0.145	986.03	2052.58	0.0288	0.0288	0.35	15.500
7	2.000	0.145	986.03	2052.58	0.0288	0.0288	0.35	17.500
8	2.250	0.145	1042.00	2169.10	0.0310	0.0310	0.35	19.750
9	2.250	0.145	1042.00	2169.10	0.0310	0.0310	0.35	22.000
10	2.000	0.145	1027.84	2139.61	0.0350	0.0350	0.35	24.000
11	2.000	0.145	1027.84	2139.61	0.0350	0.0350	0.35	26.000
12	2.000	0.145	1060.64	2207.90	0.0361	0.0361	0.35	28.000
13	2.000	0.145	1060.64	2207.90	0.0361	0.0361	0.35	30.000
14	3.000	0.145	1098.46	4800.00	0.0378	0.0378	0.47	33.000
15	1.000	0.145	1098.46	4800.00	0.0378	0.0378	0.47	34.000
16	2.000	0.145	1077.56	4800.00	0.0409	0.0409	0.47	36.000
17	2.000	0.145	1077.56	4800.00	0.0409	0.0409	0.47	38.000
18	3.500	0.145	1079.85	4800.00	0.0429	0.0429	0.47	41.500
19	2.000	0.145	1090.42	4800.00	0.0441	0.0441	0.47	43.500
20	3.500	0.120	1926.71	6390.19	0.0148	0.0148	0.45	47.000
21	4.000	0.120	1926.23	6388.57	0.0149	0.0149	0.45	51.000
22	4.000	0.120	1925.60	6386.50	0.0150	0.0150	0.45	55.000
23	5.000	0.120	2288.69	7590.71	0.0144	0.0144	0.45	60.000
24	5.000	0.120	2287.61	7587.13	0.0145	0.0145	0.45	65.000
25	5.000	0.120	2286.38	7583.06	0.0146	0.0146	0.45	70.000
26	5.000	0.120	1485.71	7575.66	0.0188	0.0188	0.48	75.000
27	5.000	0.120	1480.89	7551.11	0.0188	0.0188	0.48	80.000
28	5.000	0.120	1534.56	7824.73	0.0183	0.0183	0.48	85.000
29	5.000	0.120	2126.29	7052.10	0.0157	0.0157	0.45	90.000
30	5.000	0.120	2208.97	7326.32	0.0154	0.0154	0.45	95.000
31	5.000	0.119	2190.83	7266.15	0.0148	0.0148	0.45	100.000
32	5.000	0.107	1529.33	6428.04	0.0111	0.0111	0.47	105.000
33	5.000	0.105	1499.83	6304.07	0.0115	0.0115	0.47	110.000
34	3.500	0.105	1498.88	6300.06	0.0115	0.0115	0.47	113.500

Table 3.7-3a — {EPGB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}

(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	3.500	0.105	1498.88	6300.06	0.0115	0.0115	0.47	117.000
36	4.000	0.105	1497.80	6295.52	0.0116	0.0116	0.47	121.000
37	4.000	0.105	1497.80	6295.52	0.0116	0.0116	0.47	125.000
38	5.000	0.105	1496.62	6290.55	0.0116	0.0116	0.47	130.000
39	5.000	0.105	1496.62	6290.55	0.0116	0.0116	0.47	135.000
40	5.000	0.105	1499.19	6301.35	0.0118	0.0118	0.47	140.000
41	5.000	0.105	1499.19	6301.35	0.0118	0.0118	0.47	145.000
42	5.000	0.105	1499.59	6303.03	0.0115	0.0115	0.47	150.000
43	5.000	0.105	1499.59	6303.03	0.0115	0.0115	0.47	155.000
44	5.000	0.105	1492.24	6272.13	0.0114	0.0114	0.47	160.000
45	5.000	0.105	1492.24	6272.13	0.0114	0.0114	0.47	165.000
46	5.000	0.105	1491.55	6269.23	0.0114	0.0114	0.47	170.000
47	5.000	0.105	1491.55	6269.23	0.0114	0.0114	0.47	175.000
48	5.000	0.105	1490.29	6263.94	0.0115	0.0115	0.47	180.000
49	5.000	0.105	1490.29	6263.94	0.0115	0.0115	0.47	185.000
50	5.000	0.105	1483.08	6233.65	0.0114	0.0114	0.47	190.000
51	5.000	0.105	1483.08	6233.65	0.0114	0.0114	0.47	195.000
52	5.000	0.105	1463.88	6152.93	0.0117	0.0117	0.47	200.000
53	5.000	0.105	1463.88	6152.93	0.0117	0.0117	0.47	205.000
54	5.000	0.105	1457.87	6127.70	0.0116	0.0116	0.47	210.000
55	5.000	0.105	1457.87	6127.70	0.0116	0.0116	0.47	215.000
56	5.000	0.105	1455.49	6117.69	0.0118	0.0118	0.47	220.000
57	5.000	0.105	1455.49	6117.69	0.0118	0.0118	0.47	225.000
58	5.000	0.105	1454.14	6112.02	0.0118	0.0118	0.47	230.000
59	5.000	0.105	1454.14	6112.02	0.0118	0.0118	0.47	235.000
60	5.000	0.105	1448.83	6089.67	0.0119	0.0119	0.47	240.000
61	5.000	0.105	1448.83	6089.67	0.0119	0.0119	0.47	245.000
62	4.000	0.105	1444.06	6069.62	0.0118	0.0118	0.47	249.000
63	4.000	0.105	1444.06	6069.62	0.0118	0.0118	0.47	253.000
64	3.500	0.105	1456.47	6121.78	0.0119	0.0119	0.47	256.500
65	3.500	0.105	1456.47	6121.78	0.0119	0.0119	0.47	260.000
66	5.000	0.105	1459.76	6135.62	0.0120	0.0120	0.47	265.000
67	5.000	0.105	1472.28	6188.25	0.0119	0.0119	0.47	270.000
68	5.000	0.106	1485.96	6245.73	0.0118	0.0118	0.47	275.000

Table 3.7-3a — {EPGB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}

(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.108	1528.80	6425.82	0.0120	0.0120	0.47	280.000
70	5.000	0.112	1619.56	6807.30	0.0129	0.0129	0.47	285.000
71	5.000	0.116	1732.76	5746.92	0.0148	0.0148	0.45	290.000
72	5.000	0.119	1814.84	6019.13	0.0162	0.0162	0.45	295.000
73	5.000	0.123	2014.01	6679.72	0.0177	0.0177	0.45	300.000
74	5.000	0.124	2134.47	7079.24	0.0181	0.0181	0.45	305.000
75	5.000	0.125	2309.41	6218.26	0.0175	0.0175	0.42	310.000
76	5.000	0.125	2350.12	6327.89	0.0175	0.0175	0.42	315.000
77	5.000	0.125	2368.65	6759.12	0.0182	0.0182	0.43	320.000
78	5.000	0.125	2354.53	6718.81	0.0184	0.0184	0.43	325.000
79	5.000	0.125	2366.38	6752.62	0.0179	0.0179	0.43	330.000
80	5.000	0.125	2338.13	6672.02	0.0182	0.0182	0.43	335.000
81	5.000	0.125	2307.94	6585.86	0.0186	0.0186	0.43	340.000
82	5.000	0.125	2311.14	6594.98	0.0184	0.0184	0.43	345.000
83	5.000	0.125	2306.11	6580.65	0.0186	0.0186	0.43	350.000
84	5.000	0.125	2287.23	6526.76	0.0187	0.0187	0.43	355.000
85	5.000	0.125	2245.37	6859.73	0.0188	0.0188	0.44	360.000
86	5.000	0.125	2230.74	6815.02	0.0192	0.0192	0.44	365.000
87	5.000	0.125	2234.86	6827.60	0.0193	0.0193	0.44	370.000
88	6.000	0.125	2217.40	6774.26	0.0195	0.0195	0.44	376.000
89	6.000	0.125	2202.67	6729.28	0.0198	0.0198	0.44	382.000
90	5.000	0.125	2203.55	6731.97	0.0198	0.0198	0.44	387.000
Uniform Half-space		0.115	2641.87	6471.23	0.0204	0.0204	0.40	-

The structure basemat is founded within layer nos. 1 to 2 with the shear keys in layer nos. 3 and 4.

Table 3.7-3b — {EPGB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}
(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.000	0.145	579.79	1206.93	0.0286	0.0286	0.35	2.000
2	3.000	0.145	545.91	1136.41	0.0411	0.0411	0.35	5.000
3	3.000	0.145	503.19	1047.48	0.0583	0.0583	0.35	8.000
4	3.000	0.145	475.38	989.58	0.0719	0.0719	0.35	11.000
5	2.500	0.145	460.45	958.51	0.0799	0.0799	0.35	13.500
6	2.000	0.145	428.63	892.27	0.0946	0.0946	0.35	15.500
7	2.000	0.145	428.63	892.27	0.0946	0.0946	0.35	17.500
8	2.250	0.145	411.97	857.58	0.1040	0.1040	0.35	19.750
9	2.250	0.145	411.97	857.58	0.1040	0.1040	0.35	22.000
10	2.000	0.145	365.10	760.02	0.1242	0.1242	0.35	24.000
11	2.000	0.145	365.10	760.02	0.1242	0.1242	0.35	26.000
12	2.000	0.145	380.45	791.97	0.1255	0.1255	0.35	28.000
13	2.000	0.145	380.45	791.97	0.1255	0.1255	0.35	30.000
14	1.500	0.145	357.73	1824.10	0.1296	0.1296	0.48	31.500
15	1.500	0.145	357.73	1824.10	0.1296	0.1296	0.48	33.000
16	1.000	0.145	357.73	1824.10	0.1296	0.1296	0.48	34.000
17	2.000	0.145	345.69	1762.66	0.1342	0.1342	0.48	36.000
18	2.000	0.145	345.69	1762.66	0.1342	0.1342	0.48	38.000
19	1.750	0.145	341.19	1739.74	0.1357	0.1357	0.48	39.750
20	1.750	0.145	341.19	1739.74	0.1357	0.1357	0.48	41.500
21	2.000	0.145	326.19	1663.27	0.1380	0.1380	0.48	43.500
22	3.500	0.120	979.97	4800.00	0.0284	0.0284	0.48	47.000
23	4.000	0.120	976.69	4800.00	0.0290	0.0290	0.48	51.000
24	4.000	0.120	973.30	4800.00	0.0297	0.0297	0.48	55.000
25	5.000	0.120	1094.38	4800.00	0.0267	0.0267	0.47	60.000
26	5.000	0.120	1090.56	4800.00	0.0270	0.0270	0.47	65.000
27	5.000	0.120	1086.88	4800.00	0.0277	0.0277	0.47	70.000
28	5.000	0.120	717.58	3658.97	0.0429	0.0429	0.48	75.000
29	5.000	0.120	713.60	3638.64	0.0436	0.0436	0.48	80.000
30	5.000	0.120	734.21	3743.75	0.0429	0.0429	0.48	85.000
31	5.000	0.120	1017.60	4800.00	0.0311	0.0311	0.48	90.000
32	5.000	0.120	1054.30	4800.00	0.0300	0.0300	0.47	95.000
33	5.000	0.119	1045.94	4800.00	0.0307	0.0307	0.48	100.000
34	5.000	0.107	1017.80	4800.00	0.0184	0.0184	0.48	105.000

Table 3.7-3b — {EPGB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}
(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	5.000	0.105	999.89	4800.00	0.0158	0.0158	0.48	110.000
36	3.500	0.105	999.25	4800.00	0.0160	0.0160	0.48	113.500
37	3.500	0.105	999.25	4800.00	0.0160	0.0160	0.48	117.000
38	4.000	0.105	998.53	4800.00	0.0162	0.0162	0.48	121.000
39	4.000	0.105	998.53	4800.00	0.0162	0.0162	0.48	125.000
40	5.000	0.105	997.75	4800.00	0.0162	0.0162	0.48	130.000
41	5.000	0.105	997.75	4800.00	0.0162	0.0162	0.48	135.000
42	5.000	0.105	999.46	4800.00	0.0164	0.0164	0.48	140.000
43	5.000	0.105	999.46	4800.00	0.0164	0.0164	0.48	145.000
44	5.000	0.105	999.73	4800.00	0.0168	0.0168	0.48	150.000
45	5.000	0.105	999.73	4800.00	0.0168	0.0168	0.48	155.000
46	5.000	0.105	994.82	4800.00	0.0171	0.0171	0.48	160.000
47	5.000	0.105	994.82	4800.00	0.0171	0.0171	0.48	165.000
48	5.000	0.105	994.36	4800.00	0.0169	0.0169	0.48	170.000
49	5.000	0.105	994.36	4800.00	0.0169	0.0169	0.48	175.000
50	5.000	0.105	993.53	4800.00	0.0174	0.0174	0.48	180.000
51	5.000	0.105	993.53	4800.00	0.0174	0.0174	0.48	185.000
52	5.000	0.105	988.72	4800.00	0.0172	0.0172	0.48	190.000
53	5.000	0.105	988.72	4800.00	0.0172	0.0172	0.48	195.000
54	5.000	0.105	975.92	4800.00	0.0173	0.0173	0.48	200.000
55	5.000	0.105	975.92	4800.00	0.0173	0.0173	0.48	205.000
56	5.000	0.105	971.92	4800.00	0.0176	0.0176	0.48	210.000
57	5.000	0.105	971.92	4800.00	0.0176	0.0176	0.48	215.000
58	5.000	0.105	970.33	4800.00	0.0181	0.0181	0.48	220.000
59	5.000	0.105	970.33	4800.00	0.0181	0.0181	0.48	225.000
60	5.000	0.105	969.43	4800.00	0.0181	0.0181	0.48	230.000
61	5.000	0.105	969.43	4800.00	0.0181	0.0181	0.48	235.000
62	5.000	0.105	965.88	4800.00	0.0185	0.0185	0.48	240.000
63	5.000	0.105	965.88	4800.00	0.0185	0.0185	0.48	245.000
64	4.000	0.105	962.70	4800.00	0.0193	0.0193	0.48	249.000
65	4.000	0.105	962.70	4800.00	0.0193	0.0193	0.48	253.000
66	3.500	0.105	970.98	4800.00	0.0186	0.0186	0.48	256.500
67	3.500	0.105	970.98	4800.00	0.0186	0.0186	0.48	260.000
68	5.000	0.105	973.17	4800.00	0.0188	0.0188	0.48	265.000

Table 3.7-3b — {EPGB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}

(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.105	981.52	4800.00	0.0192	0.0192	0.48	270.000
70	5.000	0.106	990.64	4800.00	0.0198	0.0198	0.48	275.000
71	5.000	0.108	1019.20	4800.00	0.0221	0.0221	0.48	280.000
72	5.000	0.112	1050.12	4800.00	0.0248	0.0248	0.47	285.000
73	5.000	0.116	1101.64	4800.00	0.0278	0.0278	0.47	290.000
74	5.000	0.119	1174.88	4800.00	0.0291	0.0291	0.47	295.000
75	5.000	0.123	1284.38	4800.00	0.0289	0.0289	0.46	300.000
76	5.000	0.124	1372.18	4800.00	0.0284	0.0284	0.46	305.000
77	5.000	0.125	1479.99	4800.00	0.0281	0.0281	0.45	310.000
78	5.000	0.125	1558.88	4800.00	0.0271	0.0271	0.44	315.000
79	5.000	0.125	1579.10	4800.00	0.0261	0.0261	0.44	320.000
80	5.000	0.125	1569.69	4800.00	0.0263	0.0263	0.44	325.000
81	5.000	0.125	1577.59	4800.00	0.0260	0.0260	0.44	330.000
82	5.000	0.125	1558.75	4800.00	0.0263	0.0263	0.44	335.000
83	5.000	0.125	1538.63	4800.00	0.0266	0.0266	0.44	340.000
84	5.000	0.125	1540.76	4800.00	0.0263	0.0263	0.44	345.000
85	5.000	0.125	1537.41	4800.00	0.0265	0.0265	0.44	350.000
86	5.000	0.125	1524.82	4800.00	0.0265	0.0265	0.44	355.000
87	5.000	0.125	1496.92	4800.00	0.0269	0.0269	0.45	360.000
88	5.000	0.125	1487.16	4800.00	0.0271	0.0271	0.45	365.000
89	5.000	0.125	1489.91	4800.00	0.0274	0.0274	0.45	370.000
90	6.000	0.125	1478.26	4800.00	0.0274	0.0274	0.45	376.000
Uniform Half-space		0.115	1759.88	4832.47	0.0293	0.0293	0.42	-

The structure basemat is founded within layer nos. 1 to 2 with the shear keys in layer nos. 3 and 4.

Table 3.7-3c — {EPGB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}

(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.000	0.145	729.06	1517.67	0.0190	0.0190	0.35	2.000
2	3.000	0.145	710.54	1479.10	0.0249	0.0249	0.35	5.000
3	3.000	0.145	682.75	1421.27	0.0337	0.0337	0.35	8.000
4	3.000	0.145	666.46	1387.34	0.0408	0.0408	0.35	11.000
5	2.500	0.145	659.42	1372.69	0.0449	0.0449	0.35	13.500
6	2.000	0.145	650.11	1353.31	0.0522	0.0522	0.35	15.500
7	2.000	0.145	650.11	1353.31	0.0522	0.0522	0.35	17.500
8	2.250	0.145	655.19	1363.89	0.0568	0.0568	0.35	19.750
9	2.250	0.145	655.19	1363.89	0.0568	0.0568	0.35	22.000
10	2.000	0.145	612.59	1275.21	0.0659	0.0659	0.35	24.000
11	2.000	0.145	612.59	1275.21	0.0659	0.0659	0.35	26.000
12	2.000	0.145	635.23	1322.35	0.0673	0.0673	0.35	28.000
13	2.000	0.145	635.23	1322.35	0.0673	0.0673	0.35	30.000
14	3.000	0.145	626.86	3196.38	0.0700	0.0700	0.48	33.000
15	1.000	0.145	626.86	3196.38	0.0700	0.0700	0.48	34.000
16	2.000	0.145	610.33	3112.06	0.0741	0.0741	0.48	36.000
17	2.000	0.145	610.33	3112.06	0.0741	0.0741	0.48	38.000
18	1.750	0.145	606.99	3095.04	0.0763	0.0763	0.48	39.750
19	1.750	0.145	606.99	3095.04	0.0763	0.0763	0.48	41.500
20	2.000	0.145	596.40	3041.03	0.0780	0.0780	0.48	43.500
21	3.500	0.120	1374.09	4800.00	0.0205	0.0205	0.46	47.000
22	4.000	0.120	1371.61	4800.00	0.0208	0.0208	0.46	51.000
23	4.000	0.120	1369.01	4800.00	0.0211	0.0211	0.46	55.000
24	5.000	0.120	1582.62	5248.97	0.0196	0.0196	0.45	60.000
25	5.000	0.120	1579.48	5238.55	0.0198	0.0198	0.45	65.000
26	5.000	0.120	1576.40	5228.31	0.0201	0.0201	0.45	70.000
27	5.000	0.120	1032.53	5264.89	0.0284	0.0284	0.48	75.000
28	5.000	0.120	1027.99	5241.73	0.0286	0.0286	0.48	80.000
29	5.000	0.120	1061.45	5412.37	0.0280	0.0280	0.48	85.000
30	5.000	0.120	1470.96	4878.62	0.0221	0.0221	0.45	90.000
31	5.000	0.120	1526.08	5061.42	0.0215	0.0215	0.45	95.000
32	5.000	0.119	1513.76	5020.59	0.0213	0.0213	0.45	100.000
33	5.000	0.107	1247.62	5243.95	0.0143	0.0143	0.47	105.000
34	5.000	0.105	1224.61	5147.25	0.0135	0.0135	0.47	110.000

Table 3.7-3c — {EPGB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}
(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	3.500	0.105	1223.83	5143.97	0.0136	0.0136	0.47	113.500
36	3.500	0.105	1223.83	5143.97	0.0136	0.0136	0.47	117.000
37	4.000	0.105	1222.95	5140.27	0.0137	0.0137	0.47	121.000
38	4.000	0.105	1222.95	5140.27	0.0137	0.0137	0.47	125.000
39	5.000	0.105	1221.99	5136.21	0.0137	0.0137	0.47	130.000
40	5.000	0.105	1221.99	5136.21	0.0137	0.0137	0.47	135.000
41	5.000	0.105	1224.08	5145.03	0.0139	0.0139	0.47	140.000
42	5.000	0.105	1224.08	5145.03	0.0139	0.0139	0.47	145.000
43	5.000	0.105	1224.41	5146.40	0.0139	0.0139	0.47	150.000
44	5.000	0.105	1224.41	5146.40	0.0139	0.0139	0.47	155.000
45	5.000	0.105	1218.41	5121.17	0.0140	0.0140	0.47	160.000
46	5.000	0.105	1218.41	5121.17	0.0140	0.0140	0.47	165.000
47	5.000	0.105	1217.84	5118.80	0.0139	0.0139	0.47	170.000
48	5.000	0.105	1217.84	5118.80	0.0139	0.0139	0.47	175.000
49	5.000	0.105	1216.82	5114.48	0.0141	0.0141	0.47	180.000
50	5.000	0.105	1216.82	5114.48	0.0141	0.0141	0.47	185.000
51	5.000	0.105	1210.93	5089.76	0.0140	0.0140	0.47	190.000
52	5.000	0.105	1210.93	5089.76	0.0140	0.0140	0.47	195.000
53	5.000	0.105	1195.25	5023.85	0.0142	0.0142	0.47	200.000
54	5.000	0.105	1195.25	5023.85	0.0142	0.0142	0.47	205.000
55	5.000	0.105	1190.35	5003.24	0.0143	0.0143	0.47	210.000
56	5.000	0.105	1190.35	5003.24	0.0143	0.0143	0.47	215.000
57	5.000	0.105	1188.41	4995.07	0.0146	0.0146	0.47	220.000
58	5.000	0.105	1188.41	4995.07	0.0146	0.0146	0.47	225.000
59	5.000	0.105	1187.30	4990.44	0.0146	0.0146	0.47	230.000
60	5.000	0.105	1187.30	4990.44	0.0146	0.0146	0.47	235.000
61	5.000	0.105	1182.96	4972.19	0.0148	0.0148	0.47	240.000
62	5.000	0.105	1182.96	4972.19	0.0148	0.0148	0.47	245.000
63	4.000	0.105	1179.07	4955.83	0.0151	0.0151	0.47	249.000
64	4.000	0.105	1179.07	4955.83	0.0151	0.0151	0.47	253.000
65	3.500	0.105	1189.20	4998.41	0.0149	0.0149	0.47	256.500
66	3.500	0.105	1189.20	4998.41	0.0149	0.0149	0.47	260.000
67	5.000	0.105	1191.89	5009.72	0.0150	0.0150	0.47	265.000
68	5.000	0.105	1202.11	5052.68	0.0151	0.0151	0.47	270.000

Table 3.7-3c — {EPGB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}
(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.106	1213.28	5099.62	0.0153	0.0153	0.47	275.000
70	5.000	0.108	1248.26	5246.66	0.0163	0.0163	0.47	280.000
71	5.000	0.112	1304.12	5481.46	0.0179	0.0179	0.47	285.000
72	5.000	0.116	1381.62	4800.00	0.0203	0.0203	0.45	290.000
73	5.000	0.119	1460.21	4842.97	0.0217	0.0217	0.45	295.000
74	5.000	0.123	1608.34	5334.25	0.0226	0.0226	0.45	300.000
75	5.000	0.124	1711.40	5676.07	0.0227	0.0227	0.45	305.000
76	5.000	0.125	1848.76	4977.93	0.0222	0.0222	0.42	310.000
77	5.000	0.125	1914.04	5153.71	0.0218	0.0218	0.42	315.000
78	5.000	0.125	1934.00	5518.80	0.0218	0.0218	0.43	320.000
79	5.000	0.125	1922.47	5485.89	0.0220	0.0220	0.43	325.000
80	5.000	0.125	1932.14	5513.50	0.0216	0.0216	0.43	330.000
81	5.000	0.125	1909.08	5447.68	0.0219	0.0219	0.43	335.000
82	5.000	0.125	1884.42	5377.33	0.0222	0.0222	0.43	340.000
83	5.000	0.125	1887.03	5384.78	0.0220	0.0220	0.43	345.000
84	5.000	0.125	1882.93	5373.08	0.0222	0.0222	0.43	350.000
85	5.000	0.125	1867.51	5329.08	0.0223	0.0223	0.43	355.000
86	5.000	0.125	1833.34	5600.95	0.0225	0.0225	0.44	360.000
87	5.000	0.125	1821.39	5564.44	0.0228	0.0228	0.44	365.000
88	5.000	0.125	1824.75	5574.72	0.0230	0.0230	0.44	370.000
89	6.000	0.125	1810.50	5531.16	0.0231	0.0231	0.44	376.000
90	6.000	0.125	1798.48	5494.43	0.0234	0.0234	0.44	382.000
Uniform Half-space		0.115	2148.68	5263.17	0.0244	0.0293	0.0244	-

The structure basemat is founded within layer nos. 1 to 2 with the shear keys in layer nos. 3 and 4.

Table 3.7-4a — {ESWB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}

(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.860	0.145	916.77	1908.40	0.0126	0.0126	0.35	2.860
2	2.640	0.145	929.01	1933.89	0.0161	0.0161	0.35	5.500
3	2.375	0.145	926.10	1927.82	0.0200	0.0200	0.35	7.875
4	2.375	0.145	931.21	1938.46	0.0223	0.0223	0.35	10.250
5	2.375	0.145	944.36	1965.84	0.0252	0.0252	0.35	12.625
6	2.375	0.145	970.68	2020.62	0.0275	0.0275	0.35	15.000
7	2.000	0.145	986.03	2052.58	0.0288	0.0288	0.35	17.000
8	2.667	0.145	1031.51	2147.26	0.0306	0.0306	0.35	19.667
9	2.667	0.145	1040.23	2165.41	0.0315	0.0315	0.35	22.334
10	2.666	0.145	1027.84	2139.61	0.0350	0.0350	0.35	25.000
11	2.670	0.145	1048.36	2182.33	0.0357	0.0357	0.35	27.670
12	2.660	0.145	1065.33	2529.48	0.0363	0.0363	0.39	30.330
13	2.670	0.145	1098.46	4800.00	0.0378	0.0378	0.47	33.000
14	1.000	0.145	1098.46	4800.00	0.0378	0.0378	0.47	34.000
15	2.000	0.145	1077.56	4800.00	0.0409	0.0409	0.47	36.000
16	2.000	0.145	1077.56	4800.00	0.0409	0.0409	0.47	38.000
17	1.750	0.145	1079.85	4800.00	0.0429	0.0429	0.47	39.750
18	1.750	0.145	1079.85	4800.00	0.0429	0.0429	0.47	41.500
19	2.000	0.145	1090.42	4800.00	0.0441	0.0441	0.47	43.500
20	3.500	0.120	1926.71	6390.19	0.0148	0.0148	0.45	47.000
21	4.000	0.120	1926.23	6388.57	0.0149	0.0149	0.45	51.000
22	4.000	0.120	1925.60	6386.50	0.0150	0.0150	0.45	55.000
23	5.000	0.120	2288.69	7590.71	0.0144	0.0144	0.45	60.000
24	5.000	0.120	2287.61	7587.13	0.0145	0.0145	0.45	65.000
25	5.000	0.120	2286.38	7583.06	0.0146	0.0146	0.45	70.000
26	5.000	0.120	1485.71	7575.66	0.0188	0.0188	0.48	75.000
27	5.000	0.120	1480.89	7551.11	0.0188	0.0188	0.48	80.000
28	5.000	0.120	1534.56	7824.73	0.0183	0.0183	0.48	85.000
29	5.000	0.120	2126.29	7052.10	0.0157	0.0157	0.45	90.000
30	5.000	0.120	2208.97	7326.32	0.0154	0.0154	0.45	95.000
31	5.000	0.119	2190.83	7266.15	0.0148	0.0148	0.45	100.000
32	5.000	0.107	1529.33	6428.04	0.0111	0.0111	0.47	105.000
33	5.000	0.105	1499.83	6304.07	0.0115	0.0115	0.47	110.000
34	3.500	0.105	1498.88	6300.06	0.0115	0.0115	0.47	113.500

Table 3.7-4a — {ESWB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}

(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	3.500	0.105	1498.88	6300.06	0.0115	0.0115	0.47	117.000
36	4.000	0.105	1497.80	6295.52	0.0116	0.0116	0.47	121.000
37	4.000	0.105	1497.80	6295.52	0.0116	0.0116	0.47	125.000
38	5.000	0.105	1496.62	6290.55	0.0116	0.0116	0.47	130.000
39	5.000	0.105	1496.62	6290.55	0.0116	0.0116	0.47	135.000
40	5.000	0.105	1499.19	6301.35	0.0118	0.0118	0.47	140.000
41	5.000	0.105	1499.19	6301.35	0.0118	0.0118	0.47	145.000
42	5.000	0.105	1499.59	6303.03	0.0115	0.0115	0.47	150.000
43	5.000	0.105	1499.59	6303.03	0.0115	0.0115	0.47	155.000
44	5.000	0.105	1492.24	6272.13	0.0114	0.0114	0.47	160.000
45	5.000	0.105	1492.24	6272.13	0.0114	0.0114	0.47	165.000
46	5.000	0.105	1491.55	6269.23	0.0114	0.0114	0.47	170.000
47	5.000	0.105	1491.55	6269.23	0.0114	0.0114	0.47	175.000
48	5.000	0.105	1490.29	6263.94	0.0115	0.0115	0.47	180.000
49	5.000	0.105	1490.29	6263.94	0.0115	0.0115	0.47	185.000
50	5.000	0.105	1483.08	6233.65	0.0114	0.0114	0.47	190.000
51	5.000	0.105	1483.08	6233.65	0.0114	0.0114	0.47	195.000
52	5.000	0.105	1463.88	6152.93	0.0117	0.0117	0.47	200.000
53	5.000	0.105	1463.88	6152.93	0.0117	0.0117	0.47	205.000
54	5.000	0.105	1457.87	6127.70	0.0116	0.0116	0.47	210.000
55	5.000	0.105	1457.87	6127.70	0.0116	0.0116	0.47	215.000
56	5.000	0.105	1455.49	6117.69	0.0118	0.0118	0.47	220.000
57	5.000	0.105	1455.49	6117.69	0.0118	0.0118	0.47	225.000
58	5.000	0.105	1454.14	6112.02	0.0118	0.0118	0.47	230.000
59	5.000	0.105	1454.14	6112.02	0.0118	0.0118	0.47	235.000
60	5.000	0.105	1448.83	6089.67	0.0119	0.0119	0.47	240.000
61	5.000	0.105	1448.83	6089.67	0.0119	0.0119	0.47	245.000
62	4.000	0.105	1444.06	6069.62	0.0118	0.0118	0.47	249.000
63	4.000	0.105	1444.06	6069.62	0.0118	0.0118	0.47	253.000
64	3.500	0.105	1456.47	6121.78	0.0119	0.0119	0.47	256.500
65	3.500	0.105	1456.47	6121.78	0.0119	0.0119	0.47	260.000
66	5.000	0.105	1459.76	6135.62	0.0120	0.0120	0.47	265.000
67	5.000	0.105	1472.28	6188.25	0.0119	0.0119	0.47	270.000
68	5.000	0.106	1485.96	6245.73	0.0118	0.0118	0.47	275.000

Table 3.7-4a — {ESWB Common Basemat Structure Soil Layer Upper Bound Thicknesses and Properties}
(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.108	1528.80	6425.82	0.0120	0.0120	0.47	280.000
70	5.000	0.112	1619.56	6807.30	0.0129	0.0129	0.47	285.000
71	5.000	0.116	1732.76	5746.92	0.0148	0.0148	0.45	290.000
72	5.000	0.119	1814.84	6019.13	0.0162	0.0162	0.45	295.000
73	5.000	0.123	2014.01	6679.72	0.0177	0.0177	0.45	300.000
74	5.000	0.124	2134.47	7079.24	0.0181	0.0181	0.45	305.000
75	5.000	0.125	2309.41	6218.26	0.0175	0.0175	0.42	310.000
76	5.000	0.125	2350.12	6327.89	0.0175	0.0175	0.42	315.000
77	5.000	0.125	2368.65	6759.12	0.0182	0.0182	0.43	320.000
78	5.000	0.125	2354.53	6718.81	0.0184	0.0184	0.43	325.000
79	5.000	0.125	2366.38	6752.62	0.0179	0.0179	0.43	330.000
80	5.000	0.125	2338.13	6672.02	0.0182	0.0182	0.43	335.000
81	5.000	0.125	2307.94	6585.86	0.0186	0.0186	0.43	340.000
82	5.000	0.125	2311.14	6594.98	0.0184	0.0184	0.43	345.000
83	5.000	0.125	2306.11	6580.65	0.0186	0.0186	0.43	350.000
84	5.000	0.125	2287.23	6526.76	0.0187	0.0187	0.43	355.000
85	5.000	0.125	2245.37	6859.73	0.0188	0.0188	0.44	360.000
86	5.000	0.125	2230.74	6815.02	0.0192	0.0192	0.44	365.000
87	5.000	0.125	2234.86	6827.60	0.0193	0.0193	0.44	370.000
88	6.000	0.125	2217.40	6774.26	0.0195	0.0195	0.44	376.000
89	6.000	0.125	2202.67	6729.28	0.0198	0.0198	0.44	382.000
90	5.000	0.125	2203.55	6731.97	0.0198	0.0198	0.44	387.000
Uniform Half-space		0.115	2646.50	6495.00	0.0201	0.0201	0.40	-

Table 3.7-4b — {ESWB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}

(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.860	0.145	579.79	1206.93	0.0286	0.0286	0.35	2.860
2	2.640	0.145	531.67	1106.76	0.0464	0.0464	0.35	5.500
3	2.375	0.145	498.44	1037.59	0.0604	0.0604	0.35	7.875
4	2.375	0.145	480.88	1001.02	0.0689	0.0689	0.35	10.250
5	2.375	0.145	460.45	958.51	0.0799	0.0799	0.35	12.625
6	2.375	0.145	440.36	916.67	0.0892	0.0892	0.35	15.000
7	2.000	0.145	428.63	892.27	0.0946	0.0946	0.35	17.000
8	2.667	0.145	415.09	864.09	0.1023	0.1023	0.35	19.667
9	2.667	0.145	406.10	845.37	0.1066	0.1066	0.35	22.334
10	2.666	0.145	365.10	760.02	0.1242	0.1242	0.35	25.000
11	2.670	0.145	374.70	780.01	0.1250	0.1250	0.35	27.670
12	2.660	0.145	377.63	920.02	0.1260	0.1260	0.40	30.330
13	2.670	0.145	357.73	1824.10	0.1296	0.1296	0.48	33.000
14	1.000	0.145	357.73	1824.10	0.1296	0.1296	0.48	34.000
15	2.000	0.145	345.69	1762.66	0.1342	0.1342	0.48	36.000
16	2.000	0.145	345.69	1762.66	0.1342	0.1342	0.48	38.000
17	1.750	0.145	341.19	1739.74	0.1357	0.1357	0.48	39.750
18	1.750	0.145	341.19	1739.74	0.1357	0.1357	0.48	41.500
19	2.000	0.145	326.19	1663.27	0.1380	0.1380	0.48	43.500
20	3.500	0.120	979.97	4800.00	0.0284	0.0284	0.48	47.000
21	4.000	0.120	976.69	4800.00	0.0290	0.0290	0.48	51.000
22	4.000	0.120	973.30	4800.00	0.0297	0.0297	0.48	55.000
23	5.000	0.120	1094.38	4800.00	0.0267	0.0267	0.47	60.000
24	5.000	0.120	1090.56	4800.00	0.0270	0.0270	0.47	65.000
25	5.000	0.120	1086.88	4800.00	0.0277	0.0277	0.47	70.000
26	5.000	0.120	717.58	3658.97	0.0429	0.0429	0.48	75.000
27	5.000	0.120	713.60	3638.64	0.0436	0.0436	0.48	80.000
28	5.000	0.120	734.21	3743.75	0.0429	0.0429	0.48	85.000
29	5.000	0.120	1017.60	4800.00	0.0311	0.0311	0.48	90.000
30	5.000	0.120	1054.30	4800.00	0.0300	0.0300	0.47	95.000
31	5.000	0.119	1045.94	4800.00	0.0307	0.0307	0.48	100.000
32	5.000	0.107	1017.80	4800.00	0.0184	0.0184	0.48	105.000
33	5.000	0.105	999.89	4800.00	0.0158	0.0158	0.48	110.000
34	3.500	0.105	999.25	4800.00	0.0160	0.0160	0.48	113.500

Table 3.7-4b — {ESWB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}
(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	3.500	0.105	999.25	4800.00	0.0160	0.0160	0.48	117.000
36	4.000	0.105	998.53	4800.00	0.0162	0.0162	0.48	121.000
37	4.000	0.105	998.53	4800.00	0.0162	0.0162	0.48	125.000
38	5.000	0.105	997.75	4800.00	0.0162	0.0162	0.48	130.000
39	5.000	0.105	997.75	4800.00	0.0162	0.0162	0.48	135.000
40	5.000	0.105	999.46	4800.00	0.0164	0.0164	0.48	140.000
41	5.000	0.105	999.46	4800.00	0.0164	0.0164	0.48	145.000
42	5.000	0.105	999.73	4800.00	0.0168	0.0168	0.48	150.000
43	5.000	0.105	999.73	4800.00	0.0168	0.0168	0.48	155.000
44	5.000	0.105	994.82	4800.00	0.0171	0.0171	0.48	160.000
45	5.000	0.105	994.82	4800.00	0.0171	0.0171	0.48	165.000
46	5.000	0.105	994.36	4800.00	0.0169	0.0169	0.48	170.000
47	5.000	0.105	994.36	4800.00	0.0169	0.0169	0.48	175.000
48	5.000	0.105	993.53	4800.00	0.0174	0.0174	0.48	180.000
49	5.000	0.105	993.53	4800.00	0.0174	0.0174	0.48	185.000
50	5.000	0.105	988.72	4800.00	0.0172	0.0172	0.48	190.000
51	5.000	0.105	988.72	4800.00	0.0172	0.0172	0.48	195.000
52	5.000	0.105	975.92	4800.00	0.0173	0.0173	0.48	200.000
53	5.000	0.105	975.92	4800.00	0.0173	0.0173	0.48	205.000
54	5.000	0.105	971.92	4800.00	0.0176	0.0176	0.48	210.000
55	5.000	0.105	971.92	4800.00	0.0176	0.0176	0.48	215.000
56	5.000	0.105	970.33	4800.00	0.0181	0.0181	0.48	220.000
57	5.000	0.105	970.33	4800.00	0.0181	0.0181	0.48	225.000
58	5.000	0.105	969.43	4800.00	0.0181	0.0181	0.48	230.000
59	5.000	0.105	969.43	4800.00	0.0181	0.0181	0.48	235.000
60	5.000	0.105	965.88	4800.00	0.0185	0.0185	0.48	240.000
61	5.000	0.105	965.88	4800.00	0.0185	0.0185	0.48	245.000
62	4.000	0.105	962.70	4800.00	0.0193	0.0193	0.48	249.000
63	4.000	0.105	962.70	4800.00	0.0193	0.0193	0.48	253.000
64	3.500	0.105	970.98	4800.00	0.0186	0.0186	0.48	256.500
65	3.500	0.105	970.98	4800.00	0.0186	0.0186	0.48	260.000
66	5.000	0.105	973.17	4800.00	0.0188	0.0188	0.48	265.000
67	5.000	0.105	981.52	4800.00	0.0192	0.0192	0.48	270.000
68	5.000	0.106	990.64	4800.00	0.0198	0.0198	0.48	275.000

Table 3.7-4b — {ESWB Common Basemat Structure Soil Layer Lower Bound Thicknesses and Properties}
(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.108	1019.20	4800.00	0.0221	0.0221	0.48	280.000
70	5.000	0.112	1050.12	4800.00	0.0248	0.0248	0.47	285.000
71	5.000	0.116	1101.64	4800.00	0.0278	0.0278	0.47	290.000
72	5.000	0.119	1174.88	4800.00	0.0291	0.0291	0.47	295.000
73	5.000	0.123	1284.38	4800.00	0.0289	0.0289	0.46	300.000
74	5.000	0.124	1372.18	4800.00	0.0284	0.0284	0.46	305.000
75	5.000	0.125	1479.99	4800.00	0.0281	0.0281	0.45	310.000
76	5.000	0.125	1558.88	4800.00	0.0271	0.0271	0.44	315.000
77	5.000	0.125	1579.10	4800.00	0.0261	0.0261	0.44	320.000
78	5.000	0.125	1569.69	4800.00	0.0263	0.0263	0.44	325.000
79	5.000	0.125	1577.59	4800.00	0.0260	0.0260	0.44	330.000
80	5.000	0.125	1558.75	4800.00	0.0263	0.0263	0.44	335.000
81	5.000	0.125	1538.63	4800.00	0.0266	0.0266	0.44	340.000
82	5.000	0.125	1540.76	4800.00	0.0263	0.0263	0.44	345.000
83	5.000	0.125	1537.41	4800.00	0.0265	0.0265	0.44	350.000
84	5.000	0.125	1524.82	4800.00	0.0265	0.0265	0.44	355.000
85	5.000	0.125	1496.92	4800.00	0.0269	0.0269	0.45	360.000
86	5.000	0.125	1487.16	4800.00	0.0271	0.0271	0.45	365.000
87	5.000	0.125	1489.91	4800.00	0.0274	0.0274	0.45	370.000
88	6.000	0.125	1478.26	4800.00	0.0274	0.0274	0.45	376.000
89	6.000	0.125	1468.45	4800.00	0.0276	0.0276	0.45	382.000
90	5.000	0.125	1469.04	4800.00	0.0276	0.0276	0.45	387.000
Uniform Half-space		0.115	1756.00	4831.00	0.0290	0.0290	0.42	-

Table 3.7-4c — {ESWB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}
(Page 1 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
1	2.860	0.145	729.06	1517.67	0.0190	0.0190	0.35	2.860
2	2.640	0.145	702.75	1462.88	0.0273	0.0273	0.35	5.500
3	2.375	0.145	679.34	1414.17	0.0347	0.0347	0.35	7.875
4	2.375	0.145	669.05	1392.74	0.0392	0.0392	0.35	10.250
5	2.375	0.145	659.42	1372.69	0.0449	0.0449	0.35	12.625
6	2.375	0.145	653.54	1360.45	0.0495	0.0495	0.35	15.000
7	2.000	0.145	650.11	1353.31	0.0522	0.0522	0.35	17.000
8	2.667	0.145	654.24	1361.90	0.0559	0.0559	0.35	19.667
9	2.667	0.145	649.86	1352.78	0.0579	0.0579	0.35	22.334
10	2.666	0.145	612.59	1275.21	0.0659	0.0659	0.35	25.000
11	2.670	0.145	626.75	1304.69	0.0668	0.0668	0.35	27.670
12	2.660	0.145	634.20	1554.84	0.0676	0.0676	0.40	30.330
13	2.670	0.145	626.86	3196.38	0.0700	0.0700	0.48	33.000
14	1.000	0.145	626.86	3196.38	0.0700	0.0700	0.48	34.000
15	2.000	0.145	610.33	3112.06	0.0741	0.0741	0.48	36.000
16	2.000	0.145	610.33	3112.06	0.0741	0.0741	0.48	38.000
17	1.750	0.145	606.99	3095.04	0.0763	0.0763	0.48	39.750
18	1.750	0.145	606.99	3095.04	0.0763	0.0763	0.48	41.500
19	2.000	0.145	596.40	3041.03	0.0780	0.0780	0.48	43.500
20	3.500	0.120	1374.09	4800.00	0.0205	0.0205	0.46	47.000
21	4.000	0.120	1371.61	4800.00	0.0208	0.0208	0.46	51.000
22	4.000	0.120	1369.01	4800.00	0.0211	0.0211	0.46	55.000
23	5.000	0.120	1582.62	5248.97	0.0196	0.0196	0.45	60.000
24	5.000	0.120	1579.48	5238.55	0.0198	0.0198	0.45	65.000
25	5.000	0.120	1576.40	5228.31	0.0201	0.0201	0.45	70.000
26	5.000	0.120	1032.53	5264.89	0.0284	0.0284	0.48	75.000
27	5.000	0.120	1027.99	5241.73	0.0286	0.0286	0.48	80.000
28	5.000	0.120	1061.45	5412.37	0.0280	0.0280	0.48	85.000
29	5.000	0.120	1470.96	4878.62	0.0221	0.0221	0.45	90.000
30	5.000	0.120	1526.08	5061.42	0.0215	0.0215	0.45	95.000
31	5.000	0.119	1513.76	5020.59	0.0213	0.0213	0.45	100.000
32	5.000	0.107	1247.62	5243.95	0.0143	0.0143	0.47	105.000
33	5.000	0.105	1224.61	5147.25	0.0135	0.0135	0.47	110.000
34	3.500	0.105	1223.83	5143.97	0.0136	0.0136	0.47	113.500

Table 3.7-4c — {ESWB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}
(Page 2 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
35	3.500	0.105	1223.83	5143.97	0.0136	0.0136	0.47	117.000
36	4.000	0.105	1222.95	5140.27	0.0137	0.0137	0.47	121.000
37	4.000	0.105	1222.95	5140.27	0.0137	0.0137	0.47	125.000
38	5.000	0.105	1221.99	5136.21	0.0137	0.0137	0.47	130.000
39	5.000	0.105	1221.99	5136.21	0.0137	0.0137	0.47	135.000
40	5.000	0.105	1224.08	5145.03	0.0139	0.0139	0.47	140.000
41	5.000	0.105	1224.08	5145.03	0.0139	0.0139	0.47	145.000
42	5.000	0.105	1224.41	5146.40	0.0139	0.0139	0.47	150.000
43	5.000	0.105	1224.41	5146.40	0.0139	0.0139	0.47	155.000
44	5.000	0.105	1218.41	5121.17	0.0140	0.0140	0.47	160.000
45	5.000	0.105	1218.41	5121.17	0.0140	0.0140	0.47	165.000
46	5.000	0.105	1217.84	5118.80	0.0139	0.0139	0.47	170.000
47	5.000	0.105	1217.84	5118.80	0.0139	0.0139	0.47	175.000
48	5.000	0.105	1216.82	5114.48	0.0141	0.0141	0.47	180.000
49	5.000	0.105	1216.82	5114.48	0.0141	0.0141	0.47	185.000
50	5.000	0.105	1210.93	5089.76	0.0140	0.0140	0.47	190.000
51	5.000	0.105	1210.93	5089.76	0.0140	0.0140	0.47	195.000
52	5.000	0.105	1195.25	5023.85	0.0142	0.0142	0.47	200.000
53	5.000	0.105	1195.25	5023.85	0.0142	0.0142	0.47	205.000
54	5.000	0.105	1190.35	5003.24	0.0143	0.0143	0.47	210.000
55	5.000	0.105	1190.35	5003.24	0.0143	0.0143	0.47	215.000
56	5.000	0.105	1188.41	4995.07	0.0146	0.0146	0.47	220.000
57	5.000	0.105	1188.41	4995.07	0.0146	0.0146	0.47	225.000
58	5.000	0.105	1187.30	4990.44	0.0146	0.0146	0.47	230.000
59	5.000	0.105	1187.30	4990.44	0.0146	0.0146	0.47	235.000
60	5.000	0.105	1182.96	4972.19	0.0148	0.0148	0.47	240.000
61	5.000	0.105	1182.96	4972.19	0.0148	0.0148	0.47	245.000
62	4.000	0.105	1179.07	4955.83	0.0151	0.0151	0.47	249.000
63	4.000	0.105	1179.07	4955.83	0.0151	0.0151	0.47	253.000
64	3.500	0.105	1189.20	4998.41	0.0149	0.0149	0.47	256.500
65	3.500	0.105	1189.20	4998.41	0.0149	0.0149	0.47	260.000
66	5.000	0.105	1191.89	5009.72	0.0150	0.0150	0.47	265.000
67	5.000	0.105	1202.11	5052.68	0.0151	0.0151	0.47	270.000
68	5.000	0.106	1213.28	5099.62	0.0153	0.0153	0.47	275.000

Table 3.7-4c — {ESWB Common Basemat Structure Soil Layer Best Estimate Thicknesses and Properties}

(Page 3 of 3)

Layer No.	Layer Thickness (m)	Weight Density (kN/m^3)	S-Wave Velocity (m/s)	P-Wave Velocity (m/s)	S-wave Damping Ratio	P-wave Damping Ratio	Poisson's Ratio	Depth below Surface (m)
69	5.000	0.108	1248.26	5246.66	0.0163	0.0163	0.47	280.000
70	5.000	0.112	1304.12	5481.46	0.0179	0.0179	0.47	285.000
71	5.000	0.116	1381.62	4800.00	0.0203	0.0203	0.45	290.000
72	5.000	0.119	1460.21	4842.97	0.0217	0.0217	0.45	295.000
73	5.000	0.123	1608.34	5334.25	0.0226	0.0226	0.45	300.000
74	5.000	0.124	1711.40	5676.07	0.0227	0.0227	0.45	305.000
75	5.000	0.125	1848.76	4977.93	0.0222	0.0222	0.42	310.000
76	5.000	0.125	1914.04	5153.71	0.0218	0.0218	0.42	315.000
77	5.000	0.125	1934.00	5518.80	0.0218	0.0218	0.43	320.000
78	5.000	0.125	1922.47	5485.89	0.0220	0.0220	0.43	325.000
79	5.000	0.125	1932.14	5513.50	0.0216	0.0216	0.43	330.000
80	5.000	0.125	1909.08	5447.68	0.0219	0.0219	0.43	335.000
81	5.000	0.125	1884.42	5377.33	0.0222	0.0222	0.43	340.000
82	5.000	0.125	1887.03	5384.78	0.0220	0.0220	0.43	345.000
83	5.000	0.125	1882.93	5373.08	0.0222	0.0222	0.43	350.000
84	5.000	0.125	1867.51	5329.08	0.0223	0.0223	0.43	355.000
85	5.000	0.125	1833.34	5600.95	0.0225	0.0225	0.44	360.000
86	5.000	0.125	1821.39	5564.44	0.0228	0.0228	0.44	365.000
87	5.000	0.125	1824.75	5574.72	0.0230	0.0230	0.44	370.000
88	6.000	0.125	1810.50	5531.16	0.0231	0.0231	0.44	376.000
89	6.000	0.125	1798.48	5494.43	0.0234	0.0234	0.44	382.000
90	5.000	0.125	1799.19	5496.63	0.0234	0.0234	0.44	387.000
Uniform Half-space		0.115	2155	5290	0.241	0.241	0.40	-

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

(Coordinates based on CCNPP Unit 3)

(Page 1 of 2)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
1	1.69	0.71	0.00	0.82	51	31.68	72.61	25.85	86.96
2	2.23	0.80	0.00	1.15	52	31.98	72.65	26.75	87.00
3	2.24	1.05	0.00	1.15	53	32.07	72.65	26.78	87.89
4	2.74	1.07	0.02	1.42	54	32.22	73.42	26.88	87.90
5	3.10	1.59	0.02	1.46	55	32.94	73.98	27.00	88.50
6	7.60	1.63	0.27	14.14	56	33.40	74.53	27.85	88.58
7	10.79	1.68	0.53	55.99	57	33.47	74.64	28.25	88.58
8	11.79	1.71	1.02	56.00	58	33.77	74.88	28.88	88.59
9	13.83	46.21	1.51	56.01	59	34.01	74.89	29.67	88.59
10	14.19	46.22	1.51	56.51	60	34.26	74.94	30.20	88.60
11	14.46	46.24	1.51	60.18	61	34.38	74.94	30.20	88.92
12	15.12	46.25	1.51	61.56	62	34.55	74.96	31.56	88.92
13	15.87	46.48	1.52	70.26	63	34.72	75.01	32.56	88.94
14	16.41	46.48	1.52	73.10	64	35.06	75.04	34.54	88.95
15	16.80	46.54	1.52	76.80	65	35.42	75.10	35.53	89.04
16	17.78	46.54	1.54	77.09	66	35.44	75.10	36.00	89.04
17	18.22	46.57	1.60	77.43	67	35.45	75.13	37.20	89.04
18	18.85	46.77	2.82	77.43	68	35.64	75.14	37.84	89.05
19	19.52	47.91	2.82	77.44	69	36.02	75.71	38.38	89.07
20	20.09	48.42	2.96	77.55	70	36.20	76.82	38.47	89.08
21	20.57	48.42	2.96	77.86	71	36.33	77.47	38.50	89.12
22	21.10	48.42	2.98	78.51	72	36.94	78.25	38.99	89.17
23	21.34	48.42	3.04	79.23	73	37.04	78.25	39.34	89.17
24	21.47	49.62	15.51	79.24	74	37.22	78.34	40.86	89.19
25	22.56	49.79	15.60	79.73	75	37.40	78.36	41.55	89.21
26	23.23	49.79	15.66	81.35	76	37.50	78.43	42.74	89.21
27	23.24	49.79	15.71	83.35	77	37.76	78.51	43.66	89.22
28	23.96	49.82	15.71	84.05	78	38.34	78.86	45.42	89.27
29	24.55	51.15	16.17	84.26	79	38.47	78.90	45.84	89.27
30	24.59	51.17	16.18	84.89	80	38.62	78.97	46.13	89.28
31	24.78	51.20	16.73	84.89	81	38.69	79.07	46.64	89.29
32	24.83	51.20	17.02	84.89	82	38.74	79.08	46.90	89.29
33	24.84	51.21	17.39	84.90	83	39.85	79.34	48.09	89.35
34	25.21	51.94	17.74	84.92	84	43.06	80.39	51.19	89.72
35	25.45	51.95	17.74	85.74	85	44.13	81.62	51.56	89.75
36	25.56	52.10	19.79	85.74	86	45.11	82.37	51.71	90.25

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

(Coordinates based on CCNPP Unit 3)

(Page 2 of 2)

Mode #	Frequency (Hz)	Mass Participation Factors (%)			Mode #	Frequency (Hz)	Mass Participation Factors (%)		
		N-S	Vertical	E-W			N-S	Vertical	E-W
37	26.31	52.12	21.06	85.87	87	46.05	83.59	51.88	90.65
38	26.38	52.13	21.41	85.87	88	46.17	84.43	51.89	90.66
39	26.51	55.02	21.42	85.96	89	46.22	84.98	51.95	90.70
40	26.57	55.03	21.76	85.96	90	55.48	88.08	53.74	91.58
41	26.67	55.05	21.77	86.20	91	60.05	89.29	57.09	92.13
42	26.71	55.83	21.77	86.21	92	60.07	89.32	57.47	92.13
43	26.84	60.36	21.87	86.21	93	60.22	89.36	58.31	92.13
44	27.31	60.72	21.98	86.35	94	60.23	89.37	58.80	92.13
45	27.33	68.33	21.98	86.35	95	60.24	89.40	59.16	92.13
46	28.15	68.60	22.64	86.42	96	60.43	89.42	60.07	92.14
47	28.50	70.33	22.65	86.59	97	60.91	89.51	61.46	92.16
48	28.56	70.66	23.50	86.70	98	65.77	90.43	65.06	92.37
49	28.78	71.88	24.25	86.71	99	66.55	90.66	66.60	92.45
50	31.22	72.48	25.38	86.92	100	70.75	91.14	68.56	92.90

Table 3.7-6 — {Maximum Zero Period Accelerations in NI Common Basemat Structures}

NI Common Basemat Structure	Model Z coordinate (m)	Direction	ZPA (g)		Ratio (b)/(a)
			U.S. EPR™ FSAR Table 3.7.2-10 5aeh Cracked (a)	CCNPP Unit 3 Envelope (b)	
Containment Building	37.60	X(E-W)	0.85	0.21	0.25
		Y(N-S)	0.93	0.19	0.20
		Z(Vert)	0.73	0.24	0.33
	58.00	X(E-W)	1.06	0.23	0.22
		Y(N-S)	1.12	0.25	0.22
		Z(Vert)	1.60	0.45	0.28
Reactor Building Internal Structure	5.15	X(E-W)	0.37	0.16	0.43
		Y(N-S)	0.37	0.14	0.38
		Z(Vert)	0.51	0.18	0.35
	19.5	X(E-W)	0.53	0.19	0.36
		Y(N-S)	0.56	0.17	0.30
		Z(Vert)	0.60	0.21	0.35
Safeguard Building 1	8.1	X(E-W)	0.45	0.17	0.38
		Y(N-S)	0.44	0.16	0.36
		Z(Vert)	0.46	0.21	0.46
	21	X(E-W)	0.61	0.19	0.31
		Y(N-S)	0.60	0.19	0.32
		Z(Vert)	0.77	0.24	0.31
Safeguard Building 2 & 3	8.1	X(E-W)	0.95	0.19	0.20
		Y(N-S)	0.64	0.19	0.30
		Z(Vert)	0.46	0.21	0.46
	16.3	X(E-W)	1.07	0.22	0.21
		Y(N-S)	0.83	0.22	0.27
		Z(Vert)	0.54	0.27	0.50
Safeguard Building 4	21	X(E-W)	0.55	0.20	0.36
		Y(N-S)	0.58	0.22	0.38
		Z(Vert)	0.53	0.21	0.40
Fuel Building	3.7	X(E-W)	0.53	0.17	0.32
		Y(N-S)	0.41	0.15	0.37
		Z(Vert)	0.45	0.19	0.42
	14.8	X(E-W)	0.69	0.17	0.25
		Y(N-S)	0.62	0.20	0.32
		Z(Vert)	0.60	0.19	0.32

Table 3.7-7 — {Maximum Zero Period Accelerations in the Emergency Power Generating Building and Essential Services Water Building}

Structure	Z coordinate of Slab	Direction	ZPA (g) U.S. EPR™ FSAR Table 3.7.2-28 (EPGB) and 3.7-29 (ESWB)(a)	ZPA (g) CCNPP Unit 3 Envelope (b)	ZPA (g) Ratio (b)/(a)
EPGB	+68 ft - 0 in	X(E-W)	1.37	0.36	0.26
		Y(N-S)	1.58	0.31	0.20
		Z(Vert)	2.64	0.47	0.18
EPGB	+50 ft - 6 in	X(E-W)	1.22	0.33	0.27
		Y(N-S)	1.50	0.31	0.21
		Z(Vert)	3.69	0.95	0.26
EPGB	+19 ft - 3 in	X(E-W)	0.65	0.27	0.42
		Y(N-S)	1.00	0.30	0.30
		Z(Vert)	0.61	0.33	0.54
EPGB	+0 ft - 0 in	X(E-W)	0.46	0.22	0.48
		Y(N-S)	0.44	0.21	0.48
		Z(Vert)	0.58	0.33	0.57
ESWB	+63 ft - 0 in	X(E-W)	1.07	0.26	0.24
		Y(N-S)	1.01	0.23	0.23
		Z(Vert)	3.07	1.02	0.33
ESWB	+14 ft - 0 in	X(E-W)	0.50	0.19	0.38
		Y(N-S)	1.05	0.22	0.21
		Z(Vert)	0.72	0.24	0.33

Table 3.7-8 — {Worst Case Accelerations in Common Basemat Intake Structures}

UHS Makeup Water Intake Structure			
Floor Elevation	**X (N-S) Direction**	**Y (E-W) Direction**	**Z (Vert) Direction**
-22.5	0.179g	0.16g	0.196g
11.5	0.22g	0.201g	0.208g
26.5	0.247g	0.225g	0.211g
Forebay			
Floor Elevation	**X (N-S) Direction**	**Y (E-W) Direction**	**Z (Vert) Direction**
-22.5	0.199g	0.173g	0.249g

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

Table 3.7-9 — {Summary of Results - Building Stability Evaluation of the TI Structure}

(Page 1 of 3)

Basis: Control Interaction through Prevention of Structure-to-Structure Impact[1]					
SOIL CASE	COMPONENT	DEMAND(1) (kips) or (kip-ft)	REQUIRED COEFFICIENT OF FRICTION, μreq	CAPACITY(3)	FACTOR OF SAFETY = CAPACITY ÷ DEMAND
Lower Bound	Maximum Shear at Bottom of Basemat	89,999	0.33	0.52	1.58
	Vertical (Uplift) Force at Bottom of Basemat	99,204	---	311,208	3.14
	Overturning Moment Bending About Top Edge of Basemat	14,341,387	---	46,326,023	3.23
	Overturning Moment Bending About Bottom Edge of Basemat	13,635,147	---	38,322,600	2.81
	Overturning Moment Bending About Left Edge of Basemat	22,383,277	---	57,587,531	2.57
	Overturning Moment Bending About Right Edge of Basemat	16,825,248	---	62,850,032	3.74

Table 3.7-9 — {Summary of Results - Building Stability Evaluation of the TI Structure}

(Page 2 of 3)

Basis: Control Interaction through Prevention of Structure-to-Structure Impact[1]					
SOIL CASE	**COMPONENT**	**DEMAND[(1)] (kips) or (kip-ft)**	**REQUIRED COEFFICIENT OF FRICTION, μreq**	**CAPACITY[(3)]**	**FACTOR OF SAFETY = CAPACITY ÷ DEMAND**
Best Estimate	Maximum Shear at Bottom of Basemat	117,427	0.45	0.52	1.16
	Vertical (Uplift) Force at Bottom of Basemat	127,545	---	311,208	2.44
	Overturning Moment Bending About Top Edge of Basemat	19,084,957	---	46,326,023	2.43
	Overturning Moment Bending About Bottom Edge of Basemat	16,916,867	---	38,322,600	2.27
	Overturning Moment Bending About Left Edge of Basemat	27,059,275	---	57,587,531	2.13
	Overturning Moment Bending About Right Edge of Basemat	23,380,397	---	62,850,032	2.69

Table 3.7-9 — {Summary of Results - Building Stability Evaluation of the TI Structure}
(Page 3 of 3)

Basis: Control Interaction through Prevention of Structure-to-Structure Impact[1]					
SOIL CASE	**COMPONENT**	**DEMAND[(1)] (kips) or (kip-ft)**	**REQUIRED COEFFICIENT OF FRICTION, μreq**	**CAPACITY[(3)]**	**FACTOR OF SAFETY = CAPACITY ÷ DEMAND**
Upper Bound	Maximum Shear at Bottom of Basemat	57180[(4)]	0.19[(5)]	0.52	2.74
	Vertical (Uplift) Force at Bottom of Basemat	157,475	---	311,208	1.98
	Overturning Moment Bending About Top Edge of Basemat	23,951,116	---	46,326,023	1.93
	Overturning Moment Bending About Bottom Edge of Basemat	20,507,618	---	38,322,600	1.87
	Overturning Moment Bending About Left Edge of Basemat	31,586,890	---	57,587,531	1.82
	Overturning Moment Bending About Right Edge of Basemat	30,707,819	---	62,850,032	2.05

(1) Unless noted otherwise, the demands shown are based on the summation of the maximum resultant force for each spring, even though the maximum for different springs will occur at different time steps. The spring force directional sign (positive or negative) is conservatively neglected, assuming that all spring forces are acting in the same direction.

(2) Required coefficient of friction, μ_{req} = Shear demand ÷ [Structural Weight - (0.4 * Uplift Demand)]

(3) The sliding capacity is the available coefficient of friction at the interface below the TI basemat. The overturning moment capacities are the resisting moments provided by the structural weight bending about the four edges of the basemat. The passive soil resistances provided by the side soils against sliding and overturning are conservatively neglected.

(4) Value shown is the calculated shear demand for the evaluation case using time-step method, where calculation is performed at each time-step (0.005 seconds).

(5) Value shown is the calculated required coefficient of friction for the evaluation case using time-step method, where calculation is performed at each time-step (0.005 seconds).

Table 3.7-10 — {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 Impact[1]

Structure	Seismic Category	Design Code	Seismic Interaction Criteria	Seismic Interaction Evaluation
Turbine Building and Switchgear Building	SC-II[2b]	Steel – AISC N690[3] Concrete – ACI 349[3]	SSE	No Interaction
Grid Systems Control Building	CS[2a]	IBC Steel – AISC 360 Concrete – ACI 318	None	No Interaction
Circulating Water Intake Structure	SC-II[2b]	IBC Steel – AISC 341 & ACI 360 Concrete – ACI 349	SSE	No Interaction
Access Building	SC-II[2b]	Steel - AISC N690[3] Concrete - ACI 349[3]	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.

Table 3.7-10a — {Summary of Results - Building Stability Evaluation of the TI Structure}

Soil Case	Component	Demand (1) (kips) or (kip-ft)	Required (2) Coefficient of Friction, μ_{req}	Capacity (3)	Factor of Safety = Capacity ÷ Demand
Lower Bound	Maximum Shear at Bottom of Basemat	89,999	0.33	0.52	1.58
	Vertical (Uplift) Force at Bottom of Basemat	99,204	---	311,208	3.14
	Overturning Moment Bending About Top Edge of Basemat	14,341,387	---	46,326,023	3.23
	Overturning Moment Bending About Bottom Edge of Basemat	13,635,147	---	38,322,600	2.81
	Overturning Moment Bending About Left Edge of Basemat	22,383,277	---	57,587,531	2.57
	Overturning Moment Bending About Right Edge of Basemat	16,825,248	---	62,850,032	3.74
Best Estimate	Maximum Shear at Bottom of Basemat	117,427	0.45	0.52	1.16
	Vertical (Uplift) Force at Bottom of Basemat	127,545	---	311,208	2.44
	Overturning Moment Bending About Top Edge of Basemat	19,084,957	---	46,326,023	2.43
	Overturning Moment Bending About Bottom Edge of Basemat	16,916,867	---	38,322,600	2.27
	Overturning Moment Bending About Left Edge of Basemat	27,059,275	---	57,587,531	2.13
	Overturning Moment Bending About Right Edge of Basemat	23,380,397	---	62,850,032	2.69
Upper Bound	Maximum Shear at Bottom of Basemat	57180 (4)	0.19 (5)	0.52	2.74
	Vertical (Uplift) Force at Bottom of Basemat	157,475	---	311,208	1.98
	Overturning Moment Bending About Top Edge of Basemat	23,951,116	---	46,326,023	1.93
	Overturning Moment Bending About Bottom Edge of Basemat	20,507,618	---	38,322,600	1.87
	Overturning Moment Bending About Left Edge of Basemat	31,586,890	---	57,587,531	1.82
	Overturning Moment Bending About Right Edge of Basemat	30,707,819	---	62,850,032	2.05

(1) Unless noted otherwise, the demands shown are based on the summation of the maximum resultant force for each spring, even though the maximum for different springs will occur at different time steps. The spring force directional sign (positive or negative) is conservatively neglected, assuming that all spring forces are acting in the same direction.
(2) Required coefficient of friction, μ_{req} = Shear demand ÷ [Structural Weight - (0.4 * Uplift Demand)]
(3) The sliding capacity is the available coefficient of friction at the interface below the TI basemat. The overturning moment capacities are the resisting moments provided by the structural weight bending about the four edges of the basemat. The passive soil resistances provided by the side soils against sliding and overturning are conservatively neglected.
(4) Value shown is the calculated shear demand for the evaluation case using time-step method, where calculation is performed at each time-step (0.005 seconds).
(5) Value shown is the calculated required coefficient of friction for the evaluation case using time-step method, where calculation is performed at each time-step (0.005 seconds).

Table 3.7-11 — {NAB Displacements}

Structure and displacement type	Movement in X-direction (inches)	Movement in Y-direction (inches)
NAB seismic displacement (sliding and elastic)	3.67	4.62
NAB tilt	3.16	3.61
NI seismic displacement	0.92	0.89
NI tilt	1.40	1.37
Total	9.15	9.99

Table 3.7-12 — {Stability Analysis Results for the Access Building}

ITEM	UNITS	ANALYSIS CASE					
		CR-BE	CR-LB	CR-UB	UNCR-BE	UNCR-LB	UNCR-UB
$FOS_{SLIDING}$		1.49	1.73	1.40	1.48	1.71	1.38
FOS_{OT} (Transverse)		1.99	2.39	1.73	2.00	2.35	1.74
FOS_{OT} (Longitudinal)		2.23	2.65	2.02	2.23	2.62	2.00
Ground contact ratio		0.952	0.991	0.904	0.953	0.988	0.905
Uplift	[%]	4.8	0.9	9.6	4.7	1.2	9.5
Maximum Bearing Pressure	[kPa]	760	880	727	784	848	740
	[ksf]	15.9	18.4	15.2	16.4	17.7	15.5

Figure 3.7-1 — {CCNPP Unit 3 FIRS for the Nuclear Island Common Basemat Structure (Horizontal) and CCNPP Unit 3 Site SSE Spectrum, 5% damping}

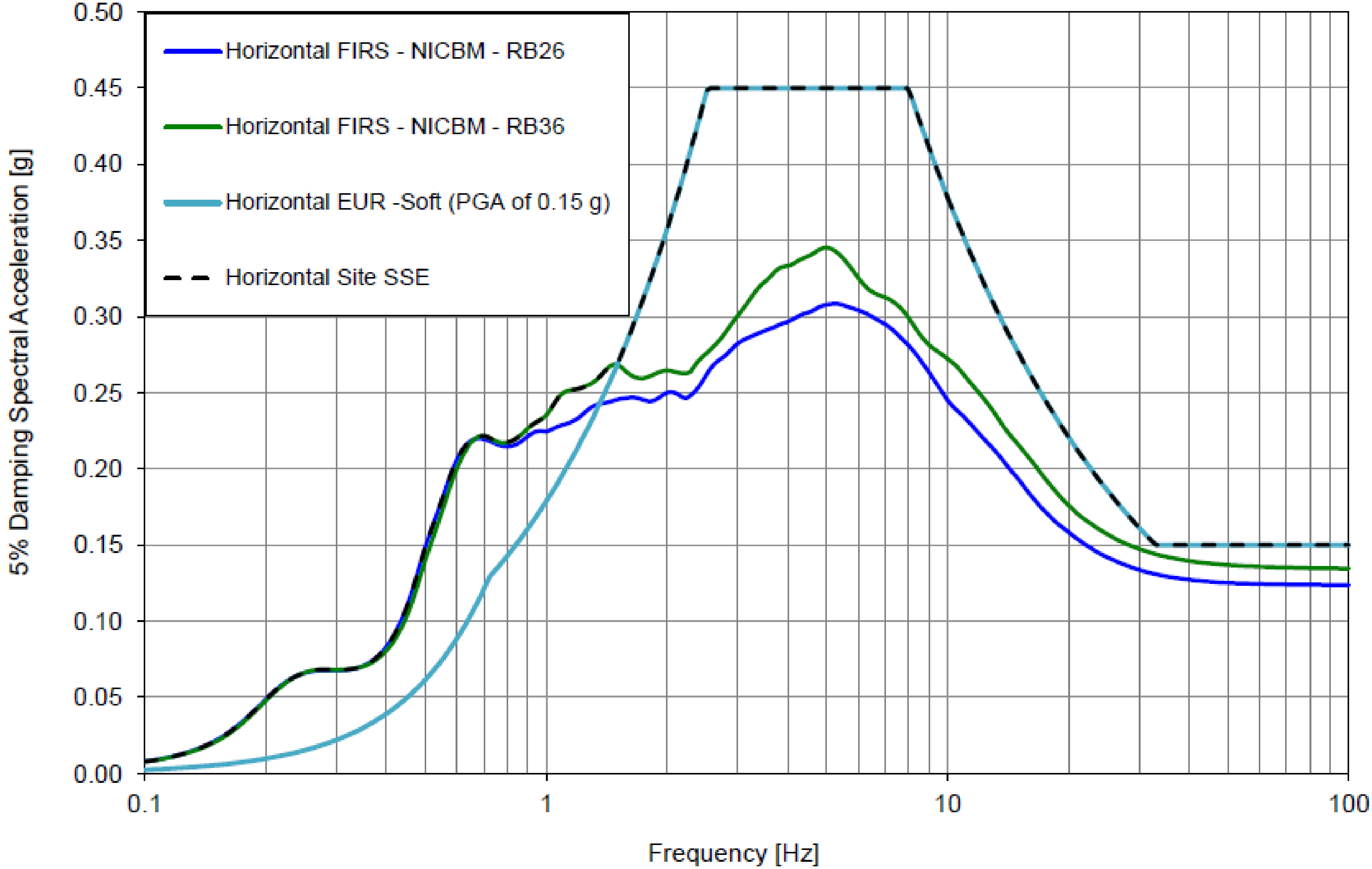


Figure 3.7-2 — {CCNPP Unit 3 FIRS for the Nuclear Island Common Basemat Structures (Vertical) and CCNPP Unit 3 Site SSE Spectrum, 5% damping}

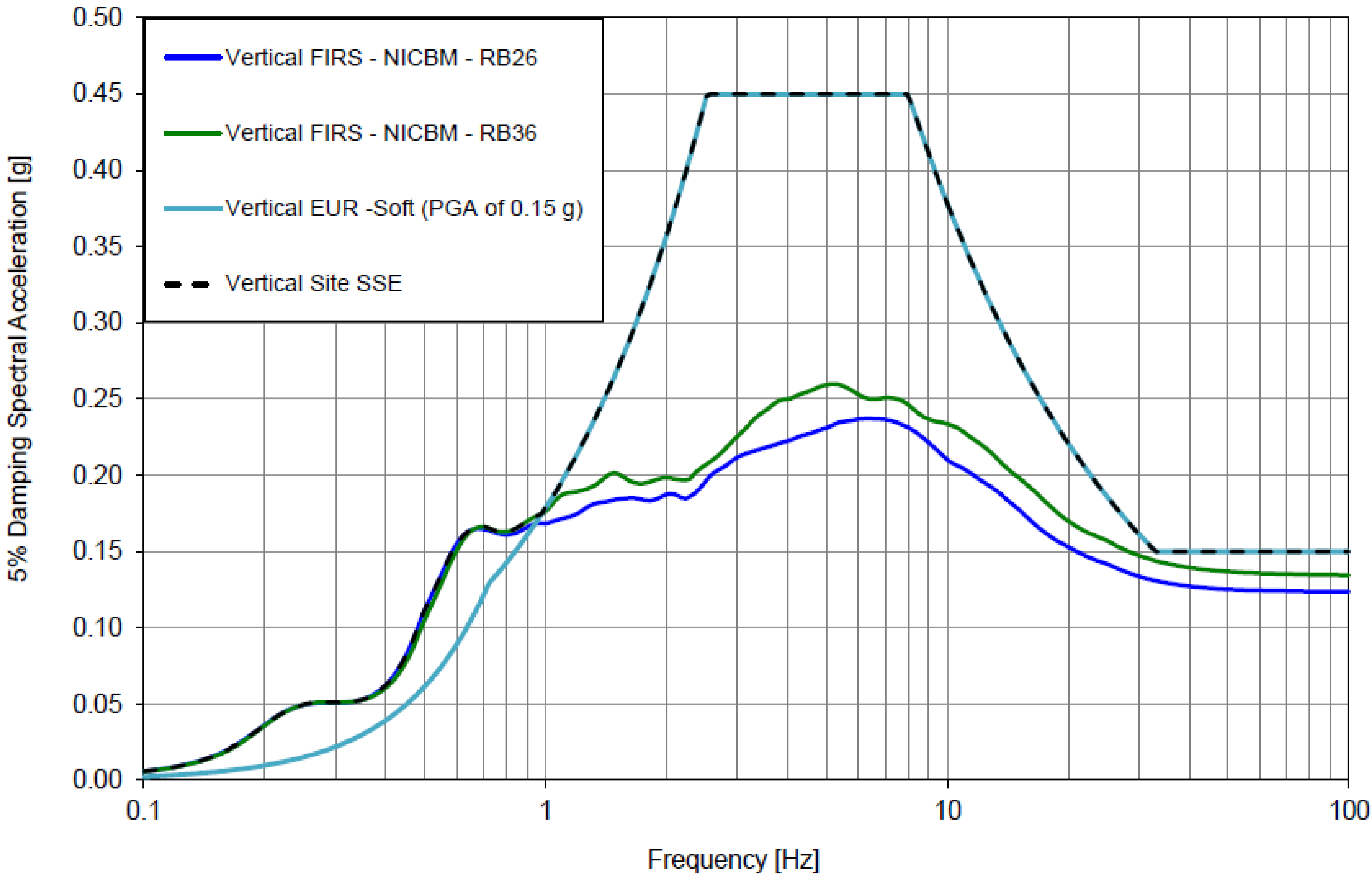


Figure 3.7-3 — {CCNPP Unit 3 Site SSE Spectrum (0.15g PGA), 5% damping}

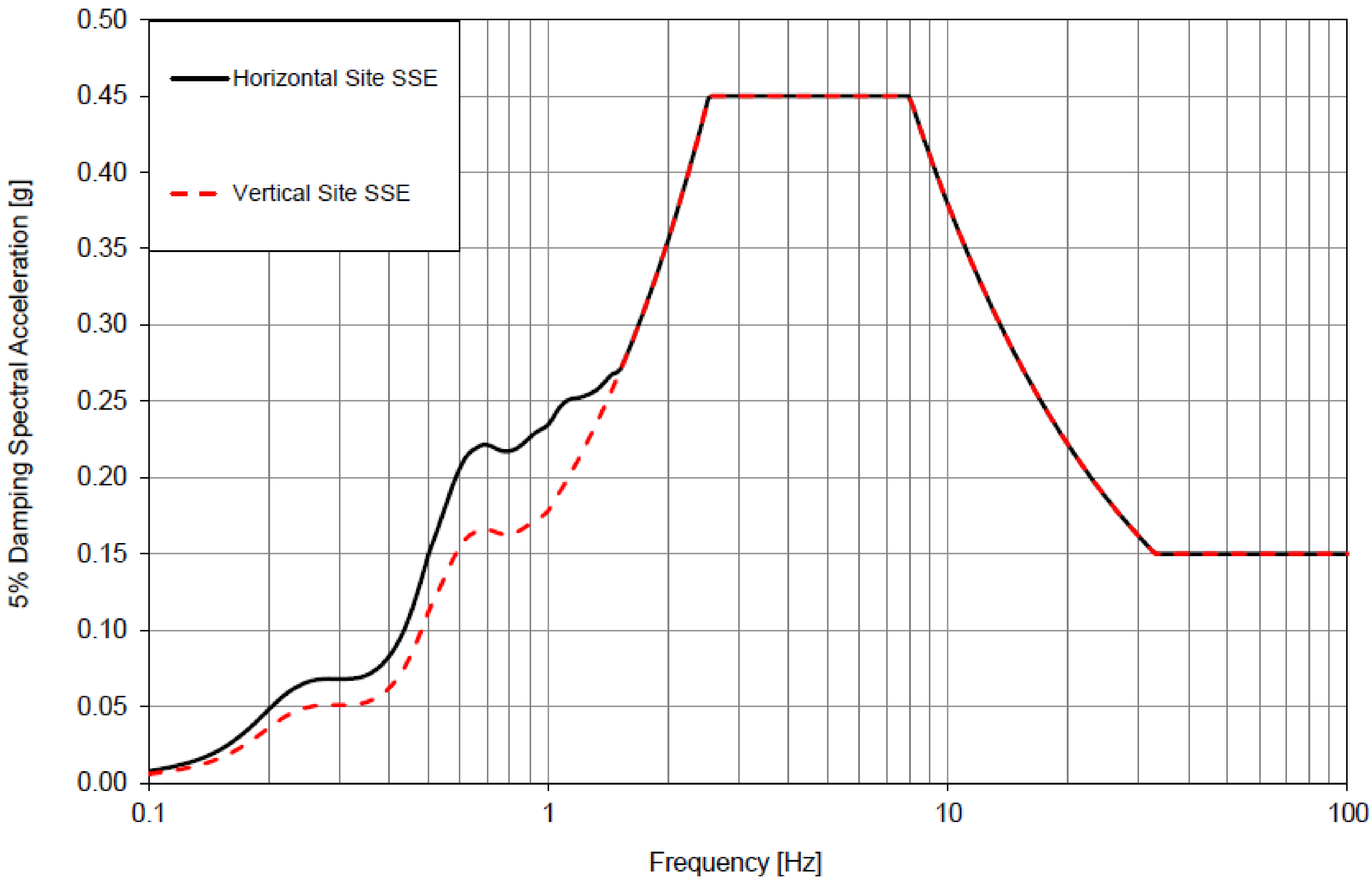


Figure 3.7-4 — {CCNPP Unit 3 Site SSE and CSDRS (Horizontal) for the Nuclear Island Common Basemat Structures}

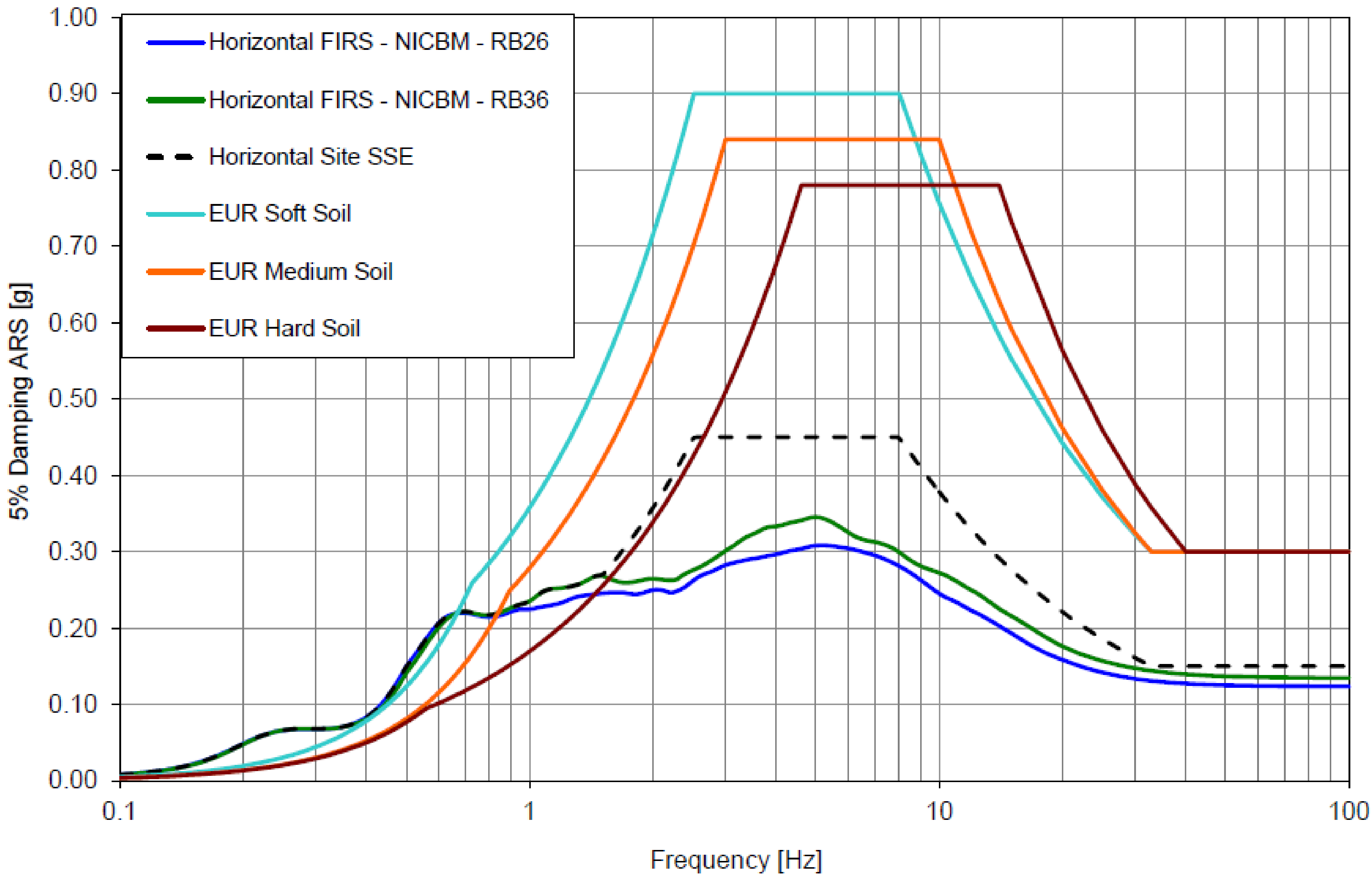


Figure 3.7-5 — {CCNPP Unit 3 GMRS Site SSE and EUR CSDRS (Vertical) for the Nuclear Island Common Basemat Structures}

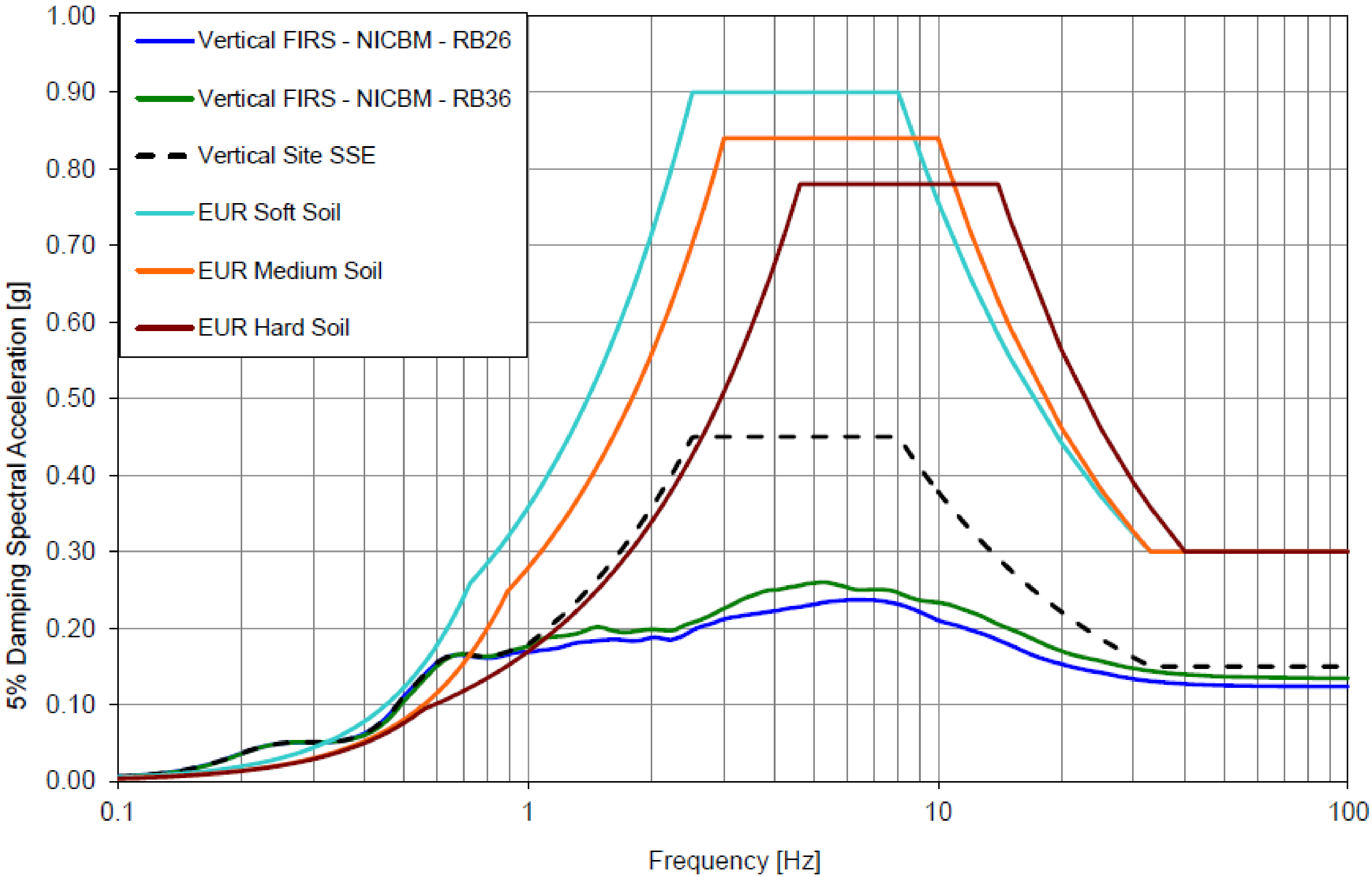


Figure 3.7-6 — {Not Used}

Figure 3.7-6 is not used.

Figure 3.7-7a — {Idealized SSSI Function for ESWB and EPGB due to Proximity to NICBM Structures}

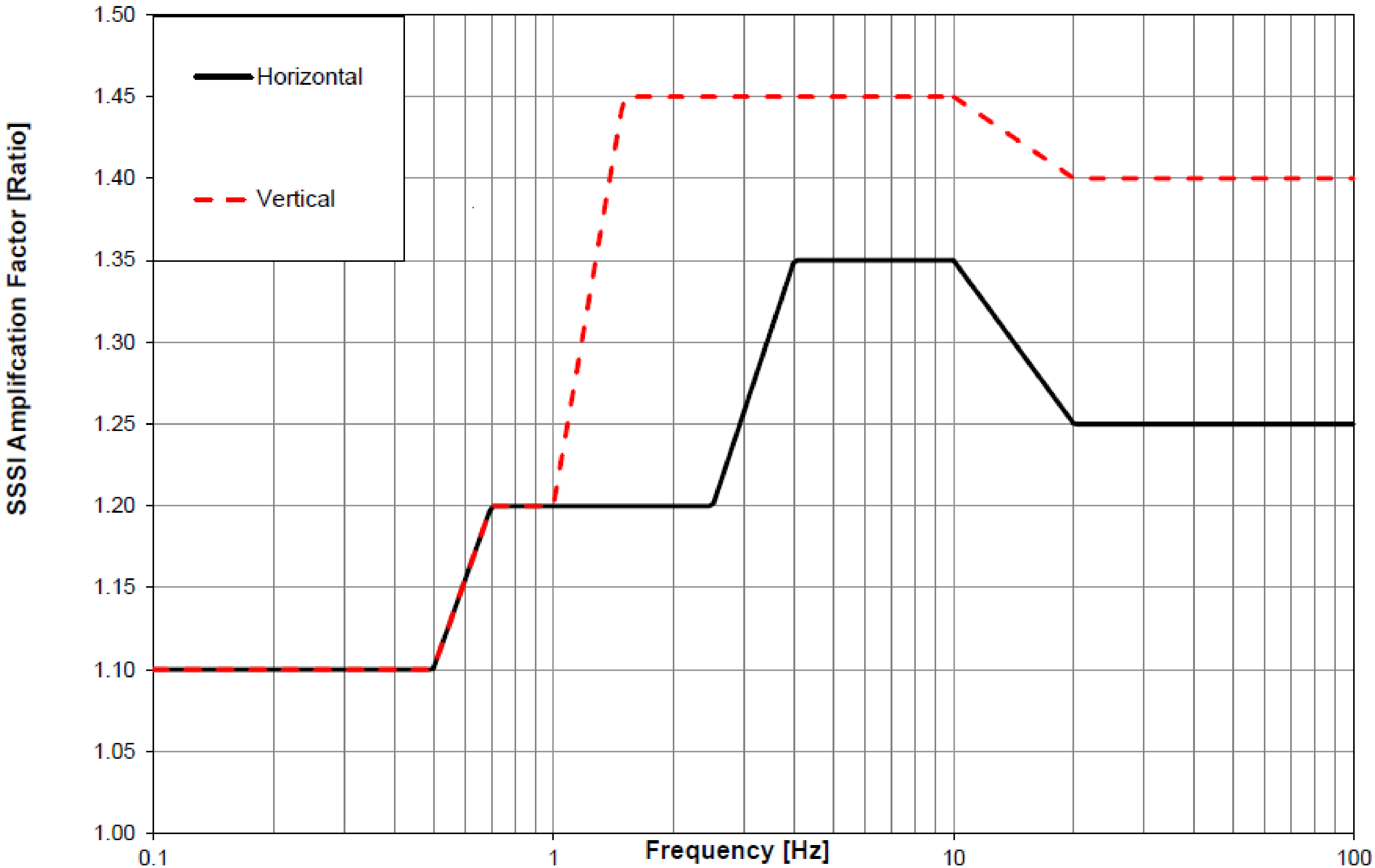


Figure 3.7-7b — {Comparison of Idealized SSI function to the actual computed for the ESWB and EPGB in the horizontal direction}

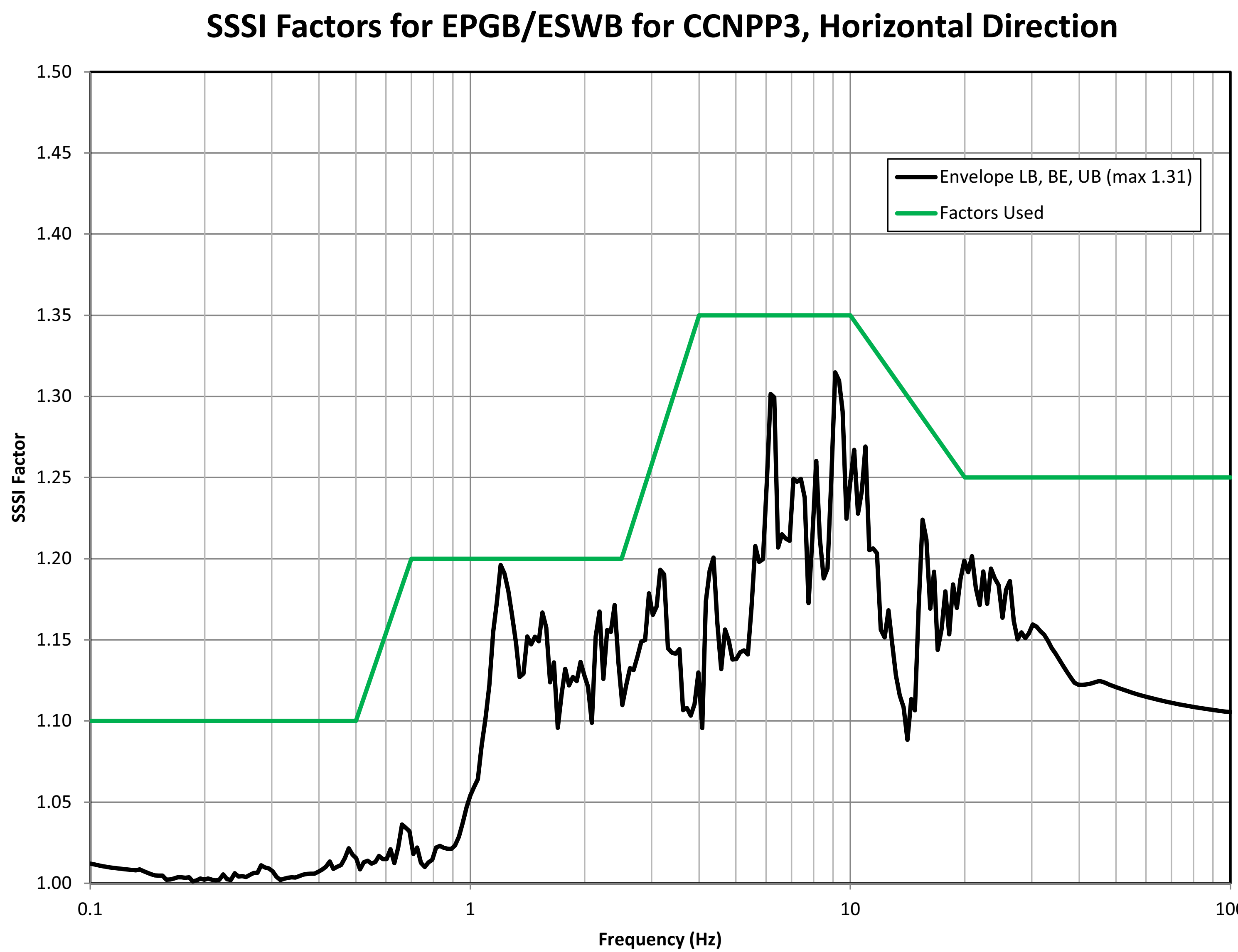


Figure 3.7-7c — {Comparison of Idealized SSI function to the actual computed for the ESWB and EPGB in the vertical direction}

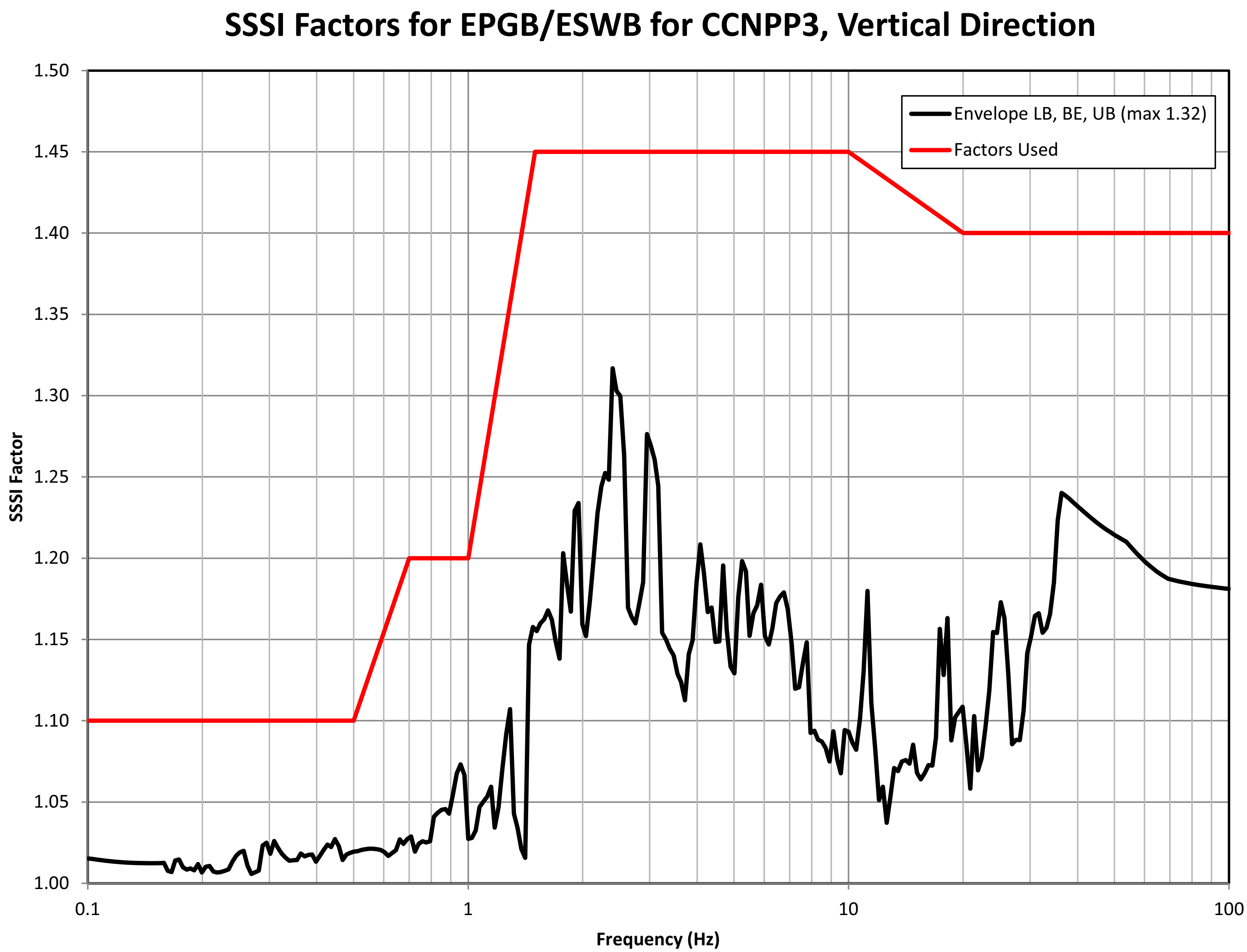


Figure 3.7-8a — {Comparison of Site SSE to Modified SSE (or SSE_{NI}) and Adjusted FIRS for ESWB and EPGB - Horizontal Direction}

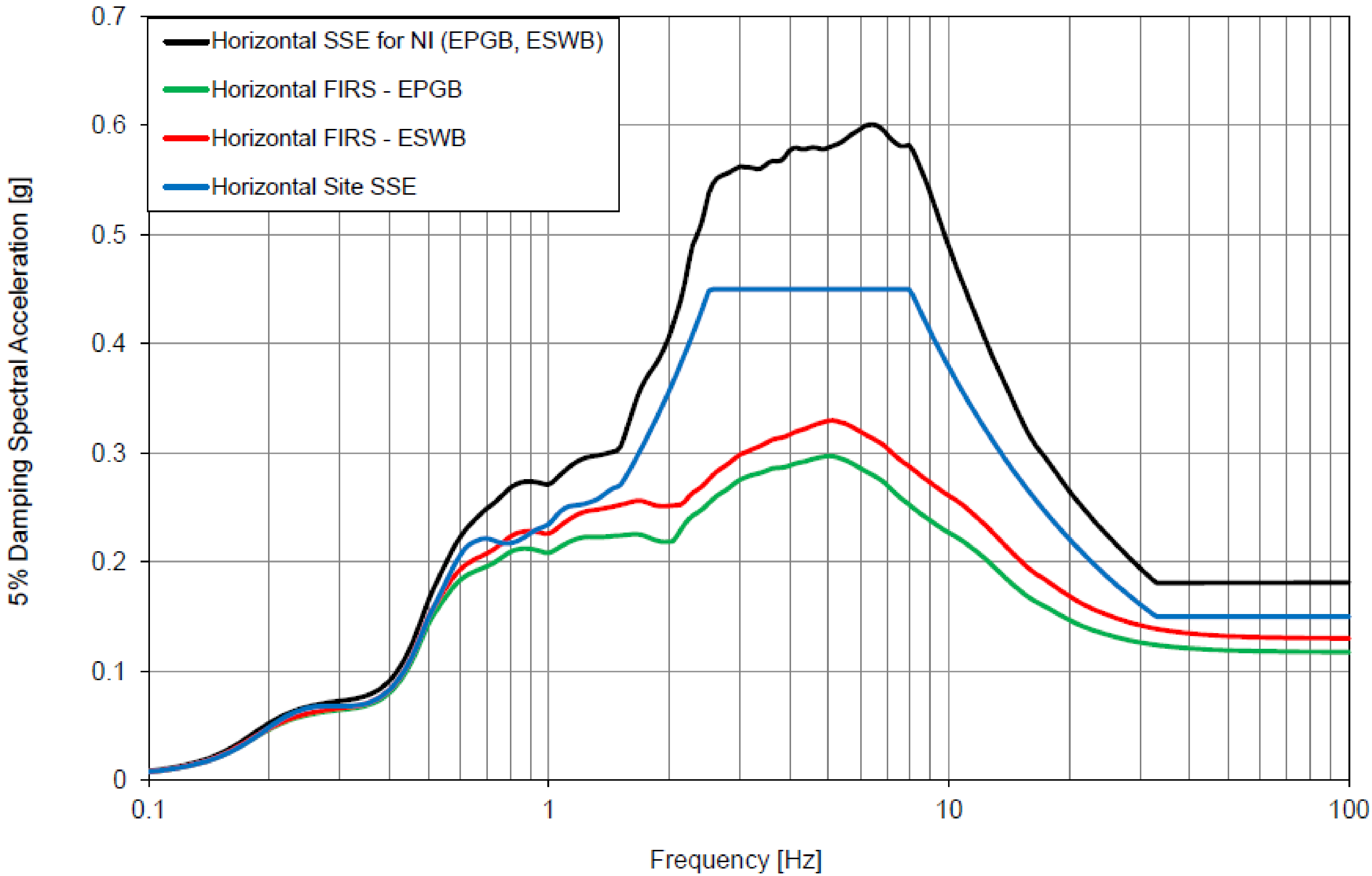


Figure 3.7-8b— {Comparison of Site SSE to Modified (or SSE_{NI}) and Adjusted FIRS for EPGB - Vertical Direction}

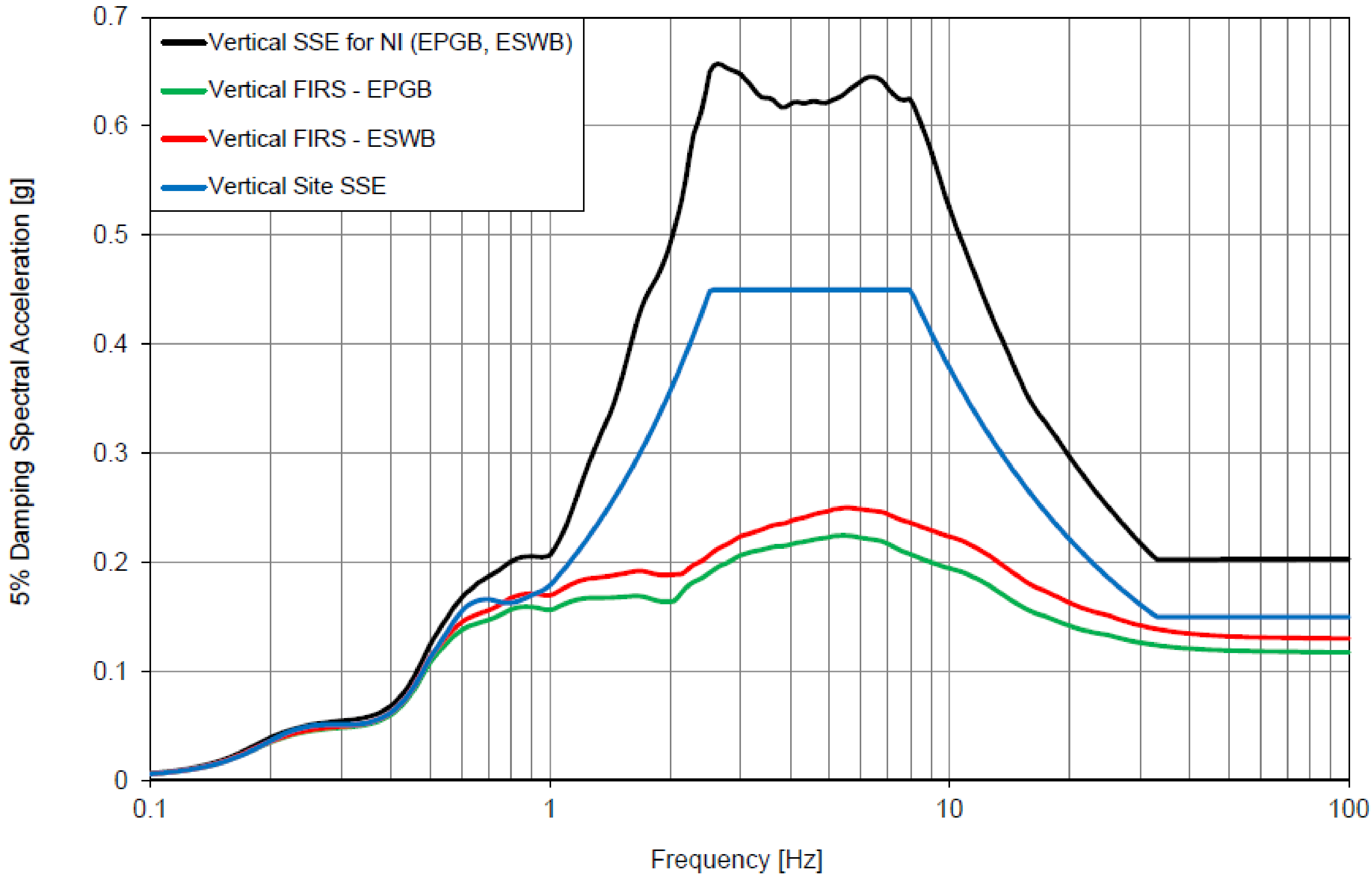


Figure 3.7-9a — {Comparison of Site SSE to SSE_{CBIS} and Adjusted FIRS for CBIS - Horizontal Direction}

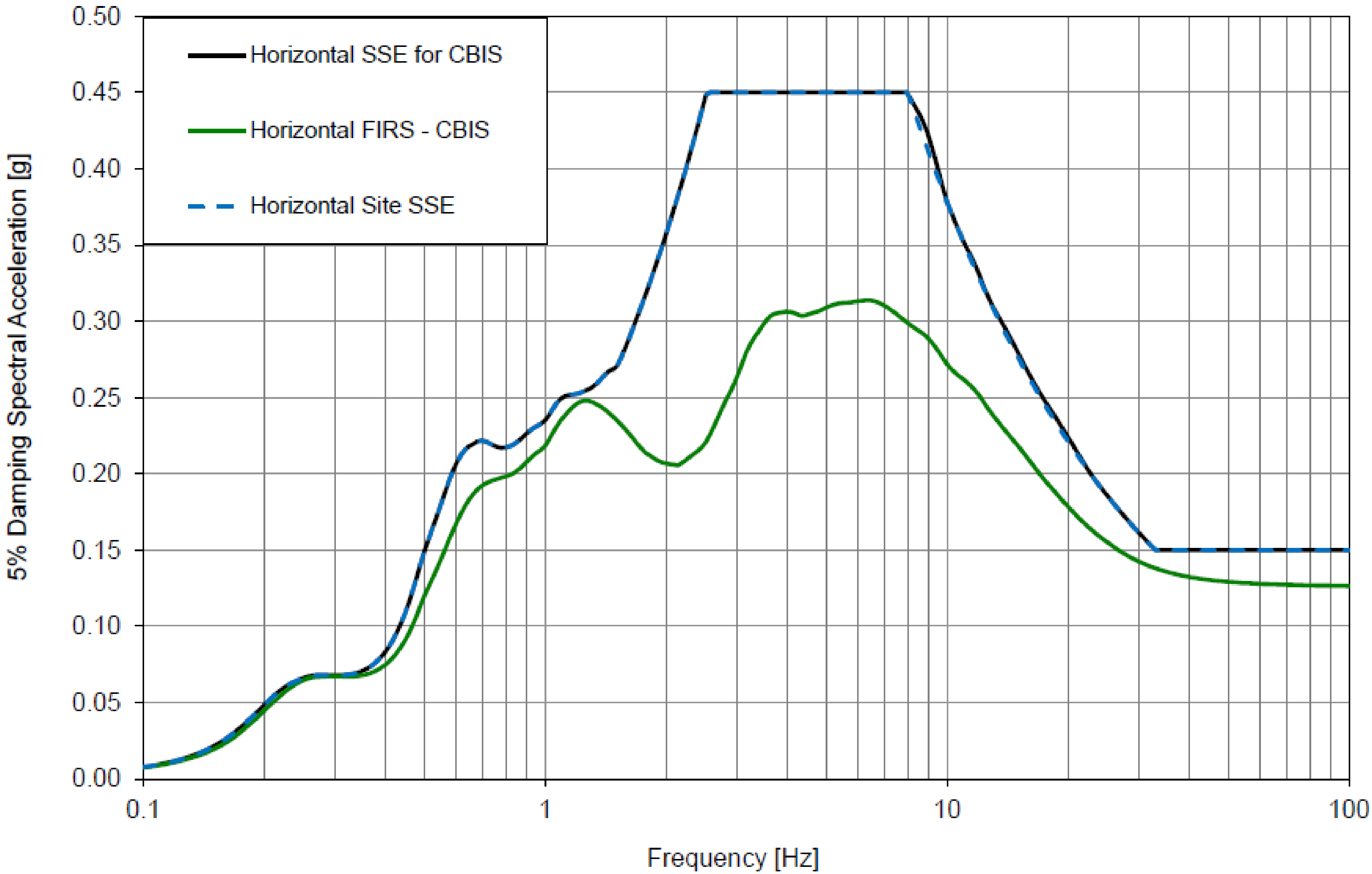


Figure 3.7-9b — {Comparison of Site SSE to SSE_{CBIS} and Adjusted FIRS for CBIS - Vertical Direction}

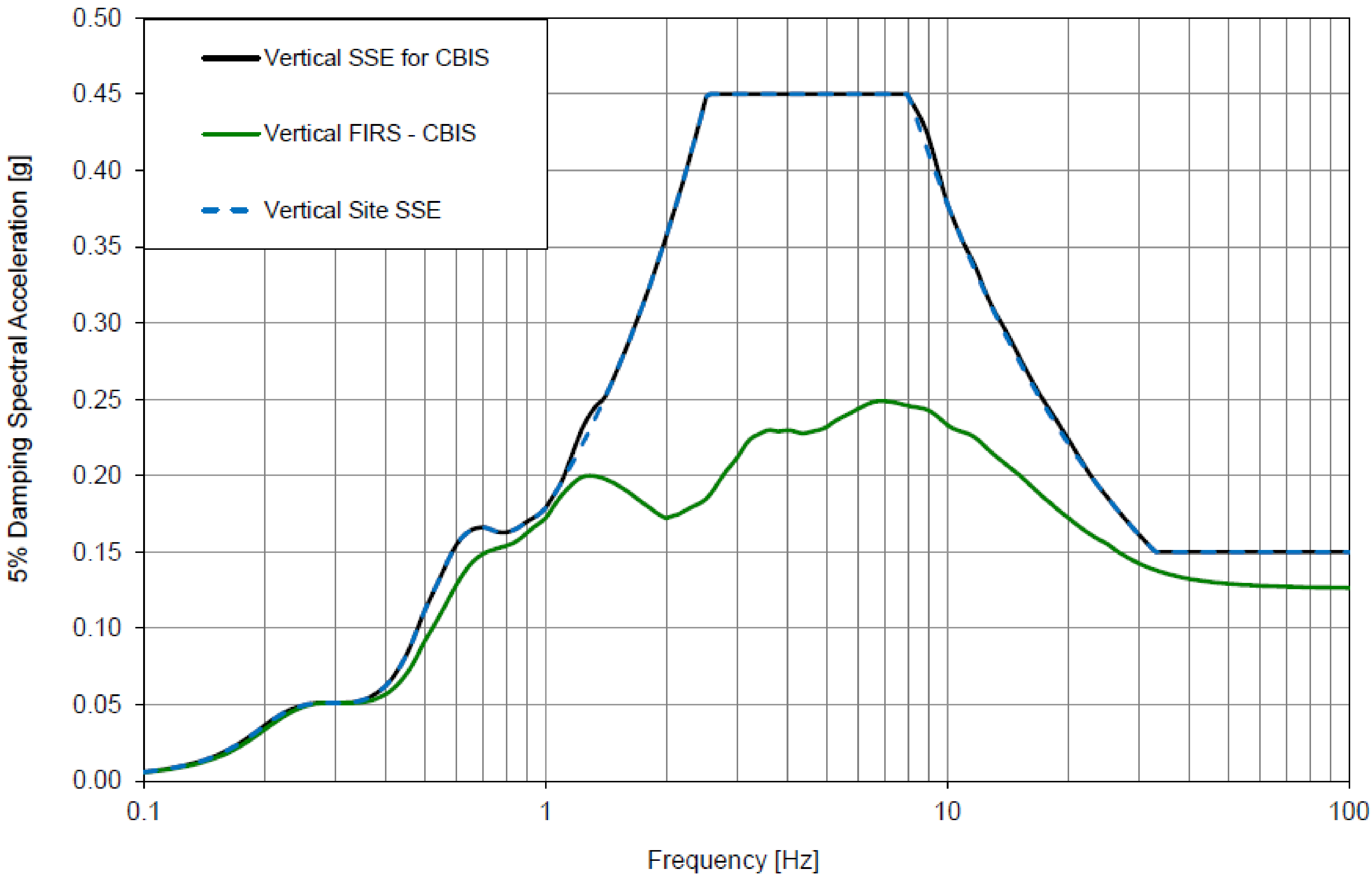


Figure 3.7-10 — {Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal Component H1}

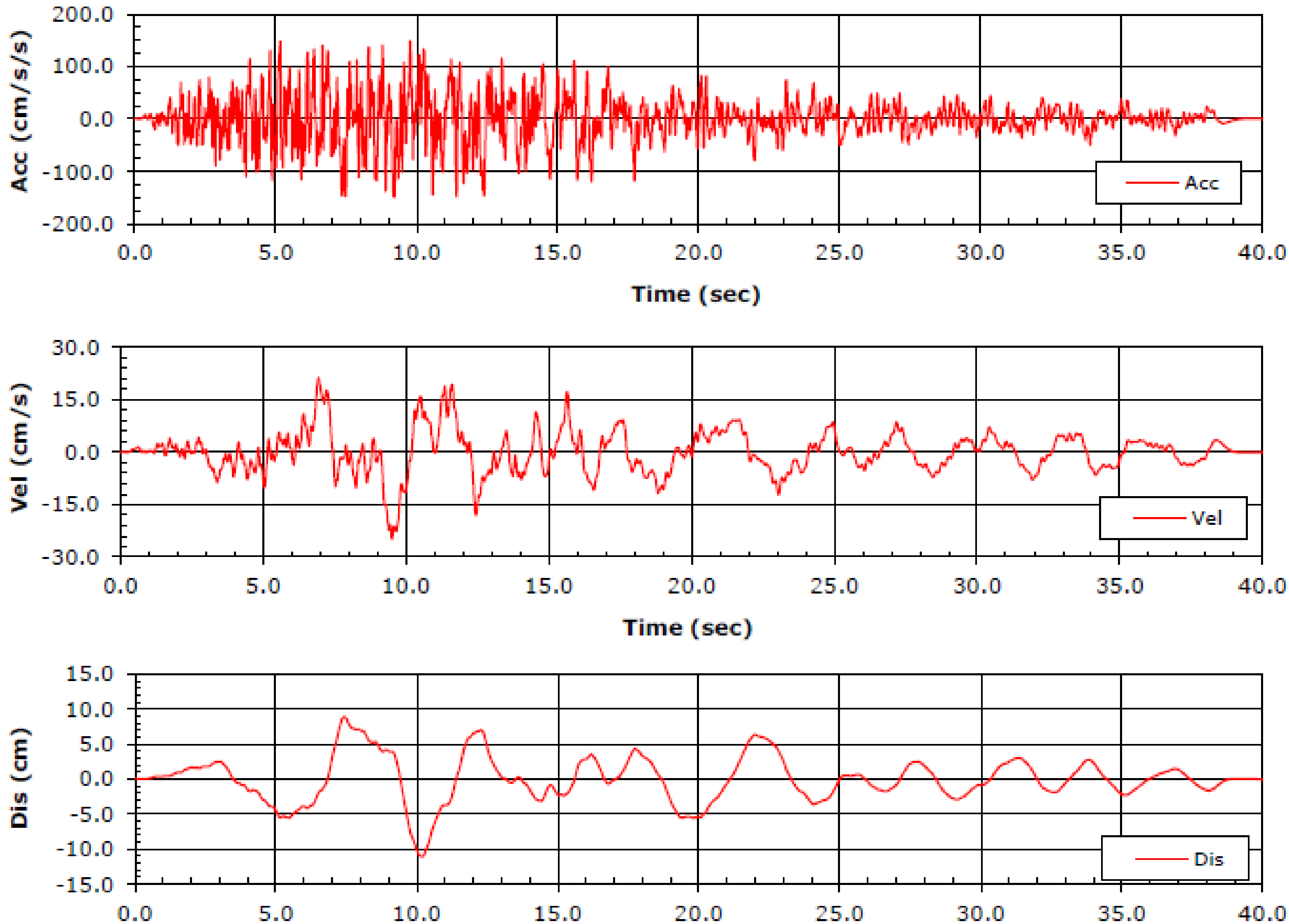


Figure 3.7-11 — {Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Horizontal Component H2}

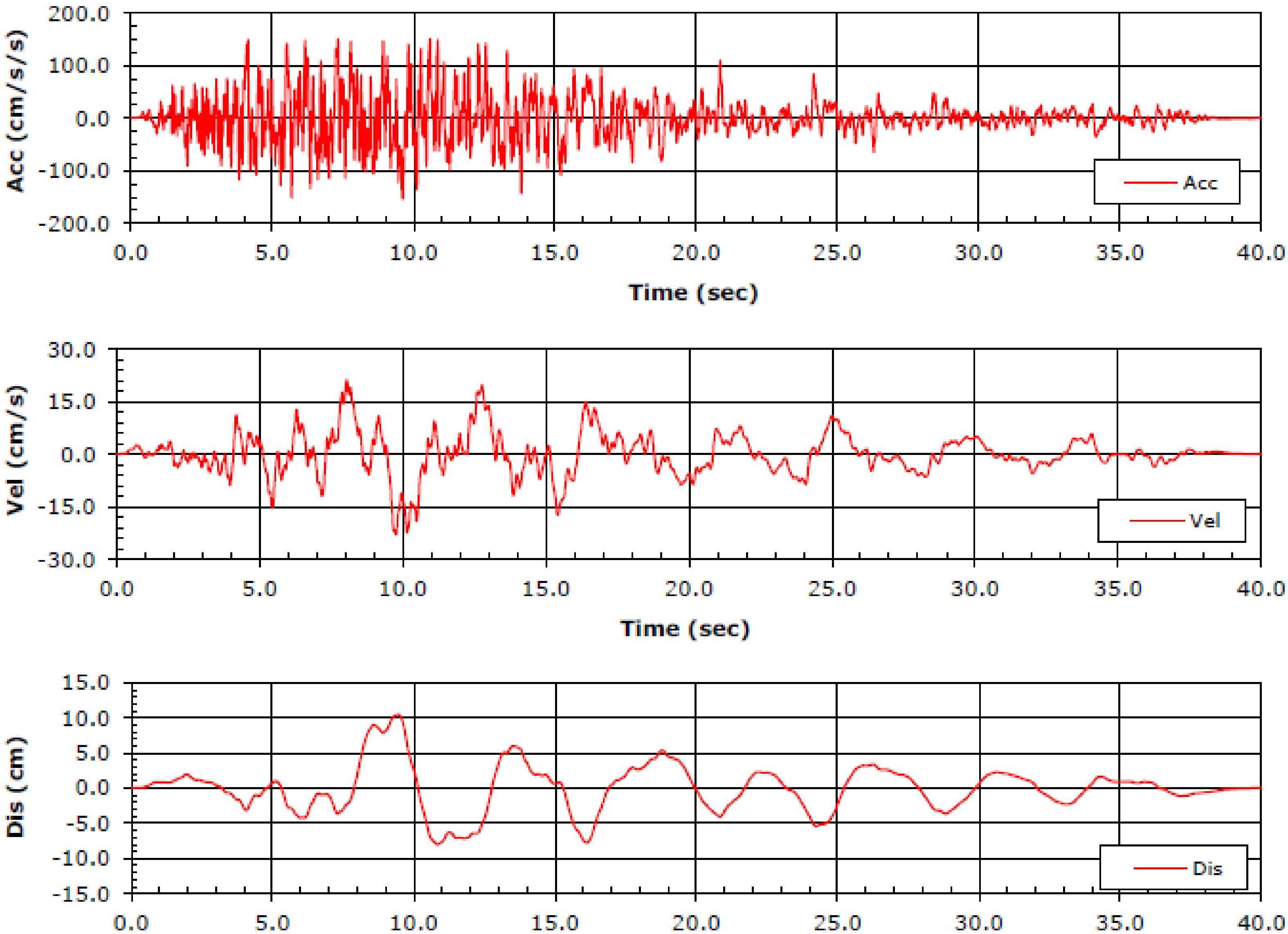


Figure 3.7-12 — {Site SSE Spectrum Compatible Acceleration, Velocity, and Displacement Time Histories for Vertical Component UP}

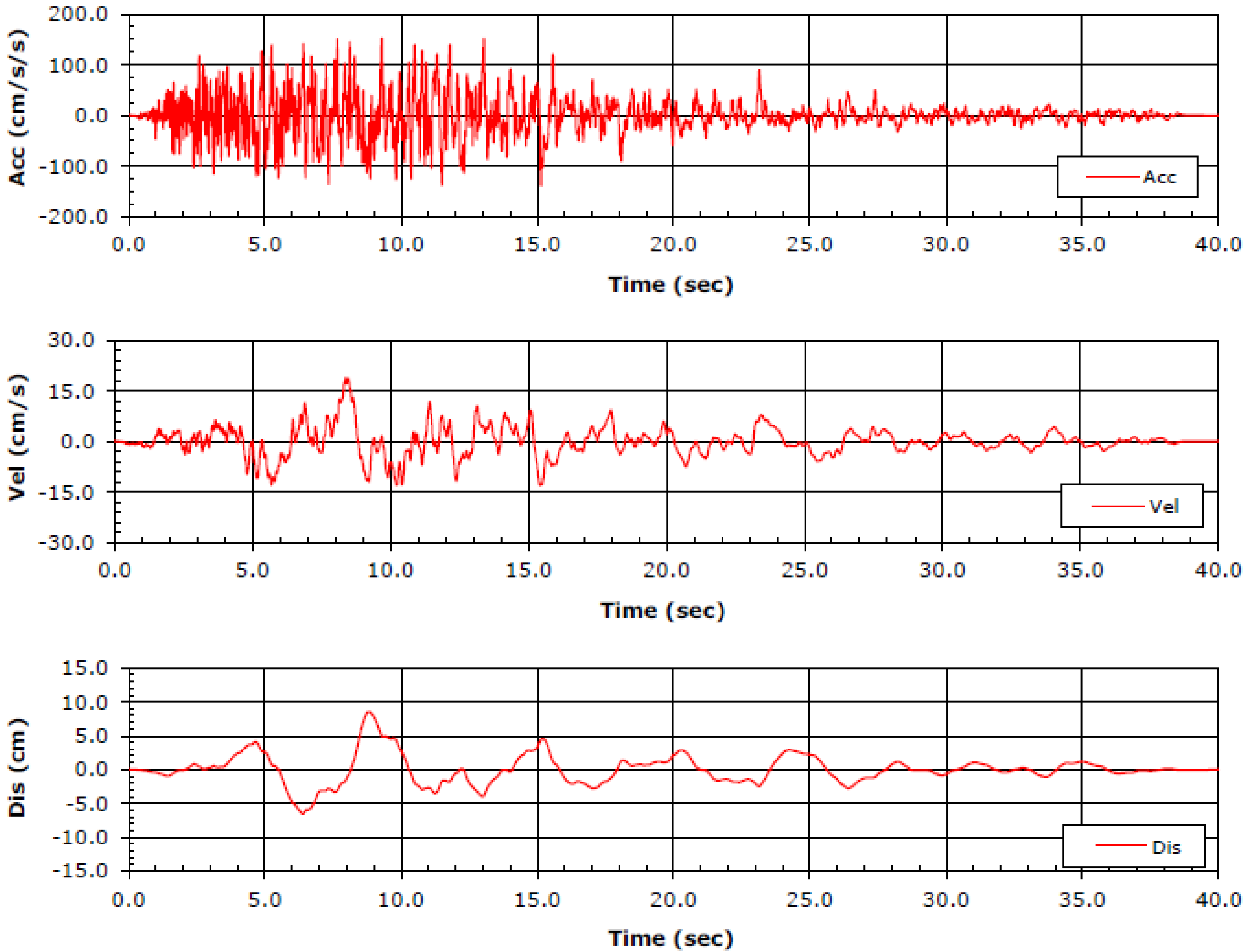
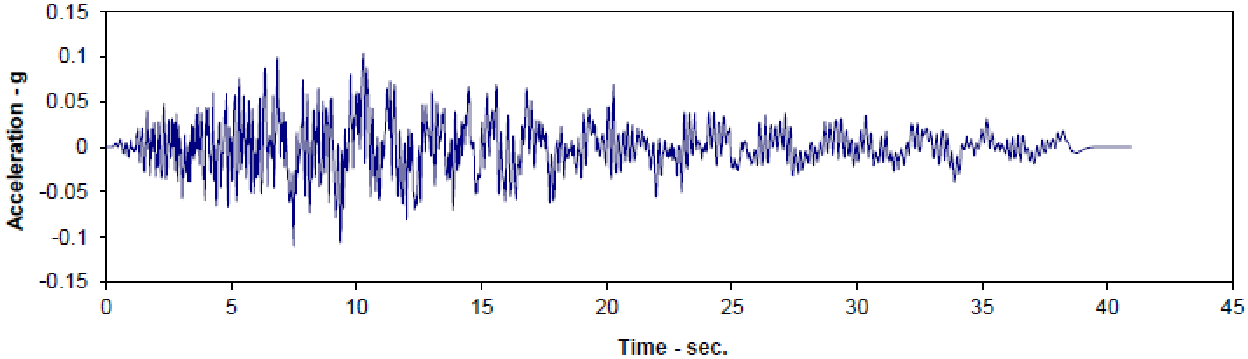
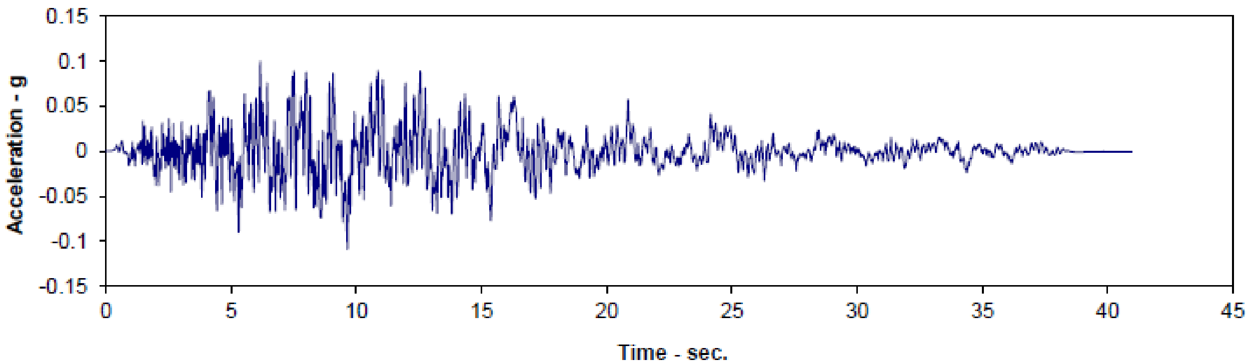


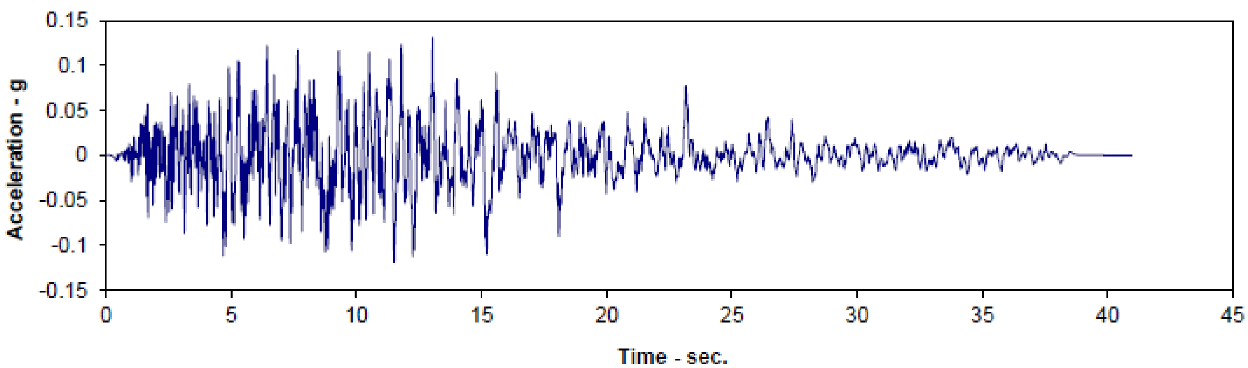
Figure 3.7-13 — {SSI "Within" Acceleration Time Histories for Input at NICBM Structures Foundation (LB Soil Case)}



a) Horizontal Direction H1

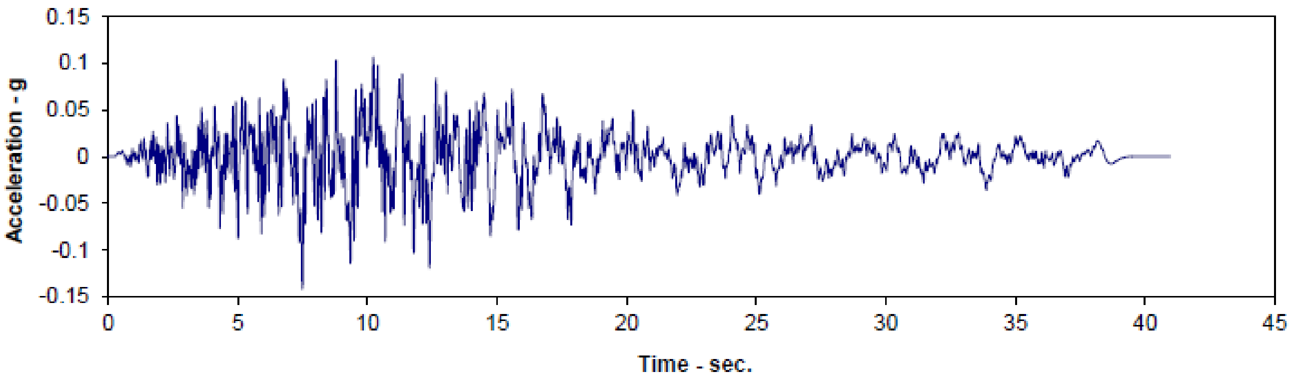


b) Horizontal Direction H2

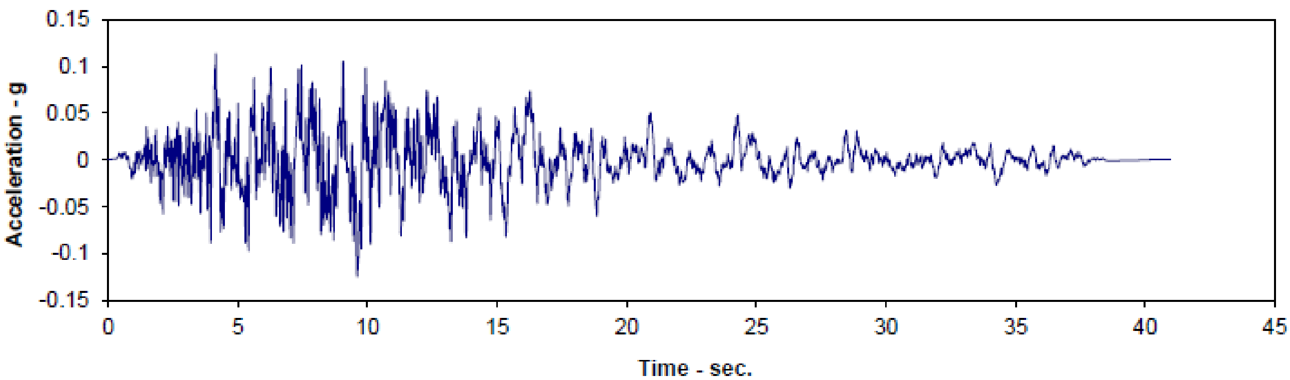


c) Vertical Direction UP

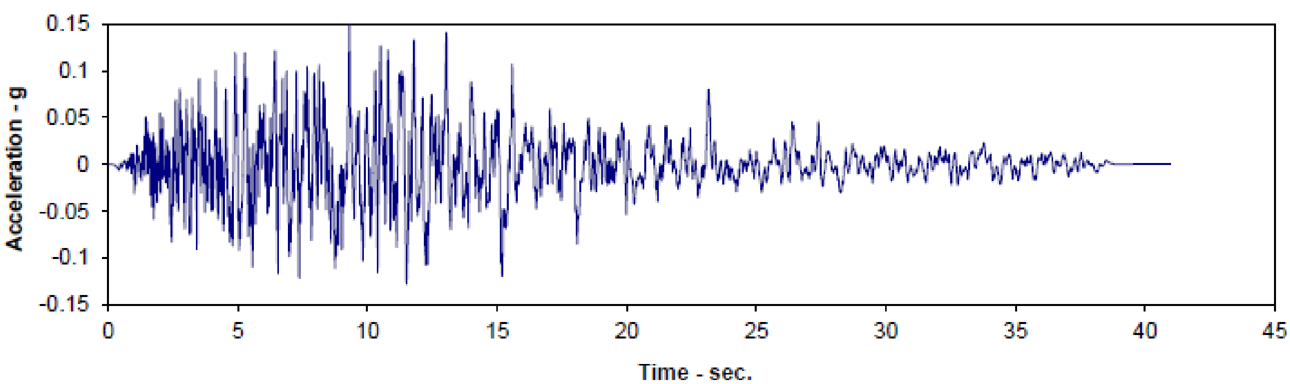
Figure 3.7-14 — {SSI "Within" Acceleration Time Histories for Input at NICBM Structures Foundation (BE Soil Case)}



a) Horizontal Direction H1

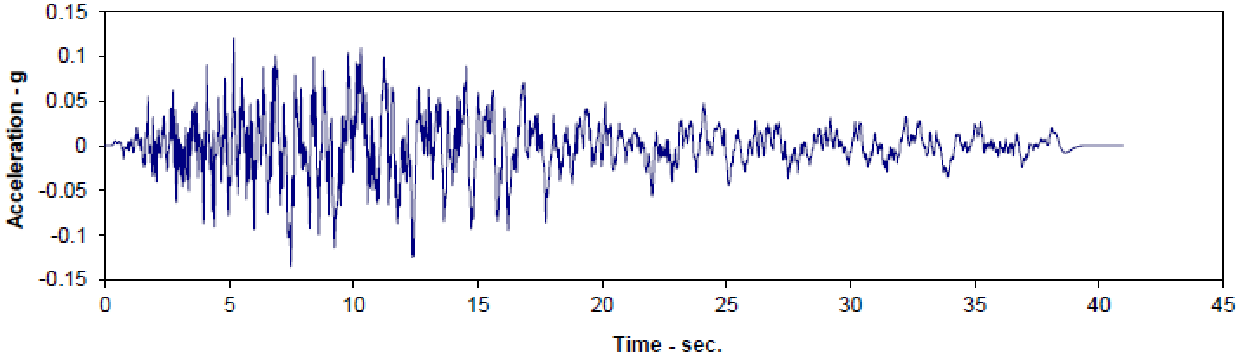


b) Horizontal Direction H2

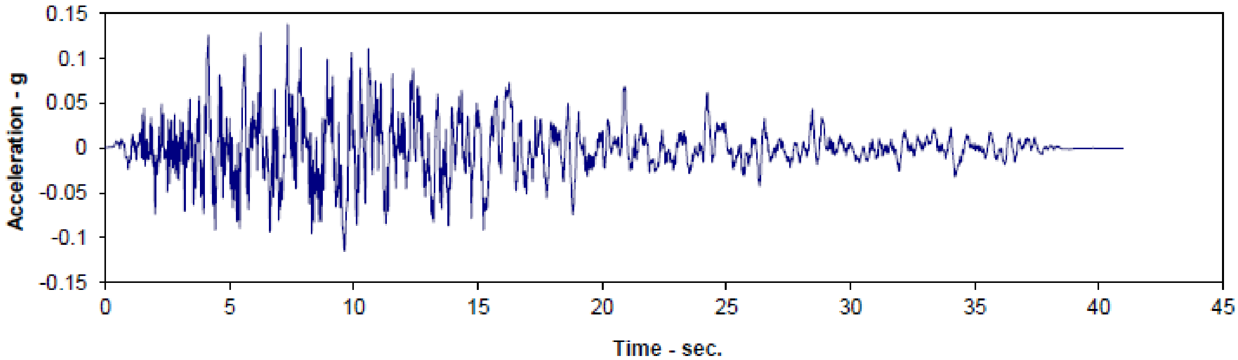


c) Vertical Direction UP

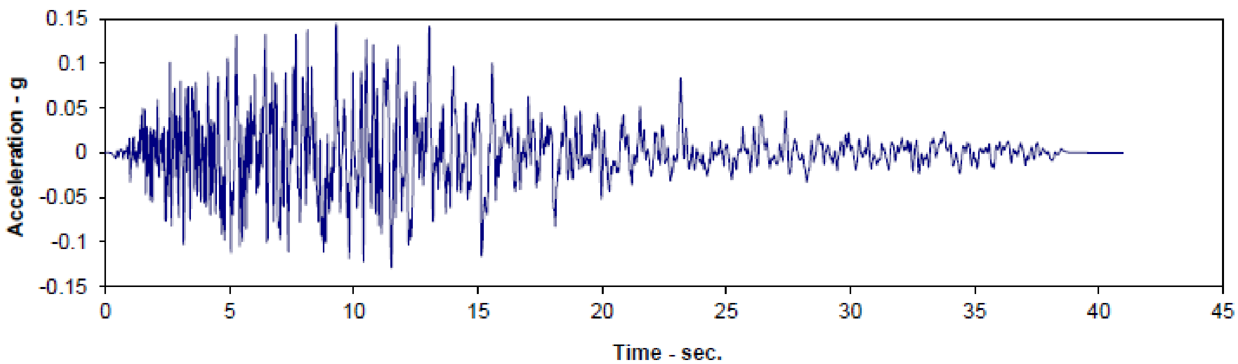
Figure 3.7-15 — {SSI "Within" Acceleration Time Histories for Input at NICBM Structures Foundation (UB Soil Case)}



a) Horizontal Direction H1



b) Horizontal Direction H2



c) Vertical Direction UP

Figure 3.7-16 — {Not Used}

Figure 3.7-16 is not used.

