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Date: 3/20/2007 10:53:44 AM
Subject: Request for Additional Information Letter Number 6 - Southern Nuclear Operating Company Early Site

Permit (ESP) Application for the Vogtle ESP Site, Site Safety Analysis Report (SSAR) Sections 2.4 and 2.5

To: J. A. Miller
From: Christian Araguas
Date: March 20, 2007
Accession No.: ML070660266

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Subject: Request for Additional Information Letter Number 6 - Southern Nuclear Operating Company Early Site
Creation Date: 3/20/2007 10:53:44 AM
From: Tony Wade

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Security:	Standard

March 15, 2007

Mr. J. A. “Buzz” Miller, Senior Vice President
Nuclear Development
Southern Nuclear Operating Company, Inc.
40 Inverness Center Parkway
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Birmingham, AL 35201

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NUMBER 6 - SOUTHERN NUCLEAR OPERATING COMPANY EARLY SITE PERMIT (ESP) APPLICATION FOR THE VOGTLE ESP SITE, SITE SAFETY ANALYSIS REPORT (SSAR) SECTIONS 2.4 AND 2.5

Dear Mr. Miller:

By letter dated August 14, 2006, Southern Nuclear Operating Company, Inc. (SNC), submitted an application for an early site permit (ESP) for the Vogtle ESP site. Subsequently, SNC submitted changes to the Vogtle ESP application by a letter dated September 13, 2006, and on November 13, 2006, submitted Revision 1 to the application.

The U.S. Nuclear Regulatory Commission (NRC) staff is performing a detailed review of your ESP application and has determined that it needs additional information to continue portions of the safety review. Therefore, the NRC staff is requesting additional information with respect to the application. The topics covered in the requests for additional information (RAIs) contained in Enclosure 1 are related to Sections 2.4 and 2.5 of the SSAR in the ESP application.

The NRC staff sent the RAIs as a draft via electronic mail on March 5, 2007, and held a follow up teleconference call on March 9, 2007. During the teleconference call the NRC staff was informed that some of the information being requested had already been provided in the application. The NRC staff agreed, and therefore three of the draft RAIs are considered resolved and do not appear in this letter.

Receipt of the requested information, within 30 days of the date of this letter, will support the NRC’s efficient and timely review of the SNC ESP application. Please note that failure to respond in a timely fashion may delay the completion of the NRC staff’s safety evaluation report.

If you have any questions or comments concerning this matter, you may contact me at (301) 415-3637 or cja2@nrc.gov.

Sincerely,

/RA by SMonarque for/

Christian Araguas, Project Manager
AP1000 Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-011

Enclosure:
As stated

cc: See next page

If you have any questions or comments concerning this matter, you may contact me at (301) 415-3637 or cja2@nrc.gov.

Sincerely,

/RA by SMonarque for/

Christian Araguas, Project Manager
AP1000 Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-011

Enclosure:
As stated

cc: See next page

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REQUESTS FOR ADDITIONAL INFORMATION (RAI) FOR VOGTLE EARLY SITE PERMIT (ESP)

SITE SAFETY ANALYSIS REPORT (SSAR) SECTIONS 2.4 AND 2.5

RAI No.	Rev.	Full Text
2.4.4-1	H. Ahn G.Bagchi PNNL	During the January site safety audit (1/10-11/2007) the NRC staff requested and the applicant provided a narrative (AR-07-0302, 2/13/2007) describing the process used to compute the maximum stage due to a cascade failure of upstream dams, including the sensitivity of the initial water surface elevations in each reservoir, and showed how the calculations provide the bounding case. The narrative included a summary of all dam breach analysis parameters. Please update the site safety analysis report (SSAR) to incorporate the information and data contained in the narrative.
2.4.1-1	H. Ahn G. Bagchi PNNL	Please revise the SSAR by incorporating Environmental Report (ER) Section 2.3.2, and Tables 2.3.2-12 and 2.3.2-13, which report the rates of total water demand. The values for the total water demand should be included in the SSAR.
2.4.7-1	H. Ahn G. Bagchi PNNL	Please revise the SSAR by providing a reference in SSAR Sections 2.3.1.3.4 through 2.4.10 to clarify the method for determining the intensity of short term rainfall for roof drainage and probable maximum winter precipitation that combines with the snow accumulation for roof loading of all safety-related structures.

2.4.12-1	H. Ahn G. Bagchi PNNL	a. Discuss the reasons why OW-1001 and OW-1001A present questionable results regarding water table elevations for the unconfined or Water Table aquifer. Are there alternate interpretations that suggest either (1) they are invalid data and the Water Table aquifer does not see any impact from the fractured and faulted Blue Bluff Marl above the Pen Branch fault, or (2) they are valid data revealing a perhaps local hydraulic connection between the Water Table aquifer and the Tertiary aquifer? b. Provide an explanation in the SSAR regarding the nomenclature used to denote an abandoned well, especially OW-1001A, which is denoted as abandoned in Appendix 2.4A, and OW-1001A, which is apparently denoted as a functioning well in Appendix 2.5A. c. In the formulation of alternate conceptual models, as well as the design of monitoring programs, describe how the OW-1001 and OW-1001A data and the remarks of Summerour et al. (1998) are taken into account regarding the potential for communication between the Water Table aquifer and the Tertiary aquifer in the vicinity of fractures and faulting in the confining unit separating these two aquifers. The authors (Summerour et al. (1998)) state, “It is unclear whether the fractures also cut the Gordon aquitard. The large number of fractures and the fact that they appear to cut most of the aquitards in the stratigraphic sequence suggests that there may be leakage between aquifers near the Pen Branch fault. Therefore, both the Pen Branch fault and the associated fracture system may provide pathways for the movement of tritium from the Upper Three Runs aquifer into deeper, normally confined aquifers.” If data from either well are identified as not being applicable to tables and/or figures in the ESP application, then revision of the tables, figures, and potentially of the text is required. For a postulated liquid radioactive release at the proposed site, any potential for leakage into the confined Tertiary aquifer should be addressed in the SSAR.

