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## 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 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

{Callaway Plant Unit 2 shares the following structures, systems, and components with Callaway Unit 1:

- ◆ Offsite transmission system - The Callaway Plant Unit 2 switchyard is electrically integrated with the existing Callaway Plant Unit 1, 345 kV, switchyard but the two are physically separated. While the offsite transmission system is shared between Callaway

Plant Unit 2 and Callaway Plant Unit 1, Callaway Plant Unit 2 has onsite AC and DC systems that are dedicated to its use. The offsite AC power sources are described in more detail in Sections 8.1 and 8.2, and the onsite power sources are described in Section 8.3.

- ◆ The cooling tower water makeup system, which draws water from a series of collector wells along the Missouri River, and the plant discharge line, which discharges cooling tower blowdown water are shared between Callaway Units 1 and 2. The cooling tower water makeup system (Collector Well River Intake System) is described in more detail in Section 9.2.9.
- ◆ The potable water and sanitary waste water systems - The potable water system provides chlorinated water for the domestic water needs of the power block and other permanent plant buildings. The sanitary waste water system provides for collection, treatment and discharge of sanitary waste water generated during site operations. These two systems are described in more detail in Section 9.2.4.
- ◆ The demineralized water makeup system provides demineralized water to support plant operations. The demineralized water supply is from Callaway Plant Unit 1. The Callaway Plant Unit 2 distribution system is addressed in Section 9.2.3.
- ◆ Meteorological tower - The meteorological tower provides meteorological data to Callaway Units 1 and 2 to support normal and emergency response operations. It is described in more detail in Section 2.3.3.
- ◆ Emergency Operations Facility (EOF) and Technical Support Center (TSC) - The EOF and TSC are 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 the 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 (SSC) are provided in [Table 3.2-1](#).

{U.S. EPR FSAR Subsection 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 defined in Subsection 3.2.1.2, Callaway Plant Unit 2 also utilizes the seismic classification Seismic Category II-SSE for Fire Protection SSC 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

{In addition to the Seismic Category II classification defined in U.S. EPR FSAR Subsection 3.2.1, Callaway Plant Unit 2 utilizes a Seismic Classification of Seismic Category II-SSE. This designation is utilized to address Fire Protection SSCs that are required 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). Subsections 3.7.2.8 and 3.7.3.12 define the analytical methods for analysis of these components.

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, Seismic Category II-SSE SSC, 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 or Seismic Category II-SSE SSC, 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

No departures or supplements.

### 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 SSCs that are not identified in this table (U.S. EPR FSAR Table 3.2.2-1).

This COL Item is addressed as follows:

The quality group classification of site-specific SSCs 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 4)

KKS System or Component Code	System or Component Description	Safety Classification <sup>(1)</sup>	Quality Group Classification	Seismic Category <sup>(2)</sup>	10CFR50 Appendix B Program	Location <sup>(3)</sup>	Comments/ Commercial Code
Table 3.2.2-1 of the U.S. EPR FSAR contains the following conceptual design information for the SM, SN, Cranes, Hoists, and Elevators category for: UKE, Access Building, and UBZ, Buried Conduit Duct Bank.							
[[UKE	Access Building	NS-AQ	N/A	CS	No	UKE	
UBZ	Buried Conduit Duct Bank	S	N/A	I	Yes	UBZ]]	
The U.S. EPR FSAR descriptions provided in U.S. EPR FSAR Table 3.2.2-1 regarding the SM, SN, Cranes, Hoists, and Elevators category for: UKE, Access Building, and UBZ, Buried Conduit Duct Bank are applicable to Callaway Plant Unit 2, and are incorporated by reference.							
<b>GFA ESWEMS System</b>							
20GFA 10/20/30/40AP001	ESWEMS Pumps	S	C	I	Yes	UQF	ASME III ANSI/HI 2.3
	Piping (20GFA 10/20/30/40) to Cooling Tower	S	C	I	Yes	UQF,UZT	ASME III
20GFA 10/20/30/40AT 001	Discharge Strainers	S	C	I	Yes	UQF	ASME III
20GFA 10/20/30/40 AA101, AA401	Motor Operated Valves	S	C	I	Yes	UQF	ASME III/IEEE
20GFA 10/20/30/40 AA002	Isolation Valve	S	C	I	Yes	UQF	ASME III
SAH	Ventilation Equipment (20SAH 10/20/30/40)	S	C	I	Yes	UQF	ASME III / ASME AG-1
20 GFA 10/20/30/40 AA301, AA302, AA303, AA304, AA305	Isolation Valves for Equipment	S	C	I	Yes	UQF	ASME III
20 GFA 10/20/30/40 AA001	Check Valve	S	C	I	Yes	UQF	ASME III
	Piping and Valves	S	C	I	Yes	UQF	ASME III
20UQF	ESWEMS Pumphouse	S	C	I	Yes	UQF	ANSI/HI 9.8/ACI 349/ ANSI/AISC N690
20UQX	ESWEMS Pond	S	C	I	Yes	UQX	
	Instrument and Controls in the ESWEMS Pumphouse	S	C	I	Yes	UQF	ASME III/IEEE
	ESWEMS Pumphouse Electrical Distribution System Equipment	S	C	I	Yes	UQF	IEEE/NEMA
	Miscellaneous piping	NS	D	II	No		ASME B31.1
	Screens	NS	D	II	No	UQF	
	Electrical Duct Banks traversing from each Essential Service Water Building to the ESWEMS Pumphouse	S	C	I	Yes	UQF/UQB/UZT	IEEE/ASCE/ACI/AA SHTO NEC
<b>PA, PAA, PAB, PAC, Circulating Water System</b>							
URA	Circulating Water Cooling Towers	NS	E	CS	No	URA	IBC
	Circulating Water Pumphouse	NS	E	CS	No	UQA	IBC

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

(Page 2 of 4)

KKS System or Component Code	System or Component Description	Safety Classification <sup>(1)</sup>	Quality Group Classification	Seismic Category <sup>(2)</sup>	10CFR50 Appendix B Program	Location <sup>(3)</sup>	Comments/ Commercial Code
20PAC10/20/30/40 AP 001	Circulating Water Pumps	NS	E	NSC	No	UQA	ASME B31.1/ANSI/HI 2.3
SAQ 50	Circulating Water Pumphouse Ventilation Fans	NS	E	NSC	No	UQA	IEEE
20PAA10/20/30/40 AT001	Removable Screens	NS	E	NSC	No	UQA	
PAB	Circulating Water Piping	NS	E	NSC	No	UQA/UZT	ASME B31.1/AWWA
	Circulating Water Valves	NS	E	NSC	No	UQA	AWWA/ASME B31.1/IEEE
	Instrumentation and Controls in Circulating Water Piping	NS	E	NSC	No		AWWA/ASME B31.1
	Cooling Tower Basins	NS	E	CS	No	URA	IBC
PAB	Circulating Water Makeup Piping	NS	E	NSC	No	UZT	AWWA/ ASME B31.1
PB	Circulating Water Chemical Treatment Piping	NS	E	NSC	No	UZT	AWWA/ASME B31.1
PAB	Circulating Water Cooling Tower Blowdown Piping	NS	E	NSC	No	URA/UZT	AWWA/ ASME B31.1
PAB	Circulating Water Bypass Piping	NS	E	NSC	No	URA/UZT	AWWA/ASME B31.1
PAB	Makeup piping Valves	NS	E	NSC	No	UQA/UZT	AWWA/ASME B31.1
	Instrumentation and Controls in Makeup Piping	NS	E	NSC	No		AWWA/ASME B31.1
	Circulating Water System Electrical Distribution Equipment	NS	E	NSC	No	UQA	IEEE/NEMA
<b>GA Raw Water System, includes Essential Service Water Normal Makeup Supply</b>							
	ESWS Normal Makeup Pumps	NS	E	NSC	No	UQA	ASME B31.1/NEMA/ANSI
	Raw Water System Piping	NS	E	NSC	No	UQA/UZT	ASME B31.1
<b>Water Treatment System</b>							
	Piping	NS	E	NSC	No	UZT	ASME B31.1
	Valves	NS	E	NSC	No	UZT	ASME B31.1/IEEE
	System Electrical Distribution Equipment	NS	E	NSC	No	UZT	IEEE/NEMA
<b>GR Sanitary Waste Water System, including Waste Water Treatment Facility</b>							
	Underground Piping	NS	E	NSC	No	UZT	ASME B31.1
	Sewage Treatment System Piping	NS	E	NSC	No	UZT	ASME B31.1
	Sewage System Electrical Distribution Equipment	NS	E	NSC	No	UZT	IEEE/NEMA
<b>Security Access Facility</b>							
UYF	Security Access Building	NS	E	CS	No	UYF	IBC

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

(Page 3 of 4)

KKS System or Component Code	System or Component Description	Safety Classification <sup>(1)</sup>	Quality Group Classification	Seismic Category <sup>(2)</sup>	10CFR50 Appendix B Program	Location <sup>(3)</sup>	Comments/ Commercial Code
	Security Access Electrical Distribution Equipment	NS	E	NSC	No	UYF	IEEE/NEMA
<b>Central Gas Supply Building</b>							
UTG	Central Gas Supply Bldg	NS	E	CS	No	UTG	IBC
	Piping	NS	E	NSC	No	UTG	ASME B31.1
	Valves	NS	E	NSC	No	UTG	ASME B31.1
	Compressed Gas Tanks	NS	E	NSC	No	UTG	DOT Standard
	Central Gas Supply Electrical Distribution Equipment	NS	E	NSC	No	UTG	IEEE/NEMA
<b>GK, GKB Potable Water System</b>							
	Piping	NS	E	NSC	No		ASME B31.1
	Valves	NS	E	NSC	No		ASME B31.1
	Potable Water System Electrical Distribution Equipment	NS	E	NSC	No		IEEE/NEMA
<b>SGA, SGA1, SGC, SGA0, SGE, SGM Fire Water Supply System</b>							
	Fire Water Distribution System, including valves and hydrants, Balance of Plant (Not providing Safe Shutdown Earthquake Protection)	NS-AQ	D	NSC	No	USG/UZT/UST/ UTG	NFPA
	Fire Water Distribution System, including valves and hydrants, Balance of Plant (Safe Shutdown Equipment Protection following SSE)	NS-AQ	D	II-SSE	Yes	USG/UZT/U QF	NFPA/ANSI/ASME B31.1
	Fire Protection Distribution System including valves and hydrants Seismic Category I Structures (Not Providing Safe Shutdown Equipment Protection following SSE)	NS-AQ	D	II	No		NFPA/ANSI/ASME B31.1
	Fire Protection Distribution System including valves and hydrants Seismic Category I Structures (Safe Shutdown Equipment Protection following SSE)	NS-AQ	D	II-SSE	Yes		NFPA/ANSI/ASME B31.1
	Fire Water Storage Tanks and Fire Protection Building	NS-AQ	D	II-SSE	Yes	USG/UZT	NFPA/ANSI/ASME B31.1/IBC
	Diesel Engine Driven Pumps and Drivers and subsystems, including diesel fuel oil supply	NS-AQ	D	II-SSE	Yes	USG	NFPA/ANSI/ASME B31.1
	Electric Motor Driven Pump and Driver	NS-AQ	D	NSC	No	USG	NFPA/ANSI/ASME B31.1
	Ventilation Equipment	NS-AQ	D	NSC	No	USG	NFPA / ASME B31.1 / ASME AG-1

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

(Page 4 of 4)

KKS System or Component Code	System or Component Description	Safety Classification <sup>(1)</sup>	Quality Group Classification	Seismic Category <sup>(2)</sup>	10CFR50 Appendix B Program	Location <sup>(3)</sup>	Comments/ Commercial Code
	Jockey Pump and driver	NS-AQ	D	NSC	No	USG	NFPA/ANSI/ASME B31.1/NEMA
	Fire Protection Makeup Piping and Valves	NS-AQ	D	NSC	No	UZZ	NFPA
<b>Fire Suppression Systems</b>							
	Fire Suppression Systems for Site Specific Buildings other than ESWEMS Pumphouse and Fire Protection Building	NS-AQ	D	NSC	No		NFPA
	Fire Suppression Systems for ESWEMS Pumphouse and Fire Protection Building	NS-AQ	D	II-SSE	Yes	UPB, UQA	NFPA/ANSI/ASME B31.1
<b>Other Site-Specific Structures</b>							
	Switchgear Building	NS	E	CS	No	UBA	IBC
	Turbine Building	NS	E	CS	No	UMA	IBC
	Switchyard Control House	NS	E	CS	No	UAC	IBC
	Electrical Duct Banks traversing from the Safeguards Buildings to the Four Essential Service Water Buildings and Both Emergency Power Generating Buildings	S	C	I	Yes	UJK/UZZ/ UQB/UBP	IEEE/ASCE/ACI/ AASHTO NEC
	Electrical Duct Banks traversing from the Safeguards Buildings to the Switchgear Building	NS	E	CS	No	UJK/UZZ/ UBA	IEEE/NEC
	Electrical Duct Banks traversing from the Emergency Auxiliary Transformers to the Safeguard Buildings	NS	E	CS	No	UBE/UZZ/ UJK	IEEE/NEC
	Electrical Duct Banks traversing from the Switchgear Building to the Circulating Water Pumphouse, Switchyard Control House, and Site Specific Auxiliary Transformer	NS	E	CS	No	UBA/UZZ/ UPQ/UQA/ URA/UAC/ UAA/UGU/ PE	IEEE/NEC
	Electrical Duct Banks traversing between miscellaneous buildings	NS	E	CS	No	UZZ	IEEE/NEC

Notes:

- As defined in U.S. EPR FSAR Section 3.2.1, the US EPR safety classifications, as supplemented by the AmerenUE Quality Assurance Program Description (QAPD) classifications, are:  
 S- Safety-related (AmerenUE QAPD classification - QA Level 1)  
 NS-AQ- Supplemented Grade (AmerenUE QAPD classification - QA Level 2)  
 NS- Non-safety-related (AmerenUE QAPD classification - QA Level 3)
- 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  
 II-SSE – Seismic Category II Fire Protection structures, systems, and components that are required to

remain functional during and following a safe shutdown earthquake to support equipment required to achieve safe shutdown. The following Fire Protection structures, systems, and components are required to remain functional during and after a seismic event: 1) Fire Water Storage Tanks; 2) Fire Protection Building; 3) Diesel driven fire pumps and their associated subsystems and components, including the diesel fuel oil system; 4) Critical support systems for the Fire Protection Building, and 5) The portions of the fire water piping system and components (including isolation valves) which supply water to the stand pipes in buildings that house the equipment required for safe shutdown of the plant following an SSE. Manual actions may be required to isolate the portion of the Fire Protection piping system that is not qualified as Seismic Category II-SSE.

CS - Conventional Seismic

NSC - Non-seismic

3. Locations are defined below:

KKS Designator	Location
UAA	Switchyard
UAC	Switchyard Control House
UBA	Switchgear Building
UBE	Auxiliary Power Transformers
UBP	Emergency Power Generating Building
UJK	Safeguard Buildings Electrical
UMA	Turbine Building
UQA	Circulating Water Pumphouse
UQB	Essential Service Water Pump Building
UQF	Essential Service Water Emergency Makeup System Pumphouse
UQX	Essential Service Water Emergency Makeup System Pond
URA	Cooling Tower Structure
USG	Fire Water Storage Tanks and Fire Protection Building
UTG	Central Gas Supply Building
UYF	Security Access Facility
UZT	Outdoor Area

### 3.3 WIND 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 and tornado design parameters and compare these to the standard plant criteria. If the site-specific wind and tornado parameters are not bounded, then the COL applicant will evaluate the design for site-specific wind 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 and tornado parameters for the U.S. EPR FSAR design and the site-specific values.

{The U.S. EPR FSAR design wind and tornado parameters bound the site-specific wind and tornado parameters. Additional discussion regarding the derivation of the site-specific wind and tornado parameters is provided in Section 2.3.1. Seismic Category I structures are designed to withstand the effects of wind and tornado loadings. Wind and tornado parameters in U.S. EPR FSAR Table 2.1-1 are used for design of Seismic Category I structures for Callaway Plant Unit 2.}

#### 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:

A discussion of site-specific structures not designed for wind or tornado loadings is provided in Section 3.3.2.3.

##### 3.3.1.1 Design Wind Velocity

{No departures or supplements.}

##### 3.3.1.2 Determination of Applied Wind Forces

{No departures or supplements.}

##### 3.3.1.2.1 Note on Values Used

No departures or supplements.

#### 3.3.2 TORNADO LOADINGS

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 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 wind or tornado loadings is provided in Section 3.3.2.3.

### **3.3.2.1 Applicable Tornado Design Parameters**

{No departures or supplements.}

### **3.3.2.2 Determination of Tornado Forces on Structures**

No departures or supplements.

### **3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado Loads**

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
- ◆ {Switchyard Control House
- ◆ Circulating Water System pump building
- ◆ Administrative and Maintenance Buildings}

{These non-safety-related structures are miscellaneous steel and concrete structures, which are not designed for high wind and tornado loadings. However, the Fire Water Storage Tanks and the Fire Protection Building are designated as Seismic Category II-SSE structures, and are designed to remain functional during and following a design basis seismic event. These structures are not located adjacent to safety-related structures. Thus, their collapse from high winds or tornado loadings would not result in an impact interaction with any safety-related structure. Missiles generated by the collapse of these structures during high wind or tornado loadings are enveloped by the design basis tornado missile loads described in U.S. EPR FSAR Section 3.5.1.4.}

### **3.3.3 REFERENCES**

{No departures or supplements.}

### 3.4 WATER LEVEL (FLOOD) DESIGN

This section of the U.S. EPR FSAR is incorporated by reference with the departures and/or 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.

{The U.S. EPR FSAR design parameters are bounding for the Callaway Plant Unit 2.}

#### 3.4.1 INTERNAL FLOOD PROTECTION

No departures or supplements.

#### 3.4.2 EXTERNAL FLOOD PROTECTION

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

The maximum groundwater elevation for the U.S. EPR generic design is 3.3 ft (1m) below finished grade. The maximum groundwater level at Callaway Plant Unit 2 is approximately 17 ft (5.2 m) below finished grade of 845 ft (msl) as discussed in section 2.4.12.5.

##### 3.4.2.1 Site-Specific ESWEMS

As show in [Figure 9.2-9](#), the normal water level in the ESWEMS Retaining Pond is at Elevation 835 ft (245.5 m) msl. In order to minimize water seepage from the pond, in-situ cohesive soil and/or category 1 cohesive fill is placed outside the zones of the category 1 granular structural fill that is below the pumphouse's basemat. A groundwater surface elevation in the vicinity of the ESWEMS Pumphouse matching the normal pond level of 835 ft (245.5 m) msl would be 5 ft (1.5 m) below finish in this area grade and is in conformance with the generic design criteria listed above.

The ESWEMS Pumphouse is classified as a safety-related building. It is designed to meet the requirements of Regulatory Guide 1.27 (NRC, 1976). The minimum 5-foot (1.5 m) thickness of the basemat provides adequate waterproofing of floor areas below grade. The earth-facing wall of the building pump wells is embedded 30 feet (9.14 m) below grade. A waterproofing system is applied to vertical wall surfaces in contact with soil. The system consists of two-component thermosetting polyurethane bitumen applied to a minimum dry film thickness of 50 mils (1.27 mm), or approved equivalent.

The waterproofing system is classified as non-safety related. Waterstops are provided at construction joints located below grade. Waterstop material is sterene-butadience synthetic rubber or an approved equivalent. Water seals are provided at all penetrations below grade. If water would seep into the piping trench pit, it can be pumped into the pump well using a sump pump. The ESWEMS Pumphouse does not require external flood doors or submarine doors.}

#### 3.4.3 ANALYSIS OF FLOODING EVENTS

##### 3.4.3.1 Internal Flooding Events

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

The ESWEMS Pumphouse floors are sloped to direct drainage water or leakage above grade back in to the pump well bay.}

#### **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 in the following section as follows:

{Site specific flooding events and analysis results discussed in Sections 2.4.2 through 2.4.10 are bounded by the U.S. EPR design basis flood values.}

#### **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 extreme water level in the ESWEMS Pond can reach Elevation 839.95 ft msl (25.60 m) as a result of the water surge, and wave run-up associated with the PMP as discussed in Section

2.4.8. The effect of such high water level is localized. The structural wall facing the water is analyzed for such water surge and wave force. The ESWEMS Pumphouse does not experience a credible external flood.}

#### **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, a permanent groundwater dewatering system is not needed for Callaway Plant Unit 2.}

### **3.4.4 ANALYSIS PROCEDURES**

No departures or supplements.

### **3.4.5 REFERENCES**

{No departures or supplements.}

## **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.

#### **3.5.1.2 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 controls 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 SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

This COL Item is addressed as follows:

{AmerenUE} shall 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 SSC important to safety, or restrained to prevent it from becoming a missile.

### 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  $1E-4$  for turbine generators favorably oriented with respect to containment.

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. 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  $1E-4$  for a favorably oriented turbine with respect to the containment.

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:

{Callaway Plant Unit 1 FSAR Section 3.5 indicates that the probability of turbine missile generation (P1) for the Callaway Plant Unit 1 turbine is less than  $1E-5$  per year, which is below the threshold value of  $1E-4$  described in Regulatory Guide 1.115 (NRC, 1977). Therefore, Callaway Plant Unit 2 safety-related SSC are adequately protected from potential Callaway Plant Unit 1 turbine missiles.}

#### **3.5.1.4 Missiles Generated by Tornadoes and 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 hurricanes and extreme 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 tornado intensity requirements of Regulatory Guide 1.76 (NRC, 2007a). The associated tornado wind speeds (230 mph (103 m/s) maximum) represent an exceedance frequency of  $1E-07$  per year. Region I 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.

{Callaway Plant Unit 2 site is located in Callaway County, Missouri. This site lies in Region I. The tornado and wind conditions established as the design envelope for the U.S. EPR bound the conditions that occur at Callaway Plant Unit 2 (See [Table 2.0-1](#)). Therefore there are no additional potential missiles to evaluate for Callaway Plant Unit 2.}

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 SSCs 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 and the ESWEMS Pumphouse 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 and pump structures, the automobile missile impact is considered on all wall elements at all elevations, but not the roof slab. {The highest elevation within the half mile radius at Callaway Plant Unit 2 is at an approximate elevation of 860 feet. Adding the 30 feet requirement, all elements below elevation 890 feet require evaluation of the automobile missile. Normal grade elevation at the location of the structures is approximately 840 feet. Therefore, structural elements less than 50 feet (890 feet minus 840 feet) require automobile missile evaluation. The height of the UHS structures above grade is approximately 96 feet. Hence, the roof slab located at elevation 96 feet above grade, on these structures does not require automobile missile evaluation. On this basis, the site specific conditions are conservatively enveloped for all required elevations.

Thus, by the standard U.S. EPR meeting the Region I tornado missile spectrum requirements for all Category I structures, the site-specific conditions at Callaway Plant Unit 2 are in compliance with all Regulatory Guide 1.76 (NRC, 2007a) tornado 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, 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 Callaway Plant Unit 2. This conclusion is substantiated by each potential external hazard being screened based on applicable regulatory guidance or the hazard was demonstrated to have an occurrence frequency 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 SSCs.

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 and close proximity of airways V12 and J19-110-134 a rigorous probabilistic risk assessment (PRA) was performed to assess the core damage frequency (CDF) effect from these hazards and is presented in Section 19.1.5.} The analysis in Section 19.1.5 demonstrates that the screening criteria of ANSI/ANS-58.21-2007, are met for this event. }

### 3.5.2 STRUCTURES, SYSTEMS, AND COMPONENTS TO BE PROTECTED FROM EXTERNALLY GENERATED MISSILES

No departures or supplements.

### 3.5.3 BARRIER DESIGN PROCEDURES

No departures or supplements.

### 3.5.4 REFERENCES

{**CFR, 2008.** Contents of Construction Permit and Operating License Applications; Technical Information, Title 10, Code of Federal Regulations, Part 50.34, U.S. Nuclear Regulatory Commission, February 2008.

**NRC, 1977.** Protection Against Low-Trajectory Turbine Missiles, Regulatory Guide 1.115, Revision 1, U.S. Nuclear Regulatory Commission, July 1977.

**NRC, 1978a.** Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants, Regulatory Guide 1.91, Revision 1, U.S. Nuclear Regulatory Commission, February 1978.

**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.}

### 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

The U.S. EPR FSAR includes the following COL Item in Section 3.6.1:

A COL applicant that references the U.S. EPR design certification will perform the pipe break hazards analysis and reconcile deviations in the as-built configuration to this analysis.

This COL Item is addressed as follows:

{AmerenUE} shall perform a pipe break hazard analysis as part of the piping design. It is used to identify postulated break locations and layout changes, support design, whip restraint design, and jet shield design. The final design for these activities shall be completed prior to fabrication and installation of the piping and connected components. The as-built reconciliation of the pipe break hazards analysis shall be completed prior to fuel load.

#### 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

The U.S. EPR FSAR includes the following COL Item in Section 3.6.2.1:

A COL applicant that references the U.S. EPR design certification will perform the pipe break hazards analysis and reconcile deviations in the as-built configuration to this analysis.

This COL Item is addressed as follows:

{AmerenUE} shall perform a pipe break hazard analysis as part of the piping design. It is used to identify postulated break locations and layout changes, support design, whip restraint design, and jet shield design. The final design for these activities shall be completed prior to fabrication

and installation of the piping and connected components. The as-built reconciliation of the pipe break hazards analysis shall be completed prior to fuel load.

### **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. EPR design certification will provide diagrams showing the final as-designed 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:

{AmerenUE} shall provide the diagrams showing the final as-designed 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:

A COL applicant that references the U.S. EPR design certification will confirm that the design LBB analysis remains bounding for each piping system and provide a summary of the results of the actual as-built, plant-specific LBB analysis, including material properties of piping and welds, stress analyses, leakage detection capability, and degradation mechanisms.

This COL Item is addressed as follows:

{AmerenUE} shall confirm that the design Leak-Before-Break (LBB) analysis remains bounding for each piping system. A summary of the results of the actual as-built, plant-specific LBB analysis, including material properties of piping and welds, stress analyses, leakage detection capability, and degradation mechanisms will be provided prior to fuel load.

### 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 describes the site-specific seismic parameters for {Callaway Plant Unit 2 and reconciles the design of seismic Category I standard plant structures with the Certified Seismic Design Response Spectra (CSDRS) (anchored at 0.3 g Peak Ground Acceleration (PGA)) and the 10 generic soil profiles used in the U.S. EPR FSAR.

##### 3.7.1.1 Design Ground Motion

{The U. S. EPR FSAR Section 3.7.1.1 is incorporated by reference with the following supplemental information.

The GMRS for Callaway Plant Unit 2, which were developed using RG 1.165 and RG 1.208, are not bounded by the CSDRS at all frequencies. This represents a departure from the U.S. EPR FSAR. This departure is justified consistent with the seismic reconciliation guidelines contained in the U.S. EPR FSAR Section 2.5.2.6, as described in Section 2.5.2.6 and Section 3.7.1.1.1.

##### Seismic Reconciliation of CSDRS and GMRS

The Callaway Plant Unit 2 seismic design parameters are enveloped by the CSDRS and the generic site soil profiles used in the certified design as described below (except as noted):

1. The PGA for the GMRS is 0.24g and 0.26g (based on the spectral amplitude at 100Hz) in the horizontal and vertical directions, respectively, which is less than 0.3g, the PGA for the CSDRS.
2. The Nuclear Island Common Basemat is founded on top of Graydon Chert Conglomerate with a low-strain, best-estimate shear wave velocity of approximately 2,340 fps. Since this shear wave velocity is greater than 1,000 fps, the Callaway Plant Unit 2 NI is founded on competent material as defined in SRP 3.7.1.
3. The FIRS for the NI Common Basemat structure is defined at the bottom of the basemat at approximately 40 feet below grade. This depth is also where the GMRS is defined. The CSDRS is exceeded by the Callaway Plant Unit 2 GMRS in both the horizontal (below about 0.4Hz and above about 10Hz) and vertical directions (below about 0.25Hz and above about 14.5Hz) as shown in [Figure 3.7-1](#) through [Figure 3.7-4](#). This represents a departure from the U.S. EPR FSAR. This departure is justified consistent with the seismic reconciliation guidelines contained in U.S. EPR FSAR Section 2.5.2.6, as described here and in Section 2.5.2.6.

The FIRS for both the Emergency Power Generating Buildings (EPGB) and the Essential Service Water Buildings (ESWB) exceeds the CSDRS as shown in [Figure 3.7-5](#) through [Figure 3.7-8](#). This represents a departure from the U.S. EPR FSAR. This departure is

justified consistent with the seismic reconciliation guidelines contained in U.S. EPR FSAR Section 2.5.2.6, as described here and in Section 2.5.2.6.

4. Horizontal soil layering is confirmed for the Callaway Plant Unit 2 site-specific soil.
5. The range of shear wave velocities of the Callaway Plant Unit 2 strain-compatible soil profiles has significant variations in the soil layering at the site from that of the generic soil profiles considered in the FSAR. Therefore, the Callaway Plant Unit 2 soil profiles cannot be concluded as being bounded by the FSAR soil profiles. This represents a departure from the U.S. EPR FSAR. This departure is justified consistent with the seismic reconciliation guidelines contained in U.S. EPR FSAR Section 2.5.2.6, as described here and in Section 2.5.2.6.
6. Condition 3 and Condition 5 above are not met for the Callaway Plant Unit 2 site because the GMRS/FIRS exceeded the CSDRS and the Callaway Plant Unit 2 site-specific idealized site soil profile does not correspond directly to the 10 generic soil profiles used for the U.S. EPR. Because the conditions are not met for Callaway Plant Unit 2, seismic reconciliation Step 7 is performed.
7. An SSI analysis of the NI Common Basement Structures is performed using the Callaway Plant Unit 2 soil profiles and ground motion to determine the NI basemat response spectra. Response spectra are also determined at the footprints of the EPGB and ESWB basemats at the elevation of the NI basemat to simulate the structure-soil-structure interaction (SSSI) effects from the NI. A comparison of these spectra with the corresponding spectra in the U.S. EPR FSAR (Figure 3.7.2-68 through Figure 3.7.2-73), which are presented in [Figure 3.7-9](#) through [Figure 3.7-29](#), shows that the Callaway Plant Unit 2 curves exceed the U.S. EPR FSAR curves. Therefore, a site-specific analysis to determine ISRS is performed.
8. Callaway Plant Unit 2 site-specific SSI analyses are performed because the site-specific GMRS/FIRS exceed the CSDRS and the site-specific soil profile does not correspond directly to the 10 generic soil profiles used for the U.S. EPR in terms of soil layering.

### **Site-Specific SSI Analyses**

#### **Soil Profiles**

[Table 3.7-1](#), [Table 3.7-2](#) and [Table 3.7-3](#) show the strain-compatible Best Estimate (BE), Lower Bound (LB) and Upper Bound (UB) soil cases, respectively, used in the site-specific SSI analysis for the NI Common Basemat Structures. Since the EPGB and ESWB are at different elevations, the soil profiles considered for these structures are different and include the structural fill from the ground surface to the individual foundations of these structures. The EPGB is surface founded and the ESWB is embedded about 22 feet.

#### **Ground Motion**

The Callaway Plant Unit 2 GMRS is used in the site-specific SSI analysis for the NI Common Basemat Structures.

The ground motion for the SSI analysis of the EPGB and ESWB are based on the FIRS developed by the site response analysis amplified by scaling factors that account for the SSSI effects due to the NI's influence on the EPGB and ESWB. The ground motions are defined as outcrop motions at the foundation level of each structure.

A comparison of the ground motion (GMRS/FIRS) for the NI, EPGB, and ESWB with the CSDRS is shown in [Figure 3.7-1](#) through [Figure 3.7-4](#) and [Figure 3.7-5](#) through [Figure 3.7-8](#).

### SSI Analysis

For the NI, the same SSI model and methodology used for Design Certification is used for the site-specific analyses. The ESWB model has the same number of nodes and elements as the original model used for Design Certification, except for the node re-sequencing and reshaping of elements. For the EPGB, the SSI model is a refined finite element model (FEM). This represents a departure from the U.S. EPR FSAR. [Figure 3.7-30](#) presents the new FEM for the EPGB.

SSI analyses for three soil cases, namely Callaway Plant Unit 2 strain-compatible BE, Callaway Plant Unit 2 strain-compatible LB, and Callaway Plant Unit 2 strain-compatible UB, were performed using the GMRS/FIRS motion as seismic input.

Response spectra for 5% damping in the three directions are generated at the following key locations:

Reactor Building Internal Structure at Elev. 5.15m and 19.5m

Safeguard Building 1 at Elev. 8.1m and 21.0m

Safeguard Building 2/3 at Elev. 8.1m and 15.4m

Safeguard Building 4 at Elev. 21.0m

Containment Building at Elev. 37.6m and 58.0m

Emergency Power Generating Building at Elev. 0.0m

Essential Service Water Building at Elev. 19.2m and 4.27m

A comparison of the 5% damped ISRS for the Callaway Plant Unit 2 BE, LB and UB soil cases with the corresponding peak broadened Design Certification ISRS shows that the certified design ISRS are exceeded by the ISRS for Callaway Plant Unit 2 by more than 10% at some of the key building locations. This includes the Reactor Building Internal Structure, Emergency Power Generating Building, and Essential Service Water Building. See [Figure 3.7-31](#) through [Figure 3.7-66](#). This represents a departure from the U.S. EPR FSAR.

This departure is justified consistent with the seismic reconciliation guidelines contained in U.S. EPR FSAR Section 2.5.2.6, as described in Section 2.5.2.6.

The maximum zero period accelerations (ZPA) at various floor locations which are generated from the SSI analysis are also compared with the Design Certification ZPA for the U.S. EPR. For the NI Common Basemat Structures, the Callaway Plant Unit 2 ZPAs are within the corresponding U.S. EPR FSAR ZPAs except a few locations at the top of the Safeguard Building 2/3. At these locations, the vertical ZPAs of Callaway Plant Unit 2 exceed those of U.S. EPR FSAR by less than 10%. For the EPGB and ESWB, the Callaway Plant Unit 2 ZPAs exceed the U.S. EPR FSAR ZPAs by more than 10% as identified in [Table 3.7-4](#) and [Table 3.7-5](#).

As discussed in Condition 8 above, there are exceedances that are greater than 10%. Therefore, additional evaluations were performed for the Callaway Plant Unit 2 and confirm that the

structures, systems and components are not affected. Descriptions of the evaluations of the structures, systems and components are provided in Section 2.5.2.6.}

Discussion of seismic system analysis due to the exceedances is discussed in Section 3.7.2 based upon instructure multi-damping spectra developed and shown in Figure 3.7-67 through Figure 3.7-75.

### Site-Specific ESWEMS

{Section 2.5.2 develops the site specific seismic design ground motion based on a Probabilistic Seismic Hazard Assessment (PSHA) for the Callaway Plant Unit 2 site and the site response analyses. The guidance of Regulatory Guide 1.208, "A performance -Based Approach to Define the Site-Specific Earthquake Ground Motion," (NRC, 2007a) was used to develop the Ground Motion Response Spectrum (GMRS) at the Callaway Plant Unit 2 site. The GMRS defines the design ground motions at top of the Graydon Chert Conglomerate at approximate elevation 812 ft msl (247.5 m).

Figure 9.2-8 through Figure 9.2-14 and Figure 3E.4-4 through Figure 3E.4-12 provide plan views and sections of the Seismic Category I Essential Service Water Emergency Makeup System (ESWEMS) Pumphouse and its associated Retaining Pond. The bottom of the ESWEMS pump well intake is situated at approximate Elevation 810 ft msl (246.9 m) above sea level based on National Geodetic Vertical Datum of 1929 (NGVD 29). Figure 3E.4-5 through Figure 3E.4-11 show the plans and sections of the ESWEMS Retaining Pond. The layout of the Seismic Category I buried electrical duct banks and Seismic Category I buried piping is outlined in Figure 3E.4-5.

The ESWEMS Pumphouse is designed as a Seismic Category I structure and is designed to remain functional following a postulated Safe Shutdown Earthquake (SSE). The SSE is defined in terms of the ground motion response spectra (GMRS) at top of the Chert at approximate elevation 812 ft (247.5 m) msl. Section 2.5.2 describes the development of the GMRS based on site geologic and seismic information. Section 3.7 presents the seismic input ground motion utilized in the seismic design of the ESWEMS components.

Soil liquefaction is not considered a risk factor. As discussed in Section 2.5.4.8, based on the screening techniques for evaluating liquefaction, there is no evidence of existence of potentially liquefiable soils at Callaway Plant Unit 2.}

Foundation Input Response Spectra (FIRS) at free-field surface Elevations of 840.0 ft msl (256 m), 835.0 ft msl (254.5 m), and 823.0 ft msl (250.9 m) have been developed as part of the seismic evaluation of the ESWEMS. The FIRS are associated with the SSE and were obtained from the site response analysis of the site specific soil column extending from hard rock to the grade elevation at the Nuclear Island.

With reference to Section 2.5.2.5, horizontal ground motion amplification factors are developed using site-specific data and estimates of near-surface soil and rock properties including the Category I structural fill overlying Chert. Based on Approach 2A of NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002), the amplification factors are used to scale the hard rock spectra and to develop Uniform Hazard Spectra accounting for site-specific conditions. Horizontal FIRS associated with the SSE are then developed utilizing the performance-based approach of ASCE/SEI 43-05 (ASCE 2005), as implemented in Regulatory Guide 1.208 (NRC, 2007a). As described in Section 2.5.2.6 the vertical FIRS associated with the SSE, are developed by scaling the horizontal SSE by a frequency-dependent vertical-to-horizontal (V:H) factor.

The seismic design input spectra for the initial Response Spectrum analysis of the ESWEMS Pumphouse is a broadened and smooth plot at 5% critical damping. These spectra have been used for the design of the safety-related components of the ESWEMS Pumphouse. The seismic soil structure interaction analysis using time history techniques utilizes the free-field soil surface FIRS to define the control motion.}

### 3.7.1.1.1 Design Ground Motion Response Spectra

{The U.S. EPR FSAR Section 3.7.1.1.1 is incorporated by reference with the following supplement.

A comparison of the Callaway Plant Unit 2 GMRS versus the CSDRS for five percent damping anchored at 0.30g is shown in [Figure 3.7-1](#) through [Figure 3.7-4](#). As shown, the CSDRS are exceeded by the Callaway Plant Unit 2 GMRS in both the horizontal (below about 0.4 Hz and above about 10 Hz) and vertical directions (below about 0.25 Hz and above about 14.5 Hz). This represents a departure from the U.S. EPR FSAR. This departure is justified consistent with the seismic reconciliation guidelines contained in the U.S. EPR FSAR Section 2.5.2.6, as described in Section 2.5.2.6 and Section 3.7.1.1.1.

Appendix S of 10 CFR Part 50 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 0.1g, which is the 0.1g EUR-based CSDRS. A comparison of the GMRS versus the 0.1g EUR-based CSDRS curves is shown in [Figure 3.7-76](#). The 0.1 EUR-based CSDRS exceeds the GMRS between about 2.2 Hz and 2.6 Hz by less than 3.3%. Therefore, the SSE for the Callaway site is defined as the envelope of the GMRS and the 0.1g EUR-based CSDRS in order to satisfy Appendix S of 10 CFR Part 50.

The design ground motion response spectra for Callaway Plant Unit 2 shall consider the envelope of the GMRS and the 0.1g EUR-based CSDRS (as a design motion in combination with the site-specific soil profiles), in addition to the CSDRS anchored at 0.3g PGA for the generic soil profiles defined in the U.S. EPR FSAR.

### Site-Specific ESWEMS

[Figure 3.7-77](#) presents the horizontal and vertical FIRS utilized in the seismic evaluation of the ESWEMS Pumphouse as discussed in section 3.7.2.1.2. In accordance with Regulatory Guide 1.208, these spectra are based on uniform hazard spectra at hard rock amplified by mean frequency dependent site amplification functions developed from site response analyses. The site response analyses consider randomized soil columns and strain dependent shear modulus and damping parameters. These FIRS represent the design ground motion at elevation 835.0 ft msl (254.5 m) and are obtained from the site response analysis of the soil column extending to the plant grade 845.0 ft msl (257.6 m).

The grade elevation at the Pumphouse is 4.5 ft (1.4 m) above the foundation elevation of 835.5 ft (254.7 m). The FIRS at 835.0 ft (254.5 m) is taken as the seismic input ground motion and is applied at the foundation level. However, the analytical model for the soil structure interaction analysis ignores the soil above the foundation level. It is noted that the ground motion including the soil above elevation 835.5 ft msl (254.7 m) used in the reported SSI analysis, is in excess of the FIRS at this elevation.

The horizontal and vertical design spectra at the soil surface exhibit peak ground acceleration of about 0.34g. The shapes of the spectra illustrate the averaged effects of site soil column frequencies. The peak spectral accelerations for the horizontal and vertical spectra are respectively, 1.16g and 0.83g.}

### 3.7.1.1.2 Design Ground Motion Time History

#### {Site-Specific ESWEMS

A set of three synthetic ground motion time histories, two horizontal and one vertical, has been developed for use in the ESWEMS Pumphouse seismic analysis. The procedure for generating the synthetic time histories is based on modifying the frequency content of selected seed time histories, which are consistent with the dominant seismic events contributing to the site seismic hazard. The response spectra of the resulting synthetic time histories match the input ground motion response spectra (also called Target FIRS) in accordance with Regulatory Guide 1.208.

Figure 3.7-78 through Figure 3.7-80 present the acceleration, velocity and displacement time histories in the horizontal and vertical directions. Figure 3.7-81 through Figure 3.7-83 present the comparison of the spectra computed from the time histories to the respective design spectra. As seen from these figures, the computed spectra are comparable to the Target FIRS. In the frequency range of interest the computed spectra are in the range of 0.9 to 1.3 times the Target spectra. The time histories have a total duration of 40 seconds and a characteristic duration (5% to 75% of Arias Intensity) of about 25 seconds.

A time history analysis is not performed for either the site-specific buried utilities or the Fire Protection piping.}

### 3.7.1.2 Percentage of Critical Damping Values

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

{In accordance with Regulatory Guide 1.61, the damping value for reinforced concrete structures for SSE level ground motion is 7% of the critical damping. However, the design analysis of the ESWEMS Pumphouse conservatively uses a damping of 5% of critical. The damping used for the foundation medium is discussed in Section 3.7.1.3.}

### 3.7.1.3 Supporting Media for Seismic Category I Structures

{The U.S. EPR FSAR Section 3.7.1.3 is incorporated by reference with the following supplemental information. The NI Common Basemat Structures supporting media shear wave velocity profiles for the seismic analysis is shown in Figure 3.7-84 through Figure 3.7-86. The variation in shear wave velocity is addressed in a site-specific soil-structure interaction analysis. The site-specific soil profile represents a departure from the U.S. EPR FSAR, as described in Section 3.7.1.1.1. Similarly, the supporting media for the EPGB and ESWB are a departure from the U.S. EPR FSAR.

#### Site-Specific ESWEMS

As described in Section 2.5.4, the subsurface at the ESWEMS Pumphouse consist of overburden soils underlain by the Graydon Chert Conglomerate. The overburden soils will be excavated and replaced by Category I structural fill prior to placing the pumphouse concrete.

As shown in Figure 3E.4-4, the ESWEMS Pumphouse is primarily supported on the Category I structural fill. The low-strain material damping values are reported in Table 2.5-55. Damping associated with radiation is implicit in the SASSI analysis. This fill extends from top of the Graydon Chert conglomerate near Elevation 810 ft msl (246.9 ft) to the bottom of Pumphouse foundation. The deeper pump well foundation is supported on the chert conglomerate. The existing soil boring data indicate that the top of the chert may be slightly higher than the top

pump well foundation. [Table 2.5-51](#), [Table 2.5-54](#) and [Table 2.5-55](#) present the static and dynamic design soil parameters of the various foundation materials.}

#### 3.7.1.4 References

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

**NRC, 1997.** Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion, Regulatory Guide 1.165, Revision 0, U.S. Nuclear Regulatory Commission, March 1997.

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

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

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

### 3.7.2 SEISMIC SYSTEM ANALYSIS

{The U.S. EPR FSAR Section 3.7.2 is incorporated by reference with the following supplemental information.

The site-specific SSI analysis of the EPGB utilized a new finite element model. This model is shown in [Figure 3.7-30](#).

The NI basemat response spectra and the response spectra at the footprints of the EPGB and ESWB basemats at the elevation of the NI basemat are provided in [Figure 3.7-87](#) through [Figure 3.7-92](#). The instructure response multi-damping spectra results for the site-specific soil-structure interaction analyses are presented in [Figure 3.7-67](#) through [Figure 3.7-75](#) and [Figure 3.7-111](#). The site-specific worst case maximum accelerations for the EPGB and ESWB are presented in [Table 3.7-6](#) and [Table 3.7-7](#) respectively. These NI basemat response spectra, response spectra at the EPGB and ESWB footprints, site-specific ISRS and maximum accelerations represent a departure from the U.S. EPR FSAR, as described in Section 3.7.1.1.1 and augment the response spectra and maximum accelerations in the U.S. EPR FSAR.}

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:

{Site-Specific ESWEMS

The site-specific Seismic category I structures associated with the ESWEMS include the following:

- ◆ Essential Service Water Emergency Makeup System (ESWEMS) Pumphouse

- ◆ ESWEMS Retaining Pond
- ◆ Buried Duct Banks and Pipes

Figure 3E.4-5 presents a site plan, which shows the location of the ESWEMS Pumphouse and the ESWEMS Retaining Pond relative to the Nuclear Island (NI). The ESWEMS Pumphouse and the Retaining Pond are located to the Plant east of Callaway Plant Unit 2, more than 650 feet (198 m) from the reactor centerline. Both the ESWEMS pond and pumphouse are part of the ESWEMS System, which provides makeup water to the Essential Service Water Cooling Tower basins as necessary to shutdown the plant during a design basis accident.}

### 3.7.2.1 Seismic Analysis Methods

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

#### 3.7.2.1.1 Time History Analysis Method

{The seismic analysis of the ESWEMS Pumphouse including soil structure interaction is performed in the frequency domain at selected analysis frequencies utilizing the program SASSI. This analysis uses the three ground motion time histories described in Section 3.7.1 above to represent the design basis seismic ground motion in the three orthogonal directions. The time histories represent the control motions at the free field soil surface of the soil-structure system.

The seismic analysis develops the following response quantities:

- ◆ The SSE structural response accelerations at discrete elevations for subsequent structural analysis and design.
- ◆ In-structure response spectra (ISRS) at the various slab elevations for equipment qualification (e.g., pumps).

Details of the analysis method is described in Section 3.7.2.4.

The seismic evaluation of the ESWEMS Retaining Pond is based on slope stability analyses of various sections of the sides of the Retaining Pond. The slope stability analyses include the effects of horizontal seismic acceleration on potential failure blocks. The slope stability analysis and the factors of safety are reported in Section 2.5.5.}

#### 3.7.2.1.2 Response Spectrum Method

{Section 3.7.2.1.1 describes the seismic analysis of records of the ESWEMS Pumphouse. The seismic design of the ESWEMS Pumphouse is based on the response spectrum analysis. Figure 3.7-95 and Figure 3.7-96 present the design response spectra at 5% damping utilized in the response spectrum analysis compared to the GMRS and the calculated FIRS. Figure 3.7-93 and Figure 3.7-94 indicate that the response spectra used in the seismic design evaluation, as summarized in Figure 3.7-95 and Figure 3.7-96, do not envelop the GMRS and the FIRS at all frequencies. However, the seismic forces and moments utilized in the design of the pumphouse structural components are conservative relative to those obtained on the basis of the seismic analysis of record described in section 3.7.2.2. This analysis implements frequency dependent soil-structure interaction parameters and uses time history analysis techniques.

The response spectrum analysis uses a 3-D FEM model of the ESWEMS Pumphouse developed in GT-STRUDL. The foundation medium is represented in the analysis model by lumped soil springs and damping coefficients. The building damping as well as the soil damping is simplified and conservatively assumed to be 5% of the critical damping. Given the shallow embedment of the main basemat at grade and a partial embedment of the pump well structure, the embedment effects are conservatively ignored.

The resulting modes, frequencies and participation factors are utilized to develop the modal response, mode combinations and directional combination of seismic response. The design seismic loads resulting from the response spectrum analysis are subsequently compared with the seismic loads based on the SASSI soil structure interaction analysis. Based on this comparison it is concluded that the dynamic response from the response spectrum method envelops the SASSI response.}

### 3.7.2.1.3 Complex Frequency Response Analysis Method

{The analysis of the ESWEMS Pumphouse does not use this method, because the structure is adequately analyzed by other methods.}

### 3.7.2.1.4 Equivalent Static Load Method of Analysis

{The analysis of the ESWEMS Pumphouse structure does not use this method, because the structure is adequately analyzed by other methods.}

### 3.7.2.2 {Nodal Accelerations} and Response Loads

{Table 3.7-8 shows a comparison for selected representative critical locations of the effective nodal acceleration based on the seismic loads implemented in the response spectrum method, with the maximum nodal accelerations resulting from the time history analysis method. The nodal locations are shown on Figure 3.7-97 and Figure 3.7-98. The results from the time history analysis method are given for the three set of soil properties: lower bound, best estimate and upper bound.

The seismic loads in the equivalent static analysis are calculated by applying accelerations determined from the soil structure interaction time history analysis to the applicable masses in the finite element model. A comparison of the nodal accelerations indicate that the response accelerations resulting from the SASSI analysis are enveloped by the effective accelerations used in the response spectrum method.}

### 3.7.2.3 Procedures Used for Analytical Modeling

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

#### 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

{The ESWEMS Pumphouse and Retaining Pond are Seismic Category I structures located outside the bounds of the Nuclear Island. The Pumphouse is a reinforced concrete shear wall structure supported by a reinforced concrete base mat. Section 3.8.4.1.11 provides a more detailed description of the ESWEMS Pumphouse, while the plan and elevation views shown on

Figure 9.2-8 through Figure 9.2-14 and Figure 3E.4-4 are utilized as basis for the development of the analytical finite element model of the pumphouse.

The earth facing wall of the pump well extending down approximately 30 feet (9.1 m) below the foundation mat is a 3 ft (914 mm) thick reinforced concrete wall (Refer to Figure 3E.4-4). The thickness of the pump well wall is determined in large part by non-seismic design requirements, i.e., the required overall weight to overcome buoyancy, soil static pressure, and surcharge from building weight. The pump well wall facing the pond is subjected to hydraulic pressure with the water column height resulting from the PMP. The common interior walls of the pump well structure are evaluated for full hydrostatic load assuming the adjacent well is dry during maintenance.

The finite element model of the ESWEMS Pumphouse is developed in GT STRUDL. It is utilized as basis for soil structure interaction time history analysis, as well as in the response spectrum analysis to facilitate structural design. This model represents the reinforced concrete base mat, floor slabs, and walls using plate elements, which capture both in-plane and out-of-plane effects from applied loads. The analysis model of the pumphouse is based on the un-cracked section properties for the shear walls.

Figure 3.7-99 presents the overall 3D structural model. The building components are modeled as shown in Figure 3E.4-1 and Figure 3E.4-2, except for four small piping trenches on the main basemat. The trench is designed as a suspended structure from bottom of the basemat. It is isolated from building settlement loads using compressible or foam type material around and underneath the trench. Figure 3E.4-3 illustrates the typical convention for force direction on a representative finite element in the GT STRUDL model.

### Analytical modeling for Response Spectrum Analysis

The model utilized in the response spectrum analysis represents the foundation soils using soil spring stiffness developed on the basis of a rigid foundation supported on a uniform elastic half-space. It conservatively ignores the effect of embedment, because only a small portion of the structure, mainly the pump well, is partially embedded. Moreover, the soil embedment is present only on the earth facing side of the pump well. Thus, in the response spectrum method of analysis, the pump well develops a potential to effect a different seismic response in the positive and negative directions toward the pond. The pump well foundation is supported at top of the chert and is represented by hinged supports at the shear keys and roller supports at the apron base to represent the worst case analysis.

- ◆ When the loadings act in the direction toward the pond, no soil translational springs are included. Assuming there is no water weight, which creates frictional resistance between the apron base and the cherty conglomerate, the supporting nodes below the apron were idealized as roller. The building surcharge also induces additional lateral soil pressure acting on the earth-facing pump well wall, and transfers to the shear keys. These conditions maximize the reactions against sliding at two shear keys below the pump well foundation. As determined, this loading direction controls stresses in the pump well walls and shear keys. It also maximizes bearing stresses on the pump well foundation and the apron base.
- ◆ As load reverses to direction away from the pond, water column is accounted for at the normal operating level during the SSE event for exerting hydrostatic pressure on the pump wall. Its dead weight will alleviate the building tendency to overturning. Nevertheless, this loading direction controls the building vertical settlement and bearing pressure on the backfill soil.

### Analytical modeling for SASSI Soil Structure Interaction Analysis

The soil subgrade within which the pumphouse is founded is generally represented in the SSI model with semi-infinite soil layers. The SSI model extends down to the Cotter/Jefferson City 1 formation at Elevation 668.65 ft. (203.8 m) a depth of about 167 feet (50.9 m) below the Pumphouse foundation. Within this depth the subgrade is represented by specific soil layers. This depth is underlain by an elastic half space. The water table is taken to be at El. 812 ft (247.5 m) near the foundation of the pump well.

The effective dynamic characteristics of the subgrade are represented by strain compatible shear and compression wave velocities, damping and poisson's ratio for the various soil layers. Consistent with the development of the FIRS, the SSI analysis considers three subgrade profiles represented by upper bound, best estimate and lower bound soil properties determined from the site response analysis described in Section 2.5.2. These soil properties account for the estimated seismic strains in the soil layers as well as the statistics of the strain compatible shear modulus and damping for the various soil layers. As shown in [Figure 3.7-100](#), the SSI analysis assumes that the low strain shear wave velocity of the backfill varies from about 600 ft/sec near grade to about 1,000 ft/sec at the interface of the backfill with in-situ chert. [Figure 3.7-101](#) presents the strain compatible soil properties for the lower bound, best estimate and the upper bound soil profiles.

Contained water mass is considered in accordance with ASCE 4-98 and Newmark and Rosenblueth (1971) is utilized to develop the effects of the hydrodynamic load due to water outside of the structure.

The SSI model is based on the 3-D representation of the pumphouse including the pump well, walls, floor slabs, structural steel framing and major penetrations and openings in the walls and slabs. For use in the SSI analysis the GT-STRUDL model is augmented with representation of the soil embedment, the excavated soil elements, the free-field soil profile and the effects of the water inside and outside the pump well. The embedded portion of the structural model was further refined to be compatible with a maximum soil layer thickness of about 2.0 feet (0.6 m) so that the effects of potential high frequency ground motion (up to about 50 Hz) are reflected in the seismic SSI response. However, the reported model represents a cut-off frequency of 25 Hz for the LB soil parameters, and 33 Hz for the UB soil parameters.

The wing walls are modeled as retaining walls with soil up to El. 835.5 ft (254.7 m) on one side and water on the other side. The hydrodynamic effects are represented as added masses at nodes of the pump well wall. Similarly, the hydrodynamic effects on the wing walls are represented as added nodal masses consistent with the constrained mass of water between the wing walls as well as the sloshing component. The wing walls and the apron slab are truncated to a distance of 24 ft (7.3 m) (on the X-axis) from the water wall of the pump well. The model is terminated at this distance by a vertical retaining wall (parallel to the y-z plane), rigidly connected to the apron slab but disconnected from the wing walls.

Because of the configuration of the pumphouse relative to the major coordinate axes, it was possible to take advantage of symmetry conditions and analyze the SSI model implementing symmetric and anti-symmetric boundary conditions. The axis of symmetry is oriented east west through the centerline of the Pumphouse.

Young's modulus and Poisson's ratio of the structural elements will be based on the recommendations of Section 3.1.2.1 of ASCE 4-98. The SSI model is calibrated by comparing the predominant frequencies resulting from SASSI to those calculated from the structural model.

The dynamic behavior of the structure is characterized on the basis of a fixed base modal analysis. The seismic mass includes the structure dead weight and major equipment loads.}

### 3.7.2.3.3 Seismic Category II Structures

{Callaway Plant Unit 2 utilizes a Seismic Classification of Seismic Category II-SSE. This designation is utilized to address Fire Protection structures, systems, and components (SSC) that are required 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).}

### 3.7.2.3.4 Conventional Seismic (CS) Structures

No departures or supplements.

### 3.7.2.4 Soil-Structure Interaction

{Site-specific structures addressed in this section include the ESWEMS Pumphouse and ESWEMS Retaining Pond.

The seismic soil structure interaction analysis of the ESWEMS Pumphouse is performed utilizing the program SASSI (Stevenson & Associates, 2006). SASSI evaluates the dynamic characteristics of the structure and of the supporting soil medium, and calculates the response of the soil-structure system subjected to an earthquake ground motion. The solution is obtained in the frequency domain, i.e. for each of the several specified frequencies of analysis. The solution of the equations of motion develops transfer functions relative to the control motion at the specified frequencies. The solution for the entire input ground motion time history is developed in the frequency domain by interpolating the solution at the specified frequencies.

SSI analyses are performed separately for three different directions of input motion, namely, north-south, east-west and vertical. Each set of analyses is further performed for the lower bound, best estimate and the upper bound soil properties. Thus a total of nine SSI analyses develop the seismic response of the Pumphouse structure. Similar response from the three directions of input motion is combined using square root of the sum of the square (SRSS) technique. The resulting response in each of the north south, east-west and the vertical directions is first enveloped and then smoothed to provide the final design response.

The soil structure interaction analysis results in accelerations at node locations of the structural model and the in-structure response spectra (ISRS) at selected locations in the structure. [Table 3.7-8](#) presents the accelerations in the North - South, East - West and Vertical directions at selected node locations. These nodal accelerations are applied in an equivalent static analysis to compute internal forces and moments in the structural components for design.

The global and local stress evaluation indicates that in general, the seismic stress levels for the structural components of the ESWEMS Pumphouse are relatively small. No major cracking of reinforced concrete components is expected.}

### 3.7.2.5 Development of Floor Response Spectra

{Site-specific structures addressed in this section include the ESWEMS Pumphouse. For the ESWEMS Pumphouse, the time history analysis provides seismic responses, including nodal accelerations, and ISRS.

In-structure floor response spectra are developed at several locations of the ESWEMS Pumphouse primarily at the first floor, mezzanine and the roof levels.

The ISRS are developed in each of the three orthogonal directions due to the seismic input in the north-south, east-west and vertical directions. The north-south response due to the north-south, east-west and the vertical inputs are combined using the SRSS method to result in the combined responses. The ISRS thus developed for the lower bound, best estimate and upper bound soil properties are first enveloped and then smoothed and broadened  $\pm 15\%$  in accordance with Regulatory Guide 1.122 (NRC, 1978) and Standard Review Plan Section 3.7. Figure 3.7-102 through Figure 3.7-110 present the resulting ISRS in the north south, east west and the vertical directions at selected locations of the ESWEMS Pumphouse.

The ISRS will be utilized for seismic equipment qualification and design of SSCs, such as piping, cable trays and commodity supports. ISRS are generated for 1, 2, 3, 5, 7, and 10 percent damping at various frequency intervals.}

### 3.7.2.6 Three Components of Earthquake Motion

{For the site-specific ESWEMS Pumphouse, three statistically independent time histories are considered in the seismic SSI analysis. The Response Spectrum (RRS) analysis is performed utilizing the GT-STRUDL finite element model. This analysis applies the inertial loads in the north-south, east-west and vertical directions and subsequently combines similar internal forces and moments using the "100-40-40" rule to calculate the overall seismic forces and moments for use in the design evaluation of structural components.}

### 3.7.2.7 Combination of Modal Responses

{Modal combination is not applicable for the time history analysis performed for the ESWEMS Pumphouse.

The conservative RRS method is used for the analysis and design of the ESWEMS Pumphouse. As such, all mass and modal combination is considered.}

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

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

A COL applicant that references the U.S. EPR design certification will provide the site-specific separation distances for the Access Building and Turbine Building.

[[The separation gaps between the AB and SBs 3 and 4 are 0.98 ft and 1.31 ft, respectively (see Figure 3B-1).]]

[[The separation between the TB and NI Common Base mat Structures is approximately 30 ft (see Figure 3B-1).]]

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

The conceptual design information identified above is incorporated by reference.

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

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

[[Fire Protection Storage Tanks and Buildings]]

[[The Fire Protection Storage Tanks and Buildings are classified as Conventional Seismic Structures.]]

[[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 43-05 using a limiting acceptance condition for the structure characterized as essentially elastic behavior with no damage (i.e., Limit State D) as specified in the Standard.]]

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

Refer to Section 3.2.1 and U.S. EPR FSAR Section 3.2.1 for the definition of seismic classifications used in this Section. {In addition, Section 3.2.1 categorizes Fire Protection SSC into two categories:

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

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

1. Fire Water Storage Tanks;
2. Fire Protection Building;
3. Diesel driven fire pumps and their associated sub systems and components, including the diesel fuel oil system;
4. Critical support systems for the Fire Protection Building;
5. The portions of the fire water piping system and components (including isolation valves) which supply water to the stand pipes in buildings that house the equipment required for safe shutdown of the plant following an SSE.

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

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

- ◆ Vent Stack

- ◆ Nuclear Auxiliary Building
- ◆ Access Building
- ◆ Turbine Building
- ◆ Radioactive Waste Processing Building
- ◆ Fire Water Storage Tanks and Fire Protection Building

The following Callaway Plant Unit 2 Seismic Category II, {Seismic Category II-SSE} and conventional seismic SSC identified in [Table 3.2-1](#) could also potentially interact with Seismic Category I SSC:

- ◆ Buried and aboveground Seismic Category II {and Seismic Category II-SSE Fire Protection SSC,} other than those addressed in the U.S. EPR FSAR.
- ◆ Conventional Seismic Switchgear Building
- ◆ {Conventional Seismic Switchyard Control Building.
- ◆ Conventional Seismic Natural Draft Cooling Towers

The buried Seismic Category II-SSE Fire Protection SSC identified in [Table 3.2-1](#) are seismically analyzed using the design response spectra identified in Section 3.7.1.1.1 for use in the analysis of the Seismic Category I site-specific buried utilities. The analysis of the buried Seismic Category II-SSE fire protection SSC shall confirm they remain functional during and following an SSE in accordance with NRC Regulatory Guide 1.189. Section 3.7.3.12 further defines the methodology for the analysis of buried Fire Protection piping. Seismic Category II-SSE buried piping is an embedded commodity that by its nature does not significantly interact with aboveground Seismic Category I SSC.

The above ground Seismic Category II and Seismic Category II-SSE Fire Protection SSC identified in [Table 3.2-1](#) are seismically analyzed utilizing the appropriate design response spectra. {The analysis of the above ground Seismic Category II-SSE fire protection SSC shall confirm they remain functional during and following an SSE in accordance with NRC Regulatory Guide 1.189 (NRC, 2007).}

The Conventional Seismic Switchgear Building, which is located adjacent to the conventional seismic Turbine Building, is analyzed using the same methodology as that employed for the Turbine Building.

{The Conventional Seismic Switchyard Control Building is located in the Switchyard area. As such, it is not located in the proximity of any Seismic Category I structures and, therefore, cannot interact with Seismic Category I structures.

The Callaway Plant Unit 2 Natural Draft Cooling Towers are located more than 600 ft (183 m) away from Seismic Category 1 structures and, therefore will not interact with any safety-related structures during a seismic event.}

### 3.7.2.9 Effects of Parameter Variations on Floor Response Spectra

{To account for uncertainties or variation in parameters, ISRS resulting from the time history analyses for the ESWEMS Pumphouse are broadened +/- 15% in accordance with ASCE 4-98 (ASCE, 1986) and Regulatory Guide 1.122 (NRC, 1978).}

### 3.7.2.10 Use of Constant Vertical Static Factors

No departures or supplements.

### 3.7.2.11 Method Used to Account for Torsional Effects

{For the ESWEMS Pumphouse, the conservatism in modeling the supporting boundary conditions with RRS analysis bounds the accidental torsion to be considered in accordance with ASCE 4-98 (ASCE, 1986).}

### 3.7.2.12 Comparison of Responses

{As multiple seismic analysis methods are not employed for the ESWEMS Pumphouse, 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

{Refer to Section 3.8.5 for specific details related to overturning, sliding, stability and bearing for the ESWEMS Pumphouse subjected to the extreme environment SSE and tornado events.}

### 3.7.2.15 Analysis Procedure for Damping

{The SSI analysis uses a structural damping of 5% and the low strain soil material damping as described in Section 3.7.1.3. These damping values are directly applied to the respective materials.

The response spectrum analysis utilized to develop conservative design seismic loads is based on an envelop response spectrum associated with a damping of 5%. Accordingly, all elements in the analytical model are assigned this damping value.}

### 3.7.2.16 References

**ASCE, 1986.** Seismic Analysis of Safety-Related Nuclear Structures and Commentary, ASCE Standard 4098, American Society of Civil Engineers, September 1986.

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

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

### **3.7.3 SEISMIC SUBSYSTEM ANALYSIS**

{The U.S. EPR FSAR Section 3.7.3 is incorporated by reference with the following supplemental information.}

#### **3.7.3.1 Seismic Analysis Methods**

No departures or supplements.

#### **3.7.3.2 Determination of Number of Earthquake Cycles**

No departures or supplements.

#### **3.7.3.3 Procedures Used for Analytical Modeling**

No departures or supplements.

#### **3.7.3.4 Basis for Selection of Frequencies**

No departures or supplements.

