Progress Energy

Serial: NPD-NRC-2009-002
January 8, 2009

10CFR52.79

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 2 AND 3
DOCKET NOS. 52-022 AND 52-023
SUPPLEMENT 1 TO RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 018 RELATED TO VIBRATORY GROUND MOTION

References: Letter from Manny Comar (NRC) to James Scarola (PEC), dated September 25, 2008, "Request for Additional Information Letter No. 018 Related to SRP Section 02.05.02 for the Harris Units 2 and 3 Combined License Application"

Letter from Garry D. Miller (PEC) to U.S. Nuclear Regulatory Commission (NRC), dated December 9, 2008, "Response to Request for Additional Information Letter No. 018 Related to Vibratory Ground Motion", Serial: NPD-NRC-2008-049

Ladies and Gentlemen:

Progress Energy Carolinas, Inc. (PEC) hereby submits our response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A partial response to the NRC request is provided in Enclosure 1. An initial submittal of responses was provided by letter dated December 9, 2008. An additional submittal is planned by February 5, 2009 to provide the remaining responses. See page 1 of Enclosure 1 for details. Enclosure 1 also identifies changes that will be made in a future revision of the Shearon Harris Nuclear Power Plant Units 2 and 3 (HAR) application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (919) 546-6107.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on January 8, 2009.

Sincerely,

Garry D. Miller
General Manager
Nuclear Plant Development

Enclosures/Attachments

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NRO

Progress Energy Carolinas, Inc.
P.O. Box 1551
Raleigh, NC 27602

cc: U.S. NRC Director, Office of New Reactors/NRLPO
U.S. NRC Office of Nuclear Reactor Regulation/NRLPO
U.S. NRC Region II, Regional Administrator
U.S. NRC Resident Inspector, SHNPP Unit 1
Mr. Manny Comar, U.S. NRC Project Manager

**Shearon Harris Nuclear Power Plant Units 2 and 3
Response to NRC Request for Additional Information Letter No. 018 Related to SRP Section 02.05.02 for the Combined License Application, dated September 25, 2008**

NRC RAI #	Progress Energy RAI #	Progress Energy Response
02.05.02-1	H-0097	Response enclosed – see following pages
02.05.02-2	H-0098	Response enclosed – see following pages
02.05.02-3	H-0099	Response enclosed – see following pages
02.05.02-4	H-0100	Response enclosed – see following pages
02.05.02-5	H-0101	December 9, 2008; NPD-NRC-2008-049
02.05.02-6	H-0102	Response enclosed – see following pages
02.05.02-7	H-0103	Future submittal – expected by 2/5/09
02.05.02-8	H-0104	December 9, 2008; NPD-NRC-2008-049
02.05.02-9	H-0105	Response enclosed – see following pages
02.05.02-10	H-0106	Future submittal – expected by 2/5/09
02.05.02-11	H-0107	Response enclosed – see following pages
02.05.02-12	H-0108	Future submittal – expected by 2/5/09
02.05.02-13	H-0109	December 9, 2008; NPD-NRC-2008-049
02.05.02-14	H-0110	Response enclosed – see following pages
02.05.02-15	H-0111	Response enclosed – see following pages
02.05.02-16	H-0112	December 9, 2008; NPD-NRC-2008-049
02.05.02-17	H-0113	December 9, 2008; NPD-NRC-2008-049
02.05.02-18	H-0114	December 9, 2008; NPD-NRC-2008-049

Attachments/Enclosures	Associated NRC RAI #	Pages Included
October 4, 2008 e-mail	02.05.02-4	1 page
Figure 2.5.2-221 (Revised)	02.05.02-11	1 page
RAI 02.05.02-14 Figure 1	02.05.02-14	1 page
RAI 02.05.02-14 Figure 2	02.05.02-14	1 page
RAI 02.05.02-14 Figure 3	02.05.02-14	1 page
RAI 02.05.02-14 Figure 4	02.05.02-14	1 page
RAI 02.05.02-15 Figure 1	02.05.02-15	1 page
RAI 02.05.02-15 Figure 2	02.05.02-15	1 page
RAI 02.05.02-15 Figure 3	02.05.02-15	1 page

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-1

Text of NRC RAI:

Section 2.5.2.1.1 does not provide any information on how m_b magnitudes were calculated for earthquakes added to the EPRI catalog. Please describe the methodology used to determine m_b magnitudes for all seismic events added either to extend or to update the original EPRI catalog.

PGN RAI ID #: H-0097

PGN Response to NRC RAI:

As indicated in FSAR Subsection 2.5.2.1.1, the primary source of the updated earthquake catalog for the HAR site was the earthquake catalog developed as part of the Bellefonte Geotechnical, Geological, and Seismological (GG&S) studies (Reference 2.5.2-208). There were four primary sources of earthquakes added to the original EPRI-SOG (Reference 2.5.2-201) catalog: the NCEER-91 catalog (Reference 2.5.2-205) as updated by the US Geological Survey (Reference 2.5.2-207), the compilations of Metzger (Reference 2.5.2-209) and Metzger et al. (Reference 2.5.2-210), and the compilation of Munsey (Reference 2.5.2-211). The process used in the Bellefonte GG&S studies (Reference 2.5.2-208) to assign m_b magnitudes to earthquakes added to the EPRI-SOG (Reference 2.5.2-201) was as follows.

- The magnitude scale used in the USGS 2002 seismic hazard mapping catalog (Reference 2.5.2-207) is m_b and earthquakes added from that source were assigned the m_b listed there.
- The compilations of Metzger (Reference 2.5.2-209) and Metzger et al. (Reference 2.5.2-210) list maximum intensities and in some cases felt areas for the earthquakes and derive moment magnitudes, **M**, from these values. For earthquakes with only maximum intensities taken from Metzger (Reference 2.5.2-209) and Metzger et al. (Reference 2.5.2-210), three conversions from maximum intensity to m_b were used:
  - the relationship of Sibol et al. (Reference RAI 02.05.02-01 01)

    $$m_b = 2.37 + 0.0466\times(MMI_{max})^2 \qquad \text{(RAI 2.5.2-1-1)}$$
  - the relationship developed by EPRI-SOG (Reference 2.5.2-201)

    $$m_b = 0.61\times MMI_{max} + 0.78 \qquad \text{(RAI 2.5.2-1-2)}$$
  - conversion of the estimated value of **M** into m_b using Woods (Reference RAI 02.05.02-01 02)

    $$m_b = \mathbf{M} + 0.36 \qquad \text{(RAI 2.5.2-1-3)}$$

  The average of these three values was adopted as the estimated m_b.

For earthquakes with felt areas reported in Metzger (Reference 2.5.2-209) and Metzger et al. (Reference 2.5.2-210), three conversions from felt area, *FA* in km^2, to m_b were used.

- Sibol et al. (1987) provides the relationships:

$$m_b = 1.46 + 0.576 \times \log_{10}(FA) \qquad \text{(RAI 2.5.2-1-4)}$$

and

$$m_b = 2.59 + 0.0688 \times [\log_{10}(FA)]^2 \qquad \text{(RAI 2.5.2-1-5)}$$

- The EPRI-SOG study (Reference 2.5.2-201) developed a piece-wise linear relationship between m_b and ln(*FA*)

$$\begin{aligned}
m_b &= 0.701 + 0.331 \times \ln(FA) && \text{for } \ln(FA) < 11 \\
m_b &= 0.895 + 0.314 \times \ln(FA) && \text{for } 11 \le \ln(FA) < 13 \\
m_b &= -2.330 + 0.562 \times \ln(FA) && \text{for } 13 \le \ln(FA) < 14 \qquad \text{(RAI 2.5.2-1-6)} \\
m_b &= -7.774 + 0.951 \times \ln(FA) && \text{for } 14 \le \ln(FA) < 15 \\
m_b &= -21.645 + 1.875 \times \ln(FA) && \text{for } 15 \le \ln(FA) < 16
\end{aligned}$$

The m_b estimates produced by the two Sibol et al. (Reference RAI 02.05.02-01 01) relationships were averaged, and then the result averaged with the EPRI-SOG estimate to produce the final m_b value.

- The compilation of Munsey (Reference 2.5.2-211) provided estimates of maximum intensity. For consistency, these estimates were converted into m_b using the same approach that was used for the Metzger (Reference 2.5.2-209) and Metzger et al. (Reference 2.5.2-210) compilation. This required estimating seismic moment, M_o, from maximum intensity using the relationship from Johnston (Reference RAI 02.05.02-01 03).

$$\log_{10}(M_o) = 19.36 + 0.481 \times (MMI_{max}) + 0.0244 \times (MMI_{max})^2 \qquad \text{(RAI 2.5.2-1-7)}$$

and then obtaining **M** using Hanks and Kanamori (Reference 2.5.2-214).

Finally, earthquakes were added to the Bellefonte GG&S earthquake catalog (Reference 2.5.2-208) to extend the time period from February 2005 through December 2006 using the listing of recent earthquakes obtained from the Advanced National Seismic System (ANSS) Website (Reference 2.5.2-212). The values of m_b listed in the ANSS catalog were used in the HAR catalog.

<u>Supporting References for Response</u>:

Reference RAI 02.05.02-01 01

Sibol, M.S., G.A. Bollinger, and J.B. Birch, 1987, Estimation of Magnitudes in Central and Eastern North America Using Intensity and Felt Area,. Bulletin of Seismological Society of America. Vol. 77. No. 5. pp. 1635-1654.

