SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NO. 2 TO THE COMBINED LICENSE NO. NPF-91

AND LICENSE NO. NPF-92

SOUTHERN NUCLEAR OPERATING COMPANY, INC

GEORGIA POWER COMPANY

OGLETHORPE POWER COMPANY

MUNCIPAL ELECTRIC AUTHORITY OF GEORGIA

CITY OF DALTON, GEORGIA

VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4

DOCKET NOS.: 52-025 AND 52-026

1.0 INTRODUCTION

By letter dated April 6, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12100A185), and revised by letters dated April 12, 2012 (ADAMS Accession No. ML12104A323), and May 7, 2012 (ADAMS Accession No. ML12130A468), Southern Nuclear Operating Company (SNC-Licensee) requested that the U.S. Nuclear Regulatory Commission (NRC) amend the combined licenses (COLs) for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, COL Numbers NPF-91 and NPF-92, respectively. The proposed amendment will revise the upper tolerance on the Nuclear Island critical sections basemat thickness as identified in the VEGP Units 3 and 4 updated final safety analysis report (UFSAR), Subsection 3.8.5, and associated Table 3.8.5-3, Note 2 where this thickness tolerance value is identified. SNC requests that this note be revised to replace the +1 inch tolerance with +4 inches.

During recent surveying of the mudmat (which forms the foundation upon which the basemat is constructed), SNC determined that the upper surface of the mudmat is not as level as would be desired for placing a near-constant thickness basemat. In its license amendment request, SNC stated that it is possible that if the basemat is placed at the intended thickness of six feet and within the thickness tolerances identified for the basemat in Note 2 of Table 3.8.5-3, the settled basemat upper surface may not be as level as would be desired. SNC expects that the upper tolerance will need to exceed the current allowable upper tolerance in order to provide a level top surface of the VEGP Unit 3 basemat upon which the remaining Nuclear Island (NI) structures would then be built. In order to improve the probability of a level surface on which to continue construction of the NI structures, SNC requested a change such that the upper tolerance may be as great as four inches for VEGP Units 3 and 4.

Additionally, the licensee's responses to request for additional information, dated June 29 (ADAMS Accession No. ML121850052), July 20 (ADAMS Accession No. ML12207A094) and August 21, 2012 (ADAMS Accession No. ML12235A518), provided information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the NRC staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on June 12, 2012 (77 FR 35076).

2.0 REGULATORY EVALUATION

Under the current licensing basis, the basemat and nuclear island structures are required to comply with the provisions of ACI 349-01, "Code Requirements for Nuclear Safety Concrete Structure" and supplementary requirements included in the VEGP Units 3 and 4 UFSAR Sections 3.7 and 3.8. UFSAR Subsection 3.8.3.2, "Applicable Codes, Standards, and Specifications" references ACI 117, "Standard Specifications for Tolerances for Concrete Construction and Materials" for construction purposes such as concrete cover, concrete and reinforcement material construction tolerance, cast in place foundation tolerances, etc. The proposed changes to the concrete and rebar detail design and the UFSAR description are required to be consistent with ACI 349-01 and other supplementary UFSAR requirements.

Appendix D, "Design Certification Rule for the AP1000 Design," of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Section VIII.B.6 requires NRC approval for departures from Tier 2* information. The proposed amendment request does involve changes to Tier 2* information. Therefore, NRC approval is required before making the Tier 2* changes addressed in this departure.

10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 1, "Quality Standards and Records," requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of safety functions to be performed.

10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena," requires that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Basis," requires that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-cooling accidents.

10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," requires nuclear power plants to be designed so that, if the safe-shutdown earthquake (SSE) ground motion occurs, certain structures, systems, and components will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of structures, systems, and components must be assured during and after the vibratory ground motion associated with the SSE ground motion through design, testing, or qualification methods.

10 CFR 100.23, “Geologic and Seismic Siting Criteria,” provides the nature of investigation required to obtain the geologic and seismic data necessary to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants.

3.0 TECHNICAL EVALUATION

3.1 Nuclear Island Basemat Evaluation

To perform the technical evaluation, the NRC staff considered UFSAR Sections 3.7, “Seismic Design,” and 3.8, “Design of Category I Structures.” The staff also examined the portions of NUREG–1793, Supplement 2, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design” (NUREG-1793) (ADAMS Accession No. ML112061231), and “Final Safety Evaluation Report for the Vogtle Electric Generating Plant Units 3 & 4 Combined License Application” (ADAMS Accession No. ML110450302) documenting the staff’s technical evaluation of those aspects of the AP1000 Design Control Document (DCD) and Vogtle COL application, respectively.

The staff reviewed the proposed license amendment request (LAR), to evaluate the impact of the requested UFSAR changes on the stability and safety of the NI foundations and structures to be constructed on the Vogtle site.

