CHAPTER 3

DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS, AND EQUIPMENT

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ACRONYMS AND ABBREVIATIONS

A/B	auxiliary building
AC/B	access building
ACI	American Concrete Institute
ARS	acceleration response spectra
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
BE	best estimate
CAV	cumulative absolute velocity
CCWS	component cooling water system
CFR	Code of Federal Regulations
COL	Combined License
COLA	Combined License Application
CPNPP	Comanche Peak Nuclear Power Plant
CSDRS	certified seismic design response spectra
DBFL	design-basis flooding level
DCD	Design Control Document
EQ	environmental qualification
EQSDS	equipment qualification summary data sheet
ESF	engineered safety features
ESW	essential service water
ESWPC	essential service water pipe chase
ESWPT	essential service water pipe tunnel
ESWS	essential service water system
FE	finite element
FIRS	foundation input response spectra
FW	feedwater
GMRS	ground motion response spectra
GWL	ground water level
HB	high bound
IEEE	Institute of Electrical and Electronic Engineers
ILRT	integrated leak rate test
ISI	inservice inspection
ISRS	in-structure response spectra
IST	inservice testing
LB	lower bound
LBB	leak before break
MCR	main control room
MOV	motor operated valve
MS	main steam

ACRONYMS AND ABBREVIATIONS (continued)

N/A	not applicable
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
NS	non-seismic
O/B	outside building
OBE	operating-basis earthquake
PAM	post accident monitoring
PBSRS	performance based surface response spectra
PCCV	prestressed concrete containment vessel
PGA	peak ground acceleration
PMP	probable maximum precipitation
PS/B	power source building
PSFSV	power source fuel storage vault
PSI	preservice inspection
QAP	quality assurance program
R/B	reactor building
RCL	reactor coolant loop
RG	Regulatory Guide
RV	reactor vessel
RWSP	refueling water storage pit
SCSR	soil column surface response
SDOF	single degree of freedom
SEI	Structural Engineering Institute
SG	steam generator
SRP	Standard Review Plan
SRSS	square root sum of the squares
SSC	structure, system, and component
SSE	safe-shutdown earthquake
SSI	soil-structure interaction
T/B	turbine building
T/G	turbine generator
UB	upper bound
UHS	ultimate heat sink
UHSRS	ultimate heat sink related structures
ZPA	zero period acceleration

3.0 DESIGN OF STRUCTURES, SYSTEMS, COMPONENTS, AND EQUIPMENT

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

This section of the referenced Design Control Document (DCD) is incorporated by reference with the following departures and/or supplements.

3.1.4.16.1 Discussion

STD COL 3.1(1) Replace the third, fourth, and fifth sentences of the first paragraph in DCD Subsection 3.1.4.16.1 with the following.

These components have suitable inspection capability enhanced with appropriate layout features, as discussed in Section 9.2. The essential service water system (ESWS) and component cooling water system (CCWS) piping is arranged to permit access for inspection. Manholes, handholes, or inspection ports are provided for periodic inspection of system components. The integrity of underground piping is demonstrated by pressure and functional tests.

3.1.7 Combined License Information

Replace the content of DCD Subsection 3.1.7 with the following.

STD COL 3.1(1) ***3.1(1)*** *Design provisions for inspections*

This Combined License (COL) item is addressed in Subsection 3.1.4.16.1.

3.2 CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS

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

3.2.1.2 Classifications

STD COL 3.2(4) Replace last sentence of first paragraph in DCD Subsection 3.2.1.2 with the following.

The site-specific, safety-related systems and components that are designed to withstand the effects of earthquakes without loss of capability to perform their safety function are identified in Table 3.2-201. The industry codes and standards applicable to those components are listed in Table 3.2-202.

3.2.2 System Quality Group Classification

STD COL 3.2(5) Replace the last sentence of the tenth paragraph in DCD Subsection 3.2.2 with the following.

The equipment class and seismic category of the site-specific safety-related and non-safety related fluid systems, components (including pressure retaining), and equipment as well as the applicable industry codes and standards are provided in Table 3.2-201.

3.2.2.5 Other Equipment Classes

STD COL 3.2(6) Replace the third paragraph in DCD Subsection 3.2.2.5 with the following.

DCD methods of equipment classification, quality assurance classification, and seismic categorization of risk-significant, non-safety related SSCs to site-specific, nonsafety-related SSCs based on their contribution to plant safety are applied to Table 3.2-201.

3.2.3 Combined License Information

Replace the content of DCD Subsection 3.2.3 with the following.

3.2(1) *Deleted from the DCD.*

3.2(2) *Deleted from the DCD.*

3.2(3) *Deleted from the DCD.*

STD COL 3.2(4)
CP COL 3.2(4)

3.2(4) *Site-specific safety-related systems and components designed to withstand earthquakes*

This COL item is addressed in Subsection 3.2.1.2 and Tables 3.2-201 and 3.2-202.

STD COL 3.2(5)
CP COL 3.2(5)

3.2(5) *Equipment class and seismic category*

This COL item is addressed in Subsection 3.2.2 and Table 3.2-201.

STD COL 3.2(6)
CP COL 3.2(6)

3.2(6) *Equipment class and seismic category of risk-significant, non-safety related SSCs*

This COL item is addressed in Subsection 3.2.2.5 and Table 3.2-201.

CP COL 3.2(4)
CP COL 3.2(5)
CP COL 3.2(6)

Table 3.2-201 (Sheet 1 of 3)
Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

System and Components	Equipment Class	Location	Quality Group	Quality Assurance Classification(5)	Code and Standards(3)	Seismic Category(4)	Notes
1. ESWS							
Basin blowdown line piping and valves from and excluding essential service water supply header piping up to the following valves: ESWS blowdown main header isolation valve to CWS blowdown main header; EWS-AOV-577	3	ultimate heat sink related structures (UHSRS), essential service water pipe tunnel (ESWPT)	C	Q	3	I	
ESWP discharge strainer backwash line to the UHS basin	3	UHSRS	C	Q	3	I	
ESWP discharge strainer backwash line to the CWS blowdown main header	3	UHSRS, ESWPT	C	Q	3	I	
Essential service water (ESW) supply line piping connected to the fire protection system in the UHSRS, and valves from and excluding ESW supply header piping up to the following isolation valves: ESW-VLV-551A, B, C, D	3	UHSRS	C	Q	3	I	
ESW supply line piping connected to the fire protection system in the reactor building (R/B), and valves from and excluding ESW supply header piping up to the following isolation valves: ESW-VLV-552A, B, C, D	3	R/B	C	Q	3	I	

CP COL 3.2(4)
CP COL 3.2(5)
CP COL 3.2(6)

Table 3.2-201 (Sheet 2 of 3)

Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

System and Components	Equipment Class	Location	Quality Group	Quality Assurance Classification(5)	Code and Standards(3)	Seismic Category(4)	Notes
2. UHS							
UHS transfer pumps	3	UHSRS	C	Q	3	I	
UHS cooling tower fans	3	UHSRS	C	Q	5	I	
UHS basins	3	UHSRS	C	Q	3	I	
Transfer line piping and valves from UHS transfer pumps to basins	3	UHSRS, ESWPT	C	Q	3	I	
ESW return line piping	3	UHSRS, ESWPT	C	Q	3	I	
Drain line branched from ESW return line from branch point from ESW return line up to and including the following drain valves: UHS-VLV-521A,B,C,D	3	UHSRS	C	Q	3	I	
Drain line branched from ESW return line downstream of and excluding the following drain valves: UHS-VLV-521A,B,C,D	9	UHSRS	NA	N	5	Non-seismic (NS)	
UHS basin makeup piping and valves	9	UHSRS	NA	N	5	Non-seismic (NS)	
3. UHS ESW pump house ventilation system							
ESW pump room exhaust fans	3	UHSRS	C	Q	5	I	
UHS transfer pump room exhaust fans	3	UHSRS	C	Q	5	I	

CP COL 3.2(4)
CP COL 3.2(5)
CP COL 3.2(6)

Table 3.2-201 (Sheet 3 of 3)

Classification of Site-Specific Mechanical and Fluid Systems, Components, and Equipment

System and Components	Equipment Class	Location	Quality Group	Quality Assurance Classification(5)	Code and Standards(3)	Seismic Category(4)	Notes
UHS ESW pump house supply and exhaust backdraft dampers	3	UHSRS	C	Q	5	I	
ESW pump room unit heaters	3	UHSRS	C	Q	5	I	
UHS transfer pump room unit heaters	3	UHSRS	C	Q	5	I	
ESW Piping Room Unit Heaters	3	UHSRS	C	Q	5	I	
UHS Transfer Piping Room Unit Heaters	3	UHSRS	C	Q	5	I	
4. Startup steam generator (SG) blowdown system							
System components, piping and valves	6	turbine building (T/B), auxiliary building (A/B), outdoors	N/A	N	6	Note 1	

Notes:

1. Seismic category meeting Table 2 of RG 1.143 (Reference 3.2-10) is applied, in accordance with the SSC classifications described in Section 10.4.8, 11.2, 11.3, and 11.4. Portions of the Equipment Class 6 SSCs on which seismic category II requirements are imposed are designed to comply with both the requirements of RG 1.143 and seismic category II.
2. Seismic category meeting RG 1.189 (Reference 3.2-11) is applied. Portions of the Equipment Class 7 SSCs on which seismic category II requirements are imposed are designed to comply with both the requirements of RG 1.189 and seismic category II.
3. Identification number for “Code and Standards”

   (1) ASME Code, Section III, Class 1 (Reference 3.2-14)

   (2) ASME Code, Section III, Class 2 (Reference 3.2-14)

   (3) ASME Code, Section III, Class 3 (Reference 3.2-14)

   (4) RG 1.26 (Reference 3.2-13), Table 1, Quality Standards for Class D

   (5) Codes and standards as defined in design bases

   (6) Codes and standards, and guidelines provided in Table 1 of RG 1.143 (Reference 3.2-10), for design of SSCs for Radwaste Facility

   (7) The codes and standards applicable to fire protection systems follow the guidance of RG 1.189 Section 1.7, and National Fire Protection Association 804.
4. Seismic category: The designations “I” or “II” indicate that the design requirements of Seismic Category I or II equipment are applied as described in Subsection 3.2.1 and Section 3.7, Seismic Design. Equipment that is not designated “I” or “II” is designated “NS.”
5. Quality Assurance Classification: The designation “Q” indicates that the quality assurance requirements of 10 CFR 50, Appendix B, are applied in accordance with the quality assurance program described in Chapter 17. The designation “A” indicates that augmented quality assurance requirements are applied, commensurate with the SSCs contribution to safety or credited for regulatory events for one or more of the following reasons:

   a. Nonsafety-related equipment required to be designed in accordance with special seismic design requirements, such as seismic category II requirements. See note 4.

   b. Nonsafety-related equipment required to be designed in accordance with radioactive waste management system requirements from RG 1.143 for Category RW-IIa, RW-IIb, and RW-IIc [See note 3(6)]. The radioactive waste management system components conform to Regulatory Guide 1.143 Table 1 [see note 3(6)].

   c. Nonsafety-related equipment required to be designed in accordance with fire protection requirements from 10 CFR 50.48 and RG 1.189. A quality assurance program meets the guidance of RG 1.189.

   d. Nonsafety-related equipment not otherwise identified in notes 5(a) though 5(c) and are identified as risk-significant in Table 17.4-1 or credited for regulatory events such as ATWS and SBO.

The designation “N” indicates that neither 10CFR50 Appendix B nor augmented quality standards are required.

CP COL 3.2(4)

Table 3.2-202 (Sheet 1 of 2) Codes and Standards Applicable to Site-Specific Mechanical and Fluid Systems, Components, and Equipment(5)

Safety-Related Piping, Valves, Pumps(1)
ASME
Section II, 2001 Edition with 2003 Addendum
Section III, 2001 Edition with 2003 Addendum
Section V, 2001 Edition with 2003 Addendum
Section IX, 2001 Edition with 2003 Addendum
Section XI, 2001 Edition with 2003 Addendum
Non-Safety-Related Piping, Valves, and Pumps(2)
ASME
B31.1-2004 “Power Piping”
Heating, Ventilation, and Air Conditioning Equipment(3)
ASME
AG-1-2003 “Code on Nuclear Air and Gas Treatment”
Air Movement and Control Association
200-1995 “Air Systems”
201-2002 “Fans and Systems”
Underwriters Laboratory
1278-2000 “Safety Movable and Wall- or Ceiling-Hung Electric Room Heaters”
1996-2009 “Safety Electric Duct Heaters”
2021-1997 “Safety Fixed and Location-Dedicated Electric Room Heaters”

CP COL 3.2(4)

Table 3.2-202 (Sheet 2 of 2)
Codes and Standards Applicable to Site-Specific Mechanical and Fluid Systems, Components, and Equipment(5)

Class 1E Components(4)
Institute of Electrical and Electronic Engineers (IEEE)
323-1974 “Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations”
323-2003 “Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations”
344-1987 as modified by NRC RG 1.100, Rev. 2 dated June 1988 , “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants”
384-1992 “Standard Criteria for Independence of Class 1E Equipment and Circuits”
603-1998 “Standard Criteria for Safety Systems for Nuclear Power Generating Stations”

Notes:

1. These codes and standards are applied to the UHS and ESW safety-related SSCs identified in Table 3.2-201.
2. These codes and standards are applied to the SG blowdown system identified in Table 3.2-201.
3. These codes and standards are applied to the heating, ventilation, and air conditioning equipment identified in Table 3.2-201.
4. These codes and standards are applied to all Class 1E equipment identified in Table 3.2-201.
5. This table identifies the current revision of documents. Later editions that are current as of procurement or manufacture may be used.

3.3 WIND, TORNADO AND HURRICANE LOADINGS

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

3.3.1.1 Design Wind Velocity and Recurrence Interval

CP COL 3.3(1) Replace the last sentence of the second paragraph in DCD Subsection 3.3.1.1 with the following.

The site-specific basic wind speed of 96 mph corresponds to a 3-second gust at 33 ft. above ground for exposure category C, with the same recurrence interval as described above, and is therefore enveloped by the basic wind speed used for the design of the standard plant. Site-specific structures, systems, and components (SSCs) are designed using the site-specific basic wind speed of 96 mph, or higher.

3.3.1.2 Determination of Applied Forces

CP COL 3.3(4) Replace the last paragraph in DCD Subsection 3.3.1.2 with the following.

Specific descriptions of wind load design method and importance factor for US-APWR site-specific plant structures are as follows:

- The UHSRS (seismic category I) are analyzed using method 2 of American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) 7-05 (Reference 3.3-1) and an importance factor of 1.15. FSAR Figures 2.5.1-215 and 2.5.5-204 show that the site does possess natural features such as escarpments or hills near the UHSRS that may promote channeling effects or the creation of wakes, but not to the extent that special consideration is warranted. Method 2 of ASCE/SEI 7-05 provides a topographic factor, K_{zt}, in Section 6.5.7 “Topographic Effects,” to address this issue when calculating the design wind loading. Also, the other buildings on the site are not of the height, plan dimension, or location relative to the UHSRS such that channeling effects or the creation of wakes or other non-standard wind effects are produced that extend beyond the provisions of the ASCE/SEI 7-05 method 2 procedure. FSAR Table 3KK-2 states that the minimum natural frequency of the UHSRS is 7.1 Hz for the east-west direction, which is the lowest fundamental frequency in any orthogonal direction for any of the soil conditions considered. This means that the UHSRS are rigid with respect to wind loading. As shown in FSAR Figures 3.8-206 through 3.8-211, the UHSRS complex is comprised of relatively low-rise, nearly rectangular structures

that do not include any unusual or irregular geometric shapes and are constructed of reinforced concrete walls, floors, and roofs. Therefore, based on the configuration and properties of the UHSRS complex, method 2 of ASCE/SEI 7-05 is an appropriate method of wind load design.

- The exposed portions of the ESWPT (seismic category I) and power source fuel storage vaults (PSFSVs) (seismic category I) are analyzed using method 1 of ASCE/SEI 7-05 (Reference 3.3-1) and an importance factor of 1.15.

CPNPP Units 3 and 4 do not have site-specific seismic category II buildings and structures. FSAR Figures 2.5.1-215 and 2.5.5-204 show that the site location does not have features promoting channeling effects or buffeting in the wake of upwind obstructions that warrant special design consideration. Therefore the wind design methods used for standard plant buildings are valid for the site.

3.3.2.1 Applicable Design Parameter

CP COL 3.3(2)
CP COL 3.3(6)

Add the following after the last paragraph in DCD Subsection 3.3.2.1.

The design-basis hurricane wind speed for site-specific seismic category I structures is 145 mph, which corresponds to a 3-second gust at 33 ft. above ground for exposure category C, with the same recurrence interval as described above, and is therefore enveloped by the basic wind speed used for the design of the standard plant. Site-specific SSCs are designed using the site-specific design basis wind speed of 145 mph, or higher.

3.3.2.2.1 Tornado and Hurricane Velocity Forces

CP COL 3.3(2)

Add the following after the third paragraph in DCD Subsection 3.3.2.2.1.

Hurricane velocity pressures for site-specific seismic category I structures are determined by converting hurricane wind speeds into effective velocity pressures in accordance with procedures accepted by SRP 3.3.1 (DCD Reference 3.3-2). Design hurricane loads for seismic category I structures are determined for enclosed and partially enclosed buildings using the analytical procedure method 1 or method 2 provided in Subsection 3.3.1.2, where:

V is the maximum hurricane windspeed = 145 mph

For the design basis hurricane, wind pressure varies with respect to height; therefore, adjustment for wind speed variation with respect to height applies.

3.3.2.2.2 Tornado Atmospheric Forces

CP COL 3.3(5) Replace the last paragraph in DCD Subsection 3.3.2.2.2 with the following.

Site-specific seismic category I structures are the UHSRS, ESWPT, and the PSFSVs.

The UHSRS, including the pump houses and transfer pump rooms, are configured with large openings and/or vents. The UHS basins and cooling tower enclosures are designed as vented with respect to tornado atmospheric differential pressure loading. Venting of the pump houses and transfer pump rooms is anticipated during a tornado event, however, for the purpose of structural design, the external walls, internal walls, and slabs of the pump houses and transfer pumps rooms are conservatively designed as unvented and the full tornado atmospheric differential pressure loading is applied. Since the full pressure differential for the structural elements is considered, a depressurization model is not used for the structural design.

The ESWPT and PSFSV structures are designed as unvented because they do not have openings that permit depressurization during a tornado.

3.3.2.2.4 Combined Tornado or Hurricane Effects

CP COL 3.3(2) Replace the first and second sentences of the last paragraph in DCD Subsection 3.3.2.2.4 with the following.

Site-specific seismic category I structures, i.e., the UHSRS and exposed portions of the ESWPT and PSFSVs, are designed for the same tornado loadings but reduced hurricane loadings (parameters for establishing qualifications specified in Table 2.0-1R) and combined tornado or hurricane effects using the same methods for qualification described for standard plant SSCs.

3.3.2.3 Effect of Failure of Structures or Components Not Designed for Tornado and Hurricane Loads

STD COL 3.3(3) Replace the last paragraph of DCD Subsection 3.3.2.3 with the following.

Other miscellaneous NS buildings and structures in the plant yard are located and/or anchored such that their failure will neither jeopardize safety-related SSCs nor generate missiles not bounded by those discussed in Subsection 3.5.1.4. Further, any site-specific or field routed safety-related SSCs in the plant yard are evaluated prior to their installation to determine if structural reinforcement and/or missile barriers are required to ensure their function and integrity.

3.3.3 Combined License Information

Replace the content of DCD Subsection 3.3.3 with the following.

CP COL 3.3(1) ***3.3(1)*** *Wind speed requirements*

This COL item is addressed in Subsection 3.3.1.1.

CP COL 3.3(2) ***3.3(2)*** *Tornado or hurricane loadings and tornado or hurricane effects*

This COL item is addressed in Subsections 3.3.2.1, 3.3.2.2.1 and 3.3.2.2.4.

STD COL 3.3(3) ***3.3(3)*** *Structures not designed for tornado and hurricane loads*

This COL item is addressed in Subsection 3.3.2.3.

CP COL 3.3(4) ***3.3(4)*** *Wind load design methods and importance factors*

This COL item is addressed in Subsection 3.3.1.2.

CP COL 3.3(5) ***3.3(5)*** *Vented and unvented requirements for site-specific buildings and structures*

This COL item is addressed in Subsection 3.3.2.2.2.

CP COL 3.3(6) ***3.3(6)*** *Hurricane speed requirements*

This COL item is addressed in Subsection 3.3.2.1.

3.4 WATER LEVEL (FLOOD) DESIGN

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

3.4.1.2 Flood Protection from External Sources

CP COL 3.4(1) Replace the first sentence of the third paragraph in DCD Subsection 3.4.1.2 with the following.

Entrances to all safety-related structures are above the design-basis flood elevations described in Section 2.4, and adequate sloped site grading and drainage prevents flooding caused by probable maximum precipitation (PMP). Entrances to all safety-related structures are also protected from flooding due to the failure of the outside tanks (such as the condensate storage tanks, refueling water storage auxiliary tank, demineralized water storage tanks, and fire water storage tanks) by the site's grading and drainage or installed curbs.

CP COL 3.4(5) Replace the fourth paragraph in DCD Subsection 3.4.1.2 with the following.

No site-specific flood protection measures such as levees, seawalls, floodwalls, site bulkheads, revetments, or breakwaters are applicable at CPNPP Units 3 and 4, since the plant is built above the design-basis flood elevations and has adequate site grading.

CP COL 1.9(3) The beyond-design-basis (BDB) flood elevation applied to the design of the site-specific structures of CPNPP Units 3 and 4 is described in Section 2.4.2. Since the design-basis flood elevations and the BDB flood elevation are equivalent, no further flood protection measure is applied to the site-specific structures for implementation of the baseline coping strategies as specified in NEI 12-06 (Reference 3.4-202).

CP COL 3.4(4) Replace the seventh paragraph in DCD Subsection 3.4.1.2 with the following.

All seismic Category 1 buildings and structures below-grade are protected against the effects of flooding, including ground water. This protection is achieved by providing a water barrier on all exterior below-grade concrete members. The water barrier consists of providing waterstops at all below-grade construction joints in the exterior wall and base mats subjected to ground water seepage, and membrane waterproofing material at all below-grade exterior wall surfaces. The

foundation slab water barrier system consists of crystalline waterproofing compound applied between the base mat and fill concrete/bedrock. The compound will either be spray applied or dry-shake to the fill concrete/bedrock. A cementitious membrane coating made out of a crystalline waterproofing compound is provided on the inside face of the UHS basin outermost walls and foundation slab, including the UHS sump pit, to prevent water migration from the UHS basin into the subgrade.

STD COL 3.4(3) Replace the last sentence in the ninth paragraph in DCD Subsection 3.4.1.2 with the following.

Site-specific potential sources of external flooding such as the cooling tower, service water piping, or circulating water piping are not located near structures containing safety-related SSCs, with the exception of piping entering plant structures. The CWS enters only within the T/B, and any postulated pipe break is prevented from back-flowing into the safety-related R/B by watertight separation. Postulated pipe breaks near structures are prevented from entering the structures by adequate sloped site grading and drainage.

3.4.1.3 Flood Protection from Internal Sources

STD COL 3.4(8) Replace the last sentence in the fourth paragraph of DCD Subsection 3.4.1.3 with the following.

Inspection and testing procedures are established prior to fuel load in accordance with manufacturer recommendations so that each water-tight door remains capable of performing its intended function.

STD COL 3.4(7) Replace the last sentence in the last paragraph of DCD Subsection 3.4.1.3 with the following.

Three site-specific structures (the UHSRS, the PSFSV, the ESWPT) and the essential service water pipe chase (ESWPC) have been evaluated for internal flooding concerns. Other site-specific buildings and structures in the plant yard are designated as non safety-related. By definition, their postulated failure due to internal flooding or other postulated events do not adversely affect safety-related SSCs or required safety functions.

Each of these structures is configured with independent compartments, divisionally separated. Internal flooding of any one compartment and corresponding division will not prevent the system from performing required safety-related functions. Postulated flooding events such as those caused by

moderate energy line break or fire suppression system activation within one division will affect that respective division only. Flooding affecting one compartment will not affect adjacent areas.

3.4.1.4 Evaluation of External Flooding

STD COL 3.4(2) Replace the last sentence in the last paragraph of DCD Subsection 3.4.1.4 with the following.

As discussed in Section 2.4, the site-specific designed-basis flood elevations do not exceed the maximum flood level for the standard plant design. Therefore, there are no static and/or dynamic flooding forces beyond those considered in the standard plant design.

CP COL 1.9(3) As per subsection 3.4.1.2 discussion on BDB external flooding, no further evaluation of external flooding is required for determination of appropriate actions to protect the site-specific structures from a BDB external flooding.

3.4.2 Analysis Procedures

STD COL 3.4(6) Replace the last paragraph of DCD Subsection 3.4.2 with the following.

No site-specific physical models are used to predict prototype performance of hydraulic structures and systems, since there are no unusual design or configuration or design or operating bases involving thermal and erosion problems.

3.4.3 Combined License Information

Replace the content of DCD Subsection 3.4.3 with the following.

STD COL 3.4(1) ***3.4(1)*** *Site-specific design of plant grading and drainage*

This COL item is addressed in Subsection 3.4.1.2.

STD COL 3.4(2) ***3.4(2)*** *DBFL applicability to site*

This COL item is addressed in Subsection 3.4.1.4.

STD COL 3.4(3) ***3.4(3)*** *Site-specific flooding hazards from engineered features*

This COL item is addressed in Subsection 3.4.1.2.

CP COL 3.4(4) ***3.4(4)*** *Additional ground water protection*

This COL item is addressed in Subsection 3.4.1.2.

CP COL 3.4(5) ***3.4(5)*** *DBFL and site-specific conditions*

This COL item is addressed in Subsection 3.4.1.2.

STD COL 3.4(6) ***3.4(6)*** *Physical models for performance of hydraulic structures and systems*

This COL item is addressed in Subsection 3.4.2.

STD COL 3.4(7)
CP COL 3.4(7) ***3.4(7)*** *Protection from internal flooding*

This COL item is addressed in Subsection 3.4.1.3 and 3K.1.

STD COL 3.4(8) ***3.4(8)*** *Inspection and testing procedures for water tight doors*

This COL item is addressed in Subsection 3.4.1.3.

3.4.4 References

Add the following reference after the last reference in DCD Subsection 3.4.4.

3.4-201 Not used.

3.4-202 *Diverse and Flexible Coping Strategies (FLEX) implementation Guide, NEI 12-06 Revision 0, August 2012.*

3.5 MISSILE PROTECTION

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

CP SUP 3.5(1)

3.5.1.1.2 High-Speed Rotating Equipment

After the fifth paragraph of DCD Subsection 3.5.1.1.2, add the following:

Potential sources of internal missiles from high-speed rotating equipment are assessed for the UHS ESW pump house. Internally generated missiles from ventilaton fans, pumps and cooling tower fans are not considered credible. Design considerations that apply include:

- Rotating elements are contained within the casing, and the induction motors are designed to withstand an over-speed.
- The fan blades of the unit heaters are contained inside the unit heater housing. The unit heater housing are designed to prevent the fan blades from penetrating it.
- The exhaust fans are mounted on the wall with steel shrouds placed around each fan. These fans are not in line with the motors so that a fan blade would not strike the motor.
- Rotation of the UHS cooling tower exhaust fans is such that if a fan blade leaves the hub it will tend to travel down since it is forcing air up. Beneath the fans, there is a substantial steel and concrete structure to restrain the blade. The fan blades are shrouded on the sides by a concrete wall that prevents the blades from leaving the shrouded area in a horizontal direction. The concrete slabs above the fans, placed there for external missile protection, also prevent any broken blades from leaving the fan room in the upward direction. The fan room itself is enclosed by concrete walls and partial roof that prevents any broken fan blade pieces from leaving the room.
- The ESW pumps and pump motors are all enclosed within concrete walls capable of preventing a generated missile from leaving the pump compartment. The transfer pump motor is enclosed within a concrete wall enclosure that isolates it from the ESW pump motor so that failure of one does not affect operation of the other. Failure of a pump impeller by fracture of the impeller blade does not affect the other pump in the same basin as the broken blade is confined within the pump casing and falls to the basin bottom when the energy is expended.

3.5.1.1.4 Gravitational Missiles

STD COL 3.5(1) Replace the paragraph of DCD Subsection 3.5.1.1.4 with the following.

Procedures will be issued prior to fuel load in accordance with Subsection 13.5.2.2 to require unsecured equipment including portable pressurized gas cylinders, located inside or outside containment for maintenance or undergoing maintenance to 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.

3.5.1.3.1 Geometry

CP COL 3.5(6) Replace the third paragraph of DCD Subsection 3.5.1.3.1.

The CPNPP site plan (Figure 1.2-1R) reflects the placement of CPNPP Units 3 and 4 in relation to existing Units 1 and 2. The location of CPNPP Units 3 and 4 is such that CPNPP Units 1 and 2 are outside the low-trajectory turbine missile strike zone inclined at 25 degrees to the turbine, and therefore no postulated low-trajectory turbine missiles affect CPNPP Units 1 and 2. Similarly, no postulated low trajectory turbine missiles from CPNPP Units 1 and 2 will affect CPNPP Units 3 and 4. The placement of CPNPP Units 3 and 4, however, does generate an unfavorable orientation, as defined in NUREG-0800, Section 3.5.1, of the turbine generator (T/G) in relationship with safety-related SSCs of the adjacent US-APWR Unit. (See Subsection 3.5.1.3.2 for impact to P_4).

3.5.1.3.2 Evaluation

CP COL 3.5(2) Replace the third paragraph of DCD Subsection 3.5.1.3.2 with the following.

Mathematically, $P_4 = P_1 \times P_2 \times P_3$, where RG 1.115 (Reference 3.5-6) considers an acceptable risk rate for P_4 as less than 10^{-7} per year. For unfavorably oriented T/Gs determined in Subsection 3.5.1.3, the product of P_2 and P_3 is estimated as 10^{-2} per year, which is a more conservative estimate than for a favorably oriented single unit. CPNPP Unit 3 and 4 procedures will be implemented 6 months prior to delivery of the T/G to require inspection intervals established in Technical Report, MUAP-07028-NP, “Probability of Missile Generation From Low Pressure Turbines” (Reference 3.5-17), and to require a turbine valve test frequency per Technical Report, MUAP-07029-NP, “Probabilistic Evaluation of Turbine Valve Test Frequency” (Reference 3.5-18), and other actions to maintain P_1 within acceptable limits as outlined in NUREG-0800, Standard Review Plan (SRP) 3.5.1.3, Table 3.5.1.3-1 (Reference 3.5-7). These inspection intervals maintain the

probability of turbine failure resulting in the ejection of turbine rotor (or internal structure) fragments through the turbine casing, P_1, as less than 10^{-5} per year. The acceptable risk rate $P_4 = P_1 \times P_2 \times P_3$ is therefore maintained as less than 10^{-7} per year.

3.5.1.4 Missiles Generated by Tornadoes, Hurricanes and Extreme Winds

CP COL 3.5(5) Add the following after the last paragraph of DCD Subsection 3.5.1.4.

The design basis spectrum of hurricane missiles for site-specific seismic category I structures conforms to the spectrum of missiles in Table 1 and Table 2 of RG 1.221 (Reference 3.5-21) and NUREG/CR-7004 (Reference 3.5-22) with a hurricane wind speed of 145 mph. The spectrum of missiles is: (1) a massive high-kinetic-energy missile that deforms on impact, (2) a rigid missile that tests penetration resistance, and (3) a small rigid missile of a size sufficient to pass through any opening in protective barriers.

Therefore, the spectrum of hurricane missiles is:

- A 4,000 pound automobile, 16.4 ft by 6.6 ft by 4.3 ft, impacting the structure at normal incidence with a horizontal velocity of 114 ft/s or a vertical velocity of 85 ft/s.
- A 6.625 inch diameter by 15 ft long schedule 40 pipe, weighing 287 pounds, impacting the structure end-on at normal incidence with a horizontal velocity of 85 ft/s or a vertical velocity of 85 ft/s.
- A 1 inch diameter solid steel sphere assumed to impinge upon barrier openings in the most damaging direction with a horizontal velocity of 73 ft/s or a vertical velocity of 85 ft/s.

Due to the robustness of the exterior wall design, CPNPP Units 3 and 4 site-specific seismic category I structures exposed to hurricane missiles are capable of withstanding the impact of each identified hurricane missile at any elevation, including the potential impact of a 4,000 pound automobile more than 30 feet above grade.

3.5.1.5 Site Proximity Missiles (Except Aircraft)

CP COL 3.5(3) Replace the paragraph of DCD Subsection 3.5.1.5 with the following.

Externally initiated missiles considered for design are based on tornado missiles and hurricane missiles as described in DCD Subsection 3.5.1.4. As described in Section 2.2, no potential site-proximity missile hazards including turbine missiles from CPNPP Units 1 and 2 are identified except aircraft, which are evaluated in Subsection 3.5.1.6. Subsection 3.5.1.3.1 provides further discussion on the assessment of a turbine missile from CPNPP Units 1 and 2.

3.5.1.6 Aircraft Hazards

CP COL 3.5(4) Replace the paragraph of DCD Subsection 3.5.1.6 with the following.

The probability of aircraft-related accidents for CPNPP Units 3 and 4 is less than an order of magnitude of 10^{-7} per year for aircraft, airway, and airport information reflected in Subsection 2.2.2.7 and expanded as follows.

- Allowing for an 8 nautical mile wide airway, the plant is at least 2 statute miles beyond the edge of the nearest federal airways.
- The reported average operations of 73 per day (26,645 per year) at Granbury Municipal airport are well below the conservative threshold of 500 D^2 operations per year, where D is the plant-to-airport distance of 10 statute miles.
- Allowing for a 10 nautical mile wide airway, the plant is 2 statute miles beyond the edge of the nearest military flight path.

Since the plant is within 5 statute miles from the nearest edge of military training route VR-158, the probability of an aircraft crashing into the plant (P_{FA}) is estimated in the following manner:

$$P_{FA} = C \times N \times A/w$$

where

C = In-flight crash rate per mile for aircraft using the airway

w = Width of airway, plus twice the distance from the airway edge to the site, conservatively provided in statute miles, equals 10 statute miles + (2 x 2 statute miles)

N = Estimated annual number of aircraft operations

A = Effective area of plant in square miles (combined effective area of Units 3 and 4)

In order to maintain P_{FA} less than the order of 10^{-7} for both Units 3 and 4, the above equation is rearranged to solve for N using values of C, A and w determined below:

$N = P_{FA} /(C \times A/w)$ = 17,600 operations per year

NUREG-0800, SRP 3.5.1.6 provides a value of $C = 4\text{x}10^{-10}$ for commercial aircraft. A table within SRP 3.5.1.6 also provides values for C for various distances up to 10 statute miles from the end of the runway, and notes data are not available for military aircraft greater than 5 statute miles from the end of runway. Since the probability of military crashes is otherwise similar or less than the probability of commercial air carriers within 5 statute miles of the end of runway, the value of $C = 4\text{x}10^{-10}$ provides a conservative approach for determining the probability of in-route crashes on military airways. This methodology is also consistent with the determination for the probability of in-flight military aircraft crash in “The Annual Probability of an Aircraft Crash on the U.S. Department of Energy Reservation in Oak Ridge, Tennessee” (Reference 3.5-201), Subsection 3.3.1.

The effective area of each unit in the plant is conservatively determined as 0.0990 square miles (0.1980 square miles for the plant) from the sum of the aircraft shadow area (A_S), skid area (A_K), and footprint area (A_B), calculated using a bounding power block volume by enveloping the outer boundaries of the R/B complex, UHSRS, ESWPT and PSFSVs of 600 ft wide by 690 ft long by 230 ft high.

A_S = 230 ft x 690 ft = 158,700 ft^2, where the shadow length is conservatively determined using a 45 degree angle from the tallest point of the power block, and the shadow width is equal to the widest dimension of the power block.

A_K = 0.6 miles (skid length) x 690 ft = 2,185,920 ft^2, where the skid length for military aircraft is determined from Reference 3.5-201, and the width of skid is equal to the widest dimension of the power block.

A_B = 600 ft x 690 ft = 414,000 ft^2 as the total land occupied by the power block.

The annual number of aircraft operations on military training route VR-158 noted in Subsection 2.2.2.7.2 confirms operations are less than 17,600 operations per year. Therefore, neither an air crash nor an air transportation accident is required to be considered as part of the design basis.

3.5.2 Structures, Systems, and Components to be Protected from Externally Generated Missiles

CP COL 3.5(5) Replace the second sentence in the second paragraph of DCD Subsection 3.5.2 with the following.

As determined in FSAR Section 2.2, Subsection 3.5.1.5 and Subsection 3.5.1.6, no site-specific hazards for external events produce missiles more energetic than tornado missiles and hurricane missiles identified for the US-APWR standard plant design. The design basis for externally generated missiles is therefore bounded by the standard plant design criteria for tornado-generated missiles and hurricane-generated missiles in Subsection 3.5.1.4.

3.5.4 Combined License Information

Replace the content of DCD Subsection 3.5.4 with the following.

STD COL 3.5(1) ***3.5(1)** Prevent unsecured equipment from becoming potential hazard*

This COL item is addressed in Subsections 3.5.1.1.2 and 3.5.1.1.4.

CP COL 3.5(2) ***3.5(2)** Maintain* P_1 *within acceptable limit*

This COL item is addressed in Subsection 3.5.1.3.2.

CP COL 3.5(3) ***3.5(3)** Presence of potential hazards and effects in vicinity of site, except aircraft*

This COL item is addressed in Subsection 3.5.1.5.

CP COL 3.5(4) ***3.5(4)** Site interface parameters for aircraft crashes and air transportation accidents*

This COL item is addressed in Subsection 3.5.1.6.

CP COL 3.5(5) ***3.5(5)** Other potential site-specific missiles*

This COL item is addressed in Subsections 3.5.1.4 and 3.5.2.

CP COL 3.5(6) ***3.5(6)** Identify SSCs to be protected, and assess the orientation of the T/B with respect to these essential SSCs*

This COL item is addressed in Subsection 3.5.1.3.1.

3.5.5 References

Add the following reference after the last reference in DCD Subsection 3.5.5.

3.5-201 *The Annual Probability of an Aircraft Crash on the U.S. Department of Energy Reservation in Oak Ridge, Tennessee*, ORNL/ENG/TM-36, Oak Ridge National Laboratory, Oak Ridge, TN, November 1992.

3.6 PROTECTION AGAINST DYNAMIC EFFECTS ASSOCIATED WITH POSTULATED RUPTURE OF PIPING

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

3.6.1.3 Postulated Failures Associated with Site-Specific Piping

STD COL 3.6(1) Replace DCD Subsection 3.6.1.3 with the following.

The site-specific systems or components that are safety-related or required for safe shutdown are limited to the essential service water system (ESWS) and the ultimate heat sink (UHS) system. There is no site-specific high-energy piping and therefore, high-energy pipe breaks are not postulated.

A pipe break hazard analysis is part of the piping design. The analysis will be performed for site-specific moderate-energy piping to confirm the protection of standard plant and site-specific safety-related SSCs so the reactor can be shut down safely and maintained in a safe, cold shutdown condition without offsite power. The as-designed pipe break hazards analysis will be completed in accordance with the criteria outlined in DCD Subsections 3.6.1.2.2, 3.6.1.2.3, and 3.6.2. Standard plant and site-specific safety-related SSCs that are potential targets for postulated failures in site-specific moderate-energy piping will be identified as part of the analysis. Table 3.6-201 identifies site-specific systems which contain high- and moderate-energy lines.

The as-designed pipe break hazard analysis report will include the following:

- The systems or components that are safety-related or required for safe shutdown that are located near site-specific moderate-energy piping systems, and are susceptible to the consequences of these piping failures will be listed.
- Site-specific moderate-energy piping systems will be listed, which includes
  - identifying properties of internal and external fluids
  - a description of the layout of all piping systems where physical arrangement of the piping systems provides the required protection
  - the design basis of structures and compartments used to protect nearby essential systems or components, or the arrangements to assure the operability of safety-related features where neither separation nor protective enclosures are practical

- The failure modes and effect analyses that verify the consequences of failures in site-specific moderate-energy piping and in standard plant design high-energy and moderate-energy piping do not affect the ability to safely shut down the plant will be described.

The locations of the postulated leakage cracks and potential targets will be established and required protection measures will be included in the analysis. The analysis will address environmental and flooding effects of cracks in site-specific moderate-energy piping.

The as-designed pipe break hazards analysis for a compartment will be completed prior to installation of the piping and connected components in that compartment, and will be made available for NRC review.

An as-built reconciliation of the pipe break hazards analysis will be completed prior to fuel load in accordance with the criteria outlined in DCD Subsections 3.6.1.2.2, 3.6.1.2.3, and 3.6.2 and in accordance with DCD Tier 1 Table 2.3-2, Item 5.

The ITAAC associated with pipe break hazard analysis are also addressed in Subsection 14.3.4.3.

3.6.2.1 Criteria used to Define Break and Crack Location and Configuration

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STD COL 3.6(4) Replace the second paragraph in DCD Subsection 3.6.2.1 with the following.

As noted in Subsection 3.6.1.3, there is no site-specific high-energy piping located near safety-related SSCs. Site-specific moderate-energy piping systems are addressed in an as-designed pipe break hazards analysis. The completed as-designed pipe break hazards analysis will implement the criteria for defining leakage crack locations and configurations for site-specific moderate-energy piping systems described in DCD Subsection 3.6.2.1. The as-designed pipe break hazard analysis report will include identifying the postulated break location for site-specific moderate-energy piping systems.

The as-built reconciliation of the pipe break hazards analysis will be performed to verify the as-built configuration of site-specific moderate-energy piping systems is consistent with the design intent.

3.6.3.3.1 Water Hammer

STD COL 3.6(10) Replace the fourth paragraph DCD Subsection 3.6.3.3.1 with the following.

Generally, water hammer is not experienced in Reactor Coolant Loop (RCL) branch piping, and the piping is designed to preclude the voiding condition according to operation at a pressure greater than the saturation pressure of the coolant. No valve that requires immediate action, such as pressurizer safety valve or relief valve, is present in the piping. Operating and maintenance procedures regarding water hammer are included in system operating procedures in Subsection 13.5.2.1. A milestones schedule for implementation of the procedures is also included in Subsection 13.5.2.1. The procedures are to address plant operating and maintenance requirements to provide adequate measures to prevent water hammer due to a voided line condition.

3.6.4 Combined License Information

Replace the content of DCD Subsection 3.6.4 with the following.

STD COL 3.6(1) ***3.6(1)*** *Postulated failures associated with site-specific piping*

This COL item is addressed in Subsection 3.6.1.3 and Table 3.6-201.

3.6(2) *Deleted from the DCD.*

3.6(3) *Deleted from the DCD.*

STD COL 3.6(4) ***3.6(4)*** *Criteria used to define break and crack location and configuration for site-specific piping.*

This COL item is addressed in Subsection 3.6.2.1.

3.6(5) *Deleted from the DCD.*

3.6(6) *Deleted from the DCD.*

3.6(7) *Deleted from the DCD.*

3.6(8) *Deleted from the DCD.*

3.6(9) *Deleted from the DCD.*

STD COL 3.6(10) ***3.6(10)*** *Operating and maintenance procedures for water hammer prevention.*

This COL item is addressed in Subsection 3.6.3.3.1.

STD COL 3.6(1)

Table 3.6-201

High and Moderate Energy Fluid Systems

System	High-Energy(1)	Moderate-Energy(1)
Site-Specific Essential Service Water System (ESWS)	-	X
Ultimate Heat Sink System (UHS)	-	X
Site-Specific Fire Protection Water Supply System (FSS)	-	X

Note

1. High-energy piping includes those systems or portions of systems in which the maximum normal operating temperature exceeds 200°F or the maximum normal operating pressure exceeds 275 psig.

   Piping systems or portions of systems pressurized above atmospheric pressure during normal plant conditions and not identified as high-energy are considered as moderate-energy.

   Piping systems that exceed 200°F or 275 psig for two percent or less of the time during which the system is in operation are considered moderate-energy

3.7 SEISMIC DESIGN

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

CP COL 3.7(20) Replace the third paragraph in DCD Section 3.7 with the following.

The SSI validation analysis of the site-independent seismic design of the standard plant for the site-specific seismic conditions is addressed in Appendix 3NN. The site-specific SSE ground motion used as input for the validation analysis envelops the site-specific ground motion response spectra (GMRS) and foundation input response spectra (FIRS) as discussed in Subsection 3.7.1.1.

CP COL 3.7(21) Replace the fourth paragraph in DCD Section 3.7 with the following.

The seismic analysis and design of site-specific seismic category I and II SSCs is performed using the site-specific SSE design ground motion as discussed in Subsection 3.7.1.1. The seismic response analyses and designs of the site-specific seismic category I structures are addressed in Appendices 3KK, 3LL, and 3MM for the ultimate heat sink related structures (UHSRS), essential service water pipe tunnel (ESWPT), and power source fuel storage vault (PSFSV), respectively.

3.7.1.1 Design Ground Motion

CP COL 3.7(1) Replace the second sentence of the first paragraph in DCD Subsection 3.7.1.1 with the following.

The applicable site-specific PGA is 0.1 g for the two horizontal directions and the vertical direction.

CP COL 3.7(22) Replace the last sentence of the second paragraph in the part titled “CSDRS” in DCD Subsection 3.7.1.1 with the following.

There are no high frequency exceedances of the CSDRS at the CPNPP site.

CP COL 3.7(2)
CP COL 3.7(5)
CP COL 3.7(6)
CP COL 3.7(20)

Replace the last two sentences of the second paragraph in the part titled “FIRS” in DCD Subsection 3.7.1.1 with the following.

Site-specific ground motion response spectra are obtained, following a methodology consistent with the approach recommended in RG 1.208 (Reference 3.7-3), as stated in Subsection 2.5.2. The site-specific analyses and calculation of the GMRS and FIRS is outlined in Subsections 2.5.2.5 and 2.5.2.6, which document the methodology and the soil properties used for calculating the GMRS and FIRS. The GMRS and FIRS for 5 percent damping are shown in Figure 3.7-201. The spectra shown in Figure 3.7-201 represent spectra for the following site-specific conditions:

FIRS1 = the GMRS, at the top of the Glen Rose Limestone Layer C (nominal elevation 782') as described in Subsections 2.5.2.5 and 2.5.2.6. The PSFSVs are founded directly on this limestone layer, except where fill concrete may be used to level the foundation bottom or provide "dental" fill. The UHSRS are founded slightly above and below the limestone layer surface, with the foundation mat bottoms of the UHS basins at elevation 786 ft and bottoms of the sumps at elevation 774 ft. Fill concrete placed between the bottom of the UHS basin mat and top of limestone is analyzed as part of the seismic structural model in the UHSRS SSI analyses.

FIRS2 = the ground motion response spectrum at elevation 779.75' slightly below the nominal top of Glen Rose Limestone Layer C, as described in Subsection 2.5.2.6. This elevation corresponds to the bottom of the foundation mat for the reactor building (R/B) complex, which extends 2.25' below the nominal top of the limestone layer.

FIRS3 = the ground motion response spectrum corresponding to typical plant grade elevation 822' with sandy engineered compacted backfill above elevation 782', as described in Subsection 2.5.2.6. FIRS3 represents a performance based surface response spectrum (PBSRS) for FIRS1 and FIRS2. FIRS3 does not serve as input motion to any seismic category I or II plant structures.

FIRS4 = the ground motion response spectrum at elevation 791.08' as described in Subsection 2.5.2.6. The FIRS4 control elevation corresponds to the bottom of the ESWPT, and approximately to the bottom of the turbine building (T/B) mat foundation at elevation 794.83'. The profile used in Subsection 2.5.2.6.2 for development of FIRS4 incorporates a 9.08' thick layer of fill concrete placed on the top of the limestone and sandy engineered compacted fill above the fill concrete. A FIRS4 soil column surface response (SCSR) is also developed to represent a PBSRS. Note that the SSI analyses of the ESWPT are not based on the FIRS 4 profile, which assumes an infinite horizontal extent of the fill concrete layer, but on the full column profile used for development of FIRS1 and FIRS2. The fill concrete underneath the footprint of the ESWPT is included in the dynamic model to provide a better representation of the limited extent of the fill concrete in the horizontal direction.

As demonstrated in Figure 3.7-201, for all frequencies the 5 percent damping site-specific GMRS/FIRS1, FIRS2, and FIRS4 are less than the 5 percent damping minimum response spectra tied to the shape of the CSDRS and anchored at 0.1 g. Therefore, the standard plant CSDRS anchored at 0.1g are used to define the site-specific design ground motion and the site-specific FIRS, which complies with the minimum ground motion requirements of 10 CFR 50 Appendix S (IV)(a)(1)(i) (Reference 3.7-7). Defined in this manner, the site-specific FIRS are exactly the same as the standard plant CSDRS, but scaled by a factor of 1/3. These site-specific FIRS characterize the input SSE design ground motion for the site-specific seismic analyses and design as outcrop motion at the bottom of seismic category I foundations.

The site-specific FIRS are presented in Figure 3.7-202 and Figure 3.7-203 for the horizontal and vertical directions, respectively. Tabulated values of the corresponding spectral accelerations for each of the spectral control points are presented in Table 3.7-201 and Table 3.7-202 for the horizontal and vertical directions, respectively. The ground motion time histories, compatible with the site-specific FIRS that are used as the SSE input motion for the site-specific seismic response analyses and design, are described below in "Site-Specific Design Ground Motion Time Histories and Durations of Motion".

CP COL 3.7(2) Replace the third paragraph in the part titled "FIRS" in DCD Subsection 3.7.1.1 with the following.

Site-specific verification analysis of the US-APWR standard plant R/B complex has been performed as described in Appendix 3NN. Based on the analyses results, no modifications to the standard plant seismic design are required to accommodate the site-specific seismic conditions.

CP COL 3.7(13) Replace the first sentence of the second paragraph in the part titled "OBE" in DCD Subsection 3.7.1.1 with the following.

For CPNPP Units 3 and 4, the value of the OBE ground motion that serves as the basis for defining the criteria for shutdown of the plant is 1/3 of the site-specific SSE defined by the minimum design earthquake spectra.

CP COL 3.7(24) Replace the next-to-last paragraph in the part titled "Design Ground Motion Time History" in DCD Subsection 3.7.1.1 with the following.

The site-specific FIRS, defined as the standard plant CSDRS scaled by a factor of 1/3, envelop the site-specific ground motion spectra provided in Subsection 2.5.2. Therefore, the site-specific ratios V/A and AD/V^2 (A, V, D, are PGA, ground velocity, and ground displacement, respectively) are consistent with values characteristic for the magnitude and distance of the appropriate controlling events defining the site-specific uniform hazard response spectra.

CP COL 3.7(30) Replace the last paragraph in the part titled "Design Ground Motion Time History" in DCD Subsection 3.7.1.1 with the following

Site-Specific Design Ground Motion Time Histories

Because the site-specific FIRS is defined as the CSDRS anchored to a zero period acceleration (ZPA) of 0.10 g, the ground motion time histories used for the standard design shown in Figure 3.7.1-3, Figure 3.7.1-4, and Figure 3.7.1-5 are scaled to 1/3 and used as input outcrop design ground motion for the site-specific seismic response analyses and design. Figure 3.7-204 presents the 1/3 scaled acceleration time histories for the horizontal directions H1 and H2, and vertical direction V. The 5% damping spectra corresponding to the outcrop motion input acceleration time histories are plotted against the minimum design earthquake spectra defining the site-specific FIRS and presented in Figure 3.7-205, Figure 3.7-206, and Figure 3.7-207 for the horizontal directions H1 and H2 , and vertical direction V, respectively. These figures demonstrate that the outcrop input motion used as input for the seismic analyses envelops the minimum required design motion.

The scaled time histories of the site-specific outcrop design ground motion in Figure 3.7-205, Figure 3.7-206, and Figure 3.7-207 are used directly as input control motion for the site-specific SSI and/or SSSI analyses of surface-mounted models that do not include the embedment soil. For site-specific SASSI analyses of embedded foundation models that include the embedment soil, the scaled standard plant design basis acceleration time histories are converted at the input control motion elevation from outcrop motion to in-layer motion. In accordance with the provisions of DC/COL-ISG-017 (Reference 3.7-65), the in-layer motion time histories are obtained as described in Subsection 2.5.2.6.3 based on the Nuclear Energy Institute (NEI) methodology provided in Section 3.2.3 of Reference 3.7-64.

In-layer ground motion time histories are obtained from site response analyses of profiles of best estimate (BE), lower bound (LB), upper bound (UB) and high bound (HB) strain-compatible shear wave and compression wave velocities used as input for the SASSI analyses of embedded models that are summarized in Subsection 3.7.2.4.5. These profiles of site-specific dynamic soil/rock properties are derived from the full column profile used for development of FIRS1, FIRS2 and FIRS3 in Subsections 2.5.2.6. Therefore, the developed in-layer motions for all seismic category I structures, including the ESWPT, are suitable for SSI analyses of models in which the layer of the fill concrete below the foundation is included as part of the structural model, not the site model. No iteration of the soil properties with strain are performed, i.e. the site-specific response analyses are performed considering linear elastic rock and soil properties. The vertical in-layer ground motion time histories are obtained from site response analyses of compression wave velocity profiles reflecting three different ground water levels (GWLs): a nominal GWL at elevation 795’, a high GWL located at the ESWPT roof top at approximately elevation 804 ft, and an unsaturated backfill when the GWL is below the surface of the rock subgrade. These GWLs are considered in the seismic analyses of the various structures as described in Appendices 3KK, 3LL, 3MM, and 3NN. The 5% damped acceleration response spectra (ARS) results of the site response analyses at the surface of the soil column are enveloped and

then compared with the PBSRS. Figures 2.5.2-266 through 2.5.2-277 show that the envelope of the soil-column responses at the ground surface level for the LB, BE, UB and HB profiles, either in the horizontal or the vertical direction, are all higher than the PBSRS. These comparisons demonstrate that the in-layer time histories comply with the NEI procedure described in Section 3.2.3 of Reference 3.7-64.

Table 3.7-203 provides a summary of the types of design-basis ground motion time histories used as input for site-specific seismic response analyses and design. Refer to Appendices 3KK, 3LL, 3MM, and 3NN for detailed descriptions of the SSI and/or SSSI analysis cases and modeling approaches. Figures 3.7-208 through 3.7-220 present the 5% damping spectra corresponding to the in-layer ground motion acceleration time histories used as input control motion for the SASSI analyses of embedded models. The response spectra of the in-layer acceleration time histories are plotted against the corresponding response spectra of the outcrop motion and the site-specific FIRS (1/3 CSDRS). The response spectra of the vertical in-layer ground motion time histories are plotted in the figures for the different GWLs considered for the design of the particular structure.

3.7.1.2 Percentage of Critical Damping Values

CP COL 3.7(4) Replace the tenth paragraph in DCD Subsection 3.7.1.2 with the following.

The OBE structural damping values in Table 3.7.3-1(b) are used for site-specific seismic analysis and design of structures and for computation of site-specific in-structure response spectra (ISRS). This is in accordance with Section 1.2 of RG 1.61 (Reference 3.7-15), and prevents non-conservative results in the site-specific analysis and design. The damping values assigned to the rock and soil profiles in the site-specific seismic analyses and design are compatible with the strains generated by the site-specific design ground motion and are well below the 15% limit set by SRP 3.7.2 on shear wave damping and the 10% limit on compression wave damping recommended by the correlation studies in DCD Reference 3.7-62. The structural damping values and the rock and soil damping values used in the site-specific seismic analyses and design are presented and justified in more detail in Subsection 3.7.2.4.5 and Appendices 3KK, 3LL, 3MM, and 3NN.

3.7.1.3 Supporting Media for Seismic Category I Structures

CP COL 3.7(7) Replace the last three sentences of the second paragraph in DCD Subsection 3.7.1.3 with the following.

For CPNPP Units 3 and 4, all seismic category I and II buildings and structures, including the R/B complex, UHSRS, ESWPT, PSFSVs, and T/B, are founded directly on solid limestone (Glen Rose Limestone Layer C) or on fill concrete which extends from the foundation bottom to the top of solid limestone at nominal elevation 782'. According to Subsection 2.5.1.2.5.2, the Glen Rose Limestone Layer C is approximately 65 ft thick and has a minimum ultimate bearing capacity of 146 ksf per Subsection 2.5.4.10.1. The dynamic properties of the supporting media used in the SSI and SSSI analyses are developed as described in Subsection 3.7.2.4.5.

The fill concrete conforms to pertinent requirements of ACI-349 such as durability. Fill concrete is used as "dental" fill in any areas where additional removal of materials below the nominal top of limestone is required in order to reach competent limestone. With respect to horizontal extent, concrete fill matches the footprint of the foundation, except that the fill is permitted to extend beyond the foundation edges to facilitate construction and placement of forms.

According to Subsection 2.5.4.5.4.1.2, the fill concrete has a minimum design compressive strength of 3,000 psi. Where applicable, the fill concrete is considered as part of the structure in the models used to perform the site-specific seismic analyses and design, which are described in Appendices 3KK, 3LL, 3MM, and 3NN.

The maximum bearing loads and available factors of safety for all seismic category I and II buildings and structures are presented in Table 3.8-202. Table 3.8-202 demonstrates that the minimum factor of safety for ultimate bearing capacity versus maximum bearing load (static + dynamic/seismic) is at least 2 for the R/B complex, UHSRS, ESWPT, PSFSVs, and T/B, based on site-specific subgrade conditions and the site-specific SSE input ground motion with a PGA of 0.1 g. Table 3.8-202 also demonstrates that the minimum factor of safety for ultimate bearing capacity versus maximum static bearing load is at least 2.5 for these structures.

3.7.2.1 Seismic Analysis Methods

CP COL 3.7(29) Replace the second sentence of the first paragraph in DCD Subsection 3.7.2.1 with the following.

Table 3.7.2-1R presents a summary of dynamic analysis and combination techniques including types of models and computer programs used, seismic analysis methods, and method of combination for the three directional components for the seismic analysis of the US-APWR site-specific and standard plant seismic category I and II buildings and structures.

3.7.2.3.1 General Discussion of Analytical Models

CP COL 3.7(3) Replace the tenth paragraph (including bullets) in DCD Subsection 3.7.2.3.1 with the following.

Analytical models used for the seismic analyses of buildings and structures are developed on a site-specific basis as follows:

- PSFSVs (seismic category I). A three-dimensional site-specific SASSI (References 3.7-17 and 3.7-63) finite element (FE) model is used for seismic analysis. The PSFSV analytical model is discussed in Appendix 3MM.
- ESWPT (seismic category I). Three-dimensional site-specific SASSI (Reference 3.7-17) FE models are used for seismic analysis. The ESWPT analytical models are discussed in Appendix 3LL.
- UHSRS (seismic category I). Three-dimensional site-specific SASSI (Reference 3.7-63) FE models are used for seismic analysis. The UHSRS analytical model is discussed in Appendix 3KK.

3.7.2.3.2 R/B Complex Dynamic Finite Element Model

CP COL 3.7(11) Replace the last three sentences of the ninth paragraph in DCD Subsection 3.7.2.3.2 with the following.

The polar crane and fuel handling crane manufacturers are selected and site-specific design of these cranes is performed prior to construction. The site-specific seismic analysis and design of the cranes consider their masses and frequencies, and are coupled with the building analyses as required by ASME NOG-1 (Reference 3.7-22) and SRP 3.7.2 (Reference 3.7-16).

3.7.2.4.5 Requirements for Site-Specific SSI Analysis of US-APWR Standard Plant

CP COL 3.7(25)
CP COL 3.7(26) Replace the first paragraph in DCD Subsection 3.7.2.4.5 with the following.

The site-specific SSI analysis for the R/B complex is performed utilizing the program ACS-SASSI (Reference 3.7-17). To assure the proper comparability with the standard plant SSI analyses, the site-specific SSI analyses use the same verified and validated models of the R/B complex as those used for the US-APWR standard plant design SSI analyses. The only differences in the dynamic model of the R/B complex structures are that the basement walls' mesh is modified to match the mesh used in modeling the site-specific backfill soil and that dynamic properties are assigned to the structural members corresponding to the site-specific conditions. Lower OBE damping values are used to account for the dissipation of energy in the structural model. In order to address the effects of concrete cracking, two sets of stiffness properties, representing the best estimates of the properties during normal operating and thermal accident conditions, are assigned to the models. Single Degree of Freedom (SDOF) oscillators are added to the models of the R/B complex, East, and West PS/B structures with full (uncracked concrete) stiffness properties to capture possible effects of a shift in frequencies due to out-of-plane cracking of flexible slabs. Site-specific SSI analyses are performed on the R/B complex models using embedded and surface-mounted foundations. The results of the site-specific analyses confirm that site-specific effects are enveloped by the standard plant design, and validate the site-independent seismic design of the R/B complex for site-specific conditions. The details of the site-specific SSI analysis of the R/B complex are addressed in Appendix 3NN.

CP COL 3.7(26) Replace the second paragraph in DCD Subsection 3.7.2.4.5 with the following.

The site-specific SSI analyses of the ESWPT are performed using the computer program ACS-SASSI (Reference 3.7-17). The site-specific SSI analyses of the UHSRS and PSFSVs are performed using the computer program SASSI2000 (Reference 3.7-63). The SASSI analyses for these structures are performed using the same basic methodology as the site-specific SASSI analysis of the R/B complex. The SASSI analyses and results for the UHSRS, ESWPT, and PSFSVs are addressed in Appendices 3KK, 3LL, and 3MM, respectively.

CP COL 3.7(10) Replace the third paragraph in DCD Subsection 3.7.2.4.5 with the following.

The potential SSSI effects of the R/B complex and T/B on the site-specific seismic category I structures are addressed in Appendices 3LL and 3MM. Appendices 3KK and 3LL also address potential SSSI effects between the site-specific seismic category I structures. The SSSI evaluations are summarized as follows:

SSSI Effects between UHSRS AB and CD (Appendix 3KK)

SSSI effects between the two UHSRS AB and CD are evaluated by comparison of the response envelopes of the UHSRS surface and embedded foundation models with and without symmetry conditions. Since UHSRS AB and UHSRS CD are almost a mirror image of each other, the standalone models with symmetry

conditions established at the end of the UHS ESWPT simulate the interaction between the two UHSRS. The nearest structures to the UHSRS are the ESWPT segments. The ESWPT segments are too small and light to have any significant effect on the response of the much heavier UHSRS, so the SSSI effects on UHSRS response from these structures are not considered.

The evaluation shows that the SSSI between UHSRS AB and CD is manifested through the backfill soil and has a small effect. The responses obtained from SSI analyses of embedded and surface-mounted standalone models provide seismic design that bounds the SSSI effects. The structural design of UHSRS uses SSE loads obtained from SSI analyses of standalone models that envelop SSSI effects on ZPAs. The SSI analyses of standalone models provide design ISRS that envelop the ISRS calculated from the SSSI analyses at all equipment locations with the exception of the ESW pump house and sump north-south walls below elevation of 827 ft, where the SSSI effects result in negligible exceedances that are less than 2.5%.

The detailed process and results for investigation of potential SSSI effects between the UHSRS are discussed in Appendix 3KK.

<u>SSSI Effects on the ESWPT (Appendix 3LL)</u>

Expansion joints are present at the interface between the standalone ESWPT segments, the UHS ESWPT attached to the UHSRS, and the ESW Pipe Chase at the R/B complex. These expansion joints restrict transfer of seismic forces. The seismic response of the ESWPT as a light underground structure is driven by the response of the surrounding soil. Therefore, the assessment of SSSI on the response of the ESWPT is focused on the effects of the nearby heavy and large buildings (the R/B complex and UHSRS) on the free field motion at ESWPT locations. From the site-specific SSI analyses of standalone models of the R/B complex and UHSRS, the response at the roof and foundation elevation along the centerline of the ESWPT is computed and compared with the free-field motion. The comparison is used to assess the SSSI effects of the R/B complex and UHSRS on the tunnel response and to compute a spectral amplification factor for every frequency of the response spectra. The spectral amplification factors are used to include SSSI effects in the design-basis ISRS and SSE loads for structural design of the ESWPT.

The detailed process and results for investigation of potential SSSI effects on the ESWPT are discussed in Appendix 3LL.

<u>SSSI Effects on the PSFSV (Appendix 3MM)</u>

SSSI analyses serve as the basis for evaluation of SSSI effects due to the R/B complex and T/B on the PSFSV ISRS, seismic inertial loads, and earth pressures in the backfill soil between the buildings. The SSSI effects are evaluated based on the results of analyses performed on two SSSI models: an embedded model which includes the east PSFSV, west PSFSV, and T/B, and a surface-mounted

model which includes the R/B complex, T/B, and west PSFSV. SSSI effects are evaluated considering LB, BE, UB, and HB conditions. To simulate the backfill soil conditions, the structures in the surface-mounted model are interconnected with massless solid elements that have stiffnesses corresponding to the backfill soil stiffnesses for the LB, BE, UB, and HB conditions. SSSI effects are evaluated by comparison of responses obtained from analysis of the SSSI models versus responses obtained from SSI analyses of the standalone models of the east and west PSFSVs with embedded and surface-mounted foundations.

To evaluate the effects of SSSI on the PSFSV design basis ISRS, spectral amplification factors are calculated for every frequency of the response spectra as the ratio of the acceleration response spectra obtained from the SSSI analyses to the acceleration response spectra obtained from the SSI analyses of the standalone PSFSV. The spectral amplification factor is assigned a value of 1 for ratios less than 1. The spectral amplification factors indicate that SSSI effects on the PSFSVs from the nearby standard plant buildings can be significant.

Amplifications due to SSSI effects are incorporated into the design-basis ISRS by enveloping the results of all SSI and SSSI analyses for the PSFSVs. For the structural design of the PSFSVs, the seismic inertia loads are increased to account for SSSI effects by conservatively amplifying nodal accelerations within a PSFSV structural component in each orthogonal direction by the largest factor obtained for all the nodes within the component for that direction. The SSSI effects on SSE lateral pressure loads applied on the PSFSV exterior walls are smaller and enveloped by the seismic lateral earth pressure loads used for the design of PSFSV structures.

The detailed process and results for investigation of potential SSSI effects on the PSFSVs are discussed in Appendix 3MM.

CP COL 3.7(8)
CP COL 3.7(25)

Replace the sixth paragraph to the ninth paragraph in DCD Subsection 3.7.2.4.5 with the following.

The input used for the site-specific SSI and SSSI analyses is derived from geotechnical and seismological investigations of the site described in Subsections 2.5.1 and 2.5.2. The input control motion compatible with the site-specific FIRS as described in Subsection 3.7.1 is applied in the SASSI analyses at the bottom-of-foundation control point. The standard plant and site-specific seismic category I and II buildings will be constructed by removing the native soil above the top of the Glen Rose Limestone Layer C at nominal elevation of 782 ft and backfilling the site to nominal plant grade elevation of 822 ft with engineered cohesionless fill material.

All standard plant and site-specific seismic category I and II buildings are founded directly on the limestone, with a layer of fill concrete (not backfill) installed underneath the entire basemat where required to fill the volume between the

basemat bottom and the top of limestone. Based on the site conditions, in which the basemats of all seismic category I and II buildings rest directly on limestone or fill concrete, dynamic testing is not required to evaluate the strain-dependent properties of the rock subgrade and compacted backfill. The strain-dependent properties are obtained as follows.

The site-specific SSI analyses account for the uncertainties and variations of the properties of the supporting rock subgrade and engineered backfill by using three sets of site profiles that represent the BE, LB, and UB soil and rock dynamic properties. Typical properties for a granular engineered backfill are adopted as the BE values for the dynamic properties of the backfill. The LB and UB soil properties cover the mean plus or minus one standard deviation for every layer. In accordance with the specific guidelines for SSI analysis contained in Section II.4 of SRP 3.7.2 (Reference 3.7-16), the LB and UB values for initial soil shear modulii (G_s) are established as follows:

$$G_s^{(LB)} = G_s^{(BE)} / (1 + C_v) \text{ and } G_s^{(UB)} = G_s^{(BE)} (1 + C_v)$$

The values of C_v used in determining G_s in the site-specific analyses all exceed 0.5, which is acceptable for a well-investigated site. An additional high bound (HB) case with a C_v of more than 1.25 is used for backfill to account for potential additional variation in embedment soil properties.

The site-specific SSI analyses described in Appendices 3KK, 3LL, 3MM, and 3NN use stiffness and damping properties of the rock subgrade and backfill materials that are compatible with the strains generated by the site-specific design earthquake. The strain-compatible properties are developed based on the results of the site response analyses of the soil column used for development of FIRS1, FIRS2 and FIRS3 as described in Subsection 2.5.2.5.2.3. This soil column consists of sub-excavation rock strata below elevation 782 ft and backfilling to plant grade elevation of 822 ft with granular engineered fill material. The fill concrete placed under some of the category I and II foundations is not part of the site profiles used for the site-specific SSI analyses. These fill concrete layers are included in all structural models for SSI analyses, including those of the ESWPT, in order to more accurately represent the limited horizontal extent of the fill concrete under the foundations.

The results of the site response analyses of the FIRS3 column profile randomized with 30% covariance described in Subsection 2.5.2.5.2.3 are used for development of BE, LB and UB strain-compatible rock and backfill soil properties. The LB, BE, and UB strain-compatible properties are developed from the median profiles plus or minus one standard deviation. The LB and UB profiles of shear wave velocity (V_s) and compression wave velocity (V_p) are adjusted to ensure variation C_v of the soil/rock shear modulus of at least 0.5 consistent with FSAR Table 2.5.2-212. The HB backfill properties are developed based on the results of the site response analyses of the FIRS3_COV50 profile randomized using a coefficient of variation of 50% as described in Subsection 2.5.2.5.2.3. The

site-specific SSI analyses consider the HB profile consisting of backfill layers that represent plus one standard deviation from the FIRS3_COV50 median profile and rock layer properties that are equivalent to those used in the UB profile. Consistent with the approach taken for the standard design described in Subsection 3.7.1.3, the site-specific compression wave velocity damping is set equal to strain-compatible shear wave velocity damping. Table 3.7-204 presents the profiles of strain-compatible dynamic properties of the rock subgrade below elevation of 782 ft that are used as input for the site-specific SSI analyses. The last column of the table provides the passing frequencies through the rock layers that are calculated based on the criteria that the thickness of the layer shall not exceed one fifth of the material wave length, i.e.:

$$f_{pass} = \frac{V_s}{5 \cdot d}$$

where f_{pass} is the maximum frequency of the waves that can be transmitted through the site model, and d and V_s are the thickness and shear wave velocity of the layer, respectively. The table shows that the site models can transmit waves with frequency up to 50 Hz through the rock layers.

The strain-compatible dynamic properties of the engineered backfill soil are presented in Table 3.7-205 for each LB, BE, UB, and HB backfill profile considered. The table presents the soil Poisson ratio for three different ground water conditions considered: nominal GWL at elevation 795 ft, high GWL located at the top of the ESWPT at approximately elevation 804 ft, and unsaturated backfill when the GWL is below the rock surface at elevation 782 ft. Based on the Poisson ratio values provided in the table, the compression wave velocities of the backfill soil layers are computed for the different GWLs using the following theory of elasticity relationship:

$$V_p = V_s \cdot \sqrt{\frac{2(1-\nu)}{1-2\nu}}$$

Prior to being used as input for the SSI analyses, the layering of the backfill model is adjusted to match the finite element mesh of the structural models of the seismic category I structures described in Appendices 3KK, 3LL, 3MM, and 3NN. Shear wave velocities and compression wave velocities (V_s and V_p) of the backfill soil layers with adjusted layer thickness H are calculated based on the equivalent arrival time principle as follows:

$$V_s = \frac{H}{\sum_{i=1}^{n} \frac{d_i}{V_{s\,i}}} \qquad V_p = \frac{H}{\sum_{i=1}^{n} \frac{d_i}{V_{p\,i}}}$$

where n is the number of the site profile layers of soils in Table 3.7-205 with shear wave velocities, V_s. The following equations are used to obtain the equivalent backfill damping and unit weight properties, D and w, as weighted averages of the damping and unit weights of the site layers D_i and w_i

$$D = \frac{\sum_{i=1}^{n} D_i d_i}{H} \qquad w = \frac{\sum_{i=1}^{n} w_i d_i}{H}$$

Figures 3.7-219, 3.7-220, and 3.7-221 present comparisons of the site-specific BE, LB and UB profiles of strain-compatible shear wave velocities (V_s), compression wave velocities (V_p) and damping with the corresponding generic profiles described in Subsection 3.7.1.3 that are used as input for the standard plant design SSI analyses. Figures 3.7-219 and 3.7-220 show that the rock subgrade of the site below the seismic category I foundations has similar dynamic properties as the generic soft rock profiles 900-200 and 900-100. Figure 3.7-221 shows that the damping values representing the energy dissipation in the site-specific soil/rock materials are higher than those used as input for the standard design. Responses obtained from the standard plant SSI analyses for rock generic profiles described in Subsection 3.7.2.2, and R/B complex site-specific SSI analyses described in Appendix 3NN, are both governed by the dynamic properties of the structures. The effects on the seismic responses of the category I and II buildings due to SSI with the site-specific rock subgrade are small. The higher site-specific soil damping will result in reduced responses of the R/B complex structures at resonant frequencies.

Shear column frequencies are calculated for the site-specific backfill profiles following the methodology in Section 01.5.2.2 of MUAP-10006 (Reference 3.7-48) using the BE, LB, UB, and HB strain-compatible properties of the 40 ft-deep engineered backfill strata. In Figure 3.7-222, the comparison of the embedment soil shear column frequencies with those of the six generic soil profiles used for standard design shows that the stiffness of the engineered fill material is lower than the stiffness of the embedment soil in the generic soil profiles. The softer site-specific backfill can result in spectral peaks at lower frequencies. As shown in Appendix 3NN, the standard plant design basis ISRS, developed from the results of standard plant SSI analyses of generic soil profiles, envelop these amplifications by a large margin.

The nominal maximum height of the water table in the general power block area is approximately elevation 795 ft, as documented in Subsection 2.4.12.5. The maximum GWL may reach the top of the ESWPT at approximately elevation 804 ft, within those plant areas bounded by the ESWPT. The P-wave velocities of the rock layers and fill concrete exceed the P-wave velocity of water (5,000 ft/s) according to Subsection 2.5.2.6.3. Therefore, the water table elevation does not affect the dynamic properties of submerged rock materials. Where backfill materials are saturated due to groundwater, the Poisson ratio is changed from 0.35 for unsaturated soil to 0.48, as described in Subsection 2.5.2.6.3.

Effects of variations in the GWL are addressed by sensitivity studies performed for the ESWPT, PSFSV, and UHSRS by considering SSI responses for different GWLs. Among the seismic category I structures, the seismic response of the ESWPT as a light underground structure is the most sensitive to GWL variations. The study is based on SSI analyses of ESWPT segment 1aN for three sets of LB, BE, UB, and HB site profiles reflecting plant nominal GWL at elevation 795 ft, high GWL located approximately at the top of the ESWPT, and unsaturated backfill when the GWL is below the top of the limestone strata. Appendix 3LL presents the results of the study and the methodology used to include GWL variation effects in the seismic design of ESWPT.

Results obtained from the GWL variation effects study performed on the ESWPT are confirmed by SSI analyses of UHSRS and PSFSV for additional sets of best estimate profiles reflecting GWLs different than the nominal GWL. The methodology used to address the effects of GWL variation on the UHSRS and PSFSV design is described in Appendices 3MM and 3LL. The study performed for standard plant design in Technical Report MUAP-11007 (Reference 3.7-52) demonstrated that the use of a high GWL provides responses of the R/B complex that are bounding for the cases when the subgrade is unsaturated. The SSI analyses of R/B complex for unsaturated soil profiles resulted in only a few small exceedances in the ISRS peak responses. The comparisons of site-specific and standard design ISRS in Appendix 3NN show that the standard design envelops the site-specific effects of GWL variations with large margins.

The effects of backfill separation on the seismic response of the PSFSV, UHSRS and R/B complex are addressed by using the envelope of responses obtained from the analyses of surface-mounted models and embedded models with full contact with backfill soil along the depth of the structure. A backfill separation study is performed on the PSFSV model to demonstrate that the envelope of surface and embedded model responses envelops the backfill separation effects. Appendix 3MM provides details about the methodology and results of the backfill separation study.

CP COL 3.7(23) Replace the tenth to the last paragraph in DCD Subsection 3.7.2.4.5 with the following.

The enveloped and broadened ISRS obtained from the site-specific SSI analyses are compared to the standard plant ISRS in Appendix 3NN. Comparisons are made at all major floor and equipment locations that are identified in Appendix 3B of standard plant Technical Report MUAP-10006 (Reference 3.7-48). The comparison documented in Appendix 3NN demonstrates that the standard plant broadened ISRS at all major floor and equipment locations envelop the site-specific broadened ISRS by a high margin.

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

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STD COL 3.7(9) Replace the fifth paragraph in DCD Subsection 3.7.2.8 with the following.

The site-specific Category I SSCs are the UHSRS, the ESWPT, and the PSFSV. The layout design of the site-specific safety-related SSCs ensures that there are no adjacent non-seismic Category I structures which may adversely affect these structures, to protect them from structural failure of non-seismic Category I structures.

3.7.2.13 Methods for Seismic Analysis of Dams

CP COL 3.7(27) Replace the paragraph in DCD Subsection 3.7.2.13 with the following.

Neither the US-APWR standard plant design nor the CPNPP Units 3 and 4 plant design include the use of dams.

3.7.3.8 Methods for Seismic Analysis of Category I Concrete Dams

CP COL 3.7(27) Replace the paragraph in DCD Subsection 3.7.3.8 with the following.

Neither the US-APWR standard plant design nor the CPNPP Units 3 and 4 plant design include the use of dams.

3.7.3.9 Methods for Seismic Analysis of Aboveground Tanks

CP COL 3.7(12) Replace the first paragraph in DCD Subsection 3.7.3.9 with the following.

The seismic category I fuel oil storage tanks are metal tanks which are enclosed by tornado/hurricane missile protecting concrete vaults (that is, the seismic category I PSFSVs). Since the PSFSVs are below-grade structures, the fuel oil storage tanks are not above-ground tanks. However, the tanks and their mountings are seismically analyzed consistent with the discussion of hydrodynamic loads for above-ground tanks given further below. The tanks' seismic analysis is based on the ISRS which are derived from site-specific SSI and SSSI analysis of the PSFSVs as documented in Appendix 3MM, using the corresponding site-specific FIRS. Flexibility of the tank shell and tank shell damping effects are considered in estimating the fundamental frequency and spectral accelerations of the tank including its impulsive fluid weight.

3.7.4.1 Comparison with Regulatory Guide 1.12

CP COL 3.7(16) Replace the second paragraph in DCD Subsection 3.7.4.1 with the following.

The criteria that define the vibratory motion that requires the shutdown of the plant are based on the site-specific OBE. The 5% damping FIRS associated with the site-specific OBE are enveloped by 1/3 of the 5% damping CSDRS. OBE motion is measured at plant grade with seismic instrumentation located in the free field. Spectra scaled from the 5% damping site-specific SSE response spectra are used directly for OBE exceedance checks. An OBE exceedance check is performed in accordance with Section 4 of RG 1.166 (Reference 3.7-41) using both a response spectrum check and a cumulative absolute velocity (CAV) check. The comparison evaluation is to be performed within 4 hours of the earthquake using data obtained from the three components of the earthquake motion as defined by the three orthogonal axes of the standard plant (two horizontal and one vertical) on the uncorrected earthquake records. The evaluation is also to include a check on the operability of the seismic instrumentation as mandated by Section 4.3 of RG 1.166 (Reference 3.7-41).

CP COL 3.7(16) Replace the third paragraph, except the first sentence, in DCD Subsection 3.7.4.1 with the following.

For the free-field instrumentation located in the plant yard, the OBE acceleration and velocity spectra for 5% critical damping are scaled directly from the corresponding SSE spectra. Using site-specific values of OBE input motion, acceleration and velocity spectra for 5% critical damping are also developed for the seismic instrumentation located at the two foundation basemat locations in the R/B complex and east PS/B. Following the guidance of RG 1.12 and RG 1.166, the basemat instrumentation locations are used for shutdown consideration only in the event that the free-field instrumentation is inoperable. The other three instrument locations in the plant superstructure described in Section 3.7.4.2 serve as data sources for long-term evaluation for start-up and as back-up data sources in the unlikely event that both the free-field and the foundation instruments are inoperable during an earthquake, as these instrument locations are not required by RG 1.12 to be used for shutdown determination.

CP COL 3.7(16) Replace the sixth paragraph in DCD Subsection 3.7.4.1 with the following.

In the event that the free-field instrumentation is inoperable, or both the free-field and the foundation-level instrumentation are inoperable, then the guidance of RG 1.166 Appendix A is applicable.

3.7.4.2 Location and Description of Instrumentation

CP COL 3.7(16) Replace the sixth bullet of the bulleted list in the second paragraph of DCD Subsection 3.7.4.2 with the following.

- In the vicinity of the power block area at surface grade, on top of backfill material, and sufficiently far away from structures in order to appropriately measure free-field ground motion.

3.7.4.3 Control Room Operator Notification

CP COL 3.7(14) Replace the third sentence of the paragraph in DCD Subsection 3.7.4.3 with the following.

For CPNPP Units 3 and 4, the anticipated seismic response is essentially the same since both units are founded at the same elevation and on the same subgrade with the same stratigraphies, and have the same backfill conditions (including fill concrete) as previously described in Subsection 3.7.1.3 and Subsection 2.5.4. Only Unit 3 will be equipped with seismic monitoring instrumentation; however, the main control room (MCR) for both units will be provided with annunciation upon triggering of the instrumentation.

3.7.4.4 Comparison with Regulatory Guide 1.166

CP COL 3.7(16) Replace the second sentence of the first paragraph in DCD Subsection 3.7.4.4 with the following.

As previously discussed in Subsection 3.7.4.1, the seismic instrumentation and OBE exceedance checks meet the requirements of RG 1.166 (Reference 3.7-41). The OBE exceedance checks can be performed using only uncorrected earthquake data for the three orthogonal plant directions (two horizontal and one vertical) obtained from seismic instrumentation installed in the free fields as described in Subsection 3.7.4.2.

3.7.4.6 Program Implementation

CP COL 3.7(19) Replace the paragraph in DCD Subsection 3.7.4.6 with the following.

The seismic instrumentation program for CPNPP Units 3 and 4 will be established at least 12 months prior to first fuel load.

3.7.5 Combined License Information

Replace the content of DCD Subsection 3.7.5 with the following.

CP COL 3.7(1) ***3.7(1)*** *Site-specific PGA*

This COL item is addressed in Subsection 3.7.1.1.

CP COL 3.7(2) ***3.7(2)*** *Analysis of Site-specific FIRS and Site-independent CSDRS*

This COL item is addressed in Subsection 3.7.1.1.

CP COL 3.7(3) ***3.7(3)*** *Analytical models for site-specific buildings and structures*

This COL item is addressed in Subsection 3.7.2.3.1, and Appendices 3KK, 3LL, and 3MM

CP COL 3.7(4) ***3.7(4)*** *Damping values for site-specific ISRS*

This COL item is addressed in Subsection 3.7.1.2 and Appendices 3KK, 3LL, 3MM, and 3NN.

CP COL 3.7(5) ***3.7(5)*** *Horizontal FIRS, Vertical FIRS, and Minimum Response Spectra*

This COL item is addressed in Subsection 3.7.1.1, Tables 3.7-201, 3.7-202, and Figures 3.7-201, 3.7-202, and 3.7-203.

CP COL 3.7(6) ***3.7(6)*** *Site-specific GMRS and FIRS*

This COL item is addressed in Section 3.7.1.1, Tables 3.7-201, 3.7-202, and Figures 3.7-201, 3.7-202, and 3.7-203.

CP COL 3.7(7) ***3.7(7)*** *Allowable static and dynamic bearing capacities*

This COL item is addressed in Subsection 3.7.1.3 and Table 3.8-202.

CP COL 3.7(8) ***3.7(8)*** *Strain-dependent variation of material dynamic properties*

This COL item is addressed in Subsection 3.7.2.4.5, Tables 3.7-204 and 3.7-205, Figures 3.7-219 through 3.7-222, and Appendices 3KK, 3LL, 3MM, and 3NN.

STD COL 3.7(9) ***3.7(9)*** *Failure or collapse of non-seismic category I structures*

This COL item is addressed in Subsection 3.7.2.8.

CP COL 3.7(10) ***3.7(10)*** *Structure-to-soil-to-structure interaction*

This COL item is addressed in Subsection 3.7.2.4.5 and Appendices 3KK, 3LL, and 3MM.

CP COL 3.7(11) ***3.7(11)*** *Subsystem Coupling Requirements*

This COL item is addressed in Subsection 3.7.2.3.2.

CP COL 3.7(12) ***3.7(12)*** *Liquid-retaining metal tanks*

This COL item is addressed in Subsection 3.7.3.9 and Appendix 3MM.

CP COL 3.7(13) ***3.7(13)*** *Value of OBE to define criteria for shutdown*

This COL item is addressed in Subsection 3.7.1.1.

CP COL 3.7(14) ***3.7(14)*** *Seismic instrumentation at multiple-unit site*

This COL item is addressed in Subsection 3.7.4.3.

3.7(15) *Deleted from the DCD.*

CP COL 3.7(16) ***3.7(16)*** *Free-field seismic instrumentation*

The COL item is addressed in Subsections 3.7.4.1, 3.7.4.2 and 3.7.4.4.

3.7(17) *Deleted from the DCD.*

3.7(18) *Deleted from the DCD.*

CP COL 3.7(19) ***3.7(19)*** *Site-specific details of seismic instrumentation program*

This COL item is addressed in Subsection 3.7.4.6.

CP COL 3.7(20) ***3.7(20)*** *Standard plant for site-specific conditions*

This COL item is addressed in Subsection 3.7, 3.7.1.1, 3.7.2.4.5 and Appendix 3NN.

CP COL 3.7(21) ***3.7(21)*** *Seismic design of non-standard plant SSCs*

This COL item is addressed in Subsection 3.7 and Appendices 3KK, 3LL, and 3MM.

CP COL 3.7(22) ***3.7(22)*** *Consideration of seismic wave transmission incoherence where high-frequency exceedances of the CSDRS occur*

This COL item is addressed in Subsection 3.7.1.1

CP COL 3.7(23) ***3.7(23)*** *Broadened ISRS*

This COL item is addressed in Subsection 3.7.2.4.5 and Appendix 3NN

CP COL 3.7(24) ***3.7(24)*** *Site-specific uniform hazard response spectra*

This COL item is addressed in Subsection 3.7.1.1.

CP COL 3.7(25) ***3.7(25)*** *SSI analysis of R/B complex to confirm that site-specific effects are enveloped by the standard design*

This COL item is addressed in Subsection 3.7.2.4.5, Table 3.7.2-1R, and Appendix 3NN.

CP COL 3.7(26) ***3.7(26)*** *SSI effects for non-standard plant structures*

This COL item is addressed in Subsection 3.7.2.4.5, and Appendices 3KK, 3LL, and 3MM.

CP COL 3.7(27) ***3.7(27)*** *Seismic analysis of dams*

This COL item is addressed in Subsections 3.7.2.13 and 3.7.3.8.

3.7(28) *Deleted from the DCD.*

CP COL 3.7(29) ***3.7(29)*** *Summary of dynamic analysis and combination techniques*

This COL item is addressed in Subsections 3.7.2.1, and Table 3.7.2-1R.

CP COL 3.7(30) ***3.7(30)*** *Site-specific design ground motion time histories*

This COL item is addressed in Subsections 3.7.1.1, Table 3.7-203, and Figures 3.7-204 through 3.7-218.

3.7.6 References

CP COL 3.7(26) Add the following reference to DCD Subsection 3.7.6.

3.7-63 *A System for Analysis of Soil-Structure Interaction,* SASSI2000 Version 3 Including User's Manual Version 3, Ostadan, F., University of California, Berkeley, April 2007.

3.7-64 Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation, Nuclear Energy Institute (NEI), June 12, 2009.

3.7-65 Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses, USNRC Interim Staff Guidance DC/COL-ISG-017, June 2009.

Table 3.7.2-1R

Summary of Dynamic Analyses and Combination Techniques (Sheet 1 of 2)

	Model	Analysis Method	Program	Three Components Combination (for Purposes of Dynamic Analysis)	Modal Combination
	Standard plant three-dimensional R/B complex SSI Model (1)	Time History Analysis in Frequency Domain using sub-structuring technique	ACS SASSI	SRSS	N/A
CP COL 3.7(25)	Site-specific three-dimensional R/B complex SSI Model (1)	Time History Analysis in Frequency Domain using sub-structuring technique	ACS SASSI	SRSS	N/A
	Standard plant three-dimensional R/B complex FE Model (2)	1g Static Analysis & Time History Analysis in Time Domain	ANSYS	N/A(2)	N/A(2)
CP COL 3.7(25)	Site-specific three-dimensional R/B complex FE Model (2)	Modal Analysis	ANSYS	N/A(2)	N/A(2)
	Three-dimensional standard plant T/B SSI Model (3)	Time History Analysis in Frequency Domain using sub-structuring technique	ACS SASSI	SRSS	N/A
	Three-dimensional standard plant T/B FE Models (2)	1g Static Analysis & Time History Analysis in Time Domain	ANSYS	N/A(2)	N/A(2)
CP COL 3.7(29)	Three-dimensional UHSRS SSI & SSSI models(4)	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI 2000	SRSS	N/A
CP COL 3.7(29)	Three-dimensional UHSRS FE models	1g Static Analysis & Modal Analysis	ANSYS	N/A(4)	N/A(4)
CP COL 3.7(29)	Three-dimensional ESWPT SSI models(5)	Time History Analysis in Frequency Domain using sub-structuring technique	ACS SASSI	SRSS	N/A
CP COL 3.7(29)	Three-dimensional ESWPT FE models	Modal Analysis	ANSYS	NA(5)	NA(5)
CP COL 3.7(29)	Three-dimensional PSFSV FE SSI model(6)	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI 2000	SRSS	N/A
CP COL 3.7(29)	Three-dimensional R/B-T/B-West PSFSV and West PSFSV-T/B-East PSFSV SSSI models(6)	Time History Analysis in Frequency Domain using sub-structuring technique	ACS SASSI	SRSS	N/A
CP COL 3.7(29)	Three-dimensional PSFSV FE models	1g Static Analysis & Modal Analysis	ANSYS	N/A(6)	N/A(6)

Table 3.7.2-1R

Summary of Dynamic Analyses and Combination Techniques (Sheet 2 of 2)

Notes:

CP COL 3.7(25) 1) The three-dimensional R/B complex SSI model for the standard plant design is addressed in Technical Report MUAP-10006 (Reference 3.7-48). The three-dimensional R/B complex SSI model for the site-specific SSI analyses is addressed in Appendix 3NN.

CP COL 3.7(25) 2) The ANSYS FE models for the T/B and R/B complex are used only for validation of the dynamic models and for static analysis for design of structural members and components as addressed in Section 3.8.

3) The three-dimensional dynamic T/B model for the standard plant design is addressed in Technical Report MUAP-11002 (Reference 3.7-61).

CP COL 3.7(29) 4) See Appendix 3KK for additional dynamic modeling, verification, and analysis information for the UHSRS. Modal analysis of the ANSYS models is used for verification of the SSI model only.

CP COL 3.7(29) 5) See Appendix 3LL for additional dynamic modeling, verification, and analysis information for the ESWPT. Modal analysis of the ANSYS model is used for verification of the SSI model only.

CP COL 3.7(29) 6) See Appendix 3MM for additional dynamic modeling, verification, and analysis information for the PSFSV. Modal analysis of the ANSYS models is used for verification of the SSI and SSSI models only.

CP COL 3.7(5)
CP COL 3.7(6)

Table 3.7-201

Site-Specific Horizontal FIRS Acceleration Values and Control Points[(1), (2), (3)]

Control Point (Hz)		Acceleration (g)
2 percent Damping		
A	(50)	0.1
B	(12)	0.353
C	(2.5)	0.427
D	(0.25)	0.057
E	(0.1)	0.0093
3 percent Damping		
A	(50)	0.1
B	(12)	0.307
C	(2.5)	0.357
D	(0.25)	0.051
E	(0.1)	0.0084
5 percent Damping		
A	(50)	0.1
B	(12)	0.26
C	(2.5)	0.313
D	(0.25)	0.047
E	(0.1)	0.008
7 percent Damping		
A	(50)	0.1
B	(12)	0.23
C	(2.5)	0.273
D	(0.25)	0.043
E	(0.1)	0.007
10 percent Damping		
A	(50)	0.1
B	(12)	0.19
C	(2.5)	0.23
D	(0.25)	0.04
E	(0.1)	0.006

Notes:
1) 0.1 g PGA
2) Amplification factors are based on RG 1.60, Rev. 1 (Reference 3.7-6).
3) For Control Points D and E acceleration is computed as follows:

Acceleration= ($\varpi^2 D$ / 386.4 in/sec^2) x F_A x 0.1

$\varpi = 2\pi$ x frequency (rad/sec)

D = Displacement (in)

F_A = Amplification Factor from RG 1.60

CP COL 3.7(5)
CP COL 3.7(6)

Table 3.7-202

Site-Specific Vertical FIRS Acceleration Values and Control Points(1), (2), (3)

Control Point (Hz)		Acceleration (g)
2 percent Damping		
A	(50)	0.1
B	(12)	0.353
C	(3.5)	0.407
D	(0.25)	0.04
E	(0.1)	0.006
3 percent Damping		
A	(50)	0.1
B	(12)	0.307
C	(3.5)	0.35
D	(0.25)	0.0353
E	(0.1)	0.0055
5 percent Damping		
A	(50)	0.1
B	(12)	0.26
C	(3.5)	0.30
D	(0.25)	0.031
E	(0.1)	0.005
7 percent Damping		
A	(50)	0.1
B	(12)	0.23
C	(3.5)	0.26
D	(0.25)	0.029
E	(0.1)	0.005
10 percent Damping		
A	(50)	0.1
B	(12)	0.19
C	(3.5)	0.217
D	(0.25)	0.027
E	(0.1)	0.004

Notes:
1) 0.1 g PGA
2) Amplification factors are based on RG 1.60, Rev. 1 (Reference 3.7-6).
3) For Control Points D and E, acceleration is computed as follows:

Acceleration= $(\varpi^2 D$ / 386.4 in/sec^2) x F_A x 0.1

$\varpi = 2\pi$ x frequency (rad/sec)

D = Displacement (in)

F_A = Amplification Factor from RG 1.60

Table 3.7-203

Summary of Input Motion Time Histories used for Site-Specific Seismic Response Analyses

SASSI Analysis			Input Control Motion			
Structures	**Appendix**	**Type**	**Control Point Elevation**	**Ground Water Level (GWL)**	**Response Spectra**	**PBSRS NEI Check**
R/B Complex	3NN	Surface	779.75 ft	N/A	Figures 3.7-205, -206, -207	N/A
		Embedded		High GWL	Figures 3.7-208, -209, -210	Figures 2.5.2-266 through 2.5.2-273
UHSRS	3KK	Surface	782 ft	N/A	Figures 3.7-205, -206, -207	N/A
		Embedded		Nominal GWL	Figures 3.7-211, -212, -213	Figures 2.5.2-266 through 2.5.2-273
ESWPT	3LL	Embedded	791.08 ft	High GWL Nominal GWL Unsaturated Backfill	Figures 3.7-214 through 3.7-218	Figures 2.5.2-274 through 2.5.2-277
PSFSV	3MM	Surface	782 ft	N/A	Figures 3.7-205, -206, -207	N/A
		Embedded		Nominal GWL	Figures 3.7-211, -212, -213	Figures 2.5.2-266 through 2.5.2-273
R/B-T/B-West PSFSV		Surface		N/A	Figures 3.7-205, -206, -207	N/A
West PSFSV-T/B-East PSFSV		Embedded		Nominal GWL	Figures 3.7-211, -212, -213	Figures 2.5.2-266 through 2.5.2-273

CP COL 3.7(8)

Table 3.7-204 (Sheet 1 of 4)
Rock Subgrade Strain-Compatible Dynamic Properties

Elev.	Thick.	w	Min. Pass. Freq.	LB			BE			UB		
				V_s	V_p	Damp.	V_s	V_p	Damp.	V_s	V_p	Damp.
ft	ft	kcf	Hz	fps	fps	%	fps	fps	%	fps	fps	%
782.0	2.24	155	410.7	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
779.8	8.97	155	102.7	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
770.8	11.21	155	82.1	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
759.6	8.97	155	102.7	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
750.6	11.21	155	82.1	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
739.4	8.97	155	102.7	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
730.5	6.72	155	136.9	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
723.7	6.72	155	136.9	4603	9138	2.76	5720	11356	1.88	7108	14112	1.29
717.0	3	135	157	2355	6341	5.49	3019	8129	3.65	3870	10421	2.42
714.0	12	155	69.5	4173	8922	2.5	5113	10932	1.71	6265	13395	1.17
702.0	12	155	69.5	4173	8922	2.5	5113	10932	1.71	6265	13395	1.17
690.0	17	155	62.1	5280	10063	2.5	6467	12324	1.71	7920	15094	1.17
673.0	17	155	62.1	5280	10063	2.5	6467	12324	1.71	7920	15094	1.17
656.0	8.5	150	75.8	3220	7319	2.59	4046	9197	1.78	5084	11556	1.22
647.5	8.5	150	75.8	3220	7319	2.59	4046	9197	1.78	5084	11556	1.22
639.0	8.5	150	75.7	3219	7316	2.6	4045	9194	1.79	5083	11555	1.23
630.5	8.5	150	75.7	3219	7316	2.6	4045	9194	1.79	5083	11555	1.23
622.0	7.25	130	65	2357	6034	2.54	2950	7553	1.74	3693	9454	1.19
614.8	7.25	130	65	2357	6034	2.54	2950	7553	1.74	3693	9454	1.19
607.5	7.25	130	65	2357	6034	2.55	2950	7553	1.75	3693	9454	1.2
600.3	7.25	130	65	2357	6034	2.55	2950	7553	1.75	3693	9454	1.2
593.0	8	135	59.1	2362	5370	4.62	3153	7167	3.13	4208	9566	2.12
585.0	8	135	59.1	2362	5370	4.62	3153	7167	3.13	4208	9566	2.12
577.0	8	135	59	2359	5362	4.64	3150	7160	3.15	4206	9560	2.13
569.0	8	135	59	2359	5362	4.64	3150	7160	3.15	4206	9560	2.13
561.0	8	135	58.9	2356	5356	4.66	3147	7153	3.16	4203	9553	2.14
553.0	8	135	58.9	2356	5356	4.66	3147	7153	3.16	4203	9553	2.14

CP COL 3.7(8)

Table 3.7-204 (Sheet 2 of 4)

Rock Subgrade Strain-Compatible Dynamic Properties

Elev.	Thick.	w	Min. Pass. Freq.	LB			BE			UB		
				V_s	V_p	Damp.	V_s	V_p	Damp.	V_s	V_p	Damp.
ft	ft	kcf	Hz	fps	fps	%	fps	fps	%	fps	fps	%
553.0	8	135	58.9	2356	5356	4.66	3147	7153	3.16	4203	9553	2.14
545.0	8	135	58.8	2354	5350	4.68	3144	7146	3.17	4200	9547	2.15
537.0	8	135	58.8	2354	5350	4.68	3144	7146	3.17	4200	9547	2.15
529.0	8	135	58.8	2351	5344	4.69	3141	7140	3.19	4197	9539	2.16
521.0	8	135	58.8	2351	5344	4.69	3141	7140	3.19	4197	9539	2.16
513.0	7.75	140	65.8	2549	6002	6.67	3305	7783	4.54	4286	10092	3.09
505.3	7.75	140	65.8	2549	6002	6.67	3305	7783	4.54	4286	10092	3.09
497.5	7.75	140	65.7	2544	5991	6.7	3300	7771	4.57	4280	10080	3.11
489.8	7.75	140	65.7	2544	5991	6.7	3300	7771	4.57	4280	10080	3.11
482.0	7.75	140	65.6	2540	5982	6.74	3296	7762	4.59	4276	10070	3.13
474.3	7.75	140	65.6	2540	5982	6.74	3296	7762	4.59	4276	10070	3.13
466.5	7.75	140	65.5	2537	5974	6.77	3292	7752	4.61	4272	10060	3.14
458.8	7.75	140	65.5	2537	5974	6.77	3292	7752	4.61	4272	10060	3.14
451.0	7.88	145	62	2440	5977	2.85	3079	7542	1.97	3885	9516	1.36
443.1	7.88	145	62	2440	5977	2.85	3079	7542	1.97	3885	9516	1.36
435.3	7.88	145	62	2440	5977	2.85	3079	7542	1.97	3885	9516	1.36
427.4	7.88	145	62	2440	5977	2.85	3079	7542	1.97	3885	9516	1.36
419.5	7.88	145	61.9	2439	5975	2.86	3078	7540	1.98	3884	9514	1.36
411.6	7.88	145	61.9	2439	5975	2.86	3078	7540	1.98	3884	9514	1.36
403.8	7.88	145	61.9	2439	5975	2.87	3078	7540	1.98	3884	9514	1.37
395.9	7.88	145	61.9	2439	5975	2.87	3078	7540	1.98	3884	9514	1.37
388.0	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
372.3	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
356.5	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
340.8	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
325.1	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
309.4	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55

CP COL 3.7(8)

Table 3.7-204 (Sheet 3 of 4)
Rock Subgrade Strain-Compatible Dynamic Properties

Elev.	Thick.	w	Min. Pass. Freq.	LB			BE			UB		
				V_s	V_p	Damp.	V_s	V_p	Damp.	V_s	V_p	Damp.
ft	ft	kcf	Hz	fps	fps	%	fps	fps	%	fps	fps	%
293.6	15.73	150	54.9	4320	8396	2.83	5344	10387	2.1	6611	12850	1.55
277.9	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
262.2	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
246.4	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
230.7	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
215.0	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
199.3	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
183.5	15.73	150	54.9	4317	8391	2.86	5341	10381	2.12	6608	12843	1.57
167.8	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
152.1	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
136.3	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
120.6	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
104.9	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
89.2	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
73.4	15.73	150	54.9	4315	8387	2.88	5338	10375	2.13	6603	12834	1.58
57.7	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
42.0	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
26.2	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
10.5	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
-5.2	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
-21.0	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
-36.7	15.73	150	54.8	4313	8383	2.89	5335	10369	2.15	6599	12826	1.59
-52.4	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-68.1	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-83.9	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-99.6	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-115.3	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6

CP COL 3.7(8)

Table 3.7-204 (Sheet 4 of 4)

Rock Subgrade Strain-Compatible Dynamic Properties

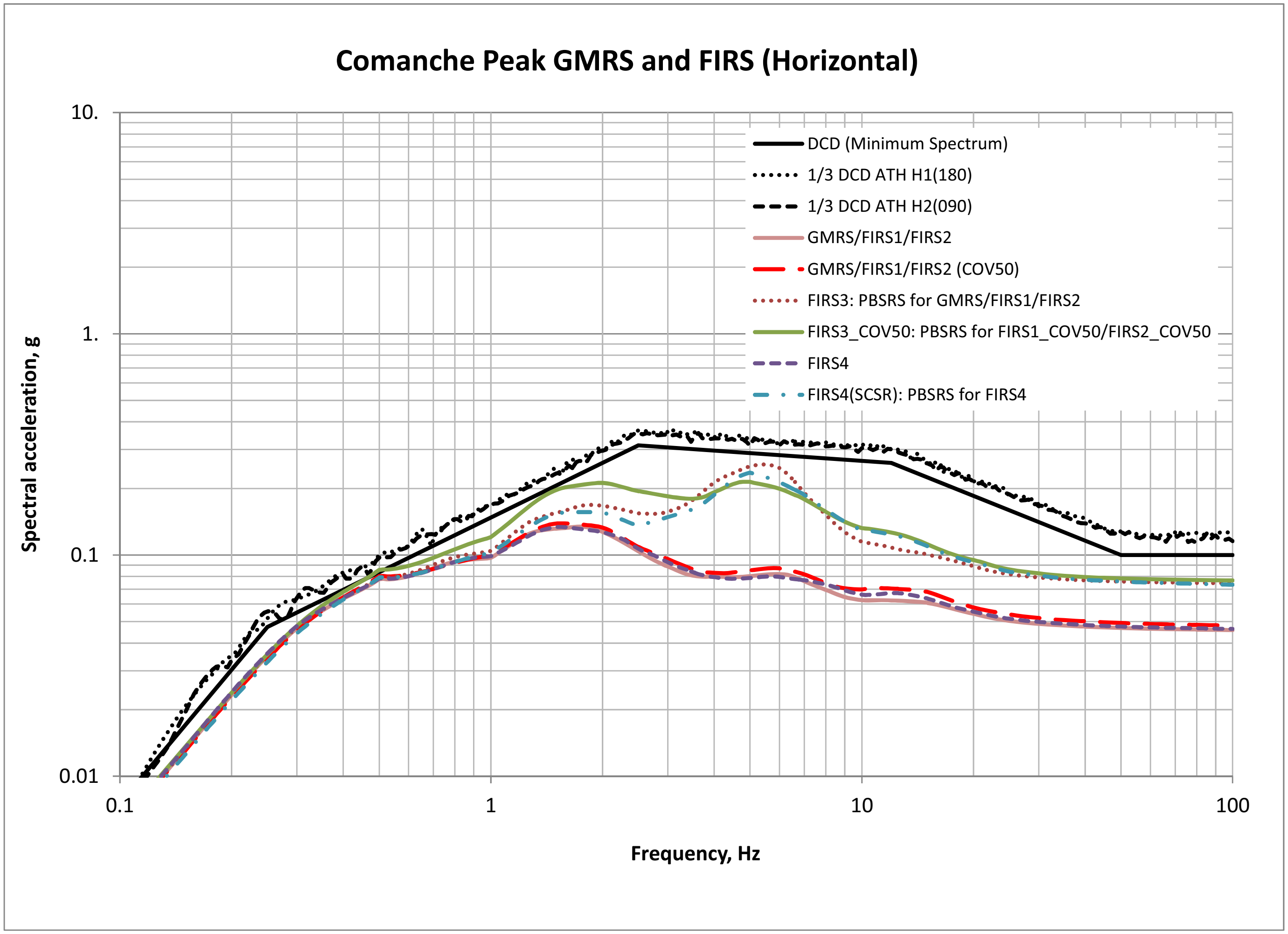
Elev.	Thick.	w	Min. Pass. Freq.	LB			BE			UB		
				V_s	V_p	Damp.	V_s	V_p	Damp.	V_s	V_p	Damp.
ft	ft	kcf	Hz	fps	fps	%	fps	fps	%	fps	fps	%
-131.1	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-146.8	15.73	150	54.8	4312	8381	2.91	5333	10366	2.16	6596	12820	1.6
-162.5	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-178.2	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-194.0	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-209.7	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-225.4	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-241.2	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61
-256.9	15.73	150	54.8	4311	8380	2.93	5331	10362	2.17	6592	12812	1.61

CP COL 3.7(8)

Table 3.7-205

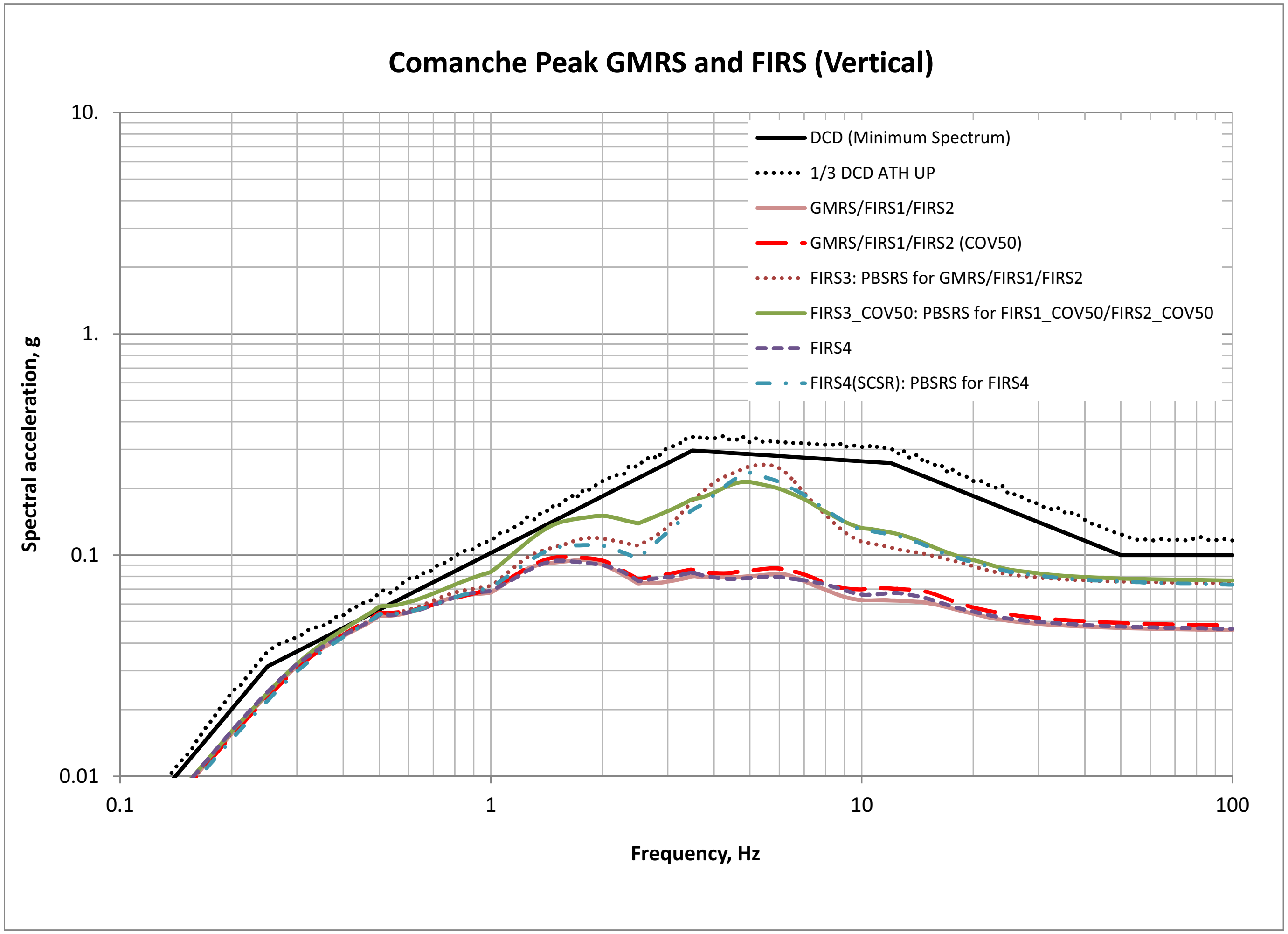
Dynamic Properties of Engineered Backfill

Elev. (ft)	Thick. (ft)	Unit Weight (lb/ft3)	V_s (ft/sec)				Damping				Poisson Ratio		
			ELB	EBE	EUB	EHB	ELB	EBE	EUB	EHB	Nominal GWL	High GWL	Unsaturated
822.0	1.5	0.125	503	653	846	1098	2.82%	1.68%	1.00%	0.59%	0.35	0.35	0.35
820.5	1.5	0.125	503	653	846	1098	2.82%	1.68%	1.00%	0.59%	0.35	0.35	0.35
819.0	2.13	0.125	571	763	1020	1363	3.48%	2.07%	1.23%	0.73%	0.35	0.35	0.35
816.9	2.13	0.125	571	763	1020	1363	3.48%	2.07%	1.23%	0.73%	0.35	0.35	0.35
814.8	2.13	0.125	551	747	1012	1372	4.36%	2.56%	1.50%	0.88%	0.35	0.35	0.35
812.6	2.13	0.125	551	747	1012	1372	4.36%	2.56%	1.50%	0.88%	0.35	0.35	0.35
810.5	1.42	0.125	533	732	1004	1379	5.14%	2.98%	1.72%	1.00%	0.35	0.35	0.35
809.1	1.42	0.125	533	732	1004	1379	5.14%	2.98%	1.72%	1.00%	0.35	0.35	0.35
807.7	1.42	0.125	533	732	1004	1379	5.14%	2.98%	1.72%	1.00%	0.35	0.35	0.35
806.2	1.23	0.125	518	719	997	1382	5.78%	3.33%	1.91%	1.10%	0.35	0.35	0.35
805.0	1.23	0.125	518	719	997	1382	5.78%	3.33%	1.91%	1.10%	0.35	0.35	0.35
803.8	1.8	0.125	518	719	997	1382	5.78%	3.33%	1.91%	1.10%	0.35	0.48	0.35
802.0	2.5	0.125	684	932	1269	1727	3.99%	2.30%	1.33%	0.77%	0.35	0.48	0.35
799.5	2.5	0.125	684	932	1269	1727	3.99%	2.30%	1.33%	0.77%	0.35	0.48	0.35
797.0	2	0.125	676	924	1264	1728	4.29%	2.47%	1.42%	0.82%	0.35	0.48	0.35
795.0	3	0.125	676	924	1264	1728	4.29%	2.47%	1.42%	0.82%	0.48	0.48	0.35
792.0	2.5	0.125	669	918	1260	1729	4.57%	2.62%	1.50%	0.86%	0.48	0.48	0.35
789.5	2.5	0.125	669	918	1260	1729	4.57%	2.62%	1.50%	0.86%	0.48	0.48	0.35
787.0	2.5	0.125	663	912	1256	1729	4.80%	2.74%	1.57%	0.89%	0.48	0.48	0.35
784.5	2.5	0.125	663	912	1256	1729	4.80%	2.74%	1.57%	0.89%	0.48	0.48	0.35



CP COL 3.7(5)
CP COL 3.7(6)

Figure 3.7-201 Nominal Horizontal GMRS and FIRS[(1),(2)] (Sheet 1 of 3)



CP COL 3.7(5)
CP COL 3.7(6)

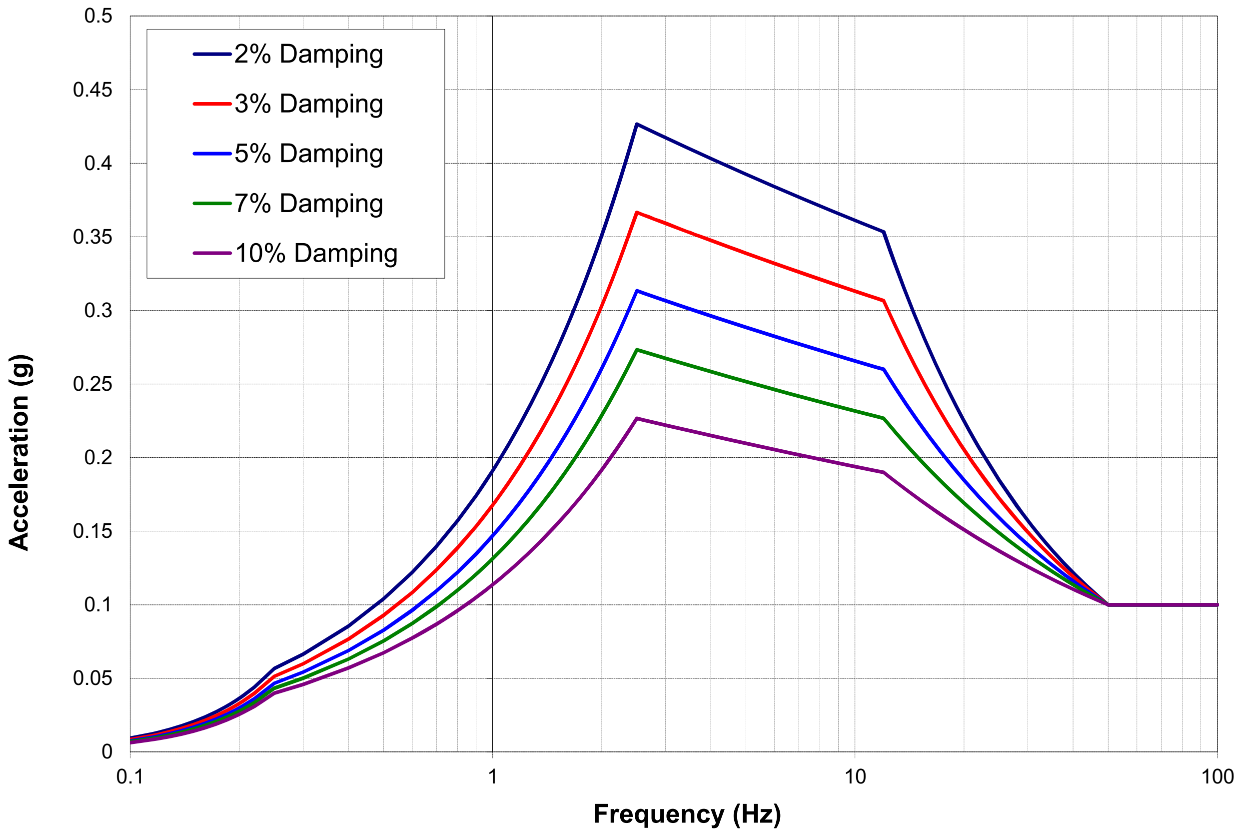
Figure 3.7-201 Nominal Vertical GMRS and FIRS[(1),(2)] (Sheet 2 of 3)

Notes:

1) Since the nominal GMRS and FIRS shown above are enveloped by the minimum design earthquake response spectra, the ground motion used for site-specific analysis and design is represented by the standard plant CSDRS anchored at 0.1 g (plotted above as a solid black line), as discussed in Subsection 3.7.1.1.
2) To account for potential variation in subgrade properties, the GMRS/FIRS1/FIRS2 and FIRS3 shown above are computed with both a 30% coefficient of variation and a 50% coefficient of variation as discussed in Subsection 2.5.2. The plots which utilize a 50% coefficient of variation are labeled as “COV50” in the figure keys.

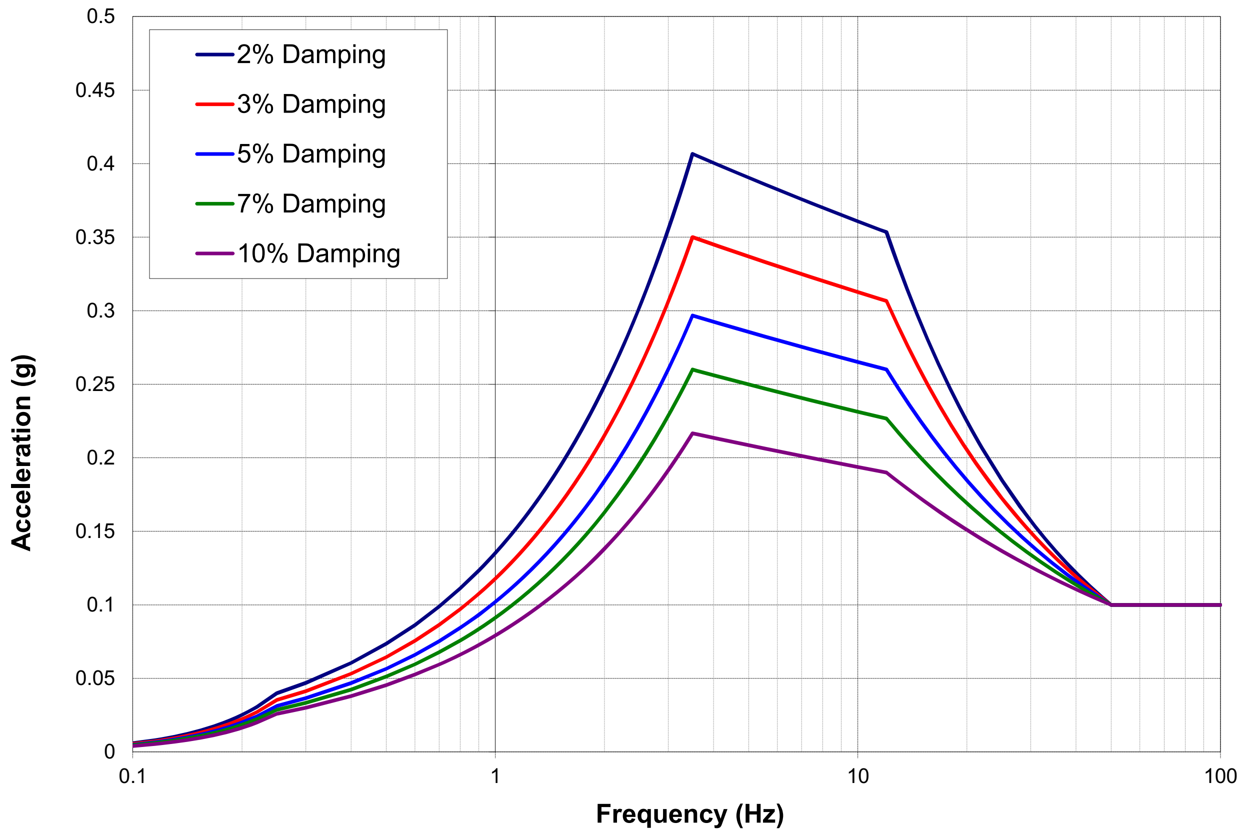
CP COL 3.7(5)
CP COL 3.7(6)

Figure 3.7-201 Nominal GMRS and FIRS (Notes) (Sheet 3 of 3)



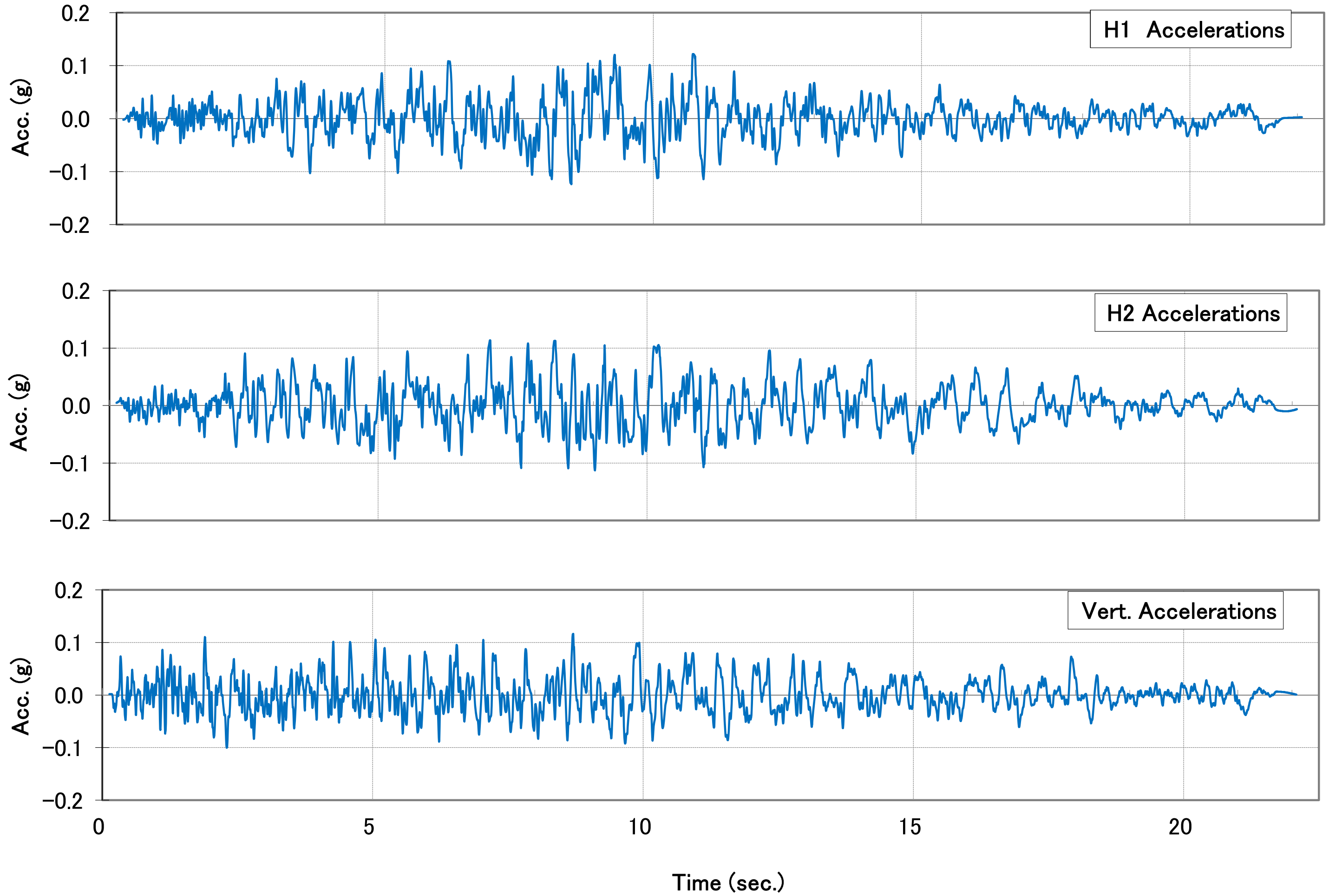
CP COL 3.7(5)
CP COL 3.7(6)

Figure 3.7-202 Comanche Peak Site-Specific Horizontal FIRS



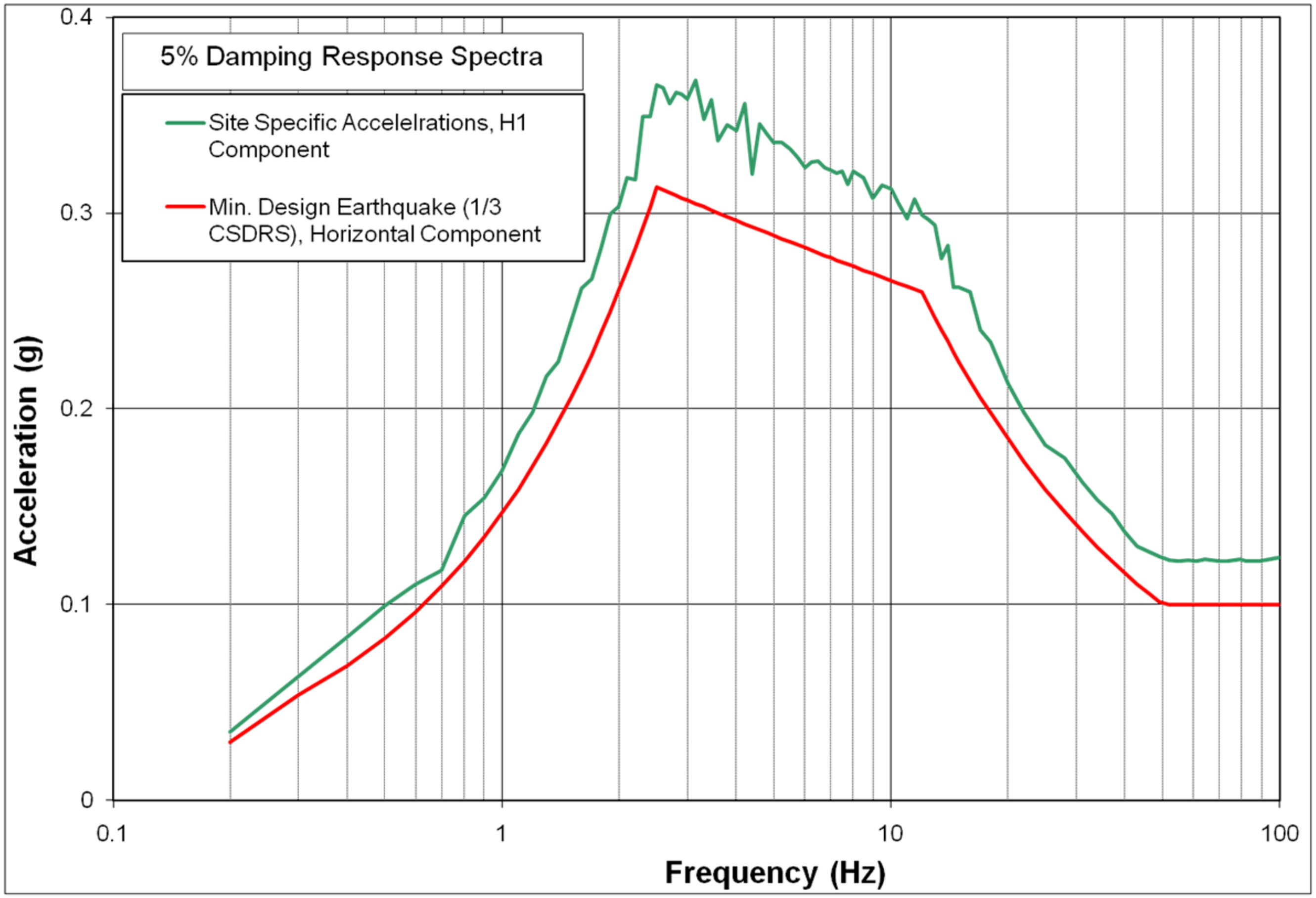
CP COL 3.7(5)
CP COL 3.7(6)

Figure 3.7-203 Comanche Peak Site-Specific Vertical FIRS



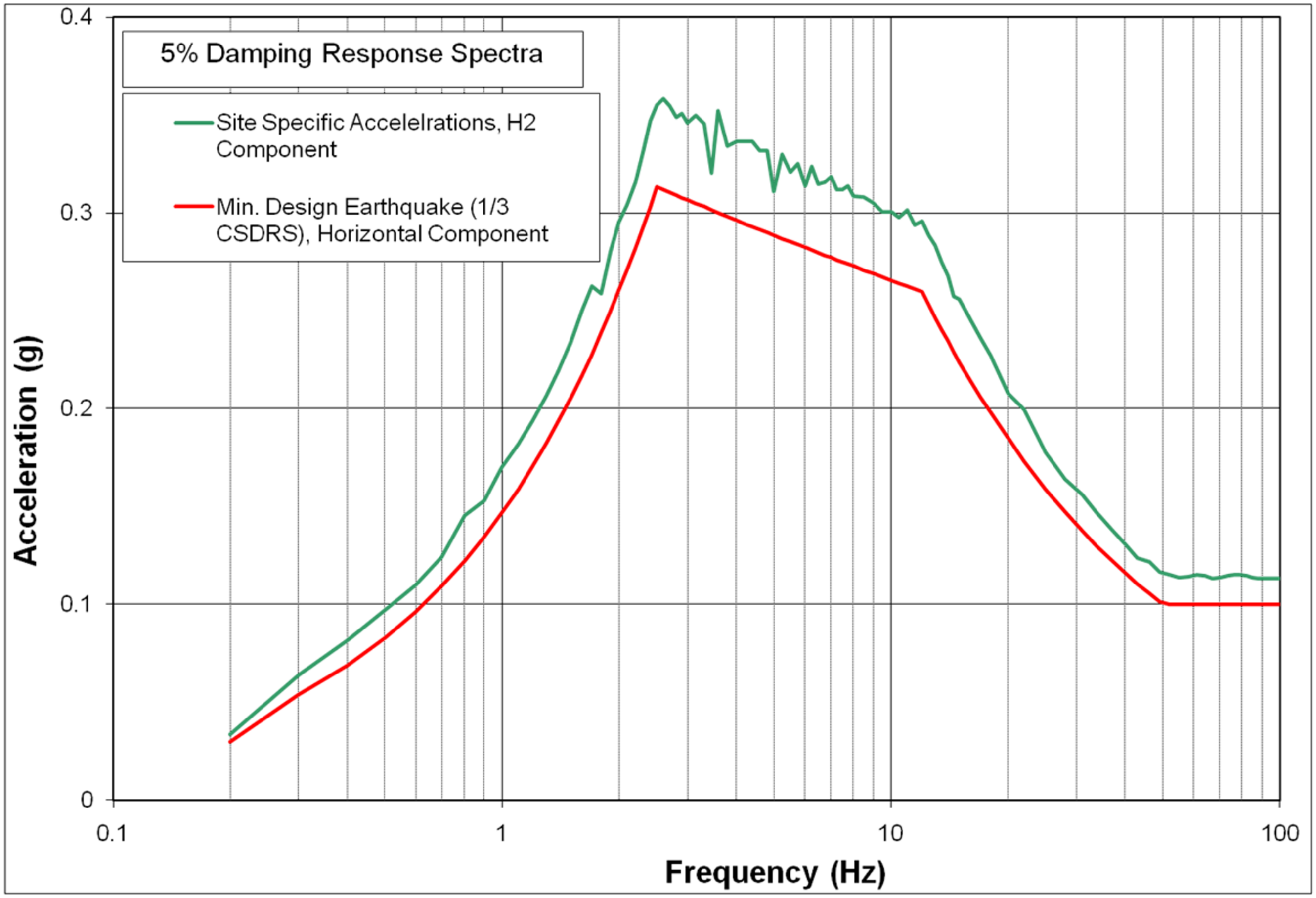
CP COL 3.7(30)

Figure 3.7-204 Acceleration Time Histories of Site-Specific Outcrop Design Ground Motion



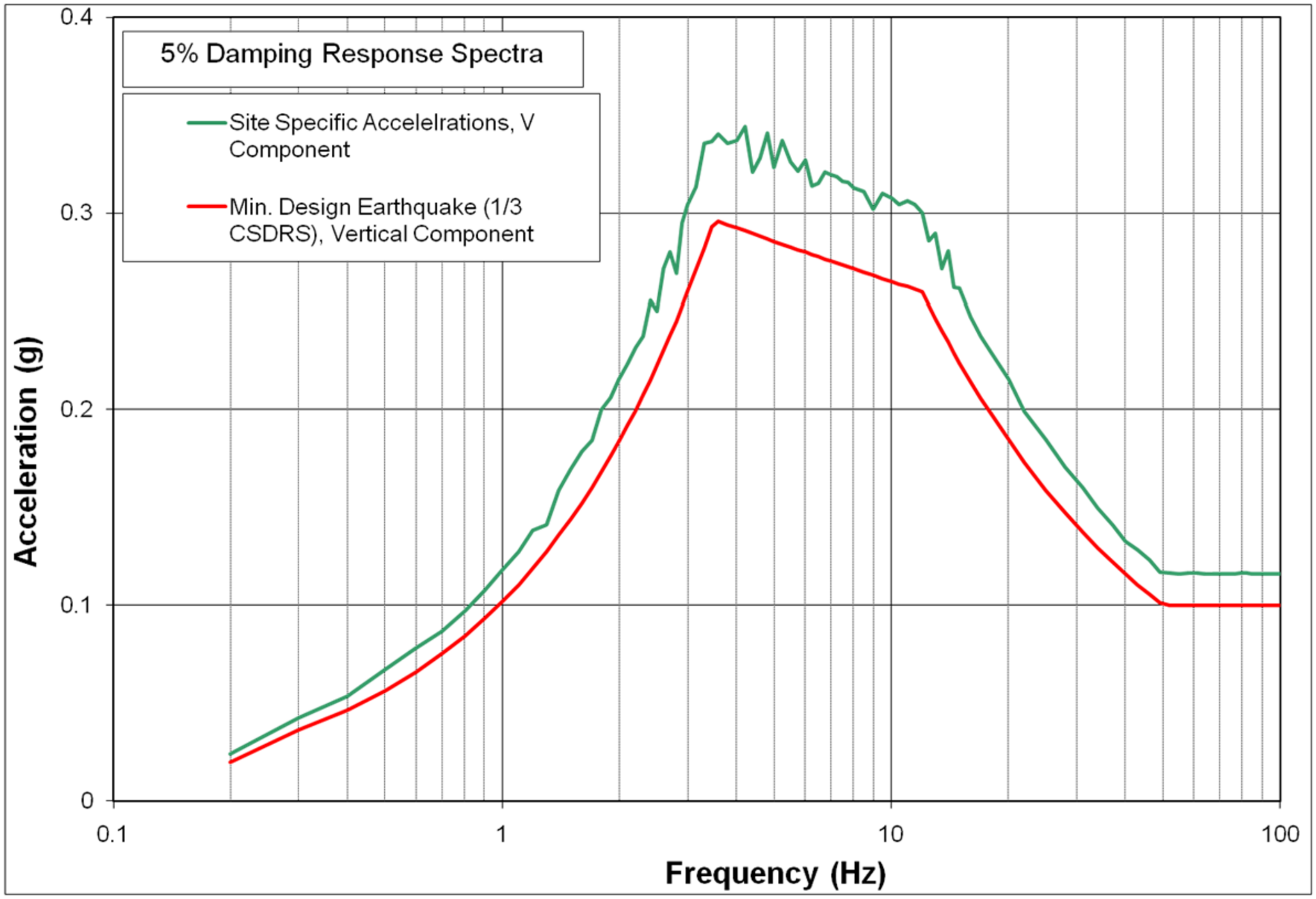
CP COL 3.7(30)

Figure 3.7-205 5% Damping Response Spectra of Site-Specific Outcrop Motion Time History, Horizontal H1 Component



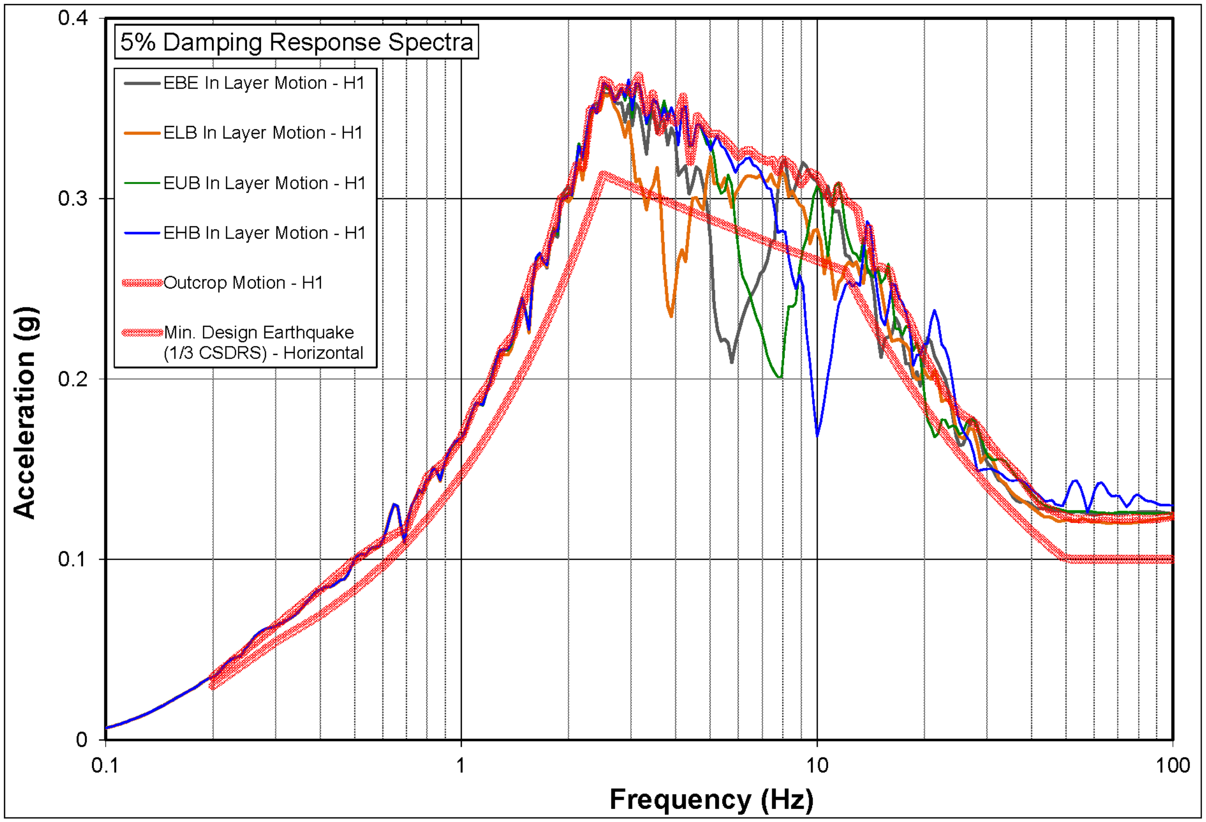
CP COL 3.7(30)

Figure 3.7-206 5% Damping Response Spectra of Site-Specific Outcrop Motion Time History, Horizontal H2 Component

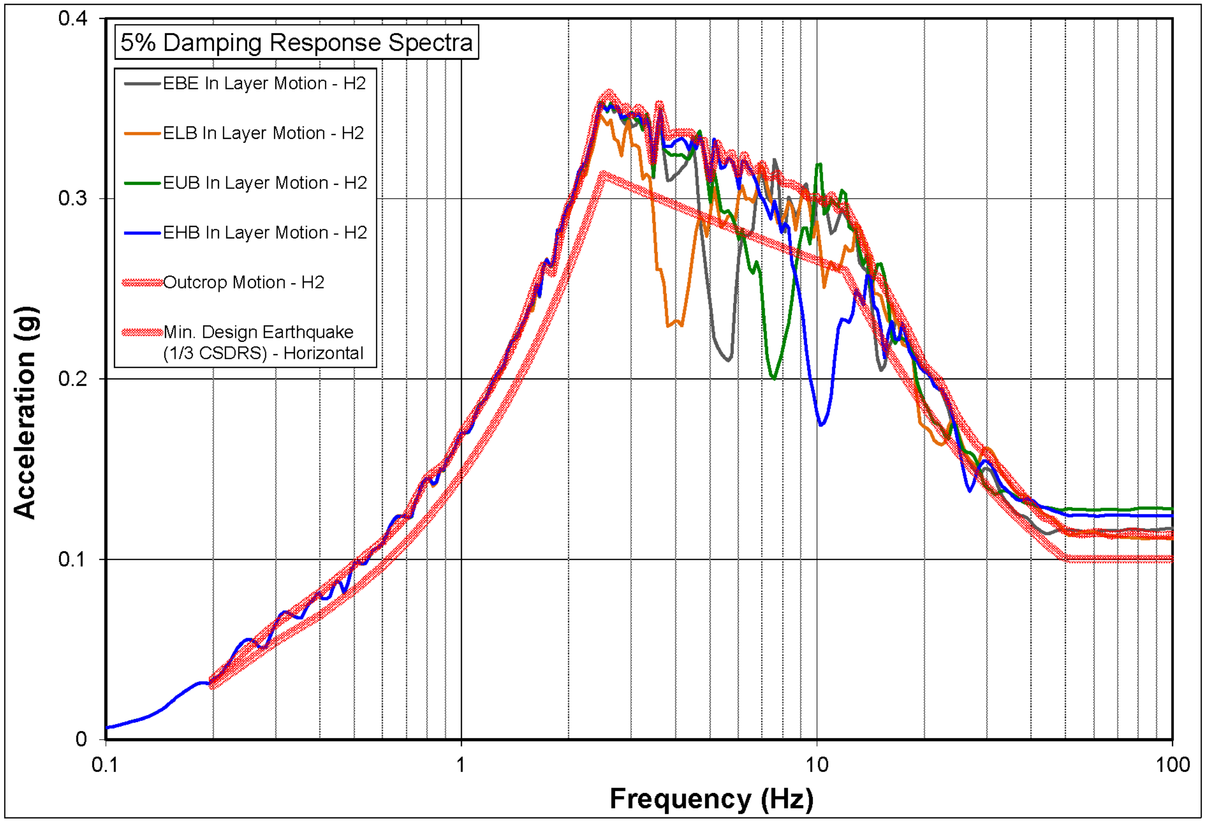


CP COL 3.7(30)

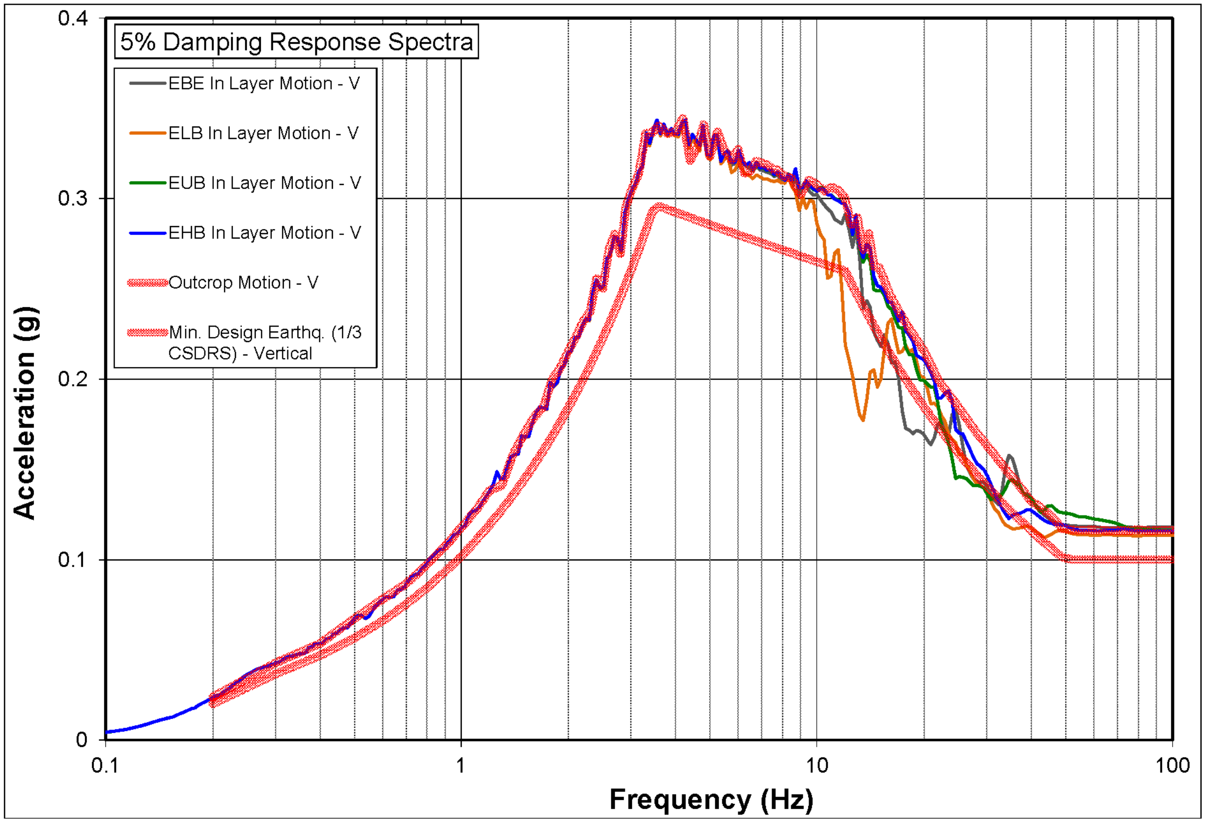
Figure 3.7-207 5% Damping Response Spectra of Site-Specific Outcrop Motion Time History, Vertical V Component



CP COL 3.7(30) **Figure 3.7-208 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H1 Component at Control Elevation 779.75 ft**

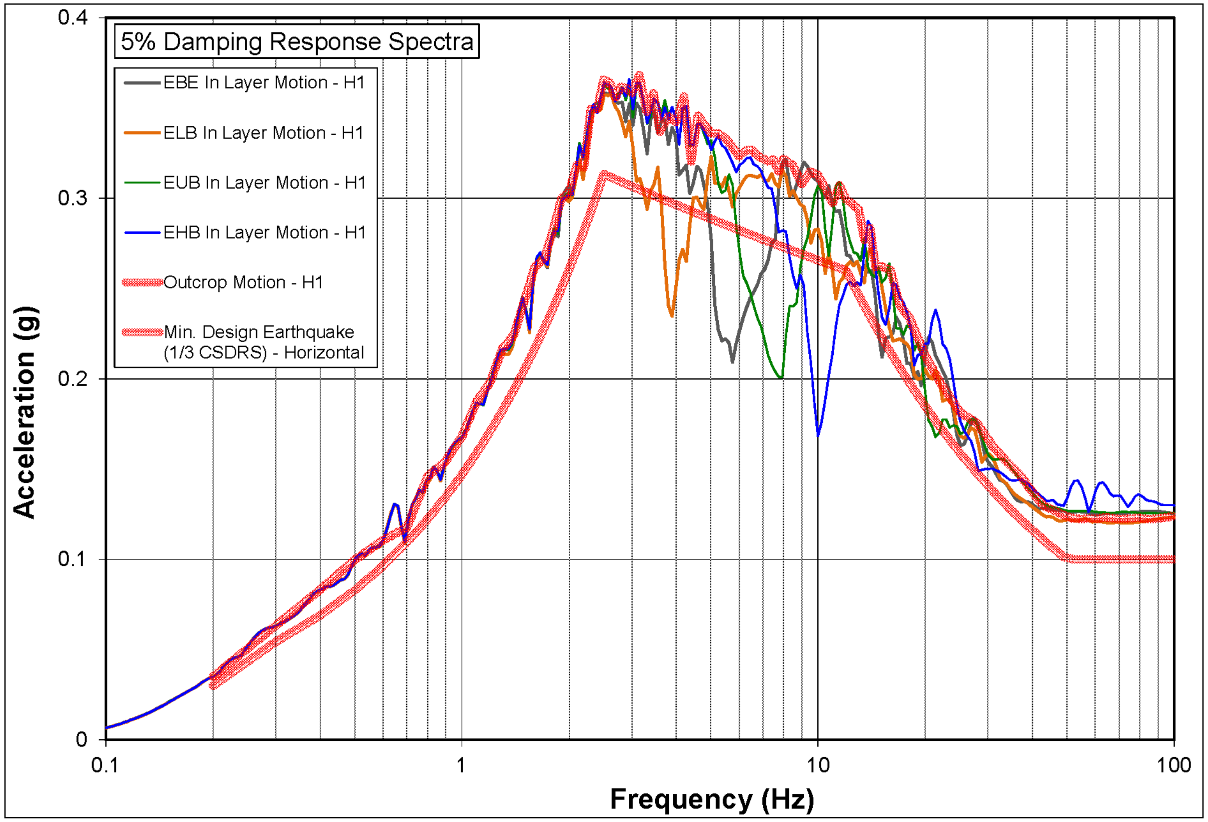


CP COL 3.7(30) **Figure 3.7-209 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H2 Component at Control Elevation 779.75 ft**



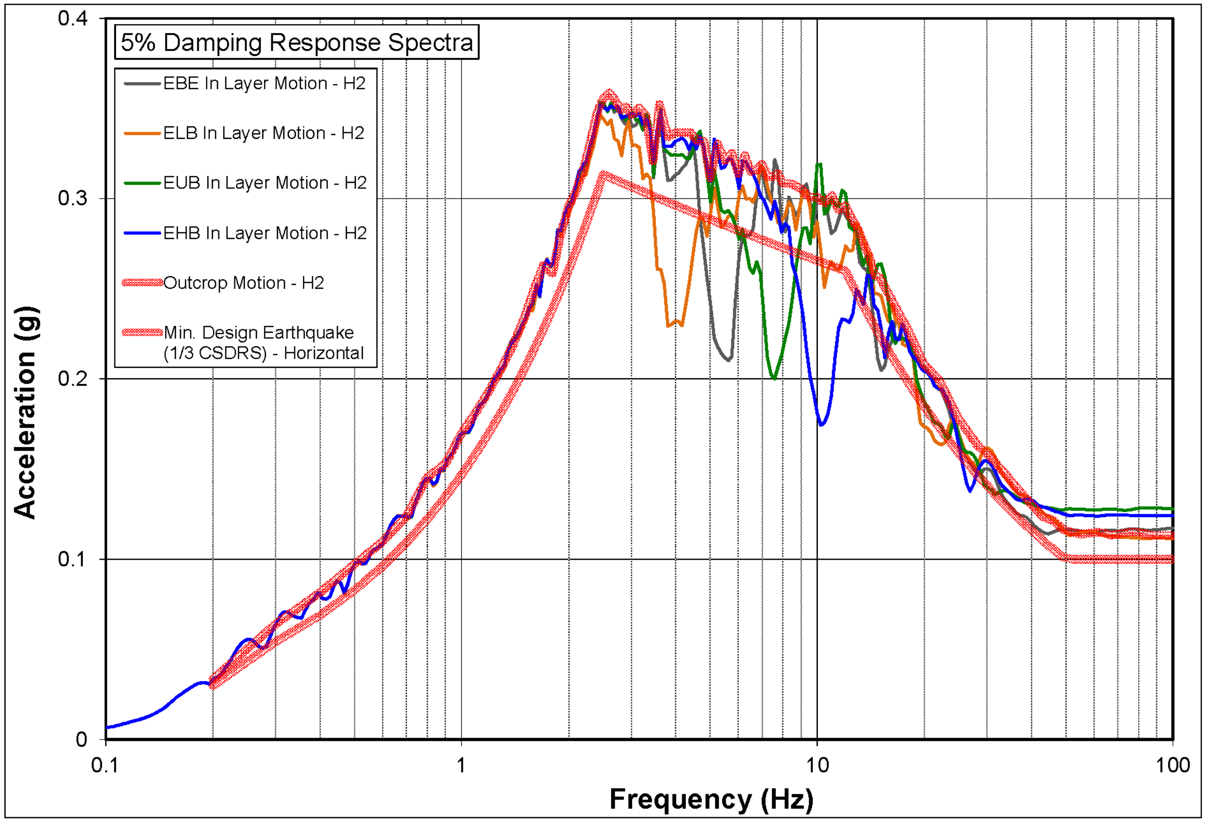
CP COL 3.7(30)

Figure 3.7-210 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Vertical V Component at Control Elevation 779.75 ft for High GWL

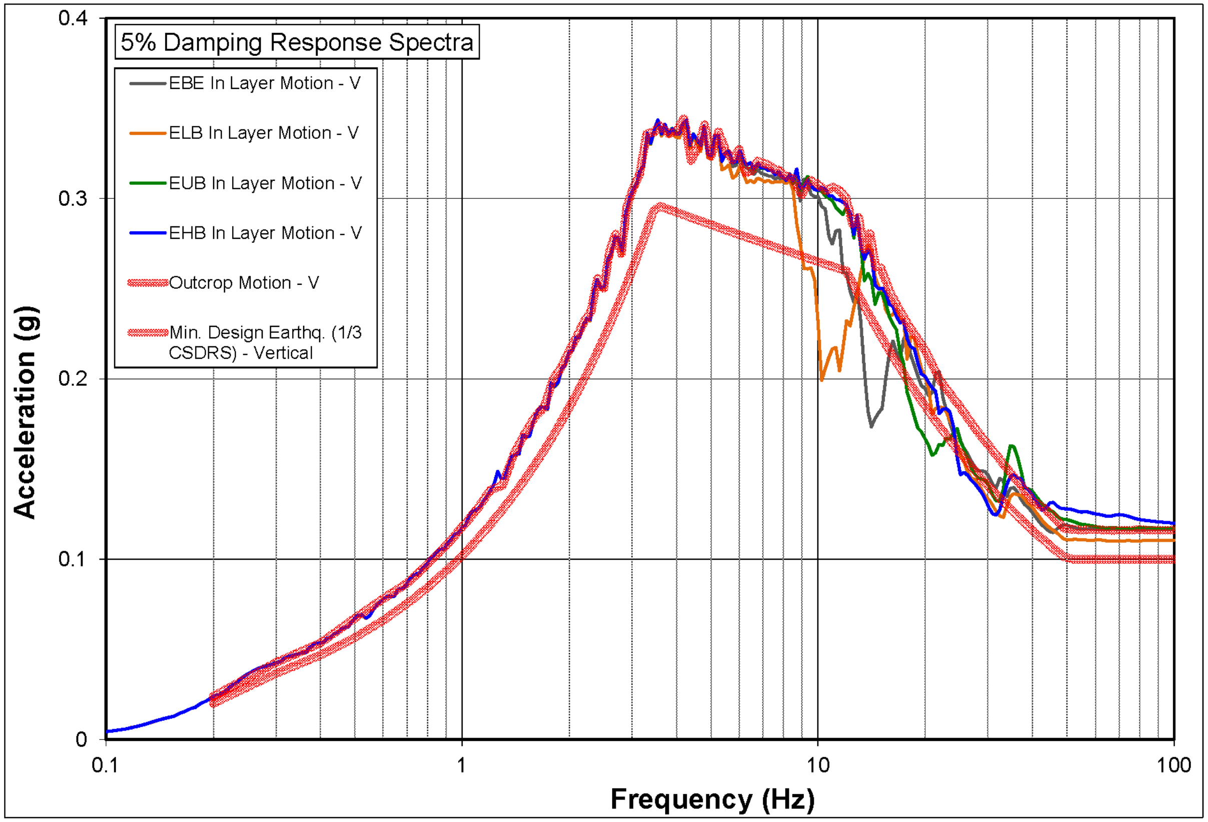


CP COL 3.7(30)

Figure 3.7-211 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H1 Component at Control Elevation 782 ft

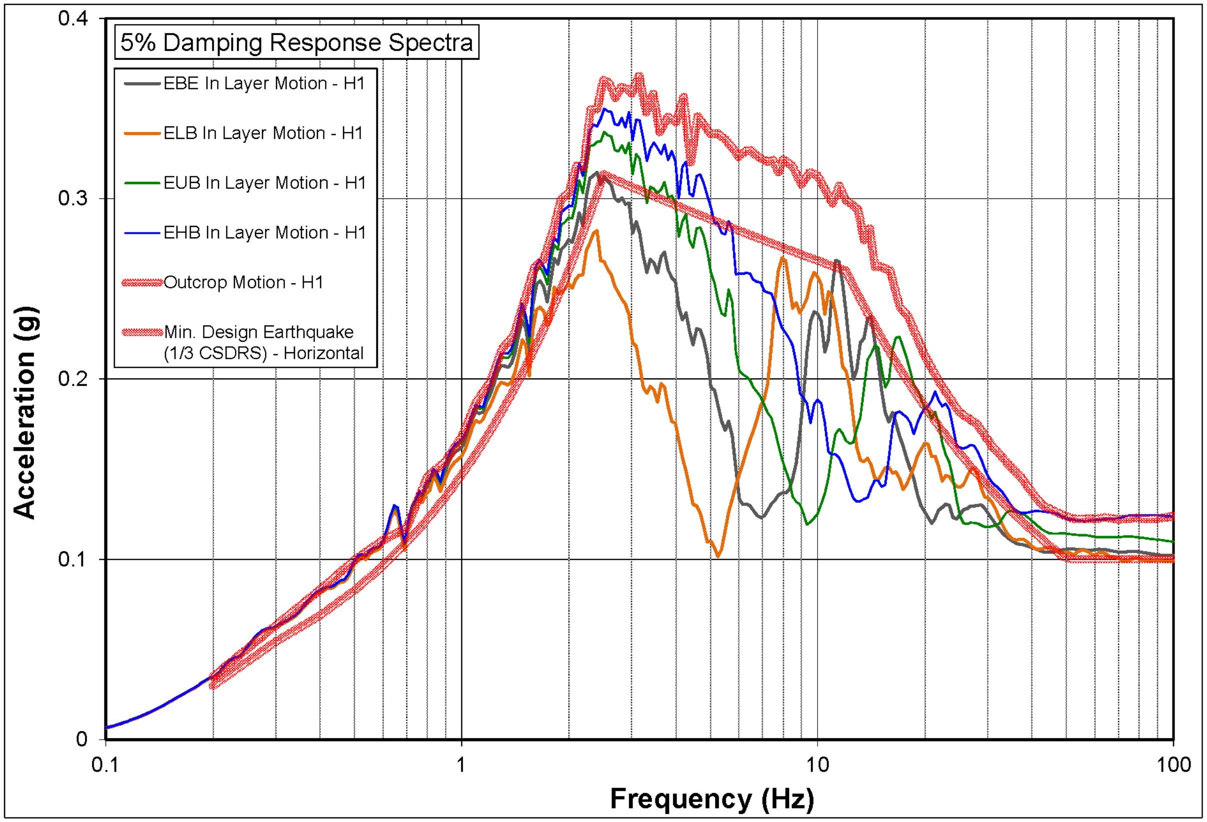


CP COL 3.7(30) **Figure 3.7-212 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H2 Component at Control Elevation 782 ft**

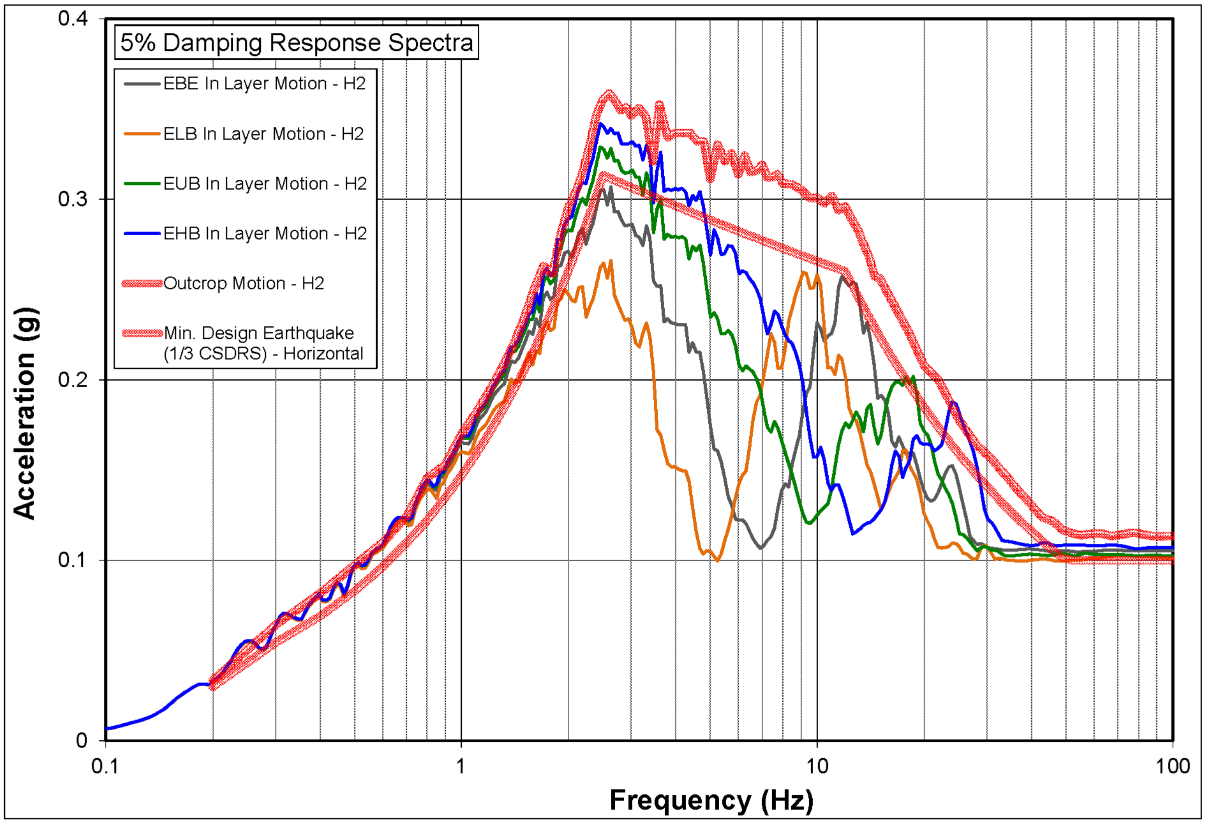


CP COL 3.7(30)

Figure 3.7-213 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Vertical V Component at Control Elevation 782 ft for Nominal GWL

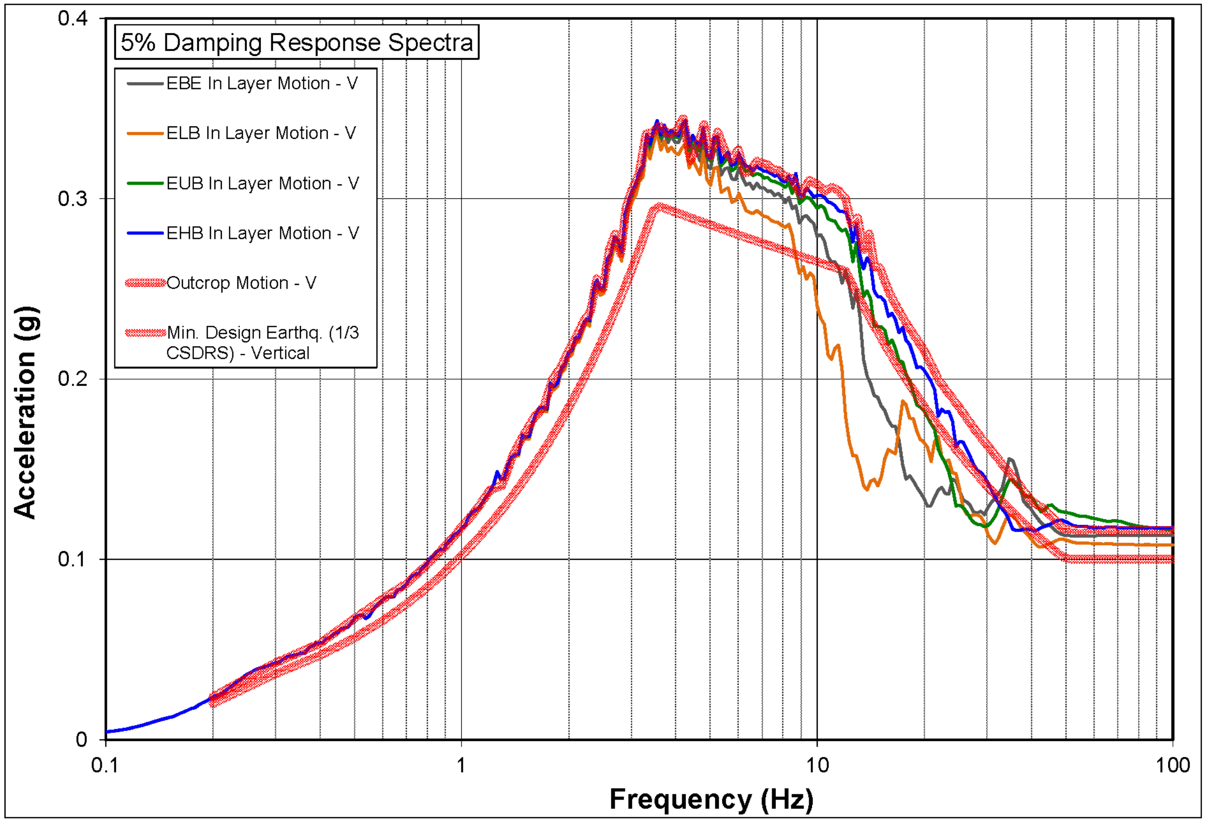


CP COL 3.7(30) **Figure 3.7-214 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H1 Component at Control Elevation 791.08 ft**



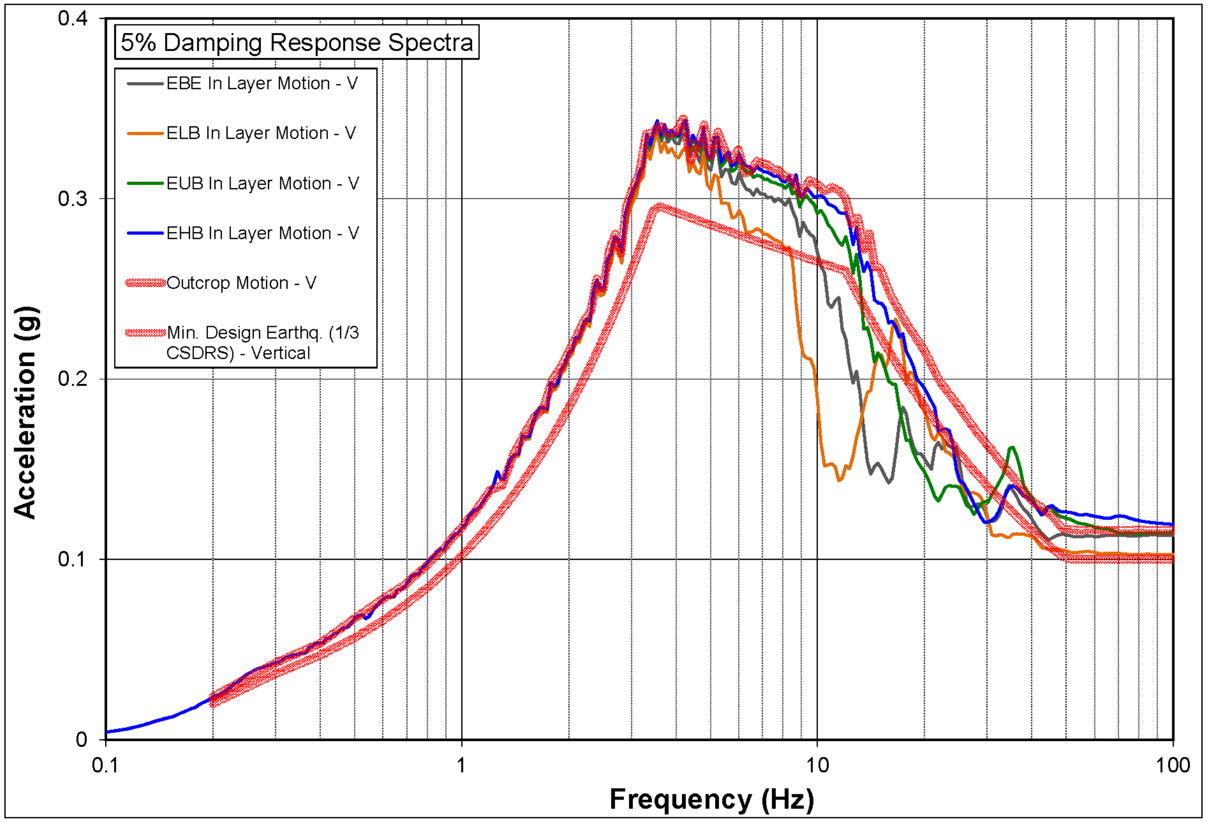
CP COL 3.7(30)

Figure 3.7-215 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Horizontal H2 Component at Control Elevation 791.08 ft



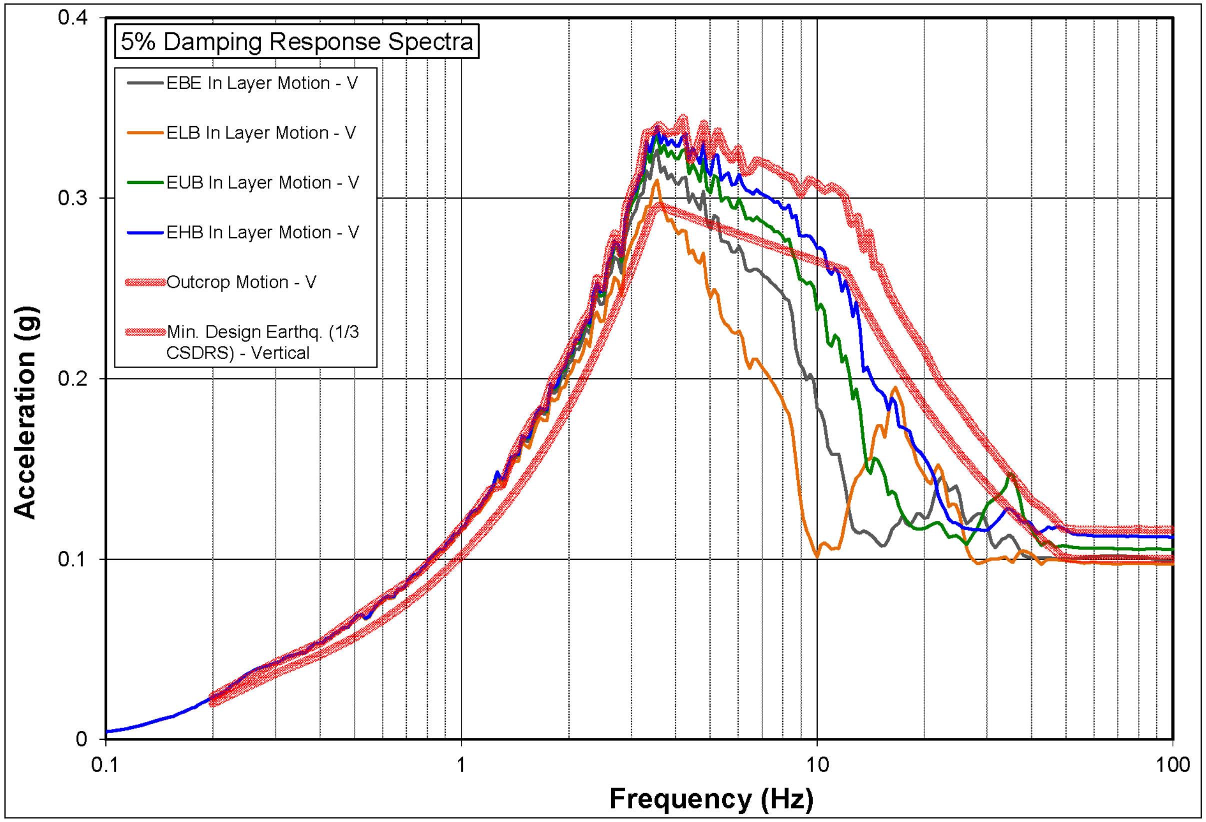
CP COL 3.7(30)

Figure 3.7-216 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Vertical V Component at Control Elevation 791.08 ft for High GWL



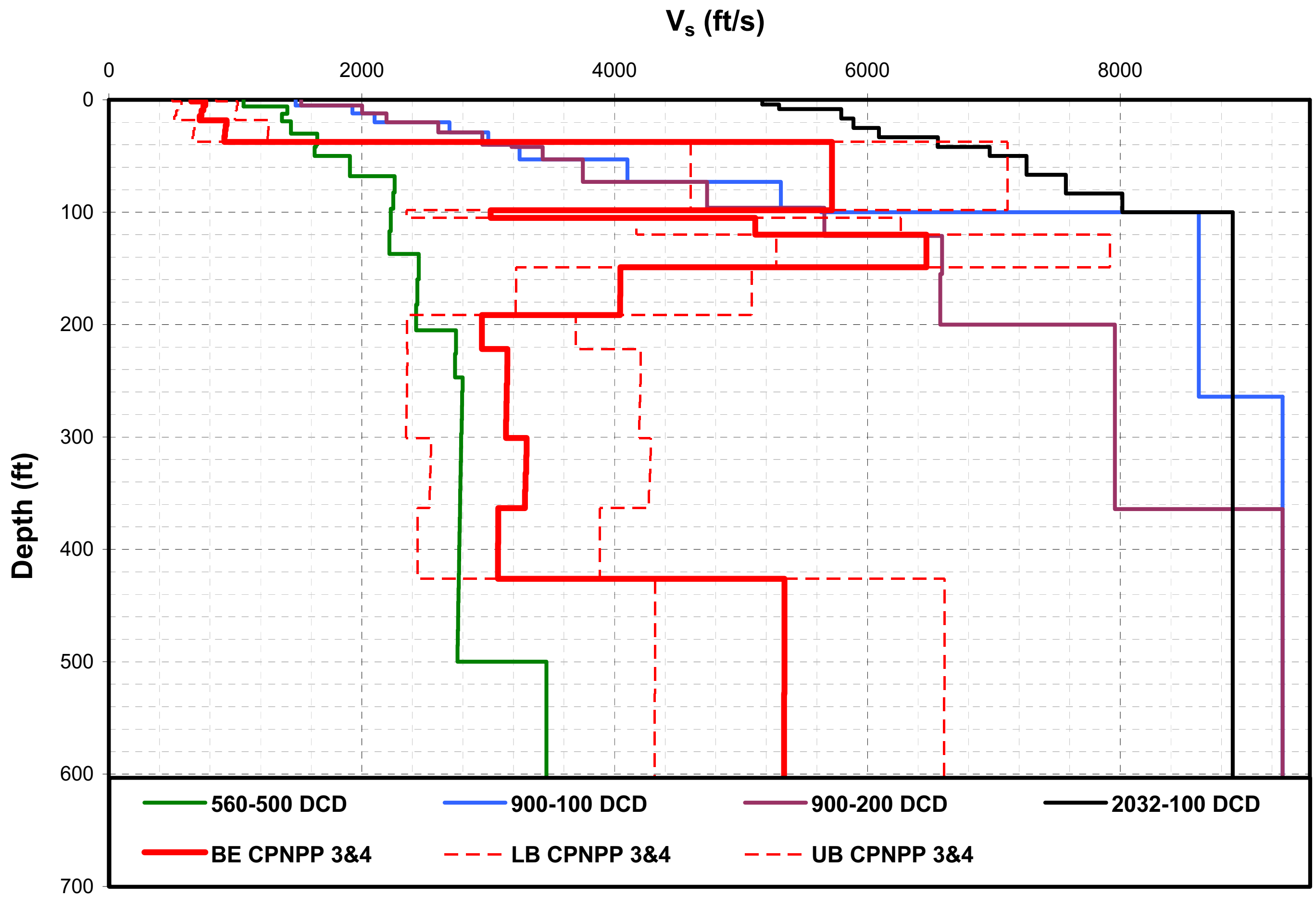
CP COL 3.7(30)

Figure 3.7-217 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Vertical V Component at Control Elevation 791.08 ft for Nominal GWL



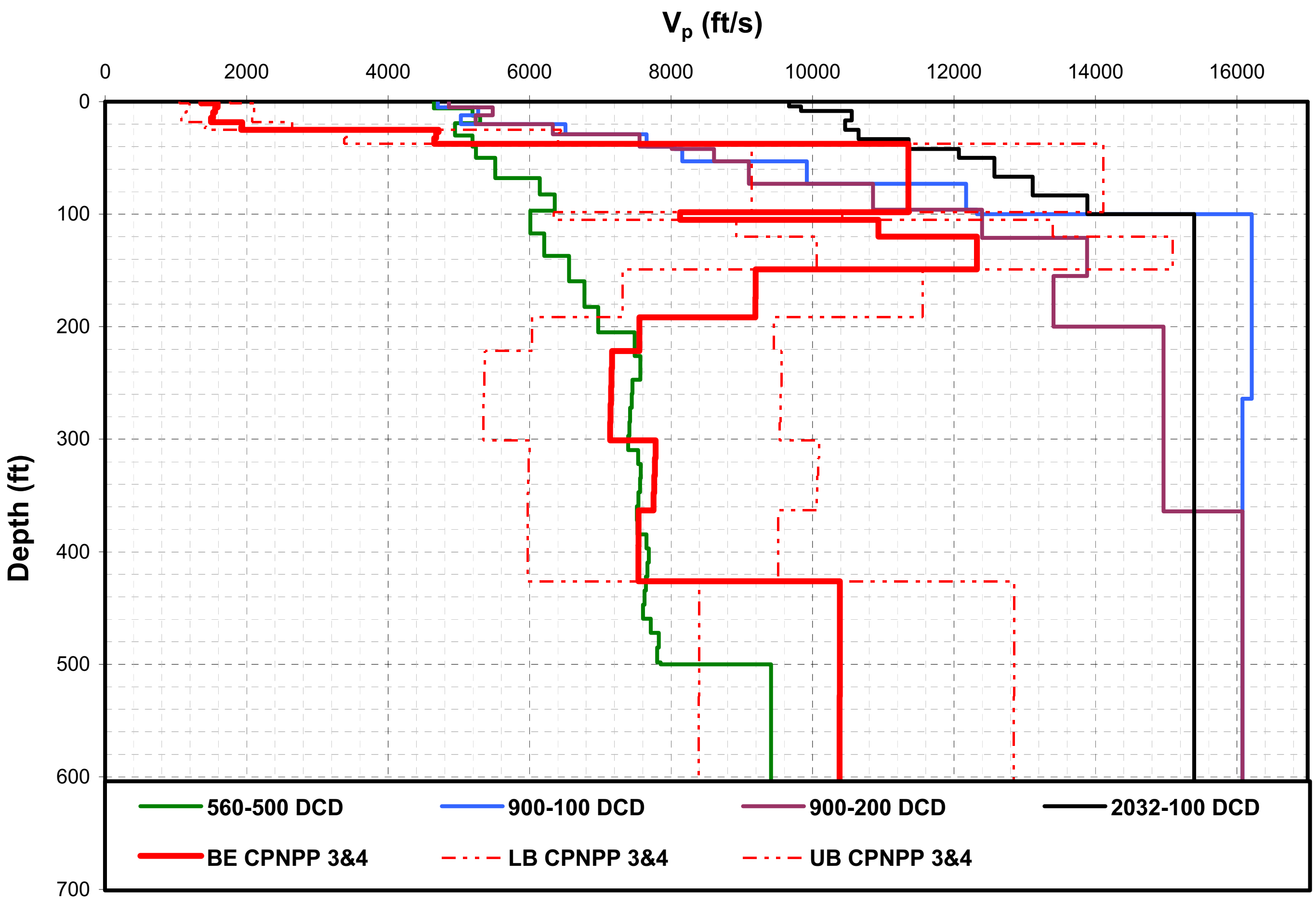
CP COL 3.7(30)

Figure 3.7-218 5% Damping Response Spectra of In-Layer Motion Acceleration Time Histories, Vertical V Component at Control Elevation 791.08 ft for Unsaturated Backfill



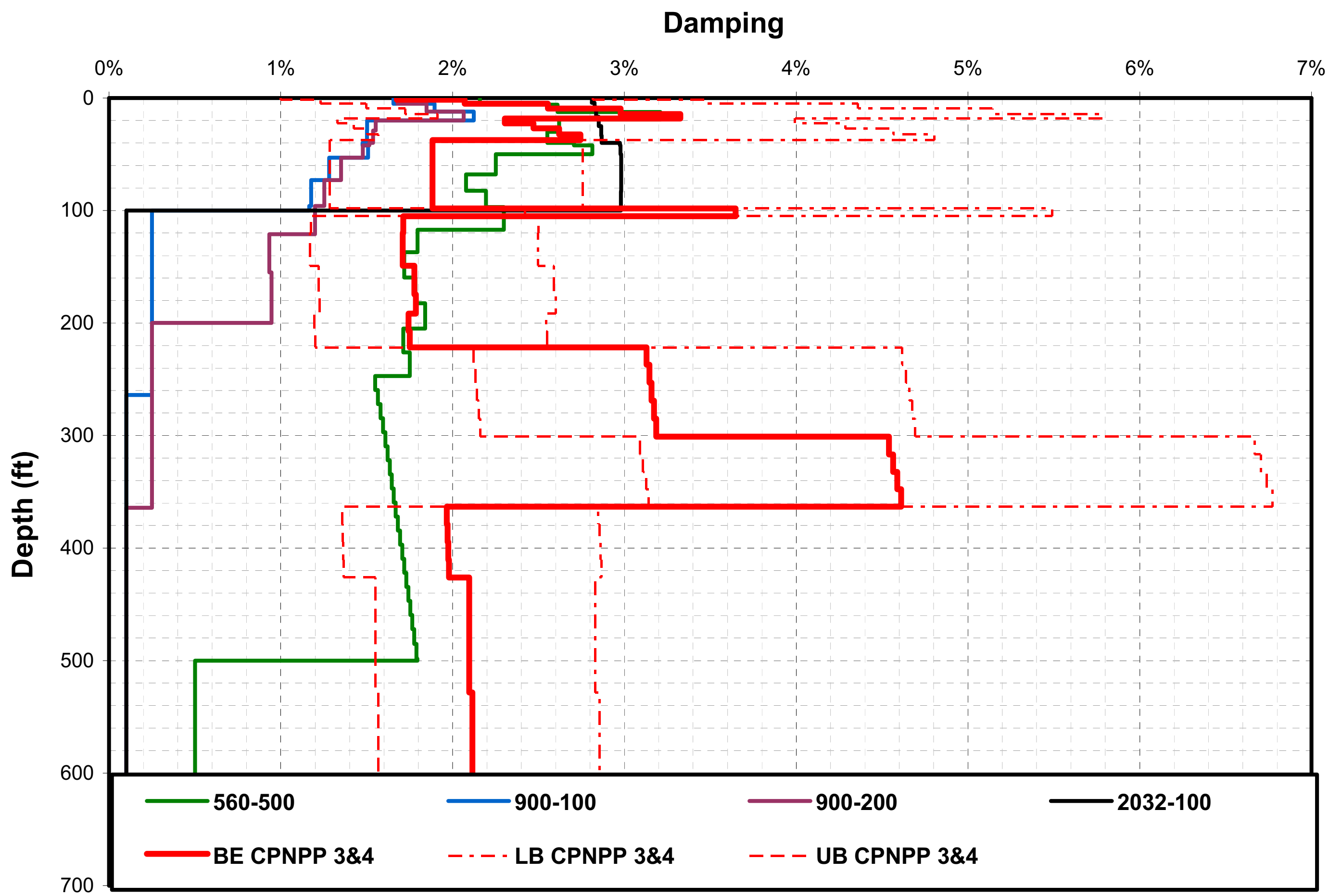
CP COL 3.7(8)

Figure 3.7-219 Comparison of Site-Specific and Standard Plant Strain-Compatible Soil Shear Wave Velocities



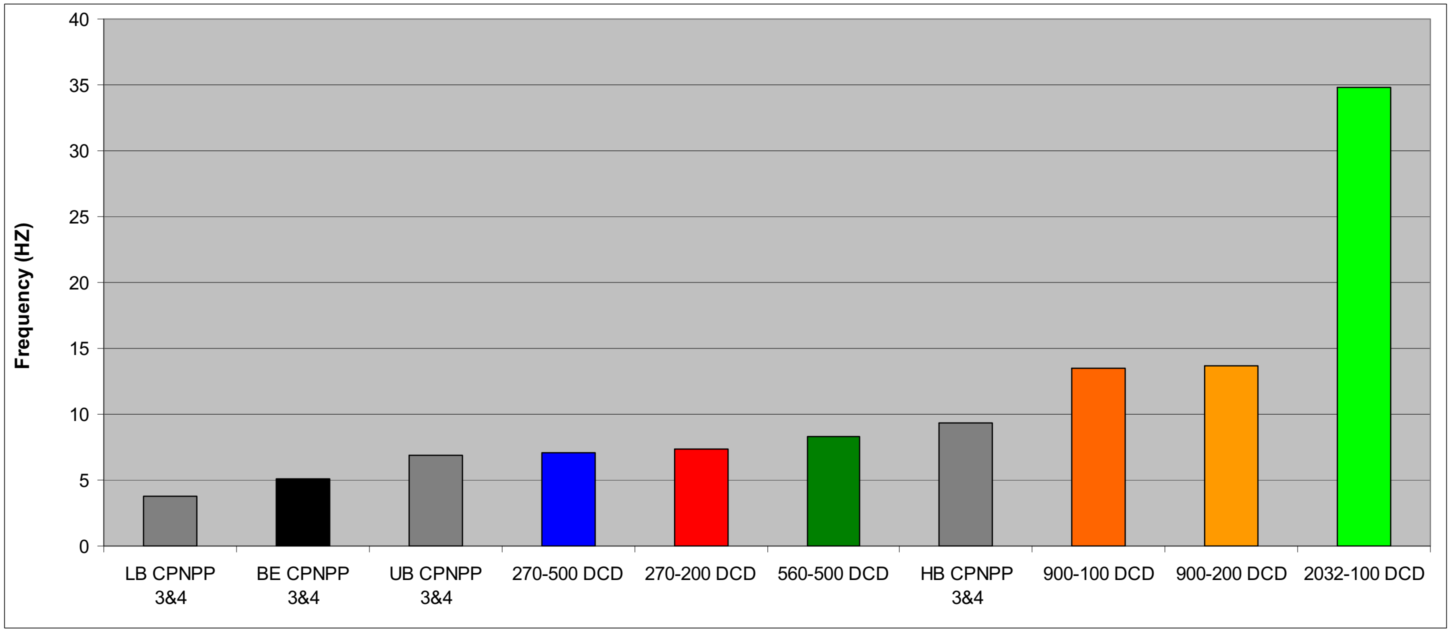
CP COL 3.7(8)

Figure 3.7-220 Comparison of Site-Specific and Standard Plant Strain-Compatible Soil Compression Wave Velocities



CP COL 3.7(8)

Figure 3.7-221 Comparison of Site-Specific and Standard Plant Strain-Compatible Soil Damping



CP COL 3.7(8)

Figure 3.7-222 Comparison of Site-Specific and Standard Plant Embedment Soil Shear Column Frequencies

3.8 DESIGN OF CATEGORY I STRUCTURES

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

3.8.1.6 Material, Quality Control, and Special Construction Techniques

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STD COL 3.8(3) Replace the second sentence of the first paragraph in DCD Subsection 3.8.1.6 with the following.

Any material changes to the site-specific materials for construction of the PCCV will meet the requirements specified in ASME Code, Section III (Reference 3.8-2), Article CC-2000, and supplementary requirements of RG 1.136 (Reference 3.8-3), as well as SRP 3.8.1 (Reference 3.8-7).

STD COL 3.8(7) Replace the first sentence of the thirteenth paragraph in DCD Subsection 3.8.1.6 with the following.

Site-specific ground water/soil at the site is not aggressive, as discussed in Subsection 2.5.4. As part of inservice inspection programs discussed in Subsection 3.8.4.7, exposed portions of below-grade concrete of seismic category I structures, including the PCCV, will be examined for signs of degradation when below-grade concrete walls and basemats are excavated for any reason, and periodic site monitoring of ground water chemistry will be performed to confirm that the ground water/soil remains nonaggressive.

STD COL 3.8(10) Replace the second and third sentences of the twenty-third paragraph in DCD Subsection 3.8.1.6 with the following.

The prestressing system is designed as a strand system.

3.8.1.7 Testing and Inservice Inspection Requirements

STD COL 3.8(14) Replace the third paragraph in DCD Subsection 3.8.1.7 with the following.

A preservice inspection (PSI) program for the PCCV will be completed prior to initial plant startup. The PSI requirements will conform to the provisions of ASME Section XI Division 1 Articles IWA-2000, IWE-2000, and IWL-2000, and the PSI establishes the baseline for the subsequent ISI activities. ISI are performed during

the initial and subsequent intervals identified in Subsections IWE and IWL Article 2400. The PCCV PSI and ISI programs include preservice examination, testing and ISI requirements, and also address personnel qualification requirements and responsibilities. The PCCV ISI program also provides detailed inspection plans and surveillance schedules consistent with those of the integrated leak rate test (ILRT) program, which is discussed further below and in Subsection 6.2.6. ASME Code Section XI requirements incorporated by reference in 10 CFR 50.55a on the date 12 months prior to issuance of the operating license, and optional ASME code cases endorsed by the NRC via RG 1.147, establish the requirements for the ISI program. ISI conducted during successive inspection intervals complies with the requirements incorporated by reference (in 10 CFR 50.55a) 12 months before the start of the 120-month inspection interval, subject to the modifications and limitations listed in paragraph (b) of that section, or the optional ASME Code cases endorsed by the NRC via RG 1.147.

The PCCV ISI program surveillance requirements for periodic surveillance and inspection of the overall structure, as well as the liner and prestressing tendon systems, are in accordance with ASME Code Section XI (Reference 3.8-4) Subsections IWA, IWE, and IWL. Further, inservice inspection requirements for the tendons also follow the applicable guidelines of RG 1.35 (Reference 3.8-5) and 1.35.1 (Reference 3.8-6). The ISI of the PCCV includes the pertinent items in all examination categories identified in Tables IWE-2500-1 and IWL-2500-1 of ASME Section XI (Reference 3.8-4), summarized as follows:

- PCCV pressure retaining boundary, including all accessible interior and exterior surfaces of the liner, penetration liners, and class MC components, parts, and appurtenances.
- Containment structural and pressure retaining boundary welds and pressure-retaining bolted connections.
- Integral structural attachments and welds connecting the attachments to the liner.
- Wetted surfaces of submerged areas [such as the refueling water storage pit (RWSP)].
- Moisture barriers (where applicable).
- Areas at tendon end anchors, wherever accessible, to inspect for concrete cracking, corrosion protection material leakage, and/or tendon cap deformation.
- Examination of, sampling, and testing corrosion protection material.
- Examination of wires or strand and anchorage hardware for cracks, wear, and corrosion.
- Determination of tendon forces by measuring lift-off forces.
- Detensioning tendons and the removal of a wire or strand for inspection for corrosion and testing to measure strength and elongation.

- Establish acceptability and compare measured lift-off values with predictions and minimum requirements.
- General visual inspection of all accessible concrete surface areas to assess the general structural condition of the containment.

3.8.4 Other Seismic Category I Structures

CP COL 3.8(15) Replace the fourth paragraph in DCD Subsection 3.8.4 with the following.

The ESWPT, UHSRS, and PSFSVs are site-specific seismic category I structures. These structures are discussed in detail in Subsection 3.8.4.1.3. No site-specific seismic category II structures are applicable at CPNPP.

3.8.4.1.3 ESWPT, UHSRS, PSFSVs, and Other Site-Specific Structures

CP COL 3.8(19) Replace the second paragraph in DCD Subsection 3.8.4.1.3 with the following.

The ESWPT, UHSRS, and PSFSVs are designed to the site-specific SSE, and are described in detail in Subsections 3.8.4.1.3.1, 3.8.4.1.3.2, and 3.8.4.1.3.3, respectively. Figure 3.8-201 provides the general arrangement of ESWPT, UHSRS, and PSFSVs. Each of these structures is separated from other structures at their interfaces with expansion/isolation joints as shown in various views in Figures 3.8-201 through 3.8-214. The procurement specifications for the expansion/isolation joints address the desired characteristics for the joints.

3.8.4.1.3.1 ESWPT

The ESWPT is an underground reinforced concrete structure. Figure 3.8-203 shows a typical section of the ESWPT. The ESWPT is comprised of four segments, as shown in Figure 3.8-201. Segments 1aN and 1aS run in a north-south direction east of the R/B complex. Segments 1bN and 1bS run in a north-south direction west of the R/B complex. The UHS ESWPT contains the plant north portions of the ESW piping and is integrated with the UHSRS. The ESWPC is integrated with the R/B complex basemat along the south face of the R/B and contains the plant south portion of the ESW piping as a standard plant structure. The plan layout for Segments 1aN and 1bN is a straight line and they interface at their north ends with the UHS ESWPT as shown in Figure 3.8-201. The plan layout for Segments 1aS and 1bS is of an L-shape and they interface at their north end with Segments 1aN and 1bN, respectively; and at their south end with the standard plant ESWPC as shown in Figure 3.8-201.

The outside dimensions of the tunnel are shown in Figure 3.8-203. The tunnel is divided into two sections by an interior concrete wall to provide separation of piping trains. Each section contains both ESWS supply and return lines. End walls are also provided where required to maintain train separation. The top of the tunnel is approximately 12.25 ft. below grade. Access to the tunnel is provided by a reinforced concrete shaft with four hatch covers, which are also used for ESWS pipe replacement.

For details see Figures 3.8-202 through 3.8-205.

The modeling and analysis of the ESWPT is described in Appendix 3LL.

All ESWPT segments have roof slab and mat slab thicknesses of 2’-0”. Segments 1aN and 1bN are similar in layout and dimensions. Segments 1aS and 1bS have a slightly different geometry and are designed separately. The east-west leg of Segment 1aS is 44’-6” shorter and 2’-0” wider than the east-west leg of Segment 1bS. It is intended that at the interface of the ESWPT standalone segments with the UHS ESWPT and standard plant ESWPC, the interior wall, mat, and slab surfaces line up evenly with the adjacent segments and any difference in slab thicknesses affects only the outer dimensions. The outer walls of the east-west leg of segment 1aS are 1’-0” thicker than those of other segments.

All expansion joints separating the four ESWPT standalone segments from the nearby structures permit the seismic and thermal deformation of the tunnel segments without transmittal of forces.

All segments are designed for the same basic load conditions.

The ESWPT contains safety-related piping and electrical cables that are qualified to withstand the maximum environmental conditions of 32°F - 115°F and 100% humidity. The ESWPT is buried approximately 12 ft below ground so the minimum temperature in the ESWPT is above 32°F. The ESWPT is ventilated with a temporary system when personnel are required to enter the area for surveillance, inspection, and maintenance activities.

3.8.4.1.3.2 UHSRS

The UHSRS consists of a cooling tower enclosure; UHS ESW pump house, UHS ESWPT and UHS basin, all of which are reinforced concrete structures, as described below.

UHS Basin - There are four basins for each unit and each reinforced concrete basin has one cooling tower with two cells. Basins A and B are combined into one integrated concrete structure (labeled as UHSRS AB) resting on a common foundation as are basins C and D. Approximately 68 ft separate the two basin structures. The foundations are rectangular in shape, constructed of reinforced concrete. Basin A is separated from basin B by a common 5-ft thick wall in the north-south direction and the configuration of basins C and D is identical. A 4-in.

expansion joint separates the UHS ESWPT segments, which are described later in this section. Each basin serves as a reservoir for the ESWS. There is a cementitious waterproofing membrane at the interior faces of the reinforced concrete walls and bottom slabs of the basins which minimizes long-term seepage of water from the basin. The UHS ESW pump house is located at the south-west corner of each basin as shown in FSAR Figure 3.8-206. Adjacent to the pump house on the east side of the basin are cooling tower enclosures supported by UHS basin walls. The UHS ESWPT, which includes the 68 feet 10 inches stretch between basins B and C, runs east-west along the south exterior wall of the UHS basins. The basins and the UHS ESWPT rest on the same foundation as shown in Figure 3.8-210.

Each basin is divided into two parts, as shown on Figure 3.8-206. The larger section of the basin shares the pump house and one cooling tower cell enclosure. The other cooling tower cell enclosure is in the smaller segment of the basin. A reinforced concrete wall, running east-west, separates the cooling tower enclosure basin area from rest of the basin. This wall is provided with slots to maintain the continuity of the reservoir.

See Figure 3.8-206 for general arrangement, layout, and dimensions of the UHSRS.

UHS ESW pump house - The pump house is an integral part of the UHS basin supported by UHS basin exterior and interior walls. Each pump house contains one ESW pump and one UHS transfer pump with associated auxiliaries. The pump bay (lowest portion of the pump house required for the pump suction) is deeper than the rest of the UHS basin. A reinforced concrete wall, running east-west, divides the pump house basin from rest of the UHS basin. This wall is provided with slots for flow of water. Two baffle walls (running east-west) are provided inside the pump house basin, before the pump bay. These baffle walls are provided with slots to maintain the flow of water and are staggered to prevent trajectory of postulated direct or deflected design basis tornado missiles and hurricane missiles.

The operating floor of the pump house is a reinforced concrete slab spanning east-west and supported by UHS basin exterior and interior walls. The operating floor supports the ESWS pump, UHS transfer pump, and motors. The roof of the pump house is a reinforced concrete slab spanning north-south and supported by reinforced concrete beams. To allow access to the ESWS pump/motor, a removable reinforced concrete cover is provided in an opening in the roof of the pump house.

Tornado/hurricane missile shields are provided to protect the air intake and air outlets of the ESWS pump house HVAC system from tornado missiles and hurricane missiles. The structural design considers tornado differential pressure loads as discussed in Subsection 3.3.2.2.2.

UHS cooling tower enclosures - Each UHS basin has one cooling tower with two cells. Each cell is enclosed by reinforced concrete structures that house the equipment required to cool the water for ESWS. The reinforced concrete wall

running north-south separates the two cell enclosures. The enclosures are an integral part of the UHS basin supported by the basin interior and exterior walls on the basemat foundation. A reinforced concrete wall, running east-west, separates the cell enclosure portion of the basin from the rest of the UHS basin. An east-west wall is provided with openings at the basemat to maintain the continuity of the UHS basin. Air intakes are located at the north and south faces of the cooling tower enclosure. The missile shields at the air intakes are configured to protect the safety-related substructures and components housed within the UHS structure from tornado missiles and hurricane missiles. FSAR Table 3.2-201 lists the site-specific equipment and components located in the UHSRS that are protected from tornado missiles and hurricane missiles. The north side air intake is an integral part of the cooling tower enclosure, whereas the south side air intake is an integral part of the UHS ESWPT as shown in Figure 3.8-202.

Each cooling tower cell enclosure is equipped with a fan and associated equipment to cool the water. Equipment includes header pipe, spray nozzles, and drift eliminators with associated reinforced concrete beams supported by the exterior walls of the enclosure. The fan and motor are supported by reinforced concrete deck above the drift eliminators. A circular opening is provided in the deck for the fan, and the deck is supported by enclosure walls and a deep upside circular concrete beam around the fan opening. The fan is supported by a north-south concrete beam at the center of enclosure. For air circulation and to protect the fan and motor from tornado missiles and hurricane missiles, a circular opening is provided at the roof of the enclosure (centered on the fan) with a reinforced concrete slab and heavy steel grating, designed for postulated tornado- and hurricane-generated missiles, between the roof and the deck. The fans, motors and associated equipment are designed to withstand the effects of design basis tornado differential pressure.

All exposed parts of cooling tower enclosure, the UHS ESWS pump house and the UHS basin that could be impacted by a tornado or hurricane missile are designed to prevent full penetration or structural failure by the spectrum of tornado missiles and hurricane missiles identified in Subsection 3.5.1.4.

UHS ESWPT - The UHS ESWPT, which includes the portion between basins B and C, is an underground reinforced concrete structure. The tunnel is comprised of two segments, as shown in Figures 3.8-201 and 3.8-206. Each segment is integrated with the corresponding UHS basins. The east segment of the pipe tunnel is integral to UHS basins A and B, and the west segment is integral to UHS basins C and D. The segments are aligned in the east-west direction and are built monolithically with the south walls of the basins. A 4-in. expansion joint separates the east segment from the west segment.

The UHS ESWPT is divided into two sections by an interior concrete wall to provide separation of piping trains. Each section contains both ESWS supply and return lines plus a portion of the UHS transfer piping. An additional end wall is also provided where required to maintain train separation.

Vertical shafts are provided on both sides of the end wall for ESWS pipe replacement and for general access and egress. The shafts are located at the east end of the west segment and are constructed integrally with the west segment. Two of the vertical shafts service the west tunnel segment associated with UHS basins C and D, and the remaining two vertical shafts service the east tunnel segment associated with UHS basins A and B. Section A6 of Figure 3.8-207 presents the details of the vertical access shafts.

The top of the UHS ESWPT is approximately 12 ft. below grade with roof and exterior wall thicknesses of 2’-0”. The south exterior wall of the basin is the shared, common 5-ft thick wall which forms the north wall of the UHS ESWPT. Pump room extensions, cooling tower south missile shields, and ESW pipe replacement shafts, and end wall are an integral parts of the UHS ESWPT. A tornado/hurricane missile shield, as shown in Section F in FSAR Figure 3.8-202 and Section C in FSAR Figure 3.8-210, extends from the top of the UHS ESWPT to protect openings in the UHS.

See Figures 3.8-201, 3.8-202, and 3.8-206 through 3.8-211 for details of the UHS basin, UHS ESW pump house, cooling tower enclosures and UHS ESWPT. Details of the UHSRS seismic analysis are provided in Appendix 3KK.

3.8.4.1.3.3 PSFSVs

The PSFSVs are underground reinforced concrete structures required to house the safety-related and non safety-related fuel oil tanks. There is one vault for each PS/B. The vault contains two safety-related and one non safety-related oil tanks. Each tank is contained in a separate compartment. Compartments are separated by reinforced concrete walls. A common mat supports the tanks and the rest of the vault. This mat has extensions of 7’-0” or 10’-0” beyond the vault footprint on three of the sides for stability purposes. Bollards and a concrete curb are provided to prevent vehicular traffic on the roof.

Access to each tank compartment in each vault is provided by a reinforced concrete pipe/access tunnel from the applicable PS/B. Each access tunnel serves also as a fuel pipe access tunnel, which is separated into two segments by a 4-in. expansion joint. The north segment is an integral part of the standard plant ESWPC, which rests on the R/B complex foundation, while the south segment is an integral part of the PSFSV.

For vault details see Figure 3.8-204 and Figures 3.8-212 through 3.8-214. Details of the PSFSV seismic analysis are provided in Appendix 3MM.

3.8.4.1.3.4 Other Site-Specific Structures

There are no additional site-specific seismic category I structures other than ESWPT, UHSRS and PSFSVs.

3.8.4.3 Loads and Load Combinations

CP COL 3.8(20) Replace the second paragraph in DCD Subsection 3.8.4.3 with the following.

Externally generated loads from the following postulated site-specific sources are evaluated in the following subsections:

- Subsection 2.4.2.3 concludes no loads induced by floods are applicable.
- Subsection 3.5.1.6 concludes no loads from non-terrorism related aircraft crashes are applicable.
- Subsection 2.2.3.1.1 concludes no explosive hazards in proximity to the site are applicable, and
- Subsection 3.5.1.6 concludes no projectiles and missiles generated from activities of nearby military installations are applicable.
- Subsection 3.7.1.1 provides the safe-shutdown earthquake response spectra used in the site-specific seismic design.
- Subsection 3.3.1.1 provides the site-specific design wind speed.

3.8.4.3.4.2 Roof Snow Loads and Roof Live Loads

CP COL 3.8(25) Add the following paragraph as the last paragraph in DCD Subsection 3.8.4.3.4.2:

The extreme winter precipitation roof load considered for site-specific seismic category I buildings and structures is 37.8 psf as given in Table 2.0-1R. The roof live load used for design of site-specific seismic category I buildings and structures is 100 psf minimum.

3.8.4.3.7.1 Operating Thermal Loads (To)

STD COL 3.8(27) Replace the second paragraph in DCD Subsection 3.8.4.3.7.1 with the following.

The UHSRS, PSFSVs, and ESWPT structures experience only small ranges of operating temperatures and loads which do not require explicit analysis. The designs of the UHSRS, PSFSVs and ESWPT accommodate normal operating

thermal loads and environmental thermal gradients such as those identified in Table 3.8-201.

3.8.4.4.1.4 Below Grade Exterior Walls

CP COL 3.8(34) Replace the four paragraphs in DCD Subsection 3.8.4.4.1.4 with the following.

The lateral pressures used in the standard plant design envelop site-specific lateral earth pressures as demonstrated in Section 3NN.6 of Appendix 3NN. The dynamic lateral earth pressures and below grade displacements for the UHSRS, ESWPT, and PSFSVs are addressed in Appendices 3KK, 3LL, and 3MM, respectively. The site-specific analysis and design of below grade exterior walls do not consider lateral pressure loads based on the passive resistance of the backfill soil because the structures do not slide, as addressed in Section 3.8.5.5, and because the deformations of the below grade structures are small and fall below those associated with plastic yield in the soil mass.

3.8.4.4.4 Other Seismic Category I Structures

CP COL 3.8(15)
CP COL 3.8(19)
CP COL 3.8(24)
CP COL 3.8(29)
CP COL 3.8(30)

Replace the last paragraph in DCD Subsection 3.8.4.4.4 with the following.

3.8.4.4.4.1 ESWPT

The ESWPT is designed to withstand the loads specified in Subsection 3.8.4.3. The structural design of the ESWPT is performed using the computer program ANSYS (Reference 3.8-14). The seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3LL.

In order to consider the effect of the subgrade stiffness, static analyses are performed on the ANSYS models of the standalone ESWPT segments placed on a layer of fill concrete resting on the supporting limestone, which is modeled using substructuring to condense subgrade finite elements together into a super-element. Separate finite element models are developed using the site specific profiles of rock subgrade properties presented in Subsection 3.7.2.4.5 and then condensed into the super-element. The analyses are performed using LB and UB stiffness properties of the super-element in order to address uncertainties related to the determination of the site-specific subgrade properties. The stress properties, Young’s modulus and Poisson’s Ratio assigned to the FE model of the subgrade are calculated using the strain-compatible shear and compression wave velocities of the rock layers presented in Table 3.7-204 using relationships from the theory of elasticity.

The following formulas show the relationships between shear and compression wave velocity and Young's modulus based on the theory of elasticity:

$Vs = (G/\rho)^{0.5}$

$Vp = [(2*(1-\upsilon)/(1-2\upsilon)]^{0.5} * (G/\rho)^{0.5}$

$E = \rho*(Vs^2 * (3*(Vp/Vs)^2 - 4))/((Vp/Vs)^2 - 1)$

$\upsilon = [(Vp/Vs)^2 – 2]/[2*(Vp/Vs)^2 – 1]$

Where

Vs = shear wave velocity

G = shear modulus

ρ = unit mass

E = Young's modulus

υ = Poisson's ratio

Vp = compression wave velocity

The modeling of the foundation subgrade with the ESWPT structure reproduces the correct theoretical soil pressure distribution under the mat due to a uniform displacement or load, within the assumptions of the theory of elasticity, under any loading pattern.

The soil stiffness adjacent to the tunnel is not included in the ANSYS design models in order to transfer the total seismic load through the structure down to the base slab. The modeling approach implemented for the static analyses enables transfer of the unbalanced horizontal load through the structure, the base slab and the fill concrete layer down to the rock subgrade. Embedment effects are included in the SSI model from which the seismic inertia loads are obtained. The seismic inertia loads are applied to the ANSYS model used for the structural design as equivalent static loads as described in Appendix 3LL. As described in Appendix 3LL, a uniformly distributed SSE horizontal pressure load applied on the ESWPT models envelops the seismic lateral earth pressure distributions obtained by the methodology of ASCE 4-98 (Reference 3.8-34), and from the numerical results of the SASSI analyses. For the buried ESWPT, the SSI analyses with HB backfill properties yielded magnitudes of seismic pressures that exceeded the values of dynamic pressures per ASCE 4-98. Site-specific static lateral earth pressures are computed using the same basic methodology described in Subsection 3.8.4.4.1.4

Gravity loads on the tunnel roof include a design surcharge pressure and are resisted by one-way slab action of the roof. These loads are distributed to the outer and interior walls, transferred through the walls down to the mat slab where they are distributed, and from the bottom of the mat slab to the concrete fill over limestone bedrock. A design surcharge pressure of 600 psf is applied on the ground surface for the design of the tunnel segments for the static loading case, and a design surcharge pressure of 200 psf is applied to the tunnel segments for the dynamic loading case.

Lateral soil pressures on outer tunnel walls are typically resisted by one-way action of the outer walls. Horizontal forces in the direction transverse to the tunnel from these pressures are transferred to the roof and mat slabs by frame action, resulting primarily in bending and some axial forces in the walls. Horizontal earth pressure loads are also transferred through roof slab friction to the ESWPT structure. The loads acting in the longitudinal direction of the tunnel are transmitted to the base slab mainly through the in-plane shear resistance of the tunnel walls. The L-shaped tunnel segments 1aS and 1bS resist lateral loads in part by moment frame action and in part by return walls located at an end of the segment (such as where the ESWPT changes direction). The ESWPT roof also resists a portion of these loads, resulting in in-plane axial forces in the roof slab.

Lateral forces that are not balanced by an equal and opposite force on the other side of the tunnel are transferred to the concrete fill below the tunnel by friction. Lateral forces in the fill are then also transferred to bedrock by friction. The coefficients of friction considered at the fill concrete/bedrock interface and the foundation concrete/fill concrete interface are no higher than 0.6, which is consistent with the values for coefficient of friction discussed in Subsection 2.5.4.10.5.

For dynamic forces oriented parallel to the length of the tunnel segment, the roof slab acts as a diaphragm that transfers loads to the outer and interior walls. The walls act as shear walls that transfer the forces to the mat slab. For dynamic forces acting perpendicular to the length of the tunnel, the roof acts as a frame member that transfers loads to the interior and exterior walls. The tunnel walls, roof, and base slab act as a moment frame causing out-of-plane bending in these elements. The exterior walls are also designed for static and dynamic soil pressure. The static soil pressures are calculated using at-rest pressures with K_o = 0.47. (= 1 – sin(φ), where the internal friction angle, φ, for the engineered compacted backfill is 32°). This is the same as the at-rest pressure coefficient given in Figure 2.5.4-243. The design of the ESWPT also considers unbalanced hydrostatic pressures by conservatively assuming that, within the perimeter of the ESWPT, the GWL is located at the top of the tunnel roof and that the GWL outside the ESWPT perimeter is below the tunnel foundation. The design also considers the load from the overburden saturated soil pressure to address the flood accidental loading case when the GWL is located 1 ft below grade. This is the same as the at-rest pressure coefficient given in Figure 2.5.4-243. The design also considers the load from the overburden pressure and the soil compaction pressure. The dynamic soil pressures are described in Appendix 3LL.

3.8.4.4.4.2 UHSRS

The UHSRS are designed to withstand the loads specified in Subsection 3.8.4.3. The structural design of the UHSRS is performed using the computer program ANSYS (Reference 3.8-14). The seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3KK.

The seismic responses for the design are calculated using a multi-step analysis method as defined in ASCE 4-98 (Reference 3.8-34). Step 1 is the SSI analysis using the program SASSI and step 2 is calculating the seismic demands for the design using equivalent static analysis and the program ANSYS as described below.

The ANSYS design analysis models for the UHSRS were placed on a super-element which is used to model the lower bound and upper bound stiffness properties of the supporting limestone, in the same manner as discussed above for the ESWPT. The fill concrete above the top of limestone is modeled as part of the UHSRS structural model and is not condensed into the super-element. The effects of embedment are included in the SSI analysis. The seismic lateral pressure and inertia loads applied to the ANSYS design model represent the total seismic loading from the SSI analysis.

The soil adjacent to the UHSRS is not included in the structural design model in order to transfer the total seismic load through the structure down to the base slab. Embedment effects are included in the SSI model from which the seismic inertia loads are based. The seismic inertia loads are applied to the ANSYS model used for the structural design as equivalent static loads as described in Appendix 3KK. The seismic lateral earth pressures are computed as described in Appendix 3KK based on the methodology of ASCE 4-98. These pressures control the design forces and moments rather than the SSI pressures. Site-specific static lateral earth pressures are computed using the same basic methodology described in Section 3.8.4.4.1.4.

Each UHS cooling tower, air intake enclosures, and ESWS pump house are designed for tornado and hurricane wind and tornado/hurricane-generated missiles and in-plane and out-of-plane seismic forces. The walls are shear/bearing walls carrying the loads from the superstructure and transferring to the basemat. The UHS basin exterior walls are also designed for static and dynamic soil pressure, and hydrostatic and hydrodynamic fluid pressures. The static soil pressures are calculated using at-rest pressures with K_o = 0.47. This is the same as the at-rest pressure coefficient given in Figure 2.5.4-243. The dynamic soil pressures are determined in accordance with ASCE 4-98 (Reference 3.8-34) and the hydrodynamic fluid pressures due to the water in the UHS basins are determined using ACI 350.3-06 (Reference 3KK-5) and modeling procedures of ASCE 4-98 as described in Appendix 3KK. Below-grade walls loaded laterally by soil pressure on the outside, or hydrostatic pressure on the inside, act as two-way slabs, spanning horizontally to perpendicular shear walls, and cantilevering vertically from the mat slab (at the pump room, the walls span

vertically between the mat slab and the pump room floor). For seismic loads, the shear walls are designed to resist 100% of the applied lateral load through in-plane shear. The shear walls transmit load to the mat slab. The shear in the mat slab is transferred to the fill concrete via friction, and direct bearing at the pump house sump. The shear in the fill concrete is transferred to the bedrock via friction and bearing at the pump hose sump. The coefficients of friction considered at the fill concrete/bedrock interface and the foundation concrete/fill concrete interface are no higher than 0.6, which is consistent with the values for coefficient of friction discussed in Subsection 2.5.4.10.5.

Above grade walls loaded laterally by seismic forces as described in Appendix 3KK, or by wind, tornado, hurricane, atmospheric and missile loads, act as two-way slabs, spanning horizontally to perpendicular shear walls and vertically to floor and roof slabs. These slabs act as horizontal diaphragms, and span horizontally to the perpendicular shear walls. The shear in the shear walls is transferred to bedrock as described above.

Vertical loads in the floor and roof slabs are due to dead load, live load, and wind, tornado, or hurricane missile loads. The floor and roof slabs act as two-way slabs, spanning to the walls or beams below in both directions. The vertical loads are transmitted to the mat slab, then into the fill concrete, and then into bedrock.

3.8.4.4.4.3 PSFSVs

The PSFSVs are designed to withstand the loads specified in Subsection 3.8.4.3. The structural design of the PSFSV is performed using demands calculated from static analyses performed using the computer program ANSYS (Reference 3.8-14). Details of the seismic analysis and the computer programs used for the seismic analysis are addressed in Appendix 3MM.

The ANSYS analyses are performed on the model placed on a 3 ft thick layer of finite elements representing the limestone and the lower subgrade which are condensed into a super-element by making use of substructuring. Stiffness properties assigned to the finite elements represent the LB and UB stiffnesses of the supporting limestone strata, as described above for the ESWPT. The super-element provides localized flexibility at the base of the structure to calculate base slab demands. Using the UB and LB values captures the governing range of stresses and displacements for the structural design.

The soil adjacent to the PSFSVs is not included in the design model in order to transfer the total seismic load through the structure down to the base slab. Embedment effects are included in the SSI model from which the seismic inertia loads are obtained. The seismic inertia loads are applied to the ANSYS model used for the structural design as equivalent static loads as described in Appendix 3MM. The seismic lateral earth pressures are computed as described in Appendix 3MM based on the methodology of ASCE 4-98. These pressures control the design forces and moments rather than the SSI pressures. Site-specific static lateral earth pressures are computed using the same basic methodology

described in Section 3.8.4.4.1.4.

Vertical loads present on the roof of the PSFSVs are carried by the perimeter and interior walls. The roof acts as a two-way slab based on its aspect ratio with a single span in the north-south direction and a 3-span continuous slab with two-way action in the east-west direction. The vertical wall loads are transmitted to the mat slab and into the bedrock. The exterior walls are also designed for static and dynamic soil pressure. The static soil pressures are calculated using at-rest pressures with K_o = 0.47. This is the same as the at-rest pressure coefficient given in Figure 2.5.4-243. The design also considers the load from the overburden pressure and the soil compaction pressure. Application of the dynamic soil pressure is described in Appendix 3MM. The exterior walls are designed with and without the roof slab for lateral static soil pressure, and with the roof slab for all other loading including seismic. Walls loaded laterally by earth pressure act as two-way plate members, spreading load to the mat slab and perpendicular shear walls. For seismic load cases, the shear walls are designed to resist 100% of the applied lateral load. The shear walls transmit load to the foundation mat along their length. The load in the foundation mat is then transferred to the bedrock via friction. The coefficient of friction considered is no higher than 0.6, which is consistent with the values for coefficient of friction discussed in Subsection 2.5.4.10.5.

3.8.4.6.1.1 Concrete

CP COL 3.8(28) Replace the third sentence of the first paragraph in DCD Subsection 3.8.4.6.1.1 with the following.

For ESWPT, UHSRS, and PSFSVs concrete compressive strength, f'_c = 5,000 psi is utilized. The compressive strength, f'_c, of the concrete fill under the ESWPT, UHSRS, and PSFSVs is 3,000 psi.

3.8.4.7 Testing and Inservice Inspection Requirements

STD COL 3.8(22)
STD COL 3.8(7)

Replace the second through last paragraph of DCD Subsection 3.8.4.7 with the following.

A site-specific program for monitoring and maintenance of seismic category I structures is performed in accordance with the requirements of NUMARC 93-01 (Reference 3.8-28) and 10 CFR 50.65 (Reference 3.8-29) as detailed in RG 1.160 (Reference 3.8-30). Monitoring of seismic Category I structures includes base settlements and differential displacements.

Prior to completion of construction, site-specific programs are developed in accordance with RG 1.127 (Reference 3.8-47) for ISI of seismic category I water control structures, including the UHSRS and any associated safety and performance instrumentation.

The site-specific programs address in particular ISI of critical areas to assure plant safety through appropriate levels of monitoring and maintenance. Any special design provisions (such as providing sufficient physical access or providing alternative means for identification of conditions in inaccessible areas that can lead to degradation) to accommodate ISI are also required to be addressed in the ISI program.

Because the site exhibits nonaggressive ground water/soil (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1,500 ppm), the program for ISI of inaccessible, below-grade concrete walls and foundations of seismic category I structures is less stringent than would be applied for sites with aggressive ground water/soil. The program is required to include requirements for (1) examination of the exposed portions of the below-grade concrete, when excavated for any reason, for signs of degradation; and (2) conducting periodic site monitoring of ground water chemistry, to confirm that the ground water remains nonaggressive.

3.8.5.1 Description of the Foundations

STD COL 3.8(23) Replace the second sentence of the second paragraph in DCD Subsection 3.8.5.1 with the following.

The 4 ft. depth exceeds the maximum depth of frost penetration.

3.8.5.1.3 Site-Specific Structures

CP COL 3.8(24) Replace the paragraph in DCD Subsection 3.8.5.1.3 with the following new subsections.

3.8.5.1.3.1 ESWPT

The ESWPT is an underground structure supported by a monolithic reinforced concrete basemat. The basemat is a 2-ft thick, 26-ft wide concrete slab in Segments 1aN, 1aS, 1bN, and 1bS as shown in Figures 3.8-203 with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the basemat is at elevation 791.08 ft. and is founded on structural concrete fill placed directly on limestone. The fill concrete is generally designed as unreinforced concrete.

See Subsection 3.8.5.1.3.2 for a description of the foundation for the UHS ESWPT.

3.8.5.1.3.2 UHSRS

Basins A and B are combined into one integrated concrete structure (labeled as UHSRS AB) while basins C and D are combined into one integrated concrete structure (labeled as UHSRS CD) as stated in Subsection 3.8.4.1.3.2. UHSRS AB and UHSRS CD, consisting of the UHS basins, ESWS pump house, UHS ESWPT, and the cooling towers are each free-standing structures supported on a reinforced concrete basemat with approximate plan dimensions of 260 ft by 160 ft. The basemat is 5 ft thick with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the UHS basemat is at elevation 786 ft., except the pump house sump mat is at elevation 774 ft. The pump house basemat is founded directly on limestone, whereas the rest of the UHS mat is founded on structural concrete fill placed directly on limestone.

The UHS ESWPT is supported on an 11 ft. extension of the UHS basemat as shown on Figure 3.8-210. The bottom of the basemat is at elevation 786 ft. with a thickness of 7 ft. 1 in. The foundation for the UHS ESWPT adjacent to the pump house is similar and lines up with the foundation for the UHS ESWPT adjacent to the cooling towers. Foundation top and bottom reinforcement in each direction are arranged in a rectangular grid pattern.

3.8.5.1.3.3 PSFSVs

PSFSVs are underground structures supported by a monolithic reinforced concrete basemat. The basemat is a 6’-6” thick concrete slab with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the basemat is at elevation 782 ft., and is founded directly on limestone. Details of the PSFSV basemat are as shown in Figures 3.8-213 and 3.8-214.

3.8.5.4.4 Analyses of Settlement

STD COL 3.8(26) Replace the last paragraph in DCD Subsection 3.8.5.4.4 with the following.

As discussed in Subsection 2.5.4.3, all the seismic category I and II buildings and structures at CPNPP Units 3 and 4 site are supported on limestone or on fill concrete supported on limestone. These supporting media are stiffer than the controlling generic soil profile of 270-500 used in the standard plant settlement

analyses. The site-specific settlements (total and differential settlements) and tilt for all seismic category I and II structures are less than those settlements and tilt determined for the standard plant design, and are therefore bounded by the values in DCD Table 2.0-1. As discussed in Section 2.5.4.10.2, maximum and differential settlements for each seismic category I building and structure at the site, including R/B complex, ESWPT, UHSRS, and PSFSVs are estimated to be less than or on the order of ½ inch, including long-term settlements.

3.8.5.5 Structural Acceptance Criteria

CP COL 3.8(25) Replace the third sentence of the first paragraph in DCD Subsection 3.8.5.5 with the following.

All seismic category I buildings and structures at the CPNPP Units 3 and 4 site, including R/B complex, ESWPT, UHSRS, and PSFSVs, are founded either directly on a limestone layer or structural concrete fill which is placed directly on the limestone. Per Subsection 2.5.4.10.1, the ultimate bearing capacity of the limestone is 146,000 psf. Table 3.8-202 shows the actual bearing pressure during static and seismic load cases with minimum factor of safety. The allowable static bearing capacity is calculated as 1/3 of the ultimate bearing capacity. The allowable dynamic bearing capacity is calculated as 1/2 of the ultimate bearing capacity. Table 3.8.5-6R shows the load combinations and factors of safety against overturning, sliding and flotation for site-specific seismic category I and II structures.

CP COL 3.8(31) Replace the second paragraph in DCD Subsection 3.8.5.5 with the following paragraph:

Seismic category I and II structures are evaluated against acceptance criteria with respect to overturning, sliding, and flotation stability. The load combinations applicable to the stability evaluations are specified in Table 3.8.5-1. For each of the specified load combinations, the acceptance criterion for the overturning, sliding, and flotation stability evaluations is the minimum factor of safety identified in Table 3.8.5-1. The design methodology and requirements for calculating the factors of safety are described further in Subsections 3.8.5.5.1 and 3.8.5.5.2. The minimum calculated factor of safety for each load combination considered in the stability evaluations is presented in Table 3.8.5-6R. Non-linear time history analysis is not used in the site-specific sliding stability evaluations.

3.8.5.5.2 Sliding Acceptance Criteria

CP COL 3.8(35) Replace the three paragraphs in the second bullet of the seventh paragraph in DCD Subsection 3.8.5.5.2 with the following.

For CPNPP Units 3 and 4, all seismic category I and II buildings and structures, including the R/B complex, UHSRS, ESWPT, PSFSVs, and T/B, are founded directly on solid limestone (Glen Rose Limestone Layer C) or on fill concrete which extends from the foundation bottom to the top of solid limestone at nominal elevation 782'. The fill concrete conforms to pertinent requirements of ACI-349 such as durability. See Subsection 3.7.1.3 for additional discussion on the use and properties of the concrete fill.

CP COL 3.8(30) Replace the last sentence of the fourth bullet in the seventh paragraph in DCD Subsection 3.8.5.5.2 with the following.

As stated in Subsection 2.5.4.10.5, a base coefficient of friction of 0.6 is used in structural pseudo-static sliding stability evaluations; therefore, roughening of fill concrete is not required.

CP COL 3.8(32) Replace the last paragraphs in DCD subsection 3.8.5.5.2 with the following.

The pseudo-static analysis method is used in the site-specific sliding stability evaluations of all seismic category I and II buildings and structures at the CPNPP Units 3 and 4 site. No credit is taken for side wall friction or passive soil resistance in calculating the site-specific factors of safety against sliding and overturning. Table 3.8.5-6R shows the load combinations and factor of safety against sliding are greater than or equal to 1.1 and the standard plant non-linear sliding stability methodology is not applicable to CPNPP Units 3 and 4. As stated above, the non-linear time history analysis method used to perform the seismic sliding evaluations is only applicable for the standard plant seismic sliding evaluations.

Although standard plant non-linear sliding stability methodology is not applicable for CPNPP sliding stability evaluations, the design of all aspects related to interaction between seismic category I and II adjacent buildings/structures and components (structural gaps, structural connections, such as buried tunnels and other umbilicals, buried commodities) will accommodate the displacements corresponding to the maximum expected sliding from the standard plant non-linear time history approach.

3.8.6 Combined License Information

Replace the content of DCD Subsection 3.8.6 with the following.

3.8(1) *Deleted from the DCD.*

3.8(2) *Deleted from the DCD.*

STD COL 3.8(3) ***3.8(3)*** *Material changes for PCCV*

This COL item is addressed in Subsection 3.8.1.6.

3.8(4) *Deleted from the DCD.*

3.8(5) *Deleted from the DCD.*

3.8(6) *Deleted from the DCD.*

STD COL 3.8(7) ***3.8(7)*** *Aggressivity of ground water/soil*

This COL item is addressed in Subsections 3.8.1.6 and 3.8.4.7.

3.8(8) *Deleted from the DCD.*

3.8(9) *Deleted from the DCD.*

STD COL 3.8(10) ***3.8(10)*** *Alternate wire prestressing system*

This COL item is addressed in Subsection 3.8.1.6.

3.8(11) *Deleted from the DCD.*

3.8(12) *Deleted from the DCD.*

3.8(13) *Deleted from the DCD.*

STD COL 3.8(14) ***3.8(14)*** *PCCV testing and ISI*

This COL item is addressed in Subsection 3.8.1.7.

CP COL 3.8(15) ***3.8(15)*** *Seismic design of SSCs not part of standard plant*

This COL item is addressed in Subsections 3.8.4 and 3.8.4.4.

3.8(16) *Deleted from the DCD.*

3.8(17) *Deleted from the DCD.*

3.8(18) *Deleted from the DCD.*

CP COL 3.8(19) ***3.8(19)*** *Design and analysis of ESWPT, UHSRS, PSFSVs, and other site-specific structures*

This COL item is addressed in Subsection 3.8.4.1.3, and Figures 3.8-201 through 3.8-214.

CP COL 3.8(20) ***3.8(20)*** *Externally generated loads*

This COL item is addressed in Subsection 3.8.4.3.

3.8(21) *Deleted from the DCD.*

STD COL 3.8(22) ***3.8(22)*** *Monitoring of seismic category I structures*

This COL item is addressed in Subsection 3.8.4.7.

STD COL 3.8(23) ***3.8(23)*** *Maximum frost penetration level*

This COL item is addressed in Subsection 3.8.5.1.

CP COL 3.8(24) ***3.8(24)*** *Design of other non-standard seismic category I buildings and structures*

This COL item is addressed in Subsections 3.8.4.4.4 and 3.8.5.1.3, and Figures 3.8-202, 3.8-213, and 3.8-214.

CP COL 3.8(25) ***3.8(25)*** *Site-specific conditions*

This COL item is addressed in Subsections 3.8.4.3.4.2 and 3.8.5.5 and Table 3.8-202.

STD COL 3.8(26) ***3.8(26)*** *Subsidence and differential displacement*

This COL item is addressed in Subsection 3.8.5.4.4.

STD COL 3.8(27)
CP COL 3.8(27) ***3.8(27)*** *Normal operating thermal loads*

This COL item is addressed in Subsection 3.8.4.3.7.1, and Table 3.8-201.

CP COL 3.8(28) ***3.8(28)*** *Concrete strength in non-standard plant seismic category I structures*

This COL item is addressed in Subsection 3.8.4.6.1.1.

CP COL 3.8(29) ***3.8(29)*** *Design and analysis procedures for ESWPT, UHSRS, and PSFSVs*

This COL item is addressed in Subsection 3.8.4.4.4, and Appendices 3KK, 3LL, and 3MM

CP COL 3.8(30) ***3.8(30)*** *Coefficient of friction used in calculating sliding resistance.*

This COL item is addressed in Subsections 3.8.4.4.4 and 3.8.5.5.2.

CP COL 3.8(31) ***3.8(31)*** *Site-specific stability evaluations for standard plant seismic category I and II structures*

This COL item is addressed in Subsection 3.8.5.5 and Table 3.8.5-6R.

CP COL 3.8(32) ***3.8(32)*** *Site-specific stability evaluations for site-specific seismic category I and II structures*

This COL item is addressed in Subsection 3.8.5.5.2 and Table 3.8.5-6R.

CP COL 3.8(33) ***3.8(33)*** *Detailed construction and inspection plans and documents*

This COL item is addressed in Subsection 3.8.3.6.1.

CP COL 3.8(34) ***3.8(34)*** *Verify that standard plant design lateral earth pressures envelop site-specific lateral earth pressures*

This COL item is addressed in Subsection 3.8.4.4.1.4.

CP COL 3.8(35) ***3.8(35)*** *Verify the degree of compaction for the backfill placed beneath foundation and friction angle of at least 35° is met*

This COL item is addressed in Subsection 3.8.5.5.2.

Table 3.8-201

CP COL 3.8(27)

Environmental Temperature Gradients for the Exterior Walls and Roofs of UHSRS, PSFSV, and ESWPT

Normal air temperatures range from a maximum of 115° F to a minimum -10° F. The seasonal soil temperature gradient follows:

	Winter (minimum °F)	Summer (maximum °F)
Plant Grade	42	92
-10 ft.	57	77
-20 ft.	62	72
-30 ft.	65	69

Note: Based on 2°F increase in range from Reference NOAA NCDC data.

CP COL 3.7(7)
CP COL 3.8(25)

Table 3.8-202

Summary of Bearing Pressures and Factor of Safety

Building	Bearing Pressures (lb/ft^2)		Ultimate Bearing Capacity (lb/ft^2)	Available Factor of Safety (Based on Ultimate Bearing Capacity)		Allowable Bearing Capacity (lb/ft^2)		Ratio of Allowable Bearing Capacity to Bearing Pressure	
	Static Case	Seismic Case		Static Case(1)	Seismic Case(2)	Static Case	Seismic Case	Static Case	Seismic Case
R/B Complex	13,100	20,900	146,000	11.1	7.0	48,700	73,000	3.7	3.5
T/B	5,900(6)	7,400(6)	146,000	24.7	19.7	48,700	73,000	8.3	9.9
PSFSVs	4,000(3)	7,600(3)	146,000	36.5	19.2	48,700	73,000	12.2	9.6
UHSRS	4,900(4)	14,900(4)	146,000	29.8	9.8	48,700	73,000	9.9	4.9
ESWPT	4,600(5)	8,500(5)	146,000	31.7	17.2	48,700	73,000	10.6	8.6

Notes:

1) Static pressures values represent average pressures under static load.
2) Seismic pressures values represent the maximum toe pressures under combination of static and seismic loads.
3) The pressure shown includes bearing pressure due to full fuel oil tanks.
4) The pressure shown includes bearing pressure due to full reservoirs.
5) The maximum bearing pressures occur underneath Segment 1aS of the ESWPT.
6) The T/B bearing pressures and Factors of Safety shown above are for the standard plant design. Due to the low seismic response at the Comanche Peak Nuclear Plant site, the T/B site-specific bearing pressures are less than, and Factors of Safety are greater than the standard plant design values for the T/B.

Table 3.8.5-6R

CP COL 3.8(31)
CP COL 3.8(32)

Load Combinations and Calculated(12) Minimum Factors of Safety for Stability of Seismic Category I and II Structures

Building/Structure	Load Combination	Overturning (FS_{ot})	Sliding (FS_{sl})	Flotation (FS_{fl})
R/B Complex	D + H + W(8)	>10	>10	N/A
	D + H + E_s	1.2	See note 11	N/A
	D + H + W_t(8)	>10	>10	N.A
	D + F_b(9)	N/A	N/A	3.8
T/B(10)	D + H + W	>10	>10	N/A
	D + H + E_s	1.2	See note 11	N/A
	D + H + W_t	>5	>5	N/A
	D + F_b	N/A	N/A	1.9
PSFSVs(7)	D + H + W(6)	N/A	N/A	-
	D + H + E_s	1.50(1), (4)	1.11(1), (4), (5)	-
	D + H + W_t(6)	N/A	N/A	-
	D + F_b	N/A	N/A	1.32(2)
UHSRS(7)	D + H + W	4.86(1)	12.8(1)	-
	D + H + E_s	2.34(1), (3)	1.30(1), (3)	-
	D + H + W_t	4.49(1)	9.16(1)	-
	D + F_b	-	-	1.66(2)
ESWPT	D + H + W(6)	N/A	N/A	-
	D + H + E_s	1.65	1.47	-
	D + H + W_t(6)	N/A	N/A	-
	D + F_b	-	-	8.41

Notes
1. Ground water elevation for the calculation of the buoyancy force is 795 ft.
2. Ground water elevation for the calculation of the buoyancy force due to flotation is 821 ft.
3. The factors of safety for the UHSRS cases including the seismic effect are computed on a time history basis. The coefficient of friction used is taken as 0.6.
4. The factors of safety for the PSFSVs cases are based upon the seismic loads which are conservatively combined in 100-100-100 percentage in each direction, on a static equivalent basis. The coefficient of friction used is taken as 0.6.
5. In evaluating the PSFSV sliding case, three full tanks are used to determine the sliding demands, but only two full tanks and one empty tank were considered in calculating resistance against sliding.

6. No wind loads or tornado wind loads are considered, since the PSFSV and ESWPT are completely buried structures.
7. Superimposed dead load (De), live load (L), and fluid load (F) are not included in the resistance portion of the stability calculation. However, superimposed dead load, fluid load, and 25% of the live load hare been included in the seismic mass.
8. Standard plant stability evaluation under wind loads and tornado wind loads is applicable to the Comanche Peak site due to unchanged design wind and tornado wind loads.
9. A site-specific flotation stability evaluation is not required since the weight of the R/B complex is identical to the one considered in the standard design and the flood ground water level remains 1ft below plant grade.
10. The T/B Factors of Safety shown above are for the standard plant design. Due to the low seismic response at the Comanche Peak Nuclear Plant site, the T/B site-specific Factors of Safety are greater than the standard plant design values for the T/B.
11. Standard plant sliding analyses documented in Technical Report MUAP-12002 have determined that sliding occurs for standard plant seismic conditions. Conservatively, the standard plant design, which accommodates a maximum R/B complex sliding displacement of 0.75” and a maximum T/B sliding displacement of 0.20’, is incorporated by reference for the Comanche Peak site.
12. Factors of safety reported in this table may show values which have been conservatively rounded down from calculated values.

(SRI)

CP COL 3.8(19)

Figure 3.8-201 General Arrangement of ESWPT, UHSRS, and PSFSV

(SRI)

CP COL 3.8(19)
CP COL 3.8(24)

Figure 3.8-202 Typical UHS ESWPT Section Adjacent to UHS Basin with Cooling Water Air Intake Missile Enclosure

(SRI)

CP COL 3.8(19)

Figure 3.8-203 Typical Section for ESWPT

(SRI)

CP COL 3.8(19)

Figure 3.8-204 Section of ESWPC at R/B Complex and PSFSVs Showing Fuel Pipe/Access Tunnel

(SRI)

CP COL 3.8(19)

Figure 3.8-205 Section of ESWPC at R/B Complex and T/B Interface

(SRI)

CP COL 3.8(19)

Figure 3.8-206 General Arrangement of UHS Basin

(SRI)

CP COL 3.8(19)

Figure 3.8-207 Plan of Fan-Supporting Structure and Concrete, and Slab/Grating Plan Above the Fan

(SRI)

CP COL 3.8(19)

Figure 3.8-208 Typical Section of UHS Looking North at Pump House, UHS Basin and Cooling Tower Fans

(SRI)

CP COL 3.8(19)

Figure 3.8-209 Typical Section Looking West at UHS Basin and Pump House Interface with UHS ESWPT

(SRI)

CP COL 3.8(19)

Figure 3.8-210 Typical Section Looking West at UHS Basin and Cooling Tower Interface with UHS ESWPT

(SRI)

CP COL 3.8(19)

Figure 3.8-211 Typical Section Looking North at UHS Basin, Elevated Cooling Tower and Pump House Slabs

(SRI)

CP COL 3.8(19)

Figure 3.8-212 Plan of East and West PSFSVs

(SRI)

CP COL 3.8(19)
CP COL 3.8(24)

Figure 3.8-213 Typical Section Looking West at PSFSV

(SRI)

CP COL 3.8(19)
CP COL 3.8(24)

Figure 3.8-214 Typical Section Looking North at PSFSV

3.9 MECHANICAL SYSTEMS AND COMPONENTS

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

3.9.2.4.1 Background

CP COL 3.9(2) Replace the first, second and third paragraphs in DCD Subsection 3.9.2.4.1 with the following.

The CPNPP Unit 3 reactor internals are classified as a prototype in accordance with RG 1.20 (Reference 3.9-21). Upon qualification of the CPNPP Unit 3 as a valid prototype, the CPNPP Unit 4 reactor internals will be classified as non-prototype category I based on the designation of RG 1.20 (Reference 3.9-21).

Following the recommendation of RG 1.20 (Reference 3.9-21), a pre-operational vibration measurement program is developed for the CPNPP Unit 3 as the first operational US-APWR reactor internals. Data will be acquired only during the hot functional test, before core loading. This is in accordance with RG 1.20. Analysis (Subsection 3.9.2.3) shows that the responses under normal operating conditions with fuel assemblies in the core are almost the same or slightly smaller than those under hot functional test conditions without the core. The final report of the results of the vibration assessment program is submitted to the NRC within 180 days following completion of vibration testing.

Subsequent to the completion of the vibration assessment program for the CPNPP Unit 3 reactor internals, the vibration analysis program will be used to qualify the CPNPP Unit 4 under the criteria for non-prototype category I.

3.9.3.3.1 Pump Operability

STD COL 3.9(10) Replace the last sentence of the first paragraph in DCD Subsection 3.9.3.3.1 with the following.

The site-specific list of active pumps is provided in Table 3.9-201.

3.9.3.4.2.5 Design Specifications

STD COL 3.9(1) Replace the second paragraph of DCD Subsection 3.9.3.4.2.5 with the following.

The design specification for snubbers installed in harsh service conditions (e.g., high humidity, temperature, radiation levels) is evaluated for the projected life of the snubber to assure snubber functionality including snubber materials (e.g., lubricants, hydraulic fluids, seals).

3.9.6 Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

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STD COL 3.9(6)
STD COL 3.9(8)

Replace the seventh paragraph in DCD Subsection 3.9.6 with the following.

The US-APWR utilizes the ASME OM Code, 2004 Edition through the 2006 Addenda (or the optional ASME Code Cases listed in NRC RG 1.192 that is incorporated by reference in paragraph (b) of 10 CFR 50.55a, subject to the applicable limitations and modifications) (Reference 3.9-13) for developing the IST Program for ASME Code, Section III, Class 1, 2 and 3 safety-related pumps, valves and dynamic restraints in US-APWR Subsection 3.9.6. The inservice testing (IST) program for pumps, valves, and dynamic restraints including the ASME OM Code edition and addenda to be used for the IST program is administratively controlled to ensure that the equipment will be capable of performing its safety function throughout the life of the plant.

Inservice Testing Program Description

The CPNPP Units 3 and 4 IST program incorporates the IST program described in US-APWR DCD Section 3.9.6 and its subsections as expanded in this FSAR subsection. The IST program is developed in accordance with the requirements delineated in ASME Code Section XI Rules for Inservice Inspection of Nuclear Power Plant Components, the ASME OM Code, the plant Technical Specifications, and good engineering practices. The IST relies on baseline information obtained during plant construction and startup testing. The program is implemented in general conformance with NUREG-1482 (Reference 3.9-60), Guidelines for Inservice Testing at Nuclear Power Plants.

Aspects of the IST program will:

a. verify the appropriate Code Class for each component of the plant, identify the system boundaries for each class of components subject to test or examination, and identify the components exempt from testing or examination requirements

b. verify the design and arrangement of system components to include allowance for adequate access and clearances for conducting the tests and examinations (done as part of the initial

design verification phase and for any subsequent plant modifications)

c. verify that appropriate IST requirements are captured in procurement specifications for ASME components

d. prepare plans and schedules for the implementation of the IST program and the performance of IST activities

e. prepare written test and examination instructions and procedures. In formulating program procedures, the appropriate code edition and addenda are to be identified and administratively controlled.

f. verify the qualification of personnel who perform and evaluate examinations and tests in accordance with the QAP

g. perform the required tests and examinations

h. record the required test and examination results that provide a basis for evaluation and facilitate comparison with the results of subsequent tests or examinations

i. evaluate tests and examination results

j. maintain adequate test and examination records in accordance with the QAP requirements

k. retain test and examination records for the service lifetime of the component or system

l. assure that any plant changes that impact IST requirements are evaluated and the IST program is adjusted accordingly

m. provide for the training of personnel assigned to perform IST functions

Additional details are provided for each component or group of components within the scope of the IST program. For example, some of the information that is incorporated in project documents such as the System Design Packages, System Descriptions, Procurement Specifications, System Requirement Documents, etc. includes:

- Equipment design, qualification, testing, inspection, surveillance, and documentation requirements

- Codes and standards to be applied, and their justification

- Regulatory guides and Code cases to be applied

- Equipment design life requirements
- Equipment design-basis calculation methodology
- Application requirements such as fluid conditions, ambient temperatures, etc. Special design requirements such as valve seat types and materials, valve stem friction limitations and materials, snubber types or pump types and materials, operating requirements methodology and assumptions such as valve thrust and torque requirement or pump flow and head requirement.
- Equipment sizing and testing methodology requirements
- Power supply design requirements, degraded voltage, ambient temperature effects, battery life, and thermal overload devices
- Lubricants and lubrication requirements
- Weak link design, qualification, and surveillance methodology requirements
- Environmental qualification methodology and qualification report requirements
- Design, qualification, surveillance, and replacement requirements for non-metallic parts
- Periodic verification and condition monitoring requirements
- Responsibilities of vendor and licensee for design, qualification, testing, and documentation

The descriptions and items identified in this section are intended to be a general outline only. They are not all inclusive but are intended to be representative of various elements of the IST program.

The IST program, including pumps, valves and dynamic restraints, will be developed and implemented per the milestone schedule provided in Table 13.4-201 for the Inservice Testing Program.

3.9.6.2 IST Program for Pumps

STD COL 3.9(11) Replace the seventh paragraph in DCD Subsection 3.9.6.2 with the following.

The site-specific safety-related pump IST parameters and frequencies are provided in Table 3.9-202.

3.9.6.3 IST Program for Valves

STD COL 3.9(12) Replace the fifth paragraph in DCD Subsection 3.9.6.3 with the following.

The types of testing and frequencies of site-specific valves subject to IST in accordance with the ASME Code are provided in Table 3.9-203.

3.9.6.4 IST Program for Dynamic Restraints

STD COL 3.9(6) Replace the second paragraph in DCD Subsection 3.9.6.4 with the following.

The IST program for dynamic restraints is implemented in accordance with the ASME OM Code.

3.9.9 Combined License Information

Replace the content of DCD Subsection 3.9.9 with the following.

STD COL 3.9(1) ***3.9(1)*** *Snubber functionality*

This COL item is addressed in Subsection 3.9.3.4.2.5

CP COL 3.9(2) ***3.9(2)*** *Classification of CPNPP Unit 3 reactor internals as prototype*

This COL item is addressed in Subsection 3.9.2.4.1.

3.9(3) *Deleted from the DCD.*

3.9(4) *Deleted from the DCD.*

3.9(5) *Deleted from the DCD.*

STD COL 3.9(6) ***3.9(6)*** *Program for IST of dynamic restraints in accordance with the ASME OM Code.*

This COL item is addressed in Subsection 3.9.6 and 3.9.6.4.

3.9(7) *Deleted from the DCD.*

STD COL 3.9(8)

3.9(8) *Administrative control of the edition and addenda to be used for the IST program and to provide a full description of their IST program for pumps, valves, and dynamic restraints.*

This COL item is addressed in Subsection 3.9.6.

3.9(9) *Deleted from the DCD.*

STD COL 3.9(10)
CP COL 3.9(10)

3.9(10) *Site-specific active pumps*

This COL item is addressed in Subsection 3.9.3.3.1, and Table 3.9-201.

STD COL 3.9(11)
CP COL 3.9(11)

3.9(11) *Site-specific, safety-related pump IST parameters and frequency*

This COL item is addressed in Subsection 3.9.6.2, and Table 3.9-202.

STD COL 3.9(12)
CP COL 3.9(12)

3.9(12) *Testing and frequency of site-specific valves subject to IST*

This COL item is addressed in Subsection 3.9.6.3, and Table 3.9-203.

CP COL 3.9(10)

Table 3.9-201

List of Site-Specific Active Pumps

Pump	System	ASME Class	Normal Operation Mode	Post LOCA Mode[2]	Basis[1]
A-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
B-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
C-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins
D-UHS Transfer Pump	UHS	3	OFF	ON	Required For Transferring Water Between Basins

Notes:

1. Except for during IST, pumps do not operate during normal operation mode. In the post LOCA mode, the pumps are operated remotely when required.

2. As necessary to maintain basin level.

Table 3.9-202

CP COL 3.9(11)

Site-Specific Pump IST Requirements

Tag No.	Description	Pump Type	ASME IST Category	Required Test				Test Frequency	Acceptance Criteria
				Outlet Flow	Differential Pressure	Vibration	Speed		
UHS-MPP -001A	A-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1)Quarterly, Required Test is conducted (2)Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code(Reference 3.9-13) is applied.
UHS-MPP -001B	B-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1)Quarterly, Required Test is conducted (2)Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code(Reference 3.9-13) is applied.
UHS-MPP -001C	C-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1)Quarterly, Required Test is conducted (2)Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code(Reference 3.9-13) is applied.
UHS-MPP -001D	D-UHS Water Transfer Pump	Vertical Line Shaft Centrifugal	B	O	-	O	N/A (constant speed induction motor)	(1)Quarterly, Required Test is conducted (2)Biennially, Comprehensive Test is conducted	Table ISTB-5200-1 in ASME OM Code(Reference 3.9-13) is applied.

CP COL 3.9(12)

Table 3.9-203 (Sheet 1 of 5)

Site-Specific Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
UHS-VLV-502A	A-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	1
UHS-VLV-502B	B-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	1
UHS-VLV-502C	C-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	1
UHS-VLV-502D	D-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	1

CP COL 3.9(12)

Table 3.9-203 (Sheet 2 of 5)

Site-Specific Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
UHS-MOV-503A	A-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-503B	B-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-503C	C-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-503D	D-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2

CP COL 3.9(12)

Table 3.9-203 (Sheet 3 of 5)

Site-Specific Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
UHS-MOV-50 6A	A-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-50 6B	B-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-50 6C	C-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2
UHS-MOV-50 6D	D-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open Maintain Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	2

Table 3.9-203 (Sheet 4 of 5)

CP COL 3.9(12)

Site-Specific Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
ESW-HCV-010	A-UHS Basin Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	3
ESW-HCV-011	B-UHS Basin Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	3
ESW-HCV-012	C-UHS Basin Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	3
ESW-HCV-013	D-UHS Basin Blowdown Control Valve	Remote AO Globe	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	3
EWS-AOV-576A, B, C, D	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	Remote AO Butterfly	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exercise/ 2 Years Exercise Full Stroke/Quarterly Operability test	3

CP COL 3.9(12)

Table 3.9-203 (Sheet 5 of 5)

Site-Specific Valve IST Requirements

Valve Tag Number	Description	Valve Type	Safety-Related Missions	Safety Functions	ASME IST Category	Inservice Testing Type and Frequency	IST Notes
ESW-AOV-57 7	ESWS Blowdown main Header Isolation Valve to CWS blowdown main header	Remote AO Butterfly	Maintain Close Transfer Close	Active-to-Fail Remote Position	B	Remote Position Indication, Exerecise/ 2 Years Exercise Full Stroke/Quarterly Operability test	3

Notes:

1) The check valve exercise test is performed during refueling outage. Valves in the inaccessible primary containment can not be tested during power operation. Test of valves in operating systems may cause impact of power operation. Simultaneous testing of valves in the same system group will be considered.
2) Remote Position indication is observed once every 2 years. Full close to open and full open to close are exercised at quarterly operability test.
3) Remote Position indication is observed once every 2 years. Full open to close are exercised at quarterly operability test.

3.10 SEISMIC AND DYNAMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

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

STD COL 3.10(3) Replace the second sentence of the fifth paragraph in DCD Section 3.10 with the following.

The files generated by the environmental qualification (EQ) Program referenced in Subsection 3.10.4.1 include provisions for recording seismic qualification information including test results. The records that form the equipment qualification files include provisions for recording seismic qualification information and are sometimes referred to as equipment qualification summary data sheets (EQSDS). The qualification records for each seismic category I and II piece of equipment are updated for individual components as new information becomes available. Information is recorded during the analysis, design, procurement (including testing information), construction, and preoperational testing phases of the project and will be available for review throughout the duration of the project. The implementation of the Operational EQ Program prior to fuel load is a license condition in accordance with Table 13.4-201.

3.10.1 Seismic Qualification Criteria

CP COL 3.10(8) Replace the last sentence of third paragraph in DCD Subsection 3.10.1 with the following.

For design of seismic category I and seismic category II SSCs that are site-specific (not part of the standard plant), the OBE is set at 1/3 of the site-specific SSE, as discussed in Subsection 3.7.1.1, and is therefore eliminated from explicit design analysis, except for fatigue effects as explained below.

3.10.2 Methods and Procedures for Qualifying Mechanical and Electrical Equipment and Instrumentation

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CP COL 3.10(9) Replace the last two sentences of the fourth paragraph in DCD Subsection 3.10.2 with the following.

However, the site-specific GMRS and FIRS as reported in Section 3.7 do not exceed the CSDRS. Therefore, high frequency exceedances of in-structure response spectra and subsequent potential effects on the functional performance

of vibration-sensitive components, such as relays and other instrument and control devices, whose output could be affected by high frequency excitation, are not applicable.

CP COL 3.10(5) Replace the twenty-sixth paragraph (starts with “Components that have been previously tested …”) in DCD Subsection 3.10.2 with the following.

Components that have been previously tested to IEEE Std 344-1971 prior to submittal of the DCD will be reevaluated six months prior to procurement of equipment to justify the appropriateness of the input motion and requalify the components using biaxial test input motion, except when a single-axis test input motion is justified. Results of the reevaluation and requalification of the above described components are incorporated into the equipment environmental qualification program.

3.10.4.1 Implementation Program and Milestones

STD COL 3.10(1) Replace the second sentence in DCD Subsection 3.10.4.1 with the following.

Technical Report MUAP-08015, "US-APWR Equipment Qualification Program" (DCD Reference 3.11-3) describes the EQ Program, as defined in DCD Tier 2 Section 3.11, for all COL applicants using the US-APWR technology. The Technical Report was submitted to the NRC as part of the US-APWR Design Certification application. Figure 2.1 of MUAP-08015 established the overall framework for implementing the EQ Program including seismic qualification. The seismic qualification program implementation schedule is part of the EQ Program implementation milestone schedule provided in FSAR Section 3.11. The seismic qualification program is implemented during the design, procurement, construction and preoperational testing phases of the project as described in MUAP-08015. The project-specific implementation milestone for the seismic qualification program is consistent with the EQ Program implementation milestone identified in FSAR Table 13.4-201. Project-specific implementation of the US-APWR EQ Program provides for the turnover of all EQ Program records to the licensee. The EQ Program is the basis for the seismic qualification program applicable to replacement parts and components during plant operation.

3.10.5 Combined License Information

Replace the content of DCD Subsection 3.10.5 with the following.

STD COL 3.10(1) ***3.10(1)*** *Equipment seismic qualification program*

This COL item is addressed in Subsection 3.10.4.1.

3.10(2) *Deleted from the DCD.*

STD COL 3.10(3) ***3.10(3)*** *Maintenance of equipment qualification files, including EQSDSs*

This COL item is addressed in Section 3.10.

3.10(4) *Deleted from the DCD.*

CP COL 3.10(5) ***3.10(5)*** *Previously tested components*

This COL item is addressed in Subsection 3.10.2.

3.10(6) *Deleted from the DCD.*

3.10(7) *Deleted from the DCD.*

CP COL 3.10(8) ***3.10(8)*** *Site-specific OBE*

This COL item is addressed in Subsection 3.10.1.

CP COL 3.10(9) ***3.10(9)*** *Applicability of high frequency*

This COL item is addressed in Subsection 3.10.2.

3.10(10) *Deleted from the DCD.*

3.11 ENVIRONMENTAL QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

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

CP COL 3.11(3) Replace the last sentence of the tenth paragraph in DCD Section 3.11 with the following.

The CPNPP Units 3 and 4 EQ Program implementation milestones are as follows:

Activity	Milestone
Formulate Units 3 and 4 EQ Program	COLA Submittal
Assist with Reactor Vendor/Architect-Engineer/Constructor EQ Program	Combined License
Operational EQ Program established	Unit 3 Fuel Load
Operational EQ Program established	Unit 4 Fuel Load

CP COL 3.11(1) Replace the first sentence of the eleventh paragraph in DCD Section 3.11 with the following.

Prior to unit fuel load, the Licensee establishes and implements an Operational EQ program and assembles and maintains the electrical and mechanical EQ records for the life of the plant to fulfill the records retention requirements delineated in 10 CFR 50.49 (Reference 3.11-2) and in compliance with the quality assurance program (QAP) described in Chapter 17.

CP COL 3.11(4) Replace the thirteenth paragraph in DCD Section 3.11 with the following.

This subsection addresses EQ implementation in conjunction with the initial design, procurement, construction, startup and testing up to the point of turnover. Implementation of the operational EQ program is included in Table 13.4-201. Periodic tests, calibrations, and inspections which verify that the identified equipment remains capable of fulfilling its intended function are described in the operational EQ program. The features of the US-APWR Equipment Qualification Program Technical Report MUAP-08015 (Reference 3.11-3) are included in the CPNPP Units 3 and 4 EQ Program.

3.11.1.1 Equipment Identification

STD COL 3.11(5) Replace the last sentence of the first paragraph in DCD Subsection 3.11.1.1 with the following.

Table 3D-201 identifies site-specific electrical and mechanical equipment locations and environmental conditions (both normal and accident) to be addressed in the EQ program. This table lists information on site-specific safety-related equipment and non-safety-related equipment which is important to safety. The provisions in the US-APWR DCD for the environmental qualification of mechanical equipment are applied to the plant-specific systems. This list forms the basis for the operational Equipment Qualification Master Equipment List (EQMEL), which will be prepared in conjunction with work activities authorized by an engineering/procurement/construction (EPC) contract.

3.11.1.2 Definition of Environmental Conditions

STD COL 3.11(9) Replace the fourth sentence of the first paragraph in DCD Subsection 3.11.1.2 with the following.

Plant-specific EQ parameters are documented in the corresponding equipment specifications, drawings, procedures, instructions, and qualification packages. When procurement specifications are developed they will contain, as applicable, the following items:

- Applicable EQ parameters for harsh or mild environments (see MUAP-08015, Chapter 4 for a list of parameters and allowable/required margins). This includes attributes such as operating and accident temperature ranges and radiation levels, qualification testing requirements typical of an equipment supplier, qualified life requirements, expectations for equipment suppliers to provide a list of components that need to be replaced periodically in order to maintain qualification, records and documentation requirements for the equipment vendor, etc.

- Applicable seismic parameters

- Applicable operating time for certain SSCs subject to harsh environment operability limitations

- Acceptable methods of qualification (test, analysis, commercial grade dedication, etc.) for each listed attribute or parameter and appropriate QA requirements
- Acceptable types of documentation to be supplied to document qualification
- Other issues pertinent to the preparation of these specifications address shipping, storage, installation and spare parts requirements.

3.11.3 Qualification Test Results

STD COL 3.11(2) Replace the fifth paragraph in DCD Subsection 3.11.3 with the following.

Test results for electrical and mechanical equipment are maintained with the project records as auditable files. Such records are maintained from the time of initial receipt through the entire period during which the subject equipment remains installed in the plant or is stored for future use. Documentation for the qualification of safety-related equipment and non-safety-related equipment, which is important to safety, is ultimately the responsibility of the COL Applicant who, later as the licensee, maintains a complete set of EQ records. The EQ records are maintained for the life of plant to fulfill the records retention requirements delineated in 10 CFR 50.49 (Reference 3.11-2) and in compliance with the QAP described in Chapter 17.

3.11.4 Loss of Ventilation

STD COL 3.11(6) Replace the second paragraph in DCD Subsection 3.11.4 with the following.

Site-specific electrical and mechanical equipment (including instrumentation and control and certain accident monitoring equipment), subject to environmental stress associated with loss of ventilation or other environmental control systems including heat tracing, heating, and air conditioning, is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.5 Estimated Chemical and Radiation Environment

STD COL 3.11(7) Replace paragraph in DCD, Subsection 3.11.5 with the following.

Chemical and radiation environmental requirements for site-specific electrical and mechanical equipment (including instrumentation and control and certain accident monitoring equipment) are included in MUAP-08015 (Reference 3.11-3). This equipment is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.6 Qualification of Mechanical Equipment

STD COL 3.11(8) Replace the second paragraph in DCD, Subsection 3.11.6 with the following.

Site-specific mechanical equipment requirements are to be included in Table 3D-201 by completion of detailed design. This equipment is qualified using the process described in MUAP-08015 (Reference 3.11-3).

3.11.7 Combined License Information

Replace the content of DCD Subsection 3.11.7 with the following.

CP COL 3.11(1) ***3.11(1)*** *Environmental qualification document assembly and maintenance*

This COL item is addressed in Section 3.11.

STD COL 3.11(2) ***3.11(2)*** *Qualification tests results recorded*

This COL item is addressed in Subsection 3.11.3.

CP COL 3.11(3) ***3.11(3)*** *Schedule for EQ program implementation milestones*

This COL item is addressed in Section 3.11.

CP COL 3.11(4) ***3.11(4)*** *Periodic tests, calibrations, and inspections*

This COL item is addressed in Section 3.11.

STD COL 3.11(5) CP COL 3.11(5) ***3.11(5)*** *Site-specific equipment addressed in EQ program*

This COL item is addressed in Subsection 3.11.1.1, Subsection 3D.1.6 and Table 3D-201.

STD COL 3.11(6) ***3.11(6)*** *Site-specific equipment qualification process*

This COL item is addressed in Subsection 3.11.4.

STD COL 3.11(7) ***3.11(7)*** *Site-specific chemical and radiation environmental requirements*

This COL item is addressed in Subsection 3.11.5.

STD COL 3.11(8)
CP COL 3.11(8)

3.11(8) *Site-specific mechanical equipment requirements*

This COL item is addressed in Subsection 3.11.6, Subsection 3D.1.6 and Table 3D-201.

STD COL 3.11(9)

3.11(9) *Parameters based on site-specific considerations*

This COL item is addressed in Subsection 3.11.1.2.

3.12 PIPING DESIGN REVIEW

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

3.12.5.1 Seismic Input Envelope vs. Site-Specific Spectra

STD COL 3.12(2) Replace the second paragraph in DCD Subsection 3.12.5.1 with the following.

For piping located in the yard that is not part of the US-APWR standard design, site specific response spectra described in Subsection 3.7.1 are used for piping analysis.

3.12.5.3.6 Wind/Tornado or Hurricane Loads

CP COL 3.12(3) Replace the paragraph in DCD Subsection 3.12.5.3.6 with the following.

There is no ASME Code, Section III (Reference 3.12-2) Class 2 or 3 piping exposed to wind, tornado or hurricane loading. Non-ASME piping, such as B31.1 (Reference 3.12-1) exposed to wind, tornado or hurricane loading, is evaluated to the wind and tornado or hurricane loading identified in Section 3.3, in conjunction with the applicable piping code load combinations.

3.12.5.6 High-Frequency Modes

CP COL 3.12(4) Replace the second sentence of the second paragraph in DCD Subsection 3.12.5.6 with the following.

For the site-specific ground motion response spectra, there are no high frequency exceedances of the CSDRS. Therefore, high frequency screening of the piping system for high frequency sensitivity is not required.

3.12.5.10 Thermal Stratification

CP COL 3.12(5) Replace the last sentence of the last paragraph in DCD Subsection 3.12.5.10 with the following.

The monitoring of the first cycle operation is performed when the CPNPP Unit 3 or 4 will be the first US-APWR Plant.

3.12.7 Combined License Information

Replace the content of DCD Subsection 3.12.7 with the following.

3.12(1) *Deleted from the DCD.*

STD COL 3.12(2) ***3.12(2)*** *Site-specific seismic response spectra for design of piping*

This COL item is addressed in Subsection 3.12.5.1.

CP COL 3.12(3) ***3.12(3)*** *Site-specific ASME Code, Section III, Class 2 or 3 piping, exposed to wind, tornado or hurricane loads*

This COL item is addressed in Subsection 3.12.5.3.6.

CP COL 3.12(4) ***3.12(4)*** *Piping systems evaluation for sensitivity to high frequency modes*

This COL item is addressed in Subsection 3.12.5.6.

CP COL 3.12(5) ***3.12(5)*** *The monitoring of thermal stratification at pressurizer surge line*

This COL item is addressed in Subsection 3.12.5.10.

3.13 THREADED FASTENERS (ASME CODE CLASS 1, 2, AND 3)

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

3.13.1.5 Certified Material Test Reports

STD COL 3.13(3) Replace the first sentence in the first paragraph in DCD Subsection 3.13.1.5 with the following.

Quality records, including certified material test reports for all property test and analytical work performed on nuclear threaded fasteners, are maintained for the life of plant as part of the QAP described in Chapter 17.

3.13.2 Inservice Inspection Requirements

STD COL 3.13(4) Replace the last sentence of the first paragraph in DCD Subsection 3.13.2 with the following.

Compliance with the requirements of the ISI program relating to threaded fasteners, including any applicable PSI and IST, is implemented as part of the operational programs. The ISI program is baselined using PSI. A PSI program relating to threaded fasteners will be implemented after the start of construction and prior to initial plant startup to comply with the requirements of ASME Section XI (Reference 3.13-14). Additionally, in accordance with ASME Section XI, IWA-1200, the PSI code requirements may be performed irrespective of location (such as at manufacturer) once the construction Code requirements have been met.

STD COL 3.13(5) Replace the first sentence of the fifth paragraph in DCD Subsection 3.13.2 with the following.

An ISI program for the pressure testing of mechanical joints utilizing threaded fasteners is implemented in accordance with the requirements of ASME Code, Section XI, IWA-5000 (Reference 3.13-14), and the requirements of 10 CFR 50.55a(b)(2)(xxvi) (Reference 3.13-11), Pressure Testing Class 1, 2, and 3 Mechanical Joints, and Removal of Insulation, paragraph (xxvii).

3.13.3 Combined License Information

Replace the content of DCD Subsection 3.13.3 with the following.

3.13(1) *Deleted from the DCD.*

3.13(2) *Deleted from the DCD.*

STD COL 3.13(3) ***3.13(3)*** *Quality records including certified material test reports for property test and analytical work on threaded fasteners*

This action is resolved in Subsection 3.13.1.5.

STD COL 3.13(4) ***3.13(4)*** *Compliance with ISI requirements*

This COL Item is addressed in Subsection 3.13.2.

STD COL 3.13(5) ***3.13(5)*** *Complying with requirements of ASME Code, Section XI, and 10 CFR 50.55a*

This COL Item is addressed in *Subsection 3.13.2*.

APPENDIX 3A

HEATING, VENTILATION, AND AIR CONDITIONING DUCTS AND DUCT SUPPORTS

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3A HEATING, VENTILATION, AND AIR CONDITIONING DUCTS AND DUCT SUPPORTS

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

APPENDIX 3B

BOUNDING ANALYSIS CURVE DEVELOPMENT FOR LEAK BEFORE BREAK EVALUATION OF HIGH-ENERGY PIPING FOR UNITED STATES — ADVANCED PRESSURIZED WATER REACTOR

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3B BOUNDING ANALYSIS CURVE DEVELOPMENT FOR LEAK BEFORE BREAK EVALUATION OF HIGH-ENERGY PIPING FOR UNITED STATES – ADVANCED PRESSURIZED WATER REACTOR

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

APPENDIX 3C

REACTOR COOLANT LOOP ANALYSIS METHODS

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3C REACTOR COOLANT LOOP ANALYSIS METHODS

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

APPENDIX 3D

EQUIPMENT QUALIFICATION LIST SAFETY AND IMPORTANT TO SAFETY ELECTRICAL AND MECHANICAL EQUIPMENT

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3D EQUIPMENT QUALIFICATION LIST SAFETY AND IMPORTANT TO SAFETY ELECTRICAL AND MECHANICAL EQUIPMENT

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

STD COL 3.11(5)
STD COL 3.11(8)

3D.1.6 Determination of Seismic Requirements

Replace the third and fourth sentences of DCD Appendix 3D, Subsection 3D.1.6 with the following.

The seismic class of safety-related mechanical, electrical, and Instrumentation and Control are shown in Table 3D-201 and DCD Table 3D-2. 10 CFR 50, Appendix B requirements will be applied to seismic category I electrical, instrumentation and control (I&C), and mechanical equipment contained in Table 3D-201 and DCD Table 3D-2, as discussed in DCD Subsections 3.2.1.1.1 and 3.2.1.1.2.

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 1 of 12)

Site-Specific Environmental Qualification Equipment List

			Location	Purpose		Environmental Conditions	Qualification Process	Seismic Category	
Item Num	Equipment Tag	Description	PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Engineered Safety Feature (ESF), Post Accident Monitoring (PAM), Other	Operational Duration	Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	Comments
1	UHS-LT-010A	A - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
2	UHS-LT-010B	A – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
3	UHS-LT-011A	B – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
4	UHS-LT-011B	B - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
5	UHS-LT-012A	C - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
6	UHS-LT-012B	C - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
7	UHS-LT-013A	D - UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
8	UHS-LT-013B	D – UHS Basin Water Level	UHSRS	PAM, Other	2 wks	Mild	E	I	
9	UHS-TE-010	A - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 2 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
10	UHS-TE-011	B - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
11	UHS-TE-012	C - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
12	UHS-TE-013	D - UHS Basin Temperature	UHSRS	PAM, Other	2 wks	Mild	E	I	
13	VRS-MFN-601A	A - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
14	VRS-MFN-601B	B - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
15	VRS-MFN-601C	C - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
16	VRS-MFN-601D	D - ESW Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
17	VRS-MFN-602A	A - UHS Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
18	VRS-MFN-602B	B - UHS Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 3 of 12)

Site-Specific Environmental Qualification Equipment List

			Location	Purpose		Environmental Conditions	Qualification Process	Seismic Category	
Item Num	Equipment Tag	Description	PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other	Operational Duration	Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	Comments
19	VRS-MFN-602C	C - UHS Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
20	VRS-MFN-602D	D - UHS Transfer Pump Room Exhaust Fan	UHSRS	ESF	1 yr	Mild	M	I	
21	VRS-MEH-601A	A - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
22	VRS-MEH-601B	B - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
23	VRS-MEH-601C	C - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
24	VRS-MEH-601D	D - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
25	VRS-MEH-602A	A - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
26	VRS-MEH-602B	B - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
27	VRS-MEH-602C	C - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
28	VRS-MEH-602D	D - ESW Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
29	VRS-MEH-603A	A - UHS Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 4 of 12)
Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
30	VRS-MEH-603B	B - UHS Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
31	VRS-MEH-603C	C - UHS Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
32	VRS-MEH-603D	D - UHS Transfer Pump Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
33	VRS-MEH-604A	A-ESW Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
34	VRS-MEH-604B	B-ESW Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
35	VRS-MEH-604C	C-ESW Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
36	VRS-MEH-604D	D-ESW Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
37	VRS-MEH-605A	A-UHS Transfer Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
38	VRS-MEH-605B	B-UHS Transfer Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
39	VRS-MEH-605C	C-UHS Transfer Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 5 of 12) Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
40	VRS-MEH-605D	D-UHS Transfer Piping Room Unit Heater	UHSRS	ESF	1 yr	Mild	M	I	
41	VRS-TS-803	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
42	VRS-TS-804	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
43	VRS-TS-805	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
44	VRS-TS-806	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
45	VRS-TS-812	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
46	VRS-TS-813	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 6 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
47	VRS-TS-814	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
48	VRS-TS-815	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
49	VRS-TS-823	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
50	VRS-TS-824	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
51	VRS-TS-825	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
52	VRS-TS-826	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
53	VRS-TS-832	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
54	VRS-TS-833	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 7 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
55	VRS-TS-834	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
56	VRS-TS-835	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
57	VRS-TS-843	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
58	VRS-TS-844	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
59	VRS-TS-845	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
60	VRS-TS-846	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
61	VRS-TS-852	C -UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
62	VRS-TS-853	C - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 8 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
63	VRS-TS-854	C - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
64	VRS-TS-855	C - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
65	VRS-TS-863	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
66	VRS-TS-864	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
67	VRS-TS-865	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
68	VRS-TS-866	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
69	VRS-TS-872	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
70	VRS-TS-873	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 9 of 12)

Site-Specific Environmental Qualification Equipment List

			Location	Purpose		Environmental Conditions	Qualification Process	Seismic Category	
Item Num	Equipment Tag	Description	PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other	Operational Duration	Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	Comments
71	VRS-TS-874	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
72	VRS-TS-875	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
73	UHS-MPP-001A	A - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
74	UHS-MPP-001B	B - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
75	UHS-MPP-001C	C - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
76	UHS-MPP-001D	D - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
77	UHS-MFN-001A	A – UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
78	UHS-MFN-001B	B – UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 10 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
79	UHS-MFN-001C	C - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
80	UHS-MFN-001D	D - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
81	UHS-MFN-002A	A – UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
82	UHS-MFN-002B	B – UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
83	UHS-MFN-002C	C - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
84	UHS-MFN-002D	D - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
85	UHS-MOV-503A	A - UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
86	UHS-MOV-503B	B – UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
87	UHS-MOV-503C	C – UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
88	UHS-MOV-503D	D – UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 11 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
89	UHS-MOV-506A	A - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
90	UHS-MOV-506B	B - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
91	UHS-MOV-506C	C - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
92	UHS-MOV-506D	D - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
93	EWS-HCV-010	A - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
94	EWS-HCV-011	B - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
95	EWS-HCV-012	C - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
96	EWS-HCV-013	D - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	

CP COL 3.11(5)
CP COL 3.11(8)

Table 3D-201 (Sheet 12 of 12)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose ESF, PAM, Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category I, II, Non	Comments
97	EWS-AOV-576A	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
98	EWS-AOV-576B	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
99	EWS-AOV-576C	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
100	EWS-AOV-576D	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
101	EWS-AOV-577	ESWS Blowdown main Header Isolation Valve to CWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	

APPENDIX 3E

HIGH ENERGY AND MODERATE ENERGY PIPING IN THE PRESTRESSED CONCRETE CONTAINMENT VESSEL AND REACTOR BUILDING

TABLE OF CONTENTS

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3E HIGH ENERGY AND MODERATE ENERGY PIPING IN THE PRESTRESSED CONCRETE CONTAINMENT VESSEL AND REACTOR BUILDING

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

APPENDIX 3F

DESIGN OF CONDUIT AND CONDUIT SUPPORTS

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3F DESIGN OF CONDUIT AND CONDUIT SUPPORTS

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

APPENDIX 3G

SEISMIC QUALIFICATION OF CABLE TRAYS AND SUPPORTS

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3G SEISMIC QUALIFICATION OF CABLE TRAYS AND SUPPORTS

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

APPENDIX 3H

MODEL PROPERTIES FOR LUMPED MASS STICK MODELS OF R/B-PCCV-CONTAINMENT INTERNAL STRUCTURES ON A COMMON BASEMAT

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3H MODEL PROPERTIES FOR LUMPED MASS STICK MODELS OF R/B-PCCV-CONTAINMENT INTERNAL STRUCTURES ON A COMMON BASEMAT

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

APPENDIX 3I

IN-STRUCTURE RESPONSE SPECTRA

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3I IN-STRUCTURE RESPONSE SPECTRA

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

APPENDIX 3J

REACTOR, POWER SOURCE AND CONTAINMENT INTERNAL STRUCTURAL DESIGN

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3J REACTOR, POWER SOURCE AND CONTAINMENT INTERNAL STRUCTURAL DESIGN

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

APPENDIX 3K

COMPONENTS PROTECTED FROM INTERNAL FLOODING

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3K-201	Location of Flood Barrier Walls UHSRS, ESWPT, and PSFSV

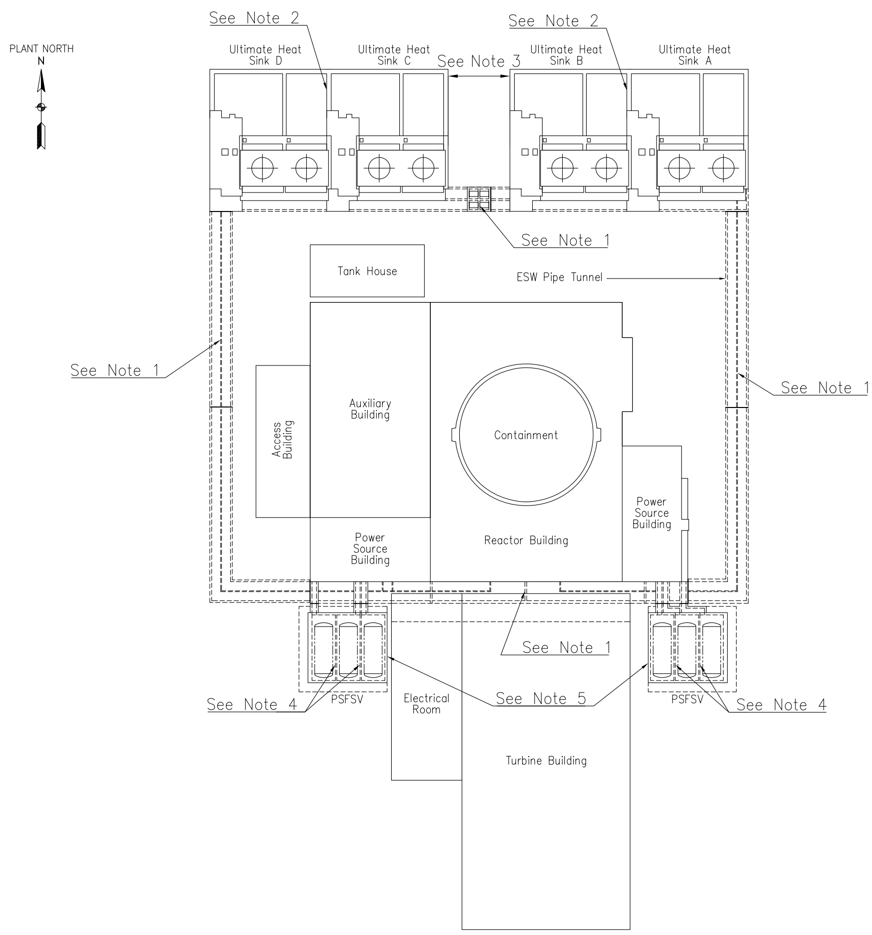
3K COMPONENTS PROTECTED FROM INTERNAL FLOODING

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

3K.1 Introduction

STD COL 3.4(7) Add the following paragraph after the last paragraph in DCD Subsection 3K.1.

Figure 3K-201 provides the location of flood barrier walls that are located in the UHSRS, the ESWPT, and the PSFSV.

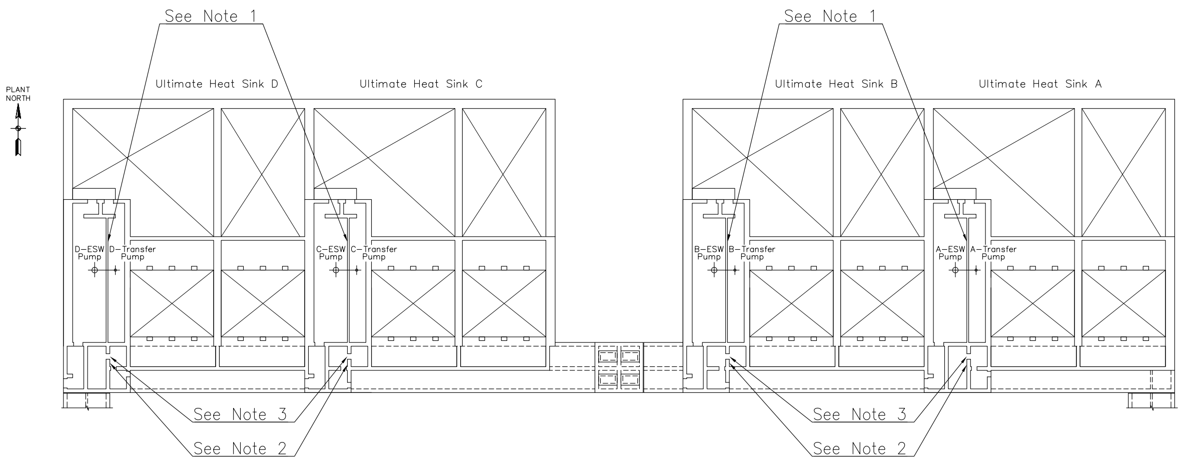


NOTES:

1. CONCRETE WALL BARRIER PROVIDES DIVISIONAL SEPARATION AND PREVENTS FLOODING BETWEEN ESWPT DIVISIONS.
2. CONCRETE WALLS BETWEEN EACH ULTIMATE HEAT SINK RELATED STRUCTURE PREVENT FLOODING COMMUNICATION BETWEEN THEM.
3. ULTIMATE HEAT SINK BASINS 'B' AND 'C' ARE PHYSICALLY SEPARATED WITH EXTERIOR CONCRETE WALL TO PREVENT FLOODING COMMUNICATION BETWEEN THEM.
4. CONCRETE WALLS BETWEEN EACH FUEL STORAGE TANK ENCLOSURE PREVENT FLOODING COMMUNICATION BETWEEN THEM.
5. POWER SOURCE FUEL STORAGE VAULTS ARE PHYSICALLY SEPARATED WITH EXTERIOR CONCRETE WALLS TO PREVENT FLOODING COMMUNICATION BETWEEN THEM.

CP COL 3.4(7)

Figure 3K-201 Location of Flood Barrier Walls UHSRS, ESWPT, and PSFSV (Sheet 1 of 2)



NOTES:

1. CONCRETE WALLS BETWEEN ESW PUMP ROOMS AND TRANSFER PUMP ROOMS PREVENT FLOODING COMMUNICATION BETWEEN THEM.
2. CONCRETE WALLS BETWEEN ESW PIPING ROOMS AND UHS TRANFER PIPING ROOMS PREVENT FLOODING COMMUNICATION BETWEEN THEM.
3. WATER-TIGHT DOORS ARE PROVIDED IN DOOR OPENINGS BETWEEN ESW PIPING ROOMS AND UHS TRANFER PIPING ROOMS PREVENT FLOODING COMMUNICATION BETWEEN THEM.

Figure 3K-201 Location of Flood Barrier Walls UHSRS, ESWPT, and PSFSV (Sheet 2 of 2)

CP COL 3.7(3)
CP COL 3.7(4)
CP COL 3.7(8)
CP COL 3.7(10)
CP COL 3.7(21)
CP COL 3.7(26)
CP COL 3.8(15)
CP COL 3.8(19)
CP COL 3.8(29)

APPENDIX 3KK

UHSRS SEISMIC MODELING, ANALYSIS, AND RESULTS

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ACRONYMS AND ABBREVIATIONS

Acronyms	Definitions
3D	three-dimensional
BE	best estimate
CTSS	Cooling Tower Support Structure
EBE	embedded best estimate
EHB	embedded high bound
ELB	embedded lower bound
ESW	essential service water
ESWPT	essential service water pipe tunnel
EUB	embedded upper bound
FE	finite element
FIRS	foundation input response spectra
GWL	ground water level
ISRS	in-structure response spectra
LB	lower bound
OBE	operating-basis earthquake
PCCV	prestressed concrete containment vessel
R/B	reactor building
SBE	surface best estimate
SLB	surface lower bound
SUB	surface upper bound
SRSS	square root sum of the squares
SSE	safe shutdown earthquake
SSI	soil-structure interaction
SSSI	structure-soil-structure interaction

Acronyms	Definitions
UB	upper bound
UHS	ultimate heat sink
UHSRS	ultimate heat sink related structure
ZPA	zero period acceleration

3KK UHSRS SEISMIC MODELING, ANALYSIS, AND RESULTS

3KK.1 Introduction

This Appendix discusses the seismic analysis of the ultimate heat sink related structures (UHSRSs). Each of the two UHSRS is an integral reinforced concrete structure that includes two ultimate heat sink (UHS) basins, two UHS pump houses, two cooling tower enclosures and the UHS essential service water pipe tunnel (UHS ESWPT) attached to the common basement on the south side. UHS Basins A and B are combined into one integrated concrete structure labeled as UHSRS AB. Approximately 69 ft west of UHSRS AB is UHSRS CD that combines UHS basins C and D, and besides their pump houses and UHS ESWPT also includes the shaft providing access for essential services water (ESW) pipe replacement. Four-inch expansion joints separate the shaft from the adjacent UHSRS AB ESWPT and the UHS ESWPT segments from standalone ESWPT segments 1aN and 1bN. The bottom of the 5 ft thick UHSRS basemat is 36 ft below the plant grade and is supported by an approximately 4-ft thick layer of fill concrete resting on the top of the limestone strata at nominal elevation of 782 ft. The UHS basins are embedded in the engineered backfill material with only 4 ft of the basin walls extending above the plant grade elevation. The sump foundation with bottom elevation of 774 ft extends 12 ft below the basin basemat into the limestone layer.

The computer program SASSI (Reference 3KK-1) serves as the platform for the soil-structure interaction (SSI) analyses. Three-dimensional (3D) finite element (FE) models of the UHSRS are developed by using the ANSYS computer program (Reference 3KK-2). The models reflect the configuration of UHSRS AB plus the ESW pipe replacement shaft that is added at the western terminus of the UHS ESWPT. Since UHSRS CD and UHSRS AB are almost a mirror image of each other, the analyses performed on this model provide responses that are applicable for both UHSRS AB and CD. Regarding the configuration of the basin water, the design of UHSRS considers two bounding cases: (1) when both basins are full (UHSRS A/B); and (2) when basin A is full and basin B is empty (UHSRS A/BE).

The ANSYS UHSRS A/B and A/BE models are translated to SASSI models which also include the subgrade layering and backfill properties. These SASSI models are validated against more refined UHSRS A/B and A/BE models that are used for ANSYS static analyses for computation of demands for structural design of UHSRS. The SASSI analyses provide in-structure response spectra (ISRS), maximum accelerations, maximum seismic displacements and dynamic soil pressures. The maximum accelerations and seismic soil pressures results are used for development of safe shutdown earthquake (SSE) loads for design of UHSRS. These loads are applied to the ANSYS refined FE models together with other design loads and load combinations in accordance with the requirements of Section 3.8. The ISRS are used as SSE loads for design of UHSRS Category I equipment and components.

The SASSI analysis and results presented in this Appendix include site-specific effects such as the layering of the subgrade, embedment of the UHSRS, flexibility of the basemat, ground water level (GWL), basin water level and structure-soil-structure interaction (SSSI) between the UHSRS AB and CD. The seismic design of UHSRS is based on an envelope of responses obtained from SSI analysis of models with embedded and surface-mounted foundation.

3KK.2 Model Description and Analysis Approach

Modeling Description

The SASSI FE structural model for the UHSRS is shown in Figure 3KK-1. As shown on Figure 3KK-1, the positive global x-direction points east, the positive global y-direction points north, and the positive global z-direction points upward. Table 3KK-1 presents the structural element material properties for the SASSI FE model. Detailed descriptions of the UHSRS are contained in Subsection 3.8.4. Figures 3.8-206 through 3.8-211 show detailed dimensions and layout of the UHSRS.

The Dynamic Model and Static ANSYS Design Model are three-dimensional finite element models of the UHSRS that are used for calculation of SSI responses and structural demands for design. The models includes all relevant structural details walls, columns, beams, major openings, masses. The two models only differ in the refinement of the finite element (FE) mesh, such that a more refined FE model is used for static analyses to accurately calculate stress distributions at critical design locations. The models include shell elements for walls and slabs, beam elements for columns and beams, mass elements for equipment and impulsive hydrodynamic fluid masses, and solid elements for the excavated volume and the concrete fill below the UHSRS main basemat. The surface-mounted foundation SSI analyses are performed on a structural model consisting of 45,118 plate/shell elements, 3,216 beam elements, 320 solid elements for the excavated soil at the sumps, 7,172 solid structural elements, 391 spring elements, and 53,099 active nodes (nodes with associated degrees of freedom). The models for SSI analysis embedded foundation UHSRS consist of 45,118 plate/shell elements, 3,216 beam elements, 41,208 solid excavation elements, 7,172 solid structural elements, 3,271 spring elements and 97,853 nodes. There are 8,404 mass elements in the A/B models (both basins full) and 4,331 mass elements in the A/BE models (basin A full and B empty), used for both surface-mounted and embedded conditions. In the embedded models, there are additional free field nodes at the ESWPT footprint locations above the base slab that are used to calculate the effect of UHSRS on the free field motion.

Density of the structural walls and slabs is modified to include the dynamic masses of self-weight plus equivalent dead load and 25 percent of live load. Equivalent dead load is 25 psf on all interior surfaces above water (except inside the air-intake or the cooling tower walls at locations beneath the fan slab) and 50 psf on all floor slabs. Live load on the elevated floor slabs is 200 psf, and live load on roof slabs is taken as 100 psf. Weights are applied in the model at appropriate

locations to represent the following equipment and component masses: transfer pump, ESW pump, tile fill located below the cooling tower fans, distribution nozzles and system, fan, fan motor, gear-reducer, driveshaft, steel grating and piping.

The seismic response dynamic and design static analyses are performed on models representing two bounding configurations of the basin water: (1) when both basins are full (UHSRS A/B); and (2) when basin A is full and basin B is empty (UHSRS A/BE). An additional study SSI analysis is performed on a model with one basin full and another half empty for one soil case to confirm that the analyses of UHSRS A/B and A/BE models provide a design that envelops other basin water configurations.

Consistent with recommendations in Section C3.1.3.1 of Reference 3KK-3, best estimate (BE) stiffness values are used for the concrete members in the SASSI analyses, considering the amount of cracking due to the stress levels present in the members. Elevated slabs and beams are assumed to be cracked with respect to their bending stiffness, except for the cooling tower east-west deep beams in the tile fill area. This will produce conservative results due to the low frequency nature of the site-specific input motion. The lowest structural frequency considering cracked bending stiffness is 6.4 Hz, which is higher than the peak of the input spectra of 2.5 Hz in the horizontal directions and 3.5 Hz in the vertical direction. Therefore, reducing the stiffness of the selected beams and slabs will increase demands on these elements. All walls and base slabs are assumed to be uncracked. All walls are uncracked for in-plane shear as the demand-to-capacity ratio for in-plane shear is low and generally less than 0.5. The out-of-plane motion of the deeply embedded UHS basin walls is controlled by the displacements of the surrounding soil. Modeling the walls as uncracked results in an increased soil pressure on the basin walls and increased stresses in the walls.

Operating-basis earthquake (OBE) structural damping values of Table 3.7.1-3(b), such as 4 percent damping for reinforced concrete, are used in the site-specific SASSI analysis. This is consistent with the requirements of Section 1.2 of RG 1.61 (Reference 3KK-4). The damping ratio for basin walls below the water elevation is set to 3% in order to consider possible reduction in energy dissipation due to presence of water inside the basins.

The lower boundary of the site model used in the UHSRS SASSI analysis is 561.1 feet below the bottom of the UHSRS foundation which is more than twice the UHSRS base dimension of (260’ x 2’ =) 520’ as recommended by SRP 3.7.2. A ten layer half-space is used below the lower boundary in the SASSI analysis consistent with SASSI manual recommendations. The SASSI half-space simulation consists of additional layers with viscous dashpots added at the base of the half-space. The half-space layer has a thickness of 1.5 Vs/f where Vs is the shear wave velocity of the half-space and f is the frequency of the analysis. The half-space is sub-divided by the selected number of layers in the half-space.

<u>Model Verification</u>

The SASSI structural model is checked against the more refined FE mesh ANSYS design model. A comparison of total weight in each direction from the more refined ANSYS model and the coarser SASSI model showed the difference in weight between the two models to be within 1%. The adequacy of the SASSI model to capture dynamic behavior of UHSRS and the accuracy of the translation of the model from ANSYS to SASSI format is confirmed by comparing the results from the ANSYS modal analysis of the fixed base refined design model and the SASSI analysis of the coarser dynamic model resting on the surface of a half-space with high stiffness. The eigenvalue analysis performed on the refined ANSYS design model provided cumulative mass participation as a function of frequency and helped identify the major modal frequencies and mode shapes. Transfer functions were computed for the SASSI model and structural frequencies are identified from the peaks of the transfer functions.

Figure 3KK-6 shows two plots of the cumulative effective mass versus the frequency for the ANSYS models UHSRS A/B and UHSRS A/BE. Approximately 60% of the mass is captured below 60 Hz for both the north-south and east-west directions. Since the basemat comprises approximately 30% of the structure mass, and is considered as essentially rigid in the horizontal directions, it is concluded that the cumulative effective mass captured in the horizontal direction satisfactorily reflects the active mass participation behavior of the UHSRS. Approximately 45% of the mass is captured in the vertical direction below 60 Hz. In addition to the basemat, the structure walls are very stiff in the vertical direction, and therefore the percentage of mass captured in the vertical direction is considered acceptable.

Table 3KK-2 presents the first few natural frequencies and descriptions of the associated modal responses of the ANSYS and SASSI fixed-base UHSRS models. Figure 3KK-5 presents example plots of the SASSI fixed-base model transfer functions for selected walls and roof slabs of the UHSRS. The natural frequencies of the ANSYS modes are plotted in Figure 3KK-5 as solid vertical lines for comparison. The close correlation between the SASSI transfer function results with the ANSYS eigenvalues results verifies the accuracy of the model translation and its ability to adequately represent the dynamic properties of UHSRS. Table 3KK-2 also presents the percentage of participating modal mass obtained from the eigenvalue analysis of the ANSYS model.

Input Control Motion

The input motion for the UHSRS SSI analysis is defined by the envelope of the site-specific foundation input response spectra (FIRS) and the minimum design earthquake spectra as discussed in Subsection 3.7.1.1. The minimum design earthquake spectra equal to 1/3 of the certified seismic design response spectra (CSDRS) defines the SSE ground motion for the design of UHSRS, since it envelops the UHSRS FIRS at all frequencies. These minimum earthquake spectra define the design ground motion as an outcrop motion at top of the limestone elevation 782 ft.

The CSDRS-compatible design basis time histories that were used as input outcrop motion for the US-APWR standard plant design are scaled to 1/3 and used as input motion for SSI analyses of the UHSRS surface-mounted foundation models. The input control motion acceleration time histories for SSI analyses of embedded UHSRS models were developed in accordance with requirements DC/COL-ISG-017 (Reference 3KK-10) following the procedure provided in Section 3.2.3 of the NEI white paper (Reference 3KK-11). These acceleration time histories represent the in-layer ground motion at the top of the limestone located at El. 782 ft. The three components of the input motion are applied to the SSI models separately by using vertically propagating shear and compression waves for the horizontal and vertical components, respectively.

Due to the low seismicity of the Comanche Peak Nuclear Power Plant site and the low energy content of the input ground motion at high-frequencies, the incoherence of the input control motion is not considered in the analysis of the UHSRS. Wave passage effects are considered small and do not impact the seismic design because the foundation is supported by a stiff limestone layer, which will experience low strains under the fairly low seismic motion at the site.

SSI Analysis Cases

The strain-compatible rock and backfill properties for the SASSI analyses are developed as discussed in Subsection 3.7.2.4.5. The SASSI analyses account for the site-specific stratigraphy and rock subgrade conditions described in Subsection 2.5.4, as well as the backfill embedment conditions around the UHSRS. Two types of SSI analyses are performed on the UHSRS A/B and A/BE dynamic FE models considering: embedded and surface-mounted conditions. The results of the two types of SSI analyses are enveloped to provide a structural design that captures the effects of variations of site-specific parameters, such as backfill separation, in an efficient and conservative manner.

The SSI analyses of embedded models are performed for full soil column site models that include the layered rock media under the foundations as well as the layers of engineered backfill material placed around the UHSRS after construction. The SSI analyses of surface foundation are performed on truncated soil column models in which the top 40-ft thick strata of engineered backfill soil is removed. The SSI analyses of embedded models consider the backfill to be in full contact (welded) with the UHSRS exterior walls along the whole embedment height.

Table 3KK-10 through Table 3KK-16 present the dynamic properties of the rock and backfill soil that are used for the SASSI analysis of the UHSRS. These soil/rock properties are compatible with the strains generated by the site-specific design ground motion and are obtained based on the result of the site response analyses of randomized profiles presented in Section 2.5.2.6.3. To account for the uncertainty in the site-specific rock properties, three profiles of site-specific rock subgrade properties are considered, including best estimate (BE), lower bound (LB), and upper bound (UB) properties. For the engineered backfill, an

additional high bound (HB) profile is also consider together with the UB rock subgrade profile to account for expected uncertainty in the backfill properties. The UHSRS SSI analyses use profiles representing dynamic properties of saturated backfill soil below GWL at nominal elevation of 795 ft.

Table 3KK-9 summarizes the SSI analysis cases for the UHSRS, the number of frequencies analyzed, cut-off frequency of the analysis, and maximum transmittable frequency of the models for each analysis case.

The maximum shear wave passing frequency for the rock subgrade layers below the base slab and concrete fill, based on layer thicknesses of 1/5 wavelength, ranges from 50.8 Hz for surface lower bound (SLB) to 77.7 Hz for the surface upper bound (SUB) profile. The shear wave passing frequency for the backfill ranges from 26.8 Hz for the embedded lower bound (ELB) soil case to 66.4 Hz for embedded higher bound (EHB) soil case. The frequency domain SSI analyses of UHSRS are performed using cutoff frequency of 50 Hz for of all surface foundation SSI analyses (SLB, surface best estimate (SBE) and SUB soil cases) as well as the embedded foundation analyses of upper bound and high bound soil cases. The cutoff frequencies of the embedded foundation SSI analyses for embedded lower bound (ELB) and embedded best estimate (EBE) soil cases are 33.5 Hz and 45.8 Hz, respectively, which is slightly higher than the backfill soil layers passing frequencies. A study was performed to demonstrate that the use of higher cut-off frequencies than the 1/5 wave length passing frequencies does not impair the accuracy of the SSI analyses results. All of the SSI analyses are performed for frequencies that capture almost all of the energy content of the input design ground motion. Figure 3KK-10 shows the ISRS for a node in the UHSRS basemat demonstrating that the spectral values beyond approximately 30 Hz in the x-direction, 20 Hz in the y-direction and 20 Hz in the z-direction are all controlled by the EHB and/or EUB cases compared to ELB or EBE. The envelope of responses obtained from the analyses of the seven soil cases provides a design that covers SSI responses up to 50 Hz for the site.

SSSI Effects

Analyses are performed on the embedded models for the best estimate (EBE) profile in order to assess effects of SSSI through the supporting rock subgrade and through the backfill. Since UHSRS CD is almost a mirror image of UHRS AB, SSI analyses on the UHSRS A/B and A/BE models with symmetry boundary conditions provide responses that capture the SSSI between the UHSRS AB and CD. In order to assess the SSSI effects on the seismic design of UHSRS and the equipment, responses obtained from these SSSI analyses were compared to the envelope of responses obtained from SSI analysis of embedded and surface-mounted UHSRS models without symmetry boundary conditions for the best estimate soil profiles (EBE and SBE).

The comparisons show that the envelope of responses obtained from SSI analyses of embedded and surface-mounted models result in a seismic design that bounds the effects of SSSI between the UHSRS AB and UHSRS CD. The

SSSI between the UHSRS through the backfill can result in zero period accelerations (ZPAs) that in few nodal locations slightly exceed the envelope of ZPA results from the SSI analyses of standalone surface and embedded models. These exceedances are local and enveloped by the SSE loads used for structural design of the UHSRS. The SSI analyses of standalone models provide design ISRS that envelop the ISRS calculated from the SSSI analyses at all equipment locations with the exception of the UHS pump house and sump north-south walls below elevation of 827 ft where the SSSI effects result in negligible exceedances that are less than 2.5%.

Kinematic SSSI effects (effects of UHSRS on the free-field motion at locations of nearby standalone ESWPT segments) are evaluated using results from SSI analyses of standalone UHSRS. Acceleration response spectra results obtained from the responses of field interaction nodes are used to assess these SSSI kinematic effects and develop spectral amplification factors that are used to incorporate the SSSI effects in the seismic design of the ESWPT presented in Appendix 3LL.

Use of Modified Subtraction Method

The SSI analyses of embedded models are performed using the modified subtraction method (MSM). To verify the accuracy of the results using the MSM, a study is performed on the quarter-model of the UHSRS model (making use of the structure symmetry) for the UB embedded condition. The study is performed by comparing results obtained from the MSM with those obtained from SSI analysis using the more computationally robust flexible volume method also known as the direct method. The difference between these two methods resides in the definition of interaction nodes for which impedances are calculated for SSI analyses. For the MSM, the choice of interaction nodes includes all nodes on the outer face of the excavation volume and every other node at the top surface of the excavation volume. The direct method considers all nodes in the excavated volume as interaction nodes.

A comparison of the transfer functions and ISRS at key locations resulting from the two methods for the UB embedded condition demonstrates that the results using the MSM appropriately capture the SSI responses. The results show that differences obtained from the two methods are negligible. Figures 3KK-8 and 3KK-9 presents examples of transfer function and ISRS comparisons, respectively, of the MSM versus the flexible volume method at several locations of the UHSRS.

Effects of Ground Water Level Variation

The SSI analysis cases in Table 3KK-9 consider dynamic properties of saturated engineered fill material for the backfill layers located below the site-specific nominal GWL of 795 ft. Besides the SSI analysis cases in Table 3KK-9, additional SSI analyses are performed with embedded best estimate (EBE) backfill properties representative of:

a. High GWL of approximately 804 ft to address the effect of the ground water accumulated within the perimeter of ESWPT south of the UHSRS, and

b. Unsaturated backfill when the GWL is located below the limestone surface.

The results of these analyses are compared to the envelope of responses obtained from SSI analysis of embedded and surface-mounted UHSRS model for the best estimate soil profiles (SBE and EBE) reflecting backfill properties with nominal GWL. The comparison of results (ZPA and ISRS) from this GWL sensitivity study shows that SSI analysis of soil profiles reflecting nominal GWL envelops responses obtained from unsaturated soil cases. The SSI analyses of surface-mounted models and models embedded in backfill with nominal GWL produce bounding results when compared with those obtained from the profiles with high GWL except for a few locations. In order to ensure the design of UHSRS bound possible amplifications of the seismic response due to the higher GWL existing at the UHSRS south end, the design ISRS and SSE loads at a limited number of locations on the UHSRS are increased. Amplifications due to the high GWL of the ZPA and ISRS were observed for the horizontal response at the UHS ESWPT walls and vertical response at the UHS ESWPT roof slab and at the cooling tower fins below the fan slab. Amplification factors are developed based on the results of the GWL sensitivity analyses and applied to the ZPA and ISRS over all frequencies to ensure that the UHSRS design is bounding with respect to GWL variations. Figure 3KK-7 presents a comparison of ISRS at the UHS ESWPT roof slab for all GWL cases evaluated in this sensitivity study.

Effects of Basin Water Level Variation

In order to investigate the effects of basin water configuration on the UHSRS seismic response, besides the SSI analysis cases in Table 3KK-9, SSI analysis is performed for the EBE soil case on the UHSRS embedded model in which the basin A is full and basin B is half full. The responses obtained from this analysis are compared with responses obtained from the SSI analyses of embedded and surface models of UHSRS A/B basin configuration (both basins full) and UHSRS A/BE basin configuration (basin A full and B empty) for the best estimate soil cases (EBE and SEB).

The comparison of ZPA and ISRS results shows that the SSE loads based on envelope of responses from SSI analyses of A/B and A/BE basin water configurations produce a UHSRS structural design that is bounding with respect to basin water variations, except at a few locations. The results of the sensitivity study show that the effect of basin water variation on the ISRS used for design of UHSRS equipment and components is small. Increases in the ISRS due to basin water variation that are above the ISRS developed as an envelope of responses from the embedded and surface A/B and A/BE models are less than 10%, with the exception of the vertical response for cooling tower fins below the fan slab, and vertical response of the UHS ESWPT roof slab. Spectral amplification factors are

developed based on the results of this basin water sensitivity study and applied to the ISRS over all frequencies to ensure that the UHSRS design is bounding with respect to basin water level variations.

Backfill Separation Effects

The SSI analyses of embedded UHSRS models assume that the backfill soil is in full contact with the structure along the total height of the embedment. To justify this assumption, a backfill separation study is performed on the PSFSV model where the top portion of the backfill soil is separated from the PSFSV exterior walls. The results of the study confirmed that the enveloped results of the SSI analysis of surface foundation models and embedded models envelop the potential effects of soil separation. The PSFSV is a significantly smaller and lighter structure than the UHSRS, and as such its response is by far more sensitive to backfill separation effects. Therefore, this study demonstrates that the surface-mounted foundation and embedded conditions, used in the design of the UHSRS, envelop the effects of backfill separation.

Hydrodynamic Effects on SSI Response

The hydrodynamic effects of the water contained in the basins, cooling towers, and pump room of the UHS A and B are considered in accordance with requirements of SRP 3.7.3 (Reference 3KK-9). The fluid mass is divided into two components, (i) impulsive and (ii) convective. The mass corresponding to each component is calculated per TID-7024 (Reference 3KK-5). The convective portion of the fluid mass is not included in the models used for SSI analyses as the frequency of the convective mass is very small and is less than 0.31 Hz. The calculated hydrodynamic frequencies are sufficiently away from the dominant structural frequencies and the SSI frequencies to be able to affect the dynamic response of the structure.

The impulsive component of the fluid mass is modeled in the SSI models by assigning masses to the nodes of the leading and trailing walls in a direction perpendicular to the wall. The hydrodynamic masses are applied uniformly along the height of the wall from its base to twice the calculated height of the impulsive portion of the water. The vertical mass of the water is distributed uniformly across the nodes of the basemat.

The effect of the convective portion of the fluid mass is considered separately in the structural design of UHSRS. The hydrodynamic pressures due to sloshing modes are calculated and applied to the design model basin walls. For the purposes of hydrodynamic analysis, the water is separated into rectangular regions to calculate hydrodynamic properties per TID-7024. The rectangular regions shown in Figure 3KK-4 are chosen since they are bounded by structural walls such that their behavior conforms to the equations derived in the above referenced documents. The key hydrodynamic properties of each region are listed in Table 3KK-7. As indicated in Table 3KK-7, the total impulsive force on the walls is evenly distributed as nodal weights above and below the height of action so as

to produce the equivalent total force and moment on the walls. Hydrodynamic masses are assigned along the basin and pump house walls and slabs accounting for the thickness of the walls and slabs. Therefore, hydrodynamic load is not applied on a wall or slab within the cross-wall thickness. The total water weight is evenly distributed as nodal loads to the basin floor slab.

The peak sloshing height in any hydrodynamic region is less than 2.0 ft. The nominal freeboard height to the top of the basin walls and underside of the pump house slab is not a concern since adequate clearance is provided to allow this amount of sloshing.

Dynamic Lateral Soil Pressures

The static equivalent loads representing dynamic lateral soil pressures are calculated based on Wood's dynamic soil pressures as given in ASCE 4-98 (Reference 3KK-3), considering 0.2g for the horizontal earthquake acceleration αh and total saturated unit weight of the backfill soil. The responses of the UHSRS due to the static equivalent pressures calculated using ASCE 4-98 methodology were confirmed to envelop the responses due to the earth pressures calculated from the enveloped SSI analyses results for soil spring forces. This was confirmed by using ANSYS to perform static analysis of the UHSRS using both the SSI soil pressures and the ASCE4-98 soil pressures applied to the external walls. The analysis showed that the resulting shear and moment demands on the external UHSRS walls are always controlled by the soil pressures calculated using ASCE 4-98, because the ASCE 4-98 pressures control over the majority of the height of the walls and therefore produce higher demands. Moment demands from the SASSI analysis of all embedded soil cases for the north wall are smaller than the corresponding moments calculated from the ANSYS model with ASCE 4-98 pressures.

Application of Seismic Results in the Structural Design

Pseudo-static analyses are performed in ANSYS (Reference 3KK-2) using the envelope of accelerations from all calculated SASSI analyses to obtain seismic design demands, which include all seismic inertial loads from SSI effects and impulsive hydrodynamic loads as described above. The seismic inertial loads are enveloped for each node for all SSI analysis cases. The conditions of both basins full, and basin A full and B empty are considered separately.

The pseudo-static analyses of the ANSYS model also include the dynamic lateral soil pressures and static soil pressures, and convective hydrodynamic loads as described above, for calculating the structural demands on the UHSRS. These loads are combined with all other applicable design loads, in accordance with the factored load combinations described in Subsection 3.8.4. For structural design of members and components, the design forces due to three different components of the earthquake are combined using the Newmark 100% - 40% – 40% method. Load combinations use the 100%-40%-40% percent combination rule described in RG 1.92 (Reference 3KK-6) because the design of elements includes the

effects of the interaction of different components, such as interaction of axial forces with the moments or axial forces with shear. Since the direction of input motion that results in the maximum axial force may be different from that producing the maximum moment or shear, the 100%-40%-40% method produces more accurate design demands. The combination method for seismic inertia loads and seismic soil pressures for stability considerations is conservatively based on 100%-100%-100%, as discussed separately in Subsection 3.8.5.

Accidental torsion is accounted for by applying an angular acceleration to the structure at its center of gravity. The shear to be resisted by in-plane shear of the walls accounts for all out-of-plane shear in cross-walls. The total adjusted wall shear forces used for design are presented in Figure 3KK-2. The forces presented in the figure are not symmetrical due to model non-symmetry including the sizes of the exterior walls.

3KK.3 Seismic Analysis Results

Table 3KK-2 presents the natural frequencies of the UHSRS FE structural model used for the SASSI analysis. Table 3KK-3 presents a summary of SSI effects on the seismic response of the UHSRS. The maximum absolute nodal accelerations obtained from the SASSI analyses are presented in Table 3KK-4 for key UHSRS locations. The values presented are the envelope of results obtained from SSI analyses of surface and embedded UHSRS A/B and A/BE models for lower bound, best estimate, upper bound and high bound soil profiles. For presentation purposes, the maximum accelerations have been obtained by combining cross-directional contributions in accordance with RG 1.92 (Reference 3KK-6) using the square root sum of the squares (SRSS) method. For the structural design, the nine components of SSE acceleration loads are applied individually and combined by using the Newmark 100% - 40% - 40% method.

The dynamic horizontal soil pressure of the backfill on the basin walls varied depending on the backfill soil case considered as the soil frequency approached that of the wall. The peak soil pressures varied along the height of the wall from values of approximately 0.5 ksf to almost 2ksf. The resulting pressure distributions show that there is significant variability in the pressures determined from SASSI.

The structural design of the UHSRS is based on seismic lateral pressure load that is calculated based on following the methodology provided in Subsection 3.5.3.2 of ASCE 4-98 (Reference 3KK-3), and using a lateral seismic coefficient of 0.2g. The calculated pressure distribution used for the structural design produces conservative moments and shears in all walls when compared to those obtained using seismic lateral pressures calculated from SASSI.

The maximum design forces and moments resulting from the design analysis are presented in Table 3KK-5 at key UHSRS locations. The force and moment values represent the enveloped results for the seismic demands for all soil cases considered in the SASSI analyses, and all considered load combinations given in

Subsection 3.8.4.3. These results are calculated from the ANSYS design model subjected to the envelope of accelerations from all calculated SASSI analyses.

Table 3KK-6 summarizes the resulting maximum displacements for enveloped seismic loading conditions at key UHSRS locations obtained from the seismic analysis.

3KK.4 In-Structure Response Spectra

The enveloped broadened in-structure response spectra (ISRS) are presented in Figure 3KK-3 for the design of components and equipment in the UHSRS with integral UHS ESWPT base slab, pump room elevated slab, pump room roof slab, and cooling tower fan support slab. The ISRS are presented for each of the three orthogonal directions (east-west, north-south, and vertical) for 0.5 percent, 2 percent, 3 percent, 4 percent, 5 percent, 7 percent, 10 percent and 20 percent damping. The ISRS for each orthogonal direction are resultant spectra, which have been combined using SRSS to account for cross-directional coupling effects in accordance with RG 1.122 (Reference 3KK-7). The ISRS are based on the envelope of responses obtained from SSI analyses of surface and embedded models representing two bounding basin water configurations for sets of soil properties.

The ISRS include effects of basin water and GWL variations and capture the effects of flexibility and concrete cracking in the roof slabs, elevated slabs and beams. Based on sensitivity studies of the basin water and GWL effects as well as the SSSI effects of the adjacent UHSRS CD, ISRS are increased at a limited number of locations over all frequencies. The ISRS have been broadened by 15 percent and all valleys in the broadened spectra are removed. No peak clipping operations are performed. The spectra are used for the design of seismic category I and II subsystems and components housed within or mounted to the UHSRS. For the design of seismic category I and II subsystems and components mounted to the UHSRS walls and slab, it is required to account for the effects of any seismic anchor motions associated with the structure seismic displacements.

3KK.5 References

3KK-1 *A System for Analysis of Soil-Structure Interaction*, SASSI2000 Version 3 Including User's Manual Version 3, Ostadan, F., University of California, Berkeley, April 2007.

3KK-2 ANSYS, Advanced Analysis Techniques Guide, Release 11.0, SAS IP, Inc. 2007.

3KK-3 *Seismic Analysis of Safety-Related Nuclear Structures,* American Society of Civil Engineers, ASCE 4-98, Reston, Virginia, 2000.

3KK-4 *Damping Values for Seismic Design of Nuclear Power Plants*, Regulatory Guide 1.61, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, March 2007.

3KK-5 "*Nuclear Reactors and Earthquakes*," (TID 7024) United States Atomic Energy Commission, 1963.

3KK-6 *Combining Responses and Spatial Components in Seismic Response Analysis*, Regulatory Guide 1.92, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC, July 2006.

3KK-7 *Development of Floor Design Response Spectra for Seismic Design of Floor-supported Equipment or Components*, Regulatory Guide 1.122, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, February 1978.

3KK-8 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities, American Society of Civil Engineers, ASCE/SEI 43-05, Reston, Virginia, 2005.

3KK-9 Seismic Subsystem Analysis, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants. NUREG-0800, United States Nuclear Regulatory Commission Standard Review Plan 3.7.3, Revision 3, March 2007.

3KK-10 Interim Staff Guidance DC/COL-ISG-017: "Ensuring Hazard-Consistent Seismic Input for Site Response and Soil Structure Interaction Analyses"

3KK-11 "Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation," NEI, June 12, 2009.

Table 3KK-1

FE Model Material Properties (1), (2)

Component	E (ksi)	Poisson's Ratio	Unit Weight (kcf)	Damping Ratio	Element type
Concrete slabs, walls, beams, and columns	4,031	0.17	0.150	0.04	Thin Shell
Concrete base mats	4,031	0.17	0.150	0.04	Thin Shell
Steel beams, columns, and other structural steel elements	28,000	0.30	0.500	0.04	Beam
Concrete fill	3,122	0.17	0.150	0.04	Brick

Notes:

1) The concrete material properties are adjusted where appropriate to account for cracking as discussed in Appendix Section 3KK.2.
2) Dynamic analysis unit weights are increased where appropriate from those shown above to account for equivalent dead loads and live loads as discussed in Appendix Section 3KK.2.
3) Damping ratio for basin walls below the water elevation is 3% to consider possible reduction in energy dissipation due to presence of water inside the basins (conservative value)

Table 3KK-2

Summary of Modal Frequencies of Fixed-Base FE Models

Model	ANSYS Model Frequency (Hz)	SASSI Model Frequency (Hz)	% Difference	Percent Effective Mass (%)	Comments
A/B	8.02	8.53	6.0	27.67	X direction, entire structure acting in east-west direction
A/BE	8.06	8.40	4.0	29.05	X direction, entire structure acting in east-west direction
A/B	8.4	8.55	1.8	20.34	Y direction, CTSS acting in north-south direction and basin walls acting out-of-plane
A/BE	8.42	8.40, 8.60	0.2, 2.1	19.24	Y direction, CTSS acting in north-south direction and basin walls acting out-of-plane
A/B	16.20	16.21	0.1	3.11	Z direction, CTSS roof slabs acting vertically
A/BE	16.25	16.40	0.3	3.04	Z direction, CTSS roof slabs acting vertically

Table 3KK-3

SSI and SSSI Results for UHSRS Seismic Response
(Sheet 1 of 2)

SSI Effect	Observed Response
Rock Subgrade	The rock subgrade has insignificant SSI effect on the UHSRS seismic response. The structural natural frequencies characterize the response of surface-mounted models because of the high stiffness of the rock and the relatively small weight of the foundation.
Backfill Embedment	The properties of the backfill embedment affect the overall response of UHSRS structure. Backfill soil frequencies, in the range of 4 Hz for lower bound to 10 Hz for high bound, characterize the UHSRS horizontal response. The basin wall responses increase as the backfill frequency approaches the wall frequency and is largest for the high bound (EHB) soil case. Frequencies of 11 Hz for lower bound, 12 Hz for best estimate, 20 Hz for upper bound, and 28 Hz for high bound, characterize the vertical response of the backfill. The resonance effects affect the out of plane response of the pump room elevated slab where the backfill frequency for upper bound case is nearly in tune with the natural frequency of the slab.
Backfill soil separation	The effects of backfill soil separation on the UHSRS response are deemed small based on the results of the study performed on the PSFSV. This sensitivity study confirmed that the enveloped results of the SSI analysis of surface foundation models and embedded models envelop the potential effects of soil separation.
Ground water level variations	Additional SSI analyses are performed for the UHSRS with best estimate (EBE) backfill properties to assess the effect of GWL variations. The comparison of the results (ZPA and ISRS) from this investigation confirmed the results of the GWL variation effects study for the ESWPT standalone model for all soil cases (Appendix 3LL) and shows that the responses obtained from SSI analysis of saturated backfill case envelops the responses obtained from the SSI analysis of the unsaturated backfill. The design ISRS and SSE loads at a limited number of locations on the UHSRS are increased to ensure the UHSRS design bounds possible amplifications of the seismic response due to the higher GWL existing at the UHSRS south end. Amplification factors are based on the results of the GWL sensitivity study.

Table 3KK-3

SSI and SSSI Results for UHSRS Seismic Response
(Sheet 2 of 2)

SSI Effect	Observed Response
Basin Water Level Variation	Besides the SSI analysis cases in Table 3KK-9, the basin water level condition of basin A full and B half full for the EBE soil case is considered to ensure that the SSI analysis conditions of A/B (both basins full) and A/BE (basin A full and B empty) are bounding. Comparison of results (ZPA and ISRS) from this investigation shows that SSI analysis cases generally produce bounding results when compared with the full-half full basin water level condition with EBE soil properties. The component spectra at a limited number of locations on the UHSRS are increased for all SSI analysis cases to ensure they produce bounded output.
SSSI influence through backfill	The SSSI between the UHSRS through the backfill are evaluated through comparison of the obtained responses from SSI analysis of the embedded UHSRS models with and without symmetry boundary conditions. The comparisons show that these SSSI effects result in localized impact on ZPAs used as the basis for development of seismic loads for structural design of UHSRS and ISRS used for equipment design.
SSSI influence through rock subgrade	The SSSI effects through rock subgrade are evaluated through comparison of the obtained responses from SSI analysis of the surface-mounted UHSRS models with and without symmetry boundary conditions. The comparisons show that the effects of SSSI through the rock subgrade are negligible.
Hydrodynamic Effects	The low frequencies characterize the sloshing, convective, effects of the top of the water retained in UHSRS. Most of the water retained in each region of the UHSRS acts in the impulsive mode rigidly with the structure. The maximum sloshing wave height, obtained from analysis of hydrodynamic effects , is less than 2 ft, which is less than the available freeboard.

Table 3KK-4

Enveloped SRSS Maximum Accelerations at Key UHSRS Locations (1), (2)

Component	N-S Acceleration (g) (+/- Y Direction)	E-W Acceleration (g) (+/- X Direction)	Vertical (g) (+/- Z Direction)
Basemat	0.13	0.14	0.13
Basin Exterior Walls	0.90	0.70	0.14
Basin Separation Wall	0.25	1.16	0.16
Pump Room Elevated Slab	0.23	0.30	0.58
Pump Room Roof Slab	0.26	0.40	0.45
Cooling Tower Fan Support Slab	0.36	0.43	0.53
Cooling Tower Roof Slab	0.64	0.50	0.83

Notes:

1) The peak accelerations presented above envelop all of the considered site conditions, i.e. UHSRS embedded in surface-mounted on BE, LB, and UB soil condition and UHSRS embedded in BE, LB, UB and HB backfill.
2) The peak accelerations include amplification effects due to out-of-plane flexibility of walls and slabs.

Table 3KK-5

Summary of Maximum and Minimum Factored Forces and Moments at Key UHSRS Locations(1), (2), (3)

Component	Max / Min	TX kip/ft	TY kip/ft	TXY(6) kip/ft	MX kip/ft	MY kip/ft	MXY kip-ft/ft	NX kip-ft/ft	NY kip-ft/ft
Basemat	+	53.2	151	119	358	384	63.6	179	392
		AB_UB	AB_UB	ABE_UB	AB_LB	AB_LB	AB_UB	AB_LB	AB_LB
	-	-229	-242	-115	-495	-369	-65.8	-611	-522
		AB_UB	AB_UB	AB_UB	ABE_UB	ABE_UB	AB_LB	AB_LB	AB_LB
Basin Exterior Walls	+	61	9.43	144	344	265	150	127	100
		AB_LB	ABE_UB	AB_LB	AB_UB	AB_LB	AB_UB	ABE_UB	ABE_LB
	-	-576	-370	-298	-591	-504	-173	-86.5	-67.7
		AB_LB	AB_LB	AB_LB	AB_LB	ABE_UB	AB_UB	AB_UB	AB_LB
Basin Separation Wall	+	206	430	285	410	533	96.6	98.4	86.2
		ABE_LB	ABE_LB	ABE_LB	AB_UB	ABE_LB	AB_UB	ABE_LB	AB_UB
	-	-403	-704	-263	-368	-569	-94.6	-79.8	-83.9
		AB_LB	AB_LB	AB_UB	AB_UB	AB_LB	AB_UB	AB_LB	AB_UB
Pump House Walls(4)	+	210	220	238	207	242	78.5	117	129
		AB_UB	AB_UB	ABE_LB	AB_UB	AB_UB	ABE_LB	AB_UB	AB_UB
	-	-389	-372	-175	-263	-323	-109	-113	-111
		AB_LB	AB_LB	AB_LB	ABE_LB	AB_UB	ABE_LB	ABE_UB	AB_LB
Upper Cooling Tower Walls(5)	+	72.8	69	115	59.6	117	67.7	30.8	46
		AB_UB	AB_UB	AB_UB	ABE_LB	AB_UB	ABE_LB	AB_UB	AB_UB
	-	-149	-251	-101	-102	-158	-60.8	-28.8	-51.6
		AB_LB	AB_LB	AB_LB	AB_LB	ABE_LB	ABE_UB	AB_UB	AB_UB
Cooling Tower Fan Support Slabs	+	60.2	47.8	33.6	34.8	37.4	7.87	14.2	18.1
		AB_UB	AB_UB	AB_UB	AB_UB	ABE_LB	ABE_UB	ABE	ABE_UB
	-	-68.3	-48.1	-37.6	-22.2	-23.8	-8.26	-14.2	-19.6
		AB_LB	AB_LB	AB_LB	AB_LB	AB_UB	AB_LB	AB_LB	AB_LB
Pump Room Elevated Slab	+	30.8	55.9	46.6	25.5	41.5	9.69	18.3	23.5
		AB_UB	AB_UB	AB_UB	AB_UB	ABE_LB	ABE_LB	ABE_LB	AB_UB
	-	-73.9	-69.9	-64.8	-14.5	-19.5	-7.75	-21.5	-19.8
		AB_LB	ABE_LB	AB_LB	ABE_LB	AB_UB	ABE_LB	ABE_LB	AB_LB

Notes:

1) The forces and moments are the maximum and minimum over all load combinations and include the combination of three orthogonal directions using the 100%-40%-40% method.
2) The element x-axis is horizontal and y-axis is vertical for walls. The element x-axis is east-west and y-axis is north-south for slabs.

   TX = In-plane force per unit length at element centroid in the direction of element x-axis

TY = In-plane force per unit length at element centroid in the direction of element y-axis

TXY = In-plane shear force per unit length at element centroid

MX = Moment per unit length at element centroid around element y-axis

MY = Moment per unit length at element centroid around element x-axis

MXY = In-Plane moment

NX = Out-of-plane shear force per unit length at centroid along element y-axis

NY = Out-of-plane shear force per unit length at centroid along element x-axis

3) The force and moment values are the maximum/minimum element forces for walls and slabs and may be a result of force concentrations due to openings or corners.
4) Includes element forces for both lower and upper walls in the pump house
5) Includes element forces for all walls above the air-intakes

Table 3KK-6

Maximum Displacements for All Enveloped Conditions at Key UHSRS Locations(1)(3)

Component	Maximum Displacement (inches)	Description
UHS ESWPT South Wall	0.14	Maximum north-south displacement
Cooling Tower Roof Slab	0.19	Maximum horizontal displacement
Pump Room Elevated Slab	0.18	Maximum vertical (out-of-plane) displacement
Pump Room Roof Slab	0.11	Maximum horizontal displacement
Air Intake Missile Shield Top Slab	0.11	Maximum horizontal displacement
Basin Exterior North Wall	0.40	Maximum out-of-plane (out-of-plane) displacement(2)
Basin Exterior East Wall	0.33	Maximum horizontal (out-of-plane) displacement(4)
Basin Exterior West Wall	0.21	Maximum horizontal (out-of-plane) displacement(4)
Basin Exterior Wall Top Corner	0.05	Maximum horizontal displacement at northeast and northwest corners
Base Slab	0.03	Maximum horizontal displacement

Notes:

1) Displacements include base flexibility, average horizontal displacements at the base slab is 0.013 inches
2) Occurs at approximately mid-span of the west basin north wall
3) The displacements are maximum relative displacements calculated in ANSYS.
4) Occurs at approximately mid-span of the UHSRS AB east (west) wall

Table 3KK-7

UHSRS Hydrodynamic Properties

Hydrodynamic Region	Length (parallel to input motion) (ft)	Width (normal to input motion) (ft)	Total Water Weight in Region (kip)	Impulsive Water Weight (W_i)/Total Water Weight	Convective Water Weight (W_c)/Total Water Weight	Convective Frequency (f_c, Hz)	Height from bottom of basin to Centroid of Impulsive Pressure (h_i, ft)	Height from bottom of basin to Centroid of Convective Pressure (h_c, ft)
1A-X	76	49	7204	0.46	0.014	0.171	11.6	17.34
1A-Y	49	31	2938	0.64	0.017	0.225	11.6	19.2
1B-X	45	34	2960	0.68	0.017	0.236	11.6	19.66
1B-Y	83	45	7225	0.42	0.017	0.236	11.6	19.66
2-X	45	83	7225	0.68	0.017	0.236	11.6	19.66
2-Y	83	45	7225	0.42	0.013	0.160	11.6	17.08
3-X	45	36	3134	0.68	0.017	0.236	11.6	19.66
3-Y	36	45	3134	0.75	0.017	0.266	12.0	21.02
4-X	45	36	3134	0.68	0.017	0.236	11.6	19.66
4-Y	36	45	3134	0.75	0.017	0.266	12.0	21.02
5A-X	27	21	1097	0.81	0.015	0.309	12.8	22.9
5B-X	27	49	3550	0.86	0.011	0.309	18.7	34.57
5-Y	70	27	4647	0.59	0.013	0.183	14.8	23.65

Table 3KK-8

Summary of Analyses Performed

Model	Loading Case	Analysis Method	Program	Input	Output	Three Components Combination
Three-dimensional UHSRS FE Model	Seismic motion	Time history soil-structure interaction analysis in frequency domain using sub-structuring technique	SASSI	Time history input matching site-specific design response spectra from site-response analysis, site-specific soil profiles.	Peak accelerations, in-structure response spectra, soil pressures	SRSS
Three-dimensional UHSRS FE Model for SSSI analysis	Seismic motion	Time history soil-structure interaction analysis in frequency domain using sub-structuring technique to obtain SSSI results	SASSI	Time history input matching site-specific design response spectra from site-response analysis, site-specific soil profiles.	Peak accelerations, in-structure response spectra, soil pressures	SRSS
Three-dimensional UHSRS FE Model	Seismic soil pressure	Static	ANSYS	Peak soil pressures based on ASCE 4-98, separate analysis for each direction of pressure.	Element and section demands for design	Added on absolute basis to seismic structural response demands in same direction and spatially combined by Newmark 100%-40%-40% combination rule
Three-dimensional UHSRS FE Model	SSE nodal accelerations	Static	ANSYS	SSE nodal accelerations based on SASSI output	Element and section demands for design	Combined by Newmark 100%-40%-40% combination rule

Table 3KK-9

SSI Analysis Cases for UHSRS

Case #	Case ID	Surface/ Embedded	Soil Case	Basin Water Condition	Number of frequencies analyzed	Cut-off frequency of Analysis	Minimum Passing frequency of structure
1	UHS_AB_SLB	Surface	Lower Bound	Basins A and B Full	68	50.00	50.79
2	UHS_ABE_SLB			Basin A Full and B Empty	68	50.00	50.79
3	UHS_AB_SBE		Best Estimate	Basins A and B Full	68	50.00	62.84
4	UHS_ABE_SBE			Basin A Full and B Empty	68	50.00	62.84
5	UHS_AB_SUB		Upper Bound	Basins A and B Full	68	50.00	77.74
6	UHS_ABE_SUB			Basin A Full and B Empty	68	50.00	77.74
7	UHS795_AB_ELB	Embedded	Lower Bound	Basins A and B Full	47	33.47	26.78
8	UHS795_ABE_ELB			Basin A Full and B Empty	47	33.47	26.78
9	UHS795_AB_EBE		Best Estimate	Basins A and B Full	63	45.77	36.60
10	UHS795_ABE_EBE			Basin A Full and B Empty	63	45.77	36.60
11	UHS795_AB_EUB		Upper Bound	Basins A and B Full	68	50.00	50.06
12	UHS795_ABE_EUB			Basin A Full and B Empty	68	50.00	50.06
13	UHS795_AB_EHB		High Bound	Basins A and B Full	68	50.00	66.42
14	UHS795_ABE_EHB			Basin A Full and B Empty	68	50.00	66.42

Table 3KK-10

Surface Lower Bound Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	5.50	0.155	4602.80	9137.70	0.02757
2	9.50	0.155	4602.80	9137.70	0.02757
3	10.00	0.155	4602.80	9137.70	0.02757
4	10.00	0.155	4602.80	9137.70	0.02757
5	10.00	0.155	4602.80	9137.70	0.02757
6	10.00	0.155	4602.80	9137.70	0.02757
7	10.00	0.155	4602.80	9137.70	0.02757
8	3.00	0.135	2355.00	6340.90	0.05490
9	12.00	0.155	4172.80	8921.80	0.02499
10	12.00	0.155	4172.80	8921.80	0.02499
11	17.00	0.155	5280.30	10062.00	0.02498
12	17.00	0.155	5280.30	10062.00	0.02498
13	10.00	0.150	3219.80	7318.80	0.02588
14	7.00	0.150	3219.80	7318.80	0.02588
15	10.00	0.150	3218.70	7316.20	0.02601
16	7.00	0.150	3218.70	7316.20	0.02601
17	7.00	0.130	2356.80	6034.30	0.02543
18	7.50	0.130	2356.80	6034.30	0.02543
19	7.00	0.130	2356.80	6034.30	0.02552
20	7.50	0.130	2356.80	6034.30	0.02552
21	8.00	0.135	2362.30	5369.70	0.04618
22	8.00	0.135	2362.30	5369.70	0.04618
23	8.00	0.135	2359.20	5362.40	0.04639
24	8.00	0.135	2359.10	5362.40	0.04639
25	8.00	0.135	2356.40	5356.30	0.04658
26	8.00	0.135	2356.40	5356.30	0.04658
27	8.00	0.135	2353.50	5349.50	0.04677
28	8.00	0.135	2353.50	5349.50	0.04677
29	8.00	0.135	2351.00	5343.90	0.04693
30	8.00	0.135	2351.00	5343.90	0.04693
31	7.75	0.140	2548.80	6002.20	0.06669
32	7.75	0.140	2548.80	6002.20	0.06669
33	7.75	0.140	2544.20	5991.30	0.06705
34	7.75	0.140	2544.20	5991.30	0.06705
35	7.75	0.140	2540.40	5982.30	0.06739
36	7.75	0.140	2540.40	5982.30	0.06739
37	7.75	0.140	2536.80	5973.80	0.06771
38	7.75	0.140	2536.80	5973.80	0.06771

Table 3KK-10

Surface Lower Bound Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
39	9.00	0.145	2440.30	5977.40	0.02848
40	9.00	0.145	2440.30	5977.40	0.02850
41	9.00	0.145	2440.30	5977.40	0.02855
42	9.00	0.145	2439.70	5976.10	0.02858
43	9.00	0.145	2439.20	5974.90	0.02861
44	9.00	0.145	2439.20	5974.90	0.02865
45	9.00	0.145	2439.20	5974.90	0.02866
46	17.00	0.150	4319.60	8395.90	0.02832
47	17.00	0.150	4319.60	8395.90	0.02832
48	17.00	0.150	4319.60	8395.90	0.02832
49	17.00	0.150	4319.60	8395.90	0.02832
50	17.00	0.150	4319.60	8395.90	0.02832
51	12.55	0.150	4319.60	8395.90	0.02832
52	12.55	0.150	4319.60	8395.90	0.02832
53	17.00	0.150	4317.20	8391.20	0.02856
Halfspace		0.150	4317.20	8391.20	0.02856

Table 3KK-11

Surface Best Estimate Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness *ft*	Unit Weight *kcf*	S-Wave Velocity *ft/sec*	P-Wave Velocity *ft/sec*	Damping Ratio
1	5.50	0.155	5720.00	11356.00	0.01883
2	9.50	0.155	5720.00	11356.00	0.01883
3	10.00	0.155	5720.00	11356.00	0.01883
4	10.00	0.155	5720.00	11356.00	0.01883
5	10.00	0.155	5720.00	11356.00	0.01883
6	10.00	0.155	5720.00	11356.00	0.01883
7	10.00	0.155	5720.00	11356.00	0.01883
8	3.00	0.135	3019.00	8128.90	0.03647
9	12.00	0.155	5113.00	10932.00	0.01713
10	12.00	0.155	5113.00	10932.00	0.01713
11	17.00	0.155	6467.00	12324.00	0.01709
12	17.00	0.155	6467.00	12324.00	0.01709
13	10.00	0.150	4046.00	9196.70	0.01777
14	7.00	0.150	4046.00	9196.70	0.01777
15	10.00	0.150	4045.00	9194.40	0.01786
16	7.00	0.150	4045.00	9194.40	0.01786
17	7.00	0.130	2950.00	7553.10	0.01743
18	7.50	0.130	2950.00	7553.10	0.01743
19	7.00	0.130	2950.00	7553.10	0.01750
20	7.50	0.130	2950.00	7553.10	0.01750
21	8.00	0.135	3153.00	7166.90	0.03130
22	8.00	0.135	3153.00	7166.90	0.03130
23	8.00	0.135	3150.00	7160.10	0.03145
24	8.00	0.135	3150.00	7160.10	0.03145
25	8.00	0.135	3147.00	7153.20	0.03159
26	8.00	0.135	3147.00	7153.20	0.03159
27	8.00	0.135	3144.00	7146.40	0.03173
28	8.00	0.135	3144.00	7146.40	0.03173
29	8.00	0.135	3141.00	7139.60	0.03185
30	8.00	0.135	3141.00	7139.60	0.03185
31	7.75	0.140	3305.00	7782.90	0.04540
32	7.75	0.140	3305.00	7782.90	0.04540
33	7.75	0.140	3300.00	7771.10	0.04565
34	7.75	0.140	3300.00	7771.10	0.04565
35	7.75	0.140	3296.00	7761.70	0.04589
36	7.75	0.140	3296.00	7761.70	0.04589

Table 3KK-11

Surface Best Estimate Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	7.75	0.140	3292.00	7752.30	0.04612
38	7.75	0.140	3292.00	7752.30	0.04612
39	9.00	0.145	3079.00	7542.00	0.01966
40	9.00	0.145	3079.00	7542.00	0.01967
41	9.00	0.145	3079.00	7542.00	0.01971
42	9.00	0.145	3078.50	7540.80	0.01973
43	9.00	0.145	3078.00	7539.50	0.01975
44	9.00	0.145	3078.00	7539.50	0.01978
45	9.00	0.145	3078.00	7539.50	0.01979
46	17.00	0.150	5344.00	10387.00	0.02096
47	17.00	0.150	5344.00	10387.00	0.02096
48	17.00	0.150	5344.00	10387.00	0.02096
49	17.00	0.150	5344.00	10387.00	0.02096
50	17.00	0.150	5344.00	10387.00	0.02096
51	12.55	0.150	5344.00	10387.00	0.02096
52	12.55	0.150	5344.00	10387.00	0.02096
53	17.00	0.150	5341.00	10381.00	0.02115
Halfspace		0.150	5341.00	10381.00	0.02115

Table 3KK-12

Surface Upper Bound Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	5.50	0.155	7108.30	14112.00	0.01286
2	9.50	0.155	7108.30	14112.00	0.01286
3	10.00	0.155	7108.30	14112.00	0.01286
4	10.00	0.155	7108.30	14112.00	0.01286
5	10.00	0.155	7108.30	14112.00	0.01286
6	10.00	0.155	7108.30	14112.00	0.01286
7	10.00	0.155	7108.30	14112.00	0.01286
8	3.00	0.135	3870.30	10421.00	0.02423
9	12.00	0.155	6265.10	13395.00	0.01174
10	12.00	0.155	6265.10	13395.00	0.01174
11	17.00	0.155	7920.40	15094.00	0.01169
12	17.00	0.155	7920.40	15094.00	0.01169
13	10.00	0.150	5084.10	11556.00	0.01220
14	7.00	0.150	5084.10	11556.00	0.01220
15	10.00	0.150	5083.40	11555.00	0.01227
16	7.00	0.150	5083.40	11555.00	0.01227
17	7.00	0.130	3692.50	9454.20	0.01195
18	7.50	0.130	3692.50	9454.20	0.01195
19	7.00	0.130	3692.50	9454.20	0.01200
20	7.50	0.130	3692.50	9454.20	0.01200
21	8.00	0.135	4208.30	9565.50	0.02122
22	8.00	0.135	4208.30	9565.50	0.02122
23	8.00	0.135	4206.00	9560.30	0.02132
24	8.00	0.135	4206.00	9560.30	0.02132
25	8.00	0.135	4202.80	9553.10	0.02142
26	8.00	0.135	4202.80	9553.10	0.02142
27	8.00	0.135	4200.10	9546.80	0.02153
28	8.00	0.135	4200.10	9546.80	0.02153
29	8.00	0.135	4196.50	9538.70	0.02161
30	8.00	0.135	4196.50	9538.70	0.02161
31	7.75	0.140	4285.50	10092.00	0.03091
32	7.75	0.140	4285.50	10092.00	0.03091
33	7.75	0.140	4280.30	10080.00	0.03108
34	7.75	0.140	4280.30	10080.00	0.03108
35	7.75	0.140	4276.40	10070.00	0.03125
36	7.75	0.140	4276.40	10070.00	0.03125

Table 3KK-12

Surface Upper Bound Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	7.75	0.140	4272.10	10060.00	0.03141
38	7.75	0.140	4272.10	10060.00	0.03141
39	9.00	0.145	3884.90	9516.10	0.01357
40	9.00	0.145	3884.90	9516.10	0.01358
41	9.00	0.145	3884.90	9516.10	0.01361
42	9.00	0.145	3884.50	9515.00	0.01363
43	9.00	0.145	3884.10	9514.00	0.01364
44	9.00	0.145	3884.10	9514.00	0.01366
45	9.00	0.145	3884.10	9514.00	0.01366
46	17.00	0.150	6611.30	12850.00	0.01552
47	17.00	0.150	6611.30	12850.00	0.01552
48	17.00	0.150	6611.30	12850.00	0.01552
49	17.00	0.150	6611.30	12850.00	0.01552
50	17.00	0.150	6611.30	12850.00	0.01552
51	12.55	0.150	6611.30	12850.00	0.01552
52	12.55	0.150	6611.30	12850.00	0.01552
53	17.00	0.150	6607.60	12843.00	0.01566
Halfspace		0.150	6607.60	12843.00	0.01566

Table 3KK-13
Embedded Lower Bound Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	3.38	0.125	509.86	1061.40	0.02891
2	3.948	0.125	570.91	1188.40	0.03496
3	3.998	0.125	551.16	1147.30	0.04362
4	1.9241	0.125	534.55	1112.80	0.05072
5	3.900	0.125	527.53	1098.10	0.05373
6	3.900	0.125	554.32	1153.90	0.05301
7	3.900	0.125	684.03	1423.90	0.03993
8	5.0499	0.125	676.18	2170.80	0.04282
9	3.500	0.125	668.73	3409.90	0.04566
10	3.250	0.125	665.45	3393.10	0.04696
11	3.250	0.125	662.66	3378.90	0.04807
12	5.500	0.155	4602.80	9137.70	0.02757
13	9.500	0.155	4602.80	9137.70	0.02757
14	10.000	0.155	4602.80	9137.70	0.02757
15	10.000	0.155	4602.80	9137.70	0.02757
16	10.000	0.155	4602.80	9137.70	0.02757
17	10.000	0.155	4602.80	9137.70	0.02757
18	10.000	0.155	4602.80	9137.70	0.02757
19	3.000	0.135	2355.00	6340.90	0.05490
20	12.000	0.155	4172.80	8921.80	0.02499
21	12.000	0.155	4172.80	8921.80	0.02499
22	17.000	0.155	5280.30	10062.00	0.02498
23	17.000	0.155	5280.30	10062.00	0.02498
24	10.000	0.150	3219.80	7318.80	0.02588
25	7.000	0.150	3219.80	7318.80	0.02588
26	10.000	0.150	3218.70	7316.20	0.02601
27	7.000	0.150	3218.70	7316.20	0.02601
28	7.000	0.130	2356.80	6034.30	0.02543
29	7.500	0.130	2356.80	6034.30	0.02543
30	7.000	0.130	2356.80	6034.30	0.02552
31	7.500	0.130	2356.80	6034.30	0.02552
32	8.000	0.135	2362.30	5369.70	0.04618
33	8.000	0.135	2362.30	5369.70	0.04618
34	8.000	0.135	2359.20	5362.40	0.04639
35	8.000	0.135	2359.10	5362.40	0.04639
36	8.000	0.135	2356.40	5356.30	0.04658

Table 3KK-13

Embedded Lower Bound Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	8.000	0.135	2356.40	5356.30	0.04658
38	8.000	0.135	2353.50	5349.50	0.04677
39	8.000	0.135	2353.50	5349.50	0.04677
40	8.000	0.135	2351.00	5343.90	0.04693
41	8.000	0.135	2351.00	5343.90	0.04693
42	7.750	0.140	2548.80	6002.20	0.06669
43	7.750	0.140	2548.80	6002.20	0.06669
44	7.750	0.140	2544.20	5991.30	0.06705
45	7.750	0.140	2544.20	5991.30	0.06705
46	7.750	0.140	2540.40	5982.30	0.06739
47	7.750	0.140	2540.40	5982.30	0.06739
48	7.750	0.140	2536.80	5973.80	0.06771
49	7.750	0.140	2536.80	5973.80	0.06771
50	9.000	0.145	2440.30	5977.40	0.02848
51	9.000	0.145	2440.30	5977.40	0.02850
52	9.000	0.145	2440.30	5977.40	0.02855
53	9.000	0.145	2439.70	5976.10	0.02858
54	9.000	0.145	2439.20	5974.90	0.02861
55	9.000	0.145	2439.20	5974.90	0.02865
56	9.000	0.145	2439.20	5974.90	0.02866
57	17.000	0.150	4319.60	8395.90	0.02832
58	17.000	0.150	4319.60	8395.90	0.02832
59	17.000	0.150	4319.60	8395.90	0.02832
60	17.000	0.150	4319.60	8395.90	0.02832
61	17.000	0.150	4319.60	8395.90	0.02832
62	12.550	0.150	4319.60	8395.90	0.02832
63	12.550	0.150	4319.60	8395.90	0.02832
64	17.000	0.150	4317.20	8391.20	0.02856
Halfspace		0.150	4317.20	8391.20	0.02856

Table 3KK-14

Embedded Best Estimate Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	3.38	0.125	663.33	1380.80	0.01720
2	3.948	0.125	762.97	1588.30	0.02080
3	3.998	0.125	746.90	1554.80	0.02556
4	1.9241	0.125	732.96	1525.80	0.02940
5	3.90	0.125	726.88	1513.10	0.03103
6	3.90	0.125	765.72	1594.00	0.03050
7	3.90	0.125	931.50	1939.10	0.02304
8	5.0499	0.125	924.47	2967.80	0.02469
9	3.50	0.125	917.80	4679.90	0.02619
10	3.25	0.125	914.83	4664.70	0.02686
11	3.25	0.125	912.30	4651.80	0.02744
12	5.50	0.155	5720.00	11356.00	0.01883
13	9.50	0.155	5720.00	11356.00	0.01883
14	10.00	0.155	5720.00	11356.00	0.01883
15	10.00	0.155	5720.00	11356.00	0.01883
16	10.00	0.155	5720.00	11356.00	0.01883
17	10.00	0.155	5720.00	11356.00	0.01883
18	10.00	0.155	5720.00	11356.00	0.01883
19	3.00	0.135	3019.00	8128.90	0.03647
20	12.00	0.155	5113.00	10932.00	0.01713
21	12.00	0.155	5113.00	10932.00	0.01713
22	17.00	0.155	6467.00	12324.00	0.01709
23	17.00	0.155	6467.00	12324.00	0.01709
24	10.00	0.150	4046.00	9196.70	0.01777
25	7.00	0.150	4046.00	9196.70	0.01777
26	10.00	0.150	4045.00	9194.40	0.01786
27	7.00	0.150	4045.00	9194.40	0.01786
28	7.00	0.130	2950.00	7553.10	0.01743
29	7.50	0.130	2950.00	7553.10	0.01743
30	7.00	0.130	2950.00	7553.10	0.01750
31	7.50	0.130	2950.00	7553.10	0.01750
32	8.00	0.135	3153.00	7166.90	0.03130
33	8.00	0.135	3153.00	7166.90	0.03130
34	8.00	0.135	3150.00	7160.10	0.03145
35	8.00	0.135	3150.00	7160.10	0.03145
36	8.00	0.135	3147.00	7153.20	0.03159

Table 3KK-14

Embedded Best Estimate Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	8.00	0.135	3147.00	7153.20	0.03159
38	8.00	0.135	3144.00	7146.40	0.03173
39	8.00	0.135	3144.00	7146.40	0.03173
40	8.00	0.135	3141.00	7139.60	0.03185
41	8.00	0.135	3141.00	7139.60	0.03185
42	7.75	0.140	3305.00	7782.90	0.04540
43	7.75	0.140	3305.00	7782.90	0.04540
44	7.75	0.140	3300.00	7771.10	0.04565
45	7.75	0.140	3300.00	7771.10	0.04565
46	7.75	0.140	3296.00	7761.70	0.04589
47	7.75	0.140	3296.00	7761.70	0.04589
48	7.75	0.140	3292.00	7752.30	0.04612
49	7.75	0.140	3292.00	7752.30	0.04612
50	9.00	0.145	3079.00	7542.00	0.01966
51	9.00	0.145	3079.00	7542.00	0.01967
52	9.00	0.145	3079.00	7542.00	0.01971
53	9.00	0.145	3078.50	7540.80	0.01973
54	9.00	0.145	3078.00	7539.50	0.01975
55	9.00	0.145	3078.00	7539.50	0.01978
56	9.00	0.145	3078.00	7539.50	0.01979
57	17.00	0.150	5344.00	10387.00	0.02096
58	17.00	0.150	5344.00	10387.00	0.02096
59	17.00	0.150	5344.00	10387.00	0.02096
60	17.00	0.150	5344.00	10387.00	0.02096
61	17.00	0.150	5344.00	10387.00	0.02096
62	12.55	0.150	5344.00	10387.00	0.02096
63	12.55	0.150	5344.00	10387.00	0.02096
64	17.00	0.150	5341.00	10381.00	0.02115
Halfspace		0.150	5341.00	10381.00	0.02115

Table 3KK-15

Embedded Upper Bound Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	3.38	0.125	862.91	1796.30	0.01024
2	3.948	0.125	1019.60	2122.50	0.01237
3	3.998	0.125	1012.20	2107.00	0.01498
4	1.9241	0.125	1005.00	2092.10	0.01705
5	3.90	0.125	1001.50	2084.90	0.01792
6	3.90	0.125	1057.70	2201.80	0.01755
7	3.90	0.125	1268.50	2640.60	0.01330
8	5.0499	0.125	1263.90	4057.50	0.01424
9	3.50	0.125	1259.60	6422.90	0.01502
10	3.25	0.125	1257.70	6412.90	0.01538
11	3.25	0.125	1256.00	6404.30	0.01568
12	5.50	0.155	7108.30	14112.00	0.01286
13	9.50	0.155	7108.30	14112.00	0.01286
14	10.00	0.155	7108.30	14112.00	0.01286
15	10.00	0.155	7108.30	14112.00	0.01286
16	10.00	0.155	7108.30	14112.00	0.01286
17	10.00	0.155	7108.30	14112.00	0.01286
18	10.00	0.155	7108.30	14112.00	0.01286
19	3.00	0.135	3870.30	10421.00	0.02423
20	12.00	0.155	6265.10	13395.00	0.01174
21	12.00	0.155	6265.10	13395.00	0.01174
22	17.00	0.155	7920.40	15094.00	0.01169
23	17.00	0.155	7920.40	15094.00	0.01169
24	10.00	0.150	5084.10	11556.00	0.01220
25	7.00	0.150	5084.10	11556.00	0.01220
26	10.00	0.150	5083.40	11555.00	0.01227
27	7.00	0.150	5083.40	11555.00	0.01227
28	7.00	0.130	3692.50	9454.20	0.01195
29	7.50	0.130	3692.50	9454.20	0.01195
30	7.00	0.130	3692.50	9454.20	0.01200
31	7.50	0.130	3692.50	9454.20	0.01200
32	8.00	0.135	4208.30	9565.50	0.02122
33	8.00	0.135	4208.30	9565.50	0.02122
34	8.00	0.135	4206.00	9560.30	0.02132
35	8.00	0.135	4206.00	9560.30	0.02132
36	8.00	0.135	4202.80	9553.10	0.02142

Table 3KK-15

Embedded Upper Bound Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-Wave Velocity	P-Wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	8.00	0.135	4202.80	9553.10	0.02142
38	8.00	0.135	4200.10	9546.80	0.02153
39	8.00	0.135	4200.10	9546.80	0.02153
40	8.00	0.135	4196.50	9538.70	0.02161
41	8.00	0.135	4196.50	9538.70	0.02161
42	7.75	0.140	4285.50	10092.00	0.03091
43	7.75	0.140	4285.50	10092.00	0.03091
44	7.75	0.140	4280.30	10080.00	0.03108
45	7.75	0.140	4280.30	10080.00	0.03108
46	7.75	0.140	4276.40	10070.00	0.03125
47	7.75	0.140	4276.40	10070.00	0.03125
48	7.75	0.140	4272.10	10060.00	0.03141
49	7.75	0.140	4272.10	10060.00	0.03141
50	9.00	0.145	3884.90	9516.10	0.01357
51	9.00	0.145	3884.90	9516.10	0.01358
52	9.00	0.145	3884.90	9516.10	0.01361
53	9.00	0.145	3884.50	9515.00	0.01363
54	9.00	0.145	3884.10	9514.00	0.01364
55	9.00	0.145	3884.10	9514.00	0.01366
56	9.00	0.145	3884.10	9514.00	0.01366
57	17.00	0.150	6611.30	12850.00	0.01552
58	17.00	0.150	6611.30	12850.00	0.01552
59	17.00	0.150	6611.30	12850.00	0.01552
60	17.00	0.150	6611.30	12850.00	0.01552
61	17.00	0.150	6611.30	12850.00	0.01552
62	12.55	0.150	6611.30	12850.00	0.01552
63	12.55	0.150	6611.30	12850.00	0.01552
64	17.00	0.150	6607.60	12843.00	0.01566
Halfspace		0.150	6607.60	12843.00	0.01566

Table 3KK-16

Embedded High Bound Soil Profile (Sheet 1 of 2)

Layer Number	Layer Thickness	Unit Weight	S-wave Velocity	P-wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
1	3.38	0.125	1122.50	2336.60	0.00610
2	3.948	0.125	1362.60	2836.60	0.00736
3	3.998	0.125	1371.60	2855.20	0.00878
4	1.9241	0.125	1378.00	2868.50	0.00988
5	3.90	0.125	1379.90	2872.60	0.01035
6	3.90	0.125	1460.90	3041.10	0.01010
7	3.90	0.125	1727.40	3595.90	0.00767
8	5.0499	0.125	1728.00	5547.30	0.00821
9	3.50	0.125	1728.80	8815.20	0.00862
10	3.25	0.125	1729.00	8816.10	0.00880
11	3.25	0.125	1729.10	8816.80	0.00895
12	5.50	0.155	7108.30	14112.00	0.01286
13	9.50	0.155	7108.30	14112.00	0.01286
14	10.00	0.155	7108.30	14112.00	0.01286
15	10.00	0.155	7108.30	14112.00	0.01286
16	10.00	0.155	7108.30	14112.00	0.01286
17	10.00	0.155	7108.30	14112.00	0.01286
18	10.00	0.155	7108.30	14112.00	0.01286
19	3.00	0.135	3870.30	10421.00	0.02423
20	12.00	0.155	6265.10	13395.00	0.01174
21	12.00	0.155	6265.10	13395.00	0.01174
22	17.00	0.155	7920.40	15094.00	0.01169
23	17.00	0.155	7920.40	15094.00	0.01169
24	10.00	0.150	5084.10	11556.00	0.01220
25	7.00	0.150	5084.10	11556.00	0.01220
26	10.00	0.150	5083.40	11555.00	0.01227
27	7.00	0.150	5083.40	11555.00	0.01227
28	7.00	0.130	3692.50	9454.20	0.01195
29	7.50	0.130	3692.50	9454.20	0.01195
30	7.00	0.130	3692.50	9454.20	0.01200
31	7.50	0.130	3692.50	9454.20	0.01200
32	8.00	0.135	4208.30	9565.50	0.02122
33	8.00	0.135	4208.30	9565.50	0.02122
34	8.00	0.135	4206.00	9560.30	0.02132
35	8.00	0.135	4206.00	9560.30	0.02132
36	8.00	0.135	4202.80	9553.10	0.02142

Table 3KK-16

Embedded High Bound Soil Profile (Sheet 2 of 2)

Layer Number	Layer Thickness	Unit Weight	S-wave Velocity	P-wave Velocity	Damping Ratio
	ft	*kcf*	*ft/sec*	*ft/sec*	
37	8.00	0.135	4202.80	9553.10	0.02142
38	8.00	0.135	4200.10	9546.80	0.02153
39	8.00	0.135	4200.10	9546.80	0.02153
40	8.00	0.135	4196.50	9538.70	0.02161
41	8.00	0.135	4196.50	9538.70	0.02161
42	7.75	0.140	4285.50	10092.00	0.03091
43	7.75	0.140	4285.50	10092.00	0.03091
44	7.75	0.140	4280.30	10080.00	0.03108
45	7.75	0.140	4280.30	10080.00	0.03108
46	7.75	0.140	4276.40	10070.00	0.03125
47	7.75	0.140	4276.40	10070.00	0.03125
48	7.75	0.140	4272.10	10060.00	0.03141
49	7.75	0.140	4272.10	10060.00	0.03141
50	9.00	0.145	3884.90	9516.10	0.01357
51	9.00	0.145	3884.90	9516.10	0.01358
52	9.00	0.145	3884.90	9516.10	0.01361
53	9.00	0.145	3884.50	9515.00	0.01363
54	9.00	0.145	3884.10	9514.00	0.01364
55	9.00	0.145	3884.10	9514.00	0.01366
56	9.00	0.145	3884.10	9514.00	0.01366
57	17.00	0.150	6611.30	12850.00	0.01552
58	17.00	0.150	6611.30	12850.00	0.01552
59	17.00	0.150	6611.30	12850.00	0.01552
60	17.00	0.150	6611.30	12850.00	0.01552
61	17.00	0.150	6611.30	12850.00	0.01552
62	12.55	0.150	6611.30	12850.00	0.01552
63	12.55	0.150	6611.30	12850.00	0.01552
64	17.00	0.150	6607.60	12843.00	0.01566
Halfspace		0.150	6607.60	12843.00	0.01566

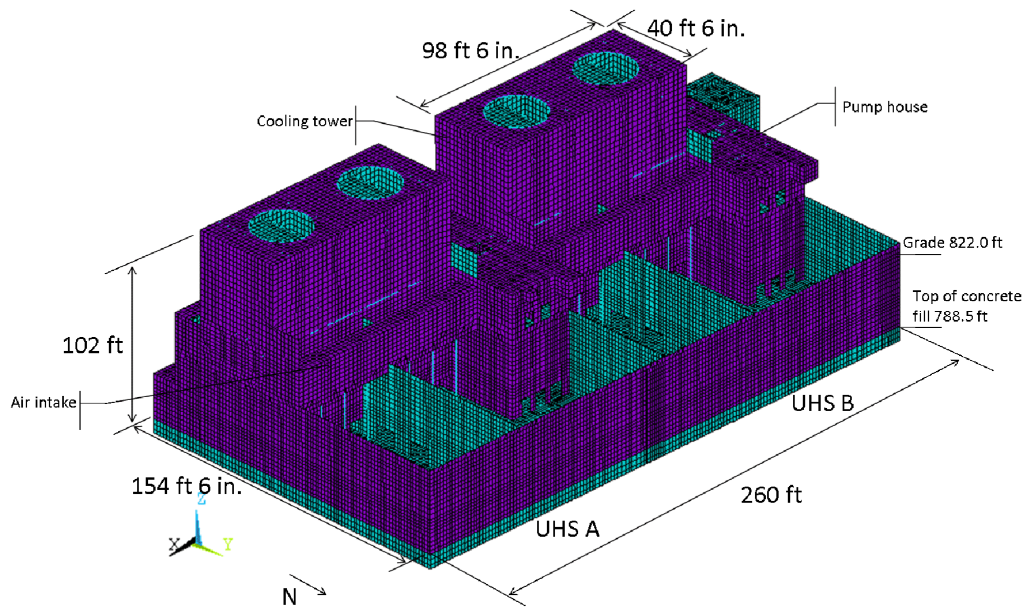
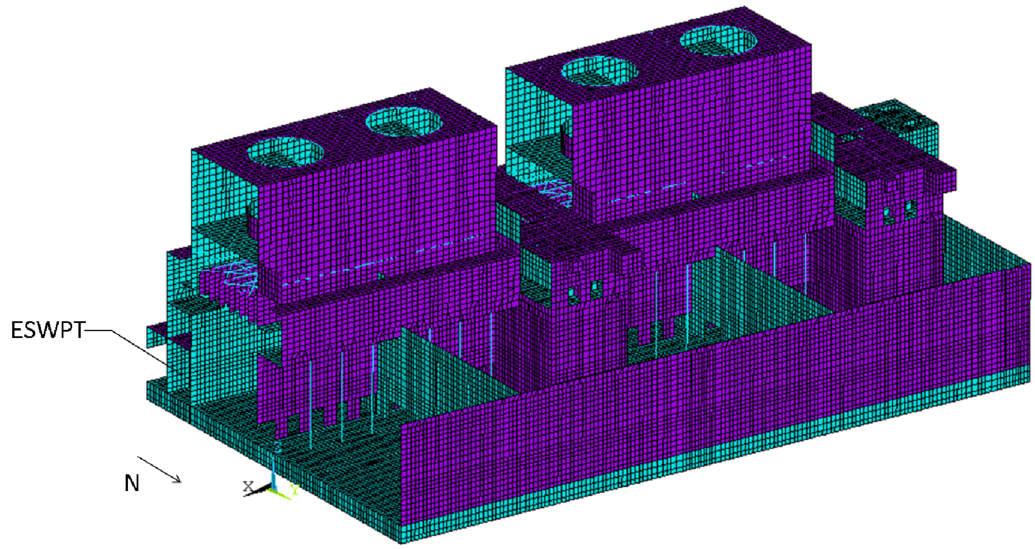


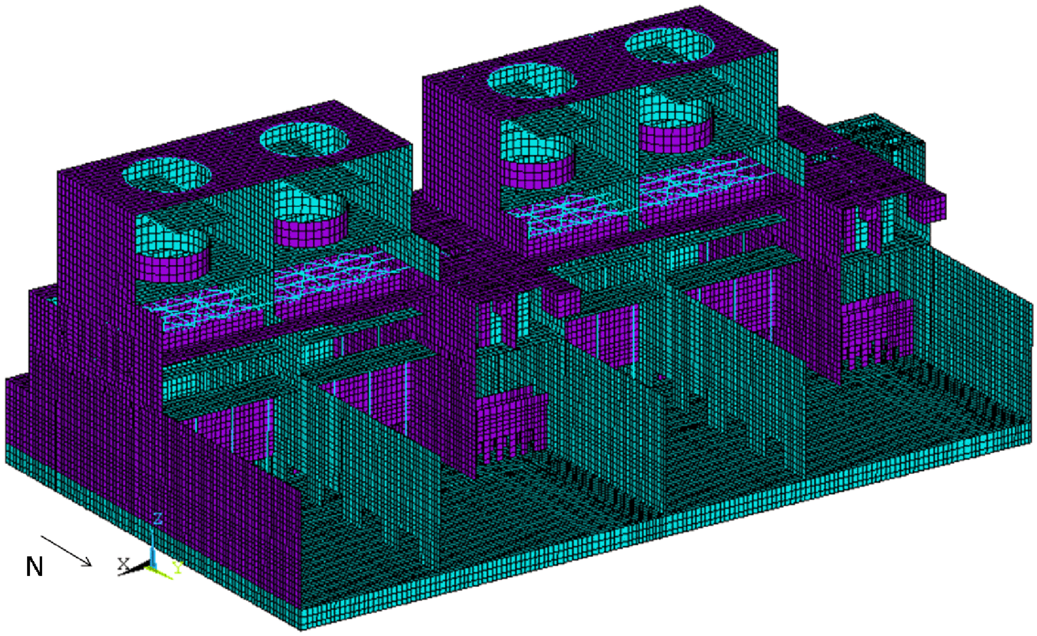
Figure 3KK-1 North-east View of UHSRS AB Finite Element Model (Sheet 1 of 3)



Notes:

1) Figure above is shown with east external walls removed.

Figure 3KK-1 North-east View of UHSRS AB Finite Element Model (Sheet 2 of 3)



Notes:

1) Figure above is shown with north external walls removed.

3KK-1 North-east View of UHSRS AB Finite Element Model (Sheet 3 of 3)

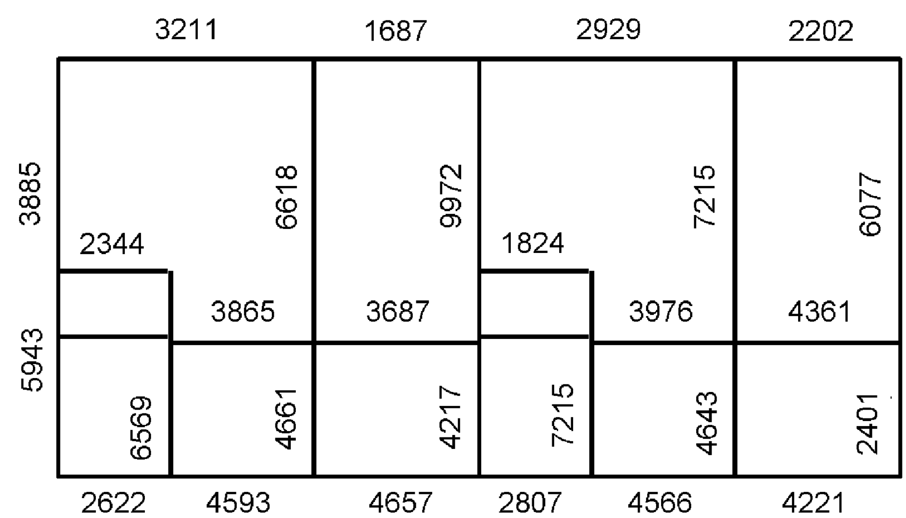


Figure 3KK-2 Wall Maximum Seismic Base Shear Forces (Sheet 1 of 2, Lower Buried UHS Basin Walls)

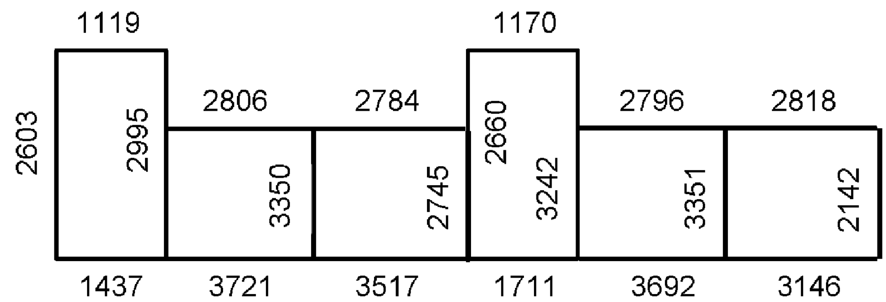


Figure 3KK-2 Wall Maximum Seismic Base Shear Forces (Sheet 2 of 2, Elevated Walls)

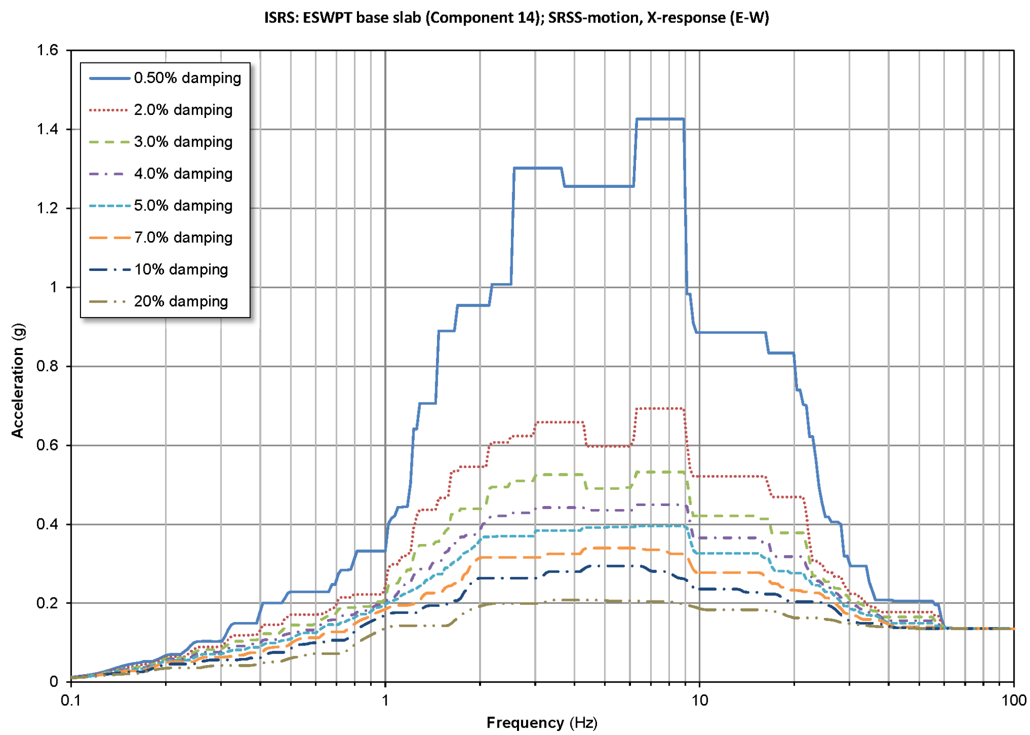


Figure 3KK-3 ISRS for UHSRS (Sheet 1 of 12)

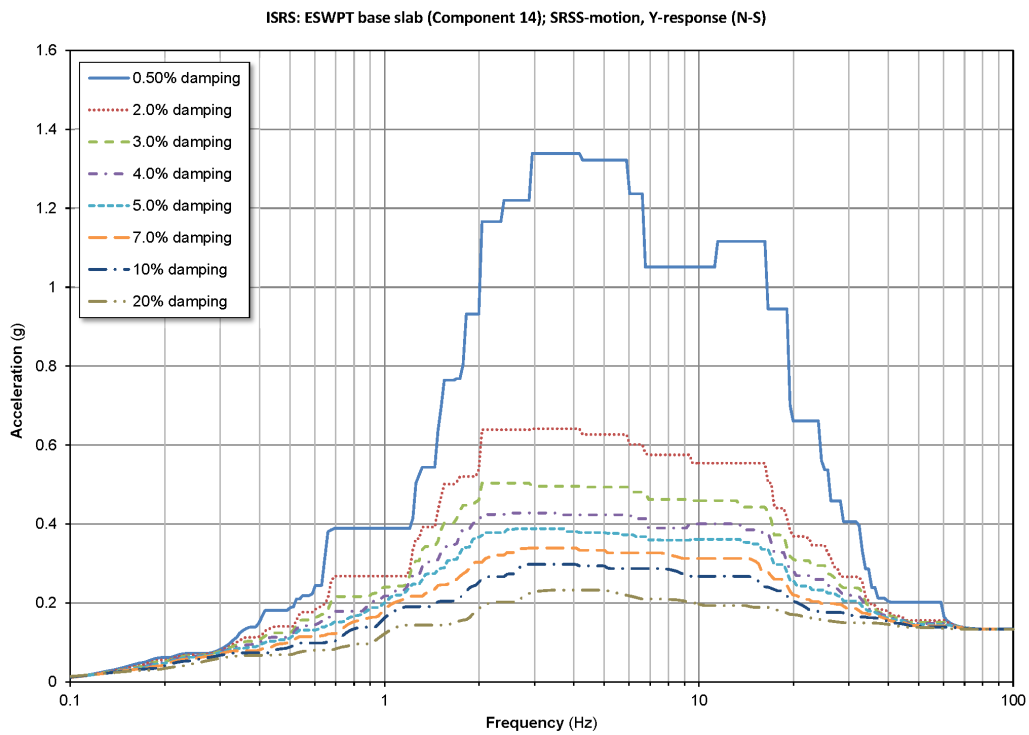


Figure 3KK-3 ISRS for UHSRS (Sheet 2 of 12)

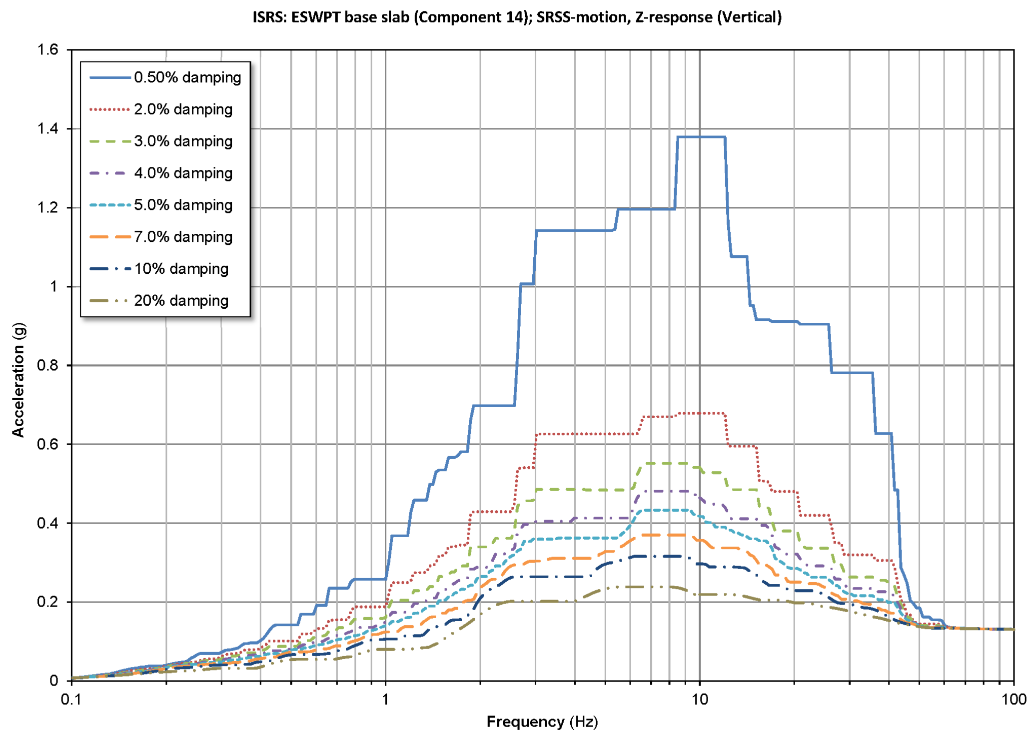


Figure 3KK-3 ISRS for UHSRS (Sheet 3 of 12)

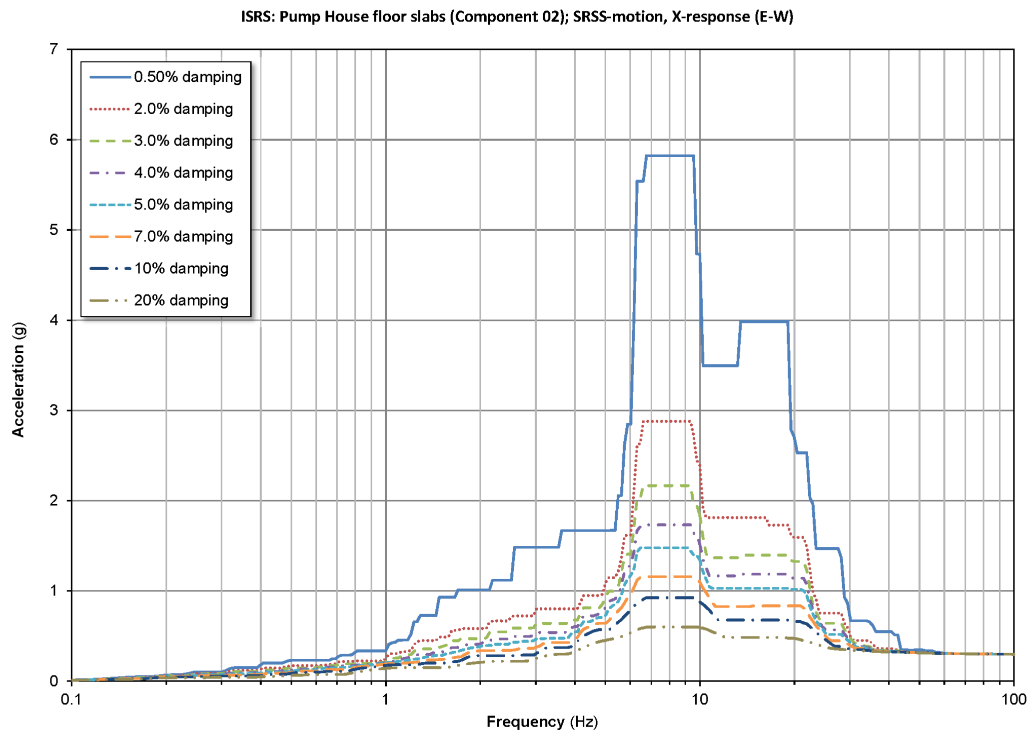


Figure 3KK-3 ISRS for UHSRS (Sheet 4 of 12)

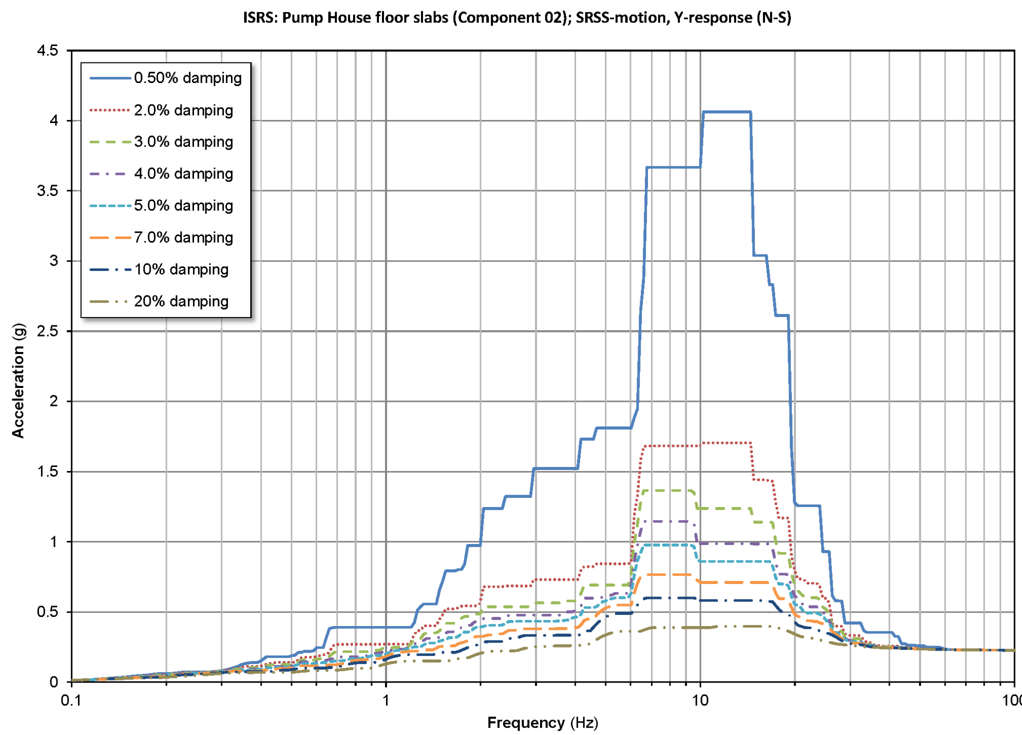


Figure 3KK-3 ISRS for UHSRS (Sheet 5 of 12)

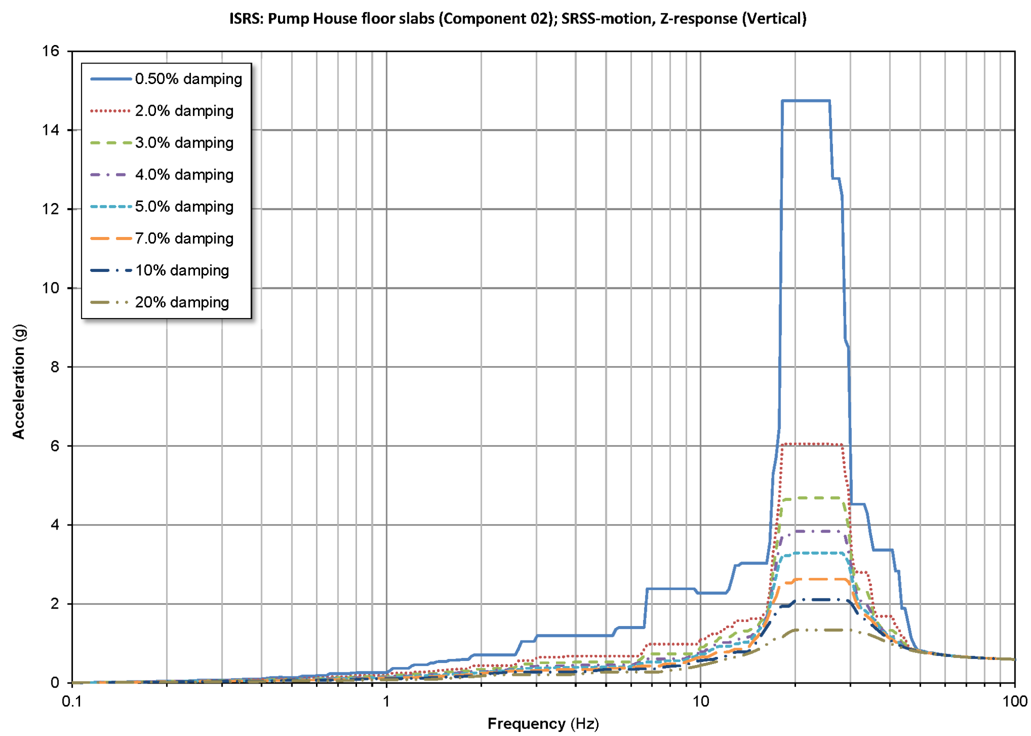


Figure 3KK-3 ISRS for UHSRS (Sheet 6 of 12)

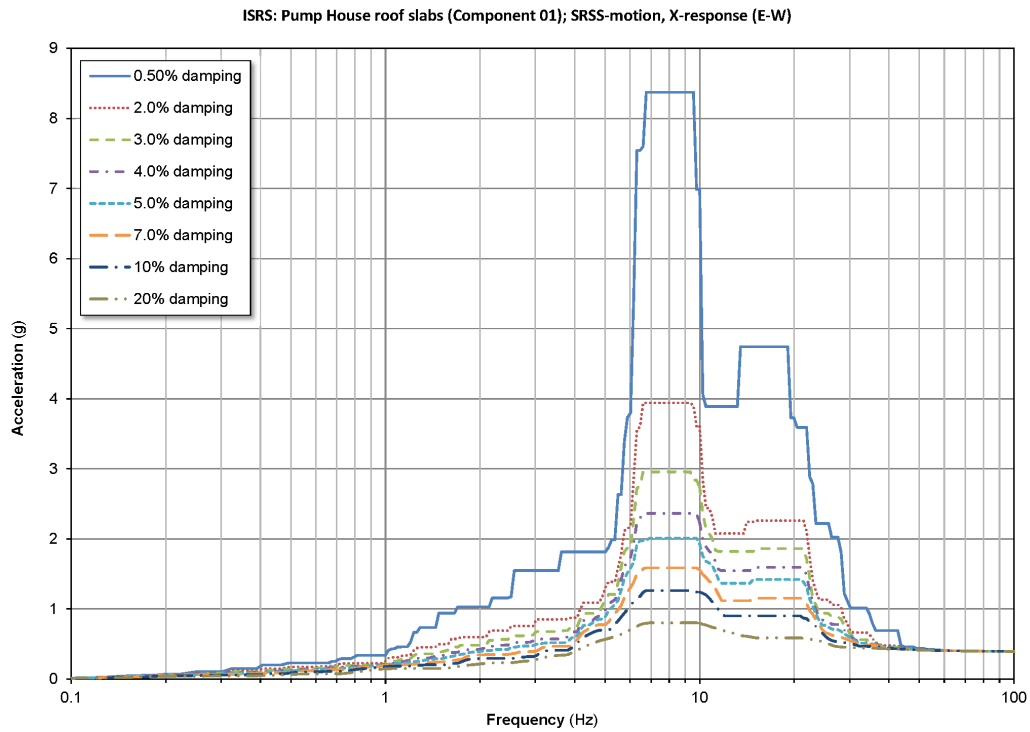


Figure 3KK-3 ISRS for UHSRS (Sheet 7 of 12)

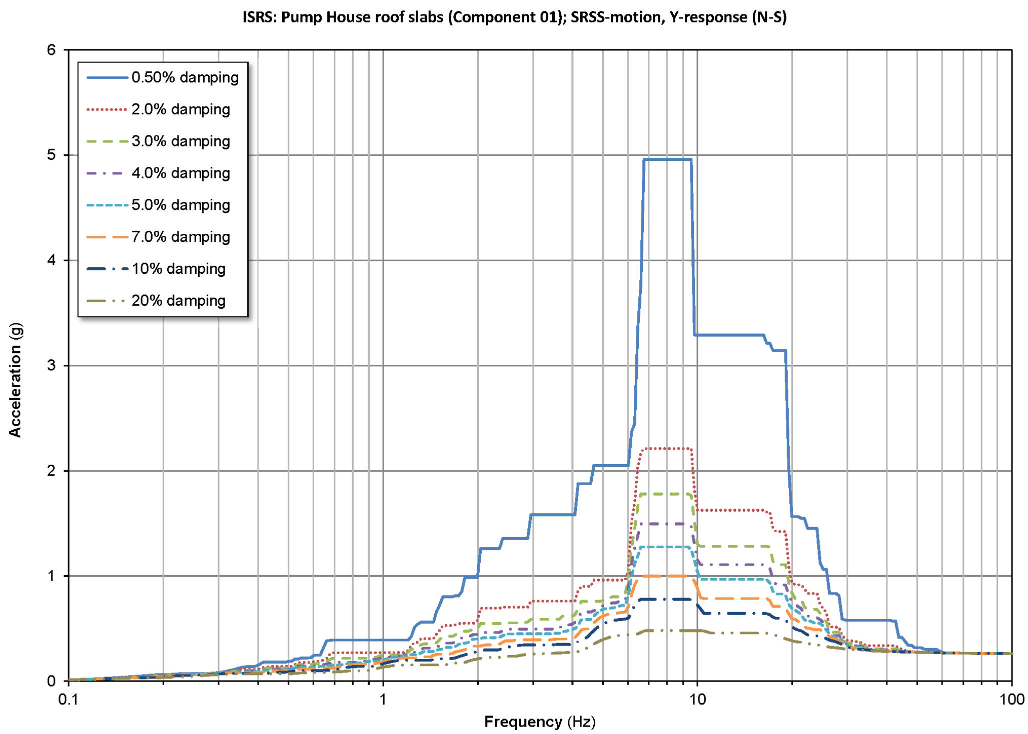


Figure 3KK-3 ISRS for UHSRS (Sheet 8 of 12)

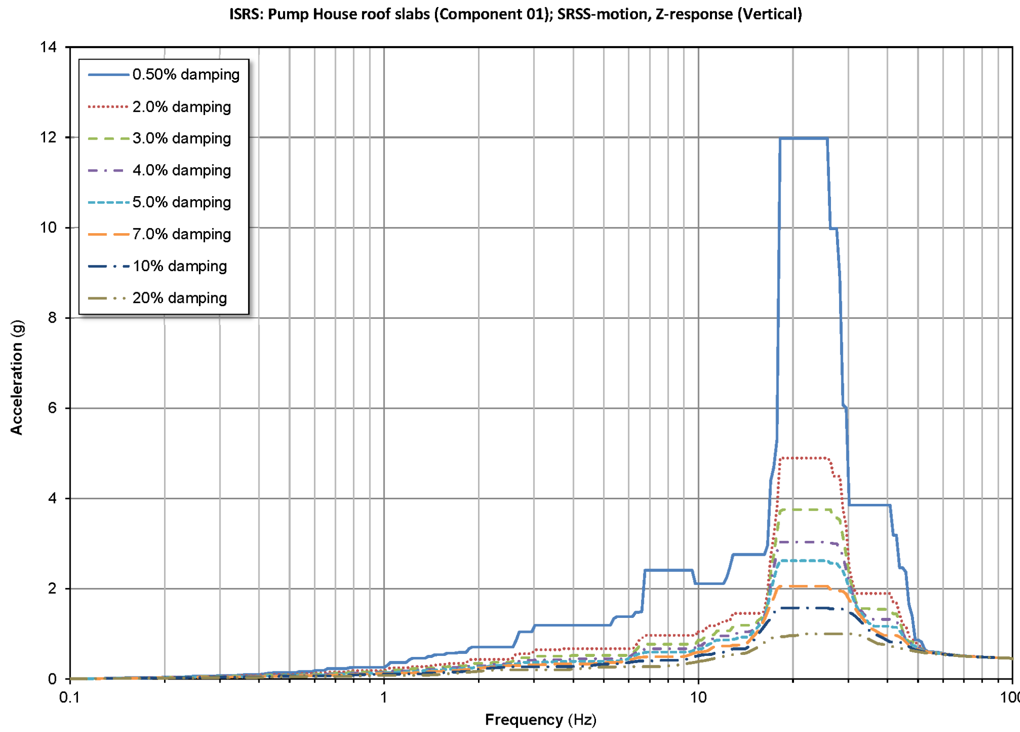


Figure 3KK-3 ISRS for UHSRS (Sheet 9 of 12)

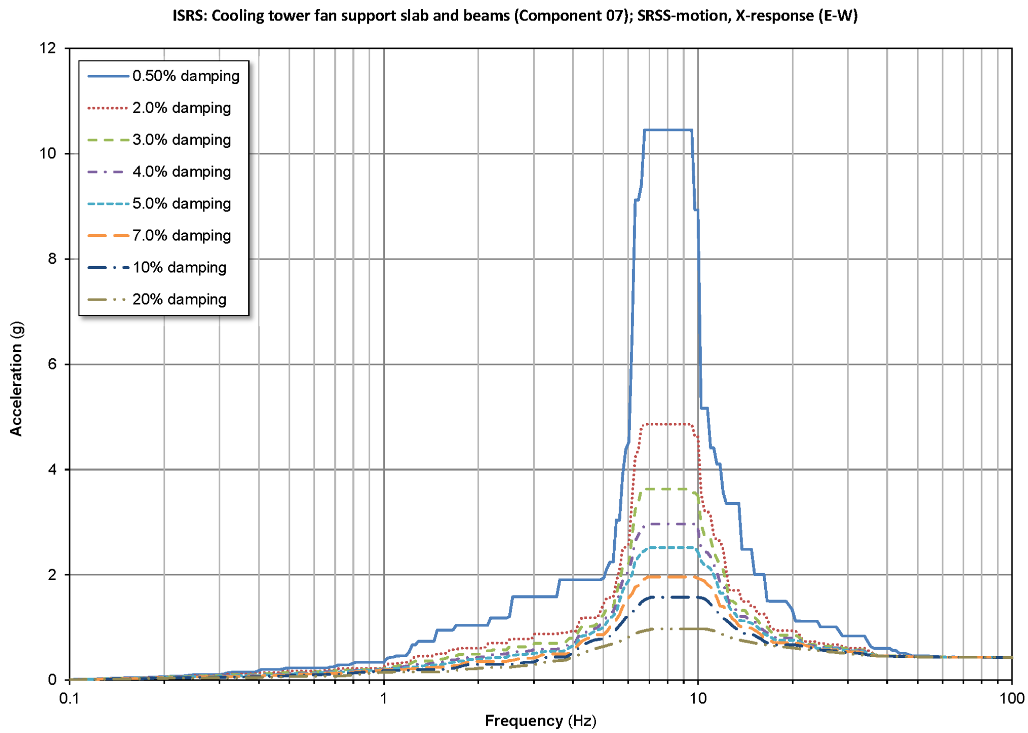


Figure 3KK-3 ISRS for UHSRS (Sheet 10 of 12)

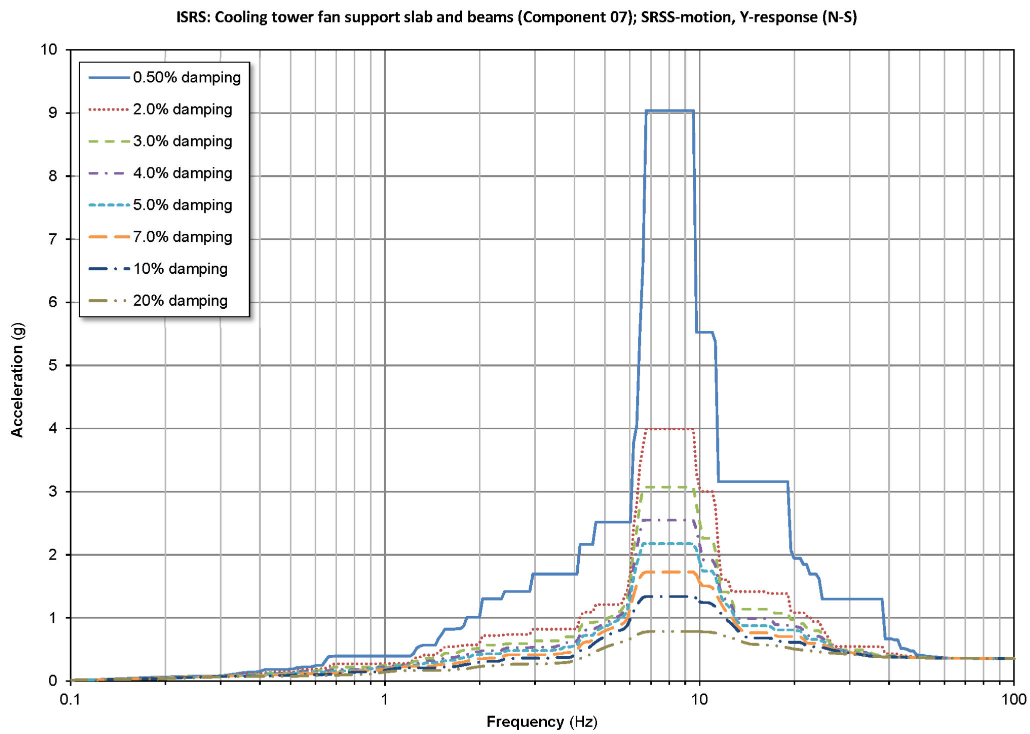


Figure 3KK-3 ISRS for UHSRS (Sheet 11 of 12)

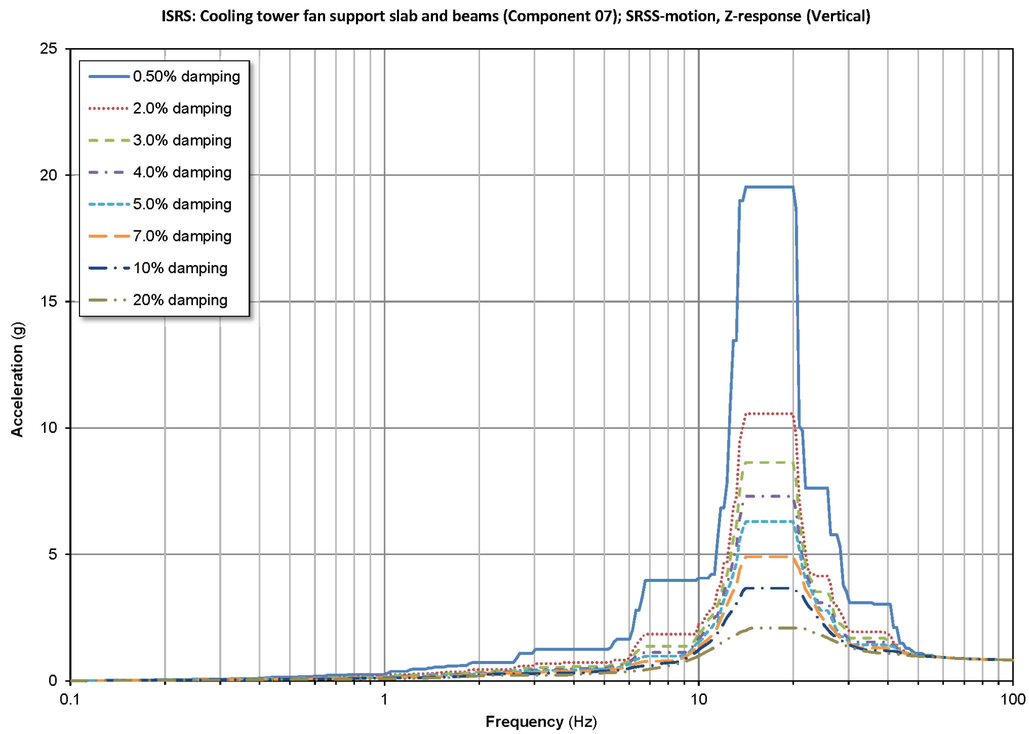
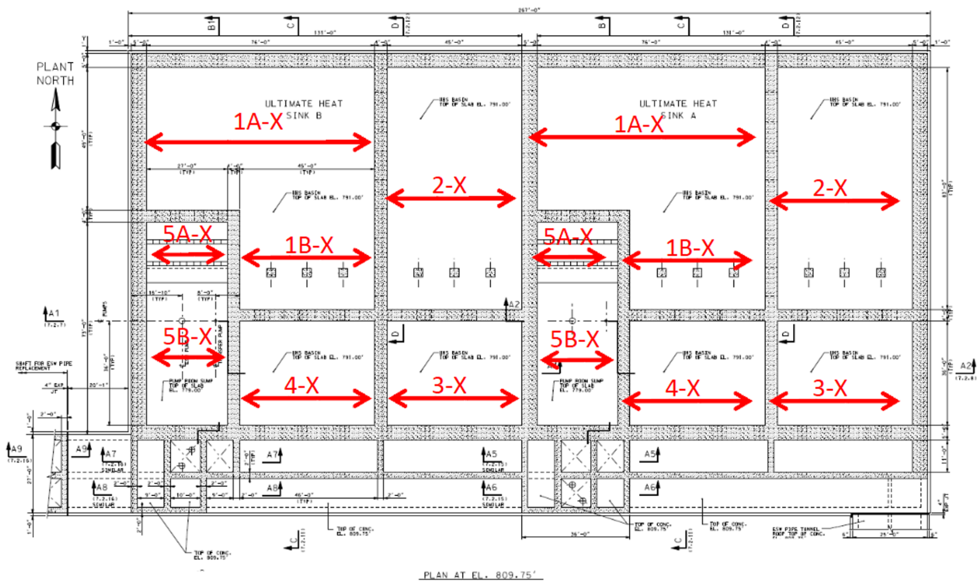
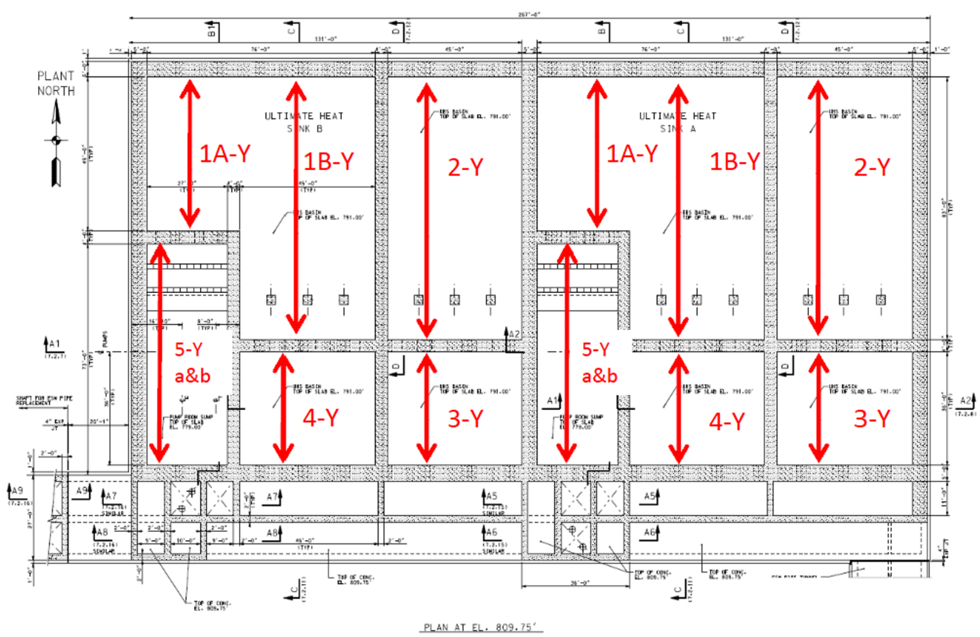


Figure 3KK-3 ISRS for UHSRS (Sheet 12 of 12)

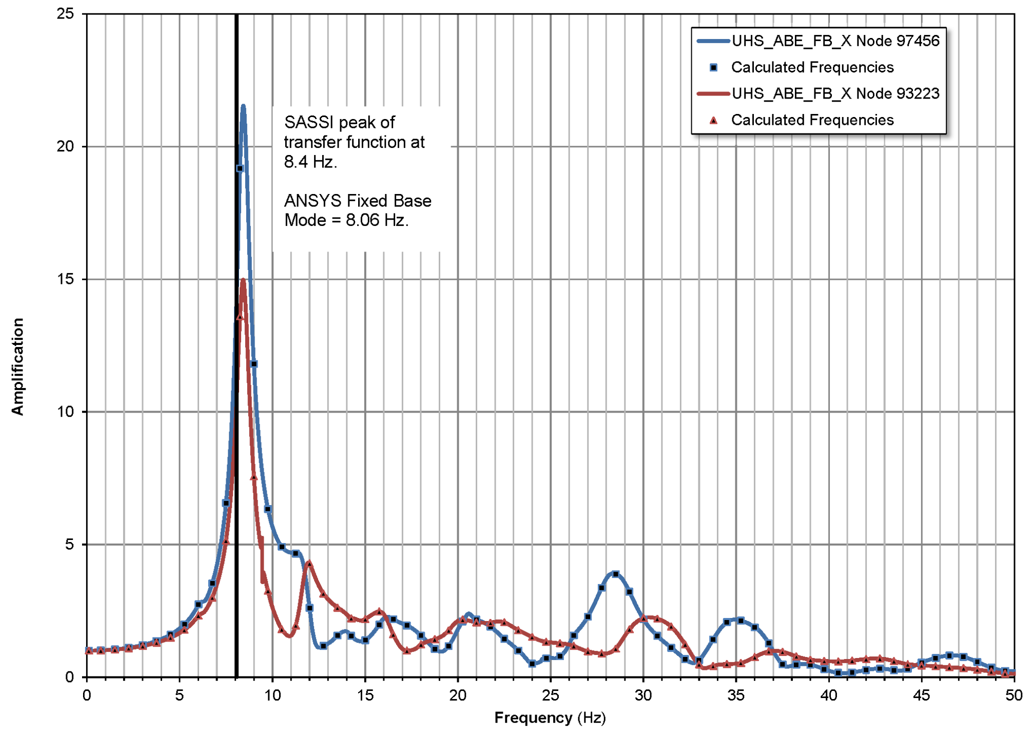


Regions considered for impulsive mass calculation for X-direction motion



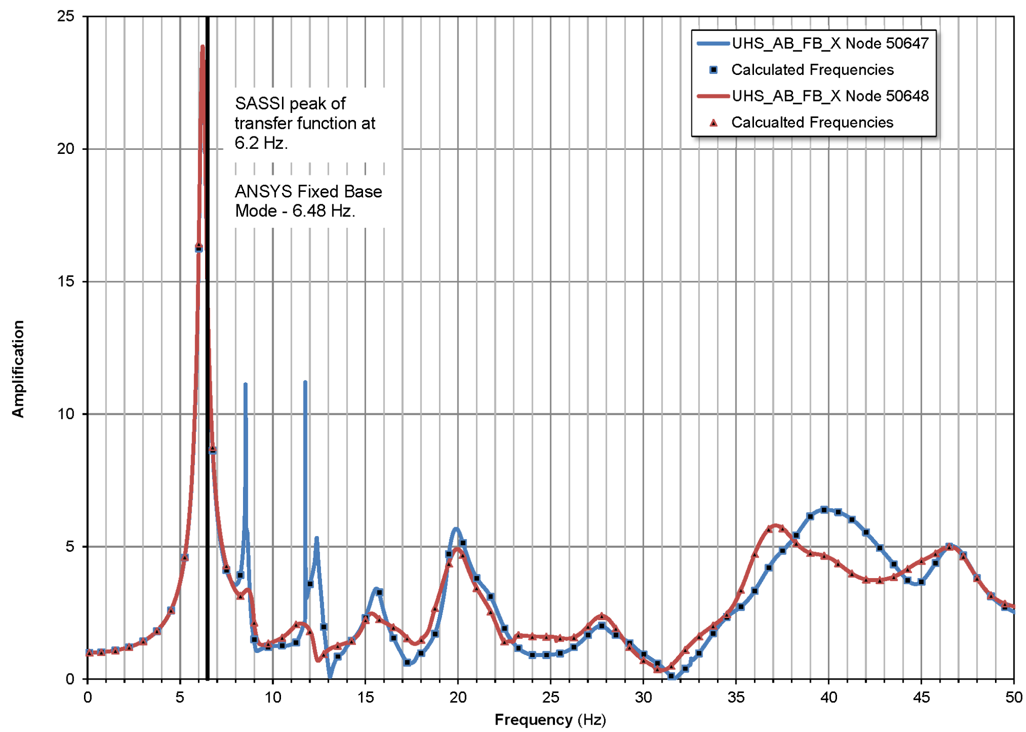
Regions considered for impulsive mass calculation for Y-direction motion

Figure 3KK-4 Regions Considered for Impulsive Mass Calculation for X- and Y-Direction Motion



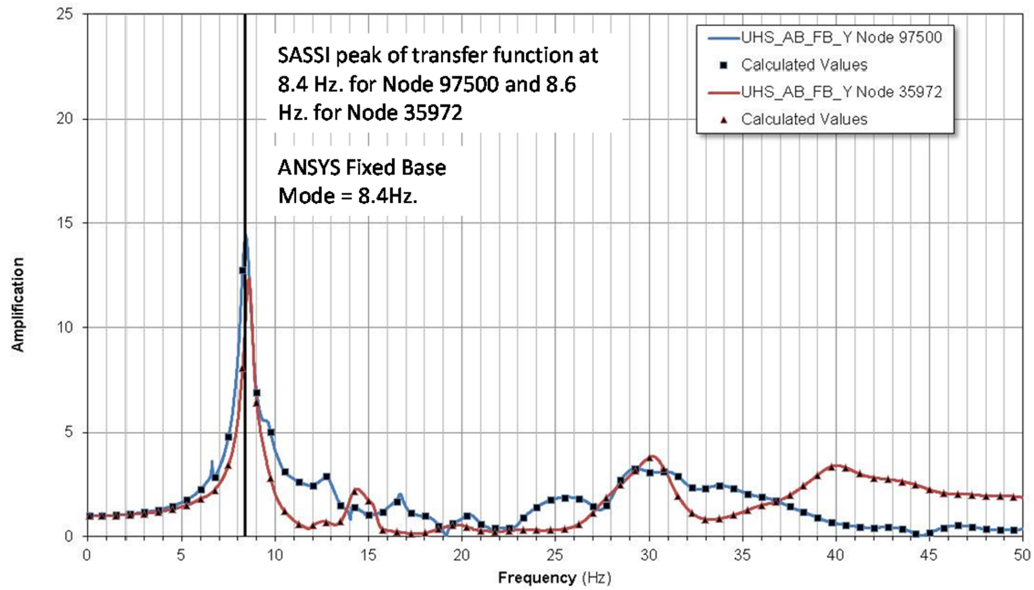
SASSI Fixed Base Transfer Functions at Mid-Height of NS Basin Baffle Wall of UHS B (Node 97456) and at Mid-Height of NS Basin Baffle Wall of UHS A (Node 93223) and ANSYS Fixed Base Major Mode in East-West (X) Direction for UHS_AB_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 1 of 6)



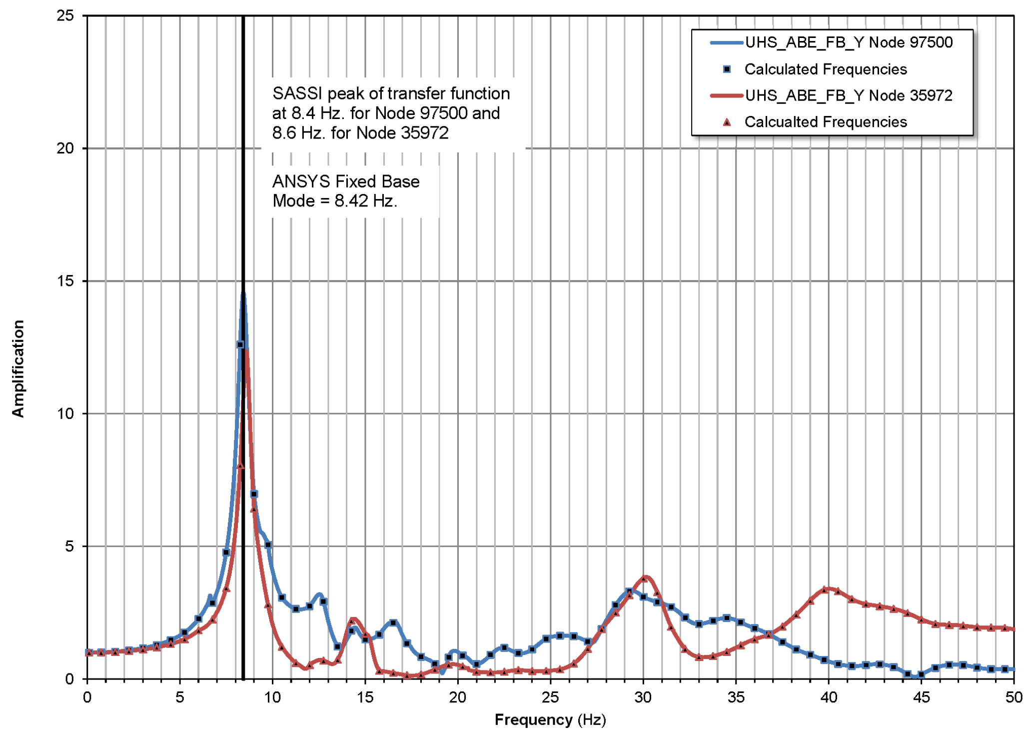
SASSI Fixed Base Transfer Functions at Mid-Height of CTSS North Wall Above Air Intake of UHS B (Node 50647) and at North-West Corner of CTSS Roof Slab of UHS A (Node 50648) and ANSYS Fixed Base Major Mode in East-West (X) Direction for UHS_ABE_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 2 of 6)



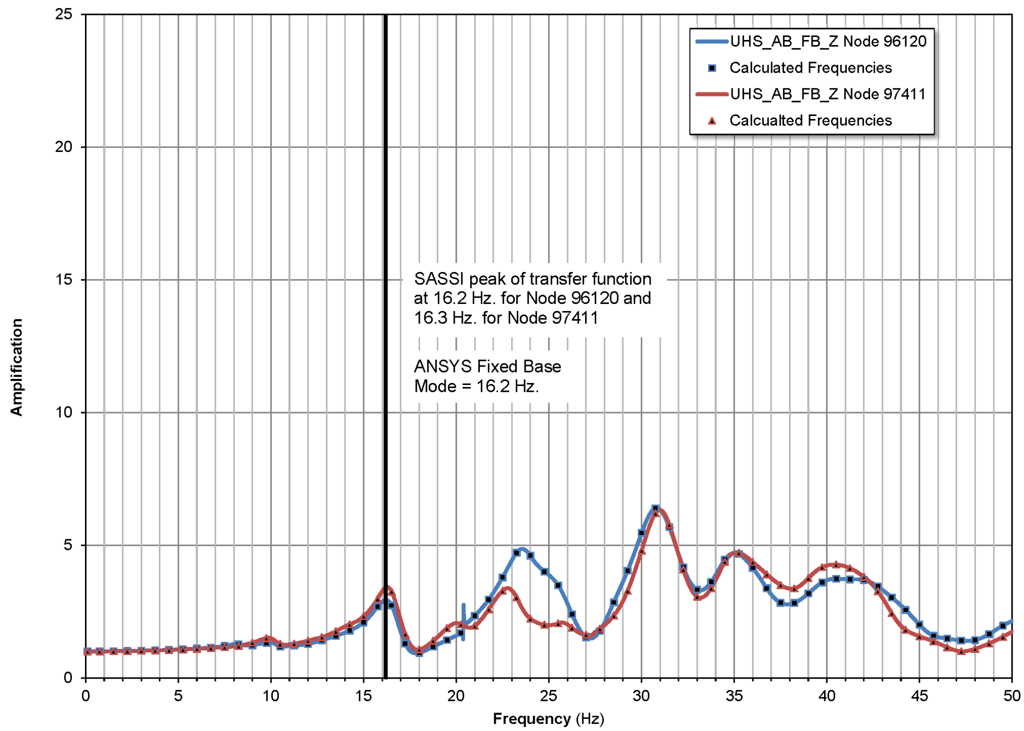
SASSI Fixed Base Transfer Functions at North-East Corner of CTSS Roof Slab of UHS A (Node 97500) and at Mid-Height of Basin North Wall of UHS A (Node 35972) and ANSYS Fixed Base Major Mode in North-South (Y) Direction for UHS_AB_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 3 of 6)



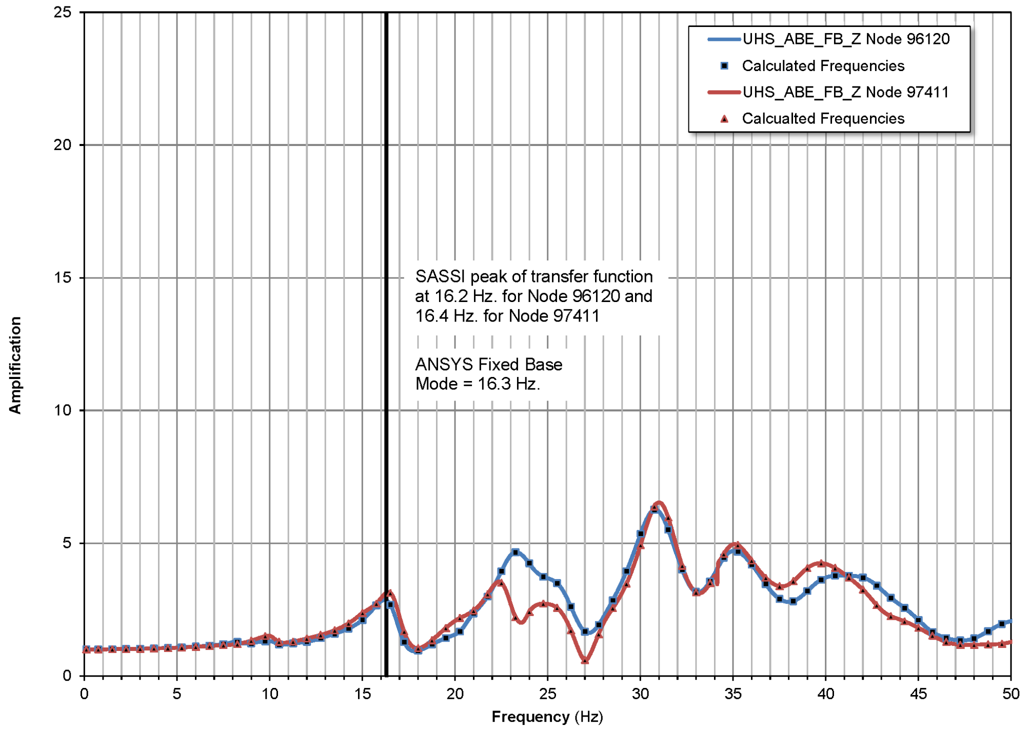
SASSI Fixed Base Transfer Functions at North-East Corner of CTSS Roof Slab of UHS A (Node 97500) and at Mid-Height of Basin North Wall of UHS A (Node 35972) and ANSYS Fixed Base Major Mode in North-South (Y) Direction for UHS_ABE_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 4 of 6)



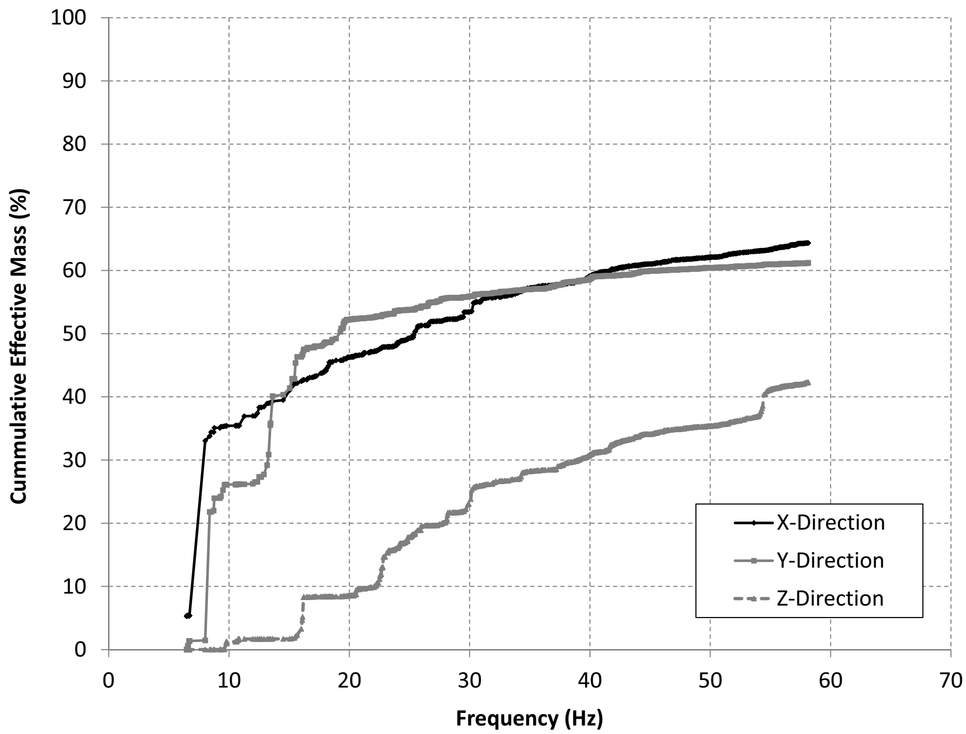
SASSI Fixed Base Transfer Functions at South-East Corner of CTSS Roof Slab for UHS A (Node 96120) and at North-West Corner of CTSS Roof Slab for UHS B (Node 97411) and ANSYS Fixed Base Major Mode in Vertical (Z) Direction for UHS_AB_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 5 of 6)



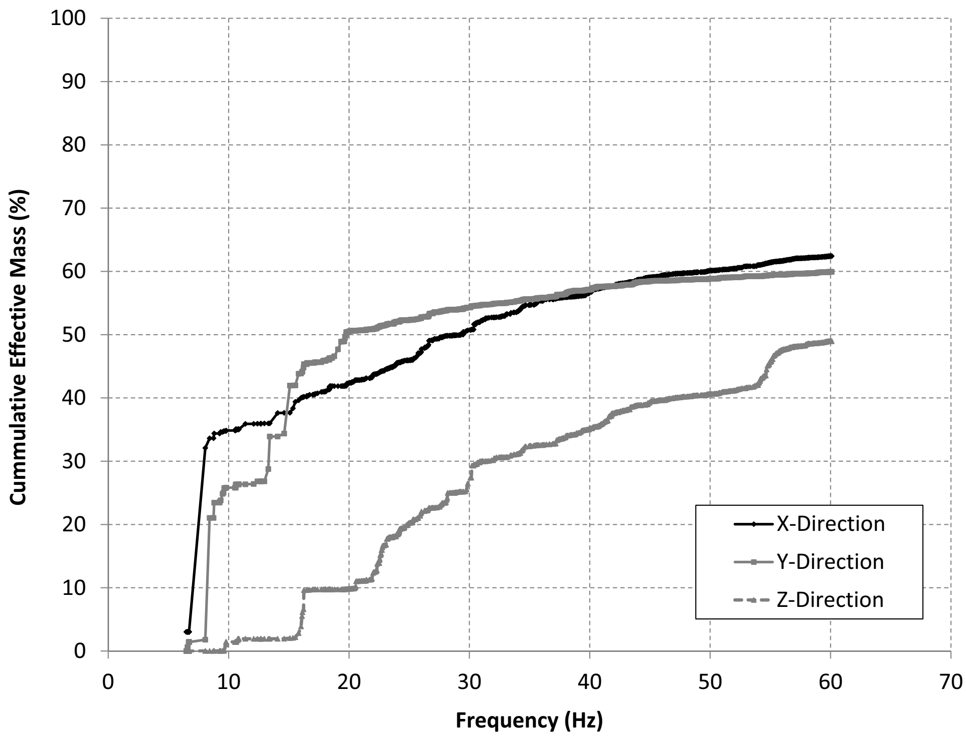
SASSI Fixed Base Transfer Functions at South-East Corner of CTSS Roof Slab for UHS A (Node 96120) and at North-West Corner of CTSS Roof Slab for UHS B (Node 97411) and ANSYS Fixed Base Major Mode in Vertical (Z) Direction for UHS_ABE_FB.

Figure 3KK-5 SASSI Fixed Base Transfer Functions for UHS Pump House Roof Panels (Sheet 6 of 6)



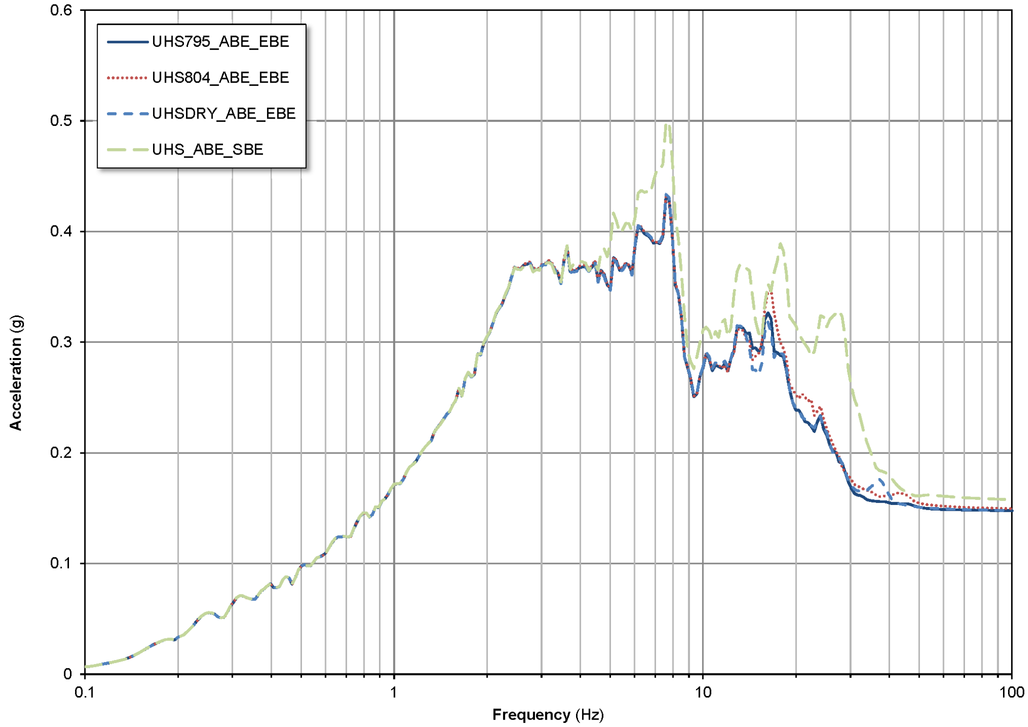
Note: Cumulative Effective Mass from ANSYS Fixed Base Model, UHS_AB_FB

Figure 3KK-6 Cumulative Effective Mass from ANSYS Fixed Base Model (Sheet 1 of 2)



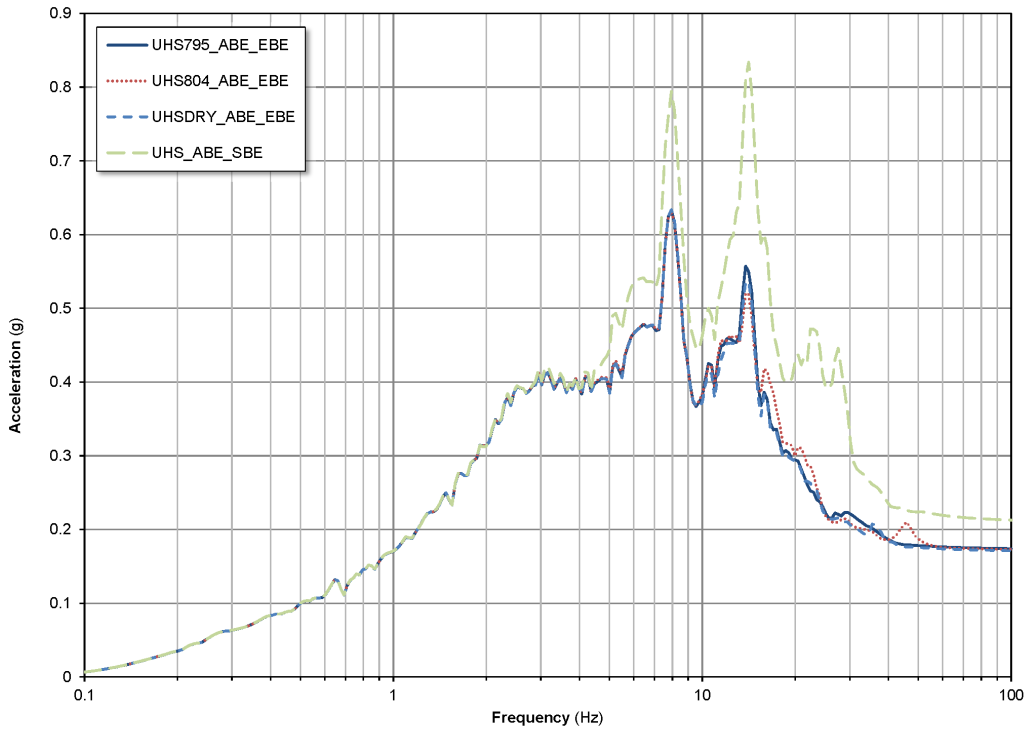
Note: Cumulative Effective Mass from ANSYS Fixed Base Model, UHS_ABE_FB

Figure 3KK-6 Cumulative Effective Mass from ANSYS Fixed Base Model (Sheet 2 of 2)



ISRS: ESWPT roof slab (Component 13); SRSS-motion, X-response; 5.0% damping

Figure 3KK-7 Comparison of In-structure Response Spectra at UHS ESWPT Roof Slab for Varying Ground Water Levels (Sheet 1 of 3)



ISRS: ESWPT roof slab (Component 13); SRSS-motion, Y-response; 5.0% damping

Figure 3KK-7 Comparison of In-structure Response Spectra at UHS ESWPT Roof Slab for Varying Ground Water Levels (Sheet 2 of 3)

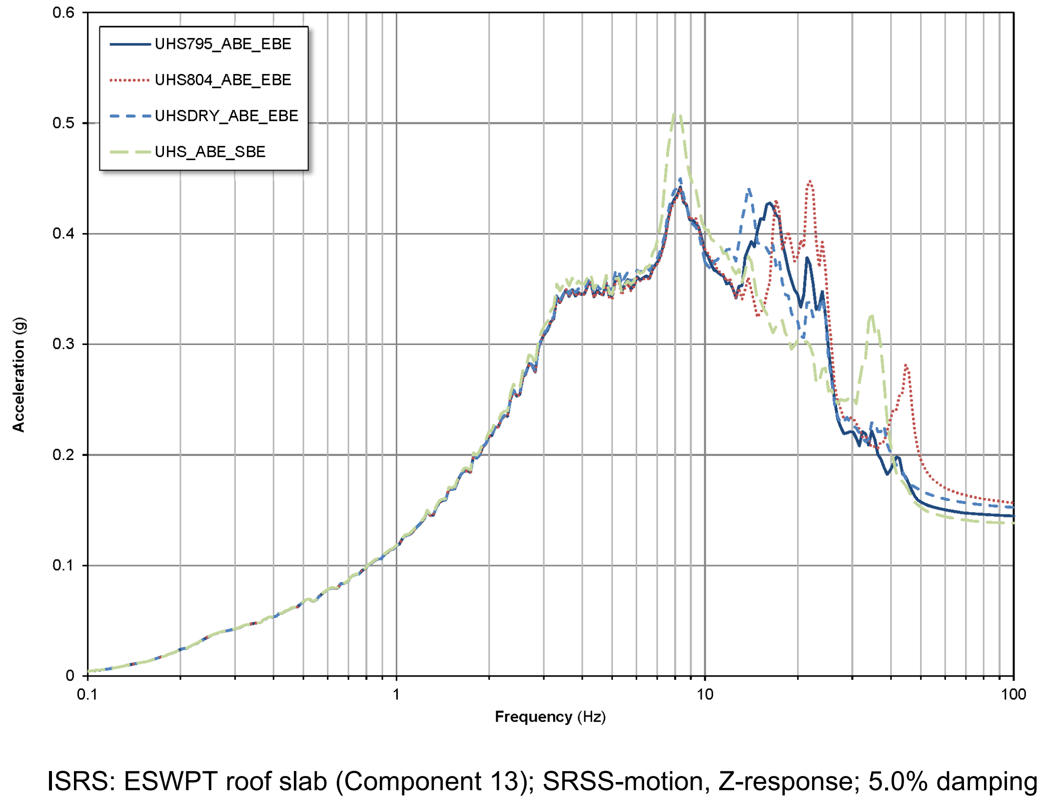
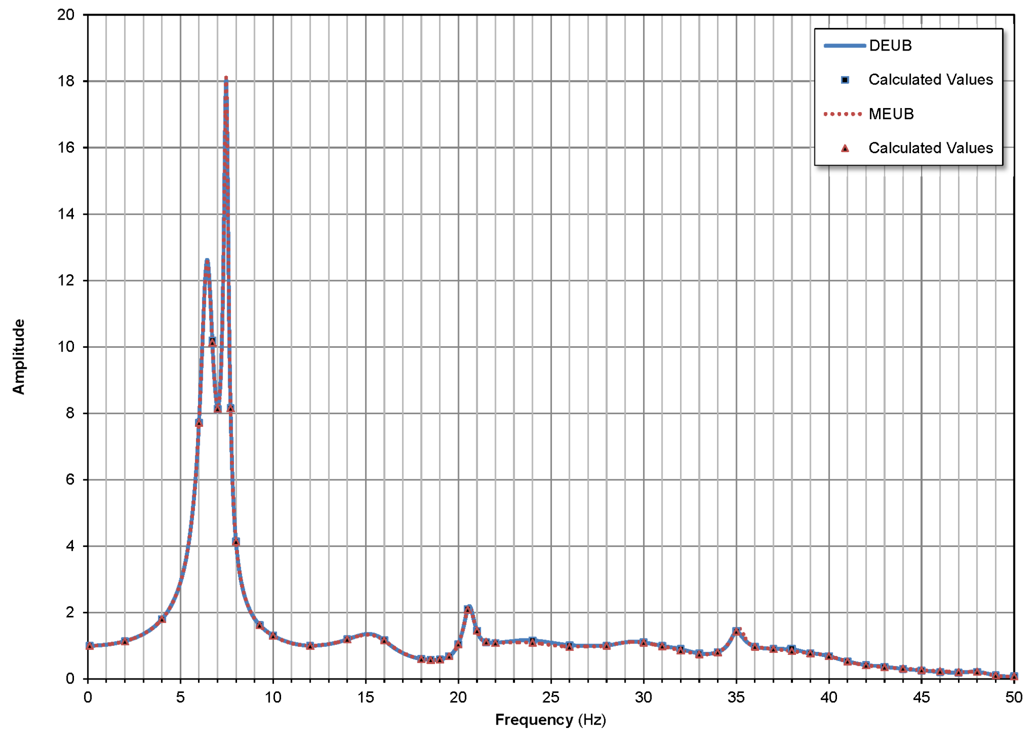
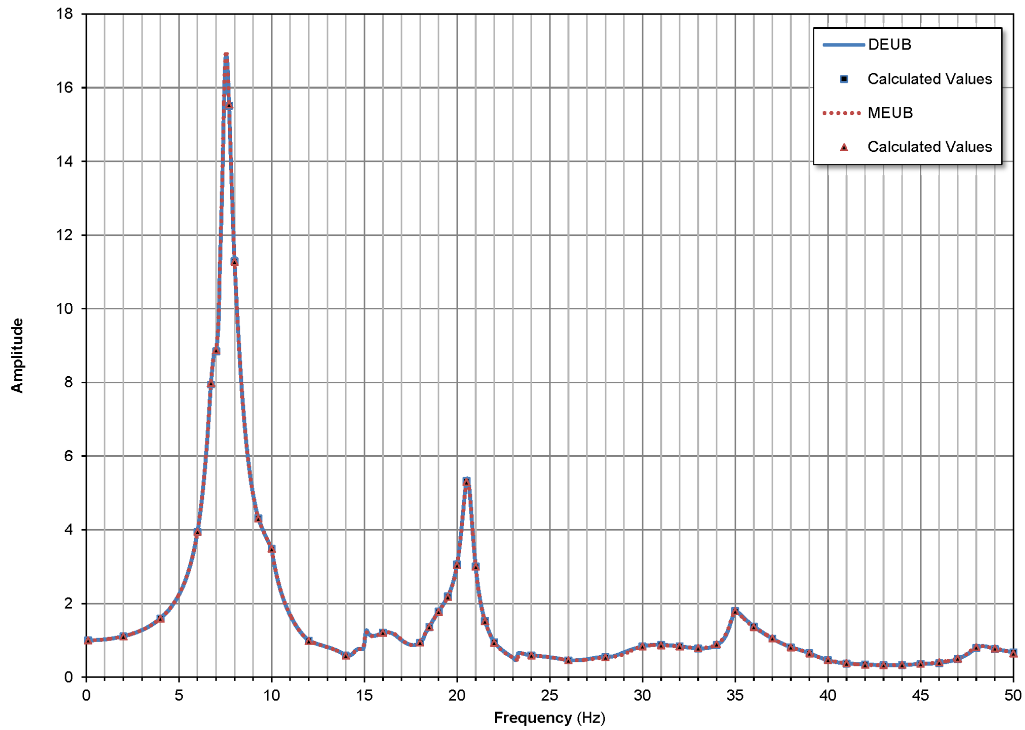


Figure 3KK-7 Comparison of In-structure Response Spectra at UHS ESWPT Roof Slab for Varying Ground Water Levels (Sheet 3 of 3)



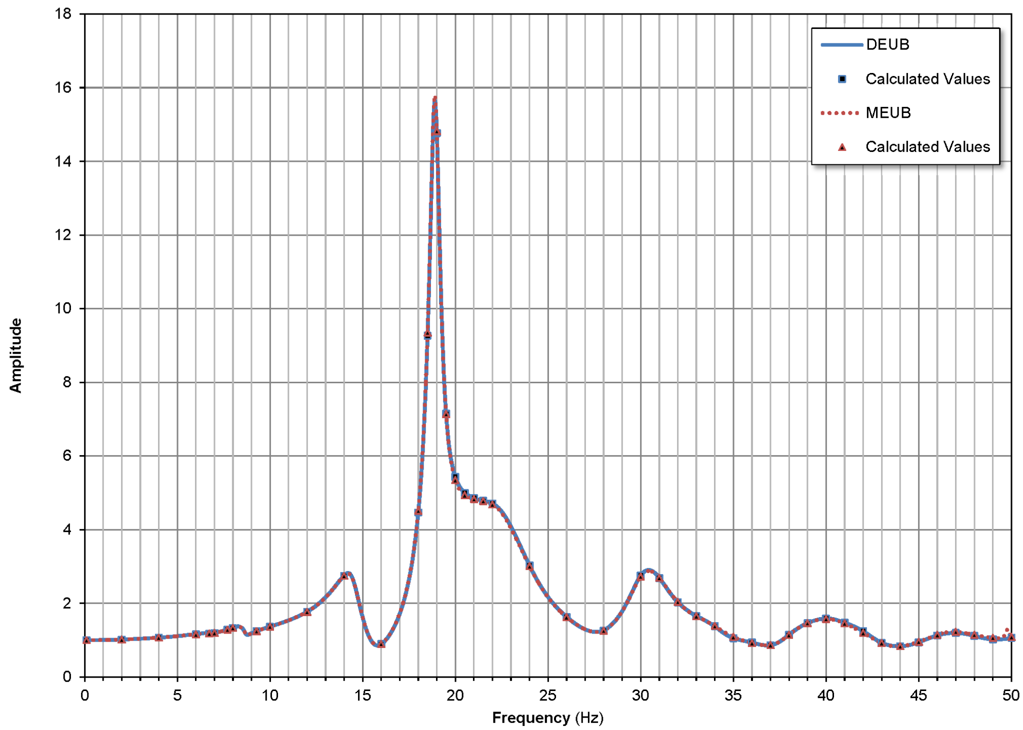
Transfer Function: Middle of South CTSS Roof (Node 23491); X-motion, X-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 1 of 6)



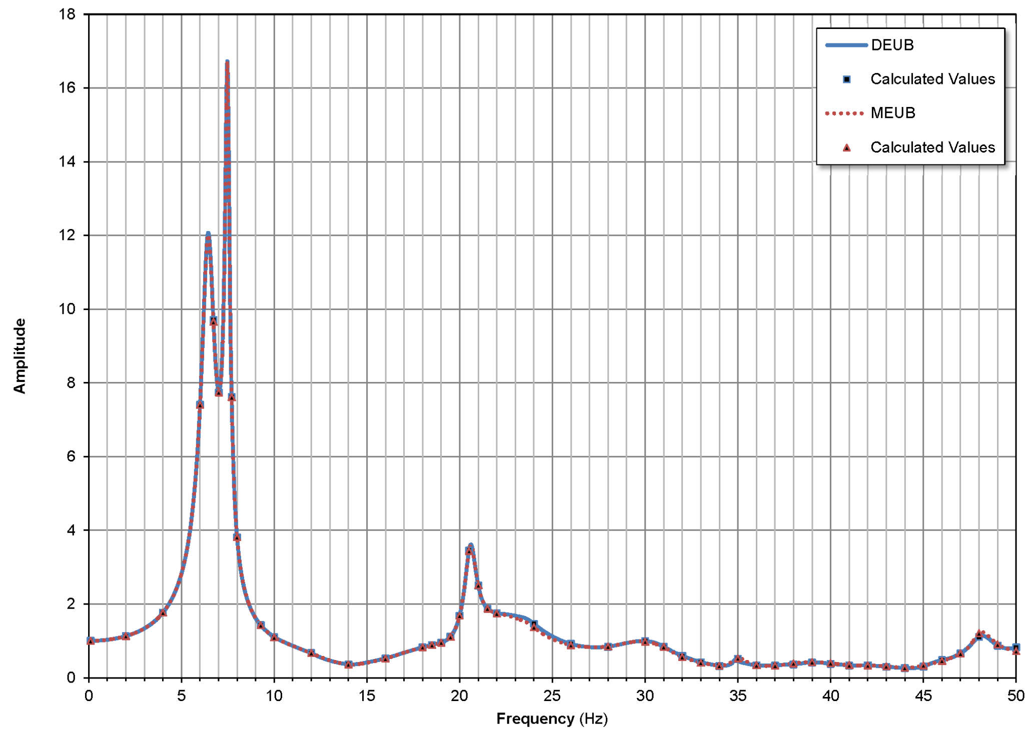
Transfer Function: Middle of South CTSS Roof (Node 23491); Y-motion, Y-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 2 of 6)



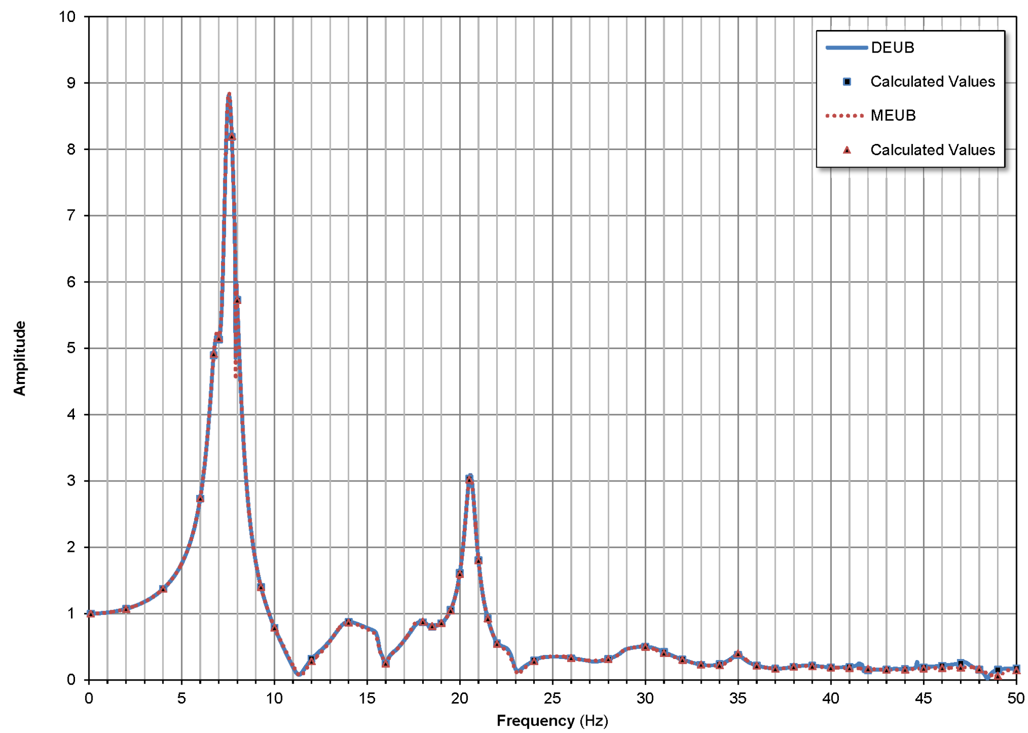
Transfer Function: Middle of South CTSS Roof (Node 23491); Z-motion, Z-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 3 of 6)



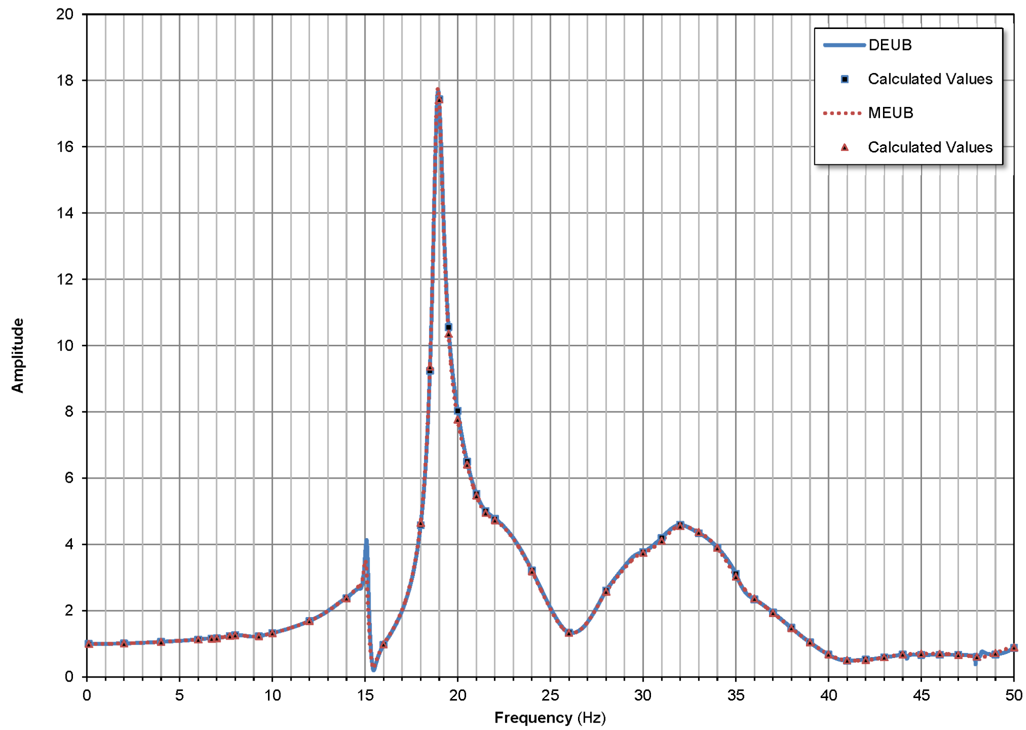
Transfer Function: North Side of Pump House Roof (Node 19427); X-motion, X-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 4 of 6)



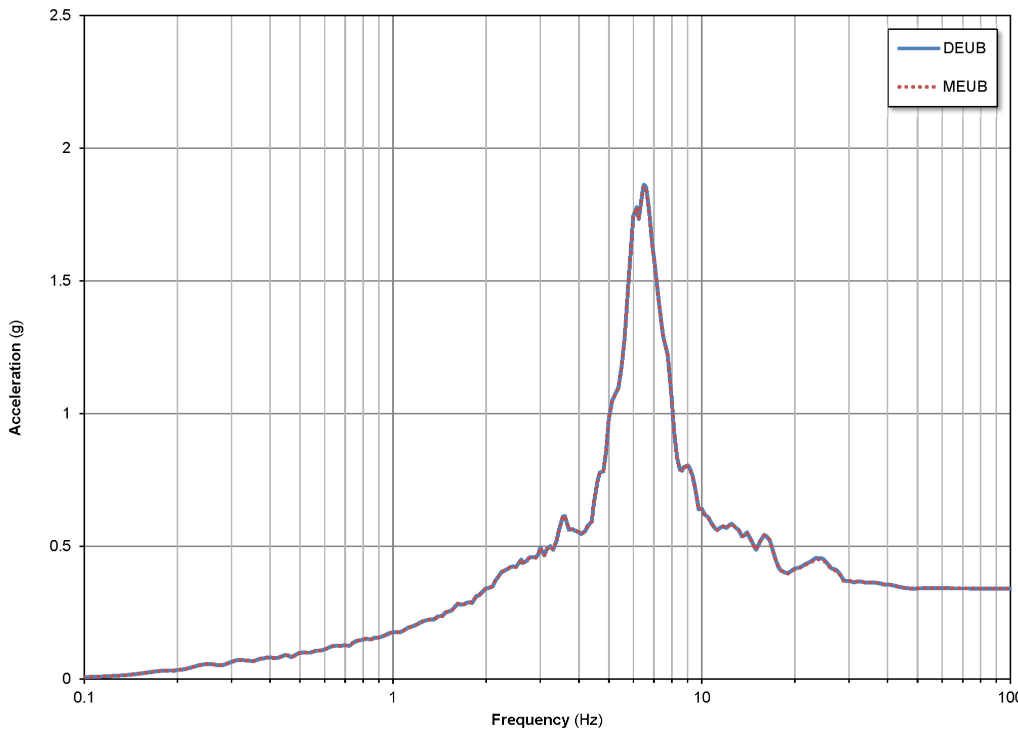
Transfer Function: North Side of Pump House Roof (Node 19427); Y-motion, Y-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 5 of 6)



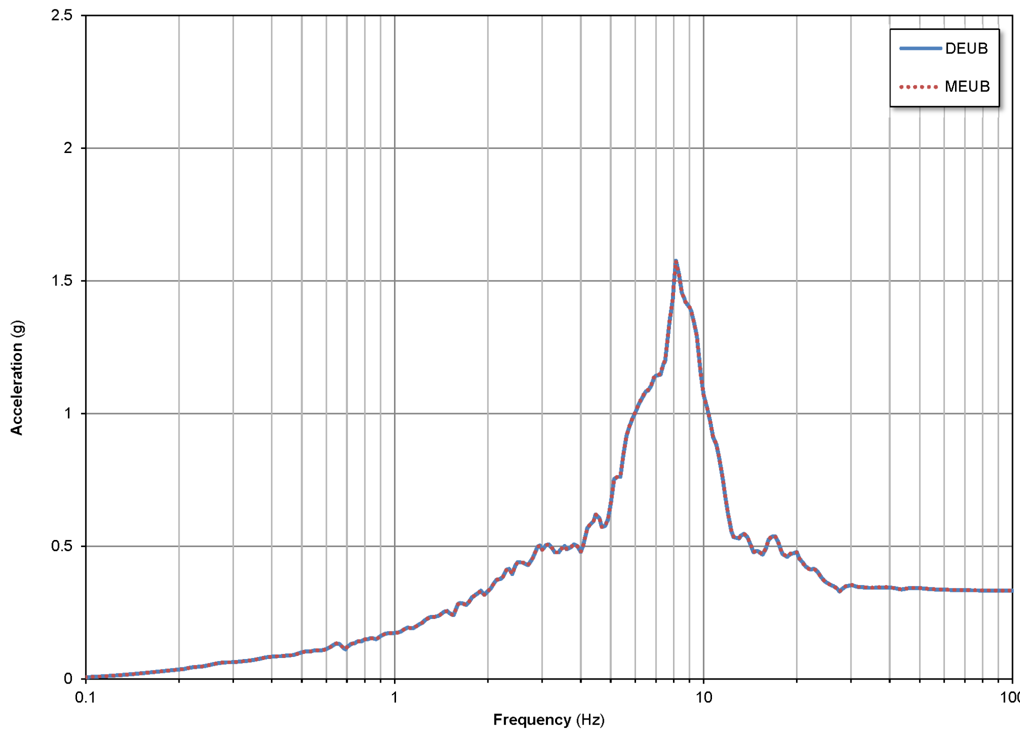
Transfer Function: North Side of Pump House Roof (Node 19427); Z-motion, Z-response

Figure 3KK-8 SASSI Transfer Function Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 6 of 6)



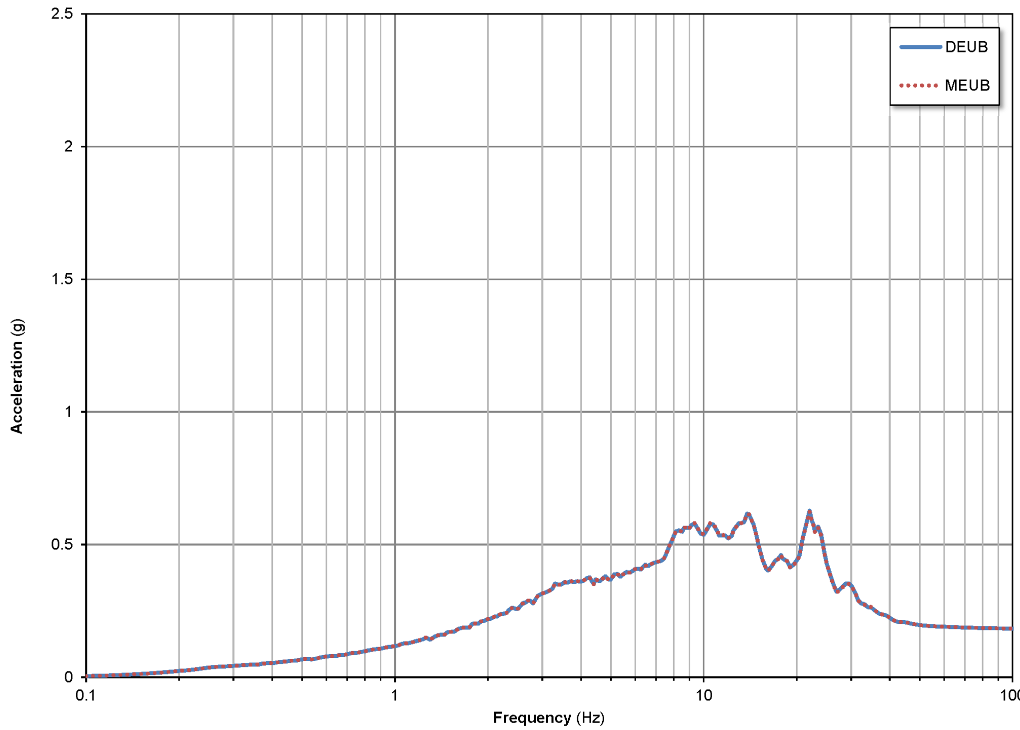
ISRS: Middle of South CTSS Roof (Node 23491); SRSS-motion, X-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 1 of 6)



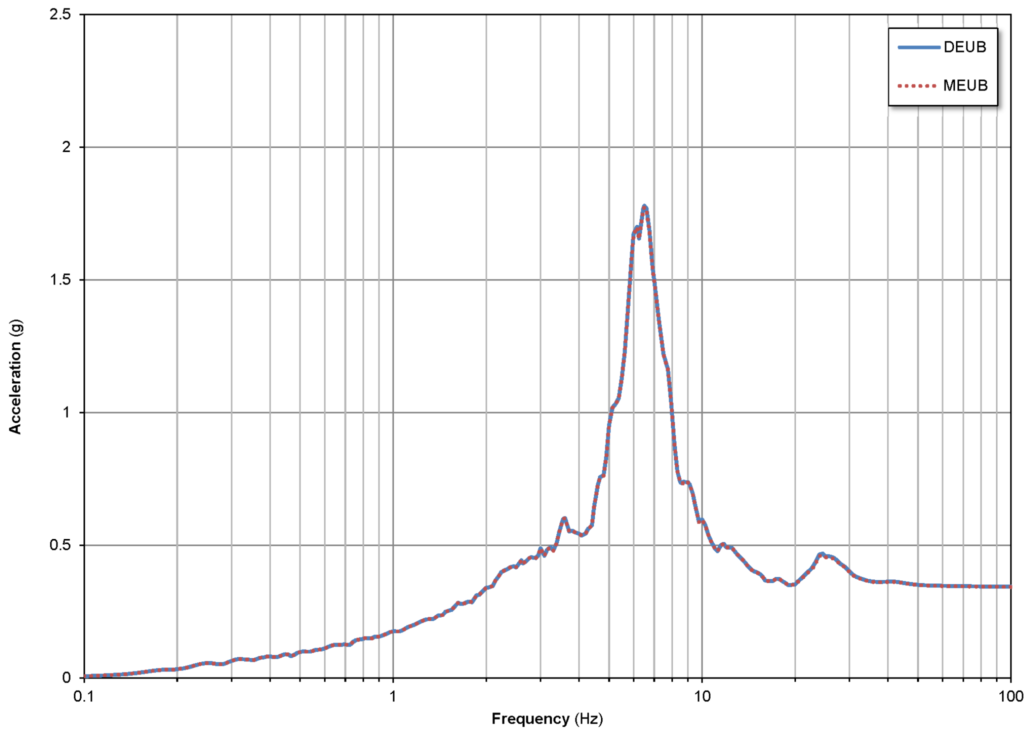
ISRS: Middle of South CTSS Roof (Node 23491); SRSS-motion, Y-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 2 of 6)



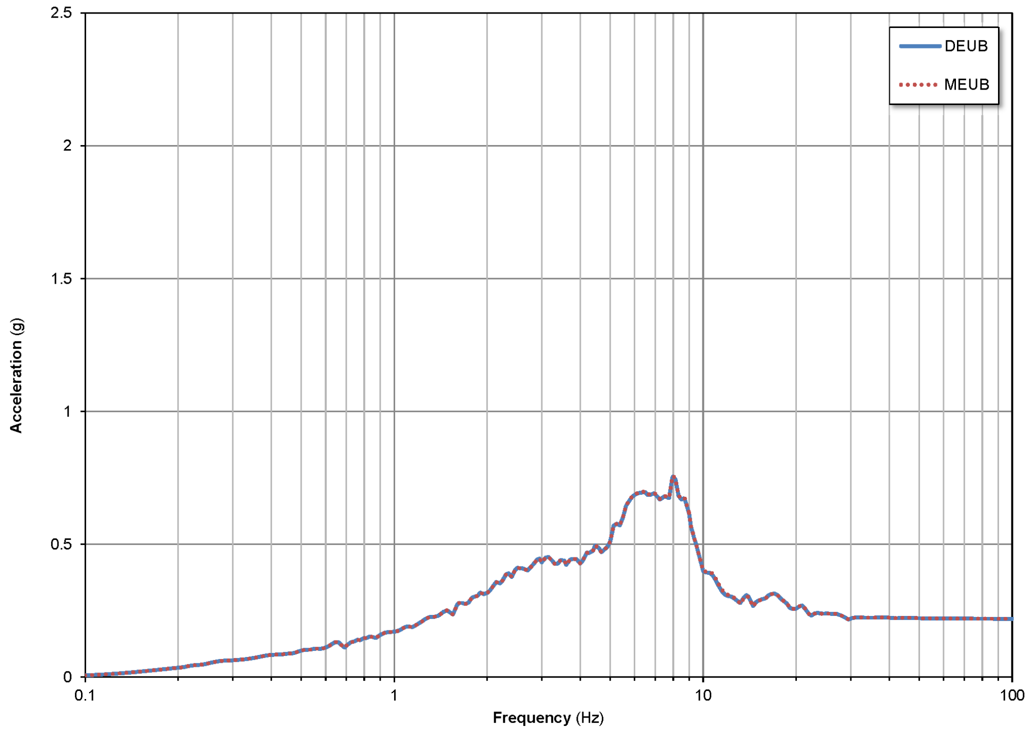
ISRS: Middle of South CTSS Roof (Node 23491); SRSS-motion, Z-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 3 of 6)



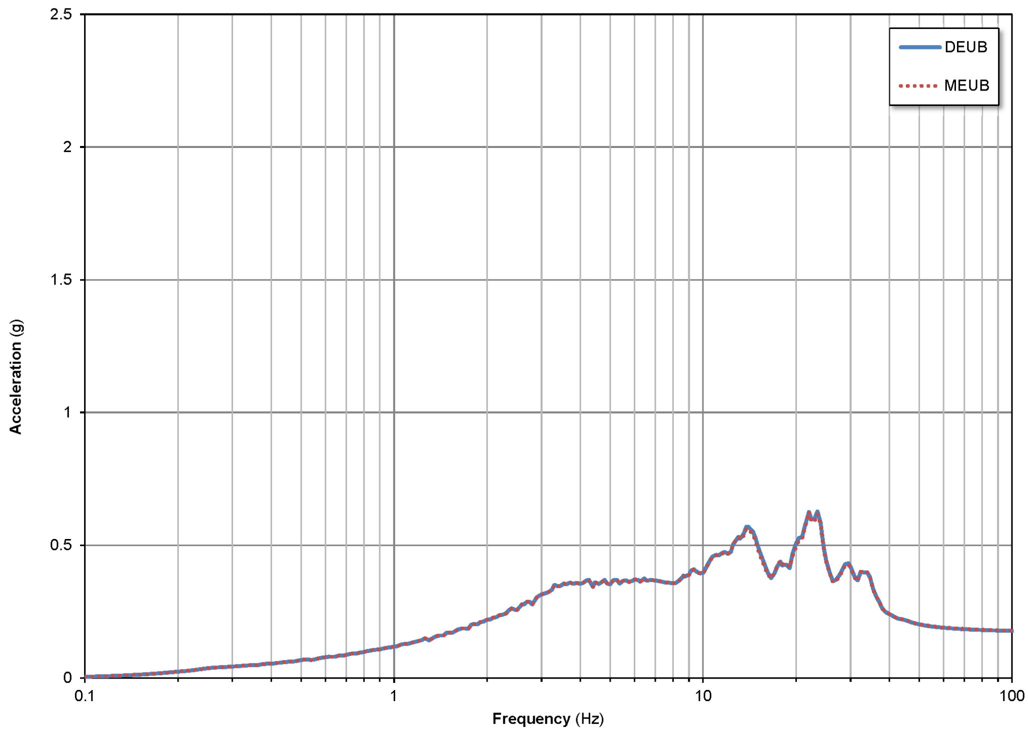
ISRS: North Side of Pump House Roof (Node 19427); SRSS-motion, X-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 4 of 6)



ISRS: North Side of Pump House Roof (Node 19427); SRSS-motion, Y-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 5 of 6)



ISRS: North Side of Pump House Roof (Node 19427); SRSS-motion, Z-response; 5.0% damping

Figure 3KK-9 SASSI In-Structure Response Spectra Comparison for UHSRS Embedded Analyses (Modified Subtraction Method versus Direct Method) (Sheet 6 of 6)

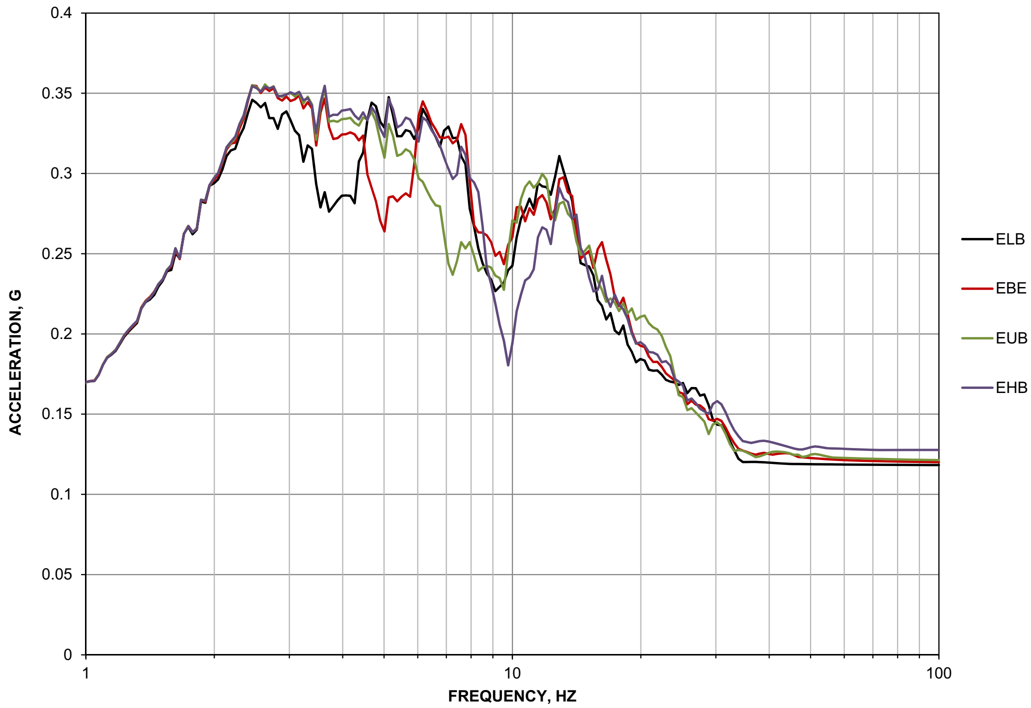


Figure 3KK-10 Comparison of ISRS for Various Embedded Conditions (Sheet 1 of 3)

This plot is for a node located at the southwest corner of the UHS basemat, for the x-direction (east-west). The spectral values for this node beyond about 30 Hz are all controlled by the EHB soil case, compared to ELB or EBE.

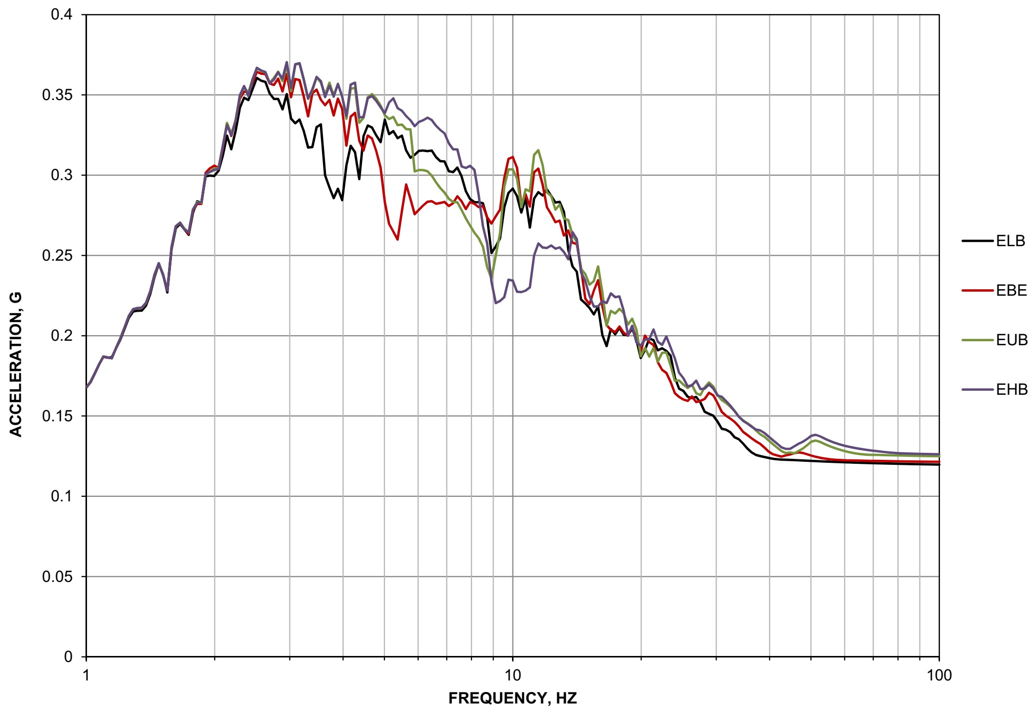


Figure 3KK-10 Comparison of ISRS for Various Embedded Conditions (Sheet 2 of 3)

This plot is for a node located at the southeast corner of the UHS basemat, for the y-direction (north-south). The spectral values for this node beyond about 20 Hz are all controlled by the EHB and/or EUB soil cases, compared to ELB or EBE.

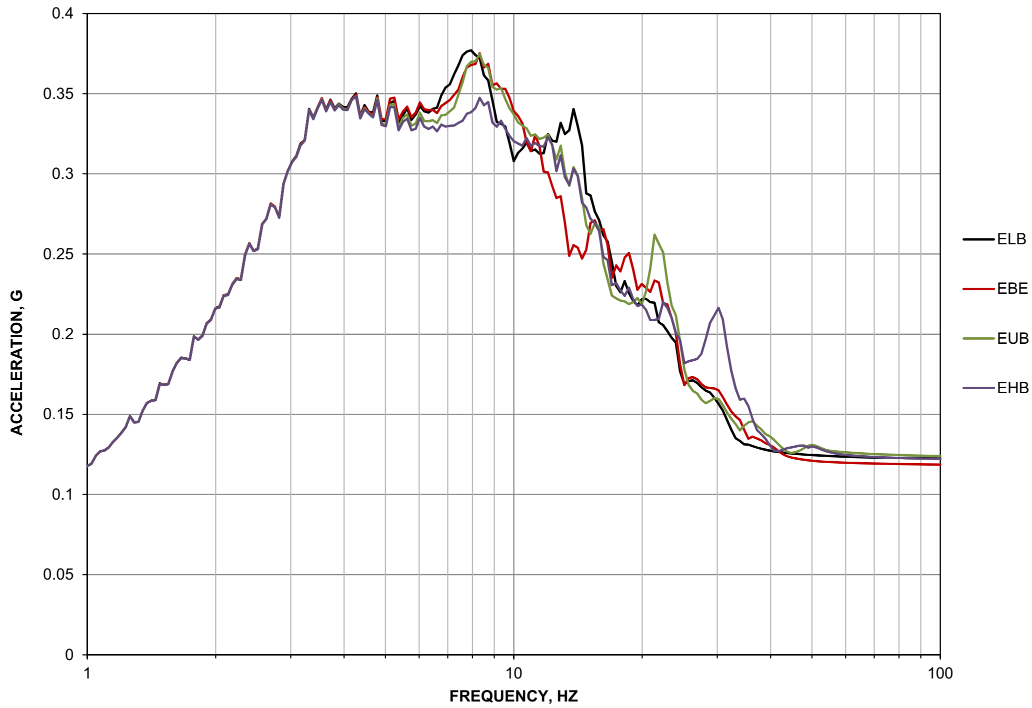


Figure 3KK-10 Comparison of ISRS for Various Embedded Conditions (Sheet 3 of 3)

This plot is for a node located at the southeast corner of the UHS basemat, for the z-direction (vertical). The spectral values for this node beyond about 20 Hz are all controlled by the EHB and/or EUB soil cases, compared to ELB or EBE.