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SOUTHERN COMPANY
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U.S. Nuclear Regulatory Commission
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Southern Nuclear Operating Company
Vogtle Electric Generating Plant Units 3 and 4 Combined License Application
Response to Request for Additional Information Letter No. 040

Ladies and Gentlemen:

By letter dated March 28, 2008, Southern Nuclear Operating Company (SNC) submitted an application for combined licenses (COLs) for proposed Vogtle Electric Generating Plant (VEGP) Units 3 and 4 to the U.S. Nuclear Regulatory Commission (NRC) for two Westinghouse AP1000 reactor plants, in accordance with 10 CFR Part 52. During the NRC's detailed review of this application, the NRC identified a need for additional information, involving seismic margins, required to complete their review of the COL application's Final Safety Analysis Report (FSAR) Section 3.7, "Seismic Margins." By letter dated September 30, 2009, the NRC provided SNC with Request for Additional Information (RAI) Letter No. 040 concerning this information need. That RAI letter contained one RAI question numbered 19-10. The enclosure to this letter provides SNC's response to this RAI.

If you have any questions regarding this letter, please contact Mr. Wes Sparkman at (205) 992-5061.

D092
NRO

Mr. Charles R. Pierce states he is the AP1000 Licensing Manager of Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and to the best of his knowledge and belief, the facts set forth in this letter are true.

Respectfully submitted,

SOUTHERN NUCLEAR OPERATING COMPANY

Charles R. Pierce

Charles R. Pierce

Sworn to and subscribed before me this 30th *day of* October *, 2009*

Notary Public: Dana M. Williams

My commission expires: 12/29/2010

CRP/BJS/dmw

Enclosure: Response to NRC RAI Letter No. 040 on the VEGP Units 3 and 4 COL Application Involving Seismic Margins

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Southern Nuclear Operating Company

ND-09-1768

Enclosure

Response to NRC RAI Letter No. 040

on the

VEGP Units 3 and 4 COL Application

Involving

Seismic Margins

FSAR Section 3.7, Seismic Margins

eRAI Tracking No. 3512

NRC RAI Number 19-10:

The Vogtle Electric Generating Plant (VEGP) ground motion response spectra (GMRS) presented in Final Safety Analysis Report (FSAR) Section 3.7 exceed the certified design response spectra (CSDRS) at certain frequencies. These exceedances and related soil-structure interaction (SSI) were evaluated by the applicant in both the FSAR and in the Site Safety Analysis Report (SSAR) for the VEGP early site permit (ESP).

The staff observes that the seismic margins evaluation in the AP1000 probabilistic risk assessment (Chapter 55, Revision 6, available via Agencywide Documents Access and Management System (ADAMS) Accession No. ML040690501) states the following:

It will be necessary for a COL (combined operating license) applicant to demonstrate that the seismic response is equal to or less than that used in the calculation of the HCLPF [high confidence of low probability of failure] values, and to evaluate the potential for soil liquefaction using the site specific conditions. This will ensure a reserve margin that exceeds a 0.5g seismic level.

The Westinghouse response to RAI-SRP19.0-SPLA-22 dated July 22, 2009, states that a revised response to OI-SRP19.0-SPLA-12 "will reflect HCLPF values for the soil sites as well as the hard rock sites." It is unclear whether this response will bound the exceedances identified in the VEGP FSAR.

The staff requests that the applicant demonstrate, given the CSDRS exceedances presented by the applicant, that VEGP will have adequate seismic margin as described in the staff requirements memorandum (SRM) for SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," dated July 21, 1993.

SNC Response:

The following response provides the requested demonstration that, for the VEGP site-specific conditions that could affect the AP1000 design, there is "adequate seismic margin as described in the staff requirements memorandum (SRM) for SECY-93-087 'Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs,' dated July 21, 1993." The demonstration of adequate seismic margin of the AP1000 design at the VEGP site is based on an evaluation for a review level earthquake (RLE) of 1.67 x Vogtle GMRS ground motion, where the VEGP site-specific RLE seismic responses and seismic loads are defined as 1.67 x VEGP GMRS seismic responses and seismic loads.

