# Enclosure 2

## Responses to RAIs on CCNPP Unit 3 FSAR Section 3.7

| RAI Set | RAI Question No. | Response Letter | Discussed in FSAR Sections |
|---|---|---|---|
| **Requests for Additional Information on FSAR Section 3.7.1** | | | |
| 58 | 03.07.01-01 | UN#09-388 | 3.7.1<br>3.7.2 |
| | 03.07.01-02 | UN#09-320 | 3.7.1.1.1<br>3.7.2.4.7<br>3F.4 |
| | 03.07.01-03 | **This letter**<br>and<br>UN#09-364<br>UN#09-329 | 3.7.1.1.1.1<br>3.7.1.1.1.2<br>3.7.1.1.1.3<br>3.7.1.1.1.4<br>3.7.1.3.2 |
| | 03.07.01-04 | UN#09-320 | 3.7.1.1.1.1<br>3.7.1.1.1.4 |
| | 03.07.01-05 | UN#09-364 | 3.7.1.1.1.1<br>3.7.1.1.1.3<br>3.7.2.4.7<br>3F.4 |
| | 03.07.01-06 | UN#09-371 | 3.7.1.1.1.1<br>3.7.1.1.1.3<br>3.7.2.4.7<br>3F.4 |
| | 03.07.01-07 | **This letter** | 3.7.1.1.1.1<br>3.7.1.1.1.4 |
| | 03.07.01-08 | UN#09-228 | See question 03.07.01-12 |
| | 03.07.01-09 | UN#09-291 | 2.5.2, 2.5.4,<br>3.7.1 and 3.7.2 |
| | 03.07.01-10 | UN#09-388 | 3.7.1.1.2.1<br>3.7.1.1.2.2 |
| 112 | 03.07.01-11 | **This letter**<br>and<br>UN#09-388 | 3.7.1.1.1.1<br>3.7.1.1.1.2<br>3.7.1.1.1.3<br>3.7.2.4.4.2 |
| 158 | 03.07.01-12 | **This letter** | 3.7.1.2<br>3.7.2.4<br>3.7.2.5 |
| 179 | 03.07.01-13 | **This letter** | 3.7.1.1.1.2<br>3.7.1.2.2<br>3.7.1.3.2<br>3.7.2.4<br>3.7.2.5 |
| | 03.07.01-14 | **This letter** | Stand alone |

| RAI Set | RAI Question No. | Response Letter | Discussed in FSAR Sections |
|---|---|---|---|
| **Requests for Additional Information on FSAR Section 3.7.2** | | | |
| 65 | 03.07.02-1 | UN#09-228 | 3.7.2.4 |
| | 03.07.02-2 | UN#09-291 | 3.7.2.2<br>3.7.2.4<br>3.7.2.5.3 |
| | 03.07.02-3 | UN#09-291 | 3.7.2.4.6.3 |
| | 03.07.02-4 | **This letter** | 3.7.2.2<br>3.7.2.4<br>3.7.2.4.4.3<br>3.7.2.5.3 |
| | 03.07.02-5 | UN#09-291 | 3.7.2.3.2 |
| | 03.07.02-6 | **This letter**<br>and<br>UN#09-339 | 3.7.1.1.1.3<br>3.7.2.4<br>3.7.2.4.1.3<br>3.7.2.4.3.3<br>3.7.2.4.5.3 |
| | 03.07.02-7 | UN#09-291 | 3.7.2.4.3.3 |
| | 03.07.02-8 | UN#09-291 | 3.7.2.3.2 |
| | 03.07.02-9 | UN#09-126 | 3.7.2.6<br>3.7.2.8<br>3.7.2.16<br>3.7.3.12<br>3.7.3.15<br>3F.1.2<br>3F.5 |
| | 03.07.02-10 | UN#09-228 | 3.7.2.3.2<br>3.7.2.4 |
| | 03.07.02-11 | UN#09-291 | 3.7.1.1.1.1<br>3.7.2.3.2 |
| | 03.07.02-12 | **This letter** | 3.7.2.4.4.3 |
| | 03.07.02-13 | UN#09-291 | 3.7.2.4 |
| | 03.07.02-14 | UN#09-228 | 3.7.2.4 |
| | 03.07.02-15 | UN#09-320 | 3.7.2.4 |
| | 03.07.02-16 | UN#09-126 | 3.7.2.4 |
| | 03.07.02-17 | **This letter** | stand alone, also<br>Figure 3.7-1 |
| | 03.07.02-18 | UN#09-329<br>UN#09-388 | 3.7.2.8 |
| | 03.07.02-19 | **This letter** | 3.7.2.8 |
| | 03.07.02-20 | UN#09-291 | Stand alone |
| | 03.07.02-21 | UN#09-228 | 3.7.2.4 |
| | 03.07.02-22 | UN#09-126 | 3.7.2.4 |

| RAI Set | RAI Question No. | Response Letter | Discussed in FSAR Sections |
|---|---|---|---|
| | 03.07.02-23 | UN#09-291 | 3.7.2.4<br>3.7.2.15 |
| | 03.07.02-24 | UN#09-388 | 3.7.2 |
| | 03.07.02-25 | UN#09-228 | 3.7.2.9 |
| | 03.07.02-26 | UN#09-291 | 3.7.2.14 |
| 113 | 03.07.02-27 | UN#09-285 | 3.7.2.4<br>3.7.2.5.1<br>3.7.2.5.2<br>3.7.2.5.3 |
| 139 | 03.07.02-28 | UN#09-371 | 3.7.2.4 |
| | 03.07.02-29 | UN#09-371 | 3.7.2.4 |
| 159 | 03.07.02-30 | **This letter** | 3.7.2.3.2<br>3.7.2.16 |
| | 03.07.02-31 | **This letter** | 3.7.2.4<br>3.8 and App 3E (later) |
| 167 | 03.07.02-32 | **This letter** | 3.7.2.4.6.3 |
| | 03.07.02-33 | **This letter** | Stand alone |
| | 03.07.02-34 | **This letter** | 3.7.2.4<br>3.7.2.3.2 |
| | 03.07.02-35 | **This letter** | 3.8 and App 3E (later) |
| | 03.07.02-36 | **This letter** | 3.7.2.3.2 |
| | 03.07.02-37 | **This letter** | 3.7.2.5.3 |
| | 03.07.02-38 | **This letter** | Table 2.5-58<br>3.7.2.14<br>3.8 and App 3E (later) |
| 168 | 03.07.02-39 | **This letter** | 3.7.2.5.1<br>3.7.2.5.2<br>3.7.2.5.3 |
| 180 | 03.07.02-40 | **This letter** | 3.7.2.4 |
| | 03.07.02-41 | **This letter** | 3.7.2.8<br>Also<br>1.7.2, Table 3.2-1, 9.5.1.2.1, 14.3-2, ITAAC Tables 2.4-26 and 2.4-27 |

| RAI Set | RAI Question No. | Response Letter | Discussed in FSAR Sections |
|---|---|---|---|
| **Requests for Additional Information on FSAR Section 3.7.3** | | | |
| 63 | 03.07.03-01 | UN#09-320 | Stand alone |
| 181 | 03.07.03-02 | **This letter** | Stand alone |

| RAI Set | RAI Question No. | Response Letter | Discussed in FSAR Sections |
|---|---|---|---|
| **Requests for Additional Information on FSAR Section 3.7.4** | | | |
| 19 | 03.07.04-01 | UN#09-372 | 3.7.1.1.1.1 |
| 25 | 03.07.04-02 | UN#09-102 | 3.7.4.2.1 |
| | 03.07.04-03 | UN#09-102 | 3.7.4.2.1 |
| 193 | 03.07.04-04 | **This letter** | 3.7.1.1.1<br>3.7.4.4 |

**03.07.01-1**

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

**Original Response** **UN#09-388**

**Update**

The original question and the response provided in UN#09-388 are still applicable. Note that referenced section, table, and figure numbers may have changed.

Soil Structure Interaction (SSI) analyses for the Nuclear Island common basemat structures use site-specific Safe Shutdown Earthquake input motion and corresponding strain-compatible soil properties. See FSAR Sections 3.7.1 and 3.7.2.

**03.07.01-2**

Provide a figure in the FSAR depicting the soil-structure-interaction (SSI) model for the nuclear island (NI) common basemat structure including the model of the supporting subgrade.

In addition, provide the following information:

- State whether or not embedment effects were considered in this analysis and, if not, what is the justification for not including them and what impact could this have on the analysis results?
- Describe the properties of the structural backfill and how the fill was modeled in the SSI analysis.
- As the groundwater table is close to the bottom of the basemat, how are groundwater effects treated in the SSI confirmatory analysis?
- Describe the computer codes used to analyze the site-specific SSI of the NI common basemat structure including a description of the code, extent of application in the analysis, and basis for computer code validation.

  Provide similar information for the codes used in the development of foundation input response spectra for each of the seismic Category I structures, as well as for the codes used in the seismic analysis of other SSCs covered in FSAR Sections 3.7.1, 3.7.2, and 3.7.3.

**Original Response** **UN#09-320**

**Update**

The original responses provided in UniStar letter UN#09-320 with respect to the NI were stand-alone (i.e., no COLA changes) Those responses are still applicable. Note that referenced section, table, and figure numbers may have changed.

The NI SSI model is presented in the U.S. EPR FSAR in Figure 3.7.2-63. Embedment effects were not included; embedment modeling produces comparable results to in-structure response spectra generated from the surface-founded model. The NI is founded on in-situ material. Structural fill is considered in the analysis of other structures. For submerged soil layers, the water P-wave velocity (4800 fps) is used where the soil P-wave velocity is less than that of water.

The computer codes used in the analysis of the structures are now identified within the text. See FSAR Sections 3.7.1.1.1, 3.7.2.4.7 and 3F.4.

**03.07.01-3**

FSAR Section 3.7.1.1.1 (Design Ground Motion Response Spectra) starting on page 3.0-31, describes the seismic reconciliation of the certified seismic design response spectra (CSDRS) and ground motion response spectra (GMRS) for the Emergency Power Generating Buildings (EPGBs) and Essential Service Water Buildings (ESWBs). A comparison is made in Figures 3.7-35 and 3.7-36 between the three European Utility Requirements (EUR) spectra that define the horizontal and vertical CSDRS for the U.S. EPR with the horizontal and vertical site specific foundation input response spectra (FIRS) defined at grade.

- How were the FIRS at grade elevation computed from the GMRS which were determined at an elevation 12.5 m (41 ft) below grade? Include in the response, computer codes, soil column model, and the basis for the shear wave velocity of the structural backfill that supports both the EPGB and ESWB and the impact of this backfill on the development of the FIRS?
- The horizontal FIRS presented in Table 3.7-4 have a peak ground acceleration of 0.0842 g's. Appendix S to 10 CFR Part 50 states that the horizontal component of the SSE ground motion in the free field at the foundation level of a structure must be an appropriate response spectrum with a peak ground acceleration of at least 0.1 g. For both the EPGB and ESWB, provide in the FSAR the Appendix S minimum spectra at the foundation level of each structure meeting Appendix S requirements.
- Provide in the FSAR a comparison of the FIRS at the foundation level of each structure meeting the requirements of Appendix S to the CSDRS provided in the U.S. EPR FSAR.

For the nuclear island (NI) common basemat structures, a confirmatory analysis was performed to demonstrate that the seismic results using the ground motion associated with the FIRS coupled with the site specific soil profile and strain dependent soil properties were bounded by the certified design results. As the soil conditions under the EPGB and ESWB are similar to that under the NI common basemat structures and as these structures are supported on a significant depth of backfill, provide the basis for not providing a similar confirmatory analysis for the EPGB and ESWB.

**Response**

Partial responses to this question were previously provided in UniStar letter UN#09-364 (first bullet) and UN#09-329 (last paragraph). These responses are no longer applicable.

- Development of the FIRS for the EPGB and ESWB is discussed in FSAR Section 3.7.1.1.1.2.
  Soil properties are discussed in Section 3.7.1.3.2.
  Discussion of computer codes is provided in Section 3F.4.

- The SSE is defined in Section 3.7.1.1.1.1.
  The design ground motion response spectra for the EPGB and ESWB discussed in Section 3.7.1.1.1.2.

- The SSE is defined in Section 3.7.1.1.1.1.
  The design ground motion response spectra for the EPGB and ESWB discussed in Section 3.7.1.1.1.2.
  The design ground motion response spectra for the UHS Buildings is discussed in Section 3.7.1.1.1.3
  The design ground motion response spectra for the Seismic Category I buried utilities is discussed

in Section 3.7.1.1.1.4.

Confirmatory Analysis for EPGB and ESWB has been performed as described in Section 3.7.1.1.1.2.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.01-4**

In FSAR Section 3.7.1.1.1, on page 3.0-32, it discusses the design response spectrum used to analyze the Ultimate Heat Sink (UHS) Makeup Water Intake Structure. The spectral comparison between the European Utility Requirements (EUR) soft soil spectrum scaled to 0.15 g, the RG 1.60 spectrum scaled to 0.1 g, and the ground motion response spectra (GMRS) shown in Fig. 3.7-38 indicates that the RG 1.60 spectrum and GMRS exceed the EUR spectrum at frequencies below 0.7 and 0.4, respectively. What is the corresponding comparison of displacements and velocities for these spectrum motions, and if the EUR displacements are exceeded, how will this be addressed in the design of piping and other appurtenances connected to these buildings including the design of buried utilities?

**Original Response** **UN#09-320**

**Update**

The previous response provided in UN#09-320 presented draft information. That information has been finalized and incorporated into the FSAR.

See FSAR Section 3.7.1.1.1.1 for development of the Site Safe Shutdown Earthquake (SSE) and Section 3.7.1.1.1.4 for discussion of buried utilities.

**03.07.01-5**

In FSAR Section 3.7.1.1.1 on page 3.0-33, it states that the design response spectra for the Ultimate Heat Sink Electrical Building (UHS EB) is conservatively established by an envelope of half the magnitude of the EUR soft soil spectrum with a zero period acceleration (ZPA) of 0.15 g and the In-Structure Response Spectra (ISRS) developed at the operating deck of the UHS makeup water intake structure (UHS MWIS). Since this is the seismic design input for this structure, provide and include in the FSAR the horizontal and vertical spectra depicting these design spectra envelopes. In addition, provide in the FSAR a reconciliation of the design response spectrum with the horizontal foundation input response spectra (FIRS) for this structure which meets the minimum requirements of 10 CFR Part 50, Appendix S. Also, include a description of how the FIRS are developed including the soil model, soil properties, backfill properties, computer programs and analysis assumptions.

**Original Response** **UN#09-364**

**Update**

The previous response provided in UN#09-364 presented draft information. That information has been finalized and incorporated into the FSAR.

See FSAR Section 3.7.1.1.1 for development of the Site SSE, Section 3.7.1.1.1.3 for discussion of UHS EB soil properties and Section 3.7.2.4.7 and Section 3F.4 for discussion of computer codes.

**03.07.01-6**

FSAR Section 3.7.1.1.1 on page 3.0-32 states that the design response spectrum used to analyze the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) is the European Utility Requirements (EUR) soft soil spectrum scaled down to a ZPA of .15 g. The acceptability of using the scaled down EUR soft soil spectrum is based on comparison of the horizontal ground motion response spectra (GMRS) and a RG 1.60 spectrum scaled down to a zero period acceleration (ZPA) of 0.10 g. It then states that upon completion of the final geotechnical site investigation, it will be confirmed that the GMRS is a conservative representation of the foundation input response spectra (FIRS) for the UHS MWIS. The horizontal component of the FIRS for this structure must meet the requirements of 10 CFR Part 50, Appendix S and have a minimum ZPA of 0.10 g. Provide in the FSAR how the design response spectrum and assumed soil properties used in the analysis of the UHS MWIS will be reconciled with the FIRS that meets the requirements of Appendix S and the final soil properties determined from the site final geotechnical studies. Include in the FSAR a comparison of the FIRS with the design response spectrum used in the analysis. Also include a description of how the FIRS are developed including the soil model, soil properties, computer programs, and analysis assumptions.

**Original Response** **UN#09-371**

**Update**

The previous response provided in UN#09-371 presented draft information. That information has been finalized and incorporated into the FSAR.

See FSAR Section 3.7.1.1.1 for development of the Site SSE, Section 3.7.1.1.1.3 for discussion of UHS MWIS soil properties and Section 3.7.2.4.7 and Section 3F.4 for discussion of computer codes.

**03.07.01-7**

FSAR Section 3.7.1.1.1 on page 3.0-33 states that half the European Utility Requirements (EUR) soft soil spectrum will be used for analysis for the site-specific buried utilities. Provide in the FSAR a discussion of the site-specific spectrums that were considered and provide justification for the use of the EUR soft soil spectrum including possible displacement and velocity differences that may exist with the use of this spectrum as opposed to using a site specific spectrum. Also provide a comparison of the EUR soft soil spectrum with appropriate site-specific spectra that are applicable to buried utilities.

**Response**

A site specific SSE has been defined in Section 3.7.1.1.1.

The FIRS developed for the NI and Intake area are shown to be comfortably enveloped by the Site SSE. Thus the Site SSE is considered as the design motion for the seismic analysis of buried utilities. A separate response analysis for buried utilities will not be performed until detailed design as discussed in 3.7.1.1.1.4.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.01-8**

In FSAR Section 3.7.1.2 (Percentage of Critical Damping Values) provide in the FSAR the structural damping values to be used in the analysis of site-specific Seismic Category I, Seismic Category II-SSE, and Seismic Category II structures and provide the justification for the values selected.

**Original Response** **UN#09-228**

**Update**

The previous response provided in UniStar letter UN#09-228 resulted in NRC issuance of RAI 158, question 03.07.01-12. This response is superseded by the response to question 03.07.01-12.

**03.07.01-9**

FSAR Section 3.7.1.1.1, page 3.0-32 characterizes the geotechnical data as preliminary. In general, noted throughout FSAR Section 3.7 there are issues that are to be resolved in the final detailed design. It is not clear how the site-specific structures will meet the requirements of GDC 2. Provide a table that lists the items to be resolved in the final detailed design, how the items will be closed, and how these are to be incorporated into the final version of the FSAR.

**Original Response** **UN#09-291**

**Update**

The previous response provided in UniStar letter UN#09-291 is complete. That response tabulated information that needed to be developed and incorporated into the COLA.

FSAR Sections 2.5.2 and 2.5.4 have been updated, see UN#09-385 and UN#09-427. Enclosure 1 of this letter updates FSAR Section 3.7.

**03.07.01-10**

In FSAR Section 3.7.1.1.2 on page 3.0-33 a description of the design ground motion time histories are presented for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). The design ground motion time histories for the nuclear island (NI) common basemat structures, Emergency Power Generating Buildings (EPGBs), and Essential Service Water Buildings (ESWBs) are not explicitly stated or provided by reference.

What are the site specific design ground motions and their bases that apply to these structures? Provide this information in this section of the FSAR.

**Original Response** **UN#09-388**

**Update**

The previous response provided in UniStar letter UN#09-388 is still applicable. Note that referenced section, table, and figure numbers may have changed.

See FSAR Section 3.7.1.1.2.1 for the design ground motion time history for the NI common basemat, and Section 3.7.1.1.2.2 for the design ground motion time history for the EPGB and ESWB basemat.

**03.07.01-11**

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

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

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

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

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

**Response**

A partial response was provided in UniStar letter UN#09-388.

a) A Site SSE is defined in FSAR Section 3.7.1.1.1.1. This curve is a composite of the EUR soft soil spectrum anchored at 0.15g and the horizontal RG 1.69 spectrum anchored at 0.10g. The Site SSE is shown in Figure 3.7-1.

b & c) The design ground motion response spectra for the NI discussed in Section 3.7.1.1.1.1.
The design ground motion response spectra for the EPGB and ESWB discussed in Section 3.7.1.1.1.2.
The design ground motion response spectra for the UHS Buildings is discussed in Section 3.7.1.1.1.3.
The design ground motion response spectra for the Seismic Category I buried utilities is discussed in Section 3.7.1.1.1.4

d) The effect of structure-soil-structure interaction for the EPGB and ESWB are described in Section 3.7.2.4.4.2.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.01-12**

In its response the applicant stated that RG 1.61 Safe Shutdown Earthquake (SSE) damping values are used in the seismic analysis of site-specific Seismic Category I and Seismic Category II-SSE structures. This is generally acceptable for obtaining structural design loads. However, RG 1.61 states that for the generation of In-structure Response Spectra (ISRS), it is necessary to use the damping compatible structural response. The use of Operating Basis Earthquake (OBE) damping values is acceptable without further staff review. If higher than OBE values are used, RG 1.61 states that a technical justification should be provided on a case-by-case basis. Given that the Zero Period Acceleration (ZPA) of the Ground Motion Response Spectra (GMRS) for CCNPP Unit 3 is relatively low, the stress levels in the Ultimate Heat Sink (UHS) Make-up Water Intake Structure (MWIS) and UHS Electrical Building (EB) may not justify the use of SSE damping for the generation of ISRS. The applicant is requested to provide the structural damping values used for the generation of ISRS including those shown on Figures 3.7-39 through 3-41, and if SSE structural damping values were used provide a technical justification for doing so including a comparison of the stress levels in each structure to its code allowable stresses.

The applicant also stated in the response that the damping values used for site-specific Seismic Category II structures correspond to response level 3 provided in Table 3-2 of ASCE Standard 43-05. For reinforced concrete structures, the damping value from the table is 10 percent which exceeds the values provided in RG 1.61. The applicant implies in its response that the seismic Category II structure is designed to Limit State A. This appears to be in conflict with CCNPP3 FSAR Section 3.7.2.3.3. EPR FSAR Section 3.7.2.3.3 stated that "the seismic analysis and design of Seismic Category II structures and members meets the requirements for Seismic Category I structures and members." CCNPP3 FSAR Section 3.7.2.3.3 did not identify any departure from the EPR FSAR other than providing a supplemental definition of Seismic Category II-SSE structures. Therefore, it is understood that the seismic analysis and design of site-specific Seismic Category II structures would also be according to the criteria provided in this Section of the EPR FSAR. Limit State A defines a structure that is just short of collapse with large permanent distortion, and does not meet analysis and design requirements of Seismic Category I structures. Therefore, the applicant is requested to explain the apparent discrepancy and confirm that the damping values used for Seismic Category II structures are consistent with those used for Seismic Category I structures, or provide justification for not doing so.

**Response**

Part 1

Soil- Structure Interaction (SSI) analysis has been performed for the Ultimate Heat Sink (UHS) Make-up Water Intake Structure (MWIS) and UHS Electrical Building (EB). The analysis and results are provided in FSAR Sections 3.7.2.4 and 3.7.2.5.

Part 2

As described in the AREVA response to U.S. EPR FSAR RAI 155 Question 3.8.3-17, U.S. EPR certified design Seismic Category II structures, systems and components (SSCs) are not necessarily designed to Seismic Category I requirements. The U.S. EPR FSAR Subsection 3.7.2.3.3 is being updated to state that "Seismic Category II SSC will be designed and analyzed to the codes and standards associated with the conventional seismic SSC but the analyses will also consider (the) SSE event." Since the

CCNPP Unit 3 FSAR Subsection 3.7.2.3.3 does not identify any departure from the U.S. EPR FSAR, the site-specific Seismic Category II structures will be designed using conventional seismic codes and standards, but will also be analyzed for the site-specific SSE to preclude seismic interaction with Seismic Category I structures.

The seismic analysis of site-specific Seismic Category II structures will utilize damping values consistent with the guidelines provided in RG 1.61, Revision 1. CCNPP Unit 3 FSAR Subsection 3.7.1.2 is revised to delete reference to ASCE 43-05, including the damping values used in seismic analyses of Seismic Category II structures.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.01-13**

The staff reviewed the partial response to RAI No. 58, Question 03.07.01-3 submitted by the applicant in its letter UN#09-329 dated July 29, 2009. The staff's assessment only addresses the response provided by the applicant regarding the seismic analysis of the Emergency Power Generating Building (EPGB) and the Essential Service Water Building (ESWB). The other issues addressed in the original question have future response dates. In response to the question as to why a confirmatory analysis was not performed for the EPGB and ESWB, the applicant states that a site-specific analysis based on CCNPP Unit 3 site-specific design SSE response spectrum and strain compatible soil properties, including the effects of structural fill and structure-soil-structure interaction due to the Nuclear Island (NI) will be performed for these structures. The applicant is requested to provide a description of the analysis and analysis results for the EPGB and ESWB in the CCNPP FSAR including comparisons with the results (structural accelerations and in-structure response spectra) of the analyses that served as the design basis for the U.S. EPR FSAR.

**Response**

A description of the analysis and results for the Seismic Category I structures have been incorporated into FSAR Section 3.7.1 and 3.7.2. Development of the ground motion response spectra for the EPGB and ESWB is discussed in Section 3.7.1.1.1.2. Ground motion time histories are discussed in Section 3.7.1.2.2, and supporting media is discussed in Section 3.7.1.3.2. Soil-Structure interaction analysis is described in Section 3.7.2.4 and development of floor response spectra is discussed in Section 3.7.2.5.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.01-14**

As a follow-up to RAI No. 58, Question 03.07.01-2, the applicant is requested to provide the following additional information:

1. The applicant has stated that the soil-structure interaction (SSI) model used for confirmatory analysis of the NI common basemat structure is identical to the SSI model used for the US EPR FSAR (Figure 3.7.2-63 of the U.S. EPR FSAR). However, there are differences that should have been considered in the NI confirmatory analysis model for CCNPP Unit 3. These differences are:

   - Nodes used to determine structure-soil-structure interaction (SSSI) effects of the nuclear island (NI) on the response of the Emergency Power Generating Buildings (EPGB) and Essential Service Water Buildings (ESWB) should be located at the proper elevations of these structures and not at the same elevation as the NI foundation as was done in the U.S. EPR FSAR.
   - The NI is an embedded structure, not surface founded.
   - The subgrade layering at CCNPP is not the same as that used for the soft soil case for the U.S. EPR FSAR.

   The applicant is requested to explain why the confirmatory analysis model for the CCNPP Unit 3 NI did not reflect the differences cited above and what impact these differences will have on the results of the analysis.

2. The applicant has stated that a parametric analysis was performed to determine the effect of NI embedment on the seismic results for this structure. The applicant is requested to provide the details of the parametric analyses including the definition of input motion and how it was derived for the embedded model. The applicant should provide results from the parametric analyses and provide a comparison to results for the surface founded NI seismic model.

3. The applicant has stated that the NI common basemat structure confirmatory SSI analysis is based on undisturbed in-situ material. Discrete thin strata or localized areas of the foundation bearing soils may be encountered during construction that do not meet the COLA required soil properties. In the event substandard materials are encountered the applicant has stated they will be replaced with engineered structural fill that has characteristics comparable to the site soil properties of the undisturbed material considered in the analyses, or a site-specific validation will be performed. Unless the proposed construction methods will make use of excavation support systems considering vertical cuts with rigid vertical walls providing excavation support, it is anticipated that excavation will extend to some potentially significant area to the sides of the NI. Therefore, even if soft soils are not encountered below the foundation of the NI, fill materials will impact the SSI evaluation. If only top-down excavation methods with vertical excavation support are to be used, the CCNPP FSAR should so state. If backfill will be used to the side of the NI, the methods that will be used to assess the impact of fill on the SSI process need to be provided. If fill materials are to be used to the side of the NI, the potential impact of this fill on the seismic response of safety related structures adjacent to the NI, including potential two- and three-dimensional effects on the SSI, needs to be described.

4. In response to a question regarding how groundwater effects are treated in the SSI

confirmatory analysis the applicant stated that for submerged soil layers, the water P-wave velocity (4800 fps) is used where the soil P-wave velocity is less than that of water. However, if the groundwater (GW) table is close to the foundation elevation, the soils above and below the GW elevation will be represented by different S-wave and P-wave parameters. Such a two-layer configuration was not included in the U.S. EPR site configuration profiles for the generic design. The applicant should provide an explanation of how this potential discontinuity in velocities impact the SSI evaluations and how they compare with those developed for the generic design.

5. The applicant has stated that two computer codes, SOILSIM and RVTSITE were used in the development of the FIRS for the Seismic Category I structures. The current NRC Interim Staff Guidance and NEI guidance document that summarize the processes to be used for transfer of probabilistic ground motions to different elevations in the soil column refer to the time-domain SHAKE code and not the RVTSITE apparently based on random vibration theory. The applicant should provide information on the appropriateness of using this model for site response analyses and compare its application to that of SHAKE.

6. The Risk Engineering Code SOILSIM has embedded within it an assumed layer correlation model for the randomization of site soil columns from which the BE, UB and LB soil columns used in the SSI calculations are determined as well as the corresponding GMRS and FIRS spectra. The applicant should provide information on the adequacy of this correlation model for the soil conditions at the CCNPP site, provide plots of velocity versus depth for each of the randomized soil columns used to develop the GMRS and indicate whether or not the resulting site columns are appropriate for the geotechnical/geological site data available and whether this correlation model reduces the computed FIRS and GMRS spectra as compared to other correlation models that can be assumed to be appropriate.

**Response**

1) The confirmatory site-specific SSI analyses performed for the Nuclear Island (NI) common basemat structures for CCNPP Unit 3 did not reflect explicitly the differences in elevation of adjacent structures and embedment effects. Confirmatory site-specific SSI analyses were performed based on the same SSI model (surface-founded stick model) used in the U.S. EPR FSAR with the site-specific strain-compatible soil profiles and site-specific safe shutdown earthquake (SSE) See the response to RAI 58, Question 03.07.01-1 in letter UN#09-388.

   The impact of these differences on the results of the parametric analysis is provided in Response 2 below.

2) For the embedded stick model of the NI common basemat structures, the generic soil profiles (used in the U.S. EPR FSAR) are extended 11.85m from the base of the structure (Elevation -11.85m) to the ground surface (Elevation – 0.0m). Three sets of three-component reference soil/rock outcrop motions corresponding to the bottom of the NI common basemat are specified in the U.S. EPR FSAR. For the embedded model, a set of three-component ground motion input are calculated at the free-field ground surface (Elevation 0.0m) from one-dimensional site response analyses (SHAKE) assuming that the reference motions correspond to the hypothetical soil/rock outcrop at the bottom of the NI common basemat (Elevation -11.85m). Results of analysis of the embedded model versus surface-founded model for Soil

case 1u (representative of the CCNPP Unit 3 soil profile) were compared. A comparison of response spectral accelerations at some of the key locations of the NI is shown in the attached figures 3.7.1-14-1A through 4C. The comparisons show that the response spectra generated from the embedded model are comparable to the surface-founded model and the peak ground accelerations are also enveloped.

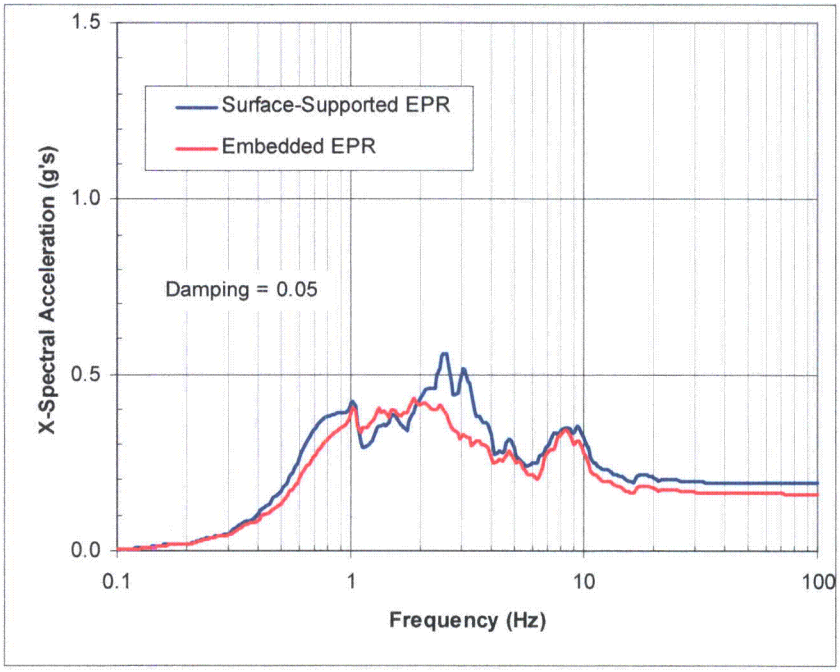



**Figure 3.7.1-14-1A: Comparison of Spectral Acceleration Response, X-Direction, RBIS at El. 5.15m, Node 1033 (Soil Case 1u/1ue, EUR Soft Motion)**

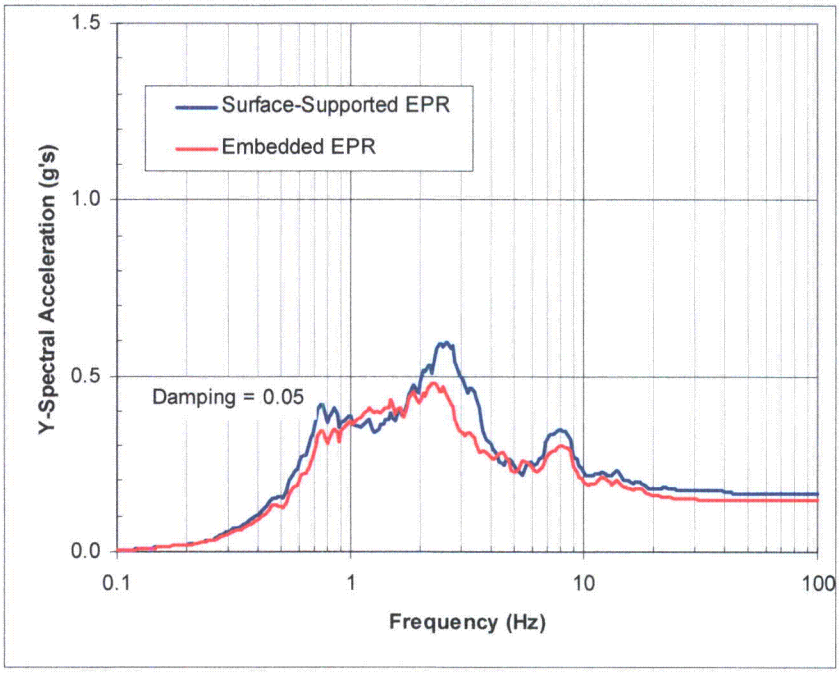



**Figure 3.7.1-14-1B: Comparison of Spectral Acceleration Response, Y-Direction, RBIS at El. 5.15m, Node 1033 (Soil Case 1u/1ue, EUR Soft Motion)**

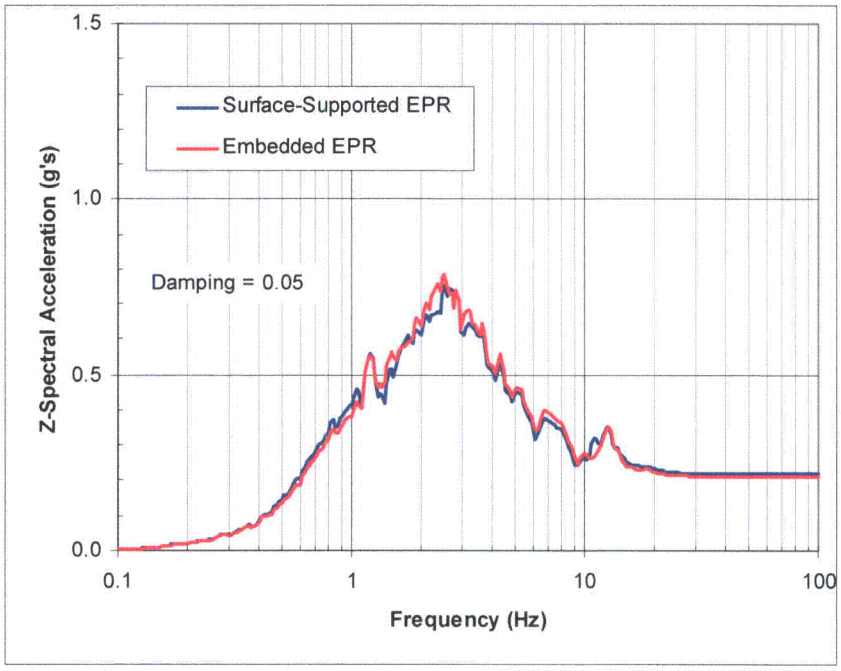



**Figure 3.7.1-14-1C: Comparison of Spectral Acceleration Response, Z-Direction, RBIS at El. 5.15m, Node 1033 (Soil Case 1u/1ue, EUR Soft Motion)**

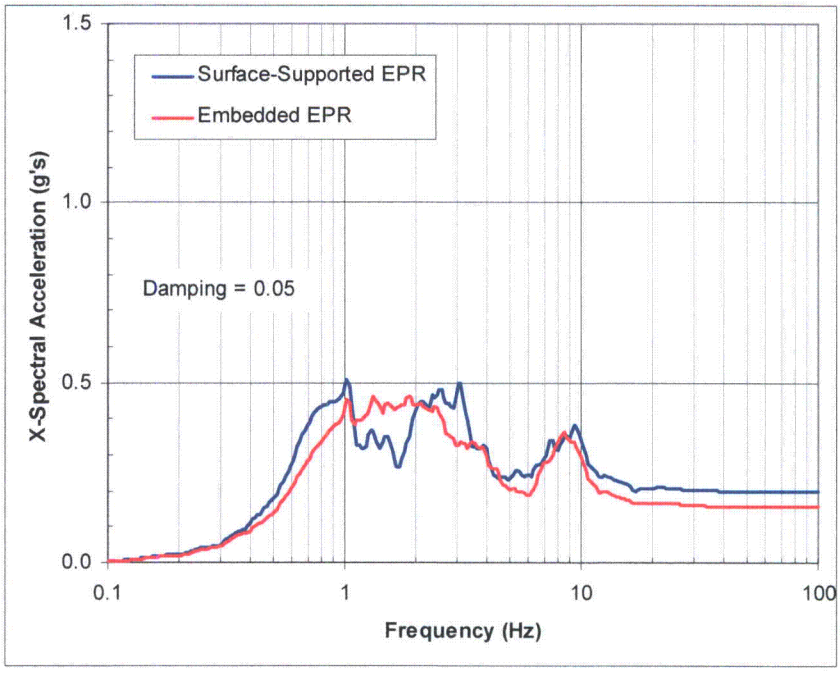



**Figure 3.7.1-14-2A: Comparison of Spectral Acceleration Response, X-Direction SB1 at El. 21.0m, Node 4073 (Soil Case 1u/1ue, EUR Soft Motion)**