Figure 3.7-17 — {Not Used}

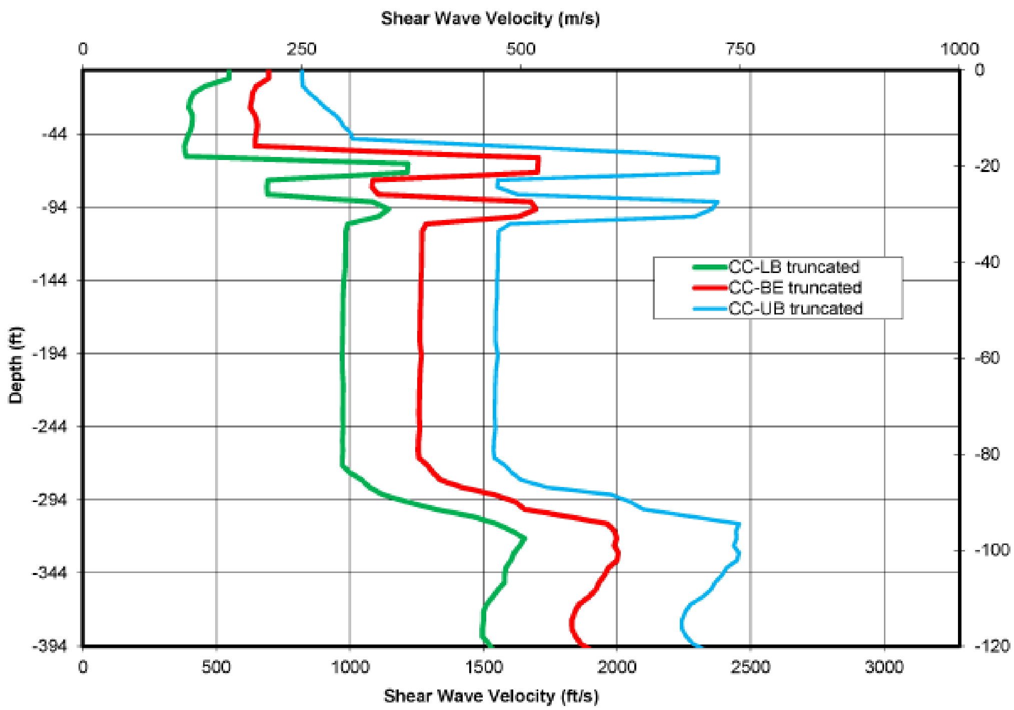
Figure 3.7-17 is not used.

Figure 3.7-18 — {Not Used}

Figure 3.7-18 is not used.

Figure 3.7-19 — {CCNPP Unit 3 Strain-Compatible Soil Profiles for NI Common Basemat Structures}

a. Profile for first 120 meters



b. Profile for 1200 meters

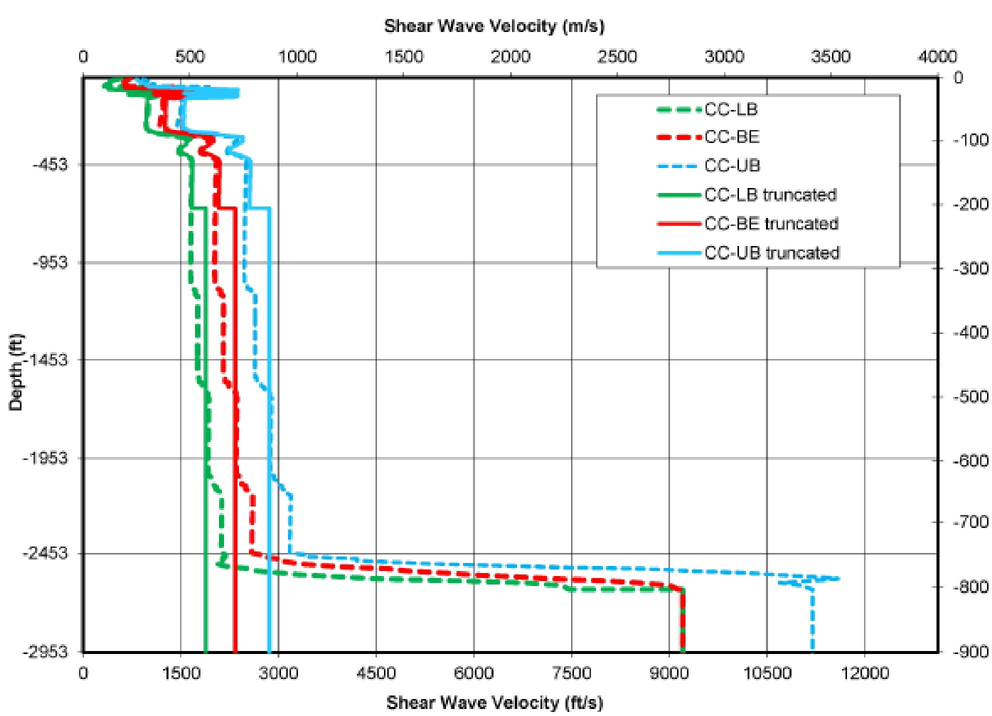
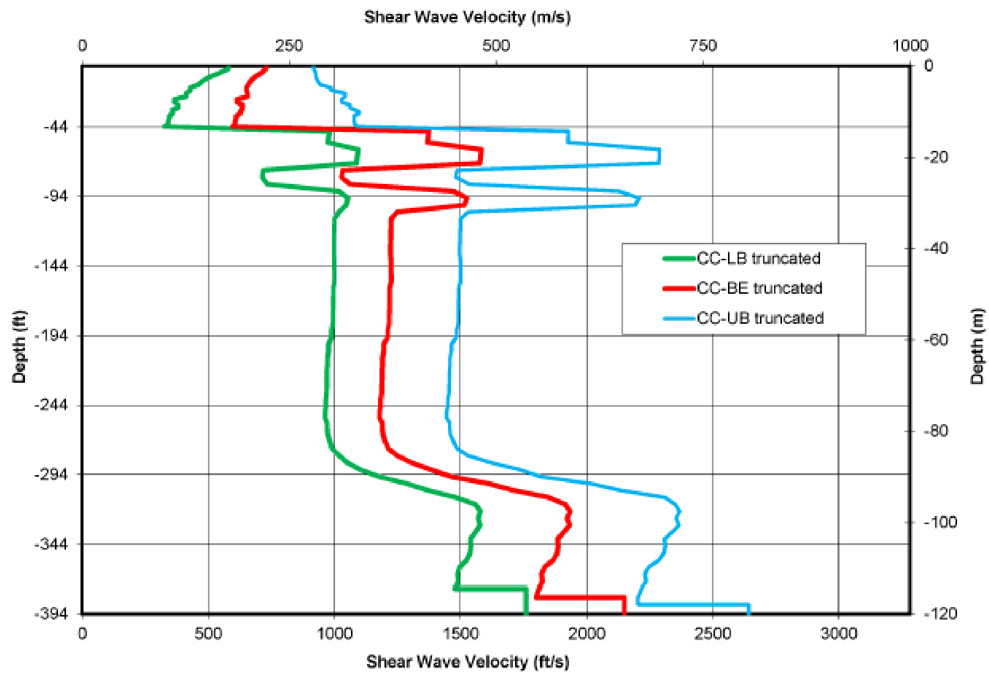


Figure 3.7-20 — {Not Used}

Figure 3.7-20 is not used.

Figure 3.7-20a — {CCNPP Unit 3 Strain-Compatible Soil Profiles for EPGBs}

a. Profile for first 120 meters



b. Profile for 1200 meters

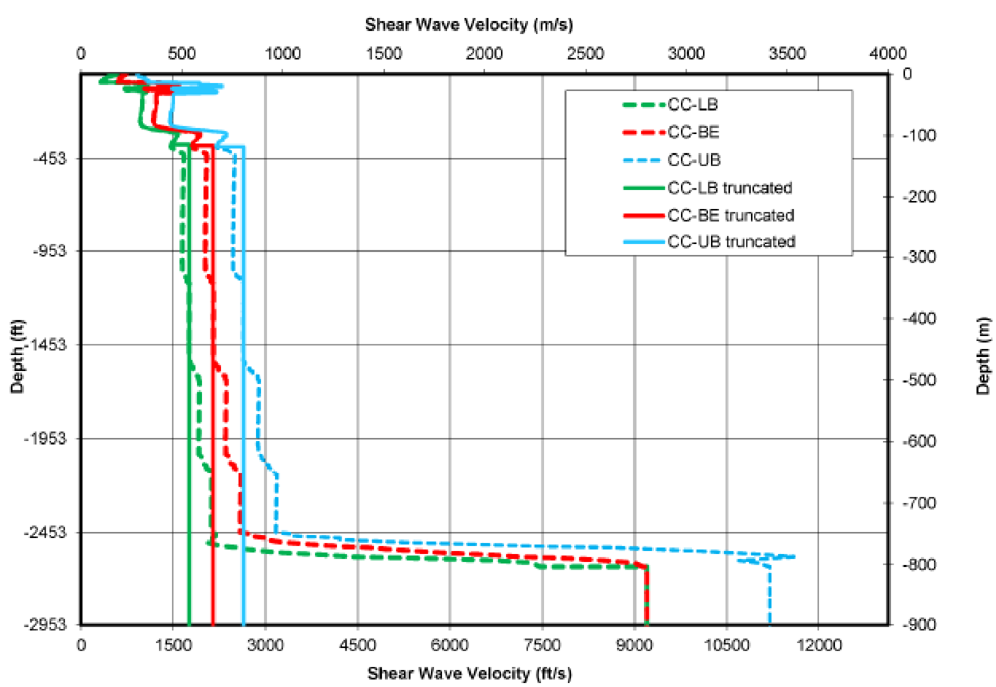
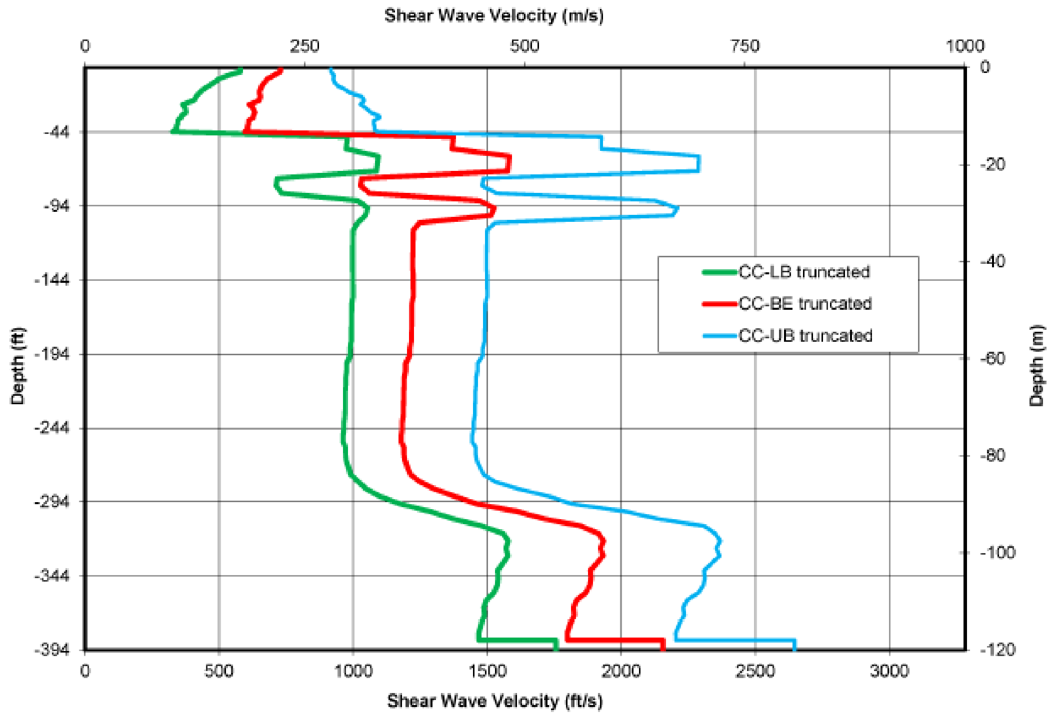


Figure 3.7-20b — {CCNPP Unit 3 Strain-Compatible Soil Profiles for ESWBs}

a. Profile for first 120 meters



b. Profile for 1200 meters

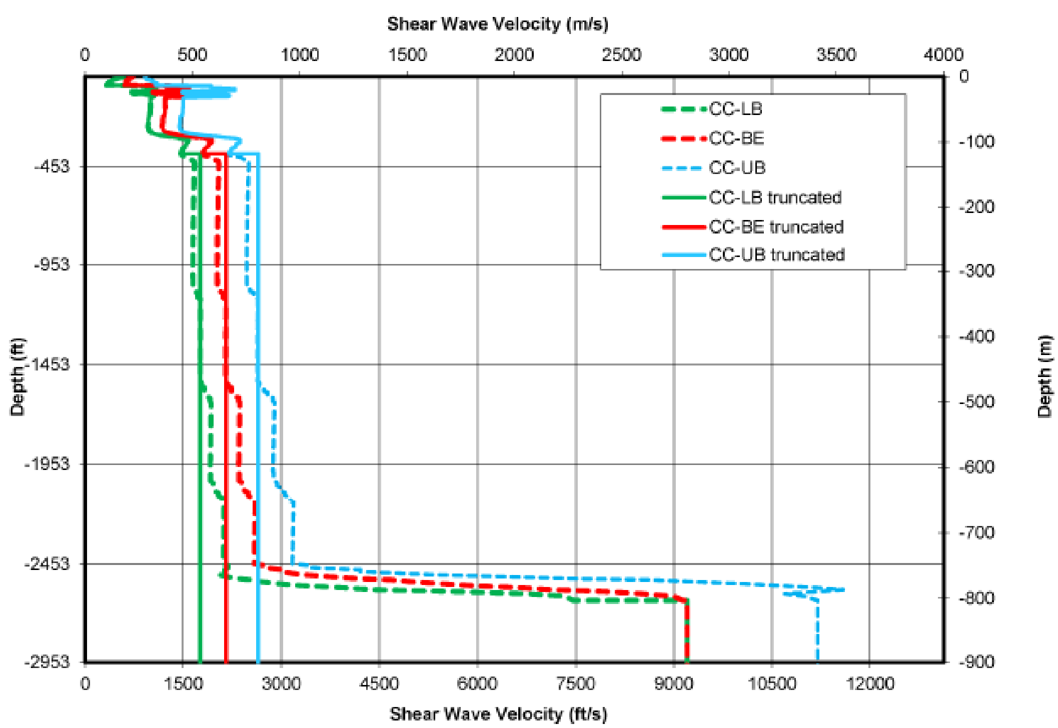


Figure 3.7-21 — {CCNPP Unit 3 Strain-Compatible Shear-Wave Velocity Profiles at the NI Area for the TI Structure}

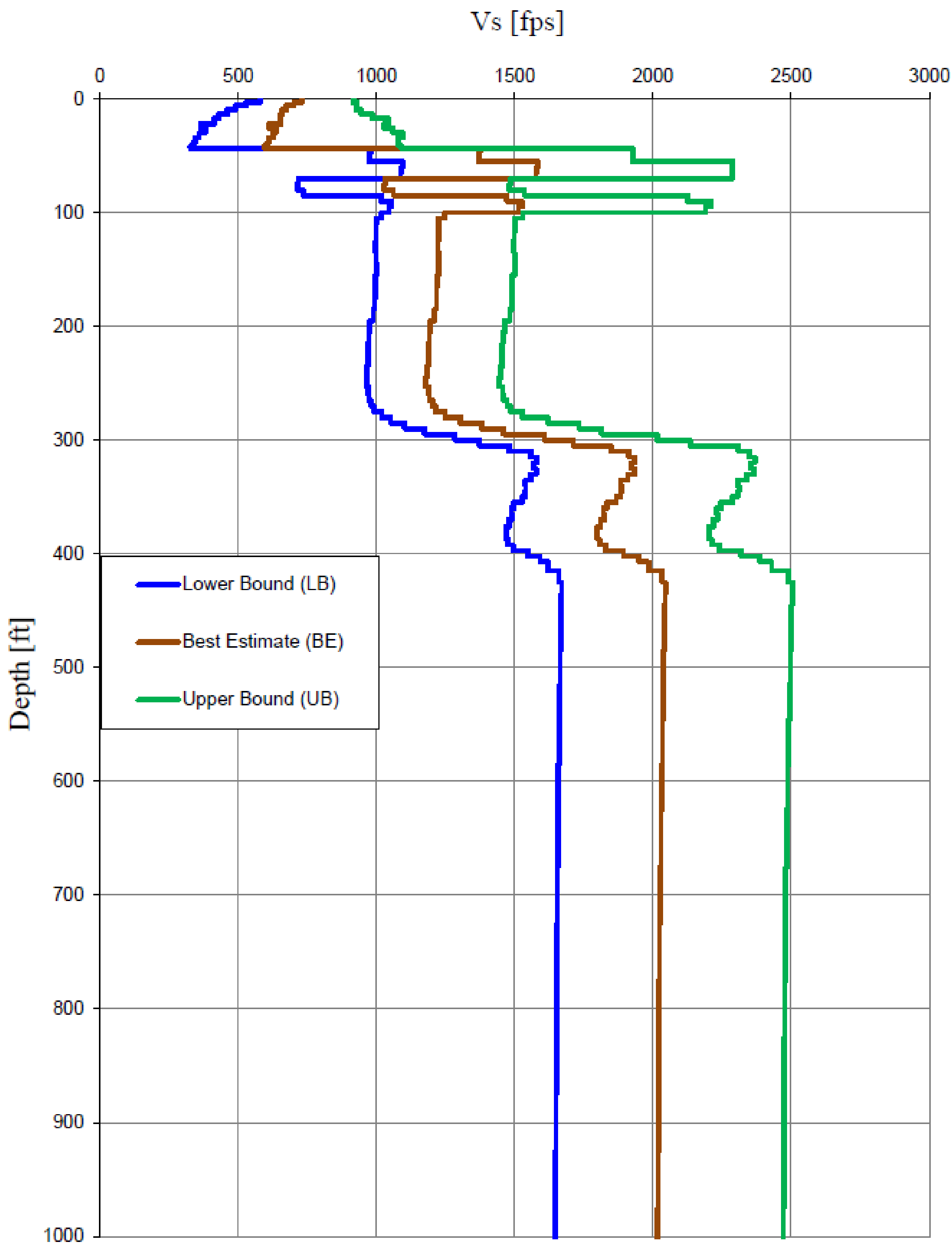


Figure 3.7-22 — {CCNPP Unit 3 Strain-Compatible Shear Wave Velocity Profiles at the Intake Area for CBIS}

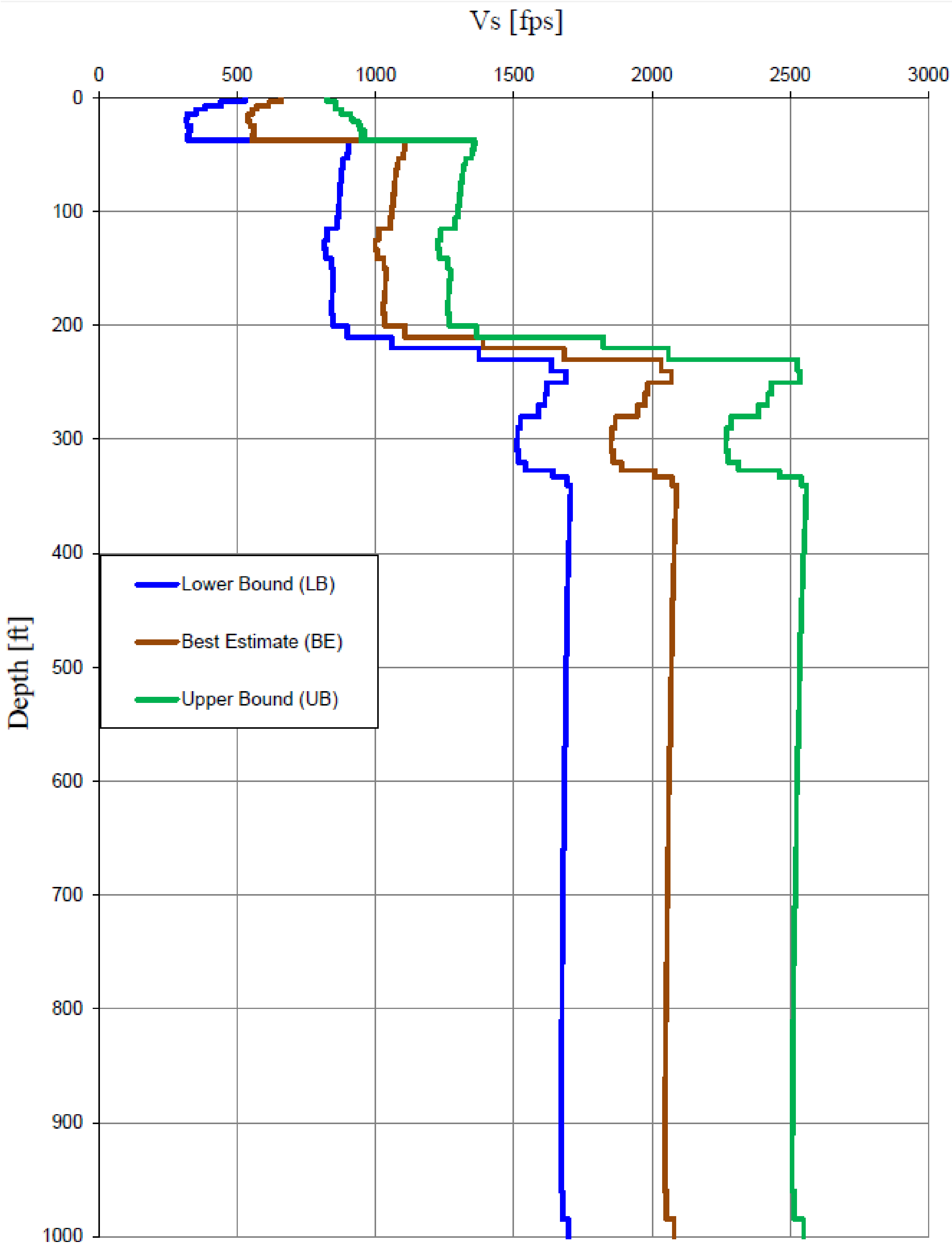


Figure 3.7-23 — {Isometric View of the Common Basemat Intake Structures}

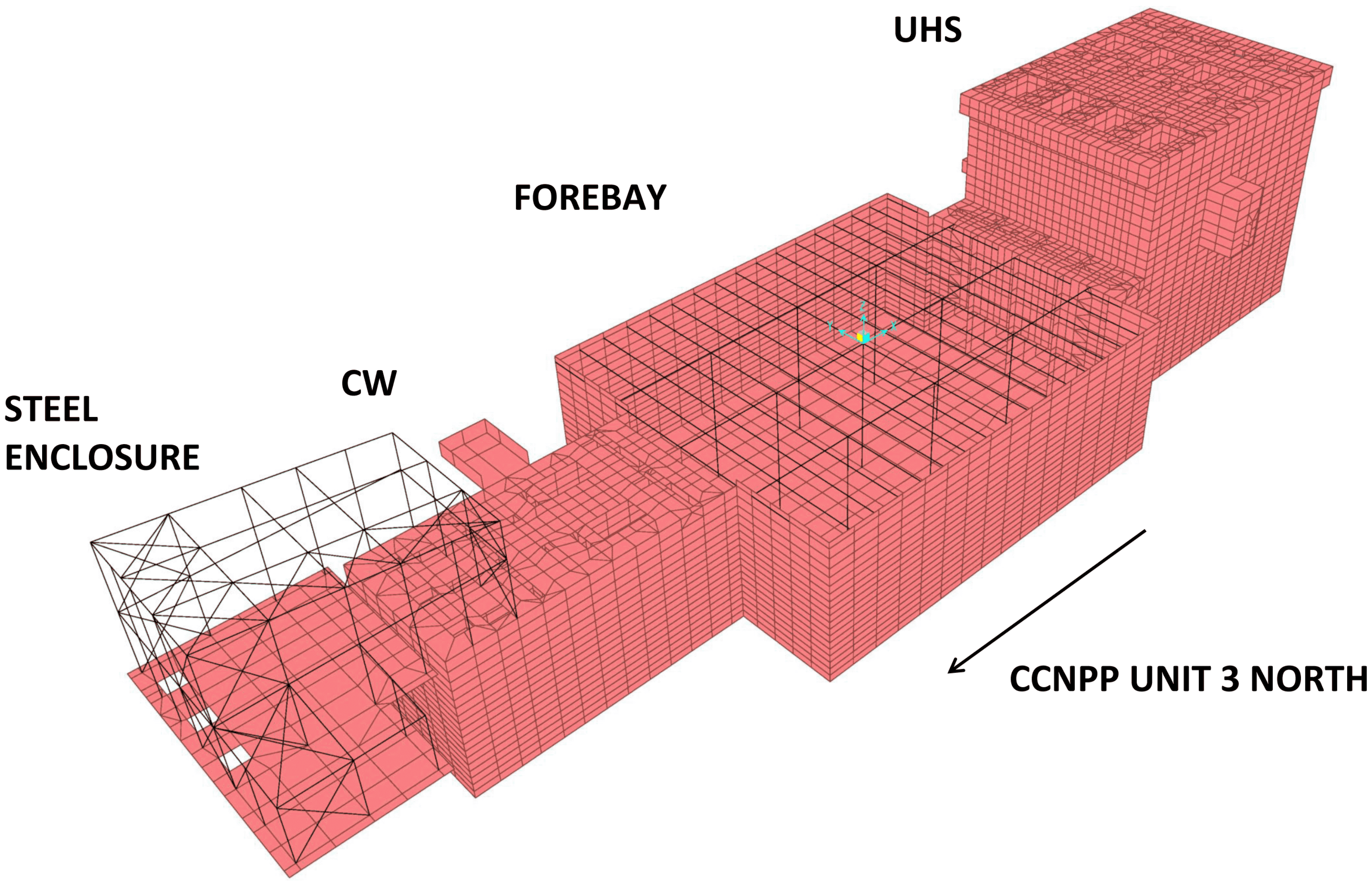


Figure 3.7-24 — {Soil-Structure Interaction (SSI) model for the Common Basemat Intake Structures (Elevations and plant coordinate system refer to CCNPP Unit 3)}

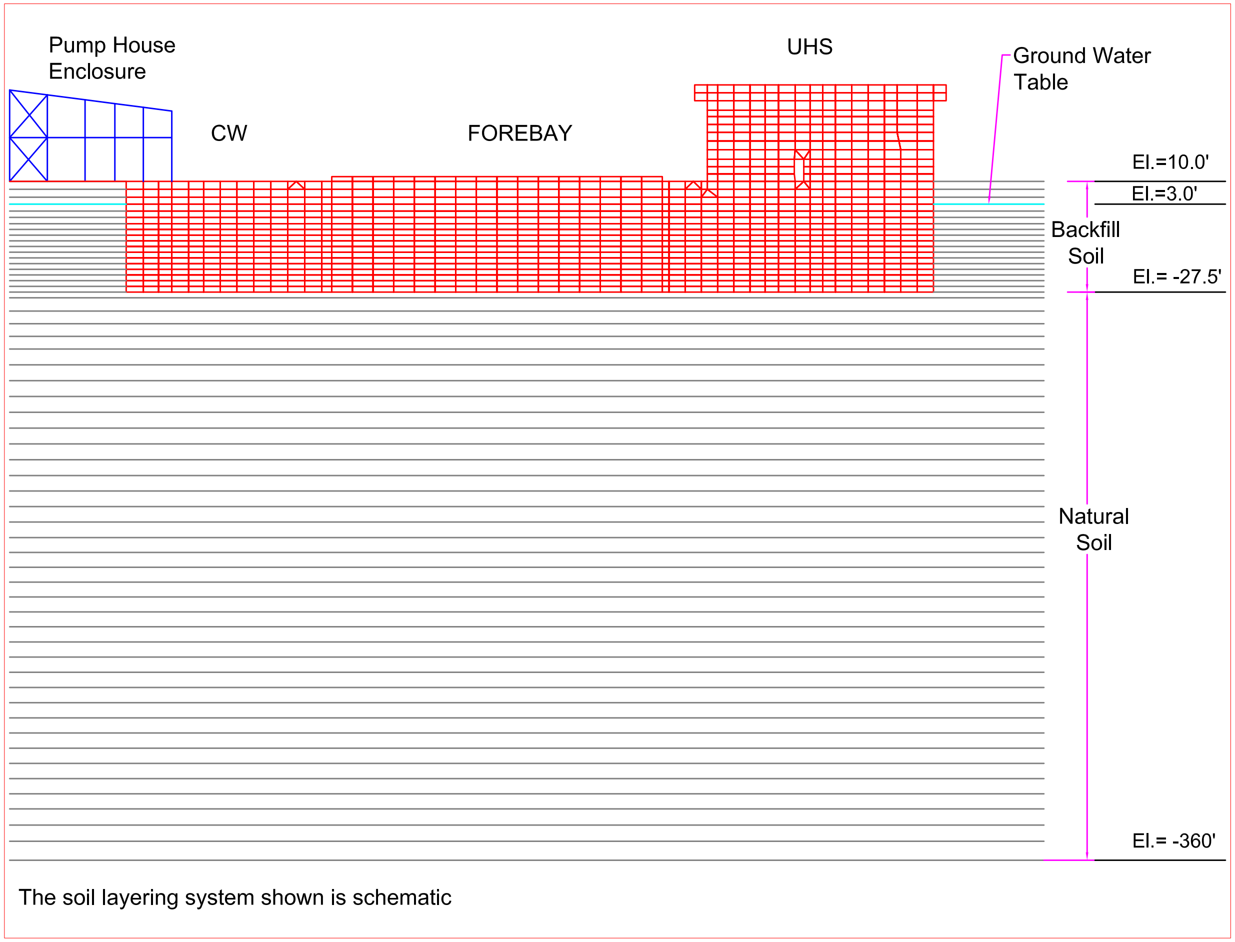


Figure 3.7-25 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Building Internal Structures, Z_{NI}+5.15 m (+16 ft - 10 3/4 in), X(E-W) Direction, Rigid Location, Damping 5%}

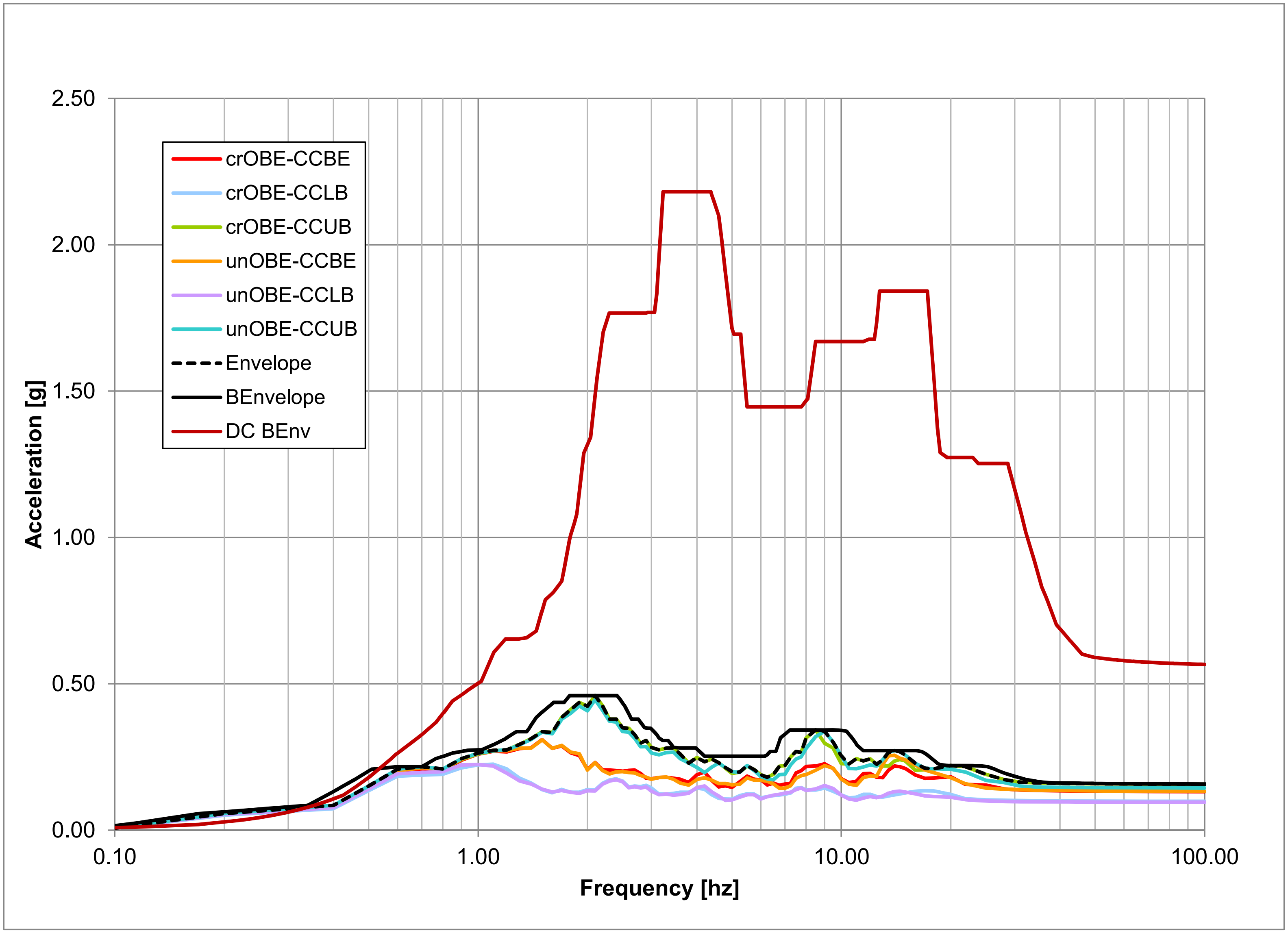


Figure 3.7-26 — {DC vs. COLA In-Structure Response spectra (ISRS), Reactor Building Internal Structures, Z_{NI} = +5.15 m (+16 ft - 10 3/4 in), Y(N-S) Direction, Rigid Location, Damping 5%}

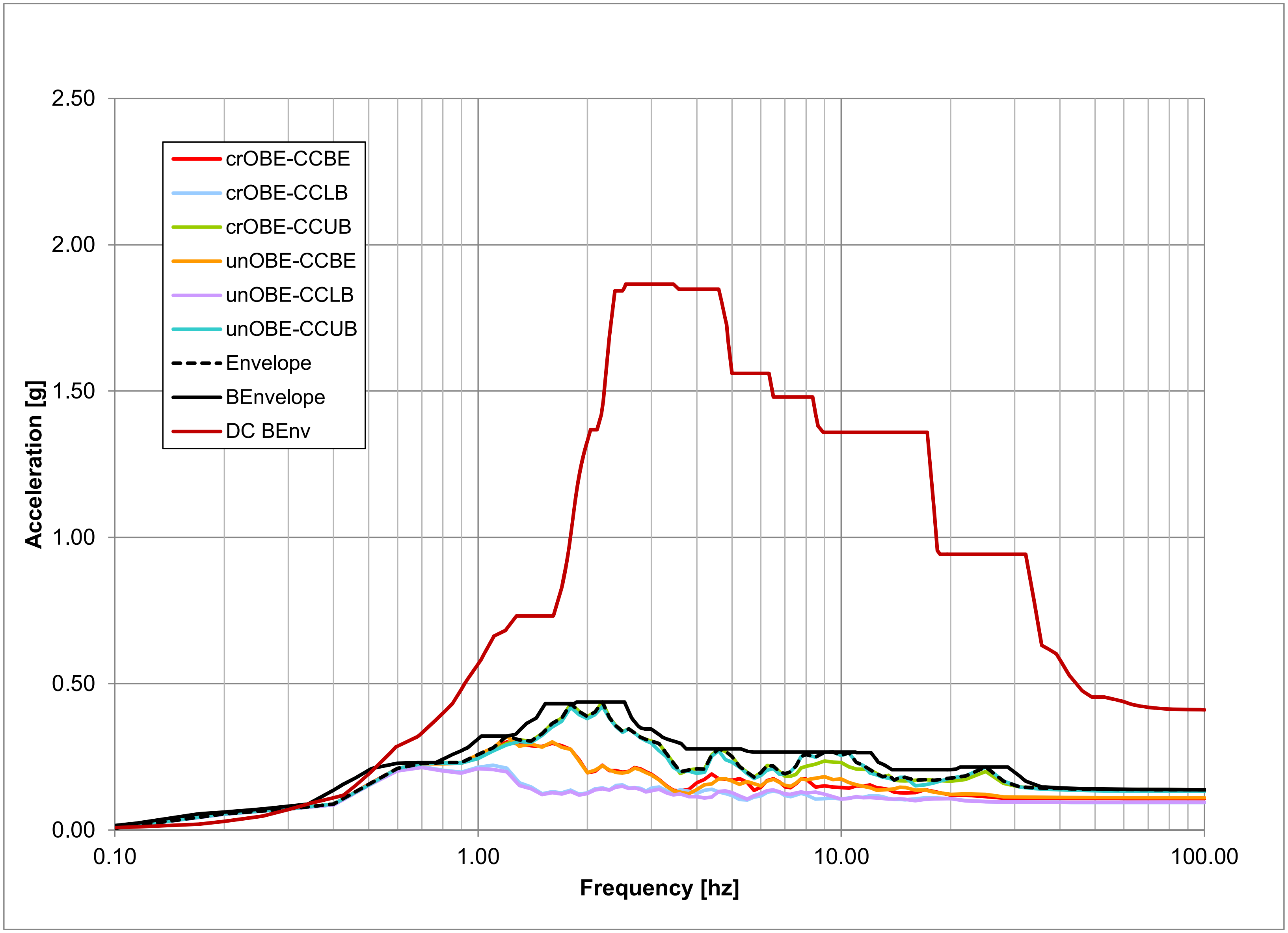


Figure 3.7-27 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Building Internal Structures, Z_{NI} = +5.15m (+16 ft - 10 3/4 in), Z(Vert) Direction, Rigid Location, Damping 5%}

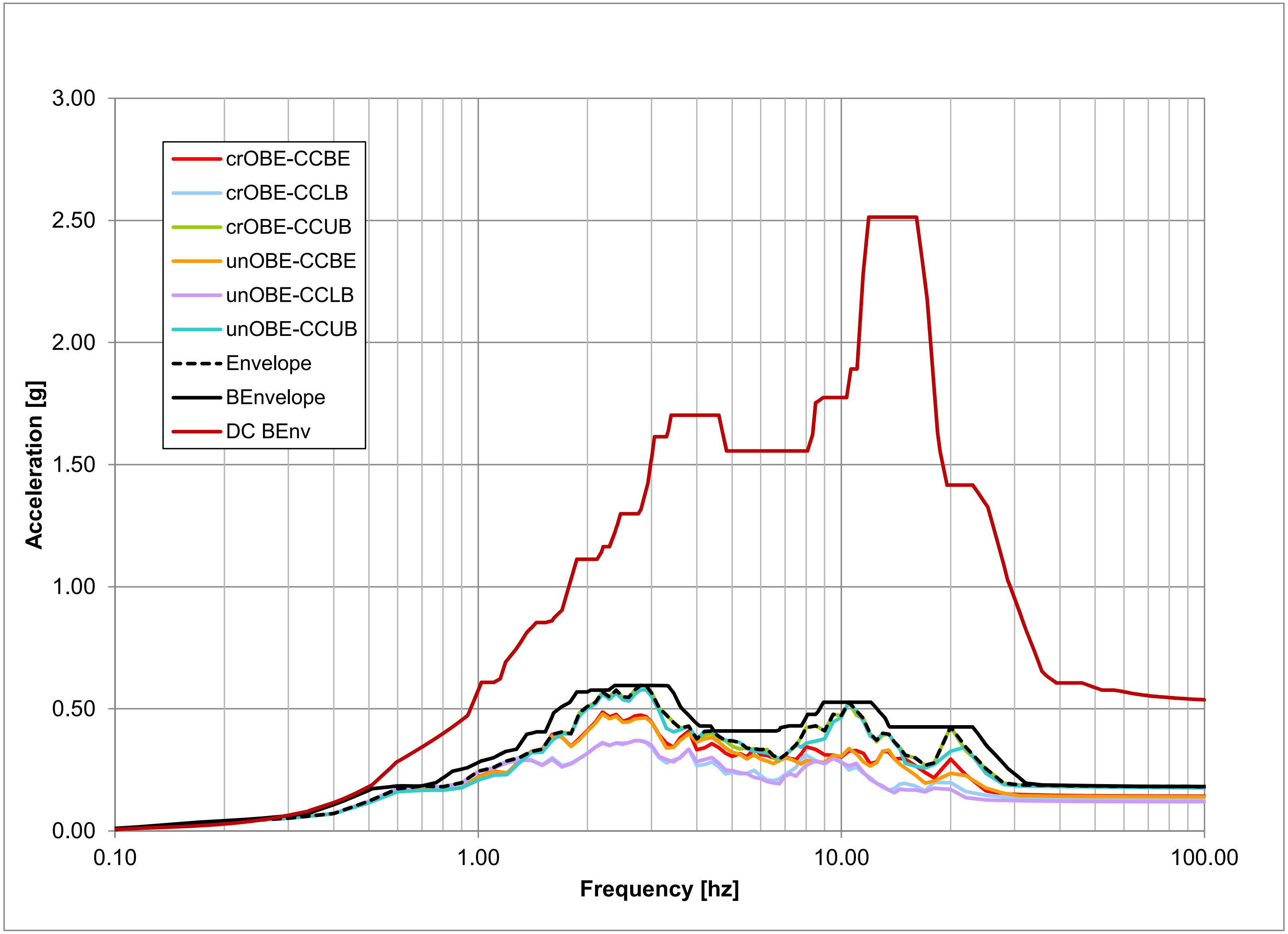


Figure 3.7-28 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Building Internal Structures, Z_{NI} = 1 +19.50 m (+63 ft - 1 3/4 in), X(E-W) Direction, Rigid Location, Damping 5%}

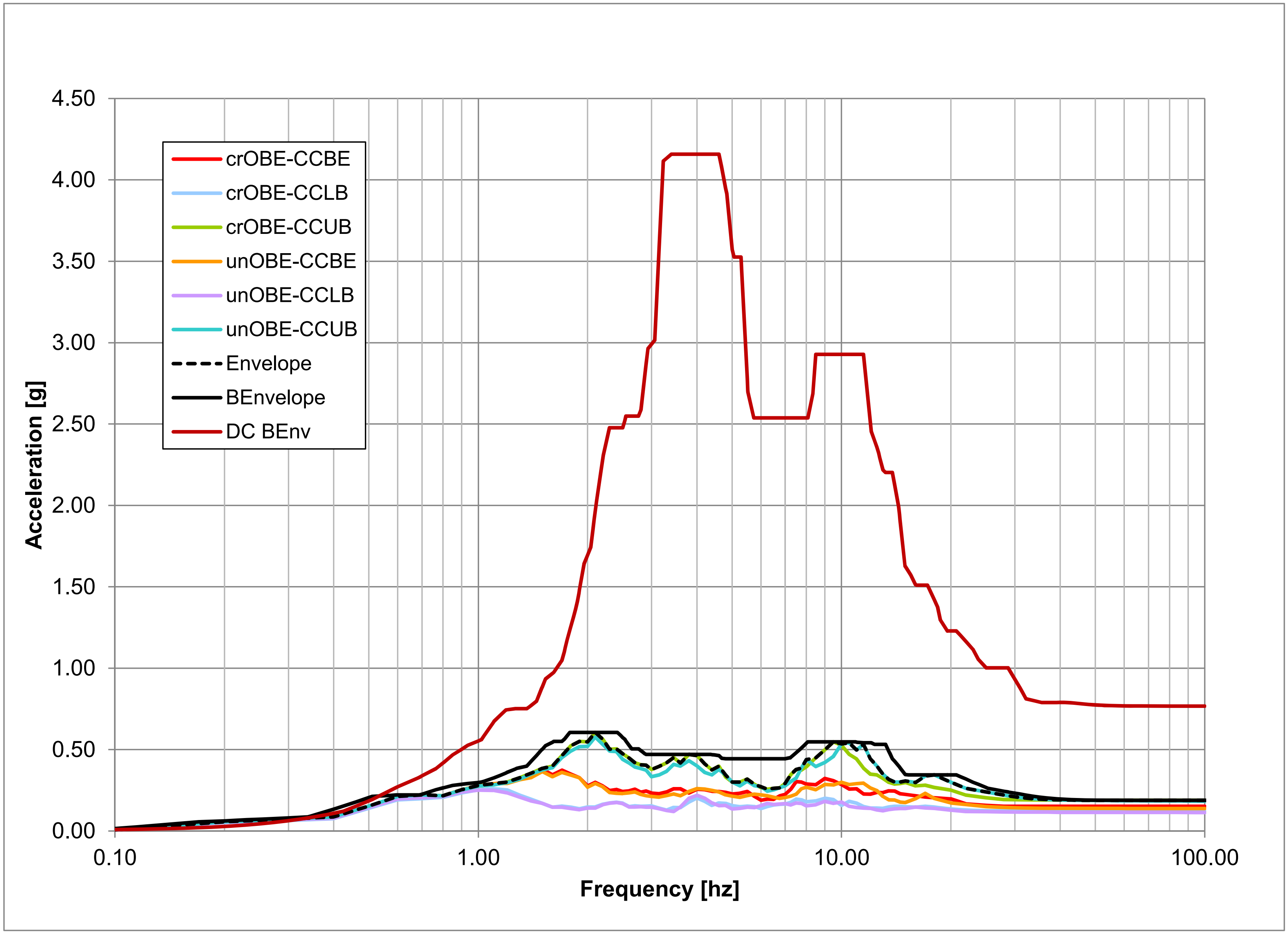


Figure 3.7-29 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Building Internal Structures, Z_{NI} = +19.50 m (+63 ft - 11 3/4 in), Y(N-S) Direction, Rigid Location, Damping 5%}

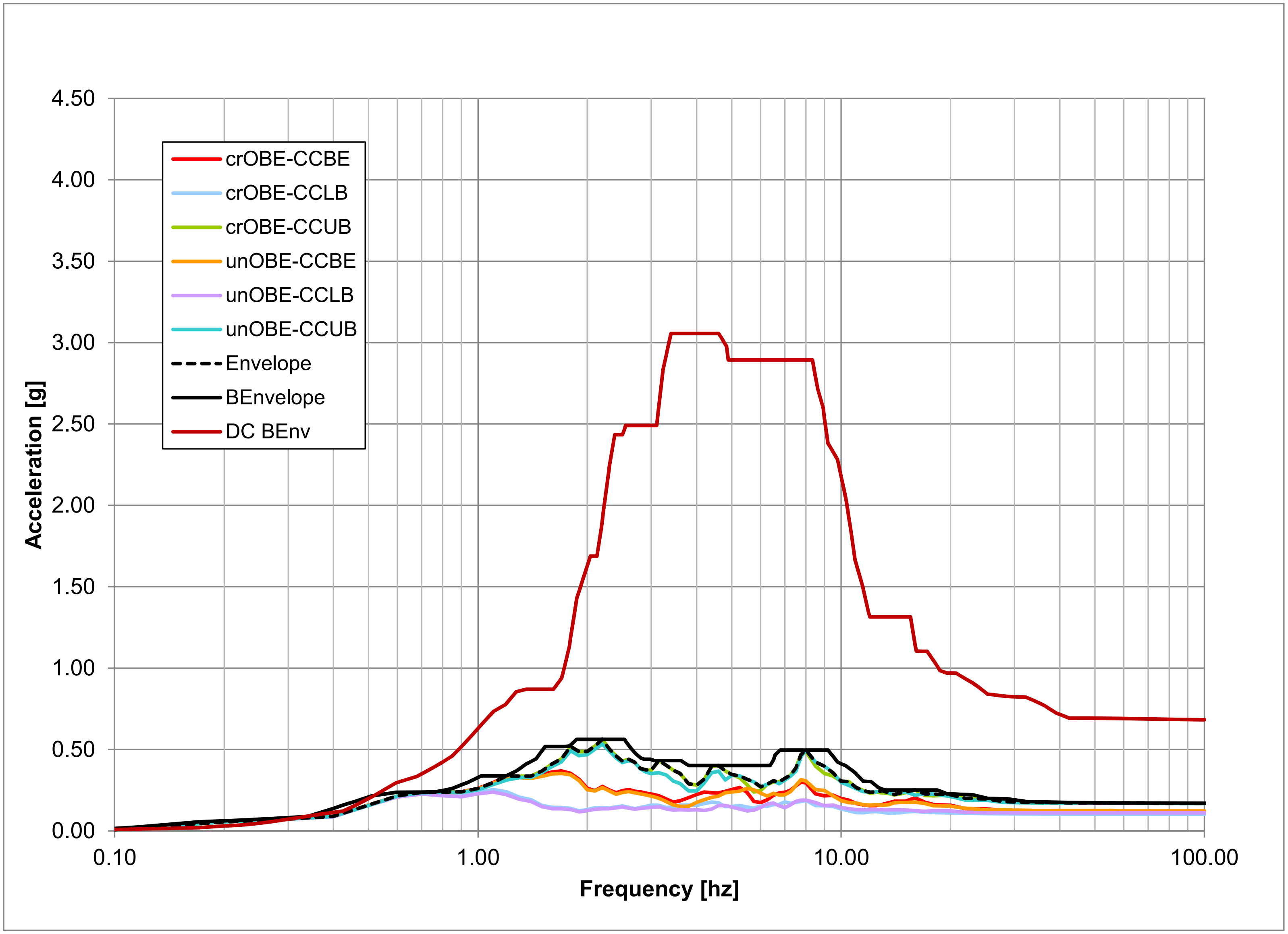


Figure 3.7-30 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Building Internal Structures, Z_{NI} = + 19.50 m (+63 ft - 11 3/4 in), Z(Vert) Direction, Rigid Location, Damping 5%}

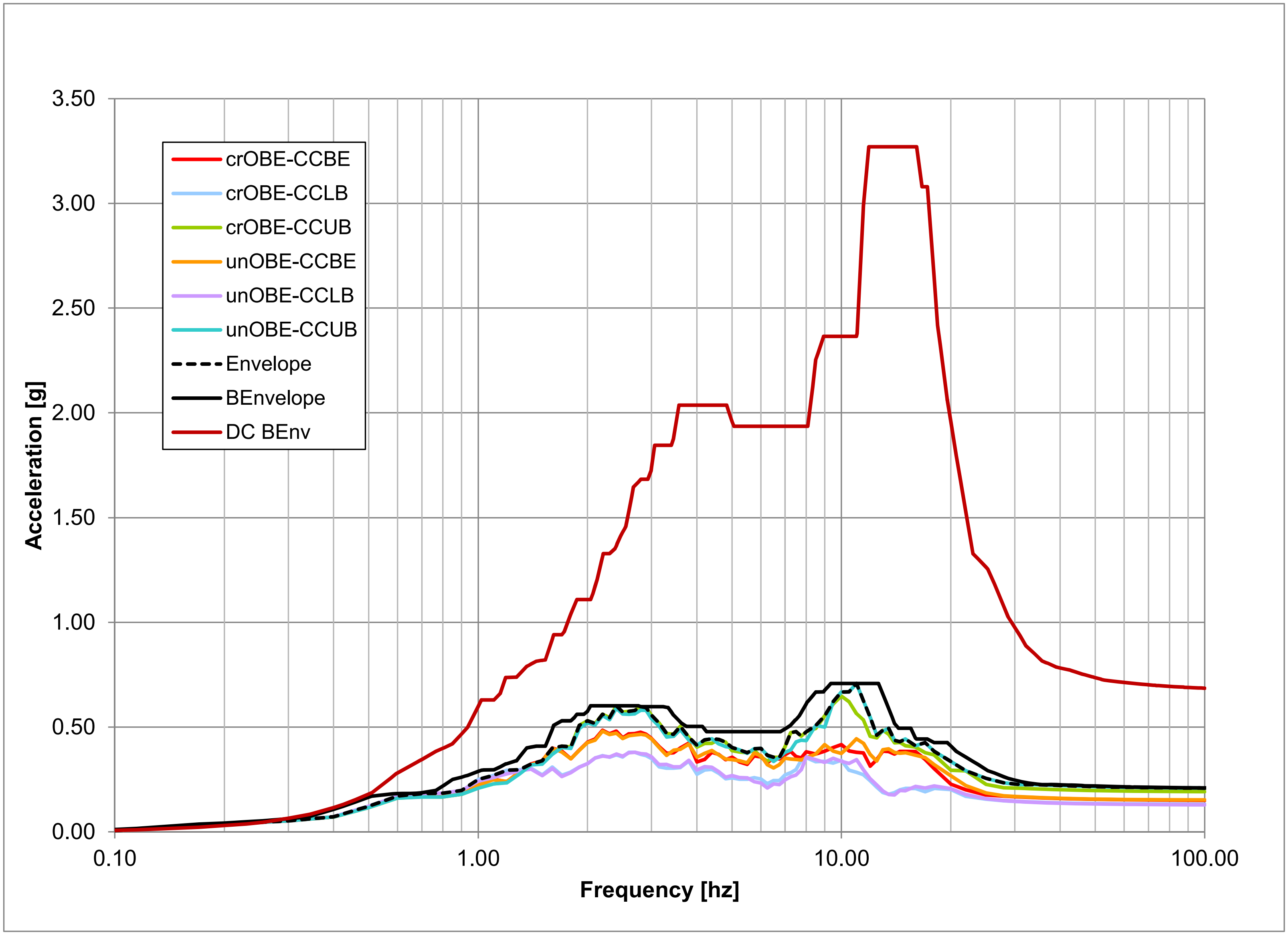


Figure 3.7-31 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = +8.10 m (+26 ft - 7 in), X(E-W) Direction, Rigid Location, Damping 5%}

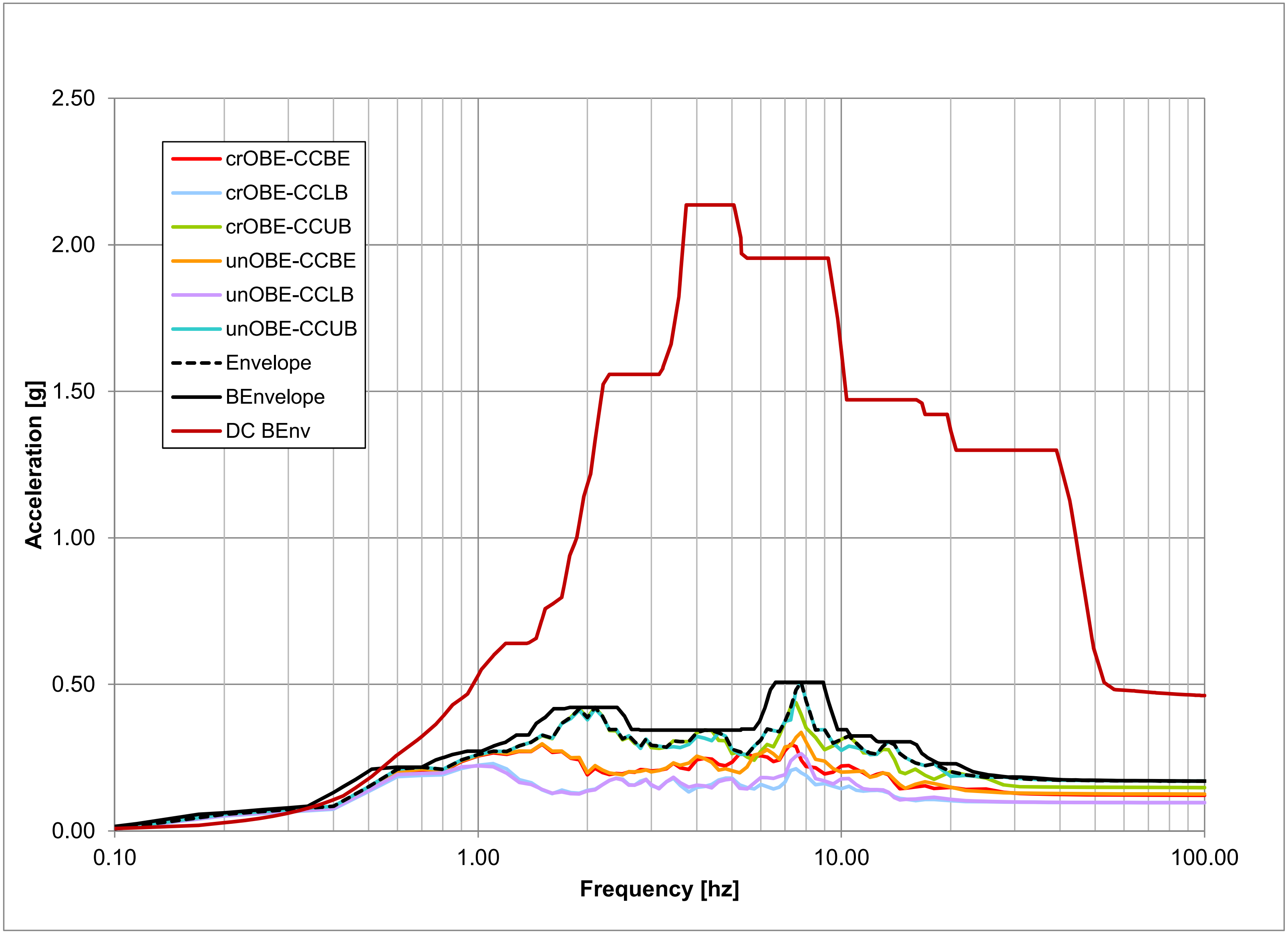


Figure 3.7-32 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = +8.10m (+26 ft - 7 in), Y(N-S) Direction, Rigid Location, Damping 5%}

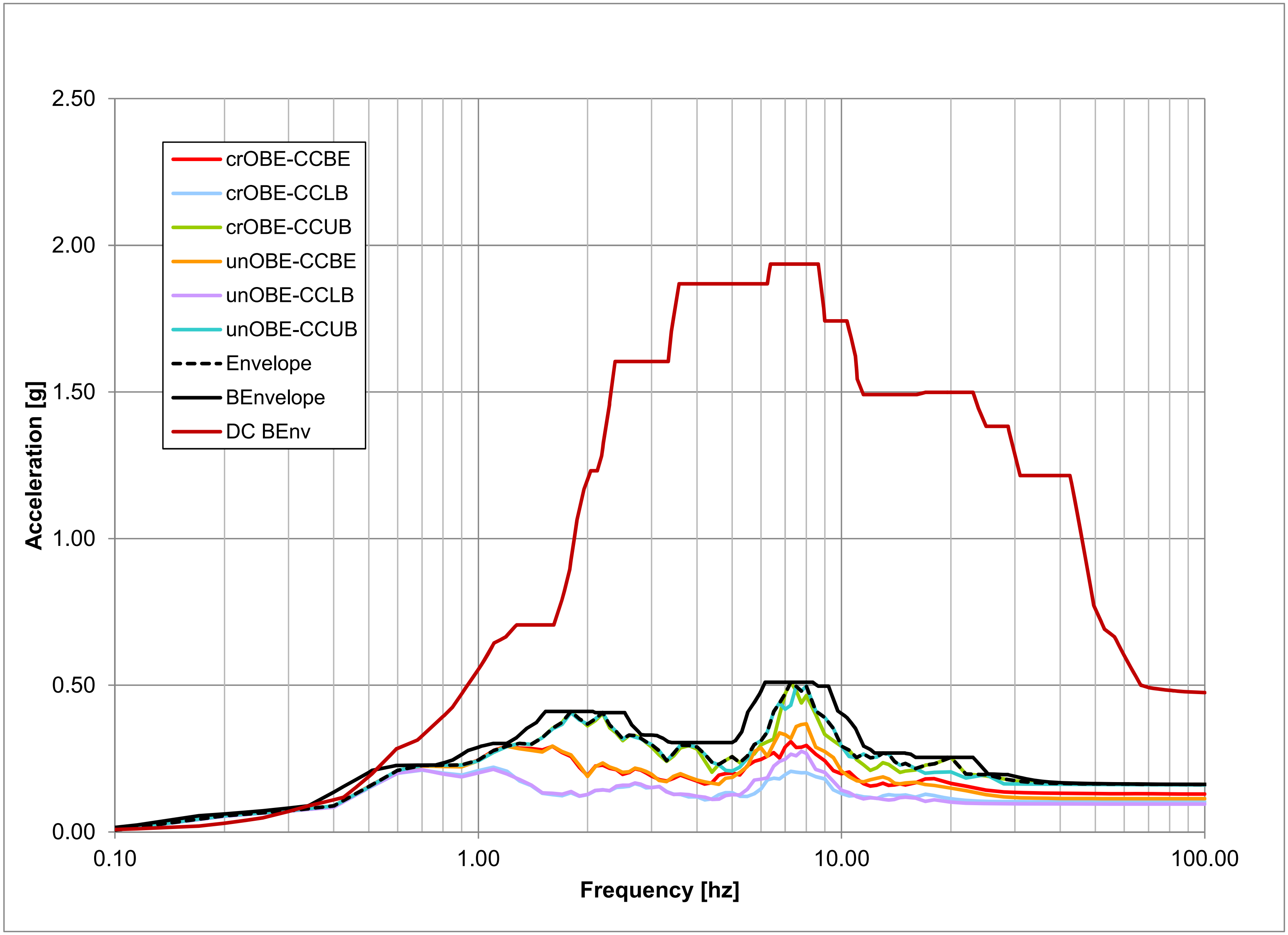


Figure 3.7-33 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = + 8.10m (+26 ft - 7 in), Z(Vert) Direction, Rigid Location, Damping 5%}

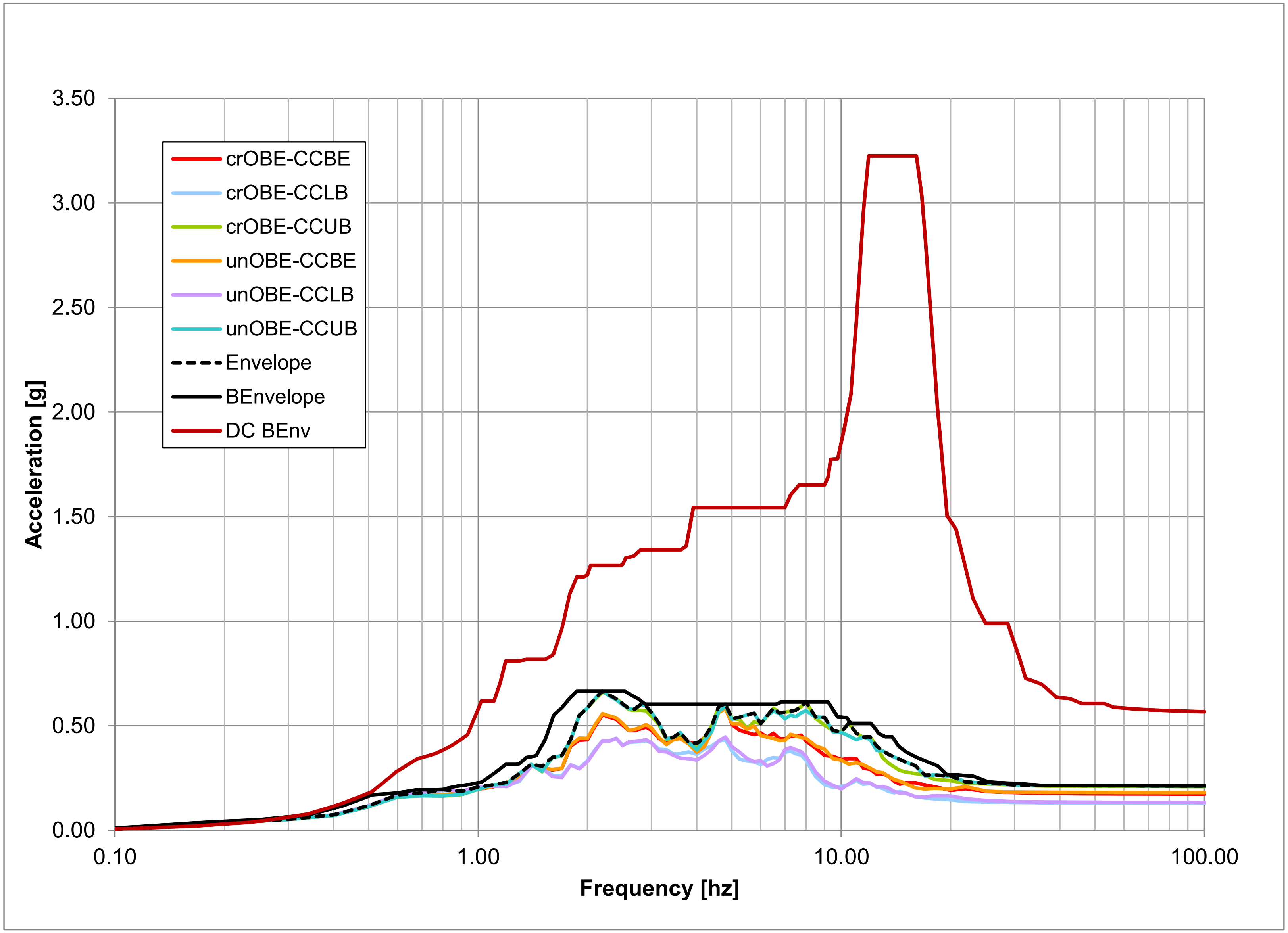


Figure 3.7-34 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = +21.00 m (+68 ft - 11 in), X(E-W) Direction, Rigid Location, Damping 5%}

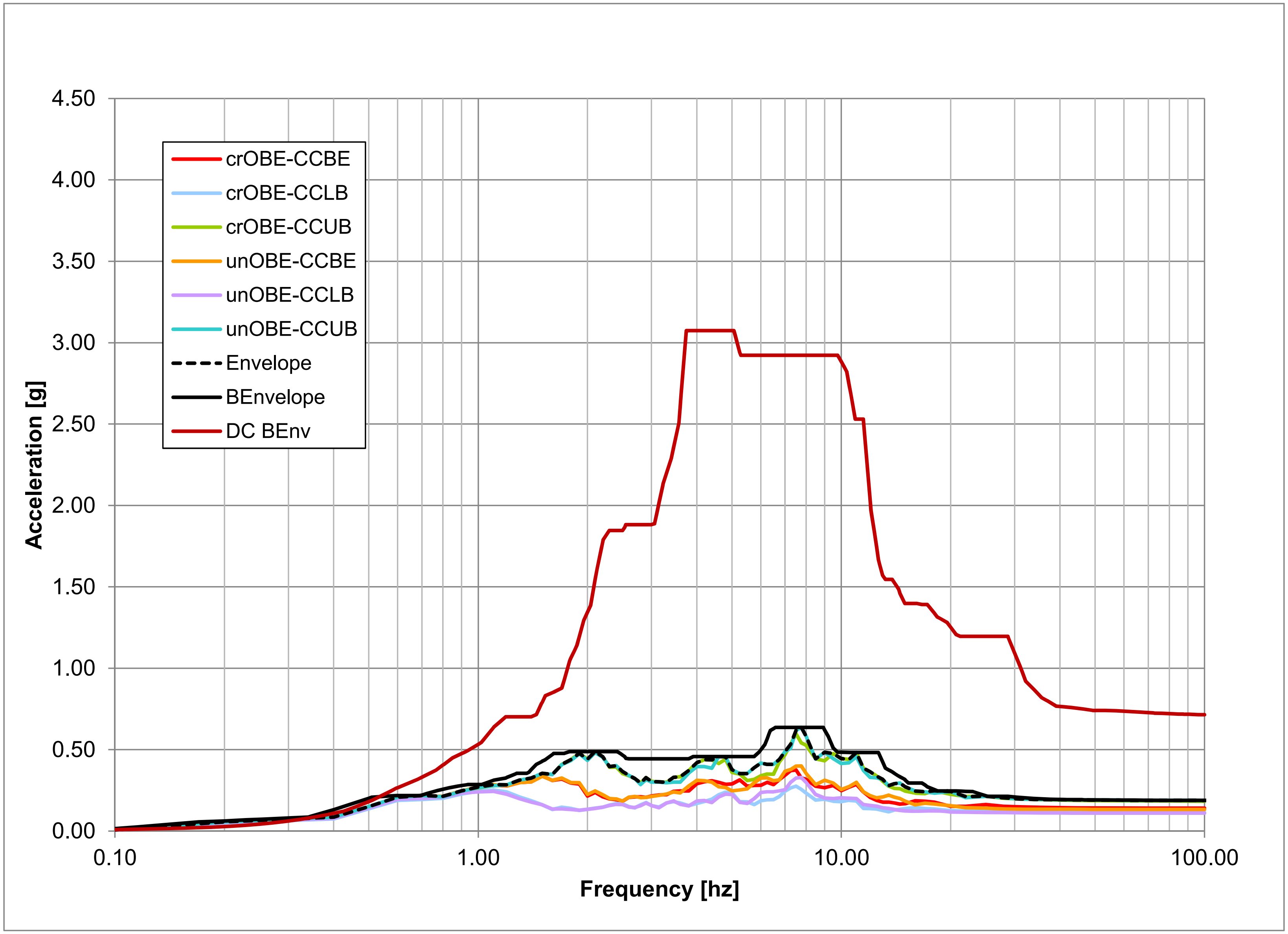


Figure 3.7-35 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = +21.00 m (+68 ft - 11 in), Y(N-S) Direction, Rigid Location, Damping 5%}

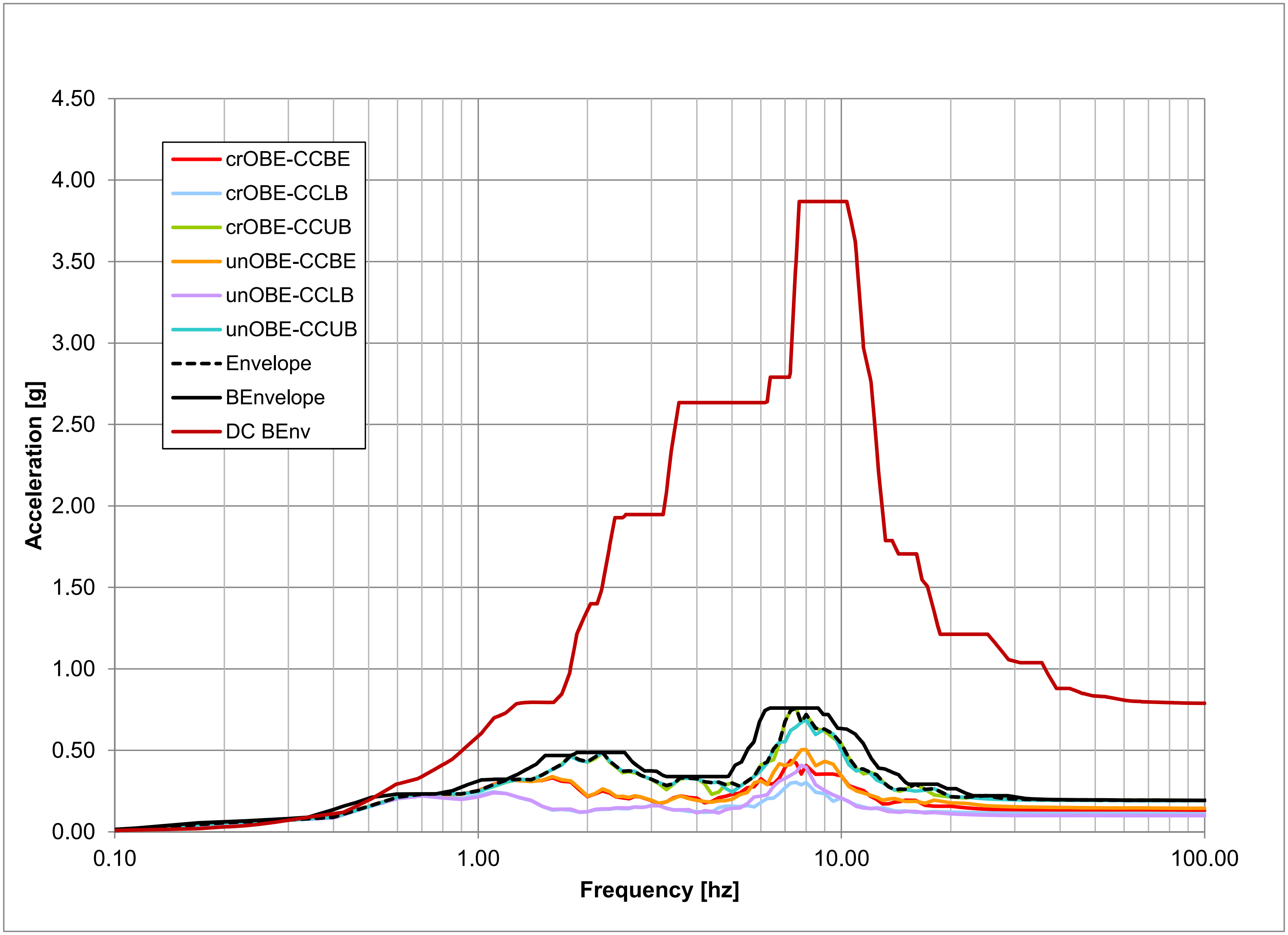


Figure 3.7-36 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 1, Z_{NI} = +21.00 m (+68 - 11 in), Z(Vert) Direction, Rigid Location, Damping 5%}

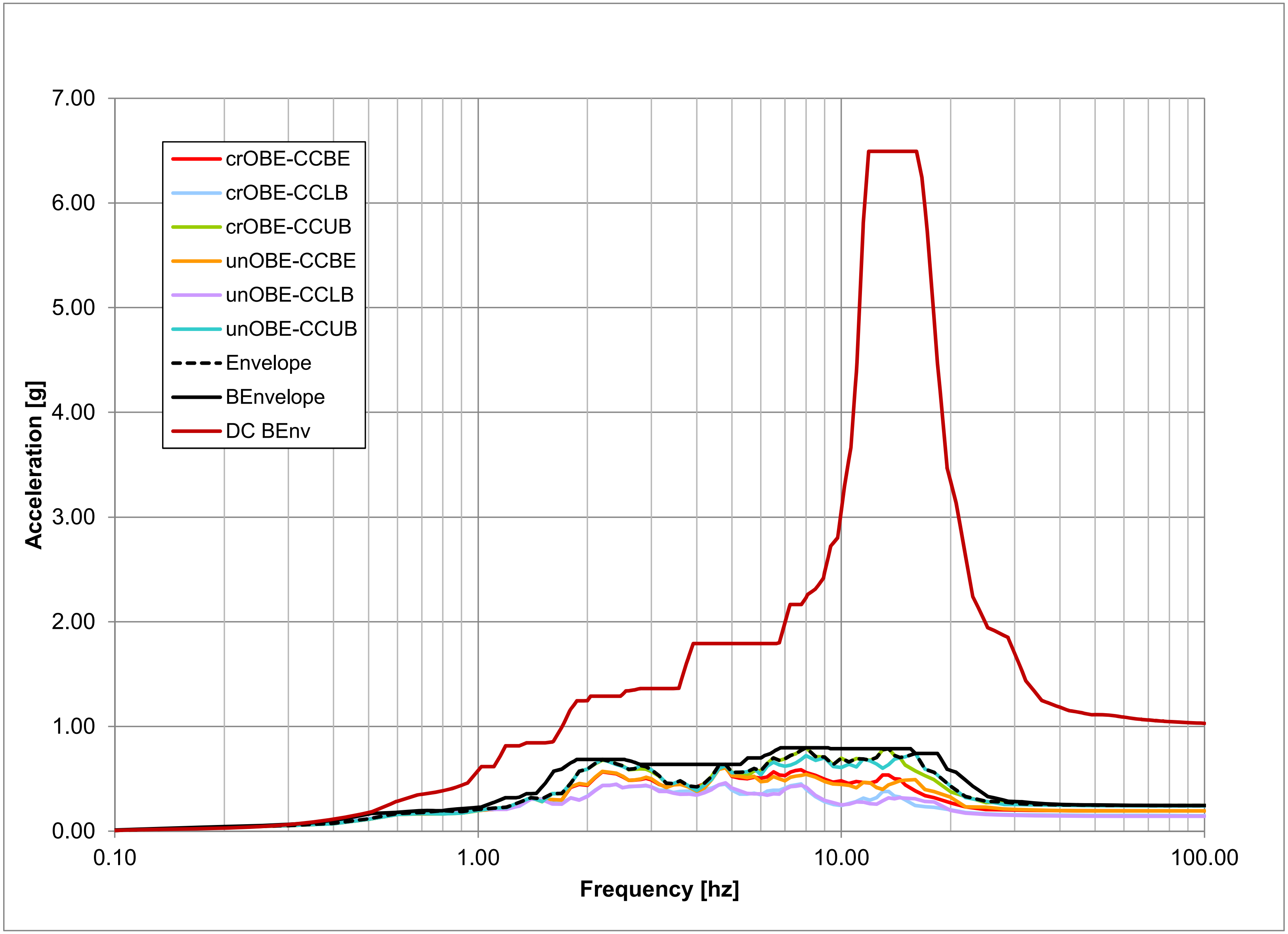


Figure 3.7-37 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 2/3, Z_{NI} = +8.10m (+26 ft - 7 in), X(E-W) Direction, Rigid Location, Damping 5%}

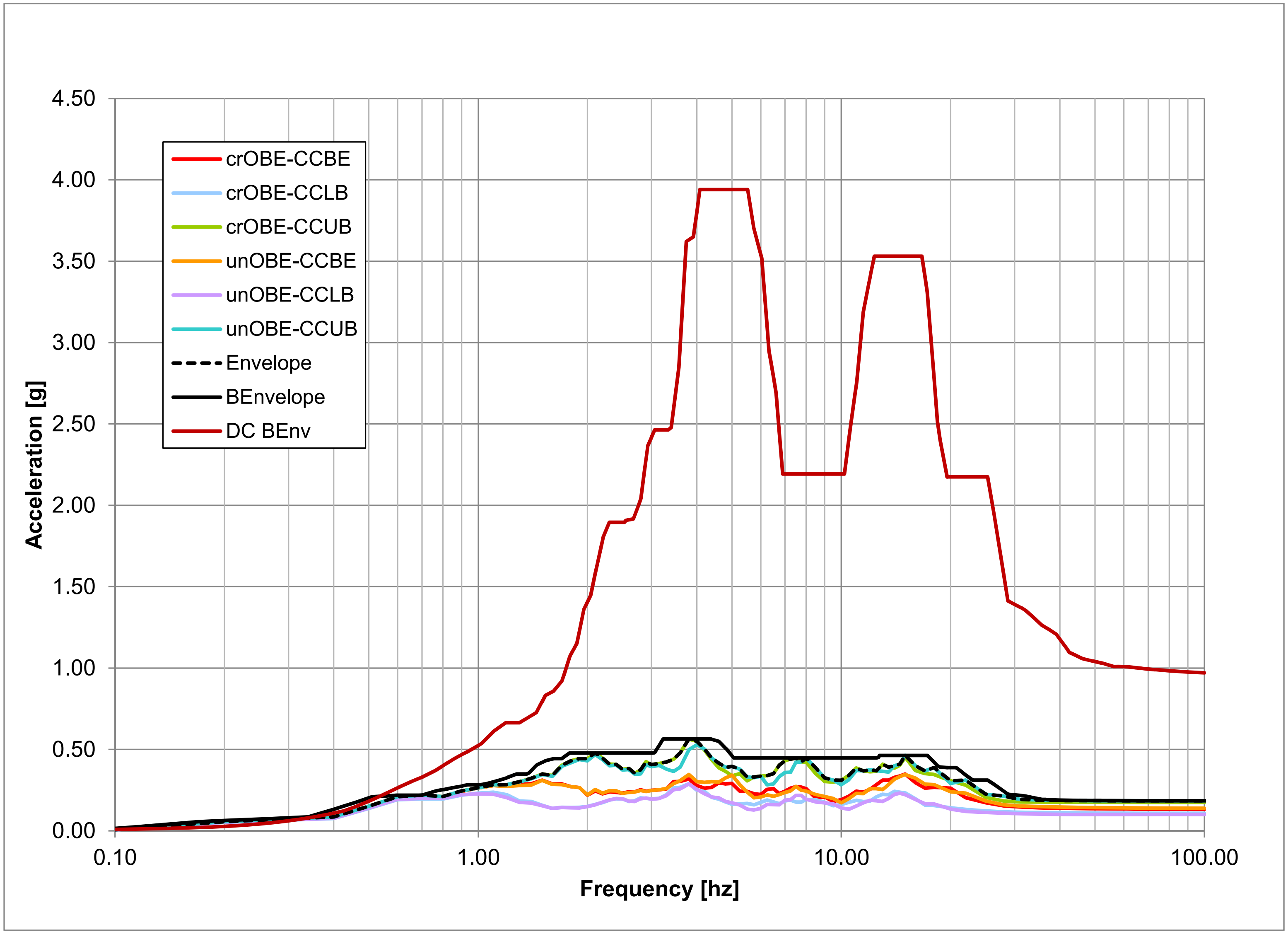


Figure 3.7-38 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 2/3, Z_{NI} = +8.10m (+26 ft - 7 in), Y(N-S) Direction, Rigid Location, Damping 5%}

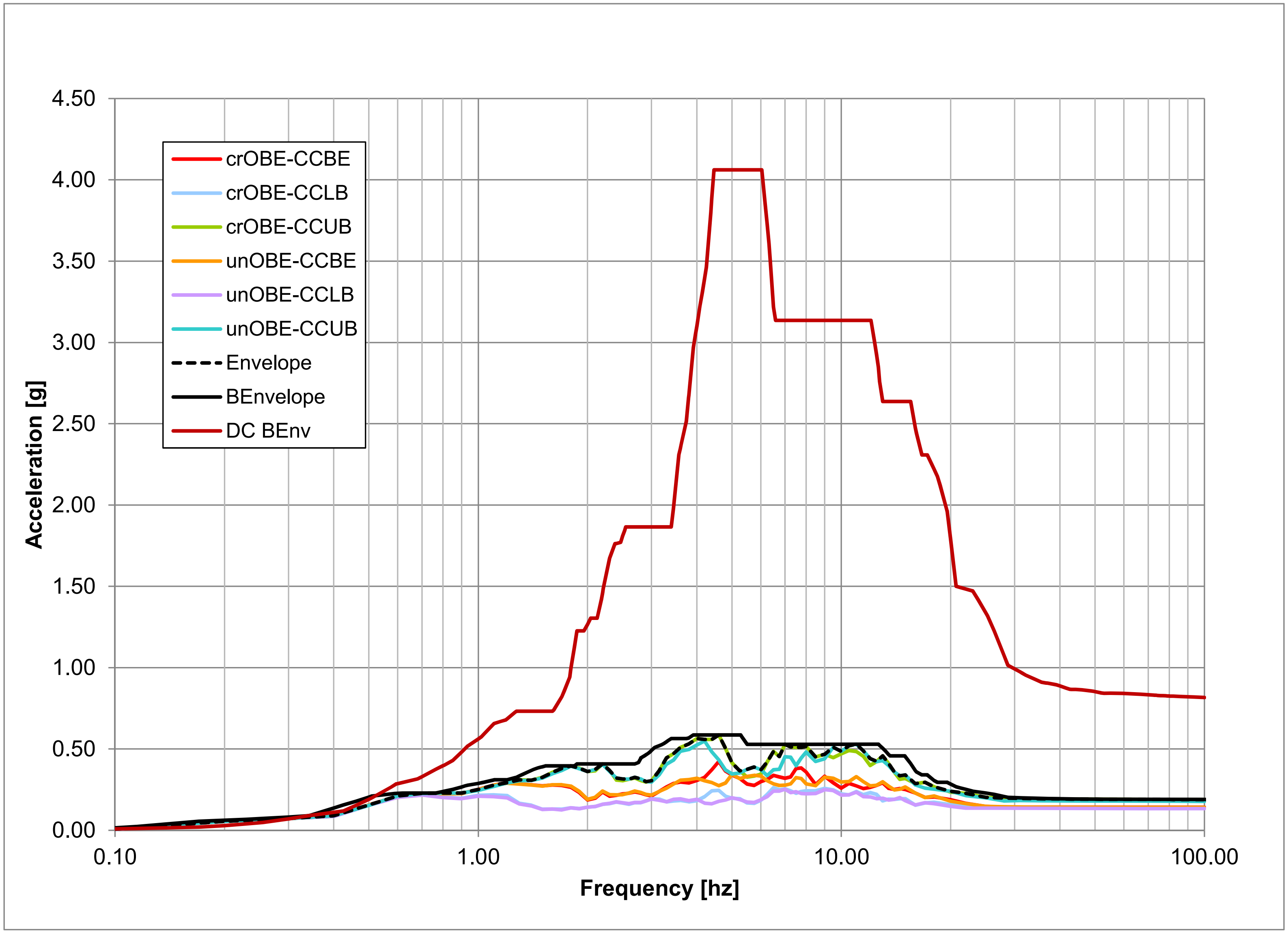


Figure 3.7-39 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 2/3, Z_{NI} = +8.10 m (+26 ft - 7 in), Z(Vert) Direction, Rigid Location, Damping 5%}

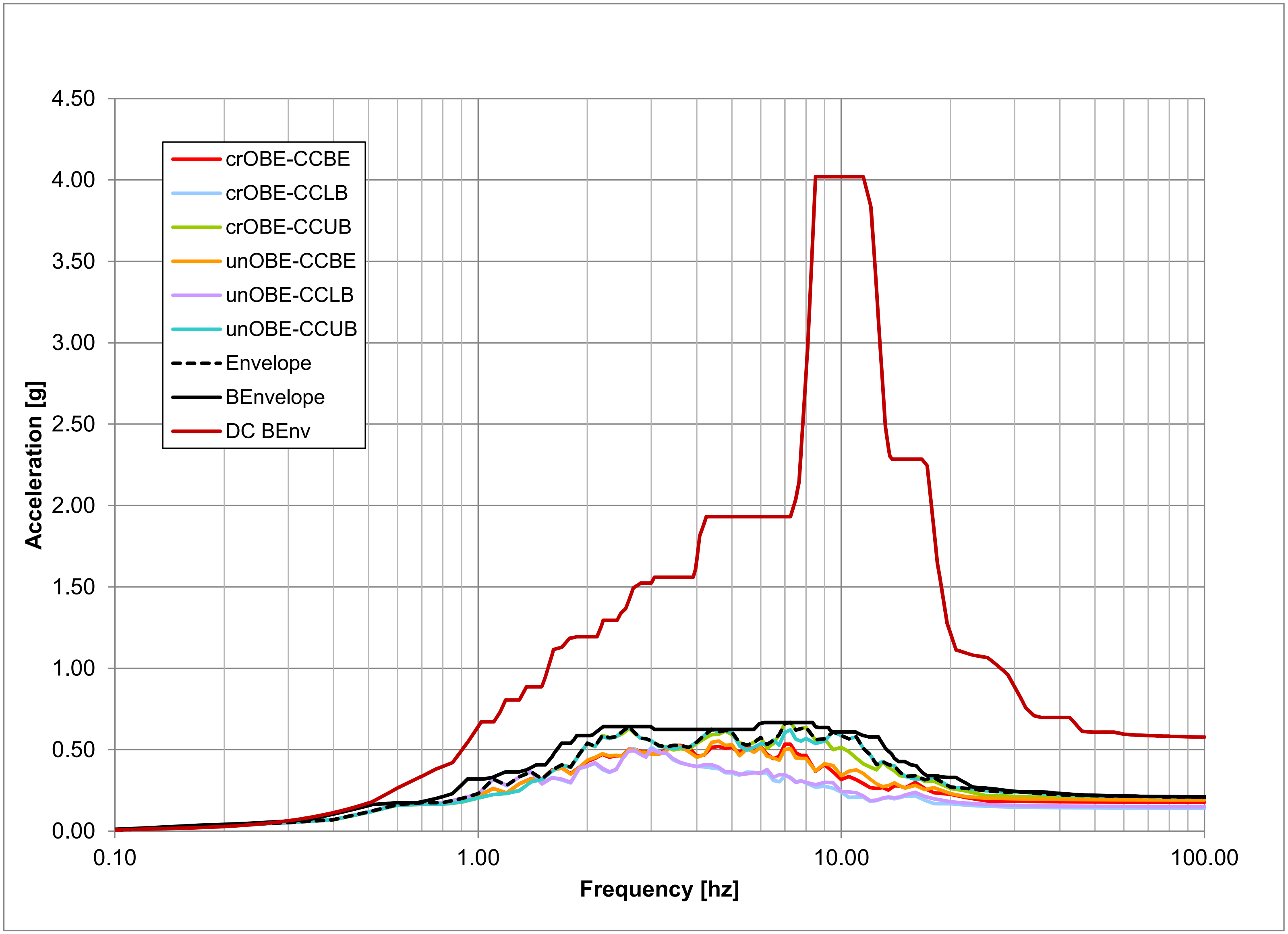


Figure 3.7-40 — DC vs. COLA In-Structure Response Spectra (ISRS), {Safeguard Building 2/3, Z_{NI} = +16.30 m (+53 ft - 6 in), X(E-W) Direction, Rigid Location, Damping 5%}

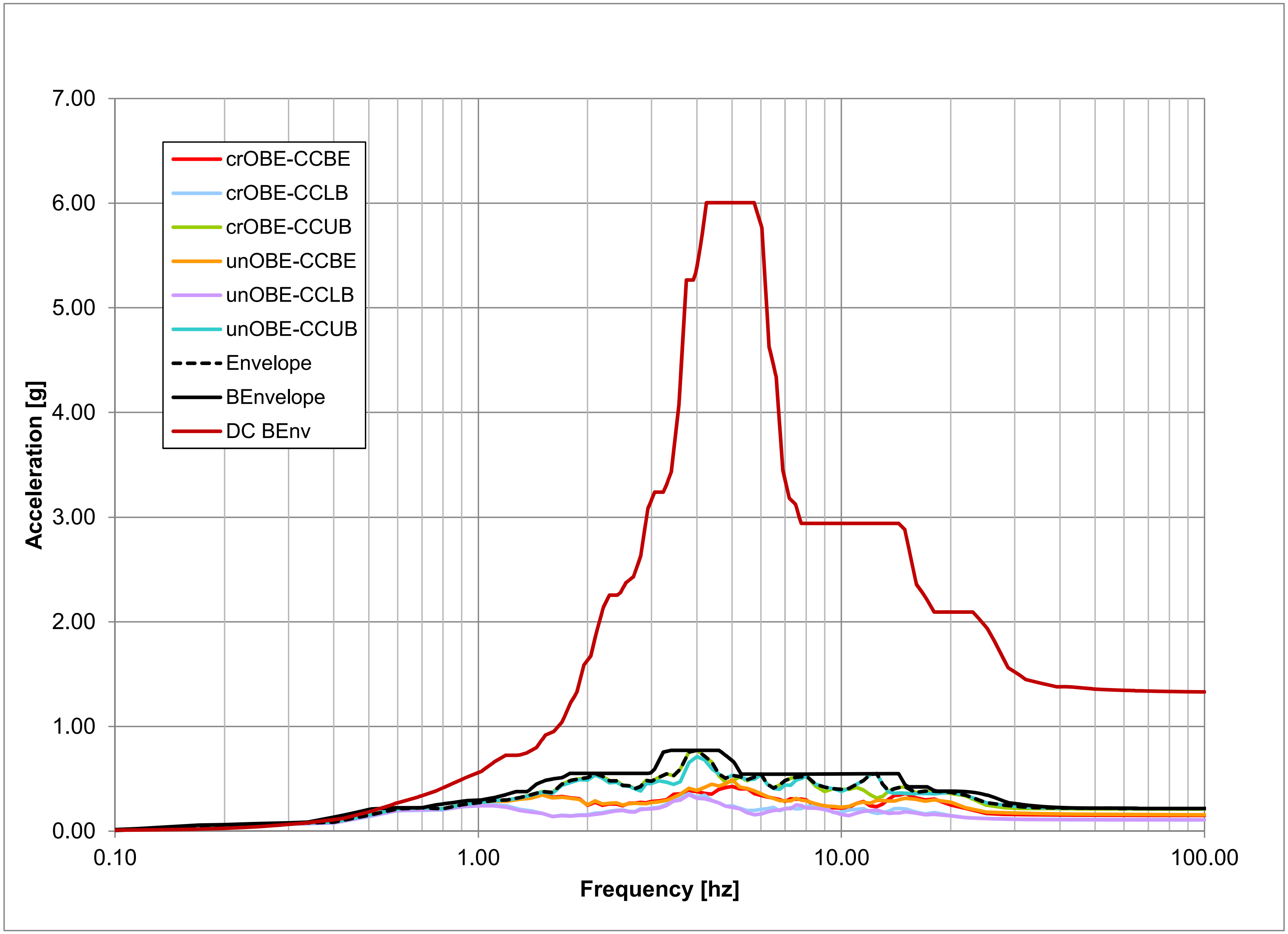


Figure 3.7-41 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 2/3, Z_{NI} = +16.30 m (+53 ft - 6 in), Y(N-S) Direction, Rigid Location, Damping 5%}

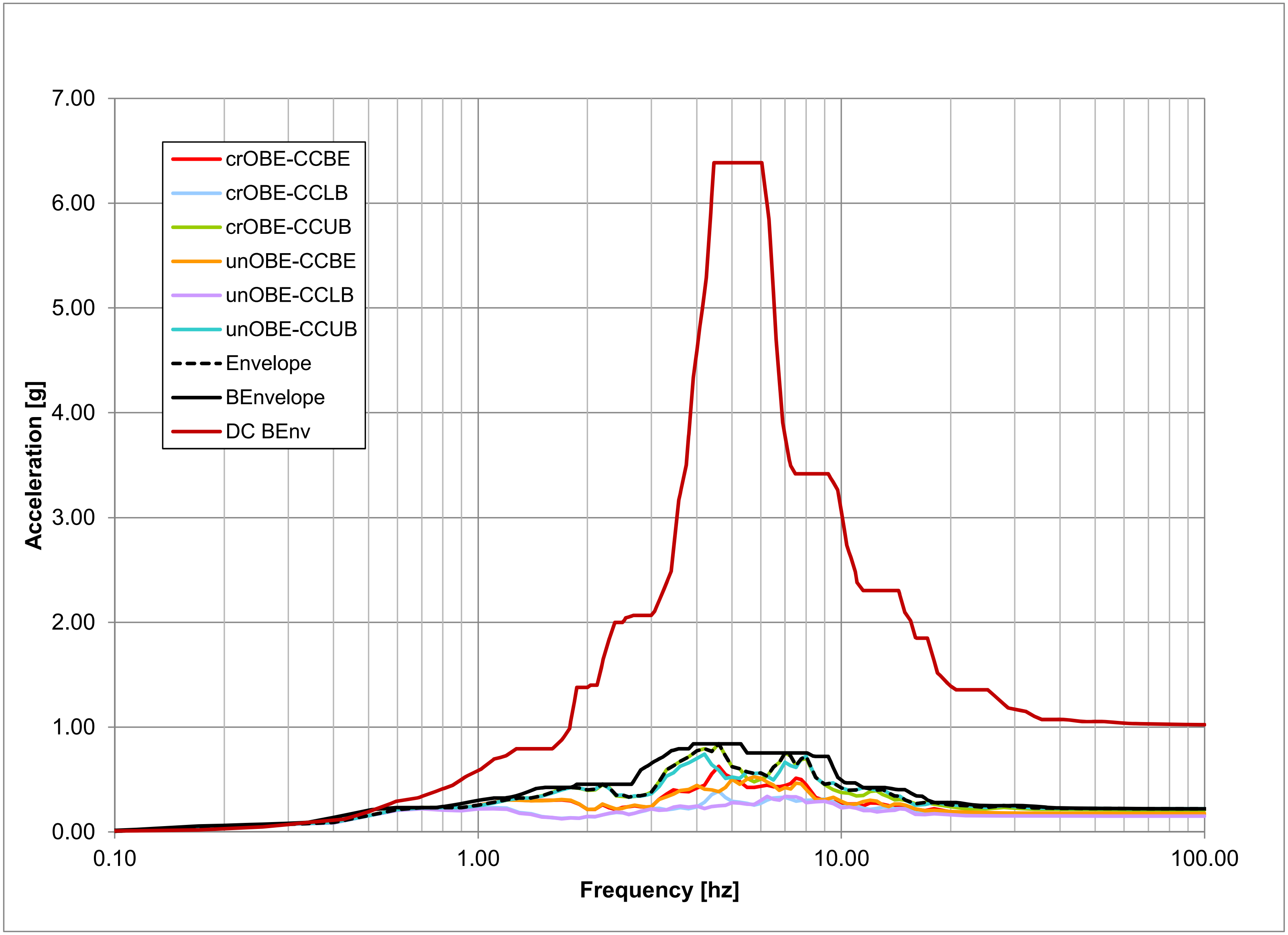


Figure 3.7-42 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 2/3, Z_{NI} = +16.30 m (+53 ft - 6 in), Z(Vert) Direction, Rigid Location, Damping 5%}

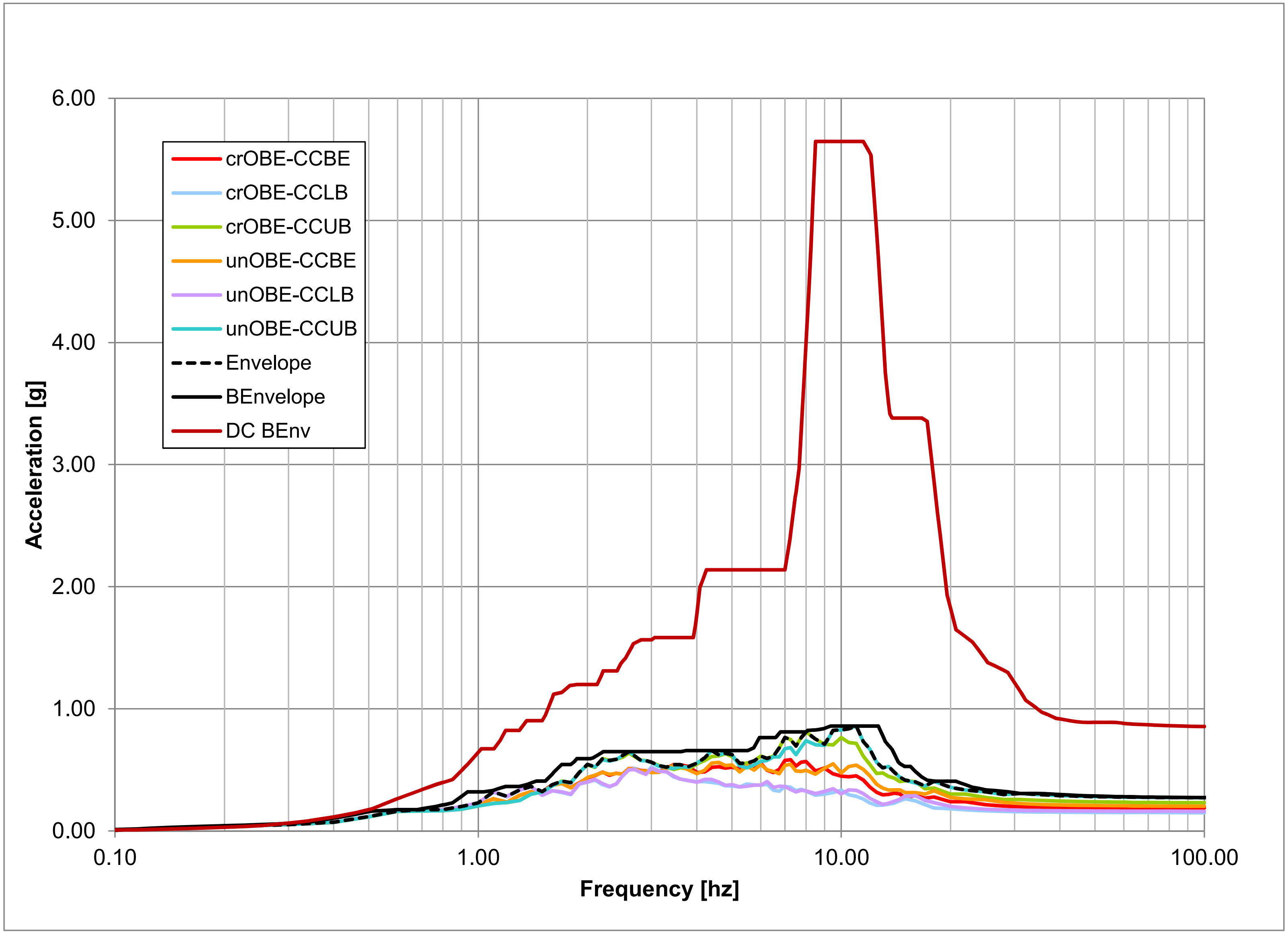


Figure 3.7-43 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 4, Z_{NI} = +21.00 m (+68 ft - 11 in), X(E-W) Direction, Rigid Location, Damping 5%}

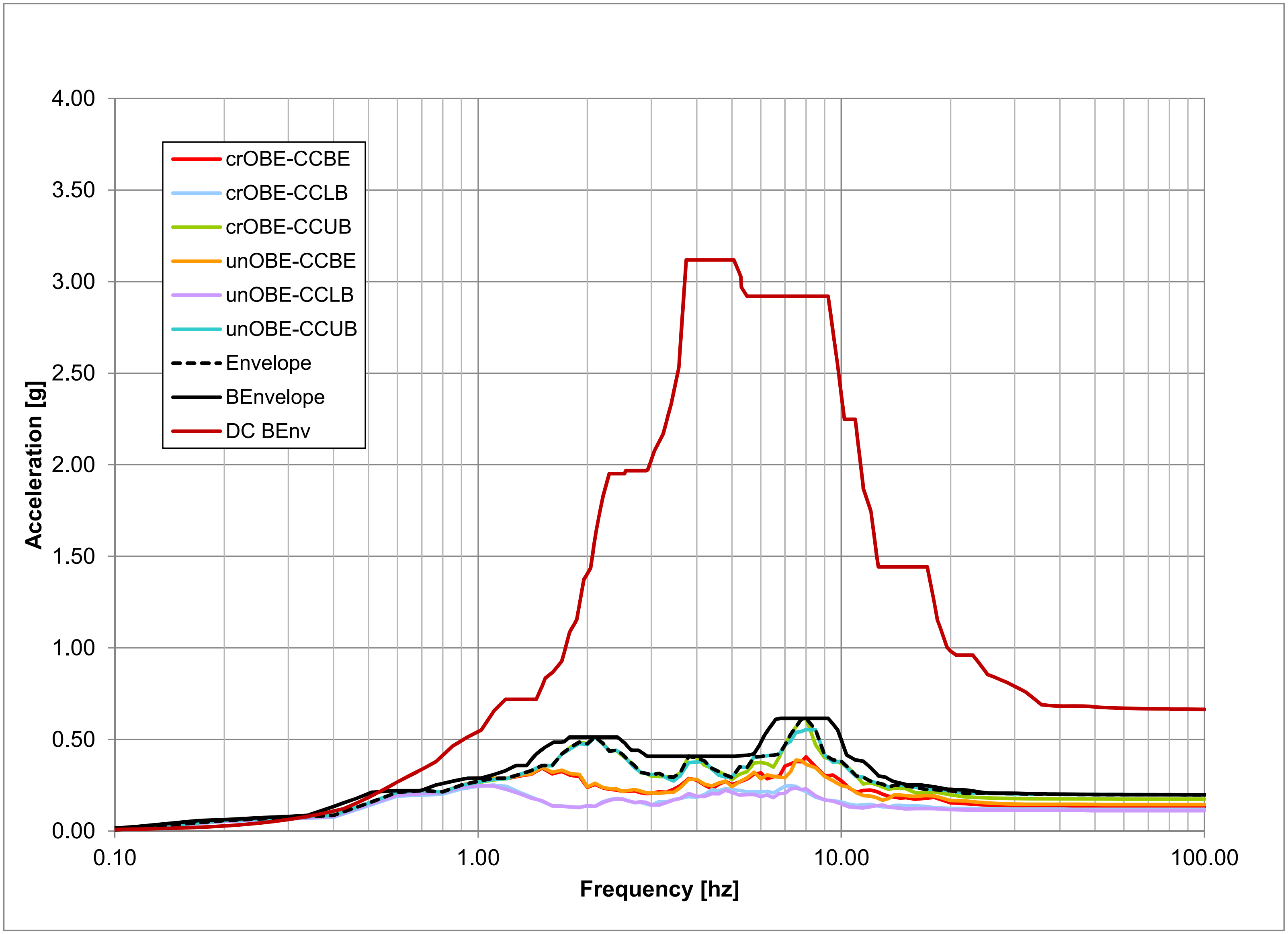


Figure 3.7-44 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 4, Z_{NI} = +21.00 m (+68 ft - 11 in), Y(N-S) Direction, Rigid Location, Damping 5%}

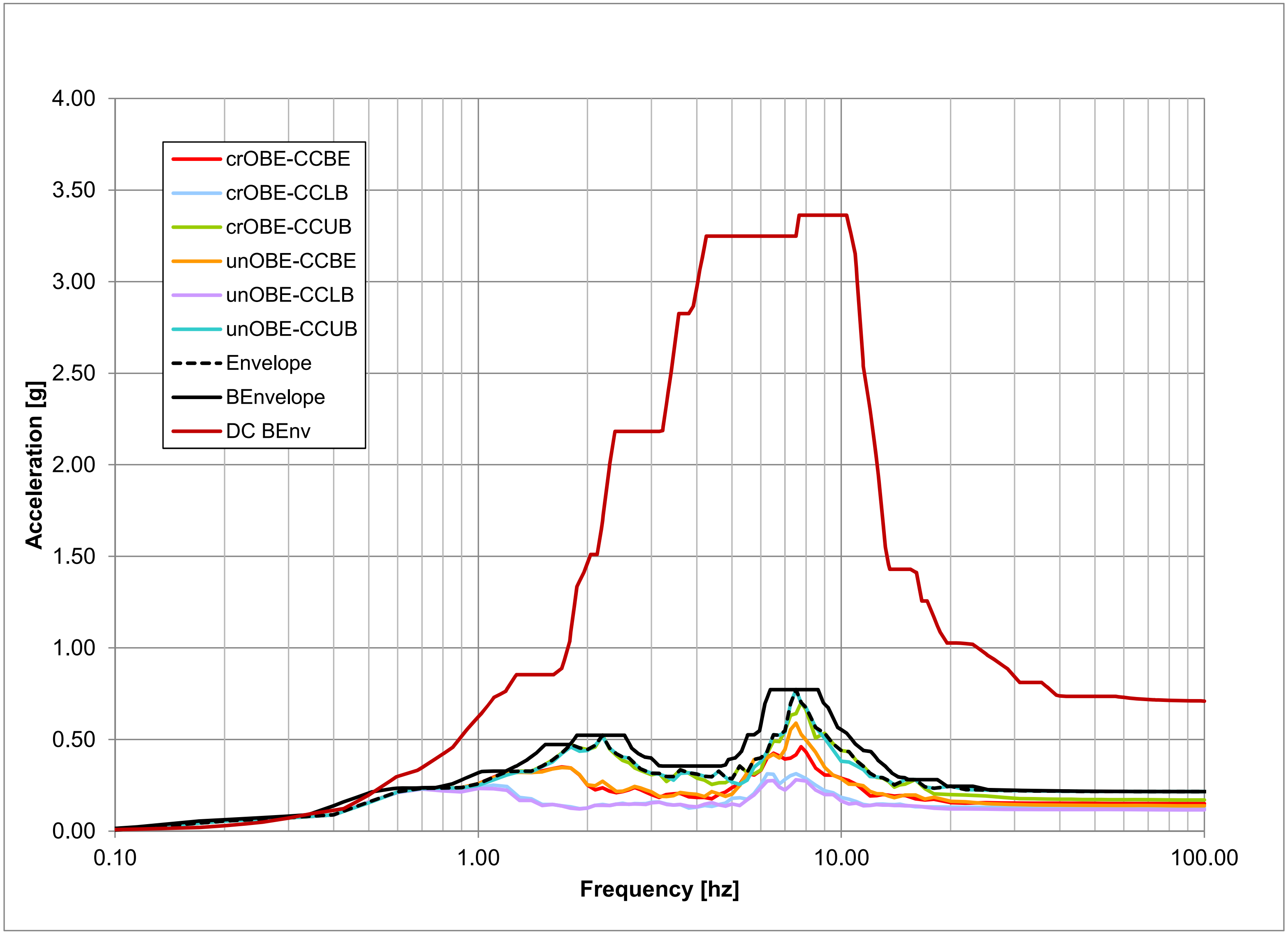


Figure 3.7-45 — {DC vs. COLA In-Structure Response Spectra (ISRS), Safeguard Building 4, Z_{NI} = +21.00 m (+68 ft - 11 in), Z(Vert) Direction, Rigid Location, Damping 5%}

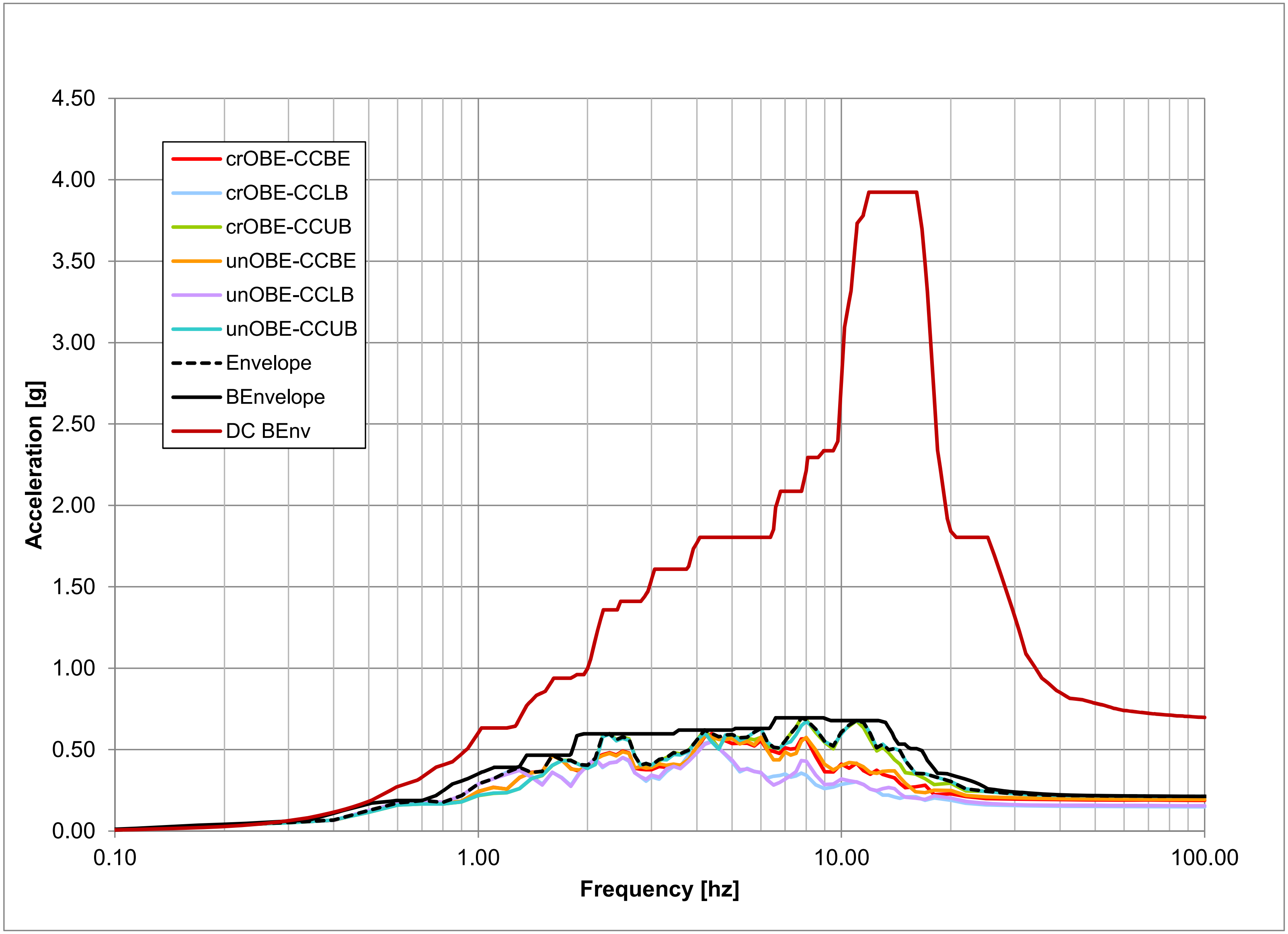


Figure 3.7-46 — {DC vs. COLA In-Structure Response Spectra (ISRS), Containment Building, Z_{NI} = +37.60 m (+123 ft - 4 1/4 in), X(E-W) Direction, Rigid Location, Damping 5%}

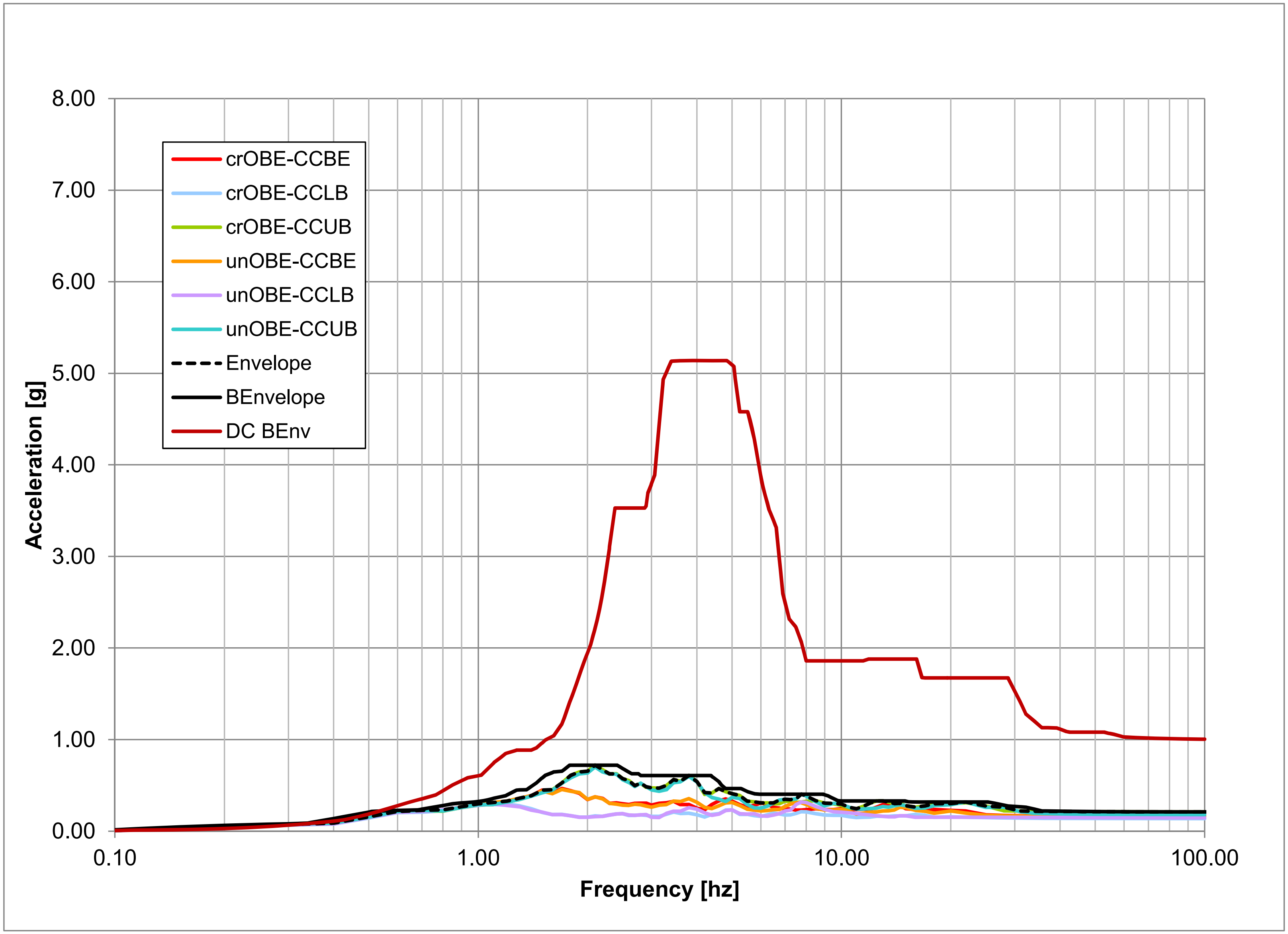


Figure 3.7-47 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Containment Response Spectra Nodes, Z_{NI} = +37.60 m (+123 ft - 4 1/4 in), Y(N-S) Direction, Rigid Location, Damping 5%}

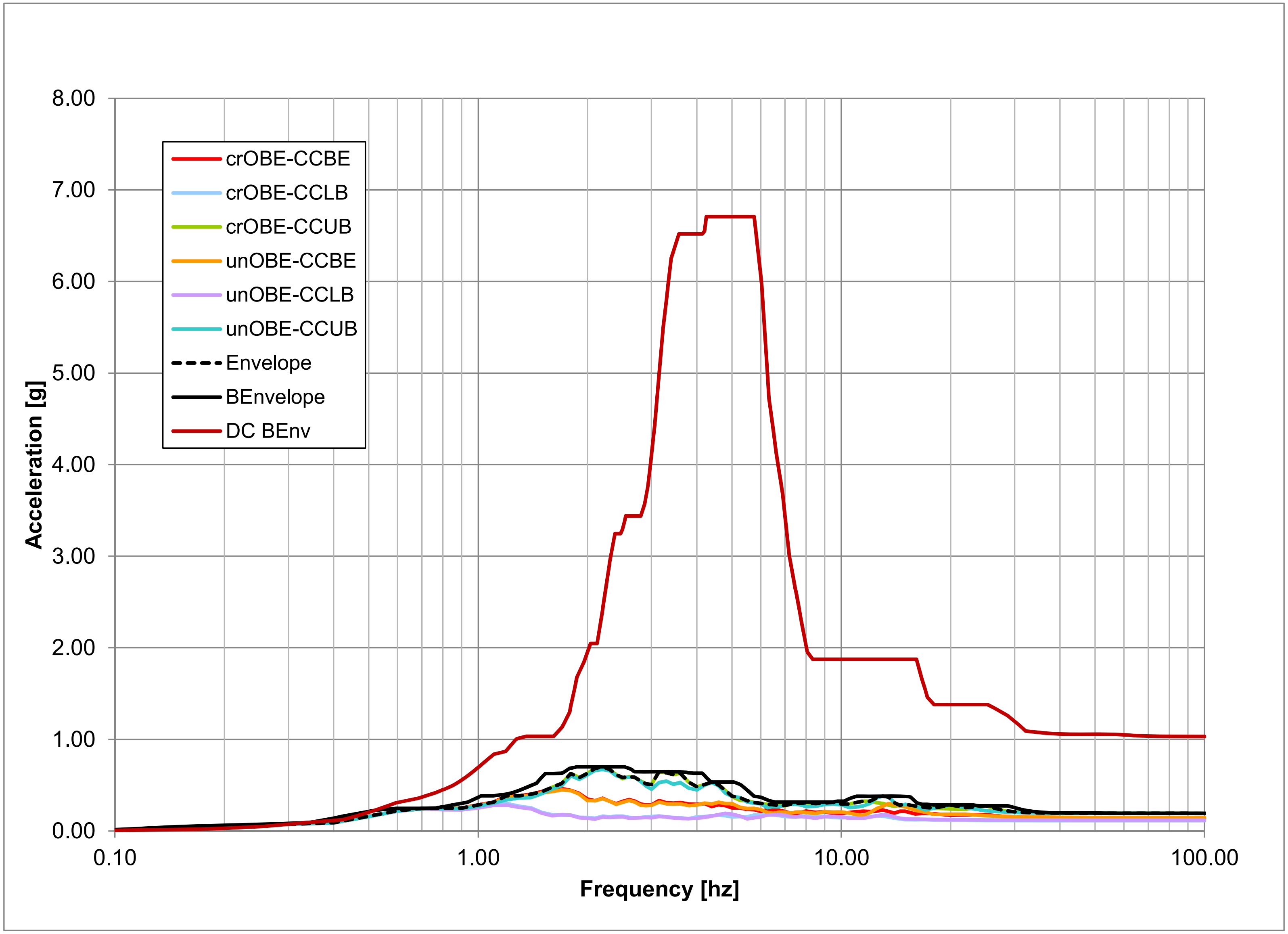


Figure 3.7-48 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Containment Response Spectra Nodes, Z_{NI} = +37.60 m (+123 ft - 4 1/4 in), Z(Vert) Direction, Rigid Location, Damping 5%}

