PMHarrisCOL PEmails

From: Manny Comar
Sent: Tuesday, October 14, 2008 4:38 PM
To: robert.kitchen@pgnmail.com; david.waters@pgnmail.com; Wilkins, Tillie
Cc: Manny Comar; HarrisCOL Resource
Subject: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 030 RELATED TO SRP SECTION 02.05.01 FOR THE SHEARON HARRIS UNITS 2 AND 3 COMBINED LICENSE APPLICATION
Attachments: Harris-RAI-LTR-30.pdf

All:

Attached is the RAI letter No. 30 related to SRP Section: 02.05.01 -Basic Geologic and Seismic Information for the Shearon Harris Units 2 and 3 Combined License Application.

The Accession number is ML082880682.

If you have any further questions, please feel free to contact me. Thanks

Manny Comar
Senior Project Manager
NRO/DNRL/NWE1
Nuclear Regulatory Commission
301-415-3863
mailto:manny.comar@nrc.gov

Hearing Identifier: ShearonHarris_COL_Public
Email Number: 183

Mail Envelope Properties (3AF7DEF82ADA8944AD8247B7ED7FD6517BFBCE71A4)

Subject: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 030 RELATED TO SRP SECTION 02.05.01 FOR THE SHEARON HARRIS UNITS 2 AND 3 COMBINED LICENSE APPLICATION
Sent Date: 10/14/2008 4:38:27 PM
Received Date: 10/14/2008 4:38:29 PM
From: Manny Comar

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Recipients:
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Tracking Status: None
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Files	**Size**	**Date & Time**
MESSAGE	504	10/14/2008 4:38:29 PM
Harris-RAI-LTR-30.pdf	202048	

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

HarrisRAIsPEm Resource

From: Manny Comar
Sent: Tuesday, October 14, 2008 4:16 PM
To: HarrisRAIsPEm Resource
Subject: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 030 RELATED TO SRP SECTION 02.05.01 FOR THE SHEARON HARRIS UNITS 2 AND 3 COMBINED LICENSE APPLICATION
Attachments: HAR-RAI-LTR-030.doc

Hearing Identifier: HarrisCOL_eRAIs
Email Number: 29

Mail Envelope Properties (3AF7DEF82ADA8944AD8247B7ED7FD6517BFBCE7130)

Subject: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 030 RELATED TO SRP SECTION 02.05.01 FOR THE SHEARON HARRIS UNITS 2 AND 3 COMBINED LICENSE APPLICATION
Sent Date: 10/14/2008 4:16:19 PM
Received Date: 10/14/2008 4:16:21 PM
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Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	13	10/14/2008 4:16:21 PM
HAR-RAI-LTR-030.doc	121850	

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

October 14, 2008

James Scarola
Senior Vice President and
Chief Nuclear Officer
PO Box 1551
411 Fayetteville Street Mall
Raleigh NC 27602

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 030 RELATED TO SRP SECTION 02.05.01 FOR THE HARRIS UNITS 2 AND 3 COMBINED LICENSE APPLICATION

Dear Mr. Scarola:

By letter dated February 18, 2008, Progress 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 301-415-3863.

Sincerely,

/**RA**/

Manny Comar, Lead Project Manager
AP1000 Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 52-022
52-023

Enclosure:
Request for Additional Information

CC: see next page

If you have any questions or comments concerning this matter, you may contact me at 301-415-3863.

Sincerely,

/**RA**/

Manny Comar, Lead Project Manager
AP1000 Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket Nos. 52-022
52-023
ERAI Tracking No. 1191

Enclosure:
Request for Additional Information

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NRO-002

OFFICE	RGS2/BC	NWE1/PM	OGC	NWE1/L-PM
NAME	CMunson*	MComar*	SBrock*	MComar*
DATE	9/15/08	9/18/08	9/26/08	9/29/08

*Approval captured electronically in the electronic RAI system.

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Request for Additional Information No. 1191

10/14/2008

Shearon Harris
Progress Energy Carolinas, Inc.
Docket No. 52-022 and 52-023
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 2.5.1.1.1 provides a discussion with figures about the regional geology around the Shearon Harris Nuclear Power Plants Units 2 and 3. (HAR)

a) Figure 2.5.1-202 (p. 2.5-13) illustrates the rift basins in the region. The figure does not have labeling to indicate where the Deep River basin lies with respect to other basins that are labeled on the figure. In order for the staff to follow the discussion in text please provide additional labels to the figure.

b) FSAR Section 2.5.1.1.1.5 (p. 2.5-16) states: "Near the transition between the embayed and Sea Island sections, the emerged Coastal Plain has been tectonically active during the Cretaceous and Cenozoic ages. This is observed at the surface with the expression of the structural Cape Fear Arch." The text has introduced a young tectonically active structure in the region that may impact issues of fault capability but does not provide enough detail for the staff to evaluate. Please provide further explanation about the limits of timing on this feature and include a map or illustration.

02.05.01-2

FSAR Section 2.5.1.1.2. provides a discussion about the geologic history of the region with respect to opening and closing of oceans and multiple episodes of metamorphism and accretion of exotic terranes.

a) There are only 2 figures that are map views only and no cross-sections illustrating the geologic history and regional evolution of structures in the region. A sequence of conceptual cross-sections is needed to help illustrate the complex history of opening and closing tectonic systems.

b) A large portion of this section is heavily based on Faill 1997a, 1997b and 1998. However, Faill's work is focused on the North Central Appalachian Orogen and does not specifically address tectonic evolution of the southern Appalachians. Please provide discussion on the geologic history and references specific to the Southern Appalachians.

c) Discussion in the texts repeatedly cites Figure 2.5.1-203 and 2.5.1-204. The figures do not correspond with each other with respect to labels used on each map. Please add terrane names from the map view to the column view so that NRC staff can connect the features in space and time, such as Carolina Magmatic arc and Laurentian rift and drift cover.

d) FSAR Section 2.5.1.1.2.2 cites Figure 2.5.1-206. The 5 cross-sections sections are not located on the map views of the same figure. Illustrate how the 5 x-sections on this figure fall out onto the 3 map views on the same figure.