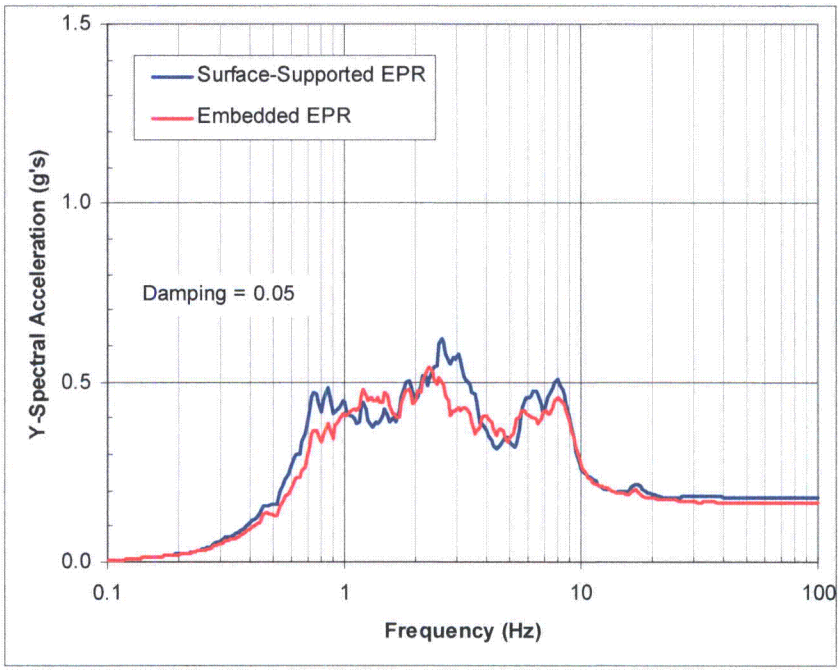



**Figure 3.7.1-14-2B: Comparison of Spectral Acceleration Response, Y-Direction SB1 at El. 21.0m, Node 4073 (Soil Case 1u/1ue, EUR Soft Motion)**

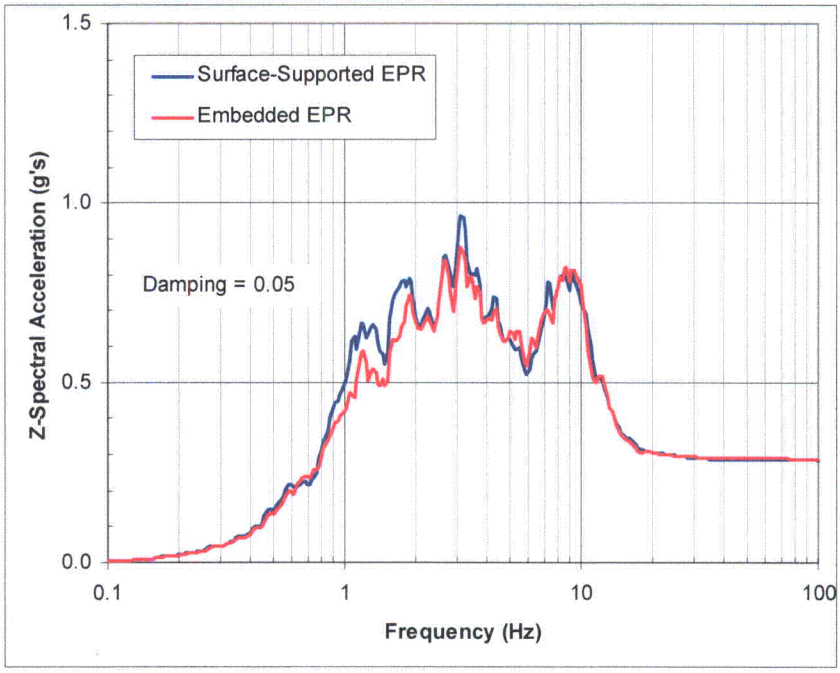



**Figure 3.7.1-14-2C: Comparison of Spectral Acceleration Response, Z-Direction SB1 at El. 21.0m, Node 4073 (Soil Case 1u/1ue, EUR Soft Motion)**

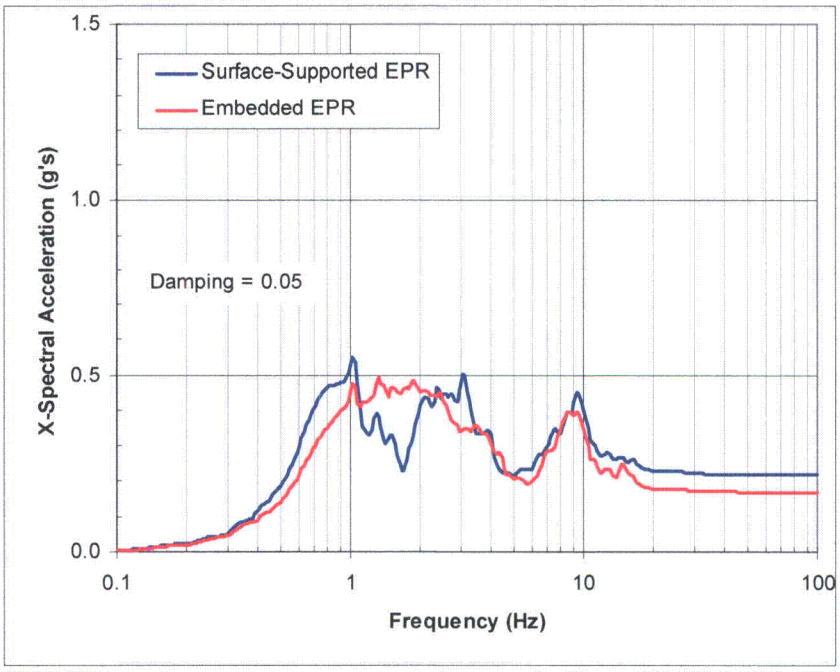



**Figure 3.7.1-14-3A: Comparison of Spectral Acceleration Response, X-Direction SB4 at El. 29.3m, Node 7093 (Soil Case 1u/1ue, EUR Soft Motion)**

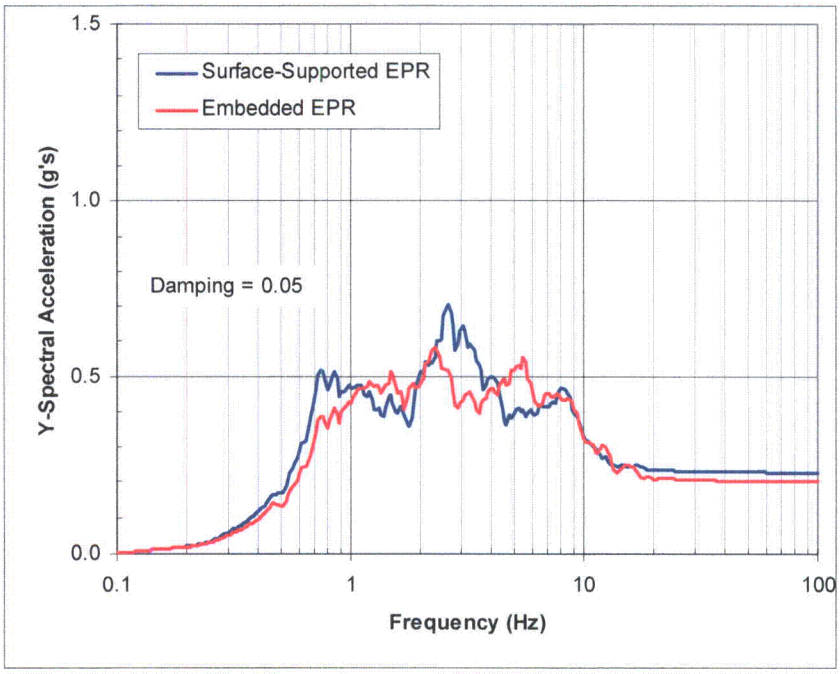



**Figure 3.7.1-14-3B: Comparison of Spectral Acceleration Response, Y-Direction SB4 at El. 29.3m, Node 7093 (Soil Case 1u/1ue, EUR Soft Motion)**

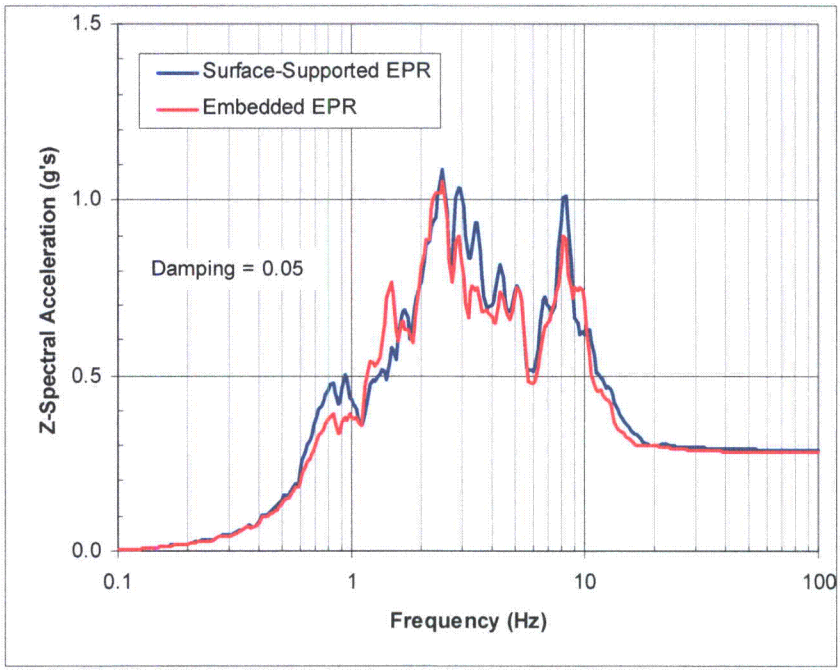



**Figure 3.7.1-14-3C: Comparison of Spectral Acceleration Response, Z-Direction SB4 at El. 29.3m, Node 7093 (Soil Case 1u/1ue, EUR Soft Motion)**

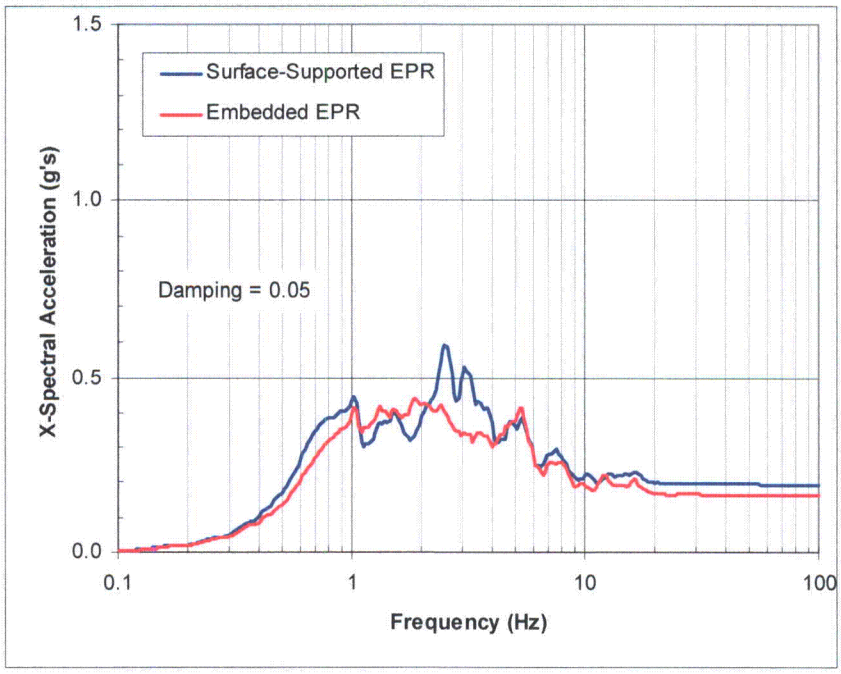



**Figure 3.7.1-14-4A: Comparison of Spectral Acceleration Response, X-Direction FB at El. 3.7m, Node 8043 (Soil Case 1u/1ue, EUR Soft Motion)**

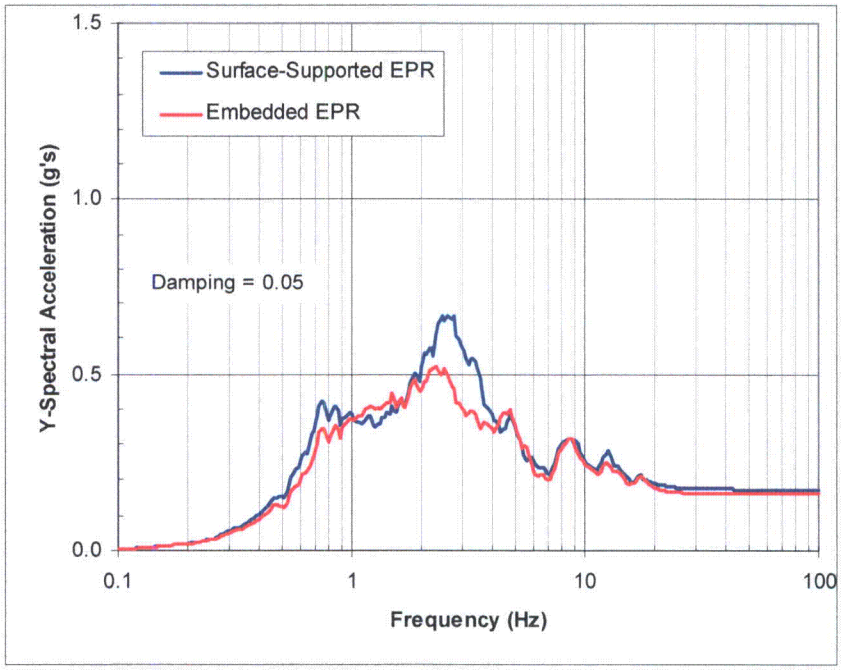



**Figure 3.7.1-14-4B: Comparison of Spectral Acceleration Response, Y-Direction FB at El. 3.7m, Node 8043 (Soil Case 1u/1ue, EUR Soft Motion)**

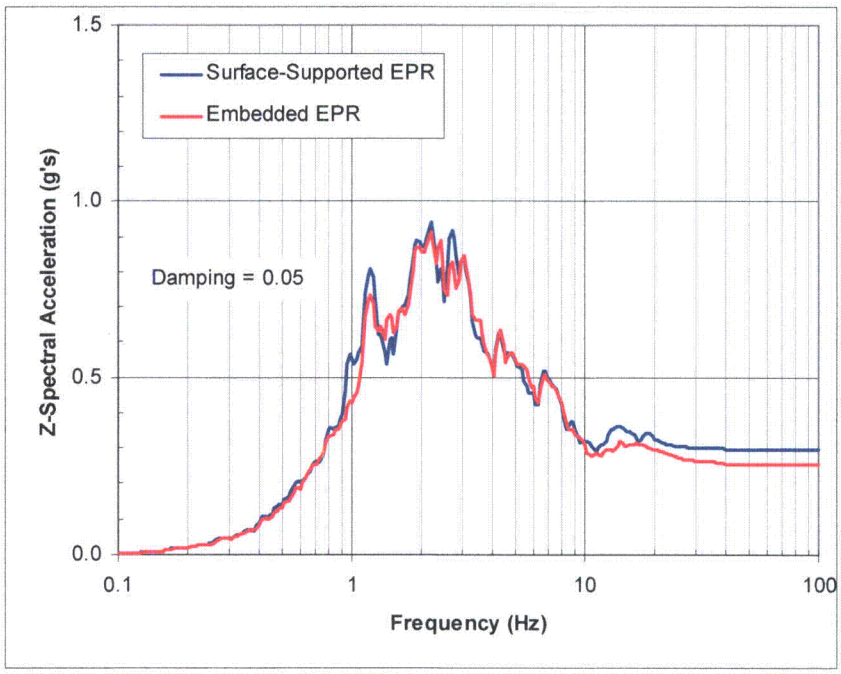



**Figure 3.7.1-14-4C: Comparison of Spectral Acceleration Response, Z-Direction FB at El. 3.7m, Node 8043 (Soil Case 1u/1ue, EUR Soft Motion)**

3) The planned open-cut excavation for CCNPP Unit 3 is shown in FSAR Figures 2.5-160 – 165 (see UN#09-427). A lean concrete fill (2500 psi strength) is planned under the NI basemat. At the sidewalls, an engineered structural backfill will be used. The properties are described in Section 2.5.4.2.4. Compaction requirements for the sidewalls backfill is discussed in Section 2.5.4.5.3. The impact of the fill, which provides embedment, on the SSI and SSSI methodology for the parametric analysis is discussed in answers (1) and (2) above. Answers to (1) and (2) above also show that backfill will not have any impact on the results of the seismic analysis; the backfill, in fact, provides the embedment feature analyzed in the responses above.

4) The groundwater (GW) table was assumed to be at grade for the surface-founded SSI analysis model used in the site-specific CCNPP Unit 3 confirmatory analysis. A parametric study to assess the effects of variation of GW table was conducted for the CCNPP Unit 3 site-specific parameters. Two SSI analysis cases with different WT elevations were run: (1) CCNPP Unit 3 Best Estimate Soil with water table 4.27m (14 ft) below bottom of basemat, and (2) CCNPP Unit 3 Lower Bound Soil with water table 8.84m (29 ft) below bottom of basemat. The location of the WT was selected considering the CCNPP Unit 3 normal WT elevation. The modeling of GW table was achieved by assigning the water P-wave velocity (4,800 fps) to the submerged soil layers if the soil P-wave velocity of the soil is less than that of water. Above the water-table actual P-wave velocity of dry layers was used, thus introducing a discontinuity in the P-wave velocity profile.

Results from this parametric study indicate that the variation of the GW table elevation does not significantly impact the site-specific seismic responses such as the in-structure response spectra (ISRS) at key locations of the Nuclear Island common basemat structures. The conclusion that the standard design bounds CCNPP Unit 3 remains valid. A comparison of the ISRS for the Reactor Building Internal Structure (RBIS) and Safeguard Building 1, for example, is shown in the attached figures.

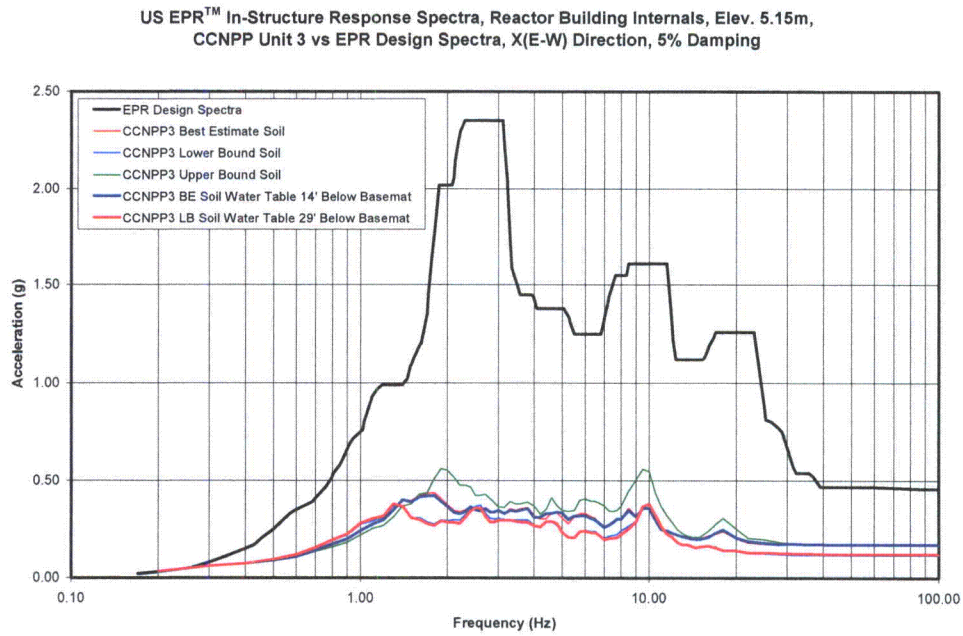



**Figure 03.07.01-14.4A: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Reactor Building Internal Structure, Elev. 5.15m, X (E-W) Direction, 5% Damping**

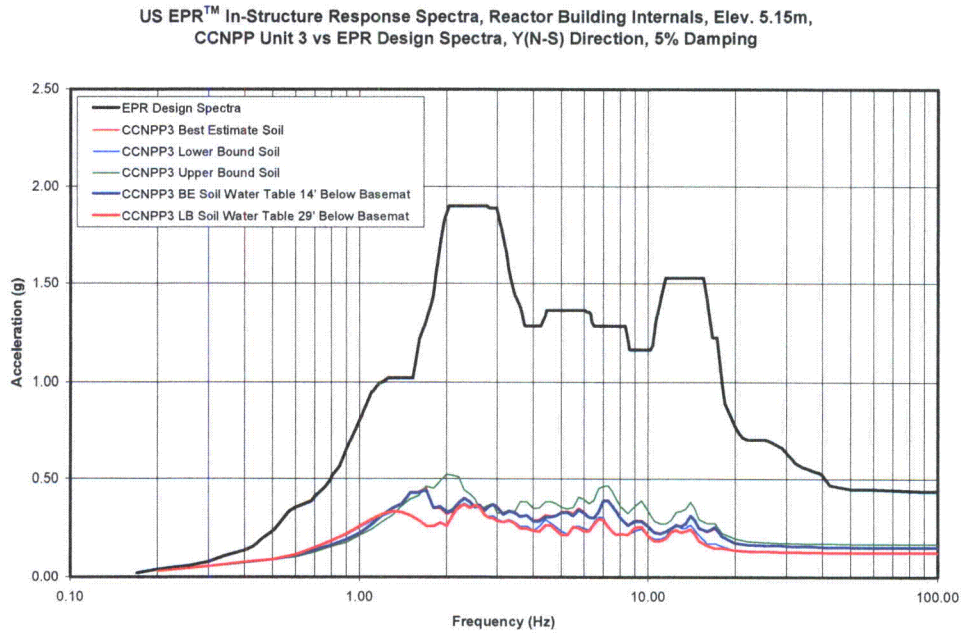



**Figure 03.07.01-14.4B: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Reactor Building Internals, Elev. 5.15m, Y (N-S) Direction, 5% Damping**

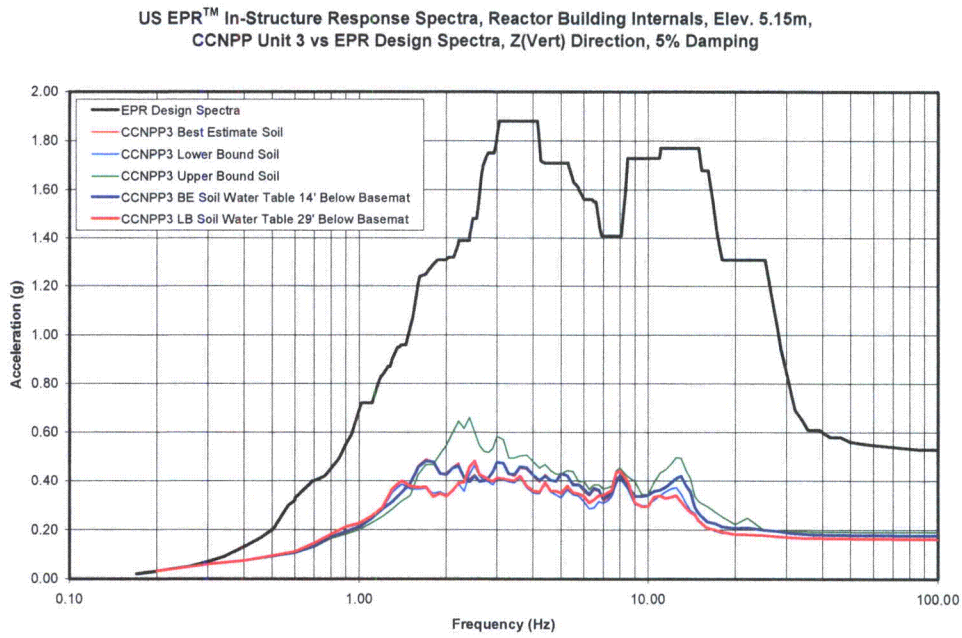



**Figure 03.07.01-14.4C: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Reactor Building Internal Structure, Elev. 5.15m, Z (Vert) Direction, 5% Damping**

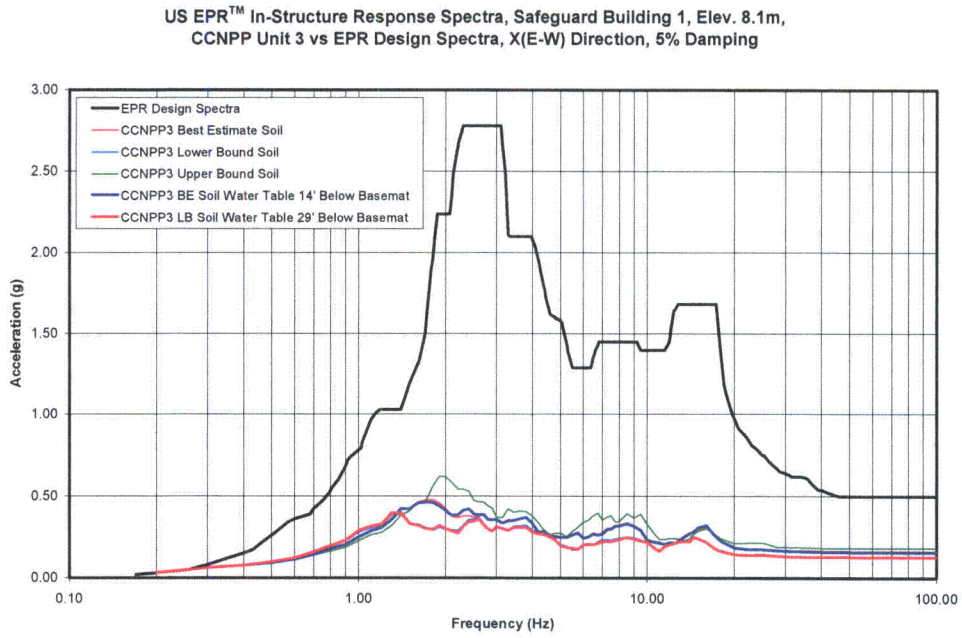



**Figure 03.07.01-14.4D: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Safeguard Building 1, Elev. 8.1m, X (E-W) Direction, 5% Damping**

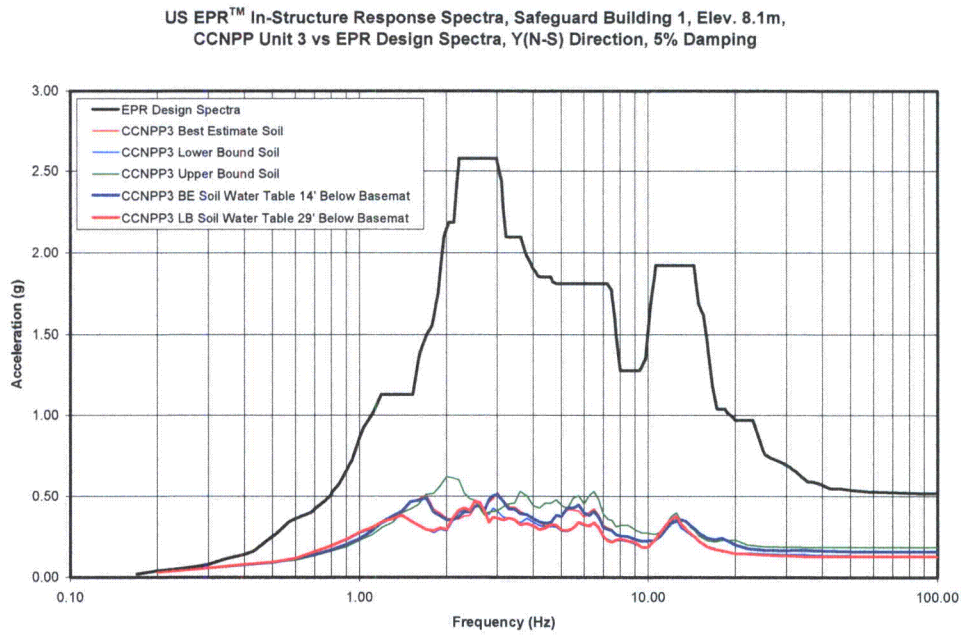



**Figure 03.07.01-14.4E: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Safeguard Building 1, Elev. 8.1m, Y (N-S) Direction, 5% Damping**

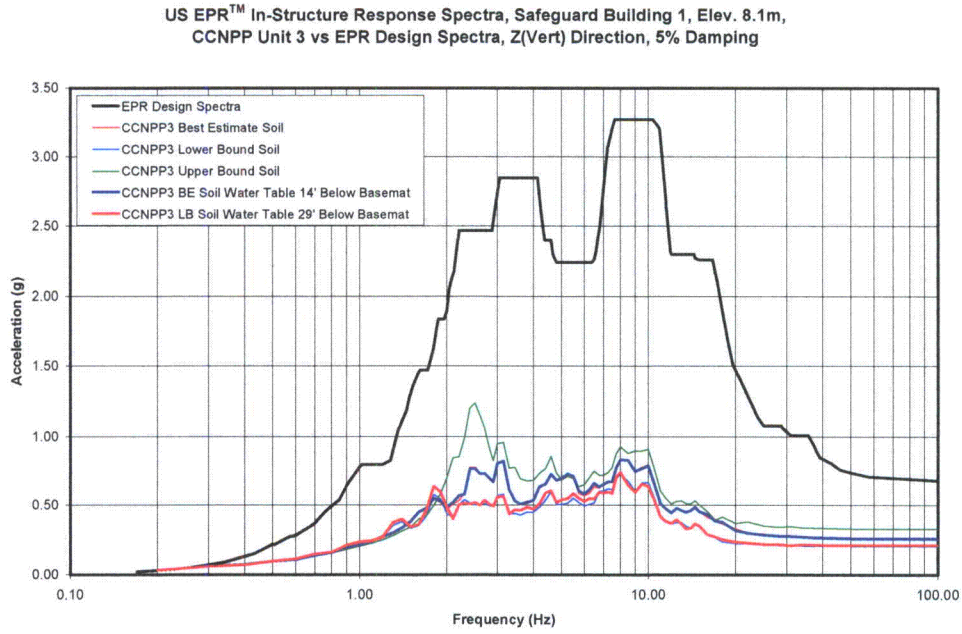



**Figure 03.07.01-14.4F: Comparison of U.S. EPR Design and CCNPP Unit 3 ISRS Considering Groundwater Effects – Safeguard Building 1, Elev. 8.1m, Z (Vert) Direction, 5% Damping**

5) NRC Interim Staff Guidance, DC/COL ISG-17 (Adams Accession No. ML092230543) and the NEI White Paper (Adams Accession No. ML091680715) refer to SHAKE as a representative program for site-response calculations, not as the only program that can be utilized for this purpose. ISG-17 and the NEI document contain passages such as " ... from a one-dimensional iterative dynamic soil column analysis program like SHAKE" and "The soil column analysis is typically performed using the one-dimensional wave propagation programs such as SHAKE." Thus, SHAKE is presented as an example of software that is used for site-response calculations, not as a requirement.

When comparing the SHAKE and RVTSITE programs, it is important to note that they have many elements in common. The mathematical frequency-domain formulation for propagation of vertical SH waves in horizontally stratified media is exactly the same, as is the equivalent-linear formulation for soil degradation. The only difference is that SHAKE works with one time history at a time, whereas RVTSITE works with the ensemble of all possible time histories associated with a given response spectrum, using random-vibration theory. Comparisons in the literature (e.g., Rathje and Ozbey, 2006) show good agreement between SHAKE and RVT site-response results. Tests with RVTSITE indicate excellent agreement in replicating example problems for the SHAKE program documented in Idriss and Sun (1992). Thus RVTSITE is an equivalent program to SHAKE in the calculations that it performs, and it is more general in that it removes the dependence on a single time history of input motion.

6) The layer-velocity correlation model used in SOILSIM to develop the synthetic profiles for the FIRS and GMRS site-response calculations is taken from Toro (1996). In particular, the model for USGS Category C ($V_s30$ 180-360 m/s) was selected on the basis of the $V_s30$ value at the CCNPP. This particular correlation model is based on the statistical analysis of 226 profiles. In this model, the correlation coefficient between $\ln[V_s]$ in two adjacent layers is composed of two parts, as follows: (1) a depth-dependent part, which is shown as a solid line in Figure 1; and (2) a thickness-dependent part, which is shown as a dashed line in Figure 1. The total correlation coefficient is the sum of the two parts, minus their product. Except for the top portion of the profile, this correlation is high.

Figures 2 through 7 show the 60 synthetic profiles used for the FIRS and GMRS site-response calculations. As a consequence of the partial correlation in $V_s$, a profile that has high $V_s$ in one layer tends to have high $V_s$ at adjacent layers. This is particularly the case in the deeper portions of the soil column. Because this correlation is only partial, and because of the randomization of layer thickness, some profiles do cross each other in some instances.

Figure 8 shows $V_s$ measurements from two boreholes at the CCNPP site, which have been smoothed using a 10 m window. Like the synthetic profiles, these profiles cross each other in a few places, in a manner similar to that exhibited by the synthetic profiles. This indicates that the site columns shown in Figures 2 through 7 are appropriate for the geotechnical/geological site data available.

Regarding other correlation models that might be assumed to be appropriate, to the best of our knowledge, the only velocity-correlation models in frequent use are the model by Toro (1996), which was used in this study, earlier versions by the same author (which are

superseded by the 1996 version), and site-specific variants for very well studied sites. Two end members that one could consider are a fully correlated model and a fully independent model. Neither of these models is consistent with the generic data analyzed by Toro (1996) or with the site-specific data shown in Figure 8. Therefore, it is not considered appropriate to use a fully correlated model or a fully independent model, particularly the latter, as the preferred model for the CCNPP site response.

However, to respond directly to the question, a sensitivity study was performed to investigate the effect of fully correlated $V_s$ on site response. To this effect, the correlation coefficient in Vs was set to unity in the randomization. In addition, the randomization of layer thickness was turned off in order to maximize the effect of the fully correlated $V_s$. Other inputs to the profile randomization algorithm were unchanged. Figure 9 shows the resulting 60 randomized profiles for the GMRS soil column. These profiles were then used to calculate the amplification factors and associated uncertainties for the $10^{-5}$ High Frequency (HF) and Low-Frequency (LF) rock inputs. Figures 10 and 11 compare the resulting median amplification factors and logarithmic standard deviations to the corresponding results obtained from the realistic model for Vs correlation used for the CCNPP site (labeled as base-case results). The conclusion from this sensitivity study is that using a fully correlated model for Vs introduces a negligible effect on the median amplification factor and a small change in the associated standard deviation (a small increase at some frequencies, a small decrease at other frequencies). These differences in the median amplification factors and uncertainties would have a very small effect on the GMRS spectrum. Thus the correlation model assumed for the site has not reduced the FIRS and GMRS spectra in a significant way, compared to the fully correlated model; and is deemed adequate for the soil conditions at the CCNPP Unit 3 site.

No sensitivity study was performed for the fully independent $V_s$ model, because this model is not considered credible. If one were to run such sensitivity study, however, it is expected that the fully independent model would give somewhat lower median amplification factors and lower logarithmic standard deviations.

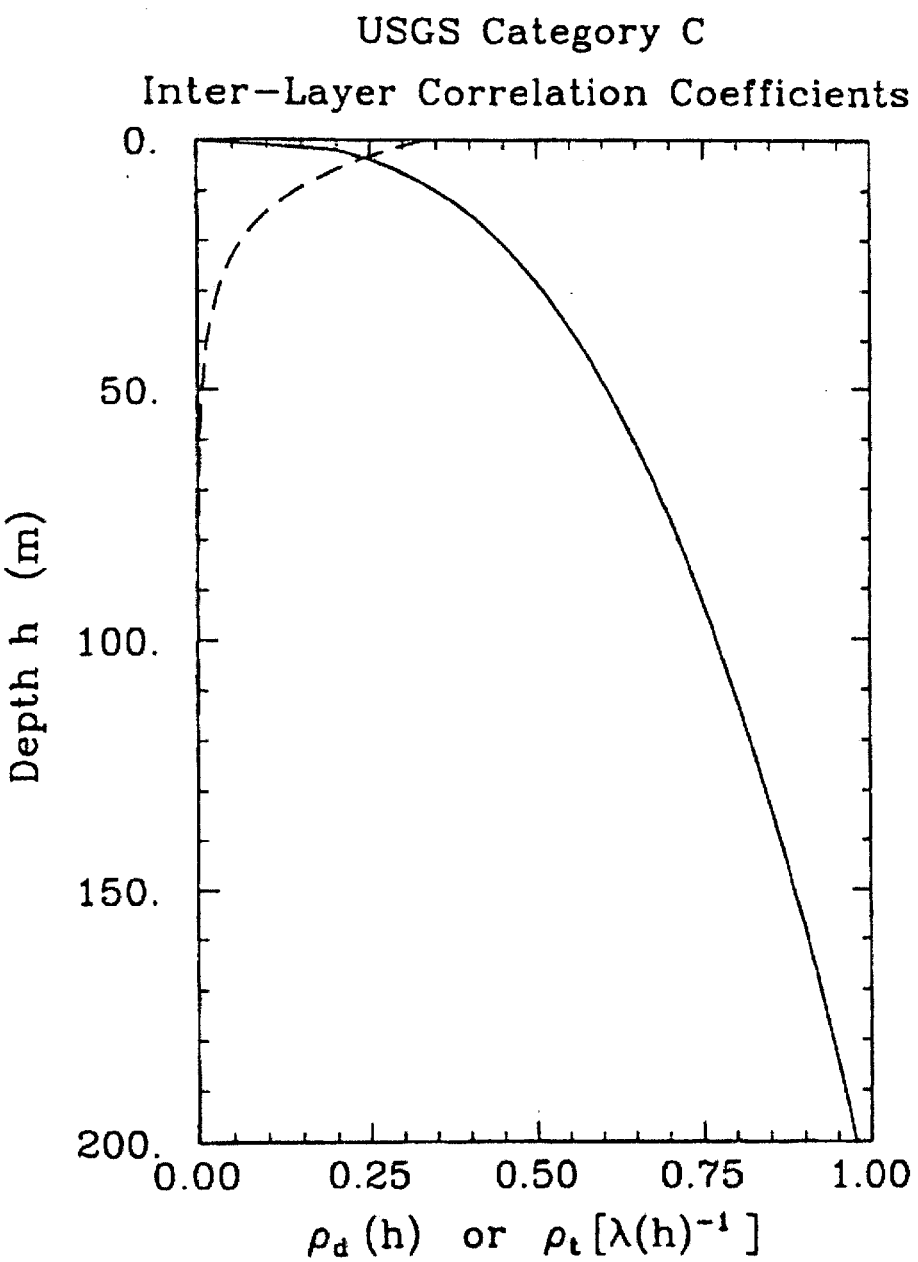



**Figure 1. Correlation coefficient between ln[$V_s$] in two adjacent layers, plotted as a function of depth.**

Solid, depth dependent part; dashed, thickness-dependent part. To show the thickness-dependent part as a function of depth, the mean thickness for each depth is calculated using the generic layer-thickness model and then this mean thickness is used to calculate the thickness-dependent correlation coefficient. At depths greater than 200 m, the correlation coefficient remains constant, with a value equal to the value attained at 200 m. Toro (1996).