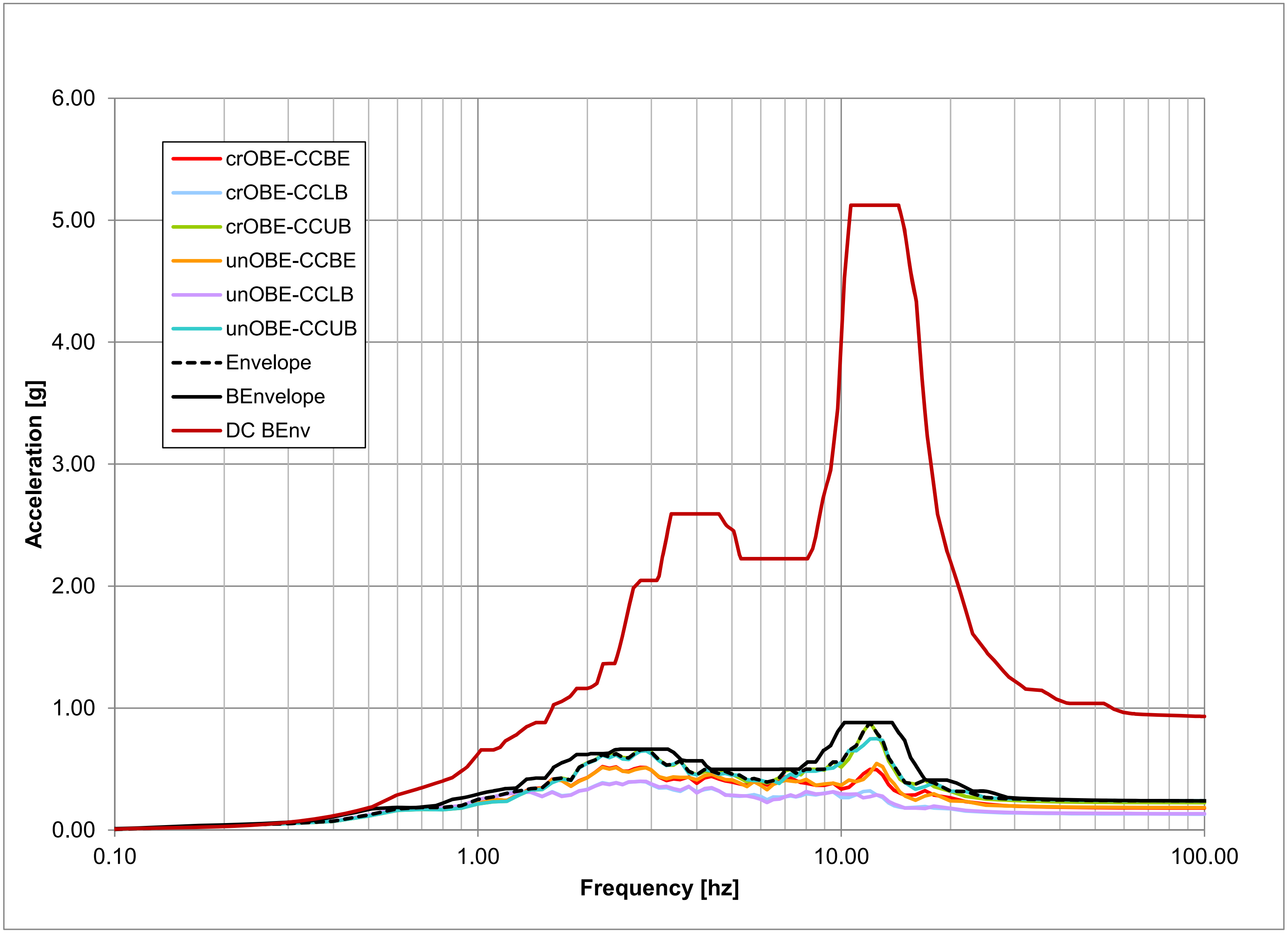


Figure 3.7-49 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Containment Response Spectra Nodes, Z_{NI} = +58.00 m (+190 ft - 3 1/2 in), X(E-W) Direction, Rigid Location, Damping 5%}

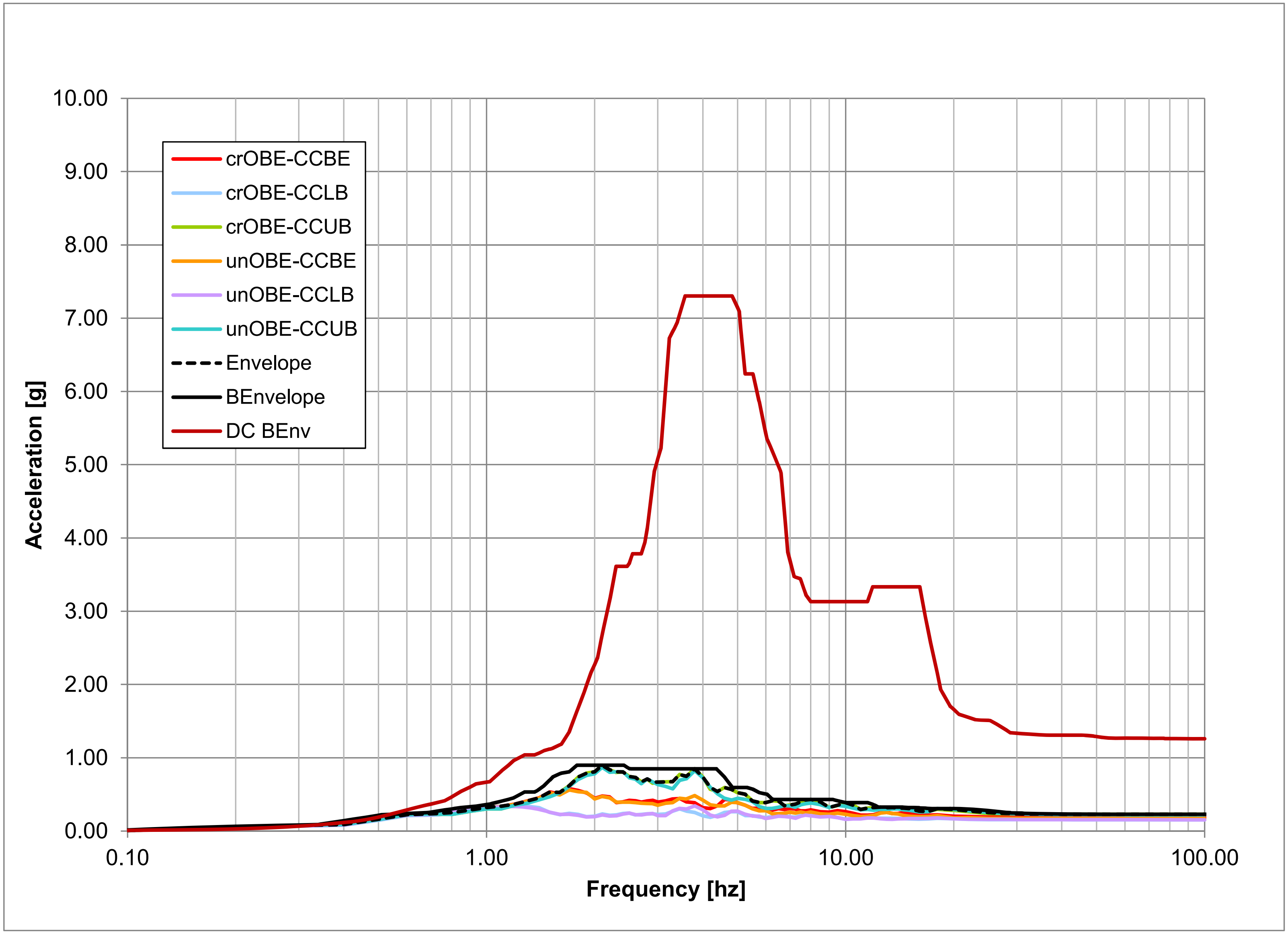


Figure 3.7-50 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Containment Response Spectra Nodes, Z_{NI} = +58.00 m (+190 ft - 3 1/2 in), Y(N-S) Direction, Rigid Location, Damping 5%}

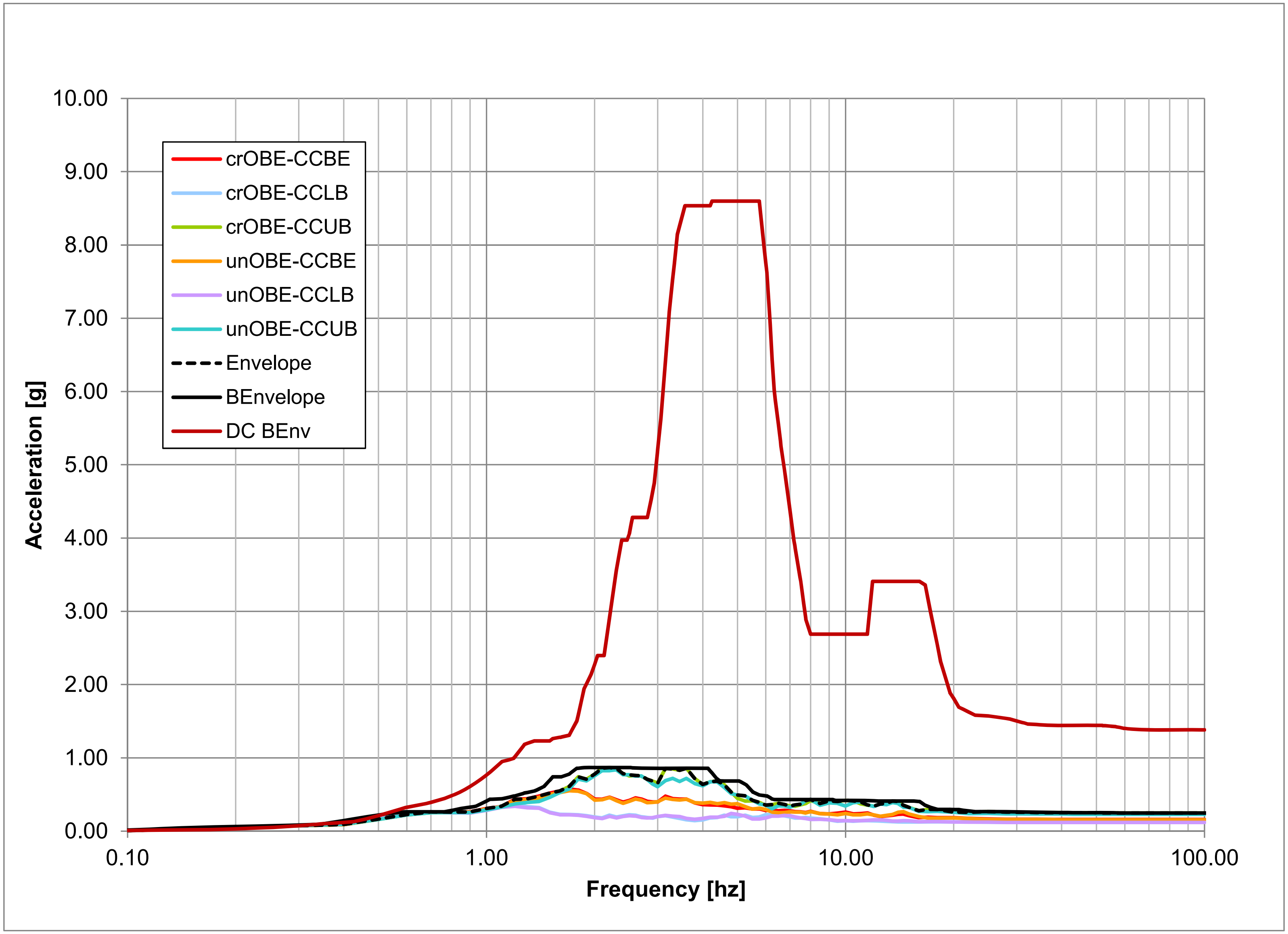


Figure 3.7-51 — {DC vs. COLA In-Structure Response Spectra (ISRS), Reactor Containment Response Spectra Nodes, Z_{NI} = +58.00 m (+190 - 3 1/2 in), Z(Vert) Direction, Rigid Location, Damping 5%}

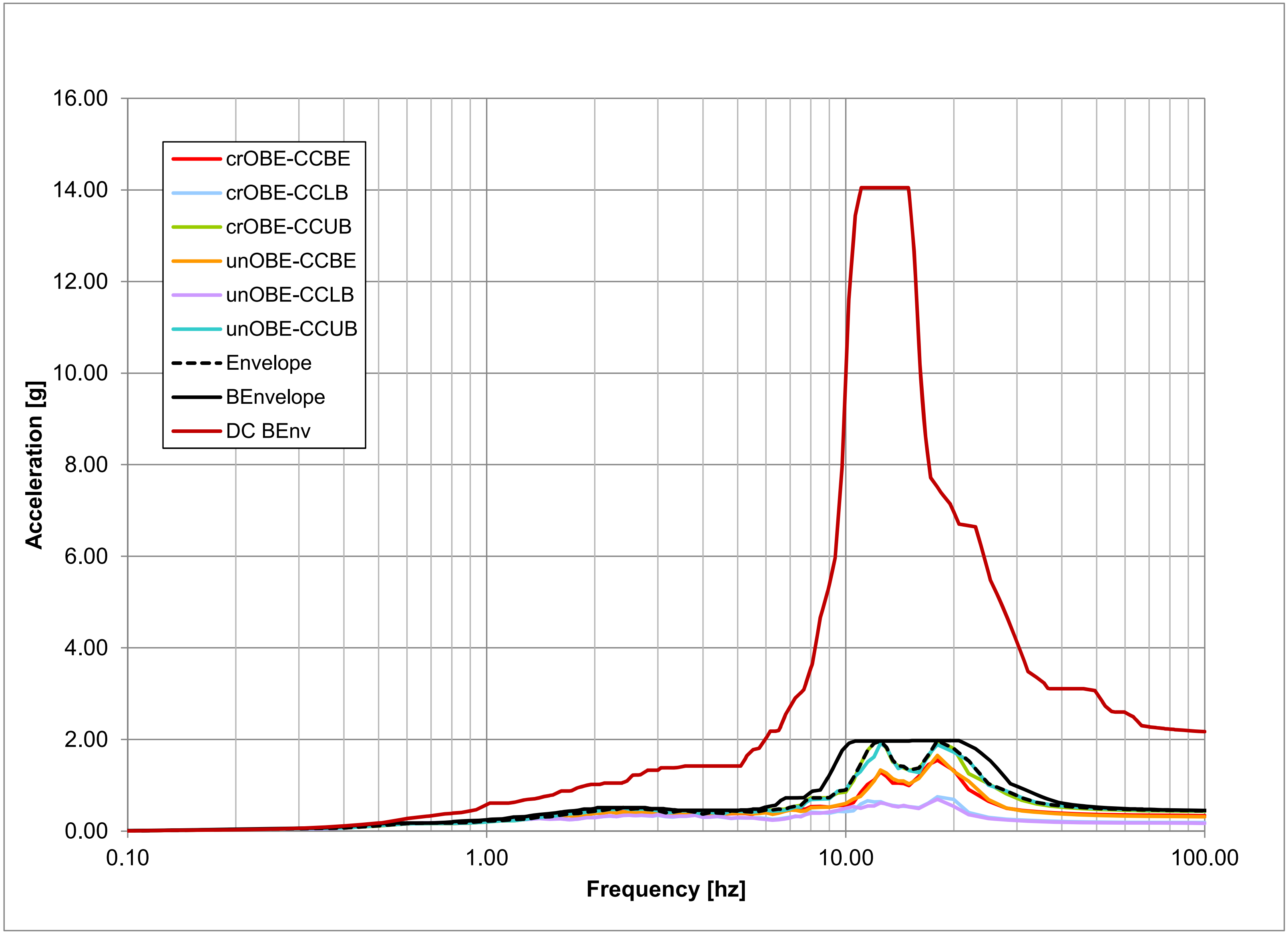


Figure 3.7-52 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building, Z_{NI} = +3.70 m (+12 ft - 1 3/4 in) X(E-W) Direction, Rigid Location, Damping 5%}

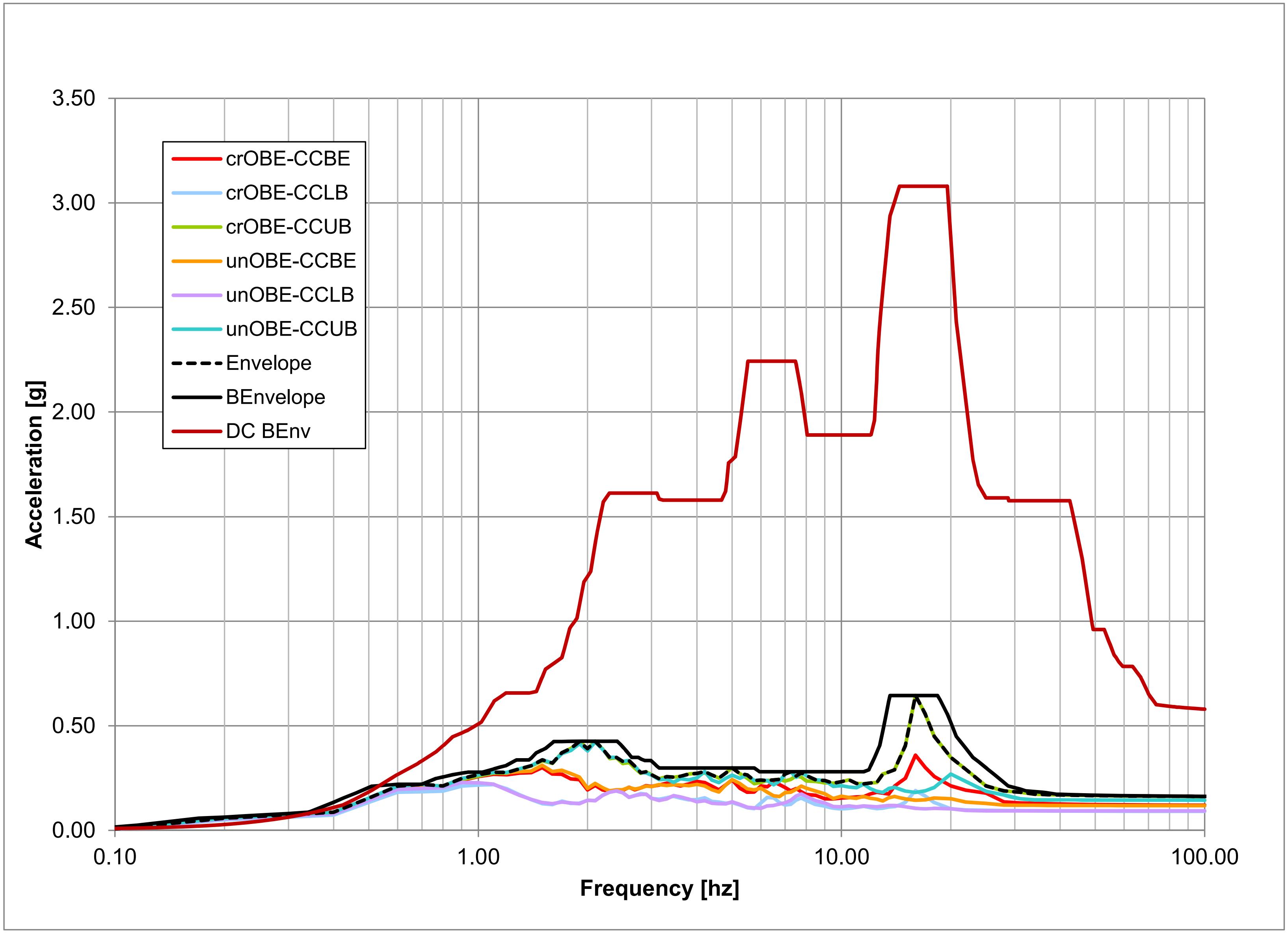


Figure 3.7-53 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building Z_{NI} = +3.70 m (+12 ft - 1 3/4 in), Y(N-S) Direction, Rigid Location, Damping 5%}

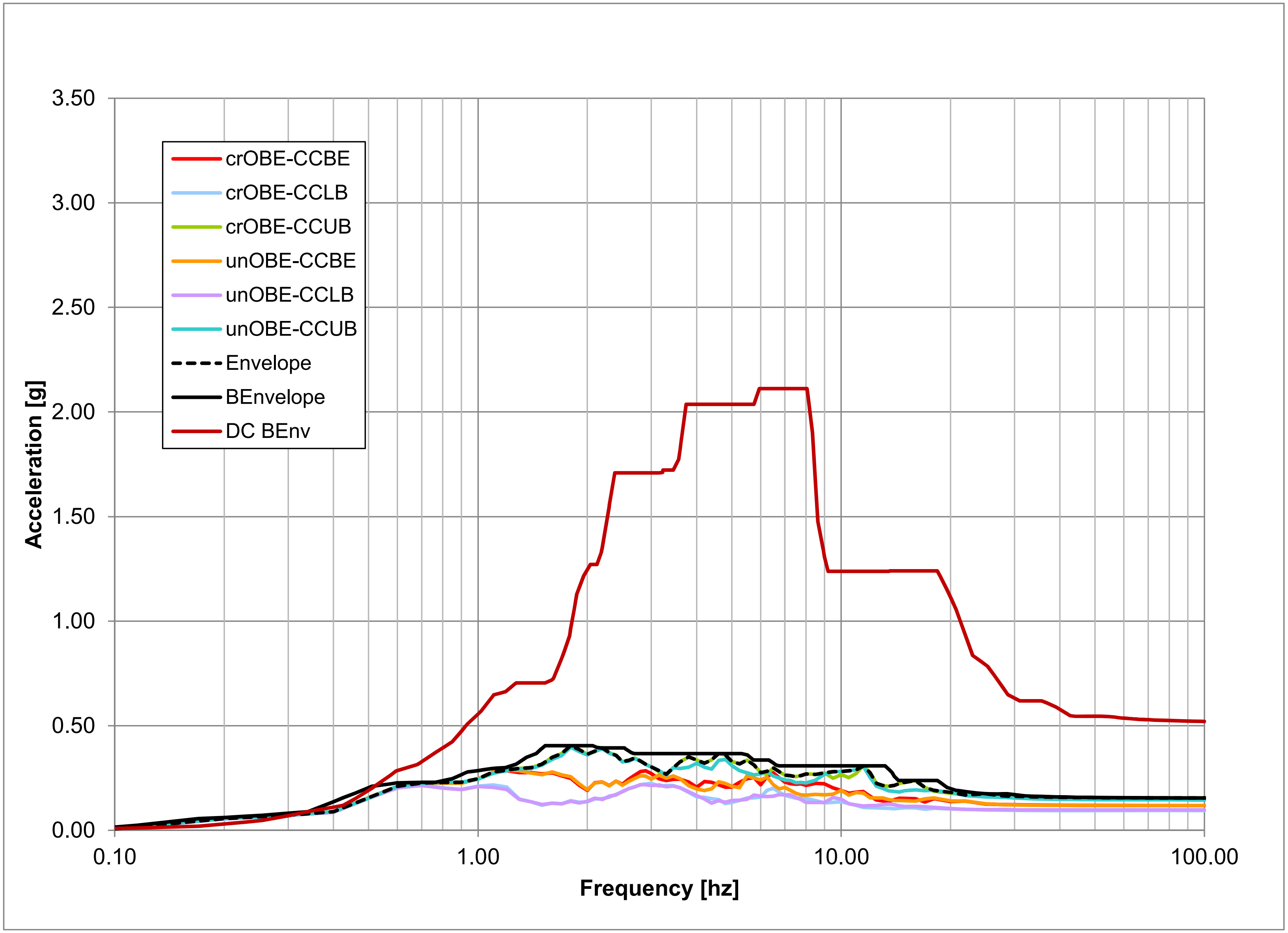


Figure 3.7-54 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building, Z_{NI} = +3.70 m (+12 ft - 1 3/4 in) Z(Vert) Direction, Rigid Location, Damping 5%}

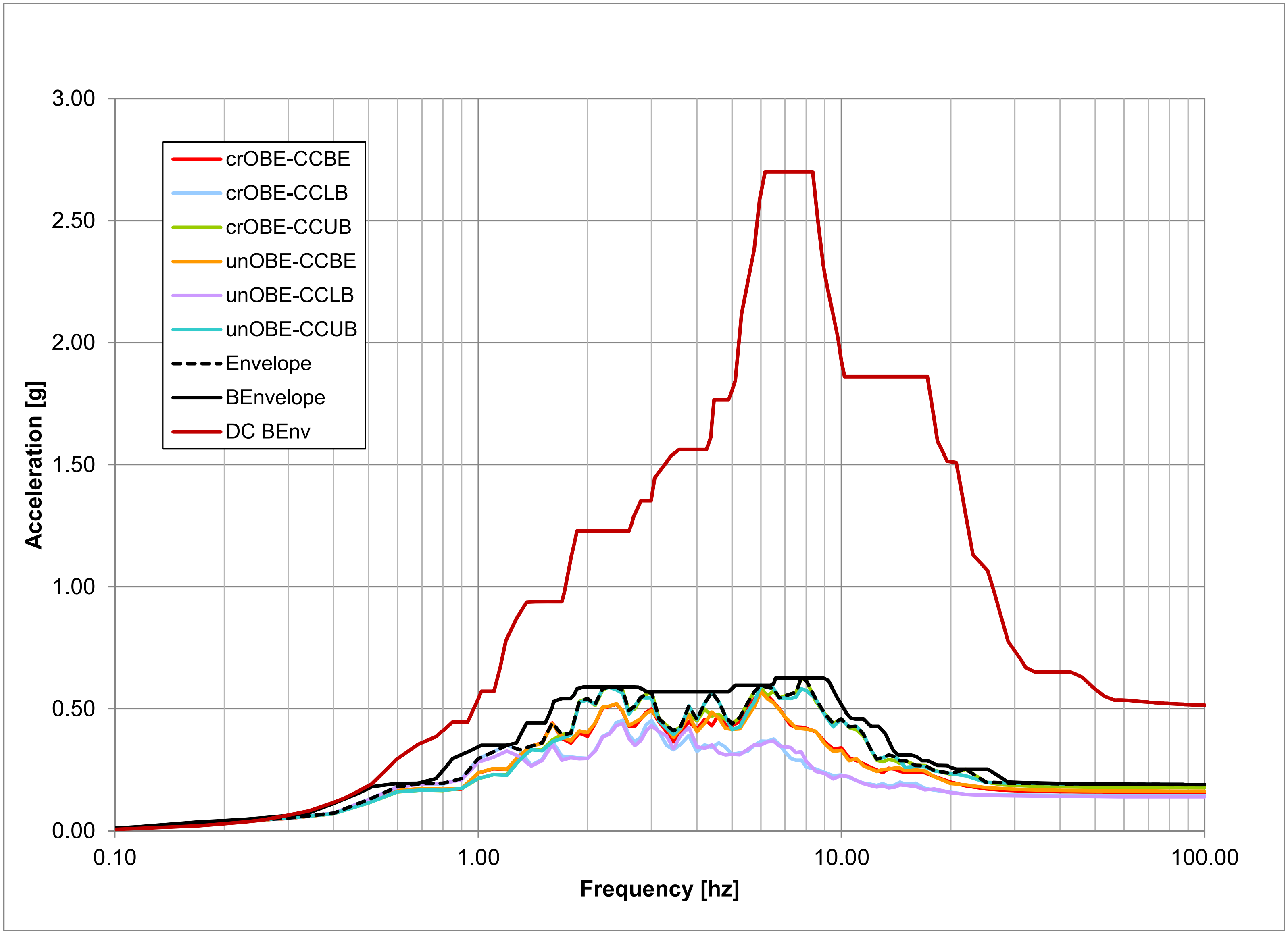


Figure 3.7-55 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building, Z_{NI} = +14.80 m (+48 ft - 6 3/4 in), X(E-W) Direction, Rigid Location, Damping 5%}

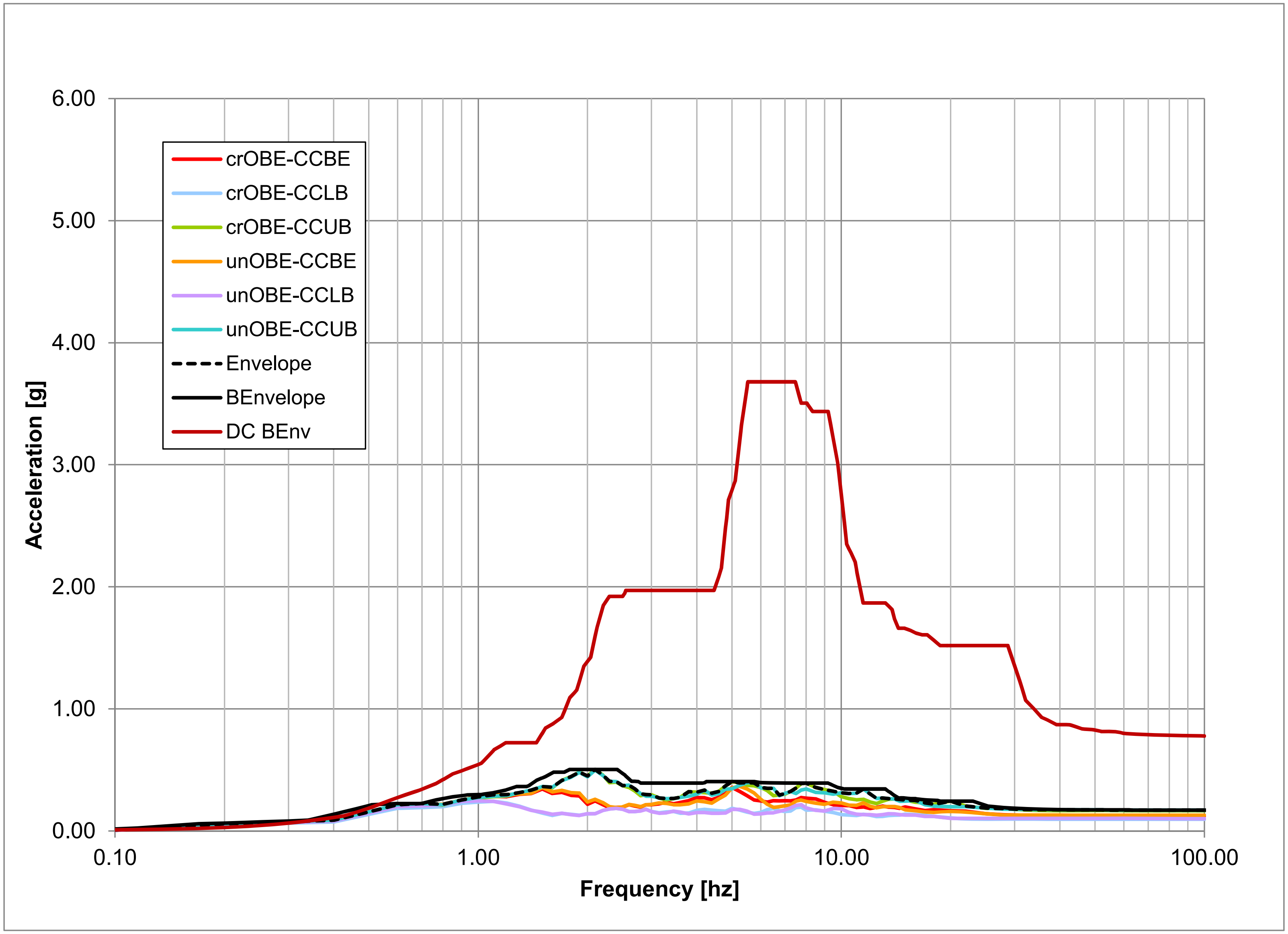


Figure 3.7-56 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building, Z_{NI} = +14.80 m (+48 ft - 6 3/4 in), Y(N-S) Direction, Rigid Location, Damping 5%}

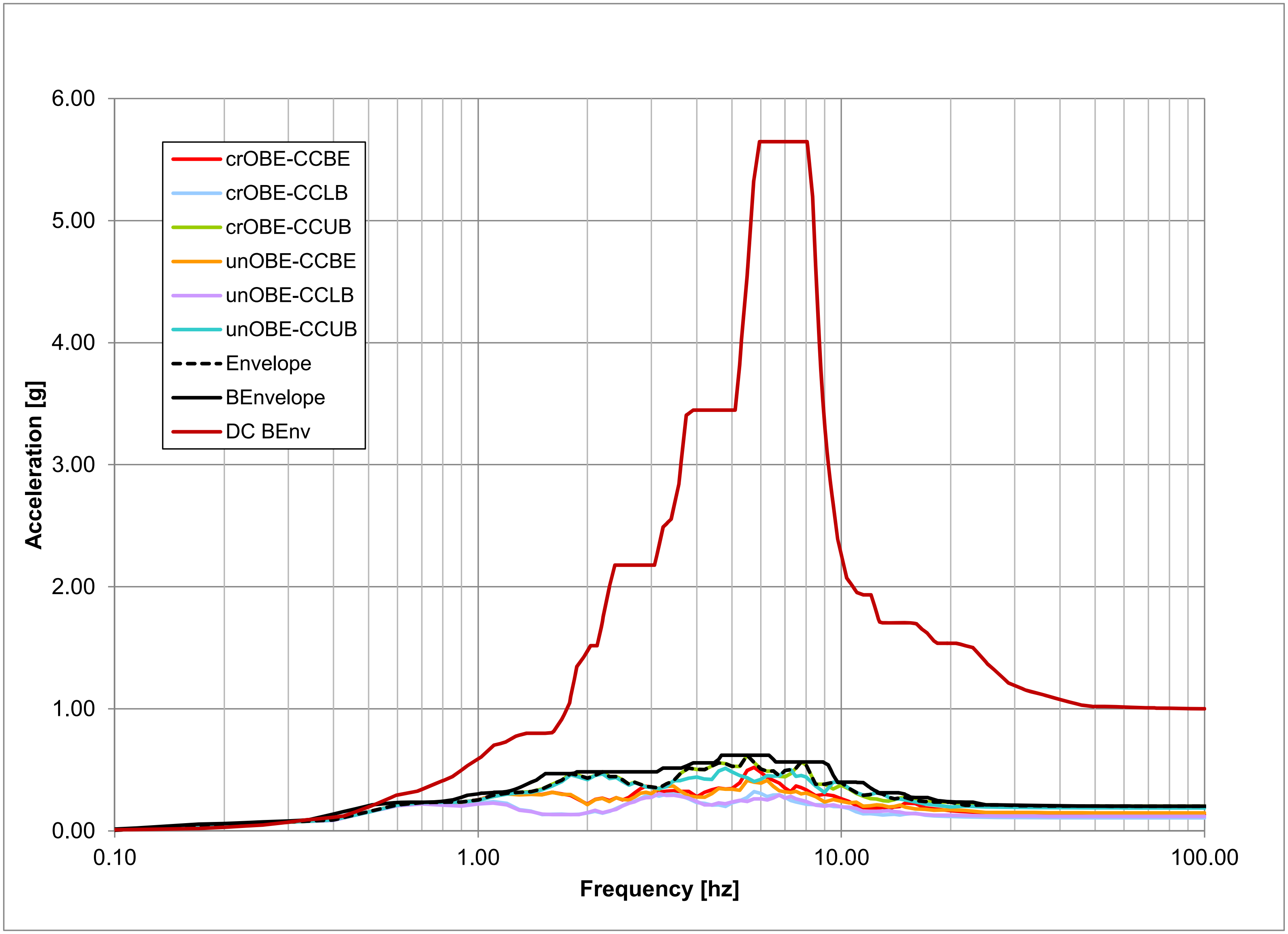


Figure 3.7-57 — {DC vs. COLA In-Structure Response Spectra (ISRS), Fuel Building, Z_{NI} = +14.80 m (+48 ft - 6 3/4 in), Z(Vert) Direction, Rigid Location, Damping 5%}

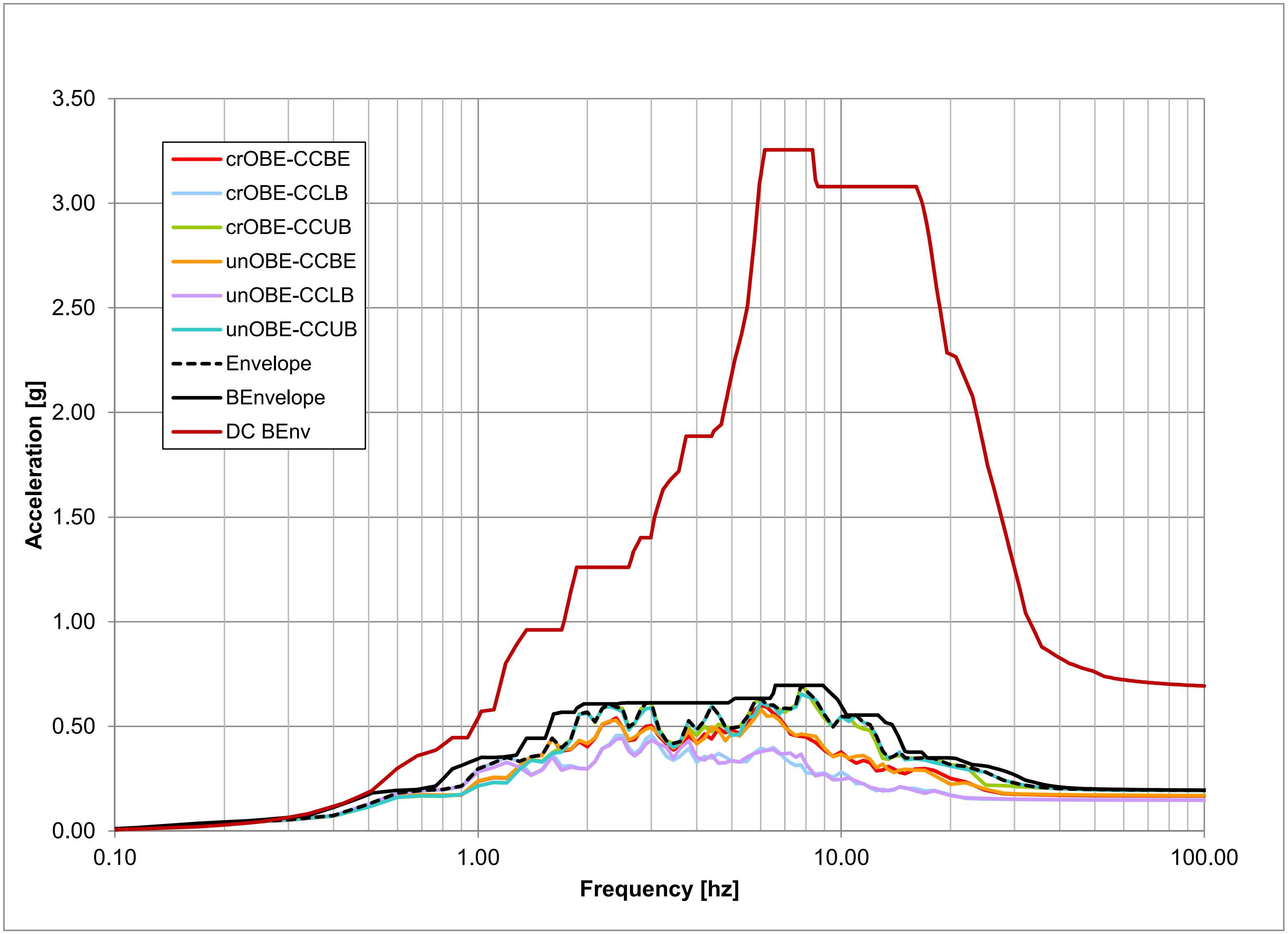


Figure 3.7-58 — {DC vs. COLA In-Structure Response Spectra (ISRS), Center of EPGB Basemat, Z_{EPGB} = -1.83 m (-6 ft - 0 in), X(E-W) Direction, Damping 5%}

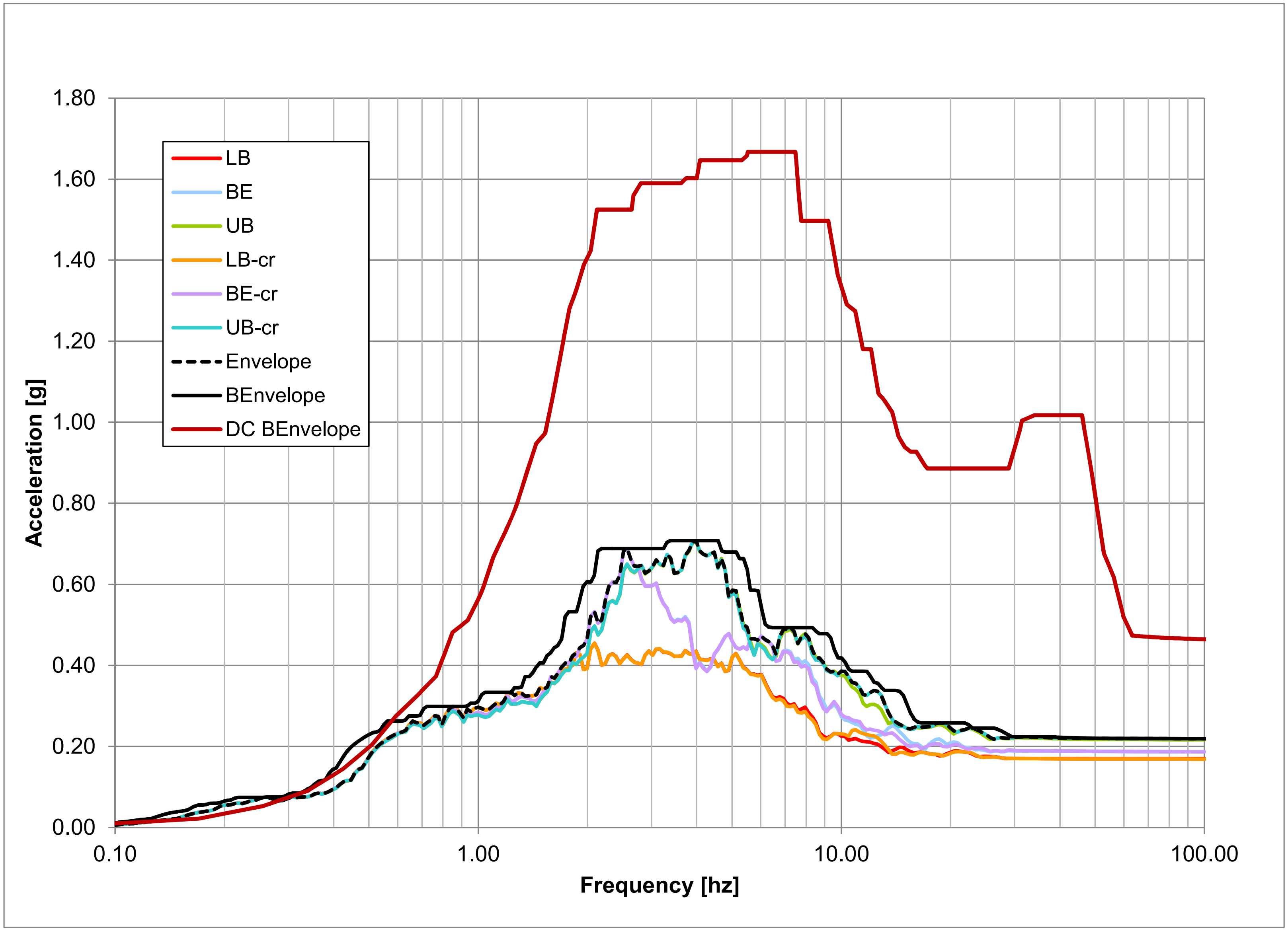


Figure 3.7-59 — {DC vs. COLA In-Structure Response Spectra (ISRS), Center of EPGB Basemat, Z_{EPGB} = -1.83 m (-6 ft - 0 in), Y (N-S) Direction, Damping 5%}

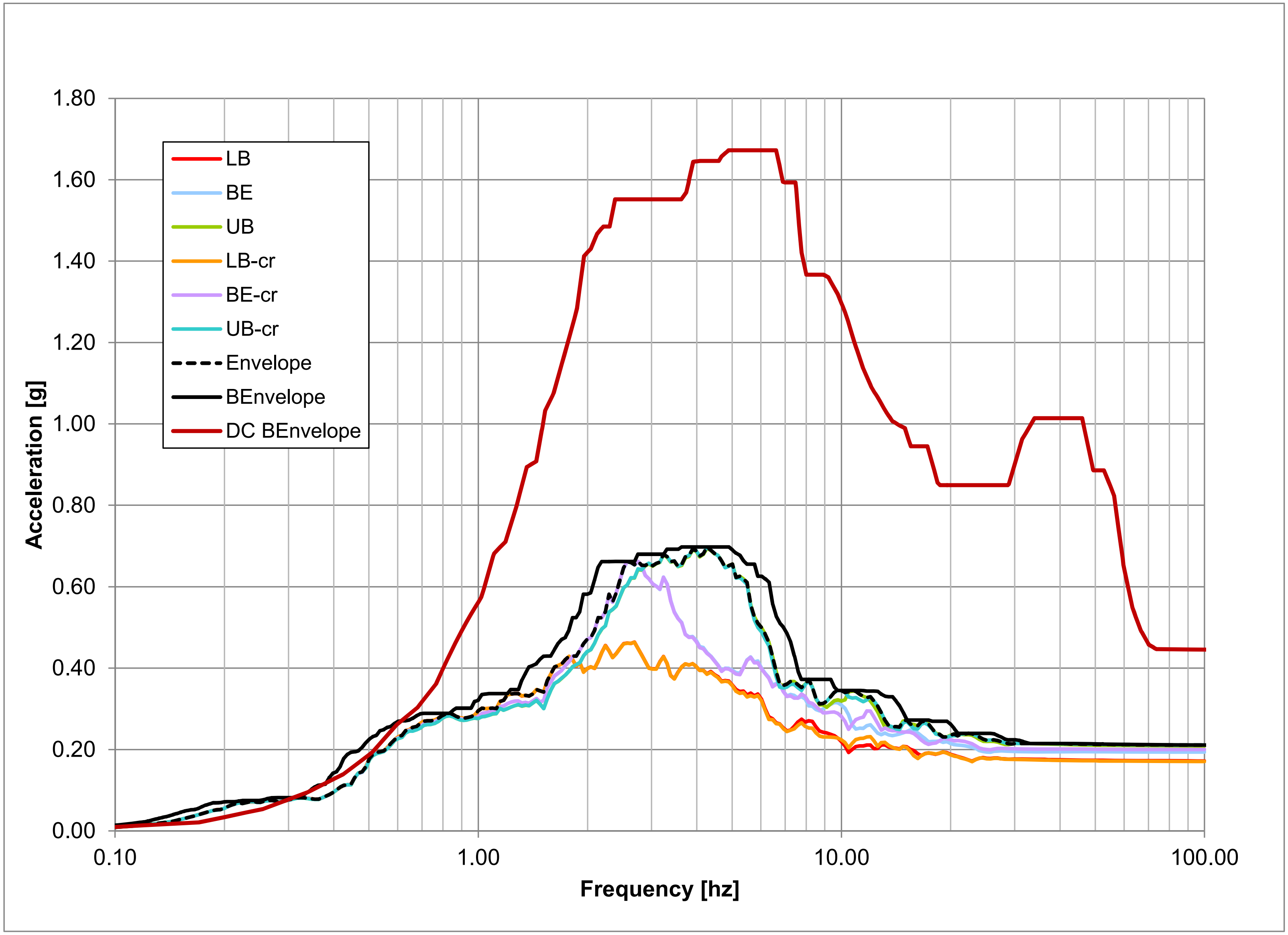


Figure 3.7-60 — {DC vs. COLA In-Structure Response Spectra (ISRS), Center of EPGB Basemat, Z_{EPGB} = -1.83 m (-6 ft - 0 in), Z (Vert) Direction, Damping 5%}

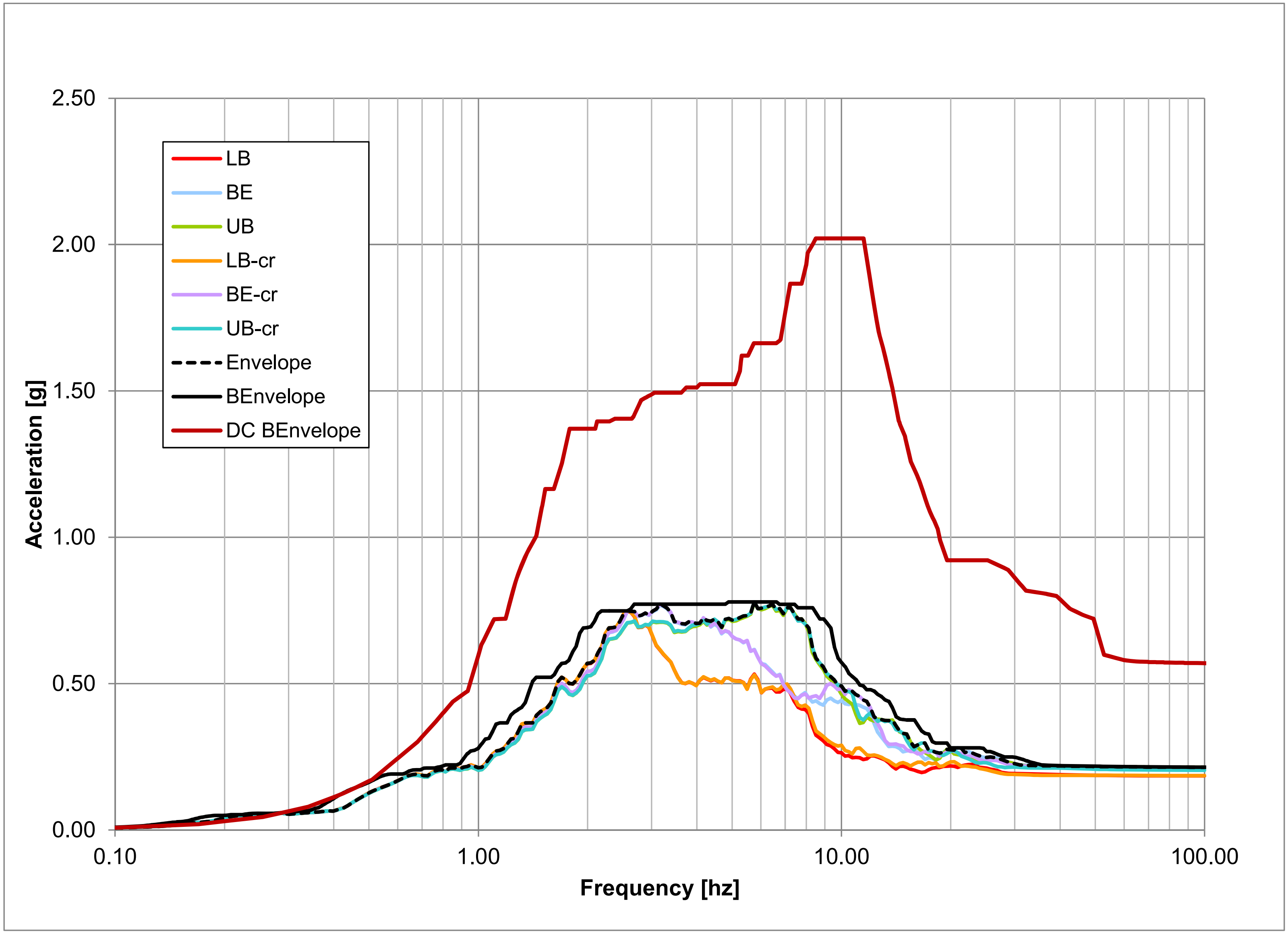


Figure 3.7-61 — {DC vs. COLA In-Structure Response Spectra (ISRS), EPGB Fan Room, Z_{EPGB} = -15.39 m (+50 ft - 6 in), X (E-W) Direction, Damping 5%}

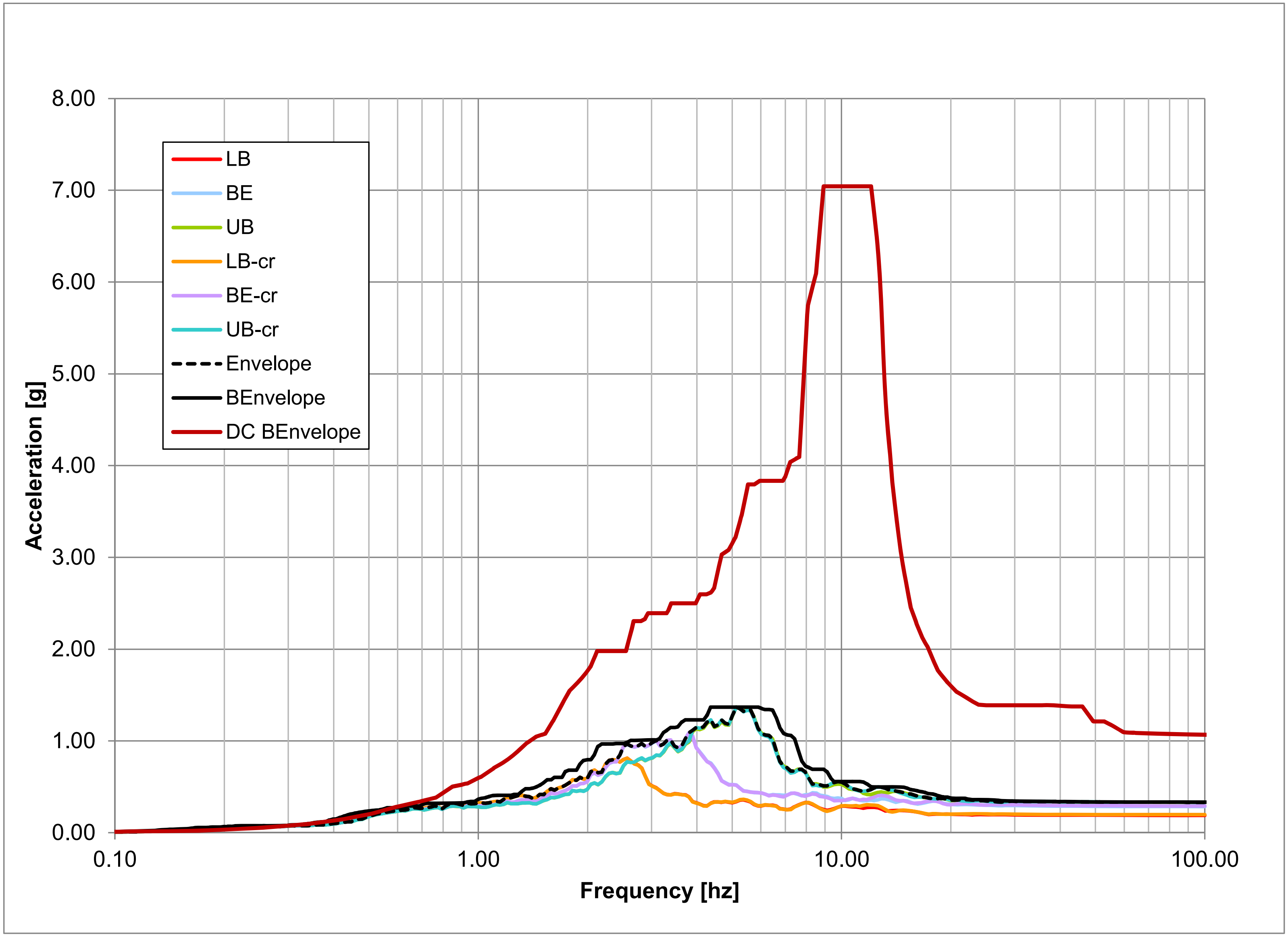


Figure 3.7-62 — {DC vs. COLA In-Structure Response Spectra (ISRS), EPGB Fan Room, Z_{EPGB} = -15.39 m (+50 ft - 6 in), X (E-W) Direction, Damping 5%}

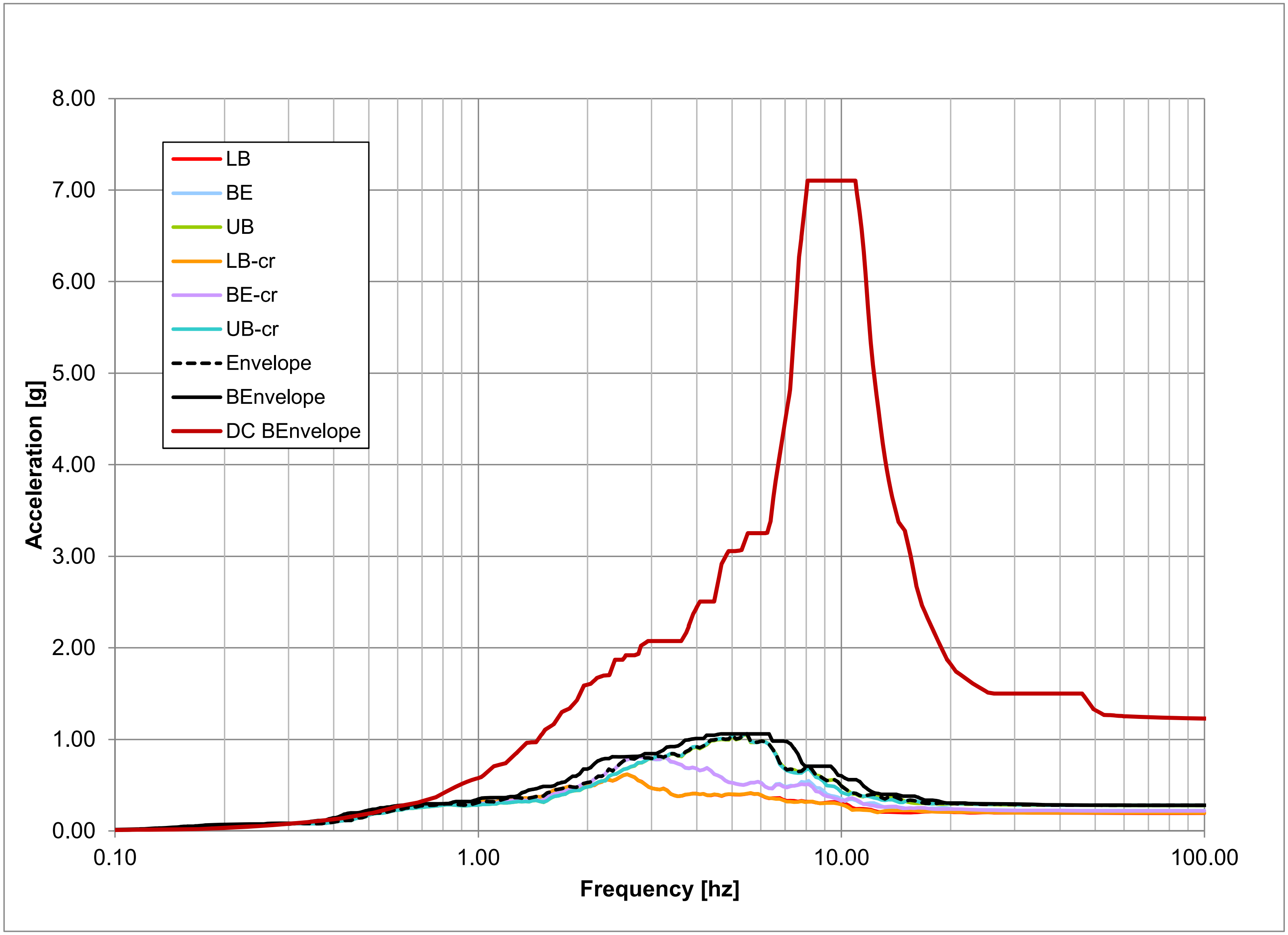


Figure 3.7-63 — {DC vs. COLA In-Structure Response Spectra (ISRS), EPGB Fan Room, Z_{EPGB} = -15.39 m (+50 ft - 6 in), Z (Vert) Direction, Damping 5%}

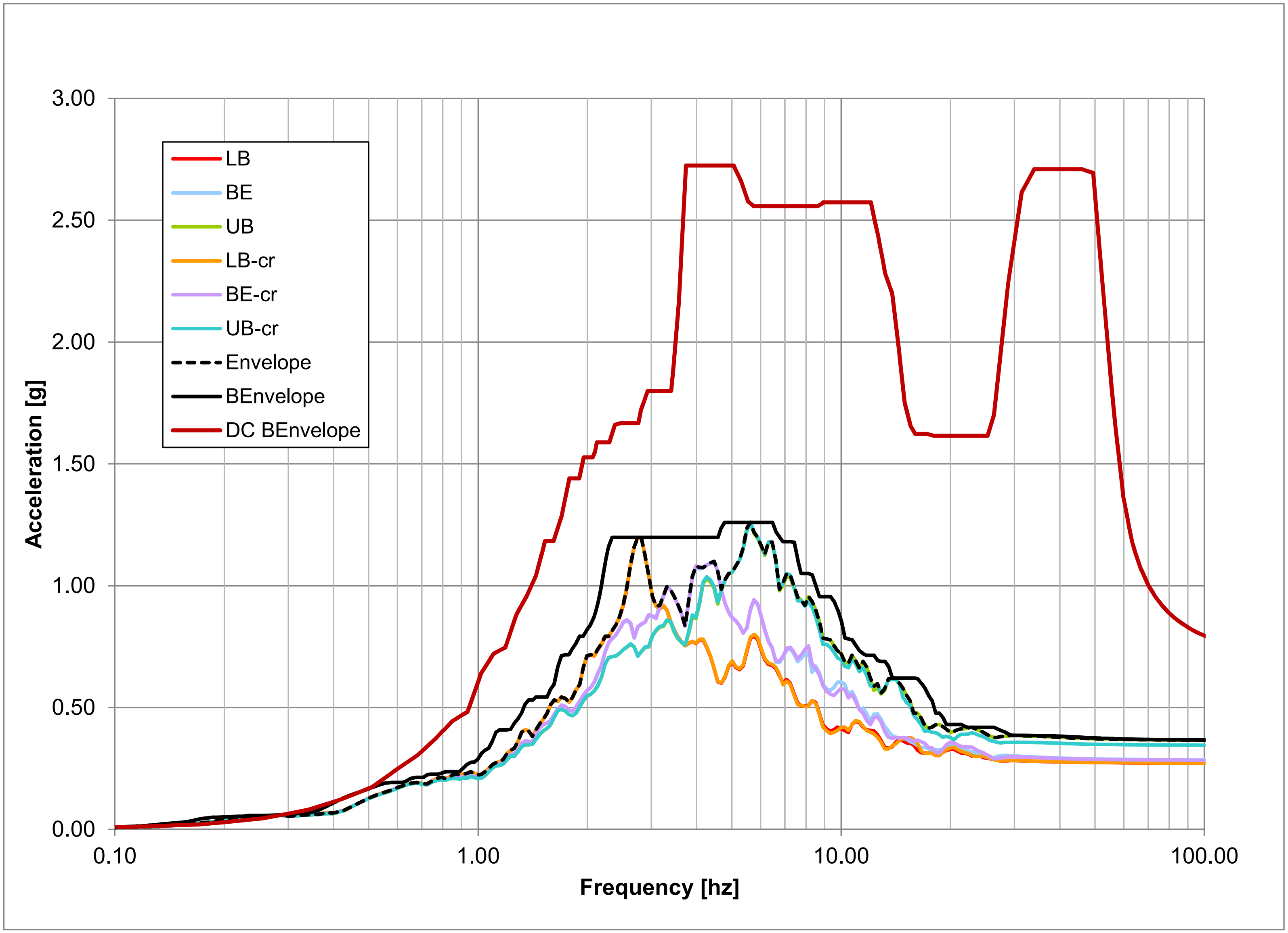


Figure 3.7-64 — {DC vs. COLA In-Structure Response Spectra (ISRS), ESWB Pump Slab, Z_{ESWB} = +4.27 m (+14 ft - 0 in), X (E-W) Direction, Damping 5% (31-36)}

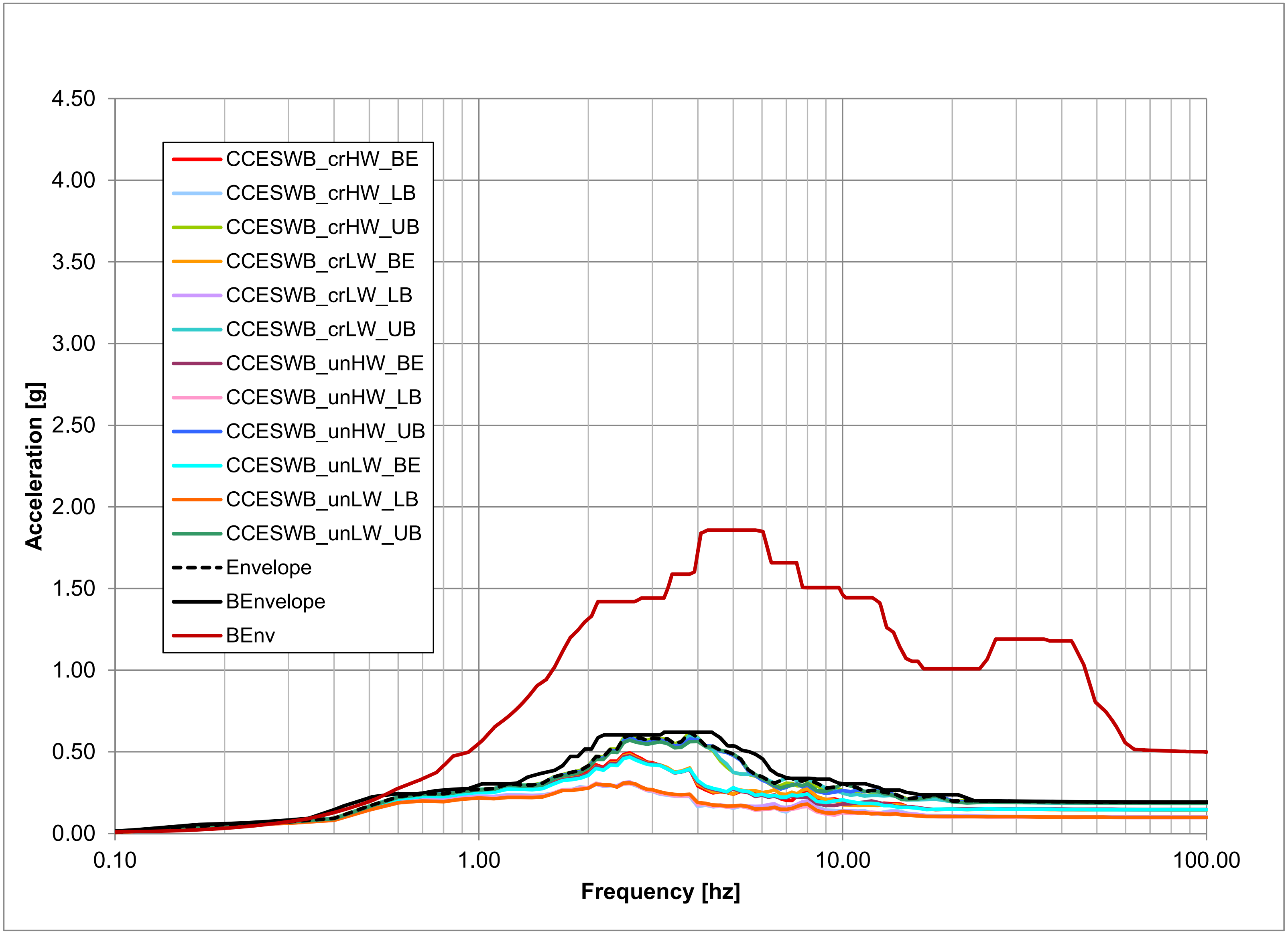


Figure 3.7-65 — {DC vs. COLA In-Structure Response Spectra (ISRS), ESWB Pump Slab, Z_{ESWB} = +4.27 m (+14 ft - 0 in), Y (N-Y (N-S) Direction, Damping 5%}

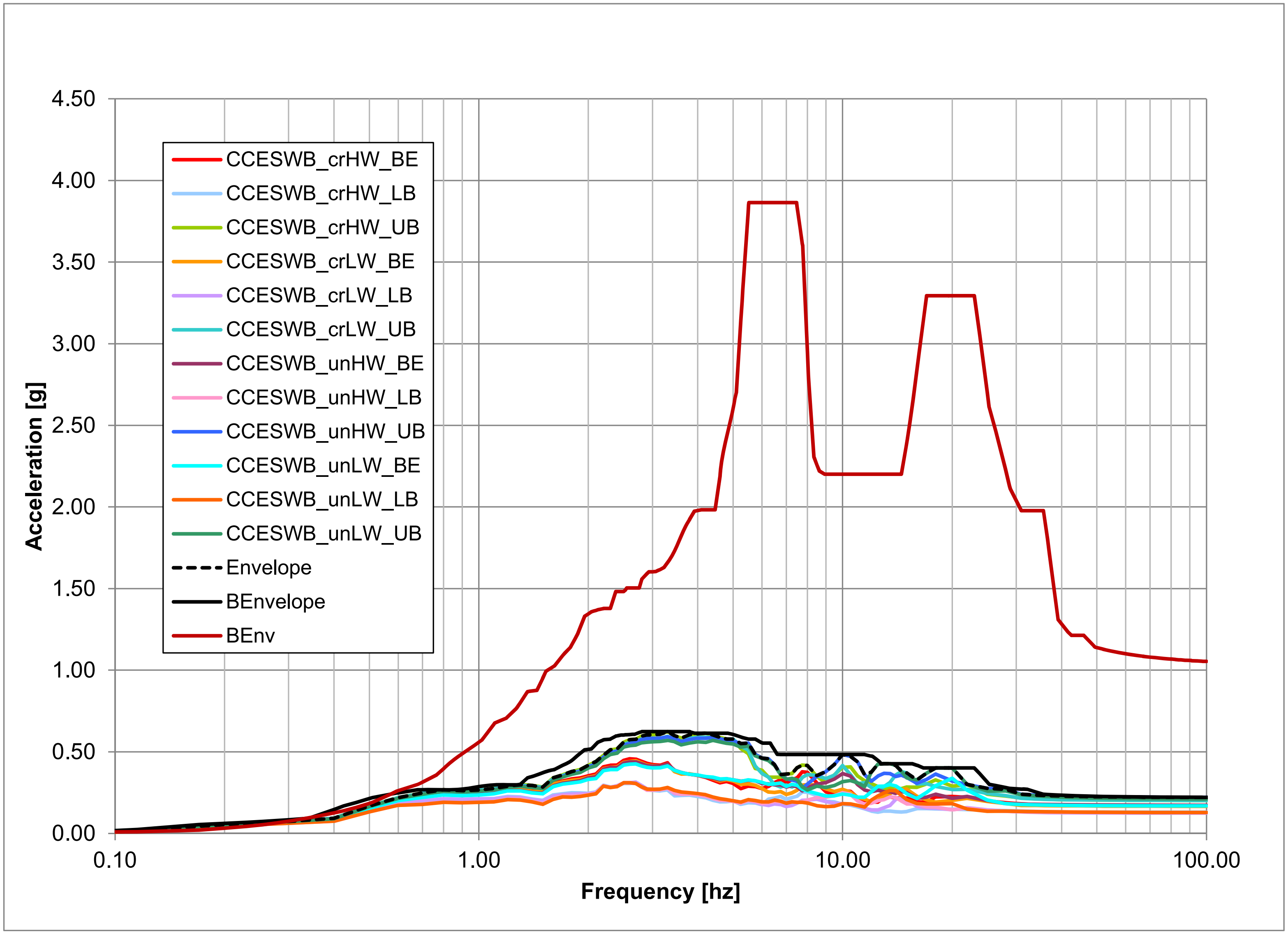


Figure 3.7-66 — {DC vs. COLA In-Structure Response Spectra (ISRS), ESWB Pump Slab, Z_{ESWB} = +4.27 m (+14 ft - 0 in), Z (Vert) Direction, Damping 5%}

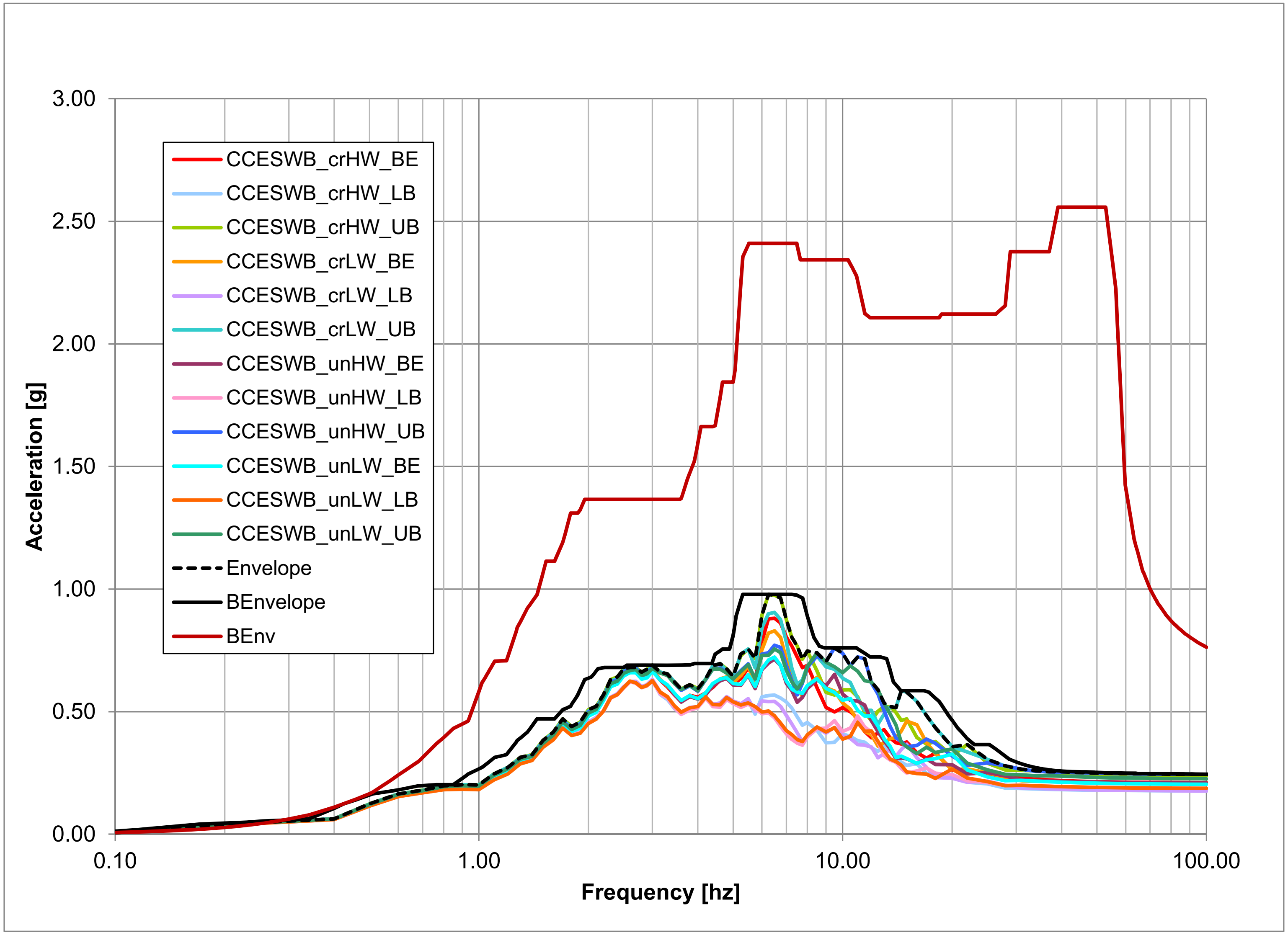


Figure 3.7-67 — {Not Used}

Figure 3.7-67 is not used.

Figure 3.7-67a — {5% Damping SSI Input ARS at Ground Surface (Direction H1) - NICBM Structures}

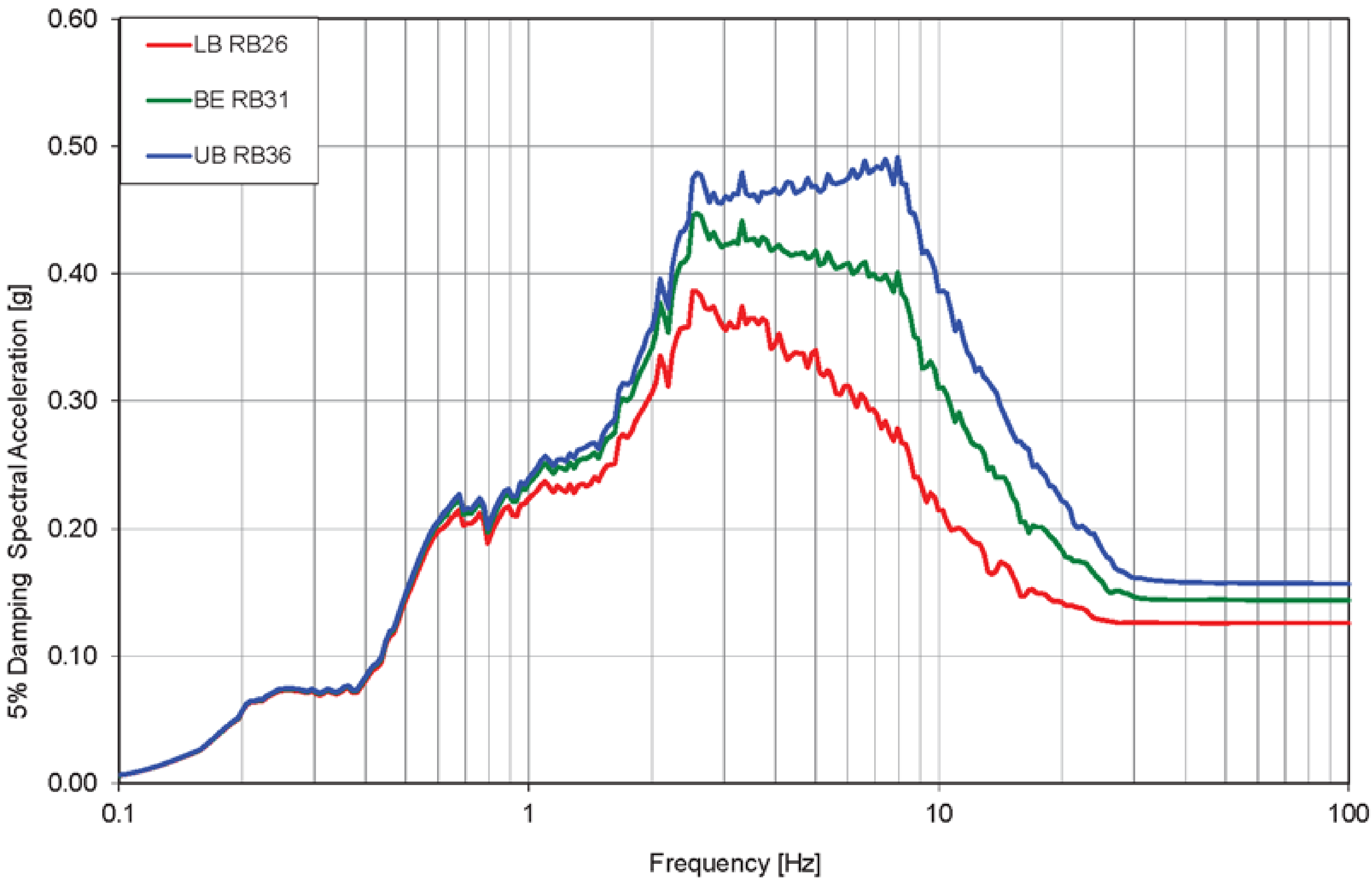


Figure 3.7-67b — {5% Damping SSI Input ARS at Ground Surface (Direction H2) - NICBM Structures}

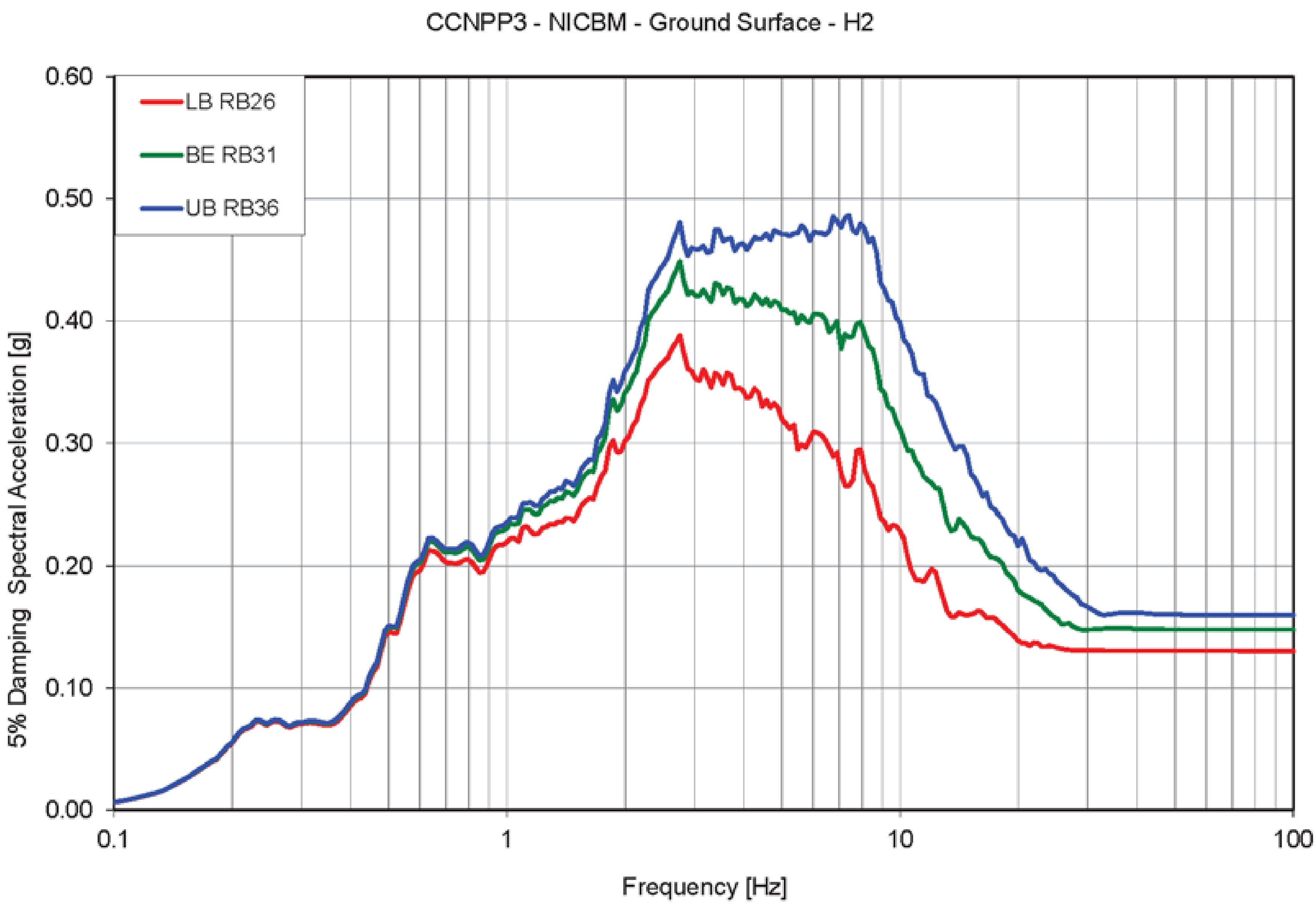


Figure 3.7-67c — {5% Damping SSI Input ARS at Ground Surface (Direction UP) - NICBM Structures}

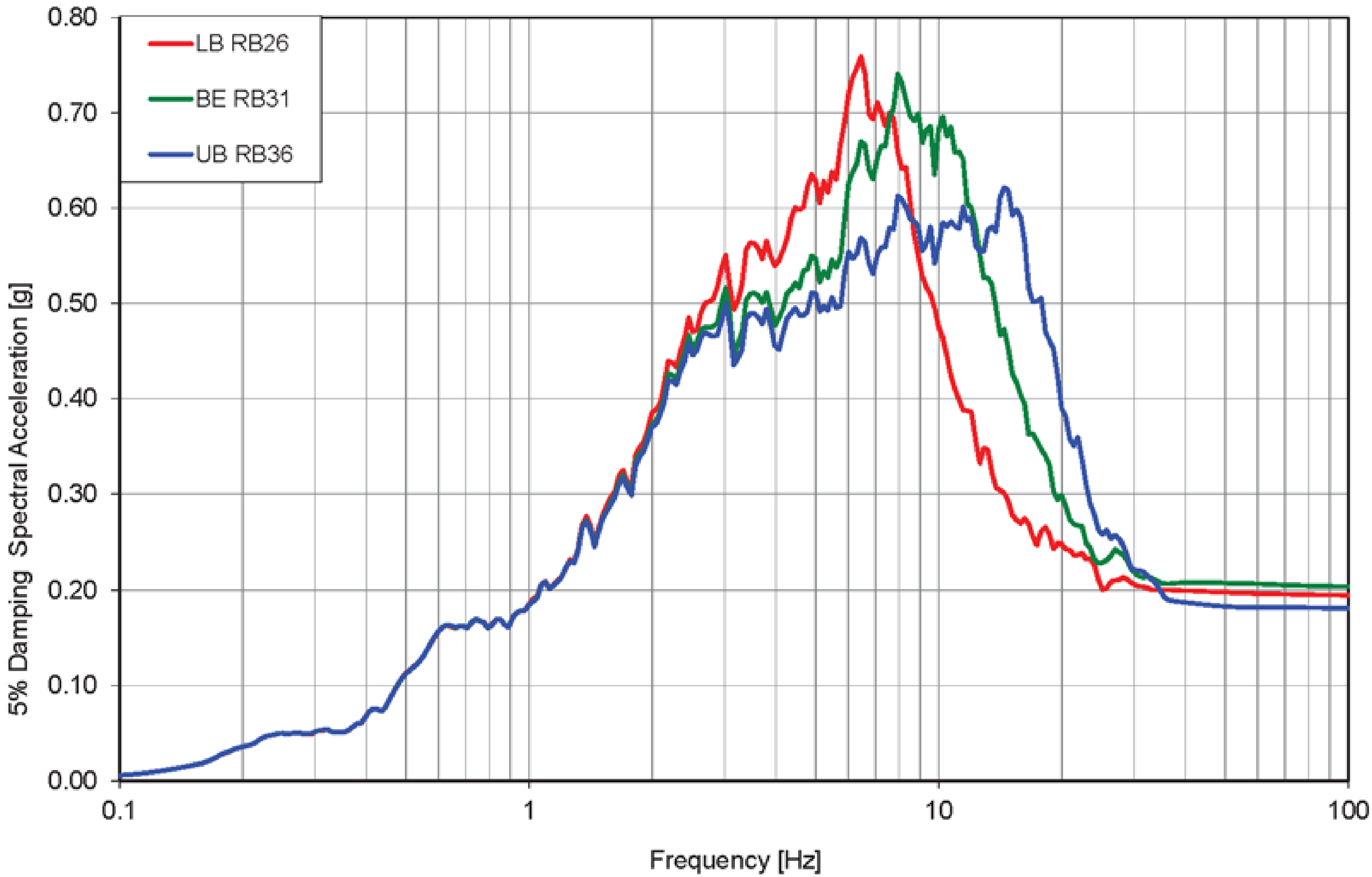


Figure 3.7-68 — {Not Used}

Figure 3.7-68 is not used.

Figure 3.7-68a — {5% Damping SSI Input ARS at Ground Surface (Direction H1) - EPGB}

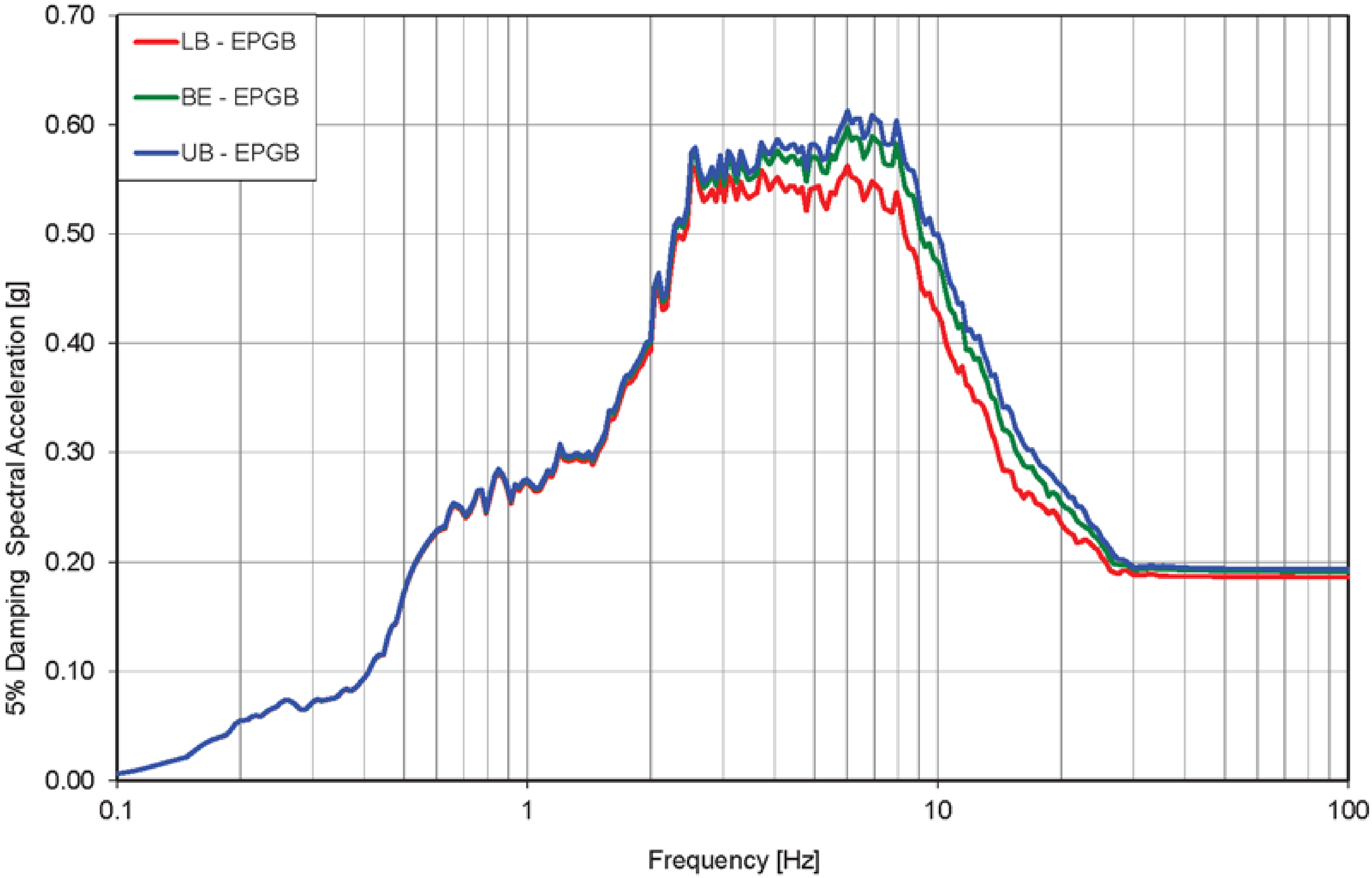


Figure 3.7-68b — {5% Damping SSI Input ARS at Ground Surface (Direction H2) - EPGB}

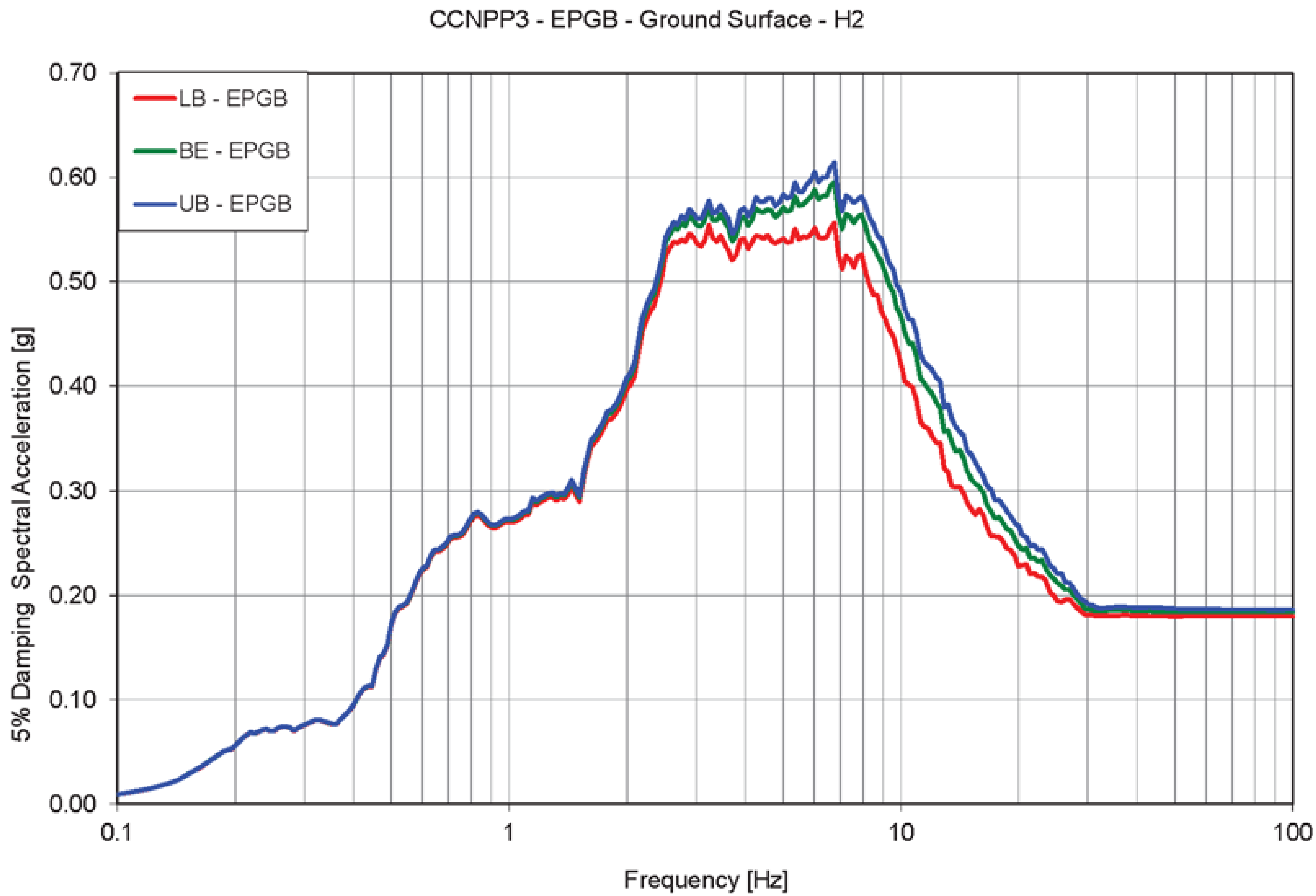


Figure 3.7-68c — {5% Damping SSI Input ARS at Ground Surface (Direction UP) - EPGB}

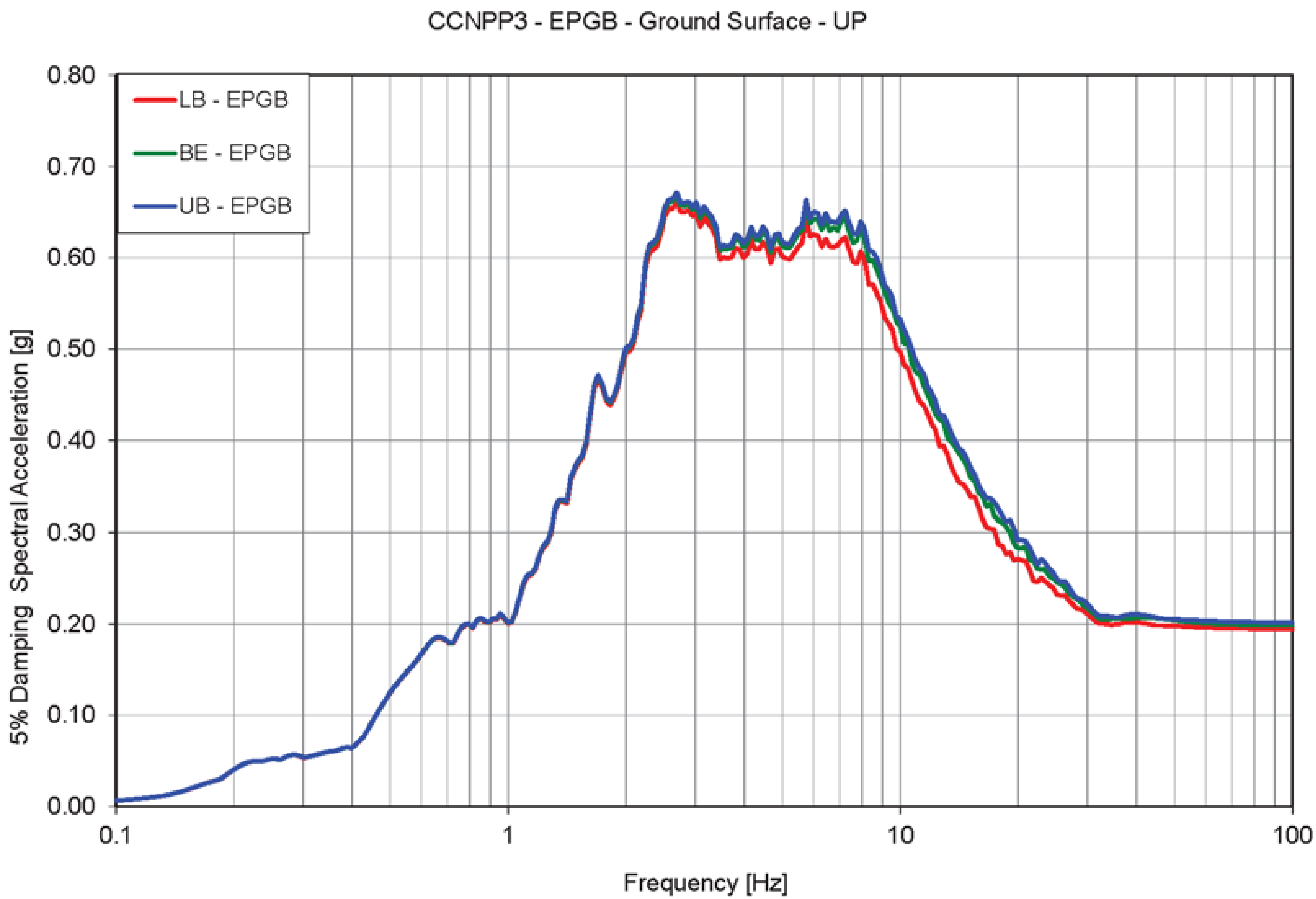


Figure 3.7-69 — {Not Used}

Figure 3.7-69 is not used.

Figure 3.7-69a — {5% Damping SSI Input ARS at Ground Surface (Direction H1) - ESWB}

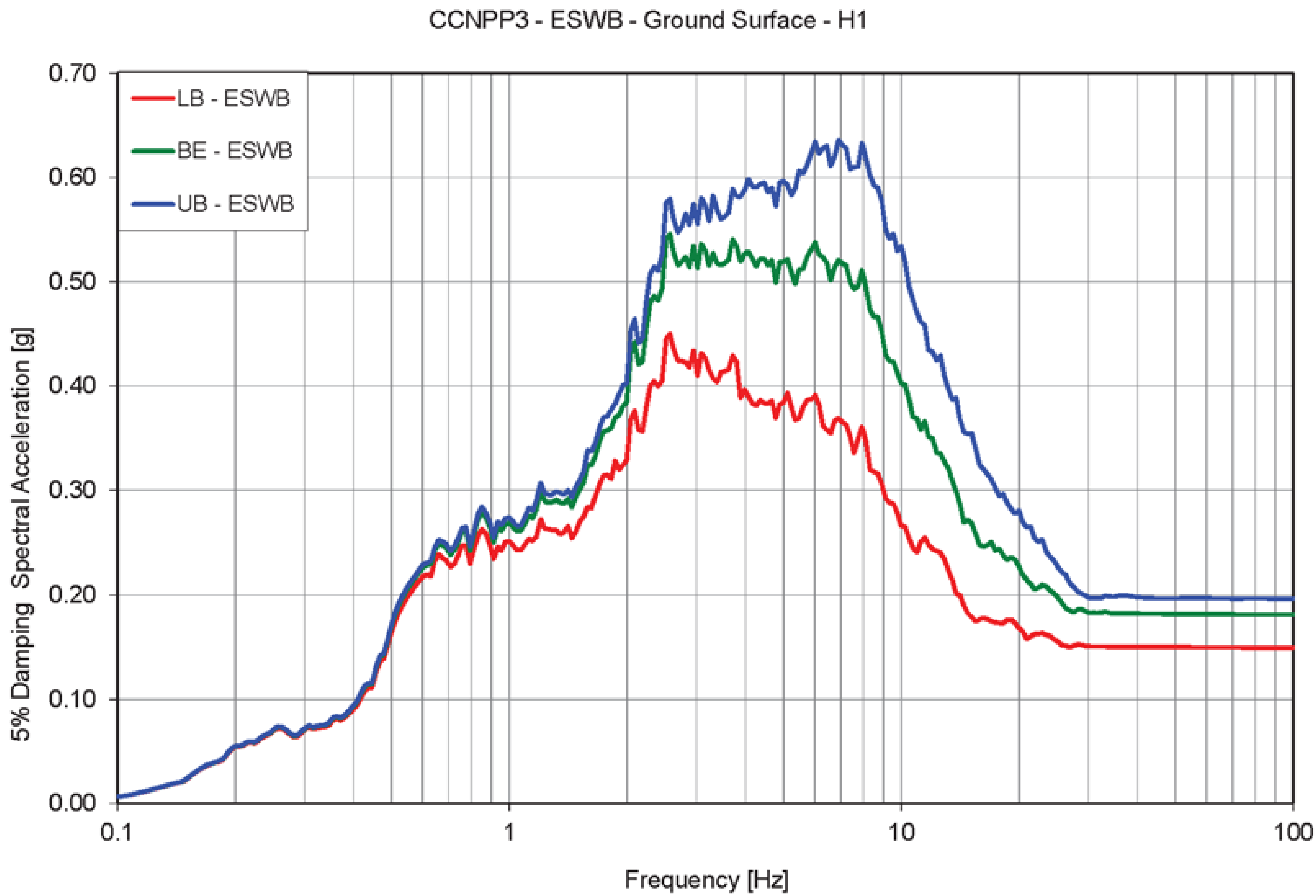


Figure 3.7-69b — {5% Damping SSI Input ARS at Ground Surface (Direction H2) - ESWB}

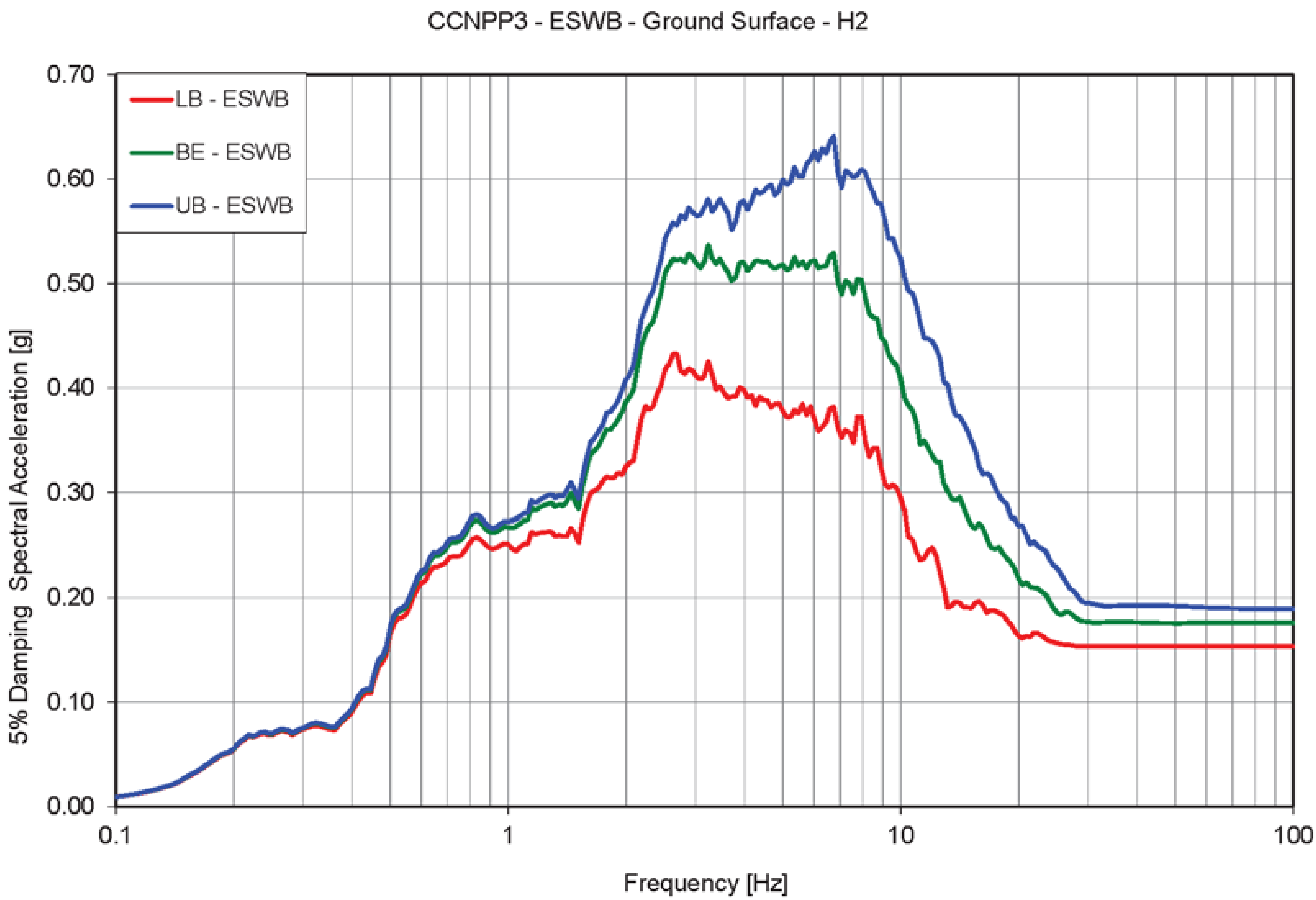


Figure 3.7-69c — {5% Damping SSI Input ARS at Ground Surface (Direction UP) - ESWB}

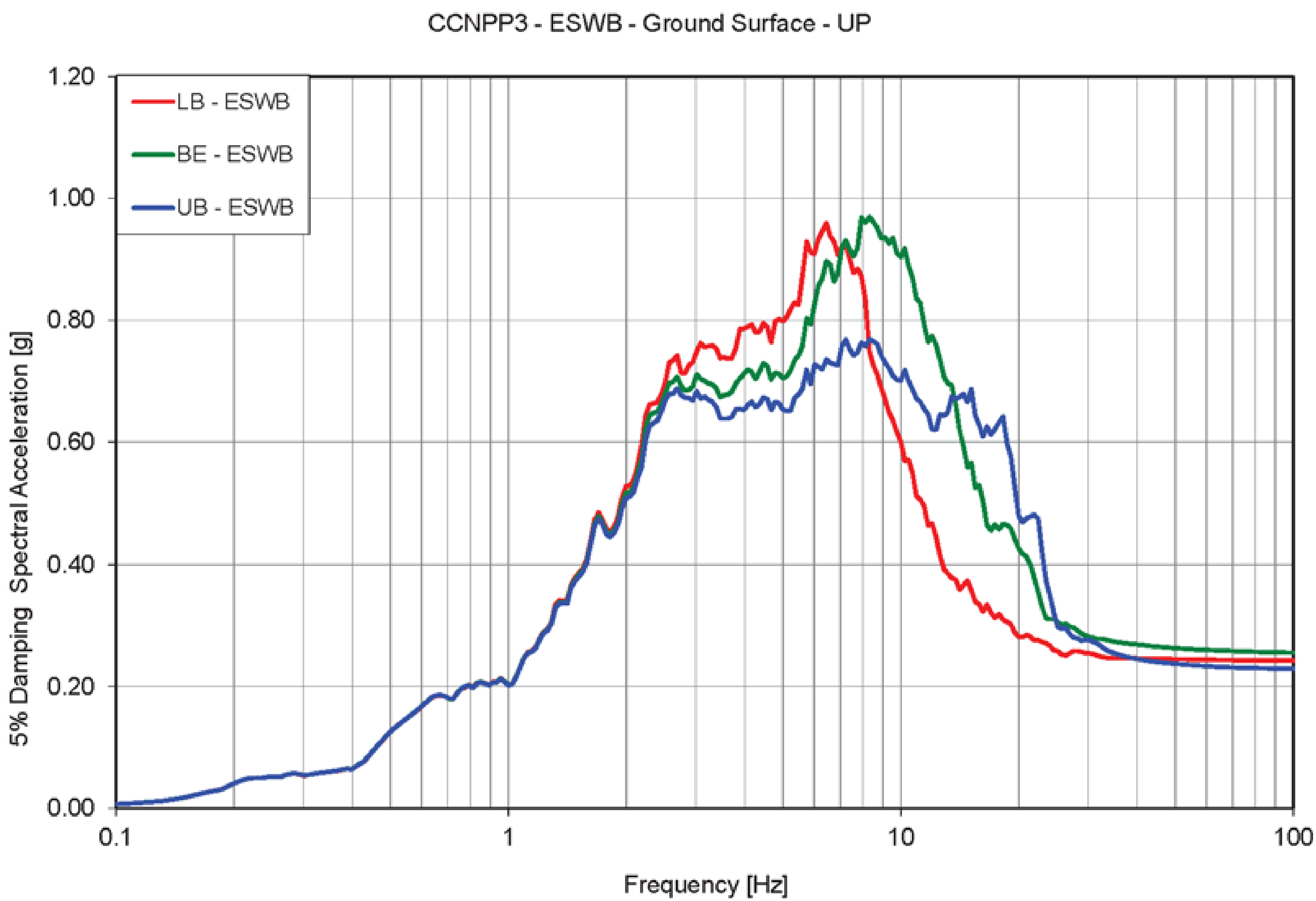


Figure 3.7-70 — {Not Used}

Figure 3.7-70 is not used.

Figure 3.7-71 — {Not Used}

Figure 3.7-71 is not used.

Figure 3.7-72 — {Not Used}

Figure 3.7-72 is not used.

Figure 3.7-73 — {ISRS for UHS Makeup Water Intake Structure at location at Elev. -22.5 ft (-6.86 m), North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

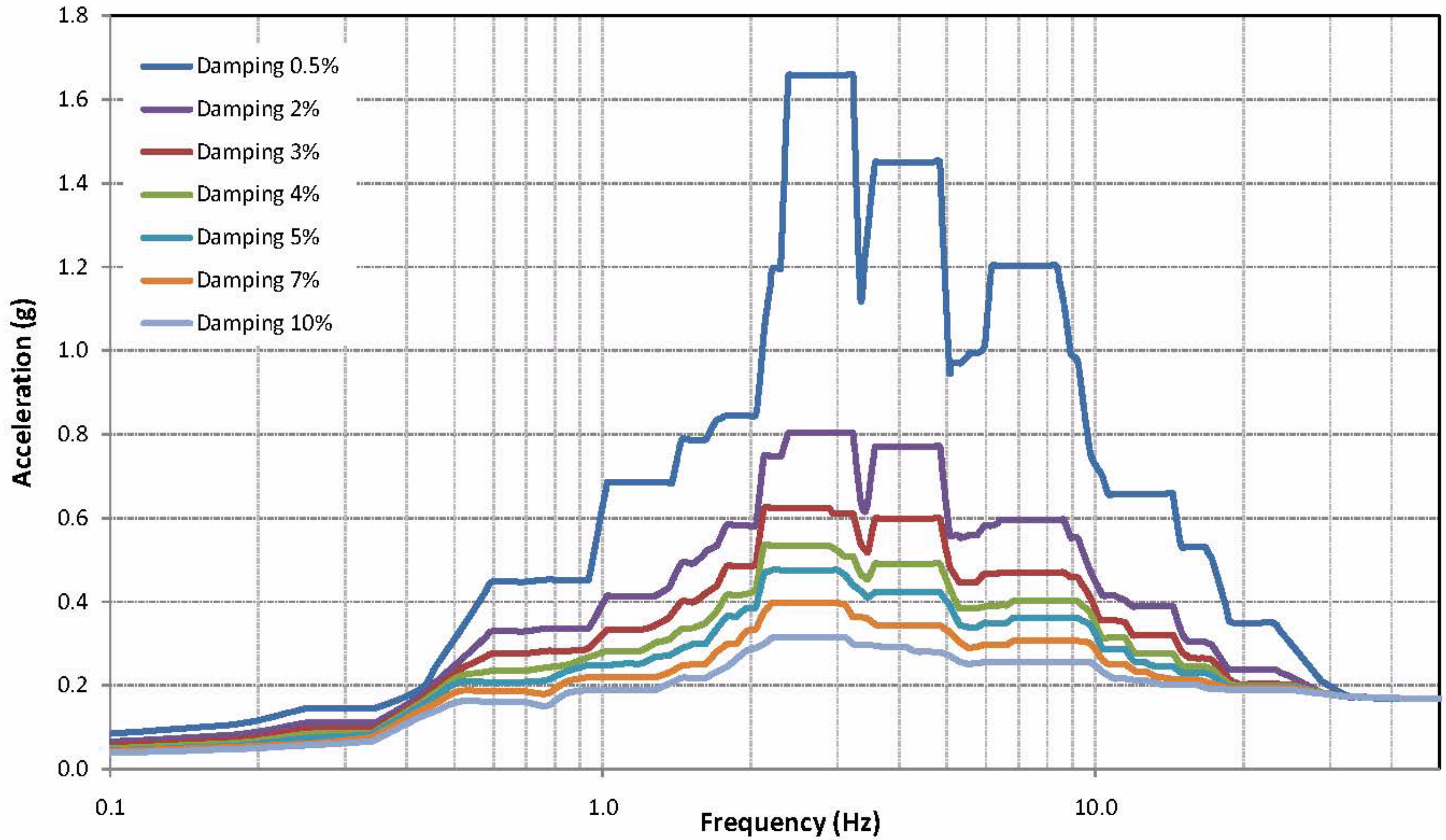


Figure 3.7-74 — {ISRS for UHS Makeup Water Intake Structure at Elev. -22.5 ft (-6.86 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3.}

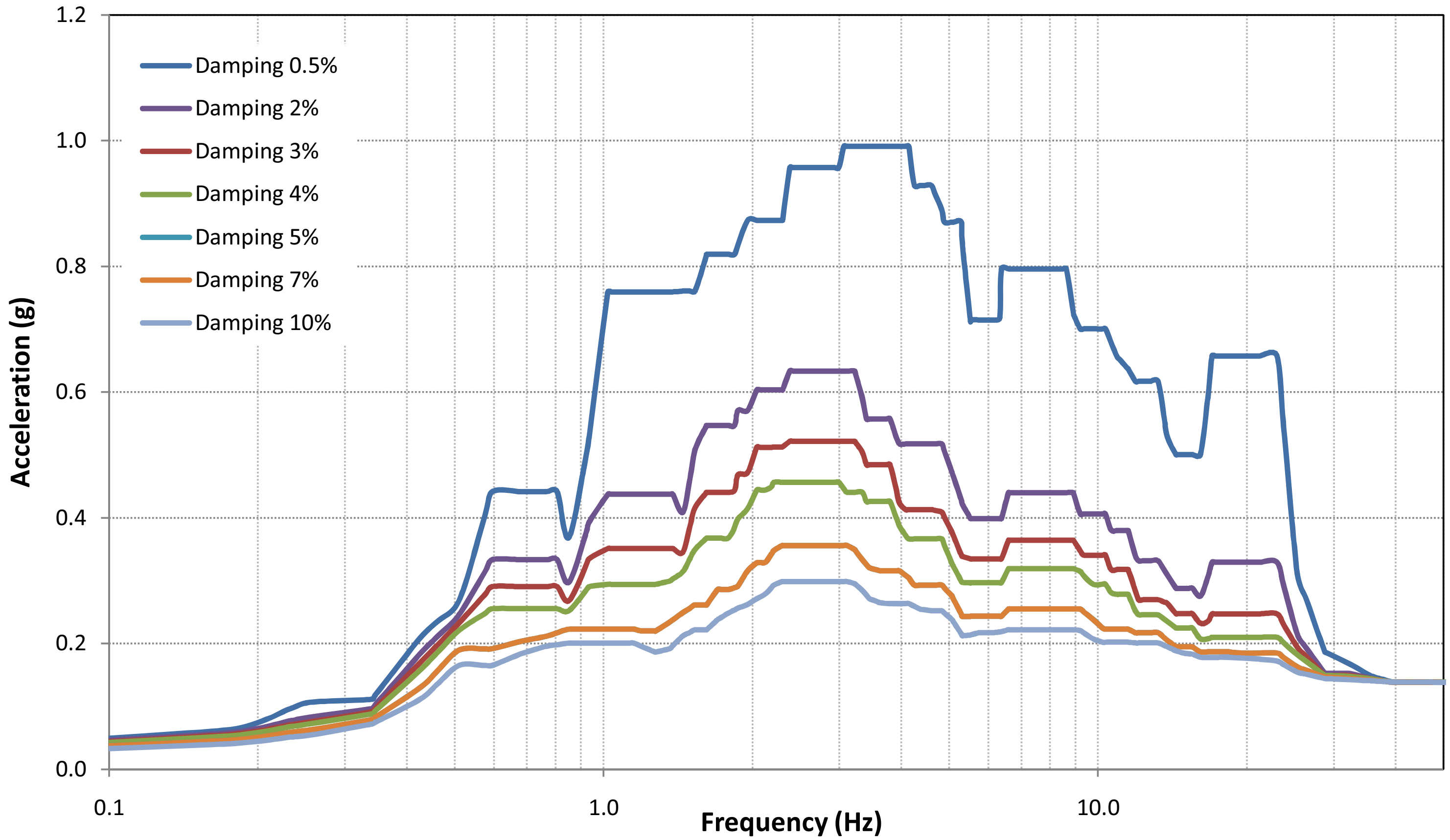


Figure 3.7-75 — {ISRS for UHS Makeup Water Intake Structure at Elev. -22.5 ft (-6.86 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

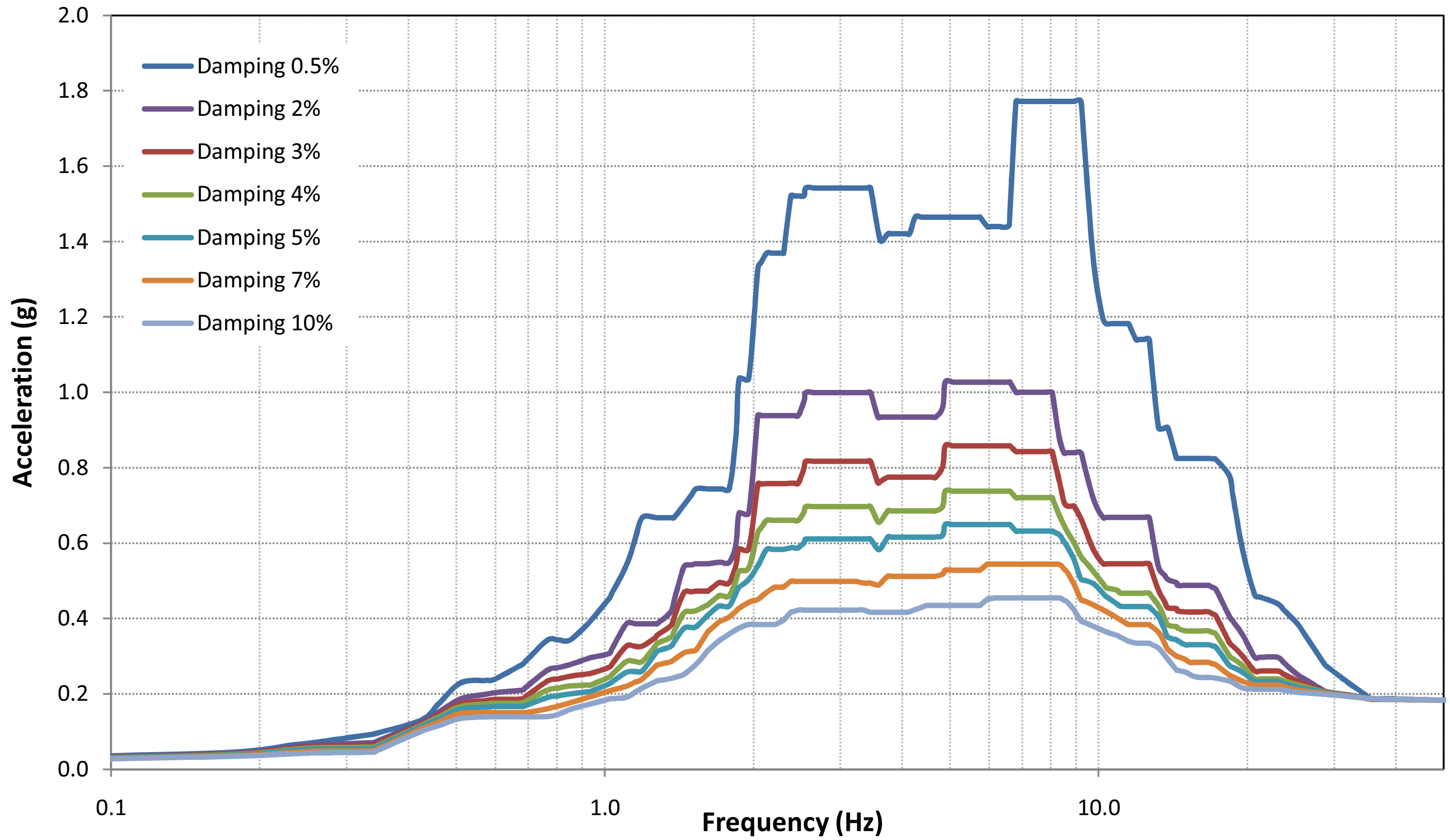


Figure 3.7-76 — {ISRS for UHS Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3.}

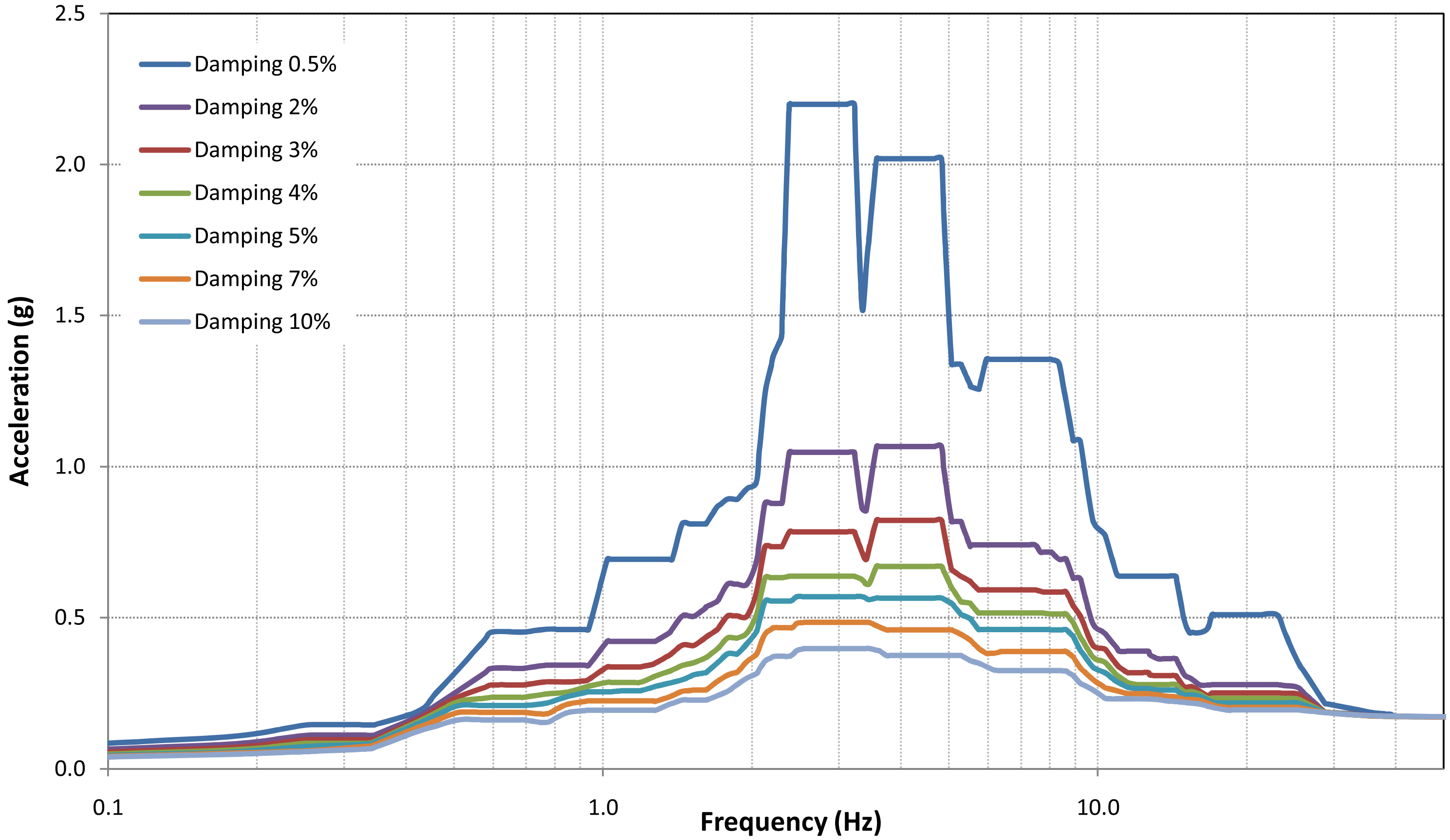


Figure 3.7-77 — {ISRS for Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

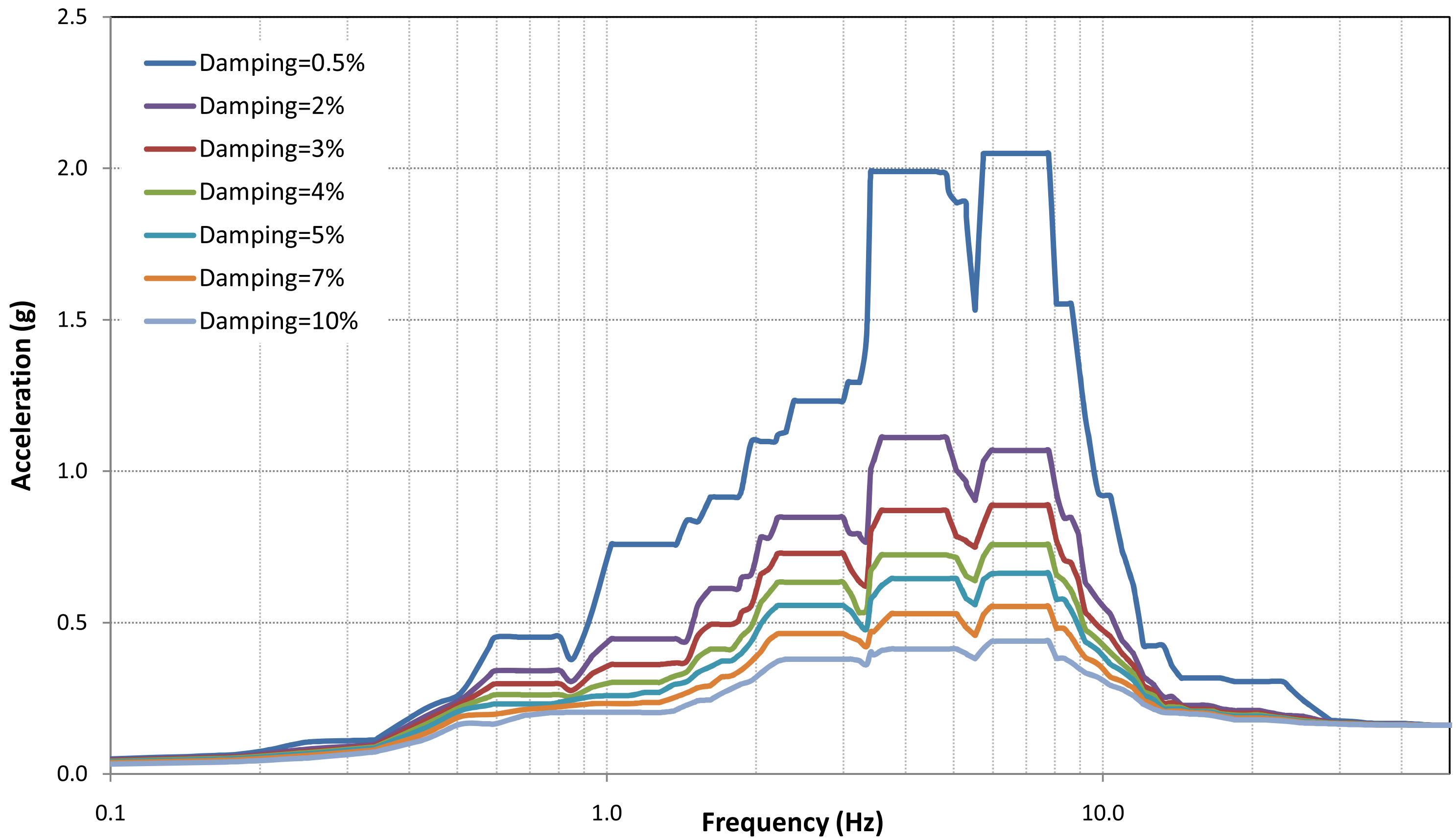


Figure 3.7-78 — {ISRS for Makeup Water Intake Structure at Elev. 11.5 ft (3.5 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

