Ronald B. Clary
General Manager
New Nuclear Deployment

SCE&G®
A SCANA COMPANY

August 31, 2009
NND-09-0259

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

ATTN: Document Control Desk

Subject: Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 Combined License Application (COLA) - Docket Numbers 52-027 and 52-028 Response to NRC Request for Additional Information (RAI) Letter No. 060

Reference: Letter from Chandu P. Patel (NRC) to Alfred M. Paglia (SCE&G), Request for Additional Information Letter No. 060 Related to SRP Section 02.05.02 for the Virgil C. Summer Nuclear Station Units 2 and 3 Combined License Application, dated July 30, 2009.

The enclosure to this letter provides the South Carolina Electric & Gas Company (SCE&G) response to the RAI items included in the above referenced letter, with the exception of RAI's 02.05.02-20 and 02.05.02-27. The responses to these additional RAI's will be provided to the NRC no later than September 14, 2009.

The enclosure also identifies any associated changes that will be incorporated in a future revision of the VCSNS Units 2 and 3 COLA.

Should you have any questions, please contact Mr. Al Paglia by telephone at (803) 345-4191, or by email at apaglia@scana.com.

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

Executed on this 31st day of August, 2009.

Sincerely,

Ronald B Clary

Ronald B. Clary
General Manager
New Nuclear Deployment

AMM/RBC/am

D083
NRO

Enclosure
c:

Luis A. Reyes
Chandu Patel
John Zeiler
Stephen A. Byrne
Jeffrey B. Archie
Ronald B. Clary
Bill McCall
William M. Cherry
Randolph R. Mahan
Kathryn M. Sutton
Amy M. Monroe
Courtney W. Smyth
John J. DeBlasio
Grayson Young
FileNet

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-21

In response to RAI 2.5.2-3, the applicant stated that: "It should be noted that discarding the Dames & Moore team's contribution incorporates not only any effects from alternative characterization of Pa for Dames & Moore source Zones 41 and 53, but also any relative differences between the Dames & Moore's model for the Charleston source and the Charleston source models of the remaining ESTs." However, FSAR Section 2.5.2.4.4 (page2.5.2-38) states that "these EPRI team Charleston sources were removed from the seismic hazard analysis." The FSAR also states that the EPRI team Charleston sources were then replaced by the applicant's Updated Charleston Seismic Source (UCSS) model.

Please address the above discrepancy between the response to RAI 2.5.2-3 and the FSAR text. Specifically, please explain why the original EPRI-SOG EST Charleston seismic sources were not removed from the hazard model and instead replaced by the UCSS model in the sensitivity study results presented in response to RAI 2.5.2-3. Please re-evaluate the response to RAI 2.5.2-3 without using the EPRI-SOG Charleston seismic source models. In addition, please provide an electronic data file containing the contribution to the total mean hazard (1 and 10 Hz) from each of the EPRI-SOG ESTs as well as updated Charleston and New Madrid seismic sources, separately. Please also verify that the final hazard results (and resulting GMRS) reflect the inclusion of the UCSS rather than the original EPRI-SOG Charleston seismic source models.

VCSNS RESPONSE:

The implication in the next to last paragraph of the response to RAI 2.5.2-3 that the Dames and Moore contribution to earthquake hazard at the V. C. Summer site is less than that from the other Earth Science Teams (ESTs) in part because the contribution from the Dames and Moore characterization of the Charleston source was less than that from other ESTs is incorrect. The Updated Charleston Seismic Source (UCSS) model was used instead of the original EPRI-SOG Charleston seismic source models for all ESTs so that the contribution to earthquake hazard at the V. C. Summer site from all EST's is the same. Similarly, the updated New Madrid seismic source was used for all ESTs.

The final hazard results in the VCSNS FSAR do reflect the inclusion of the UCSS rather than the original EPRI-SOG Charleston seismic source models.

The observation made in this same RAI 2.5.2-3 response paragraph; "contributions to total hazard from Dames & Moore source Zones 41 and 53 are much less than from the Charleston sources, therefore, modifications to the Pa of these zones is relatively insignificant," remains correct. The fundamental conclusion drawn in response to RAI 2.5.2-3; "deleting the Dames & Moore team from the V. C. Summer seismic hazard analysis would not lead to a significant change in hazard at the GMRS amplitudes," under the proposed criterion for "significance" given, also remains correct.

The Table RAI 02.05.02-21-1 and Figures RAI 02.05.02-21-1 and RAI 02.05.02-21-2 below show the contribution to the weighted mean hazard (1 and 10 Hz) separated into contributions from the UCSS, New Madrid, and conditional (unweighted) mean hazards from the remaining sources for each of the EPRI-SOG ESTs

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

Table RAI 02.05.02-21-1 (Sheet 1 of 2)
Contributions to the total mean hazard (10 Hz) from each of the EPRI-SOG ESTs

Spectral Acceleration (g)	Charleston	New Madrid	BEC_Other	D&M_Other	LAW_Other	RND_Other	WCC_Other	WGC_Other	Weighted Mean Hazard
0.001	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	5.1239E-05	2.4592E-05	3.5628E-04
0.0015	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.002	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.003	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.005	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.007	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.01	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.015	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.02	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8651E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.03	2.9736E-04	2.4070E-05	3.8069E-05	6.1945E-06	2.8650E-05	6.0159E-05	7.5308E-05	2.4592E-05	3.6026E-04
0.05	2.9622E-04	2.3700E-05	3.8051E-05	6.1886E-06	2.8607E-05	6.0129E-05	7.4896E-05	2.4577E-05	3.5866E-04
0.07	2.8976E-04	2.2360E-05	3.7934E-05	6.1503E-06	2.8343E-05	5.9910E-05	7.3311E-05	2.4503E-05	3.5048E-04
0.1	2.6433E-04	1.8570E-05	3.7444E-05	5.9858E-06	2.7206E-05	5.8867E-05	6.8474E-05	2.4130E-05	3.1992E-04
0.15	1.9824E-04	1.1390E-05	3.5768E-05	5.4893E-06	2.3749E-05	5.5109E-05	5.7985E-05	2.2809E-05	2.4311E-04
0.2	1.3691E-04	6.3820E-06	3.3507E-05	4.9112E-06	1.9846E-05	5.0109E-05	4.8911E-05	2.1033E-05	1.7302E-04
0.3	6.2682E-05	2.0150E-06	2.8678E-05	3.9084E-06	1.3649E-05	4.0304E-05	3.6842E-05	1.7433E-05	8.8166E-05
0.5	1.5468E-05	2.8600E-07	2.0160E-05	2.5840E-06	7.1760E-06	2.6230E-05	2.3626E-05	1.1812E-05	3.1019E-05
0.7	4.8711E-06	6.0290E-08	1.3947E-05	1.7683E-06	4.2399E-06	1.7672E-05	1.5911E-05	8.1021E-06	1.5205E-05
1	1.1802E-06	9.2830E-09	8.1357E-06	1.0437E-06	2.1664E-06	1.0347E-05	9.2079E-06	4.7816E-06	7.1366E-06
1.5	1.8565E-07	8.4010E-10	3.6110E-06	4.8206E-07	8.4913E-07	4.8063E-06	4.1395E-06	2.2090E-06	2.8693E-06
2	4.2792E-08	1.2790E-10	1.7893E-06	2.5062E-07	3.8695E-07	2.5140E-06	2.0952E-06	1.1438E-06	1.4062E-06
3	4.3211E-09	6.9070E-12	5.6183E-07	8.7366E-08	1.0735E-07	8.7255E-07	6.8731E-07	3.8977E-07	4.5536E-07
5	1.6299E-10	7.7570E-14	9.9296E-08	1.9039E-08	1.5868E-08	1.7950E-07	1.3052E-07	7.8766E-08	8.7327E-08
7	1.4445E-11	6.7640E-18	2.6790E-08	6.2101E-09	3.7410E-09	5.4088E-08	3.7150E-08	2.3697E-08	2.5294E-08
10	7.9842E-13	6.4690E-33	5.7567E-09	1.6980E-09	6.8632E-10	1.3117E-08	8.4679E-09	5.8238E-09	5.9258E-09