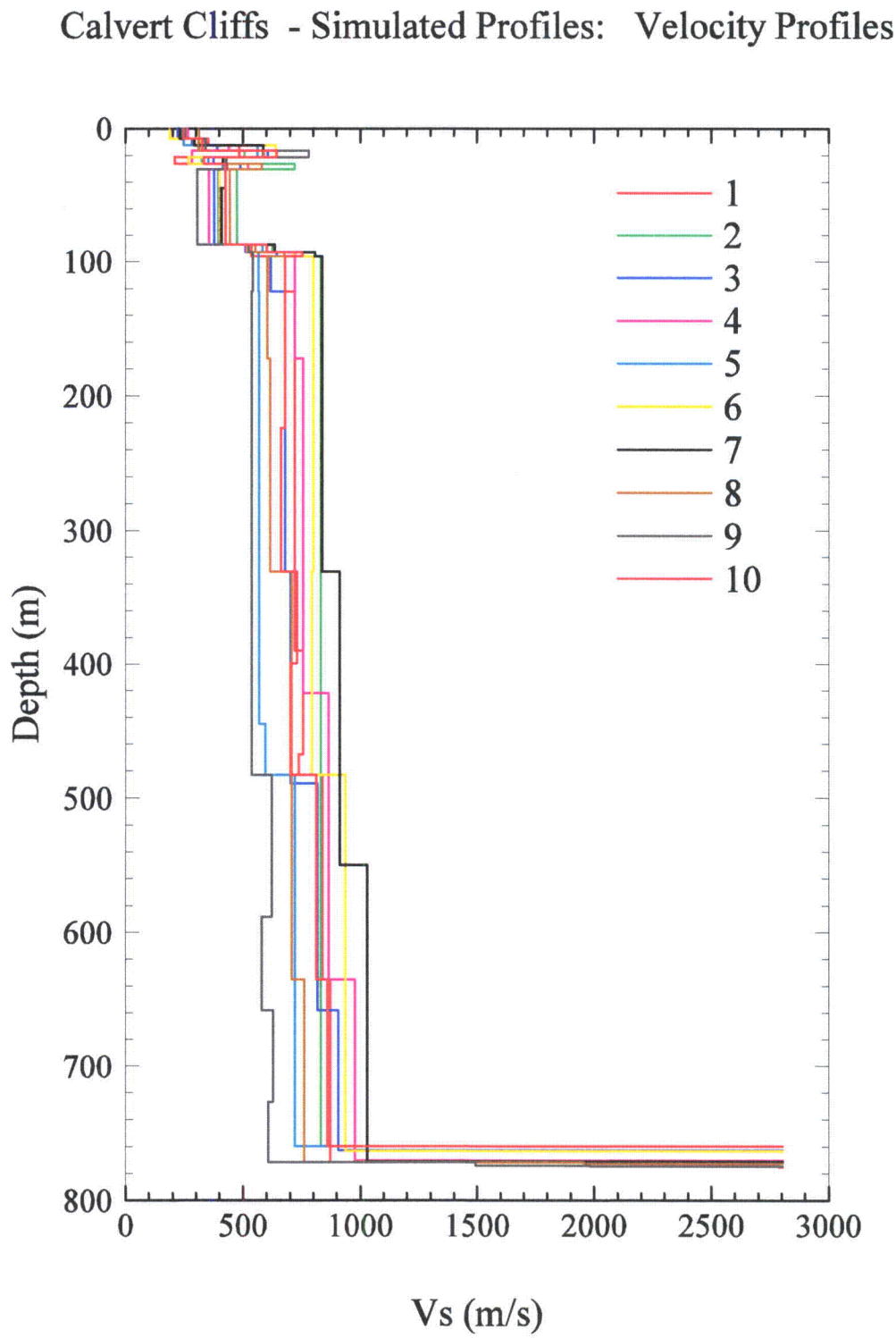



**Figure 2. Synthetic profiles number 1 through 10**

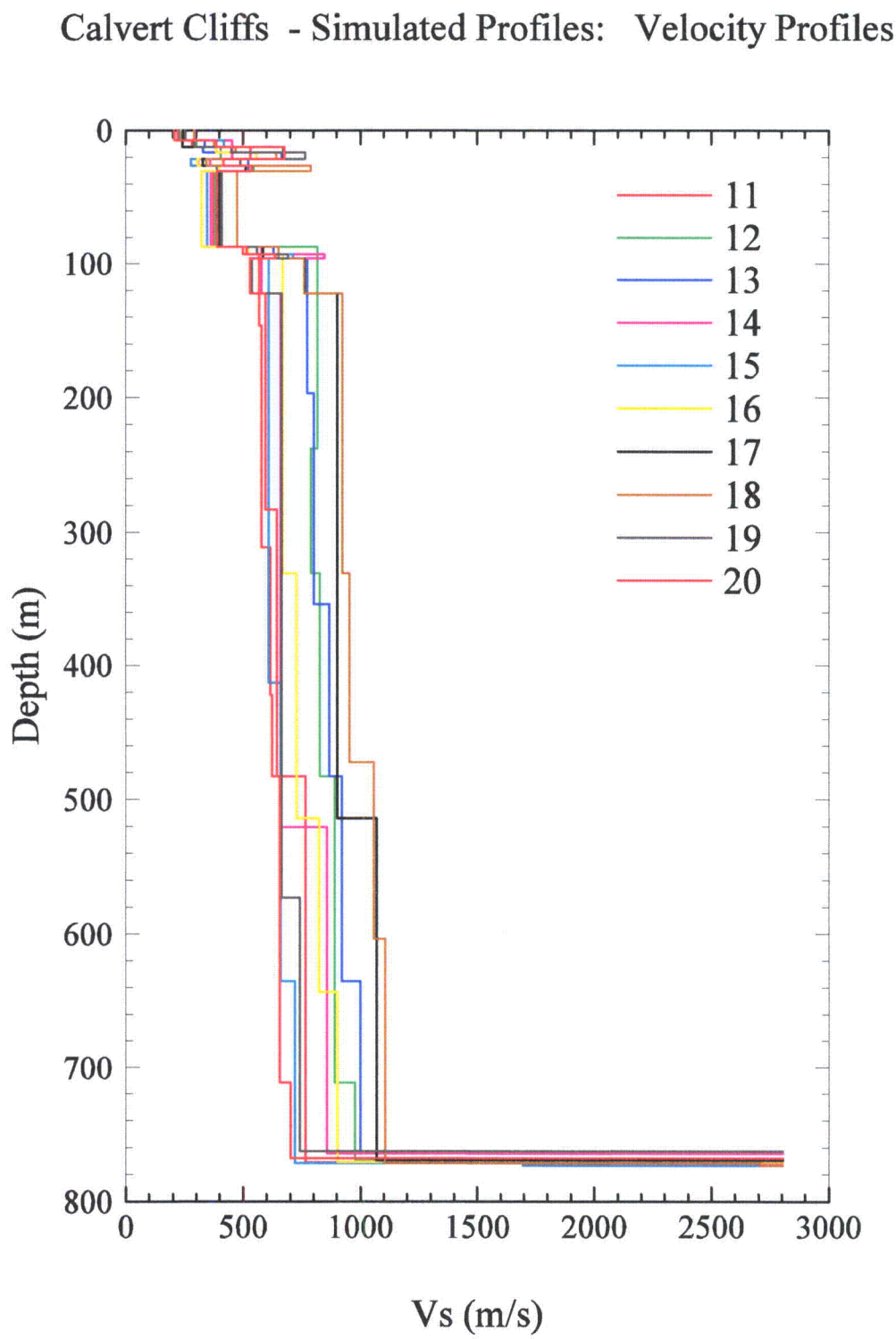



**Figure 3. Synthetic profiles number 11 through 20**

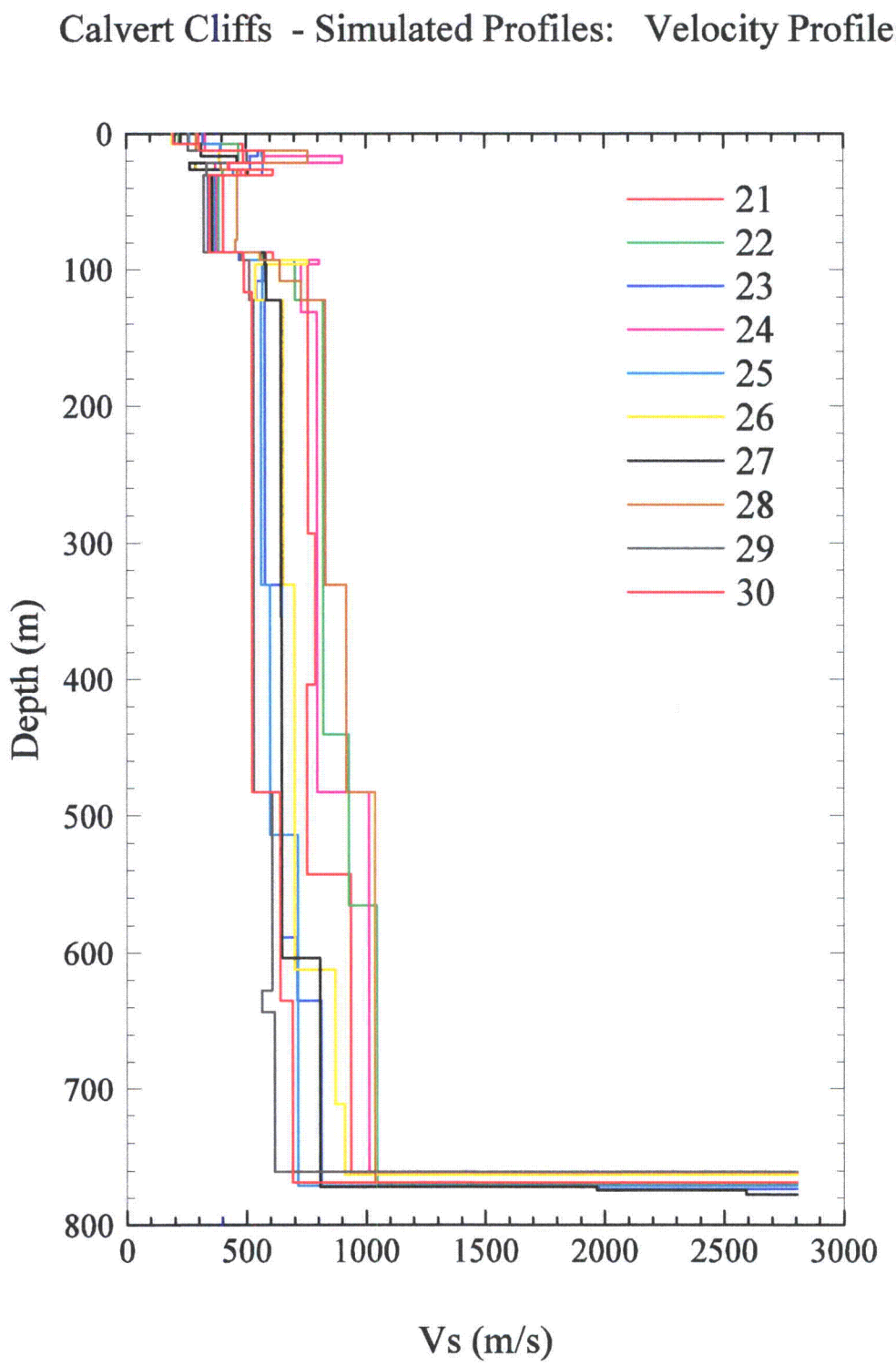



**Figure 4. Synthetic profiles number 21 through 30**

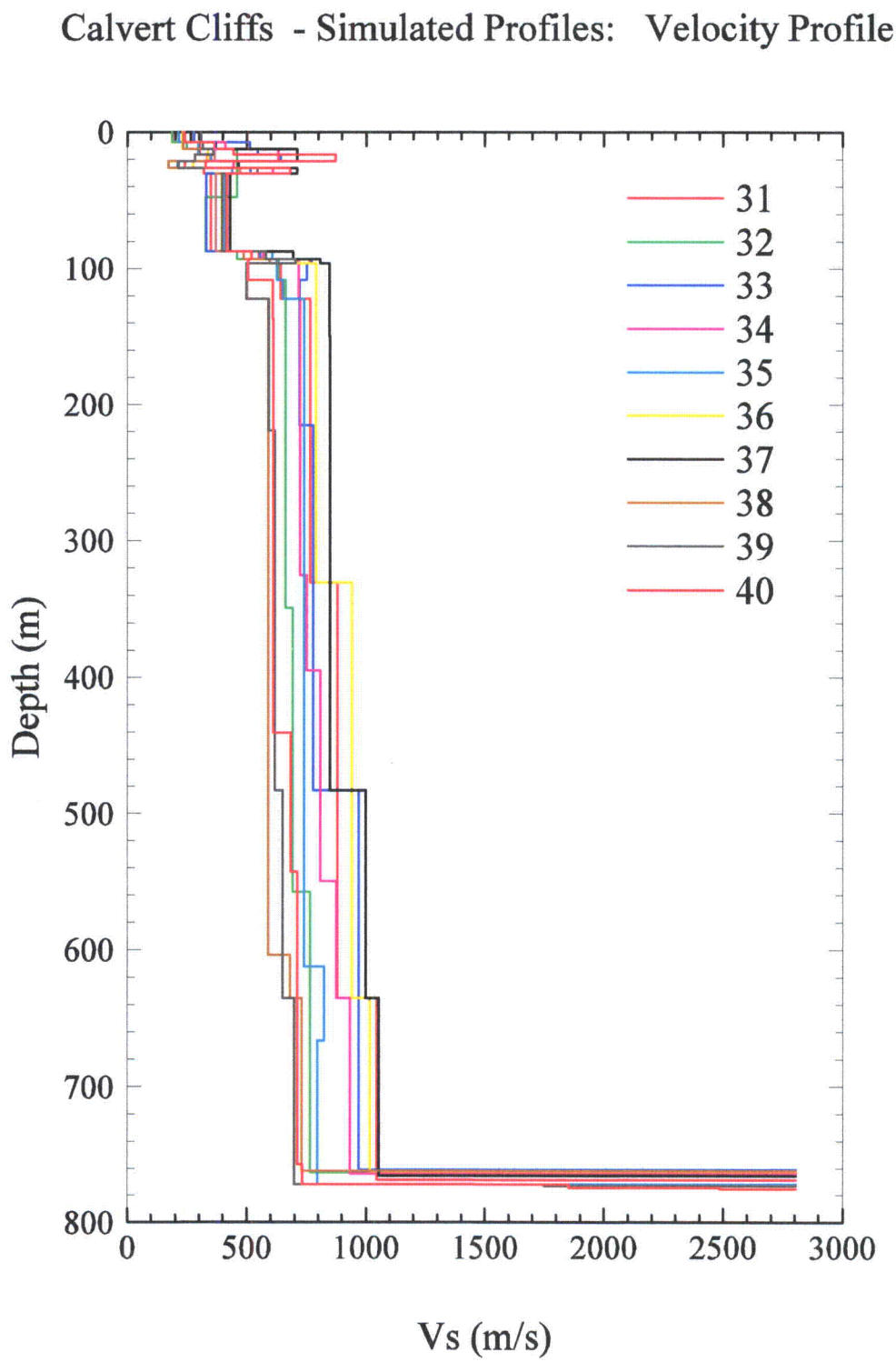



**Figure 5. Synthetic profiles number 31 through 40**

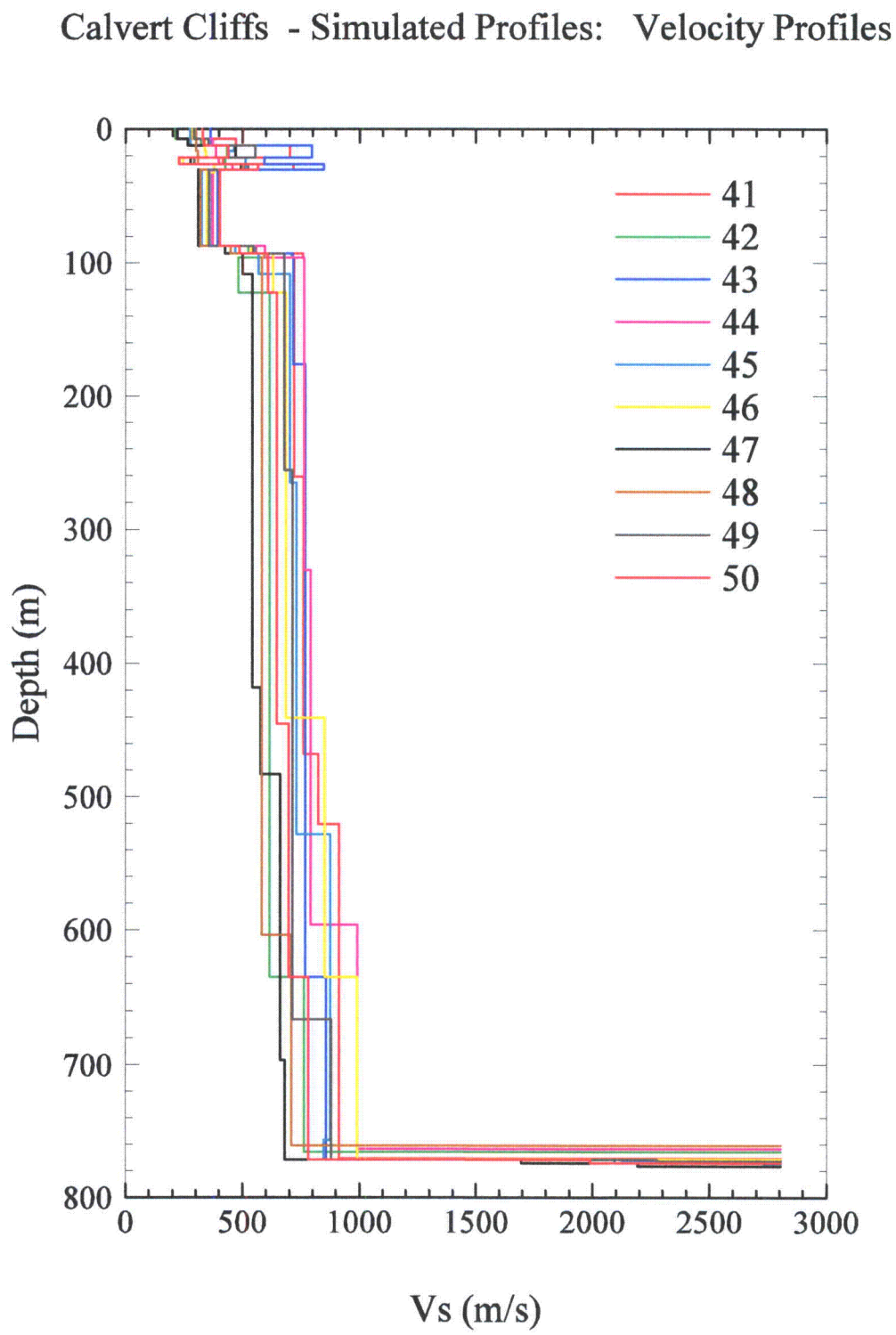



**Figure 6. Synthetic profiles number 41 through 50.**

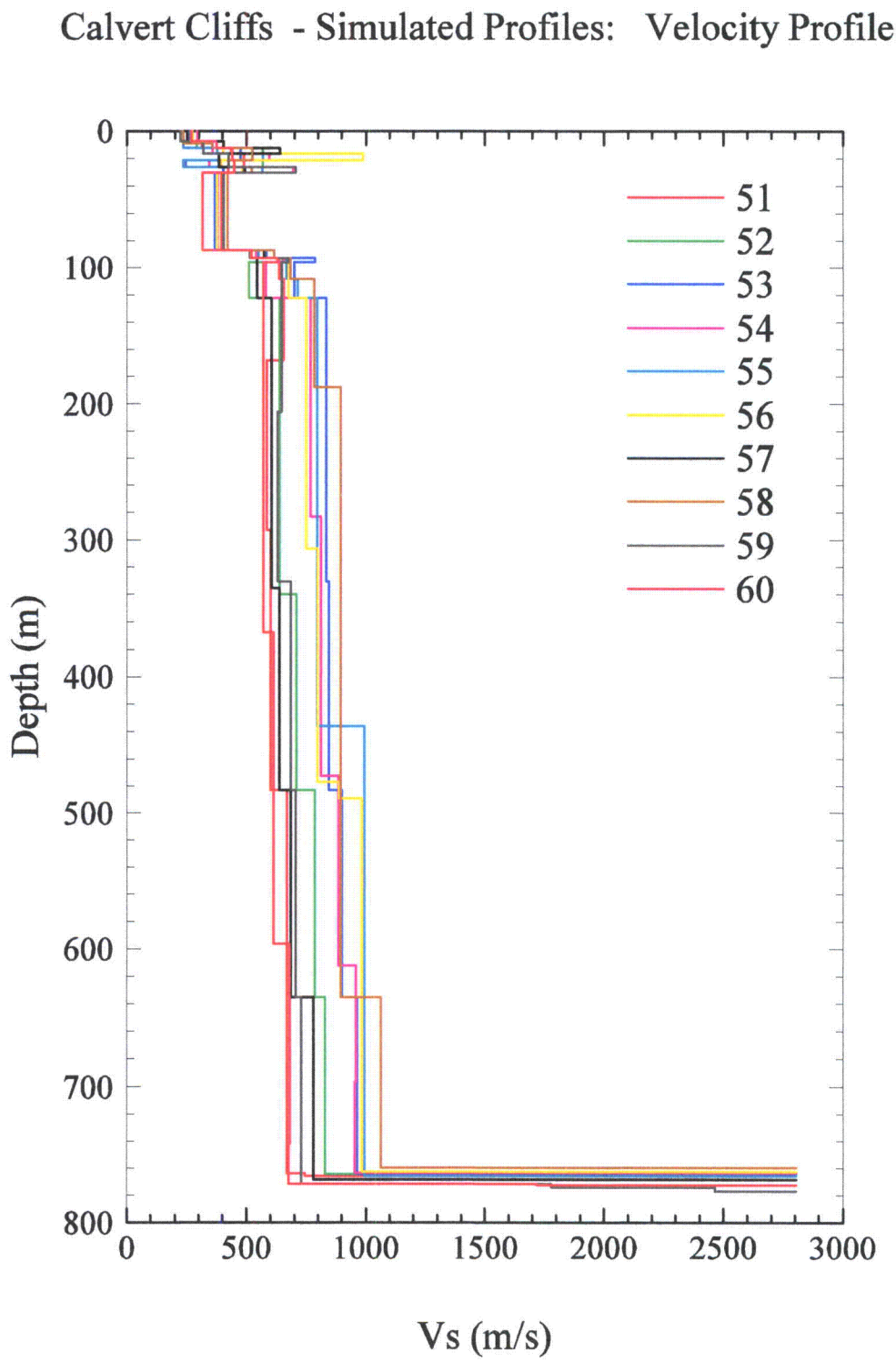



**Figure 7. Synthetic profiles number 51 through 60.**

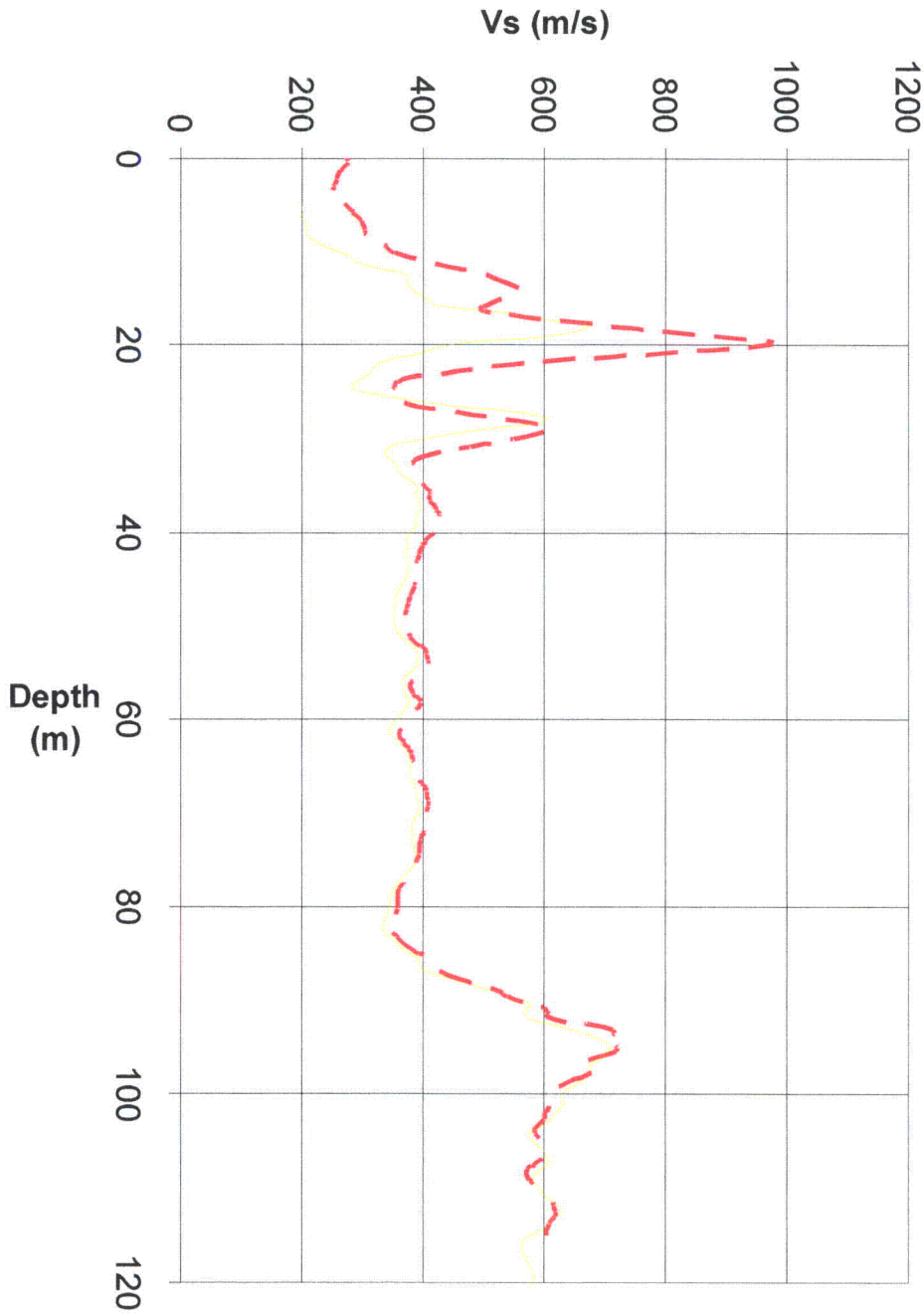



**Figure 8. Measured $V_s$ values from two deep boreholes at CCNPP.**

Red dashed line, B-301; Yellow solid line, B-401.

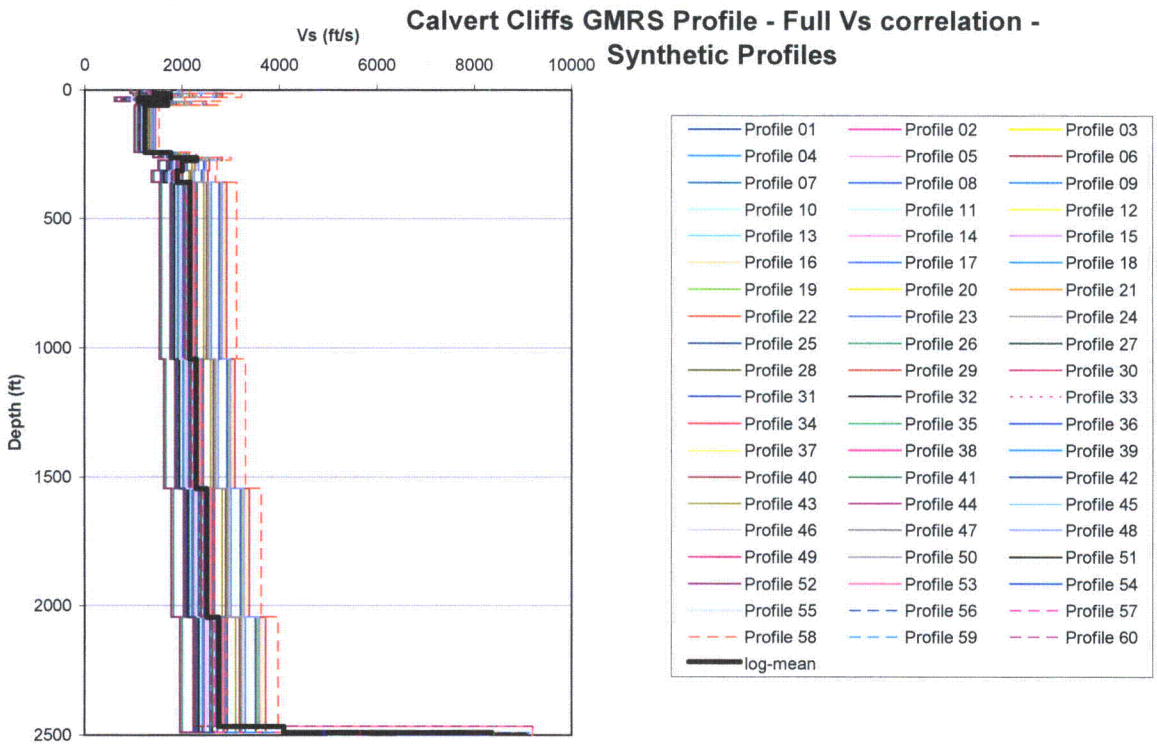



**Figure 9. Synthetic profiles with fully correlated $V_s$.**

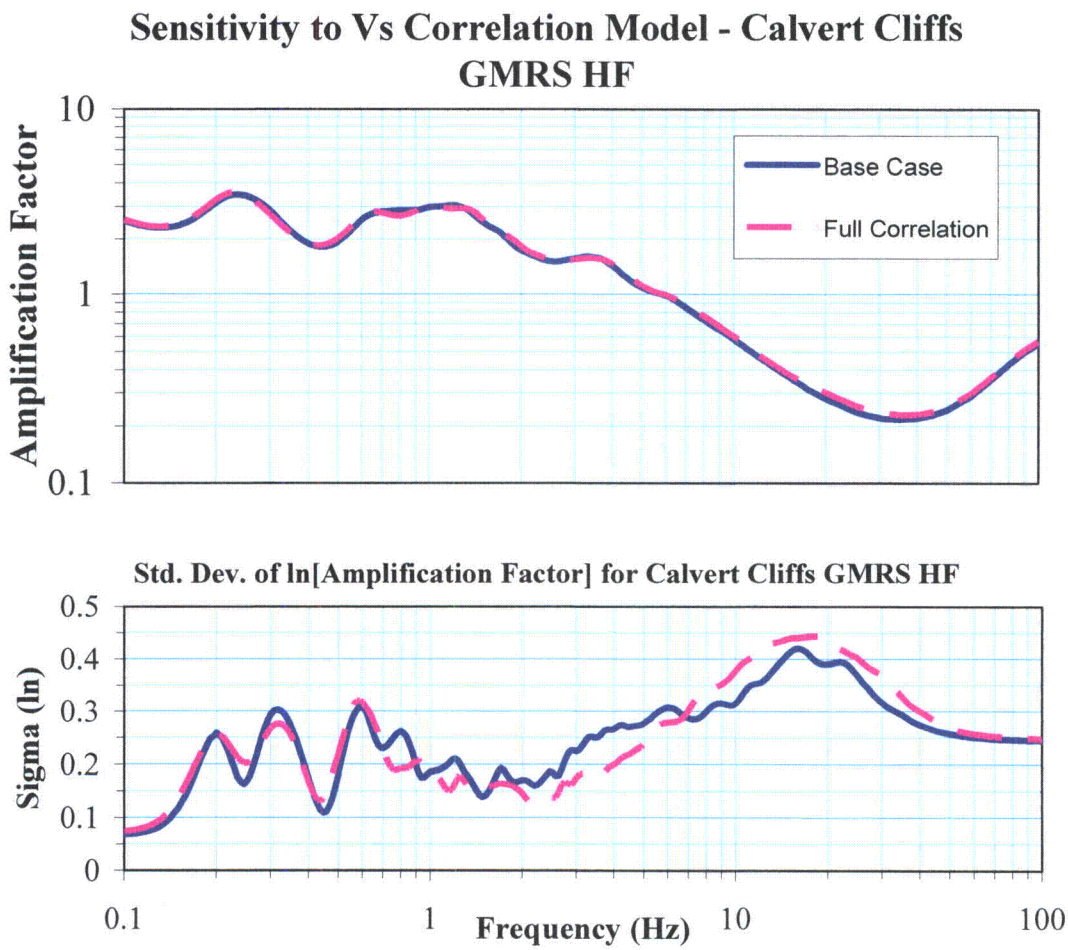



**Figure 10. Sensitivity of amplification factor to $V_s$ correlation models. Comparisons for $10^{-5}$ HF rock motion.**

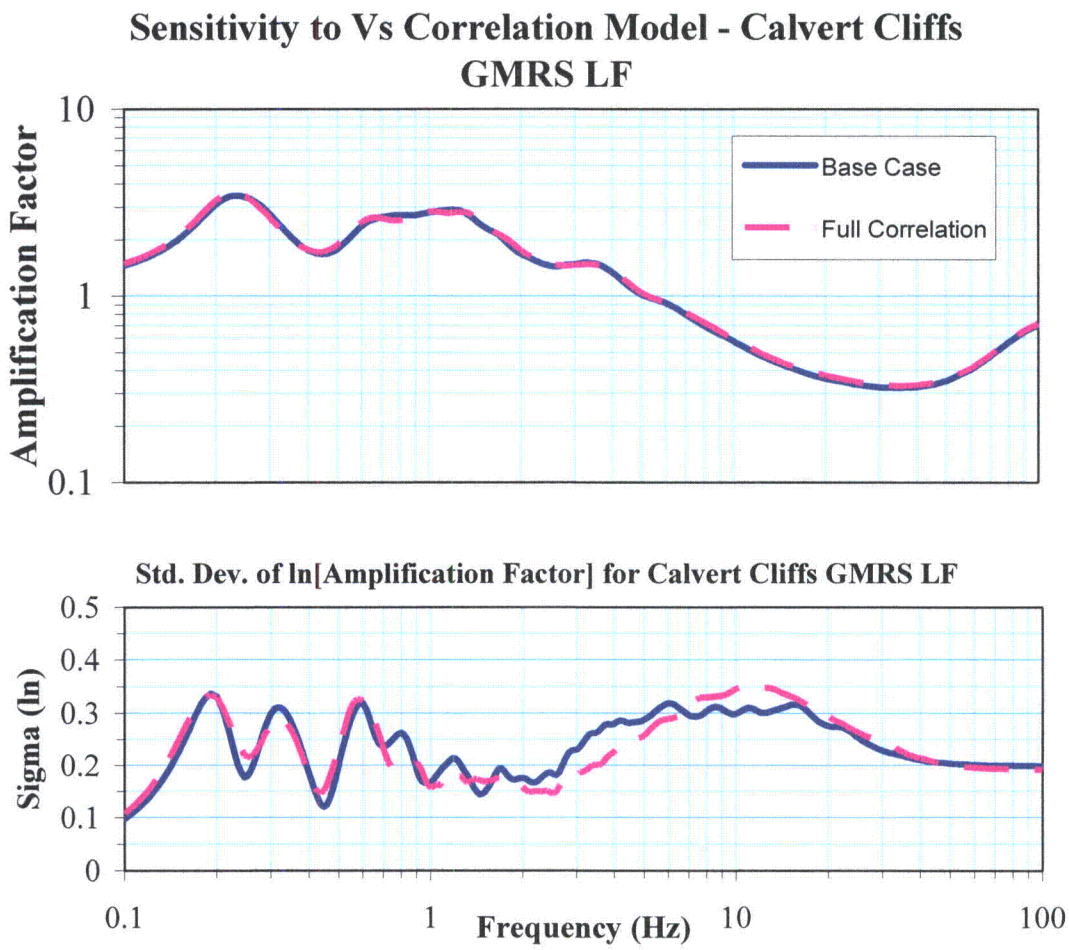



**Figure 11. Sensitivity of amplification factor to $V_s$ correlation models. Comparisons for $10^{-5}$ LF rock motion**

**COLA Impact**

No FSAR change required

**03.07.02-1**

In FSAR Section 3.7.2.1.1 (Time History Analysis Method) on page 3.0-34, it states that the Ultimate Heat Sink (UHS) Electrical Building (EB) is fully embedded and relatively rigid compared to the soil stiffness, and consequently there is no significant amplification above the ground surface input motion. The UHS Makeup Water Intake Structure (MWIS) is similar to the UHS EB in that it is relatively rigid and almost entirely embedded. The zero period acceleration (ZPA) input to the UHS MWIS is 0.15 g and the structural response at grade is approximately 0.35 g in the North-South direction. This equates to an amplification of approximately 2.33 over the input motion ZPA. Why wouldn't a similar result occur for the UHS EB, and what is the technical basis for stating that there is no significant amplification above the ground surface input motion for this structure?

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-228 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in FSAR Section 3.7.2.4.

**03.07.02-2**

In FSAR Section 3.7.2.1.4 (Equivalent Static Load Method of Analysis) on page 3.0-35, it states that the equivalent static load method is used for the UHS EB by applying 0.5 g acceleration in all directions. Assuming the zero period acceleration (ZPA) of the design input ground motion is .35 g, provide the justification for the amplification of ground acceleration used for this structure, i.e. .5/.35, or 1.43. In addition, an assumption is made that the walls and slabs are stiff. This is used as the basis for assuming there is no additional amplification of the seismic response of the structure due to local flexibility of the structural elements. While it may be true the in-plane stiffness of the walls and slabs exceed 33 Hz, it may not be true that this is the case for their out-of-plane response. Provide the results of an analysis that demonstrates that the out-of-plane response for walls and slabs exceeds 33 Hz. Include in this analysis technical consideration of whether the walls and slabs are cracked or uncracked under the applied design loads.

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The UHS EB is included in the integrated model used for SASSI analysis, which includes the local flexibility of structural panels. The SASSI analysis is described in FSAR Section 3.7.2.4 and the structural response is presented in FSAR Sections 3.7.2.2 and 3.7.2.5.3.

**03.07.02-3**

As shown in the applicant's FSAR, no specific dynamic analysis has been performed for the Ultimate Heat Sink Electrical Building. How are the building displacements calculated which are needed as inputs for the analysis of buried conduit, duct banks, and piping that interface with this structure?

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The UHS EB is included in the integrated model used for SASSI analysis. The building displacements can be determined at any location from the analysis, including the locations where buried commodities interface with the structure. FSAR Section 3.7.2.4.6.3 is updated to include this discussion.