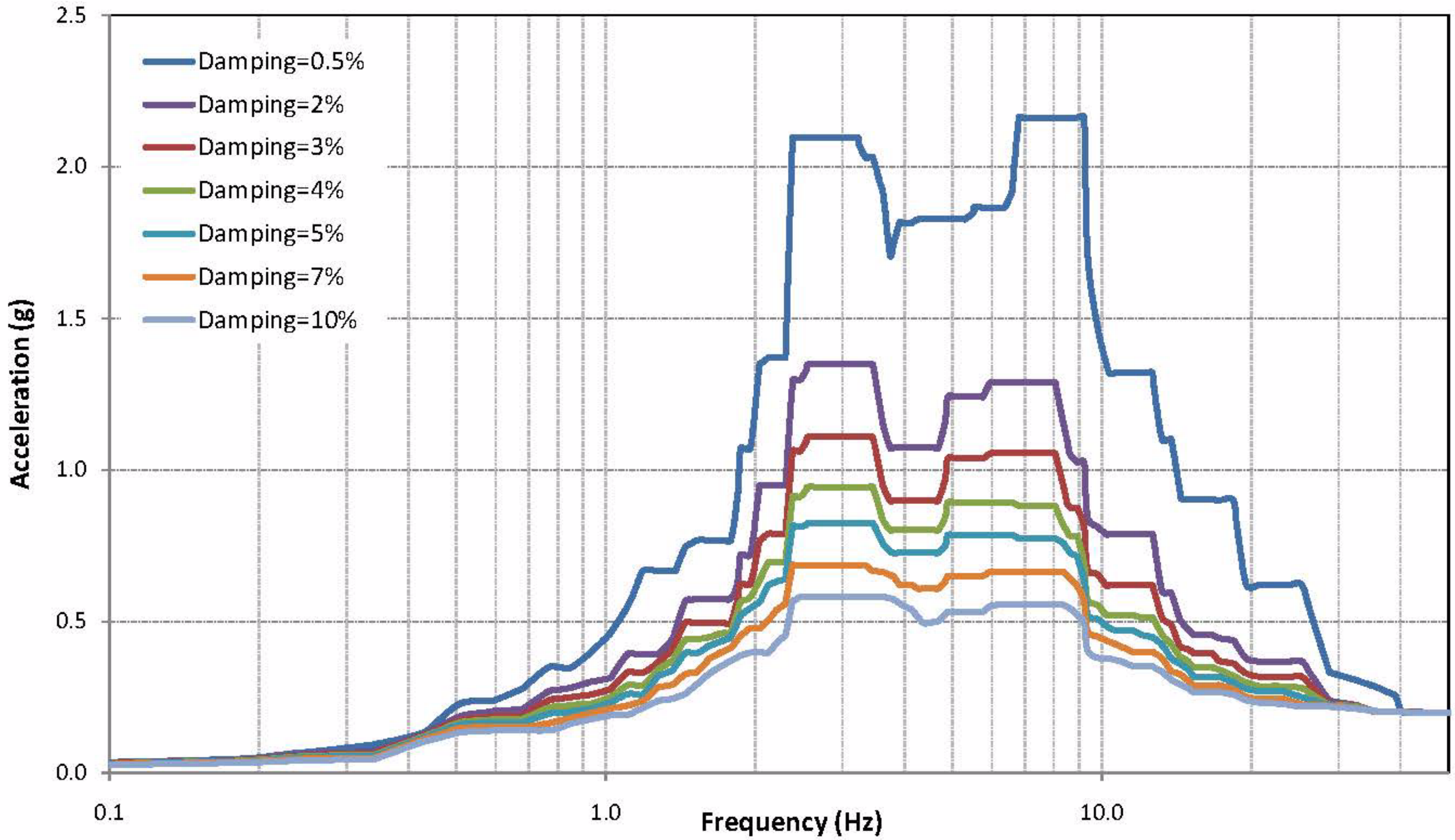


Figure 3.7-79 — {ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), North-South Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

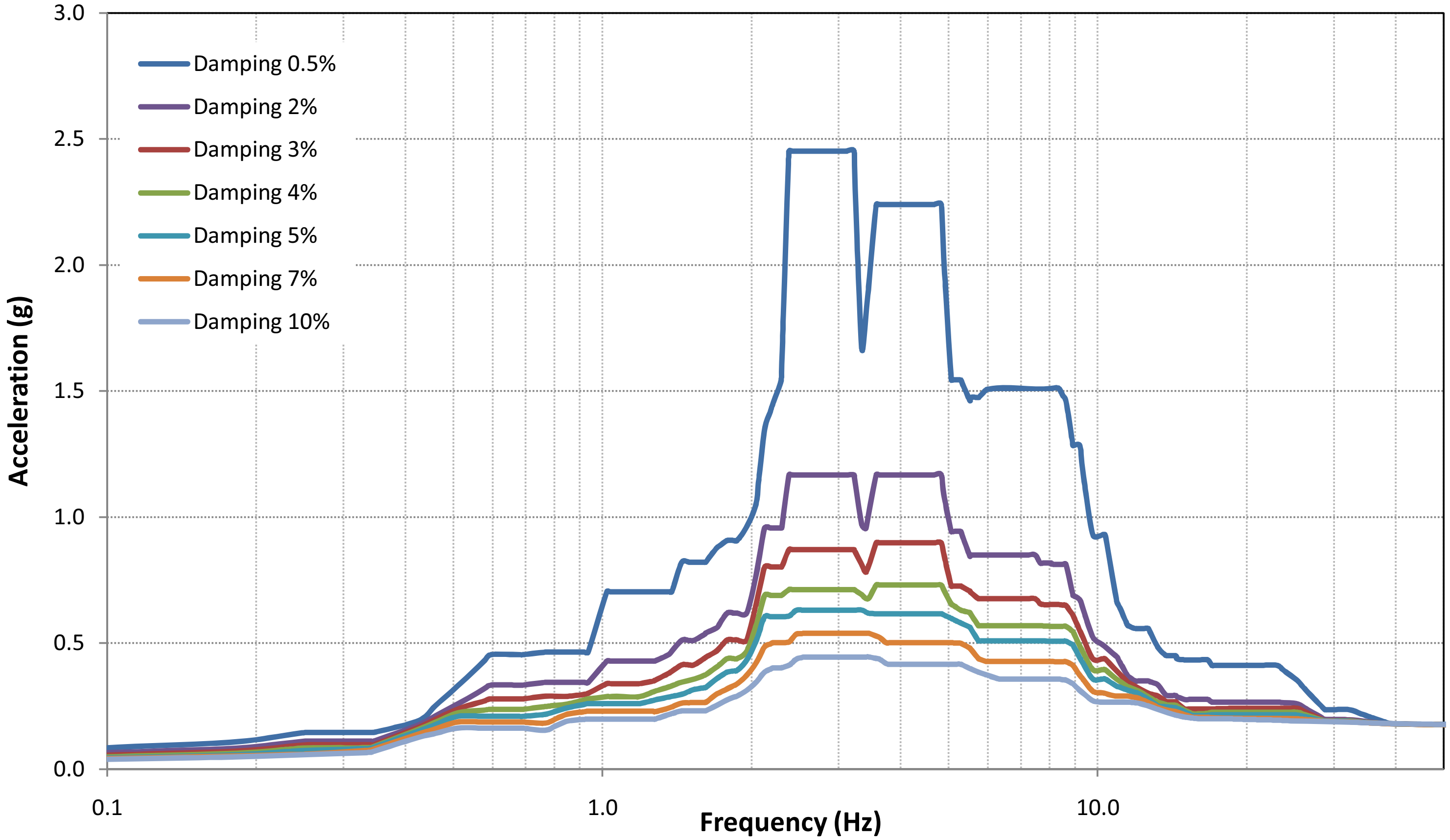


Figure 3.7-80 — {ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), East-West Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

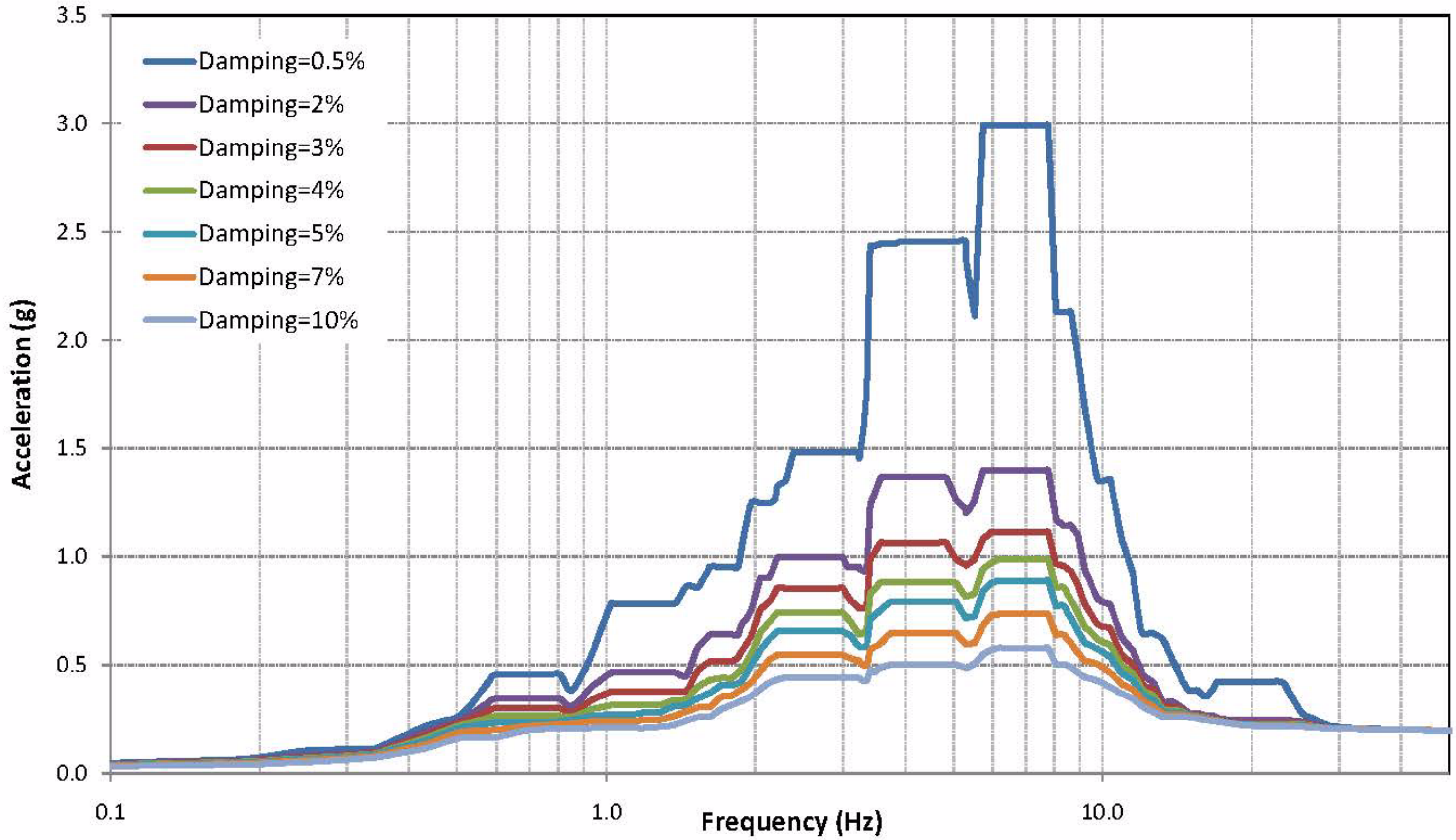


Figure 3.7-81 — {ISRS for Makeup Water Intake Structure at Elev. 26.5 ft (8.08 m), Vertical Direction. Elevations and plant coordinate system refer to CCNPP Unit 3}

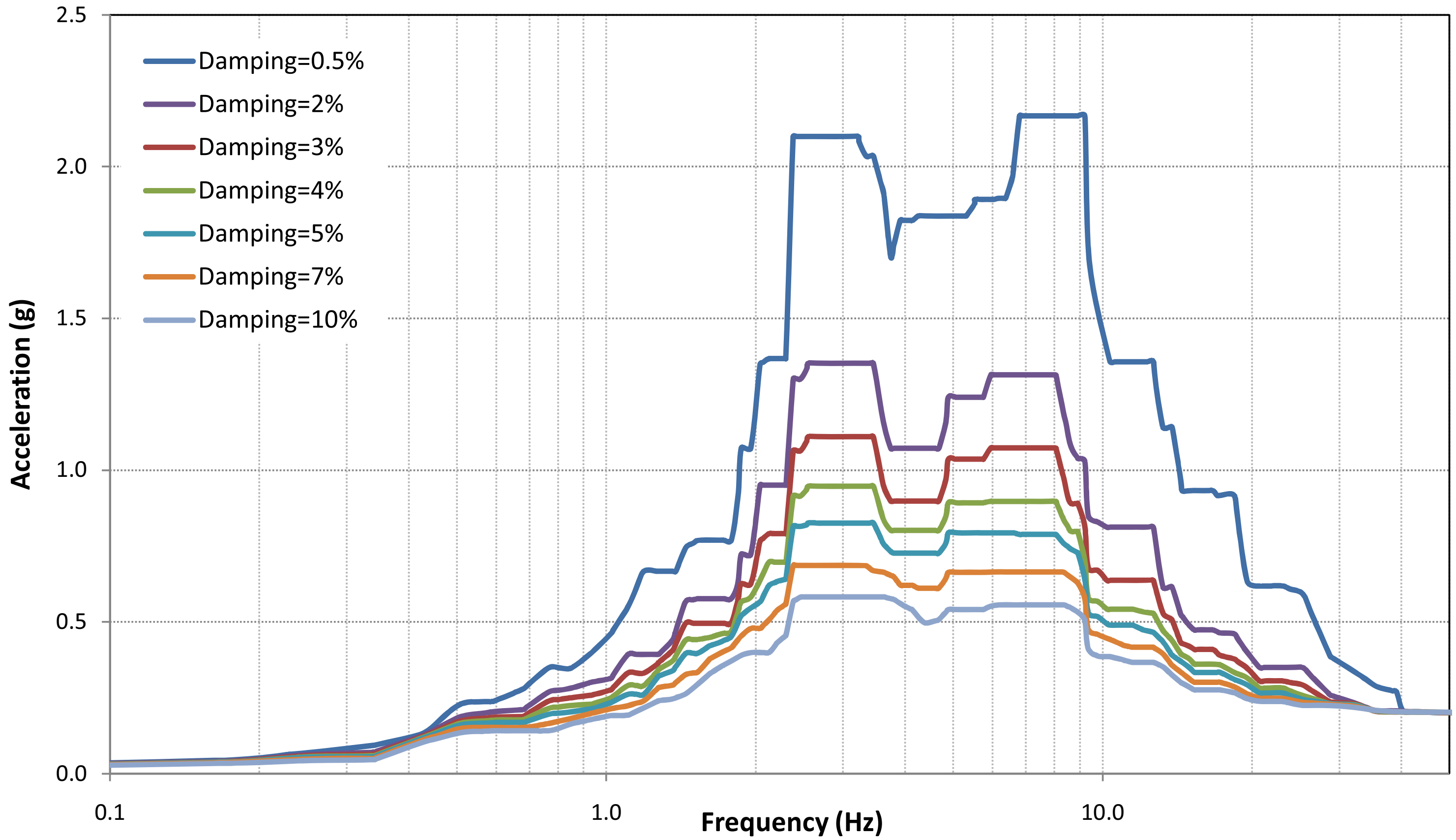


Figure 3.7-82 — {View of Typical Bay Perpendicular to the Turbine Generator (GT Strudl Finite Element Model)}

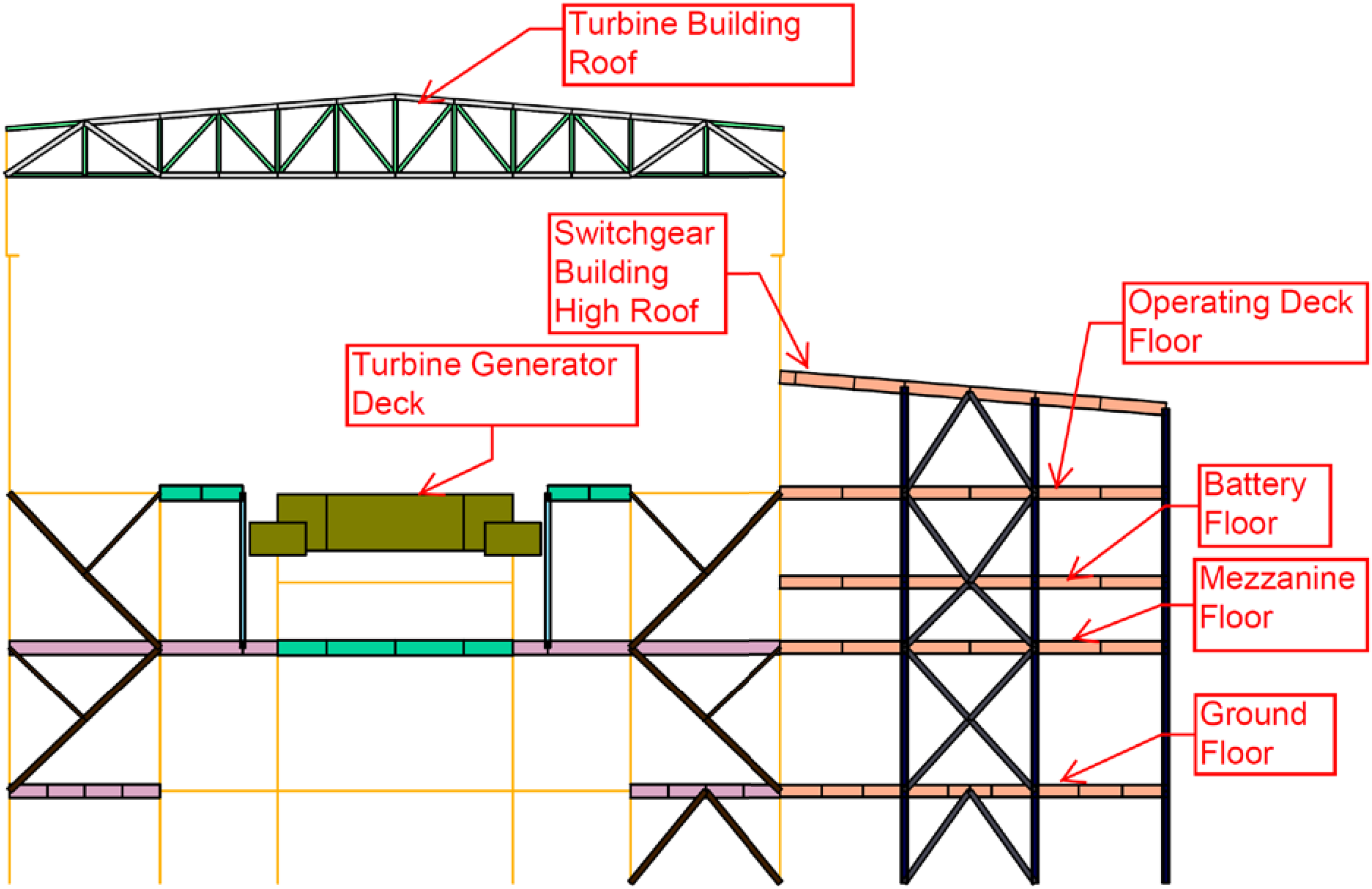


Figure 3.7-83 — {Cut - Isometric View of the Turbine Island Structure with shear walls (GT Strudl Finite Element Model)}

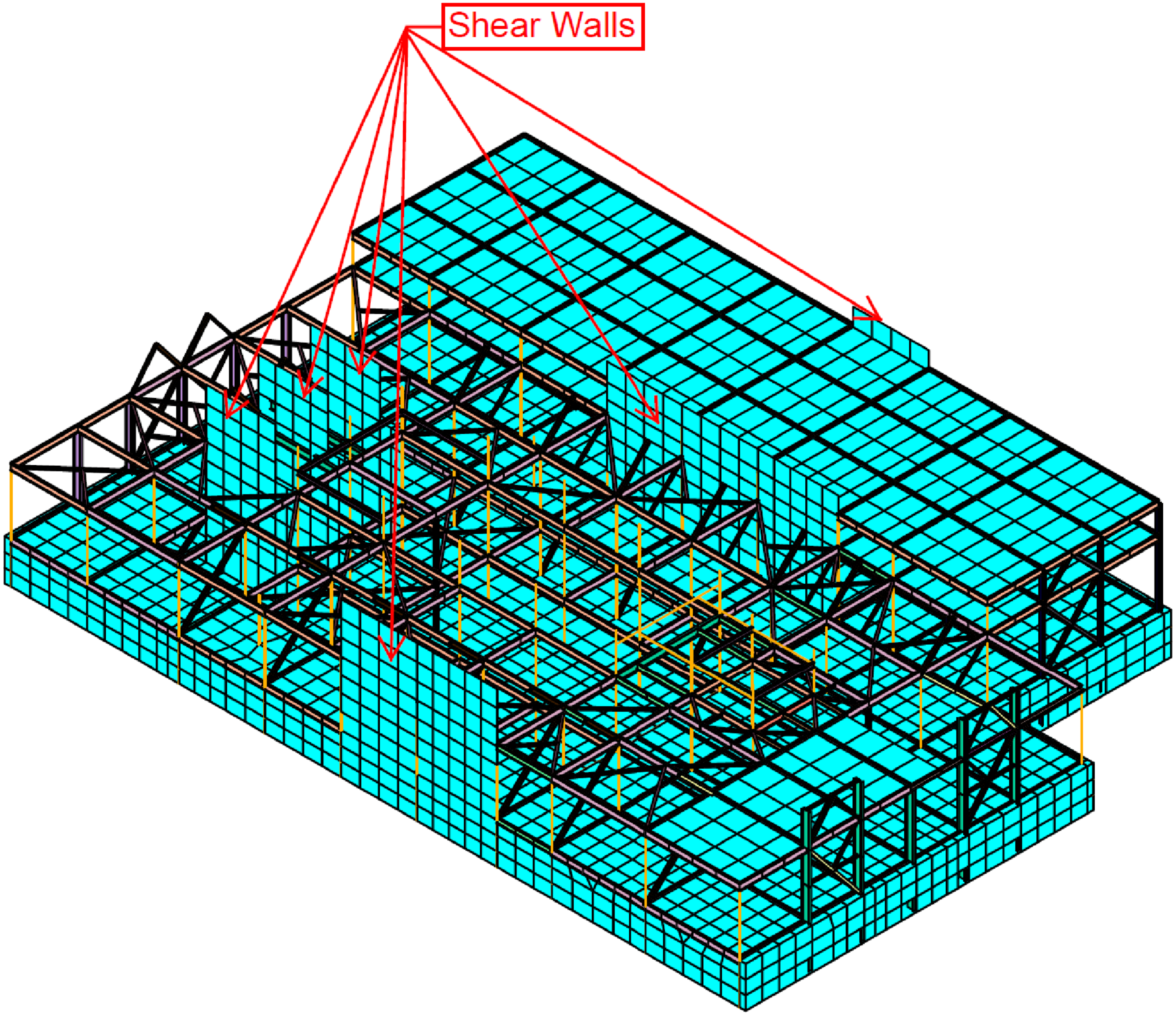


Figure 3.7-84 — {Isometric View of the Turbine Island Structure (GT Strudl Finite Element Model)}

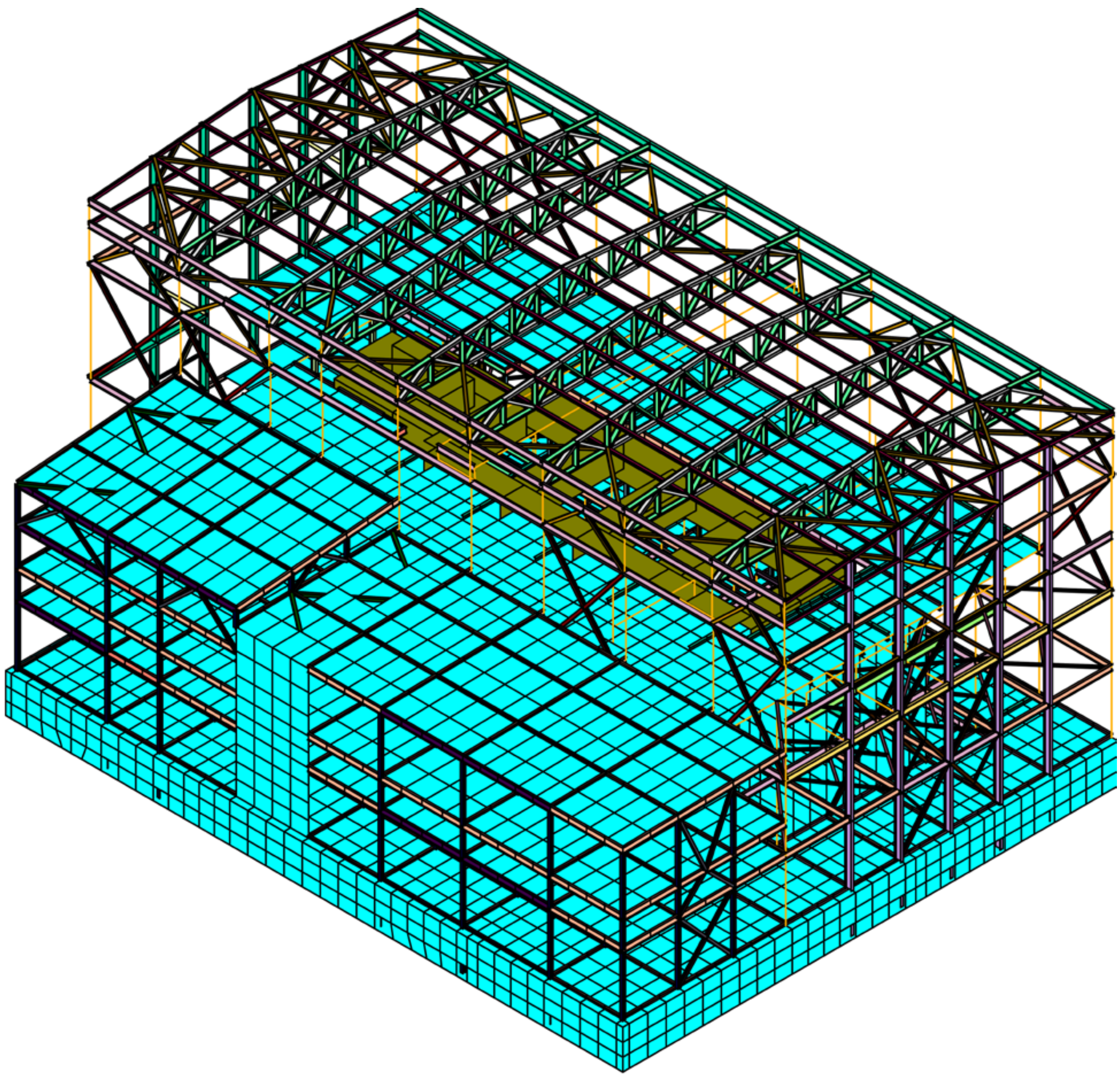


Figure 3.7-85 — {Turbine Island Upper Bound Soil Case - Required Coefficient of Friction for Sliding}

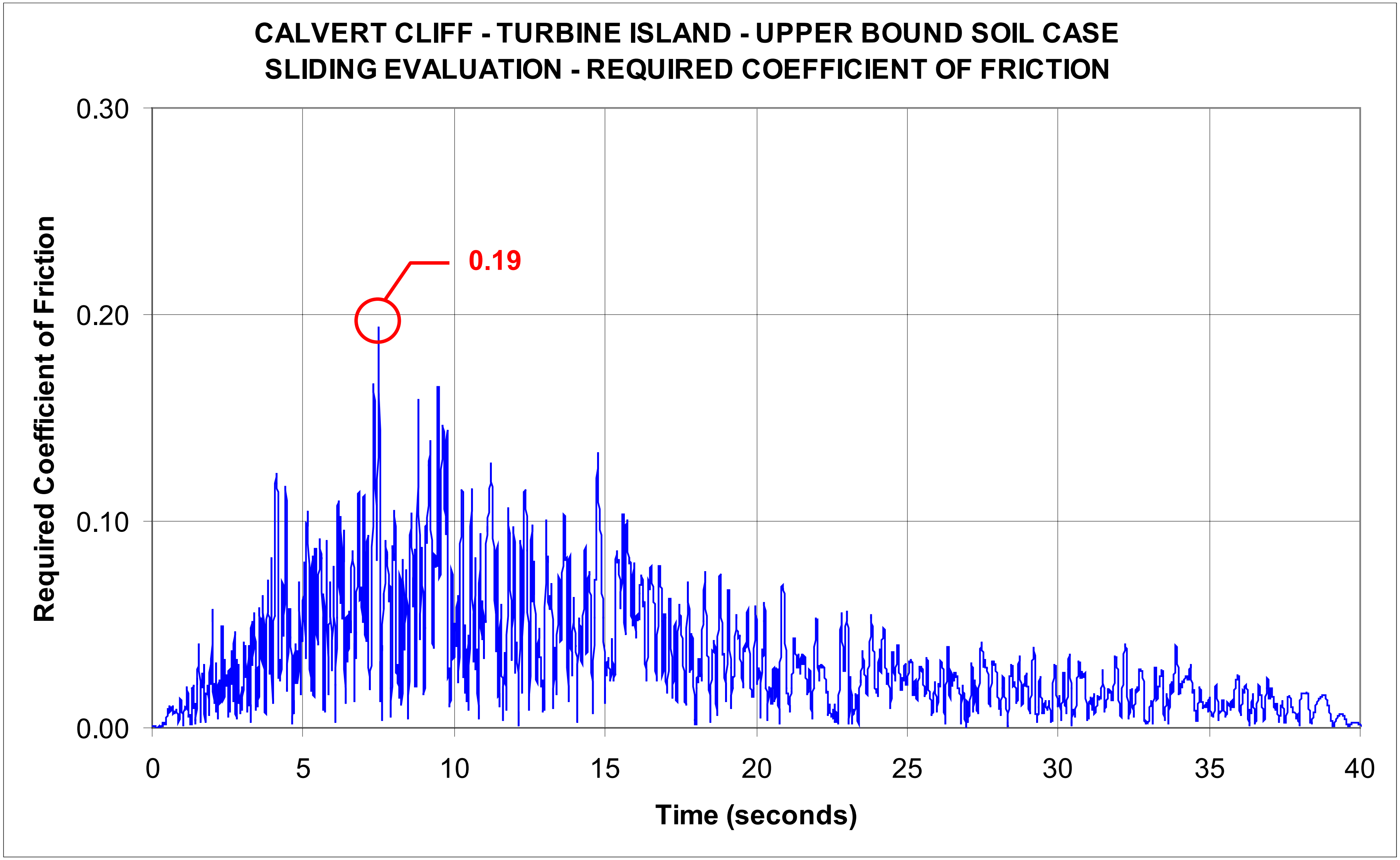


Figure 3.7-86 — {Nuclear Island/Nuclear Auxiliary Building/Access Building Model (NI/NAB/AB)}

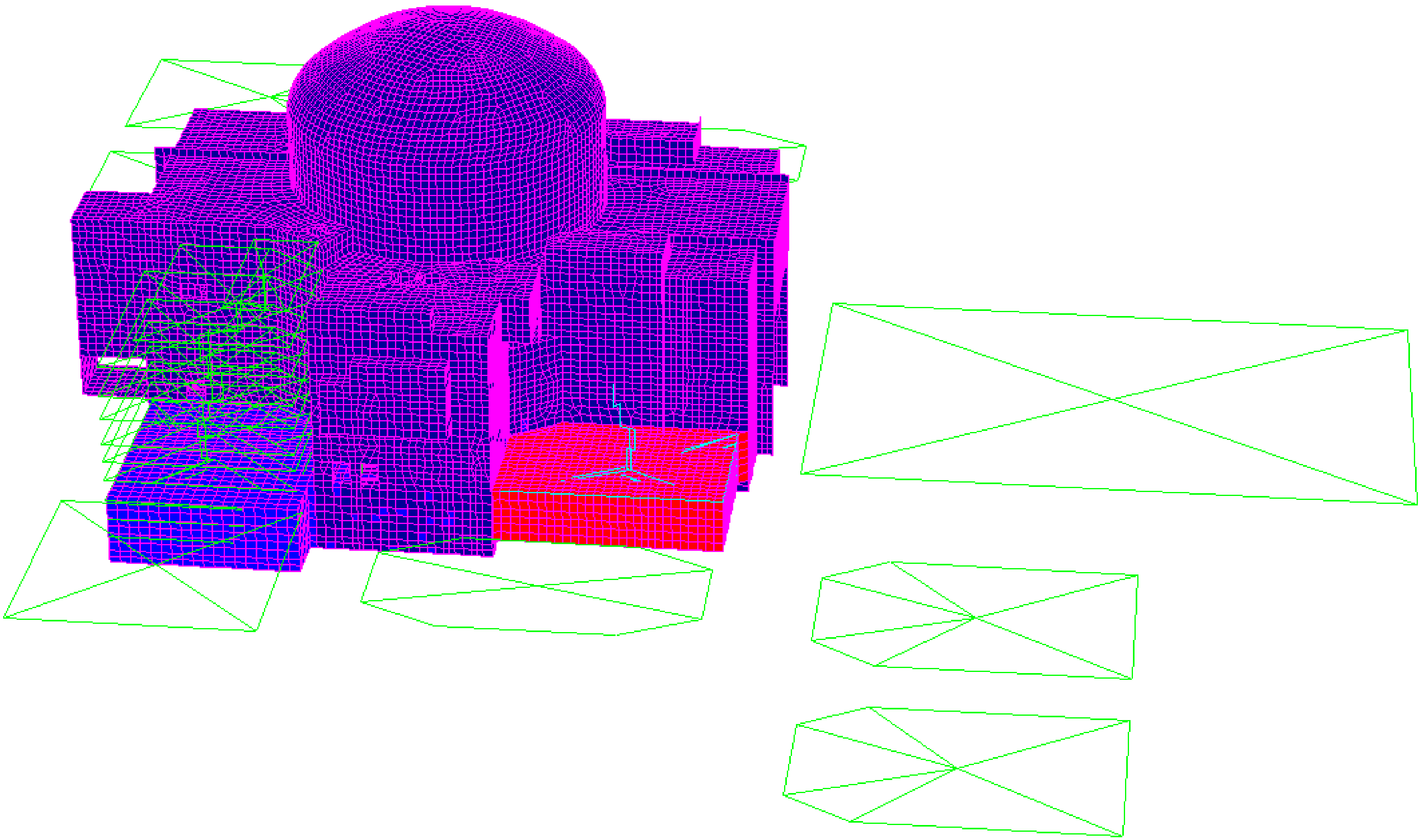


Figure 3.7-87 — {Access Building Finite Element Method (FEM) Model}

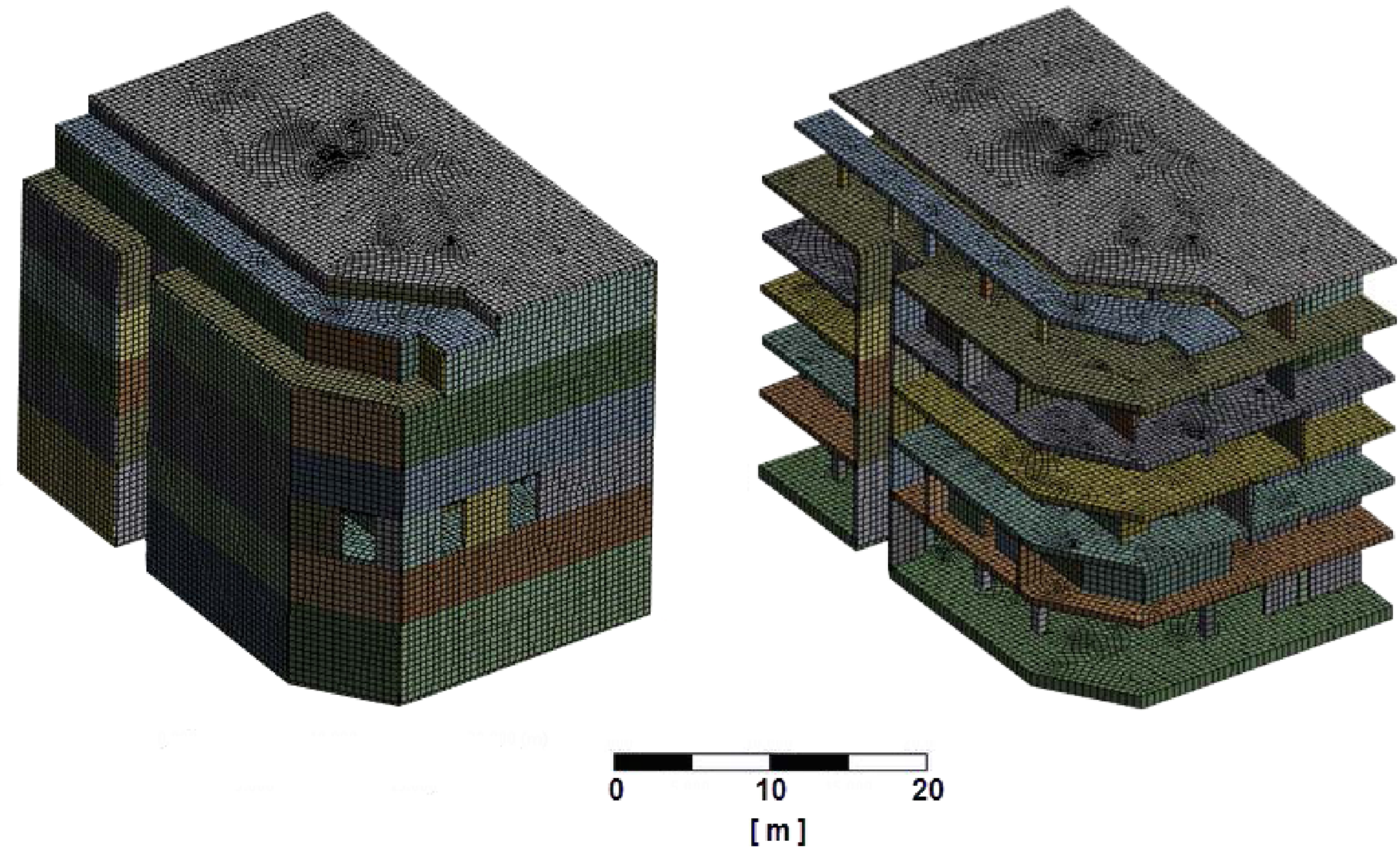
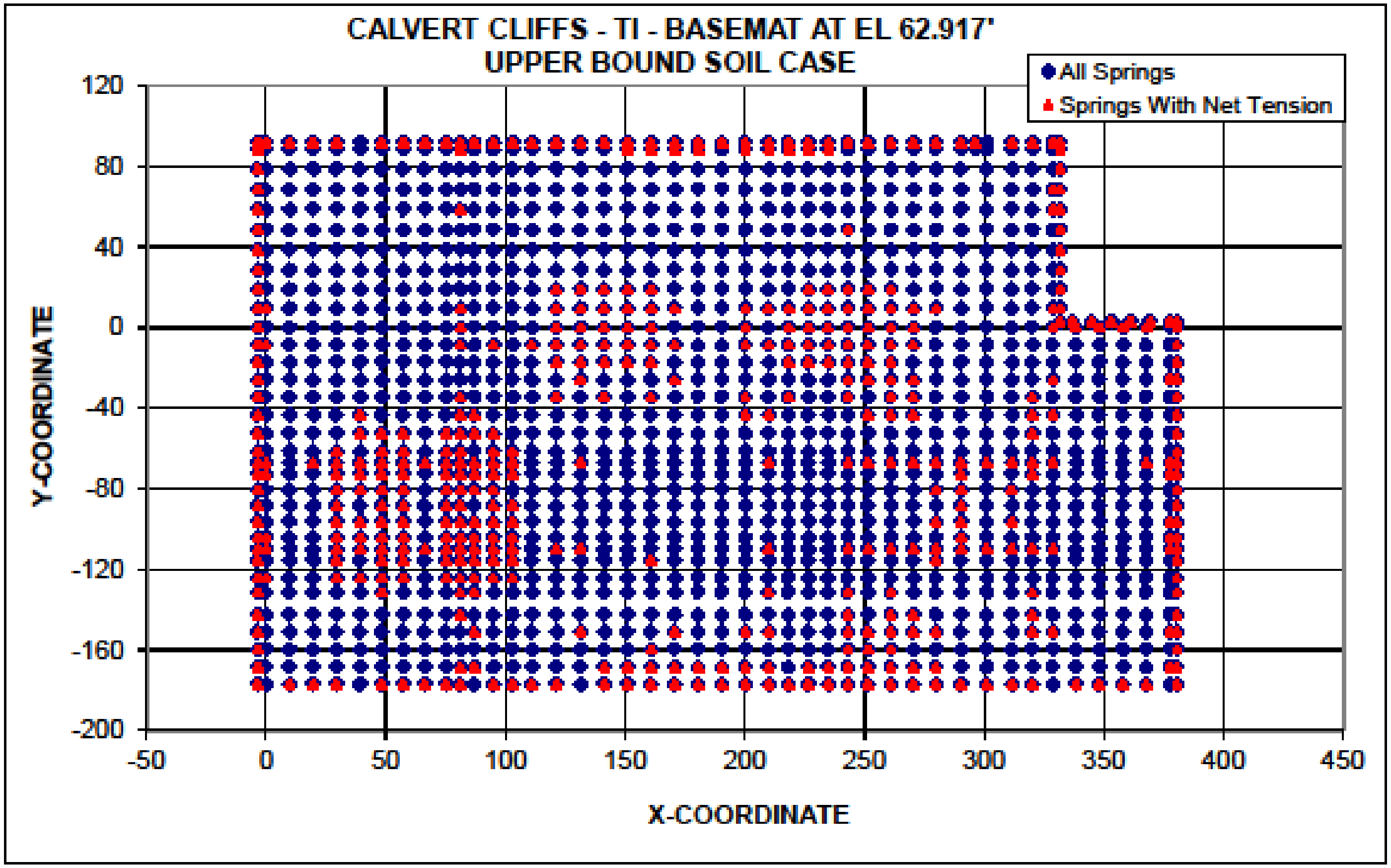


Figure 3.7-88 — {Turbine Island Upper Bound Soil Case - Springs With Net Tension at Basemat}



3.8 DESIGN OF CATEGORY I STRUCTURES

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

3.8.1 Concrete Containment

No departures or supplements.

3.8.1.1 Description of the Containment

No departures or supplements.

3.8.1.2 Applicable Codes, Standards, and Specifications

No departures or supplements.

3.8.1.3 Loads and Load Combinations

The U.S. EPR FSAR includes the following COL Item in Section 3.8.1.3:

> A COL applicant that references the U.S. EPR design certification will confirm that site-specific loads lie within the standard plant design envelope for the RCB, or perform additional analyses to verify structural adequacy.

This COL Item is addressed as follows:

{The RCB design for CCNPP Unit 3 is the standard RCB design as described in the U.S. EPR FSAR without departures.

Site-specific loads are confirmed to lie within the standard U.S. EPR design certification envelope, except for the loads resulting from the seismic response spectra and soil profiles described in Section 3.7.1. Additional confirmatory evaluations for the site-specific ground response spectra have been performed and confirm that the RCB is acceptable for the CCNPP Unit 3 site. These evaluations confirm CCNPP Unit 3 site-specific ZPA values for the RCB are enveloped by the standard U.S. EPR design certification ZPA values for the RCB.}

3.8.1.4 Design and Analysis Procedures

No departures or supplements.

3.8.1.5 Structural Acceptance Criteria

No departures or supplements.

3.8.1.6 Materials, Quality Control, and Special Construction Techniques

No departures or supplements.

3.8.1.6.1 Concrete Materials

No departures or supplements.

3.8.1.6.2 Reinforcing Steel and Splice Materials

No departures or supplements.

3.8.1.6.3 Tendon System Materials

No departures or supplements.

3.8.1.6.4 Liner Plate System and Penetration Sleeve Materials

No departures or supplements.

3.8.1.6.5 Steel Embedments

No departures or supplements.

3.8.1.6.6 Corrosion Retarding Compounds

No departures or supplements.

3.8.1.6.7 Quality Control

The QA program for this section is discussed in Section 3.1.1.1.1.

3.8.1.6.8 Special Construction Techniques

No departures or supplements.

3.8.1.7 Testing and Inservice Inspection Requirements

No departures or supplements.

3.8.2 Steel Containment

No departures or supplements.

3.8.3 Concrete and Steel Internal Structures of Concrete Containment

3.8.3.1 Description of the Internal Structures

No departures or supplements.

3.8.3.1.1 Reactor Vessel Support Structure and Reactor Cavity

No departures or supplements.

3.8.3.1.2 Steam Generator Support Structures

No departures or supplements.

3.8.3.1.3 Reactor Coolant Pump Support Structures

No departures or supplements.

3.8.3.1.4 Pressurizer Support Structure

No departures or supplements.

3.8.3.1.5 Operating Floor and Intermediate Floors

No departures or supplements.

3.8.3.1.6 Secondary Shield Walls

No departures or supplements.

3.8.3.1.7 Refueling Canal Walls

No departures or supplements.

3.8.3.1.8 Polar Crane Support Structure

No departures or supplements.

3.8.3.1.9 Reactor Building Internal Structures Basemat, In-Containment Refueling Water Storage Tank, and Core Melt Retention Area

No departures or supplements.

3.8.3.1.10 Distribution System Supports

No departures or supplements.

3.8.3.1.11 Platforms and Miscellaneous Structures

No departures or supplements.

3.8.3.1.12 Reactor Containment Building Rupture and Convection Foils

No departures or supplements.

3.8.3.1.13 Reactor Containment Building Doors

No departures or supplements.

3.8.3.2 Applicable Codes, Standards, and Specifications

No departures or supplements.

3.8.3.3 Loads and Load Combinations

The U.S. EPR FSAR includes the following COL Item in Section 3.8.3.3:

> A COL applicant that references the U.S. EPR design certification will confirm that site-specific loads lie within the standard design envelope for RB internal structures, or perform additional analyses to verify structural adequacy.

This COL Item is addressed as follows:

{The Reactor Building (RB) (i.e., the Reactor Containment Building (RCB)) internal structures are the standard design as described in the U.S. EPR FSAR.

Site-specific loads are confirmed to lie within the standard U.S. EPR design certification envelope, except for the loads resulting from the ground response spectra and soil profiles described in Section 3.7.1. Additional confirmatory evaluations for the site-specific seismic response spectra have been performed and confirm that the RB internal structures are acceptable for the CCNPP Unit 3 site. These evaluations confirm that the CCNPP Unit 3 site-specific ZPA values for the are enveloped by the standard U.S. EPR design certification ZPA values for the RB internal structures}

3.8.3.4 Design and Analysis Procedures

No departures or supplements.

3.8.3.5 Structural Acceptance Criteria

No departures or supplements.

3.8.3.6 Materials, Quality Control, and Special Construction Techniques

No departures or supplements.

3.8.3.7 Testing and Inservice Inspection Requirements

No departures or supplements.

3.8.4 Other Seismic Category I Structures

3.8.4.1 Description of the Structures

The U.S. EPR FSAR includes the following COL Items in Section 3.8.4:

> A COL applicant that references the U.S. EPR design certification will describe any differences between the standard plant layout and design of Seismic Category I structures required for site-specific conditions.
>
> A COL applicant that references the U.S. EPR design certification will address site-specific Seismic Category I structures that are not described in this section.

The COL Items are addressed as follows:

{The standard plant layout and design of other Seismic Category I Structures is as described in the U.S. EPR FSAR without departures.

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

- ♦ Buried Conduit and Duct banks (Section 3.8.4.1.8).
- ♦ Buried Pipe and Pipe Ducts (Section 3.8.4.1.9).
- ♦ Forebay and UHS Makeup Water Intake Structure (Section 3.8.4.1.11).}

3.8.4.1.1 Reactor Shield Building and Annulus

No departures or supplements.

3.8.4.1.2 Fuel Building

No departures or supplements.

3.8.4.1.3 Safeguard Buildings

No departures or supplements.

3.8.4.1.4 Emergency Power Generating Buildings

No departures or supplements.

3.8.4.1.5 Essential Service Water Buildings

No departures or supplements.

3.8.4.1.6 Distribution System Supports

No departures or supplements.

3.8.4.1.7 Platforms and Miscellaneous Structures

No departures or supplements.

3.8.4.1.8 Buried Conduit and Duct Banks

The U.S. EPR FSAR includes the following COL Item and conceptual design information in Section 3.8.4.1.8:

> A COL applicant that references the U.S. EPR design certification will provide a description of Seismic Category I buried conduit and duct banks.
>
> [[Buried conduits are steel while conduits in encased duct banks may be poly-vinyl-chloride (PVC) or steel. Duct banks may be directly buried in the soil; encased in lean concrete, concrete, or reinforced concrete. Concrete or reinforced concrete encased duct banks will be used in heavy haul zones, under roadway crossings, or where seismic effects dictate the requirement. Encasement in lean concrete may be used in areas not subject to trenching or passage of heavy haul equipment, or where seismic effects on the conduit are not significant.]]

{This COL Item is addressed as follows, and the conceptual design information is replaced with site-specific information for CCNPP Unit 3:

Figure 3.8-1 provides an overall site plan of Seismic Category I buried duct banks. The buried duct banks run between the Nuclear Island (NI) and the Intake Structures along the utility corridor. Figure 3.8-2 provides a detail plan of Seismic Category I buried duct banks in the vicinity of the NI. No Seismic Category I buried conduits exist for CCNPP Unit 3.

Seismic Category I buried electrical duct banks traverse from:

- Each Essential Service Water Building to the UHS Makeup Water Intake Structure including underneath the main heavy haul road.
- The Safeguards Buildings to the four Essential Service Water Buildings and both Emergency Power Generating Buildings.

Buried electrical duct banks consist of polyvinyl chloride (PVC) conduit encased in reinforced concrete. In addition to its structural function, the reinforced concrete facilitates maintenance of conduit spacing / separation requirements and protects the conduit.

Where buried safety-related electrical duct banks and the UHS makeup water pipes traversing between the UHS Makeup Water Intake Structure and the four ESWBs need to cross each other, the buried electrical duct banks are located below the pipes to facilitate future pipe maintenance. To facilitate cable pulling and routing, manholes are provided at strategic locations.

Buried safety-related electrical duct banks that are located below the projected maximum, steady state, post-construction, groundwater table level have water-tight construction joints utilizing water stops. The joints between these buried duct banks and manholes have PVC water stops to prevent water intrusion.

Buried electrical duct banks have drain pipes at the bottom, and are constructed such that they slope from manhole to manhole. The low point manholes have a sump with a pump for collecting and disposing water.

Waterproofing membrane, as described in Section 3.8.4.6.1, is used, as necessary, to protect buried electrical duct banks from the corrosive effects of low-pH groundwater from the Surficial aquifer in the powerblock area.}

3.8.4.1.9 Buried Pipe and Pipe Ducts

The U.S. EPR FSAR includes the following COL Item in Section 3.8.4.1.9:

> A COL applicant that references the U.S. EPR design certification will provide a description of Seismic Category I buried pipe and pipe ducts.

This COL Item is addressed as follows:

{Figure 3.8-3 provides an overall site plan of Seismic Category I buried pipe. Pipes run beneath the final site grade. Buried pipe ducts are not used for CCNPP Unit 3. Two buried Unit 3 Intake Pipes run from the CCNPP Unit 3 Inlet Area to the CCNPP Unit 3 Forebay (See Figure 2.4-56). Four UHS Makeup Water pipes emanate from the UHS Makeup Water Intake Structure and terminate at the ESWBs. These pipes run within the utility corridor, shown in Figure 3.8-3, and pass under the main Haul Road which runs in the East-West direction adjacent to the North side of the CCNPP Unit 3 powerblock.

Figure 3.8-4 provides a detail plan of Seismic Category I buried ESW pipe in the vicinity of the NI. As illustrated in the figure, the Seismic Category I buried ESW piping consists of:

- Large diameter supply and return pipes between the Safeguards Buildings and the ESWBs.

- Large diameter supply and return pipes from the EPGBs which tie in directly to the aforementioned pipes.

Fire Protection pipe traverses from the UHS Makeup Water Intake Structure to the vicinity of the NI, where a loop is provided to all buildings. In accordance with Section 3.2.1, site-specific Fire Protection piping connected to Seismic Category I structures that is classified as Conventional Seismic, designated as CS-I and is designed to remain functional during and following an SSE event.

The buried piping is directly buried in the soil (i.e., without concrete encasement) unless detailed analysis indicates that additional protection is required. The depth of the soil cover is generally sufficient to provide protection against frost (top surface of the pipe is below the site-specific frost depth), surcharge effects, and hurricane and tornado missiles. Structural fill is used as bedding material underneath the pipe. As an alternate, lean concrete may be used. Additionally, soil surrounding the pipe is compacted structural fill.}

3.8.4.1.10 Masonry Walls

{No departures or supplements.}

3.8.4.1.11 {Forebay and UHS Makeup Water Intake Structure}

{This section is added as a supplement to U.S. EPR FSAR Section 3.8.4.1.

The Seismic Category I Forebay and UHS Makeup Water Intake Structure are reinforced concrete structures situated along the western shoreline of the Chesapeake Bay. As illustrated in Figure 3.8-4, the Forebay is connected to the CWS Makeup Water Intake Structure (Seismic Category II) and the Intake Pipes (Seismic Category I) from the north (plant reference) and the UHS Makeup Water Intake Structure from the south. The two intake pipes transport water (under gravitational head) from the Chesapeake Bay to the Forebay, which supplies water to both the CWS Makeup Water Intake Structure and the UHS Makeup Water Intake Structure. The UHS Makeup Water Intake Structure houses components associated with the UHS Makeup Water System, which provides makeup water to the Essential Service Water Cooling Tower basins for extended cooling that starts 72 hours after a design basis accident. Figure 3.8-1 shows the position of the Forebay and UHS Makeup Water Intake Structure relative to the NI.

A general area drawing of the UHS Makeup Water Intake Structure, Circulating Water Makeup Intake Structure and the Forebay is shown in Figure 9.2-4. Plan views of the UHS Makeup Water Intake Structure are shown in Figure 9.2-5 and Figure 9.2-6. A section view is shown in Figure 9.2-8.

The Forebay is a below-grade reinforced concrete water basin, with overall dimensions of 109 ft (33.2 m) long by 89 ft (27.1 m) wide by 39 ft (11.9 m) deep, including a 5 ft (1.5 m) thick basemat. Inside dimensions of the Forebay are 100 ft (30.5 m) long by 80 ft (24.4 m) wide, with 4.5 ft

(1.4 m) thick walls. The Forebay is embedded approximately 37.5 ft (11.4 m) below the nominal grade elevation of 10 ft (3.0 m), with the top of the walls at elevation 11.5 ft (3.5 m) and the top of the basemat at elevation -22.5 ft (-6.9 m).

The UHS Makeup Water Intake Structure is a reinforced concrete structure 93 ft (28.3 m) long by 58 ft (17.7 m) wide by 69 ft (21 m) high, including a 5 ft (1.5 m) thick basemat that is integrally connected with the Forebay basemat. The structure consists of a below-grade water basin 59 ft (18.0 m) long by 58 ft (17.7 m) wide by 39 ft (11.9 m) deep situated approximately 37.5 ft (11.4 m) below the nominal grade elevation of 10 ft (3.0 m) and an above-grade pump house structure situated partially above the water basin and partially over structural fill.

The five main elevations of the UHS Makeup Water Intake Structure are:

- Elevation -22.5 ft (-6.9 m): Bottom of the water basin and top of the basemat. There are four independent pump bays in the water basin, separated by reinforced concrete walls.

- Elevation 11.5 ft (3.5 m): Top of the operating deck and pump house floor, which includes four make-up water pump rooms separated by reinforced concrete walls. Each of the four make-up water pump rooms contains an air handling unit. The pump rooms are water-tight to protect against hurricane floods.

- Elevation 21.0 ft (6.4 m): Top of floor containing four makeup water traveling screens, which includes four traveling screen rooms separated by reinforced concrete walls. The rooms are elevated above probable maximum storm surge floods and the walls are water-tight to protect against hurricane floods, including surge, wave heights, and wave run-up.

- Elevation 26.5 ft (8.1 m): Top of the floor containing four UHS makeup water transformer rooms, each of which houses a transformer, and four air cooled condenser rooms, each of which houses an air cooled condenser.

- Elevation 41.5 ft (12.6 m): Top of the nominally 2 ft (0.6 m) thick, reinforced concrete roof slab.

Functional components within the water basin include UHS Makeup Water pumps, intake bar screens and traveling screens to preclude debris intake, and stop logs provision to facilitate maintenance.

Exterior walls for the pump house are 2 ft (0.6 m) thick, to withstand hurricane and tornado missile impact and the wave pressures of the Probable Maximum Hurricane (PMH) extreme environmental event and the Standard Project Hurricane (SPH) severe environmental event. Interior walls that are subject only to minor lateral loads are one ft (0.3 m) thick. The exterior walls of the basin of the UHS Makeup Water Intake Structure are all 4 ft (1.2 m) thick, while the divider walls in the North-South direction are 3.3 ft (1.0 m) thick. A 2.5 ft (0.8 m) thick, inclined partial-height wall faces the Forebay.}

3.8.4.2 Applicable Codes, Standards, and Specifications

No departures or supplements.

3.8.4.3 Loads and Load Combinations

The U.S. EPR FSAR includes the following COL Item in Section 3.8.4.3:

> A COL applicant that references the U.S. EPR design certification will confirm that site-specific loads lie within the standard design envelope for other Seismic Category I structures, or perform additional analyses to verify structural adequacy.

This COL Item is addressed as follows:

Seismic Category 1 structures as identified in Section 3.8.4 for CCNPP Unit 3, are designed to the load conditions as described in the U.S. EPR FSAR.

As described in Section 3.7.2.5, in-structure response spectra (ISRS) for the NI Common Basemat Structures, EPGB and ESWB based on the site-specific SSE, exceed the ISRS based on the certified seismic design response spectra (CSDRS) for frequencies below approximately 0.7 Hz. Additional confirmatory evaluations for the site-specific response spectra and soil profiles were performed and confirm that the standard design NI Common Basemat Structures, EPGB, and ESWB Structures are acceptable for the CCNPP Unit 3 site.

Design loads and load combinations for site-specific Seismic Category I structures are addressed in Section 3.8.4.3.1 and 3.8.4.3.2, respectively.}

3.8.4.3.1 Design Loads

{Design loads defined in the U.S. EPR FSAR Section 3.8.4.3.1 are applicable for the design of site-specific Seismic Category I structures, with the following exceptions:

- Live loads (L) - Design live load due to rain, snow and ice is based on the normal and extreme winter precipitation events described in Section 2.3.1.2.2.12.
- Soil loads and lateral earth pressure (H) - Static lateral soil pressure is calculated based on site-specific soil parameters and groundwater elevation. Design unit weight for the structural fill (95% Modified Proctor) used in the intake area is as follows:
    - Moist unit weight: 149 pcf
    - Saturated unit weight: 153 pcf

Lateral earth pressure coefficients are defined in Table 2.5-60. A coefficient of 0.5 is used conservatively for the structural fill for at-rest condition. The groundwater table in the intake area is at about Elevation 3 ft. A normal surcharge load of 500 psf minimum is considered for calculating the lateral earth pressures. Lateral pressures due to compaction associated with structural fill are also considered.

- Safe shutdown earthquake (E') -
    - Site-specific SSE is defined in Section 3.7.1.1.1.1, which has a peak ground acceleration of 0.15 g, as shown in Figure 3.7-1.
    - Dynamic soil pressure: Effects of dynamic soil pressure on the intake structures are captured by the SSI analysis described in Section 3.7.2.4.

- Abnormal loads - Abnormal loads generated by a postulated high-energy pipe break accident are not applicable, since such pipes are not present in the subject structures.
- Operating basis earthquake (OBE) - OBE is defined in Section 3.7.1.1.1.1 and shown in Figure 3.7-6, which is essentially one-third of the site-specific SSE. As such, OBE loads are not explicitly considered for the design of the site-specific Seismic Category I structures.

The hurricane wave pressure on the exterior walls of the UHS Makeup Water Intake Structure is obtained based on the methodology presented in Chapter 5 of ASCE 7-05 (ASCE, 2006). The total wave pressure is equal to the sum of hydrostatic pressure and hydrodynamic wave pressure and breaking wave pressures. The hydrostatic pressure is calculated based on the storm surge still water level of Elevation 13.65 ft (4.16m) and Elevation 17.6 ft (5.35 m) NGVD 29 for SPH and PMH, respectively. The still water depth (d_S) for PMH condition is 7.6 ft.

The four sides of UHS Makeup Water Intake Structure are considered to be subject to breaking wave pressures (including the hydrostatic pressure) and the hydrodynamic wave pressure.

According to ASCE 7-05 (ASCE, 2006), the crest of the reflected wave is located at a distance 1.2 d_S above the still water elevation, and the maximum breaking wave pressure is at the still water elevation. Wave runup for PMH conditions is given as El. 33.2 ft in Section 2.4.5.3.2. The equation given in ASCE 7-05 is modified slightly so that the crest of the reflected wave is located at El. 33.2 ft for PMH conditions as given in Section 2.4.5.3.2. The modification involves defining the crest of the reflected wave at a distance 2.1 d_S above the still water elevation instead of 1.2 d_S. This adjustment to the ASCE 7-05 equation increases the breaking wave pressures, thus resulting in conservative values.

Concurrent hurricane wind speeds based on the 3 second wind gust at 32.8 ft (10 m) high are 110 mph (177 km/hr) and 195 mph (314 km/hr) for SPH and PMH, respectively. Conservatively, the concurrent hurricane wind pressure for design of site-specific Seismic Category I structures is based on the U.S. EPR standard design wind speeds of 145 mph (233 km/hr) and 230 mph (370 km/hr), for SPH and PMH respectively, utilizing the procedures presented in Chapter 6 of ASCE 7-05 (ASCE, 2006).

Due to much higher grade elevation, structures in the powerblock area are not affected by the wave pressure associated with the postulated hurricanes. Concurrent hurricane wind loads are enveloped by the wind and extreme wind loads presented in the U.S. EPR FSAR Sections 3.3.1 and 3.3.2, respectively.

In addition, the UHS Makeup Water Intake Structure is designed to withstand a peak positive incident overpressure (due to postulated explosions) of at least 1 psi without loss of function based on the guidance in RG 1.91, Rev. 1 (NRC, 1978a).}

3.8.4.3.2 Loading Combinations

{The following additional factored load combinations apply to the reinforced concrete design of the Forebay, UHS Makeup Water Intake Structure, and Seismic Category I buried electrical bank and piping in the intake area:

- Severe Environment SPH:

  $U = 1.4 (D + F) + 1.7 (L + H + R_o + SPH)$

- Extreme Environment PMH:

  $U = D + F + L + H + R_o + PMH$

These two load combinations are in addition to the load combinations specified in U.S. EPR FSAR Section 3.8.4.3.2.

For all the load combinations, according to ACI 349/349R-01 (ACI, 2001a), if any load reduces the effects of other loads, the corresponding load factor is taken as 0.9 if that load is always present or occurs simultaneously with the other loads. Otherwise, the factor for that load is taken as zero.}

3.8.4.4 Design and Analysis Procedures

No departures or supplements.

3.8.4.4.1 General Procedures Applicable to Other Seismic Category I Structures

No departures or supplements.

3.8.4.4.2 Reactor Shield Building and Annulus, Fuel Building, and Safeguard Buildings – NI Common Basemat Structure

No departures or supplements.

3.8.4.4.3 Emergency Power Generating Buildings

No departures or supplements.

3.8.4.4.4 Essential Service Water Buildings

No departures or supplements.

3.8.4.4.5 Buried Conduit and Duct Banks, and Buried Pipe and Pipe Ducts

The U.S. EPR FSAR includes the following COL Items in Section 3.8.4.4.5:

> A COL applicant that references the U.S. EPR design certification will describe the design and analysis procedures used for buried conduit and duct banks, and buried pipe and pipe ducts.
>
> A COL applicant that references the U.S. EPR design certification will use results from site-specific investigations to determine the routing of buried pipe and pipe ducts.
>
> A COL applicant that references the U.S. EPR design certification will perform geotechnical engineering analyses to determine if the surface load will cause lateral or vertical displacement of bearing soil for the buried pipe and pipe ducts and consider the effect of wide or extra heavy loads.

The COL Items identified above are addressed as follows:

{The analysis and design of Seismic Category I, buried electrical duct banks, buried Essential Service Water pipes, buried UHS Makeup Water Pipes, and buried CCNPP Unit 3 Intake Pipes (hereafter in this section referred to as buried duct banks and buried pipes) for all the imposed loads, follows the procedures outlined in U.S. EPR FSAR Section 3.8.4.4.5. The analysis and design of the buried pipes also follow the procedures described in Appendix 3F.3.10 of the U.S. EPR FSAR.

The design of buried duct banks and buried pipes demonstrates sufficient strength to accommodate:

- ♦ Strains imposed by seismic ground motion.
- ♦ Static surface surcharge loads due to vehicular loads (AASHTO HS-20 (AASHTO, 2002) truck loading, minimum, or other vehicular loads, including during construction) on designated haul routes.
- ♦ Static surface surcharge loads during construction activities, e.g., for equipment laydown or material laydown.
- ♦ Hurricane and tornado missiles and, within their zone of influence, turbine generated missiles.
- ♦ Ground water effects.

Terrain topography and the results from the CCNPP Unit 3 geotechnical site investigation will be used as design input to confirm the routing of buried pipe and duct banks reflected in Figure 3.8-1 through Figure 3.8-4.

The seismic design of buried duct banks and buried pipe is discussed in Section 3.7.3. Other loads are addressed in this section, but are combined with seismic effects of the aforementioned section.

Soil overburden pressures on buried duct banks and buried pipes typically do not induce significant bending or shear effects, because the soil cover and elastic support below the buried duct banks and buried pipes are considered effective and uniform over the entire length of the buried duct bank and buried pipe. When this is not the case, vertical soil overburden pressure is determined by the Boussinesq method.

Transverse stirrups used to reinforce the concrete duct banks are open ended to mitigate magnetic effects on the electrical conduits. Distribution of transverse and longitudinal steel reinforcement is sufficient to maintain the structural integrity of the electrical duct bank, for all imposed loads, in accordance with ACI 349/349R-01 (ACI, 2001a) (with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001)).

As noted in Section 3.8.4.1.9, buried pipes are located such that the top surface of the pipe is below the site-specific frost depth, with additional depth used to mitigate the effects of surcharge loads and hurricane, tornado or turbine generated missiles. In lieu of depressing the pipes in the soil beyond that required for frost protection, i.e., to obviate the risk of hurricane, tornado or turbine generated missile impacts, permanent protective steel plates, located at grade, may be designed.

Bending stresses in buried pipe due to surcharge loading are determined via manual calculations, treating the flexible pipe as a beam on an elastic foundation. Resulting stresses are combined with operational stresses, as appropriate.}

3.8.4.4.6 Design Report

{Design reports for the Forebay and UHS Makeup Water Intake Structure are presented in Appendix 3E.4. Design reports for Seismic Category I Buried Piping and Seismic Category I Buried Duct Banks are presented in Appendices 3E.5 and 3E.6, respectively.}

3.8.4.4.7 {Forebay and UHS Makeup Water Intake Structure

This section is added as a supplement to U.S. EPR FSAR Section 3.8.4.4.

The Forebay and UHS Makeup Water Intake Structure are reinforced concrete shear wall structures. Vertical loads are transferred to the foundation basemat through the reinforced concrete walls before being transferred to the supporting soil through bearing pressure. Lateral loads, including those that are seismically induced, are transferred to the supporting soil by the foundation basemats and below-grade walls through friction, adhesion, and passive soil pressure, if necessary.

A finite element (FE) model was created for the Seismic Category I Forebay, UHS Makeup Water Intake Structure and Seismic Category II CWS Makeup Water Intake Structure, using STAAD Pro (Version 8i). The CWS Makeup Water Intake Structure is included in the FE model since it is integrally connected to the Forebay, shown in Figure 9.2-4. Since the CWS Makeup Water Intake Structure, Forebay, and UHS Makeup Water Intake Structure share a common basemat, they are also known as the Common Basemat Intake Structures (or CBIS).

STAAD Pro is a commercial structural engineering computer program developed by Bentley Systems, Inc. QA and QC requirements for safety-related structures are documented in the vendor's validation and verification manuals. The program is accepted for use in accordance with RIZZO's engineering department and QA procedures. The program is in compliance with the requirements of ASME NQA-1-1994 (ASME, 1994). The STAAD Pro FE model is converted to a SASSI model using ACS SASSI, Version 2.3.0, to perform soil-structure interaction (SSI) analysis. SSI analysis is discussed in Section 3.7.2. Due to the limitations of the computer code, the SASSI model has a slightly coarser mesh than the STAAD model.

The STAAD Pro FE model is also used to conduct static analysis under non-seismic loads to compute the structural responses, generate results for the design of reinforced concrete structural elements, and perform static stability and bearing pressure evaluations. The finite element analysis results from the SSI analysis and the static analysis are combined to determine the reinforced concrete design forces and moments under seismic load cases.

The FE model is described in detail in Section 3.7.2.3. Figure 3.7-23 and Figure 3E-5 depicts the FE model for the static analysis of the CBIS. The entire CBIS is modeled, without assuming a symmetry plane, and the UHS MWIS is modelled in greater detail.

For the static analysis, the soil medium below the foundation basemat is represented by soil spring elements. The modulus of subgrade reaction for the soil spring elements is based on the site-specific soil properties presented in Section 2.5.4. Effects of the following loads are calculated from the static analysis: dead loads, live loads (including snow loads), hydrostatic loads, lateral earth pressure loads (including groundwater effects), buoyancy loads, wind loads, hurricane and tornado loads (including wind pressure and differential pressure effects), SPH and PMH loads (including hydrostatic pressure, buoyancy, wave pressure, and concurrent wind pressure effects). Pipe reactions are considered by applying a blanket load of 50 psf to the structure.

During maintenance of the UHS Makeup Water Intake Structure, when stop logs are installed, interior or exterior below-grade cells may be empty. The exterior embedded walls, with the empty adjacent cell, are subject to lateral soil pressure, surcharge and hydrostatic pressure from a normal groundwater level of +3 ft (0.9 m) NVGD 29. This postulated maintenance condition is considered in the FE model for designing the side walls of the UHS Makeup Water Intake Structure.

Seismic induced hydrodynamic loads associated with the water contained in the CBIS are calculated according to the provisions of ACI 350.3-06 (ACI, 2006). Effects of the impulsive and convective components of the hydrodynamic loads are calculated in the SSI analysis by including the corresponding water mass and springs in the ACS SASSI model.

The accelerations determined from the SSI analysis are applied to the FE model and combined with other static analyses to generate design forces and moments for load combinations involving seismic effects, in accordance with Section 3.8.4.3.2. Seismic accelerations for a particular earthquake direction are computed by adding the accelerations of three directions at a given location using the algebraic summation method for each point in time. Accelerations are then enveloped for a particular direction for all soil profiles (i.e., UB, BE, LB described in Section 3.7.1.3.3).

Following application of the SASSI accelerations from the three components of earthquake motions to the static model, the results are combined using the Square Root of the Sum of the Squares (SRSS) method, as described in Section 3.7.2.6. The design forces and moments from seismic and non-seismic load combinations are used to design reinforced concrete shear walls and slabs according to the provisions of ACI 349/349R-01 (ACI, 2001a) (with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001)). Results of the reinforced concrete design are provided in Appendix 3E Section 3E.4.5.

The evaluation of slabs and walls for external hazards (e.g., hurricane and tornado generated missiles) is performed by local analyses, following the procedure outlined in U.S. EPR FSAR Section 3.8.4.4.1. Procedures for stability evaluation and bearing pressure calculation are discussed in Section 3.8.5.4.6.}

3.8.4.5 Structural Acceptance Criteria

The U.S. EPR FSAR includes the following COL Item in Section 3.8.4.5:

> A COL applicant that references the U.S. EPR design certification will confirm that site-specific conditions for Seismic Category I buried conduit, electrical duct banks, pipe, and pipe ducts satisfy the criteria specified in Section 3.8.4.4.5 and those specified in U.S. EPR FSAR Appendix 3F.

This COL Item is addressed as follows:

Design of all safety-related, Seismic Category I buried electrical duct banks and pipe meet the requirements specified in U.S. EPR FSAR Section 3.8.4.4.5 and U.S. EPR FSAR Appendix 3F.

Acceptance criteria for the buried electrical duct banks are in accordance with IEEE 628-2001(R2006) (IEEE, 2001), ASCE 4-98 (ASCE, 2000), Seismic Response of Buried Pipes and Structural Components Report (ASCE, 1983) and ACI 349/349R-01 (ACI, 2001a), with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001).

{Acceptance criteria for the buried Essential Service Water Pipes, buried UHS Makeup Water Pipes, and buried CCNPP Unit 3 Intake Pipes are identical to that stated above. Member stresses are maintained lower than allowable stresses. When allowable stresses are exceeded, joints are added as required to increase flexibility and hence, to mitigate member stresses.

Acceptance criteria for the reinforced concrete design of site-specific Seismic Category I Forebay and UHS Makeup Water Intake Structure are identical to those described in the U.S. EPR FSAR Section 3.8.4.5.}

3.8.4.6 Materials, Quality Control, and Special Construction Techniques

No departures or supplements.

3.8.4.6.1 Materials

{As discussed in Section 2.5.4.2.5.2, all natural soils at the site are considered aggressive to concrete. However, structures and buried duct banks and pipes will be surrounded and supported by non-aggressive structural fill obtained from off-site borrow sources. Hence, the durability requirements of below-grade concrete walls and buried duct banks and pipes are based on the chemical properties of groundwater.

There are two hydrogeologic units of groundwater affecting the CCNPP Unit 3 structures and buried utilities - the Surficial aquifer, which is present in the powerblock area only, and the upper Chesapeake unit, which underlies both the intake and the powerblock areas. Observed groundwater chemical properties (pH, sulfates and chlorides) for the Surficial aquifer and the Upper Chesapeake unit are provided in Table 3.8-5.

Comparing the observed pH, sulfate, and chloride values with the SRP 3.8.4 (NRC, 2007) acceptance criteria for aggressive groundwater, i.e., pH < 5.5, chlorides > 500 parts per million (ppm), and/or sulfates > 1500 ppm, groundwater from the Surficial aquifer in the powerblock area is considered aggressive due to its low pH-value. Groundwater in the intake area is considered non-aggressive.

As stated in Section 2.4.12.5, the post-development groundwater elevation in the powerblock area is at about 30 ft (9.1 m) below the finished site grade level of 85 ft (25.9 m). The NI common basemat structures are embedded approximately 40 ft (12.2 m) below the finished grade. Therefore, the lower portions of the NI common basemat structures are submerged in the low-pH groundwater from the Surficial aquifer. In addition, Seismic Category I ESWBs are founded below the post-development groundwater elevation. Other Seismic Category I structures in the powerblock area, i.e., the EPGBs, are located above the post-development groundwater level and are not affected by the low-pH groundwater.

Waterproofing systems are provided to protect the Seismic Category I reinforced concrete NI common basemat structures and ESWBs from the corrosive effects of low-pH groundwater. Due to close proximity with the NI common basemat structures, the Nuclear Auxiliary Building (NAB) and Access Building (AB) will be protected by waterproofing systems. As illustrated in Figure 3.8-6, the waterproofing system consists of a primary geomembrane envelope located under the foundation and mud mat between two sand layers and attached to the below-grade walls, extending up to Elevation 57'-0" (17.4 m) NGVD 29, or about 2 ft (0.6 m) above the highest projected post-development groundwater level. Secondary waterproofing starts at the bottom of the below-grade walls, continues above the groundwater level and terminates at about 1 ft (0.3 m) above the finished grade level. A groundwater monitoring system (consisting of risers and drain sumps) is provided inside the geomembrane envelope within the sand layer to monitor and pump out any water that may leak through the primary geomembrane. A vertical drainage layer is placed between the primary and secondary waterproofing membranes to facilitate the flow of any leaked groundwater down to the sumps.

Seismic Category I EPGBs are located above the post-development groundwater level and are not in constant contact with the low-pH groundwater. As illustrated in Figure 3.8-7, the dampproofing system for the EPGBs consists of an HDPE geomembrane located between the mudmat and underlying structural fill. Dampproofing for below-grade walls consists of liquid applied membrane or HDPE geomembrane placed directly against concrete.

A majority of the buried electrical duct banks are located above the post-development groundwater level in the powerblock area and are not affected by the low-pH groundwater. For the duct banks in the utility corridor and buried Seismic Category I duct banks and pipes, that may be exposed to the low-pH groundwater, liquid-applied or geomembrane waterproofing is applied for protection against prolonged exposure to the groundwater. Protective measures for buried pipe include protective wrapping and/or coatings that are acid-resistant. Dampproofing is not required for buried duct bank and pipe.

As the Seismic Category I Forebay and UHS Makeup Water Intake Structure contact water both inside and outside, these structures will not be waterproofed or dampproofed.

As noted in Table 3.8-5, the maximum observed sulfate concentration in the groundwater is 365 ppm. According to ACI 349/349R-01 (ACI, 2001a) Table 4.3.1, this concentration is considered a moderate exposure (also identified as "Class 1 Exposure" in ACI 201.2R-01 (ACI, 2001b)) and requires the use of ASTM C150 (ASTM, 2009) Type II or equivalent cement, a maximum water-cementitious materials ratio of 0.5, and a minimum concrete compressive strength of 4000 psi.

Additionally, for concrete structures subject to the brackish water from the Chesapeake Bay, Table 4.2.2 of ACI 349/349R-01 (ACI, 2001a) requires the use of a maximum water-cementitious materials ratio of 0.4 and a minimum specified compressive strength of 5000 psi.

Based on aforementioned requirements, concrete mixtures for Seismic Category I Forebay, UHS Makeup Water Intake Structure and buried utilities (i.e., buried concrete electrical duct banks and pipes) will have a maximum water-cementitious materials ratio of 0.4 and a minimum specified compressive strength of 5000 psi. As stated in Section 3.7.2, the Essential Service Water Buildings can also be subjected to brackish water, since these structures take the brackish water from UHS Makeup Water Intake Structure and Forebay for maintaining safe shutdown of the plant 72 hours after a design basis accident. Therefore, a maximum water-cementitious materials ratio of 0.4 and a minimum compressive strength of 5000 psi are also specified for the concrete mixtures for the Essential Service Water Buildings, including their foundations. Concrete mixtures for other Seismic Category I structures will have a maximum water-cementitious materials ratio of 0.45.

For improved resistance to sulfate attack and chloride ion penetration, about 20-25% of the total weight of the cementitious materials in all concrete mixtures will be replaced with fly ash (conforming to ASTM C618 (ASTM, 2005) Class F) to limit temperature gain, thus reducing peak hydration temperature and permeability of the concrete.}

3.8.4.6.2 Quality Control

No departures or supplements.

3.8.4.6.3 Special Construction Techniques

{Special construction techniques are not expected to be used for the Seismic Category I Emergency Power Generating Buildings, Essential Service Water Buildings, Forebay, UHS Makeup Water Intake Structure, and buried utilities.}

3.8.4.7 Testing and Inservice Inspection Requirements

The U.S. EPR FSAR included the following COL Item in Section 3.8.4.7:

> A COL applicant that references the U.S. EPR design certification will address examination of buried safety-related piping in accordance with ASME Section XI, IWA-5244, "Buried Components."

The COL Item is addressed as follows:

> An examination of buried safety-related piping is performed in accordance with ASME Section XI, IWA-5244, "Buried Components."

{As discussed in Section 2.5.4.2.5.2, although the CCNPP Unit 3 in-situ soil is aggressive to concrete, it will be replaced by non-aggressive structural fill under and around the structures and buried duct banks and buried pipes. In addition, the foundations of Seismic Category I structures, and buried utilities are protected by waterproofing and dampproofing systems. As a result, the structures and buried utilities are not directly exposed to the in-situ soil or the low-pH groundwater.

For normally inaccessible below-grade concrete walls and foundations and buried utilities that are not exposed to low-pH groundwater, the inservice inspection program is limited to examination of the exposed portions of below-grade concrete walls and buried utilities for signs of degradation, when excavated for any reason. Exposed geomembrane and related waterproofing systems are also inspected during the excavation.

For the structures in the powerblock area where waterproofing systems are provided to protect the reinforced concrete, in-service inspection utilizes a groundwater monitoring system consisting of risers and drain sumps. The risers and sumps will be subject to periodic monitoring to confirm that groundwater leaking through the geomembrane envelope is being effectively removed and is not ponded against the concrete structure. Such monitoring will:

- Occur at multiple locations in the monitoring system;
- Be performed on a frequency based on the leakage rate through the primary geomembrane. The leakage rate will be determined by monitoring water levels in the risers and drain sumps. Initially the monitoring frequency is expected to be high until the performance of the geomembrane is established. As the operation proceeds, the monitoring interval will be expanded, possibly to once per cycle;
- Utilize manual techniques or electronic water level sensors.

The buried duct banks have shallow embedment depth. Therefore, the condition of the buried concrete duct banks in the utility corridor that may be exposed to low-pH groundwater of the Surficial aquifer will be monitored by excavating the surrounding soil. The frequency of this monitoring will be determined based on the groundwater level and pH values recorded by the groundwater monitoring program described in Section 3.8.5.7.

In-service inspection of buried piping will be performed when exposed during an excavation for any reason. As described in Section 9.2.1.6 and Section 9.2.5.6, periodic inservice testing of buried Essential Service Water (ESW) and Ultimate Heat Sink (UHS) Makeup Water piping will be performed using flow or pressure tests, regardless of groundwater exposure conditions. As described in Section 6.6.4, testing will be performed at a four-year frequency.

Groundwater levels throughout the powerblock area will also be monitored to confirm that no other below-grade concrete requires dewatering provisions to protect it from prolonged exposure to the low-pH groundwater from the Surficial aquifer. The groundwater chemical properties are monitored through the monitoring program described in Section 3.8.5.7.

The in-service inspection program and performance monitoring will be designed and conducted in conformance with the requirements of 10 CFR 50.65 (CFR, 2008) and Regulatory Guide 1.160 (NRC, 1997). The in-service inspection program for the UHS Makeup Water Intake Structure and the Forebay are developed and conducted in accordance with Regulatory Guide 1.127 (NRC, 1978b). The in-service program includes below-grade walls and buried utilities addressed in this section, as well as foundations addressed in Section 3.8.5.}

3.8.5 Foundations

3.8.5.1 Description of the Foundations

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.1:

> A COL applicant that references the U.S. EPR design certification will describe site-specific foundations for Seismic Category I structures that are not described in this section.

This COL Item is addressed as follows:

{The foundations for the site-specific Seismic Category I Forebay and UHS Makeup Water Intake Structure are discussed in Section 3.8.5.1.4.}

3.8.5.1.1 Nuclear Island Common Basemat Structure Foundation Basemat

No departures or supplements.

3.8.5.1.2 Emergency Power Generating Buildings Foundation Basemats

No departures or supplements.

3.8.5.1.3 Essential Service Water Buildings Foundation Basemats

No departures or supplements.

3.8.5.1.4 {Forebay and UHS Makeup Water Intake Structure Basemats

This section is added as a supplement to the U. S. EPR FSAR.

A general area drawing of the UHS Makeup Water Intake Structure, Circulating Water Makeup Water Intake Structure and the Forebay is shown in Figure 9.2-4. Plan views of the UHS Makeup Water Intake Structure are shown in Figure 9.2-5 and Figure 9.2-6. A section view is shown in Figure 9.2-8. A general description of the structures, including descriptions of all functional levels, is provided in Section 3.8.4.1.11. Figure 3.8-1 shows the position of the Forebay and UHS Makeup Water Intake Structure, relative to the NI.

As shown in Figure 9.2-4, Seismic Category II CWS Makeup Water Intake Structure and Seismic Category I Forebay and UHS Makeup Water Intake Structure share a 5 ft (1.5 m) thick common basemat, with its top elevation at -22.5 ft (-6.9 m).

The reinforced concrete basemat for the Forebay is 109 ft (33.2 m) long by 89 ft (27.1 m) wide. The reinforced concrete basemat for the UHS Makeup Water Intake Structure is 89 ft (27.1 m) long by 58 ft (17.7 m) wide. Concrete walls bearing on the foundation basemats of Forebay and UHS Makeup Water Intake Structure are described in Section 3.8.4.1.11 and shown on Figures 3E-1 and 3E-2.

Lateral loads, including those that are seismically induced, are transferred to the supporting soil by the foundation basemats and below-grade walls through friction, adhesion, and passive soil pressure, if necessary. Vertical forces from the super structures are transferred to the foundation basemat through the bearing walls, before being transferred to the supporting soil through bearing pressure.}

3.8.5.2 Applicable Codes, Standards, and Specifications

No departures or supplements.

3.8.5.3 Loads and Load Combinations

{Structural loads and load combinations for reinforced concrete basemat design of site-specific Seismic Category I structures are defined in Sections 3.8.4.3.1 and 3.8.4.3.2.

Load combinations for stability evaluation, including sliding, overturning, and flotation, are described in U.S. EPR FSAR Section 3.8.5.3. Additional stability load combinations for sliding and overturning evaluations include:

- D + H + SPH
- D + H + PMH

These load combinations are analogous to the stability load combinations for wind, hurricane and tornado loading.

Load combinations for bearing pressure evaluation are as follows:

Service loads

- D + H + L + F +Fb

Severe environmental loads

- D + H + L + F +Fb + W
- D + H + L + F +Fb + SPH

Extreme environmental loads

- D + H + L + F +Fb + Wt
- D + H + L + F +Fb + E'
- D + H + L + F +Fb + PMH}

3.8.5.4 Design and Analysis Procedures

No departures or supplements.

3.8.5.4.1 General Procedures Applicable to Seismic Category I Foundations

No departures or supplements.

3.8.5.4.2 Nuclear Island Common Basemat Structure Foundation Basemat

No departures or supplements.

3.8.5.4.3 Emergency Power Generating Buildings Foundation Basemats

No departures or supplements.

3.8.5.4.4 Essential Service Water Buildings Foundation Basemats

No departures or supplements.

3.8.5.4.5 Design Report

{Design reports for the Forebay and UHS Makeup Water Intake Structure basemats are presented in Appendix 3E.4.}

3.8.5.4.6 {Forebay and UHS Makeup Water Intake Structure Basemats

This section is added as a supplement to U.S. EPR FSAR Section 3.8.5.4.

As shown in Figure 3.7-23, the foundation basemats are part of the finite element model used for the analysis and design of the Seismic Category I Forebay and UHS Makeup Water Intake Structure. The finite element mesh of the basemats is shown in Figure 3.8-5. Analysis and critical section design procedures for these structures are presented in Section 3.8.4.4.7.

To ensure the stability of the structures during various design basis events, the Common Basemat Intake Structures (CBIS) are checked for sliding, overturning, and flotation using the stability load combinations described in Section 3.8.5.3.

Static and dynamic bearing pressures are calculated and compared with the bearing capacities defined in Table 2.5-67.

For the static load combinations, the STAAD model maximum bearing pressures at each node are obtained by dividing the nodal reaction (spring force) by the nodal tributary area.

Results from the SASSI analysis are used to calculate sliding forces and overturning moments for seismic loads, as described in Section 3.7.2.14.3. The loads contributing to the structural mass in the SSI analysis are used to calculate the resistance to sliding and overturning. These loads include 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.

For the non-seismic loads, basemat reactions from STAAD Pro analysis are used to calculate sliding forces and overturning moments and results are reported in Table 3.8-2. The dead load used to calculate the resistance to sliding and overturning includes the self weight of the structures, permanent equipment and water inside structures during the normal operation, SPH and PMH conditions.

Flotation is checked under normal operation, SPH, and PMH conditions, including the draw-down condition during a PMH event, with the water inside the CBIS at the minimum design level of -8 ft (-2.4 m). Resistance to flotation is provided by dead load.

Sliding is checked at various sliding interfaces below the foundation basemats. The CBIS sits on top of a mud mat, which is placed directly on the in-situ soil stratum IIc (Chesapeake clay/silt). Therefore, resistance to sliding is provided by friction between the basemat and the mud mat and friction and adhesion between the mud mat and soil stratum IIc. Passive soil pressure is not utilized for the stability of the CBIS. The static coefficients of friction for various sliding interfaces are presented in Table 3.8-1.

Frictional resistance is reduced by the effects of any upward forces, such as upward seismic forces and buoyancy. Overturning resistance is reduced by buoyancy.

The factors of safety from aforementioned stability evaluations are compared with the minimum required factors of safety specified in U.S. EPR FSAR Table 3.8-11. The minimum required factors of safety for sliding and overturning associated with SPH and PMH are the same as those for wind, hurricane, and tornado, respectively. The minimum required factor of safety for flotation, including SPH and PMH conditions, is 1.1.

Results of the stability and bearing pressure evaluations are presented in Section 3.8.5.5.4.}

3.8.5.5 Structural Acceptance Criteria

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.5:

> A COL applicant that references the U.S. EPR design certification will evaluate site-specific methods for shear transfer between the foundation basemats and underlying soil for site-specific soil characteristics that are not within the envelope of the soil parameters specified in Section 2.5.4.2.

This COL Item is addressed as follows:

{For the Nuclear Island (NI) common basemat structures, Emergency Power Generating Buildings (EPGBs), and Essential Service Water Building (ESWBs), U.S. EPR FSAR Section 2.5.4.2 specifies a minimum coefficient of friction of 0.5 for interfaces between the foundation basemat and soil, or for cohesive soil cases the soil will have an undrained strength equivalent to or exceeding a drained strength of 26.6 degrees yielding a friction coefficient greater than or equal to 0.5. As identified in Table 3.8-1, the coefficient of friction for underlying interfaces is typically greater than 0.5. In those instances where the coefficient of friction is less than 0.5, there is an adhesion component providing additional resistance to movement (see Table 3.8-1). As identified in Table 2.5-54, the drained strength or drained friction angle (f') is greater than 26.6 degrees.

Site-specific sliding evaluations were performed to confirm the stability of NI Common Basemat Structures, EPGBs, ESWBs, NAB, AB, and Turbine Island (TI). These structures are located in the powerblock area, which will be excavated and backfilled. Mud mats are used under the basemat of each structure to facilitate construction. As described in Section 3.8.4.6.1, a waterproofing system is used to protect the NI Common Basemat Structures, ESWBs, NAB, and AB from the low-pH groundwater, as illustrated in Figure 3.8-6. The potential sliding interfaces down to the natural soils under the NI Common Basemat Structures, ESWBs, NAB, and AB are:

- Basemat - mud mat
- Mud mat - sand
- Sand - waterproofing membrane
- Sand - structural fill
- Structural fill - soil stratum IIb

As described in Section 3.8.4.6.1, a dampproofing system is used for the EPGBs (and will also be used for the TI), as illustrated in Figure 3.8-7. EPGBs and TI are not exposed to low-pH groundwater and, therefore, do not require protective waterproofing and dampproofing systems. However, as a good construction practice and for defense in depth, waterproofing and dampproofing systems are applied to these structures in accordance with Sections 1805.2 and 1805.3 of the IBC 2009 (IBC, 2009). The potential sliding interfaces under the EPGBs and TI are:

- Basemat-mud mat
- Mud mat-dampproofing membrane
- Dampproofing membrane - sand
- Sand - structural fill
- Structural fill - soil stratum IIb

Frictional parameters at the various sliding interfaces are presented in Table 3.8-1. Bearing pressures, percent uplift, and factors of safety against sliding, overturning and flotation have been calculated using the site specific SSE and soil conditions, with the methodology described in Section 3.7.2.14.1 and 3.7.2.14.2. Results are presented in Table 3.8-4. The minimum required factor of safety of 1.1 is achieved for the buildings. In addition, bearing pressures have been determined to be acceptable based on site specific conditions, since the dynamic bearing pressure of the Nuclear Island Common Basemat Structures exceed the design parameters established in Table 2.0-1.}

3.8.5.5.1 Nuclear Island Common Basemat Structure Foundation Basemat

The U.S. EPR FSAR included the following COL Item in Section 3.8.5.5.1:

A COL applicant that references the U.S. EPR design certification will compare the NI common basemat site-specific predicted angular distortion to the angular distortion in the relative differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-124 through U.S. EPR FSAR Figure 3.8-134, using methods described in U.S. Army Engineering Manual 1110-1-1904. The comparison is made through the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of the NI common basemat structure is less than the angular distortion shown for each of the construction steps, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

The COL Item is addressed as follows:

{The Calvert Cliffs Unit 3 site-specific soil spring values are the same as the values used in the U.S. EPR Standard Plant settlement analysis. Due to these input values being the same as well as the construction sequence, models, methodologies, and procedures, the predicted angular distortion of the NI common basemat structure is the same for both CCNPP Unit 3 and the U.S. EPR Standard Plant. Additionally, the U.S. EPR Standard Plant NI common basemat foundation is analyzed separately from the superstructure. Therefore, reconciliation of the seismic response in the superstructure is not adequate for reconciliation of the NI basemat design.

The basemat design reconciliation is performed by comparing the critical attributes which result in forces and moments for the foundation design. These critical attributes are the results from the site specific settlement analysis, the site specific stability analysis, and the inertia loads from the site specific SSI analysis for the NI.

The stability analysis was performed as described in Section 3.7.2.14.1. The stability results are summarized in Table 3.8-4. The CCNPP Unit 3 NI site-specific maximum edge bearing pressure is 1,073 kPa or 22.4 ksf. The U.S. EPR maximum edge bearing pressure is 1,123 kPa or 23.5 ksf for the soil case 1n2u. Soil case 1n2u is a soft soil case similar to CCNPP Unit 3. The basemat design shear forces and moments are therefore higher in the U.S. EPR design with the higher bearing pressures.

There is no foundation uplift in the CCNPP Unit 3 NI site-specific stability analysis. U.S. EPR NI design foundation uplift area is 4.6% for the soft soil case 1n2u. The U.S. EPR NI foundation uplift percentage is significantly higher than the CCNPP Unit 3 NI foundation uplift percentage. The larger basemat uplift area percentage results in higher stresses on the footing due to separation from the soil. The separation from the soil results in larger load eccentricities and higher moments in the basemat in the U.S. EPR design.

The U.S. EPR NI basemat design shear forces and moments resulting from the dynamic bearing pressures are enveloped by the forces and moments for CCNPP Unit 3 NI basemat.

The CCNPP Unit 3 site-specific minimum NI overturning factor of safety is 4.17. The U.S. EPR NI minimum overturning factor of safety is 2.8 for the soft soil case. The higher CCNPP Unit 3 NI overturning factor of safety, which is also on a soft soil, demonstrates that the demand on the CCNPP Unit 3 NI basemat is less than the demand included in the U.S. EPR NI basemat design.

Table 3.8-7 is a comparison of the maximum total seismic inertia forces and moments at the center of gravity of the NI basemat for the U.S. EPR and CCNPP Unit 3. The maximum ratio of the

CCNPP Unit 3 NI to U.S. EPR NI is 0.41. This ratio of seismic shear forces and moments demonstrates that the demand on the CCNPP Unit 3 NI basemat is less than the demand included in the U.S. EPR NI basemat design.}

3.8.5.5.2 Emergency Power Generating Buildings Foundation Basemats

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.5.2:

> A COL applicant that references the U.S. EPR design certification will compare the EPGB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in Figure 3.8-135, using methods described in U.S. Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of EPGB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.
>
> The COL Item is addressed as follows:
>
> {The Calvert Cliffs Unit 3 site-specific angular distortion values were compared to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-135, using methods described in U.S. Army Engineering Manual 1110-1-1904. The same models, methodologies and procedures are used as with the U.S. EPR Standard Plant design. The basemat area is partitioned into separate slab design areas in both the east-west and north-south directions. The maximum CCNPP Unit 3 angular distortion is less than the maximum angular distortion in every slab design area for the softest soil case in U.S. EPR FSAR Table 3.7.1-8; thus, the U.S. EPR design envelops the site.}

{The following departure is taken from U.S. EPR FSAR Section 3.8.5.5.2.

Section 2.5.4.10.2 of the U.S. EPR FSAR states that:

> "The design of Seismic Category I foundations for the U.S. EPR is based on a maximum differential settlement of ½ inch per 50 ft in any direction across the basemat."

The U.S. EPR FSAR maximum allowable differential settlement of ½ inch per 50 ft may also be expressed as a fraction, i.e., 1/1200.

According to Section 2.5.4.10.2, the estimated site-specific differential settlement is 1/1166, which is about 3% higher than the allowable value described in the U.S. EPR FSAR.

A finite element analysis of the entire EPGB structure, including CCNPP Unit 3 site-specific soil springs, indicates the maximum differential settlement within the confines of the EPGB basemat is 1/2714, or substantially less than the allowable value of the U.S. EPR FSAR. The variation of the finite element analysis differential settlement (1/2714) with the estimated differential settlement value of 1/1166 is attributed to the conventional geotechnical treatment of the foundation as a flexible plate, a condition much more conservative than the actual 6 ft thick reinforced concrete basemat.

To verify the finite element analysis results, a manual calculation is performed for a selected beam strip (1 ft (0.3 m) wide by 6 ft (1.8 m) deep) of the EPGB basemat, plan view of which is shown in U.S. EPR FSAR Figure 3E.2-3. The beam strip is located at the centerline of the basemat and is perpendicular to the center reinforced concrete bearing wall. The selected two-span beam strip is 96 ft (29.3 m) long, with the aforementioned center wall and two parallel primary reinforced concrete bearing walls serving as pinned supports. Soil bearing pressures are applied to the beam strip and beam deflection is calculated. The calculation results confirm similar findings as the finite element analysis results, i.e., the maximum differential settlement of the EPGB basemat is substantially less than 1/1200.

To further evaluate the effects of the higher site-specific differential settlement, a finite element analysis of the entire EPGB is performed to evaluate the effect of a more conservative overall building tilt of L/550, where L is the least basemat dimension. For this analysis:

- Spring stiffnesses are adjusted until a tilt of L/550 is achieved.
- The elliptical distribution of soil springs is maintained.
- Soil spring stiffnesses along the centerline of the basemat (perpendicular to the direction of tilt) are retained.
- Adjustment is made to all other springs as a function of the distance from the basemat centerline.

The finite element analysis results show that increase in EPGB basemat design moment based on the more conservative differential settlement value of 1/550 (based on the overall tilt) is less than 3% of the U.S. EPR FSAR maximum design moment. Therefore, EPGB basemat is structurally adequate to resist the increased moments. Additionally, the U.S. EPR Standard Plant EPGB foundation is analyzed separately from the superstructure. Therefore, reconciliation of the seismic response in the superstructure is not adequate for reconciliation of the EPGB basemat design.

The EPGB basemat design reconciliation is performed by comparing the critical attributes which result in forces and moments for the foundation design. These critical attributes are the results from the site specific settlement analysis, the site specific stability analysis, and the inertia loads from the site specific seismic analysis for each of the structures.

The stability analysis was performed as described in Section 3.7.2.14.1. Stability results are summarized in Table 3.8-4.

The CCNPP Unit 3 EPGB site-specific maximum edge bearing pressure is 344.74 kPa or 7.17 ksf. The U.S. EPR EBGB maximum edge bearing pressure is 604 kPa or 12.56 ksf for the soil case 1n2u. Soil case 1n2u is a soft soil case similar to CCNPP Unit 3. The resultant basemat design shear forces and moments are therefore higher in the U.S. EPR design with the higher bearing pressures than those calculated for CCNPP Unit 3 EPGB.

There is no foundation uplift in the CCNPP Unit 3 EPGB site-specific stability analysis. U.S. EPR EPGB design foundation uplift area is 6.94% for the saturated soft soil case and 5.8% for the moist soft soil case. The U.S. EPR EPGB foundation uplift percentage is higher than the CCNPP Unit 3 EPGB foundation uplift percentage. The basemat uplift results in higher stresses on the footing. The separation from the soil results in larger load eccentricities and higher moments in the basemat in the U.S. EPR design, than that of CCNPP Unit 3.

The U.S. EPR EPGB basemat design shear forces and moments resulting from the dynamic bearing pressures are enveloped by the forces and moments for CCNPP Unit 3 EPGB basemat.

The CCNPP Unit 3 site-specific minimum EPGB overturning factor of safety is 2.5. The U.S. EPR EPGB minimum overturning factor of safety is 1.52 for soft soil case 1n2u. The higher CCNPP Unit 3 EPGB overturning factor of safety demonstrates that the demand on the CCNPP Unit 3 EPGB basemat is less than the demand included in the U.S. EPR EPGB basemat design.

Table 3.8-7 is a comparison of the maximum total seismic inertia forces and moments at the center of gravity of the EPGB basemat for the U.S. EPR and CCNPP Unit 3. The maximum ratio of the CCNPP Unit 3 EPGB to U.S. EPR EPGB is 0.45. This ratio of seismic shear forces and moments demonstrates that the demand on the CCNPP Unit 3 EPGB basemat is less than the demand included in the U.S. EPR EPGB basemat design.}

3.8.5.5.3 Essential Service Water Buildings Foundation Basemats

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.5.3:

> A COL applicant that references the U.S. EPR design certification will compare the ESWB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of ESWB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

The COL Item is addressed as follows:

> {The site-specific angular distortion values were compared to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1-1904 (USACE, 1990). The same models, methodologies and procedures are used as with the U.S. EPR Standard Plant design. The basemat area is partitioned into separate slab design areas based on maximum angular distortion. The maximum angular distortion is less than the maximum angular distortion in every slab design area for the softest soil case in U.S. EPR FSAR Table 3.7.1-8; thus, the U.S. EPR design envelops the site.}

{The following departure is taken from U.S. EPR FSAR Section 3.8.5.5.3.

U.S. EPR FSAR Section 2.5.4.10.2 states that:

> "The design of Seismic Category I foundations for the U.S. EPR is based on a maximum differential settlement of ½ inch per 50 ft in any direction across the basemat."

The U.S. EPR FSAR maximum allowable differential settlement of ½ inch per 50 ft may also be expressed as a fraction, i.e., 1/1200.

According to Section 2.5.4.10.2, the maximum site-specific differential settlement is 1/845, which exceeds the allowable value specified in the U.S. EPR FSAR.

A finite element analysis of the entire ESWB structure, including CCNPP Unit 3 site-specific soil springs, indicates the maximum differential settlement within the confines of the ESWB basemat is 1/1417, or less than the allowable value of the U.S. EPR FSAR. The variation of the finite element analysis differential settlement (1/1417) with the estimated differential settlement value of 1/845 is attributed to the conventional geotechnical treatment of the foundation as a flexible plate, a condition much more conservative than the actual 6 ft thick reinforced concrete basemat.

To verify the finite element analysis results, a manual calculation is performed for a selected beam strip (1 ft (0.3 m) wide by 6 ft (1.8 m) deep) of the ESWB basemat, plan view of which is shown in U.S. EPR FSAR Figure 3E.3-3. The beam strip is located at the centerline of the basemat and is perpendicular to the reinforced concrete bearing wall separating the two cooling towers. The selected two-span beam strip extends for the length of the two cooling towers, with the aforementioned divider wall and two parallel reinforced concrete bearing walls serving as pinned supports. Soil bearing pressures are applied to the beam strip and beam deflection is calculated. The calculation results confirm similar findings as the finite element analysis results, i.e., the maximum differential settlement of the ESWB basemat is less than 1/1200.

To further evaluate the effects of the higher site-specific differential settlement, a finite element analysis of the entire ESWB is performed to evaluate the effect of a more conservative overall building tilt of L/600, where L is the least basemat dimension. For this analysis:

- Spring stiffnesses are adjusted until a tilt of L/600 is achieved.
- The elliptical distribution of soil springs is maintained.
- Soil spring stiffnesses along the centerline of the basemat (perpendicular to the direction of tilt) are retained.
- Adjustment is made to all other springs as a function of the distance from the basemat centerline.

The finite element analysis results show that increase in the ESWB basemat design moments based on the more conservative differential settlement value of 1/600 (based on the overall tilt) is less than 5% of the U.S. EPR FSAR maximum design moments. So, the ESWB basemat is structurally adequate to resist the increased moments. Additionally, the U.S. EPR Standard Plant ESWB foundation is analyzed separately from the superstructure. Therefore, reconciliation of the seismic response in the superstructure is not adequate for reconciliation of the ESWB basemat design.

The ESWB basemat design reconciliation is performed by comparing the critical attributes which result in forces and moments for the foundation design. These critical attributes are the results from the site specific settlement analysis, the site specific stability analysis, and the inertia loads from the site specific seismic analysis for each of the structures.

The stability analysis was performed as described in Section 3.7.2.14.1. Stability results are summarized in Table 3.8-4.

The CCNPP Unit 3 ESWB site-specific maximum edge bearing pressure is 512.32 kPa or 10.7 ksf. The U.S. EPR ESWB maximum edge bearing pressure is 569.8 kPa or 11.9 ksf for the soil case 1n2u. Soil case 1n2u is a soft soil case similar to CCNPP Unit 3. The resultant basemat design shear forces and moments are therefore higher in the U.S. EPR design with the higher bearing pressures, than those calculated for CCNPP Unit 3 ESWB.

There is no foundation uplift in the CCNPP Unit 3 ESWB site-specific stability analysis. U.S. EPR ESWB design foundation uplift area is 18% for the soft soil case, 1n2u. The U.S. EPR ESWB foundation uplift percentage is higher than the CCNPP Unit 3 ESWB foundation uplift percentage. The larger foundation uplift area percentage results in higher stresses on the footing due to separation from the soil. The separation from the soil results in larger load eccentricities and higher moments in the basemat in the U.S. EPR design.

The U.S. EPR ESWB basemat design shear forces and moments resulting from the dynamic bearing pressures are enveloped by the forces and moments for CCNPP Unit 3 ESWB basemat.

The CCNPP Unit 3 site-specific minimum ESWB overturning factor of safety is 4.5. The U.S. EPR ESWB minimum overturning factor of safety is 1.46 for soft soil case 1n2u. The higher CCNPP Unit 3 ESWB overturning factor of safety demonstrates that the demand on the CCNPP Unit 3 ESWB basemat is less than the demand included in the U.S. EPR ESWB basemat design.

Table 3.8-7 is a comparison of the maximum total seismic inertia forces and moments at the center of gravity of the ESWB basemat for the U.S. EPR and CCNPP Unit 3. The maximum ratio of the CCNPP Unit 3 NI to U.S. EPR ESWB is 0.43. This ratio of seismic shear forces and moments demonstrates that the demand on the CCNPP Unit 3 NI basemat is less than the demand included in the U.S. EPR ESWB basemat design.}

3.8.5.5.4 {Forebay and UHS Makeup Water Intake Structure Basemats

This section is added as a supplement to U.S. EPR FSAR Section 3.8.5.5.

Acceptance criteria for reinforced concrete design of basemat critical sections are described in Section 3.8.4.5.

Stability and bearing pressure of the CBIS are evaluated following the procedures presented in Section 3.8.5.4.6. As reported in Table 3.8-2, factors of safety from various stability load combinations show that the minimum required values are achieved. Therefore, the CBIS are stable under various design conditions.

The average bearing pressures across the CBIS basemat and maximum localized pressures for each load combination are provided in Table 3.8-3.

Static Load Combinations

The bearing pressures for the static load combinations are obtained from the STAAD model.

The bearing capacity as reported in Table 2.5-67 is associated with the global soil failure underneath the foundation (general shear failure) rather than a local failure such as the failure of a soil element at a corner of the foundation. Therefore, the local maximum bearing pressure is not comparable to the bearing capacity reported in Table 2.5-67.

In order to make a relevant comparison, the following three steps are implemented:

1. Calculation of the resultant foundation load and its corresponding eccentricity that is equivalent to the bearing pressure distribution of each load combination.

2. Determination of the reduced area (effective area) due to eccentricity.

3. Computation of the increased average bearing pressure as the ratio of the total vertical load to the reduced area.

The reduced area or effective area calculated based on the eccentricity is at least 65% of the overall area. To be conservative, a reduction of 50% in the area of the CBIS is considered in the calculation of the average bearing pressure. The increased average bearing pressures corresponding to the 50% reduction in the area are shown in Table 3.8-3 and these are lower than the bearing capacity.

Seismic Load Combinations

For the seismic load combination (D+L+F+E'), the static bearing pressures are summed with the seismic bearing pressures. The STAAD model is not used to evaluate seismic bearing pressures, since it is too conservative to assume maximum accelerations for all nodes to occur simultaneously. Instead, results from the SSI SASSI analysis are used to evaluate the seismic bearing pressures.

For the evaluation of seismic bearing pressures, average bearing pressures are obtained for the part of the foundation that is not subjected to uplift as follows:

1. For a given time step, the nodal net vertical pressure (seismic vertical pressure from SASSI+static vertical pressure from PLAXIS 3D) is obtained.

2. If the nodal net pressure is compressive, the pressure is multiplied with the nodal tributary area to get the nodal compressive force; negative nodal pressures are not accounted for.

3. The total compressive forces from all nodes that are in compression are summed, and divided by the area that is under compression.

The seismic bearing capacity check is conducted for the following time steps:

1. The time step of maximum uplift, which represents the smallest area subjected to compression

2. The time step at which the compressive pressure as defined above is maximum.

3. The time step at which the overturning factor of safety is minimum

4. The time step at which the sliding factor of safety is minimum.

These time steps are the critical time steps in terms of bearing capacity check.

In addition to checking for average seismic bearing pressures, all local seismic bearing pressures are also checked at all time steps at all locations.

The SASSI simulations for all three soil cases are conducted for the operational water level and for both SSE and OBE conditions. In addition, seismic stability is checked for the maintenance and the maximum water level cases with the BE soil profile and SSE conditions.

The maximum average seismic bearing pressure is less than 4.0 ksf based on the area that is in compression. Similar to the static case, a 50% reduction to the area in compression (not the entire CBIS area) is applied to account for eccentricity, resulting in an average pressure of 8.0 ksf, which is lower than the seismic bearing capacity.

The maximum local bearing pressure, when all time steps and all cases are considered, is 18.6 ksf. For the 558 CBIS basemat solid elements checked and for more than 8000 time steps, the local bearing pressures are below 17.6 ksf except on one corner element at two time steps.

Average seismic bearing pressures for the CBIS basemat (Table 3.8-3) are below the seismic bearing capacity.

The calculated maximum bearing pressures are smaller than the bearing capacities presented in Table 2.5-67 under both static and dynamic conditions.

Differential settlement across the CBIS is within the U.S. EPR FSAR differential settlement criterion of 1/1200.}

3.8.5.6 Materials, Quality Control, and Special Construction Techniques

No departures or supplements.

3.8.5.6.1 Materials

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.6.1:

> A COL applicant that references the U.S. EPR design certification will evaluate the use of epoxy coated rebar for foundations subjected to aggressive environments, as defined in ACI 349/349R-01, Chapter 4. In addition, waterproofing and dampproofing system of Seismic Category I foundations subjected to aggressive environments will be evaluated for use in aggressive environments. Also, the concrete of Seismic Category I foundations subjected to aggressive environments will meet the durability requirements of ACI 349/349R-01, Chapter 4 or ASME Code, Section III, Division 2, Article CC-2231.7, as applicable.

This COL Item is addressed as follows:

{As described in Section 3.8.4.6.1, Seismic Category I structures other than NI common basemat structures and the ESWBs are not exposed to low-pH groundwater and, therefore, do not require protection to perform their safety function. However, in line with good construction practices and to fulfill defense in depth requirements, waterproofing and dampproofing systems are applied in accordance with Sections 1805.2 and 1805.3 of the IBC 2009 (IBC, 2009) to Seismic Category I foundations. For NI common basemat structures and the ESWBs, a waterproofing membrane is used to eliminate the prolonged exposure of below grade concrete from the low pH groundwater of Surficial aquifer, as described in Section 3.8.4.6.1. Since groundwater in the intake area is considered non-aggressive, and as the Seismic Category I Forebay and UHS Makeup Water Intake Structure contact water both inside and outside, these structures will not be waterproofed or dampproofed. Discussion of concrete mix design for improved resistance to sulfate attack and chloride ion penetration is also presented in Section 3.8.4.6.1. Epoxy coated rebar is not used.}

3.8.5.6.2 Quality Control

No departures or supplements.

3.8.5.6.3 Special Construction Techniques

{Special construction techniques are not expected to be used for the Emergency Power Generating Buildings, Essential Service Water Buildings, Forebay and UHS Makeup Water Intake Structure.}

3.8.5.7 Testing and Inservice Inspection Requirements

The U.S. EPR FSAR includes the following COL Items in Section 3.8.5.7:

> A COL applicant that references the U.S. EPR design certification will identify site-specific settlement monitoring requirements for Seismic Category I foundations based on site-specific soil conditions.
>
> A COL applicant that references the U.S. EPR design certification will describe the program to examine inaccessible portions of below-grade concrete structures for degradation and monitoring of groundwater chemistry.

These COL Items are addressed as follows:

{The settlement monitoring program shall employ conventional monitoring methods using standard surveying equipment and concrete embedded survey markers. Survey markers are embedded in the concrete structures during construction and located in conspicuous locations above grade for measurement purposes throughout the service life of the plant as necessary. Actual field settlement is determined by measuring the elevation of the marker relative to a reference elevation datum. The reference datum selected is located away from areas susceptible to vertical ground movement and loads. If field measured settlements are found to be trending greater than expected values, an evaluation will be conducted to ensure compliance with design basis requirements.

The settlement monitoring program shall satisfy the requirements for monitoring the effectiveness of maintenance specified in 10 CFR 50.65 (CFR, 2008) and Regulatory Guide 1.160 (NRC, 1997), as applicable to structures.

The CCNPP Unit 3 below-grade concrete degradation monitoring program is described in Section 3.8.4.7. This program calls for:

- Examination of exposed portions of below-grade concrete, including buried utilities, for signs of degradation when excavated for any reason; and
- Periodic monitoring of risers and drain sumps for the NI common basemat structures to ensure that the groundwater leaking through the geomembrane envelope, if any, is being effectively removed and is not ponding against the concrete structure.

As stated in Section 3.8.4.7, groundwater levels throughout the powerblock area will be monitored. The CCNPP Unit 3 geochemical groundwater monitoring program is established on the following bases:

- Recorded baseline pH values and groundwater geochemistry concentrations prior to start of excavation.
- Recorded pH values and groundwater geochemistry concentrations after backfill is completed and at six month intervals thereafter.
- One-year after backfill is completed:
    - If no negative trend is identified, inspection intervals can be increased to once per year.

- If a negative trend is identified, need for dewatering provisions will be evaluated for other below-grade concrete structures and utilities.}

3.8.6 References

{**AASHTO, 2002.** Standard Specifications for Highway Bridges, 17th Edition, American Association of State and Highway Transportation Officials, September 2002.

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

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Dean, 1974. Evaluation and Development of Water Wave Theories for Engineering Application. Special Report No. I. Coastal Engineering Research Center, U.S. Army Corps of Engineers, November 1974.

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NRC, 1978b. Inspection of Water-Control Structures Associated with Nuclear Power Plants, Regulatory Guide 1.127, Revision 1, U.S. Nuclear Regulatory Commission, March 1978.

NRC, 1997. Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Regulatory Guide 1.160, Revision 2, U.S. Nuclear Regulatory Commission, March 1997.

NRC, 2001. Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments), Regulatory Guide 1.142, Revision 2, U.S. Nuclear Regulatory Commission, November 2001.

NRC, 2007. NUREG-0800, Standard Review Plan, Section 3.8.4, "Other Seismic Category I Structures," Revision 2, U.S. Nuclear Regulatory Commission, March 2007.

USACE, 1990. U. S. Army Engineering Manual 1110-1-1904, “Settlement Analysis,” U.S. Army Corps of Engineers, September 1990.

USACE, 2006. Coastal Engineering Manual. Engineering Manual EM 1110-2-1100, U.S. Army Corps of Engineers, 2006.}

Table 3.8-1 — {Static Frictional Parameters}

Interface Friction	Coefficient	Adhesion (ksf)
NI Common Basemat Structures, ESWBs, NAB, and AB		
Basemat - Mudmat	0.60	-
Mud mat - Sand	0.58	-
Sand - Waterproofing	0.52	-
Sand - Structural Fill	0.58	-
Structural Fill - Stratum IIb	0.47	1.0
EPGBs and TI		
Basemat - Mudmat	0.60	-
Mudmat - Dampproofing (See Note)	≥ 0.52	-
Dampproofing - Sand	0.52	-
Sand - Structural Fill	0.58	-
Structural Fill - Stratum IIb	0.47	1.0
CBIS		
Basemat - Mudmat	0.60	-
Mudmat - Stratum IIc	0.21	1.2
Side wall - Structural fill	0.58	-
Note: The Mudmat - Dampproofing interface must be made by pouring the mudmat directly onto the textured surface of the HDPE used for dampproofing. Therefore, the Mudmat - Dampproofing interface resistance will be the full shear strength of the HDPE material, and the weaker interface will be the Dampproofing - Sand interface.		

Table 3.8-2 — {Stability Evaluation Results for the CBIS}

Load Combination (LC)	Factors of Safety (FOS)		
	Sliding	Overturning	Flotation
D + H + W	106	2.1	-
D + H + Wt	11.9	1.6	-
D + H + E	1.1	1.2	-
D + F'(1)	-	-	1.33
D + H + PMH	28.1	1.2	-
D + H + SPH	66.4	1.5	-

Note:

(1.) Factor of safety against flotation (D+F') is governed by the PMH draw-down condition.

Table 3.8-3 — {Bearing Capacity Evaluation Results for the CBIS}

	Load Combination	Maximum Local Pressure (KSF)	Average Bearing Pressure (1) (KSF)	Bearing Capacity (KSF)
Static	D + L + F	14.8	5.1	11.7
	D + L + F + W	14.9	5.0	
	D + L + F + Wt	15.6	4.9	
	D + L + F + SPH	14.9	4.9	
	D + L + F + PMH	16.9	4.7	
Seismic	D + L + F + E′	18.6	8.0(2)	17.6

Notes:

(1.) Effective area of the foundation resisting the load is assumed as the 50% of the CBIS basemat area.

(2.) Effective area of the foundation resisting the load is assumed as the 50% of the CBIS area that is in compression.

Table 3.8-4 — {Stability of Standard Design Category I Structures (NI Common Basemat Structures, EPGB, and ESWB)}

Building	Factors of Safety[1]			Maximum Basemat Area under Uplift (%)	Static Bearing Pressure[2]			Dynamic Bearing Pressure[2]		
	Sliding	Overturning	Flotation		Bearing Pressure (ksf)	U.S. EPR Design Pressure (ksf)	Capacity (ksf)	Bearing Pressure (ksf)	U.S. EPR Design Pressure (ksf)	Capacity (ksf)
NI	1.8	4.2	22.3	0.0	12.9	23.1	23.5	22.4	38.0	35.2[3]
EPGB	1.6	2.5	N/A[4]	0.0	3.6	23.1	34.1	72	38.0	51.1
ESWB	2.0	4.5	34.0	0.0	6.3	23.1	31.0	10.7	38.0	41.3

Notes

(1) Factors of Safety must be greater than 1.1.

(2) Bearing pressure must be less than the U.S. EPR Design pressure, and the Site Capacity must be greater than the U.S. EPR Design pressure. If the site capacity is less than the U.S. EPR Design Pressure, a departure exists.

(3) The CCNPP Unit 3 dynamic bearing capacity is less than the U.S. EPR design dynamic bearing pressure. This is a departure. This departure has no safety significance because the site capacity is less than the actual bearing pressure calculated using site specific conditions. See COLA Part 7 for additional discussion.

(4) There is no groundwater under the EPGB, therefore no flotation.

Table 3.8-5 — {Observed Chemical Properties of Groundwater}

Properties	Surficial aquifer	Upper Chesapeake unit
pH (average)	5.2	7.4
Sulfate (ppm, maximum)	68.6	365
Chloride (ppm, maximum)	47.4	370

Notes:
Sulfate and chloride concentrations indicate the maximum observed values at the powerblock and intake areas.
ppm = parts per million.

Table 3.8-6 — {Fire Protection Conventional Seismic-I SSC Seismic Design Criteria Summary}

Site-Specific FPS CS-I SSC	Seismic Input	Seismic Model	Methods of Seismic Analysis	Acceptance Criteria	Codes and Standards
Buried FPS Piping	CCNPP Unit 3 Site SSE	As described for SC I buried piping in CCNPP Unit 3 FSAR Section 3.8.4.4.5	As described for SC I buried piping in CCNPP Unit 3 FSAR Section 3.8.4.4.5	As described for SC I buried piping in CCNPP Unit 3 FSAR Section 3.8.4.4.5	As described for SC I buried piping in CCNPP Unit 3 FSAR Section 3.8.4.4.5
FPS HVAC Ducts and Supports	CCNPP Unit 3 Site SSE or appropriate ISRS created from site-specific SSE	As described for SC I HVAC Ducts and supports in CCNPP Unit 3 FSAR Appendix 3A.2	As described for SC I HVAC Ducts and supports in CCNPP Unit 3 FSAR Appendix 3A.2	As described for SC I HVAC Ducts and supports in CCNPP Unit 3 FSAR Appendix 3A.2	As described for SC I HVAC Ducts and supports in CCNPP Unit 3 FSAR Appendix 3A.2
FPS Mechanical & Electrical Equipment and supports	CCNPP Unit 3 Site SSE or appropriate ISRS created from site-specific SSE	As described for SC I mechanical & electrical equipment and supports in CCNPP Unit 3 FSAR Section 3.10 markup	As described for SC I mechanical & electrical equipment and supports in CCNPP Unit 3 FSAR Section 3.10 markup	As described for SC I mechanical & electrical equipment and supports in CCNPP Unit 3 FSAR Section 3.10 markup	As described for SC I mechanical & electrical equipment and supports in CCNPP Unit 3 FSAR Section 3.10 markup
Above Ground FPS Piping and Supports	CCNPP Unit 3 Site SSE or appropriate ISRS created from site-specific SSE	As described in CCNPP Unit 3 FSAR Section 3.9.3	As described in CCNPP Unit 3 FSAR Section 3.9.3	As described in CCNPP Unit 3 FSAR Section 3.9.3	As described in CCNPP Unit 3 FSAR Section 3.9.3
FPS Cable Tray, Conduit & Support	CCNPP Unit 3 Site SSE	As described for SC I cable tray, conduit and supports in CCNPP Unit 3 FSAR Appendix 3A.3	As described for SC I cable tray, conduit and supports in CCNPP Unit 3 FSAR Appendix 3A.3	As described for SC I cable tray, conduit and supports in CCNPP Unit 3 FSAR Appendix 3A.3	As described for SC I cable tray, conduit and supports in CCNPP Unit 3 FSAR Appendix 3A.3

Table 3.8-7 — {Maximum Total Inertia Force Comparison}

Structure	Force	CCNPP Unit 3 (a)	Certified Design (b)	Ratio (a)/(b)
NI	Fx (kips)	140,371	398,586	0.35
	Fy (kips)	139.809	467,603	0.30
	Fz (kips)	155,883	376,780	0.41
	Mx (kip*ft)	13,217,111	55,066,379	0.24
	My (kip*ft)	12,199,275	49,940,323	0.24
	Mz (kip*ft)	1,657,302	7,877,162	0.21
EPGB	Fx (kips)	10,938	29,177	0.37
	Fy (kips)	10,063	27,824	0.36
	Fz (kips)	9,612	21,584	0.45
	Mx (kip*ft)	332,145	1,254,138	0.26
	My (kip*ft)	369,637	1,192,876	0.31
	Mz (kip*ft)	27,117	189,960	0.14
ESWB	Fx (kips)	22,980	65,190	0.35
	Fy (kips)	20,380	66,180	0.31
	Fz (kips)	25,270	58,930	0.43
	Mx (kip*ft)	942,900	3,812,000	0.25
	My (kip*ft)	1,075,000	3,757,000	0.29
	Mz (kip*ft)	83,680	536,800	0.16

Figure 3.8-1 — {Schematic Site Plan of Seismic Category I Buried Utilities (Electrical Duct Banks)}

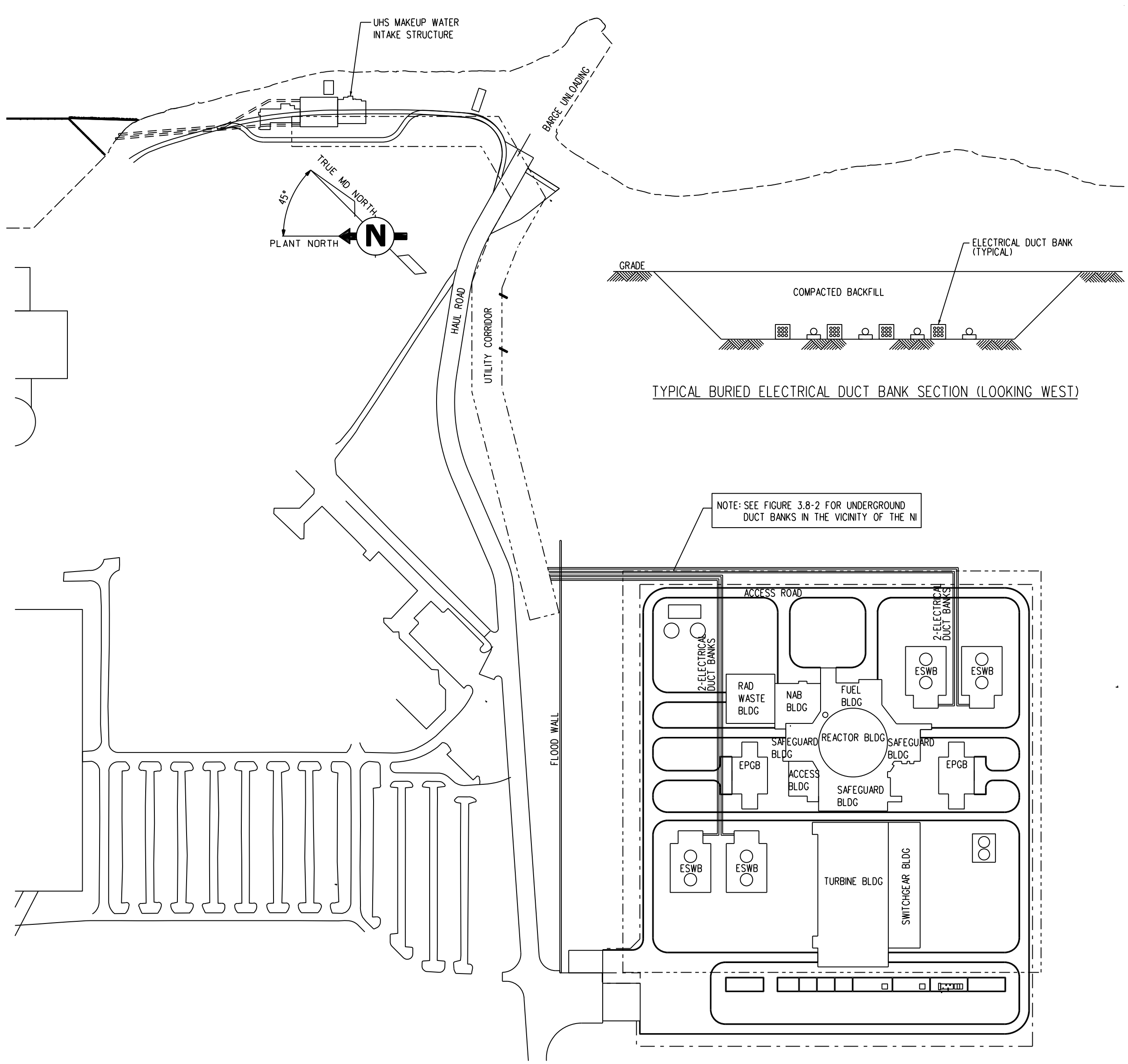


Figure 3.8-2 — {Schematic Site Plan of Seismic Category I Buried Utilities at the NI (Electrical Duct Banks)}

[Security Related Information - Withheld under 10 CFR 2.390. See Part 9 of the COL Application.]

Figure 3.8-3 — {Schematic Site Plan of Seismic Category I Buried Utilities (Underground Piping)}

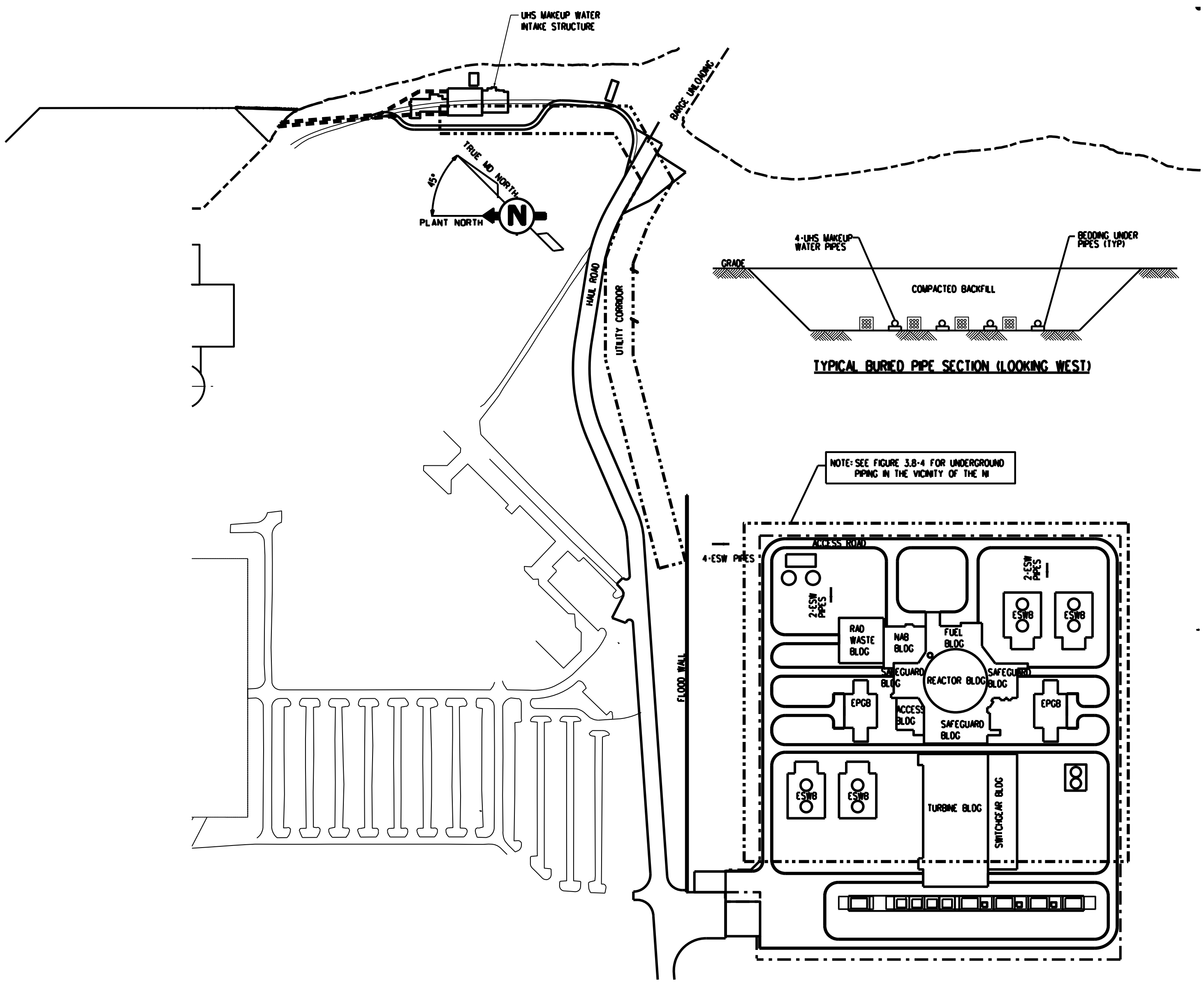


Figure 3.8-4 — {Schematic Site Plan of Seismic Category I Buried Utilities (Underground Piping)}

[Security Related Information - Withheld under 10 CFR 2.390. See Part 9 of the COL Application.]

