PMLevyCOLPEm Resource

From: Kitchen, Robert [robert.kitchen@pgnmail.com]
Sent: Thursday, June 28, 2012 2:37 PM
To: Habib, Donald
Subject: RE: Materials for 7/5 Call
Attachments: RAI L-0998 Outline - 6-20-12.pdf

Attached is the DRAFT RAI outline. I plan to send the other 3 items by Monday.

From: Habib, Donald [mailto:Donald.Habib@nrc.gov]
Sent: Thursday, June 28, 2012 2:19 PM
To: Kitchen, Robert
Cc: Snyder, Amy
Subject: Materials for 7/5 Call

Bob –

As we discussed, I am expecting you to send me an outline of the seismic response later today.

Additionally, on Monday, I am expecting 3 items:

1. the revised draft seismic response
2. draft FSAR revisions related to boreholes, pier sockets, and grout mobility
3. draft changes to organizational chart

The materials you send will be made publicly available for the public meeting.

Thanks for your assistance in preparing for the public meeting.
Don

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Hearing Identifier: Levy_County_COL_Public
Email Number: 1121

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Subject: RE: Materials for 7/5 Call
Sent Date: 6/28/2012 2:36:55 PM
Received Date: 6/28/2012 2:37:04 PM
From: Kitchen, Robert

Created By: robert.kitchen@pgnmail.com

Recipients:
"Habib, Donald" <Donald.Habib@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	1015	6/28/2012 2:37:04 PM
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Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

NRC RAI

Evaluate the seismic hazard at your site against current NRC requirements and guidance and, if necessary, update the design basis and structures systems and components important to safety to protect against updated hazards (seismic portion only – of detailed Recommendation 2.1 – Enclosure 7 of SECY-12-0025).

Response L-0998 Outline:

Sensitivity evaluations were performed to develop LNP site hard rock seismic hazard, finished grade 10^{-5} Uniform Hazard Response Spectra (UHRS), Ground Motion Response Spectra (GMRS), finished grade Performance Based Surface Response Spectra (PBSRS), and Foundation Interface Response Spectra (FIRS) (EL +11 ft.) using the Central and Eastern United States Seismic Source Characterization (CEUS SSC) (NUREG 2115) methodology and the modified cumulative absolute velocity (CAV) filter (NRC SECY-2012-0025 Enclosure 7 – Attachment 1 to Enclosure 1). The LNP site hard rock seismic hazard, finished grade 10^{-5} UHRS, GMRS, finished grade PBSRS, and FIRS (EL +11 ft.) using the CEUS SSC model were compared to the corresponding hazard and response spectra using the updated Electric Power Research Institute Seismic Owners Group (EPRI SOG) methodology. The updated EPRI SOG methodology included the updated EPRI SOG earthquake catalog through end of 2006 and use of the Updated Charleston Seismic Source (UCSS). It was concluded that the site specific designs (liquefaction evaluations, Soil Structure Interaction (SSI) analysis, and the evaluations for seismic interaction between the Annex Building (AB), Turbine Building (TB), and Radwaste Building (RB) with the nuclear island) for the CEUS SSC methodology ground motions are bounded by that for the updated EPRI SOG methodology currently presented in the FSAR. Similarly, the Seismic Margin Assessments for the standard plant components, site liquefaction potential, adjacent buildings' seismic interaction with the nuclear island, and the RCC bridging mat capacity for the CEUS SSC methodology ground motions are bounded by that for the updated EPRI SOG methodology currently presented in the FSAR.

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Sensitivity Evaluations for CEUS SSC

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The CEUS SSC methodology, verification of the CEUS SSC methodology implementation, the LNP site hard rock seismic hazard, finished grade 10^{-5} UHRS, GMRS, finished grade PBSRS, FIRS (EL +11 ft.), and their comparison to the corresponding LNP site seismic hazards and amplified ground motions (to meet 10 CFR Part 50 Appendix S requirements) using the updated EPRI SOG model currently presented in the FSAR can be summarized as follows:

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Summarize the CEUS SSC Evaluations and comparisons to the updated EPRI SOG response spectra from the CEUS SSC detailed calculation including text, figures, and tables. Provide justification for the use of FSAR amplification functions for the CEUS SSC response spectra based on rock hazard curves and deaggregation results.

Scaled GMRS

For site specific evaluations and design (liquefaction evaluations, seismic interaction of the AB, TB, and RB with the NI, Soil Structure Interaction analysis of the NI, and the design of the RCC bridging mat), scaled PBSRS and scaled FIRS (EL +11 ft.) are used.

The scale factor of 1/0.825 was used so that the FIRS has a zero period acceleration of 0.1g as required by 10 CFR Part 50 Appendix S. To be consistent with the site specific evaluations and design, the GMRS was also scaled by the 1/0.0825 factor. The scaled horizontal and vertical GMRS are presented in Figures RAI L-0998-9 and RAI L-0998-10. The scaled GMRS represents the licensing basis GMRS for the LNP site.

The scaled horizontal and vertical GMRS are compared to the Westinghouse Certified Seismic Design Response Spectra (CSDRS) (Reference 2.5.2-273) on Figure 2.5.2-296. The site scaled GMRS are enveloped by the CSDRS.

Site Liquefaction Evaluations

The soils under the nuclear island (NI) will be excavated and backfilled with Roller Compacted Concrete (RCC). Thus, no liquefaction potential exists under the NI foundation. To evaluate the liquefaction potential of soils under the adjacent AB, TB, and RB, earthquake induced cyclic stresses in the soil column were based on ground motions consistent with the finished grade scaled PBSRS. As shown in Figure RAI L-0998-3, the CEUS SSC PBSRS is enveloped by the updated EPRI SOG scaled PBSRS. Thus, the liquefaction evaluations based on the updated EPRI SOG LNP ground motions bound those from the CEUS SSC ground motions.

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Soil Structure Interaction Analysis

The scaled updated EPRI SOG scaled FIRS (EL +11 ft.) was the input ground motion for the LNP site specific SSI analysis. As shown in Figure RAI L-0998-5 (horizontal) and Figure RAI L-0998-8 (vertical), the CEUS SSC FIRS (EL +11 ft.) is enveloped by the corresponding updated EPRI SOG scaled FIRS (EL +11 ft.). Thus, the conclusions of the LNP site specific SSI analysis that the LNP floor response spectra (FRS) at the six key locations are bounded by the CSDRS FRS and the maximum bearing pressure is less than the 24 ksf design value are also valid for the for the LNP site ground motions based on the CEUS SSC model.

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Seismic Interaction between the Adjacent Buildings with the Nuclear Island

The updated EPRI SOG scaled finished grade PBSRS was used to show that there is no interaction between the adjacent AB, TB, and RB with the NI. As shown in Figure RAI L-0998-3, the CEUS SSC finished grade PBSRS is enveloped by the updated EPRI SOG scaled finished grade PBSRS. Thus, the conclusions that there is no interaction between the adjacent AB, TB, and RB with the NI is valid for the LNP site ground motions based on the CEUS SSC model.

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Seismic Margin Analysis

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As shown in Figures RAI L-0998-2 and RAI L-0998-3, both the CEUS SSC GMRS and the PBSRS are enveloped by the AP1000 CSDRS. As stated above, the CEUS SSC LNP site specific floor response spectra (FRS) at the six key locations are bounded by the CSDRS FRS and the maximum bearing pressure is less than the 24 ksf design value. Thus, LNP site unique foundation conditions and CEUS SSC ground motions do not lower the High Confidence Low Probability of Failure (HCLPF) values calculated for the certified design.

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To evaluate the HCLPF liquefaction potential of soils under the adjacent AB, TB, and RB, earthquake induced cyclic stresses in the soil column based on ground motions consistent with the updated EPRI SOG finished grade 10^{-5} UHRS were used. As shown in Figures RAI L-0998-6 and RAI L-0998-7, 1.67*GMRS and 1.67*PBSRS developed using the CEUS SSC methodology and modified CAV filter are enveloped by the updated EPRI SOG finished grade 10^{-5} UHRS. Thus, HCLPF capacity for no liquefaction potential of soil under the AB, TB, and RB exceeds the 1.67*GMRS goal for the plant level HCLPF for the CEUS SSC ground motions.

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To calculate the HCLPF capacity for seismic interaction between the AB, TB, and RB and the NI, the AB, TB, and RB displacements relative to the NI were calculated using the updated EPRI SOG finished grade 10^{-5} UHRS. As shown in Figures RAI L-0998-6 and RAI L-0998-7, 1.67*GMRS and 1.67*PBSRS developed using the CEUS SSC methodology and modified CAV filter are enveloped by the updated EPRI SOG finished grade 10^{-5} UHRS. Thus, HCLPF capacity for no seismic interaction between the AB, TB, and RB and the NI exceeds the 1.67*GMRS goal for the plant level HCLPF for the CEUS SSC ground motions.

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The HCLPF capacity of the RCC mat was calculated as 0.30g using the conservative deterministic failure margin (CDFM) methodology of FSAR Reference 19.55.7-201. The peak ground acceleration for the CEUS SSC GMRS is 0.073. Thus, the 0.30g HCLPF capacity of the RCC bridging mat exceeds the overall plant HCLPF acceptance criteria of 1.67*GMRS using the CEUS SSC methodology and modified CAV filter.