2.4.12-2	H. Ahn G. Bagchi PNNL	a. Figure 2.4.12-4 indicates that Water Table Aquifer recovery to an asymptotic value following cessation of dewatering requires 1.5 to 2 years. However, there is no record of the period preceding the dewatering activity in the figure. Also Figures 2.4.12-4, -5 & -6 show that the groundwater levels in the Water Table Aquifer vary significantly from year to year or even from season to season for some periods of time and not for others. These facts indicate that the Water Table Aquifer is able to undergo substantial change in water table elevation (with a corresponding movement of water) while not undergoing substantial local stress (pumping), and being isolated from the underlying confined Tertiary aquifer that is stressed by Unit 1 & 2 operations. It is essential that the underlying conceptual model of the unconfined aquifer and key parameters describing the aquifer should be in agreement with this known system behavior, (e.g., that the hydraulic conductivity, storativity, and porosity, should be consistent with the ability of the unconfined aquifer to respond to dewatering, severe drought, and the return to a normal precipitation level) in order to identify potential contamination pathways in the ground and to estimate corresponding travel times. b. Provide and incorporate into the SSAR a discussion of the process used to develop the site hydrologic conceptual model. Discuss the various conceptual models considered in developing the final conceptual model, and how your model contrasts with the conceptual models of the Vogtle Electric Generating Plant (VEGP) Updated Final Safety Analysis Report, and United States Geological Survey (USGS) studies (Clark and West 1997; Cherry 2006). Describe the data sets and rationale used to establish the final conceptual model. This discussion of the conceptual model should cover the continuity or discontinuity of the hydrogeologic units, and their connectivity to the other surface water features, and then to the Savannah River. c. Discuss the reasons why the temporal variability of the water levels in the Water Table Aquifer during the period from 2005 to 2006 (Figure 2.4.12-6) were reduced substantially compared to those before 2005 (Figures 2.4.12-4&5).

2.4.12-3	H. Ahn G. Bagchi PNNL	a. Include in the SSAR all available information and data (including the historical groundwater levels at the Water Table aquifer near the ESP site, such as those at the 179, 809, 803A, and 804 observation wells), and update the contour maps depicting (i) the thickness of the Utley Limestone layer, and (ii) the top and (iii) the bottom elevations of the Blue Bluff Marl of the Lisbon Formation in the ESP site area. Please depict as much of the area as possible in the vicinity of the ESP site in the contour map(s), (i.e., include the area from the southern drainages to Telfair Pond, the northern drainage to Mallard Pond, and the eastern drainage to Savannah River). b. In conjunction with the above information, data, and plots, include a discussion of the continuity of the Utley Limestone, the composition and integrity of the Utley Limestone relative to Huddlestun and Summerour report (1996), and the presence or absence of Karst characteristics. Please incorporate the discussion into the subsurface conceptual model.
2.4.13-1	H. Ahn G. Bagchi PNNL	Provide and incorporate into the SSAR a discussion of the process used to establish that the conceptual model for the transport pathways and travel times presented in the SSAR represents the most conservative of the various other feasible alternative estimates by considering other pathways from the south of a proposed plant where a radwaste holding tank might be located. For example, a potential pathway might consist of travel of contaminants towards the west and then to the north towards the Mallard Pond. Provide and incorporate into the SSAR a discussion of the process used to conservatively bound the hydraulic properties (gradient, hydraulic conductivity, porosity, etc.) used in safety related calculations. Provide a summary data set utilizing data from the ER and SSAR that presents the bounding hydraulic properties of soil/sediment overlying the Blue Bluff Marl of the Lisbon Formation. Provide and incorporate into the SSAR new calculations of the accidental release from the effluent hold-up tank that utilize the above described and supported conceptual model and data.
2.4.13-2	H. Ahn G. Bagchi PNNL	Discuss the process used to evaluate the potential for and the impact of chelation and complexation agents (e.g. organic acids) to mix with radiological liquid effluents either within the facility or along the transport pathway in the environment outside the facility. In this discussion, make a clear statement regarding whether or not it is possible for any chelation agents to be mixed with radiological liquid effluents within the ESP facility.

2.4.13-3	H. Ahn G. Bagchi PNNL	The SSAR should include a description of the process followed, and the bases used, to estimate the groundwater outflow to Mallard Pond from the accidental release, and the estimate of the minimum discharge from Mallard Pond. As discussed during the March 9, 2007, conference call, please revise the SSAR to correct the typographical error reporting a value of 0.7 gpm (2.65 lpm) as the groundwater outflow to the pond from the accidental release. Please include a redacted version of the calculation package showing all parameters, measurements, and assumptions used in the calculation of the 0.07 gpm (0.26 lpm) rate. Also please include a redacted version of the calculation package showing all parameters, measurements, and assumptions leading to the minimum discharge flow rate estimate of 250 gpm (946 lpm) for Mallard Pond. In both of these cases, the redaction should simply remove final calculated values.
2.5.1-1	G. Stirewalt	Section 2.5.1.1.3.5 of the SSAR, under "Quaternary Surfaces and Deposits", identifies a series of four abandoned fluvial terrace levels (i.e., Qty, Qtb, Qte, and Qto from youngest to oldest) that occur in the site area above Quaternary alluvium of the present-day flood plain of the Savannah River (SSAR Figure 2.5.1-29), and acknowledges that such features ideally can be used to evaluate Quaternary deformation. a. Please indicate whether these terraces are regional in extent, or whether they only occur locally and mainly in the vicinity of the Pen Branch Fault. b. Please provide information on the proposed origin of these fluvial terraces.
2.5.1-2	G. Stirewalt	Section 2.5.1.1.3.5 of the SSAR, under "Quaternary Surfaces and Deposits", states that terrace Qtb ranges from 8-13 m (26-43 ft) above the Savannah River surface at the Savannah River Site, and also indicates that terrace Qte shows a range in surface elevation from 17-25m (56-82 ft) above the Savannah River surface. Section 2.5.1.2.4.3 of the SSAR indicates a detectable resolution limit for observable deformation of terrace Qte of about 1m (3 ft) (pg 2.5.1-79), suggesting that less than 1m (3 ft) of warping or tilting of this terrace surface would not be detected. a. Please provide information to address whether the elevation ranges noted above suggest tilting of terrace surfaces. b. Please discuss implications of a deformation detection limit of about 1m (3 ft) for these fluvial terraces.