Table RAI 02.05.02-21-1 (Sheet 2 of 2)
Contributions to the total mean hazard (1 Hz) from each of the EPRI-SOG ESTs

Spectral Acceleration (g)	Charleston	New Madrid	BEC_Other	D&M_Other	LAW_Other	RND_Other	WCC_Other	WGC_Other	Weighted Mean Hazard
0.0005	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8650E-05	6.0159E-05	5.1239E-05	2.4592E-05	3.5628E-04
0.0007	2.9737E-04	2.4090E-05	3.8069E-05	6.1955E-06	2.8650E-05	6.0159E-05	7.5329E-05	2.4592E-05	3.6029E-04
0.001	2.9737E-04	2.4090E-05	3.8069E-05	6.1954E-06	2.8650E-05	6.0159E-05	7.5327E-05	2.4592E-05	3.6029E-04
0.0015	2.9737E-04	2.4090E-05	3.8049E-05	6.1931E-06	2.8645E-05	6.0146E-05	7.5315E-05	2.4590E-05	3.6028E-04
0.002	2.9737E-04	2.4090E-05	3.8039E-05	6.1902E-06	2.8633E-05	6.0129E-05	7.5295E-05	2.4576E-05	3.6027E-04
0.003	2.9735E-04	2.4090E-05	3.7899E-05	6.1726E-06	2.8570E-05	6.0012E-05	7.5173E-05	2.4513E-05	3.6017E-04
0.005	2.9676E-04	2.4080E-05	3.7245E-05	6.0875E-06	2.8228E-05	5.9381E-05	7.4502E-05	2.4209E-05	3.5911E-04
0.007	2.9524E-04	2.4070E-05	3.6114E-05	5.9408E-06	2.7589E-05	5.8182E-05	7.3265E-05	2.3632E-05	3.5676E-04
0.01	2.8988E-04	2.4000E-05	3.3833E-05	5.6460E-06	2.6208E-05	5.5580E-05	7.0620E-05	2.2452E-05	3.4961E-04
0.015	2.7340E-04	2.3710E-05	2.9581E-05	5.0815E-06	2.3365E-05	5.0235E-05	6.5195E-05	2.0112E-05	3.2937E-04
0.02	2.5066E-04	2.3120E-05	2.5530E-05	4.5221E-06	2.0436E-05	4.4740E-05	5.9474E-05	1.7787E-05	3.0253E-04
0.03	2.0095E-04	2.1200E-05	1.8974E-05	3.5657E-06	1.5380E-05	3.5107E-05	4.8890E-05	1.3815E-05	2.4477E-04
0.05	1.2125E-04	1.6180E-05	1.1022E-05	2.2952E-06	8.8832E-06	2.2196E-05	3.2866E-05	8.6430E-06	1.5175E-04
0.07	7.3504E-05	1.1630E-05	6.8959E-06	1.5680E-06	5.4478E-06	1.4838E-05	2.2375E-05	5.7522E-06	9.4613E-05
0.1	3.6772E-05	6.8750E-06	3.7983E-06	9.7084E-07	2.8991E-06	8.8559E-06	1.3017E-05	3.4306E-06	4.9142E-05
0.15	1.3543E-05	2.9280E-06	1.7056E-06	5.1805E-07	1.2382E-06	4.4168E-06	5.8315E-06	1.7240E-06	1.9043E-05
0.2	5.7970E-06	1.3390E-06	8.9505E-07	3.1696E-07	6.2461E-07	2.5175E-06	2.9275E-06	9.9609E-07	8.5156E-06
0.3	1.4372E-06	3.4370E-07	3.2500E-07	1.4975E-07	2.1407E-07	1.0369E-06	9.5787E-07	4.2575E-07	2.2991E-06
0.5	1.7780E-07	4.0500E-08	7.6381E-08	5.2621E-08	4.6470E-08	2.8824E-07	1.9661E-07	1.2923E-07	3.4990E-07
0.7	3.6616E-08	7.6720E-09	2.6410E-08	2.4506E-08	1.5086E-08	1.1146E-07	6.4192E-08	5.4595E-08	9.3663E-08
1	5.7259E-09	1.0580E-09	7.7367E-09	1.0047E-08	4.0706E-09	3.6717E-08	1.8323E-08	2.0336E-08	2.2989E-08
1.5	5.5151E-10	8.4650E-11	1.6646E-09	3.2325E-09	7.8036E-10	9.0126E-09	3.9441E-09	5.9555E-09	4.7344E-09
2	8.9830E-11	1.1810E-11	5.0660E-10	1.3244E-09	2.1567E-10	3.0098E-09	1.2118E-09	2.3071E-09	1.5309E-09
3	5.4945E-12	5.3730E-13	8.1347E-11	3.2847E-10	2.9707E-11	5.5105E-10	1.9779E-10	5.3724E-10	2.9363E-10
5	9.5226E-14	1.9730E-15	6.1869E-12	4.4352E-11	1.8152E-12	4.9549E-11	1.5313E-11	6.8601E-11	3.1067E-11

