## 2.5S.2 Vibratory Ground Motion

The following site-specific supplement addresses COL License Information Items 2.24, 2.26, and 2.30.

This section provides a detailed description of the vibratory ground motion assessment for the STP 3 & 4 site. This assessment was performed under the guidance in Regulatory Guide (RG) 1.208. RG 1.208 incorporates developments in ground motion estimation models; updated models for earthquake sources; methods for determining site response; and new methods for defining a site-specific, performance-based earthquake ground motion that satisfy the requirements of 10 CFR 100.23 and lead to the establishment of the safe shutdown earthquake ground motion (SSE). The purpose of this section is to develop the site-specific ground motion response spectrum (GMRS) characterized by horizontal and vertical response spectra determined as free-field motions on the ground surface using performance-based procedures.

The GMRS represents the first part in development of an SSE for a site as a characterization of the regional and local seismic hazard. The GMRS will be used to determine the adequacy of the Certified Seismic Design Response Spectra (CSDRS) for the GE ABWR Design Certification Document (DCD). The CSDRS will be the SSE for the site, the vibratory ground motion for which certain structures, systems, and components are designed to remain functional, pursuant to Appendix S to 10 CFR Part 50.

The starting point for the GMRS assessment is the seismicity, seismic source models, and ground motion attenuation relations of EPRI-SOG probabilistic seismic hazard analysis (PSHA) evaluation (Reference 2.5S.2-1).

Subsections 2.5S.2.1 through 2.5S.2.4 document the review and update of the available EPRI seismicity, seismic source, and ground motion models. Subsection 2.5S.2.5 summarizes information about the seismic wave transmission characteristics of the STP 3 & 4 site with reference to more detailed discussion of all engineering aspects of the subsurface in Subsection 2.5S.4.

Subsection 2.5S.2.6 describes development of the horizontal GMRS ground motion for the STP 3 & 4 site. Following RG 1.208, the selected ground motion is based on the risk-consistent/performance-based approach. Site-specific horizontal ground motion amplification factors are developed using site-specific estimates of sub-surface soil and rock properties. These amplification factors are then used to scale the hard rock spectra to develop Uniform Hazard Response Spectra (UHRS) accounting for site-specific conditions using Approach 2A of NUREG/CR-6769 (Reference 2.5S.2-2).

Subsection 2.5S.2.6 also describes vertical GMRS, developed by scaling the horizontal GMRS by a frequency-dependent vertical-to-horizontal (V/H) factor.

### 2.5S.2.1 Seismicity

The seismic hazard analysis conducted by EPRI (Reference 2.5S.2-1) relied on an analysis of historical seismicity in the Central and Eastern United States (CEUS) to

estimate seismicity parameters (rates of activity and Richter b-values) for individual seismic sources. The historical earthquake catalog used in the EPRI analysis was complete through 1984. The earthquake data for the site region since 1984 were reviewed and used to update the EPRI catalog. The EPRI methodology did not originally incorporate contributions from seismic sources in the Gulf of Mexico except along its immediate coast. Special attention was paid to earthquakes in the Gulf of Mexico because two moderate earthquakes occurred recently in the Gulf of Mexico and the STP 3 & 4 site borders it.

### 2.5S.2.1.1 Regional Seismicity Catalog Used for EPRI Seismic Hazard Analysis Study

Many seismic networks record earthquakes in the CEUS. An effort was made during the EPRI seismic hazard analysis study to combine available data on historical earthquakes and to develop a homogeneous earthquake catalog that contained all recorded earthquakes for the region. “Homogeneous” means that estimates of body-wave magnitude (mb) for all earthquakes are consistent, duplicate earthquakes have been removed, non-earthquakes (e.g., mine blasts and sonic booms) have been eliminated, and significant events in the historical record have not been missed. The EPRI catalog (Reference 2.5S.2-3) forms a strong basis on which to estimate seismicity parameters such as recurrence rate and maximum magnitude.

### 2.5S.2.1.2 Updated Seismicity Data

The earthquake catalog was updated to determine whether regional earthquake patterns and parameters developed from the EPRI catalog (Reference 2.5S.2-3) remained unchanged. RG 1.206 specifies that earthquakes of Modified Mercalli Intensity (MMI) greater than or equal to IV or magnitude greater than or equal to 3.0 should be listed “that have been reported within 200 miles (320 km) of the site.” In updating the EPRI catalog, a latitude-longitude window of 24° to 40° N, 107° to 83° W was used. This window incorporates the 200 mi (320 km) radius “site region” and all seismic sources contributing significantly to STP 3 & 4 site earthquake hazard. Figure 2.5S.1-1 shows the site and its associated site region. Figures 2.5S.2-1 through 2.5S.2-6 show the site, this site region, the defined latitude-longitude window, both the original EPRI catalog earthquakes and updated seismicity data, and the original EPRI source zones.

Seismicity catalogs used to update the EPRI catalog are described below:

ANSS Catalog. The ANSS catalog (Reference 2.5S.2-4) was searched on November 28, 2006, for all records within the site region latitude-longitude window, resulting in 8229 records from February 1931 to November 2006. Of these, 5202 records are for events which occurred in 1985 or later.

ISC Catalog. The International Seismological Centre (ISC) catalog (Reference 2.5S.2-5) was searched on November 28, 2006, for all records within the site region latitude-longitude window, resulting in 841 records from November 1928 to September 2006. 643 records are for events which occurred in 1985 or later.

Stover and Coffman. The catalog from Stover and Coffman (Reference 2.5S.2-6), referred to USHIS, was searched on November 30, 2006, for all records within the site region latitude-longitude window, resulting in 182 records. Of these, eight records are for events which occurred in 1985 or later.

Stover et al. A search was made on November 30, 2006 using the catalog from Stover et al. (Reference 2.5S.2-7), also referred to as SRA, for all records within the site region latitude-longitude window, resulting in 2572 records. 119 records are for events which occurred in 1985 or later.

Rinehart et al. A search was made on November 30, 2006 using the catalog from Rinehart et al. (Reference 2.5S.2-8), also known as Mexico, Central America, and Caribbean or MCAC, for all records within the site region latitude-longitude window. There were no records recovered from this catalog due to its temporal coverage.

PDE Catalog. The catalog of Preliminary Determination of Epicenters (PDE) (Reference 2.5S.2-9), available from the National Earthquake Information Center (NEIC), was searched on November 30, 2006, resulting in 1080 records within the site region latitude-longitude window. 800 records are for events which occurred in 1985 or later.

In the event of duplicate entries in these six catalogs, the preference order chosen was: ANSS, ISC, USHIS, SRA, MCAC, and PDE. Non-preferred duplicate entries were deleted from the final catalog.

The magnitudes given in the catalogs were converted to EPRI best, or expected, estimates of body wave magnitude (E[mb], also referred to as Emb in Reference 2.5S.2-3) using the conversion factors given as equation 4-1 and Table 4-1 in Reference 2.5S.2-3:

$$Emb = 0.253 + 0.907 \cdot Md \qquad \text{Equation 2.5S.2-1}$$

$$Emb = 0.655 + 0.812 \cdot ML \qquad \text{Equation 2.5S.2-2}$$

where Md is duration (or coda) magnitude and ML is “local” magnitude.

The EPRI PSHA study expressed maximum magnitude ($M_{max}$) values in terms of body-wave magnitude ($m_b$), whereas most modern seismic hazard analyses describe $M_{max}$ in terms of moment magnitude (**M**). To provide a consistent comparison between magnitude scales, body-wave magnitude was related to moment magnitude using the arithmetic average of three equations, or their inversions, presented by Reference 2.5S.2-10, 2.5S.2-11, and 2.5S.2-12. Throughout the discussion below in Subsections 2.5S.2.2 and 2.5S.2.3, the largest values of $M_{max}$ distributions assigned by the Earth Science Teams (Reference 2.5S.2-13) to seismic sources are presented for both magnitude scales ($m_b$ and **M**). For example, EPRI mb values of $M_{max}$ are followed by the equivalent **M** value. Conversion values from $m_b$ to **M** and **M** to $m_b$ are provided in Table 2.5S.2-1.

Events reported in Ms (surface wave magnitude) were translated to M from the relationship illustrated in Reference 2.5S.2-14. The moment magnitude was then converted to mb using conversion values from Table 2.5S.2-1.

The EPRI-SOG methodology modifies the Emb values to develop unbiased estimates of seismicity recurrence parameters. The modified Emb magnitudes are designated uniform magnitude $m_b$* (referred to as Rmb in Reference 2.5S.2-3). Equation 4-2 of Reference 2.5S.2-3 indicates that the equation from which mb* is estimated from E[$m_b$] and the standard deviation of $m_b$, $\sigma_{mb}$, (referred to as Smb in Reference 2.5S.2-3) is:

$$m_b^* = E[m_b] + (1/2)\cdot ln(10)\cdot b\cdot\sigma^2_{mb} \qquad \text{Equation 2.5S.2-3}$$

where $b$ = 1.0.

Values for $\sigma_{mb}$ [Smb] were estimated for the six catalogs, and $m_b$* [Rmb] were calculated for each event added to the updated catalog.

The result of the above process was an update of the EPRI catalog (Reference 2.5S.2-3) for the site region latitude-longitude window. For the purpose of recurrence analysis, all events added for the update are assumed to be independent events.

### 2.5S.2.1.3 Gulf of Mexico Seismicity

Two observations suggested that additional examination of earthquakes in the Gulf of Mexico was needed. First, earthquakes commonly cataloged as located within the Gulf of Mexico are often reported by so few nearby stations that determination of their epicenters may not be considered reliable (Reference 2.5S.2-15). This indicated that locations of Gulf of Mexico seismicity needed to be evaluated. Second, an examination of the original EPRI analysis (Reference 2.5S.2-16) indicated that earthquake recurrence parameters had not been evaluated for much of the Gulf of Mexico (see Figure 5-2 of EPRI [Reference 2.5S.2-13] and Figure 2.5S.2-7). The occurrence of two recent moderate earthquakes in the Gulf of Mexico (see below) indicated the potential for a significant contribution to seismic hazard at the STP 3 & 4 site from this area. This required a careful evaluation of Gulf of Mexico seismicity, both before and after the development of the EPRI earthquake catalog.

The seismicity was therefore re-evaluated with specific emphasis on the southeast portion of the project investigation region (24°N to 32°N, 100°W to 83°W) referred to as the “Gulf of Mexico investigation region.” The objective was to develop an improved characterization of seismicity for all time within the Gulf of Mexico investigation region for events of a minimum size (EPRI recurrence magnitude Rmb ≥ 3.0 or intensity ≥ IV). When combined with the seismicity catalog described in 2.5S.2.1.2 the EPRI catalog MAIN events (Reference 2.5S.2-3) and re-evaluated Gulf of Mexico seismicity, would constitute an improved characterization of the seismicity within the project investigation window (107°W to 83°W, 24°N to 40°N).

In the process of developing the updated seismicity catalog, a very large area was initially considered (14°N to 40°N, 107°W to 79°W), but particular care was taken with the characterization of earthquake parameters in the Gulf of Mexico where there were

no EPRI (Reference 2.5S.2-16) recurrence parameters. This sub-area of the Gulf of Mexico investigation region is referred to herein as the “Re-Focus Zone” (see Figure 2.5S.2-7). The seismicity within the Re-Focus Zone is used to develop estimates for periods of completeness of records of earthquakes within the Gulf of Mexico as a function of magnitude and location. These values (see Subsection 2.5S.2.1.5) are then used in subsection 2.5S.2.4 to supplement the EPRI (Reference 2.5S.2-16) seismicity recurrence parameterization to include seismic sources within the Gulf of Mexico. These parameters provide contributions to seismic hazard at the STP 3 & 4 site from the Gulf of Mexico sources to be included in the PSHA analysis.

Ten significant regional, national, international, and global seismicity catalogs were considered in the development of the re-evaluated seismicity catalog for the Gulf of Mexico:

- Electric Power Research Institute (EPRI) (Reference 2.5S.2-3)
- Frohlich and Davis (DPC, FDNC, PDEf) (Reference 2.5S.2-17)
- Engdahl et. al. (EHB98) (Reference 2.5S.2-18)
- Perez (PEREZ) (Reference 2.5S2-19)
- Advanced National Seismic System (ANSS) (Reference 2.5S.2-20)
- International Seismological Centre (ISC) (Reference 2.5S.2-21)
- Significant U.S. Earthquakes (USHIS) (Reference 2.5S.2-6)
- Mexico, Central America and Caribbean, 1900 – 1979 (NGDC) (Reference 2.5S.2-8)
- Eastern, Central, And Mountain States of The United States (SRA) (Reference 2.5S.2-7)
- NEIC Preliminary Determination of Epicenters (PDE, PDE-W, PDE-Q) (Reference 2.5S.2-22)

The preference order chosen among the catalogs was initially: EPRI, DPC, FDNC, PDEf, EHB98, PEREZ, ANSS, ISC, USHIS, NGDC, SRA, PDE, PDE-W, and PDE-Q. Later, ISC entries were given preference over ANSS entries for events in the Gulf of Mexico if event-specific ISC evaluations had been made. A few ANSS locations for events in the Gulf of Mexico were found to have few recordings from nearby stations and to have unacceptably large travel time residuals for these few nearby stations. This was the sole change of catalog preference and all other portions of the preference order remain the same.

A detailed review of all duplicate information (more than one record per event) was made for the Gulf of Mexico investigation region. The review included examining phase data for events. Events that were reported only at distant networks and not re-

evaluated by ISC were scrutinized and removed if warranted. Manmade and spurious events, as listed in Reference 2.5S.2-17, were also removed.

For the purpose of developing recurrence statistics in the Gulf of Mexico investigation region, it was necessary to eliminate dependent events (e.g., foreshock, aftershocks, and secondary events of an apparent seismicity cluster). As discussed earlier, the EPRI catalog has MAIN (independent) events distinguished from dependent events. Guided by the EPRI characterization of MAIN vs. non-MAIN, as well as by apparent spatial and temporal similarity between events, dependent events were identified and removed. Further, certain or likely non-seismic events (e.g., blasts) were identified and eliminated. The remaining events in the Gulf of Mexico investigation region were assessed to be equivalent to EPRI MAIN events.

In the development of the revised composite project seismicity catalog, the magnitudes given in all catalogs were converted to best, or expected, estimates of $m_b$ (Emb), using the same conversion equations discussed above with the following additions:

Surface wave magnitudes [Ms] given in the catalogs were converted to EPRI best, or expected, estimates of body wave magnitude (E[mb], also referred to as Emb in Reference 2.5S.2-3) using the conversion factors given as equation 4-1 and Table 4-1 in Reference 2.5S.2-3:

$$Emb = 2.302 + 0.618 \cdot Ms \qquad \text{Equation 2.5S.2-4}$$

where Ms is surface wave magnitude.

If no explicit magnitudes are available for an event, an available maximum intensity value [Io] was converted to Emb, using a relationship from Table 4-1 in Reference 2.5S.2-3:

$$Emb = 0.709 + 0.599 \cdot Io \qquad \text{Equation 2.5S.2-5}$$

### 2.5S.2.1.4 Final Seismicity Catalog

The final seismicity catalog for the project investigation region (24°N to 40°N, 107°W to 83°W) is in Tables 2.5S.2-2 and 2.5S.2-3. Table 2.5S.2-2 is a catalog of pre-1985 earthquakes in the Gulf of Mexico Investigation Region (100°W to 83°W, 24°N to 32°N) with an Rmb magnitude 3.0 or greater or intensity IV or greater. These six earthquakes supplement EPRI data for this important subarea of the project investigation region. The seismicity presented in Table 2.5S.2-3 updates the EPRI catalog temporally as described above. Outside the Gulf of Mexico investigation region (24°N to 32°N, 100°W to 83°W) earthquakes compiled for the events in Table 2.5S.2-3 were assumed to be independent and equivalent to EPRI MAIN events. Updated catalog earthquake recurrence rates will be conservative compared to recurrence rates developed from the original EPRI MAIN events.

Tables 2.5S.2-2 and 2.5S.2-3, along with the EPRI MAIN events constitute a characterization of the mainshock seismicity within the project investigation window.

Within the updated seismicity catalog (1985 to present) there are two new moderate seismic events in the Gulf of Mexico that are significant for an updated characterization of the regional seismicity. These are (a) a **M** 5.1 ($m_b$ 5.5) event occurred on February 10, 2006, offshore of the Louisiana coast within the Gulf of Mexico and (b) a magnitude **M** 5.8 ($m_b$ 6.1) event occurred on September 10, 2006 offshore of the Florida coast and within the Gulf of Mexico.

A moment-tensor source can be used to model the surface waves generated by the February 10, 2006 earthquake if the earthquake centroid is placed within a few miles of the earth's surface in a medium with a very low shear modulus. The explanation for the February 10th earthquake that is currently in best agreement with the observed seismic data is a gravity-driven displacement surface within a thick shallow sedimentary wedge (Reference 2.5S.2-23).

The focal mechanism for the September 10, 2006 event indicates a reverse sense of motion, and the event depth is reported as 13 to 19 mi (22 to 31 km) (Reference 2.5S.2-24). This mechanism is that of an earthquake caused by tectonically driven stresses within the earth's crust.

The implications of these events for the characterization of earthquake potential in the Gulf of Mexico are discussed in Subsection 2.5S.2.3.

### 2.5S.2.1.5 Periods of Completeness for the Reporting of Gulf of Mexico Earthquakes

The EPRI methodology (Reference 2.5S.2-3) uses estimates of periods of completeness for the reporting of earthquakes as a function of magnitude. This methodology employs a matrix of probability of detection of earthquakes for an area for selected ranges of time-before-present and magnitude. The purpose of this section is to develop a matrix of detection probability for the Gulf of Mexico Re-Focus Zone (see Figure 2.5S.2-7) where such information is not available in the original EPRI parameterization (Reference 2.5S.2-16). This matrix is used later in Subsection 2.5S.2.4 to develop EPRI-consistent recurrence parameters for the Gulf of Mexico for use in the PSHA analysis of the STP 3 & 4 site.

Table 2.5S.2-4 lists the 22 events within the Gulf of Mexico Re-Focus Zone, considered EPRI MAIN or equivalent events, that were used to develop the matrix of detection probability for this area. This matrix was prepared to be consistent with the EPRI (Reference 2.5S.2-3) methodology of evaluating seismicity completeness considering various seismologically sound assumptions. Generation of the matrix of detection probability used, as a conservative guideline, the adjacent EPRI matrices of detection probability available onshore. The regional b-value based on the Gulf of Mexico seismicity catalog was reasonable and compatible with the Gulf of Mexico detection probability matrix developed for this study.

EPRI (Reference 2.5S.2-3) used a detailed analysis of United States demographics and history, number, and quality and distribution of seismographic instruments to develop matrices of probability of completeness as a function of time period, gridded area, and magnitude interval. Given uneven population distributions over time and

uneven deployment of seismographic networks these completeness probability matrices also vary by location. EPRI "Incompleteness Regions" 2 and 3 are closest to the part of the Gulf of Mexico that is nearest the STP 3 & 4 site (see Reference 2.5S.2-3, Figure 5-2).

It was assumed that the probabilities of earthquake detection for the Gulf of Mexico would be less than those given for onshore coastal locations for comparable time periods. The procedure followed for estimating detection probabilities for the Gulf of Mexico was, therefore, to start with the available EPRI matrix suggesting the lowest probabilities along the shoreline (EPRI Incompleteness Region 2) and to assume lower probabilities of detection within the Gulf. The very detailed analysis performed by EPRI was not attempted.

Table 2.5S.2-5 is a version of the EPRI Incompleteness Region 2 matrix, modified to add additional years since 1984 (the last complete year in the Reference 2.5S.2-3 earthquake catalog). The latest bin time of the Incompleteness Region 2 matrix (1973 – 1983) has detection probabilities of 1.00 for all magnitude bins. Therefore, given that detection probability would not be expected to decrease with time, additional time bins with detection probabilities of 1.00 for all magnitudes were appended to the Incompleteness Region 2 table.

The matrix of detection probability shown in Table 2.5S.2-5 is appropriate for onshore sites of seismic activity near the project site. This matrix may be used for seismicity occurring through the year 2006.

In developing a matrix of detection probability appropriate for the Gulf of Mexico region, Table 2.5S.2-5 was qualitatively modified in consideration of the following constraints:

- For a given magnitude bin, detection probability for a given time bin would be expected to be the same or more than the detection probability of an adjacent earlier time bin. That is, the overall trend is for detection probabilities for a given magnitude interval to increase with time.
- For a given time bin, the detection probability for a given magnitude bin would be the same or more than the detection probability an adjacent smaller magnitude bin. That is, the overall trend is for detection probabilities for a given time interval to increase with magnitude.

Given the lack of regional seismographic stations in the Gulf of Mexico, as well as the obvious lack of felt or damage reports in the Gulf, detection probabilities for the Gulf of Mexico are expected to be no higher for any magnitude and time bin than that corresponding to the nearest onshore location of lowest detection probabilities.

It was assumed that after the advent of the World-Wide Standardized Seismograph Network in the mid-1960s most earthquakes of magnitude 5.5 and greater would be detectable and recorded (Reference 2.5S.2-25).

Preliminary analysis of Gulf of Mexico seismicity found a slope for the Gutenberg-Richter recurrence relation (the b-value) of about 0.5, which is notably less than typical

b global values of ~1 (see Table 2 of Reference 2.5S.2-25; Table 4-7 of Reference 2.5S.2-26 for stable continental regions). It was judged that there was no known reason for which a low value should occur in this region when a more typical value for the CEUS is ~1 as used in previous EPRI recurrence model characterizations (Reference 2.5S.2-16).

Following these elements of expert judgment, the EPRI Incompleteness Region 2 matrix of detection probability given in Table 2.5S.2-5 was modified for the Gulf of Mexico, as presented in Table 2.5S.2-6. The probability of detection estimates in this matrix are governed by the considerations described above (unshaded bins), while the values in the blue shaded bins are also the results of a modest parametric variation of "b".

In general, global "b" values tend to average about 0.8 to 1.2. Using the detection probability matrix of Table 2.5S.2-6 with the seismicity of the Gulf of Mexico, results in a b value of 1.055. The b value of 1.055 and maximum-likelihood fit to the data are both good and reasonable evaluations, allowing the conclusion that the matrix of detection probability presented in Table 2.5S.2-6 is a reasonable characterization of the completeness of the seismicity in the Gulf of Mexico.

### 2.5S.2.1.5.1 Central American Seismicity

An area of more frequent seismicity occurs to the southwest along the west coast of Mexico and northern Central America, located approximately ~~600 miles (1000 km)~~ 800 miles (1300 km) from the STP site. The largest event in this century from this source was the Michoacan earthquake of 1985 with an approximate magnitude **M** 8.0 (Reference 2.5S.2-19).

Felt effects from Michoacan earthquake of 1985 were reported at several locations in Texas. The intensity observations for the Michoacan event are approximately a MMI II and include: vibrations in tall buildings and bridges and residential and commercial pool seiches. Minor disturbances of industrial and laboratory equipment were also observed and include slight movement of laboratory scales and vibrations in tools used to make crystals (Reference 2.5S.2-17).

~~Based on preliminary review, contribution of this Central America Seismicity (CAS) to overall STP earthquake hazard does not exceed the considerable margin between site-specific SSE ground motion (GMRS) and the certified design spectra (CSDRS).~~As discussed in FSAR Section 2.5S.2.4.8, a sensitivity study was performed to evaluate the contribution to seismic hazard from the Middle America Trench (MAT), a major source of Central America Seismicity (CAS), to the overall STP earthquake hazard. It is concluded that the hazard contribution to the STP 3 & 4 site is not significant.

## 2.5S.2.2 Geologic and Tectonic Characteristics of Site and Region

A comprehensive review of available geological, seismological, and geophysical data was performed for the STP 3 & 4 site region and adjoining areas. The following sections describe significant seismic sources from the 1986 EPRI study (Reference

2.5S.2-13) for the STP 3 & 4 site and modifications to the EPRI sources as parameterized in EQHAZARD Primer (Reference 2.5S.2-16).

In the EPRI study, six independent Earth Science Teams (ESTs) evaluated geologic, geophysical, and seismological data, and each team developed a seismic source model for the CEUS. The six EST source models were used in a PSHA (Reference 2.5S.2-1) to model strong vibratory ground motion hazards at nuclear power plant sites across the CEUS.

Based on new information developed since publication of the EPRI study, the EPRI source models have been modified for the STP 3 & 4 COLA as follows:

- Two moderate earthquakes have occurred within the Gulf of Mexico since the EPRI 1986 study. The magnitudes of these events exceed the upper and/or lower bound of the maximum magnitude ($M_{max}$) distributions originally proposed by some of the EPRI ESTs for large areal source zones that encompass large portions of the Gulf Coastal Plain and the Gulf of Mexico. The $M_{max}$ distributions have been revised for five of the six EPRI EST source zones to account for these earthquakes in the hazard calculations.

- Research post-dating the 1986 EPRI study has developed new information regarding the earthquake behavior of the New Madrid Seismic Zone. In calculating ground motion hazard at the STP 3 & 4 site, an updated characterization of the New Madrid Seismic Zone developed by the Exelon Generation Company (Reference 2.5S.2-27) has been added to the EPRI EST source model to account for new data on the recurrence rates and $M_{max}$ values for the characteristic earthquake behavior of the New Madrid Seismic Zone.

In addition, the following changes to the EPRI model parameters are implemented to more accurately model seismic hazard at the STP 3 & 4 site:

- The Dames & Moore EST characterized their areal source zone containing STP 3 & 4 (South Coastal Margin, zone 20) with no smoothing of seismicity parameters, resulting in no contribution to hazard at the STP 3 & 4 site from this source zone despite earthquakes occurring elsewhere within the zone (see Subsection 2.5S.2.4) (Reference 2.5S.2-16). The smoothing parameters for the Dames & Moore South Coastal Margin (zone 20) have been revised to ensure that seismicity within the South Coastal Margin source zone contributes to the seismic hazard at STP 3 & 4.

- The calculation of seismic hazard within the EPRI computational model developed following the 1986 study (i.e., EQHAZARD) (Reference 2.5S.2-16) from background source zones depends on the presence of a suite of seismicity parameters gridded throughout the source zone. Seismicity parameters in the original model within the Gulf of Mexico region were not calculated or gridded south of 28º N, and thus regions of background source zones that extend south of 28º N do contribute to the seismic hazard at STP 3 & 4 in the original parameterization of the EPRI 1986 model (References 2.5S.2-3 and 2.5S.2-16). For the EPRI source model used in the hazard analysis for STP 3 & 4, seismicity parameters were

calculated for regions south of 28º N to ensure that seismicity parameters are gridded within the full extent of source zones within the Gulf Coastal Plain and Gulf of Mexico region.

### 2.5S.2.2.1 Summary of EPRI Seismic Sources

The six ESTs involved in the EPRI project (the Bechtel Group, Dames & Moore, Law Engineering, Rondout Associates, Weston Geophysical Corporation, and Woodward-Clyde Consultants) each produced a report providing detailed descriptions of their individual philosophy and methodology used in identifying tectonic features, evaluating tectonic features as seismic sources, and parameterizing seismic sources (Reference 2.5S.2-13). For the computation of hazard in the 1989 study (Reference 2.5S.2-1), some of the seismic source parameters were modified or simplified from the original parameters determined by the six ESTs (Reference 2.5S.2-13). These modifications are summarized in another EPRI report (Reference 2.5S.2-16), which is the primary source for the seismicity parameters evaluated in this study.

The seismic source zones from each of the six EPRI ESTs that contributed to 99% of the total hazard at STP 1 & 2 (Reference 2.5S.2-1) and contribute to 99% of the total hazard at STP 3 & 4 are shown on Figure 2.5S.2-1 through Figure 2.5S.2-6. The parameters assigned to each source zone by their respective EST are summarized in Table 2.5S.2-7 through Table 2.5S.2-12. The tables also indicate whether new information has been identified that requires a revision of the source's geometry, maximum earthquake magnitude, or recurrence parameters. For those source zones where revisions are required (see Subsection 2.5S.2.6.2 and 2.5S.2.6.3), the revised values used in the hazard analysis for STP 3 & 4 are given in Table 2.5S.2-13.

Earthquakes with Emb > 3.0 are also shown on Figure 2.5S.2-1 through Figure 2.5S.2-6 to demonstrate the spatial distribution of seismicity relative to the seismic sources. Earthquake epicenters include events from the EPRI earthquake catalog for the period between 1627 and 1984 and an updated seismicity catalog for the period from 1985 to 2006 (see Subsection 2.5S.2.1.2). As described in Subsection 2.5S.2.1.2, the updated catalog within the Gulf of Mexico was for all time and captured six events that occurred between 1847 and 1984 that were not included in the original EPRI catalog.

The following sections summarize the seismic sources and their characterization parameters in the EPRI study (References 2.5S.2-1 and 2.5S.2-13). The discussion is limited to those sources that were determined during a 1989 EPRI study to contribute to 99% of the seismic hazard at STP 1 & 2 (Reference 2.5S.2-1).

### 2.5S.2.2.2 Sources Used for EPRI PSHA – Bechtel Group

The Bechtel Group EST source model includes two seismic source zones that contribute to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-7). Both of these sources are within the STP 3 & 4 site region (Figure 2.5S.2-1). No other source zones identified by the Bechtel Group occur within the site region.

Following is a brief discussion of each of the two seismic sources in the Bechtel Group source model that contributed to 99% of the site hazard:

*(1)* Gulf Coast (BZ1)

The STP 3 & 4 site is located within the Bechtel Group Gulf Coast Zone (BZ1). This zone is a large background source that extends from the continental shelf off eastern Florida to the western coastal plain of Texas and encompasses the majority of the site region (Figure 2.5S.2-1). The largest $M_{max}$ assigned by the Bechtel Group to this zone was $m_b$ 6.6 (Table 2.5S.2-7).

*(2)* Texas Platform (BZ2)

The STP 3 & 4 site is located approximately 51 miles (82 km) from the nearest extent of the Bechtel Group Texas Platform Zone (BZ2). This zone is a large areal source that extends from the northern edge of the Texas coastal plain to the northwest into New Mexico and encompasses a portion of the site region (Figure 2.5S.2-1). The largest $M_{max}$ assigned by the Bechtel Group to this zone was $m_b$ 6.6 (Table 2.5S.2-7).

### 2.5S.2.2.3 Sources Used for EPRI PSHA – Dames & Moore

The Dames & Moore EST source model includes three seismic source zones that contribute to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-8): South Coastal Margin (20), Ouachitas Fold Belt (25), and Combination Zone (C08). All of these source zones are within the site region.

Dames & Moore identified one additional source zone within the site region that does not contribute to 99% of the hazard (Figure 2.5S.2-2), the New Mexico Zone (67).

Following is a brief discussion of each of the three seismic sources in the Dames & Moore source model that contributed to 99% of the site hazard:

*(1)* South Coastal Margin (20)

The STP 3 & 4 site is located within the Dames & Moore South Coastal Margin Zone (20). This zone is a large background source that extends from the continental shelf off eastern Florida, along the Texas coastal plain, and into Mexico (Figure 2.5S.2-2). This source zone encompasses the majority of the site region. The largest $M_{max}$ assigned by Dames & Moore to this zone was $m_b$ 7.2 (Table 2.5S.2-8).

*(2)* Ouachitas Fold Belt (25)

At its closest approach, the STP 3 & 4 site is located approximately 106 mi (171 km) from the nearest extent of the Dames & Moore Ouachitas Fold Belt Zone (25). This zone encompasses the Ouachita mountain belt extending from Arkansas, through Oklahoma, following the buried trend of the Ouachita belt beneath the Texas coastal plain, and westward into Mexico (Figure 2.5S.2-2). This source zone encompasses a portion of the STP 3 & 4 site region. The largest $M_{max}$ assigned by Dames & Moore to this zone was $m_b$ 7.2 (Table 2.5S.2-8).

*(3)* Combination Zone (C08)

The STP 3 & 4 site is located approximately 106 miles (171 km) from the nearest extent of the Dames & Moore Combination Zone C08. This zone is spatially equivalent to the Ouachitas Fold Belt Source Zone (25) with the exclusion of the kink in the Ouachita fold belt (25A) at the Texas-Oklahoma border (Figure 2.5S.2-2). Combination Zone (C08) encompasses a portion of the STP 3 & 4 site region. The largest $M_{max}$ assigned by Dames & Moore to this zone was $m_b$ 7.2 (Table 2.5S.2-8).

### 2.5S.2.2.4 Sources Used for EPRI PSHA – Law Engineering

The Law Engineering source model includes two seismic source zones that contribute to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-9). Both of these source zones are within the site region (Figure 2.5S.2-3). No other source zones defined by Law Engineering extend into the site region.

Following is a brief discussion of the two seismic sources in the Law Engineering source model that contributed to 99% of the site hazard:

*(1)* New Mexico-Texas Block (124)

The closest approach of the STP 3 & 4 site to the Law Engineering New Mexico-Texas Block Source Zone (124) is approximately 76 miles (122 km). This zone is a large areal source defined by the boundaries of the Oklahoma Aulacogen, the Ouachita gravity high, and magnetic trend of the Rio Grande-Colorado Front Ranges. This zone encompasses the majority of Texas, excluding the Gulf Coastal Plain, and extends into eastern New Mexico (Figure 2.5S.2-3). The southeastern most extent of this zone occurs within the site region. The largest $M_{max}$ assigned by Law Engineering to this zone was $m_b$ 5.8 (Table 2.5S.2-9).

*(2)* South Coastal Block (126)

The STP 3 & 4 site is located within the Law Engineering South Coastal Block Source Zone (126) (Figure 2.5S.2-3). This zone is a large areal source that extends from the continental shelf off eastern Florida westward into Texas and Mexico (Figure 2.5S.2-3). The northern edge of the zone was defined to coincide with the Paleozoic edge of the North American craton. This source zone encompasses the majority of the site region. The largest $M_{max}$ assigned by Law Engineering to this zone was $m_b$ 4.9 (Table 2.5S.2-9).

### 2.5S.2.2.5 Sources Used for EPRI PSHA – Rondout Associates

The Rondout Associates source model includes one seismic source zone that contributes to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-10), the Gulf Coast to Bahamas Fracture Zone (51). This source zone lies partially within the site region (Figure 2.5S.2-4).

Rondout Associates also identified one other source zone as occurring within the site region (Figure 2.5S.2-4) that does not contribute to 99% of the hazard at STP 3 & 4, the Background 50 (C02) Zone.

Following is a brief discussion of the one seismic source in the Rondout Associates source model that contributed to 99% of the site hazard:

*(1)* Gulf Coast to Bahamas Fracture Zone (51)

The Gulf Coast to Bahamas Fracture Zone (51) is a large areal source defined by the presence of Paleozoic crust along the Gulf coastal region, and a stress regime with the maximum horizontal tensile stress directed at a high angle to the coast (Reference 2.5S.2-13). The zone extends from southern Florida eastward to Texas and Mexico (Figure 2.5S.2-4) and encompasses the majority of the site region. The largest $M_{max}$ assigned by Rondout Associates to this zone was $m_b$ 5.8 (Table 2.5S.2-10).

### 2.5S.2.2.6 Sources Used for EPRI PSHA – Weston Geophysical

The Weston Geophysical source model includes one seismic source zone that contributes to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-11), the Gulf Coast (107) Zone. This source zone is within the site region (Figure 2.5S.2-5).

Weston Geophysical also identified one combination source zone within the site region (Figure 2.5S.2-5) that does not contribute to 99% of the hazard at the STP 3 & 4 site, the Combination Zone C31.

Following is a brief discussion of the one seismic source in the Weston Geophysical source model that contributed to 99% of the site hazard:

*(1)* Gulf Coast (107)

The Weston Geophysical Gulf Coast Zone (107) is a large areal source that extends from Florida through Texas and into eastern Mexico (Figure 2.5S.2-5). The majority of the site region occurs within the source zone. The largest $M_{max}$ assigned by Weston to this zone was $m_b$ 6.0 (Table 2.5S.2-11).

### 2.5S.2.2.7 Sources Used for EPRI PSHA – Woodward-Clyde Consultants

The Woodward-Clyde Consultants source model includes one seismic source that contributes to 99% of the hazard at the STP 3 & 4 site (Table 2.5S.2-11), the Central United States Backgrounds (B43) Source Zone. This source zone encompasses nearly all of the site region (Figure 2.5S.2-6). Woodward-Clyde Consultants did not identify any other source zones within the site region.

Following is a brief discussion of the one seismic source in the Woodward-Clyde Consultants source model that contributed to 99% of the site hazard:

*(1)* Central United States Backgrounds (B43)

The Central United States Backgrounds (B43) Zone is a large areal background source centered on the STP 3 & 4 site, and it is a quadrilateral with sides approximately 6º in length (Figure 2.5S.2-6). The largest $M_{max}$ assigned by Woodward Clyde Consultants to this zone was $m_b$ 6.5 (Table 2.5S.2-11).

### 2.5S.2.2.8 Post-EPRI Seismic Source Characterization Studies

Since publication of the 1986 EPRI study (Reference 2.5S.2-13), only one major published study has been performed to characterize seismic sources within the STP 3 & 4 site region, The U.S. Geological Survey's National Seismic Hazard Mapping Project (Reference 2.5S.2-11 and 2.5S.2-28).The relevant content of this study is summarized in the following paragraphs.

In 2002, the USGS produced seismic hazard maps for the coterminous United States based on new seismological, geophysical, and geological information (Reference 2.5S.2-28). The 2002 maps reflect changes to the source model used to construct a previous version of the national seismic hazard maps made in 1996 (Reference 2.5S.2-11). The most significant changes to the CEUS portion of the source model included changes in the recurrence and geometry of the Charleston source as well as changes in the recurrence, $M_{max}$, and geometry of New Madrid sources.

~~Unlike the 1986 EPRI model (Reference 2.5S.2-13) that incorporates many background zones and local sources for a detailed description of the tectonics and seismicity, the USGS source model in the CEUS includes only a small number of sources. The hazard is largely based on historical seismicity and the variation of that seismicity within large background or "maximum magnitude" zones. Within the STP 3 & 4 site region the USGS model defines a single seismic source (the Extended Margin Background zone) that covers nearly the entire eastern and southeastern United States. The USGS assigned a $M_{max}$ value of **M** 7.5 ($m_b$ 7.2) to this zone. The rationale for the relatively large $M_{max}$ value used by the USGS for the Extended Margin Background Zone was based on developing a simple source model capable of explaining the 1886 **M** 7.3 ($m_b$ 7.1) Charleston earthquake (Reference 2.5S.2-11) and recognizing that $M_{max}$ over this broad area did not make a significant difference for hazard estimates at the periods of interest for the USGS study.~~ Similar to the 1986 EPRI model, the USGS model for the CEUS uses historical seismicity to determine the rates and relative magnitudes of earthquakes. Both models used a weighted distribution of different methods to calculate the rates and relative magnitudes. The 1986 EPRI model incorporates many background zones and local sources each with individual $M_{max}$ distributions. In contrast, the USGS source model in the CEUS defines only five $M_{max}$ zones between which $M_{max}$ values are allowed to vary. The vast majority of the STP 3 & 4 site region, including the site, is within the USGS Extended Margin $M_{max}$ zone that includes all of the CEUS seaward of the limit of Precambrian crustal rifting associated with opening of the Iapetan ocean (Reference 2.5S.2-11 and 2.5S.2-28). The USGS assigned a $M_{max}$ value of **M** 7.5 ($m_b$ 7.2) to the Extended Margin $M_{max}$ zones. The rationale for the relatively large $M_{max}$ value used by the USGS for the Extended Margin $M_{max}$ zone was based on an interpretation of the origin of the 1886 **M** 7.3 ($m_b$ 7.1) Charleston earthquake, and the recognition that $M_{max}$ over

this broad area did not make a significant difference to hazard estimates at the periods of interest for the USGS study (Reference 2.5S.2-11).

During development of the 1986 EPRI model, the individual ESTs were aware of the 1886 **M** 7.3 ($m_b$ 7.1) Charleston earthquake and chose to account for this seismicity by defining sources local to the Charleston area (Reference 2.5S.2-13). In so doing, the ESTs treated the Charleston event as one that occurred on a unique, fixed source in the Charleston area, rather than as a "floating" earthquake capable of occurring anywhere within the extended crust underlying the Atlantic and Gulf Coast margins. Following the approach of the original ESTs, the high $M_{max}$ values adopted in the more recent 1996 and 2002 USGS source models (Reference 2.5S.2-28) for the Extended Margin Background Zone do not justify changing any of the EPRI (Reference 2.5S.2-13) seismic source zone parameterizations that contribute to 99% of the hazard at STP 3 & 4.

### 2.5S.2.3 Correlation of Earthquake Activity with Seismic Sources

The distribution of earthquake epicenters from both the EPRI catalog (Reference 2.5S.2-3) and updated earthquake catalog (see discussion in Subsection 2.5S.2.1) relative to the seismic sources in the six EPRI EST source models is shown in Figures 2.5S.2-1 through 2.5S.2-6. Comparison of the updated earthquake catalog to the EPRI (Reference 2.5S.2-3) earthquake catalog yields the following observations:

- The updated catalog does not include any earthquakes in the site region that can be associated with a known tectonic structure.
- The updated catalog does not include a unique cluster of seismicity that would suggest a new seismic source not recognized or accounted for in the EPRI seismic source model.
- The updated catalog does not show a pattern of seismicity that would require significant revision to the EPRI seismic source geometry.

The updated catalog contains a concentration of seismicity in the New Madrid Seismic Zone (Figure 2.5S.2-9) that has a spatial pattern consistent with seismicity patterns apparent in the EPRI earthquake catalog (Reference 2.5S.2-3) and consistent with observations made in the original EPRI-SOG study (Reference 2.5S.2-13). In particular, the original EPRI (Reference 2.5S.2-3) and updated catalog both demonstrate the presence of two northeast trending bands of seismicity in the New Madrid region offset by a third northwest-trending band of seismicity (Figure 2.5S.2-9).

The updated catalog includes two earthquakes that are larger in magnitude than some of the upper- and/or lower-bound values used by ESTs to characterize the $M_{max}$ distribution of source zones within which these earthquakes occurred. These earthquakes are the February 10, 2006 Emb 5.5 earthquake, and the September 10, 2006 Emb 6.11 earthquake. These events require revisions to some of the ESTs $M_{max}$ distributions for background source zones, as described below in Subsection 2.5S.2.6.2. The February 10, 2006 Emb 5.5 earthquake has been potentially associated with specific geologic structures and is discussed in the paragraph below.

The September 10, 2006 Emb 6.1 earthquake has not been tied to any unique geologic structure.

The February 10, 2006 Emb 5.5 earthquake reported in the updated catalog has been proposed by Reference 2.5S.2-23 to be related to gravity sliding on a low-angle normal fault at the edge of the continental shelf. This hypothesis suggests a potential association between seismicity in the Gulf of Mexico and normal growth faults at the edge of the continental shelf; however, no other events within the updated catalog have been attributed to such mechanisms. The edge of the continental shelf (Figure 2.5S.1-20) generally is encompassed by the various EST areal source zones for the Gulf of Mexico and environs (Figure 2.5S.1-1 and Figure 2.5S.2-1 to Figure 2.5S.2-6). As such, increases in $M_{max}$ to account for the February 10, 2006 Emb 5.5, as well as the September 10, 2006 Emb 6.1 earthquake (both described in Subsection 2.5S.2.6.2), adequately account for any potential association between earthquakes within the Gulf of Mexico and normal faults along the edge of the continental shelf.

## 2.5S.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquake

This section describes the PSHA conducted for the STP 3 & 4 site. Following the procedures outlined in RG 1.208, Subsection 2.5S.2.4.1 discusses the basis for the PSHA, which is the 1989 EPRI study (Reference 2.5S.2-1). Subsection 2.5S.2.4.2 presents sensitivity studies using the updated earthquake catalog of Subsection 2.5S.2.1 that includes an analysis of historical earthquakes through 2005. The significance of new information on maximum magnitudes and on seismic source characterization is discussed in Subsections 2.5S.2.4.3 and 2.5S.2.4.4, respectively. The effects of recent models to characterize earthquake ground motions in the central and eastern United States are presented in Subsection 2.5S.2.4.5. Subsection 2.5S.2.4.6 presents the results of these revisions to the PSHA in the form of uniform hazard response spectra (UHRS). Finally, Subsection 2.5S.2.4.7 develops vertical ground motions in the form of vertical UHRS that are consistent with the horizontal UHRS, to present a complete representation of earthquake shaking.

### 2.5S.2.4.1 EPRI seismic hazard study

The 1989 EPRI study (Reference 2.5S.2-1) was the starting point for probabilistic seismic hazard calculations. An underlying principle of this study was that expert opinion on alternative, competing models of earthquake occurrence (e.g., size, location, and rates of occurrence) and of ground motion amplitude and its variability should be used to weight alternative hypotheses. The result is a family of weighted seismic hazard curves from which mean and fractile seismic hazard can be derived.

The first task was to calculate seismic hazard using the assumptions on seismic sources and ground motion equations developed in the 1989 EPRI study to ensure that seismic sources were modeled correctly and that the software being used (Reference 2.5S.2-29) could accurately reproduce the 1989 study results. The results of this comparison are different depending on the EPRI EST. Table 2.5S.2-14 compares the mean annual frequencies of exceedance calculated for the STP site to published annual frequencies of exceedance from the 1989 EPRI project for this site for the Bechtel Group EST. All results are for hard rock conditions. The “% diff” row shows

the percent difference of rock hazard recalculated at the STP site compared to the 1989 result. Comparisons are shown for peak ground acceleration (PGA) hazard for the 15th mean, median, and 85th fractile hazard curves. For the mean hazard curves, the current calculation indicates slightly higher hazard, with up to +3.1% difference at 500 cm/s2. For ground motions associated with typical seismic design levels (PGA <0.25g), the differences in mean hazard are less than 1%. Differences in hazard are also small for the 15%, 50%, and 85% hazard, less than 7.7%, with the highest differences occurring at the largest ground motions.

Comparisons with some of the EPRI EST results were problematic, because some teams adopted distributions of maximum magnitude ($M_{max}$) for sources in the region of the site that included values less than $m_b$ 5.0. For these values of $M_{max}$, the current hazard calculations indicate an annual frequency of exceedance of zero, because the lower-bound magnitude for calculations was $m_b$ 5.0. Thus, for some lower percentiles the indicated hazard is zero, yet the EPRI (Reference 2.5S.2-1) results indicate a finite hazard for that case. For one team (the Law team), the host source has all values of $M_{max}$ below 5.0, and an adjacent source (about 100 km from the site) has a distribution of $M_{max}$ values that extends below 5.0. ~~For this team the current calculations indicate very low hazard, but the published EPRI (Reference 2.5S.2-1) results are not low in comparison to other teams.~~ For this team, the current calculations indicate very low hazard, but the published EPRI (Reference 2.5S.2-1) results are not as low as would be expected in comparison to the hazards from the other EST teams. All differences for these teams are attributable to cases in which $M_{max}$ values extend below 5.0, or to cases where seismicity parameters were missing from EPRI computer files in degree cells adjacent to the site. These differences were not resolved in detail because the $M_{max}$ values of all seismic sources are reassessed (increased above 5.0) in this project (see Subsection 2.5S.2.4.3) and new seismicity parameters are calculated for all degree cells adjacent to the site using an updated seismicity catalog (see Subsection 2.5S.2.1).