In the LAR, the licensee proposed to depart from the plant-specific DCD Tier 2* information by increasing the NI basemat thickness tolerance. The LAR evaluates the effect of the revised basemat thickness tolerance on the AP1000 foundation design and NI structures. As part of the licensee’s supporting technical bases for the design change, the significance of concrete strength ranging from 4000 psi (27.6 megapascals (MPa)) to 5000 psi (34.5 MPa) on analysis results was assessed. UFSAR Table 3.8.5-3, Note 2 (Tier 2* bracketed) will be amended to state:

> [*The thickness of these sections is 6’ 0” with a construction tolerance of +4 inch, -3/4 inch*]*

During the review, the staff applied the guidance of Standard Review Plan (SRP) Sections 3.7 and 3.8, as well as relevant regulatory guides, with references to related industry standards. The staff’s technical evaluation of the LAR focused on verifying whether the proposed changes will affect the NI seismic response, foundation stability, and basemat design. For determining the adequacy of the proposed UFSAR changes, the staff considered the effect of increasing the upper tolerance of the basemat thickness on (1) compliance with applicable codes and standards, (2) seismic response, (3) foundation stability (effect of increasing thickness tolerance on sliding and overturning), and (4) structural design of the basemat. The staff’s technical evaluation is summarized below.

3.1.1 Compliance of the Basemat Thickness Tolerance with Applicable Codes and Standards

UFSAR Subsection 3.8.4.2, “Applicable Codes, Standards, and Specifications” describes the applicable codes and standards used in the design of the AP1000 basemat. UFSAR Subsection 3.8.3.2, “Applicable Codes, Standards, and Specifications” references ACI 117, "Standard Specifications for Tolerances for Concrete Construction and Materials" for construction purposes such as concrete cover, concrete and reinforcement material construction tolerance, cast in place foundation tolerances, etc.

The LAR proposes to revise the upper tolerance of the basemat thickness from +1 inch to +4 inches. In the LAR, the licensee stated that the increased upper tolerance is in conformance with standard concrete tolerances in ACI 117.

Staff reviewed applicable ACI 349-01 code provisions and related construction standards such as ACI 117. Staff's review of ACI 349-01 and the ACI 117 standard finds that ACI 117 provisions address the lower-limit tolerance for foundations and do not prohibit the use of an upper limit tolerance. In addition, staff also reviewed the more recent standard ACI 117-10, "Specification for Tolerances for Concrete Construction and Materials and Commentary," Section 3.5, Figure R 3.5.3, and finds that the more recent code revision also does not specify or prohibit the use of an upper limit tolerance for the foundation thickness. Accordingly, the staff finds the design change in basemat upper tolerance of +1 inch to +4 inches is in conformance with codes and standards referenced in the UFSAR.

Staff notes that while the basemat thickness change is in conformance with the UFSAR referenced codes and standards, the change in thickness will increase stiffness and mass and therefore will affect seismic analysis results. The applicant assessed the impact of the thickness change on the seismic analysis of the NI, and the staff's review of the licensee's assessment is described below.

3.1.2 Effect of Increasing Basemat Thickness Tolerance on Seismic Analysis

The seismic analysis performed for the VEGP Units 3 and 4 is described in UFSAR Section 3.7, Appendix 3G, and Appendix 3GG. The seismic design of the AP1000 seismic Category I and seismic Category II structures, systems, and components is based on the AP1000 certified seismic design response spectra (CSDRS). The CSDRS are based on a modified Regulatory Guide RG 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," broad-banded design spectra with a peak ground acceleration of 0.3 g. For design purposes, seismic demands are based on the envelope of six soil cases, which include a hard rock site, a soft rock site, a firm rock site, an upper bound soft-to-medium soil site, a soft-to-medium soil site, and a soft soil site.

The seismic model used for performing the AP1000 soil-structure interaction analysis is the system for analysis of soil structure interaction (SASSI) NI-20 model (UFSAR Appendix 3G). SASSI is a soil-structure interaction (SSI) code capable of modeling the seismic response of embedded structures in layered site conditions. The staff's detailed review of this model is described in NUREG-1793 (Section 3.7).

In UFSAR Appendix 3GG, the licensee describes the site-specific analysis performed to demonstrate suitability of the AP1000 standard design for the Vogtle site. The licensee performed site-specific analysis to evaluate the exceedance of the site-specific ground motion response spectra (GMRS) above the AP1000 CSDRS. The seismic analysis was based on the site-specific ground motion and the envelope of the best-estimate, lower bound, and upper bound shear-wave velocity soil profiles. Comparisons at six key NI locations showed that the AP1000 standard plant seismic demands (i.e., based on the CSDRS) envelope the site-specific analysis results except for a narrow frequency range at about 0.55 hertz (Hz) for some locations. The licensee concluded that these narrow low-frequency exceedances had no design consequences since there are no AP1000 structures, systems, or components with resonant frequencies in this range. The staff's detailed review of the licensee's site-specific analysis and justification for exceedances above the AP1000 CSDRS is described in the VEGP Units 3 and 4 Final Safety Evaluation Report (FSER) dated August 5, 2011, Section 3.7.

In a letter dated August 21, 2012, the licensee describes SSI sensitivity analyses performed to assess the effect of the increased mass and stiffness due to the increased basemat thickness. The analysis was performed using the SASSI NI-20r model, which is the same analysis model used in AP1000 DCD analysis with a slight modification. The licensee modified the SASSI model by changing the thickness of the basemat shell elements to reflect the additional thickness of the basemat. The SASSI model was based on the Vogtle best-estimate soil profile and site-specific seismic input. The licensee did not identify any departures in seismic analysis methods.