02.05.01-3

FSAR Section 2.5.1.1.3 discusses the complex, regional stratigraphy of the 200 mile regional boundary of the site.

a) The stratigraphic relationships within and between each tectonic regime is not provided, and terrane boundaries are not identified. Rock type is mixed in with rock age and is based on physiographic areas. Please provide a description of the regional stratigraphy by lithotectonic provinces or geologic belts and update the FSAR accordingly. Provide the boundaries for each lithotectonic province (fault systems) and then the internal stratigraphic relationships. Revise FSAR as needed.

b) FSAR Section 2.5.1.1.3.1 is a discussion of the Piedmont. There is no description of the northwestern and southeastern boundary of the Piedmont terrane. Please provide a clear discussion of stratigraphic relationships within the Piedmont litho-tectonic terrane and between other bordering litho-tectonic terranes.

c) The Mesozoic rift basins are discussed in the Piedmont section. Rift basins formed under a different tectonic regime. Please provide a discussion of the litho-tectonic terrane responsible for the development of extended crust and the Mesozoic rift basins and related rock.

d) The FSAR cites Figure 2.5.1-210. The explanation on the figure does not correspond to patterns on map. Please revise the explanation on the figure to match the map.

e) FSAR section 2.5.1.1.3.1.2.4 discusses Coastal Plain sediments in the Piedmont section. Coastal Plain and other Cenozoic rock formed under a completely different tectonic regime than the Piedmont. Please provide a discussion of the Coastal Plain section with boundaries and internal stratigraphic relationships.

02.05.01-4

FSAR Section 2.5.1.1.3.2 provides a discussion of the stratigraphy of the Blue Ridge.

a) The tectonic boundaries for the Blue Ridge are not provided. There are no maps or figures illustrating these relationships. Please provide a description of regional stratigraphic relationships within the lithotectonic terrane of the Blue Ridge province. Provide a figure or map illustrating these relationships. Provide a concise description of the northwest and southeast boundaries to the Blue Ridge.

b) The FSAR cites Reference 2.5.1-208. This is a WEB site of the Maryland Geological survey. The FSAR must reference official agency (NCGS) records. If the WEB site is the official agency record, then it must be preserved and retrievable if the WEB site changes at a later date.

c) The interpretation statements are very wide reaching throughout this section and there is little attribution to the original source of investigation and information. Please provide the reference to the scientists who did the original work.

d) FSAR section 2.5.1.1.3.2.1, discusses the Geochronology of Blue Ridge. There are three sentences presented about southern Appalachian basement rocks in general with no relationship to the preceding discussion of Blue Ridge stratigraphy. Please define these basement rocks with respect to the rocks discussed in previous section.

e) FSAR section 2.5.1.1.3.2.1, introduces the Mars Hill terrane for the first time. There is no geologic map to locate this feature. Please provide a geologic map to illustrate the location of the

terrane and a discussion to explain the field relations and geochronology that leads to the age estimate of this terrane.

02.05.01-5

FSAR Section 2.5.1.1.3.3 provides a discussion of the coastal Plain stratigraphy. There is no stratigraphic column illustrating relationships. The text begins by breaking out the upper, middle and lower Coastal Plain, however, the following text does not break out the formations according to those introduced categories. Provide a stratigraphic column and define what is meant by "constructional topography".

02.05.01-6

FSAR Section 2.5.1.1.4.2.1. provides a discussion of late Proterozoic to early Paleozoic basement structures.

a) The text does not provide a well defined northwest boundary to the Iapetan normal fault zone of Wheeler. Because of the potential for location of seismic sources, both the northwest and southeast boundary of this zone needs to be illustrated with the location of HAR site included.

b) The text discusses the findings of Hatcher & Lemiszki, 1998 and Hatcher et al, 1998 with respect to faults formed beneath the Blue Ridge thrust. However, there is no indication where these faults are with respect to Wheeler's southeast or northwest boundary of intact Iapetan faults. There is no illustration of the locations of the faults and boundaries. Please provide a map of features discussed in text.

c) The faults defined by the Lawrence and Hoffman paper are Paleozoic-age faults. They seem to be located incorrectly in this section? Please explain this discrepancy.

02.05.01-7

FSAR Section 2.5.1.1.4.2.2 provides a discussion about Paleozoic tectonic structures. Figure 2.5.1-214 shows that the Piedmont suture is closer to HAR than either the Brevard fault zone or the BRT. The Brevard fault essentially terminates against this fault. In addition this fault is shown to truncate against the Nutbush Creek fault.

a) The discussion of the Piedmont suture is limited to the geographic location and does not address the timing of movement or how it relates to other large fault systems with the 200 mile radius of the SHNPP. Please provide more information about this fault system from the most recent literature. Explain how it relates to the Nutbush Creek fault and to the Brevard fault zone.

b) The Brevard fault zone is a major tectonic feature in the 200 mile radius for the site and the FSAR refers the reader to the work of others for summaries of the geologic models of the Brevard Fault zone. However, the FSAR does not actually provide any review or summary of Brevard Fault zone models. Please provide a summary of current conceptual models for the Brevard Fault zone in the FSAR.

c) Figure 2.5.1-211 shows several regional faults located within the 200 mile radius of the site whose age of movement are not indicated on the figure legend nor are there discussions of these faults provided in the text. Please provide discussion of these faults and the likely age of

movement. These faults include: Nubush Creek fault, Augusta fault, Modoc zone, faults in the vicinity of the Sauratown Mtn Window, the Gold Hill and Silver Hill faults.

d) The FSAR states that most of the HAR site is located within the Atlantic Coast tectonic province. Zoback and Zoback, 1989 indicate that there is no separate stress province for the Atlantic Coastal plain. Please define this tectonic province and cite recent literature.