Given these considerations, the comparisons shown in Table 2.5S.2-14 are considered acceptable agreement, and indicate that, for a given set of assumptions on seismic sources, seismicity parameters, and ground motion equations, the same hazard results would be calculated today as in the original EPRI study.

Several types of new information on the sources of earthquakes may require changes in inputs to PSHA, resulting in changes in the level of seismic hazard at the STP site compared to what would be calculated based on the EPRI (Reference 2.5S.2-1) evaluation. Seismic source characterization data and information that could affect the calculated level of seismic hazard include:

- Effects caused by an updated earthquake catalog and resulting changes in the characterization of the rate of earthquake occurrence as a function of magnitude for one or more seismic sources
- Identification of possible new seismic sources in the site vicinity
- Changes in the characterization of the maximum magnitude for seismic sources

- Changes to models used to estimate strong ground shaking and its variability in the central and eastern United States

Possible changes to seismic hazard caused by changes in these areas are addressed in the following sections.

### 2.5S.2.4.2 Update of Seismicity Parameters

Subsection 2.5S.2.1 describes the development of an updated earthquake catalog. This updated catalog includes modifications to the EPRI evaluation by subsequent researchers, the addition of earthquakes that have occurred after completion of the EPRI evaluation development (post 1985), and identification of additional earthquakes in the time period covered by the EPRI evaluation for the project region (1758 to 1984). In addition, the study region of the original EPRI catalog was extended to the south to include additional areas of the Gulf of Mexico that were outside the original study region. The impact of the new catalog information was assessed in two areas. First, investigation was made of the effect of the new earthquake data on earthquake recurrence estimates within a several-hundred-kilometer region around the STP site (Figure 2.5S.2-10). Second, the final seismicity catalog was used to estimate seismicity parameters for EPRI EST sources that extend into the Gulf of Mexico and adjacent on-shore regions that were not included in the original EPRI study region. This second step produced more complete estimates of seismicity parameters for coastal EPRI EST sources than were previously available.

#### 2.5S.2.4.2.1 Local Region

The effect of the updated earthquake catalog on earthquake occurrence rates in the local region around the STP site was assessed by computing earthquake recurrence parameters for the test area shown in Figure 2.5S.2-10. This consisted of a rectangular area with dimensions 4o latitude by 4o longitude encompassing seismicity in the vicinity of the site, and because local events within 100 km of the site dominate the hazard (with the exception of the New Madrid Seismic Zone, which is treated separately). These dimensions were chosen to encompass historical seismicity in the vicinity of the site. The truncated exponential recurrence model was fit to historical seismicity data using the EPRI EQPARAM program, which uses the maximum likelihood technique. Earthquake recurrence parameters were computed first using the original EPRI catalog and periods of completeness and then using the updated catalog and extending the periods of completeness to 2006, assuming that the probability of detection for all magnitudes is unity for the time period 1985 to 2006. The resulting earthquake recurrence rates are compared in Figure 2.5S.2-11 for the test area. The comparison shows that the extended earthquake catalog results in earthquake recurrence rates that are comparable to, and slightly higher than, rates from the original earthquake catalog. The difference in calculated rates occurrence of earthquakes for all magnitude levels is about 4%.

On the basis of the comparison shown in Figure 2.5S.2-11, it is concluded that the earthquake occurrence rate parameters developed in the EPRI (Reference 2.5S.2-1) evaluation for seismic sources to the west and north of the site are comparable to the rate parameters that would be estimated with an updated catalog. Conclusions for

sources with degree cells to the east and south of the site are addressed in the following section.

### 2.5S.2.4.2.2 Gulf of Mexico and Coastal Regions

For locations south and east of the site, the original EPRI (Reference 2.5S.2-1) study region was limited (see Figure 2.5S.2-7). Subsection 2.5S.2.1.3 describes how the seismicity catalog was extended, and Subsection 2.5S.2.1.5 describes how periods of complete reporting were developed for this region. With these inputs, the EPRI EQPARAM software was run to calculate seismicity parameters (a- and b-values) for degree cells that were not available from the original analysis. This unavailability was a result of the original EPRI analysis extending only as far south, as the site region shown in Figure 2.5S.2-1. Therefore no parameters were calculated south of the EPRI Incompleteness Regions shown in Figure 2.5S.2-7. The seismicity parameters of the following EPRI EST sources were recalculated.

- Bechtel Group: source -BZ1
- Dames & Moore: source 20
- Law Engineering: source 126
- Rondout: source 51
- Woodward-Clyde: source B43
- Weston Geophysical: source 107

The original EPRI EST smoothing assumptions were used for each source, except for that of Dames & Moore, where updated smoothing parameters (see Subsections 2.5S.2.2 and 2.5S.2.4.5.1) have been developed. These updated sources were adopted because they were based on a more complete earthquake catalog (through 2006), and because this catalog covered an extended region not included in the original EPRI (Reference 2.5S.2-1) study.

### 2.5S.2.4.2.3 New Madrid Region

As discussed in Subsection 2.5S.1.1.4.4.5.3, paleoliquefaction studies have been conducted in the region of the 1811-1812 New Madrid, Missouri earthquakes. These studies have identified several sequences of pre-historic earthquakes that allow estimation of recurrence intervals between major earthquakes in the region. These sequences have led to an estimated mean recurrence interval for large earthquakes in the New Madrid region of approximately 500 years. This mean recurrence interval represents a higher activity rate than was estimated by the EPRI ESTs. Therefore, an updated New Madrid seismic source model was included in the seismic source interpretation for each EPRI EST, as discussed in Subsection 2.5S.2.4.4 below.

### 2.5S.2.4.3 New Maximum Magnitude Information

Geological and seismological data published since the 1986 EPRI seismic source model are summarized and discussed in Subsections 2.5S.1 and 2.5S.2.1, respectively. Based on a review of these data, the weighted ranges of $M_{max}$ for some of the EST background source zones that extend into the Gulf of Mexico and contain the STP 3 & 4 site (Figure 2.5S.2-8) are revised. For convenience, EPRI EST source zones that extend into and include the Gulf of Mexico are referred to here as Gulf Coastal Source Zones (GCSZs). A review of the $M_{max}$ distributions for each EPRI EST is provided in Table 2.5S.2-7 through Table 2.5S.2-12 and a summary of $M_{max}$ distributions for GCSZs is provided in Table 2.5S.2-13.

$M_{max}$ values for some of the GCSZs are updated to reflect earthquakes that occurred after the development of the EPRI 1986 source model, as documented in the updated seismicity catalog (Subsection 2.5S.2.1). In particular, the February 10, 2006 Emb 5.5 earthquake and the September 10, 2006 Emb 6.1 earthquake are of greater magnitude than the lower, and in some cases upper, bound $M_{max}$ values of some of the GCSZs in which the earthquakes occur or to which the earthquakes are in very close proximity (Figure 2.5S.2-8). The $M_{max}$ distribution for a particular GCSZ is updated only when two conditions are met: (1) one or both of the 2006 moderate-magnitude earthquakes cannot be determined to have occurred outside the source zone with reasonable certainty and (2) the observed Emb magnitude for the largest earthquake in the zone is greater than the minimum $m_b$ magnitude of the EPRI 1986 source model $M_{max}$ distribution.

These criteria result in updates to five of the six EST GCSZs $M_{max}$ distributions (Table 2.5S.2-13). The updated distributions were developed by following the original methodology used by the ESTs in the 1986 EPRI study, as described in their respective volumes (Reference 2.5S.2-13) and the EQHAZARD Primer (Reference 2.5S.2-16) as closely as possible. Following the original EST methodology is intended to ensure consistency between the original distributions and those updated here using more recent seismicity data. Details on the revisions for each of the EST GCSZs, where required, are described in Subsections 2.5S.2.4.3.1 through 2.5S.2.4.3.6. In these sections all $M_{max}$ values are given as body wave ($m_b$) magnitudes.

#### 2.5S.2.4.3.1 Bechtel Group Gulf Coast Source Zone (Zone BZ1)

Bechtel Group assigned $M_{max}$ values of 5.4, 5.7, 6.0, and 6.6 to the Gulf Coast Source Zone (Zone BZ1) (Table 2.5S.2-13). Because the Emb 5.5 and Emb 6.1 earthquakes from the updated catalog occur well within this zone (Table 2.5S.2-15) (Figure 2.5S.2-8), and because these magnitudes are greater than the lowest $M_{max}$ values for the source zone, the $M_{max}$ distribution for this source zone has been updated.

The updated $M_{max}$ values of 6.1, 6.4, and 6.6 with weightings of 0.1, 0.4, and 0.5 used here (Table 2.5S.2-13) follow from the Bechtel Group's methodology of defining $M_{max}$ distributions as follows (Reference 2.5S.2-13):

- The lower bound magnitude of the distribution is defined as the greater of either the largest observed earthquake magnitude within the zone, or $m_b$ 5.4

- The next higher magnitude is 0.3 magnitude units greater than the minimum
- The third magnitude is 0.6 magnitude units above the minimum
- The fourth magnitude, and upper bound of the distribution, is $m_b$ 6.6
- The weightings on the four $M_{max}$ values are 0.1, 0.4, 0.4, and 0.1, assigned consecutively from the minimum $M_{max}$ value

If these guidelines result in an upper bound magnitude or magnitudes greater than $m_b$ 6.6, then the upper $M_{max}$ distribution is truncated at $m_b$ 6.6, and all weightings for magnitudes greater than or equal to 6.6 summed and collapsed onto the magnitude 6.6 upper bound.

### 2.5S.2.4.3.2 Dames & Moore South Coastal Margin (Zone 20)

Dames & Moore assigned $M_{max}$ values of 5.3 and 7.2 to the South Coastal Margin Source Zone (Zone 20) (Table 2.5S.2-13). The Emb 5.5 and Emb 6.1 earthquakes from the updated catalog are 11 mi (18 km) and 152 mi (245 km) outside this zone, respectively (Table 2.5S.2-15) (Figure 2.5S.2-8). The Emb 6.1 earthquake was well recorded by regional and global seismograph networks, and its epicentral location is robust enough to conclude that it is outside the source zone (Reference 2.5S.2-30). The Emb 5.5 earthquake was not well recorded (Reference 2.5S.2-20 and 2.5S.2-21), and attempts at relocating the event by the U.S. Geological Survey using proprietary data from ocean bottom seismographs have resulted in significant variations (10s of km) in earthquake epicentral location (Reference 2.5S.2-30) relative to the location reported in the updated seismicity catalog (see Subsection 2.5S.2.1). This event is conservatively assumed to have occurred within the boundary of the source zone. Because the Emb 5.5 magnitude is larger than the lower bound $M_{max}$ value, the $M_{max}$ distribution for this source zone has been revised.

Documentation of the methodology used to determine the $M_{max}$ distribution for the South Coastal Margin zone in the EPRI model is not explicitly provided in either the Dames & Moore EST volume from the EPRI study (Reference 2.5S.2-13), or the description of the EPRI PSHA model in the EQHAZARD Primer (Reference 2.5S.2-16). Given the lack of a well-documented methodology to follow, the $M_{max}$ distribution used here results from increasing the lower $M_{max}$ bound to match the magnitude of the observed Emb 5.5 earthquake while maintaining the same upper bound and weightings of the original $M_{max}$ distribution for the source zone. The updated $M_{max}$ values are $m_b$ 5.5 and 7.2 with weightings of 0.8 and 0.2, respectively (Table 2.5S.2-13).

### 2.5S.2.4.3.3 Law Engineering South Coastal Block (Zone 126)

Law Engineering assigned $M_{max}$ values of 4.6 and 4.9 to the South Coastal Block Source Zone (Zone 126) (Table 2.5S.2-13). The Emb 5.5 and Emb 6.1 earthquakes from the updated catalog are 39 mi (63 km) and 97.6 mi (157 km) outside this zone, respectively (Table 2.5S.2-15) (Figure 2.5S.2-8). The Emb 6.1 earthquake was well recorded and clearly lies outside the source zone (Reference 2.5S.2-30). The Emb 5.5

earthquake was not well recorded (Reference 2.5S.2-20 and 2.5S.2-21), and attempts at relocating the event from the position reported in the updated seismicity catalog (Subsection 2.5S.2.6.1) using proprietary data from ocean bottom seismographs have resulted in significant (10s of kilometers) variation in the position of the earthquake epicenter (Reference 2.5S.2-30). Although current published locations of the Emb 5.5 earthquake locate it outside the source zone boundaries, the uncertainty in the epicentral location of the earthquake is such that it could have occurred within the source zone. The earthquake is conservatively assumed to have occurred within the South Coastal Block Zone. Because the Emb 5.5 earthquake is larger than the lower bound $M_{max}$ value of the South Coastal Block Source Zone, the $M_{max}$ distribution has been revised accordingly.

The updated $M_{max}$ values of 5.5 and 5.7, adopted here (Table 2.5S.2-13), are derived using Law Engineering's methodology for developing $M_{max}$ distributions, as follows (Reference 2.5S.2-13):

*(1)* The lower bound $M_{max}$ is the magnitude of the maximum observed earthquake in the zone

*(2)* The upper bound $M_{max}$ magnitude defined by Law Engineering for regions with earthquakes occurring within 6.2 mi (10 km) of the surface is $m_b$ 5.7

Weights for the original $M_{max}$ distribution (0.9 on the lower bound $M_{max}$ and 0.1 on the upper bound $M_{max}$) (Reference 2.5S.2-1 and 2.5S.2-13) are retained in the updated $M_{max}$ distribution for the STP 3 & 4 hazard analysis (Table 2.5S.2-13).

### 2.5S.2.4.3.4 Rondout Associates Gulf Coast to Bahamas Fracture Zone (Zone 51)

Rondout Associates assigned $M_{max}$ values of 4.8, 5.5, and 5.8 to the Gulf Coast to Bahamas Fracture Zone Source Zone (Zone 51) (Table 2.5S.2-13). Because both the Emb 5.5 and Emb 6.1 earthquakes from the updated catalog occur well within this zone (Table 2.5S.2-15) (Figure 2.5S.2-8), and because these magnitudes are greater than the lowest $M_{max}$ values for the source zone, the $M_{max}$ distribution for this source zone has been updated.

The updated $M_{max}$ values of 6.1, 6.3, and 6.5 with weightings of 0.3, 0.55, and 0.15 (respectively) used here (Table 2.5S.2-13) follow from reclassifying the source zone as one capable of producing moderate earthquakes instead of the original classification of the source zone as one only capable of producing smaller than moderate earthquakes (Reference 2.5S.2-13). The original Rondout $M_{max}$ distribution for moderate earthquake source zones is 5.2, 6.3, and 6.5 with weightings of 0.3, 0.55, and 0.15, respectively. The updated $M_{max}$ distribution for the STP 3 & 4 COL application follows this distribution with the exception of an increase in the lower bound of the distribution to 6.1 to account for the observed Emb 6.1 earthquake within this zone.

### 2.5S.2.4.3.5 Weston Geophysical Corporation Gulf Coast Source Zone (Zone 107)

Weston Geophysical Corporation assigned $M_{max}$ values of 5.4 and 6.0 to the Gulf Coast Source Zone (Zone 107) (Table 2.5S.2-13). Both the Emb 5.5 and Emb 6.1 earthquakes from the updated catalog occur well within this zone (Table 2.5S.2-15) (Figure 2.5S.2-8). Because these magnitudes are greater than the 1986 $M_{max}$ values for the source zone, the $M_{max}$ distribution for this source zone has been revised.

Weston Geophysical Corporation's (Reference 2.5S.2-13) methodology for defining $M_{max}$ is based on developing discrete distributions for the probability of $M_{max}$ being a particular value. For the Gulf Coast Source Zone, these $M_{max}$ values and probabilities determined by the Weston Geophysical Corporation EST are: 3.6 (0.04628), 4.2 (0.11982), 4.8 (0.27542), 5.4 (0.34415), 6.0 (0.16169), 6.6 (0.04461), and 7.2 (0.00553) (Reference 2.5S.2-13). Following Weston Geophysical Corporation's methodology, this discrete probability distribution is truncated at the magnitude that is closest to, yet greater than, the maximum observed earthquake within the source zone. For this study the distribution is truncated at 6.6 because the Emb 6.1 earthquake occurred within the source zone, and the next highest discrete magnitude in the distribution is 6.6. The truncated distribution is then renormalized so that the sum of all the probabilities is 1.0. The final $M_{max}$ values are the truncated distribution, and the weights are the renormalized probabilities.

### 2.5S.2.4.3.6 Woodward-Clyde Consultants Central United States Backgrounds Source Zone (Zone B43)

Woodward-Clyde Consultants assigned $M_{max}$ values of 4.9, 5.4, 5.8, and 6.5 to the Central United States Background Source Zone (zone B43) (Table 2.5S.2-13). Because the Emb 5.5 and Emb 6.1 earthquakes are 170 mi (273 km) and 395 mi (635 km) from the boundary of the source zone, respectively (Table 2.5S.2-15) (Figure 2.5S.2-8), the $M_{max}$ distribution for this source zone is not revised.

### 2.5S.2.4.4 Updated Seismic Source Characterization

Geological, geophysical, and seismological information developed since the 1986 EPRI study (Reference 2.5S.2-13) was reviewed to identify seismic sources not included in the original EPRI screening for STP 1 & 2 (Reference 2.5S.2-1), and which should be evaluated to determine their potential contribution to seismic hazard at STP 3 & 4. Two sources were re-evaluated as described below:

- The Mt. Enterprise-Elkhart Graben (MEEG), located to the northeast of STP 3 & 4 just inside the 200-mile site region radius (Figure 2.5S.1-17 and Figure 2.5S.1-25)
- The New Madrid Seismic Zone located in the border region of Missouri, Arkansas and Tennessee northeast of the STP 3 & 4 site region (Figure 2.5S.1-26 and Figure 2.5S.2-9)

### 2.5S.2.4.4.1 Mt. Enterprise-Elkhart Graben

The MEEG is comprised of a system of roughly east-west-striking normal faults of various length and width scales (Reference 2.5S.2-31, 2.5S.2-32, 2.5S.2-33, 2.5S.2-

34, and 2.5S.2-35). The STP 1 & 2 UFSAR (Reference 2.5S.2-36) concluded that the most recent movement on the faults that comprise the MEEG system, referred to as the Mount Enterprise fault zone in the STP 1 & 2 UFSAR, was likely Eocene in age or younger. Several publications that predate the 1986 EPRI studies present multiple lines of evidence that document Quaternary motion and active creep along the MEEG (see detailed discussion in Subsection 2.5S.1.1.4.4.5.1). Subsurface structure, imaged by seismic reflection data, indicate that the MEEG is rooted in the Jurassic Louann Salt at maximum depths of 4.5 to 6 km (Reference 2.5S.2-32 and 2.5S.2-35). This suggests that late Quaternary displacement and contemporary creep across the MEEG may be driven by movement of salt at depth, indicating that the fault is not accommodating tectonic deformation and thus is not an independent source of moderate to large earthquakes. Presumably, this was the evaluation of the EPRI ESTs, which had access to the pre-1986 literature on the MEEG and did not specifically characterize it as a Quaternary tectonic fault and potentially capable structure (Reference 2.5S.2-13). Subsequent research and publications reflect uncertainty among some members of the informed technical community regarding the seismic potential of the fault system (Reference 2.5S.2-34). Although no new data have been published since the 1986 EPRI studies to support an interpretation that the MEEG is a capable tectonic structure (Subsection 2.5S.1.1.4.4.5.1), the MEEG is included here in a sensitivity analysis with a low probability of activity (Pa = 0.2) to account for this uncertainty. The source characterization is described as follows.

For the purpose of modeling hazard at the STP 3 & 4 site, MEEG is represented as a western and eastern line source spanning the extent of the normal fault system shown in Figure 2.5S.1-24. The lengths of the respective line sources are 56 mi (90 km) and 37 mi (59 km). Published cross sections based on borehole and seismic reflection data show MEEG faults as conjugate pairs dipping to the north and south at average dips of 60º, and with maximum widths of 2.9 to 4.4 miles (4.6 to 7 km) (Reference 2.5S.2-31, 2.5S.2-32, 2.5S.2-33, and 2.5S.2-34). Because no single, uniform dip direction characterizes the MEEG, we model the structure as a vertical fault. We emphasize that adopting a vertical fault approximation for the MEEG is intended to capture its average behavior as a source of strong ground motion only. Documented local observations of the magnitude and direction of dip on the MEEG are retained for the purposes of determining slip rate and maximum magnitude.

As discussed in Subsection 2.5S.1.1.4.4.5.1, there are two estimates of offset across the MEEG:

- A long-term average separation rate determined from offset Quaternary gravels of approximately 0.02 mm/yr (0.00079 in/yr) corresponding to 0.023 mm/yr (0.00091 in/yr) of dip slip on a 60º fault
- A short-term separation rate determined from geodetic leveling spanning 1920 to the 1950s of approximately 4.3 mm/yr (0.17 in/yr) corresponding to 5.0 mm/yr (0.20 in/yr) of dip slip on a 60º dipping fault

The apparent modern creep rate of 4.3 mm/yr (0.17 in/yr) documented by geodetic leveling (Reference 2.5S.2-31), if accurate, likely reflects movement of salt at depth

and is not indicative of the rate of tectonic strain accumulation on the MEEG, so the offset Quaternary gravels are used as the basis for estimating the tectonic slip rate of the MEEG. Because only one slip rate estimate is available, the 0.023 mm/yr (0.00091 in/yr) is taken as the mean slip rate with an uncertainty of + 50%, resulting in a slip rate distribution of 0.012 mm/yr (0.00047244 in/yr), 0.023 mm/yr (0.00091 in/yr), and 0.035 mm/yr (0.0013780 in/yr) with weightings of 0.2, 0.6, and 0.2, respectively.

$M_{max}$ values are estimated following two methods:

- Using empirical relations for magnitude and rupture area, as well as observations of rupture aspect ratios for normal faults
- Using empirical relations for the magnitude and maximum displacement during a single event

Data compiled worldwide from earthquakes associated with normal fault rupture demonstrates that the rupture length to width ratio for normal faulting earthquakes is generally less than 4:1 (Reference 2.5S.2-37) and usually closer to 1:1 (Reference 2.5S.2-38). These observations suggest that given the width of the MEEG faults, rupture of the full fault lengths of 56 mi (90 km) and 37 mi (59 km) in a single event is not likely. To take into account these observations, $M_{max}$ values are calculated using the normal faulting relationship of Reference 2.5S.2-37 using a fault width of 4.6 and 7 km and an aspect ratio of 4:1. The resulting $M_{max}$ values are:

$M_{max}$ of **M** 5.9 for a fault area of 11 mi x 2.9 mi (18.4 km x 4.6 km)

$M_{max}$ of **M** 6.3 for a fault area of 17 mi x 4.4 mi (28 km x 7 km)

Reference 2.5S.2-37 present relationships between the maximum coseismic displacement and earthquake magnitude. Using the relationship appropriate for normal faults and the 66 cm (26 inches) of observed offset in Quaternary gravels (see Subsection 2.5S.1.1.4.4.5.1), a third $M_{max}$ value for MEEG is **M** 6.5.

The three $M_{max}$ estimates presented above (**M** 5.9, 6.3, and 6.5) are used as the distribution of $M_{max}$ values for the MEEG with weightings of 0.2, 0.6, and 0.2, respectively. These **M** magnitudes are converted to $m_b$ magnitudes following the procedure outlined in Subsection 2.5S.2.1.2. The final distribution of $M_{max}$ values with weights is $m_b$ 6. (0.2), $m_b$ 6.5 (0.6), $m_b$ 6.6 (0.2).

### 2.5S.2.4.4.2 New Madrid Seismic Zone

The New Madrid Seismic Zone extends from southeastern Missouri to southwestern Tennessee and is located more than 500 mi (800 km) northeast of the STP 3 & 4 site (Figure 2.5S.1-26. The New Madrid Seismic Zone produced a series of large-magnitude earthquakes between December 1811 and February 1812 (Reference 2.5S.2-39). Subsection 2.5S.1.1.4.4.5.3 presents a detailed discussion of the New Madrid Seismic Zone. Several studies that post-date the 1986 EPRI EST assessments demonstrate that the source parameters for geometry, $M_{max}$, and recurrence of $M_{max}$ in the New Madrid region need to be updated to capture a more current understanding of this seismic source (Reference 2.5S.2-28, 2.5S.2-39, 2.5S.2-40, 2.5S.2-41, 2.5S.2-42, and 2.5S.2-43).

The original EPRI screening study for the STP 1 & 2 UFSAR did not show any New Madrid Source Zones from the EPRI-SOG ESTs as contributing to 99% of the hazard (Reference 2.5S.2-1) because New Madrid was only considered as a potential source if it was within 500 miles of the site (Reference 2.5S.2-1). However, the updated geometry, $M_{max}$ values, and recurrence intervals for the New Madrid source and updated ground motion attenuation relations developed for the CEUS require reevaluation of the New Madrid Seismic Zone as a potential contributor to 99% of the hazard at STP3 & 4. The updated New Madrid seismic source model described in Exelon's ESP Application (Reference 2.5S.2-27) (Figures 2.5S.2-12 and 2.5S.2-12) and ground motion attenuation models published in EPRI (Reference 2.5S.2-44) form the basis for determining the potential contribution from the New Madrid Seismic Zone to seismic hazard at STP 3 & 4. This model accounts for new information on recurrence intervals for large earthquakes in the New Madrid area, for recent estimates of possible earthquake sizes on each of the active faults, and for the possibility of multiple earthquake occurrences within a short period of time (earthquake clusters).

Three faults are identified in the New Madrid Seismic Zone, each with two alternative geometries, as follows (Figures 2.5S.2-12):

| Fault | Geometry |
|---|---|
| Blytheville | Blytheville arch/Bootheel lineament<br>Blytheville arch/Blytheville Fault Zone |
| Northern | New Madrid north<br>New Madrid north with extension |
| Reelfoot | Reelfoot central section<br>Reelfoot full length |

Earthquakes are treated as characteristic events in terms of magnitudes, with the following sets of magnitudes modeled for each fault (Reference 2.5S.2-27):

| Blytheville | Reelfoot | Northern | Weight |
|---|---|---|---|
| 7.3 | 7.5 | 7.0 | 0.1667 |
| 7.2 | 7.4 | 7.0 | 0.1667 |
| 7.2 | 7.4 | 7.2 | 0.0833 |
| 7.6 | 7.8 | 7.5 | 0.25 |
| 7.9 | 7.8 | 7.6 | 0.1667 |
| 7.8 | 7.7 | 7.5 | 0.1667 |

The above magnitudes represent the centers of characteristic magnitude ranges that extend ±0.25 magnitude units above and below the indicated magnitude.

Seismic hazard is calculated considering the possibility of clustered earthquake occurrences. The modeling of earthquake clusters in the New Madrid Seismic Zone has undergone considerable study, and this model will continue to evolve as further field evidence on paleo-earthquakes is found and analyzed. In the adopted model, all three faults rupture during each “event,” and the hazard is computed using this simplified model. This simplified model results in slightly higher ground motion hazard than if the possibility of two fault ruptures is considered or if a smaller-magnitude earthquake is considered for one of the three ruptures. The occurrence rate of earthquake clusters is developed using two models, a Poisson model and a lognormal renewal model with a range of coefficients of variation (Reference 2.5S.2-27). Consistent with Reference 2.5S.2-27, all faults are assumed to be vertical and to extend from the surface to 20 km depth. A finite rupture model is used to represent an extended rupture on all faults. Because of the large distance between the New Madrid Seismic Zone and STP 3 & 4, the details of the geometrical representation of each fault are not critical to the seismic hazard calculations.

### 2.5S.2.4.5 Other Revisions to the EPRI Source Model

#### 2.5S.2.4.5.1 Revised Smoothing Parameters for Dames & Moore’s South Coastal Margin Source Zone

In the 1986 EPRI model, there are no seismicity parameters calculated and assigned to the degree cells adjacent to STP 3 & 4 for the Dames & Moore South Coastal Margin Source Zone (zone 20) (Reference 2.5S.2-1). The lack of parameters in this region is due to the combination of Dames & Moore adopting zero smoothing for the source

zone, and the absence of seismicity from the 1986 EPRI model seismicity catalog within the degree cells that would be used to make estimates of these parameters (Reference 2.5S.2-1). Without parameters for these degree cells, the geographic regions adjacent to STP 3 & 4 do not contribute to the hazard at STP 3 & 4.

The smoothing for Dames & Moore's South Coastal Margin Source Zone has been updated for STP 3 & 4 hazard calculations to ensure that seismicity parameters are defined for degree cells adjacent to the site, and thus that these cells contribute to the calculated hazard at the site. The updated smoothing options and associated weights are (Table 2.5S.2-13):

- Constant a, constant b, strong prior on b of 1.04 (weight 0.2)
- Medium smoothing on a, medium smoothing on b, strong prior on b of 1.04 (weight 0.4)
- High smoothing on a, high smoothing on b, strong prior on b of 1.04 (weight 0.4)

These smoothing options are based on those used within in the 1986 EPRI model (Reference 2.5S.2-13 and 2.5S.2-16). The use of a strong prior on b of 1.04 reflects the preference of the Dames & Moore EST for a prior on b of 1.04 for other background source zones within the 1986 model (Reference 2.5S.2-13 and 2.5S.2-16).

### 2.5S.2.4.5.2 Update of the EPRI Model Southern Extent

The calculation of seismic hazard within the EPRI computational model developed following the 1986 study (i.e., EQHAZARD) (Reference 2.5S.2-16) from background source zones depends on the presence of a suite of seismicity parameters gridded throughout the source zone. Seismicity parameters in the original model within the Gulf of Mexico region were not calculated or gridded south of 28º N near the site. (See Figure 2.5S.2-7 for the complete definition of this boundary.) Consequently, a sensitivity analysis performed for seismic hazard at STP 3 & 4 confirmed that regions of GCSZs that extend south of 28º N were not included in the calculation of vibratory ground motion hazard at the STP 3 & 4 (Reference 2.5S.2-16) when the original parameterization of the EPRI model (Reference 2.5S.2-1 and 2.5S.2-13) was used. In particular, regions of the Gulf of Mexico and western Texas that are within contributing GCSZs that encompass STP 3 & 4 did not contribute to the hazard at STP 3 & 4. For the EPRI source model used in the final rock hazard calculation for STP 3 & 4, seismicity parameters were calculated for regions south of 28º N using supplemental estimates of periods of incompleteness for this region (see Subsection 2.5S.2.1) to ensure that seismicity parameters are gridded within the full extent of source zones within the Gulf Coastal Plain and Gulf of Mexico region.

### 2.5S.2.4.6 New Ground Motion Models

Since the EPRI study (Reference 2.5S.2-1), ground motion models for CEUS have evolved. An EPRI project was conducted to summarize knowledge about CEUS ground motions, and results were published by EPRI (Reference 2.5S.2-44). These updated equations estimate median spectral acceleration and its uncertainty as a

function of earthquake magnitude and distance. Epistemic uncertainty is modeled using multiple ground motion equations with weights, and multiple estimate of aleatory uncertainty, also with weights. Different sets of sources are recommended for seismic sources that represent rifted vs. non-rifted regions of the earth's crust. Equations are available for spectral frequencies at hard rock sites of 100 Hz (which is equivalent to peak ground acceleration, PGA), 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1 Hz, and 0.5 Hz.

The aleatory uncertainties published in the EPRI (Reference 2.5S.2-44) 2004 model were re-examined by EPRI (Reference 2.5S.2-45) because it was thought that the EPRI (Reference 2.5S.2-44) 2004 aleatory uncertainties were probably too large, resulting in over-estimates of seismic hazard. The EPRI (Reference 2.5S.2-45) study recommends a revised set of aleatory uncertainties and weights that can be used to replace the original EPRI (Reference 2.5S.2-44) 2004 aleatory uncertainties.

In summary, the ground motion models used in the seismic hazard calculations consisted of the median equations from EPRI (Reference 2.5S.2-44) combined with the updated aleatory uncertainties of the EPRI study (Reference 2.5S.2-45).

### 2.5S.2.4.7 Updated Probabilistic Seismic Hazard Analysis and Deaggregation

The seismic hazard at the STP site was investigated with the changes described in Subsection 2.5S.2.4.2 through 2.5S.2.4.6 to seismic sources, seismicity parameters, maximum magnitudes, and ground motion equations. The PSHA was made first for hard rock conditions. A PSHA consists of calculating annual frequencies of exceeding various threshold ground motion amplitudes for all possible earthquakes that are hypothesized in a region. The seismic sources are characterized by the rates of occurrence of earthquakes as a function of magnitude and distance, and the ground motion model estimates the distribution of ground motions at the site for each event. Multiple weighted hypotheses on seismic sources, earthquake rates of occurrence, and ground motions (characterized by the median ground motion amplitude and its uncertainty) result in multiple weighted seismic hazard curves, and from these the mean and fractile seismic hazard can be determined. The calculation is made separately for each of the six EPRI ESTs, and the seismic hazard distributions for the teams are combined, weighting each team equally. This combination gives the overall mean and distribution of rock seismic hazard at the site. The effects of local site conditions on seismic ground motions are taken into account below.

As described in Subsection 2.5S.2.4.4, a review of geological, geophysical, and seismological information developed since the 1986 EPRI study (Reference 2.5S.2-13) identified the MEEG and the New Madrid Seismic Zone as two seismic sources that were not included in the in the original EPRI screening for STP 1 & 2 (Reference 2.5S.2-1). The review indicated these sources should be evaluated to determine their potential contribution to seismic hazard at STP 3 & 4. A sensitivity analysis was completed using these sources in conjunction with the EPRI (Reference 2.5S.2-44) ground motion equations and the aleatory uncertainty model to determine if the two new sources contribute to 99% of the hazard at STP 3 & 4. The results of the analysis showed that MEEG provided an insignificant contribution to hazard, well below 1% of the hazard, and that the New Madrid Seismic Zone was a significant contributor.

Based on the results of the sensitivity analysis, the final PSHA for hard rock conditions was calculated with the EPRI (Reference 2.5S.2-1) team sources, modified as discussed above for additional seismicity in the Gulf of Mexico, with the addition of the New Madrid Seismic Zone model to each team's interpretations. The following EPRI EST sources were included:

- Bechtel Group: sources BEC-BZ1, BEC-BZ2
- Dames & Moore: sources DAM-20, DAM-25, DAM-C08
- Law: sources LAW-124, LAW-126
- Rondout: source RND-51
- Woodward-Clyde: source WCC-B43
- Weston: source WGC-107

Figures 2.5S.2-14 and 2.5S.2-15 show mean rock hazard by team for 10 Hz and 1 Hz spectral accelerations, respectively. The team weights are not reflected in Figures 2.5S.2-14~~15~~ and 2.5S.2-15~~16~~, i.e. each team is effectively given a weight of 1.0 in those figures. The mean hazard curves are similar, particularly for 1 Hz, because the New Madrid seismic source is common to all teams and dominates the hazard for this frequency. This is further illustrated in Figures 2.5S.2-16 and 2.5S.2-17, where mean seismic hazard curves are plotted for individual sources for 10 Hz and 1 Hz, respectively. In these figures the probability of activity of each source is reflected in the hazard (the probability of exceedance of ground motion amplitudes), but the team weights (1/6 each) are not reflected. The New Madrid seismic source dominates the 1 Hz hazard for annual frequencies of exceedance down to $10^{-6}$, and has a major contribution to 10 Hz hazard for annual frequencies of exceedance in the range $10^{-3}$ to $10^{-4}$.

Figures 2.5S.2-18 through 2.5S.2-24 show total rock hazard as the mean, ~~15th, 50th, and 85th~~ 5th, 16th, 50th, 84th, and 95th fractile curves. One of the characteristics of the low spectral frequency hazard curves (1 Hz and 0.5 Hz, in particular) is that the mean rock hazard curves exceed~~s~~ the ~~85th~~ 84th fractile at high ground motion amplitudes. This is the case when the New Madrid seismic source dominates the hazard, and is caused by a few EPRI (Reference 2.5S.2-44) ground motion equations indicating relatively high hazards for the large distance between the New Madrid seismic source and the STP 3 & 4 site. This is shown in Figure 2.5S.2-25, which plots the 1 Hz spectral acceleration hazard from the New Madrid seismic source only, for the 12 ground motion equations used for that source. The curve indicated as "F9" with a weight of 0.036, indicates the highest hazard, more than a factor of 10 above all other curves. This curve alone will cause the mean hazard to coincide with a very high fractile hazard curve for cases where the New Madrid seismic source dominates the hazard.

Figure 2.5S.2-26 shows the mean and median ~~$10^{-4}$ and $10^{-5}$~~ $10^{-4}$, $10^{-5}$, and $10^{-6}$ uniform hazard response spectra (UHRS) for hard rock conditions, based on the seven

ground motion frequencies for which ground motion estimates are available. Numerical values for the mean UHRS are shown in Table 2.5S.2-16.

The seismic hazard was deaggregated following the guidelines of RG 1.208. Specifically, the mean contributions to seismic hazard for 1 Hz and 2.5 Hz were deaggregated by magnitude and distance for the mean $10^{-4}$ ground motions at 1 Hz and 2.5 Hz, and these deaggregations were combined. Figure 2.5S.2-27 shows this combined deaggregation. Similar deaggregations of the mean hazard were performed for 5 and 10 Hz spectral accelerations (Figure 2.5S.2-28). Deaggregations of the mean hazard for $10^{-5}$ and $10^{-6}$ ground motions are shown in Figures 2.5S.2-29 through 2.5S.2-32. Deaggregation of the mean seismic hazard is recommended in RG 1.206. The contribution of the New Madrid source to seismic hazard is plotted in the deaggregation figures in the last distance interval, which represents 248 mi or greater (400+ km); the New Madrid source is actually about 1000 km from the STP 3 & 4 site.

Figures 2.5S.2-27 through 2.5S.2-32 include the contribution to hazard by, which is the number of logarithmic standard deviations that the applicable ground motion ($10^{-4}$, $10^{-5}$, or $10^{-6}$) is above the logarithmic mean. These figures indicate that the largest contribution to hazard for $10^{-4}$ and $10^{-5}$ ground motions comes from values between 0 and 2 standard deviations above the mean, which is a common result.

The deaggregation plots in Figures 2.5S.2-27 through 2.5S.2-30 for $10^{-4}$ and $10^{-5}$ ground motions indicate that the New Madrid seismic source has a major contribution to seismic hazard at the STP 3 & 4 site. For $10^{-4}$ annual frequency of exceedance, this source is the largest contributor to seismic hazard for both 5 and 10 Hz (Figure 2.5S.2-27) and 1 and 2.5 Hz (Figure 2.5S.2-28). For an annual frequency of $10^{-5}$, the contribution is smaller particularly for high frequencies (see Figures 2.5S.2-29 and 2.5S.2-30). For an annual frequency of $10^{-6}$, virtually all hazard at high frequencies comes from local sources (Figure 2.5S.2-32~~33~~), while low frequencies have about equal contributions from the New Madrid seismic source and from local sources (Figure 2.5S.2-31). All of these observations are confirmed qualitatively in Figures 2.5S.2-16 and 2.5S.2-17, which compare the hazard from the New Madrid source to the hazard from local sources for 10 Hz and 1 Hz.

Table 2.5S.2-17 summarizes the mean magnitude and distance resulting from these deaggregations, for all contributions to hazard and for contributions with distances exceeding 100 km. For the 1 and 2.5 Hz results, contributions from events with R>100 km exceed 5% of the total hazard. As a result, following the guidance of RG 1.208, the controlling earthquake for low frequencies (LF) ground motions was selected from the R>100 km calculation, and the controlling earthquake for high frequencies (HF) ground motions was selected from the overall calculation. The values of **M** and R selected in this way are shown in shaded cells in Table 2.5S.2-17.

Smooth rock UHRS were developed from the UHRS amplitudes in Table 2.5S.2-16, using controlling earthquake **M** and R values shown in Table 2.5S.2-17 and using the hard rock spectral shapes for CEUS earthquake ground motions recommended in NUREG/CR-6728 (Reference 2.5S.2-46). Separate spectral shapes were developed for HF and LF. In order to reflect accurately the UHRS values calculated by the PSHA

as shown in Table 2.5S.2-16, the HF spectral shape was anchored to the UHRS values from Table 2.5S.2-16 at 100 Hz, 25 Hz, 10 Hz, and 5 Hz. In between these frequencies, the spectrum was calculated using shapes anchored to the next higher and lower frequency and weighting those shapes. The weighting was based on the inverse logarithmic difference between the intermediate frequency and the next higher or lower frequency. This technique provided a smooth, realistic spectral shape at these intermediate frequencies. Below 5 Hz, the HF shape was extrapolated from 5 Hz.

For the LF spectral shape a similar procedure was used except that the LF spectral shape was anchored to the UHRS values at all seven ground motion frequencies for which hazard calculations were made (100 Hz, 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1 Hz, and 0.5 Hz). Anchoring the LF spectral shape to all frequencies was necessary because otherwise the LF spectral shape exceeded the HF spectral shape at high frequencies. This results from the contribution of extreme ground motions ($\varepsilon$>1, see for example Figures 2.5S.2-29) at low spectral frequencies, and a resulting UHRS shape that differs from the median shape predicted in NUREG/CR-6728.

Figures 2.5S.2-33 and 2.5S.2-34 show the horizontal HF and LF spectra calculated in this way for $10^{-4}$ and $10^{-5}$ annual frequencies of exceedance, respectively; see Tables 2.5S.2-18 and 2.5S.2-19 for sampled numerical values of these rock response spectra. As mentioned previously, these spectra accurately reflect the UHRS amplitudes in Table 2.5S.2-16 that were calculated for the seven spectral frequencies at which PSHA calculations were done. Because the HF and LF spectra were scaled to the same high-frequency amplitudes, they are very similar at high frequencies. These spectra were used in site amplification calculations.

### 2.5S.2.4.8 Middle America Trench Seismic Hazard Sensitivity

The Middle America Trench [MAT] along the western coast of Mexico is over 800 miles (1300 km) from the STP 3 & 4 site at its closest approach. However, due to the low levels of seismicity within Texas and the relatively frequent large magnitude earthquakes observed from subduction along the MAT, the possibility that earthquakes along the MAT off Mexico could contribute to hazard at the project site was examined. A seismic hazard sensitivity study was performed to assess the significance of that hazard relative to the hazard presented from the other seismic sources already being considered. Given the large distance and the average crustal attenuation characteristics between the MAT and the project site, it was assessed that longer period motions would be most likely to contribute to the seismic hazard at the STP 3 & 4 site. For this reason, the sensitivity study focused on 1 Hz ground motion. Further, for the purpose of the sensitivity study, focus was placed on the subduction interface earthquakes, the source of earthquakes observed as large as nearly **M**~8 and arguably with the potential of being as large as **M**~9. The sensitivity study required development of a seismic source model for the large magnitude MAT subduction interface earthquakes, as well as a long-distance 1 Hz ground motion attenuation relationship. Detailed assessment of uncertainties was considered in both the seismic source and ground motion models.

*Seismic Source Model*

The MAT off of the west coast of Mexico was divided into four distinct segments based on variations in the age of the subducted oceanic crust, dip of the subducting plate, extent of historic interplate earthquake ruptures, and the presence or absence of fracture zones and ridges on the subducting plate. While the historical record of seismicity within this region shows that the MAT has been characterized by single-segment ruptures roughly corresponding to the four segments, the MAT seismic source model also considered the possibility of multi-segment ruptures.

A logic-tree approach was used to parameterize the MAT seismic source model. Besides the possibility of single or multiple-segment ruptures, associated distributions of maximum magnitudes were considered. Plate convergence rates and a distribution of plate coupling – a measure of the portion of the plate motion that is manifested as seismicity as opposed to aseismic deformation – were considered to model a range of slip rates for each of the single and multiple segments.

*1 Hz Ground Motion Attenuation Model*

An assessment of seven published attenuation models for 1 Hz spectral acceleration attenuation from subduction zone interface earthquakes was made. The relationships are based on both empirical and modeled data. While only two of the published relations were presented as applicable to the large distances needed for the PSHA – both relationships based on modeling studies – all seven were evaluated as to their median attenuation behavior over a magnitude range 6.5 to 8.5 and for distances out to 2,000 km. As a result of the comparison, a representative model among the suite of relationships was chosen for a median 1 Hz ground motion estimate. Epistemic uncertainty was evaluated and a bounding value appropriate for the purposes of the sensitivity study was developed.

*Seismic Hazard Sensitivity Assessment*

A PSHA was performed using the seismic source and ground motion models, summarized above. Comparison of the resulting 1 Hz hazard curve was made to an early version of the total PSHA using the significant updated EPRI-SOG sources, discussed in this section. Note that the early version of the total PSHA was sufficiently similar to the final version, presented here, for the purposes of the sensitivity study. At the 1 Hz ground motion acceleration corresponding to the $10^{-4}$ hazard level of the total hazard curve (excluding MAT contribution), the MAT hazard curve was less than 1% of that given by the total hazard curve. As the MAT hazard curve decreases faster than the total hazard curve with increasing ground motion, the relative MAT hazard at the $10^{-5}$ hazard level of the total hazard would be even less. Given the specification of the subset of EPRI-SOG sources in the CEUS to be considered as those contributing to 99% of the total hazard, the MAT contribution to the total is too small for further PSHA consideration.

### 2.5S.2.4.9 ~~2.5S.2.4.8~~Vertical ground motions

Vertical spectra were derived from horizontal spectra after accounting for site amplification. V/H ratios were used to estimate $10^{-4}$ and $10^{-5}$ vertical spectra from the

consistent horizontal spectra. This process, and the resulting spectra, are described in Subsection 2.5S.2.6.

### 2.5S.2.5 Seismic Wave Transmission Characteristics of the Site

The UHRS described in the previous section are defined on hard rock characterized with shear wave velocity Vs = 9200 fps, which is located at more than 30,000 feet (9144 m) below the ground surface. This section describes the development of the site amplification factors that result from the transmission of the seismic waves through the thick soil column. The effect is modeled by a truncated soil column, extending from the ground surface to a depth of about ~~30,000~~ 8100 feet (~~914~~2469 meters), and an adjustment to the soil damping within the truncated soil column to represent the anelastic attenuation of ground motion by the entire soil column (the "kappa" value).

The development of the site amplification factors is performed in the following steps:

*(1)* Develop a model of the base case soil column using site-specific geotechnical and geophysical data to a depth of about 600 feet (182 meters), augmented to a depth of about ~~3000~~ 8100 feet (~~914~~ 2469 meters) with deep velocity profiles ~~taken~~ obtained from ~~EPRI (Reference 2.5S.2-12)~~available deep sonic log data. The model for the upper 600 feet (182 meters) is based on mean shear wave velocities measured at the site and shear modulus and damping strain dependencies taken from selected generic curves ~~(Reference 2.5S.2-12)~~ to match the Resonant Shear Column Torsional (RCTS) testing results (see Subsection 2.5S.4.7). The deeper soil layers are assumed to behave linearly. This model provides the base case representation of the dynamic properties of STP 3 & 4 site subsurface.

*(2)* Confirm~~, through sensitivity analyses,~~ that this model adequately captures the frequency-dependent response of the deep soil column over all frequencies of interest.

*(3)* Calculate strain-independent (linear-elastic) material damping values for the deep soil strata (~~182 to 914 meters~~600 to 8100 ft), which experience small levels of strain during the earthquake to ensure that the truncated site model accurately accounts for the dissipation of energy in the deep soil site. This is done by constraining the damping within these deeper strata to replicate an estimate of the total kappa for the site.