#### **3.7.3.5 Analysis Procedure for Damping**

No departures or supplements.

#### **3.7.3.6 Three Components of Earthquake Motion**

No departures or supplements.

#### **3.7.3.7 Combination of Modal Responses**

No departures or supplements.

#### **3.7.3.8 Interaction of Other Systems with Seismic Category I Systems**

No departures or supplements.

#### **3.7.3.9 Multiple-Supported Equipment and Components with Distinct Inputs**

No departures or supplements.

#### **3.7.3.10 Use of Equivalent Vertical Static Factors**

No departures or supplements.

#### **3.7.3.11 Torsional Effects of Eccentric Masses**

No departures or supplements.

#### **3.7.3.12 Buried Seismic Category I Piping, Conduits, and Tunnels**

{For Callaway Plant Unit 2, 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, 1986) and ACI

349-01(ACI, 2001), including supplemental guidance of Regulatory Guide 1.142 (NRC, 2001). The use of ACI 349-01, in lieu of ACI 349-97 (ACI, 1997) as invoked in Subsection 4.9.4.15 of IEEE 628-2001 (R2006), is to provide a consistent design basis with all other Seismic Category I structures. 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, 1986), including dynamic soil pressures.

Seismic Category I buried Essential Service Water Pipes and Seismic Category II and Seismic Category II-SSE buried Fire Protection pipe are analyzed for the effects of seismic waves traveling through the surrounding soil in accordance with the specific requirements of ASCE 4-98 (ASCE, 1986):

- ◆ 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, 1986). These equations reflect seismic wave propagation and incorporate the material's modulus of elasticity to determine the corresponding maximum axial and bending stresses. The procedure combines stresses from compression, shear and surface waves by the square root of the sum of the squares (SRSS) method. Maximum stresses for each wave type are then combined using the SRSS method. Subsequently, seismic stresses are combined with stresses from other loading conditions, e.g., long-term surcharge loading.

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

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

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

### 3.7.3.13 Methods for Seismic Analysis of Category I Concrete Dams

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

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

This COL Item is addressed as follows:

{No Seismic Category I dams will be utilized for the ESWEMS Retaining Pond at Callaway Plant Unit 2.}

### 3.7.3.14 Methods for Seismic Analysis of Aboveground Tanks

No departures or supplements.

### 3.7.3.15 References

{**ACI, 1997.** Code Requirements for Nuclear Safety-Related Concrete Structures, ACI 349-97, American Concrete Institute, 1997.

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

**ASCE, 1986.** Seismic Analysis of Safety-Related Nuclear Structures and Commentary, ASCE 4-98, American Society of Civil Engineers, September 1986.

**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:

{Callaway Plant Unit 2 is a single unit, U.S. EPR facility. Annunciation of the seismic instrumentation for Callaway Plant Unit 2 is provided in the Callaway Plant Unit 2 main control room.}

#### 3.7.4.2.1 Field Mounted Sensors

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

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

This COL Item is addressed as follows:

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

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

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

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

#### **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 or 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.

#### 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—{Best Estimate Soil (Callaway Plant Unit 2 Strain Compatible Profile)}**

**Minimum P-Wave Velocity of Submerged Layer (4800 fps) 1463 m/s**  
**Average water table depth** **Top of layer 1**

Layer No.	Layer Thk. (m)	Wt. Density (kN/m <sup>3</sup> )	S-Wave Vel. (m/s)	P-Wave Vel. (m/s)	S-Damp Ratio	P-Damp Ratio	Poisson's Ratio	Freq Pass (Hz)	Depth (m)
1	0.61	22.31	717	2190	0.0351	0.0117	0.44	235	0.0
2	0.61	22.31	716	2186	0.0358	0.0119	0.44	235	-0.6
3	0.61	22.31	714	2181	0.0370	0.0123	0.44	234	-1.2
4	0.61	22.31	712	2174	0.0382	0.0127	0.44	233	-1.8
5	0.61	22.31	710	2168	0.0393	0.0131	0.44	233	-2.4
6	0.61	22.31	707	2161	0.0405	0.0135	0.44	232	-3.0
7	0.61	22.31	705	2154	0.0417	0.0139	0.44	231	-3.7
8	0.61	22.31	703	2147	0.0429	0.0143	0.44	231	-4.3
9	0.61	22.31	700	2139	0.0441	0.0147	0.44	230	-4.9
10	0.58	22.31	682	2082	0.0457	0.0152	0.44	234	-5.5
11	0.58	22.31	679	2075	0.0467	0.0156	0.44	233	-6.1
12	0.58	22.31	677	2069	0.0477	0.0159	0.44	232	-6.7
13	0.58	22.31	675	2063	0.0486	0.0162	0.44	231	-7.2
14	0.58	22.31	673	2057	0.0494	0.0165	0.44	231	-7.8
15	0.58	22.31	672	2052	0.0501	0.0167	0.44	230	-8.4
16	0.58	22.31	670	2047	0.0508	0.0169	0.44	230	-9.0
17	1.02	25.13	1268	2987	0.0040	0.0013	0.39	248	-9.6
18	1.02	25.13	1268	2987	0.0040	0.0013	0.39	248	-10.6
19	1.58	25.29	1831	3811	0.0050	0.0017	0.35	231	-11.6
20	1.58	25.29	1831	3811	0.0050	0.0017	0.35	231	-13.2
21	1.51	25.29	1091	2939	0.0050	0.0017	0.42	144	-14.8
22	1.51	25.29	1091	2939	0.0050	0.0017	0.42	144	-16.3
23	1.51	25.29	1091	2939	0.0050	0.0017	0.42	144	-17.8
24	1.51	25.29	1091	2939	0.0050	0.0017	0.42	144	-19.3
25	2.16	26.23	2468	5433	0.0020	0.0007	0.37	228	-20.8
26	2.16	26.23	2468	5433	0.0020	0.0007	0.37	228	-23.0
27	3.05	26.23	2523	5555	0.0020	0.0007	0.37	166	-25.2
28	2.07	26.23	2538	5587	0.0020	0.0007	0.37	245	-28.2
29	2.07	26.23	2538	5587	0.0020	0.0007	0.37	245	-30.3
30	2.50	24.66	2166	4300	0.0140	0.0047	0.33	174	-32.3
31	2.50	24.66	2166	4300	0.0140	0.0047	0.33	174	-34.8
32	2.50	24.66	2166	4300	0.0140	0.0047	0.33	174	-37.3
33	2.50	24.66	2166	4300	0.0140	0.0047	0.33	174	-39.8
34	3.61	24.66	2568	4510	0.0140	0.0047	0.26	142	-42.3
35	3.61	24.66	2568	4510	0.0140	0.0047	0.26	142	-45.9
36	2.93	24.66	2560	4495	0.0140	0.0047	0.26	175	-49.5
37	2.93	24.66	2560	4495	0.0140	0.0047	0.26	175	-52.5
38	2.93	24.66	2560	4495	0.0140	0.0047	0.26	175	-55.4
39	2.93	24.66	2560	4495	0.0140	0.0047	0.26	175	-58.3
40	2.93	24.66	2560	4495	0.0140	0.0047	0.26	175	-61.2
41	2.64	24.66	2550	4478	0.0140	0.0047	0.26	193	-64.2
42	2.64	24.66	2550	4478	0.0140	0.0047	0.26	193	-66.8
43	2.64	24.66	2550	4478	0.0140	0.0047	0.26	193	-69.5
44	2.13	24.66	2557	4489	0.0140	0.0047	0.26	240	-72.1
45	2.13	24.66	2557	4489	0.0140	0.0047	0.26	240	-74.2
46	3.66	24.66	2556	4488	0.0140	0.0047	0.26	140	-76.4
47	3.66	24.66	2556	4488	0.0140	0.0047	0.26	140	-80.0
48	3.66	24.66	2556	4488	0.0140	0.0047	0.26	140	-83.7
49	3.28	24.66	2540	4459	0.0140	0.0047	0.26	155	-87.3
50	3.28	24.66	2540	4459	0.0140	0.0047	0.26	155	-90.6
Halfspace		24.66	2540	4459	0.0140	0.0047	0.26		-93.9

**Table 3.7-2—{Lower Bound Soil (Callaway Plant Unit 2 Strain-Compatible Profile)}**

**Minimum P-Wave Velocity of Submerged Layer (4800 fps) 1463 m/s**  
**Average water table depth** **Top of layer 1**

Layer No.	Layer Thk. (m)	Wt. Density (kN/m <sup>3</sup> )	S-Wave Vel. (m/s)	P-Wave Vel. (m/s)	S-Damp Ratio	P-Damp Ratio	Poisson's Ratio	Freq Pass (Hz)	Depth (m)
1	0.61	22.31	585	1788	0.0451	0.0150	0.44	192	0.0
2	0.61	22.31	584	1785	0.0460	0.0153	0.44	192	-0.6
3	0.61	22.31	583	1780	0.0475	0.0158	0.44	191	-1.2
4	0.61	22.31	581	1775	0.0490	0.0163	0.44	191	-1.8
5	0.61	22.31	579	1770	0.0506	0.0169	0.44	190	-2.4
6	0.61	22.31	578	1765	0.0522	0.0174	0.44	189	-3.0
7	0.61	22.31	576	1759	0.0539	0.0180	0.44	189	-3.7
8	0.61	22.31	574	1753	0.0556	0.0185	0.44	188	-4.3
9	0.61	22.31	572	1747	0.0572	0.0191	0.44	188	-4.9
10	0.58	22.31	556	1700	0.0591	0.0197	0.44	191	-5.5
11	0.58	22.31	555	1694	0.0604	0.0201	0.44	190	-6.1
12	0.58	22.31	553	1689	0.0616	0.0205	0.44	190	-6.7
13	0.58	22.31	551	1684	0.0627	0.0209	0.44	189	-7.2
14	0.58	22.31	550	1680	0.0637	0.0212	0.44	188	-7.8
15	0.58	22.31	548	1675	0.0646	0.0215	0.44	188	-8.4
16	0.58	22.31	547	1671	0.0655	0.0218	0.44	188	-9.0
17	1.02	25.13	912	2147	0.0040	0.0013	0.39	179	-9.6
18	1.02	25.13	912	2147	0.0040	0.0013	0.39	179	-10.6
19	1.58	25.29	1495	3112	0.0050	0.0017	0.35	189	-11.6
20	1.58	25.29	1495	3112	0.0050	0.0017	0.35	189	-13.2
21	1.51	25.29	891	2399	0.0050	0.0017	0.42	118	-14.8
22	1.51	25.29	891	2399	0.0050	0.0017	0.42	118	-16.3
23	1.51	25.29	891	2399	0.0050	0.0017	0.42	118	-17.8
24	1.51	25.29	891	2399	0.0050	0.0017	0.42	118	-19.3
25	2.16	26.23	2015	4436	0.0020	0.0007	0.37	187	-20.8
26	2.16	26.23	2015	4436	0.0020	0.0007	0.37	187	-23.0
27	3.05	26.23	2060	4536	0.0020	0.0007	0.37	135	-25.2
28	2.07	26.23	2072	4562	0.0020	0.0007	0.37	200	-28.2
29	2.07	26.23	2072	4562	0.0020	0.0007	0.37	200	-30.3
30	2.50	24.66	1768	3511	0.0140	0.0047	0.33	142	-32.3
31	2.50	24.66	1768	3511	0.0140	0.0047	0.33	142	-34.8
32	2.50	24.66	1768	3511	0.0140	0.0047	0.33	142	-37.3
33	2.50	24.66	1768	3511	0.0140	0.0047	0.33	142	-39.8
34	3.61	24.66	2097	3682	0.0140	0.0047	0.26	116	-42.3
35	3.61	24.66	2097	3682	0.0140	0.0047	0.26	116	-45.9
36	2.93	24.66	2090	3670	0.0140	0.0047	0.26	143	-49.5
37	2.93	24.66	2090	3670	0.0140	0.0047	0.26	143	-52.5
38	2.93	24.66	2090	3670	0.0140	0.0047	0.26	143	-55.4
39	2.93	24.66	2090	3670	0.0140	0.0047	0.26	143	-58.3
40	2.93	24.66	2090	3670	0.0140	0.0047	0.26	143	-61.2
41	2.64	24.66	2082	3656	0.0140	0.0047	0.26	158	-64.2
42	2.64	24.66	2082	3656	0.0140	0.0047	0.26	158	-66.8
43	2.64	24.66	2082	3656	0.0140	0.0047	0.26	158	-69.5
44	2.13	24.66	2087	3665	0.0140	0.0047	0.26	196	-72.1
45	2.13	24.66	2087	3665	0.0140	0.0047	0.26	196	-74.2
46	3.66	24.66	2087	3664	0.0140	0.0047	0.26	114	-76.4
47	3.66	24.66	2087	3664	0.0140	0.0047	0.26	114	-80.0
48	3.66	24.66	2087	3664	0.0140	0.0047	0.26	114	-83.7
49	3.28	24.66	2074	3641	0.0140	0.0047	0.26	127	-87.3
50	3.28	24.66	2074	3641	0.0140	0.0047	0.26	127	-90.6
Halfspace		24.66	2074	3641	0.0140	0.0047	0.26		-93.9

**Table 3.7-3—{Upper Bound Soil (Callaway Plant Unit 2 Strain-Compatible Profile)}**

**Minimum P-Wave Velocity of Submerged Layer (4800 fps) 1463 m/s**  
**Average water table depth** **Top of layer 1**

Layer No.	Layer Thk. (m)	Wt. Density (kN/m <sup>3</sup> )	S-Wave Vel. (m/s)	P-Wave Vel. (m/s)	S-Damp Ratio	P-Damp Ratio	Poisson's Ratio	Freq Pass (Hz)	Depth (m)
1	0.61	22.31	878	2682	0.0251	0.0084	0.44	288	0.0
2	0.61	22.31	876	2678	0.0257	0.0086	0.44	288	-0.6
3	0.61	22.31	874	2671	0.0265	0.0088	0.44	287	-1.2
4	0.61	22.31	872	2663	0.0273	0.0091	0.44	286	-1.8
5	0.61	22.31	869	2655	0.0281	0.0094	0.44	285	-2.4
6	0.61	22.31	866	2647	0.0288	0.0096	0.44	284	-3.0
7	0.61	22.31	864	2638	0.0295	0.0098	0.44	283	-3.7
8	0.61	22.31	861	2629	0.0303	0.0101	0.44	282	-4.3
9	0.61	22.31	858	2620	0.0310	0.0103	0.44	281	-4.9
10	0.58	22.31	835	2550	0.0323	0.0108	0.44	286	-5.5
11	0.58	22.31	832	2541	0.0331	0.0110	0.44	285	-6.1
12	0.58	22.31	829	2534	0.0338	0.0113	0.44	284	-6.7
13	0.58	22.31	827	2526	0.0345	0.0115	0.44	283	-7.2
14	0.58	22.31	825	2519	0.0351	0.0117	0.44	283	-7.8
15	0.58	22.31	823	2513	0.0356	0.0119	0.44	282	-8.4
16	0.58	22.31	821	2507	0.0360	0.0120	0.44	281	-9.0
17	1.02	25.13	1554	3658	0.0040	0.0013	0.39	304	-9.6
18	1.02	25.13	1554	3658	0.0040	0.0013	0.39	304	-10.6
19	1.58	25.29	2242	4668	0.0050	0.0017	0.35	283	-11.6
20	1.58	25.29	2242	4668	0.0050	0.0017	0.35	283	-13.2
21	1.51	25.29	1337	3599	0.0050	0.0017	0.42	177	-14.8
22	1.51	25.29	1337	3599	0.0050	0.0017	0.42	177	-16.3
23	1.51	25.29	1337	3599	0.0050	0.0017	0.42	177	-17.8
24	1.51	25.29	1337	3599	0.0050	0.0017	0.42	177	-19.3
25	2.16	26.23	3023	6654	0.0020	0.0007	0.37	280	-20.8
26	2.16	26.23	3023	6654	0.0020	0.0007	0.37	280	-23.0
27	3.05	26.23	3091	6804	0.0020	0.0007	0.37	203	-25.2
28	2.07	26.23	3108	6842	0.0020	0.0007	0.37	300	-28.2
29	2.07	26.23	3108	6842	0.0020	0.0007	0.37	300	-30.3
30	2.50	24.66	2652	5266	0.0140	0.0047	0.33	213	-32.3
31	2.50	24.66	2652	5266	0.0140	0.0047	0.33	213	-34.8
32	2.50	24.66	2652	5266	0.0140	0.0047	0.33	213	-37.3
33	2.50	24.66	2652	5266	0.0140	0.0047	0.33	213	-39.8
34	3.61	24.66	3145	5523	0.0140	0.0047	0.26	174	-42.3
35	3.61	24.66	3145	5523	0.0140	0.0047	0.26	174	-45.9
36	2.93	24.66	3135	5506	0.0140	0.0047	0.26	214	-49.5
37	2.93	24.66	3135	5506	0.0140	0.0047	0.26	214	-52.5
38	2.93	24.66	3135	5506	0.0140	0.0047	0.26	214	-55.4
39	2.93	24.66	3135	5506	0.0140	0.0047	0.26	214	-58.3
40	2.93	24.66	3135	5506	0.0140	0.0047	0.26	214	-61.2
41	2.64	24.66	3123	5485	0.0140	0.0047	0.26	236	-64.2
42	2.64	24.66	3123	5485	0.0140	0.0047	0.26	236	-66.8
43	2.64	24.66	3123	5485	0.0140	0.0047	0.26	236	-69.5
44	2.13	24.66	3131	5498	0.0140	0.0047	0.26	294	-72.1
45	2.13	24.66	3131	5498	0.0140	0.0047	0.26	294	-74.2
46	3.66	24.66	3130	5496	0.0140	0.0047	0.26	171	-76.4
47	3.66	24.66	3130	5496	0.0140	0.0047	0.26	171	-80.0
48	3.66	24.66	3130	5496	0.0140	0.0047	0.26	171	-83.7
49	3.28	24.66	3110	5462	0.0140	0.0047	0.26	190	-87.3
50	3.28	24.66	3110	5462	0.0140	0.0047	0.26	190	-90.6
Halfspace		24.66	3110	5462	0.0140	0.0047	0.26		-93.9

**Table 3.7-4—{Comparison of Worst Case Maximum Accelerations in EPGB}**

	Callaway Plant Unit 2 EPGB - ENVELOP RESULTS			U.S. EPR FSAR EPGB RESULTS		
	1+0.4+0.4 X-Acceleration (g)	1+0.4+0.4 Y-Acceleration (g)	1+0.4+0.4 Z-Acceleration (g)	X-Acceleration (g)	Y-Acceleration (g)	Z-Acceleration (g)
Slab at EL 68.0'	1.41 <sup>(1)</sup>	1.22	0.77	1.15	1.364	1.116
Slab at EL 51.5'	1.23 <sup>(1)</sup>	1.14	0.78	1.01	1.089	0.977
Slab at EL 19.25'	0.84 <sup>(1)</sup>	0.87 <sup>(1)</sup>	0.6	0.645	0.756	0.646
Slab at EL 0.0'	0.69 <sup>(1)</sup>	0.73 <sup>(1)</sup>	0.61	0.499	0.523	0.633

Notes:

- (1) Exceeds U.S. EPR FSAR values by more than 10%.

**Table 3.7-5—{Comparison of Worst Case Maximum Accelerations in ESWB}**

	Callaway Plant Unit 2 ESWB -ENVELOP RESULTS			U.S. EPR FSAR ESWB RESULTS		
	1+0.4+0.4 X-Acceleration (g)	1+0.4+0.4 Y-Acceleration (g)	1+0.4+0.4 Z-Acceleration (g)	X-Acceleration (g)	Y-Acceleration (g)	Z-Acceleration (g)
Slab at EL 114.0'	0.88	1.19 <sup>(1)</sup>	1.01	0.957	1.018	1.481
Slab at EL 80.75'	0.78	0.92 <sup>(1)</sup>	1.2	0.79	0.754	1.218
Slab at EL 61.83'	0.62	1.03	0.47	0.584	1.087	0.738
Slab at EL 33.0'	0.55	0.56	0.42	0.586	0.561	0.617
Slab at EL 0.0'	0.44	0.33	0.36	0.447	0.372	0.568

Notes:

- (1) Exceeds U.S. EPR FSAR values by more than 10%.

**Table 3.7-6—{Comparison of Worst Case Maximum Accelerations in EPGB}**

	Callaway Plant Unit 2 EPGB -ENVELOP RESULTS		
	1+0.4+0.4 X-Acceleration (g)	1+0.4+0.4 Y-Acceleration (g)	1+0.4+0.4 Z-Acceleration (g)
Slab at EL 68.0'	1.41	1.22	0.77
Slab at EL 51.5'	1.23	1.14	0.78
Slab at EL 19.25'	0.84	0.87	0.6
Slab at EL 0.0'	0.69	0.73	0.61

**Table 3.7-7—{Comparison of Worst Case Maximum Accelerations in ESWB}**

	Callaway Plant Unit 2 ESWB - ENVELOP RESULTS		
	1+0.4+0.4 X-Acceleration (g)	1+0.4+0.4 Y-Acceleration (g)	1+0.4+0.4 Z-Acceleration (g)
Slab at EL 114.0'	0.88	1.19	1.01
Slab at EL 80.75'	0.78	0.92	1.2
Slab at EL 61.83'	0.62	1.03	0.47
Slab at EL 33.0'	0.55	0.56	0.42
Slab at EL 0.0'	0.44	0.33	0.36

**Table 3.7-8—{Comparison of SRSS Combined Maximum Nodal Accelerations between the Response Spectra Analysis (GT-Strudl) and the Time History Analysis (SASSI)}**

Joint No	Response Direction	Response Spectra Analysis Amax (g)	Time History Analysis		
			Soil Parameters		
			LB Amax (g)	BE Amax (g)	UB Amax (g)
'B26'	E-W	1.594	0.253	0.228	0.274
'TW200'	E-W	1.530	0.263	0.250	0.305
'S180'	E-W	1.432	0.261	0.249	0.309
'S13'	E-W	1.068	0.213	0.174	0.193
'S81'	E-W	1.229	0.239	0.215	0.274
'B26'	N-S	1.025	0.259	0.264	0.303
'TW200'	N-S	1.144	0.313	0.297	0.349
'S180'	N-S	1.019	0.208	0.184	0.173
'S13'	N-S	0.484	0.160	0.144	0.150
'S81'	N-S	0.842	0.228	0.216	0.245
'B26'	Vertical	2.178	0.172	0.187	0.213
'TW200'	Vertical	2.580	0.312	0.378	0.423
'S180'	Vertical	0.542	0.215	0.203	0.217
'S13'	Vertical	0.462	0.169	0.180	0.203
'S81'	Vertical	0.904	0.187	0.187	0.209

Figure 3.7-1—{Comparison of EPR (Standard Plant) and Callaway Plant Unit 2 Ground Design Spectra Horizontal Direction, 5% Damping}

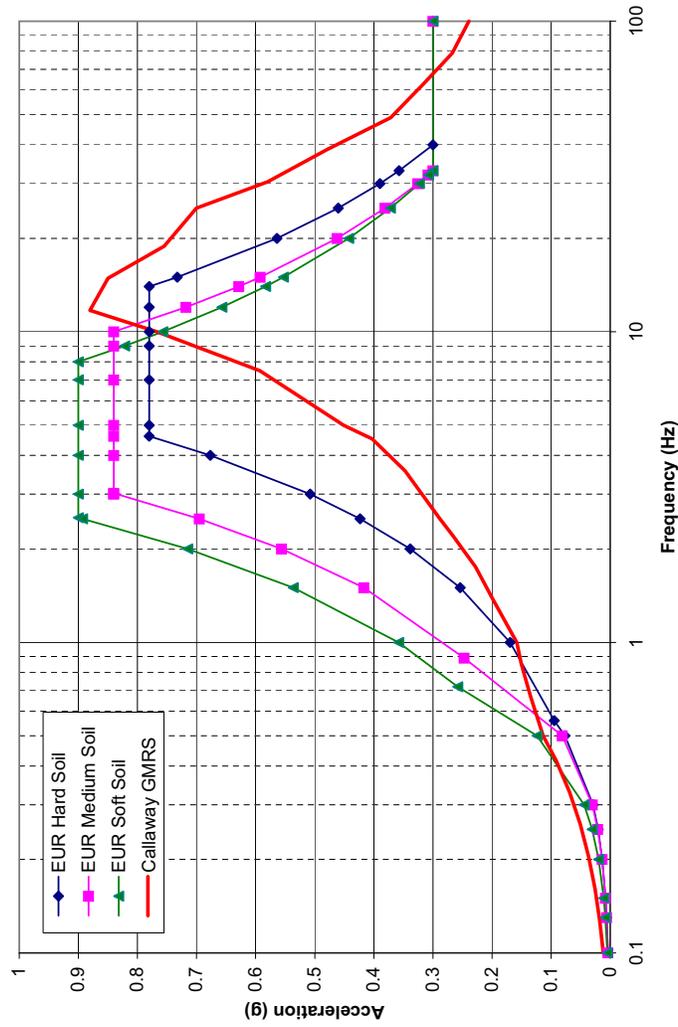


Figure 3.7-2—{Comparison of EPR (Standard Plant) and Callaway Plant Unit 2 Ground Design Spectra Vertical Direction, 5% Damping}

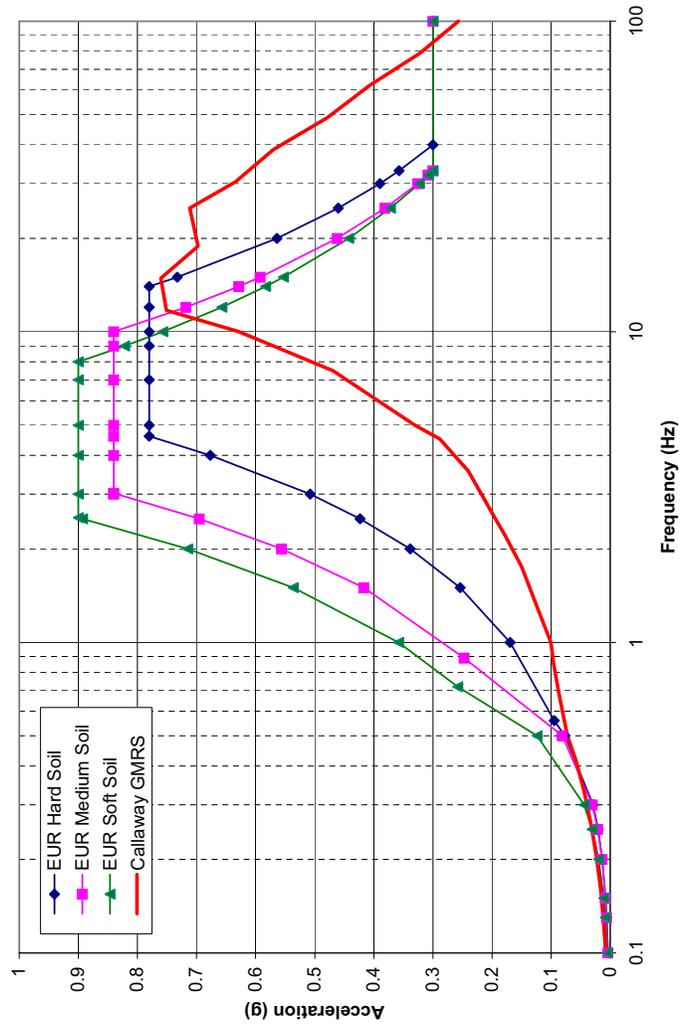


Figure 3.7-3—{Comparison of EPR (Standard Plant) and Callaway Plant Unit 2 Ground Design Spectra Horizontal Direction, Low Frequencies, 5% Damping}

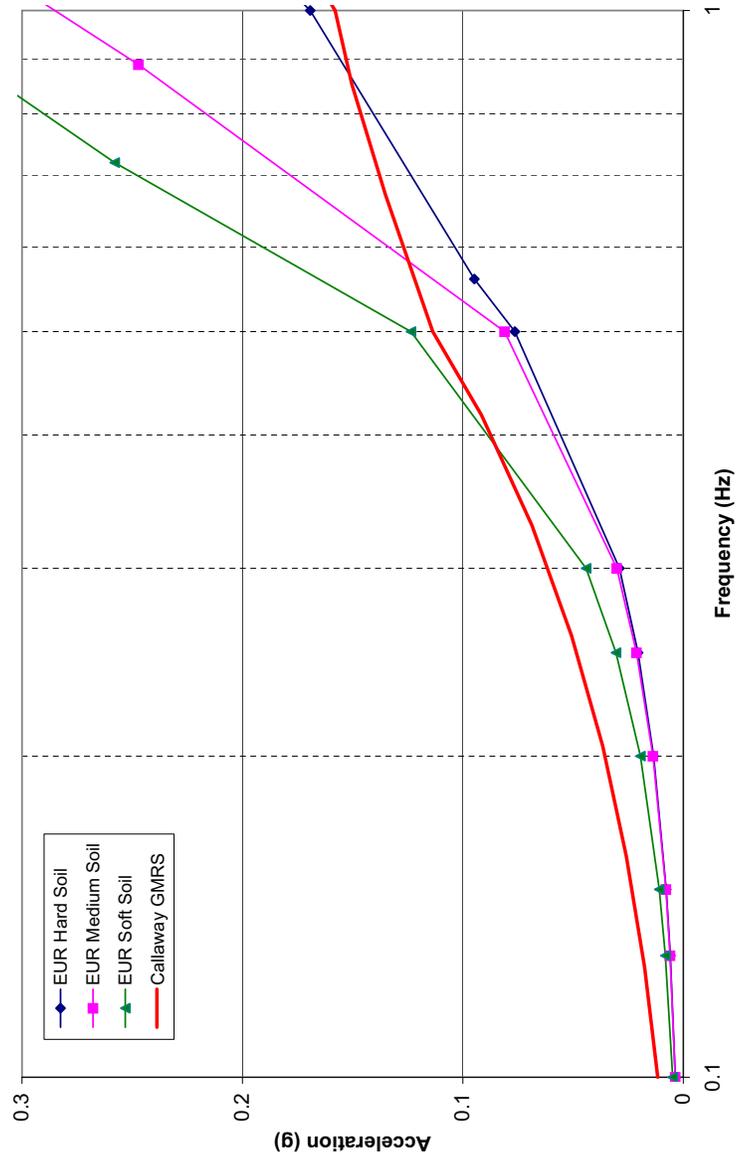


Figure 3.7-4—{Comparison of EPR (Standard Plant) and Callaway Plant Unit 2 Ground Design Spectra Vertical Direction, Low Frequencies, 5% Damping}

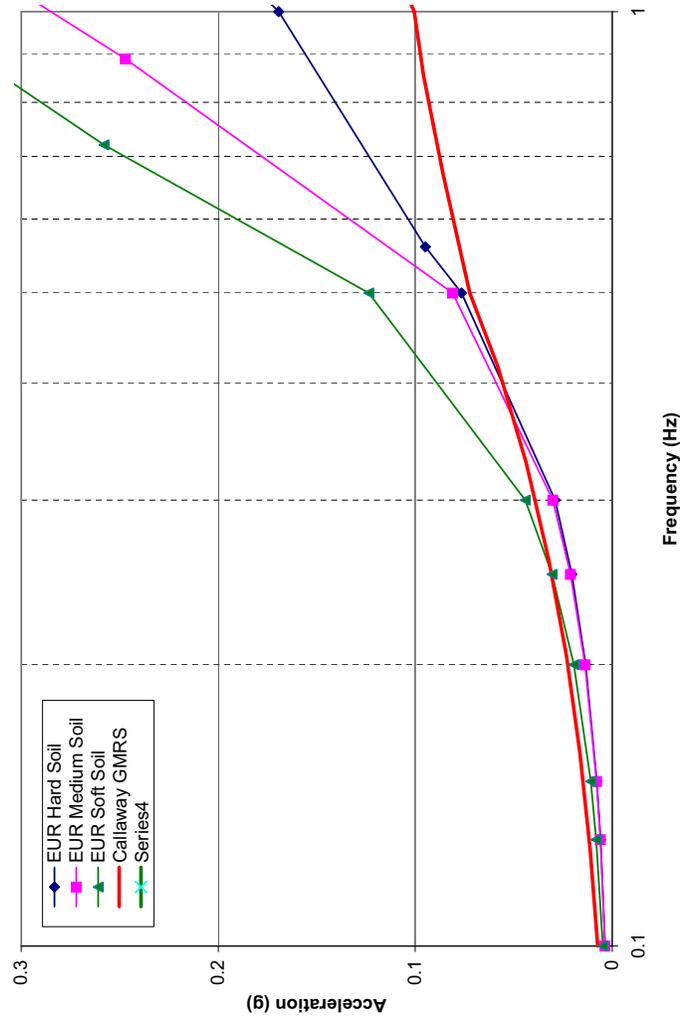


Figure 3.7-5—{Comparison of EPGB FIRS (Callaway Plant Unit 2) and CSDRS Horizontal Direction, 5% Damping}

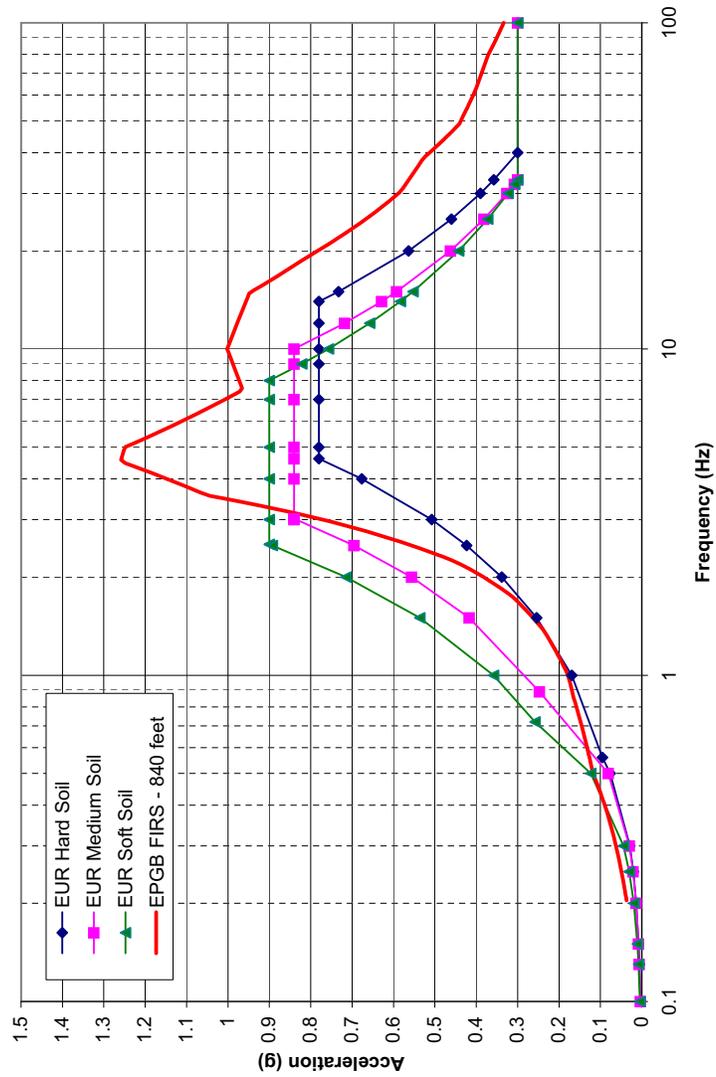


Figure 3.7-6—{Comparison of EPGB FIRS (Callaway Plant Unit 2) and CSDRS Vertical Direction, 5% Damping}

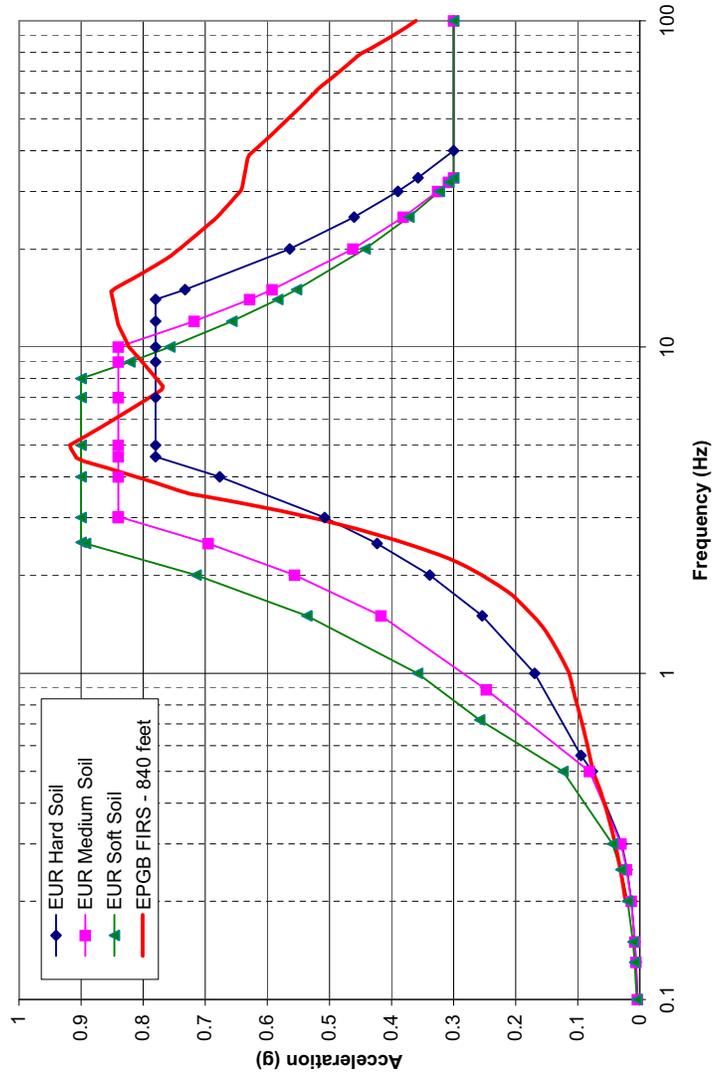


Figure 3.7-7—{Comparison of ESWB FIRS (Callaway Plant Unit 2) and CSDRS Horizontal Direction, 5% Damping}

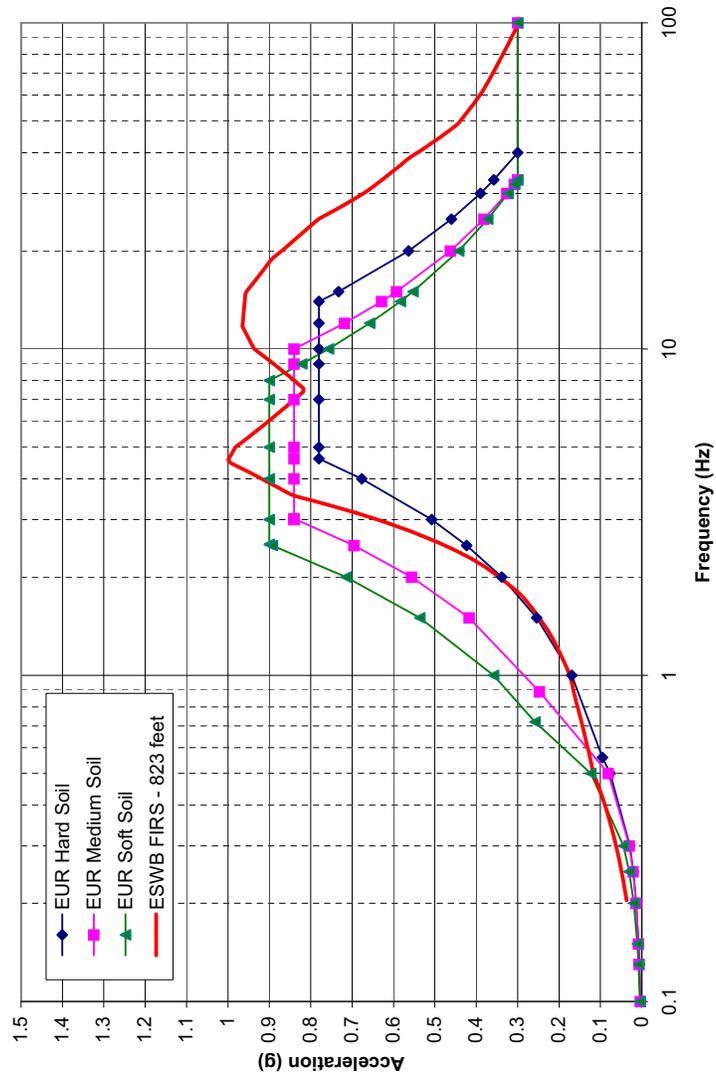
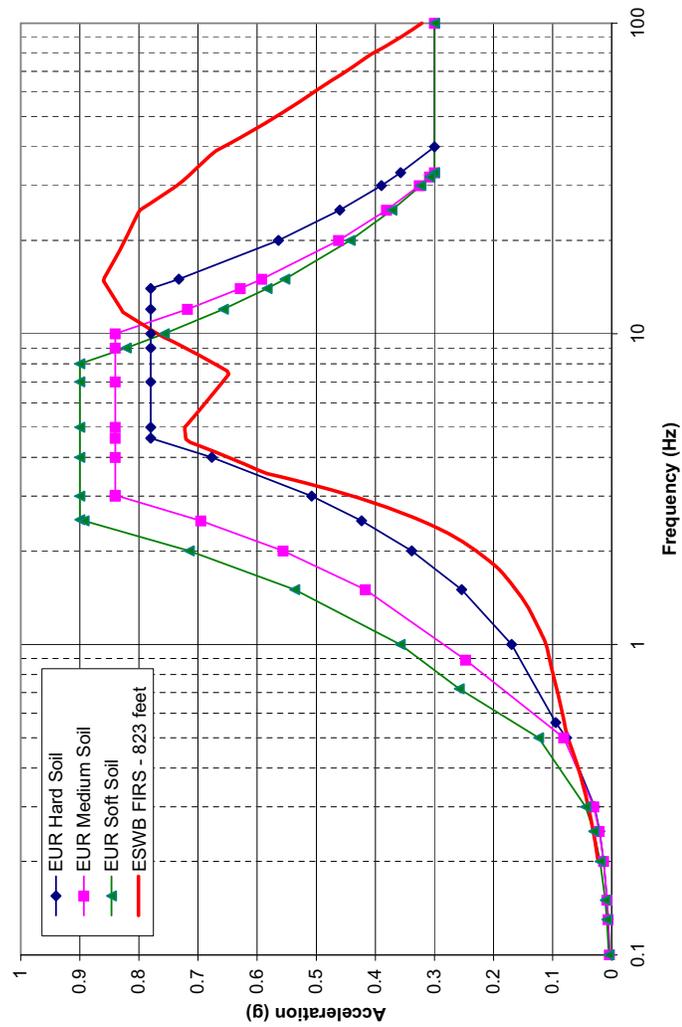
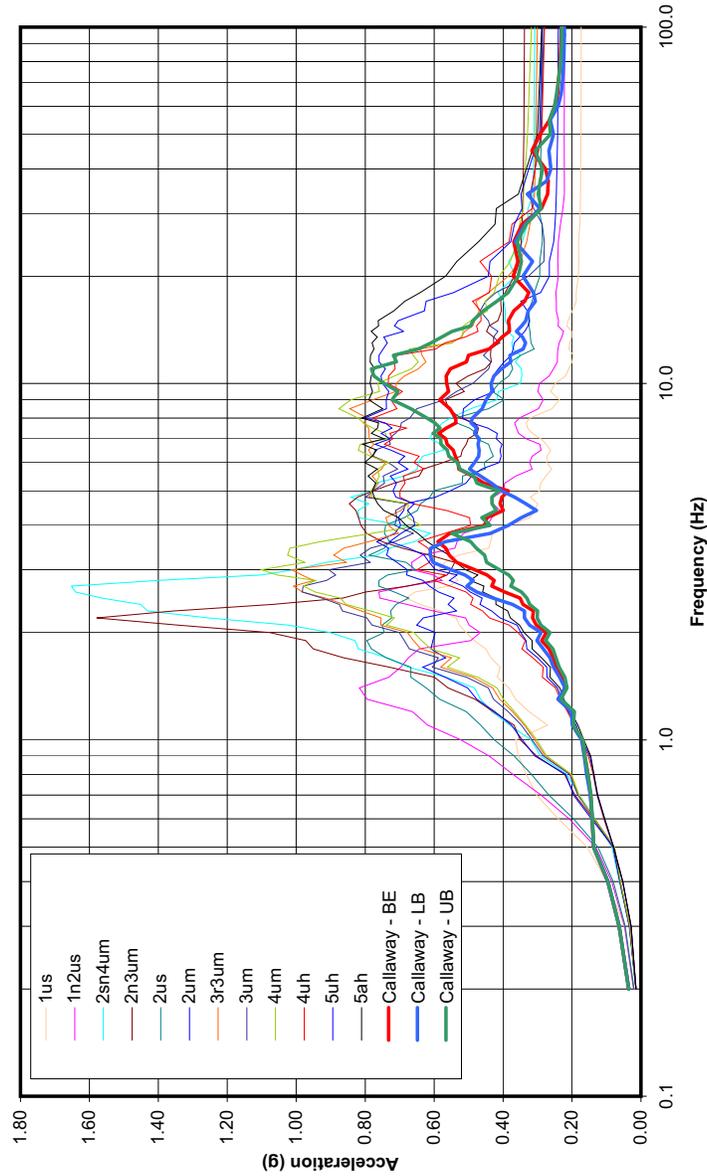


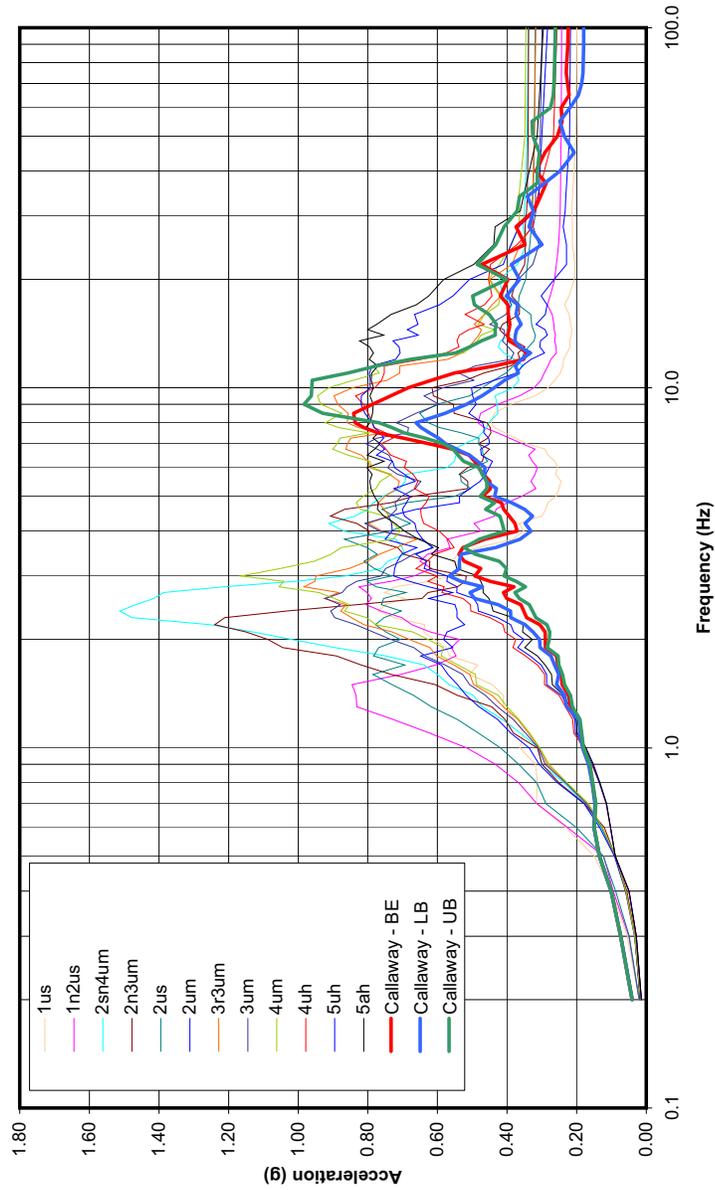
Figure 3.7-8—{Comparison of ESWB FIRS (Callaway Plant Unit 2) and CSDRS Vertical Direction, 5% Damping}



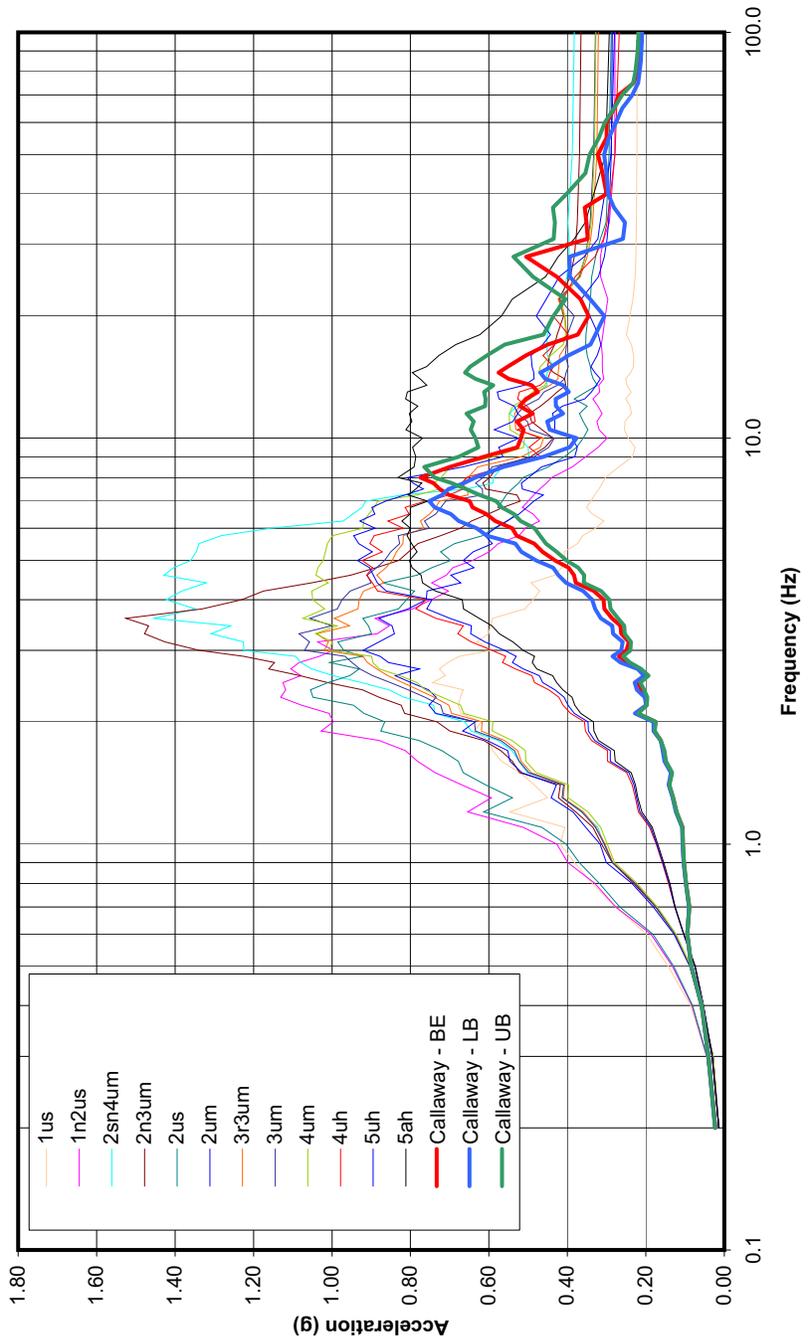
**Figure 3.7-9—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of NI Basemat, X(E-W) Direction, 5% Damping}**



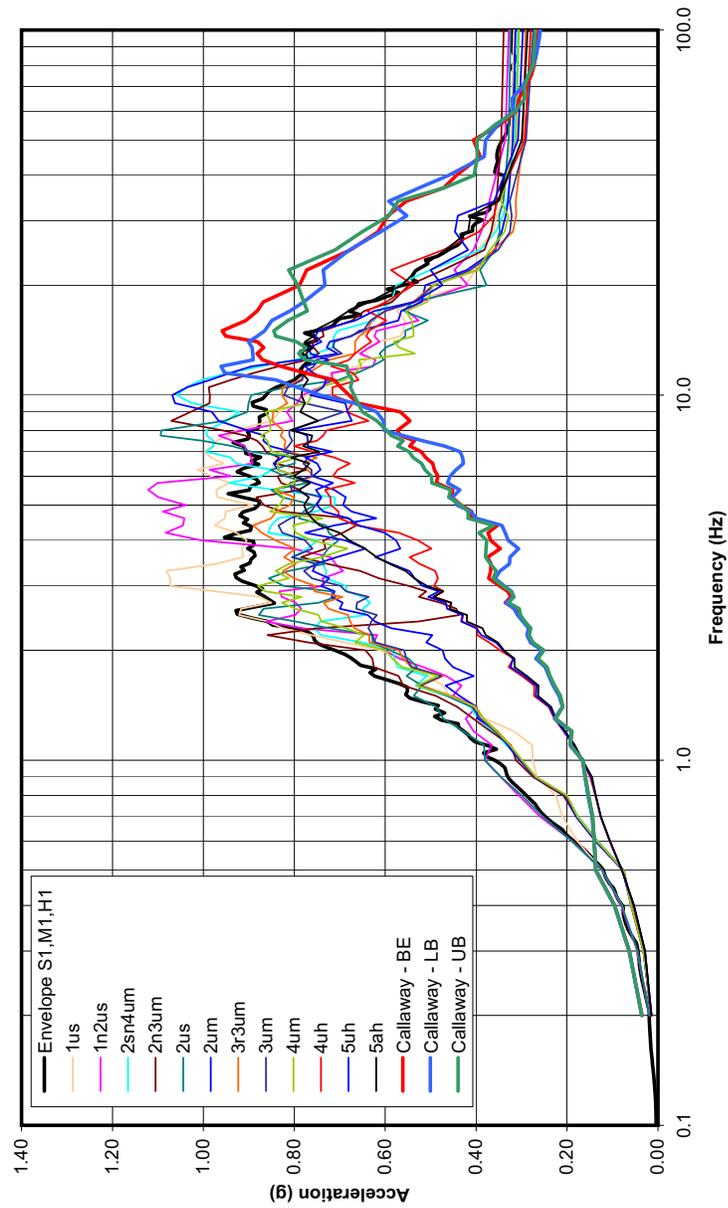
**Figure 3.7-10—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of NI Basemat, Y(N-S) Direction, 5% Damping}**



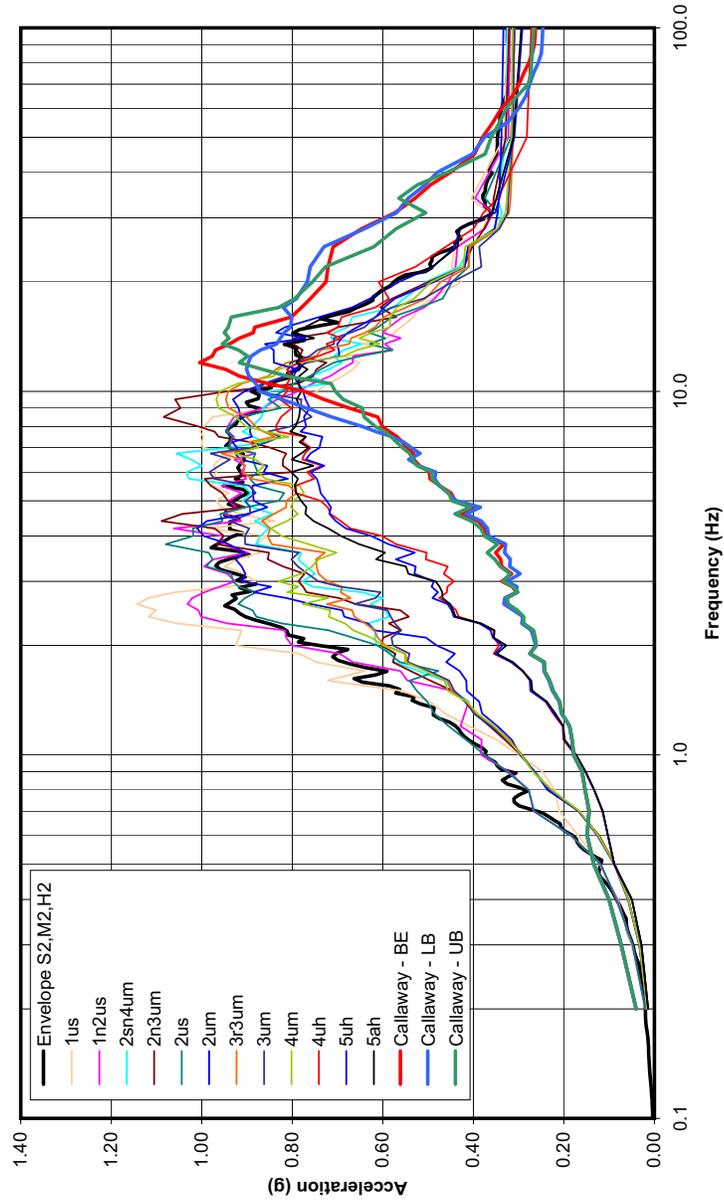
**Figure 3.7-11 —{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of NI Basemat, Z(Vertical) Direction, 5% Damping}**



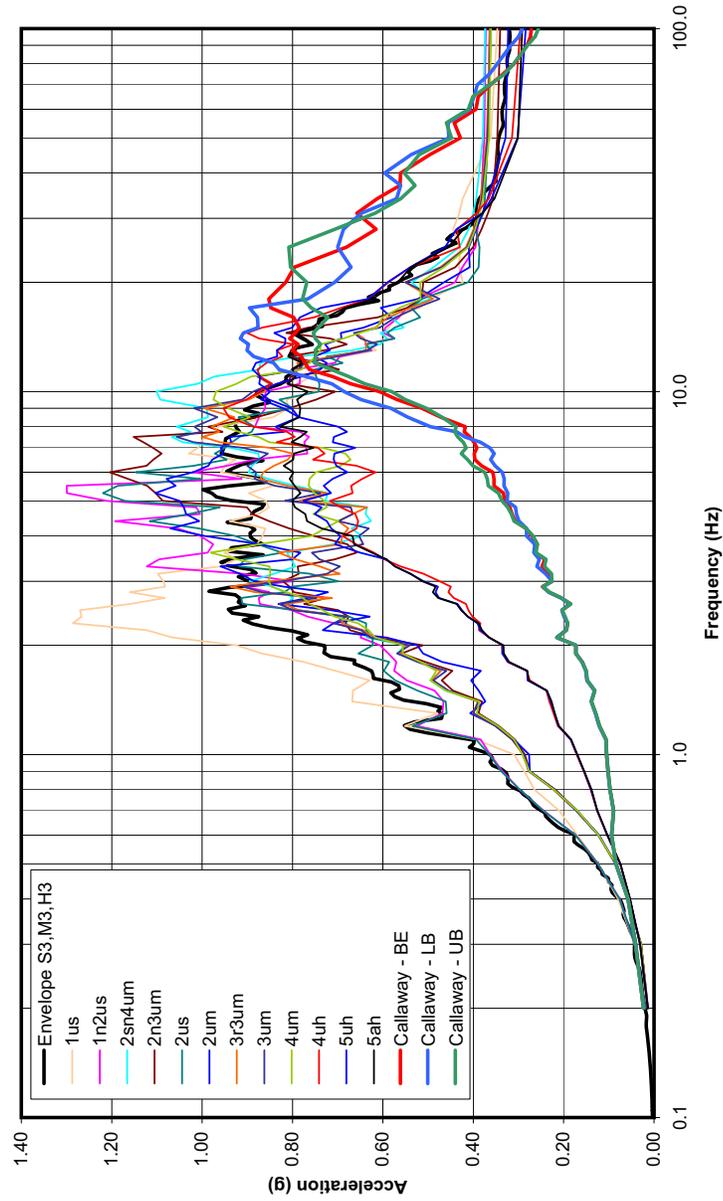
**Figure 3.7-12—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 1&2 Basemat, X(E-W) Direction, 5% Damping}**



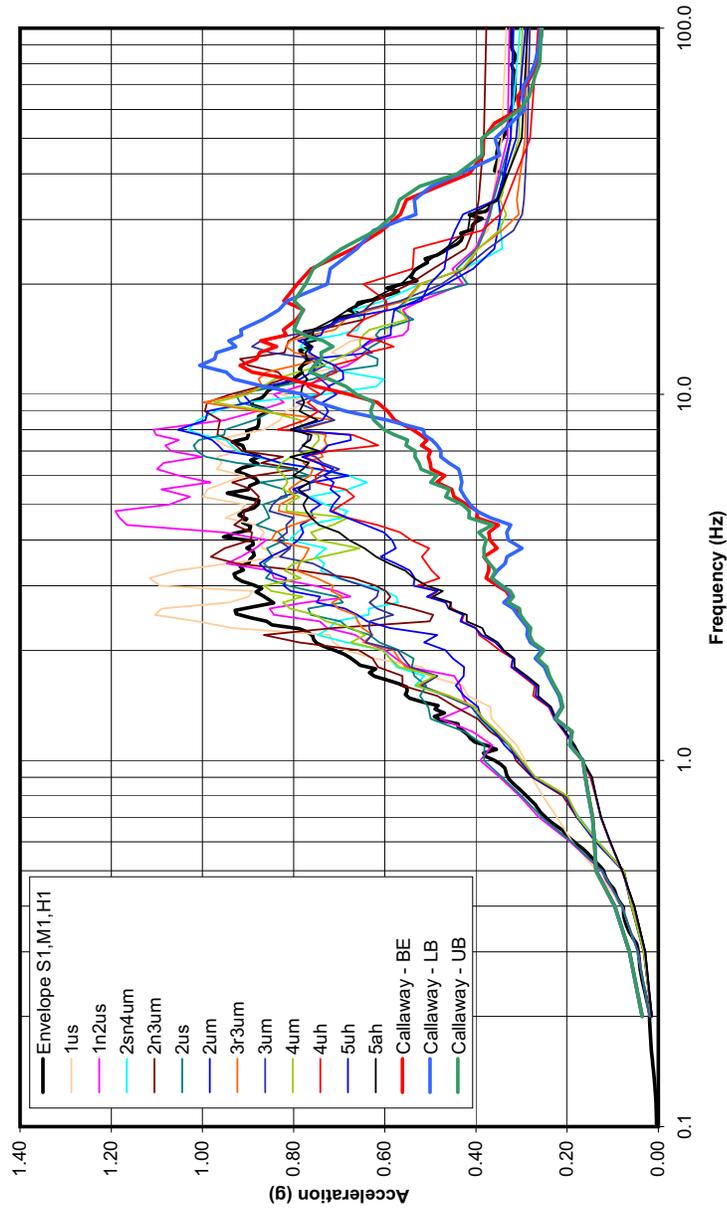
**Figure 3.7-13—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 1&2 Basemat, Y(N-S) Direction, 5% Damping}**



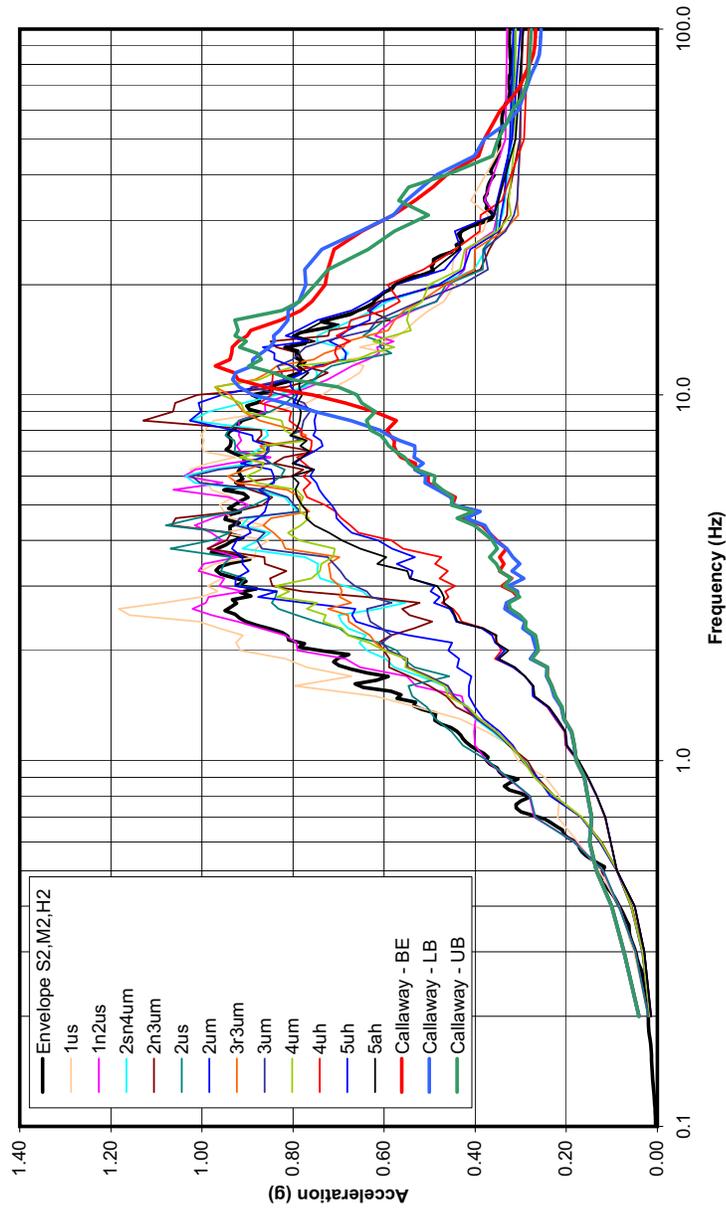
**Figure 3.7-14—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 1&2 Basemat, Z(Vertical) Direction, 5% Damping}**