Reference RAI 02.05.02-01 02

Woods, B.B., 2003, Revising U.S. Moment Catalog to Lower Magnitudes, U.S. Geological Survey External Research Program Final Technical Report Award #01-HQ-GR-0158. 43 pp. July 11.

Reference RAI 02.05.02-01 03

Johnston, A., 1996, Moment magnitude assessment of stable continental earthquakes, Part 2: historical seismicity, Geophysical Journal International, v. 125, pp. 639-678

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

None.

NRC Letter No.: HAR-NRC-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-2

Text of NRC RAI:

Section 2.5.2.1.1 states that seismic moments are listed in the table provided in Appendix 2AA. However, the table in Appendix 2AA does not include any moment values. Please update the catalog by adding moment magnitudes and the seismic moment values mentioned and provide an electronic copy of the final earthquake catalog.

PGN RAI ID #: H-0098

PGN Response to NRC RAI:

The values of average **M** and M_o will be added to the table provided in Appendix 2AA. The catalog has also been reduced to only the events within 200 miles of the Harris site (see response to RAI 02.05.02-18 in PEC letter to NRC dated December 9, 2008, serial: NPD-NRC-2008-049).

In the revised table, the moment magnitude for the 1886 Charleston earthquake is taken to be the weighted average of the moment magnitude estimates for the 1886 Charleston earthquake contained in SNC (Reference 2.5.2-230). Moment magnitude estimates for seven other earthquakes (1852/04/09, 1861/08/31, 1875/12/23, 1897/05/31, 1912/06/12, 1913/01/01, and 1969/11/20) are provided in Johnston et al. (Reference 2.5.2-213). These values are used in Appendix 2AA. For the remaining earthquakes within 200 miles of the HAR site, moment magnitudes were computed using the three m_b to **M** conversions used in the PSHA for the HAR site. These are the relationships:

by Atkinson and Boore (Reference 2.5.2-241),

$$\mathbf{M} = -0.39 + 0.98m_b \qquad \text{for } m_b \leq 5.5$$

(RAI 2.5.2-2-1)

$$\mathbf{M} = 2.715 - 0.277m_b + 0.127m_b^2 \qquad \text{for } m_b > 5.5$$

by Johnston (Reference 2.5.2-242):

$$\mathbf{M} = 1.14 + 0.24m_b + 0.0933m_b^2 \qquad \text{(RAI 2.5.2-2-2)}$$

extended to magnitudes less than m_b 4.5 using **M** = -0.39 + m_b, and by EPRI (Reference 2.5.2-243):

$$m_b = -10.23 + 6.105\mathbf{M} - 0.7632\mathbf{M}^2 + 0.03436\mathbf{M}^3 \qquad \text{(RAI 2.5.2-2-3)}$$

The resulting values were then averaged to provide the value of **M** listed in the revised Appendix 2AA. The logarithm of the seismic moment is computed from the average moment magnitude using Hanks and Kanamori (Reference 2.5.2-214) formula.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future revision:

1. Replace FSAR Appendix 2AA in its entirety. See Response to HAR RAI 02.05.02-18 in PEC letter to NRC dated December 9, 2008, serial: NPD-NRC-2008-049.

2. Revise FSAR Section 2.5.2.1.2 description of October 22, 1886 earthquake from:

   "An average moment magnitude of 4.81 is computed from m_b using different conversion equations, and a seismic moment of 2.04×10^{23} dyne-cm is computed from the estimated moment magnitude using the Hanks and Kanamori formula (Reference 2.5.2-214)."

   To read:

   "An average moment magnitude of 4.7 is computed from m_b using different conversion equations, and a seismic moment of 1.4×10^{23} dyne-cm is computed from the estimated moment magnitude using the Hanks and Kanamori formula (Reference 2.5.2-214)."

3. Revise FSAR Section 2.5.2.1.2 description of June 12, 1912 earthquake from:

   "The maximum intensity in the epicentral area is quantified as VII in the MMI scale from which EPRI determined a moment magnitude (**M**) of 4.5 (corresponding to a seismic moment of 7×10^{22}), which was subsequently converted to m_b 4.9 (Reference 2.5.2-213)."

   To read:

   "The maximum intensity in the epicentral area is quantified as VII in the MMI scale from which Johnston et al. (Reference 2.5.2-213) estimated a moment magnitude (**M**) of 4.5 (corresponding to a seismic moment of 6.3×10^{22} dyne-cm). The estimated m_b is 4.9."

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-3

Text of NRC RAI:

Section 2.5.2.4.1.2 states that adjusted magnitudes, m_b*, were used in computing earthquake recurrence parameters. However, the seismic catalog provided in Appendix 2AA also introduces a term called "Final m_b". The distinction between the definitions of "m_b*" and "Final m_b" listed in the catalog is not clear. Please explain the differences in these two notations.

PGN RAI ID #: H-0099

PGN Response to NRC RAI:

The term "Final m_b" refers to the best estimate of the actual m_b magnitude for the earthquake. It is equivalent to the EMB magnitudes reported in the EPRI-SOG catalog (Reference 2.5.2-201) and denoted as E[m_b] in the text of Reference 2.5.2-201. The relationship between m_b (Final m_b) and m_b* is defined in FSAR Subsection 2.5.2.1.2 by Equation (2.5.2-1)

$$m_b^* = m_b - \beta\sigma^2_{m_b|m_b\,instrumental}/2 \qquad (2.5.2\text{-}1)$$

when m_b is based on instrumentally recorded m_b magnitudes and by Equation (2.5.2-2)

$$m_b^* = m_b + \beta\sigma^2_{m_b|X}/2 \qquad (2.5.2\text{-}2)$$

when m_b is based on other size measures X, such as maximum intensity, I_0, or felt area (Reference 2.5.2-201). Note that in these equations β is the Gutenberg-Richter b-value in natural log units ($\beta = \ln(10) \times b$].

Appendix 2AA is being revised in response to RAI 02.05.02-02 and RAI 02.05.02-18. In that revision the column heading "Final m_b" will be replaced by "m_b" for clarity.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future revision:

1. Revise label for 11th column of Appendix 2AA of FSAR from:

   "Final m_b"

   To read:

   "m_b"

Attachments/Enclosures to Response to NRC:

None.

NCR Letter No.: HAR-NRC-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-4

Text of NRC RAI:

Section 2.5.2.1.2 describes the uncertainty associated with the location of one of the significant earthquakes, the January 8, 1817, event with an estimated magnitude m_b = 5.0, identified in the HAR earthquake catalog. The EPRI catalog places this event about 145 km to the west of the HAR site. However, the location was significantly revised by later studies. The NCEER-91 (National Center for Earthquake Engineering Research) Catalog places this event off shore about 1000km east of the HAR site. Yet, the USGS catalog places it near Charleston, about 300 km south of the HAR site. You used the USGS location in your safety analysis. However, this location appears to be in conflict with the earthquake's felt area reports. While the felt area from this earthquake, as reported in Section 2.5.2.1.2, stretches from Milledgeville, GA, to Baltimore, MD, this reassigned location near Charleston is significantly closer to the southern end of the felt area. The northern end of the felt area is about 800km away from this location. Please provide further justification for relocating this event in the Charleston area and discuss how you account for this apparent discrepancy between the epicenter location and the felt area reports. Given the uncertainty in the location of this event, also provide a discussion about the potential impact on hazard at the HAR site, if the location were to be at the approximate center of the felt area, as it is normally observed in felt area/earthquake location studies.

PGN RAI ID #: H-0100

PGN Response to NRC RAI:

As discussed in FSAR Subsection 2.5.2.1.2, the location of the January 8, 1817 earthquake is highly uncertain.

- The current location in the USGS catalog is at Charleston, SC with a reference to Stover and Coffman (Reference 2.5.1-279). The location in Stover and Coffman (Reference 2.5.1-279), 32.9°N, 80°W, is attributed to Bollinger and Visvanathan (1977). Figure RAI 2.5.2-4-1 shows the map of intensity data presented in Bollinger and Visvanathan (1977), who list the event location as "Charleston".
- The EPRI-SOG (Reference 2.5.2-201) location, 36°N, 80.2°W, is roughly in the middle of the felt area.
- MacCarthy (1957) indicates an earthquake "felt in the Winston-Salem," NC area on that date, MacCarthy (1961) indicates that "the epicenter appears to have been quite close to Charleston," and MacCarthy (1964) indicates that the event's "epicenter was probably somewhere in the Carolinas." It should be noted, however, that the felt reports shown on Figure RAI 2.5.2-4-1 are generally low in North Carolina and higher in South Carolina and Georgia.
- The NCEER91 catalog (Reference 2.5.2-205) lists the earthquake location as 33°N 70°W. FSAR Subsection 2.5.2.1.2 incorrectly states that this is likely an error. John Armbruster was contacted concerning this location, and he indicated that he placed the

event offshore near other Bermuda earthquakes because of the intensity pattern (see attached e-mail).

The location adopted for the updated seismicity catalog for the HAR site was that given in the US Geological Survey National Seismic Hazard Mapping catalog (Reference 2.5.2-207) because it represented the most recent work. However, as discussed in FSAR Subsection 2.5.2.4.3.1.2, the highly uncertain location for this event is one of the reasons for using the alternative interpretation of the Dames and Moore seismic source combinations. This interpretation accounts for a location of an earthquake of approximately m_b 5 (the expected magnitude in the EPRI-SOG catalog is 4.9) in western North Carolina.