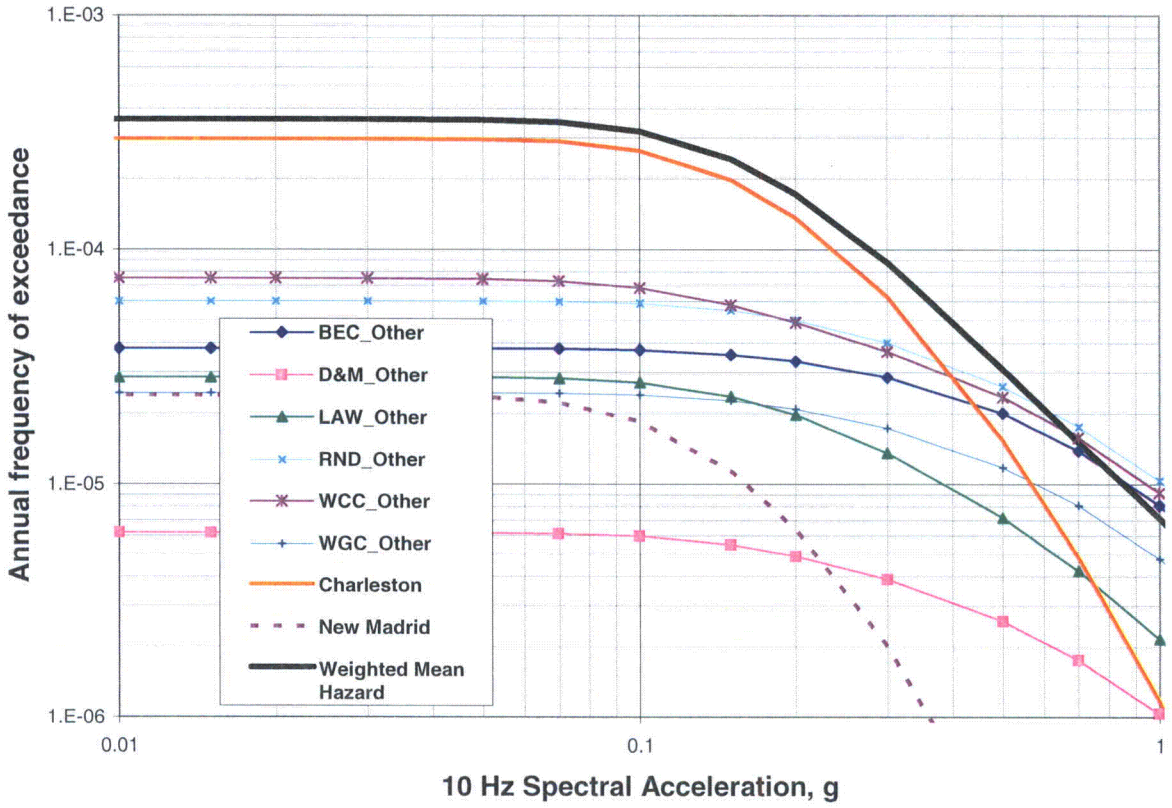

Figure RAI 02.05.02-21-1
Contributions to the total mean hazard (10 Hz) from each of the EPRI-SOG ESTs as well as from the updated Charleston and New Madrid seismic sources

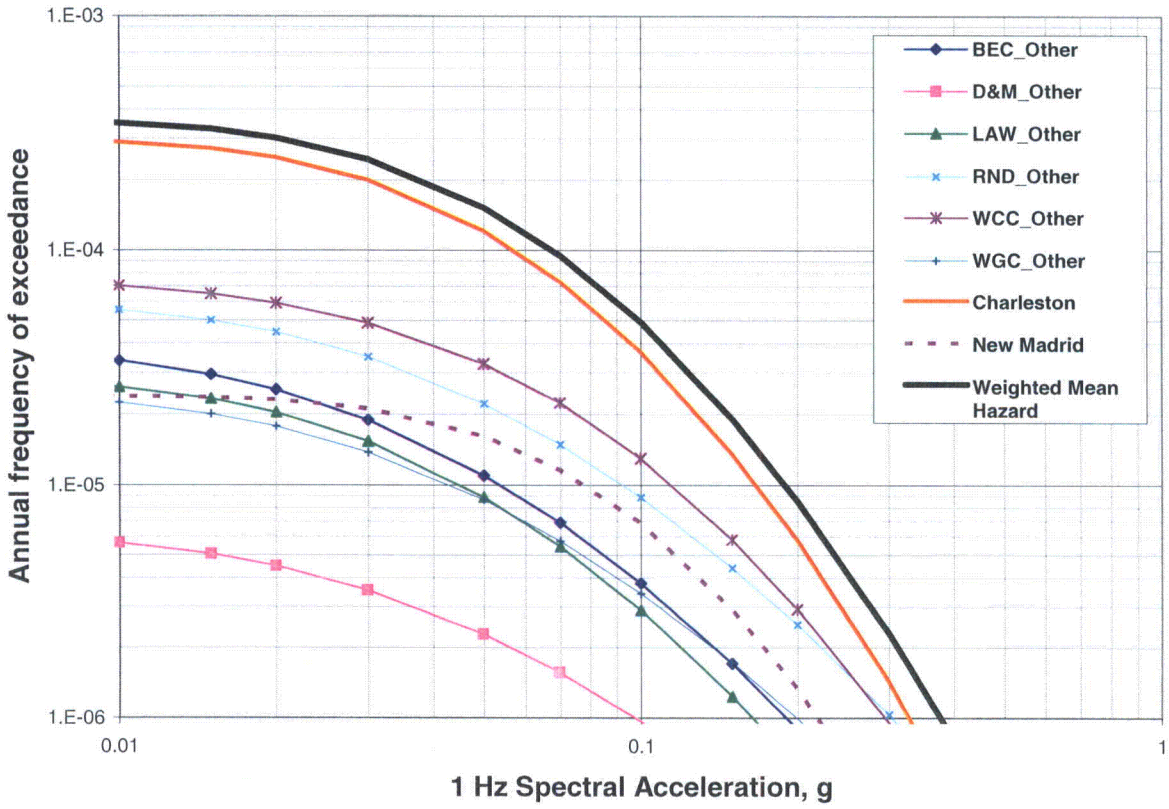

Figure RAI 02.05.02-21-2
Contributions to the total mean hazard (1 Hz) from each of the EPRI-SOG ESTs as well as from the updated Charleston and New Madrid seismic sources

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-22

In response to RAI 2.5.2-4, the applicant stated that it obtained values for smb from the original 1988 EPRI catalog. However, the response did not contain a discussion as to whether these smb values are appropriate to use for the new catalog data. Please provide justification for the use of the $\beta\mu\sigma$ values from the original 1988 EPRI catalog. Please also provide the updated seismicity catalog with the original magnitude values, as well as the converted magnitude values, in order for the staff to verify these conversions.

VCSNS RESPONSE:

In response to RAI 02.05.02-6 it is noted that in the development of the EPRI (VCSNS FSAR Section 2.5.2 Reference 235) methodology and database an effort was made to develop a uniform characterization of body-wave magnitude [m_b] for each earthquake in the EPRI seismicity catalog in order to develop a robust database from which rigorous assessments of magnitude-frequency recurrence and maximum magnitudes could be made for subsequent input to probabilistic seismic hazard analyses [PSHA]. In the EPRI methodology Emb is the best estimate of m_b, also referred to as E[m_b]. VCSNS FSAR Section 2.5.2 Reference 235 discusses the statistical analyses that were applied to the EPRI seismicity catalog to develop the magnitude conversion relations, referenced in the VCSNS FSAR as Equations 2.5.2-1 and 2.5.2-2.

The parameter Smb (also referred to as σ_{mb}, or the standard deviation of Emb) is obtained from the regression equations for converted values when direct instrumental values for m_b are not available (VCSNS FSAR Section 2.5.2 Reference 231).

The EPRI seismicity catalog and the magnitude conversion relations developed from that database are still considered to be an adequate characterization of seismicity in the central and eastern U.S. through 1984.

There are very few data occurring after 1984 with which to supplement the rigorous statistical analysis done by EPRI (VCSNS FSAR Section 2.5.2 Reference 235). In the updated catalog there are only 10 events with both the selected Emb values determined from M_d using Equation 2.5.2-1 and an alternate and independent m_b value. All of the Emb values determined from M_L and Equation 2.5.2-2 are obtained from the ANSS catalog, which presents only a single magnitude field, precluding investigation of an Emb(M_L) trend considering these data. An attempt to improve the EPRI Emb equations

and their associated Smb values for the recent period of the updated seismicity would not be meaningful with these few new data.

Also, as noted in the response to RAI 02.05.02-6, alternative Smb values over the range used to convert Emb to "uniform magnitude" Rmb (also referred to as m_b*) to develop statistically unbiased estimates of Gutenberg-Richter recurrence parameters would not be reasonably expected to have a significant effect on the results.

A catalog of the updated seismicity with the original magnitude values, as well as the converted magnitude values, is appended in the table below. In this table, a supplemented version of Table 2.5.2-202 of the VCSNS FSAR including all magnitude values available in the source catalog used, all earthquakes are from either the SEUSSN or ANSS catalogs as described in the VCSNS FSAR.

