July 9, 2010

Mr. Joseph A. (Buzz) Miller
Executive Vice President
Southern Nuclear Operating Company
P.O. Box 1295
Birmingham, AL 35201-1295

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT ESP SITE - ISSUANCE OF AMENDMENT RE: REQUEST FOR CHANGES TO THE CLASSIFICATION OF BACKFILL OVER THE SLOPES OF UNITS 3 AND 4 EXCAVATIONS.

Dear Mr. Miller:

The U.S. Nuclear Regulatory Commission (NRC, the Commission) has issued the enclosed Amendment No. 3 to Early Site Permit No. ESP-004 for the Vogtle Electric Generating Plant Early Site Permit (ESP) Site. The amendment consists of changes to the Site Safety Analysis Report in response to your application dated May 24, 2010, as supplemented on June 2 and June 22, 2010.

This amendment revises the Vogtle Electric Generating Plant ESP Site Safety Analysis Report (SSAR) to change the classification of backfill over the slopes of the Units 3 and 4 excavations from Category 1 and 2 backfill to engineered granular backfill (EGB).

The Notice of Issuance will be included in a future *Federal Register* notice.

Sincerely,

/RA/

Terri Spicher, Project Manager
AP1000 Branch 1
Division of New Reactors Licensing
Office of New Reactors

Docket No. 52-011

Enclosures:
1. Amendment No. 3 to ESP-004
2. Safety Evaluation

cc w/encl: Distribution via Listserv

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SOUTHERN NUCLEAR OPERATING COMPANY

VOGTLE ELECTRIC GENERATING PLANT ESP SITE

DOCKET NO. 52-011

AMENDMENT TO EARLY SITE PERMIT AND LIMITED WORK AUTHORIZATION

Amendment No. 3
Early Site Permit (ESP) No. ESP-004

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The request for an amendment submitted by Southern Nuclear Operating Company, on behalf of itself and Georgia Power Company, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and the City of Dalton, Georgia (the ESP holders), dated May 24, 2010, as supplemented on June 2 and June 22, 2010, complies with the applicable standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations;

   B. There is reasonable assurance that the facility will be constructed and will be operated in conformity with the license, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, as requested in the application dated May 24, 2010, as supplemented on June 2 and June 22, 2010, the ESP holders are authorized to revise the Site Safety Analysis Report (SSAR) as specified in the ESP holders' request dated May 24th and June 22, 2010, to allow the use of engineered granular backfill (EGB) over the excavation side slopes rather than Category 1 and 2 backfill as is currently stated in the ESP SSAR. The ESP holders shall update the SSAR by adding these changes, as authorized by this amendment.

3. This license amendment is effective as of its date of issuance and shall be implemented within 15 days.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Jeffrey Cruz, Chief
AP1000 Branch 1
Division of New Reactors Licensing
Office of New Reactors

Date of Issuance: July 9, 2010

SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NO. 3 TO EARLY SITE PERMIT NO. ESP-004

SOUTHERN NUCLEAR OPERATING COMPANY

VOGTLE ELECTRIC GENERATING PLANT ESP SITE

DOCKET NO. 52-011

1.0 INTRODUCTION

By letter dated May 24, 2010 (Reference 1), as supplemented by letters dated June 2 (Reference 11) and June 22, 2010 (Reference 2), Southern Nuclear Operating Company (SNC) ("applicant"), on behalf of itself and Georgia Power Company, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and the City of Dalton, Georgia, submitted a request to amend the Early Site Permit (ESP) and Limited Work Authorization (LWA) that was issued to SNC and the same co-applicants on August 26, 2009, for the Vogtle Electric Generating Plant (VEGP) site (Reference 3). In particular, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 52.39(e), the applicant seeks to amend the ESP Site Safety Analysis Report (SSAR) (Reference 4) to change the classification of backfill over the slopes of the Units 3 and 4 excavations from Category 1 and 2 backfill to engineered granular backfill (EGB).

The requested changes are based on the fact that actual excavation from the SSAR identified borrow areas has yielded significantly less Category 1 and 2 backfill material than predicted, resulting in a shortfall of available Category 1 and 2 backfill for the VEGP site; and, according to the applicant, the technical evaluation and sensitivity studies show that the proposed changes will not affect site stability, seismic response, liquefaction analyses, and radionuclide transport results presented in the ESP SSAR. Therefore, the applicant has concluded that use of the EGB backfill will not affect the stability and safety of the site and nuclear power plant facilities but will greatly reduce the need for Category 1 and 2 backfill material to continue the previously-authorized LWA construction.

This safety evaluation is to document the NRC staff's determination on the suitability of using engineering granular backfill to replace Category 1 and 2 backfill material over the slopes of the Units 3 and 4 excavations as specified in this license amendment request (LAR).

2.0 REGULATORY EVALUATION

10 CFR 52.39, "Finality of early site permit determinations," states that the holder of an ESP may not make changes to the ESP, including the SSAR, without prior Commission approval in the form of an application for a license amendment.

10 CFR 20.1301 and 20.1302, as they relate to the radiological dose limits for individual members of the public.

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 1, “Quality Standards and Records,” as it relates to safety-related structures being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection Against Natural Phenomena,” relates to the consideration of the most severe of the natural phenomena, such as wind, tornadoes, floods, earthquakes, that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, in determining the design of the safety-related structures and their capability to withstand the effects of such natural phenomena and the appropriate combination of all loads, and still perform their safety functions.

10 CFR Part 50, Appendix S, is applicable to applications for a design certification or combined license pursuant to 10 CFR Part 52. Appendix S requires that, for SSE ground motions, SSCs will remain functional and within applicable stress, strain, and deformation limits. The required safety functions of SSCs must be assured during and after the vibratory ground motion through design, testing, or qualification methods. The evaluation must take into account SSI effects and the expected duration of the vibratory motion. Appendix S also requires that the horizontal component of the SSE ground motion in the free field at the foundation level of the structures must be an appropriate response spectrum with a peak ground acceleration (PGA) of at least 0.10g.