The updated earthquake catalog for the HAR site used the most recent information for earthquake location. Evaluation of the effect of the updated earthquake catalog on earthquake occurrence rates (FSAR Subsection 2.5.2.4.1.2) concluded that the EPRI-SOG (Reference 2.5.2-201) seismicity parameters adequately modeled the occurrence rate of earthquakes in the site vicinity. Therefore, the earthquake occurrence parameters developed in the EPRI-SOG (Reference 2.5.2-201) study for the EPRI-SOG seismic sources were used in the updated PSHA for the HAR site. These parameters were calculated with the location of the 1817 earthquake at 36°N, 80.2°W. Thus, a location in the approximate center of the felt area has been accounted for in the PSHA for the HAR site.

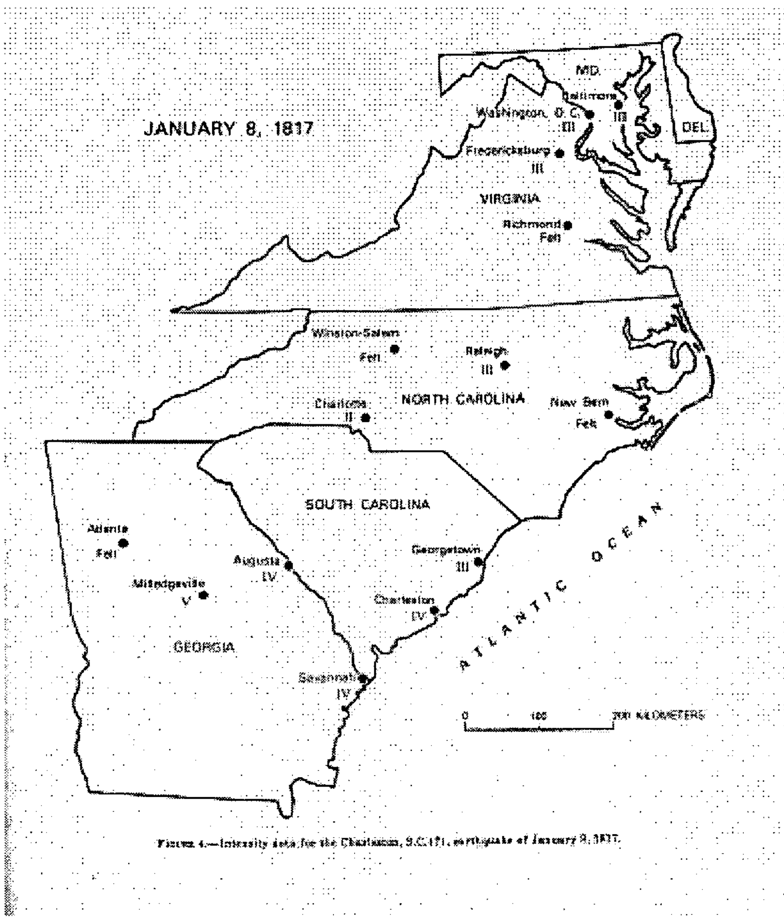


Figure RAI 2.5.2-4-1 Intensity distribution for the January 8, 1817 earthquake (Bollinger and Visvanathan, 1977)

Supporting References for Response:

Bollinger, G.A., and T.R. Visvanathan, 1977, The seismicity of South Carolina prior to 1886, Geological Survey Profession Paper 1028-C, p. 33-42.

MacCarthy, G.R., 1957, An annotated list of the North Carolina earthquakes: Journal of the Elisha Mitchell Scientific Society, v. 73, no. 1, p. 84-100.

MacCarthy, Gerald R., 1961, North Carolina Earthquakes 1958 and 1959, with additions to previous lists, Journal of the Elisha Mitchell Scientific Society, v. 77, no. 1, p. 62-64.

MacCarthy, G.R., 1964, A descriptive list of Virginia earthquakes through 1960, Journal of the Elisha Mitchell Scientific Society, v. 80, no. 2, p. 94-114.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future amendment:

1. Revise the first bulleted paragraph of FSAR Section 2.5.2.1.2 from:

- "**January 8, 1817.** The location of this intensity V event is uncertain and it was reported to have been felt in Milledgeville, Georgia; Charleston, South Carolina; New Bern and Salem, North Carolina; and Baltimore, Maryland. The EPRI-SOG catalog locates this event in North Carolina at latitude 36N, longitude 80.2W, and lists an expected m_b value of 4.9 (Reference 2.5.2-201). The NCEER-91 catalog lists the magnitude as m_b 5 based on felt area and the location as 33N, 70W (Reference 2.5.2-205). The longitude is obviously an error as felt area could not be assessed for an event that far offshore. The HAR catalog uses the USGS National Hazard Mapping catalog, which lists the location as latitude 32.9N, longitude 80W, near Charleston, South Carolina.

To read:

- "**January 8, 1817.** The location of this intensity V event is uncertain and it was reported to have been felt in Milledgeville, Georgia; Charleston, South Carolina; New Bern and Salem, North Carolina; and Baltimore, Maryland. The EPRI-SOG catalog locates this event in North Carolina at latitude 36N, longitude 80.2W, and lists an expected m_b value of 4.9 (Reference 2.5.2-201). The NCEER-91 catalog lists the magnitude as m_b 5 based on felt area and the location as 33N, 70W (Reference 2.5.2-205). The HAR catalog uses the USGS National Hazard Mapping catalog, which lists the location as latitude 32.9N, longitude 80W, near Charleston, South Carolina.

Attachments/Enclosures:

10/4/08 e-mail from John Armbruster

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-6

Text of NRC RAI:

In Section 2.5.2.4.2.1, you stated that "As presented in Subsection 2.5.2.4.4, large-magnitude earthquakes at very small distances are not a significant contributor to the hazard". The referenced subsection (Subsection 2.5.2.4.4) does not include much discussion on this issue. Please explain in detail what you meant by this statement.

PGN RAI ID #: H-0102

PGN Response to NRC RAI:

The statement is intended to indicate that the events have a very small contribution to the hazard. It is made on the basis of the deaggregation of the rock hazard results.
Figures 2.5.2-243, 2.5.2-244, 2.5.2-245, and 2.5.2-246 show the deaggregation of the rock hazard for annual exceedance levels of 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6}, respectively. These figures show only a small contribution to the hazard from earthquakes of m_b larger than 6.5 occurring at distances of 25 km and smaller.

Table RAI 2.5.2-6-1 summarizes the percent contribution to the hazard from earthquakes larger than m_b 6.5 occurring at distances of 25 km or less from the HAR site. These results show that these events contribute less that 1 percent of the hazard at the exceedance levels that control the development of the GMRS (10^{-4} and 10^{-5}).

Table RAI 2.5.2-6-1
Contribution to Rock Hazard from Earthquakes
of m_b > 6.5 at distances ≤ 25 km.

Exceedance Level	5 and 10 Hz	1 and 2.5 Hz
10^{-3}	0.01%	0.01%
10^{-4}	0.09%	0.08%
10^{-5}	0.70%	0.54%
10^{-6}	3.31%	2.74%

Associated HAR COL Application Revisions:

Change wording in Section 2.5.2.4.2.1 from "not a significant contributor" to "have a very small contribution." Text change will be incorporated as part of text revision in response to RAI 02.05.02-11.

Attachments/Enclosures to Response to NRC:

None.

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-9

Text of NRC RAI:

In Section 2.5.2.4.1.3, you stated that "The minimum values for a few of these (magnitude) distributions (sources 107 and 217 defined by Law Engineering and sources C18 and 103 defined by Weston Geophysical) were adjusted to be consistent with the largest observed earthquake in these sources". While the changes for the Law Engineering team are shown on Table 2.5.2-203, the changes made to the Weston Geophysical model are not shown in Table 2.5.2-205. Please update the table and provide a copy of the revised table.

PGN RAI ID #: H-0105

PGN Response to NRC RAI:

The EPRI (Reference 2.5.2-202) maximum magnitude value for Weston source 103 (and its complementary sources C17, C18, and C19) is m_b 5.4, not 5.7 as incorrectly reported in Table 2.5.2-205. This value was increased for the HAR Site to m_b 5.7 for sources 103 and C18, to be consistent with the largest observed earthquake (1897 Giles County earthquake) that occurred within the source boundaries. The maximum magnitude distribution was not modified for the complementary source zones C17 and C19 because they do not include this earthquake.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future revision:

1. Revise Table 2.5.2-205 of FSAR Section 2.5.2.4.1.3 from:

"Table 2.5.2-205

Weston Geophysical Team Seismic Sources

Source	P*	Closest Distance to HAR Site (km)	EPRI (1989a) Maximum Magnitude Distribution for HNP Site (m_b)	Maximum Magnitude Distribution Used in PSHA for HAR Site (m_b)
EPRI (Reference 2.5.2-202) Source Set				
104 Southern Coastal Plain[a,b]	1	0	5.4 [0.24], 6.0 [0.61], 6.6 [0.15]	5.4 [0.24], 6.0 [0.61], 6.6 [0.15]
25 Charleston[a,c]	0.99	256	6.6 [0.9], 7.2 [0.1]	6.6 [1.0]
26 South Carolina[a,c]	0.86	94	6.0 [0.67], 6.6 [0.27], 7.2 [0.06]	6.0 [0.67], 6.6 [0.27], 7.2 [0.06]
22 Central Virginia[a]	0.82	165	5.4 [0.19], 6.0 [0.65], 6.6 [0.16]	5.4 [0.19], 6.0 [0.65], 6.6 [0.16]
28D Mesozoic Basin[a,b]	0.26	0	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]
103 Southern Appalachian (C19)[a,d]	1	124	5.7 [0.26], 6.0 [0.58], 6.6 [0.16]	5.7 [0.26], 6.0 [0.58], 6.6 [0.16]
Additional Sources				
23 Giles County[a]	0.9	212	6.0 [0.81], 6.6 [0.19]	6.0 [0.81], 6.6 [0.19]
24 New York – Alabama – Clingman Lineaments[a,d]	0.9	250	5.4 [0.26], 6.0 [0.58], 6.6 [0.16]	5.4 [0.26], 6.0 [0.58], 6.6 [0.16]
28C and 28 E Mesozoic Basins	0.26	111	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]	Not Included

a) Included in HAR PSHA.

b) Host/background sources.

c) Charleston sources.

d) East Tennessee seismic zone sources.