*(4)* Generate a set of 60 artificial "randomized" soil profiles by using the base soil column and developing a probabilistic model that describes the uncertainties in the above soil properties, location of layer ~~and hard rock~~ boundaries, correlation between the velocities in adjacent layers and the overall dissipation of energy in the site. Use the $10^{-4}$ and $10^{-5}$ annual-frequency-of-exceedance smooth LF and HF hard rock spectra of Subsection 2.5S.2.4 for input into the base of the randomized soil columns, calculate dynamic response of the site for each of the 60 artificial profiles by using an equivalent-linear site-response formulation together with Random Vibration Theory (RVT), and calculate the mean ~~and standard deviation~~ of site response. Time

histories for the site response analysis are not required for the frequency-domain RVT approach to site response analysis. This step is repeated for each of the four input motions ($10^{-4}$ and $10^{-5}$ annual frequencies, HF and LF smooth spectra).

These steps are described in detail in the following subsections. The resulting site-specific ~~amplification factors~~ ARS are used ~~with the hard rock spectra of Subsection 2.5S.2.4~~ to develop GMRS in Subsection 2.5S.2.6

### 2.5S.2.5.1 Base Case Soil Column and Uncertainties

Development of a base case soil column is described in detail in Subsection 2.5S.4. Summaries of the low strain shear wave velocity, material damping, and strain-dependent properties of the base case soil strata are provided below in this section. These parameters serve as input for the site response analyses.

The geology at the STP 3 & 4 site consists of deep marine and fluvial deposits overlying bedrock. The upper approximately 600 feet (182 m) of the site soils were investigated using test borings, Cone Penetration Testing (CPT), test pits, and geophysical methods. Based on the results from these tests, soils in the upper layers of the site can generally be divided into the following geotechnical strata:

- Stratum A: Clay (CH), medium stiff to very stiff
- Stratum B: loose to dense Silty Sand (SM) and sandy silt (ML), or medium stiff to ~~very~~ stiff clay
- Stratum C: Silty Sand (SM), dense to very dense
- Stratum D: Silty Clay (CH), very stiff to hard
- Stratum E: Slightly Silty Fine Sand (SP-SM), dense to very dense
- Stratum F: Silty Clay (CH/CL), very stiff to hard
- Stratum H: Silty Sand (SM), very dense
- Stratum J: Silty Clay (CL/CH) with Interbedded Silt, Silty Sand, Clayey Sand, or Sand, hard
- Stratum K: Sandy Clay, with Interbedded Silt or Silty Sand, stiff to hard
- Stratum L: Silty Clay (CL/CH), very stiff to hard
- Stratum M: Silty Sand (SM), dense to very dense
- Stratum N: Silty Clay (CH) with Interbedded Sand or Silty sand, very stiff to hard

The Primary-Secondary (P-S) suspension measurements and CPT results provided shear and compression wave velocities of the soil at 1.6 feet (0.5 m) intervals. These

data were used to develop mean shear wave profile for the upper 600 feet (182 m) of soil. Unit weights for the upper 600 feet (182 m) soil are in the range of 120 pounds per cubic foot (pcf) to 128 pcf.

~~Generic EPRI curves (Reference 2.5S.2-12) were adopted to describe the strain-dependencies of shear modulus and damping for the~~ The nonlinear degradation soil shear modulus and damping curves based on RCTS test results are described in Section 2.5S.4.7.3 and are used for the upper 600 feet (182 m) of soils. ~~For cohesionless soils, eight sets of shear modulus and damping degradation curves were interpolated from the generic EPRI curves based upon approximate mid-thickness-depth of soil strata or sub-strata, as shown in Figures 2.5S.4-57 and 2.5S.4-59. Five sets of curves were developed for the cohesive soils by interpolating from the generic EPRI curves based on the clay Plasticity Index (PI), shown in Figures 2.5S.4-58 and 2.5S.4-60. An alternative set of the strain dependent properties was developed for the cohesionless soils by using Peninsular curves from a Brookhaven National Laboratory report (Reference 2.5S.2-47) where two sets of stiffness and damping curves were used for the cohesionless soils at depths above and below 50 feet (15 m) depth.~~ Numerical values of the recommended curves are provided in Table 2.5S.4-34b (degradation soil shear modulus) and Table 2.5S.4-34c (damping ratio).

Information on subsurface conditions for depths below approximately 600 feet (182 m) ~~and extending to the maximum drilling depth of 2620 feet (798 m)~~ was assembled from available sonic log data and used to develop the shear-wave velocity profile as well as other properties such as Poisson's ratio, refer to Section 2.5S.4. ~~the Updated Final Safety Analysis Report (UFSAR) (Reference 2.5S.2-36) for the existing STP 1 & 2 that are located approximately 1500 feet (500 m) to 2500 feet (833 m) from STP 3 & 4 site. At depths below 600 feet (182 m), the soil profile consists of alternating layers of very stiff to hard clay (with some claystone and siltstone) and very dense, fine to silty fine sand. The claystone and siltstone occur at depths greater than approximately 880 feet (268 m) and frequency of occurrence increases with depth. Three cases of shear wave velocity profiles with different probability weights were developed for the deep soil strata based on EPRI (Reference 2.5S.2-48).~~ Linear elastic properties are assigned to the soil at depths below 600 feet (182 m) by assuming that the strains in these deep soil layers remain small during the earthquakes. Unit weight of the deep soils (below approximately 600 feet, 182 meters) range from 129 pcf to ~~135~~ 140 pcf. A value of ~~140~~ 170 pcf was assigned for the bedrock unit weight.

Damping values were developed for the linear deep soil layers to maintain the total kappa for the site as described below.

Low-strain kappa (k) value, a near surface damping parameter for modeling site-dependent effects, is used as a measure of the total dissipation of energy of the site during the small strain events. The site kappa (k) value is directly related to damping of the soil layers and scattering of the waves at layer interface boundaries. The kappa associated for soil layer damping is additive for all layers. The following expression shows the relationship between kappa (ki) and the damping coefficient, (zi) of the soil layer (i):

$$\kappa_i = \frac{2H_i\xi_i}{Vs_i}$$ Equation 2.5S.2-6

where: Hi is the thickness and Vsi is the shear wave velocity of the soil layer (i). Total kappa (k) value of the site associated with material damping equals the sum of the ki values of all soil layers included in the model:

$$\kappa = \sum_i \kappa_i$$ Equation 2.5S.2-7

The value of total kappa (k) is directly evaluated from recordings of earthquakes. One of the nearest and most applicable measures of total kappa is a value of 0.058 sec based on inversions of regional earthquakes located and recorded within the deeper portions of the Mississippi Embayment in the area just south of Saint Louis, Missouri and Memphis, Tennessee (Reference 2.5S.2-49). For various other study areas in the Mississippi Embayment also lacking in direct measurements of total (k), a more conservative value (i.e., corresponding to lower damping) of 0.046 sec has been used (Reference 2.5S.2-48).

A kappa (k) value of 0.006 sec is assumed to apply to the central and eastern United States crystalline basement and below (Reference 2.5S.2-12), leaving a total soil kappa (k) value of 0.040 sec for the damping of the full depth of the Mississippi Embayment soils. EPRI (Reference 2.5S.2-12) presents a standard deviation of 0.4 natural log units to be appropriate for sites in the eastern United States. This is consistent with Reference 2.5S.2-48 in considering ±50% variation about the base case value of kappa (k) for Mississippi embayment sites. Therefore, a base case kappa (k) value of 0.040 sec is used for STP 3 & 4 site model with a standard deviation of 0.4 natural log units.

The following procedure is used to assign the damping to the models of the soil at depths below 600 feet (182 m) in order to match the assigned kappa (k) value:

*(1)* From Equations 2.5S.2-6 and 2.5S.2-7, kappa (k) associated with material damping is calculated for the top 600 feet (182 m) of soil strata by using small strain damping for each soil layer.

*(2)* The kappa (k) value of the top 600 feet (182 m) of soil is deducted from the total kappa (k) value, and a constant damping value is assigned to deep soil layers. ~~In this calculation the kappa associated with scattering of the waves in the randomized profiles is computed to ensure the kappa associated with both soil layer damping with scattering of the waves in the layered profiles maintains the total kappa adopted for the deep soil profile at the site.~~

*(3)* The damping of each deep soil layer is randomized with consideration given to the mean and variation of the total kappa.

The input motion for soil amplification analysis was specified at the bottom of the soil profile, below which the halfspace was modeled with shear wave velocity of 9200 fps and a damping ratio of 0.2%.

~~Selection of base soil profile for the STP 3 & 4 site considered the effects of variation of several different input parameters. Analysis showed that the differences in calculated site responses obtained from three different EPRI (Reference 2.5S.2-48) deep soil models were not significant. Nevertheless, a weighted average of the three profiles was selected for this part of the base case model. Another sensitivity analysis showed that the difference between results found using the EPRI (Reference 2.5S.2-12) and Peninsular Range (Reference 2.5S.2-47) strain dependency curves was negligible due to the very low level of shear strain in the soil layers. The EPRI set of soil strain dependency curves has been adopted for the base site model. A final sensitivity analysis also compared results of site responses obtained from profiles with different depths (1500 ft to 3500 ft; 457 m to 1066 m) to demonstrate that the truncation of the soil column does not affect the site response results over the frequency range of interest. Comparison of the results obtained from the profiles with different depths shows that the acceleration response spectra (ARS) amplification values within the frequency range of interest are very similar for all profiles. Based on the results of this comparison, a base profile truncated at 2500 +/- 500 ft (762 m) was adopted for the site response analyses of STP 3 & 4.~~

~~As described in Subsection 2.5S.4.7, Resonant Column Torsional Shear (RCTS) testing was delayed and the preliminary analysis for the development of site-specific amplification factors was conducted using measured wave velocity profiles combined with published shear modulus and damping degradation curves. Results from five RCTS tests have been obtained and are discussed in Subsection 2.5S.4.7.3.3. Comparisons of these results with the generic EPRI curves selected for the corresponding soil layers in the base case soil column model demonstrate good correlation up to 10-2% strain (Reference Figures 2.5S.4-62 through 2.5S.4-64). Some divergence from the selected EPRI values above 10-2% strain can be observed for the samples from layers M-Sand and N-Sand (Reference Figures 2.5S.4-62 and 2.5S.4-63, respectively). For Substratum N-Clay (Reference Figure 2.5S.4-64), which presents data from 3 samples taken at different depths, the measured values straddled the assumed curves, dependent in part on the test confining pressure.~~The soil column was truncated at a depth of 8100 ft (2469 meter). This depth was selected such that the resulting soil column captures the site response in the range of frequency of interest, greater than 0.1 Hertz. The natural soil column frequency was therefore calculated, starting from the best estimate shear-wave velocity profile, as shown in Figure 2.5S.2.35a, for the full soil column and confirmed to be less than 0.1 Hertz at 8100 ft depth.

As described in Subsection 2.5S.2.5.2, the soil properties for each layer were randomized to account for the inherent natural variability of soil deposits, as well as the (epistemic) uncertainty associated with the choice of curves for variation of shear modulus and damping with strain level. Therefore, the actual site response analysis comprised a range of soil properties for each layer, and in particular, a range of initial small strain shear modulus and degradation curves. Because of different properties in each of the randomized profiles, the site response analysis generated a range of results, as reported in Subsection 2.5S.2.5.4. ~~As more RCTS tests are completed, the site-specific curves describing changes in shear modulus and damping with strain level may differ from those assumed in the analysis. However, the small strain shear~~

~~modulus will remain unchanged. Given the reasonable, but also wide range of strain-dependent soil properties used for the randomization study, the effect of using site-specific RCTS data on soil amplification is expected to be small. This is particularly true considering that the sensitivity analysis described above clearly demonstrated that the use of EPRI curves rather than the Peninsular curves had little impact on site-response, due to the low level of strains in the soil layers.~~

~~In addition, recognizing the margin between the site-specific GMRS described in Subsection 2.5S.2.6 (Figure 2.5S.2-52), and the RG 1.60, 0.3g CSDRS, it is expected that when the site-specific GMRS has been updated using all site-specific RCTS results, the GMRS will remain bounded by the CSDRS.~~

### 2.5S.2.5.2 Site Properties Representing Uncertainties and Correlations

To account for variations in shear-wave velocity across the site, 60 artificial profiles were generated using the stochastic model discussed in Reference 2.5S.2-50, with some modifications to account for conditions at the STP 3 & 4 site. These randomized profiles represent the truncated soil column from the top of bedrock with shear-wave velocity of 9200 feet per second (fps) to the ground surface. This model uses as inputs the following quantities:

- A shear-wave velocity profile for the upper 600 feet (182 m) of soil, which is equal to the base-case soil profile described above.
- ~~A weighted average of the three deep (600 ft to 2500 ft; 182 m to 762 m) shear-wave velocity profiles with the weighting values obtained from Reference 2.5S.2-48.~~A shear-wave velocity profile for the deeper soil column at depths greater than 600 feet (182 m) obtained from available deep sonic log data.
- The standard deviation of ln(Vs) (the natural logarithm of the shear-wave velocity) as a function of depth, which was developed using available site and regional data (See Subsection 2.5S.4).
- The correlation coefficient between ln(Vs) in adjacent layers, which is taken from generic studies, using the inter-layer correlation model for category US Geological Survey “C” soils (Reference 2.5S.2-50).
- The probabilistic characterization of layer thickness consists of a function that describes the rate of layer boundaries as a function of depth. This study used a generic form of this function, taken from Reference 2.5S.2-50~~(Reference 2.5S.2-50)~~, and then modified to allow for sharp changes in the adopted base-case velocity profile.
- The profiles of the median and plus/minus one standard deviation of the shear wave velocity profile are shown in Figure 2.5S.2-35b for the upper 1000 ft~~Figure 2.5S.2-35~~. The variation was used in the randomization of the shear wave velocity profile.

- The assigned depth to bedrock of 8,100 ft to ensure the site response is captured~~, which is randomized about the depth of 2500 ft ± 500 ft (762 m ± 152 m) based on result of the comparative study of truncated profiles. Note that Subsection 2.5S.4.7.2.2.1 discusses that the shear-wave velocity of 9200 ft/s is modeled at a depth of approximately 2500 ft (762 m). This value is taken as the base case or median depth. Depth to bedrock is characterized by a uniform distribution over the interval of 2500 ft (762 m), plus or minus 500 ft (152 m). Because bedrock occurs at a large depth, the specific details of modeling uncertainty in this depth are not critical to the calculation of site response~~ in the frequency range of interest, greater than 0.1 Hertz.

- Median values of shear stiffness (G/GMAX) and damping for each geologic unit are described in Subsection 2.5S.4. Uncertainties in the strain-dependent properties for each soil unit are characterized using the values in Reference 2.5S.2-51. Figures 2.5S.2-37 and 2.5S.2-38 illustrate the shear stiffness and damping curves generated for one of the geologic units, Stratum ~~M~~C, described in Subsection 2.5S.4.

Figure 2.5S.2-36 illustrates the 60 Vs profiles generated, using the median, logarithmic standard deviation, and correlation model described above. ~~These profiles include variation in depth to bedrock.~~ The same figure compares the median of these 60 Vs profiles to the median Vs profile described in the previous section, indicating good agreement.

This set of 60 profiles, consisting of Vs versus depth, depth to bedrock, stiffness, and damping, are used to calculate and quantify site response and its uncertainty, as described in the following sections.

### 2.5S.2.5.3 Correction of Damping for Scattering Effects to Maintain Total Site Kappa

The process of the randomization of soil velocity profiles introduces additional scattering of upward propagating shear waves (S-waves) in such a manner that the median response of all randomized profiles is lower than the response obtained from the analyses of the median profile. These scattering effects are accounted for by decreasing the damping value of the deep soil layers in the randomized profiles by 15%. Due to this modification, the mean (log-average) damping value of deep soil layer changes from ~~1.26%~~ 0.60% to ~~1.09%~~ 0.51% and the median values of total kappa (k) coefficient of site is reduced by ~~0.0023~~ 0.005 sec. ~~The modification has a very small effect on the variation of the randomized kappa (k) values as measured by the presented log-standard deviation.~~

### 2.5S.2.5.4 Site Response Analyses

The site response analysis performed for the STP 3 & 4 site uses Random Vibration Theory (RVT) (References 2.5S.2-52 and 2.5S.2-53) with the following assumptions:

- Vertically-propagating shear waves are the dominant contributor to site response

- An equivalent-linear formulation of soil nonlinearity is appropriate for the characterization of site response

These are the same assumptions that are implemented in the SHAKE program (Reference 2.5S.2-54) and that constitute standard practice for site-response calculations. In this respect, RVT and SHAKE solve the same problem, but RVT works with ground-motion power spectral densities or response spectra (and its relation to peak values), while SHAKE works with individual time histories and their Fourier spectra.

The RVT site-response analysis requires the following additional parameters:

- Strong-motion duration. ~~These are calculated from the mean magnitudes and distances from the deaggregation using values of crustal shear wave velocity and seismic stress drop typical of Eastern North America.~~ The RVT methodology requires this parameter, but results are not very sensitive to it. These are calculated from the mean magnitudes resulting from deaggregation. Table 2.3.1 in Reference 2.5S.2-58 provides strong motion duration values as a function of magnitude. Accordingly, strong motion durations were assigned for each of the cases considered ($10^{-4}$ and $10^{-5}$ annual frequencies, HF and LF smooth spectra), presented in Table 2.5S.2-20.~~Parametric studies during the site response analysis showed that the effect of this parameter is insignificant. A value of 10 seconds is used.~~

- Effective strain ratio. A value of 0.65 is used. Effective strain ratio is defined as the ratio between the peak acceleration of earthquake time history and the equivalent harmonic wave going through the soil layers (Reference 2.5S.2-55).

Figure 2.5S.2-39 shows with thick red lines the logarithmic mean ~~and standard deviation~~ of site amplification factors at ground surface from the analysis ~~analyses~~ of the 60 modified random profiles with the $10^{-4}$ LF input motion. As would be expected due to the large depth of sediments at the site, amplifications are largest at low frequencies (below ~~2.0~~ 3 Hz) and small de-amplification occurs at high frequencies because of soil damping. The maximum strains in the soil column are low for this motion, and this is shown in Figure 2.5S.2-40, which plots the maximum strains versus depth that are calculated for the 60 profiles and their logarithmic mean (in red thick line). The logarithmic mean of maximum strains is less than ~~0.025%~~0.03%. The maximum strain calculated from the analyses of all profiles is ~~0.055%~~ 0.05% in the upper 600 feet (182 m) of soil. The maximum strains in the deep soil layer at depths below 600 feet (182 m) are very small and do not exceed value of ~~0.015%~~0.02%.

Figure 2.5S.2-41 and Figure 2.5S.2-42 show similar plots of amplification factors and maximum strains obtained from the analysis ~~analyses~~ with $10^{-4}$ HF motion. The maximum strain results show that the soil column exhibits a lower level of straining under this earthquake with maximum strains being less than ~~0.02%~~0.025%. Figure 2.5S.2-43 through Figure 2.5S.2-46 show comparable plots of amplification factors and maximum strains from the analyses performed with the $10^{-5}$ input motion, both LF and HF. For this higher motion, larger maximum strains are observed, but the

maximum logarithmic mean does not exceed ~~0.1%~~0.11%. From all of the 60 profiles, a maximum strain of ~~0.45%~~ 0.19% is calculated in the upper 600 feet (182 m) of soil. The maximum strain in the deep soil layers is very small, less than ~~0.05%~~0.06%.

Comparison of the profiles of logarithmic mean maximum strain in Figure 2.5S.2-47 clearly indicates that response of the site under the LF motions is stronger than under HF motions. Figure 2.5S.2-48 shows the logarithmic mean profiles for the strain-compatible damping that is a measure of energy dissipation in the soil profile during the shaking. Corresponding to the strains, a maximum damping value of ~~6.8%~~ 3.4% in the upper 600 feet (182 m) of soil is calculated for the analyses with the $10^{-5}$ LF motion. The strain compatible damping calculated for is the $10^{-4}$ LF motion small and does not exceed ~~3.5%~~1.9%. The small strain-compatible damping results in relatively small de-amplification of the site response at high frequencies.

A comparison of log-mean soil amplification factors at the ground surface level for LF and HF $10^{-4}$ and $10^{-5}$ input motions is shown in ~~Figure 2.5S.2-49~~ Figure 2.5S.2-49a. As shown in this figure, the amplifications at $10^{-4}$ level of input motion between the LF and HF input motions are about the same up to 7 Hz. De-amplification occurs at higher frequencies ~~is small particularly for the LF input motion,~~, larger than 10 Hz, followed by amplification of the peak ground acceleration ~~(about 1.6)~~ at high frequencies (above ~~80~~ 40 hz). The amplification due to $10^{-5}$ level of input motion follows the same trend compared to the amplification due to $10^{-4}$ motion indicating limited extent of soil nonlinearity in the soil column. The corresponding amplified ARS at ground surface are presented in Figure 2.5S.2-49b.

~~The corresponding numerical values of the soil amplification factors are tabulated in Table 2.5S.2-18 and 2.5S.2-19.~~

## 2.5S.2.6 Ground Motion Response Spectra

The following site-specific supplement addresses COL License Information Item 2.2.

The GMRS ground motion was developed starting from the $10^{-4}$ and $10^{-5}$ HF and LF rock UHRS shown in Figures 2.5S.2-33 and 2.5S.2-34. Site response was calculated for each of these rock input motions. Figure 2.5S.2-50 shows the resulting logarithmic mean spectra for surface conditions for each of these input rock motions; see Tables 2.5S.2-18 and 2.5S.2-19 for sampled numerical values of these rock response spectra. The broad-banded LF motion dominates the site response for the $10^{-4}$ rock input motion, but for $10^{-5}$ the HF rock motion indicates higher response in the frequency range 12.5 to 3.3 Hz. The envelope spectra for $10^{-4}$ and $10^{-5}$ were determined from these individual results, and these envelope spectra were smoothed with a running average filter to smooth out peaks and valleys that are not statistically significant. These envelope spectra are shown in Figure 2.5S.2-51; see Tables 2.5S.2-18 and 2.5S.2-19 for sampled numerical values of these rock response spectra.

This procedure corresponds to Approach 2A in NUREG/CR-6769 (Reference 2.5S.2-2), wherein the rock UHRS (for example, at $10^{-4}$) is multiplied by a mean amplification factor at each frequency to estimate the $10^{-4}$ site UHRS.

The low-frequency character of the spectra in ~~Figures 2.5S.2-34 and 2.5S.2-50~~ Figures 2.5S.2-33, 2.5S.2-34, and 2.5S.2-20 reflects the low-frequency amplification of the site. This is a deep soil site and there is a fundamental site resonance at about 0.6 Hz, with a dip in site response at about 0.7 Hz, and this dip occurs for all 60 of the site profiles that were used to characterize the site profile. As a result, there is a dip in the site spectra for $10^{-4}$ and $10^{-5}$ at 0.7 Hz that reflects the site characteristics.

The horizontal GMRS was developed from the horizontal UHRS using the approach described in ASCE/SEI Standard 43-05 (Reference 2.5S.2-56) and RG 1.208. The ASCE/SEI Standard 43-05 approach defines the GMRS using the site-specific UHRS, which is defined for Seismic Design Category SDC-5 at a mean $10^{-4}$ annual frequency of exceedance. The procedure for computing the GMRS is as follows.

For each spectral frequency at which the UHRS is defined, a slope factor AR is determined from:

$$A_R = SA(10^{-5})/SA(10^{-4}) \qquad \text{Equation 2.5S.2-8}$$

where $SA(10^{-4})$ is the spectral acceleration SA at a mean UHRS exceedance frequency of $10^{-4}$/yr (and similarly for $SA(10^{-5})$). A Design Factor "DF" is defined based on $A_R$, which reflects the slope of the mean hazard curve between $10^{-4}$ and $10^{-5}$ mean annual frequencies of exceedance. The DF at each spectral frequency is given by:

$$DF = 0.6(A_R)^{0.80} \qquad \text{Equation 2.5S.2-9}$$

and

$$GMRS = \max[SA(10^{-4}) \times \max(1, DF), 0.45 \times SA(10^{-5})] \qquad \text{Equation 2.5S.2-10}$$

The derivation of DF is described in detail in the Commentary to ASCE/SEI Standard 43-05 (Reference 2.5S.2-56) and in RG 1.208. Table 2.5S.2-21~~20~~ shows the values of AR and DF calculated at each structural frequency and the resulting GMRS. The horizontal GMRS is plotted in Figure 2.5S.2-52. This horizontal GMRS is enveloped at all frequencies by the CSDRS, defined as the horizontal RG 1.60 spectrum anchored at a PGA of 0.30g.

A vertical GMRS was calculated by deriving vertical-to-horizontal (V/H) ratios and applying them to the horizontal $10^{-4}$ AND $10^{-5}$ UHRS. The V/H ratios were obtained by the applying the following steps described below.

For CEUS soil sites NUREG/CR-6728 (Reference 2.5S.2-46) suggests a methodology for estimating V/H using available empirical Western United States (WUS) ground motion attenuation relations for both soil and rock, horizontal and vertical motions, and ground motion modeling to develop transfer functions to translate WUS V/H estimates to CEUS V/H estimates. This methodology results in several significant trends in the derived ratios that depend on the frequency of the ground motion, the magnitude and distance of an earthquake, and the subsurface material properties at a site. Among these trends are: the tendency for V/H to increase with frequency, and (for soil sites) to increase with higher magnitudes and smaller distances in the high-frequency range,

but to decrease with higher magnitude and smaller distances in the low-frequency range.

Using the attenuation relations of Reference 2.5S.2-57 for WUS soil V/H values, and using the controlling earthquake magnitudes and conservative values for distance for low- and broad-band frequency characterization of site-specific UHRS (for R>100 km and "overall" hazard, respectively, see Table 2.5S.2-17), V/H ratios have been developed for the STP 3 & 4 site. Figure 2.5S.2-53 shows all three magnitude V/H ratios at 93 mi (150km) distance. The specification of the distance of 150 km is based on the far-distance limit of the data used by Reference 2.5S.2-57 in their ground motion attenuation relations. In the high-frequencies, where V/H varies the most, V/H decreases with greater distance, so use of the distance of 150km, compared to the greater controlling distances in Table 2.5S.2-17, gives reasonable, if not conservative guidance on appropriate V/H for the project site. To account for the WUS-to-CEUS high-frequency transformation, discussed in EPRI (Reference 2.5S.2-12) and NUREG/CR-6728, these V/H ratios have been shifted toward higher frequencies. The value of this frequency shift (by a factor of 3.74) is derived by considering the V/H ratios presented in NUREG/CR-6728, and dividing the peak frequency for CEUS [~62.5Hz] by the peak frequency for WUS [~16.7Hz].

The V/H values from RG 1.60 are also shown in the Figure 2.5S.2-53. They have been adopted for the STP 3 & 4 site because they are conservative, acceptable, and simple. ~~The recommended V/H ratio is 1.0 for frequencies greater than 3.5 Hz, 0.667 for frequencies less than 2.5 Hz, and is interpolated (log-linear) between X and Y Hz.~~ Figure 2.5S.2-54 plots the resulting vertical UHRS, calculated in this manner from the horizontal UHRS. The vertical GMRS was developed from the vertical UHRS in a manner identical to that used for the horizontal GMRS, and the vertical GMRS is also plotted in Figure 2.5S.2-54. Table 2.5S.2-22~~21~~ lists the vertical UHRS, factors AR and DF, and the vertical GMRS amplitudes. This vertical GMRS is enveloped at all frequencies by the vertical CSDRS, defined as the vertical RG 1.60 spectrum anchored at a PGA of 0.30g.

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**Table 2.5S.2-1 Conversion between body-wave ($m_b$) and moment (M) magnitudes [1]**

| Convert $m_b$ | To M | Convert M | To $m_b$ |
|---|---|---|---|
| 4.00 | 3.77 | 4.00 | 4.28 |
| 4.10 | 3.84 | 4.10 | 4.41 |
| 4.20 | 3.92 | 4.20 | 4.54 |
| 4.30 | 4.00 | 4.30 | 4.66 |
| 4.40 | 4.08 | 4.40 | 4.78 |
| 4.50 | 4.16 | 4.50 | 4.90 |
| 4.60 | 4.24 | 4.60 | 5.01 |
| 4.70 | 4.33 | 4.70 | 5.12 |
| 4.80 | 4.42 | 4.80 | 5.23 |
| 4.90 | 4.50 | 4.90 | 5.33 |
| 5.00 | 4.59 | 5.00 | 5.43 |
| 5.10 | 4.69 | 5.10 | 5.52 |
| 5.20 | 4.78 | 5.20 | 5.61 |
| 5.30 | 4.88 | 5.30 | 5.70 |
| 5.40 | 4.97 | 5.40 | 5.78 |
| 5.50 | 5.08 | 5.50 | 5.87 |
| 5.60 | 5.19 | 5.60 | 5.95 |
| 5.70 | 5.31 | 5.70 | 6.03 |
| 5.80 | 5.42 | 5.80 | 6.11 |
| 5.90 | 5.54 | 5.90 | 6.18 |
| 6.00 | 5.66 | 6.00 | 6.26 |
| 6.10 | 5.79 | 6.10 | 6.33 |
| 6.20 | 5.92 | 6.20 | 6.40 |
| 6.30 | 6.06 | 6.30 | 6.47 |
| 6.40 | 6.20 | 6.40 | 6.53 |
| 6.50 | 6.34 | 6.50 | 6.60 |
| 6.60 | 6.49 | 6.60 | 6.66 |
| 6.70 | 6.65 | 6.70 | 6.73 |
| 6.80 | 6.82 | 6.80 | 6.79 |
| 6.90 | 6.98 | 6.90 | 6.85 |
| 7.00 | 7.16 | 7.00 | 6.91 |

**Table 2.5S.2-1 Conversion between body-wave ($m_b$) and moment (M) magnitudes [1] (Continued)**

| Convert $m_b$ | To M | Convert M | To $m_b$ |
|---|---|---|---|
| 7.10 | 7.33 | 7.10 | 6.97 |
| 7.20 | 7.51 | 7.20 | 7.03 |
| 7.30 | 7.69 | 7.30 | 7.09 |
| 7.40 | 7.87 | 7.40 | 7.15 |
| 7.50 | 8.04 | 7.50 | 7.20 |
| - | - | 7.60 | 7.26 |
| - | - | 7.70 | 7.32 |
| - | - | 7.80 | 7.37 |
| - | - | 7.90 | 7.43 |
| - | - | 8.00 | 7.49 |

[1] Average of relations given by References 2.5S.2-10, 2.5S.2-11, and 2.5S.2-12.

## Table 2.5S.2-2 Seismicity Catalog for pre-1985 for the Gulf of Mexico

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Latitude (°N) | Longitude (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DPC | 1847 | 2 | 14 | 2 | 0 | 0.00 | 29.600 | -98.000 | 0 | 5 | 3.60 | 0.56 | 3.96 |
| DPC | 1887 | 1 | 5 | 17 | 57 | 0.00 | 30.150 | -97.060 | 0 | 5 | 4.10 | 0.56 | 4.46 |
| DPC | 1887 | 1 | 31 | 22 | 14 | 0.00 | 30.530 | -96.300 | 0 | 4 | 3.30 | 0.56 | 3.66 |
| DPC | 1902 | 10 | 9 | 19 | 0 | 0.00 | 30.100 | -97.600 | 0 | 4 | 3.90 | 0.56 | 4.26 |
| SRA | 1981 | 2 | 13 | 2 | 15 | 0.00 | 30.000 | -91.800 | 0 | 4 | 3.11 | 0.56 | 3.47 |
| ANSS | 1984 | 1 | 23 | 0 | 11 | 59.38 | 26.716 | -87.339 | 5 | | 2.85 | 0.41 | 3.04 |

**Investigation Region (100°W to 83°W, 24°N to 32°N) [1]**

[1] Exclusive of EPRI events, for which the events are Rmb magnitude ≥ 3.0 or intensity ≥ IV and are equivalent to EPRI MAIN mainshock events (i.e., independent)