Figure 3.8-5 — {Isometric View of the Basemat Finite Element Mesh (STAAD Pro Static Analysis Model) for the CWS Makeup Water Intake Structure, Forebay and UHS Makeup Water Intake Structure}

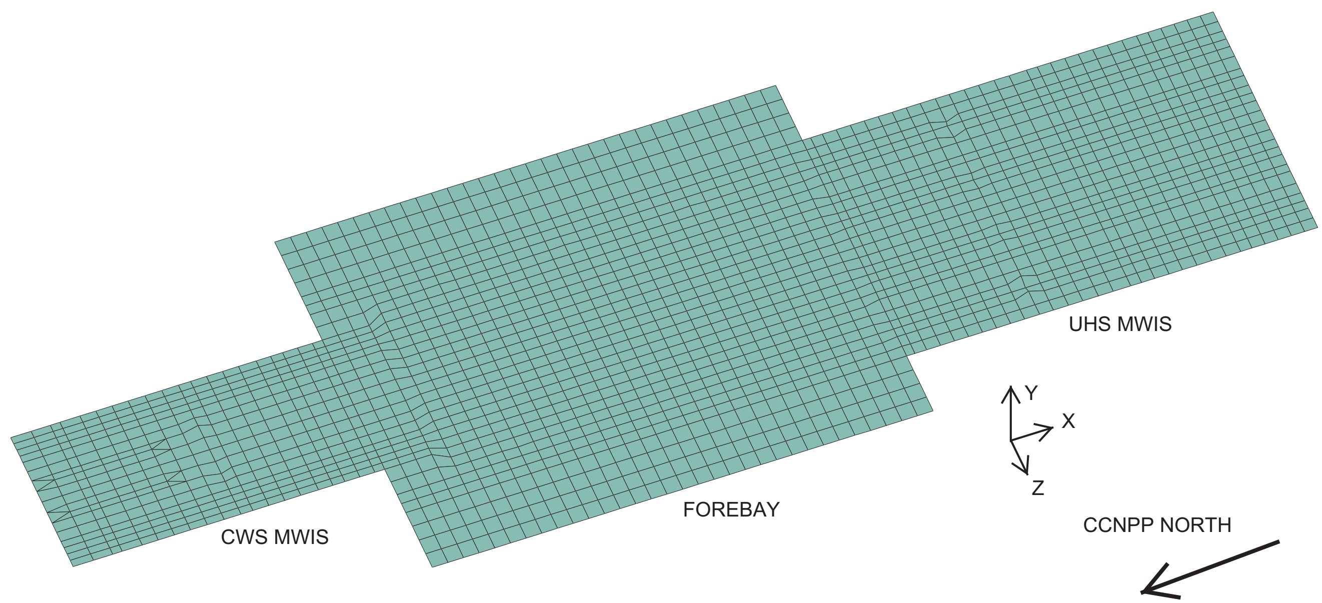


Figure 3.8-6 — {Conceptual Configuration of Waterproofing Membrane}

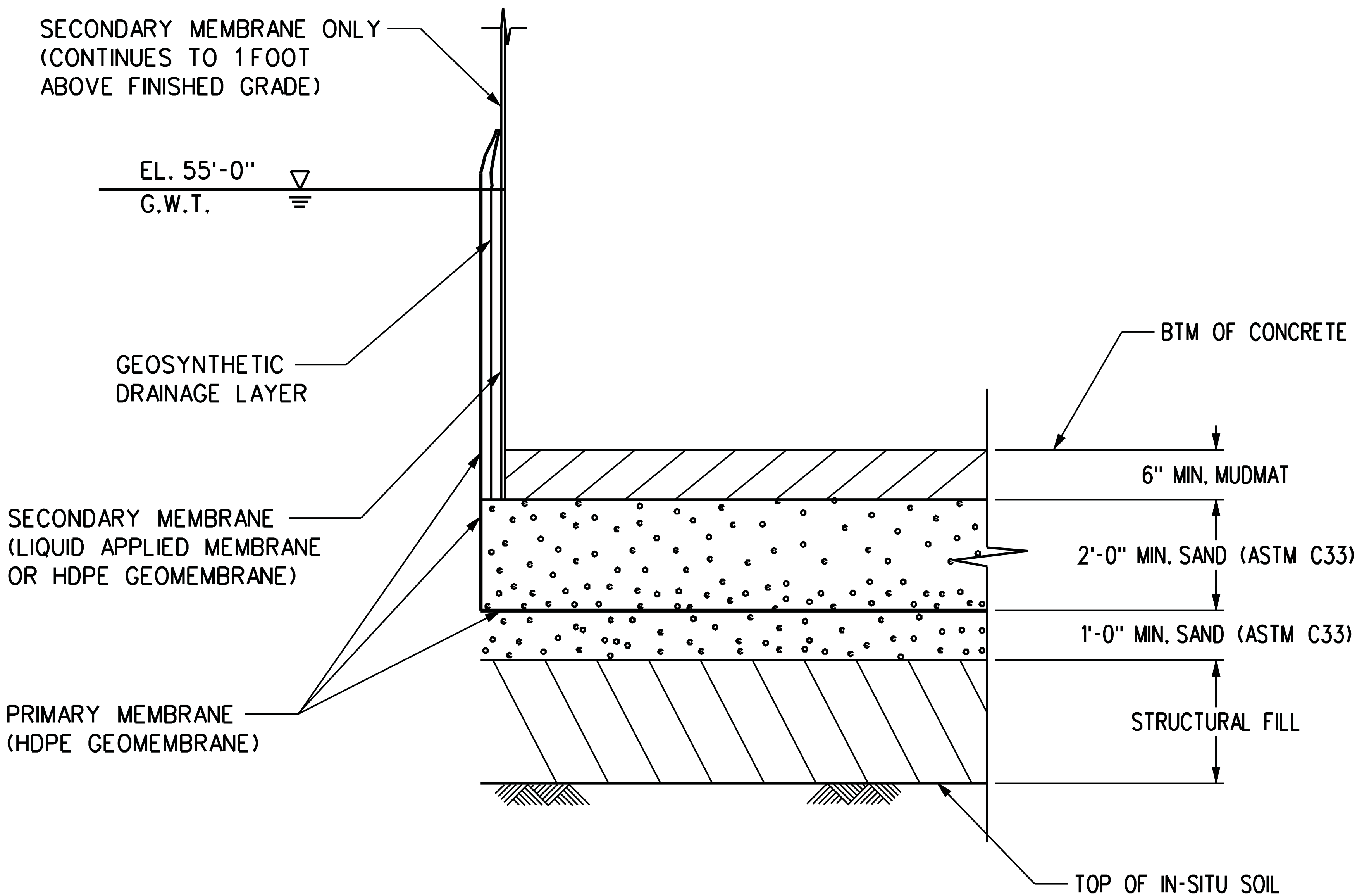
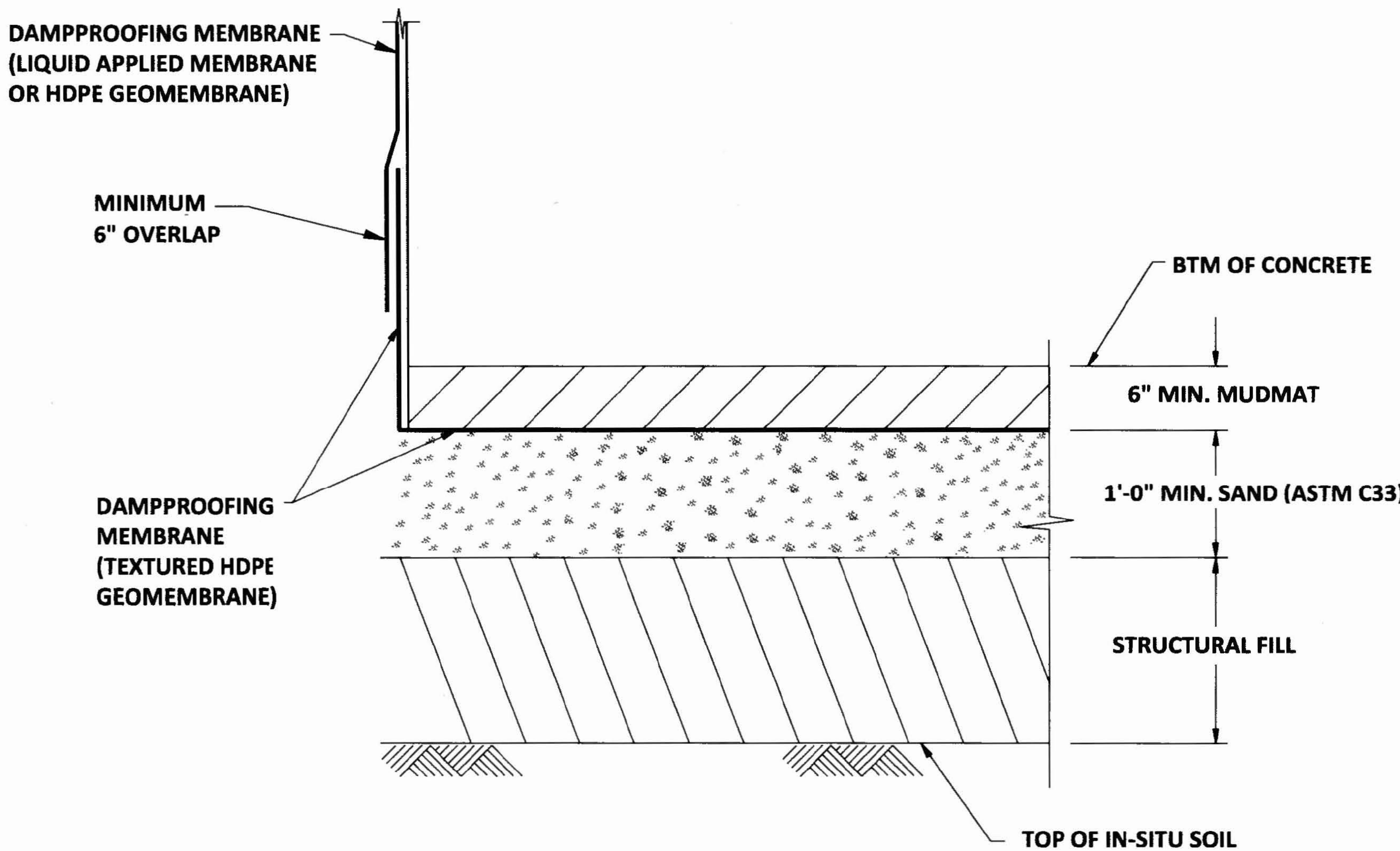


Figure 3.8-7 — {Conceptual Configuration of Dampproofing Membrane}



3.9 MECHANICAL SYSTEMS AND COMPONENTS

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

3.9.1 Special Topics for Mechanical Components

No departures or supplements.

3.9.1.1 Design Transients

No departures or supplements.

3.9.1.2 Computer Programs Used in Analyses

The U.S. EPR FSAR includes the following COL Items in Section 3.9.1.2:

> Pipe stress and support analysis will be performed by a COL applicant that references the U.S. EPR design certification.
>
> A COL applicant that references the U.S. EPR design certification will either use a piping analysis program based on the computer codes described in Section 3.9.1 and Appendix 3C or will implement a U.S. EPR benchmark program using models specifically selected for the U.S. EPR.

These COL Items are addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall perform the required pipe stress and support analysis and shall utilize a piping analysis program based on the computer codes described in U.S. EPR FSAR Section 3.9.1 and U.S. EPR FSAR Appendix 3C. {In addition, CCNPP Unit 3 will utilize the piping analysis program supplemented as follows:

- ♦ CE099

  The CE099 (Transient Analysis in Liquid Systems), version 5.0.1 (Build 261a), computer program calculates unsteady flow conditions in closed conduit liquid networks. The method of characteristics as applied to the one dimensional unsteady flow equations is utilized to compute the time variable pressure and flows throughout the network. Hydraulic devices typically encountered in piping networks such as pumps, valves, surge tanks, and other pipeline components are included in the model. It is required for work on cooling water systems, water supply pipelines, petrochemical plant systems, LNG systems, airport fuel loading systems, hydropower systems, and mining water and tailings pipelines.}

3.9.1.3 Experimental Stress Analysis

No departures or supplements.

3.9.1.4 Considerations for the Evaluation of the Faulted Condition

No departures or supplements.

3.9.1.5 References

No departures or supplements.

3.9.2 Dynamic Testing and Analysis of Systems, Components, and Equipment

No departures or supplements.

3.9.2.1 Piping Vibration, Thermal Expansion, and Dynamic Effects

No departures or supplements.

3.9.2.2 Seismic Analysis and Qualification of Seismic Category I Mechanical Equipment

No departures or supplements.

3.9.2.3 Dynamic Response Analysis of Reactor Internals Under Operational Flow Transients and Steady-State Conditions

No departures or supplements.

3.9.2.4 Preoperational Flow-Induced Vibration Testing of Reactor Internals

The U.S. EPR FSAR includes the following COL Item in Section 3.9.2.4:

> A COL applicant that references the U.S. EPR design certification will submit the results from the vibration assessment program for the U.S. EPR RPV internals, in accordance with Regulatory Guide 1.20.

In addition, Section 3.9.2.4 of Regulatory Guide 1.206 (NRC, 2007b) requests the following information for COL applicants with a prototype reactor:

> For a prototype reactor, if the FIV testing of reactor internals is incomplete at the time the COL application is filed, the applicant should provide documentation describing the implementation program, including milestones, completion dates and expected conclusions.

The COL Item and Regulatory Guide 1.206 request are addressed as follows:

{The U. S. EPR FSAR designates the Reactor Pressure Vessel (RPV) internals as a prototype design in accordance with the guidance of Regulatory Guide 1.20 (NRC, 2007a). The CCNPP Unit 3 RPV internals are currently classified as the U.S. EPR prototype for RPV internals testing. However, should a comprehensive vibration assessment program for an EPR unit other than CCNPP Unit 3 be completed and approved by the U.S Nuclear Regulatory Commission prior to initiation of start-up testing at CCNPP Unit 3, CCNPP Unit 3 will be reclassified as a non-prototype Category I RPV internals design and the associated experimental and/or analytical justification, including any required changes to the comprehensive vibration assessment program, will be provided to the U.S Nuclear Regulatory Commission for review and approval.

A methodology for the comprehensive vibration assessment program that the U.S. Nuclear Regulatory Commission considers acceptable for use is provided in Regulatory Guide 1.20 and shall be utilized at CCNPP Unit 3. For CCNPP Unit 3, performance of vibration testing during Hot

Functional Testing, and associated field testing, shall be as described in U.S. EPR FSAR Section 3.9.2.4 and U.S. EPR FSAR Section 14.2.11.

The visual inspection plan of the comprehensive vibration assessment program to be used for the prototype RPV internals at CCNPP Unit 3 involves performance of visual inspections before and after the preoperational tests of the RPV internals. These visual examinations are concerned with the accessible areas of the RPV internals, and in particular the fastening devices, the bearings surfaces, the interfaces between the RPV internals parts that are likely to experience relative motions, and the inside of the RPV. The visual inspections of the lower and upper RPV internals shall be performed at CCNPP Unit 3 as described in ANP-10306P.

The activities and milestones for implementation of the comprehensive vibration assessment program at CCNPP Unit 3 are as follows.

- A summary of the vibration analysis program, including a description of the vibration measurement and inspection phases, shall be provided to the U.S. Nuclear Regulatory Commission at least 120 days prior to initiation of Hot Functional Testing (i.e., 15 months prior to commercial operation).
- Visual inspections of the RPV internals shall be performed prior to initiation of Hot Functional Testing.
- Vibration testing shall be performed during Hot Functional Testing (i.e., 11 months prior to commercial operation).
- Visual inspections of the RPV internals shall be performed after completion of Hot Functional Testing.
- The preliminary and final comprehensive vibration assessment reports, which together summarize the results of the vibration analysis, measurement, and inspection programs (including correlation of analysis and test results), shall be submitted to the U.S. Nuclear Regulatory Commission at least 30 days prior to initial fuel loading (i.e., 9 months prior to commercial operation) and at least 30 days prior to initial criticality (i.e., 7 months prior to commercial operation), respectively. This schedule is within the Regulatory Guide 1.20 request to submit these reports within 60 and 180 days, respectively, following the completion of vibration testing.

These milestones are aligned with the milestones set forth in U. S. EPR FSAR Section 14.2 for the initial plant test program. The estimated date for the start of commercial operation at CCNPP Unit 3 is December 31, 2015.}

3.9.2.4.1 Exceptions to Regulatory Guide 1.20

No departures or supplements.

3.9.2.5 Dynamic System Analysis of the Reactor Internals Under Faulted Conditions

No departures or supplements.

3.9.2.6 Correlations of Reactor Internals Vibration Tests with the Analytical Results

No departures or supplements.

3.9.2.7 References

{**AREVA, 2013.** Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report. ANP-10306P, Revision 1, AREVA NP Inc., January 2013.

NRC, 2007a. Comprehensive Vibration Assessment Program for Reactor Internals during Preoperational And Initial Startup Testing, Regulatory Guide 1.20, Revision 3, U.S. Nuclear Regulatory Commission, March 2007.

NRC, 2007b. Combined License Applications for Nuclear Power Plants (LWR Edition), Regulatory Guide 1.206, Revision 0, U. S. Nuclear Regulatory Commission, June 2007.}

3.9.3 ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures

The U.S. EPR FSAR includes the following COL Item in Section 3.9.3:

> A COL applicant that references the U.S. EPR design certification will prepare the design specifications and design reports for site-specific ASME Class 1, 2, and 3 components, piping, supports, and core support structures that comply with and are certified to the requirements of Section III of the ASME Code. The design specification and design reports will address the results and conclusions from the reactor internals material reliability programs applicable to the U.S. EPR reactor internals with regard to known aging degradation mechanisms such as irradiation-assisted stress corrosion cracking and void swelling addressed in Section 4.5.2.1.

This COL Item is addressed as follows:

Design specifications will be prepared for NRC review and audit prior to the issuance of the COL for site-specific ASME Class 1, 2, and 3 components that comply with and are certified to the requirements of Section III of the ASME Code (ASME, 2004). Design reports will be prepared for site-specific ASME Class 1, 2, and 3 components. The design specifications or design reports will address the results and conclusions from the reactor internals material reliability programs applicable to the U.S. EPR reactor internals with regard to known aging degradation mechanisms such as irradiation-assisted stress corrosion cracking and void swelling addressed in Section 4.5.2.1 of the U.S. EPR FSAR.

{Conventional Seismic fire protection piping, designated as CS-I, will follow the same seismic analysis and seismic design methodology including seismic modeling, acceptance criteria and codes and standards, as described for ASME III, Class 3 Seismic Category I piping. Seismic input will be based on site-specific SSE. In addition, a functional capability check shall be performed per NUREG-1367. Pipe supports designated as CS-I will be designed per procedures and codes for Seismic Category II pipe supports.}

3.9.3.1 Loading Combinations, System Operating Transients, and Stress Limits

No departures or supplements.

3.9.3.1.1 Loads for Components, Component Supports, and Core Support Structures

The U.S. EPR FSAR includes the following COL Item in U.S. EPR FSAR Appendix 3F:

> As noted in U.S. EPR FSAR Appendix 3F, should a COL applicant that references the U.S. EPR design certification find it necessary to route Class 1, 2, and 3 piping not included in the U.S. EPR design certification so that it is exposed to wind, hurricane, and tornadoes, the design must withstand the plant design-bases loads for this event.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall route Class 1, 2, or 3 piping not included in the U.S. EPR design certification in a manner so that it is not exposed to wind, hurricane, or tornadoes.

The U.S. EPR FSAR includes the following COL Item in U.S. EPR FSAR Appendix 3F:

> As noted in U.S. EPR FSAR Appendix 3F, a COL applicant that references the U.S. EPR design certification will describe essential elements of a program to confirm that thermal deflections do not create adverse conditions during hot functional testing.

This COL Item is addressed as follows:

> The essential elements of a program to confirm that thermal deflections do not create adverse conditions during hot functional testing, consistent with NRC Bulletin 88-11, are described in the initial test program for the pressurizer surge line (Test #165 and Test #168 of U.S. EPR FSAR Tier 2, Section 14.2).

3.9.3.1.2 Load Combinations and Stress Limits for Class 1 Components

No departures or supplements.

3.9.3.1.3 Load Combinations and Stress Limits for Class 2 and 3 Components

No departures or supplements.

3.9.3.1.4 Load Combinations and Stress Limits for Class 1 Piping

No departures or supplements.

3.9.3.1.5 Load Combinations and Stress Limits for Class 2 and 3 Piping

No departures or supplements.

3.9.3.1.6 Load Combinations and Stress Limits for Core Support Structures

No departures or supplements.

3.9.3.1.7 Load Combinations and Stress Limits for Class 1, 2 and 3 Component Supports

No departures or supplements.

3.9.3.1.8 Load Combinations and Stress Limits for Class 1, 2 and 3 Pipe Supports

No departures or supplements.

3.9.3.1.9 Piping Functionality

No departures or supplements.

3.9.3.2 Design and Installation of Pressure-Relief Devices

No departures or supplements.

3.9.3.3 Pump and Valve Operability Assurance

No departures or supplements.

3.9.3.4 Component Supports

No departures or supplements.

3.9.3.5 References

{**ASME, 2004**. Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, Section III, The American Society of Mechanical Engineers, 2004 edition.

NRC, 1979. Cracking in Feedwater System Piping, NRC Bulletin 79-13, Revision 2, U.S. Nuclear Regulatory Commission, October 16, 1979.

NRC, 1992. Functional Capability of Piping Systems, NUREG-1367, Revision 0, U.S. Nuclear Regulatory Commission, November, 1992.}

3.9.4 Control Rod Drive System

No departures or supplements.

3.9.5 Reactor Pressure Vessel Internals

No departures or supplements.

3.9.6 Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

The U.S. EPR FSAR includes the following COL Items, respectively, in Section 3.9.6:

> A COL applicant that references the U.S. EPR design certification will submit the PST program and IST program for pumps, valves, and snubbers as required by 10 CFR 50.55a.
>
> A COL applicant that references the U.S. EPR design certification will identify the implementation milestones and applicable ASME OM Code for the preservice and inservice examination and testing programs. These programs will be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.

These COL Items are addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} will implement the preservice testing (PST) and inservice testing (IST) programs for pumps, valves, and dynamic restraints described in Section 3.9.6 of the U.S. EPR FSAR. Because of site specific needs, the following supplements will be included in the programs.

> {The UHS Makeup Water System is a site-specific safety-related system that is subject to PST and IST program requirements identified in 10 CFR 50.55a. This system's pumps, valves and piping components included in these testing programs are provided in Table 3.9-1 and Table 3.9-2. There are no snubbers in the UHS Makeup Water System.}

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall submit the PST and IST programs prior to performing the tests and following the start of construction and prior to the anticipated date of commercial operation, respectively. The implementation milestones for these programs are provided in Table 13.4-1. These programs shall include the implementation milestones and applicable ASME OM Code (ASME, 2004b) and shall be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.

3.9.6.1 Functional Design and Qualification of Pumps, Valves, and Dynamic Restraints

{The UHS Makeup Water System, including the individual components and the UHS Makeup Water Intake Structure, are designed, manufactured, tested, and installed in such fashion as to ensure and facilitate actual demonstration of design basis performance.

Component design considerations include function and performance requirements that support the overall system performance, as well as materials of construction, wear tolerances, and configuration that are selected to assure accommodation of service limits and the required component longevity. In addition, provisions are designed in as necessary for measuring or examining component characteristics such as vibration, bearing temperatures, or pressure boundary thickness, using either permanent or temporary equipment, to demonstrate during actual operating conditions that they are within the design tolerances.

Component manufacturing is accomplished in accordance with quality program requirements that verify component physical and material requirements. Pre-approved performance test procedures are used by the manufacturer to demonstrate/verify that actual component capabilities meet design requirements.

The UHS Makeup Water System layout is completed with consideration of maintenance and repair efforts, parameters to be monitored during operation, and periodic inspection and testing. Accordingly, sufficient space is allocated around components, system test connections are accessible, and the test bypass line is designed specifically for demonstration of the system's maximum flow rate at design conditions as specified in the plant accident analyses. There are no snubbers incorporated into this system.

The UHS Makeup Water System pumps, valves and piping components will incorporate the necessary test and monitoring connections to demonstrate the capacity of the pumps and valves to perform their intended function through the full range of system differential pressures and flows at ambient temperatures and available voltages.

Particular attention will be given to flow-induced loading in functional design and qualification to degraded flow conditions to account for the presence of debris, impurities, and contaminants in the fluid system.}

3.9.6.2 Inservice Testing Program for Pumps

The U.S. EPR FSAR includes the following COL Items in Section 3.9.6.2:

> A COL applicant that references the U.S. EPR design certification will identify any additional site-specific pumps in Table 3.9.6-1 to be included within the scope of the IST program.

This COL Item is addressed as follows:

Table 3.9-1 identifies the additional site-specific pumps that are included within the scope of the IST program.

3.9.6.3 Inservice Testing Program for Valves

The U.S. EPR FSAR includes the following COL Items in Section 3.9.6.3:

> A COL applicant that references the U.S. EPR design certification will identify any additional site-specific valves in Table 3.9.6-2 to be included within the scope of the IST program.

This COL Item is addressed as follows:

Table 3.9-2 identifies the additional site-specific valves that are included within the scope of the IST program.

In addition, the following supplement to U.S. EPR FSAR Section 3.9.6.3 is provided:

{The UHS Makeup Water System Class 3 site-specific valves (motor-operated, manually-operated, check, safety, and relief valves) will be tested in accordance with ASME OM 2004 code, section ISTC (ASME, 2004b).}

3.9.6.3.1 Inservice Testing Program for Motor-Operated Valves

No departures or supplements.

3.9.6.3.2 Inservice Testing Program for Power-Operated Valves Other Than MOVs

{There are no power-operated valves in the UHS Makeup Water System, other than the MOVs.}

3.9.6.3.3 Inservice Testing Program for Check Valves

No departures or supplements.

3.9.6.3.4 Pressure Isolation Valve Leak Testing

No departures or supplements.

3.9.6.3.5 Containment Isolation Valve Leak Testing

{There are no Class 3 site-specific containment isolation valves in the UHS Makeup Water System.}

3.9.6.3.6 Inservice Testing Program for Safety and Relief Valves

No departures or supplements.

3.9.6.3.7 Inservice Testing Program for Manually Operated Valves

No departures or supplements.

3.9.6.3.8 Inservice Testing Program for Explosively Actuated Valves

{There are no Class 3 site-specific explosively actuated valves in the UHS Makeup Water System.}

3.9.6.4 Inservice Testing Program for Dynamic Restraints

The U.S. EPR FSAR includes the following COL Item in Section 3.9.6.4:

> A COL applicant that references the U.S. EPR design certification will provide a table identifying the safety-related systems and components that use snubbers in their support systems, including the number of snubbers, type (hydraulic or mechanical), applicable standard, and function (shock, vibration, or dual-purpose snubber). For snubbers identified as either a dual-purpose or vibration arrester type, the COL applicant shall indicate whether the snubber or component was evaluated for fatigue strength.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall provide a table identifying the safety-related systems and components that use snubbers in their support systems, including the number of snubbers, type (hydraulic or mechanical), applicable standard, and function (shock, vibration, or dual-purpose snubber). For snubbers identified as either a dual-purpose or vibration arrester type, {Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall denote whether the snubber or component was evaluated for fatigue strength. This information shall be provided prior to installation of any of the snubbers.

{The UHS Makeup Water System does not incorporate snubbers in the system design.}

3.9.6.5 Relief Requests and Alternative Authorizations to the OM Code

No departures or supplements.

3.9.6.6 References

{ASME, 2004a. Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, Section III, The American Society of Mechanical Engineers, 2004 edition.

ASME, 2004b. Code for Operation and Maintenance of Nuclear Power Plants, ASME OM Code, The American Society of Mechanical Engineers, 2004 edition.}

Table 3.9-1 — {Site-Specific Inservice Pump Testing Program Requirements}

Pump ID [8]	Description	Pump Type	ASME Code Class	ASME Code Group	Testing and Frequency [6, 9]				
					Rotational Speed [4]	Pump Discharge Pressure [2]	Differential Pressure	Flow Rate	Vibration[5]
30PED 10 AP001 A	Ultimate Heat Sink (UHS) Makeup Water Pump	Vertical Solid Shaft	3	B	N/A[1]	N/A	Q/2Y	Q/2Y	Q/2Y
30PED 20 AP001 A	Ultimate Heat Sink (UHS) Makeup Water Pump	Vertical Solid Shaft	3	B	N/A[1]	N/A	Q/2Y	Q/2Y	Q/2Y
30PED 30 AP001 A	Ultimate Heat Sink (UHS) Makeup Water Pump	Vertical Solid Shaft	3	B	N/A[1]	N/A	Q/2Y	Q/2Y	Q/2Y
30PED 40 AP001 A	Ultimate Heat Sink (UHS) Makeup Water Pump	Vertical Solid Shaft	3	B	N/A[1]	N/A	Q/2Y	Q/2Y	Q/2Y

Notes:

1. Pump is directly coupled to a constant speed synchronous or induction type driver.
2. Discharge pressure is a required parameter for positive displacement pumps only.
3. dP is not a required parameter for positive displacement pumps (not applicable to site-specific UHS Makeup Water Intake System).
4. Variable speed pumps only.
5. Displacement or velocity.
6. Test and their frequency are in accordance with subsection ISTB of ASME OM code.
7. This test does not apply to positive displacement pumps (not applicable to site-specific UHS Makeup Water System).
8. The U. S. EPR subscribes to the Kraftworks Kennzeichen System (KKS) for coding and nomenclature of SSCs.
9. Group B pumps go through a Quarterly Group B Test Procedure (ISTB-5122) and biennially Comprehensive test (ISTB-5123).

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}
(Page 1 of 7)

Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments
Essential Service Water (ESW) System - Train 1										
30PEB15A A001	ESW Basin External Access Piping Isolation Valve Train 1	GT	MA	N/A	B	P	C	ET PI	2Y 2Y	(Note 13)
30PEB15A A401	ESW Basin External Access Piping Drain Valve Train 1	GB	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
30PEB15A A501	ESW Basin External Access Piping Vent Valve Train 1	GT	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
Essential Service Water (ESW) System - Train 2										
30PEB25A A001	ESW Basin External Access Piping Isolation Valve Train 2	GT	MA	N/A	B	P	C	ET PI	2Y 2Y	(Note 13)
30PEB25A A401	ESW Basin External Access Piping Drain Valve Train 2	GB	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
30PEB25A A501	ESW Basin External Access Piping Vent Valve Train 2	GT	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
Essential Service Water (ESW) System - Train 3										
30PEB35A A001	ESW Basin External Access Piping Isolation Valve Train 3	GT	MA	N/A	B	P	C	ET PI	2Y 2Y	(Note 13)
30PEB35A A401	ESW Basin External Access Piping Drain Valve Train 3	GB	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
30PEB35A A501	ESW Basin External Access Piping Vent Valve Train 3	GT	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
Essential Service Water (ESW) System - Train 4										
30PEB45A A001	ESW Basin External Access Piping Isolation Valve Train 4	GT	MA	N/A	B	P	C	ET PI	2Y 2Y	(Note 13)
30PEB45A A401	ESW Basin External Access Piping Drain Valve Train 4	GB	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)
30PEB45A A501	ESW Basin External Access Piping Vent Valve Train 4	GT	MA	N/A	B	P	O	ET PI	2Y 2Y	(Note 13)

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}
(Page 2 of 7)

Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments
Ultimate Heat Sink (UHS) Makeup Water System - Train 1										
30PED10AA002A	UHS Makeup Water Pump Minimum Flow Valve Train 1	BF	MO	3	B	A	C	ET PI	Q 2Y	
30PED10AA190A	UHS Makeup Water Pump Air Release/ Vacuum Breaker Valve Train 1	RV	SA	3	A/C	A	O/C	ET LT	2Y 2Y	(Note 12)
30PED10AA201A	UHS Makeup Water Pump Discharge Check Valve Train 1	CK	SA	3	C	A	O	ET	Q	
30PED10AA001A	UHS Makeup Water Pump Discharge Isolation Valve Train 1	BF	MO	3	B	A	O	ET PI	Q 2Y	
30PED10AA008A	UHS Makeup Water Test Bypass Isolation Valve Train 1	GT	MA	3	B	P	C	ET PI	2Y 2Y	(Note 13)
30PED10AA006A	UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 1	GT	MO	3	B	A	C	ET PI	Q 2Y	
30PED10AA003A	UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 1	BF	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED10AA005A	UHS Makeup Water Traveling Screen Wash Isolation Valve Train 1	GT	MO	3	B	A	O	ET PI	Q 2Y	
30PED10AA007A	UHS Makeup Water Traveling Screen Wash Throttling Valve Train 1	GB	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED10AA029A	POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 1	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED10AA223A	POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 1	CK	SA	3	C	A	O/C	ET	Q	
30PED10AA028A	UHS Makeup Keep-Fill Line Isolation Valve Train 1	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED10AA222A	UHS Makeup Keep-Fill Line Check Valve Train 1	CK	SA	3	C	A	O/C	ET	Q	

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}

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Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive [6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments
Ultimate Heat Sink (UHS) Makeup Water System - Train 2										
30PED20AA002A	UHS Makeup Water Pump Minimum Flow Valve Train 2	BF	MO	3	B	A	C	ET PI	Q 2Y	
30PED20AA190A	UHS Makeup Water Pump Air Release/ Vacuum Breaker Valve Train 2	RV	SA	3	A/C	A	O/C	ET LT	2Y 2Y	(Note 12)
30PED20AA201A	UHS Makeup Water Pump Discharge Check Valve Train 2	CK	SA	3	C	A	O	ET	Q	
30PED20AA001A	UHS Makeup Water Pump Discharge Isolation Valve Train 2	BF	MO	3	B	A	O	ET PI	Q 2Y	
30PED20AA008A	UHS Makeup Water Test Bypass Isolation Valve Train 2	GT	MA	3	B	P	C	ET PI	2Y 2Y	(Note 13)
30PED20AA006A	UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 2	GT	MO	3	B	A	C	ET PI	Q 2Y	
30PED20AA003A	UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 2	BF	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED20AA005A	UHS Makeup Water Traveling Screen Wash Isolation Valve Train 2	GT	MO	3	B	A	O	ET PI	Q 2Y	
30PED20AA007A	UHS Makeup Water Traveling Screen Wash Throttling Valve Train 2	GB	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED20AA029A	POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 2	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED20AA223A	POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 2	CK	SA	3	C	A	O/C	ET	Q	
30PED20AA028A	UHS Makeup Keep-Fill Line Isolation Valve Train 2	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED20AA222A	UHS Makeup Keep-Fill Line Check Valve Train 2	CK	SA	3	C	A	O/C	ET	Q	

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}

(Page 4 of 7)

Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments
Ultimate Heat Sink (UHS) Makeup Water System - Train 3										
30PED30AA002A	UHS Makeup Water Pump Minimum Flow Valve Train 3	BF	MO	3	B	A	C	ET PI	Q 2Y	
30PED30AA190A	UHS Makeup Water Pump Air Release/ Vacuum Breaker Valve Train 3	RV	SA	3	A/C	A	O/C	ET LT	2Y 2Y	(Note 12)
30PED30AA201A	UHS Makeup Water Pump Discharge Check Valve Train 3	CK	SA	3	C	A	O	ET	Q	
30PED30AA001A	UHS Makeup Water Pump Discharge Isolation Valve Train 3	BF	MO	3	B	A	O	ET PI	Q 2Y	
30PED30AA008A	UHS Makeup Water Test Bypass Isolation Valve Train 3	GT	MA	3	B	P	C	ET PI	2Y 2Y	(Note 13)
30PED30AA006A	UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 3	GT	MO	3	B	A	C	ET PI	Q 2Y	
30PED30AA003A	UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 3	BF	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED30AA005A	UHS Makeup Water Traveling Screen Wash Isolation Valve Train 3	GT	MO	3	B	A	O	ET PI	Q 2Y	
30PED30AA007A	UHS Makeup Water Traveling Screen Wash Throttling Valve Train 3	GB	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED30AA029A	POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 3	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED30AA223A	POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 3	CK	SA	3	C	A	O/C	ET	Q	
30PED30AA028A	UHS Makeup Keep-Fill Line Isolation Valve Train 3	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED30AA222A	UHS Makeup Keep-Fill Line Check Valve Train 3	CK	SA	3	C	A	O/C	ET	Q	

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}
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Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments
Ultimate Heat Sink (UHS) Makeup Water System - Train 4										
30PED40AA002A	UHS Makeup Water Pump Minimum Flow Valve Train 4	BF	MO	3	B	A	C	ET PI	Q 2Y	
30PED40AA190A	UHS Makeup Water Pump Air Release/ Vacuum Breaker Valve Train 4	RV	SA	3	A/C	A	O/C	ET LT	2Y 2Y	(Note 12)
30PED40AA201A	UHS Makeup Water Pump Discharge Check Valve Train 4	CK	SA	3	C	A	O	ET	Q	
30PED40AA001A	UHS Makeup Water Pump Discharge Isolation Valve Train 4	BF	MO	3	B	A	O	ET PI	Q 2Y	
30PED40AA008A	UHS Makeup Water Test Bypass Isolation Valve Train 4	GT	MA	3	B	P	C	ET PI	2Y 2Y	(Note 13)
30PED40AA006A	UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 4	GT	MO	3	B	A	C	ET PI	Q 2Y	
30PED40AA003A	UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 4	BF	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED40AA005A	UHS Makeup Water Traveling Screen Wash Isolation Valve Train 4	GT	MO	3	B	A	O	ET PI	Q 2Y	
30PED40AA007A	UHS Makeup Water Traveling Screen Wash Throttling Valve Train 4	GB	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED40AA029A	POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 4	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED40AA223A	POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 4	CK	SA	3	C	A	O/C	ET	Q	
30PED40AA028A	UHS Makeup Keep-Fill Line Isolation Valve Train 4	GT	MA	3	B	P	O	ET PI	2Y 2Y	(Note 13)
30PED40AA222A	UHS Makeup Keep-Fill Line Check Valve Train 4	CK	SA	3	C	A	O/C	ET	Q	
Miscellaneous Manual Valves										
Later	UHS Makeup Water System Manual Valves	Various	MA	3	B	P	O/C	ET PI	2Y 2Y	(Note 13)

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}
(Page 6 of 7)

Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments

Notes:

1. The U. S. EPR subscribes to the Kraftworks Kennzeichen System (KKS) for coding and nomenclature of SSCs.

2. Valve Type
GB – Globe
GT – Gate
CK – Check
RV – Relief
RD – Rupture Disk
DI – Diaphragm
BF – Butterfly
PL – Plug

3. Valve Actuator
MO – Motor-operated
SO – Solenoid-operated
AO – Air-operated
HO – Hydraulic-operated
SA – Self-actuated
MA – Manual
PA – Pilot-actuated

4. ASME Code Class as determined by quality groups from Regulatory 1.26.

5. ASME Code Category A, B, C, D as defined in ASME OM Code 2004, Subsection ISTC-1300

6. ASME functional category as defined in ASME OM Code 2004, Subsection ISTA-2000

7. Valve safety function position(s), specify both positions for valves that perform a safety function in both the open and closed positions. Valves are exercised to the position (s) required to fulfill their safety function(s). Check valve tests include both open and closed tests.

8. Required tests per ASME OM Code 2004, Subsection ISTC-3000
LT – Leakage test per Table ISTC-3500-1 and ISTC-3000
ET – Exercise test per Table ISTC-3500-1 and ISTC-3510-1, nominally every 3 months
PI – Position indication verification per Table ISTC-3500-1 and ISTC-3700
ST – Stroke time test per ISTC-5000 (in conjunction with exercise test), as applicable.

Table 3.9-2 — {Site-Specific Inservice Valve Testing Program Requirements}
(Page 7 of 7)

Valve Identification Number [1]	Description /Valve Function	Valve Type [2]	Valve Actuator [3]	ASME Code Class [4]	ASME OM Code Category [5]	Active/ Passive[6]	Safety Position [7]	Test Required [8, 11]	Test Frequency [9]	Comments

9. Test frequencies abbreviations per NUREG-1482, Revision 1:
   Q test performed once every 92 days
   CS – test performed during cold shutdown, but no more frequently than once every 92 days
   RF – test performed each refueling outage
   2Y – test performed once every 2 years
   5Y – test performed once every 5 years (per ASME OM, ISTC-3540)
   10Y – test performed once every 10 years
   RV – test relief valve at OM schedule.

10. Deleted.

11. The switch for a fail-safe valve functions by interrupting (de-energizing) the electrical or pneumatic actuating force for the valve whenever the switch is moved to the fail-safe position. Therefore, this normal valve operation demonstrates the valve's fail-safe capability, which is verified during valve exercise testing by remote position indication. Since a successful exercise test satisfies a valve's fail-safe testing requirements, a separate test for fail-safe capability is not required and is not specified in this table.

12. Air Release/Vacuum Breaker valves are leak tested every two years in accordance with ASME OM Code Mandatory Appendix I, paragraph I-1380.

13. The manual valves identified with position indication (PI) as a Required Test that do not have remote position indication at a control panel will be verified locally by direct observation of the valve stem or use other indications to verify position.

3.10 SEISMIC AND DYNAMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

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

For CCNPP Unit 3, seismic and dynamic qualification of mechanical and electrical equipment (identified in Table 3.10-1) includes equipment associated with the:

- UHS Makeup Water System, including the UHS Makeup Water Intake Structure; and
- Fire Protection System components that are required to protect equipment required to achieve safe shutdown following an earthquake, including the Fire Protection Building and Fire Water Storage Tanks.

Results of seismic and dynamic qualification of equipment by testing and/or analysis were not available at the time of submittal of the original COL application. Thus, in conformance with NRC Regulatory Guide 1.206 (NRC, 2007), a seismic qualification implementation program is provided. As depicted in Table 3.10-2, the qualification program will be implemented in five major phases.

Phase I (Seismic Qualification Methodology) involves the development of a summary table for equipment. This summary table shall:

- List equipment, along with the associated equipment identification number.
- Define the building in which each equipment is located, along with the equipment mounting elevation.
- Clarify whether the equipment is wall mounted, floor mounted, or line mounted.
- For mechanical equipment, identify if the equipment is active or passive.
- Provide a description of the intended mounting (e.g., skid mounted versus mounted directly on the floor, welded versus bolted, etc.).
- List the applicable In-Structure Response Spectra or, for line mounted equipment, the required input motion.
- Define operability and functionality requirements.
- Identify the acceptable qualification methods (i.e., analysis, testing, and/or a combination of both).
- Provide a requirement for environmental testing prior to seismic testing, when applicable.

The basis and criteria established in Phase I shall be used as technical input to the Phase II (Specification Development) technical requirements that will be provided to bidders. In addition, the specification will include the applicable seismic qualification requirements of the U.S. EPR FSAR which are incorporated by reference in this section (e.g., invoking industry standard IEEE 344).

The technical specification developed in Phase II shall also outline the requirements for the submittal (with each bidder's proposal) of either a detailed seismic qualification methodology or, for cases where seismic analysis and/or testing has previously been performed, the seismic qualification report. The seismic qualification methodology for each bidder shall be required to carry the overall methodology of Phase I to a much more detailed level. As examples, the detailed methodology shall be required to address:

- ♦ Which portions of the equipment will be qualified by analysis, testing and/or a combination of both, with technical justification.
- ♦ The technical justification when other than bi-axial, phase incoherent test input motions (or multiple input-motions in-phase and 180 degrees out-of-phase) are used for floor mounted equipment.

Early in the Procurement Phase, Phase III (Technical Bid Evaluations) shall be performed. The scope of Phase III will vary depending on whether the proposed seismic qualification for the specific piece of equipment will utilize analysis and/or testing performed previously. For each case where seismic qualification (by either analysis and/or testing) has not been performed, the detailed methodology shall be compared with the technical specification requirements. For each case where seismic qualification has been performed previously and the reports are submitted with the proposal, the Technical Bid Evaluation shall consist of a detailed review of the seismic qualification report, including a comparison of the detailed methodology employed versus the technical specification requirements. The technical review shall be performed expeditiously to mitigate the potential for anomalies (e.g., those pertaining to test equipment calibration) to be identified late in the Procurement cycle. When applicable, Requests for Clarification (RFC) shall be provided to the bidder for resolution of anomalies. If, after vendor clarification, the existing qualification report is determined to be insufficient technically, additional analysis and/or testing may be required.

During Phase IV (New Seismic Analysis and/or Testing), the supplier shall perform new analysis and/or testing, to either seismically qualify the equipment or, if a previously submitted qualification report is determined to be insufficient, to supplement the previously submitted seismic qualification. The analysis (or analysis portion of combined analysis and test seismic qualification) shall be reviewed in detail, to assure compliance with the technical specification requirements. Where testing is to be employed, a detailed review of the test procedure shall be performed at least one month prior to the test. New testing will be independently observed to assure conformance with the reviewed test procedure.

Phase V (Documentation of Results) shall consist of the preparation of a Seismic Qualification Data Package (SQDP) for each piece of equipment seismically qualified. As a minimum, the SQDP will include information required in the U.S. EPR FSAR, Appendix D, Attachment F.}

3.10.1 Seismic Qualification Criteria

3.10.1.1 Qualification Standards

The U.S. EPR FSAR includes the following COL Item in Section 3.10.1.1:

> A COL applicant that references the U. S. EPR design certification will identify any additional site-specific components that need to be added to the equipment list in Table 3.10-1.

This COL Item is addressed as follows:

A list of site-specific seismically and dynamically qualified mechanical, electrical, and instrumentation and control equipment is provided in Table 3.10-1. Table 3.10-1 also identifies the type of environment to which the equipment is subjected.

{The Fire Protection components designated as CS-I in Table 3.10-1 are seismically qualified to remain functional using methods and procedures as described above for Seismic Category I components.}

3.10.1.2 Performance Requirements for Seismic Qualification

No departures or supplements.

3.10.1.3 Acceptance Criteria

No departures or supplements.

3.10.1.4 Input Motion

{See Section 3.10.}

3.10.2 Methods and Procedures for Qualifying Mechanical, Electrical and I&C Equipment

No departures or supplements.

3.10.3 Methods and Procedures for Qualifying Supports of Mechanical and Electrical Equipment and Instrumentation

No departures or supplements.

3.10.4 Test and Analysis Results and Experience Database

The U.S. EPR FSAR includes the following COL Item in Section 3.10.4:

> If the seismic and dynamic qualification testing is incomplete at the time of the COL application, a COL applicant that references the U.S. EPR design certification will submit an implementation program, including milestones and completion dates, for NRC review and approval prior to installation of the applicable equipment.

This COL Item is addressed as follows:

The seismic and dynamic qualification implementation program, including milestones and completion dates, shall be developed and submitted for U.S. Nuclear Regulatory Commission approval prior to installation of the applicable equipment.

3.10.5 References

{**NRC, 2007.** Combined License Applications for Nuclear Power Plants, Regulatory Guide 1.206, Revision 0, U.S. Nuclear Regulatory Commission, June 2007.}

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 1 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Essential Service Water (ESW) System									
Train 1									
ESW Basin External Access Piping Isolation Valve Train 1	30PEB15 AA001	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Drain Valve Train 1	30PEB15 AA401	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Vent Valve Train 1	30PEB15 AA501	31URB02001	M	M	-	CS-1	NS-AQ		Y(5)
Train 2									
ESW Basin External Access Piping Isolation Valve Train 2	30PEB25 AA001	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Drain Valve Train 2	30PEB25 AA401	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Vent Valve Train 2	30PEB25 AA501	32URB02001	M	M	-	CS-1	NS-AQ		Y(5)
Train 3									
ESW Basin External Access Piping Isolation Valve Train 3	30PEB35 AA001	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Drain Valve Train 3	30PEB35 AA401	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Vent Valve Train 3	30PEB35 AA501	33URB02001	M	M	-	CS-1	NS-AQ		Y(5)
Train 4									
ESW Basin External Access Piping Isolation Valve Train 4	30PEB45 AA001	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Drain Valve Train 4	30PEB45 AA401	30UZT	M	M	-	CS-1	NS-AQ		Y(5)
ESW Basin External Access Piping Vent Valve Train 4	30PEB45 AA501	34URB02001	M	M	-	CS-1	NS-AQ		Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 2 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Ultimate Heat Sink (UHS) Makeup System									
Train 1									
UHS Makeup Water Pump Train 1	30PED10AP001	30UPF01001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Motor Train 1	30PED10AP001	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Root Valve Train 1	30PED10AA303	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Train 1	30PED10CP001	30UPF02001	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 1 Train 1	30PED10AA307	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Flow Element/Instrument Train 1	30PED10CF003	30UPF02001	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 2 Train 1	30PED10AA308	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Train 1	30PED10AA002	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 1	30PED10AA002	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Line Orifice Plate Train 1	-	30UPF02001	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Vent Valve Train 1	30PED10AA301	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Isolation Valve Train 1	30PED10AA302	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve Train 1	30PED10AA190	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Check Valve Train 1	30PED10AA201	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Train 1	30PED10AA001	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Motor Actuator Train 1	30PED10AA001	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
(Page 3 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Low Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 1	30PED10AA304	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 1	30PED10CP002	30UPF02001	M	M	ES	SI	S		Y(5)
High Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 1	30PED10AA305	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Train 1	30PED10AT001	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 1	30PED10AT001	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Drain Valve 1 Train 1	30PED10AA405	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Drain Valve 2 Train 1	30PED10AA406	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 1	30PED10AA006	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 1	30PED10AA006	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 1	30PED10AA003	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Sample Connection Valve Train 1	30PED10AA601	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 1	-	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 1	-	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Air Cooled Condenser (ACC) Train 1	-	30UPF03001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Fan Motor Train 1	-	30UPF03001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Compressor Motor Train 1	-	30UPF03001	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
(Page 4 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Building Safety Related Dampers Train 1	-	-	M	M	ES	SI	S	C/NM	Y(5)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 1	-	30UPF02001	M	M	ES	SI	S		Y(5)
Low Side Root Valve for ΔP Measurement Across AHU Filter Train 1	-	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
High Side Root Valve for ΔP Measurement Across AHU Filter Train 1	-	30UPF02001	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 1	-	30UPF02001	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 1	-	-	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Safety Related Tornado Dampers (All) Train 1	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Train 1	30PED10AA005	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Actuator Train 1	30PED10AA005	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Train 1	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Motor Train 1	-	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Throttling Valve Train 1	30PED10AA007	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 1	30PED10CP003	30UPF03011	M	M	ES	SI	S		Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Root Valve Train 1	30PED10AA306	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 1	-	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Train 1	-	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 1	-	30UPF03011	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 1	-	30UPF03011	M	M	ES	SI	S		Y(5)
UHS Makeup Water Intake Structure Level Measurement (All) Train 1	-	-	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Orifice Train 1		31UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 1	30PED10AA029	31UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 1	30PED10AA223	31UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Isolation Valve Train 1	30PED10AA028	31UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Check Valve Train 1	30PED10AA222	31UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Water Test Bypass Isolation Valve Train 1	30PED10AA008	31UQB	M	M	ES	SI	S		Y (5)
Train 2									
UHS Makeup Water Pump Train 2	30PED20AP001	30UPF01002	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Motor Train 2	30PED20AP001	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Root Valve Train 2	30PED20AA303	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Train 2	30PED20CP001	30UPF02004	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 1 Train 2	30PED20AA307	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Flow Element/Instrument Train 2	30PED20CF003	30UPF02004	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 2 Train 2	30PED20AA308	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Train 2	30PED20AA002	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 2	30PED20AA002	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Line Orifice Plate Train 2	-	30UPF02004	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Vent Valve Train 2	30PED20AA301	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Isolation Valve Train 2	30PED20AA302	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve Train 2	30PED20AA190	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Check Valve Train 2	30PED20AA201	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Train 2	30PED20AA001	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Motor Actuator Train 2	30PED20AA001	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
Low Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 2	30PED20AA304	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 2	30PED20CP002	30UPF02004	M	M	ES	SI	S		Y(5)
High Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 2	30PED20AA305	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Train 2	30PED20AT001	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 2	30PED20AT001	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Drain Valve 1 Train 2	30PED20AA405	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Drain Valve 2 Train 2	30PED20AA406	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 2	30PED20AA006	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 2	30PED20AA006	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 2	30PED20AA003	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Sample Connection Valve Train 2	30PED20AA601	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 2	-	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 2	-	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Air Cooled Condenser (ACC) Train 2	-	30UPF03004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Fan Motor Train 2	-	30UPF03004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Compressor Motor Train 2	-	30UPF03004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Safety Related Dampers Train 2	-	-	M	M	ES	SI	S	C/NM	Y(5)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 2	-	30UPF02004	M	M	ES	SI	S		Y(5)
Low Side Root Valve for ΔP Measurement Across AHU Filter Train 2	-	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
High Side Root Valve for ΔP Measurement Across AHU Filter Train 2	-	30UPF02004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 2	-	30UPF02004	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 2	-	-	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Safety Related Tornado Dampers (All) Train 2	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Train 2	30PED20AA005	30UPF03012	M	M	-	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Actuator Train 2	30PED20AA005	30UPF03012	M	M	-	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Train 2	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Motor Train 2	-	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Throttling Valve Train 2	30PED20AA007	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 2	30PED20CP003	30UPF03012	M	M	ES	SI	S		Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Root Valve Train 2	30PED20AA306	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 2	-	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Train 2	-	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 2	-	30UPF03012	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 2	-	30UPF03012	M	M	ES	SI	S		Y(5)
UHS Makeup Water Intake Structure Level Measurement (All) Train 2	-	-	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Orifice Train 2	-	32UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 2	30PED20AA029	32UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 2	30PED20AA223	32UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Isolation Valve Train 2	30PED20AA028	32UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Check Valve Train 2	30PED20AA222	32UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Water Test Bypass Isolation Valve Train 2	30PED20AA008	32UQB	M	M	ES	SI	S		Y (5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 9 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Train 3									
UHS Makeup Water Pump Train 3	30PED30AP001	30UPF01003	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Motor Train 3	30PED30AP001	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Root Valve Train 3	30PED30AA303	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Train 3	30PED30CP001	30UPF02006	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 1 Train 3	30PED30AA307	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Flow Element/Instrument Train 3	30PED30CF003	30UPF02006	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 2 Train 3	30PED30AA308	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Train 3	30PED30AA002	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 3	30PED30AA002	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Line Orifice Plate Train 3	-	30UPF02006	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Vent Valve Train 3	30PED30AA301	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Isolation Valve Train 3	30PED30AA302	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve Train 3	30PED30AA190	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Check Valve Train 3	30PED30AA201	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Train 3	30PED30AA001	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Motor Actuator Train 3	30PED30AA001	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 10 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Low Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 3	30PED30AA304	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 3	30PED30CP002	30UPF02006	M	M	ES	SI	S		Y(5)
High Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 3	30PED30AA305	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Train 3	30PED30AT001	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 3	30PED30AT001	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Drain Valve 1 Train 3	30PED30AA405	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Drain Valve 2 Train 3	30PED30AA406	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 3	30PED30AA006	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 3	30PED30AA006	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 3	30PED30AA003	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Sample Connection Valve Train 3	30PED30AA601	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 3	-	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 3	-	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Air Cooled Condenser (ACC) Train 3	-	30UPF03006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Fan Motor Train 3	-	30UPF03006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Compressor Motor Train 3	-	30UPF03006	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 11 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Building Safety Related Dampers (All) Train 3	-	-	M	M	ES	SI	S	C/NM	Y(5)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 3	-	30UPF02006	M	M	ES	SI	S		Y(5)
Low Side Root Valve for ΔP Measurement Across AHU Filter Train 3	-	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
High Side Root Valve for ΔP Measurement Across AHU Filter Train 3	-	30UPF02006	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 3	-	30UPF02006	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 3	-	-	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Safety Related Tornado Dampers Train 3	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Train 3	30PED30AA005	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Actuator Train 3	30PED30AA005	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Train 3	-	-	M	M	-	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Motor Train 3	-	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Throttling Valve Train 3	30PED30AA007	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 3	30PED30CP003	30UPF03013	M	M	ES	SI	S		Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Root Valve Train 3	30PED30AA306	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 3	-	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Train 3	-	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 12 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 3	-	30UPF03013	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 3	-	30UPF03013	M	M	ES	SI	S		Y(5)
UHS Makeup Water Intake Structure Level Measurement (All) Train 3	-	-	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Orifice Train 3	-	33UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 3	30PED30AA029	33UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 3	30PED30AA223	33UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Isolation Valve Train 3	30PED30AA028	33UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Check Valve Train 3	30PED30AA222	33UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Water Test Bypass Isolation Valve Train 3	30PED30AA008	33UQB	M	M	ES	SI	S		Y (5)
Train 4									
UHS Makeup Water Pump Train 4	30PED40AP001	30UPF01004	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Motor Train 4	30PED40AP001	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Root Valve Train 4	30PED40AA303	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Pressure Instrument Train 4	30PED40CP001	30UPF02008	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 1 Train 4	30PED40AA307	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Flow Element/Instrument Train 4	30PED40CF003	30UPF02008	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Discharge Flow Element Instrument Root Valve 2 Train 4	30PED40AA308	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Valve Train 4	30PED40AA002	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
(Page 13 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 4	30PED40AA002	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Minimum Flow Line Orifice Plate Train 4	-	30UPF02008	M	M	ES	SI	S		Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Vent Valve Train 4	30PED40AA301	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve, Isolation Valve Train 4	30PED40AA302	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Air Release/Vacuum Breaker Valve Train 4	30PED40AA190	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Check Valve Train 4	30PED40AA201	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Train 4	30PED40AA001	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Isolation Valve Motor Actuator Train 4	30PED40AA001	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
Low Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 4	30PED40AA304	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 4	30PED40CP002	30UPF02008	M	M	ES	SI	S		Y(5)
High Side Isolation Valve for ΔP Measurement Across Pump Discharge Strainer Train 4	30PED40AA305	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Train 4	30PED40AT001	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 4	30PED40AT001	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Drain Valve 1 Train 4	30PED40AA405	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Drain Valve 2 Train 4	30PED40AA406	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Train 4	30PED40AA006	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 4	30PED40AA006	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Pump Discharge Strainer Isolation Valve Train 4	30PED40AA003	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Sample Connection Valve Train 4	30PED40AA601	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 4	-	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 4	-	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Air Cooled Condenser (ACC) Train 4	-	30UPF03008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Fan Motor Train 4	-	30UPF03008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building ACC Compressor Motor Train 4	-	30UPF03008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building Safety Related Dampers Train 4	-	-	M	M	ES	SI	S	C/NM	Y(5)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 4	-	30UPF02008	M	M	ES	SI	S		Y(5)
Low Side Root Valve for ΔP Measurement Across AHU Filter Train 4	-	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
High Side Root Valve for ΔP Measurement Across AHU Filter Train 4	-	30UPF02008	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 4	-	30UPF02008	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 4	-	-	M	M	ES	SI	S		Y(5)
UHS Makeup Water Building Safety Related Tornado Dampers Train 4	-	-	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Train 4	30PED40AA005	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
UHS Makeup Water Traveling Screen Wash Isolation Valve Actuator Train 4	30PED40AA005	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Train 4	-	-	M	M	-	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Motor Train 4	-	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Throttling Valve Train 4	30PED40AA007	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 4	30PED40CP003	30UPF03014	M	M	ES	SI	S		Y(5)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Root Valve Train 4	30PED40AA306	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 4	-	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Train 4	-	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 4	-	30UPF03014	M	M	ES	SI	S	C/NM	Y(5)
UHS Makeup Water Traveling Screen Room Unit Heater Train 4	-	30UPF03014	M	M	ES	SI	S		Y(5)
UHS Makeup Water Intake Structure Level Measurement (All) Train 4	-	-	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Orifice Train 4	-	34UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Isolation Valve Train 4	30PED40AA029	34UQB	M	M	ES	SI	S		Y(5)
POST-DBA UHS Makeup Keep-Fill Line Check Valve Train 4	30PED40AA223	34UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-FIll Line Isolation Valve Train 4	30PED40AA028	34UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Keep-Fill Line Check Valve Train 4	30PED40AA222	34UQB	M	M	ES	SI	S		Y(5)
UHS Makeup Water Test Bypass Isolation Valve Train 4	30PED40AA008	34UQB	M	M	ES	SI	S		Y (5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}

(Page 16 of 17)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
Fire Protection System									
Fire Protection Diesel Engine(s)/Diesel Engine Pump(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection Diesel Engine(s)/Pump(s) Instrument(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Standby Diesel Generator for Fire Protection Building Ventilation System		30USG	M	M		CS-I	NS-AQ		Y (5)
Standby Diesel Generator for Fire Protection Building Ventilation System Instrument(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection Diesel Engine(s)/Pump(s) Valve(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection System Isolation Valve(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection System Check Valve(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection System Pressure Relief Valve(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection Water Storage Tanks Isolation Valve(s)		30USG	M	M		CS-I	NS-AQ		Y (5)
Fire Protection System Post Indicator Valve(s)		30UZT	M	M		CS-I	NS-AQ		Y (5)
Fire Protection System Hydrant Isolation Valve(s)		30UZT	M	M		CS-I	NS-AQ		Y (5)
Hydrants Supplying Protection to SSE Buildings		30UZT	M	M		CS-I	NS-AQ		Y (5)
UHS Makeup Water Intake Structure Hose Station(s)		30UPF	M	M		CS-I	NS-AQ		Y (5)
Fans/Motors		30USG	M	M		CS-I	NS-AQ		Y (5)
Electric Heaters		30USG	M	M		CS-I	NS-AQ		Y (5)
Ductwork		30USG	M	M		CS-I	NS-AQ		Y (5)
Damper Motors		30USG	M	M		CS-I	NS-AQ		Y (5)
Class 1E Emergency Power Supply (EPSS)									
31BMT05 6.9 kV to 480 V (XFMR)	31BMT05GT0		M	M	ES	SI	S		Y (5)
32BMT05 6.9 kV to 480 V (XFMR)	32BMT05GT0		M	M	ES	SI	S		Y (5)
33BMT05 6.9 kV to 480 V (XFMR)	33BMT05GT0		M	M	ES	SI	S		Y (5)
34BMT05 6.9 kV to 480 V (XFMR)	34BMT05GT0		M	M	ES	SI	S		Y (5)
31BNG 1E 480 V Bus (MCC)	31BNG01GW0		M	M	ES	SI	S		Y (5)
32BNG 1E 480 V Bus (MCC)	32BNG01GW0		M	M	ES	SI	S		Y (5)

Table 3.10-1 — {Seismic and Dynamic Qualifications of Mechanical and Electrical Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)		EQ Program Designation (Note 5)
33BNG 1E 480 V Bus (MCC)	33BNG01GW0		M	M	ES	SI	S		Y (5)
34BNG 1E 480 V Bus (MCC)	34BNG01GW0		M	M	ES	SI	S		Y (5)
Essential Service Water System (ESWS)									
UHS Tower Basin Level Indicator	30PEB10CL001	31URB01003	M	M	ES PAM	SI	S 1E EMC		Y (5) Y (6)
UHS Tower Basin Level Indicator	30PEB20CL001	32URB01003	M	M	ES PAM	SI	S 1E EMC		Y (5) Y (6)
UHS Tower Basin Level Indicator	30PEB30CL001	33URB01003	M	M	ES PAM	SI	S 1E EMC		Y (5) Y (6)
UHS Tower Basin Level Indicator	30PEB40CL001	34URB01003	M	M	ES PAM	SI	S 1E EMC		Y (5) Y (6)

Notes:

1. EQ Environment (M= Mild, H= Harsh)
2. Radiation Environment Zone (M= Mild, H= Harsh)
3. RT (Reactor Trip), ES (Engineered Safeguards), PAM (Postaccident Monitoring), SI (Seismic I), SII (Seismic II), CS (Conventional Seismic), CS-I (Conventional Seismic-I)
4. Safety Class: S (Safety-Related (i.e., QA Level I)), NS-AQ (Supplemental Grade Non-Safety (i.e., QA Level II)), 1E (Class 1E), EMC (Electromagnetic Compatibility), C/NM (Consumables/ Non Metallics)
5. Yes (1) = Full EQ Electrical, Yes (2) = EQ Radiation Harsh-Electrical, Yes (3) = EQ Radiation Harsh-Consumables, Yes (4) = EQ for Consumables, Yes (5) = EQ Seismic, Yes (6) = EQ EMC.

Table 3.10-2 — Seismic Qualification Implementation Program

Phase	Scope Definition	Schedule
I	Seismic Qualification Methodology	Prior to Procurement
II	Specification Development	Prior to Procurement
III	Technical Bid Evaluations	Early in the Procurement Phase
IV	New Seismic Analysis and/or Testing (when required)	Prior to Initial Pre-operational Testing
V	Documentation of Results	Prior to Initial Pre-operational Testing

3.11 ENVIRONMENTAL QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

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

3.11.1 Equipment Identification and Environmental Conditions

No departures or supplements.

3.11.1.1 Equipment Identification

No departures or supplements.

3.11.1.1.1 Nuclear Island

No departures or supplements.

3.11.1.1.2 Balance of Plant (BOP) and Turbine Island (TI)

No departures or supplements.

3.11.1.1.3 Equipment Review and Screening

The U.S. EPR FSAR includes the following COL Item in Section 3.11.1.1.3:

> A COL applicant that references the U. S. EPR design certification will identify additional site-specific components that need to be added to the environmental qualification list in Table 3.11-1.

This COL Item is addressed as follows:

Table 3.11-1 provides the list of additional site-specific components to add to the equipment list in U.S. EPR FSAR Table 3.11-1. {It includes the safety-related and augmented quality items of the site-specific portion of the UHS Makeup Water System and Fire Protection System.} The cable types listed are typical of those which are anticipated to be utilized throughout the plant in safety-related applications, including those which are site-specific. However, the function and location related columns in the attached table entries are for site-specific applications only. The environmental qualification parameters shown in the attached table are based on the criteria described in U.S. EPR FSAR Section 3.11.

The regulatory guidance identified in U.S. EPR FSAR Section 3.11.2.3.6 for the environmental qualification of Class 1E electric cables and field splices will be used in conjunction with Regulatory Guide 1.89 (NRC, 1984), as appropriate, for evaluating the environmental qualification of Class 1E electric cables and field splices for site-specific portions of {UHS Makeup Water System} and Fire Protection System. Site-specific safety-related cables and components will be procured in accordance with these standards and regulations as appropriate.

There are six primary types of cable: Medium voltage power, low voltage power, low voltage control, shielded instrumentation, thermocouple extension and fiber optic communication cable. Medium and low voltage power cables, low voltage control cables and shielded instrumentation cables will be rated at 90°C in accordance with ICEA Standards. Thermocouple extension cable is intended for measuring service and will employ insulation rated at 300 VAC minimum.

Fiber optic communication cable may be employed in the safety-related site-specific portion of the {UHS Makeup Water System}.

3.11.1.2 Definition of Environmental Conditions

No departures or supplements.

3.11.1.3 Equipment Operability Times

No departures or supplements.

3.11.2 Qualification Tests and Analysis

This subsection of the U.S. EPR FSAR is incorporated by reference with the following supplements.

3.11.2.1 Environmental Qualification of Electrical Equipment

No departures or supplements.

3.11.2.2 Environmental Qualification of Mechanical Equipment

No departures or supplements.

3.11.2.2.1 Identifying Safety-Related Mechanical Equipment Located in Harsh Environment Areas

No departures or supplements.

3.11.2.2.2 Identifying Nonmetallic Subcomponents of this Equipment

No departures or supplements.

3.11.2.2.3 Identifying the Environmental Conditions and Process Parameters for Which the Equipment Must be Qualified

No departures or supplements.

3.11.2.2.4 Identifying Nonmetallic Material Capabilities

No departures or supplements.

3.11.2.2.5 Evaluating Environmental Effects on the Nonmetallic Material Components of the Equipment

No departures or supplements.

3.11.2.2.6 Maintaining Mechanical Equipment Qualification

The operational programs for maintaining equipment qualification during the life of the plant will include the following aspects:

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

3.11.2.2.6.1 Justification for Using Latest IEEE Standards not Endorsed by a RG

No departures or supplements

3.11.3 Qualification Test Results

The U.S. EPR FSAR includes the following COL Item in Section 3.11.3:

> If the equipment qualification testing is incomplete at the time of the COL application, a COL applicant that references the U. S. EPR design certification will submit an implementation program, including milestones and completion dates, for NRC review and approval prior to installation of the applicable equipment.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall develop and submit the equipment qualification testing program, including milestones and completion dates, prior to installation of the applicable equipment.

The documentation necessary to support the continued qualification of the equipment installed in the plant that is within the Environmental Qualification (EQ) Program scope is available in accordance with 10 CFR Part 50 Appendix A, General Design Criterion 1. The licensee is responsible for the maintenance of the equipment qualification file upon receipt from the reactor vendor.

Test results for site-specific electrical and mechanical equipment are maintained with the project records as auditable files. Such records are maintained from the time of initial receipt through the entire period during which the subject equipment remains installed in the plant, is stored for future use, or is held for permit verification. Full responsibility is assumed for the EQ program at time of license issuance. The EQ records are maintained for the life of plant to fulfill the records retention requirements delineated in 10 CFR 50.49, and in compliance with the Quality Assurance Program described in Chapter 17.

EQ files developed are maintained as applicable for equipment and certain post-accident monitoring devices that are subject to a harsh environment. The contents of the qualification files are discussed in U.S. EPR FSAR Section 3D.8. The files are maintained for the operational life of the plant. For equipment not located in a harsh environment, design specifications received from the vendor are retained. Any plant modifications that impact the equipment use the original specifications for modification or procurement. This process is governed by applicable plant design control or configuration control procedures.

Central to the EQ Program is the EQ Master Equipment List (EQMEL). This EQMEL identifies the electrical and mechanical equipment or components that must be environmentally qualified for use in a harsh environment. The EQMEL consists of equipment that is essential to emergency reactor shutdown, containment isolation, reactor core cooling, or containment and reactor heat removal, or that is otherwise essential in preventing significant release of radioactive material to the environment. This list is developed from the equipment list provided in U.S. EPR FSAR Tables 3.10-1 and 3.11-1. The EQMEL and a summary of equipment qualification results are maintained as part of the equipment qualification file for the operational life of the plant.

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

This justification consists of an analysis of the component, an associated circuit review if appropriate, and a safety evaluation. The justification is released and/or referenced on an appropriate change document. For changes to the EQMEL, supporting documentation is completed and approved prior to issuing the changes. This documentation includes safety reviews and new or revised EQ files. Plant modifications and design basis changes are subject to change process reviews, e.g. reviews in accordance with 10 CFR 50.59 or Section VIII of Appendix D to 10 CFR Part 52, in accordance with appropriate plant procedures.

These reviews address EQ issues associated with the activity. Any changes to the EQMEL that are not the result of a modification or design basis change are subject to a separate review that is accomplished and documented in accordance with plant procedures.

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

Table 13.4-1 provides milestones for EQ implementation.

3.11.4 Loss of Ventilation

No departures or supplements.

3.11.5 Estimated Chemical and Radiation Environment

No departures or supplements.

3.11.6 Qualification of Mechanical Equipment

No departures or supplements.

3.11.7 References

{**NRC, 1984.** Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants, Regulatory Guide 1.89, Revision 1, U.S. Nuclear Regulatory Commission, June 1984.}

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}

(Page 1 of 11)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
UHS Makeup Water System											
Train 1											
UHS Makeup Water Pump Motor Train 1	30PED10AP001	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Pressure Instrument Train 1	30PED10CP001	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Flow Element/ Instrument Train 1	30PED10CF003	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 1	30PED10AA002	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Pump Discharge Isolation Valve Motor Actuator Train 1	30PED10AA001	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 1	30PED10CP002	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 1	30PED10AT001	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 1	30PED10AA006	30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 1		30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
(Page 2 of 11)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
UHS Makeup Water Building Pump Room AHU Fan Motor Train 1		30UPF02001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building ACC Fan Motor Train 1		30UPF03001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building ACC Compressor Motor Train 1		30UPF03001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 1			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 1			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 1			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Intake Structure Level Measurement (All) Train 1			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Motor Train 1	-	30UPF03011	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Isolation Valve Motor Train 1	30PED10AA005	30UPF03011	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 1	30PED10CP003	30UPF03011	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Unit Heater Train 1	-	30UPF03011	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 1	-	30UPF03011	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
Train 2											
UHS Makeup Water Pump Motor Train 2	30PED20AP001	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Pressure Instrument Train 2	30PED20CP001	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Flow Element/ Instrument Train 2	30PED20CF003	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 2	30PED20AA002	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Pump Discharge Isolation Valve Motor Actuator Train 2	30PED20AA001	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 2	30PED20CP002	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 2	30PED20AT001	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 2	30PED20AA006	30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 2		30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 2		30UPF02004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building ACC Fan Motor Train 2		30UPF03004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
UHS Makeup Water Building ACC Compressor Motor Train 2		30UPF03004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 2			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 2			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 2			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Intake Structure Level Measurement (All) Train 2			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Motor Train 2	-	30UPF03012	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Isolation Valve Motor Train 2	30PED20AA005	30UPF03012	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 2	30PED20CP003	30UPF03012	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Unit Heater Train 2		30UPF03012	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 2		30UPF03012	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
Train 3											
UHS Makeup Water Pump Motor Train 3	30PED30AP001	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Pressure Instrument Train 3	30PED30CP001	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Flow Element/ Instrument Train 3	30PED30CF003	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 3	30PED30AA002	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Pump Discharge Isolation Valve Motor Actuator Train 3	30PED30AA001	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 3	30PED30CP002	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 3	30PED30AT001	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 3	30PED30AA006	30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 3		30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 3		30UPF02006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building ACC Fan Motor Train 3		30UPF03006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
UHS Makeup Water Building ACC Compressor Motor Train 3		30UPF03006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Pump Room AHU ΔP Measurement Across Filter Instrument Train 3			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 3			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 3			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Intake Structure Level Measurement (All) Train 3			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Motor Train 3	-	30UPF03013	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Isolation Valve Motor Train 3	30PED30AA005	30UPF03013	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 3	30PED30CP003	30UPF03013	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Unit Heater Train 3	-	30UPF03013	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 3	-	30UPF03013	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
Train 4											
UHS Makeup Water Pump Motor Train 4	30PED40AP001	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Pressure Instrument Train 4	30PED40CP001	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Flow Element/ Instrument Train 4	30PED40CF003	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Minimum Flow Valve Motor Actuator Train 4	30PED40AA002	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Pump Discharge Isolation Valve Motor Actuator Train 4	30PED40AA001	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer ΔP Measurement Instrument Train 4	30PED40CP002	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Motor Actuator Train 4	30PED40AT001	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Pump Discharge Strainer Blowdown Isolation Valve Motor Actuator Train 4	30PED40AA006	30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room Air Handling Unit (AHU) Train 4		30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room AHU Fan Motor Train 4		30UPF02008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building ACC Fan Motor Train 4		30UPF03008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
UHS Makeup Water Building ACC Compressor Motor Train 4		30UPF03008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Pump Room AHU ΔP Across Filter Measurement Instrument Train 4			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building AHU Supply Side Flow Measurement Instrument Train 4			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Building Temperature Measurement Instruments (All) Train 4			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Intake Structure Level Measurement (All) Train 4			M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Motor Train 4	-	30UPF03014	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Isolation Valve Motor Train 4	30PED40AA005	30UPF03014	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Wash Pressure Instrument Train 4	30PED40CP003	30UPF03014	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Unit Heater Train 4	-	30UPF03014	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
UHS Makeup Water Traveling Screen Room Vane Axial Exhaust Fan Motor Train 4	-	30UPF03014	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
Fire Protection System											
Fire Protection Diesel Engine(s)/ Diesel Engine Pump(s)		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Fire Protection Diesel Engine Batteries		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Fire Protection Diesel Engine(s)/ Pump(s) Instrument(s) (local)		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Fire Protection Diesel Engine(s)/ Pump(s) Valve(s)		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Fire Protection System Isolation Valve(s)		30USG	M	M		CS-I	NS-AQ		EMC**	Y(5)	Y(6)
Standby Diesel Generator for Fire Protection Building Ventilation System		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Standby Diesel Generator for Fire Protection Building Ventilation System Instrument(s)		30USG	M	M		CS-I	NS-AQ		EMC	Y(5)	Y(6)
Fire Protection Water Storage Tanks Isolation Valve(s)		30USG	M	M		CS-I	NS-AQ		EMC**	Y(5)	Y(6)
Fire Protection System Post Indicator Valve(s)		30UZT	M	M		CS-I	NS-AQ		EMC**	Y(5)	Y(6)
Fire Protection System Hydrant Isolation Valve(s)		30UZT	M	M		CS-I	NS-AQ		EMC**	Y(5)	Y(6)
Fans/Motors		30USG	M	M		CS-I	NS-AQ			Y (5)	Y (6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)		Safety Class (Note 4)			EQ Program Designation (Note 5)	
Class 1E Emergency Power Supply (EPSS)											
31BMT05 6.9 kV to 480 V (XFMR)	31BMT05GT0	30UPF03002	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
32BMT05 6.9 kV to 480 V (XFMR)	32BMT05GT0	30UPF03005	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
33BMT05 6.9 kV to 480 V (XFMR)	33BMT05GT0	30UPF03007	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
34BMT05 6.9 kV to 480 V (XFMR)	34BMT05GT0	30UPF03009	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
31BNG 1E 480 V Bus (MCC)	31BNG01GW0	30UPF2001	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
32BNG 1E 480 V Bus (MCC)	32BNG01GW0	30UPF2004	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
33BNG 1E 480 V Bus (MCC)	33BNG01GW0	30UPF2006	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
34BNG 1E 480 V Bus (MCC)	34BNG01GW0	30UPF2008	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Site Specific Safety Related Electrical Power Cable Types											
Medium Voltage Power Cable	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Low Voltage Power Cable	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Low Voltage Control Cable (600V)	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Shielded Instrumentation Cable (600V)	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Thermocouple Extension Cable	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	Y(6)
Fiber Optic Communication Cable	various	multiple	M	M	ES	SI	S	1E	EMC	Y(5)	
Essential Service Water System (ESWS)											
UHS Tower Basin Level Indicator	30PEB10CL001	31URB01003	M	M	ES	PAM SI	S	1E	EMC	Y(5)	Y(6)
UHS Tower Basin Level Indicator	30PEB20CL001	32URB01003	M	M	ES	PAM SI	S	1E	EMC	Y(5)	Y(6)
UHS Tower Basin Level Indicator	30PEB30CL001	33URB01003	M	M	ES	PAM SI	S	1E	EMC	Y(5)	Y(6)
UHS Tower Basin Level Indicator	30PEB40CL001	34URB01003	M	M	ES	PAM SI	S	1E	EMC	Y(5)	Y(6)

Table 3.11-1 — {Site-Specific Environmentally Qualified Electrical/I&C Equipment}
(Page 11 of 11)

Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)	Safety Class (Note 4)	EQ Program Designation (Note 5)

Notes:

1. EQ Environment: M (Mild), H (Harsh)
2. Radiation Environment Zone: M (Mild), H (Harsh)
3. EQ Designated Function: RT (Reactor Trip), ES (Engineered Safeguards), PAM (Postaccident Monitoring), SI (Seismic I), CS (Conventional Seismic), CS-I (Conventional Seismic-I)
4. Safety Class: S (Safety-Related (i.e., QA Level I)), NS-AQ (Supplemental Grade Non-Safety (i.e., QA Level II)), 1E (Class 1E), EMC (Electromagnetic Compatibility), C/NM (Consumables/Non Metallics).
5. Yes(1)=Full EQ Electrical, Yes(2)=EQ Radiation Harsh-Electrical, Yes(3)=EQ Radiation Harsh-Consumables, Yes(4)=EQ for Consumables, Yes(5)=EQ Seismic, Yes(6)=EQ EMC.

** Fire Protection System isolation valves are equipped with tamper switches, hence identified for EMC.

3.12 ASME CODE CLASS 1, 2, AND 3 PIPING SYSTEMS, PIPING COMPONENTS, AND THEIR ASSOCIATED SUPPORTS

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

3.12.1 Introduction

No departures or supplements.

3.12.2 Codes and Standards

No departures or supplements.

3.12.3 Piping Analysis Methods

No departures or supplements.

3.12.4 Piping Modeling Techniques

3.12.4.1 Computer Codes

No departures or supplements.

3.12.4.2 Dynamic Piping Model

The U.S. EPR FSAR includes the following COL Item in Section 3.12.4.2:

> A COL applicant that references the U.S. EPR design certification will perform a review of the impact of contributing mass of supports on the piping analysis following the final support design to confirm that the mass of the support is no more than ten percent of the mass of the adjacent pipe span. If the impact review determines the existing piping analysis does not bound the additional mass of the pipe support, the COL applicant will perform reanalysis of the piping to include the additional mass.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall perform a review of the impact of contributing mass of supports on the piping analysis following the final support design to confirm that the mass of the support is no more than ten percent of the mass of the adjacent pipe span. If the impact review determines the existing piping analysis does not bound the additional mass of the pipe support, reanalysis of the piping to include the additional mass will be performed.

3.12.4.3 Benchmark Program

The U.S. EPR FSAR includes the following COL Item in Section 3.12.4.3:

> As indicated in U.S. EPR FSAR Appendix 3F.5.3, pipe and support stress analysis will be performed by the COL applicant that references the U.S. EPR design certification. If the COL applicant that references the U.S. EPR design certification chooses to use a piping analysis program other than those listed in Appendix 3F.5.1 of the U.S. EPR FSAR, the COL applicant will implement a benchmark program using models specifically selected for the U.S. EPR.

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall use piping analysis programs listed in Appendix 3F.5.1 of the U.S. EPR FSAR.

3.12.4.4 Decoupling Criteria

No departures or supplements.

3.12.5 Piping Stress Analysis Criteria

3.12.5.1 Seismic Input Envelope versus Site-Specific Spectra

{The site-specific seismic response is within the parameters of U.S. EPR FSAR Section 3.7.2 as discussed in Section 3.7.2. The In-Structure Response Spectra (ISRS) is generated from the soil cases defined in the U.S. EPR FSAR Section 3.7.1 and is used for pipe stress and support analysis on systems within the scope of the U.S. EPR FSAR certified design for Category I structures. Site-specific ISRS defined in FSAR Section 3.7.2.5 for the UHS MWIS is used for the pipe stress and support analysis of site-specific systems within the structure. These site-specific ISRS are based on foundation input response spectra for site-specific structures discussed in Section 3.7.1.1.1.}

3.12.5.2 Design Transients

No departures or supplements.

3.12.5.3 Loadings and Load Combinations

No departures or supplements.

3.12.5.4 Damping Values

No departures or supplements.

3.12.5.5 Combination of Modal Responses

No departures or supplements.

3.12.5.6 High-Frequency Modes

No departures or supplements.

3.12.5.7 Fatigue Evaluation for ASME Code Class 1 Piping

No departures or supplements.

3.12.5.8 Fatigue Evaluation of ASME Code Class 2 and 3 Piping

No departures or supplements.

3.12.5.9 Thermal Oscillations in Piping Connected to the Reactor Coolant System

The following guidelines and Bulletins are utilized when reviewing unisolable piping connected to the RCS for the potential to be subjected to stresses from temperature stratification or temperature oscillations that could be induced by leaking valves and that were not evaluated in the design analysis of the piping.

- Utilization of the Electric Power Research Institute (EPRI) thermal management guidelines provided in EPRI Reports TR-1011955 (Reference 3 of U.S. EPR FSAR Tier 2, Section 3.12.7) and TR-103581 (Reference 4 of U.S. EPR FSAR Tier 2, Section 3.12.7).

- Verification that the U.S. EPR design incorporates lessons learned from the operating experience documented in NRC Bulletin 88-08 (including the supplements) and EPRI Report TR-1011955 (e.g. confirmation that the injection line (SIS/RHRS) continually rises in elevation from the check valve; therefore, assuring that it is not susceptible to valve leakage-induced cyclic thermal stratification).

The U.S. EPR FSAR includes the following COL Item in Section 3.12.5.9:

> A COL applicant that references the U.S. EPR design certification will describe essential elements of a program to monitor the RHR/SIS/EBS injection piping from the RCS to the first isolation valve (all four trains), and the RHR/SIS suction piping from the RCS to the first isolation valve (trains 1 and 4) during the first cycle of the first U.S. EPR initial plant operation to verify that the operating conditions have been considered in the design unless data from a similar plant's operation demonstrated that thermal oscillation is not a concern for piping connected to the RCS.

The COL Item is addressed as follows:

The essential elements of a program shall be described to monitor the RHR/SIS/EBS injection piping from the RCS to the first isolation valve (all four trains), and the RHR/SIS suction piping from the RCS to the first isolation valve (trains 1 and 4) during the first cycle to verify that the operating conditions have been considered in the design are described below unless data from a similar plant's operation demonstrated that thermal oscillation is not a concern for piping connected to the RCS.

- Monitoring devices shall be located in sufficient quantity in order to obtain a temperature profile on the cross section of the subject pipe.

- Plant parameters including pressurizer temperature, pressurizer level, hot leg and cold leg temperatures, RCS fluid flow rates and reactor coolant pump status shall also be recorded.

- The monitoring should record data from the installed instruments as well as the applicable plant data on a time dependent basis for review and potential analysis later.

- Prerequisites for this monitoring include the RCS and attached piping systems are ready for service.

- No special testing is required for this monitoring program.

- Verifying that the contribution of normal and upset condition stratification cycles is considered in the fatigue analysis of these piping systems.

3.12.5.10 Thermal Stratification

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

3.12.5.10.1 Pressurizer Surge Line Stratification (NRC Bulletin 88-11)

The U.S. EPR FSAR includes the following COL Items in Section 3.12.5.10.1:

> A COL applicant that references the U.S. EPR design certification will describe essential elements of a program to monitor pressurizer surge line temperatures during the first fuel cycle of initial plant operation to verify that the design transients for the surge line are representative of actual plant operations.

The COL Item is addressed as follows:

> The essential elements of a program to monitor the pressurizer surge line temperatures to verify that the design transients for these lines are representative of actual plant operations are described below.

- ♦ The thermal stratification data collected in U.S. EPR FSAR Tier 2, Section 14.2, Test #168, the piping displacement data collected in U.S. EPR FSAR Tier 2, Section 14.2, Test #165 will verify that the design transients are representative of actual operations.
- ♦ Conducting visual inspections (ASME, Section XI, VT -3) of the pressurizer surge line.
- ♦ Monitoring devices shall be located in sufficient quantity in order to obtain a temperature profile on the cross section of the subject pipe.
- ♦ Plant parameters including pressurizer temperature, pressurizer level, hot leg and cold leg temperatures, RCS fluid flow rates and reactor coolant pump status shall also be recorded.
- ♦ The monitoring should record data from the installed instruments as well as the applicable plant data on a time dependent basis for review and potential analysis later.
- ♦ Prerequisites for this monitoring include the RCS and attached piping systems are ready for service.
- ♦ No special testing is required for this monitoring program.
- ♦ Verifying that the contribution of normal and upset condition stratification cycles is considered in the fatigue analysis of the surge line piping.

3.12.5.10.2 Pressurizer Stratification

No departures or supplements.

3.12.5.10.3 Spray Line Stratification

The U.S. EPR FSAR includes the following COL Items in Section 3.12.5.10.3:

A COL applicant that references the U.S. EPR design certification will describe essential elements of a program to monitor the normal spray line temperatures during the first cycle of the first U.S. EPR initial plant operation to verify that the design transients for the normal spray are representative of actual plant operations unless data from a similar plant's operation determines that monitoring is not warranted.

The COL Item is addressed as follows:

The essential elements of a program to monitor the pressurizer normal spray line temperatures to verify that the design transients for these lines are representative of actual plant operations, unless data from a similar plant's operation determines that monitoring is not warranted, are described below.

- Verifying that the normal spray lines contain stratified liquid and steam during the initial part of the heatup as the horizontal sections in each of the two lines are filled from the cold leg at the same time that the pressurizer is being filled.
- Monitoring devices shall be located in sufficient quantity in order to obtain a temperature profile on the cross section of the subject pipe.
- Plant parameters including pressurizer temperature, pressurizer level, hot leg and cold leg temperatures, RCS fluid flow rates and reactor coolant pump status shall also be recorded.
- The monitoring should record data from the installed instruments as well as the applicable plant data on a time dependent basis for review and potential analysis later.
- Prerequisites for this monitoring include the RCS and attached piping systems are ready for service.
- No special testing is required for this monitoring program.
- Verifying that the contribution of normal and upset condition stratification cycles is considered in the fatigue analysis of the normal spray line piping.

3.12.5.10.4 Feedwater Line Stratification (NRC Bulletin 79-13)

No departures or supplements.

3.12.5.11 Safety Relief Valve Design, Installation, and Testing

No departures or supplements.

3.12.5.12 Functional Capability

No departures or supplements.

3.12.5.13 Combination of Inertial and Seismic Anchor Motion Effects

No departures or supplements.

3.12.5.14 Operating Basis Earthquake as a Design Load

No departures or supplements.

3.12.5.15 Welded Attachments

No departures or supplements.

3.12.5.16 Modal Damping for Composite Structures

No departures or supplements.

3.12.5.17 Minimum Temperature for Thermal Analyses

No departures or supplements.

3.12.5.18 Intersystem Loss-of-Coolant Accident

No departures or supplements.

3.12.5.19 Effects of Environment on Fatigue Design

No departures or supplements.

3.12.6 Piping Support Design Criteria

No departures or supplements.

3.12.7 References

{Incorporated by reference with no departures or supplements.}

3.13 THREADED FASTENERS (ASME CODE CLASS 1, 2, AND 3)

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

3.13.1 Design Considerations

No departures or supplements.

3.13.2 Inservice Inspection Requirements

The U.S. EPR FSAR includes the following COL Item in Section 3.13.2:

> A COL applicant referencing the U.S. EPR design certification will submit the inservice inspection program for ASME Class 1, Class 2, and Class 3 threaded fasteners to the NRC prior to performing the first inspection. The program will identify the applicable edition and addenda of ASME Section XI and ensure compliance with the requirements of 10 CFR 50.55a(b)(2)(xxvii).

This COL Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall submit the inservice inspection plan for ASME Class 1, Class 2, and Class 3 threaded fasteners to the U.S. Nuclear Regulatory Commission and identify the applicable edition and addenda of ASME, Section XI, and ensure compliance with the requirements of 10 CFR 50.55a(b)(2)(xxvii) prior to performing the first inspection.

3.13.3 References

No departures or supplements.

3A CRITERIA FOR DISTRIBUTION SYSTEM ANALYSIS AND SUPPORT

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

3A.1 {Piping and Supports

No departures or supplements.}

3A.2 {Heating, Ventilation, and Air Conditioning Ducts and Supports

Fire Protection Building related HVAC ductwork and its associated support structures, designated as Conventional Seismic-I (CS-I), will follow the same seismic analysis and design methodology including seismic modeling, acceptance criteria and codes and standards, as described for Seismic Category I HVAC ductwork and its associated support structures in U.S. EPR FSAR Appendix 3A.2, except that the seismic input will be based on site-specific SSE or appropriate ISRS created from site-specific SSE}.

3A.3 {Cable Tray, Conduit, and Supports

Fire Protection Building related cable trays, conduits, and the associated supports and restraints designated as Conventional Seismic-I (CS-I) will follow the same seismic design methodology, including seismic modeling, acceptance criteria, and codes and standards, as described for Seismic Category-I cable trays, conduits, and the associated supports and restraints in the U.S. EPR FSAR Appendix 3A.3, except that the seismic input will be based on the site-specific SSE}.

3A.4 {References

No departures or supplements.}.

3B DIMENSIONAL ARRANGEMENT DRAWINGS

This section of the U.S. EPR FSAR is incorporated by reference.

3C REACTOR COOLANT SYSTEM STRUCTURAL ANALYSIS METHODS

{This section of the U.S. EPR FSAR is incorporated by reference.}

3D METHODOLOGY FOR QUALIFYING SAFETY-RELATED ELECTRICAL AND MECHANICAL EQUIPMENT

{This section of the U.S. EPR FSAR is incorporated by reference.}

3E DESIGN DETAILS AND CRITICAL SECTIONS FOR SAFETY-RELATED CATEGORY I STRUCTURES

This section of the U.S. EPR FSAR is incorporated by reference, with the following supplements and departure.

The U.S. EPR FSAR contains the following COL item in Appendix 3E:

> A COL applicant that references the U.S. EPR design certification will address critical sections relevant to site-specific Seismic Category I structures.

This COL item is addressed as follows:

{Section 3E.4 of Appendix 3E provides the discussion regarding the critical sections of the site-specific Seismic Category I Structures:

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

Section 3E.5 of Appendix 3E provides the discussion regarding the critical sections of the site-specific Seismic Category I buried piping.

Section 3E.6 of Appendix 3E provides the discussion regarding the critical sections of the site-specific Seismic Category I buried duct banks.}

3E.1 Nuclear Island Structures

No departures or supplements.

3E.2 Emergency Power Generating Buildings

No departures or supplements.

3E.3 Essential Service Water Buildings

No departures or supplements.

3E.4 {Forebay and UHS Makeup Water Intake Structure

This section is a supplement to U.S. EPR FSAR Appendix 3E.

3E.4.1 Structural Description and Geometry

The General Arrangement plans and elevations of the Forebay and UHS Makeup Water Intake Structure are provided as Figure 9.2-4, Figure 9.2-5 and Figure 9.2-6. A general description of the structures is provided in Section 3.8.4.1.11. Section 3.8.5.1.4 provides additional details regarding the basemats.

A Foundation Plan for the Forebay and UHS Makeup Water Intake Structure at Elevation -22 ft 6 in (-6.9 m) is provided as Figure 3E-1. As described in Section 3E.4.4, the following critical structural elements are selected for design based on their location, dimension, support conditions, and applied loads:

- Basemat of the Forebay and UHS Makeup Water Intake Structure (Figure 3E-1).
- Long wall of the Forebay (Figure 3E-1 and Figure 3E-4).
- Side wall of the UHS Makeup Water Intake Structure water basin (Figure 3E-1 and Figure 3E-3).
- Side wall of the UHS Makeup Water Intake Structure pump house (Figure 3E-3).

Forebay and UHS Makeup Water Intake Structure share a common basemat, as described in Section 3.8.5.1.4. Additional descriptions of the critical structural elements are provided in Section 3E.4.4.

3E.4.2 Material Properties

Concrete and reinforcing steel materials for the site-specific Seismic Category I structures conform to the requirements of U.S. EPR FSAR Sections 3.8.4.6 and 3.8.5.6. The following material properties are used in critical section design:

- Concrete
  - Compressive strength (fc'): 5000 psi (34.5 MPa) minimum at 28 days
  - Modulus of elasticity (E): 4031 ksi (2.779E+04 MPa)
  - Shear modulus (G): 1722 ksi (1.188E+04 MPa)
  - Poisson's ratio: 0.17
- Reinforcement
  - Yield stress (fy): 60 ksi (413.7 MPa)

General description of foundation soil is provided in Section 2.5.4. Soil properties and ground water table for calculating lateral earth pressure are described in Section 3.8.4.3.1.

3E.4.3 Structural Loads and Load Combinations

Structural loads and load combinations for the design of site-specific Seismic Category I structures are specified in Sections 3.8.4.3.1 and 3.8.4.3.2, respectively. For convenience, the basic load combinations used for concrete design are repeated below:

- Normal: 1.4(D + F) + 1.7(L + H)
- Wind: 1.4(D + F) + 1.7(L + H + W)
- SPH: 1.4(D + F) + 1.7(L + H + SPH)
- SSE: D + L + H + F + E'
- Tornado: D + L + H + F + Wt
- PMH: D + L + H + F + PMH

Where:

D	=	Dead load
L	=	Live load
F	=	Hydrostatic load from water inside structures
H	=	Lateral earth pressure including load due to water outside structures and compaction pressures.
W	=	Normal wind load
Wt	=	Tornado wind load
SPH	=	Standard Project Hurricane load
PMH	=	Probable Maximum Hurricane load
E'	=	Safe Shutdown Earthquake (SSE) load

Additional load combinations for stability and bearing pressure evaluation are specified in Section 3.8.5.3.

3E.4.4 Structural Analysis and Design

The analysis and design procedures for Forebay and UHS Makeup Water Intake Structure are presented in Sections 3.8.4.4.7 and 3.8.5.4.6, including the procedures for stability and bearing pressure evaluation. Structural acceptance criteria are presented in Sections 3.8.4.5 and 3.8.5.5. Selection and design of critical elements is further discussed in this section.

Selection of Critical Elements

The following critical sections are selected for design. Clear dimensions are used in the descriptions.

- *Foundation Basemats (Figure 3E-1):* Foundation basemats transfer all applicable vertical and horizontal structural loads to the supporting soil. Therefore, basemats of the Forebay and UHS Makeup Water Intake Structure are selected as critical structural elements. Basemats of Forebay and UHS Makeup Water Intake Structure are part of the common basemat of the CBIS and are integrally connected. Further descriptions of the basemats are provided in Section 3.8.5.1.4.

- *Forebay Long Wall (Figures 3E-1 and 3E-4):* Long walls in the plant north-south direction are subject to large lateral earth pressure. Each wall is 100 ft (30.5 m) long, 34 ft (10.4 m) high, and 4.5 ft (1.4 m) thick. Due to its length and support conditions, the center portion of each wall behaves like a cantilever making it a critical element.

- *UHS Makeup Water Intake Structure Side Walls (Figures 3E-1 and 3E-3):* Below-grade side walls of the UHS Makeup Water Intake Structure in the plant north-south direction are subject to large lateral earth pressures. Each wall is 80.5 ft (24.5 m) long, 31 ft (9.4 m) high, and 4 ft (1.2 m) thick. The loading condition is more critical when the adjacent pump bay is emptied for maintenance. Side walls of the Pump House, which sit above the operating deck (Elevation 11'-6" (3.51 m)), are 69.5 ft (21.2 m) long, 13 ft (4.0 m) tall, and 2 ft (0.61 m) thick and subject to large hurricane wave pressures.

Design of Critical Elements

Structural analysis and design of the aforementioned critical sections are performed using the procedures outlined in Section 3.8.4.4.7. Each critical concrete section is designed for combined axial force and bending moment, shear friction, in-plane and out-of-plane shear according to the applicable provisions of ACI 349/349R-01 (ACI, 2001).

As stated in Section 3.8.4.4.7, accelerations are calculated using the finite element results from SASSI for seismic loads and applied to the STAAD Pro model to be combined with other non-seismic loads. Design for combined axial force (P) and bending moment (M) is based on P-M interaction of element level results. Design for shear friction, in-plane, and out-of-plane shear is based on section cuts at critical locations of a wall or basemat.

The following provisions from ACI 349/349R-01 (ACI, 2001) are used for design:

- *Axial force and bending moment:* Sections 7.12, 9.3, 10.2, 10.3, 14.3, and 21.6.
- *Shear friction:* Section 11.7. A friction coefficient of 1.0 is used for concrete placed against hardened concrete with surface intentionally roughened. The beneficial effect of compression is ignored.
- *In-plane shear:* Section 11.10 (non-seismic loads) and Section 21.6 (seismic loads). As discussed in U.S. EPR FSAR Section 3.8.4.4.1, a shear strength reduction factor of 0.85 is used.
- *Out-of-plane shear:* Sections 11.1, 11.3, 11.5, and 11.12.

For all section cuts, the design reinforcement is based on the sum of reinforcement required for in-plane shear and combined axial force and bending moment. For a section cut subject to shear friction requirement, the reinforcement provided for combined axial force and bending moment is checked for shear friction and increased, if necessary. Minimum reinforcement required by the code is satisfied. Maximum concrete section strengths limited by the code are also satisfied.

Results of critical section design in terms of the demand to capacity ratios and estimated reinforcements are presented in Section 3E.4.5.

3E.4.5 Summary of Results

Arrangement of main reinforcement for the Forebay and UHS Makeup Water Intake Structure is shown in Figure 3E-2 through Figure 3E-4. Note that supplementary shrinkage and temperature reinforcement is not shown for clarity, but it will be provided where required. The maximum demand to capacity ratios are presented in Table 3E-1 through Table 3E-4 for various design load combinations.

Stability evaluation results of the Forebay and UHS Makeup Water Intake Structure are presented in Table 3.8-3. Bearing pressure calculation results are presented in Table 3.8-2. These results are discussed in Section 3.8.5.5.4.

3E.4.6 Conclusions

The critical sections of the Forebay and UHS Makeup Water Intake Structure have adequate strength to resist the structural loads from various design basis events. The structures satisfy the minimum required factors of safety against sliding, overturning and flotation loading conditions. The foundation soil has adequate capacity to resist bearing pressure.

3E.4.7 References

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

3E.5 {Buried Utilities – Seismic Category I Buried Piping

This section is a supplement to U.S. EPR FSAR Appendix 3E.

3E.5.1 Structural Description and Geometry

The layout of the Seismic Category I buried underground piping is shown in Figure 3.8-3 and Figure 3.8-4.

The Seismic Category I buried underground piping consists of the following:

- *Essential Service Water System (ESWS):* As seen in Figure 3.8-4, the buried portions of the ESWS are located in the Nuclear Island. Two 30" diameter steel pipes traverse from each of the four Safeguards Buildings to the four Essential Service Water Buildings. Two 10" diameter steel pipes traverse from the Emergency Power Generating Buildings and tie into the aforementioned pipes. A cross section of the buried piping in the Nuclear Island is provided in Figure 3E-6.

- *Ultimate Heat Sink Makeup Water System (UHSMWS):* As seen in Figure 2.4-49, two 60" diameter steel pipes traverse from the CCNPP Unit 3 Inlet Area to the CCNPP Unit 3 Forebay. A cross section of the 60" diameter steel pipe is provided in Figure 3E-8. Four 8" diameter steel pipes emanate from the UHS Makeup Water Intake Structure and terminate at the Essential Service Water Buildings. These pipes run within the utility corridor, shown in Figure 3.8-3. A cross section of the buried utilities in the Utility Corridor is provided in Figure 3E-7.

3E.5.2 Material Properties

The 30" and 10" diameter pipe will be comprised of carbon steel material ASME SA-106 Grade C UNS K03501 and shall conform to the requirements of Section 9.2.1.3.5.

The 8" diameter pipe will be comprised of stainless steel material ASME SB-690 UNS N08367 and shall conform to the requirements of Section 9.2.5.3.2.

The 60" diameter pipe will be comprised of carbon steel material ASME SA-672 Grade B70 UNS K03101 and shall conform to the requirements of Section 9.2.5.3.2.

3E.5.3 Structural Loads and Load Combinations

Structural Loads

Dead Load

Dead load is calculated considering pipe dead weight, soil overburden load and weight of water in pipe. The soil overburden load is calculated considering depth of groundwater table using Equation 3-2 of American Lifelines Alliance Guidelines for the Design of Buried Steel Pipe **(ASCE, 2001).**

Live Load

The static surface load, or live load, is calculated based on AASHTO HS-20 loading (AASHTO, 2002).

Seismic Load

Per Section 3.7.1.1.4, site SSE is considered as the design ground motion for the seismic analysis of the buried utilities. From Figure 3.7-1, site SSE PGA is 0.15g. Per Reference 1 of Regulatory Guide 1.60 Revision 1, the maximum ground velocity for peak ground acceleration of 1.0g is taken as 4.0 fps. Therefore the peak ground velocity for SSE is 0.15*4 fps = 0.6 fps.

The upper bound maximum axial and bending strains due to seismic propagation are calculated using equations in ASCE Report Seismic Response of Buried Pipes and Structural Components **(ASCE, 1983)**. Equation 3, 5 and 7 of ASCE Report **(ASCE, 1983)** provide maximum axial and bending strains due to compression, shear and surface waves. These equations are similar to Equation 3.5-3 for axial strain and Equation 3.5-5 for bending strain of ASCE 4-98 **(ASCE, 2000)**. The minimum slippage length is calculated using Equation 5 in Appendix VII, Procedures for the Design of Restrained Underground Piping, of ASME B31.1 **(ASME, 2004b)**. If the longest maximum run of pipe is shorter than the minimum slippage length, the pipe is not long enough to develop the full friction and therefore, slippage would occur at the soil-pipe interface. In these situations, the axial stress in the pipe cross section will be limited to the friction force action on the pipe cross section. The maximum axial and bending strains from compression, shear and surface waves are combined using the square root of the sum of the squares (SRSS). Axial and bending strains are converted to axial and bending stresses using the pipe's modulus of elasticity.

Per ASCE 4-98 **(ASCE, 2000)** forces due to maximum dynamic movement between anchor points, such as a building attachment point, should be considered in the seismic analysis of buried piping. For long, straight segments the axial stresses and bending stresses in the pipe near the entry of the building due to the seismic differential movement between the building and the soil are calculated using Equation 6-16 and 6-25 respectively per Bechtel Topical Report BC-Top-4-A **(BECHTEL, 1974)**.

Load Combinations

For the design of the steel buried piping, Appendix 3F of U.S. EPR FSAR states that the design code for Class 1, 2, and 3 piping will be ASME Boiler and Pressure Vessel Code Section III, Division I, 2004 edition **(ASME, 2004a)** with the restriction that the treatment of dynamic loads will be according to sub-articles NB/NC/ND-3650 of the 1993 Addenda of the ASME Code **(ASME, 1992**). Therefore load combinations are taken from Section ND-3652 and ND-3653 Equations 8 through 11 of ASME Section III **(ASME, 2004a and 1992)** and Appendix 3F-4 of U.S.

EPR FSAR. The buried piping for the ESWS and UHS are classified as Class 3 per U.S. EPR FSAR Section 9.2.5.3.2. Therefore both systems will be designed to Section ND-3600 of ASME Section III **(AREVA, 2004a)**. For convenience, the basic load combinations are repeated below:

- Primary Stress Loads

$$S_{SL} = B_1 \cdot \left(\frac{P \cdot D}{2 \cdot t}\right) + B_2 \cdot \left(\frac{M_A}{Z}\right) + \left(\frac{F_b \cdot L^2}{10 \cdot Z}\right) + 4 \cdot E \cdot \left(\frac{\Delta}{D} \cdot \frac{t}{D}\right) \le 1.5 \cdot S_h$$

- Occasional Stress Loads

$$S_{OL} = B_1 \cdot \left(\frac{P_{max} \cdot D}{2 \cdot t}\right) + B_2 \cdot \left(\frac{M_A + M_B}{Z}\right) \le \min\left(1.8 \cdot S_h, 1.5 \cdot S_y\right)$$

- Sustained plus Secondary Stress Loads

  Note: For equation below, 0.75*i shall not be less than 1.0

$$S_{TE} = \left(\frac{P \cdot D}{4 \cdot t}\right) + 0.75 \cdot i \cdot \left(\frac{M_A}{Z}\right) + i \cdot \left(\frac{M_C}{Z}\right) + E \cdot \alpha \cdot \left(T_2 - T_1\right) \le \left(S_h + S_a\right)$$

- Faulted Stress Loads

$$S_{NSSE} = \frac{i \cdot M_C}{Z} + \frac{i \cdot M_{SSE}}{Z} + \varepsilon_b \cdot E + \varepsilon_a \cdot E + E \cdot \alpha \cdot \left(T_2 - T_1\right) \le \min\left(3 \cdot S_h, 2 \cdot S_y\right)$$

$$S_{SSE} = \frac{2 \cdot i \cdot M_{SSE}}{Z} + 2 \cdot \varepsilon_a \cdot E + 2 \cdot \varepsilon_b \cdot E \le \min\left(3 \cdot S_h, 2 \cdot S_y\right)$$

Where:
B_1, B_2 = Primary stress indices for the specific product from Fig. ND-3673.2(b)-1 (**ASME, 2004a**)
D = Outside diameter, in
t = Nominal wall thickness of pipe, in
Z = Pipe elastic section modulus, in^3
E = Modulus of elasticity at design temperature of pipe, psi
Δ = Vertical deflection of the pipe due to ovality, in
P = Internal design pressure, psi
P_{max} = Maximum internal design pressure, psi
F_b = Buoyancy force per unit length of pipe, lb/in
L = Length of the utility in the buoyancy zone, in
M_A = Resultant moment on piping cross section due to weight and other sustained loads, in-lb (includes dead and live loads)
M_B = Resultant moment on piping cross section due to occasional loads, in-lb
M_C = Range of resultant bending moment on piping cross section due to restrained thermal expansion, in-lb
M_{SSE} = Amplitude of moments due to earthquake moment loading and anchor movements, in-lb
i = Stress intensification factor, from Fig. ND-3673.2(b)-1 (**ASME, 2004a**)
ε_b = Bending strain in the pipe due to seismic waves, in/in (calculated from Equation 3, 5 and 7 of ASCE Report (ASCE, 1983))
ε_a = Axial strain in the pipe due to seismic waves, in/in (calculated from Equation 3, 5 and 7 of ASCE Report (ASCE, 1983))
α = Coefficient of thermal expansion of the pipe, in/in/°F
T_2 = Maximum operating temperature of fluid in the pipe, °F
T_1 = Burial installation temperature, °F
S_h = Basic material allowable stress at design temperature, psi
S_y = Material yield strength at temperature consistent with the loading under consideration, psi
S_a = Allowable stress range for expansion stresses from ND-3611.2 (**ASME, 2004a**), psi

3E.5.4 Structural Analysis and Design

The analysis and design procedures for Seismic Category I buried piping are presented in Sections 3.7.3.12, 3.8.4.1.9 and 3.8.4.4.5. Structural acceptance criteria are presented in Section 3.8.4.5.

Selection of Critical Elements

Per Section 3.7.3.12, the analysis of Seismic Category I buried underground piping is divided into two major parts: long, straight segments and pipe bends.

Design of Critical Elements

Two values of modulus of subgrade reaction are used in the design of buried piping. For static load cases (dead and live load case), a range of values for modulus of subgrade reaction has been determined from design soil properties. For dynamic cases (seismic load case), Equation 2 in Appendix VII, Procedures for the Design of Restrained Underground Piping, of ASME B31.1 **(ASME, 2004b)** has been used. Per NUREG-0800 Section 3.7.2, a range of values should be considered. Therefore, for dynamic case the upper bound value considered is twice the best estimate value and the lower bound value considered is one-half the best estimate value.

Long, Straight Segments

The long, straight segments of pipe are analyzed as beams on elastic foundation subjected to uniform loads resulting from dead load and live load. For each load case, moments and shear are calculated using Hetenyi's equations for beams with finite lengths resting on elastic foundations. Using appropriate load combinations specified in 3E.5.3, moments from dead load and live load are combined with thermal stresses, stresses due to traveling seismic waves and stresses due to seismic differential movement between the building and the soil.

Pipe Bends/Elbows

Pipe bends/elbows are conservatively evaluated using the same loads and load combinations as long, straight segments. However, primary stress indices (B_1, B_2) and stress intensification factor (i) have been calculated from Figure ND-3673.2(b)-1 of ASME Section III **(ASME, 2004a)** and utilized in the appropriate load combinations to factor in for the irregular shape of the pipe bends/elbows.

3E.5.5 Summary of Results

The maximum demand to capacity ratios for long, straight segments of pipe are presented in Table 3E-5 for various design load combinations. The maximum demand to capacity ratios for pipe bends are presented in Table 3E-6 for various design load combinations.

The cross sections for buried piping are provided in Figures 3E-6 to 3E-8.

3E.5.6 Conclusions

The critical sections of Seismic Category I buried underground piping have adequate strength to resist the structural loads from various design basis events.

3E.5.7 References

AASHTO, 2002. Standard Specifications for Highway Bridges, 17th Edition, Association of State and Highway Transportation Officials, September 2002.

ASCE, 1983. Seismic Response of Buried Pipes and Structural Components, Report by the Seismic Analysis Committee of the ASCE Nuclear Structures and Materials.

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

ASCE, 2001. American Lifelines Alliance Guidelines for the Design of Buried Steel Pipe, July 2001 (with addenda through February 2005).

ASME, 1992. Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, Section III, Division 1, The American Society of Mechanical Engineers, 1992 edition through 1993 addenda.

ASME, 2004a. Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, Section III, Division 1, The American Society of Mechanical Engineers, 2004 edition.

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

BECHTEL, 1974. Seismic Analysis of Structures and Equipment for Nuclear Power Plants, Revision 3, Bechtel Topical Report BC-TOP-4-A, November 1974.}

3E.6 {Buried Utilities – Seismic Category I Buried Duct Banks

This section is a supplement to U.S. EPR FSAR Appendix 3E.

3E.6.1 Structural Description and Geometry

The layout of the Seismic Category I buried duct banks is shown in Figures 3.8-1 and 3.8-2.

The Seismic Category I buried duct banks traverse from:

- Each Essential Service Water Building to the UHS Makeup Water Intake Structure.
- The four Safeguard Buildings to the four Essential Service Water Building.

As seen in Figure 3.8-1, the duct banks exit the Nuclear Island, head east towards the Intake Area, and are routed through a Utility Corridor. There are various sizes of duct banks to be analyzed. Three sizes – 8ft x 8ft, 3ft – 2in x 2ft – 5in and 3ft – 2in x 3ft – 2in have been chosen from the various sizes of duct banks. The duct banks will have a minimum clear cover of 4ft. Engineered fill shall be used to backfill the duct bank trenches. The cross section of the duct banks are shown in Figure 3E-9. The cross section of the buried duct banks along with buried piping in the Utility Corridor is provided in Figure 3E-7.

3E.6.2 Material Properties

The duct banks sections shall be comprised of reinforced concrete and conform to the requirements of Section 3.8.4.6.1 and U.S. EPR FSAR Section 3.8.4.6.

- Concrete
    - Compressive strength (fc'): 5000 psi (34.5 MPa) minimum at 28 days
    - Modulus of elasticity (E): 4031 ksi (2.779E+04 MPa)
    - Shear modulus (G): 1722 ksi (1.188E+04 MPa)
    - Poisson's ratio: 0.17
    - Maximum water-cementitious ratio of 0.4
- Reinforcement
    - Yield stress (fy): 60 ksi (413.7 MPa)

General description of structural fill is provided in Section 2.5, Table 2.5-48.

3E.6.3 Structural Loads and Load Combinations

Structural Loads

Dead Load

Self weight of duct banks is calculated considering the cross section of duct banks. Soil overburden load inclusive of groundwater effect is calculated per American Lifelines Alliance Guidelines for the Design of Buried Steel Pipe **(ASCE, 2001)**.

Live Load

The static surface load, or live load, is calculated based on AASHTO HS-20 loading from Table 4.1-1 of American Lifelines Alliance Guidelines for the Design of Buried Steel Pipe **(ASCE, 2001)**.

Seismic Load

Per Section 3.7.1.1.4, site SSE is considered as the design ground motion for the seismic analysis of the buried utilities. From Figure 3.7-1, site SSE PGA is 0.15g. Per Reference 1 of Regulatory Guide 1.60 Revision 1, the maximum ground velocity for peak ground acceleration of 1.0g is taken as 4.0 fps. Therefore the peak ground velocity considered for SSE is 0.15*4 fps = 0.6 fps.

The upper bound maximum axial and bending strains due to seismic propagation are calculated using equations in ASCE Report Seismic Response of Buried Pipes and Structural Components **(ASCE, 1983)**. Equations on page 13 and 14 of ASCE Report **(ASCE, 1983)** provide maximum axial and bending strains due to compression, shear and surface waves. These equations are similar to Equation 3.5-3 for axial strain and Equation 3.5-5 for bending strain of ASCE 4-98 **(ASCE, 2000)**. The minimum slippage length is calculated using Equation 5 in Appendix VII, Procedures for the Design of Restrained Underground Piping, of ASME B31.1 **(ASME, 2004b)**. If the longest maximum run of duct bank is shorter than the minimum slippage length, the duct bank is not long enough to develop the full friction and therefore, slippage would occur at the soil-pipe interface. In these situations, the axial stress in the duct bank cross section will be limited to the friction force action on the pipe cross section. The maximum axial and bending strains from compression, shear and surface waves are combined using the square root of the sum of the squares (SRSS).

The dynamic movement between anchor points, such as a building attachment point, shall not be considered as the duct banks planned to have straight runs and at any change in direction or at building interface, manholes shall be provided (refer to discussion in Section 3E.6.4). The tieins between the duct bank and manholes will have flexible couplings. This will preclude additional stresses due to building movements.

Load Combinations

For the design of the concrete duct banks, structural loads and load combinations for the design of site-specific Seismic Category I structures are specified in Sections 3.8.4.3.1 and 3.8.4.3.2, respectively. For convenience, the basic load combinations are repeated below:

- Normal: 1.4*D + 1.7*(L + H)
- Tornado: D + L + H + To + Wt *
- SSE: D + L + H + To + E’

Where:
D = Dead Load
L = Live Load
H = Soil Overburden Load
Wt = Tornado Wind Load*
E’ = Safe Shutdown Earthquake (SSE) load
* Loading of tornado generated automobile missile shall be considered

3E.6.4 Structural Analysis and Design

The analysis and design procedures for Seismic Category I buried duct banks are presented in Sections 3.7.3.12, 3.8.4.1.8 and 3.8.4.4.5. Structural acceptance criteria are presented in Section 3.8.4.5.

Selection of Critical Elements

The analysis of Seismic Category I buried duct bank is performed as straight segments with a maximum length of 150ft between the manholes to facilitate cable pulling. At any change in direction or at building interface, manholes shall be provided. The tie-ins between the duct bank and manholes will have flexible couplings.

Design of Critical Elements

The long, straight segments of duct banks are analyzed as beams on elastic foundation subjected to uniform loads resulting from dead weight of duct banks and soil overburden pressure. Surface load (live load) considered is based on AASHTO HS-20 loading. For each load case, moments and shear are calculated using Hetenyi's equations for beams with finite lengths resting on elastic foundations. The maximum axial and bending strain calculated due to seismic waves are converted to axial and bending stresses using the duct bank's modulus of elasticity. Seismic stresses are then converted into moments and shear and combined with moments and shear from dead load, soil load and live load using appropriate load combinations. The moments and shear obtained above are compared with the design allowables as per ACI 349/349R-01 (ACI, 2001).

3E.6.5 Summary of Results

The maximum demand to capacity ratios for segments of duct banks are presented in Table 3E-7 and 3E-8 for various design load combinations.

The cross sections for buried duct banks are provided in Figures 3E-9. Reinforcement is shown in Figure 3E-10.

3E.6.6 Conclusions

The critical sections of Seismic Category I buried duct banks have adequate strength to resist the structural loads from various design basis events.

3E.6.7 References

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

ASCE, 1983. Seismic Response of Buried Pipes and Structural Components, Report by the Seismic Analysis Committee of the ASCE Nuclear Structures and Materials, 1983.