02.05.01-8

FSAR section 2.5.1.1.4.2.3 discusses Mesozoic tectonic structures and cites several figures.

a) Figure 2.5.1-209 does not label the Dan River, Wadesboro, Sanford and Durham basins. Please revise figure and label appropriately.

b) Figure 2.5.1-213 shows faults associated with the Triassic basins incorrectly colored. These faults should be color/labeled as Mesozoic because that is when the adjacent and associated basins were formed.

c) The Pembroke faults are discussed in text and are not included in any figure. The Eastern Piedmont fault system is included in Figure 2.5.1-213, but there is no discussion in the text about the Eastern Piedmont fault system. Please revise figure and text appropriately.

d) The Chatham fault is called out in text. However, in Figure 2.5.1-215, the Chatham fault is not identified. Please revise figure and include label.

e) The Colon cross structure and the Peking cross structures are not defined or described in the text. Define and describe these structures.

f) The FSAR states that the Jonesboro fault was probably seismologically similar to modern-day segmented, active basin-bounding normal faults in extensional tectonic settings. Please provide the basis for that statement and provide a discussion of the relevance to the HAR and any evidence for historic seismicity on this structure.

02.05.01-9

FSAR section 2.5.1.1.4.2.4 provides a discussion of Cretaceous and Cenozoic tectonic structures.

a) The FSAR introduces the Neuse hinge and Onslow and Albermarle blocks. However, these features are not defined in the text as to what they are nor are they included in any figure. Please include further details for these features.

b) The FSAR has not distinguished between the Grainger's wrench zone and the Grainger's basin area. Please clarify.

c) FSAR section 2.5.1.1.4.2.5.1 introduces a lineament observed in LIDAR data. The discussion contains numerous speculative statements about the nature and significance of the feature but does not provide details for the basis of the interpretations. Please describe the topographic expression and trenching investigations of the lineament identified by Wieczorek et al (2004) in greater detail. Include the evidence that suggests Pleistocene or Holocene movement on the fault. Explain why the results of the trenching are equivocal. How does trench evidence suggest faulting as young as Holocene?

d) The discussion about the CVSZ in the FSAR does not make any concluding statement about the CVSZ seismic zone with respect to the seismic evaluations for the SHNPP. In addition the FSAR does not cite any of the discussion or final disposition for the CVSZ developed for NUREG

1835, North Anna ESP. Please provide more information and make a concluding statement about the impact of CVSZ to SHNPP.

e) Figure 2.5.1-216 is a figure showing Quaternary features in the eastern US and shows the 200mile radius boundary of the SHNPP. The Neuse hinge, Onslow and Albermarle Blocks are discussed in text but are not indicated on this map. The features under discussion in the text are focused on a small crowded portion of the map so they are difficult to discern while trying to understand the discussion in the text. Please revised figure so that features being discussed in the text are clearly distinguished and legible. Single out the largest historical quake recorded for the CVSZ on the map.

f) Section 2.5.1.1.4.2.5, under Charleston Liquefaction features, states: "The causative fault or faults that produced this event, as well as the prehistoric events know from locations and dates of liquefaction have not been identified". The applicant provides only one reference for this section. However, there are many publications in the published literature for the Charleston Earthquake structural features, for example: Dave Amick and others; P. Talwani and others, Chapman and others, Obermeir and others. Please develop a more comprehensive discussion for these features that is more comprehensive of the scientific literature.

02.05.01-10

FSAR section 2.5.1.1.4.2.5.5 provides a discussion about the three segments of East Coast Fault System (ECFZ). The FSAR states that most of the evidence in the literature is in support of the southern segment with increasingly less support for the central and northern segments.

In order to discount the central segment of the ECFS proposed by Marple and Talwani, provide an alternative, non-tectonic interpretation or additional data to the contrary of Marple and Talwani's interpretation similar to what was presented previously for the northern segment for the North Anna ESP. Please discuss the different types of evidence used to infer late Quaternary movement on all segments of the ECFZ but specifically the central segment and the possible alternative explanation for such evidence.

In addition please provide the following:

a) There are several statements in this section that are vague and made without listing or explaining the evidence for them and without appropriate references. Examples include: "any significant geomorphic changes", "it does not seem warranted base on review of the data", "performed in this study suggest that the postulated ECFS-C may not exist, or has very low probability of activity if is does exist". Please provide related specifics for these statements.

b) The FSAR presents a major conclusion about seismic activity on the ECFS based on an EIS and an ESP (FSAR ref 2.5.1-263; FSAR ref 2.5.1-264). Please provide specific details from those documents to justify the findings stated in this FSAR such as: "The evaluation for the Vogtle ESP (Rev2) judged the ECFS-S (FSAR ref 2.5.1-264) to have a relatively low likelihood of producing Charleston-type earthquakes." Please summarize why the ECFZ-S is a possible seismic source of low likelihood; include an explanation of what low likelihood means.

c) The FSAR (p. 2.5-44) cites a sensitivity analysis performed for the North Anna site on the ECFS-N. Please provide some specific results or conclusions in this FSAR.

d) Evaluate how the types of evidence have been used along the central fault segment to argue for recent movement.

e) The FSAR states that Wheeler stated that he found no evidence for sudden uplift anywhere along the fault system. Please provide information about what criteria would be used to determine sudden uplift. What is the implication of sudden uplift to seismicity rates or size of earthquakes along the ECFS.