In the letter dated August 21, 2012, the licensee described sensitivity analyses performed to assess the impact of variations in concrete compressive strength. The analysis considered concrete strengths ranging from 4,000 psi to 5,000 psi and also made use of the SASSI NI-20 model. The SASSI model was modified by changing the modulus of elasticity of the basemat shell elements to reflect the various concrete strengths.

The licensee made comparisons of in-structure response spectra (ISRS) at six key NI locations for the case of 5,000 psi concrete strength and a basemat tolerance of +4 inches. The results are shown in the LAR. The licensee concluded that, based on the comparisons, the differences in ISRS at the key locations at all frequencies are less than 1 percent.

In addition, the licensee evaluated the exceedances described in UFSAR Subsection 3.7.1.1.1, and found that the change in basemat thickness does not change or shift the frequency ranges of the ISRS at which the exceedences occur. The licensee found that the difference in ISRS (for the +1-inch and +4-inches tolerance cases) in the frequency range of the exceedance (~0.55 Hz) were less than 0.1 percent.

Based on its review of the LAR, the staff finds the approach for adjusting the NI 20 SASSI model basemat thickness and modulus of elasticity to be consistent with standard practice and ACI 349-01 Chapter 8.5, and therefore acceptable. Staff also reviewed the licensee's sensitivity studies and finds that the comparisons indicate minimal differences (less than 2 percent) in ISRS for +1 and +4 in basemat tolerance, including the frequency range of the exceedance (0.55 Hz). In addition, the comparisons all show that the site-specific demands remain bounded by the standard plant design spectra (for frequencies greater than 1 Hz). Staff also concludes that the effect of varying concrete strength from 4,000 psi to 5,000 psi has minimal impact on the seismic analysis results.

Based on the licensee's sensitivity studies, which show minimal differences in seismic response for the increase in basemat thickness, staff concludes the design change will have negligible effect on the site-specific seismic analysis used to demonstrate suitability of the AP1000 standard plant to the Vogtle site. The staff also concludes that the AP1000 standard plant continues to envelope the Vogtle site-specific seismic demands (for frequencies greater than 1 Hz) and that the proposed design change, which also considered a range of concrete strength from 4,000 psi to 5,000 psi, does not affect the staff's conclusions regarding the low-frequency exceedances of the standard plant design spectra.

3.1.3 Effect of Increasing Basemat Thickness Tolerance on Sliding and Overturning

The analyses of foundation sliding and overturning for VEGP Units 3 and 4 are described in UFSAR Subsections 3.8.5.5.3 and 3.8.5.5.4, respectively. The NI basemat is supported on a concrete mudmat (nominally 12-inches thick) with an embedded waterproofing membrane described in UFSAR Subsection 3.8.5.1. Sliding resistance of the basemat is provided by friction forces developed at the various material interfaces (basemat-to-mudmat, mudmat-to-waterproofing membrane, and mudmat-to-soil). A coefficient of friction is assumed to be 0.55 at the basemat-to-mudmat interface. At the interface of the waterproofing membrane and the mudmat, the coefficient of friction is assumed to be 0.7 as described in UFSAR Subsection 3.8.5.1. The governing friction value in the soil below the mudmat has a minimum angle of internal friction of 35 degrees.

While the effect of buoyancy caused by the water table is included in the calculation of sliding resistance, the effect of passive soil pressure is conservatively not credited. Factors of safety to resist sliding are shown in UFSAR Table 3.8.5-2 and are based on the envelope of the soil and rock cases described in UFSAR Section 3.7.1. This table indicates the minimum factor of safety to resist sliding under the SSE demands is 1.1.

The analysis of NI overturning considers the effects of nuclear island dead weight, buoyancy, active pressure, and overburden pressure. The effect of passive pressure is not credited in the analysis. Factors of safety to resist overturning are shown in UFSAR Table 3.8.5-2 and are based on the envelope of the standard plant soil and rock cases. This table indicates that the minimum factor of safety to resist overturning under SSE demands is 1.17.

The staff evaluation of sliding and overturning is described in NUREG-1793, Section 3.8.

In the LAR, the licensee stated that the seismic sensitivity analysis showed that the change in maximum seismic plus deadweight soil pressure on the soil elements beneath the Vogtle basemat is less-than-1-percent. The licensee also stated that there is negligible change in the uplift contact area beneath the Vogtle basemat based on the less-than-1-percent change in soil pressure and the less-than-1-percent change in the ISRS at the six key locations.

Staff concludes that the comparisons indicate minimal differences in ISRS for an increase in basemat tolerance. In addition, the comparisons all show that the site-specific seismic demands remain bounded by the AP1000 standard plant design spectra. Consequently, the staff finds that the Vogtle site-specific factors of safety for sliding and overturning remain bounded by the standard plant factors of safety.

Based on the licensee’s sensitivity studies, which show minimal differences in seismic response for a +4-inches increase in basemat tolerance, the staff concludes that the proposed change will have negligible effect on factors of safety to resist sliding and overturning of the NI.