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1985 | 2 | 10 | 14 | 16 | 52.20 | 36.450 | -98.410 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1985 | 2 | 13 | 10 | 22 | 24.00 | 38.420 | -87.500 | 18 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1985 | 2 | 15 | 15 | 56 | 10.00 | 37.230 | -89.330 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1985 | 3 | 16 | 21 | 55 | 2.47 | 38.558 | -105.850 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1985 | 5 | 1 | 1 | 16 | 27.80 | 37.780 | -87.610 | 10 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1985 | 5 | 4 | 7 | 7 | 11.86 | 36.282 | -90.879 | 10 | | 2.85 | 0.41 | 3.04 |
| SRA | 1985 | 5 | 6 | 2 | 11 | 16.20 | 34.969 | -97.482 | 5 | 5 | 2.30 | 0.1 | 2.31 |
| ANSS | 1985 | 6 | 5 | 10 | 36 | 0.60 | 32.562 | -106.916 | 6 | | 3.01 | 0.41 | 3.20 |
| SRA | 1985 | 6 | 27 | 18 | 20 | 0.00 | 33.621 | -106.475 | 0 | | 3.40 | 0.1 | 3.41 |
| ANSS | 1985 | 7 | 12 | 18 | 20 | 28.30 | 35.202 | -85.148 | 20 | | 2.97 | 0.3 | 3.08 |
| ANSS | 1985 | 7 | 21 | 21 | 22 | 11.80 | 37.980 | -90.620 | 6 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1985 | 8 | 2 | 4 | 23 | 10.80 | 35.223 | -92.213 | 7 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1985 | 8 | 3 | 4 | 23 | 11.00 | 35.210 | -92.200 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1985 | 8 | 16 | 14 | 56 | 52.96 | 34.130 | -106.832 | 7 | | 3.98 | 0.41 | 4.18 |
| ANSS | 1985 | 9 | 6 | 22 | 17 | 2.85 | 35.814 | -93.123 | 2 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1985 | 9 | 18 | 15 | 54 | 4.64 | 33.548 | -97.051 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1985 | 10 | 12 | 6 | 43 | 42.50 | 38.510 | -89.010 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1985 | 11 | 8 | 19 | 56 | 48.52 | 35.223 | -92.188 | 4 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1985 | 11 | 12 | 6 | 50 | 35.03 | 29.438 | -104.800 | 5 | | 4.30 | 0.1 | 4.31 |
| ANSS | 1985 | 12 | 5 | 22 | 59 | 41.11 | 35.896 | -89.995 | 6 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1985 | 12 | 15 | 7 | 14 | 52.23 | 35.281 | -104.635 | 5 | | 3.60 | 0.1 | 3.61 |
| ANSS | 1985 | 12 | 16 | 22 | 20 | 4.38 | 35.736 | -90.245 | 11 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1985 | 12 | 22 | 0 | 56 | 5.00 | 35.701 | -83.720 | 13 | | 3.25 | 0.3 | 3.35 |
| ANSS | 1985 | 12 | 29 | 8 | 56 | 58.30 | 38.490 | -89.020 | 1 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1986 | 1 | 1 | 14 | 13 | 22.65 | 35.886 | -89.991 | 8 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1986 | 1 | 7 | 1 | 26 | 43.30 | 35.610 | -84.761 | 23 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1986 | 1 | 29 | 8 | 16 | 7.80 | 38.350 | -87.540 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1986 | 1 | 30 | 22 | 26 | 37.07 | 32.066 | -100.693 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1986 | 2 | 15 | 11 | 1 | 12.80 | 38.250 | -89.770 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1986 | 2 | 17 | 19 | 13 | 6.70 | 37.940 | -90.400 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1986 | 2 | 26 | 15 | 3 | 0.50 | 38.390 | -89.100 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1986 | 2 | 26 | 22 | 49 | 59.03 | 24.815 | -100.190 | 33 | | 4.40 | 0.1 | 4.41 |
| SRA | 1986 | 2 | 28 | 4 | 12 | 57.90 | 33.296 | -83.245 | 1 | 4 | 1.79 | 0.27 | 1.88 |
| ANSS | 1986 | 3 | 3 | 11 | 45 | 17.48 | 35.308 | -102.514 | 5 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1986 | 4 | 11 | 6 | 17 | 14.75 | 38.982 | -106.940 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1986 | 4 | 19 | 7 | 40 | 53.00 | 35.187 | -85.510 | 27 | | 2.97 | 0.3 | 3.08 |
| ANSS | 1986 | 4 | 27 | 21 | 33 | 22.50 | 37.960 | -90.190 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1986 | 5 | 7 | 2 | 27 | 0.46 | 33.233 | -87.361 | 1 | | 4.50 | 0.1 | 4.51 |
| ANSS | 1986 | 5 | 9 | 21 | 55 | 26.71 | 38.887 | -106.884 | 5 | | 2.85 | 0.41 | 3.04 |
| ISC | 1986 | 5 | 12 | 4 | 18 | 2.70 | 27.714 | -88.726 | 10 | . | 3.50 | 0.1 | 3.51 |
| ANSS | 1986 | 5 | 12 | 4 | 18 | 48.30 | 30.900 | -89.150 | 10 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1986 | 5 | 24 | 8 | 16 | 1.50 | 35.118 | -92.217 | 4 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1986 | 5 | 24 | 12 | 48 | 14.43 | 36.484 | -89.917 | 13 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1986 | 6 | 2 | 4 | 4 | 5.20 | 39.344 | -99.781 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1986 | 6 | 4 | 4 | 38 | 10.68 | 25.211 | -100.717 | 33 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1986 | 6 | 8 | 8 | 52 | 55.36 | 24.497 | -100.015 | 10 | | 3.70 | 0.1 | 3.71 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1986 | 7 | 11 | 14 | 26 | 14.80 | 34.937 | -84.987 | 13 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1986 | 8 | 26 | 16 | 41 | 24.80 | 38.320 | -89.790 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 1986 | 8 | 27 | 18 | 6 | 56.38 | 35.160 | -105.094 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1986 | 10 | 20 | 4 | 32 | 49.00 | 37.918 | -101.372 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1986 | 10 | 29 | 5 | 3 | 41.30 | 38.440 | -89.040 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1986 | 11 | 6 | 19 | 21 | 47.20 | 38.110 | -90.420 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1986 | 12 | 12 | 23 | 51 | 48.26 | 36.903 | -89.128 | 12 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1986 | 12 | 30 | 7 | 15 | 19.09 | 36.418 | -89.629 | 13 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1987 | 1 | 16 | 3 | 25 | 35.96 | 35.902 | -90.012 | 8 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1987 | 1 | 24 | 16 | 8 | 17.00 | 35.828 | -98.097 | 5 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1987 | 3 | 13 | 18 | 37 | 7.00 | 39.090 | -89.410 | 1 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1987 | 3 | 14 | 11 | 51 | 1.29 | 36.117 | -89.770 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1987 | 3 | 27 | 7 | 29 | 30.50 | 35.565 | -84.230 | 19 | | 4.07 | 0.41 | 4.26 |
| ANSS | 1987 | 4 | 16 | 10 | 55 | 9.49 | 38.358 | -105.651 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1987 | 4 | 26 | 0 | 56 | 21.50 | 38.540 | -89.410 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1987 | 5 | 2 | 19 | 51 | 28.81 | 36.290 | -89.553 | 10 | | 3.01 | 0.41 | 3.20 |
| PDE | 1987 | 5 | 14 | 15 | 59 | 58.46 | 33.545 | -106.519 | 0 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1987 | 5 | 20 | 0 | 2 | 12.64 | 35.155 | -92.244 | 3 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1987 | 5 | 23 | 19 | 8 | 23.82 | 36.614 | -89.620 | 11 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1987 | 6 | 4 | 17 | 19 | 23.40 | 37.939 | -85.800 | 8 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1987 | 6 | 10 | 23 | 48 | 53.90 | 38.710 | -87.950 | 5 | | 4.88 | 0.41 | 5.07 |
| ANSS | 1987 | 6 | 13 | 21 | 17 | 13.50 | 36.576 | -89.735 | 10 | | 3.98 | 0.41 | 4.18 |
| ANSS | 1987 | 6 | 15 | 15 | 5 | 16.41 | 36.547 | -89.697 | 13 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1987 | 6 | 19 | 3 | 46 | 38.29 | 36.466 | -89.587 | 19 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1987 | 6 | 23 | 0 | 0 | 19.40 | 38.720 | -87.950 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1987 | 6 | 26 | 18 | 39 | 20.38 | 36.534 | -89.674 | 13 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1987 | 7 | 7 | 19 | 19 | 6.30 | 36.941 | -89.148 | 17 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1987 | 7 | 11 | 0 | 4 | 29.50 | 36.105 | -83.816 | 25 | | 3.66 | 0.41 | 3.85 |
| ANSS | 1987 | 7 | 11 | 2 | 48 | 5.90 | 36.103 | -83.819 | 24 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1987 | 7 | 20 | 16 | 19 | 16.10 | 38.955 | -106.507 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1987 | 8 | 14 | 18 | 27 | 56.67 | 35.706 | -90.385 | 11 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1987 | 8 | 31 | 17 | 12 | 35.20 | 38.300 | -89.680 | 0 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1987 | 9 | 1 | 23 | 2 | 49.40 | 35.515 | -84.396 | 21 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1987 | 9 | 22 | 17 | 23 | 50.10 | 35.623 | -84.312 | 19 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1987 | 9 | 29 | 0 | 4 | 56.13 | 36.953 | -89.159 | 11 | | 4.15 | 0.41 | 4.34 |
| ANSS | 1987 | 10 | 14 | 15 | 49 | 40.10 | 37.050 | -88.780 | 2 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1987 | 11 | 17 | 15 | 52 | 21.10 | 38.720 | -87.960 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1987 | 12 | 8 | 1 | 42 | 40.30 | 36.055 | -98.024 | 5 | | 3.70 | 0.1 | 3.71 |
| ANSS | 1988 | 1 | 5 | 14 | 39 | 18.20 | 38.720 | -87.960 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1988 | 1 | 9 | 1 | 7 | 40.60 | 35.279 | -84.199 | 12 | | 3.16 | 0.3 | 3.26 |
| ANSS | 1988 | 1 | 15 | 7 | 33 | 29.20 | 37.515 | -106.684 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1988 | 1 | 31 | 0 | 12 | 44.36 | 35.664 | -90.440 | 15 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1988 | 1 | 31 | 9 | 24 | 36.30 | 29.945 | -105.076 | 5 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1988 | 2 | 18 | 0 | 37 | 45.40 | 35.346 | -83.837 | 2 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1988 | 2 | 27 | 15 | 17 | 6.50 | 36.680 | -89.520 | 15 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1988 | 3 | 10 | 21 | 24 | 9.50 | 37.750 | -88.830 | 4 | | 3.09 | 0.41 | 3.28 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1988 | 3 | 15 | 12 | 34 | 48.70 | 38.300 | -89.000 | 12 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1988 | 4 | 14 | 9 | 39 | 31.47 | 39.093 | -99.155 | 5 | | 3.60 | 0.1 | 3.61 |
| ANSS | 1988 | 5 | 2 | 13 | 43 | 59.42 | 35.666 | -90.351 | 8 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1988 | 5 | 20 | 23 | 6 | 23.90 | 37.310 | -92.670 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1988 | 6 | 25 | 15 | 2 | 49.26 | 36.669 | -89.593 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1988 | 9 | 7 | 2 | 28 | 9.54 | 38.143 | -83.878 | 10 | | 4.60 | 0.1 | 4.61 |
| ANSS | 1988 | 9 | 7 | 2 | 30 | 32.90 | 38.170 | -83.756 | 8 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1988 | 9 | 18 | 16 | 16 | 1.00 | 37.310 | -87.210 | 13 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1988 | 10 | 5 | 0 | 38 | 55.00 | 38.660 | -88.020 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1988 | 12 | 25 | 15 | 57 | 57.83 | 34.206 | -92.658 | 12 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1988 | 12 | 29 | 2 | 52 | 13.70 | 38.990 | -87.730 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1988 | 12 | 31 | 14 | 24 | 20.68 | 36.193 | -89.430 | 6 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1989 | 1 | 3 | 19 | 8 | 51.30 | 38.990 | -87.720 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1989 | 1 | 29 | 5 | 7 | 15.33 | 35.221 | -104.093 | 7 | | 3.34 | 0.3 | 3.44 |
| ANSS | 1989 | 2 | 28 | 17 | 31 | 50.84 | 33.643 | -87.092 | 0 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1989 | 4 | 15 | 16 | 39 | 51.66 | 36.558 | -89.682 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1989 | 4 | 27 | 16 | 47 | 51.33 | 36.088 | -89.775 | 12 | | 4.15 | 0.41 | 4.34 |
| ANSS | 1989 | 6 | 8 | 18 | 18 | 43.37 | 39.165 | -99.477 | 5 | | 4.00 | 0.1 | 4.01 |
| ANSS | 1989 | 6 | 16 | 14 | 53 | 53.12 | 39.143 | -99.457 | 5 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1989 | 6 | 28 | 9 | 35 | 0.20 | 37.810 | -88.950 | 13 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1989 | 7 | 6 | 10 | 38 | 25.56 | 38.772 | -102.635 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1989 | 7 | 13 | 18 | 35 | 22.90 | 39.168 | -99.472 | 5 | | 3.40 | 0.1 | 3.41 |
| ANSS | 1989 | 7 | 14 | 23 | 32 | 22.39 | 36.295 | -89.494 | 11 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1989 | 7 | 15 | 0 | 8 | 2.64 | 38.607 | -83.569 | 10 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1989 | 7 | 15 | 18 | 58 | 28.00 | 34.373 | -87.323 | 14 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1989 | 7 | 20 | 6 | 7 | 50.42 | 36.434 | -98.876 | 5 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1989 | 8 | 13 | 20 | 16 | 2.90 | 33.632 | -87.086 | 0 | | 3.40 | 0.1 | 3.41 |
| ANSS | 1989 | 8 | 20 | 0 | 3 | 18.30 | 34.803 | -87.596 | 7 | | 3.82 | 0.41 | 4.02 |
| ANSS | 1989 | 9 | 14 | 17 | 31 | 27.90 | 36.558 | -89.630 | 12 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1989 | 10 | 9 | 1 | 43 | 33.19 | 35.794 | -90.153 | 13 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1989 | 10 | 30 | 5 | 6 | 56.46 | 36.555 | -89.696 | 8 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1989 | 11 | 29 | 6 | 54 | 38.50 | 34.455 | -106.891 | 13 | | 4.52 | 0.3 | 4.62 |
| ANSS | 1989 | 12 | 1 | 9 | 26 | 51.30 | 36.216 | -89.440 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1989 | 12 | 2 | 13 | 31 | 45.60 | 35.993 | -83.847 | 11 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1990 | 1 | 24 | 18 | 20 | 26.20 | 38.140 | -86.490 | 10 | | 3.82 | 0.41 | 4.02 |
| ANSS | 1990 | 1 | 27 | 14 | 5 | 51.67 | 38.184 | -86.430 | 5 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1990 | 1 | 29 | 13 | 16 | 10.68 | 34.463 | -106.879 | 12 | | 4.80 | 0.1 | 4.81 |
| ANSS | 1990 | 1 | 31 | 1 | 8 | 19.29 | 34.445 | -106.860 | 10 | | 4.00 | 0.1 | 4.01 |
| ANSS | 1990 | 2 | 21 | 12 | 2 | 19.34 | 34.014 | -106.544 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 1990 | 2 | 27 | 13 | 23 | 22.00 | 33.953 | -106.588 | 5 | | 3.79 | 0.3 | 3.89 |
| ANSS | 1990 | 3 | 2 | 7 | 1 | 48.07 | 38.851 | -89.170 | 0 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1990 | 3 | 9 | 21 | 2 | 54.80 | 38.140 | -86.190 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1990 | 3 | 12 | 16 | 48 | 1.67 | 36.359 | -92.251 | 0 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1990 | 3 | 18 | 16 | 22 | 33.19 | 36.692 | -91.505 | 1 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1990 | 4 | 24 | 9 | 41 | 36.57 | 38.955 | -88.201 | 18 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1990 | 5 | 5 | 16 | 26 | 22.89 | 34.449 | -106.878 | 7 | | 3.52 | 0.3 | 3.62 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1990 | 6 | 23 | 20 | 44 | 2.74 | 33.762 | -87.969 | 1 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1990 | 7 | 15 | 18 | 22 | 48.50 | 37.880 | -90.840 | 3 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1990 | 7 | 21 | 19 | 28 | 22.79 | 34.458 | -106.858 | 12 | | 2.97 | 0.3 | 3.08 |
| ANSS | 1990 | 7 | 21 | 20 | 30 | 31.34 | 34.455 | -106.856 | 7 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1990 | 7 | 21 | 23 | 48 | 4.92 | 34.453 | -106.854 | 7 | | 3.16 | 0.3 | 3.26 |
| ANSS | 1990 | 7 | 22 | 21 | 27 | 5.13 | 34.838 | -106.006 | 10 | | 3.61 | 0.3 | 3.71 |
| ANSS | 1990 | 7 | 28 | 7 | 53 | 33.75 | 34.600 | -93.376 | 4 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1990 | 7 | 31 | 7 | 32 | 40.18 | 34.456 | -106.862 | 8 | | 3.25 | 0.3 | 3.35 |
| ANSS | 1990 | 8 | 7 | 5 | 5 | 56.22 | 36.857 | -89.237 | 7 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1990 | 8 | 17 | 21 | 1 | 15.90 | 36.934 | -83.384 | 1 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1990 | 8 | 24 | 19 | 43 | 50.60 | 37.200 | -89.110 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1990 | 8 | 29 | 19 | 34 | 59.25 | 35.785 | -89.644 | 15 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1990 | 9 | 2 | 4 | 35 | 40.20 | 33.758 | -87.928 | 1 | | 3.16 | 0.3 | 3.26 |
| ANSS | 1990 | 9 | 8 | 0 | 3 | 57.40 | 38.061 | -83.731 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1990 | 9 | 12 | 21 | 38 | 57.62 | 39.701 | -106.206 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1990 | 9 | 16 | 21 | 14 | 13.19 | 35.537 | -92.275 | 2 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1990 | 9 | 26 | 13 | 18 | 51.71 | 37.152 | -89.613 | 1 | | 4.55 | 0.41 | 4.75 |
| ANSS | 1990 | 9 | 27 | 1 | 47 | 52.95 | 37.172 | -89.594 | 15 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1990 | 10 | 24 | 8 | 20 | 3.67 | 38.346 | -88.971 | 1 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1990 | 11 | 8 | 10 | 8 | 25.40 | 37.108 | -83.031 | 0 | | 3.16 | 0.3 | 3.26 |
| ANSS | 1990 | 11 | 8 | 10 | 46 | 53.77 | 34.449 | -106.856 | 6 | | 4.40 | 0.1 | 4.41 |
| ANSS | 1990 | 11 | 8 | 11 | 3 | 46.51 | 34.453 | -106.861 | 9 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1990 | 11 | 9 | 3 | 39 | 15.92 | 36.537 | -89.632 | 10 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1990 | 11 | 10 | 12 | 18 | 16.85 | 34.450 | -106.851 | 7 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1990 | 11 | 15 | 7 | 25 | 24.38 | 34.457 | -106.859 | 7 | | 3.52 | 0.3 | 3.62 |
| ANSS | 1990 | 11 | 15 | 11 | 44 | 41.40 | 34.760 | -97.590 | 5 | | 3.90 | 0.1 | 3.91 |
| ANSS | 1990 | 11 | 15 | 11 | 45 | 35.06 | 35.603 | -93.042 | 29 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1990 | 12 | 20 | 14 | 4 | 17.40 | 39.590 | -86.630 | 5 | | 3.66 | 0.41 | 3.85 |
| ANSS | 1991 | 1 | 23 | 9 | 25 | 23.20 | 37.940 | -88.873 | 1 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1991 | 1 | 24 | 5 | 0 | 26.90 | 36.378 | -97.300 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1991 | 1 | 28 | 11 | 43 | 55.70 | 37.349 | -87.324 | 1 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1991 | 2 | 6 | 10 | 3 | 2.72 | 28.428 | -106.332 | 5 | | 3.90 | 0.1 | 3.91 |
| ANSS | 1991 | 2 | 11 | 0 | 0 | 12.70 | 35.950 | -89.930 | 14 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1991 | 2 | 11 | 15 | 36 | 44.30 | 34.108 | -90.599 | 12 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 3 | 23 | 10 | 5 | 54.70 | 36.074 | -89.805 | 13 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 4 | 16 | 4 | 6 | 37.80 | 38.593 | -88.007 | 7 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 5 | 4 | 1 | 18 | 54.60 | 36.575 | -89.825 | 11 | | 4.31 | 0.41 | 4.50 |
| ANSS | 1991 | 5 | 10 | 12 | 15 | 54.33 | 37.459 | -106.578 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1991 | 5 | 30 | 22 | 7 | 44.00 | 39.200 | -99.400 | 5 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1991 | 6 | 1 | 22 | 1 | 41.30 | 36.521 | -89.616 | 2 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 6 | 5 | 18 | 44 | 14.90 | 34.447 | -106.849 | 4 | | 2.97 | 0.3 | 3.08 |
| ISC | 1991 | 6 | 20 | 16 | 5 | 0.00 | 33.619 | -106.475 | 0 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1991 | 7 | 7 | 21 | 24 | 3.60 | 36.685 | -91.567 | 8 | | 3.82 | 0.41 | 4.02 |
| ANSS | 1991 | 7 | 22 | 3 | 31 | 0.30 | 36.468 | -89.546 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 9 | 24 | 7 | 21 | 7.00 | 35.701 | -84.117 | 13 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1991 | 10 | 3 | 11 | 46 | 4.90 | 36.856 | -89.449 | 2 | | 2.85 | 0.41 | 3.04 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1991 | 10 | 30 | 14 | 54 | 12.60 | 34.904 | -84.713 | 8 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1991 | 11 | 11 | 9 | 20 | 44.00 | 38.905 | -87.710 | 0 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1991 | 11 | 13 | 9 | 43 | 15.70 | 35.728 | -90.292 | 13 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1991 | 11 | 16 | 3 | 39 | 2.01 | 25.895 | -100.581 | 5 | | 3.60 | 0.1 | 3.61 |
| ANSS | 1991 | 12 | 9 | 12 | 47 | 16.50 | 34.850 | -106.553 | 14 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1991 | 12 | 13 | 11 | 41 | 46.50 | 35.856 | -90.085 | 14 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1992 | 1 | 2 | 11 | 45 | 35.61 | 32.336 | -103.101 | 5 | | 5.00 | 0.1 | 5.01 |
| ANSS | 1992 | 1 | 21 | 11 | 36 | 21.00 | 38.000 | -92.670 | 5 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1992 | 2 | 23 | 16 | 17 | 52.51 | 30.646 | -105.507 | 5 | | 3.40 | 0.1 | 3.41 |
| ISC | 1992 | 3 | 31 | 14 | 59 | 43.60 | 26.311 | -85.895 | 5 | . | 3.80 | 0.1 | 3.81 |
| ANSS | 1992 | 4 | 3 | 3 | 6 | 4.20 | 35.832 | -89.499 | 8 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1992 | 4 | 15 | 22 | 46 | 5.08 | 37.335 | -104.773 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1992 | 4 | 30 | 0 | 1 | 30.51 | 36.932 | -90.439 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1992 | 5 | 2 | 10 | 19 | 29.81 | 37.378 | -104.778 | 5 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1992 | 7 | 15 | 2 | 56 | 40.75 | 38.760 | -99.549 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1992 | 7 | 30 | 14 | 40 | 55.87 | 24.705 | -99.779 | 10 | | 4.30 | 0.1 | 4.31 |
| ANSS | 1992 | 8 | 26 | 3 | 24 | 52.67 | 32.173 | -102.708 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1992 | 8 | 26 | 5 | 41 | 39.06 | 37.641 | -89.683 | 2 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1992 | 9 | 11 | 16 | 34 | 11.70 | 33.171 | -87.501 | 7 | | 2.97 | 0.3 | 3.08 |
| ISC | 1992 | 9 | 27 | 17 | 2 | 34.40 | 28.192 | -88.431 | 10 | . | 3.58 | 0.41 | 3.77 |
| ANSS | 1992 | 10 | 1 | 1 | 31 | 48.97 | 27.832 | -102.374 | 5 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1992 | 11 | 10 | 17 | 16 | 46.80 | 35.644 | -84.132 | 10 | | 2.97 | 0.3 | 3.08 |
| ANSS | 1992 | 12 | 17 | 7 | 18 | 4.27 | 34.744 | -97.581 | 5 | | 3.60 | 0.1 | 3.61 |
| ANSS | 1992 | 12 | 27 | 10 | 12 | 58.76 | 37.501 | -89.616 | 10 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1993 | 1 | 3 | 21 | 14 | 54.14 | 35.194 | -90.244 | 17 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1993 | 1 | 8 | 13 | 1 | 18.70 | 35.929 | -90.036 | 22 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1993 | 1 | 14 | 17 | 6 | 10.45 | 36.595 | -98.275 | 5 | | 3.10 | 0.1 | 3.11 |
| ANSS | 1993 | 1 | 15 | 2 | 2 | 50.90 | 35.039 | -85.025 | 8 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1993 | 1 | 21 | 19 | 46 | 20.07 | 36.229 | -89.597 | 6 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1993 | 1 | 29 | 13 | 56 | 24.17 | 39.033 | -89.030 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1993 | 2 | 6 | 2 | 9 | 45.63 | 36.664 | -89.733 | 8 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1993 | 2 | 24 | 12 | 41 | 21.80 | 36.167 | -89.473 | 13 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1993 | 2 | 28 | 21 | 48 | 1.33 | 26.063 | -101.930 | 5 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1993 | 3 | 2 | 0 | 29 | 11.86 | 36.673 | -89.494 | 9 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1993 | 3 | 16 | 7 | 38 | 10.27 | 35.605 | -90.478 | 12 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1993 | 3 | 24 | 2 | 32 | 3.50 | 35.391 | -104.195 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1993 | 3 | 29 | 15 | 37 | 21.13 | 36.555 | -89.586 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1993 | 3 | 31 | 20 | 23 | 21.30 | 36.799 | -89.423 | 4 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1993 | 4 | 28 | 22 | 40 | 1.96 | 36.196 | -89.442 | 7 | | 3.42 | 0.41 | 3.61 |
| ISC | 1993 | 6 | 10 | 15 | 10 | 0.00 | 33.619 | -106.475 | 0 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1993 | 6 | 16 | 1 | 47 | 12.62 | 37.651 | -89.756 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1993 | 7 | 8 | 4 | 3 | 52.25 | 39.227 | -106.715 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1993 | 7 | 16 | 10 | 54 | 32.86 | 31.747 | -88.341 | 5 | | 3.70 | 0.1 | 3.71 |
| ANSS | 1993 | 8 | 5 | 7 | 21 | 37.45 | 36.009 | -89.885 | 12 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1993 | 8 | 27 | 0 | 8 | 33.35 | 38.091 | -90.437 | 22 | | 3.33 | 0.41 | 3.53 |
| ANSS | 1993 | 9 | 24 | 18 | 27 | 15.04 | 36.564 | -89.582 | 7 | | 2.93 | 0.41 | 3.12 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1993 | 9 | 29 | 2 | 1 | 19.06 | 35.868 | -102.981 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1993 | 11 | 30 | 3 | 7 | 31.82 | 35.863 | -103.026 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1993 | 12 | 5 | 0 | 58 | 20.23 | 27.831 | -102.737 | 5 | | 4.70 | 0.1 | 4.71 |
| ANSS | 1993 | 12 | 22 | 19 | 25 | 11.39 | 33.331 | -105.682 | 10 | | 3.16 | 0.3 | 3.26 |
| ANSS | 1994 | 1 | 5 | 23 | 0 | 56.00 | 25.887 | -106.933 | 10 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1994 | 2 | 5 | 14 | 55 | 37.79 | 37.368 | -89.188 | 16 | | 4.07 | 0.41 | 4.26 |
| ANSS | 1994 | 2 | 28 | 18 | 29 | 49.07 | 37.833 | -89.374 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1994 | 3 | 21 | 17 | 34 | 18.16 | 36.860 | -89.172 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1994 | 4 | 5 | 22 | 22 | 0.40 | 34.969 | -85.491 | 24 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1994 | 4 | 6 | 17 | 38 | 56.17 | 38.156 | -89.214 | 15 | | 3.25 | 0.41 | 3.45 |
| ISC | 1994 | 4 | 16 | 7 | 20 | 20.00 | 34.660 | -97.710 | 5 | | 3.17 | 0.23 | 3.23 |
| ANSS | 1994 | 4 | 23 | 19 | 46 | 47.90 | 35.965 | -90.050 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1994 | 4 | 29 | 3 | 28 | 58.68 | 36.250 | -98.090 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1994 | 5 | 4 | 9 | 12 | 3.40 | 34.222 | -87.195 | 19 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1994 | 6 | 10 | 23 | 34 | 2.92 | 33.013 | -92.671 | 5 | | 3.20 | 0.1 | 3.21 |
| ISC | 1994 | 6 | 30 | 1 | 8 | 24.00 | 27.849 | -90.123 | 10 | . | 3.70 | 0.1 | 3.71 |
| ANSS | 1994 | 8 | 19 | 16 | 3 | 30.65 | 35.508 | -89.919 | 11 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1994 | 8 | 20 | 10 | 45 | 45.33 | 36.140 | -91.063 | 10 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1994 | 9 | 26 | 14 | 23 | 22.84 | 36.960 | -88.920 | 13 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1994 | 11 | 6 | 12 | 50 | 38.95 | 35.949 | -89.060 | 11 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1994 | 11 | 20 | 23 | 31 | 48.98 | 36.437 | -89.514 | 6 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1994 | 12 | 25 | 19 | 6 | 7.52 | 39.290 | -104.811 | 10 | | 4.00 | 0.1 | 4.01 |
| FDNC | 1995 | 1 | 4 | 1 | 46 | 14.10 | 29.450 | -96.950 | 5 | 4 | 2.70 | 0.1 | 2.71 |
| ANSS | 1995 | 1 | 18 | 15 | 51 | 39.42 | 34.774 | -97.596 | 5 | | 4.20 | 0.1 | 4.21 |
| ANSS | 1995 | 1 | 31 | 11 | 33 | 52.17 | 27.739 | -105.114 | 10 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1995 | 2 | 19 | 12 | 57 | 6.00 | 39.120 | -83.470 | 10 | | 3.52 | 0.3 | 3.62 |
| ANSS | 1995 | 3 | 11 | 8 | 15 | 52.32 | 36.959 | -83.133 | 1 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1995 | 3 | 11 | 9 | 50 | 4.44 | 36.990 | -83.180 | 1 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1995 | 3 | 18 | 22 | 6 | 20.80 | 35.422 | -84.941 | 26 | | 3.25 | 0.3 | 3.35 |
| ANSS | 1995 | 3 | 19 | 18 | 36 | 43.97 | 35.000 | -104.212 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1995 | 4 | 5 | 5 | 31 | 16.23 | 35.200 | -99.028 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1995 | 4 | 14 | 0 | 32 | 56.17 | 30.285 | -103.347 | 18 | | 5.60 | 0.1 | 5.61 |
| ANSS | 1995 | 4 | 14 | 2 | 19 | 38.50 | 30.300 | -103.350 | 10 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1995 | 4 | 15 | 14 | 33 | 29.51 | 30.271 | -103.324 | 10 | | 4.00 | 0.1 | 4.01 |
| ANSS | 1995 | 4 | 27 | 0 | 42 | 35.00 | 36.690 | -89.480 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 5 | 27 | 19 | 51 | 8.00 | 36.180 | -89.390 | 10 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1995 | 5 | 28 | 15 | 28 | 36.95 | 33.191 | -87.827 | 1 | | 3.40 | 0.1 | 3.41 |
| ANSS | 1995 | 5 | 31 | 19 | 57 | 36.23 | 24.948 | -103.869 | 10 | | 3.80 | 0.1 | 3.81 |
| ANSS | 1995 | 6 | 1 | 1 | 6 | 15.70 | 30.300 | -103.350 | 10 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1995 | 6 | 1 | 4 | 49 | 29.32 | 34.287 | -96.732 | 5 | | 3.00 | 0.1 | 3.01 |
| ANSS | 1995 | 6 | 6 | 21 | 27 | 8.00 | 36.180 | -89.370 | 8 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1995 | 6 | 29 | 9 | 27 | 19.00 | 36.630 | -89.780 | 12 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1995 | 6 | 29 | 20 | 7 | 48.00 | 36.580 | -89.770 | 10 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 7 | 4 | 3 | 59 | 4.53 | 36.246 | -104.814 | 5 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1995 | 7 | 5 | 14 | 16 | 44.70 | 35.334 | -84.163 | 10 | | 3.66 | 0.41 | 3.85 |
| ANSS | 1995 | 7 | 9 | 12 | 42 | 56.00 | 35.880 | -91.400 | 5 | | 2.93 | 0.41 | 3.12 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1995 | 7 | 15 | 1 | 3 | 28.35 | 33.478 | -87.665 | 1 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1995 | 7 | 20 | 2 | 10 | 34.00 | 36.540 | -89.620 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1995 | 7 | 31 | 0 | 47 | 48.00 | 37.690 | -90.810 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 8 | 17 | 23 | 18 | 52.00 | 36.110 | -89.370 | 18 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1995 | 8 | 28 | 15 | 13 | 39.05 | 34.205 | -106.942 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 9 | 5 | 23 | 1 | 21.00 | 38.360 | -89.040 | 4 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1995 | 9 | 15 | 0 | 31 | 33.26 | 36.870 | -98.690 | 5 | | 3.98 | 0.41 | 4.18 |
| ANSS | 1995 | 10 | 2 | 18 | 0 | 54.00 | 35.340 | -90.120 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1995 | 10 | 26 | 0 | 37 | 28.96 | 37.053 | -83.121 | 1 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1995 | 11 | 12 | 17 | 45 | 59.40 | 30.300 | -103.350 | 10 | | 3.58 | 0.41 | 3.77 |
| ANSS | 1995 | 11 | 24 | 1 | 52 | 35.00 | 36.600 | -89.820 | 18 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 12 | 1 | 14 | 37 | 40.44 | 35.061 | -99.337 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1995 | 12 | 15 | 10 | 16 | 39.90 | 36.193 | -83.694 | 10 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1995 | 12 | 23 | 6 | 51 | 48.88 | 38.732 | -104.917 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 1995 | 12 | 31 | 0 | 37 | 38.19 | 38.716 | -104.910 | 5 | | 2.93 | 0.41 | 3.12 |
| ISC | 1996 | 3 | 15 | 12 | 3 | 35.50 | 33.230 | -104.740 | 0 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1996 | 3 | 15 | 13 | 17 | 57.22 | 33.586 | -105.694 | 10 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1996 | 3 | 24 | 20 | 16 | 12.70 | 34.255 | -105.681 | 10 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1996 | 3 | 24 | 20 | 19 | 23.10 | 34.270 | -105.689 | 10 | | 3.66 | 0.41 | 3.85 |
| ANSS | 1996 | 3 | 25 | 6 | 43 | 46.86 | 35.610 | -102.601 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1996 | 3 | 25 | 14 | 15 | 50.55 | 32.131 | -88.671 | 5 | | 3.50 | 0.41 | 3.69 |
| ISC | 1996 | 3 | 31 | 18 | 39 | 42.60 | 37.077 | -83.899 | 0 | | 3.50 | 0.1 | 3.51 |
| ANSS | 1996 | 4 | 4 | 23 | 55 | 5.00 | 35.520 | -90.540 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1996 | 4 | 11 | 21 | 54 | 56.00 | 34.900 | -91.310 | 6 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1996 | 4 | 19 | 8 | 50 | 14.01 | 36.981 | -83.018 | 0 | | 3.90 | 0.1 | 3.91 |
| ISC | 1996 | 5 | 13 | 20 | 18 | 59.30 | 36.776 | -83.004 | 13 | | 3.40 | 0.1 | 3.41 |
| ANSS | 1996 | 7 | 5 | 21 | 37 | 9.60 | 35.200 | -84.000 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1996 | 7 | 16 | 0 | 35 | 6.00 | 35.760 | -90.200 | 7 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1996 | 7 | 22 | 10 | 6 | 14.98 | 34.204 | -105.711 | 10 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1996 | 8 | 1 | 5 | 44 | 22.75 | 37.398 | -104.247 | 5 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1996 | 8 | 1 | 5 | 55 | 54.16 | 37.378 | -104.196 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1996 | 8 | 11 | 18 | 17 | 49.88 | 33.577 | -90.874 | 10 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1996 | 10 | 13 | 18 | 57 | 46.00 | 38.410 | -89.380 | 23 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1996 | 11 | 1 | 3 | 9 | 28.35 | 37.349 | -104.232 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1996 | 11 | 5 | 19 | 48 | 19.00 | 37.330 | -90.220 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1996 | 11 | 23 | 10 | 54 | 18.50 | 35.040 | -100.504 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1996 | 11 | 29 | 5 | 41 | 34.00 | 35.930 | -89.930 | 20 | | 4.15 | 0.41 | 4.34 |
| ANSS | 1996 | 11 | 29 | 10 | 47 | 10.00 | 36.240 | -89.450 | 4 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1996 | 12 | 15 | 7 | 19 | 57.00 | 36.030 | -89.830 | 8 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1996 | 12 | 16 | 1 | 58 | 31.35 | 39.500 | -87.400 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1997 | 1 | 9 | 3 | 7 | 25.99 | 33.200 | -92.600 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1997 | 1 | 18 | 22 | 4 | 39.00 | 39.100 | -105.100 | 5 | | 3.30 | 0.1 | 3.31 |
| ANSS | 1997 | 1 | 19 | 4 | 36 | 15.00 | 39.100 | -105.100 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1997 | 2 | 12 | 23 | 53 | 10.77 | 34.947 | -100.890 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1997 | 2 | 15 | 9 | 8 | 55.46 | 34.973 | -100.569 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1997 | 3 | 16 | 19 | 7 | 28.00 | 34.270 | -93.490 | 5 | | 3.42 | 0.41 | 3.61 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ISC | 1997 | 4 | 18 | 14 | 57 | 46.30 | 26.922 | -87.284 | 33 | . | 3.80 | 0.1 | 3.81 |
| ANSS | 1997 | 5 | 4 | 3 | 39 | 12.99 | 31.000 | -87.400 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1997 | 5 | 19 | 19 | 45 | 35.80 | 34.622 | -85.353 | 3 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1997 | 5 | 20 | 9 | 41 | 5.82 | 34.188 | -105.742 | 10 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1997 | 5 | 31 | 3 | 26 | 41.34 | 33.182 | -95.966 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1997 | 7 | 19 | 17 | 6 | 34.40 | 34.953 | -84.811 | 3 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1997 | 7 | 30 | 12 | 29 | 25.30 | 36.512 | -83.547 | 23 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1997 | 9 | 6 | 23 | 38 | 0.91 | 34.660 | -96.435 | 5 | | 4.31 | 0.41 | 4.50 |
| ANSS | 1997 | 9 | 13 | 19 | 50 | 32.00 | 38.290 | -89.710 | 16 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1997 | 9 | 17 | 18 | 16 | 32.00 | 35.670 | -90.490 | 7 | | 3.74 | 0.41 | 3.93 |
| ANSS | 1997 | 9 | 24 | 4 | 20 | 26.00 | 36.580 | -89.890 | 12 | | 2.93 | 0.41 | 3.12 |
| ANSS | 1997 | 9 | 27 | 12 | 14 | 10.00 | 36.200 | -89.420 | 9 | | 3.01 | 0.41 | 3.20 |
| ISC | 1997 | 10 | 19 | 11 | 12 | 12.10 | 32.332 | -103.395 | 0 | | 3.58 | 0.1 | 3.59 |
| EHB98 | 1997 | 10 | 24 | 8 | 35 | 18.83 | 31.126 | -87.283 | 3 | . | 4.80 | 0.1 | 4.81 |
| ISC | 1997 | 12 | 6 | 11 | 11 | 23.60 | 34.895 | -95.968 | 5 | | 3.01 | 0.1 | 3.02 |
| ANSS | 1997 | 12 | 11 | 11 | 34 | 57.00 | 37.101 | -98.480 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1997 | 12 | 12 | 8 | 42 | 20.25 | 33.466 | -87.306 | 1 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1997 | 12 | 31 | 13 | 28 | 30.05 | 34.533 | -106.154 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1997 | 12 | 31 | 13 | 32 | 6.60 | 34.550 | -106.150 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1997 | 12 | 31 | 13 | 33 | 58.90 | 34.550 | -106.150 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1998 | 1 | 2 | 15 | 47 | 16.43 | 37.828 | -103.408 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 1998 | 1 | 4 | 8 | 5 | 31.87 | 34.553 | -106.191 | 5 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1998 | 1 | 28 | 22 | 5 | 12.00 | 36.100 | -89.770 | 8 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1998 | 2 | 12 | 9 | 37 | 49.00 | 36.140 | -89.710 | 9 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1998 | 2 | 19 | 14 | 5 | 27.00 | 36.530 | -89.580 | 8 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1998 | 4 | 8 | 18 | 16 | 49.00 | 36.940 | -89.010 | 8 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1998 | 4 | 9 | 5 | 13 | 41.00 | 36.400 | -89.500 | 7 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1998 | 4 | 15 | 10 | 33 | 42.42 | 30.188 | -103.303 | 10 | | 3.58 | 0.41 | 3.77 |
| ANSS | 1998 | 4 | 18 | 22 | 45 | 43.10 | 39.100 | -105.100 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1998 | 4 | 27 | 15 | 22 | 46.25 | 35.453 | -102.383 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1998 | 4 | 28 | 14 | 13 | 1.68 | 34.782 | -98.416 | 5 | | 4.07 | 0.41 | 4.26 |
| ANSS | 1998 | 5 | 7 | 12 | 24 | 41.40 | 32.370 | -88.110 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 1998 | 6 | 17 | 8 | 0 | 23.90 | 35.944 | -84.392 | 11 | | 3.58 | 0.41 | 3.77 |
| ISC | 1998 | 6 | 18 | 17 | 21 | 5.90 | 25.183 | -106.684 | 0 | | 4.50 | 0.1 | 4.51 |
| ANSS | 1998 | 6 | 24 | 15 | 20 | 1.39 | 32.502 | -87.954 | 5 | | 3.42 | 0.41 | 3.61 |
| ISC | 1998 | 7 | 6 | 6 | 54 | 4.10 | 25.035 | -93.626 | 10 | . | 3.40 | 0.1 | 3.41 |
| ANSS | 1998 | 7 | 7 | 18 | 44 | 44.46 | 34.719 | -97.589 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 1998 | 7 | 14 | 5 | 38 | 48.75 | 35.344 | -103.473 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1998 | 7 | 15 | 4 | 24 | 51.00 | 36.690 | -89.520 | 14 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1998 | 7 | 22 | 22 | 11 | 57.00 | 37.670 | -90.020 | 5 | | 2.85 | 0.41 | 3.04 |
| ISC | 1998 | 8 | 14 | 17 | 5 | 11.80 | 27.744 | -99.864 | 0 | | 3.90 | 0.1 | 3.91 |
| ANSS | 1998 | 10 | 15 | 9 | 47 | 22.00 | 35.630 | -90.430 | 4 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1998 | 10 | 30 | 17 | 41 | 22.20 | 36.800 | -97.600 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 1999 | 1 | 7 | 5 | 16 | 26.96 | 38.674 | -99.378 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1999 | 1 | 17 | 18 | 38 | 5.10 | 36.893 | -83.799 | 1 | | 3.06 | 0.3 | 3.17 |
| ANSS | 1999 | 1 | 18 | 7 | 0 | 53.47 | 33.405 | -87.255 | 1 | | 4.80 | 0.1 | 4.81 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 1999 | 2 | 25 | 2 | 11 | 31.00 | 34.180 | -89.810 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1999 | 3 | 1 | 8 | 0 | 23.50 | 32.573 | -104.656 | 1 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1999 | 3 | 14 | 22 | 43 | 17.97 | 32.591 | -104.630 | 1 | | 3.90 | 0.41 | 4.10 |
| ANSS | 1999 | 3 | 17 | 12 | 29 | 23.11 | 32.582 | -104.672 | 1 | | 3.43 | 0.3 | 3.53 |
| ANSS | 1999 | 5 | 13 | 14 | 18 | 22.75 | 39.100 | -94.700 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1999 | 5 | 30 | 19 | 4 | 25.60 | 32.575 | -104.664 | 10 | | 3.82 | 0.41 | 4.02 |
| ANSS | 1999 | 8 | 23 | 12 | 12 | 41.00 | 36.260 | -89.500 | 9 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1999 | 10 | 21 | 8 | 17 | 59.00 | 36.540 | -91.100 | 11 | | 3.82 | 0.41 | 4.02 |
| ANSS | 1999 | 10 | 21 | 8 | 49 | 49.00 | 36.500 | -90.990 | 9 | | 3.17 | 0.41 | 3.37 |
| ANSS | 1999 | 10 | 25 | 23 | 19 | 58.37 | 36.846 | -99.659 | 26 | | 3.09 | 0.41 | 3.28 |
| ANSS | 1999 | 11 | 26 | 6 | 54 | 59.00 | 36.480 | -92.400 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 1999 | 11 | 28 | 11 | 0 | 9.30 | 33.416 | -87.253 | 1 | | 3.74 | 0.41 | 3.93 |
| ISC | 2000 | 1 | 14 | 10 | 39 | 34.90 | 34.674 | -95.095 | 18 | | 3.09 | 0.23 | 3.15 |
| ANSS | 2000 | 1 | 18 | 22 | 19 | 32.20 | 32.920 | -83.465 | 19 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2000 | 2 | 2 | 7 | 14 | 20.26 | 32.582 | -104.629 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2000 | 2 | 4 | 1 | 36 | 26.88 | 39.092 | -99.417 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2000 | 2 | 26 | 3 | 1 | 0.83 | 30.243 | -103.612 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2000 | 3 | 6 | 15 | 2 | 28.00 | 38.100 | -87.570 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2000 | 4 | 14 | 3 | 54 | 20.00 | 39.760 | -86.750 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2000 | 4 | 28 | 23 | 36 | 26.00 | 37.690 | -88.460 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2000 | 5 | 28 | 11 | 32 | 7.02 | 33.809 | -87.820 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2000 | 6 | 15 | 23 | 17 | 14.63 | 25.450 | -100.999 | 33 | | 4.60 | 0.1 | 4.61 |
| ANSS | 2000 | 6 | 27 | 1 | 28 | 45.00 | 35.800 | -92.750 | 0 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2000 | 6 | 27 | 6 | 2 | 57.00 | 37.130 | -88.870 | 4 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2000 | 8 | 2 | 12 | 21 | 30.06 | 35.200 | -101.900 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2000 | 8 | 7 | 17 | 19 | 8.00 | 35.392 | -101.812 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2000 | 8 | 7 | 18 | 34 | 9.00 | 35.392 | -101.812 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2000 | 8 | 7 | 21 | 36 | 21.00 | 35.392 | -101.812 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2000 | 8 | 10 | 13 | 39 | 50.00 | 35.392 | -101.812 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2000 | 8 | 17 | 1 | 8 | 5.45 | 35.390 | -101.814 | 5 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2000 | 8 | 22 | 20 | 12 | 15.00 | 36.490 | -91.110 | 11 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2000 | 9 | 20 | 6 | 24 | 59.00 | 24.622 | -99.933 | 33 | | 4.20 | 0.1 | 4.21 |
| ANSS | 2000 | 12 | 7 | 14 | 8 | 50.00 | 38.010 | -87.680 | 5 | | 3.82 | 0.41 | 4.02 |
| ISC | 2000 | 12 | 9 | 6 | 46 | 9.20 | 28.017 | -90.134 | 10 | . | 3.90 | 0.1 | 3.91 |
| ANSS | 2000 | 12 | 16 | 22 | 8 | 54.00 | 35.400 | -101.800 | 5 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2001 | 3 | 3 | 10 | 46 | 13.00 | 33.190 | -92.660 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2001 | 3 | 7 | 17 | 12 | 23.80 | 35.552 | -84.850 | 7 | | 3.25 | 0.41 | 3.45 |
| ISC | 2001 | 3 | 16 | 4 | 39 | 9.30 | 28.545 | -88.946 | 10 | . | 3.70 | 0.1 | 3.71 |
| ANSS | 2001 | 3 | 21 | 23 | 35 | 34.90 | 34.847 | -85.438 | 0 | | 3.16 | 0.3 | 3.26 |
| ANSS | 2001 | 3 | 30 | 17 | 13 | 55.60 | 37.933 | -93.327 | 5 | | 3.17 | 0.41 | 3.37 |
| ISC | 2001 | 4 | 4 | 10 | 27 | 19.80 | 24.145 | -106.838 | 137 | | 3.20 | 0.1 | 3.21 |
| ANSS | 2001 | 4 | 13 | 16 | 36 | 20.70 | 36.526 | -83.342 | 0 | | 2.97 | 0.3 | 3.08 |
| ANSS | 2001 | 5 | 4 | 6 | 42 | 12.00 | 35.240 | -92.250 | 10 | | 4.23 | 0.41 | 4.42 |
| ANSS | 2001 | 5 | 4 | 8 | 31 | 43.00 | 35.250 | -92.230 | 0 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2001 | 5 | 5 | 7 | 38 | 44.00 | 35.210 | -92.230 | 7 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2001 | 6 | 2 | 1 | 55 | 53.72 | 32.334 | -103.141 | 5 | | 3.33 | 0.41 | 3.53 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 2001 | 7 | 7 | 20 | 45 | 43.00 | 36.270 | -89.400 | 14 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2001 | 7 | 14 | 22 | 40 | 28.00 | 36.260 | -89.420 | 7 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2001 | 7 | 22 | 19 | 22 | 45.57 | 39.022 | -105.129 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2001 | 7 | 24 | 14 | 2 | 35.00 | 37.700 | -97.000 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2001 | 7 | 26 | 5 | 26 | 46.00 | 35.971 | -83.552 | 14 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2001 | 8 | 4 | 1 | 13 | 28.00 | 34.420 | -93.230 | 0 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2001 | 8 | 28 | 14 | 16 | 9.52 | 37.088 | -104.692 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2001 | 8 | 28 | 14 | 22 | 0.33 | 37.091 | -104.655 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2001 | 9 | 4 | 12 | 22 | 44.97 | 37.107 | -104.622 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2001 | 9 | 4 | 12 | 45 | 53.22 | 37.143 | -104.650 | 5 | | 3.90 | 0.41 | 4.10 |
| ANSS | 2001 | 9 | 5 | 10 | 52 | 7.89 | 37.143 | -104.618 | 5 | | 4.31 | 0.41 | 4.50 |
| ANSS | 2001 | 9 | 5 | 14 | 48 | 58.26 | 37.112 | -104.611 | 5 | | 3.66 | 0.41 | 3.85 |
| ANSS | 2001 | 9 | 6 | 9 | 41 | 43.59 | 37.110 | -104.628 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2001 | 9 | 6 | 11 | 28 | 26.49 | 37.140 | -104.585 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2001 | 9 | 10 | 18 | 56 | 0.37 | 37.108 | -104.602 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2001 | 9 | 13 | 11 | 22 | 16.48 | 37.108 | -104.703 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2001 | 9 | 13 | 16 | 39 | 5.44 | 37.091 | -104.593 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2001 | 9 | 21 | 19 | 10 | 59.67 | 37.121 | -104.706 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2001 | 11 | 13 | 1 | 56 | 13.13 | 39.996 | -100.208 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2001 | 11 | 22 | 0 | 7 | 8.02 | 31.786 | -102.631 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2001 | 12 | 8 | 1 | 8 | 22.40 | 34.710 | -86.231 | 0 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2001 | 12 | 15 | 7 | 58 | 31.36 | 36.859 | -104.797 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2001 | 12 | 17 | 1 | 54 | 44.76 | 33.200 | -92.700 | 10 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 1 | 26 | 1 | 6 | 3.86 | 36.860 | -104.784 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2002 | 2 | 7 | 5 | 19 | 55.41 | 36.857 | -104.744 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 2 | 8 | 16 | 7 | 13.60 | 34.727 | -98.361 | 5 | | 3.74 | 0.41 | 3.93 |
| ANSS | 2002 | 2 | 17 | 23 | 1 | 41.00 | 36.540 | -89.640 | 8 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2002 | 3 | 12 | 8 | 30 | 47.00 | 37.250 | -89.960 | 10 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2002 | 3 | 31 | 2 | 54 | 8.13 | 35.359 | -101.824 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 4 | 14 | 3 | 35 | 2.13 | 39.939 | -100.320 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 4 | 20 | 20 | 0 | 0.00 | 36.130 | -89.390 | 7 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 4 | 27 | 2 | 33 | 43.00 | 35.960 | -89.960 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2002 | 5 | 21 | 20 | 35 | 34.43 | 32.797 | -88.102 | 5 | | 3.17 | 0.41 | 3.37 |
| ISC | 2002 | 5 | 27 | 0 | 28 | 22.00 | 27.664 | -94.530 | 10 | . | 3.90 | 0.1 | 3.91 |
| ANSS | 2002 | 5 | 31 | 9 | 57 | 10.02 | 34.025 | -97.619 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2002 | 6 | 18 | 9 | 12 | 36.66 | 36.881 | -104.779 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2002 | 6 | 18 | 17 | 37 | 15.17 | 37.987 | -87.780 | 5 | | 5.01 | 0.1 | 5.02 |
| ANSS | 2002 | 6 | 19 | 12 | 14 | 20.30 | 36.568 | -103.028 | 5 | | 3.66 | 0.41 | 3.85 |
| ANSS | 2002 | 7 | 29 | 11 | 28 | 7.00 | 35.920 | -90.030 | 8 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 8 | 11 | 23 | 19 | 47.00 | 34.340 | -90.180 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 9 | 8 | 9 | 3 | 24.00 | 35.670 | -89.640 | 6 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2002 | 9 | 17 | 15 | 45 | 14.47 | 32.581 | -104.630 | 10 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2002 | 9 | 17 | 23 | 34 | 19.35 | 32.576 | -104.631 | 10 | | 3.33 | 0.41 | 3.53 |
| ISC | 2002 | 9 | 19 | 14 | 44 | 36.20 | 27.820 | -89.131 | 10 | . | 3.80 | 0.1 | 3.81 |
| ANSS | 2002 | 10 | 13 | 22 | 18 | 54.59 | 39.203 | -106.654 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 10 | 20 | 2 | 18 | 13.00 | 34.274 | -96.079 | 5 | | 3.42 | 0.41 | 3.61 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 2002 | 10 | 26 | 14 | 8 | 39.00 | 36.470 | -89.550 | 8 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2002 | 10 | 26 | 20 | 5 | 55.00 | 33.950 | -90.720 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2002 | 11 | 1 | 11 | 8 | 56.28 | 39.119 | -99.089 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2002 | 11 | 1 | 14 | 19 | 56.16 | 39.077 | -99.101 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2002 | 11 | 14 | 4 | 56 | 52.26 | 36.917 | -104.768 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2002 | 12 | 11 | 14 | 25 | 23.54 | 39.360 | -99.403 | 5 | | 2.93 | 0.41 | 3.12 |
| ISC | 2002 | 12 | 31 | 19 | 2 | 29.10 | 37.034 | -104.620 | 0 | | 4.66 | 0.1 | 4.67 |
| ANSS | 2003 | 1 | 1 | 7 | 43 | 37.91 | 39.155 | -106.759 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2003 | 1 | 3 | 16 | 17 | 7.00 | 37.830 | -88.090 | 5 | | 3.01 | 0.41 | 3.20 |
| ISC | 2003 | 1 | 4 | 23 | 25 | 5.90 | 24.344 | -100.159 | 10 | | 3.30 | 0.1 | 3.31 |
| ANSS | 2003 | 1 | 10 | 10 | 29 | 22.46 | 38.256 | -102.622 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2003 | 4 | 1 | 13 | 9 | 49.61 | 39.244 | -99.487 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2003 | 4 | 7 | 10 | 2 | 12.51 | 33.892 | -97.695 | 5 | | 3.01 | 0.41 | 3.20 |
| ISC | 2003 | 4 | 13 | 4 | 52 | 53.90 | 26.096 | -86.080 | 10 | . | 3.50 | 0.1 | 3.51 |
| ANSS | 2003 | 4 | 17 | 17 | 31 | 59.07 | 39.255 | -99.482 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2003 | 4 | 28 | 7 | 32 | 26.04 | 36.844 | -104.923 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2003 | 4 | 29 | 8 | 59 | 38.10 | 34.445 | -85.620 | 9 | | 4.39 | 0.41 | 4.58 |
| ANSS | 2003 | 4 | 29 | 9 | 45 | 45.00 | 34.440 | -85.640 | 3 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2003 | 4 | 30 | 4 | 56 | 22.00 | 35.920 | -89.920 | 24 | | 3.90 | 0.41 | 4.10 |
| ANSS | 2003 | 5 | 2 | 3 | 25 | 3.00 | 36.730 | -89.680 | 2 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2003 | 5 | 2 | 8 | 10 | 13.00 | 37.960 | -88.650 | 1 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2003 | 5 | 2 | 10 | 48 | 44.00 | 34.490 | -85.610 | 15 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2003 | 5 | 30 | 2 | 18 | 24.00 | 36.130 | -89.390 | 6 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2003 | 6 | 3 | 18 | 9 | 27.84 | 36.994 | -104.768 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2003 | 6 | 6 | 12 | 29 | 34.00 | 36.870 | -88.980 | 3 | | 3.90 | 0.41 | 4.10 |
| ANSS | 2003 | 6 | 10 | 7 | 46 | 31.00 | 36.020 | -91.390 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2003 | 6 | 15 | 0 | 22 | 17.97 | 36.910 | -104.763 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2003 | 6 | 21 | 2 | 3 | 9.56 | 32.665 | -104.505 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2003 | 7 | 8 | 5 | 55 | 5.00 | 38.150 | -91.500 | 3 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2003 | 7 | 29 | 21 | 52 | 46.86 | 24.595 | -105.120 | 10 | | 4.33 | 0.3 | 4.44 |
| ANSS | 2003 | 7 | 30 | 2 | 50 | 19.00 | 36.520 | -89.530 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2003 | 8 | 14 | 0 | 11 | 8.96 | 36.945 | -104.870 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2003 | 8 | 26 | 2 | 26 | 58.00 | 37.100 | -88.680 | 2 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2003 | 9 | 8 | 11 | 2 | 49.31 | 37.369 | -104.685 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2003 | 9 | 13 | 15 | 22 | 40.99 | 36.831 | -104.907 | 5 | | 3.74 | 0.41 | 3.93 |
| ANSS | 2003 | 9 | 16 | 2 | 22 | 45.00 | 36.100 | -89.760 | 7 | | 2.85 | 0.41 | 3.04 |
| ISC | 2003 | 9 | 19 | 18 | 14 | 25.40 | 36.982 | -104.751 | 0 | | 4.50 | 0.1 | 4.51 |
| ANSS | 2003 | 9 | 24 | 15 | 2 | 9.09 | 35.277 | -101.742 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2003 | 9 | 30 | 2 | 28 | 3.38 | 31.115 | -87.520 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2003 | 10 | 25 | 12 | 55 | 55.58 | 37.031 | -104.836 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2003 | 11 | 24 | 7 | 5 | 57.72 | 36.958 | -104.828 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2003 | 12 | 14 | 10 | 16 | 41.00 | 35.200 | -92.250 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2003 | 12 | 15 | 5 | 57 | 18.00 | 35.200 | -92.240 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2003 | 12 | 21 | 5 | 20 | 6.00 | 36.290 | -89.500 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2003 | 12 | 28 | 2 | 55 | 2.32 | 37.596 | -105.280 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2003 | 12 | 28 | 3 | 57 | 3.21 | 37.584 | -105.298 | 5 | | 3.17 | 0.41 | 3.37 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 2003 | 12 | 29 | 9 | 2 | 8.00 | 38.130 | -90.170 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2003 | 12 | 31 | 15 | 8 | 5.68 | 33.668 | -91.695 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2004 | 1 | 14 | 1 | 14 | 15.47 | 37.018 | -104.842 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 2 | 3 | 14 | 34 | 22.57 | 36.932 | -104.861 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2004 | 2 | 8 | 5 | 56 | 45.00 | 39.490 | -91.880 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 2 | 9 | 18 | 21 | 49.00 | 36.350 | -90.750 | 13 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 3 | 20 | 10 | 40 | 35.47 | 33.232 | -87.008 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2004 | 3 | 22 | 12 | 9 | 56.46 | 36.855 | -104.851 | 5 | | 4.40 | 0.1 | 4.41 |
| ANSS | 2004 | 3 | 30 | 1 | 2 | 55.40 | 36.892 | -104.876 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2004 | 3 | 30 | 2 | 23 | 37.86 | 36.876 | -104.831 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2004 | 3 | 30 | 2 | 41 | 4.15 | 37.036 | -104.931 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2004 | 4 | 6 | 19 | 1 | 2.70 | 25.172 | -99.532 | 38 | | 4.33 | 0.3 | 4.44 |
| ANSS | 2004 | 4 | 22 | 16 | 13 | 2.25 | 34.804 | -97.677 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 5 | 3 | 19 | 25 | 48.00 | 36.280 | -89.450 | 3 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2004 | 5 | 9 | 8 | 56 | 10.43 | 33.231 | -86.960 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2004 | 5 | 23 | 9 | 22 | 5.28 | 32.525 | -104.566 | 5 | | 4.00 | 0.1 | 4.01 |
| ANSS | 2004 | 5 | 24 | 21 | 36 | 28.56 | 34.465 | -106.899 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2004 | 5 | 31 | 3 | 27 | 43.77 | 36.935 | -104.835 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2004 | 6 | 8 | 0 | 15 | 9.99 | 34.233 | -97.254 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2004 | 6 | 10 | 12 | 30 | 9.86 | 34.236 | -97.267 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 6 | 15 | 8 | 34 | 21.00 | 36.730 | -89.680 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2004 | 6 | 16 | 4 | 7 | 21.00 | 36.730 | -89.690 | 4 | | 2.93 | 0.41 | 3.12 |
| ISC | 2004 | 6 | 18 | 19 | 20 | 56.40 | 27.027 | -86.997 | 10 | | 3.50 | 0.1 | 3.51 |
| ANSS | 2004 | 6 | 22 | 8 | 55 | 28.23 | 32.528 | -104.584 | 5 | | 3.66 | 0.41 | 3.85 |
| ANSS | 2004 | 7 | 16 | 3 | 25 | 17.00 | 36.860 | -89.180 | 4 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2004 | 8 | 1 | 6 | 50 | 47.63 | 36.874 | -105.104 | 5 | | 4.66 | 0.1 | 4.67 |
| ANSS | 2004 | 8 | 19 | 23 | 51 | 49.42 | 33.203 | -86.968 | 5 | | 3.70 | 0.1 | 3.71 |
| ANSS | 2004 | 8 | 26 | 18 | 45 | 18.62 | 32.582 | -104.505 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2004 | 8 | 28 | 5 | 6 | 43.67 | 33.221 | -86.924 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2004 | 9 | 10 | 6 | 39 | 21.00 | 35.369 | -98.048 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2004 | 9 | 12 | 13 | 5 | 19.00 | 39.590 | -85.790 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2004 | 9 | 12 | 23 | 31 | 23.00 | 36.420 | -89.920 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2004 | 9 | 17 | 15 | 21 | 43.60 | 36.933 | -84.004 | 1 | | 3.66 | 0.41 | 3.85 |
| ANSS | 2004 | 10 | 28 | 2 | 59 | 4.82 | 32.604 | -104.499 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2004 | 11 | 7 | 11 | 20 | 21.43 | 32.649 | -87.933 | 5 | | 4.66 | 0.1 | 4.67 |
| ANSS | 2004 | 11 | 14 | 21 | 27 | 49.90 | 33.253 | -106.201 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2004 | 11 | 22 | 23 | 42 | 13.45 | 34.864 | -97.672 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2004 | 11 | 30 | 23 | 59 | 34.00 | 36.940 | -93.890 | 9 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2004 | 11 | 30 | 23 | 59 | 34.20 | 36.936 | -83.893 | 10 | | 2.97 | 0.3 | 3.08 |
| ANSS | 2004 | 12 | 23 | 6 | 54 | 20.70 | 35.429 | -84.204 | 8 | | 2.97 | 0.3 | 3.08 |
| ANSS | 2005 | 1 | 5 | 3 | 37 | 56.76 | 27.750 | -104.987 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2005 | 1 | 10 | 10 | 14 | 59.15 | 37.007 | -104.675 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2005 | 1 | 27 | 17 | 52 | 55.00 | 35.200 | -92.220 | 4 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2005 | 2 | 10 | 14 | 4 | 54.00 | 35.760 | -90.250 | 16 | | 3.98 | 0.41 | 4.18 |
| ANSS | 2005 | 3 | 18 | 1 | 2 | 16.00 | 35.720 | -84.160 | 9 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2005 | 3 | 22 | 8 | 11 | 50.51 | 31.836 | -88.060 | 5 | | 3.33 | 0.41 | 3.53 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 2005 | 4 | 3 | 14 | 39 | 16.97 | 28.393 | -100.305 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2005 | 4 | 5 | 20 | 37 | 43.00 | 36.150 | -83.690 | 10 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2005 | 4 | 6 | 8 | 45 | 24.57 | 36.881 | -104.794 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2005 | 4 | 14 | 15 | 38 | 16.00 | 35.470 | -84.090 | 15 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2005 | 4 | 22 | 5 | 17 | 4.09 | 34.179 | -95.192 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 4 | 24 | 11 | 2 | 35.90 | 36.920 | -105.070 | 5 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2005 | 5 | 1 | 12 | 37 | 32.00 | 35.830 | -90.150 | 10 | | 3.98 | 0.41 | 4.18 |
| ANSS | 2005 | 5 | 16 | 22 | 29 | 46.84 | 35.250 | -97.608 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2005 | 5 | 18 | 19 | 59 | 42.90 | 38.460 | -93.967 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2005 | 6 | 2 | 11 | 35 | 11.00 | 36.150 | -89.470 | 15 | | 3.82 | 0.41 | 4.02 |
| ANSS | 2005 | 6 | 7 | 16 | 33 | 36.71 | 33.531 | -87.304 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2005 | 6 | 20 | 2 | 0 | 32.00 | 36.930 | -88.990 | 10 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2005 | 6 | 20 | 12 | 21 | 42.00 | 36.920 | -89.000 | 19 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2005 | 6 | 27 | 15 | 46 | 52.00 | 37.630 | -89.420 | 10 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 7 | 4 | 10 | 45 | 24.50 | 36.860 | -105.097 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 7 | 8 | 6 | 24 | 1.12 | 36.938 | -104.886 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 7 | 13 | 12 | 8 | 13.00 | 35.810 | -90.160 | 11 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2005 | 7 | 31 | 7 | 7 | 7.97 | 38.718 | -92.725 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2005 | 8 | 10 | 22 | 8 | 16.96 | 36.952 | -104.822 | 5 | | 4.10 | 0.1 | 4.11 |
| ANSS | 2005 | 8 | 10 | 22 | 24 | 33.94 | 36.982 | -104.959 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 8 | 15 | 0 | 12 | 57.00 | 35.870 | -90.010 | 6 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2005 | 10 | 12 | 6 | 27 | 30.00 | 35.510 | -84.540 | 8 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2005 | 10 | 20 | 8 | 15 | 36.58 | 36.970 | -104.849 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2005 | 11 | 16 | 3 | 11 | 32.64 | 37.099 | -104.897 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2005 | 12 | 6 | 16 | 24 | 14.00 | 38.420 | -89.200 | 4 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2005 | 12 | 19 | 20 | 27 | 40.37 | 32.528 | -104.549 | 5 | | 4.41 | 0.1 | 4.42 |
| ANSS | 2005 | 12 | 20 | 0 | 52 | 20.51 | 30.258 | -90.708 | 5 | | 3.09 | 0.41 | 3.28 |
| ISC | 2005 | 12 | 22 | 14 | 30 | 12.40 | 32.599 | -104.390 | 0 | | 3.25 | 0.1 | 3.26 |
| ANSS | 2005 | 12 | 25 | 14 | 33 | 45.00 | 36.530 | -89.660 | 12 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2006 | 1 | 2 | 21 | 48 | 57.00 | 37.840 | -88.420 | 11 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2006 | 1 | 27 | 16 | 7 | 45.84 | 32.551 | -104.577 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2006 | 1 | 27 | 18 | 48 | 49.23 | 37.030 | -104.968 | 5 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2006 | 2 | 4 | 19 | 55 | 10.68 | 32.575 | -104.617 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2006 | 2 | 10 | 4 | 14 | 17.80 | 27.597 | -90.163 | 5 | . | ~~5.5~~ 5.52 | 0.41 | 5.71 |
| ANSS | 2006 | 2 | 11 | 13 | 3 | 50.48 | 37.076 | -105.444 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2006 | 2 | 18 | 5 | 49 | 41.45 | 35.672 | -101.794 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2006 | 3 | 1 | 17 | 42 | 42.00 | 37.500 | -88.980 | 6 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 3 | 4 | 17 | 14 | 58.25 | 30.289 | -103.674 | 5 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2006 | 3 | 11 | 2 | 37 | 20.00 | 35.200 | -88.010 | 2 | | 2.85 | 0.41 | 3.04 |
| ANSS | 2006 | 3 | 15 | 8 | 30 | 25.86 | 35.091 | -96.300 | 5 | | 2.97 | 0.3 | 3.08 |
| ANSS | 2006 | 3 | 20 | 17 | 55 | 29.12 | 32.600 | -104.563 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 3 | 28 | 23 | 55 | 11.49 | 35.363 | -101.871 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 4 | 5 | 18 | 46 | 23.14 | 34.069 | -97.314 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 4 | 8 | 15 | 59 | 43.25 | 28.010 | -105.123 | 10 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2006 | 4 | 8 | 18 | 8 | 35.23 | 31.954 | -101.419 | 5 | | 3.01 | 0.41 | 3.20 |