f) The FSAR (p 2.5-42) states: "The feature that Marple and Talwani describe as a fault or flexure in basement appears to coincide with such a merged escarpment, and it is likely that the feature is related to shoreline erosion rather than faulting." Please describe and locate on a map which basement feature from Marple and Talwani is being correlated with a buried, merged escarpment. Where exactly is the merged escarpment and how did you determine that it was shoreline erosion and not faulting.

g) Provide a discussion of how the LiDAR data affects the evaluation of features used as evidence of the ECFS.

h) Text about new LiDAR data analysis on page 2.5-42 states that there are no river anomalies save the Cap Fear River observed in this data. Other river course changes at the boundary of the ECFS-C in other rivers or tributaries are not explained in this section:

- Unnamed river (sw of Lumbar River) has sharp river course change to NE.
- South River shows sinuosity greatly increased to the west of ECFS.
- Mill Creek shows an arc to SE and back to earlier trend.
- Neuse River shows the confluence of 4 rivers at the upstream boundary as well as a sharp turn to the SW along the upstream side of ECFS boundary.

Please explain these features.

i) FSAR (p. 2.5-43) provides a discussion of paleoliquefaction sites at the SC/NC state border. For Amick et al. (1990a; Reference 2.5.1-270) the areas searched are not specified nor how those sites were selected. There is no detail about the liquefaction susceptibility for those areas. The FSAR provides no detail for the Quaternary terrace mapping project by Owens et al. (1989; Reference 2.5.1-271). Please provide more specific details for these two investigations. To what degree do these two studies preclude large earthquakes near the Harris site?

02.05.01-11

The FSAR sections 2.5.1.1.4.2.5.5 and 2.5.1.1.4.2.5.6 discuss stream profiles derived from recent LiDAR data to makes various arguments in the case of the ECFZ and the Falls Lines (FSAR Figure 2.5.1-220). The FSAR states that the LiDAR data show "no consistent vertical anomalies in the modern drainage." However, the scale of the profiles in Figure 2.5.1-220 is too small to show any anomalies that might be there. The graph does not provide a high enough resolution to support the discussion of neotectonic expression along portions of stream profiles. Neotectonic uplift is not going to be on the scale of 10s of meters. Please provide a comparison of stream profiles used by Marple and Talwani with the newly created stream profiles from the LiDAR data at the same scales. Please explain in more detail how points used to construct the profiles were measured from the imagery.

02.05.01-12

FSAR section 2.5.1.1.4.2.5.6 provides an extensive discussion of the Fall lines of Weems (1998). The FSAR cites a conclusion made in the North Anna ESP that the seven fall lines do not represent a capable tectonic source.

a) The FSAR (p 2.5-45) states that a comparison was made of the Falls Lines (Weems, 1998) with recent geologic mapping. There is no description of this mapping in the text and no reference is provided. Please provide the references and summarize the results.

b) Figure 2.5.1-220 provides the longitudinal stream profiles. The figure has omissions: H & J profiles are not mark with DFL; M profile is obscured at the point of interest by a graphics element; B profile needs to zoom in on the point of interest. Since this information is essential to follow the text please provide clarification or revision.

c) In the text (p 2.5-45), in the discussion of the DFL, a zone of mapped faults is cited as a reason for the fall line to correlate through a section close to SHNPP. The faults are shown on Figure 2.5.1-219. However, reference to the original documentation for the faults is not provided in the text. The references provided on the figure are not listed in the reference section and so are incomplete. Are these faults Mesozoic faults? What do the river terraces in this area look like with the idea of neotectonism in mind.

02.05.01-13

FSAR Ref 2.5.1-208 and Ref 2.5.1-275 cite the NCGS web site for geologic map of NC and electronic communication.

a) The web site URL as stated in the FSAR document does not actually work when typed into the URL line of a browser application. Also, the NCGS web site presents several geologic maps on the final page. Which geologic map is being referenced in the FSAR? These maps have been digitized from the original to be served up on the internet. The original and official agency document needs to be referenced. In addition the web site has a disclaimer page that states: "These images are used for internal purposes by NCDENR. We assume no responsibility to maintain the data for the recipient in any manner or form." A WEB reference for a government agency must include a reference to the official agency record. If the WEB site is the official agency record, then it must be preserved and retrievable if the WEB site changes at some later date. Explain how you will meet this requirement.

b) What does “electronic communication” mean? How do we see or examine this information? Who is responsible for the content of this information?

02.05.01-14

FSAR section 2.5.1.1.4.2.5.6 (p. 2.5-46) refers to a Paleozoic mylonitic shear zone in the discussion of the Nutbush fall line along with Parker’s (1979) reverse fault. The mylonite zone is not marked on the map. Please locate this feature on a map and explain the significance of Parker’s reverse fault.

02.05.01-15

FSAR Section 2.5.1.1.4.2.6 discusses the ETSZ & GCVSZ in this section about seismic zones.

a) The Charleston SZ is excluded. GCVSZ is within the 200mile boundary, Charleston is sitting on the 200 mile boundary and the ETSZ is outside the 200 mile boundary. Please explain why Charleston is not included in this section.

b) Figure 2.5.1-216 presents items discussed in the text in a confusing manner. Features that are liner versus zonal or areal are not represented consistently on the figure. It is hard to locate these items when reviewing the text. The figure also covers a much larger region than is

being discussed so that the items of interest are constrained to a small portion of the entire figure, making the graphic elements crowded and confusing. Please revise figure for clarity and relevance to the text.

c) In the discussion of the GCVSZ, p. 2.5-47 The FSAR concludes: “definitive evidence is lacking for a capable tectonic source and for the recurrence of large earthquakes similar to or larger than the 1897 Giles County earthquake.” What information has the applicant provided that would support the lack of evidence for the recurrence of the large earthquake. Were any paleoliquefaction studies completed within the zone?

d) FSAR 2.5.1.1.4.2.6.1 (p. 2.5-47) discusses the Pembroke faults. Underlying solution collapse and slumps are given as alternative interpretations for the origin of the Pembroke faults. Describe in more detail the supporting evidence for these nontectonic interpretations

e) In the discussion of the ETSZ, p. 2.5-47, The FSAR references information about the earthquakes to a USGS web site poster. A WEB reference for a government agency must include a reference to the official agency record. If the WEB site is the official agency record, then it must be preserved and retrievable if the WEB site changes at some later date. Explain how you will meet this requirement.