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<u>FSAR Revisions</u>

FSAR revision are shown in the attached markup for Subsections 2.5.0, 2.5.2, 3.7, and 19.55

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<u>Figures and Tables</u>

Chapter 2:

Deleted: New Figures RAI L-0998-1 through RAI L-0998-7 are attached

- Comparison of CEUS Modified CAV filter horizontal GMRS with CSDRS and updated EPRI SOG scaled horizontal GMRS and horizontal CSDRS (Figure RAI L-0998-2)
- Comparison of CEUS SSC PBSRS with scaled updated EPRI SOG PBSRS and CSDRS (Figure RAI L-0998-3)
- Figure RAI L-0998-9: Scaled Horizontal GMRS (El +36 ft.)
- Figure RAI L-0998-10: Scaled Vertical GMRS (El +36 ft.)
- Tables for digitized CEUS SSC GMRS (Table RAI L-0998-2) and PBSRS (Table RAI L-0998-3) and updated EPRI SOG scaled horizontal and vertical GMRS ((Table RAI L-0998-9 and Table RAI L-0998-10)
- Other figures and table needed for describing the CEUS SSC evaluations in FSAR subsection 2.5.2.7
- Revise Figure 2.5.2-296 comparing the scaled GMRS with the CSDRS

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Chapter 3:

- Comparison of CEUS SSC horizontal FIRS (EL +11 ft.) with scaled updated EPRI SOG horizontal FIRS (EL +11 ft.) (Figure RAI L-0998-5)
- Comparison of 1.67*GMRS developed using the CEUS SSC methodology

and modified CAV filter with the updated EPRI SOG 10^{-5} UHRS (Figure RAI L-0998-6)

- Comparison of 1.67* PBSRS, developed using the CEUS SSC methodology and modified CAV filter, with the updated EPRI SOG 10^{-5} UHRS (Figure RAI L-0998-7)
- Comparison of CEUS SSC vertical FIRS (EL +11 ft.) with scaled updated EPRI SOG vertical FIRS and veridical CSRDS (Figure RAI L-0998-8)
- Tables for digitized CEUS SSC horizontal FIRS (EL +11 ft.) (Table RAI L-0998-5) and vertical FIRS (EL +11 ft.) (Table RAI L-0998-8)

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Figure RAI L-0998-2 compare the scaled GMRS based on the EPRI-SOG/UCSS model with full CAV with the GMRS based on the CEUS SSC model with modified CAV. The scaled GMRS based on the CEUS SSC is lower than the GMRS based on the EPRI-SOG/UCSS model with full CAV except for frequencies between 0.2 and 2 Hz where the maximum increase is approximately 4 percent at 1 Hz.

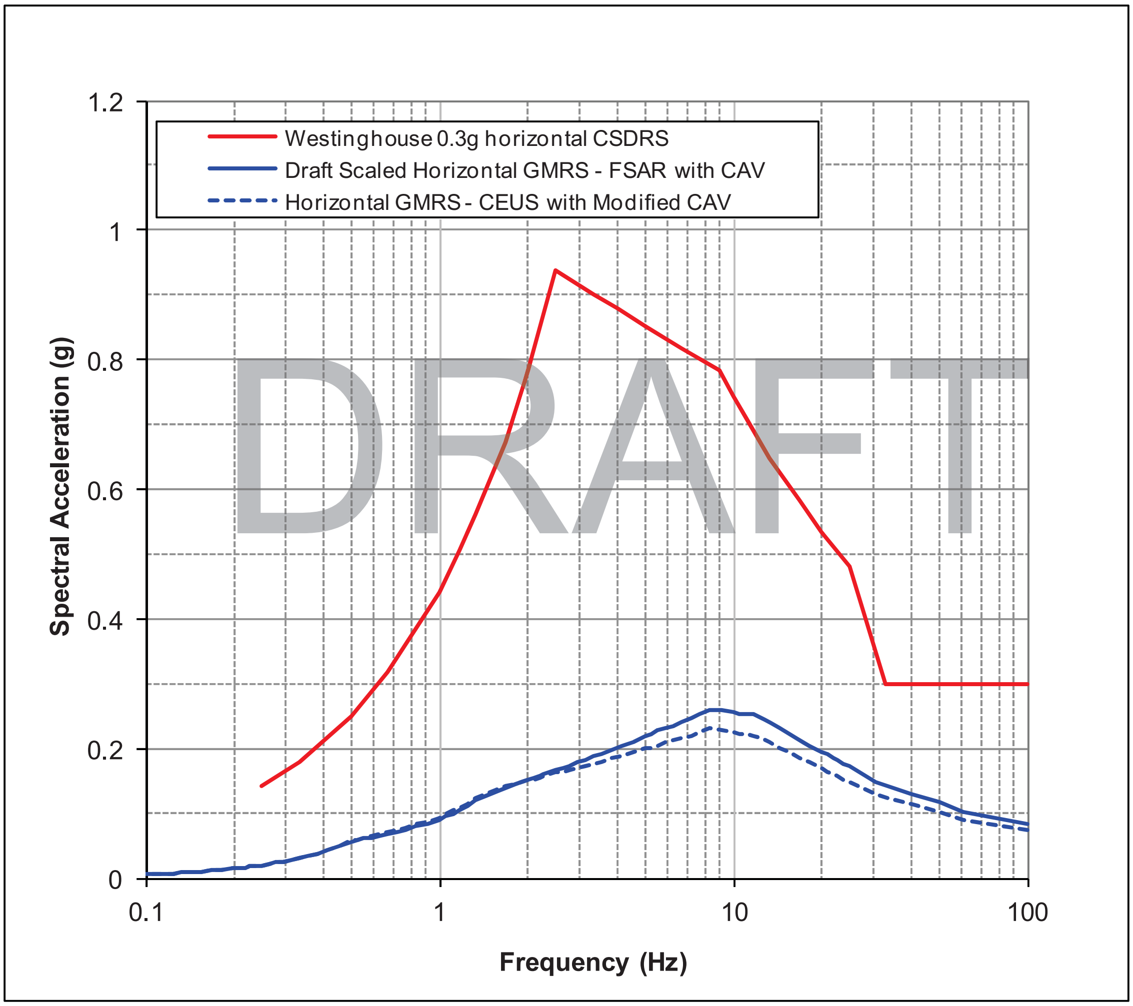

Figure RAI L-0998-2: Comparison of scaled GMRS based on EPRI-SOG/UCSS model with full CAV with the GMRS based on the CEUS SSC model with modified CAV

Figure RAI L-0998-3 compares the scaled PBSRS based on the EPRI-SOG/UCSS model with full CAV with the PBSRS based on the CEUS SSC model with modified CAV. The PBSRS based on the CEUS SSC model is enveloped by the scaled PBSRS based on the EPRI-SOG/UCSS model at all frequencies,

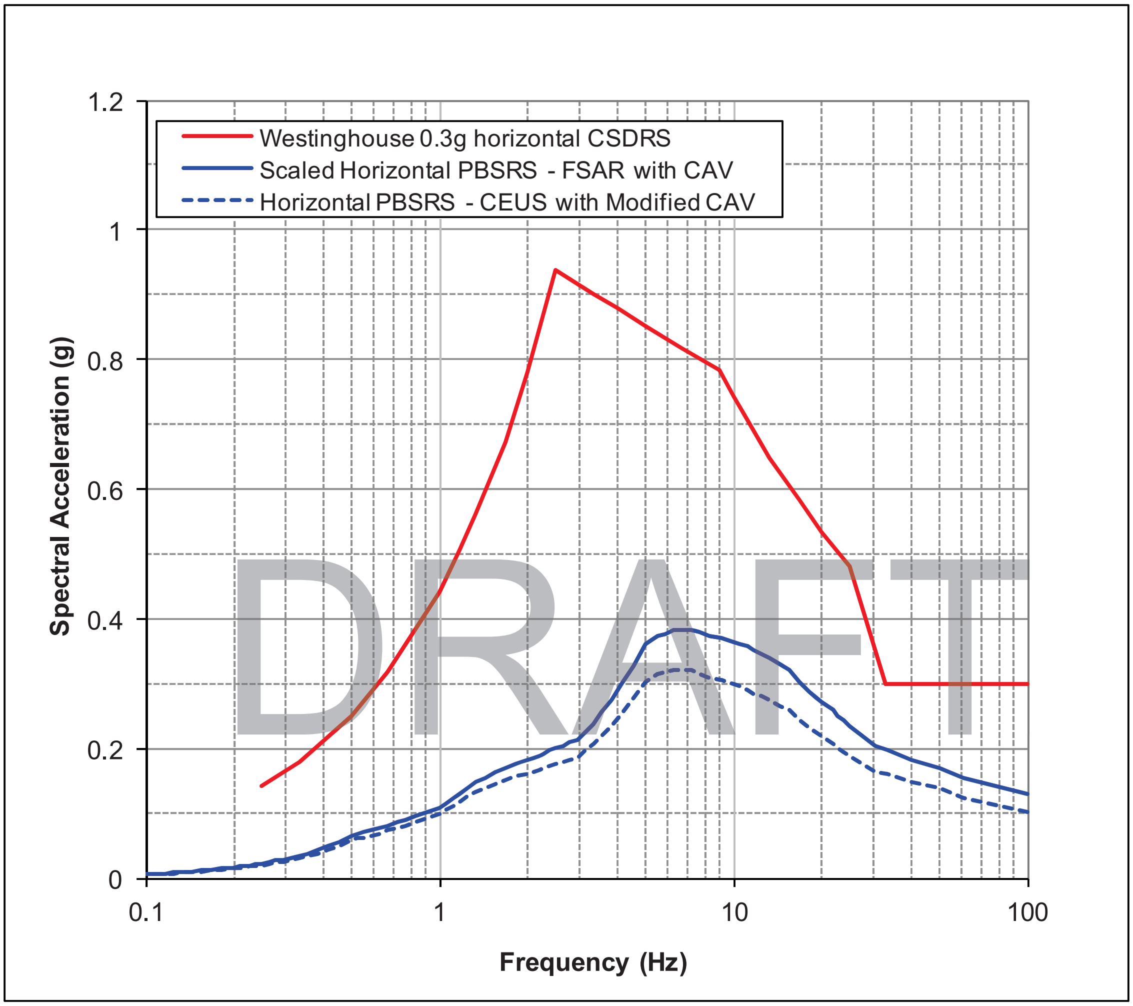

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Figure RAI L-0998-3: Comparison of PBSRS based on EPRI-SOG/UCSS model with full CAV with the PBSRS based on the CEUS SSC model with modified CAV

