LeeRAIsPEm Resource

From: Brian Hughes
Sent: Thursday, January 08, 2009 4:15 PM
To: LeeRAIsPEm Resource
Subject: RAI LETTER NO. 059 RELATED to SRP 02.05.01 FOR THE LEE UNITS 1 AND 2 COL
Attachments: LEE-RAI-LTR-059.doc

Brian Hughes
Project Manager
NRO/DNRL/NWE1
US NRC
301-415-6582

Hearing Identifier: Lee_COL_RAI
Email Number: 69

Mail Envelope Properties (D841D501B2C4D244B75AB897F70C1494857761AB71)

Subject: RAI LETTER NO. 059 RELATED to SRP 02.05.01 FOR THE LEE UNITS 1 AND 2 COL
Sent Date: 1/8/2009 4:14:38 PM
Received Date: 1/8/2009 4:14:38 PM
From: Brian Hughes

Created By: Brian.Hughes@nrc.gov

Recipients:
"LeeRAIsPEm Resource" <LeeRAIsPEm.Resource@nrc.gov>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	96	1/8/2009 4:14:38 PM
LEE-RAI-LTR-059.doc	129530	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

January 9, 2008

Mr. Peter S. Hastings, P.E.
Licensing Manager, Nuclear Plant Development
Duke Energy
526 South Church Street
Charlotte, NC 28201-1006

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 059 RELATED TO SRP 02.05.01 FOR THE WILLIAM STATES LEE III UNITS 1 AND 2 COMBINED LICENSE APPLICATION

Dear Mr. Hastings:

By letter dated December 12, 2007, as supplemented by letters dated January 28, 2008, February 6, 2008 and February 8, 2008, Duke Energy submitted its application to the U. S. Nuclear Regulatory Commission (NRC) for a combined license (COL) for two AP1000 advance passive pressurized water reactors pursuant to 10 CFR Part 52. The NRC staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed application.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter.

To support the review schedule, you are requested to respond within 30 days of the date of this letter. If changes are needed to the final safety analysis report, the staff requests that the RAI response include the proposed wording changes.

If you have any questions or comments concerning this matter, you may contact me at 301-415-6582.

Sincerely,

/**RA**/

Brian Hughes, Senior Project Manager
AP1000 Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 52-018
52-019

Enclosure:
Request for Additional Information

CC: see next page

If you have any questions or comments concerning this matter, you may contact me at 301-415-6582.

Sincerely,

/**RA**/

Brian Hughes, Senior Project Manager
AP1000 Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 52-018
52-019

eRAI Tracking No. 1657

Enclosure:
Request for Additional Information

Distribution:

Public	SBrock	
RidsNroDnrlNwe1	CMunson	GStirewalt
RidsNroLAKGoldstein	BHughes	RidsOgcMailCenter
RidsAcrsAcnwMailCenter	RidsRgn2MailCenter	RidsNroDnrlNwe2
VGraizer	CAraguas	

NRO-002

OFFICE	RGS2/BC	RGS2	OGC	NWE1/L-PM
NAME	CMunson*	GStirewalt*	SBrock*	BHughes*
DATE	1/19/08	11/18/08	11/20/08	01/09/09

*Approval captured electronically in the electronic RAI system.

OFFICIAL RECORD COPY

Request for Additional Information No. 1657

1/9/2009

William States Lee III, Units 1 and 2
Duke Energy Carolinas, LLC
Docket No. 52-018 and 52-019
SRP Section: 02.05.01 - Basic Geologic and Seismic Information
Application Section: 2.5.1

QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)

02.05.01-1

FSAR Section 2.5.1 (page 2.5-2, 3rd paragraph) states that certain basic geologic and seismic information was acquired through interviews with experts in site region geology and seismotectonics, but does not provide any references to document these important information sources. The same statement is made throughout FSAR Section 2.5.1, and Section 2.5.3 as well, without specifying the sources.

In order for the staff to evaluate the specific sources of information, please indicate these sources by references to personal communications, including names of the specialists interviewed and their expertise.

02.05.01-2

FSAR Section 2.5.1 (page 2.5-2, 3rd paragraph) states that the FSAR presents geologic and seismic information developed from review of previous reports prepared for the Lee site, but without any specific reference to indicate the pedigree of that information. The same statement is made throughout FSAR Section 2.5.1, and Section 2.5.3 as well, with reference to the PSAR for the Cherokee site.

In order for the staff to evaluate the specific sources of information, please provide references to the specific reports, including the Cherokee PSAR, from which information is drawn for the FSAR.

02.05.01-3

FSAR Section 2.5.1.1.1 (page 2.5-3, 3rd paragraph) references Figure 2.5.1-202a and states that the Blue Ridge and Piedmont physiographic provinces are further divided into different lithotectonic terranes. However, the cited figure does not include Blue Ridge lithotectonic sub-divisions, but rather those for only a part of the Piedmont (i.e., the Carolina Zone of the Central Piedmont in which the site is located and the geologic/lithotectonic terranes therein). Also, FSAR Sections 2.5.1.1.1.3 and 2.5.1.1.1.4 reference Figures 2.5.1-202a and 2.5.1-202b, but regional relationships between the adjacent geologic/lithotectonic terranes, the regional faults which separate them, and the Carolina Zone are not clearly distinguished in a single figure.

In order for the staff to completely understand the geologic setting of the Lee site with respect to the surrounding region, please prepare a single figure that illustrates the geologic/lithotectonic subdivisions (including the Valley and Ridge, Blue Ridge, Western Piedmont, and Central Piedmont relative to the Coastal Plain physiographic province), the regional fault zones which separate them, and the Carolina Zone of the Central Piedmont in which the site is located to place them in the regional geologic/tectonic context before finer details of these subdivisions are presented in existing FSAR Figures 2.5.1-202a and 2.5.1-202b and discussed in the text.