3.1.4 Effect of Increasing Basemat Thickness Tolerance on Basemat Design

The design and analysis procedures of the AP1000 basemat are described in UFSAR Subsection 3.8.5.4, “Design and Analysis Procedures.” This section states that the seismic Category I structures are concrete, shear-wall structures consisting of vertical shear/bearing walls and horizontal floor slabs. The walls carry the vertical loads from the structure to the basemat. Lateral loads are transferred to the walls by the roof and floor slabs. The walls then transmit the loads to the basemat. The design of the basemat consists primarily of applying the design loads to the structures, calculating shears and moments in the basemat, and determining the required reinforcement. UFSAR Subsection 3.8.4.2 states that the design, materials, fabrication, construction, inspection, and testing of the basemat foundation are in accordance with ACI 349-01.

In the LAR, the licensee stated that, based on sensitivity studies, the change in basemat from 6-foot to 6-foot 4 inches thickness, in conjunction with increasing the basemat compressive strength from 4,000 psi to 5,000 psi, will not have an adverse impact on the capacity of the basemat or the response of basemat to loads. The licensee concluded that the evaluation of the basemat showed that there was a minimal change in the stresses in the basemat due to the proposed change.

The licensee also stated that the percent change in the average seismic membrane plus bending stress in the Vogtle basemat compared to the AP1000 generic average seismic membrane and bending stresses is approximately 3.3 percent. The licensee concluded that the despite the small increase in basemat stresses (corresponding to basemat thickness), the design remains enveloped by the standard plant. The Vogtle basemat average seismic membrane and bending stresses are 57.2 and 63 percent of the corresponding AP1000 generic maximum stresses, respectively. As such substantial margin exists in the design.

Staff concludes that the comparisons indicate minimal differences in ISRS for the increased basemat thickness, and minimal increases in seismic demands on the basemat. In addition, the ISRS comparisons all show that the site-specific demands remain bounded by the standard plant design spectra. Consequently, staff finds that the design of the basemat remains bounded by the standard plant.

Based on the licensee's sensitivity analysis (which considered a maximum of 5,000 psi concrete strength), which indicates minimal differences in seismic response and basemat stresses, and existing margin compared to the AP1000 standard design, staff concludes that the design change from +1 to +4 inches basemat thickness tolerance will not result in changes to the required steel reinforcement and will not impact the ability of the basemat to perform its intended function.

3.1.5 Conclusions

Based on the staff's technical evaluation, the staff concludes that:

1. The proposed increase in basemat thickness tolerance from +1 inch to +4 inches conforms to ACI 349-01 code provisions and related standards.
2. The proposed increase in basemat thickness tolerance, which also considered a concrete strength of 5,000 psi, will have a negligible effect on the site-specific seismic analysis used to demonstrate suitability of the AP1000 standard plant to the Vogtle site.
3. The AP1000 standard plant continues to envelope the Vogtle site-specific seismic demands (for frequencies greater than 1 Hz), and the proposed design change does not affect the staff's conclusions regarding the low-frequency exceedances of the standard plant design spectra.
4. The proposed increase in basemat thickness tolerance will have a negligible effect on factors of safety to resist sliding and overturning of the AP1000 nuclear island.
5. The proposed increase in basemat thickness tolerance will have minimal increase in seismic demands on the basemat and no additional reinforcement is required. In addition, the comparisons all show that the site-specific demands remain bounded by

the standard plant design spectra. Consequently, the staff finds that the design of the basemat remains bounded by the standard plant design.

3.2 Nuclear Island Foundation Stability Evaluation

To perform the technical evaluation, the NRC staff reviewed UFSAR Section 2.5.4.10 "Static Stability." The staff also considered portions of NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) Site" (U.S. NRC, 2009) (NUREG-1923), and "Final Safety Evaluation Report for the Vogtle Electric Generating Plant Units 3 and 4 Combined License Application" (ADAMS Accession No. ML110450302) documenting the staff's technical evaluation of the COL application.

The staff reviewed the LAR to evaluate the impact of the requested changes on the stability and safety of foundations and structures to be constructed at the Vogtle site.

During the review, the staff applied the requirements of 10 CFR Part 50, Appendix A, Appendix S and 10 CFR100.23, as well as relevant regulatory guides, with references to related industry standards. The staff's technical evaluation focused on verifying whether the proposed change of thickness of the basemat of Units 3 and 4 will affect the stability of foundations. The mudmat construction at Unit 4 is still in progress (ADAMS Accession No. ML12207A094) and no survey information is available at this time. However, since the backfill operations for both VEGP Units 3 and 4 followed the same specifications and are subject to the identical Inspections, Tests, Analyses and Acceptance Criteria (ITAAC), this evaluation is also applicable for VEGP Unit 4.

For determining the adequacy of the LAR proposed increase of the upper tolerance on the Nuclear Island critical sections basemat thickness from +1 inch to +4 inches, the staff considered its effect on the SSI analysis and foundation stabilities that include bearing capacity and settlement analyses. The staff's technical evaluation is summarized below.

3.2.1 Foundation Stability Evaluation

Since the stability of the foundation will be affected by any change of foundation design and/or expected loading conditions, when there is change of thickness of the basemat of the foundation, its impacts on the foundation stability, specifically bearing capacity and settlement of the foundation, need to be evaluated.