Notes:

P* = the probability that the source is included in the hazard model.

To read:

Table 2.5.2-205

Weston Geophysical Team Seismic Sources

Source	P*	Closest Distance to HAR Site (km)	EPRI (1989a) Maximum Magnitude Distribution for HNP Site (m_b)	Maximum Magnitude Distribution Used in PSHA for HAR Site (m_b)
EPRI (Reference 2.5.2-202) Source Set				
104 Southern Coastal Plain[a,b]	1	0	5.4 [0.24], 6.0 [0.61], 6.6 [0.15]	5.4 [0.24], 6.0 [0.61], 6.6 [0.15]
25 Charleston[a,c]	0.99	256	6.6 [0.9], 7.2 [0.1]	6.6 [1.0]
26 South Carolina[a,c]	0.86	94	6.0 [0.67], 6.6 [0.27], 7.2 [0.06]	6.0 [0.67], 6.6 [0.27], 7.2 [0.06]
22 Central Virginia[a]	0.82	165	5.4 [0.19], 6.0 [0.65], 6.6 [0.16]	5.4 [0.19], 6.0 [0.65], 6.6 [0.16]
28D Mesozoic Basin[a,b]	0.26	0	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]
103 Southern Appalachian (C17, C18, C19)[a,d]	1	124	5.4 [0.26], 6.0 [0.58], 6.6 [0.16]	5.7 [0.26], 6.0 [0.58], 6.6 [0.16] for 103 and C18 5.4 [0.26], 6.0 [0.58], 6.6 [0.16] for C17 and C19
Additional Sources				
23 Giles County[a]	0.9	212	6.0 [0.81], 6.6 [0.19]	6.0 [0.81], 6.6 [0.19]
24 New York – Alabama – Clingman Lineaments[a,d]	0.9	250	5.4 [0.26], 6.0 [0.58], 6.6 [0.16]	5.4 [0.26], 6.0 [0.58], 6.6 [0.16]
28C and 28 E Mesozoic Basins	0.26	111	5.4 [0.65], 6.0 [0.25], 6.6 [0.1]	Not Included

a) Included in HAR PSHA.

b) Host/background sources.

c) Charleston sources.

d) East Tennessee seismic zone sources.

Notes:

P* = the probability that the source is included in the hazard model.

Attachments/Enclosures to Response to NRC:

None.

NRC Letter No.: HAR-RAI-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-11

Text of NRC RAI:

In Section 2.5.2.4.2.1, you compared the impacts of new ground motion models proposed since the publication of the EPRI 2004 models. However, you did not include a 2005 Eastern North America ground motion prediction model developed by Tavakoli and Pezeshk (BSSA, 2005, v.95[6], 2283-2296) in your sensitivity analysis. Please provide comparative charts showing the differences between the ground motions calculated with this new model and the other models used in the HAR study.

PGN RAI ID #: H-0107

PGN Response to NRC RAI:

FSAR Figure 2.5.2-221 will be modified in a future revision to include a comparison of the Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01) ground motion model with the EPRI (Reference 2.5.2-248) ground motion models. The Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01) model is a hybrid ground motion model; Revised Figure 2.5.2-221 (attached) compares this model with the EPRI (Reference 2.5.2-248) ground motion models for Cluster 3. The Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01) model predictions generally fall within the range of the EPRI (Reference 2.5.2-248) cluster 3 medians except for 1 Hz ground motions from small magnitude events at short rupture distances. As presented in Subsection 2.5.2.4.4, small-magnitude earthquakes at close distances have a small contribution to the low-frequency hazard.

Associated HAR COL Application Revisions:

The following changes will be made to HAR FSAR Chapter 2 in a future revision:

1. Revise the fourth paragraph of FSAR Section 2.5.2.4.2.1 from:

   "The EPRI (Reference 2.5.2-248) ground motion median models for clusters 1 and 2 were based in large part on the CEUS ground motion models developed by Silva et al. (Reference 2.5.2-249) and Atkinson and Boore (Reference 2.5.2-241), respectively. Silva et al. (Reference 2.5.2-250) and Atkinson and Boore (Reference 2.5.2-251) have since developed updated versions of their models. These newer models are compared to the EPRI (Reference 2.5.2-248) models on Figure 2.5.2-221. The two plots on the left compare the EPRI (Reference 2.5.2-248) 5th percentile, 50th percentile, and 95th percentile 10- Hz and 1-Hz median models for ground motion cluster 1 with the three single-corner stochastic models developed by Silva et al. (Reference 2.5.2-250). The updated models all fall well within the range of the EPRI models (Reference 2.5.2-248). The two plots on the right compare the EPRI (Reference 2.5.2-248) 5th percentile, 50th percentile, and 95th percentile 10-Hz and 1-Hz median models for ground motion cluster 2 with the model developed by Atkinson and Boore (Reference 2.5.2-251). The Atkinson and Boore (Reference 2.5.2-251) model uses rupture distance as the distance measure, while the EPRI

(Reference 2.5.2-248) cluster 2 models use Joyner-Boore distance. The comparisons shown on Figure 2.5.2-221 were made assuming that the top of rupture for the **M** 5 earthquake is at a depth of 4 km (2.5 mi.), based on a mean point-source depth of 6 km (3.7 mi.) (Reference 2.5.2-250). The median ground motions produced by the updated Atkinson and Boore (Reference 2.5.2-251) model fall within the range of the EPRI (Reference 2.5.2-248) cluster 2 medians except for distances less than about 7 km (4.3 mi.) for large-magnitude earthquakes. As presented in Subsection 2.5.2.4.4, large-magnitude earthquakes at very small distances are not a significant contributor to the hazard. On the basis of the comparisons shown on Figure 2.5.2-221, it is concluded that the EPRI median ground motion models are appropriate for use in computing the hazard for the HAR site (Reference 2.5.2-248)".

To read:

"The EPRI (Reference 2.5.2-248) median ground-motion models for clusters 1, 2, and 3 were based in large part on the CEUS ground-motion models developed by Silva et al. (Reference 2.5.2-249), Atkinson and Boore (Reference 2.5.2-241), and Campbell (Reference 2.5.2-272), respectively. Silva et al. (Reference 2.5.2-250) and Atkinson and Boore (Reference 2.5.2-251) have since developed updated versions of their models. In addition, Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01) present a hybrid ground-motion model for the CEUS based on the approach developed by Campbell (Reference RAI 02.05.02-11 02). These newer models are compared to the EPRI (Reference 2.5.2-248) models on Figure 2.5.2-221. The two plots on the left compare the EPRI (Reference 2.5.2-248) 5th percentile, 50th percentile, and 95th percentile 10- Hz (top) and 1-Hz (bottom) median models for ground motion cluster 1 with the three single-corner stochastic models developed by Silva et al. (Reference 2.5.2-250). The two plots in the center of Figure 2.5.2-221 compare the EPRI (Reference 2.5.2-248) 5th percentile, 50th percentile, and 95th percentile 10-Hz (top) and 1-Hz (bottom) median models for ground motion cluster 2 with the model developed by Atkinson and Boore (Reference 2.5.2-251). The Atkinson and Boore (Reference 2.5.2-251) model uses rupture distance as the distance measure, while the EPRI (Reference 2.5.2-248) cluster 2 models use Joyner-Boore distance. The comparisons shown on Figure 2.5.2-221 were made assuming that the top of rupture for the **M** 5 earthquake is at a depth of 2.5 mi. (4 km), based on a mean point-source depth of 3.7 mi. (6 km) (Reference 2.5.2-250). The median ground motions produced by the updated Atkinson and Boore (Reference 2.5.2-251) model fall within the range of the EPRI (Reference 2.5.2-248) cluster 2 medians except for distances less than about 4.3 mi. (7 km) for large-magnitude earthquakes. The two plots on the right of Figure 2.5.2-221 compare the EPRI (Reference 2.5.2-248) 5th percentile, 50th percentile, and 95th percentile 10-Hz (top) and 1-Hz (bottom) median models for ground motion cluster 3 with the model developed by Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01). The Tavakoli and Pezeshk (Reference RAI 02.05.02-11 01) model predictions generally fall within the range of the EPRI (Reference 2.5.2-248) cluster 3 medians except the 1 Hz estimates for small magnitudes at short rupture distances. As presented in Subsection 2.5.2.4.4, large-magnitude earthquakes at very small distances have a very small contribution to the hazard. Also, small-magnitude earthquakes at close distances have a small contribution to the low-frequency hazard. On the basis of the comparisons shown on Figure 2.5.2-221, it is concluded that the EPRI (Reference 2.5.2-248) median ground-motion models are appropriate for use in computing the hazard for the HAR site."