02.05.01-4

FSAR Section 2.5.1.1.1.4 (pages 2.5-7 and 2.5-8) describes the Carolina Zone of the Central Piedmont, including the Charlotte terrane of the Carolina Zone in which the Lee site is located. The most recent reference cited is Hibbard et al (2002), while other references cited are substantially older. More recently-published references (e.g., from 2007) exist in which the lithologic, stratigraphic, and structural geologic characteristics of the site region, including the Carolina Zone, are discussed.

In order for the staff to assess the most recent geologic literature and determine if the information presented in the FSAR represents an up-to-date characterization of regional geology, please incorporate pertinent information from more recently-published references for description of the lithologic, stratigraphic, and structural geologic characteristics of the Carolina Zone of the Piedmont physiographic province in which the site is located.

02.05.01-5

FSAR Section 2.5.1.1.2.3.1 (page 2.5-17) states that regional gravity data acquisition and modeling studies performed to date show no evidence for Cenozoic tectonic activity or specific Cenozoic structures. Similarly, FSAR Section 2.5.1.1.2.3.2 (page 2.5-20) states that regional magnetic data show no evidence for Cenozoic structures in the site region. No explanation is provided in regard to how regional gravity or magnetic data can be used to determine that a given tectonic feature is Cenozoic in age. Also, FSAR Figure 2.5.1-206 shows prominent northeast-trending aeromagnetic lows within the Lee site vicinity, and Figure 2.5.1-208 locates these lows in a profile drawn across the site vicinity. With the exception of the magnetic low corresponding to the Modoc shear zone, these low magnetic anomalies are not discussed in the FSAR even though the magnetic highs are discussed (pages 2.5-19 and 2.5-20).

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please discuss the criteria applied for determining the presence of Cenozoic tectonic structures based on regional gravity and magnetic data. Please also locate the site on Figure 2.5.1-208 and discuss the significance of magnetic anomalies in the site vicinity as they may relate to geologic structures or lithlologies.

02.05.01-6

FSAR Section 2.5.1.1.3.2 (page 2.5-19) describes magnetic anomalies defined based on data derived from survey lines flown 1.6 km (1 mi) apart and 152 m (500 ft) above the ground. It is not clear whether these data were specifically acquired for the Lee COL application, or if they are regional data presented in Figure 2.5.1-206. In the same and following paragraphs of Section 2.5.1.1.3.2 (pages 2.5-19 and 2.5-20), the FSAR also describes several anomalies in the site vicinity and area and refers the reader to Figure 2.5.1-206, but this figure is not at a scale suitable for illustrating certain of these finer-scale anomalies.

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please clarify whether the flight lines data were acquired specifically for the Lee COL application. If finer-scale magnetic data exist, please also provide a map at a scale appropriate for illustrating the magnetic anomalies discussed for the site vicinity and area in FSAR Section 2.5.1.1.3.2.

02.05.01-7

FSAR Section 2.5.1.1.2.4.1 (page 2.5-21, 2nd paragraph) indicates that both Figures 2.5.1-209 and 2.5.1-211 show the location of the East Coast Magnetic Anomaly (ECMA). However, the ECMA is not shown on Figure 2.5.1-209 as applicant implies.

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please include the ECMA in Figure 2.5.1-209 if it is to be cited as showing it, or refer to the correct figure in which it is shown.

02.05.01-8

Pg 2.5-22, FSAR Section 2.5.1.1.2.4.1 (page 2.5-22, 1st paragraph) indicates that both Figures 2.5.1-209 and 2.5.1-211 show the location of the Appalachian Gravity Gradient. However, this gravity gradient is not shown on Figure 2.5.1-211 as applicant implies.

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please include the Appalachian Gravity Gradient in Figure 2.5.1-211 if is to be cited as showing it, or refer to the correct figure in which it is shown.

02.05.01-9

FSAR Section 2.5.1.1.2.4.1 (page 2.5-22) indicates that the New York-Alabama Lineament (NYAL) is shown on both Figures 2.5.1-209 and 2-5-1-211. However, the NYAL is not shown on Figure 2.5.1-209 as applicant implies.

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please include the NYAL in Figure 2.5.1-209 if it is to be cited as showing it, or refer to the correct figure in which it is shown.

02.05.01-10

FSAR Section 2.5.1.1.2.4.2 (page 2.5-24, 1st paragraph) defines the Appalachian decollement structure as an important feature into which major faults sole at depth in the site region. This structure is also often considered to be the boundary below which seismogenic crust exists in the CEUS, but it is not labeled in the geologic profile of Figure 2.5.1-207.

In order for the staff to determine the adequacy of the regional geologic characterization provided in the FSAR, please label the Appalachian decollement structure in the geologic profile of Figure 2.5.1-207.

02.05.01-11

FSAR Section 2.5.1.1.2.4.2 (pages 2.5-24 through 2.5-26) discusses fault zones considered to be Paleozoic in age. This section indicates that the Kings Mountain Shear Zone is interpreted to be part of the Central Piedmont Shear Zone (CPSZ). This section also states that some of these fault zones have constraining relative ages and are characterized by ductile (i.e., mylonitic) deformation fabrics, with both lines of evidence indicative of deep-seated, older deformation. However, the discussion for certain faults (e.g., the Cross Anchor fault, the southwest extension of the Boogertown Shear Zone, and the Reedy River Thrust) does not mention both relative age constraints and mylonitic fabric to confirm deep-seated, older deformation histories.

In order for the staff to assess the hazard potential for these faults, please provide all pertinent information from published literature that documents a Paleozoic age for the faults discussed in FSAR Section 2.5.1.1.2.4.2. Please also define which of the regional faults are interpreted to be part of the CPSZ, with evidence for this interpretation, since this feature is interpreted to be a deep-seated, older structure.