Figure RAI L-0998-5 compares the scaled Reactor Building FIRS based on the EPRI-SOG/UCSS model with full CAV with the Reactor Building FIRS based on the CEUS SSC model with modified CAV. The Reactor Building FIRS based on the CEUS SSC model is enveloped by the scaled Reactor Building FIRS based on the EPRI-SOG/UCSS model at all frequencies.

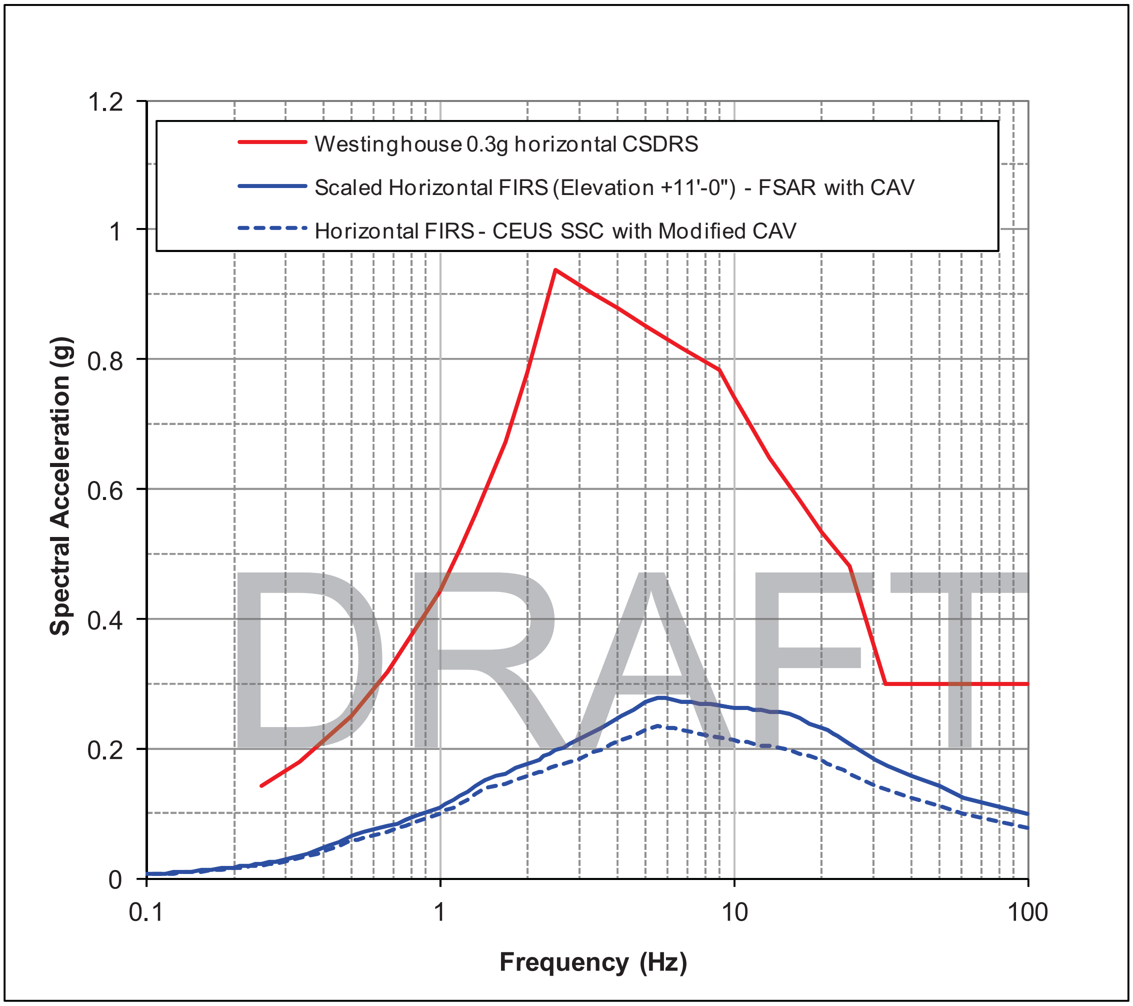

Figure RAI L-0998-5: Comparison of RB FIRS (+11 ft) based on EPRI-SOG/UCSS model with full CAV with the RB FIRS based on the CEUS SSC model with modified CAV

Figures RAI L-0998-6 and -7 compare the 10^{-5} horizontal surface UHRS based on the EPRI-SOG/UCSS model with full CAV to 1.67 x the GMRS and PBSRS, respectively, based on the CEUS SSC model with modified CAV. The 1.67 x the GMRS and PBSRS based on the CEUS SSC model with modified CAV are enveloped by the 10^{-5} horizontal surface UHRS based on the EPRI-SOG/UCSS model with full CAV.

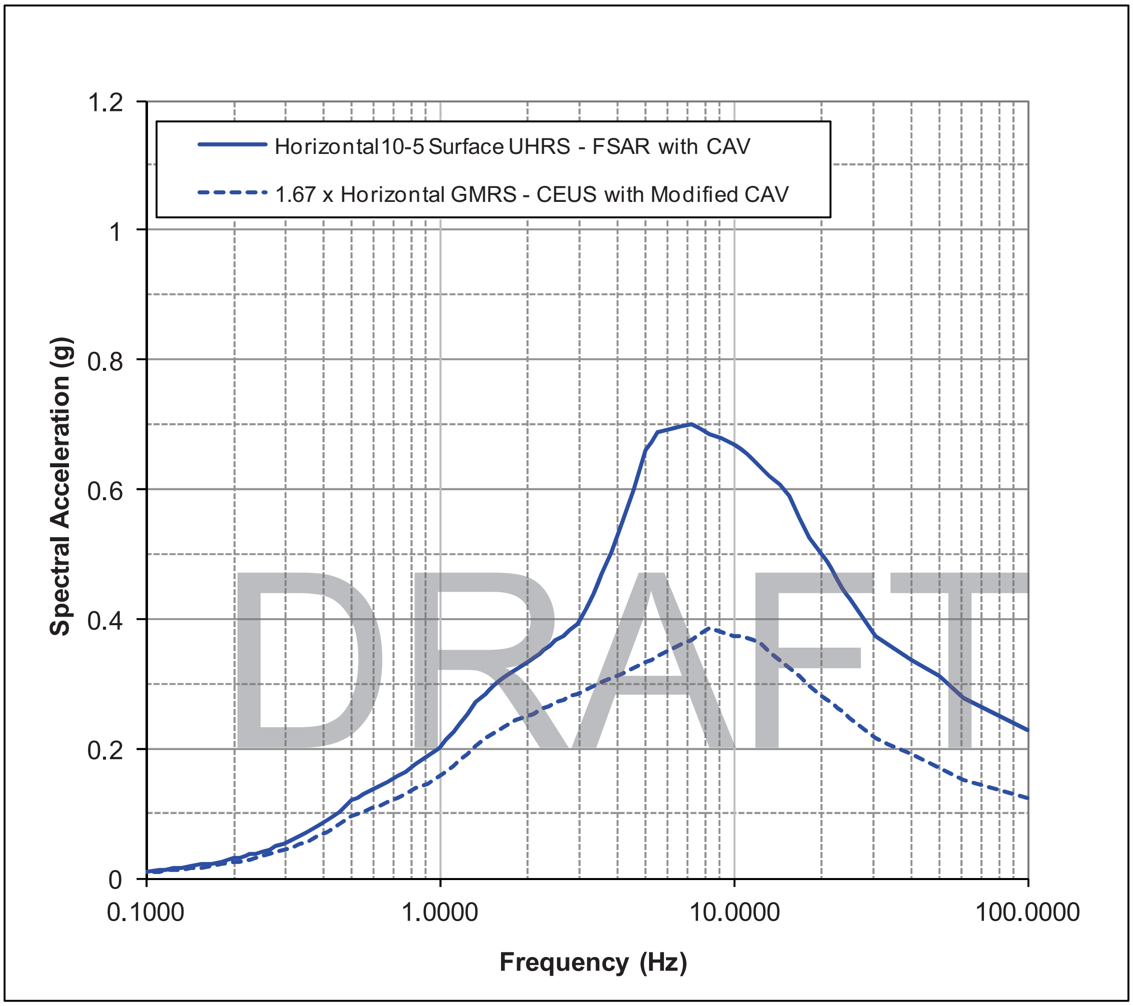

Figure RAI L-0998-6: Comparison of the horizontal 10^{-5} UHRS at finished grade developed using the EPRI-SOG/UCSS source model presented in the FSAR with 1.67 x the GMRS developed using the CEUS SSC model with modified CAV.