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

ASCE, 2001, American Lifelines Alliance Guidelines for the Design of Buried Steel Pipe, July 2001 (with addenda through February 2005).}

Table 3E-1 — {Demand and Capacity for In-Plane Shear}

Section	Load [a] Combination	Vu [b] (kip)	φVc [c] (kip)	D/C [d]
Forebay Long Wall	Normal	1006	40700	0.02
	Wind	1189	40700	0.03
	SSE	2770	40700	0.07
	Tornado	441	40700	0.01
	PMH	1208	40700	0.03
	SPH	1149	40700	0.03
UHS MWIS Water Basin Side Wall	Normal	2880	13399	0.22
	Wind	2895	13402	0.22
	SSE	2725	20885	0.13
	Tornado	2027	13244	0.15
	PMH	1993	13342	0.15
	SPH	2776	13403	0.21
UHS MWIS Pump House Side Wall	Normal	137	6751	0.02
	Wind	69	3895	0.02
	SSE	308	3895	0.08
	Tornado	106	6751	0.02
	PMH	270	3895	0.07
	SPH	238	6751	0.04

Notes:

(a) Load combinations are defined in Section 3E.4.3

(b) Vu = Maximum in-plane shear demand

(c) φVc = Nominal in-plane shear strength due to concrete as defined in Section 3E.4.4

(d) D/C = Demand/Capacity, i.e. Vu/φVn

Table 3E-2 — {Demand and Capacity for Out-of-Plane Shear}

Section	Load [a] Combination	Vu [b] (kip)	φVc [c] (kip)	D/C [d]
Common Basemat	Normal	5184	8955	0.58
	Wind	5174	8955	0.58
	SSE	3262	8470	0.39
	Tornado	3771	8792	0.43
	PMH	3129	8752	0.36
	SPH	5466	8966	0.61
Forebay Long Wall	Normal	5173	7676	0.67
	Wind	5160	7674	0.67
	SSE	2937	7566	0.39
	Tornado	3594	7588	0.47
	PMH	2697	7524	0.36
	SPH	5292	7689	0.69
UHS MWIS Water Basin Side Wall	Normal	678	3515	0.19
	Wind	676	3513	0.19
	SSE	861	3437	0.25
	Tornado	434	3470	0.13
	PMH	334	2075	0.16
	SPH	378	2083	0.18
UHS MWIS Pump House Side Wall	Normal	17	685	0.03
	Wind	18	700	0.03
	SSE	46	669	0.07
	Tornado	49	1181	0.04
	PMH	576	1186	0.49
	SPH	437	1200	0.36

Notes:
(a) Load combinations are defined in Section 3E.4.3
(b) Vu = Maximum out-of-plane shear demand
(c) φVc = Nominal out-of-plane shear strength due to concrete as defined in Section 3E.4.4
(d) D/C = Demand/Capacity, i.e. Vu/φVc

Table 3E-3 — {Demand and Capacity for Combined Moment and Axial Force}

(Page 1 of 3)

Section Direction	Load [(a)] Combination	Mu [(b)] (kip-ft)	Pu [(c)] (kip)	φMn [(d)] (kip-ft)	φPn [(e)] (kip)	D/C [(f)]
(a) CBIS Common Basemat (5 ft thick) (for areas where 1 layer of #11 @ 6" each face is required)						
N-S	Normal	-277	31	-798	1909	0.35
	Wind	-276	31	-798	1909	0.35
	SSE	-273	0	-747	-223	0.37
	Tornado	-247	84	-889	1909	0.28
	PMH	-21	-255	-199	-329	0.78
	SPH	-331	76	-875	1909	0.38
E-W	Normal	-474	322	-1734	2104	0.27
	Wind	19	-178	371	-330	0.54
	SSE	-5	-109	-523	-335	0.33
	Tornado	303	74	894	1909	0.34
	PMH	-5	-109	-523	-335	0.33
	SPH	19	-171	387	-329	0.52
(b) CBIS Common Basemat (5 ft thick) (for areas where 2 layers of #11 @ 6" each face is required)						
N-S	Normal	19	-176	374	-330	0.54
	Wind	-446	290	-1714	2104	0.26
	SSE	-122	-6	-1399	-625	0.09
	Tornado	-367	238	-1673	2104	0.22
	PMH	-148	-375	-666	-614	0.61
	SPH	-506	249	-1684	2104	0.30
E-W	Normal	885	104	1590	2098	0.56
	Wind	883	104	1590	2099	0.56
	SSE	689	0	1460	2104	0.47
	Tornado	641	68	1545	2104	0.42
	PMH	216	-494	417	-584	0.85
	SPH	941	107	1593	2089	0.59
(c) Forebay Long Wall (4.5 ft thick) (for areas where 2 layers of #11 @ 6" each face is required)						
Vertical	Normal	-907	82	-1321	1878	0.69
	Wind	901	77	1316	1880	0.68
	SSE	662	49	1289	1932	0.51
	Tornado	-664	59	-1298	1932	0.51
	PMH	506	33	1273	1932	0.40
	SPH	959	78	1317	1858	0.73

Table 3E-3 — {Demand and Capacity for Combined Moment and Axial Force}

(Page 2 of 3)

Section Direction	Load (a) Combination	Mu (b) (kip-ft)	Pu (c) (kip)	φMn (d) (kip-ft)	φPn (e) (kip)	D/C (f)
Horizontal	Normal	184	-262	814	-589	0.45
	Wind	184	-262	814	-589	0.45
	SSE	-533	55	-1347	1932	0.40
	Tornado	122	-193	940	-619	0.31
	PMH	100	-174	976	-629	0.28
	SPH	206	-275	791	-578	0.48
(d) Forebay Walls (4.5 ft thick) (for areas where 3H+2V layers of #11 @ 6" each face are required)(g)						
Vertical	Normal	-441	69	-1308	1932	0.34
	Wind	-443	70	-1309	1932	0.34
	SSE	242	42	1282	1932	0.19
	Tornado	324	43	1283	1932	0.25
	PMH	254	30	1271	1932	0.20
	SPH	-462	73	-1312	1932	0.35
Horizontal	Normal	169	-152	1588	-933	0.16
	Wind	172	-154	1584	-932	0.17
	SSE	462	49	1868	2127	0.25
	Tornado	122	-107	1663	-956	0.11
	PMH	192	-531	939	-922	0.58
	SPH	181	-172	1555	-928	0.19
(e) UHS MWIS Water Basin Walls and El+11.5' Floor (4 ft thick) (1 layer of #11 @ 9" each face)						
Vertical or E-W	Normal	72	1407	731	1501	0.94
	Wind	80	1332	814	1501	0.89
	SSE	106	1034	1034	1501	0.69
	Tornado	50	974	1062	1501	0.65
	PMH	306	814	1113	1501	0.54
	SPH	39	1208	923	1501	0.80
Horizontal or N-S	Normal	40	-164	119	-204	0.80
	Wind	34	-153	139	-208	0.74
	SSE	6	-128	185	-222	0.58
	Tornado	28	-113	212	-211	0.54
	PMH	-276	-60	-299	-74	0.92
	SPH	41	-133	177	-204	0.65

Table 3E-3 — {Demand and Capacity for Combined Moment and Axial Force}
(Page 3 of 3)

Section Direction	Load [a] Combination	Mu [b] (kip-ft)	Pu [c] (kip)	φMn [d] (kip-ft)	φPn [e] (kip)	D/C [f]
(f) UHS MWIS Water Basin Walls (4 ft thick) (2 layers of #11 @ 6" in pairs each face)						
Vertical	Normal	-28	-483	-1361	-1335	0.36
	Wind	-25	-468	-1383	-1337	0.35
	SSE	-29	-411	-1466	-1334	0.31
	Tornado	-19	-332	-1581	-1339	0.25
	PMH	-36	-513	-1317	-1331	0.39
	SPH	-21	-439	-1426	-1338	0.33
Horizontal	Normal	809	-159	1944	-884	0.42
	Wind	784	-150	1957	-898	0.40
	SSE	-4	-150	-1958	-1347	0.11
	Tornado	650	-136	1979	-979	0.33
	PMH	478	-80	2065	-1079	0.23
	SPH	885	-175	1919	-838	0.46
(g) UHS MWIS Walls, Floors and Roof (2 ft thick) (1 layer of #9 @ 9" each face)						
Vertical or E-W	Normal	-28	10	-128	769	0.22
	Wind	-29	9	-127	769	0.23
	SSE	11	-27	102	-132	0.20
	Tornado	-19	1	-123	769	0.16
	PMH	42	16	131	769	0.32
	SPH	-34	41	-146	769	0.23
Horizontal or N-S	Normal	-116	226	-231	768	0.50
	Wind	-113	224	-230	768	0.49
	SSE	-3	-40	-93	-141	0.28
	Tornado	-89	166	-201	769	0.45
	PMH	0	-51	-85	-144	0.36
	SPH	-121	246	-239	767	0.51

Notes:
(a) Load combinations are defined in Section 3E.4.3
(b) Mu = Bending moment demand
(c) Pu = Axial force demand (positive for compression)
(d) φMn = Bending moment capacity
(e) φPn = Axial force capacity
(f) D/C = Demand/capacity, Ratio of Mu/φMn and Pu/φPn

Table 3E-4 — {Demand and Capacity for Shear Friction}

Section	Load [a] Combination	Nu [b] (kip)	Vu [c] (kip)	φVn [d] (kip)	D/C [e]
Forebay Long Wall (2 layers of #11@6”)	Normal	-68	2010	16083	0.13
	Wind	-65	2010	16083	0.13
	SSE	-387	1364	16083	0.08
	Tornado	13	1389	16083	0.09
	PMH	70	1550	16083	0.10
	SPH	-14	2201	16083	0.14
UHS MWIS Water Basin Side Wall (1 layer of #11@9”)	Normal	-2295	2279	9921	0.23
	Wind	-2317	2285	9921	0.23
	SSE	-1498	760	5618	0.14
	Tornado	-1481	1550	9921	0.16
	PMH	-1822	1110	9921	0.11
	SPH	-2226	2156	9921	0.22
UHS MWIS Walls 2' Thick (1 layer of #9@9”)	Normal	-958	140	7067	0.02
	Wind	-337	75	4077	0.02
	SSE	-686	312	4077	0.08
	Tornado	-619	113	7067	0.02
	PMH	-775	267	4077	0.07
	SPH	-731	190	7067	0.03

Notes:
(a) Load combinations are defined in Section 3E.4.3
(b) Nu = Normal force on friction interface (positive for tension)
(c) Vu = Shear demand, vector sum of in-plane and out-of-plane shear
(d) φVn = Nominal shear friction strength
(e) D/C = Demand/Capacity, i.e. Vu/φVn

Table 3E-5 — {Demand and Capacity Evaluation for Long, Straight Segments of Seismic Category I Buried Piping}

Section	Load Combination[a]	Actual Stress (ksi)	Allowable Stress (ksi)	D/C[b]
8" Diameter	Primary Stress Loads	11.03	40.65	0.27
	Occasional Stress Loads	19.35	48.78	0.40
	Sustained plus Secondary Stress Loads	20.75	67.75	0.31
	Faulted Stress Loads (Eq. A)	61.71	81.30	0.76
	Faulted Stress Loads (Eq. B)	80.80	81.30	0.99
10" Diameter	Primary Stress Loads	7.90	30.00	0.26
	Occasional Stress Loads	7.63	36.00	0.21
	Sustained plus Secondary Stress Loads	17.06	50.00	0.34
	Faulted Stress Loads (Eq. A)	39.91	60.00	0.67
	Faulted Stress Loads (Eq. B)	43.99	60.00	0.73
30" Diameter	Primary Stress Loads	15.41	30.00	0.51
	Occasional Stress Loads	13.30	36.00	0.37
	Sustained plus Secondary Stress Loads	18.42	50.00	0.37
	Faulted Stress Loads (Eq. A)	44.04	60.00	0.73
	Faulted Stress Loads (Eq. B)	47.44	60.00	0.79
60" Diameter	Primary Stress Loads	25.35	30.00	0.85
	Occasional Stress Loads	17.72	36.00	0.49
	Sustained plus Secondary Stress Loads	23.00	50.00	0.46
	Faulted Stress Loads (Eq. A)	49.33	60.00	0.82
	Faulted Stress Loads (Eq. B)	52.47	60.00	0.87

Notes:

(a) Load combinations are defined in Section 3E.5.3

(b) D/C = Demand/Capacity, i.e. Actual/Allowable

Table 3E-6 — {Demand and Capacity Evaluation for Pipe Bends of Seismic Category I Buried Piping}

Section	Load Combination[(a)]	Actual Stress (ksi)	Allowable Stress (ksi)	D/C[(b)]
8" Diameter	Primary Stress Loads	11.18	40.65	0.27
	Occasional Stress Loads	19.49	48.78	0.40
	Sustained plus Secondary Stress Loads	20.75	67.75	0.31
	Faulted Stress Loads (Eq. A)	62.42	81.30	0.77
	Faulted Stress Loads (Eq. B)	80.80	81.30	0.99
10" Diameter	Primary Stress Loads	7.56	30.00	0.25
	Occasional Stress Loads	7.29	36.00	0.20
	Sustained plus Secondary Stress Loads	17.06	50.00	0.34
	Faulted Stress Loads (Eq. A)	40.43	60.00	0.67
	Faulted Stress Loads (Eq. B)	43.99	60.00	0.73
30" Diameter	Primary Stress Loads	18.31	30.00	0.61
	Occasional Stress Loads	16.20	36.00	0.45
	Sustained plus Secondary Stress Loads	18.59	50.00	0.37
	Faulted Stress Loads (Eq. A)	54.33	60.00	0.91
	Faulted Stress Loads (Eq. B)	58.40	60.00	0.97
60" Diameter	Primary Stress Loads	14.30	30.00	0.48
	Occasional Stress Loads	23.07	36.00	0.64
	Sustained plus Secondary Stress Loads	23.00	50.00	0.46
	Faulted Stress Loads (Eq. A)	38.84	60.00	0.65
	Faulted Stress Loads (Eq. B)	53.42	60.00	0.89

Notes:

(a) Load combinations are defined in Section 3E.5.3

(b) D/C = Demand/Capacity, i.e. Actual/Allowable

Table 3E-7 — {Demand and Capacity Moment Evaluation of Seismic Category I Duct Banks}

Section	Load Combination[(a)]	Demand Moment (kip-ft)	Capacity Moment (kip-ft)	D/C[(b)]
8ft x 8ft	Normal	2699.8	7798.8	0.35
	Tornado	3337.4	7798.8	0.43
	SSE	3870.8	7798.8	0.50
3ft – 2in x 2ft – 5in	Normal	326.2	656.7	0.50
	Tornado	455.8	656.7	0.69
	SSE	228.9	656.7	0.35
3ft – 2in x 3ft – 2in	Normal	547.7	1130.2	0.48
	Tornado	742.6	1130.2	0.66
	SSE	396.0	1130.2	0.35

Notes:

(a) Load combinations are defined in Section 3E.5.3

(b) D/C = Demand/Capacity, i.e. Actual/Allowable

Table 3E-8 — {Demand and Capacity Shear Evaluation of Seismic Category I Duct Banks}

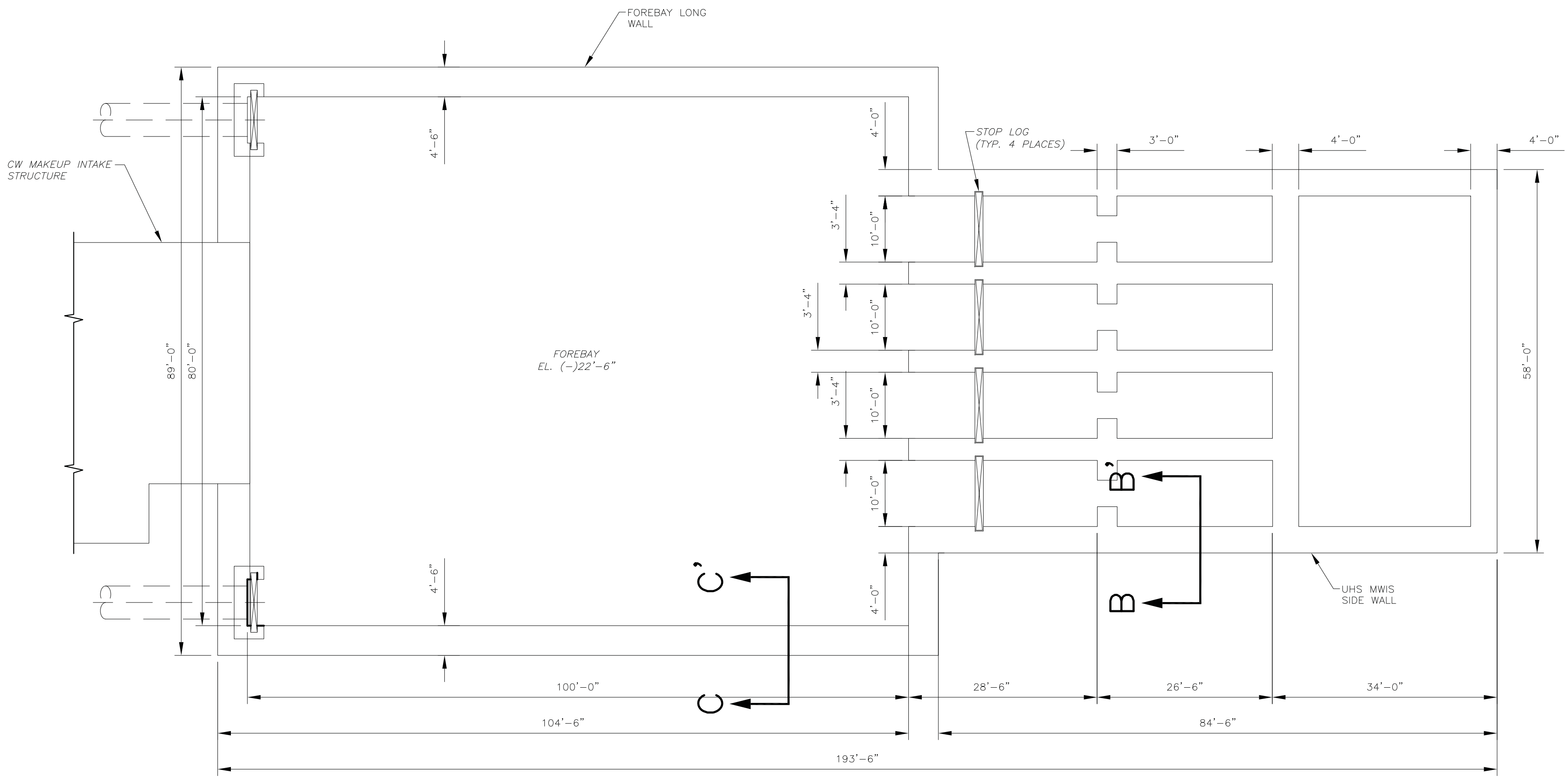
Section	Load Combination[(a)]	Demand Shear (kip)	Capacity Shear (kip)	D/C[(b)]
8ft x 8ft	Normal	362.4	790.7	0.46
	Tornado	453.9	790.7	0.57
	SSE	231.0	790.7	0.29
3ft – 2in x 2ft – 5in	Normal	50.6	95.7	0.53
	Tornado	87.4	95.7	0.91
	SSE	31.0	95.7	0.32
3ft – 2in x 3ft – 2in	Normal	73.9	126.4	0.58
	Tornado	114.3	126.4	0.90
	SSE	45.6	126.4	0.36

Notes:

(a) Load combinations are defined in Section 3E.5.3

(b) D/C = Demand/Capacity, i.e. Actual/Allowable

Figure 3E-1 — {Foundation Plan for the Forebay and UHS Makeup Water Intake Structure @ Elevation -22.5 ft (-6.86 m)}



SCALE: 1/16"=1'−0"

Figure 3E-2 — {Reinforcement for Forebay and UHS Makeup Water Intake Structure Basemat}

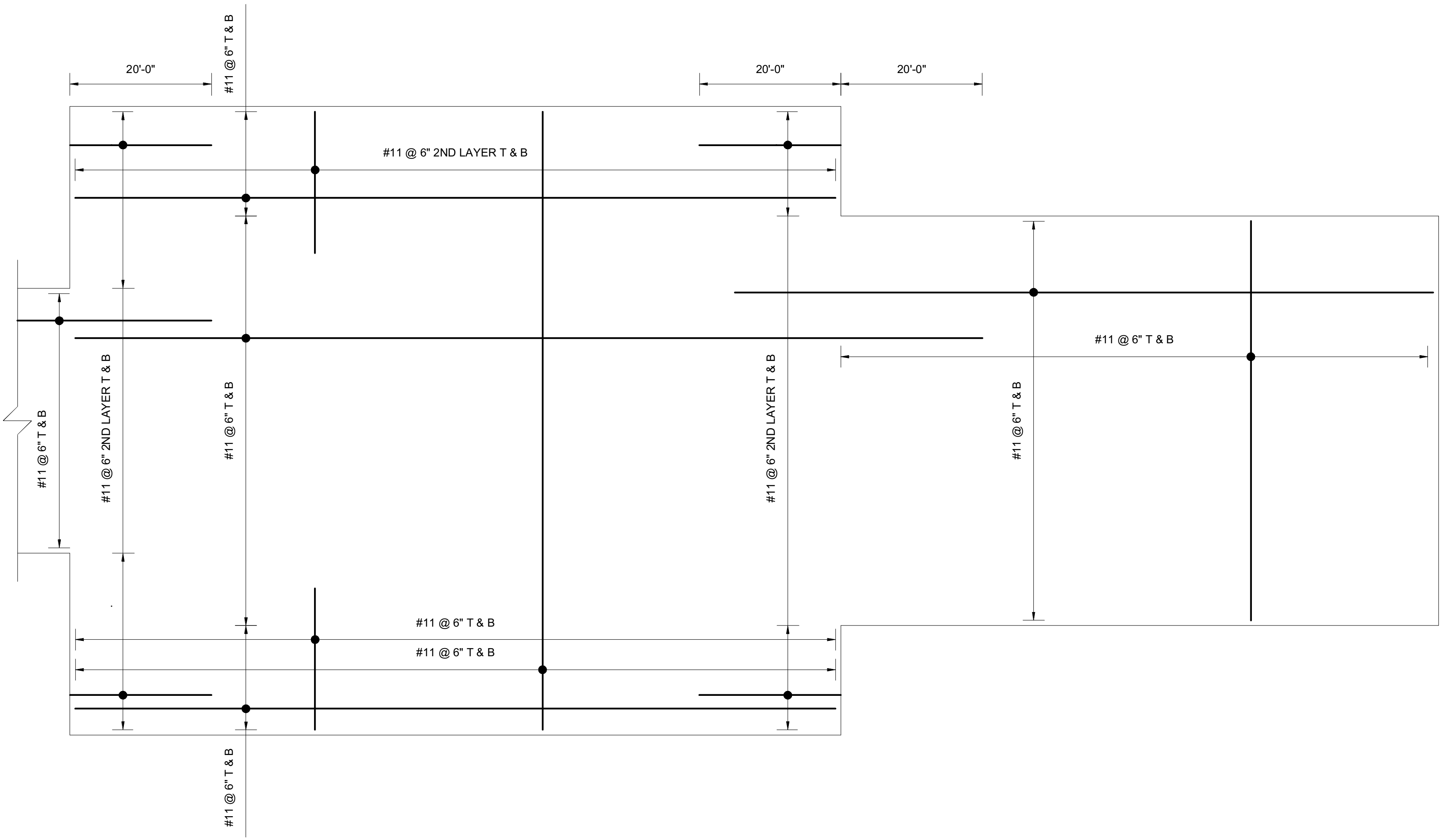


Figure 3E-3 — {Reinforcement for Forebay and UHS Makeup Water Intake Structure Walls – UHS Makeup Water Intake Structure Side Wall (Section B)}

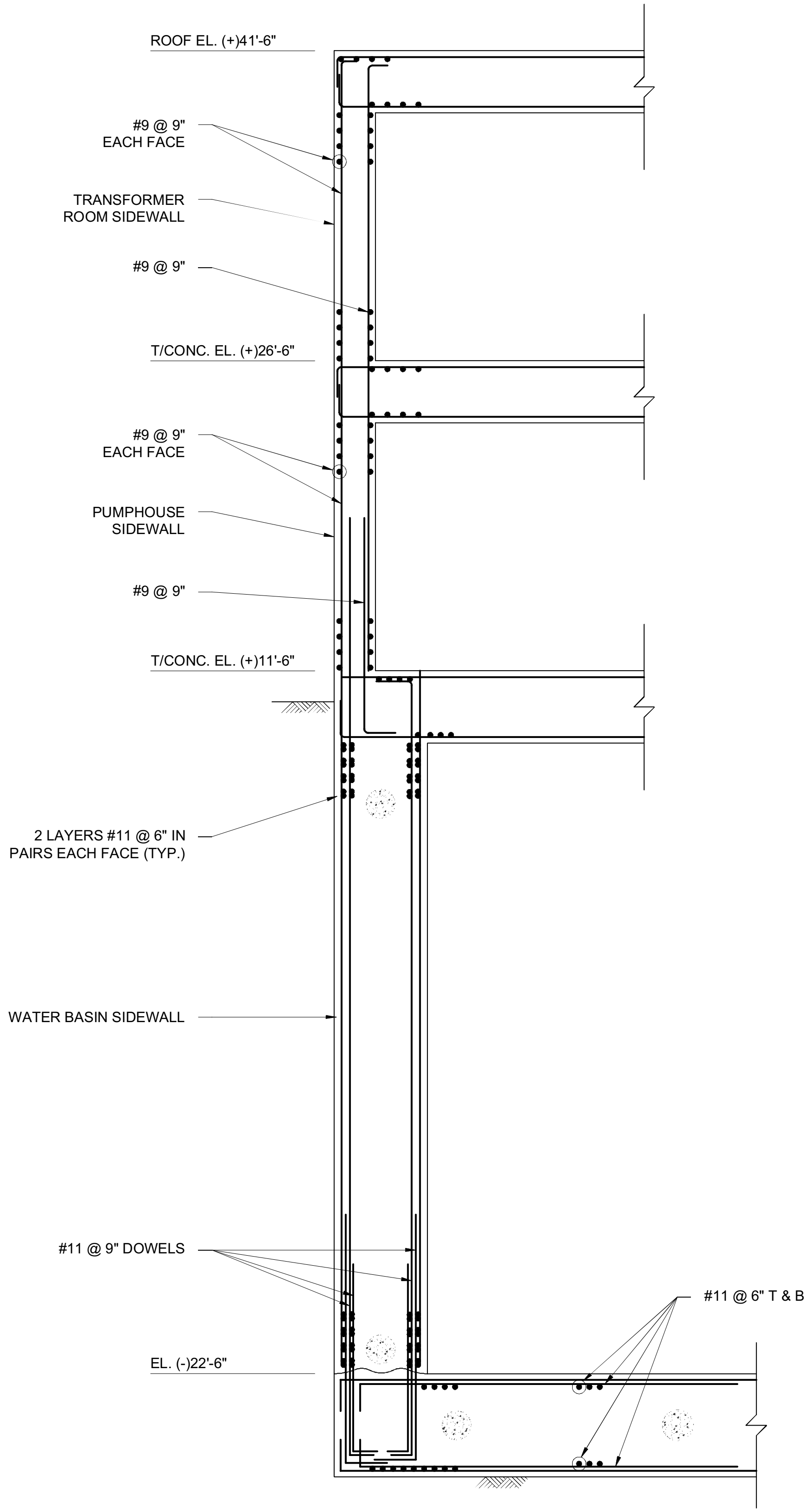


Figure 3E-4 — {Reinforcement for Forebay and UHS Makeup Water Intake Structure Walls – Forebay Long Wall (Section C)}

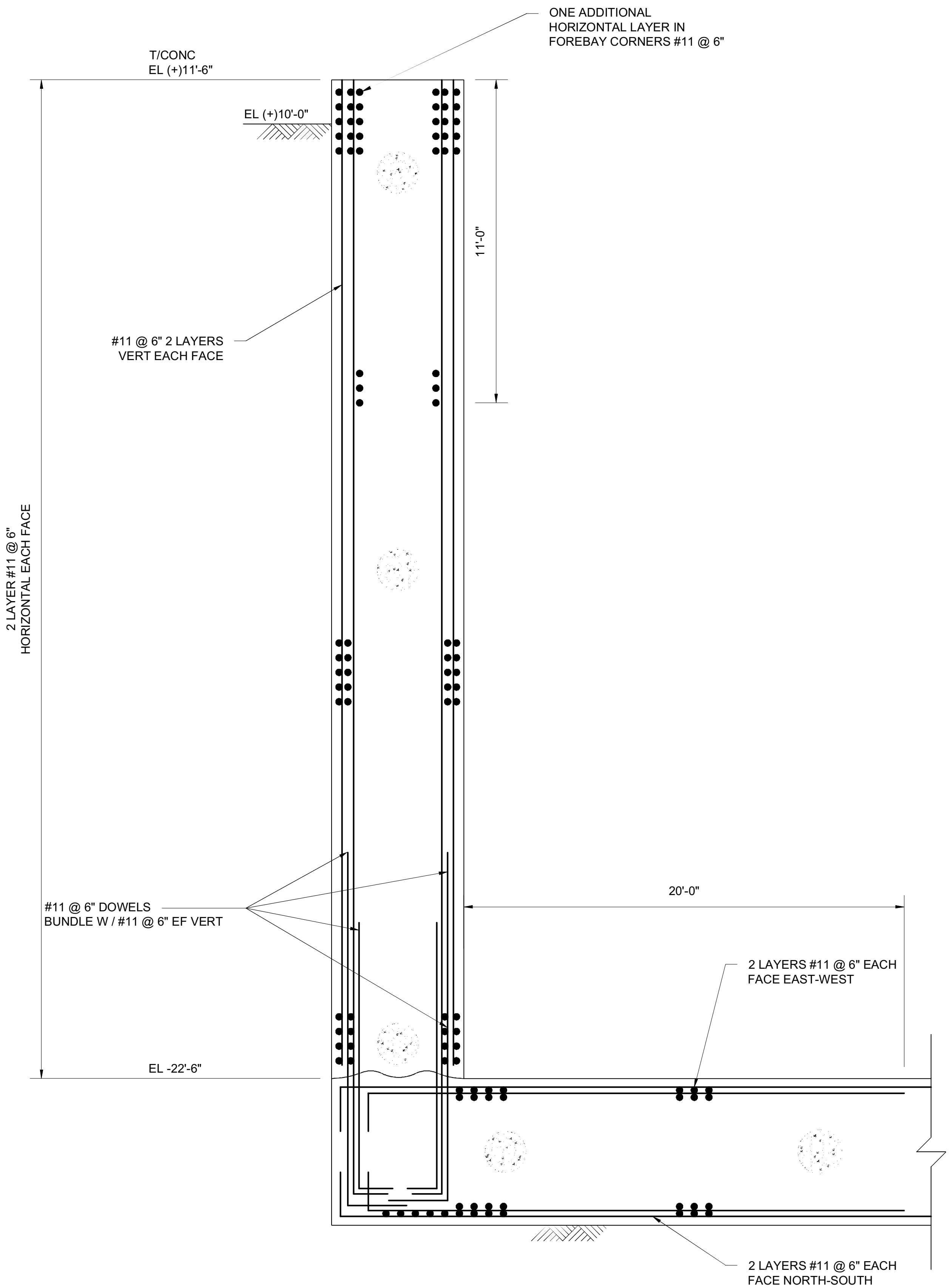


Figure 3E-5 — {Isometric View of the Common Basemat Intake Structures STAAD Pro Model for Static Analyses}

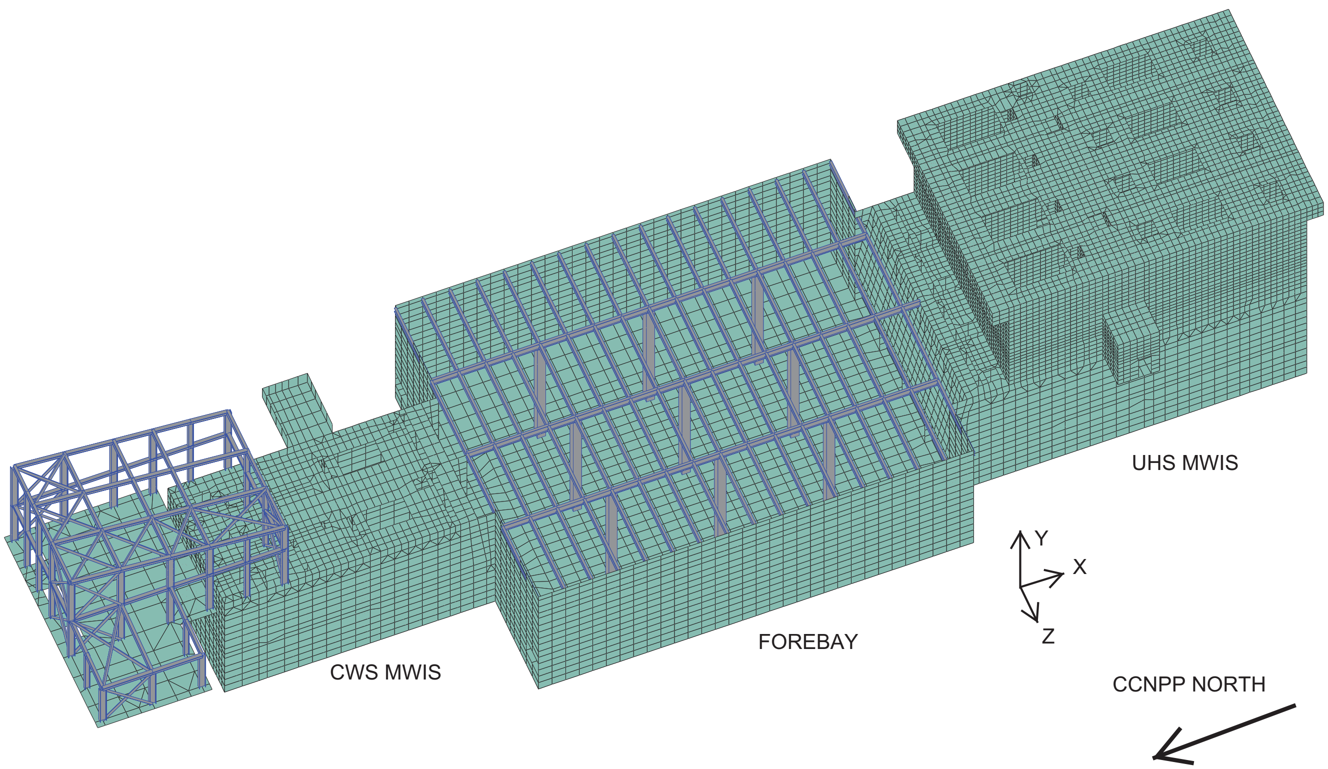
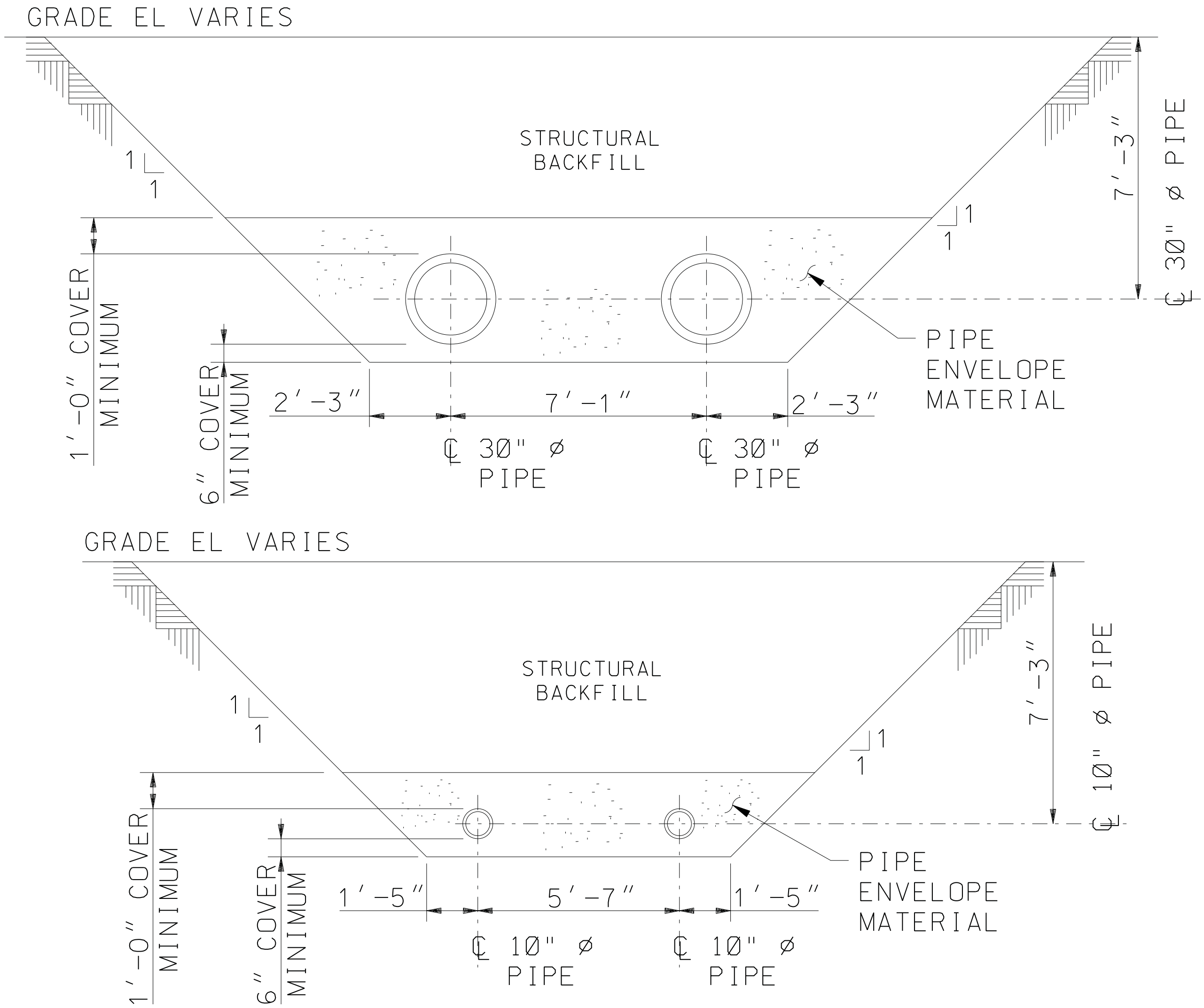


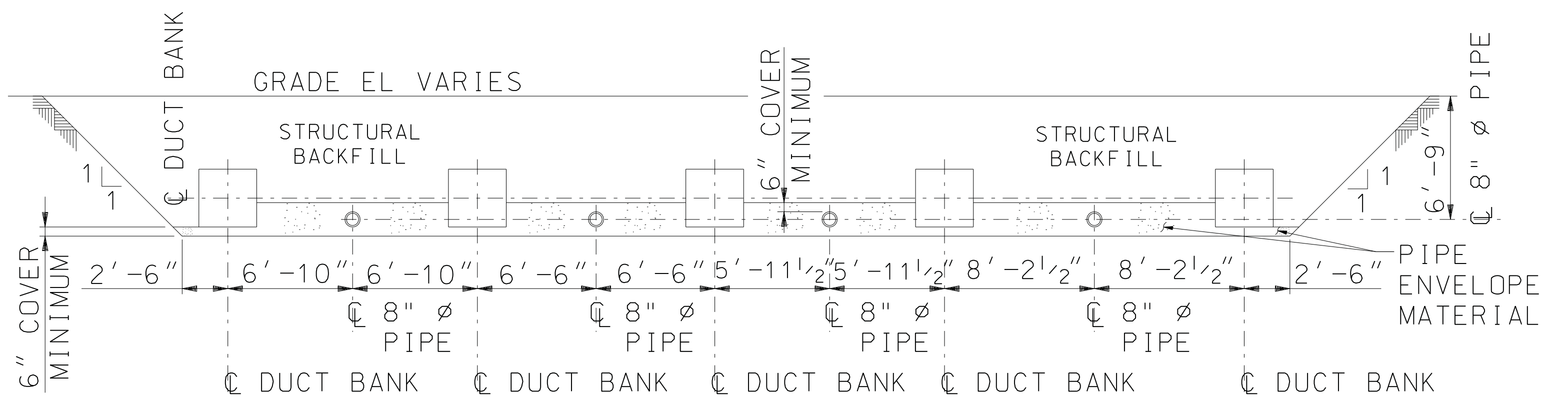
Figure 3E-6 — {Cross Section of Seismic Category I Buried Piping in the Nuclear Island}



NOTES:

1. 30" DIAMETER PIPE IS SPECIFIED AS ASME SA-106 GR. C, UNS K03501, WALL THICKNESS = 0.75", INTERNALLY LINED WITH MORTAR USING TYPE II CEMENT PER ASTM C150 AND EXTERNALLY COATED WITH A HIGH SOLIDS EPOXY.
2. 10" DIAMETER PIPE IS SPECIFIED AS ASME SA-106 GR. C, UNS K03501, WALL THICKNESS = 0.594", INTERNALLY AND EXTERNALLY COATED WITH 2-LAYER FUSION BONDED EPOXY.
3. PIPE ENVELOPE MATERIAL SHALL BE WELL DENSIFIED CLEAN, COARSE SAND.
4. EXTERIOR SURFACE OF PIPES SHALL BE CATHODICALLY PROTECTED.

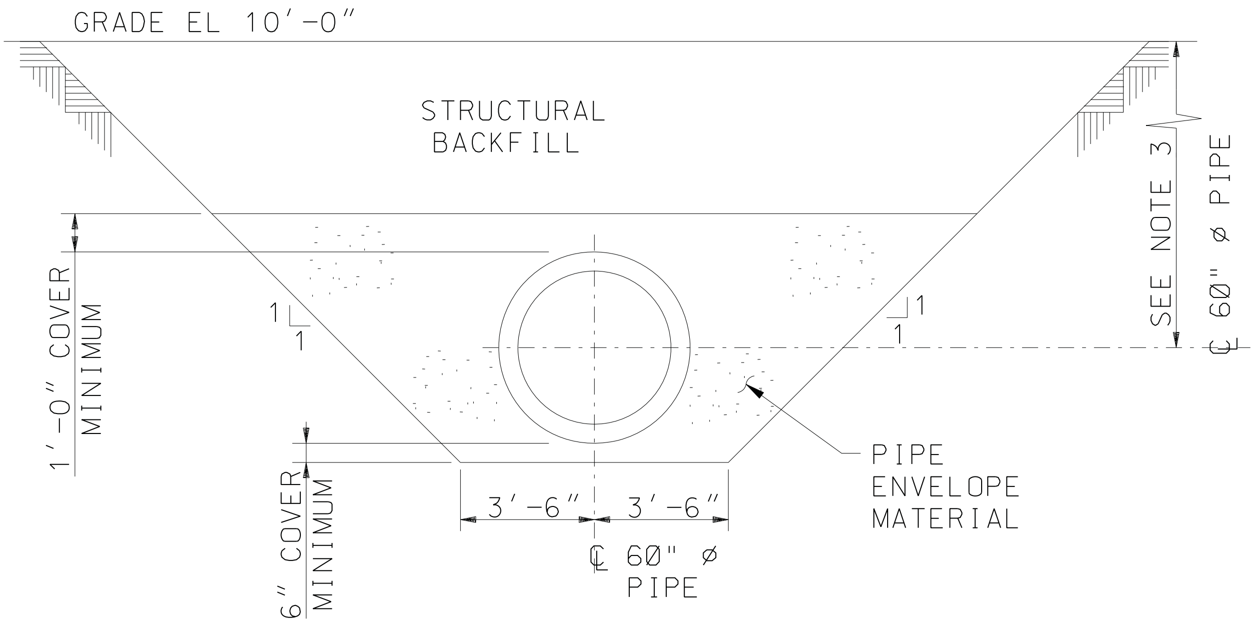
Figure 3E-7 — {Cross Section of Seismic Category I Buried Utilities in the Utility Corridor}



NOTES:

1. 8″ DIAMETER PIPE IS SPECIFIED AS ASME SB-690, UNS N08367, WALL THICKNESS = 0.50″ WITH SUITABLE EXTERNAL PROTECTION FROM SOIL AND STRAY CURRENT.
2. DUCT BANK SIZE IS 3′-2″ X 3′-2″.
3. DUCT BANK MATERIAL IS SPECIFIED AS CONCRETE WITH MINIMUM COMPRESSIVE STRENGTH (f′c) OF 5000 PSI (34.9 MPa) AT 28 DAYS AND REINFORCEMENT WITH YIELD STRESS (fy) OF 60 KSI (413.7 MPa).
4. PIPE ENVELOPE MATERIAL SHALL BE WELL DENSIFIED CLEAN, COARSE SAND.
5. EXTERIOR SURFACE OF PIPES SHALL BE CATHODICALLY PROTECTED.

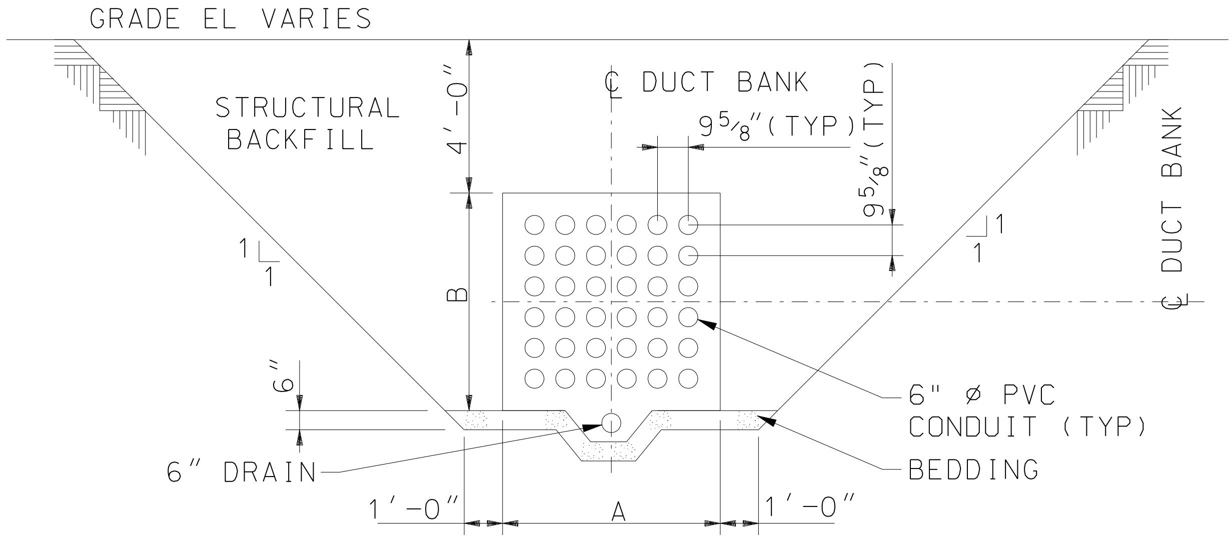
Figure 3E-8 — {Cross Section of Seismic Category I Buried Pipe in Intake Area}



NOTES:

1. 60" DIAMETER PIPE IS SPECIFIED AS ASME SA-672 GR. B70, UNS K03101, WALL THICKNESS = 2.25", INTERNALLY LINED WITH ASTM C150 TYPE II CEMENT AND EXTERNALLY COATED WITH A HIGH SOLIDS EPOXY.
2. PIPE ENVELOPE MATERIAL SHALL BE WELL DENSIFIED CLEAN, COARSE SAND.
3. DEPTH MEASURED FROM PIPE CENTERLINE TO GRADE ELEVATION VARIES FROM 25 FT AT INTAKE TO 27 FT AT FOREBAY.
4. EXTERIOR SURFACE OF PIPES SHALL BE CATHODICALLY PROTECTED.

Figure 3E-9 — {Cross Section of Seismic Category I Buried Duct Banks in the Nuclear Island}

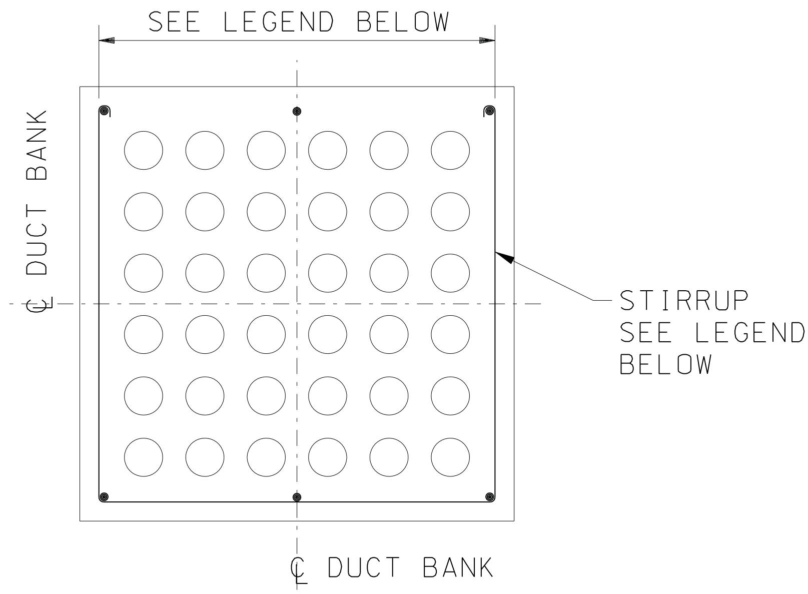


LEGEND:

A= 8'-0" / 3'-2" / 3'-2"
B= 8'-0" / 2'-5" / 3'-2"

NOTES:
1. BEDDING MATERIAL SHALL BE STRUCTURAL FILL.

Figure 3E-10 — {Reinforcement Arrangement for Seismic Category I Buried Duct Banks}



LEGEND:

FOR 8'-0" X 8'-0" -

#10 @ 6" O.C. T & B
2-LEGGED #6 @ 9" O.C.

FOR 3'-2" X 2'-5" -

#9 @ 6" O.C. T & B
2-LEGGED #4 @ 12" O.C.

FOR 3'-2" X 3'-2" -

#10 @ 6" O.C. T & B
2-LEGGED #4 @ 12" O.C.}

3F U.S. EPR PIPING ANALYSIS AND PIPE SUPPORT DESIGN

{This section of the U.S. EPR FSAR is incorporated by reference.}

{AND SITE RESPONSE ANALYSIS AND SSI ANALYSIS INPUT FOR NI/NAB/AB EPGB, ESWB, CBIS, AND TI STRUCTURE

This portion of the Appendix is site-specific and added as a Supplement to the U.S. EPR FSAR.

This appendix discusses in detail the development of the seismic ground motions and the strain-compatible soil profile properties, which are used in the Soil-Structure Interaction (SSI) analysis of Seismic Category I structures, as well as the Seismic Category II Nuclear Auxiliary Building (NAB), Access Building (AB) and Turbine Island (TI) Structure. The NAB and NI are analyzed within the Nuclear Island Soil Structure Interaction (SSI) model, referred to as the NI/NAB/AB model. Structures analyzed in the intake area include the Common Basemat Intake Structures (CBIS). The CBIS includes two Seismic Category I structures: the Ultimate Heat Sink (UHS) Makeup Water Intake Structure and the Forebay, as well as the Seismic Category II Circulating Water Makeup Intake Structure, which all share the same basemat. Structures analyzed in the vicinity of the NI/NAB/AB include the Emergency Power Generating Buildings (EPGB), the Essential Service Water Buildings (ESWB), and the TI Structure. Seismic ground motions and the strain-compatible soil profile properties for the structures associated with the NI/NAB/AB are also discussed in this appendix.

Section 3F.1 describes the development of the Foundation Input Response Spectra (FIRS). The FIRS are developed in accordance with Regulatory Guide 1.208 (NRC, 2007), through seismic site response analysis using the rock motion spectra, presented in Section 2.5.2.5.1.4, and the soil profile properties, presented in Section 2.5.4.2. The FIRS are modified according to the requirements for checking the adequacy of the SSI input motion (NRC, 2010 and NEI, 2009). FIRS for TI, EPGB and ESWB are amplified to account for the structure-soil-structure Interaction (SSSI) effects due to interaction with the NI/NAB/AB.

The Site Safe Shutdown Earthquake (Site SSE), presented in Section 3.7.1.1.1.1, envelops the Adjusted FIRS, and therefore is adequate for use in SSI analysis. The Site SSE strain-compatible soil properties are discussed in Section 3F.2. The acceleration time histories that are to be applied at the foundation of the structures in the SSI analysis are presented in Section 3F.3. Section 3F.4 describes the computer codes used in the analyses, while Section 3F.5 includes a list of the references.

3F.1 Foundation Input Response Spectra (FIRS)

The bottom of foundation for the NI at the CCNPP Unit 3 site is modeled at Elevation +46 feet, equivalent to a depth of 39 feet (11.4 m) below grade. Finished grade in the NI area is at Elevation +85 feet. All elevations are based on MSL datum. The EPGB, ESWB, and TI Structure are situated at the CCNPP Unit 3 site in the NI area. The bottom of the EPGB basemat is situated at 11 ft (3.3 m) below grade, while the ESWB basemat is situated 33 ft (10.1 m) below grade, and the TI Structure foundation is situated approximately 22 ft (6.7 m) below grade. In the confirmatory SSI analysis, the NI/NAB/AB, as well as the EPGB and ESWB are all treated as a embedded structures, and their respective FIRS as full-outcrop motions. Similarly, the TI Structure is analyzed as an embedded structure and its corresponding FIRS is calculated as a full-column outcrop motion.

The site-specific Seismic Category I CBIS are situated at the CCNPP Unit 3 intake area, along the west bank of the Chesapeake Bay. The bottom of the CBIS common basemat is situated approximately 37.5 ft (11.4 m) below finished grade, which corresponds to Elevation +10 ft in the Intake area. Table 3F-1 summarizes the bottom of foundation depths and elevations.

The generation of low-strain site-specific simulated soil property profiles is described in Section 3F1.1, the site response analysis and the calculation of FIRS are presented in Section 3F.1.2, and the adjustment of FIRS is described in Section 3F.1.3. The development of the SSE motions is presented in Section 3F.1.4, and the structure-soil-structure interaction (SSSI) effects are discussed in Section 3F.1.5. The spectral matching of acceleration time histories to the outcrop SSE motions is presented in Section 3F.1.6. The Site SSE envelops the Adjusted FIRS, and is therefore adequate for use in the SSI analysis.

3F.1.1 Dynamic Soil Profile and Stochastic Simulation

The computer program SPS, described in Section 3F.4, is used to generate site-specific simulated (randomized) soil profiles to represent the dynamic properties of the site while considering the uncertainty associated with each of these properties. The generation of the low-strain simulated soil profiles requires the input Best Estimate (BE) properties and their associated uncertainty. The uncertainty is expressed in terms of statistical distribution, standard deviation (SD), and correlation among engineering parameters.

The static and dynamic soil properties, required to generate the simulated profiles for the NI and Intake areas, are provided in Section 2.5.4.2. These properties include shear wave velocity, thicknesses, unit weight, and the strain-dependent property curves (shear modulus reduction and damping ratio) for the different soil layers (including the structural backfill).

The depth of backfill under the NI/NAB/AB ranges from 49 feet to 59 feet below grade (corresponding to Elevation +36 feet and +26 feet, respectively). Two soil columns are analyzed, and represent the varying range of backfill depth. The two soil columns are referred to as "RB36" and "RB26", corresponding to the backfill extending down to Elevation +36 feet and +26 feet, respectively. Figure 3F-1a presents the BE low-strain shear-wave velocity profiles for the RB26 soil column. Figure 3F-1b presents the associated log-standard deviation for the shear wave velocity for the NI/NAB/AB. Figure 3F-1c and Figure 3F-2 present the BE low-strain shear wave velocity profile for the NI area and Intake area, respectively (also see Figure 2.5-156 and Figure 2.5-158). The total BE soil column thickness is about 2,500 ft (762 m) in both areas. At that depth, bedrock is defined with a shear-wave velocity of 9,200 ft/sec (2,804 m/sec). Figure 3F-3 and Figure 3F-4a present the associated log-standard deviation for the shear wave velocity profile at the NI area and Intake area, respectively. While the two areas share similar properties for the deep soil strata, they are different with respect to finished grade elevation, ground water level elevation, thickness of backfill, and the upper soil strata.

Two sets of 60 simulated profiles, representing the RB36 and RB26 soil columns, are generated. Figure 3F-4b presents the set of 60 simulated low-strain shear-wave velocity profiles for the RB36 soil column, which includes the thickness variation of the soil layers. The figure also presents the BE profile used as input for simulation and the simulated median profile, calculated as the log-mean of the 60 simulated profiles, and shows a close match between these two profiles. Figure 3F-4c presents the corresponding low-strain shear-wave velocity profiles for the RB26 soil column, also having a close match between the BE and simulated median.

Similarly, two sets of 60 simulated profiles, representing the NI and Intake area site conditions, are generated. Figure 3F-5 presents the set of 60 simulated low-strain shear wave velocity profiles for the NI area, while Figure 3F-6 presents the corresponding low-strain shear wave velocity profiles for the Intake area.

As an example, the simulated shear strength reduction and damping ratio curves for the uppermost fill layer (referred to as Fill 1) at the NI area are presented in Figure 3F-7 and Figure 3F-8, respectively. In these figures, the BE and simulated median are compared as well as the input log-standard deviation (Input SD) and simulated log-standard deviation (Simulated SD). Maximum and minimum bounds of twice the SD around the BE are imposed on the strain-dependent property curves. Note that damping curves, in Figure 3F-8, are truncated at a maximum of 15% as described by NUREG/CR-1161, which explains the discrepancy between input and simulated properties once that upper limit is reached. The damping truncation at 15% is a conservative measure with respect to their subsequent use in site response analysis.

3F.1.2 Site Response Analysis

The low-frequency (LF) and high frequency (HF) input rock spectra at the 1E-4 and 1E-5 hazard levels (or annual probability of exceedance) are presented in Section 2.5.2.5.1.4, Figure 2.5-63 and Figure 2.5-64. The rock spectra are applied at bedrock having a shear wave velocity of 9,200 ft/sec (2,804 m/sec), and are propagated from bedrock to the ground surface, through the four sets of 60 simulated profiles, for the RB36 and RB26 soil columns (representing the NI/NAB/AB structures site conditions) and for the NI and Intake areas, using the computer program P-SHAKE (described in Section 3F.4).

As an input for site response analysis, the duration of the input motion is specified as a parameter in P-SHAKE. The strong motion durations are determined using the magnitudes (M) and distances of the four input rock motions (see Table 3F-2), and Table 3-2 in NUREG/CR-6728 (McGuire et al., 2001). The magnitudes and corresponding durations are reported in Table 3F-2. An additional parameter required for P-SHAKE is the effective strain ratio, which is calculated as a function of earthquake magnitude, as shown in Equation 3F-1 (Idriss and Sun, 1992). Kramer (1996) recommends the range for the effective strain ratio to be between 0.5 and 0.7. This range is imposed on the ratios calculated using Equation 3F-1. The resulting effective strain ratios used in site response analysis are reported in Table 3F-2a.

Effective Strain Ratio = (M-1)/10 Equation (3F-1)

The free field 5% damping Acceleration Response Spectra (ARS) at the ground surface and at the bottom of foundation elevations are computed as outcrop motions through analysis of the full soil column up to the ground surface. All spectra are calculated at 301 points equally spaced in log-scale in the frequency range from 0.1 to 100 Hz (a period range of 0.01 to 10 seconds). The cut-off frequency of the P-SHAKE runs is 100 Hz. Log-mean (median) ARS are calculated from the ARS results for all 60 simulated profiles, for each set of P-SHAKE analyses. ARS amplification functions are calculated at each horizon, by dividing the ARS of the given horizon by the ARS of the input rock motion. Figure 3F-9a and Figure 3F-9b present the ARS amplification functions calculated at 39 ft (11.7 m) depth for the RB36 and RB26 soil columns, respectively. Figure 3F-9c presents the ARS amplification functions calculated at 34 ft depth for the NI area. Note that for the EPGB at 11 ft depth, ARS amplifications are calculated at 9.5 ft and 13.5 ft depth and enveloped. Similarly, for the ESWB at 33 ft depth, ARS amplifications are calculated at 30 ft and 34 ft depth and enveloped. The ARS amplification functions are also calculated at ground surface in the NI area, and at ground surface and at 37.5 ft below grade in the Intake area, but are not presented in figures.

The P-SHAKE runs provide the strain compatible shear wave velocities and damping ratio profiles (presented in Section 3F.2) as well as the maximum strains within each soil layer. Figure 3F-10a and Figure 3F-10b present the log-mean strain profiles for the RB36 and RB26 soil columns, respectively. Figure 3F-10c and Figure 3F-11 present the log-mean strain profiles for the NI area and Intake area, respectively.

FIRS Calculation

The horizontal Foundation Input Response Spectra (FIRS) are calculated using the procedure described in Section 5.1 of Regulatory Guide 1.208 (NRC, 2007). At 1E-4 hazard level, the log-mean ARS are obtained by enveloping the log-mean ARS for LF and HF for the horizon of interest. The same procedure is repeated for 1E-5 hazard level. Equations 3F-2 and 3F-3 are used to determine AR and DF factors for the horizon of interest.

$$A_R(f) = \frac{ARS_{1E-5}}{ARS_{1E-4}} \qquad \text{Equation (3F-2)}$$

$$DF(f) = \max\{1.0, 0.6(A_R)^{0.8}, 0.45A_R\} \qquad \text{Equation (3F-3)}$$

The A_R and *DF* factors at the considered horizon are calculated as a function of frequency (f). The notation indicating the dependency on frequency is implied in Equation 3F-4. Given DF from Equation 3F-3, horizontal FIRS at the considered horizon are calculated using Equation 3F-4:

$$FIRS = DF \times ARS_{1E-4} \qquad \text{Equation (3F-4)}$$

The FIRS are calculated using the 5% damping “outcrop” ARS. At ground surface, the FIRS are also designated as the performance-based surface response spectra (PBSRS).

The horizontal FIRS are scaled by an appropriate V/H scaling function to obtain the corresponding vertical FIRS. For this calculation, the V/H function is that presented in FSAR Section 2.5.2.6 (Table 2.5-23) and presented below as Equation 3F-5, and is applicable for both rock and soil spectra at Calvert Cliffs:

V/H = 0.75	Freq ≤ 5 Hz	
= log-linearly interpolated	5 Hz < Freq < 25 Hz	Equation (3F-5)
= 1.00	Freq ≥ 25 Hz	

Figure 3F-12a and Figure 3F-12b present the horizontal and vertical FIRS calculated for the RB36 and RB26 soil columns, respectively. Figure 3F-12c presents the horizontal and vertical FIRS calculated for the NI area, and Figure 3F-13 presents the horizontal and vertical FIRS calculated for the Intake area.

Best Estimate (BE), lower bound (LB) and upper bound (UB) soil properties are calculated consistent with the FIRS motions. The BE profile consists of the log-mean profile properties, and the LB and UB profiles are calculated maintaining a minimum variation of 0.5 on the shear modulus. Figure 3F-14a presents the shear wave velocity profiles strain-compatible with FIRS for the RB36 soil column. FIRS strain-compatible damping and P-wave velocity profiles, for the RB36 soil column, are presented in Figure 3F-14b and Figure 3F-14c, respectively. The corresponding profiles for the RB26 soil column are presented in Figure 3F-14d through Figure 3F-14f. Figure 3F-14g presents the shear wave velocity profiles strain-compatible with FIRS for the NI area. FIRS strain-compatible damping and P-wave velocity profiles, for the NI area, are presented in Figure 3F-15 and Figure 3F-16, respectively. The corresponding profiles for the Intake area are presented in Figure 3F-17, Figure 3F-18 and Figure 3F-19. Note that the lower shear wave and primary wave velocity are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile.

3F.1.3 FIRS Adjustment

The adequacy of the horizontal and vertical FIRS, calculated at depth, as input ground motions for SSI analysis is evaluated by ensuring that the FIRS convolved from the foundation level up to the surface using the LB, BE, and UB FIRS strain-compatible soil properties envelop the PBSRS (i.e., the FIRS at ground surface). This verification is referred to as the NEI check in reference to the Nuclear Energy Institute (NEI) white paper (NEI, 2009) and Interim Staff Guidance 017 (NRC, 2010). The check is conducted for each of the embedded FIRS, namely at the foundation elevation of NI/NAB/AB, the EPGB, the ESWB, and the TI Structure, as well as the CBIS in the Intake area (refer to Table 3F-1 for foundation elevations).

For the NEI check, the horizontal and vertical FIRS are applied at the foundation level using the LB, BE, and UB FIRS strain-compatible soil properties, using P-SHAKE. The horizontal FIRS are convolved to the surface using vertically propagating shear-waves (V_S) and the vertical FIRS are convolved to the surface through vertically propagating P-waves (V_P). Shear-wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. The horizontal and vertical free field 5% damping ARS at surface corresponding to each FIRS are determined and the envelope ARS resulting from the LB, BE and UB soil columns is compared to the PBSRS. In the event the envelope of the LB, BE and UB ARS (at surface) does not envelop the corresponding PBSRS, the FIRS must be modified. The frequency dependent adjustment factor is either unity or the ratio of PBSRS to the envelope of LB, BE, and UB ARS, whichever is greater. This adjustment factor is applied to the computed FIRS at the foundation level to yield the horizontal and vertical Adjusted FIRS.

Figure 3F-20 presents the horizontal 5% damping ARS calculated at the ground surface using the FIRS at 37.5 ft depth for the Intake area as input to P-SHAKE, and using the LB, BE and UB FIRS strain-compatible damping and shear-wave velocity profiles. The PBSRS is divided by the envelope of the response of the 3 soil cases to calculate the FIRS adjustment factor (also shown in Figure 3F-20), which is applied to the FIRS only if greater than 1. Figure 3F-21 presents the corresponding plot for the vertical 5% damping ARS. This check was also performed for the NI/NAB/AB FIRS at 39 ft depth (RB36 and RB26 soil columns) and the NI area FIRS at 11 ft, 22 ft, and 33 ft depths, but these checks are not presented in figures. Note that only in the case of the FIRS at 37.5 ft depth, does the FIRS adjustment factor exceed 1 with a maximum of less than 1.09 in the horizontal direction and a maximum of about 1.16 in the vertical direction. Hereafter FIRS that have been subjected to the NEI check are referred to as Adjusted FIRS (whether or not a FIRS adjustment was necessary).

The horizontal and vertical Adjusted FIRS for the Intake area are presented in Figure 3F-22.

3F.1.4 SSE Development

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/NAB/AB has a peak ground acceleration of 0.135 g. As illustrated in Figure 3F-23a, the Site SSE ground motion for CCNPP Unit 3 is defined as the envelope of the site-specific Adjusted FIRS for the NI structures and the U.S. EPR FSAR European Utility Requirements (EUR) Soft Soil spectrum anchored at 0.15 g, therefore satisfying the requirements of Appendix S of 10 CFR Part 50. As illustrated in Figure 3F-23b, the vertical SSE is composed of the envelope of the vertical EURS anchored at 0.15g and the vertical adjusted FIRS for the NI/NAB/AB structures. The 5% damped horizontal and vertical ARS for the Site SSE ground motion are presented in Figure 3F-23c and Table 3F-2b.

For other Seismic Category I structures in the NI area, namely the EPGB, ESWB and TI Structure, one SSE motion (SSE_{NI}) is developed for all three structures. First, the envelope of the Adjusted FIRS for all three structures is calculated ($FIRS_{NI}$). Second, the SSE for the three structures is calculated as the envelope of ($FIRS_{NI/NAB/AB}$ x Site SSE / $FIRS_{NI}$ x SSSI function) and Site SSE. As such, the SSE_{NI} takes into account the difference in elevations between the NI/NAB/AB structures and other Seismic Category I/II structures in the NI area, as well as the structure-soil-structure interaction (SSSI) effects due to the proximity of these three structures to the NI/NAB/AB. The SSSI function is described in detail in Section 3F.1.5. The resulting horizontal and vertical SSE_{NI} are presented in Figure 3F-24.

The SSE motion for the CBIS in the intake area is developed in a similar manner, except that no SSSI effects are taken into consideration due to the large distance separating it from the NI area. The SSE for the CBIS is calculated as the envelope of ($FIRS_{CBIS}$ x Site SSE / $FIRS_{NI/NAB/AB}$) and Site SSE. The resulting horizontal and vertical SSE $_{CBIS}$ are presented in Figure 3F-25.

3F.1.5 SSSI Effects

An amplification function is developed to account for the structure-soil-structure interaction (SSSI) that affects the seismic response of the buildings in the NI area, namely the EPGB, the ESWB, and the TI Structure, due to their proximity to the NI/NAB/AB. The idealized SSSI amplification function is shown in Figure 3F-26. As discussed in Section 3F.1.4, the developed functions are used to amplify the motion for the EPGB, ESWB and TI Structure in the NI area.

As part of the site-specific SSI analysis of the NI/NAB/AB, the site-specific SSSI amplification effects are computed and compared to the idealized SSSI function to verify the adequacy of the latter, see Section 3.7.1.1.1.2 and Appendix 3J.

3F.1.6 Outcrop Acceleration Time Histories

For each structure, 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 component 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 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 from the database of candidate time histories provided with NUREG/CR-6728 (McGuire et al., 2001) from the Central and Eastern United States (CEUS) soil cases for an earthquake with magnitude (Mw) between 6-7 and distances between 10 km and 50 km. This magnitude and distance range was selected based on the available magnitude and distance bins provided in the NUREG/CR-6728 (McGuire et al., 2001) database of time histories and the deaggregation results for the project site. The selection of a seed time history from the soil database bins rather than the rock database bins was driven by the target spectrum used in the spectral matching procedure being more typical of a soil site condition than a CEUS hard rock site condition.

One set of acceleration time histories is developed to match the 5% damped acceleration response spectra of each SSE motion, presented in Section 3F.1.4, namely Site SSE for the NI/NAB/AB structures, SSE_{NI} for the EPGB, ESWB and TI Structure and SSE $_{CBIS}$ for the CBIS structure. Figure 3F-27a presents the acceleration, velocity and displacement time histories for the first horizontal component (H1) spectrally matched to Site SSE. Figure 3F-27b presents the time histories for the second horizontal component (H2) and Figure 3F-27c presents the time histories for the vertical component (UP). Bechtel proprietary computer program RSPM (Version 1.1) was used to develop these spectrally matched time histories.

Figure 3F-28a through Figure 3F-28c present the acceleration, velocity and displacement time histories for the three components of SSE_{NI} motions, and Figure 3F-28d through Figure 3F-28f present the same for the SSE_{CBIS} motion.

3F.2 Site SSE Strain-Compatible Soil Property Profiles

A set of lower bound (LB), best estimate (BE) and upper bound (UB) profiles, strain-compatible with the SSE motion, is developed for each of the four analyzed soil columns, namely, RB36 and RB26 for the NI/NAB/AB, the NI area soil column for the EPGB, ESWB and TI Structure, and the Intake area soil column for the CBIS. The approach used here is iterative and consists of running the site response analysis, using P-SHAKE, with modified rock motions (input at bedrock) convolved through each set of 60 simulated profiles and computing the response at the foundation elevation horizons of interest. The analysis is repeated, modifying the input rock motion each time, until the 5% damping mean ARS at the FIRS horizons roughly matches the SSE motion. The set of iterated properties resulting from the set of runs yielding an approximate match of the log-mean response to SSE motion are considered to be the BE SSE strain-compatible properties.

The LB and UB values are calculated as -/+ one log-standard deviation from the log average values (i.e., BE values) using the following equations where S is the soil property considered, μ_{ln}, is the log-mean and σ_{ln} is the log-standard deviation of that property:

$$S_{LB} = \exp\left(\ln(\mu_{ln}) - \sigma_{ln}\right) \qquad \text{Equation (3F-6)}$$

$$S_{UB} = \exp\left(\ln(\mu ln) + \sigma_{ln}\right) \qquad \text{Equation (3F-7)}$$

Lower bound and upper bound damping ratios corresponding to BE SSE are calculated using Equation 3F-6 and Equation 3F-7, respectively. Lower bound shear wave velocity profiles are calculated as the minimum resulting from Equation 3F-6 and $BE(V_S)/\sqrt{1.5}$, and upper bound shear wave velocity profiles are calculated as the maximum resulting from Equation 3F-7 and $BE(V_S) \times \sqrt{1.5}$. LB, BE, and UB primary wave velocities are calculated using Equation 3F-8 where ν is the Poisson's ratio, and V_S is LB, BE, and UB shear wave velocities. In addition, below the ground water level, a minimum P-wave velocity of 4800 ft/sec (1,463 m/sec) is imposed, on the condition that ν does not exceed 0.48.

$$V_P = V_S \sqrt{\frac{2-2v}{1-2v}} \qquad \text{Equation (3F-8)}$$

The resulting SE strain-compatible soil profiles are plotted in Figure 3F-29 through Figure 3F-31 for the upper 1000 ft (305m) for NI area site conditions, and reported in Table 3F-3 through Table 3F-5 for the upper 300 ft. Note that the lower shear wave and primary wave velocity are used in conjunction with the higher damping values to form the LB profile, and vice versa for the UB profile. The presented profiles are used in the SSI analysis for the ESWB and EPGB in the NI area. The resulting SSE strain-compatible soil profiles for the Intake area site conditions are presented in Figure 3F-32 through Figure 3F-34a for the upper 1000 ft (305m) and reported in Table 3F-6 through Table 3F-8 for the upper 300 ft. The Intake area profiles are used in the SSI analysis for the CBIS.

In the case of the NI/NAB/AB, where two soil columns, RB36 and RB26, are used in the site amplification analysis, one set of LB, BE and UB profiles is considered for SSI analysis. As presented in Figure 3F-34b, the LB profile for the RB26 soil column (with the backfill material extending to a larger depth of 59 ft) provides the LB profile for SSI analysis, while the UB profile of the RB36 soil column (with the backfill extending to a smaller depth of 49 ft) provides the UB profile for SSI analysis. The BE profile is taken as an intermediate profile between the BE RB36 and BE RB26 profiles, with backfill extending to a depth of 54 ft (BE RB31). The developed set provides an extended range of analysis and, therefore, bounding conditions, from softest to stiffest, under the foundation of the NI/NAB/AB, as well as the best estimate for the overall layout. Figure 3F-34c and Figure 3F-34d present the strain-compatible damping and P-wave velocity profiles, respectively, for the top 1000 ft. Table 3F-9 through Table 3F-11 report the dynamic profile profiles that are strain-compatible with the Site SSE for the top 300 ft. These properties are appropriate for use in the SSI confirmatory analysis of the NI/NAB/AB structures.

3F.3 SSI Input Acceleration Time Histories

The input time history needed for SSI analysis of the embedded structures (NI/NAB/AB, EPGB, ESWB, and TI Structure in the NI area and CBIS in the Intake area) are “within” motions at the foundation elevation corresponding to each of the LB, BE, and UB soil profiles. As such, each of outcrop SSE acceleration time-histories (two horizontal and one vertical) presented in Section 3F.1.6, is used as input at the foundation level to a SHAKE2000 soil column model of the corresponding LB, BE, and UB profile, and their corresponding 5% damping within time histories are obtained at the foundation elevation as well as the ground surface time histories. The horizontal acceleration time histories are applied using strain compatible shear-wave velocities (VS) and the vertical acceleration time-history is applied using corresponding P-wave velocities (VP). The strain compatible shear-wave damping is used for both vertical and horizontal analyses. The analyses are carried out linearly with no further degradation of the strain-compatible shear modulus and damping profiles. This analysis results in a set of 3 “within” motions: two horizontal and one vertical. Three sets are developed corresponding to the LB, BE and UB profiles for each structure. The calculated “within” time histories are applied at the foundation horizon, or alternatively the ground surface time histories are applied as outcrop at the ground surface horizon, and are used in combination with their corresponding SSE strain-compatible soil profiles, described in Section 3F.2. The 5% damping ARS for the calculated within ground motions are presented in Figure 3F-35 through Figure 3F-49.

3F.4 Computer Codes

The computer codes SPS, SHAKE2000 and P-SHAKE are used in the analyses discussed herein, and are described in this section.

3F.4.1 Soil Profile Simulation (SPS) Program

Description

SPS (Version 1.0 / 2009) is a Bechtel proprietary program. SPS generates a set of site-specific stochastically simulated soil profiles to represent the dynamic properties of the site while considering the uncertainty associated with each of the properties. The output is intended for use in site response analysis using the Bechtel computer programs SHAKE2000 (Section 3F.4.2) or P-SHAKE (Section 3F.4.3).

Validation

SPS was developed by Bechtel. The program validation documents are located in Bechtel's Computation Service Library.

Extent of Application

SPS is used to generate sets of stochastically simulated profiles to represent the site conditions for the NI and Intake areas.

3F.4.2 SHAKE2000

Description

The original SHAKE computer program for earthquake response analysis of horizontally layered sites was developed at the University of California, Berkeley, by B. Schnabel, John Lysmer and H. B. Seed in 1972. SHAKE2000 (Version 1.1 / 2006) is a Bechtel proprietary modified version of SHAKE, and is a separate program. SHAKE2000 generates the design earthquake-induced strain-compatible soil properties and site response motions.

Validation

SHAKE2000 was developed by Bechtel. The program validation documents are located in Bechtel's Computation Service Library.

Extent of Application

SHAKE2000 is used to convert outcrop acceleration time histories at the foundation elevation for different structures to within (in-column) acceleration time histories.

3F.4.3 P-SHAKE

Description

P-SHAKE (Version 2.0 / 2009) is a Bechtel proprietary modified version of SHAKE2000, and is a separate program. P-SHAKE generates the same design earthquake-induced strain-compatible soil properties and site response motions as SHAKE2000 does, and the input files of the two programs for the most parts are compatible. However, P-SHAKE is built on different program logic that allows the site response analysis to be performed with an acceleration response spectrum as input, instead of an acceleration time history as used by SHAKE2000.

Validation

P-SHAKE was developed by Bechtel. The program validation documents are located in Bechtel's Computation Service Library.

Extent of Application

P-SHAKE is used to provide site-specific earthquake-induced design ground motions and the associated strain-compatible soil properties.

3F.4.4 RSPM

Description

RSPM (Version 1.1, 2011) performs a time domain modification of a given input acceleration time history to make it spectrum compatible with a user specified target design spectrum. The program was developed based on the theory presented in Lilhanand and Tseng (1988). The computer program was originally written by Norm A. Abrahamson (1993) and further enhanced by Bechtel.

Validation

RSPM program validation documents are located in Bechtel's Computer Service Library.

Extent of Application

RSPM is used for spectral matching acceleration time histories to the target acceleration response spectra, subsequently used in the SSI analysis of Seismic Category I/II structures.

3F.5 References

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Table 3F-1 — {Bottom of Foundation Depths and Elevations}

Building	Location (Area)	Bottom of Foundation Depth [ft]	Bottom of Foundation Elevation [ft]
Nuclear Island Common Basemat (NICBM) Structures	NI	39	46
Emergency Power Generator Building (EPGB) *	NI	11	74
Essential Service Water Building (ESWB)	NI	33	52
Turbine Island (TI) Structure	NI	22*	63
Common Basemat Intake Structures (CBIS)	Intake	37.5	-27.5
* This depth corresponds to the depth of foundation in the finite element model			

Table 3F-2a — {Input Rock Motions and Associated Parameters}

Rock Motion	Magnitude (M)	Distance (km)	Duration [sec]	Effective Strain Ratio
LF 1E-4	7.3	502	26.3	0.63
HF 1E-4	6.1	52	8.4	0.51
LF 1E-5	7.5	483	26.3	0.65
HF 1E-5	6.0	18	3.7	0.50

Table 3F-2b — {Site SSE 5% Damped Acceleration Response Spectra}

Frequency [Hz]	Horizontal Site SSE [g]	Vertical Site SSE [g]
0.1	7.82E-03	5.86E-03
0.125	1.31E-02	9.82E-03
0.15	2.15E-02	1.61E-02
0.2	4.85E-02	3.63E-02
0.3	6.81E-02	5.10E-02
0.4	8.33E-02	6.25E-02
0.5	1.49E-01	1.12E-01
0.6	2.06E-01	1.55E-01
0.7	2.21E-01	1.66E-01
0.8	2.17E-01	1.63E-01
0.9	2.26E-01	1.70E-01
1	2.35E-01	1.79E-01
1.25	2.54E-01	2.23E-01
1.5	2.70E-01	2.68E-01
2	3.57E-01	3.57E-01
2.5	4.46E-01	4.46E-01
3	4.50E-01	4.50E-01
4	4.50E-01	4.50E-01
5	4.50E-01	4.50E-01
6	4.50E-01	4.50E-01
7	4.50E-01	4.50E-01
8	4.48E-01	4.48E-01
9	4.11E-01	4.11E-01
10	3.79E-01	3.79E-01
12.5	3.18E-01	3.18E-01
15	2.76E-01	2.76E-01
20	2.21E-01	2.21E-01
25	1.86E-01	1.86E-01
30	1.62E-01	1.62E-01
35	1.50E-01	1.50E-01
40	1.50E-01	1.50E-01
45	1.50E-01	1.50E-01
50	1.50E-01	1.50E-01
60	1.50E-01	1.50E-01
70	1.50E-01	1.50E-01
80	1.50E-01	1.50E-01
90	1.50E-01	1.50E-01
100	1.50E-01	1.50E-01

Table 3.F-3 — {Best Estimate SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	729.1	1517.7	1.90
2	3.0	3.0	0.145	701.3	1459.8	2.78
3	3.5	6.0	0.145	673.5	1402.0	3.66
4	1.5	9.5	0.145	659.4	1372.7	4.49
5	2.5	11.0	0.145	659.4	1372.7	4.49
6	4.0	13.5	0.145	650.1	1353.3	5.22
7	4.5	17.5	0.145	655.2	1363.9	5.68
8	4.0	22.0	0.145	612.6	1275.2	6.59
9	4.0	26.0	0.145	635.2	1322.3	6.73
10	3.0	30.0	0.145	626.9	3196.4	7.00
11	1.0	33.0	0.145	626.9	3196.4	7.00
12	4.0	34.0	0.145	610.3	3112.1	7.41
13	3.5	38.0	0.145	607.0	3095.0	7.63
14	2.0	41.5	0.145	596.4	3041.0	7.80
15	3.5	43.5	0.120	1374.1	4800.0	2.05
16	4.0	47.0	0.120	1371.6	4800.0	2.08
17	4.0	51.0	0.120	1369.0	4800.0	2.11
18	5.0	55.0	0.120	1582.6	5249.0	1.96
19	5.0	60.0	0.120	1579.5	5238.6	1.98
20	5.0	65.0	0.120	1576.4	5228.3	2.01
21	5.0	70.0	0.120	1032.5	5264.9	2.84
22	5.0	75.0	0.120	1028.0	5241.7	2.86
23	5.0	80.0	0.120	1061.5	5412.4	2.80
24	5.0	85.0	0.120	1471.0	4878.6	2.21
25	5.0	90.0	0.120	1526.1	5061.4	2.15
26	5.0	95.0	0.119	1513.8	5020.6	2.13
27	5.0	100.0	0.107	1247.6	5244.0	1.43
28	5.0	105.0	0.105	1224.6	5147.2	1.35
29	7.0	110.0	0.105	1223.8	5144.0	1.36
30	8.0	117.0	0.105	1222.9	5140.3	1.37
31	10.0	125.0	0.105	1222.0	5136.2	1.37
32	10.0	135.0	0.105	1224.1	5145.0	1.39
33	10.0	145.0	0.105	1224.4	5146.4	1.39
34	10.0	155.0	0.105	1218.4	5121.2	1.40
35	10.0	165.0	0.105	1217.8	5118.8	1.39

Table 3.F-3 — {Best Estimate SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}

(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
36	10.0	175.0	0.105	1216.8	5114.5	1.41
37	10.0	185.0	0.105	1210.9	5089.8	1.40
38	10.0	195.0	0.105	1195.3	5023.8	1.42
39	10.0	205.0	0.105	1190.3	5003.2	1.43
40	10.0	215.0	0.105	1188.4	4995.1	1.46
41	10.0	225.0	0.105	1187.3	4990.4	1.46
42	10.0	235.0	0.105	1183.0	4972.2	1.48
43	8.0	245.0	0.105	1179.1	4955.8	1.51
44	7.0	253.0	0.105	1189.2	4998.4	1.49
45	5.0	260.0	0.105	1191.9	5009.7	1.50
46	5.0	265.0	0.105	1202.1	5052.7	1.51
47	5.0	270.0	0.106	1213.3	5099.6	1.53
48	5.0	275.0	0.108	1248.3	5246.7	1.63
49	5.0	280.0	0.112	1304.1	5481.5	1.79
50	5.0	285.0	0.116	1381.6	4800.0	2.03
51	5.0	290.0	0.119	1460.2	4843.0	51
52	5.0	295.0	0.123	1608.3	5334.2	52

Table 3F-4 — {Lower Bound SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	579.8	1206.9	2.86
2	3.0	3.0	0.145	529.0	1101.1	4.74
3	3.5	6.0	0.145	490.3	1020.6	6.38
4	1.5	9.5	0.145	460.5	958.5	7.99
5	2.5	11.0	0.145	460.5	958.5	7.99
6	4.0	13.5	0.145	428.6	892.3	9.46
7	4.5	17.5	0.145	412.0	857.6	10.40
8	4.0	22.0	0.145	365.1	760.0	12.42
9	4.0	26.0	0.145	380.5	792.0	12.55
10	3.0	30.0	0.145	357.7	1824.1	12.96
11	1.0	33.0	0.145	357.7	1824.1	12.96
12	4.0	34.0	0.145	345.7	1762.7	13.42
13	3.5	38.0	0.145	341.2	1739.7	13.57
14	2.0	41.5	0.145	326.2	1663.3	13.80
15	3.5	43.5	0.120	980.0	4800.0	2.84
16	4.0	47.0	0.120	976.7	4800.0	2.90
17	4.0	51.0	0.120	973.3	4800.0	2.97
18	5.0	55.0	0.120	1094.4	4800.0	2.67
19	5.0	60.0	0.120	1090.6	4800.0	2.70
20	5.0	65.0	0.120	1086.9	4800.0	2.77
21	5.0	70.0	0.120	717.6	3659.0	4.29
22	5.0	75.0	0.120	713.6	3638.6	4.36
23	5.0	80.0	0.120	734.2	3743.7	4.29
24	5.0	85.0	0.120	1017.6	4800.0	3.11
25	5.0	90.0	0.120	1054.3	4800.0	3.00
26	5.0	95.0	0.119	1045.9	4800.0	3.07
27	5.0	100.0	0.107	1017.8	4800.0	1.84
28	5.0	105.0	0.105	999.9	4800.0	1.58
29	7.0	110.0	0.105	999.3	4800.0	1.60
30	8.0	117.0	0.105	998.5	4800.0	1.62
31	10.0	125.0	0.105	997.7	4800.0	1.62
32	10.0	135.0	0.105	999.5	4800.0	1.64
33	10.0	145.0	0.105	999.7	4800.0	1.68
34	10.0	155.0	0.105	994.8	4800.0	1.71
35	10.0	165.0	0.105	994.4	4800.0	1.69
36	10.0	175.0	0.105	993.5	4800.0	1.74
37	10.0	185.0	0.105	988.7	4800.0	1.72
38	10.0	195.0	0.105	975.9	4800.0	1.73

Table 3F-4 — {Lower Bound SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}

(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
39	10.0	205.0	0.105	971.9	4800.0	1.76
40	10.0	215.0	0.105	970.3	4800.0	1.81
41	10.0	225.0	0.105	969.4	4800.0	1.81
42	10.0	235.0	0.105	965.9	4800.0	1.85
43	8.0	245.0	0.105	962.7	4800.0	1.93
44	7.0	253.0	0.105	971.0	4800.0	1.86
45	5.0	260.0	0.105	973.2	4800.0	1.88
46	5.0	265.0	0.105	981.5	4800.0	1.92
47	5.0	270.0	0.106	990.6	4800.0	1.98
48	5.0	275.0	0.108	1019.2	4800.0	2.21
49	5.0	280.0	0.112	1050.1	4800.0	2.48
50	5.0	285.0	0.116	1101.6	4800.0	2.78
51	5.0	290.0	0.119	1174.9	4800.0	2.91
52	5.0	295.0	0.123	1284.4	4800.0	2.89

Table 3F-5 — {Upper Bound SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	916.8	1908.4	1.26
2	3.0	3.0	0.145	929.7	1935.3	1.63
3	3.5	6.0	0.145	925.1	1925.8	2.10
4	1.5	9.5	0.145	944.4	1965.8	2.52
5	2.5	11.0	0.145	944.4	1965.8	2.52
6	4.0	13.5	0.145	986.0	2052.6	2.88
7	4.5	17.5	0.145	1042.0	2169.1	3.10
8	4.0	22.0	0.145	1027.8	2139.6	3.50
9	4.0	26.0	0.145	1060.6	2207.9	3.61
10	3.0	30.0	0.145	1098.5	4800.0	3.78
11	1.0	33.0	0.145	1098.5	4800.0	3.78
12	4.0	34.0	0.145	1077.6	4800.0	4.09
13	3.5	38.0	0.145	1079.8	4800.0	4.29
14	2.0	41.5	0.145	1090.4	4800.0	4.41
15	3.5	43.5	0.120	1926.7	6390.2	1.48
16	4.0	47.0	0.120	1926.2	6388.6	1.49
17	4.0	51.0	0.120	1925.6	6386.5	1.50
18	5.0	55.0	0.120	2288.7	7590.7	1.44
19	5.0	60.0	0.120	2287.6	7587.1	1.45
20	5.0	65.0	0.120	2286.4	7583.1	1.46
21	5.0	70.0	0.120	1485.7	7575.7	1.88
22	5.0	75.0	0.120	1480.9	7551.1	1.88
23	5.0	80.0	0.120	1534.6	7824.7	1.83
24	5.0	85.0	0.120	2126.3	7052.1	1.57
25	5.0	90.0	0.120	2209.0	7326.3	1.54
26	5.0	95.0	0.119	2190.8	7266.1	1.48
27	5.0	100.0	0.107	1529.3	6428.0	1.11
28	5.0	105.0	0.105	1499.8	6304.1	1.15
29	7.0	110.0	0.105	1498.9	6300.1	1.15
30	8.0	117.0	0.105	1497.8	6295.5	1.16
31	10.0	125.0	0.105	1496.6	6290.6	1.16
32	10.0	135.0	0.105	1499.2	6301.4	1.18
33	10.0	145.0	0.105	1499.6	6303.0	1.15
34	10.0	155.0	0.105	1492.2	6272.1	1.14
35	10.0	165.0	0.105	1491.5	6269.2	1.14

Table 3F-5 — {Upper Bound SSE Strain-Compatible Profiles for the EPGB, ESWB and TI Structure in the NI Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
36	10.0	175.0	0.105	1490.3	6263.9	1.15
37	10.0	185.0	0.105	1483.1	6233.7	1.14
38	10.0	195.0	0.105	1463.9	6152.9	1.17
39	10.0	205.0	0.105	1457.9	6127.7	1.16
40	10.0	215.0	0.105	1455.5	6117.7	1.18
41	10.0	225.0	0.105	1454.1	6112.0	1.18
42	10.0	235.0	0.105	1448.8	6089.7	1.19
43	8.0	245.0	0.105	1444.1	6069.6	1.18
44	7.0	253.0	0.105	1456.5	6121.8	1.19
45	5.0	260.0	0.105	1459.8	6135.6	1.20
46	5.0	265.0	0.105	1472.3	6188.2	1.19
47	5.0	270.0	0.106	1486.0	6245.7	1.18
48	5.0	275.0	0.108	1528.8	6425.8	1.20
49	5.0	280.0	0.112	1619.6	6807.3	1.29
50	5.0	285.0	0.116	1732.8	5746.9	1.48
51	5.0	290.0	0.119	1814.8	6019.1	1.62
52	5.0	295.0	0.123	2014.0	6679.7	1.77

Table 3F-6 — {Best Estimate SSE Strain-Compatible Profiles for the CBIS in the Intake Area}
(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.5	0.0	0.145	660.1	1374.2	2.23
2	3.5	3.5	0.145	613.9	1277.9	3.72
3	3.0	7.0	0.145	571.0	2911.6	5.05
4	4.5	10.0	0.145	554.8	2828.8	6.08
5	3.5	14.5	0.145	540.3	2755.0	6.88
6	2.5	18.0	0.145	539.1	2748.6	7.36
7	4.0	20.5	0.145	547.0	2789.0	7.79
8	4.0	24.5	0.145	562.0	2865.7	8.08
9	4.0	28.5	0.145	561.0	2860.5	8.38
10	5.0	32.5	0.145	552.1	2815.2	8.79
11	3.5	37.5	0.115	1109.2	5083.2	2.22
12	4.0	41.0	0.115	1106.5	5070.7	2.26
13	4.0	45.0	0.115	1103.4	5056.3	2.30
14	4.0	49.0	0.115	1100.3	5042.0	2.34
15	5.0	53.0	0.105	1083.1	4963.6	2.30
16	5.0	58.0	0.105	1078.2	4941.1	2.39
17	5.0	63.0	0.105	1075.2	4927.2	2.46
18	7.0	68.0	0.105	1072.0	4912.4	2.52
19	10.0	75.0	0.105	1067.9	4893.7	2.61
20	10.0	85.0	0.105	1063.7	4874.7	2.69
21	10.0	95.0	0.105	1060.1	4858.1	2.77
22	10.0	105.0	0.106	1053.2	4826.4	2.63
23	10.0	115.0	0.113	1010.4	4800.0	1.65
24	8.0	125.0	0.115	999.1	4800.0	1.47
25	8.0	133.0	0.113	1005.4	4800.0	1.49
26	9.0	141.0	0.107	1030.7	4800.0	1.51
27	10.0	150.0	0.105	1037.5	4800.0	1.50
28	10.0	160.0	0.105	1034.8	4800.0	1.52
29	10.0	170.0	0.105	1032.1	4800.0	1.53
30	10.0	180.0	0.105	1029.2	4800.0	1.55
31	10.0	190.0	0.105	1034.4	4800.0	1.57
32	10.0	200.0	0.108	1107.0	5073.0	1.70
33	10.0	210.0	0.119	1389.7	4800.0	2.09
34	10.0	220.0	0.125	1681.3	5576.3	2.28
35	10.0	230.0	0.125	2033.5	5475.4	2.02
36	10.0	240.0	0.125	2069.7	5906.1	2.05

Table 3F-6 — {Best Estimate SSE Strain-Compatible Profiles for the CBIS in the Intake Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
37	10.0	250.0	0.125	1985.2	5665.0	2.11
38	10.0	260.0	0.125	1974.3	5633.9	2.13
39	10.0	270.0	0.125	1947.2	5556.4	2.22
40	10.0	280.0	0.125	1866.8	5703.2	2.32
41	10.0	290.0	0.125	1854.2	5664.8	2.30

Table 3F-7 — {Lower Bound Site SSE Strain-Compatible Profiles for the CBIS in the Intake Area}

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.5	0.0	0.145	527.3	1097.7	3.38
2	3.5	3.5	0.145	440.8	917.7	6.34
3	3.0	7.0	0.145	382.2	1948.8	8.91
4	4.5	10.0	0.145	350.7	1788.2	10.63
5	3.5	14.5	0.145	320.4	1633.8	11.98
6	2.5	18.0	0.145	316.5	1613.8	12.65
7	4.0	20.5	0.145	318.8	1625.5	13.23
8	4.0	24.5	0.145	334.1	1703.4	13.44
9	4.0	28.5	0.145	327.2	1668.3	13.87
10	5.0	32.5	0.145	321.7	1640.2	14.23
11	3.5	37.5	0.115	905.7	4618.2	2.81
12	4.0	41.0	0.115	903.5	4606.8	2.88
13	4.0	45.0	0.115	900.9	4593.7	2.94
14	4.0	49.0	0.115	898.4	4580.7	3.00
15	5.0	53.0	0.105	884.4	4509.5	3.09
16	5.0	58.0	0.105	880.4	4489.0	3.22
17	5.0	63.0	0.105	877.9	4476.5	3.30
18	7.0	68.0	0.105	875.3	4463.0	3.39
19	10.0	75.0	0.105	871.9	4446.0	3.49
20	10.0	85.0	0.105	868.5	4428.7	3.60
21	10.0	95.0	0.105	865.6	4413.6	3.69
22	10.0	105.0	0.106	859.9	4384.8	3.69
23	10.0	115.0	0.113	824.9	4206.4	2.47
24	8.0	125.0	0.115	815.7	4159.4	1.91
25	8.0	133.0	0.113	820.9	4185.9	1.92
26	9.0	141.0	0.107	841.6	4291.4	1.98
27	10.0	150.0	0.105	847.1	4319.4	1.97
28	10.0	160.0	0.105	844.9	4308.2	2.01
29	10.0	170.0	0.105	842.7	4296.8	2.03
30	10.0	180.0	0.105	840.3	4285.0	2.07
31	10.0	190.0	0.105	844.6	4306.6	2.12
32	10.0	200.0	0.108	897.6	4576.8	2.42
33	10.0	210.0	0.119	1058.7	4800.0	2.81
34	10.0	220.0	0.125	1372.8	4800.0	2.81
35	10.0	230.0	0.125	1636.6	4800.0	2.50
36	10.0	240.0	0.125	1689.9	4822.4	2.42

Table 3F-7 — {Lower Bound Site SSE Strain-Compatible Profiles for the CBIS in the Intake Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
37	10.0	250.0	0.125	1620.9	4800.0	2.56
38	10.0	260.0	0.125	1612.0	4800.0	2.61
39	10.0	270.0	0.125	1589.9	4800.0	2.73
40	10.0	280.0	0.125	1524.2	4800.0	2.83
41	10.0	290.0	0.125	1514.0	4800.0	2.80

Table 3F-8 — {Upper Bound Site SSE Strain-Compatible Profiles for the CBIS in the Intake Area

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.5	0.0	0.145	826.4	1720.2	1.47
2	3.5	3.5	0.145	854.8	1779.4	2.18
3	3.0	7.0	0.145	853.1	4350.2	2.86
4	4.5	10.0	0.145	877.6	4474.9	3.48
5	3.5	14.5	0.145	911.1	4645.6	3.95
6	2.5	18.0	0.145	918.1	4681.5	4.28
7	4.0	20.5	0.145	938.5	4785.3	4.59
8	4.0	24.5	0.145	945.5	4800.0	4.86
9	4.0	28.5	0.145	961.9	4800.0	5.06
10	5.0	32.5	0.145	947.6	4800.0	5.43
11	3.5	37.5	0.115	1358.5	6225.6	1.75
12	4.0	41.0	0.115	1355.2	6210.3	1.77
13	4.0	45.0	0.115	1351.4	6192.7	1.80
14	4.0	49.0	0.115	1347.5	6175.1	1.83
15	5.0	53.0	0.105	1326.6	6079.1	1.71
16	5.0	58.0	0.105	1320.6	6051.5	1.78
17	5.0	63.0	0.105	1316.9	6034.6	1.83
18	7.0	68.0	0.105	1312.9	6016.4	1.87
19	10.0	75.0	0.105	1307.9	5993.6	1.95
20	10.0	85.0	0.105	1302.8	5970.2	2.01
21	10.0	95.0	0.105	1298.4	5949.9	2.08
22	10.0	105.0	0.106	1289.9	5911.1	1.88
23	10.0	115.0	0.113	1237.4	5670.6	1.10
24	8.0	125.0	0.115	1223.6	5607.2	1.13
25	8.0	133.0	0.113	1231.4	5643.0	1.16
26	9.0	141.0	0.107	1262.4	5785.1	1.15
27	10.0	150.0	0.105	1270.7	5822.9	1.14
28	10.0	160.0	0.105	1267.4	5807.8	1.15
29	10.0	170.0	0.105	1264.0	5792.5	1.15
30	10.0	180.0	0.105	1260.5	5776.4	1.16
31	10.0	190.0	0.105	1266.9	5805.7	1.16
32	10.0	200.0	0.108	1365.3	6256.8	1.20
33	10.0	210.0	0.119	1824.2	6050.2	1.55
34	10.0	220.0	0.125	2059.2	6829.5	1.85
35	10.0	230.0	0.125	2526.7	6803.4	1.63
36	10.0	240.0	0.125	2534.9	7233.5	1.74

Table 3F-8 — {Upper Bound Site SSE Strain-Compatible Profiles for the CBIS in the Intake Area

(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
37	10.0	250.0	0.125	2431.4	6938.2	1.74
38	10.0	260.0	0.125	2418.0	6900.0	1.74
39	10.0	270.0	0.125	2384.8	6805.2	1.80
40	10.0	280.0	0.125	2286.4	6985.0	1.90
41	10.0	290.0	0.125	2271.0	6938.0	1.89

Table 3F-9 — {Best Estimate Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}

(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	715.7	1489.9	1.99
2	3.0	3.0	0.145	673.0	1401.0	3.01
3	3.5	6.0	0.145	650.5	1354.1	3.93
4	4.0	9.5	0.145	640.8	1333.9	4.78
5	4.0	13.5	0.145	631.5	1314.5	5.49
6	4.5	17.5	0.145	635.2	1322.2	6.05
7	4.0	22.0	0.145	622.9	1296.7	6.45
8	4.0	26.0	0.145	646.5	1345.8	6.61
9	3.0	30.0	0.145	649.4	3311.2	6.84
10	3.0	33.0	0.145	653.1	3330.0	7.00
11	3.0	36.0	0.145	653.6	3332.9	7.17
12	3.0	39.0	0.145	649.6	3312.5	7.34
13	3.0	42.0	0.145	652.3	3326.0	7.47
14	4.0	45.0	0.145	637.6	3251.0	7.71
15	3.0	49.0	0.145	650.2	3315.2	7.76
16	2.0	52.0	0.145	648.0	3304.0	7.88
17	6.0	54.0	0.120	1705.1	5655.2	1.95
18	5.0	60.0	0.120	1703.1	5648.4	1.97
19	5.0	65.0	0.120	1700.9	5641.4	1.99
20	5.0	70.0	0.120	1085.2	5533.7	2.66
21	5.0	75.0	0.120	1081.9	5516.8	2.69
22	5.0	80.0	0.120	1106.8	5643.7	2.69
23	5.0	85.0	0.120	1677.5	5563.7	2.02
24	5.0	90.0	0.120	1697.0	5628.4	2.02
25	5.0	95.0	0.118	1631.7	5411.8	1.92
26	5.0	100.0	0.106	1286.2	5406.1	1.35
27	5.0	105.0	0.105	1270.5	5340.3	1.29
28	7.0	110.0	0.105	1269.9	5337.5	1.31
29	8.0	117.0	0.105	1269.1	5334.4	1.31
30	10.0	125.0	0.105	1268.3	5331.0	1.32
31	10.0	135.0	0.105	1266.1	5321.6	1.29
32	10.0	145.0	0.105	1265.8	5320.6	1.32
33	10.0	155.0	0.105	1262.7	5307.5	1.35
34	10.0	165.0	0.105	1262.1	5304.6	1.35
35	10.0	175.0	0.105	1261.0	5300.4	1.36
36	10.0	185.0	0.105	1268.4	5331.2	1.39
37	10.0	195.0	0.105	1262.9	5308.1	1.39
38	10.0	205.0	0.105	1260.6	5298.6	1.42

Table 3F-9 — {Best Estimate Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
39	10.0	215.0	0.105	1259.6	5294.2	1.43
40	10.0	225.0	0.105	1258.7	5290.6	1.45
41	10.0	235.0	0.105	1261.2	5300.9	1.43
42	8.0	245.0	0.105	1256.8	5282.8	1.45
43	7.0	253.0	0.105	1255.6	5277.5	1.44
44	5.0	260.0	0.105	1258.2	5288.5	1.42
45	5.0	265.0	0.106	1290.3	5423.3	1.47
46	5.0	270.0	0.107	1311.2	5511.1	1.50
47	5.0	275.0	0.110	1337.9	5623.2	1.64
48	5.0	280.0	0.114	1418.5	5962.1	1.79
49	5.0	285.0	0.118	1540.2	5108.2	1.95
50	5.0	290.0	0.120	1619.5	5371.3	2.04
51	5.0	295.0	0.122	1653.0	5482.3	2.12

Table 3F-10 — {Lower Bound Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}
(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	579.6	1206.6	3.00
2	3.0	3.0	0.145	511.9	1065.7	5.06
3	3.5	6.0	0.145	463.5	964.8	6.92
4	4.0	9.5	0.145	427.8	890.6	8.49
5	4.0	13.5	0.145	402.0	836.8	9.70
6	4.5	17.5	0.145	403.7	840.5	10.53
7	4.0	22.0	0.145	394.3	820.9	11.17
8	4.0	26.0	0.145	412.3	858.3	11.36
9	3.0	30.0	0.145	413.1	2106.3	11.61
10	3.0	33.0	0.145	406.0	2070.0	11.71
11	3.0	36.0	0.145	410.2	2091.6	11.84
12	3.0	39.0	0.145	398.7	2033.1	12.20
13	3.0	42.0	0.145	398.8	2033.3	12.29
14	4.0	45.0	0.145	377.2	1923.2	12.79
15	3.0	49.0	0.145	384.2	1959.0	12.85
16	3.0	52.0	0.145	380.4	1939.8	13.00
17	4.0	55.0	0.145	387.9	1978.1	13.25
18	5.0	59.0	0.120	1218.3	4800.0	2.63
19	6.0	64.0	0.120	1215.1	4800.0	2.67
20	5.0	70.0	0.120	693.8	3537.6	4.12
21	5.0	75.0	0.120	690.2	3519.2	4.21
22	5.0	80.0	0.120	692.7	3531.9	4.26
23	5.0	85.0	0.120	1085.8	4800.0	2.94
24	5.0	90.0	0.120	1144.8	4800.0	2.83
25	5.0	95.0	0.118	1106.7	4800.0	2.74
26	5.0	100.0	0.105	993.2	4800.0	1.60
27	5.0	105.0	0.105	984.3	4800.0	1.64
28	7.0	110.0	0.105	983.6	4800.0	1.66
29	8.0	117.0	0.105	982.9	4800.0	1.66
30	10.0	125.0	0.105	982.1	4800.0	1.67
31	10.0	135.0	0.105	977.3	4800.0	1.67
32	10.0	145.0	0.105	974.9	4800.0	1.59
33	10.0	155.0	0.105	974.2	4800.0	1.65
34	10.0	165.0	0.105	973.3	4800.0	1.66
35	10.0	175.0	0.105	972.5	4800.0	1.68
36	10.0	185.0	0.105	970.9	4800.0	1.70
37	10.0	195.0	0.105	972.0	4800.0	1.82
38	10.0	205.0	0.105	975.3	4800.0	1.81

Table 3F-10 — {Lower Bound Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
39	10.0	215.0	0.105	974.4	4800.0	1.83
40	10.0	225.0	0.105	973.6	4800.0	1.84
41	10.0	235.0	0.105	974.5	4800.0	1.83
42	8.0	245.0	0.105	972.5	4800.0	1.80
43	7.0	253.0	0.105	973.7	4800.0	1.82
44	5.0	260.0	0.105	972.1	4800.0	1.83
45	5.0	265.0	0.105	971.8	4800.0	1.85
46	5.0	270.0	0.107	999.8	4800.0	1.97
47	5.0	275.0	0.109	1044.2	4800.0	2.13
48	5.0	280.0	0.113	1073.3	4800.0	2.46
49	5.0	285.0	0.116	1123.4	4800.0	2.65
50	5.0	290.0	0.120	1212.7	4800.0	2.81
51	5.0	295.0	0.123	1318.2	4800.0	2.83

Table 3F-11 — {Upper Bound Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}
(Page 1 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
1	3.0	0.0	0.145	823.9	1715.0	1.34
2	3.0	3.0	0.145	818.8	1704.4	1.89
3	3.5	6.0	0.145	819.9	1706.7	2.59
4	4.0	9.5	0.145	837.9	1744.1	3.21
5	4.0	13.5	0.145	858.9	1787.9	3.68
6	4.5	17.5	0.145	891.5	1855.9	3.99
7	4.0	22.0	0.145	915.9	1906.7	3.93
8	4.0	26.0	0.145	946.2	1969.6	4.06
9	3.0	30.0	0.145	963.3	4800.0	4.29
10	3.0	33.0	0.145	964.1	4800.0	4.51
11	3.0	36.0	0.145	983.5	4800.0	4.57
12	3.0	39.0	0.145	1005.7	4800.0	4.68
13	3.0	42.0	0.145	1003.0	4800.0	4.87
14	4.0	45.0	0.145	1024.3	4800.0	4.96
15	6.0	49.0	0.120	1958.0	6493.9	1.50
16	5.0	55.0	0.120	2377.3	7884.6	1.45
17	5.0	60.0	0.120	2376.9	7883.4	1.46
18	5.0	65.0	0.120	2376.5	7882.0	1.46
19	5.0	70.0	0.120	1554.1	7924.3	1.82
20	5.0	75.0	0.120	1551.7	7912.3	1.83
21	5.0	80.0	0.120	1626.9	8295.4	1.82
22	5.0	85.0	0.120	2375.9	7879.9	1.44
23	5.0	90.0	0.120	2354.8	7810.1	1.47
24	5.0	95.0	0.118	2290.1	7595.5	1.39
25	5.0	100.0	0.106	1599.8	6724.4	1.09
26	5.0	105.0	0.105	1556.1	6540.5	1.10
27	7.0	110.0	0.105	1555.3	6537.1	1.11
28	8.0	117.0	0.105	1554.4	6533.3	1.11
29	10.0	125.0	0.105	1553.4	6529.1	1.11
30	10.0	135.0	0.105	1550.6	6517.6	1.11
31	10.0	145.0	0.105	1550.3	6516.3	1.11
32	10.0	155.0	0.105	1546.5	6500.4	1.12
33	10.0	165.0	0.105	1545.7	6496.8	1.12
34	10.0	175.0	0.105	1544.5	6491.6	1.13
35	10.0	185.0	0.105	1553.4	6529.4	1.14

Table 3F-11 — {Upper Bound Site SSE Strain-Compatible Profiles for the NI Common Basemat Structures in the NI Area}
(Page 2 of 2)

Layer No.	Thickness [ft]	Top Depth [ft]	Unit Weight [kcf]	S-Wave Vel. [ft/sec]	P-Wave Vel. [ft/sec]	Damping [%]
36	10.0	195.0	0.105	1546.7	6501.1	1.15
37	10.0	205.0	0.105	1543.9	6489.4	1.16
38	10.0	215.0	0.105	1542.7	6484.1	1.17
39	10.0	225.0	0.105	1541.6	6479.6	1.18
40	10.0	235.0	0.105	1544.6	6492.3	1.19
41	8.0	245.0	0.105	1539.3	6470.0	1.18
42	7.0	253.0	0.105	1537.8	6463.5	1.16
43	5.0	260.0	0.105	1541.0	6477.1	1.14
44	5.0	265.0	0.106	1580.3	6642.1	1.14
45	5.0	270.0	0.107	1605.9	6749.7	1.14
46	5.0	275.0	0.110	1641.0	6897.5	1.17
47	5.0	280.0	0.114	1737.5	7303.1	1.24
48	5.0	285.0	0.118	1976.9	6556.7	1.39
49	5.0	290.0	0.120	2048.7	6794.7	1.49
50	5.0	295.0	0.122	2096.6	6953.7	1.56
51	5.0	300.0	0.123	2275.5	7546.9	1.66

Figure 3F-1a — {Low-Strain Shear-Wave Velocity Profile for the NI Common Basemat Structures - RB26 Soil Column}

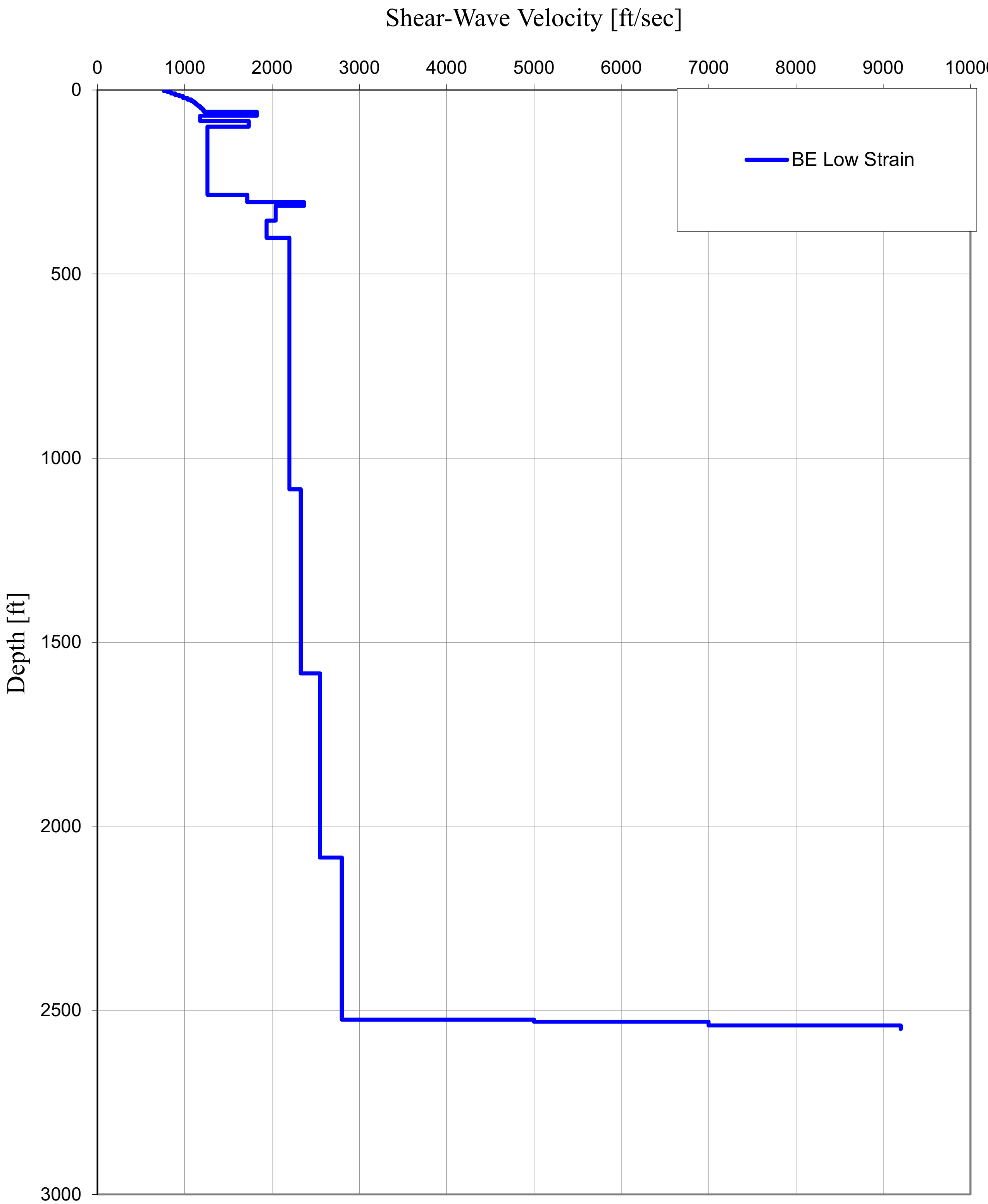

Figure 3F-1b — {Log - Standard Deviation for Low-Strain Shear-Wave Velocity Profile for the NI Common Basemat Structures - RB26 soil Column}

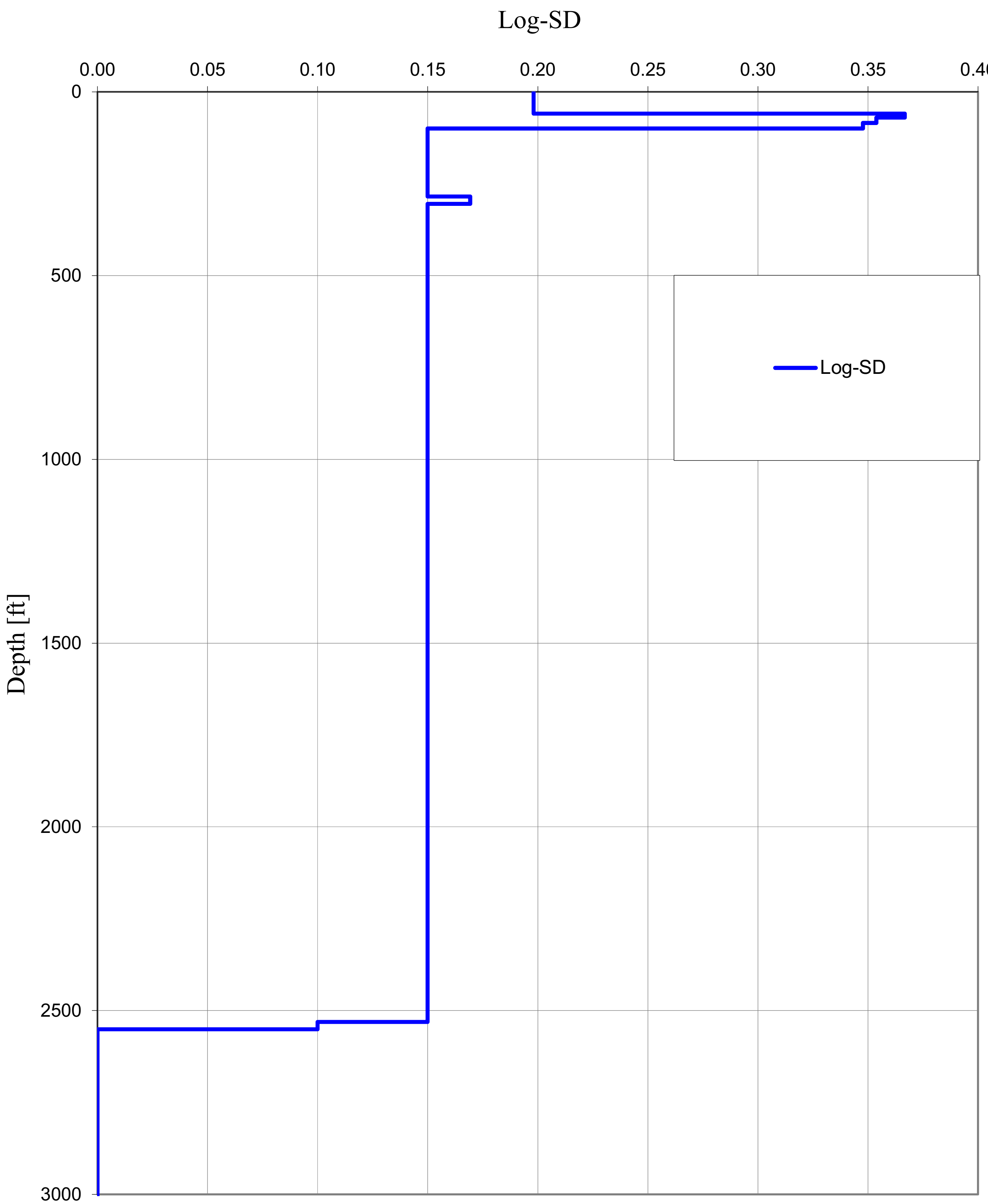

Figure 3F-1c — {Low-Strain Shear Wave Velocity Profile at the NI Area}

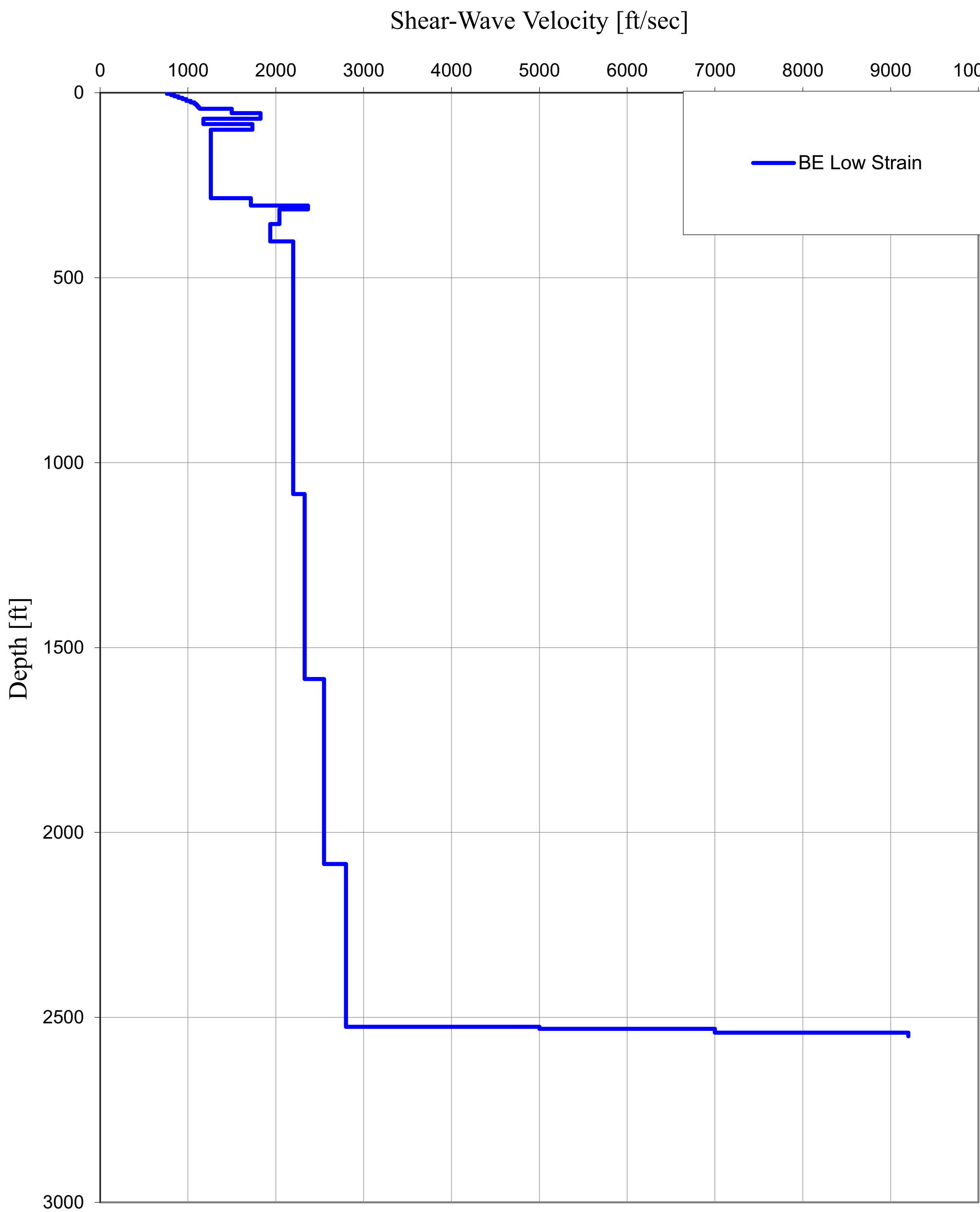

Figure 3F-2 — {Low-Strain Shear Wave Velocity Profile at the Intake Area}

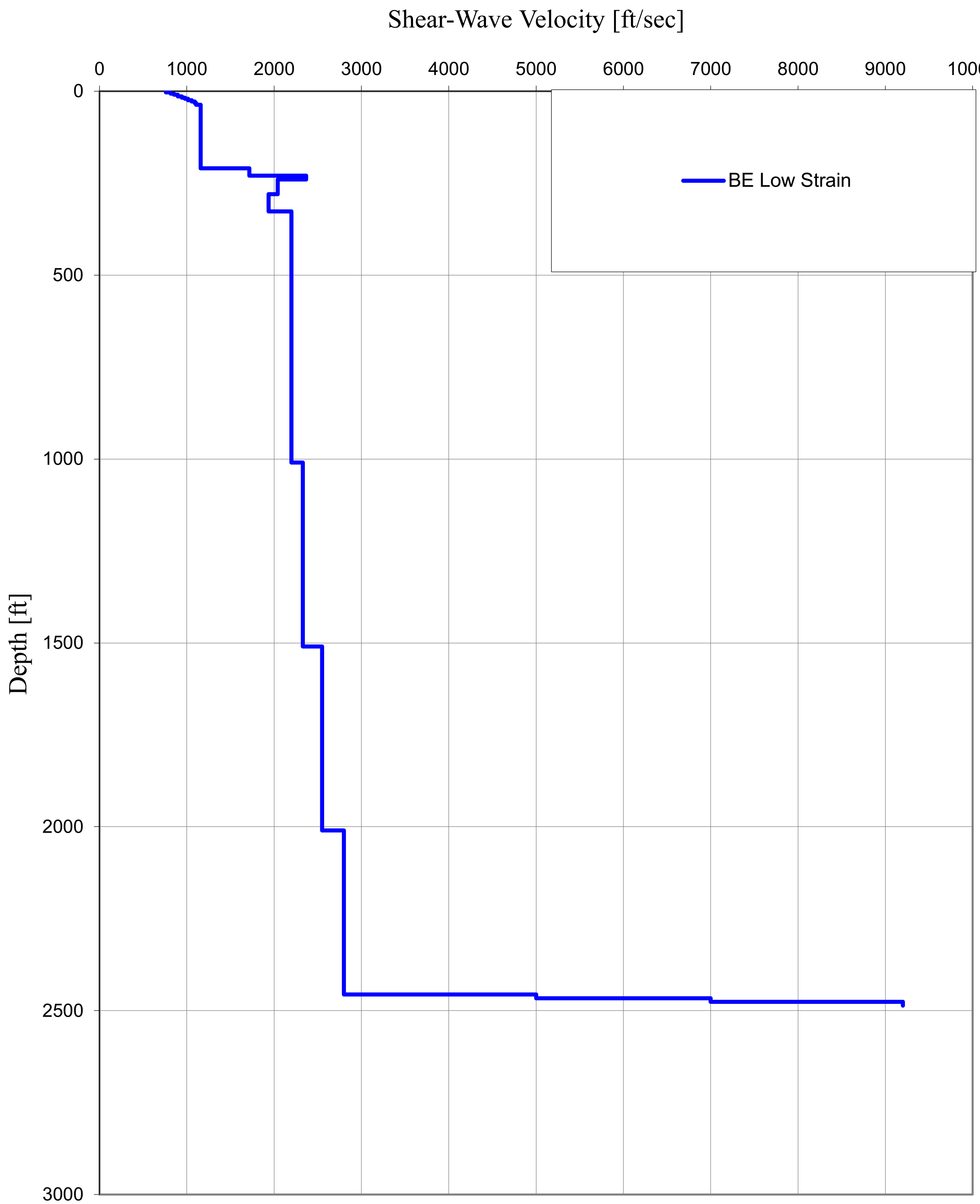

Figure 3F-3 — {Log-Standard Deviation for Low-Strain Shear Wave Velocity Profile at the NI Area}

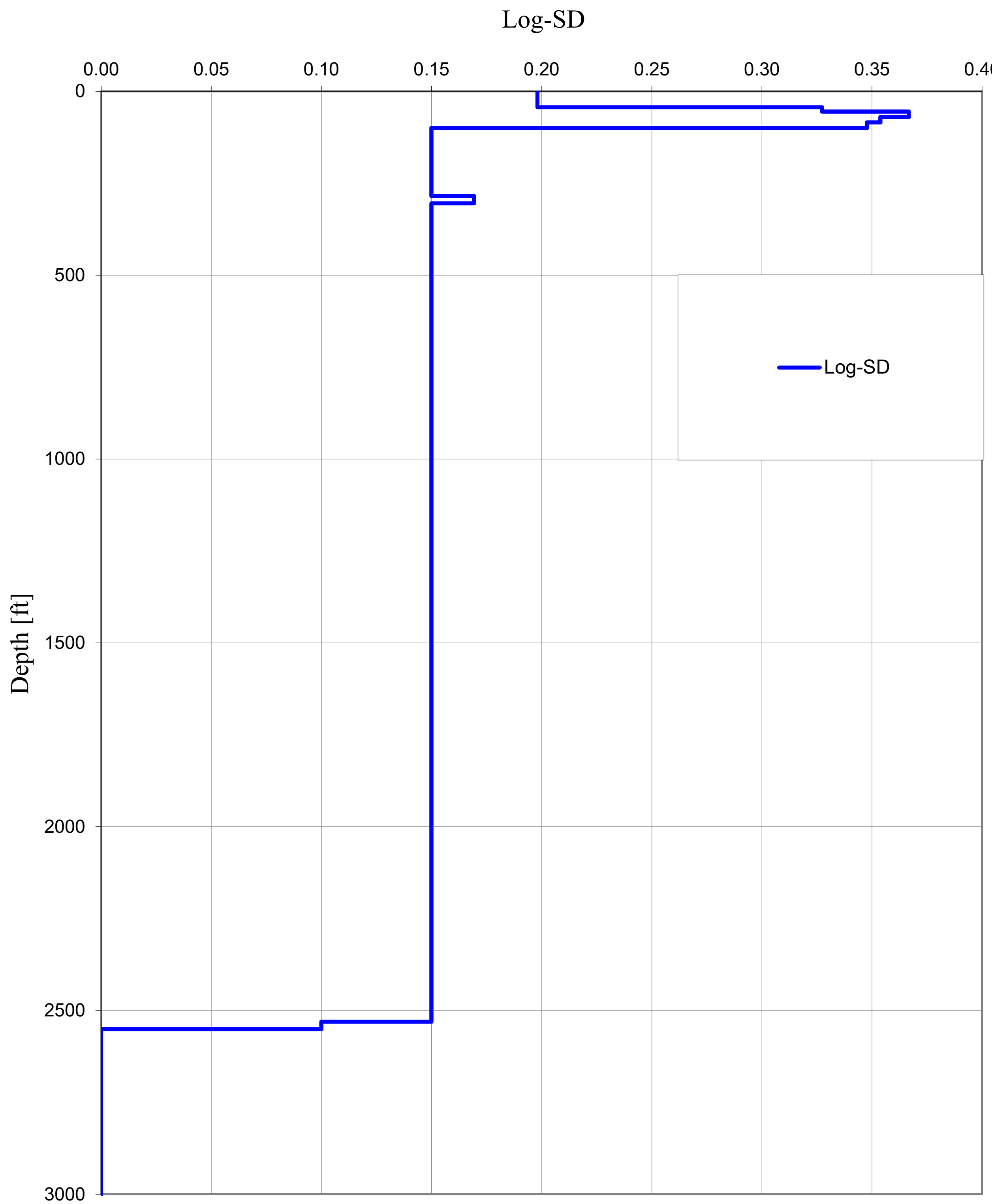

Figure 3F-4a — {Log-Standard Deviation for Low-Strain Shear Wave Velocity Profile at the Intake Area}

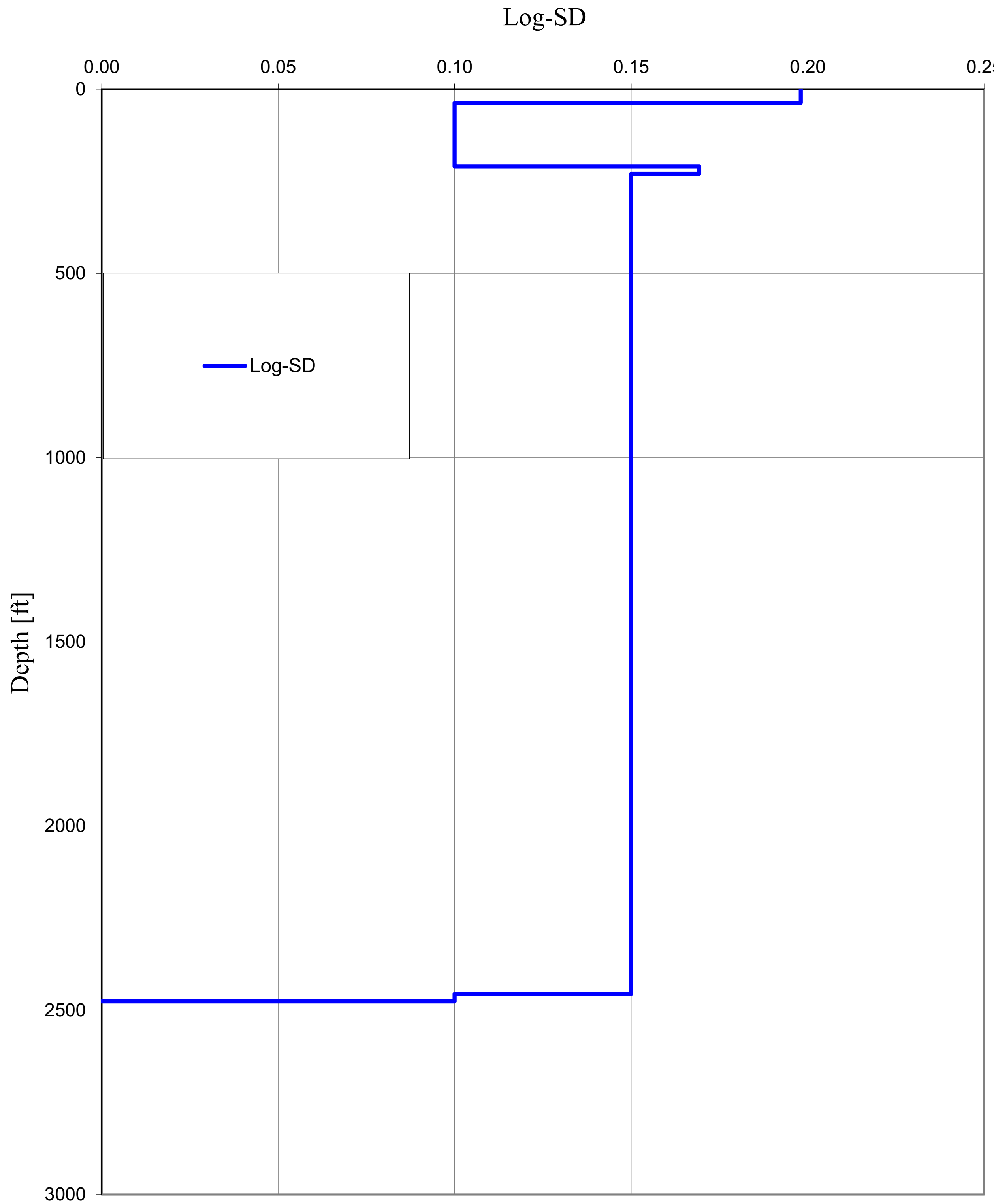

Figure 3F-4b — {Shear-Wave Velocity for 60 Simulated Profiles - RB36 Soil Column (Halfspace at First Occurrence of Vs = 9200 ft/sec)}

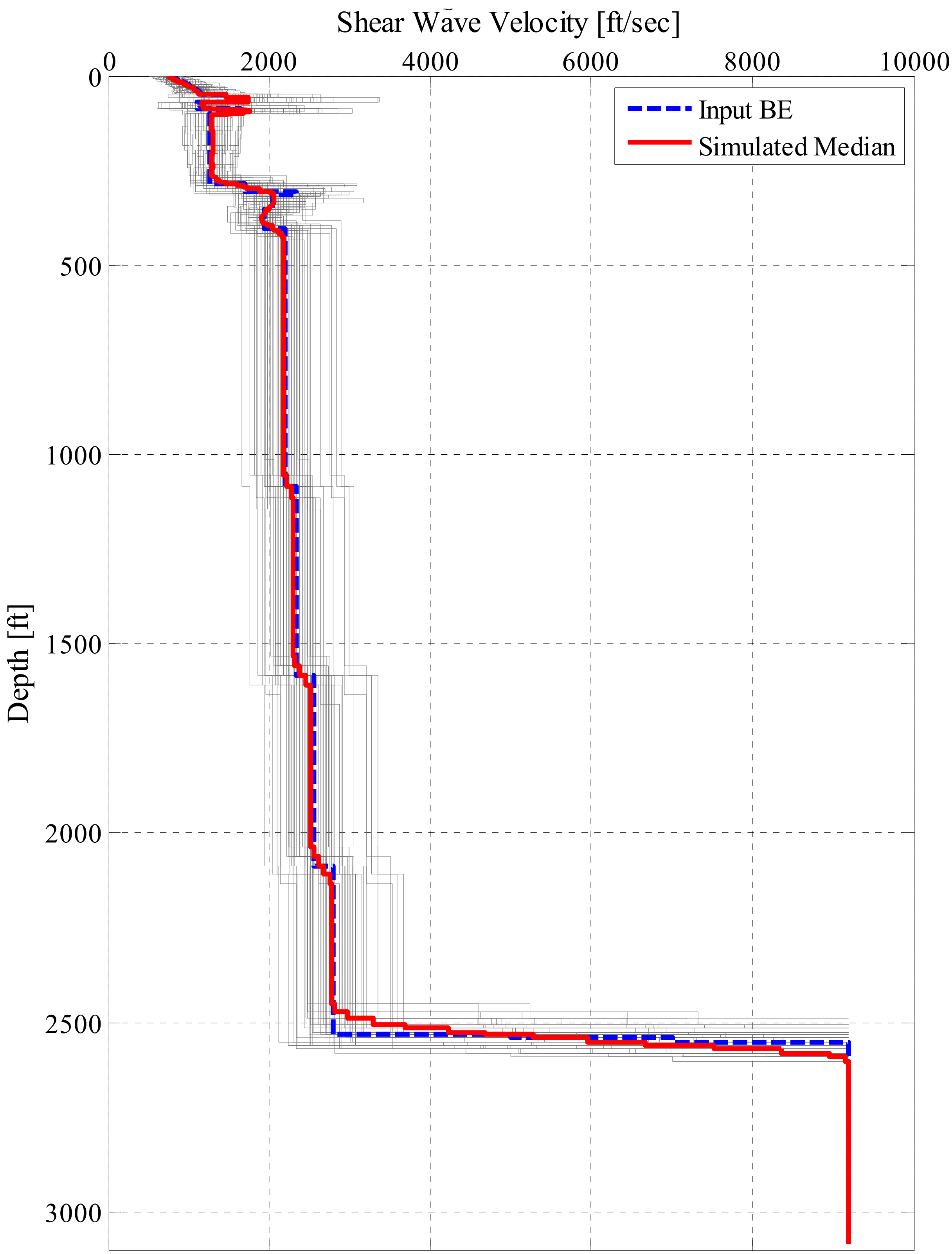

Figure 3F-4c — {Shear-Wave Velocity for 60 Simulated Profiles - RB26 Soil Column (Halfspace at First Occurrence of Vs = 9200 ft/sec)}

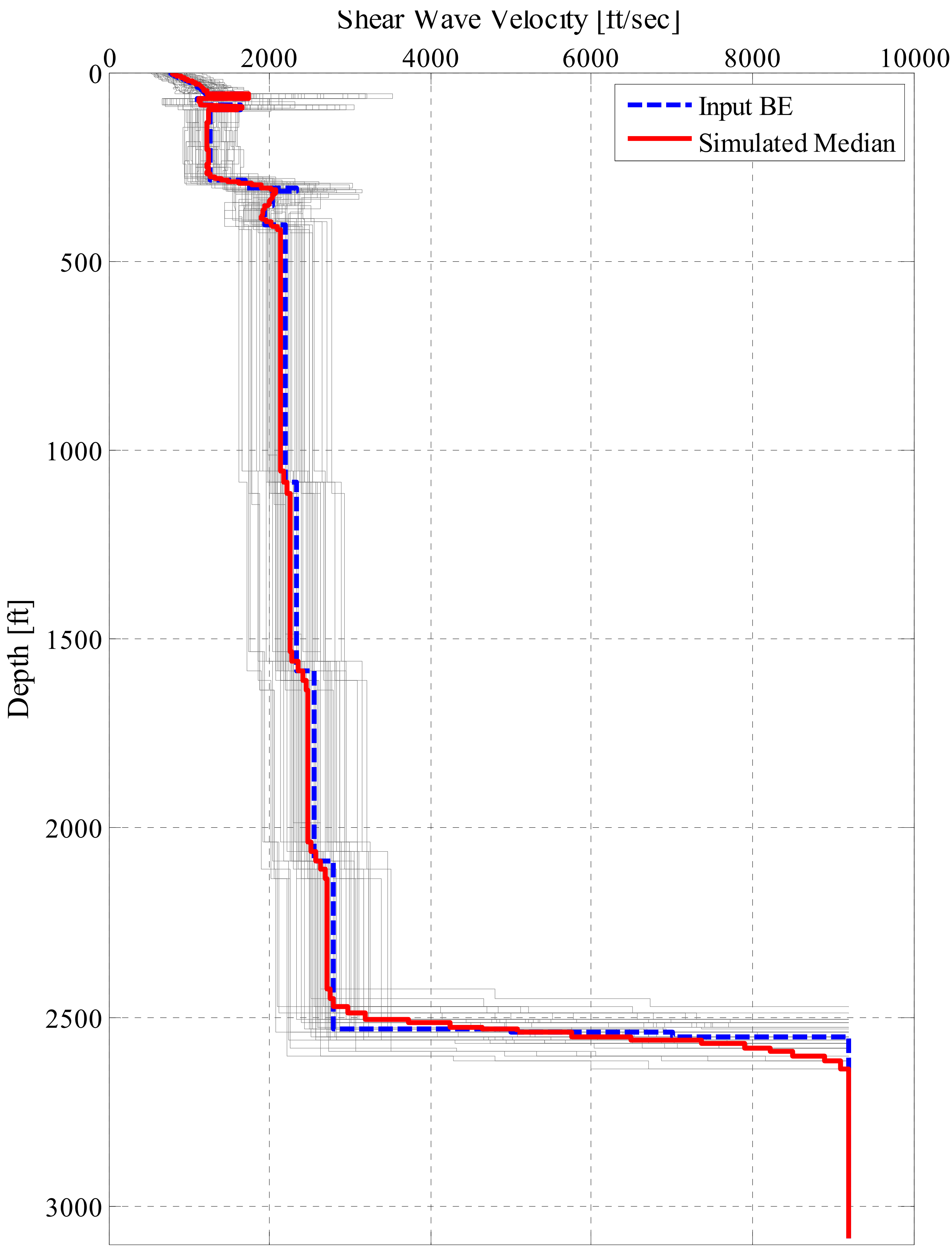

Figure 3F-5 — {Shear Wave Velocity for 60 Simulated Profiles – NI Area (Halfspace at first occurrence of Vs = 9200 ft/sec)}