2.5.1-3	G. Stirewalt	Section 2.5.1.1.3.5 of the SSAR describes terrace Qty, positioned between the modern-day flood plain of the Savannah River and the next oldest overlying terrace (Qtb) as “minor and not laterally continuous.” Terrace Qty occurs along a stretch of the Savannah River that is relatively straight (SSAR Figure 2.5.1-29) where the river is incised, and appears to be mainly located southeast of the postulated surface trace of the Pen Branch Fault. Section 2.5.1.1.3.5 reports that terrace Qtb, immediately overlying Qty, is about 90,000 years old (Pleistocene) based on correlation, relative position, and morphology. Brooks and Sassaman (1990) suggested an age of 4,000 years for the modern-day flood plain. This information suggests that Qty, the lowest and youngest terrace, could be between 4,000 - 90,000 years old and therefore possibly Holocene in age. Considering origin, location, and approximate age of terrace Qty, please discuss the implications for possible Quaternary displacement on the Pen Branch Fault.
2.5.1-4	G. Stirewalt	SSAR Figure 2.5.1-29 shows the Savannah River to be relatively straight in the site area in the vicinity of (i.e., southeast of) the proposed surface trace of the Pen Branch Fault. Section 2.5.1.2.1 of the SSAR describes the Savannah as incised at that location. Please provide information to address why the Savannah River is straight and incised at a position that appears to correspond with the location of the Pen Branch Fault “block” on the southeastern side of the fault.
2.5.1-5	G. Stirewalt USGS	In Section 2.5.1.1.4.3, rocks of the Augusta and Modoc fault zones are described as containing both mylonitic (i.e., ductile) and brittle deformation fabrics. While the mylonitic fabric is clearly of Alleghanian age, there is no explanation of whether the brittle fabric is the result of late-stage Alleghanian deformation along these zones, either at shallower depths or lower slip rates; cross-cuts the mylonitic fabric and the product of later-stage folding or unloading rather than fault movement; or the result of a much younger, more recent episode of fault movement along the mylonitic zones. For both faults, please provide information on characteristics of the mylonitic and brittle fabrics (including textural, petrologic, structural, and orientation data or other evidence that may constrain age of the brittle deformation) which demonstrates that the brittle fabric likely did not form during a post-Alleghanian deformation event, e.g., during the Quaternary, or at least during the present-day stress regime.

2.5.1-6	G. Stirewalt	For faults listed under “Other Paleozoic Faults” in SSAR Section 2.5.1.1.4.3, the Central Piedmont Suture and the Eastern Piedmont Fault System are not shown in Figure 2.5.1-14. Please correct Figure 2.5.1-14 to include these two faults since others listed are shown therein.
2.5.1-7	G. Stirewalt USGS	In Section 2.5.1.1.4.3, the Grenville Front is not described under “Regional Geophysical Anomalies and Lineations”, although it is listed among the features occurring within 200 mi of the VEGP site and shown in SSAR Figure 2.5.1-12. Please describe this regional feature, including whether or not is considered to be a potential seismic source, and provide a basis for the conclusion.
2.5.1-8	G. Stirewalt USGS	Of the six regional geophysical anomalies and lineaments listed in SSAR Section 2.5.1.1.4.3, information is presented to explain why the East Coast and Blake Spur magnetic anomalies are not considered as potential seismic sources. Discussions of the New York-Alabama, Clingman, and Ocoee lineaments do not indicate whether or not they could be potential seismic sources. Also, locations of the Clingman and Ocoee Lineaments and the Ocoee Block are not illustrated in Figure 2.5.1-12, and earthquakes interpreted by Wheeler (1996) as occurring within the Ocoee block in the “modern” tectonic setting were not quantified with regard to the age of faulting with which these earthquakes were associated. (SSAR Section 2.5.1.1.4.6 includes a discussion of the Eastern Tennessee Seismic Zone in which seismic events have occurred that are related to the Ocoee block.) a. Please correct Figure 2.5.1-12 to include the Clingman and Ocoee Lineaments and the Ocoee Block. b. Please indicate the age of the ”modern” tectonic setting with regard to whether faults in that setting are potential seismically capable structures to be considered for the VEGP site, and explain whether or not these three lineaments are specifically considered to be potential seismic sources and provide the basis for the conclusion.

2.5.1-9	USGS	Section 2.5.1.1.4.3 describes Regional Mesozoic Tectonic Structures and states that normal faults which "bound Triassic basins may be listric into the Paleozoic detachments faults (Dennis et al., 2004) or may penetrate through the crust as high-angle faults." The distinction between these basin-bounding faults being listric or penetrating through the crust as high-angle faults is crucial to their potential for generating large-magnitude earthquakes. a. Please discuss the evidence related to whether or not these structures could extend through the crust to depths where large-magnitude earthquakes commonly nucleate. b. Please explain how the distinction between listric and high-angle fault geometries is treated in the probabilistic seismic hazard analysis (PSHA), and explain how the difference between the two geometries would affect hazard at the site. Alternatively, cross-reference a SSAR section that provides the explanation.
2.5.1-10	USGS	Section 2.5.1.1.4.3 discusses the Belair Fault and indicates that this structure is likely a tear fault or lateral ramp in the hanging wall of the Augusta fault zone. Age constraints on last movement of the Belair Fault are sometime between post-late Eocene and pre-26,000 years ago (Prowell, 2005). Thus, the Belair Fault is one of the few structures in the region with interpreted evidence of late Cenozoic movement (SSAR Figures 2.5.1-3 and 2.5.1-13). If the Belair is a tear fault or lateral ramp associated with the Augusta fault zone, then movement on the Belair may be related to movement on the larger, regional-scale Augusta fault. Please explain how the inference of possible Cenozoic movement on the Belair Fault and its possible association with the Augusta fault zone might affect seismic hazard at the Vogtle site.
2.5.1-11	L. Bauer	Figure 2.5.1-19 of SSAR Section 2.5.1.1.4.4 is important for illustrating what is known or inferred about which liquefaction features may be related to the 1886 Charleston earthquake as opposed to other past earthquake events, and for correlating geographic proximity of individual liquefaction features with each other and with proposed sources. Please provide new figures that clearly distinguish the liquefaction features related to the 1886 Charleston earthquake from each of the proposed paleoliquefaction events A,B,C',E,F' (C' to include C and D events from Talwani and Schaeffer, 2001 and F' to include F and G events, also from Talwani and Schaeffer, 2001). These figures should outline the areal extent of the features associated with each event, how they correlate with areal coverage of 1886 features, and their proximity to the regional tectonic structures shown in SSAR Figure 2.5.1-19.