**03.07.02-4**

In FSAR Section 3.7.2.4, there is no description of a soil-structure-interaction (SSI) analysis for the Ultimate Heat Sink (UHS) Electrical Building (EB). Appendix S of 10 CFR Part 50 states that for Safe Shutdown Earthquake (SSE) ground motion SSCs will remain functional and that required safety functions must be assured during and after the vibratory ground motion. It also states that the evaluation of SSCs must take into account SSI effects and the expected duration of the vibratory ground motion. SRP 3.7.1, SRP Acceptance Criteria 4.A.vii. provides SSI analysis acceptance criteria for a COL application referencing a certified design. Provide in this section of the FSAR, the results of an SSI analysis for the UHS EB that meets SRP Acceptance Criteria 4.A.vii. of SRP 3.7.1 as well as SRP Acceptance Criteria 4 of SRP 3.7.2 using a subgrade model based on the final soil properties and properties of the compacted backfill used below the building, or justify an alternative.

Include the effects of structure-to-structure interaction and reconcile the results of this analysis with the assumed seismic response of the building and with the In-Structure Response Spectra used to qualify the electrical equipment.

**Response**

The results of SASSI analysis of UHS EB, using the final soil and backfill properties are provided in FSAR Section 3.7.2.4.

The SSSI effects are included by modeling the UHS EB along-with the Common Basemat Intake Structures for the SASSI analysis. The SSSI analysis is described in FSAR Section 3.7.2.4.4.3.

The results of SASSI analysis are presented in FSAR Section 3.7.2.2. Since the new analysis replaces the existing analysis, no reconciliation comparison is made.

The ISRS at the location of electrical equipment based on the SASSI analysis are presented in FSAR Section 3.7.2.5.3. Since the new analysis replaces the existing analysis, no reconciliation comparison is made.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-5**

In FSAR Section 3.7.2.3.2 (Seismic Category I Structures - Not on Nuclear Island Common Base Mat) on page 3.0-36, it describes the finite element model used in the analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS).

- SRP 3.7.2, SRP Acceptance Criteria 3.C.ii. states the element mesh size should be selected on the basis that further refinement has only a negligible effect on the solution results. Describe any sensitivity studies that were implemented in determining the mesh size for the UHS MWIS, and if no sensitivity study was performed provide justification for not doing so.
- SRP 3.7.2, SRP Acceptance Criteria 3.D. states that in addition to the structural mass, a floor load of 244.64 kg/m2 (50 pounds/ft2) should be included to represent miscellaneous dead weights and a mass equivalent to 25 percent of the floor design live load and 75 percent of the roof design snow load should be included in the model. Describe how this acceptance criterion has been addressed in the model of the UHS MWIS, and if no additional mass was added provide the justification for not doing so.

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are still applicable. Note that referenced Section, Table, and Figure numbers may have changed.

The mesh size used in the finite element model, which is used for SASSI analysis, is sufficiently refined to accurately capture the global and local dynamic response.

The structural mass included in the finite element model used for SASSI analysis meets the acceptance criterion 3.D of SRP 3.7.2, as described in FSAR Section 3.7.2.3.2.

**03.07.02-6**

FSAR Section 3.7.2.4 (Soil-Structure Interaction) starting on page 3.0-37 describes soilstructure-interaction (SSI) for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). The basis for this analysis is ASCE 4-98 which has not been endorsed by the staff for performing SSI analysis. Describe how the analysis performed meets the guidance provided in SRP 3.7.1, SRP Acceptance Criteria 4.A.vii. for performing SSI analysis or provide justification for an alternative. Also for the analysis described, provide in the FSAR the following information:

- A figure depicting the soil-structure model used for the seismic analysis.
- The basis for the assumed soil properties and profile used to calculate the frequency independent impedance functions.
- The method and formulas used to calculate the values of the soil springs under the foundation as well as the lateral soil springs that represent the embedment effect.
- State whether the soil properties used in the analysis are strain dependent or simply the low strain values. If these are low strain values, justify their use and quantify the impact of not using strain dependent properties on the results of the analysis. If the soil properties are strain dependent, describe how the final soil properties are determined in the analysis.
- For large values of Poisson's ratio, the dynamic stiffness and damping are frequency dependent. Provide justification for assuming that the impedance functions of the supporting foundation are frequency independent.
- FSAR Section 3.7.2.4 on page 3.0-37 indicates that the control motion is applied at the bottom of the basemat. Confirm that this is intended to state that the control motion is applied at the base of the soil structure analysis model and revise the FSAR accordingly.
- Provide a reconciliation of the final soil properties and the foundation input response spectra (FIRS) that are based on these properties with the seismic analysis results described in the FSAR.

**Response**

Note: A partial response to this question was provided in UN#09-399. However, that information is no longer applicable.

The time history analysis for UHS MWIS and equivalent static method of analysis for UHS EB is superseded by SASSI analysis. The SASSI analysis of UHS MWIS is described in FSAR Section 3.7.2.4.

- The model used for performing the seismic SASSI analysis is depicted in FSAR Figure 3.7-26.
- FSAR Sections 3.7.2.4.1.3 and 3.7.2.4.3.3 have been updated to include the final soil properties used in the SASSI analysis.
- FSAR Section 3.7.2.4 has been updated. The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in

Section 3.7.2.4.

- FSAR Sections 3.7.2.4.1.3 and 3.7.2.4.3.3 have been updated to include the final soil properties used in the SASSI analysis.
- The effect of high ground water table (i.e., high Poisson's ratio) has been included in developing the soil model as described in FSAR Section 3.7.2.4.3.3.
- The application of control motion for SASSI analysis is described in FSAR Section 3.7.2.4.5.3.
- FSAR Section 3.7.1.1.1.3 describes the development of FIRS for the Common Basemat Intake Structures and UHS EB. The strain-compatible soil properties used for the SASSI analysis of Common Basemat Intake Structures and UHS EB are described in FSAR Section 3.7.2.4.1.3. The SASSI analysis supersedes the previous time history analysis, therefore no reconciliation is necessary.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-7**

In FSAR Section 3.7.1.1 (pg 3.0-29), it indicates that the Category I makeup water intake structure (MWIS) is founded below sea level. The description of the soil-structure-interaction- (SSI) analysis for this structure does not describe how the ground water effects were included in the analysis. Describe how the SSI calculations included these effects, and if they did not, provide justification for not doing so and address the impact.

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The effect of high ground water table is included in the soil model as described in FSAR Section 3.7.2.4.3.3.

**03.07.02-8**

FSAR Section 3.7.2.3.2 states that the Ultimate Heat Sink Makeup Water Intake Structure is analyzed in GTSTRUDL. It further states that the walls "are not anticipated" to crack. Provide the basis for this statement including numerical results for typical concrete sections using the applicable wall design loads.

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The model used in FSAR Section 3.7.2.3.2 for SSI analysis uses element properties assigned based on anticipated cracking of structural panels due to SSE loads.

**03.07.02-9**

The reference for ASCE 4-98 in Section 3.7.2.4 on page 3.0-38 and elsewhere in the text is listed as ASCE, 1986. State which code revision is being used and correct the revision dates stated in the FSAR.

**Original Response** **UN#09-126**

**Update**

The original question and the response provided in UN#09-126 are applicable.

The FSAR has been updated to reference the 2000 code revision to ASCE 4-98.

**03.07.02-10**

In FSAR Section 3.7.2.4 (Soil-Structure Interaction) on page 3.0-37, it states that in the analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) the impulsive forces of water acting on the walls of the intake structure are calculated using an acceleration of 0.5 g. What is the basis for this acceleration value? How is the impulsive weight calculated, and is the impulsive mass of water included in the soilstructure- interaction analysis of the structure? If it is not included, describe why it was not and provide the impact this will have on the natural frequencies of the structure, provided in Tables 3.7-7 thru 3.7-12, and on the building structural loads.

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-228 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4. FSAR Section 3.7.2.3.2 has been revised to discuss the inclusion of impulsive water masses for the new SASSI analysis.

**03.07.02-11**

In FSAR Section 3.7.2.4 on page 3.0-37, it states that the convective frequencies associated with sloshing effects occur in the range where the scaled down European Utility Requirements (EUR) spectra do not exceed either the CCNPP Unit 3 spectra (zero period acceleration (ZPA) of 0.067 g) or Regulatory Guide 1.60 spectra scaled to a ZPA of 0.10 g. It goes on to say that due to the lower acceleration levels at the convective frequencies and the lower convective water mass, the convective forces are anticipated to be minimal with respect to the impulsive forces. If the foundation input response spectra (FIRS) for this structure are the scaled down EUR spectra, explain why this is an appropriate response spectra for this site when the low frequency input is less than that of the ground motion response spectra (GMRS) which has a ZPA of .067 g. What is the basis for the calculation of the convective water mass? Why was this mass not included in the analysis of the UHS MWIS? How will the difference in input response spectra be resolved in determining the proper convective design loads for the structure?

**Original Response** **UN#09-291**

**Update**

The original question, and the response provided in UN#09-291 is no longer applicable.

FSAR Section 3.7.1.1.1.1 describes the suitability of the Site SSE shown in Figure 3.7-1 as the appropriate design spectra for CCNPP Unit 3 site.

For the new analysis in FSAR section 3.7.2.3.2, the convective water masses and frequencies are calculated using the ACI 350.3-06 methodology. Since the convective frequencies are very low, the corresponding spectral accelerations are insignificant. Therefore, the convective loads are negligible and are ignored in the seismic analysis. The difference in input response spectrum mentioned in the question is no longer applicable, since the site SSE spectrum is used.

**03.07.02-12**

In FSAR Section 3.7.2.4 on page 3.0-38, it states that structure-to-structure interaction exists between the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) and the UHS Electrical Building (EB). It then states that as a consequence the design response spectra for the UHS EB is an envelope of half the European Utility Requirements (EUR) soft soil ground motion response spectra (zero period acceleration (ZPA) of 0.15 g) and the In-Structure Response Spectra (ISRS) developed at the operating deck of the UHS MWIS (ZPA of .35 g). Provide the results of a structure-to-structure interaction analysis that supports this assumption.

**Response**

The SSSI effects between the UHS MWIS and UHS EB are included by modeling the UHS EB along with the Common Basemat Intake Structures for the SASSI analysis. The SSSI analysis is described in FSAR Section 3.7.2.4.4.3.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-13**

In FSAR Section 3.7.2.6 (Three Components of Earthquake Motion) on page 3.0-40, it states for the Ultimate Heat Sink (UHS) Electrical Building that due to building symmetry cross-coupling is determined to be negligible. As no dynamic analysis was performed for this structure, what is the justification for this statement?

**Original Response** **UN#09-291**

**Update**

The original question, and the response provided in UN#09-291 is no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-14**

In FSAR Section 3.7.2.6 on page 3.0-40, it states that separate manual calculations, using the equivalent static analysis method are performed to determine the structural response of the site-specific Ultimate Heat Sink Electrical Building in each of the three directions. On page 3.0-35, it states that 0.5 g acceleration is used in all directions. Describe in the FSAR the manual calculations that were used, how the structural response was obtained, and provide examples of how the three components of earthquake motion are combined comparing the results to those of the 100-40-40 rule presented in RG 1.92, Revision 2, or justify an alternative. Also describe how the forces and moments are determined to design the individual elements (walls and slabs) of this structure, or justify an alternative.

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-228 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-15**

In FSAR Section 3.7.2.6 on page 3.0-40, it states that for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS), three statistically independent time histories are applied for each of the six soil cases to determine accelerations at select locations. Describe how the accelerations obtained from this dynamic analysis are applied to the static model to obtain forces and moments for structural design and provide examples of how the three components of earthquake motion are combined and compare the results to those of the 100-40-40 rule presented in RG 1.92, Revision 2. The use of an equivalent static approach to determine forces and moments in the structure may not be conservative as dynamically computed forces and moments will retain the appropriate sign from the analysis and the static approach will not. How will this be addressed in the development of loads used in the design of the structure?

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-320 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-16**

In FSAR Section 3.7.2.7 (Combination of Modal Responses) on page 3.0-40, it states that modal combination is not applicable to the time history analysis performed for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). Since it is not clear from the text of FSAR Section 3.7.2, describe the method of time history analysis that was performed for this structure and, if time history integration was used, provide the time steps used in the analysis.

**Original Response** **UN#09-126**

**Update**

The original question and the response provided in UN#09-126 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-17**

The interaction of non-seismic Category I structures with Seismic Category I systems is described in FSAR Section 3.7.2.8. In this section on page 3.0-41, it states that fire protection SSCs are categorized as either Seismic Category II-SSE, meaning the SSC must remain functional during and after a Safe Shutdown Earthquake (SSE), or Seismic Category II, meaning the SSC must remain intact after an SSE without deleterious interaction with a Seismic Category I or Seismic Category II-SSE SSC. In the U.S. EPR FSAR on page 3.7-95, it states that Seismic Category II is designed to the same criteria as Seismic Category I structures. In SRP 3.7.2, SRP Acceptance Criteria 8, which addresses the interaction of non-Category I structures with Category I SSCs, it states that when non-Category I structures are designed to prevent failure under SSE conditions; the margin of safety shall be equivalent to that of the Seismic Category I structure.

- Describe how this margin of safety is achieved for the Seismic Category II-SSE and Seismic Category II portions of the fire protection system. Include in your response the seismic inputs, loading combinations, codes and acceptance criteria. What are the differences in the method of design for these two seismic categories?
- Describe the basis and provide figures in the FSAR of the design response spectra used to analyze above ground seismic Category II and seismic Category II-SSE fire protection SSCs including the fire protection tanks.
- What are the methods of analysis and acceptance criteria for both the buried and above ground portions of the fire protection system that are Seismic Category IISSE that will ensure that these portions of the system will remain functional following an SSE event?
- What are the modeling and analysis methods used for the fire protection tanks and to what extent do the fire protection tanks meet the acceptance criteria of SRP 3.7.3, SRP Acceptance Criteria 14.A. thru J.? When the tank analysis does not meet the acceptance criteria, provide the technical justification for not doing so.

**Background**

Both Seismic Category II (Cat II) and Seismic Category II-SSE (Cat II-SSE) Fire Protection Structures, Systems and Components (SSCs) are designed to withstand the safe shutdown earthquake (SSE) event with essentially elastic behavior (the same requirement as for a Cat I SSC). The difference in their respective design approaches is that Cat II-SSE SSCs are required to maintain their function during and after the SSE due to the significance of fire protection systems to help maintain the performance of necessary safe-shutdown functions in accordance with Regulatory Guide 1.189, whereas Cat II SSCs are simply designed to maintain essentially elastic behavior (i.e., continuing functionality of the system or component is not expected).

The term Cat II has been used to classify SSCs that have the potential to interact with their proximate Seismic Category I (Cat I) SSCs. However, certain SSCs within the fire protection/suppression systems do not fall in this category because they are sufficiently distant from the plant Cat I SSCs. Fire water tanks and Fire Protection Building (and systems/components inside) are examples of this. In such instances, the Cat II-SSE designation simply denotes their safety function in that these SSCs are expected to be available for

fire events in the aftermath of the SSE. Thus, these SSCs comply with SRP 3.7.2 Acceptance Criterion 8A.

Because a potential for interaction does exist for the remaining Cat IISSE SSCs and all Cat II SSCs within the fire protection/suppression system, they need to be evaluated for SRP 3.7.2 Acceptance Criterion 8C.

**Response**

- Both Cat II and Cat II-SSE SSCs will be designed to remain elastic at the SSE excitation. The design will be based on codes/standards such as ASCE 4-98, ACI 349, as appropriate. The relevant acceptance criteria in SRP Section 3.7 (seismic inputs, loading combinations, codes and acceptance criteria) will also be satisfied. Therefore, the design approach for Cat II and Cat II-SSE SSCs is fundamentally the same as that for Cat I SSCs. The applicable seismic design spectra are identified in the response to the second sub-question below.

  One characteristic of Cat II-SSE SSCs, which differentiates them from Cat II SSCs, is that Cat II-SSE SSCs may include mechanical/electrical equipment (e.g., pump, motor, valves, etc), and piping. These types of SSCs will be designed and qualified as if they are Seismic Category I mechanical/electrical equipment and piping in accordance with the seismic requirements of SRP Sections 3.9 through 3.12.

  The seismic margin for Cat I SSCs corresponds to the reactor core damage (CD) level response state, which lies somewhere between first onset of significant inelastic deformation (FOSID) and imminent collapse. The actual SSC response level at which core damage occurs depends on the conditional responses of intervening SSCs. In contrast, for a Cat II SSC or a Cat II-SSE SSC in vicinity of a Cat I SSC, the potential for core damage is initiated only if it incurs collapse, since only then are the nearby Cat I SSCs endangered. Furthermore, any impact/pounding interaction resulting from collapse of Cat II SSCs does not necessarily mean that the nearby Cat I SSC will reach its CD level response state. Taken together, this implies that the Cat II SSCs will tend to have a somewhat higher level of seismic margin against core damage than that for the Cat I SSCs.

- The site SSE for Calvert Cliffs Unit 3 is shown in Figure 3.7-1. Cat II-SSE SSCs and those Cat II SSCs that are in the proximity of Cat I SSCs will be designed using this spectrum. In light of their potential for interaction with the U.S. EPR standard plant SSCs, the rest of the Cat II and Cat II-SSE SSCs will be designed using the Certified Seismic Design Response Spectrum to assure equivalent margin as that for the standard plant SSCs. The design spectra will be modified, if appropriate, to include structure-soil-structure interaction and site amplification effects.

- The methods of analysis and acceptance criteria for above ground portions of the fire protection system that are Seismic Category II-SSE are provided in U.S. EPR FSAR Sections 3.9.2.2.2 and 3.12.

  The acceptance criteria for buried segments of the fire protection system are provided in U.S. EPR FSAR Section 3.12.3.8, which refers to U.S. EPR FSAR Section 3.10 (Section 3.12 of the CCNPP Unit 3 FSAR refers to Section 3.12 of U.S. EPR FSAR).

- The modeling and analysis methods for tanks will be consistent with techniques specified in ASCE 4-98 Section 3.5.4 and will also comply with acceptance criteria specified in SRP 3.7.3 Acceptance Criteria 14 A through J. These techniques will assure that the fire tanks are designed for essentially elastic

behavior for site-specific SSE.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

Additionally, Table 3.2-1 will be updated as shown Enclosure 3.

**03.07.02-18**

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

- The Fire Protection Tanks and Fire Protection Building are classified as Seismic Category II-SSE in the CCNPP Unit 3 FSAR. This is an exception to the U.S. EPR FSAR which classifies them as conventional seismic. Please revise this section of the CCNPP FSAR to identify and clarify this difference.
- A seismic analysis was performed for the NAB in the U.S. EPR FSAR. Since this structure could potentially interact with Seismic Category I structures, the CCNPP FSAR needs to reconcile the U.S. EPR analysis with the site-specific soil properties and foundation input response spectra (FIRS) for the NAB. Also demonstrate in the FSAR that the displacement of this structure relative to the nuclear island common basemat structure is enveloped by the results of the U.S. EPR analysis.

**Original Response** **UN#09-228 (first bullet)**
**UN#09-388 (second bullet)**

**Update**

The original question and the responses provided in UN#09-329 and UN#09-388 are still applicable. FSAR Section 3.2 and 3.7.2.8 were updated in Revision 6 (UN#09-385) to better describe Seismic Category II-SSE. In-Structure Response Spectra (ISRS) for the NAB are provided in FSAR Section 3.7.2.5.1.

**03.07.02-19**

In FSAR Section 3.7.2.8 on page 3.0-42 it states that the conventional seismic switchgear building, conventional seismic grids systems control building, the conventional seismic circulating water intake structure and the Seismic Category II retaining wall surrounding the CCNPP Unit 3 intake channel could potentially interact with Seismic Category I SSCs. For each of the above structures, describe in the FSAR how the seismic interaction acceptance criteria of SRP 3.7.2, SRP Acceptance Criteria 8 are met, or justify an alternative. If they are intended to meet criterion B, provide the technical basis for the determination that the collapse of the non-Category I structure is acceptable. For criterion C, confirm that the structure will be analyzed and designed to have a margin of safety equivalent to that of a Category I structure and state how this will be accomplished.

**Response**

The seismic interaction for each of the four structures mentioned in the question is addressed below. Table 1 provides the criteria used to prevent seismic interaction with other Seismic Category I structures, systems and components (SSCs).

Switchgear Building

The Switchgear Building is a steel framed structure located adjacent to the Turbine Building, as mentioned in FSAR Section 3.7.2.8. The Turbine Building and Switchgear Building together comprise a common Turbine Island (TI) structure. The Switchgear Building is reclassified as a Seismic Category II structure and will be analyzed using the same methodology as the Turbine Building, which is described in response to U.S. EPR FSAR NRC RAI 248 Question 03.07.02-56. Specifically, the Turbine Building and Switchgear Building will be designed using conventional seismic codes and standards (IBC, ACI 318, AISC 341 and AISC 360 as per Table 1), but also will be analyzed and designed using site-specific SSE Foundation Input Response Spectrum (FIRS) to prevent seismic interaction with the Seismic Category I SSCs.

The design based on this methodology will meet the acceptance criteria 8.A of SRP 3.7.2.

Conventional Seismic Grid Systems Control Building

The seismic interaction of Conventional Seismic Grid Systems Control Building is addressed in FSAR Section 3.7.2.8. This building is located in the Switchyard area, and has a minimum separation distance of approximately 700 ft from the nearest Seismic Category I structures, systems, and components (see FSAR Figures 2.1-5). Therefore, collapse of this building has no adverse impact on the function of Seismic Category I SSCs. This meets the acceptance criteria 8.A of SRP 3.7.2.

Circulating Water System (CWS) Makeup Water Intake Structure (MWIS)

CWS MWIS is reclassified as a Seismic Category II structure. As shown in FSAR Figures 9.2-4, 10.4-4 and 10.4-5, the CWS MWIS is situated between the safety-related buried intake pipes, and is integrally connected to the Seismic Category I Forebay Structure, which in turn is integrally connected to the Seismic Category I Ultimate Heat Sink (UHS) MWIS. The CWS MWIS, Forebay Structure and UHS MWIS are supported on a common basemat.

The safety-related buried intake pipes are at least 15 ft away from the embedded walls of the CWS MWIS, and therefore, there is no possibility of any seismic interaction. Since the CWS MWIS is connected to Seismic Category I Forebay Structure, the embedded concrete portion of the CWS MWIS will be designed as a Seismic Category I structure. Therefore, the design methodology for embedded concrete structure will meet the acceptance criteria 8.C of SRP 3.7.2.

The minimum distance between the aboveground steel enclosure, which is approximately 30 ft high and is supported on the operating deck slab of CWS MWIS, from the North Wall of Forebay Structure is approximately 50 ft, and there is no potential for an adverse interaction between the steel enclosure and the Seismic Category I SSCs. This will meet the acceptance criteria 8.A of SRP 3.7.2.

Forebay Structure (Retaining Wall surrounding the intake channel)

At the new location of intake structures, the Forebay Structure located between the UHS MWIS and CWS MWIS is classified as a Seismic Category I structure (see FSAR Figure 9.2-4). Therefore, the seismic interaction of Forebay Structure is not addressed in this response.

**Table 1 - Seismic Structural Interaction Criteria for Calvert Cliffs 3 Site-Specific Building Structures**

| Basis: Control Interaction through Prevention of Structure-to-Structure Impact[1] | | | | |
|---|---|---|---|---|
| **Structure** | **Seismic Category** | **Design Code** | **Seismic Interaction Criteria** | **Seismic Interaction Evaluation** |
| Turbine Building and Switchgear Building | SC-II[2b] | IBC<br>Steel – AISC 341, AISC 360 & AISC N690[3]<br>Concrete – ACI 318 & ACI 349[3] | SSE | No Interaction |
| Grid Systems Control Building | CS[2a] | IBC<br>Steel – AISC 360<br>Concrete – ACI 318 | None | No Interaction |
| Circulating Water Intake Structure | SC-II[2b] | IBC<br>Steel – AISC 360<br>Concrete – ACI 349 | SSE | No Interaction |

**Notes:**

1. This table is not applicable to equipment and subsystems qualification criteria.
2. Seismic Classification
   a. Conventional Seismic
   b. Seismic Category II
3. AISC N690 and ACI 349, as applicable, will be used for SSE and tornado load combinations in the design of the Lateral Force Resisting System (LFRS).

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

FSAR Table 3.2-1 will be updated to include the seismic classification of Turbine Building and Switchgear Building with the RAI 109 Question 03.02.01-5 response.

**03.07.02-20**

In FSAR Section 3.7.2.8 on page 3.0-42, it states that the existing non-seismic bulkhead could potentially interact with the Ultimate Heat Sink (UHS) Makeup Water Intake Structure and UHS Electrical Building. Identify and describe the methods used to determine that this structure will not have any unacceptable interaction with either of the Seismic Category I structures?

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are still applicable. The reconfigured UHS was previously added to the FSAR and is shown in Rev 6 (UN#09-385)

**03.07.02-21**

For FSAR Section 3.7.2.11 (Method Used to Account for Torsional Effects) covered on page 3.0-43, describe how the methods used meet SRP 3.7.2, SRP Acceptance Criteria 11. How are the seismic forces due to torsional effects calculated and how are they combined with the other seismic forces of the structure?

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-228 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-22**

In FSAR Section 3.7.2.15 (Analysis Procedure for Damping) on page 3.0-44, for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure, it states that calculated stiffness is lumped for the whole foundation and that subsequently the stiffness is distributed based on tributary area. What equations are used to calculate the stiffness for the whole foundation and how is this stiffness distributed to tributary areas?

**Original Response** **UN#09-126**

**Update**

The original question, and the response provided in UN#09-126 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-23**

At the end of FSAR Section 3.7.2.15, on page 3.0-44, there is a description of a comparison of an analysis result using ANSYS to solve the complex eigen-value solution of the non-classical damping formulation with an analysis result using GT STRUDL to solve the real eigen-value solution of the classical damping formulation in which the offdiagonal terms of the damping matrix are neglected. It is not clear from the discussion which of the damping methods was used in the seismic analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). In addition, no comparison of the results using the two methods cited has been provided. Provide the method used to account for damping in the seismic analysis of the UHS MWIS and provide in the FSAR the results of the study comparing the non-classical damping formulation with the classical damping formulation.

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4. The comparison of non-classical damping with classical damping is no longer applicable. FSAR Section 3.7.2.15 has been revised.

**03.07.02-24**

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

**Original Response** **UN#09-388**

**Update**

The original question and the response provided in UN#09-388 are still applicable. Note that referenced Section, Table, and Figure numbers may have changed. In-Structure Response Spectra (ISRS) of the Nuclear Auxiliary Building and the Radioactive Waste Processing Building are developed and discussed in Section 3.7.2.5.1.

**03.07.02-25**

FSAR Section 3.7.2.9 (Effect of Parameter Variation on Floor Response Spectra) on page 3.0-43 describes the effects of parameter variations on floor response spectra. It states that to account for uncertainties or variations in parameters, In-Structure Response Spectra (ISRS) for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) are broadened +/- 15 percent in accordance with ASCE 4-98 and RG 1.122. Since ASCE 4-98 has not been accepted for use by the staff to develop ISRS and as it describes methods to account for uncertainties and parameter variations that are not included in RG 1.122, the applicant is requested to confirm that only the guidance provided in the RG is used for peak broadening or provide justification for not doing so.

**Original Response** **UN#09-228**

**Update**

The original question and the response provided in UN#09-228 are still applicable. The effect of parameter variation on floor response spectra are evaluated in conformance with the U.S. EPR FSAR. Section 3.7.2.9 has been updated to state "No departures or supplements"

**03.07.02-26**

SRP 3.7.2, SRP Acceptance Criteria 14 states that the determination of seismic overturning moments and sliding forces should include three components of input motion and conservative consideration of the simultaneous action of the vertical and horizontal seismic forces. How overturning moments and sliding forces are determined has not been provided in either FSAR Section 3.7.2, 3.8.5 or in Section 3E.4. The applicant is requested to provide this information in Section 3.7.2 and describe how this information is used in determining the overturning and sliding stability of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure and UHS Electrical Building

**Original Response** **UN#09-291**

**Update**

The original question and the response provided in UN#09-291 are no longer applicable.

The methodology for determination of overturning moment and sliding forces is different for the SASSI analysis. Therefore, Section 3.7.2.14 describes the methodology based on SASSI analysis.

**03.07.02-27**

Please clarify how locations are selected within the Ultimate Heat Sink (UHS) Make-up Water Intake Structure (MWIS) floors, or within the UHS Electrical Building (EB) for the development of in-structure response spectra (ISRS) which are required for the qualification of equipment, components, and piping. In addition, it was stated during the structural audit that the ISRS developed as part of the U.S.EPR certified design would be used to qualify piping systems located within EPR standard design structures for Calvert Cliffs. COL Information Item 3.9-10 of the U.S. EPR FSAR states that pipe stress and support analysis will be performed by a COL applicant that references the U.S. EPR design certification. Please clarify the source of the input structure response spectra for this analysis. In addition to providing information on how locations within the UHS MWIS and UHS EB are selected for the generation of ISRS, please provide additional information confirming that the Certified Design ISRS documented in the U.S. EPR FSAR are used for the qualification of piping and pipe supports within the buildings of the U.S. EPR Certified Design. Please also address the same question for seismic Category I equipment and components.

**Original Response** **UN#09-285**

**Update**

The original response provided in UN#09-285 is no longer applicable.

ISRS at the location of safety-related equipment are developed using the SSI model described in Section 3.7.2.4. Floor response spectra for the Nuclear Island Common Basemat Structures are discussed in 3.7.2.5.1. Floor response spectra for the EPGB and ESWB Structures are discussed in 3.7.2.5.2. Floor response spectra for the UHS Structures are discussed in 3.7.2.5.3.

**03.07.02-28**

Follow-up 1 to Question 03.07.02-16 (RAI No. 65)

The staff reviewed the response to RAI No. 65, Question 03.07.02-16 and the proposed change to the CCNPP Unit 3 FSAR (UniStar letter No. UN#09-126, dated March 19, 2009) for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure, and found them acceptable based on the fact that the time history method used meets the guidance provided in Regulatory Guide (RG) 1.92. However, in the March 19 RAI response, the proposed revision to FSAR Section 3.7.2.7 states that the combination of modal responses does not apply to the UHS Electrical Building (EB). Instead, because of its small cross-section size and significant stiffness, the response of the UHS EB is based on the ground motion Zero Period Acceleration (ZPA). Please include in FSAR Section 3.7.2.7 additional technical justification for the assumed seismic response of the UHS EB, or include references to other FSAR Sections where such technical justification may have been provided.

**Original Response** **UN#09-371**

**Update**

The original question and the response provided in UN#09-371 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-29**

Follow-up 1 to Question 03.07-02-22 (RAI No. 65)

The staff reviewed the response to RAI No. 65, Question 03.07.02-22 (UniStar letter No. UN#09-126, dated March 19, 2009) regarding the distribution of foundation stiffness to the basemat nodes, and concluded that the response included only a concept of how the springs are calculated for the tributary areas, and did not provide enough information as to how this was accomplished for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). Provide a specific example showing how the methodology is applied to the UHS MWIS, including how the nodes are distributed in the foundation, and how the tributary area is determined for each node. Also, the March 19 RAI response stated that the stiffness values are amplified to account for embedment effects using factors given in Table C3.3-1 of American Society of Civil Engineers (ASCE) 4-98, "Seismic Analysis of Safety-Related Nuclear Structures," which is applicable to circular foundations. In the forthcoming response to RAI No. 65, Question 03.07.02-6, which will address issues regarding the Soil Structure Interaction (SSI) analysis of this structure, provide discussion of how embedment effects are determined, including justification for the use of Table C3.3.1 for the UHS MWIS, which has a rectangular foundation and is not embedded on all sides, and how the stiffness of the soil is calculated.

**Original Response** **UN#09-371**

**Update**

The original question and the response provided in UN#09-371 are no longer applicable.

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**03.07.02-30**

Follow-up Question to RAI No. 65, Question No. 03.07.02-10:

The staff reviewed the applicant's response and requests the applicant to provide the following additional information in order for the staff to complete its review:

1. The applicant stated in its response that the entire water mass was conservatively considered in determining the impulsive load acting perpendicular to each wall for the equivalent static analysis. In the next sentence of the response, the applicant stated that the impulsive masses of contained water inside each chamber of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) are calculated in accordance with Equation (9-1) of Section 9.2.1 in ACI 350.3-06. The applicant is requested to clarify why two different methods are referred for calculation of impulsive water mass, and how the above two methods were used.
2. The applicant stated in the response that "Westergaard Added Mass" methodology was used for calculating the impulsive water mass associated with the fore bay water on the exposed side of the intake structure. The staff notes that the above methodology has limitations on its application, and may not be appropriate for intake structures having complex geometry like the UHS MWIS. Further, the added mass representation of hydrodynamic pressure ignores the effects of water compressibility and water-foundation interaction which may be significant in certain instances. The applicant is, therefore, requested to provide justification why the Westergaard Added Mass methodology is considered adequate either by comparing the results with those from a more refined analysis, or providing results of any existing comparative analysis that may be considered applicable to this case, or by any other suitable means.
3. The applicant did not provide enough information in the response about how the impulsive water mass was included in the soil-structure-interaction analysis of the UHS MWIS in order for the staff to review if the guidance provided in the SRP 3.7.2 Acceptance Criteria 14 were met. The applicant is, therefore, requested to describe how the analysis of the UHS MWIS for hydrodynamic loads meets the guidance provided in SRP 3.7.2 Acceptance Criteria 14.A through 14.J, or provide justification for not doing so.

**Response**

1) This response is based on the current configuration with integrated structures comprising of Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS), Forebay and Circulating Water System (CWS) MWIS (see COLA FSAR Figure 9.2-4).

As clarified in response to Part 2, "Westergaard Added Mass" methodology is not used in the new configuration.

The methodology described in ACI 350.3-06 is used for calculation of hydrodynamic loads for these structures. For illustration purposes, the discussion here is limited to the calculation of impulsive loads for the UHS MWIS, which is representative of the methodology for the integrated structure.

Figure 1 shows the plan view of the UHS Makeup Water Intake Structure water basin which is used as an example to demonstrate the calculation of impulsive loads on both exterior and

interior walls.

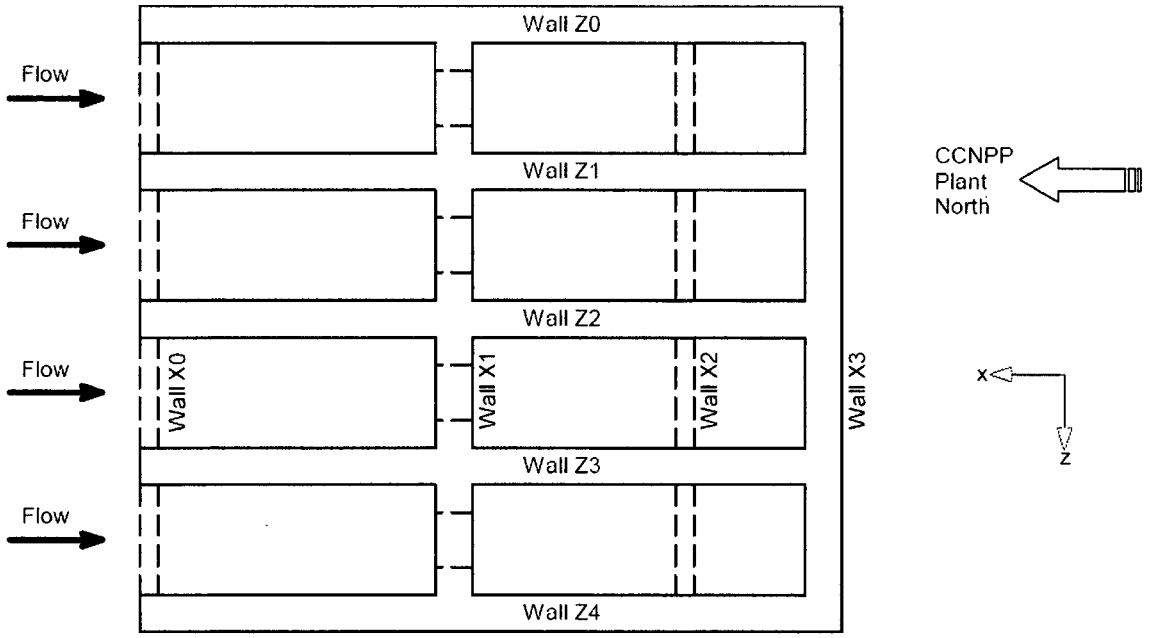
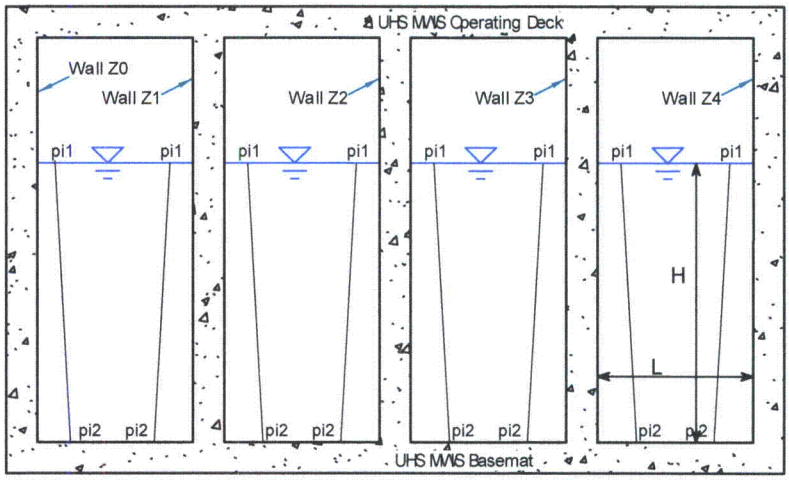



**Figure 1 Plan View -UHS MWIS**

During an earthquake in East-West (E-W) direction, walls along North-South (N-S) (wall Z0 through Z4) will be subjected to impulsive water pressures. There are four identical water basins in the structure as shown in Figure 1. Impulsive pressures pi1 and pi2 in each basin is calculated using dimension L (in the direction of the earthquake) and liquid height H of the chamber using Section 9.2 of ACI 350.3. Note that interior walls carry impulsive pressures from both sides as shown in Figure 2.



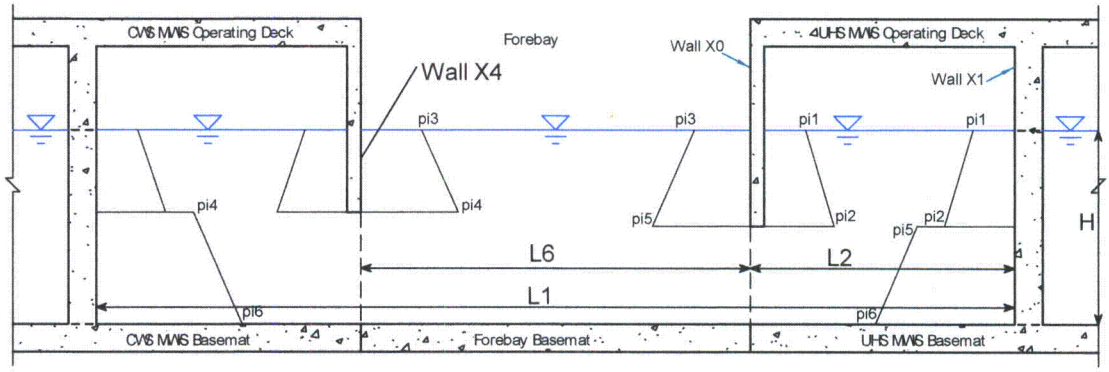

Section View (Looking South)

**Figure 2 Impulsive Load in E-W Direction**

Walls along E-W (Walls X0 through X3, see Figure 1) are subjected to impulsive pressures due to earthquake in the N-S direction. This configuration is a little complex due to openings/discontinuous in some walls as shown in Figure 3.