The SEUSSN catalog presents three magnitude fields of magnitude by type:

Mag#	Type	Description
1	N	m_b from Lg wave data (Nuttli, 1973)
2	D	M_d from duration or coda length
3	I	m_b from intensity data

The type "N" and "I" magnitudes are taken as directly equivalent to Emb. The duration magnitude type D is converted to Emb, using VCSNS FSAR Equation 2.5.2-1:

$$Emb = 0.253 + 0.907 \cdot M_d.$$

In the event of multiple magnitudes reported, the selected Emb is the largest evaluated.

ANSS presents only one magnitude field, but variable magnitude types, which in this dataset included "Mb", "mblg", "Mblg", and "ML". Mb, mblg, and Mblg magnitudes are all equivalent to m_b to which Emb is taken to be equal. The local magnitude type ML [same as M_L] is converted to Emb, using VCSNS FSAR Equation 2.5.2-2:

$$Emb = 0.655 + 0.812 \cdot M_L$$

RAI 02.05.02-4 presents the primary correlation table between available earthquake size measures and assigned Smb values. An additional correlation estimate for Smb of 0.25 is used where both a duration or coda magnitude [SEUSSN magnitude type "D"] and an m_b magnitude from intensity [SEUSSN magnitude type "I"] are given. This is a similar, but slightly smaller uncertainty than with the primary correlation table estimate of 0.27 for coda magnitude and intensity.

Rmb was calculated from the Emb and Smb values using VCSNS FSAR Equation 2.5.2-3:

$$Rmb = Emb + (1/2)\cdot ln(10)\cdot b\cdot Smb^2 ,$$

Or, in equivalent EPRI symbology, as presented in the VCSNS FSAR:

$$m_b^* = E[m_b] + (1/2)\cdot ln(10)\cdot b\cdot \sigma^2_{mb} \quad \text{, where } b=1.0$$

It is noted that Rmb was calculated from the pre-rounded values of Emb; that is, values of Emb directly from the conversion relationship results are used, rather than the 2-digit truncated version of Emb given in the seismicity table.

References for the Response:

Nuttli, O. W., (1973), Seismic wave attenuation and magnitude relations for eastern North America, Journal of Geophysical Research, 78, pp. 876-885.

Applicable VCSNS FSAR Section 2.5.2 References:

231. EPRI, EQHAZARD Primer: Prepared by Risk Engineering for Seismicity Owners Group and EPRI, EPRI Report NP-6452-D, Palo Alto, California, June 1989.

235. EPRI, Seismic Hazard Methodology for the Central and Eastern United States, Volume 1, Part 2: Methodology (Revision 1). EPRI Report NP-4726-A, Rev. 1, Palo Alto, California, November 1988

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1985	3	12	8	57	43.30	35.294	-84.482	11.3				1.5	D	1.61							4	1.61	0.27	1.70
1985	5	1	1	16	27.80	37.780	-87.610	10										2.9	ML	3.0		3.01	0.41	3.20
1985	6	10	12	22	38.30	37.248	-80.485	11.1	3.2	N	3.2	2.8	D	2.79	3.3	I	3.3					3.30	0.10	3.31
1985	7	12	18	20	28.30	35.202	-85.148	19.6				3.0	D	2.97								2.97	0.30	3.08
1985	12	22	0	56	5.00	35.701	-83.720	13.4				3.3	D	3.25								3.25	0.30	3.35
1986	1	7	1	26	43.30	35.610	-84.761	23.1				3.1	D	3.06								3.06	0.30	3.17
1986	2	3	0	53	6.80	35.928	-83.634	19.1				1.3	D	1.43							4	1.43	0.27	1.52
1986	2	13	11	35	45.55	34.755	-82.943	5										3.5	mblg	3.5		3.50	0.10	3.51
1986	3	13	2	29	31.40	33.229	-83.226	5				2.4	D	2.43	3.3	I	3.3					3.30	0.25	3.37
1986	3	26	16	36	23.90	37.245	-80.494	11.9				2.9	D	2.88	3.3	I	3.3					3.30	0.25	3.37
1986	4	19	7	40	53.00	35.187	-85.510	27.3				3.0	D	2.97								2.97	0.30	3.08
1986	5	7	2	27	0.46	33.233	-87.361	1										4.5	mblg	4.5		4.50	0.10	4.51
1986	5	13	14	30	36.00	35.539	-84.176	14.3				1.6	D	1.70							5	1.70	0.27	1.79
1986	5	18	2	18	5.20	35.508	-83.642	15.7				0.9	D	1.07							6	1.07	0.27	1.15
1986	6	21	0	40	2.30	35.374	-85.144	16.6				1.7	D	1.79							4	1.79	0.27	1.88
1986	7	11	14	26	14.80	34.937	-84.987	13	3.8	N	3.8	3.7	D	3.61	3.8	I	3.8					3.80	0.10	3.81
1986	7	25	12	43	55.10	35.635	-84.253	14.2				1.5	D	1.61							4	1.61	0.27	1.70
1986	9	17	9	33	49.50	32.931	-80.159	6.7				2.6	D	2.61	3.3	I	3.3					3.30	0.25	3.37
1986	10	26	8	19	33.30	35.903	-83.917	18.9				1.2	D	1.34							4	1.34	0.27	1.43
1986	11	15	12	7	56.20	35.885	-83.826	13.9				2.1	D	2.16							4	2.16	0.27	2.24
1986	12	3	9	44	21.20	37.580	-77.458	1.6				1.5	D	1.61	3.3	I	3.3					3.30	0.25	3.37
1986	12	10	11	30	6.10	37.585	-77.468	1.2	2.5	N	2.5	2.2	D	2.25	3.5	I	3.5					3.50	0.10	3.51
1986	12	24	17	58	38.30	37.583	-77.458	1				1.6	D	1.70	3.3	I	3.3					3.30	0.25	3.37
1987	1	13	14	50	40.90	37.584	-77.465	2.5				1.9	D	1.98	3.3	I	3.3					3.30	0.25	3.37
1987	3	16	13	9	26.80	34.560	-80.948	3				3.1	D	3.06								3.06	0.30	3.17
1987	3	27	7	29	30.50	35.565	-84.230	18.5	4.2	N	4.2	4.2	D	4.06	3.8	I	3.8					4.20	0.10	4.21
1987	5	5	2	3	30.60	36.398	-84.079	19				1.2	D	1.34							4	1.34	0.27	1.43