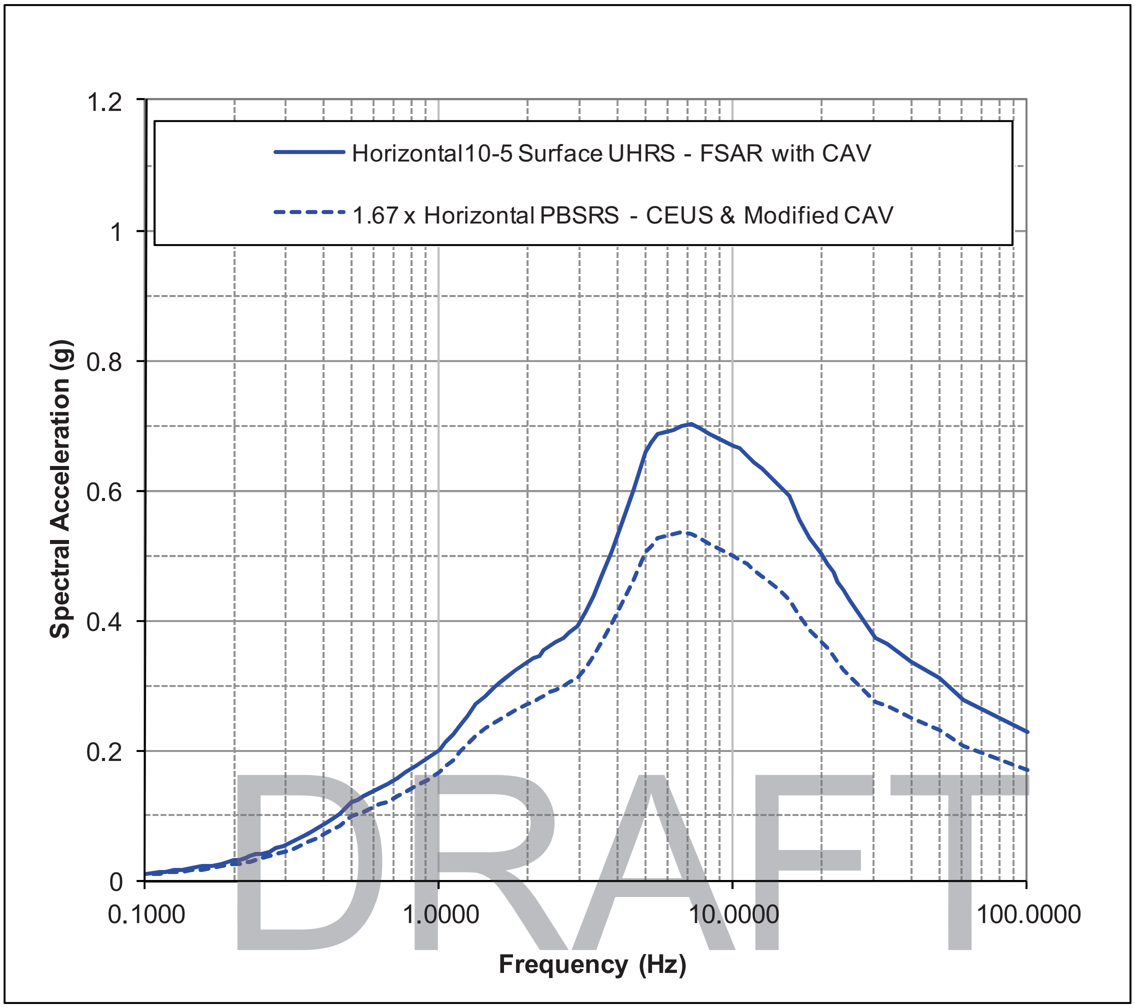

Figure RAI L-0998-7: Comparison of the horizontal 10^{-5} UHRS at finished grade developed using the EPRI-SOG/UCSS source model presented in the FSAR with 1.67 x the PBSRS developed using the CEUS SSC model with modified CAV.

LNP SUP 2.0-1

Table 2.0-201 (Sheet 2 of 9)
Comparison of AP1000 DCD Site Parameters and LNP Site Characteristics

	AP 1000 DCD Site Parameters	LNP Site Characteristics	LNP Site Characteristic Reference	Bounding Yes/No
Seismic				
CSDRS	CSDRS free field peak ground acceleration of 0.30 g with modified Regulatory Guide 1.60 response spectra (see Figures 5.0-1 and 5.0-2.). The SSE is now referred to as CSDRS. Seismic input is defined at finished grade except for sites where the nuclear island is founded on hard rock. If the site-specific spectra exceed the response spectra in Figures 5.0-1 and 5.0-2 at any frequency, or if soil conditions are outside the range evaluated for AP1000 design certification, a site-specific evaluation can be performed. This evaluation will consist of a site-specific dynamic analysis and generation of in-structure response spectra at key locations to be compared with the floor response spectra of the certified design at 5 percent damping. The site is acceptable if the floor response spectra from the site-specific evaluation do not exceed the AP1000 spectra for each of the locations or the exceedances are justified. The HRHF envelope response spectra are shown in Figure 5.0-3 and Figure 5.0-4 defined at the foundation level for 5 percent damping. The HRHF envelope response spectra provide an alternative set of spectra for evaluation of site-specific GMRS. A site is acceptable if its site-specific GMRS falls within the AP1000 HRHF envelope response spectra. Evaluation of a site for application of the HRHF envelope response spectra includes consideration of the limitation on shear wave velocity identified for use of the HRHF envelope response spectra. This limitation is defined by a shear wave velocity at the bottom of the basemat equal to or higher than 7,500 ft/sec, while maintaining a shear wave velocity equal to or above 8,000 ft/sec at the lower depths. [(d)]	For updated EPRI SOG scaled GMRS peak ground accelerations: 0.084 g horizontal 0.062 g vertical For CEUS SSC GMRS peak ground accelerations: 0.073 g horizontal 0.054 g vertical GMRS peak ground acceleration defined at 100 Hz. Ground Response Spectra: At LNP 1 and LNP 2: The horizontal and vertical updated EPRI SOG scaled GMRS and CEUS SSC GMRS are bounded by the horizontal and vertical CSDRS (Figure 2.5.2-296)	FSAR Subsections 2.5.2.6 and 3.7	Yes

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separating the Upper Floridan aquifer within the Avon Park Formation from the Lower Floridan aquifer within the Oldsmar Limestone.

The LNP site stratigraphy and surface morphology are consistent with expected characteristics of a developed, older (paleo) karst landscape mantled by several meters of sand (i.e., a mantled epikarst subsurface). Although there are no recognized sinkholes in the State of Florida sinkhole database or the SDII Global Corporation's much larger, private database (Reference 2.5.1-328) within 2 km (1.28 mi.) of the LNP site and no sinkholes at the land surface were observed during site investigations and reconnaissance within the LNP site, the presence of a few voids at depths identified in some borings suggests that paleo sinks such as those developed on the barren mature epikarst surface are locally present at the site.

Based on the review and updating of the geological, seismological, geophysical, and geotechnical data for the LNP site, nothing was identified that would preclude the safe operation of the facilities. The only geologic hazard identified in the LNP site area is potential surface deformation related to carbonate dissolution and slow cover subsidence related to the occurrence of karst. Karst features encountered below the nuclear islands at the LNP site are determined to be associated with near-vertical to vertical fractures and subhorizontal bedding planes, and vary in size from a few centimeters to approximately 1.5 m (5 ft.). Karst-related solution zones and/or infilled zones that exist in the subsurface beneath the LNP foundation will be addressed through appropriate design considerations in the LNP foundation conceptual design, as described in FSAR Subsection 2.5.4.

2.5.0.2 Vibratory Ground Motion

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The selected starting point for developing the site-specific ground motion assessments for the LNP site was the Probabilistic Seismic Hazard Analysis (PSHA) conducted by the EPRI-SOG in the 1980s. Following guidance in the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.208, the adequacy of the EPRI-SOG hazard results was evaluated in light of new data and interpretations and evolving knowledge pertaining to seismic hazard evaluation in the central and eastern United States (CEUS). PSHA sensitivity analyses were conducted to test the effect of the new information on the seismic hazard. Using these results, an updated PSHA analysis was performed; the results of that analysis have been used to develop uniform hazard response spectra (UHRS) and the identification of the controlling earthquakes.

Sensitivity evaluations were performed for the CEUS SSC (NUREG 2115) and the modified CAV filter (SECY-2012-0025 Enclosure 7 – Attachment 1 to Enclosure 1) to show that the site specific ground response spectra obtained using the CEUS SSC are bounded by those using the updated EPRI SOG methodology scaled to meet 10 CFR Part 50 Appendix S requirements. The updated EPRI SOG methodology included the updated EPRI SOG earthquake catalog through end of 2006 and use of the Updated Charleston Seismic Source

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(UCSS). The CEUS SSC sensitivity evaluations are described in Subsection 2.5.2.7.

