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SOUTHERN COMPANY
Energy to Serve Your World℠

DEC 1 1 2007

Docket No.: 52-011

AR-07-2258

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Southern Nuclear Operating Company
Vogtle Early Site Permit Application
Supplemental Information Regarding Safety Evaluation Report Open Items

Ladies and Gentlemen:

By letter dated August 30, 2007, the U.S. Nuclear Regulatory Commission (NRC) provided Southern Nuclear Operating Company (SNC) with the Safety Evaluation Report (SER) for the Vogtle Early Site Permit (ESP) Application with 41 open items (OIs). SNC responded to the NRC SER OIs in letter AR-07-1773, dated October 15, 2007. Since that date, SNC has discussed the responses to SER OIs 2.5-1 and 2.5-3 in regards to the use of the "Dames & Moore" and "Eastern Tennessee seismic zone" models in the Vogtle probabilistic seismic hazards analysis (PSHA). In support of the ongoing discussions, SNC has obtained comments from industry seismic experts addressing the EPRI-SOG seismic source model characterization development process and questions concerning the Vogtle PSHA. Enclosure 1 includes letters from Dr. Robert Kennedy, Dr. Martin Chapman, Dr. Joe Litehiser and Dr. Robin K. McGuire.

The SNC contact for this OI supplemental information letter is J. T. Davis at (205) 992-7692.

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NRO

Mr. J. A. (Buzz) Miller states he is a Senior Vice President of Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and to the best of his knowledge and belief, the facts set forth in this letter are true.

Respectfully submitted,

SOUTHERN NUCLEAR OPERATING COMPANY

Joseph A. (Buzz) Miller

Sworn to and subscripted before me this 11th *day of* December, *2007*

Dana M. Williams
Notary Public

My commission expires: 12/29/2010

JAM/BJS/dmw

Enclosure: Supplemental Information for Vogtle ESP SER Open Items 2.5-1 and 2.5-3

cc: Southern Nuclear Operating Company
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Mr. J. T. Gasser, Executive Vice President, Nuclear Operations (w/o enclosures)
Mr. T. E. Tynan, Vice President - Vogtle (w/o enclosures)
Mr. D. M. Lloyd, Vogtle Deployment Director (w/o enclosures)
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Mr. D. P. Moore, Engineering Programs Consulting Engineer (w/o enclosures)
Document Services RTYPE: AR01
File AR.01.01.06

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Ms. K. K. Patterson, Project Manager (w/o enclosures)

Southern Nuclear Operating Company

AR-07-2258

Enclosure

Supplemental Information for

Vogtle ESP SER Open Items 2.5-1 and 2.5-3

NOTE: This enclosure consists of the following four (4) documents:

1. Letter to Donald P. Moore from Dr. Robin K. McGuire of Risk Engineering, dated December 7, 2007 (2 pages)
2. Letter to Donald P. Moore from Dr. Joe Litehiser, dated December 6, 2007 (2 pages)
3. Comments on SER Open Item 2.5-1 of the VEGP ESP by Dr. R. P. Kennedy, dated October 30, 2007 (3 pages)
4. Comments on SER Open Item 2.5-3 by Dr. Martin Chapman (undated) (2 pages)

RISK
ENGINEERING, INC.

December 7, 2007

Mr. Donald P. Moore
Southern Nuclear Company
40 Inverness Center Parkway
Birmingham, AL 35242

Dear Mr. Moore:

I wish to give further background to my letter dated October 30, 2007, regarding the evaluation of various team interpretations from the 1989 EPRI seismic hazard study. Much has been made of a quote from a 1991 Risk Engineering, Inc. report to Westinghouse Savannah River Company that states, "...the EPRI Dames & Moore team does not fully account for seismicity, using a probability of activity of 0.26 in the vicinity of the SRS."

The Dames & Moore team developed a tectonic basis for representing earthquakes with m_b>5 and did not develop background sources to represent seismicity outside the locations of their tectonic-structure-specific seismic sources. This is stated specifically in the 1989 EPRI report (EPRI 1989, page 3-3): "The Dames & Moore team specified activity probabilities using P^a and did not use background sources." For example, they developed tectonic sources representing Mesozoic basins on the east coast. Dames & Moore assigned the Mesozoic basins (sources 47 through 52) a combined probability of activity of 0.74 to explain earthquakes with m_b >5, and assigned the remaining probability of 0.26 to a large default zone (source 53). In the case where their Mesozoic basin sources were the correct explanation for earthquakes with m_b>5, their source 53 could not generate earthquakes with m_b>5.