2.5.1-12	USGS	SSAR Section 2.5.1.1.4.4 discusses Charleston Tectonic Features and cites Figure 2.5.1-18. The isoseismal contour lines for the 1886 Charleston earthquake in this figure are attributed to Bollinger (1977), but this reference is not included in the list of references for Section 2.5.1. Please include Bollinger (1977) in the list of references cited.
2.5.1-13	G. Stirewalt	SSAR Section 2.5.1.1.4.4 states that it describes all the faults that occur within the meizoseismal area for the 1886 Charleston earthquake, but appears to exclude the Gants and Drayton Faults. Please provide a description of these two faults since they are shown in SSAR Figures 2.5.1-19 and 2.5.1-20.
2.5.1-14	G. Stirewalt	SSAR Section 2.5.1.1.4.5 discusses faults postulated for the Savannah River Site (SRS) by Cumbest et al (1998) which are illustrated in SSAR Figure 2.5.1-22. The density of faults shown in this figure suggests there may be faults at the VEGP site which have not yet been identified. Please address the issue of why density of faults on the eastern side of the Savannah River around the SRS is much greater than that currently shown for the VEGP site on the western side of the river, and the implication for seismic hazard at the ESP site.
2.5.1-15	G. Stirewalt	SSAR Section 2.5.1.1.4.5 on SRS Tectonic Features does not summarize pertinent information collected from the SRS that was used to define fault traces at the SRS and draw the conclusion, presented in SSAR Sections 2.5.1.2.4 and 2.5.3.1.3, that no faults, in particular the Pen Branch, are capable features at the VEGP site. a. Please provide a concise summary of definitive data collected at the SRS, including direct evidence from borings and seismic profiles, which demonstrate that the Pen Branch Fault is not a capable structure at the SRS. b. Please compare data collected and analyses performed for the SRS to demonstrate the most recent movement on the Pen Branch fault with data and analyses employed to make this determination for the VEGP site, leading to the conclusion that the Pen Branch Fault is not a capable structure at the VEGP site.

2.5.1-16	USGS	Section 2.5.1.2.4 discusses faults in the site area that involve deformation of basement rocks. The Steel Creek fault is not considered to be a capable tectonic source, but this conclusion is not substantiated. Please provide information and references that support the conclusion that the Steel Creek Fault is not a capable tectonic source.
2.5.1-17	G. Stirewalt	In the brief history of the Pen Branch Fault presented in SSAR Section 2.5.1.2.4.1, there is no reference to the suggestion of Hanson et al (1993) that possible rejuvenation of drainage along traces of the Pen Branch and Steel Creek Faults on the SRS may suggest either local tectonic uplift along these faults or non-tectonic geologic or geomorphic processes. Please discuss this suggestion of possible displacement along the Pen Branch Fault in relation to potential implications for the VEGP site.
2.5.1-18	G. Stirewalt	SSAR Section 2.5.1.2.4.2 states that the Pen Branch Fault at the VEGP site is made up of two specific fault segments trending N45^0 E and N34^0 E with a dip of 45^0 SE. Cumbest et al (2000) reported a N46^0 - 66^0 E range in strike of the Pen Branch Fault at the SRS. Please discuss whether or not either fault segment at the VEGP site is favorably oriented to experience slip in response to the existing regional stress field defined by Moos and Zobach (2001).

2.5.2-4	S. Gonzalez Y. Li	Regulatory Guide 1.165 describes the necessity of updating the Electric Power Research Institute (EPRI) and Lawrence Livermore National Laboratory seismic sources and using the Senior Seismic Hazard Analysis Committee (SSHAC) recommendation to implement a probabilistic seismic hazards assessment (PSHA). SSAR Section 2.5.2.2.2.4 describes the updated Charleston seismic source model (UCSS). Please justify your rationale for using the SSHAC Level 2 methodology for the UCSS update. In addition, please describe the implementation of the SSHAC Level 2 methodology. Specifically, how were the experts' opinions integrated into the development of the final UCSS model? How were any conflicting opinions between the experts dealt with, and how does the final source model represent the informed consensus of the community beyond those selected for the UCSS update? In addition, please justify the adequacy of a Level 2 study for the update of Charleston seismic source zone, rather than a level 3 or 4 study?
2.5.2-5	USGS	In SSAR Sections 2.5.1.1.4.6 and 2.5.2.2.1 the range of M_{max} values developed by each EST are given as m_b. Please provide a table for converting values of m_b to M_w by the equations used for the SSAR.