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1987	5	10	19	47	41.90	37.793	-83.393	0.7				3.0	D	2.97								2.97	0.30	3.08
1987	5	12	12	17	59.60	35.988	-83.998	13.3				1.0	D	1.16							5	1.16	0.27	1.24
1987	6	4	17	19	23.40	37.939	-85.800	7.6				3.1	D	3.06								3.06	0.30	3.17
1987	7	4	10	47	25.00	35.540	-84.445	16.1				0.9	D	1.07							4	1.07	0.27	1.15
1987	7	11	0	4	29.50	36.105	-83.816	25.1	3.7	N	3.7	3.9	D	3.79	3.5	I	3.5					3.79	0.10	3.80
1987	7	11	2	48	5.90	36.103	-83.819	23.8	3.2	N	3.2	3.5	D	3.43	3.3	I	3.3					3.43	0.10	3.44
1987	9	1	23	2	49.40	35.515	-84.396	21.1				3.1	D	3.06								3.06	0.30	3.17
1987	9	22	17	23	50.10	35.623	-84.312	19.4	3.3	N	3.3	3.3	D	3.25	3.5	I	3.5				3	3.50	0.10	3.51
1987	10	14	15	49	40.10	37.050	-88.780	2										3.8	ML	3.7		3.74	0.41	3.93
1987	10	20	22	49	55.90	35.841	-84.444	12.8				2.3	D	2.34							5	2.34	0.27	2.42
1987	11	27	18	58	29.30	36.852	-83.110	26.8	3.5	N	3.5	3.5	D	3.43	3.5	I	3.5					3.50	0.10	3.51
1987	11	29	2	10	51.40	36.862	-83.107	8.6				2.0	D	2.07							5	2.07	0.27	2.15
1987	11	30	7	2	44.10	36.095	-83.805	20.8				0.8	D	0.98							6	0.98	0.27	1.06
1987	12	12	3	53	28.79	34.244	-82.628	5										3.0	mblg	3.0		3.00	0.10	3.01
1988	1	9	1	7	40.60	35.279	-84.199	12.2				3.2	D	3.16	3.3	I	3.3					3.30	0.25	3.37
1988	1	23	1	57	16.40	32.935	-80.157	7.4				3.3	D	3.25	3.5	I	3.5					3.50	0.25	3.57
1988	2	16	15	26	54.80	36.595	-82.274	4	3.3	N	3.3	3.3	D	3.25	3.3	I	3.3					3.30	0.10	3.31
1988	2	18	0	37	45.40	35.346	-83.837	2.4	3.5	N	3.5	3.3	D	3.25	3.3	I	3.3					3.50	0.10	3.51
1988	2	27	17	36	32.60	35.266	-84.622	19.3				0.4	D	0.62							4	0.62	0.27	0.70
1988	3	10	21	24	9.50	37.750	-88.830	4.4										3.0	ML	3.1		3.09	0.41	3.28
1988	6	15	14	46	16.60	34.630	-82.529	1.4				1.4	D	1.52							4	1.52	0.27	1.61
1988	7	3	11	28	8.30	35.686	-84.302	17.7				0.8	D	0.98							4	0.98	0.27	1.06
1988	8	27	16	52	29.50	37.718	-77.775	14.3				2.7	D	2.7	3.3	I	3.3				5	3.30	0.25	3.37
1988	9	18	16	16	1.00	37.310	-87.210	12.6										2.7	ML	2.8		2.85	0.41	3.04
1988	11	1	13	7	40.70	35.743	-84.087	11.2				1.6	D	1.7							4	1.70	0.27	1.79
1989	1	21	23	50	8.90	33.391	-80.688	4.3				1.6	D	1.7							4	1.70	0.27	1.79

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1989	2	28	17	31	50.84	33.643	-87.092	0										3.5	mblg	3.5		3.50	0.10	3.51
1989	6	2	5	4	34.00	32.934	-80.166	5.8				2.0	D	2.07	3.3	I	3.3					3.30	0.25	3.37
1989	6	28	9	35	0.20	37.810	-88.950	12.7										2.9	ML	3.0		3.01	0.41	3.20
1989	7	15	18	58	28.00	34.373	-87.323	13.9	2.8	N	2.8	3.2	D	3.16								3.16	0.10	3.17
1989	8	13	20	16	2.90	33.632	-87.086	0										3.4	mblg	3.4		3.40	0.10	3.41
1989	8	20	0	3	18.30	34.803	-87.596	6.7	3.9	N	3.9	3.5	D	3.43	4.0	I	4.0				6	4.00	0.10	4.01
1990	5	30	9	12	54.50	35.246	-84.359	6.1				0.1	D	0.34							5	0.34	0.27	0.43
1990	6	23	20	44	2.10	33.720	-87.946	6.4				3.1	D	3.06								3.06	0.30	3.17
1990	6	30	16	38	32.80	33.734	-88.063	2				2.2	D	2.25							5	2.25	0.27	2.33
1990	8	17	21	1	15.90	36.934	-83.384	0.6	4.0	N	4.0	3.5	D	3.43	3.4	I	3.4					4.00	0.10	4.01
1990	9	2	4	35	40.20	33.758	-87.928	0.9				3.2	D	3.16								3.16	0.30	3.26
1990	11	8	10	8	25.40	37.108	-83.031	0.4				3.2	D	3.16								3.16	0.30	3.26
1990	11	13	15	22	13.00	32.947	-80.136	3.4	3.5	N	3.5	3.2	D	3.16	3.5	I	3.5					3.50	0.10	3.51
1991	1	11	21	1	59.00	37.510	-78.190	9.6				2.0	D	2.07							5	2.07	0.27	2.15
1991	1	23	9	25	23.20	37.940	-88.873	0.8										3.1	ML	3.2		3.17	0.41	3.37
1991	1	28	11	43	55.70	37.349	-87.324	1.2										2.8	ML	2.9		2.93	0.41	3.12
1991	3	15	6	54	8.30	37.746	-77.909	15.5	3.8	N	3.8	3.3	D	3.25	3.5	I	3.5					3.80	0.10	3.81
1991	4	22	1	1	20.20	37.942	-80.205	14.8	3.5	N	3.5	3.5	D	3.43	3.3	I	3.3					3.50	0.10	3.51
1991	5	10	19	40	36.60	34.865	-85.201	11.2				2.2	D	2.25							5	2.25	0.27	2.33
1991	6	2	6	5	34.90	32.980	-80.214	5				1.7	D	1.79	3.5	I	3.5					3.50	0.25	3.57
1991	9	24	7	21	7.00	35.701	-84.117	13.3	3.0	N	3.0	3.3	D	3.25	3.3	I	3.3					3.30	0.10	3.31
1991	10	9	1	29	23.30	34.895	-85.327	6.5				0.4	D	0.62							4	0.62	0.27	0.70
1991	10	28	10	46	20.90	35.615	-84.712	11.5				1.6	D	1.70							4	1.70	0.27	1.79
1991	10	30	14	54	12.60	34.904	-84.713	8.1				3.1	D	3.06								3.06	0.30	3.17
1992	1	3	4	21	23.90	33.981	-82.421	3.3				3.4	D	3.34	3.5	I	3.5					3.50	0.25	3.57
1992	2	1	5	6	30.30	33.991	-82.425	4.8				2.1	D	2.16							5	2.16	0.27	2.24

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1992	8	21	16	31	56.10	32.985	-80.163	6.5	4.1	N	4.1	4.1	D	3.97	3.8	I	3.8				1	4.10	0.10	4.11
1992	9	6	11	15	51.80	32.945	-80.130	5.8				0.8	D	0.98							6	0.98	0.27	1.06
1992	9	11	16	34	11.70	33.171	-87.501	6.5				3.0	D	2.97								2.97	0.30	3.08
1992	11	10	17	16	46.80	35.644	-84.132	10.2				3.0	D	2.97							1	2.97	0.27	3.06
1993	1	1	5	8	5.20	35.878	-82.086	2.3				3.0	D	2.97								2.97	0.30	3.08
1993	1	15	2	2	50.90	35.039	-85.025	8.1	3.1	N	3.1	3.3	D	3.25	3.3	I	3.3					3.30	0.10	3.31
1993	4	15	6	34	56.40	35.867	-83.620	16.5				1.3	D	1.43							5	1.43	0.27	1.52
1993	5	19	10	31	18.20	35.505	-84.890	22.7				2.3	D	2.34							4	2.34	0.27	2.42
1993	7	1	21	24	34.00	35.972	-82.519	2.4				2.3	D	2.34							4	2.34	0.27	2.42
1993	7	12	4	48	20.80	36.035	-79.823	5	2.7	N	2.7				3.3	I	3.3					3.30	0.10	3.31
1993	7	16	10	54	32.86	31.747	-88.341	5										3.7	mblg	3.7		3.70	0.10	3.71
1993	8	8	9	24	32.40	33.597	-81.591	8.5	3.2	N	3.2	2.9	D	2.88	3.5	I	3.5					3.50	0.10	3.51
1994	1	31	14	33	8.90	35.756	-84.599	10.2				2.3	D	2.34							4	2.34	0.27	2.42
1994	2	12	2	40	24.50	36.800	-82.000	5										3.4	ML	3.4		3.42	0.41	3.61
1994	2	27	22	36	42.90	37.279	-80.760	2.1				1.1	D	1.25							5	1.25	0.27	1.33
1994	4	5	22	22	0.40	34.969	-85.491	24.3	3.2	N	3.2	3.4	D	3.34	3.5	I	3.5					3.50	0.10	3.51
1994	4	16	20	10	12.20	35.752	-83.968	1.8				1.5	D	1.61	3.5	I	3.5					3.50	0.25	3.57
1994	4	30	1	56	16.80	32.835	-80.187	3.4				0.6	D	0.80							5	0.80	0.27	0.88
1994	5	4	9	12	3.40	34.222	-87.195	19.3	3.0	N	3.0	3.3	D	3.25	3.1	I	3.1					3.25	0.10	3.26
1994	9	26	14	23	22.84	36.960	-88.920	12.7										3.4	ML	3.4		3.42	0.41	3.61
1995	3	2	0	2	18.10	32.962	-80.165	4.6				0.7	D	0.89							4	0.89	0.27	0.97
1995	3	11	8	15	52.32	36.959	-83.133	1										3.8	mblg	3.8		3.80	0.10	3.81
1995	3	11	9	50	4.44	36.990	-83.180	1										3.3	mblg	3.3		3.30	0.10	3.31
1995	3	18	22	6	20.80	35.422	-84.941	26				3.3	D	3.25							4	3.25	0.27	3.33
1995	4	17	13	46	0.00	32.997	-80.171	8.4	3.9	N	3.9	3.2	D	3.16								3.90	0.10	3.91
1995	5	28	15	28	37.00	33.191	-87.827	1	3.4	N	3.4										F	3.40	0.10	3.41

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1995	6	26	0	36	17.10	36.752	-81.481	1.8	3.4	N	3.4	3.3	D	3.25							3	3.40	0.10	3.41
1995	7	5	14	16	44.70	35.334	-84.163	10	3.7	N	3.7										6	3.70	0.10	3.71
1995	7	7	21	1	3.00	36.493	-81.833	10	3.0	N	3.0	3.1	D	3.06								3.06	0.10	3.08
1995	7	15	1	3	28.40	33.478	-87.665	1	3.3	N	3.3											3.30	0.10	3.31
1995	8	18	20	11	23.20	32.932	-80.143	3.6				0.2	D	0.43							4	0.43	0.27	0.52
1995	8	19	3	59	8.80	32.979	-80.188	7.3				0.0	D	0.25							4	0.25	0.27	0.34
1995	9	16	12	53	50.70	32.979	-80.157	3.9				2.3	D	2.34							5	2.34	0.27	2.42
1996	3	25	14	15	50.55	32.131	-88.671	5										3.5	ML	3.5		3.50	0.41	3.69
1996	4	19	8	50	14.01	36.981	-83.018	0										3.9	Mb	3.9		3.90	0.10	3.91
1997	3	29	10	16	57.10	37.088	-81.906	4.4				2.3	D	2.34							4	2.34	0.27	2.42
1997	5	4	3	39	12.80	30.934	-87.494	0	3.1	N	3.1	3.1	D	3.06								3.10	0.10	3.11
1997	5	19	19	45	35.80	34.622	-85.353	2.7	2.9	N	2.9	3.1	D	3.06								3.06	0.10	3.08
1997	7	19	17	6	34.40	34.953	-84.811	2.8	3.5	N	3.5	3.7	D	3.61								3.61	0.10	3.62
1997	7	30	12	29	25.30	36.512	-83.547	23	3.8	N	3.8	3.8	D	3.70								3.80	0.10	3.81
1997	9	14	7	24	54.50	34.533	-85.693	8.2				0.8	D	0.98							4	0.98	0.27	1.06
1997	9	14	7	53	37.90	34.505	-85.628	10.7				0.6	D	0.80							4	0.80	0.27	0.88
1997	10	19	18	39	55.10	35.286	-84.753	15.1				2.4	D	2.43							6	2.43	0.27	2.51
1997	10	24	8	35	17.90	31.118	-87.339	10	4.9	N	4.9	4.8	D	4.61								4.90	0.10	4.91
1997	10	26	23	27	12.00	31.118	-87.339	10	3.7	N	3.7	3.6	D	3.52								3.70	0.10	3.71
1997	10	28	9	0	11.00	31.100	-87.300	10	3.0	N	3.0										6	3.00	0.10	3.01
1997	10	28	10	36	46.56	37.162	-82.025	1										3.4	ML	3.4		3.42	0.41	3.61
1997	12	12	8	42	20.25	33.466	-87.306	1										4.0	ML	3.9		3.90	0.41	4.10
1997	12	24	1	35	49.40	35.493	-85.125	6.5				1.6	D	1.70							4	1.70	0.27	1.79
1997	12	27	3	36	46.20	34.126	-87.263	0				1.9	D	1.98							5	1.98	0.27	2.06
1997	12	27	7	44	46.70	37.985	-79.953	0				2.2	D	2.25							4	2.25	0.27	2.33
1998	4	13	9	56	15.60	34.471	-80.603	6.6	3.9	N	3.9	4.0	D	3.88								3.90	0.10	3.91

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
1998	6	5	2	31	3.90	35.554	-80.785	9.4	3.2	N	3.2	3.4	D	3.34							5	3.34	0.10	3.35
1998	6	17	8	0	23.90	35.944	-84.392	11.3	3.6	N	3.6	3.6	D	3.52								3.60	0.10	3.61
1998	6	24	15	20	4.70	32.760	-87.759	2.7	3.4	N	3.4	3.2	D	3.16								3.40	0.10	3.41
1998	7	24	13	56	26.60	37.245	-87.219	9.7				2.3	D	2.34							5	2.34	0.27	2.42
1998	10	21	5	56	46.90	37.422	-78.439	12.6	3.8	N	3.8	3.4	D	3.34								3.80	0.10	3.81
1999	1	17	18	38	5.10	36.893	-83.799	1				3.1	D	3.06								3.06	0.30	3.17
1999	1	18	7	0	53.47	33.405	-87.255	1										4.8	Mb	4.8		4.80	0.10	4.81
1999	3	29	14	49	37.80	33.064	-80.140	10.7				3.0	D	2.97								2.97	0.30	3.08
1999	11	28	11	0	9.30	33.416	-87.253	1										3.8	ML	3.7		3.74	0.41	3.93
2000	1	18	22	19	32.20	32.920	-83.465	19.2	3.5	N	3.5	3.2	D	3.16								3.50	0.10	3.51
2000	4	10	12	48	15.50	35.458	-84.175	10.3				1.8	D	1.89							4	1.89	0.27	1.97
2000	4	28	23	36	26.00	37.690	-88.460	5										2.9	ML	3.0		3.01	0.41	3.20
2000	5	28	11	32	6.30	33.708	-87.811	0	3.0	N	3.0	3.0	D	2.97								3.00	0.10	3.01
2000	6	27	6	2	57.00	37.130	-88.870	4.1										2.9	ML	3.0		3.01	0.41	3.20
2000	8	10	23	54	13.00	33.016	-80.179	7.1				1.6	D	1.70							5	1.70	0.27	1.79
2000	12	7	14	8	49.40	37.973	-87.660	5	3.9	N	3.9											3.90	0.10	3.91
2001	3	7	17	12	23.80	35.552	-84.850	6.8	3.2	N	3.2	3.2	D	3.16							3	3.20	0.10	3.21
2001	3	21	23	35	34.90	34.847	-85.438	0				3.2	D	3.16							3	3.16	0.27	3.24
2001	3	30	22	1	12.30	35.508	-84.481	18.1				1.8	D	1.89							5	1.89	0.27	1.97
2001	4	13	16	36	20.70	36.526	-83.342	0				3.0	D	2.97								2.97	0.30	3.08
2001	6	11	18	27	54.25	30.226	-79.885	10										3.3	ML	3.3		3.33	0.41	3.53
2001	7	26	5	26	46.00	35.971	-83.552	14.3	3.2	N	3.2	3.3	D	3.25								3.25	0.10	3.26
2001	9	22	16	1	20.60	38.026	-78.396	0.4	3.2	N	3.2	2.5	D	2.52								3.20	0.10	3.21
2001	12	4	21	15	13.90	37.726	-80.752	8.5	3.1	N	3.1											3.10	0.10	3.11
2001	12	8	1	8	22.40	34.710	-86.231	0	3.9	N	3.9	3.7	D	3.61								3.90	0.10	3.91
2002	5	21	20	35	31.90	32.456	-88.221	27.4				3.0	D	2.97								2.97	0.30	3.08

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
2002	6	18	17	37	15.17	37.987	-87.780	5										5.0	Mblg	5.0		5.00	0.10	5.01
2002	7	26	21	7	3.00	33.060	-80.195	10				3.0	D	2.97								2.97	0.30	3.08
2002	11	8	13	29	3.19	32.422	-79.950	3.9										3.5	ML	3.5		3.50	0.41	3.69
2002	11	11	23	39	29.72	32.404	-79.936	2.4										4.4	ML	4.2		4.23	0.41	4.42
2003	1	3	16	17	7.00	37.830	-88.090	5										2.9	ML	3.0		3.01	0.41	3.20
2003	3	15	9	2	24.40	32.918	-80.160	5.8				0.9	D	1.07							5	1.07	0.27	1.15
2003	3	18	6	4	24.21	33.689	-82.888	5										3.5	ML	3.5		3.50	0.41	3.69
2003	4	29	8	59	38.10	34.445	-85.620	9.1	4.6	N	4.6	4.9	D	4.70								4.70	0.10	4.71
2003	4	29	9	45	45.00	34.440	-85.640	3.1										2.9	ML	3.0		3.01	0.41	3.20
2003	5	2	8	10	13.00	37.960	-88.650	0.6										3.2	ML	3.3		3.25	0.41	3.45
2003	5	2	10	48	44.00	34.490	-85.610	14.5										3.1	ML	3.2		3.17	0.41	3.37
2003	5	5	10	53	49.90	33.055	-80.190	11.4				3.1	D	3.06								3.06	0.30	3.17
2003	5	5	16	32	33.90	37.655	-78.055	2.8	3.9	N	3.9											3.90	0.10	3.91
2003	5	8	11	33	6.00	33.989	-81.053	0.9				1.5	D	1.61							6	1.61	0.27	1.70
2003	6	6	12	29	34.00	36.870	-88.980	2.6										4.0	ML	3.9		3.90	0.41	4.10
2003	7	13	20	15	16.96	32.335	-82.144	5										3.6	ML	3.6		3.58	0.41	3.77
2003	8	26	2	26	58.00	37.100	-88.680	1.9										3.1	ML	3.2		3.17	0.41	3.37
2003	9	30	2	28	4.50	31.022	-87.462	12.5				3.0	D	2.97								2.97	0.30	3.08
2003	12	9	20	59	18.70	37.774	-78.100	10	4.5	N	4.5											4.50	0.10	4.51
2003	12	22	23	50	26.00	32.924	-80.157	5.6				3.0	D	2.97							6	2.97	0.27	3.06
2004	3	20	10	40	34.80	33.267	-86.955	0				3.0	D	2.97								2.97	0.30	3.08
2004	5	7	22	43	24.80	35.240	-84.297	8.4				1.5	D	1.61							5	1.61	0.27	1.70
2004	5	9	8	56	10.40	33.231	-86.960	5	3.3	N	3.3											3.30	0.10	3.31
2004	7	20	9	13	14.40	32.972	-80.248	10.3				3.1	D	3.06								3.06	0.30	3.17
2004	8	19	23	51	49.40	33.203	-86.968	5	3.5	N	3.5											3.50	0.10	3.51
2004	9	17	15	21	43.60	36.933	-84.004	1.3	3.7	N	3.7											3.70	0.10	3.71

Table RAI 02.05.02-22-1
Events with Rmb 3.0 or Greater or Intensity 4.0 or Greater with SEUSSN and ANSS Magnitudes

Year	Month	Day	Hour	Minute	Second	Lat	Lon	Depth	SEUSSN Magnitudes									ANSS Magnitudes			Int	EMB	SMB	RMB
									Mag1	Mag1 Type [1]	EMB1	Mag2	Mag2 Type [2]	EMB2	Mag3	Mag3 Type [3]	EMB3	Mag	Mag Type [4]	EMB				
2004	11	7	11	20	25.70	32.976	-87.913	11.4				4.6	D	4.43								4.43	0.30	4.53
2004	11	30	23	59	34.20	36.936	-83.893	10				3.0	D	2.97								2.97	0.30	3.08
2004	12	23	6	54	20.70	35.429	-84.204	7.7				3.0	D	2.97								2.97	0.30	3.08
2005	2	8	11	42	53.00	37.220	-81.930	9.4										2.7	ML	2.8		2.85	0.41	3.04
2005	2	15	2	36	55.00	37.190	-81.920	11.2										2.8	ML	2.9		2.93	0.41	3.12
2005	2	18	14	21	54.00	34.050	-81.110	5										3.1	ML	3.2		3.17	0.41	3.37
2005	3	18	1	2	16.00	35.720	-84.160	9.1										2.7	ML	2.8		2.85	0.41	3.04
2005	3	22	8	11	50.51	31.836	-88.060	5										3.3	ML	3.3		3.33	0.41	3.53
2005	4	5	20	37	43.00	36.150	-83.690	10										2.9	ML	3.0		3.01	0.41	3.20
2005	4	14	15	38	16.00	35.470	-84.090	15.4										2.8	ML	2.9		2.93	0.41	3.12
2005	6	7	16	33	36.71	33.531	-87.304	5										2.8	ML	2.9		2.93	0.41	3.12
2005	6	20	2	0	32.00	36.930	-88.990	9.8										2.7	ML	2.8		2.85	0.41	3.04
2005	6	20	12	21	42.00	36.920	-89.000	18.7										3.6	ML	3.6		3.58	0.41	3.77
2005	8	25	3	9	42.00	35.880	-82.800	7.9										3.7	ML	3.7		3.66	0.41	3.85
2005	10	12	6	27	30.00	35.510	-84.540	8.2										3.6	ML	3.6		3.58	0.41	3.77
2005	12	7	19	29	45.83	35.862	-82.380	5										2.8	ML	2.9		2.93	0.41	3.12
2006	1	2	21	48	57.00	37.840	-88.420	10.7										3.6	ML	3.6		3.58	0.41	3.77
2006	3	1	17	42	42.00	37.500	-88.980	6.2										3.0	ML	3.1		3.09	0.41	3.28
2006	3	7	10	28	2.00	35.910	-82.340	3.7										2.8	ML	2.9		2.93	0.41	3.12
2006	3	11	2	37	20.00	35.200	-88.010	1.7										2.7	ML	2.8		2.85	0.41	3.04
2006	4	11	3	29	21.00	35.360	-84.480	19.6										3.3	ML	3.3		3.33	0.41	3.53
2006	5	10	12	17	29.00	35.530	-84.400	24.6										3.2	ML	3.3		3.25	0.41	3.45
2006	6	16	0	57	27.00	35.510	-83.200	1.4										3.4	ML	3.4		3.42	0.41	3.61
2006	8	7	8	44	28.00	34.940	-85.460	14.2										2.9	ML	3.0		3.01	0.41	3.20