02.05.01-16

FSAR Section 2.5.1.1.4.3 (p. 2.5-51) concludes:

“Based on our independent evaluation of the geomorphic, seismic reflection, and seismicity data, our confidence in the existence and activity of the ECFS is low to moderate. In our judgment, all of the geomorphic “anomalies” have credible nontectonic (i.e., fluvial geomorphic) explanations. Our three-dimensional (3-D) analysis of microseismicity in the vicinity of the ECFS does not clearly define a discrete structure (Figure 5) [Figure 2.5.1-225]. Available seismic reflection data do not unambiguously delineate a through-going structure in the vicinity of the ECFS.”

a) This conclusion about the ECFS is not supported by the analysis provided in the text. More details about specifically what data was examined and how it supports or refutes previous investigator’s conclusions needs to be provided. Specifically, more details on the analysis of the seismic reflection data and the 3-D analysis of microseismicity. Figure 2.5.2-225 does not present a 3-D analysis of microseismicity, it only provides the x, y 2-D expression of seismicity.

b) In the section for the Adams Run fault, (p 2.5-52) reference is made to a 3-D microseismicity analysis. Please explain the 3-D microseismicty analysis.

c) In the section for the Sawmill Branch Fault,(p 2.5-52) please define the 3 features that Talwani and Katuna used in their paper. Please explain the 3-D microseismicty analysis and how the applicant reached the conclusion that the Ashley river fault and the Sawmill Branch fault are the same fault. Please discuss the errors associated with earthquake locations in the Ashley River area and provide figures of cross-sectional views of the microseismicity in relation to the local faults.

d) In the discussion of the Helena Banks fault zone, (p2.5-53) there is no explanation why Crone and Wheeler, 2000 classified the zone as C. Please clarify. Why did Wheeler 2005 eliminate the zone? It has been 6 years since the earthquake. No references are provided. Have any papers been published?

02.05.01-17

FSAR section 2.5.1.1.4.4 discusses regional gravity and magnetic data and provides Figure 2.5.1-228, a Bouguer gravity map.

a) In Figure 2.5.1-228, it is hard to determine the patterns between high and lows and the steepness of gravity gradients because the color ramp is muted and very gradational. The ideas discussed in text are not at all obvious on the figure. The graphic element added to the map is very clear but it also obscures examination of the real data. Please revise the figure for clarity and relevance to the text.

b) FSAR section 2.5.1.1.4.4.1 (p 2.5-61) discusses gravity data. The Kane and Godson citation points out that there are 2 sub-parallel chains of elongate highs on the gravity map. The description of the significance of these features is unclear. Please clarify.

c) FSAR section 2.5.1.1.4.4.2 (p 2.5-62) discusses magnetic data and states: "Most anomalies on the gravity map are attributed to sources in the crystalline basement, whereas the magnetic anomalies are attributed to sources in the crystalline basement, volcanic units within a kilometer or so of the surface, or igneous intrusions (Reference 2.5.1-319)". This statement is confusing. Please clarify.

d) FSAR section 2.5.1.1.4.4.2 (p 2.5-63) states: "The aeromagnetic map of North Carolina, at a scale of 1:1,000,000, reveals more detailed features of the study region (Reference 2.5.1-330)." This figure is not provided in the FSAR. Please provide a figure of the map cited.

02.05.01-18

FSAR section 2.5.1.2.2, covers many topics about the geologic history of the site at the area scale. Specifically:

a) The FSAR (p. 2.5-65) states: "Amygdules in some of the dikes at current surface levels in the site vicinity indicate that the dikes were intruded when the ancestral surface was less than about 300 m (1000 ft) above the present surface. This association indicates that a major period of erosion followed deposition of the original thicknesses of Triassic sediments, but occurred before intrusion of the diabase dikes". Please explain in more detail how this interpretation is made.

b) The FSAR (p. 2.5-66) states: "This episode of movement on the Harris fault and other faults; the folding of the Triassic rocks to form the Colon cross structure and other, more minor folds; and intrusion of diabase dikes all took place during Late Triassic-Jurassic time". Please provide further explanation of the formation of these structures, where they are located with respect to one another and how the age was determined.

c) The FSAR (p. 2.5-66) states: "Emplacement of a pluton of granitic rock a few miles east of the site may have occurred late in the history of movement on the Jonesboro fault. The pluton is expressed on the gravity map of the Triassic basin, on the aeromagnetic map, and in side-looking airborne radar (SLAR) imagery". Please provide further explanation of the pluton: where is it on a map, what is the tectonic significance with respect to the Jonesboro fault.

d) The FSAR (p. 2.5-66) states: "Little movement took place on the Harris fault after intrusion of the youngest dikes, which are Jurassic in age". Please provide clarification: what dikes are the oldest and what dikes are the youngest.

e) FSAR Section 2.5.1.2.2, (p. 2.5-65 to 67) provides a discussion of the Mesozoic period at the site geology scale. Please provide an integrated and straightforward explanation about the

evolution from Triassic basin sedimentation to burial and burial-metamorphism, to erosion, and then Coastal Plain deposition. Please include appropriate references, currently there are none.