10 CFR Part 100.20(c)(3), as it relates to factors important to hydrological radionuclide transport (e.g., soil, sediment, and rock characteristics, adsorption and retention coefficients, groundwater velocity, and distances to the nearest receptors).

10 CFR Section 100.23, “Geologic and Seismic Siting Criteria,” provides the nature of the investigations 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.

In addition, in accordance with the guidance of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” the determination of suitability of using engineering granular backfill to replace Category 1 and 2 backfill material over the slopes of Units 3 and 4 excavations for this ESP License Amendment should be consistent with appropriate sections from Regulatory Guide (RG) 1.28, “Quality Assurance Program Requirements (Design and Construction);” RG 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants;” RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition);” and RG 1.208, “A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion.”

3.0 TECHNICAL EVALUATION

To perform the technical evaluation, the NRC staff considered Vogtle ESP SSAR Sections 2.5.2.9, "Sensitivity Studies" and 2.5.4.5, "Excavation and Backfill" with a focus on SSAR Section 2.5.4.5.1, "Extent of Excavations, Fills, and Slopes." The staff also examined the 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) (FSER) documenting the staff's technical evaluation of those aspects of the ESP and LWA application (Reference 5).

The staff reviewed the LAR to evaluate the impact of the requested SSAR changes on the stability and safety of foundations and structures to be constructed on the Vogtle site. Under the LAR, the applicant proposed to add a new subsection 2.5.2.9.4, "Study of Engineered Granular Backfill Placed over the Slopes of the Excavation" to SSAR section 2.5.2.9 and add a discussion regarding engineered granular backfill (EGB) to SSAR Section 2.5.4.5.1, "Extent of Excavations, Fills and Slopes." The LAR stated that:

> Engineered granular backfill (EGB) will be placed above the slopes, outside the specified lateral extent of the Category 1 and 2 backfill, as defined in Figure 2.5.4-16. The areas where EGB will be placed will not affect the static or seismic performance of the safety-related facilities. The EGB will be well-compacted granular backfill meeting the following requirements;
>
> - Compacted to a minimum of 95% of modified Proctor (ASTM D1557) maximum dry density value.
>
> - Consist of sands, silty sands and clayey sands (SP, SP-SM, SP-SC, SW, SW-SM, SW-SC, SC, SC-SM, or SM based on the Unified Soil Classification System (ASTM D2487)).
>
> - Have a maximum plasticity index (PI) of 25 and a maximum fines content (% passing the No. 200 sieve) of 35%.
>
> Materials that exceed the limits for PI and fines content may be accepted on a case-by-case basis after an engineering evaluation has been performed.

The applicant revised SSAR Figures 2.5.4-16 and 2.5.4-17 accordingly to illustrate the location and extent of the EGB. Figure 1 below replicates the revised SSAR Figure 2.5.4-16. The applicant also revised SSAR subsection 2.5.4.5.4, "Backfill Sources" to reflect the reduced quantity of Category 1 and 2 backfill needed for construction.