Examining historical earthquakes from the EPRI catalog in Dames & Moore source 53, one event occurred in 1966 with m_b=4.7, and all other historical earthquakes had $m_b \leq 4.3$. A search of the PDE and ISC catalogs indicates that the 1966 event was an offshore explosion, and if so, the largest historical earthquake in source 53 was $m_b \sim 4.3$. In any case the quotation in the 1st paragraph above is accurate relative to historical earthquakes with $m_b \leq 4.7$, but the Dames & Moore interpretation is not inconsistent with the occurrence of earthquakes with m_b>5. Stated another way, no earthquakes with m_b>5 have occurred historically in Dames & Moore source 53, and Dames & Moore said there is a 26% chance that earthquakes with m_b>5 will occur there in the future.

As stated in my October 30, 2007 letter, the quote from my 1991 report was taken from a study that had the purpose of reconciling hazard curves from the EPRI and LLNL reports. In my role as a seismic-hazard analyst in that project (rather than an expert in seismic source characterization), I achieved the project goal by giving credibility only to those interpretations that were consistent with historical seismicity at all magnitude levels. Interpretations that were high or low

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relative to historical seismicity were given zero weight. The remaining interpretations gave hazard that was relatively consistent (as one would expect), which achieved the purpose of the study. Thus the down-weighting of the Dames & Moore source model was not made on the basis of its geologic or tectonic merits.

Note also that the 1991 Risk Engineering, Inc. report was written before the Senior Seismic Hazard Analysis Committee (SSHAC) report in 1997, which documented and emphasized the value and integrity of a SSHAC Level 4 study. Given the SSHAC recommendations made in 1997, I would not come to the same conclusions today regarding the EPRI report that I reached in 1991. Currently, I would not recommend down-weighting or modifying the Dames & Moore source model, because it resulted from a high-level SSHAC study, unless there was a strong technical basis supported by new seismological, geologic, or geophysical data.

Sincerely,

RISK ENGINEERING, INC.

Robin K. McGuire, Ph.D.
President

RKM/jp

Reference

EPRI (1989). *Probabilistic seismic hazard evaluations at nuclear plant sites in the central and eastern United States: resolution of the Charleston earthquake issue*, Elec. Power Res. Inst. Rept. NP-6395-D, April.

December 6, 2007

Mr. Donald P. Moore
Southern Nuclear Company
40 Inverness Center Parkway
Birmingham, AL 35242

Dear Mr. Moore:

At the request of SNC Vogtle ESP project I provide my thoughts, as the leader of the Bechtel Earth Science Team, concerning the EPRI-SOG seismic source model characterizations development process and my professional opinion concerning when there is a need to update the EPRI-SOG characterization to maintain its integrity for current licensing decisions. The following is my response to SNC's request:

As the leader of the Bechtel Earth Science Team for the EPRI-SOG development of seismic source characterizations to be used for PSHA analysis of the CEUS, my recollection is that a concerted effort was made to examine all available information of possible relevance (certainly including a careful evaluation of historic earthquake data as well as of all past or then-current explanations for the time, location, recurrence, and size distributions of past and potential future earthquakes).

During the EPRI-SOG study emphasis was placed on process such that, while free and encouraged to develop seismic source models that represented independent conclusions, each EST also benefited from the shared ideas of all ESTs and a shared methodology to reduce geologic, tectonic, and seismologic concepts into numbers that could be fed in a consistent way into the PSHA analysis. The goal, as I remember it, and the result, as I interpret it, was a balance of informed expert opinion leading to a conclusion that captured both mean consensus and the range of alternative opinions.

A part of the process that I would emphasize is that ESTs, having proposed a model for the CEUS, were shown the implications of that model compared to the historic earthquake record and to PSHA results at a number of sites. Further, ESTs were shown how their PSHA results compared to the PSHA results of the other ESTs for selected locations, and they were then given the opportunity to change their models if these comparisons suggested to them that they should be changed. The result was, I believe, that the EPRI-SOG seismic source models, spread across the ESTs, represented a comprehensive set of possibility with, in today's terms, inclusion of an appropriate amount of epistemic uncertainty. Given this background I would have been surprised, as a member of one of the ESTs, to find that my interpretation was to be singled out for exclusion or to be reinterpreted by a third party in a way that I had not intended simply because the PSHA results of my seismic model were too low or too high compared to the results, for a given site, of my fellow ESTs. This would have seemed to me to violate the whole purpose of the process.