f) FSAR Section 2.5.1.2.2, (p. 2.5-67) states: "The depth of Jurassic burial was relatively great or the burial spread over much of the Piedmont, because subsequent erosion of this material and the underlying Piedmont and rejuvenated Appalachian rocks has furnished about 600 million cubic miles of sediment to the Coastal Plain, more than half of it Cretaceous in age". Please provide a reference for this claim. This statement covers a lot of different geologic 'ground.' Distinguish the different sources for the Coastal Plain sediments and explain the basis of the sequence of events: Jurassic age sediments, followed by Piedmont erosion, followed by rejuvenated Appalachian rocks. Define Appalachian rocks.

g) FSAR Section 2.5.1.2.2, (p. 2.5-67) states: "Following the Jurassic metamorphic event, erosion of large quantities of sediments from the Triassic basin resulted in deposition of great quantities of Late Jurassic-Cretaceous marine sediments in the Coastal Plain….." and later "Since the Late Jurassic period, less than 300 m (1000 ft) of Triassic rocks have been eroded." These statements seem to contradict each other, please clarify.

h) FSAR Section 2.5.1.2.2, (p. 2.5-67) states: "Because the Jonesboro and other faults do not offset these materials, and to the north appear to offset only slightly a dike of Jurassic age, last movement on the Jonesboro and Harris faults took place no more recently than the Late Jurassic". This is an important conclusion and there are no references provided. Please provide appropriate references.

i) FSAR Section 2.5.1.2.2, (p. 2.5-67) states: "Younger sediments associated with higher stands of sea level, such as during the Cretaceous and Cenozoic, are preserved in some areas of the site vicinity, and Quaternary terrace deposits occur along the Cape Fear River". What are the geologic units that are preserved in the site vicinity. Please indicate where they are on a map. Are they located near any interpreted faults, folds or lineaments?

j) FSAR Section 2.5.1.2.2, (p. 2.5-67) states: "Possible [Pliocene or Pleistocene] faulting was recognized at only one locality within the site vicinity, approximately 23 km (14 mi.) from the HAR site where upland gravels of unknown age are thrust over metamorphic rocks [Reference 2.5.1-228]." Please provide more details about the "possible Pliocene or Pleistocene faulting". What evidence, if any, constrains the age of the gravels?

02.05.01-19

FSAR Section 2.5.1.2.3.2 provides a lengthy discussion of the Triassic rock at the scale of site area geology.

a) The document does not contain a stratigraphic column or a correlation chart. The Regional stratigraphic column, Figure 2.5.1-208, is outdated and needs revision with respect to material covered in the FSAR text. Please develop a set of panels (conceptual if that is all you have) that includes the Coastal Plain Section, Triassic formations and lithofacies assoc., and the rocks of the Piedmont province. Since the most important portion of the stratigraphy deals with Triassic rock, illustrate the relationship from Newark Supergroup through the Chatham Formation at the Deep River basin scale to Lithofacies association at the Durham basin local scale.

b) The FSAR presents 2 completely different types of stratigraphy for the Triassic basin rock: a classic lithostratigraphic description of formations and a recently completed Lithofacies association. The formation discussion relates associations across subbasins and also

provides the dimension of depth and time into consideration. The lithofacies approach does not describe either the aspect of depth or time. Does the lithofacies as mapped reflect the paleo-environment of deposition at the end of the Jurassic? Please provide further explanation about the relationship between the two types of analysis.

c) FSAR Section 2.5.1.2.3.2.4 (p. 2.5-73) states that the Triassic basin sediments at the site are variable both laterally and with depth and that this is due to the mechanisms of deposition of the Triassic basin environment. The geologic mapping of NCGS indicates that the HAR is sited on their Lithofacies association II which is a meandering fluvial system flowing into a deltaic and lacustrine environment (FSAR Figure 2.5.1-233). This paleo-environment would likely produced variable sediment types that change abruptly in the lateral dimension but would not typically have steeply dipping strata. The FSAR refers the reader to cross sections of rock that show inclined lithologic layers that are dipping about 14 degrees when vertical exaggeration is taken into account.

1. How does the interpretation in these cross sections integrate with the geologic lithofacies association completed by NCGS?

2. At what depths would you expect to encounter the contact between Lithofacies association II and Lithofacies association I and III?

3. How would you explain the dipping strata in the FSAR cross sections, and changing lithology with respect to shear wave velocity measurements taken for geotechnical evaluations?

d) FSAR Section 2.5.1.2.3.24 (p. 2.5-73) states: "Thicknesses of individual strata or beds typically range from a few centimeters (few inches) to several meters (tens of feet). Although the beds are variable in thickness and extent, the beds typically transition compactly into one another and typically exhibit no structural weakness." Explain how you evaluated the presence or absence of structural weakness and what do you mean by transition compactly.

02.05.01-20

FSAR Section 2.5.1.2.4 provides a discussion of the structural geology at the site area scale. Several faults near the HAR are covered in this section.

a) FSAR (p. 2.5-77) states that the eastern boundary of the Deep river basin is step faulted. Do you mean the western boundary of the basin?

b) FSAR (p. 2.5-78) states: "West/northwest-east/southeast-trending faults east of the Jonesboro fault are brittle faults that dip 60 to 70 degrees to the north or south and commonly are characterized by quartz breccia zones. These faults are associated with extension and opening of Mesozoic basins". Provide a reference for the stated interpretation.

c) FSAR (p. 2.5-79) states: "Vertically aligned cobbles and clastic dikes and pillar structures in the Durham basin suggest that ground shaking and liquefaction accompanied some large paleoseismic events along the Jonesboro fault during deposition of Triassic sediments in the adjacent basin (Reference 2.5.1-339)". Provide further explanation of why this is evidence of paleoliquefaction.

d) The FSAR (p. 2.5-80) provides a discussion of fracture and joints in the site area with respect to the local faults. The numerous sets of joint orientations are described in difficult to understand manner. Please provide rose diagrams or stereo net projection diagrams for the joint and fracture data discussed in the text. Keep the data separated/segregated per study area, such as the Low Level Radiological Waste site (LLRW), the Borrow pits, auxiliary dam,

etc. Some of these data need to be added to the geologic maps to enable examination of the relationship to the local geology and to each group of joints.

f) FSAR (p. 2.5-80) states: “Faulting and fault-related folding were revealed in the south borrow pit by changes in the orientation of bedding.” Is the fault seen in field exposure or is it inferred from analysis of bedding plane attitude? Please provide more details along with structural measurements (strike and dip on a geologic map).

g) FSAR states: “The South Borrow Pit fault (SBPF) is characterized by breccia, foliated breccia, and clay gouge.” Are there photographs available to show the fault in the field setting along with the location of the breccias and gouge within the rock?

h) FSAR states: “Map units in the hanging wall of the SBPF form an outcrop-scale syncline having an east/southeast-plunging axis parallel to the SBPF.” Please explain further by providing structural data on a map to illustrate the syncline.

i) FSAR (p. 2.5-82) states: “Examination of the strata adjacent to the W8 fault, regional relations, and seismic reflection data suggest that the W8 fault and other nearby, smaller north-south-trending faults were last active in the Triassic, but did not produce surface rupture”. Please explain how these data were used to constrain age of movement.

j) FSAR states: “Drag along the fault is revealed as a change in the orientation of bedding from easterly to westerly across the fault within the fault zone”. Provide further explanation about what this statement means including and illustration of structural measurements on a geologic map.

k) FSAR (p. 2.5-82) states: “Figure 2.5.1-236 presents a schematic block diagram showing a conceptual structural model of the faults discussed previously”. Please revise this figure so that it can be related to the discussion in the text. Specifically the ‘A’ panel is not legible and doesn’t have the HAR located for orientation and the ‘B’ panel is confusing and it is unclear what it is attempting to illustrate.

02.05.01-21

FSAR Section 2.5.1.2.4.1 (p. 2.5-83) discusses the geophysical studies of structural features that were discussed previously in section 2.5.1.2.4. The gravity map being discussed in this section is not illustrated and the discussion in the text cannot be followed without that map. Please provide a figure for this discussion.

02.05.01-22

FSAR Section 2.5.1.2.4.1.3 (p. 2.5-87) provides a discussion of the Jonesboro fault based on seismic reflection data. The Figure 2.5.1-241 called out in the text is an interpretive drawing of the seismic reflection line, not the actual seismic data. Please provide 2 additional figures that have the portion of interest in an un-interpreted seismic reflection line and a reflection line with the major points discussed in text drawn in.

02.05.01-23

FSAR Section 2.5.3 (p. 2.5-198) discusses seismic reflection studies at the site area scale.

a) The FSAR states that seismic refraction survey lines were shot to find evidence for surface faulting on the Harris fault and figure 2.5.3-201 is referenced. The geophysical lines, as indicated in map explanation, did not cross the interpreted Harris fault trace. Please clarify if there are seismic refraction lines that were not plotted on that map.

b) The FSAR states that: "The results of this study are well documented in a report by Ebasco Services, Inc. (Reference 2.5.3-202)". The pertinent material from that report needs to be included in this document. Please provide a detailed summary of that previous work, evaluated in terms of current scientific knowledge. The previous work needs to be integrated with the current work, under headings of the specific faults or structures being discussed so that all evidence past and present is one paragraph or section.

c) Figure 2.5.1-230 is a site vicinity scale geologic map. It does not show the location of the minor faults exposed in igneous and metamorphic rock at the Main Dam, 5 mi south of SHNPP. Please revise figure.

02.05.01-24

FSAR section 2.5.3.2.1.1 (p. 2.5-200) concludes that the Jonesboro fault is not capable mostly based on documents that are old: the Carolina Power and Light Co. 1983 report, Ebasco Services (1975) report, and Prowell, 1983. Then the FSAR states: "More recent studies do not reveal any evidence of faulting in Cretaceous or younger sediments on the Jonesboro fault (Reference 2.5.3-208). Field and aerial reconnaissance reveal little to no geomorphic expression of the Jonesboro fault to suggest reactivation of the fault in the contemporary tectonic environment, and there are no known localities at present where the fault is exposed (Figure 2.5.3-205). Field and aerial reconnaissance investigations conducted for this study confirm the observations and conclusions cited in the HNP FSAR that indicate the Jonesboro fault is not a capable tectonic source."

a) The "more recent studies" cited is unpublished NCGS geologic mapping with a nebulous date of May 25, Sept 8 and Oct 10, 2006. Please provide more details about this mapping so that NRC staff can understand what was actually done. Include figures. Since this mapping is unpublished how is this information an official agency record? Has it been peer reviewed at the NCGS?

b) Who did the field and aerial reconnaissance, HAR or NCGS? What was examined and what criteria were used to determine 'no expression'.

02.05.01-25

FSAR section 2.5.3.2.1.2 (p. 2.5-201) is about the Harris fault. The entire section about the Harris fault is based on two references: Reference 2.5.3-202, Reference 2.5.3-201, from 1975 and 1983.

a) Are there more recent studies that have been completed? If there are not, the FSAR should specifically state that the applicant looked and found none more recent or did no further work.

b) Please include one typical trench map from the original investigation of the Harris fault.

c) What marker horizon proved to be the most continuous? Please provide one example of a geophysical /geological log correlation across the fault.

02.05.01-26

FSAR section 2.5.3.2.1.4 (p. 2.5-203) discusses the work that NCGS did on the Borrow pit faults. There are some confusing statements in this section that need clarification.

a) Why are there 2 names for each fault, in the text and on figure 2.5.3-201?

b) Please explain how the faults are interpreted with respect to field data, how shear sense is determined, and how timing on the fault is determined.

c) If the faults are solely inferred from orientation of bedding planes as stated in the text, then a close-up field map with outcrop locations and associated strike and dip measurements need to be provided.

d) Explain “longitudinal normal faulting”.