## Table 2.5S.2-3 Seismicity Catalog from 1985 to Present for the Project Investigation Region [107°W to 83°W, 24°N to 40°N] for which the Events are Rmb Magnitude ≥ 3.0 or Intensity ≥ IV (Continued)

| Catalog Reference | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANSS | 2006 | 4 | 9 | 14 | 41 | 29.00 | 35.240 | -92.240 | 8 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2006 | 4 | 11 | 3 | 29 | 21.00 | 35.360 | -84.480 | 20 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2006 | 4 | 17 | 16 | 25 | 12.29 | 24.432 | -100.091 | 17 | | 4.10 | 0.1 | 4.11 |
| ANSS | 2006 | 5 | 6 | 17 | 7 | 1.34 | 37.014 | -104.768 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2006 | 5 | 10 | 12 | 17 | 29.00 | 35.530 | -84.400 | 25 | | 3.25 | 0.41 | 3.45 |
| ISC | 2006 | 5 | 14 | 3 | 4 | 0.50 | 26.058 | -106.944 | 33 | | 4.10 | 0.1 | 4.11 |
| ANSS | 2006 | 5 | 18 | 13 | 1 | 15.00 | 38.050 | -90.530 | 6 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2006 | 5 | 26 | 6 | 14 | 25.12 | 36.795 | -104.832 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2006 | 6 | 16 | 0 | 57 | 27.00 | 35.510 | -83.200 | 1 | | 3.42 | 0.41 | 3.61 |
| ANSS | 2006 | 7 | 11 | 11 | 53 | 37.78 | 36.964 | -104.929 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2006 | 8 | 7 | 8 | 44 | 28.00 | 34.940 | -85.460 | 14 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2006 | 8 | 12 | 10 | 49 | 9.67 | 32.895 | -100.894 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2006 | 8 | 24 | 14 | 4 | 25.88 | 37.014 | -105.013 | 5 | | 3.17 | 0.41 | 3.37 |
| ANSS | 2006 | 9 | 7 | 13 | 51 | 13.00 | 36.270 | -89.500 | 8 | | 3.33 | 0.41 | 3.53 |
| ANSS | 2006 | 9 | 9 | 9 | 54 | 6.65 | 37.296 | -104.770 | 5 | | 3.25 | 0.41 | 3.45 |
| ANSS | 2006 | 9 | 9 | 12 | 53 | 14.21 | 37.368 | -104.865 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 9 | 9 | 18 | 5 | 41.79 | 37.374 | -104.736 | 5 | | 3.01 | 0.41 | 3.20 |
| ANSS | 2006 | 9 | 9 | 23 | 14 | 35.54 | 37.298 | -104.794 | 5 | | 3.58 | 0.41 | 3.77 |
| ANSS | 2006 | 9 | 10 | 14 | 56 | 8.16 | 26.319 | -86.606 | 14 | | 6.11 | 0.1 | 6.12 |
| ANSS | 2006 | 9 | 14 | 13 | 3 | 24.26 | 37.010 | -104.867 | 5 | | 3.09 | 0.41 | 3.28 |
| ANSS | 2006 | 9 | 30 | 12 | 40 | 0.12 | 37.061 | -104.971 | 5 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2006 | 10 | 6 | 22 | 13 | 16.78 | 34.122 | -97.625 | 5 | | 3.50 | 0.41 | 3.69 |
| ANSS | 2006 | 10 | 17 | 5 | 18 | 4.00 | 35.230 | -92.290 | 4 | | 2.93 | 0.41 | 3.12 |
| ANSS | 2006 | 10 | 18 | 20 | 59 | 21.00 | 36.540 | -89.640 | 8 | | 3.42 | 0.41 | 3.61 |

## Table 2.5S.2-4 Seismicity Events Recommended for Recurrence Analysis within the Gulf of Mexico

| Catalog | Year | Month | Day | Hour | Minute | Second | Lat (°N) | Lon (°E) | Depth (km) | Intensity | Emb | Smb | Rmb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPRI | 1927 | 12 | 15 | 4 | 30 | 0.00 | 28.900 | -89.400 | 0 | 4 | 3.80 | 0.30 | 3.90 |
| EPRI | 1929 | 7 | 28 | 17 | 0 | 0.00 | 28.900 | -89.400 | 0 | 4 | 3.80 | 0.30 | 3.90 |
| EPRI | 1958 | 11 | 6 | 23 | 8 | 0.00 | 29.900 | -90.100 | 0 | 4 | 3.11 | 0.56 | 3.47 |
| EPRI | 1963 | 11 | 5 | 22 | 45 | 3.40 | 27.490 | -92.580 | 15 | . | 4.71 | 0.20 | 4.76 |
| EPRI | 1978 | 7 | 24 | 8 | 6 | 16.90 | 26.380 | -88.720 | 15 | . | 4.88 | 0.10 | 4.89 |
| EPRI | 1980 | 1 | 10 | 19 | 16 | 23.50 | 24.130 | -85.710 | 15 | . | 3.88 | 0.10 | 3.89 |
| SRA | 1981 | 2 | 13 | 2 | 15 | 0.00 | 30.000 | -91.800 | 0 | 4 | 3.11 | 0.56 | 3.47 |
| ANSS | 1984 | 1 | 23 | 0 | 11 | 59.38 | 26.716 | -87.339 | 5 | . | 2.85 | 0.41 | 3.04 |
| ISC | 1986 | 5 | 12 | 4 | 18 | 2.70 | 27.714 | -88.726 | 10 | . | 3.50 | 0.10 | 3.51 |
| ISC | 1992 | 3 | 31 | 14 | 59 | 43.60 | 26.311 | -85.895 | 5 | . | 3.80 | 0.10 | 3.81 |
| ISC | 1992 | 9 | 27 | 17 | 2 | 34.40 | 28.192 | -88.431 | 10 | . | 3.58 | 0.41 | 3.77 |
| ISC | 1994 | 6 | 30 | 1 | 8 | 24.00 | 27.849 | -90.123 | 10 | . | 3.70 | 0.10 | 3.71 |
| ISC | 1997 | 4 | 18 | 14 | 57 | 46.30 | 26.922 | -87.284 | 33 | . | 3.80 | 0.10 | 3.81 |
| ISC | 1998 | 7 | 6 | 6 | 54 | 4.10 | 25.035 | -93.626 | 10 | . | 3.40 | 0.10 | 3.41 |
| ISC | 2000 | 12 | 9 | 6 | 46 | 9.20 | 28.017 | -90.134 | 10 | . | 3.90 | 0.10 | 3.91 |
| ISC | 2001 | 3 | 16 | 4 | 39 | 9.30 | 28.545 | -88.946 | 10 | . | 3.70 | 0.10 | 3.71 |
| ISC | 2002 | 5 | 27 | 0 | 28 | 22.00 | 27.664 | -94.530 | 10 | . | 3.90 | 0.10 | 3.91 |
| ISC | 2002 | 9 | 19 | 14 | 44 | 36.20 | 27.820 | -89.131 | 10 | . | 3.80 | 0.10 | 3.81 |
| ISC | 2003 | 4 | 13 | 4 | 52 | 53.90 | 26.096 | -86.080 | 10 | . | 3.50 | 0.10 | 3.51 |
| ISC | 2004 | 6 | 18 | 19 | 20 | 56.40 | 27.027 | -86.997 | 10 | . | 3.50 | 0.10 | 3.51 |
| ANSS | 2006 | 2 | 10 | 4 | 14 | 17.80 | 27.597 | -90.163 | 5 | . | ~~5.5~~ 5.52 | 0.41 | 5.71 |
| ANSS | 2006 | 9 | 10 | 14 | 56 | 8.16 | 26.319 | -86.606 | 14 | . | ~~6.1~~ 6.11 | 0.10 | 6.12 |

## Table 2.5S.2-5 Region 2 Matrix of Detection Probability Modified to Extend the Matrix to Recent Years [2006 being the last year incorporated]

| Matrix of Detection Probability: EPRI (Reference 2.5S.2-3) Incompleteness Region 2 [Modified] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Magnitude Intervals | Year Intervals | | | | | | | TOTAL YEARS |
| | 1625-1779 | 1780-1859 | 1860-1909 | 1910-1949 | 1950-1974 | 1975-1984 | 1985 - 2006 | |
| | 155 years | 80 years | 50 years | 40 years | 25 years | 10 years | 22 years | |
| 3.3-3.89 | 0.00 | 0.00 | 0.10 | 0.51 | 0.63 | 1.00 | 1.00 | 73.2 |
| 3.9-4.49 | 0.00 | 0.00 | 0.15 | 0.90 | 1.00 | 1.00 | 1.00 | 100.5 |
| 4.5-5.09 | 0.00 | 0.00 | 0.24 | 0.98 | 1.00 | 1.00 | 1.00 | 108.2 |
| 5.1-5.69 | 0.00 | 0.00 | 0.24 | 0.98 | 1.00 | 1.00 | 1.00 | 108.2 |
| 5.7-6.29 | 0.00 | 0.00 | 0.70 | 1.00 | 1.00 | 1.00 | 1.00 | 132.0 |
| 6.3-7.5 | 0.00 | 0.01 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 147.8 |

## Table 2.5S.2-6 Matrix of Detection Probability for the Gulf of Mexico

| Magnitude Intervals | Year Intervals | | | | | | | | | | | TOTAL YEARS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1625-1779 | 1780-1859 | 1860-1899 | 1900-1924 | 1925-1949 | 1950-1959 | 1960-1964 | 1965-1969 | 1970-1974 | 1975-1979 | 1980-2006 | |
| | 155 years | 80 years | 40 years | 25 years | 25 years | 10 years | 5 years | 5 years | 5 years | 5 years | 27 years | |
| 3.3-3.89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 8.1 |
| 3.9-4.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.60 | 18.7 |
| 4.5-5.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.70 | 0.70 | 0.90 | 33.8 |
| 5.1-5.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | 0.90 | 1.00 | 1.00 | 1.00 | 45.0 |
| 5.7-6.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 73.5 |
| 6.3-7.5 | 0.00 | 0.00 | 0.00 | 0.30 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 87.0 |

Note: see Subsection 2.5S.2.1.5 for explanation of shaded cells.

## Table 2.5S.2-7 Summary of Bechtel Group Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (f) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| BZ1 | Gulf Coast | 0 | 0 | 1.0 | 5.4 [0.1]<br>5.7 [0.4]<br>6.0 [0.4]<br>6.6 [0.1] | 1 [0.33]<br>2 [0.34]<br>3 [0.33] | Yes | No | Yes | No |
| BZ2 | Texas Platform | 82 | 51 | 0.1 | 5.4 [0.1]<br>5.7 [0.4]<br>6.0 [0.4]<br>6.6 [0.1] | 1 [0.33]<br>2 [0.34]<br>4 [0.33] | Yes | No | No | No |

[1] Shortest distance between STP 3 & 4 and source zone

[2] Probability of activity

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.)

[4] Smoothing options

1 = constant a, constant b, no b prior

2 = low smoothing on a, high smoothing on b, no b prior

3 = low smoothing on a, low smoothing on b, no b prior

4 = low smoothing on a, low smoothing on b, weak b prior of 1.05

Weights on magnitude intervals are [1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0]

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No, unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

## Table 2.5S.2-8 Summary of Dames & Moore Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| 20 | South Coastal Margin | 0 | 0 | 1.0 | 5.3 [0.8]<br>7.2 [0.2] | 1 [0.75]<br>2 [0.25] | Yes | No | Yes | No |
| 25 | Ouachitas Fold Belt | 170 | 106 | 0.35 | 5.5 [0.8]<br>7.2 [0.2] | 1 [0.75]<br>2 [0.25] | Yes | No | No | No |
| C08 | Combination zone: 25 (Ouachitas Fold Belt) excluding 25A (Kink in Fold Belt) | 170 | 106 | NA | 5.5 [0.8]<br>7.2 [0.2] | 1 [0.75]<br>2 [0.25] | Yes | No | No | No |
| 67 | New Mexico | 288 | 179 | 1.0 | 5.0 [0.8]<br>7.2 [0.2] | 1 [0.75]<br>2 [0.25] | No | No | No | No |

[1] Shortest distance between STP 3 & 4 and source zone

[2] Probability of activity

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.).

[4] Smoothing options

1 = no smoothing on a, no smoothing on b, strong b prior of 1.04

2 = no smoothing on a, no smoothing on b, weak b prior of 1.04

Weights on magnitude intervals are [0.1, 0.2, 0.4, 1.0, 1.0, 1.0, 1.0]

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No, unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

## Table 2.5S.2-9 Summary of Law Engineering Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| 124 | New Mexico –Texas Block | 123 | 76 | 1.0 | 4.9 [0.3]<br>5.5 [0.5]<br>5.8 [0.2] | 1a [1.0] | Yes | No | No | No |
| 126 | South Coastal Block | 0 | 0 | 1.0 | 4.6 [0.9]<br>4.9 [0.1] | 1a [1.0] | Yes | No | Yes | No |

[1] Shortest distance between STP 3 & 4 and source zone.

[2] Probability of activity

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.).

[4] Smoothing options

1a = high smoothing on a, constant b, strong b prior of 1.05

Weights on magnitude intervals are all 1.0

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No, unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

## Table 2.5S.2-10 Summary of Rondout Associates Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| 51 | Gulf Coast to Bahamas Fracture Zone | 0 | 0 | 1.0 | 4.8 [0.2]<br>5.5 [0.6]<br>5.8 [0.2] | 3 [1.0] | Yes | No | Yes | No |
| C02 | Background 50 | 206 | 128 | NA | 4.8 [0.2]<br>5.5 [0.6]<br>5.8 [0.2] | 3 [1.0] | No | No | No | No |

[1] Shortest distance between STP 3 & 4 and source zone

[2] Probability of activity

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.)

[4] Smoothing options

3 = low smoothing on a, constant b, strong b prior of 1.0

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No, unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

## Table 2.5S.2-11 Summary of Weston Geophysical Corporation Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| 107 | Gulf Coast | 0 | 0 | 1.0 | 5.4 [0.71]<br>6.0 [0.29] | 1a [0.2]<br>2a [0.8] | Yes | No | Yes | No |
| C31 | Combination zone: 109 (Southwest) excluding 37 (Delaware Basin) | 206 | 128 | NA | 5.4 [0.33]<br>6.0 [0.49]<br>6.6 [0.18] | 1a [0.7]<br>2a [0.3] | No | No | No | No |

[1] Shortest distance between STP 3 & 4 and source zone

[2] Probability of activity (Pa)

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.).

[4] Smoothing options

1b = constant a, constant b, medium b prior of 0.9

2a = medium smoothing on a, medium smoothing on b, medium b prior of 1.0

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No, unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

## Table 2.5S.2-12 Summary of Woodward-Clyde Consultants Seismic Source Zones

| Source | Description | Distance [1] | | Pa [2] | $M_{max}$ ($m_b$) and Wts. [3] | Smoothing Options and Wts. [4] | Contributes to 99% of Hazard [5] | New Information to Suggest Change in Source | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | (mi) | | | | | Geometry [6] | $M_{max}$ [7] | RI [8] |
| B43 | Central US Backgrounds | 0 | 0 | NA | 4.9 [0.17]<br>5.4 [0.28]<br>5.8 [0.27]<br>6.5 [0.28] | 1 [0.25]<br>6 [0.25]<br>7 [0.25]<br>8 [0.25] | Yes | No | No | No |

[1] Shortest distance between STP 3 & 4 and source zone

[2] Probability of activity (Pa)

[3] Maximum earthquake magnitude ($M_{max}$) in body-wave magnitude ($m_b$) and weighting (Wts.)

[4] Smoothing options

1 = low smoothing on a, high smoothing on b, no b prior

6 = low smoothing on a, high smoothing on b, moderate b prior of 1.0

7 = low smoothing on a, high smoothing on b, moderate b prior of 0.9

8 = low smoothing on a, high smoothing on b, moderate b prior of 0.8

Weights on magnitude intervals are all 1.0

[5] Whether or not the source contributes to 99% of the hazard at STP 3 & 4

[6] No unless new geometry proposed in literature

[7] No, unless $M_{max}$ exceeded in literature

[8] RI = recurrence interval; assumed no change if no new paleoseismic data or rate of seismicity has not significantly changed

**Table 2.5S.2-13 Comparison of EPRI EST Characterizations of Gulf of Mexico Costal Source Zones and Modifications for STP 3 & 4**

| EPRI EST | Source | Description | EPRI Model | | Updated Model for STP 3 & 4 | |
|---|---|---|---|---|---|---|
| | | | $M_{max}$ ($m_b$) and Wts. [1] | Contributes to 99% of Hazard [2] | $M_{max}$ ($m_b$) and Wts [3] | Smoothing Options and Wts. [4] |
| Bechtel Group | BZ1 | Gulf Coast | 5.4 [0.1]<br>5.7 [0.4]<br>6.0 [0.4]<br>6.6 [0.1] | Yes | 6.1 [0.10]<br>6.4 [0.40]<br>6.6 [0.50] | No Update |
| Dames & Moore | 20 | South Coastal Margin | 5.3 [0.8]<br>7.2 [0.2] | Yes | 5.5 [0.80]<br>7.2 [0.20] | I (0.2)<br>II (0.4)<br>III (0.4) |
| Law Engineering | 126 | South Coastal Block | 4.6 [0.9]<br>4.9 [0.1] | Yes | 5.5 [0.90]<br>5.7 [0.10] | No Update |
| Rondout Associates | 51 | Gulf Coast to Bahamas Fracture Zone | 4.8 [0.2]<br>5.5 [0.6]<br>5.8 [0.2] | Yes | 6.1 [0.30]<br>6.3 [0.55]<br>6.5 [0.15] | No Update |
| Weston Geophysical Corporation | 107 | Gulf Coast | 5.4 [0.71]<br>6.0 [0.29] | Yes | 6.6 [0.89]<br>7.2 [0.11] | No Update |
| Woodward-Clyde Consultants | B43 | Central US Backgrounds | 4.9 [0.17]<br>5.4 [0.28]<br>5.8 [0.27]<br>6.5 [0.28] | Yes | No Update | No Update |

[1] Mmax distribution and weights from EPRI 1986 model (EPRI, Reference 2.5S.2-16)
[2] Whether or not the source contributes to 99% of the hazard at STP 3 & 4
[3] Updated Mmax distributions and weights as described in Subsection 2.5S.2.6.2
[4] Updated smoothing options and weights as described in Subsection 2.5S.2.6.2.7.1
I: Constant a, constant b, strong prior on b of 1.04
II: Medium smoothing on a, medium smoothing on b, strong prior on b of 1.04
III: high smoothing on a, high smoothing on b, strong prior on b of 1.04

**Table 2.5S.2-14 Comparison of EPRI (Reference 2.5S.2-16) and current hazard results for Bechtel Group EST using EPRI (Reference 2.5S.2-16) assumptions**

| PGA amp, | | | | |
|---|---|---|---|---|
| cm/s$^2$ | Hazard | EPRI | Current results | % difference |
| 100 | mean | 1.19E-05 | 1.20E-05 | 0.8% |
| | 15% | 4.22E-06 | 4.27E-06 | 1.2% |
| | 50% | 9.09E-06 | 9.12E-06 | 0.3% |
| | 85% | 1.82E-05 | 1.82E-05 | 0.0% |
| 250 | mean | 1.35E-06 | 1.36E-06 | 0.7% |
| | 15% | 4.62E-07 | 4.68E-07 | 1.3% |
| | 50% | 9.58E-07 | 9.33E-07 | -2.6% |
| | 85% | 2.28E-06 | 2.29E-06 | 0.4% |
| 500 | mean | 1.30E-07 | 1.34E-07 | 3.1% |
| | 15% | 3.08E-08 | 3.16E-08 | 2.6% |
| | 50% | 8.87E-08 | 9.55E-08 | 7.7% |
| | 85% | 2.23E-07 | 2.34E-07 | 4.9% |

**Table 2.5S.2-15 Table 2.5S.2-15 Closest Approach of Gulf of Mexico Earthquakes with Emb > 5.5 to Boundary of EPRI EST Gulf Coastal Source Zones**

| Earthquake | EPRI EST Gulf Coastal Source Zone | | | | | |
|---|---|---|---|---|---|---|
| | Bechtel Group Gulf Coast (BZ1) | Dames & Moore South Coastal Margin (20) | Law Engineering South Coastal Block (126) | Rondout Associates Gulf Coast to Bahamas | Weston Geophysical Corporation Gulf Coast (107) | Woodward-Clyde Consultants Central US Backgrounds (B43) |
| 2006-02-10 Emb 5.5 | 159 mi (256 km) | -11 mi (-18 km) | -39 mi (-63 km) | 147 mi (236 km) | 179 mi (288 km) | -170 mi (-273 km) |
| 2006-09-10 Emb 6.1 | 73.3 mi (118 km) | -152 mi (-245 km) | -97.6 mi (-157 km) | 70.8 mi (114 km) | 85.8 mi (138 km) | -395 mi (-635 km) |

Note: Negative values indicate that earthquake occurred outside the source zone

**Table 2.5S.2-16 Mean Rock Uniform Hazard Response Spectral Accelerations (g)**

| Mean rock UHRS | | | |
|---|---|---|---|
| **Freq, Hz** | **$10^{-4}$ mean** | **$10^{-5}$ mean** | **$10^{-6}$ mean** |
| 100 [PGA] | ~~0.0341~~0.0327 | ~~0.114~~0.126 | ~~0.243~~0.517 |
| 25 | ~~0.0414~~0.0784 | ~~0.114~~0.340 | ~~0.235~~1.408 |
| 10 | ~~0.0552~~0.0684 | ~~0.154~~0.253 | ~~0.353~~0.896 |
| 5 | 0.0620 | 0.200 | 0.583 |
| 2.5 | ~~0.0684~~0.0552 | ~~0.253~~0.154 | ~~0.896~~0.353 |
| 1 | ~~0.0784~~0.0414 | ~~0.340~~0.114 | ~~1.41~~0.235 |
| 0.5 | ~~0.0327~~0.0341 | ~~0.126~~0.114 | ~~0.517~~0.243 |

**Table 2.5S.2-17 Controlling Magnitudes and Distances from Deaggregation**

| Struct. frequency | Annual Freq. Exceed. | Overall hazard | | Hazard from R>100 km | |
|---|---|---|---|---|---|
| | | **M** | **R, km** | **M** | **R, km** |
| 1 & 2.5 Hz | 1E-4 | 7.4 | ~~890~~600 | 7.6 | ~~930~~880 |
| 5 & 10 Hz | 1E-4 | ~~6.6~~6.7 | ~~600~~230 | 7.5 | ~~880~~790 |
| 1 & 2.5 Hz | 1E-5 | 7.3 | ~~790~~380 | 7.7 | ~~930~~890 |
| 5 & 10 Hz | 1E-5 | ~~5.9~~6.1 | ~~270~~46 | 7.7 | ~~910~~850 |
| 1 & 2.5 Hz | 1E-6 | 6.9 | ~~550~~122 | 7.8 | ~~930~~890 |
| 5 & 10 Hz | 1E-6 | ~~5.4~~5.6 | ~~38~~10 | 7.8 | ~~920~~860 |

Shaded cells indicate values used to construct UHRS

Table 2.5S.2-18 ~~Horizontal $10^{-4}$ Rock and Site Specific UHRS (in g)~~

| ~~Freq. (Hz)~~ | ~~Rock UHRS~~ | | ~~Transfer Functions~~ | | ~~Surface UHRS~~ | | ~~Raw Envelope Sa (g)~~ | ~~Smooth Spectrum Sa (g)~~ |
|---|---|---|---|---|---|---|---|---|
| | ~~LF Sa (g)~~ | ~~HF Sa (g)~~ | ~~LF Amp~~ | ~~HF Amp~~ | ~~LF Sa (g)~~ | ~~HF Sa (g)~~ | | |
| ~~100~~ | ~~3.27E-02~~ | ~~3.27E-02~~ | ~~1.975~~ | ~~1.268~~ | ~~6.47E-02~~ | ~~4.15E-02~~ | ~~6.47E-02~~ | ~~6.47E-02~~ |
| ~~90~~ | ~~3.57E-02~~ | ~~3.57E-02~~ | ~~1.812~~ | ~~1.163~~ | ~~6.47E-02~~ | ~~4.15E-02~~ | ~~6.47E-02~~ | ~~6.47E-02~~ |
| ~~80~~ | ~~4.08E-02~~ | ~~4.09E-02~~ | ~~1.586~~ | ~~1.018~~ | ~~6.47E-02~~ | ~~4.16E-02~~ | ~~6.47E-02~~ | ~~6.47E-02~~ |
| ~~70~~ | ~~4.86E-02~~ | ~~4.87E-02~~ | ~~1.333~~ | ~~0.856~~ | ~~6.48E-02~~ | ~~4.17E-02~~ | ~~6.48E-02~~ | ~~6.48E-02~~ |
| ~~60~~ | ~~5.84E-02~~ | ~~5.86E-02~~ | ~~1.110~~ | ~~0.714~~ | ~~6.48E-02~~ | ~~4.18E-02~~ | ~~6.48E-02~~ | ~~6.48E-02~~ |
| ~~50~~ | ~~6.79E-02~~ | ~~6.82E-02~~ | ~~0.957~~ | ~~0.618~~ | ~~6.50E-02~~ | ~~4.21E-02~~ | ~~6.50E-02~~ | ~~6.50E-02~~ |
| ~~45~~ | ~~7.17E-02~~ | ~~7.20E-02~~ | ~~0.908~~ | ~~0.589~~ | ~~6.51E-02~~ | ~~4.24E-02~~ | ~~6.51E-02~~ | ~~6.51E-02~~ |
| ~~40~~ | ~~7.46E-02~~ | ~~7.49E-02~~ | ~~0.876~~ | ~~0.571~~ | ~~6.53E-02~~ | ~~4.28E-02~~ | ~~6.53E-02~~ | ~~6.53E-02~~ |
| ~~35~~ | ~~7.66E-02~~ | ~~7.69E-02~~ | ~~0.857~~ | ~~0.565~~ | ~~6.57E-02~~ | ~~4.34E-02~~ | ~~6.57E-02~~ | ~~6.57E-02~~ |
| ~~30~~ | ~~7.78E-02~~ | ~~7.80E-02~~ | ~~0.852~~ | ~~0.572~~ | ~~6.63E-02~~ | ~~4.46E-02~~ | ~~6.63E-02~~ | ~~6.63E-02~~ |
| ~~25~~ | ~~7.84E-02~~ | ~~7.84E-02~~ | ~~0.862~~ | ~~0.597~~ | ~~6.76E-02~~ | ~~4.68E-02~~ | ~~6.76E-02~~ | ~~6.76E-02~~ |
| ~~20~~ | ~~7.68E-02~~ | ~~7.73E-02~~ | ~~0.909~~ | ~~0.654~~ | ~~6.98E-02~~ | ~~5.06E-02~~ | ~~6.98E-02~~ | ~~6.98E-02~~ |
| ~~15~~ | ~~7.39E-02~~ | ~~7.46E-02~~ | ~~1.006~~ | ~~0.787~~ | ~~7.43E-02~~ | ~~5.87E-02~~ | ~~7.43E-02~~ | ~~7.43E-02~~ |
| ~~12.5~~ | ~~7.16E-02~~ | ~~7.21E-02~~ | ~~1.094~~ | ~~0.913~~ | ~~7.83E-02~~ | ~~6.58E-02~~ | ~~7.83E-02~~ | ~~7.83E-02~~ |
| ~~10~~ | ~~6.84E-02~~ | ~~6.84E-02~~ | ~~1.233~~ | ~~1.107~~ | ~~8.44E-02~~ | ~~7.58E-02~~ | ~~8.44E-02~~ | ~~8.44E-02~~ |
| ~~9~~ | ~~6.79E-02~~ | ~~6.81E-02~~ | ~~1.303~~ | ~~1.201~~ | ~~8.84E-02~~ | ~~8.18E-02~~ | ~~8.84E-02~~ | ~~8.84E-02~~ |
| ~~8~~ | ~~6.71E-02~~ | ~~6.75E-02~~ | ~~1.385~~ | ~~1.319~~ | ~~9.29E-02~~ | ~~8.90E-02~~ | ~~9.29E-02~~ | ~~9.29E-02~~ |
| ~~7~~ | ~~6.59E-02~~ | ~~6.64E-02~~ | ~~1.515~~ | ~~1.494~~ | ~~9.99E-02~~ | ~~9.92E-02~~ | ~~9.99E-02~~ | ~~9.99E-02~~ |
| ~~6~~ | ~~6.44E-02~~ | ~~6.47E-02~~ | ~~1.669~~ | ~~1.677~~ | ~~1.07E-01~~ | ~~1.09E-01~~ | ~~1.09E-01~~ | ~~1.08E-01~~ |
| ~~5~~ | ~~6.20E-02~~ | ~~6.20E-02~~ | ~~1.843~~ | ~~1.835~~ | ~~1.14E-01~~ | ~~1.14E-01~~ | ~~1.14E-01~~ | ~~1.14E-01~~ |
| ~~4~~ | ~~5.96E-02~~ | ~~5.50E-02~~ | ~~2.052~~ | ~~2.062~~ | ~~1.22E-01~~ | ~~1.13E-01~~ | ~~1.22E-01~~ | ~~1.22E-01~~ |
| ~~3~~ | ~~5.67E-02~~ | ~~4.50E-02~~ | ~~2.364~~ | ~~2.392~~ | ~~1.34E-01~~ | ~~1.08E-01~~ | ~~1.34E-01~~ | ~~1.35E-01~~ |
| ~~2.5~~ | ~~5.52E-02~~ | ~~3.82E-02~~ | ~~2.595~~ | ~~2.639~~ | ~~1.43E-01~~ | ~~1.01E-01~~ | ~~1.43E-01~~ | ~~1.39E-01~~ |
| ~~2~~ | ~~5.16E-02~~ | ~~2.98E-02~~ | ~~2.585~~ | ~~2.488~~ | ~~1.33E-01~~ | ~~7.41E-02~~ | ~~1.33E-01~~ | ~~1.35E-01~~ |
| ~~1.5~~ | ~~4.71E-02~~ | ~~2.04E-02~~ | ~~2.712~~ | ~~2.693~~ | ~~1.28E-01~~ | ~~5.51E-02~~ | ~~1.28E-01~~ | ~~1.29E-01~~ |
| ~~1.25~~ | ~~4.37E-02~~ | ~~1.59E-02~~ | ~~2.905~~ | ~~2.818~~ | ~~1.27E-01~~ | ~~4.47E-02~~ | ~~1.27E-01~~ | ~~1.24E-01~~ |
| ~~1~~ | ~~4.14E-02~~ | ~~1.16E-02~~ | ~~2.794~~ | ~~2.680~~ | ~~1.16E-01~~ | ~~3.10E-02~~ | ~~1.16E-01~~ | ~~1.14E-01~~ |
| ~~0.9~~ | ~~4.09E-02~~ | ~~9.94E-03~~ | ~~2.684~~ | ~~2.547~~ | ~~1.10E-01~~ | ~~2.53E-02~~ | ~~1.10E-01~~ | ~~1.10E-01~~ |
| ~~0.8~~ | ~~3.96E-02~~ | ~~8.40E-03~~ | ~~2.632~~ | ~~2.494~~ | ~~1.04E-01~~ | ~~2.10E-02~~ | ~~1.04E-01~~ | ~~1.07E-01~~ |
| ~~0.7~~ | ~~3.77E-02~~ | ~~6.94E-03~~ | ~~2.961~~ | ~~2.869~~ | ~~1.12E-01~~ | ~~1.99E-02~~ | ~~1.12E-01~~ | ~~1.12E-01~~ |
| ~~0.6~~ | ~~3.64E-02~~ | ~~5.54E-03~~ | ~~3.372~~ | ~~3.417~~ | ~~1.23E-01~~ | ~~1.89E-02~~ | ~~1.23E-01~~ | ~~1.23E-01~~ |
| ~~0.5~~ | ~~3.41E-02~~ | ~~4.23E-03~~ | ~~2.981~~ | ~~2.878~~ | ~~1.02E-01~~ | ~~1.22E-02~~ | ~~1.02E-01~~ | ~~1.02E-01~~ |
| ~~0.4~~ | ~~2.45E-02~~ | ~~3.01E-03~~ | ~~2.710~~ | ~~2.565~~ | ~~6.64E-02~~ | ~~7.71E-03~~ | ~~6.64E-02~~ | ~~6.64E-02~~ |
| ~~0.3~~ | ~~1.52E-02~~ | ~~1.89E-03~~ | ~~3.464~~ | ~~3.358~~ | ~~5.26E-02~~ | ~~6.36E-03~~ | ~~5.26E-02~~ | ~~5.26E-02~~ |
| ~~0.2~~ | ~~6.79E-03~~ | ~~9.42E-04~~ | ~~2.832~~ | ~~2.677~~ | ~~1.92E-02~~ | ~~2.52E-03~~ | ~~1.92E-02~~ | ~~1.92E-02~~ |
| ~~0.15~~ | ~~3.39E-03~~ | ~~5.51E-04~~ | ~~2.223~~ | ~~1.987~~ | ~~7.53E-03~~ | ~~1.10E-03~~ | ~~7.53E-03~~ | ~~7.53E-03~~ |
| ~~0.125~~ | ~~2.04E-03~~ | ~~3.85E-04~~ | ~~2.129~~ | ~~1.787~~ | ~~4.35E-03~~ | ~~6.88E-04~~ | ~~4.35E-03~~ | ~~4.35E-03~~ |
| ~~0.1~~ | ~~1.02E-03~~ | ~~2.43E-04~~ | ~~2.268~~ | ~~1.664~~ | ~~2.31E-03~~ | ~~4.04E-04~~ | ~~2.31E-03~~ | ~~2.31E-03~~ |

Table 2.5S.2-18 Horizontal $10^{-4}$ Rock and Site Specific UHRS (in g)

| Freq. (Hz) | Rock UHRS LF Sa (g) | Rock UHRS HF Sa (g) | Transfer Functions LF Amp | Transfer Functions HF Amp | Surface UHRS LF Sa (g) | Surface UHRS HF Sa (g) | Raw Envelope Sa (g) | Smooth Spectrum Sa (g) |
|---|---|---|---|---|---|---|---|---|
| 100 | 3.27E-02 | 3.27E-02 | 2.190 | 1.556 | 7.17E-02 | 5.09E-02 | 7.17E-02 | 7.17E-02 |
| 90 | 3.57E-02 | 3.57E-02 | 2.009 | 1.427 | 7.17E-02 | 5.10E-02 | 7.17E-02 | 7.17E-02 |
| 80 | 4.08E-02 | 4.09E-02 | 1.759 | 1.249 | 7.18E-02 | 5.11E-02 | 7.18E-02 | 7.18E-02 |
| 70 | 4.86E-02 | 4.88E-02 | 1.479 | 1.050 | 7.19E-02 | 5.12E-02 | 7.19E-02 | 7.19E-02 |
| 60 | 5.84E-02 | 5.87E-02 | 1.232 | 0.876 | 7.20E-02 | 5.14E-02 | 7.20E-02 | 7.20E-02 |
| 50 | 6.79E-02 | 6.83E-02 | 1.063 | 0.759 | 7.22E-02 | 5.18E-02 | 7.22E-02 | 7.22E-02 |
| 45 | 7.17E-02 | 7.22E-02 | 1.010 | 0.724 | 7.24E-02 | 5.22E-02 | 7.24E-02 | 7.25E-02 |
| 40 | 7.46E-02 | 7.51E-02 | 0.976 | 0.704 | 7.28E-02 | 5.28E-02 | 7.28E-02 | 7.29E-02 |
| 35 | 7.66E-02 | 7.71E-02 | 0.959 | 0.698 | 7.34E-02 | 5.38E-02 | 7.34E-02 | 7.35E-02 |
| 30 | 7.78E-02 | 7.82E-02 | 0.958 | 0.711 | 7.46E-02 | 5.56E-02 | 7.46E-02 | 7.46E-02 |
| 25 | 7.84E-02 | 7.84E-02 | 0.977 | 0.748 | 7.65E-02 | 5.86E-02 | 7.65E-02 | 7.67E-02 |
| 20 | 7.68E-02 | 7.78E-02 | 1.041 | 0.823 | 8.00E-02 | 6.40E-02 | 8.00E-02 | 8.02E-02 |
| 15 | 7.39E-02 | 7.52E-02 | 1.170 | 0.982 | 8.65E-02 | 7.38E-02 | 8.65E-02 | 8.66E-02 |
| 12.5 | 7.16E-02 | 7.25E-02 | 1.274 | 1.118 | 9.13E-02 | 8.11E-02 | 9.13E-02 | 9.14E-02 |
| 10 | 6.84E-02 | 6.84E-02 | 1.444 | 1.333 | 9.88E-02 | 9.12E-02 | 9.88E-02 | 9.86E-02 |
| 9 | 6.79E-02 | 6.81E-02 | 1.511 | 1.413 | 1.03E-01 | 9.63E-02 | 1.03E-01 | 1.02E-01 |
| 8 | 6.71E-02 | 6.74E-02 | 1.593 | 1.523 | 1.07E-01 | 1.03E-01 | 1.07E-01 | 1.08E-01 |
| 7 | 6.59E-02 | 6.63E-02 | 1.741 | 1.710 | 1.15E-01 | 1.13E-01 | 1.15E-01 | 1.15E-01 |
| 6 | 6.44E-02 | 6.46E-02 | 1.961 | 1.970 | 1.26E-01 | 1.27E-01 | 1.27E-01 | 1.26E-01 |
| 5 | 6.20E-02 | 6.20E-02 | 2.165 | 2.162 | 1.34E-01 | 1.34E-01 | 1.34E-01 | 1.35E-01 |
| 4 | 5.94E-02 | 5.48E-02 | 2.417 | 2.446 | 1.44E-01 | 1.34E-01 | 1.44E-01 | 1.43E-01 |
| 3 | 5.66E-02 | 4.58E-02 | 2.728 | 2.765 | 1.54E-01 | 1.27E-01 | 1.54E-01 | 1.56E-01 |
| 2.5 | 5.52E-02 | 4.01E-02 | 3.059 | 3.123 | 1.69E-01 | 1.25E-01 | 1.69E-01 | 1.64E-01 |
| 2 | 5.17E-02 | 3.31E-02 | 2.862 | 2.852 | 1.48E-01 | 9.45E-02 | 1.48E-01 | 1.52E-01 |
| 1.5 | 4.73E-02 | 2.46E-02 | 3.120 | 3.125 | 1.48E-01 | 7.69E-02 | 1.48E-01 | 1.46E-01 |
| 1.25 | 4.39E-02 | 1.98E-02 | 3.146 | 3.133 | 1.38E-01 | 6.21E-02 | 1.38E-01 | 1.39E-01 |
| 1 | 4.14E-02 | 1.49E-02 | 3.061 | 3.070 | 1.27E-01 | 4.58E-02 | 1.27E-01 | 1.26E-01 |
| 0.9 | 4.08E-02 | 1.30E-02 | 2.897 | 2.896 | 1.18E-01 | 3.76E-02 | 1.18E-01 | 1.22E-01 |
| 0.8 | 3.95E-02 | 1.11E-02 | 3.026 | 3.031 | 1.20E-01 | 3.36E-02 | 1.20E-01 | 1.16E-01 |
| 0.7 | 3.75E-02 | 9.28E-03 | 2.894 | 2.843 | 1.09E-01 | 2.64E-02 | 1.09E-01 | 1.16E-01 |
| 0.6 | 3.62E-02 | 7.54E-03 | 3.292 | 3.319 | 1.19E-01 | 2.50E-02 | 1.19E-01 | 1.11E-01 |
| 0.5 | 3.41E-02 | 5.88E-03 | 3.041 | 3.066 | 1.04E-01 | 1.80E-02 | 1.04E-01 | 1.04E-01 |
| 0.4 | 2.48E-02 | 4.31E-03 | 3.124 | 3.059 | 7.73E-02 | 1.32E-02 | 7.73E-02 | 7.94E-02 |
| 0.3 | 1.57E-02 | 2.85E-03 | 3.238 | 3.212 | 5.08E-02 | 9.16E-03 | 5.08E-02 | 5.05E-02 |
| 0.2 | 7.39E-03 | 1.53E-03 | 2.842 | 2.756 | 2.10E-02 | 4.22E-03 | 2.10E-02 | 2.25E-02 |
| 0.15 | 3.92E-03 | 9.48E-04 | 2.983 | 2.943 | 1.17E-02 | 2.79E-03 | 1.17E-02 | 1.18E-02 |
| 0.125 | 2.48E-03 | 6.86E-04 | 3.358 | 3.331 | 8.34E-03 | 2.28E-03 | 8.34E-03 | 8.25E-03 |
| 0.1 | 1.33E-03 | 4.50E-04 | 3.125 | 3.005 | 4.17E-03 | 1.35E-03 | 4.17E-03 | 4.17E-03 |