Coming from a background of licensing of nuclear power plants based on a "deterministic" characterization of design ground motion, in which differences in expert opinion could, and often did, have a very large effect on the conclusion, the integrative approach of the EPRI-SOG process (and PSHA itself as an element of that process) led to much more stable results, allowing much more stable regulatory positions on adequate seismic design ground motions. Recognizing, I believe, both the scientific and regulatory advantages of handling uncertainty in potential earthquake activity in the CEUS in this way, the NRC subsequently adopted, in RG 1.165, the results of the EPRI-SOG study as one possible benchmark against which future licensing decisions could be made.

RG 1.165 recognizes the possibility that new information may become available that was not available to the ESTs. This new information could be in the form, certainly, of new earthquakes, particularly if occurring in a place or with a size that the EPRI-SOG earthquake catalog would not have suggested or the EST seismic source models did not, in aggregate, allow. It could be in the form of new geologic data, such as that leading to more modern estimates of shorter recurrence intervals for large earthquakes in the Charleston, SC, or New Madrid, MO, areas. Data of these types have become available and have been used to update source models and the resulting PSHA values at a number of sites after careful examination and general acceptance within the scientific community.

But the bar set for incorporation of these types of revisions of the EPRI-SOG model is rather high. RG 1.165 speaks in terms of new information "validated by a strong technical basis," that, "would result in a significant increase in the hazard estimate for a site." Therefore, any new "information," whether data, hypothesis, or simple opinion, should be tested against these two criteria. Does it have a strong technical basis, either as confidently accepted data (the location of a new moderate or larger earthquake, for example, if one were to occur) or as more equivocal data that has been accepted after consensus building within the scientific community (such as the implications of liquefaction features around Charleston, SC, to the frequency and areal distribution of characteristic earthquakes in the area)? If it does enjoy this strong technical basis, would it result in a significant increase in the hazard estimate for a site (that is, for example, would it change, if accepted, the EST aggregate regional seismic source model maximum magnitude for a site)? If it does not meet both of these criteria it does not, in my opinion, require incorporation under RG 1.165.

Sincerely,

Joe Litehiser

Comments on Open Item 2.5-1 of Vogtle ESP

R.P. Kennedy
October 30, 2007

The goal is to maintain a stable process for developing seismic source models to use in probabilistic seismic hazard analyses (PSHA) for the purpose of defining site specific design response spectra (GMRS) for multiple sites. In order to achieve this goal, the EPRI source models from the six Earth Science Teams (ESTs) should only be revised or updated when there is a strong basis of new data overwhelming supporting the need for a revision or update. Under the SSHAC process, it is unacceptable to discount, re-weight, or alter the source model of any of the ESTs simply because their model produces either low or high results relative to results from the other models.

The attached figure shows the 10 Hz total mean hazard curve together with the contributing mean hazard curves from the updated Charleston source and each of the six ESTs source models. At any spectral acceleration SA, the total mean annual frequency of exceedance H is given by combining the Charleston source mean annual frequency of exceedance (AFE) with the mean of the 6 ESTs mean AFE, i.e.:

$$H = H_C + (H_R + H_{WC} + H_{We} + H_L + H_B + H_{DM})/6 \quad (1)$$

where H_C is the mean annual frequency of exceedance from the updated Charleston source, and H_R, H_{WC}, H_{We}, H_L, H_B, H_{DM}, are the mean AFE from the Rondout, Woodward-Clyde, Weston, Law, Bechtel, and Dames and Moore teams, respectively. At SA=0.42g, Table 1 lists the mean AFE scaled from the attached figure for each of the mean hazard curves, and the combined total.

It has been suggested by some people that the Dames and Moore source model should be revised or deleted because it produces outlier low H_{DM} results when compared to results from the other 5 ESTs. However, H_{DM} from the Dames and Moore source model is no more of an outlier than is H_R from the Rondout source model. Table 2 shows the change to H from deleting H_{DM}, deleting H_R, and deleting both H_{DM} and H_R.