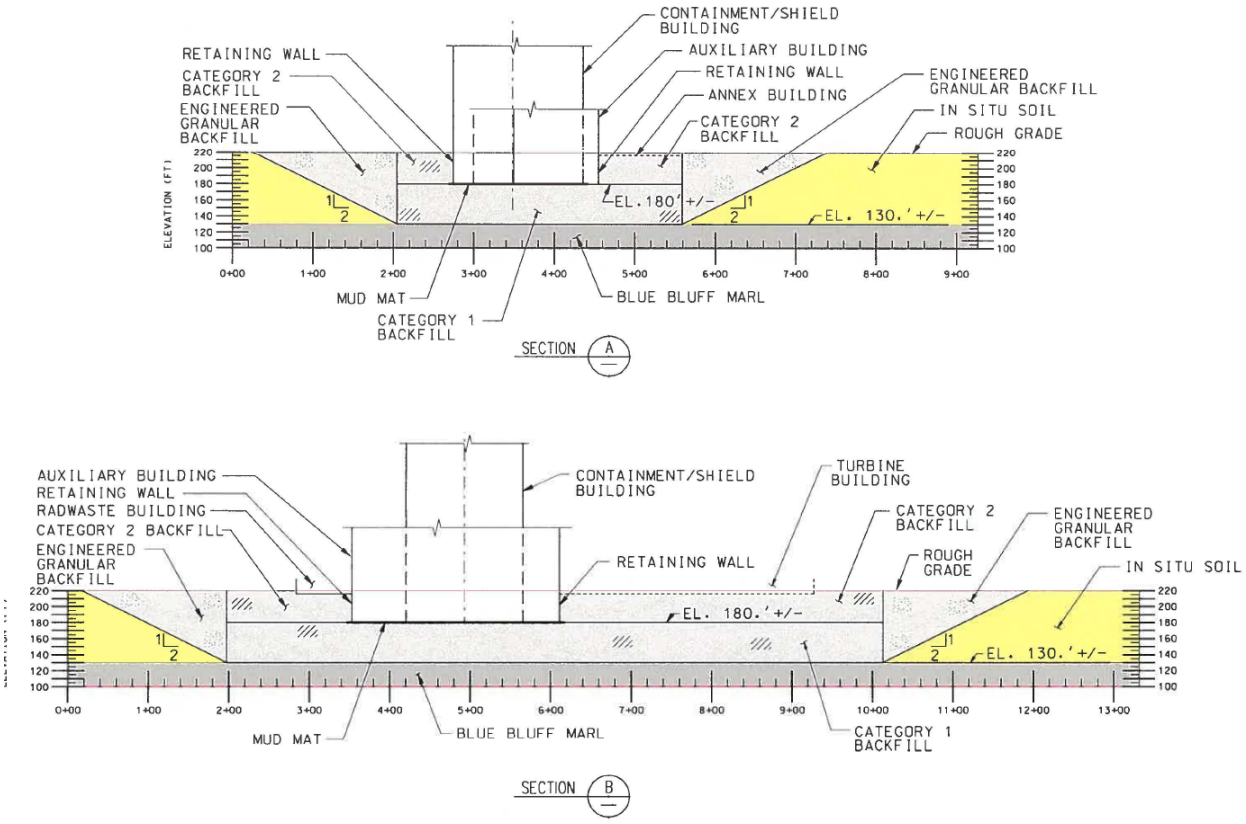

Figure 1. Power Block Excavation Sections (Source: Reference 1)

During the review, the staff applied the guidance of 10 CFR Part 50, Appendix A and 10 CFR 100.23, as well as relevant regulatory guides, with references to related industrial standards, and the same criteria that were used to approve the Vogtle ESP and LWA as presented in NUREG-1923. The staff's technical evaluation focused on verifying whether the proposed change of the classification of backfill over the slopes of Units 3 and 4 excavations from Category 1 and 2 backfill to engineering granular backfill will affect the stability of subsurface materials and foundations at the site.

For determining the adequacy of the LAR proposed SSAR changes, the staff considered the effect of replacing Category 1 and 2 backfill by EGB material over the slopes of excavations on seismic site response analysis and site and foundation stability analyses that include liquefaction potential, bearing capacity, and settlement. The staff's technical evaluation is summarized below.

3.1 The Effect of Using the EGB Material on Seismic Site Response Analysis

In the proposed revision to SSAR Section 2.5.2.9.2, the applicant's comparison of 1D SHAKE site response results with the 2D SASSI model results confirmed that the 1D SHAKE analyses are adequate for the development of the ground motion given the geometry of the backfill at the

site. To evaluate the proposed change in backfill geometry in this LAR, the applicant compared the original 2D SASSI model results to the results of a modified 2D SASSI model. The applicant stated that it used the same 2D SASSI model and inputs, except that it varied the material over the slopes of the excavation.

The applicant stated that it considered three different cases for Category 1 and 2 backfill material placed over the slopes of the excavation. According to the applicant, Case 1 is a hypothetical case of no slope excavation (i.e. a vertical cut) with the full depth of the Upper Sands brought up to the bottom toe of the exposed Blue Bluff Marl. Case 2 is a hypothetical lower bound of well-compacted EGB. The applicant considered Case 2 to be an extreme lower bound for engineered backfill, and assigned shear (S)-wave velocities less than 1000 feet per second (fps) at the NI foundation elevation. Case 3 is a hypothetical upper bound of well-compacted EGB. The applicant considered this case to be an extreme upper bound for the EGB, and assigned S-wave velocities significantly greater than 1000 fps at the NI foundation elevation. Figure 2.5.2-66 plots the low strain S-wave velocity profiles for Case 1, Case 2, and Case 3. This figure also plots the Lower Bound (LB), Best Estimate (BE), and Upper Bound (UB) low strain S-wave velocity profiles for the ESP Category 1 and 2 backfill, which the applicant used to develop the SSAR Section 2.5.2.9.2 2D SASSI models. The applicant used the BE S-wave velocity profile for the purpose of this comparison.

The applicant compared the results of Cases 1, 2, and 3 to the 2D SASSI results originally presented in SSAR Section 2.5.2.9.2. Figure 2.5.2-68 shows the results in the form of spectral amplification factors versus frequency at a depth of 0 ft, which corresponds to the location of the ground motion response spectra (GMRS). The applicant concluded that the 2D SASSI model results for the three different cases of backfill over the slopes are very similar to the original SASSI 2D model results presented in SSAR Section 2.5.2.9.2. The applicant further concluded that, because of this similarity, the proposed EGB material placed over the slopes of the excavation would not affect the VEGP site response analysis used to define the VEGP GMRS.

The staff reviewed the applicant's site response sensitivity analysis and in RAI VOGAMEND#2 - 2.5.2-1 requested the applicant to: a) Specify which backfill properties were changed and provide their corresponding values within the 2D SASSI model (including the 2D S-wave velocity profile); b) Specify the output node of the GMRS shown in Figure 2.5.2-68; and c) Quantitatively compare the 2D SASSI model results shown in SSAR Figure 2.5.2-68 with the 1D SHAKE results shown in SSAR Figure 2.5.2-55.

In part a) of its response to RAI VOGAMEND#2 - 2.5.2-1, the applicant provided Figure 2.5.2-1A to show the 2D SASSI model for the site response analysis. The applicant stated that this figure illustrates the portions of the model where the backfill properties were varied. The applicant further stated that the only portion of the model that was changed was the backfill material properties over the slopes of the excavation (i.e. wedge portions). Otherwise the models, including the input motions, are identical to those used in SSAR Section 2.5.2.9.2 "Study of Backfill Geometry." The applicant also provided the following additional information on the backfill properties for Cases 1, 2, and 3. The applicant stated that Case 1 reflects the in-situ Upper Sands material with the S-wave velocity profile described in ESP SSAR Section 2.5.4.7.1.1 "Soil S-Wave Velocity Profile" and shown in ESP SSAR Figure 2.5.4-6a. The variation of shear modulus and damping with shear strain is taken from the Electric Power Research Institute (EPRI)

family of curves for depths of 0-20 ft, 20-50 ft, and 50-120 ft (EPRI, 1993, Reference 6). A unit weight of 113 pounds per cubic foot (pcf) is used to a depth of 65.5 feet. Below 65.5 feet, a unit weight of 115 pcf is used. In addition, the applicant stated that Cases 2 and 3 represent the lower and upper ranges of the EGB, respectively. The applicant used the same shear modulus reduction and damping curves to represent the EGB that it used for the ESP Category 1 and 2 backfill, which are provided in SSAR Table 2.5.4-12 and SSAR Figures 2.5.4-9 and 2.5.4-11. The applicant assigned a unit weight of 127.5 pcf and 128.4 for Case 2 and Case 3, respectively.