SEUSSN magnitude types

1	N	m_b from Lg wave data (Nuttli, 1973)
2	D	M_d from duration or coda length
3	I	m_b from intensity data

ANSS magnitude types

4 "Mb", "mblg", "Mblg" are equivalent to m_b
"ML" is the same as M_L

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-23

In response to RAI 2.5.2-6, the applicant stated the following: "In addition, although Emb values for earthquakes in the updated portion of the catalog are derived from several directly reported magnitude scales, all have been assumed to have uncertainties represented by standard deviations between 0.1 and 0.41. For σ values in this range, and for b-values between 0.95 and 1.1, the correction to Emb from Equation 2.5.2-3 of the FSAR is 0.02 or less indicating that the use of a b-value of 1.0 is not critical."

Please clarify the above statement, since the Emb is derived from FSAR Equations 2.5.2-1 and 2.5.2-2, and not FSAR Equation 2.5.2-3 as stated above in the applicant's response. In addition, please clarify what is meant by "...Emb values for earthquakes in the updated portion of the catalog are derived from several directly reported magnitude scales...".

VCSNS RESPONSE:

Based on the questions asked in both RAI 02.05.02-6 and 02.05.02-23, further clarification on the use of FSAR equation 2.5.2-3 is provided below. RAI 2.5.2-6 contains several requests for additional information. The text quoted above is in response to the question,

> "...Also, in FSAR Equation 2.5.2-3 (page 2.5.2-3), you use b=1.0. Is this b-value supported by the regional seismicity data?"

Therefore, it is the b-value of FSAR Equation 2.5.2-3 that is addressed in this part of the response to RAI 2.5.2-6, not the estimation of Emb using FSAR Equations 2.5.2-1 and 2.5.2-2. Once best estimate, or Emb, values have been found, these values are adjusted through the use of Equation 2.5.2-3 to get Rmb which, per the EPRI (FSAR Reference 235) methodology, is a more statistically appropriate magnitude to use in earthquake recurrence regression analysis.

In FSAR Equation 2.5.2-3 the adjustment to Emb depends, in part, on an estimate of uncertainty in the data used to calculate Emb. In the EPRI methodology this estimate of uncertainty, σ, is made on the basis of what data were used to develop the Emb estimate. These data may be intensity, felt area, local magnitude (ML), duration magnitude (MD), body-wave magnitude (mb) or some combination of these parameters. For the updated portion of the catalog all earthquakes had either a published MD, ML, or mb value. Therefore Embs were estimated from "directly reported" magnitudes

rather than from more subjective, non-instrumental measures such as intensity or felt area. For Embs estimated from ML, MD, or mb, a σ of 0.41, 0.30, or 0.10, respectively, is used, following the EPRI methodology.

References for the Response:

FSAR Section 2.5.2 Reference:

235. EPRI, Seismic Hazard Methodology for the Central and Eastern United States, Volume 1, Part 2: Methodology (Revision 1). EPRI Report NP-4726-A, Rev. 1, Palo Alto, California, November 1988.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-24

Please provide data and or documentation to support Dr. Talwani's conclusion that water level changes in the Monticello Reservoir have not been correlated with any reservoir-induced seismicity.

VCSNS RESPONSE:

From 1981 through 1995, Dr. Talwani prepared quarterly reports titled "Seismic Activity Near the V. C. Summer Nuclear Station" which provided the updated data and conclusions from his studies of reservoir-induced seismicity near the V. C. Summer site. These reports were then transmitted to the NRC by SCE&G on a periodic basis. As the years progressed, these reports concluded that there was no observed systematic correlation between the reservoir level fluctuations and seismicity in the area.

While these reports have been previously provided to the NRC by SCE&G, copies of these reports (dating from 1981 through 1995) are also being placed in the Westinghouse office reading room.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-26

In your response to RAI 2.5.2-13, you stated that: "The seismic hazard analysis for the Summer site used the weights given in EPRI (2004) for all clusters and all equations within a cluster." Please clarify whether or not you used the ground motion model clusters, individual models, and weights recommended for hazard calculations incorporating multiple source types (i.e. shown in Figure RAI-13C).

VCSNS RESPONSE:

The ground motion clusters, individual models, and weights recommended in EPRI (2004) for hazard calculations incorporating multiple source types (i.e. shown in Figure RAI-13C) were used in hazard calculations.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 060 Dated July 30, 2009

SRP Section: 02.05.02 – Vibratory Ground Motion

Questions for Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.02-25

Please provide additional discussion regarding other possible differences between the computer software used in the 1989 EPRI analysis and Risk Engineering, Inc.'s FRISK88 software, which may be the source of the observed differences in hazard.

VCSNS RESPONSE:

The distribution of seismic hazard is calculated from a family of individual seismic hazard curves, each of which is assigned a weight. For the EPRI 1989 calculations, six teams provided alternative interpretations of seismic sources and parameters, so numerous seismic hazard curves represented epistemic uncertainty on seismic sources and parameters. Also, three ground motion equations were used in the EPRI 1989 calculations.

Seismic hazard curves have a downward-concave character (when plotted on log-log scale), that is, the slopes of the curves steepen as amplitude increases. Further, at any given ground motion amplitude, curves in the lower part of the family are steeper than curves in the upper part of the family. Said another way, lower fractile hazard curves, at any given ground motion amplitude, are more concave downward than are upper fractile hazard curves. This effect arises because both the uncertainty in the hazard and the skewness of the hazard distribution increase as the amplitude increases, while the mean hazard curve remains mildly concave. Because the lower fractile hazard curves are steeper at any ground motion amplitude, there is more imprecision in replicating annual frequencies of exceedence for these fractiles than for the more important mean or upper fractiles of the distribution.

During the original replication calculations, a post-processing algorithm was used to calculate overall fractiles that efficiently gives approximate, generally conservative estimates of hazard fractiles from the family of all hazard curves, but is less accurate at representing lower fractiles of highly skewed distributions of hazard. Rerunning this algorithm without the approximation indicates a better agreement of the median hazard curve with the EPRI 1989 hazard results. In summary, the reasons for differences between the current calculations and those reported in the EPRI 1989 study are well understood, and the EPRI 1989 seismic sources have been modeled appropriately and conservatively.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None