Deleting H_{DM} increases the total mean AFE by only approximately 5%. Conversely, deleting H_R decreases the total mean AFE by approximately 7%. Deleting both H_{DM} and H_R decreases the total mean AFE by about 2%. It can be seen that at a mean AFE of 1.0×10^{-4}, the computed mean AFE are not significantly influenced by either H_{DM} or H_R. Furthermore, H_R from the Rondout team source model has more influence on the mean AFE than does H_{DM} from the Dames & Moore source model. Similar results exist at a spectral acceleration corresponding to mean AFE of 1.0×10^{-5}.

Neither the Dames and Moore team results nor the Rondout team results are outlier results. The difference in results simply reflects the diversity of scientific judgement. It would be capricious to discount or re-weight any of the ESTs results.

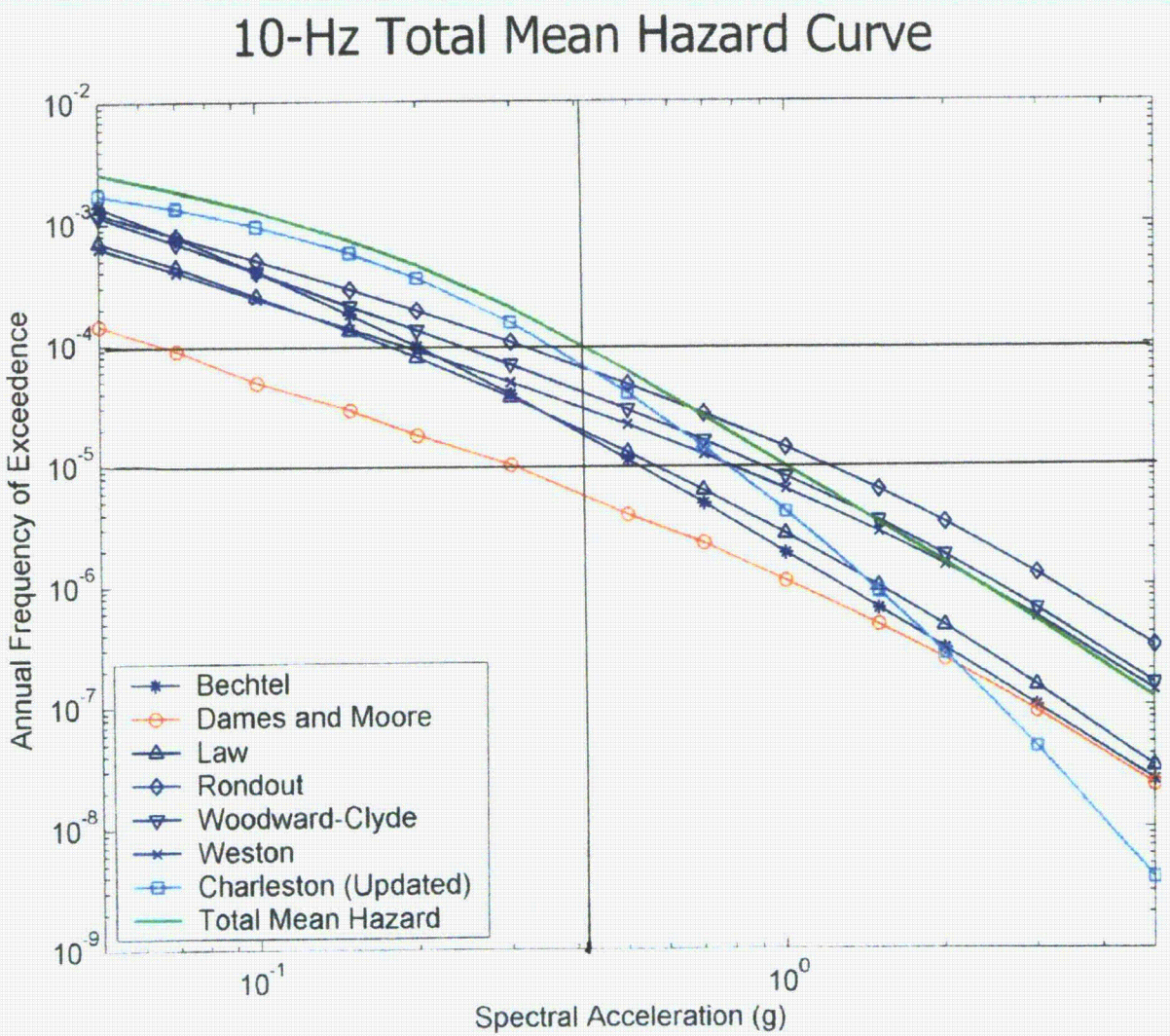
Table 1
Contribution to Mean
Annual Frequency of Exceedance (AFE)
for $SA_{10Hz} = 0.42g$