Table 2.5S.2-19 ~~Horizontal $10^{-5}$ Rock and Site Specific UHRS (in g)~~

| ~~Freq. (Hz)~~ | ~~Rock UHRS~~ | | ~~Transfer Functions~~ | | ~~Surface UHRS~~ | | ~~Raw Envelope Sa (g)~~ | ~~Smooth Spectrum Sa (g)~~ |
|---|---|---|---|---|---|---|---|---|
| | ~~LF Sa (g)~~ | ~~HF Sa (g)~~ | ~~LF Amp~~ | ~~HF Amp~~ | ~~LF Sa (g)~~ | ~~HF Sa (g)~~ | | |
| ~~100~~ | ~~1.26E-01~~ | ~~1.26E-01~~ | ~~1.37~~ | ~~0.93~~ | ~~1.73E-01~~ | ~~1.17E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~90~~ | ~~1.39E-01~~ | ~~1.39E-01~~ | ~~1.25~~ | ~~0.84~~ | ~~1.73E-01~~ | ~~1.17E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~80~~ | ~~1.60E-01~~ | ~~1.61E-01~~ | ~~1.08~~ | ~~0.73~~ | ~~1.73E-01~~ | ~~1.18E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~70~~ | ~~1.93E-01~~ | ~~1.94E-01~~ | ~~0.90~~ | ~~0.61~~ | ~~1.73E-01~~ | ~~1.18E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~60~~ | ~~2.36E-01~~ | ~~2.38E-01~~ | ~~0.74~~ | ~~0.50~~ | ~~1.73E-01~~ | ~~1.18E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~50~~ | ~~2.78E-01~~ | ~~2.81E-01~~ | ~~0.62~~ | ~~0.42~~ | ~~1.73E-01~~ | ~~1.19E-01~~ | ~~1.73E-01~~ | ~~1.73E-01~~ |
| ~~45~~ | ~~2.97E-01~~ | ~~3.00E-01~~ | ~~0.59~~ | ~~0.40~~ | ~~1.74E-01~~ | ~~1.19E-01~~ | ~~1.74E-01~~ | ~~1.74E-01~~ |
| ~~40~~ | ~~3.12E-01~~ | ~~3.15E-01~~ | ~~0.56~~ | ~~0.38~~ | ~~1.74E-01~~ | ~~1.21E-01~~ | ~~1.74E-01~~ | ~~1.74E-01~~ |
| ~~35~~ | ~~3.24E-01~~ | ~~3.27E-01~~ | ~~0.54~~ | ~~0.37~~ | ~~1.74E-01~~ | ~~1.22E-01~~ | ~~1.74E-01~~ | ~~1.74E-01~~ |
| ~~30~~ | ~~3.33E-01~~ | ~~3.36E-01~~ | ~~0.52~~ | ~~0.37~~ | ~~1.75E-01~~ | ~~1.26E-01~~ | ~~1.75E-01~~ | ~~1.75E-01~~ |
| ~~25~~ | ~~3.40E-01~~ | ~~3.40E-01~~ | ~~0.52~~ | ~~0.39~~ | ~~1.76E-01~~ | ~~1.32E-01~~ | ~~1.76E-01~~ | ~~1.76E-01~~ |
| ~~20~~ | ~~3.22E-01~~ | ~~3.27E-01~~ | ~~0.56~~ | ~~0.44~~ | ~~1.79E-01~~ | ~~1.45E-01~~ | ~~1.79E-01~~ | ~~1.79E-01~~ |
| ~~15~~ | ~~2.95E-01~~ | ~~3.01E-01~~ | ~~0.63~~ | ~~0.57~~ | ~~1.86E-01~~ | ~~1.71E-01~~ | ~~1.86E-01~~ | ~~1.86E-01~~ |
| ~~12.5~~ | ~~2.77E-01~~ | ~~2.81E-01~~ | ~~0.69~~ | ~~0.69~~ | ~~1.92E-01~~ | ~~1.93E-01~~ | ~~1.93E-01~~ | ~~1.93E-01~~ |
| ~~10~~ | ~~2.53E-01~~ | ~~2.53E-01~~ | ~~0.80~~ | ~~0.88~~ | ~~2.03E-01~~ | ~~2.22E-01~~ | ~~2.22E-01~~ | ~~2.22E-01~~ |
| ~~9~~ | ~~2.46E-01~~ | ~~2.47E-01~~ | ~~0.85~~ | ~~0.97~~ | ~~2.09E-01~~ | ~~2.41E-01~~ | ~~2.41E-01~~ | ~~2.41E-01~~ |
| ~~8~~ | ~~2.37E-01~~ | ~~2.39E-01~~ | ~~0.92~~ | ~~1.08~~ | ~~2.18E-01~~ | ~~2.58E-01~~ | ~~2.58E-01~~ | ~~2.58E-01~~ |
| ~~7~~ | ~~2.27E-01~~ | ~~2.29E-01~~ | ~~1.01~~ | ~~1.24~~ | ~~2.29E-01~~ | ~~2.85E-01~~ | ~~2.85E-01~~ | ~~2.85E-01~~ |
| ~~6~~ | ~~2.15E-01~~ | ~~2.16E-01~~ | ~~1.14~~ | ~~1.43~~ | ~~2.45E-01~~ | ~~3.10E-01~~ | ~~3.10E-01~~ | ~~3.09E-01~~ |
| ~~5~~ | ~~2.00E-01~~ | ~~2.00E-01~~ | ~~1.32~~ | ~~1.65~~ | ~~2.63E-01~~ | ~~3.29E-01~~ | ~~3.29E-01~~ | ~~3.23E-01~~ |
| ~~4~~ | ~~1.89E-01~~ | ~~1.70E-01~~ | ~~1.52~~ | ~~1.87~~ | ~~2.88E-01~~ | ~~3.18E-01~~ | ~~3.18E-01~~ | ~~3.18E-01~~ |
| ~~3~~ | ~~1.70E-01~~ | ~~1.33E-01~~ | ~~1.88~~ | ~~2.23~~ | ~~3.18E-01~~ | ~~2.95E-01~~ | ~~3.18E-01~~ | ~~3.18E-01~~ |
| ~~2.5~~ | ~~1.54E-01~~ | ~~1.10E-01~~ | ~~2.10~~ | ~~2.50~~ | ~~3.23E-01~~ | ~~2.74E-01~~ | ~~3.23E-01~~ | ~~3.26E-01~~ |
| ~~2~~ | ~~1.46E-01~~ | ~~8.39E-02~~ | ~~2.31~~ | ~~2.49~~ | ~~3.38E-01~~ | ~~2.09E-01~~ | ~~3.38E-01~~ | ~~3.34E-01~~ |
| ~~1.5~~ | ~~1.36E-01~~ | ~~5.64E-02~~ | ~~2.47~~ | ~~2.65~~ | ~~3.35E-01~~ | ~~1.50E-01~~ | ~~3.35E-01~~ | ~~3.38E-01~~ |
| ~~1.25~~ | ~~1.26E-01~~ | ~~4.32E-02~~ | ~~2.73~~ | ~~2.84~~ | ~~3.45E-01~~ | ~~1.23E-01~~ | ~~3.45E-01~~ | ~~3.33E-01~~ |
| ~~1~~ | ~~1.14E-01~~ | ~~3.09E-02~~ | ~~2.77~~ | ~~2.70~~ | ~~3.15E-01~~ | ~~8.34E-02~~ | ~~3.15E-01~~ | ~~3.24E-01~~ |
| ~~0.9~~ | ~~1.18E-01~~ | ~~2.63E-02~~ | ~~2.73~~ | ~~2.57~~ | ~~3.22E-01~~ | ~~6.77E-02~~ | ~~3.22E-01~~ | ~~3.18E-01~~ |
| ~~0.8~~ | ~~1.19E-01~~ | ~~2.20E-02~~ | ~~2.62~~ | ~~2.49~~ | ~~3.13E-01~~ | ~~5.49E-02~~ | ~~3.13E-01~~ | ~~3.18E-01~~ |
| ~~0.7~~ | ~~1.18E-01~~ | ~~1.79E-02~~ | ~~2.80~~ | ~~2.84~~ | ~~3.29E-01~~ | ~~5.09E-02~~ | ~~3.29E-01~~ | ~~3.29E-01~~ |
| ~~0.6~~ | ~~1.18E-01~~ | ~~1.41E-02~~ | ~~3.21~~ | ~~3.40~~ | ~~3.77E-01~~ | ~~4.80E-02~~ | ~~3.77E-01~~ | ~~3.77E-01~~ |
| ~~0.5~~ | ~~1.14E-01~~ | ~~1.06E-02~~ | ~~3.30~~ | ~~2.91~~ | ~~3.75E-01~~ | ~~3.09E-02~~ | ~~3.75E-01~~ | ~~3.75E-01~~ |
| ~~0.4~~ | ~~8.21E-02~~ | ~~7.43E-03~~ | ~~2.91~~ | ~~2.57~~ | ~~2.39E-01~~ | ~~1.91E-02~~ | ~~2.39E-01~~ | ~~2.39E-01~~ |
| ~~0.3~~ | ~~5.14E-02~~ | ~~4.62E-03~~ | ~~3.61~~ | ~~3.34~~ | ~~1.85E-01~~ | ~~1.54E-02~~ | ~~1.85E-01~~ | ~~1.85E-01~~ |
| ~~0.2~~ | ~~2.33E-02~~ | ~~2.26E-03~~ | ~~2.95~~ | ~~2.67~~ | ~~6.89E-02~~ | ~~6.02E-03~~ | ~~6.89E-02~~ | ~~6.89E-02~~ |
| ~~0.15~~ | ~~1.18E-02~~ | ~~1.29E-03~~ | ~~2.28~~ | ~~2.00~~ | ~~2.70E-02~~ | ~~2.59E-03~~ | ~~2.70E-02~~ | ~~2.70E-02~~ |
| ~~0.125~~ | ~~7.20E-03~~ | ~~8.82E-04~~ | ~~2.17~~ | ~~1.81~~ | ~~1.56E-02~~ | ~~1.60E-03~~ | ~~1.56E-02~~ | ~~1.56E-02~~ |
| ~~0.1~~ | ~~3.63E-03~~ | ~~5.34E-04~~ | ~~2.28~~ | ~~1.71~~ | ~~8.27E-03~~ | ~~9.15E-04~~ | ~~8.27E-03~~ | ~~8.27E-03~~ |

Table 2.5S.2-19 Horizontal $10^{-5}$ Rock and Site Specific UHRS (in g)

| Freq. (Hz) | Rock UHRS LF Sa (g) | Rock UHRS HF Sa (g) | Transfer Functions LF Amp | Transfer Functions HF Amp | Surface UHRS LF Sa (g) | Surface UHRS HF Sa (g) | Raw Envelope Sa (g) | Smooth Spectrum Sa (g) |
|---|---|---|---|---|---|---|---|---|
| 100 | 1.26E-01 | 1.26E-01 | 1.583 | 1.175 | 1.99E-01 | 1.48E-01 | 1.99E-01 | 1.99E-01 |
| 90 | 1.39E-01 | 1.39E-01 | 1.438 | 1.066 | 1.99E-01 | 1.48E-01 | 1.99E-01 | 1.99E-01 |
| 80 | 1.60E-01 | 1.61E-01 | 1.245 | 0.921 | 2.00E-01 | 1.48E-01 | 2.00E-01 | 2.00E-01 |
| 70 | 1.93E-01 | 1.95E-01 | 1.033 | 0.764 | 2.00E-01 | 1.49E-01 | 2.00E-01 | 2.00E-01 |
| 60 | 2.36E-01 | 2.38E-01 | 0.848 | 0.627 | 2.00E-01 | 1.49E-01 | 2.00E-01 | 2.00E-01 |
| 50 | 2.78E-01 | 2.82E-01 | 0.719 | 0.533 | 2.00E-01 | 1.51E-01 | 2.00E-01 | 2.00E-01 |
| 45 | 2.97E-01 | 3.01E-01 | 0.676 | 0.504 | 2.01E-01 | 1.52E-01 | 2.01E-01 | 2.01E-01 |
| 40 | 3.12E-01 | 3.16E-01 | 0.645 | 0.485 | 2.01E-01 | 1.54E-01 | 2.01E-01 | 2.01E-01 |
| 35 | 3.24E-01 | 3.28E-01 | 0.624 | 0.477 | 2.02E-01 | 1.57E-01 | 2.02E-01 | 2.02E-01 |
| 30 | 3.33E-01 | 3.37E-01 | 0.613 | 0.483 | 2.04E-01 | 1.62E-01 | 2.04E-01 | 2.04E-01 |
| 25 | 3.40E-01 | 3.40E-01 | 0.611 | 0.509 | 2.08E-01 | 1.73E-01 | 2.08E-01 | 2.08E-01 |
| 20 | 3.22E-01 | 3.29E-01 | 0.670 | 0.586 | 2.16E-01 | 1.93E-01 | 2.16E-01 | 2.16E-01 |
| 15 | 2.95E-01 | 3.03E-01 | 0.788 | 0.753 | 2.32E-01 | 2.28E-01 | 2.32E-01 | 2.33E-01 |
| 12.5 | 2.77E-01 | 2.82E-01 | 0.882 | 0.891 | 2.44E-01 | 2.51E-01 | 2.51E-01 | 2.52E-01 |
| 10 | 2.53E-01 | 2.53E-01 | 1.044 | 1.119 | 2.64E-01 | 2.83E-01 | 2.83E-01 | 2.83E-01 |
| 9 | 2.46E-01 | 2.47E-01 | 1.120 | 1.211 | 2.75E-01 | 2.99E-01 | 2.99E-01 | 2.98E-01 |
| 8 | 2.37E-01 | 2.38E-01 | 1.203 | 1.314 | 2.85E-01 | 3.13E-01 | 3.13E-01 | 3.16E-01 |
| 7 | 2.27E-01 | 2.28E-01 | 1.328 | 1.489 | 3.02E-01 | 3.40E-01 | 3.40E-01 | 3.41E-01 |
| 6 | 2.15E-01 | 2.15E-01 | 1.540 | 1.743 | 3.31E-01 | 3.75E-01 | 3.75E-01 | 3.72E-01 |
| 5 | 2.00E-01 | 2.00E-01 | 1.789 | 1.972 | 3.57E-01 | 3.94E-01 | 3.94E-01 | 3.89E-01 |
| 4 | 1.88E-01 | 1.70E-01 | 2.014 | 2.239 | 3.79E-01 | 3.81E-01 | 3.81E-01 | 3.86E-01 |
| 3 | 1.69E-01 | 1.36E-01 | 2.371 | 2.585 | 4.01E-01 | 3.52E-01 | 4.01E-01 | 4.01E-01 |
| 2.5 | 1.54E-01 | 1.16E-01 | 2.700 | 2.940 | 4.14E-01 | 3.41E-01 | 4.14E-01 | 4.13E-01 |
| 2 | 1.46E-01 | 9.26E-02 | 2.735 | 2.785 | 4.00E-01 | 2.58E-01 | 4.00E-01 | 4.04E-01 |
| 1.5 | 1.36E-01 | 6.60E-02 | 2.973 | 3.041 | 4.04E-01 | 2.01E-01 | 4.04E-01 | 3.99E-01 |
| 1.25 | 1.27E-01 | 5.20E-02 | 3.066 | 3.079 | 3.88E-01 | 1.60E-01 | 3.88E-01 | 3.85E-01 |
| 1 | 1.14E-01 | 3.82E-02 | 2.997 | 3.018 | 3.41E-01 | 1.15E-01 | 3.41E-01 | 3.48E-01 |
| 0.9 | 1.18E-01 | 3.28E-02 | 2.815 | 2.846 | 3.32E-01 | 9.34E-02 | 3.32E-01 | 3.41E-01 |
| 0.8 | 1.19E-01 | 2.77E-02 | 2.935 | 2.976 | 3.50E-01 | 8.24E-02 | 3.50E-01 | 3.37E-01 |
| 0.7 | 1.17E-01 | 2.27E-02 | 2.809 | 2.788 | 3.29E-01 | 6.34E-02 | 3.29E-01 | 3.51E-01 |
| 0.6 | 1.17E-01 | 1.81E-02 | 3.243 | 3.269 | 3.80E-01 | 5.90E-02 | 3.80E-01 | 3.54E-01 |
| 0.5 | 1.14E-01 | 1.37E-02 | 3.009 | 3.014 | 3.42E-01 | 4.12E-02 | 3.42E-01 | 3.46E-01 |
| 0.4 | 8.27E-02 | 9.61E-03 | 3.241 | 3.063 | 2.68E-01 | 2.94E-02 | 2.68E-01 | 2.70E-01 |
| 0.3 | 5.27E-02 | 5.97E-03 | 3.276 | 3.153 | 1.73E-01 | 1.88E-02 | 1.73E-01 | 1.72E-01 |
| 0.2 | 2.49E-02 | 2.89E-03 | 2.899 | 2.763 | 7.23E-02 | 7.98E-03 | 7.23E-02 | 7.72E-02 |
| 0.15 | 1.32E-02 | 1.64E-03 | 3.018 | 2.910 | 3.99E-02 | 4.76E-03 | 3.99E-02 | 4.03E-02 |
| 0.125 | 8.38E-03 | 1.11E-03 | 3.389 | 3.299 | 2.84E-02 | 3.66E-03 | 2.84E-02 | 2.81E-02 |
| 0.1 | 4.49E-03 | 6.67E-04 | 3.154 | 3.014 | 1.42E-02 | 2.01E-03 | 1.42E-02 | 1.42E-02 |

**Table 2.5S.2-20 Input Rock Motion Durations**

| Set of Runs | Input Rock Spectra | | | |
|---|---|---|---|---|
| | Description | Recurrence | Magnitude | Duration [sec] |
| LF $10^{-4}$ | Low Freq. | $10^{-4}$ | 7.6 | 13 |
| HF $10^{-4}$ | High Freq | $10^{-4}$ | 6.7 | 10 |
| LF $10^{-5}$ | Low Freq. | $10^{-5}$ | 7.7 | 13 |
| HF $10^{-5}$ | High Freq. | $10^{-5}$ | 6.1 | 7 |

**Table 2.5S.2-21 Horizontal $10^{-4}$ and $10^{-5}$ Site Specific UHRS (in g) and Calculation of GMRS (in g)**

| Freq. | $10^{-4}$ smooth spectrum | $10^{-5}$ smooth spectrum | AR | DF | GMRS |
|---|---|---|---|---|---|
| 100 | 7.17E-02 | 1.99E-01 | 2.78 | 1.36 | 9.75E-02 |
| 90 | 7.17E-02 | 1.99E-01 | 2.78 | 1.36 | 9.75E-02 |
| 80 | 7.18E-02 | 2.00E-01 | 2.78 | 1.36 | 9.76E-02 |
| 70 | 7.19E-02 | 2.00E-01 | 2.78 | 1.36 | 9.76E-02 |
| 60 | 7.20E-02 | 2.00E-01 | 2.78 | 1.36 | 9.78E-02 |
| 50 | 7.22E-02 | 2.00E-01 | 2.77 | 1.36 | 9.80E-02 |
| 45 | 7.25E-02 | 2.01E-01 | 2.77 | 1.35 | 9.82E-02 |
| 40 | 7.29E-02 | 2.01E-01 | 2.76 | 1.35 | 9.85E-02 |
| 35 | 7.35E-02 | 2.02E-01 | 2.75 | 1.35 | 9.91E-02 |
| 30 | 7.46E-02 | 2.04E-01 | 2.74 | 1.34 | 1.00E-01 |
| 25 | 7.67E-02 | 2.08E-01 | 2.72 | 1.34 | 1.02E-01 |
| 20 | 8.02E-02 | 2.16E-01 | 2.69 | 1.33 | 1.06E-01 |
| 15 | 8.66E-02 | 2.33E-01 | 2.69 | 1.32 | 1.15E-01 |
| 12.5 | 9.14E-02 | 2.52E-01 | 2.76 | 1.35 | 1.23E-01 |
| 10 | 9.86E-02 | 2.83E-01 | 2.87 | 1.39 | 1.37E-01 |
| 9 | 1.02E-01 | 2.98E-01 | 2.90 | 1.41 | 1.44E-01 |
| 8 | 1.08E-01 | 3.16E-01 | 2.93 | 1.42 | 1.53E-01 |
| 7 | 1.15E-01 | 3.41E-01 | 2.95 | 1.43 | 1.65E-01 |
| 6 | 1.26E-01 | 3.72E-01 | 2.95 | 1.43 | 1.80E-01 |
| 5 | 1.35E-01 | 3.89E-01 | 2.88 | 1.40 | 1.89E-01 |
| 4 | 1.43E-01 | 3.86E-01 | 2.69 | 1.33 | 1.90E-01 |
| 3 | 1.56E-01 | 4.01E-01 | 2.57 | 1.28 | 1.99E-01 |
| 2.5 | 1.64E-01 | 4.13E-01 | 2.53 | 1.26 | 2.06E-01 |
| 2 | 1.52E-01 | 4.04E-01 | 2.66 | 1.31 | 1.99E-01 |
| 1.5 | 1.46E-01 | 3.99E-01 | 2.74 | 1.34 | 1.96E-01 |
| 1.25 | 1.39E-01 | 3.85E-01 | 2.77 | 1.36 | 1.89E-01 |
| 1 | 1.26E-01 | 3.48E-01 | 2.76 | 1.35 | 1.70E-01 |
| 0.9 | 1.22E-01 | 3.41E-01 | 2.81 | 1.37 | 1.67E-01 |
| 0.8 | 1.16E-01 | 3.37E-01 | 2.92 | 1.41 | 1.63E-01 |
| 0.7 | 1.16E-01 | 3.51E-01 | 3.03 | 1.46 | 1.69E-01 |
| 0.6 | 1.11E-01 | 3.54E-01 | 3.18 | 1.51 | 1.68E-01 |
| 0.5 | 1.04E-01 | 3.46E-01 | 3.31 | 1.56 | 1.63E-01 |
| 0.4 | 7.94E-02 | 2.70E-01 | 3.40 | 1.60 | 1.27E-01 |
| 0.3 | 5.05E-02 | 1.72E-01 | 3.41 | 1.60 | 8.08E-02 |
| 0.2 | 2.25E-02 | 7.72E-02 | 3.44 | 1.61 | 3.62E-02 |
| 0.15 | 1.18E-02 | 4.03E-02 | 3.42 | 1.60 | 1.89E-02 |
| 0.125 | 8.25E-03 | 2.81E-02 | 3.41 | 1.60 | 1.32E-02 |
| 0.1 | 4.17E-03 | 1.42E-02 | 3.40 | 1.60 | 6.65E-03 |

Table 2.5S.2-20 ~~Horizontal $10^{-4}$ and $10^{-5}$ Site Specific UHRS (in g) and Calculation of GMRS (in g)~~

| ~~Freq.~~ | ~~$10^{-4}$ smooth spectrum~~ | ~~$10^{-5}$ smooth spectrum~~ | ~~AR~~ | ~~DF~~ | ~~GMRS~~ |
|---|---|---|---|---|---|
| ~~100~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.675~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~90~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.675~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~80~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.674~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~70~~ | ~~6.48E-02~~ | ~~1.73E-01~~ | ~~2.673~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~60~~ | ~~6.48E-02~~ | ~~1.73E-01~~ | ~~2.672~~ | ~~1.317~~ | ~~8.54E-02~~ |
| ~~50~~ | ~~6.50E-02~~ | ~~1.73E-01~~ | ~~2.669~~ | ~~1.316~~ | ~~8.55E-02~~ |
| ~~45~~ | ~~6.51E-02~~ | ~~1.74E-01~~ | ~~2.665~~ | ~~1.315~~ | ~~8.56E-02~~ |
| ~~40~~ | ~~6.53E-02~~ | ~~1.74E-01~~ | ~~2.660~~ | ~~1.312~~ | ~~8.57E-02~~ |
| ~~35~~ | ~~6.57E-02~~ | ~~1.74E-01~~ | ~~2.651~~ | ~~1.309~~ | ~~8.59E-02~~ |
| ~~30~~ | ~~6.63E-02~~ | ~~1.75E-01~~ | ~~2.634~~ | ~~1.302~~ | ~~8.63E-02~~ |
| ~~25~~ | ~~6.76E-02~~ | ~~1.76E-01~~ | ~~2.604~~ | ~~1.290~~ | ~~8.72E-02~~ |
| ~~20~~ | ~~6.98E-02~~ | ~~1.79E-01~~ | ~~2.560~~ | ~~1.273~~ | ~~8.89E-02~~ |
| ~~15~~ | ~~7.43E-02~~ | ~~1.86E-01~~ | ~~2.498~~ | ~~1.248~~ | ~~9.28E-02~~ |
| ~~12.5~~ | ~~7.83E-02~~ | ~~1.93E-01~~ | ~~2.463~~ | ~~1.234~~ | ~~9.67E-02~~ |
| ~~10~~ | ~~8.44E-02~~ | ~~2.22E-01~~ | ~~2.634~~ | ~~1.302~~ | ~~1.10E-01~~ |
| ~~9~~ | ~~8.84E-02~~ | ~~2.41E-01~~ | ~~2.723~~ | ~~1.337~~ | ~~1.18E-01~~ |
| ~~8~~ | ~~9.29E-02~~ | ~~2.58E-01~~ | ~~2.775~~ | ~~1.358~~ | ~~1.26E-01~~ |
| ~~7~~ | ~~9.99E-02~~ | ~~2.85E-01~~ | ~~2.849~~ | ~~1.387~~ | ~~1.39E-01~~ |
| ~~6~~ | ~~1.08E-01~~ | ~~3.09E-01~~ | ~~2.852~~ | ~~1.388~~ | ~~1.51E-01~~ |
| ~~5~~ | ~~1.14E-01~~ | ~~3.23E-01~~ | ~~2.831~~ | ~~1.379~~ | ~~1.57E-01~~ |
| ~~4~~ | ~~1.22E-01~~ | ~~3.18E-01~~ | ~~2.602~~ | ~~1.290~~ | ~~1.58E-01~~ |
| ~~3~~ | ~~1.35E-01~~ | ~~3.18E-01~~ | ~~2.354~~ | ~~1.190~~ | ~~1.61E-01~~ |
| ~~2.5~~ | ~~1.39E-01~~ | ~~3.26E-01~~ | ~~2.349~~ | ~~1.188~~ | ~~1.65E-01~~ |
| ~~2~~ | ~~1.35E-01~~ | ~~3.34E-01~~ | ~~2.482~~ | ~~1.242~~ | ~~1.67E-01~~ |
| ~~1.5~~ | ~~1.29E-01~~ | ~~3.38E-01~~ | ~~2.631~~ | ~~1.301~~ | ~~1.67E-01~~ |
| ~~1.25~~ | ~~1.24E-01~~ | ~~3.33E-01~~ | ~~2.684~~ | ~~1.322~~ | ~~1.64E-01~~ |
| ~~1~~ | ~~1.14E-01~~ | ~~3.24E-01~~ | ~~2.832~~ | ~~1.380~~ | ~~1.58E-01~~ |
| ~~0.9~~ | ~~1.10E-01~~ | ~~3.18E-01~~ | ~~2.891~~ | ~~1.403~~ | ~~1.54E-01~~ |
| ~~0.8~~ | ~~1.07E-01~~ | ~~3.18E-01~~ | ~~2.978~~ | ~~1.436~~ | ~~1.53E-01~~ |
| ~~0.7~~ | ~~1.12E-01~~ | ~~3.29E-01~~ | ~~2.952~~ | ~~1.427~~ | ~~1.59E-01~~ |
| ~~0.6~~ | ~~1.23E-01~~ | ~~3.77E-01~~ | ~~3.078~~ | ~~1.475~~ | ~~1.81E-01~~ |
| ~~0.5~~ | ~~1.02E-01~~ | ~~3.75E-01~~ | ~~3.684~~ | ~~1.703~~ | ~~1.73E-01~~ |
| ~~0.4~~ | ~~6.64E-02~~ | ~~2.39E-01~~ | ~~3.591~~ | ~~1.668~~ | ~~1.11E-01~~ |
| ~~0.3~~ | ~~5.26E-02~~ | ~~1.85E-01~~ | ~~3.522~~ | ~~1.643~~ | ~~8.65E-02~~ |
| ~~0.2~~ | ~~1.92E-02~~ | ~~6.89E-02~~ | ~~3.583~~ | ~~1.666~~ | ~~3.20E-02~~ |
| ~~0.15~~ | ~~7.53E-03~~ | ~~2.70E-02~~ | ~~3.578~~ | ~~1.664~~ | ~~1.25E-02~~ |
| ~~0.125~~ | ~~4.35E-03~~ | ~~1.56E-02~~ | ~~3.581~~ | ~~1.665~~ | ~~7.25E-03~~ |
| ~~0.1~~ | ~~2.31E-03~~ | ~~8.27E-03~~ | ~~3.578~~ | ~~1.664~~ | ~~3.85E-03~~ |

**Table 2.5S.2-22 Vertical $10^{-4}$ and $10^{-5}$ Site Specific UHRS (in g) and Calculation of GMRS (in g)**

| Freq | V/H ratio | $10^{-4}$ vertical UHRS | $10^{-5}$ vertical UHRS | AR | DF | DRS |
|---|---|---|---|---|---|---|
| 100 | 1 | 7.17E-02 | 1.99E-01 | 2.78 | 1.36 | 9.75E-02 |
| 90 | 1 | 7.17E-02 | 1.99E-01 | 2.78 | 1.36 | 9.75E-02 |
| 80 | 1 | 7.18E-02 | 2.00E-01 | 2.78 | 1.36 | 9.76E-02 |
| 70 | 1 | 7.19E-02 | 2.00E-01 | 2.78 | 1.36 | 9.76E-02 |
| 60 | 1 | 7.20E-02 | 2.00E-01 | 2.78 | 1.36 | 9.78E-02 |
| 50 | 1 | 7.22E-02 | 2.00E-01 | 2.77 | 1.36 | 9.80E-02 |
| 45 | 1 | 7.25E-02 | 2.01E-01 | 2.77 | 1.35 | 9.82E-02 |
| 40 | 1 | 7.29E-02 | 2.01E-01 | 2.76 | 1.35 | 9.85E-02 |
| 35 | 1 | 7.35E-02 | 2.02E-01 | 2.75 | 1.35 | 9.91E-02 |
| 30 | 1 | 7.46E-02 | 2.04E-01 | 2.74 | 1.34 | 1.00E-01 |
| 25 | 1 | 7.67E-02 | 2.08E-01 | 2.72 | 1.34 | 1.02E-01 |
| 20 | 1 | 8.02E-02 | 2.16E-01 | 2.69 | 1.33 | 1.06E-01 |
| 15 | 1 | 8.66E-02 | 2.33E-01 | 2.69 | 1.32 | 1.15E-01 |
| 12.5 | 1 | 9.14E-02 | 2.52E-01 | 2.76 | 1.35 | 1.23E-01 |
| 10 | 1 | 9.86E-02 | 2.83E-01 | 2.87 | 1.39 | 1.37E-01 |
| 9 | 1.000 | 1.02E-01 | 2.98E-01 | 2.90 | 1.41 | 1.44E-01 |
| 8 | 1.000 | 1.08E-01 | 3.16E-01 | 2.93 | 1.42 | 1.53E-01 |
| 7 | 1.000 | 1.15E-01 | 3.41E-01 | 2.95 | 1.43 | 1.65E-01 |
| 6 | 0.999 | 1.26E-01 | 3.72E-01 | 2.95 | 1.43 | 1.80E-01 |
| 5 | 0.999 | 1.35E-01 | 3.88E-01 | 2.88 | 1.40 | 1.89E-01 |
| 4 | 0.999 | 1.43E-01 | 3.86E-01 | 2.69 | 1.33 | 1.90E-01 |
| 3 | 0.857 | 1.34E-01 | 3.44E-01 | 2.57 | 1.28 | 1.71E-01 |
| 2.5 | 0.715 | 1.17E-01 | 2.95E-01 | 2.53 | 1.26 | 1.47E-01 |
| 2 | 0.710 | 1.08E-01 | 2.87E-01 | 2.66 | 1.31 | 1.42E-01 |
| 1.5 | 0.704 | 1.03E-01 | 2.81E-01 | 2.74 | 1.34 | 1.38E-01 |
| 1.25 | 0.701 | 9.75E-02 | 2.70E-01 | 2.77 | 1.36 | 1.32E-01 |
| 1 | 0.696 | 8.79E-02 | 2.42E-01 | 2.76 | 1.35 | 1.19E-01 |
| 0.9 | 0.694 | 8.44E-02 | 2.37E-01 | 2.81 | 1.37 | 1.16E-01 |
| 0.8 | 0.691 | 8.00E-02 | 2.33E-01 | 2.92 | 1.41 | 1.13E-01 |
| 0.7 | 0.689 | 7.97E-02 | 2.42E-01 | 3.03 | 1.46 | 1.16E-01 |
| 0.6 | 0.686 | 7.64E-02 | 2.43E-01 | 3.18 | 1.51 | 1.15E-01 |
| 0.5 | 0.682 | 7.13E-02 | 2.36E-01 | 3.31 | 1.56 | 1.11E-01 |
| 0.4 | 0.678 | 5.38E-02 | 1.83E-01 | 3.40 | 1.60 | 8.58E-02 |
| 0.3 | 0.672 | 3.39E-02 | 1.16E-01 | 3.41 | 1.60 | 5.43E-02 |
| 0.2 | 0.668 | 1.50E-02 | 5.16E-02 | 3.44 | 1.61 | 2.42E-02 |
| 0.15 | 0.668 | 7.88E-03 | 2.69E-02 | 3.42 | 1.60 | 1.26E-02 |
| 0.125 | 0.668 | 5.51E-03 | 1.88E-02 | 3.41 | 1.60 | 8.83E-03 |
| 0.1 | 0.668 | 2.79E-03 | 9.46E-03 | 3.40 | 1.60 | 4.45E-03 |

Table 2.5S.2-21 ~~Vertical $10^{-4}$ and $10^{-5}$ Site Specific UHRS (in g) and Calculation of GMRS (in g)~~

| ~~Freq~~ | ~~V/H ratio~~ | ~~$10^{-4}$ vertical UHRS~~ | ~~$10^{-5}$ vertical UHRS~~ | ~~$A_R$~~ | ~~DF~~ | ~~DRS~~ |
|---|---|---|---|---|---|---|
| ~~100~~ | ~~1~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.675~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~90~~ | ~~1~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.675~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~80~~ | ~~1~~ | ~~6.47E-02~~ | ~~1.73E-01~~ | ~~2.674~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~70~~ | ~~1~~ | ~~6.48E-02~~ | ~~1.73E-01~~ | ~~2.673~~ | ~~1.318~~ | ~~8.53E-02~~ |
| ~~60~~ | ~~1~~ | ~~6.48E-02~~ | ~~1.73E-01~~ | ~~2.672~~ | ~~1.317~~ | ~~8.54E-02~~ |
| ~~50~~ | ~~1~~ | ~~6.50E-02~~ | ~~1.73E-01~~ | ~~2.669~~ | ~~1.316~~ | ~~8.55E-02~~ |
| ~~45~~ | ~~1~~ | ~~6.51E-02~~ | ~~1.74E-01~~ | ~~2.665~~ | ~~1.315~~ | ~~8.56E-02~~ |
| ~~40~~ | ~~1~~ | ~~6.53E-02~~ | ~~1.74E-01~~ | ~~2.660~~ | ~~1.312~~ | ~~8.57E-02~~ |
| ~~35~~ | ~~1~~ | ~~6.57E-02~~ | ~~1.74E-01~~ | ~~2.651~~ | ~~1.309~~ | ~~8.59E-02~~ |
| ~~30~~ | ~~1~~ | ~~6.63E-02~~ | ~~1.75E-01~~ | ~~2.634~~ | ~~1.302~~ | ~~8.63E-02~~ |
| ~~25~~ | ~~1~~ | ~~6.76E-02~~ | ~~1.76E-01~~ | ~~2.604~~ | ~~1.290~~ | ~~8.72E-02~~ |
| ~~20~~ | ~~1~~ | ~~6.98E-02~~ | ~~1.79E-01~~ | ~~2.560~~ | ~~1.273~~ | ~~8.89E-02~~ |
| ~~15~~ | ~~1~~ | ~~7.43E-02~~ | ~~1.86E-01~~ | ~~2.498~~ | ~~1.248~~ | ~~9.28E-02~~ |
| ~~12.5~~ | ~~1~~ | ~~7.83E-02~~ | ~~1.93E-01~~ | ~~2.463~~ | ~~1.234~~ | ~~9.67E-02~~ |
| ~~10~~ | ~~1~~ | ~~8.44E-02~~ | ~~2.22E-01~~ | ~~2.634~~ | ~~1.302~~ | ~~1.10E-01~~ |
| ~~9~~ | ~~1~~ | ~~8.84E-02~~ | ~~2.41E-01~~ | ~~2.723~~ | ~~1.337~~ | ~~1.18E-01~~ |
| ~~8~~ | ~~1~~ | ~~9.29E-02~~ | ~~2.58E-01~~ | ~~2.775~~ | ~~1.358~~ | ~~1.26E-01~~ |
| ~~7~~ | ~~1~~ | ~~9.99E-02~~ | ~~2.85E-01~~ | ~~2.849~~ | ~~1.387~~ | ~~1.39E-01~~ |
| ~~6~~ | ~~1~~ | ~~1.08E-01~~ | ~~3.09E-01~~ | ~~2.852~~ | ~~1.388~~ | ~~1.51E-01~~ |
| ~~5~~ | ~~1~~ | ~~1.14E-01~~ | ~~3.23E-01~~ | ~~2.831~~ | ~~1.379~~ | ~~1.57E-01~~ |
| ~~4~~ | ~~1~~ | ~~1.22E-01~~ | ~~3.18E-01~~ | ~~2.602~~ | ~~1.290~~ | ~~1.58E-01~~ |
| ~~3~~ | ~~0.847~~ | ~~1.14E-01~~ | ~~2.70E-01~~ | ~~2.354~~ | ~~1.190~~ | ~~1.36E-01~~ |
| ~~2.5~~ | ~~0.667~~ | ~~9.25E-02~~ | ~~2.17E-01~~ | ~~2.349~~ | ~~1.188~~ | ~~1.10E-01~~ |
| ~~2~~ | ~~0.667~~ | ~~8.98E-02~~ | ~~2.23E-01~~ | ~~2.482~~ | ~~1.242~~ | ~~1.11E-01~~ |
| ~~1.5~~ | ~~0.667~~ | ~~8.57E-02~~ | ~~2.26E-01~~ | ~~2.631~~ | ~~1.301~~ | ~~1.12E-01~~ |
| ~~1.25~~ | ~~0.667~~ | ~~8.28E-02~~ | ~~2.22E-01~~ | ~~2.684~~ | ~~1.322~~ | ~~1.09E-01~~ |
| ~~1~~ | ~~0.667~~ | ~~7.64E-02~~ | ~~2.16E-01~~ | ~~2.832~~ | ~~1.380~~ | ~~1.05E-01~~ |
| ~~0.9~~ | ~~0.667~~ | ~~7.33E-02~~ | ~~2.12E-01~~ | ~~2.891~~ | ~~1.403~~ | ~~1.03E-01~~ |
| ~~0.8~~ | ~~0.667~~ | ~~7.12E-02~~ | ~~2.12E-01~~ | ~~2.978~~ | ~~1.436~~ | ~~1.02E-01~~ |
| ~~0.7~~ | ~~0.667~~ | ~~7.44E-02~~ | ~~2.20E-01~~ | ~~2.952~~ | ~~1.427~~ | ~~1.06E-01~~ |
| ~~0.6~~ | ~~0.667~~ | ~~8.18E-02~~ | ~~2.52E-01~~ | ~~3.078~~ | ~~1.475~~ | ~~1.21E-01~~ |
| ~~0.5~~ | ~~0.667~~ | ~~6.79E-02~~ | ~~2.50E-01~~ | ~~3.684~~ | ~~1.703~~ | ~~1.16E-01~~ |
| ~~0.4~~ | ~~0.667~~ | ~~4.43E-02~~ | ~~1.59E-01~~ | ~~3.591~~ | ~~1.668~~ | ~~7.39E-02~~ |
| ~~0.3~~ | ~~0.667~~ | ~~3.51E-02~~ | ~~1.24E-01~~ | ~~3.522~~ | ~~1.643~~ | ~~5.77E-02~~ |
| ~~0.2~~ | ~~0.667~~ | ~~1.28E-02~~ | ~~4.60E-02~~ | ~~3.583~~ | ~~1.666~~ | ~~2.14E-02~~ |
| ~~0.15~~ | ~~0.667~~ | ~~5.02E-03~~ | ~~1.80E-02~~ | ~~3.578~~ | ~~1.664~~ | ~~8.36E-03~~ |
| ~~0.125~~ | ~~0.667~~ | ~~2.90E-03~~ | ~~1.04E-02~~ | ~~3.581~~ | ~~1.665~~ | ~~4.83E-03~~ |
| ~~0.1~~ | ~~0.667~~ | ~~1.54E-03~~ | ~~5.52E-03~~ | ~~3.578~~ | ~~1.664~~ | ~~2.57E-03~~ |