Reference RAI 02.05.02-11 01

Tavakoli, B. and S. Pezeshk, "Empirical-Stochastic Ground-Motion Prediction for Eastern North America," *Bulletin of the Seismological Society of America*, Vol. 95, No. 6, December 2005

Reference RAI 02.05.02-11 02

Campbell, K.W., "Prediction of Strong Ground Motion Using the Hybrid Empirical Method and Its Use in the Development of Ground-Motion (Attenuation) Relations in Eastern North America," *Bulletin of the Seismological Society of America*, Vol. 93, 2003.

Attachments/Enclosures to Response to NRC:

Figure 2.5.2-221 (Revised)

NRC Letter No.: HAR-NRC-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-14

Text of NRC RAI:

In section 2.5.2.5.1.4, you stated that "The κ values are reduced by an additional 0.0002 second to account for the effects of scattering due to randomization of the velocity profiles". Please explain the basis for this reduction value of 0.0002 sec. Is this number based on any scientific study results, or is it a best estimate value?

PGN RAI ID #: H-0110

PGN Response to NRC RAI:

The value of κ assigned to the site profile is a measure of the total damping due to both material damping and scattering (reflection) of waves off layer boundaries. The amount of "scattering κ" present in the randomized velocity profiles for the HAR 2 and 3 sites was assessed using the following procedure.

First, site response analyses were conducted using the 60 randomized velocity profiles for HAR 2 shown on FSAR Figures 2.5.2-264 and 2.5.2-265. These calculations were performed using a very low level of input motion in order to maintain linear behavior. Also, the material damping in the rock layers was developed using the lower value of site κ of 0.0014 seconds to maximize the influence of scattering on the site response. The median of the response spectra for the computed surface motions is shown on Figure RAI 2.5.2-14-1. Then a second set of site response calculations was performed using a single velocity profile equal to the median of the randomized velocity profiles. This profile is shown on Figure RAI 2.5.2-14-2. The scattering effect of the lower velocity zone at a depth of 100 ft was accounted for by replacing that layer and the layer above by a single layer with an equivalent uniform shear wave velocity. The response of this profile was computed using the full set of rock motions and the median response spectrum for the surface motions was obtained. This spectrum, shown on Figure RAI 2.5.2-14-1, is slightly higher at frequencies above 20 Hz than the median spectrum obtained using the randomized profiles. The difference is attributed to the scattering effect of the velocity contrasts in the velocity profiles. The amount of "scattering κ" was assessed by repeating the analyses using the randomized profiles, gradually reducing the value of κ used to obtain material damping in the rock layers until the median response of the randomized profiles reached the same level as that for the single median profile at high frequencies. This result was achieved with a value of κ equal to 0.0012 seconds, as shown on Figure RAI 2.5.2-14-1.

The above process was repeated using the HAR3a profile. Figure RAI 2.5.2-14-3 compares the median response spectra for the randomized profiles with κ equal to 0.0014 seconds, for the single velocity profile without randomization, and for the randomized profiles with reduced κ. Figure RAI 2.5.2-14-4 shows the median of the randomized velocity profiles for the HAR3a case. Again, a κ equal to 0.0012 seconds was found to produce similar response in the randomized and median velocity profiles at high frequency.

On the basis of these calculations, the total site κ values were reduced by 0.0002 seconds before being used to obtain material damping in the rock layers.

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

RAI 02.05.02-14 Figure 1

RAI 02.05.02-14 Figure 2

RAI 02.05.02-14 Figure 3

RAI 02.05.02-14 Figure 4

NRC Letter No.: HAR-NRC-LTR-018

NRC Letter Date: September 25, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 02.05.02-15

Text of NRC RAI:

Section 2.5.2.6 provides a table (Table 2.5.2-221) showing the spectral acceleration ratios computed with CAV and no-CAV filters. The table lists ratios greater than 1.0 for the 10^{-6} Probability of Exceedance values at frequencies of 10, 25, and 100Hz. Please provide an explanation of why the surface UHRS with CAV would produce higher amplitudes in spectral acceleration.

PGN RAI ID #: H-0111

PGN Response to NRC RAI:

The reason that the calculation of hazard using the CAV filter produces slightly higher hazard at low exceedance frequencies is due to the contribution from earthquakes smaller that the minimum magnitude used in the non-CAV hazard calculation. RAI 02.05.02-15 Figure 1 shows values of the probability that the value of CAV will exceed 0.16 g-seconds as a function of earthquake magnitude and peak acceleration level. These values are computed using the EPRI (Reference 2.5.2-271) CAV model for a V_{S30} of 1548 m/sec, the value for the GMRS horizon at the HAR site. These results show that for higher peak acceleration levels associated with low exceedance frequencies, the probability that small magnitude earthquakes can produce CAV greater than 0.16 g-seconds is well above 0. Thus, these earthquakes would contribute to the site hazard.

The following simple example calculation illustrates this point. The example calculation is for a site located at the center of a 100km×100km square source zone in which the occurrence rate for earthquakes of moment magnitude, **M**, 4 and larger is 1 event every 50 years and the maximum magnitude is **M** 7.5. Moment magnitudes are used in this example for simplicity, but the same conclusions apply when there is a conversion to m_b. Hazard calculations are performed for peak ground acceleration using the EPRI (Reference 2.5.2-248) median ground motion model for Cluster 2 and the EPRI (Reference 2.5.2-252) aleatory variability model 1A+2A. Three calculations are performed. The first uses a minimum magnitude, m_0, of **M** 4.0; the second uses a minimum magnitude of **M** 5.0, which is a typical "standard" PSHA calculation; and the third uses the CAV filter considering all magnitudes larger than **M** 4.0.

RAI 02.05.02-15 Figure 2 shows the hazard curves computed for the three cases. The difference in the results for $m_0 = 4$ and $m_0 = 5$ indicate the contribution of earthquakes of **M** less than 5.0 to the frequency of exceedance. The CAV model indicates that most of these earthquakes are not expected to produce damaging ground motions. The CAV model does indicate, however, that as the peak acceleration level increases, an increasing proportion of earthquakes less than **M** 5 can produce potentially damaging ground motions. Thus, the hazard curve for $m_0 = 4$, CAV crosses the hazard curve for $m_0 = 5$ at higher ground motion levels.

RAI 02.05.02-15 Figure 3 shows the deaggregation of the example hazard results for a peak acceleration of 0.5 g. These deaggregation plots show the percent contribution from earthquakes in various magnitude and distance bins to the hazard normalized to the frequency of exceedance for $m_0 = 4$. The top plot of Figure RAI 2.5.2-15-3 indicates that there is a large contribution from earthquakes less than **M** 5.0. When these are completely removed from the hazard ($m_0 = 5$), then there is a reduction in the total. The bottom plot shows the deaggregation for $m_0 = 4$ with CAV. For this case, some of the events of magnitude **M** 5 and larger are removed because *P*(CAV > 0.16 g-s) is less than 1. However, a substantial fraction of events smaller than **M** 5 are included in the hazard because their frequency of occurrence is larger than those for **M** 5 and larger and *P*(CAV > 0.16 g-s) is well above 0.

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

RAI 02.05.02-15 Figure 1

RAI 02.05.02-15 Figure 2

RAI 02.05.02-15 Figure 3

List of Attachments/Enclosures:

1. NRC RAI # 02.05.02-04 (PGN RAI ID #H-0100):
   10/4/08 e-mail from John Armbruster (1 page)

2. NRC RAI # 02.05.02-11 (PGN RAI ID #H-0107):
   Figure 2.5.2-221 (Revised) (1 page)

3. NRC RAI # 02.05.02-14 (PGN RAI ID #H-0110):
   RAI 02.05.02-14 Figure 1 (1 page)

4. NRC RAI # 02.05.02-14 (PGN RAI ID #H-0110):
   RAI 02.05.02-14 Figure 2 (1 page)

5. NRC RAI # 02.05.02-14 (PGN RAI ID #H-0110):
   RAI 02.05.02-14 Figure 3 (1 page)

6. NRC RAI # 02.05.02-14 (PGN RAI ID #H-0110):
   RAI 02.05.02-14 Figure 4 (1 page)

7. NRC RAI # 02.05.02-15 (PGN RAI ID #H-0111):
   RAI 02.05.02-15 Figure 1 (1 page)

8. NRC RAI # 02.05.02-15 (PGN RAI ID #H-0111):
   RAI 02.05.02-15 Figure 2 (1 page)

9. NRC RAI # 02.05.02-15 (PGN RAI ID #H-0111):
   RAI 02.05.02-15 Figure 3 (1 page)

From: john armbruster [armb@ldeo.columbia.edu]
Sent: Saturday, October 04, 2008 6:10 AM
To: Bob Youngs
Subject: Re: January 8, 1817 earthquake

Bob Youngs,

I apparently looked at the intensity reports of this event when I compiled the NCEER catalog and decided it was a "Bermuda" quake.