Impulsive pressures on each wall are calculated by taking into account the openings, height of water H and length of chamber L in the direction of the earthquake, using ACI 350.3 as shown in Figure 3. For example, the impulsive pressures (pi3 and pi5) on wall X0 and pi3 and pi4 on wall X4 are conservatively calculated assuming that walls X0 and X4 run full height and then using only top portion of this pressure diagram. This pressure diagram is calculated for full water height H and length of chamber L6 but only part of it from bottom of walls X0/X4 is used, as shown in Figure 3. Similar approach is used to calculate pressures on the other side of these intermediate partial walls using the corresponding water height and chamber length from that side (Figure 3).

For walls such as X1, the equivalent pressure diagrams are conservatively estimated as a combination of two parts using ACI 350.3 approach (1) bottom portion of pressure diagram (up to the bottom of wall X0) is determined by assuming the full length L1 of the chamber for the bottom portion of the liquid and full liquid height H and (2) top portion of the pressure diagram (above bottom of Wall X0) is estimated based on the chamber length L2 and liquid height H. The composite pressure diagram that represents an equivalent pressure acting on Wall X1 is shown in Figure 3. Similarly pressure diagrams are estimated on the other side of wall X1. Wall X1 will carry impulsive pressure from both sides as shown in Figure 3. The methodology presented above adequately captures the impulsive pressure effect on external and internal walls of the UHS MWIS. Similar process is used in impulsive pressure determination of other structures.




Section View (Looking East)

**Figure 3 Impulsive Loading in N-S Direction**

2) In the new analysis, the 'Westergaard Added Mass' method referred in the response to question 03.07.02-10 is not used. Therefore, FSAR Sections 3.7.2.3.2 and 3.7.2.16 have been revised accordingly.

3) The hydrodynamic load effects have been included in the SASSI analysis, as described in FSAR Section 3.7.2.3.2.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-31**

Follow-up Question to RAI No. 65, Question No. 03.07.02-14:

The staff reviewed the applicant's response to question 03.07.02-14, and requests the applicant to provide the following additional information to complete its review:

1. In its response the applicant stated that 20 percent damping was used for soil driven modes. SRP 3.7.1, SAC-2 states that the maximum soil damping acceptable to the staff is 15 percent. In addition, no amplification factor was used in applying the maximum response from the input design spectra to the structure. However, as a soil-structure interaction (SSI) analysis using the SASSI code will be performed to confirm the design loads for the structure, this part of the response is acceptable pending the results of that analysis. Therefore, the applicant is requested to include in the FSAR a description of the proposed SASSI analysis along with a comparison of the preliminary design input used for design of the structure with the results obtained from the SASSI analysis.
2. At the end of the response the applicant stated that for the Ultimate Heat Sink (UHS) Electrical Building (EB), the design is governed by the probable maximum hurricane (PMH). According to the drawings the structure is almost completely buried. It is not readily apparent how the PMH controls the design. The applicant is requested to elaborate on how the PMH controls the design of the building.

**Response**

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4. Therefore no comparison has been made.

The UHS EB location and configuration has changed since the response to question 03.07.02-14 was submitted. For the new location and configuration, the seismic demand is determined using a soil-structure interaction (SSI) analysis, including structure-soil-structure interaction (SSSI) effects from the UHS Makeup Water Intake Structure.

An analysis for non-seismic loads (including PMH) will be performed, and the results will be updated in FSAR Section 3.8.4, Section 3.8.5 and Appendix 3E.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

COLA FSAR Section 3.8.4, Section 3.8.5 and Appendix 3E will be updated in a future submittal.

**03.07.02-32**

Follow-up Question to RAI 65, Question 03.07.02-3

The staff reviewed the response to RAI No. 65, Question 03.07.02-3, submitted by the applicant in its letter UN#09-291 dated June 12, 2009. The staff noted that the applicant will quantify the building seismic relative displacements in a structure-soil-structure interaction (SSSI) analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) and the UHS Electrical Building (EB) after a geotechnical site investigation. Since this analysis will provide input for design of seismic category I buried commodities, please confirm that the SSSI analysis was performed and the results used for design of seismic category I buried commodities, and update the FSAR accordingly.

**Response**

The UHS MWIS and UHS EB are included in the integrated finite element model used for SASSI analysis, which can be used to determine the relative displacement at the interface of buried commodities with these structures. For the design of Seismic Category I buried commodities, the response time histories of relative displacements between the UHS MWIS and UHS EB at the building interface locations are used. This is discussed in FSAR Section 3.7.2.4.6.3.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-33**

Follow-up Question to RAI 65, Question 03.07.02-5

The staff reviewed the response to RAI No. 65, Question 03.07.02-5, submitted by the applicant in its letter UN#09-291 dated June 12, 2009. The applicant stated in the response that GT STRUDL element type SBHQ6 was used in the finite element analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). The SBHQ6 element is a stretching and bending element appropriate for thin plates and shells. However, the foundation and some of the walls of this structure have low span-to-depth ratios such that out-of-plane shear deformations could be significant. Therefore, please provide a technical basis for using the SBHQ6 element for the static analysis of the UHS MWIS.

**Response**

The static analysis of the integrated GTSTRUDL finite element model of Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS), (including the Forebay and the Circulating Water Intake Structure) and the UHS Electrical Building utilizes GTSTRUDL element SBHQ6, a thin plate element. The element SBHQ6 does not include the effects of out-of-plane shear deformations. However, this element was used because the design of the walls is governed by in-plane shear. The design of the common basemat is governed by bending in the forebay portion. Specific locations in the structure having low span-to-depth ratios where out-of-plane shear deformations could become significant will be evaluated during the detailed design, as appropriate.

The dynamic soil structure interaction analysis of the integrated finite element model is performed using SASSI2000 element SHL17, a thick plate element. The element SHL17 captures the effects of out-of-plane shear deformations.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-34**

Follow-up Question to RAI 65, Question 03.07.02-7

The staff reviewed the response to RAI No. 65, Question 03.07.02-7, submitted by the applicant in its letter UN#09-291 dated June 12, 2009. The staff noted that the applicant's current analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) is based on preliminary soil data, and a soil-structure interaction (SSI) analysis that will include effects of ground water will be performed after further geological investigations. Therefore, please provide a detailed description of the SSI analysis of the UHS MWIS including the boundary conditions, modeling assumptions, how the dynamic input was determined, how ground water effects were accounted for, and revise the FSAR accordingly.

**Response**

A detailed description of the SASSI analysis of UHS MWIS has been provided in FSAR Section 3.7.2.4. Additional description about the analytical modeling of UHS MWIS is provided in FSAR Section 3.7.2.3.2.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-35**

Follow-up Question to RAI 65, Question 03.07.02-8

In order for the staff to complete its review of response to RAI No. 65, Question 03.07.02-8, submitted by the applicant in its letter UN#09-291 dated June 12, 2009, please provide the following additional information:

1. Please explain the difference between the results which represent seismic and non-seismic loading combinations (north-south exterior wall) and results which represent the worst case loading condition (other structural elements) by providing the specific loading combinations used for each result, identifying the locations of the other structural elements and describing for the other structural elements how the worst case loading combination was determined.
2. FSAR Table 3E.4-2, "Demand Table for the UHS MWIS Side Walls," contains a load combination of (DL+LL+H), in which the MYY moment is 418.65 kip-ft/ft. Please explain why the results for this loading combination are repeated in the bottom row of the same table.
3. Please explain why in note 1, Table 1 of Enclosure 3 of the response referred to above, the load combination of DL + LL+ H is divided by a factor of 1.5.

**Response**

The information provided in the response to NRC RAI 65 Question 03.07.02-8 was based on analysis and design of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) in Revision 5 of the COLA FSAR. The analysis and design results in FSAR Sections 3.8.4, 3.8.5, and Appendix 3E will be updated in a future submittal.

**COLA Impact**

FSAR Section 3.8 and Appendix 3E will be updated in a future submittal.

**03.07.02-36**

Follow-up Question to RAI 65, Question 03.07.02-11

In its response to RAI No. 65, Question 03.07.02-11 submitted via letter UN#09-291 dated June 12, 2009, the applicant provided reasonable assumptions regarding the preliminary design approach to account for the convective forces of sloshing water and its impact on the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). In FSAR Section 3.7.2.4 it states that during detailed design it will be confirmed that the convective forces of water sloshing have a negligible impact on both the overall design of the structure and component design. Therefore, please include in the FSAR a comparison of the results from a soil-structure interaction (SSI) analysis which includes the effect of the convective water mass with the preliminary design approach, and confirm that the convective forces on the structure are acceptable.

**Response**

FSAR Section 3.7.2.3.2 includes a discussion for convective frequencies for the Common Basemat Intake Structures.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-37**

Follow-up Question to RAI 65, Question 03.07.02-23

The staff reviewed the applicant's response to RAI No.65, Question 03.07.02-23 submitted via letter UN#09-291 dated June 12, 2009, and found the results of the comparison of modal damping ratios using composite modal damping formulation and complex eigensolution to be acceptable. The use of 7 percent structural damping for the generation of in-structure response spectra (ISRS) is justified if the stresses in the structure are near their code allowables as this implies concrete sections are cracked. The applicant in its response to Question 03.07.02-8 states that the use of uncracked section properties is justified for the seismic analysis of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). This suggests that structural damping values used in seismic analysis to generate ISRS should be 4% not 7%. Therefore, please demonstrate the validity of the ISRS for the UHS MWIS currently shown in FSAR Figures 3.7-39 through 3.7-41 by comparing them with the ISRS obtained by soil-structure interaction (SSI) analysis using 4 percent structural damping per RG 1.61, and update the FSAR accordingly. Similarly, ISRS used for the UHS EB should be confirmed by the SSI analysis for that structure using 4 percent structural damping.

**Response**

The ISRS for UHS MWIS and UHS EB from the new SASSI analysis are developed using 4% structural damping. FSAR Section 3.7.2.5.3 provides the ISRS for these structures.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-38**

Follow-up Question to RAI 65, Question 03.07.02-26

The staff reviewed the applicant's response to RAI No. 65, Question 03.07.02-26 submitted via letter UN#09-291 dated June 12, 2009. The approach used by the applicant to determine the sliding forces and overturning moments considered the three components of earthquake response, and is acceptable to the staff. However, in order for the staff to complete its evaluation the applicant needs to provide the following additional information:

- The applicant stated that the stability of the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) for applicable loading is determined using the stability load combinations provided in SRP 3.8.5, Acceptance Criteria 3 (NRC, 2007a), which are listed as Load Combinations 6 to 9 in FSAR Table 3E.4-1. However the restoring moments apparently include (in addition to the self weight of the structure and the weight of the permanent equipment) the contained water during normal operation, 25% of the design live load and 75% of the design snow load. Please provide technical justification for including these additional loads in developing the restoring moment for the structure.
- It is not clear if, in calculating the resistance to sliding, the applicant has reduced the deadweight of the structure by the effect of the structure's vertical acceleration. Please include this clarification in the FSAR.
- Table 2.5-36 provides coefficients of friction for the native soils but does not provide a coefficient of friction for the structural backfill that will support the UHS MWIS foundation and the foundations of other seismic Category I structures. Please identify the coefficient of friction for structural backfill used in the sliding computation.

**Response**

FSAR Section 3.7.2.14 provides the methodology to evaluate overturning as required by RG1.206. The demand and subsequent factors of safety are part of Section 3.8.5.

Table 2.5-58 of the updated FSAR Section 2.5.4 provided in UniStar letter UN#09-427 indicates a coefficient of sliding friction of 0.40 for the backfill.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

FSAR sections 3.8 and Appendix 3E will be updated in a future submittal.

**03.07.02-39**

Follow-up Question to RAI 113, Question 03.07.02-27

In its response to RAI No. 113, Question 03.07.02-27, sent via letter UN#09-285 dated June 18, 2009, the applicant provided the basis for selecting the locations for generation of in-structure response spectra (ISRS) for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS), which is based on two locations of safety-related pumps on the operating deck at elevation 11.5 ft. The applicant further stated in the response that as the locations of safety-related piping and components are finalized supplemental ISRS will be generated. The approach is reasonable and acceptable to the staff. However, current text in FSAR Section 3.7.2.5 does not reflect this. Therefore, please revise FSAR Section 3.7.2.5 to clarify that the ISRS provided in Figures 3.7-39 through 3.7-41 are applicable only to the pumps or other equipment at the two locations at elevation 11.5 ft (3.51M), and that supplemental ISRS at additional locations will be generated on an as-needed basis.

The text in Section 3.7.2.4 states that the design response spectra for the UHS Electrical Building (EB) are envelope of half EUR soft soil ground motion response spectra with ZPA of 0.15g and ISRS developed for the operating deck of the UHS MWIS, and are used for structural design and equipment qualification purposes. However, in the response the applicant stated that SASSI analysis will be performed for development of ISRS for the EB. Therefore, please revise FSAR Section 3.7.2.4 to reflect that ISRS for the EB are developed from a SASSI analysis of the structure, and include in the FSAR the ISRS for appropriate slab elevations of the EB.

The applicant, in response to a request to clarify the source of ISRS for the pipe stress and support analysis within the U.S.EPR Certified Design, has stated that the ISRS are generated from the soil cases of U.S. EPR FSAR Section 3.7.1. However the specific soil cases and design response spectra used to generate the ISRS have not been identified. Therefore, please provide this additional information, and include the ISRS applicable to the NI, ESWB and EPGB in FSAR Section 3.7.2.5.

**Response**

FSAR Section 3.7.2.5.3 includes a discussion about the locations within UHS MWIS and UHS EB where the ISRS are developed from the SASSI analysis.

The specific soil cases used to generate the ISRS within the U.S. EPR Certified Design are described in US EPR FSAR, Tier 2, Section 3.7.1.3 and Table 3.7.1-6. The ground design response spectra used for the NI are described in U.S. EPR FSAR, Tier 2, Section 3.7.1.1.1 and shown in Figures 3.7.1-1 and 3.7.1-2. For the EPGB and ESWB, the ground design response spectra are described in U.S. EPR FSAR, Tier 2, Section 3.7.1.1.1 and shown in U.S. EPR FSAR, Tier 2, Figures 3.7-1.33 and 3.7.1-34. The ISRS applicable to the NI Common Basemat Structures, EPGB, and ESWB are shown in the U.S. EPR FSAR, Tier 2, Figures 3.7.2-74 through 3.7.2-112. The ISRS envelopes are used to design the NI Common Basemat Structures, EPGB, and ESWB, including piping, cable trays and commodity supports.

Section 3.7.2.5.1 and 3.7.2.5.2 include this clarification.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-40**

Follow-up Question to RAI No. 65, Question 03.07.02-15

Overall, the weighted average process described by the applicant in its response to RAI No. 65, Question 03.07.02-15 appears to provide a systematic method for taking the accelerations obtained from the dynamic analysis and applying them to the static model to obtain forces and moments for structural design. However, it is not clear when calculating the weighted average, if the actual sign at a particular mass point is considered in the summation. For example, it appears from the bubble plot for acceleration in the Y direction due to a Z direction earthquake that the structure is rocking about the X axis. Presumably this results in positive Y accelerations on one side of the slab and negative Y accelerations on the other side. Summing these could result in a small weighted average for the slab in the Y direction due to an earthquake in the Z direction. The applicant is requested to clarify if the absolute or signed acceleration values are used in the weighted average calculation. If the signed acceleration values are used, the applicant needs to address why this is acceptable as this could underestimate the actual slab bending forces due to the overturning effect of the earthquake. A similar situation can arise regarding accelerations in the X and Z directions when structure twists about the Y axis.

**Response**

The time history analysis for the UHS MWIS and the equivalent static method of analysis for the UHS EB are superseded by the SASSI analysis described in Section 3.7.2.4.

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

**03.07.02-41**

Follow-up Question to Partial Response to RAI No. 65, Question 03.07.02-18

The staff reviewed the partial response to RAI No. 65, Question 03.07.02 -18 submitted by the applicant in its letter UN#09-329 dated July 29, 2009. The staff's assessment only addresses the response regarding the seismic classification of the Fire Protection Building and Fire Protection Tanks. The other issues addressed in the original question have a future response date. In its response the applicant has provided a revision to the CCNPP FSAR which clarifies the change of seismic category for portions of the fire protection system that must remain functional from conventional seismic as stated in the U.S. EPR FSAR to Seismic Category II-SSE, and identified the fire protection systems under this category. In its response the applicant has also stated that certain portions of the fire protection system are only required to remain intact after a safe shutdown earthquake (SSE) without deleterious interaction with Seismic Category I or Seismic Category II-SSE components and classified them as Seismic Category II, but did not identify which systems fall under this category. The applicant is requested to identify and include in the FSAR the Seismic Category II portions of the fire protection structures, systems and components.

**Response**

The portions of fire protection systems and components classified as Seismic Category II referred in the NRC question are the following:

- The automatic suppression systems located above and/or protecting the Seismic Category II-SSE systems and components within the Fire Protection Building;
- The automatic suppression systems located above and/or protecting the Seismic Category I systems and components within the UHS Makeup Water Intake Structure; and
- The automatic suppression systems located above and/or protecting the Seismic Category I systems and components within the UHS Electrical Building.

Although not required to function in the event of an SSE in accordance with Regulatory Guide 1.189, these Seismic Category II suppression systems are designed to maintain their pressure boundaries in the event of an SSE so that no action is required to isolate these systems from the Seismic Category II-SSE systems and components. Isolation valves designated as Seismic Category II-SSE are provided to isolate Seismic Category II systems from Seismic Category II-SSE systems.

All other fire protection systems and components are designated as:

- Seismic Category II-SSE if these are essential to the supply of standpipes and hose stations required for manual fire fighting in areas containing equipment required for safe plant shutdown in the event of a SSE in accordance with Regulatory Guide 1.189 (this includes those systems and components designated as Seismic Category II in the U.S. EPR FSAR Table 3.2.2-1 that remain functional in the event of a SSE);
- Seismic Category I if these are required for containment isolation as identified in the U.S. EPR FSAR Table 3.2.2-1; or

- Non-Seismic.

FSAR Section 3.7.2.8 was revised to clarify the capability of Seismic Category II portions of fire protection SSCs to maintain a pressure boundary after an SSE event

**COLA Impact**

See revised FSAR Section 3.7 in Enclosure 1 of this letter.

Changes to other pages are provided in Enclosure 3.

- FSAR Table 1.7-2 to include Figures 9.5-2 through 9.5-5 in the Table of Piping Instrumentation Diagrams;

- FSAR Table 3.2-1 to differentiate between Seismic Category II-SSE standpipes and hose stations and Seismic Category II suppression systems;

- FSAR Section 9.5.1.2.1 to provide a written description of the addition of Figures 9.5-4 and 9.5-5;

    - Revised Figures 9.5-2 and 9.5-3 and new Figures 9.5-4 & -5 to clearly illustrate the underground and aboveground fire protection systems associated with the Balance of Plant Structures;

- FSAR Table 14.3-2 to include a line item identifying the ITAAC screening summary for Standpipes and Hose Stations protecting the UHS Makeup Water Intake Structure and the UHS Electrical Building. Note: This additional line item differentiates between Seismic Category II automatic suppression systems and Seismic Category II-SSE standpipes and hose stations; and

- Tables 2.4-26 and 2.4-27 of COLA Part 10 (ITAAC) to clarify the ITAAC Commitments, Inspections, Tests, Analyses and Acceptance Criteria for the fire suppression systems identified as Seismic Category II and the standpipe and hose stations identified as Seismic Category II-SSE.

**03.07.03-1**

FSAR Section 3.7.3.12 starting on page 3.0-45 describes the analysis for buried Seismic Category I piping, conduits and tunnels. For the analysis of these buried utilities, provide the following information:

- Describe any computer codes used for the analysis and their application to the analysis and design of buried utilities.
- Provide the soil properties used in the analysis and explain how differences in soil properties were accommodated in the analysis.
- Provide the design codes and acceptance criteria for each category of buried utilities.
- Describe the missile protection provided for safety-related buried utilities.
- Describe how ground water effects were considered in the analysis.
- For utility runs that are both above and below ground, describe how above ground inertial effects were combined with below ground seismic wave effects.
- Describe how the wave velocities were determined for calculating the maximum axial strain.
- Provide the basis for determining the maximum friction force per unit length of pipe.
- Describe how the building anchor point displacements were determined and how these were combined with seismic wave effects and soil loads.

**Original Response** **UN#09-320**

**Update**

The previous response provided in UniStar letter UN#09-320 is still applicable.

Note that the reference geotechnical investigation has been completed and soil properties are provided in the revised FSAR Section 2.5.4 provided by letter UN#09-427.

**03.07.03-2**

The applicant stated in its response to RAI No. 63, Question 03.07.03-1 that if backfill material extends well below the buried commodity (more than several feet) and if its modulus degradation and damping characteristics are significantly different than the native soil properties in the surrounding area, then the backfill properties will be used to obtain the spectrum at the buried commodity elevation. The applicant also stated that most likely any such exercise will be shown to be unnecessary because the site specific safe shutdown earthquake (SSE) chosen for Calvert Cliffs will well exceed the spectrum obtained from site response analyses. The applicant is requested to describe the process used in the site response analyses and how a spectrum based on these analyses will be determined. In addition the applicant should define the site SSE and how it is derived. Regarding the selection of values for peak ground displacement (PGD) the applicant stated that the PGD value is determined directly from the constant displacement portion of the acceleration spectra. The applicant is requested to identify which acceleration spectrum is being used and why the PGD value will be conservative. For determining a value for peak ground velocity (PGV), the applicant stated that the greater of values based on: (i) Equation 5-10 in NCHRP Report No. 611 "Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments" (Transportation Research Board, 2008), and (ii) the empirical rule of 4 ft/sec PGV per 1.0g peak ground acceleration (PGA), is used to provide a conservative value. However, other empirical estimate values can also be used for such design in addition to the values mentioned in the response above. The applicant is requested to state why the ones identified in the response are conservative.

**Response**

For clarity of the response the Question is divided into four parts as discussed below.

- The applicant is requested to describe the process used in the site response analyses and how a spectrum based on these analyses will be determined.

  Site response analysis for the soil columns in the NI and Intake areas are described in COLA FSAR Subsection 3.7.1.1 and Appendix 3F. Comparison of FIRS in these areas with Site SSE is also described in Subsection 3.7.1.1; it is shown that the Site SSE comfortably envelops the FIRS in these areas. Site SSE spectrum is applicable for the design of buried utilities in the NI area and the Intake area.

  As described in COLA FSAR Subsection 3.7.1.1.1.4, no site response analysis has been performed for the soil columns along the utility corridor running between intake and NI areas, shown in COLA FSAR Figures 3.8-1 and 3.8-3. However, once the layout, configuration and elevations of the utilities in the utility corridor have been confirmed during detailed design engineering phase, appropriate site response analysis will be performed using methodologies similar to those described in Appendix 3F.

- In addition the applicant should define the site SSE and how it is derived.

  Site SSE is shown in COLA FSAR Figure 3.7-1. The development of Site SSE is discussed in FSAR Subsection 3.7.1.1.1.1.

- The applicant is requested to identify which acceleration spectrum is being used and why the PGD value will be conservative.

The PGD value is determined as the greater of the values considering the constant displacement region of the site SSE spectrum, FIRS for NI area, and FIRS for MWIS area. The PGD value based on the site SSE spectrum, whose constant displacement region (i.e., the low frequency region) corresponds to the 0.1g RG 1.60 spectrum, is 3.60 inch (since 1.0g PGA in RG 1.60 corresponds to 36 inch PGD). The larger of the PGD values associated with these two FIRS was estimated to be 3.1 inch (calculated as: spectral acceleration of 0.078g at 0.10 Hz / $(2 \times \pi \times 0.1\ \text{Hz})^2$), which is lower than 3.6 inch.

However, the 3.1 inch PGD from these FIRS corresponds to a (site-specific) PGD/PGA ratio of about 0.11 $s^2$, whereas the PGD/PGA ratio implied in RG 1.60 is (36 inch / 386.4 inch/$s^2$) = 0.093 $s^2$. This indicates that the site-specific PGD/PGA value (0.11 $s^2$) should be considered for determining the PGD corresponding to the 0.15g PGA value of the Site SSE. The PGD value based on this approach is 0.11 $s^2$ X (0.15 X 386.4 inch/$s^2$) = 6.4 inch. As can be seen, the proposed PGD value of 6.4 inch is quite conservative.

- The applicant is requested to state why the ones (PGV values) identified in the response are conservative.

  The Site SSE is a composite of 0.15g EURS spectrum and 0.10g RG 1.60 spectrum (the RG-based spectrum governs at frequencies below 0.73 Hz). Review of the associated artificial (spectrally matched) time-histories shown in Figures 3.7-10 through 3.7-12 indicates that the maximum peak ground velocity (PGV) from the three sets of time-histories is about 19 cm/sec (7.5 inch/s). RG 1.60 provides an empirical rule of 4 ft/sec PGV per 1g of PGA. This suggests that the PGV corresponding to 0.15g PGA of the site SSE will be 0.15g X 4 ft/s X 12 inch/ft = 7.2 inch/sec. It is noted that the PGV equation (Eq. 5-10) in NCHRP Report 611 is conservatively biased as it seeks to predict mean-plus one standard deviation as the target and is based on ground motion data presented in NUREG/CR-6728. This empirical equation requires $S_1$ value (the spectral acceleration corresponding to 1-second period), which is equal to 0.18g in the Site SSE spectrum. Use of Eq. 5-10 in NCHRP Report No. 611 thus leads to a PGV prediction of approximately 10 inch/sec. It can thus be seen that the NCHRP equation provides a conservative estimate of the PGV and is therefore satisfactory for design purposes.

**<u>References for Response</u>:**

Regulatory Guide 1.60, Revision 1, "Design Response Spectra for Seismic Design of Nuclear Power Plant"

NCHRP Report 611 (2008), "Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes and Embankments"

NUREG/CR 6728 (October 2001), "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard-and Risk-consistent Ground Motion Spectra Guidelines"

**COLA Impact**

None

# Enclosure 3

## Conforming changes to other FSAR Sections and COLA Parts

**Table 1.1-1—{Acronyms Used in this Document}**
(Page 1 of 4)

| Acronym | Description |
|---|---|
| χ/Q | Atmospheric Dispersion Value |
| A/E | Architect – Engineer |
| AASHTO | American Association of State Highway and Transportation Officials |
| AB | Access Building |
| ACI | American Concrete Institute |
| AFDD | Accumulated Freezing Degree-Days |
| ALOHA | Areal Locations of Hazardous Atmospheres |
| ANS | American Nuclear Society |
| ANSI | American National Standards Institute |
| ANSS | Advanced National Seismic Network |
| AOV | Air-Operated Valve |
| AQCR | Air Quality Control Region |
| ASCE | American Society of Civil Engineers |
| ASHRAE | American Society of Heating, Refrigerating, and Air Conditioning Engineers |
| AWWA | American Water Works Association |
| BE | Best Estimate |
| BF | Butterfly Valve |
| BGE | Baltimore Gas and Electric |
| BMA | Brun |
| BWI | Baltimore/Washington International |
| C/NM | Consumable/Non-Metallic |
| CAM | Continuous Air Monitor |
| CBBT | Chesapeake Bay Bridge Tunnel |
| CCNPP | Calvert Cliffs Nuclear Power Plant |
| CD | Certified Design |
| CEUS | Central and Eastern United States |
| CK | Check Valve |
| CPCN | Certificate of Public Convenience and Necessity |
| CPT | Cone Penetrometer Test |
| CR | |
| CRE | Control Room Envelope |
| CRR | Cyclic Resistance Ratio |
| CSR | Cyclic Stress Ratio |
| CTI | Cooling Tower Institute |
| CVSZ | Central Virginia Seismic Zone |
| D.C. | District of Columbia |
| D/Q | Deposition Factor |
| DAC | Derived Air Concentration |
| DC | Direct Current |
| DCPLNG | Dominion Cove Point Liquefied Natural Gas |
| DI | Diaphragm Valve |
| DNAG | Decade of North American Geology |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| EC | Erosion/Corrosion |
| ECFS | East Coast Fault System |
| ECL | Effluent Concentration Limits |
| ECMA | East Coast Magnetic Anomaly |
| EMC | Electromagnetic Compatibility |

CBIS | Common Basemat Intake Structures

CSDRS | Certified Seismic Design Response Spectra


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**Table 1.1-1—{Acronyms Used in this Document}**
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| Acronym | Description |
|---|---|
| EPA | Environmental Protection Agency |
| EPIX | Equipment Performance and Information Exchange |
| EPR | Evolutionary Power Reactor |
| EQ | Environmental Qualification |
| ER | Environmental Report or Electrical Resistivity |
| ERC | Estuarine Research Center |
| ES | Engineered Safeguards |
| ESP | Early Site Permit |
| EST | Earth Science Team |
| ESWB | Essential Service Water B |
| ETR | Energy Transfer Ratio |
| FERC | Federal Energy Regulatory Commission |
| FFD | Fitness for Duty |
| FHA | Fire Hazards Analysis |
| FOS | Factor of Safety |
| FPE | Fire Protection Engineer |
| GB | Globe Valve |
| GSA | Geological Society of America |
| GT | Gate Valve |
| HF | High Frequency |
| HMR | Hydrometeorological Report |
| HO | Hydraulic Operated |
| HPS | Health Physics Society |
| ICEA | Insulated Cable Engineers Association |
| ICRP | International Commission on Radiological Protection |
| ID | Identification |
| IDLH | Immediately Dangerous to Life and Health |
| IRC | Independent Review Committee |
| ISFSI | Independent Spent Fuel Storage Installation |
| JFD | Joint Frequency Distribution |
| JPM | Job Performance Measures |
| KKS | Kraftworks Kennzeichen System |
| LB | Lower Bound |
| LERF | Large Early Release Frequency |
| LF | Low Frequency |
| LFL | Lower Flammability Limit |
| LiDAR | Light Detection and Ranging |
| LLC | Limited Liability Company |
| LNG | Liquefied Natural Gas |
| LSS | Low Safety Significance |
| LSZ | Lancaster Seismic Zone |
| MA | Manual Actuated |
| MD | Maryland |
| MDE | Maryland Department of Environment |
| MDNR | Maryland Department of Natural Resources |
| MED | Master Equipment Database |
| MEDEVAC | Medical Evacuation |
| MEOW | Maximum Envelopes of Water |
| MGS | Maryland Geological Survey |

FIRS | Foundation Input Response Spectra

GMRS | Ground Motion Response Spectra


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**Table 1.1-1—{Acronyms Used in this Document}**
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| Acronym | Description |
|---|---|
| MHHW | Mean Higher High Water |
| MLLW | Mean Lower Low-Water |
| MLW | Mean Low Water |
| MMI | Modified Mercalli Intensity |
| MOM | Maximum of the MEOWS |
| MPSSZ | Middleton Place-Summerville Seismic Zone |
| MRFF | Maintenance Rule Functional Failure |
| MSL | Mean Sea Level |
| MSS | Medium Safety Significance |
| NAAQS | National Ambient Air Quality Standards |
| NAS | Naval Air Station |
| NEC | National Electrical Code |
| NEI | Nuclear Energy Institute |
| NERC | North American Electric Reliability Corporation |
| NGVD 29 | National Geodetic Vertical Datum of 1929 |
| NHC | National Hurricane Center |
| NIC | National Ice Center |
| NIOSH | National Institute for Occupational Safety and Health |
| NJ | New Jersey |
| NLSWE | Nonlinear Shallow Water Equations |
| NOAA | National Oceanic and Atmospheric Admin |
| NP | Non-Proprietary |
| NPDES | National Pollution Discharge Elimination System |
| NPRDS | Nuclear Plant Reliability Data System |
| NRC | Nuclear Regulatory Commission |
| NRCS | U.S. National Resources Conservation Service |
| NWS | National Weather Service |
| NYAL | New York – Alabama Lineament |
| OCR | Over Consolidation Ratio |
| ODCM | Offsite Dose Calculation Manual |
| OJT | On-the-Job Training |
| OSHA | Occupational Safety and Health Administration |
| P | Proprietary |
| PA | Pilot Actuated |
| PCP | Process Control Program |
| PEPCO | Potomac Electric Power Company |
| PGA | Peak Ground Acceleration |
| PJM | Pennsylvania, New Jersey, and Maryland Regional Transmission Organization |
| PL | Plug Valve |
| PMH | Probable Maximum Hurricane |
| PMSS | Probable Maximum Storm Surge |
| PMT | Probable Maximum Tsunami |
| PMWP | Probable Maximum Winter Precipitation |
| PPRP | Power Plant Research Program |
| PSAR | Preliminary Safety Analysis Report |
| PSHA | Probabilistic Seismic Hazard Analysis |
| PSP | Physical Security Plan |
| PST | Pre-Service Testing |

OBE | Operating Basis Earthquake


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**Table 1.1-1—{Acronyms Used in this Document}**
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| Acronym | Description |
|---|---|
| PTS | Pressurized Thermal Shock |
| QAPD | Quality Assurance Program Description |
| QC | Quality Control |
| RCA | Radiologically Controlled Area |
| RCTS | Resonant Column Torsional Shear |
| RD | Rupture Disk Valve |
| REMP | Radiological Environmental Monitoring Program |
| RETS | Radiological Effluent Technical Specifications |
| RMS | Records Management System |
| RV | Relief Valve |
| RVT | Random Vibration Theory |
| SA | Self Actuated |
| SAR | Safety Analysis Report |
| SARA | Superfund Amendments and Reauthorization Act |
| SCDOT | South Carolina Department of Transportation |
| SCR | Stable Continental Region |
| SDWIS | Safe Drinking Water Information |
| SECPOP | Sector Population Land Fraction |
| SEUSSN | Southeastern U.S. Seismic Network |
| SGA | Salisbury Geophysical Anomaly |
| SLOSH | Sea, Lake, and Overland Surges from Hurricanes |
| SOV | Solenoid-Operated Valve |
| SPH | Standard Project Hurricane |
| SPT | Standard Penetration Test |
| STEL | Short-Term Exposure Limit |
| TEDE | Total Effective Dose Equivalent |
| TIP | Trial Implementation Project |
| TLD | Thermoluminescent Dosimeter |
| TNT | Trinitrotoluene |
| TOC | Total Organic Carbon |
| TRT | Tritium |
| TSU | Tsunami |
| TWA | Time Weighted Average |
| UB | Upper Bound |
| UCSS | Updated Charleston Seismic Source |
| UFL | Upper Flammability Limit |
| UFSAR | Updated Final Safety Analysis Report |
| UHS | Uniform Hazard Spectra or Ultimate Heat Sink |
| USACE | U.S. Army Corps of Engineers |
| USCG | United States Coast Guard |
| USCS | Unified Sort Classification System |
| USGS | U.S. Geological Survey |
| USNSN | U.S. National Seismograph Network |
| VA | Virginia |
| Vp | Compressional Wave Velocity |
| Vs | Shear-Wave Velocity |
| WOH | Weight of Hammer |
| WOR | Weight of Rod |
| WUS | Western United States |

| | |
|---|---|
| SSE | Safe Shutdown Earthquake |
| SSI | Soil-Structure Interaction |
| SSSI | Structure-Soil-Structure Interaction |

| | |
|---|---|
| UHS EB | Ultimate Heat Sink Electrical Building |
| UHS MWIS | Ultimate Heat Sink Makeup Water Intake Structure |


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**Table 1.7-2—{Piping and Instrumentation Diagrams}**

| FSAR Figure Number | Title |
|---|---|
| 9.2-1 | Potable Water System |
| 9.2-2 | Sanitary Waste Water System |
| 9.2.-3 | Normal Makeup, Ultimate Heat Sink Makeup, Blowdown & Chemical Treatment |
| 9.2-4 | Raw Water & Desalinated Water Supply |
| 9.4-1 | Ultimate Heat Sink Makeup Water Intake Structure Ventilation System and UHS Electrical Building Ventilation System |
| 10.4-1 | Circulating Water System P& ID (Circulating Water Pump Building) |
| 10.4-2 | Circulating Water System P& ID (Turbine Building) |
| 10.4-5 | Circulating Water System P&ID (Cooling Tower) |
| 10.4-6 | Circulating Water System Makeup System P& ID |
| 10.4-9 | Circulating Water System P&ID (Blowdown Flowpath) |
| 9.5-2 | CCNPP Unit 3 Cooling Tower Loop |
| 9.5-3 | CCNPP Unit 3 Intake Structure Yard Loop |
| 9.5-4 | CCNPP Unit 3 UHS Makeup Water Intake Structure |
| 9.5-5 | CCNPP Unit 3 UHS Makeup Water Intake Structure Electrical Building |


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## 1.8 INTERFACES WITH STANDARD DESIGNS AND EARLY SITE PERMITS

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

The U.S. EPR FSAR includes the following COL Item in Section 1.8:

> A COL applicant that references the U.S. EPR design certification will describe where the interface requirements are satisfied in the COL Final Safety Analysis (FSAR) to demonstrate compatibility with the U.S. EPR design.

This COL Item is addressed as follows:

Interface requirements for systems, structures, and components (SSCs) that relate to specific mechanical, electrical, nuclear, or structural systems are identified in appropriate sections of the FSAR. Table 1.8-1 provides a cross-reference to the description of these interfaces.

### 1.8.1 COL INFORMATION ITEMS

The U.S. EPR FSAR includes the following COL Item in Section 1.8.1:

> A COL applicant that references the U. S. EPR design certification will identify the FSAR section, or provide a list, that demonstrates how the COL information items have been addressed.

This COL Item is addressed as follows:

The text of the COL Items and COL No. identifier listed in Table 1.8-2 of the U.S. EPR FSAR are presented in Table 1.8-2. For each COL Item listed, the corresponding section of this FSAR that addresses the COL Item is identified. Additional explanatory comments are provided as necessary or appropriate.