02.05.01-12

FSAR Section 2.5.1.1.2.4.2 (page 2.5-25) discusses the Gold Hill-Silver Hill Shear Zone (GHSZ), indicating that relative age relationships between the Deal Creek Shear Zone (DCSZ) and intrusive igneous bodies constrain displacement on the GHSZ to between 400-325 my ago. A 1998 reference is cited. However, the DCSZ is not shown on referenced Figure 2.5.1-210, and more recent published references (e.g., Hibbard and others, 2007; Allen, 2007) present newer information on the GHSZ.

In order for the staff to assess the hazard potential of these shear zones, please locate the DCSZ on Figure 2.5.1-210 since it is used to constrain age of last displacement on the GHSZ; assess the references cited above; and discuss current interpretations related to the GHSZ.

02.05.01-13

FSAR Section 2.5.1.1.2.4.2 (page 2.5-25) indicates that the Modoc Shear Zone contains both ductile and brittle fabrics produced during an early phase of the Alleghanian orogeny about 315 my ago, and states that there is no evidence for post-315 my displacement along this shear zone. No documentation of a similar age for both the ductile and brittle fabrics is presented, although such fabrics suggest either development at different crustal levels or at different strain rates, either of which could indicate late-stage brittle deformation following deep-seated ductile deformation.

In order for the staff to assess the hazard potential of the Modoc shear zone, please present information to document a Paleozoic age of both the ductile and brittle fabrics in the Modoc shear zone which confirms that both fabrics are old and the brittle fabric is not a late-stage event superimposed over the earlier ductile fabric.

02.05.01-14

FSAR Section 2.5.1.1.2.4.2 (page 2.5-26) defines several other Paleozoic faults in the site region which parallel the northeast-trending regional structural grain, but does not include the Hyco shear zone which occurs northeast of the site as shown in FSAR Figure 2.5.1-209 or the Brindle Creek fault west and northwest of the site as shown in FSAR Figure 2.5.1-210. This section also does not provide referenced information to document a Paleozoic age for any of these “other” faults and does not refer to figures that show locations of the faults.

In order for the staff to assess the hazard potential of these structures, please include the Hyco shear zone and the Brindle Creek fault in the list of other Paleozoic faults in the site region and document a Paleozoic age for these “other” faults with proper references, including citation of figures showing locations of these faults.

02.05.01-15

FSAR Section 2.5.1.1.2.4.3 states that known or postulated faults of Mesozoic age which are discussed on pages 2.5-26 through 2.5-28 are shown on both Figures 2.5.1-209 and 2.5.1-210. Other than the rift basins and the Mulberry Creek fault, the faults discussed are not located on Figure 2.5.1-209. Also, the Longtown Fault, discussed on page 2.5-27, is not shown on Figure 2.5.1-210.

In order for the staff to assess the hazard potential of these structures, please cite the correct figure for location of the known or postulated Mesozoic faults (i.e., Figure 2.5.1-210 apparently) and show location of the Longtown fault in Figure 2.5.1-210.

02.05.01-16

FSAR Section 2.5.1.1.2.4.3 (pages 2.5-26 and 2.5-27) discusses regional Mesozoic tectonic structures. This section states that motion on the Wateree Creek fault is constrained to be Mesozoic or pre-Mesozoic, and the Summers Branch and Ridgeway faults are both interpreted to be Mesozoic structures on the basis of their association with the Wateree Creek fault.

In order for the staff to assess the hazard potential of these structures, please summarize the information used to constrain timing of fault displacement along the Summers Branch and Ridgeway faults in regard to their association with the Wateree Creek fault.

02.05.01-17

FSAR Section 2.5.1.1.2.4.3 (page 2.5-28) states that Mesozoic rift basins are areas of extended crust that potentially contain the largest earthquakes, but no earthquake epicenters are shown in relation to these areas in Figure 2.5.1-212 to support the conclusion made by the applicant that no seismicity is attributed to faults that bound these Mesozoic basins. This conclusion is supported, in part, by locations of seismic zones and seismicity in the CEUS as shown in Figure 2.5.1-214, however, and this figure could be referenced.

Furthermore, although FSAR Section 2.5.1.1.2.4.3 (page 2.5-28) states that no seismicity is attributed to Mesozoic rift basins, FSAR Section 2.5.3.1.5 (page 2.5-145) indicates that two September 2006 earthquakes, which occurred near Bennettsville, SC more than 120.7 km (75 mi) east-southeast of the Lee site, were spatially associated with a small Mesozoic extensional basin lying beneath the Coastal Plain as mapped by Benson (1992). If the September 2006 earthquakes are best explained as having occurred on faults related to a buried Mesozoic rift basin, the presence of such basins in the site region may have implications for the existence of potentially capable tectonic structures.

In order for the staff to assess the hazard potential of these structures, please add epicenters to Figure 2.5.1-212 to show their locations relative to areas of extended crust, or cite other FSAR figures as appropriate to support the conclusion that no seismicity is attributed to faults that bound these Mesozoic basins. Please also summarize the logic for the conclusion drawn in FSAR Section 2.5.1.1.2.4.3 (page 2.5-28) that Mesozoic structures in the site region are not interpreted to be capable tectonic sources.

02.05.01-18

FSAR Section 2.5.1.1.2.4.5 (pg 2.5-30) states that, based on review of published literature, field reconnaissance, and work performed as part of the North Anna ESP application (Reference 398), the Fall Lines of Weems (1998) are interpreted to be erosional features related to contrasting erosional resistances of adjacent rock types, and are not tectonic in origin.

In order for the staff to assess the basis for the conclusion that the Fall Lines of Weems (1998) are erosional in nature, please summarize the pertinent information which leads to this conclusion by presenting pertinent data from primary sources which render this conclusion plausible.