The demonstration of adequate seismic margin is provided for the following VEGP site-specific conditions that could affect the AP1000 design:

- Soil liquefaction and bearing
- AP1000 Nuclear Island seismic demand due to VEGP site-specific RLE
- AP1000 Nuclear Island seismic stability due to VEGP site-specific RLE

The demonstrations either show that the factor of safety, defined as the ratio of capacity to demand, is sufficiently high that the site-specific condition can be screened out as a contributor to the sequence level HCLPF of 1.67 x VEGP GMRS; or comparison of site-specific seismic response to the AP1000 CSDRS enveloping seismic response or demand shows that the AP1000 standard design seismic margins would bound (or envelope) those required for the site-specific condition.

Soil Liquefaction & Bearing:

Conservative deterministic liquefaction assessments have been carried out for Units 3 and 4 at the Vogtle site, and are reported in the Site Safety Analysis Report (SSAR). In summary, the layer susceptible to liquefaction, the Upper Sands (Barnwell Formation), is being removed and replaced with densely compacted granular backfill. Thus, the possibility of liquefaction occurring at the Vogtle site is negligible to nil. However, as detailed in the SSAR, for completeness a liquefaction analysis was carried out for isolated lenses of coarse-grained material within the Blue Bluff Marl (BBM). In addition, assessment of the compacted structural fill was made based on the standard penetration test (SPT) blowcounts (N-values) measured in the Phase 1 test pad (Appendix 2.5D of the SSAR) and comparison with results for Units 1 and 2. For the margin assessment, those BBM and structural fill results have been revisited based on the requirement to analyze the effect of an increased seismic demand (1.67 times the GMRS, which results in a peak ground acceleration [pga] of 0.44g) on the subsurface soils beneath Units 3 and 4.

Unlike the deterministic analysis carried out for the SSAR, the seismic margin assessment has its roots in probabilistic evaluation. As such, the margin assessment is based on a combination of a best estimate-type response and an appropriate definition of soil strength. The soil strength pertains to both the material type as well as values of standard penetration test (SPT) resistance (N-values). The margin assessments for the BBM and compacted backfill are discussed in the following paragraphs.

The BBM is a highly overconsolidated, very strong middle Eocene-age material consisting almost entirely of clay with some partially cemented, well indurated lenses. These materials are not susceptible to liquefaction (refer to Vogtle ESPA RAI 2.5.4-14 response transmitted via SNC letter AR-07-0801, dated April 16, 2007). During the COL investigation, 742 SPT samples were obtained in the BBM with only eight (8) (approximately one percent) classified as coarse-grained. The coarse fraction of five (5) of these samples consisted of gravel- and sand-sized cemented particles from indurated layers within the BBM. Silty sands (SM) with an average fines content of 46% were found in three (3) samples in layers approximately 5 feet thick. These samples were encountered in two (2) of the 70 borings taken in the power block area and account for less than approximately one-half percent of the BBM drilled. Thus, for all practical purposes, the BBM is a very old clay deposit, very strong and overconsolidated and not susceptible to seismic liquefaction. Therefore, it is not considered further for this margin assessment.

The dense compacted structural fill that will be placed beneath and around the Nuclear Island (NI) is not expected to liquefy or experience strength loss at earthquakes levels having peak ground acceleration (pga) values of 1.67 times GMRS (0.44g) and less. Standard penetration test N-values are expected to be as high or higher than measured in the Phase 1 test pad constructed for Units 3 and 4. A plot of the SPT $(N_1)_{60}$ values for the Unit 3 and 4 test pad is given in Figure 16 of Appendix 2.5D of the SSAR. Given that the structural backfill will be tightly controlled and placed in a consistent manner throughout construction, these $(N_1)_{60}$ values are expected to be representative of the engineered backfill throughout its entire depth. Utilizing these values, liquefaction potential factor of safety is high (greater than 2). Thus, the liquefaction potential of the engineered structural fill is nil, with no measureable settlement affecting the NI due to the increased seismic demand.

In terms of dynamic bearing capacity, the average site-specific ultimate dynamic bearing capacity (C) will reduce, while the seismic bearing pressure (D) will increase. However, the resulting capacity (C) to demand (D) ratio, C/D is still more than adequate (greater than 2), providing sufficient margin with respect to the increased seismic demand.