### 1.8.2 DEPARTURES

The U.S. EPR FSAR includes the following COL Item in Section 1.8.2:

> A COL applicant that references the U. S. EPR design certification will provide a list of any departures from the FSAR in the COL FSAR.

| In-Structure Response Spectra | FSAR 3.7.2.5.2 |
|---|---|

{The list of departures from the U.S. EPR FSAR is as follows:

| | |
|---|---|
| Maximum Differential Settlement | FSAR 2.5.4 and 3.8.5 |
| Maximum Annual Average Atmospheric Dispersion Factor | FSAR 2.3.5 |
| Accident Atmospheric Dispersion Factor from 0 - 2 Hours for the Low Population Zone | FSAR 2.3.4 and 15.0.3 |
| Maximum Ground Water Elevation | FSAR 2.4.12, 3.4.2, and 3.8.5 |
| Toxic Gas Detection and Isolation | FSAR 3.11, 6.4, 9.4.1 and 14.2.12 |
| Technical Specifications Setpoint Control Program | FSAR 16.3.3, 16.5.5, and Bases 16.3.3 |

Justification for these departures is presented in Part 7 of the COL application.}


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## Table 2.0-1—{U.S. EPR Site Design Envelope Comparison}

(Page 1 of 5)

| | U.S. EPR FSAR Design Parameter Value/Characteristic | CCNPP Unit 3 Design Parameter Value/Characteristic |
|---|---|---|
| **Precipitation** | | |
| Rainfall rate | <19.4 in/hr | |
| Normal ground precipitation load | <100 psf (100-year MRI) | |
| Normal roof precipitation load | ≤ 70 psf (100-year MRI) | |
| 48-hour PMWP liquid roof load | 0 psf[a] | |
| 48-hour PMWP frozen ground load | ≤ 43 psf (based on 55 inches) | |
| 48-hour PMWP frozen roof load | ≤ 30 psf | |
| Extreme winter precipitation roof load | ≤ 100 psf (100-year MRI) | 38.0 psf (185.5 kg/m$^2$) |
| **Seismology** | | |
| Horizontal SSE Acceleration | 0.3g Peak (CSDRS shapes – See Section 3.7.) | ~~Design Values are enveloped~~ (See Sections 2.5.2 and 3.7) |
| Vertical SSE Acceleration) | 0.3g Peak (CSDRS shapes – See Section 3.7.) | ~~Design Values are enveloped~~ (See Sections 2.5.2 and 3.7) |
| Fault Displacement Potential | No fault displacement is considered for safety-related SSCs in U.S. EPR design certification. | No fault displacement potential (See Section 2.5.3) |
| **Soil** | | |
| Minimum Static Bearing Capacity | 22 ksf in localized areas at the bottom of the Nuclear Island basemat and 15 ksf on average across the total area of the bottom of the Nuclear Island basemat. | 24 ksf in localized areas of the NI Basemat and 15 ksf on the average across the total area of the bottom of the NI basemat (See section 2.5.4) |
| Minimum dynamic bearing capacity | 34.56 ksf at the Nuclear Island basemat | {35 ksf at the Nuclear Island basemat} |
| Minimum Shear Wave Velocity (Low strain best estimate average value at bottom of basemat) | 1000 fps | 1450 fps (See Section 2.5.2.6) |
| Liquefaction | None | None (See section 2.5.4) |
| Slope Failure Potential | No slope failure potential is considered in the design of safety-related SSCs for U.S. EPR design certification. | No slope failure potential that would adversely affect the safety of the proposed CCNPP Unit 3 (See Section 2.5.5) |

0.076g GMRS, 0.15g Site SSE.
The GMRS is enveloped by the CSDRS shapes as required by the U. S. EPR FSAR. Because this spectrum is very low, a Site SSE has been established as the envelope of the U.S. EPR FSAR European Utility Requirements (EUR) Soft Soil Spectrum anchored at 0.15g and the horizontal RG 1.60 Spectrum anchored at 0.10g. The Site SSE exceeds the CSDRS in the low frequency range.



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from the Center Ditch will discharge into the East Ditch before overflowing the eastern edge of the East Ditch.

Grading in the vicinity of the safety-related structures slopes away from the individual structures such that PMP ground and roof runoff will sheet flow away from each of these structures towards the collection ditches. Thus, sheet flows are prevented from entering the structures.

The maximum computed PMP water level in the power block area is Elevation 81.5 ft (24.8 m). However, the maximum PMP water level associated with a safety-related structure is Elevation 81.4 ft (24.8 m) which is 3.2 ft (1.0 m) below the reactor complex grade slab at Elevation 84.6 ft (25.8 m).

Based on the power block grading, entrance locations, and peak PMP water levels in the site ditches, all safety-related facility entrances are located above peak PMP ditch water levels and PMP sheet flows are prevented from reaching safety-related entrances.

### 2.4.9.5 Human-Induced Channel Flooding

Human-induced channel flooding of the Chesapeake Bay is not assumed because the Bay is a major drainage path for the Susquehanna River. There are no known Federal projects to channel or dam any portion of the Chesapeake Bay. The channel and diversion walls and site grading discussed above will be maintained to direct stormwater and ditch overflows away from the site and towards the Chesapeake Bay.

### 2.4.9.6 Alternate Water Sources

An alternate water source is not required for the CCNPP Unit 3 design. The emergency safety-related water supply to the Essential Service Water System cooling tower basins is brackish water from the Chesapeake Bay. In the event normal water supply is lost, there is a 72-hour volume of water available at each tower basin to deal with system losses before the emergency UHS makeup water supply is required to be initiated. In the event of a probable maximum hurricane where extreme weather conditions can persist for at most one day as discussed in Section 2.4.11, there is no need to switch to alternate UHS makeup sources. At the end of 72 hours, at least two out of four safety-related trains of makeup water will be put in operation to feed the corresponding basins with water drawn from the Chesapeake Bay.

### 2.4.9.7 Other Site-Related Evaluation Criteria

The potential for channel diversion from seismic or severe weather events is not considered to result in a loss of cooling water supply. The new common forebay of Unit 3 intakes is a seismic Category ~~II~~ I structure, as described in Section 2.4.1 and no additional measures are necessary to protect against a potential channel diversion due to seismic events. Makeup water withdrawn from the Chesapeake Bay adjacent to the Units 1 and 2 intake forebay will be conveyed to the common forebay by pipes that will meet seismic Category I requirements. A postulated collapse of the shoreline cliffs to the north or south of the CCNPP site during a seismic or severe weather event not expected to result in silt depositing in the Units 1 and 2 forebay to such an extent that it would cause a loss of cooling water supply to the Unit 3 intakes.

### 2.4.9.8 References

**CBP, 2004.** Chesapeake Bay – Introduction to an Ecosystem, Chesapeake Bay Program, EPA 903-R-04-003, CBP/TRS 230/00, 2004.


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## 2.5.2 VIBRATORY GROUND MOTION

The U.S. EPR FSAR includes the following COL Item for Section 2.5.2:

> A COL applicant that references the U.S. EPR design certification will review and investigate site-specific details of the seismic, geophysical, geological, and geotechnical information to determine the safe shutdown earthquake (SSE) ground motion for the site and compare site-specific ground motion to the Certified Seismic Design Response Spectra (CSDRS) for the U.S. EPR.

This COL Item is addressed as follows:

{This section provides a detailed description of the vibratory ground motion assessment that was carried out for the CCNPP Unit 3 site, resulting in the development of the CCNPP Unit 3 ~~site Safe Shutdown Earthquake (SSE)~~ ground motion response spectra. The starting point for this site assessment is the EPRI-SOG probabilistic seismic hazard analysis (PSHA) methodology outlined in EPRI NP-4726-A 1988 (EPRI, 1988) and tectonic interpretations in EPRI NP-4726 1986 (EPRI, 1986).

Nuclear Regulatory Commission (NRC) Regulatory Guide 1.165, "Identification And Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," March, 1997, (NRC, 1997a) states in Section B, Discussion:

> "The CEUS is considered to be that part of the United States east of the Rocky Mountain front, or east of Longitude 105 West (Refs. 4, 5). To determine the SSE in the CEUS, an accepted PSHA methodology with a range of credible alternative input interpretations should be used. For sites in the CEUS, the seismic hazard methods, the data developed, and seismic sources identified by Lawrence Livermore National Laboratory (LLNL) (Refs. 4-6) and the Electric Power Research Institute (EPRI) (Ref. 7) have been reviewed and accepted by the staff."

Reference 7 is Electric Power Research Institute, "Probabilistic Seismic Hazard Evaluations at Nuclear Power Plant Sites in the Central and Eastern United States," NP-4726, All Volumes, 1989-1991. The title and number of the referenced document are not in agreement. The title of EPRI-4726 is "Seismic Hazard Methodology for the Central and Eastern United States." No document could be found that had the title provided by the NRC.

In lieu of the reference 7, i.e., EPRI document, NP-4726, All Volumes, 1989-1991, Section 2.5.2 will implement EPRI NP-4726, "Seismic Hazard Methodology for the Central and Eastern United States," 1986 and EPRI-4726-A, "Seismic Hazard Methodology for the Central and Eastern United States,"1988. EPRI NP-4726-1986 and EPRI-4726-A, 1988 have been determined to be acceptable as described below.

Additionally, the PSHA methodology used for the CCNPP 3 site is described in EPRI NP-6395-D-1989 (EPRI, 1989a). EPRI NP-6395-D (EPRI, 1989a) has been determined to be an acceptable PSHA methodology by the NRC is also described below.

The NRC has accepted the use of the following, which were included in the North Anna Early Site Permit Application by Dominion Nuclear North Anna, LLC, which was approved in NUREG-1835, Safety Evaluation Report for an Early Site Permit (ESP) at the North Anna Site, 2005. (NRC, 2005)


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- EPRI 4726, 1986, "Seismic Hazard Methodology for the Central and Easter United States" was included in the Early Site Permit Application as reference 120. It is also specifically included as a reference in Section C of NUREG-1835.

- EPRI-NP-6395-D, 1989, "Probabilistic seismic hazard evaluation at nuclear plant sites in the central and eastern United States, Resolution of the Charleston Earthquake Issue."

  a. Early Site Permit Application as reference 115.

  b. Generic Letter 88-20, "Individual Plant Examinations of External Events (IPEEE) for Severe Accident Vulnerabilities" (NRC, 1991)

The NRC has accepted the use of the EPRI NP-4726-A, 1988 in the letter dated Oct 31, 2005, T. Mundy, Exelon to NRC, Subject: Response Supplemental Draft Safety Evaluation Report (DSER) Item, page 16 of 112 and page 54 of 112, (Adams Accession No. ML053120131) (Exelon, 2005).

The EPRI-SOG tectonic interpretations in EPRI NP-4726 1986 (EPRI, 1986). were updated with more recent geological, seismological, and geophysical data under the guidance of NRC Regulatory Guide 1.165, (NRC, 1997a). Sections 2.5.2.1 through 2.5.2.3 document this review and update, as needed, of the EPRI-SOG seismicity, seismic source, and ground motion models.

Section 2.5.2.4 develops PSHA parameters at the site assuming the very hard rock foundation conditions implied by currently accepted ground motion attenuation models.

response spectra (GMRS)

Section 2.5.2.5 summarizes information about the seismic wave transmissio the CCNPP Unit 3 site with reference to more detailed discussion of all engineering aspects of the subsurface in Section 2.5.4.

Section 2.5.2.6 describes the development of the horizontal ~~SSE~~ ground motion for the CCNPP Unit 3 site. The selected ~~SSE~~ ground motion is based on the risk-consistent/performance-based approach of Regulatory Guide 1.208, A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion (NRC, 2007a), with reference to NUREG/CR-6728 (NRC, 2001), NUREG/CR-6769 (NRC, 2002b), and ASCE/SEI 43-05 (ASCE 2005). Horizontal ground motion amplification factors are developed using site-specific data and estimates of near-surface soil and rock properties. These amplification factors are then used to scale the hard rock spectra to develop Uniform Hazard Spectra accounting for site-specific conditions using Approach 2A of NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002). ~~Horizontal SSE~~ spectra are developed from these soil Uniform Hazard Spectra using the ~~performance-based approach~~ of ASCE/SEI 43-05 (ASCE 2005), as implemented in Regulatory Guide 1.208 (NRC, 2007a). ~~The SSE motion~~ is defined at the free ground surface of a hypothetical outcrop ~~at the~~ base of the nuclear island foundation. See Sections 2.5.4 and 2.5.2.5 for further discussion ~~of the~~ subsurface conditions.

GMRS

Section 2.5.2.6 also describes vertical ~~SSE spectra~~, which are developed by scaling the horizontal ~~SSE~~ by a frequency-dependent vertical-to-horizontal (V:H) factor.

The ~~SSE~~ spectra that are described in this section are considered performance goal-based (risk-informed) site specific safe shutdown earthquake response spectra. ~~The SSE spectra~~, and its specific location at a free ground surface, reflect the seismic hazard in terms of a PSHA and geologic characteristics of the site and represent the site-specific ground motion response ~~spectrum~~ (GMRS) of Regulatory Guide 1.208 (NRC, 2007a). These spectra are expected to be modified as appropriate to develop ground motion for design considerations.


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GMRS

The ~~SSE~~ developed in this section ~~meets the requirements of paragraph (d)~~ of 10 CFR 100.23 (CFR, 2007).

is smaller than minimum Safe Shutdown Earthquake Ground Motion for design identified in paragraph (d)(1)

### 2.5.2.1 Seismicity

The seismic hazard analysis conducted by EPRI as delineated in NP-6395-D 1989 (EPRI, 1989a) relied, in part, on an analysis of historical seismicity in the central and eastern United States (CEUS) to estimate seismicity parameters (rates of activity and Richter b-values) for individual seismic sources. The historical earthquake catalog used in the EPRI analysis was complete through 1984. The earthquake data for the site region that has occurred since 1984 was reviewed and used to update the EPRI catalog (EPRI, 1988).

Therefore a Safe Shutdown Earthquake (SSE) for design is developed in Section 3.7.1.

Geologic evidence for prehistoric seismicity in the site region is discussed in Section 2.5.2.2.1.7.

Sections 2.5.2.1.1 and 2.5.2.1.2 are added as a supplement to the U.S. EPR FSAR.

#### 2.5.2.1.1 Regional Seismicity Catalog Used for 1989 Seismic Hazard Analysis Study

Many seismic networks record earthquakes in the CEUS. A large effort was made during the EPRI seismic hazard analysis study to combine available data on historical earthquakes and to develop a homogeneous earthquake catalog that contained all recorded earthquakes for the region. "Homogeneous" means that estimates of body-wave magnitude, $m_b$, for all earthquakes are consistent, that duplicate earthquakes have been eliminated, that non-earthquakes (e.g., mine blasts and sonic booms) have been eliminated, and that significant events in the historical record have not been missed. Thus, the EPRI catalog (EPRI, 1988) forms a strong basis on which to estimate seismicity parameters.

#### 2.5.2.1.2 Updated Seismicity Data

Regulatory Guide 1.165 (NRC, 1997a) specifies that earthquakes of a Modified Mercalli Intensity (MMI) greater than or equal to IV or of a magnitude greater than or equal to 3.0 should be listed for seismic sources, "any part of which is within a radius of 200 mi (320 km) of the site (the site region)." While updating the EPRI catalog (EPRI, 1988) for this evaluation of vibratory ground motion a latitude-longitude window of 35° to 43° N, 71° to 83° W was used. This window incorporates the 200 mi (320 km) radius "site region" and seismic sources contributing significantly to CCNPP Unit 3 site earthquake hazard. Figure 2.5-1 shows the CCNPP Unit 3 site and its associated site region. Figure 2.5-45 through Figure 2.5-50 show this site region and the defined latitude-longitude window.

The updated catalog was compiled from the following sub-catalogs:

- EPRI Catalog (EPRI, 1988). The various data fields of the EPRI catalog are described in EPRI NP-4726-A 1988 (EPRI, 1988).
- Southeastern US Seismic Network (SEUSSN) Catalog. The SEUSSN catalog is available from the Virginia Tech Seismological Observatory web site (SEUSSN, 2006). On the date of September 8, 2006, the SEUSSN catalog had 1223 records dating from March 1568 to December 2004 within the site region latitude-longitude window. Of these, 230 records occurred in 1985 or later.
- Advanced National Seismic System (ANSS) Catalog. The ANSS catalog (ANSS 2006) was searched on September 8, 2006, for all records within the site region latitude-longitude window, resulting in 570 records from 1964 to July 11, 2006. Of these, 402 records occurred in 1985 or later.


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Table 5.0-1 of the U.S. EPR FSAR identifies shear wave velocity as a required parameter to be enveloped, defined as "Minimum shear wave velocity of 1000 feet per second (Low strain best estimate average value at bottom of basemat)."

Figure 2.5-102 compares the 10 generic soil profile cases used for the U.S. EPR and the average shear wave velocity profile that was adopted for the CCNPP site (shown in Figure 2.5-125 and Figure 2.5-145.

The CCNPP Unit 3 Average Profile shown in the Figure 2.5-102 is for soils below El. +44 ft (bottom of the basemat is zero in the figure). Soils such as Stratum I Terrace Sand will not be used for support of foundations of Category I structures. Therefore, shear wave velocity measurements in the CCNPP site soils above El. +44 ft. regardless of value, are excluded from this evaluation as they lie above the basemat. Results from the above Figure indicate that:

1. The CCNPP Unit 3 Average Profile is bounded by the 10 generic profiles used for the U.S. EPR.

2. The CCNPP Unit 3 Average Profile offers a shear wave velocity at the bottom of the basemat (approx. El. +44 ft (or depth = 0 in Figure 2.5-102)) of 1,450 ft/sec.

3. The minimum shear wave velocity from the CCNPP Unit 3 Average Profile is 1,130 ft/sec.

4. The characteristic shear wave velocity of the soil column (weighted with respect to the 344 ft soil column) is 1,510 ft/sec.

On the basis of the above, the idealized CCNPP Unit 3 site shear wave vel~~co~~ocity profile is bounded by the 10 generic soil profiles used for the U.S. EPR and meets the minimum 1,000 ft/sec criterion identified in the U.S. EPR FSAR.

GMRS was conducted in accordance with the performance-based approach described in Regulatory Position 5 of Regulatory Guide 1.208 (NRC, 2007a).

GMRS

~~The Safe Shutdown Earthquake (SSE) ground motion~~ was developed starting from the $10^{-4}$ and $10^{-5}$ rock Uniform Hazard Spectra. At high frequencies, the appropriate ($10^{-4}$ or $10^{-5}$) HF mean amplification factor was applied to the $10^{-4}$ and $10^{-5}$ rock spectrum, to calculate site spectral amplitudes for $10^{-4}$ and $10^{-5}$ annual frequencies of exceedance. At low frequencies, a similar technique was used with the LF mean amplification factors. At intermediate frequencies the larger of the HF and LF site spectral amplitudes was used.

Figure 2.5-86 illustrates the resulting site spectra. At high frequencies the HF spectral amplitudes are always greater, and at low frequencies the LF spectral amplitudes are always greater. The two sets of spectral amplitudes cross at 2-3 Hz.

This procedure corresponds to Approach 2A in NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002b), wherein the rock Uniform Hazard Spectra (for example, at $10^{-4}$) is multiplied by a mean amplification factor at each frequency to estimate the $10^{-4}$ site Uniform Hazard Spectra. Note that the amplification factors plotted in Figure 2.5-78, Figure 2.5-80, Figure 2.5-82, and Figure 2.5-84 are mean logarithmic amplification factors, which correspond approximately to the median. The amplification factors used to prepare Figure 2.5-86 are arithmetic mean amplification factors, which are slightly higher than the median.


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The low-frequency character of the spectra in Figure 2.5-86 reflects the low-frequency amplification of the site, as shown in the amplification factors of Figure 2.5-78, Figure 2.5-80, Figure 2.5-82, and Figure 2.5-84. That is, there is a fundamental site resonance at about 0.22 Hz, with a dip in site response at about 0.4 Hz, and this dip occurs for all 60 of the site profiles that were used to characterize the site profile. As a result, there is a dip in the site spectra for $10^{-4}$ and
$10^{-5}$ at 0.4 Hz that reflects the site characteristics.

a GMRS

The ASCE (ASCE, 2005) performance-based approach was used to derive ~~an SSE~~ from the $10^{-4}$ and $10^{-5}$ site spectra. The SSE spectrum is derived at each structural frequency as follows:

$$A_R = SA(10^{-5})/SA(10^{-4})$$

$$\mathrm{DF} = 0.6\ A_R^{0.8}$$

GMRS

$$\cancel{SSE} = max(SA(10^{-4}) \times max(1.0, \mathrm{DF}), 0.45 \times SA(10^{-5}))$$

The last term in the above equation was not published in this form in ASCE (ASCE, 2005) but is a supplemental modified form, as presented in NRC Regulatory Guide 1.208 (NRC, 2007a). The resulting horizontal ~~SSE~~ spectrum is plotted in Figure 2.5-87. This spectrum has been smoothed slightly, particularly around 1.5 Hz, to remove slight bumps and dips in the spectrum resulting from the site amplification calculations that are not statistically significant. The average change in spectral amplitudes for the 5 frequencies that were smoothed was an increase of 1%, which is not significant.

spectrum

A vertical ~~SSE spectrum~~ was calculated by deriving vertical-to-horizontal (V:H) ratios and applying them to the horizontal ~~SSE~~. As background and for comparison purposes, V:H ratios were obtained by the following methods:

1. Rock V:H ratios for the central and eastern United States (CEUS) were calculated from NUREG-6728 (NRC, 2001), using the recommended ratios for *PGA* < 0.2g, which applies at this site (see Figure 2.5-88).

2. Soil V:H ratios for the western United States (WUS) were calculated from two publications (Abrahamson, 1997) (Campbell, 1997) that have equations estimating both horizontal and vertical motions on soil. Horizontal and vertical motions were predicted from these two references for **M** = 5.5 and *R* = 9 mi (15 km). **M** = 5.5 was selected because earthquakes around this magnitude dominate the high frequency motions, and *R* = 9 mi (15 km) was selected because this distance resulted in a horitontal PGA of approximately 0.1 g at the site, which is close to the PGA associated with the horizontal SSE. For each reference, the V:H ratio was formed, and the average ratio (average from the two references) was then calculated.

3. The WUS V/H ratios for soil were modified in an approximate way for CEUS conditions by shifting the frequency axis of the V:H ratios so that they more closely resemble what might be expected at a soil site. This shifted the WUS peak V/H ratio from about 15 Hz to about 45 Hz.

Figure 2.5-88 shows these three V:H ratios plotted vs. structural frequency. As a conservative choice, the envelope V/H ratio shown as a thick dashed line was selected because this envelops all three approaches. The recommended V:H ratio is 1.0 for frequencies greater than 25 Hz, 0.75 for frequencies less than 5 Hz, and is interpolated (log-linear) between 5 and 25 Hz.


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Figure 2.5-87 plots the resulting vertical ~~SSE~~ spectrum, calculated in this manner from the horizontal ~~SSE~~ GMRS. Table 2.5-22 lists the horizontal and vertical ~~SSE~~ GMRS amplitudes.

#### 2.5.2.7 Conclusions

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

Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC used the seismic source and ground motion models published by the Electric Power Research Institute (EPRI) for the central and eastern United States (CEUS), Seismic Hazard Methodology for the Central and Eastern United States, (EPRI, 1986). As such, FSAR Section 2.5.2 focuses on those data developed since publication of this 1986 EPRI report. Regulatory Guide 1.165, Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion, (NRC, 1997), indicates that applicants may use the seismic source interpretations developed by Lawrence Livermore National Laboratory (LLNL) in the "Eastern Seismic Hazard Characterization Update," published in 1993, or the EPRI document as inputs for a site-specific analysis.

Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC also used the guidance of Regulatory Guide 1.208, A Performance–Based Approach to Define the Site-Specific Earthquake Ground Motion, (NRC, 2007a) to develop the Ground Motion Response Spectrum (GMRS) ~~used for the development of the Safe Shutdown Earthquake (SSE)~~.

Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC has provided a characterization of the seismic sources surrounding the site, as required by 10 CFR 100.23. Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC has adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, and that this PSHA followed the guidance provided in Regulatory Guide 1.208 (NRC, 2007a).

The GMRS developed by UniStar Nuclear Operating Services, LLC uses the performance-based approach described in Regulatory Guide 1.208 (NRC, 2007a), adequately representing the regional and local seismic hazards and accurately includes the effects of the local CCNPP Unit 3 subsurface properties.

The performance-based approach outlined in Regulatory Guide 1.208 (NRC, 2007a) is an advancement over the solely hazard-based reference probability approach recommended in Regulatory Guide 1.165 (NRC, 1997) and it was used where appropriate in the determination of the GMRS. The performance-based approach uses not only the seismic hazard characterization of the site from the PSHA but also basic seismic fragility SSC modeling in order to obtain an SSE that directly targets a structural performance frequency value. Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC conclude that the application for the CCNPP Unit 3 site is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23(d) (CFR, 2007).

However, because the site specific SSE is smaller than the minimum Safe Shutdown Earthquake Ground Motion for design identified in paragraph (d)(1), a Site SSE for design is developed in Section 3.7.1.

Deviations from the NRC guidance in Regulatory Guide 1.165 (NRC, 1997), Regulatory Guide 1.208 (NRC, 20
identified and

#### 2.5.2.8 Re

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


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- Structural fill dynamic testing (RCTS).

Information from the Phase III investigation is presented in several geotechnical and laboratory testing data reports (MACTEC, 2009b) (MACTEC, 2009c) (MACTEC, 2009d).

The referenced geotechnical reports for the three phases of the investigation are provided in COLA Part 11J: Geotechnical Data Report and COLA Part 11K: Mactec Report.

The CCNNP3 Unit 3 site covers an area of approximately 460 acres. Figure 2.5-103 provides the site utilization plan. The following areas are identified:

1. Powerblock Area – Safety-related facilities in this area include the Reactor Building (RB), Fuel Building (FB) and Safeguard Buildings (Nuclear Island, NI), Essential Service Water Buildings (ESWB), and Emergency Power Generation Buildings (EPGB); other important facilities are the Nuclear Auxiliary Building (NAB), the Radioactive Waste Processing Building (RWPB), the Access Building (AB), and the Turbine Building (TB). The Powerblock Area is enlarged in Figure 2.5-104.

2. Intake Area – Safety-related facilities in this area include the Ultimate Heat Sink Makeup Water Intake Structure (UHS-MWIS), ~~and the~~ Ultimate Heat Sink Electrical Building (UHS-EB), ~~other facilities are~~ the Ultimate Heat Sink Forebay ~~and~~ the Circulating Water Makeup Intake Structure and the Fish Return. The Intake Area is enlarged in Figure 2.5-105.

3. Utility Corridor Area.

4. Construction Laydown Area (CLA).

5. Unit 3 Switchyard.

6. Unit 3 Cooling Basin and Cooling Tower.

The Powerblock, Construction Laydown Area, switchyard and cooling tower and basin are collectively referred to as the CCNPP Unit 3 Area.

The natural topography at the CCNPP site varies throughout the site with differences in elevation up to 100 ft. In the area where CCNPP Unit 3 is planned, ground surface elevations at the time of the exploration ranged from approximately El. 47 ft to El. 121 ft, with an average of 86 ft. The planned elevation (rough grade) in the Powerblock Area ranges from about El. 75 ft to El. 85 ft, with the centerline of Unit 3 at El. 84.7 ft, or approximately El. 85 ft.

In the Intake Area, ground surface elevations at the time of the exploration ranged from approximately El. 7 ft to 12 ft with an average of approximately 9.5 ft. The planned rough grade in the Intake Area is El. 10 ft.

The focus of Section 2.5.4 is the Powerblock Area and the Intake Area. These zones house the safety-related, Seismic- Category I facilities, with the Utility Corridor Area in between. Numerous natural and man-made slopes are identified across the plan. The safety of slopes is addressed in Section 2.5.5.

The subsurface conditions were established from the information contained in the Geotechnical Subsurface Investigation Data Reports from all Phases of the investigation (MACTEC, 2009a) (MACTEC, 2009b) (MACTEC, 2009c) (MACTEC, 2009d) (Schnabel, 2007a)

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| | |
|---|---|
| Figure 2.5-109 | Subsurface profile C-C' at the Powerblock looking south through the NI and TB. |
| Figure 2.5-110 | Subsurface profile D-D' at the Powerblock looking south through 1EPBG, 3ESWB, and the RWPB. |
| Figure 2.5-111 | Subsurface profile E-E' at the Powerblock looking east through the RWPB, NAB, NI (Safeguard North), 2ESWB and 1ESWB. |
| Figure 2.5-112 | Subsurface profile F-F' at the Intake Area, looking east through the UHS-MWIS and UHS-EB. |

2.5.4.2.5.

The recommendations for soil properties (Section 2.5.4.2.5) to be used for analysis and design of foundation are provided in tabular form for each layer identified. Table 2.5-25 presents the depths and thicknesses of the layers encountered at the site. The data is provided for the entire site and independently for the Powerblock Area and the Intake Area. Information on deeper soils (below 400 ft) was obtained from literature research and it is discussed in Section ~~2.5.4.7~~. Identification of Strata I through III was based on their physical and engineering characteristics. The characterization of the soils was based on a suite of tests performed on these soils, consisting of standard penetration tests (SPT) in soil borings including hammer energy measurements, cone penetration test (CPT) soundings, test pits, geophysical suspension P-S velocity logging, field electrical resistivity testing, and observation wells, as well as extensive laboratory testing.

#### 2.5.4.2.1.1 Stratum I – Terrace Sand

The Terrace Sand stratum consists primarily of light-brown to brown sand with varying amounts of silt, clay, and/or gravel, sometimes with silt or clay interbeds. This stratum was fully penetrated by boreholes installed within CCNPP Unit 3 Powerblock Area and the adjoining CLA area (the 300 and 400 series borings) and by a majority of boreholes drilled outside of these two areas including the Intake Slope and the Utility Corridor (the 700 series borings). This stratum was not encountered in low lying areas.

The thickness of Stratum I soils was estimated from the boring logs and CPT logs. In CCNPP Unit 3 area, its thickness with respect to the existing ground surface is shown in Table 2.5-25. The average bottom for Stratum I soils is about El. 62 ft in CCNPP Unit 3 area. Stratum I Terrace Sand does not exist in the Intake Area.

At isolated locations, sandy soils with an appearance similar to Stratum I soils were encountered. Materials that were probably man-made, (hereafter referred to as "fill"), and disturbed soils were encountered, beginning at the existing ground surface at isolated locations at the CCNPP Unit 3 site. These materials were predominantly sand with varying amounts of silt and clay. In the Intake Area (B-701, B-702, B-771 through B-776, B-780 through B-782, and B-821), the depth of these materials varied from approximately 6 to 11 ft below existing grade. They were present at the ground surface and were encountered in 25 borings (B-303, B-309, B-318, B-336, B-340, B-341, B-352, B-356, B-357, B-406, B-409, B-412, B-415, B-419, B-420, B-432, B-437, B-438/A, B-439, B-440, B-701, B-710, B-713, B-768, and B-791). Mainly, they were found in areas which had previously been developed at the site, such as Camp Conoy, roadways, and ball field areas. Their thickness ranged from approximately 0.5 ft to 17 ft, with an average thickness of about 6 ft.

Stratum I soils are characterized, on average, as non-plastic with an average fines content (materials passing No. 200 Sieve) of 20 percent. Grain size analyses indicated that these soils are primarily fine or fine-medium sands. The Unified Soil Classification System (USCS) designations were poorly-graded sand/silty sand, silty sand, well-graded sand, clayey sand, clay of high

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#### 2.5.4.2.1.6 Subsurface Materials below 400 Feet

The field exploration for the CCNPP Unit 3 extended to a maximum depth of about 400 ft below ground. Coastal Plain sediments, however, are known to extend below this depth, to a depth of approximately 2,500 ft, or to top of bedrock (BGE, 1982). The subsurface conditions below 400 ft were addressed through reference to existing literature and work that had been done by others, primarily for the purpose of seismic site characterization. The subsurface conditions below 400 ft are addressed in Sections ~~2.5.4.7 and 2.5.2.5.~~ 2.5.2.5 and 2.5.4.2.5.

#### 2.5.4.2.2 Field Investigation Program

The planning of the field investigation referred to the guidance provided in NRC Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants" (USNRC, 2003a). References to the industry standards used for field tests completed for the CCNPP Unit 3 subsurface investigation are shown in Table 2.5-26. The details and results of the field investigation are included as COLA Part 11J. The work was performed under the Bechtel QA program with work procedures developed specifically for the CCNPP Unit 3 subsurface investigation, including a subsurface investigation plan developed by Bechtel. A complementary Phase II investigation was performed in 2008 as part of the detailed design of the project, with reference to guidance in Regulatory Guide 1.132 (USNRC, 2003a) to verify subsurface uniformity at locations where coverage was not available in the initial phase of the investigation due to shifting locations of some structures. Results of the additional (Phase II) investigation are presented herein, and in the data report (Schnabel, 2009) (MACTEC, 2009a). Locations of the field tests are shown in Figure 2.5-103, Figure 2.5-104, and Figure 2.5-105.

##### 2.5.4.2.2.1 Previous Subsurface Investigations

Based on limited information available from the CCNPP Units 1 and 2 UFSAR (BGE, 1982), the original subsurface investigations for the CCNPP Units 1 and 2 performed in 1967 consisted of a total of 10 exploratory borings, ranging in depth from 146 to 332 ft, with soil samples obtained at various intervals for soil identification and testing. Seven piezometers were also installed for groundwater observation and monitoring. The 1967 investigation included other field investigations (two seismic survey lines using Microtremor) and laboratory testing (moisture content, density, particle size, permeability, cation exchange, and x-ray diffraction). Supplemental investigations in support of detailed design were performed in July 1967 (5 borings), August 1967 (23 borings), December 1968 (18 borings), and 1969 (5 borings). Additional investigations were performed in 1980/1981 (borings, CPT soundings, and observation wells) in order to site a "generic Category I structure," and in 1992 additional investigations (borings, dilatometer soundings, crosshole seismic survey, field resistivity) were performed for an additional Diesel Generator Building (Bechtel, 1992). Various laboratory testing was also performed on selected portions of the recovered soils.

Geological descriptions in CCNPP Units 1 and 2 UFSAR (BGE, 1982) indicate the surficial deposits to be Pleistocene Age soils extending from the ground surface to about El. 70 ft. These soils were estimated to extend to an average El. 60 ft based on the CCNPP subsurface investigation. CCNPP Units 1 and 2 UFSAR (BGE, 1982) indicates that Chesapeake Group soils were encountered in the 1967 investigation between El. 70 ft and El. -200 ft. These soils were estimated to extend to approximately El. -200 ft based on the CCNPP Unit 3 investigation. CCNPP Units 1 and 2 UFSAR (BGE, 1982) indicates that Eocene deposits lie below El. -200 ft and consist of glauconitic sands. Comparable observations were made on these, and the overlying deposits, from the CCNPP Unit 3 subsurface investigation borings. The CCNPP Units 1 and 2 UFSAR (BGE, 1982) remarked that "good correlation of subsurface stratigraphy was obtained between the borings." This remark is corroborated by the results obtained from the CCNPP subsurface investigation.

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#### 2.5.4.6.4 Permeability Testing

developed in Section 2.5.2.6

Testing for permeability of the site soils was performed using Slug tests, as discussed in Section 2.5.4.2.3. A detailed description of the tests and the results is provided in Section 2.4.12. A summary of the hydraulic conductivity values is presented in Table 2.5-33.

a Site SSE for design is developed in Section 3.7.1.

#### 2.5.4.6.5 History Of Groundwater Fluctuations

are

A detailed treatment of the groundwater conditions is provided in Section 2.4.12.

### 2.5.4.7 Response Of Soil And Rock To Dynamic Loading

The ~~SSE~~ spectra and its specific location at a free ground surface reflect the seismic hazard in terms of PSHA and geologic characteristics of the site and represent the site-specific ground motion response spectrum. These spectra ~~would be expected to be~~ modified ~~as appropriate~~ to develop ground motion for design considerations. Detailed descriptions on response of site soils and rocks to dynamic loading are addressed in Section 2.5.2.

Sections 2.5.4.7.1 through 2.5.4.7.3 are added as a supplement to the U.S. EPR FSAR.

#### 2.5.4.7.1 Soil Velocity Profiles

Section 2.5.4.2.5.8 provides a detailed discussion of the selected soil velocity profiles used for the site response analysis. Details of the site response analysis are provided in Section 2.5.2.

#### 2.5.4.7.2 Site Seismic History

The seismic history of the area and the site, including any prior history of seismicity, evidence of liquefaction or boils, is addressed in Sections 2.5.1.1.4.4.5 and 2.5.1.2.6.4.

#### 2.5.4.7.3 Acceleration Time History For Soil-structure Interaction Analysis

A spectrum-compatible acceleration-time history was developed for use with the velocity profile described in Section 2.5.4.8. This acceleration-time history was chosen based on the probabilistic seismic hazard deaggregation information described in Section 2.5.2.

The development of the single horizontal component spectrum-compatible time history is based on the mean $10^{-4}$ uniform hazard target spectrum described in Section 2.5.2. The spectrum compatible time history was developed for the frequency range of 100 Hz to 0.5 Hz.

Using the site-specific soil column extended to the ground surface and the amplification factor, and the performance-based hazard methodology utilized to develop the Safe Shutdown Earthquake (SSE) (refer to Sections 2.5.2.5 and 2.5.2.6), a zero depth peak ground acceleration of 0.084 g associated with a magnitude **M**5.5 earthquake was computed. However, the SSE of the CCNPP Unit 3 uses a peak ground acceleration of 0.15 g.

For reconciliation of site specific design parameters affecting the SSE analysis results, refer to Sections 3.7.1 and 3.7.2.

### 2.5.4.8 Liquefaction Potential

The potential for soil liquefaction at the CCNPP Unit 3 site was evaluated following NRC Regulatory Guide 1.198 (USNRC, 2003c). The soil properties and profiles utilized are those described in Section 2.5.4.2.

Sections 2.5.4.8.1 through 2.5.4.8.6 are added as a supplement to the U.S. EPR FSAR.

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#### 2.5.4.8.1 Previous Liquefaction Studies

Two liquefaction studies are cited in the CCNPP Units 1 and 2 UFSAR (BGE, 1982), as follows. The same reference cites a horizontal ground acceleration of 0.08 g and a Richter magnitude of 4 to 5 for the OBE case, and a horizontal ground acceleration of 0.15 g and a Richter magnitude of 5 to 5.5 for the SSE case.

CCNPP Units 1 and 2 UFSAR (BGE, 1982) reports that the liquefaction potential at the site was evaluated using data from standard penetration test borings, laboratory test results, in-place density determinations, and geologic origin of the site soils. The results showed that the site soils did not possess the potential to liquefy. Quantitative values for the factor of safety against liquefaction were not given.

CCNPP Units 1 and 2 UFSAR (BGE, 1982) also reports on results of a liquefaction study for the siting of the Diesel Generator Building in the North Parking area as a part of CCNPP Units 1 and 2 development. This liquefaction evaluation was performed on data from standard penetration test borings, resulting in computed factors of safety from 1.3 to 2.4, with a median value of 1.8. On this basis, it was determined that the site of the Diesel Generator Building had adequate factor of safety against liquefaction (Bechtel, 1992).