3.2.1.1 Bearing Capacity Evaluation

An increase of basemat thickness will increase the load on the foundation; therefore, its impact on the bearing capacity of the foundation needs to be examined. The estimated factors of safety of bearing capacity for the original foundation design are 11.9 for static loadings and 2.9 for dynamic loadings, as presented by the licensee in UFSAR 2.5.4.10.1, "Bearing Capacity." A three (3.0) inch increase in thickness of the basemat will result in about a 0.036 ksf increase in the static loading, which is an increase of only about 0.4% of the standard design static loading of 8.6 ksf and will have no impact on dynamic loading. Since the factors of safety for static and dynamic bearing capacity are much greater than the minimum requirements, normally 3.0 for static and 1.5 for dynamic loading conditions, this three (3.0) inch increase of basemat thickness will have minimal impact on the bearing capacity of the foundation.

3.2.1.2 Foundation Settlement Evaluation

Since the Vogtle site is a deep soil site, one of the most influential factors on foundation stability is foundation settlement. The LAR states that during recent surveying of the mudmat, it was determined that the upper surface of the mudmat is not as level as would be desired for placing a near-constant thickness basemat. It also states that "[i]t is expected that the upper tolerance will need to exceed the current allowable upper tolerance in order to provide a level top surface of the Unit 3 basemat upon which the remaining nuclear structures would then be built." Since there is a specific settlement requirement in the AP1000 DCD, as well as a mudmat thickness specification in the UFSAR 2.5.4.1.3, the staff issued a request for additional information (RAI) (ADAMS Accession No. ML12172A122) to seek clarification on whether the uneven level of the upper surface of the mudmat was caused by uneven placement of the mudmat, or by additional backfill settlement. The staff also asked the licensee to explain whether additional settlement, both total and differential settlement, will occur upon placement of the basemat to justify the need for a 4 inch upper tolerance.

In its response dated July 20, 2012 (ADAMS Accession No. ML12207A094), the licensee states that the mudmat construction includes a plus or minus three-fourths of an inch tolerance during concrete placement, and the additional compaction and backfill settlement of soil materials adjacent to the work area behind the mechanically-stabilized earth wall influenced the surroundings, which resulted in an uneven surface of the mudmat. In its response, the licensee provides survey data that shows the difference in thickness for the mudmat is about 1.2 inches, and the average settlement of the mudmat was about 1.5 inches from July 2011 to July 2012. The survey also shows that the variation in elevation across the mudmat was about 1.2 inches in July 2012. Based on the survey data, the licensee concludes that since the mudmat surface concrete unevenness began as ~1.2 inches in July 2011 and is still ~1.2 inches in July 2012, settlement is not the predominant cause of the need for an increase in the basemat upper tolerance limit, but it is a contributor.

The staff examined the survey data and generated some plots to visualize the data (Figure 1 to Figure 3). Based on the information provided, the staff observed that:

1. The survey elevations at surface of subgrade (the top of backfill soil) randomly vary about 0.84 inches ranging from EL 179.49 to 179.56 ft;
2. The surveyed elevations at the surface of the mudmat randomly vary about 0.84 inches, and survey elevations range from EL 180.48 to 180.55 ft;
3. The thickness of the mudmat randomly varies from 11.5 to 12.7 inches;
4. The mean settlement is about 1.0 inch and varies from 0.71 to 1.5 inches among the settlement markers from July 21, 2011 to July 2, 2012;
5. The mean settlement is about 0.012 inches and varies from -0.024 to +0.096 inches among the settlement markers from March 7, 2012 to July 2, 2012.

The staff then estimated the static settlement caused by the weight of the mudmat. Since the backfill material is sandy soil with less than 25% fines (i.e., it is essentially cohesionless soil), most settlement will be contributed from immediate or elastic settlement. Using the backfill soil properties specified in SSAR Table 2.5.4-1 and commonly used methods, such as the Berardi and Lancellota method and Mayne and Poulos method, the estimated settlement caused by the weight of the mudmat would be about 0.03 to 0.12 inches, depending on the model and model parameters used. When the six feet thick basemat is placed, the estimated settlement induced by the weight of basemat would be about 1.9 inches. In addition, if the upper limit of the tolerance on the NI critical sections basemat thickness increases from +1 inch to +4 inches, or three inches thicker for the concrete slab, the additional settlement would be about 0.02 to 0.04 inches.

Based on the survey data and staff's estimates of the foundation settlement, the staff concludes that:

1. The variation of elevations at the subgrade surface and at the mudmat surface resulted from the construction process and did not show any abnormality;
2. The variation of thickness of the mudmat is within the design allowance (plus or minus three-fourths of an inch tolerance);
3. The observed settlement from July 21, 2011, to July 2, 2012, after placement of the mudmat, is more than the model predicted, about 1 inch versus 0.2 inches. The observed settlement apparently included the settlement caused by the weight of the mudmat, the continued consolidation of over 40 ft of backfill soil, and other factors, such as the modeled settlement mark elevations of July 21, 2011;
4. The measured settlements from March 7, 2012, to July 2, 2012, vary from -0.024 to +0.096 inches. This observation shows that the settlement is minimal, or even within the data accuracy because of the negative settlement obtained, during this period of time and it indicates that the subgrade soil is stabilized;
5. The foundation settlement after the completion of the six-feet basemat is estimated at about 1.9 inches, and the total settlement would be about 2.9 inches if taking the surveyed current settlement into account. To make the elevation of the surface of the basemat meet the design requirement, the upper tolerance of thickness for the basemat has to be able to compensate for the elevation variation up to about 2.74 inches; therefore, increasing the original one inch upper tolerance limit is necessary.