Contributor		Mean AFE ($x10^{-5}$)
Charleston	H_C	6.6
Rondout	H_R	6.6
Woodward-Clyde	H_{WC}	4.1
Weston	H_{We}	3.0
Law	H_L	2.6
Bechtel	H_B	2.4
Dames & Moore	H_{DM}	0.6
Total	H	9.8

Table 2
Comparison of Mean AFE
When Teams Are Deleted

	Mean AFE ($x10^{-5}$)
All 6	9.8
Delete H_{DM}	10.3
Delete H_R	9.1
Delete $H_{DM} + H_R$	9.6

2.5.2 Vibratory Ground Motion



Comments of Open Item 2.5-3
Martin Chapman

It is my view that the EPRI-SOG treatment of the Eastern Tennessee seismic zone remains viable for PSHA.

The EPRI-SOG teams were aware of the main geophysical characteristics of the eastern Tennessee area, including elevated microearthquake activity (M<3.0) as indicated by regional seismic network monitoring and correlation of that seismicity with crustal scale potential field anomalies (NY-AL lineament). In the years since the EPRI-SOG project was completed, studies have contributed to our understanding of the seismic zone, particularly in regard to the crustal structure, stress field and the preferred orientation of basement faults responsible for the seismicity. These studies have developed an improved image of the crustal volume containing the earthquakes and the data collected as a result of regional seismic network monitoring have allowed some hypothesis testing concerning gross geological characteristics of the seismicity. Unfortunately, the results of these studies actually represent only a modest addition to the relevant information that was available to EPRI-SOG, for quantification of the parameters necessary for PSHA, and their associated uncertainties.

The basic seismicity information for PSHA is aimed at developing three elements of the PSHA model and their uncertainties: 1) seismic sources, 2) seismicity rates for the sources and 3) maximum magnitudes of the sources. In developing the model, the uncertainties associated with the parameterization of these three elements must be rigorously incorporated. The EPRI-SOG study followed such a process.

Particularly in regard to sources, the studies of Chapman et al. (1997) and Dunn and Chapman (2005) identified areas within the ETSZ where organized seismicity and consistent focal mechanisms provide information on the orientation of seismogenic faults. However, unequivocal identification of basement faults capable of generating damaging ground motion has NOT been achieved and it is my opinion that incorporation of the existing information and associated uncertainty in PSHA at present is best done by the use of source areas rather than fault sources.

In regard to seismicity rates, the results of EPRI-SOG have been updated with the latest catalog information for the Vogtle ESP.

In regard to maximum earthquake, no new data relevant for eastern Tennessee have come to light subsequent to the estimates made by the EPRI-SOG teams, with the exception of the occurrence of the Fort Payne, Alabama shock. The magnitude of that event required a modification of the lower-bound limit of the Mmax distribution for some of the teams. The TIP study (Savy et al., 2002) was a trial implementation of the SHACC process. The resulting composite range for the maximum magnitudes for the Eastern Tennessee seismic zone is from M 4.5 to 7.5. I maintain that this result reflects the continuing absence of data that can be brought to bear on the problem, rather than new information.

A composite result with a similar range of uncertainty on Mmax was derived in the EPRI-SOG study.

References:

Chapman, M.C., C.A. Powell, G. Vlahovic and M. S. Sibol (1997), A statistical analysis of earthquake focal mechanisms and epicenter locations in the eastern Tennessee seismic zone, Bull. Seism. Soc. Am. Vol 87, 1522-1536.

Dunn, M. M. and M.C. Chapman (2006). Fault Orientation in the Eastern Tennessee Seismic Zone: A Study Using the Double-Difference Earthquake Location Algorithm, Seismological Research Letters, 77, no. 4, 494-504.

Savy, J.B., W. Foxall, N. Abrahamson and D. Bernreuter (2002). Guidance for Performing Probabilistic Seismic Hazard Analysis for a Nuclear Plant Site: Example Application to the Southeastern United States, NUREG/CR-6607, prepared for Division of Engineering Technology, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC.