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
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
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
N/A	not applicable
NRC	U.S. Nuclear Regulatory Commission

ACRONYMS AND ABBREVIATIONS (continued)

NS	non-seismic
O/B	outside building
OBE	operating-basis earthquake
PAM	post accident monitoring
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
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

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 eleventh 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 and seismic categorization of risk-significant, non-safety related SSCs based on their safety role assumed in the PRA and treatment by the D-RAP described in Chapter 17 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) ***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 Table 3.2-201.

STD 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	10 CFR 50 Appendix B (Reference 3.2-8)	Code and Standards[3]	Seismic Category	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	YES	3	I	
ESWP discharge strainer backwash line to the UHS basin	3	UHSRS	C	YES	3	I	
ESWP discharge strainer backwash line to the CWS blowdown main header	3	UHSRS, ESWPT	C	YES	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	YES	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	10 CFR 50 Appendix B (Reference 3.2-8)	Code and Standards[3]	Seismic Category	Notes
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	YES	3	I	
2. UHS							
UHS transfer pumps	3	UHSRS	C	YES	3	I	
UHS cooling tower fans	3	UHSRS	C	YES	5	I	
UHS basins	3	UHSRS	C	YES	3	I	
Transfer line piping and valves from UHS transfer pumps to basins	3	UHSRS, ESWPT	C	YES	3	I	
ESW return line piping	3	UHSRS, ESWPT	C	YES	3	I	
UHS basin makeup piping and valves	9	UHSRS	NA	NA	5	Non-seismic (NS)	
3. UHS ESW pump house ventilation system							
ESW pump room exhaust fans	3	UHSRS	C	YES	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	10 CFR 60 Appendix B (Reference 3.2-8)	Code and Standards(3)	Seismic Category	Notes
UHS transfer pump room exhaust fans	3	UHSRS	C	YES	5	I	
UHS ESW pump house supply and exhaust backdraft dampers	3	UHSRS	C	YES	5	I	
ESW pump room unit heaters	3	UHSRS	C	YES	5	I	
UHS transfer pump room unit heaters	3	UHSRS	C	YES	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	not applicable (N/A)	6	Note 1	

Notes:

1. Seismic category meeting RG 1.143 (Reference 3.2-10) is applied.
2. Not used.
3. Identification number for “Code and Standards”
   (1) American Society of Mechanical Engineers (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
   (5) Codes and standards as defined in design bases
   (6) Codes and standards, and guidelines provided in RG 1.143 (Reference 3.2-10), for design of SSCs for Radwaste Facility
4. Not used

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”

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 AND TORNADO 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.

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 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 and

combined tornado 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 Loads

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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 loadings and combined tornado effects*

This COL item is addressed in Subsection 3.3.2.2.4.

STD COL 3.3(3) ***3.3(3)*** *Structures not designed for tornado 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.

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

STD 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 flooding level (DBFL) listed in Section 2.4, and adequate sloped site grading and drainage prevents flooding caused by probable maximum precipitation (PMP) or postulated failure of non safety-related, non seismic storage tanks located on site.

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 DBFL and has adequate site grading. The lowest point of the structure foundation is above the groundwater elevation identified in Section 2.4, and therefore no permanent dewatering system is required.

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

The lowest point of the structure foundation is above the groundwater elevation identified in Section 2.4. In addition, no intermittent head of water occurs from surface precipitation or groundwater due to the placement of course aggregate wrapped in geotextile filter fabric with perforated drainage pipe sloped to daylight to Squaw Creek Reservoir. Construction joints in the exterior walls and base mats are provided with water stops to prevent seepage of ground water. A dampproofing barrier treatment that resists the passage of ground water in the absence of hydrostatic pressure is therefore applied to all subgrade outer foundation walls in accordance with American Concrete Institute (ACI) 515.1R-79 (Reference 3.4-201). A cementitious membrane waterproofing is provided on the inside face of the UHS basin 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(7) Replace the last sentence in the last paragraph of DCD Subsection 3.4.1.3 with the following.

Three site-specific safety-related structures have been evaluated for internal flooding concerns: the UHSRS, the ESWPT, and the PSFSV. 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 three 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 (MELB) 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 DBFL does 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.

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) ***3.4(7)*** *Protection from internal flooding*

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

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.

3.5.1.5 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 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

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:

$N = P_{FA} /(C \times A/w)$ = 19,300 operations per year

NUREG-0800, SRP 3.5.1.6 provides a value of $C = 4\times10^{-10}$ 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 $C = 4\times10^{-10}$ 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 is conservatively determined as 0.0907 square miles 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, access building (AC/B), A/B, power source buildings (PS/Bs), and T/B of 490 ft wide by 650 ft long by 230 ft high.

A_S = 230 ft x 650 ft = 149,500 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 650 ft = 2,059,200 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 = 490 ft x 650 ft = 318,500 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 19,300 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 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 in DCD 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 Subsection 3.5.2.

CP COL 3.5(6) ***3.5(6)*** *Orientation of T/G of other unit(s)*

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 the paragraph in 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 within the protective walls of the ESWPT and UHSRSs and therefore, high-energy pipe breaks are not postulated for site-specific piping within these protective walls. The site-specific moderate-energy piping systems are the ESWS and the fire protection water supply system (FSS).

A qualitative evaluation of site-specific moderate-energy piping systems to assess environmental and flooding impacts is provided below.

The ESWS and the UHS consist of four independent trains with each train providing fifty percent (50%) of the cooling capacity required for a design basis accident and subsequent placement of the plant in the safe shutdown condition. Each train of the ESWS in the ESWPT is physically separated from the other trains by concrete walls and floors, and piping penetrations to other buildings are sealed. The failure in the piping of one ESWS train will not affect the other trains of the ESWS from an environmental and flooding perspective. Therefore, the consequences of failures in site-specific ESWS piping does not affect the ability to safely shut down the plant.

The failure in the FSS piping will not affect the safety function of the ESWS and the UHS from an environmental perspective because the FSS water temperature is approximately room temperature. From a flooding perspective, the ESWS is safe from a FSS pipe failure because FSS piping does not exist in the ESWPT, and the ESWPT piping penetrations prevent intrusion from any postulated FSS spillage in other buildings. Therefore, the consequences of the failure in site-specific FSS piping does not affect the ability to safely shut down the plant.

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 within the protective walls of the ESWPT and UHSRSs. The site-specific moderate energy piping systems are the ESWS and the FSS. A crack in the moderate-energy piping ESWS and FSS does not affect the safety function of the ESWS and the UHS that are required for a design basis accident and for safe shutdown, as described in Subsection 3.6.1.3.

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.

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.

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 validity of the site-independent seismic design of the standard plant for the site-specific seismic conditions is addressed in this Section 3.7, and in Appendix 3NN. The site-specific ground motion response spectra (GMRS), which are developed as free-field outcrop motions on the uppermost in-situ competent material, are discussed in Subsection 3.7.1.1.

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

For the site-specific seismic design of those seismic category I and seismic category II SSCs that are not part of the US-APWR standard plant, spectra appropriately derived from the site-specific GMRS are used to define the site-specific safe-shutdown earthquake (SSE) design ground motion. The response spectra of the site-specific SSE are developed following the requirements of RG 1.208 (Reference 3.7-3), and represent the envelope of the foundation input response spectra (FIRS) and a minimum response spectra as discussed in Subsection 3.7.1.1.

CP COL 3.7(6) Replace the fifth paragraph in DCD Section 3.7 with the following.

Site-specific GMRS and FIRS are developed by analysis methodology described in Subsection 3.7.1.1 and account for the upward propagation of the GMRS. The site-specific horizontal GMRS are shown in Figure 3.7-201 as FIRS1. The FIRS are compared to the minimum design earthquake which is defined as the certified seismic design response spectra (CSDRS) scaled to a 0.1 g peak ground acceleration (PGA). This confirms that the minimum design earthquake envelopes the FIRS at all locations for all frequencies by a large margin.

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 ninth paragraph in DCD Subsection 3.7.1.1 with the following.

The CPNPP is not in a high seismic area, is not founded on hard rock, and the site-specific seismic GMRS and FIRS demonstrate that there are no high frequency exceedances of the CSDRS that could create damaging effects.

CP COL 3.7(5) Replace the last two sentences of the sixteenth paragraph in DCD Subsection 3.7.1.1 with the following.

The site-specific horizontal response spectra are obtained from site-specific response analyses performed in accordance with RG 1.208 (Reference 3.7-3) and account for upward propagation of the GMRS. The calculation of the GMRS and FIRS is outlined in Subsections 2.5.2.5 and 2.5.2.6, respectively. Subsections 2.5.2.5 and 2.5.2.6 document the site response methodology used, the soil properties used, and the methodology for calculating the GMRS. The nominal GMRS and FIRS for 5 percent damping resulting from these site-specific response analyses are shown in Figure 3.7-201. The spectra shown in Figure 3.7-201 represent nominal spectra for the following site-specific conditions:

FIRS1 = the nominal GMRS, at the top of the stiff limestone (nominal elevation 782') described in Subsections 2.5.2.5 and 2.5.2.6. The R/B-prestressed concrete containment vessel (PCCV)-containment internal structure, PS/Bs, UHSRS, PSFSVs, ESWPT, and A/B are founded directly on this limestone layer, have a thin layer of fill concrete placed between the top of limestone and bottom of mat foundation, and/or the fill concrete is analyzed in SASSI (Reference 3.7-17) as part of the seismic structural model.

FIRS2 = the nominal response spectrum for structures located on a layer of fill concrete placed between the top of the limestone at nominal elevation 782' and bottom of the structure's foundation. Note that a comparison of FIRS1 and FIRS2 shows that the presence of several feet of fill concrete does not result in amplification of the ground motion seismic response, and is well below the minimum design earthquake.

FIRS3 = nominal response spectrum corresponding to typical plant grade elevation 822' for shallow-embedment structures founded on native, in-situ, undisturbed materials occurring below plant grade as described in Subsections 2.5.2.5 and 2.5.2.6. FIRS3 does not apply currently to any plant structures. FIRS3 represents the free-field ground motion.

FIRS4 = nominal response spectrum corresponding to typical plant grade elevation 822' for shallow-embedment structures founded on engineered and compacted structural backfill that extends down to top of limestone at nominal elevation 782'. FIRS4 is computed using both a 30 percent and a 50 percent coefficient of variation for the engineered fill properties to account for a wide range of potential backfill materials.

The 5 percent damping site-specific horizontal response spectra accelerations for all frequencies, at all FIRS locations, are less than those of the 5 percent damping minimum response spectra tied to the shape of the CSDRS and anchored at 0.1 g, as demonstrated in Figure 3.7-201. Similarly, the 5 percent damping site-specific vertical response spectra, which are developed from the horizontal response spectra using vertical/horizontal response spectral ratios appropriate for the site, are less than the 5 percent damping minimum vertical response spectra tied to the shape of the CSDRS and anchored at 0.1g. The nominal site-specific response spectra described above are less than the minimum required response spectra, and are therefore not used for site-specific design. Instead, the site-specific SSE and FIRS are defined as the shape of the CSDRS anchored at 0.1g, in order to comply with the intent of Appendix S (IV)(a)(1)(i) of 10 CFR 50 (Reference 3.7-7). The site-specific SSE, defined at ground surface (plant grade elevation 822 ft), consistent with the requirements of Appendix S, is the same as the FIRS used as input for site-specific seismic design. By definition, the site-specific SSE and FIRS are automatically enveloped by the CSDRS given in DCD Figures 3.7.1-1 and 3.7.1-2 for standard plant seismic category I structures. The site-specific FIRS (CSDRS anchored at 0.1 g) are used for the design of seismic category I and II SSCs that are not part of the US-APWR standard plant.

The site-specific SSE and FIRS are presented in Figures 3.7-202 and 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 Tables 3.7-201 and 3.7-202 for the horizontal and vertical directions, respectively.

CP COL 3.7(2) Replace the seventeenth paragraph in DCD Subsection 3.7.1.1 with the following.

The site-specific verification analysis of US-APWR standard plant seismic category I structures has been performed considering SSI effects and using the site-specific FIRS as described in Subsection 3.7.2.4.1.

CP COL 3.7(13) Replace the first and second sentences of the nineteenth paragraph in DCD Subsection 3.7.1.1 with the following.

For CPNPP Units 3 and 4, the value of the operating-basis earthquake (OBE) ground motion that serves as the basis for defining the criteria for shutdown of the plant is 1/3 of the site-specific FIRS shown in Figures 3.7-202 and 3.7-203. Option

A is maintained for site-specific seismic category I structures; therefore, OBE is not a site-specific seismic design case.

CP COL 3.7(24) Replace the first sentence of the next-to-last paragraph in DCD Subsection 3.7.1.1 with the following.

In development of the site-specific GMRS, as provided in Subsection 2.5.2, the site-specific ratios V/A and AD/V^2 (A, V, D, are PGA, ground velocity, and ground displacement, respectively) are verified to be 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 DCD Subsection 3.7.1.1.with the following

Site-Specific Design Ground Motion Time Histories and Durations of Motion

For the site-specific design of the UHSRS, ESWPT, and PSFSVs, one set of three statistically independent time histories of seismic motion is synthesized artificially for use as the input outcrop motion in the earthquake response analyses. The 3-component record from the LA University Hospital (ground floor) during the 1994 Northridge earthquake is used as the starting time history for these artificial time histories. The time histories are compatible with the minimum required design spectra discussed above. The three time histories are developed to represent the ground motion for the three orthogonal earthquake components, two horizontal (“H1” and “H2”) and vertical (“V”) following the requirements and conditions set in Section II of SRP 3.7.1 (Reference 3.7-10) for the development of a single set of time histories Option 1, Approach 2. Figures 3.7-204, 3.7-205, and 3.7-206 provide H1, H2, and V time histories, respectively, used for the design of UHSRS, ESWPT, and PSFSVs and site-specific verification analysis of US-APWR standard plant. Approach 2 is utilized with the objective to generate artificial acceleration time histories with response spectra which achieve approximately mean based fits to the site-specific FIRS target spectra, as shown in Figures 3.7-207, 3.7-208, and 3.7-209. The average ratio of the acceleration response spectra (ARS) calculated from the artificial time histories to the corresponding target spectra is kept only slightly greater than one. The spectral acceleration ratio is calculated frequency by frequency.

The time histories meet the requirements of Approach 2 steps (a) through (d) as follows:

a) Total duration is 40 seconds and the time step is 0.005 seconds (Nyquist frequency is 100 Hz). Note that the total duration of the artificial time histories is increased by zero packing.

b) Spectral accelerations at 5 percent damping are computed at a minimum of 100 points per frequency decade, uniformly spaced over the log frequency scale from 0.1 Hz to 100 Hz. A comparison of the response spectra obtained from the time histories to the FIRS spectra is made at each of the frequencies in this range.

c) The computed 5 percent damped spectra do not fall more than 8 percent below target spectra at any one frequency, which meets the 10 percent nonexceedance requirement. Also, any nonexceedance windows are less than +/- 10 percent of the particular frequency upon which they are centered.

d) The computed 5 percent damped response spectra of the artificial time histories do not exceed the target spectra by more than 6 percent (factor of 1.06) in the frequency range of interest.

The cross-correlation coefficients between the three components of the design time histories are as follows:

ρ_{12} = 0.116, ρ_{23} = 0.154, and ρ_{31} = 0.071

where 1, 2, and 3 have been adopted as the same three global directions used for the standard plant. Because the cross-correlation coefficients do not exceed 0.16, they are statistically independent of each other and acceptable.

The strong durations of motion of the site-specific time histories are each at least 8.1 seconds and the total durations are each at least 40 seconds, which exceeds SRP 3.7.1 (Reference 3.7-10) criteria. The durations of motion have been determined using random phase characteristics, and it has been demonstrated that they are long enough such that adequate representation of the Fourier components at low frequency are included in the time histories. The corresponding stationary phase strong-motion duration is consistent with the longest duration of strong motion from the earthquakes defined in SRP 2.5.2 (Reference 3.7-8) at low and high frequency and as presented in NUREG/CR-6728 (Reference 3.7-14). The uniformity of the growth of this Arias Intensity has been examined and is acceptable.

3.7.1.2 Percentage of Critical Damping Values

CP COL 3.7(4) Replace the last three sentences of the second paragraph in DCD Subsection 3.7.1.2 with the following.

Since the design of the UHSRS, ESWPT, and PSFSVs considers site-specific subgrade conditions, the lower damping values in Table 3.7.3-1(b) are used, both for analysis of the structures and for computation of their 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 design. Further, the lower OBE damping values of Table 3.7.3-1(b) are also used for the site-specific SASSI (Reference 3.7-17) analysis of the R/B-PCCV-containment internal structure described in Subsection 3.7.2.4.1, in order to confirm that the ISRS and site-specific effects are enveloped by the standard plant design.

3.7.1.3 Supporting Media for Seismic Category I Structures

CP COL 3.7(28) Replace the second sentence of the first paragraph in DCD Subsection 3.7.1.3 with the following.

The overall basemat dimensions, basemat embedment depths, and maximum height of seismic category I buildings and structures are given in Table 3.7.1-3R.

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-PCCV-containment internal structure on a common mat, the PS/Bs, UHSRS, ESWPT, PSFSVs, A/B, and T/B, are founded directly on solid limestone 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. 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 slightly to facilitate construction and placement of forms. The material properties of the limestone are presented in Table 3.7-203. The underlying stratigraphy is discussed further in Subsection 2.5.4.

The fill concrete has a design compressive strength of 3,000 psi that corresponds to a shear wave velocity of 6,400 ft/sec. To further assure that the site-specific effects of the fill concrete are captured, where applicable, the fill concrete is considered as part of the structure in the site-specific SASSI (Reference 3.7-17) models used to perform the site-specific SSI analyses of the R/B-PCCV-containment internal structure, UHSRS, ESWPT, and PSFSVs.

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-PCCV-containment internal structure, PS/Bs, UHSRS, ESWPT, PSFSVs, A/B, and T/B, based on site-specific subgrade conditions and the site-specific FIRS ground input 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 standard and site-specific seismic category I buildings and structures.

3.7.2.3.1 General Discussion of Analytical Models

CP COL 3.7(3) Replace the sixth 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 (Reference 3.7-17) 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 3.7-17) FE models are used for seismic analysis. The UHSRS analytical model is discussed in Appendix 3KK.

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

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CP COL 3.7(25) Replace the first and second paragraph in DCD Subsection 3.7.2.4.1 with the following.

The site-specific SSI analysis for the R/B-PCCV-containment internal structure is performed utilizing the program ACS-SASSI Version 2.2 (Reference 3.7-17). The analysis confirms that site-specific effects are enveloped by the standard design. The site-specific SSI analysis of the R/B-PCCV-containment internal structure is addressed in Appendix 3NN.

CP COL 3.7(26) Replace the third paragraph in DCD Subsection 3.7.2.4.1 with the following.

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

The SSI analyses of the A/B and T/B are performed based on lumped parameter SSI analyses which consider a range of subgrade conditions that envelope the site-specific subgrade conditions, including site-specific effects due to soil layering and location of the water table. The SSI damping values used do not exceed the values specified by ASCE 4-98 (Reference 3.7-9).

CP COL 3.7(8) Replace the sixth, seventh, and eighth paragraphs with the following.

The SSI analysis uses stiffness and damping properties of the subgrade materials that are compatible with the strains generated by the site-specific design earthquake.

All standard plant and site-specific seismic category I and II buildings and major structures are founded directly on a limestone stratum approximately 65 ft. thick, 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. The dynamic properties of the rock subgrade at CPNPP Units 3 and 4 are considered to be strain-independent. The mean shear wave velocity of the top 400 ft. of subgrade below seismic category I and II buildings and structures is 3,830 ft/s. This is above the limit of 3,500 ft/s (corresponding to subgrade material defined as rock with strain-independent dynamic properties) typically used as the cut-off point, below which dynamic testing of the subgrade material would be implemented. At depths below the 400 ft. range discussed above, the shear wave velocity of the rock is higher than 5,500 ft/s. Due to the low site seismicity, the anticipated strains in the rock subgrade due to the site-specific earthquake are very low, less than 0.01 percent. As previously mentioned in Subsection 3.7.2.4, the seismic design of the R/B-PCCV-containment internal structure does not rely on the backfill present on the sides of the building to derive lateral or structural support. Furthermore, the seismic designs of all other seismic category I and II buildings and structures, including the PS/Bs, A/B, T/B, UHSRS, ESWPT, and PSFSVs, also do not rely on backfill for lateral or structural support. The designs

of the exterior walls of the building basements consider the earth pressures generated by the design earthquake.

Based on these 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 at CPNPP Units 3 and 4.

The water table at the site is located below the basemat bottom elevations and is taken as no higher than elevation 780 ft. for purposes of seismic analysis. The P-wave velocities of the saturated rock layers exceed the P-wave velocity of the water (5,000 ft/s). Therefore, the water table elevation does not affect the P-wave velocities of the submerged subgrade materials. Significant variations in the water table elevation and significant variations of the subgrade properties in the horizontal direction are addressed by using additional sets of site profiles.

In order to accurately capture effects of basemat embedment and flexibility, a 3-D finite element model is used to represent the stiffness and mass inertia of the basement in the SASSI model developed for the site-specific SSI verification analysis. To assure proper comparability with the US-APWR standard plant design, the above-ground portion of the R/B-PCCV-containment internal structure is modeled using lumped mass stick models with properties identical to those of the verified and validated lumped mass stick models of the building superstructure used in the US-APWR standard design.

The properties of the SASSI (Reference 3.7-17) seismic model are verified by an SSI analysis of the building resting on the surface of a hard rock subgrade that simulates fixed base conditions. The results of the SASSI analysis are demonstrated to match the results from the time history analyses of fixed base lump mass stick models.

CP COL 3.7(23) Replace the third sentence of the tenth paragraph in DCD Subsection 3.7.2.4.1 with the following.

The results of the site-specific SSI analysis documented in Appendix 3NN demonstrate that the standard plant broadened ISRS contained in Appendix 3I for the R/B-PCCV-containment internal structure are enveloped by a high margin. Considering the low site-specific seismic response (based on FIRS tied to 0.1 g versus standard plant CSDRS tied to 0.3 g), it is concluded from the review of the Appendix 3NN results that the R/B basemat seismic pressures and basement walls lateral soil pressures are also enveloped by the US-APWR standard design.

The range of subgrade properties considered in the A/B and T/B SSI lumped parameter models envelope site-specific variations related to subgrade stratigraphy and foundation flexibility. The SSI lumped parameter A/B and T/B models consider sets of subgrade translational and rotational spring constants that are based on shear wave velocities of 3,500 ft/s and 6,500 ft/s. These shear

wave velocity values envelope the average shear wave velocity of about 5,800 ft/s that was calculated for the site-specific subgrade stratigraphy to a depth of approximately 400 ft below the bottoms of the foundations. The standard plant A/Bs and T/Bs are designed with an SSE corresponding to the CSDRS tied to a 0.3 g PGA. The site-specific SSE used for seismic design and analyses is the same shape but tied to 0.1 g. Further, this shape envelopes by a large margin the theoretical FIRS that are developed for the site, as demonstrated in Figure 3.7-201. Because of the large ratio of the standard plant input motion versus the site-specific input motion, the assumptions for the standard plant design of the A/Bs and T/Bs were considered to envelope the critical responses of the non-uniform site-specific soil column profiles, and were not validated by performing site-specific SSI analyses. Since the basemat embedment effects are neglected, this also yields conservative results which envelope the site-specific responses.

The standard plant PS/Bs are designed with an SSE corresponding to the standard plant CSDRS, which is anchored at a 0.3g PGA. Because of the large ratio of the standard plant input motion versus the site-specific input motion, the design of the PS/Bs is not validated by performing site-specific SSI analyses. Instead, the design is considered suitable based on the large margin by which the R/B standard plant ISRS envelope the ISRS obtained from the site-specific SSI analysis for the R/B, as documented in Appendix 3NN. Therefore, site-specific analysis of SSI effects for the PS/Bs at CPNPP site is not required based on the comparisons of the R/B standard plant ISRS versus site-specific ISRS documented in Appendix NN.

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

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CP COL 3.7(10) Replace the last sentence of the fifth paragraph in DCD Subsection 3.7.2.8 with the following.

Structure-to-structure interactions, which could potentially influence the measured seismic response levels, will not occur because the R/B and PS/B are both founded on the same very stiff limestone layer and are separated by expansion joints which prevent seismic interaction.

Site-specific conditions at CPNPP Units 3 and 4 do not result in exceedance of the assumed pressure distributions used for the US-APWR standard plant design.

STD COL 3.7(9) Replace the seventh 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 seismic Category I 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 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 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 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.

CP COL 3.7(5) ***3.7(5)*** *Horizontal FIRS, Vertical FIS, 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 and Figure 3.7-201.

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, Table 3.7-203, 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 3.7.2.4.1.

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-structure interaction*

This COL item is addressed in Subsection 3.7.2.8.

3.7(11) *Deleted from the DCD.*

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 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.

CP COL 3.7(22) ***3.7(22)*** *High seismic areas*

This COL item is addressed in Subsection 3.7.1.1

CP COL 3.7(23) ***3.7(23)*** *Broadened ISRS and lateral soil pressure*

This COL item is addressed in Subsection 3.7.2.4.1 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-PCCV-containment internal structure and PS/B model*

This COL item is addressed in Subsection 3.7.2.4.1, 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 3.7.2.4.1, 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.

CP COL 3.7(28) ***3.7(28)*** *Overall site-specific building dimensions*

This COL item is addressed in Subsection 3.7.1.3, and Table 3.7.1-3R.

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 and duration*

This COL item is addressed in Subsections 3.7.1.1, and Figures 3.7-204 through 3.7-209.

Table 3.7.1-3R

Major Dimensions of Seismic Category I Structures[1]

Structure	Basemat Embedment Depth Below Grade (ft)	Basemat Width and Length (ft)	Max. Structure Height
R/B	38'-10"	210' x 309'[3]	190' - 9"
PCCV	See note 2.	See note 2.	268' - 3"
Containment Internal Structure	See note 2.	See note 2.	175'-9" (top of pressurizer compartment)
PS/B	38'-10"	(66'-0") x (111'-6")[3]	87'-4"
CP COL 3.7(28) PSFSV	40'-0" (nominal)	88'-6" x 78'-6"	42'-7" (+/-) [4],[6]
CP COL 3.7(28) UHSRS	47'-0"/35'-0"	131'-6" x 131'-6" [5]	112'-0" [4]
CP COL 3.7(28) ESWPT	30'-11" (typical) 31'-5" (maximum) [7]	26' (typical) / 35' (maximum) [7] x length connecting R/B to UHSRS	18'-8" (typical) [4] 51'-5" (maximum) [7]

Notes:

1) The dimensions shown are approximate and are based on the general arrangement drawings in Section 1.2.
2) The R/B, PCCV, and containment internal structure rest on a common basemat as shown on the general arrangement drawings in Section 1.2.
3) Width and length are the distances between column lines of exterior walls.
4) The maximum structure height indicated for these structures is from bottom of mat to top of structure. The shear key dimensions of the ESWPT and PSFSVs are not included.

CP COL 3.7(28) 5) Each mat foundation supports one UHS basin with one pool.

6) This includes height of curb at the high point on the roof slab.
7) The maximum dimensions occur at the UHS air intake missile shields mounted on the ESWPT adjacent to the UHSRS.

Table 3.7.2-1R

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

	Model	Analysis Method	Program	Three Components Combination (for Purposes of Dynamic Analysis)	Modal Combination
	Three-dimensional R/B-PCCV-containment internal structure Lumped Mass Stick Model (4)	Direct Integration Time History Analysis	ANSYS	square root sum of the squares (SRSS)	N/A
	Three-dimensional R/B-PCCV-containment internal structure FE Model (1)	Time History Analysis in Frequency Domain	ANSYS	N/A	N/A
CP COL 3.7(29)	Three-dimensional R/B-PCCV-containment internal structure SSI Model	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	N/A (5)	N/A
	Three-dimensional reactor coolant loop (RCL) Piping FE Model (2)	Direct Integration Time History Analysis	ANSYS	SRSS	N/A
	Three-dimensional PS/Bs Lumped Mass Stick Models (3)	Direct Integration Time History Analysis	ANSYS	SRSS	N/A
	Three-dimensional RCL-R/B-PCCV-containment internal structure Lumped Mass Stick Model	Direct Integration Time History Analysis	ANSYS	SRSS	N/A
CP COL 3.7(29)	Three-dimensional UHSRS FE model (6)	Response Spectra Analysis	ANSYS	Newmark 100-40-40	Lindley-Yow method
CP COL 3.7(29)	Three-dimensional UHSRS SSI model	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
CP COL 3.7(29)	Three-dimensional ESWPT FE models	Modal Analysis	ANSYS	N/A(7)	N/A
CP COL 3.7(29)	Three-dimensional ESWPT SSI models	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A
CP COL 3.7(29)	Three-dimensional PSFSV FE model	Modal Analysis	ANSYS	N/A(7)	N/A
CP COL 3.7(29)	Three-dimensional PSFSV SSI model	Time History Analysis in Frequency Domain using sub-structuring technique	SASSI	SRSS	N/A

Table 3.7.2-1R

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

Notes:

1) The FE model for the R/B-PCCV-containment internal structure on their common basemat is used only for validation of the dynamic lumped mass stick models and for static analysis for design of structural members and components as addressed in Section 3.8.
2) The FE model for the RCL is addressed in a Technical Report (Reference 3.7-18).
3) The lumped mass stick models for the PS/Bs are addressed in a Technical Report (Reference 3.7-33).
4) Three-dimensional RCL-R/B-PCCV-containment internal structure lumped mass stick models are addressed in a Technical Report (Reference 3.7-18).

CP COL 3.7(29) 5) SASSI analysis of the R/B-PCCV-containment internal structure on their common basemat is used only for validation of the dynamic lumped mass stick modeling approach with respect to capturing site-specific effects.

CP COL 3.7(29) 6) Response spectra analysis is performed to obtain response under seismic design loads for UHSRS and is described further in Appendix KK. The seismic response obtained from the response spectra analysis envelopes the results of SASSI analysis of UHSRS.

CP COL 3.7(29) 7) The modal analysis performed on ANSYS FE models of ESWPTs and PSFSVs are used only for the validation of SASSI models.

CP COL 3.7(5)

Table 3.7-201

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

Control Point (Hz)		Acceleration (g)
0.5 percent Damping		
A	(50)	0.1
B	(12)	0.50
C	(2.5)	0.60
D	(0.25)	0.073
E	(0.1)	0.012
2 percent Damping		
A	(50)	0.1
B	(12)	0.353
C	(2.5)	0.43
D	(0.25)	0.057
E	(0.1)	0.009
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)

Table 3.7-202

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

Control Point (Hz)		Acceleration (g)
0.5 percent Damping		
A	(50)	0.1
B	(12)	0.50
C	(3.5)	0.57
D	(0.25)	0.05
E	(0.1)	0.008
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
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

CP COL 3.7(7)

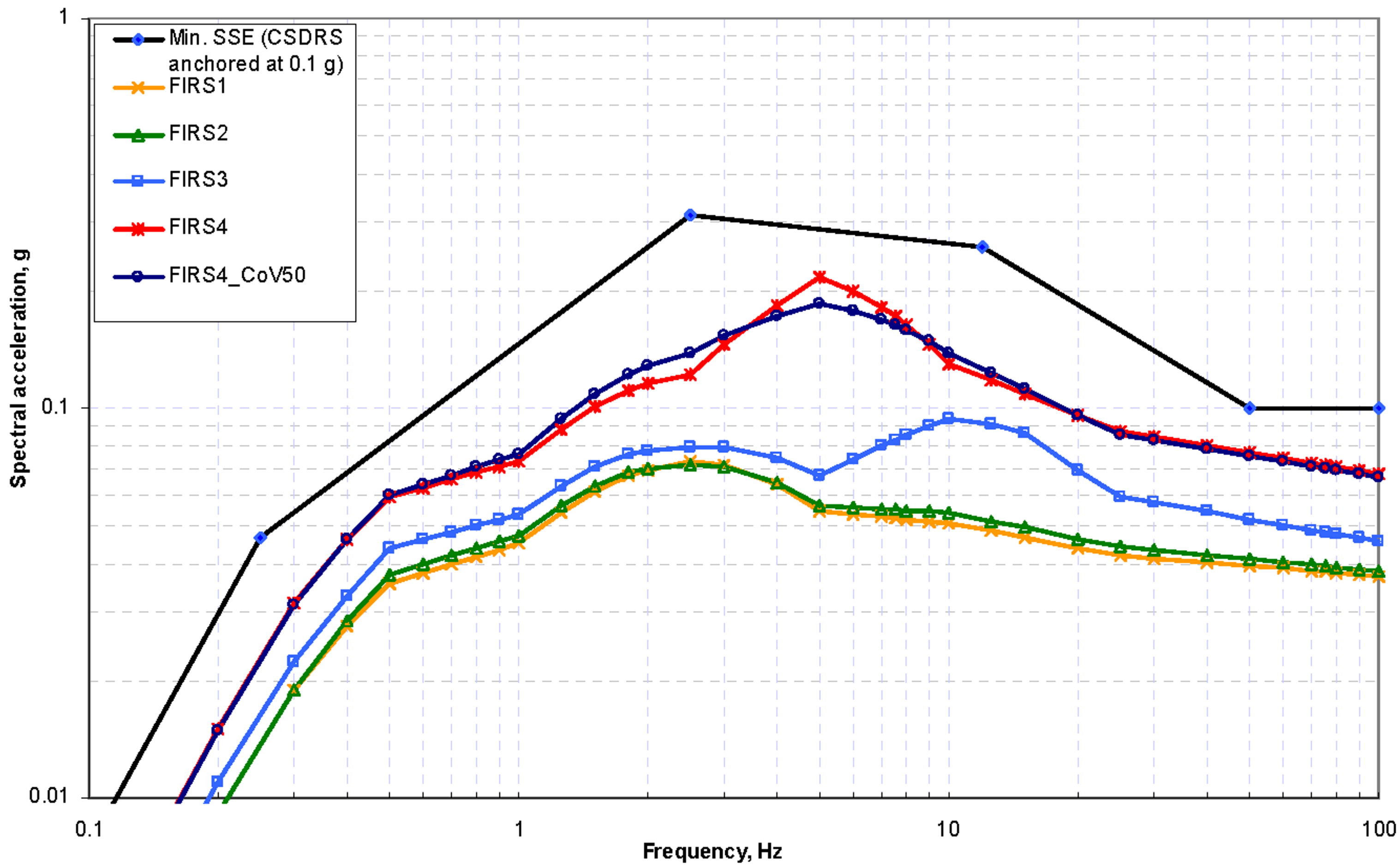
Table 3.7-203

Material Properties of Limestone Layer Supporting Seismic Category I and II Buildings and Structures

Description	Value
Ultimate bearing capacity	146 ksf
Mean shear wave velocity (V_s)	5,685 ft/s[(1)]
Poisson's ratio	0.33
Mean shear modulus (G_s)	1,080.4 ksi
Density	155 pcf (wet), 148.0 pcf (dry)
Low shear strain damping value (D_s)	1.8 percent
Low unconstrained compression damping value (D_c)	0.9 percent

Notes:

1) The mean shear wave velocity shown is for the top limestone layer, approximately 65 ft. thick, located directly underneath the seismic category I and II structures on site. The average value of V_s for the top 400 ft. of subgrade beneath the structures is 3,830 ft/s, computed based on the equivalent arrival time method.



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

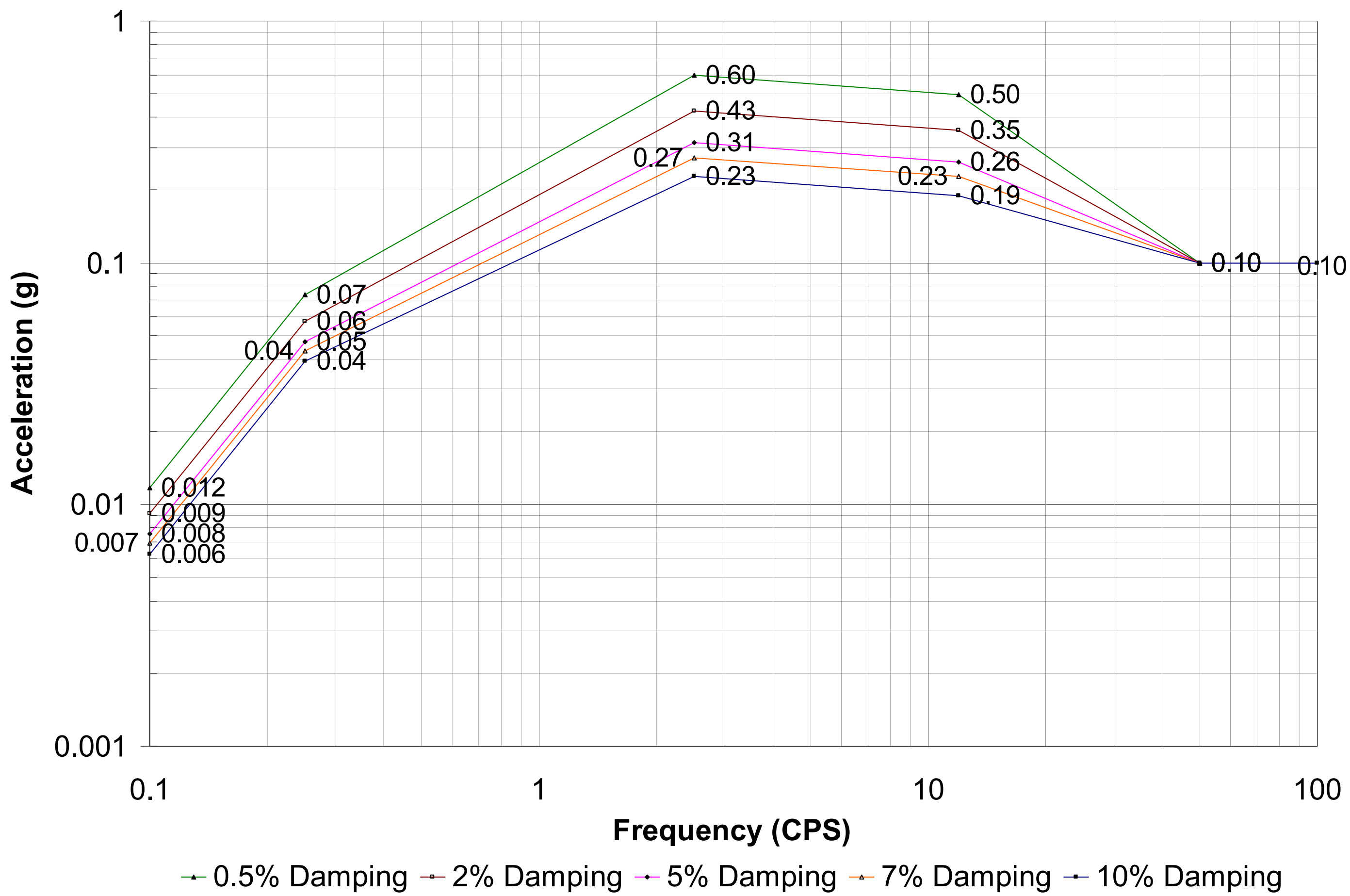
Figure 3.7-201 Nominal Horizontal GMRS and FIRS(1),(2) (Sheet 1 of 2)

Notes:

1) The site-specific horizontal ground motion response spectrum is shown as “FIRS1” in the figure above and represents the GMRS corresponding to top of limestone at nominal elevation 782’. The site-specific FIRS and GMRS shown above are discussed in Subsection 3.7.1.1.
2) The nominal site-specific GMRS and FIRS for CPNPP Units 3 and 4 are shown above. However, the nominal GMRS and FIRS are less than the minimum required design response spectra, which are the standard plant CSDRS anchored at 0.1 g as discussed in Subsection 3.7.1.1. Therefore, for site-specific design, the nominal GMRS and FIRS are ***not*** used. Instead, the minimum applicable design response spectra for site-specific design are the CSDRS anchored at 0.1 g, which are shown separately in Figures 3.7-202 and 3.7-203 for the horizontal and vertical directions, respectively.

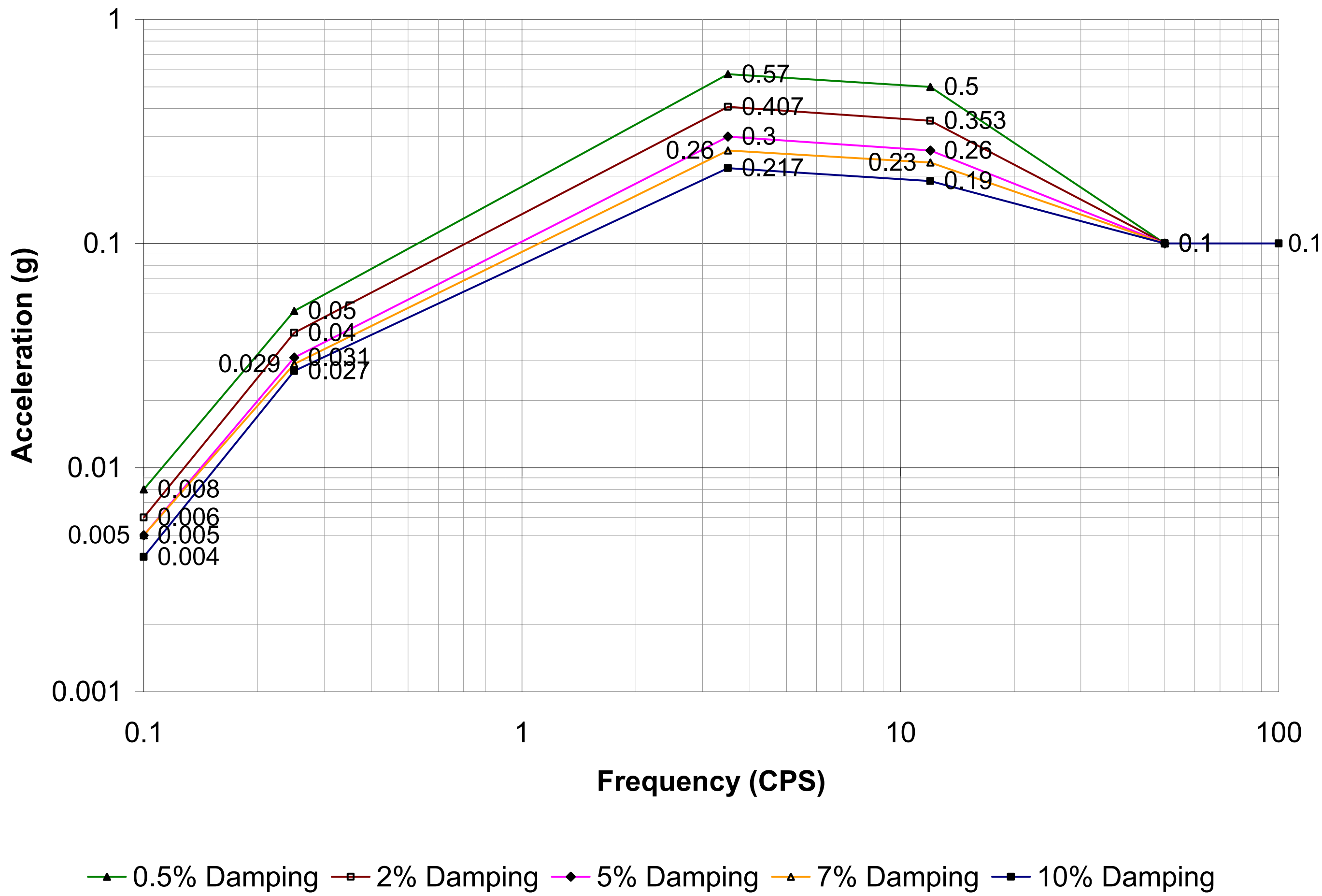
CP COL 3.7(5)
CP COL 3.7(6)

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



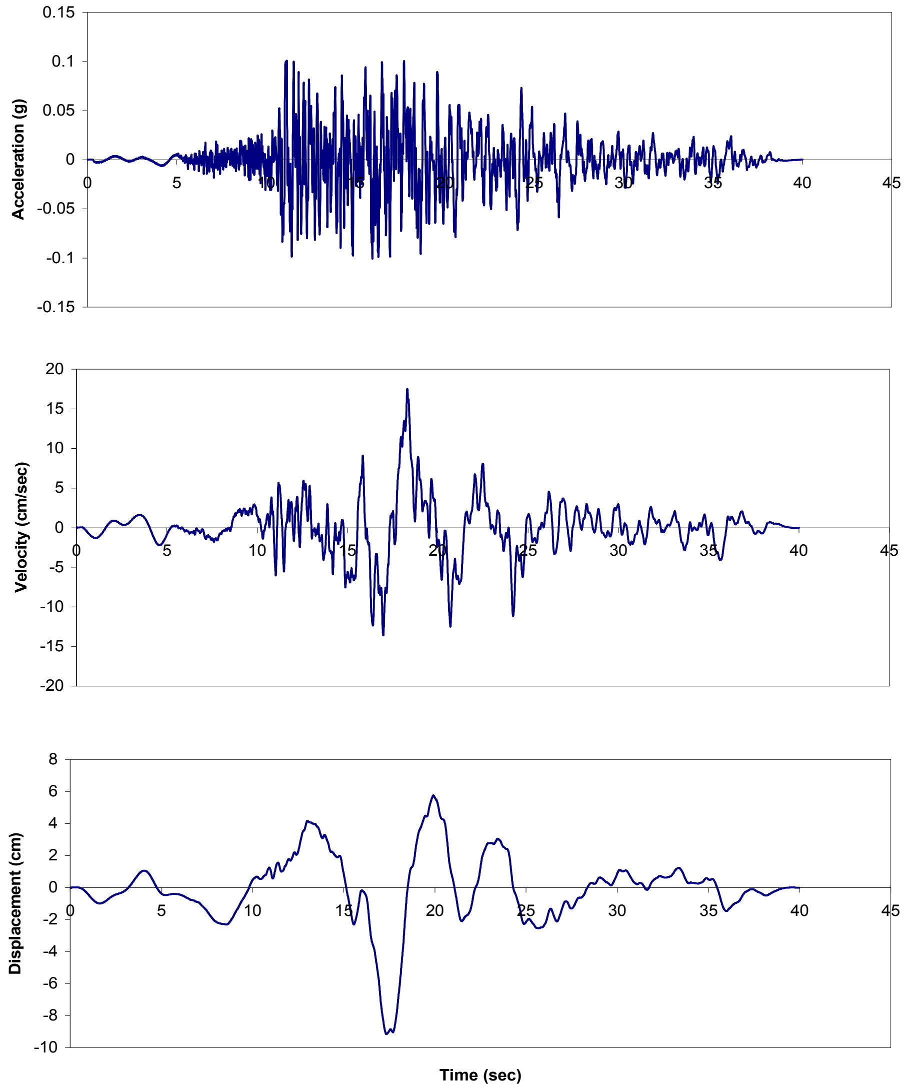
CP COL 3.7(5)

Figure 3.7-202 Comanche Peak Site-Specific Horizontal SSE and FIRS

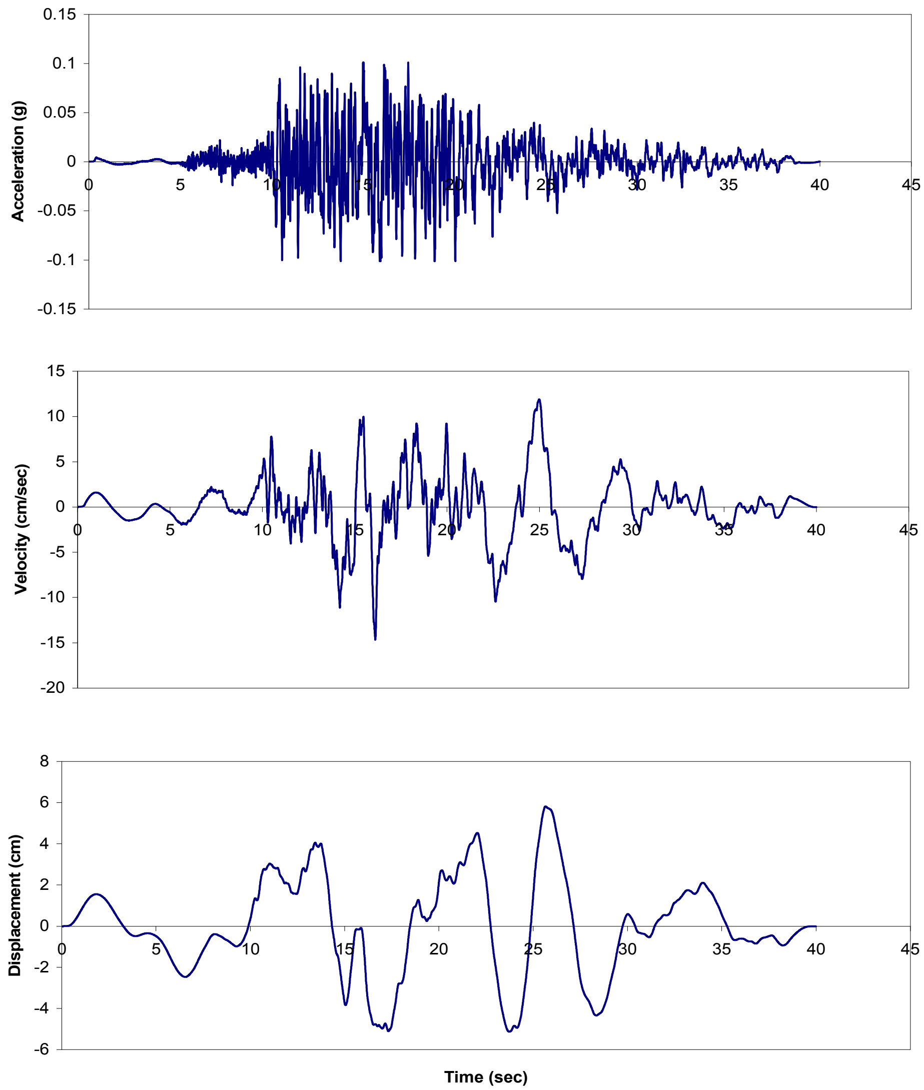


CP COL 3.7(5)

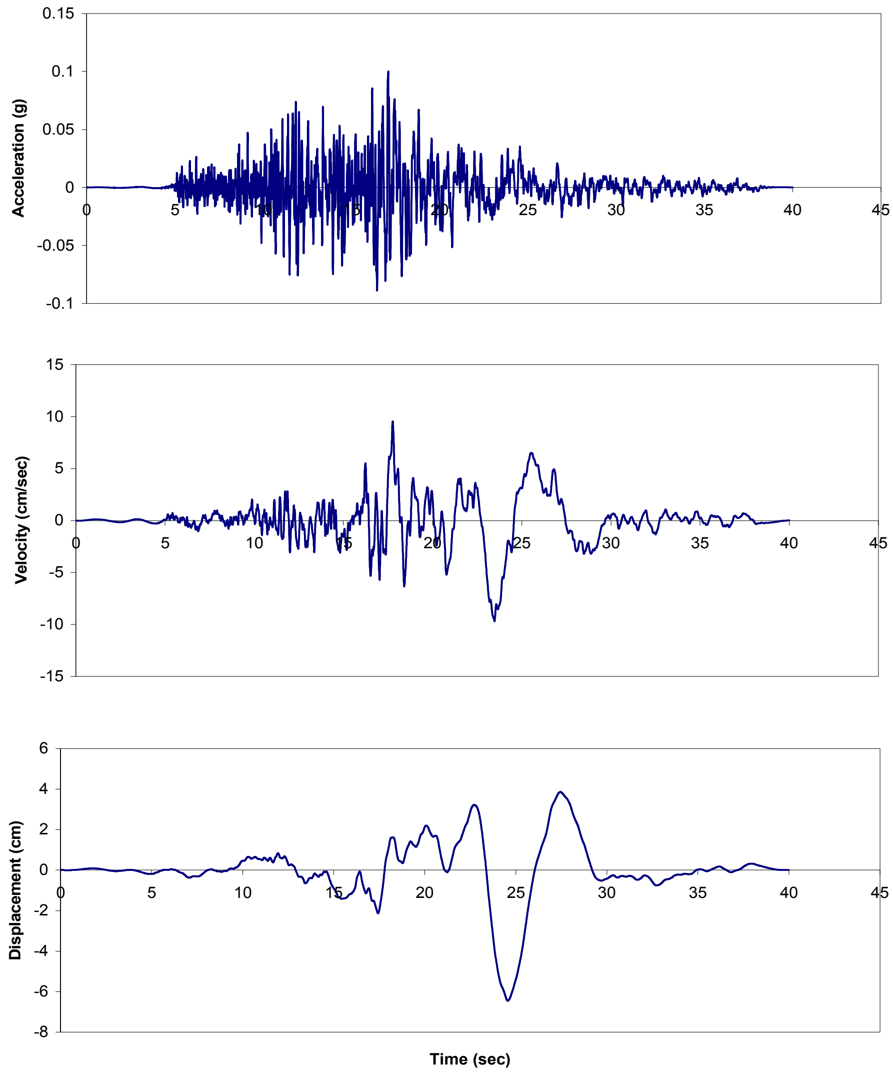
Figure 3.7-203 Comanche Peak Site-Specific Vertical SSE and FIRS



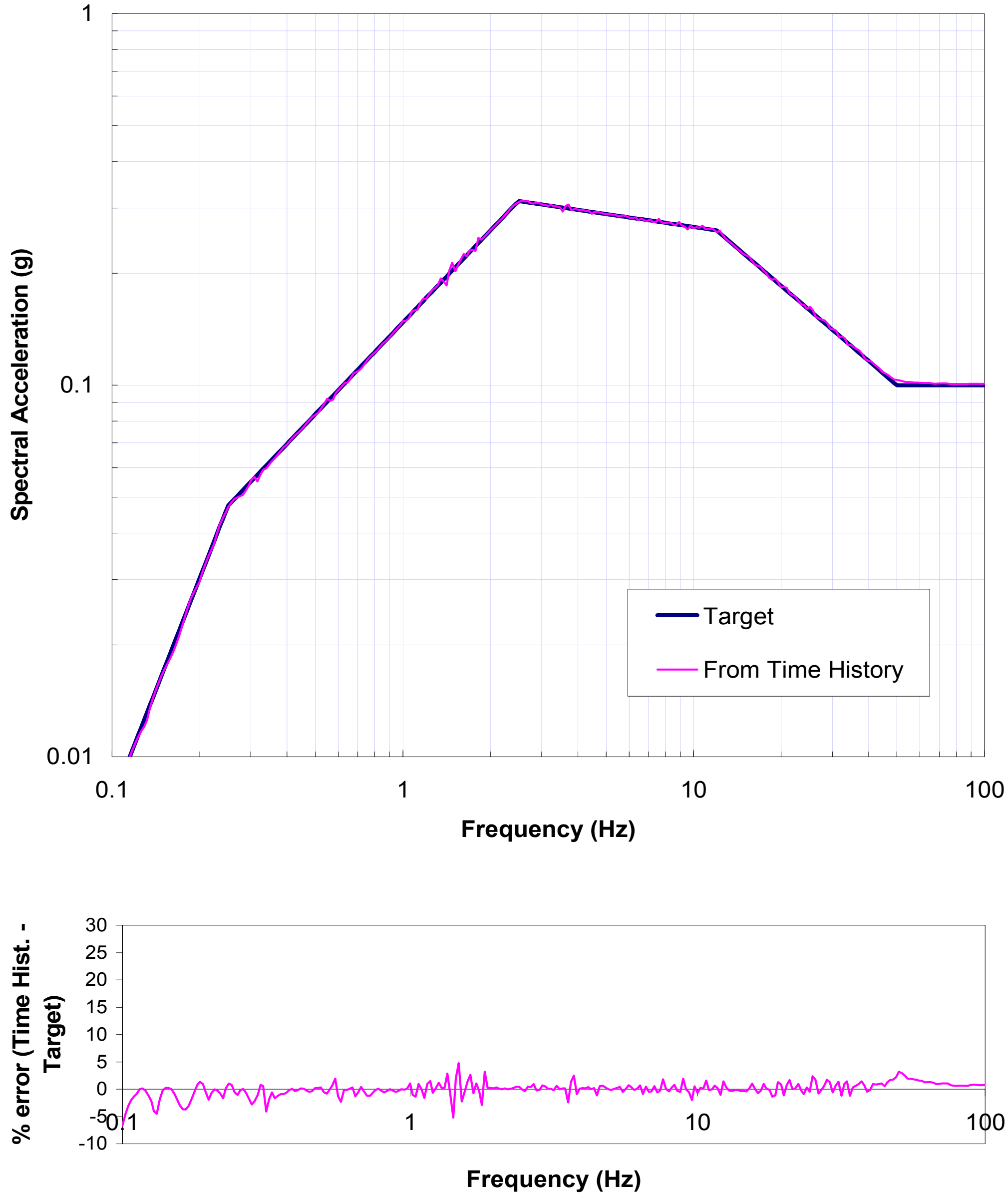
CP COL 3.7(30) **Figure 3.7-204 Time Histories of Acceleration, Velocity, and Displacement – First Horizontal Component (H1) – Compatible to Site-specific SSE Design Spectra**



CP COL 3.7(30) **Figure 3.7-205 Time Histories of Acceleration, Velocity, and Displacement – Second Horizontal Component (H2) – Compatible to Site-specific SSE Design Spectra**

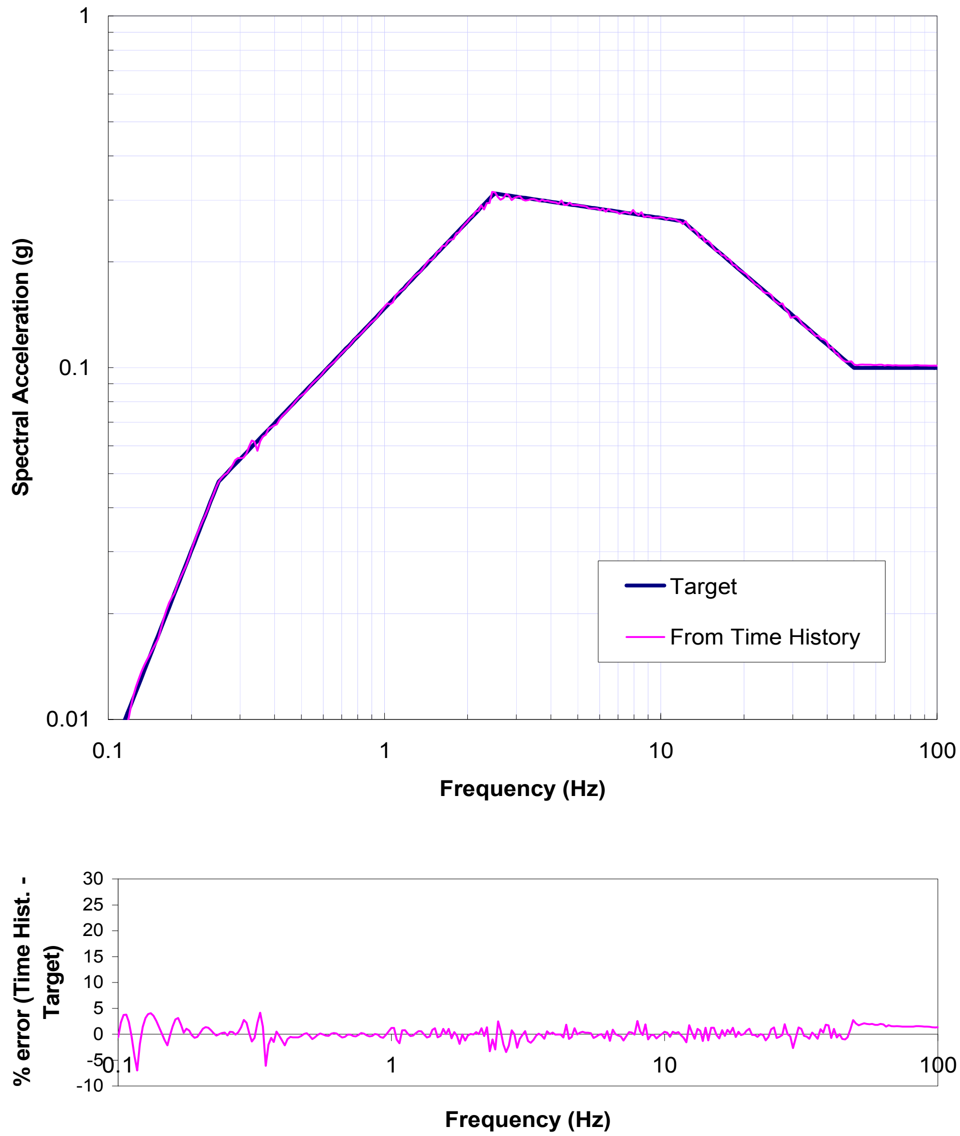


CP COL 3.7(30) **Figure 3.7-206 Time Histories of Acceleration, Velocity, and Displacement – Vertical Component (V) – Compatible to Site-specific SSE Design Spectra**



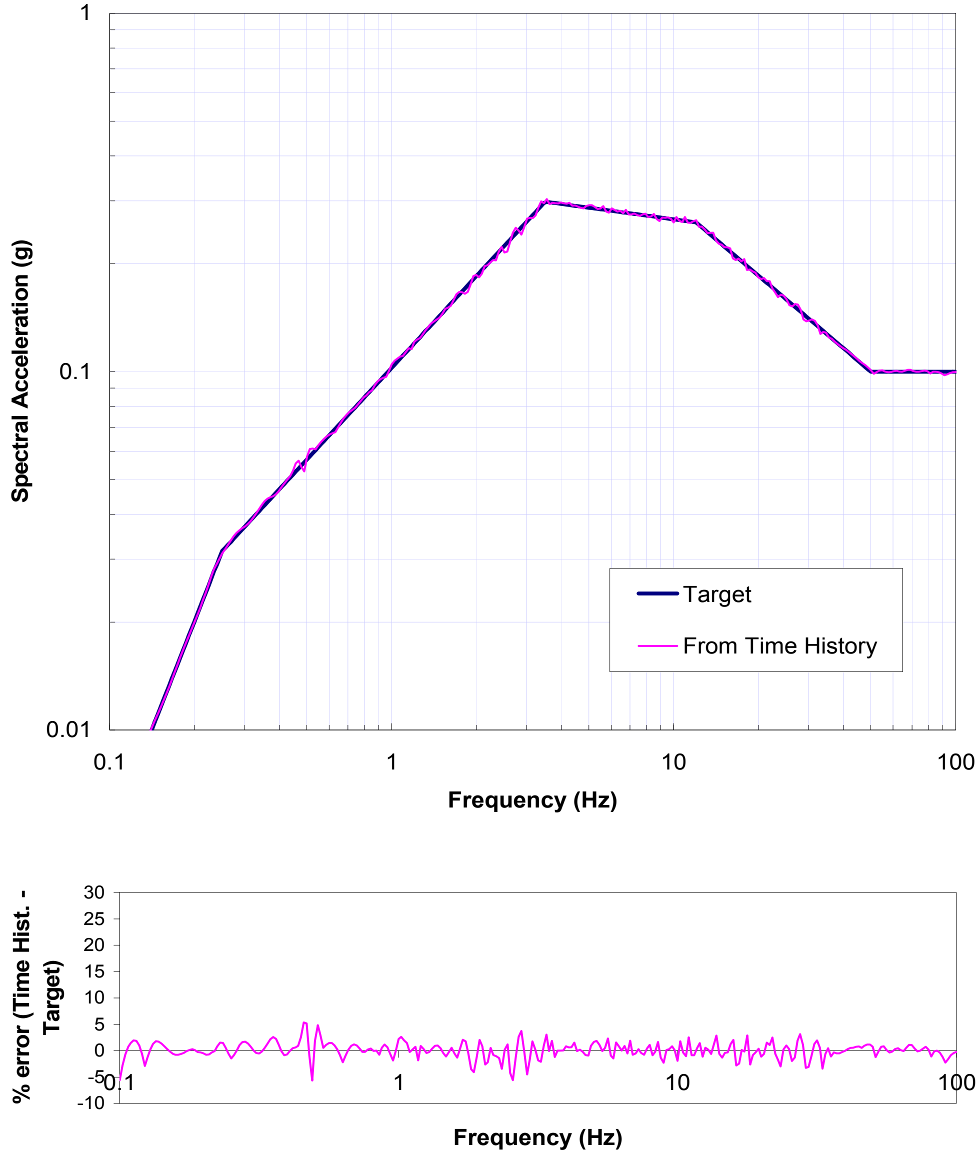
CP COL 3.7(30)

Figure 3.7-207 Calculated Response Spectra Versus Site-specific SSE Design Target Spectra – First Horizontal Component (H1)



CP COL 3.7(30)

Figure 3.7-208 Calculated Response Spectra Versus Site-specific SSE Design Target Spectra – Second Horizontal Component (H2)



CP COL 3.7(30)

Figure 3.7-209 Calculated Response Spectra Versus Site-specific SSE Design Target Spectra – Vertical Component (V)

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 with expansion/isolation joints as shown in various views in Figures 3.8-201 through 3.8-214. The performance specifications for the elastomeric joint or seal materials address requirements for critical characteristics such as bounding the allowable stress-strain properties, durability requirements, and associated material testing. In lieu of expansion joints, the interfaces below grade may be left empty and waterproof joint sealants provided along the perimeter at grade. The sealant will be inspected periodically to maintain integrity.

3.8.4.1.3.1 ESWPT

The ESWPT is an underground reinforced concrete structure. Figure 3.8-203 shows the typical section of the ESWPT. The tunnel layout is a rectangular configuration forming a closed looped structure starting at the UHS Basins and terminating at the T/B. 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 reinforced concrete manholes.

The following structures are supported by the ESWPT as an integral part of the tunnel:

- Fuel/Pipe access tunnels, providing access from the PS/B to the PSFSVs are shown in Figures 3.8-204 and 3.8-212.
- Reinforced concrete air intake enclosures projecting above the ground for ESWS piping from the ESWS pump houses.

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

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

The ESWPT is divided into three segments separated by expansion joints. A key plan showing the locations of the three segments is included in Figure 3.8-201. The segments are defined as follows:

- Tunnel Segment 1, as shown in Section G in FSAR Figure 3.8-203, is representative of the typical tunnel segments to the east and west of the R/B.
- Tunnel Segment 2, as shown in Section F and F' in FSAR Figure 3.8-202, is representative of segments adjacent to the Ultimate Heat Sink (UHS) structures. A tornado missile shield extends from the top of this segment to protect openings in the UHS.
- Tunnel Segment 3, as shown in Section H and H' in FSAR Figure 3.8-204 is representative of segments with fuel pipe access tunnels extending from the top. These are located adjacent to the PSFSVs.

Each segment has a somewhat different geometry and is designed separately. Segments 1 and 3 have roof slab and mat slab thicknesses of 2'-0" while Segment 2 has a roof slab and mat slab thickness of 2'-6".

All segments are designed for the same basic load conditions, but due to differing geometry the values of some of the loads (seismic, soil pressure, live loads, etc.) varied. The resulting moments and shears also varied. Thus, Segment 2 requires a thicker roof slab because this segment includes the tornado missile shield structure. This requires a thicker roof to resist additional reactions not present in the roof slabs of the other segments.

Similarly, a thicker mat slab is required in Segment 2 to resist additional moments and shears at the two large shear keys and to resist additional bearing pressures. The keys are required to resist soil dynamic and active pressures because over most of the length of this segment backfill is placed only on one side of the structure. In this segment there are unbalanced soil pressures, thus requiring shear keys to resist the lateral forces. Higher bearing pressures are placed on the

mat slab as well due to overturning moments and a greater overall weight of this segment versus the other segments.

It is intended that at the interface of two different segments, 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 of the ESWPT segments.

3.8.4.1.3.2 UHSRS

The UHSRS consists of a cooling tower enclosure; UHS ESW pump house, and UHS basin. All of them are reinforced concrete structures, described below.

UHS Basin - There are four basins for each unit and each reinforced concrete basin has one cooling tower with two cells. Each basin rests on a separate foundation, is square in shape, constructed of reinforced concrete, and separated from the adjacent basin by a minimum 4 inch expansion joint. A site-specific specification for the expansion/separation joint that provides material or system performance requirements will be prepared. Performance requirements for an elastomeric material include requirements bounding the allowable stress-strain properties, durability requirements, and specification for a material testing program. See Section 3.8.4.1.3 for alternate to expansion joints. Each basin serves as a reservoir for the ESWS. There is a cementitious membrane adhered to the interior faces of the reinforced concrete walls of the basins which minimizes long-term seepage of water from the basin. An UHS ESW pump house is located at the south-west corner of each basin. Adjacent to the pump house on the east side of the basin are cooling tower enclosures supported by UHS basin walls. The ESWPT runs east-west along the south exterior wall of the UHS basin, and is separated by a minimum 4 inch expansion joint.

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.

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 missile shields are provided to protect the air intake and air outlets of the ESWS pump house HVAC system from tornado 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. FSAR Table 3.2-201 lists the site-specific equipment and components located in the UHSRS that are protected from tornado 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 ESWPT, and is supported by reinforced concrete piers which are supported by the ESWPT walls and basemat.

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, a circular opening is provided at the roof of the enclosure (centered on the fan) with a reinforced concrete slab and heavy steel grating between the roof and the deck. The fans, motors and associated equipment are designed with consideration given to 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 missile are designed to prevent full penetration or structural failure by the spectrum of tornado missiles identified in Subsection 3.5.1.4.

For details see Figures 3.8-207 through 3.8-211 for the UHS basin, UHS ESW pump house and cooling tower enclosures. 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. The PSFSV roof slab is sloped to facilitate drainage. The highest point of the roof slab is slightly above grade. Bollards and a concrete curb are provided to prevent vehicular traffic on the roof.

Access to each vault is provided by a reinforced concrete tunnel from the applicable PS/B. Each tank compartment has a separate pipe/access tunnel, which is an integral part of the ESWPT.

For vault details see 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.

3.8.4.4.3 Other Seismic Category I Structures

CP COL 3.8(29)
CP COL 3.8(30) Replace the last paragraph in DCD Subsection 3.8.4.4.3 with the following.

3.8.4.4.3.1 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.

The static analyses are performed on the ANSYS model placed on soil springs at the top of the concrete fill representing the stiffness of the support provided by the

concrete fill and limestone. The stiffness of the subgrade springs under different sections of the ESWPT is calculated using the methodology in ASCE-4 Section 3.3.4.2 (Reference 3.8-34), for vibration of a rectangular foundation resting on an elastic half space. The springs are included to provide localized flexibility at the base of the structure to calculate base slab demands. The soil stiffness adjacent to the tunnel 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 lateral soil pressures and inertia loads are based upon. The subgrade stiffness calculated from ASCE-4 Section 3.3.4.2 is used for analysis of both static and seismic loads. The equivalent shear modulus for the ASCE spring calculations is based on the equivalent shear wave velocity, which is determined using the equivalent shear wave travel time method described in Appendix 3NN. The equivalent Poisson's ratio and density are based on the weighted average with respect to layer thickness. The springs are included in the model using three individual, uncoupled uni-directional spring elements that are attached to each node of the base mat. The same stiffness is applied to all springs and the sum of all nodal springs in each of the three orthogonal directions are equal to the corresponding generalized structure-foundation stiffness in the same direction calculated from ASCE 4-98. In the vertical direction, the smaller of the ASCE 4-98 vertical or rocking stiffness is used. Matching of the torsional stiffness is not considered since significant torsional response is not expected (or observed) in any of the structures.

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 to tunnel segments 1 and 2 and a design surcharge pressure of 200 psf is applied to tunnel segment 3.

Lateral soil pressures on outer tunnel walls are typically resisted by one-way action of the outer walls. Forces from these pressures are transferred to the roof and mat slabs. Where axial force in the roof and mat slabs transverse to the tunnel axis are not balanced by an equal and opposite force from the other side of the tunnel, the roof and mat slabs work with the walls as a moment frame to resist the unbalanced lateral forces. Corner tunnel segments resist unbalanced 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).

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, and where a shear key is present, by friction and lateral bearing of the shear key on the fill concrete. Lateral forces in the fill are then transferred to bedrock by friction, and where required, by lateral bearing of another shear key that extends into bedrock.

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. 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.

3.8.4.4.3.2 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 the program ANSYS as described below.

The ANSYS design analysis models for the UHSRS were placed on soil springs calculated by methods provided in ASCE 4-98 (Reference 3.8-34) to provide localized flexibility at the base of the structure. The flexibility of the base allows for calculation of the base slab demands. 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.

ANSYS analyses are performed based on two support conditions: (1) flexible rock subgrade by applying soil springs across all base slab nodes and (2) rigid base by applying fixed restraints across all base slab nodes. All results from these two conditions are enveloped for design. The stiffness of the subgrade springs is calculated using the methodology in ASCE-4 Section 3.3.4.2 (Reference 3.8-34) for vibration of a rectangular foundation resting on an elastic half space. The springs were included to provide localized flexibility at the base of the structure to calculate base slab demands. The soil adjacent to the UHSRS 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 lateral soil pressures and inertia loads are based. The evaluation of subgrade stiffness considers the best estimate properties of the layers above elevation 393 ft. Since the support below the structure will not exhibit long-term settlement effects, the subgrade stiffness calculated from ASCE-4 Section 3.3.4.2 is used for analysis of both static and seismic loads.

The equivalent shear modulus for the ASCE spring calculations is based on the equivalent shear wave velocity which is determined using the equivalent shear wave travel time method described in Appendix 3NN. The equivalent Poisson's ratio and density are based on the weighted average with respect to layer thickness. The springs are included in the model using three individual, uncoupled uni-directional spring elements that are attached to each node of the base mat. The same stiffness is applied to all springs and the sum of all nodal springs in each of the three orthogonal directions are equal to the corresponding generalized structure-foundation stiffness in the same direction calculated from ASCE 4-98 (Reference 3.8-34). In the vertical direction, the smaller of the spring stiffness that matches the ASCE 4-98 vertical or rocking stiffness is used. Matching of the torsional stiffness is not considered since significant torsional response is not expected (or observed) in any of the structures.

Each UHS cooling tower, air intake enclosures, and ESWS pump house are designed for tornado wind and tornado 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 design also considers the load from soil compaction pressure. The dynamic soil pressures are determined in accordance with ASCE 4-98 (Reference 3.8-34) and the hydrodynamic fluid pressures 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 or tornado wind, 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 or tornado 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.

3.8.4.4.3.3 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 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 soil springs at the bottom of the concrete fill / top of limestone level representing the stiffness provided by the rock subgrade. The stiffness of the subgrade springs is calculated using the methodology in ASCE-4 Section 3.3.4.2 (Reference 3.8-34) for vibration of a rectangular foundation resting on an elastic half space. The springs are included to provide localized flexibility at the base of the structure to calculate base slab demands. 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 lateral soil pressures and inertia loads are based. The evaluation of subgrade stiffness considers the best estimate properties of the layers above elevation 215 ft. Since the support below the structure will not exhibit long-term settlement effects, the subgrade stiffness calculated from ASCE-4 Section 3.3.4.2 is used for analysis of both static and seismic loads.

The equivalent shear modulus for the ASCE spring calculations is based on the equivalent shear wave velocity, which is determined using the equivalent shear wave travel time method described in Appendix 3NN. The equivalent Poisson's ratio and density are based on the weighted average with respect to layer thickness. The springs are included in the model using three individual, uncoupled uni-directional spring elements that are attached to each node of the base mat. The same stiffness is applied to all springs and the sum of all nodal springs in each of the three orthogonal directions are equal to the corresponding generalized structure-foundation stiffness in the same direction calculated from ASCE 4-98 (Reference 3.8-34). In the vertical direction, the smaller of the spring stiffness that matches the ASCE 4-98 vertical or rocking stiffness is used. Matching of the torsional stiffness is not considered since significant torsional response is not expected (or observed) in any of the structures.

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 and shear keys.

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 ESPWT is an underground structure supported by a monolithic reinforced concrete basemat. The basemat is a 2 ft. thick concrete slab in Segments 1 and 3 as shown in Figures 3.8-203 and 3.8-204, respectively, and is 2'-6" thick adjacent to the UHSRS in Segment 2 as shown in Figure 3.8-202, with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the basemat is at elevation 791.08 ft. (elevation 790.58 ft. adjacent to the UHSRS), and is founded on structural concrete fill placed directly on limestone. The basemat has a shear key which extends into the fill concrete in the portion of ESWPT adjacent to the UHSRS as shown in Figure 3.8-202. The fill concrete at this portion also has a shear key which extends into the limestone as shown in Figure 3.8-202. Except at this portion where the fill concrete is locally reinforced, the fill concrete is generally designed as unreinforced concrete.

3.8.5.1.3.2 UHSRS

The UHS basins, ESWS pump house, and the cooling towers are free-standing structures supported on a reinforced concrete basemat. Each basin, including its pump house and cooling towers, rests on a 4 ft. thick mat with top and bottom reinforcement in each direction arranged in a rectangular grid.

The bottom of the UHS basemat is at elevation 787 ft., except the pump house sump mat is at elevation 775 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.

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. Shear keys are provided which extend into the limestone 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 sentence of the first paragraph in DCD Subsection 3.8.5.4.4 with the following.

As discussed in Section 2.5.4.10.2, maximum and differential settlements of all the seismic category I buildings and structures at the site, including R/B, PS/Bs, ESWPT, UHSRS, and PSFSVs are estimated to be less than ½ inch, including long-term settlements.

3.8.5.5 Structural Acceptance Criteria

CP COL 3.8(25) Replace the second 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, PS/Bs, ESWPT, UHSRS, and PSFSVs, are founded either directly on a limestone layer or structural concrete fill which is placed directly on the limestone. 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 3.8-203 shows the load combinations and factors of safety against overturning, sliding and flotation for site-specific buildings and structures.

3.8.5.5.2 Sliding Acceptance Criteria

CP COL 3.8(30) Replace the last paragrap in DCD Subsection 3.8.5.5.2 with the following.

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

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 Subsection 3.8.4.

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 Subsection 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 3.8.4.4.3, 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 3.8.4.4.3 and 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(1),(2)		Static Case	Seismic Case	Static Case	Seismic Case	Static Case	Seismic Case
R/B	11,300	18,900	146,000	12.9	7.7	48,700	73,000	4.3	3.9
T/B	5,900	7,400	146,000	24.7	19.7	48,700	73,000	8.3	9.9
A/B	6,600	10,800	146,000	22.1	13.5	48,700	73,000	7.4	6.8
PS/Bs	4,300	7,400	146,000	34	19.7	48,700	73,000	11.3	9.9
PSFSVs	2,900(3)	5,100(3)	146,000	50.3	28.6	48,700	73,000	16.8	14.3
UHSRS	4,500(4)	16,200(4)	146,000	32.4	9	48,700	73,000	10.8	4.5
ESWPT	3,600(5)	12,400(5)	146,000	40.6	11.8	48,700	73,000	13.5	5.9

Notes:

1) All seismic case bearing pressures are based on the site-specific FIRS with 0.1 g PGA as described in Subsection 3.7.1.
2) Seismic case bearing pressures shown above include static bearing pressures.
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 the portion of the ESWPT supporting the air intake missile shields adjacent to the UHSRS.

Table 3.8-203

Load Combinations and Factor of Safety for Buildings and Structures

Building/Structure	Load Combination (per SRP 3.8.5)	Overturning (FS_{ot})	Sliding (FS_{sl})	Flotation (FS_{fl})
PFSVs	D + H + W	5.51	1.85(2)	N/A
	D + H + E_s	3.29	1.28(2)	N/A
	D + H + W_t	5.51	1.85(2)	N/A
	D + F_b	N/A	N/A	1.71
UHSRS	D + H + W	>6	1.77	N/A
	D + H + E_s	>3	1.10	N/A
	D + H + W_t	>>1.1(4)	>>1.1(4)	N/A
	D + F_b	N/A	N/A	1.13(1)
ESWPT	D + H + W	3.56(5)	1.61(3)(5)	N/A
	D + H + E_s	1.57(5)	1.18(3)(5)	N/A
	D + H + W_t	3.56(5)	1.61(3)(5)	N/A
	D + F_b	N/A	N/A	2.0

Notes

1. The value shown is based on the assumption that a UHS basin is completely emptied of water (such as for maintenance) concurrent with a local intense precipitation event that causes saturation of the adjacent backfill up to elevation 821 ft. This is conservative because, as stated in Subsection 2.4.2.3, the UHSRS are adjacent to downward slopes leading into the Squaw Creek Reservoir which allow drainage to pass freely without accumulating.

2. Shear keys are used to prevent sliding and the FS is based on the shear key capacities.

3. Adjacent to the UHSRS, a shear key is used at both the tunnel base slab-to-concrete fill interface and the concrete fill-to-limestone interface, and the FS is based on shear key capacity.

4. Global stability is governed by wind and seismic load combinations for the UHSRS and is not explicitly calculated for the tornado load combination. In terms of total base shear force, the seismic demand is more than 10 times the tornado demand.

5. The factors of safety shown are for the ESWPT segment adjacent to the UHSRS, which governs the design with respect to these safety factors due to the mass and exposure of the UHS air intake missile shields that are integrally attached to the tunnel at this location.

(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 ESWPT Sections Adjacent to UHS Basin with Cooling Water Air Intake Missile Shield Enclosure Supported by the Tunnel

(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 ESWPT at PS/B and PSFSVs Showing Fuel Pipe/Access Tunnel

(SRI)

CP COL 3.8(19)

Figure 3.8-205 Section of ESWPT at R/B 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 ESWPT

(SRI)

CP COL 3.8(19)

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

STD COL 3.9(8) Replace the second sentence of the third paragraph in DCD Subsection 3.9.6 with the following.

The inservice testing (IST) program for pumps, valves, and dynamic restraints is administratively controlled to ensure that the equipment will be capable of performing its safety function throughout the life of the plant.

3.9.6.2 IST Program for Pumps

STD COL 3.9(11) Replace the third 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 plan for dynamic restraints (snubbers) complies with the requirements in the latest edition and addenda of the Nonmandatory Appendix A

of ASME OM Code incorporated by reference in 10 CFR 50.55a (Reference 3.9-29). The IST program plan for dynamic restraints will be provided 12 months prior to fuel load.

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) *Deletedfrom the DCD.*

3.9(5) *Deletedfrom the DCD.*

STD COL 3.9(6) ***3.9(6)*** *Program plan for IST of dynamic restraints*

This COL item is addressed in Subsection 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 used for the IST program*

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.

CP COL 3.9(11)

Table 3.9-202

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 6)

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	3
UHS-VLV-502B	B-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	3
UHS-VLV-502C	C-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	3

CP COL 3.9(12)

Table 3.9-203 (Sheet 2 of 6)

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-502D	D-UHS Transfer Pump Discharge Check Valve	Check	Transfer Close Transfer Open	Active	BC	Check Exercise / Refueling Outage	3
UHS-MOV-503A	A-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-503B	B-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

CP COL 3.9(12)

Table 3.9-203 (Sheet 3 of 6)
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-503C	C-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-503D	D-UHS Transfer Pump Discharge Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506A	A-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

CP COL 3.9(12)

Table 3.9-203 (Sheet 4 of 6)
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-506B	B-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506C	C-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	
UHS-MOV-506D	D-UHS Transfer Line Basin Inlet Valve	Remote MO Butterfly	Maintain Close Transfer Close Transfer Open	Active Remote Position	B	Remote Position Indication, Exercise/2 Years Exercise Full Stroke/Quarterly Operability Test	

CP COL 3.9(12)

Table 3.9-203 (Sheet 5 of 6)

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	
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	
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	
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	

Table 3.9-203 (Sheet 6 of 6)

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
EWS-AOV-576 A, 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	
ESW-AOV-577	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	

Notes:
1) Not used.
2) Not used.
3) 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.
4) Not used.
5) Not used.
6) Not used.
7) Not used.
8) Not used.
9) Not used.
10) Not used.
11) Not used.
12) Not used.
13) Not used.
14) Not used.

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 fifth 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 sixth 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 eighth 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.

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.

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 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 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 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 or tornado loading. Non-ASME piping, such as B31.1 (Reference 3.12-1) exposed to wind or tornado loading, is evaluated to the wind and tornado 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.

3.12.7 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 or tornado 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.

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

TABLE OF CONTENTS

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

TABLE OF CONTENTS

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

TABLE OF CONTENTS

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

TABLE OF CONTENTS

LIST OF TABLES

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 11)

Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	Purpose Engineered Safety Feature (ESF), Post Accident Monitoring (PAM), Other	Operational Duration	Environmental Conditions Harsh or Mild	Qualification Process E=Electrical M=Mechanical	Seismic Category 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 11)

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
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 11)

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
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 11)
Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
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-TS-803	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
34	VRS-TS-804	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
35	VRS-TS-805	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
36	VRS-TS-806	A - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
37	VRS-TS-812	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
38	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 5 of 11)

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
39	VRS-TS-814	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
40	VRS-TS-815	A - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
41	VRS-TS-823	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
42	VRS-TS-824	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
43	VRS-TS-825	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
44	VRS-TS-826	B - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
45	VRS-TS-832	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
46	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 6 of 11)

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
47	VRS-TS-834	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
48	VRS-TS-835	B - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
49	VRS-TS-843	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
50	VRS-TS-844	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
51	VRS-TS-845	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
52	VRS-TS-846	C - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
53	VRS-TS-852	C -UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
54	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 7 of 11)

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
55	VRS-TS-854	C - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
56	VRS-TS-855	C - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
57	VRS-TS-863	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
58	VRS-TS-864	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
59	VRS-TS-865	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
60	VRS-TS-866	D - ESW Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
61	VRS-TS-872	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
62	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 8 of 11)

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
63	VRS-TS-874	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
64	VRS-TS-875	D - UHS Transfer Pump Room Temperature	UHSRS	Other	2 wks	Mild	E	I	
65	UHS-MPP-001A	A - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
66	UHS-MPP-001B	B - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
67	UHS-MPP-001C	C - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
68	UHS-MPP-001D	D - UHS Transfer Pump	UHSRS	ESF	1 yr	Mild	M	I	
69	UHS-MFN-001A	A – UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
70	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 9 of 11)

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	UHS-MFN-001C	C - UHS Cooling Tower Fan NO.1	UHSRS	ESF	1 yr	Mild	M	I	
72	UHS-MFN-001D	D - UHS Cooling Tower Fan No.1	UHSRS	ESF	1 yr	Mild	M	I	
73	UHS-MFN-002A	A – UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
74	UHS-MFN-002B	B – UHS Cooling Tower Fan NO.2	UHSRS	ESF	1 yr	Mild	M	I	
75	UHS-MFN-002C	C - UHS Cooling Tower Fan NO.2	UHSRS	ESF	1 yr	Mild	M	I	
76	UHS-MFN-002D	D - UHS Cooling Tower Fan No.2	UHSRS	ESF	1 yr	Mild	M	I	
77	UHS-MOV-503A	A - UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
78	UHS-MOV-503B	B – UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
79	UHS-MOV-503C	C – UHS Transfer Pump Discharge Valve	UHSRS	ESF	1 yr	Mild	M	I	
80	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 10 of 11)
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
81	UHS-MOV-506A	A - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
82	UHS-MOV-506B	B - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
83	UHS-MOV-506C	C - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
84	UHS-MOV-506D	D - UHS Transfer Line Basin Inlet Valve	UHSRS	ESF	1 yr	Mild	M	I	
85	EWS-HCV-010	A - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
86	EWS-HCV-011	B - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
87	EWS-HCV-012	C - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	
88	EWS-HCV-013	D - UHS Basin Blowdown Control Valve	UHSRS	ESF	1 yr	Mild	M	I	

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CP COL 3.11(8)

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Site-Specific Environmental Qualification Equipment List

Item Num	Equipment Tag	Description	Location	Purpose	Operational Duration	Environmental Conditions	Qualification Process	Seismic Category	Comments
			PCCV, R/B, A/B, O/B, T/B, UHSRS, ESWPT	ESF, PAM, Other		Harsh or Mild	E=Electrical M=Mechanical	I, II, Non	
89	EWS-AOV-576A	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
90	EWS-AOV-576B	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
91	EWS-AOV-576C	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
92	EWS-AOV-576D	ESWP Discharge Strainer Backwash Isolation Valve to ESWS blowdown main header	UHSRS	ESF	1 yr	Mild	M	I	
93	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

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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

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SEISMIC QUALIFICATION OF CABLE TRAYS AND SUPPORTS

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3G SEISMIC QUALIFICATION OF CABLE TRAYS AND SUPPORTS

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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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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 COMPONENTS PROTECTED FROM INTERNAL FLOODING

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

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APPENDIX 3KK

MODEL PROPERTIES AND SEISMIC ANALYSIS RESULTS FOR UHSRS

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ACRONYMS AND ABBREVIATIONS

Acronyms	Definitions
3D	three-dimensional
BE	best estimate
ESW	essential service water
ESWPT	essential service water pipe tunnel
FE	finite element
FIRS	foundation input response spectra
ISRS	in-structure response spectra
LB	lower bound
OBE	operating-basis earthquake
PCCV	prestressed concrete containment vessel
R/B	reactor building
SRSS	square root sum of the squares
SSI	soil-structure interaction
UB	upper bound
UHS	ultimate heat sink
UHSRS	ultimate heat sink related structure
ZPA	zero period acceleration

3KK MODEL PROPERTIES AND SEISMIC ANALYSIS RESULTS FOR UHSRS

3KK.1 Introduction

This Appendix discusses the seismic analysis of the ultimate heat sink related structures (UHSRSs), including the ultimate heat sink (UHS) Basin and its pump house. The computer program SASSI (Reference 3KK-1) serves as the platform for the soil-structure interaction (SSI) analyses. The three-dimensional (3D) finite element (FE) models of the UHSRS used in the SASSI analysis are generated from FE models with finer mesh patterns initially developed using the ANSYS computer program (Reference 3KK-2). The coarser mesh SSI model is confirmed by comparing the structural frequencies between the SSI model mesh and the fine mesh design model. The structural frequencies are calculated from modal analysis performed in ANSYS, and the similar results ensure compatibility between the two models and indicate that the SSI model is acceptable.

Dynamic analysis is performed in SASSI to obtain seismic responses including in-structure response spectra (ISRS), maximum accelerations, and dynamic soil pressures of the structure that includes SSI effects. Response spectra analyses are performed in ANSYS to obtain seismic demands. used for design (Table 3KK-8 summarizes the analyses performed for calculating seismic demands) The SASSI analyses results for ISRS at the base slab and seismic soil pressures are used to verify the load demands assigned to the ANSYS structural design analysis that are included in the load combinations in accordance with the requirements of Section 3.8. The SASSI analysis include site-specific features such as the layering of the subgrade, embedment of the UHSRS, flexibility of the basemat and seismic motion scattering. Due to the low seismic response at the Comanche Peak Nuclear Power Plant site and lack of high-frequency exceedances, the spatial variation of the input ground motion is deemed not significant for the design of the UHSRS. Therefore, the SASSI capability to consider incoherence of the input control motion is not implemented in the analysis of the UHSRS.

3KK.2 Model Description and Analysis Approach

The SASSI FE structural model for the UHSRS is shown in Figures 3KK-1. 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 fine mesh model, or ANSYS Design Model, is a three-dimensional finite element model of the UHSRS that is used for calculation of demands for design. The model includes all relevant structural details (walls, columns, beams, major openings, masses) with adequate mesh refinement to accurately calculate member demands at critical design locations. The model includes shell elements for walls and slabs, beam elements for columns and beams, mass elements for

equipment and impulsive hydrodynamic fluid masses, and springs and mass for elements for convective hydrodynamic fluid. This model consists of approximately 29,000 shell elements, 1600 beam elements, and 57,000 nodes. The SASSI SSI Model is the model used for soil structure interaction analyses, and consists of the same makeup of elements and masses but uses a less refined mesh to reduce the analysis time.

The UHSRS model is developed and analyzed using methods and approaches consistent with ASCE 4 (Reference 3KK-3), and accounting for the site-specific stratigraphy and subgrade conditions described in Subsection 2.5.4, as well as the backfill conditions around the embedded UHSRS. The four UHSRS (per unit) are nearly identical with minor variations on backfill layout for the east and west walls. The essential service water pipe tunnel (ESWPT) is present along the full length on the south side of the UHSRS and the two structures are separated by an isolation joint. Backfill is present on the north and west sides of UHSRS B and D, and on the north and east sides of UHSRS A and C. Since the structures are otherwise identical, SSI analysis is performed only on UHSRS B/D, and the responses are deemed applicable to the other UHSRS. SSI analyses including adjacent structures was not performed because: (1) the structures are separated by an isolation joint and not directly connected and (2) the in-structure response spectra calculated in SASSI at the base slab of the UHSRS is nearly the same as the design input response spectra indicating that the SSI effects are small.

The input within-layer motion and strain-compatible backfill properties for the SASSI analysis are developed from site response analyses described in Section 3NN.2 of Appendix 3NN by using the site-specific foundation input response spectra (FIRS) discussed in Subsection 3.7.1.1. The properties of the supporting media (rock) as well as the site-specific strain-compatible backfill properties used for the SASSI analysis of the UHSRS are the same as those presented in Appendix 3NN for the reactor building (R/B)-prestressed concrete containment vessel (PCCV)-containment internal structure SASSI analyses. To account for uncertainty in the site-specific properties (as described in Appendix 3NN), three profiles of subgrade properties are considered, including best estimate (BE), lower bound (LB), and upper bound (UB). For backfill, an additional high bound (HB) profile is also used together with the UB subgrade profile to account for expected uncertainty in the backfill properties.

The following SSI analyses and site profiles are used for calculating seismic responses of UHSRS:

- a surface foundation condition (without the presence of backfill) with the lower bound in-situ soil properties below the base slab (lower bound case)
- an embedded foundation without separation of the backfill from the UHSRS exterior walls for the best estimate case
- an embedded foundation with separation of the backfill from the UHSRS exterior walls for all four soil cases, namely; LB, BE, UB, and HB

The analysis with the best estimate soil including soil separation was shown to produce the larger soil pressure and response spectra, and therefore subsequent analyses with LB, UB, and HB soil cases were performed only using soil separation to produce the bounding maximum response. The backfill separation is modeled by reducing the shear wave velocity by a factor of 10 for all soil elements adjacent to the structure within the separation depth. The factor of 10 on shear wave velocity represents a factor of 100 on soil shear modulus and Young's modulus. This value is considered adequate to reduce soil pressures sufficiently to represent soil separation. Soil pressures calculated in these layers show that very little pressure is transferred in these layers and the response will not be significantly influenced by the small pressures. The potential for separation of backfill is determined by comparing the peak envelope soil pressure results for the best estimate (BE) case to the at-rest soil pressure. Consideration of all these conditions assures that the enveloped results presented herein capture all potential seismic effects of a wide range of backfill properties and conditions in combination with the site-specific supporting media conditions. Table 3KK-10 provides the SSI analysis cases for the UHSRS.

The maximum shear wave passing frequency for all layers below the base slab and concrete fill based on layer thicknesses of 1/5 wavelength, ranges from 30.6 Hz for LB to 50.4 Hz for HB. The passing frequency for the backfill ranges from 14.7 Hz for the LB to 37.2 Hz for the HB.

The lower boundary used in the SASSI analysis is 759 feet below grade. This depth is more than twice the size of foundation plus embedment (131' x 2 + 47' = 309') recommended by SRP 3.7.2. A ten layer half-space is used below the lower boundary is 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 and it is divided by the selected number of layers in the half-space.

The cutoff frequencies for all cases are greater than 37 Hz and a minimum of 57 frequencies are analyzed for SSI analyses. The SASSI analysis frequencies are selected to cover the range between 1 Hz and the cutoff frequency. This frequency range includes the SSI frequency and primary structural frequencies. The 1 Hz lower limit was shown to be low enough to be outside the range of SSI or structural mode amplification. It was verified that as the transfer functions approached the zero frequency (static input), the co-directional transfer function approached unity while the cross-directional terms approached zero.

The UHSRS analyses were verified by the following methods:

- Comparison of eigenvalue analysis results between a coarser mesh (used for SASSI SSI analyses) and a finer mesh (used for ANSYS design analyses), the results are presented in Table 3KK-9.

Review of SASSI transfer functions to verify that interpolation was reasonable and that expected structural responses were observed. All SASSI output results were compares between soil profiles to verify reasonably similar responses between the cases.

Operating-basis earthquake (OBE) structural damping values of Chapter 3 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) for structures on sites with low seismic responses where the analyses consider a relatively narrow range of site-specific subgrade conditions. The SASSI analyses produce results including peak accelerations, in-structure response spectra, and seismic soil pressures. All results from SSI analyses represent the envelope of the six soil conditions. The SASSI analyses results are used to produce the final response spectra and provide confirmation of the design spectra and seismic soil pressures used in ANSYS.

Shell elements are used to model the basemat and brick elements are used for the concrete fill that is present beneath basemat and for the soil on the sides. Beam elements are used for the concrete beams, which support slabs and equipment in the structure, and for the concrete columns in the cooling towers. Beam elements are also used to model the steel members in the UHSRS. Shell elements are also used for the reinforced concrete walls and elevated slabs. Where shell elements and brick elements are connected, the shell element is connected to overlap a face of the brick element. There are no locations in the models where shell elements are connected perpendicularly to the brick elements with the intention of transferring moments through nodal rotational degrees of freedom. Walls are modeled using gross section properties at the centerline. All roof slabs and elevated slabs (pump room, fan slab, missile shield protection) are considered as cracked with an out-of-plane bending stiffness of ½ of the gross section stiffness in accordance with ASCE 43-05 (Reference 3KK-10). The properties assigned to the slab elements are modified to account for cracked out-of plane flexural stiffness and non-cracked in-plane axial and shear stiffness of the slabs as follows:

$$E_{cracked} = [1/(C_F)^{0.5}] \cdot E_{concrete}$$

$$t_{cracked} = (C_F)^{0.5} \cdot t$$

$$\gamma_{cracked} = [1/(C_F)^{0.5}] \cdot \gamma_{concrete}$$

where:

C_F = the factor for the reduction of flexural stiffness, taken as 1/2,

$t_{cracked}$ = the effective slab thickness to account for cracking

t = the gross section thickness

$\gamma_{cracked}$ = the effective unit weight to offset the reduced stiffness and provide the same total mass

$\gamma_{concrete}$ = unit weight of concrete

$E_{cracked}$ = effective modulus to account for the reduction in thickness that keeps the same axial stiffness while reducing the flexural stiffness by C_F.

$E_{concrete}$ = modulus of elasticity of concrete.

The above approach is conservative because slab flexural cracking results in a lower frequency which is closer to the input spectra peak and produces higher design demands. Also, flexural cracking of the slabs does not change the primary load paths for the overall structure and has negligible effect on dynamic load distribution and response.

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 50 psf on all interior surfaces above water (except inside the air-intake or the cooling tower walls at locations beneath the fan slab). 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, essential service water (ESW) pump, tile fill located below the cooling tower fans, distribution nozzles and system, fan, fan motor, gear-reducer, driveshaft, steel grating.

The hydrodynamic effects of the water contained in the basins, cooling towers, and pump room of the UHS are considered for dynamic analyses used in development of dynamic demands in accordance with requirements of SRP 3.7.3 (Reference 3KK-9). The hydrodynamic properties are calculated using the methodology specified in ACI 350.3-06 (Reference 3KK-5) and modeling is performed following the procedures of ASCE 4-98 (Reference 3KK-3). The properties calculated using ACI 350.3-06 meet or exceed relevant requirements of SRP 3.7.3. For the purposes of hydrodynamic analysis, the water is separated into rectangular regions to calculate hydrodynamic properties per ACI 350.3-06. 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, impulsive hydrodynamic mass was modeled over the entire depth of water (which represents an impulsive mass centroid located at 1/2 of the water depth), with the distribution intended to be conservative. Additional confirmatory seismic analyses were performed considering the impulsive mass distributed over a height of 3/4 of the water depth (which represents an impulsive mass centroid located at 3/8 of the water depth) in accordance with documents referenced in SRP 3.7.3

Acceptance Criteria 14 (Reference 3KK-9). The basin walls contain adequate design margins to resist demands considering either impulsive fluid mass distribution. Due to the embedment, squat dimensions, and small intensity base excitations, uplifting of this structure is not considered in the UHSRS model.

Following the recommended modeling procedures of ASCE 4-98 (Reference 3KK-3), the water mass within each region is separated into impulsive and convective components (W_i and W_c in Table 3KK-7). The impulsive mass of the water is applied to nodes of walls at each end of the rectangular region, in the direction perpendicular to the wall, and applied uniformly along the walls using directional masses from the bottom of the basin to a height of twice the impulsive pressure distribution (h_i, values in Table 3KK-7). The convective mass is included in the analysis using point masses and uni-directional springs which are attached to the end walls of each hydrodynamic region at the height of the convective pressure distribution centroid, hc (see Table 3KK-7). The mass is equal to the convective mass (W_c) noted in the attached table and the springs are assigned stiffness such that the mass-spring system has a frequency equal to the convective frequency (f_c) noted in the table. Separate mass-spring systems are provided for all hydrodynamic regions. The vertical mass of the water is distributed uniformly across the base mat using directional mass elements. Support flexibility is considered by enveloping demands of a fixed-base model and a model supported on flexible soil springs.

Response spectra analyses are performed in ANSYS (Reference 3KK-2) to obtain seismic design demands, which include all structural and hydrodynamic effects as described above. The impulsive hydrodynamic modes include the basin flexibility directly in the FE analysis. All structural and impulsive modes (frequencies > 1Hz) are assigned 5% damping. The convective modes are assigned 0.5% damping by increasing the input response spectrum for frequencies less than 1 Hz (only includes the convective modes). Modal combination is performed in accordance with RG 1.92 (Reference 3KK-6), using Combination Method B for combination of periodic and rigid modes, using the low frequency correction α=0 for frequencies below the peak of the spectra. Periodic modal response is combined using the grouping method. Spatial combination is performed using the Newmark 100-40-40 percent combination rule.

The peak sloshing height in any hydrodynamic region is equal to 1.91 ft. This height includes spatial combination of sloshing in each region using the Newmark 100-40-40 percent directional combination rule. 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.

The fine mesh ANSYS model is used for the calculation of both seismic and non-seismic demands for design. The seismic structural demands of the UHSRS are calculated from the seismic soil pressure and seismic inertia including hydrodynamic effects which are then added to all other design loads discussed in Section 3.8.4.3. Seismic inertial responses are calculated using response spectra

analyses in ANSYS using the design input response spectra based on the standard plant CSDRS anchored to 0.10 g acceleration, which envelops the site-specific FIRS spectra. Hydrodynamic effects are included in the response spectra analysis as described above except that the convective mass is included in the analysis using point masses and uni-directional springs which are attached to the end walls of each hydrodynamic region at the height of the convective pressure distribution centroid, h_c (see Table 3KK-7). The mass is equal to the convective mass (W_c) noted in the table and the springs are assigned stiffness such that the mass-spring system has a frequency equal to the convective frequency (f_c) noted in the table. Separate mass-spring systems are provided for all hydrodynamic regions.

For seismic soil pressure cases, analyzed statically in ANSYS, seismic soil pressure demands are applied to the structural elements as equivalent static pressures. The equivalent trapezoidal pressures applied are larger than the resultant pressures calculated by ASCE 4-98 elastic solution based on J.H. Wood, 1973 and the enveloped of SASSI results.

Demands calculated from the response spectra and soil pressure analyses performed in ANSYS are combined on an absolute basis to produce the maximum demands for each direction of motion.

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 results envelope all site conditions considered. 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.

The dynamic horizontal soil pressure of the backfill on the basin walls varied depending on the 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 dynamic horizontal soil pressure used for design varied linearly from a value of 0.50ksf at the base slab to 1.5ksf at soil grade. The peak dynamic soil pressure from each soil case was obtained from SASSI and compared with the dynamic soil pressure distribution applied in ANSYS. The resulting pressure distributions show that there is significant variability in the pressures determined from SASSI. The applied pressure distribution used for design analyses (based on ASCE 4 elastic methods) produced conservative moments at the base of the basin walls and approximately equal base shear when compared to the pressures calculated in SASSI. The peak design vertical soil pressure calculated under the base slab is 11.7 ksf, which reduces away from edges. This value excludes the peak corner pressure of 23.0 ksf calculated on a single element, representing less than 0.2 percent of the total

base slab area. The average peak vertical seismic pressure calculated under the base slab is 1.6 ksf.

For design of the UHSRS per the loads and load combinations given in Section 3.8.4.3, response spectra analysis is performed in ANSYS to obtain seismic demands. The eigenvalue analysis of the UHS produced more than 400 modes below 40 Hz. The modes include 16 convective fluid modes ranging from 0.16 to 0.66 Hz and the peak sloshing height in any hydrodynamic region is equal to 1.91 ft. The first three structural modes are listed in Table 3KK-9. The response spectra analysis includes sloshing effects on the basins considering 0.5 percent damping, and follows the Lindley-Yow method (Reference 3KK-8) and 10 percent modal combination method. Note that the rigid response coefficient is set to zero for frequencies below the spectral peak acceleration (2.5 Hz for horizontal directions, 3.5 Hz for vertical direction) in accordance with RG 1.92 (Reference 3KK-6). Since the sloshing modes are well separated from all structural modes, the decreased level of damping is accounted for by increasing the spectrum for frequencies below 1.0Hz (all sloshing mode frequencies are below this value and all structural mode frequencies are above 4 Hz). The spectrum is increased by a factor of 1.57, which is equal to the ratio of 0.5% damped spectral values to 5 percent damped values at 0.25 Hz based on the standard plant CSDRS (Table 3.7.1-1 of the DCD) and Table 1 of RG 1.60. An equivalent static acceleration equal to the ZPA (0.10g) which accounts for “missing mass” is also applied to the UHSRS, and the results are combined with the Lindley-Yow spectral response using SRSS. The spectra used for this approach (based on the standard plant CSDRS and RG 1.60 minimum spectra as described above) were confirmed to be higher than the enveloped base spectra calculated from the SASSI analysis.

For structural design of members and components, the design seismic forces due to three different components of the earthquake are combined using the Newmark 100 percent - 40 percent – 40 percent combination method. The walls’ shear forces were increased to account for 5 percent accidental torsion, and total base shear to be resisted by in-plane shear of the walls. Figure 3KK-2 presents the total adjusted wall seismic shear forces used for design.

The model used for response spectra seismic design analysis considered two bounding base slab behaviors; (a) flexible base slab – modeled with slab supported by using soil springs calculated using ASCE 4 (Reference 3KK-3) methodology as described in Section 3.8.4.4.3.2, and (b) rigid base slab – modeled by fixing the nodes across the base of the structure. The design analysis enveloped the demands from these two cases.

A comparison of the SASSI generated site-specific in-structure response spectra at the base slab to the ANSYS input spectra confirms that the input used for the ANSYS analyses is conservative. A comparison of the SASSI generated soil pressures with the soil pressures used for the seismic soil pressure analyses performed in ANSYS confirms that the applied loading used for design exceeds that calculated in the SASSI analyses.

The seismic 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. The seismic demands calculated using the ANSYS design model have been confirmed to exceed the demands calculated by the SASSI analysis.

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 (ISRS)

The enveloped broadened in-structure response spectra (ISRS) calculated in SASSI are presented in Figure 3KK-3 for the UHSRS base slab, pump room elevated slab, pump room roof slab, and cooling tower fan support slab for each of the three orthogonal directions (east-west, north-south, 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 include the envelope of the six site conditions (BE, LB, UB, and HB, BE without backfill separation from the structure, and the no-fill surface foundation condition with LB subgrade conditions). All results have been broadened by 15 percent and all valleys removed. 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 out-of-plane flexibility, including seismic anchor moments.

3KK.5 References

3KK-1 *An Advanced Computational Software for 3D Dynamic Analysis Including Soil Structure Interaction,* ACS SASSI Version 2.2, Ghiocel Predictive Technologies, Inc., July 23, 2007.

3KK-2 ANSYS 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 *Seismic Design of Liquid-Containing Concrete Structures and Commentary,* ACI 350.3, American Concrete Institute, Farmington Hills, Michigan, 2006.

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 Morante, R. and Wang, Y. *Reevaluation of Regulatory Guidance on Modal Response Combination Methods for Seismic Response Spectrum Analysis*, NUREG/CR-6645, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC, December 1999.

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

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	Shell
Concrete base mats	4,031	0.17	0.150	0.04	Shell
Steel beams, columns, and other structural steel elements	30,000	0.30	0.49	0.04	Beam
Concrete fill	3,125	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.

Table 3KK-2

Natural Frequencies of Dynamic FE Models

Frequency (Hz)	Percentage of Effective Mass	Comments
7.1	26%	East-West Response
7.6	19%	North-South response
20.7	0.7%	Fan Slabs out of plane response
11.5	7.0%	Pump room elevated slab out of plane response

Notes:

1) Natural frequencies and effective masses were calculated in ANSYS using the same mesh as used for SASSI analyses.
2) Effective mass is that portion of mass of the overall structure which can participate in the seismic response in the frequency range of interest (< 50 Hz). This is considered to be the mass associated with the total dynamic weight of the UHS. The weight corresponding to the effective mass is 73,400 kips.

Table 3KK-3

SASSI Results for UHSRS Seismic Response

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 because of the high stiffness of the rock and the 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 8 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 soil case. Frequencies of 7 Hz for lower bound, 11 Hz for best estimate, 14 Hz for upper bound, and 17 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 small.
Motion Scattering Effects	Motion scattering effects are inherent in the SASSI analysis results. The dynamic properties mismatch between the backfill and the rock results in reflection of the seismic waves within the backfill stratum. Consequentially, multiple modes characterize the backfill soil column and affect the UHSRS response when their frequencies are close to the structural frequencies.
Hydrodynamic Effects	The low frequencies characterize the sloshing effects of the top of the water retained in UHSRS. The lower part of the water retained in each region of the UHSRS acts rigidly with the structure. In all regions except between the baffle walls in the pump room the sloshing frequencies range between 0.16 to 0.30 Hz and the frequency of sloshing in between the baffle walls is 0.65 Hz. In general, the sloshing portion of the water mass ranges from 5-50% of the total water mass in any particular region of the UHSRS. The maximum sloshing wave height, obtained from analysis of hydrodynamic effects using the response spectrum analysis, is less than 2 ft, which is less than the available freeboard.

Table 3KK-4

SASSI FE Model Peak 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	0.11	0.11	0.12
Basin Exterior Walls	1.72	0.82	0.13
Basin Separation Wall	0.13	0.99	0.12
Pump Room Elevated Slab	0.16	0.23	0.81
Pump Room Roof Slab	0.20	0.34	0.54
Cooling Tower Fan Support Slab	0.38	0.42	1.33
Cooling Tower Roof Slab	0.56	0.46	0.25

Notes:

1) The peak accelerations presented above envelope all of the considered site conditions, i.e. UHSRS embedded in BE, LB, UB, and HB backfill with soil separation, UHSRS embedded in BE backfill without soil separation, as well as the UHSRS supported by a surface foundation.
2) The peak accelerations include amplification effects due to out-of-plane flexibility of walls and slabs.

Table 3KK-5

Maximum Component Seismic Forces and Moments at Key UHSRS Locations(1),(2),(3)

Component		Maximum component forces and moments							
		N_V (k/ft)	N_L (k/ft)	Q_V (k/ft)	Q_L (k/ft)	S_W (k/ft)	M_V (k-ft/ft)	M_L (k-ft/ft)	M_{VL} (k-ft/ft)
Basemat	+/-	159	70.1	54.5	72.6	93.3	265	332	52.4
Basin Exterior Walls	+/-	215	99.1	127	113	71.6	530	508	144
Basin Separation Wall	+/-	236	128	114	110	96.4	366	291	68.9
Cooling Tower Below Grade Exterior Walls	+/-	367	91.2	67.0	51.9	101	187	161	46.4
Pump Room Walls(4)	+/-	218	214	50.8	71.3	132	222	135	69.7
Upper Cooling Tower Walls(5)	+/-	243	152	62.8	84.3	60.2	105	147	55.5
Cooling Tower Fan Support Slabs	+/-	38.2	25.5	5.60	4.33	26.3	11.1	9.38	5.31
Pump Room Elevated Slab	+/-	91.5	25.8	16.0	12.8	30.3	30.6	16.9	8.80

Notes:

1) The forces and moments are obtained by combination of the three orthogonal directions using the Newmark 100%-40%-40% method.
2) In the table above the vertical and longitudinal directions define the plane of the walls. N stands for axial force, Q for out-of-plane shear, S_W for in-plane shear and M for moment. The M_V results in normal stresses in the vertical direction of the wall and similarly, M_L results in normal stresses in the longitudinal (horizontal) direction of the wall, and M_{VL} is the torsional moment on the wall. The Q_V is out-of-plane shear force acting on horizontal cross section of the wall, and Q_L is out-of-plane shear force acting on a vertical cross section of the wall. For slabs, the referenced “vertical” axis is oriented along the east-west direction and the longitudinal in the north-south direction
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 (4’ thick) and upper (2’ thick) walls in the pump room
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)]

Component	Maximum Displacement (inches)	Description
UHSRS South Wall	0.09	Maximum north-south displacement adjacent to ESWPT
Cooling Tower Roof Slab	0.24	Maximum horizontal displacement
Pump Room Elevated Slab	0.08	Maximum vertical (out-of-plane) displacement
Pump Room Roof Slab	0.11	Maximum horizontal displacement
Air Intake Missile Shield Top Slab	0.13	Maximum horizontal displacement
Basin Exterior Wall	0.61	Maximum out-of-plane displacement[(2)]
Basin Exterior Wall Top Corner	0.06	Maximum horizontal displacement at northeast and northwest corners

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

Table 3KK-7

UHS Hydrodynamic Properties

Hydrodynamic Region	N-S dimension (ft)	E-W dimension (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)
X1	60	75	8705	0.46	0.55	0.17	11.6	17.4
Y1	60	30	3482	0.56	0.47	0.20	11.6	18.2
X2	24	45	2089	0.68	0.37	0.24	11.6	19.7
Y2	84	45	7312	0.42	0.59	0.16	11.6	17.0
X3	44	27	3188	0.92	0.16	0.31	20.2	37.0
Y3	44	27	3188	0.82	0.26	0.24	18.6	32.6
X4	36	45	3134	0.68	0.37	0.24	11.6	19.7
Y4	36	45	3134	0.76	0.30	0.27	12.1	21.0
X5	84	45	7312	0.68	0.37	0.24	11.6	19.7
Y5	84	45	7312	0.42	0.59	0.16	11.6	17.0
X6	6	27	313	0.85	0.23	0.31	13.0	22.9
Y6	6	27	313	0.99	0.05	0.66	14.9	29.1
X7	6	27	313	0.85	0.23	0.31	13.0	22.9
Y7	6	27	313	0.99	0.05	0.66	14.9	29.1

Table 3KK-8

Summary of Analyses Performed

Model	Loading Case	Analysis Method	Program	Input	Output	Three Components Combination	Modal Combination (for Dynamic Analyses)
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	N/A
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 percent combination rule	N/A
Three-dimensional UHSRS FE Model	Seismic base spectra	Response Spectra Analysis	ANSYS	Site specific design response spectra 5% damped, modified to 0.5% damping at convective hydrodynamic modes.	Element and section demands for design	Combined by Newmark 100-40-40 percent combination rule	RG 1.92 Combination Method B

Table 3KK-9

Comparison of Major Structural Modes of UHSRS between ANSYS Design Model and SASSI SSI Model(1)

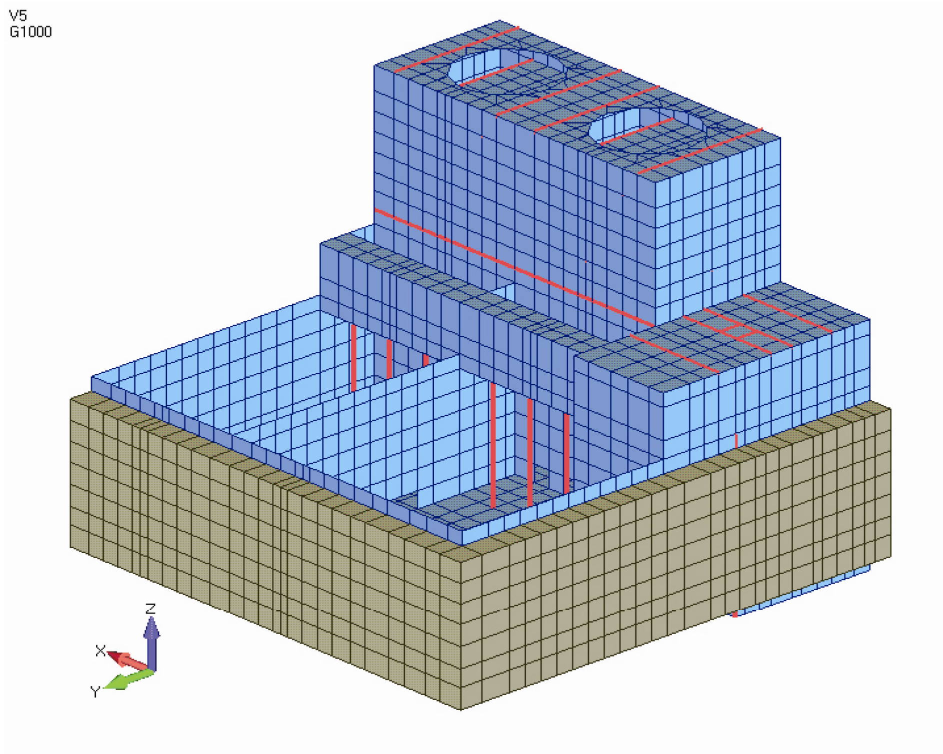
Mode	Frequency (Hz)		Modal Participation Factor (calculated per ASCE 4-98)(4)		Modal Mass Ratio	
	ANSYS Design Model(2)	SSI Model Mesh(3)	ANSYS Design Model(2)	SSI Model Mesh(3)	ANSYS Design Model(2)	SSI Model Mesh(3)
E-W, Mode 1	6.77	7.08	7.07	7.28	0.251	0.306
E-W, Mode 2	6.55	6.78	2.93	2.48	0.043	0.035
E-W, Mode 3	4.15	4.48	2.89	2.84	0.042	0.047
N-S, Mode 1	7.37	7.62	5.86	5.84	0.172	0.203
N-S, Mode 2	11.49	11.23	2.44	3.55	0.030	0.075
N-S, Mode 3	13.86	14.73	2.33	2.38	0.027	0.033
Vertical, Mode 1	17.37	17.73	2.15	2.00	0.023	0.020
Vertical, Mode 2	10.65	10.67	2.05	1.91	0.021	0.018
Vertical, Mode 3	12.88	16.89	2.04	1.90	0.021	0.018

1. All eigenvalue analyses are performed in ANSYS
2. ANSYS Design Model is the fine mesh model used to calculate demands for design
3. SSI Model Mesh is the identical mesh of the UHSRS used for SSI analysis but eigenvalue analysis is performed in ANSYS
4. Modal Participation factors reported are based on total model mass. Active mass is 87% and 50% of the total mass for horizontal and vertical directions respectively.

Table 3KK-10

SSI Analysis Cases for UHSRS

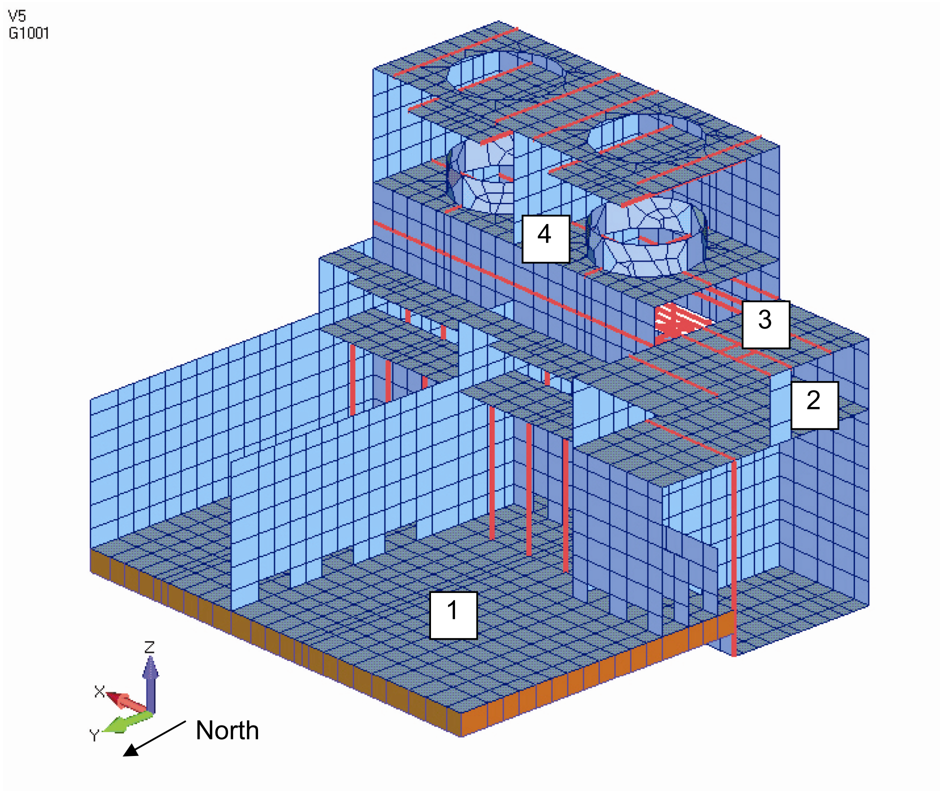
Analysis	Description	Backfill Soil	Rock Subgrade	Soil Separation
1	Best Estimate	Best estimate	Best estimate	No
2	Best Estimate Separated	Best estimate	Best estimate	Yes
3	Lower Bound Separated	Lower bound	Lower bound	Yes
4	Upper Bound Separated	Upper bound	Upper bound	Yes
5	High Bound Separated	High bound	Upper bound	Yes
6	Lower Bound No Fill	-	Lower bound	N/A



Notes:

1) The soil (backfill) elements are on the north and west faces of the structure as shown above.

Figure 3KK-1 Overall SASSI Model of UHSRS (Sheet 1 of 2)



Legend:

1 = Base Slab

2 = Pump Room Elevated Slab

3 = Pump Room Roof Slab

4 = Cooling Tower Fan Support Slab

Note: ISRS are presented in Figure 3KK-3 for the locations identified in the legend above.

Figure 3KK-1 Overall SASSI Model of UHSRS (Sheet 2 of 2, Cutaway View of SASSI Model of UHSRS)

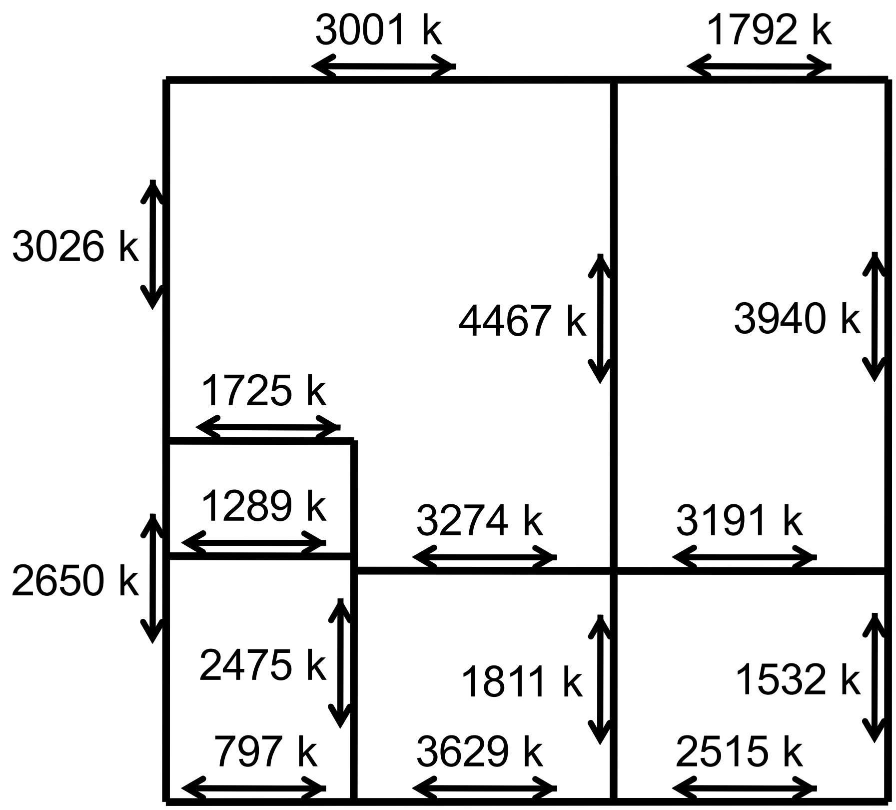


Figure 3KK-2 Wall Maximum Seismic Base Shear Forces (Sheet 1 of 2, Lower Buried UHS Basin Walls)

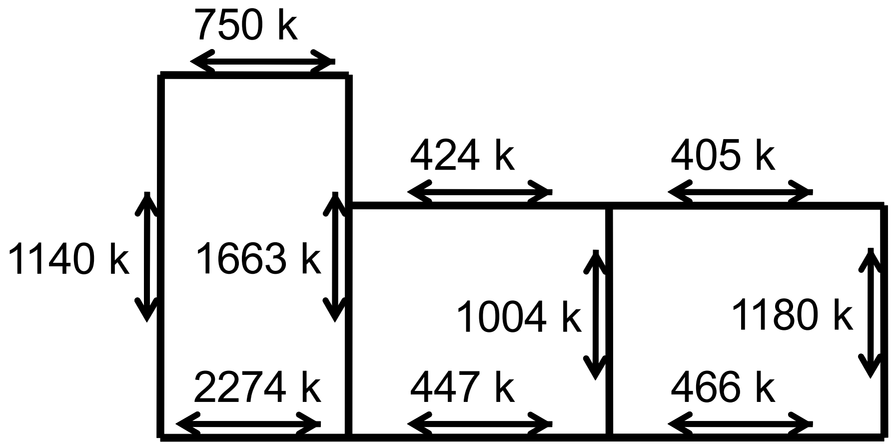


Figure 3KK-2 Wall Maximum Seismic Base Shear Forces (Sheet 2 of 2, Elevated Walls, EL. 828')

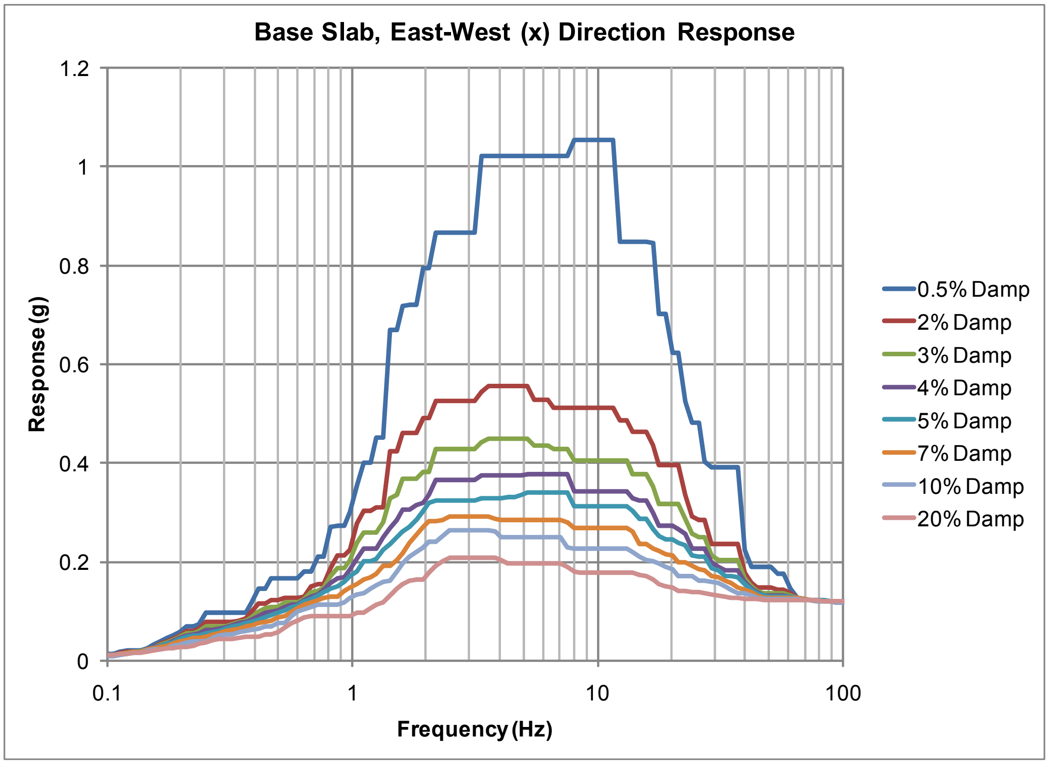


Figure 3KK-3 ISRS for UHSRS (Sheet 1 of 12)

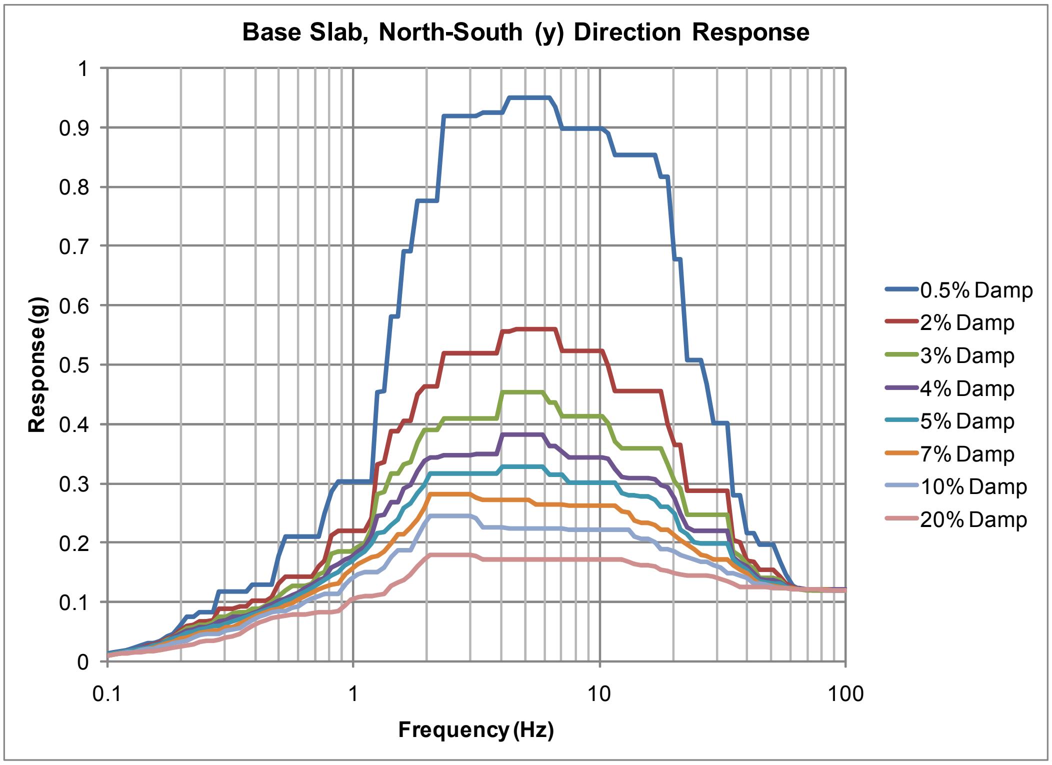


Figure 3KK-3 ISRS for UHSRS (Sheet 2 of 12)

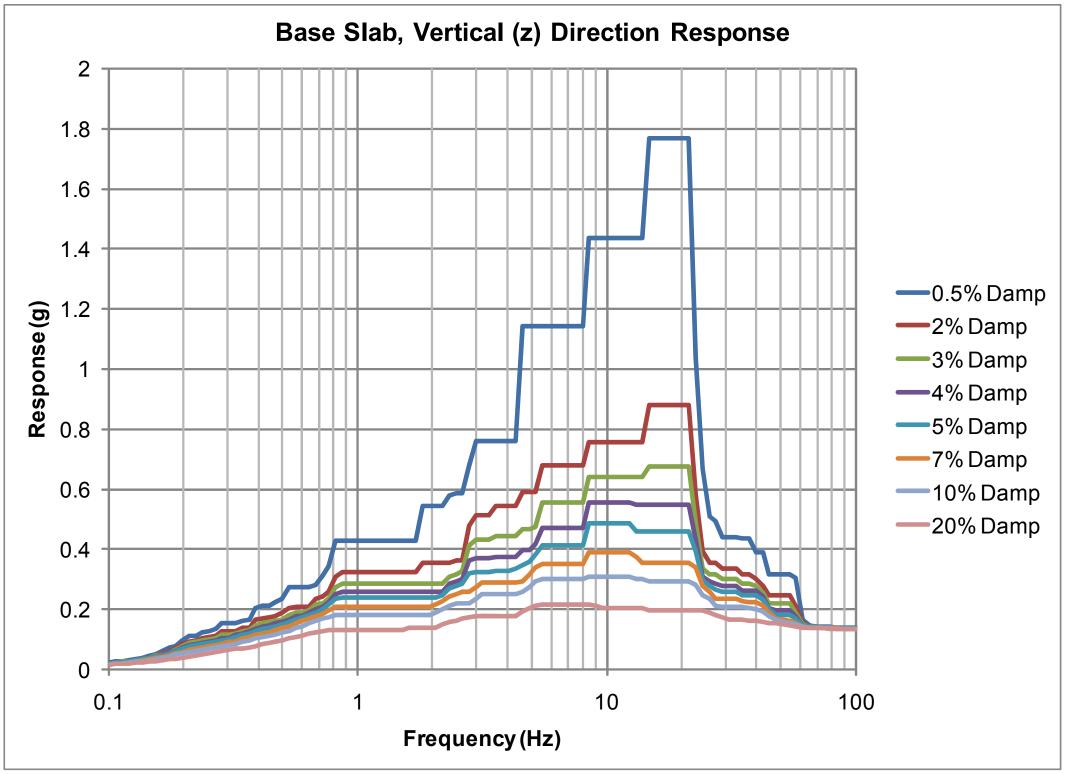


Figure 3KK-3 ISRS for UHSRS (Sheet 3 of 12)

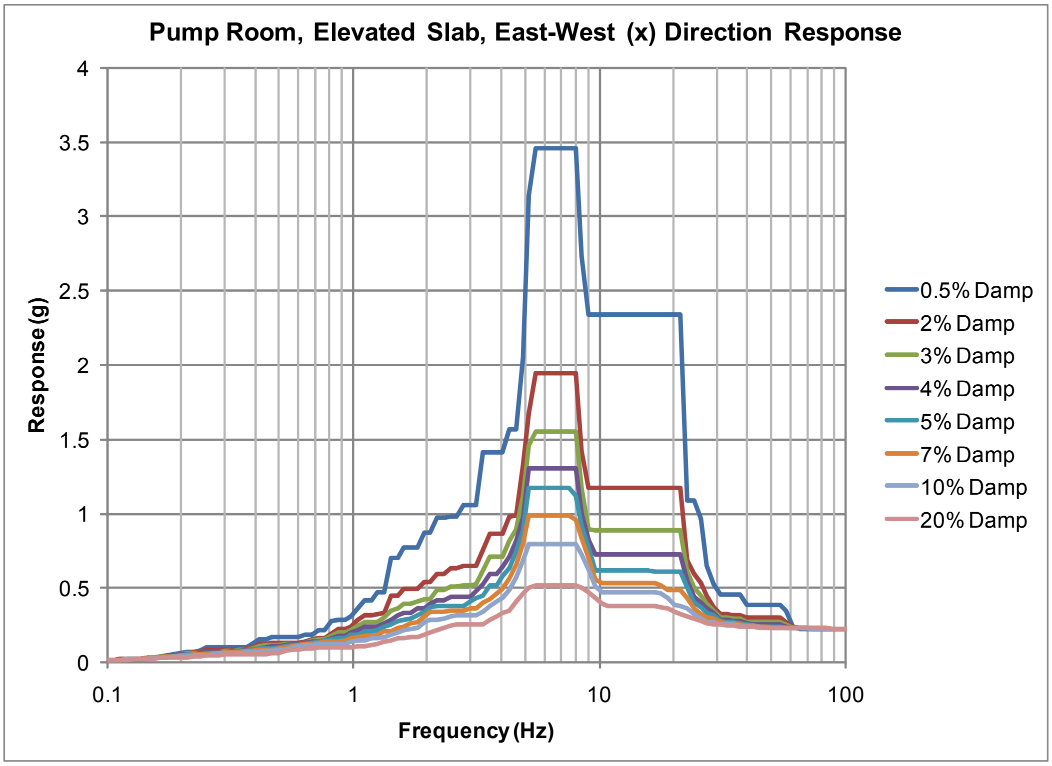


Figure 3KK-3 ISRS for UHSRS (Sheet 4 of 12)

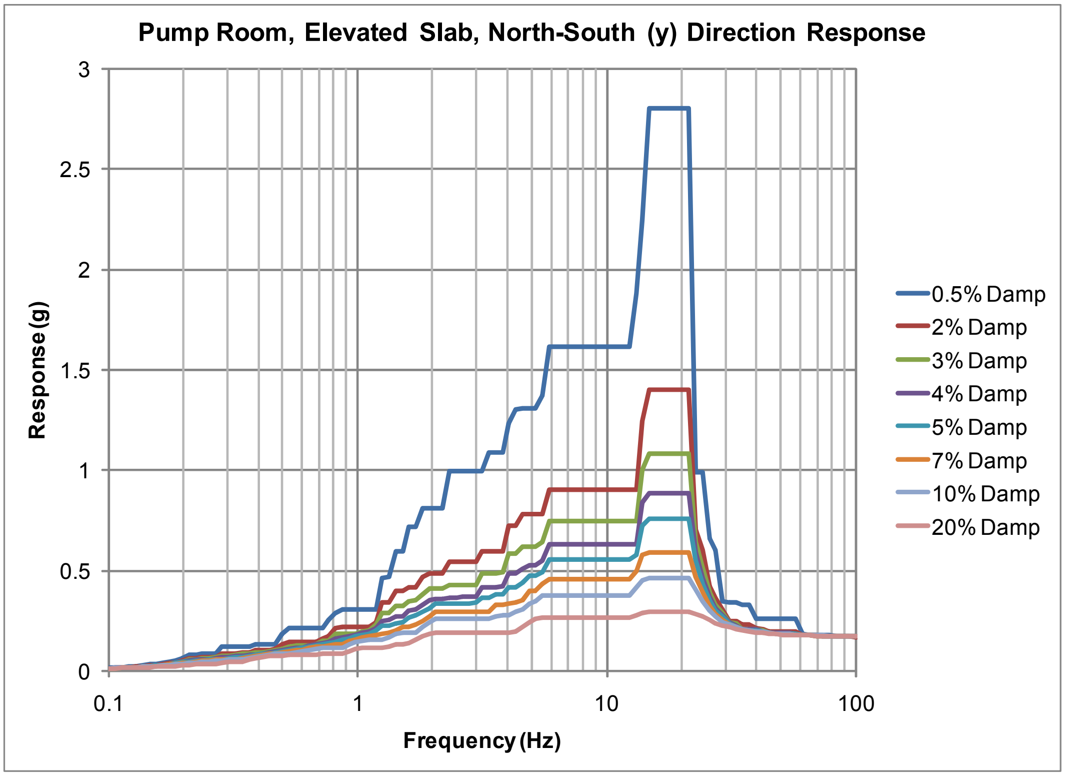


Figure 3KK-3 ISRS for UHSRS (Sheet 5 of 12)

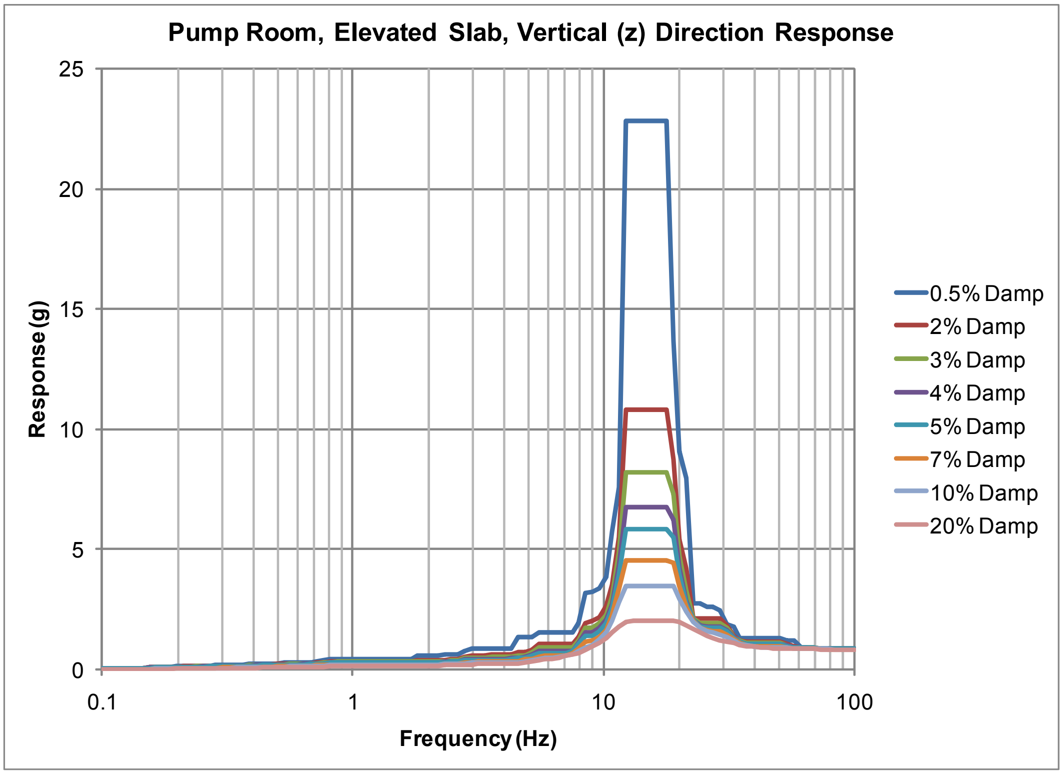


Figure 3KK-3 ISRS for UHSRS (Sheet 6 of 12)

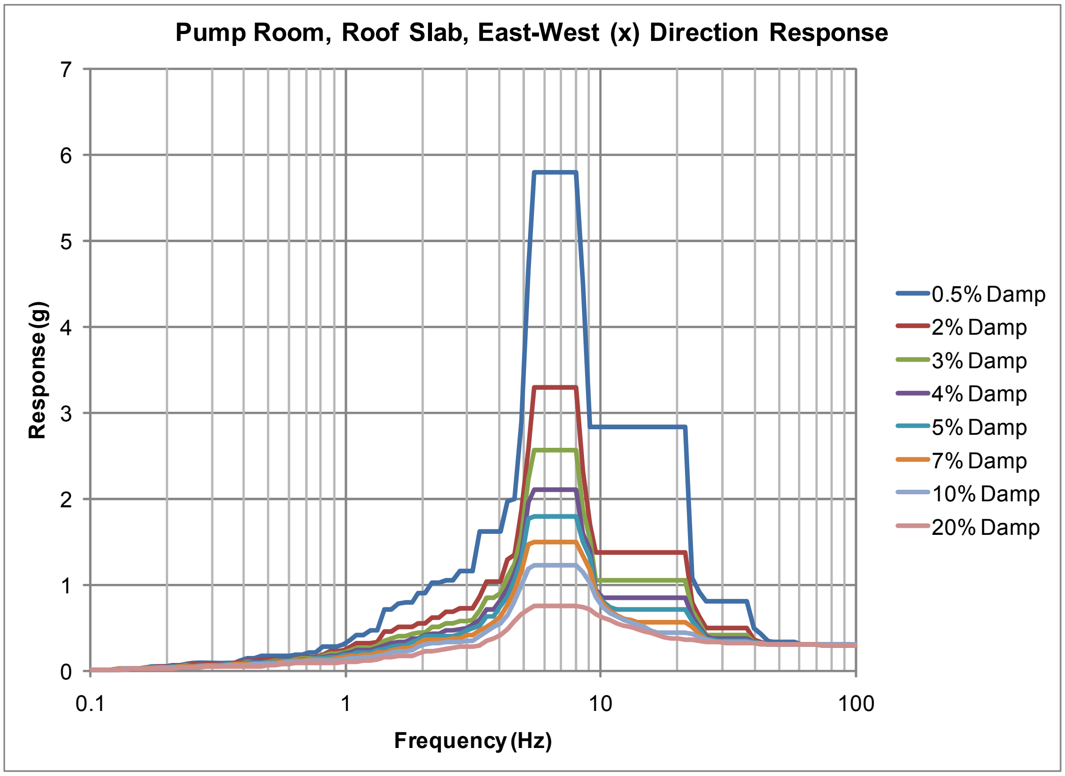


Figure 3KK-3 ISRS for UHSRS (Sheet 7 of 12)

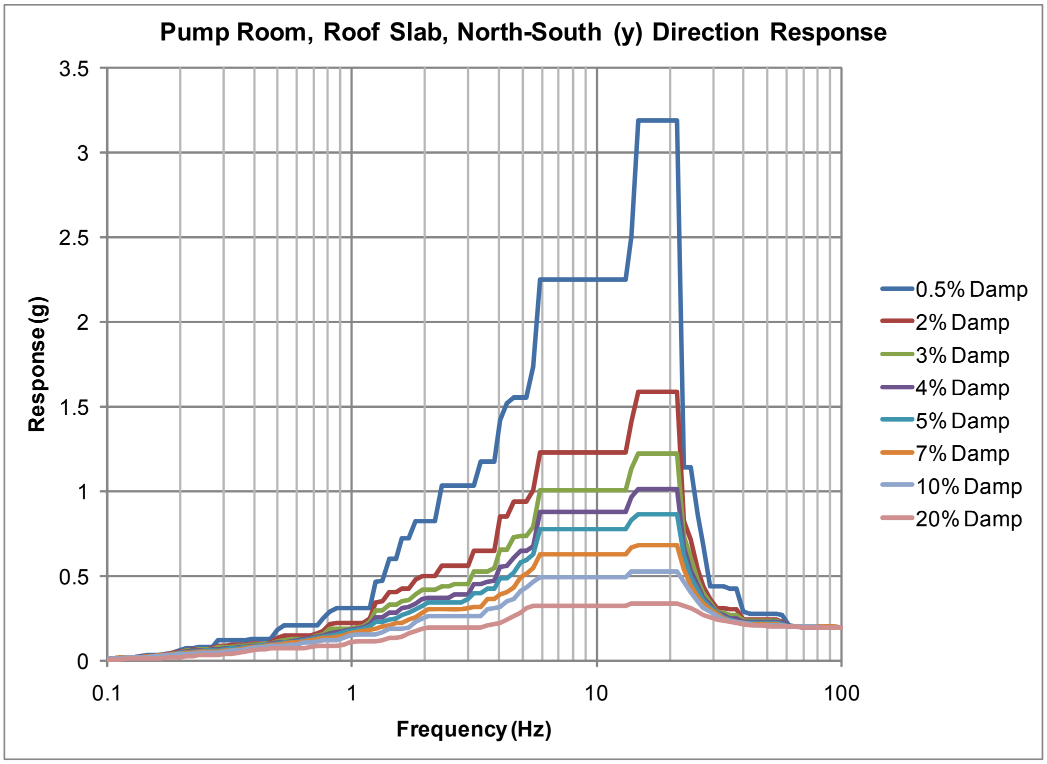


Figure 3KK-3 ISRS for UHSRS (Sheet 8 of 12)

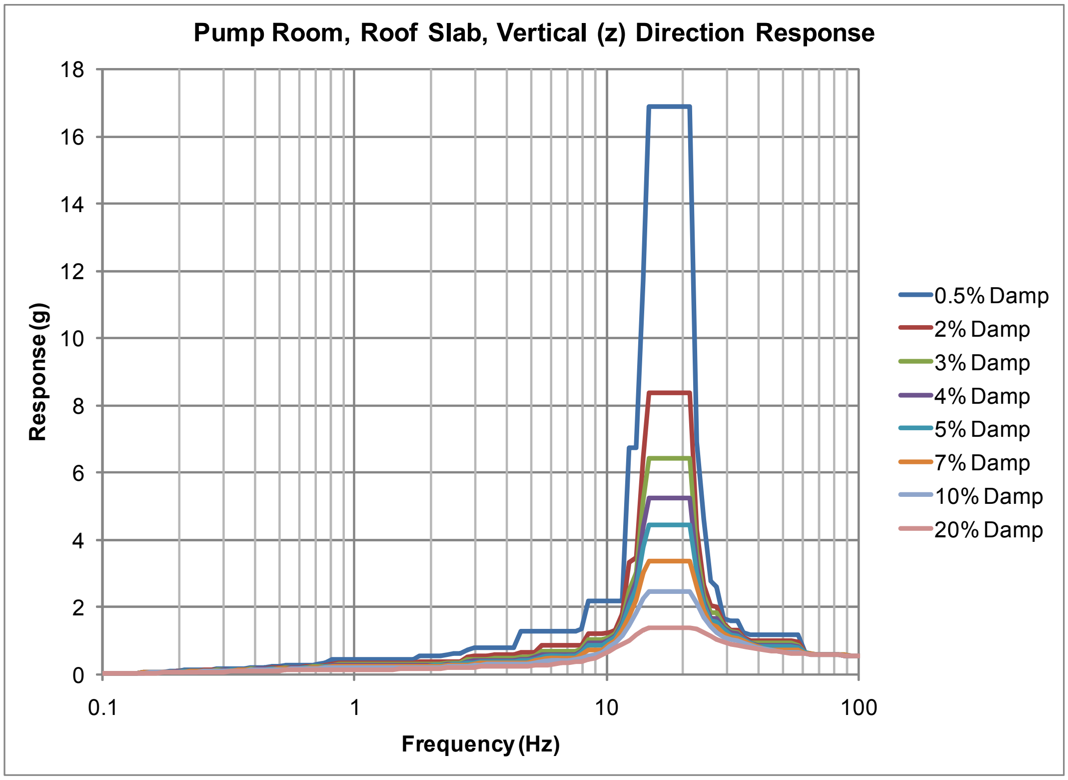


Figure 3KK-3 ISRS for UHSRS (Sheet 9 of 12)

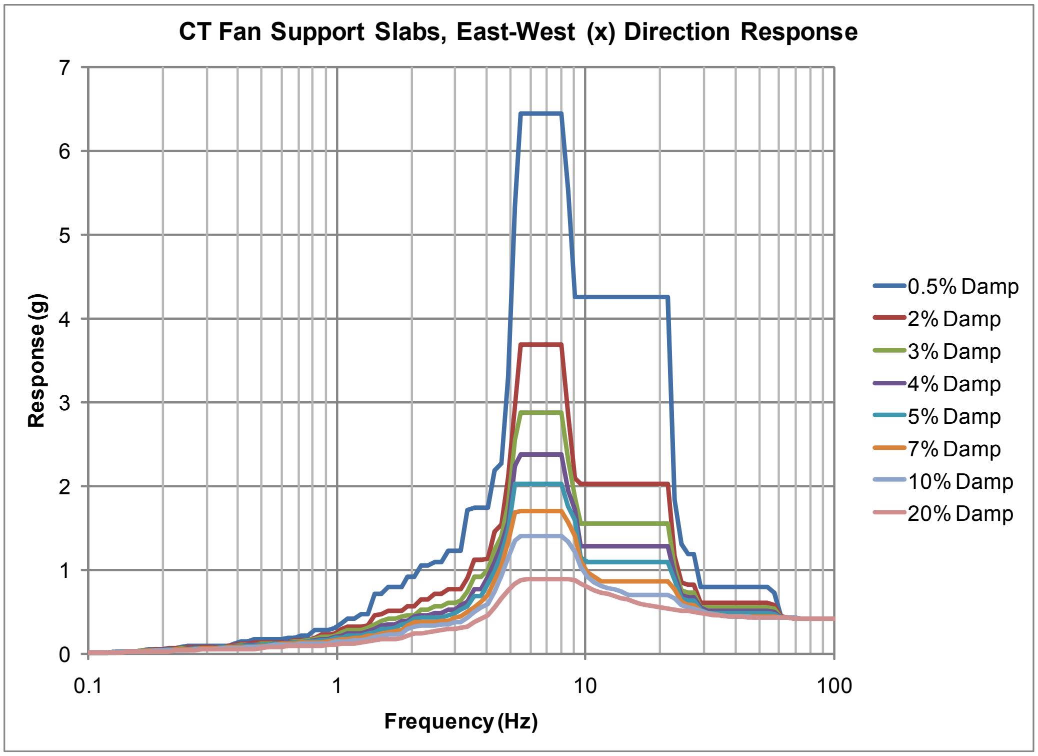


Figure 3KK-3 ISRS for UHSRS (Sheet 10 of 12)

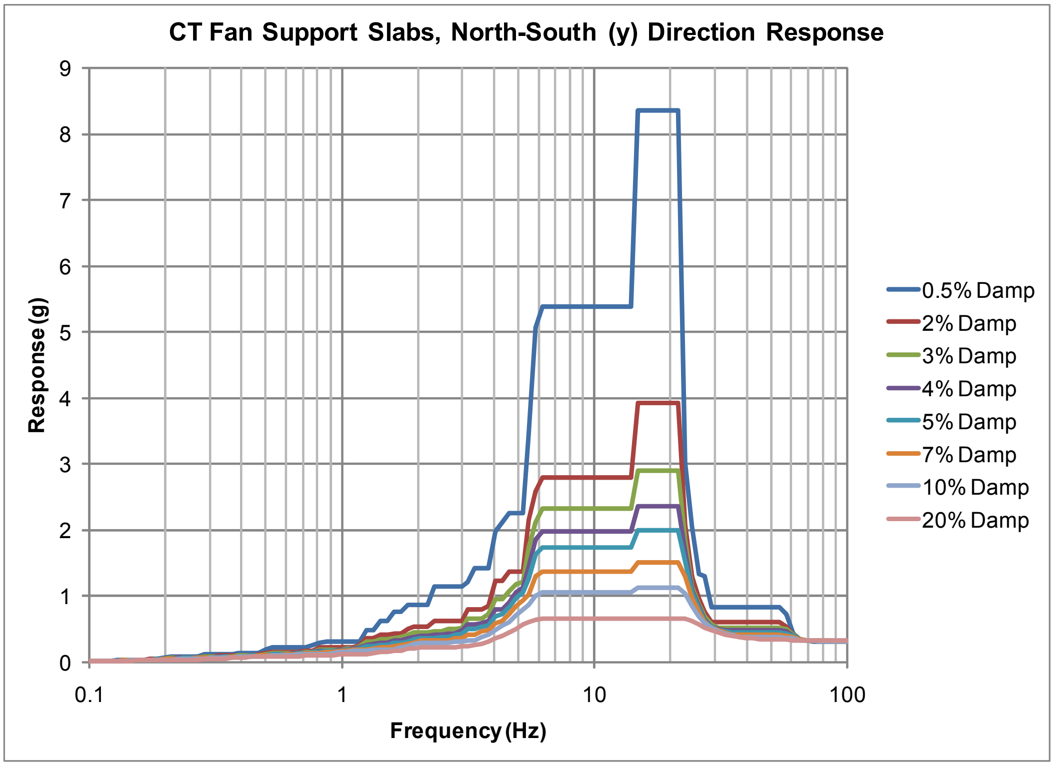


Figure 3KK-3 ISRS for UHSRS (Sheet 11 of 12)

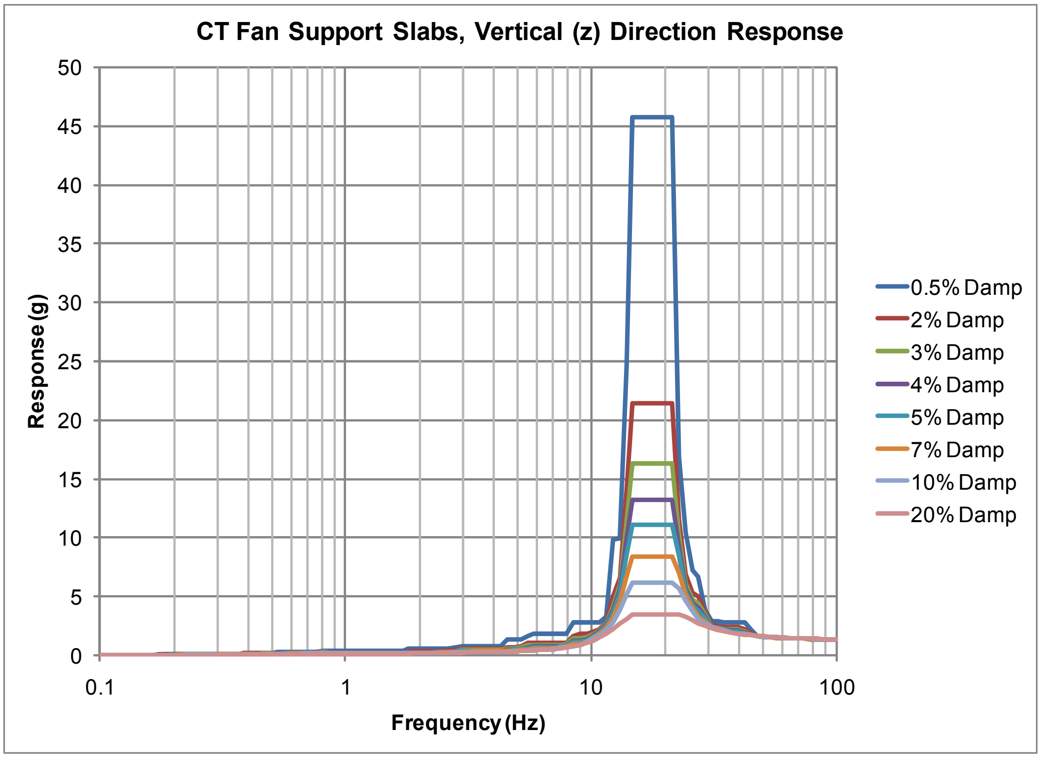
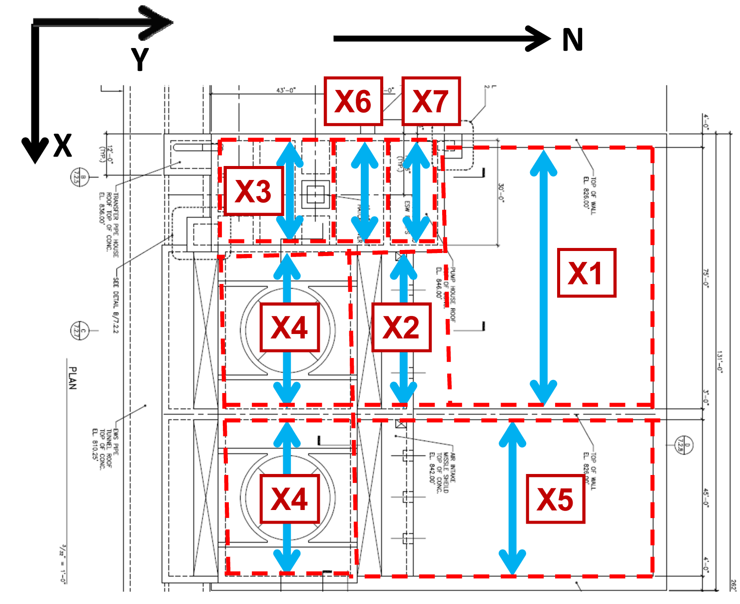


Figure 3KK-3 ISRS for UHSRS (Sheet 12 of 12)



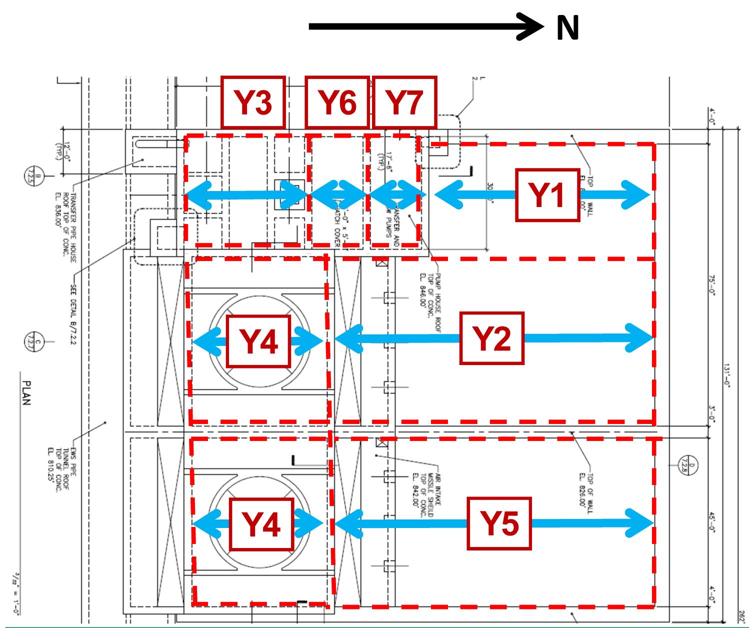


Figure 3KK-4 Rectangular Hydrodynamic Regions Used for Analysis