02.05.01-19

FSAR Section 2.5.1.1.2.4.4 (page 2.5-29) discusses arches and embayments but does not show the location of the Yamacraw Arch on Figure 2.5.1-209 on which the Cape Fear Arch is located. This section states that late Cretaceous through Pleistocene (i.e., as young as 1.8 my to 10,000 yrs in age) differential tectonic movement is indicated by these features, although Crone and Wheeler (2000) label them as Class C features. Furthermore, FSAR Section 2.5.1.1.2.4.5, page 2.5-31, mentions the Cape Fear Arch, but not the Yamacraw, in relation to potential regional Quaternary tectonic structures.

In order for the staff to assess the hazard potential for these features, please locate the Yamacraw Arch on Figure 2.5.1-209 and include a discussion of this arch in FSAR Section 2.5.1.1.2.4.5, as was done for the Cape Fear Arch. Please also refer to primary sources of data which render the conclusions about these features plausible rather than relying on the compiled information presented by Crone and Wheeler (2000).

02.05.01-20

FSAR Section 2.5.1.1.2.4.5 (page 2.5-31) discusses the Belair Fault and indicates that this structure may be a tear fault or lateral ramp in the hanging wall of the Augusta fault zone. If the Belair fault is associated with the Augusta fault zone in this manner, then movement on the Belair may be related to movement on the larger, regional-scale Augusta fault. The FSAR indicates that information exits (Prowell and O'Connor, 1978) which appears to constraint the age of last movement on the Belair Fault to sometime between post-late Eocene and pre-26,000 years ago, rendering this fault to be one of the few structures in the region interpreted to show possible evidence of Quaternary movement.

In order for the staff to assess the geologic hazard potential for the Belair fault, please discuss how the inference of possible Quaternary movement on this fault, coupled with its potential structural relationship to the regional-scale Augusta fault zone, might affect seismic hazard at the Lee site.

02.05.01-21

FSAR Section 2.5.1.1.2.4.5 (page 2.5-32) discusses the postulated Stanleytown-Villa Heights faults which have been interpreted to juxtapose Quaternary alluvium against Cambrian rocks, but are interpreted to likely be the result of landsliding based on evidence cited. Crone and Wheeler (2000) classify these faults as Class C structures.

In order for the staff to assess the geologic hazard potential for these faults, please concisely summarize evidence for a non-tectonic, landslide mechanism for these postulated faults since Quaternary age deposits are involved. Please also refer to primary sources of data which render the conclusions about these faults plausible rather than relying on the compiled information presented by Crone and Wheeler (2000).

02.05.01-22

FSAR Section 2.5.1.1.2.4.5 (page 2.5-32) discusses the postulated Pembroke faults which are classified as Class B structures (i.e., possible Quaternary faulting) by Crone and Wheeler (2000), but no information is provided on fault geometry or fault length and the FSAR states that it is unclear whether they are of tectonic origin or the result of dissolution collapse.

In order for the staff to assess the geologic hazard potential for these faults, please summarize information on fault geometry and fault length and present lines of evidence related to whether these features are tectonic or non-tectonic (i.e., related to dissolution collapse) in origin. Please also refer to primary sources of data which render the conclusions about these faults plausible rather than relying on the compiled information presented by Crone and Wheeler (2000).

02.05.01-23

FSAR Section 2.5.1.1.3.2.1 describes potential source faults in the Charleston area. Based on the occurrence of conjugate normal faults in the walls of Colonial Fort Dorchester in the Charleston area, the Dorchester fault has been proposed by Bartholomew and Rich (2007) in the area south of the Ashley River fault zone, but this fault is not described in FSAR Section 2.5.1.1.3.2.1 or located in the appropriate figure illustrating potential Charleston tectonic features (e.g., Figure 2.5.1-216). In addition, under the discussion of the Sawmill Branch fault in FSAR Section 2.5.1.1.3.2.1 (page 2.5-36), displacements in the walls of Fort Dorchester are related to shaking and not fault rupture, but there is no indication of whether the 2007 publication by Bartholomew and Rich was taken into account.

In order for the staff to assess the geologic hazard potential of the Dorchester fault, please discuss this proposed fault and its perceived relationship to other potential Charleston source faults and locate this structure on the appropriate map.

02.05.01-24

FSAR Section 2.5.1.1.3.2.1 (page 2.5-36) discusses the postulated Sawmill Branch fault and states that it trends northwest. However, this postulated fault is shown with two different strike directions, a northwest strike on Figure 2.5.1-217 and a northeast strike on Figure 2.5.1-216. Section 2.5.1.1.3.2.1 indicates it is a segment of the Ashley River fault, yet Figure 2.5.1-217 clearly shows it crossing the Ashley River fault while Figure 2.5.1-216 shows that intersects, but does not cross, the Woodstock fault.

In order for the staff to assess the geologic hazard potential of the Sawmill Branch fault, please provide a corrected figure to illustrate location, orientation, and cross-cutting character of this fault and explain its proposed relationship to the Ashley River and Woodstock faults.

02.05.01-25

FSAR Section 2.5.1.1.3.2.1 (page 2.5-37) discusses the Middleton Place-Summerville seismic zone which includes the Sawmill Branch fault, among other postulated structures. Based on new data, Dura-Gomez and Talwani (2008) propose that the Sawmill Branch fault strikes northwest parallel to the Ashley River fault, is the most active fault in the Summerville area, and offsets the Woodstock fault.

In order for the staff to assess the most recent geologic literature and determine if the information presented in the FSAR represents an up-to-date characterization of the Sawmill Branch fault, please incorporate the recent data on significance of this fault in the area of the Middleton Place-Summerville Seismic Zone.

02.05.01-26

FSAR Section 2.5.1.1.3.2.2 (pgs 2.5-39 and 2.5-40) discusses the six EPRI/SOG team source zones and corresponding Mmax values for the Eastern Tennessee Seismic Zone (ETSZ). The FSAR (pg 2.5-39) specifies the upper-bound maximum range of the EPRI/SOG teams Mmax values as M 6.3 to 7.5 (converted from mb values 5.2 to 7.2). Although the FSAR (pg 2.5-40) states that more recent estimates of Mmax are captured in the range of Mmax values used by the EPRI/SOG teams, the FSAR cites post-EPRI/SOG Mmax estimates of M 6.3 (Bollinger, 1992) and M 7.5 (Frankel and others, 2002) but not the alternate higher estimate of M 7.8 by Bollinger (1992) which is presented in FSAR Section 2.5.2.2.2.5 (pg 2.5-114).

In order for the staff to assess the information presented in the FSAR on the ETSZ, please tabulate the EPRI/SOG team Mmax estimates for the ETSZ source zones for FSAR Section 2.5.1.1.3.2.2, or at least tabulate source zone names, so that Tables 2.5.2-202 through 2.5.2-207 can be referred to easily. Please also clarify why FSAR Section 2.5.1.1.3.2.2 does not include the Bollinger (1992) Mmax estimate of M 7.8 since this value is not captured in the range of Mmax values used by the EPRI/SOG teams as claimed.

02.05.01-27

FSAR Section 2.5.1.1.3.2.2 (pg 2.5-39) states that a lack of seismicity in the relatively shallow Appalachian thrust sheets implies that seismogenic structures in the ETSZ are unrelated to surficial geology of the Appalachian orogen. The FSAR also states (pg 2.5-40) that the lack of seismicity in the shallow Appalachian thrust sheets, estimated to be about 3.2-5.1 km (2-3.5 mi) thick, implies that seismogenic structures in the Giles County seismic zone are also unrelated to surficial geology of the Appalachian orogen.

In order for the staff to assess the interpretation that seismogenic structures in the ETSZ (and also the Giles County seismic zone) are unrelated to surficial geology, please accomplish the following:

(a) Document any direct evidence available from seismograms for constraining earthquakes in the ETSZ to depths between 4.8-25.7 km (3-16 mi), precluding a possible association with known shallow faults.

(b) Summarize the available evidence supporting the statement that the basal Appalachian detachment, into which thrust faults in the ETSZ sole out, has a maximum depth of 4.8 km (3 mi).

(c) Given the degree of uncertainty in [1] phase identification present in most seismic network data (particularly for distances corresponding to stations in the ETSZ), [2] distance to the nearest station, [3] seismograph station density, and [4] velocity structure and its relationship to models used in routine hypocenter determination, please discuss what modifications to some or all of these uncertainties would be necessary to enable location of some of the earthquake hypocenters on one of the mapped faults shown in Figure 2.5.1-210 and whether this amount of modification is in the zero to one sigma uncertainty bound.

02.05.01-28

FSAR Section 2.5.1.1.3.2.3 (pgs 2.5-40 and 2.5-41), states that earthquakes in the Giles County seismic zone occur within Precambrian crystalline basement rocks beneath the Appalachian thrust sheets at depths from 4.8-25.7 km (3-16 mi) and cites Reference 360. This reference is also cited to suggest that the earthquake activity is related to contractional reactivation of late Precambrian or Cambrian normal faults that initially formed during rifting associated with opening of the Iapetan Ocean. Reference 360 does not explicitly discuss the Giles County seismic zone or rifting associated with opening of the Iapetan Ocean.

In order for the staff to evaluate specific sources of information cited in the FSAR, please correct the in-text citation for Reference 360.

02.05.01-29

FSAR Section 2.5.1.2.1 (page 2.5-45) describes five lineaments which occur within the site vicinity, and indicates that they are interpreted to be the result of drainage patterns, variations of bedrock to weathering, and land use rather than to differential movement related to capable tectonic structures. FSAR Section 2.5.1.2.5.1 (page 2.5-55), however, states that jointing and structural fabric locally control drainage directions, indicating that such geologic features control linear segments of stream channels, result in enhanced erosion along resistant ridges, and consequently may define lineaments.

In order for the staff to assess the character of these lineaments in regard to control by potential geologic structures, please discuss the possibility that certain lineaments reflected in drainage patterns may be related to regional joint trends in the site area, and therefore exist because of control by non-capable geologic structures.

02.05.01-30

FSAR Section 2.5.1.2.1 (page 2.5-45) states that the most erosion-resistant rock types in the site area contain large amounts of quartz and often cap linear ridges, and cites Figures 2.5.1- 219a, 2.5.1-219b, and 2.5.1-220. Neither Figure 2.5.1-219a nor 2.5.1-219b show topographic contours to clearly indicate that such rock types cap linear ridges. Figure 2.5.1-220 is a relief map, but also does not show topographic contours.

In order for the staff to assess whether or not these linear ridges are related to geologic structures in the site area, please provide and cite an appropriate figure to illustrate the concept that erosion-resistant rock units cap linear ridges.

02.05.01-31

FSAR Section 2.5.1.2.1 (pg 2.5-45) discusses Lineament 1 and describes it as trending northeast and “having a steeper slope to the northwest” based on Figures 2.5.1-219a, 2.5.1-219b, and 2.5.1-221. The lineament is only located on Figure 2.5.1-221, and the 100-ft contour interval on that figure does not permit definition of a slope located along the trace of the lineament. It is unclear, therefore, whether the “steeper northwest slope” refers to the slope on the northwest side of the topographic ridge which defines the lineament. The FSAR further states that the lineament results from enhancement by erosion of a northeast-striking, resistant quartzite which holds up the ridge, and that the lineament is non-tectonic in origin even though it parallels the northeast-trending regional structural grain. Geologic control on drainage in relation to development of Lineament 1, a concept discussed under RAI 34, is not addressed. (Lineament 1 is also discussed in FSAR Section 2.5.3.1.6, page 2.5-146, and this RAI applies there as well.)