It rang the statehouse bell in Milledgeville GA Felt equally in Savannah, Charleston and Georgetown Felt slightly in Raleigh, NC

There may be other intensity reports I had in 1990 when I made the decision to make the location 33 70. It is not strong enough in Charleston to be centered there, "pretty severe shock" "rumbling noise like the passing of a carriage". At 4:15 am local I conclude it woke up some people but not everyone. If you move it offshore the next source seen in the instrumental data is Bermuda.

John Armbruster

>Subject: January 8, 1817 earthquake
>Date: Fri, 3 Oct 2008 16:50:19 -0700
>From: "Bob Youngs" <BYoungs@geomatrix.com>
>To: <armb@ldeo.columbia.edu>

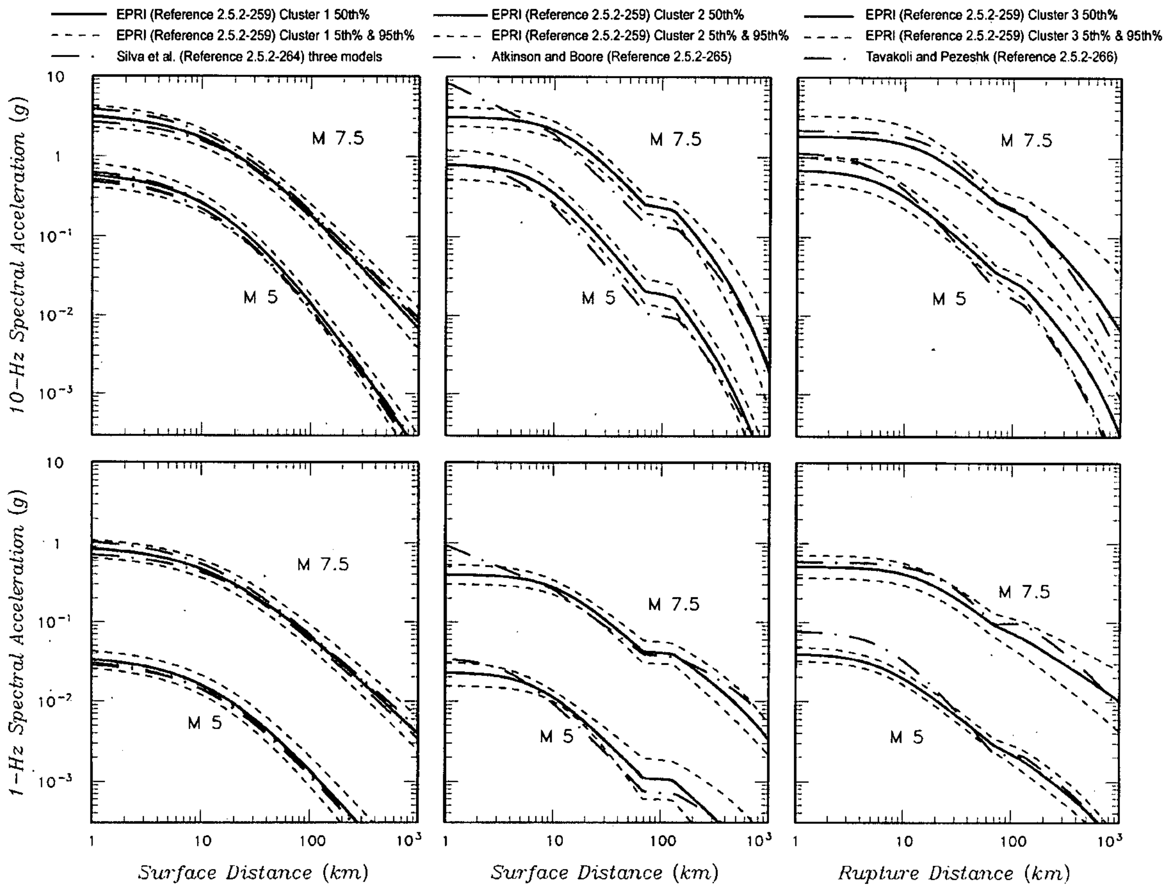
Dear John:

I was wondering if it is possible for you to check on the location of the January 8, 1817 earthquake given in the NCEER91 catalog. The listed location is 33N, 70W, which places it well offshore in the Atlantic. Is it possible that longitude should be 80W? We are responding to a US NRC review question about the various locations listed for this event. The USGS national hazard mapping catalog and US Earthquakes list the location at 32.9N, 80W near Charleston while the EPRI catalog has the location as 36N, 80.2W.

I would greatly appreciate any information you could provide.

Sincerely,

Bob Youngs



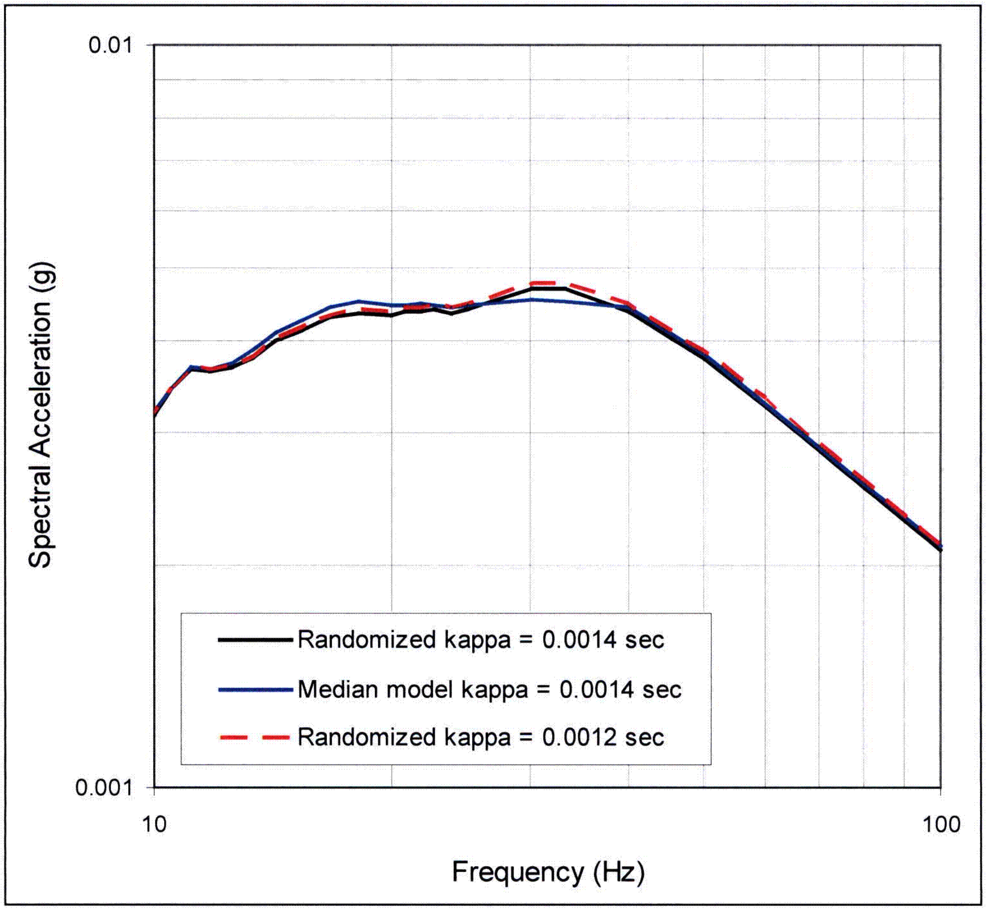
Progress Energy Carolinas

Shearon Harris Nuclear Power Plant Units 2 and 3 Part 2, Final Safety Analysis Report

New Hill, North Carolina

Comparison of EPRI (2004) Median Ground Motion Models with More Recent Models

FIGURE 2.5.2-221 (Revised)