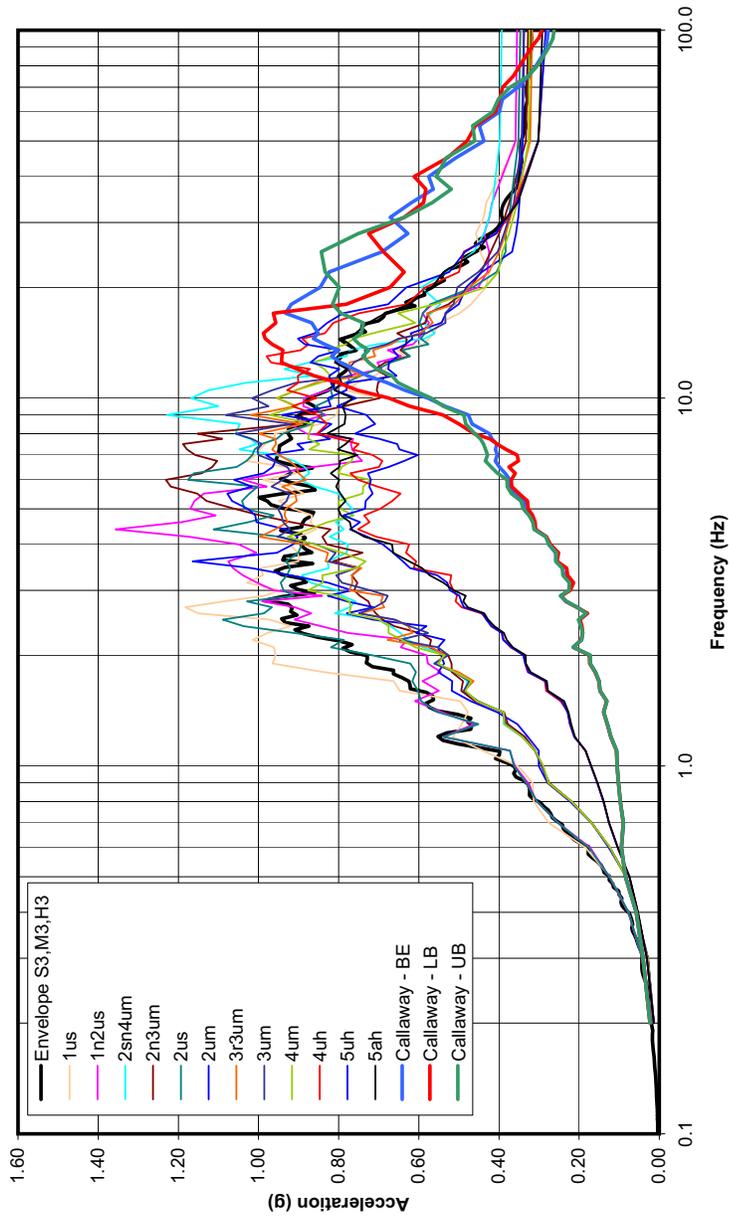
**Figure 3.7-15—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 3&4 Basemat, X(E-W) Direction, 5% Damping}**



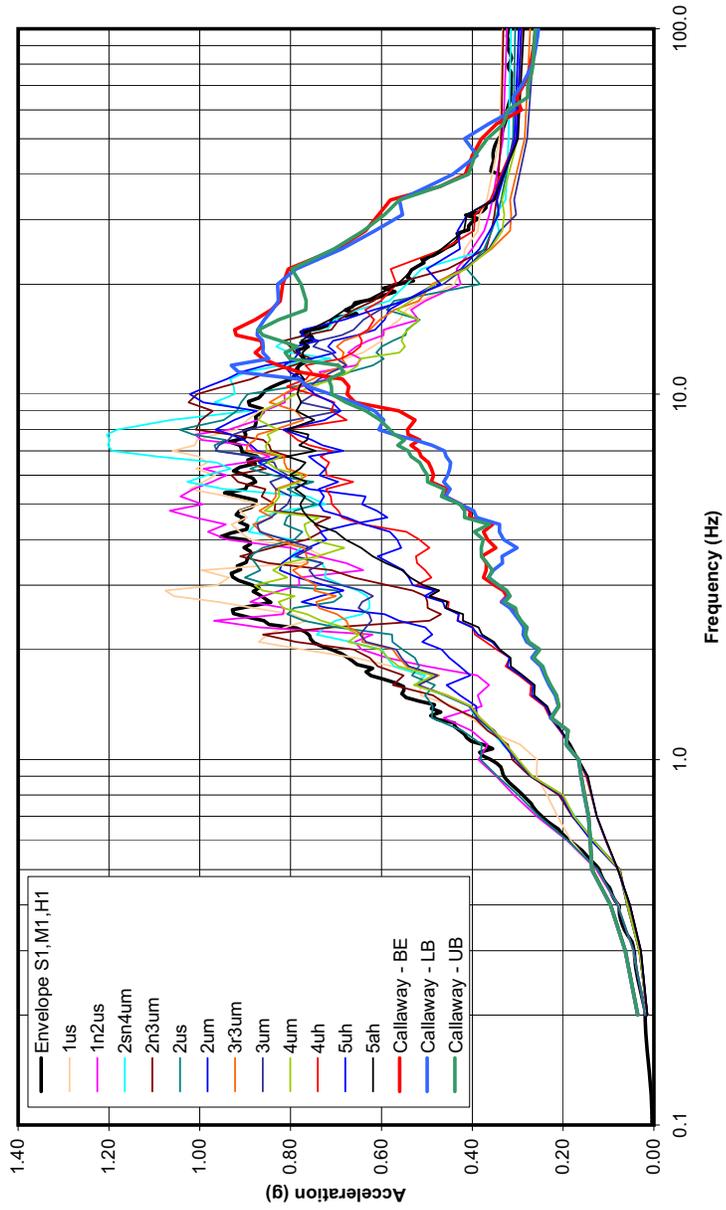
**Figure 3.7-16—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 3&4 Basemat, Y(N-S) Direction, 5% Damping}**



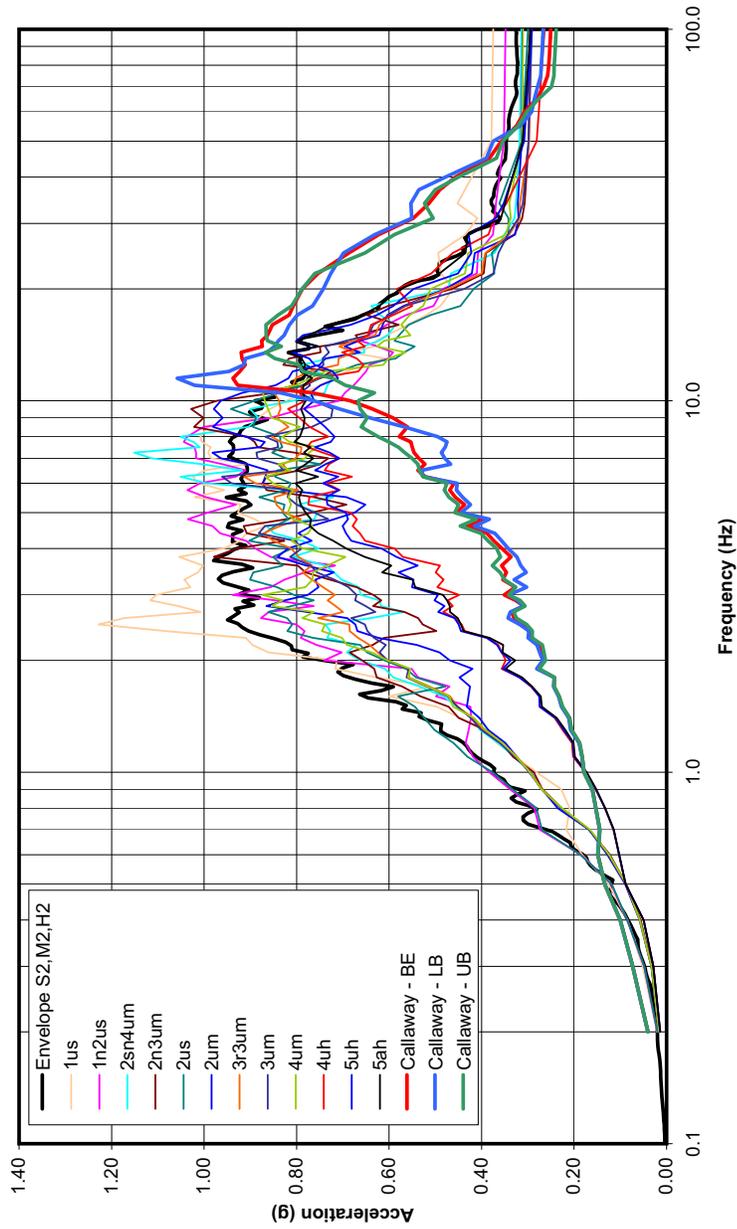
**Figure 3.7-17—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of EPGB 3&4 Basemat, Z(Vertical) Direction, 5% Damping}**



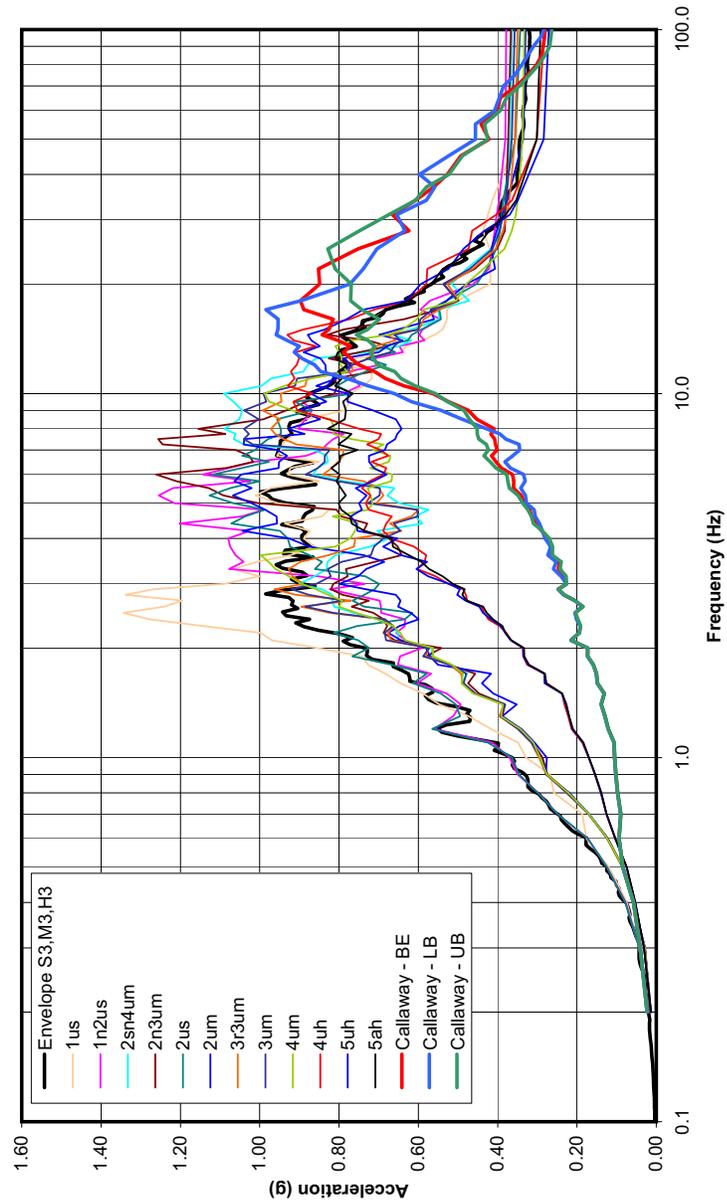
**Figure 3.7-18—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 1 Basemat, X(E-W) Direction, 5% Damping}**



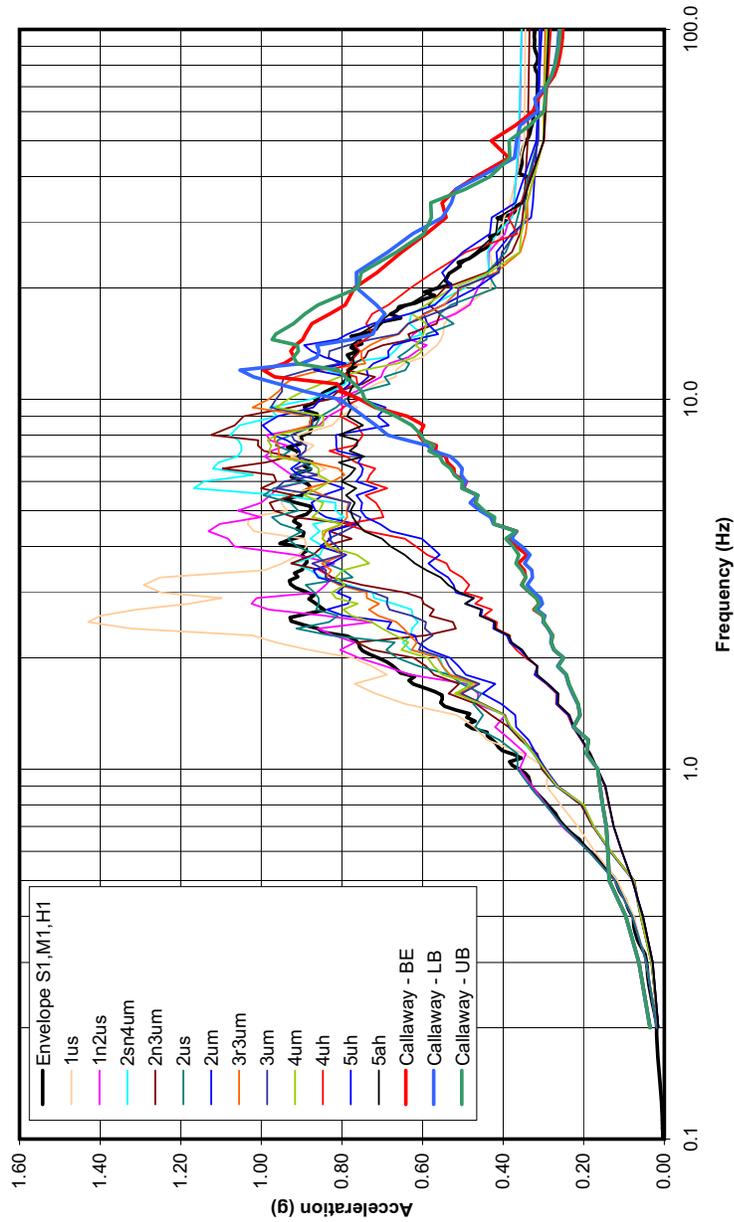
**Figure 3.7-19—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 1 Basemat, Y(N-S) Direction, 5% Damping}**



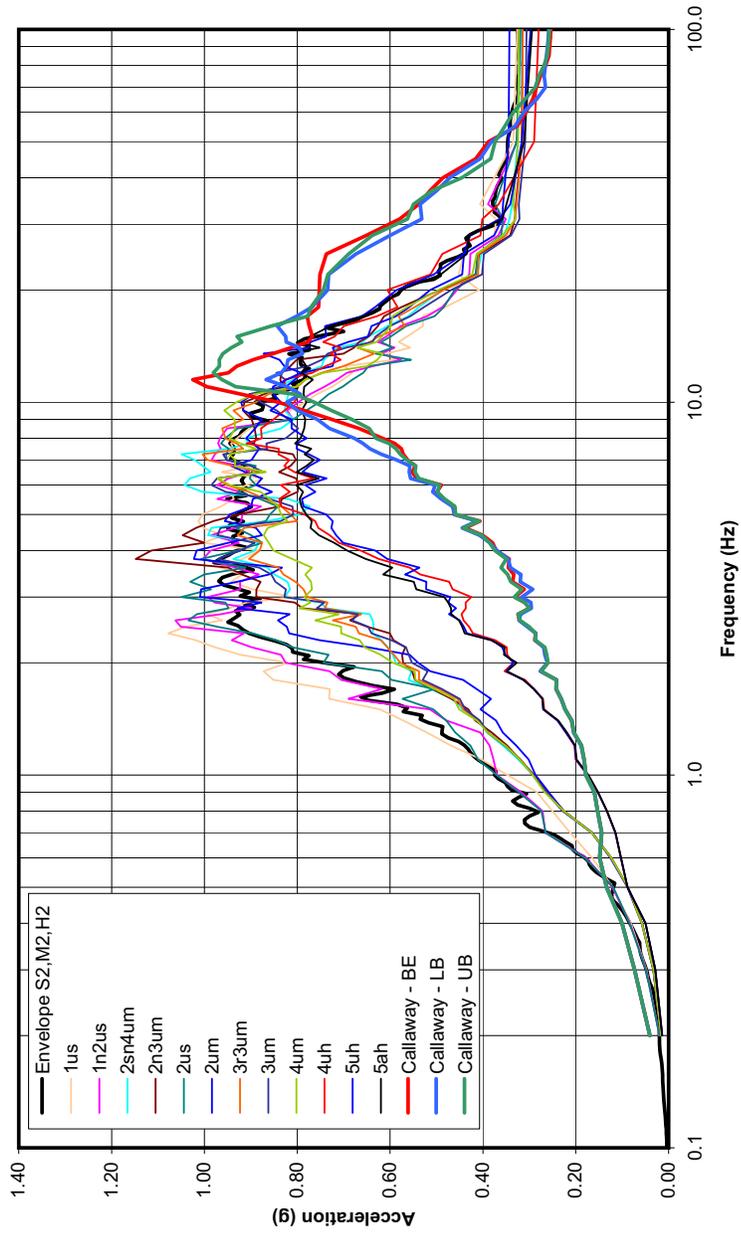
**Figure 3.7-20—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 1 Basemat, Z(Vertical) Direction, 5% Damping}**



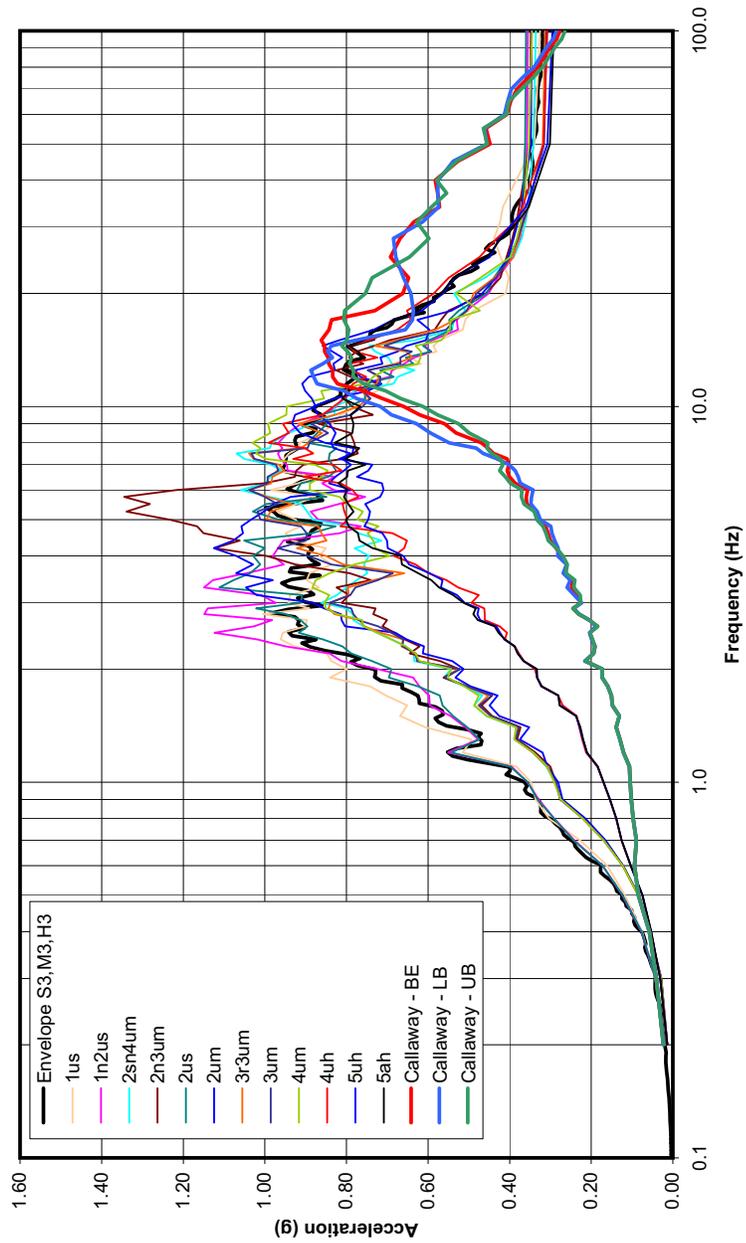
**Figure 3.7-21 — {Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 2 Basemat, X(E-W) Direction, 5% Damping}**



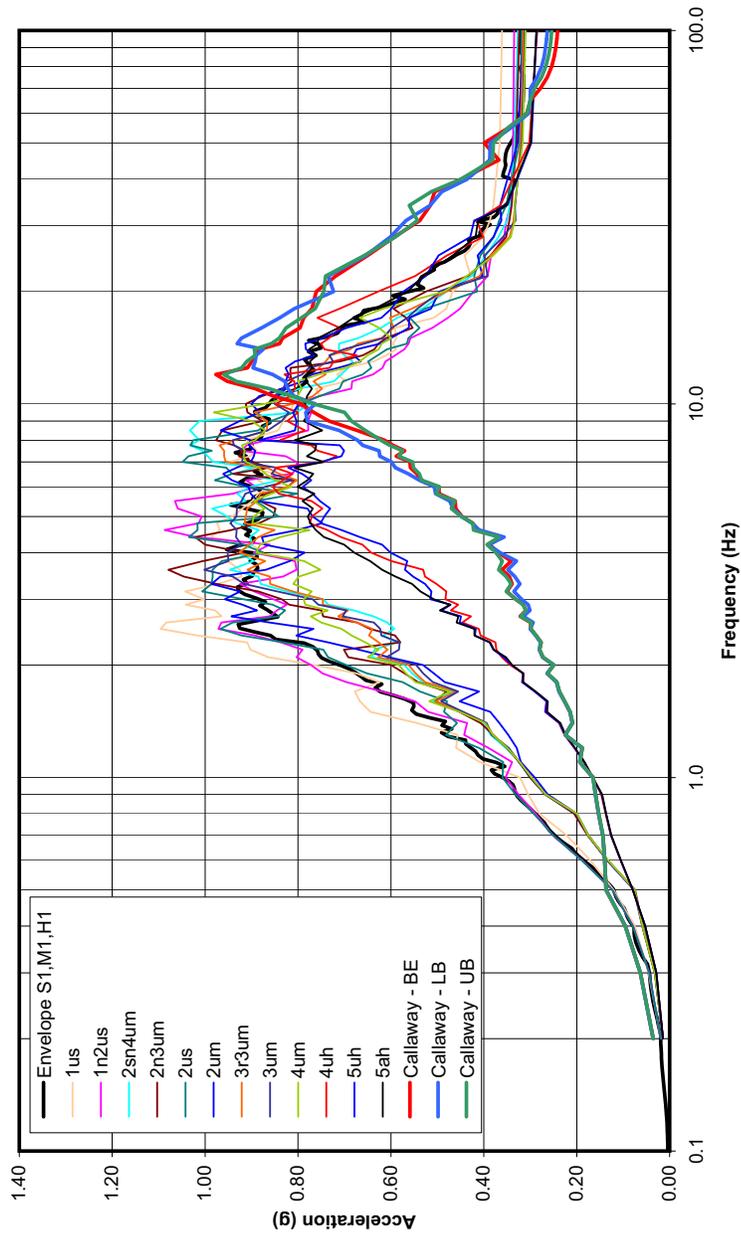
**Figure 3.7-22—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 2 Basemat, Y(N-S) Direction, 5% Damping}**



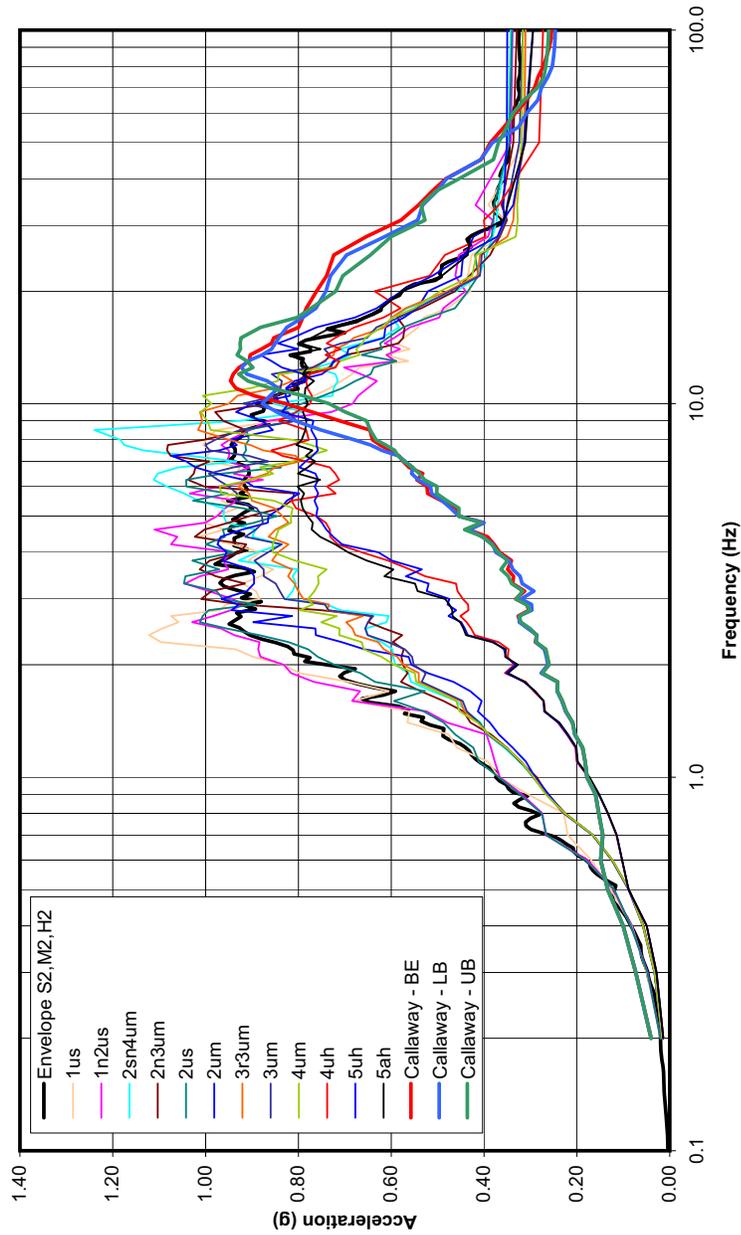
**Figure 3.7-23—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 2 Basemat, Z(Vertical) Direction, 5% Damping}**



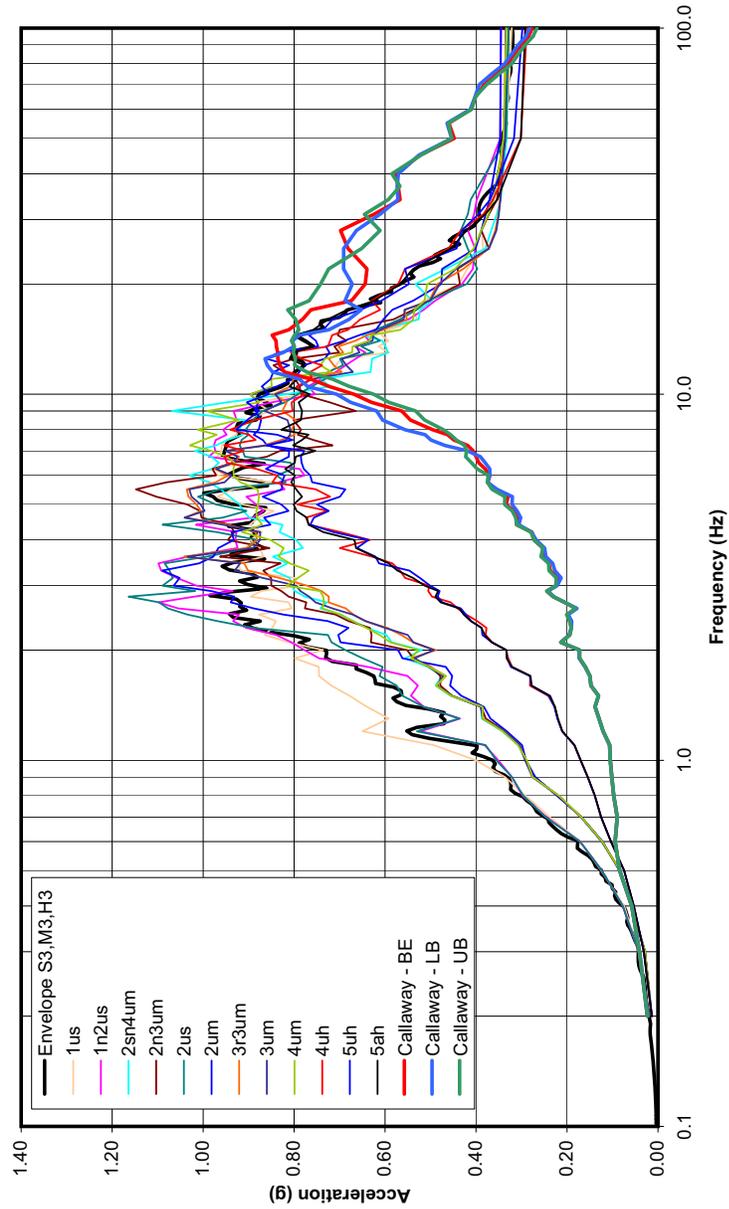
**Figure 3.7-24—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 3 Basemat, X(E-W) Direction, 5% Damping}**



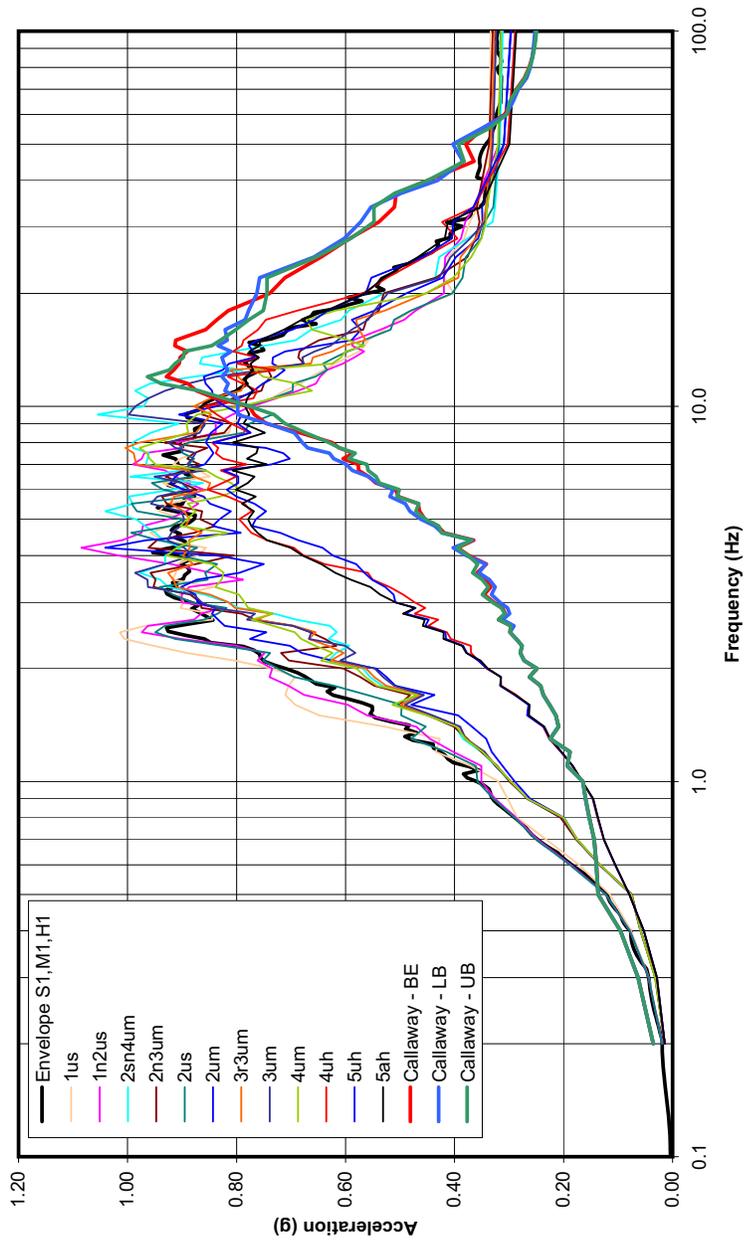
**Figure 3.7-25—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 3 Basemat, Y(N-S) Direction, 5% Damping}**



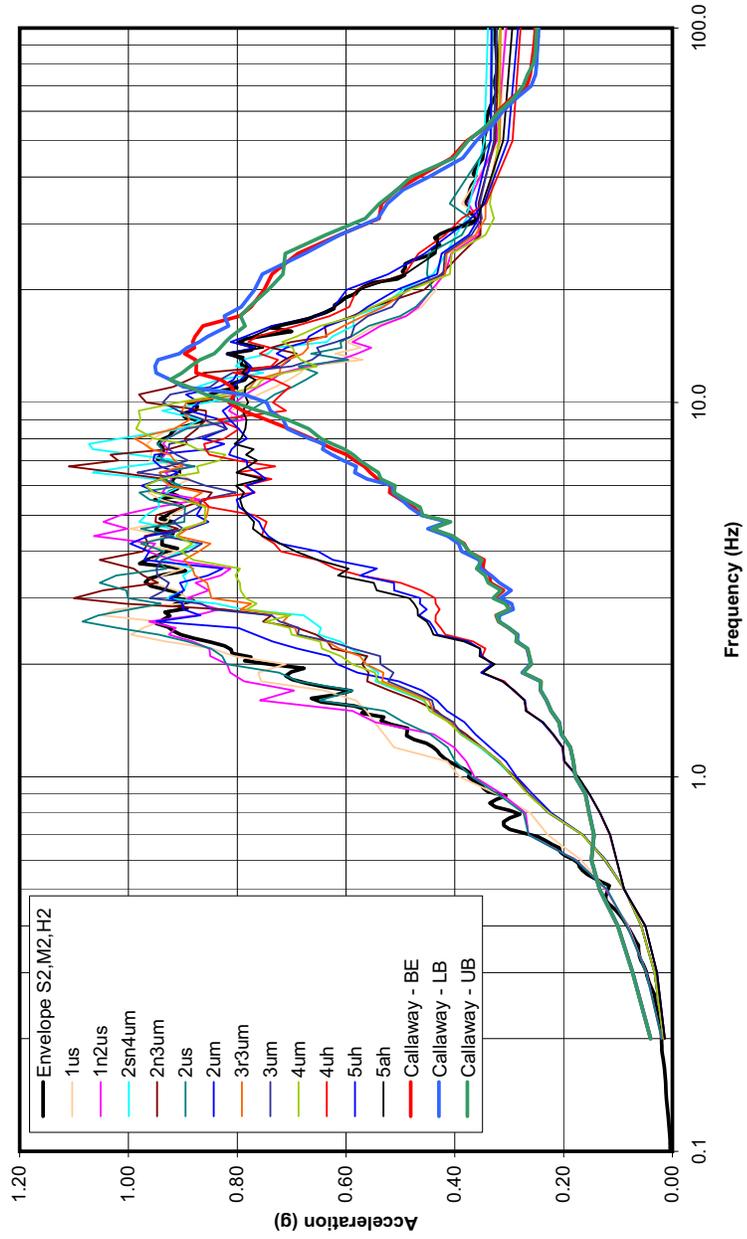
**Figure 3.7-26—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 3 Basemat, Z(Vertical) Direction, 5% Damping}**



**Figure 3.7-27—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 4 Basemat, X(E-W) Direction, 5% Damping}**



**Figure 3.7-28—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 4 Basemat, Y(N-S) Direction, 5% Damping}**



**Figure 3.7-29—{Comparison of Callaway Plant Unit 2 versus US EPR Standard In-structure Response Spectra, Center of ESWB 4 Basemat, Z(Vertical) Direction, 5% Damping}**

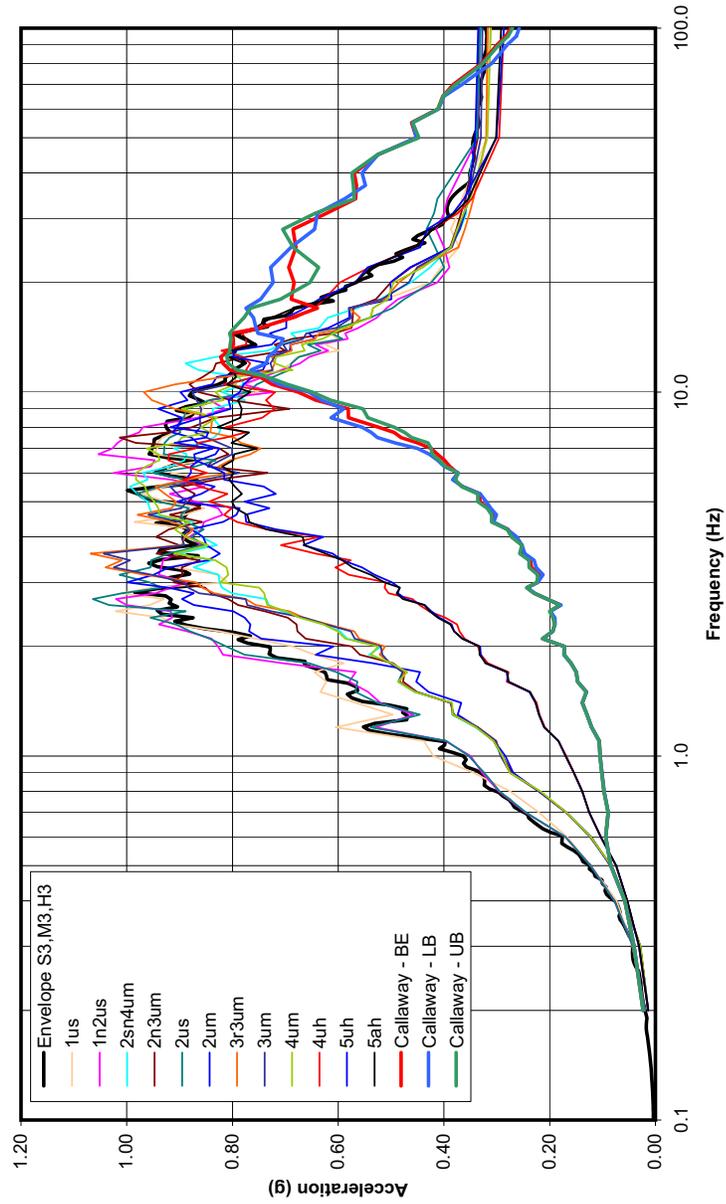
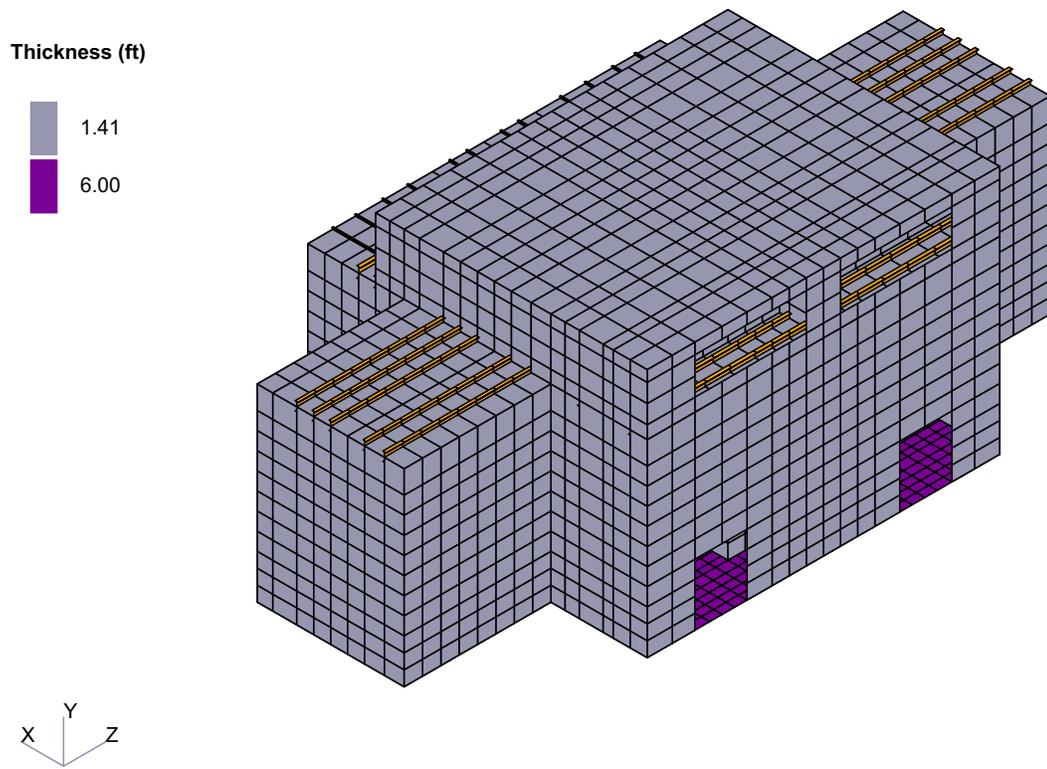
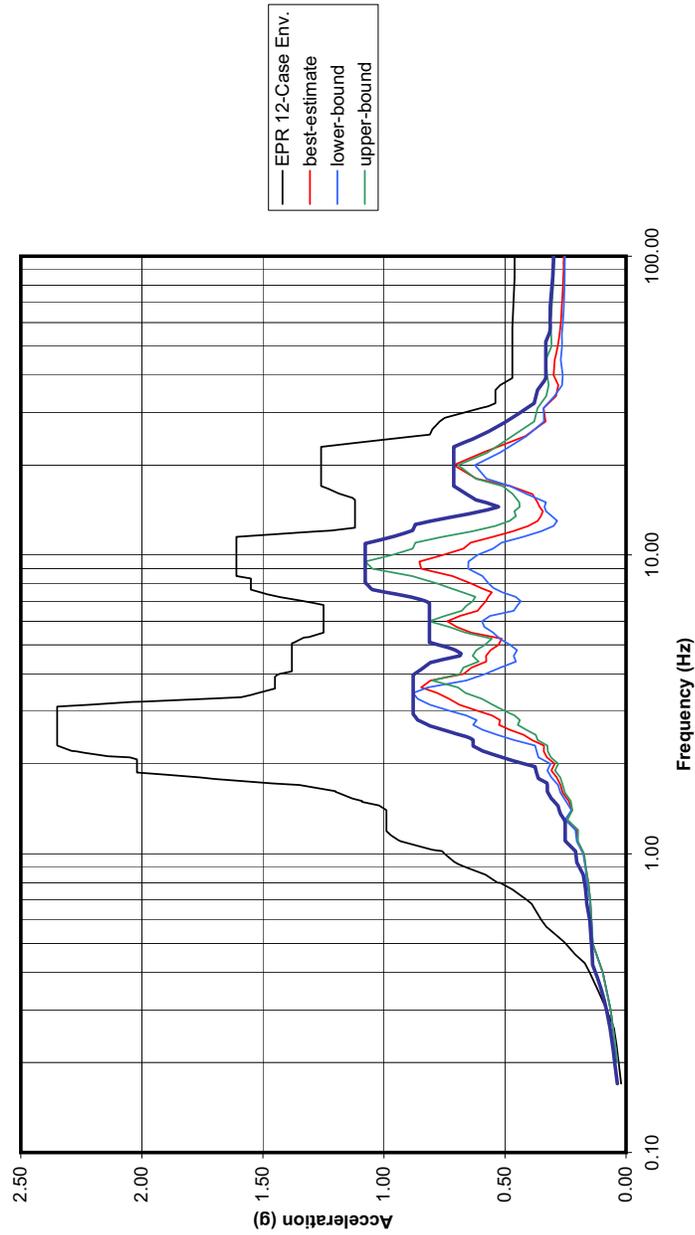


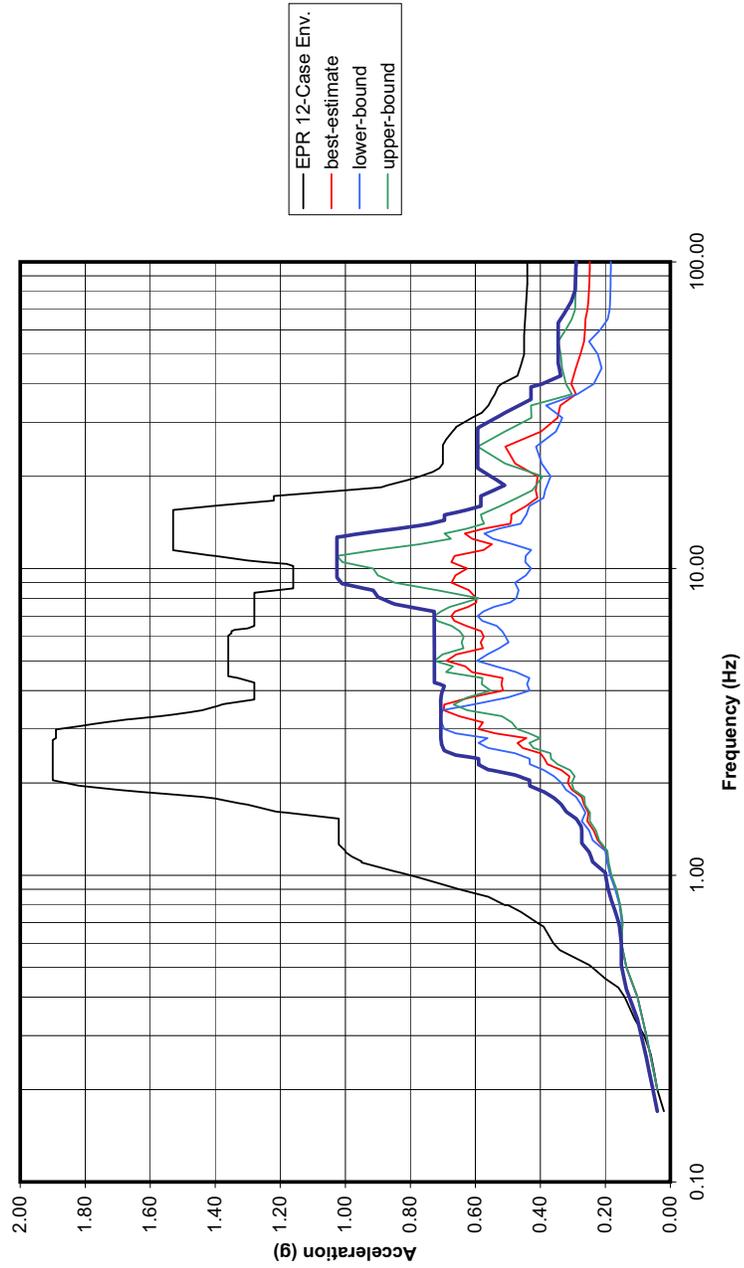
Figure 3.7-30—{Isometric View of FEM for EPGB}



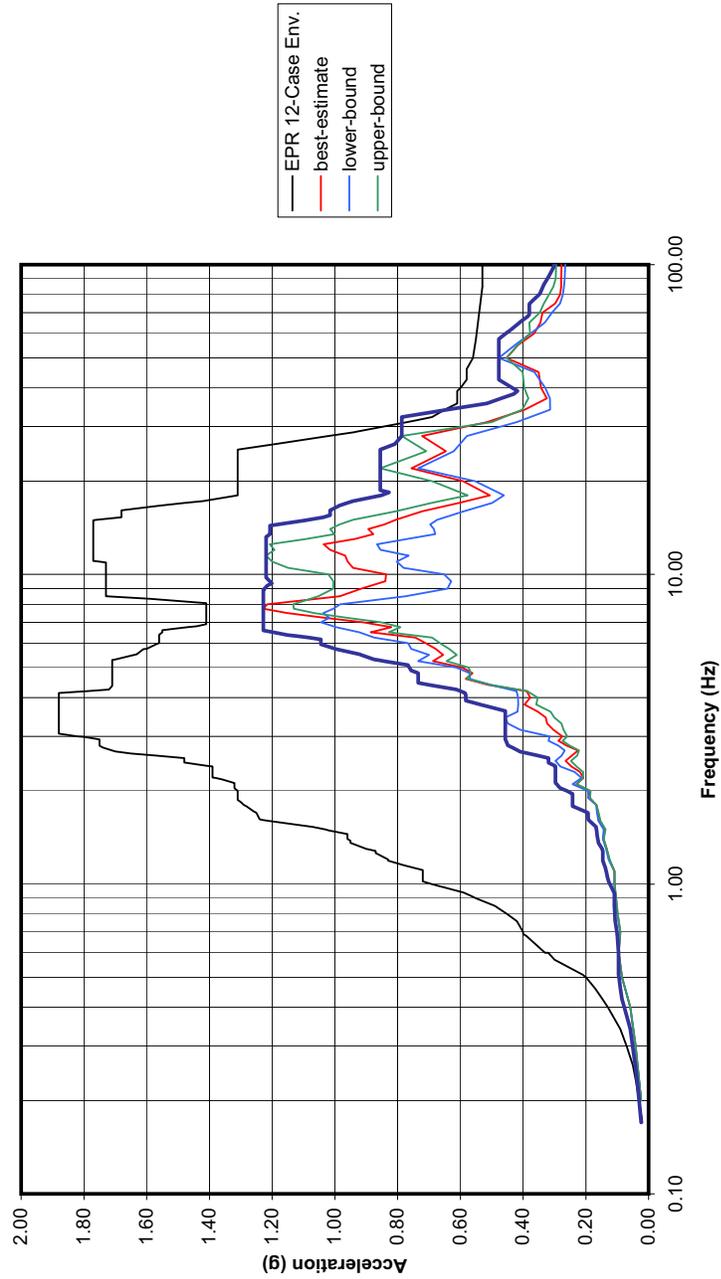
**Figure 3.7-31**—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 5.15m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}



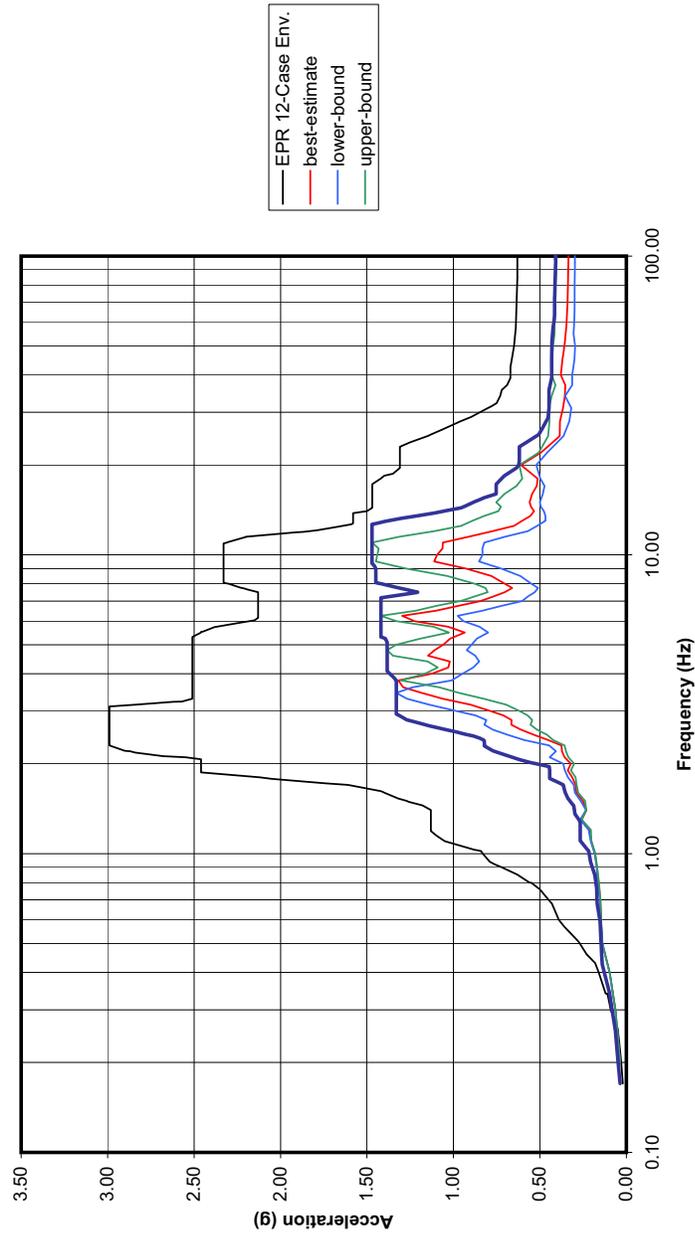
**Figure 3.7-32—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 5.15m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



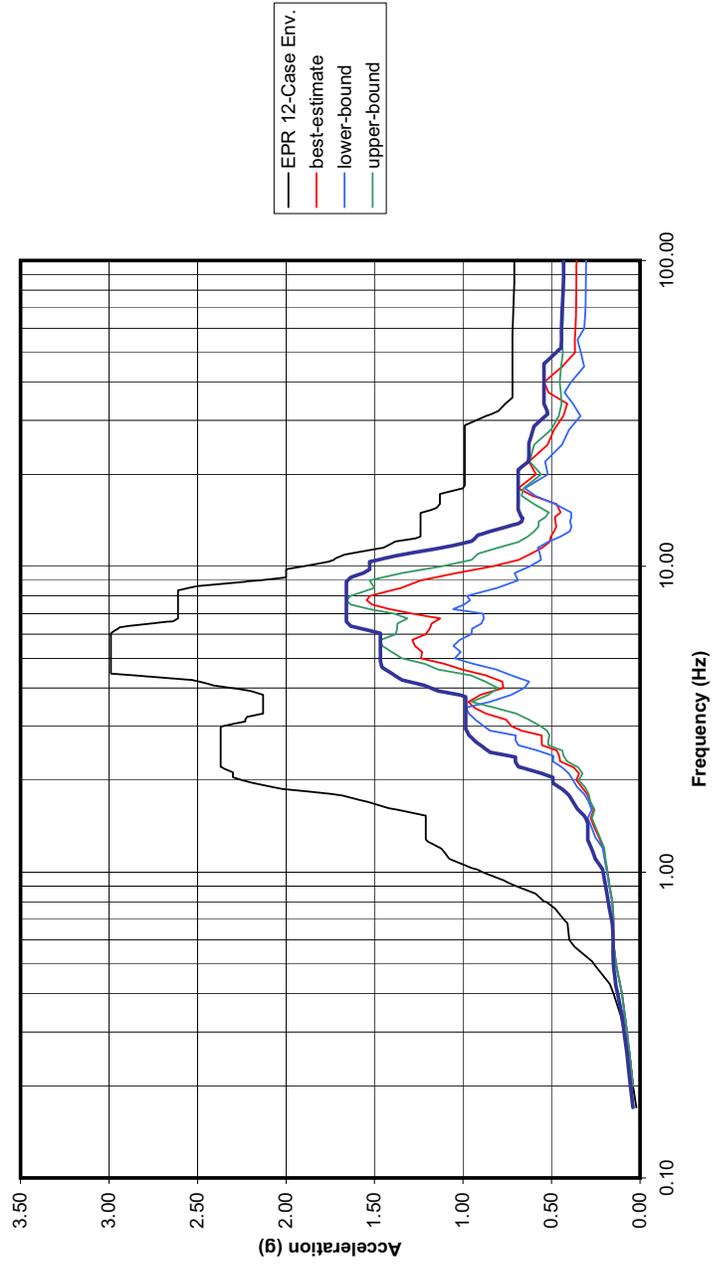
**Figure 3.7-33—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 5.15m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



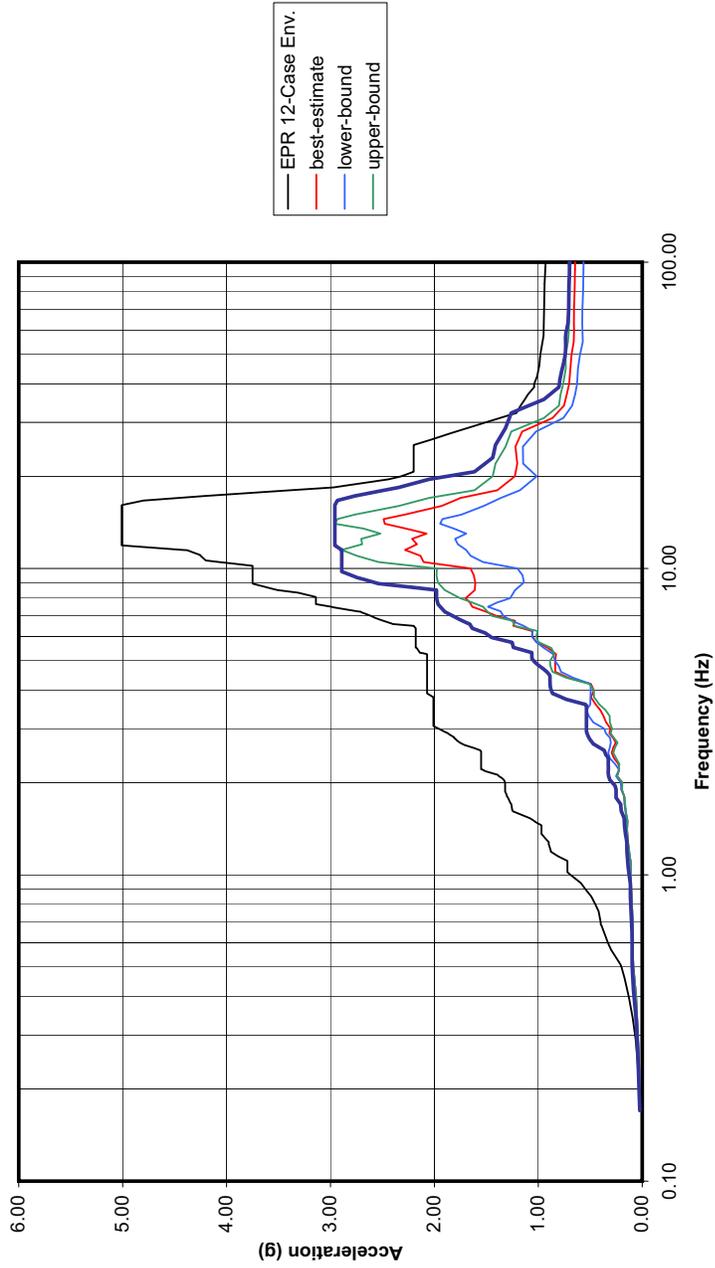
**Figure 3.7-34—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 19.50m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



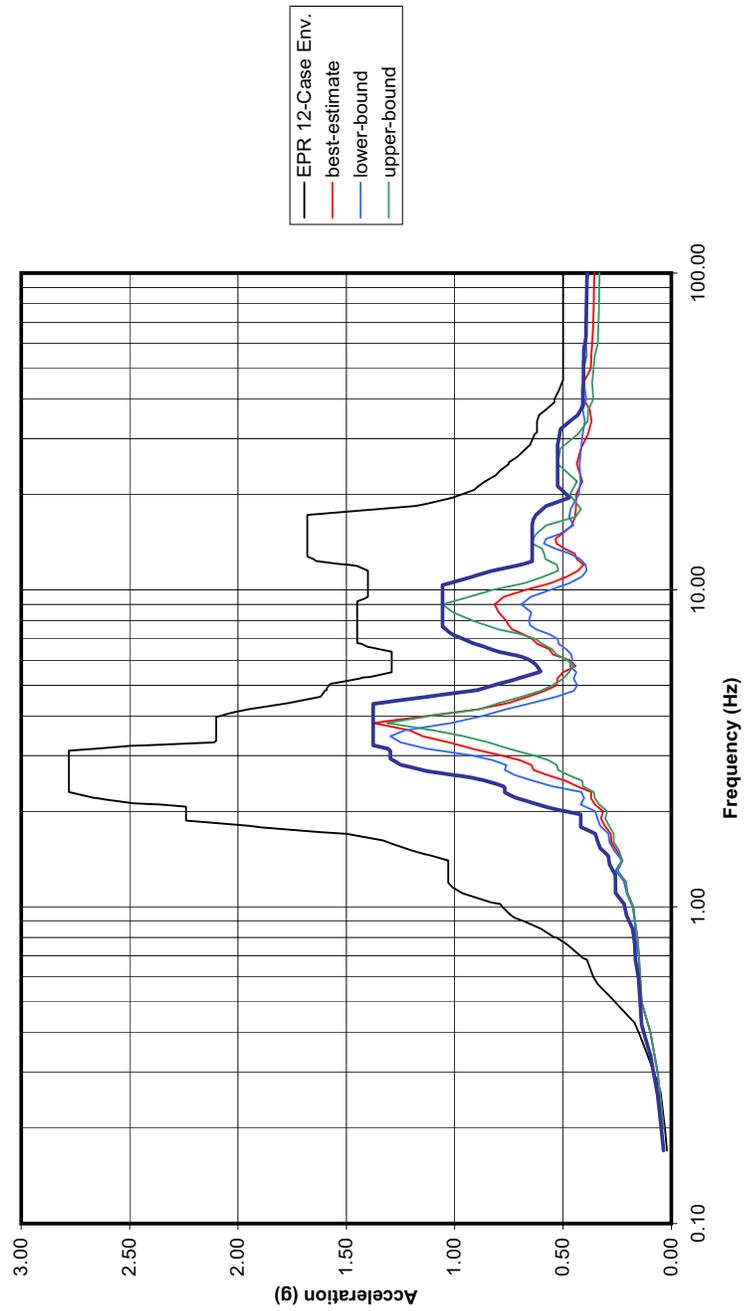
**Figure 3.7-35—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 19.50m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



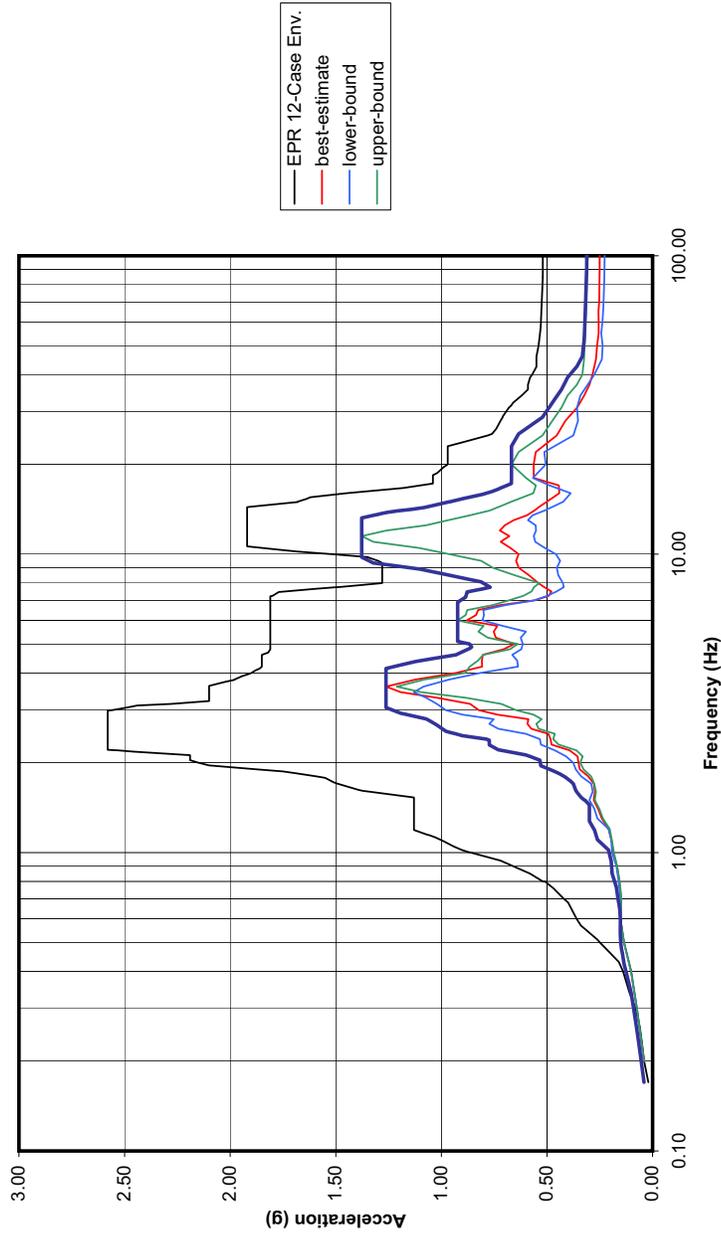
**Figure 3.7-36—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Reactor Building Internals, Elev. 19.50m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



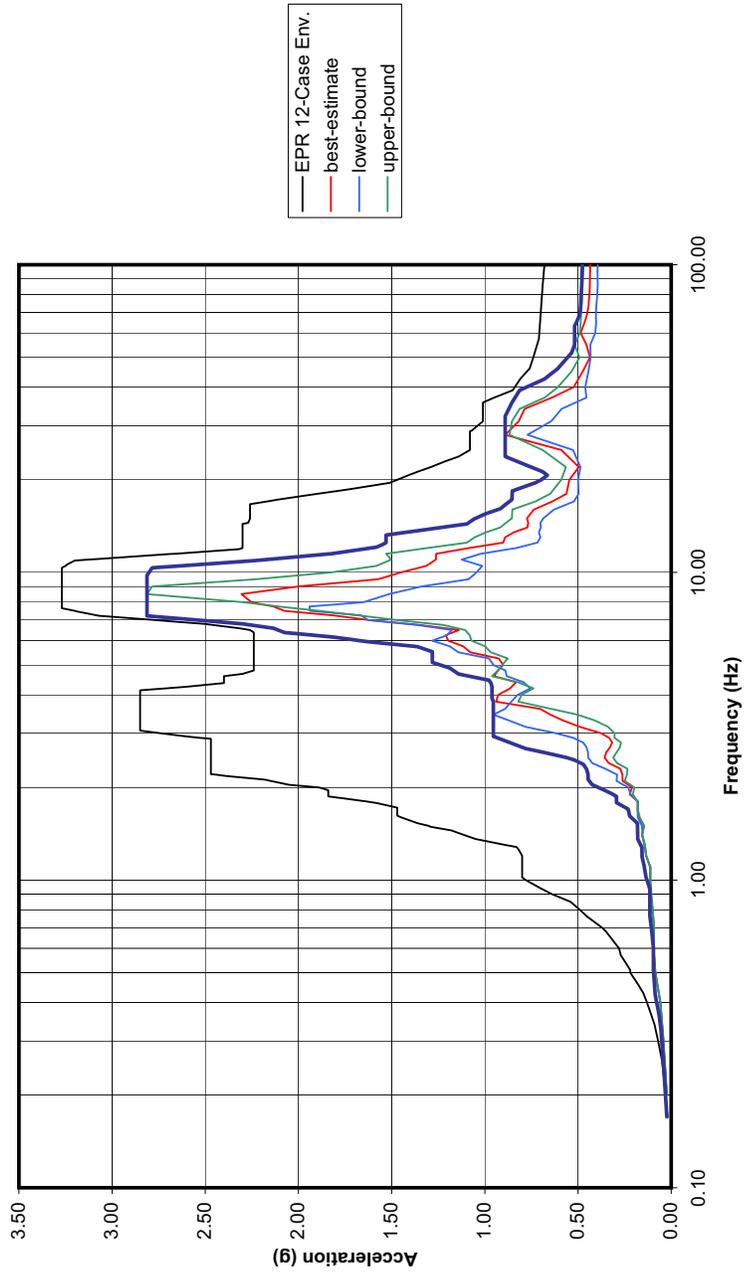
**Figure 3.7-37—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 8.1 m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



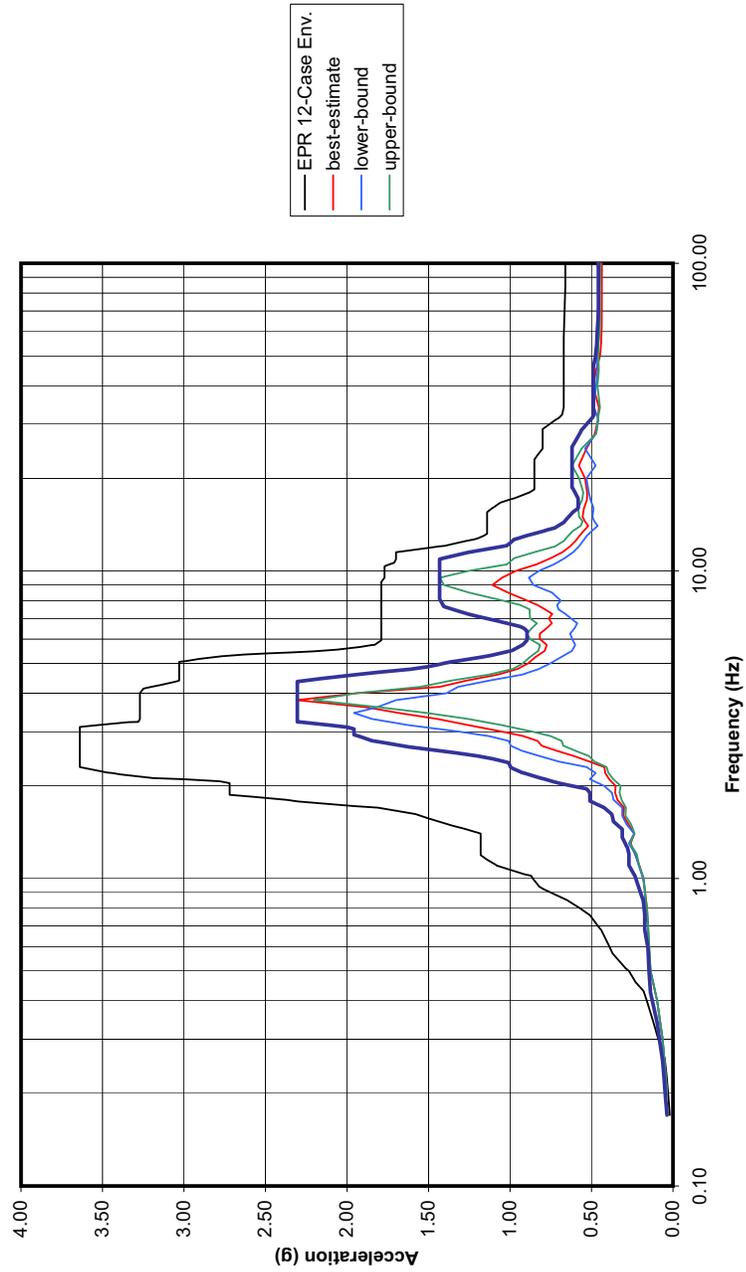
**Figure 3.7-38—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 8.1m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



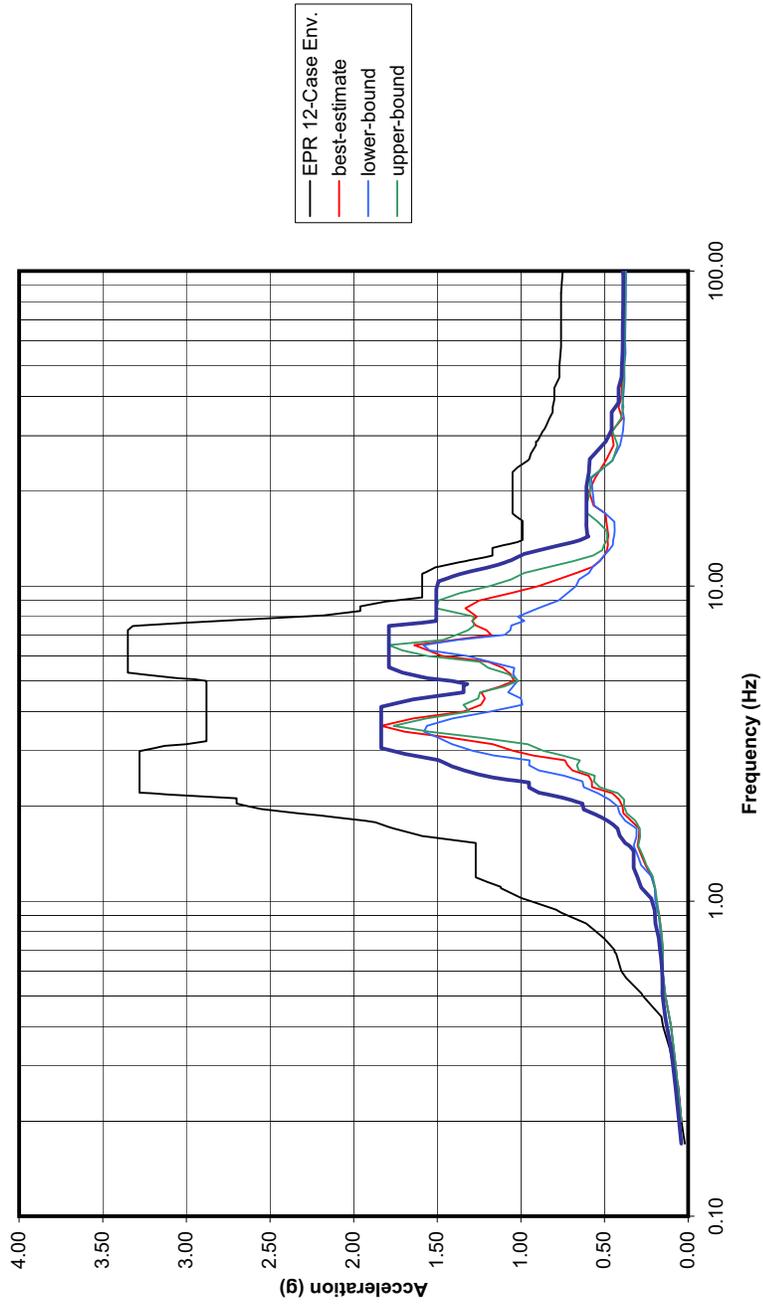
**Figure 3.7-39—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 8.1 m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



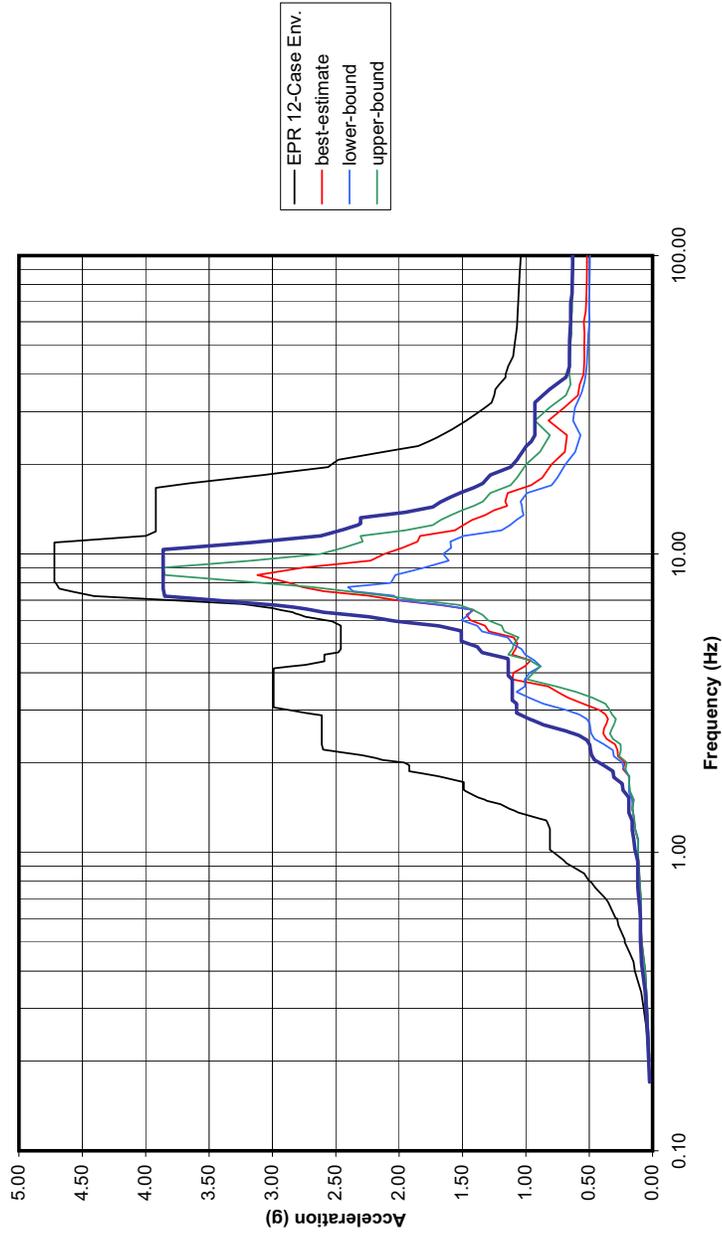
**Figure 3.7-40—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 21.0m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



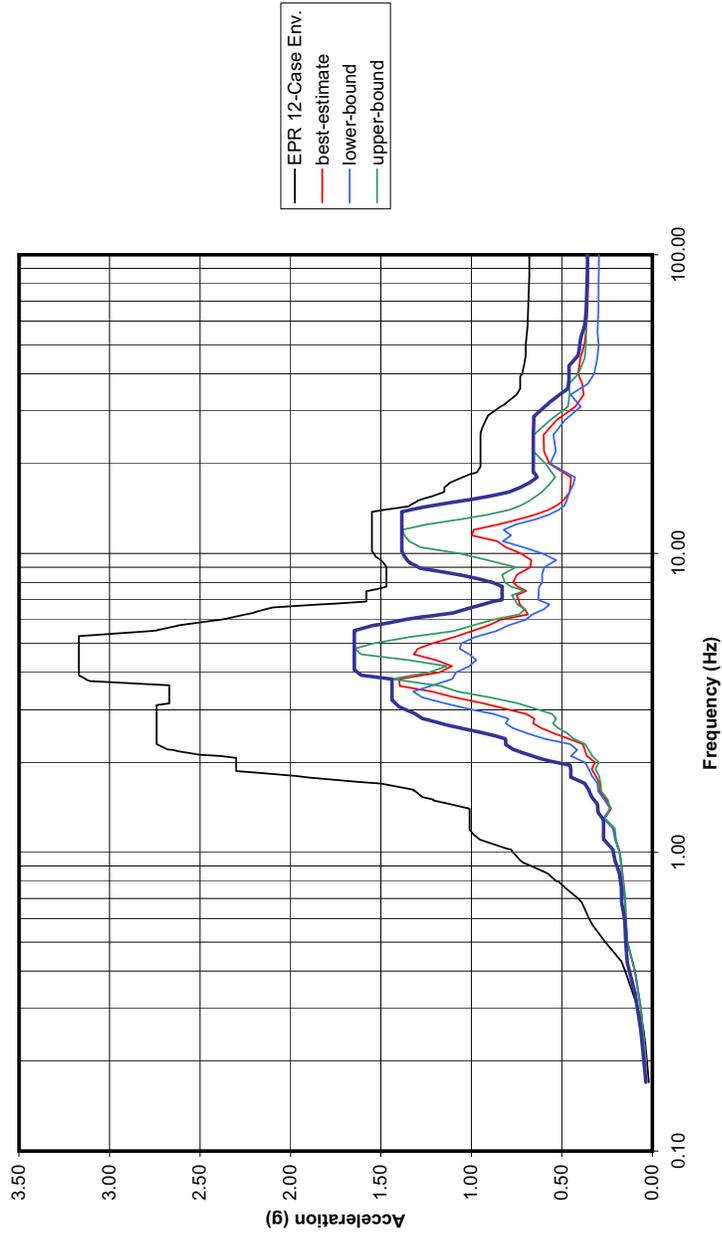
**Figure 3.7-41**—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 21.0m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}



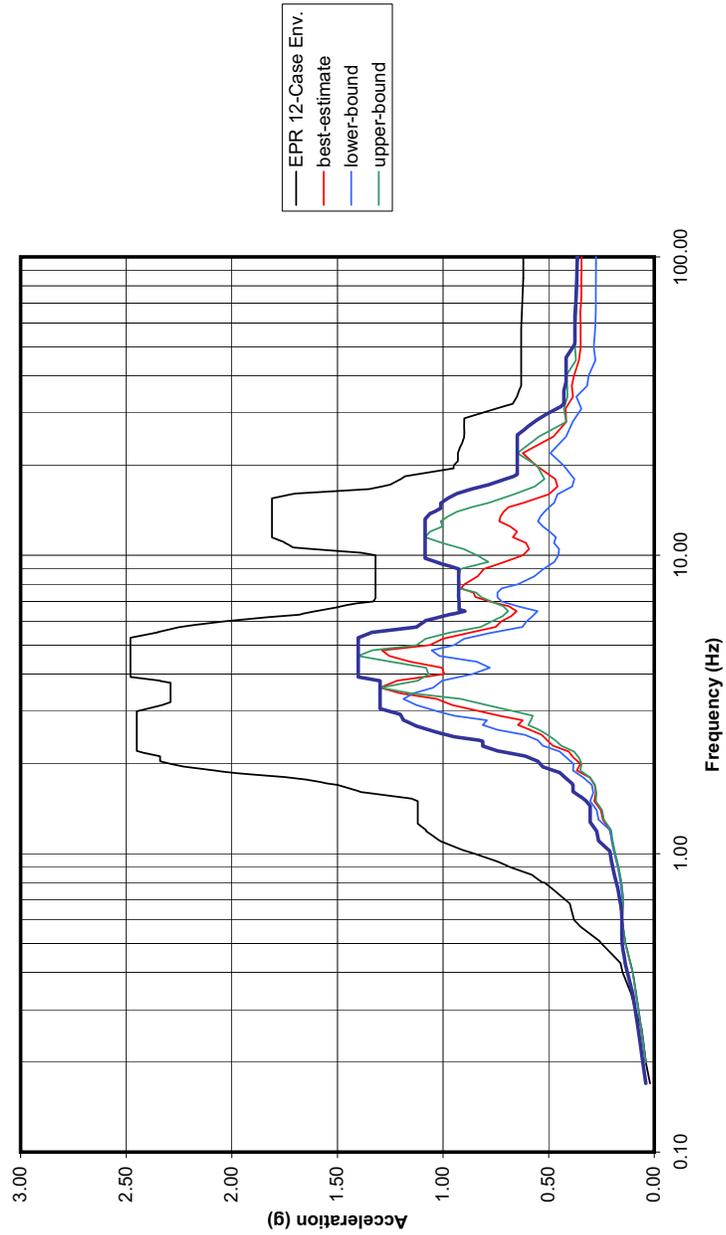
**Figure 3.7-42—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 1, 21.0m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



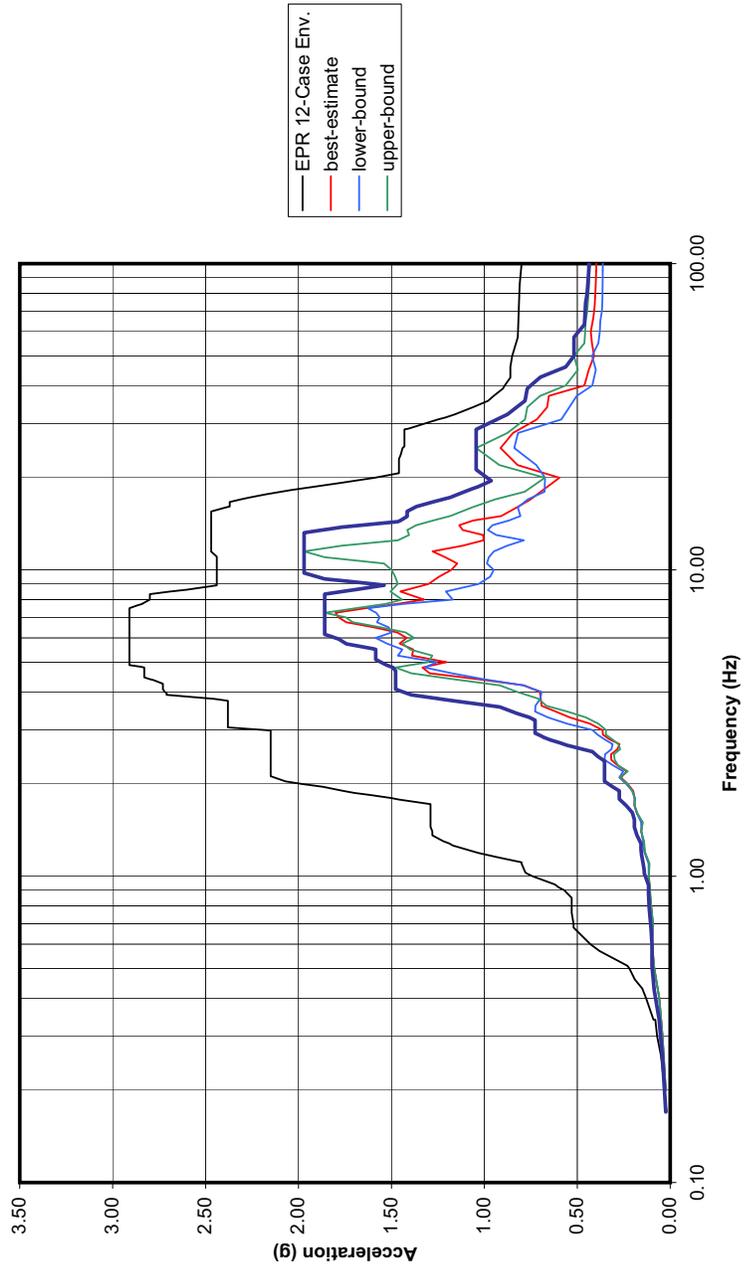
**Figure 3.7-43—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 8.1m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



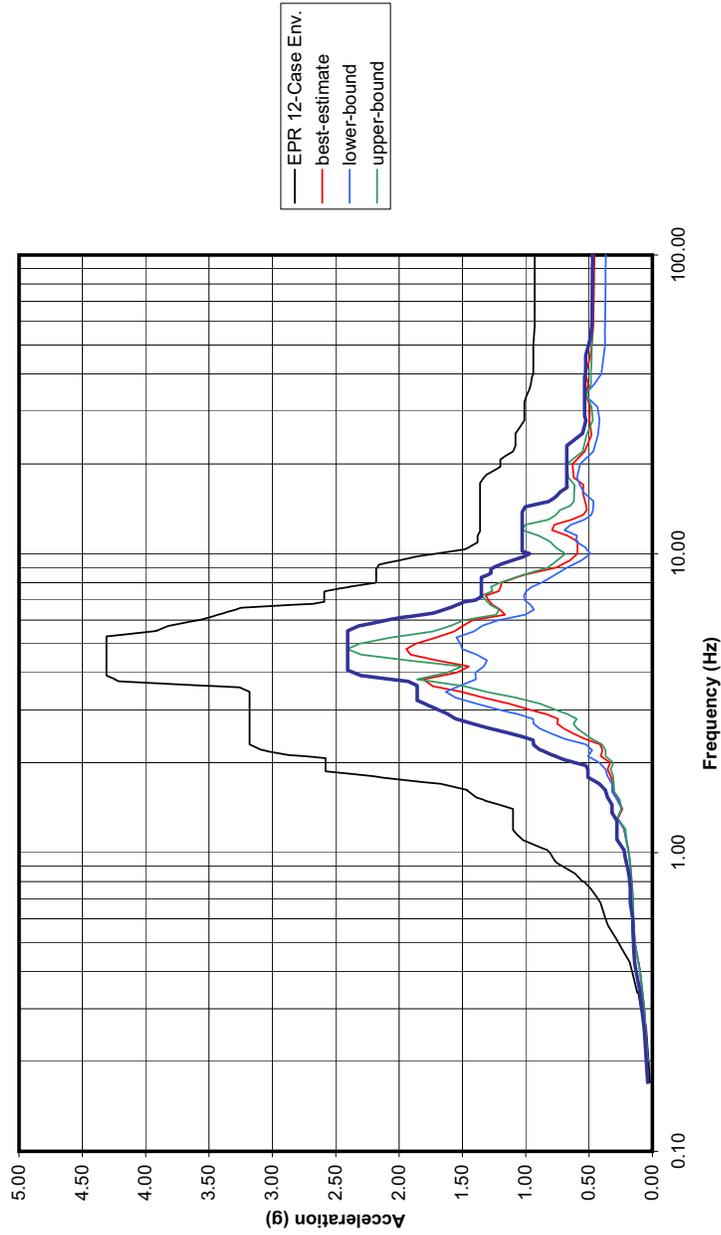
**Figure 3.7-44—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 8.1 m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



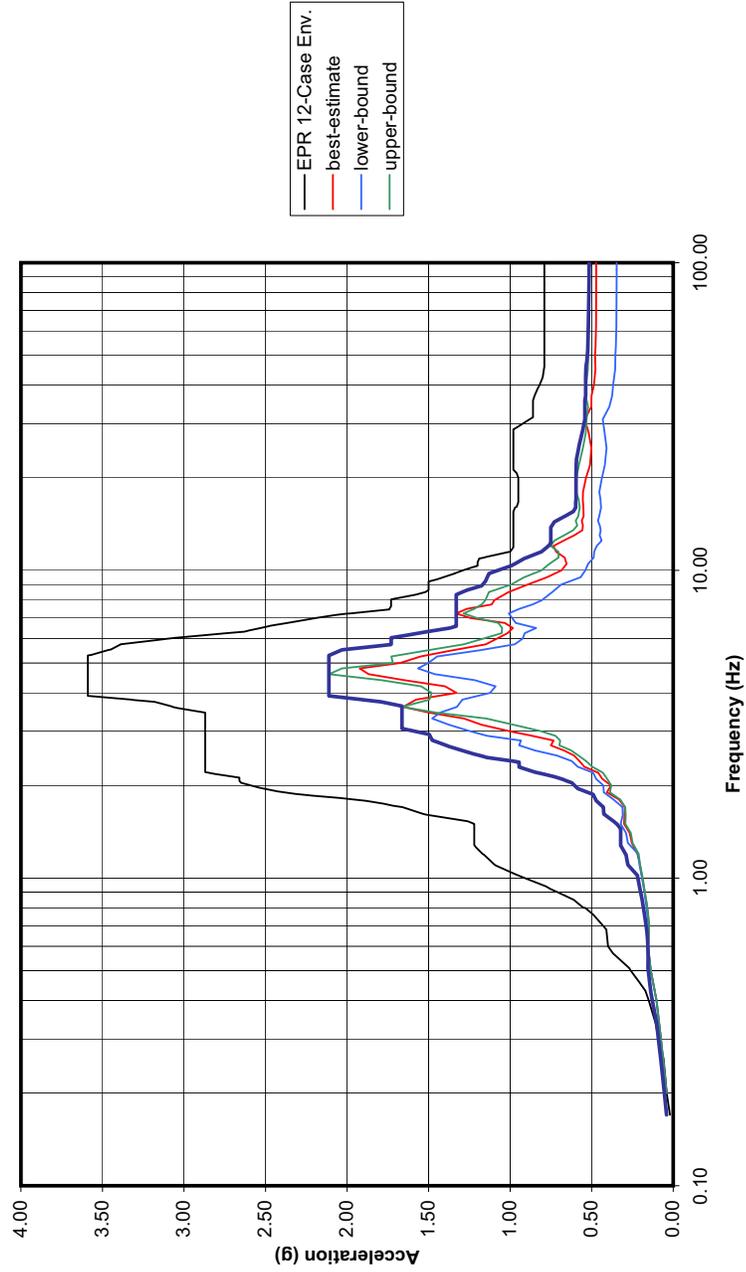
**Figure 3.7-45—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 8.1m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



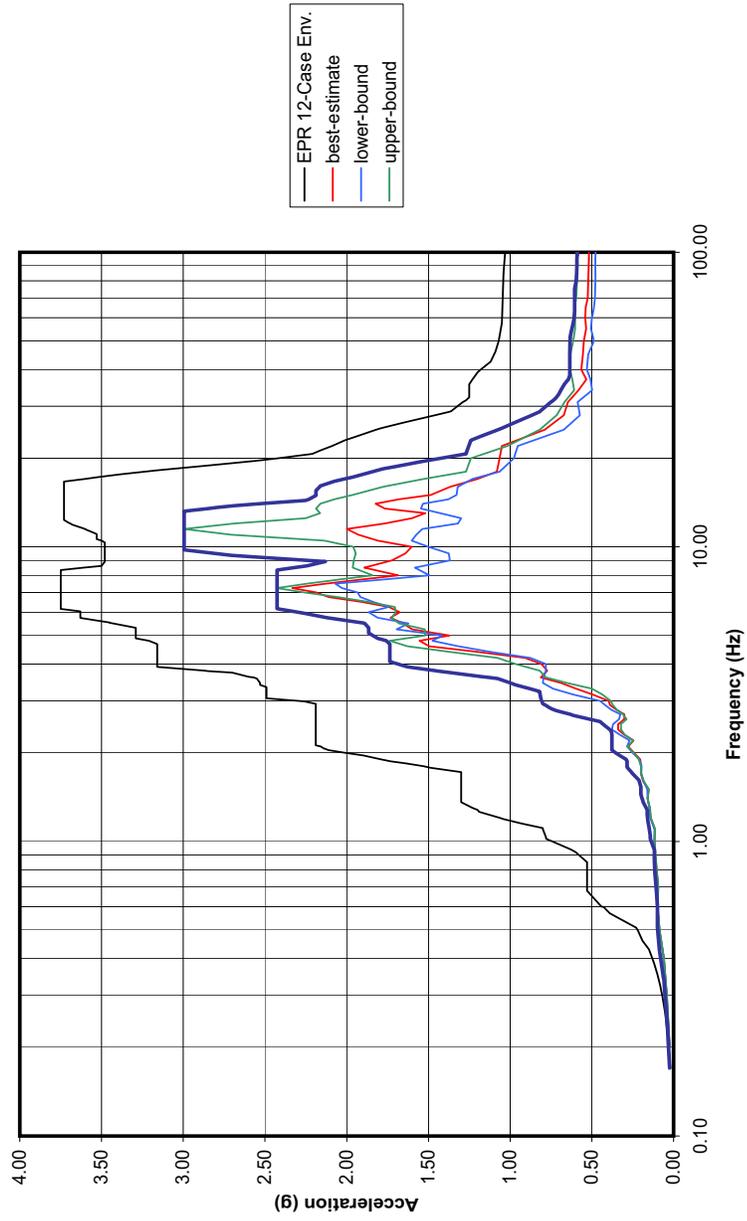
**Figure 3.7-46—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 15.4m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



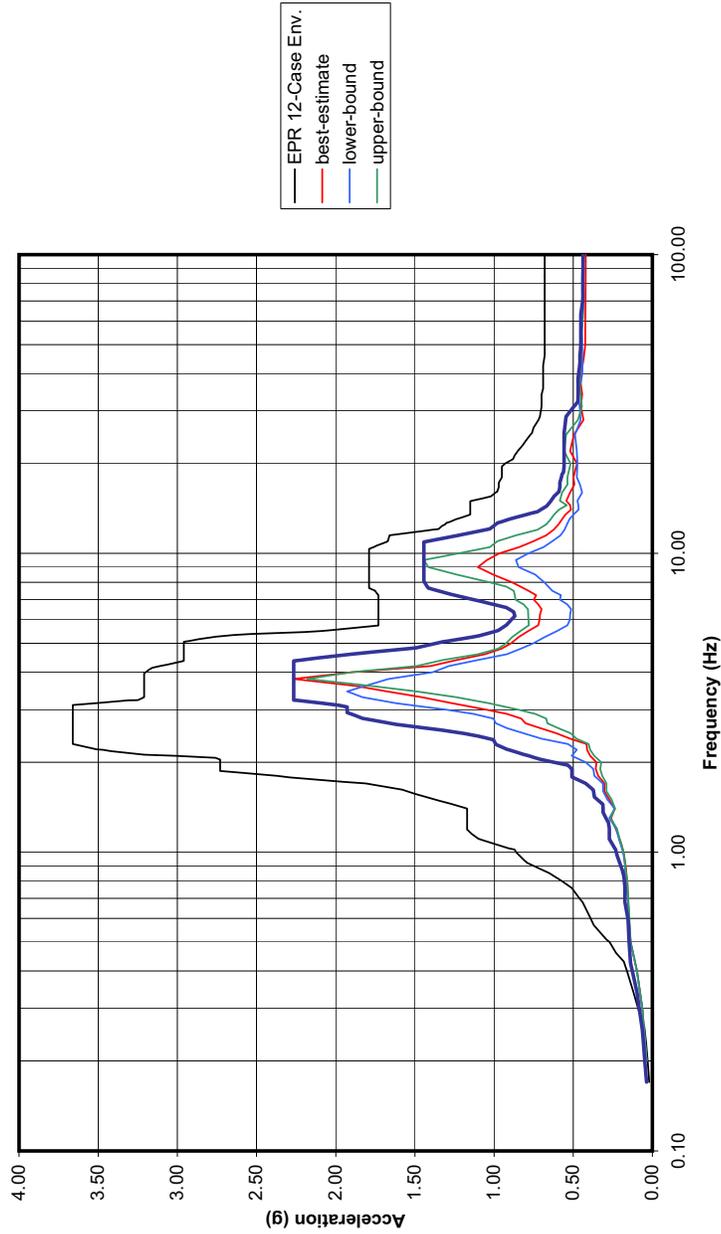
**Figure 3.7-47—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 15.4m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



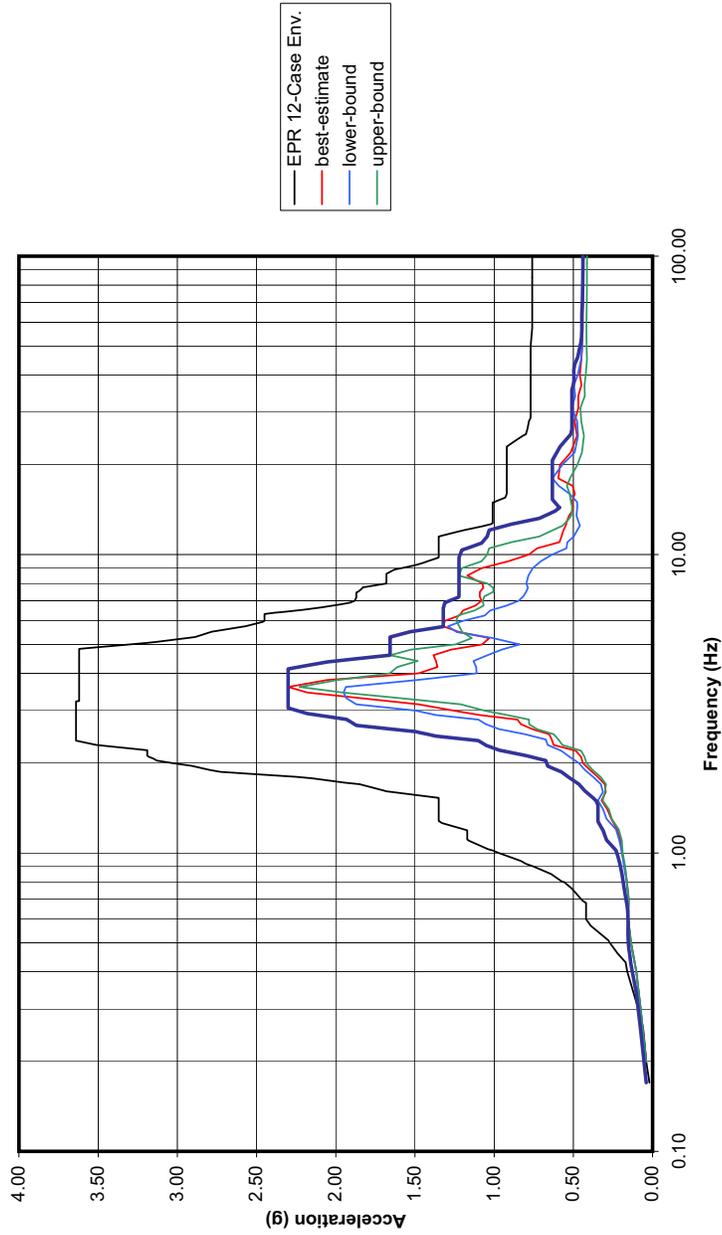
**Figure 3.7-48—(Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 2/3, 15.4m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping)**



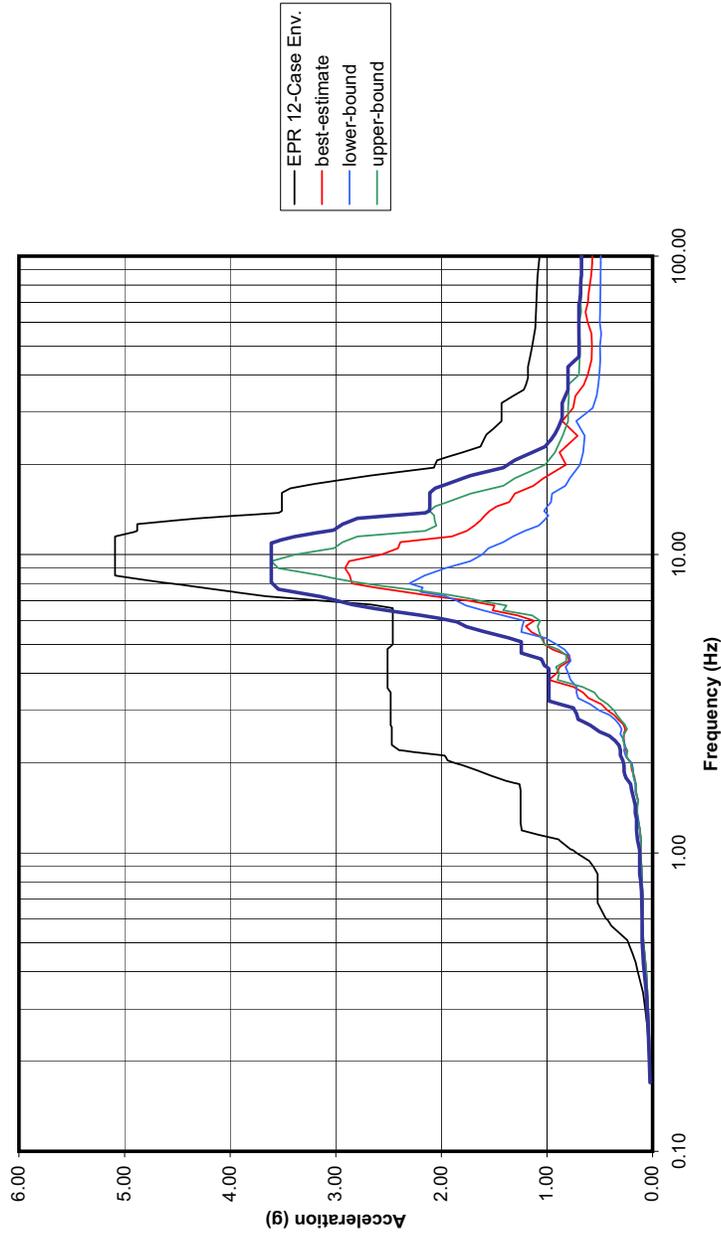
**Figure 3.7-49—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 4, 21.0m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



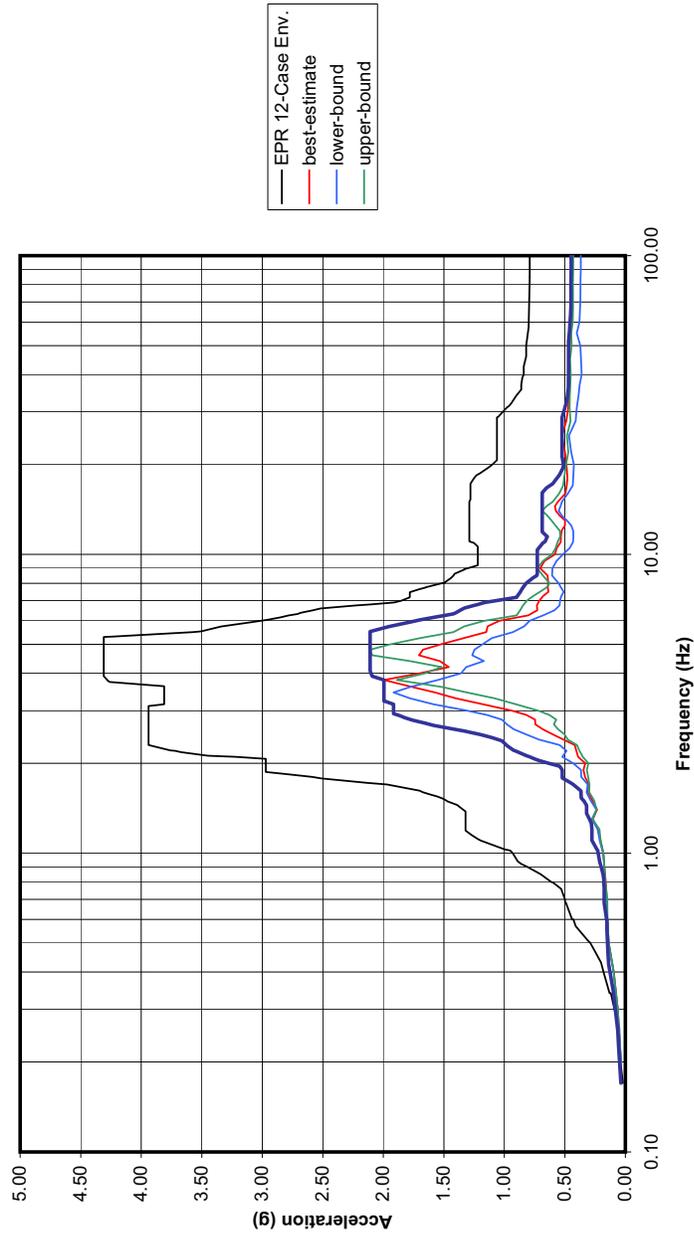
**Figure 3.7-50—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 4, 21.0m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



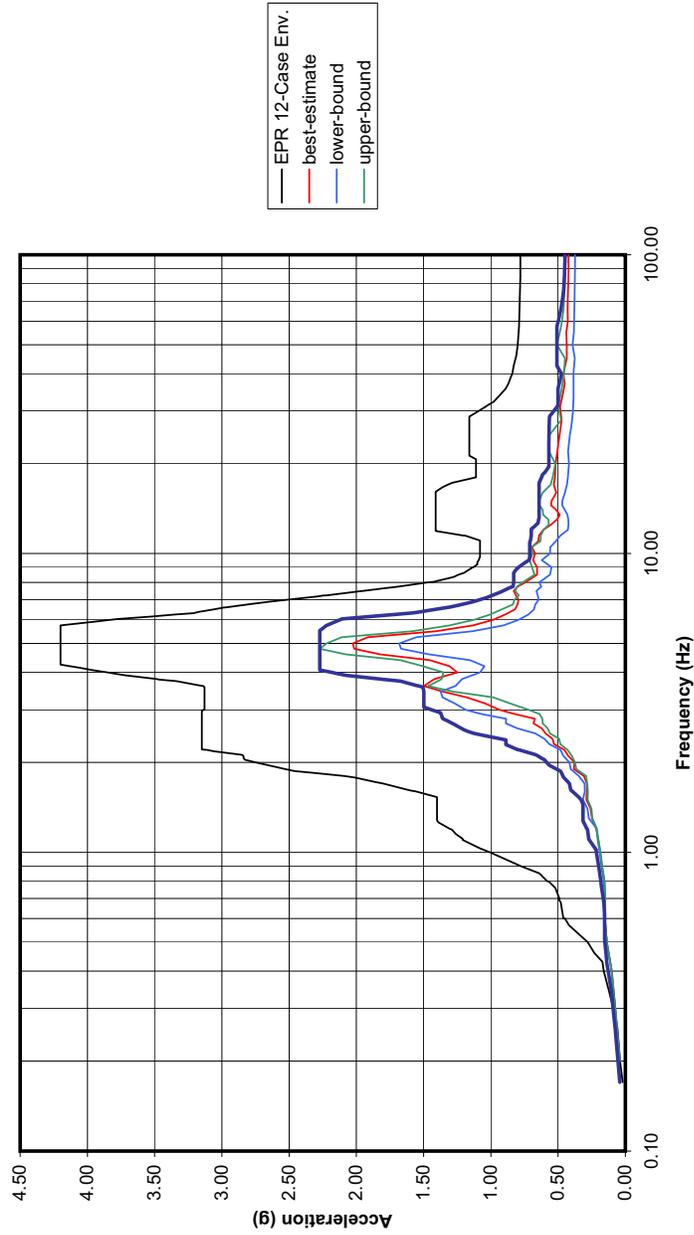
**Figure 3.7-51 — {Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Safeguard Building 4, 21.0m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



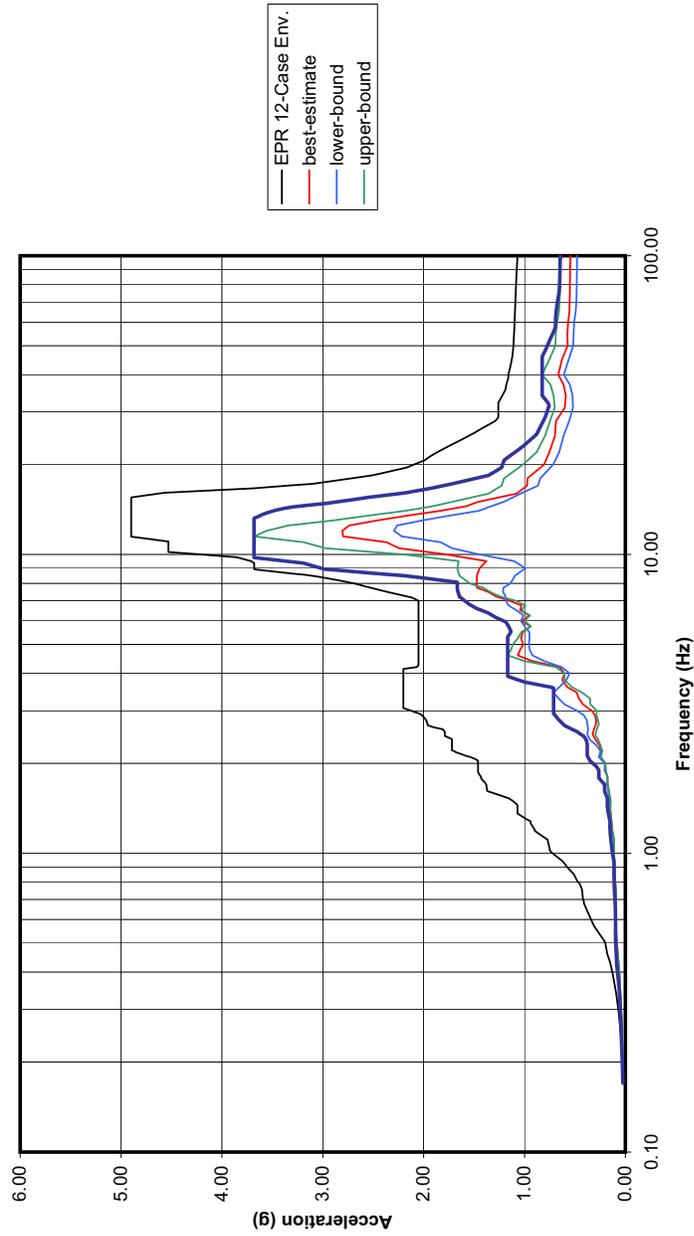
**Figure 3.7-52—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 37.60m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



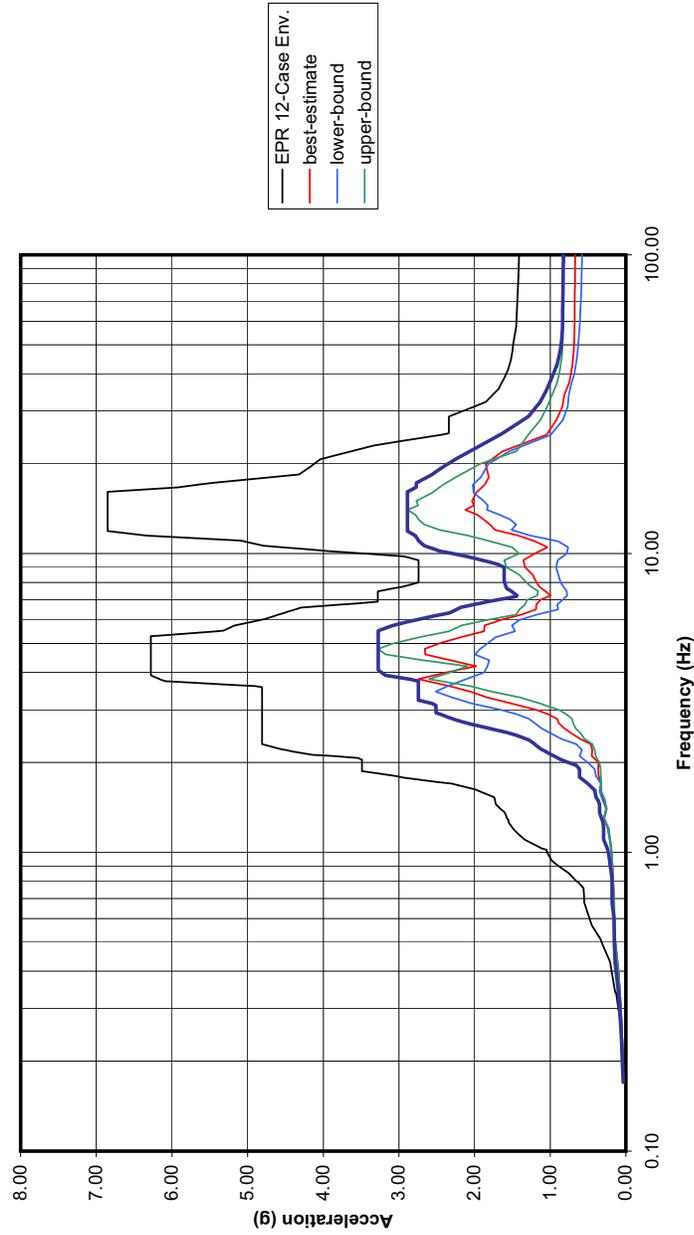
**Figure 3.7-53—(Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 37.60m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping)**



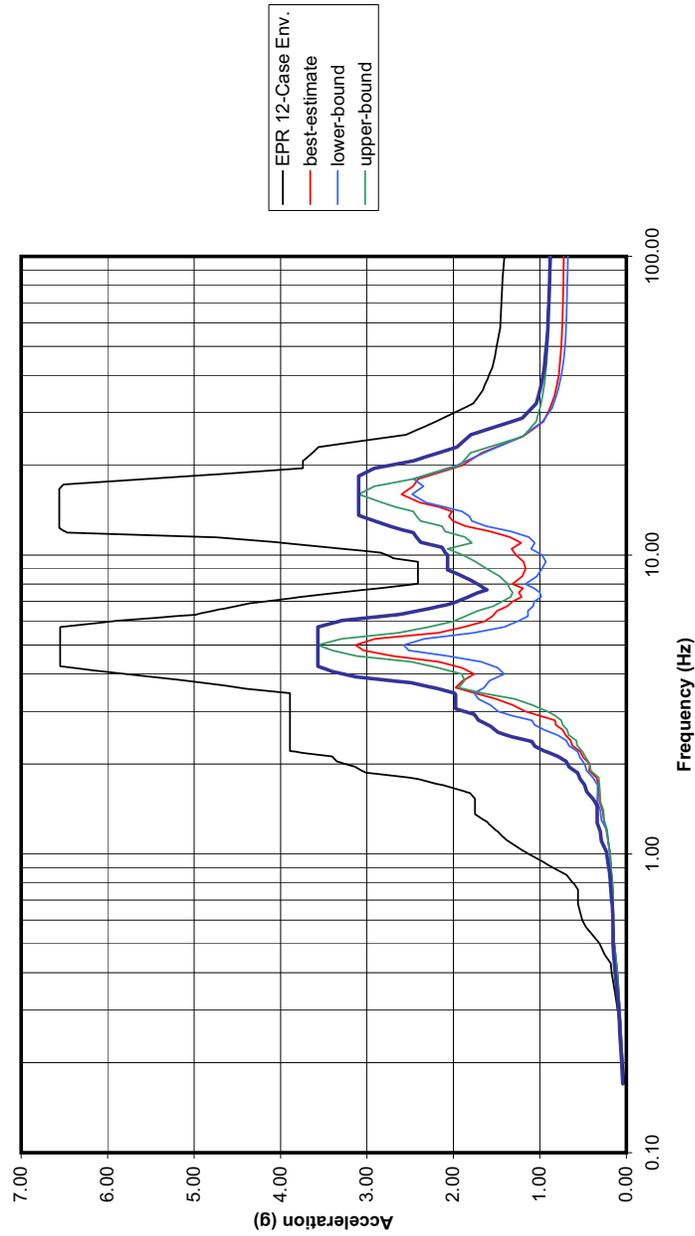
**Figure 3.7-54—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 37.60m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**



**Figure 3.7-55—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 58.00m, ±15% Peak-Broadened, X(E-W) Direction, 5% Damping}**



**Figure 3.7-56—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 58.00m, ±15% Peak-Broadened, Y(N-S) Direction, 5% Damping}**



**Figure 3.7-57—{Comparison of Callaway Plant Unit 2 (bold, dark blue) versus US EPR Standard In-structure Response Spectra, Containment Building, Elev. 58.00m, ±15% Peak-Broadened, Z(Vertical) Direction, 5% Damping}**

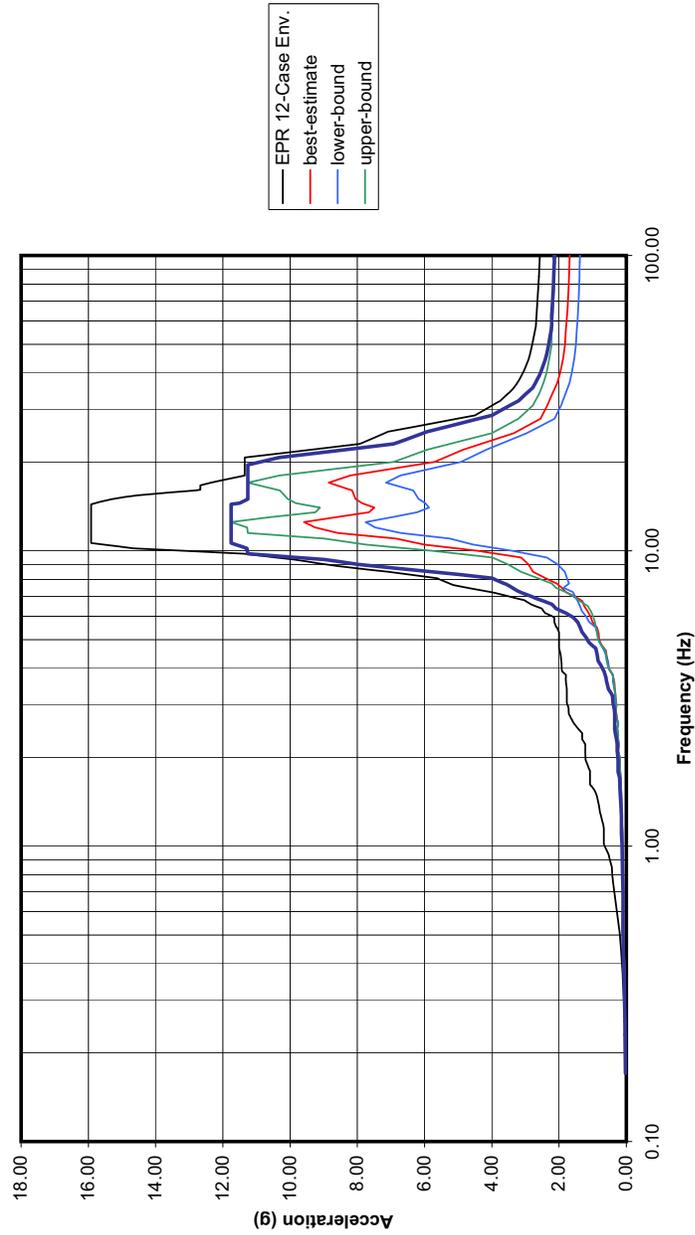


Figure 3.7-58—{Callaway EPGB, Elev. 0.0m, X(E-W) Direction, 5% Damping}

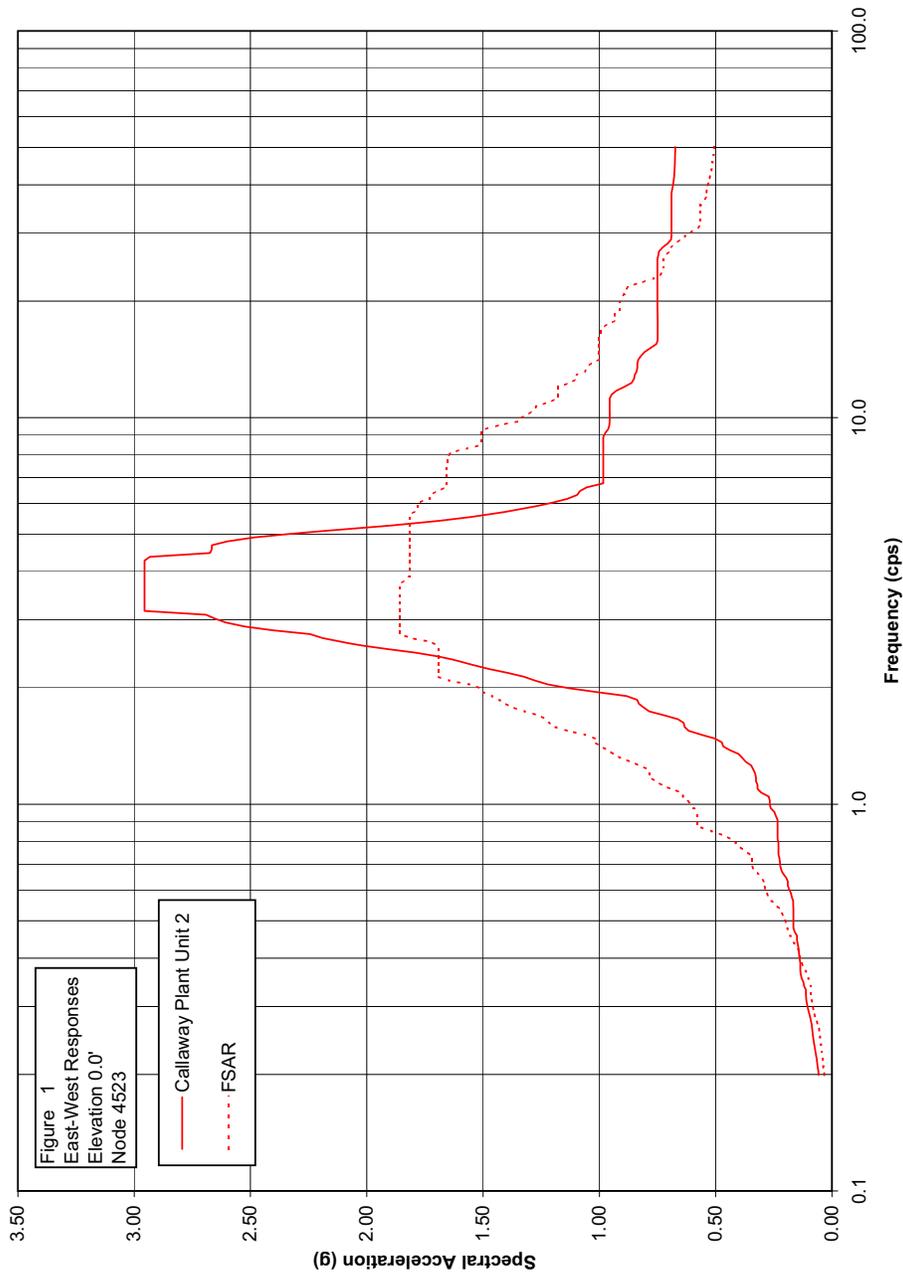


Figure 3.7-59—{Callaway EPGB, Elev. 0.0m, Y(N-S) Direction, 5% Damping}

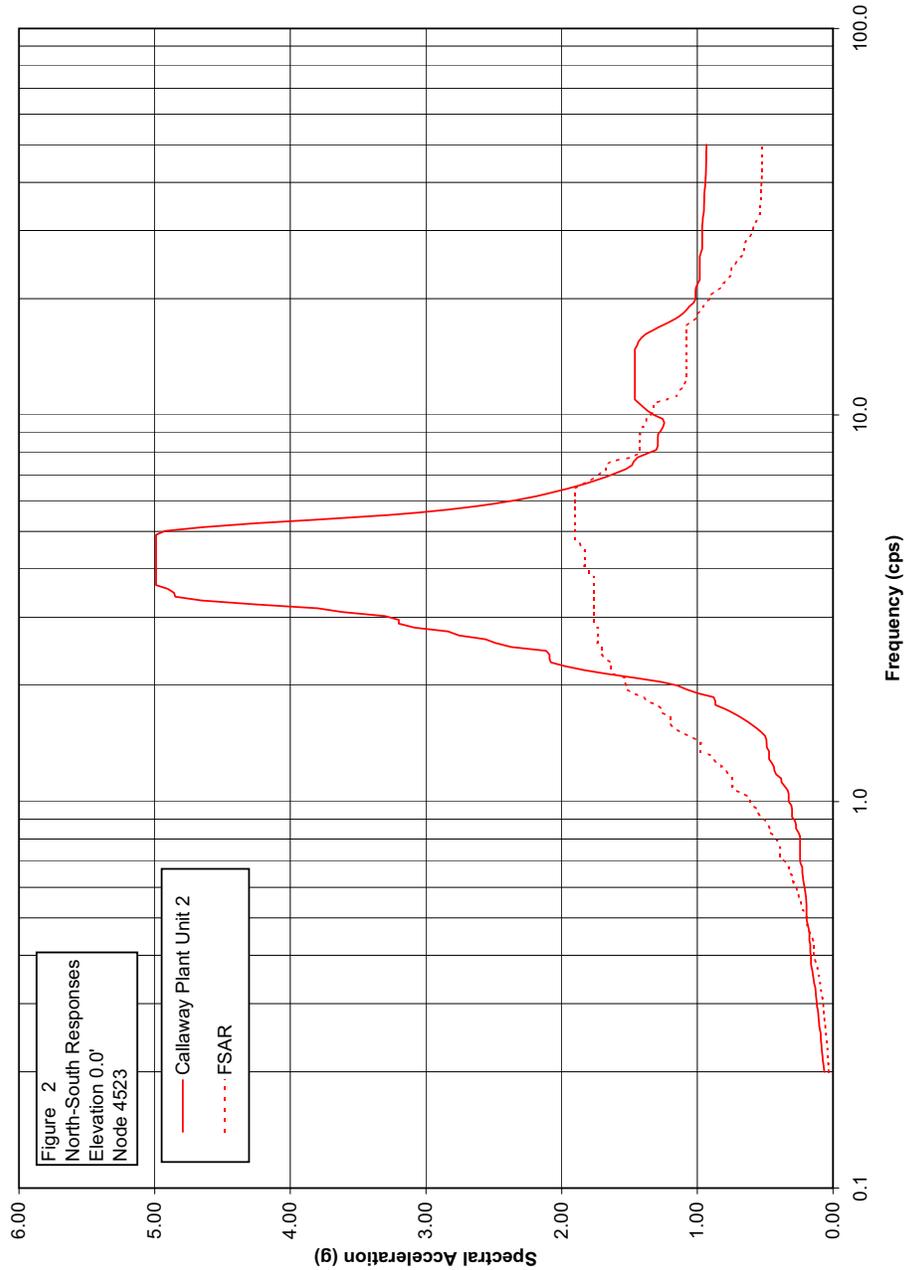


Figure 3.7-60—{Callaway EPGB, Elev. 0.0m, Z(Vertical) Direction, 5% Damping}

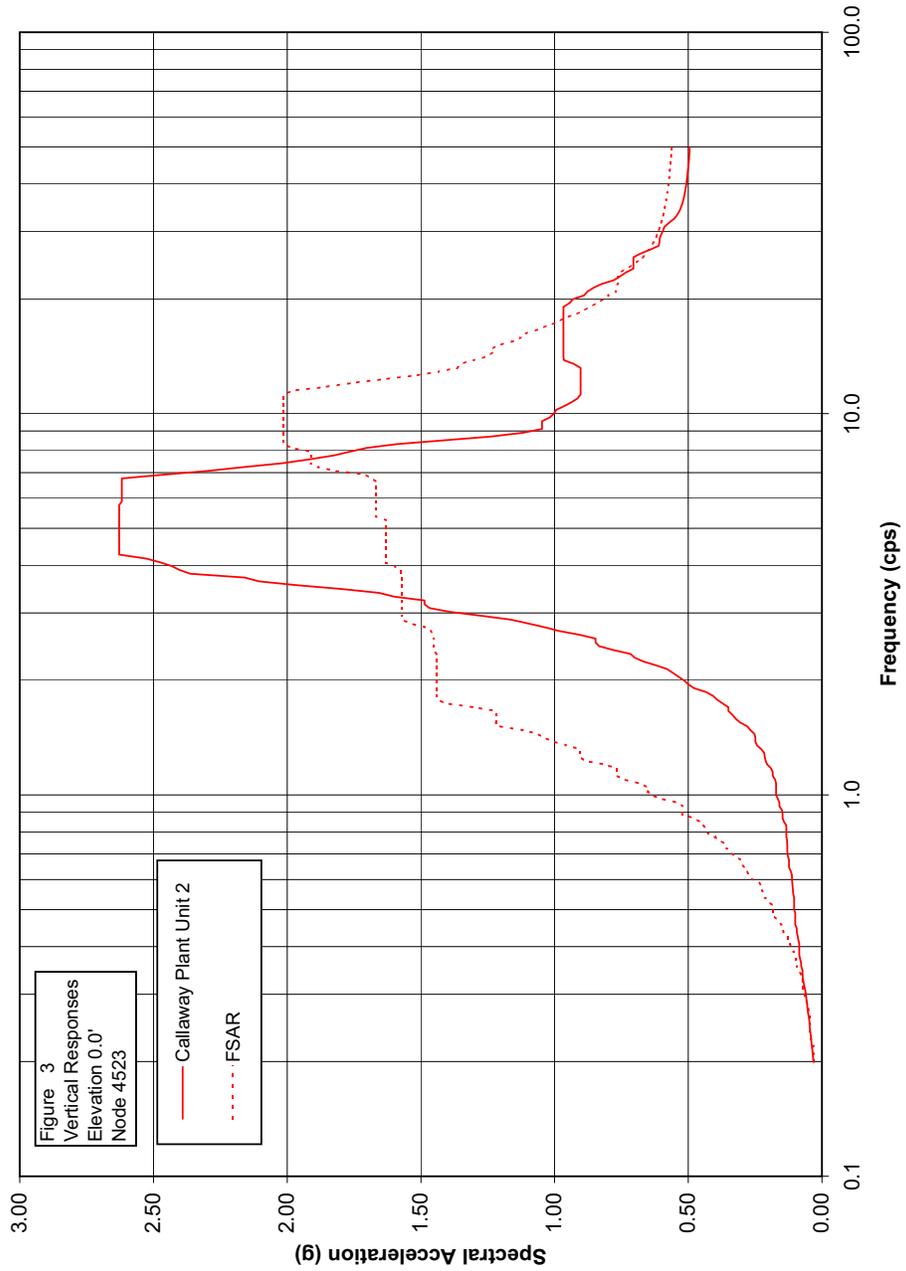


Figure 3.7-61 — {Callaway ESWB, Elev. 19.20m, X(E-W) Direction, 5% Damping}

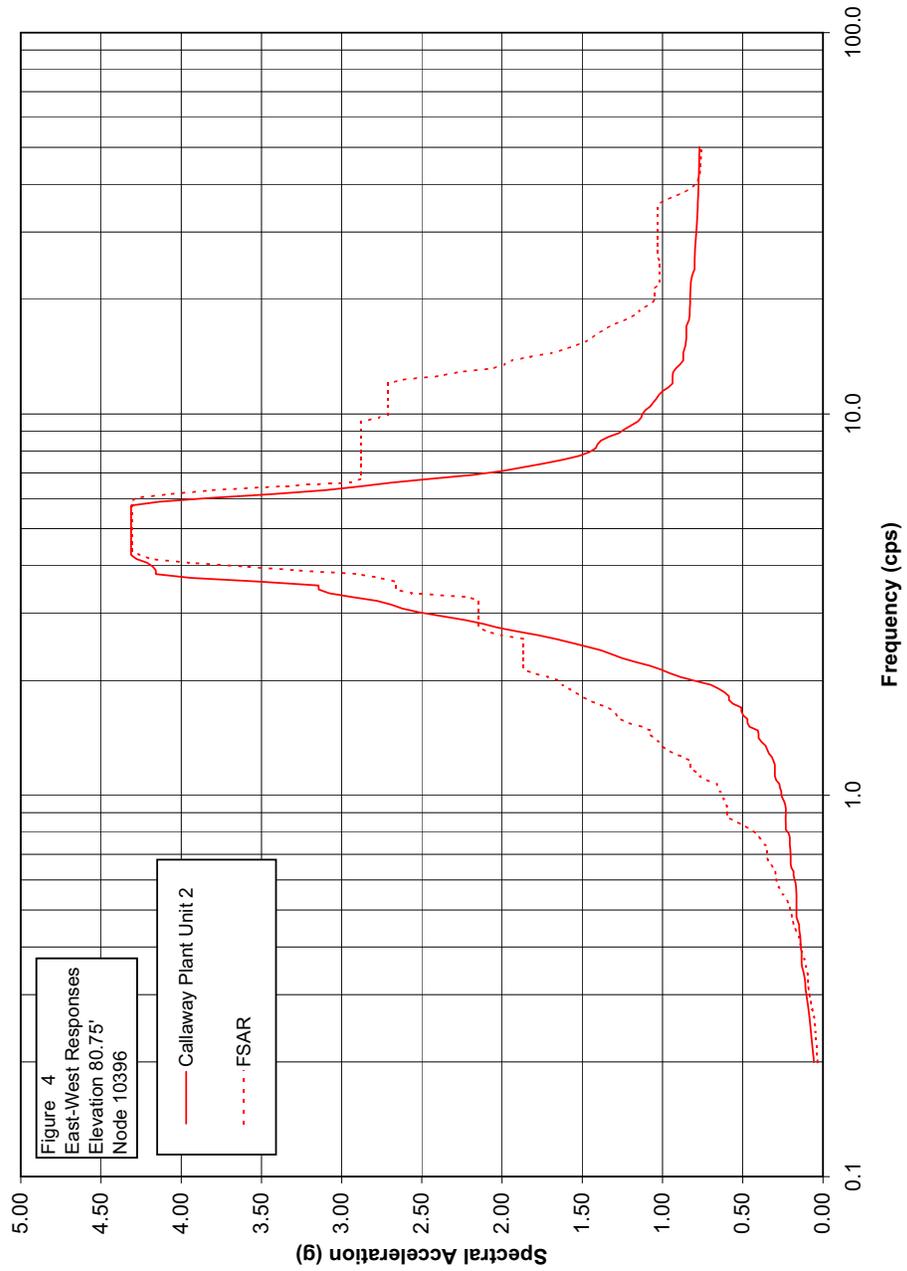


Figure 3.7-62—{Callaway ESWB, Elev. 19.20m, Y(N-S) Direction, 5% Damping}

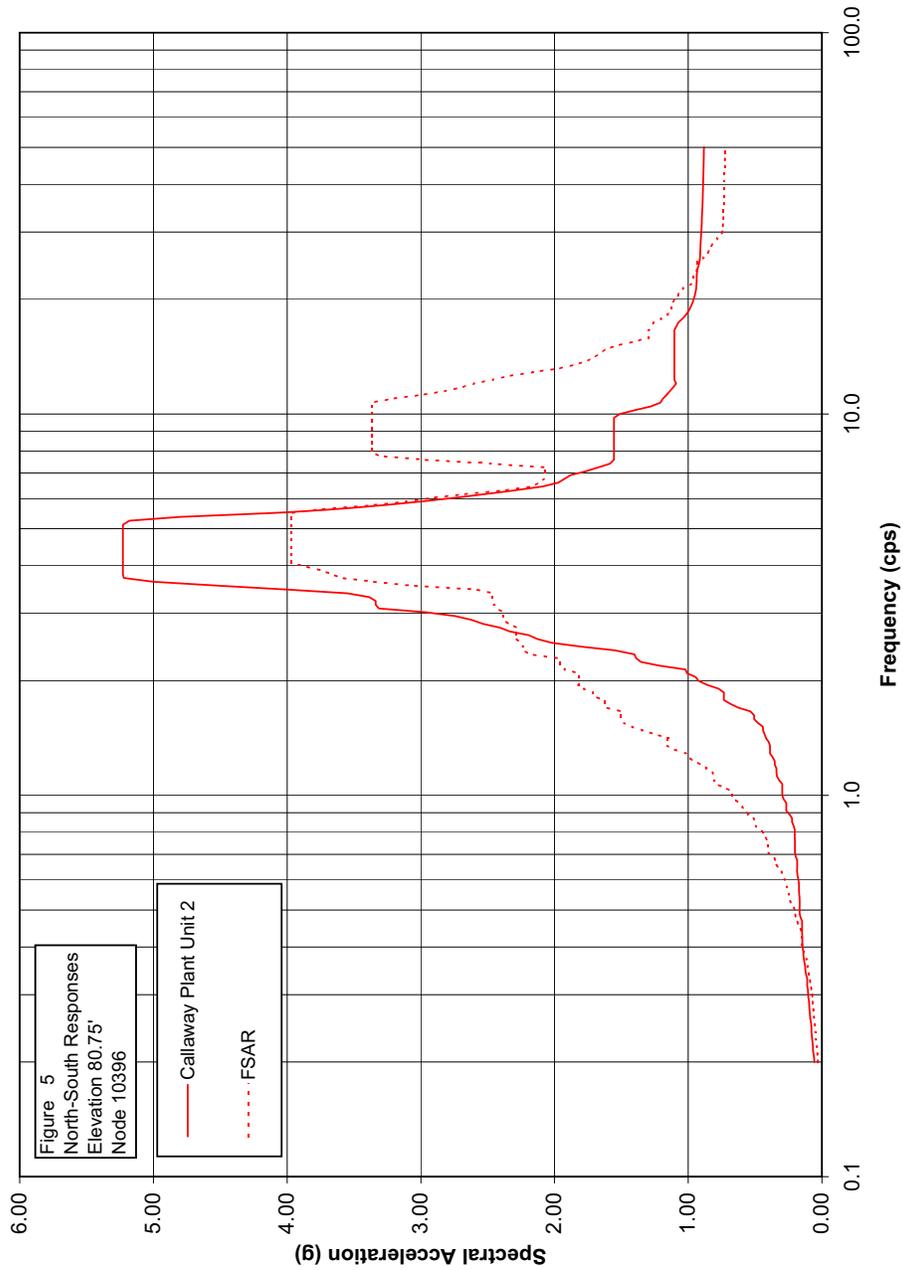
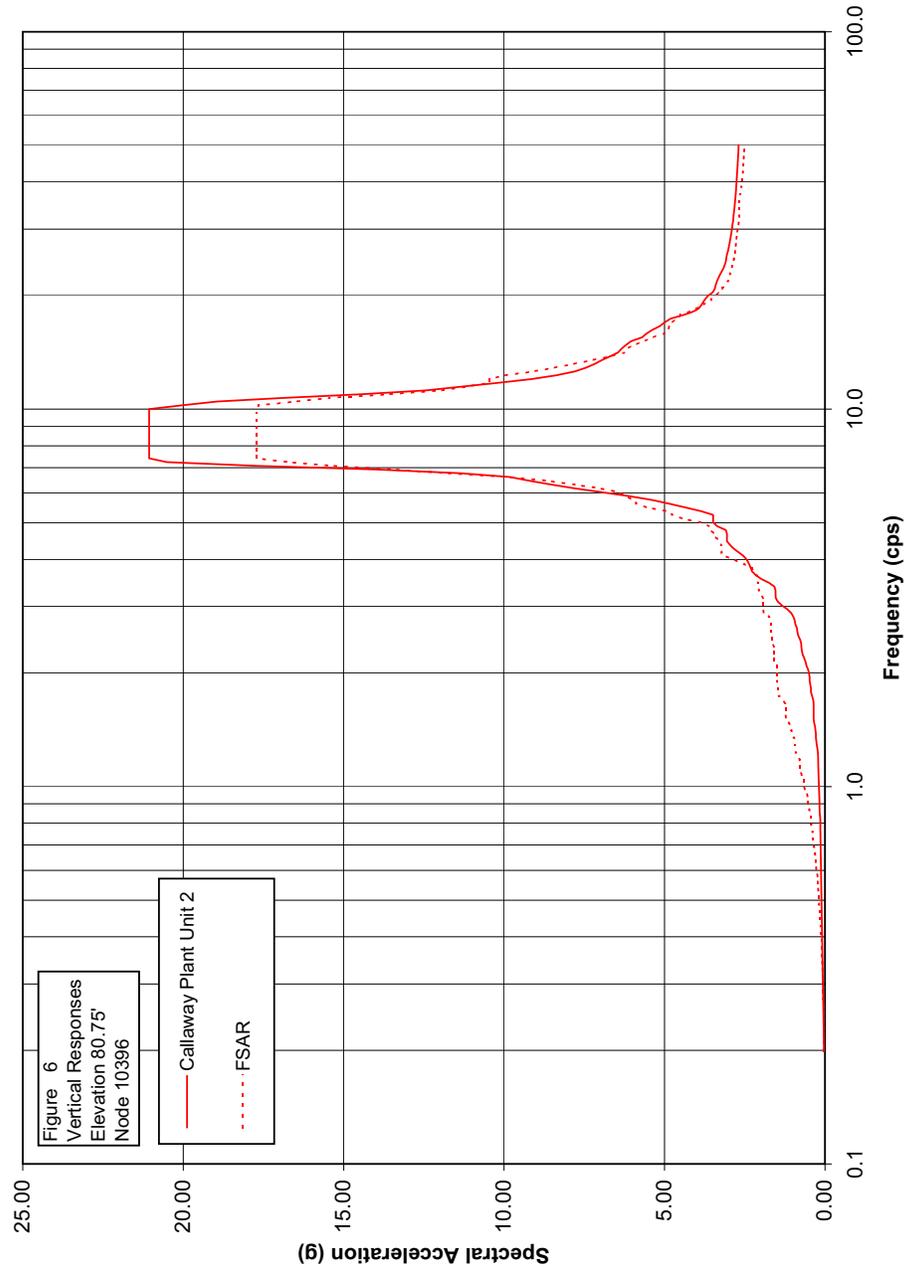


Figure 3.7-63—Callaway ESWB, Elev. 19.20m, Z(Vertical) Direction, 5% Damping



**Figure 3.7-64—Callaway ESWB, Elev. 4.27m, X(E-W) Direction, 5% Damping**

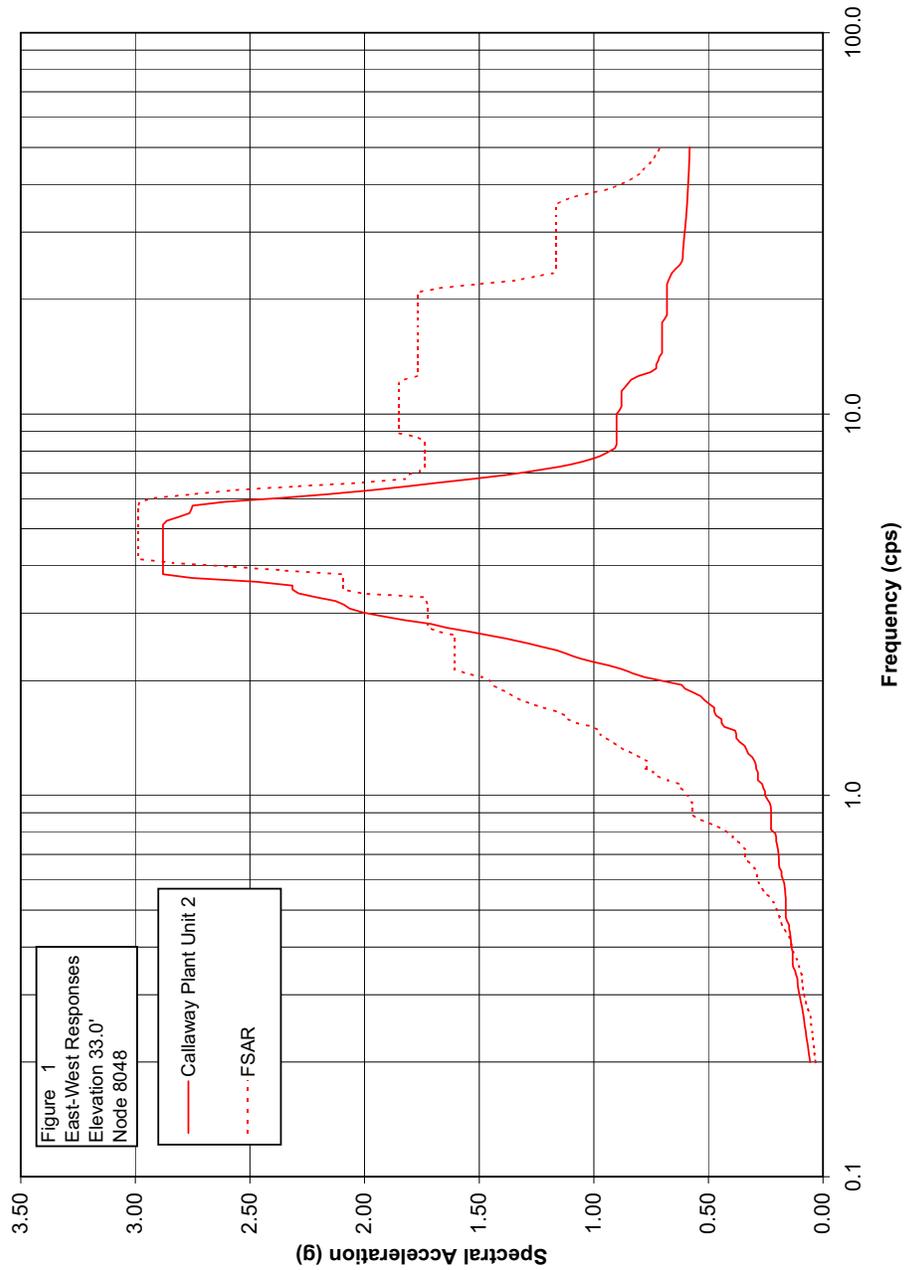


Figure 3.7-65—Callaway ESWB, Elev. 4.27m, Y(N-S) Direction, 5% Damping

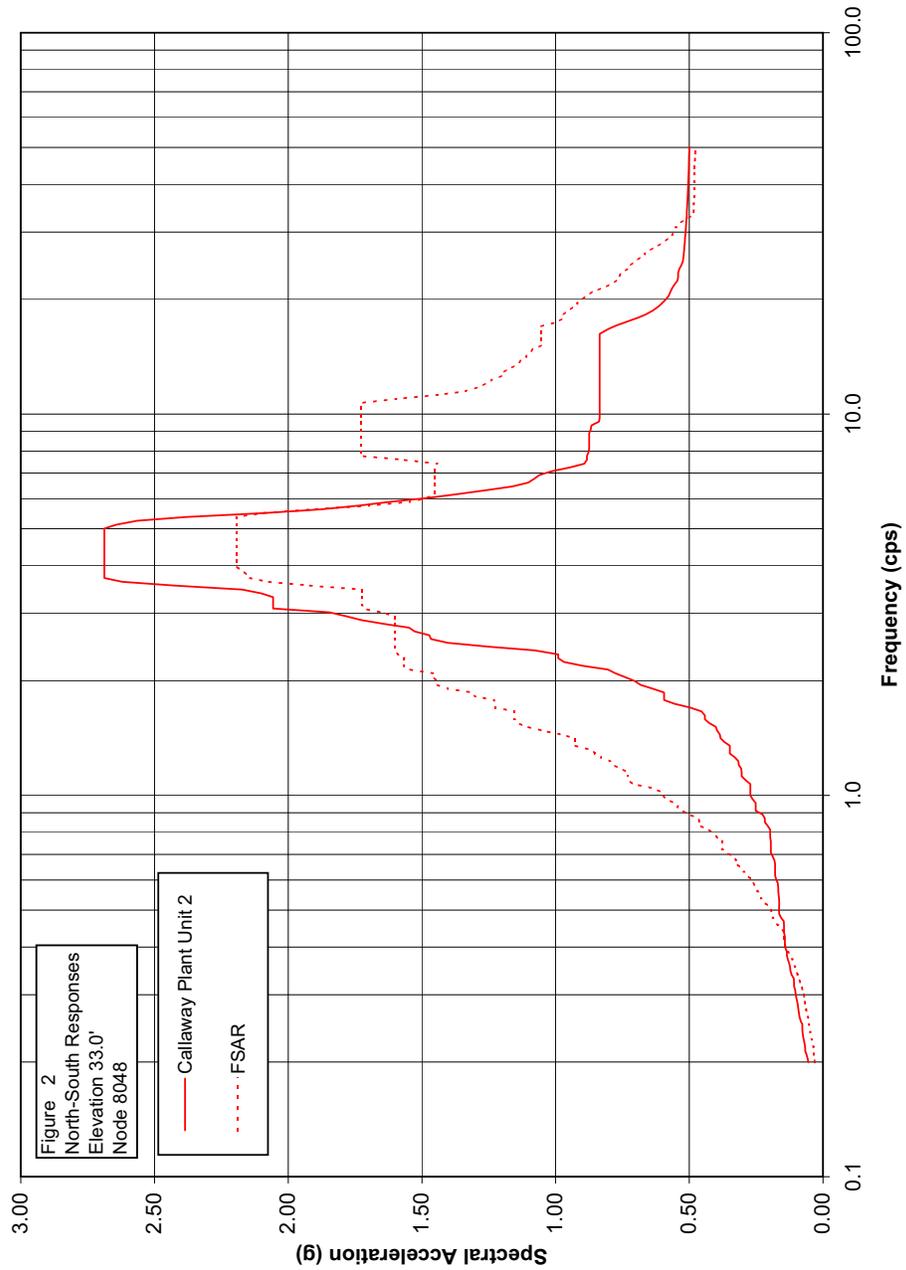
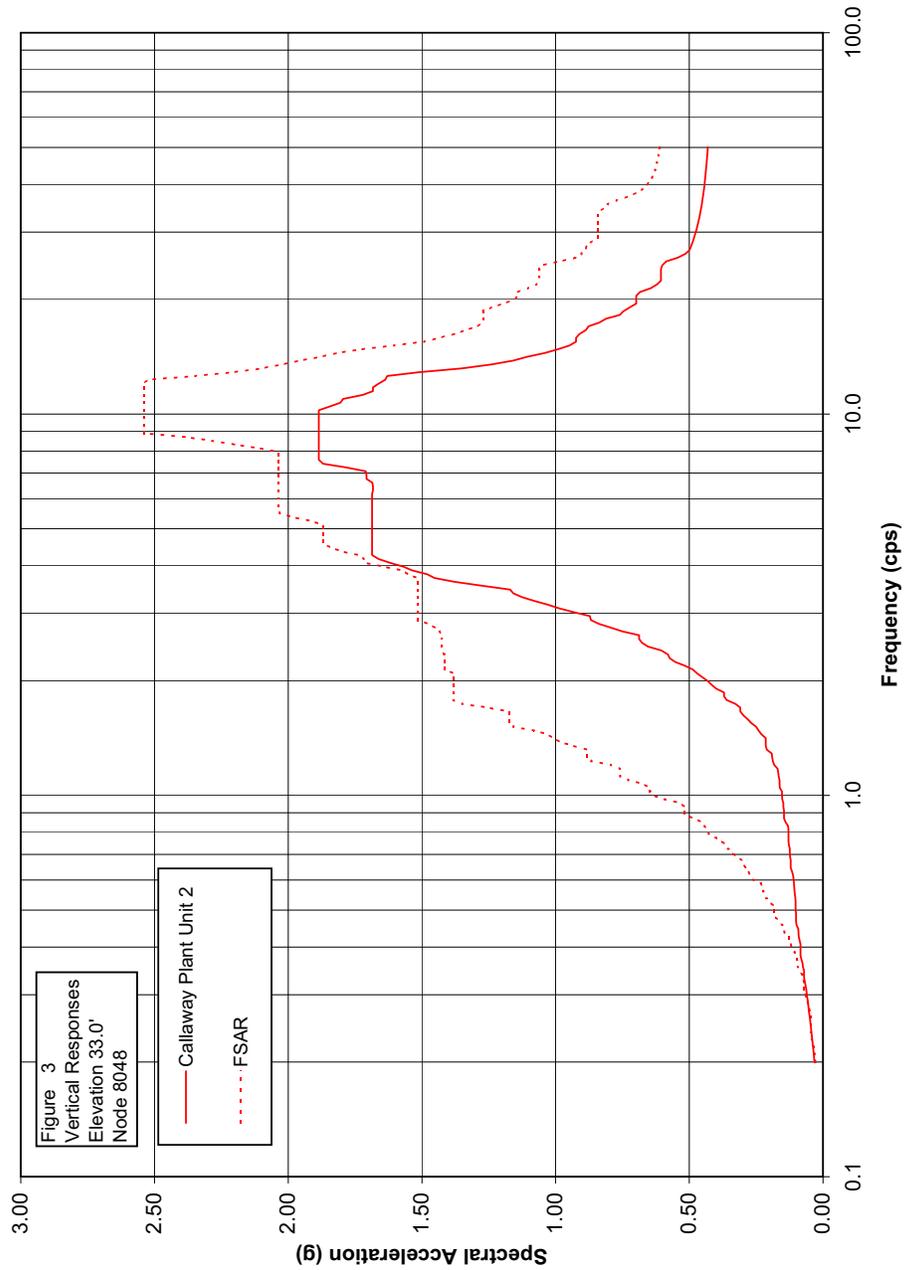
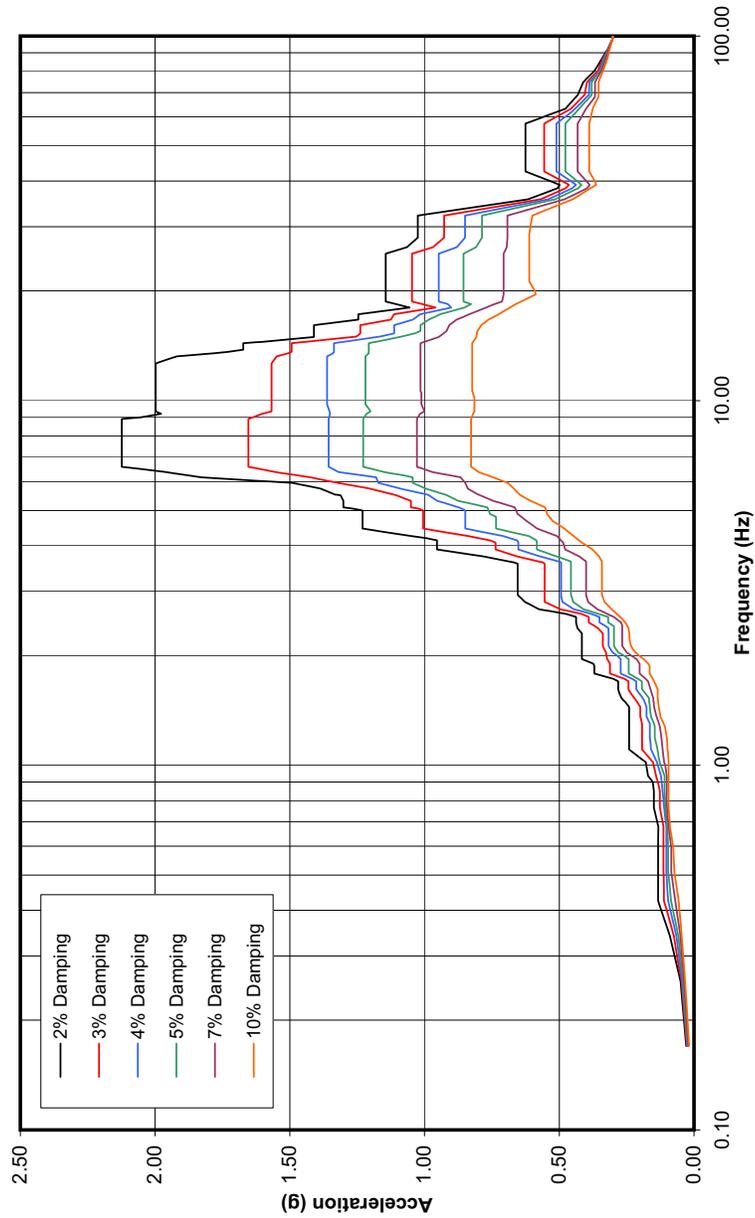


Figure 3.7-66—Callaway ESWB, Elev. 4.27m, Z(Vertical) Direction, 5% Damping



**Figure 3.7-67—US EPR Callaway Plant Unit 2 In-structure Response Spectra, Reactor Building Internals, Elev. 5.15m, ±15% Peak-Broadened, Z(Vertical) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**



**Figure 3.7-68—Callaway Spectrum Envelope of EPGB, Elev. 0.0m, X(E-W) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**

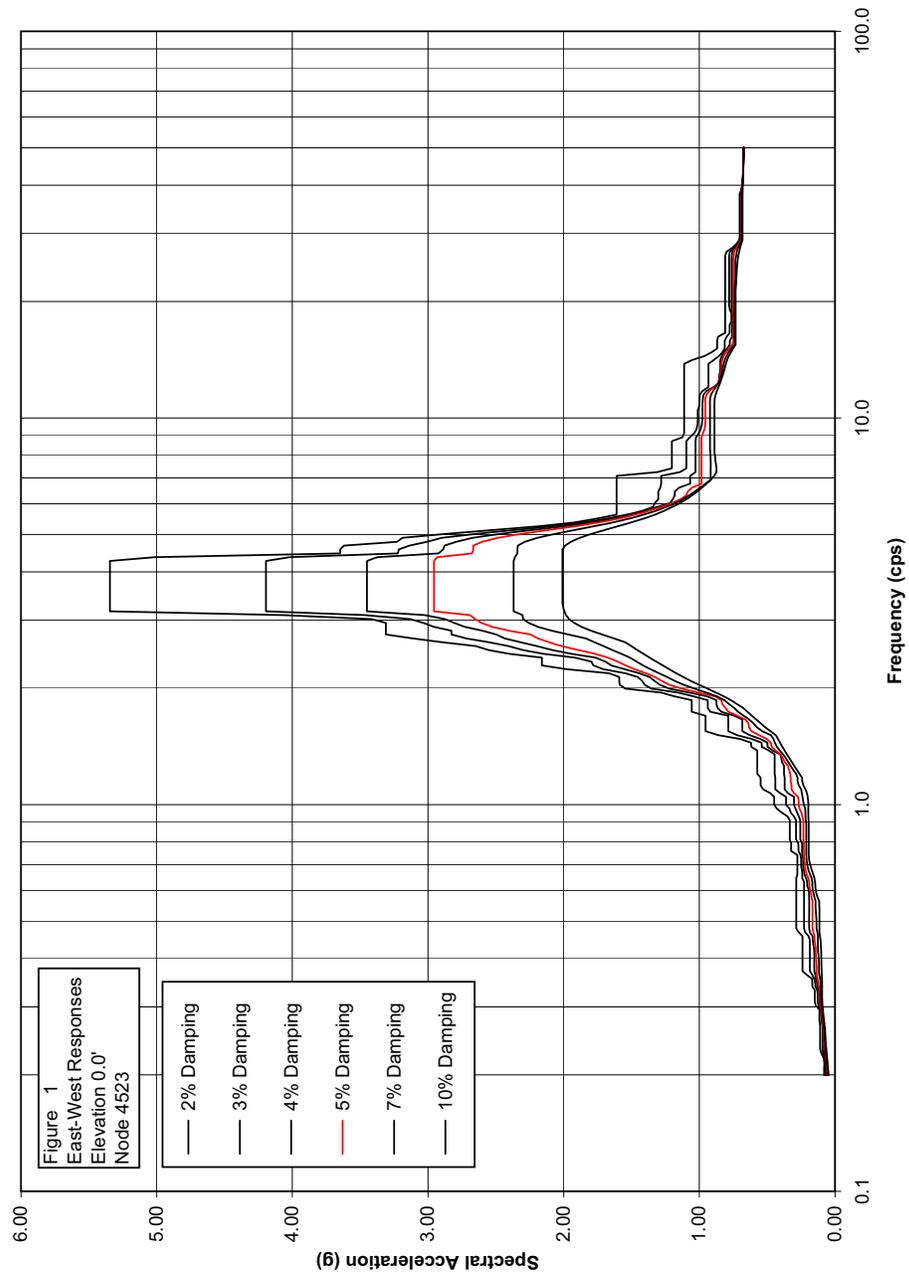
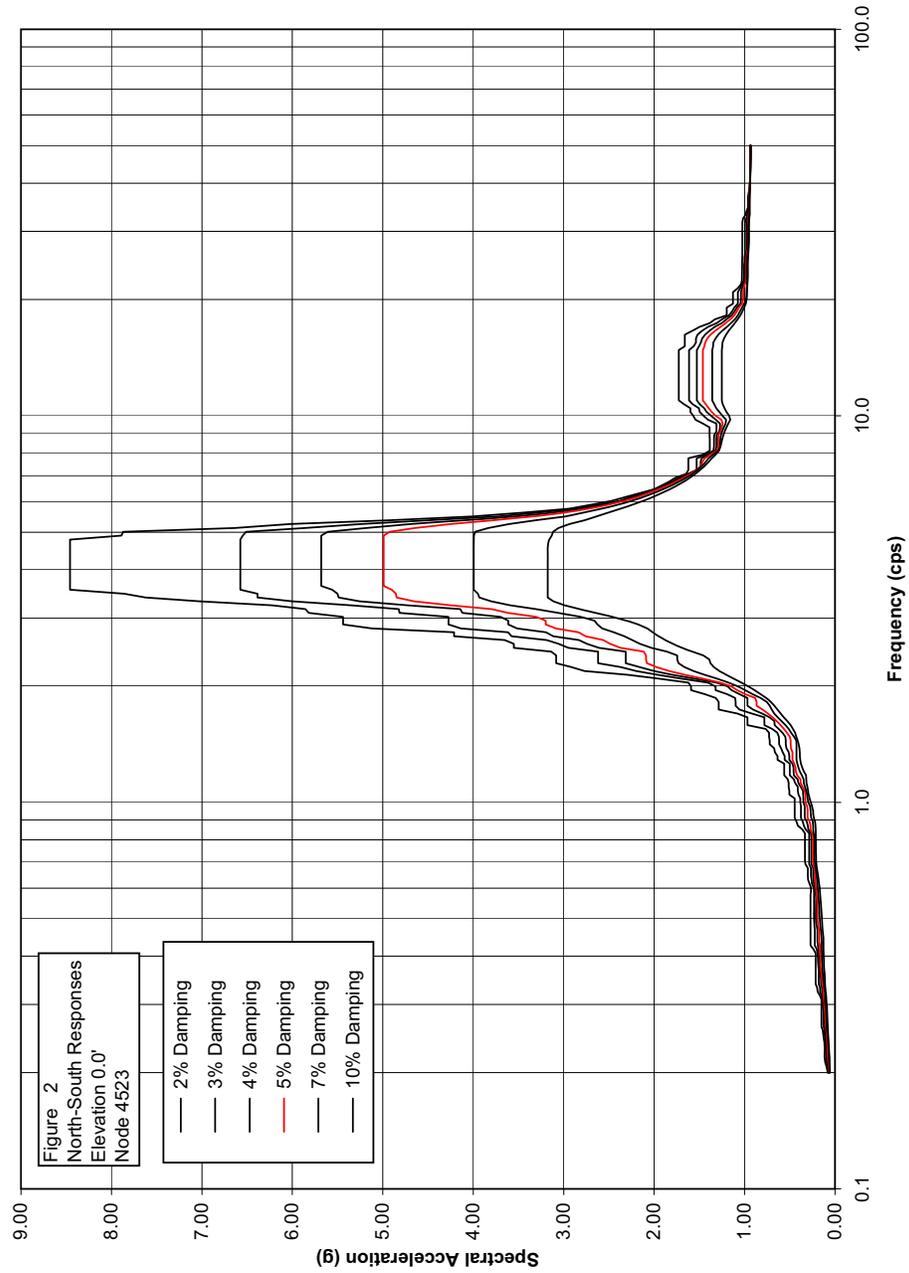
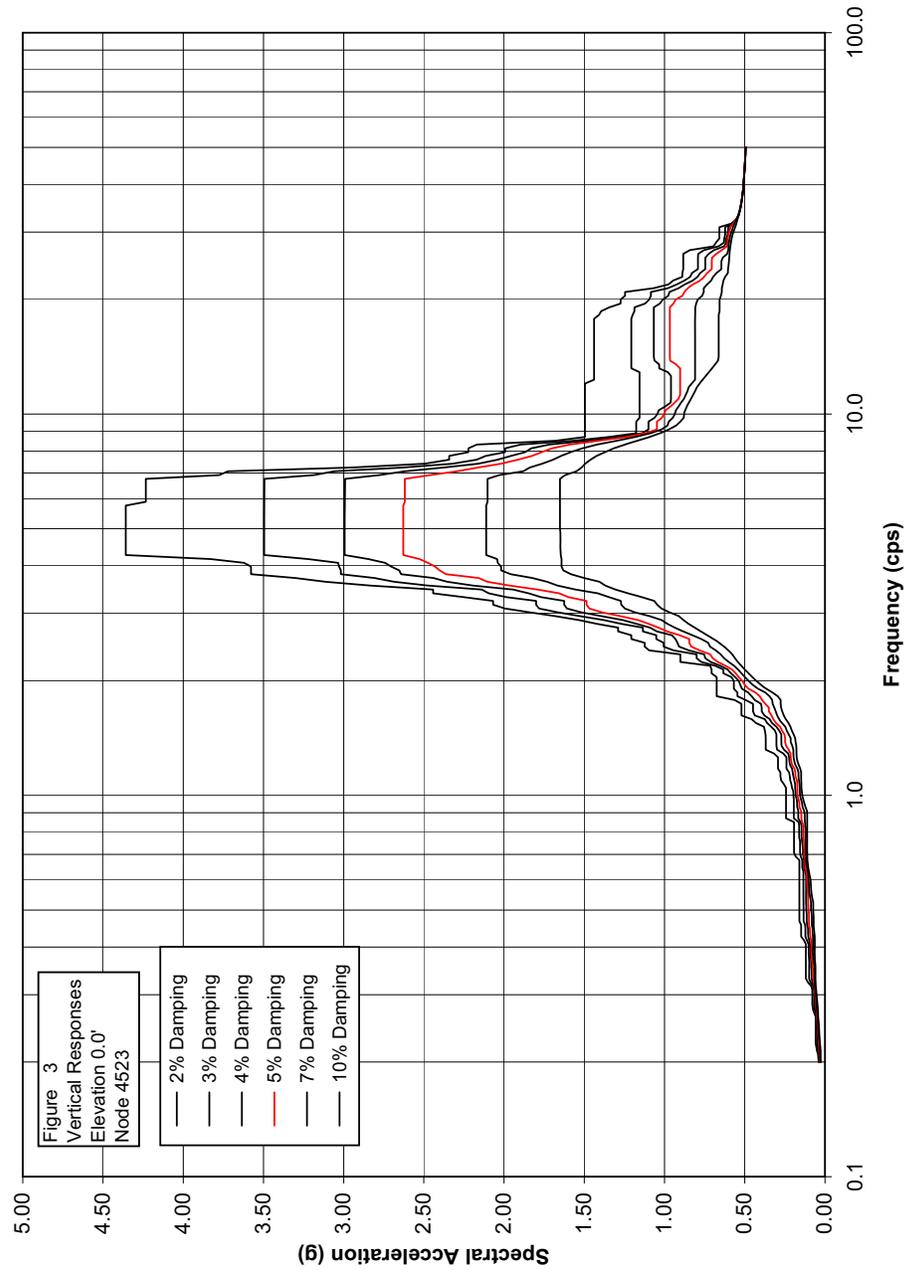


Figure 3.7-69—Callaway Spectrum Envelope of EPGB, Elev. 0.0m, Y(N-S) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping



**Figure 3.7-70—Callaway Spectrum Envelope of EPGB, Elev. 0.0m, Z(Vertical) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**



**Figure 3.7-71—Callaway Spectrum Envelope of ESWB, Elev. 19.20m, X(E-W) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**

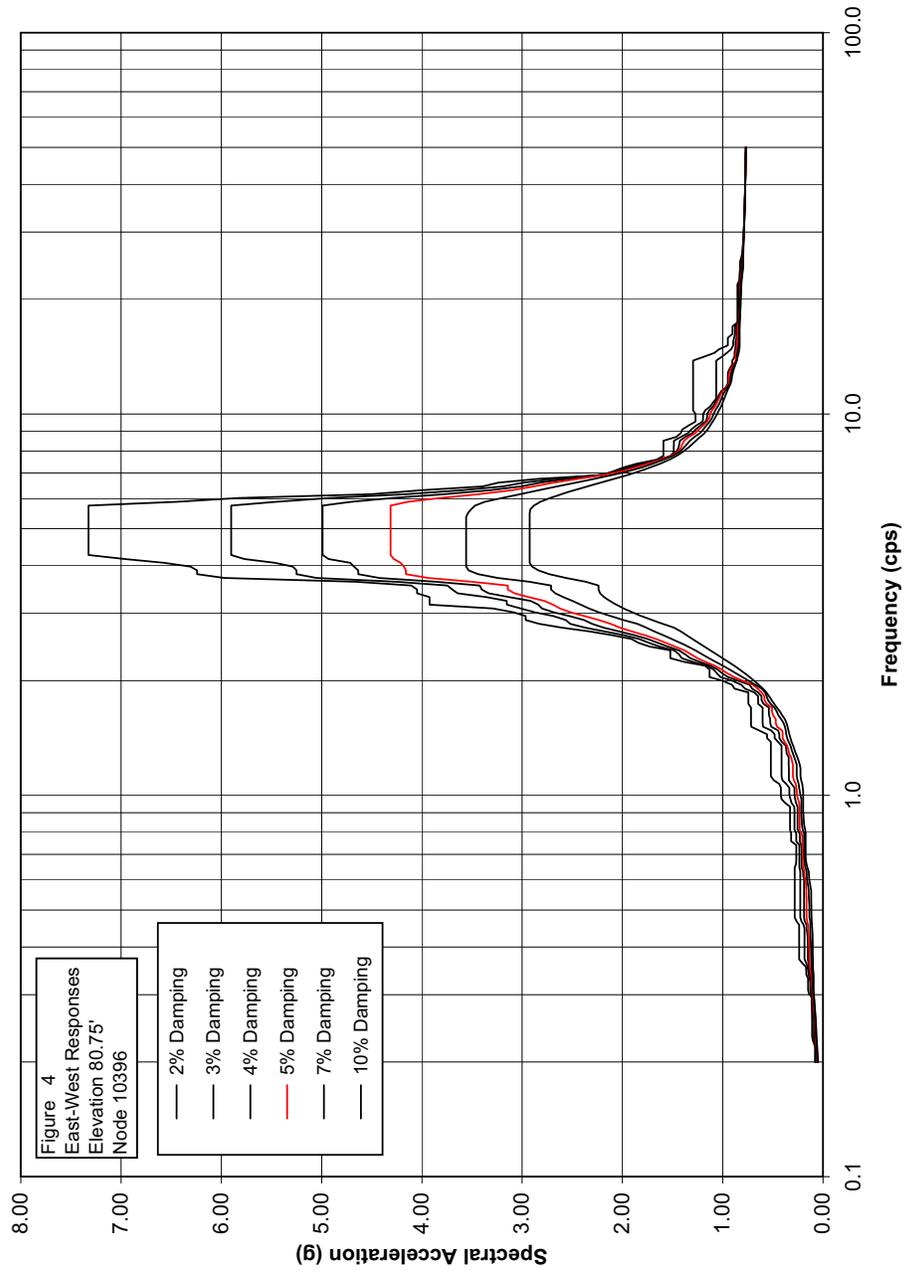
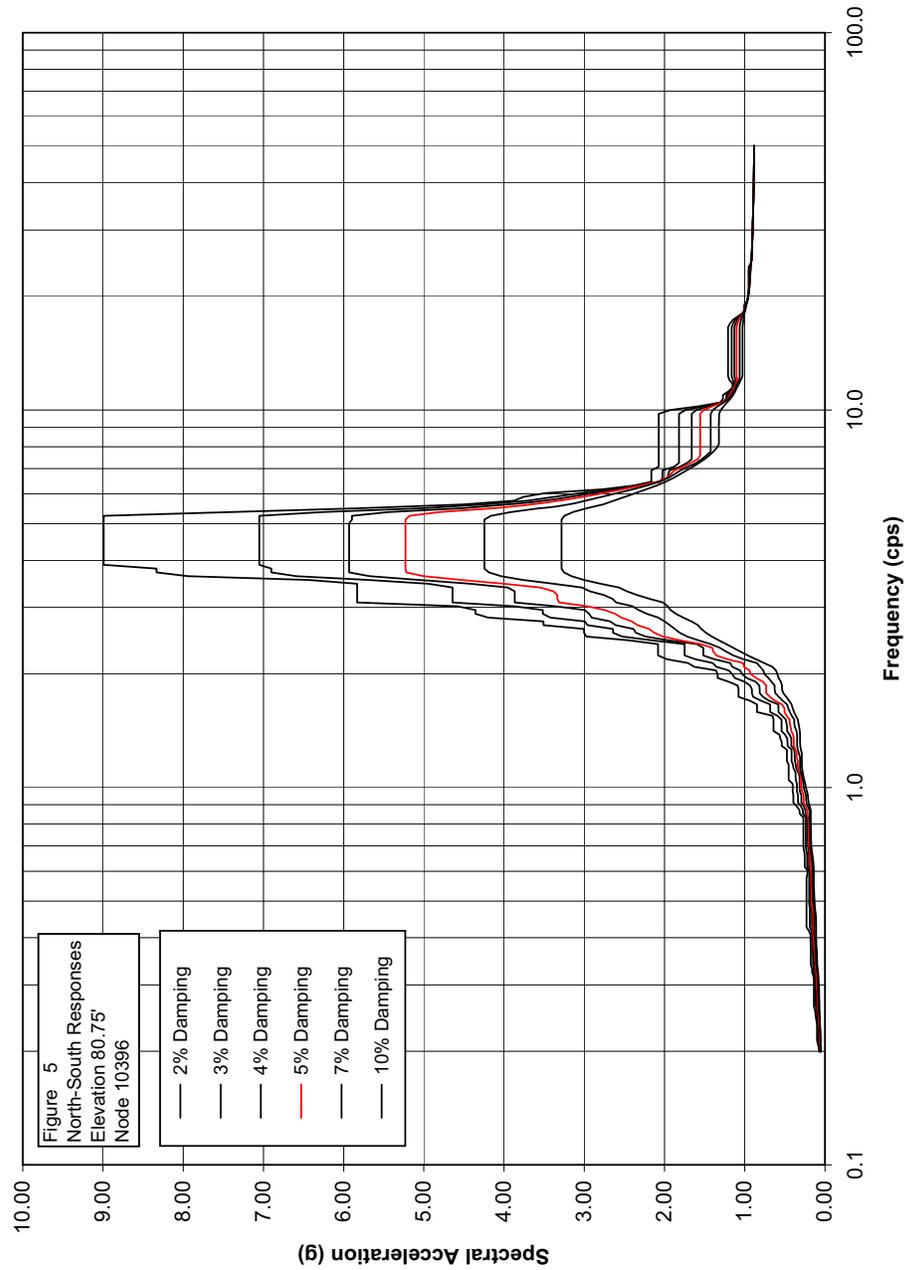
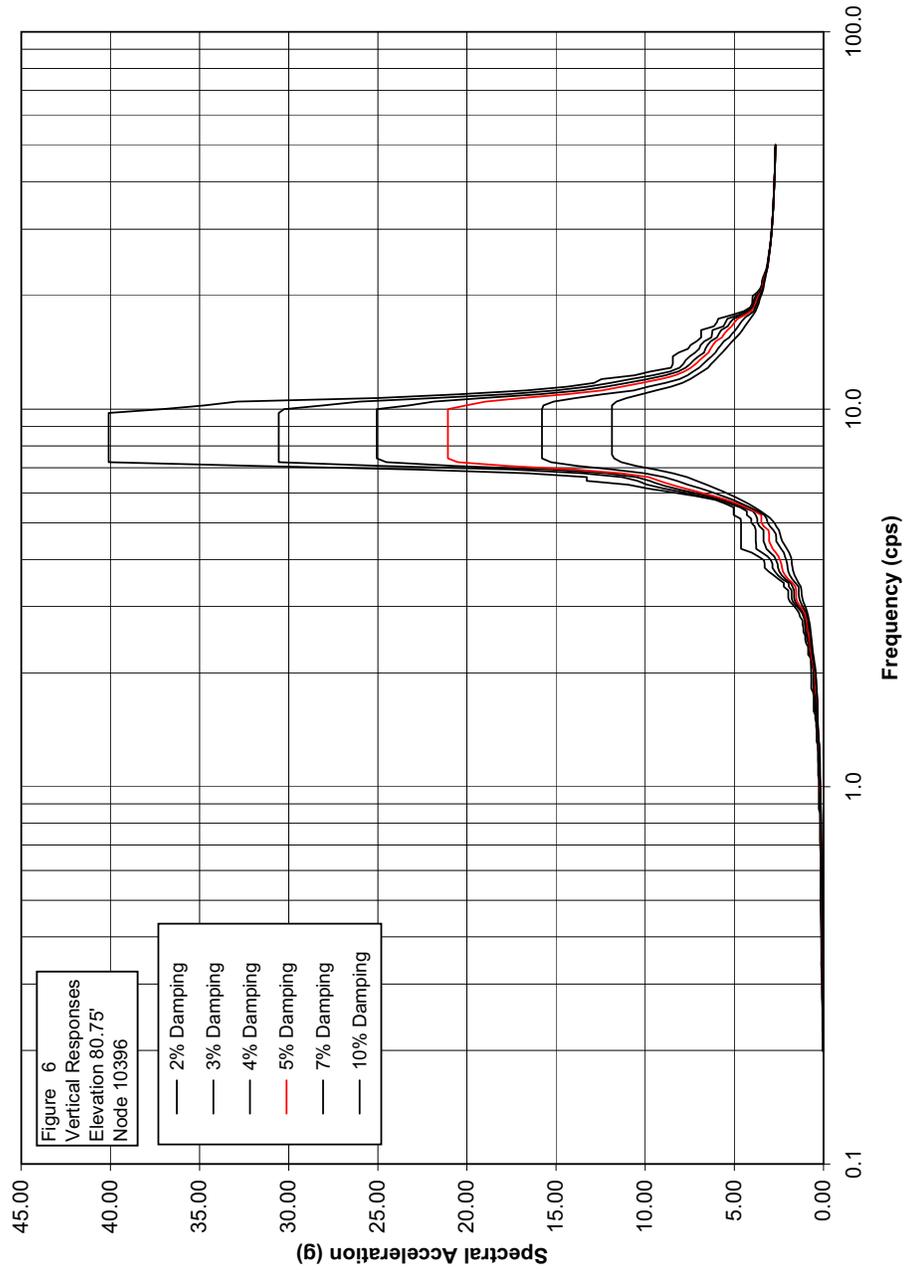


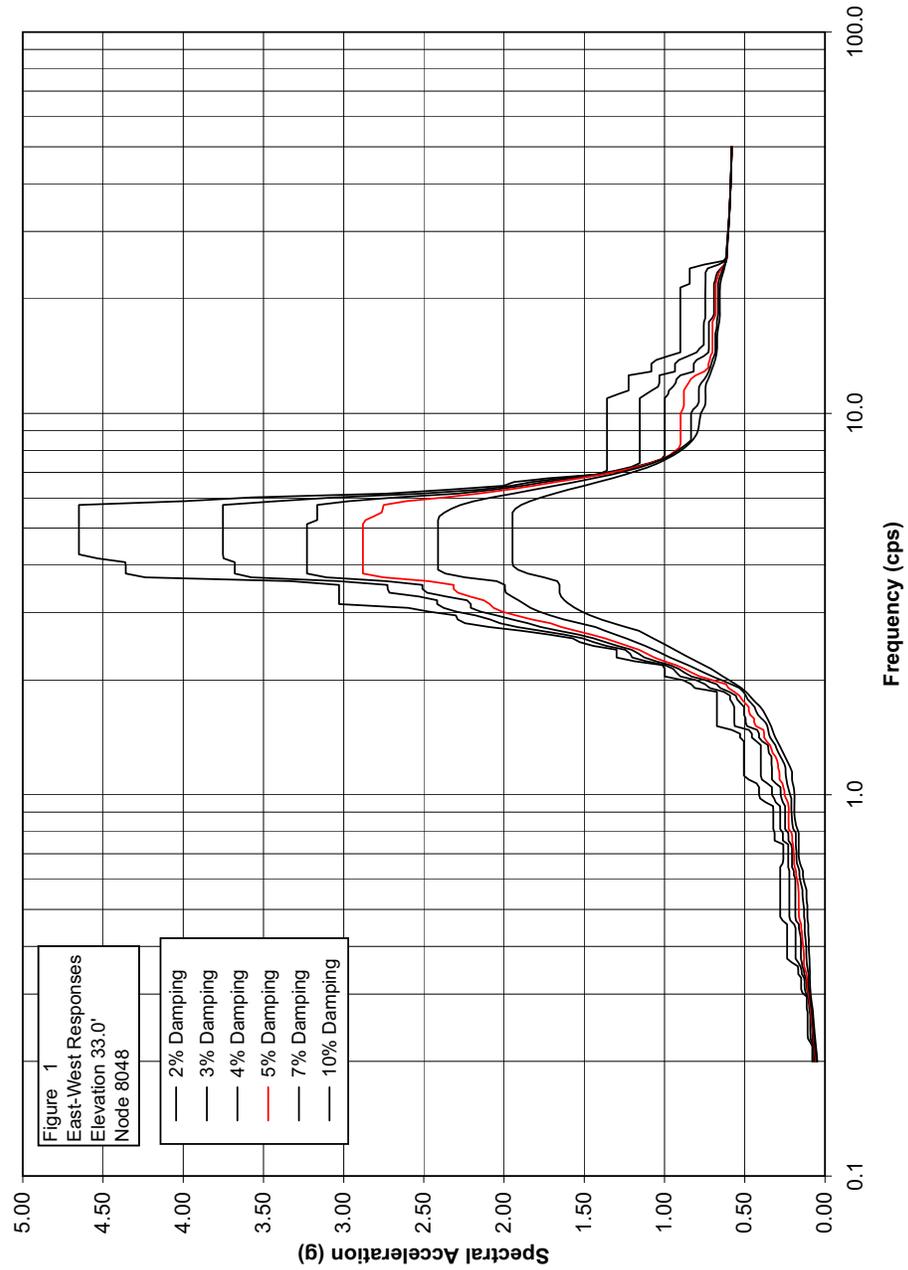
Figure 3.7-72—Callaway Spectrum Envelope of ESWB, Elev. 19.20m, Y(N-S) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping



**Figure 3.7-73—Callaway Spectrum Envelope of ESWB, Elev. 19.20m, Z(Vertical) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**



**Figure 3.7-74—Callaway Spectrum Envelope of ESWB, Elev. 4.27m, X(E-W) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**



**Figure 3.7-75—Callaway Spectrum Envelope of ESWB, Elev. 4.27m, Y(N-S) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping**

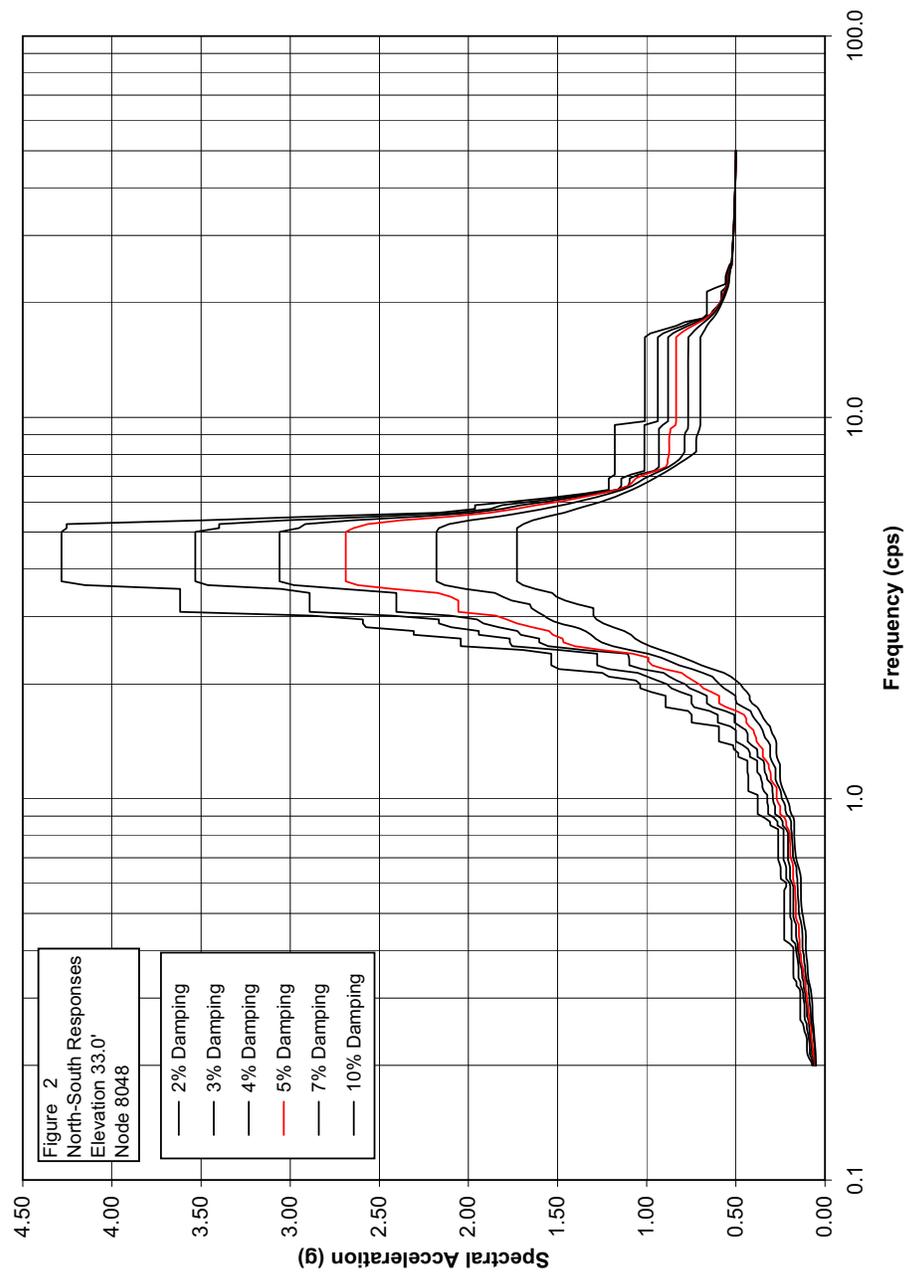


Figure 3.7-76—{Comparison of Callaway Plant Unit 2 GMRS and CSDRS at 0.1g PGA (Horizontal)}

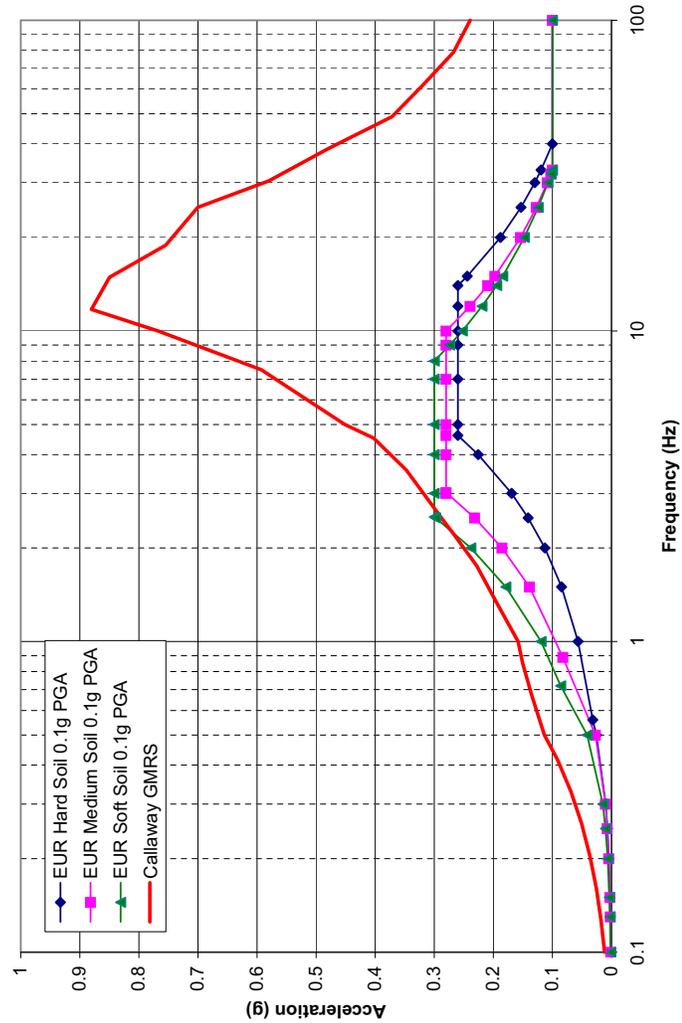
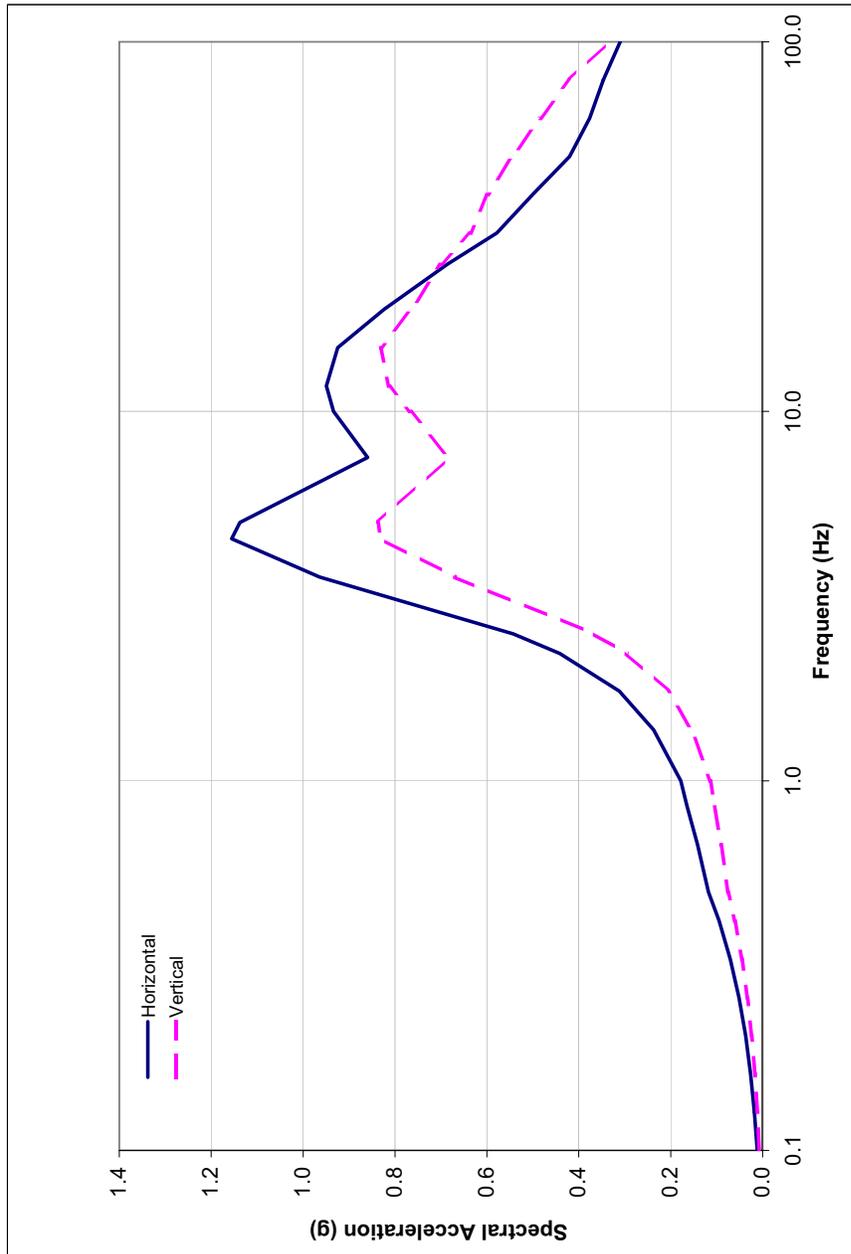
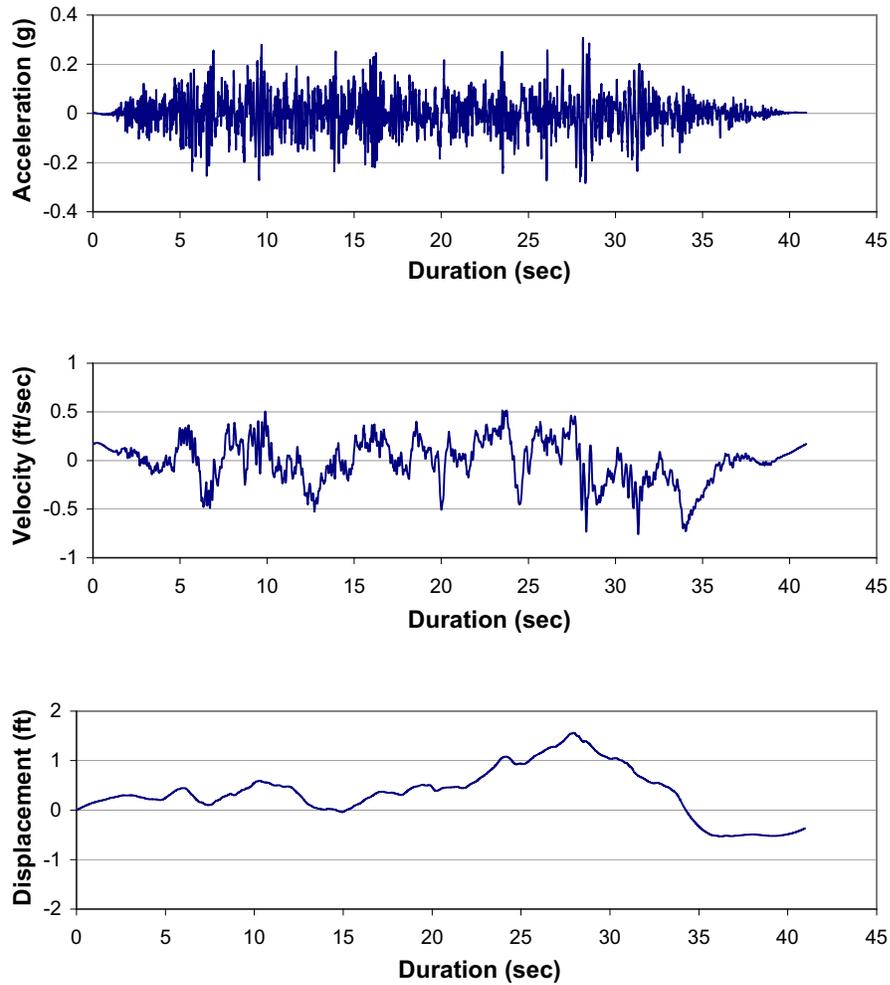


Figure 3.7-77—FIRS at ESWEMS Pump House Foundation Level

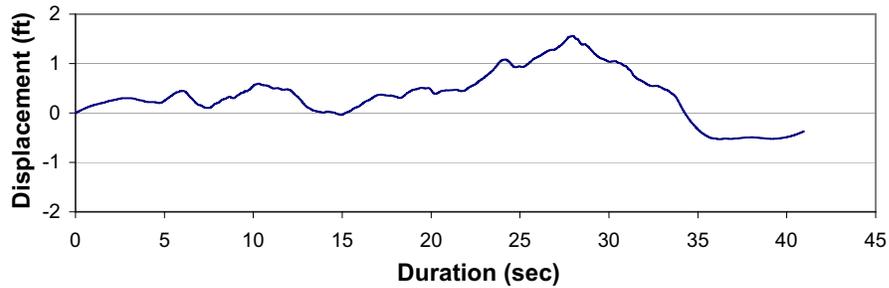
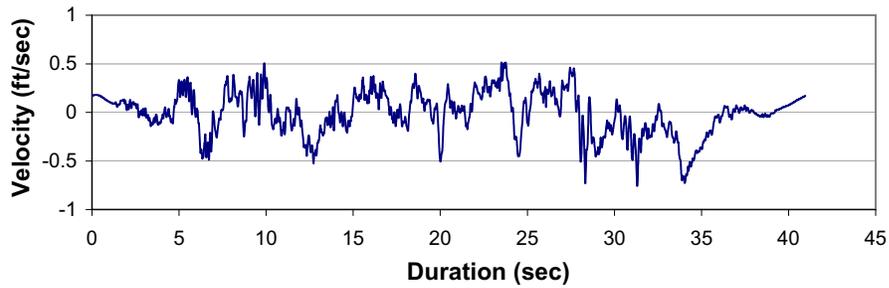
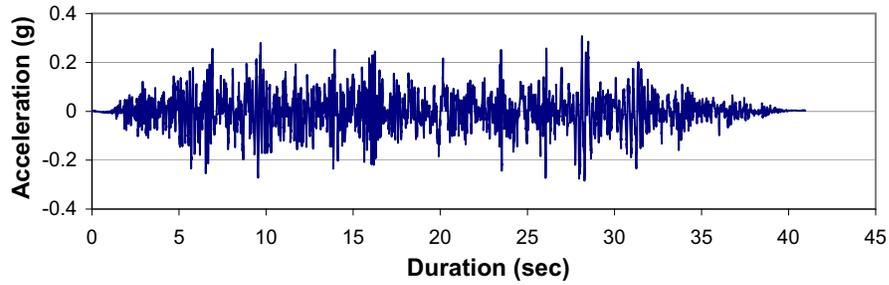


**Figure 3.7-78—North-South Time Histories Matching ESWEMS Foundation Level FIRS**



PGA(g)	PGV(ft/s)	PGD(ft)
0.31	0.76	1.56

**Figure 3.7-79—East-West Time Histories Matching ESWEMS Foundation Level FIRS**



PGA(g)	PGV(ft/s)	PGD(ft)
0.31	0.83	1.41

**Figure 3.7-80—Vertical Time Histories Matching ESWEMS Foundation Level FIRS**

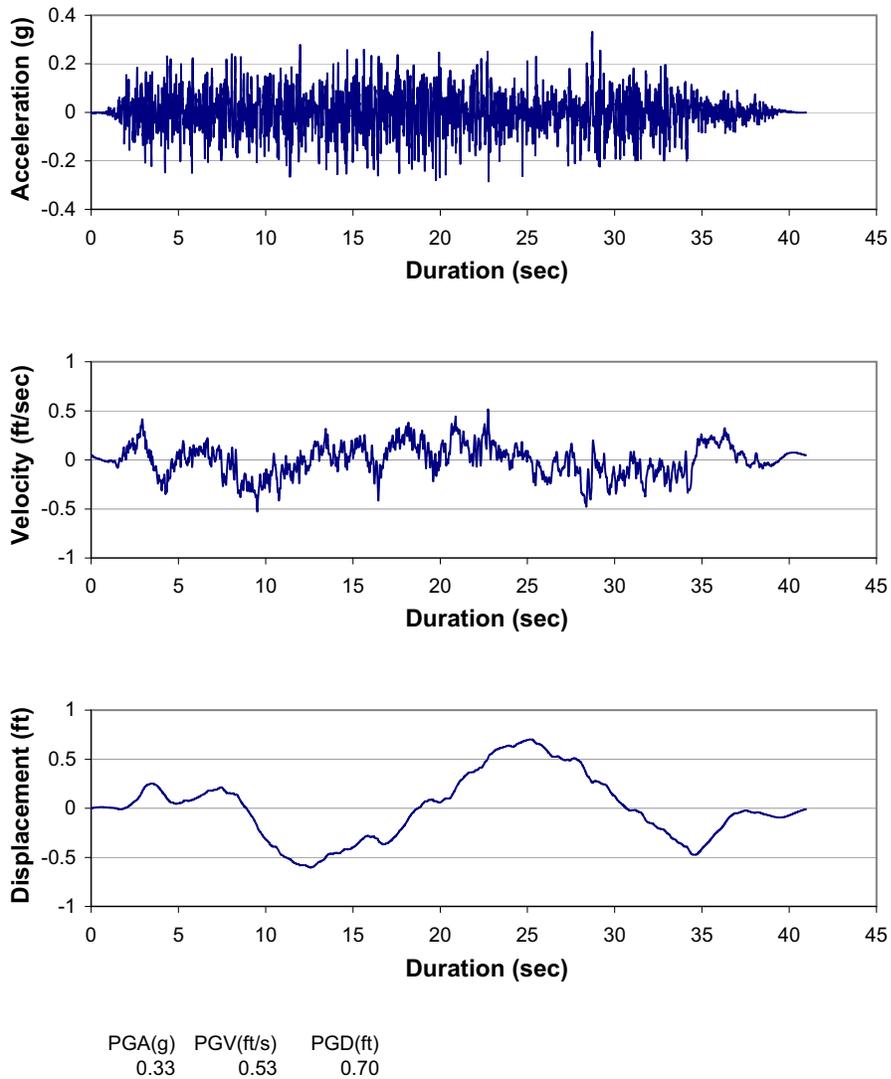


Figure 3.7-81—Callaway Plant Unit 2 North-South FIRS at Elev. 835ft

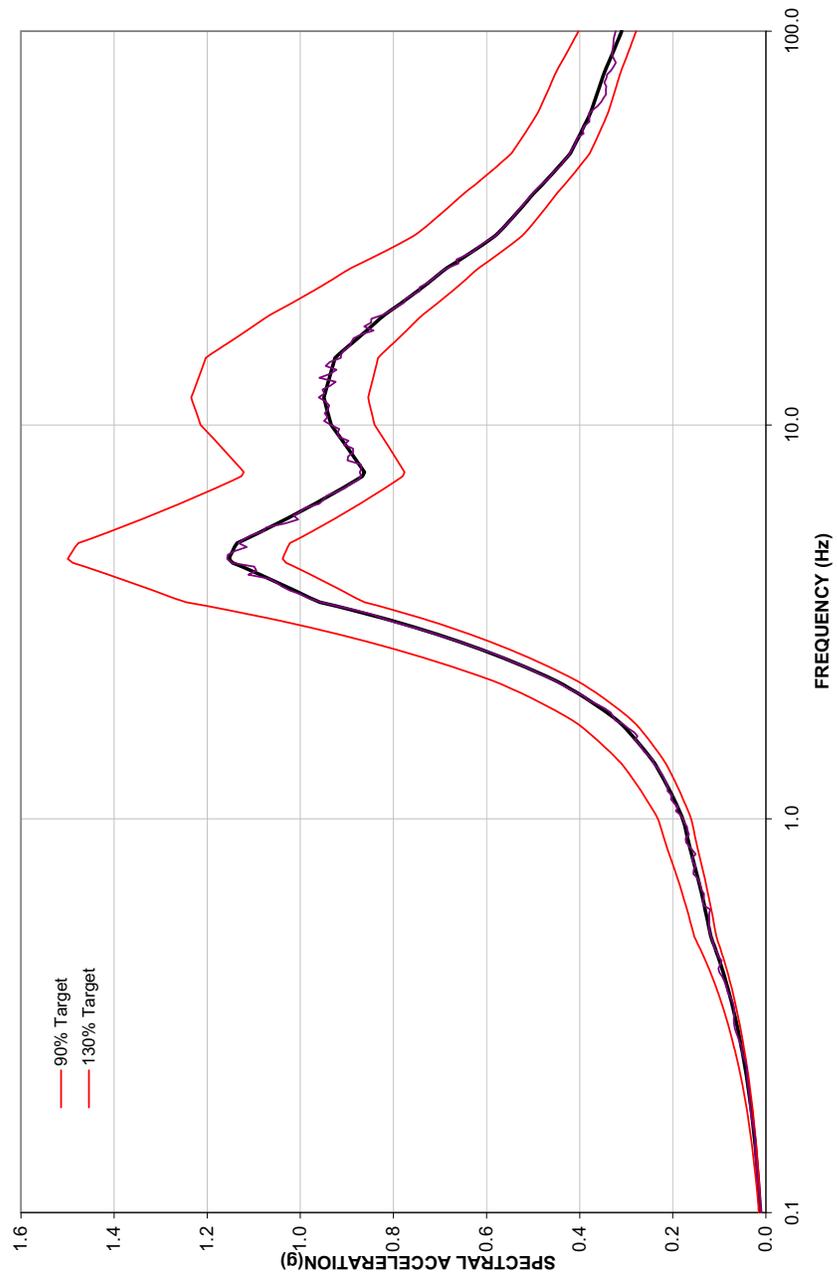


Figure 3.7-82—Callaway Plant Unit 2 East-West FIRS at Elev. 835ft

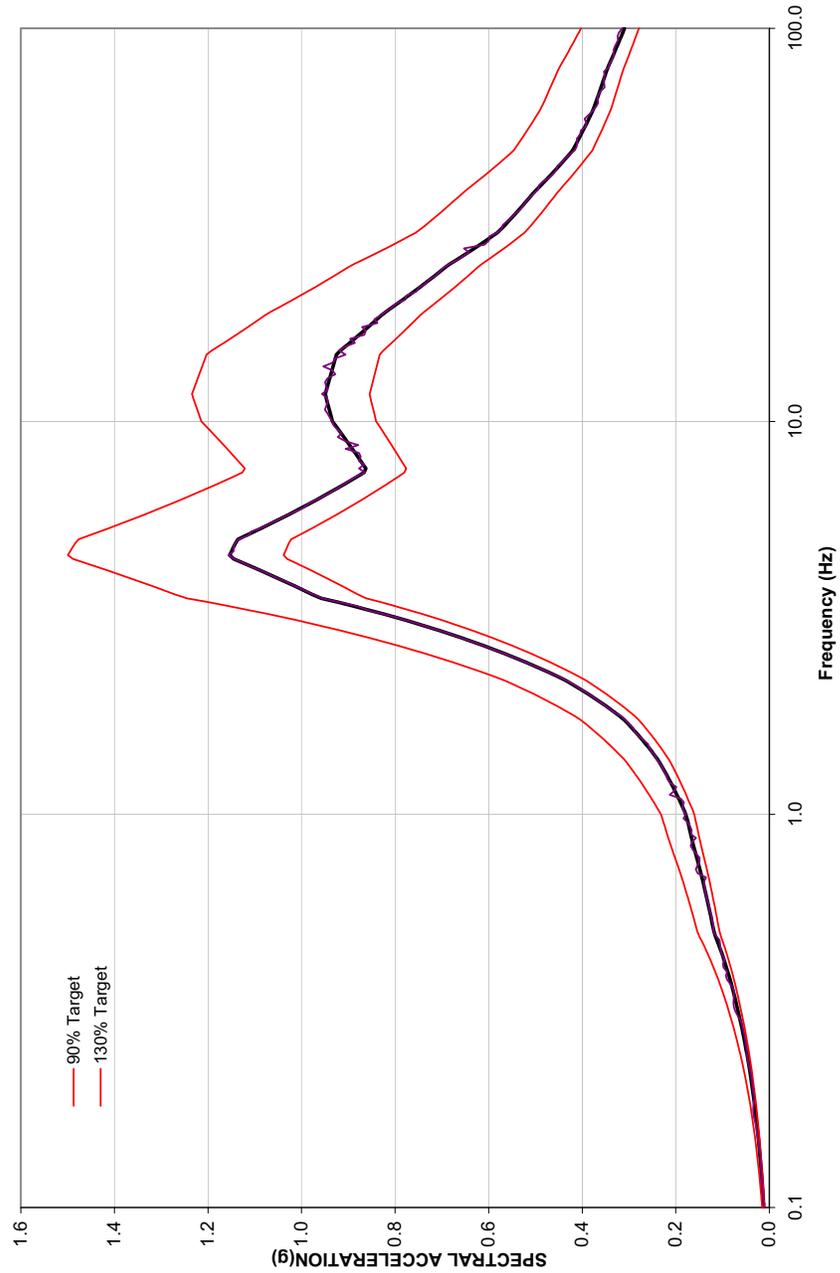


Figure 3.7-83—Callaway Plant Unit 2 Vertical FIRS at Elev. 835ft

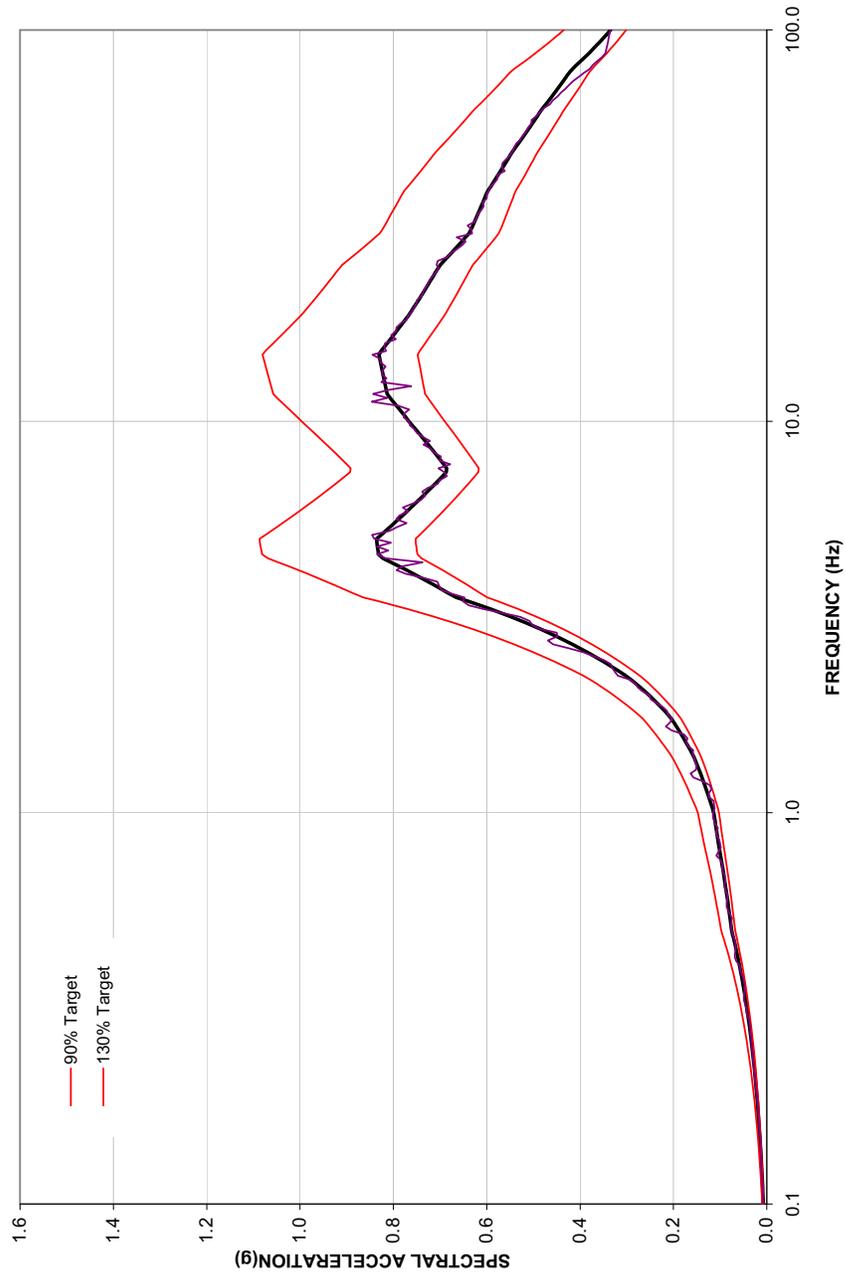


Figure 3.7-84—Callaway Plant Unit 2 Strain-Compatible Site Profile

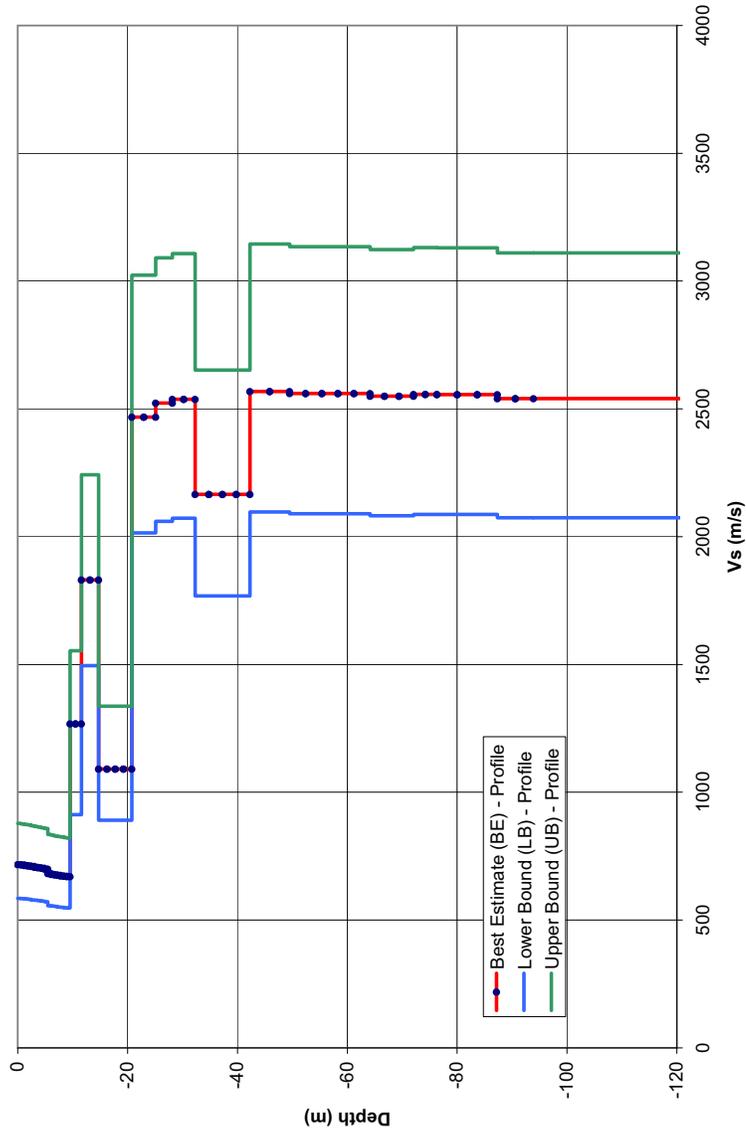


Figure 3.7-85—Callaway Plant Unit 2 Vs EPR DC Soil Cases

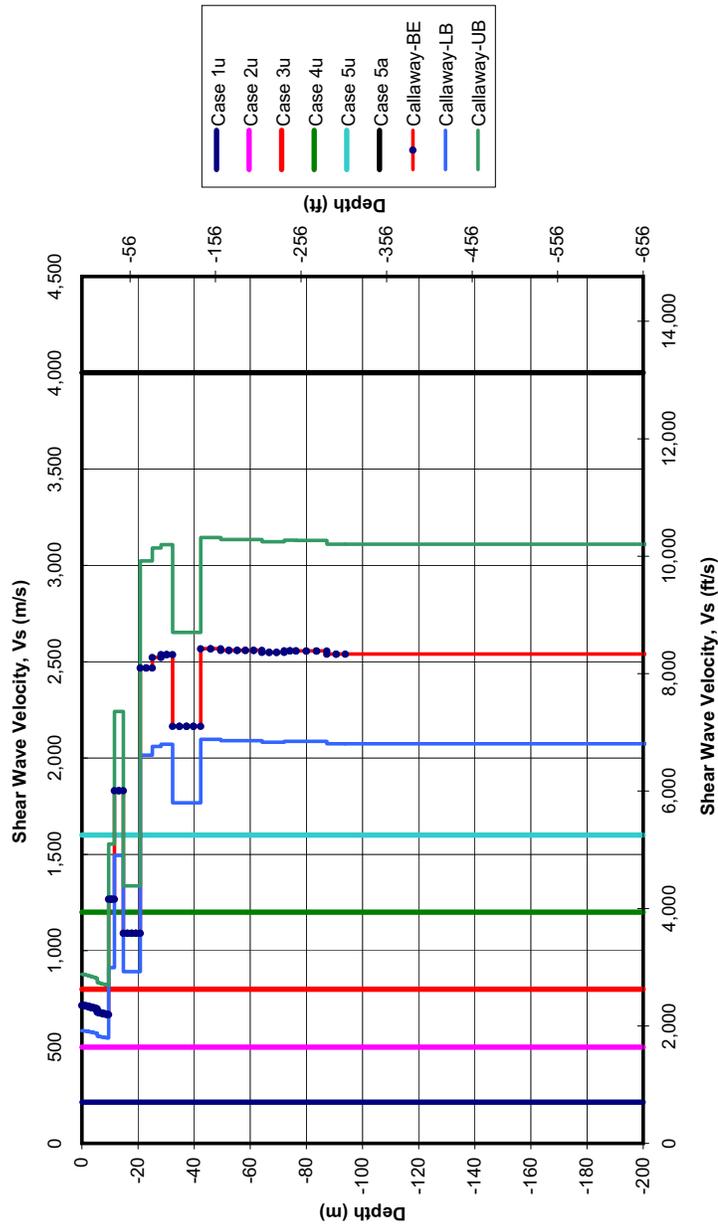


Figure 3.7-86—Callaway Plant Unit 2 Vs EPR DC Soil Cases

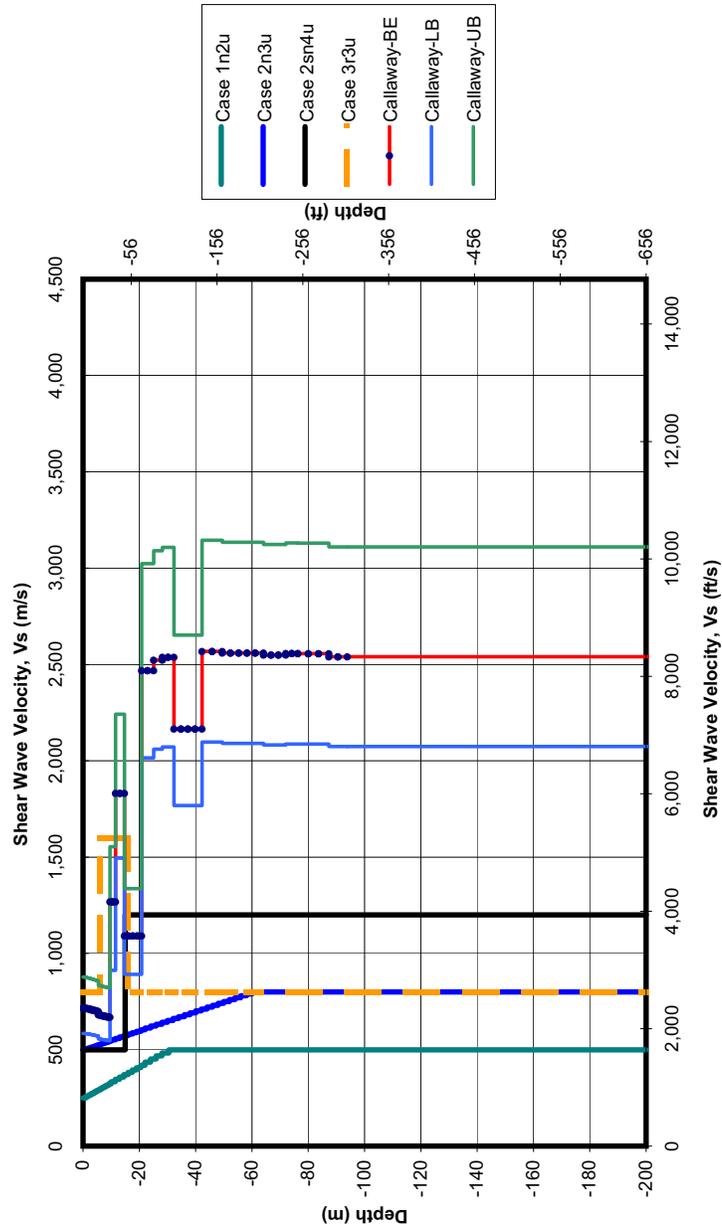


Figure 3.7-87—Response Spectra at NI Common Basemat Bottom Node 417 - 5% Damping X-Direction

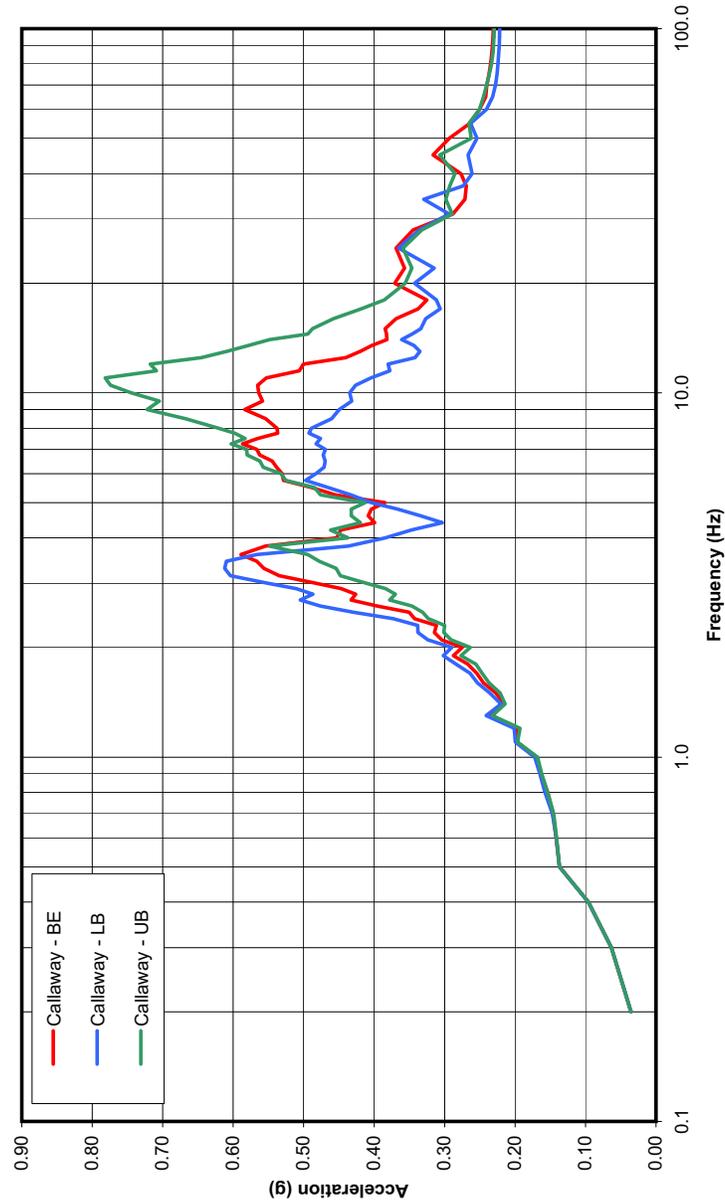


Figure 3.7-88—Response Spectra at NI Common Basemat Bottom Node 417 - 5% Damping Y-Direction

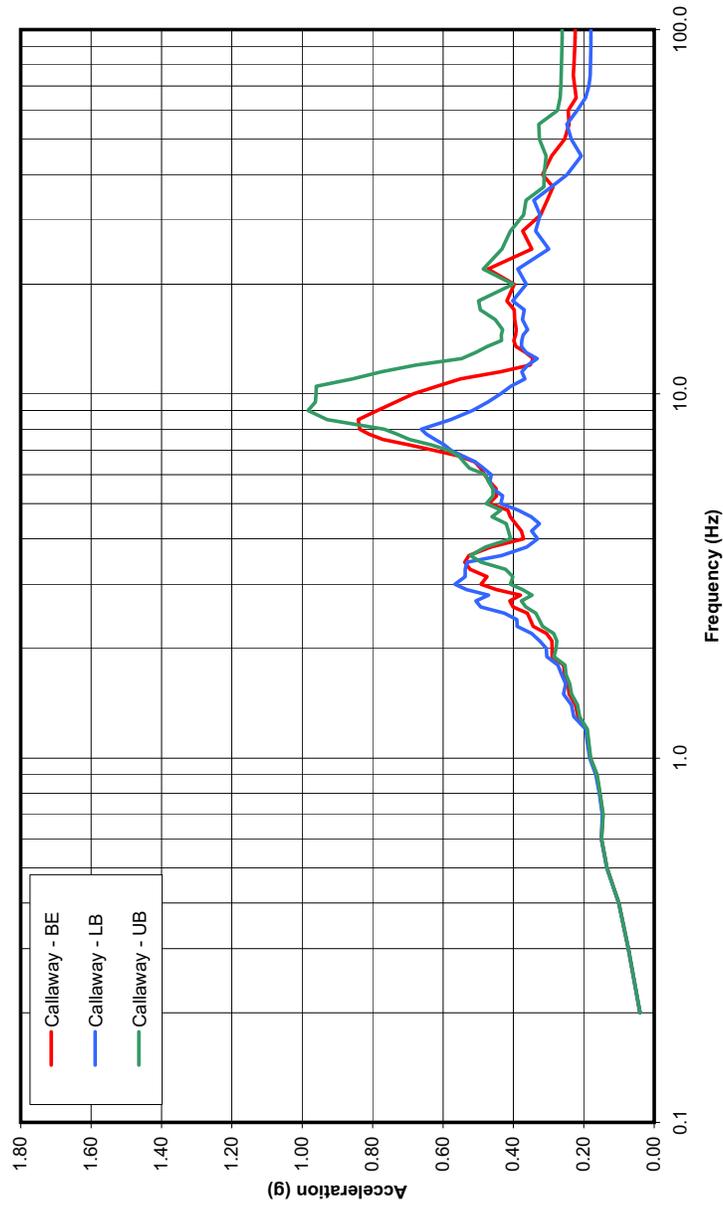


Figure 3.7-89—Response Spectra at NI Common Basemat Bottom Node 417 - 5% Damping Z-Direction

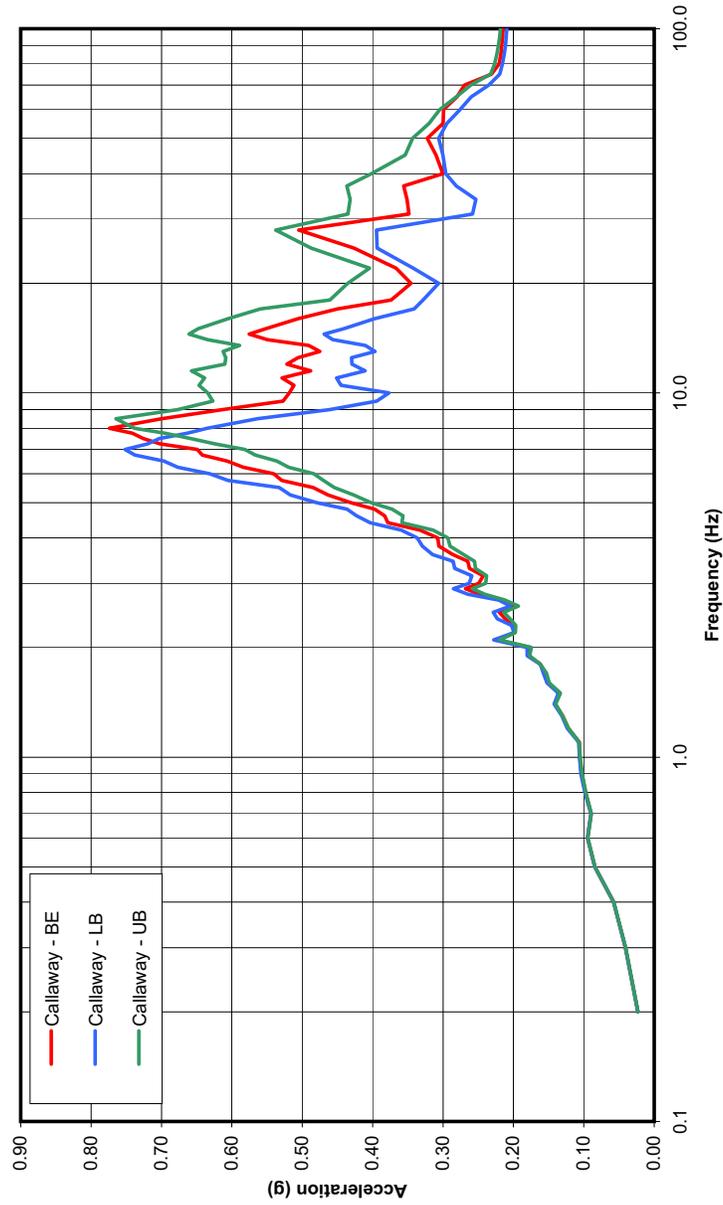


Figure 3.7-90—Soil Model Surface Response Spectra at Centers of Footprints of EPGB & ESWB - 5% Damping X-Direction

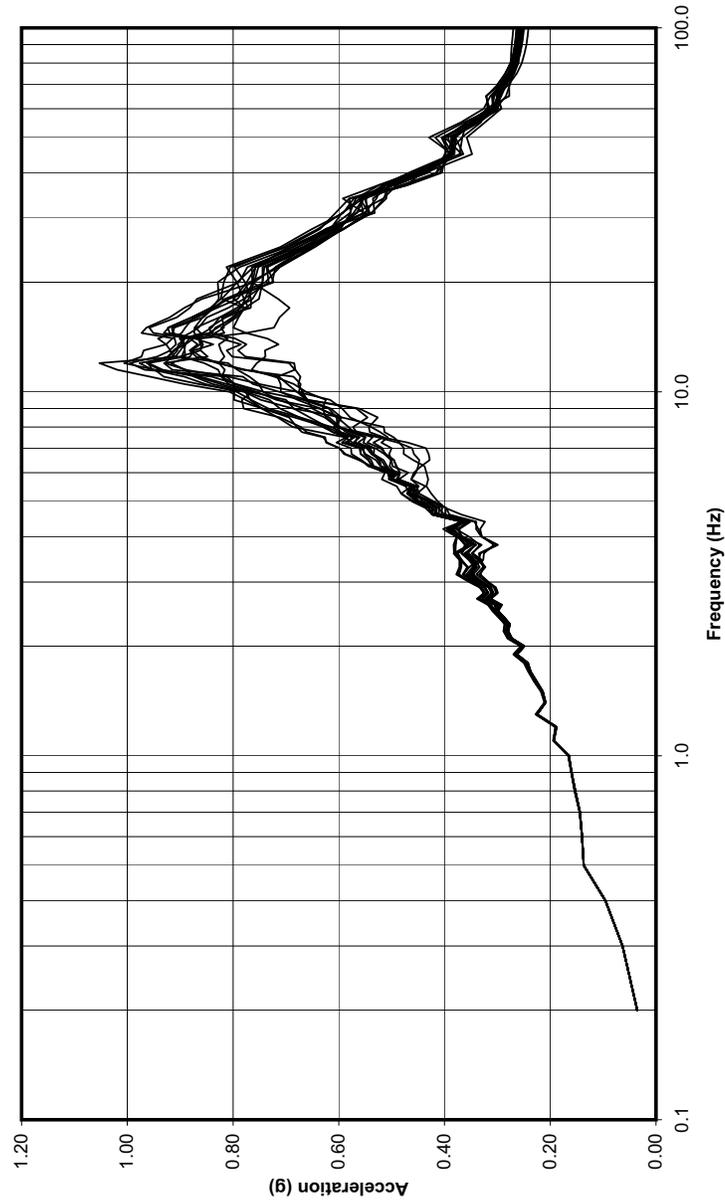


Figure 3.7-91—Soil Model Surface Response Spectra at Centers of Footprints of EPGB & ESWB - 5% Damping Y-Direction

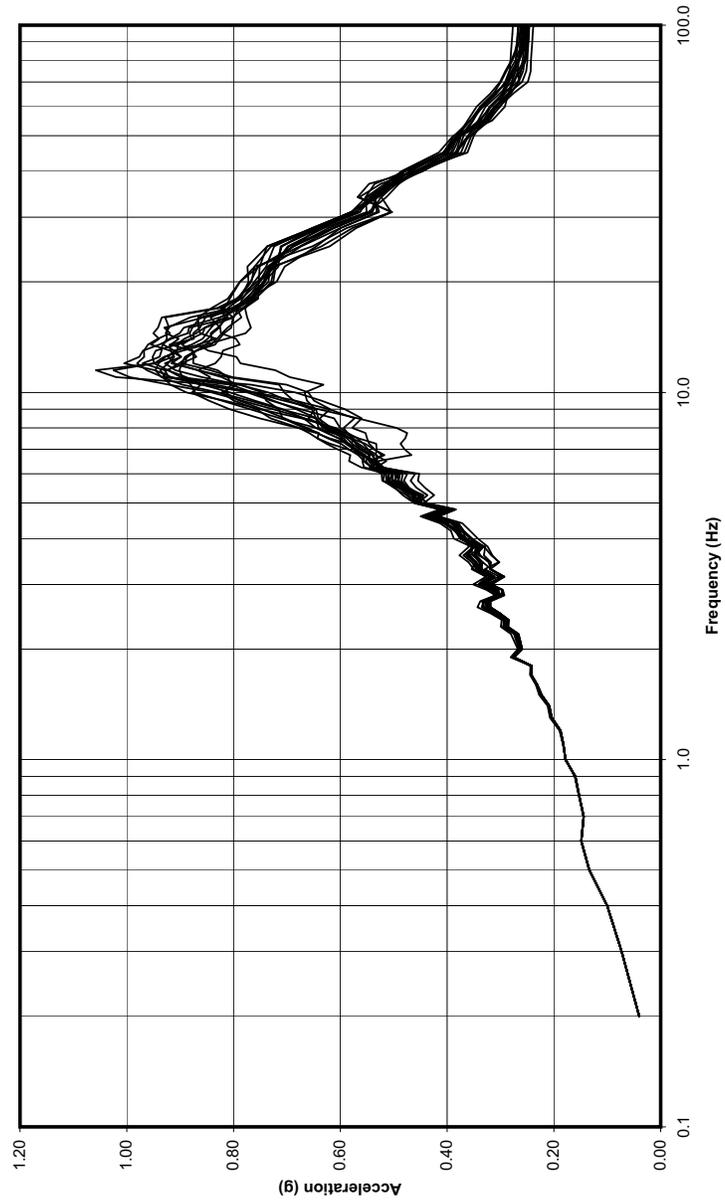


Figure 3.7-92—Soil Model Surface Response Spectra at Centers of Footprints of EPGB & ESWB - 5% Damping Z-Direction

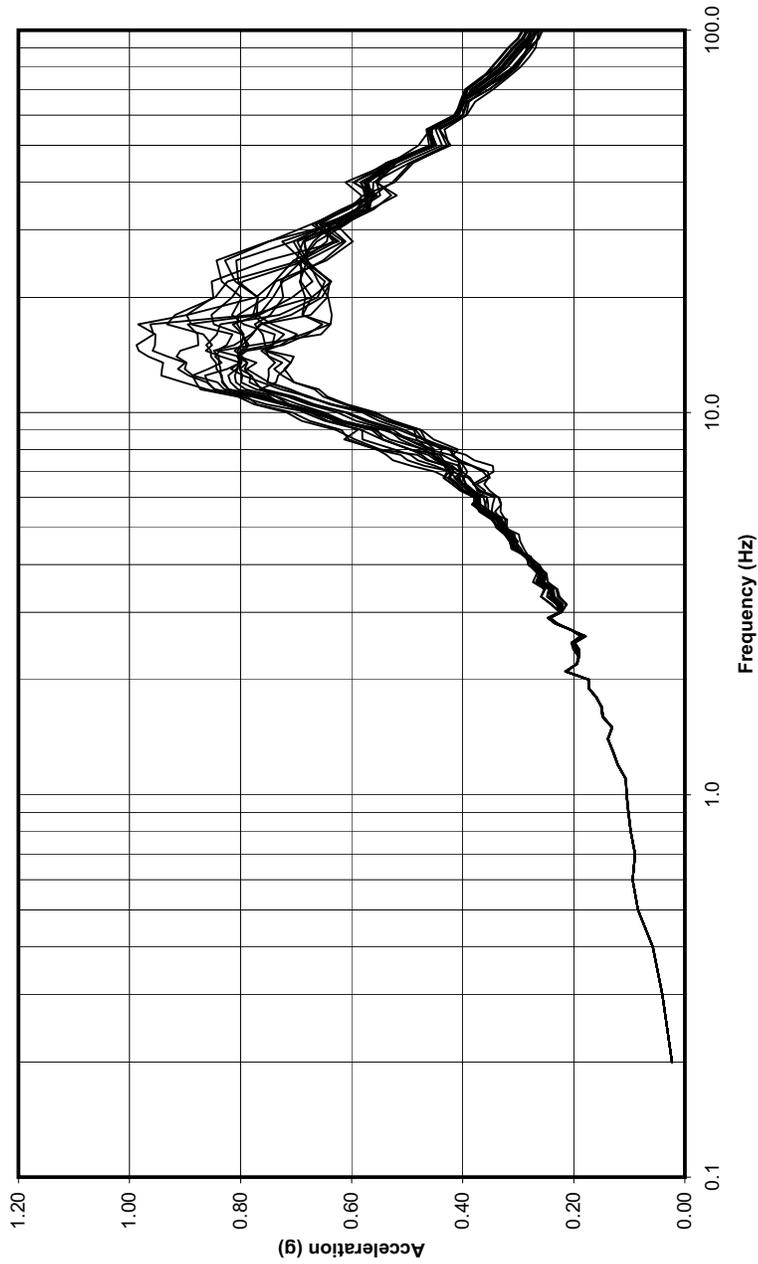
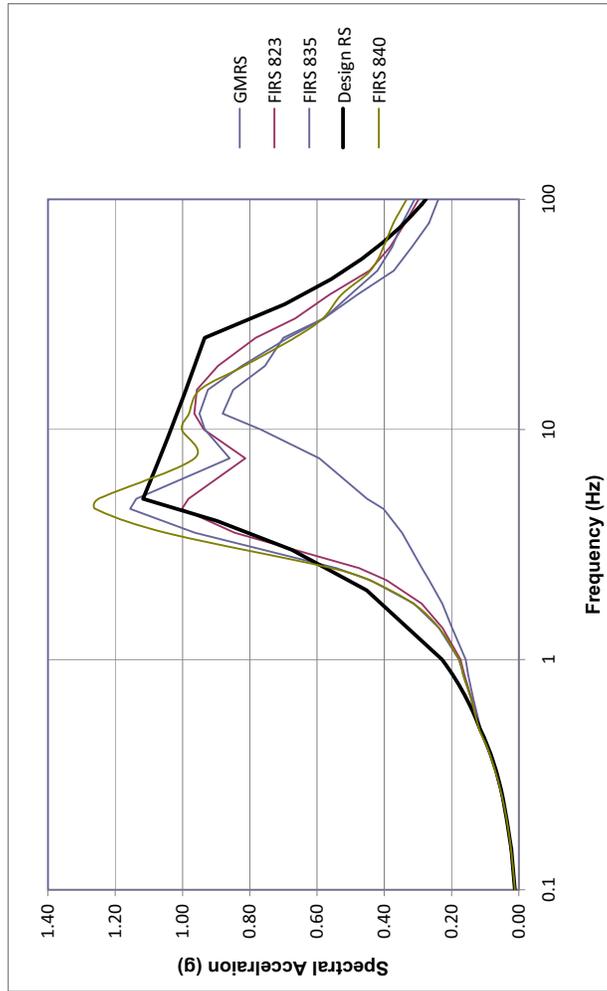


Figure 3.7-93—Horizontal Spectrum for Response Spectrum Analysis



**Figure 3.7-94— Vertical Spectrum for Response Spectrum Analysis**

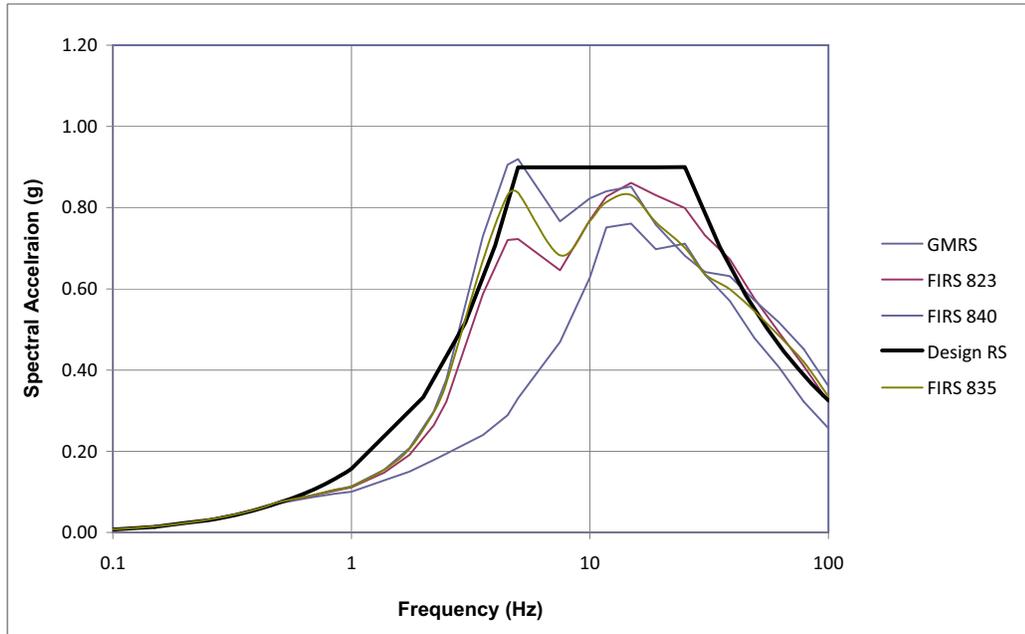


FIG 8-9 ground motion SJ 06-18-08 (2) wo EUR.XLS

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Figure 3.7-95—ESWEMS Pumphouse Horizontal Response Spectrum with 5% Damping

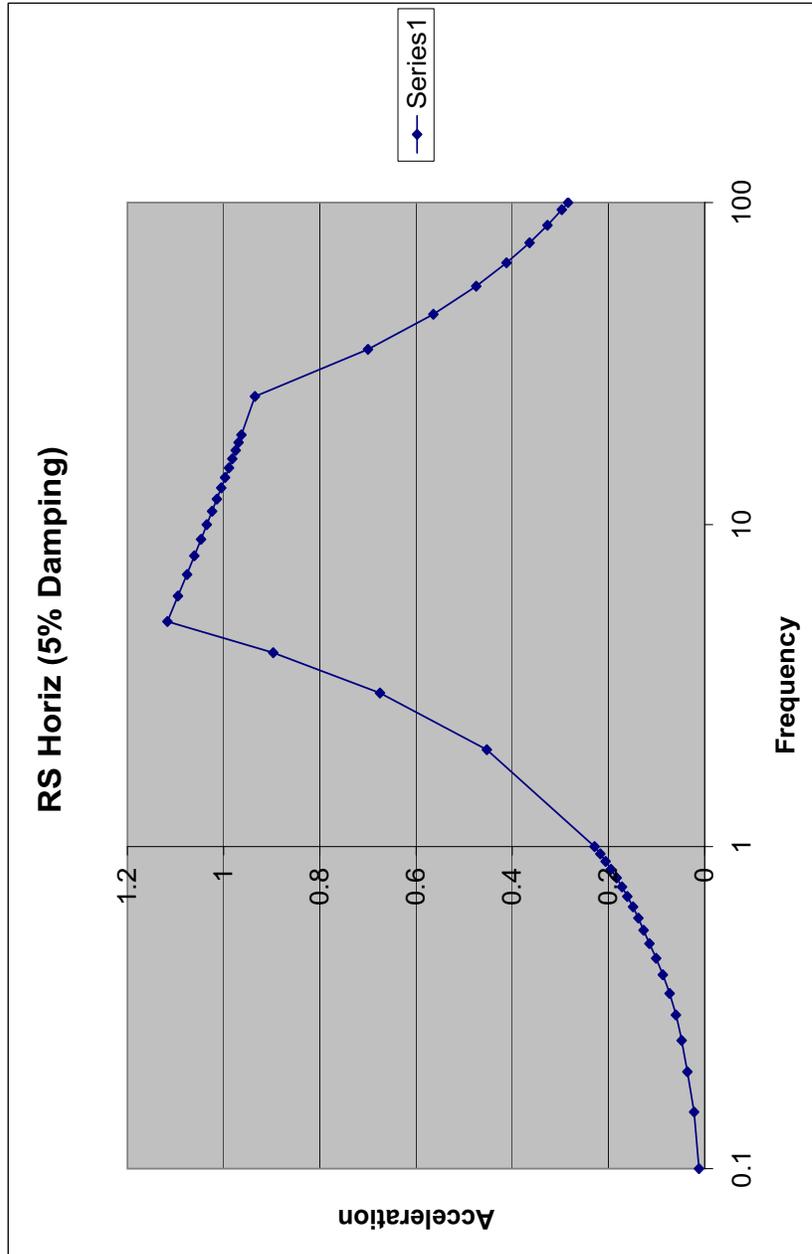
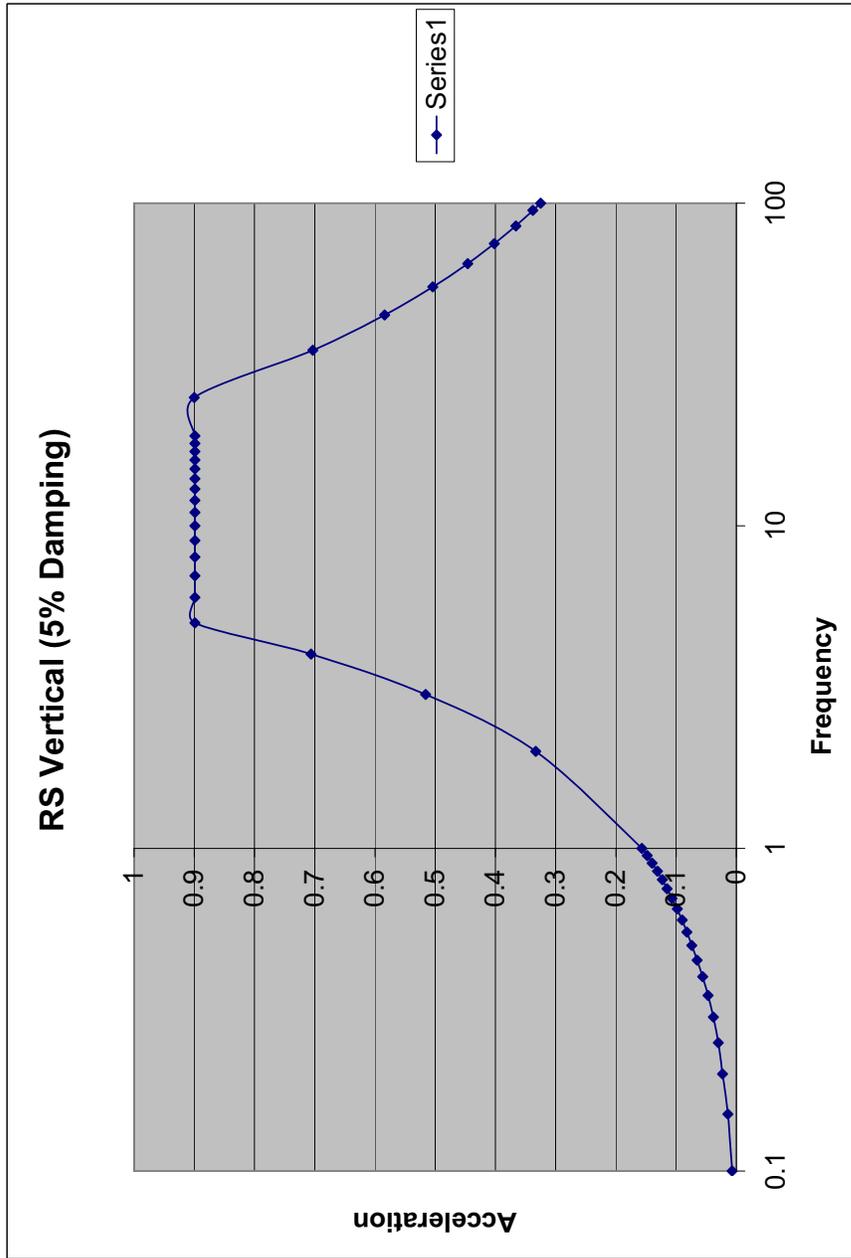
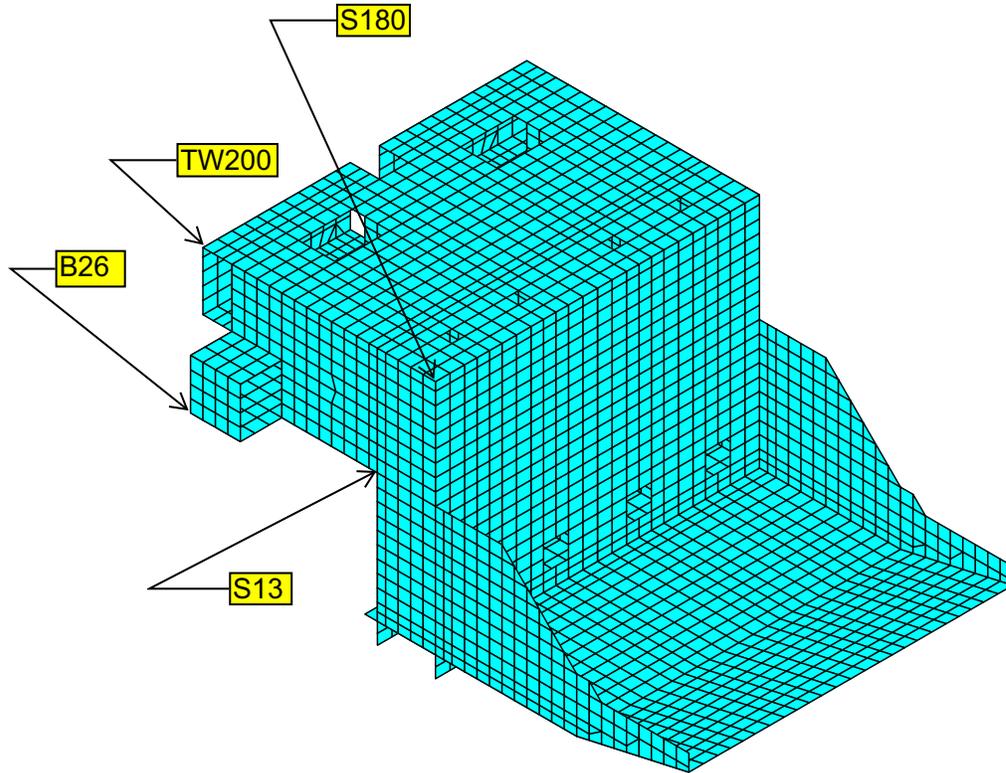


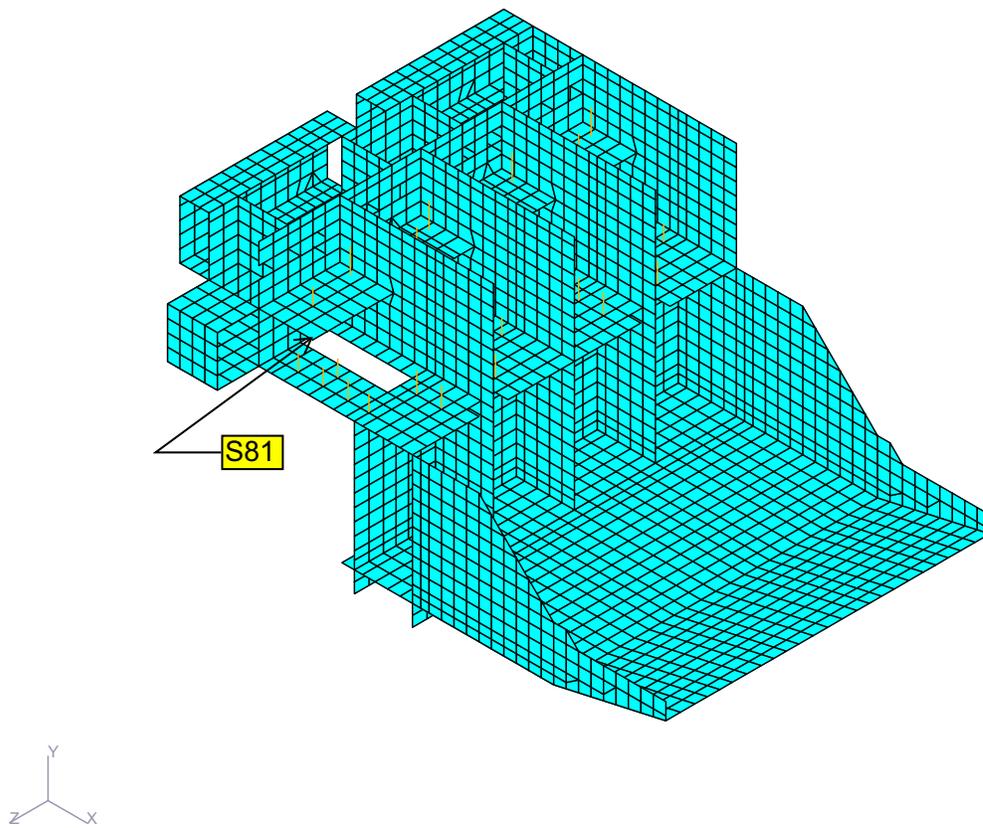
Figure 3.7-96—ESWEMS Pumphouse Vertical Response Spectrum with 5% Damping



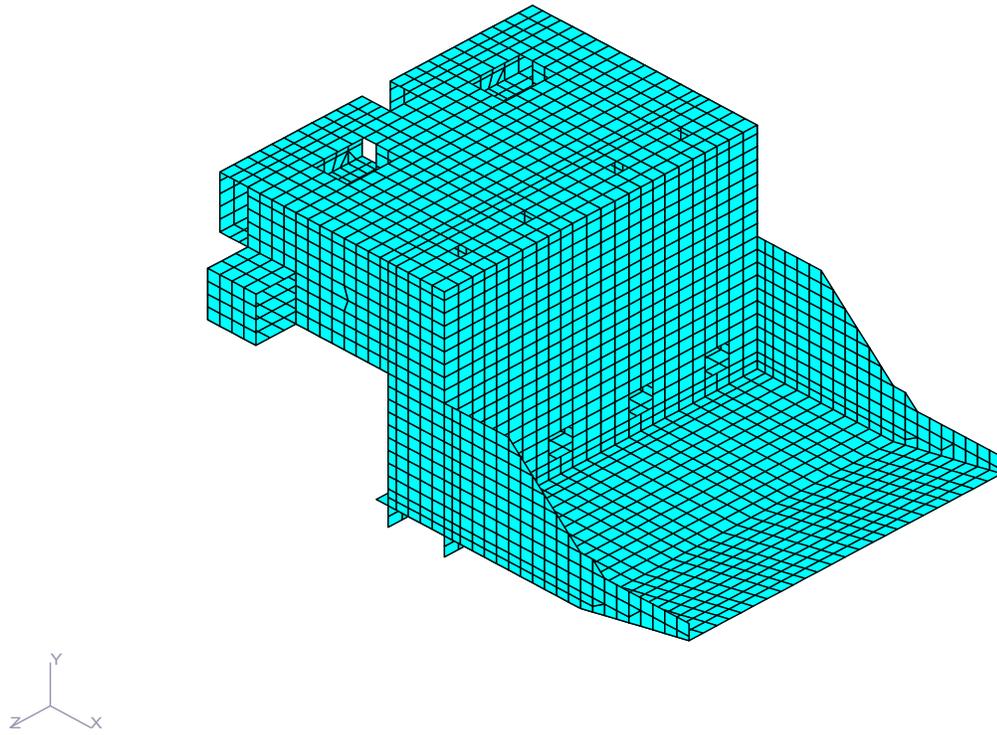
**Figure 3.7-97—Legend of Joints/Nodes in ESWEMS Pumphouse at Locations of High Demand Stresses**



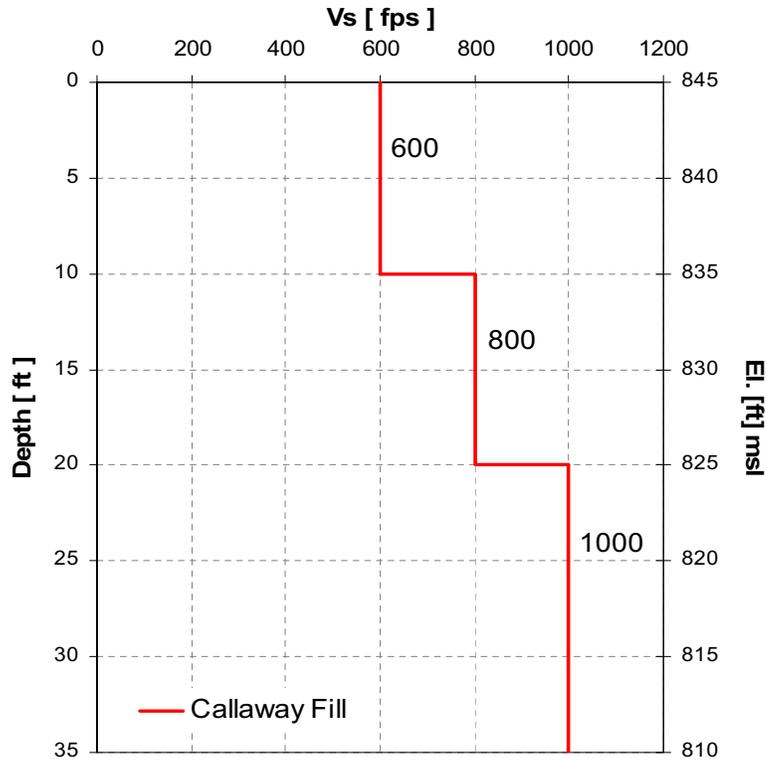
**Figure 3.7-98—Legend of Internal Joints/Nodes at Locations of High Demand Stress**



**Figure 3.7-99—Finite Element Model of ESWEMS Pump House**

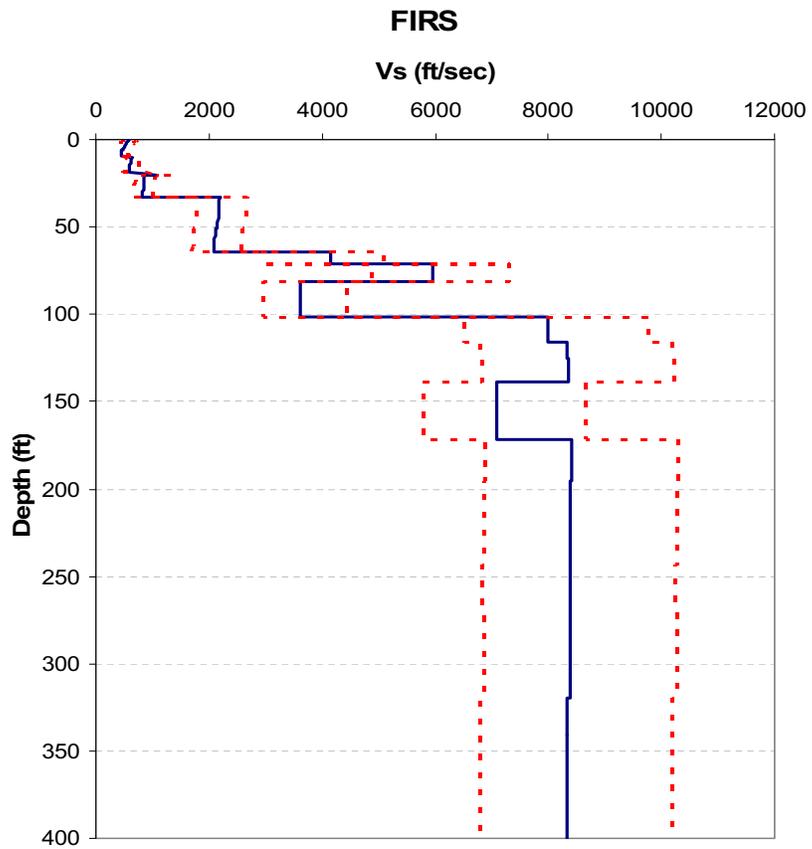


**Figure 3.7-100—Assumed Shear Wave Velocities in Structural Fill Under ESWEMS Pump House**



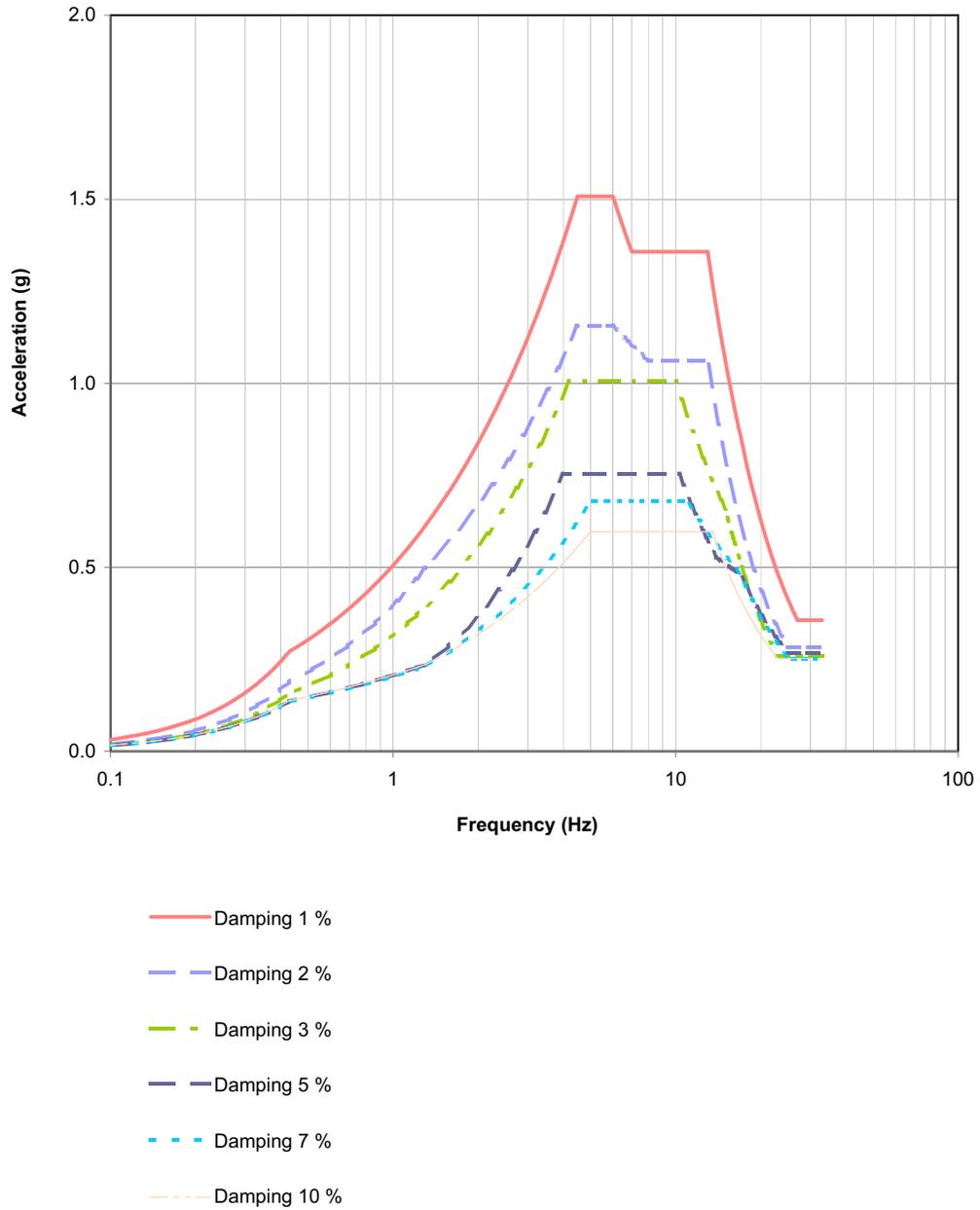
Engineered fill extends from the top of the Graydon Chert Conglomerate to grade Elevations.

**Figure 3.7-101—Strain Compatible Shear Wave Velocities in Subgrade Profile Used in SSI Analysis**

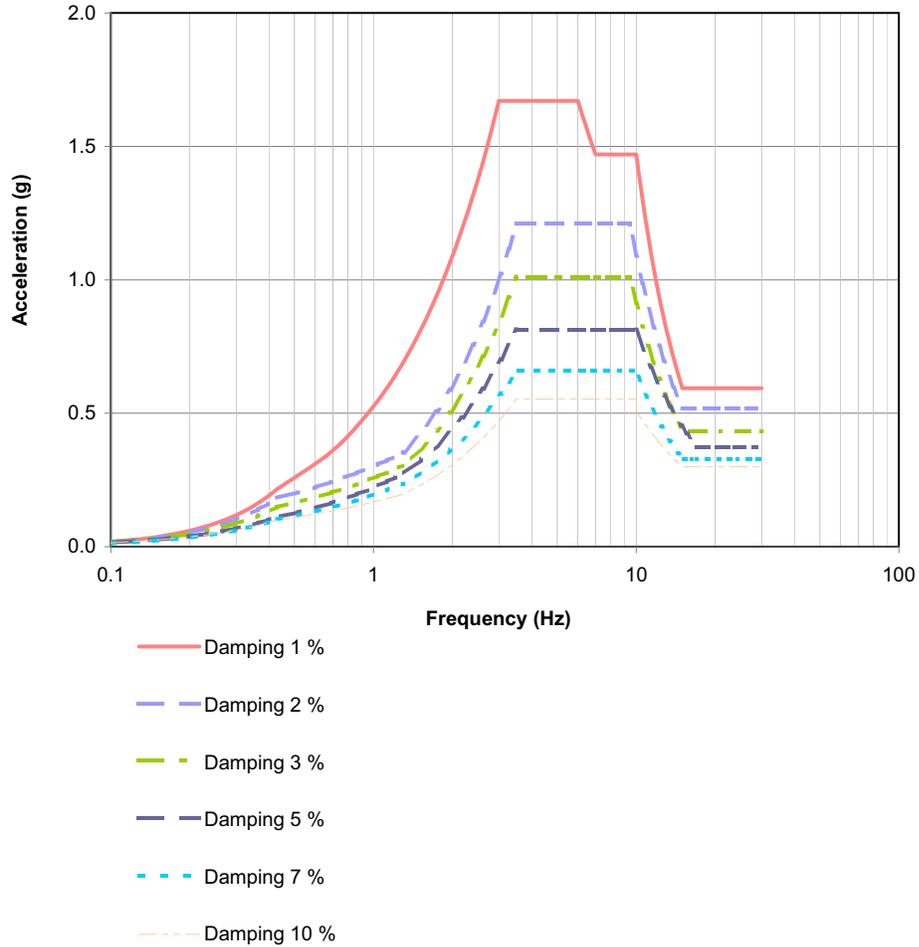


Profile consists of site specific stratigraphy to a depth of 180 feet underlain by an elastic half space.

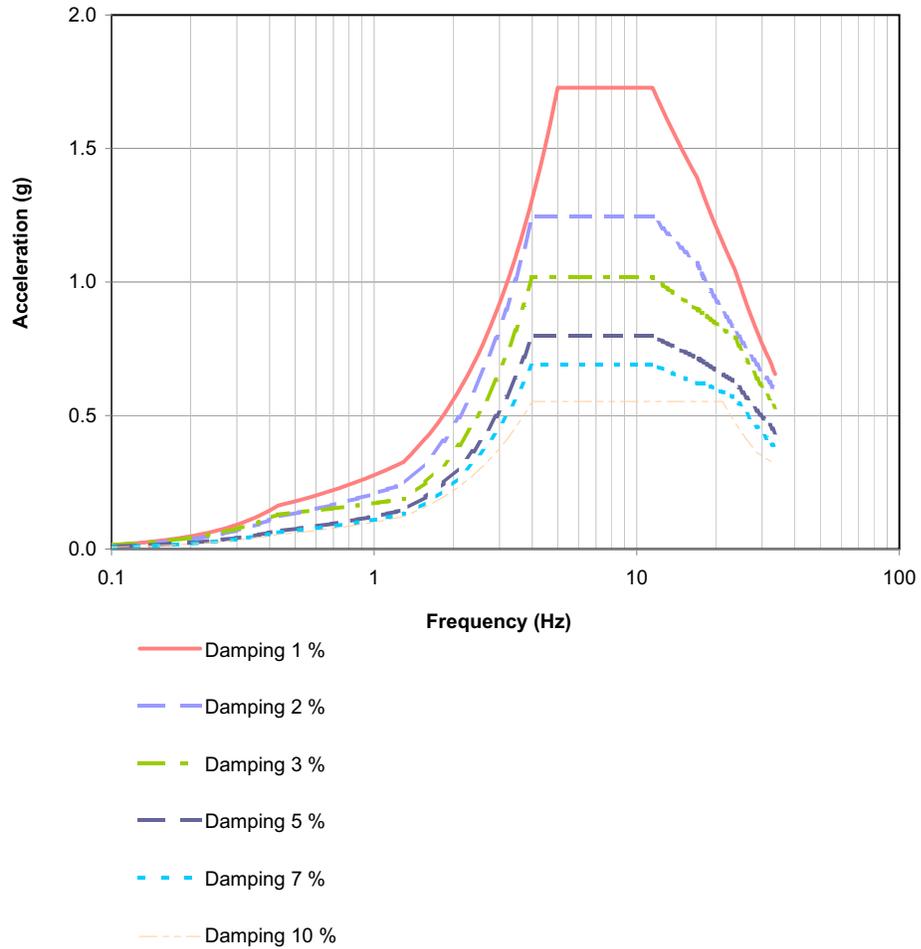
**Figure 3.7-102—In-structure Floor Response Spectra in E-W Direction at First Floor Level of the ESWEMS Pump House**



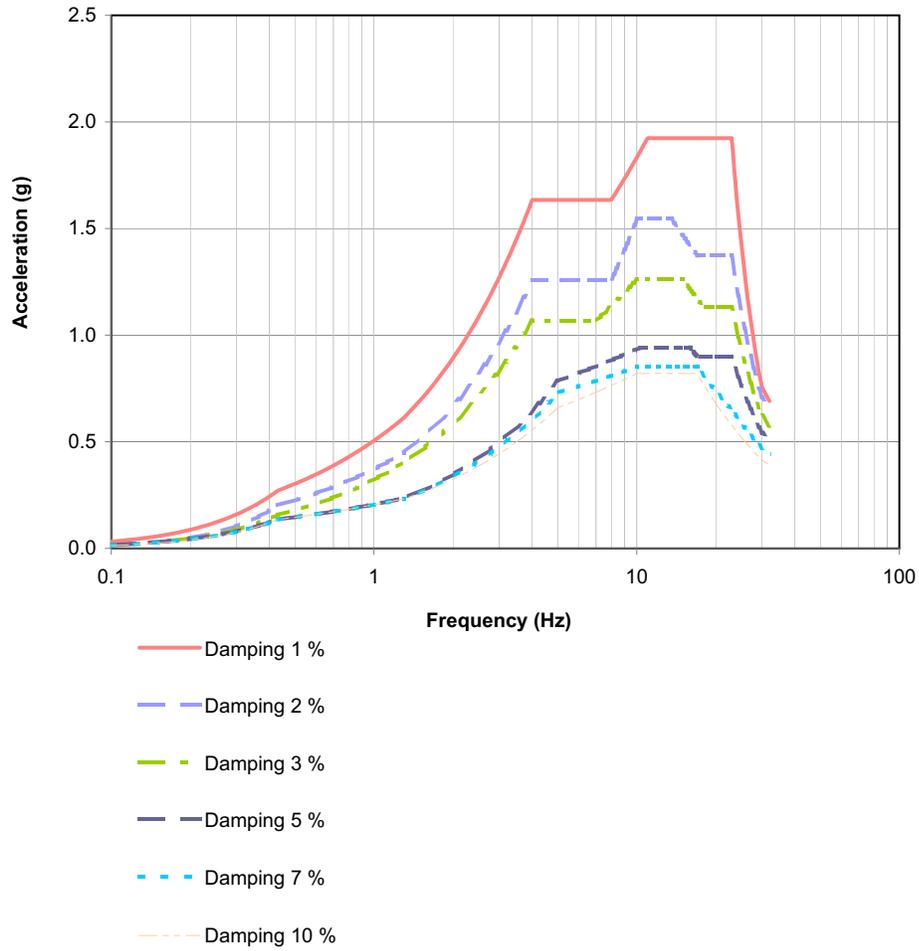
**Figure 3.7-103—In-structure Floor Response Spectra in N-S Direction at First Floor Level of the ESWEMS Pump House**



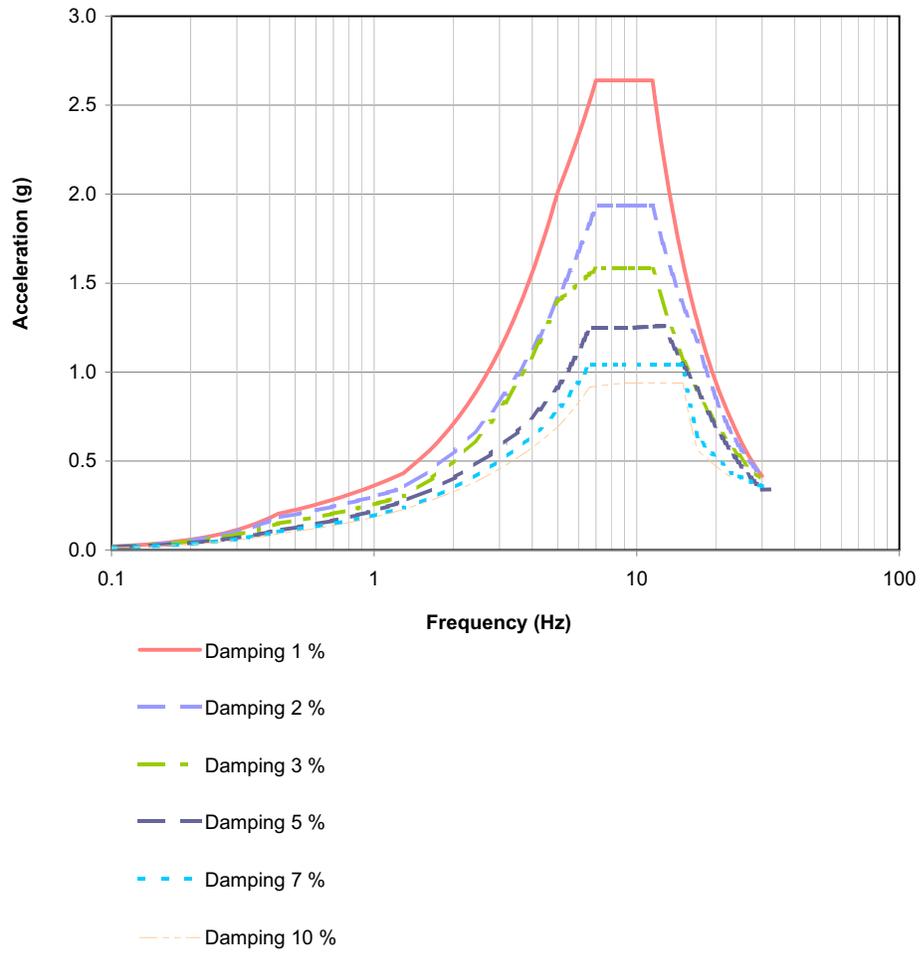
**Figure 3.7-104—In-structure Floor Response Spectra in Vertical Direction at First Floor Level of the ESWEMS Pump House**



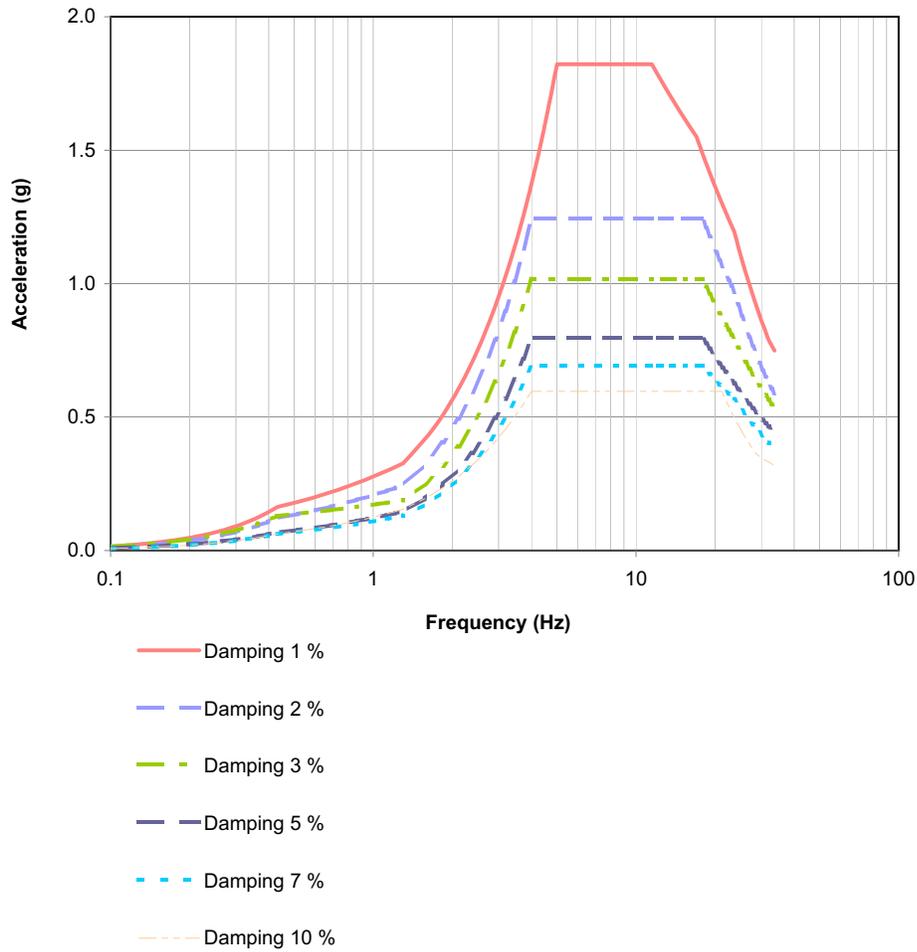
**Figure 3.7-105—In-structure Floor Response Spectra in E-W Direction at Mezzanine Level of the ESWEMS Pump House**



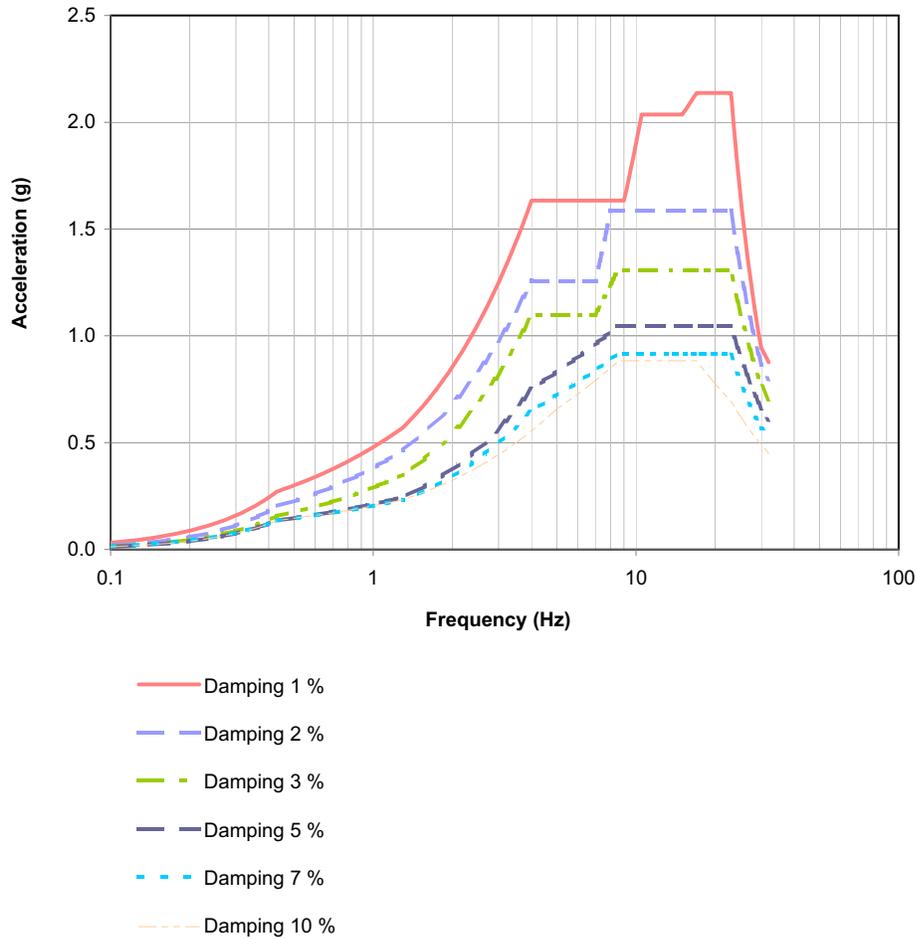
**Figure 3.7-106—In-Structure Floor Response Spectra in N-S Direction at Mezzanine Level of the ESWEMS Pump House**



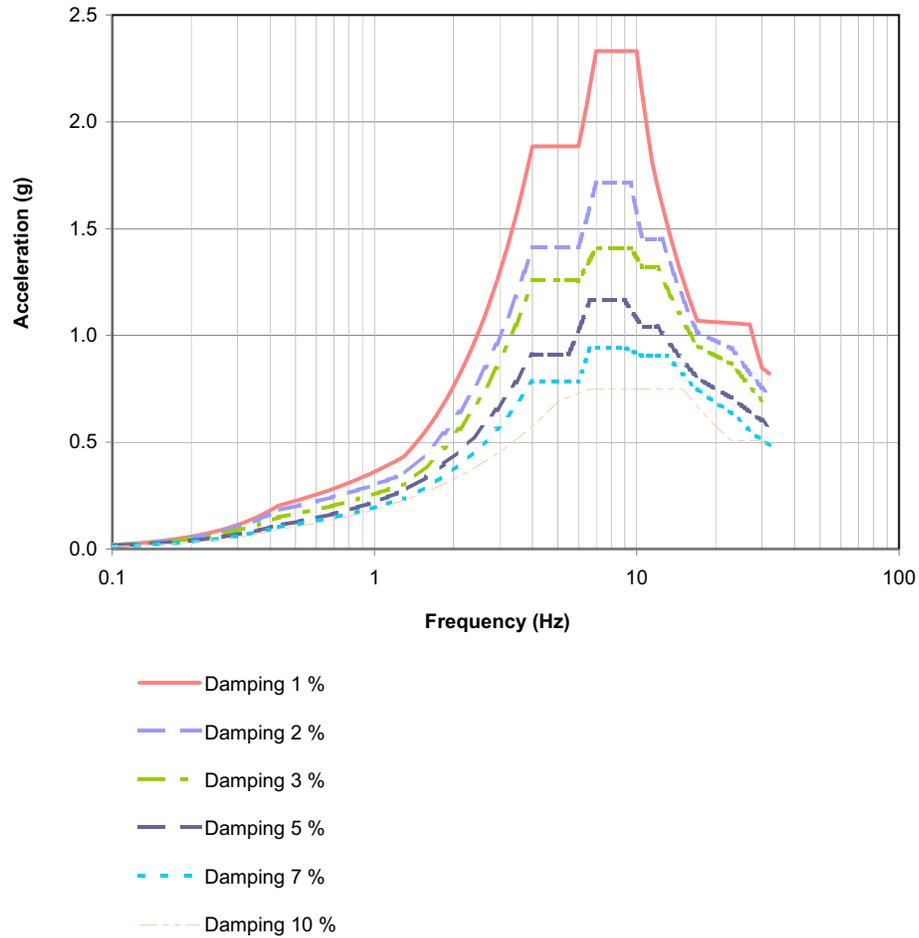
**Figure 3.7-107—In-structure Floor Response Spectra in Vertical Direction at Mezzanine Level of the ESWEMS Pump House**



**Figure 3.7-108—In-structure Floor Response Spectra in E-W Direction at Roof Level of the ESWEMS Pump House**



**Figure 3.7-109—In-structure Floor Response Spectra in N-S Direction at Roof Level of the ESWEMS Pump House**



**Figure 3.7-110—In-structure Floor Response Spectra in Vertical Direction at Roof Level of the ESWEMS Pump House**

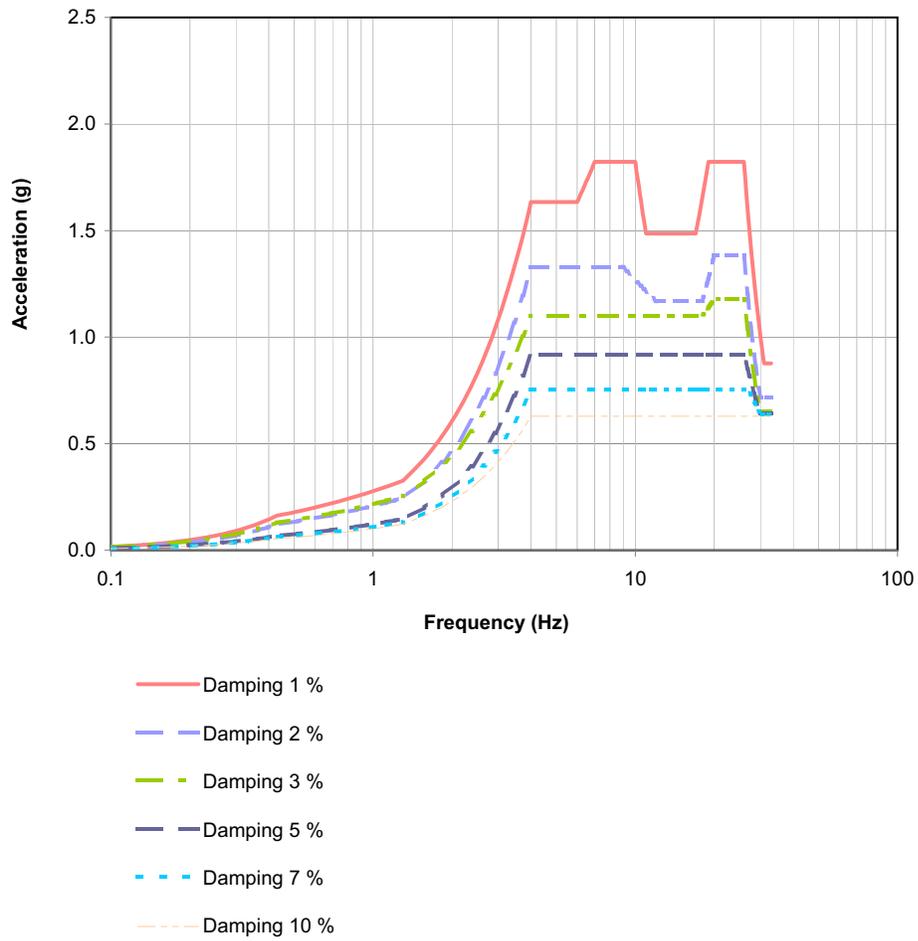
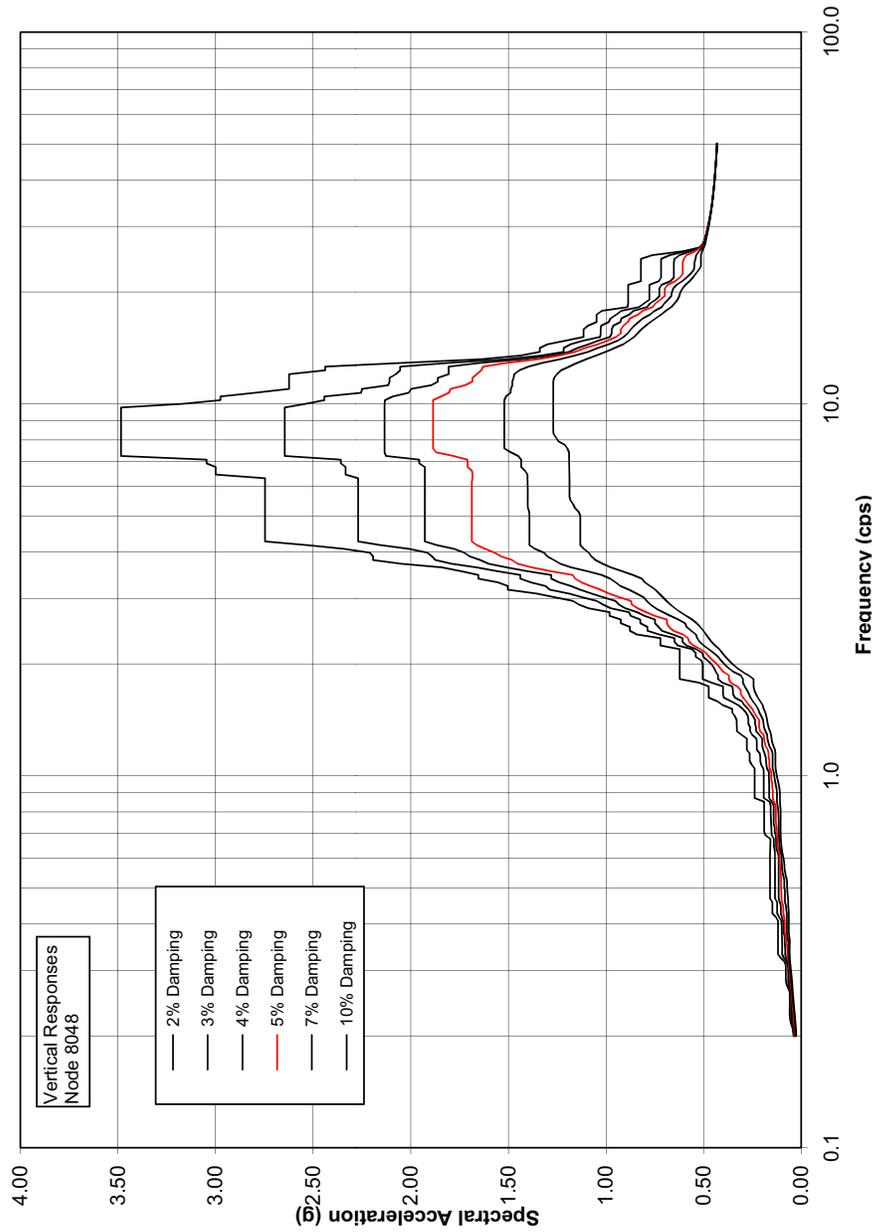


Figure 3.7-111 — {Spectrum Envelope of ESWB Elev. 4.27 m, Z(Vert) Direction, 2%, 3%, 4%, 5%, 7%, and 10% Damping}



### 3.8 DESIGN OF CATEGORY I STRUCTURES

This section of the U.S. EPR FSAR is incorporated by reference with the departures and/or 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 Reactor Shield Building (RSB) RCB design for Callaway Plant Unit 2 is the standard RCB design as described in the U.S. EPR FSAR without departures, except for the loads resulting from the seismic response spectra and soil profiles described in Section 3.7.1.

Site specific RCB design loads are confirmed to lie within the standard U.S. EPR design certification envelope except for design loads resulting from the Callaway Plant Unit 2 site-specific seismic 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 RCB is acceptable for the Callaway Plant Unit 2 site. These evaluations confirm:

- ◆ Callaway Plant Unit 2 site-specific NI Common Basemat Structure foundation soil springs are enveloped by the standard U.S. EPR design certification soil springs.
- ◆ Callaway Plant Unit 2 site-specific NSSS support loads are enveloped by the standard U.S. EPR design certification NSSS support loads.
- ◆ Callaway Plant Unit 2 site-specific ZPA values for the RCB are enveloped by the standard U.S. EPR design certification ZPA values for the RCB.

Relative site-specific seismic, Reactor Shield Building (RSB) and buoyancy conditions are addressed in Sections 3.7.2, 3.8.4 and 3.8.5, respectively.}

##### 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.

**3.8.3.2 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) internal structural design for Callaway Plant Unit 2 is the standard design as described in the U.S. EPR FSAR without departures, except for the loads resulting from the seismic response spectra and soil profiles described in Section 3.7.1.

Site-specific RB internal structure design loads are confirmed to lie within the standard U.S. EPR design certification envelope except for design loads resulting from the Callaway Plant Unit 2 site-specific seismic response spectra and soil profiles described in Section 3.7.1. Additional confirmatory evaluations for the site-specific seismic response spectra are performed and confirm that the RB internal structures are acceptable for the Callaway Plant Unit 2 site. These evaluations confirm:

- ◆ Callaway Plant Unit 2 site-specific NI Common Basemat Structure foundation soil springs are enveloped by the standard U.S. EPR design certification soil springs.
- ◆ Callaway Plant Unit 2 site-specific NSSS support loads are enveloped by the standard U.S. EPR design certification NSSS support loads.
- ◆ Callaway Plant Unit 2 site-specific ZPA values for the RB internal structures are enveloped by the standard U.S. EPR design certification ZPA values for RB internal structures.

Relative site-specific seismic conditions are addressed in Section 3.7.2.}

### 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 site-specific Seismic Category I structures at Callaway Plant Unit 2 are:

- ◆ Buried Conduit and Duct banks (Section 3.8.4.1.8).
- ◆ Buried Pipe and Pipe Ducts (Section 3.8.4.1.9).
- ◆ Essential Service Water Emergency Makeup System (ESWEMS) Pumphouse and Retaining Pond (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 Callaway Plant Unit 2:

Figure 3E.4-5 provides an overall site plan of Seismic Category I buried duct banks. Figure 3.8-1 provides a detail plan of Seismic Category I buried duct banks in the vicinity of the Nuclear Island (NI). No Seismic Category I buried conduits exist at Callaway Plant Unit 2.

Seismic Category I buried electrical duct banks traverse from:

- ◆ Each ESWEMS Pumphouse bay to the respective ESWS Cooling Tower.
- ◆ The Safeguards Buildings to the four Essential Service Water Buildings and both Emergency Power Generating Buildings.

For the first item, the ESWEMS Pumphouse is a discrete structure housing mechanical and electrical equipment, respectively.

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. To facilitate cable pulling and routing, electrical manholes are provided at strategic locations.}

#### **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 banks.

This COL Item is addressed as follows:

{Figure 3E.4-5 provides an overall site plan of Seismic Category I buried pipe. Pipes run beneath the final site grade. Seismic Category I Buried pipe ducts are not used for Callaway Plant Unit 2.

The four ESW pipes emanate from the ESWEMS Pumphouse and terminate at the ESWBs.

Figure 3.8-2 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.
- ◆ Small diameter supply and return pipes from the EPGBs which tie in directly to the aforementioned pipes.

Fire Protection pipe traverses from the ESWEMS Pumphouse to the vicinity of the NI, where a loop is provided to all buildings. In accordance with Section 3.2.2. Fire Protection pipe to

Seismic Category I structures that are classified as: 1) Seismic Category II is designed to maintain its pressure boundary after an SSE event; and 2) Seismic Category II-SSE is designed to remain functional 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 cover is of sufficient depth to provide protection against frost, surcharge effects, and tornado missiles. Bedding material is provided underneath the pipe. Soil surrounding the pipe is typically compacted structural backfill. As an alternate, lean concrete may be used.}

#### 3.8.4.1.10 Masonry Walls

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

The ESWEMS pumphouse does not use masonry walls.}

#### 3.8.4.1.11 {ESWEMS Pumphouse and ESWEMS Retaining Pond}

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

The Seismic Category I ESWEMS Pumphouse and the ESWEMS Retaining Pond consist of components, which provide emergency makeup water to the Essential Service Water Cooling Tower basins for the shutdown of the plant, following a design basis accident. [Figure 3E.4-5](#) provides a site plan for Callaway Plant Unit 2, which shows the position of the ESWEMS Pumphouse and ESWEMS Retaining Pond relative to the Nuclear Island (NI).

As illustrated in [Figure 9.2-8](#) through [Figure 9.2-14](#) and [Figure 3E.4-4](#) and [Figure 3E.4-12](#), the ESWEMS Pumphouse is approximately 80 ft (24.4 m) long by 51 ft (15.5 m) wide by 24 ft (7.3 m) high, including a 5 ft (1.5 m) thick base mat. The structure houses a pump well portion, inside dimension nominally 76 ft (23.2 m) long by 11 ft-8 in (3.5 m) wide by 30 ft (9.1 m) deep. The entire ESWEMS Pumphouse is constructed of reinforced concrete. Main elevations include:

- ◆ Elevation 840.5 ft (256.2 m) msl: Top of the main foundation basemat.
- ◆ Elevation 864.5 ft (263.5 m) msl: Top of the concrete roof.
- ◆ Elevation 852.5 ft (259.8 m) msl : Top of the mezzanine floor.
- ◆ Elevation 810 ft (246.9 m) msl: Top of the pump well foundation.

Components within the pumphouse include ESWEMS makeup pumps, intake bar screens and strainers screens to preclude debris intake.

Exterior walls for the Pumphouse are 2 ft (0.6 m) thick minimum, to withstand the wave pressures of the PMP, earth and water pressures, and extreme environmental events. Key interior shear/bearing walls are at least 1'-6" (0.46 m) thick.

The ESWEMS pond is illustrated in [Figure 3E.4-5](#) through [Figure 3E.4-11](#) and the pond features are described in Section 2.4.8.2 and Section 9.2.5.3.}

#### 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:

{All seismic Category 1 structures as identified in Section 3.8.4 for Callaway Plant Unit 2, are designed to the load conditions as described in the U.S. EPR FSAR without departures, except for the loads resulting from the seismic response spectra and soil profiles described in Section 3.7.1.

Site specific load conditions are confirmed to lie within the standard U.S. EPR design certification envelope, except for the design loads resulting from the Callaway Plant Unit 2 site specific seismic response spectra and soil profiles described in Section 3.7.1. Additional confirmatory evaluations for the site-specific response spectra and soil profiles are performed and confirm that the Other Seismic Category 1 Structures are acceptable for the Callaway Plant Unit 2 site.}

#### 3.8.4.3.1 Design Loads

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

The design loads for the ESWEMS Pumphouse include:

##### Severe Environmental Loads

- ◆ Normal wind load
- ◆ Snow and water ponding on building roof.

##### Extreme Environmental Loads

- ◆ Tornado wind loading
- ◆ Safe-Shutdown Earthquake
- ◆ Load from water wave surge.

The factored load combinations in Section 3.8.4.3.2 apply for reinforced concrete design of the ESWEMS Pumphouse.}

#### 3.8.4.3.2 Loading Combinations

{Figure 3E.4-2 and Figure 3E.4-3 provide the description of the loading combinations and the minimum required factor-of-safety.}

#### 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 Base Mat Structure [and] Other Seismic Category I Nuclear Island Structures**

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 design of Seismic Category I buried electrical duct banks and buried Essential Service Water pipes (hereafter in this section referred to as buried duct banks and buried pipe) demonstrate sufficient strength to accommodate:

- ◆ Strains imposed by seismic ground motion.
- ◆ Static surface surcharge loads due to vehicular loads (AASHTO HS-20 (AASHTO, 2001) 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.
- ◆ Tornado missiles and, within their zone of influence, turbine generated missiles.
- ◆ Ground water effects.

Terrain topography and the results from the Callaway Plant Unit 2 geotechnical site investigation are used as design input to confirm the routing of buried pipe and duct banks reflected in [Figure 3E.4-5](#), [Figure 3.8-1](#) and [Figure 3.8-2](#).

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 typically do not induce significant bending or shear effects, because the soil cover and elastic support below the beam are considered effective and uniform over the entire length of the buried duct bank.

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 349-01 (ACI, 2001a).

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

As noted in Section 3.8.4.1.9, buried pipes are located such that the pipe is below the site-specific frost depth, with additional depth as necessary used to mitigate the effects of surcharge loads and 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 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 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**

No departures or supplements.

#### **3.8.4.4.7 {ESWEMS Pumphouse & Retaining Pond**

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

A GT STRUDL finite element model is created for the site-specific ESWEMS Pumphouse to:

- ◆ Provide accurate representation of the structure for a time history analysis (Refer to Section 3.7.2 for additional information on the seismic time history analysis).
- ◆ Conduct Response Spectrum analysis of the structure components, including equivalent static seismic loads, for evaluation of structural integrity and stability.
- ◆ Provide output for the design of reinforced concrete structural elements.

The finite element model consists of plate elements representing the load carrying reinforced concrete walls and slabs, which are suitable for capturing both the in-plane and out-of-plane effects from the corresponding applied loads.

Figure 3E.4-1 and Figure 3E.4-2 depict the finite element models for the ESWEMS Pumphouse.

The finite element response spectrum representing the ESWEMS Pumphouse includes dead loads, live loads, snow loads, equipment loads, building surcharge, soil pressure, hydrostatic pressure, seismic loads, normal wind, tornado wind, and wind induced wave forces.

The results from the GT STRUDL Response Spectrum analysis are used to design reinforced concrete shear walls and slabs according to provisions of ACI 349-01 (ACI, 2001a) (with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001)).

The evaluation of slabs and walls for external hazards (e.g., tornado generated missiles, wave inducing pressure, etc.) is performed by local analyses.

The ESWEMS pumphouse is only partially embedded, therefore the embedment effect is conservatively ignored, except there is an accounting for surcharge from building vertical load acting on the earth-facing wall of the pump well structure. Reinforced concrete shear walls and slabs are designed in accordance with ACI 349-01 (ACI, 2001a) (with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001)).

The safety analysis for the ESWEMS Pond includes a slope stability evaluation including horizontal seismic loads. The pond slopes are a permanent design feature and were evaluated using GSTABL7. Factors of safety for various sections are presented in Section 2.5 of the FSAR.}

### 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 AREVA NP Inc., U.S. EPR Piping Analysis and Support Design Topical Report.

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 the Areva NP Topical Report ANP-10264(NP) (AREVA, 2006){ unless technically justified}.

Acceptance criteria for the buried electrical duct banks are in accordance with IEEE 628-2001(R2006) (IEEE, 2001), ASCE 4-98 (ASCE, 1998) and ACI 349-01 (ACI, 2001a), with supplemental guidance of Regulatory Guide 1.142 (NRC, 2001). The use of ACI 349-01, in lieu of ACI 349-97 (ACI, 1997) as invoked in Subsection 4.9.4.15 of IEEE 628-2001 (R2006), is to provide a consistent design basis with all other Seismic Category I structures.

{Acceptance criteria for the buried Essential Service Water Pipes are identical to that of non-buried pipe. 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.

The site-specific ESWEMS is depicted in [Figure 9.2-8](#) through [Figure 9.2-14](#) and [Figure 3E.4-4](#) through [Figure 3E.4-12](#), and Appendix 3E provides the details for the analysis of critical locations.}

### **3.8.4.6 Materials, Quality Control, and Special Construction Techniques**

No departures or supplements.

#### **3.8.4.6.1 Materials**

{This section is added as a supplement to U.S. EPR FSAR Section 3.8.4.6.1.

Waterproofing material is provided to function as a barrier system for below-grade portions of Seismic Category I ESWEMS Pumphouse. Waterproofing material is applied to external surfaces of below grade vertical walls. The concrete basemat is thick enough to provide a waterproofing function for the below grade horizontal concrete surface of the ESWEMS. The waterproofing serves a non-safety related function to reduce housekeeping concerns related to ground water in-leakage.

The required concrete compressive strength for the ESWEMS Pumphouse is  $(f_c') = 5,000$  psi (34.5 MPa) at 28 days.}

#### **3.8.4.6.2 Quality Control**

No departures or supplements.

#### **3.8.4.6.3 Special Construction Techniques**

{Special construction techniques were not used for the Emergency Power Generating Buildings, Essential Service Water Buildings, ESWEMS Pumphouse, and associated buried utilities.}

#### **3.8.4.7 Testing and Inservice Inspection Requirements**

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

Inservice Inspection requirements pertain to ground water chemistry and potential degradation of below-grade concrete walls and buried duct banks. Special Inservice Inspection requirements are not applied in Callaway Plant Unit 2 ESWEMS Pumphouse and its associated buried duct banks and pipes given non-aggressive ground water condition at the site.}

## **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 foundation for the ESWEMS Pumphouse is discussed in Section 3.8.5.1.4.}

**3.8.5.1.1 Nuclear Island Common Basement Structure Foundation Base Mat**

No departures or supplements.

**3.8.5.1.2 Emergency Power Generating Buildings Foundation Base Mats**

No departures or supplements.

**3.8.5.1.3 Essential Service Water Buildings Foundation Base Mats**

No departures or supplements.

**3.8.5.1.4 {ESWEMS Pumphouse Base Mat}**

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

Plans, sections and details for the ESWEMS Pumphouse are provided in [Figure 9.2-8](#) through [Figure 9.2-14](#) and [Figure 3E.4-4](#), as applicable. A general description of the structures, including descriptions of all functional levels, is provided in Section 3.8.4.1.11. [Figure 3E.4-5](#) provides a site plan for Callaway Plant Unit 2, which shows the position of the ESWEMS Pumphouse relative to the NI.

The main reinforced concrete basemat for the ESWEMS Pumphouse is nominally 80 ft (24.4 m) by 51 ft (15.5 m) by 5 ft (1.52 m) thick. For the structure, heavily reinforced concrete shear walls, divider walls and earth retaining walls function as bearing walls to transfer vertical loads from the slabs above.}

**3.8.5.2 Applicable Codes, Standards, and Specifications**

No departures or supplements.

**3.8.5.3 Loads and Load Combinations**

{Additional loads and load combinations include those defined in Sections 3.8.4.3.1 and 3.8.4.3.2.}

**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 Base Mat Structure Foundation Base Mat**

No departures or supplements.

**3.8.5.4.3 Emergency Power Generating Buildings Foundation Base Mats**

No departures or supplements.

**3.8.5.4.4 Essential Service Water Buildings Foundation Base Mats**

No departures or supplements.

#### 3.8.5.4.5 Design Report

No departures or supplements.

#### 3.8.5.4.6 {ESWEMS Pumphouse Base Mat}

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

A static and dynamic Response Spectrum GT STRUDL analysis for the ESWEMS Pumphouse envelops the time history SASSI analysis results.

An isometric view of a segment of the model, including the base mat, exterior walls, interior divider walls, and pump well foundation is provided as [Figure 3.8-3](#) and [Figure 3.8-4](#).

During maintenance within the ESWEMS Pumphouse, stop logs are installed, and interior or exterior cells may be empty. For an exterior wall, with the adjacent outer cell empty, wall pressures include soil, surcharge and hydrostatic pressure from maximum water column is calculated.}

#### 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 soil parameters that are not within the envelope specified in Section 2.5.4.2.

This COL Item is addressed as follows:

{Site specific parameters for underlying soil layers in contact with the foundation fall outside conservative limits assumed in the U.S. EPR FSAR. This is addressed in Sections 3.8.5.5.1 through 3.8.5.5.3 for the NI common basemat, EPGB, and ESWB foundations, respectively.

Seismic Category 1 structures, other than those founded on the NI common basemat foundation basemat, are founded on engineered structural fill that meet the structure requirements specified in U.S. EPR FSAR Section 2.5.4.2 except as noted in Sections 3.8.5.5.2 and 3.8.5.5.3.

For the design of the site specific ESWEMS foundations the shear transfer of loads from the base mats to the underlying soil is via:

- ◆ Friction between the basemat, mud mat and the underlying soil
- ◆ Friction between the pump well concrete foundation and the mud mat or chert conglomerate.
- ◆ Friction between the apron base and the mud mat and the underlying chert conglomerate
- ◆ The presence of two shear keys embedded inside the chert.

For the ESWEMS Pumphouse, the static and dynamic coefficient of friction between concrete and soil is 0.5 and 0.70, for static and dynamic condition, respectively, without water proofing

membrane on the horizontal surfaces. A reduction in the coefficient of friction is applied for vertical waterproof walls.}

#### **3.8.5.5.1 Nuclear Island Common Base Mat Structure Foundation Base Mat**

{The U.S. EPR FSAR, Section 3.8.5.5.1, is incorporated by reference with the following supplemental information.

U.S. EPR FSAR Section 2.5.4.2 states acceptable limits and ranges of soil properties underlying the foundation structure.

The angle of internal friction for underlying soil layers in contact with the Nuclear Island foundations falls outside conservative limits assumed in the U.S. EPR FSAR. Additional analyses address the reduced angle of internal friction, and subsequent reduction in the friction factor, for the underlying soil layers in contact with the Nuclear Island (NI) Common Basemat Structures. These analyses demonstrate that the additional displacement due to sliding under seismic conditions is acceptable for the Callaway Plant Unit 2 site specific parameters. Additionally, a nonlinear time history analysis of the NI under seismic loads determines that the possible amount of uplift is negligible for the Callaway Plant Unit 2 site specific parameters.

The U.S. EPR FSAR states the acceptable limits of soil densities when saturated, moist, and dry. The Callaway Plant Unit 2 saturated, moist, and dry soil densities exceed those specified in the U.S. EPR FSAR. These parameters have been evaluated and are determined to be acceptable.}

#### **3.8.5.5.2 Emergency Power Generating Buildings Foundation Base Mats**

{The U.S. EPR FSAR, Section 3.8.5.5.2, is incorporated by reference with the following supplemental information.

The standard U.S. EPR FSAR Section 2.5.4.2 states acceptable limits and ranges of soil properties underlying the foundation structure.

Evaluation of the EPGB foundation basemat for maximum bearing pressures under sliding and overturning confirms the EPGB is acceptable for Callaway Plant Unit 2 site specific parameters.

The U.S. EPR FSAR states the acceptable limits of soil densities when saturated, moist, and dry. The Callaway Plant Unit 2 engineered structural fill saturated, moist, and dry soil densities exceed those specified in the U.S. EPR FSAR. The EPGB is a surface founded structure with no below grade walls. Therefore, the soil densities are determined to be acceptable.}

#### **3.8.5.5.3 Essential Service Water Buildings Foundation Base Mats**

{The U.S. EPR FSAR, Section 3.8.5.5.3, is incorporated by reference with the following supplemental information.

The standard U.S. EPR FSAR Section 2.5.4.2 states acceptable limits and ranges of soil properties underlying the foundation structure.

Evaluation of the ESWB foundation basemat for maximum bearing pressures under sliding and overturning confirms the ESWB is acceptable for Callaway Plant Unit 2 site specific parameters.

The U.S. EPR FSAR states the acceptable limits of soil densities when saturated, moist, and dry. The Callaway Plant Unit 2 engineered structural fill saturated, moist, and dry soil densities

exceed those specified in the U.S. EPR FSAR. These parameters have been evaluated and are determined to be acceptable.}

#### **3.8.5.5.4 Essential Service Water Emergency Makeup System Base Mat**

This section is added as a supplement to U.S. EPR FSAR Section 3.8.5.5.

Appendix 3E, Section 3E.4 provides applicable details of the base mat design for the ESWEMS Pumphouse.

Maximum soil bearing pressures under the ESWEMS Pumphouse foundation are provided in [Table 3.8-1](#). In the same table, calculated and allowable stability Factors of Safety (FS) are provided for the governing extreme environmental event (SSE) and normal or upset design load combinations.

Soil bearing stresses are less than the allowable bearing stresses of 5 ksf (240 kPa) and 10.0 ksf (480 kPa), for static and dynamic loading conditions, respectively in which, a minimum factor of safety of 3 and 2 are applied against the soil ultimate bearing pressure for allowable soil pressure for static and dynamic conditions respectively. The site-specific allowable bearing pressures are confirmed with soil boring data.

A finite element analysis of the entire ESWEMS Pumphouse, including Callaway Plant Unit 2 EPR site-specific soil springs, indicates the maximum differential settlement within the confines of the ESWEMS base mat to be less than 1/2 inch per 50 ft. Un-factored base mat bending moments confirm an un-cracked condition is maintained.

U.S. EPR FSAR Section 3.8.4.3.1 considers soil loads for saturated soil up to a ground water elevation of 3.3 ft (1.0 m) below finished grade. The ESWEMS Pumphouse design is adequate for the Callaway Plant Unit 2 site ground water elevation.}

#### **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 and identify the need for the use of waterproofing membranes and epoxy coated rebar based on site-specific ground water conditions.

This COL Item is addressed as follows:

{The U.S. EPR FSAR, Section 3.8.5.6.1, is incorporated by reference with the following supplemental information.

Callaway Plant Unit 2 site water table maximum elevation is approximately 828 ft and the expected final grade elevation is 845 ft. This yields that the water level is 17 ft below the powerblock site grade.

The U.S. EPR NI Common Basemat Structures foundation is embedded approximately 40 ft (12.2m) below site grade as discussed in the U.S. EPR FSAR; therefore, approximately 23 ft (7.0m) of the reinforced concrete NI foundation is submerged in water. The ESWB foundation is

embedded approximately 22 ft (6.7m) below site grade and the EPGB foundation is embedded approximately 5 ft (1.5m) below site grade, as discussed in the U.S. EPR FSAR. Therefore, approximately 5 ft of the reinforced concrete ESWB foundation is submerged in water, while the reinforced concrete foundation of the EPGB lies approximately 12 ft above the maximum water level.

U.S. EPR FSAR Section 2.5.4.2 specifies chemical properties for groundwater.

The maximum chloride content for Callaway Plant Unit 2 is within limitations for nonaggressive groundwater because it lies within the range of 0 to 500 ppm.

The maximum sulfate content for groundwater tested at the Callaway Plant Unit 2 falls between 0 and 1,500 ppm. The sulfate exposure in the groundwater is therefore considered to be nonaggressive.

The pH range for the groundwater at the Callaway Plant Unit 2 site is considered to be neutral and nonaggressive. A site which has a groundwater pH value > 5.5 has nonaggressive groundwater.

Based on these findings, there is no concern for an aggressive chemical attack due to ground water at Callaway Plant Unit 2. Therefore, the use of epoxy coated rebar and waterproofing membranes for the resistance of corrosive materials is not required for the Callaway Plant Unit 2 site.

Water proofing is provided for the ESWEMS Pumphouse and epoxy coated rebar is not necessary. The waterproofing system provides a barrier against ground water as described in Section 3.4.2 and Section 3.8.4.6.1.

Site-specific structures and their required minimum concrete compressive strength ( $f_c'$ ) are:

◆ ESWEMS Pumphouse:

$$f_c' = 5000 \text{ psi (34.5 MPa) at 28 days}$$

### 3.8.5.6.2 Quality Control

No departures or supplements.

### 3.8.5.6.3 Special Construction Techniques

{Special construction techniques were not used for the Emergency Power Generating Buildings, Essential Service Water Buildings, or the ESWEMS Pumphouse.}

### 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 if any site-specific settlement monitoring requirements for Seismic Category I foundations are required 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 ground water chemistry.

These COL Items are addressed as follows:

{The U.S. EPR FSAR, Section 3.8.5.7, is incorporated by reference with the following supplemental information.

Although settlement and differential settlement of foundations are not likely to affect the structures, systems, and components that make up the standard plant U.S. EPR due to the robust design of all Seismic Category I structures, a site specific settlement monitoring program will be established as a prudent measure of confirmation between expected or predicted settlement and actual field measured settlement values.

The settlement monitoring program employs 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 satisfies the requirements for monitoring the effectiveness of maintenance specified in 10 CFR 50.65(a)(2) and Regulatory Guide 1.160, C.1.5, as applicable to structures.

The Callaway Plant Unit 2 ground water/soil is considered to be nonaggressive as discussed in Section 3.8.5.6.1. The testing and inspection program will follow the nonaggressive soil/water intervals for inspecting normally inaccessible below-grade concrete walls and foundations. This interval calls for (1) examine the exposed portions of below-grade concrete for signs of degradation, when excavated for any reason, and (2) conduct periodic site monitoring of groundwater chemistry to confirm that the groundwater remains nonaggressive.}

### 3.8.6 REFERENCES

{**AASHTO, 2002.** Standard Specifications for Highway Bridges, 17th Edition, American Association of State and Highway Transportation Officials, September 2002.

**ACI, 1985.** Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete, ACI 515.1R-79, American Concrete Institute, 1985.

**ACI, 1997.** Code Requirements for Nuclear Safety-Related Concrete Structures, ACI 349-97, American Concrete Institute, 1997.

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

**ACI, 2001b.** Guide to Durable Concrete, ACI 201.2R-01, American Concrete Institute, 2001.

**ACI, 2006a.** Code Requirements for Environmental Engineering Concrete Structure, ACI 350-06, American Concrete Institute, 2006.

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

**AREVA, 2006.** U. S. EPR Piping Analysis and Pipe Support Design, Revision 0, AREVA NP Inc., September 2006.

**ASCE, 1998,** Seismic Analysis of Safety-Related Nuclear Structures and Commentary, ASCE 4-98, American Society of Civil Engineers, 1998.

**CFR, 2008.** Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Title 10, Code of Federal Regulations, Part 50.65, 2008.

**IEEE, 2001.** 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, 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.}

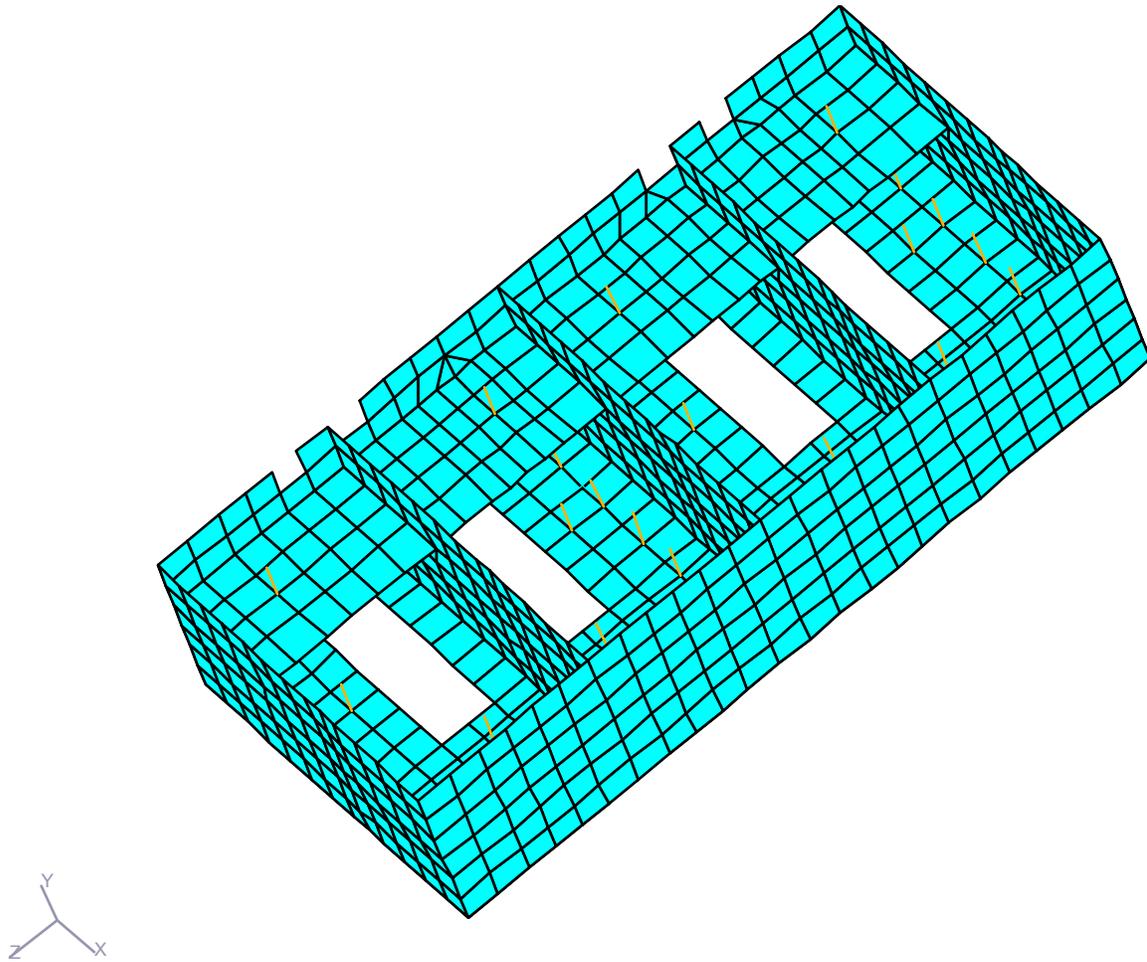
**Table 3.8-1—{ESWEMS Pumphouse Basemat & Pump Well Foundation Summary  
Table on the Building Stability}**

Required Stability Item	Static Load Condition		Dynamic Load Condition	
	Calculated	Allowable	Calculated	Allowable
Factor-Of-Safety Against Overturning	3.76	1.5 minimum	2.07	1.1 minimum
Factor-Of-Safety Against Sliding	2.58	1.5 minimum	1.1	1.1 minimum
Factor-Of-Safety Against Flotation	3.02	1.1 minimum	N/A	N/A
Soil Bearing Pressure (ksf) Based On Static / RRS Analysis	2.45	5.0 maximum	7.44	10.0 maximum
Building Maximum Global Displacements in X (vertical) direction (inches) Based On Static / RRS Analysis	0.24	N/A	0.55	N/A
Building Maximum Global Displacements in Y (vertical) direction (inches) Based On Static / RRS Analysis	0.50	1.0 maximum	0.73	1.0 maximum
Building Maximum Global Sway (Displacements at Roof Level) in Z (N-S) Direction (inches) Based On Static / RRS Analysis	0.03	N/A	0.22	N/A

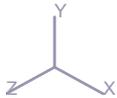
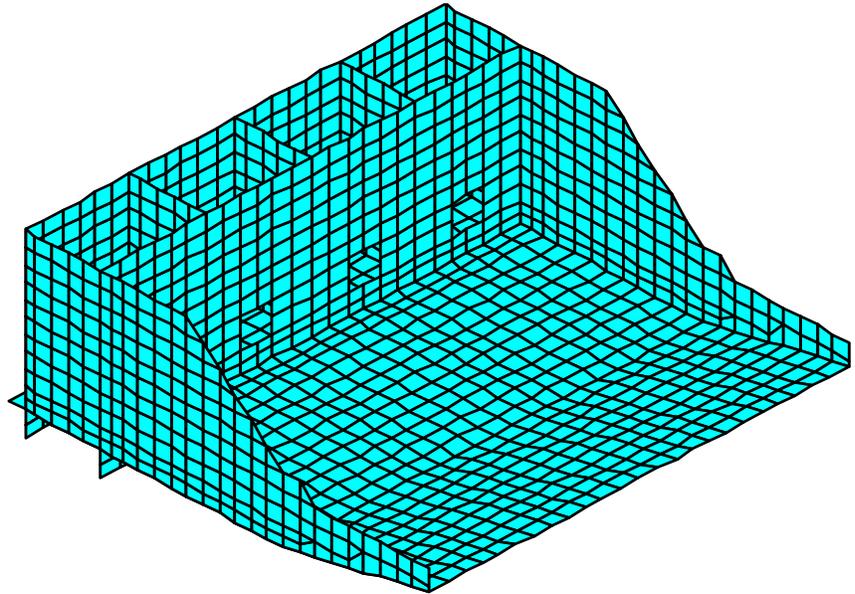
**Figure 3.8-1— {Schematic Site Plan of Seismic Category I Buried Utilities at the NI (Electrical Duct Banks)}**

**Figure 3.8-2—{Schematic Site Plan of Seismic Category I Buried Utilities at the NI (Underground Piping)}**

**Figure 3.8-3—{Isometric View of the GTStrudl Finite Element Model for the ESWEMS Pumphouse Structure (Partial View of Basemat, Exterior Walls and Interior Divider Walls)}**



**Figure 3.8-4—{Isometric View of the GTStrudl Finite Element Model for the ESWEMS Pumphouse Structure (Partial View of Pump Wells, Wing Walls and Apron)}**



### **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 an NRC-approved benchmark program using methods specifically selected for the U.S. EPR.

These COL Items are addressed as follows:

{AmerenUE} 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.

##### **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 Callaway Plant Unit 2 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 Callaway Plant Unit 2 (such as Calvert Cliffs Nuclear Power Plant Unit 3) be completed and approved by the U.S. Nuclear Regulatory Commission prior to initiation of start-up testing at Callaway Plant Unit 2, Callaway Plant Unit 2 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 Callaway Plant Unit 2. For Callaway Plant Unit 2, 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 in accordance with the Hot Functional Testing milestone identified in U.S. EPR FSAR Figure 14.2-1.

The visual inspection plan of the comprehensive vibration assessment program to be used for the prototype RPV internals at Callaway Plant Unit 2 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 Callaway Plant Unit 2 as described in U.S. EPR FSAR Tables 3.9.2-1 through 3.9.2-5.

The activities and milestones for implementation of the comprehensive vibration assessment program at Callaway Plant Unit 2 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.}

### **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**

{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 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.

This COL Item is addressed as follows.

{AmerenUE} shall prepare the design specifications and design reports for 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). The design specifications shall be prepared prior to procurement of the components while the ASME code reports shall be prepared during as-built reconciliation of the systems and components conducted prior to fuel load.

### **3.9.3.1 Loading Combinations, System Operating Transients, and Stress Limits**

The U.S. EPR FSAR includes the following COL Item in Section 3.9.3.1:

A COL applicant that references the U.S. EPR design certification will provide a summary of the maximum total stress, deformation (where applicable), and cumulative usage factor values for each of the component operating conditions for ASME Code Class 1 components. For those values that differ from the allowable limits by less than 10%, the COL applicant will provide the contribution of each of the loading categories (e.g., seismic, pipe rupture, dead weight, pressure, and thermal) to the total stress for each maximum stress value identified in this range.

This COL Item is addressed as follows:

{AmerenUE shall provide a summary of the maximum total stress, deformation (where applicable), and cumulative usage factor values for each of the component operating conditions for ASME Code Class 1 components. For those values that differ from the allowable limits by less than 10%, AmerenUE shall provide the contribution of each of the loading categories (e.g., seismic, pipe rupture, dead weight, pressure, and thermal) to the total stress for each maximum stress value identified in this range. This information shall be supplied prior to procurement of the ASME Code Class 1 components.}

#### **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 Section 3.9.3.1.1:

As noted in ANP-10264(NP), 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 and tornadoes, the design must withstand the plant design-bases loads for this event.

This COL Item is addressed as follows:

{AmerenUE} 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 or tornadoes.

The U.S. EPR FSAR includes the following COL Items in Section 3.9.3.1.1:

As noted in ANP-10264(NP), a COL applicant that references the U.S. EPR design certification will confirm that thermal deflections do not create adverse conditions during hot functional testing.

A COL applicant that references the U.S. EPR design certification will examine the feedwater line welds after hot functional testing prior to fuel loading and at the first refueling outage, in accordance with NRC Bulletin 79-13. A COL applicant that references the U.S. EPR design certification will report the results of inspections to the NRC, in accordance with NRC Bulletin 79-13.

These COL Items are addressed as follows:

{AmerenUE} shall:

- ◆ Confirm that thermal deflections do not create adverse conditions during hot functional testing.
- ◆ Examine the feedwater line welds after hot functional testing prior to fuel loading and at the first refueling outage, and will report the results of the inspections to the U.S. Nuclear Regulatory Commission, in accordance with NRC Bulletin 79-13 (NRC, 1979).

#### **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.}

### 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 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:

{The ESWEMS is a site-specific safety-related system that is subject to preservice testing (PST) and inservice testing (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 ESWEMS.}

{AmerenUE} 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 (CFR, 2008) 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 ESWEMS, including the individual components and the Pumpouse 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 ESWEMS 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 verification of the system's performance as specified in the plant accident analyses. There are no snubbers incorporated into this system.

The ESWEMS 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.}

### 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 ESWEMS Class 3 site-specific 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 ESWEMS, 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 ESWEMS.}

**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 explosive valves in the ESWEMS.}

**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. Per ASME Code Section III, Subsection NF, the fatigue evaluation is not required for shock snubbers.

This COL Item is addressed as follows.

{AmerenUE} 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, {AmerenUE} shall denote whether the snubber or component was evaluated for fatigue strength. Per ASME Section III, Subsection NF (ASME, 2004a), the fatigue evaluation shall not be required for shock snubbers. This information shall be provided prior to installation of any of the snubbers.

{The ESWEMS 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.

**CFR, 2008.** Codes and Standards, Title 10, Code of Federal Regulations, Part 50.55a, U. S. Nuclear Regulatory Commission, 2008.}

**Table 3.9-1—{Site-Specific Inservice Pump Testing Program Requirements}**

Pump ID <sup>8</sup>	Description	Pump Type	ASME Code Class	ASME Code Group	Testing and Frequency <sup>(6),(9)</sup>				
					Rotational Speed <sup>(4)</sup>	Pump Discharge Pressure <sup>(2)</sup>	Differential Pressure	Flow Rate	Vibration <sup>(5)</sup>
20 GFA 10 AP001	Train 1 Essential Service Water Emergency Makeup Pump	Vertical Solid Shaft	3	B	N/A <sup>1</sup>	N/A	Q/2Y	Q/2Y	Q/2Y
20 GFA 20 AP001	Train 2 Essential Service Water Emergency Makeup Pump	Vertical Solid Shaft	3	B	N/A <sup>1</sup>	N/A	Q/2Y	Q/2Y	Q/2Y
20 GFA 30 AP001	Train 3 Essential Service Water Emergency Makeup Pump	Vertical Solid Shaft	3	B	N/A <sup>1</sup>	N/A	Q/2Y	Q/2Y	Q/2Y
20 GFA 40 AP001	Train 4 Essential Service Water Emergency Makeup Pump	Vertical Solid Shaft	3	B	N/A <sup>1</sup>	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). Variable speed pumps only.
- (4). Displacement or velocity.
- (5). Test and their frequency are in accordance with subsection ISTB of ASME OM code.
- (6). The U. S. EPR subscribes to the Kraftworks Kennzeichen System (KKS) for coding and nomenclature of SSCs.
- (7). 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 2)

Valve Identification Number <sup>1</sup>	Description /Valve Function	Valve Type <sup>2</sup>	Valve Actuator <sup>3</sup>	ASME Code Class <sup>4</sup>	ASME OM Code Category <sup>5</sup>	Active/Passive <sup>6</sup>	Safety Position <sup>7</sup>	Test Required <sup>8</sup>	Test Frequency <sup>9</sup>	Comments
20GFA10 AA101	Train 1 ESWEMS Recirculation Control Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA10 AA401	Train 1 ESWEMS Flushing Line Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA10 AA001	Train 1 ESWEMS Pump Discharge Check Valve	CK	SA	3	C	A	O	ET	Q	
20GFA20 AA101	Train 2 ESWEMS Recirculation Control Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA20 AA401	Train 2 ESWEMS Flushing Line Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA20 AA001	Train 2 ESWEMS Pump Discharge Check Valve	CK	SA	3	C	A	O	ET	Q	
20GFA30 AA101	Train 3 ESWEMS Recirculation Control Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA30 AA401	Train 3 ESWEMS Flushing Line Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA30 AA001	Train 3 ESWEMS Pump Discharge Check Valve	CK	SA	3	C	A	O	ET	Q	
20GFA40 AA101	Train 4 ESWEMS Recirculation Control Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA40 AA401	Train 4 ESWEMS Flushing Line Valve	BF	MO	3	B	A	C	ET PI	Q 2Y	
20GFA40 AA001	Train 4 ESWEMS Pump Discharge Check Valve	CK	SA	3	C	A	O	ET	Q	
LATER	ESWEMS Makeup Water System Manual Valves	Various	MA	3	B	P	O/C	ET PI	5Y 2Y	See Note 10

**Table 3.9-2—{Site-Specific Inservice Valve Testing Program Requirements}**  
(Page 2 of 2)

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 ISTC-1300
7.	Valve safety function positions, 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 per test per ISTC-5000 (in conjunction with exercise test).
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 every 2 years 5Y – test performed once every 5 years (per ASME OM, ISTC-3540) RV – test relief valve at OM schedule.
10.	Table entries for manual valves will be developed during detailed design engineering.

### 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/or departures as described in the following sections.

Callaway Plant Unit 2 seismic qualification of equipment is performed using the Callaway Plant Unit 2 design ground motion response spectra described in Section 3.7.1 and ISRS provided in Section 3.7.2, instead of the U.S. EPR design certification SSE (CSDRS) and ISRS.

{For Callaway Plant Unit 2, seismic and dynamic qualification of site-specific mechanical and electrical equipment (identified in [Table 3.10-1](#)) includes equipment associated with the:

- ◆ Essential Service Water Emergency Makeup System (ESWEMS); 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 site-specific 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 site-specific equipment. This summary table shall:

- ◆ List site-specific 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

This 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 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 list is provided in [Table 3.10-1](#). [Table 3.10-1](#) also identifies the type of environment to which the equipment is subjected.

#### **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**

{Departure is discussed in Section 3.10.}

### **3.10.2 METHODS AND PROCEDURES FOR QUALIFYING MECHANICAL, ELECTRICAL AND I&C EQUIPMENT**

This U.S. EPR FSAR includes the following COL Item in Section 3.10.2:

If experience data are used to establish equipment qualification, a COL applicant that references the U. S. EPR design certification will document the qualification methodology and supporting data.

This COL Item is addressed as follows:

{AmerenUE} shall not use experience data to establish equipment qualification.

#### **3.10.2.1 Seismic Qualification of Electrical Equipment and Instrumentation**

No departures or supplements.

#### **3.10.2.2 Seismic Qualification of Active Mechanical Equipment**

No departures or supplements.

#### **3.10.2.3 Seismic Qualification of Non-Active Mechanical 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**

This U.S. EPR FSAR includes the following COL Items in Section 3.10.4:

A COL applicant that references the U. S. EPR design certification will create and maintain the SQDP file during the equipment selection and procurement phase.

This COL Item is addressed as follows:

{AmerenUE shall create and maintain the SQDP file. This activity shall be initiated during the equipment selection and procurement phase. The SQDP file shall be maintained for the life of the plant.}

This U.S. EPR FSAR also includes the following COL Items 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 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**

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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)
ESWEMS Pump Building Pump Bay 1 Class 1E 6.9KV-480V Transformer	21 BMT05	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E 6.9KV-480V Transformer	22 BMT05	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E 6.9KV-480V Transformer	23 BMT05	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E 6.9KV-480V Transformer	24 BMT05	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 1 Class 1E 480V Motor Control Center	21 BNG01	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E 480V Motor Control Center	22 BNG01	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E 480V Motor Control Center	23 BNG01	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E 480V Motor Control Center	24 BNG01	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 1 Class 1E Remote I/O Cabinet	20 CFH10	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E Remote I/O Cabinet	20 CFH20	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E Remote I/O Cabinet	20 CFH30	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E Remote I/O Cabinet	20 CFH40	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA10 CP002	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Instrument Valve 2 (Isolate Delta-Pressure Transmitter)	20 GFA10 AA302	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Instrument Valve 3 (Isolate Delta-Pressure Transmitter)	20 GFA10 AA303	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Pressure Transmitter	20 GFA10 CP001	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Instrument Valve 1 (Isolate Pressure Transmitter)	20 GFA10 AA301	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Temperature Indicator	20 GFA10 CT001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH10 CT005	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 2 of 9)

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 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH10 CT006	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH10 CT008	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH10 CP001	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA20 CP002	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Instrument Valve 2 (Isolate Delta-Pressure Transmitter)	20 GFA20 AA302	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Instrument Valve 3 (Isolate Delta-Pressure Transmitter)	20 GFA20 AA303	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Pressure Transmitter	20 GFA20 CP001	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Instrument Valve 1 (Isolate Pressure Transmitter)	20 GFA20 AA301	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Temperature Indicator	20 GFA20 CT001	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH20 CT005	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH20 CT006	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH20 CT008	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH20 CP001	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA30 CP002	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Instrument Valve 2 (Isolate Delta-Pressure Transmitter)	20 GFA30 AA302	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Instrument Valve 3 (Isolate Delta-Pressure Transmitter)	20 GFA30 AA303	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Pressure Transmitter	20 GFA30 CP001	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Instrument Valve 1 (Isolate Pressure Transmitter)	20 GFA30 AA301	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Temperature Indicator	20 GFA30 CT001	20UPF01 003	M	M	ES SI	S	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 3 of 9)

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 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH30 CT005	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH30 CT006	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH30 CT008	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH30 CP001	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA40 CP002	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Instrument Valve 2 (Isolate Delta-Pressure Transmitter)	20 GFA40 AA302	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Instrument Valve 3 (Isolate Delta-Pressure Transmitter)	20 GFA40 AA303	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Pressure Transmitter	20 GFA40 CP001	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Instrument Valve 1 (Isolate Pressure Transmitter)	20 GFA40 AA301	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Temperature Indicator	20 GFA40 CT001	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH40 CT005	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH40 CT006	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH40 CT008	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH40 CP001	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 Essential Service Water Emergency Makeup Pump	20 GFA10 AP001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 Essential Service Water Emergency Makeup Pump Motor	20 GFA10 AP001	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 Essential Service Water Emergency Makeup Pump	20 GFA20 AP001	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 Essential Service Water Emergency Makeup Pump Motor	20 GFA20 AP001	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 Essential Service Water Emergency Makeup Pump	20 GFA30 AP001	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 Essential Service Water Emergency Makeup Pump Motor	20 GFA30 AP001	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 Essential Service Water Emergency Makeup Pump	20 GFA40 AP001	20UPF01 004	M	M	ES SI	S	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
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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 Essential Service Water Emergency Makeup Pump Motor	20 GFA40 AP001	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Flushing Line Valve	20 GFA10 AA401	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Flushing Line Valve Motor	20 GFA10 AA401	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Flushing Line Valve	20 GFA20 AA401	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Flushing Line Valve Motor	20 GFA20 AA401	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Flushing Line Valve	20 GFA30 AA401	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Flushing Line Valve Motor	20 GFA30 AA401	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Flushing Line Valve	20 GFA40 AA401	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Flushing Line Valve Motor	20 GFA40 AA401	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Recirculation Control Valve	20 GFA10 AA101	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Recirculation Control Valve Motor	20 GFA10 AA101	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Recirculation Control Valve	20 GFA20 AA101	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Recirculation Control Valve Motor	20 GFA20 AA101	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Recirculation Control Valve	20 GFA30 AA101	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Recirculation Control Valve Motor	20 GFA30 AA101	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Recirculation Control Valve	20 GFA40 AA101	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Recirculation Control Valve Motor	20 GFA40 AA101	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Automatic Strainer	20 GFA10 AT001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Automatic Strainer Motor	20 GFA10 AT001	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Automatic Strainer	20 GFA20 AT001	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Automatic Strainer Motor	20 GFA20 AT001	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Automatic Strainer	20 GFA30 AT001	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Automatic Strainer Motor	20 GFA30 AT001	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Automatic Strainer	20 GFA40 AT001	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Automatic Strainer Motor	20 GFA40 AT001	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH10 AH002	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH10 AH003	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH20 AH002	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
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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 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH20 AH003	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH30 AH002	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH30 AH003	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH40 AH002	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH40 AH003	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Intake Control Damper 1	20 SAH10 AA 101	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH10 AA 101	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Intake Control Damper 1	20 SAH20 AA 101	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH20 AA 101	20UPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Intake Control Damper 1	20 SAH30 AA 101	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH30 AA 101	20UPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Intake Control Damper 1	20 SAH40 AA 101	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH40 AA 101	20UPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Emergency Cooling Fan	20 SAH10 AN001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH10 AN001	20UPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Emergency Cooling Fan	20 SAH20 AN001	20UPF01 002	M	M	ES SI	S	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
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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 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH20 AN001	20UJPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Cooling Fan	20 SAH30 AN001	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH30 AN001	20UJPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Cooling Fan	20 SAH40 AN001	20UJPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH40 AN001	20UJPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Emergency Condensing Unit	20 SAH10 AC002	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH10 AC002	20UJPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Emergency Condensing Unit	20 SAH20 AC002	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH20 AC002	20UJPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Condensing Unit	20 SAH30 AC002	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH30 AC002	20UJPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Condensing Unit	20 SAH40 AC002	20UJPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH40 AC002	20UJPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Pump Room Exhaust Backdraft Damper	20 SAH10 AA003	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation System Pump Room Exhaust Backdraft Damper	20 SAH20 AA003	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation System Pump Room Exhaust Backdraft Damper	20 SAH30 AA003	20UJPF01 003	M	M	ES SI	S	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
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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 ESWEMS Pump Building Ventilation System Pump Room Exhaust Backdraft Damper	20 SAH40 AA003	20UJPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation System Cooling Fan Volume Damper	20 SAH10 AA004	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation System Cooling Fan Volume Damper	20 SAH20 AA004	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation System Cooling Fan Volume Damper	20 SAH30 AA004	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Building Ventilation System Cooling Fan Volume Damper	20 SAH40 AA004	20UJPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH10 CH003	20UJPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH20 CH003	20UJPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH30 CH003	20UJPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH40 CH003	20UJPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Discharge Flow Transmitter	20 GFA10 CF001	20UJPF01 001	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 1 ESWEMS Pump Discharge Flow Orifice	20 GFA10 AO001	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Instrument Valve 4 (Isolate Flow Transmitter)	20 GFA10 AA304	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Instrument Valve 5 (Isolate Flow Transmitter)	20 GFA10 AA305	20UJPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Flow Transmitter	20 GFA20 CF001	20UJPF01 002	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 2 ESWEMS Pump Discharge Flow Orifice	20 GFA20 AO001	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Instrument Valve 4 (Isolate Flow Transmitter)	20 GFA20 AA304	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Instrument Valve 5 (Isolate Flow Transmitter)	20 GFA20 AA305	20UJPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Flow Transmitter	20 GFA30 CF001	20UJPF01 003	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 3 ESWEMS Pump Discharge Flow Orifice	20 GFA30 AO001	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Instrument Valve 4 (Isolate Flow Transmitter)	20 GFA30 AA304	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Instrument Valve 5 (Isolate Flow Transmitter)	20 GFA30 AA305	20UJPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Flow Transmitter	20 GFA40 CF001	20UJPF01 004	M	M	ES SI	S 1E	Yes (5) Yes (6)
Train 4 ESWEMS Pump Discharge Flow Orifice	20 GFA40 AO001	20UJPF01 004	M	M	ES SI	S	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEMS Pumphouse}**  
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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 ESWEMS Instrument Valve 4 (Isolate Flow Transmitter)	20 GFA40 AA304	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Instrument Valve 5 (Isolate Flow Transmitter)	20 GFA40 AA305	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Isolation Valve	20GFA10 AA002	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Isolation Valve	20GFA20 AA002	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Isolation Valve	20GFA30 AA002	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Isolation Valve	20GFA40 AA002	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Check Valve	20GFA10 AA001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Check Valve	20GFA20 AA001	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Check Valve	20GFA30 AA001	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Check Valve	20GFA40 AA001	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Vent Valve	20GFA10 AA501	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Vent Valve	20GFA20 AA501	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Vent Valve	20GFA30 AA501	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Vent Valve	20GFA40 AA501	20UPF01 004	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Discharge Drain Valve	20GFA10 AA402	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Discharge Drain Valve	20GFA20 AA402	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Discharge Drain Valve	20GFA30 AA402	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 4 ESWEMS Pump Discharge Drain Valve	20GFA40 AA402	20UPF01 004	M	M	ES SI	S	Yes (5)
Fire Protection Diesel Engine(s)/Diesel Engine Pump(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection Diesel Engine(s)/Pump(s) Instrument(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection Diesel Engine(s)/Pump(s) Valve(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection System Isolation Valve(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection System Check Valve(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection System Pressure Relief Valve(s)		20USG	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection Water Storage Tanks Isolation Valve(s)			M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection System Post Indicator Valve(s)		20UZT	M	M	SII-SSE	NS-AQ	Yes (5)
Fire Protection System Hydrant Isolation Valve(s)		20UZT	M	M	SII-SSE	NS-AQ	Yes (5)
Hydrants Supplying Protection to SSE Buildings		20UZT	M	M	SII-SSE	NS-AQ	Yes (5)
ESWEMS Hose Station(s)		20UPF	M	M	SII-SSE	NS-AQ	Yes (5)

**Table 3.10-1 —{Seismically and Dynamically Qualified Mechanical and Electrical Equipment for Site Specific ESWEEMS Pumphouse}**

(Page 9 of 9)

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)
<b>NOTES</b>							
<ol style="list-style-type: none"> <li>1. EQ Environment: (M= Mild, H= Harsh)</li> <li>2. Radiation Environment Zone: (M= Mild, H= Harsh)</li> <li>3. EQ Designated Function: RT (Reactor Trip), ES (Engineered Safeguards), PAM (Post Accident Monitoring), SI (Seismic I), SII (Seismic II)</li> <li>4. Safety Class: S (Safety Related), NS-AQ (Supplemental Grade Non-Safety), 1E (Class 1E), EMC (Electromagnetic Compatibility), C/NM (Consumables/Non-Metallics)</li> <li>5. EQ Program Designation: 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.</li> </ol>							

**Table 3.10-2—Seismic Qualification Implementation Program**

<b>Phase</b>	<b>Scope Definition</b>	<b>Schedule</b>
<b>I</b>	Seismic Qualification Methodology	Prior to Procurement
<b>II</b>	Specification Development	Prior to Procurement
<b>III</b>	Technical Bid Evaluations	Early in the Procurement Phase
<b>IV</b>	New Seismic Analysis and/or Testing (when required)	Prior to Initial Pre-operational Testing
<b>V</b>	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.

The U.S. EPR FSAR includes the following COL Item in Section 3.11:

A COL applicant that references the U.S. EPR design certification will maintain the equipment qualification test results and qualification status file during the equipment selection, procurement phase and throughout the installed life in the plant.

This COL Item is addressed as follows:

{AmerenUE} shall maintain the equipment qualification test results and qualification status file during the equipment selection, procurement phase and throughout the installed life in the plant.

#### 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 Essential Service Water Emergency Makeup System (ESWEMS) 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.

Regulatory Guide 1.131, "Qualification Tests of Electric Cables and Field Splices for Light-Water-Cooled Nuclear Power Plants" (NRC, 1977) endorses IEEE Std 383-1974, "Standard for Type Test of Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations" (IEEE, 1974). These documents contain guidance for the environmental qualification of Class 1E electric cables and field splices, and 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 {ESWEMS} 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 {ESWEMS}.

#### **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**

No departures or supplements.

### **3.11.3 QUALIFICATION TEST RESULTS**

This 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:

{AmerenUE} shall develop and submit the equipment qualification testing program, including milestones and completion dates, prior to installation of the applicable equipment.

**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**

{**IEEE, 1974.** Standard for Type Test of Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations, IEEE Std 383-1974, IEEE, 1974.

**NRC, 1977.** Qualification Tests of Electric Cables and Field Splices and Connections for Light-Water-Cooled Nuclear Power Plants, Regulatory Guide 1.131, U.S. Nuclear Regulatory Commission, August 1977.

**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—{Environmentally Qualified Electrical/I&C Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 1 of 5)

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)
ESWEMS Pump Building Pump Bay 1 Class 1E 6.9kV-480V Transformer	21 BMT05	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E 6.9kV-480V Transformer	22 BMT05	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E 6.9kV-480V Transformer	23 BMT05	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E 6.9kV-480V Transformer	24 BMT05	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 1 Class 1E 480V Motor Control Center	21 BNG01	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E 480V Motor Control Center	22 BNG01	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E 480V Motor Control Center	23 BNG01	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E 480V Motor Control Center	24 BNG01	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 1 Class 1E Remote I/O Cabinet	20 CFH10	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 2 Class 1E Remote I/O Cabinet	20 CFH20	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 3 Class 1E Remote I/O Cabinet	20 CFH30	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
ESWEMS Pump Building Pump Bay 4 Class 1E Remote I/O Cabinet	20 CFH40	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA10 CP002	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Discharge Pressure Transmitter	20 GFA10 CP001	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Discharge Temperature Indicator	20 GFA10 CT001	20UPF01 001	M	M	ES SI	S	Yes (5)
Train 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH10 CT005	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH10 CT006	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)

**Table 3.11-1—{Environmentally Qualified Electrical/I&C Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 2 of 5)

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 1 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH10 CT008	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH10 CP001	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA20 CP002	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Discharge Pressure Transmitter	20 GFA20 CP001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Discharge Temperature Indicator	20 GFA20 CT001	20UPF01 002	M	M	ES SI	S	Yes (5)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH20 CT005	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH20 CT006	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH20 CT008	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH20 CP001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA30 CP002	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Discharge Pressure Transmitter	20 GFA30 CP001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Discharge Temperature Indicator	20 GFA30 CT001	20UPF01 003	M	M	ES SI	S	Yes (5)
Train 3 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH30 CT005	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH30 CT006	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH30 CT008	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH30 CP001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Automatic Strainer Differential Pressure Transmitter	20 GFA40 CP002	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Discharge Pressure Transmitter	20 GFA40 CP001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Discharge Temperature Indicator	20 GFA40 CT001	20UPF01 004	M	M	ES SI	S	Yes (5)

**Table 3.11-1—{Environmentally Qualified Electrical/I&C Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 3 of 5)

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 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 2 (Safety Related)	20 SAH40 CT005	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 3 (Safety Related)	20 SAH40 CT006	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Temperature Sensor 5 (Safety Related)	20 SAH40 CT008	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Cooling Fan Filter Differential Pressure Transmitter	20 SAH40CP001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 Essential Service Water Emergency Makeup Pump Motor	20 GFA10 AP001	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 Essential Service Water Emergency Makeup Pump Motor	20 GFA20 AP001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 Essential Service Water Emergency Makeup Pump Motor	20 GFA30 AP001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 Essential Service Water Emergency Makeup Pump Motor	20 GFA40 AP001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Flushing Line Valve Motor	20 GFA10 AA401	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Flushing Line Valve Motor	20 GFA20 AA401	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Flushing Line Valve Motor	20 GFA30 AA401	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Flushing Line Valve Motor	20 GFA40 AA401	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Recirculation Control Valve Motor	20 GFA10 AA101	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Recirculation Control Valve Motor	20 GFA20 AA101	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Recirculation Control Valve Motor	20 GFA30 AA101	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Recirculation Control Valve Motor	20 GFA40 AA101	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Automatic Strainer Motor	20 GFA10 AT001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Automatic Strainer Motor	20 GFA20 AT001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Automatic Strainer Motor	20 GFA30 AT001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Automatic Strainer Motor	20 GFA40 AT001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH10 AH002	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH10 AH003	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH20 AH002	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH20 AH003	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)

**Table 3.11-1—{Environmentally Qualified Electrical/I&C Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 4 of 5)

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 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH30 AH002	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH30 AH003	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Electric Heater 2 (Safety Related)	20 SAH40 AH002	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation Pump Room Electric Heater 3 (Safety Related)	20 SAH40 AH003	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH10 AA101	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH20 AA101	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH30 AA101	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Intake Control Damper 1 Motor	20 SAH40 AA101	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH10 AN001	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH20 AN001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH30 AN001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Cooling Fan Motor	20 SAH40 AN001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH10 AC002	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH20 AC002	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH30 AC002	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Condensing Unit Motor	20 SAH40 AC002	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH10 CH003	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)

**Table 3.11-1—{Environmentally Qualified Electrical/I&C Equipment for Site Specific ESWEMS Pumphouse}**  
(Page 5 of 5)

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 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH20 CH003	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH30 CH003	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Building Ventilation System Emergency Cooling Air Smoke Detector	20 SAH40 CH003	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 1 ESWEMS Pump Discharge Flow Transmitter	20 GFA10 CF001	20UPF01 001	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 2 ESWEMS Pump Discharge Flow Transmitter	20 GFA20 CF001	20UPF01 002	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 3 ESWEMS Pump Discharge Flow Transmitter	20 GFA30 CF001	20UPF01 003	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Train 4 ESWEMS Pump Discharge Flow Transmitter	20 GFA40 CF001	20UPF01 004	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Medium Voltage Power Cable	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Low Voltage Power Cable	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Low Voltage Control Cable (600V)	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Shielded Instrumentation Cable (600V)	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Thermocouple Extension Cable	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)
Fiber Optic Communication Cable	various	multiple	M	M	ES SI	S 1E EMC	Yes (5) Yes (6)

**NOTES**

- EQ Environment: (M= Mild, H= Harsh)
- Radiation Environment Zone: (M= Mild, H= Harsh)
- EQ Designated Function: RT (Reactor Trip), ES (Engineered Safeguards), PAM (Post Accident Monitoring), SI (Seismic I), SII (Seismic II)
- Safety Class: S (Safety Related), NS-AQ (Supplemental Grade Non-Safety), 1E (Class 1E), EMC (Electromagnetic Compatibility), C/NM (Consumables/Non Metallics)
- EQ Program Designation: 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.

### **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.

This COL Item is addressed as follows:

{AmerenUE} 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.

##### **3.12.4.3 Piping Benchmark Program**

The U.S. EPR FSAR includes the following COL Item in Section 3.12.4.3:

If the COL applicant that references the U.S. EPR design certification chooses to use a piping analysis program other than those listed in Section 5.1 of the referenced topical report, the COL applicant will implement a NRC benchmark program using models specifically selected for the U.S. EPR.

This COL Item is addressed as follows:

{AmerenUE} shall use piping analysis programs listed in Section 5.1 of the topical report ANP-10264(NP)(AREVA, 2006).

##### **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 U.S. EPR FSAR includes the following COL Item in Section 3.12.5.1:

As indicated in Section 2.5.2, a COL applicant will confirm the site-specific seismic response is within the parameters of Section 2.5.2.

This COL Item is addressed as follows:

The site-specific seismic response {has been reconciled with Certified Design Response Spectra (CSDRS) as discussed in Sections 3.7.1 and 3.7.2.}

#### **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**

No departures or supplements.

#### **3.12.5.10 Thermal Stratification**

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**

{AREVA, 2006. U. S. EPR Piping Analysis and Pipe Support Design, ANP-10264(NP), Revision 0, AREVA NP Inc., September, 2006.}

**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 plan for ASME Class 1, Class 2, and Class 3 threaded fasteners to the NRC prior to performing the first inspection.

This COL Item is addressed as follows:

{AmerenUE} shall submit the inservice inspection plan for ASME Class 1, Class 2, and Class 3 threaded fasteners to the U.S. Nuclear Regulatory Commission prior to performing the first inspection.

### **3A CRITERIA FOR DISTRIBUTION SYSTEM ANALYSIS AND SUPPORT**

This section of the U.S. EPR FSAR is incorporated by reference.

### **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 {with the following departure:

The Callaway Plant Unit 2 design ground motion response spectra are as described in Section 3.7.1, instead of the U.S. EPR design certification SSE (CSDRS).}

### **3D METHODOLOGY FOR QUALIFYING SAFETY-RELATED ELECTRICAL AND MECHANICAL EQUIPMENT**

This section of the U.S. EPR FSAR is incorporated by reference {with the following departure.

The Callaway Plant Unit 2 design ground motion response spectra are as described in Section 3.7.1, instead of the U.S. EPR design certification SSE (CSDRS).}

### **3E CRITICAL SECTIONS FOR SAFETY-RELATED CATEGORY I STRUCTURES**

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

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:

{The values in the governing forces and moments tables are based on the U.S. EPR design certification loads. Evaluations of Seismic Category I structures for the site-specific GMRS/FIRS and site-specific soil profiles are described in Section 3.8.

- ◆ Essential Service Water Emergency Makeup Water (ESWEMS) Pumphouse
- ◆ ESWEMS Retaining Pond}

**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 {ESWEMS PUMPHOUSE AND ESWEMS RETAINING POND**

This section is a supplement to U.S. EPR FSAR Appendix 3E.

**Description of Critical Sections of the ESWEMS Pumphouse and ESWEMS Retaining Pond**

The General Arrangement plans and elevations of the ESWEMS Pumphouse and its associated ESWEMS Retaining Pond are provided as [Figure 3E.4-4](#) through [Figure 3E.4-12](#) and [Figure 9.2-8](#) through [Figure 9.2-14](#), as applicable. A general description of both structures is provided below, with additional information contained in Section 3.8.4.1.11.

The ESWEMS Pumphouse is a reinforced concrete structure approximately 80 ft (24.4 m) long by 51 ft (15.5 m) wide by 24 ft (7.3 m) high, consisting of the following levels:

- ◆ Elevation 840.5 ft (256 m) msl: Top of concrete (TOC) for the 5 ft (1.5 m) thick basemat.
- ◆ Elevation 852.5 ft (259.8) msl: TOC of the 2 ft (0.6 m) thick mezzanine floor.
- ◆ Elevation 864.5 ft (263.5 m) msl: TOC of the 2 ft (0.6 m) thick concrete roof.
- ◆ Elevation 810 ft (246.9 m) msl: TOC for the 3 ft (0.9 m) thick pump well foundation.
- ◆ Elevation 810 ft (246.9 m) msl sloped up to nominal Elevation 818 (249.3 m) for TOC of the 3 ft (0.9m) thick x 60 ft (18.3 m) long concrete apron pad with wing walls.
- ◆ Exterior walls of the ESWEMS Pumphouse (i.e., walls located above main basemat deck) are 2 ft (0.61 m) thick as required for tornado generated missile protection.
- ◆ Earth-facing wall of the pump wells is 3 ft (0.9 m) thick due to heavy building surcharge and soil pressures in addition to globally inducing static and dynamic loadings.
- ◆ Water-facing wall of the pump wells is 2 ft (0.6 m) thick due to the magnitude of the PMP wave pressures and as required for tornado generated missile protection.

The main basemat of the ESWEMS Pumphouse is situated on top of Category I structural fill material. The building pump well foundation is founded on top of a cherty conglomerate.

The ESWEMS Pond is illustrated in [Figure 3E.4-5](#) through [Figure 3E.4-11](#).

**Design Criteria**

The ESWEMS Pumphouse is designed in accordance with the provisions of ACI 349-01 (Ad, 2001) (as supplemented by Regulatory Guide 1.142 (NRC, 2001). Loading includes dead loads (including equipment dead loads), live loads, construction loads, snow loads, pipe loads, soil

pressure, hydrostatic pressure, seismic response (including associated dynamic soil pressures), normal wind, tornado wind, tornado generated missiles, and PMP wave forces. [Table 3E.4-1](#) and [Table 3E.4-2](#) provides the governing design load combinations and the required minimum Factor-of-Safety for building stability. For design, load combinations are conservatively simplified and enveloped in Load Combination Cases 2, 3, and 4.

The pump well compartment wall is evaluated for possible ice expansion forces on its interior confined walls. The Safety-Related HVAC system provides the environmental control inside the building to ensure the temperature remains above the freezing point for water. Ice forming between the wing walls of the apron will not develop the full expansion force on the walls, because it is free to expand toward the pond shore. The ice impact force on the water-facing wall of the pump well, is less than impact from tornado generated missiles because the ice is free to expand toward the pond shore. The induced additional local stresses are accounted for in the detail design.

The ESWEMS Pond design features are described in Section 2.4.8.2 and Section 9.2.5.3. Factors of safety for pond sections are discussed in Section 3.8.4.4.7.

### 3E.4.1 ESWEMS Pumphouse

#### Description of the Critical Section and Computer Model

The main floor basemat, see [Figure 3E.4-4](#), consists of 5 ft (1.5 m) thick reinforced concrete slab on a structural backfill layer. Three divider walls and two exterior walls of 2 ft (610 mm) thick concrete are located parallel to the direction of pumped water flow and bear on the basemat. Thus, vertical loads from the roof and operating mezzanine deck are distributed to the basemat. Additional vertical loads, mainly over the pump well areas are transferred down to the pump well base founded on the chert. The concrete apron and its associated wing walls are designed to resist the global overturning moments from wind and seismic loadings. The apron mitigates the bearing stress in the basemat and pump well base.

The two shear keys embedded in the chert are designed to withstand the building sliding shear in W-E direction beyond the resisting friction that is developed between building foundation and the soil or the chert conglomerate.

[Figure 9.2-8](#) through [Figure 9.2-14](#) and [Figure 3E.4-4](#) through [Figure 3E.4-12](#), provide plans, elevations, and sections for the Pumphouse and its associated retaining pond. The associated finite element mesh for the basemat is provided in [Figure 3E.4-11](#) and [Figure 3E.4-2](#). [Figure 3E.4-1](#) provides Isometric View of ESWEMS Pumphouse Main Basemat & Pump Well Base - Finite Element Mesh. Isometric View of the ESWEMS Pumphouse GTStrudl Finite Element Model - Exterior Wall, Roof, and Apron is provided in [Figure 3E.4-2](#).

#### Design using GT STRUDL Response Spectrum Method

SSE accelerations are applied to dead load, equipment load (e.g., electrical, HVAC, pumps, etc), 25% of live load, and minimum 75% of the design snow load.

The PMP pressures are applied to walls and slabs of the ESWEMS pump wells structural finite element model and consist of:

- ◆ Hydrostatic pressures associated with the PMP maximum water column elevation.

- ◆ Coincident wind induced wave pressures associated with a (0.15% Exceedance Probability) wave height of 1.7 ft (0.5 m). These wall pressures vary with the location on the structure and the direction of the wave. The maximum applied pressure is 0.4 kips (19 kPa) per square foot at the water-facing of the pump well wall.
- ◆ Surcharge due to the Pumphouse dead weight acting on the earth-facing wall of the pump well structure.

Stability against both overturning and sliding of the ESWEMS Pumphouse has been verified for all seismic load cases as well as the static wind conditions.

### Results of Critical Section Design

Using enveloping loading conditions, including the extreme environment events (i.e., SSE and PMP), the base mat for the ESWEMS Pumphouse structure had the maximum static and dynamic soil bearing pressures as shown in [Table 3.8-1](#). These values are within the corresponding allowable soil bearing capacities of 5 ksf (240 kPa) and 10 ksf (480 kPa), respectively. The building design satisfies the soil bearing pressures and Factor-of-Safety for both static and dynamic conditions.

Base mat separation from the underlying soil during the SSE is mitigated via extensions beyond the ESWEMS Pumphouse periphery. The mat dimensions used in the seismic analysis are based on the building periphery and not the extended base mat. Thus, the maximum difference between the base mat dimension in soil contact and the corresponding mat dimension used in the dynamic analysis is 8 ft (2.4 m), or approximately 15% of the overall mat dimension. Detail design confirms that the mat extensions do not adversely impact the accelerations and in-structure response spectra generated via the seismic analysis.

For the determination of steel reinforcement, calculations are performed to determine the maximum positive and negative bending moments and shears within structural components. The factored maximum moments, shears for critical components, such as the basemat, pump well foundation, exterior walls, and the shear keys, etc., are determined and tabulated in [Table 3E.4-3](#) to [Table 3E.4-6](#). The GT STRUDL force and moment directional reference is provided in [Figure 3E.4-3](#). In general, reinforcing bar #11 will be used for concrete reinforcement. [Figure 3E.4-12](#) provides a typical section showing reinforcing arrangement.}

### 3E.4.2 References

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

**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.}

**Table 3E.4-1—{Design Load Combinations for ESWEMS Pumphouse Structure}**

For detailed design, the load combinations are in accordance with ACI 349-05 and/or ACI 318-05. The enveloped load combinations of the combinations 2, 3 and 4, listed below, have been used in the initial stage of the design and are conservative. Reaction loads from piping are factored in the equipment weight and/or live load.

1.	$U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7R_o$
2.	$U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7W + 1.7R_o$
3.	$U = D + F + L + H + T_o + R_o + E_{ss}$
4.	$U = D + F + L + H + T_o + R_o + W_t$
5.	$U = D + F + L + H + T_a + R_a + 1.25P_a$
6.	$U = D + F + L + H + T_a + R_a + 1.0P_a + 1.0(Y_r + Y_j + Y_m) + 1.0E_{ss}$
7.	$U = 1.05D + 1.05F + 1.3L + 1.3H + 1.05T_o + 1.3R_o$
8.	$U = 1.05D + 1.05F + 1.3L + 1.3H + 1.3W + 1.05T_o + 1.3R_o$

Where:

D = dead loads, or related internal moments and forces, including piping and equipment dead loads

Ess = load effects of safe shutdown earthquake (SSE), or related internal moments and forces, including SSE-induced piping and equipment reactions

F = loads due to weight and pressures of fluids with well-defined densities and controllable maximum heights, or related internal moments and forces

H = loads due to weight and pressure of soil, water in soil, or other materials, or related internal moments and forces

L = live loads, or related internal moments and forces, including live load in conjunction with seismic loadings

Pa = differential pressure load, or related internal moments and forces, generated by a postulated pipe break

Ra = piping and equipment reactions, or related internal moments and forces, under thermal conditions generated by a postulated pipe break and including Ro.

Ro = piping and equipment reactions, or related internal moments and forces, which occur under normal operating and shutdown conditions, excluding dead load and earthquake reactions

Ta = internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of accident conditions generated by a postulated pipe break and including To

To = internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of normal operating or shutdown conditions

U = required strength to resist factored loads or related internal moments and forces

W = operating basis wind load (OBW), or related internal moments and forces

Wt = loads generated by the design basis tornado (DBT), or related internal moments and forces. These include loads due to tornado wind pressure, tornado created differential pressures, and tornado generated missiles

Yj = jet impingement load, or related internal moments and forces, on the structure generated by a postulated pipe break

Ym = missile impact load, or related internal moments and forces, on the structure generated by a postulated pipe break, such as pipe whip

Yr = loads, or related internal moments and forces, on the structure generated by the reaction of the broken pipe during a postulated break

**Table 3E.4-2—{Required Factor of Safety for ESWEMS Pumphouse Stability}**

Load Combination	Minimum Factors of Safety		
	Overturning	Sliding	Flotation
D + F' (Buoyant forces of design basis flood)			1.1
D + F (Buoyant forces of design ground water)+ W + H (Lateral earth pressure)	1.5	1.5	
D + F +E + H'	1.5	1.5	
D + F + Wt (Extreme wind load) + H	1.1	1.1	
D + F + E'(Safe Shutdown Earthquake loads) + H' (Lateral earth pressure including dynamic increment)	1.1	1.1	
D + F' (Buoyant forces of design basis flood)			1.1
D + F (Buoyant forces of design ground water)+ W + H (Lateral earth pressure)	1.5	1.5	

Load combinations are based on NUREG 0800, Section 3.3.5, Subsection II.3 and II.5

**Table 3E.4-3—{Demand Table for the ESWEMS Pumphouse Basemat Resultant Membrane Forces and Moments}**

<b>Controlled Load Combination for Preliminary Design</b>	<b>Nxx (kip/ft)</b>	<b>Nyy (kip/ft)</b>	<b>Nxy (kip/ft)</b>	<b>Mxx (kft/ft)</b>	<b>Myy (kft/ft)</b>	<b>Mxy (kft/ft)</b>	<b>Vxx (kip/ft)</b>	<b>Vyy (kip/ft)</b>
Enveloped static condition, including normal wind loading.	418.6	127.5	63.5	499.0	896.0	560.8	870.9	283.2
Enveloped static condition including tornado wind loading.	281	88.8	43.0	337.9	604.0	380.0	581.3	264.1
Average values for dynamic condition, including SSE loading.	670.7	246.6	165.3	884.8	469.3	284.0	204.1	156.2

**Notes:**

For initial design, reactions from equipment are accounted for in the design live load or equipment masses.

The above resultant membrane forces are the enveloped resultants for the load combination cases, which are considered essential and bounding the design of the ESWEMS Pumphouse structure. Other loading cases, including piping, equipment, temperature loads, etc., are considered in detailed design.

Nxx: In-plan force in X axis

Nyy: In-plan force in Y axis

Nxy: Torsional shear force

Mxx: Out-Of-Plan Bending Moment against X Direction

Myy: Out-Of-Plan Bending Moment against Y Direction

Mxy: Torsional Moment

Vxx: Normal force

Vyy: Normal force

**Table 3E.4-4—{Demand Table for the ESWEMS Pump Well Foundation Group Resultant Membrane Forces and Moments}**

<b>Controlled Load Combination for Preliminary Design</b>	<b>Nxx (kip/ft)</b>	<b>Nyy (kip/ft)</b>	<b>Nxy (kip/ft)</b>	<b>Mxx (kft/ft)</b>	<b>Myy (kft/ft)</b>	<b>Mxy (kft/ft)</b>	<b>Vxx (kip/ft)</b>	<b>Vyy (kip/ft)</b>
Enveloped static condition, including normal wind loading.	29.1	4.1	5.1	30.2	24.5	5.7	6.6	9.9
Enveloped static condition including tornado wind loading.	19.9	2.7	3.6	21.1	15.3	3.6	4.4	7.2
Average values for dynamic condition, including SSE loading.	262.6	57.3	130.5	545.8	119.2	82.1	286.5	55.5

**Notes:**

For initial design, reactions from equipment are accounted for in the design live load or equipment masses. The above resultant membrane forces are the enveloped resultants for the load combination cases, which are considered essential and bounding the design of the ESWEMS pumphouse structure. Other loading cases, including piping, equipment, temperature loads, etc., are considered in detailed design.

- Nxx : In-plan force in X axis
- Nyy : In-plan force in Y axis
- Nxy: Torsional shear force
- Mxx: Out-Of-Plan Bending Moment against X Direction
- Myy: Out-Of-Plan Bending Moment against Y Direction
- Mxy: Torsional Moment
- Vxx : Normal force
- Vyy: Normal force

**Table 3E.4-5—{Demand Table for the ESWEMS Shear Keys Reaction Forces and Moments}**

<b>Controlled Load Combination for Preliminary Design</b>	<b>Nxx (kip/ft)</b>	<b>Nyy (kip/ft)</b>	<b>Nxy (kip/ft)</b>	<b>Mxx (kft/ft)</b>	<b>Myy (kft/ft)</b>	<b>Mxy (kft/ft)</b>	<b>Vxx (kip/ft)</b>	<b>Vyy (kip/ft)</b>
Enveloped static condition, including normal wind loading.	21.4	3.7	8.1	4.9	24.5	13.4	7.7	9.7
Enveloped static condition including tornado wind loading.	13.9	2.6	5.5	0.34	15.4	7.8	6.1	6.0
Average values for dynamic condition, including SSE loading.	277.1	48.7	120.6	538.0	289.7	270.9	104.0	63.3

**Notes:**

For design, reactions from equipment are accounted for in the design live load or equipment masses. The above resultant forces are the enveloped and/or resultants for the load combination cases, which are considered essential and bounding the design of the ESWEMS pumphouse structure. Other loading cases, including piping, equipment, temperature loads, etc., are considered in detailed design.

- Nxx : In-plan force in X axis
- Nyy : In-plan force in Y axis
- Nxy: Torsional shear force
- Mxx: Out-Of-Plan Bending Moment against X Direction
- Myy: Out-Of-Plan Bending Moment against Y Direction
- Mxy: Torsional Moment
- Vxx : Normal force
- Vyy: Normal force

**Table 3E.4-6—{Demand Table ESWEMS Pumphouse Walls Resultant Membrane Forces and Moments}**

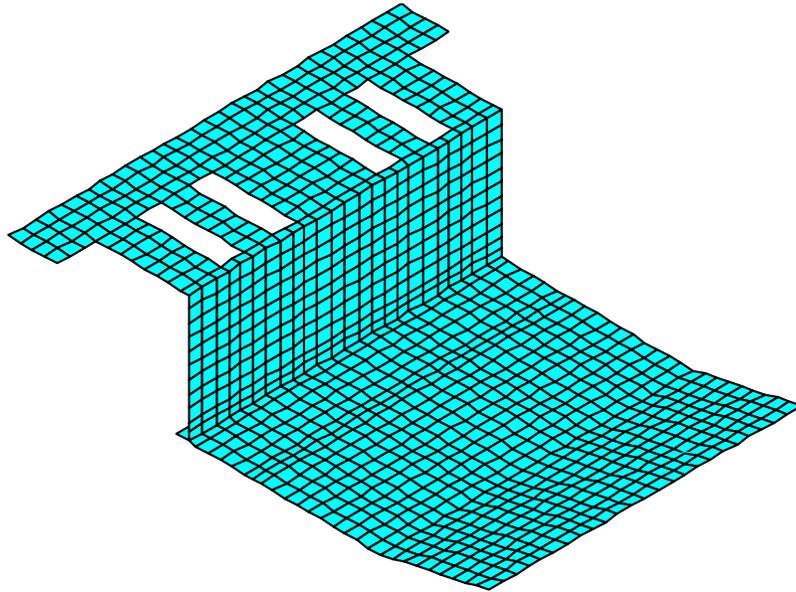
<b>Controlled Load Combination for Preliminary Design</b>	<b>Nxx (kip/ft)</b>	<b>Nyy (kip/ft)</b>	<b>Nxy (kip/ft)</b>	<b>Mxx (kft/ft)</b>	<b>Myy (kft/ft)</b>	<b>Mxy (kft/ft)</b>	<b>Vxx (kip/ft)</b>	<b>Vyy (kip/ft)</b>
Enveloped static condition, including normal wind loading.	267.8	87.7	140.4	446.7	108.0	71.6	118.2	99.8
Enveloped static condition including tornado wind loading.	180.5	60.1	93.3	297.5	64.2	44.3	78.8	65.4
Average values for dynamic condition, including SSE loading.	289.6	435.5	180.5	125.5	79.1	39.3	92.3	102.0

**Notes:**

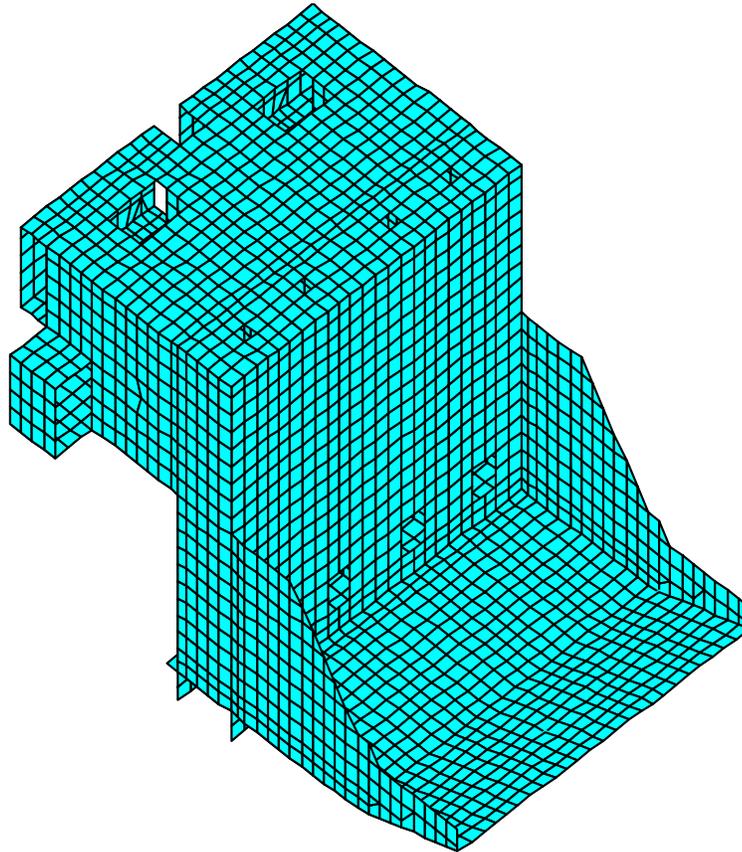
For design, reactions from equipment are accounted for in the design live load or equipment masses. The above resultant membrane forces are the enveloped resultants for the load combination cases, which are considered essential and bounding the design of the ESWEMS pumphouse structure. Other loading cases, including piping, equipment, temperature loads, etc., are considered in detailed design.

Nxx : In-plan force in X axis  
 Nyy : In-plan force in Y axis  
 Nxy: Torsional shear force  
 Mxx: Out-Of-Plan Bending Moment against X Direction  
 Myy: Out-Of-Plan Bending Moment against Y Direction  
 Mxy: Torsional Moment  
 Vxx : Normal force  
 Vyy: Normal force

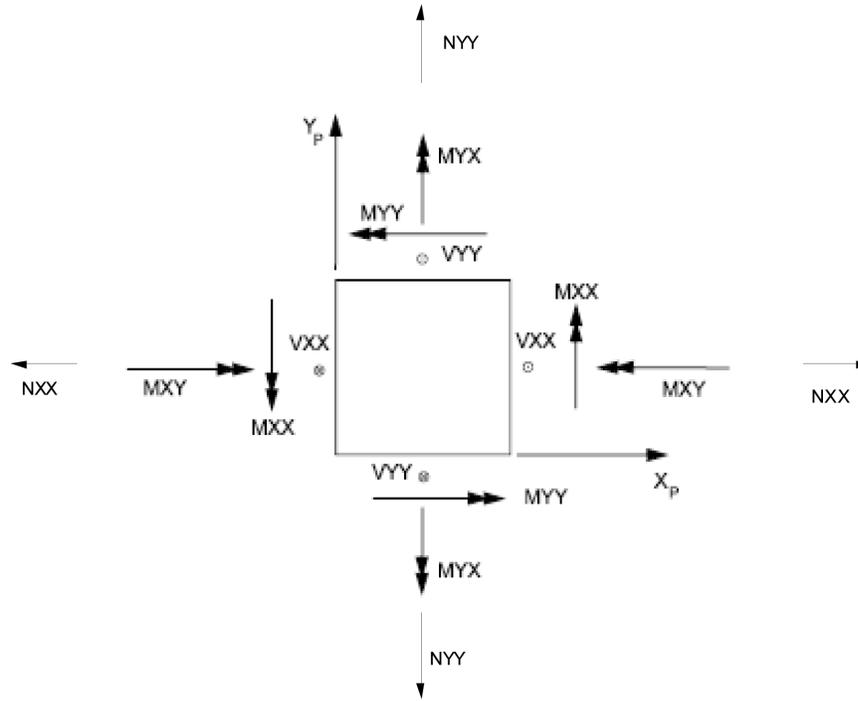
**Figure 3E.4-1—{Isometric View of ESWEMS Pumphouse Main Basemat & Pump Well Base - Finite Element Mesh}**



**Figure 3E.4-2—{Isometric View of the ESWEMS Pumphouse GTStrudl Finite Element Model-Exterior Wall, Roof, and Apron}**



**Figure 3E.4-3—{GT Strudl Finite Element Planar Reference System}**



**Plate Resultant Forces and Moments**





Figure 3E.4-6—{Plant Arrangement - ESWEMS Pond Typical Riprap Detail}

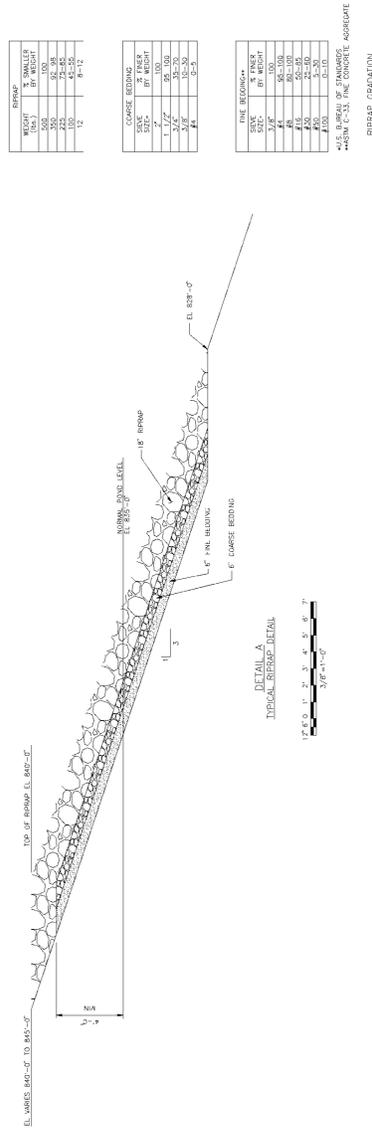


Figure 3E.4-7—{Plant Arrangement - ESWEMS Pond Spillway Plan}

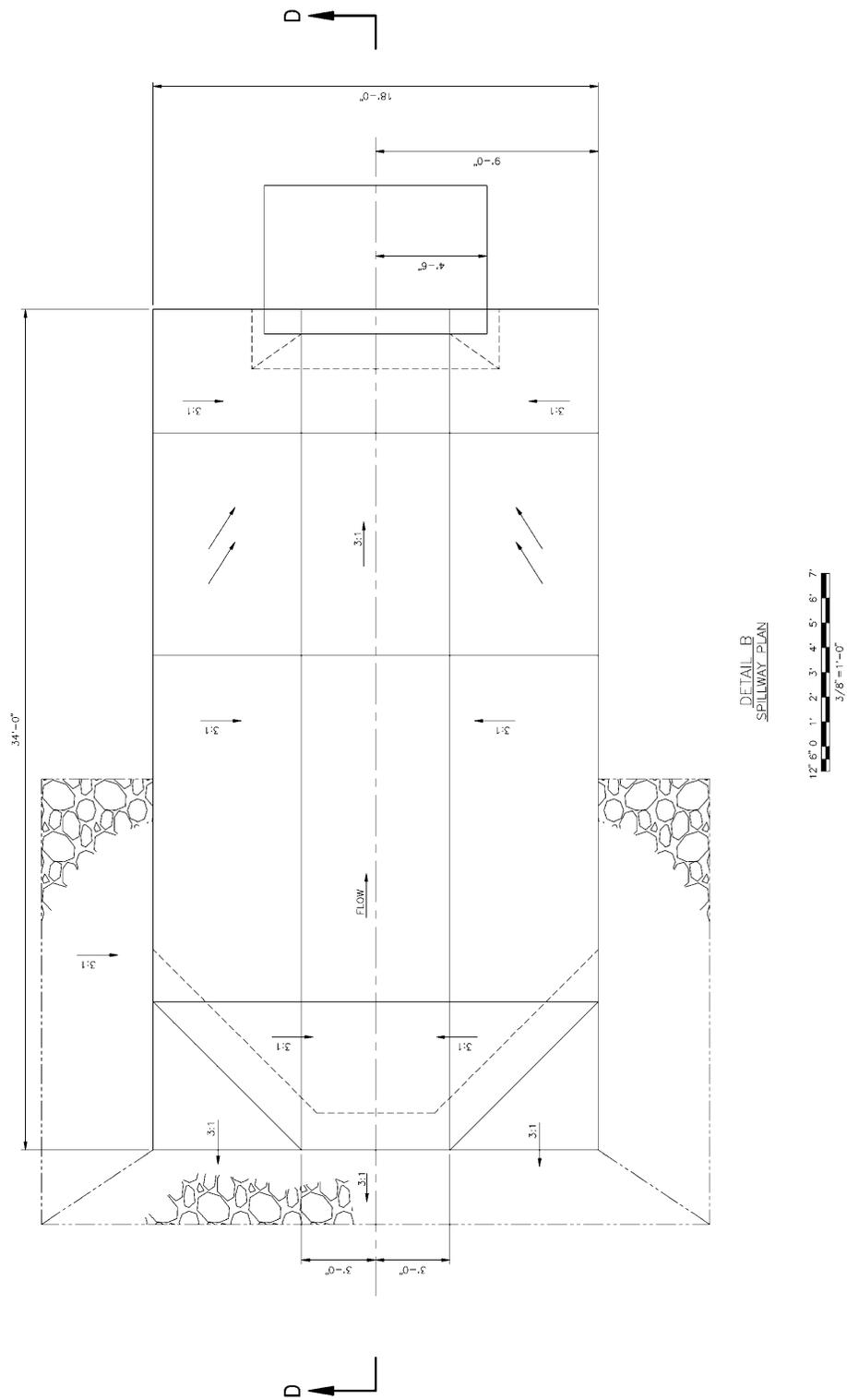




Figure 3E.4-9—{Plant Arrangement - ESWEMS Pond Section at Embankment}

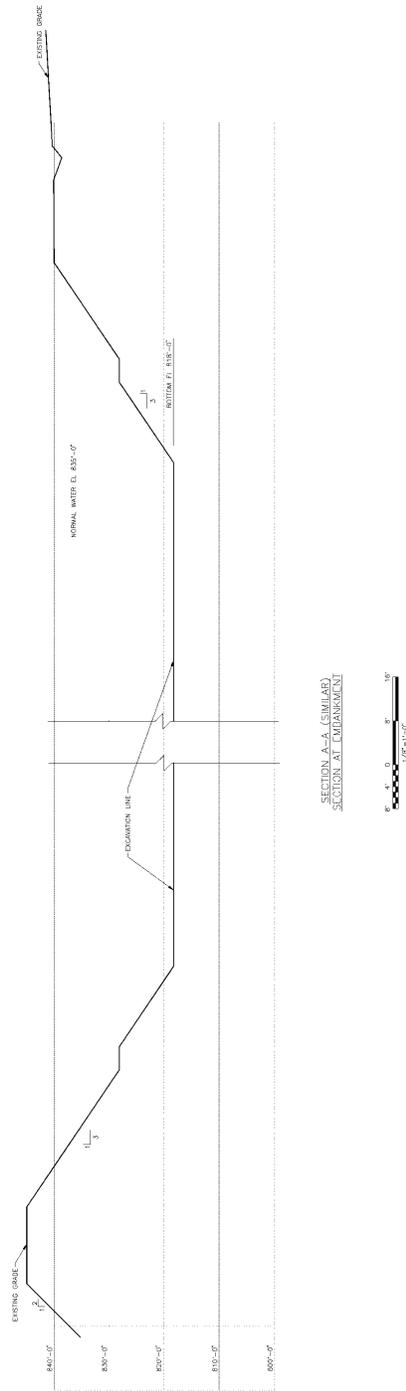


Figure 3E.4-10—{Plant Arrangement -ESWEMS Pond Section at Embankment}

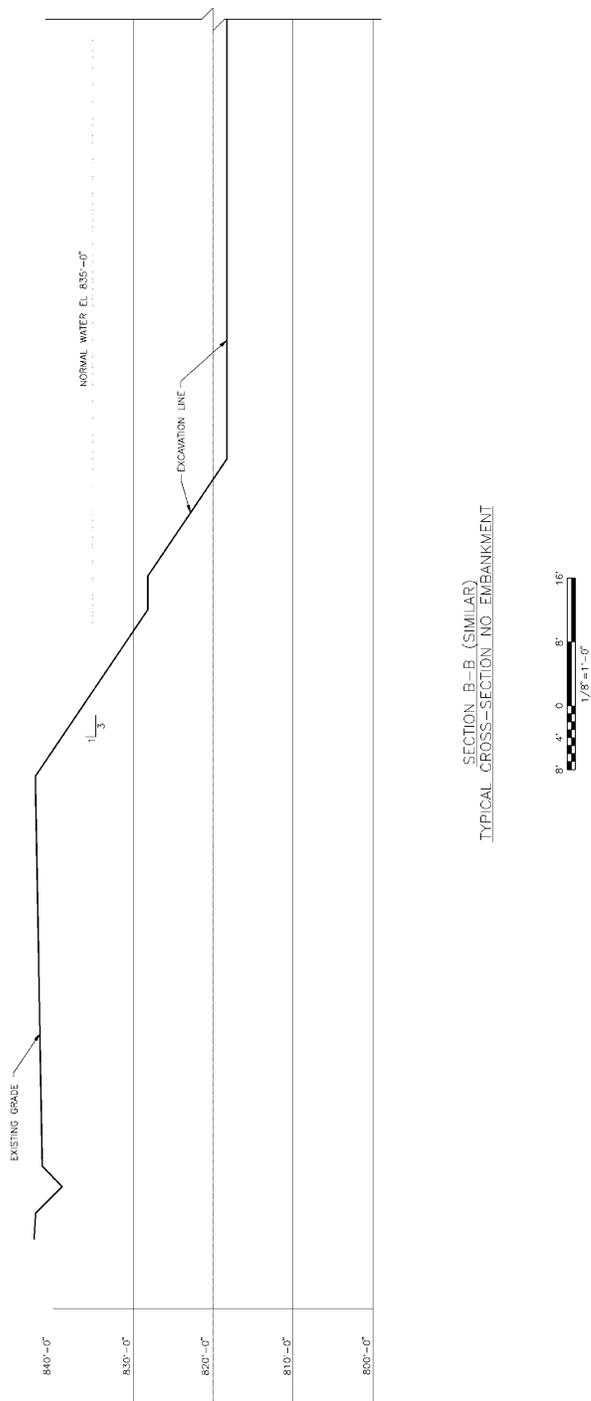


Figure 3E.4-11 — {Plant Arrangement - ESWEMS Pond Section at Embankment}

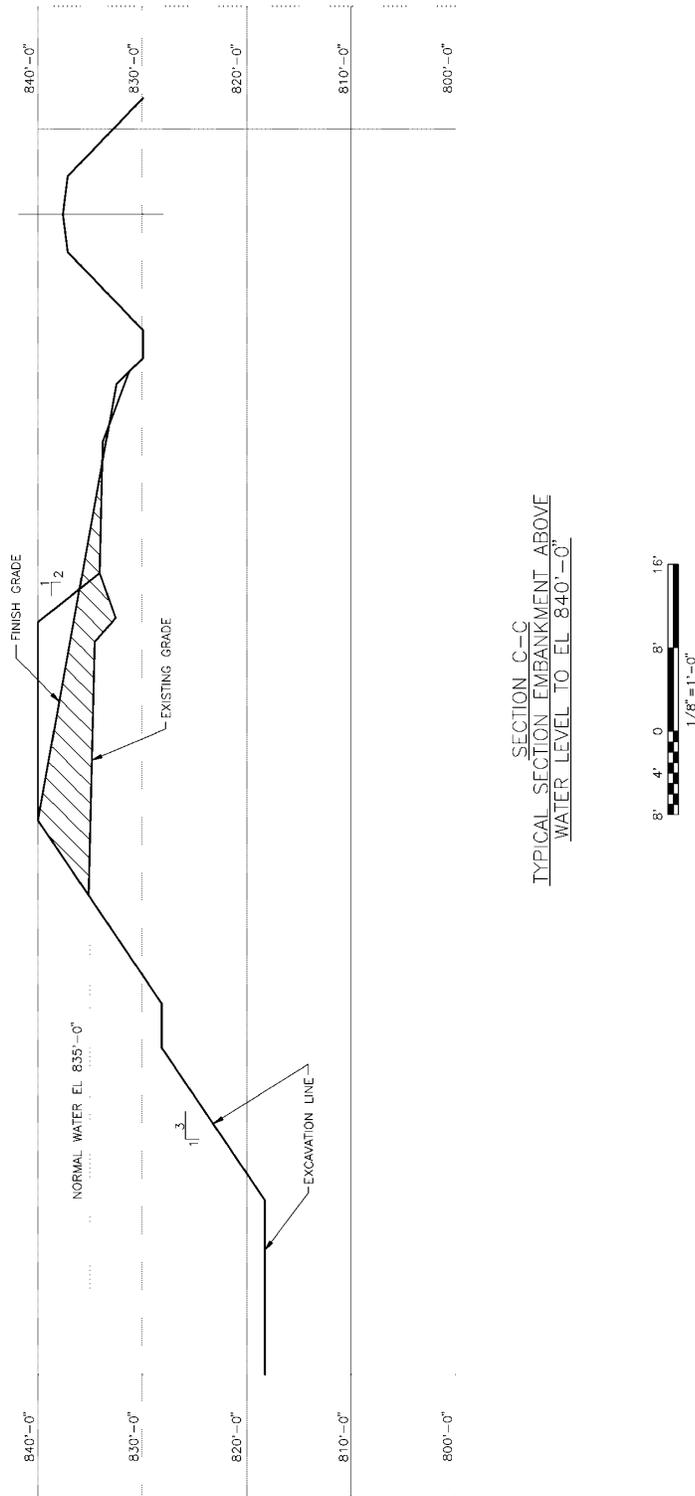


Figure 3E.4-12—{Plant Arrangement - ESWEMS Pumphouse Rebar}