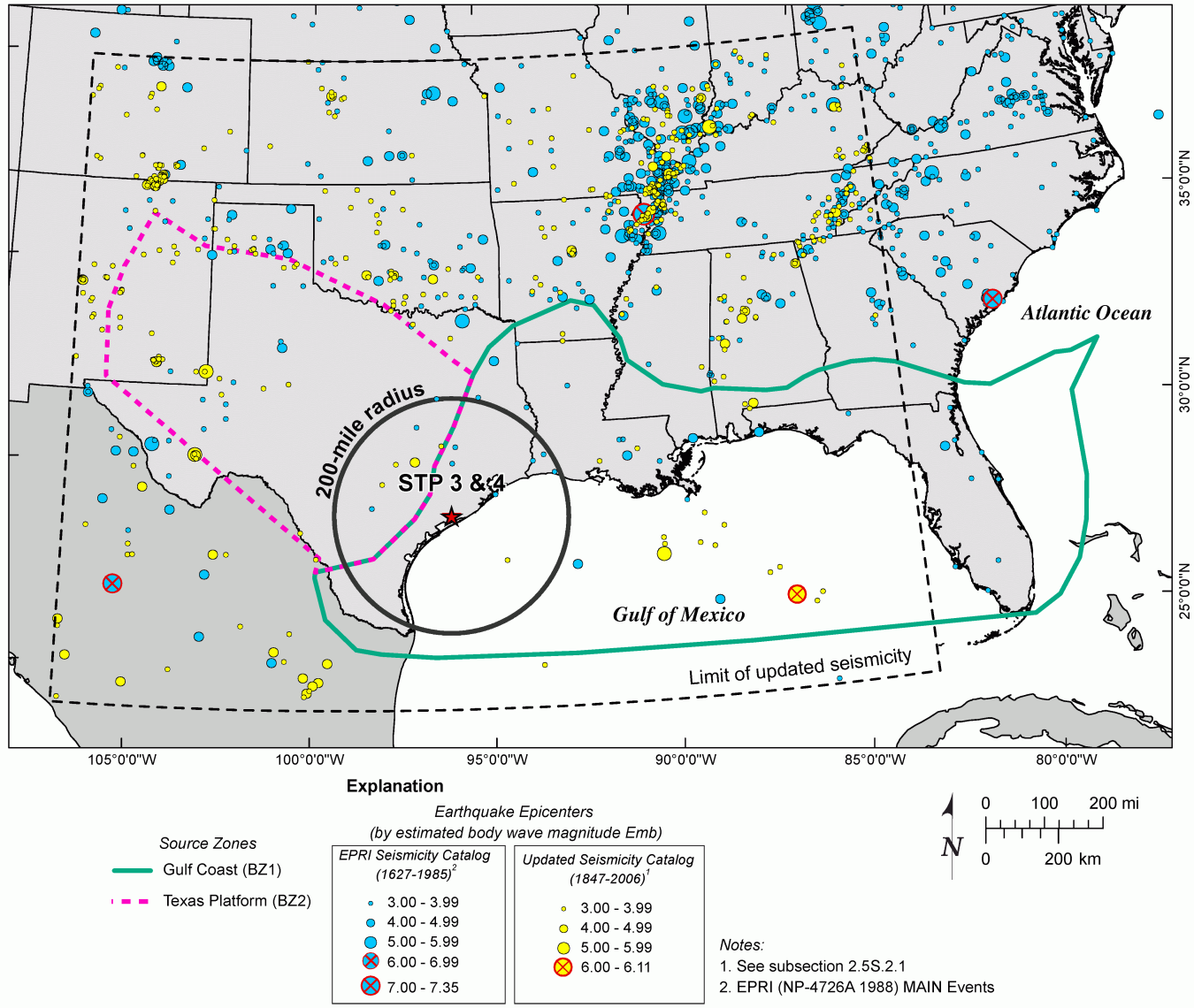


**Figure 2.5S.2-1 Bechtel Group EPRI Source Zones**

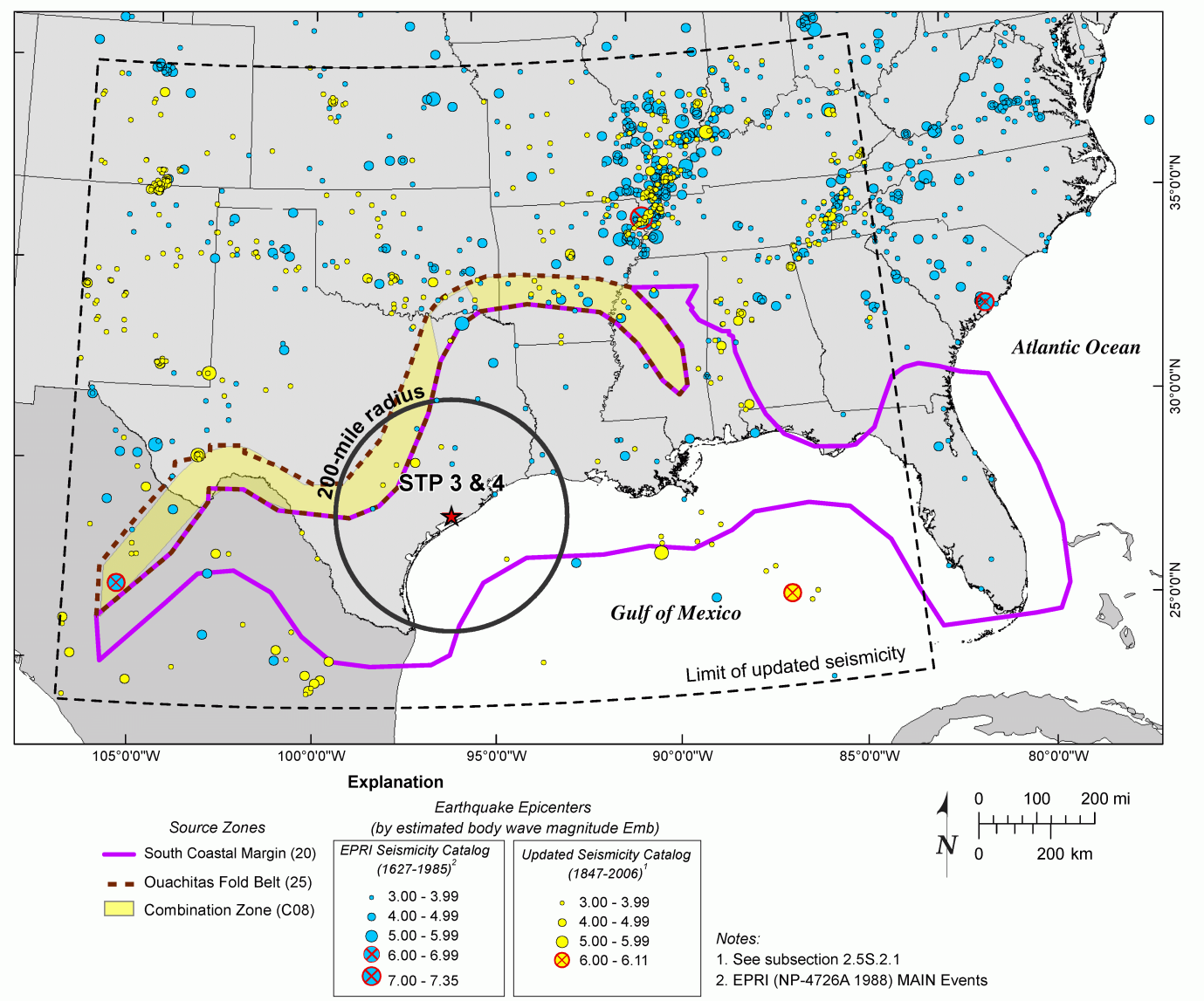


**Figure 2.5S.2-2 Dames and Moore EPRI Source Zones**

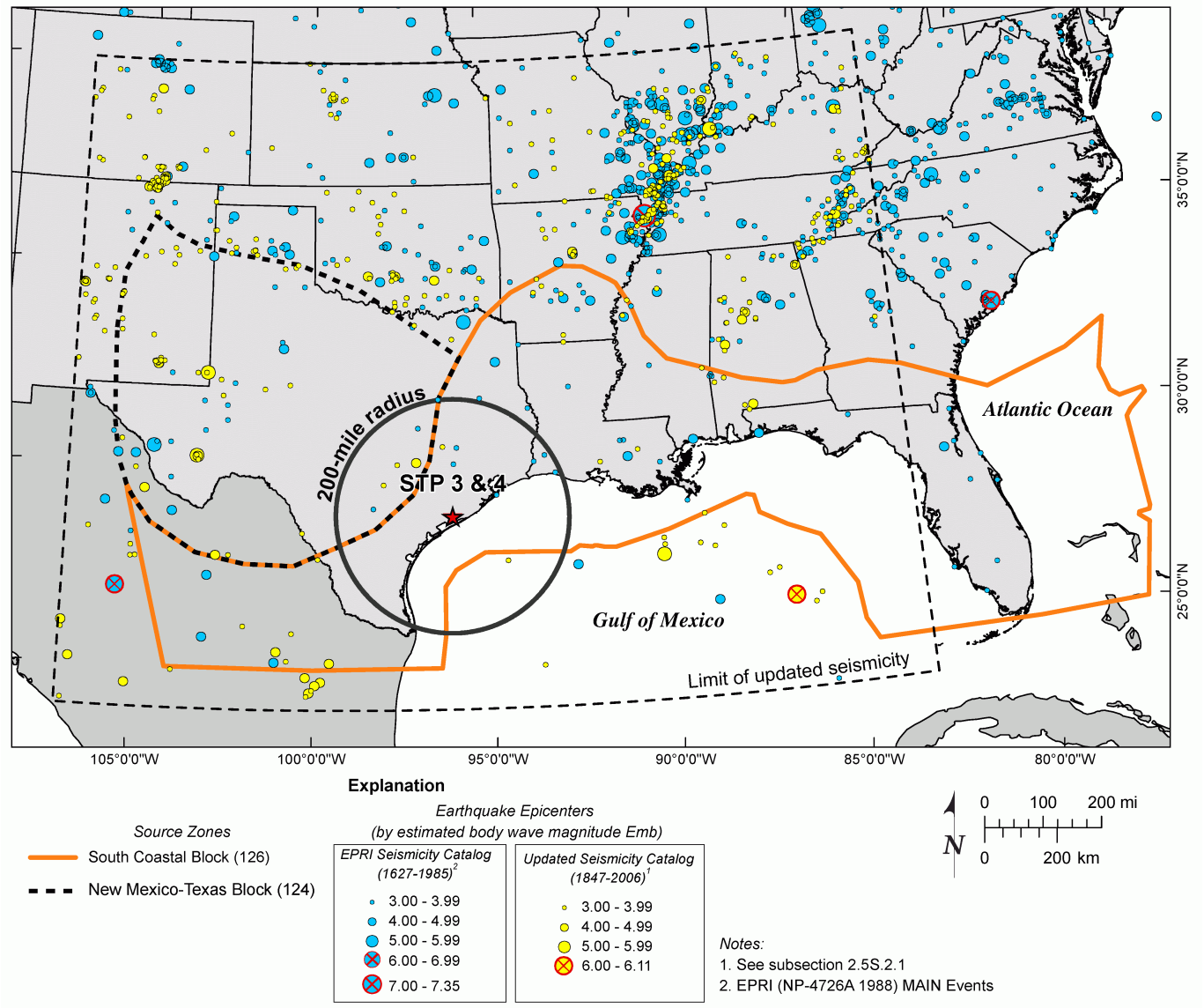


**Figure 2.5S.2-3 Law Engineering EPRI (1988) Source Zones**

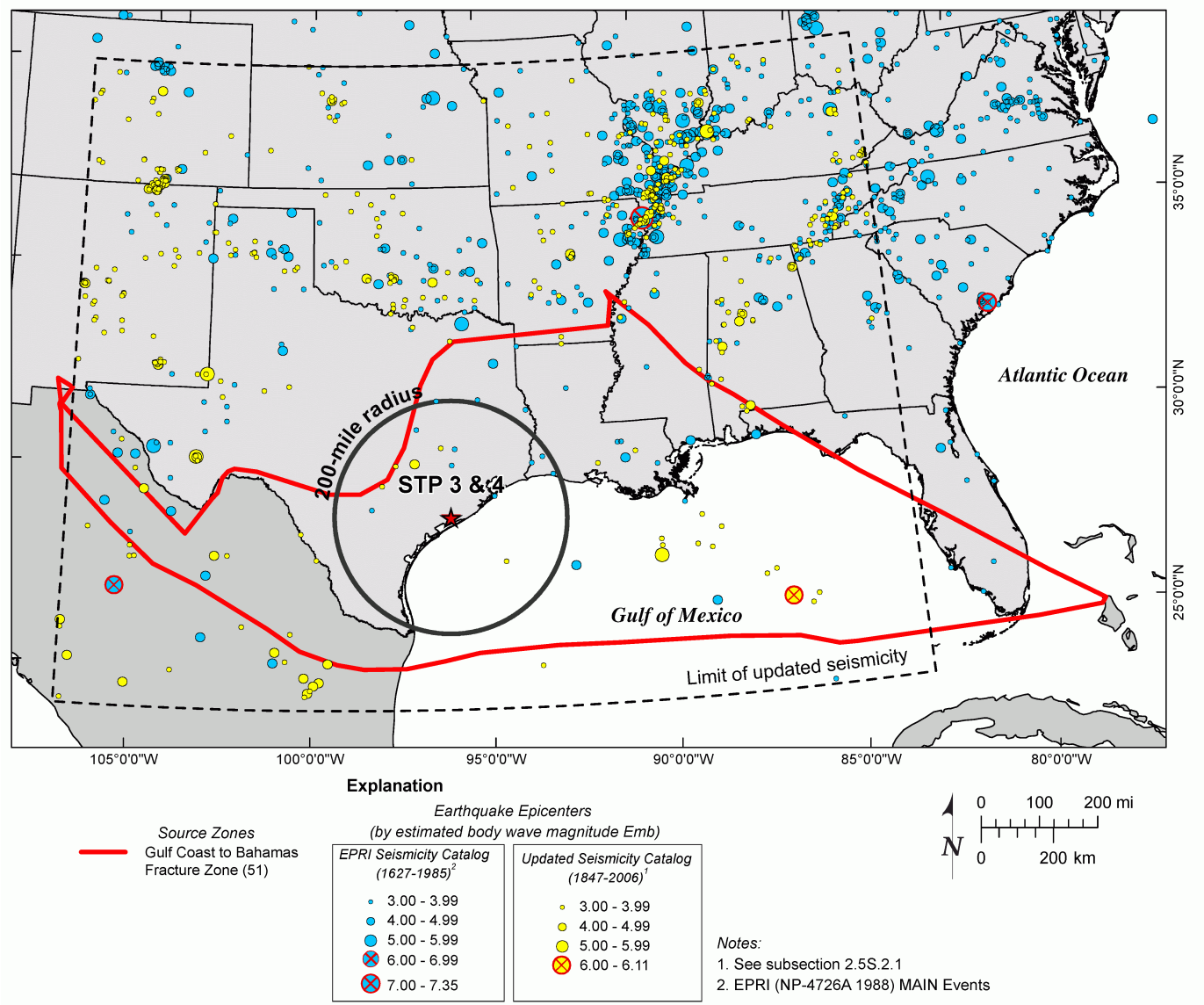


**Figure 2.5S.2-4 Rondout Associates EPRI Source Zones**

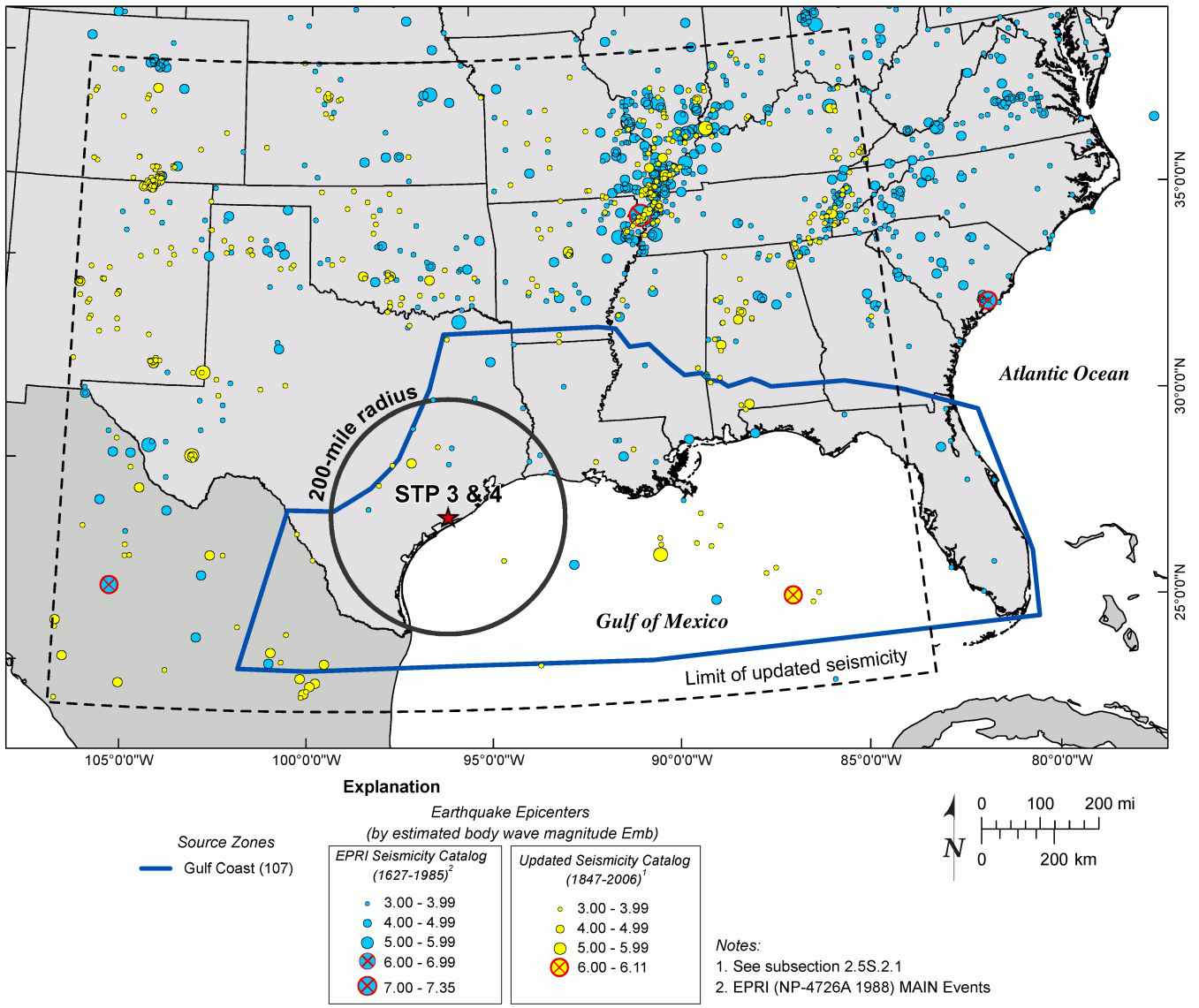


**Figure 2.5S.2-5 Weston Geophysical Corporation EPRI (1989) Source Zones**

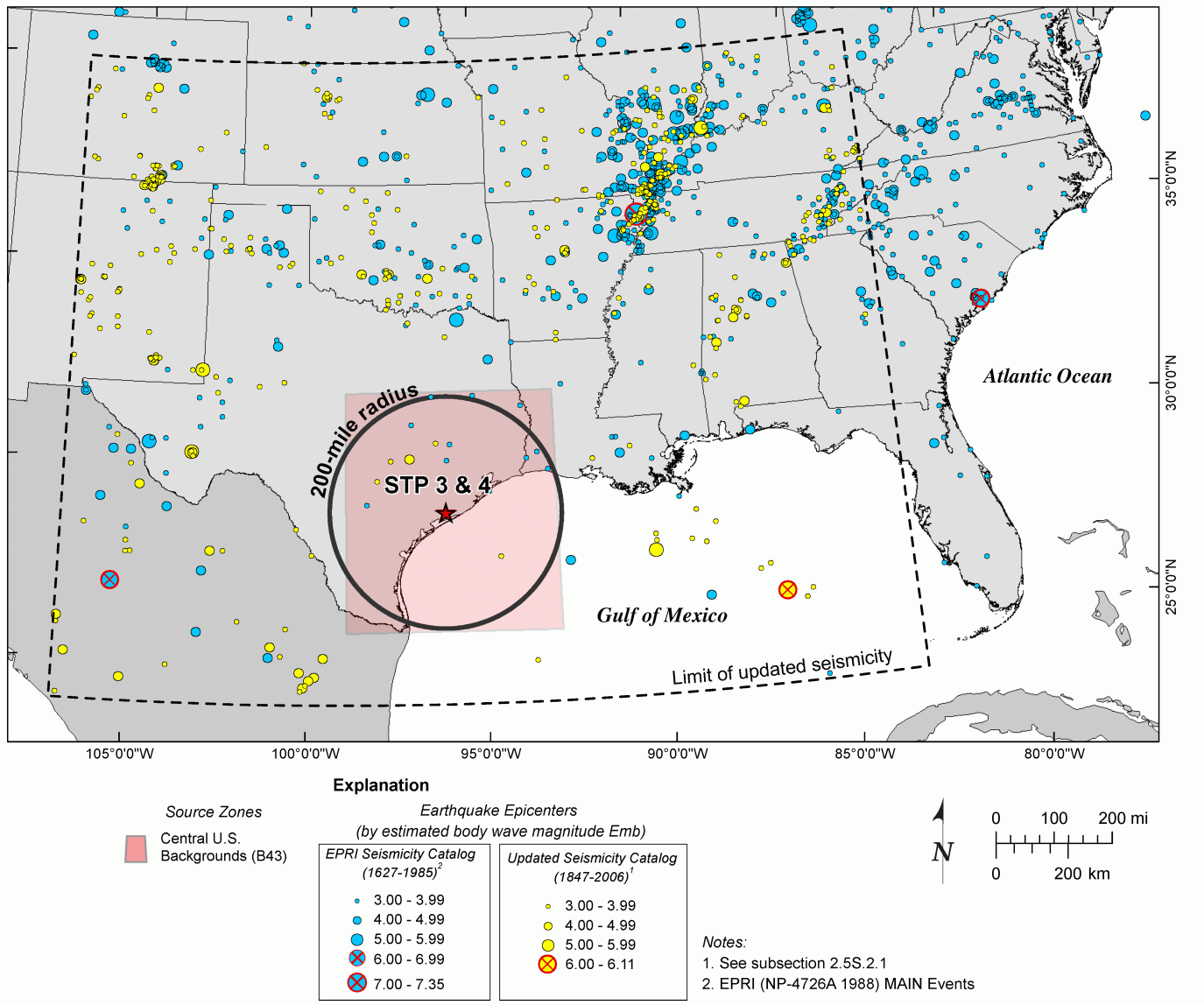


**Figure 2.5S.2-6 Woodward-Clyde Consultants EPRI Source Zones**

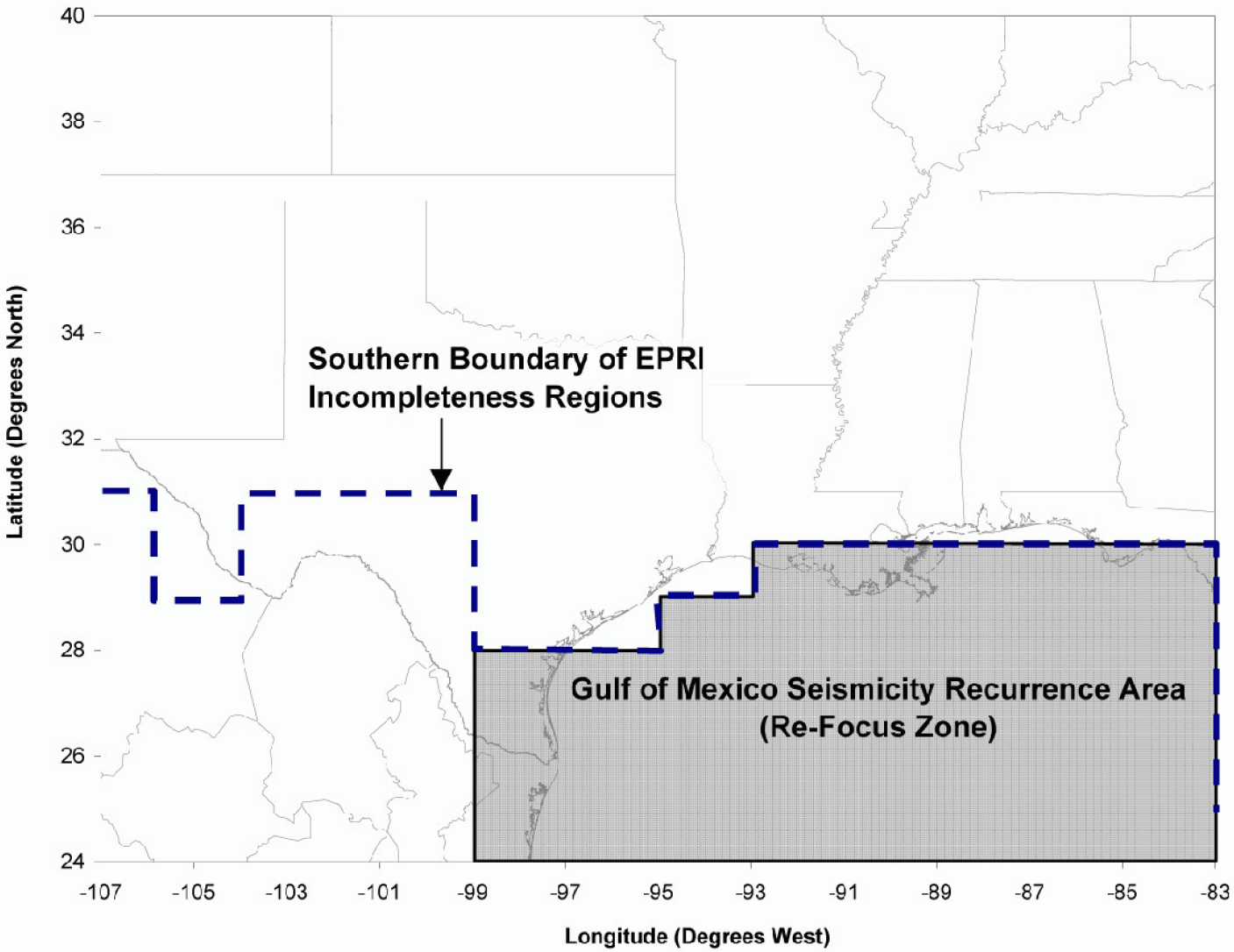


**Figure 2.5S.2-7 Southern Boundary of EPRI Incompleteness Regions (~~Reference 2.5S.2-3~~Table 5-1 of Reference 2.5S.2-16) and Gulf of Mexico Seismicity Recurrence Area (Re-Focus Zone)**

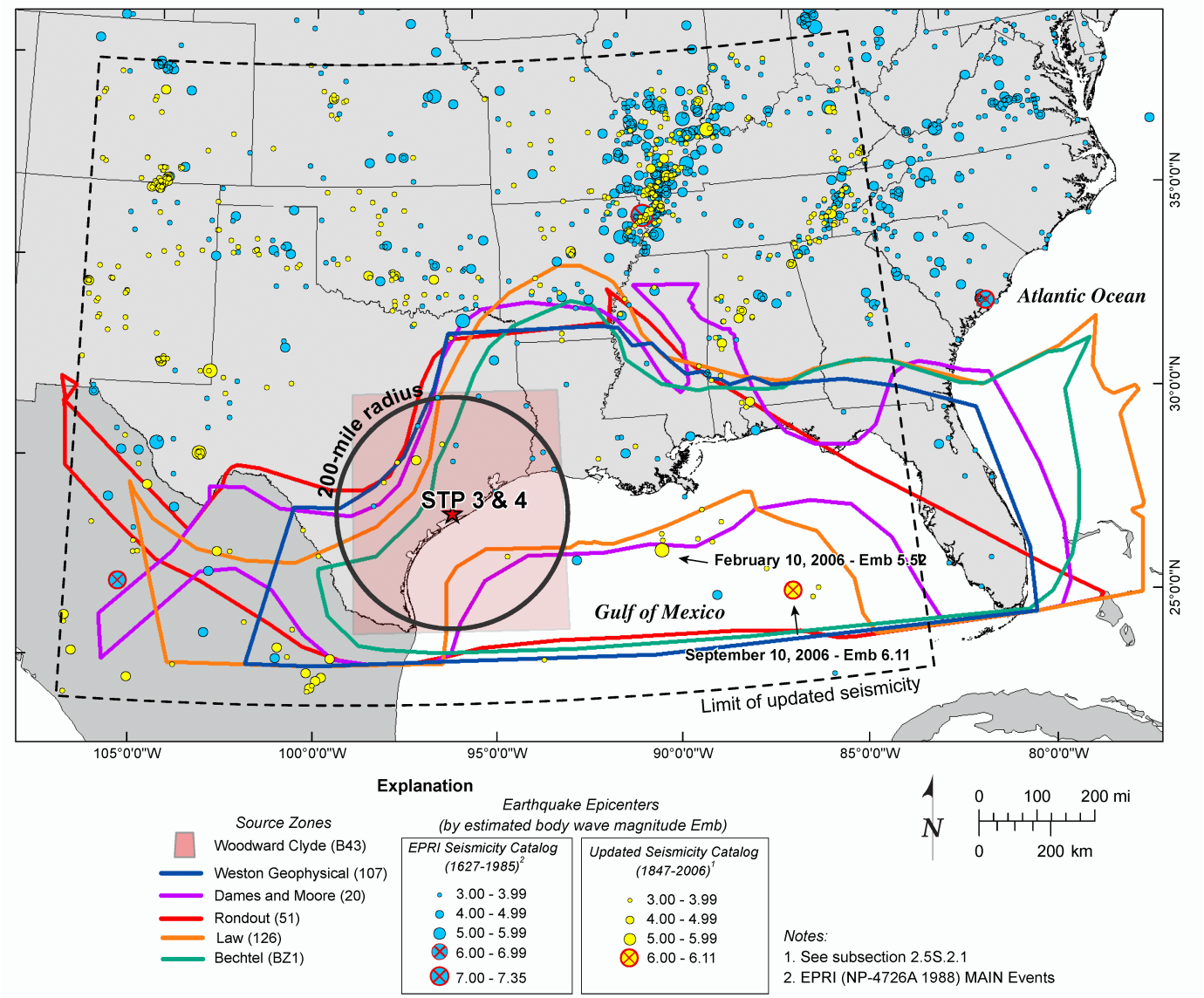


**Figure 2.5S.2-8 EPRI EST Gulf Coast Background Source Zones**

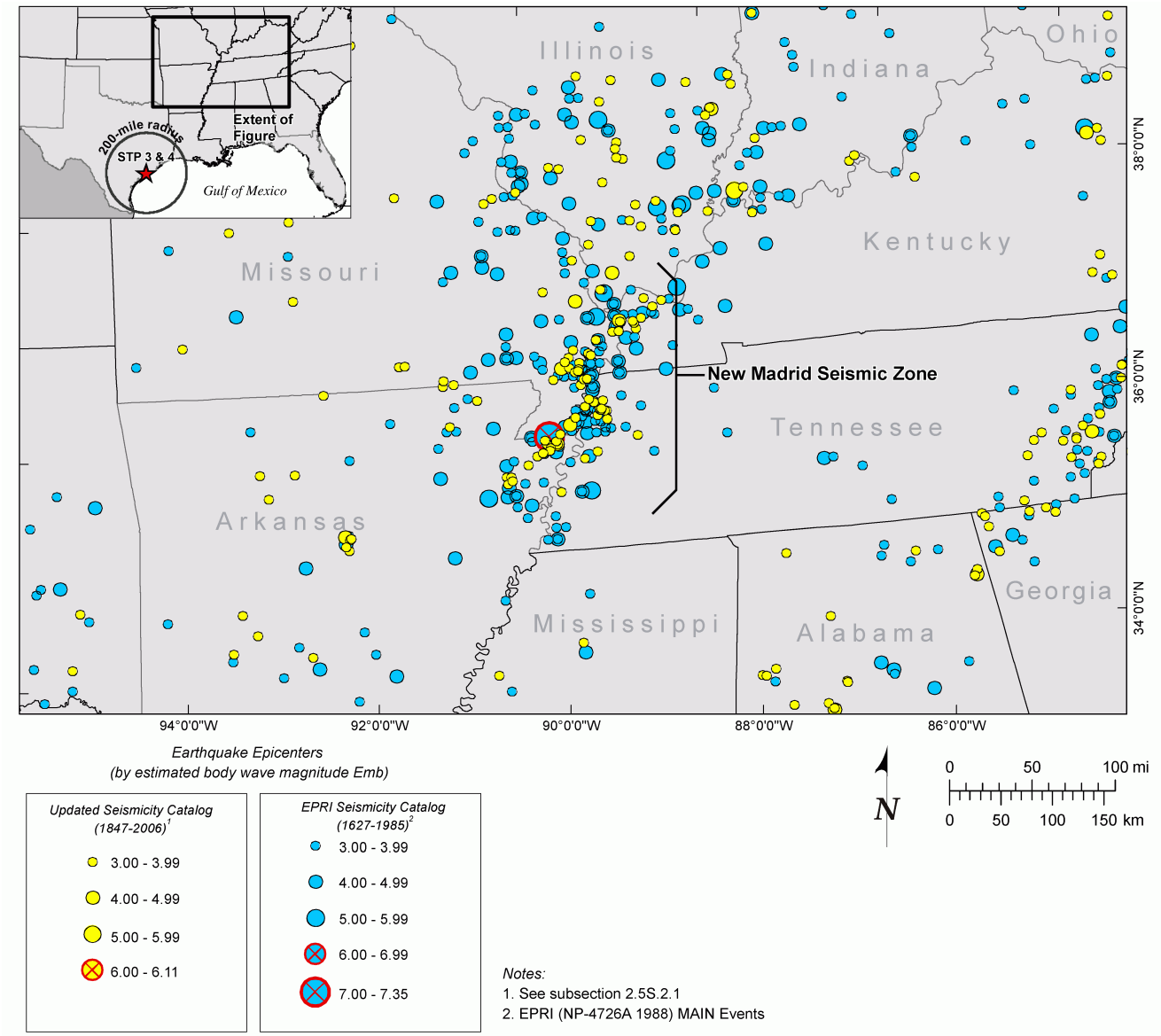


**Figure 2.5S.2-9 New Madrid Seismic Zone Seismicity**

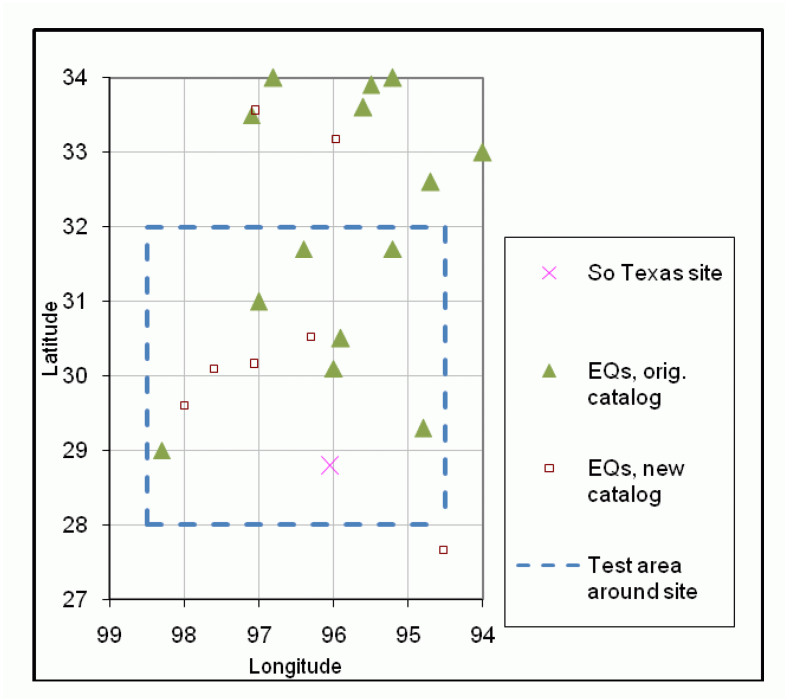


**Figure 2.5S.2-10 Historical Seismicity in the Vicinity of South Texas Site and Test Area Used to Test the Effects of Additional Seismicity**

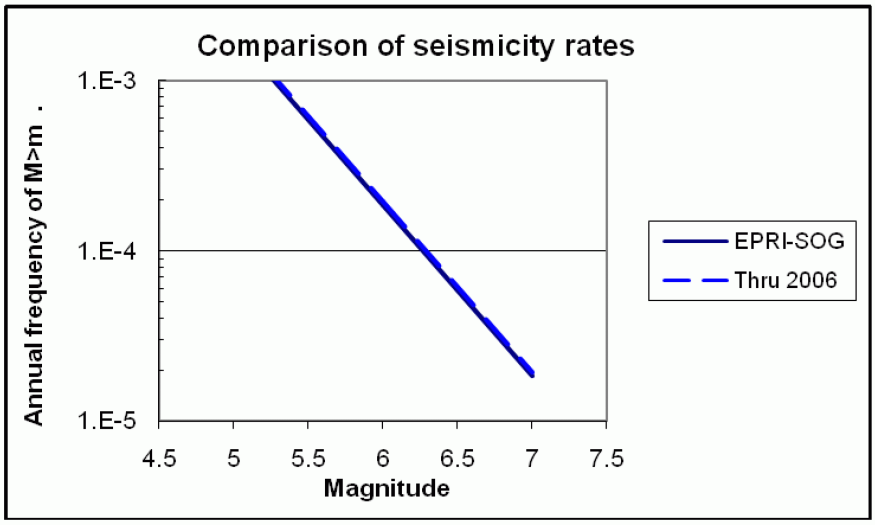


**Figure 2.5S.2-11 Earthquake Occurrence Rates for EPRI (1989) Catalog and for Catalog Extended through 2006, for Test Area**