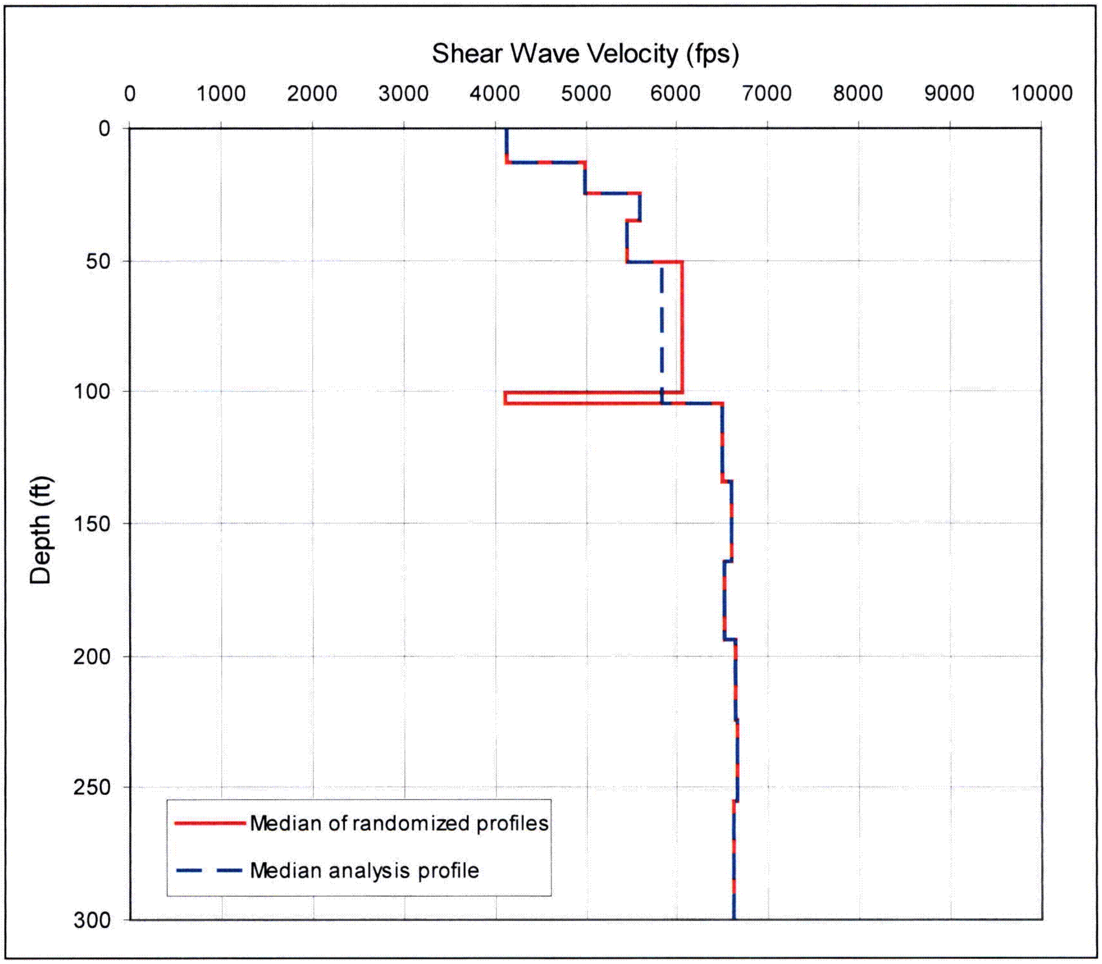
Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Median Surface Response Spectra Used to Assess "scattering κ" for the HAR 2 Profile
RAI 2.5.2-14 Figure 1

S:\11100\11151.002\Figures\RAI\RAI 02.05.02-14 Figure 1.ai Date: [12/12/2008]; User: [sbozkurt]

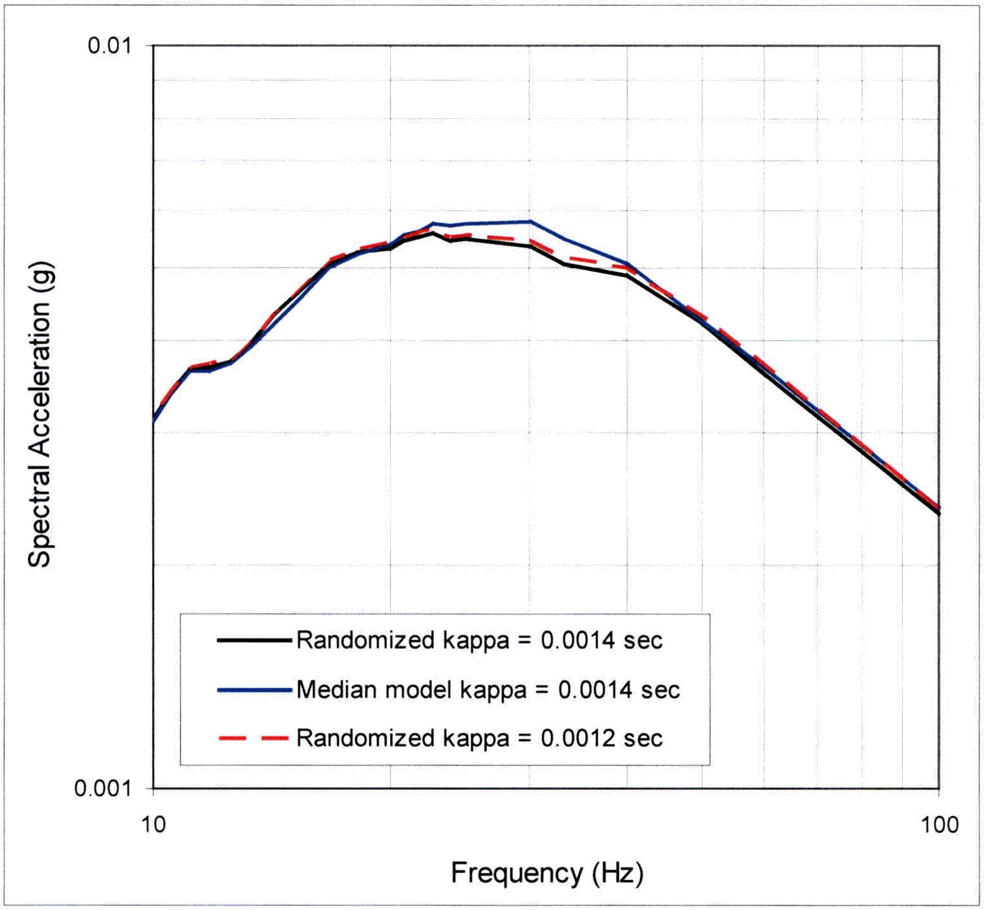


Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Velocity Profiles Used for Assessing
"scattering κ" at HAR 2
RAI 2.5.2-14 Figure 2

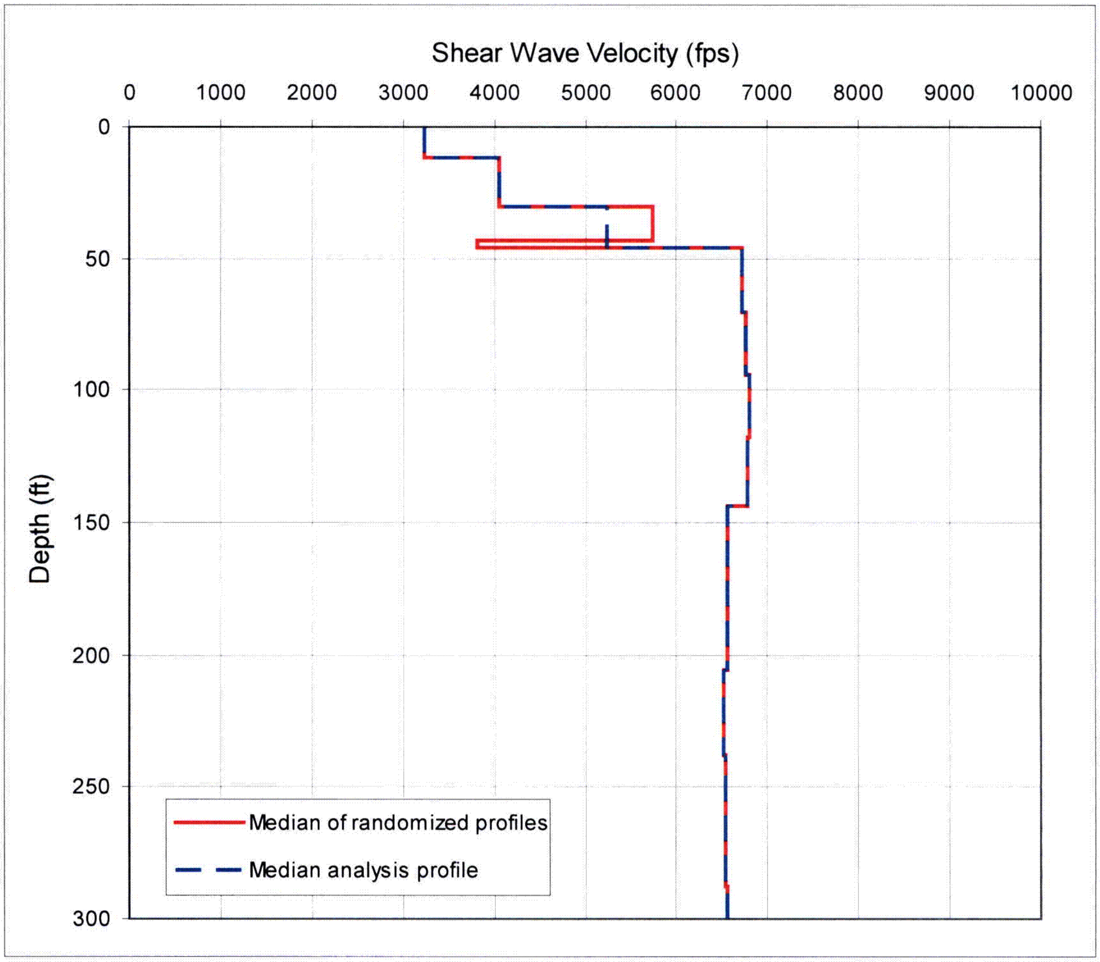


Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Median Surface Response Spectra Used to Assess "scattering κ" for the HAR 3a Profile
RAI 2.5.2-14 Figure 3