In order for the staff to assess the possibility that Lineament 1 may be related to a geologic structure, please clarify the description of the physical expression of this lineament in regard to the northwest slope alluded to in the FSAR and discuss the importance of geologic features in development and control of this lineament. Please also include Lineament 1 in all figures cited as illustrating it.

02.05.01-32

FSAR Section 2.5.1.2.2 (pg 2.5-46) describes geologic setting and history of the Charlotte terrane in which the Lee site is located. This terrane is an infrastructural lithotectonic element within the Carolina Zone. The FSAR does not concisely define lithologies that occur in the Charlotte terrane on geologic maps of the site vicinity and site area (i.e., Figures 2.5.1-218a and 2.5.1-219a respectively), but rather presents a mix of terminology for rock units (e.g., Figure 2.5.1-218a contains “Zbp” of the Battleground Formation at the same location for which Figure 2.5.1-219a shows “Zbct” of the Kings Mountain Sequence). This approach makes it difficult to correlate between descriptions in FSAR Section 2.5.1.2.2 and the geologic maps shown in Figures 2.5.1-218a and 2.5.1-219a. In addition, Figure 2.5.1-223 on site area chronology for regional deformation events lacks any references to indicate sources of the information shown therein.

In order for the staff to completely understand geologic setting of the Lee site with regard to lithologies which comprise the Charlotte terrane in which the site is located, please include in a single table the lithologic units and formations which make up the Carolina Zone, broken down to those units and formations of the Charlotte terrane, to enable correlation with geologic map data shown in Figures 2.5.1-218a and 2.5.1-219a. Please also provide references for information shown in Figure 2.5.1-223.

02.05.01-33

FSAR Section 2.5.1.2.2 (pg 2.5-47) states that the Gold Hill-Silver Hill shear zone (GHSZ) exhibits Devonian tectonothermal activity in the Charlotte terrane, and this activity was highly localized. No references for this interpretation are cited. Based on information published in 2007, the main motion on the GHSZ was Late Ordovician sinistral thrusting, with remobilization in Late Devonian time.

In order for the staff to assess the hazard potential of the GHSZ, please clarify the displacement history for this shear zone in light of information published in 2007.

02.05.01-34

FSAR Section 2.5.1.2.2 (pg 2.5-47) states that deformation of the Charlotte terrane occurs mainly in discrete shear zones within the terrane and at the Central Piedmont shear zone (CPSZ), a regional structural boundary. The fault segments that make up the CPSZ in the site vicinity are not specified, and the shear zone is not located on the geologic map of the site vicinity in Figure 2.5.1-218a.

In order for the staff to understand which faults comprise the CPSZ and to assess the hazard potential of this shear zone, please locate the CPSZ on the site vicinity geologic map of Figure 2.5.1-218a, correlating it with the faults already shown on that map since this shear zone is a major pre-Quaternary tectonic feature within the site vicinity.

02.05.01-35

FSAR Section 2.5.1.2.2 (pg 2.5-48) summarizes deformation and metamorphism in the site area. It is not clear whether the summary is meant to cover only the major orogenies. No Ordovician event history is shown and no references are provided to support the statement that Silurian-Devonian deformation is limited in the site area. Mesozoic age cataclasites, which developed as a result of faulting, are reported for the region in the published literature. However, this information from the published literature is not included in the summary, although the undeformed (presumably Mesozoic age) diabase dikes are discussed.

In order for the staff to fully understand the deformation events which have affected the site area and assess the hazard potential related to these events, please refine the summary of site area geologic setting and history.

02.05.01-36

FSAR Section 2.5.1.2.3 (pgs 2.5-48 through 2.5-51) discusses the Battleground Formation which generally underlies the site, but the formation is not consistently keyed to geologic maps provided in Figures 2.5.1-218a (Site Vicinity Geologic Map), 2.5.1-219a (Site Area Geologic Map), and 2.5.1-220 (Site Geologic Map). This situation occurs, in part, because the FSAR presents several geologic maps from several different workers, making it difficult to either define the extent of the Battleground Formation at the site location and in the site area or to determine which unit described in the FSAR text is actually Zto, the foundation unit at the Lee site. For example, on page 2.5-49, the mapped unit Zto is described as a Neoproteroic metatonolite (Figure 2.5.1-218b), a metatonolite and volcaniclastic rock of the Kings Mountain Sequence (Figure 2.5.1-219b), and an undifferentiated intrusive plutonic rock which is mapped separate from the Battleground Formation (Figure 2.5.1-220).

In order for the staff to fully understand extent of rock unit Zto of the Battleground Formation, the foundation unit at the Lee site, please provide a consistent nomenclature and description for unit Zto and present a proper description of the rock mass in the FSAR.

02.05.01-37

FSAR Section 2.5.1.2.3 (pg 2.5-48, last paragraph) suggests a relationship between the South Fork antiform and a homocline in the Battleground Formation which is used to infer a stratigraphic sequence. The antiform and homocline are not shown on the site area geologic map of Figure 2.5.1-219a, so the basis for the discussion in relation to developing stratigraphic relationships for the site and site area is not clear. Furthermore, the citation of Reference 336 (Amick and others, 1990) in regard to the South Fork antiform seems to be incorrect.

In addition, FSAR Figure 2.5.1-224 schematically illustrates stratigraphic relationships in the site area prior to folding and faulting, even though the figure shows all units as metamorphosed rather than protolith non-metamorphosed equivalents. Little explanation is provided to document this schematic stratigraphic “column”, even though a reference (Howard, 2004) for the information is cited. Also, units and relationships shown in Figure 2.5.1-224 do not match the discussion in the text (e.g., metaandesite and metadacite of the Battleground Formation, presented as the oldest mapped units within the Lee Nuclear Site area, are absent from Figure 2.5.1-224). Metatonalite appears to be spelled incorrectly as “metatolanite” in Figure 2.5.1-224.