2.5.0.2.1 Seismicity

For this study, an updated earthquake catalog was created that includes additional historical and instrumental events through December 2006. Only 15 earthquakes larger than body-wave magnitude (m_b) 3.0 have occurred within the LNP site region. The largest event, an m_b 4.3 earthquake, occurred at a distance of 76.6 km (47.6 mi.) from the LNP site and is the only event within 80 km (50 mi.) of the site.

Seismicity that is occurring beyond the site region also was considered. The occurrence of two moderate earthquakes in the Gulf of Mexico in 2006 has implications to the evaluation of seismicity parameters for the Gulf Coast basin source zones that include the LNP site.

2.5.0.2.2 Geologic Structures and Seismic Source Models

In the review of seismic source characterization models developed for post-EPRI-SOG seismic hazard analyses, and comparison of the updated earthquake catalog to the EPRI-SOG evaluation, one additional specific seismic source was identified and evaluated: repeated large-magnitude earthquakes in the vicinity of Charleston, South Carolina.

The EPRI-SOG seismic source models in the vicinity of Charleston, South Carolina, were updated in 2006 by the Southern Nuclear Company (SNC), in support of the Vogtle Early Site Permit Application, to incorporate new information on the possible source of future large earthquakes similar to the 1886 Charleston earthquake; new assessments of the size of the 1886 earthquake; and new information on the occurrence rate for large earthquakes in the vicinity of Charleston, South Carolina. The result was the development of an updated Charleston seismic source (UCSS).

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2.5.0.2.3 Correlation of Earthquake Activity with Seismic Sources

Comparison of the updated earthquake catalog to the EPRI-SOG earthquake catalog and EPRI-SOG sources yields the following conclusions:

- In addition to those included in the EPRI-SOG characterizations, the updated earthquake catalog does not show a pattern of seismicity within the site region different from that exhibited by earthquakes in the EPRI-SOG catalog that would suggest a new seismic source.
- The updated earthquake catalog shows similar spatial distribution of earthquakes to that shown by the EPRI-SOG catalog, suggesting that no significant revisions to the geometry of seismic sources defined in the EPRI-SOG characterization is required based on seismicity patterns.

2.5.2 VIBRATORY GROUND MOTION

LNP COL 2.5-2

This subsection provides a detailed description of vibratory ground motion assessments that were carried out for LNP 1 and LNP 2. The subsection begins with a review of the approaches outlined in NRC Regulatory Guide 1.208 for conducting the vibratory ground motion studies. Following this review of the regulatory framework used for the project, results of the seismic hazard evaluation are documented and the site-specific GMRS for horizontal and vertical motions are developed. In addition, sensitivity evaluations were performed for the CEUS SSC (NUREG 2115) and the modified CAV filter (SECY-2012-0025 Enclosure 7 – Attachment 1 to Enclosure 1) to show that the site specific groung response spectra (PBSRS and FIRS (EL +11 ft.)) obtained using the CEUS SSC are bounded by those using the EPRI SOG methodology scaled to meet 10 CFR Part 50 Appendix S requirements. The updated EPRI SOG methodology included the updated EPRI SOG earthquake catalog through end of 2006 and use of the Updated Charleston Seismic Source (UCSS). The CEUS SSC sensitivity evaluations are described in Subsection 2.5.2.7.

The NRC Regulatory Guide 1.208 provides guidance on methods acceptable to the NRC to satisfy the requirements of the seismic and geologic regulation, 10 Code of Federal Regulations (CFR) 100.23, for assessing the appropriate safe shutdown earthquake (SSE) ground motion levels for new nuclear power plants. Regulatory Guide 1.208 states that the PSHA conducted by the EPRI-SOG in the 1980s (References 2.5.2-201 and 2.5.2-202) has been used for studies in the past. The EPRI-SOG study involved a comprehensive compilation of geological, geophysical, and seismological data; evaluations of the scientific knowledge concerning earthquake sources, maximum earthquakes, and earthquake rates in the CEUS by six multidisciplinary teams of experts in geology, seismology, and geophysics; and separately, development of state-of-knowledge earthquake ground motion modeling, including epistemic and aleatory uncertainties.[c] The uncertainty in characterizing the frequency and maximum magnitude of potential future earthquakes associated with these sources and the ground motion that may be produced was assessed and explicitly incorporated in the seismic hazard model.

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c. Epistemic uncertainty is uncertainty attributable to incomplete knowledge about a phenomenon that affects the ability to model it. Epistemic uncertainty is reflected in a range of viable models, model parameters, multiple expert interpretations, and statistical confidence. In principle, epistemic uncertainty can be reduced by the accumulation of additional information. Aleatory uncertainty (often called aleatory variability or randomness) is uncertainty inherent in a nondeterministic (stochastic, random) phenomenon. Aleatory uncertainty is accounted for by modeling the phenomenon in terms of a probability model. In principle, aleatory uncertainty cannot be reduced by the accumulation of more data or additional information.

2.5.2.6.3 Horizontal GMRS

Regulatory Guide 1.208 defines the GMRS as a risk-consistent design response spectrum computed from the site-specific UHRS at a mean annual frequency of exceedance of 10^{-4} by the relationship:

$$GMRS = DF \times UHRS\ (10^{-4}) \qquad \text{Equation 2.5.2-215}$$

Parameter DF is the design factor specified by the expression:

$$DF = \text{Maximum}\ (1.0,\ 0.6(A_R)^{0.8}) \qquad \text{Equation 2.5.2-216}$$

In which A_R is the ratio of the UHRS ground motions for annual exceedance frequencies of 10^{-4} and 10^{-5}, specifically:

$$A_R = \frac{UHRS(10^{-5})}{UHRS(10^{-4})} \qquad \text{Equation 2.5.2-217}$$

Regulatory Guide 1.208 also specifies that when the value of A_R exceeds 4.2, value of the GMRS is to be no less than 0.45 × $SA(0.1H_D)$ that is, 45 percent of the 10^{-5} UHRS. As the 10^{-4} UHRS with CAV is 0, this second criteria is used to define the horizontal GMRS. Figure 2.5.2-294 shows the horizontal GMRS calculated as 0.45 × $SA(0.1H_D)$. These values are listed in Table 2.5.2-226 along with the horizontal mean 10^{-5} UHRS.

For site specific evaluations and design (liquefaction evaluations, seismic interaction of the AB, TB, and RB with the NI, Soil Structure Interaction analysis of the NI, and the design of the RCC bridging mat), scaled PBSRS and scaled FIRS described in Subsectionare 2.5.2.6.6 are used. The scale factor of 1/0.0825 was used so that the FIRS has a zero period acceleration of 0.1g as required by 10 CFR Part 50 Appendix S. To be consistent with the site specific evaluations and design, the horizontal GMRS was also scaled by the 1/0.0825 factor. The scaled horizontal GMRS is presented in Figures RAI L-0998-9. The scaled horizontal GMRS represents the licensing basis horizontal GMRS for the LNP site.

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2.5.2.6.4 Vertical GMRS

The vertical GMRS were developed from the horizontal GMRS using vertical to horizontal (V/H) spectral ratios recommended by McGuire et al. (Reference 2.5.2-263). These are given as a function of frequency for three levels of horizontal peak acceleration. Given the low amplitude of the horizontal GMRS of the LNP site, the V/H ratios for peak acceleration less than 0.2g are used. These ratios are plotted on Figure 2.5.2-295 for the WUS and CEUS.

McGuire et al. (Reference 2.5.2-263) indicate that V/H for intermediate sites can be obtained as a weighted combination of the V/H for WUS rock and CEUS rock with the weights determined as a function of the site κ relative to the CEUS κ of 0.006 seconds and the WUS κ of 0.04 seconds. However, computing a weighted combination would flatten the WUS and CEUS peaks in V/H at spectral frequencies of 17 and 63 Hz, respectively, without producing a peak at an intermediate frequency. It is likely that sites with intermediate values of κ would have peaks in the V/H ratios of comparable amplitude but at an intermediate frequency.

Accordingly, an intermediate V/H ratio was developed for the LNP site by first shifting the WUS and CEUS V/H amplitudes to an intermediate frequency and then averaging their amplitudes. The best estimate value of κ for the LNP site is intermediate between the WUS and CEUS values. The WUS and CEUS V/H shapes were thus shifted to a frequency midway in log space between the two. The resulting V/H ratio is shown on Figure 2.5.2-295. In computing the intermediate V/H, a minimum value of 0.5 was used for the WUS V/H ratios to make them consistent in shape to the CEUS V/H ratios. A vertical GMRS was then computed by multiplying the horizontal GMRS by this V/H ratio. The resulting vertical GMRS is listed in Table 2.5.2-226 along with the values of V/H.

For site specific Soil Structure Interaction (SSI) analysis of the NI scaled vertival FIRS described in Subsectionare 2.5.2.6.6 was used. The scale factor of 1/0.0825 was used so that the horizontal FIRS has a zero period acceleration of 0.1g as required by 10 CFR Part 50 Appendix S. To be consistent with the site specific SSI, the vertical GMRS was also scaled by the 1/0.0825 factor. The scaled vertical GMRS is presented in Figures RAI L-0998-10. The scaled vertical GMRS represents the licensing basis vertical GMRS for the LNP site.