2.5.2-6	USGS	SSAR Section 2.5.2.2.1 summarizes the EPRI source zones that include the site, and the M_{max} values and weights that each EPRI Earth Science Team (EST) assigned to these source zones. M_{max} values of the zones have a weighted mean of about M_w 6.0. M_{max} values of M_w 7.5 and larger were assigned low probabilities that average 0.08. In contrast, the USGS national seismic-hazard maps utilize an M_{max} that is based on (1) A.C. Johnston's (1994, EPRI) survey of large earthquakes worldwide in areas that are tectonically similar to the U.S. east of the Rockies, and on (2) L. Kanter's (1994, EPRI) final assessments of the tectonic setting of each earthquake. The 1996, 2002, and 2007 USGS national hazard maps use M_{max} of M_w 7.5 with high weights for the area that includes the site. a. Please explain whether or not the Johnston (1994) findings, the final versions of the Kanter (1994) assessments, and USGS's use of them as support for high M_{max}, constitute new information that requires an update of the 1989 EPRI PSHA, and why. b. Please explain why you believe that an M_{max} value of M_w 7.5 with a weight of 0.5 or larger is not warranted.
2.5.2-7	USGS	SSAR Section 2.5.2.2.2.3 (page 2.5.2-16) states that the results of the Lawrence Livermore National Laboratory Trial Implementation Project (TIP) study are not explicitly included in the SSAR because the study was as much "a test of the methodology as a real estimate of seismic hazard". Please clarify why you believe the TIP was more of a test of the methodology rather than a real estimate of the seismic hazard. Please provide more detail explaining why the TIP results were not used.

2.5.2-8	USGS	SSAR Section 2.5.2.2.2.4.1 states that the characteristics of the 1886 Charleston earthquake, and the greatest density of prehistoric liquefaction features, taken together "show that future earthquakes having magnitudes comparable to the Charleston earthquake of 1886 most likely will occur within the area defined by Geometry A. A weight of 0.7 is assigned to Geometry A …" (page 2.5.2-18). Additionally, Figure 2.5.2-9 indicates no likelihood that an 1886-sized earthquake has occurred inland from the coastal region, except along Geometry C, and then only with a probability of 0.1. a. Please summarize the age, liquefaction susceptibility, and geographic distribution of liquefiable deposits in the zone 50 km (31 miles) - 150 km (93 miles) inland from the coast, and explain whether this information supports a negligible probability of large inland earthquakes. b. Please reconcile a negligible probability of large inland earthquakes, as indicated in Figure 2.5.2-9, with the discovery of prehistoric liquefaction features as much as 100 km (62 miles) inland in fluvial deposits of the Edisto River (Obermeier, 1996, *in* McCalpin, J., ed., "Paleoseismology", Fig. 7.6; same figure is Fig. 11 in Engineering Geology, 1996, v. 44, p. 1-76).
2.5.2-9	USGS	SSAR Section 2.5.2.2.2.4.3 suggests that the liquefaction features attributed to a single large, prehistoric earthquake might actually have been produced by several moderate-magnitude earthquakes that are closely spaced in time (page 2.5.2-26). Please determine whether Talwani or Obermeier have data on sizes of prehistoric liquefaction craters, and whether these or any related data might constrain the possible magnitudes of the prehistoric earthquakes.

2.5.2-10	L. Bauer	SSAR Section 2.5.2.2.2.4.3 states that liquefaction from the 1886 Charleston earthquake is preserved in geologic deposits at numerous locations and that liquefaction deposits from earlier earthquakes are preserved in the region. For each of the pre-1886 events please summarize the number of liquefaction features and sites that have been documented, the areal extent of liquefaction (i.e., how many square kilometers), how many dates have been collected, and how well the features correlate from one site to the next.
2.5.2-11	L. Bauer	SSAR Section 2.5.2.2.2.4.3 states that paleoliquefaction Event C is defined by features north of Charleston while Event D is defined by sites south of Charleston. Events C and D are combined as a single large event C'. Please provide any information on liquefaction features, geographically located between these two areas, that have similar radiocarbon ages which supports your characterization of these events as a single large event rather than two separate events. Provide justification that there is enough paleoliquefaction data to support a single large event C' from a single source.
2.5.2-12	S. Gonzalez USGS	SSAR Section 2.5.2.2.2.4.3 describes the calculation of two average recurrence intervals covering two different time intervals, which are used as two recurrence branches on the logic tree. Please justify in greater detail your rationale for the weighting of the two recurrence branches on the logic tree. In addition, please justify your use of these two scenarios rather than another case study (for example, ten large-magnitude earthquakes occurring at approximately regular intervals during the past 5,000 years), including its impact on the hazard calculation you could have considered.

2.5.2-13	C. Munson Y. Li	SSAR Section 2.5.2.4.4 states that "the new interpretation of the Charleston source indicates that a source of the large earthquakes in the Charleston area exists with weight 1.0..." Although the UCSS update of the Charleston source zone covers a fairly large area, the weighting and source geometries give the largest hazard only inside Zone A (either 0.9 (A, B, B') or 1.0 (A, B, B', C)), which is a relatively small zone. In view of this result, provide justification for the UCSS source geometries and weighting scheme and define what is meant by the "Charleston area".
2.5.2-14	Y. Li	SSAR Section 2.5.2.2.2.4.1 states that the width of Geometry B is 80 km (50 miles). However, SSAR Figure 2.5.2-9 shows the width of Geometry B to be approximately 100 km (62 miles). Please provide the actual dimensions of Geometry B used for the UCSS.
2.5.2-15	Y. Li	As stated in SSAR Section 2.5.2.2.2.4.1, the offshore Helena Banks fault zone was detected by multiple seismic reflection profiles. Please explain why the two seismic events (mb 3.5 and 4.4) in 2002, which occurred in the vicinity of the Helena Bank fault system, cannot be positively correlated with the fault zone, and did not demonstrate recent activity for the fault zone. Could the seismicity symbolize the reactivation of the Helena Bank fault zone?
2.5.2-16	S. Gonzalez	SSAR Section 2.5.2.2.2.5 discusses the Eastern Tennessee Seismic Zone (ETSZ). Please provide, electronically, the geographic coordinates defining the geometry of the Eastern Tennessee Seismic Zone (ETSZ) seismic source zones and associated seismicity parameters (including M_{max} magnitude distributions) for each EPRI-SOG EST.
2.5.2-17	S. Gonzalez USGS	SSAR Section 2.5.2.2.2.5 discusses the Eastern Tennessee Seismic Zone (ETSZ). Please justify in greater detail your rationale for not updating the ETSZ as characterized by the EPRI ESTs. In addition, please discuss how the M_{max} magnitude distributions developed by each EST compare with more recent M_{max} estimates by the USGS hazard model (Frankel et al 2002) and Bollinger (1992). SSAR Section 2.5.2.2.2.5 states that the ETSZ does not contribute significantly to the hazard at the VEGP site. Please explain whether and how this would change if the EST's source zones representing the ETSZ were assigned a single M_{max} of M_w 7.5. Alternatively, explain why you believe an M_{max} value of M_w 7.5 with a weight of 0.5 or higher is not warranted for the ETSZ.