In conclusion, for the "beyond design basis" seismic event (1.67 times GMRS), liquefaction potential of the BBM and the compacted backfill remains negligible to nil. These conditions will not result in any measureable settlement in the BBM or the well-compacted engineered structural fill. In addition, the increased seismic bearing pressure (D) is well below the associated bearing capacity (C) resulting in sufficient margin (greater than 2) to resist the beyond design basis dynamic bearing pressure. Thus, there is no impact on the NI resulting from deformation of the subsurface soils due to the increased seismic demand.

AP1000 Nuclear Island Seismic Demand Due To VEGP site-specific RLE:

As noted in the NRC staff question, the Vogtle Electric Generation Plant (VEGP) ground motion response spectra (GMRS) presented in the VEGP COLA, Part 2, Final Safety Analysis Report (FSAR), shown in Figures 3.7-201 and 3.7-202 do exceed the Certified Design Response Spectra (CSDRS) at certain frequencies. Because of these exceedances, and the fact that VEGP is a deep soft soil site, a plant specific seismic evaluation was performed to demonstrate that the AP1000 plant designed for the CSDRS is acceptable for the Vogtle site. The results from a Vogtle site specific two-dimensional seismic evaluation that demonstrates the acceptability of the Vogtle site are given in ESPA SSAR Appendix 2.5E. Additionally, a Vogtle site specific three-dimensional seismic evaluation that demonstrates the acceptability of the Vogtle site is given in COLA Appendix 3GG. Based on these Vogtle site specific seismic evaluations, it can also be concluded that the standard AP1000 plant certified design is fully acceptable at Vogtle plant site. Results from the Vogtle site specific three-dimensional seismic evaluation were provided to the NRC in supplemental response to RAI 03.07.02-1 (transmittal letter ND-09-0331, dated March 2, 2009) and RAI 03.07.02-3 (transmittal letter ND-09-1040, dated July 1, 2009).

As noted in ESPA SSAR Appendix 2.5E from comparison of seismic response spectra (Section 5.1), there is a slight exceedance in the range from 0.5 hertz to 0.6 hertz in the NS direction and 0.45 hertz to 0.65 hertz in the EW direction. The only dynamic response in this region is due to tank sloshing. It is shown that the sloshing frequencies are away from this region of exceedance. In COLA Appendix 3GG, the results of the Vogtle site-specific 3D SSI analysis in-structure response spectra (ISRS) were compared with the enveloping 3D CSDRS-based in-structure response spectra. The 3D analyses of the AP1000 at the Vogtle site show small exceedances of the envelope spectra at two of the six key locations specified in the DCD for site specific evaluations in addition to the exceedance at 0.55 Hz where it was shown to have no impact on the AP1000 design. These additional exceedances occur in the frequency range of

1.5 to 2 Hz at high elevations in the East-West direction. As discussed in Section 6.1 of COLA Appendix 3GG, Westinghouse has reviewed the seismic Category I systems, structures and components located above elevation 180' where the site specific analysis indicates exceedances of the AP1000 design ISRS and concluded that there is no item having a fundamental frequency in this range and therefore, the exceedances have no impact on the AP1000 design.

It is noted that both the AP1000 generic seismic response spectra and the Vogtle seismic response spectra are increased the same amount (1.67) for the review level earthquake, and therefore, there will be no increase in exceedances due to the spectra broadening effect.

Since there are no seismic Category I systems, structures and components within the areas of exceedances of the Vogtle spectra compared to the AP1000 CSDRS spectra as discussed above, and there will not be any additional exceedances due to spectra broadening effect considering the review level earthquake, the VEGP site will have adequate seismic margin. The seismic margin for the systems, structures and components reported for the AP1000 generic seismic margin analysis that considers hard rock and the generic soil sites can be used for the VEGP site. It is further noted that since the AP1000 seismic margin analysis considers all of the generic sites (hard rock, firm rock, soft rock, upper bound soft to medium, soft to medium, and soft soil sites), the VEGP actual seismic margin is equal to or greater than reported for the AP1000.

AP1000 Nuclear Island Seismic Stability Due To VEGP site-specific RLE:

The plant specific seismic stability analyses for VEGP are reported in ESPA SSAR Appendix 2.5E (Section 6.0). Table 6.2-1 provides seismic sliding and overturning stability factors of safety for ESP ground motion, i.e., the Vogtle GMRS. Equation 6.1 is used to recalculate the overturning stability factor of safety with a seismic demand equal to 1.67 x VEGP GMRS. Equation 6.2 identified friction force and shear force as the seismic components that affect the sliding stability factor. These seismic components are compared to the AP1000 seismic values to demonstrate that the Vogtle potential sliding response will be less than the AP1000 generic response.