#### 2.5.4.8.2 Soil and Seismic Conditions For CCNPP Unit 3 Liquefaction Analysis

Preliminary assessments of liquefaction for the CCNPP Unit 3 soils were based on observations and conclusions contained within CCNPP Units 1 and 2 UFSAR (BGE, 1982). The site soils that were investigated for the design and construction of CCNPP Units 1 and 2 did not possess the potential to liquefy. Given the relative uniformity in geologic conditions between existing and planned units, the soils at CCNPP Unit 3 were preliminarily assessed as not being potentially liquefiable for similar ground motions, and were further evaluated for confirmation, as will be described later in this subsection. Based on this assessment, it was determined that aerial photography as outlined in Regulatory Guide 1.198 (USNRC, 2003c) would not add additional information to the planning and conduct of the subsurface investigation; therefore, was not conducted.

A common stratigraphy was adopted for the purpose of establishing soil boundaries for liquefaction evaluation. The adopted stratigraphy was that shown generically in Figure 2.5-106 and also by the veloc[illegible] the upper 400 ft of the sit[illegible] CCNPP Unit 3 subsurf[illegible] geologically old and s[illegible] ll be further discussed in Section 2.5.4.8.4.

The liquefaction analysis was performed using a peak ground acceleration (PGA) of 0.15 g from the Site Safe Shutdown Earthquake (SSE) developed in Section 3.7.1.

~~As described in Section 2.5.4.7.3, the resulting peak ground acceleration for the site was found to be 0.084 g associated with a magnitude M5.5 earthquake. For conservatism, a peak ground acceleration of 0.15 g and an earthquake magnitude of 6.0 were adopted and used for the liquefaction analysis.~~

#### 2.5.4.8.3 Liquefaction Evaluation Methodology

Liquefaction is defined as the transformation of a granular material from a solid to a liquefied state as a consequence of increased pore water pressure and reduced effective stress (Youd, et al., 2001). The prerequisite for soil liquefaction occurrence (or lack thereof) are the state of soil saturation, density, gradation and plasticity, and earthquake intensity. The present liquefaction analysis employs state-of-the-art methods (Youd, et al., 2001) for evaluating the liquefaction potential of soils at the CCNPP Unit 3 site. Given the adequacy of these methods in assessing


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is considered high. A FOS = 1.1 appears to be the lowest acceptable value. On the same issue, the Committee on Earthquake Engineering of the National Research Council (CEE, 1985) states that "There is no general agreement on the appropriate margin (factor) of safety, primarily because the degree of conservatism thought desirable at this point depends upon the extent of the conservatism already introduced in assigning the design earthquake. If the design earthquake ground motion is regarded as reasonable, a safety factor of 1.33 to 1.35... is suggested as adequate. However, when the design ground motion is excessively conservative, engineers are content with a safety factor only slightly in excess of unity." This, and a minimum FOS = 1.1 in NRC Regulatory Guide 1.198 (USNRC, 2003c), are consistent with the FOS = 1.1 adopted for the assessment of FOSs for the CCNPP Unit 3 site soils, considering the conservatism adopted in ignoring the cem[illegible]ts, as well as the seismic acceleration and ma[illegible] evaluation, in conjunction with ignoring the geologic factors discussed above, justifies the use of FOS = 1.1 for liquefaction assessment of the CCNPP site soils.

ground motion response spectra (GMRS)

### 2.5.4.9 Earthquake Site Characteristics

Section 2.5.2.6 describes the development of the horizontal ~~Safe Shutdown Earthquake (SSE) ground motion~~ for the CCNPP Unit 3 site. The selected ~~SSE~~ ground motion is based on the risk-consistent/performance-based approach of NRC Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion" (USNRC, 2007b) with reference to NUREG/CR-6728 (REI, 2001) and ASCE/SEI 43-05 (ASCE, 2005). Any deviation from the guidance provided in Regulatory Guide 1.208 is discussed in Section 2.5.2. Horizontal ground motion amplification factors are developed in Section 2.5.2.5 using [illegible] data and estimates of near-surface soil and rock properties presented in Section 2.5.4. These amplification factors are then used to scale the hard rock spectra, presented in Section 2.5.2.4, to develop a soil Uniform Hazard Spectra (UHS), accounting for site-specific conditions using Approach 2A of NUREG/CR-6769 (USNRC, 2002). Horizontal ~~SSE~~ spectra are developed from these soil UHS, using the performance-based approach of ASCE/SEI 43-05, accepted by Regulatory Guide 1.208. The ~~SSE~~ motion is defined at the free ground surface of a hypothetical outcrop at the base of the foundation. Section 2.5.2.6 also describes vertical ~~SSE~~ ground motion, which was developed by scaling the horizontal ~~SSE~~ by a frequency-dependent vertical-to-horizontal (V:H) factor, presented in Section 2.5.2.6.

ground motion

### 2.5.4.10 Static Stability

The CCNPP Powerblock Area is graded to establish the final site elevation, which will range from about El. 81 ft to 85 ft. An average grade elevation of 83 ft is assumed. The Reactor, Safeguards, and Fuel Buildings are seismic Category I structures and are supported on a common basemat. For a basemat thickness of 10 ft and top of basemat about 31.5 ft below grade, th[illegible] The common [illegible] rea, with out[illegible] estimatio[illegible] on, depth, a[illegible] Powerblock area. This information is also shown in Figure 2.5-183.

Section 3.7.1 develops a Site Safe Shutdown Earthquake (Site SSE) that satisfies the minimum Safe Shutdown Earthquake Ground Motion for design identified in paragraph (d)(1) of 10 CFR 100.23 (CFR, 2007).

Construction of the common basemat requires an excavation of about 41 to 42 ft (from approximately El. 83 ft). The resulting rebound (heave) in the ground due to the removal of the soils is expected to primarily take place in Stratum IIc Chesapeake Clay/Silt soils. A rebound of about 4 in is estimated due to excavation for the common basemat, and is expected to take place concurrent with the excavation. Ground rebound is monitored during excavation. The heave estimate is made based on the elastic properties of the CCNPP site soils and the response

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surfaces, e.g., circular, planar, composite, or block type, and locates the critical surface with the lowest possible FOS. The reasonableness of the surface, however, should be determined by the user as SLOPE/W, or other similar applications, cannot be expected to make these judgments. SLOPE/W also allows for the incorporation of forces due to water, as well as negative porewater (suction) and externally applied forces, when needed. Material properties may simply be defined in terms of unit weight, friction and/or cohesion, or made a function of other parameters, e.g., change in stress. SLOPE/W has two options for evaluating slopes subjected to rapid loading; namely, pseudo-statically or using results from other dynamic analyses such as a companion program that obtains dynamic stresses and porewater pressure. A complete description of SLOPE/W and slope stability formulations is given in SLOPE/W user manual (GEO-SLOPE, 2007).

The effect of surcharge loading was excluded from the analyses. Planned structures are sufficiently set back from edges of slopes so that they do not impose surcharge loading on the slope. The location and relative positions of safety-related structures to slopes in Sections A', G' and G" for the powerblock and intake area are shown in Figure 2.5-201 and Figure 2.5-202. The site soils are not considered liquefiable for the seismic conditions of the site; therefore, liquefaction is not applicable to stability of slopes at the site. Liquefaction potential is addressed in detail in Section 2.5.4.8.

For the pseudo-static analysis in the CCNPP Unit 3 site, the inertial effect coefficient $k_h = 0.15$ was used, based on $a_h = 0.15g$, ~~as discussed in Section 2.5.4.7~~. The vertical component, $k_v$, was chosen as 0.075.

from the Site Safe Shutdown Earthquake (Site SSE) developed in Section 3.7.1.

In the static analysis, a Mohr-Coulomb
used. For the sand layers, it is assumed that the effective cohesion, c', is equal to zero. This is a conservative approach which yields a lower factor of safety (FOS). The sand layers at the site contain varying amounts of clay and silt as shown in the boring logs provided in COLA Part 11J: Geotechnical Subsurface Investigation Data Report. The effective friction angle ($\phi'$) for the sand layers is based on standard penetration and cone penetration tests correlations, direct shear and CIU-bar triaxial compression tests. For the clay/silt layers, c' and $\phi'$ were obtained from the CIU-bar triaxial compression and direct shear tests.

Two cases were considered for the dynamic analysis:

- A Mohr-Coulomb failure criterion based on total stress conditions was used, to account for the hydrostatic pressure buildup. For the sand layers, total strength parameters (cohesion, c, and friction angle, $\phi$) were obtained from CIU triaxial compression and direct shear tests. For the clay/silt layers, the undrained shear strength, $s_u$, obtained from Unconsolidated Undrained (UU) and Unconfined Compression (UC) tests was used (Table 2.5-54).

- A Mohr-Coulomb failure criterion based on effective stress conditions, using the same parameters as in the static analysis.

Material properties for the slope stability analysis are presented for the powerblock, utility corridor, and the intake slope and intake area in Table 2.5-71.

Result of the static and pseudo-static slope stability analyses for critical surfaces, that is, surfaces with the lowest FOS, are shown in Figure 2.5-203 through Figure 2.5-211. In these figures, TSA and ESA represent total stress analysis and effective stress analysis, respectively. The computed FOSs shown on these figures are based on the Morgenstern-Price method

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**Table 2.5-22—{~~Recommended~~ Horizontal and Vertical ~~SSE and OBE~~ Amplitudes and Common V/H Ratios}**

| Freq | Horizontal ~~SSE~~ (g) | Vertical ~~SSE~~ (g) | Horizontal OBE (g) | Vertical OBE (g) | V/H |
|---|---|---|---|---|---|
| 0.1 | 2.70E-03 | 2.03E-03 | 9.00E-04 | 6.75E-04 | 0.75 |
| 0.125 | 4.70E-03 | 3.52E-03 | 1.57E-03 | 1.17E-03 | 0.75 |
| 0.15 | 7.85E-03 | 5.89E-03 | 2.62E-03 | 1.96E-03 | 0.75 |
| 0.2 | 2.02E-02 | 1.52E-02 | 6.74E-03 | 5.05E-03 | 0.75 |
| 0.3 | 3.35E-02 | 2.51 E-02 | 1.12E-02 | 8.36E-03 | 0.75 |
| 0.4 | 3.57E-02 | 2.68E-02 | 1.19E-02 | 8.93E-03 | 0.75 |
| 0.5 | 4.25E-02 | 3.19E-02 | 1.42E-02 | 1.06E-02 | 0.75 |
| 0.6 | 6.73E-02 | 5.04E-02 | 2.24E-02 | 1.68E-02 | 0.75 |
| 0.7 | 8.19E-02 | 6.14E-02 | 2.73E-02 | 2.05E-02 | 0.75 |
| 0.8 | 9.14E-02 | 6.85E-02 | 3.05E-02 | 2.28E-02 | 0.75 |
| 0.9 | 9.55E-02 | 7.16E-02 | 3.18E-02 | 2.39E-02 | 0.75 |
| 1 | 1.03E-01 | 7.69E-02 | 3.42E-02 | 2.56E-02 | 0.75 |
| 1.25 | 1.23E-01 | 9.23E-02 | 4.10E-02 | 3.08E-02 | 0.75 |
| 1.5 | 1.28E-01 | 9.64E-02 | 4.28E-02 | 3.21 E-02 | 0.75 |
| 2 | 1.23E-01 | 9.26E-02 | 4.11 E-02 | 3.09E-02 | 0.75 |
| 2.5 | 1.29E-01 | 9.70E-02 | 4.31 E-02 | 3.23E-02 | 0.75 |
| 3 | 1.51 E-01 | 1.14E-01 | 5.05E-02 | 3.78E-02 | 0.75 |
| 4 | 1.69E-01 | 1.27E-01 | 5.63E-02 | 4.23E-02 | 0.75 |
| 5 | 1.72E-01 | 1.29E-01 | 5.75E-02 | 4.31 E-02 | 0.75 |
| 6 | 1.80E-01 | 1.40E-01 | 6.01 E-02 | 4.68E-02 | 0.778 |
| 7 | 1.72E-01 | 1.38E-01 | 5.73E-02 | 4.60E-02 | 0.802 |
| 8 | 1.64E-01 | 1.35E-01 | 5.46E-02 | 4.49E-02 | 0.823 |
| 9 | 1.57E-01 | 1.32E-01 | 5.23E-02 | 4.40E-02 | 0.841 |
| 10 | 1.50E-01 | 1.28E-01 | 4.99E-02 | 4.28E-02 | 0.858 |
| 12.5 | 1.38E-01 | 1.23E-01 | 4.59E-02 | 4.10E-02 | 0.892 |
| 15 | 1.28E-01 | 1.18E-01 | 4.27E-02 | 3.93E-02 | 0.921 |
| 20 | 1.09E-01 | 1.05E-01 | 3.62E-02 | 3.50E-02 | 0.965 |
| 25 | 9.80E-02 | 9.80E-02 | 3.27E-02 | 3.27E-02 | 1 |
| 30 | 8.77E-02 | 8.77E-02 | 2.92E-02 | 2.92E-02 | 1 |
| 35 | 8.27E-02 | 8.27E-02 | 2.76E-02 | 2.76E-02 | 1 |
| 40 | 7.97E-02 | 7.97E-02 | 2.66E-02 | 2.66E-02 | 1 |
| 45 | 7.81 E-02 | 7.81 E-02 | 2.60E-02 | 2.60E-02 | 1 |
| 50 | 7.73E-02 | 7.73E-02 | 2.58E-02 | 2.58E-02 | 1 |
| 60 | 7.63E-02 | 7.63E-02 | 2.54E-02 | 2.54E-02 | 1 |
| 70 | 7.59E-02 | 7.59E-02 | 2.53E-02 | 2.53E-02 | 1 |
| 80 | 7.57E-02 | 7.57E-02 | 2.52E-02 | 2.52E-02 | 1 |
| 90 | 7.56E-02 | 7.56E-02 | 2.52E-02 | 2.52E-02 | 1 |
| 100 | 7.55E-02 | 7.55E-02 | 2.52E-02 | 2.52E-02 | 1 |


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**Figure 2.5-87—{Recommended Horizontal and Vertical ~~SSE Spectra~~}**

GMRS

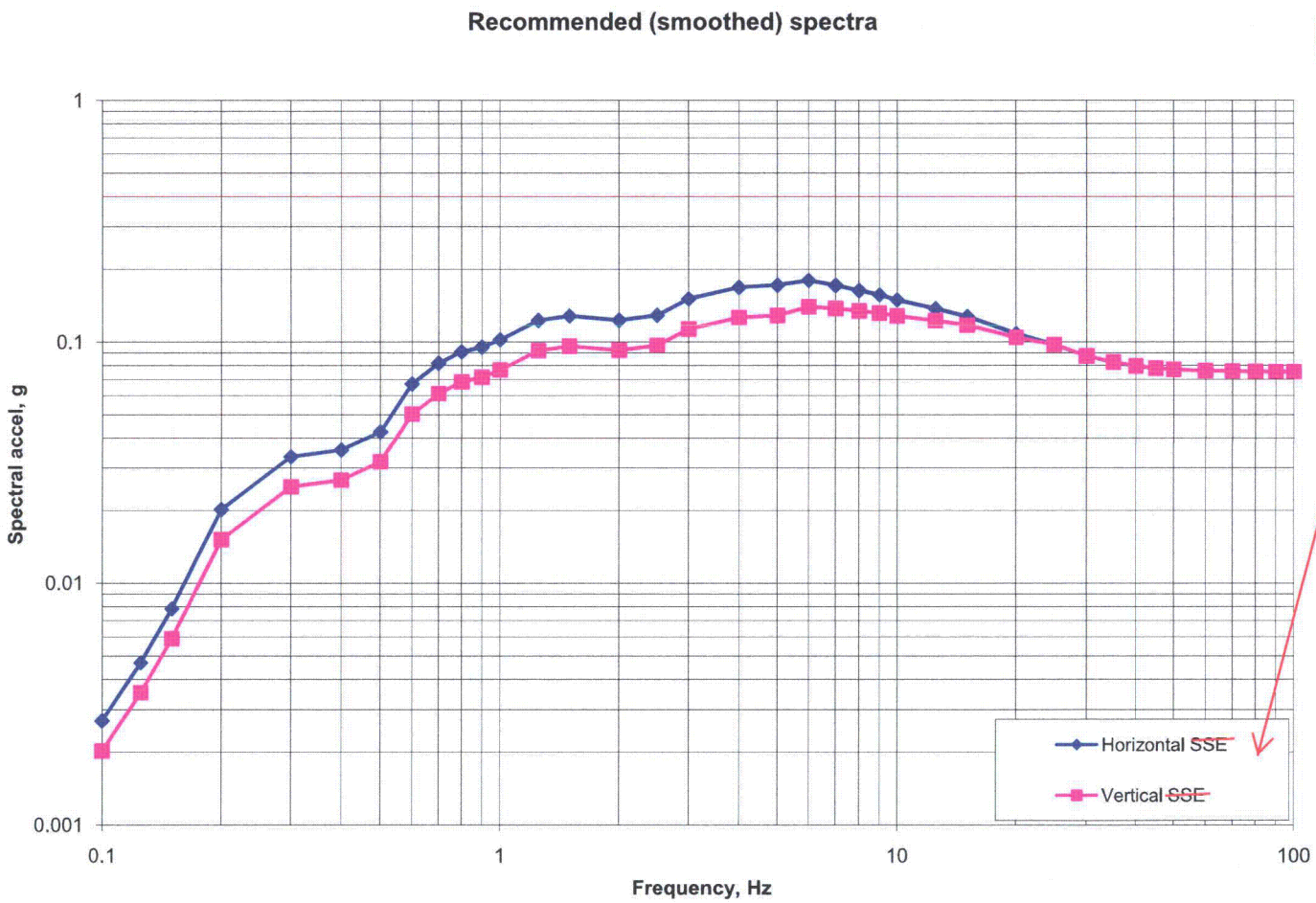



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**Table 3.2-1—{Classification Summary for Site-Specific SSCs}** Note 5

(Page 1 of 7)

| KKS System or Component Code | SSC Description | Safety Classification (Note 1) | Quality Group Classification | Seismic Category (Note 2) | 10CFR50 Appendix B Program | Location (Note 3) | Comments/ Commercial Code |
|---|---|---|---|---|---|---|---|
| Table 3.2.2-1 of the U.S. EPR FSAR contains the following conceptual design information for the SM, SN, Cranes, Hoists, and Elevators category for: UKE, Access Building, and UBZ, Buried Conduit Duct Bank. | | | | | | | |
| [[UKE | Access Building | NS-AQ | N/A | CS | No | UKE | |
| UBZ | Buried Conduit Duct Bank | S | N/A | I | Yes | UBZ]] | |
| The U.S. EPR FSAR descriptions provided in U.S. EPR FSAR Table 3.2.2-1 regarding the SM, SN, Cranes, Hoists, and Elevators category for: UKE, Access Building, and UBZ, Buried Conduit Duct Bank are applicable to CCNPP Unit 3, and are incorporated by reference. | | | | | | | |
| **PED UHS Makeup Water System** | | | | | | | |
| 30PED 10/20/30/40/A P001 | UHS Makeup Water Pumps | S | C | I | Yes | UPB | ASME III ANSI/HI 2.3 |
| 30PED 10/20/30/40/A H001 | UHS Makeup Water Pump Motors (30 PED 10/20/30/40/ AH001) | S | C | I | Yes | UPB | IEEE/NEMA |
| PED | Piping (30PED 10/20/30/40) to Cooling Tower | S | C | I | Yes | UPB, UZT | ASME III |
| 30PED 10/20/30/40/A T 001/AT002 | Discharge Strainer | S | C | I | Yes | UPB | ASME III |
| 30PED 10/20/30/40/ AA001, 30 PED 10/20/30/40/ AA005 | Isolation Valves | S | C | I | Yes | UPB/ UZT | ASME III/IEEE |
| PED | Ventilation Equipment Piping | S | C | I | Yes | UPB | ASME III |
| PED | Ventilation Equipment | S | C | I | Yes | UPB | ASME III / ASME AG-1 |
| 30 PED 11/21/31/41/A C001 | Isolation Valves for Equipment | S | C | I | Yes | UPB | ASME III |
| PED | Piping and Valves | S | C | I | Yes | UPB/UZT | ASME III |
| 30UPB10 01/02/03/04 | UHS Makeup Water Intake Structure, UHS Makeup Pump Rooms | S | C | I | Yes | UPB | ANSI/HI 9.8/ACI 349/ ANSI/AISC N690 |
| PED | Instrument and Controls in the UHS Makeup Water Intake Structure | S | C | I | Yes | UPB | ASME III/IEEE |
| PED | UHS Makeup Water System Electrical Distribution System Equipment | S | C | I | Yes | UPB | IEEE/NEMA |
| UPB | UHS Electrical Building | S | C | I | Yes | UPB | ACI 349/ ANSI/AISC N690 |
| PED | Miscellaneous piping | NS | D | II | No | | ASME B31.1 |
| PED | Traveling Screens | NS | D | II | No | UPB | |
| PED | Buried Intake Pipes | S | C | I | Yes | UPE/ UPB | ASME III/ASCE 4-98/ ASME B31.1, App. VII |
| PED | Forebay | NS-AQ | D | II | No | UPE/ UPB | ACI 349 / ASCE 43-05 |
| PED | Sheet Pile Wall | NS-AQ | E | CS | No | | IBC |


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**Table 3.2-1—{Classification Summary for Site-Specific SSCs}**
(Page 4 of 7)

| KKS System or Component Code | SSC Description | Safety Classification (Note 1) | Quality Group Classification | Seismic Category (Note 2) | 10CFR50 Appendix B Program | Location (Note 3) | Comments/ Commercial Code |
|---|---|---|---|---|---|---|---|
| QJ | Central Gas Supply Electrical Distribution Equipment | NS | E | NSC | No | UTG | IEEE/NEMA |
| **GK, Potable and Sanitary Water Systems** | | | | | | | |
| GK | Piping | NS | E | NSC | No | | ASME B31.1 |
| GK | Valves | NS | E | NSC | No | | ASME B31.1 |
| GK | Tanks | NS | E | CS | No | | AWWA /ASME VIII/IBC |
| GK | Pump/Motors | NS | E | NSC | No | | ASME B31.1/ANSI/NEMA |
| GK | Potable Water System Electrical Distribution Equipment | NS | E | NSC | No | | IEEE/NEMA |
| **SG, SGA, SGAO, SGM Fire Water Supply System** | | | | | | | |
| SGA | Fire Water Distribution System, including valves and hydrants, Balance of Plant (Not providing Safe Shutdown Earthquake Protection) | NS-AQ | D | NSC | No | | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 214, 2005 ed.<br>NFPA 804, 2006 ed. |
| SGA | Fire Water Distribution System, including valves and hydrants, Balance of Plant (Safe Shutdown Equipment Protection following SSE) | NS-AQ | D | II-SSE | Yes | | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| | | | | | | | |
| USG | Fire Water Storage Tanks and Fire Protection Building | NS-AQ | D | II-SSE | Yes | USG/ UZT | NFPA 20, 2007 ed.<br>NFPA 22, 2003 ed.<br>NFPA 25, 2002 ed.<br>AWWA D100, 2005 ed.<br>ASCE 43, 2005 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| SGM | Diesel Engine Driven Pumps and Drivers and subsystems, including diesel fuel oil supply | NS-AQ | D | II-SSE | Yes | USG | NFPA 20, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ASCE 43, 2005 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| SGM | Electric Motor Driven Pump and Driver | NS-AQ | D | NSC | No | USG | NFPA 20, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed. |
| SA | Ventilation Equipment | NS-AQ | D | II-SSE | Yes | USG | NFPA 20, 2007 ed.<br>NFPA 90A, 2002 ed. Including 2003 & 2005 Errata<br>ASME AG-1, 2003 ed. Including 2004 Addenda<br>ASME N-509, 2002 ed.<br>ASCE 43, 2005 ed. |
| SGM | Jockey Pump and driver | NS-AQ | D | NSC | No | USG | NFPA 20, 2007 ed,<br>NFPA 25, 2002 ed,<br>NFPA 804, 2006 ed. |

ACI 349/ANSI/AISC N690/ASCE 4-98


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

(Page 5 of 7)

| KKS System or Component Code | SSC Description | Safety Classification (Note 1) | Quality Group Classification | Seismic Category (Note 2) | 10CFR50 Appendix B Program | Location (Note 3) | Comments/ Commercial Code |
|---|---|---|---|---|---|---|---|
| SG | Fire Protection Makeup Piping and Valves From Raw (Desalinated) Water Supply System | NS-AQ | D | NSC | No | UZT | NFPA 22, 2003 ed, ~~ed.~~ |
| **Fire Suppression Systems** | | | | | | | |
| | Fire Suppression ~~Systems for~~ Site Specific Buildings other than UHS Makeup Water Intake Structure, UHS Electrical Building, and Fire Protection Building | NS-AQ | D | NSC | No | UST<br>UTG<br>UYF<br>UPQ | NFPA 13, 2007 ed,<br>NFPA 14, 2007 ed.<br>NFPA 25, 2002 ed,<br>NFPA 804, 2006 ed, |
| | Fire Suppression Systems for UHS Makeup Water Intake Structure, UHS Electrical Building, and Fire Protection Building | NS-AQ | D | ~~II-SSE~~ II | ~~Yes~~ No | UPB, USG | NFPA 13, 2007 ed,<br>~~NFPA 14, 2007 ed,~~<br>NFPA 25, 2002 ed,<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| **Other Site-Specific Structures** | | | | | | | |
| UBA | Switchgear Building | NS | E | CS | No | UBA | IBC |
| UMA | Turbine Building | NS | E | CS | No | UMA | IBC |
| UAC | Grid Systems Control Building | NS | E | CS | No | UAC | IBC |
| UQZ | Electrical Duct Banks traversing from the Safeguards Buildings to the Four Essential Service Water | S | C | I | Yes | UJK/<br>UZT/<br>UQB/ | IEEE/ACI-349/NEC |
| | from the Emergency Auxiliary Transformers to the Safeguard Buildings | | | | | UZT/ UJK | |
| UBZ | Electrical Duct Banks traversing from the Switchgear Building to the Desalination Plant, Circulating Water Pump Building, Cooling Tower, Switchyard Control House, Site Specific Auxiliary Transformer, Sewage Treatment Plant, and CW Makeup Water Intake Structure | NS | E | CS | No | UBA/<br>UZT/<br>UPQ/<br>UQA/<br>URA/<br>UAC/<br>UAA/<br>UGV/ UPE | IEEE/NEC |
| | Electrical Duct Banks traversing between miscellaneous buildings | NS | E | CS | No | UZT | IEEE/NEC |
| | Electrical Duct Banks traversing between miscellaneous buildings | NS | E | CS | No | UZT | IEEE/NEC |

Systems and Standpipes and Hose Stations for

| | | | | | | |
|---|---|---|---|---|---|---|
| Standpipes and Hose Stations for UHS Makeup Water Intake Structure and UHS Electrical Building | NS-AQ | D | II-SSE | Yes | UPB | NFPA 14, 2007 ed,<br>NFPA 25, 2002 ed,<br>NFPA 804, 2006 ed,<br>ANSI/ASME B31.1, 2004 ed. |



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**Table 3.2-1—{Classification Summary for Site-Specific SSCs}**
(Page 7 of 7)

| KKS System or Component Code | SSC Description | Safety Classification (Note 1) | Quality Group Classification | Seismic Category (Note 2) | 10CFR50 Appendix B Program | Location (Note 3) | Comments/ Commercial Code |
|---|---|---|---|---|---|---|---|

4. Acronyms are defined below:

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

5. Those SSC classified as "NS-AQ" (for Safety Class) and classified as "Yes" for 10 CFR 50 Appendix B will be subject only to those quality assurance requirements of Appendix B that are pertinent to that SSC based on the potential affect of the SSC on safety-related functions.


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## 3.10 SEISMIC AND DYNAMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT

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

For CCNPP Unit 3, seismic and dynamic qualification of site-specific mechanical and electrical equipment (identified in Table 3.10-1) includes equipment associated with the:

- UHS Makeup Water System, including the UHS Makeup Water Intake Structure and the UHS Electrical Building; and
- Fire Protection System components that are required to protect equipment required to achieve safe shutdown following an earthquake, including the Fire Protection Building and Fire Water Storage Tanks.

For CCNPP Unit 3, seismic qualification of equipment located in the EPGB and ESWB is performed using the In-Structure Response Spectra (ISRS) provided in Section 3.7.2.5 instead of the U.S. EPR FSAR ISRS.

Results of seismic and dynamic analysis were not available at the conformance with NRC Regulat implementation program is provided. As depicted in Table 3.10-2, the qualification program will be implemented in five major phases.

Phase I (Seismic Qualification Methodology) involves the development of a summary table for site-specific equipment. This summary table shall:

- List site-specific equipment, along with the associated equipment identification number.
- Define the building in which each equipment is located, along with the equipment mounting elevation.
- Clarify whether the equipment is wall mounted, floor mounted, or line mounted.
- For mechanical equipment, identify if the equipment is active or passive.
- Provide a description of the intended mounting (e.g., skid mounted versus mounted directly on the floor, welded versus bolted, etc.).
- List the applicable In-Structure Response Spectra or, for line mounted equipment, the required input motion.
- Define operability and functionality requirements.
- Identify the acceptable qualification methods (i.e., analysis, testing, and/or a combination of both).
- Provide a requirement for environmental testing prior to seismic testing, when applicable.

The basis and criteria established in Phase I shall be used as technical input to the Phase II (Specification Development) technical requirements that will be provided to bidders. In addition, the specification will include the applicable seismic qualification requirements of the U.S. EPR FSAR which are incorporated by reference in this section (e.g., invoking industry standard IEEE 344).


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A list of site-specific seismically and dynamically qualified mechanical, electrical, and instrumentation and control equipment is provided in Table 3.10-1. Table 3.10-1 also identifies the type of environment to which the equipment is subjected.

#### 3.10.1.2 Performance Requirements for Seismic Qualification

No departures or supplements.

#### 3.10.1.3 Acceptance Criteria

No departures or supplements.

#### 3.10.1.4 Input Motion

~~{No departures or supplements.}~~ {See Section 3.10}

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

No departures or supplements.

### 3.10.3 METHODS AND PROCEDURES FOR QUALIFYING SUPPORTS OF MECHANICAL AND ELECTRICAL EQUIPMENT AND INSTRUMENTATION

No departures or supplements.

### 3.10.4 TEST AND ANALYSIS RESULTS AND EXPERIENCE DATABASE

The U.S. EPR FSAR includes the following COL Holder Item in Section 3.10.4:

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

This COL Holder Item is addressed as follows:

{Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC} shall create and maintain the SQDP file. This activity shall be initiated during the equipment selection and procurement phase. The SQDP file shall be maintained for the life of the plant.

The U.S. EPR FSAR also includes the following COL Item in Section 3.10.4:

> If the seismic and dynamic qualification testing is incomplete at the time of the COL application, a COL applicant that references the U.S. EPR design certification will submit an implementation program, including milestones and completion dates, for NRC review and approval prior to installation of the applicable equipment.

This COL Item is addressed as follows:

The seismic and dynamic qualification implementation program, including milestones and completion dates, shall be developed and submitted for U.S. Nuclear Regulatory Commission approval prior to installation of the applicable equipment.

### 3.10.5 REFERENCES

{**NRC, 2007.** Combined License Applications for Nuclear Power Plants, Regulatory Guide 1.206, Revision 0, U.S. Nuclear Regulatory Commission, June 2007.}


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## 9.5 OTHER AUXILIARY SYSTEMS

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

## 9.5.1 FIRE PROTECTION SYSTEM

No departures or supplements.

### 9.5.1.1 Design Basis

Appendix 9B of this COL FSAR supplements Appendix 9A of the U.S. EPR FSAR.

### 9.5.1.2 System Description

#### 9.5.1.2.1 General Description

For all aspects of the site specific Fire Protection Program (FPP), the same codes and standards and applicable edition years apply for fire protection as listed in Section 9.5.1.7 of the U.S. EPR FSAR.

Table 9.5-1 provides supplemental information for select items/statements in U.S. EPR FSAR Table 9.5.1-1 identified as requiring COL Applicant input. The supplemental information is in a column headed {"CCNPP Unit 3 Supplement"} and addresses {CCNPP Unit 3} conformance to the identified requirement of Regulatory Guide 1.189 (NRC, 2007).

The U.S. EPR includes the following COL item in Section 9.5.1.2.1:

> A COL applicant that references the U.S. EPR design certification will provide a description and simplified Fire Protection System piping and instrumentation diagrams for site-specific systems.

Th fire water to the above ground manual and automatic suppression systems identified in Figure 9.5-4 and Figure 9.5-5. These figures illustrate the Seismic Category II-SSE standpipe and hose stations and wer the Seismic Category II sprinkler systems specified for the UHS Makeup ment Water Intake Structure and the associated Electrical Building.}

Figure 9.5-3 illustrates the site-specific fire main yard loop supplying the Intake Structure area. The Seismic Category II-SSE loop supplies ~~the seismically qualified standpipes and hose systems providing manual hose protection within the UHS Makeup Water Intake Structure and its associated electrical building. In addition, the loop supplies fire water to the sprinkler systems protecting the UHS Makeup Water Intake Structure as well as the yard fire hydrants.}~~

**Plant Fire Prevention and Control Features**

*Plant Arrangement*

{The site building layout is shown in Figure 2.1-1. An enlargement of the power block area is provided in Figure 2.1-5.} Details of the arrangement of the Turbine Building, Switchgear Building, Auxiliary Power Transformer Area, Generator Transformer Area (the remaining power block structures) and non-power block structures are provided in Appendix 9B of this COL application.