2.5.2-18	S. Gonzalez	SSAR Section 2.5.2.4.2 describes the effects of the new regional earthquake catalog. Figure 2.5.2-16 shows the two areas used to examine the effect of the new seismicity information. Please provide a justification for the geometries of the two areas.
2.5.2-19	S. Gonzalez	SSAR Section 2.5.2.5.1 describes the development of the site amplification functions and the soil uniform hazard response spectra (UHRS) for the 10^{-4} and 10^{-5} hazard levels. Please provide a detailed step-by step discussion of the methodology used to develop the site amplification functions (i.e. Steps 1 to 6 in SSAR Section 2.5.2.5.1.1) and the 10^{-4} and 10^{-5} soil UHRS. If possible, please illustrate each step with relevant data. In addition, please discuss the following: a. In Step 5 of SSAR Section 2.5.2.5.1.1, what does the "envelope motion" refer to? b. In Step 6, please explain why either the high- or low-frequency mean amplification factor was used instead of their envelope? c. Step 6 states that "at some intermediate frequencies between 2 and 8 Hz, the high frequency (HF) and low frequency (LF) soil amplification factors (AF) are weighted in order to achieve a smooth transition between HF and LF spectra". Please provide more information regarding this weighting procedure.
2.5.2-20	S. Gonzalez	SSAR Section 2.5.2.5.1.3 describes the development of low- and high- frequency target spectra using the average of the single and double corner source models from NUREG/CR-6728. Please explain why the 2004 EPRI (EPRI 1009684 2004) ground motion models were not used instead.
2.5.2-21	S. Gonzalez	SSAR Table 2.5.2-17 and Section 2.5.2.5.1.3 provides the computed and recommended Mbar and Dbar values used for the development of the high- and low-frequency target response spectra. Please explain how the "recommended" Dbar and Mbar values were calculated.

2.5.2-22	S. Gonzalez	SSAR Section 2.5.2.5.1.4 describes the spectral matching of the selected seed time histories to the target response spectra and states that the "spectral matching criteria given in NUREG/CR-6728 (McGuire et al. 2001) were used to check the average spectrum from the 30 time histories for a given frequency range (high- or low- frequency) and annual probability level. This is the recommended procedure in NUREG/CR-6728 (McGuire et al. 2001) when multiple time histories are being generated and used." In addition, Section 2.5.2.5.1.5 states that "Each of the 60 randomized soil profiles were paired with 30 seed time histories (each time history was applied to two of the randomized soil profiles)". Please provide a justification for not using the criteria provided in NUREG/CR-6728 to check each individual time history against the target spectrum.
2.5.2-23	S. Gonzalez	SSAR Section 2.5.2.5.1.5 describes the results of the site response calculations for the ESP site. Please discuss the results of site response calculations in terms of the following: a. The effects of the six alternative site response profiles in terms of the different depths to the top of the Paleozoic crystalline rocks. b. The possible effects of the Pen Branch fault zone (i.e. as a low velocity zone or weak zone). c. The effects of the low velocity zones within the Blue Bluff Marl and Lower Sand Stratum. In addition, please justify the adequacy of using an equivalent-linear approach rather than a nonlinear approach to model site response at the ESP site.

2.5.2-24	S. Gonzalez	SSAR Sections 2.5.2.7.1.1 to 2.5.2.7.1.3 describe the development of vertical-to-horizontal response spectral (V/H) ratios based on the results of NUREG/CR-6728 and Lee (2001). a. Please justify your rationale for assigning the approximate weights of 1:3 to the respective "near" and "far" estimates of $V/H_{CEUS,Soil}$. b. Please discuss the similarities and differences between the site-specific soil profile used by Lee (2001) and the Vogtle ESP site response profile. c. Please justify in greater detail your rationale for the relative weights assigned to the NUREG/CR-6728 and Lee (2001) results and the final smoothing. In addition, SSAR Section 2.5.2.7.1.3 states that "both results give minimum V/H values, particularly in the lower frequencies, which appear lower than engineering judgment may suggest acceptable in the current state-of-knowledge". Please explain the meaning of this statement in greater detail and its implication for the final ESP site V/H ratios.
2.5.3-1	G. Stirewalt	SSAR Sections 2.5.3.1.2 and 2.5.3.1.7 refer to features mapped by McDowell and Houser (1933) and Bartholomew et al (2002), including "clastic dikes", that these authors interpreted as possibly related to tectonism during late Eocene to late Miocene. These features are attributed to a non-tectonic origin in SSAR Sections 2.5.3.1.2, 2.5.3.1.7, and 2.5.3.8.2.2 without any discussion of the field evidence for this conclusion. Please discuss criteria used to determine that these features are non-tectonic in origin and related to pedogenic soil-forming processes, including a comparison with characteristics of clastic dikes mapped in trenches in the site area which are also described as non-tectonic features in the SSAR.