In part b) of the applicant's response to RAI VOGAMEND#2 - 2.5.2-1, the applicant stated that the location of the output node for the GMRS shown in Figure 2.5.2-68 is 0 ft depth (i.e. plant grade) at the center line of the excavation, which is shown as "Node Used for GMRS" in Figure 2.5.2-1A.

In part c) of its response to VOGAMEND#2 - RAI 2.5.2-1, the applicant provided Figure 2.5.2-1C, which compares the SASSI 2D model results shown in Figure 2.5.2-68 with the 1D SHAKE model results shown in ESP SSAR Figure 2.5.2-55.

The staff reviewed the applicant's response to RAI VOGAMEND#2 - 2.5.2-1 and concluded that the applicant adequately described the material properties (i.e. 2D S-wave velocity profile, shear modulus reduction and damping curves, and unit weights) of the 2D SASSI model and clearly explained how these values differed from the original 2D SASSI model. The staff concluded that the three different S-wave velocity profiles (i.e. Cases 1, 2, and 3) are adequate because they represent the upper and lower bound velocities of the EGB material. The staff also concluded that the applicant provided the output node of the GMRS within the 2D SASSI model, which is an appropriate location because it is located directly on Category 1 and Category 2 backfill. The staff also reviewed the applicant's site amplification comparisons presented in Figure 2.5.2-1C and concludes that the new SASSI 2D model results are consistent with the original 2D SASSI model and 1D SHAKE results presented in SSAR Section 2.5.2.9.2 and remain well within the design envelope. Therefore, the staff concludes that the placement of EGB material on the slopes of the excavation would have a negligible effect on the site response calculations used to determine the VEGP GMRS.

3.2 The Effect of Using the EGB Material on Site Subsurface and Foundation Stability

The applicant's analysis of site subsurface and foundation stability included liquefaction potential analysis, bearing capacity calculation, and settlement calculation. The original site subsurface material and foundation stability analyses in the ESP application were based on the assumptions that the Category 1 and 2 backfill material will be used to backfill all excavated areas. The proposed EGB material has different material and engineering properties from the Category 1 and 2 backfill. The staff therefore compared the properties of these two types of backfill materials and evaluated the effect of replacing the Category 1 and 2 backfill along the side slopes with EGB on the stability of site subsurface and foundations.

3.2.1 Comparison of Category 1 and 2 backfill and EGB materials

According to the VEGP ESP SSAR, the classification of the Category 1 and 2 backfill soil includes poorly graded sands (SP), silty sands (SM), and silty to poorly graded sand (SP-SM);

the Category 1 and 2 backfill soil is designed to have at least 95% modified Proctor compaction with gradation described in SSAR Table 2.5.4-14 and associated text in Section 2.5.4.5.3, the fines content ranging from 3 to 25 percent, and the unit weight is 123 pcf; and the Category 1 and 2 backfill soil is designed to have the following engineering properties: drained internal angle of friction of 36°; S-wave velocity of 1,000 fps at and below the nuclear island foundation level; designed backfill soil degradation properties developed from resonant column torsional shear (RCTS) testing of COL samples; shear modulus reduction curves as specified in SSAR Table 2.5.4-12a and Figure 2.5.4-9a; and damping curves as specified in SSAR Table 2.5.4-12a and Figure 2.5.4-11a. The hydraulic conductivity used for the Category 1 and 2 backfill is 3.3 ft/day.

The proposed engineered granular backfill (EGB), as stated in the Enclosure 2 of the letter dated May 24, 2010 (Reference 1), and Enclosure 1 of the letter dated June 22, 2010 (Reference 2), will consist of sands, silty sands and clayey sands (SP, SP-SM, SP-SC, SW, SW-SM, SW-SC, SC, SC-SM, or SM), and will be compacted to a minimum of 95% of modified Proctor maximum dry density value. The fines content will be limited to 35% with maximum plasticity index of 25; and the unit weight is from 127.5 to 128.4 pcf. The applicant estimated that the internal friction angle for the EGB would range from 31° to 38°, and the applicant stated that the hydraulic conductivity of the EGB is expected to be equal to or less than that of the Upper Sands or 32 ft/day. The applicant also stated that the shear wave velocity profiles of the EGB are similar to those illustrated in SSAR Figure 2.5.2-66 and that resonant column torsional shear (RCTS) test results showed that the proposed EGB has similar soil degradation properties as that of Category 1 and 2 backfill. Two RCTS samples, taken from onsite borrow sources, were designated as clayey sand (SC) and did not meet the requirements for Category 1 and 2 backfill.

Although the soil classification and compaction requirements are similar for Category 1 and 2 backfill and EGB soils, the engineering properties for these backfill soils are slightly different. The major differences are for:

- Soil unit weight (i.e. 123 pcf for Category 1 and 2 backfill soil versus 127.5 to 128.4 pcf for the EGB).
- Internal friction angle (i.e. 36° for Category 1 and 2 backfill soil versus 31° to 38° for the EGB).
- Soil hydraulic conductivity (i.e. 3.3 ft/day for Category 1 and 2 backfill soil versus 32 ft/day for the EGB).
- S-wave velocity (i.e. 1000 fps at and below the nuclear island foundation level for Category 1 and 2 backfill versus values bounded by Case 2 and Case 3 in Figure 2.5.2-66).