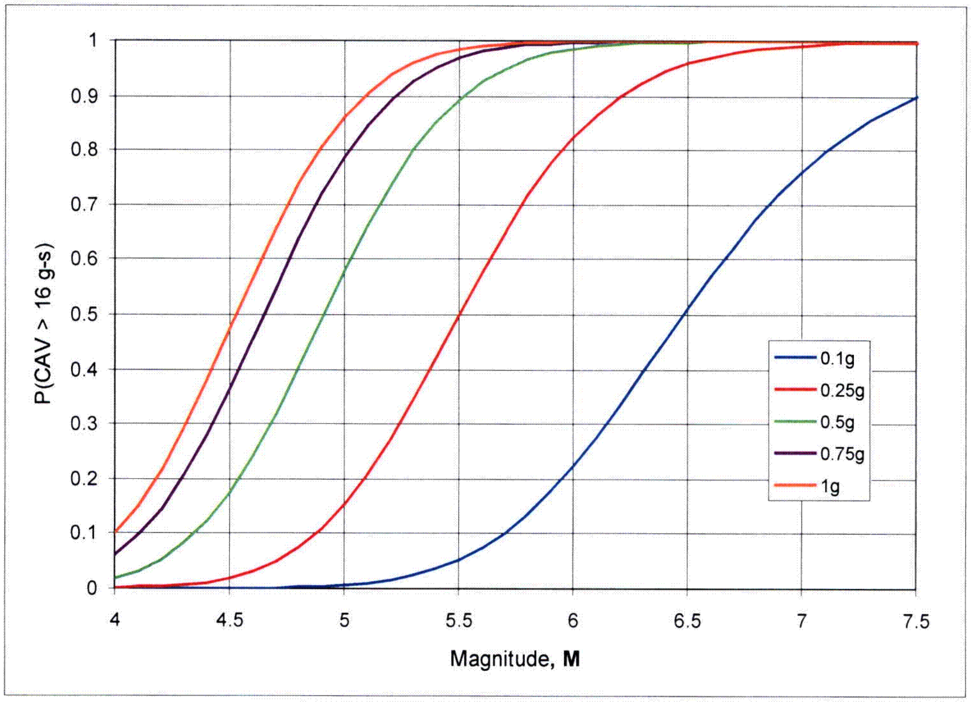
Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Velocity Profiles Used for Assessing
"scattering κ" at HAR 3a
RAI 2.5.2-14 Figure 4

S:\11100\11151.002\Figures\RAI\RAI 02.05.02-14 Figure 4.ai Date: [12/12/2008]; User: [sbozkurt]

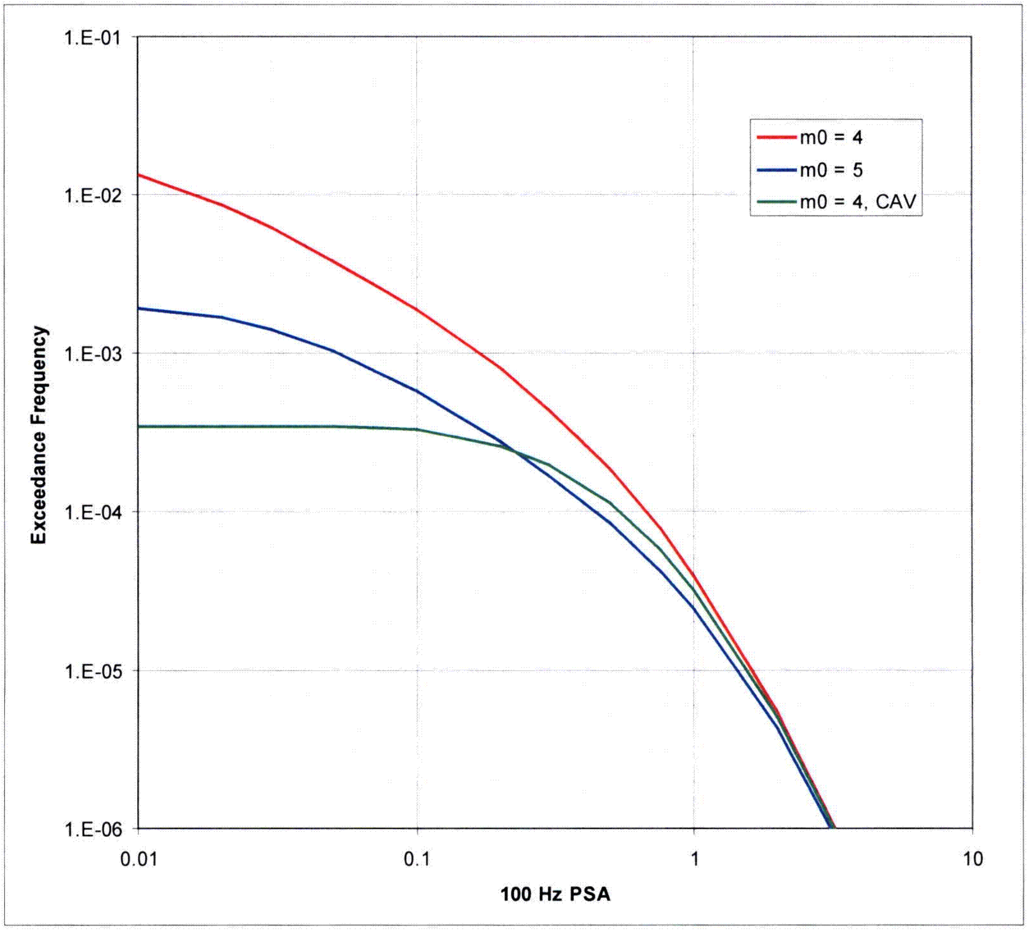


Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Probability that CAV exceeds 0.16 g seconds for VS30 of 1548 m/sec
RAI 2.5.2-15 Figure 1



Progress Energy Carolinas

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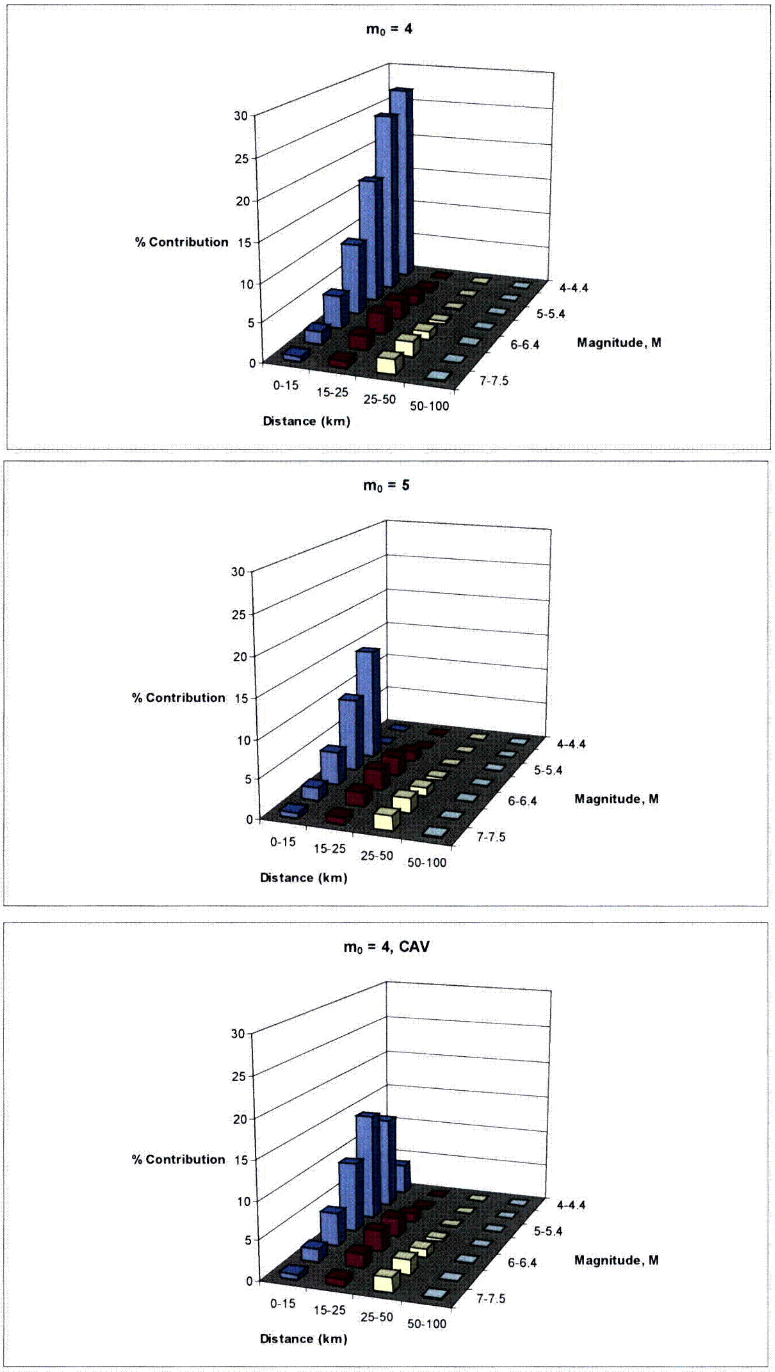
New Hill, North Carolina

Example Hazard Calculations for Different Minimum Magnitude (m0) Conditions
RAI 2.5.2-15 Figure 2



All percent contributions are normalized to the hazard computed for m_0 = 4.

Progress Energy Carolinas

Shearon Harris Nuclear Power Plant
Units 2 and 3
Part 2, Final Safety Analysis Report

New Hill, North Carolina

Deaggregation of the Example Hazard Calculations
RAI 2.5.2-15 Figure 3