2.5.3-2	G. Stirewalt & USGS	SSAR Sections 2.5.3.8.2.1 and 2.5.3.8.2.2 discuss features interpreted to be non-tectonic in origin that include warped bedding, fractures, small-scale faults, injected sand dikes, and clastic dikes. Warped bedding, fractures, small-scale faults, and injected sand dikes are interpreted to indicate local dissolution of the underlying Utley Limestone and resultant plastic and brittle collapse of overlying Tertiary sediments which occurred more than 10,000 years ago. No formation mechanism is described for the injected sand dikes. The clastic dikes are interpreted to result from weathering and pedogenic soil-forming processes that were enhanced along older fractures initially produced by dissolution of the underlying Utley Limestone. a. Please describe where these non-tectonic features are located relative to the proposed trace of the Pen Branch Fault at the VEGP site. b. Please discuss field data, observations, and reasoning which resulted in the conclusion about a dissolution origin for the warped bedding, fractures, small-scale faults, and injected sand dikes, including a specific explanation of the formation mechanism for the injected dikes. c. Please discuss field data, observations, and reasoning which resulted in the conclusion that the injected sand and clastic dikes do not represent a response to Quaternary or Holocene earthquakes.
2.5.4-1	T. Cheng	SSAR Section 2.5.4.2.2 states that information has been taken from the 14 borings and 10 cone penetrometer tests performed during the ESP subsurface investigation. However, Section 2.2.1 of Appendix 2.5A, "Geotechnical and Laboratory Testing Data Report," to SSAR Section 2.5 states that 12 borings, designated B-1001 through B-1011 and B-1013, were drilled at the site. Please clarify this inconsistency and also describe how the other 2 borings were taken.

2.5.4-2	T. Cheng	SSAR Section 2.5.4.2.1 states that the Upper Sand Stratum (Group 1 soils) will be completely removed and replaced with compacted structural fill prior to the construction of VEGP Units 3 and 4. SSAR Section 2.5.4.5.3 describes the sources and quality control of the structural fill. a. Please explain whether the excavation and backfill will cover only the foot-print of the power block or extend to certain distance from the foundation footprint. b. If the site excavations will not extend to significant distances to the side of the plant, shouldn't the seismic hazard calculations be carried to the free-ground surface including the Barnwell Group in the base-case site soil columns? What is the basis for this column analysis which presumes that the fill extends uniformly in all horizontal directions, while the actual excavation and backfill will extend only in the immediate vicinity of the plant? (Page 2.5.2-39) c. SSAR Section 2.5.4.5.3 states that backfill will be placed with as much as 25-percent fines. This is significantly higher fines content than used for building foundations. How will compaction controls be implemented for such materials?

2.5.4-3	T. Cheng	According to Table 2 of Appendix A, "Boring Data," to Appendix 2.5A of the SSAR, only 4 borings (B-1002, B1003, B1004 and B-1005) went through the Blue Bluff Marl material (Group 2 Zone) and reached the Lower sand Stratum (Group 3 Zone - coarse-to fine sand with interbedded thin seams of silt and/or clay). Since the top layer of soil (Group 1 soil) will be removed and backfilled with compacted structural fill prior to the construction of VEGP, Units 3 and 4, only the information collected from these 4 borings can be used for the investigation of Group 2 and Group 3 soil that are supposed to be the primary load-bearing component of safety-related facilities. Please provide justification for the following: a. With the data from 4 borings and no significant samples taken in Group 3 zone, what is the basis for the development of geotechnical parameters of Groups 2 and 3 layers? b. SSAR Section 2.5.2.5.1.2 indicates that base case soil velocity profiles together with their uncertainty were developed from the available data. If only 12 borings were taken at the site, and most of these borings did not extend to depths below 91 m (300 ft), how were these parameters developed? c. Are there any indications of soft zones, such as those encountered at the Savannah site, in the upper soils of the profile above the Blue Bluff Marl which may be collapsible under a seismic event? Even though soils under the foundation footprint are to be removed, how far to the side of the plant does collapsibility become unimportant? d. Soft soils were indicated in the lower soils below the Blue Bluff Marl. Standard Penetration Test (SPT) blow counts for the lower sands in B-1002 are indicated to be as low as 10 bpf (Page "4 of 6" of Soil Test Boring Record of Appendix A to Mactec's report). Please explain what is the implication of such low values even though the average blow count through this material is indicated to be about 60 bpf?
2.5.4-4	T. Cheng	SSAR Section 2.5.2.5.1.2 states that the backfill shear wave velocities were determined from measurements made on the existing backfill at the site under Units 1 and 2 as summarized in Tables 2.5.4-10 and 2.5.4-11. As indicated in these tables, the shear velocities in the top layers of backfill are well below 305 mps (1,000 fps). How were shear wave velocity values generated at depths of 15 m (50 ft) or more below the top of the backfill? Were effects of confinement considered?

2.5.4-5	T. Cheng	SSAR Section 2.5.4.7.2.1 (Page 2.5.4-27) indicates that the EPRI 1993 soil degradation relationships were used to perform SHAKE analyses and derive the shear modulus reduction factors. It is the NRC staff's understanding that the appropriateness of using the EPRI 1993 curves for fine-grained soils is not obvious since they were generally developed for sands and but not fine grained silts or clays. (The degradation models at the Savannah River site were generated from laboratory testing of in-situ soils.) Please explain the significance of using such models for fine-grained soils on the computed results?
2.5.4-6	T. Cheng	Regarding the ground water control, SSAR Sections 2.5.4.5 and 2.5.4.6 state that (1) the total depth of construction excavation to the Blue Bluff Marl bearing stratum will range from approximately 80 to 90 ft (4 to 27 m) below ground surface (SSAR Section 2.5.4.5.1), (2) the groundwater generally occurs at a depth of about 60 ft (18 m) below the existing ground surface (SSAR Section 2.5.4.6.1), and (3) due to the relatively impermeable nature of the Upper Sand Stratum, sump-pumping of ditches will be adequate to dewater the soil. Please explain what dewatering procedures and what criteria will be developed to "minimize effects on the surrounding area and the existing power block"? (The impact of the simple use of sumps and pumps on any existing area of the site will depend on the extent of time during which drawdown will occur.)
2.5.4-7	Z. Cruz	SSAR Section 2.5.4.2.2.2 states that 15 unconsolidated undrained (UU) tests were performed on Blue Bluff Marl samples and that the measured undrained shear strength ranged from 150 to 4,300 psf. Both of these values are significantly lower than the 10,000 psf design value. Please justify the wide range of values and why they differ substantially from the values measured previously for Units 1 and 2. In addition, elaborate on how the Standard Penetration Test N-values measured during the ESP investigations support the use of the 10,000 psf design value.