These differences are mainly caused by the fact that if EGB is used there would be no soil gradation control and a higher fines content would be allowed.

3.2.2 Effect of EGB materials on site liquefaction potential analysis

In the LAR, the applicant stated that:

> The proposed EGB includes clayey and silty sands as well as clean sands (well-graded and poorly-graded). These materials are generally consistent with Category 1 and 2 backfill, except that they can contain a higher percentage of fines and contain plastic fines instead of silt fines. Given that the EGB will also be compacted to a minimum of 95% of ASTM D1557, and can contain plastic fines instead of silt fines, the liquefaction potential of the EGB is expected to be equal to or less than that of Category 1 and 2 backfill. Thus, it is concluded that EGB compacted to the same requirements as Category 1 and 2 backfill will not liquefy during a design basis earthquake.

The staff evaluated the liquefaction potential for Category 1 and 2 backfill and concluded that this backfill soil will not liquefy during the design basis earthquake. This conclusion was based on the fact that, as described in the original SSAR Subsection 2.5.4.8.3.3, the Category 1 and 2 backfill will be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 1557, and that the backfill materials, construction, and field compaction methods will be consistent with those used during the construction of Units 1 and 2.

It is well known that liquefaction can occur when the following criteria are met: (1) seismic/dynamic loading, or the design ground motion acceleration for a site is high, 2) the soil is saturated (i.e., the soil is close to or below the water table), and 3) the site soils are sands or silty sands in a loose or medium dense condition. It has long been recognized that relatively "clean" sandy soils, with few fines, are potentially vulnerable to seismically-induced liquefaction; but it is also well known that one of the mitigation methods (Reference 7) for liquefaction is soil compaction to specifications requiring not less than 95% relative compaction based on the maximum dry density as determined by a Modified Compaction Test of ASTM 1557D.

The staff considered the following factors when evaluating the liquefaction potential of EGB soil:

1. The currently used "simplified method" (Reference 8) for evaluation of soil liquefaction uses Standard Penetration Test (SPT), Cone Penetration Test (CPT) and shear wave velocity based liquefaction assessment. For SPT-based liquefaction assessment method, soil generally will not liquefy if the normalized STP $(N_1)_{60}$ value is greater than 30 (according to Idriss and Boulanger (2006, Reference 9), this value is about 32). For Category 1 and 2 backfill, the $(N_1)_{60}$ value is tested at about 40; and for EGB soil, since because it is well compacted (95% relative compaction ASTM 1557D) sandy soil, the estimated $(N_1)_{60}$ value is equal to or greater than 30 (Reference 10).

2. There will be a greater percentage of fines in the EGB soil as compared to Category 1 and 2 backfill. Both the SPT- and CPT-based liquefaction assessment charts show that higher fines content will reduce the soil liquefaction potential because cohesion of the soil increases.

3. There will be no EGB soil directly placed beneath or surrounding the safety-related structure foundations.

Based on the above considerations, the staff concludes that EGB soil will not liquefy during the design basis earthquake and use of that soil as proposed in the LAR will not have any negative impact on the stability of safety-related structure foundations since it will not be placed underneath or surround the foundations of safety-related structures.

3.2.3 Effect of EGB materials on bearing capacity calculation

The applicant stated that there would be no effect on reported foundation bearing capacities by replacing Category 1 and 2 backfill with EGB soil over the slopes of the excavation, because no safety-related structures bear on or are in contact with the EGB, and the specified requirement in the LAR on the selection and compaction of the EGB would provide reasonable assurance of a competent interface with the Category 1 and 2 backfill.

Although the safety-related structures will be founded on Category 1 backfill and be surrounded by Category 2 backfill, it does not mean that the EGB soil has no effect on the bearing capacity of the site. This is because the basic equation for the bearing capacity calculation assumes that the soil underneath and surrounding the foundation is uniform, and is placed at an extent far enough away to be outside the stress influence zone, which is produced by all possible loadings applied on the foundation. Generally, the bearing capacity of the foundation is determined by the shear strength underneath and surrounding the foundation within the zone where the soil will bear the loading. Since the load-bearing zone may include the EGB soil, and the shear strength of the EGB soil is weaker than the Category 1 and 2 backfill, the bearing capacity of the foundation soil may be smaller than that originally calculated. Accordingly, the staff examined the detailed bearing capacity calculation originally provided by the applicant in the SSAR (Reference 5). In that analysis, the applicant used a conservative estimate for the bearing capacity which did not take credit for the backfill soil above the foundation level. Consequently, the properties of the backfill have no effect on the results of the bearing capacity calculation, and therefore the staff concludes that the proposed use of EGB does not alter the original estimate of bearing capacity.

3.2.4 Effect of EGB materials on settlement calculation

The applicant stated that there would be no effect on the reported estimated total or differential settlements of the major structures of the nuclear power plant by replacing Category 1 and 2 backfill with EGB soil over the slopes of the excavation, because no safety-related structures are bearing on or in contact with the EGB. The staff examined the revised SSAR Figure 2.5.4-16 and determined that the EGB soil will be placed outside all safety-related structures; therefore it will have no direct effect on the settlement of structures that will be founded on Category 1 and 2 backfill. In addition, since for the reasons explained above the EGB soil will not liquefy during a design basis earthquake, it will have no indirect influence on the settlement of structures. The staff concludes that the proposed use of EGB will not change the original estimate of the total or differential settlements of the major structures of the nuclear power plant.