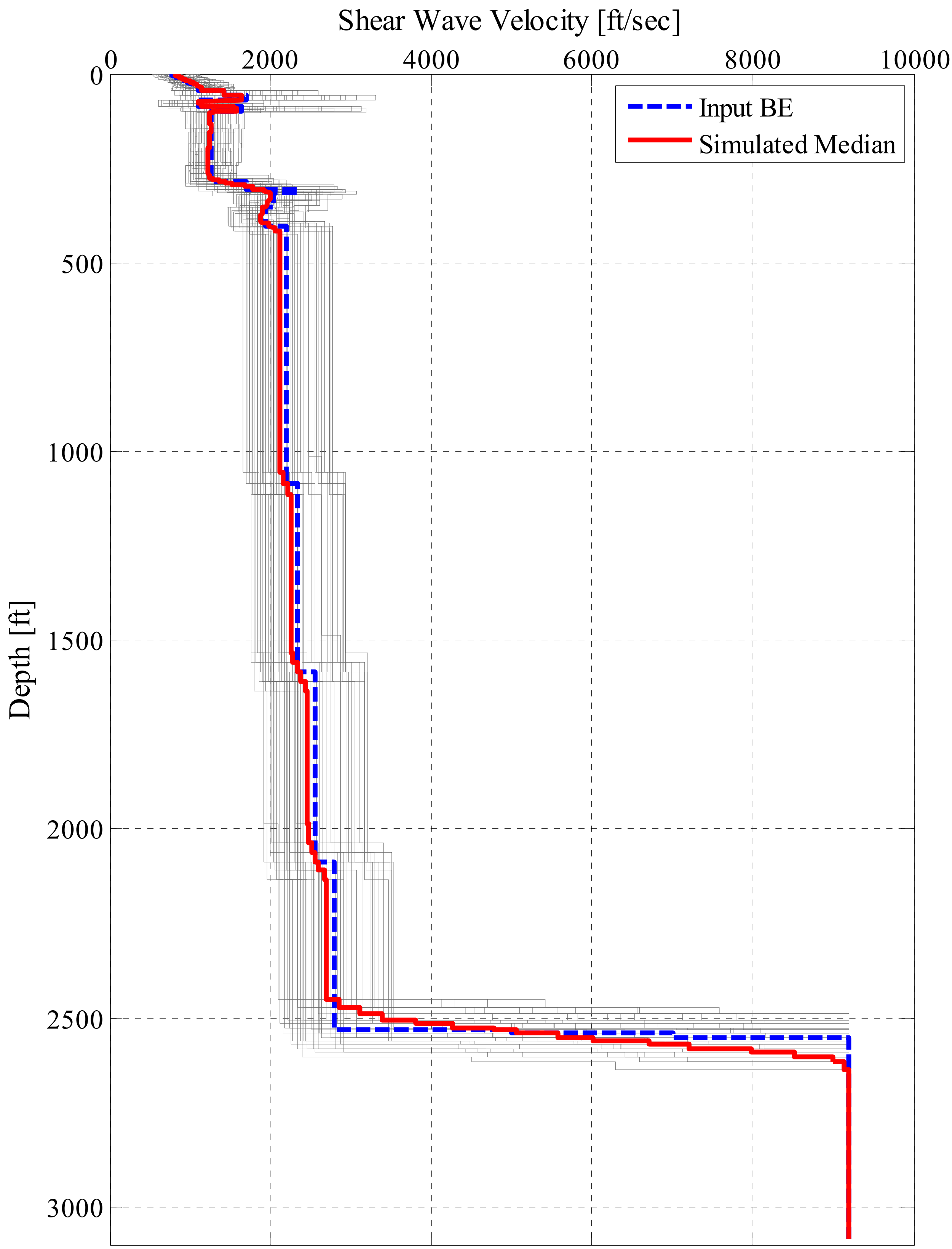

Figure 3F-6 — {Shear Wave Velocity for 60 Simulated Profiles – Intake Area (Halfspace at first occurrence of Vs =9200 ft/sec)}

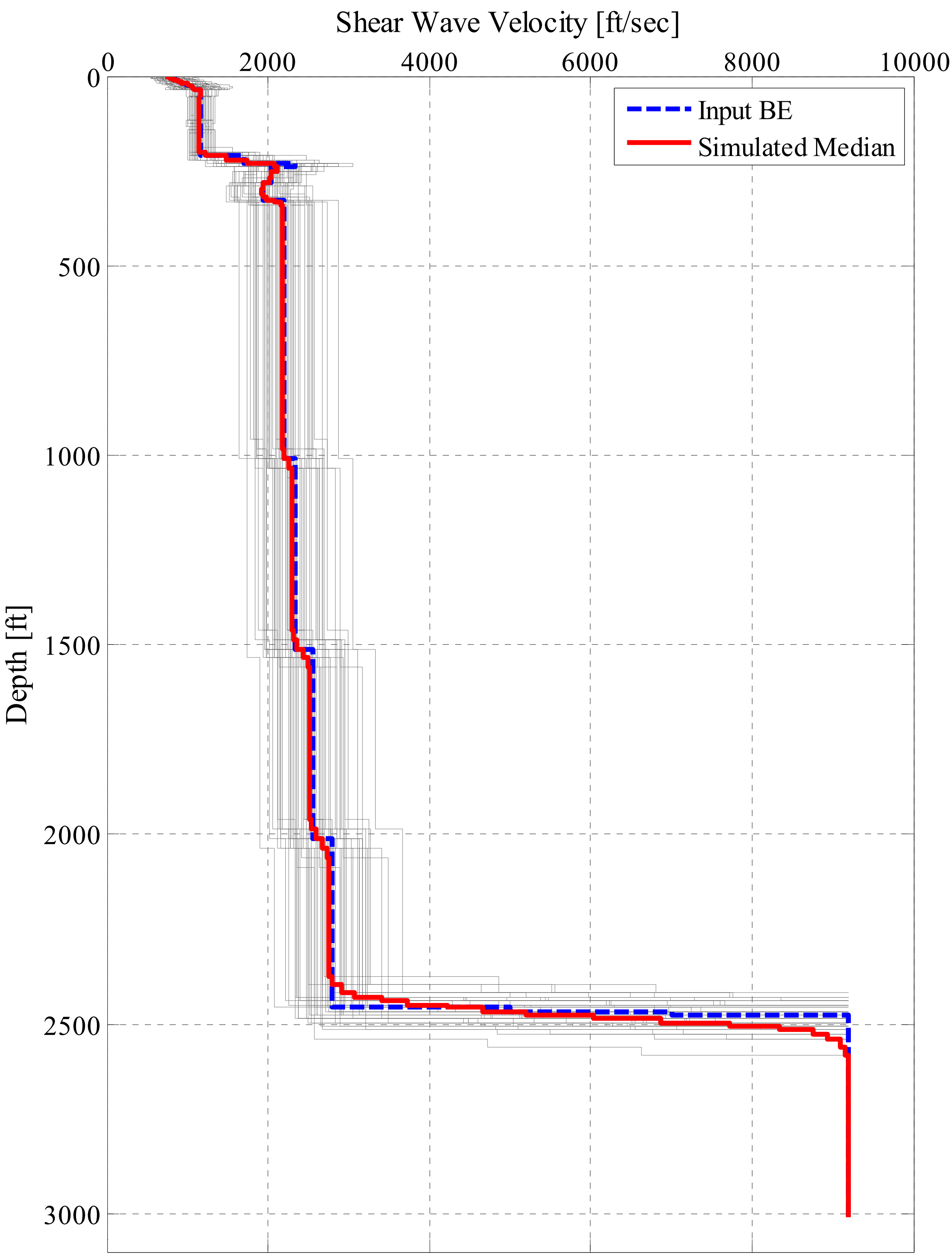

Figure 3F-7 — {Fill 1 Shear Modulus Reduction Curves for 60 Simulated Profiles – NI Area}

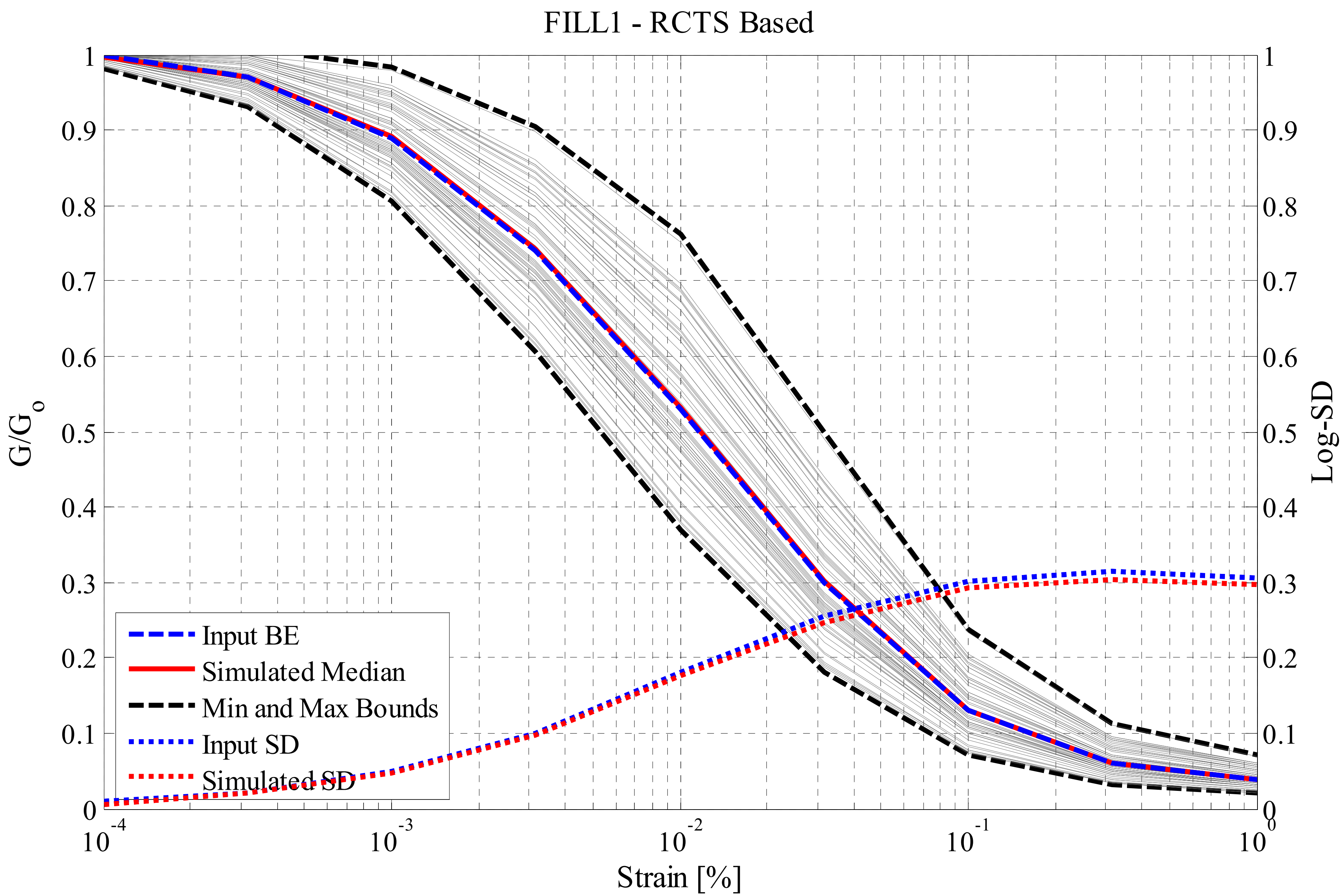

Figure 3F-8 — {Fill 1 Damping Ratio Curves for 60 Simulated Profiles – NI Area}

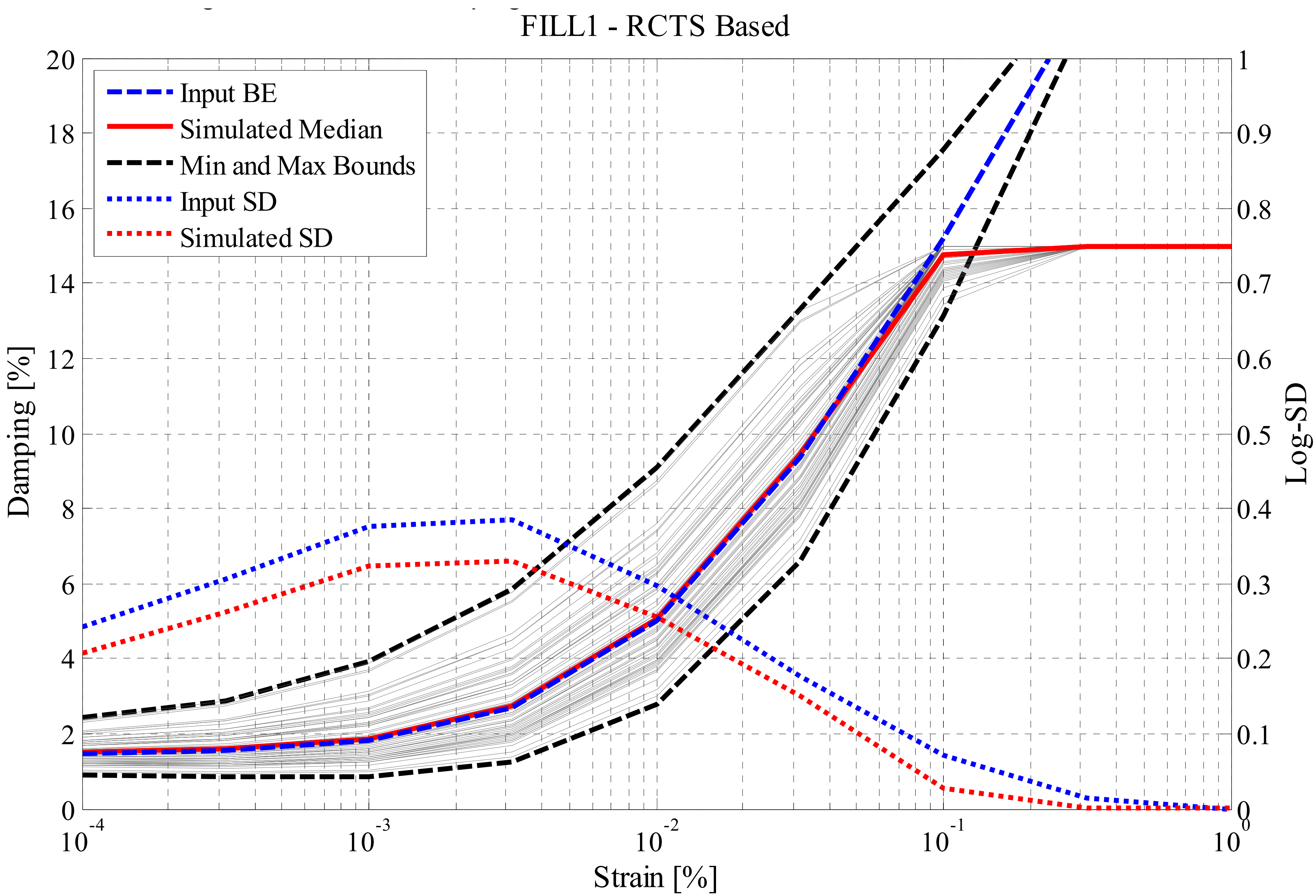

Figure 3F-9a — {5% Damping ARS Amplification Functions at 39 ft Depth - RB36 Soil Column}

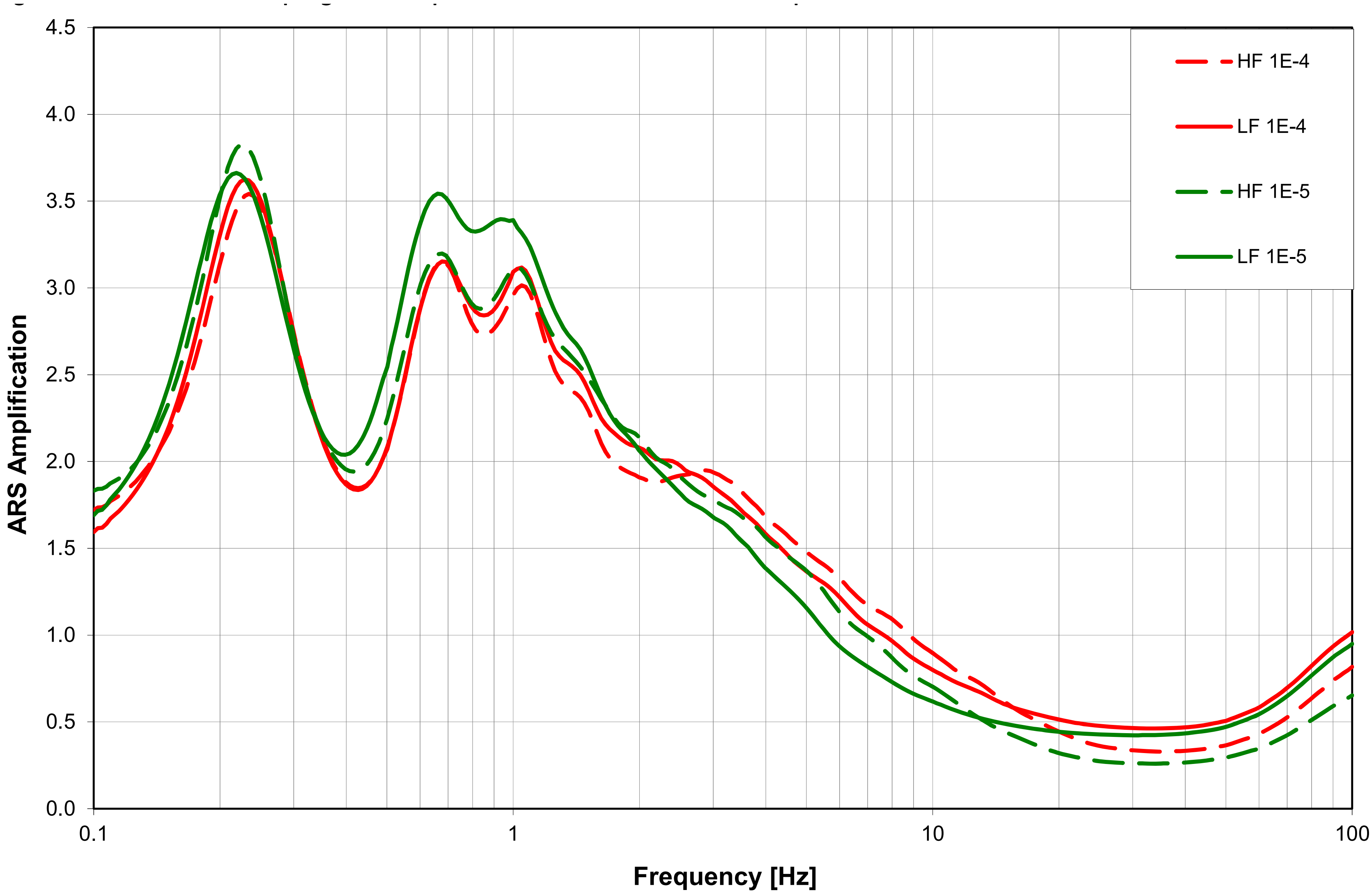

Figure 3F-9b — {5% Damping ARS Amplification Functions at 39 ft Depth - RB26 Soil Column}

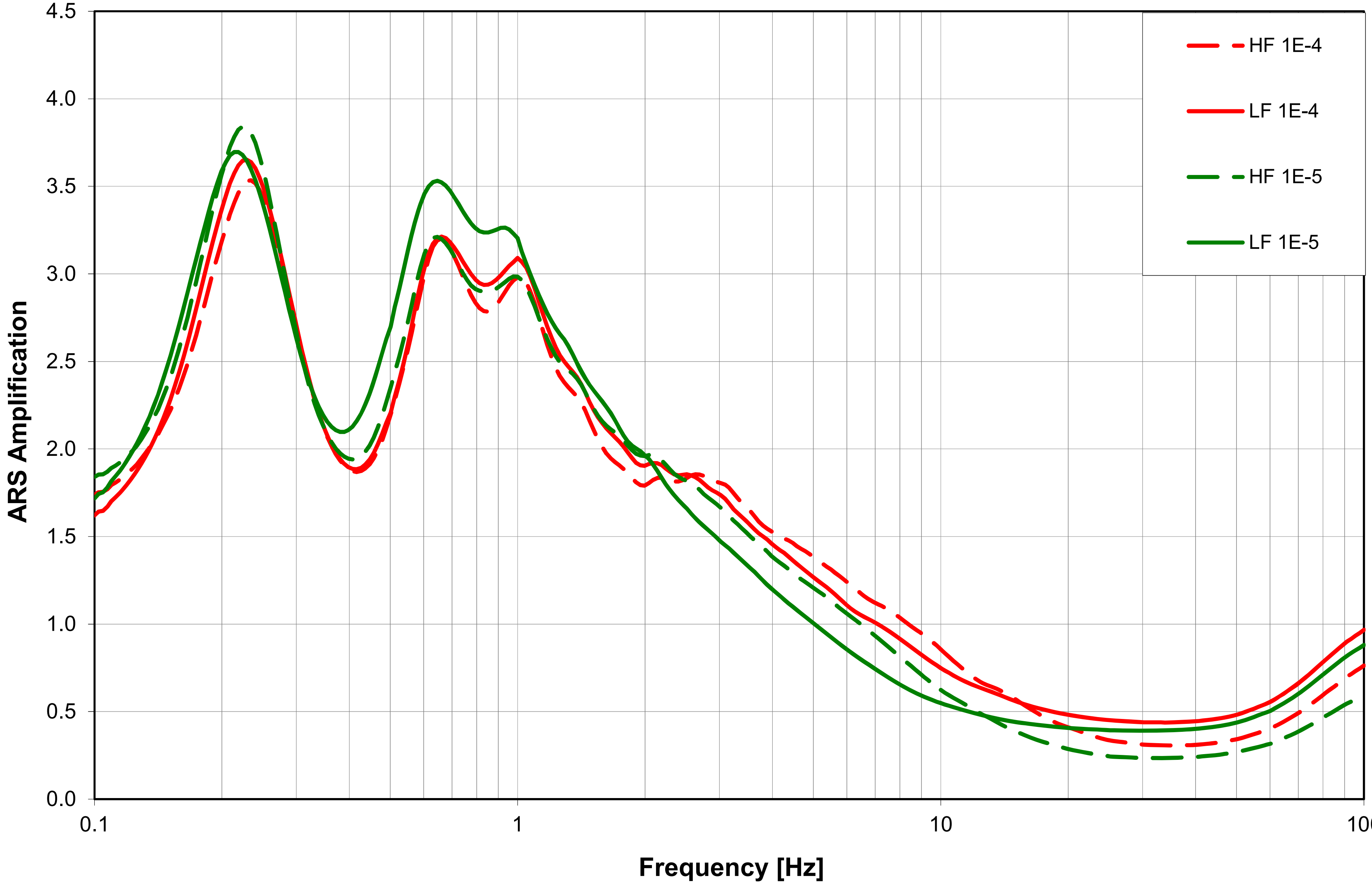

Figure 3F-9c — {5% Damping ARS Amplification Functions at 34 ft Depth - NI Area}

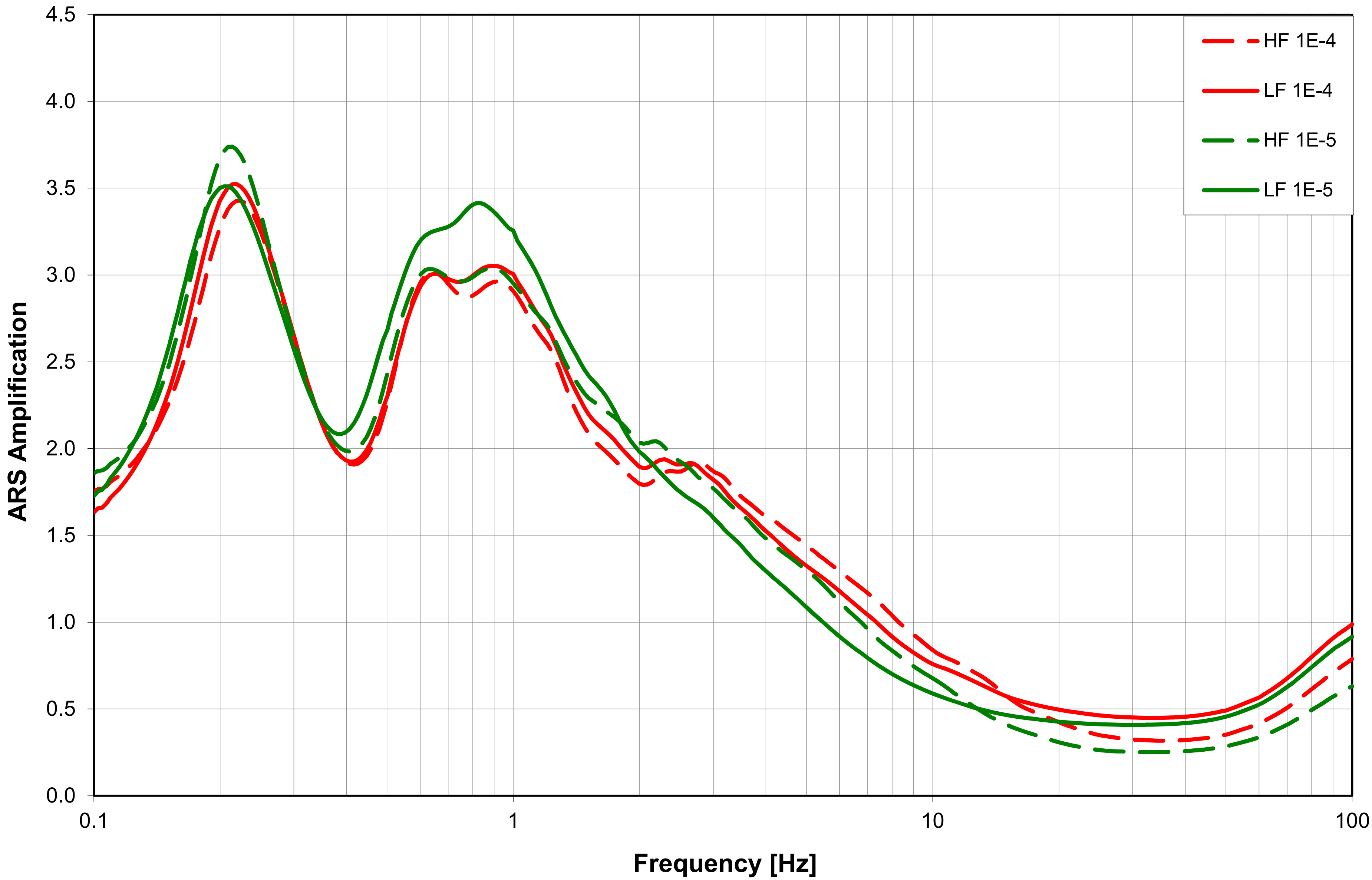

Figure 3F-10a — {Log-Mean Strain Profiles - RB36 Soil Column}

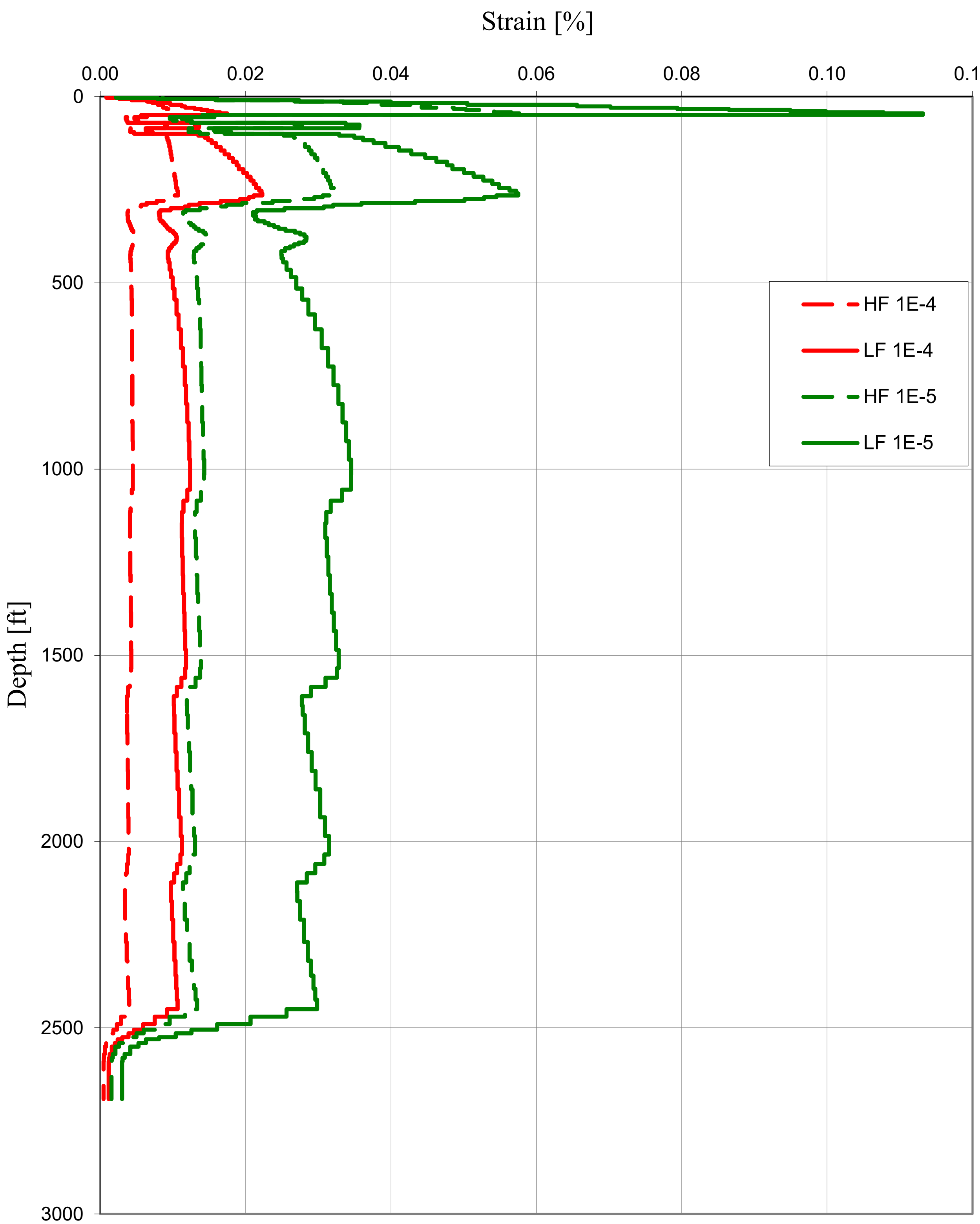

Figure 3F-10b — {Log-Mean Strain Profiles - RB26 Soil Column}

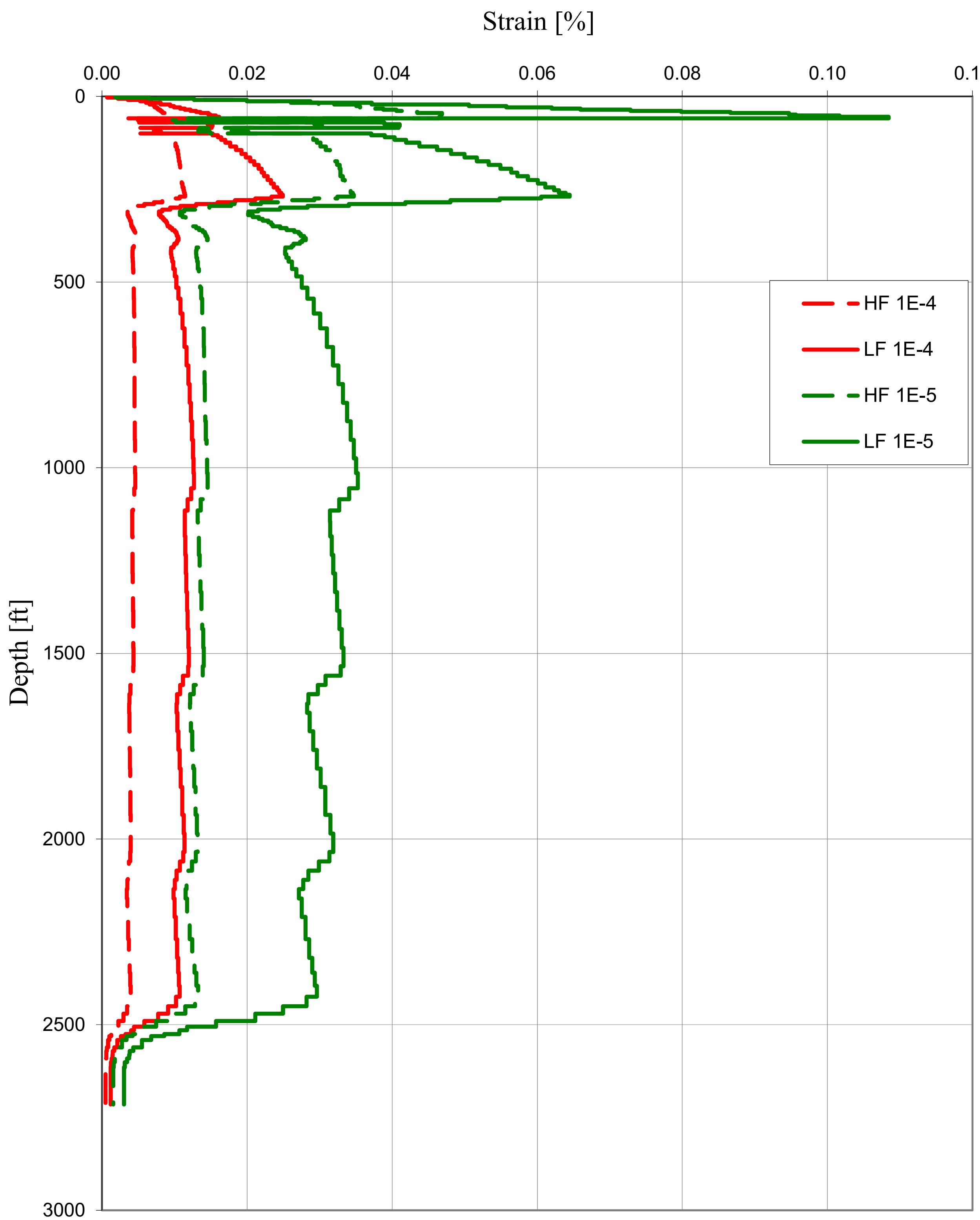

Figure 3F-10c — {Log-Mean Strain Profiles - NI Area}

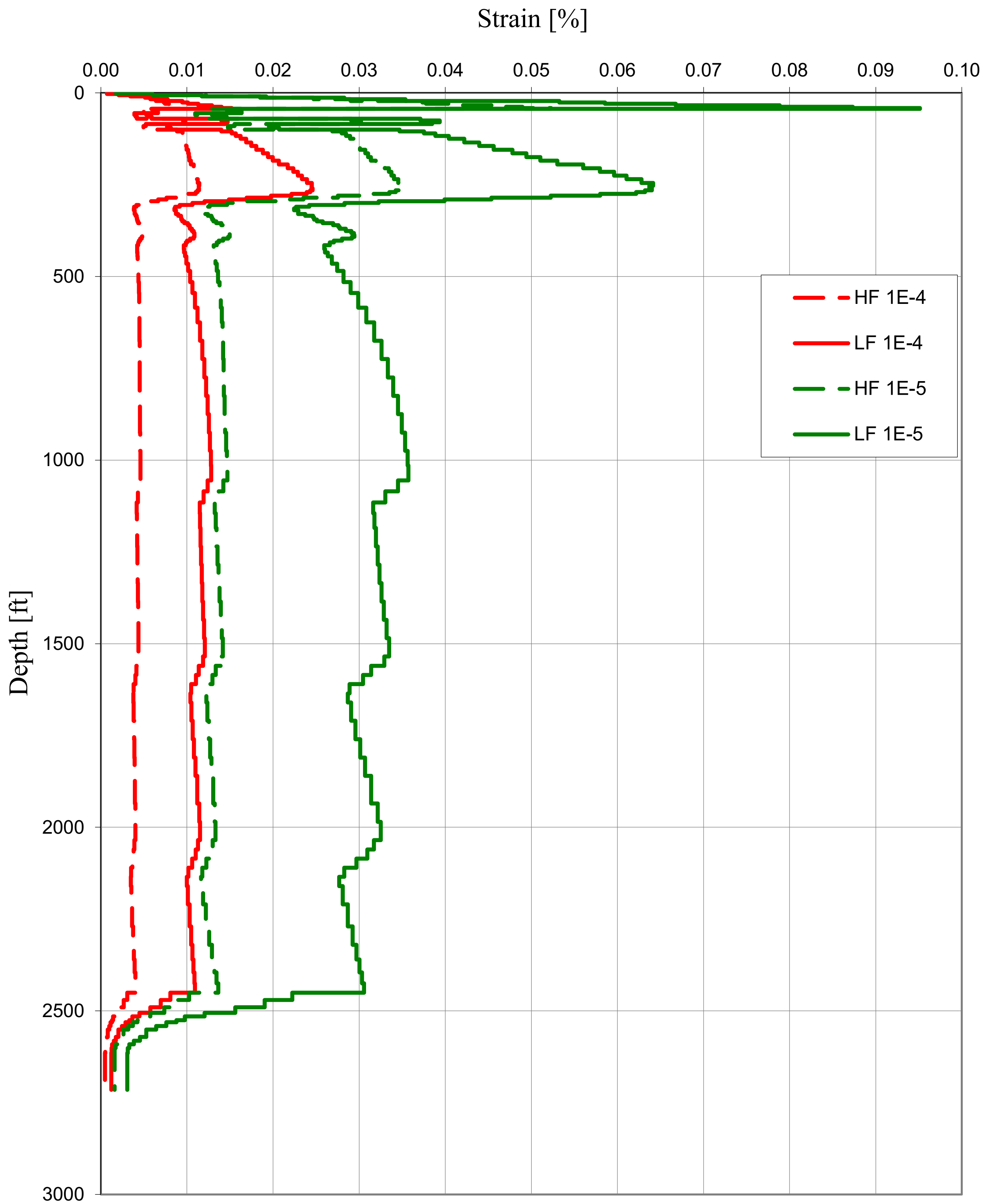

Figure 3F-11 — {Log-Mean Strain Profiles - Intake Area}

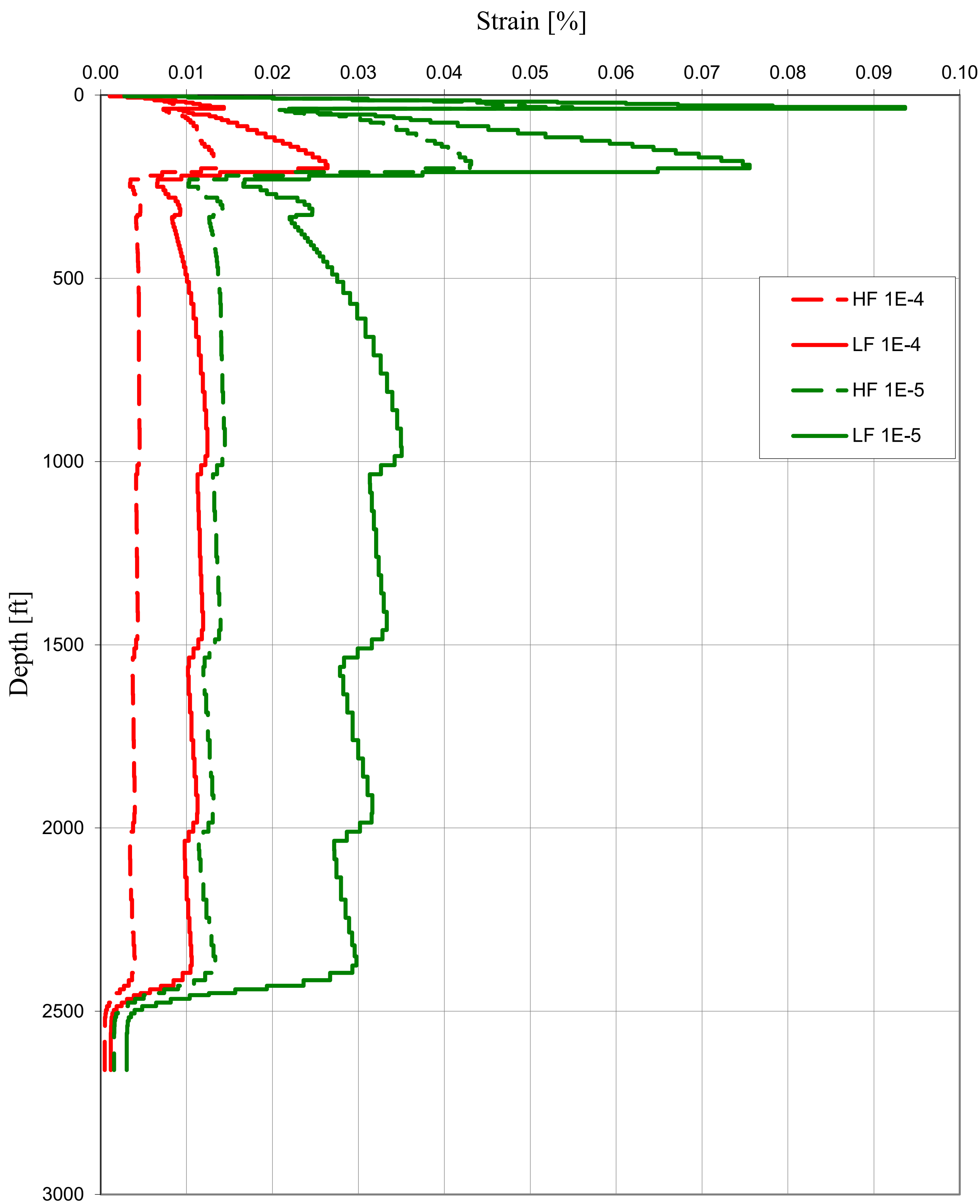

Figure 3F-12a — {5% Damping Horizontal and Vertical FIRS – RB36 Soil Column}

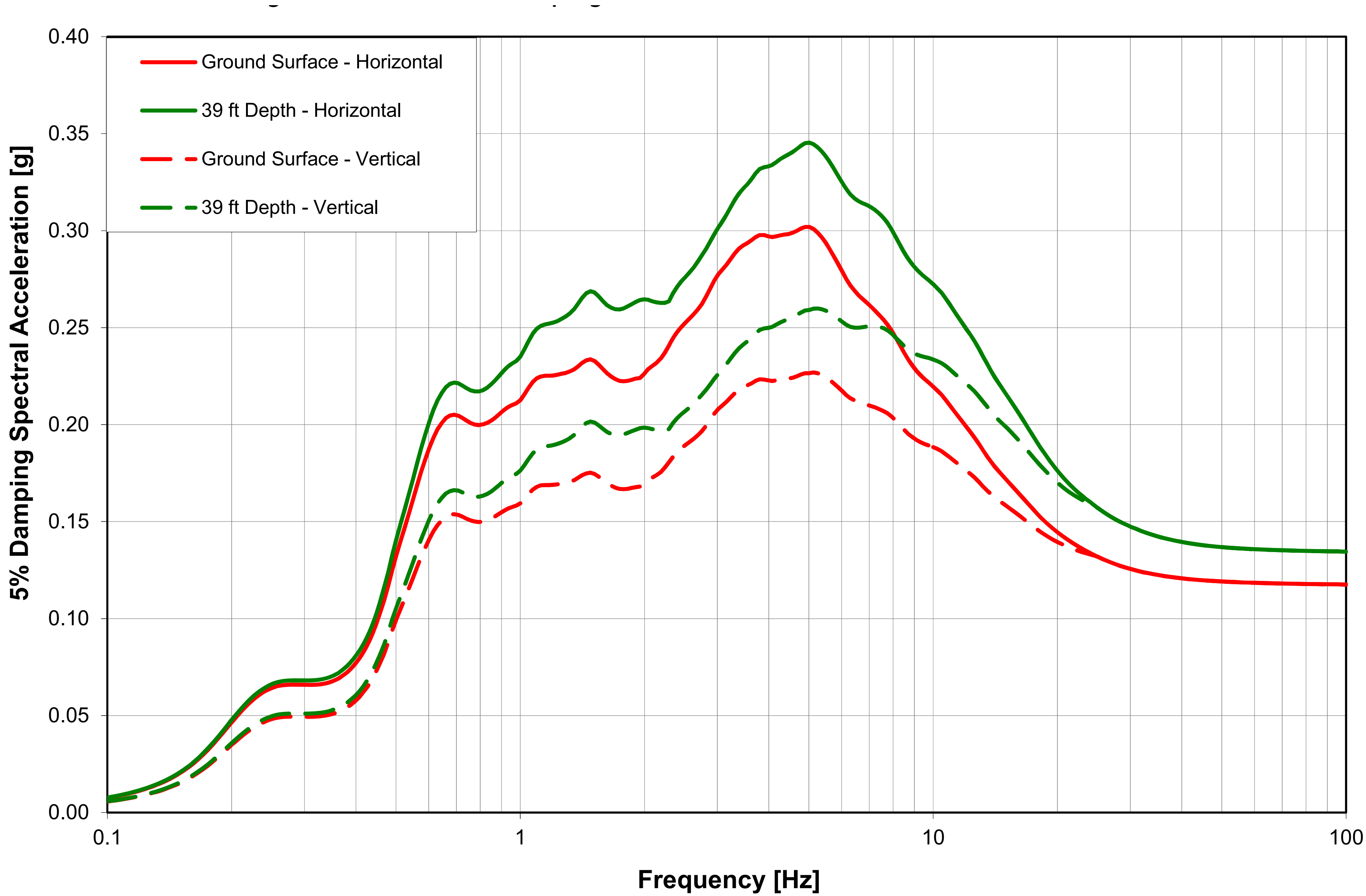

Figure 3F-12b — {5% Damping Horizontal and Vertical FIRS – RB26 Soil Column}

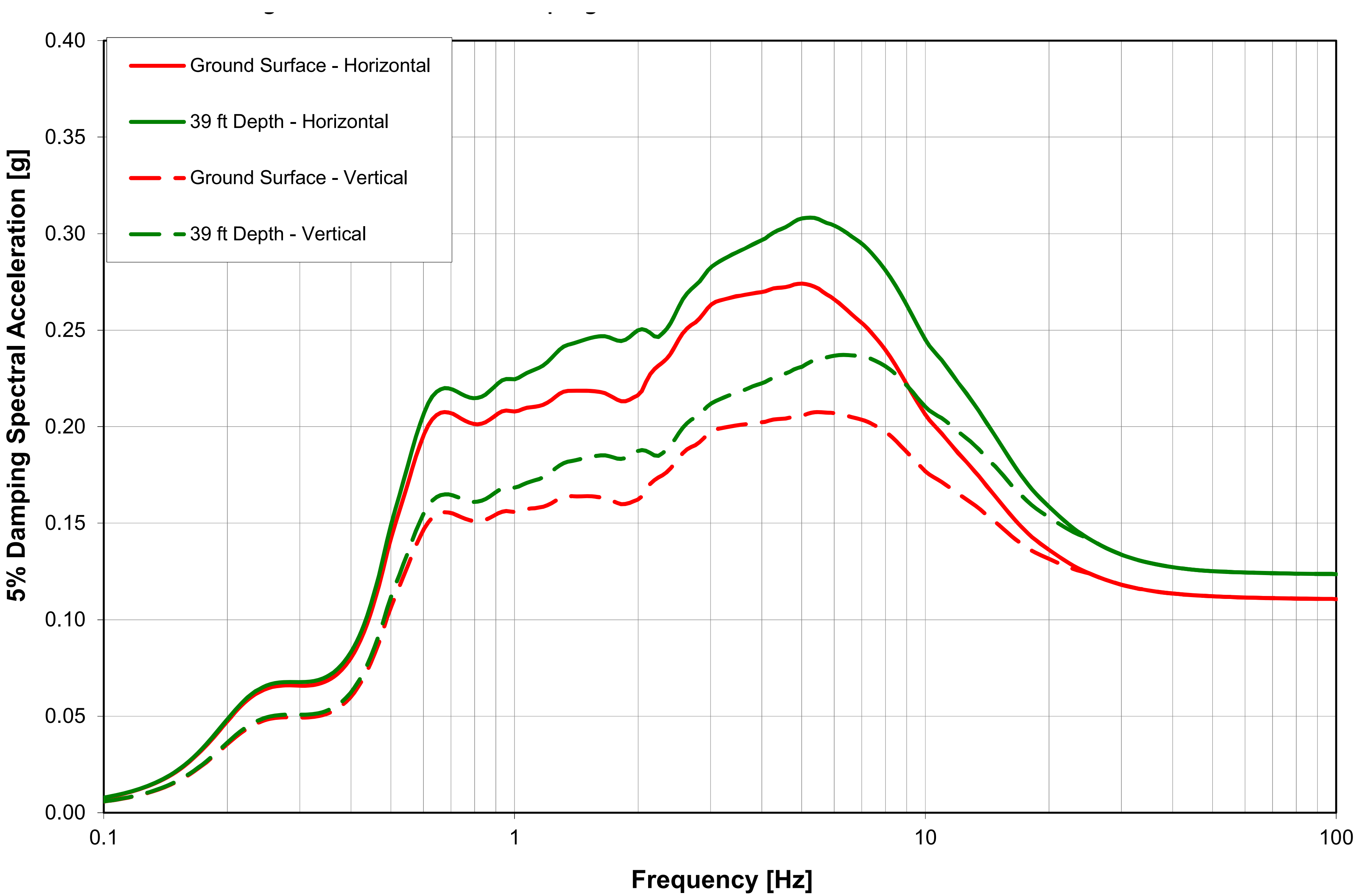

Figure 3F-12c — {5% Damping Horizontal and Vertical FIRS – NI Area}

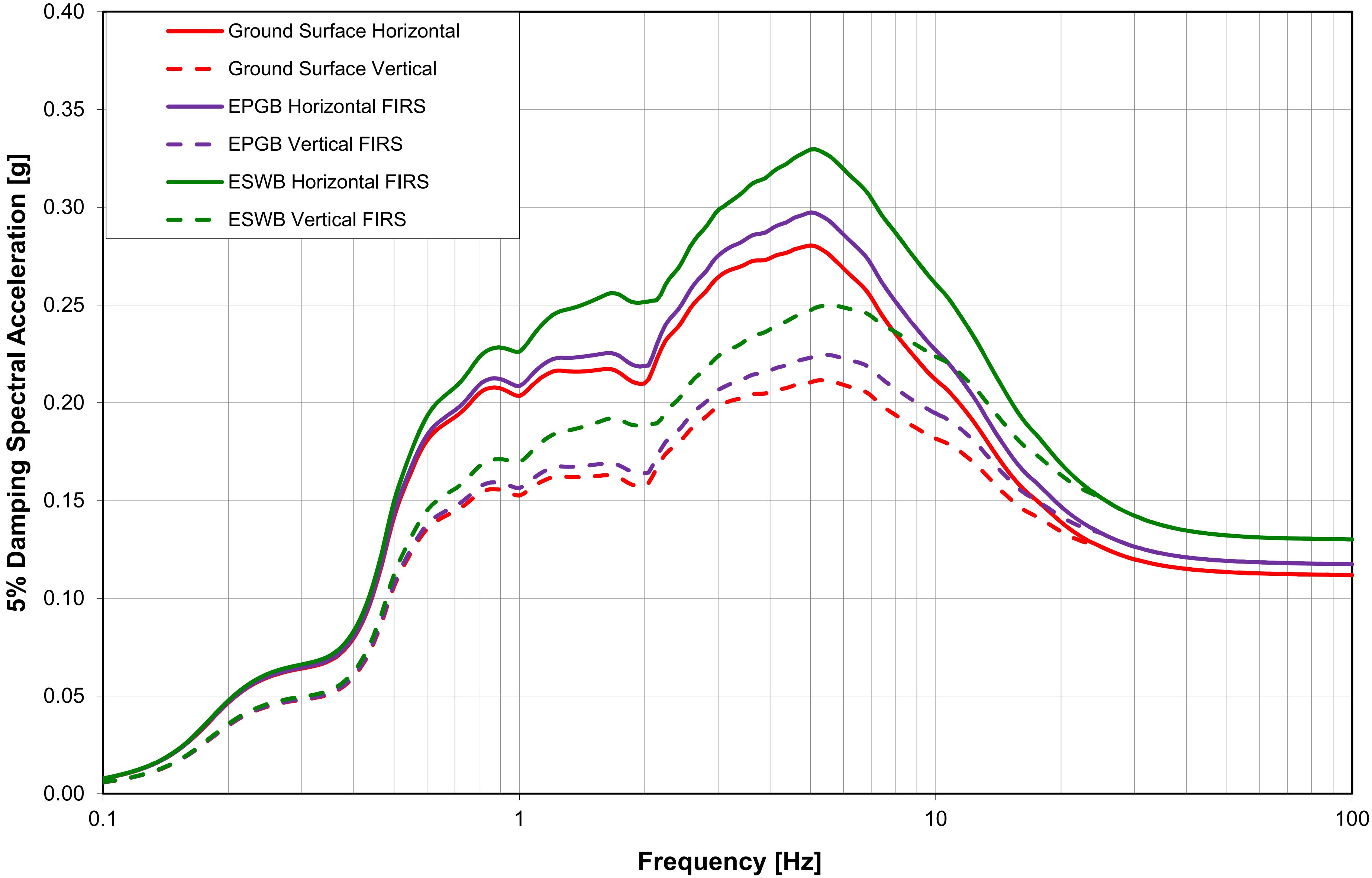

Figure 3F-13 — {5% Damping Horizontal and Vertical FIRS – Intake Area}

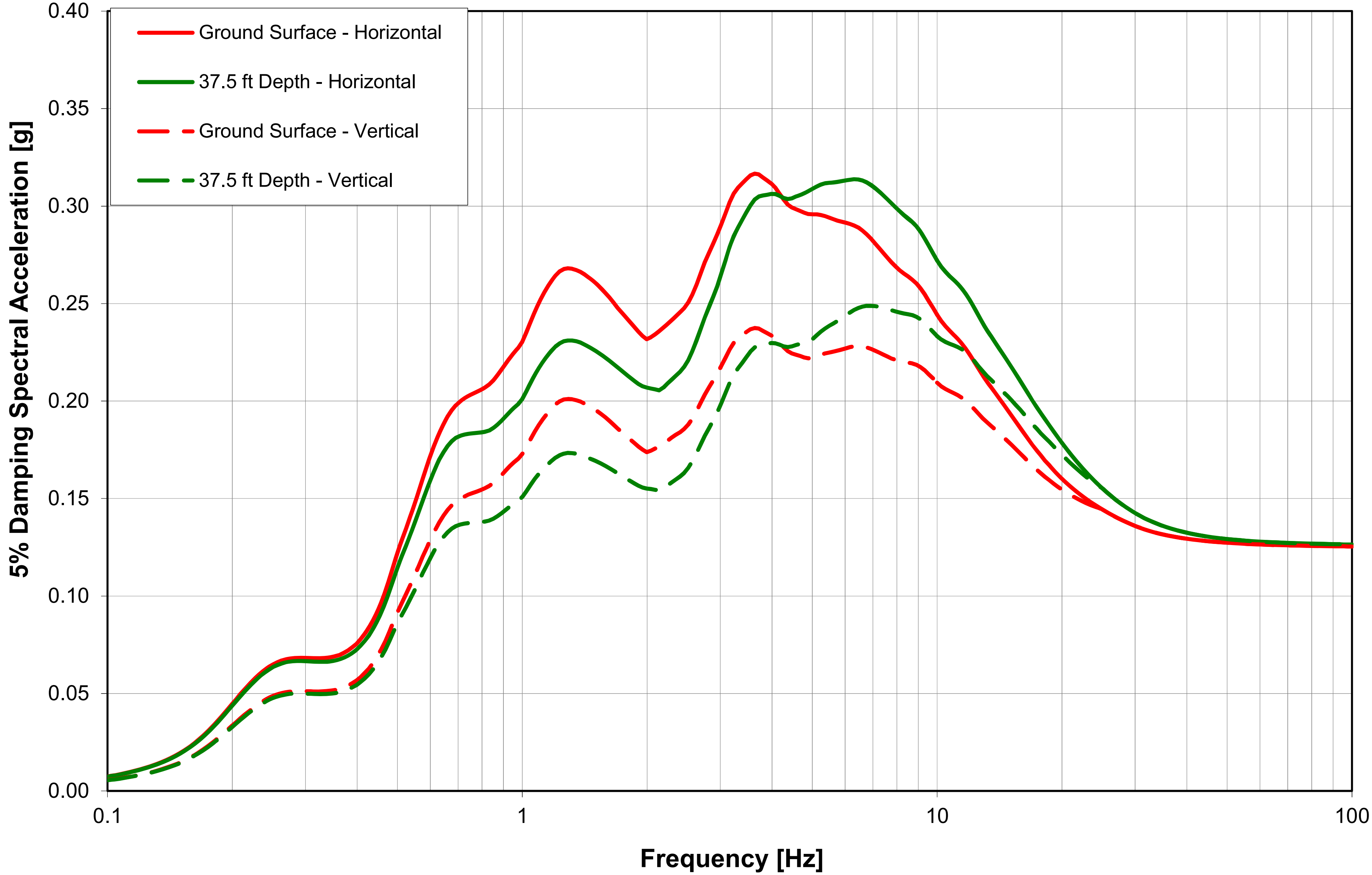

Figure 3F-14a — {Shear-Wave Velocity Profiles Strain-Compatible with FIRS for the RB36 Soil}

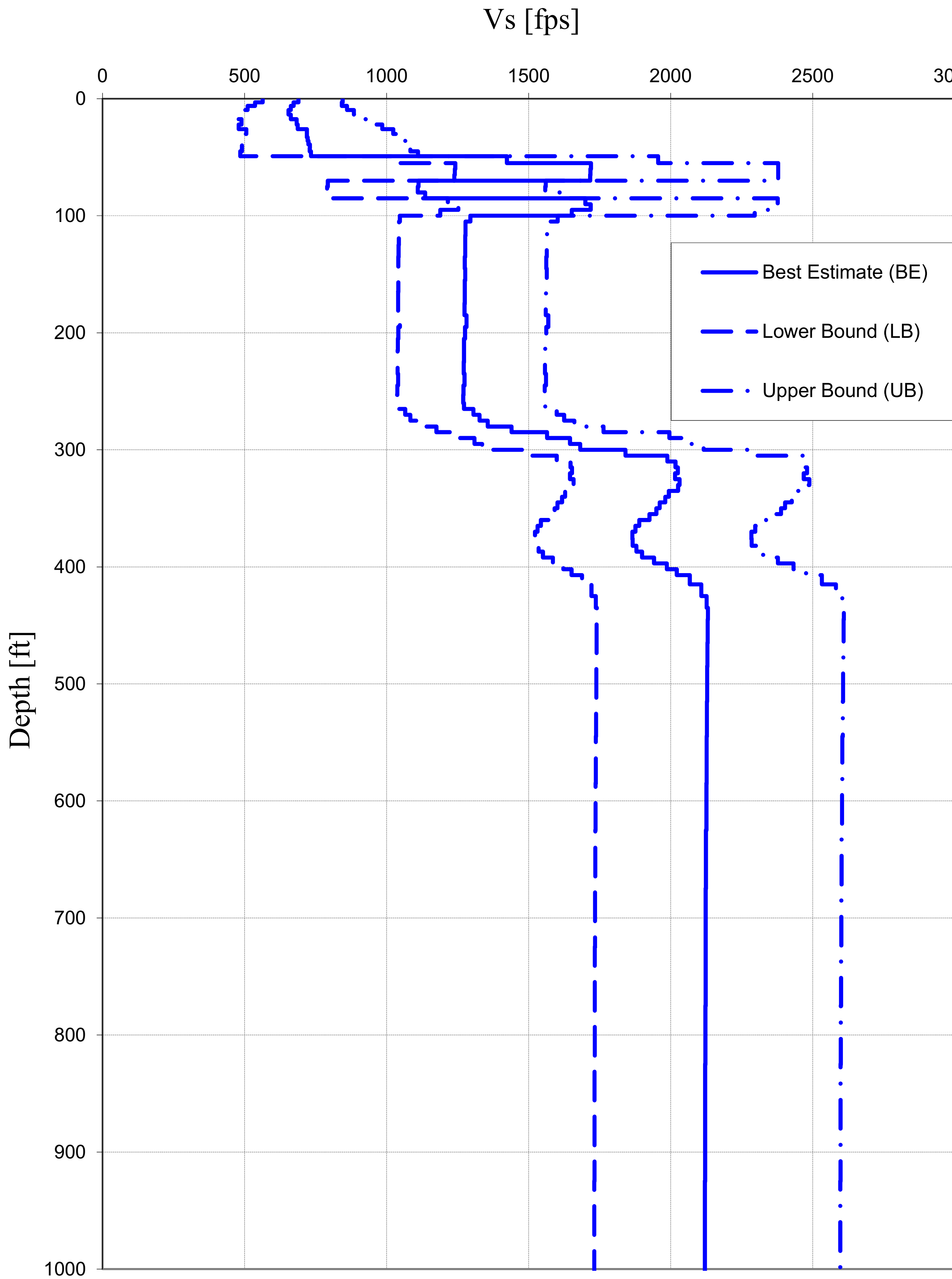

Figure 3F-14b — {Damping Ratio Profiles Strain-Compatible with FIRS for the RB36 Soil Column}

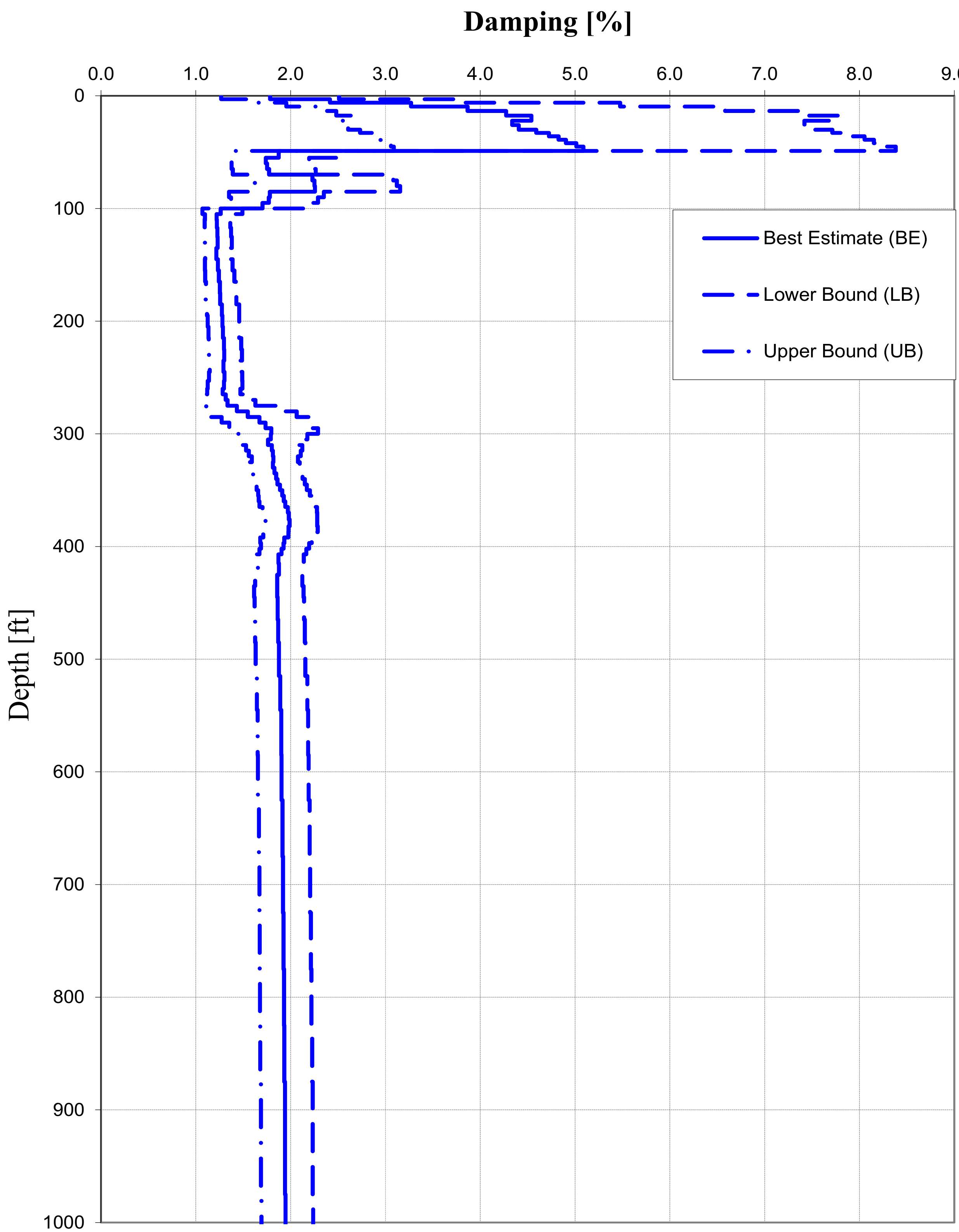

Figure 3F-14c — {P-Wave Velocity Profiles Strain-Compatible with FIRS for the RB36 Soil Column}

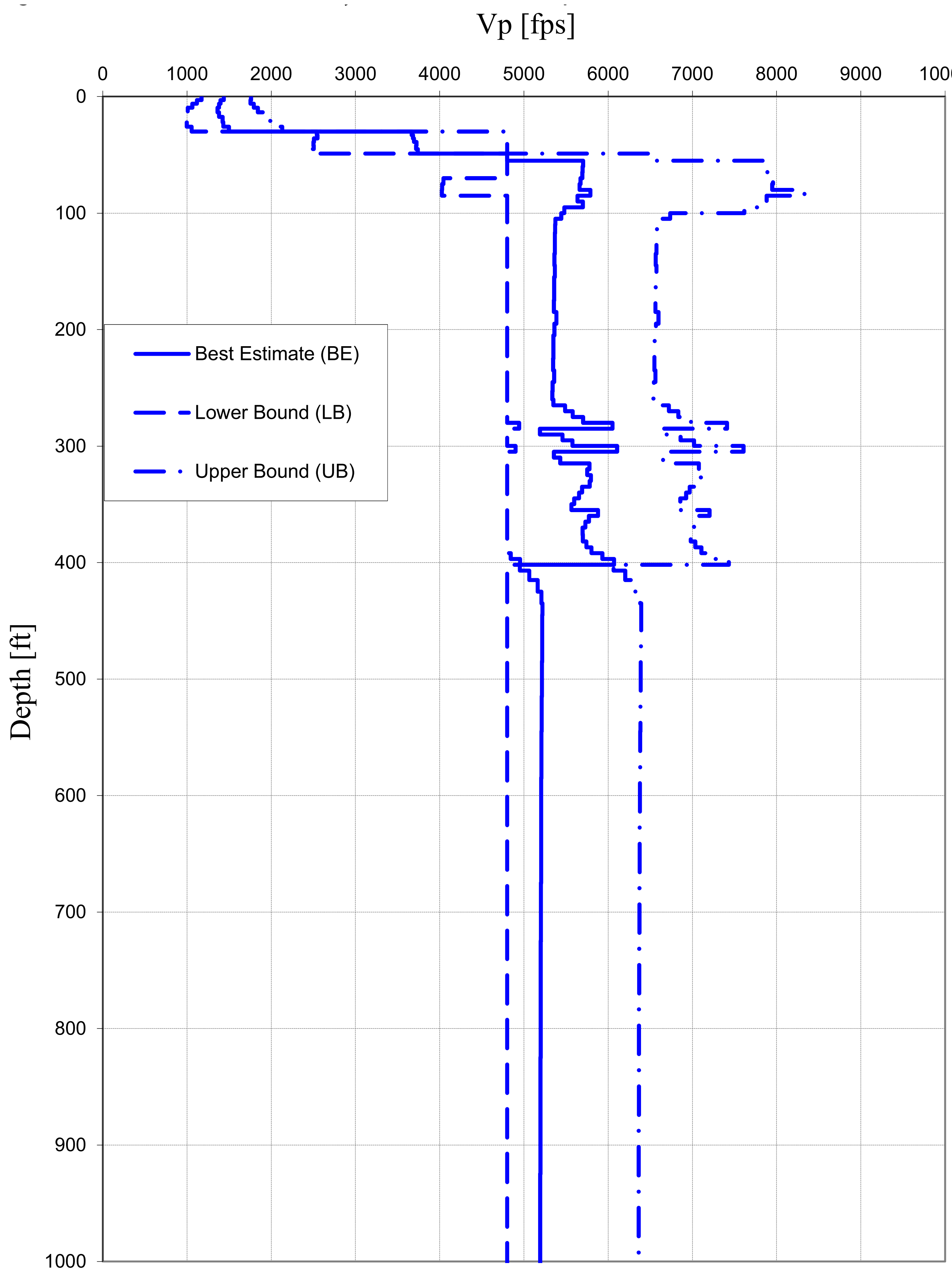

Figure 3F-14d — {Shear-Wave Velocity Profiles Strain-Compatible with FIRS for the BRB26 Soil Column}

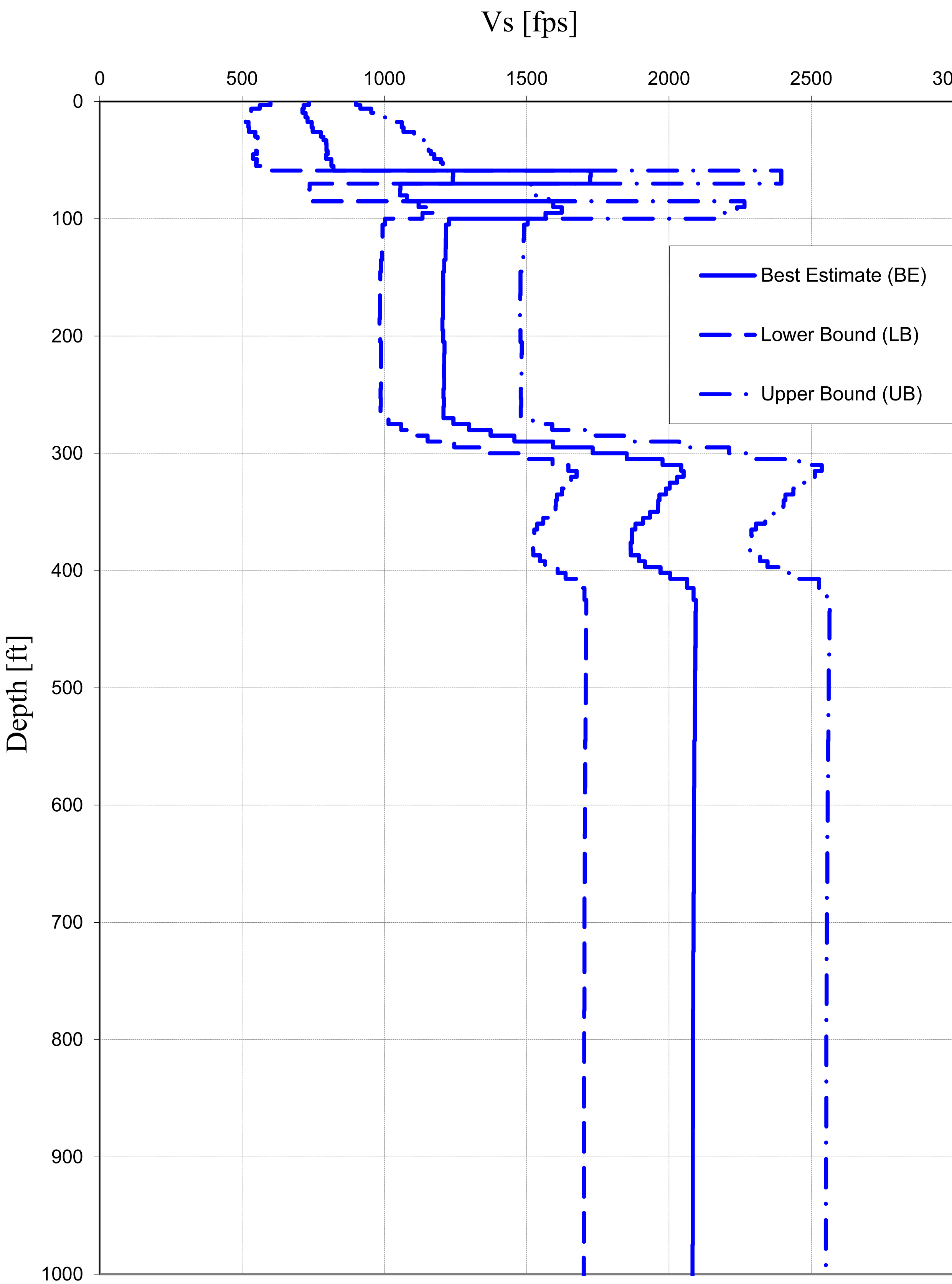

Figure 3F-14e — {Damping Ratio Profiles Strain-Compatible with FIRS for the RB26 Soil Column}

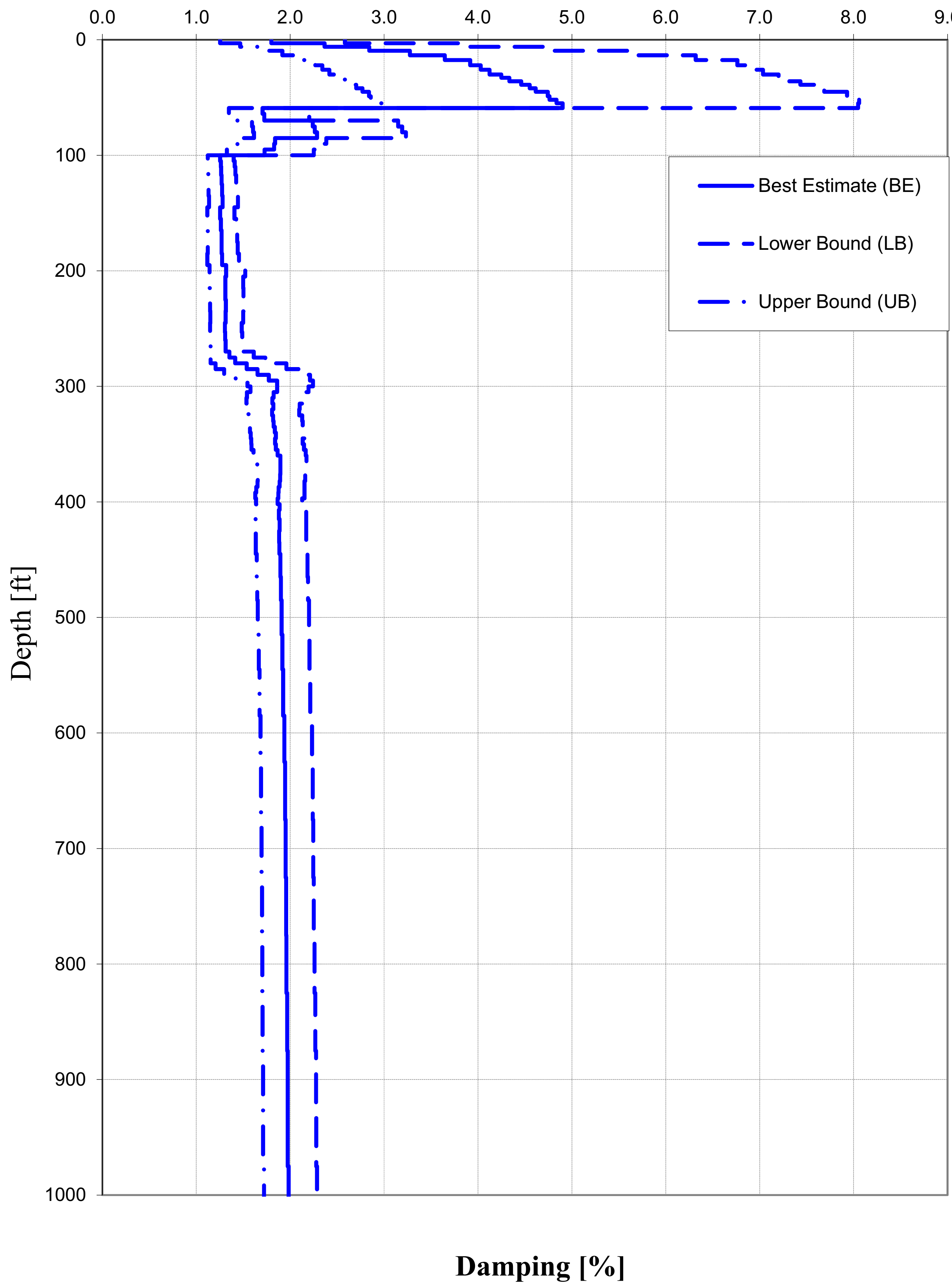

Figure 3F-14f — {Shear-Wave Velocity Profiles Strain-Compatible with FIRS for the RB26 Soil Column}

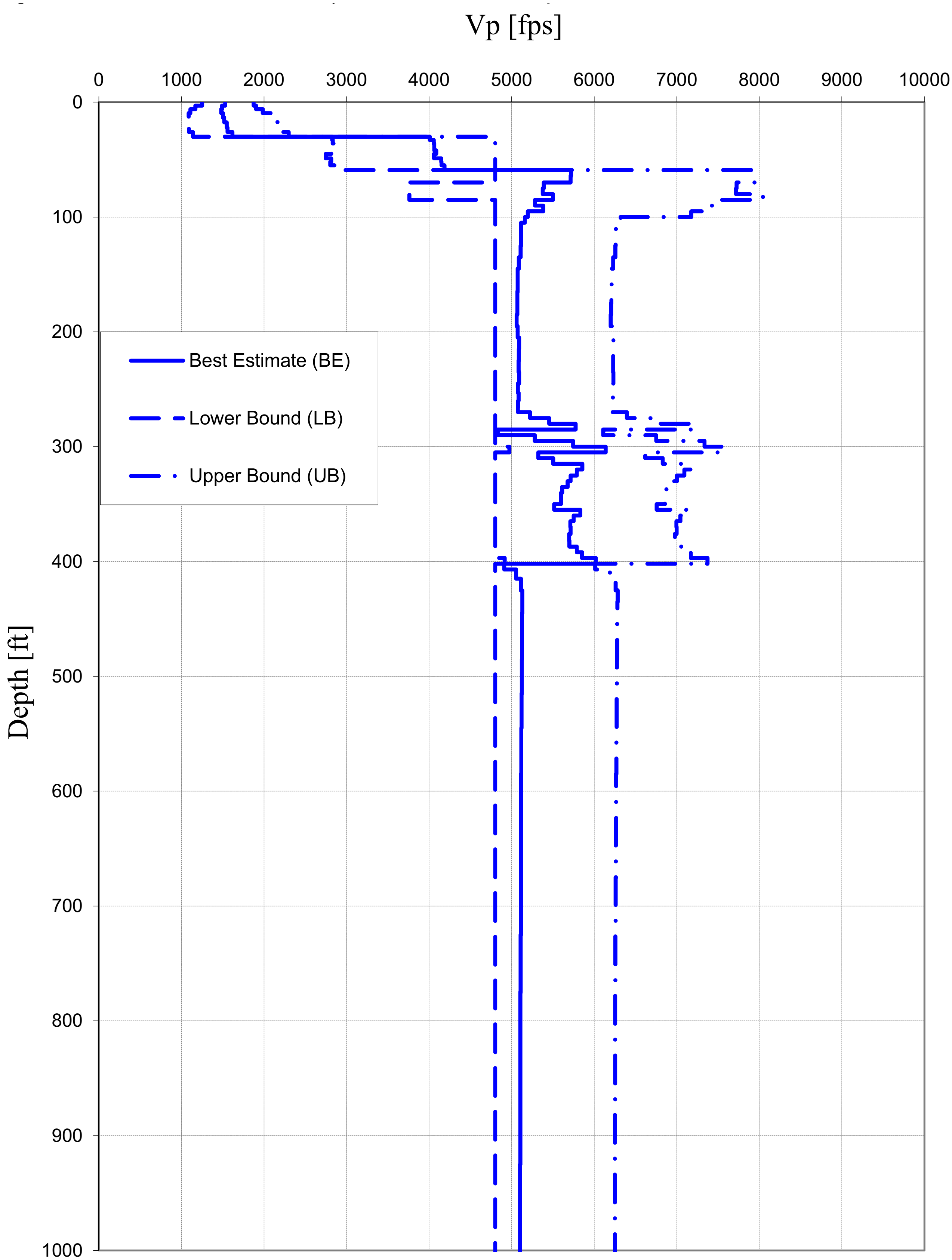

Figure 3F-14g — {Shear-Wave Velocity Profiles Strain-Compatible with FIRS for the NI Area}

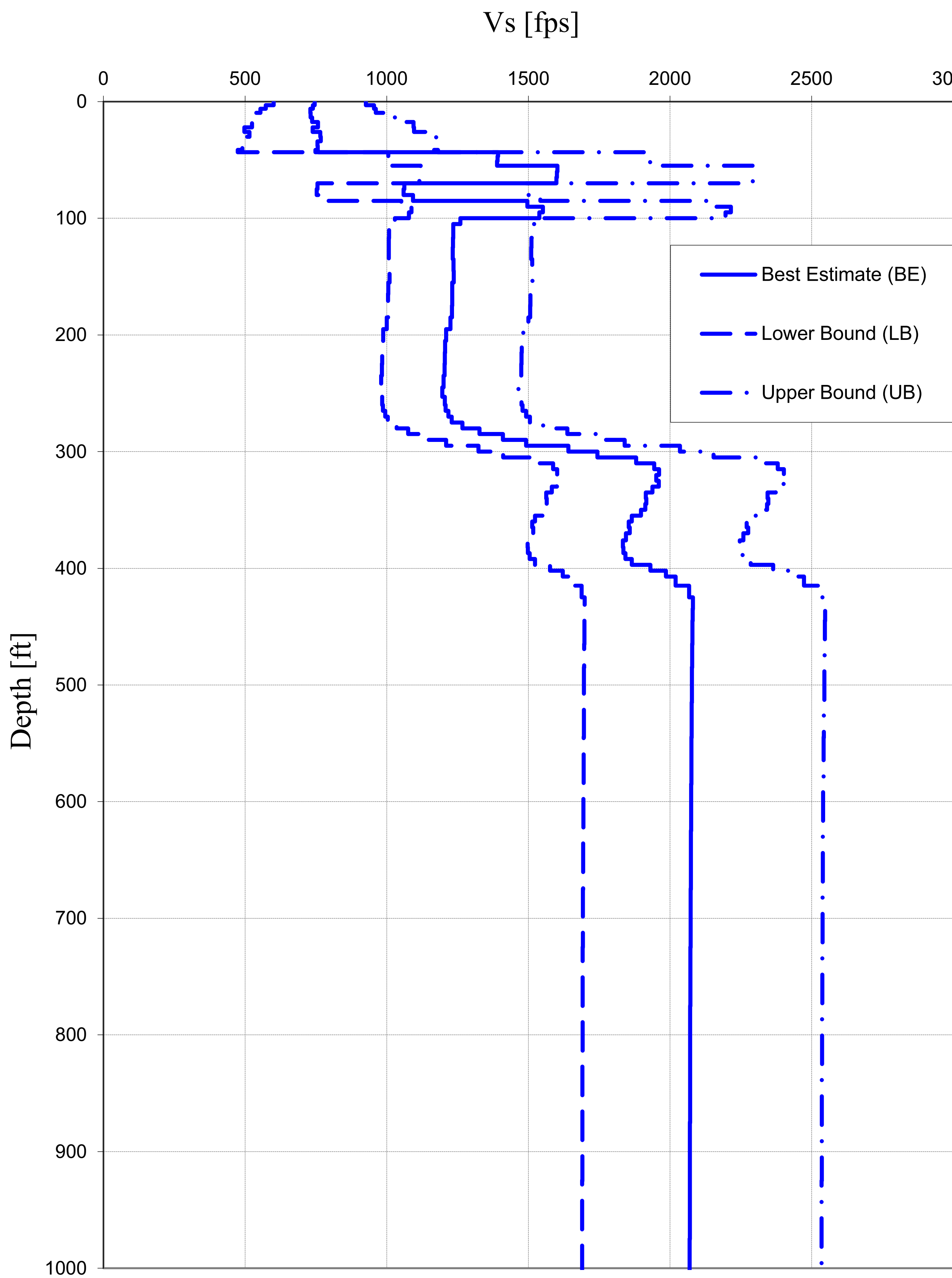

Figure 3F-15 — {Damping Profiles Strain-Compatible with FIRS for the NI Area}

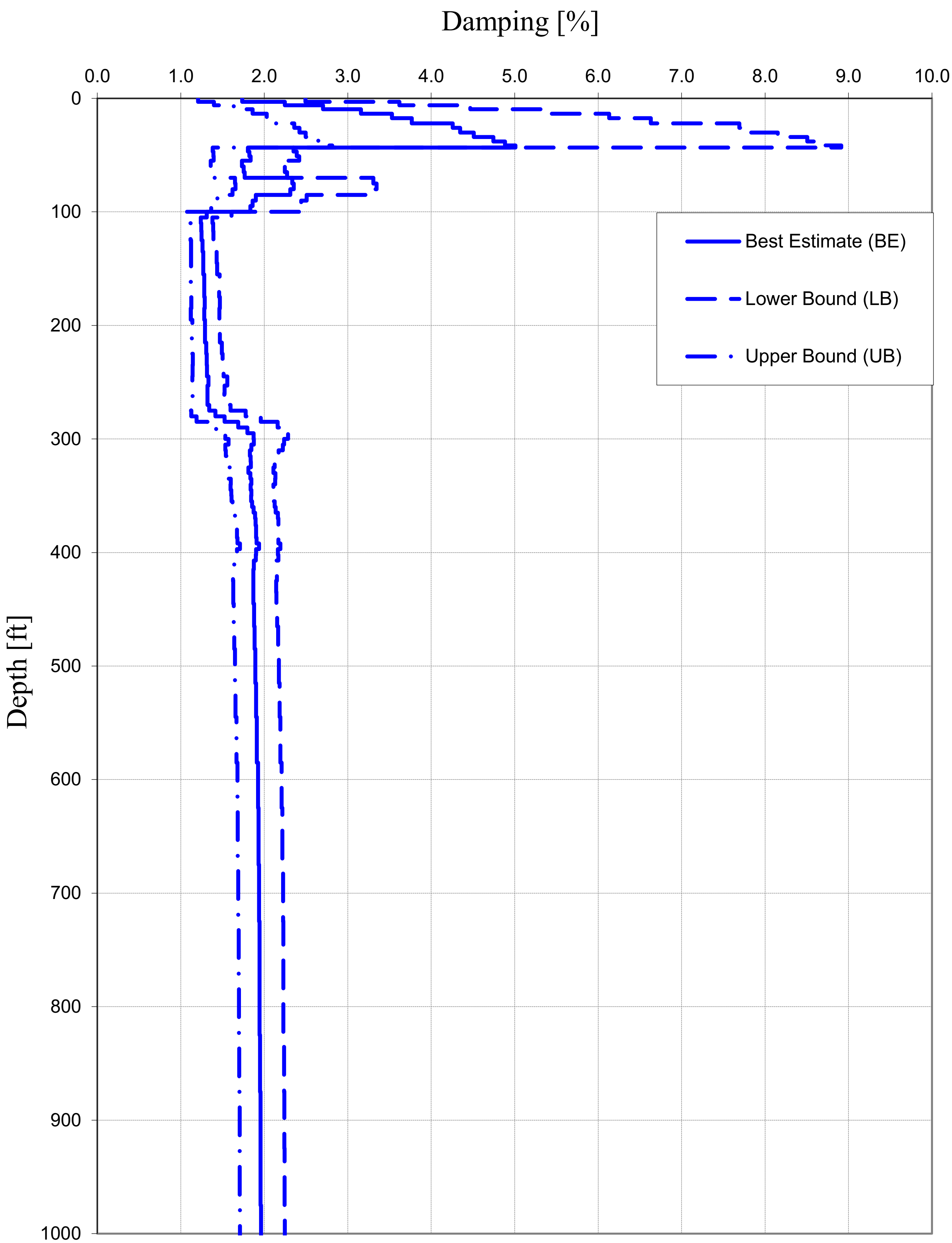

Figure 3F-16 — {FIRS P-Wave Velocity Profiles for the NI Area}

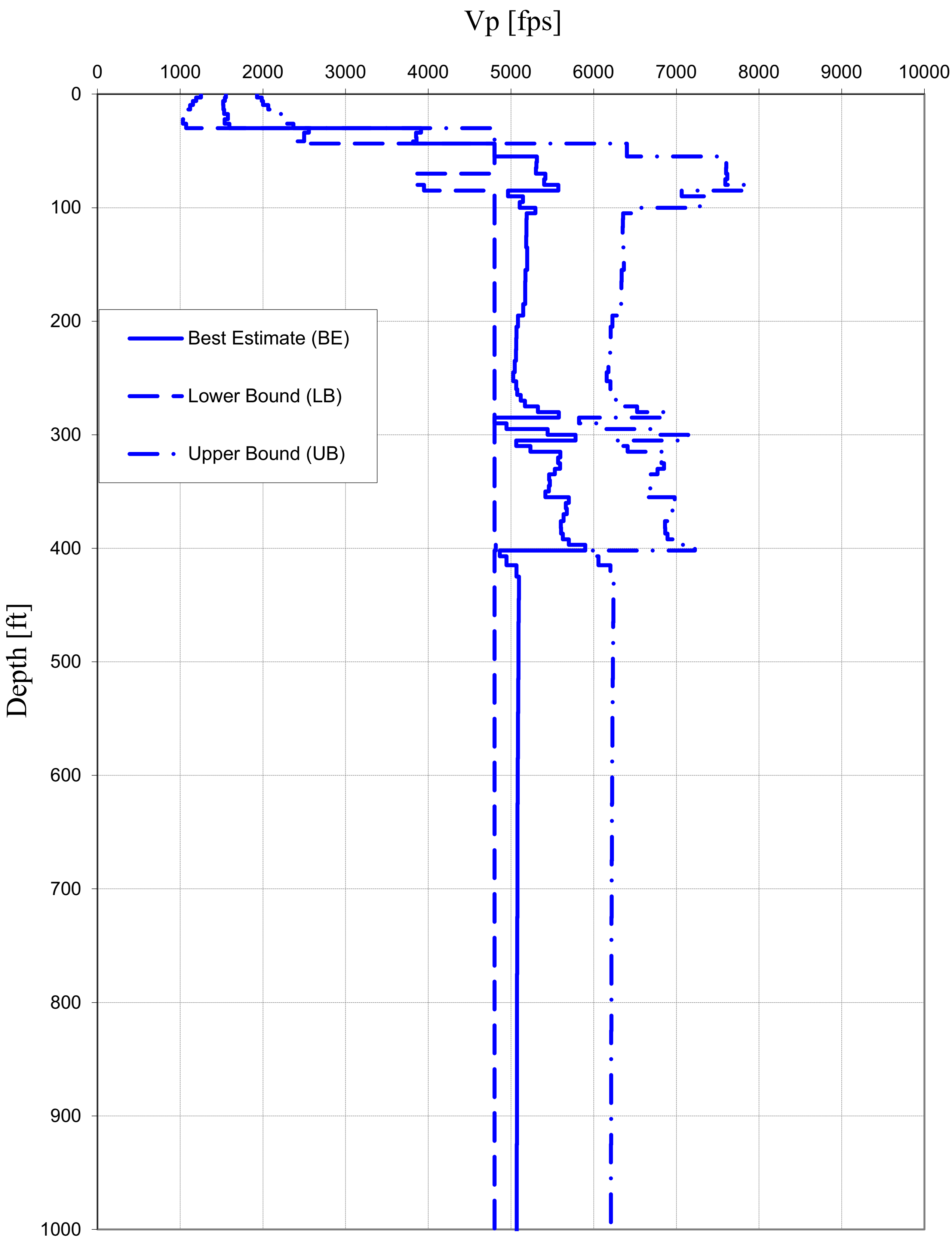

Figure 3F-17 — {Shear-Wave Velocity Profiles Strain-Compatible with FIRS for the Intake Area}

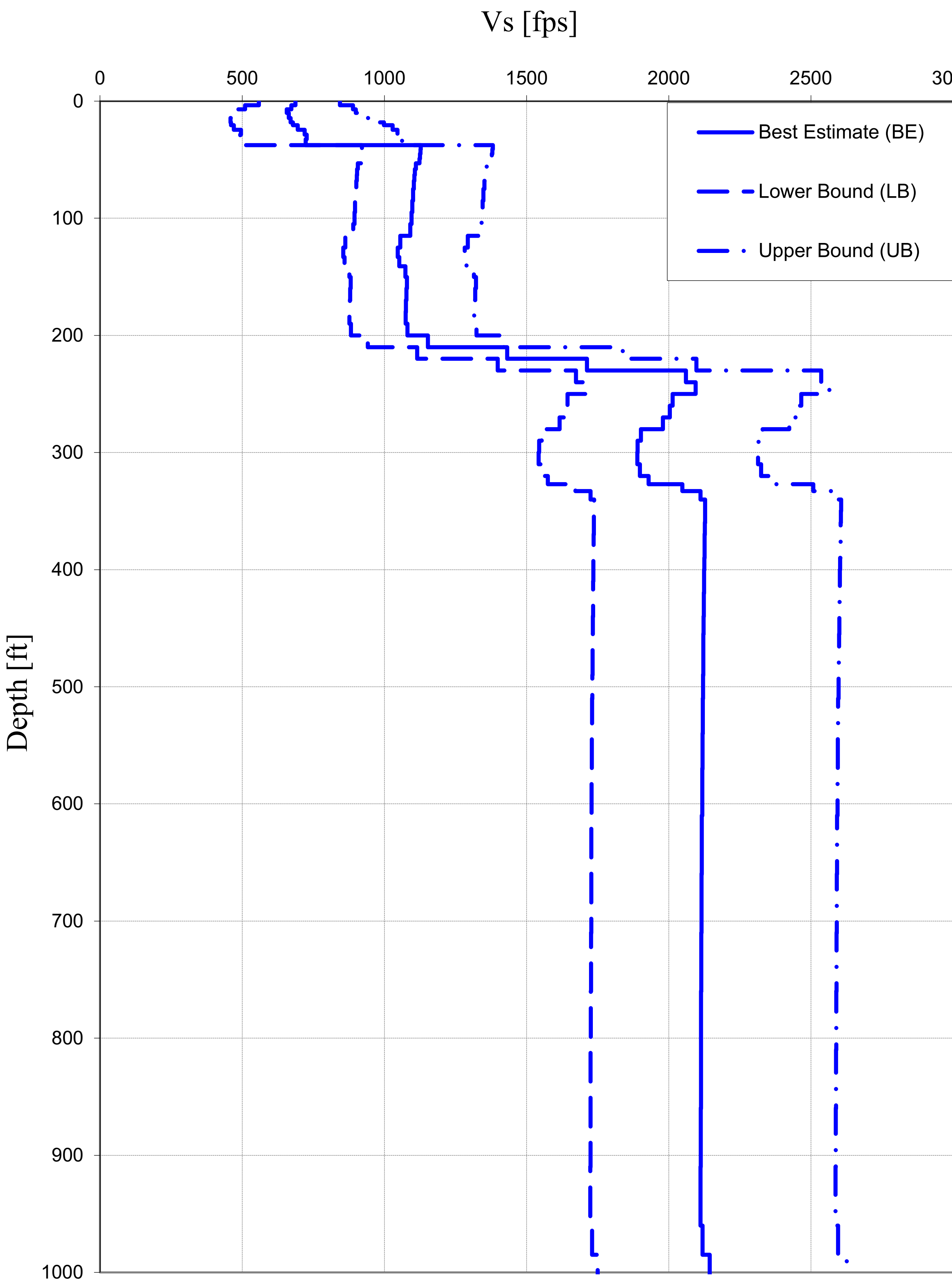

Figure 3F-18 — {Damping Profiles Strain-Compatible with FIRS for the Intake Area}

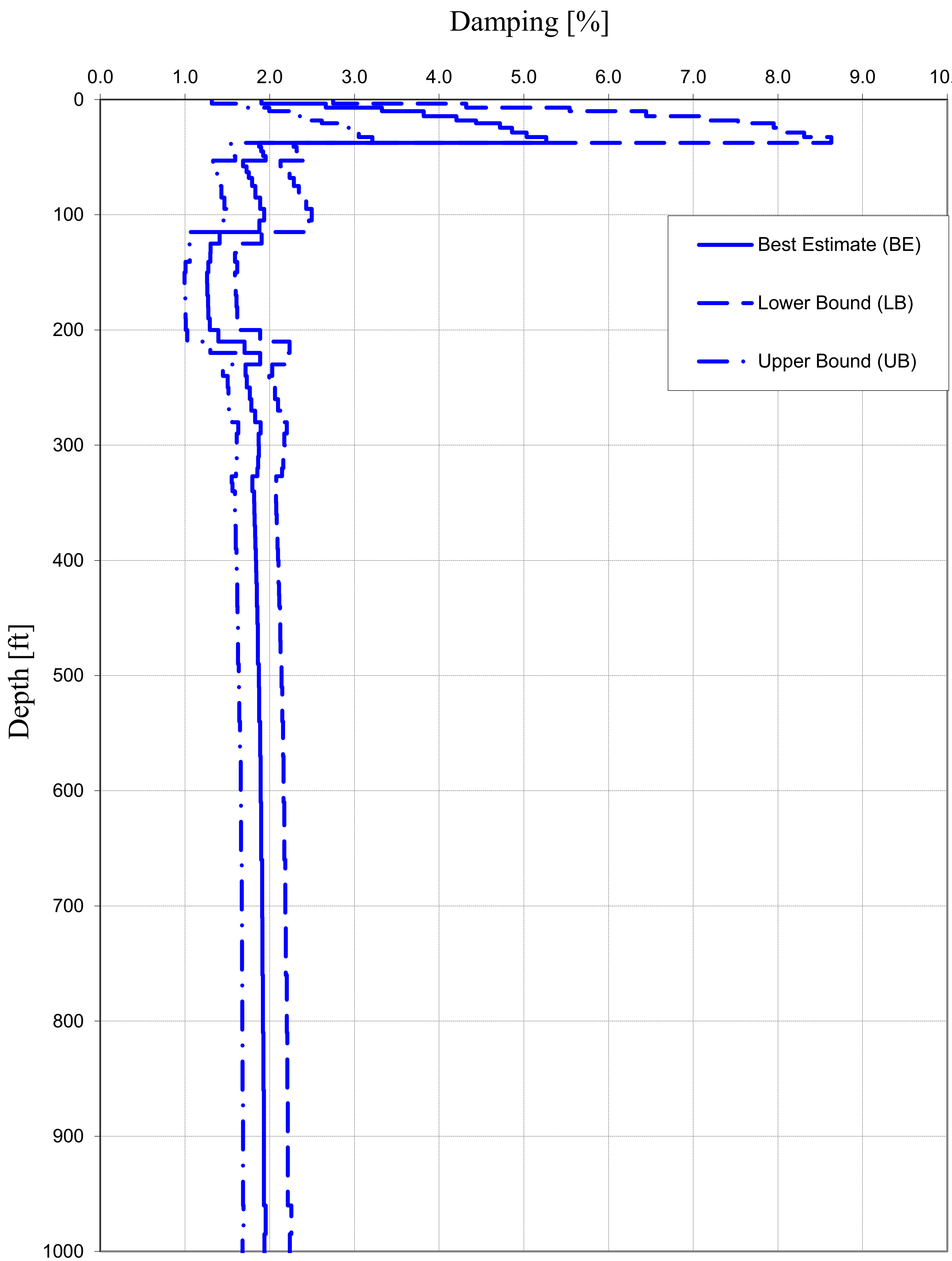

Figure 3F-19 — {FIRS P-Wave Velocity Profiles for the Intake Area}

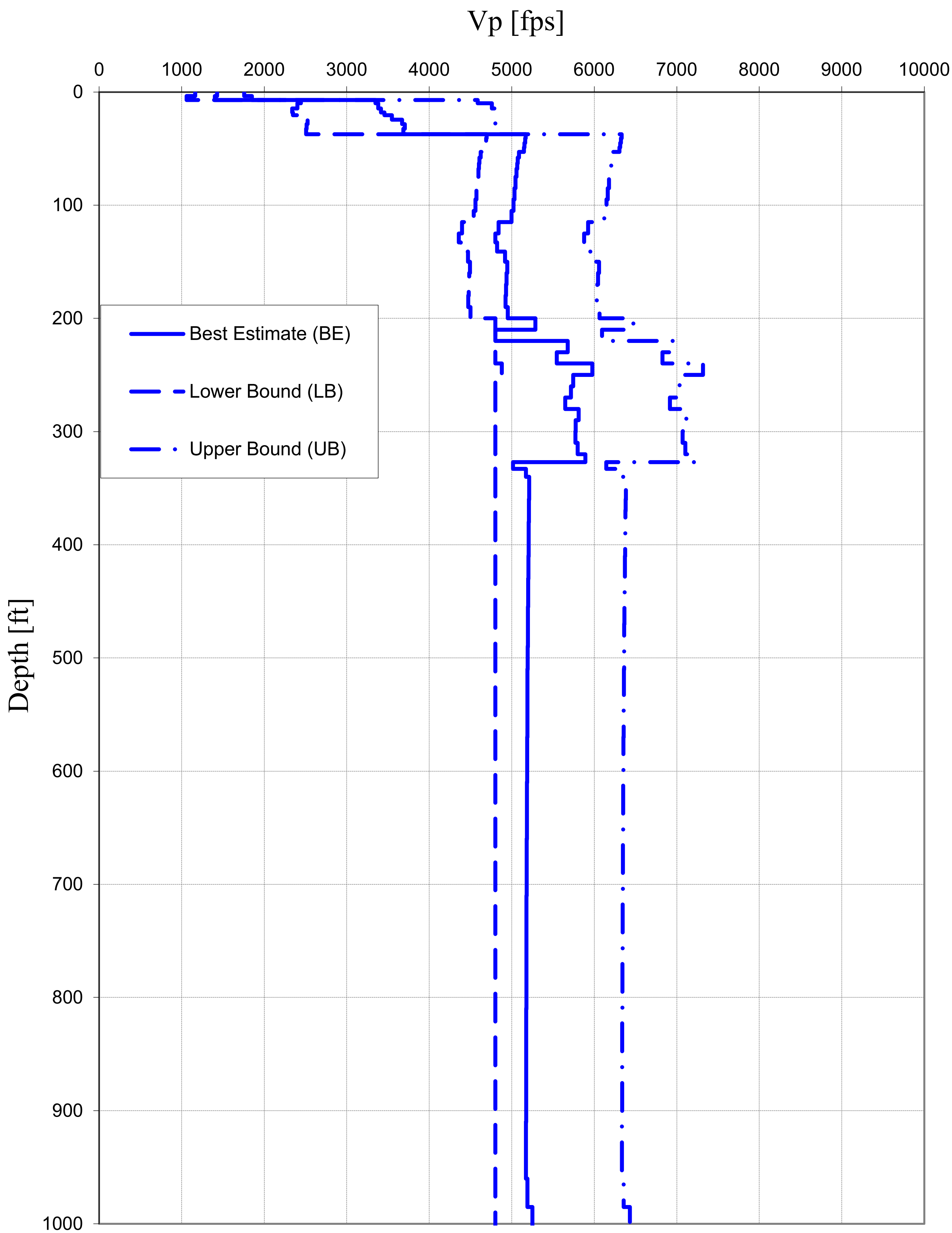

Figure 3F-20 — {Check for Horizontal FIRS at 37.5 ft Depth at the Intake Area}

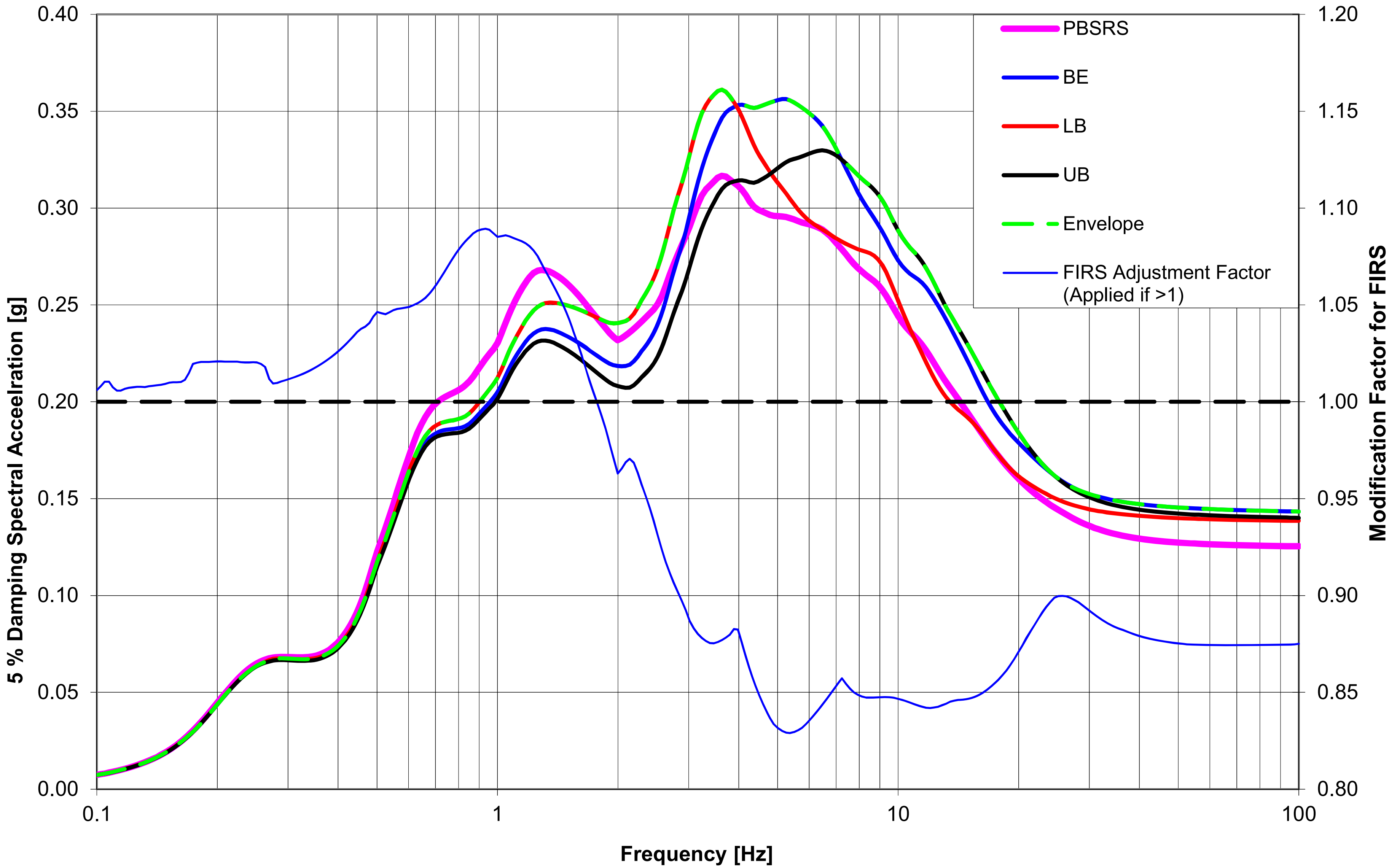

Figure 3F-21 — {Check for Vertical FIRS at 37.5 ft Depth at the Intake Area}

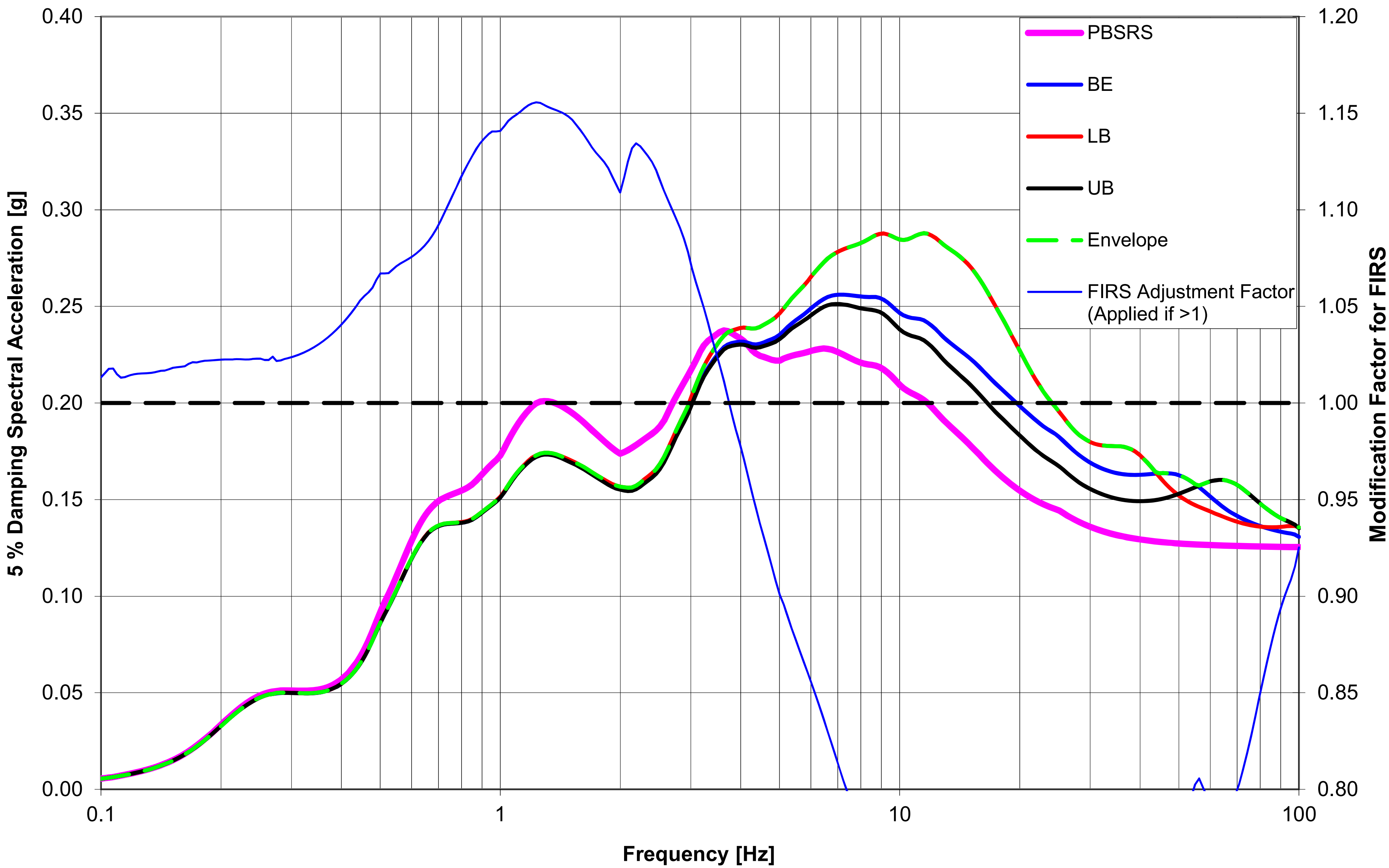

Figure 3F-22 — {Horizontal and Vertical Adjusted FIRS - Intake Area}

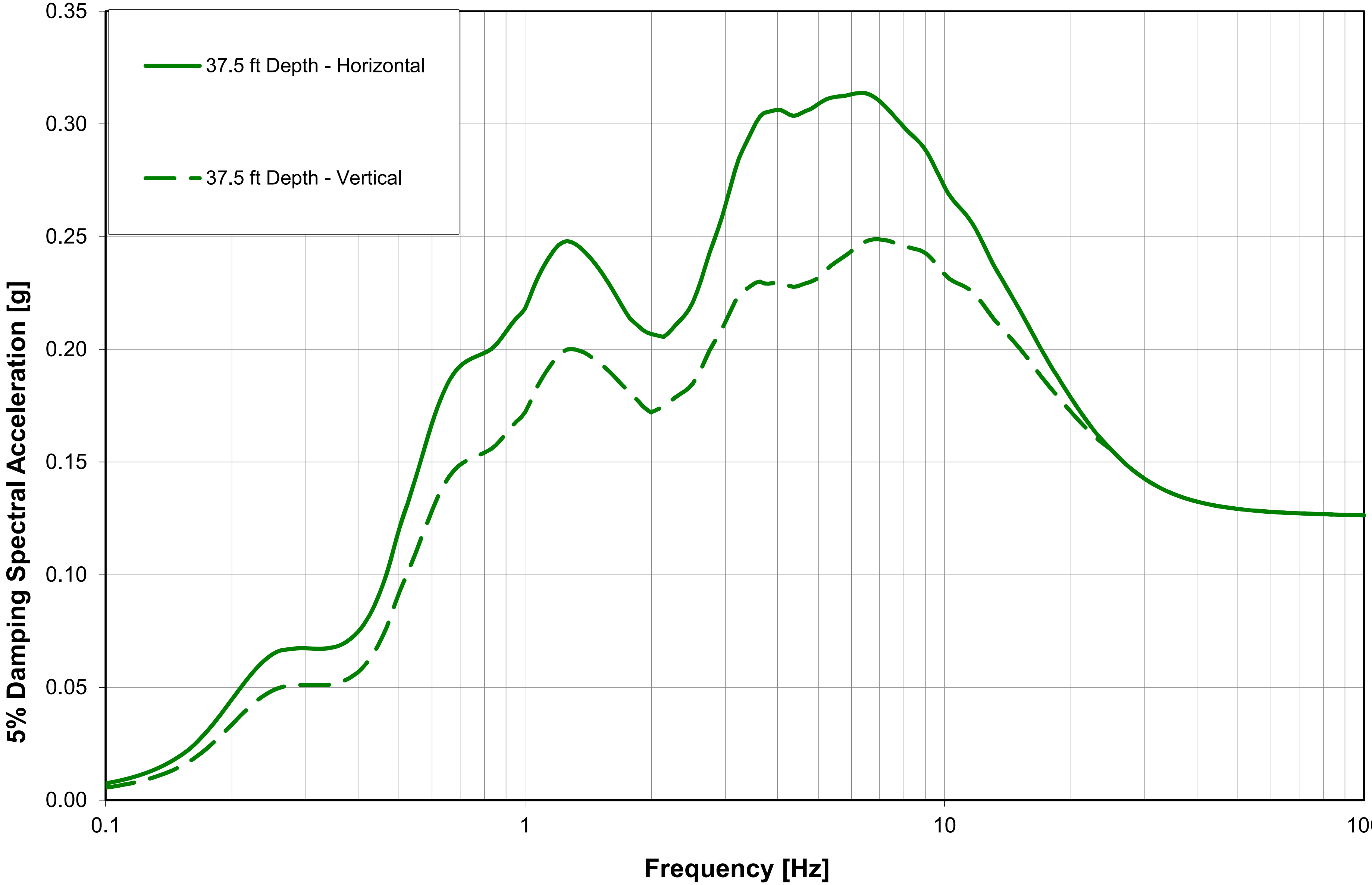

Figure 3F-23a — {Development of Horizontal Site SEE Acceleration Response Spectra - NI Common Basemat Structures)}

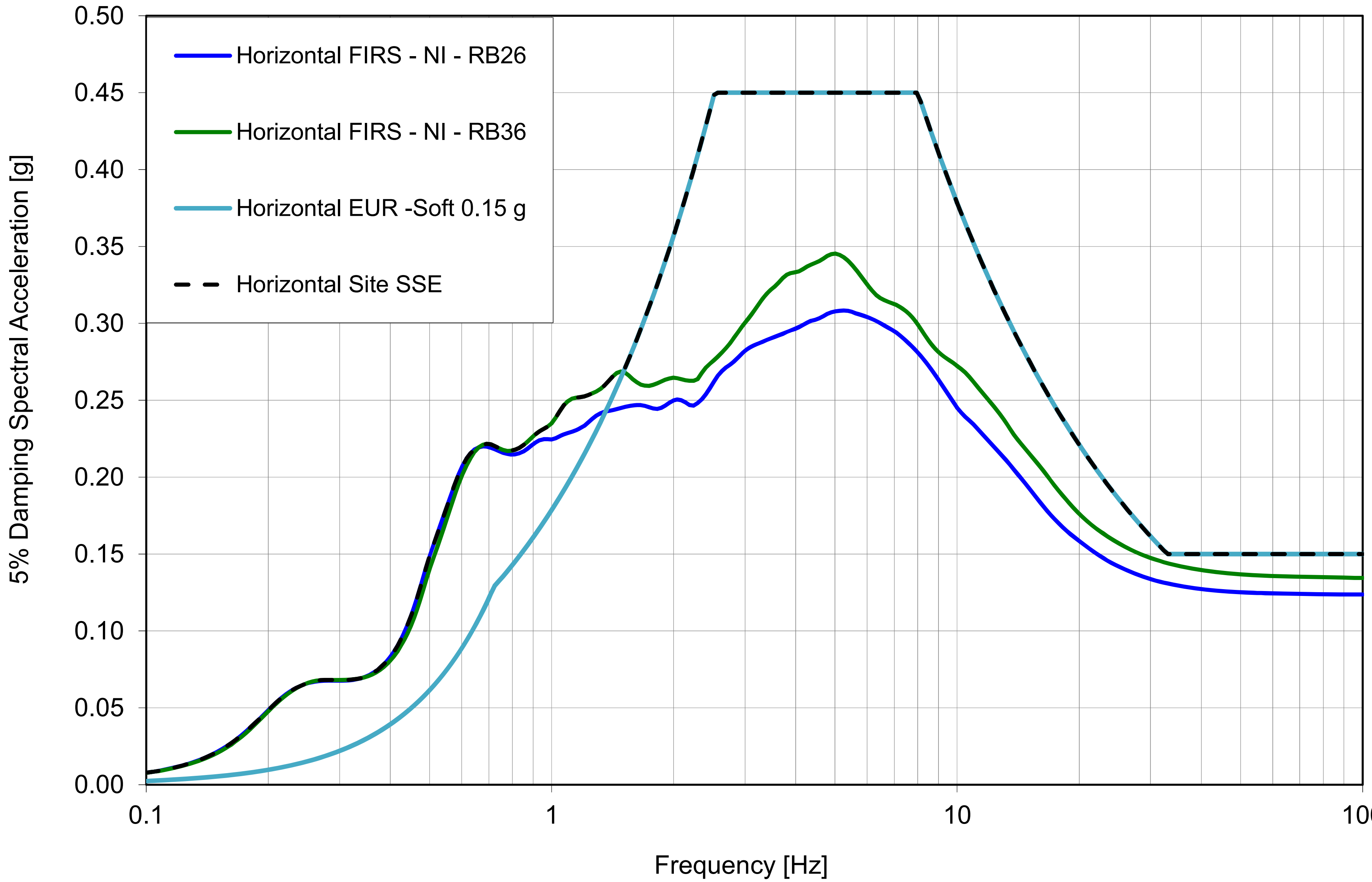

Figure 3F-23b — {Development of Vertical Site SEE Acceleration Response Spectra - NI Common Basemat Structures)}

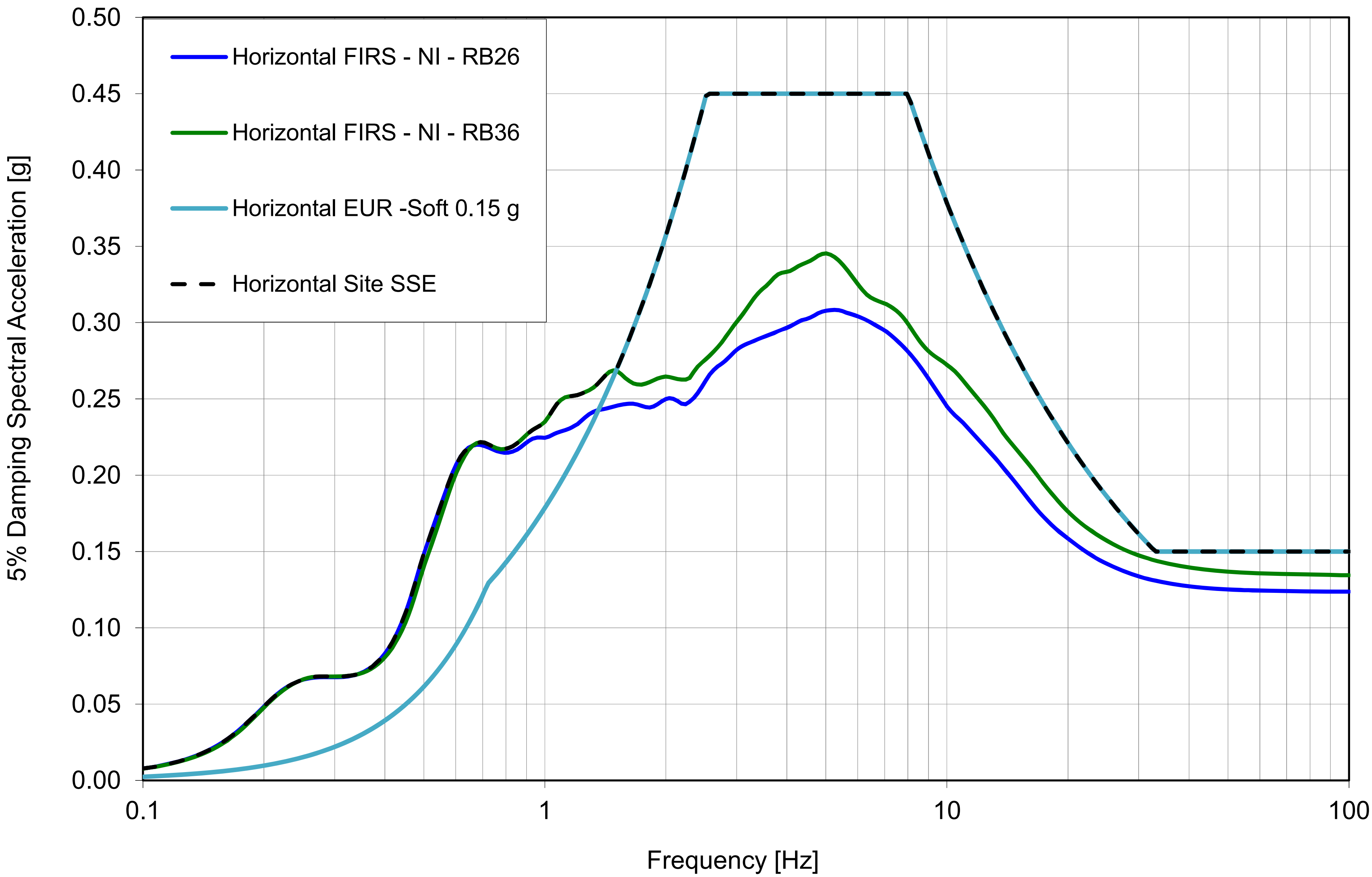

Figure 3F-23c — {Site SEE Acceleration Response Spectra - NI Common Basemat Structures)}

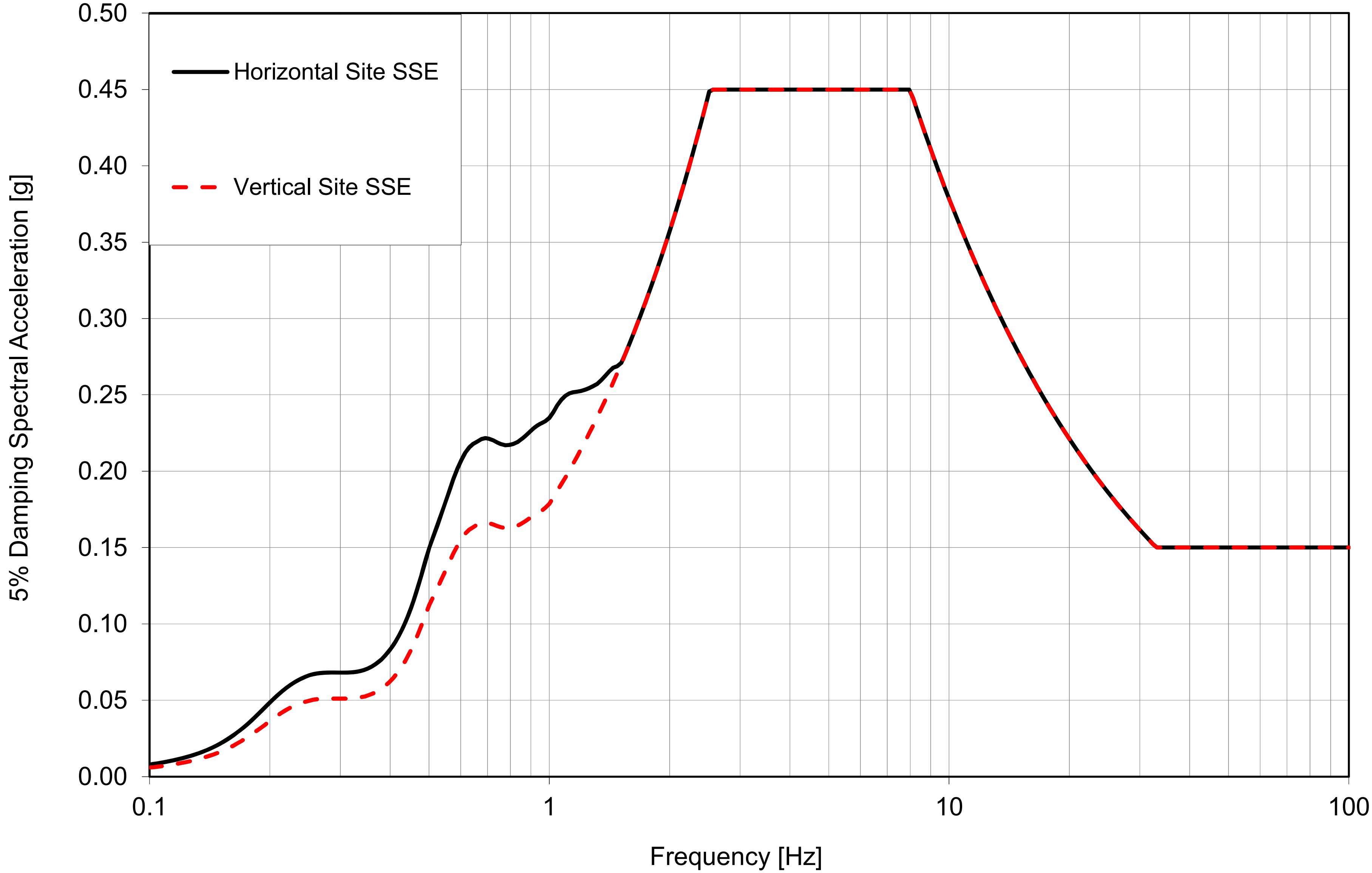

Figure 3F-24 — {SEE for EPFGB, ESWB and TI Structure Including SSSI Effects}

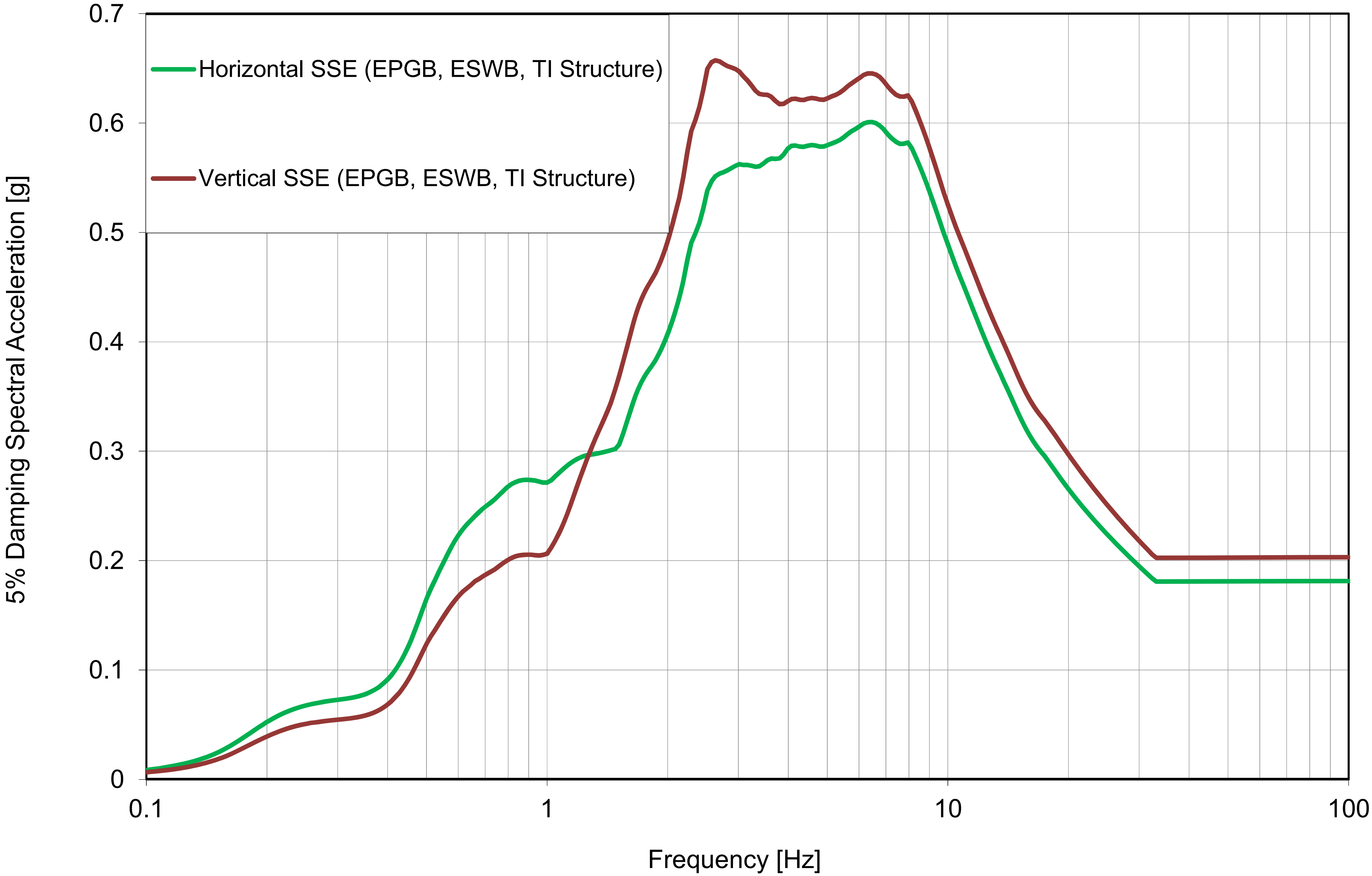

Figure 3F-25 — {SEE for CBIS - Intake Area}

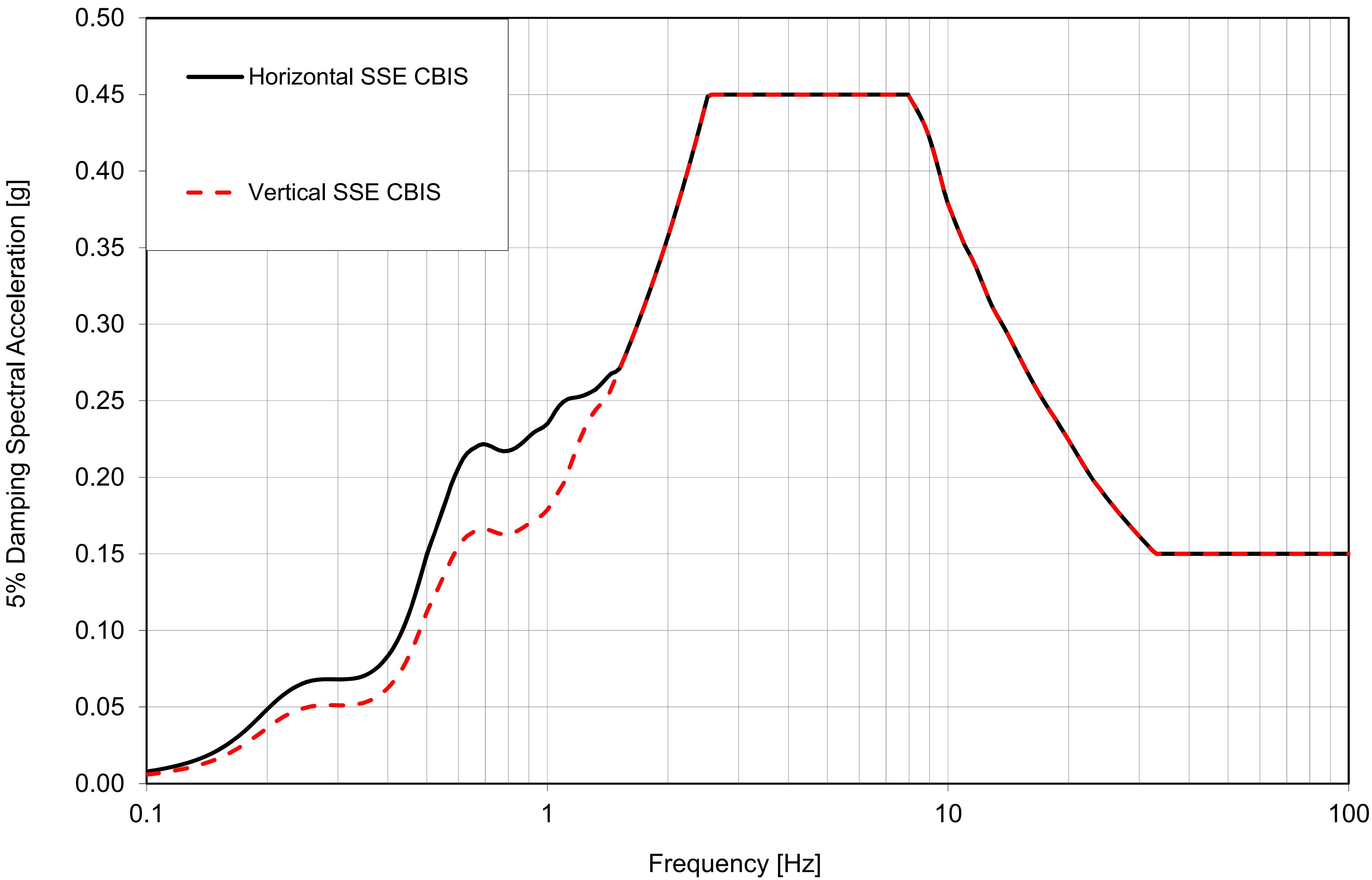

Figure 3F-26 — {SSSI Effect 5% Damping ARS Amplification Functions for EPGB, ESWB and TI Structure}