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2.5.2.6.5 Comparison of Scaled GMRS with CSDRS

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The scaled horizontal and vertical GMRS are compared to the Westinghouse Certified Seismic Design Response Spectra (CSDRS) (Reference 2.5.2-273) on Figure 2.5.2-296. The site scaled GMRS are enveloped by the CSDRS.

2.5.2.6.6 PBSRS and FIRS

Following the guidance given in Section 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017, a horizontal PBSRS is developed from the design grade UHRS shown on Figure 2.5.2-308 by applying the relationships described in FSAR Subsection 2.5.2.6.3. Figure 2.5.2-309 shows the resulting PBSRS spectra. At frequencies above about 1 Hz the PBSRS is controlled by the 10^{-4} UHRS multiplied by the design factor (DF). At lower frequencies the PBSRS is controlled by 0.45 times the 10^{-5} UHRS.

Section 5.2.1 of the Interim Staff Guidance DC/COL-ISG-017 procedure was then followed to develop SSI input time histories and soil profiles. The first step was to construct a FIRS at the appropriate foundation elevation by extracting ground motions as outcropping motions from the full column site response analyses used to develop the PBSRS. These outcropping motions are used to construct amplification functions that are in turn used to construct a SCOR FIRS

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0 to 15 ft.) and rock (depths greater than 75 ft.) are the same as in the LB soil profile. The low strain shear modulus of the in-situ soil is reduced by 10 percent and the new reduced shear wave velocity was calculated from the shear modulus. The compression wave velocity (V_P) for the in-situ soil was calculated as follows: For in-situ soil below the water table, if the V_P is less than that of water (i.e., 5000 ft/sec), the V_P of the soil is set to 5000 ft/sec (layers 5 to 14 in Table 2.5.2-231). If the V_P is greater than 5000 ft/sec (layer 15 to 19 in Table 2.5.2-231), the V_P is then reduced in the same ratio that the shear wave velocity is being reduced (approximately 5 percent).

2.5.2.7 Sensitivity Evaluations for CEUS SSC

This subsection describes the sensitivity evaluations performed using the CEUS SSC (NUREG 2115) and the modified CAV filter (SECY-2012-0025 Enclosure 7 – Attachment 1 to Enclosure 1) and present the comparison of the CEUS hard rock seismic hazards, 10^{-5} finished grade UHRS, GMRS, PBSRS, and FIRS (EL +11 ft.) using the CEUS SSC methodology and those using the updated EPRI SOG methodology scaled to meet 10 CFR Part 50 Appendix S requirements. The updated EPRI SOG methodology includes the updated EPRI SOG earthquake catalog through end of 2006 and use of the Updated Charleston Seismic Source (UCSS).

This subsection will present the CEUS SSC Evaluations and comparisons to the updated EPRI SOG response spectra from the CEUS SSC detailed calculation including text, figures, and tables. Provide justification for the use of FSAR amplification functions for the CEUS SSC response spectra based on rock hazard curves and deaggregation results.

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For the area under the Annex, Turbine, and Radwaste building footprint, in-situ soil will be replaced or improved to a depth of approximately 2.1 m (7 ft.) below existing grade (elevation 12.8 m [42 ft.] NAVD88). The plant design grade will be established at elevation 15.5 m (51 ft.) NAVD88 by placing engineered fill above the improved / replaced in-situ material. In addition, the earthwork design incorporates vertical and horizontal drains to prevent buildup of excess pore pressures that cause liquefaction as shown in Figures 2.5.4.8-205 and 2.5.4.8-206 for LNP 1 and 2 respectively.

2.5.4.8.6 Median Centered Liquefaction Evaluations for 10^{-5} UHRS

As a sensitivity analysis, the median centered liquefaction potential (factor of safety <1.0) for 10^{-5} UHRS was evaluated. The methodology and design parameters used for 10^{-5} UHRS liquefaction analysis were the same as that used for design basis liquefaction analysis described in FSAR Subsection 2.5.4.8 except liquefaction was postulated when the computed factor of safety was <1.0 and the soil cyclic shear stress were computed for the 10^{-5} UHRS ground motions and the median shear wave velocity soil profile derived from the randomized soil profiles used to compute the 10^{-5} UHRS. In addition, the equivalent number of stress cycles was computed for the weighted average moment magnitude of 5.74 for the site. Tables 2.5.4.8-203A and 2.5.4.8-203B present liquefaction analysis results for 10^{-5} UHRS for LNP 1 and 2 respectively. The results include the computed factors of safety against liquefaction and the depth below the Annex, Radwaste, or Turbine Building foundation mat where liquefaction is postulated. Figures 2.5.4.8-207 and 2.5.4.8-208 show, in plan and elevation respectively, the location of the liquefaction zones identified in Table 2.5.4.8-203A for LNP 1. Figure 2.5.4.8-209 and Figure 2.5.4.8-210 show, in plan and elevation view respectively, the liquefaction zones identified in Table 2.5.4.8-203B for LNP 2. In these figures, the liquefaction zones with a factor of safety of less than or equal to 1.0 are shown by circles with yellow infill. For Unit 1, liquefiable zones were postulated in boreholes O-2, A-15, A-18/O-4, A-13, and B-28. Boreholes O-2, A-15 and A-18/O-4 are in the nuclear island excavation zone. Borehole A-13 (factor of safety = 1.0) is under the Radwaste Building, and B-28 is under the Annex Building. For Unit 2, liquefiable zones were postulated for boreholes B-01, B-07, B-07A, B-31, and B-33. Borehole B-01 is well away from the AP1000 footprint. Boreholes B-07, B-07A, B-31, and B-33 are under the Turbine Building. Based on these figures, it can be concluded that liquefiable zones under the LNP 1 and 2 footprints are confined to the northwest corner of the LNP 2 Turbine Building and in isolated random pockets under the remaining LNP 1 and 2 footprints. These conclusions for median centered liquefaction potential for 10^{-5} UHRS are the same as the conclusions for the design basis liquefaction analysis described in FSAR Subsection 2.5.4.8.

2.5.4.8.7 Liquefaction Potential Evaluations for CEUS SSC

The soils under the nuclear island (NI) will be excavated and backfilled with Roller Compacted Concrete (RCC). Thus, no liquefaction potential exists under the NI foundation. To evaluate the liquefaction potential of soils under the

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adjacent AB, TB, and RB, earthquake induced cyclic stresses in the soil column were based on ground motions consistent with the finished grade scaled PBSRS. As shown in Figure RAI L-0998-3, the CEUS SSC PBSRS is enveloped by the update EPRI SOG scaled PBSRS. Thus, the liquefaction evaluations based on the updated EPRI SOG LNP ground motions bound those from the CEUS SSC ground motions.

To evaluate the HCLPF liquefaction potential of soils under the adjacent AB, TB, and RB, earthquake induced cyclic stresses in the soil column based on ground motions consistent with the updated EPRI SOG finished grade 10^{-5} UHRS were used. As shown in Figures RAI L-0998-6 and RAI L-0998-7, 1.67*GMRS and 1.67*PBSRS developed using the CEUS SSC methodology and modified CAV filter are enveloped by the updated EPRI SOG finished grade 10^{-5} UHRS. Thus, HCLPF capacity for no liquefaction potential of soil under the AB, TB, and RB exceeds the 1.67*GMRS goal for the plant level HCLPF for the CEUS SSC ground motions.

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3.7 SEISMIC DESIGN

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

Add Subsection 3.7.1.1.1 as follows:

3.7.1.1.1 Design Ground Motion Response Spectra

LNP SUP 3.7-3 Figure 2.5.2-296 shows the comparison of the scaled horizontal and scaled vertical site-specific ground motion response spectra (GMRS) to the AP1000 certified design seismic design response spectra (CSDRS). The GMRS was developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material (elevation 11 m (36 ft.) NAVD88) as described in Subsection 2.5.2.6.

Plant design grade will be established at elevation 15.5 m (51 ft.) NAVD88 by placing engineered fill above in-situ material. Performance based surface horizontal and vertical response spectra (PBSRS) at the design grade elevation were developed as described in Subsection 2.5.2.6. Figure 2.5.2-297 presents the comparison of the AP1000 CSDRS with the scaled PBSRS for horizontal and vertical ground motions. The CSDRS envelops the scaled horizontal and the vertical PBSRS.

Figures 3.7-206 and 3.7-207 show the conceptual grading plan and the conceptual grading section for the LNP site respectively. The plant Nuclear Island (NI) footprint (approximately 0.8 acres for each unit) is small compared to the approximately 347 acres where fill will be placed to raise the existing grade level. The existing grade in the plant footprint area is at approximate elevation 12.8 m (42 ft.) NAVD88. The design grade in the 347 acre fill area will vary from elevation 15.2 m (50 ft.) NAVD88 to elevation 14.3 m (47 ft.) NAVD88. The large extent of the fill area compared to the NI footprint and because the PBSRS is higher than the GMRS for the LNP site, the fill to design grade was included in the DC/COL-ISG-017 free field response analysis and the SSI analysis presented in Subsection 3.7.2.4.1.