In order for the staff to fully understand structural features and stratigraphic relationships in the site area, please accomplish the following:

(a) Locate the antiform and homocline on the site geologic map and clearly explain the basis for the stratigraphic relationships shown in the stratigraphic “column” of Figure 2.5.1-224.

(b) Check Reference 336 to determine whether it is appropriate as cited.

(c) Render Figure 2.5.1-224 and the discussion of site area stratigraphy in Section 2.5.1.2.3 consistent, or justify the exclusion of the oldest rock units at the site from the stratigraphic “column”.

(d) Correct the spelling of metatonalite in Figure 2.5.1-224.

02.05.01-38

FSAR Section 2.5.1.2.3 (pg 2.5-50, 1st full paragraph) states that Murphy and Butler (1991) interpret certain rock units as “pyroclasts and reworked pyroclastic material”. It is not clear to which rock units this description applies. Also, while rock units may be pyroclastic, they are not “pyroclasts”.

In order for the staff to fully understand the rock units making up the Battleground Formation which occur at the site, please clarify which rock units are being described and correct the misconception that rock units are pyroclasts.

02.05.01-39

FSAR Section 2.5.1.2.3 (pg 2.5-51) includes unmetamorphosed diabase dikes (Jurassic-Triassic in age) and colluvial and alluvial sediments found in river and stream valleys under the description of the Battleground Formation. However, neither the dikes nor the sediments are part of the Battleground Formation.

In order for the staff to fully understand the rock units making up the Battleground Formation, please clarify why the dikes, colluvium, and alluvium are listed under the description of rock units comprising the Battleground Formation.

02.05.01-40

FSAR Section 2.5.1.2.4.1 (pg 2.5-53) states that the Cherokee Falls synform is an F2 structure resulting from deformation phase D2, and indicates that more recent mapping by Nystrom (2004) does not include this synform. However, the geologic map shown in Figure 2.5.1-219a is based on the mapping of Nystrom (2004) and includes the axis of the synform.

In order for the staff to fully understand the deformation history of the site region and the potential geologic structures which occur at the site, please discuss the significance of the implied difference in interpretation of the Cherokee Falls synform in regard to site structural geology, and clarify why the synformal axis is shown on the map derived from Nystrom (2004) even though he apparently discounted this structure.

02.05.01-41

FSAR Section 2.5.1.2.4.1 (pg 2.5-54) states that recent mapping by Nystrom (2004) also does not include the Draytonville synform, but this structure is presented on Figure 2.5.1-219a in the area of Nystrom's mapping. The same situation exists for the McKnowns Creek antiform (pg 2.5-56 and Figure 2.5.1-219a). A similar contradiction also exists on page 2.5-56 in the discussion of the McKowns Creek antiform.

In order for the staff to fully understand the deformation history of the site region and the potential geologic structures which occur at the site, please discuss the significance of the implied difference in interpretation of the Draytonville synform and McKnowns Creek antiform in regard to site structural geology, and clarify why the axes of these two structures are shown on the map derived from Nystrom (2004) even though he apparently discounted them.

02.05.01-42

FSAR Section 2.5.1.2.4.1 (page 2.5-54) discusses minor striated (i.e., slickensided) surfaces which occur at Cherokee Falls (4.8 km (3 mi) northwest of the site) and Draytonville (6.4 km (4 mi) west of the site), as described in the Cherokee PSAR, and states that they are "local" features. FSAR Section 2.5.1.2.4.1 (page 2.5-54) also mentions minor faults identified 6.4 km (4 mi) north and 9.7 km (6 mi) northwest of the site. None of these features are located on a map in the FSAR, and it is uncertain whether they may occur along a linear trace, even if discontinuously. It is also uncertain whether all slickensides are marked by the presence of epidote which the applicant interprets to indicate an old and deep-seated, rather than a recent and near-surface, environment of formation.

In order for the staff to assess whether or not these “local” geologic features may represent geologic structures with a hazard potential for the Lee site, please accomplish the following:

(a) Locate these geologic features on a map, if possible, and summarize information (possibly from the Cherokee PSAR) which is used to suggest that the slickensides are old and neither they nor the minor faults represent the trace of a structure of some finite length exhibiting late-stage movement.

(b) Define “near-surface” and discuss information related to minimum temperature and pressure conditions required for epidote formation in the context of the implication in the FSAR that the presence of epidote precludes recent seismogenic movement.

(c) Provide a reference for the statement that slickensided surfaces and other minor, localized features with no tectonic significance occur throughout the Piedmont.

(d) Summarize information from the Cherokee PSAR which is used to discount a fault proposed by Keith and Sterrett (1931) in the vicinity of Draytonville, taking into account the possible spatial relationship between the Draytonville slickensides and this proposed fault.

(e) Discuss the minor offsets which were first described in the Cherokee PSAR and apparently occur 6.4 km (4 mi) north and 9.7 km (6 mi) northwest of the Lee site in the context of regional geology, and provide constraints on timing of these fault offsets.

02.05.01-43

FSAR Section 2.5.1.2.5.2 (page 2.5-55) states that the site has undergone “at least two” deformational events and metamorphism, yet FSAR Section 2.5.1.2.4 defines five deformational events, D1 through D5, for the site area. It is not clear whether two of the five deformation events are simply more strongly registered in the rock fabric at the site location, or whether fabrics from only two events are shown.

In order for the staff to fully understand the deformation history of the site and the potential geologic structures which occur at the site, please clarify whether there are two deformational events, or five, registered in the deformation fabrics of rock units at the site location.

02.05.01-44

FSAR Section 2.5.1.2.5.3 (pg 2.5-55) discusses colluvial and alluvial material which occurs at the site. On Figure 2.5.1-220, all unconsolidated deposits are mapped as a single unit, Qal.

In order for the staff to fully understand the distribution of Quaternary deposits at the site and whether or not any of these deposits may be expected to record Quaternary deformation (e.g., fault displacement, folding over near-surface but buried faults, or liquefaction related to seismicity), please discuss the basis for not differentiating

Quaternary deposits and discuss whether any Quaternary deposits or surfaces may be candidates for assessing the presence of Quaternary deformation at the site.