UFSAR Section 2.5.4.10.2, "Settlement Analysis" states that based on a detailed settlement analysis for VEGP Units 3 and 4 utilizing similar elastic properties used for the analysis of Units 1 and 2, which incorporated excavation, dewatering, and a timeline of construction to estimate, as much as practical, mat displacement time histories, total settlements ranging from about 2 to 3 inches, with a tilt of approximately one-fourth inch in 50 feet, and a predicted differential settlement between structures of less than 1 inch. The staff already evaluated and concurred with this statement as documented in NUREG-1923. Based on the previous evaluation and information obtained from the LAR, the staff further concludes that the field settlement survey data did not show any sign of unexpected weakness of the foundation soil and the observed and estimated settlements are within the range of original total settlement estimation. Therefore there is no foundation stability concern regarding the settlement. However, while not creating additional licensee obligations, the staff emphasizes that the settlement of the foundation needs to be closely monitored during construction (see UFSAR Section 2.5.4.10.2) because of the deep soil layers underneath the foundation and the fact that larger than estimated settlement was observed after the placement of the mudmat, even if it was possibly caused by reasons other than actual foundation soil settlement.

3.2.1.3 Summary of Staff Evaluation

Based on the staff's technical evaluation, the staff concludes that:

1. The variation of elevations at subgrade surface (the top of backfill soil) and at mudmat surface resulted from the construction process and the variation of thickness of the mudmat is within the design allowance (plus or minus ¾ of an inch tolerance).
2. The measured foundation settlements after the placement of the mudmat varied from -0.024 to +0.096 inches during the period from March 7, 2012, to July 2, 2012. This minimal foundation settlement indicates that the subgrade soil has been stabilized.
3. Accounting for the foundation settlement after the completion of basemat and the surface level variation of the mudmat, increasing the one inch upper tolerance limit for critical sections of the basemat is necessary to make the surface elevation of the basemat meet the design requirement.
4. The proposed increase to the upper tolerance for the basemat from 1.0 inch to 4.0 inches is in conformance with standard concrete tolerances in the ACI-117 standard. ACI-117-90, Subsection 3.4.1.3 "Vertical dimension (thickness)", specifies the low tolerance of five (5) percent for concrete footings without upper tolerance specification; therefore, the 4.0 inches upper tolerance for six (6) feet concrete basemat is allowed.
5. A three-inch thickness increase of the concrete basemat will increase the static loading applied to the foundation by about 0.4% of the standard design static loading of 8.6 ksf, which will have minimal effect on the originally calculated factor of safety of bearing capacity: 11.9 for static loadings and 2.9 for dynamic loadings.
6. The three-inch thickness increase of the concrete basemat will not cause any notable additional foundation settlement; less than 0.04 inches would be added to the total settlement based on staff's confirmatory settlement calculations.
7. There is no sign of weakness of the subgrade soil under the Nuclear Island foundation and the observed and estimated settlements are within the range of original total settlement estimation, therefore no foundation stability concern is raised.
8. While not creating any additional licensee obligations, staff emphasizes that the foundation settlements, total and differential settlements, still need to be closely monitored during and after construction because of the deep soil layers underlying the foundation and the larger than estimated settlement observed after the placement of the mudmat.

3.3 Conclusions

For the reasons specified above, the staff finds the proposed UFSAR amendments to increase basemat thickness tolerance will not affect the analysis results and related conclusions presented in the AP1000 DCD and UFSAR related to concrete materials, seismic analysis, foundation stability, and basemat design. Consequently, the NRC staff concludes that there is reasonable assurance that the requirements of Appendix A to 10 CFR Part 50, Appendix S to 10 CFR Part 50, and Appendix D (Section VIII B6) to 10 CFR Part 52 will continue to be met. Therefore, the staff finds the proposed change acceptable.

In addition, the staff finds that the proposed increase of the upper tolerance on the Nuclear Island critical sections basemat thickness from +1.0 inch to +4.0 inches is in conformance with the ACI-117 standard; it will not have negative impact on foundation/structure stability (bearing capacity, total and differential settlement) but is necessary to ensure that the surface elevation of basemat meets the design requirement, and it therefore meets the relevant requirements of 10 CFR 100.23, 10 CFR Part 50, Appendix S, 10 CFR Part 50, Appendix A, General Design Criterion (GDC1 and GDC2).

4.0 STATE CONSULTATION

In accordance with the Commission's regulations (10 CFR 50.91(b)), the Georgia State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (77 FR 35076; published on June 12, 2012). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1. Request for License Amendment- Nuclear Island Basemat Thickness Tolerance, letters from Southern Nuclear Operating Company (SNC) dated April 6, April 12, May 07, June 29, July 20, and August 21, 2012.

2. Vogtle Electric Generating Plant (VEGP) Updated Final Safety Analysis Report (UFSAR), Revision 1, dated June 24 2012.

3. AP1000 DCD Revision 19, June 13, 2012.

4. VEGP Final Safety Evaluation Report (FSER) dated August 5, 2011.

5. Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design, NUREG 1793, August 5, 2011.

6. NUREG-800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition.

7. ACI 349-01 “Code Requirements for Nuclear Safety Related Concrete Structures.”

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9. NUREG-1923, “Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) Site,” U.S. NRC, 2009.

10. Final Safety Evaluation Report for the Vogtle Electric Generating Plant Units 3 and 4 Combined License Application.

11. Foundation Engineering Handbook, A. Vesic, H. Winterkorn and H. Fang, Editors, Van Nostrand Reinhold Co. 1975.

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13. Berardi, R., and Lancellotta, R. 1991. Stiffness of Granular Soil from Field Performance. Geotechnique Vol. 41, Issue 1, pp 149-157.

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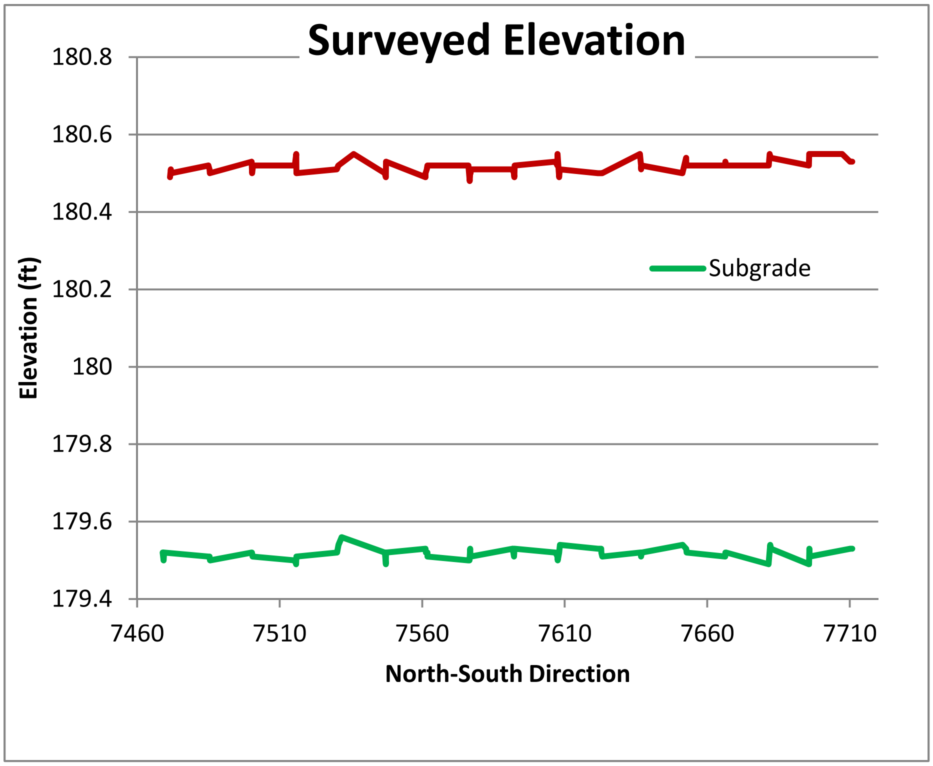
Figure 1 Elevations at Subgrade and Top of the Mudmat, VEGP Unit 3