3.3 Sensitivity Study for Site Seismic SSI Analyses

In the original SSAR Section 2.5.2.9.2, the applicant described sensitivity studies performed to evaluate the effects of backfill geometry on the dynamic response of the AP1000 Nuclear Island (NI). The applicant stated that, due to the large volume of excavation and lateral extent of the backfill, the backfill layers were modeled as free-field layers (with infinite extent). This one-dimensional model was used for modeling the soil profile and developing ground motion input to the site-specific soil-structure interaction (SSI) analysis. To validate the above one-dimensional modeling assumption, the applicant also performed sensitivity studies using a two-dimensional SASSI model to evaluate the effect of the extent of backfill on SSI analysis. In NUREG-1923 (Reference 5), Section 3.7.2.3.2.2, the staff reviewed the applicant's backfill sensitivity analysis and found that the influence of backfill excavation geometry on the NI dynamic response was insignificant.

In the proposed SSAR Section 2.5.2.9.4, the applicant describes how the 2D SASSI sensitivity models were updated to include the backfill soil cases (Case 1, Case 2, and Case 3). The purpose of these analyses was to study the effects of using engineered granular backfill (EGB) over the excavation slopes on the dynamic response of the AP1000 NI. With the exception of the backfill materials over the slopes, the SSI modeling parameters (e.g., time histories, material degradation models, material damping, etc.) were kept the same.

In support of the present LAR, the applicant compared in-structure response spectra for the original 2D SASSI Bathtub model and the three backfill sensitivity cases. SSAR Figures 2.5.2-71 through 2.5.2-76 illustrate in-structure response spectra at the AP1000 NI six key locations from the original SSAR (using Category 1 and 2 backfill) as compared to the LAR (using EGB). The staff performed a review of these figures and finds that the results indicate that the effects of varying backfill properties on the AP1000 in-structure response are small and would remain well within the AP1000 design envelope.

3.3.1 Correlation of Backfill Material Properties with Assumed Shear Wave Velocity Profiles

In proposed SSAR Section 2.5.2.9.4, the applicant describes the sensitivity studies performed for the site-specific seismic SSI analysis. The applicant stated that the same 2D SASSI bathtub model was used as in the present ESP SSAR except that the material over the excavation slopes was varied using three backfill cases.

The staff reviewed the three backfill cases proposed for the sensitivity study and found that SSAR Section 2.5.4.5.1 stated that the EGB will be compacted to a minimum of 95% of modified Proctor (ASTM D1557) maximum dry density and will consist of sands, silty sands and clayey sands (SP, SP-SM, SP-SC, SW, SW-SM, SW, SC, SC, SC-SM, or SM based on the Unified Soil Classification System (ASTM D2487). The EGB material is indicated to have a maximum fines content of 35% and a maximum plasticity index (PI) of 25. The staff found that this description of backfill was inadequate for correlating shear wave velocity with material classification. To address this concern, the staff issued RAI VOGAMEND#2 - 3.7.2-1, which requested that the applicant provide clarification on how the aforementioned properties correlate with the assumed shear wave velocity profiles (depicted in SSAR Figure 2.5.2-66).

In a June 22, 2010 letter response, the applicant justified the assumed shear wave velocity profiles using both laboratory test results and empirical relationships. The applicant performed resonant column torsional shear (RCTS) tests on samples expected to be representative of the EGB designations. RCTS tests were conducted on materials designated as clayey sands (SC) and a well graded silty sand (SW-SM).

The applicant also used empirical relationships which accounted for estimated (e.g., void ratio) and measured properties (e.g., fines content) to verify the reasonableness of the velocity profiles determined from the RCTS testing. The staff reviewed the comparisons of the assumed shear wave velocity profiles (Case 1, Case 2, and Case 3) with the RCTS results and found them to be in good agreement with the empirical relationships for shear wave velocity. Accordingly, the staff finds them to be acceptable.

3.3.2 Vertical Interface Between EGB and Category 1 and Category 2 Backfill Materials

The applicant's proposed Power Block Excavation Sections are shown in SSAR Figures 2.5.4-16 and 17. The staff reviewed these figures and noted that a vertical boundary between the engineered granular fill and the Category 1 and 2 backfill is proposed. The staff found that the SSAR did not describe how this vertical boundary would be maintained during construction and was concerned that misalignment of this boundary could result in an as-built difference with what was assumed in the seismic analysis models. To address this issue, the staff issued RAI VGAMEND#2 - 3.7.2-2, which requested that the applicant describe how this boundary will be maintained during placement of backfill such that the Category 1 and 2 backfill zones will not be mixed with EGB.

In a June 22, 2010 letter response, the applicant stated that in terms of placement of compaction, the construction procedures will assure that the horizontal extent of the Category 1 and Category 2 backfill will be maintained beyond the extent assumed in the analysis. The Category 1 and 2 backfill will extend beyond the vertical interface to assure that any blending of the EGB will occur outside of the vertical interface assumed in the analysis. Compaction of the EGB will be controlled as a distinct effort because moisture conditioning and materials for the EGB and Category 1 and 2 backfills may be different. At this interface, the applicant plans to make overlapping passes with compaction equipment which will provide assurance that material across the interface will be compacted to the specified requirement of 95% of ASTM D1557.

The staff reviewed the applicant's proposed method for maintaining the vertical interface between the EGB and the Category 1 and 2 backfill materials. Based on the applicant's proposal to have the interface of the EGB material extend beyond that assumed in the site-specific seismic analysis, and the overlapping passes with compaction equipment, the staff finds the applicant's method acceptable.

3.4 Effect of Changing Backfill Material on Radiological Transport in Groundwater

In Vogtle ESP SSAR Section 2.4.13, the applicant analyzed the radiological transport of a postulated accidental release to groundwater. The applicant conservatively assumed that the effluent from a ruptured tank moves instantly and vertically downward to the groundwater through the backfill. The effluent then moves through the backfill zone to the northwest along

the groundwater direction, and follows the groundwater flow northerly through the Barnwell Sand and Utley Limestone zones to Mallard Pond and Savannah River through a small creek. A criterion used to determine site suitability was that the sum of the ratios of individual radionuclide concentration and the concentration limit established in 10 CFR Part 20, Appendix B, may not exceed "1" (i.e., unity). In the SSAR, the applicant demonstrated that the estimated sum of concentration ratios at a receptor point is far below unity, thus the applicant concluded that the site meets the requirements of Part 20, Appendix B.