02.05.01-45

FSAR Section 2.5.1.2.5.3 (page 2.5-55) describes the foundation rock mass as a metagranodiorite to metatonalite intrusive rock, but it is mapped on Figure 2.5.1-220 (Site Geologic Map) as "undifferentiated intrusive plutonic rocks" (Zto). Descriptions in text and figures should agree for the foundation rock mass.

In order for the staff to fully understand the rock type comprising the foundation rock mass, please make descriptions of foundation rock unit Zto agree between text and figures.

02.05.01-46

FSAR Section 2.5.1.2.5.4 (page 2.5-56) discusses deformation at the site location, indicating that deformational event D2 exercised major control on geologic features and map patterns. This section states that two quartzite-capped ridges occur on the west flank of the McKown's Creek antiform, although the map pattern (Figure 2.5.1-219a) shows quartzite units (Zbq and Zbkq) both east and west of the antiformal axis. Furthermore, it is not clear from the description whether foliation surface S2, or an earlier foliation, is folded in the nose of the McKown's Creek antiform, although this section states that the antiform is the result of deformation D2. Even though a site area structural chronology chart is shown in Figure 2.5.1-223, it is not clear how many deformational events are reflected in the rock fabric at the site location, or which deformational event produced which geologic structure and fabric (e.g., early foliations, shear and breccia zones, dilation fractures, joints, slickensides) at the site location.

In order for the staff to fully understand the deformation history of the site and the potential geologic structures which occur at the site, please review Figure 2.5.1-219a and the statements about where the quartzite-capped ridges occur relative to the antiformal axis and correctly state their location relative to this axis. Please also clearly describe structures and deformational history at the site location, including a summary chart indicating which deformation events produced which geologic structures and fabrics.

02.05.01-47

FSAR Section 2.5.1.2.5.5 (pages 2.5-60 and 2.5-61) discusses confirmation testing of previous geologic mapping conducted for the Cherokee site, but does not show pertinent portions of previous geologic maps which may be used for the Lee site or provide a comparison geologic map to confirm previous mapping at the Cherokee site.

In order for the staff to evaluate specific sources of information used for the Lee site, please indicate what specific data collected by previous geologic mapping at the Cherokee site are being used to supplement geologic data for the Lee site. Please also provide a geologic map which documents the proclaimed confirmation of the previous geologic mapping.

02.05.01-48

FSAR Section 2.5.1.2.5.5 (page 2.5-61) states that the site and surrounding area is underlain by rock units of the Battleground Formation. However, the legend of Figure 2.5.1-220 does not include rock mass Zto, which underlies the foundation, as one of the rock units of the Battleground Formation. In addition, it is not clear whether units Zbvf and Ztrs, one listed under the Battleground Formation and one not, are equivalent rock units and actually occur in the Battleground Formation.

In order for the staff to fully understand the rock units comprising the Battleground Formation, please correct discrepancies in Figure 2.5-220 to show that the Battleground Formation, including unit Zto, underlies the site and the surrounding area as described in the text. Please also clarify whether or not Zbvf and Ztrs are equivalent rock units of the Battleground Formation.

02.05.01-49

FSAR Section 2.5.1.2.5.5 (page 2.5-61) cross-references data in FSAR Section 2.5.4.2 and states that the boundary of the rock mass which is the foundation unit was confirmed to be an intrusive contact (i.e., rather than a fault). However, no summary of the pertinent information is provided in Section 2.5.1.2.5.5. Also, Figure 2.5.1-226 shows that some boreholes placed to define the contact provided no data, and some provided “unknown” rock material. In addition, this rock mass is labeled as (1) a granotoid pluton, (2) a pluton, and (3) a granodiorite, although it is referred to in other parts of the FSAR as a metatonolite. FSAR Section 2.5.1.2.6 (page 2.5-61) describes the foundation unit as a felsic and mafic granitoid complex.

In order for the staff to assess the presence or absence of a fault along the contact of the plutonic rock mass which comprises the foundation unit (i.e., Zto), please summarize the data used to determine that the contact is not a fault or shear zone in light of the fact that certain boreholes yielded no data or unknown units. Please also be consistent in definition of rock type since this is the foundation unit.

02.05.01-50

FSAR Section 2.5.1.2.7 (page 2.5-62) refers to extensive outcrop studies performed as a part of the Lee COL project, and states that these studies show no evidence for post-Miocene earthquake activity within the site area. However, no information is presented to document this statement.

In order for the staff to assess seismic hazard potential for the site as inferred from a lack of detected paleoliquefaction features, please provide information to document that new studies performed for the Lee COL application did not reveal any evidence for post-Miocene earthquake activity.

02.05.01-51

In Figure 2.5.1-220 showing site geology, the McKown's Creek antiform is not shown, nor are the Mesozoic diabase dikes that FSAR Section 2.5.1.2.3 indicates occur cross-cutting the Battleground Formation. Also, the scale on this map is not correct and unit "me" is also not included in the legend

In order for the staff to fully understand site-specific geology, please locate the McKown's Creek antiform and the Mesozoic diabase dikes on the site geology map of Figure 2.5.1-220 (scale permitting), correct the map scale, and include rock unit "me" in the legend.

02.05.01-52

Figure 2.5.1-229, a map showing surficial geology of the existing excavation, does not distinguish Mesozoic diabase dikes that FSAR Section 2.5.1.2.3 indicates cross-cut the Battleground Formation.

In order for the staff to fully understand site-specific geology, please include any Mesozoic diabase dikes, if they occur in the excavation, to render the map shown in Figure 2.5.1-229 complete (map scale permitting) and distinguish them from the deformed metamorphosed rock units (e.g., the metadiorite).