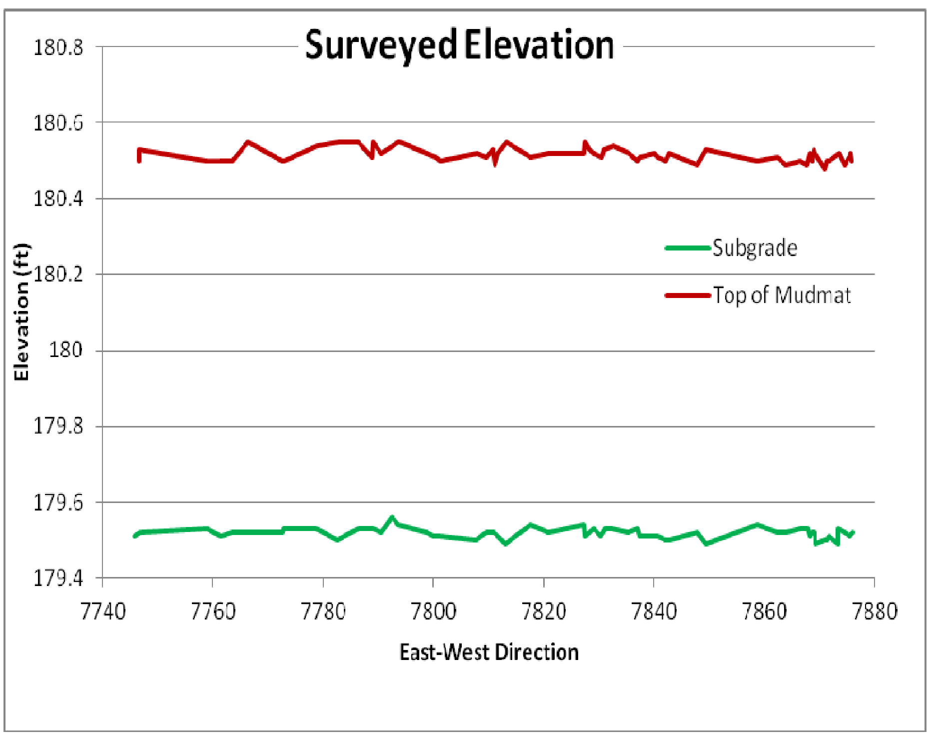
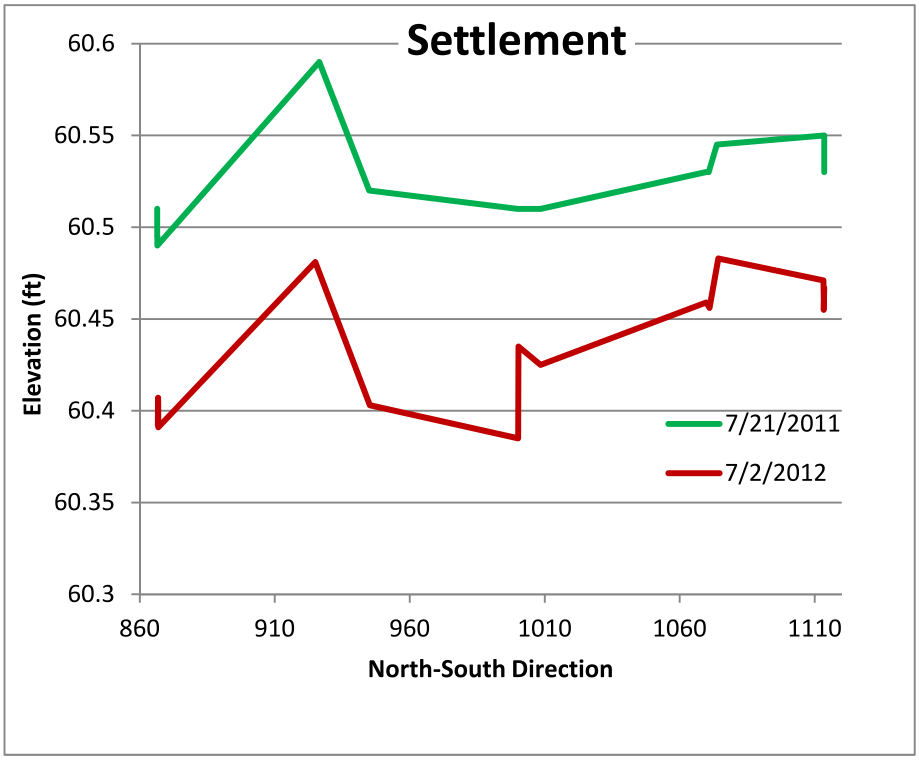


Figure 2 Foundation Settlement from July 21, 2011 to July 2, 2012 at Nuclear Island, VEGP Unit 3



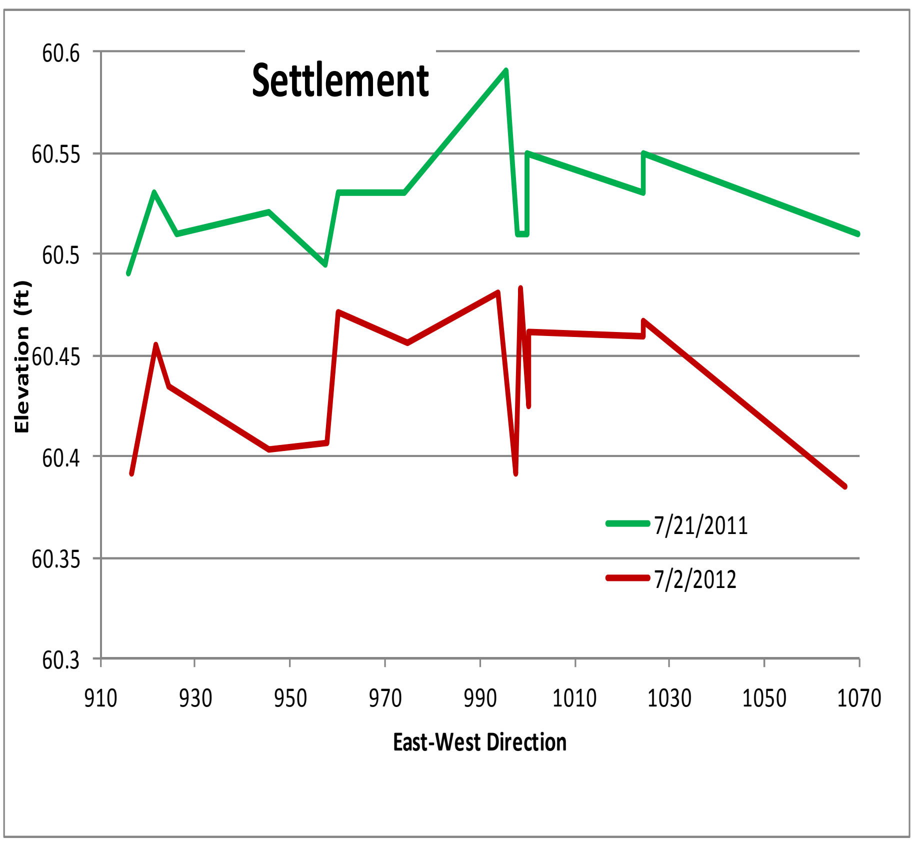


Figure 3 Foundation Settlement from March 7, 2012 to July 2, 2012 at Nuclear Island, VEGP Unit 3