The applicant's letter dated May 24, 2010, proposed a change of the classification of backfill over the slope of the excavation from Category 1 and 2 to engineered granular backfill (EGB). The EGB will consist of sands, silty sands and clayey sands, and will be compacted to a minimum of 95% of modified Proctor maximum dry density value. The hydraulic conductivity of the Category 1 and 2 backfill material is 3.3 ft/day; however, the hydraulic conductivity of the proposed EGB is expected to be equal to or less than 32 ft/day. The applicant stated in its May 24, 2010, letter that the SSAR Section 2.4.13 radiological transport analysis took no credit for any backfill over the slope of the excavation, and it therefore determined that the safety conclusion of SSAR Section 2.4.13 is still valid.

The staff performed a independent confirmatory analysis to check the validity of the applicant's conclusion. In Section 2.4.13 of NUREG-1923 (the Vogtle ESP FSER), the staff performed a conservative radiological consequence analysis. In that analysis, the staff used the above release scenario with the lengths of groundwater pathway through the backfill, Barnwell Sand, and Utley Limestone zones of 150 ft, 1500 ft, and 2400 ft, respectively. This scenario resulted in the sum of radionuclide ratios of 0.336 at the creek below Mallard Pond as reported in NUREG-1923. To evaluate the effect on that analysis of the change to the backfill material proposed in the LAR, the staff conservatively assumed that the lengths of the groundwater pathway through the Category 1 and 2 backfill zone and the combination of EGB backfill and Barnwell Sand zone are 100 ft and 1150 ft, respectively. Under this conservative scenario, the travel time through backfill is reduced from 2.4 years to 1.6 years, while the travel time through the Barnwell Sand zone is increased from 2.6 years to 2.7 years. The corresponding sum of radionuclide ratios is increased from 0.336 to 0.352, but still remains below unity. Because the change of the sum of the radionuclide ratios is insignificant (less than 5%) and remains below unity, the staff concludes that the conclusion of the radiological consequence analysis in Vogtle ESP SSAR Section 2.4.13 is still valid.

3.5 Summary of NRC Staff Evaluation

The NRC staff has reviewed the LAR request to amend Vogtle ESP SSAR Sections 2.5.2 and 2.5.4 regarding replacing Category 2 backfill with EGB soil over the side slopes of the excavation. Based on the staff's technical evaluation, the staff concludes that:

1. The proposed EGB soil placed over the slopes of the excavation would not affect the site response analysis used to define the VEGP GMRS

2. The differences in material and engineering properties between the proposed EGB soil and the Category 1 and 2 backfill are small, and the LAR's specified criteria for the

selection and compaction of the EGB would provide reasonable assurance of a competent interface with the Category 1 and 2 backfill.

3. The liquefaction potential of the proposed EGB soil at the site is negligible during a design basis earthquake; therefore, the original ESP analysis and conclusion with respect to site liquefaction remains valid.

4. The LAR's proposed use of EGB soil will not have any negative impact on the stability of the foundation and structures to be built at the VEGP Unit 3 and 4 site because there are no safety-related structures bearing on or in contact with the EGB, and the EGB soil will only be placed above the foundation level and on the slopes of the excavation; therefore, the original site soil bearing capacity and settlement (total and differential settlement) estimate will not change.

5. Replacing the Category 1 and Category 2 backfill materials with EGB (over the excavation slopes) has an insignificant effect on the seismic response of the AP1000 NI. Consequently, the maximum horizontal and vertical inertial forces, used to compute sliding and overturning factors-of-safety for the AP1000 NI, will not increase due to the use of EGB over the excavation slopes.

6. The use of empirical relationships, which account for estimated (e.g., void ratio) and measured properties (e.g., fines content), as well as limited RCTS testing to verify the reasonableness of the Case 1, Case 2, and Case 3 velocity profiles is acceptable to the staff.

7. The proposed method for extending the interface between the EGB and the Category 1 and 2 backfill materials beyond that assumed in the site-specific seismic analysis and using overlapping passes with compaction equipment is acceptable to the staff.

8. The proposed change of backfill material will have negligible impacts on the radiological consequence of accidental releases to groundwater, and that the result of the radiological consequence analysis in Vogtle ESP SSAR Section 2.4.13 is still valid.

For the reasons specified above, the staff finds that the proposed modifications to the SSAR, authorizing the applicant to replace Category 1 and 2 backfill with EGB soil over the slopes of the Units 3 and 4 excavations, will not affect the analyses and related conclusions presented in the VEGP ESP SSAR on seismic site response, liquefaction potential, foundation/structure stability (bearing capacity, total and differential settlement), and radionuclide transport, and therefore meet the relevant requirements of 10 CFR Part 100, 10 CFR Part 20, 10 CFR Part 50, Appendix S, and 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 1 and 2.

4.0 FINAL NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

The Commission's regulations in 10 CFR 50.92 state that the Commission may make a final determination that a license amendment involves no significant hazards consideration if

operation of the facility in accordance with the amendment would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in the margin of safety.