The backfill provides lateral support to the drilled shafts supporting the Turbine Building (TB), Annex Building (AB), and Radwaste Building (RB). Thus, the backfill will be controlled engineered fill under the footprint of the TB, AB, and RB and to a lateral extent of ~30 ft. beyond the building footprint as shown in Figure 3.7-208. The remainder of the fill required for site grading shown in Figure 3.7-206 will not be controlled engineered fill. As shown in Figure 3.7-209, the TB, AB, and RB buildings are supported on 3 ft., 4 ft., and 6 ft. diameter drilled shafts. The seismic II/I interaction evaluations show that for drilled shafts up to 6 ft. in diameter, the lateral stiffness of the drilled shafts is primarily dependent on the soil property of the top 16 ft. of soil. The ~30 ft. lateral extent of the controlled engineered fill corresponds to the lateral extent of the passive

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Add Subsection 3.7.1.1.2 as follows:

3.7.1.1.2 Foundation Input Response Spectra

The nuclear island is supported on 10.7 meters (35 feet) of roller compacted concrete over rock formations at the site as described in Subsection 2.5.4.5. As described in Subsection 2.5.2.6.6, foundation input response spectra (FIRS) were developed at elevation -7.3 m (-24 ft.) NAVD88, the base of planned excavation beneath the nuclear island. This FIRS was scaled to ensure that the computed soil column outcropping response (SCOR) at the AP1000 foundation elevation 3.4 m (11 ft.) NAVD88 meets the 0.1g minimum ZPA requirement of 10 CFR 50 Appendix S. The scaled SCOR FIRS at elevation -7 m (-24 ft.) NAVD88 and at elevation 3.4 m (11 ft.) NAVD88 are shown on Figures 3.7-201 and 3.7-205 respectively.

As shown in Figures RAI L-0998-5 and RAI L-0998-8, the CEUS SSC horizontal and vertical FIRS is enveloped by the updated EPRI SOG scaled horizontal and vertical FIRS used for site specific soil structure interaction analysis described in Subsection 3.7.2.4.1. Thus, the conclusions of the soil structure analysis presented in Subsections 3.7.2.4.1.5 and 3.7.2.4.1.6 are valid for the LNP site ground motions based on the CEUS SSC model.

The seismic Category II and non-seismic adjacent structures are supported on drilled shafts. The top of the basemat for the Annex Building, Radwaste Building, and the Turbine Building (except for the condenser pit area) is at design grade elevation 15.5 m (51 ft.) NAVD88. The PBSRS described in Subsection 3.7.1.1.1 (Figure 2.5.2-297 and Table 2.5.2-227) are used to compute the maximum relative displacements of the Annex Building, Turbine Building, and the Radwaste Building drilled shaft foundation with respect to the nuclear island to evaluate site-specific aspect of the seismic interaction of these buildings with the nuclear island.

As shown in Figure RAI L-0998-3, the CEUS SSC PBSRS is enveloped by the updated EPRI SOG scaled PBSRS used for site specific displacement of the Annex Building, Turbine Building, and the Radwaste Building as described in Subsections 3.7.2.8.1, 3.7.2.8.2, and 3.7.2.8.3. Thus the conclusions in these subsections of no seismic interaction between the Annex Building, Turbine Building, and Radwaste Building and the NI is valid for the LNP site ground motions based on the CEUS SSC model.

Add the following subsections after DCD Subsection 3.7.2.4.

3.7.2.4.1 Site Specific Soil Structure Analysis

LNP SUP 3.7-6 3.7.2.4.1.1 Soil Profiles for Soil Structure Analysis

LNP SUP 3.7-3

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from the relative displacements during the seismic event. Thus, no seismic interaction between the Radwaste Building foundation mat and the NI is expected.

3.7.2.8.3 Turbine Building

Add the following text to the end of DCD Subsection 3.7.2.8.3.

LNP SUP 3.7-5

The computed probable maximum relative displacement between the NI and the Turbine Building foundation mat from a Performance Based Surface Response Spectra (PBSRS) is less than 2.5 cm (1 in.). The probable maximum relative displacement calculation included the drilled shaft supported foundation mat displacements including the drilled shaft to drilled shaft interaction effects, additional displacement due to soil column displacement, and the NI displacement at design grade. The SRSS method was used to compute the probable maximum relative displacement. Figure 3.7-226 shows the conceptual design detail for the interface between the Nuclear Island (NI) and the drilled shaft supported foundation mat of the Turbine Building. This design detail provides the 5.0 cm. (2 in.) gap between the Turbine Building foundation and the NI consistent with DCD Subsection 3.8.5.1. The top of the diaphragm wall and controlled low strength material fill between the diaphragm wall and the NI wall is at least 1.5 m (5 ft.) below the bottom of the Turbine Building foundation mat as stated in Subsection 2.5.4.5.1. Engineered fill is used from the top of the controlled low strength material fill to the bottom of the Turbine Building foundation mat as stated in Subsection 2.5.4.5.4. This interface is designed to avoid hard contact between the NI and the Turbine Building foundation mat resulting from the relative displacements during the seismic event. Thus, no seismic interaction between the Turbine Building foundation mat and the NI is expected.

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3.7.2.8.4 Median Centered Adjacent Building Relative Displacements for 10^{-5} UHRS

As a sensitivity analysis, the median centered probable maximum relative displacements between the NI and the adjacent Turbine, Annex, and Radwaste Buildings' foundation mat were calculated for updated EPRI SOG 10^{-5} UHRS. The drilled shaft supported foundation mat lateral displacements were obtained from 21 randomly selected soil profiles from the set of several hundred randomized soil profiles used to develop the updated EPRI SOG 10^{-5} UHRS. The median shear wave velocity profile for the 21 soil profiles closely matches the median shear wave velocity profile for the entire set of randomized soil profiles used to develop the updated EPRI SOG 10^{-5} UHRS as shown in Figure 3.7-227. The probable maximum relative displacement between the NI and the TB, AB, and the RB foundation mats was computed by combining the soil column displacements for UHRS, the NI displacement at the design grade, and the Turbine, Annex, and Radwaste Buildings' foundation mat displacements for updated EPRI SOG 10^{-5} UHRS using the square root of the sum of squares

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(SRSS) method. The computed probable maximum median relative displacements between the NI and the adjacent Turbine, Annex, and Radwaste Buildings' foundation mat for updated EPRI SOG 10^{-5} UHRS are less than 2.5 cm. (1 in.). Figure 3.7-226 shows the conceptual design detail for the interface between the Nuclear Island (NI) and the drilled shaft supported foundation mat of the Turbine Building. This design detail provides the 5.0 cm. (2 in.) gap between the Turbine, Annex, and Radwaste Buildings' foundation mat and the NI consistent with DCD Subsection 3.8.5.1. The top of the diaphragm wall and controlled low strength material fill between the diaphragm wall and the NI wall is at least 1.5 m (5 ft.) below the bottom of the Turbine Building foundation mat as stated in Subsection 2.5.4.5.1. Engineered fill is used from the top of the controlled low strength material fill to the bottom of the Turbine Building foundation as stated in Subsection 2.5.4.5.4. This interface is designed to avoid hard contact between the NI and the Turbine Building foundation resulting from the relative displacements during the seismic event. Thus, no seismic interaction between the Turbine, Annex, and the Radwaste Buildings' foundation mat and the NI is expected for updated EPRI SOG 10^{-5} UHRS.

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To evaluate the HCLPF capacity for no seismic interaction between the AB, TB, and RB foundation mats and the NI, the relative displacement between the NI and the AB, TB, and RB foundations was computed based on the updated EPRI SOG 10^{-5} UHRS. As shown in Figures RAI L-0998-6 and RAI L-0998-7, 1.67*GMRS and 1.67*PBSRS developed using the CEUS SSC methodology and modified CAV filter are enveloped by the updated EPRI SOG 10^{-5} UHRS. Thus, HCLPF capacity for no seismic interaction between the AB, TB, and RB foundation mats and the NI exceeds the 1.67*GMRS goal for the plant level HCLPF for the CEUS SSC ground motions.

3.7.2.12 Methods for Seismic Analysis of Dams

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Add the following text to the end of DCD Subsection 3.7.2.12.

LNP COL 3.7-1 There are no existing dams that can affect the site interface flood level as specified in DCD Subsection 2.4.1.2 and discussed in FSAR Subsection 2.4.4.

3.7.4.1 Comparison with Regulatory Guide 1.12

Add the following text to the end of DCD Subsection 3.7.4.1.

STD SUP 3.7-1 Administrative procedures define the maintenance and repair of the seismic instrumentation to keep the maximum number of instruments in-service during plant operation and shutdown in accordance with Regulatory Guide 1.12.