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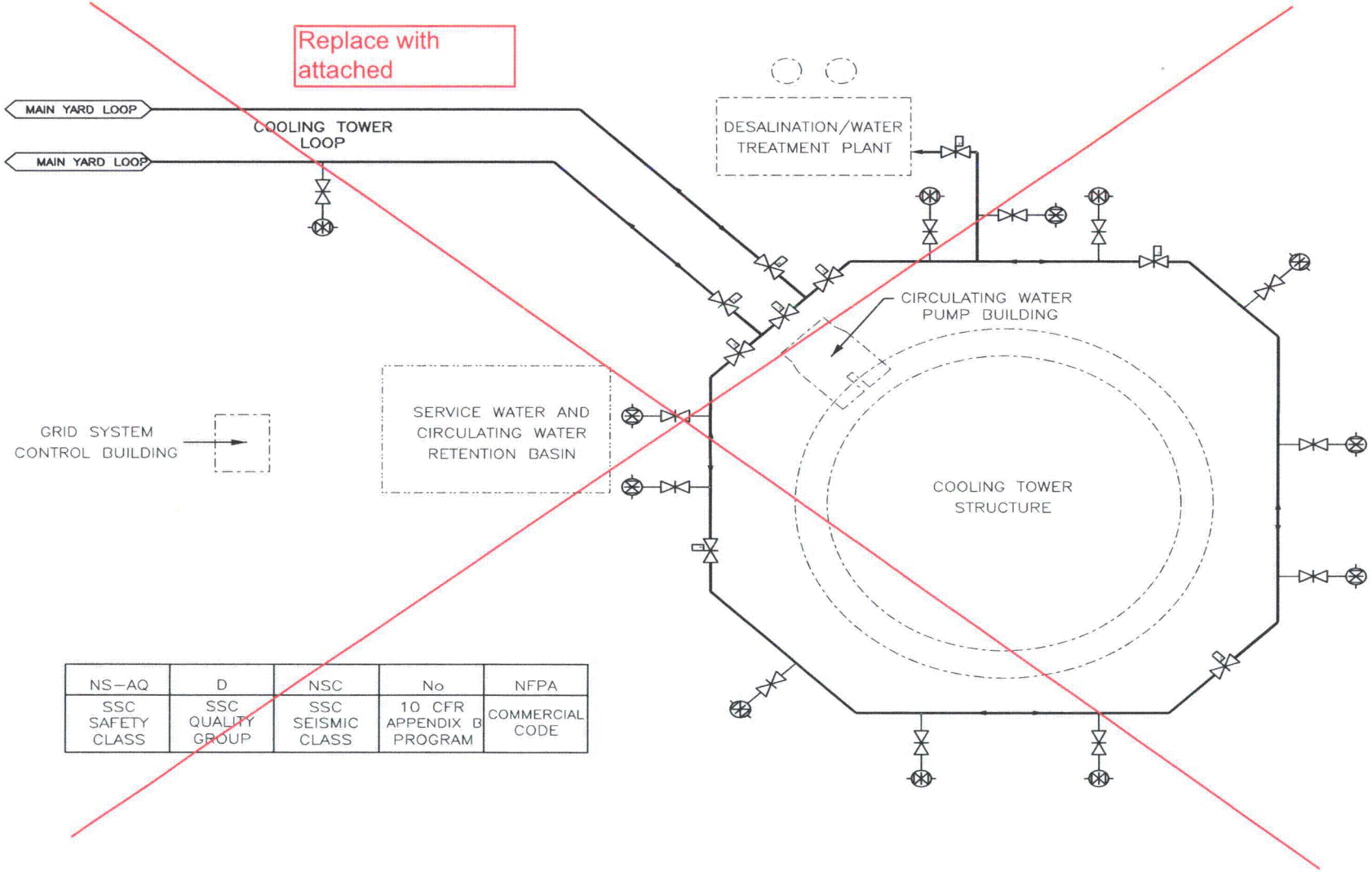
**Figure 9.5-2—{CCNPP Unit 3 Fire Water Distribution System – Cooling Tower Loop}**




| NS–AQ | D | NSC | No | NFPA |
|---|---|---|---|---|
| SSC SAFETY CLASS | SSC QUALITY GROUP | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM | COMMERCIAL CODE |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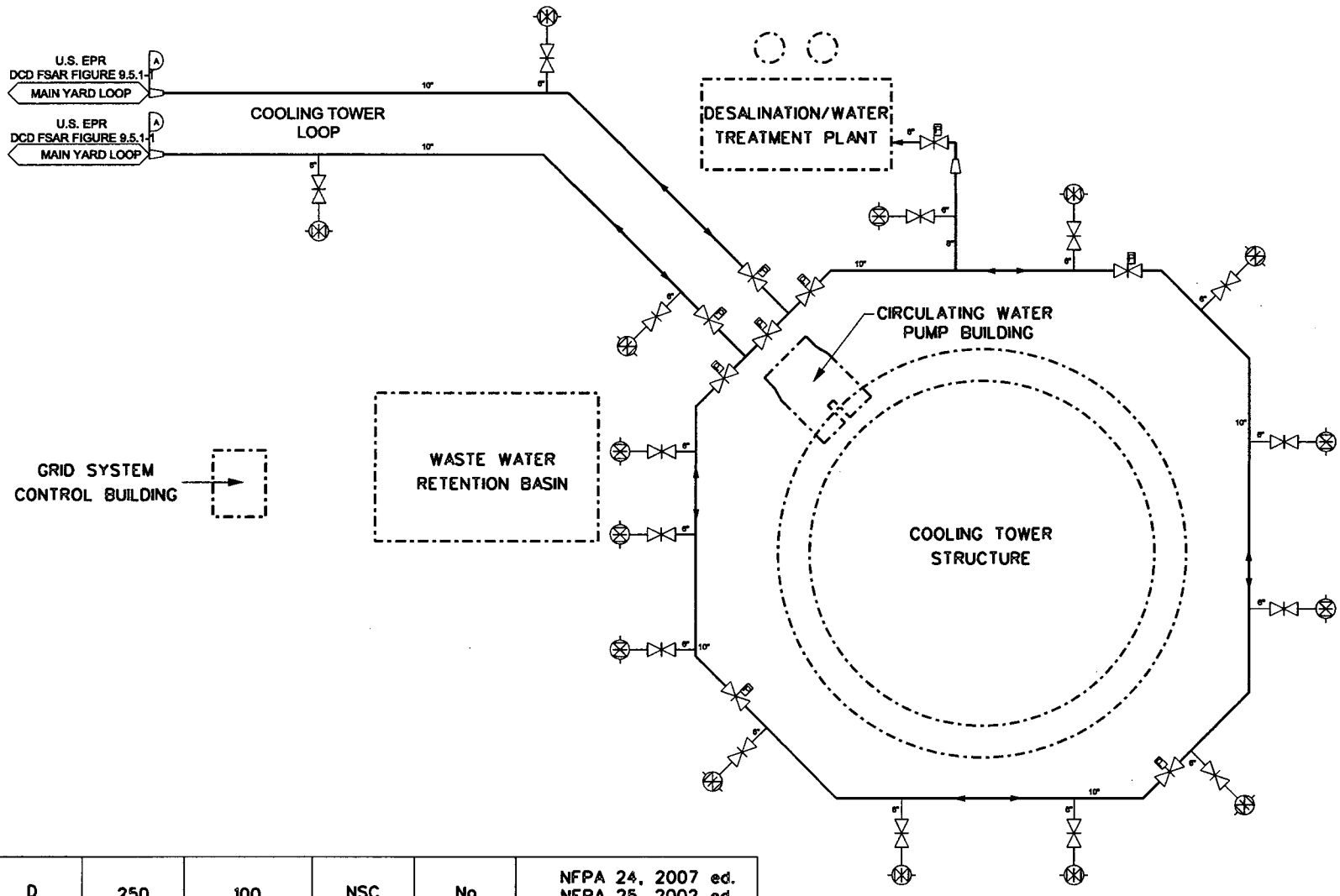
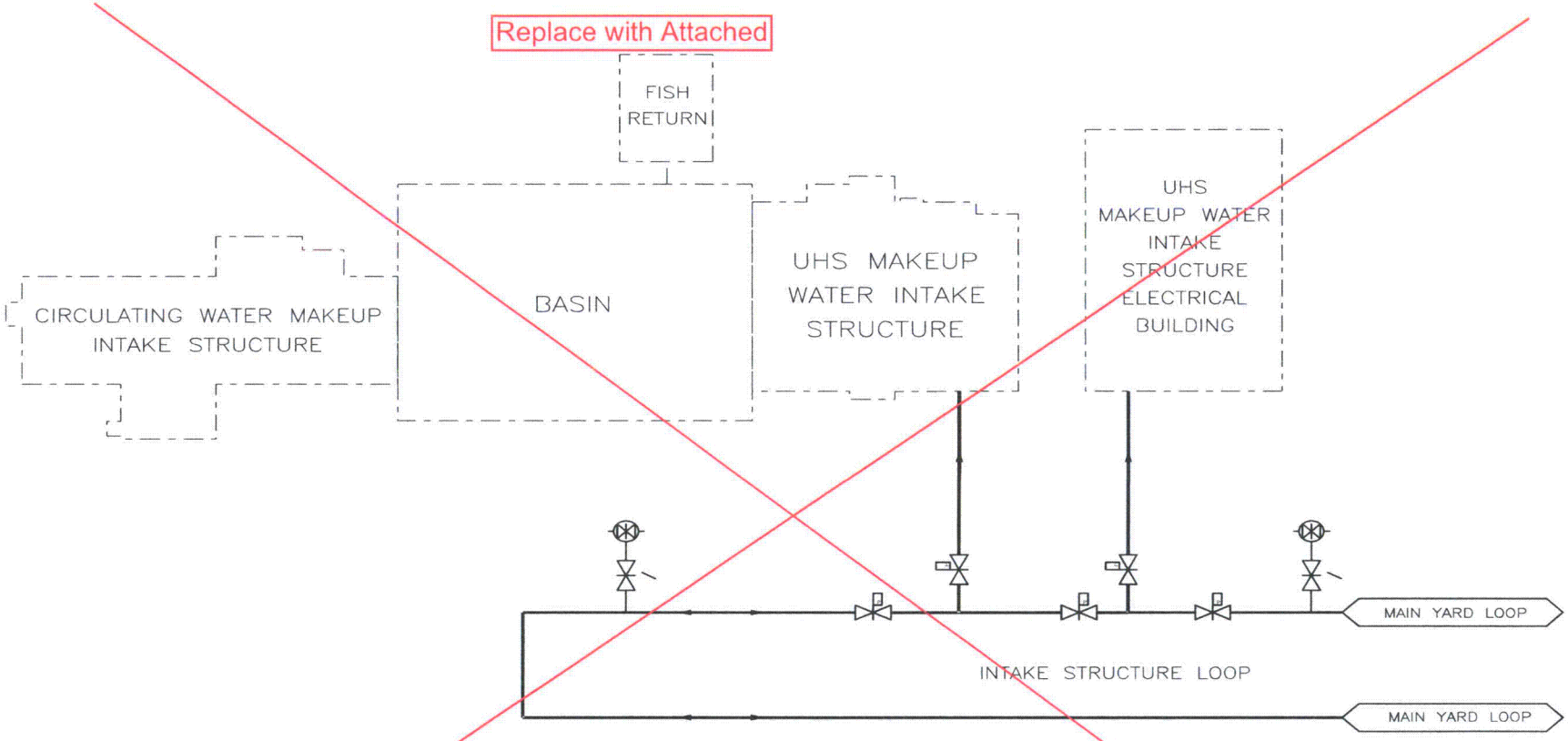



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | NS-AQ | D | 250 | 100 | NSC | No | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2005 ed. |
| DESIGN AREA | SSC SAFETY CLASS | SSC QUALITY GROUP | DESIGN PRESSURE PSIG | DESIGN TEMPERATURE °F | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM | COMMERCIAL CODE |

**Figure 9.5-3—{CCNPP Unit 3 Fire Water Distribution System – Intake Structure Loop}**




| NS–AQ | D | II–SSE | Yes | NFPA/ANSI /ASME B31.1 |
|---|---|---|---|---|
| SSC SAFETY CLASS | SSC QUALITY GROUP | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM | COMMERCIAL CODE |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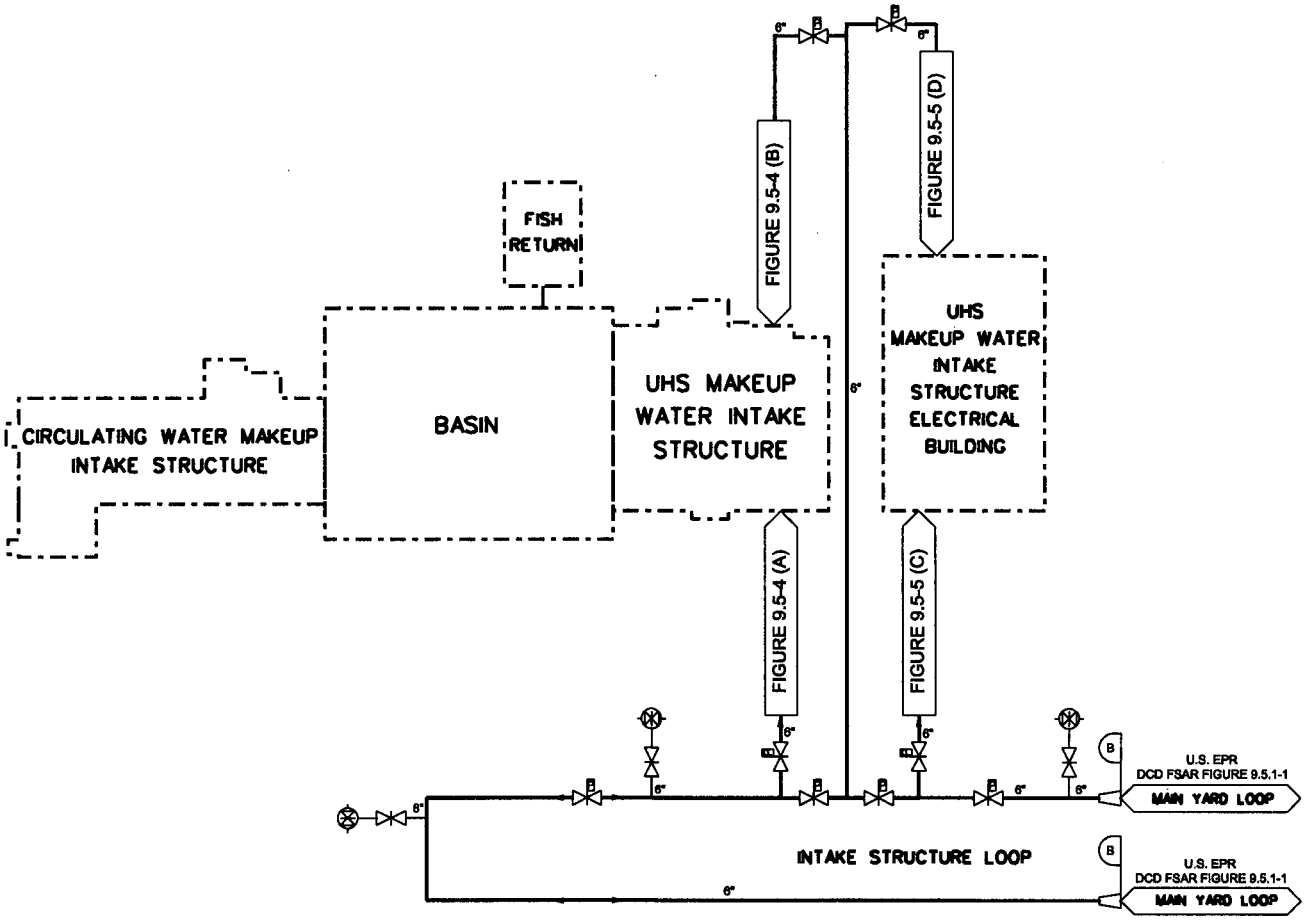
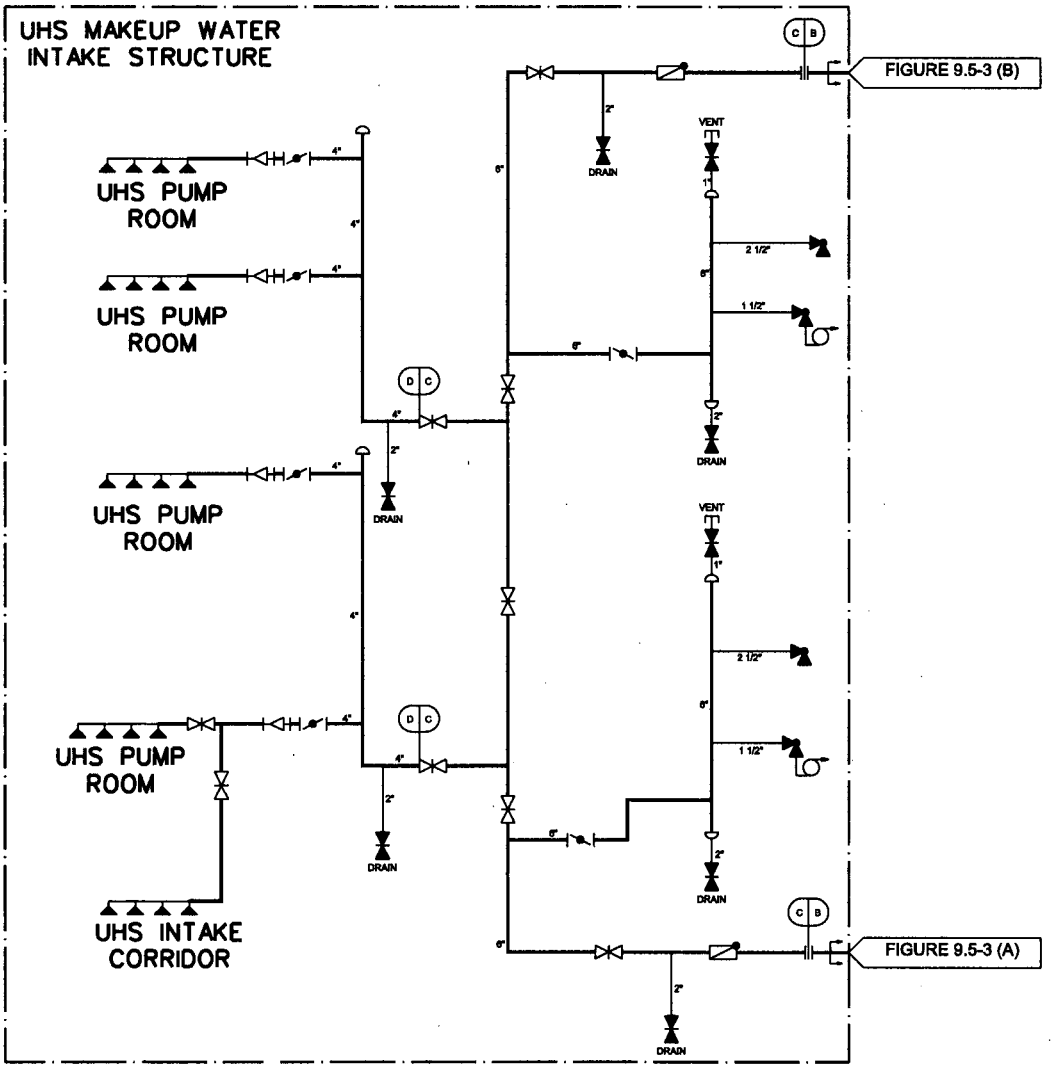



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B | NS-AQ | D | 250 | 100 | II-SSE | Yes | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| DESIGN AREA | SSC SAFETY CLASS | SSC QUALITY GROUP | DESIGN PRESSURE PSIG | DESIGN TEMPERATURE °F | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM (NOTE 1) | COMMERCIAL CODE |

NOTE 1: THOSE SSCs CLASSIFIED AS NS-AQ (FOR SAFETY CLASS) AND CLASSIFIED AS "YES" FOR 10 CFR 50 APPENDIX B WILL BE SUBJECT ONLY TO THOSE QUALITY ASSURANCE REQUIREMENTS OF APPENDIX B THAT ARE PERTINENT TO THAT SSC BASED ON POTENTIAL AFFECT OF THE SSC ON SAFETY-RELATED FUNCTIONS.

INSERT AS NEW FIGURE

# FIGURE 9.5-4 CCNPP UNIT 3 UHS MAKEUP WATER INTAKE STRUCTURE

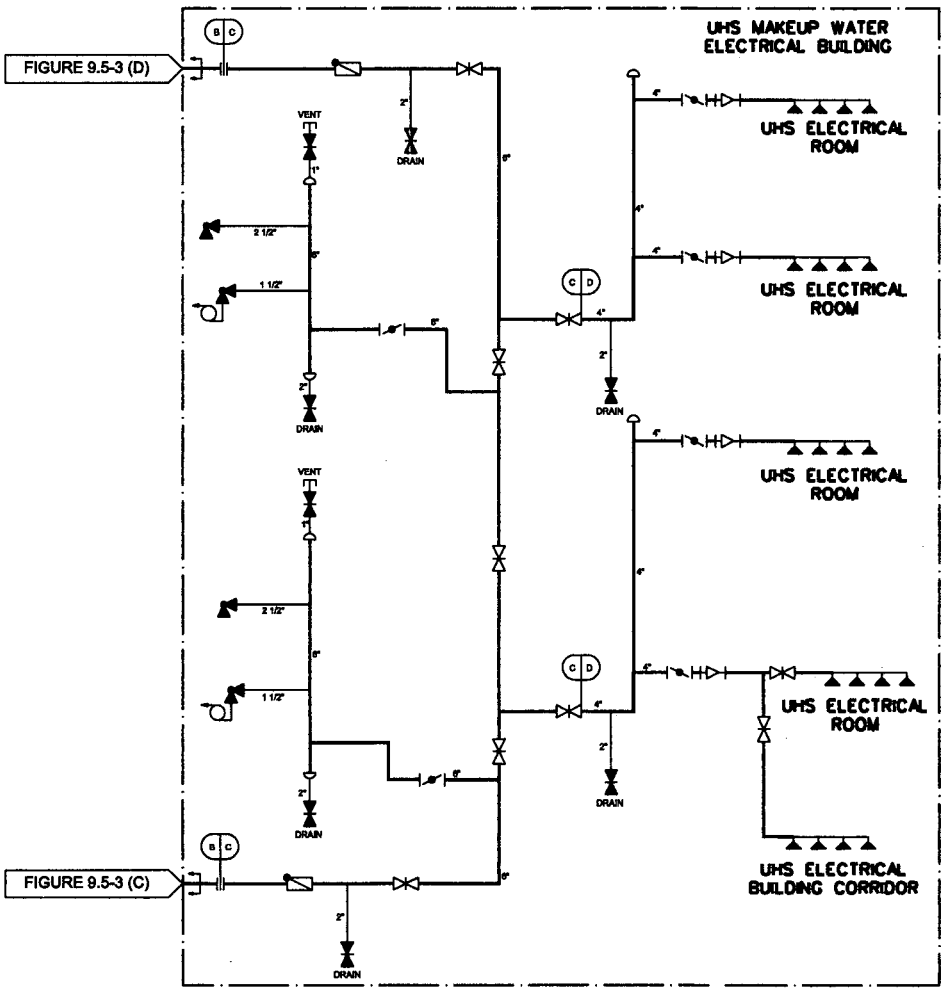



| DESIGN AREA | SSC SAFETY CLASS | SSC QUALITY GROUP | DESIGN PRESSURE PSIG | DESIGN TEMPERATURE °F | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM (NOTE 1) | COMMERCIAL CODE |
|---|---|---|---|---|---|---|---|
| D | NS-AQ | D | 250 | 100 | II | NO | NFPA 13, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| C | NS-AQ | D | 250 | 100 | II - SSE | YES | NFPA 13, 2007 ed.<br>NFPA 14, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| B | NS-AQ | D | 250 | 100 | II - SSE | YES | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |

NOTE 1: THOSE SSCs CLASSIFIED AS NS-AQ (FOR SAFETY CLASS) AND CLASSIFIED AS "YES" FOR 10 CFR 50 APPENDIX B WILL BE SUBJECT ONLY TO THOSE QUALITY ASSURANCE REQUIREMENTS OF APPENDIX B THAT ARE PERTINENT TO THAT SSC BASED ON POTENTIAL AFFECT OF THE SSC ON SAFETY-RELATED FUNCTIONS.

INSERT AS NEW FIGURE

# FIGURE 9.5-5 CCNPP UNIT 3 UHS MAKEUP WATER INTAKE STRUCTURE ELECTRICAL BUILDING




| DESIGN AREA | SSC SAFETY CLASS | SSC QUALITY GROUP | DESIGN PRESSURE PSIG | DESIGN TEMPERATURE °F | SSC SEISMIC CLASS | 10 CFR APPENDIX B PROGRAM (NOTE 1) | COMMERCIAL CODE |
|---|---|---|---|---|---|---|---|
| D | NS-AQ | D | 250 | 100 | II | NO | NFPA 13, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| C | NS-AQ | D | 250 | 100 | II - SSE | YES | NFPA 13, 2007 ed.<br>NFPA 14, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |
| B | NS-AQ | D | 250 | 100 | II - SSE | YES | NFPA 24, 2007 ed.<br>NFPA 25, 2002 ed.<br>NFPA 804, 2006 ed.<br>ANSI/ASME B31.1, 2004 ed. |

NOTE 1: THOSE SSCs CLASSIFIED AS NS-AQ (FOR SAFETY CLASS) AND CLASSIFIED AS "YES" FOR 10 CFR 50 APPENDIX B WILL BE SUBJECT ONLY TO THOSE QUALITY ASSURANCE REQUIREMENTS OF APPENDIX B THAT ARE PERTINENT TO THAT SSC BASED ON POTENTIAL AFFECT OF THE SSC ON SAFETY-RELATED FUNCTIONS.

## Table 14.3-2—{Site Specific SSC ITAAC Screening Summary}

| Site-Specific Structure, System, or Component | U.S. EPR Interface | Selected for ITAAC |
|---|---|---|
| **Structure** | | |
| Fire Protection Building | Yes | Yes |
| Switchgear Building | Yes | Yes |
| Turbine Building | Yes | Yes |
| Access Building | Yes | Yes |
| UHS Makeup Water Intake Structure, including CCNPP Unit 3 Intake Channel | Yes | Yes |
| UHS Electrical Building | Yes | Yes |
| Warehouse Building | Yes | Yes |
| Central Gas Supply Building | Yes | Yes |
| Grid Systems Control Building (i.e., Control House) | Yes | Yes |
| Circulating Water System Cooling Tower Structure | Yes | Yes |
| Circulating Water System Pump Building | Yes | Yes |
| Circulating Water System Makeup Water Intake Structure | Yes | Yes |
| Circulating Water System Retention Basin | No | No |
| Desalinization / Water Treatment Building (i.e., Desalinization Plant) | Yes | Yes |
| Waste Water Treatment Plant | No | No |
| **Component** | | |
| Buried Ductbanks | Yes | Yes |
| Buried Pipe | Yes | Yes |
| New and Spent Fuel Storage Racks | Yes | Yes |
| Waterproofing Membrane for Seismic Category I and Seismic Category II-SSE Concrete Foundations and Walls Exposed to Groundwater | No | Yes |
| **System** | | |
| Offsite Power System | Yes | Yes |
| Power Transmission System (Main Generator, Main Transformer, Protection & Synchronization) | Yes | Yes |
| Essential Service Water Blowdown System | No | No |
| Essential Service Water Makeup System Chemical Treatment System | No | No |
| Normal Essential Service Water Makeup System | | |
| UHS Makeup Water System | | |
| Potable Water System, including Potable Water Tank | | |
| Sanitary Waste Water System | | |
| Raw Water System, including Desalinization Plant | Yes | Yes |
| systems (i.e., Cooling Tower Makeup emical Treatment System, Circulating r System Outfall) | No | No |
| on System | No | Yes |
| ~~UHS Electrical Building Ventilation System~~ | No | Yes |
| Fire Protection Building Ventilation System | No | Yes |
| Central Gas Distribution System | No | No |
| Fire Detection and Alarm Systems for Balance of Plant | No | No |
| Fire Water Distribution System, including Fire Protection Storage Tanks | Yes | Yes |
| Fire Suppression Systems for UHS Makeup Water Intake Structure, UHS Electrical Building, and Fire Protection Building) | No | Yes |
| Fire Suppression Systems for ~~Balance of Plant~~ | No | No |
| Standpipes and Hose Stations for ~~Balance of Plant~~ | No | No |
| Standpipes and Hose Stations for UHS Makeup Water Intake Structure and UHS Electrical Building | No | Yes |

Site specific Buildings other than UHS Makeup Water Intake Structure and UHS Electrical Building

Site specific Buildings other than UHS Makeup Water Intake Structure, UHS Electrical Building, and Fire Protection Building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## 1.1 DEPARTURES

This Departure Report includes deviations in the CCNPP Unit 3 COL application FSAR from the information in the U.S. EPR FSAR, pursuant to 10 CFR Part 52. The U.S. EPR Design Certification Application is currently under review with the NRC. However, for the purposes of evaluating these deviations from the information in the U.S. FSAR, the guidance provided in Regulatory Guide 1.206, Section C.IV.3.3, has been utilized.

The following Departures are described and evaluated in detail in this report:

1. Maximum Ground Water Level
2. Maximum Differential Settlement (across the basemat)
3. Maximum Annual Average Atmospheric Dispersion Factor (0.5 mile – limiting sector)
4. Accident Atmospheric Dispersion Factor (0-2 hour, Low Population Zone, 1.5 miles)

### 1.1.1 Maximum Ground Water Level

Affected U.S. EPR FSAR Sections: Tier 1 Table 5.0-1, Tier 2 Table 2.1-1, Tier 2 Section 3.8.4.3.1

**Summary of Departure:**

The U.S. EPR FSAR identifies a maximum groundwater level of 3.3 ft below grade. Emergency Power Generating Building 1/2 an
groundwater levels that exceed th

8. In-Structure Response Spectra

(note
items 5, 6 and 7 were added by LBDCR 09-359,
letter UN#09-477)

**Scope/Extent of Departure:**

This Departure is identified in CCN

**Departure Justification:**

The post construction groundwater level for Emergency Power Generating Building 1/2 is calculated to be 3.0 ft (0.9 m) below finished grade, or 0.3 ft (0.09 m) above the U.S. EPR FSAR site parameter value of 3.3 ft (1.0 m) below grade, and the post construction groundwater level for one corner of Essential Service Water System Cooling Tower 1 is calculated to be slightly above the U.S. EPR site parameter value of 3.3 ft (1.0 m) below grade (but averages 4.0 ft (1.2 m) below grade at Essential Service Water Cooling Tower 1).

For Emergency Power Generating Building 1/2, separate foundation design calculations were performed for both the U.S. EPR FSAR and CCNPP Unit 3 specific groundwater levels, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.2. The results show a variation in Emergency Power Generating Building 1/2 soil bearing pressures and basemat design moments of less than 5%. Factors of safety against sliding and overturning remain within allowable values for both groundwater levels.

For slight groundwater level departure associated with the one corner of Essential Service Water System Cooling Tower 1, as discussed in CCNPP Unit 3 FSAR Section 3.8.5.5.3, the effects of this local anomaly on stability (i.e., factors of safety against sliding and overturning) and soil bearing pressures of Essential Service Water System Cooling Tower 1 were determined to be negligible.


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5. Create a possibility for an accident of a different type than any evaluated previously in the plant-specific FSAR;

6. Create a possibility for a malfunction of an SSC important to safety with a different result than any evaluated previously in the plant-specific FSAR;

7. Result in a design basis limit for a fission product barrier as described in the plant specific FSAR being exceeded or altered; or

8. Result in a departure from a method of evaluation described in the plant-specific FSAR used in establishing the design bases or in the safety analyses.

This Departure does not affect resolution of a severe accident issue identified in the plant specific FSAR.

Therefore, this Departure has no safety significance.

Insert attached


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### 1.1.8 In-Structure Response Spectra (ISRS)

Affected U.S. EPR FSAR Sections: Tier 2 Section 3.7.2

**Summary of Departure:**

The U.S. EPR FSAR identifies ISRS at representative locations of the EPGB, and ESWB. The corresponding CCNPP Unit 3 ISRS are identified in the CCNPP3 FSAR Section 3.7.2.5 and represent a departure from the U.S. EPR FSAR.

**Scope/Extent of Departure:**

This Departure is identified in Part 2 FSAR, Section 3.7.2.5.2.

**Departure Justification:**

This departure is justified using the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines. The CCNPP Unit3 site-specific in-structure response spectra (ISRS) for the EPGB and ESWB are developed from the CCNPP Unit 3 Site SSE spectrum and soil profiles and are compared with the U.S. EPR design certification ISRS.

For critical locations in EPGB and ESWB at frequencies greater than approximately 0.3 Hz, the CCNPP Unit 3 site-specific ISRS do not exceed the ISRS for the U.S. EPR.

For frequencies less than approximately 0.3 Hz where the site-specific ISRS exceed the design ISRS by more than 10 %, evaluations of safety-related structures, systems, and components (SSC) were performed in accordance with Step 9 of U.S. EPR FSAR 2.5.2.6. These evaluations are discussed in Sections 3.7.2.5.2 and 3.10 and confirm the SSCs will perform their safety related functions following an SSE.

**Departure Evaluation:**

This Departure, associated with ISRS, has been evaluated in accordance with the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines and determined to not affect the safety function of the safety-related SSCs of the U.S. EPR at the building locations where CCNPP Unit 3 site-specific ISRS exceed the ISRS for the U.S. EPR design certification by more than 10%. Accordingly, this Departure does not:

1. Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the plant-specific FSAR;

2. Result in more than a minimal increase in the likelihood of occurrence of malfunction of a structure, system, or component (SSC) important to safety and previously evaluated in the plant-specific FSAR;

3. Result in more than a minimal increase in the consequences of an accident previously Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the plant-specific FSAR;

4. Create a possibility for an accident of a different type than any evaluated previously in the plant-specific FSAR;

5. Create a possibility for a malfunction of an SSC important to safety with a different result than any evaluated previously in the plant-specific FSAR;

6. Result in a design basis limit for a fission product barrier as described in the plant-specific FSAR being exceeded or altered; or

7. Result in a departure from a method of evaluation described in the plant-specific FSAR used in establishing the design bases or in the safety analyses.

This Departure does not affect resolution of a severe accident issue identified in the plant-specific FSAR.

Therefore, this Departure has no safety significance.

Replace with updated Table 2.4-26

**Table 2.4-26—{Fire Water Distribution System Inspections, Tests, Analyses, and Acceptance Criteria}**

| | Commitment Wording | Inspection, Test, or Analysisign | Acceptance Criteria |
|---|---|---|---|
| 1 | The fire protection storage tanks will be in close proximity to the fire protection building. | An inspection of the as-built location of the tanks will be conducted. | The as-built fire protection storage tanks are located within 50 ft of the as-built Fire Protection Building, as measured from the closest outside surfaces of the structures. |
| 2 | The following Fire Water Distribution System equipment and piping are designated as Seismic Category II-SSE, and can withstand seismic design basis loads without losing the capability to perform its function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed on the equipment and piping.<br>b. Inspections will be conducted of the as-built equipment.<br>c. Inspections will be conducted on the as-built equipment supports and restraints. | a. The as-built Fire Water Distribution System equipment and piping designated as Seismic Category II-SSE can withstand a design basis seismic load without loss of its ability to perform its function.<br>b. The as-built Fire Water Distribution System equipment and piping designated as Seismic Category II-SSE are installed as designed.<br>c. The as-built equipment supports and restraints are seismically bounded by tested or analyzed conditions. |
| 3 | Fire Water Distribution System equipment and piping that could impact the capability of Seismic Category 1 Structures to perform its safety function are designated as Seismic Category II or Seismic Category II-SSE, and can withstand design basis seismic loads without impacting the capability of equipment designated as Seismic Category 1 from performing its safety function. | a. Type tests, tests, analysis, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Water Distribution System equipment and piping that are designated as Seismic Category II or Seismic Category II-SSE can withstand design basis seismic loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br>b. Fire Water Distribution System equipment and piping that are designated as Seismic Category I are installed as designed. |
| 4 | The Fire Water Distribution System utilizing the diesel driven fire pumps can be initiated manually. | Tests of the as-built system will be conducted. | Fire Water Distribution System utilizing the diesel driven fire pumps starts upon receipt of a manual initiation signal. |
| 5 | Buried Fire Protection piping to Seismic Category I structures that does not support equipment required to perform during a Safe Shutdown Earthquake is designated as Seismic Category II, and can withstand a design basis seismic event without losing the integrity of its pressure boundary. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the buried Fire Protection piping to Seismic Category I structures. | a. The as-built buried Fire Protection piping to Seismic Category I structures that does not support equipment required to perform during a Safe Shutdown Earthquake can withstand a design basis seismic event without losing the integrity of its pressure boundary.<br>b. The as-built buried Fire Protection piping to Seismic Category I structures that does not support equipment required to perform during a Safe Shutdown Earthquake are installed as designed. |


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Updated Table

**Table 2.4-26– {Fire Water Distribution System Inspections, Tests, Analyses, and Acceptance Criteria}**

| | Design Commitment | Inspections, Tests, Analysis | Acceptance Criteria |
|---|---|---|---|
| 1 | The fire protection storage tanks will be in close proximity to the fire protection building. | An inspection of the as-built location of the tanks will be conducted. | The as-built fire protection storage tanks are located within 50 ft of the as-built Fire Protection Building, as measured from the closest outside surfaces of the structure. |
| 2 | ~~The following~~ Fire Water Distribution System equipment and piping ~~are~~ designated as Seismic Category II-SSE~~, and~~ can withstand seismic design basis loads without losing the capability to perform its function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed on the equipment and piping.<br>b. Inspections will be conducted of the as-built equipment.<br>c. Inspections will be conducted on the as-built equipment supports and restraints. | a. The as-built Fire Water Distribution System equipment and piping designated as Seismic Category II-SSE can withstand a design basis seismic load without loss of its ability to perform its function.<br>b. The as-built Fire Water Distribution System equipment and piping designated as Seismic Category II-SSE are installed as designed.<br>c. The as-built equipment supports and restraints are seismically bounded by tested or analyzed conditions. |
| 3 | Fire Water Distribution System equipment and piping that could impact the capability of Seismic Category I structures to perform its safety function are designated as ~~Seismic Category II or~~ Seismic Category II-SSE and can withstand design basis seismic loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Water Distribution System equipment and piping that are designated as ~~Seismic Category II or~~ Seismic Category II-SSE can withstand design basis seismic loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br>b. Fire Water Distribution System equipment and piping that are designated as Seismic Category II-SSE is installed as designed ~~are designed as installed~~. |
| 4 | The Fire Water Distribution System utilizing the diesel driven fire pumps can be initiated manually. | Tests of the as-built system will be conducted. | Fire Water Distribution System utilizing the diesel driven fire pumps starts upon receipt of a manual initiation signal. |
| ~~5~~ | ~~Buried Fire Protection piping to Seismic I structures that does not support equipment required to perform during a Safe Shutdown Earthquake is designated as Seismic Category II, and can withstand a design basis seismic event without losing the integrity of its pressure boundary.~~ | ~~a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.~~<br>~~b. Inspections will be conducted of the buried Fire Protection Piping to Seismic Category I structures.~~ | ~~a. The as-built buried fire protection piping to Seismic Category I structures that does not support equipment required to perform during a Safe Shutdown Earthquake can withstand a design basis seismic event without losing the integrity of its pressure boundary.~~<br>~~b. The as-built buried fire protection piping to Seismic Category I structures that does not support equipment required to perform during a safe shutdown earthquake are installed as design.~~ |

Replace with updated Table 2.4-27

**Table 2.4-27—{Fire Suppression Systems Inspections, Tests, Analyses, and Acceptance Criteria}**

| | Commitment Wording | Inspection, Test, or Analysis | Acceptance Criteria |
|---|---|---|---|
| 1 | The Fire Suppression System components for the UHS Makeup Water Intake Structure are designated as Seismic Category II-SSE, and can withstand seismic design basis loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the UHS Makeup Water Intake Structure designated as Seismic Category II-SSE can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br>b. The as-built Fire Suppression System components for the UHS Makeup Water Intake Structure designated as Seismic Category II-SSE are installed as designed. |
| 2 | The Fire Suppression System components for the UHS Electrical Building are designated as Seismic Category II-SSE and can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the UHS Electrical Building designated as Seismic Category II-SSE can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br>b. The as-built Fire Suppression System components for the UHS Electrical Building designated as Seismic Category II-SSE are installed as designed. |
| 3 | The Fire Suppression System components for the Fire Protection Building are designated as Seismic Category II-SSE, and can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category II-SSE from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the Fire Protection Building designated as Seismic Category II-SSE can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category II-SSE from performing its function.<br>b. The as-built Fire Suppression System components for the Fire Protection Building designated as Seismic Category II-SSE in are installed as designed. |


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Updated Table

**Table 2.4-27– {Fire Suppression Systems Inspections, Tests, Analyses, and Acceptance Criteria}**

| | Design Commitment | Inspections, Tests, Analysis | Acceptance Criteria |
|---|---|---|---|
| 1 | The Standpipe and Hose Station components for the UHS Makeup Water Intake Structure are designated Seismic Category II-SSE and can withstand seismic design basis loads without losing the capability to perform their function. | a. Type tests, test, analyses, or a combination of test and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. The as-built Standpipe and Hose Station components designated as Seismic Category II-SSE can withstand a design basis seismic load without loss of its ability to perform its function.<br><br>b. The as-built Standpipe and Hose Station components designated as Seismic Category II-SSE are installed as designed.<br><br>c. The as-built equipment supports and restraints designated as Seismic Category II-SSE are seismically bounded by tested or analyzed conditions. |
| 2 | The Standpipe and Hose Station components for the UHS Makeup Water Intake Structure are designated Seismic Category II-SSE and can withstand seismic design basis loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Standpipe and Hose Station components for the UHS Makeup Water Intake Structure designated as Seismic Category II-SSE can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br><br>b. The as-built Standpipe and Hose Station components for the UHS Makeup Water Intake Structure designated as Seismic Category II-SSE are installed as designed. |
| ~~1~~3 | The Fire Suppression System components for the UHS Makeup Water Intake Structure are designated Seismic Category II-~~SSE~~ and can withstand seismic design basis loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the UHS Makeup Water Intake Structure designated as Seismic Category II-~~SSE~~ can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br><br>b. The as-built Fire Suppression System components for the UHS Makeup Water Intake Structure designated as Seismic Category II-~~SSE~~ are installed as designed. |
| 4 | The Standpipe and Hose Station components for the UHS Electrical Building are designated Seismic Category II-SSE and can withstand seismic design basis loads without losing the capability to perform their function. | a. Type tests, test, analyses, or a combination of test and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. The as-built Standpipes and Hose Station components designated as Seismic Category II-SSE can withstand a design basis seismic load without loss of its ability to perform its function.<br><br>b. The as-built Standpipe and Hose Station components designated as Seismic Category II-SSE are installed as designed. |

Updated Table

| | | | |
|---|---|---|---|
| | | | c. The as-built equipment supports and restraints designated as Seismic Category II-SSE are seismically bounded by tested or analyzed conditions. |
| 5 | The Standpipe and Hose Station components for the UHS Electrical Building are designated Seismic Category II-SSE and can withstand seismic design basis loads without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | c. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br><br>d. Inspections will be conducted of the as-built equipment. | c. A report exists and concludes that the as-built Standpipe and Hose Station components for the UHS Electrical Building designated as Seismic Category II-SSE can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br><br>d. The as-built Standpipe and Hose Station components for the UHS Electrical Building designated as Seismic Category II-SSE are installed as designed. |
| ~~2~~ 6 | The Fire Suppression System components for the UHS Electrical Building are designated as Seismic Category II-~~SSE~~ and can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the UHS Electrical Building designated as Seismic Category II-~~SSE~~ can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category I from performing its safety function.<br><br>b. The as-built Fire Suppression System components for the UHS Electrical Building designated as Seismic Category II-~~SSE~~ are installed as designed. |
| ~~3~~ 7 | The Fire Suppression System components for the Fire Protection Building are designated as Seismic Category II-~~SSE~~ and can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category II-SSE from performing its safety function. | a. Type tests, tests, analyses, or a combination of tests and analyses will be performed.<br><br>b. Inspections will be conducted of the as-built equipment. | a. A report exists and concludes that the as-built Fire Suppression System components for the Fire Protection Building designated as Seismic Category II-~~SSE~~ can withstand a design basis seismic load without impacting the capability of equipment designated as Seismic Category II-SSE from performing its safety function.<br><br>b. The as-built Fire Suppression System components for the Fire Protection Building designated as Seismic Category II-~~SSE~~ are installed as designed. |