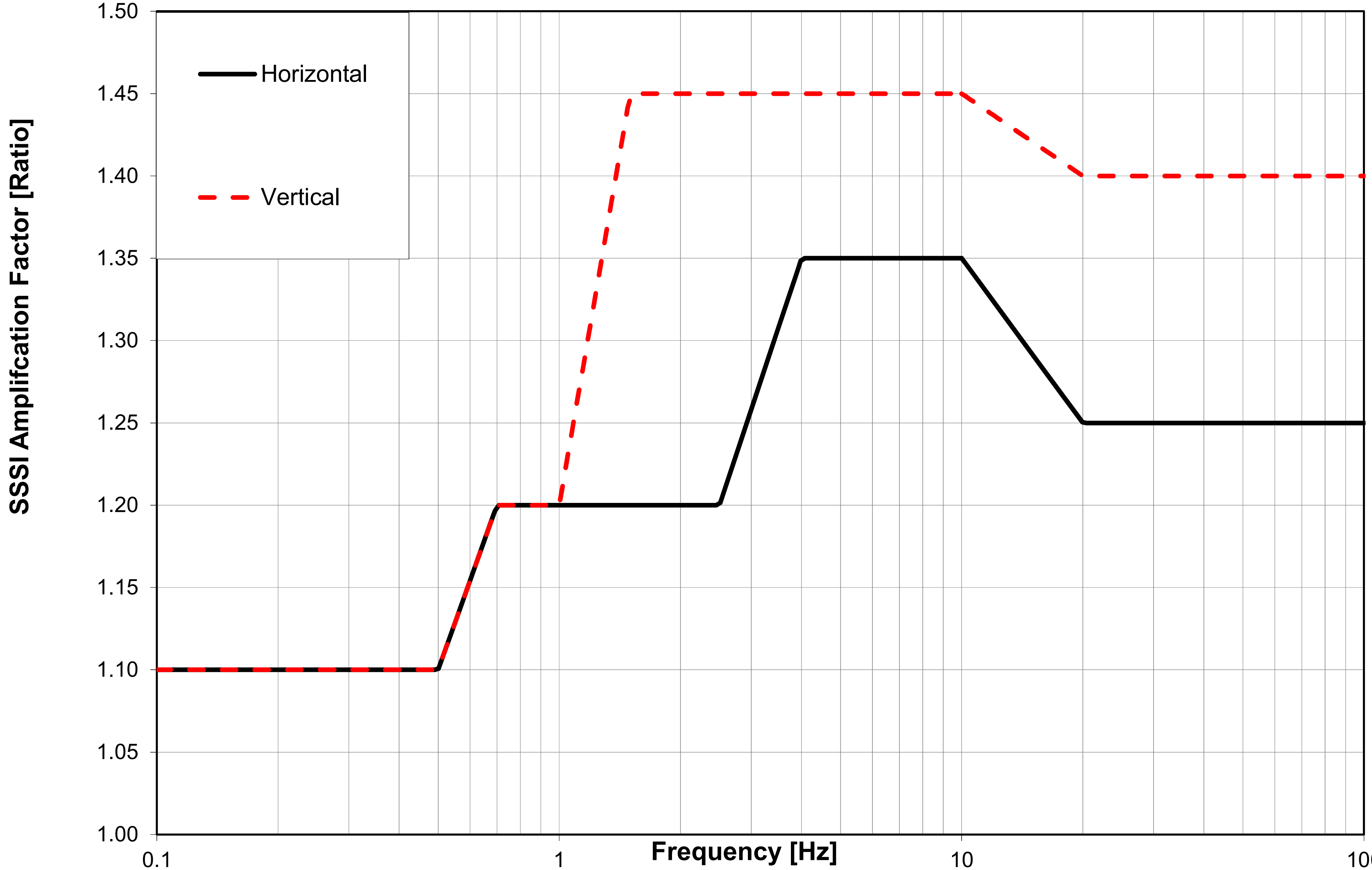

Figure 3F-27a — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to Site SSE - Horizontal Component H1}

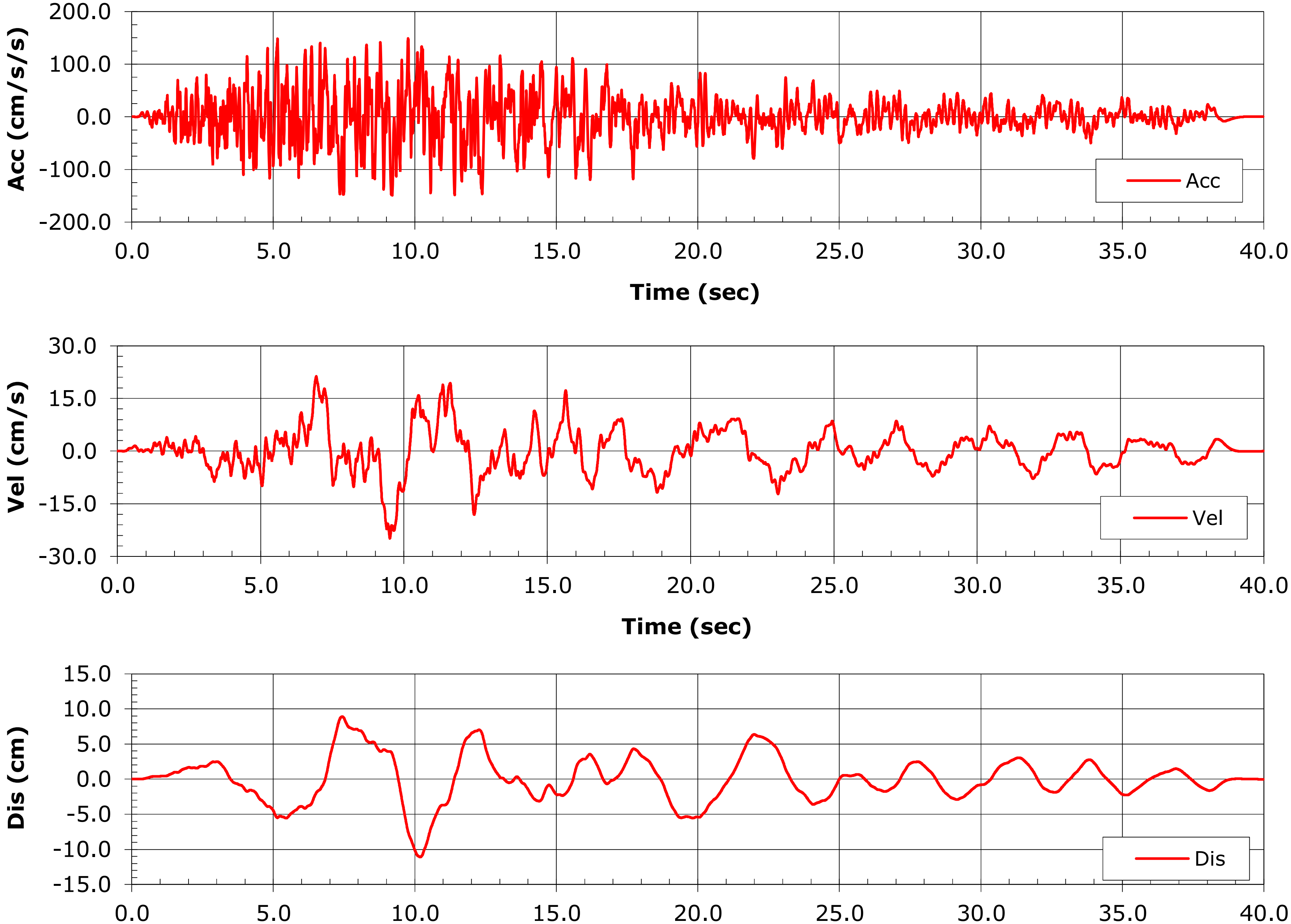

Figure 3F-27b — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to Site SSE - Horizontal Component H2}

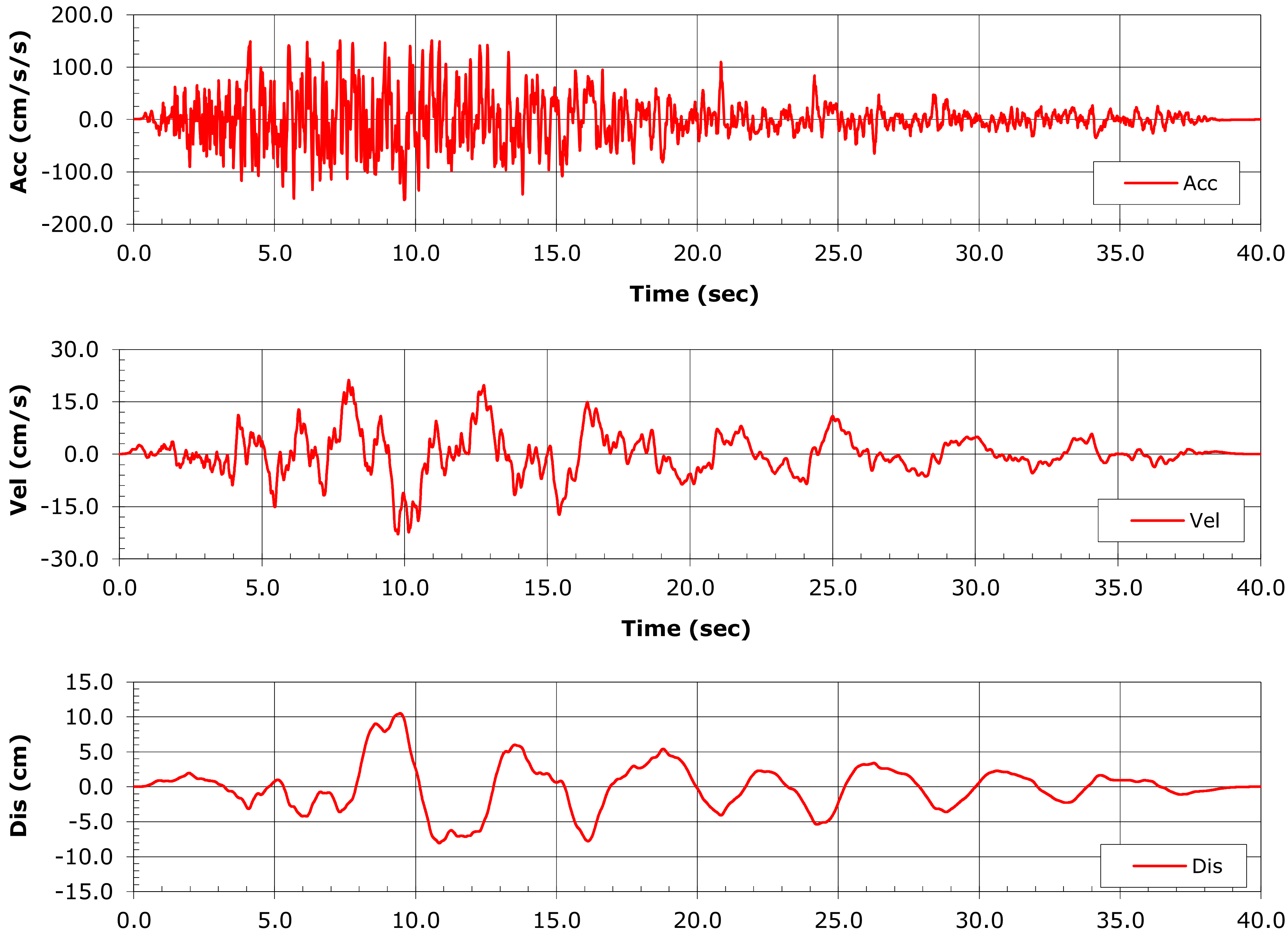

Figure 3F-27c — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to Site SSE - Vertical Component UP}

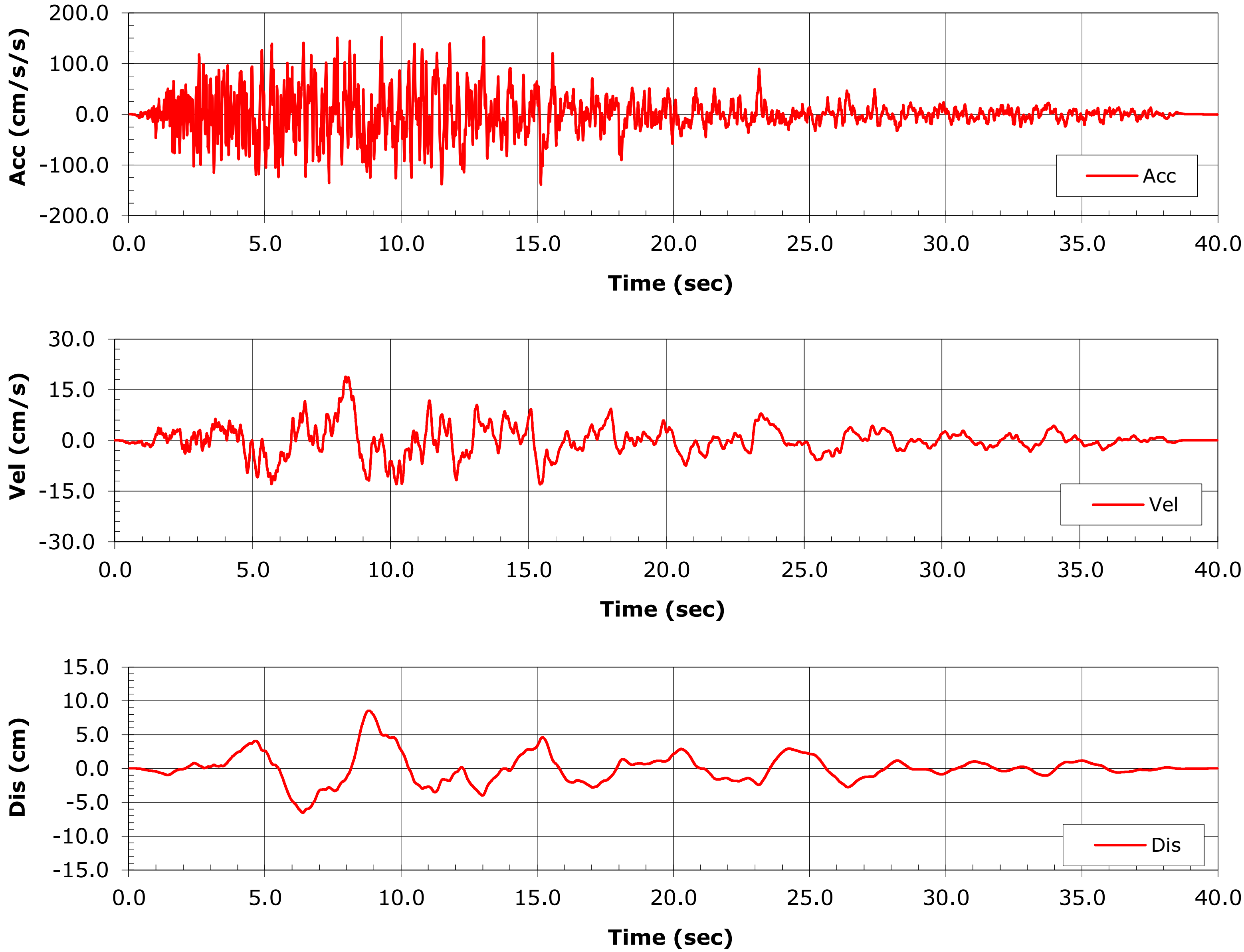

Figure 3F-28a — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{NI} for EPGB, ESWB and TI Structure - Horizontal Component H1}

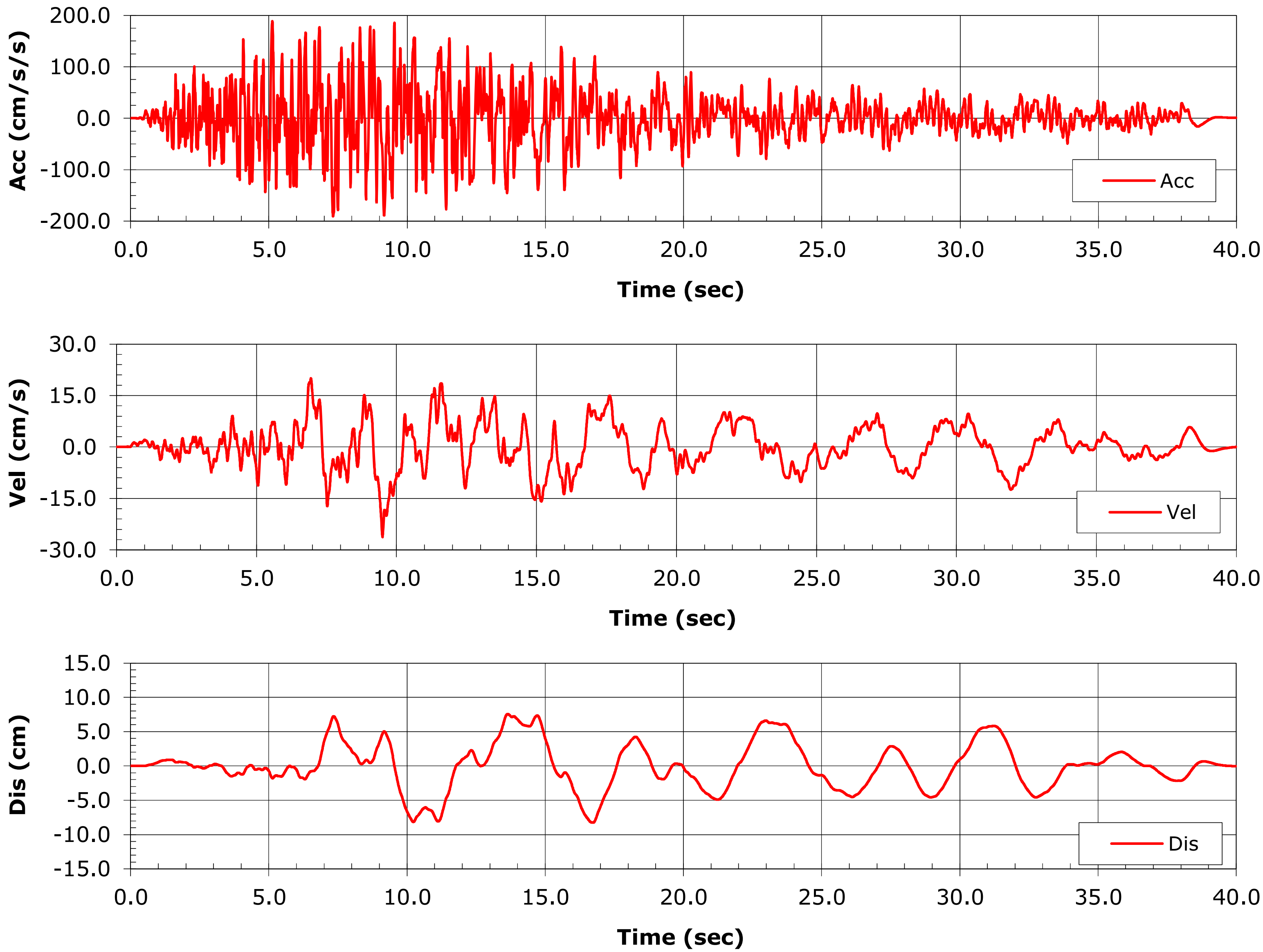

Figure 3F-28b — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{NI} for EPGB, ESWB and TI Structure - Horizontal Component H2}

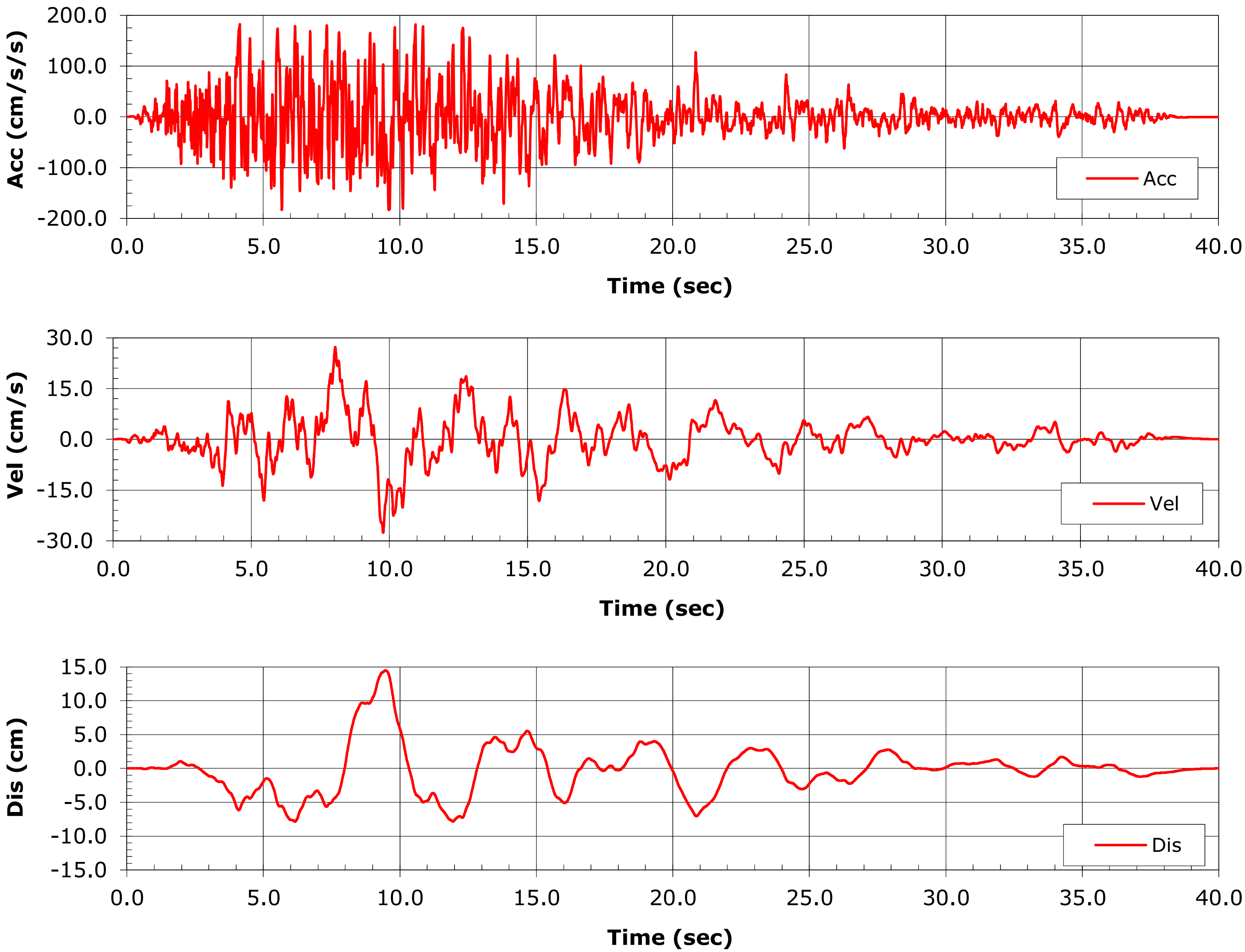

Figure 3F-28c — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{NI} for EPGB, ESWB and TI Structure - Vertical Component UP}

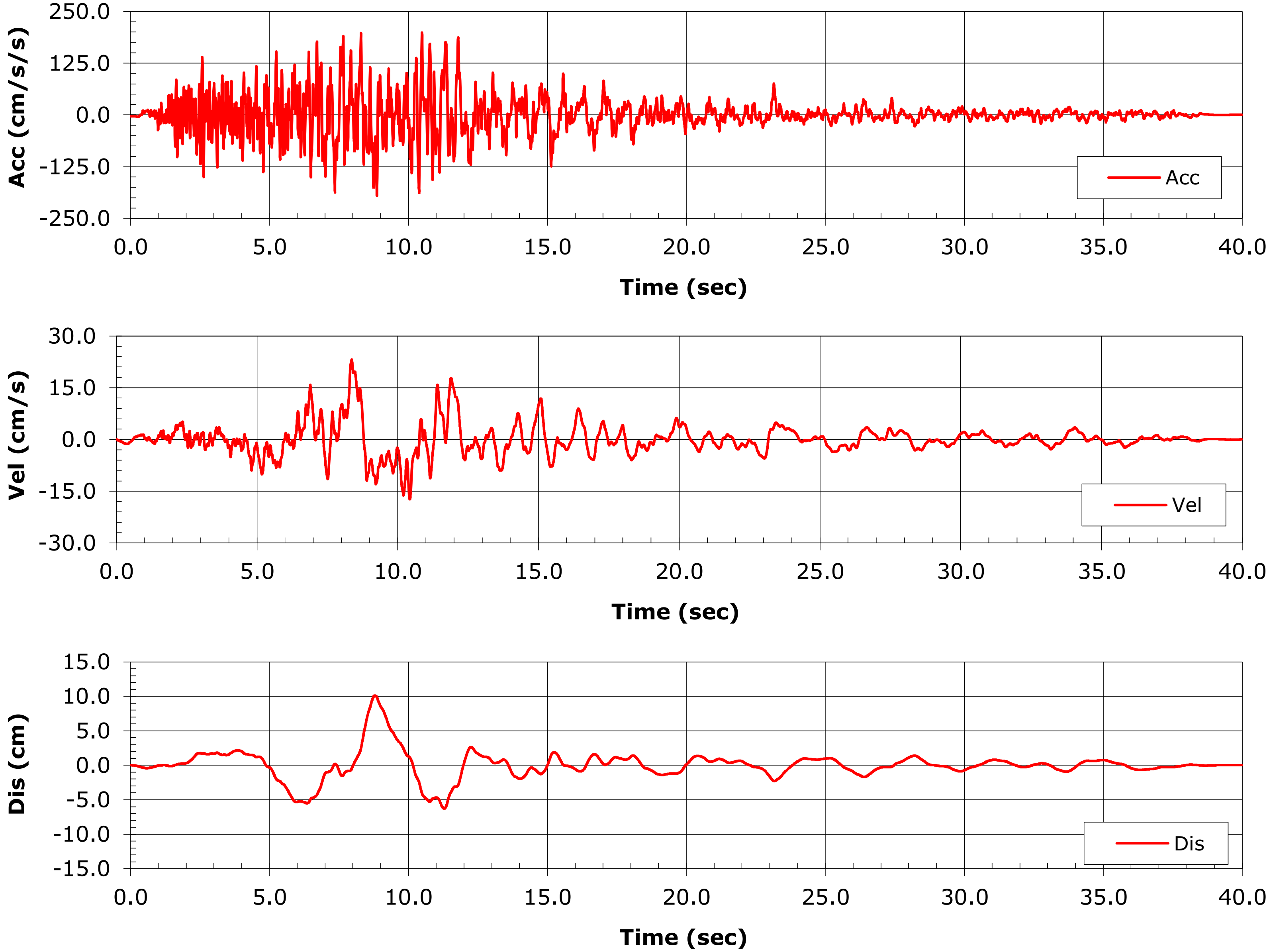

Figure 3F-28d — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{CBIS} for CBIS - Horizontal Component H1}

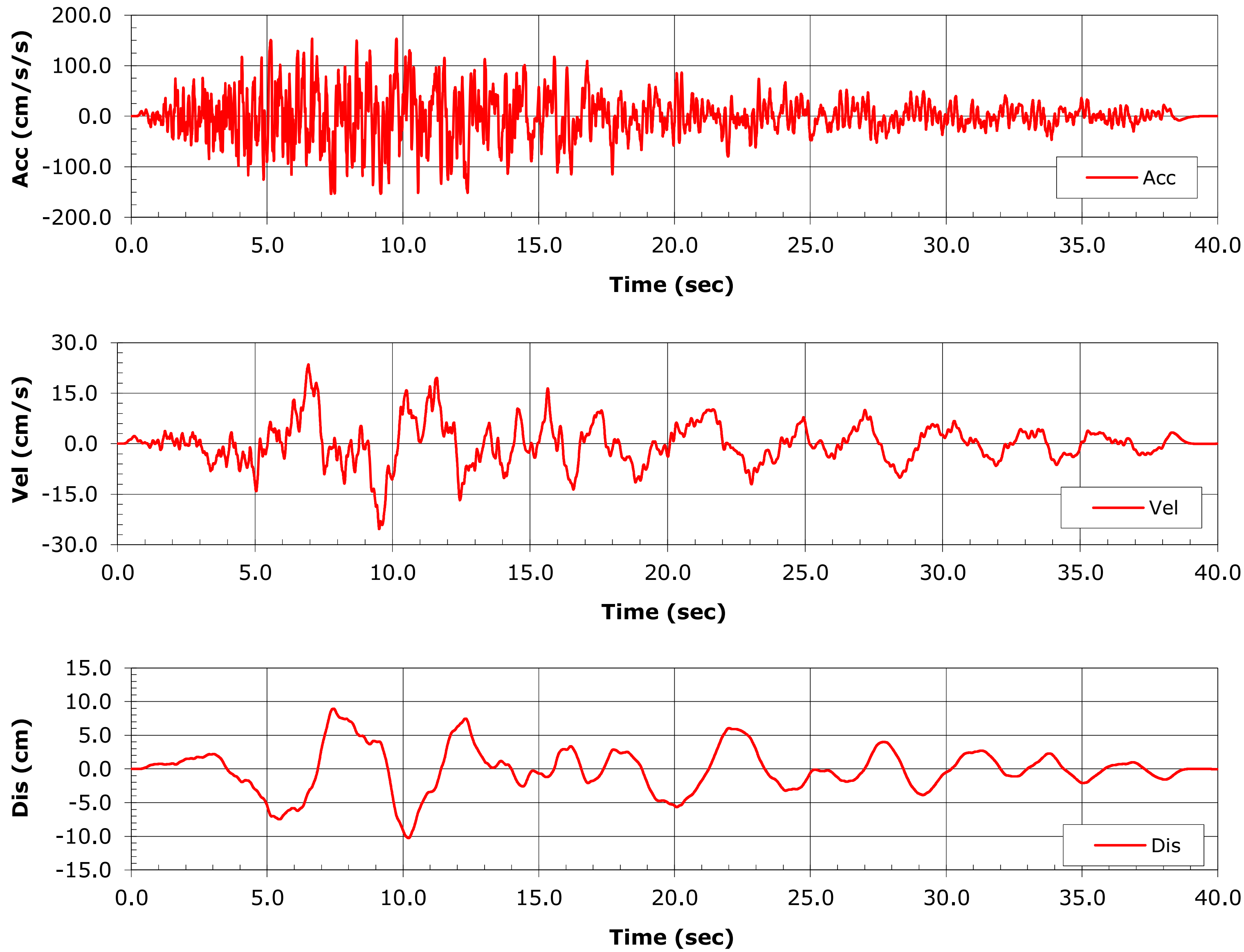

Figure 3F-28e — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{CBIS} for CBIS - Horizontal Component H2}

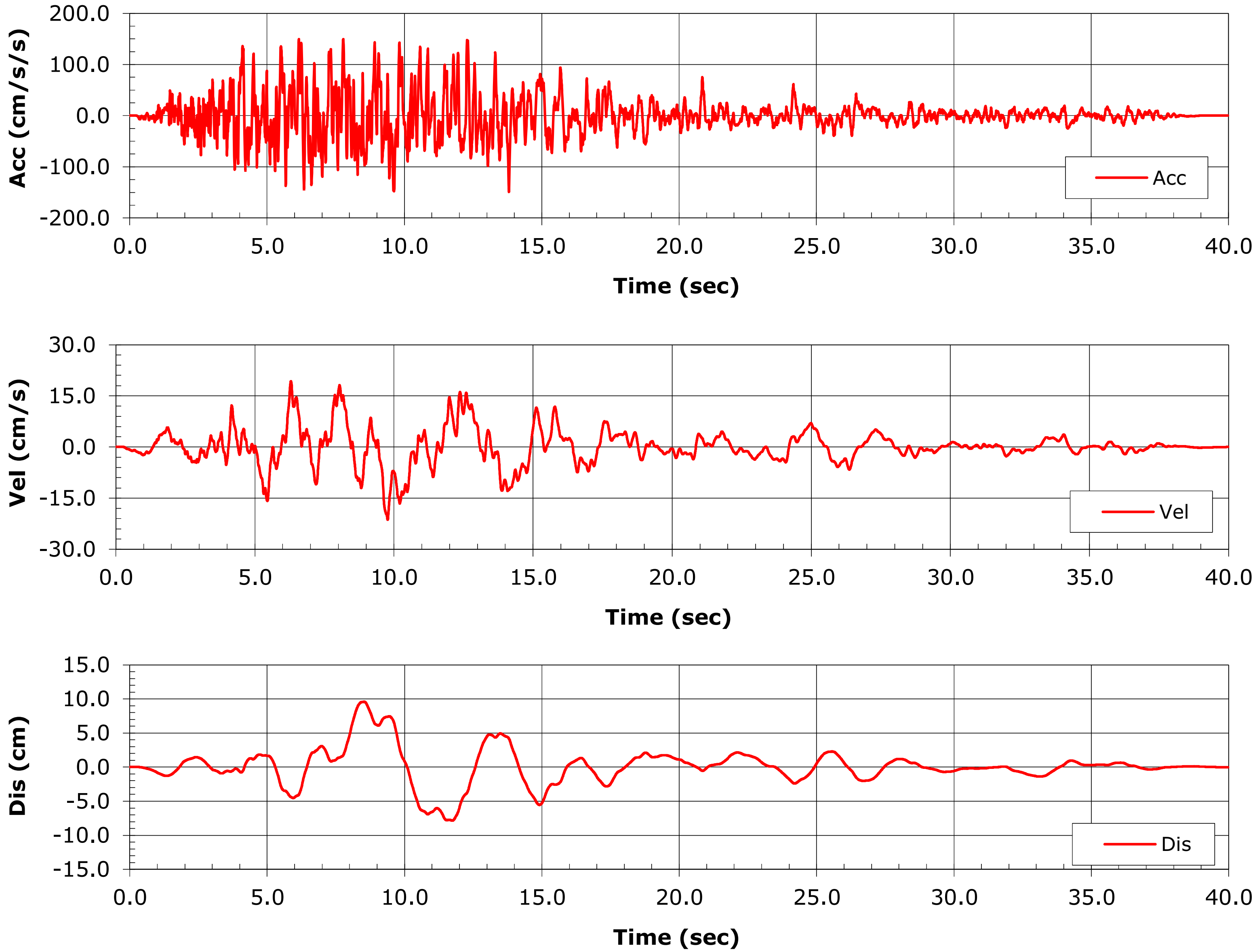

Figure 3F-28f — {Acceleration, Velocity and Displacement Time Histories Spectrally Matched to SSE_{CBIS} for CBIS - Vertical Component UP}

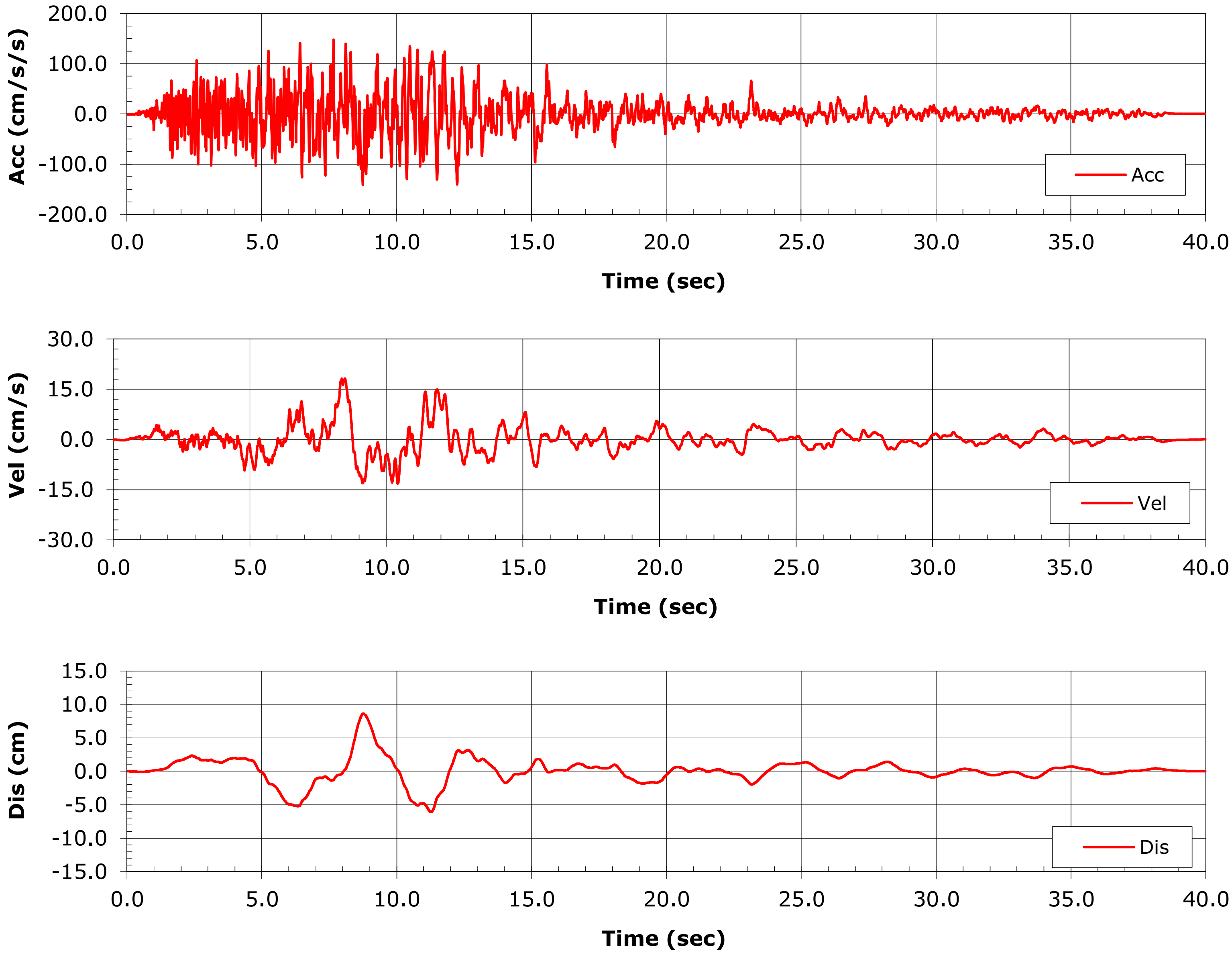

Figure 3F-29 — {Shear Wave Velocity Profiles Strain-Compatible with SSE_{NI} for the EPGB, ESWB and TI Structure}

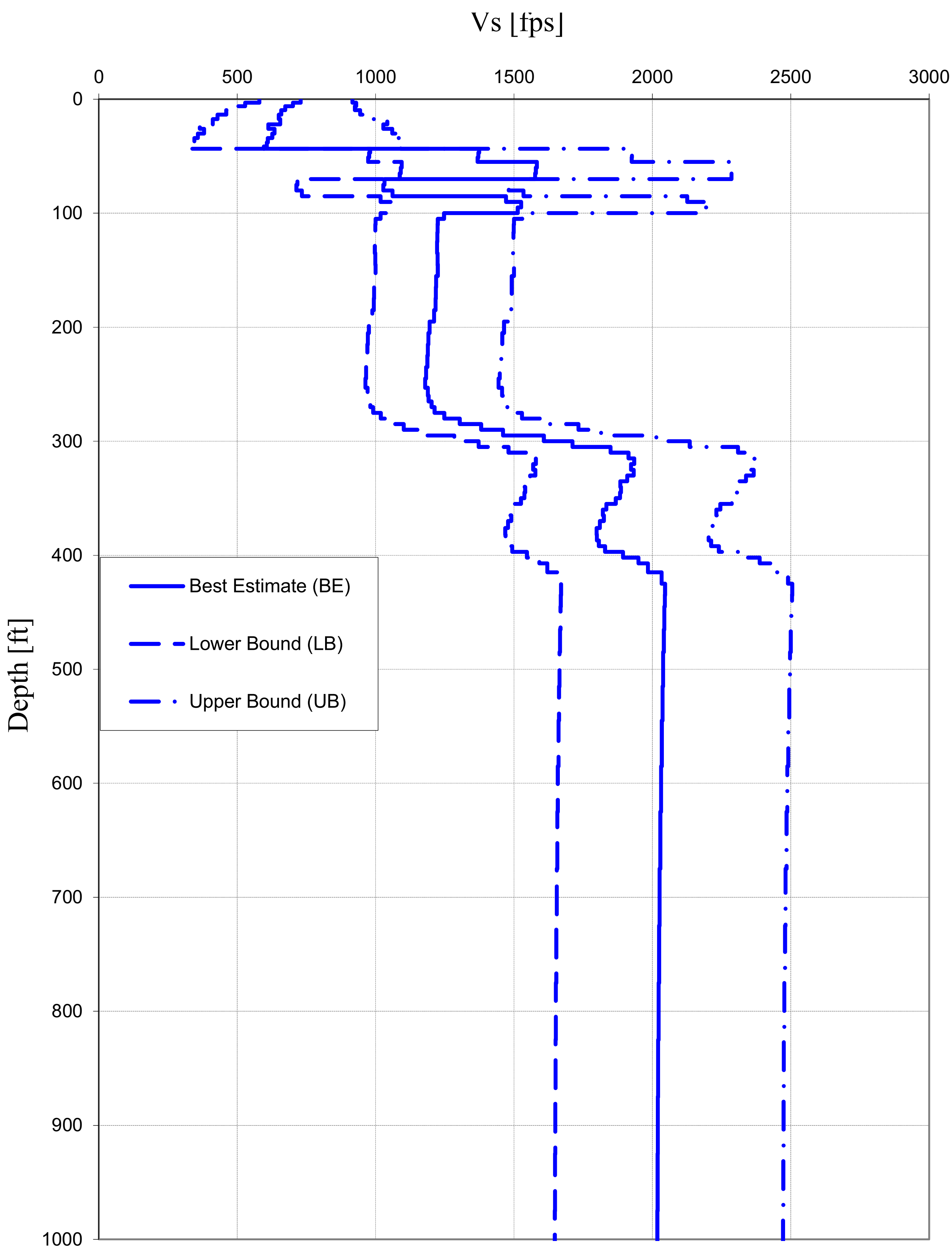

Figure 3F-30 — {Damping Profiles Strain-Compatible with SSE_{NI} for the EPGB, ESWB and TI Structure}

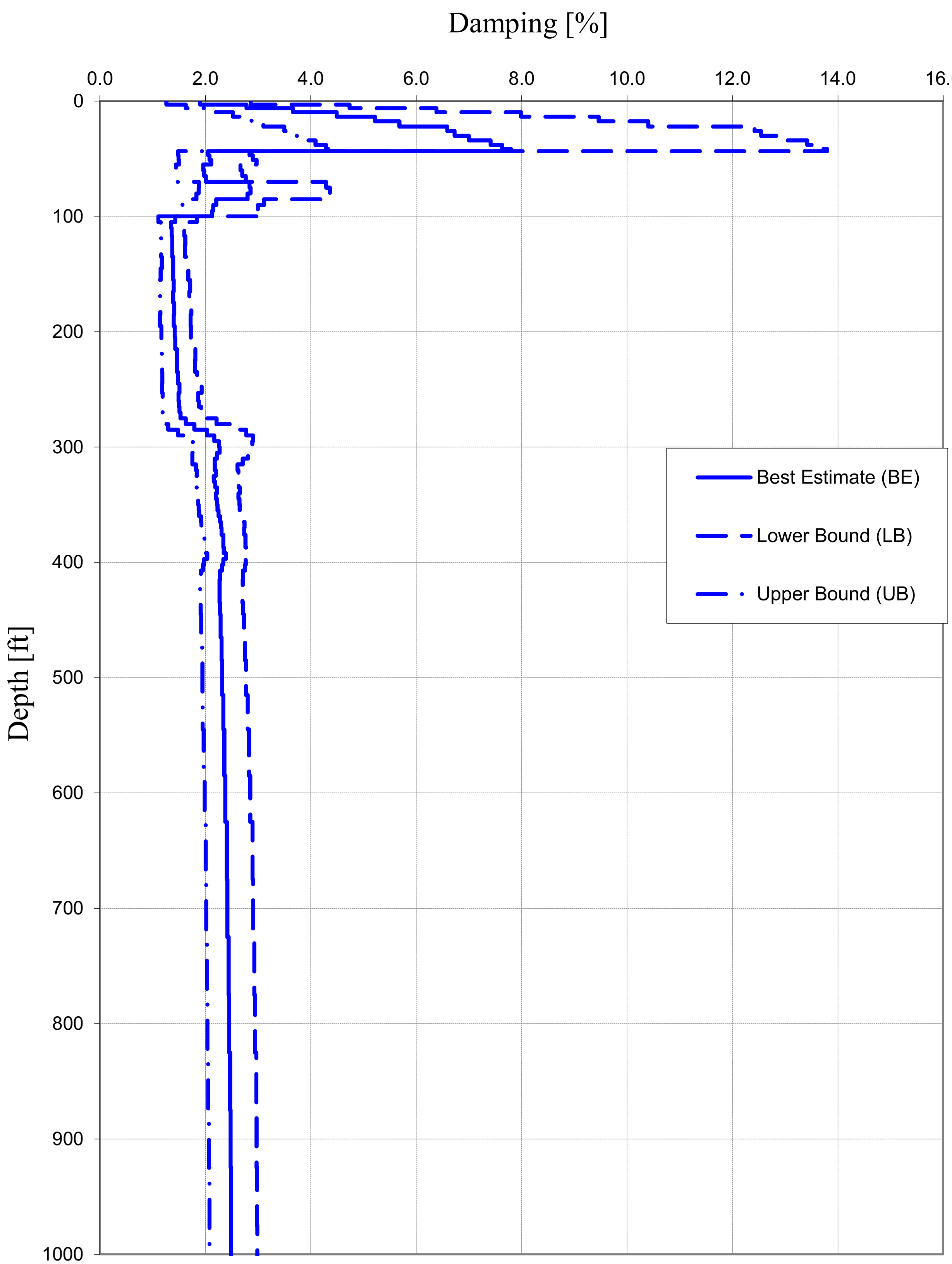

Figure 3F-31 — {P-Wave Velocity Profiles Strain-Compatible with SSE_{NI} for the EPGB, ESWB and TI Structure}

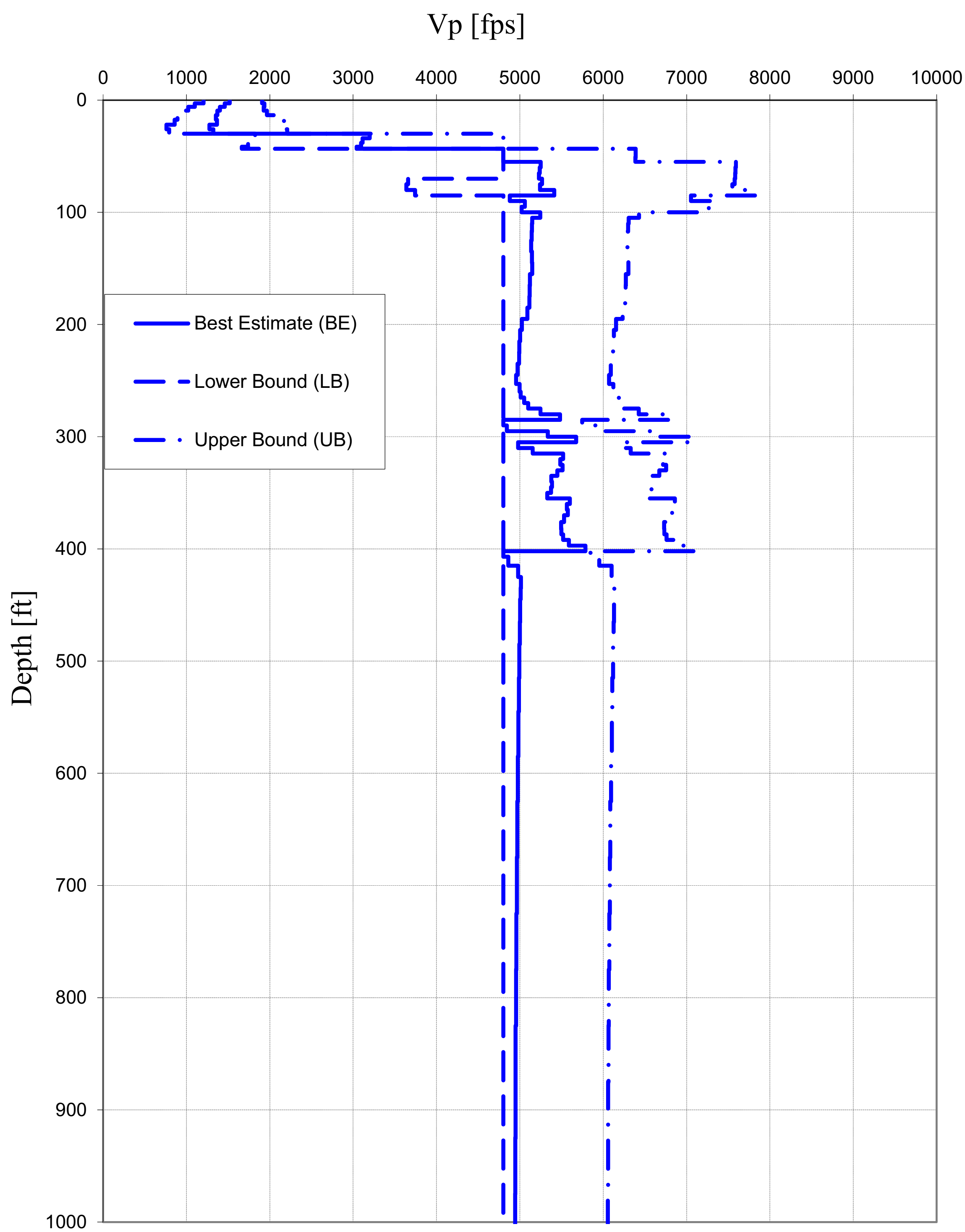

Figure 3F-32 — {Shear Wave Velocity Profiles Strain-Compatible with SSE_{CBIS} for the Intake Area}

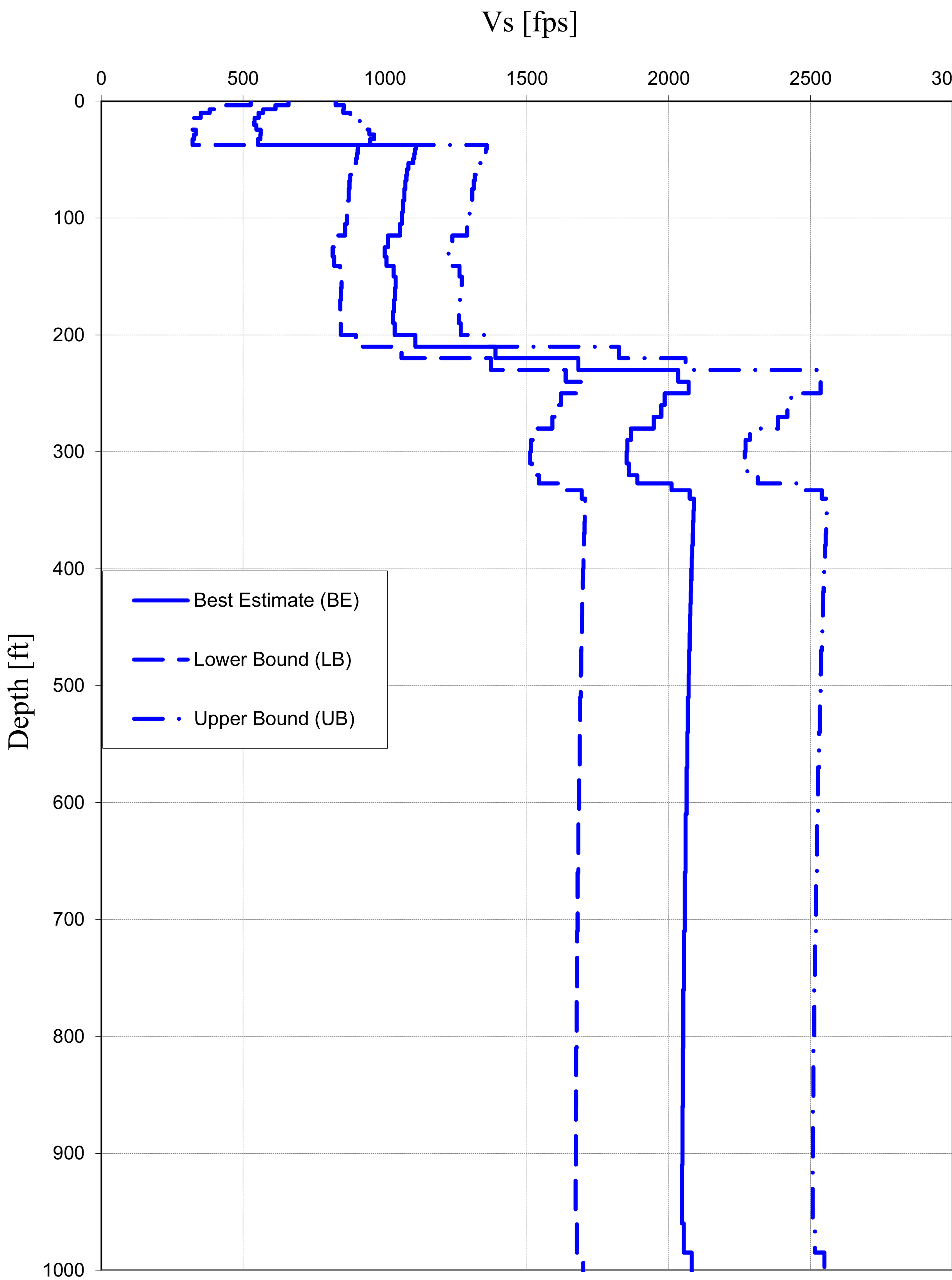

Figure 3F-33 — {Damping Profiles Strain-Compatible with SSE_{CBIS} for the Intake Area}

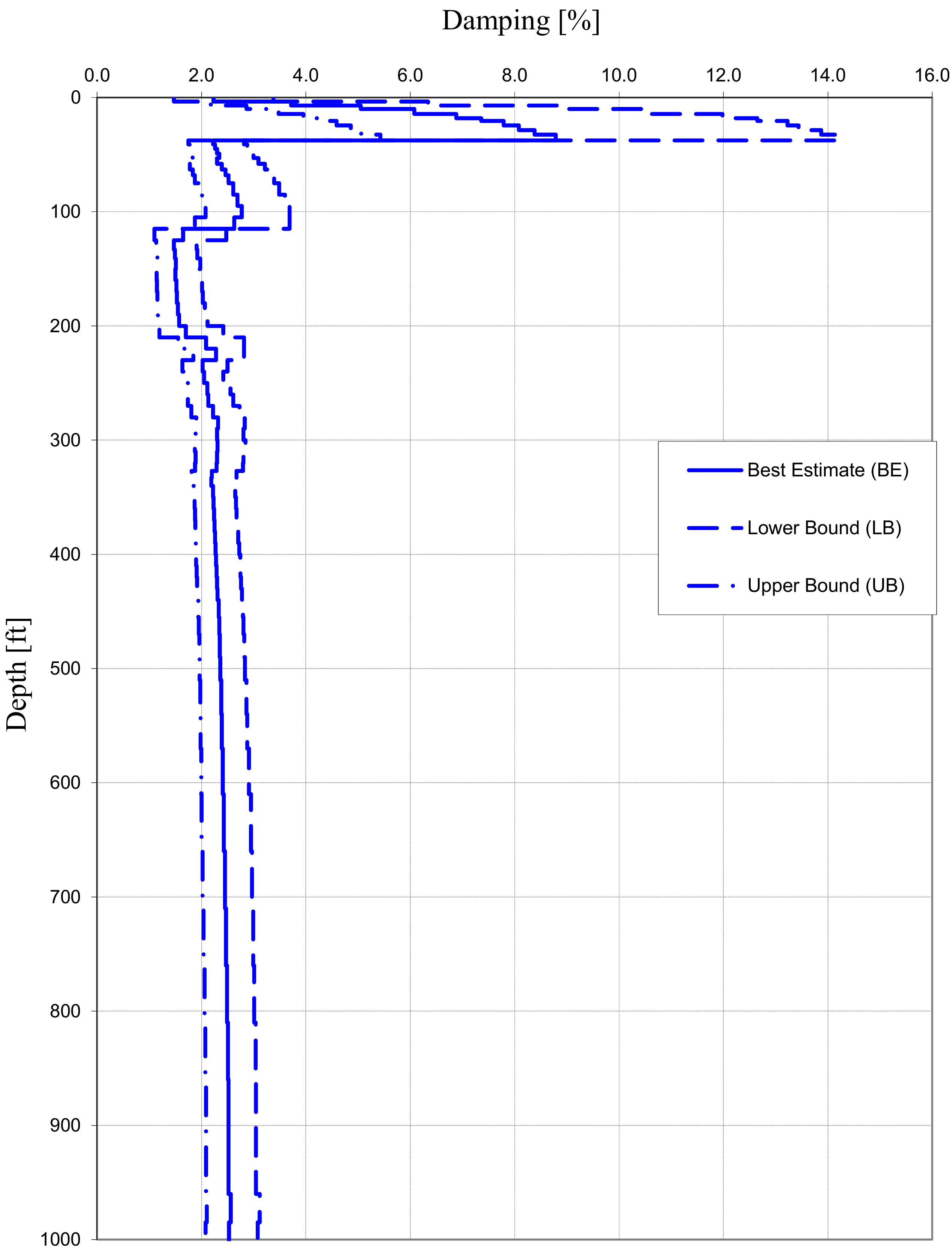

Figure 3F-34a — {P-Wave Velocity Profiles Strain-Compatible with SSE_{CBIS} for the Intake Area}

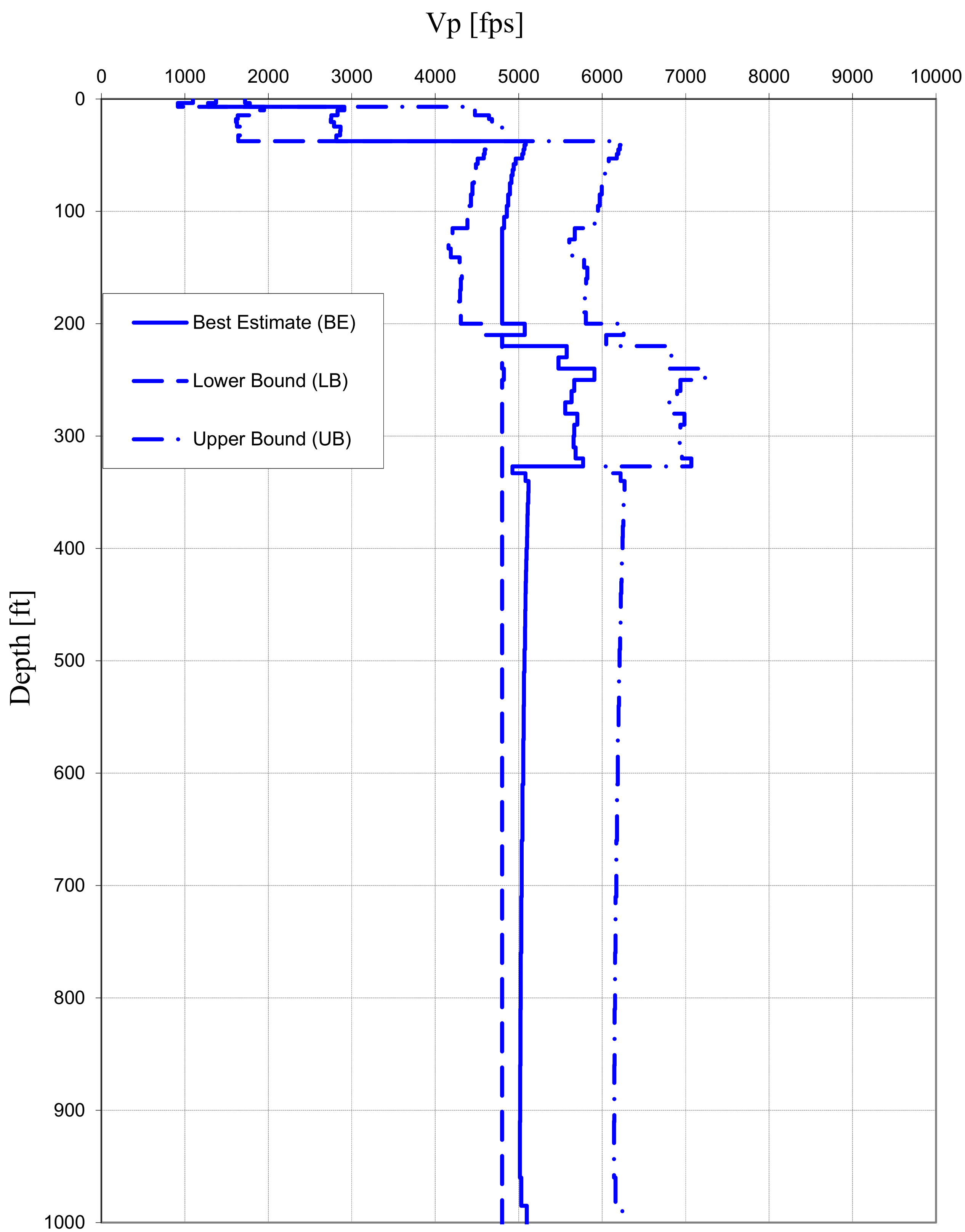

Figure 3F-34b — {Shear Wave Velocity Profiles Strain-Compatible with Site SSE for the NI Common Basemat Structures}

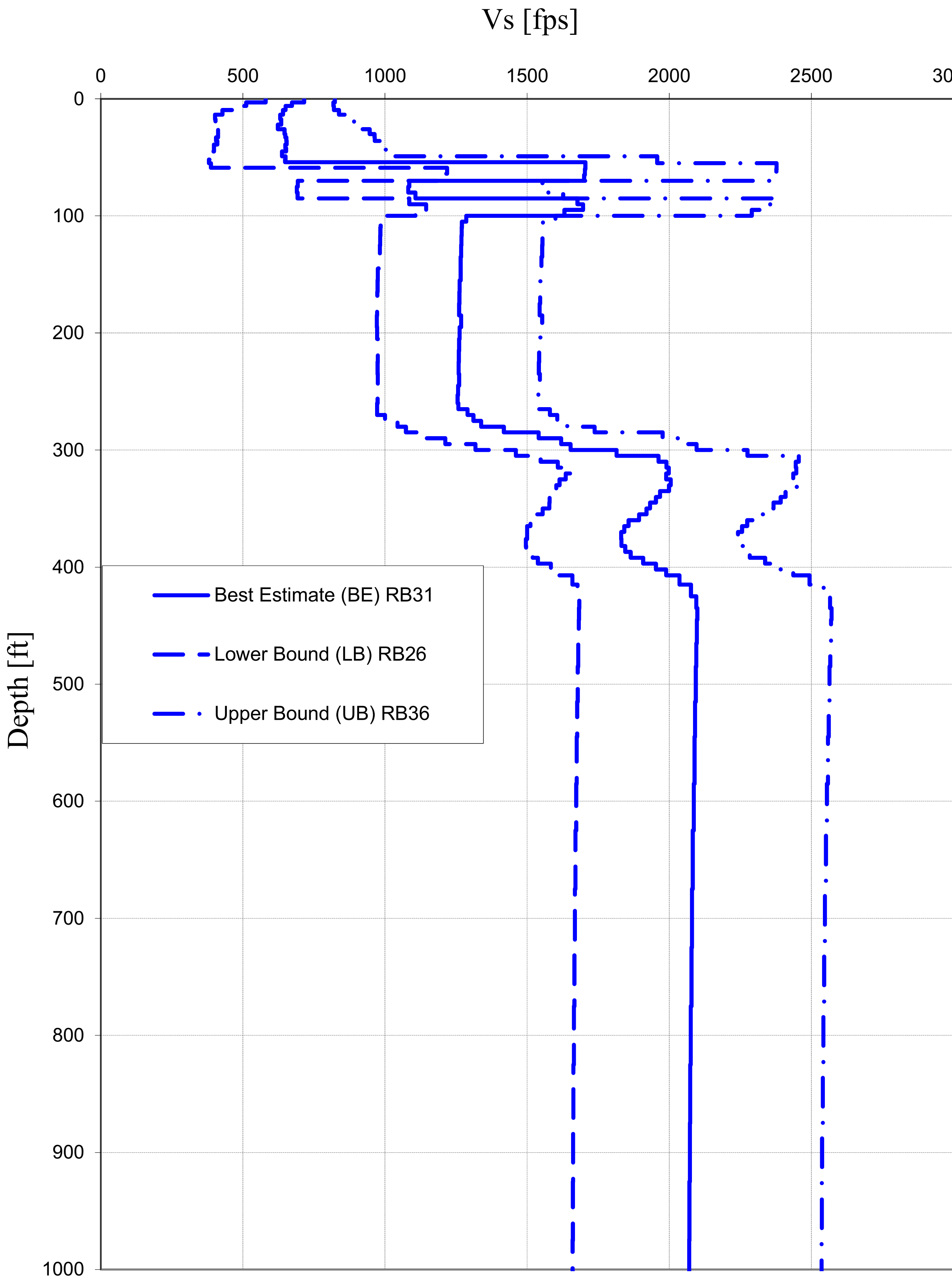

Figure 3F-34c — {Damping Profiles Strain-Compatible with SSE for the NI Common Basemat Structures}

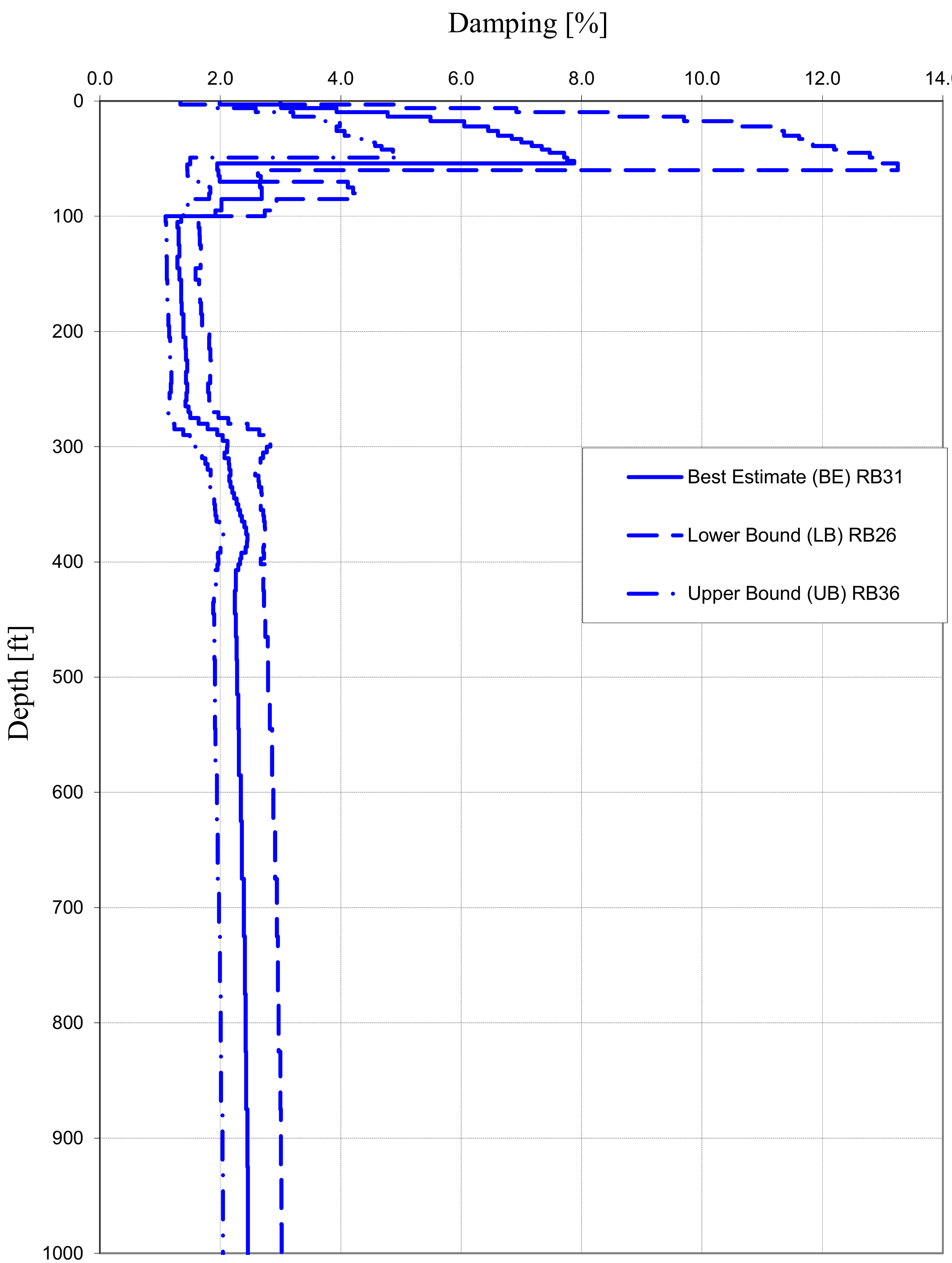

Figure 3F-34d — {P-Wave Velocity Profiles Strain-Compatible with SSE for the NI Common Basemat Structures}

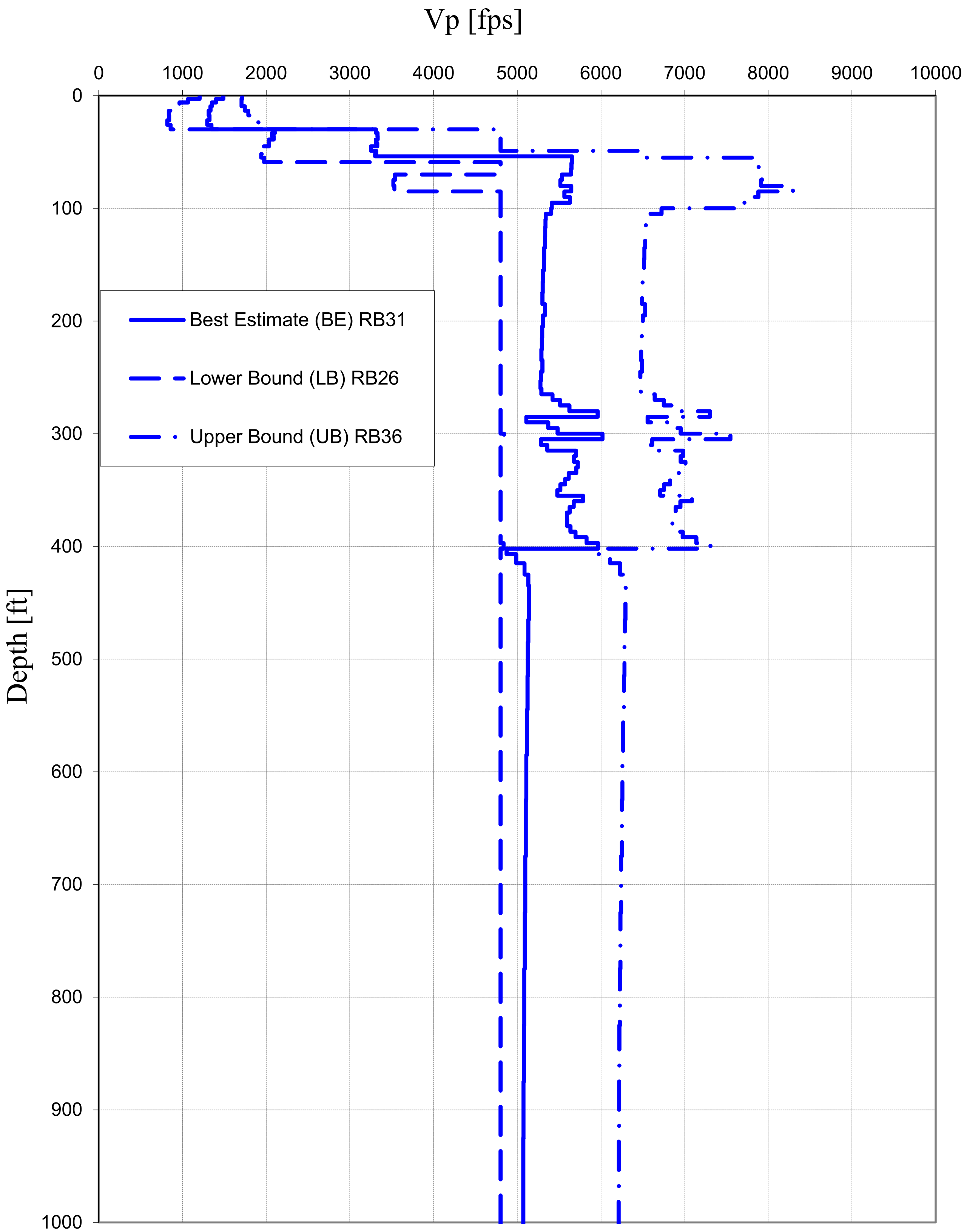

Figure 3F-35 — {5% Damping within ARS at EPGB Foundation Horizontal Direction (H1) - NI Area (11 ft Depth)}

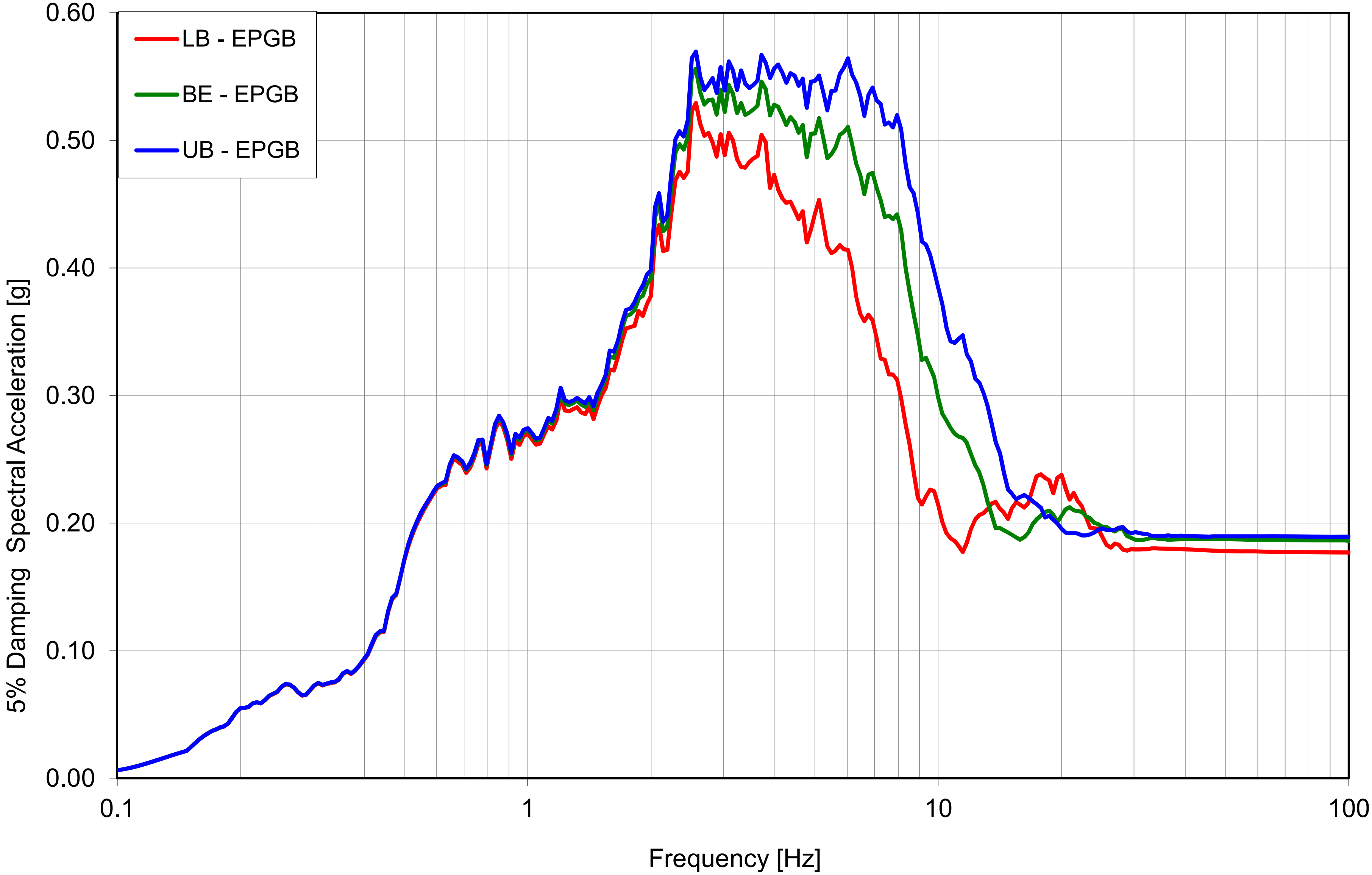

Figure 3F-36 — {5% Damping within ARS at EPGB Foundation Horizontal Direction (H2) - NI Area (11 ft Depth)}

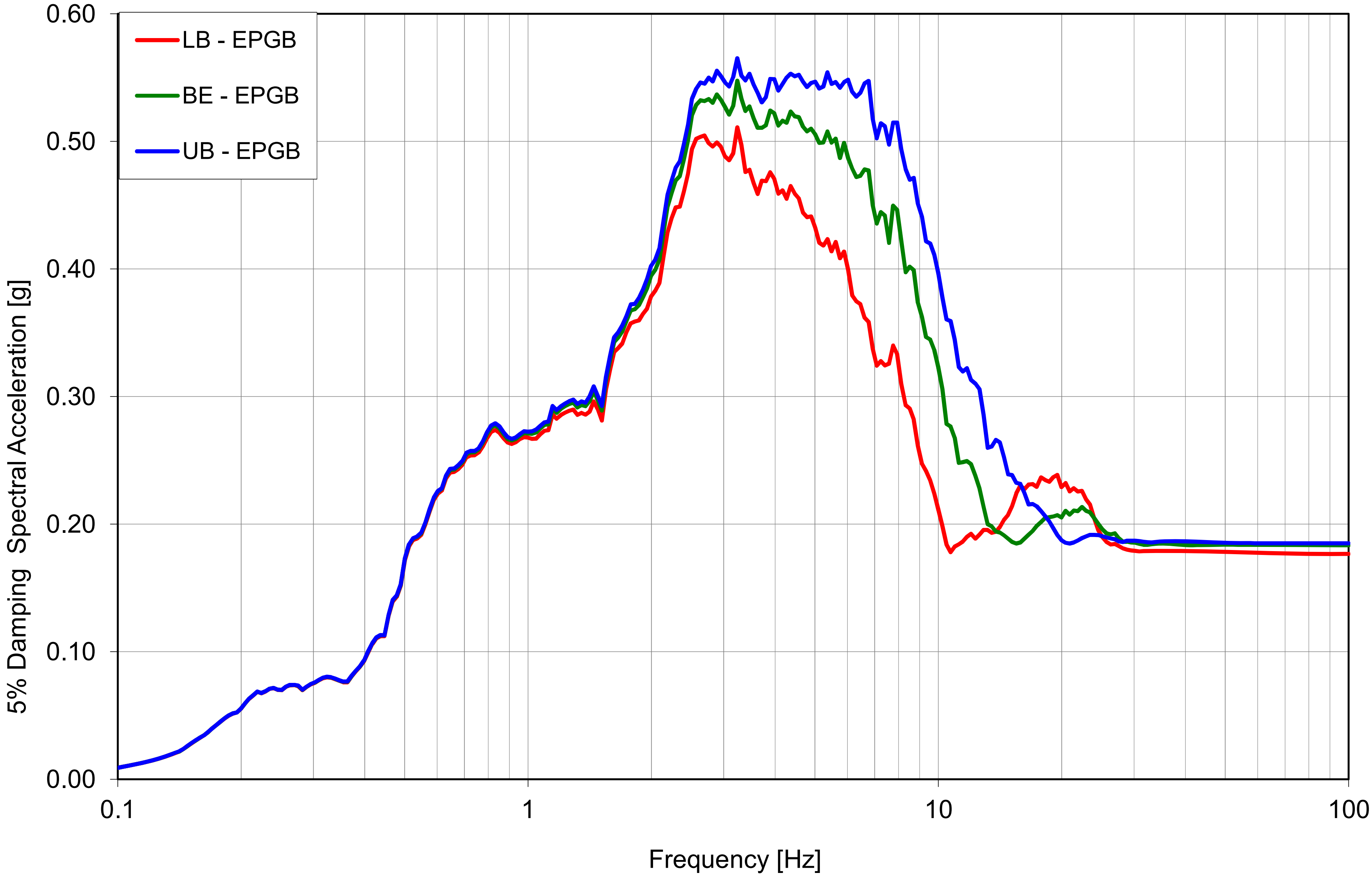

Figure 3F-37 — {5% Damping within ARS at EPGB Foundation Vertical Direction (UP) - NI Area (11 ft Depth)}

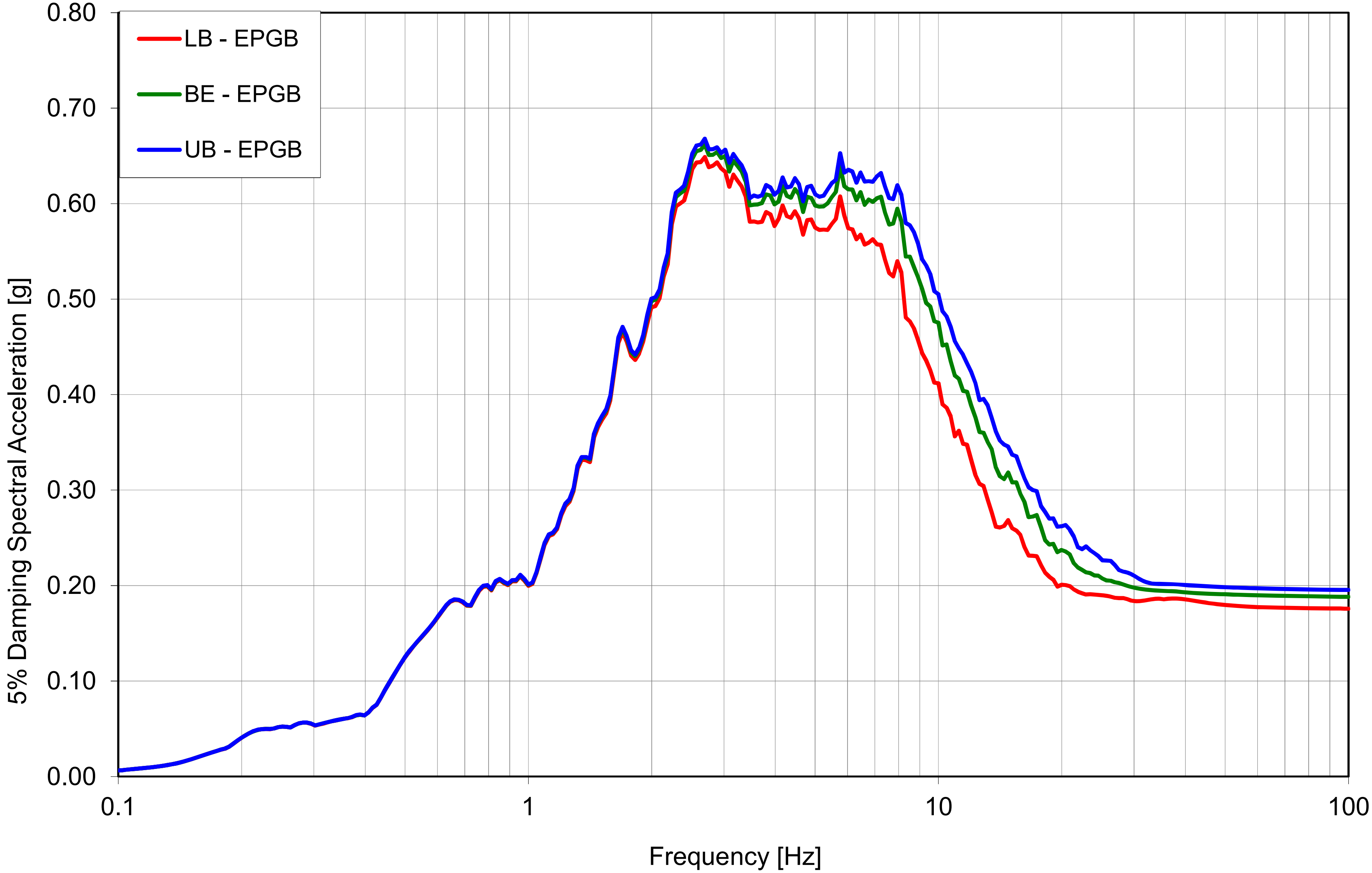

Figure 3F-38 — {5% Damping within ARS at TI Structure Foundation Horizontal Direction (H1) NI Area (21 ft Depth)}

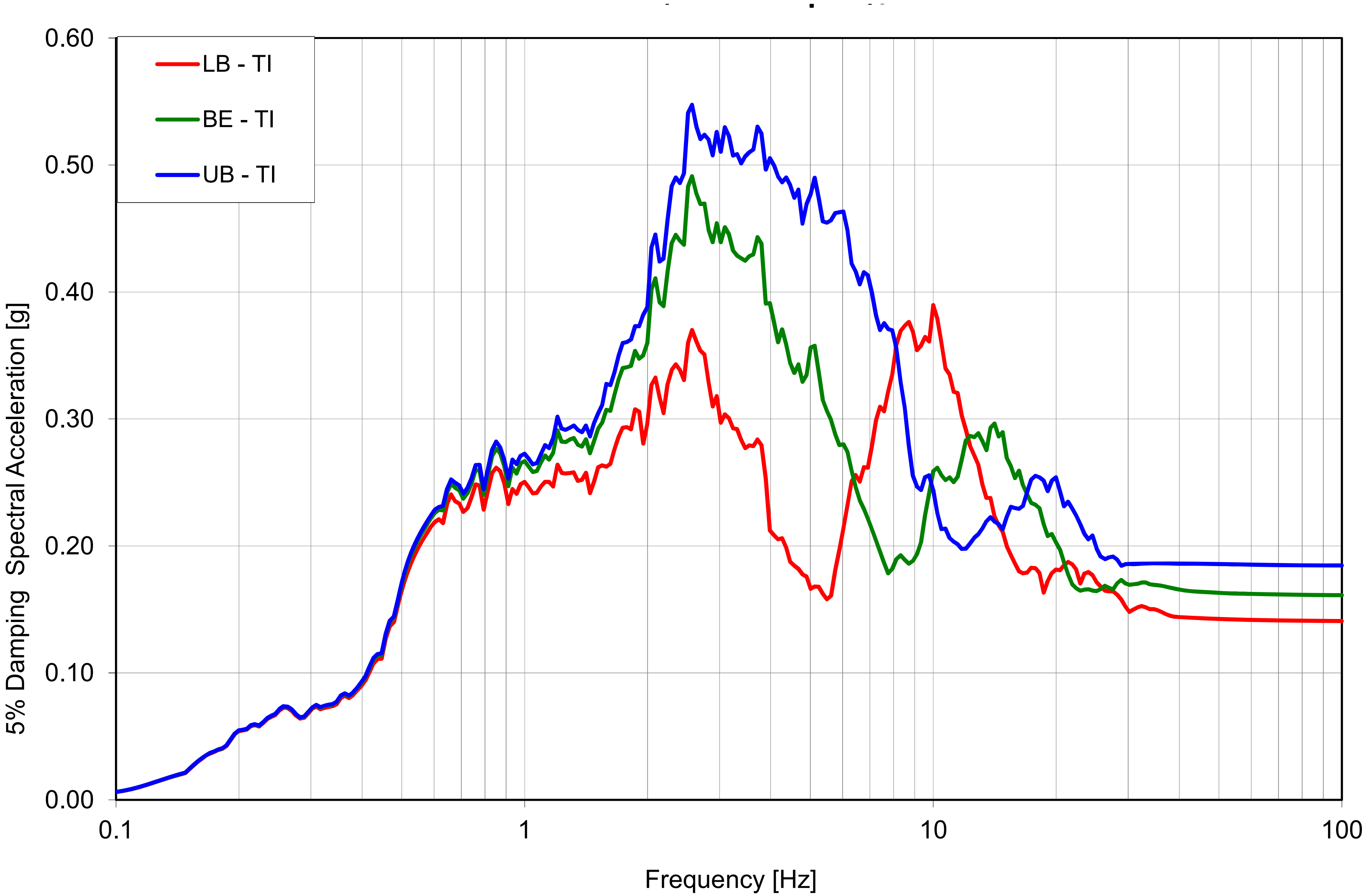

Figure 3F-39 — {5% Damping within ARS at TI Structure Foundation Horizontal Direction (H2) - NI Area (21 ft Depth)}

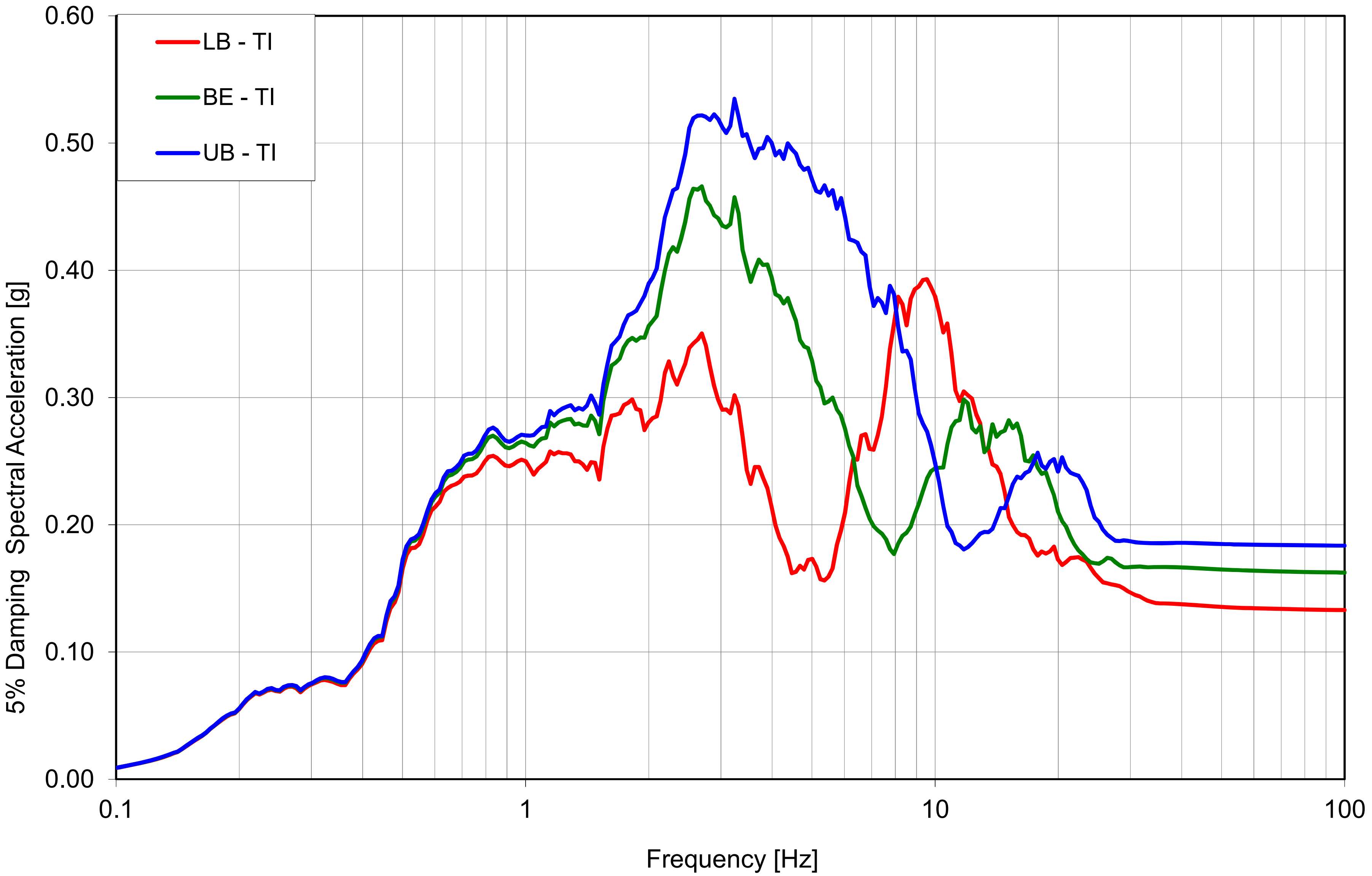

Figure 3F-40 — {5% Damping within ARS at TI Structure Foundation Vertical Direction (UP) - NI Area (21 ft Depth)}

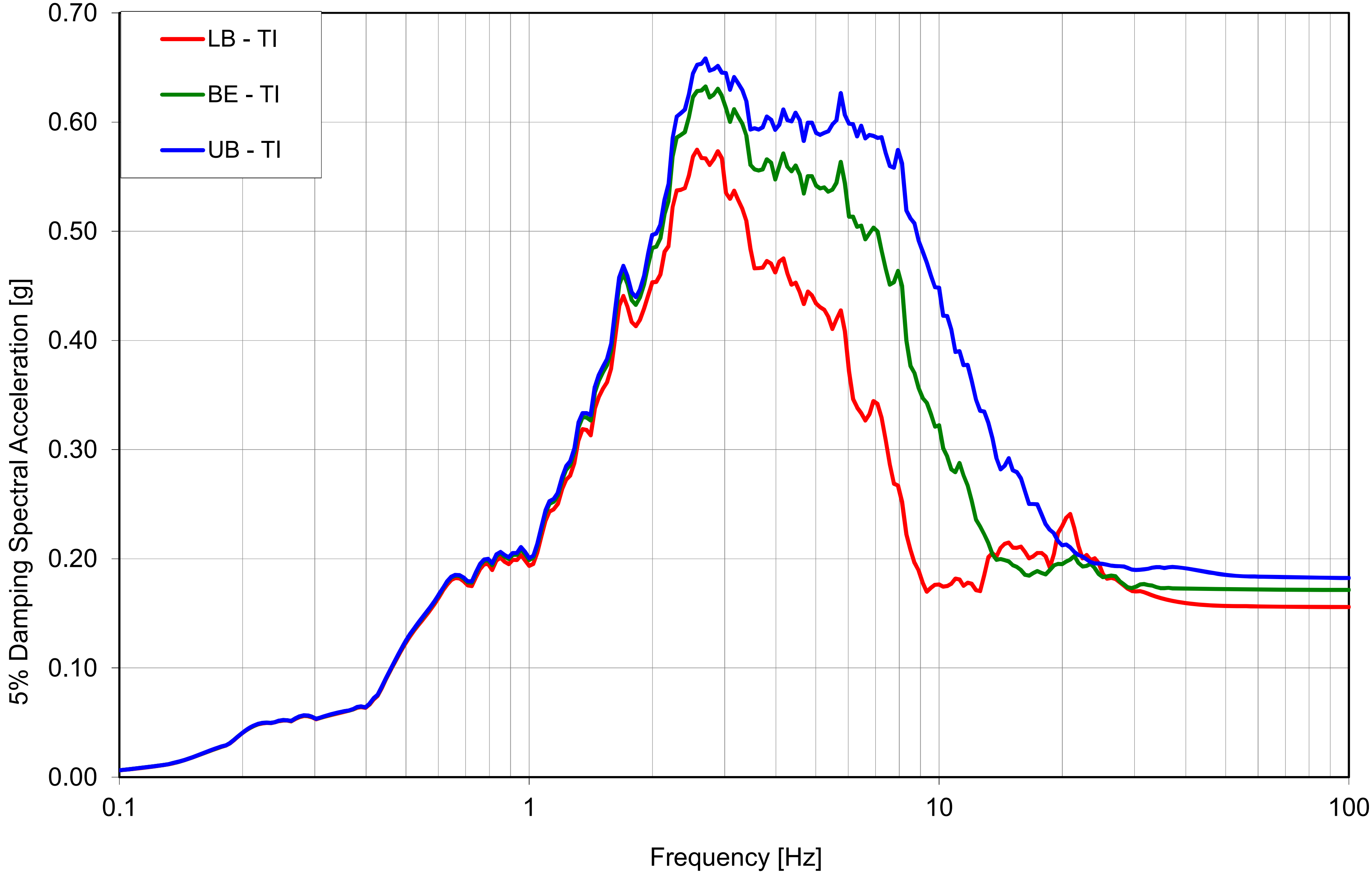

Figure 3F-41 — {5% Damping within ARS at ESWB Foundation Horizontal Direction (H1) - NI Area (33 ft Depth)}

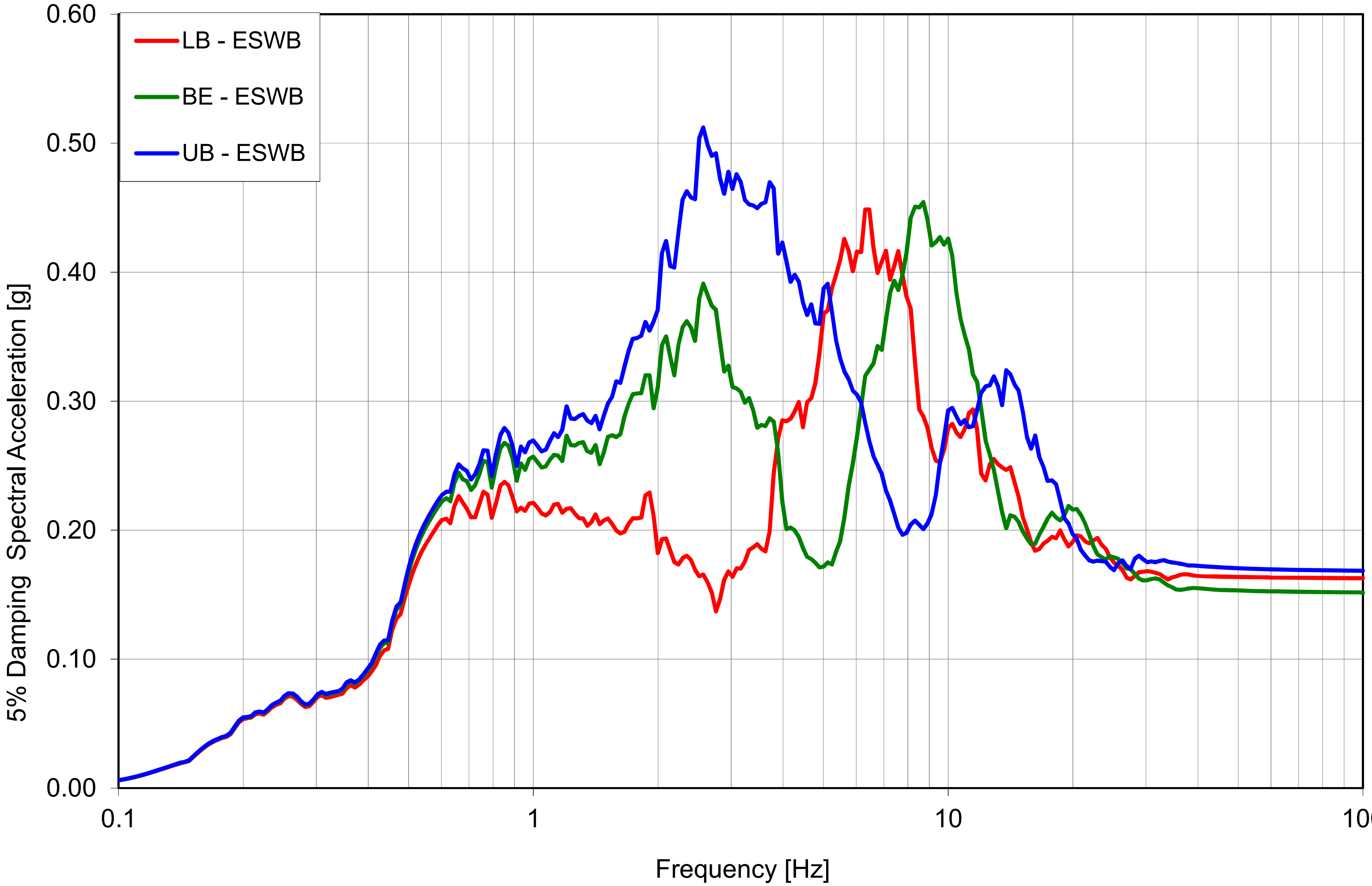

Figure 3F-42 — {5% Damping within ARS at ESWB Foundation Horizontal Direction (H2) – NI Area (33 ft Depth)}

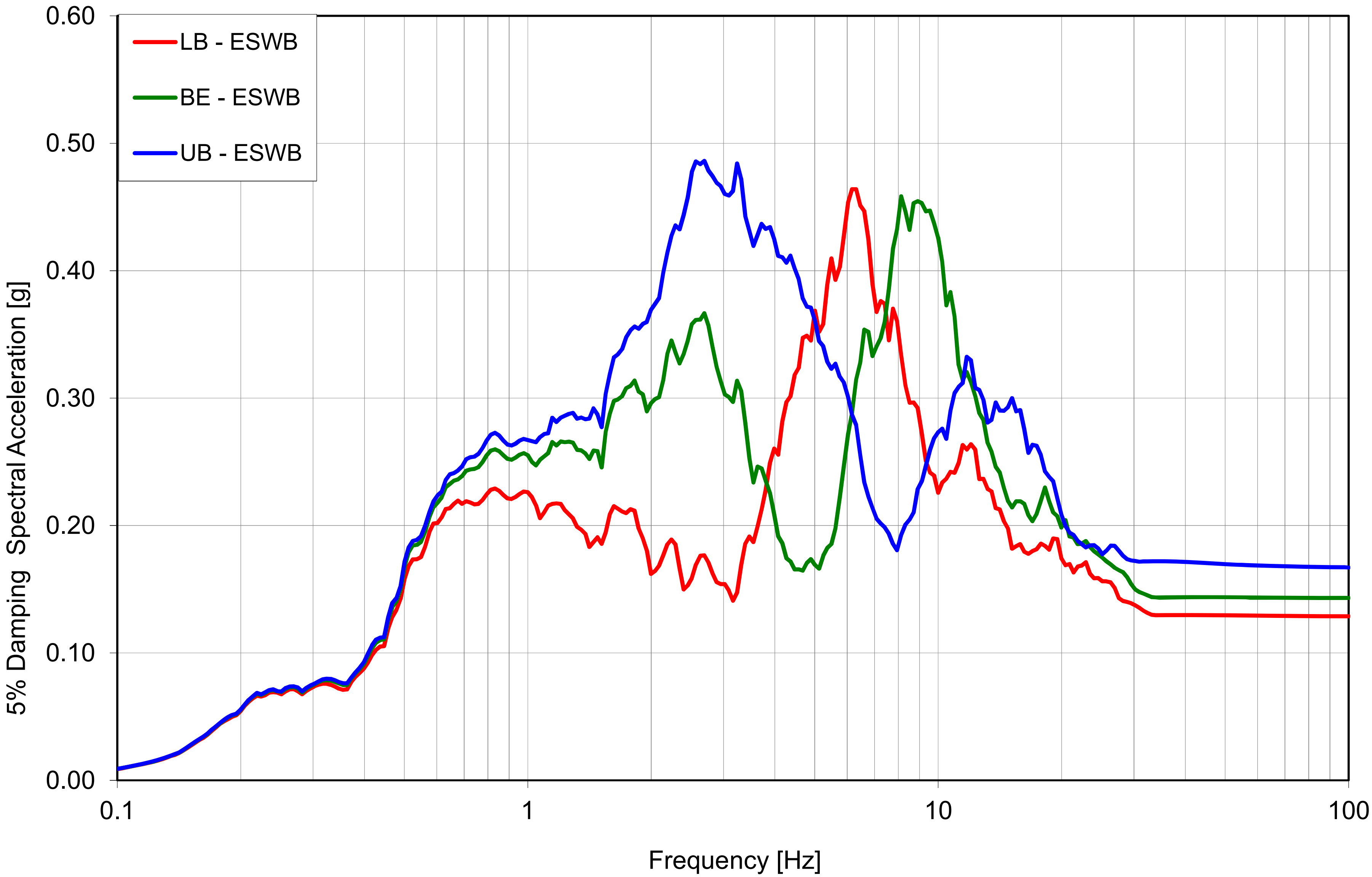

Figure 3F-43 — {5% Damping within ARS at ESWB Foundation Vertical Direction (UP) – NI Area (33 ft Depth)}

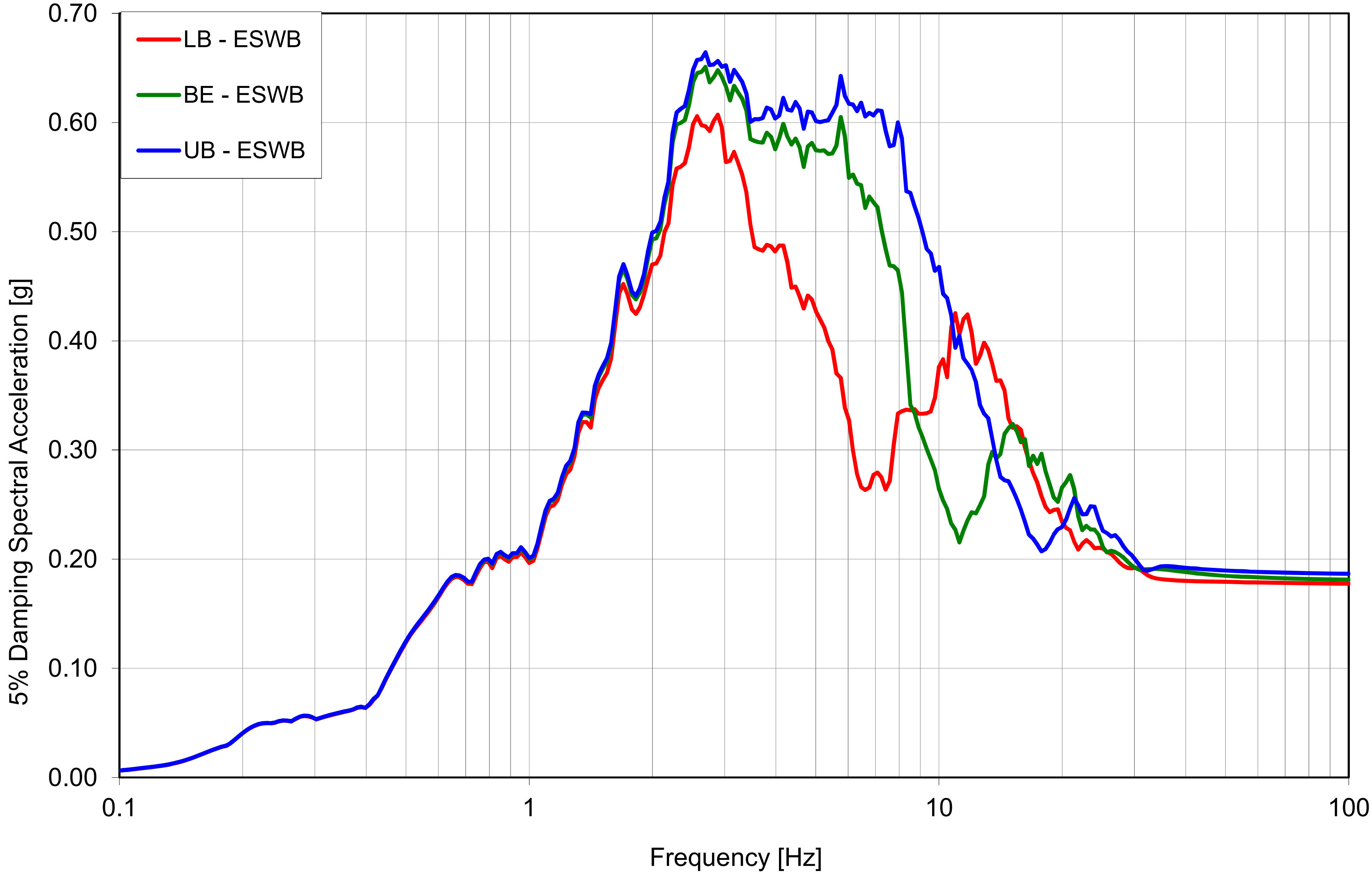

Figure 3F-44 — {5% Damping within ARS at CBIS Foundation Horizontal Direction (H1) – Intake Area (37.5 ft Depth)}

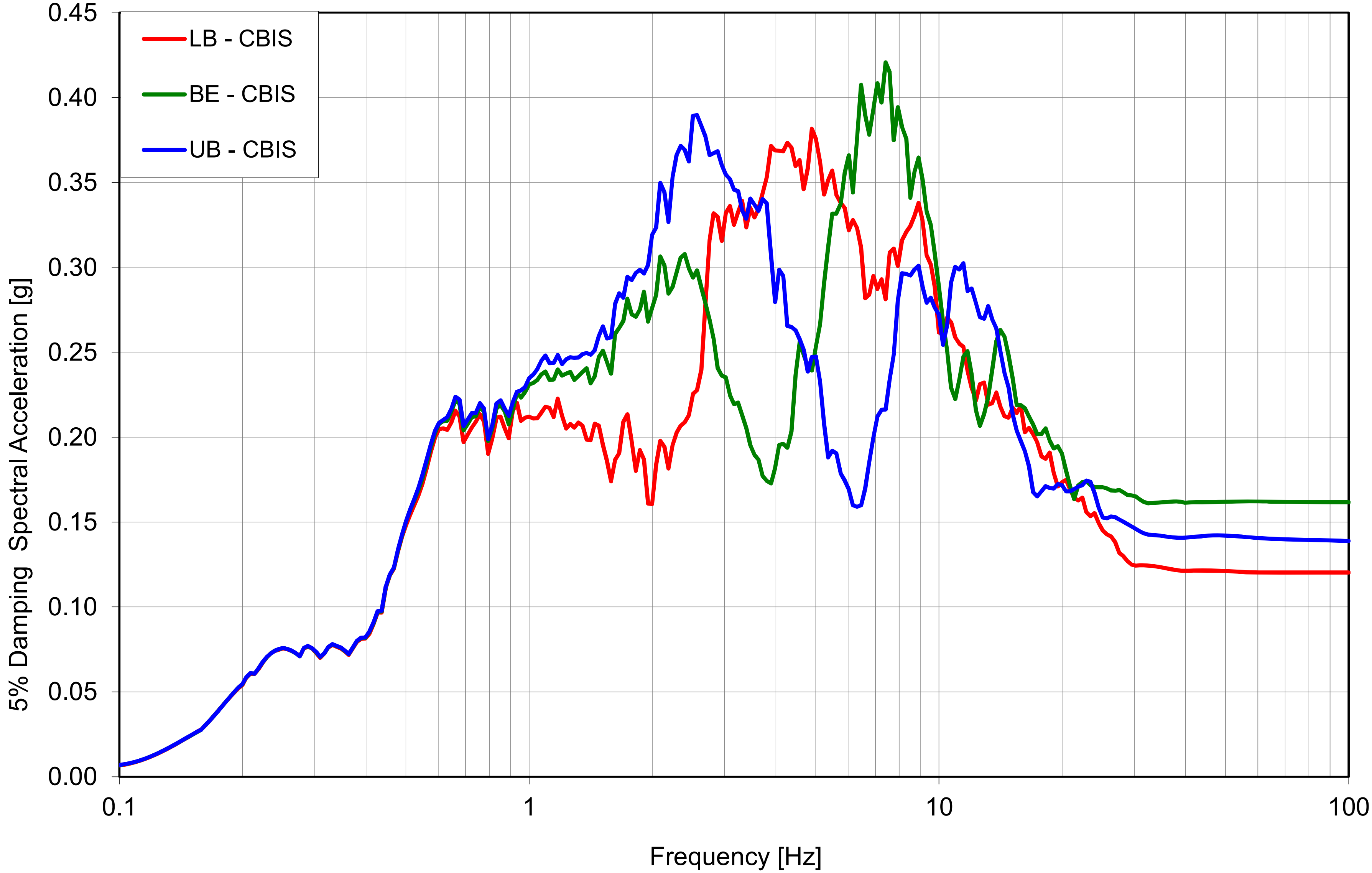

Figure 3F-45 — {5% Damping within ARS at CBIS Foundation Horizontal Direction (H2) – Intake Area (37.5 ft Depth)}

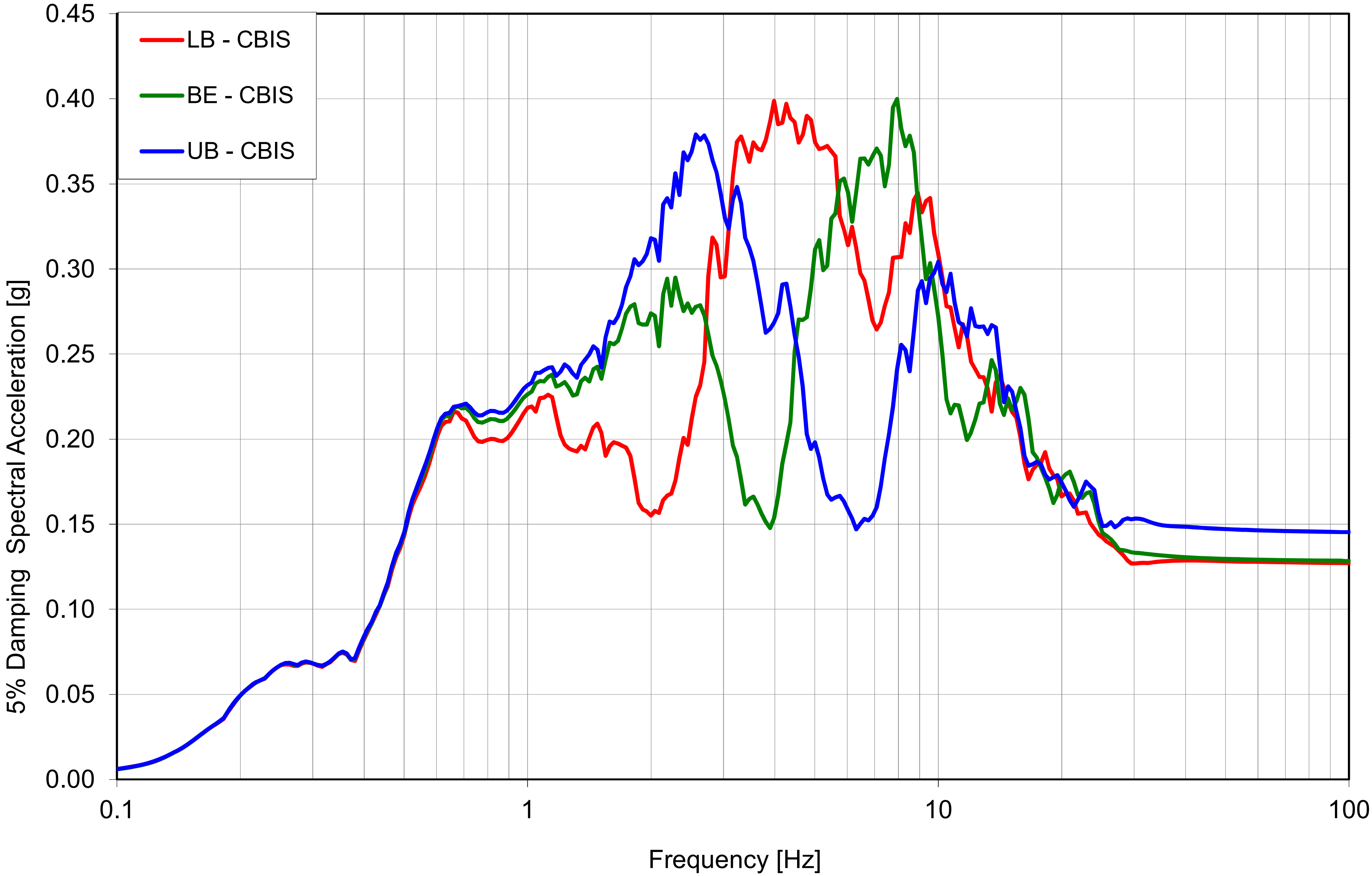

Figure 3F-46 — {5% Damping within ARS at CBIS Foundation Vertical Direction (UP) – Intake Area (37.5 ft Depth)}

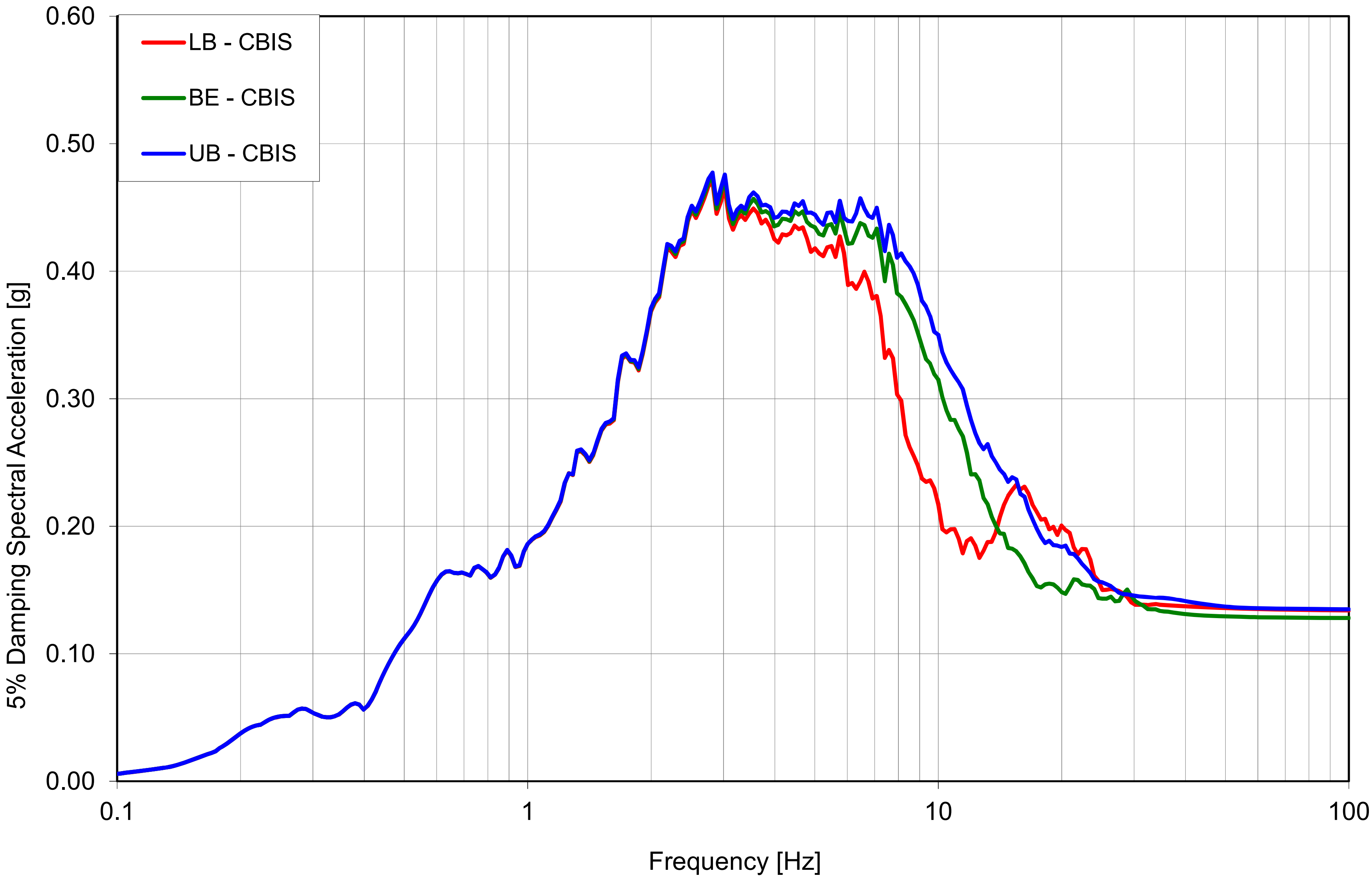

Figure 3F-47 — {5% Damping within ARS at NI Common Basemat Foundation Horizontal Direction (H1, 39 ft Depth)}

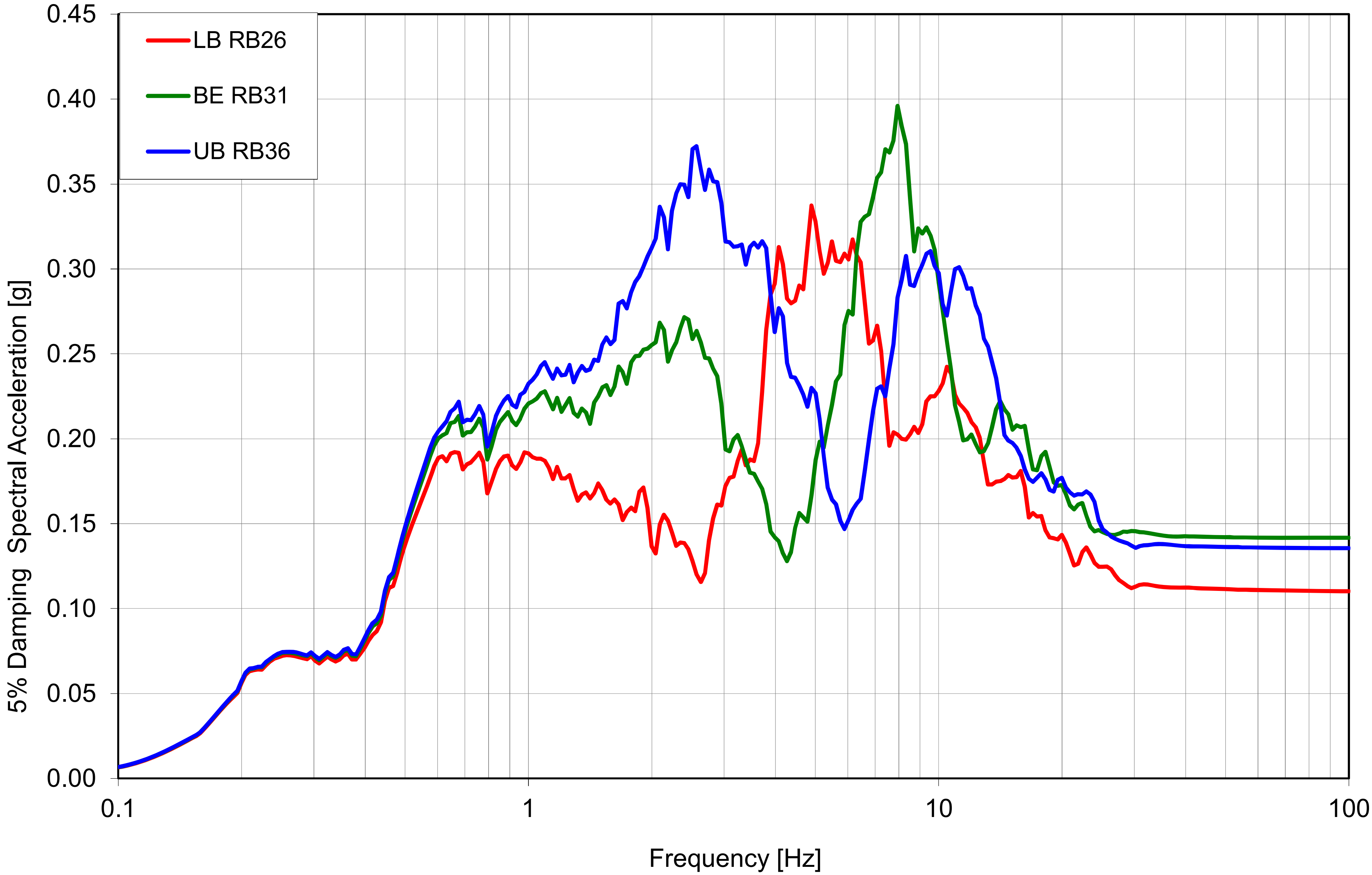

Figure 3F-48 — {5% Damping within ARS at NI Common Basemat Foundation Horizontal Direction (H2, 39 ft Depth)}

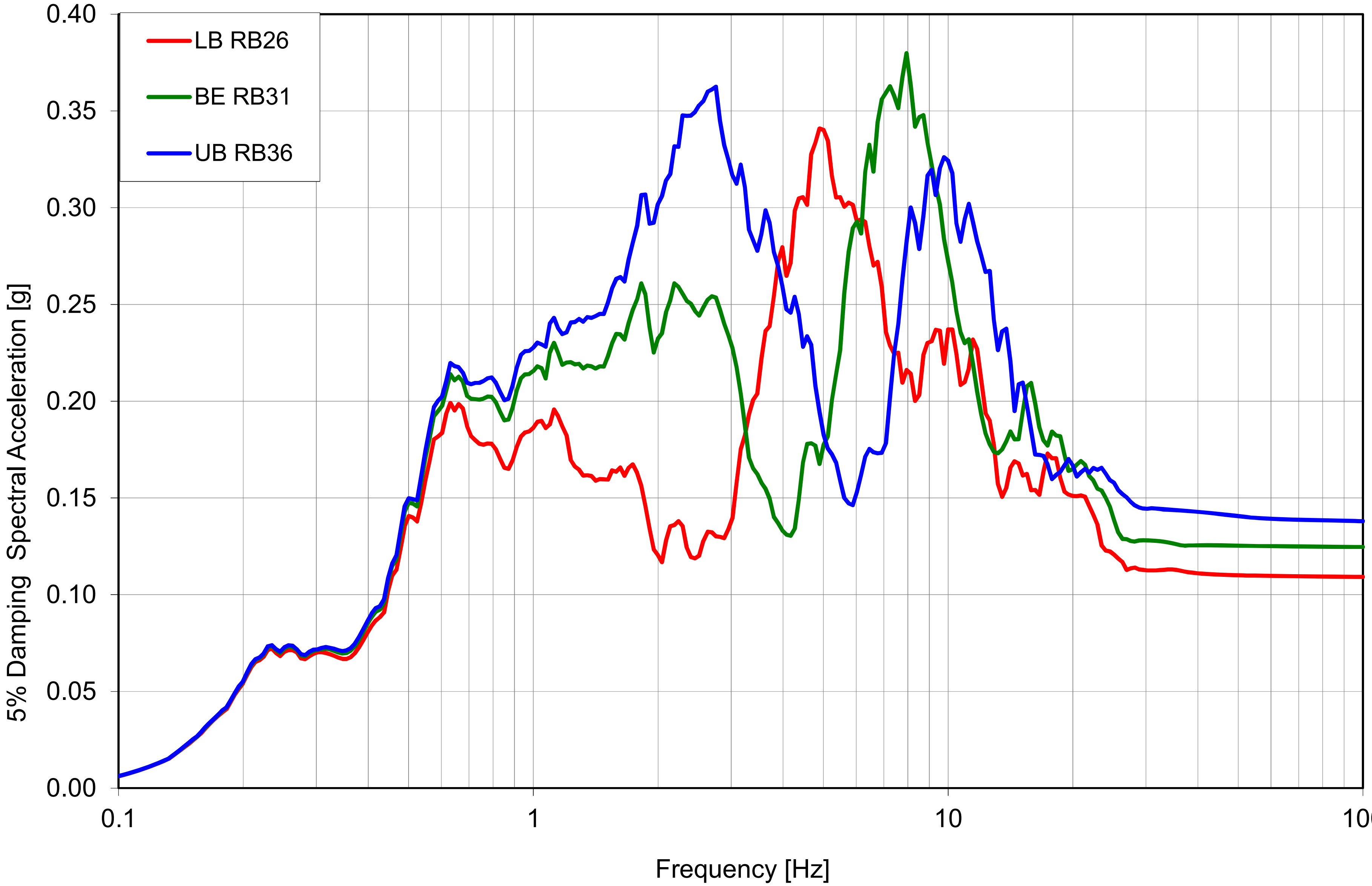

Figure 3F-49 — {5% Damping within ARS at NI Common Basemat Foundation Vertical Direction (UP, 39 ft Depth)}