02.05.01-27

FSAR section 2.5.3.2.1.5 (p. 2.5-204) discusses the faults exposed at the LLRW Disposal Site. The text states: “A comparison was made between topographic lows and faulting at the LLRW disposal facility site. Many of the topographic lows appear to be controlled by stratigraphy rather than by structure. Saddles and strike-parallel drainages tend to be underlain by fine-grained units such as mudstones and ridges tend to be associated with sandstone units (Reference 2.5.3-204).” The figure provided for this section, 2.5.3-201, does not illustrate the topographic highs and lows that the text speaks to when examining the faults for evidence of recent movement. Please provide an additional figure that shows how this interpretation is possible or revise figure -210.

02.05.01-28

FSAR section 2.5.3.2.1.6 (p. 2.5-204) discusses several un-named faults in the site area (5 miles).

a) Please provide a map at the proper scale to demonstrate the items discussed in text.

b) Provide a table of all these un-named faults that provides character of fault, data available for interpretation; best estimate of timing on movement.

c) The applicant has not consistently provided a concluding statement for all the foregoing fault discussions about the age of last movement or the likelihood of the fault being active. Please provide that information.

02.05.01-29

FSAR section 2.5.3.2.2 (p. 2.5-206) discusses the lineament analysis and identifies the possible extension of several close-by faults to HAR as well as the description of a new structural element that may carry some significance to the site.

a) The FSAR states that: “The possible eastward extension of the Harris fault, as well as the SBPF and W82 faults, characterized in the LLRW disposal facility site to the west all appear to coincide with a set of generally east-to-west trending lineaments having regional extent (Figure 2.5.3-203).” If the LiDAR lineaments extend the traces of the nearby LLRW and Harris faults, please explains what additional investigation has the applicant completed to determine the veracity of this conclusion?

b) The FSAR states that bedding in the Fire Pond Lineament area strikes N15E with dips of 17 to 30° to the NE. Do you mean with dips to the NW or SE. Dips to the NE are not possible.

c) In the Results of Lineament analysis, the FSARstates that many new lineaments were interpreted with the new, higher-resolution LiDAR data. One lineament, oriented N85W, warranted field checking and this is now identified as the Fire Pond lineament (FPL). The FSAR provides a map with the hillshade base layer with the interpreted FPL (FSAR Figure 2.5.3-207) and a photo of a rock fracture or joint, the outcrop expression of that lineament. The fracture is described as 'open'. The FSAR indicates that this lineament lies just north of 3 and is sub-parallel to the Harris fault. This lineament is extended to the east, to the Jonesboro fault and tied it in with the northern end of an approximately 5-km (3-mi.) wide zone of hanging wall deformation associated with the Jonesboro fault and defined by small normal faults identified in Texaco (Reference 2.5.3-216) seismic line 85SD12 (Figure 2.5.1-241).

- Please provide further explanation along with illustration how the FPL can be extended east in the LIDAR data to the Jonesboro fault.
- What is the implication for the FPL with connecting it with deformation associated with the Jonesboro fault.
- Reference a map to show where the Texaco 85Sd12 seismic reflection line is located. Provide a full reference for this seismic reflection data. Provide an un-interpreted seismic reflection line figure.
- Do the FPL and the Harris fault merge?
- Can the FPL be interpreted as a fault?

d) Examination of Figure 5.2.1-230 suggests that the projection of both structural features (FPL and Harris extended fault) may intersect a group of folds (NW axial plane strike). Are the antithetic hanging wall faults of the Jonesboro fault and these folds the same feature?

e) The applicant correlated/projected the hanging wall deformation of the Jonesboro fault back to the HAR site and located HAR 2 and 3 in this zone between the Harris fault and the FPL. Is there direct evidence to do make this interpretation or is it speculation?

f) There seems to be no seismic data (reflection or refraction) lines that actually cross the Harris fault normal to strike nor including the FPL. Please identify any seismic refraction or reflection lines completed normal to the Harris fault and the FPL If there are none how do you determine if the hanging deformation associated with the Jonesboro fault and implied for Harris fault and the FPL is present or not?

g) The applicant has not provided a concluding statement about the significance of these features (Harris fault, FPL and Jonesboro fault) and the correlation with the regional features. Further explanation is needed to explain the analysis and pull it together in one place in the FSAR. Appropriate scale maps and cross sections must be included that contain all the features discussed in the analysis.

02.05.01-30

FSAR Section 2.5.3.4 (p. 208) discusses ages of most recent deformations in the study area.

a) Please provide a concluding statement about the FPL with respect to age of formation and significance.

b) Please provide a concluding statement about the FPL's relationship to regional structures.

02.05.01-31

FSAR 2.5.3.6 (p. 209) provides a concluding discussion about all the possible capable tectonic sources. The last 2 bulleted items have not been fully developed in the previous sections and so these concluding statement need more justification.

a) The FSAR has not illustrated how the identified FPL must be interpreted as non-tectonic. What bedrock unit is less resistant and where is that unit mapped with respect to the FPL. What pre-exisitng structure is the FSAR referring to?

b) The FSAR states that folds and faults associated with the Harris fault and expressed as lineaments are not capable tectonic sources. Each fault or lineament that the FSAR has associated with the Harris fault must have its own unique assesment that it is not capable whether by direct or indirect evaluation. The FPL has not been completely evaluated with respect to the possibility that the feature may be a fault associated not only with the Harris fault but also with the Jonesboro fault.

c) The FSAR states "Excavation exposures for HAR safety-related facilities will be mapped in detail and the surface rupture and ground motion generating potential of any deformation features identified will be assessed." Are there plans to excavate a trench across the FPL?