To further assess the seismic sliding stability of the Nuclear Island (NI) at the Vogtle site for a review level earthquake of 1.67 x VEGP GMRS without consideration of the side soil contribution to stability, reference is made to the Vogtle ESP response to RAI 3.8.5-4 (SNC letter AR-08-1171, dated August 14, 2008). As requested in the RAI, the VEGP GMRS seismic shear and friction forces at the bottom of the NI basemat are provided without any side soil contribution to stability. This is shown in Table 3.8.4-1 of the RAI response. The lowest ratio of friction force to seismic shear is the Vogtle East-West (EW) upper bound ESP case. The friction and shear force for this upper bound ESP case are shown in Table 1.

As stated in the response to the AP1000 RAI-TR85-SEB1-10, Rev. 3, the AP1000 generic stability analysis is performed without passive soil resistance. The EW seismic response controls. Table RAI-TR85-SEB1-10-13 provides seismic deflections at the bottom of the NI basemat due to sliding for a coefficient of friction of 0.55. This analysis is based on a nonlinear time history analysis of the NI with no side soil for three different AP1000 generic rock/soil cases (hard rock, upper bound soft to medium soil, and soft to medium soil). Passive soil pressure is not considered in this stability calculation. As seen in Table RAI-TR85-SEB1-10-13, the maximum deflections are negligible (0.045 inch and smaller).

Given in Table 1 is a comparison of the VEGP EW upper-bound (UB) ESP case from Vogtle RAI 3.8.5-4, Table 3.8.5-4-1, which has the largest lateral seismic load and smallest friction resistance force for comparison to the AP1000 generic stability sliding analyses for the Soft to Medium (SM) and Upper Bound Soft to Medium (UBSM) soil cases that control. All three cases neglect side soil contribution to sliding stability.

As seen from the comparison given in Table 1, the VEGP friction resistance force is higher than the seismic shear; but for the AP1000 generic cases the friction resistance force is lower than the maximum seismic shear force. Therefore the Vogtle site specific conditions produce more sliding stability than these AP1000 generic cases. Further, it is noted that even though the coefficient of friction for the VEGP is 0.45 and the AP1000 generic seismic coefficient of friction is 0.55, the resisting friction force for VEGP is larger than the values in the AP1000 generic stability analyses. The buoyant force is considered for the AP1000 generic stability analysis; whereas VEGP is a dry site with the water table below the NI foundation basemat.

From these comparisons, it can be concluded that the VEGP site will have higher seismic margin in regards to seismic sliding of the Nuclear Island given the Vogtle review level seismic event than the AP1000 generic sites for the AP1000 review level seismic event. The resulting maximum displacements due to sliding would be relatively small (equal to or less than 0.1" without consideration of passive pressure) considering the time varying earthquake loading as exemplified by the nonlinear time history results shown in Table RAI-TR85-SEB1-10-13, and the additional limitation of sliding due to embedment of the NI in 40' of side soil. All safety related structures, systems, and components (SSCs) are within the NI which has a single basemat; and therefore any relatively small displacements due to sliding would not challenge the safety function of the AP1000 SSCs.

In Vogtle ESP SSAR Appendix 2.5E Table 6.2-1, the seismic stability factors of safety associated with overturning are given for the different soil conditions considered for the VEGP site due to ESP or GMRS ground motion. The Upper Bound ESP case for the EW response has the smallest factor of safety which is equal to 2.45 which is significantly greater than that smallest factor of safety reported for the AP1000 generic design. These factors of safety are based on equation 6.1 which is the static evaluation formula for overturning seismic stability. Using equation 6.1, but increasing the seismic loads by a factor of 1.67, results in a seismic factor of safety for overturning equal to 1.4 without consideration of passive pressure. Since this factor of safety is above 1.0, the review level earthquake requirement for Vogtle is met using this formulation.

Table 1 – NI Basemat Seismic Sliding Reactions
Units: Kips

Component	VEGP ESP UB	AP1000 Generic SM	AP1000 Generic UBSM
Seismic Shear	95,800	94,234	96,781
Friction Force	116,405	78,900	81,483

This response is PLANT-SPECIFIC.