19.55 SEISMIC MARGIN ANALYSIS

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

Add the following Subsection after DCD Subsection 19.55.6.2:

19.55.6.3 Site-Specific Seismic Margin Analysis

LNP COL 19.59.10-6 The LNP GMRS was developed as the Truncated Soil Column Surface Response (TSCSR) on the uppermost in-situ competent material at elevation 11 m (36 ft.) NAVD88 as described in Subsection 2.5.2.6. Since plant design grade will be established at elevation 15.5 m (51 ft.) NAVD88 by engineered fill above in-situ material as noted in Subsection 2.5.4.5, performance based surface horizontal and vertical response spectra (PBSRS) at the design grade scaled to meet 10 CFR Part 50 Appendix S requirements were developed as described in Subsection 2.5.2.6. Both the LNP scaled GMRS and the scaled PBSRS are enveloped by the AP1000 Certified Seismic Response Spectra as documented in Subsection 2.5.2.6. In addition, LNP site-specific SSI analysis was performed to evaluate the effect of the LNP unique foundation conditions on seismic demand. It was determined that the LNP site-specific seismic floor response spectra (FRS) at the six key locations are enveloped by the AP1000 CSDRS based FRS at the six key locations. In addition, the LNP maximum bearing pressure is less than the CSDRS based maximum bearing pressure of 24 ksf for soft rock sites. For the 24 ksf bearing pressure, the LNP site specific bearing factor of safety is greater than the acceptable factor of safety for static and dynamic loadings (Subsection 2.5.4.10.1.1). The LNP SSI analysis results are documented in Subsection 3.7.1.1.1. Thus, LNP site unique foundation conditions do not lower the High Confidence Low Probability of Failure (HCLPF) values calculated for the certified design.

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As shown in Figures RAI L-0998-2 and RAI L-0998-3, both the CEUS SSC GMRS and the PBSRS are enveloped by the AP1000 CSDRS. As discussed in Subsection 3.7.1.1.2, the CEUS SSC LNP site specific floor response spectra (FRS) at the six key locations are bounded by the CSDRS FRS. In addition, the CEUS SSC LNP site specific nuclear island maximum bearing pressure is less than the 24 ksf design value. Thus, LNP site unique foundation conditions and CEUS SSC ground motions do not lower the High Confidence Low Probability of Failure (HCLPF) values calculated for the certified design.

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The soils under the LNP 1 and LNP 2 nuclear islands (NI) foundations will be excavated to rock and backfilled with Roller Compacted Concrete (RCC), as discussed in Subsection 2.5.4.5.3. For the NI, this eliminates any potential site-specific effects such as seismically induced liquefaction settlements, slope stability, foundation failure or relative settlements that would lower the HCLPF values calculated for the certified design. As described in Subsection 2.5.4.8, the LNP site-specific soil conditions also do not affect the nuclear island sliding and

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overturning stability based on Westinghouse analysis. Thus, LNP site-specific soil conditions do not lower the HCLPF values calculated for the certified design.

As described in Subsection 2.5.4.8, LNP site-specific liquefaction analysis (for PBSRS) was performed for soil beyond the nuclear island perimeter which will be left in place. Based on the liquefaction analysis, it was concluded that liquefiable zones under the LNP 1 and 2 footprints are confined to the northwest corner of the Unit 2 Turbine Building and in isolated random pockets under the remaining LNP 1 and 2 footprints. The LNP earthwork design will incorporate vertical and horizontal drains that will prevent liquefaction in the northwest corner of the Unit 2 Turbine Building and in isolated random pockets under the remaining LNP 1 and 2 footprints. The extent of these horizontal and vertical drains is shown in Figures 2.5.4.8-205 and 2.5.4.8-206. Liquefaction analysis was also performed for 10^{-5} uniform hazard response spectra (UHRS) for soil beyond the nuclear island perimeter which will be left in place as is described in Subsection 2.5.4.8. Based on this liquefaction analysis, it can be concluded that liquefiable zones under the LNP 1 and 2 footprints for 10^{-5} UHRS are confined soil zones where LNP earthwork design will incorporate vertical and horizontal drains that prevent liquefaction (Figures 2.5.4.8-205 and 2.5.4.8-206). As stated previously, the 10^{-5} UHRS is greater than 1.67 times the LNP scaled GMRS and the scaled PBSRS developed using the updated EPRI SOG methodology, and the GMRS and the PBSRS developed using the CEUS SSC methodology and modified CAV filter (Subsection 2.5.2.7). Thus, liquefaction potential of soil beyond the nuclear island perimeter which will be left in place has the potential to drive the plant level HCLPF; however the soil liquefaction HCLPF exceeds the 1.67*GMRS goal for the plant level HCLPF.

Seismic Category II structures (Annex Building [AB] and the first bay of the Turbine Building [TB]) and nonsafety-related structures (rest of the TB and Radwaste Building [RB]) adjacent to the NI will be supported on drilled shaft foundations. The Seismic Category II/I interaction issues between the adjacent drilled shaft supported structures and the NI have been addressed in Subsections 3.7.2.8.1, 3.7.2.8.2, and 3.7.2.8.3. The probable maximum relative displacements between the NI and the adjacent Turbine, Annex, and Radwaste Buildings' foundation mat for the PBSRS and the 10^{-5} UHRS are less than the 50 mm (2.0 inch) gap between the NI and the adjacent buildings' foundation mats. The 10^{-5} UHRS is greater than 1.67 times higher than the LNP scaled GMRS and the scaled PBSRS developed using the updated EPRI SOG methodology (Subsection 2.5.2.6), and the GMRS and the PBSRS developed using the CEUS SSC methodology and modified CAV filter (Subsection 2.5.2.7). Thus, Seismic Category II/I interaction between the NI and the adjacent buildings has the potential to drive the plant level HCLPF; however the HCLPF for Seismic Category II/I interaction between the NI and the adjacent buildings exceeds the 1.67*GMRS goal for the plant level HCLPF.

The LNP RCC bridging mat is designed to span the postulated (conservative) design basis karst void of 10 ft. The failure of the RCC bridging mat can result in displacement of the AP1000 nuclear island foundation in excess of the maximum 6 in. displacements specified in DCD Tier 1 Table 5.0-1. In the AP1000 PRA-

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based Seismic Margin Assessment, the RCC bridging mat failure is conservatively assumed to fall within the gross structural collapse event modeled in the hierarchical event tree discussed in DCD Section 19.55. As gross structural collapse is assumed to directly lead to core damage, failure of the RCC bridging mat has the potential to drive the plant level high confidence low probability of failure (HCLPF) value. The HCLPF capacity of the RCC mat was calculated as >0.14g using the conservative deterministic failure margin (CDFM) methodology of Reference 19.55.7-201. The >0.14g HCLPF capacity of the RCC bridging mat exceeds the overall plant HCLPF acceptance criteria of 1.67*scaled GMRS using the updated EPRI SOG methodology (Subsection 2.5.2.6) and the 1.67*GMRS developed using the CEUS SSC methodology and modified CAV filter (Subsection 2.5.2.7).

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Table 19.55-201 summarizes the HCLPF capacities of the LNP site-specific design features (e.g., RCC bridging mat, potential against soil liquefaction, and Seismic Category II/I interaction between the nuclear island and the adjacent buildings).

Thus, it can be concluded that the Seismic Margin Assessment analysis documented in Section 19.55 is applicable to the LNP site. Exceeding the HCLPF capacities for soil liquefaction and Seismic Category II/I interaction effects of buildings adjacent to the nuclear island will not affect the plant level HCLPF capacity. The RCC bridging mat HCLPF capacity, while potentially driving the plant-level HCLPF, exceeds the plant level HCLPF goal of 1.67*scaled GMRS using the updated EPRO SOG methodology (Subsection 2.5.2.6) and the GMRS developed using the CEUS SSC methodology and modified CAV filter (Subsection 2.5.2.7).

19.55.7 REFERENCES

Add the following information at the end of DCD Subsection 19.55.7:

201. EPRI Report No. NP-6041-SL, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin", Revision 1, August 1991.

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Table 19.55-201
HCLPF Capacities for LNP Site Specific Design Features

LNP COL 19.59.10-6

Description	HCLPF Capacity[a]	HCLPF/GMRS[b]	Basis
Soil Liquefaction Potential under Adjacent Buildings	> 0.14g	> 1.67 GMRS	(c)
Seismic II/I Interaction Potential	> 0.14g	> 1.67 GMRS	(d)
RCC bridging mat	>0.14g	>1.67 GMRS	(e)

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Notes:

a) LNP scaled Ground Motion Response Spectra (GMRS) peak ground acceleration (PGA) is 0.084g using updated EPRI SOG methodology (Subsection 2.5.2.6). The GMRS PGA using CEUS SSC methodology and modified CAV filter is 0.073g (Subsection 2.5.2.7).

b) HCLPF Capacity as a fraction of LNP updated EPRI SOG scaled GMRS PGA.

c) Liquefaction potential of soils under the adjacent buildings was evaluated for the LNP updated EPRI SOG 10^{-5} annual exceedance probability Uniform Hazard Response Spectra (10^{-5} UHRS). The LNP updated EPRI SOG 10^{-5} UHRS is greater than 1.67*scaled GMRS using the updated EPRI SOG methodology (Subsection 2.5.2.6) and the CEUS SSC GMRS with the modified CAV filter (Subsection 2.5.2.7).

d) Relative displacement between the NI and adjacent buildings for the LNP updated EPRI SOG 10^{-5} UHRS is less than the gap provided. The LNP updated EPRI SOG 10^{-5} UHRS is greater than 1.67*scaled GMRS using the updated EPRI SOG methodology (Subsection 2.5.2.6) and the CEUS SSC GMRS with the modified CAV filter (Subsection 2.5.2.7).

e) HCLPF capacity calculated using conservative deterministic failure margin method of Reference 19.55.7-201.

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