As required by 10 CFR 50.91(a), the licensee has provided its analysis of the issue of no significant hazards consideration in its letter dated May 24, 2010, as presented below:

1. Does the proposed amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The technical evaluation provided in the new SSAR section 2.5.2.9.4, "Study of Engineered Granular Backfill Placed over the Slopes of the Excavation", demonstrates that the results and conclusions in the Vogtle Electric Generating Plant (VEGP) ESP SSAR 2.5.2.9.2, "Study of the Effects of Backfill Geometry," remain valid; backfill material placed over the slopes of the excavation does not affect the VEGP site response analysis used to define the VEGP Ground Motion Response Spectra (GMRS) and Foundation Input Response Spectra (FIRS) or the VEGP SASSI SSI seismic analyses of the Nuclear Island (NI). Reclassifying backfill over the slopes of the excavation does not invalidate the VEGP site-specific seismic analyses. The placement of EGB is outside the zone of influence. Use of EGB will have no effect on reported foundation bearing capacities, estimated total or differential settlements, or liquefaction potential. Because the hydraulic conductivity of EGB material is conservative relative to the values used in the hydrological analysis, the hydrological analysis will be unaffected. As such, the use of EGB material over the slopes of the excavation does not affect the accidental radiation release to groundwater evaluated in the SSAR. Therefore, the proposed SSAR change does not significantly increase the probability or consequences of an accident previously evaluated.

2. Does the proposed amendment create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The sensitivity analyses described in this amendment provide a basis for concluding that the ESP SSAR seismic analyses are not sensitive to the properties of the material over the slopes of the excavation. Also, the material over the side slopes of the excavation is outside the static zone of influence of the AP1000 power block structures, and thus cannot impact the safety performance of any safety related structure. Consequently, no new accident scenarios, failure mechanisms or limiting single failures are introduced as a result of the proposed changes. The changes have no adverse effects on any safety-related system and do not challenge the performance or integrity of any safety-related system. Therefore, all accident analyses criteria continue to be met and these changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed amendment involve a significant reduction in a margin of safety?

   Response: No.

   The technical evaluation provided in the new SSAR section 2.5.2.9.4, "Study of Engineered Granular Backfill Placed over the Slopes of the Excavation," demonstrates that the results and conclusions in the VEGP ESP SSAR 2.5.2.9.2, "Study of the Effects of Backfill Geometry", remain valid, backfill material placed over the slopes of the excavation does not affect the VEGP site response analysis used to define the VEGP GMRS and FIRS or the VEGP SASSI SSI seismic analyses of the Nuclear Island (NI). Reclassifying backfill over the slopes of the excavation does not invalidate the VEGP site-specific seismic analyses. In addition, the design function of Category 1 and 2 backfill related to bearing capacity, settlement, and liquefaction is unaffected. The evaluations and analysis results demonstrate applicable acceptance criteria are met. Therefore, the proposed changes do not involve a reduction in a margin of safety.

The NRC staff has reviewed the licensee's analysis and, based on that review, the staff concludes that the amendment meets the three criteria of 10 CFR 50.92. Therefore, the NRC staff has made a final determination that the amendment does not involve a significant hazards consideration.

5.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Georgia State official was notified of the proposed issuance of the amendment. The State official had no comments.

6.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.32, the Commission has determined that this amendment will not have a significant effect on the quality of the human environment (Environmental Assessment published in the *Federal Register* on July 8, 2010, 75 FR 39284).

7.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) the amendment does not (a) involve a significant increase in the probability or consequences of an accident previously evaluated, or (b) create the possibility of a new or different kind of accident from any previously evaluated, or (c) involve a significant reduction in a margin of safety and therefore, the amendment does not involve a significant hazards consideration; (2) there is reasonable assurance that the health and safety of the public will not be endangered by construction activities in the proposed manner; (3) such activities will be conducted in compliance with the Commission's regulations; and (4) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

8.0 REFERENCES

1. Letter from Charles R. Pierce, Southern Nuclear Operating Company, Inc. to NRC, "Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, Site Safety Analysis Report License Amendment Request, Revise Backfill Geometry." Dated May 24, 2010. ADAMS No.:101470213.

2. Letter from B.L. "Pete" Ivey, Southern Nuclear Operating Company, Inc. to NRC, "Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, Site Safety Analysis Report License Amendment Request, Revise Backfill Geometry- Response to Request for Additional Information." Dated June 22, 2010. ADAMS No.:101740488.

3. Southern Nuclear Operating Company, Vogtle Electric Generating Plant ESP Site, Docket No. 52-011, Early Site Permit and Limited Work Authorization. Early Site Permit No. ESP-004, U.S. Nuclear Regulatory Commission. ADAMS No.: ML092290157.

4. Southern Nuclear Operating Company Vogtle Early Site Permit Application - Revision 5, December 23, 2008.

5. NUREG-1923, "Safety Evaluation Report for an Early Site Permit (ESP) at the Vogtle Electric Generating Plant (VEGP) ESP Site," August 14, 2009.

6. Electric Power Research Institute. "Modeling of Dynamic Soil Properties" Appendix 7.A of Report No. TR-102293 entitled Guidelines for Determining the Design Basis Ground Motions, Palo Alto, CA, 1993.

7. R. B. Seed, et al, (2003), "Recent Advances In Soil Liquefaction Engineering: A Unified And Consistent Framework," 26th Annual ASCE Los Angeles Geotechnical Spring Seminar, Keynote Presentation, H.M.S. Queen Mary, Long Beach, California, April 30, 2003.

8. H.B. Seed and I.M. Idriss (1971), "Simplified Procedure for Evaluating Soil Liquefaction Potential". Journal of Geotechnical Engineering." Div., ASCE 97 9 (1971), pp. 1249–1273.

9. I.M. Idriss and R.W. Boulanger (2006), "Semi-empirical Procedures for Evaluating Liquefaction Potential during Earthquakes." Journal of Soil Dynamics and Earthquake Engineering, Elsevier, 26, 115-130.

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

11. Letter from Michael K Smith, Southern Nuclear Operating Company, Inc. to NRC, “Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, Site Safety Analysis Report License Amendment Request, Revised Backfill Geometry- Response to Request for Additional Information.” Dated June 2, 2010. ADAMS No.:101550510

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