2.5.4-8	Z. Cruz	SSAR Section 2.5.4.2.2.2 states, “Previous laboratory test results indicate the Blue Bluff Marl to be highly preconsolidated ... the preconsolidation pressure of the Blue Bluff Marl stratum was estimated to be 80,000 psf. Settlements due to loadings from new structures would be small due to this preconsolidation pressure.” a) Provide a description of the “previous” laboratory testing methods and results. b) Justify the assumption of an undrained shear strength of 16,000 psf as UU Test results range from 150 to 4,300 psf. Were consolidation tests performed to verify this assumption? c) The preconsolidation pressure for the Blue Bluff Marl is given as 80,000 psf and is based on the plasticity index values (which ranged from 2 to 70 with an average value of 25) and a PI of 25, which results in a su/p (undrained shear strength / effective preconsolidation pressure) ratio of 0.2. Provide a complete description of the Skempton (1957) method used to determine the ratio of 0.2. Also, justify the use of 0.2 for the ratio in view of the wide range of PI values. In addition, justify the estimated preconsolidation pressure for the Blue Bluff Marl based on the wide range of PI values. d) Justify your conclusion, “settlements due to loadings from new structures would be small due to this preconsolidation pressure,” in view of settlements for the current Units 1 and 2 and also with regard to the su/p ratio of 0.2, which indicates that the soil is under consolidated (0.25 is an indication of normally consolidated soil).
2.5.4-9	Z. Cruz	SSAR Section 2.5.4.2.5.2 cites Bowles (1982) as the reference for determining the effective angle of internal friction for site soils. It is not clear how the effective angle of internal friction was calculated using this reference. Provide an example of a calculation and justify the accuracy of the results in view of the range of N-values.
2.5.4-10	W. Wang	Provide relative densities for Blue Bluff Marl.

2.5.4-11	W. Wang	SSAR Section 2.5.4 states that high strain elastic modulus for Upper Sand and Lower Sand Strata were derived based on the Davie and Lewis (1988) relationships. Explain why these relationships are applicable to the ESP soil strata. What is the scientific consensus on Davie and Lewis' relationship between SPT values and elastic modulus, as well as the relationship between undrained shear strength and elastic modulus? How extensively are these relationships used?
2.5.4-12	Z. Cruz Y. Li	SSAR Table 2.5.4-1 presents average static engineering properties of the subsurface material. Explain how the value for the unit weights for the different soils were obtained. Based on the discussion in the last paragraph on page 2.5.4-10, the average values are higher than those listed in the table. Also, explain why the plasticity index, liquid limit, and plastic limit values are different from those discussed on page 2.5.4-5 for the Blue Bluff Marl.
2.5.4-13	Z. Cruz Y. Li	SSAR Section 2.5.4.7 states that: "The EPRI curves were extended beyond the 1 percent strain values reported in EPRI (Technical Report (TR)-102293 1993) to 3.3 percent using values provided by Silva (2006)." Provide Silva's values, justification for use of these values, and a detailed description on how the shear modulus and damping curves were extended.
2.5.4-14	Z. Cruz Y. Li	Since the Blue Bluff Marl has a relatively high variable fines content (24-77 percent) and saturation level (14-67 percent) and since there is also a potentially high ground motion level at the site, justify why liquefaction analyses were not performed.

2.5.4-15	Z. Cruz Y. Li	SSAR Section 2.5.4.10.2 states that: "For the large mat foundations that support the major power plant structures, general considerations based on geotechnical experience indicate that total settlement should be limited to 2 in., while differential settlement should be limited to ¾ in. **(Peck et al. 1974)**. For footings that support smaller plant components, the total settlement should be limited to 1 in., while the differential settlement should be limited to ½ in. **(Peck et al. 1974)**." a) Provide justification for adopting the Peck et al. (1974) settlement and differential settlement values as guidelines. b) What are the main causes for exceeding these settlement values at the foundation levels for Units 1 and 2? What kind of measures will be taken to prevent settlements and differential settlements for the new units? c) Justify the use of an average bearing pressure of 5 ksf for the settlement analyses of compacted fills.
2.5.4-16	T. Terry	SSAR Section 2.5.4.10 provides two general scenarios for bearing capacity and settlement analyses. However, in order to meet the requirements of 10 CFR Parts 50 and 100, the stability of all planned safety-related facilities should be analyzed including bearing capacity, rebound, settlement, and differential settlements under deadloads of fills and plant facilities, as well as lateral loading conditions. Please provide justification for not addressing the above information for each planned safety-related structure.
2.5.4-17	Z. Cruz	SSAR Section 2.5.4.7 states that EPRI Procedure TR-102293 was used to develop the shear modulus and damping curves based on the site shear wave velocities and plasticity index values. Please provide a complete description, including sample calculations, to show how the shear modulus and damping curves were developed and how uncertainties in the site parameters were incorporated into their development.
2.5.4-18	T. Terry	SSAR Section 2.5.4.10.1 provides a brief description of the allowable bearing capacity value, which is based on Terzaghi's bearing capacity equations modified by Vesic (1975). Please provide a more detailed description of how the allowable bearing capacity value was obtained that includes the actual calculations.

2.5.4-19	T. Terry	SSAR Section 2.5.4.11 does not provide the complete design criteria or actual design methods that will be employed in the geotechnical review. Please provide justification for not providing the above information. SSAR Section 2.5.4.11 provides two factors of safety for slope stability with references to Section 2.5.5.2. Neither of these factors of safety is listed in Section 2.5.5. Please explain their omission.
2.5.4-20	T. Terry	SSAR Section 2.5.4 does not provide the relationship of foundations to the underlying materials in the form of plot plans and profiles. In addition, foundation stability with respect to groundwater conditions is not described, and detailed dewatering plans are also missing. Please provide justification for not providing the above information.