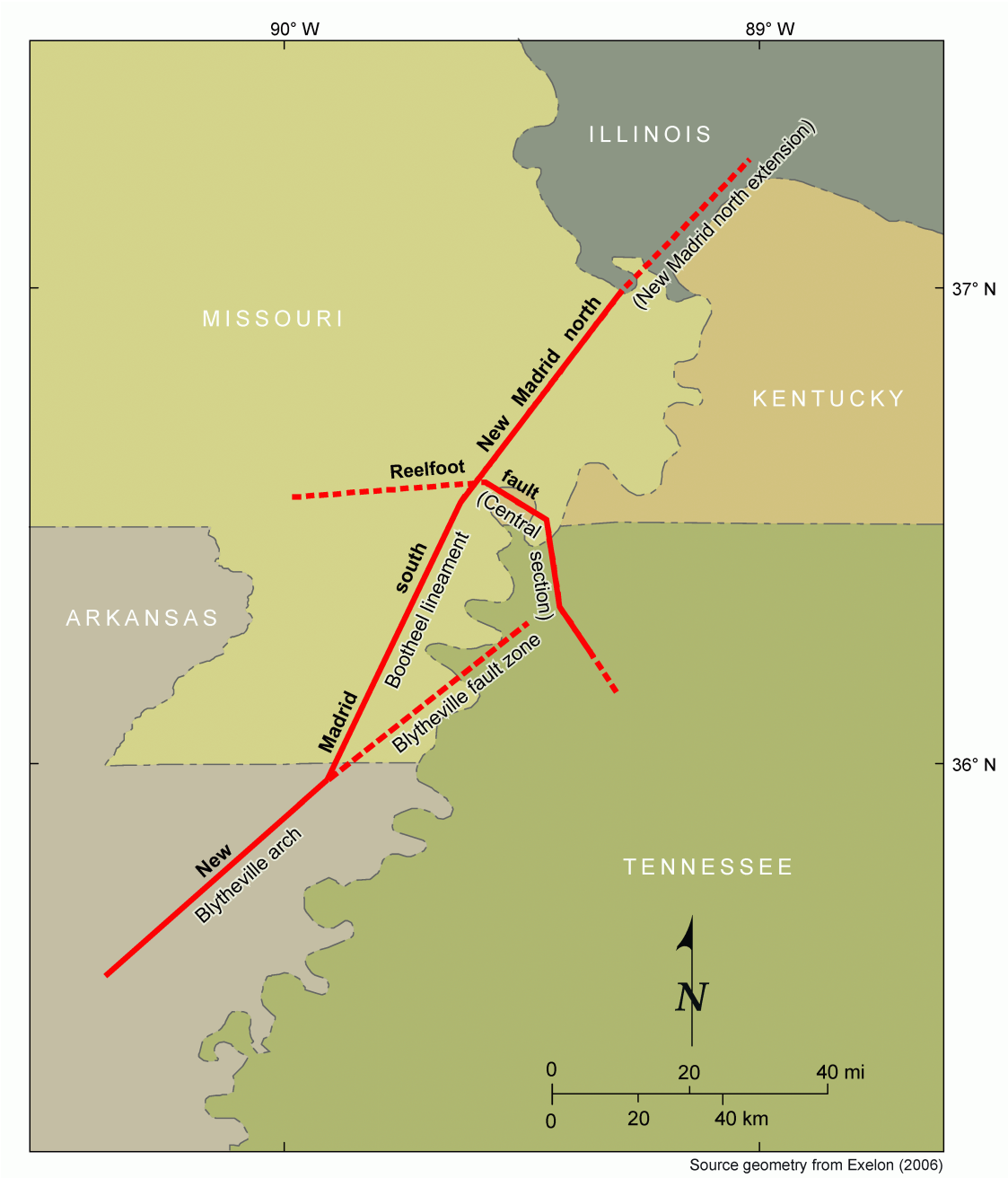


**Figure 2.5S.2-12 New Madrid Faults from Clinton ESP Source Model**

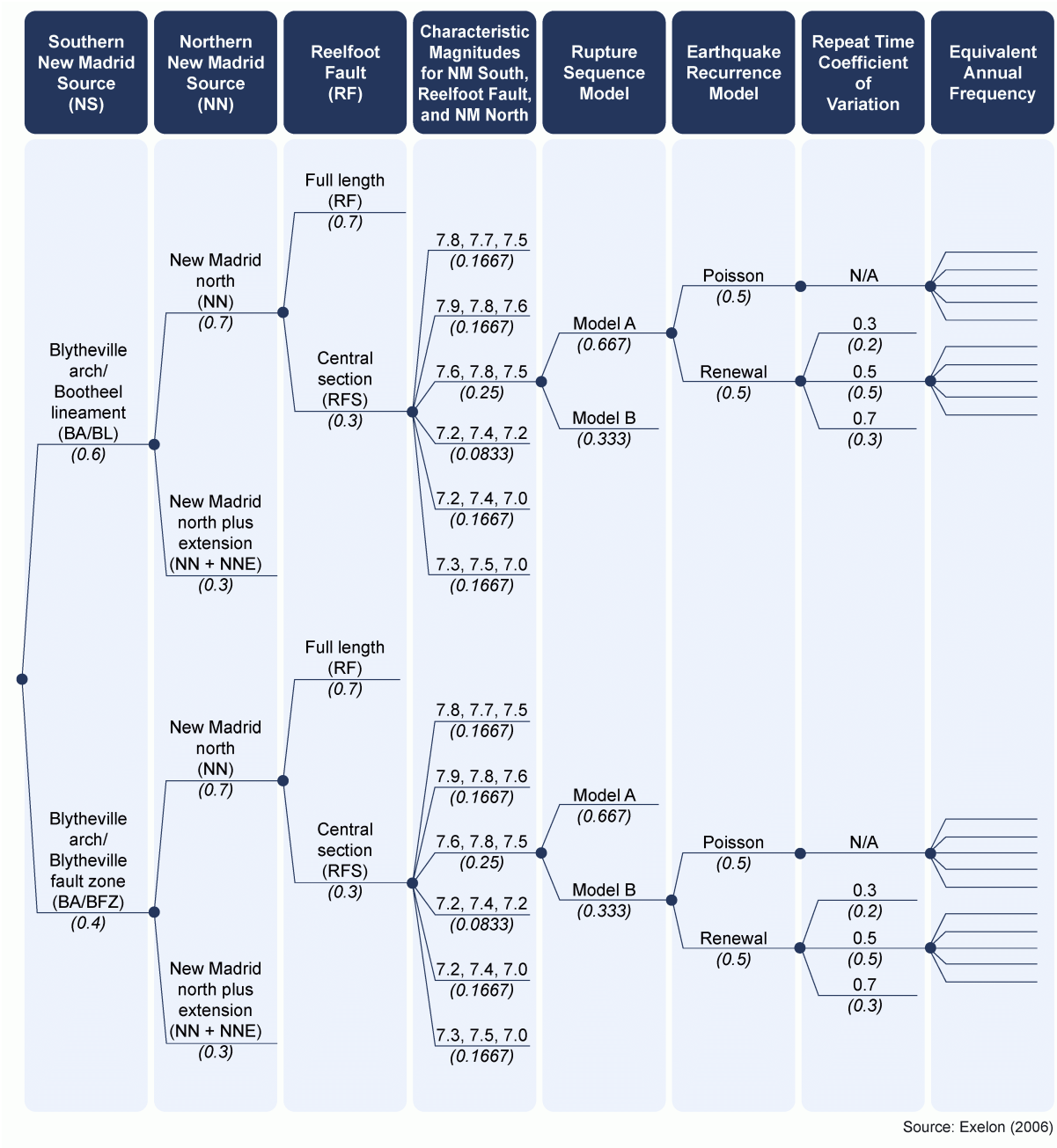


**Figure 2.5S.2-13 Source Characterization Logic Tree for Characteristic New Madrid Earthquakes**

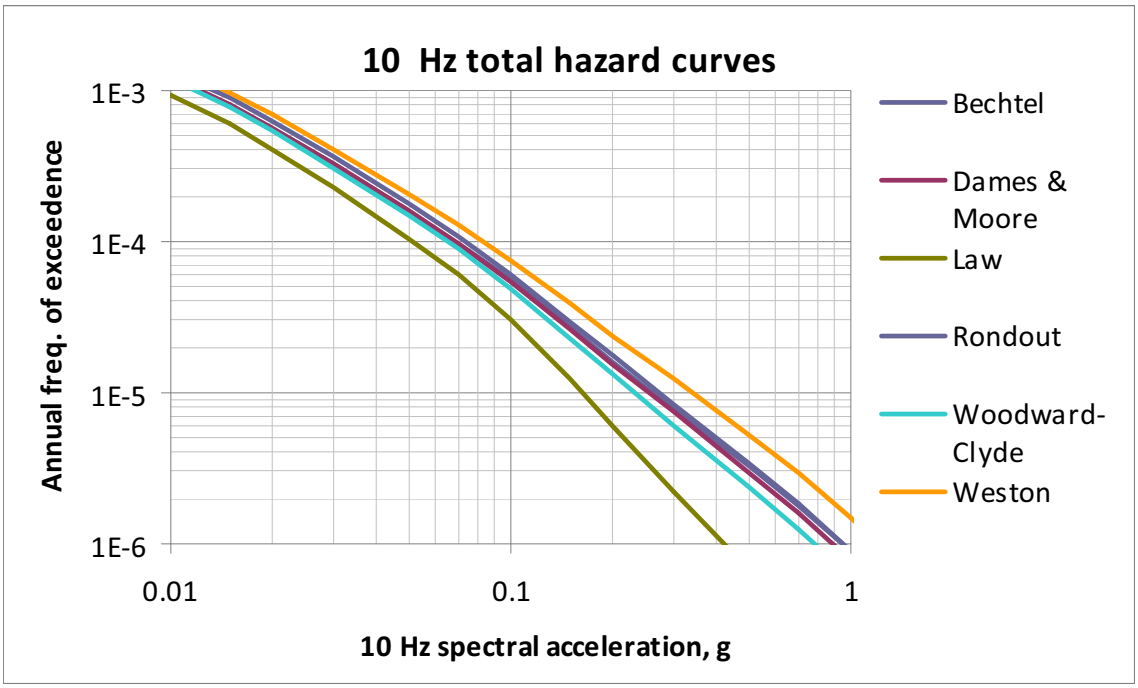


Figure 2.5S.2-14 Mean 10 Hz Rock Hazard Curves by EST

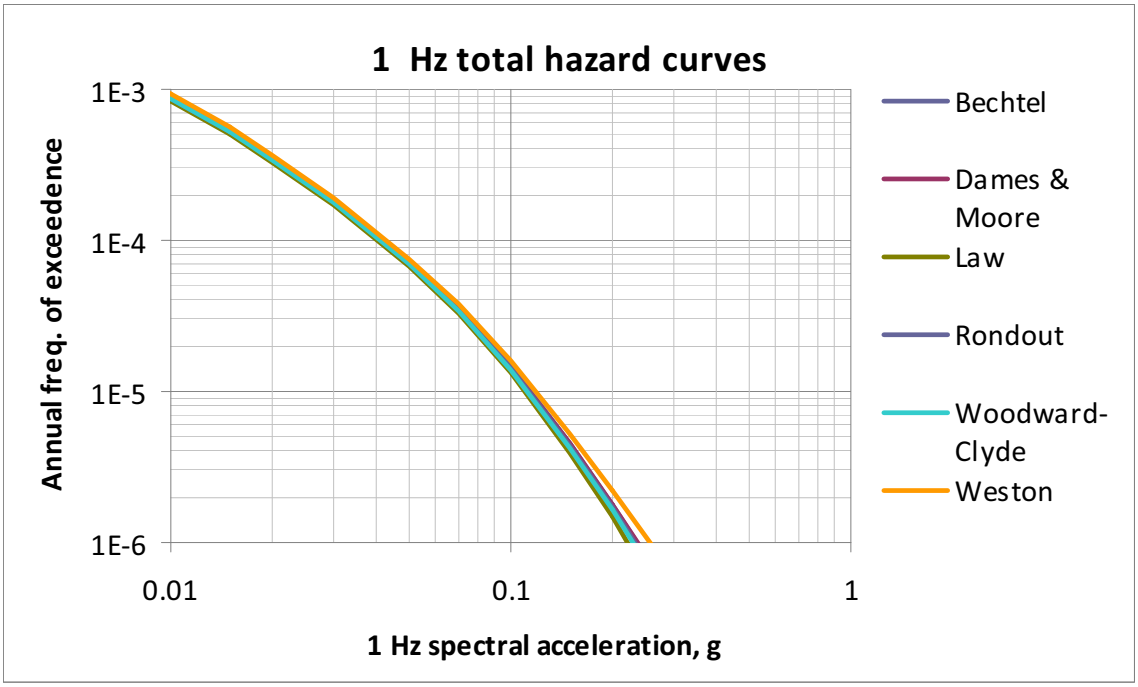


Figure 2.5S.2-15 Mean 1 Hz Rock Hazard Curves by EST

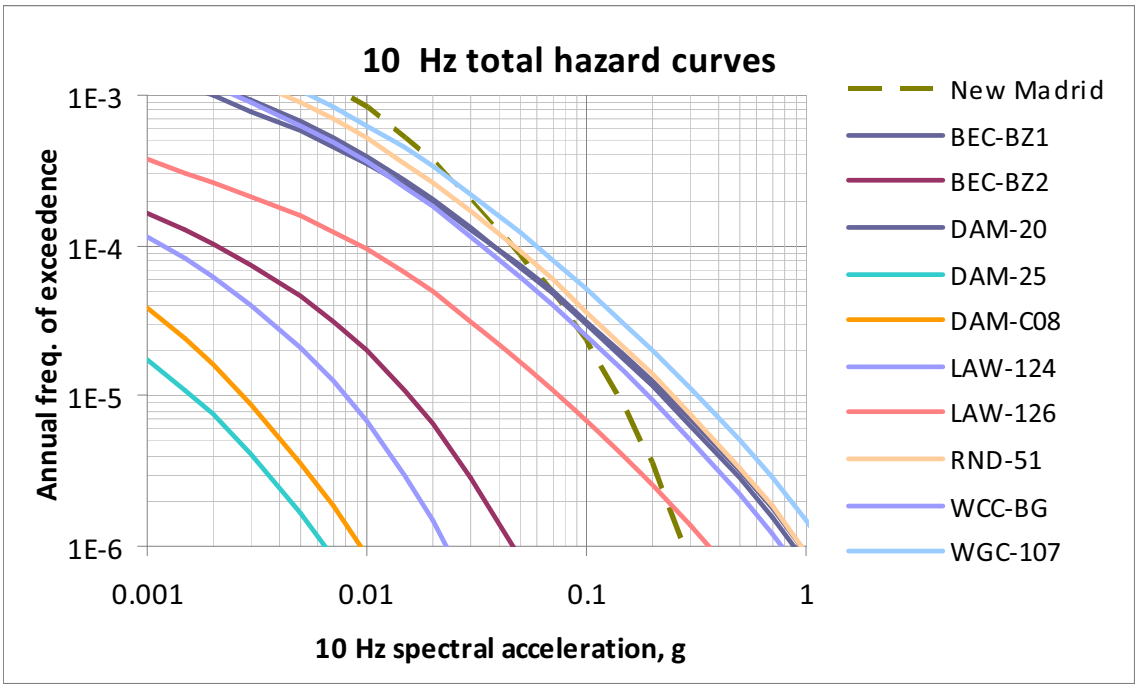


**Figure 2.5S.2-16 Mean 10 Hz Rock Hazard Curves by Seismic Source**

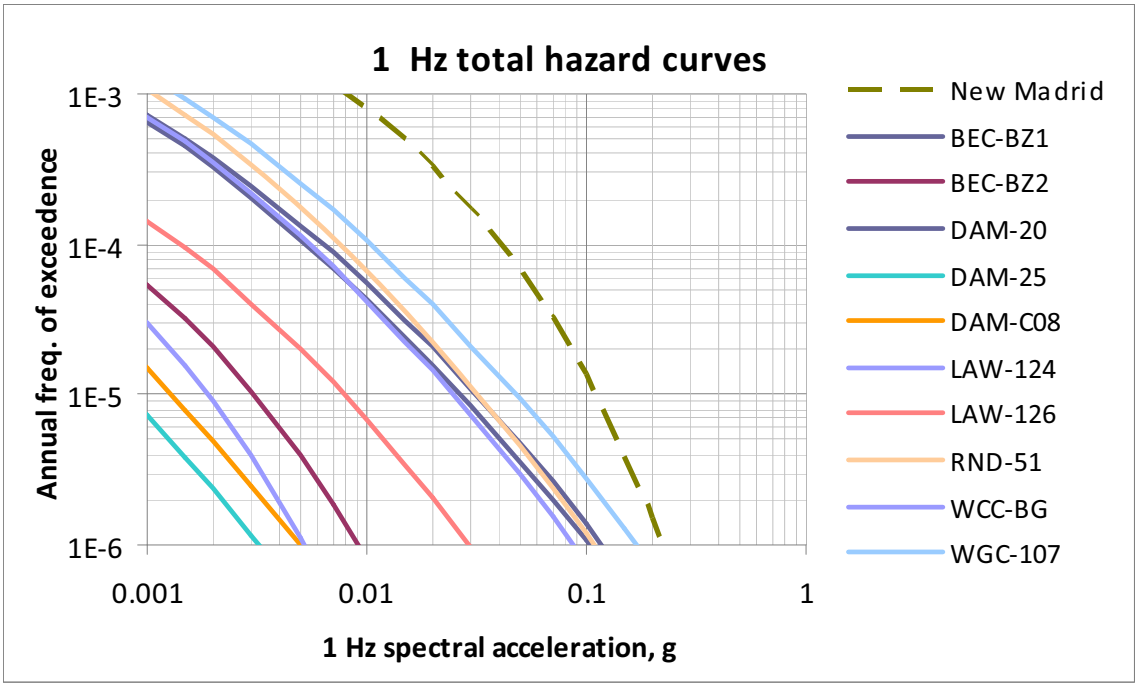


**Figure 2.5S.2-17 Mean 1 Hz Rock Hazard Curves by Seismic Source**

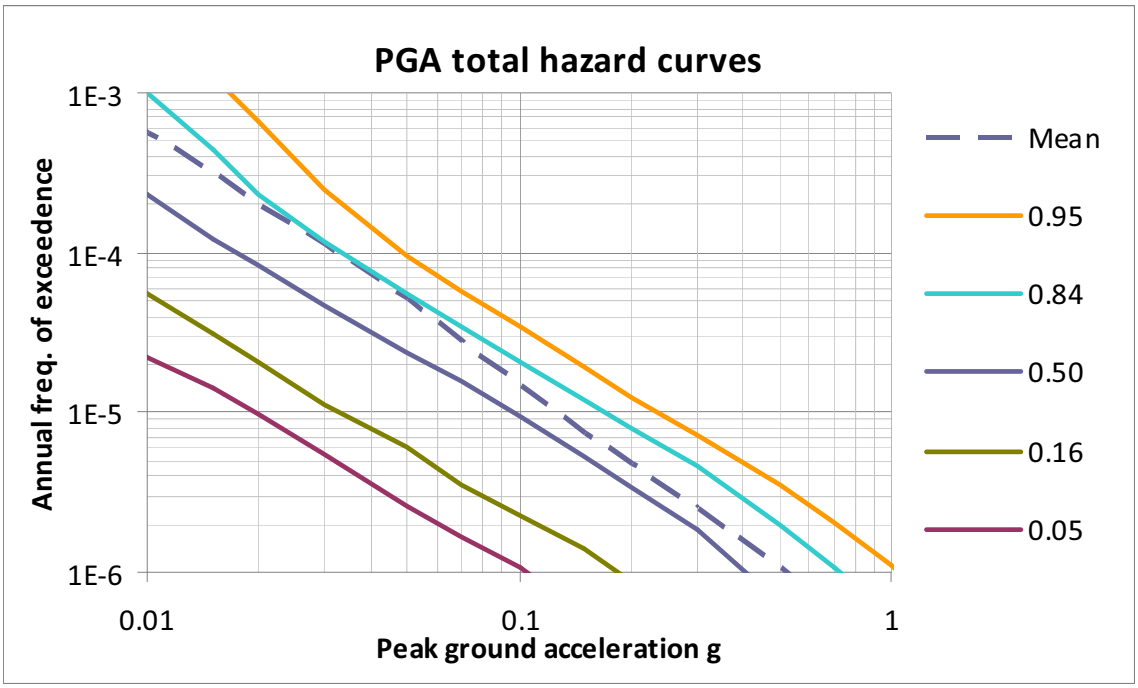


Figure 2.5S.2-18 Mean and Fractile PGA Rock Hazard Curves

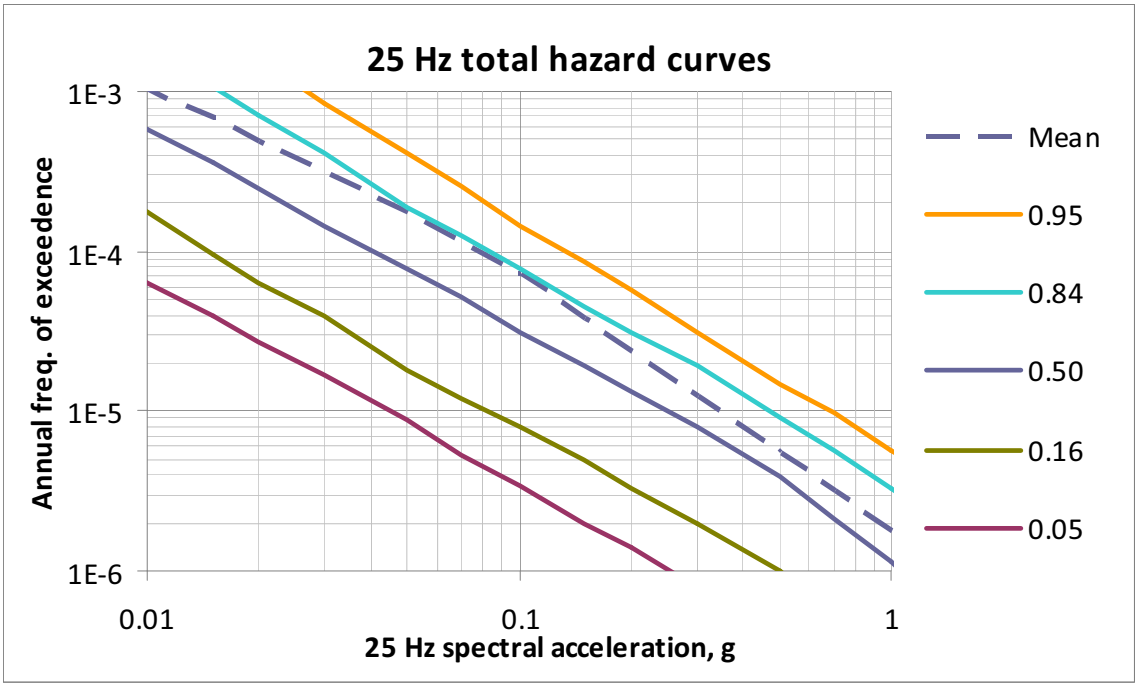


Figure 2.5S.2-19 Mean and Fractile 25 Hz Rock Hazard Curves

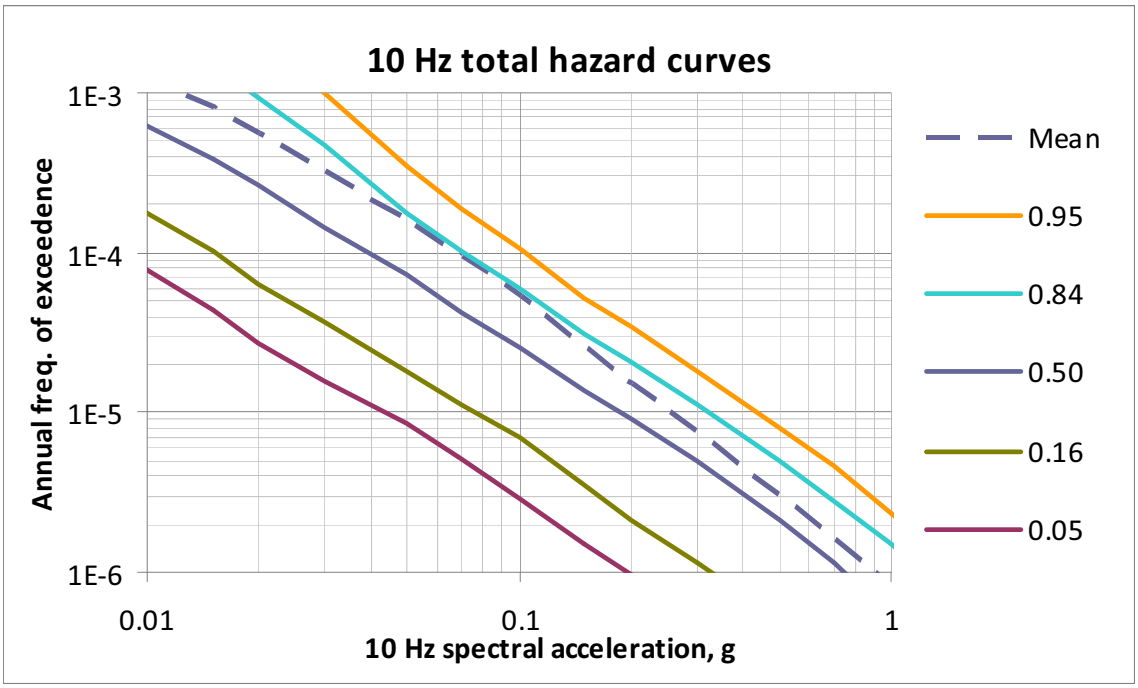


**Figure 2.5S.2-20 Mean and Fractile 10 Hz Rock Hazard Curves**

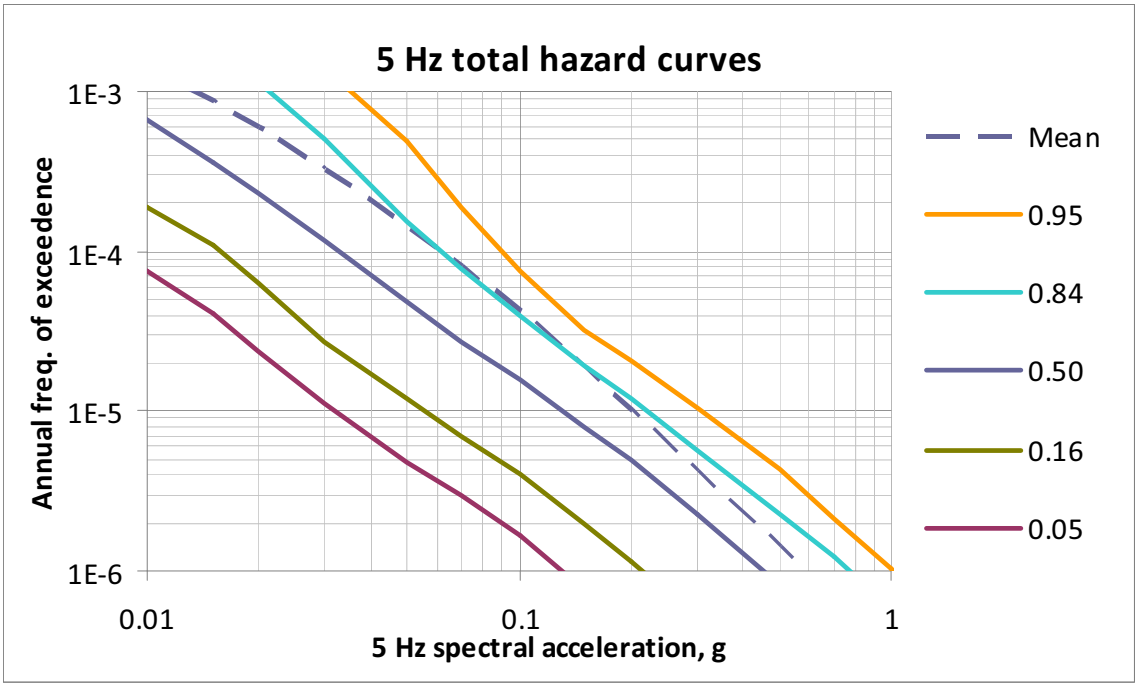


**Figure 2.5S.2-21 Mean and Fractile 5 Hz Rock Hazard Curves**

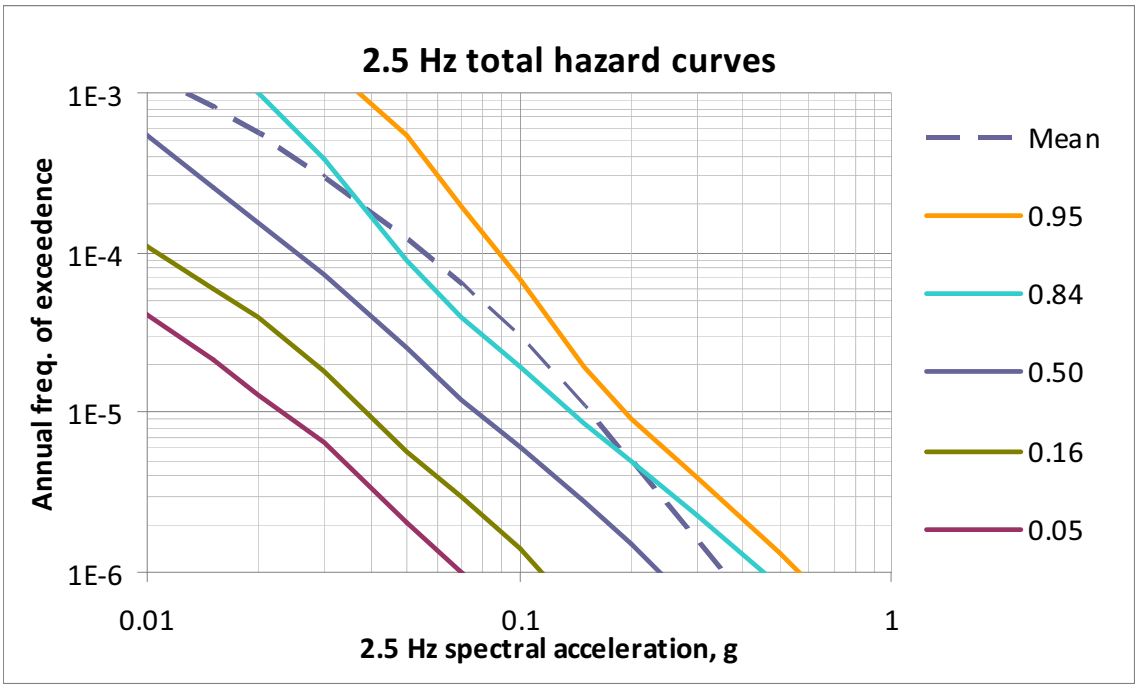


Figure 2.5S.2-22 Mean and Fractile 2.5 Hz Rock Hazard Curves

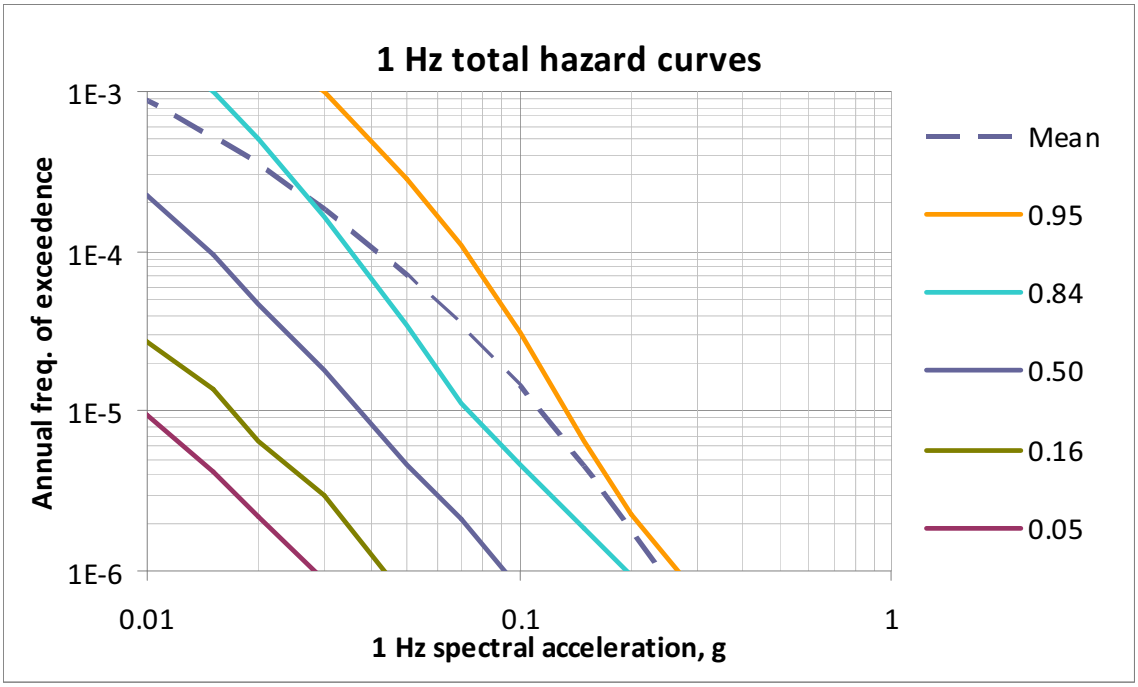


Figure 2.5S.2-23 Mean and Fractile 1 Hz Rock Hazard Curves

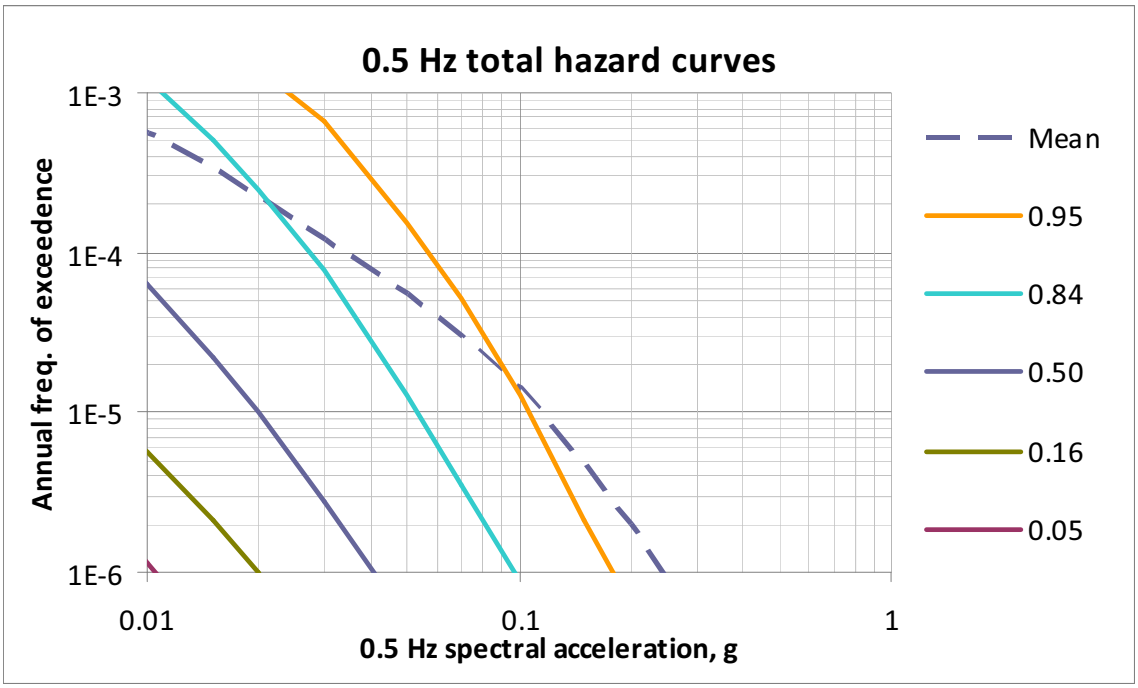


**Figure 2.5S.2-24 Mean and Fractile 0.5 Hz Rock Hazard Curves**

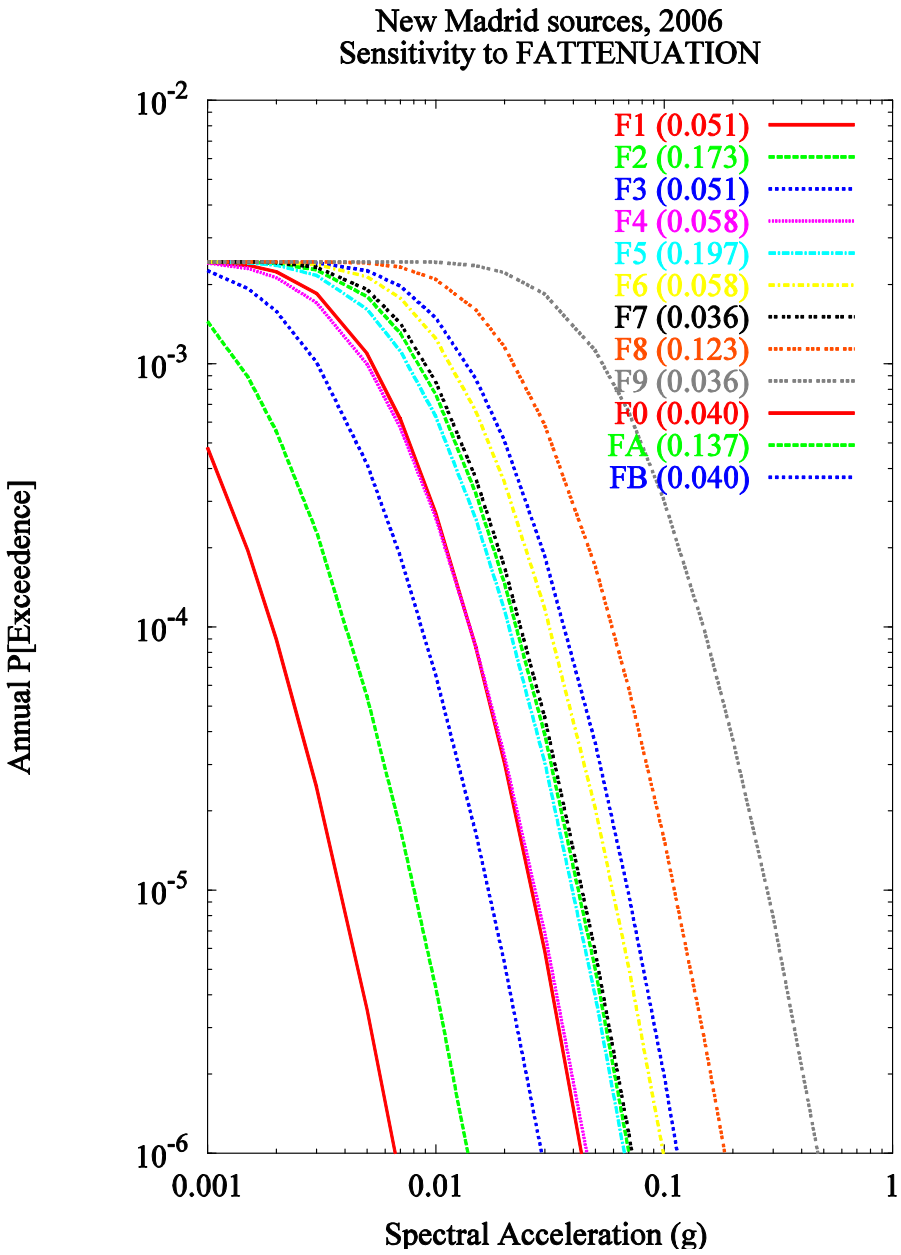


**Figure 2.5S.2-25 1 Hz Rock Hazard Curves for the New Madrid Source, by Ground Motion Equation**

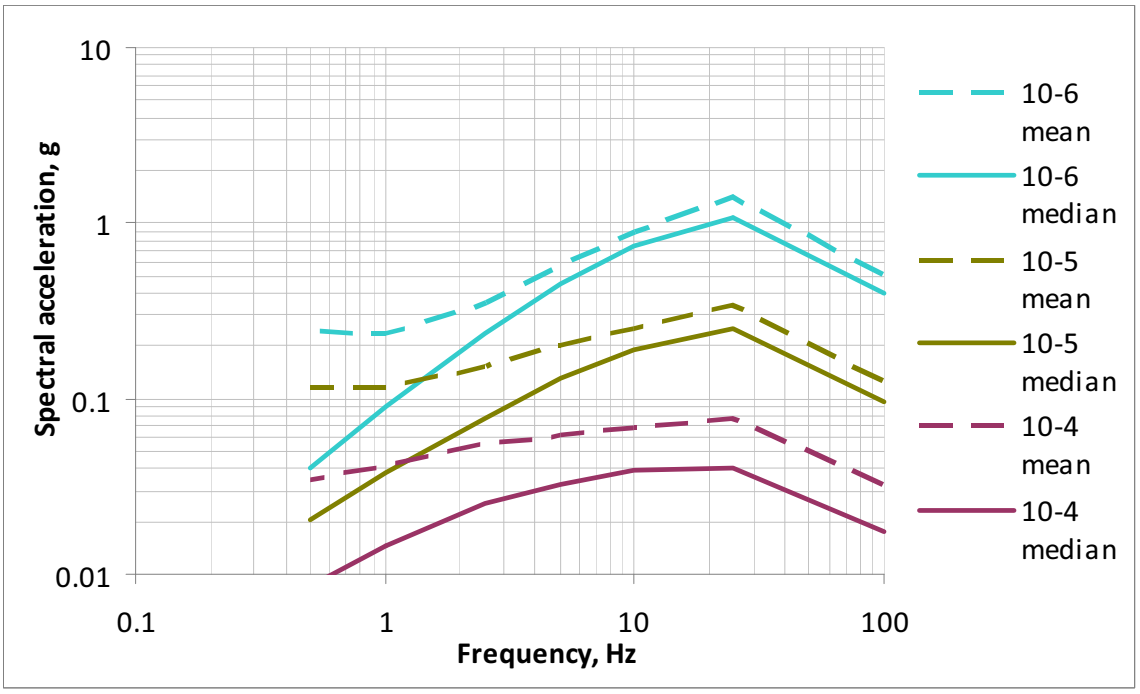


**Figure 2.5S.2-26 Mean and Median Rock Uniform Hazard Response Spectra (UHRS)**

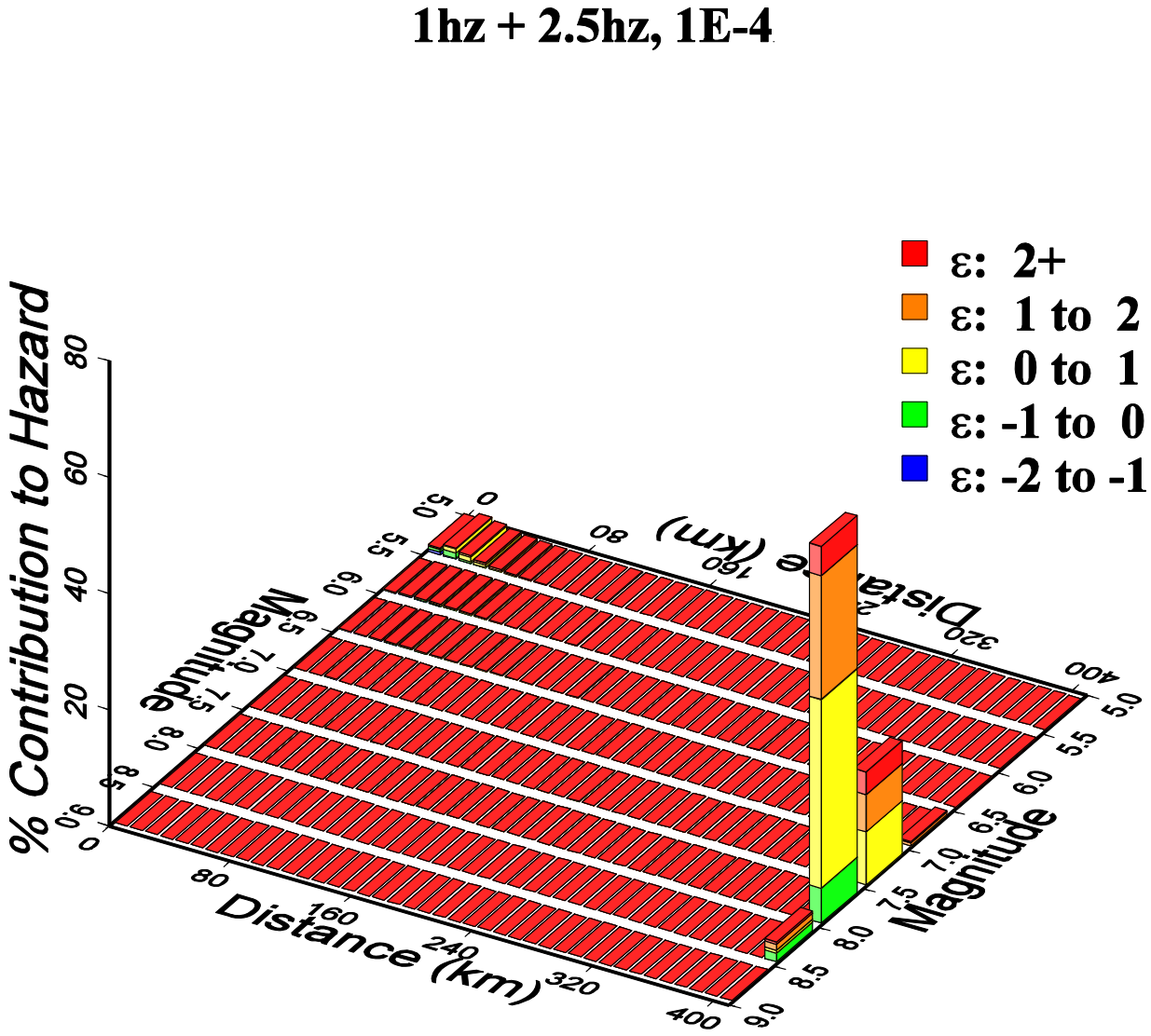


**Figure 2.5S.2-27 M and R Deaggregation for 1 and 2.5 Hz at $10^{-4}$ Annual Frequency of Exceedence**

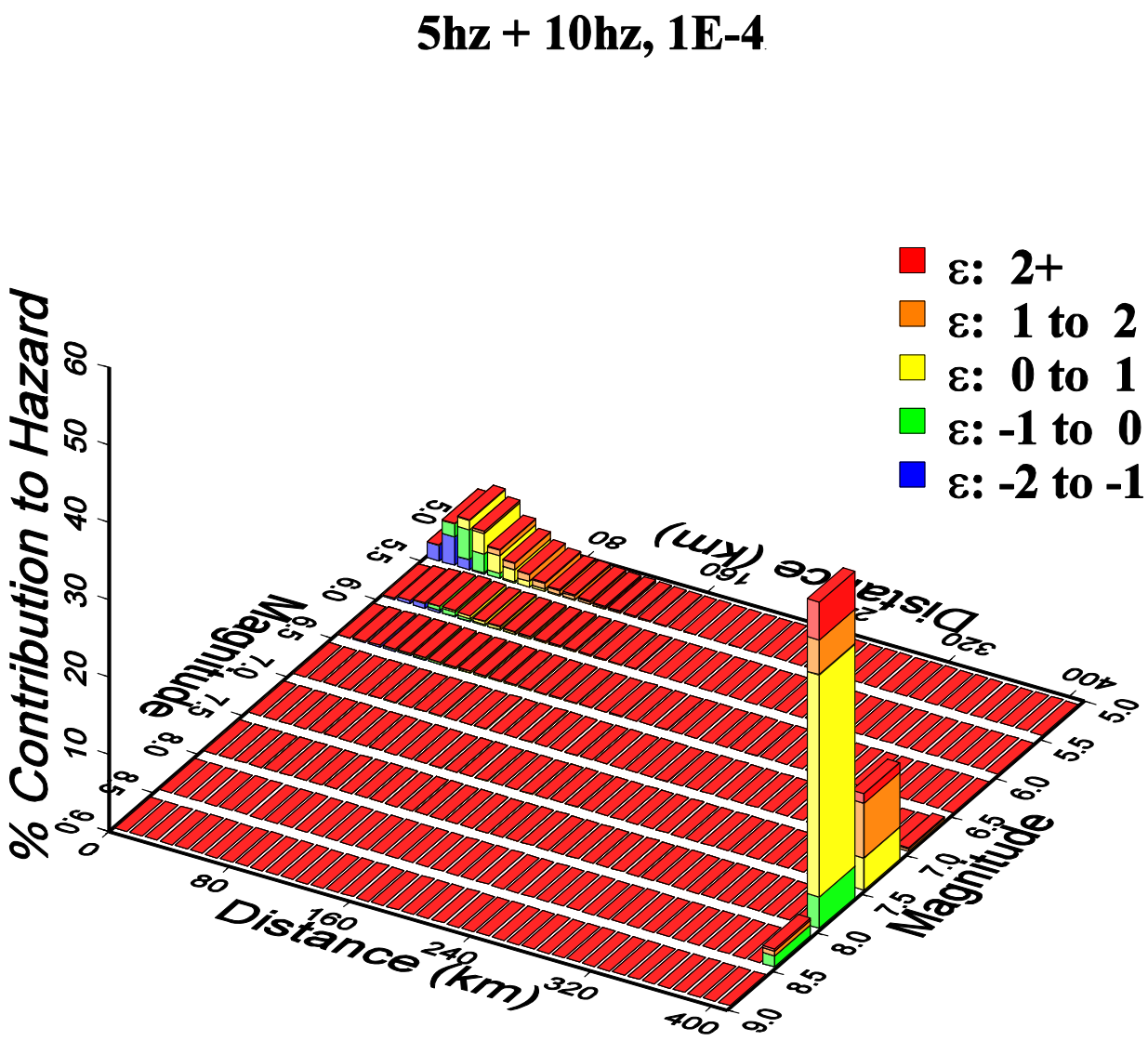


**Figure 2.5S.2-28 M and R Deaggregation for 5 and 10 Hz at $10^{-4}$ Annual Frequency of Exceedence**

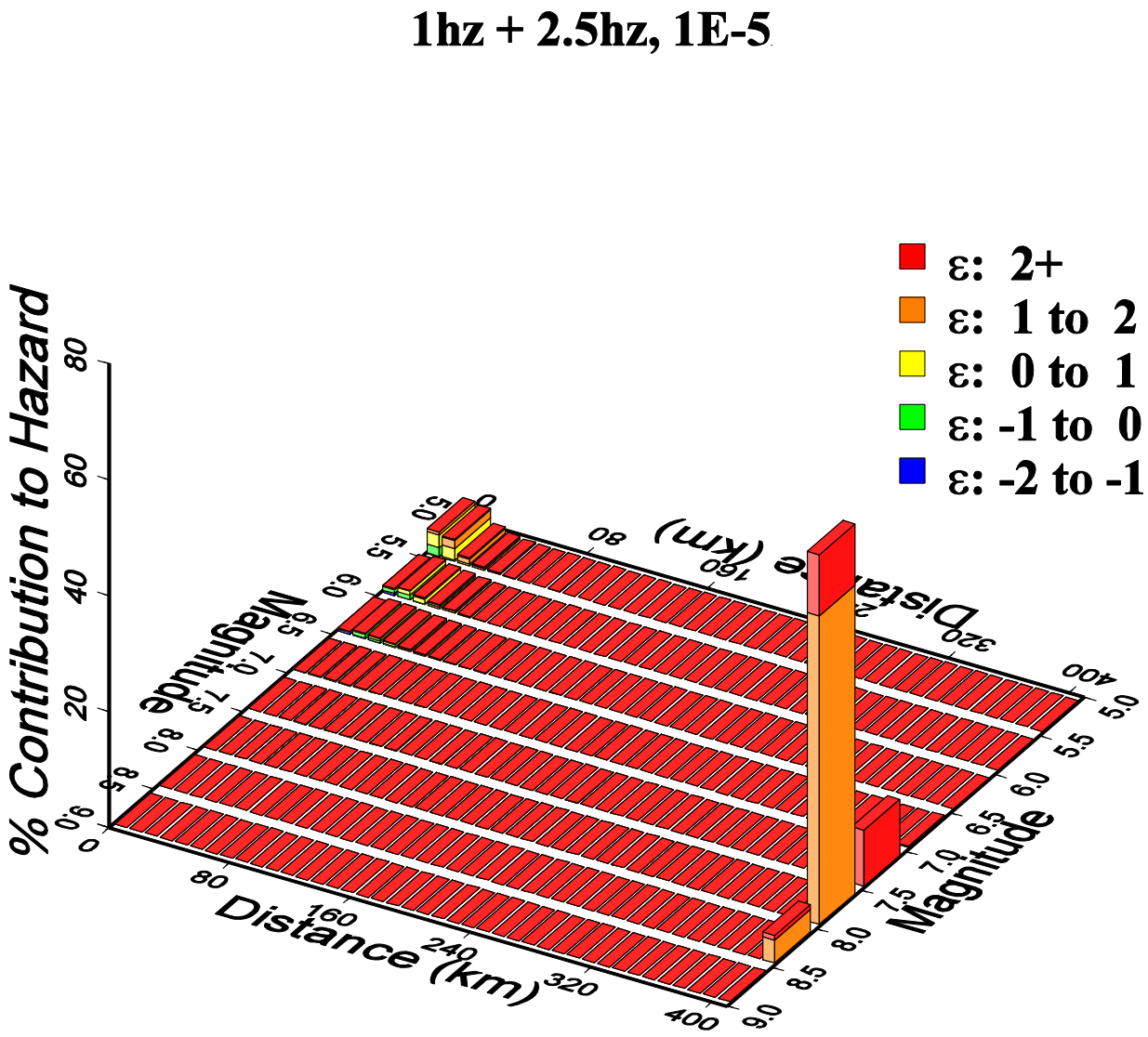


**Figure 2.5S.2-29 M and R Deaggregation for 1 and 2.5 Hz at $10^{-5}$ Annual Frequency of Exceedence**

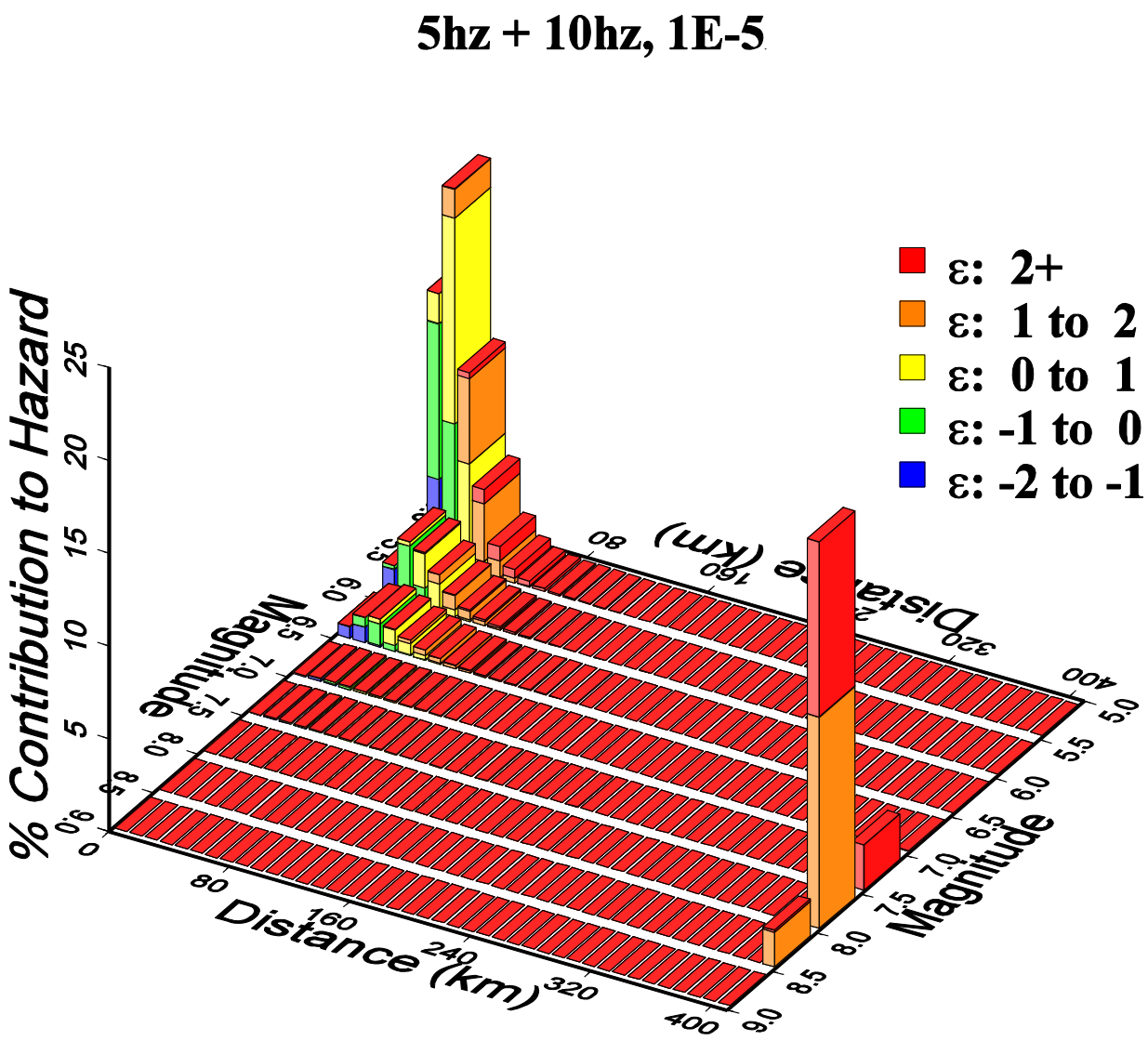


**Figure 2.5S.2-30 M and R Deaggregation for 5 and 10 Hz at $10^{-5}$ Annual Frequency of Exceedence**

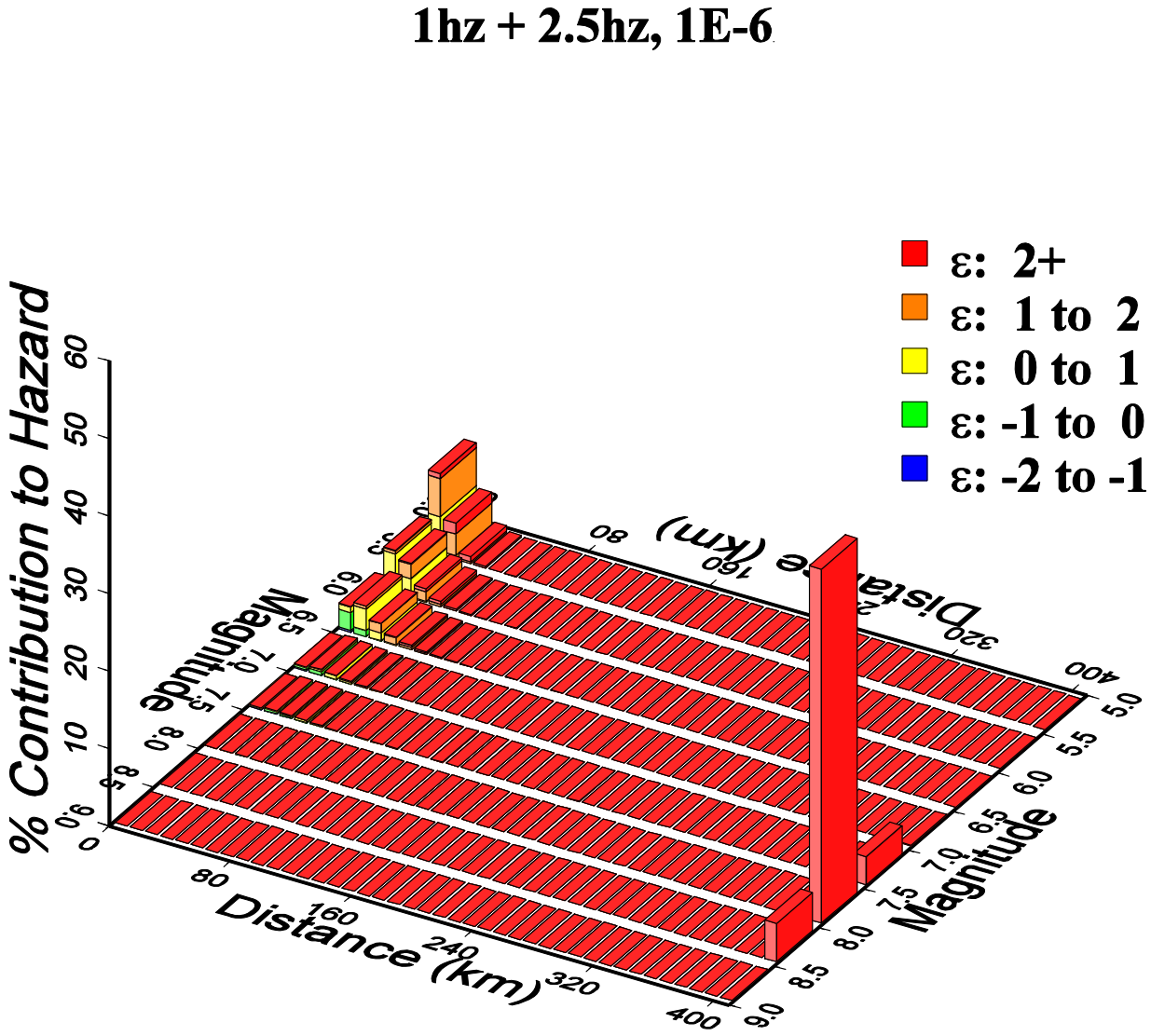


**Figure 2.5S.2-31 M and R Deaggregation for 1 and 2.5 Hz at $10^{-6}$ Annual Frequency of Exceedence**

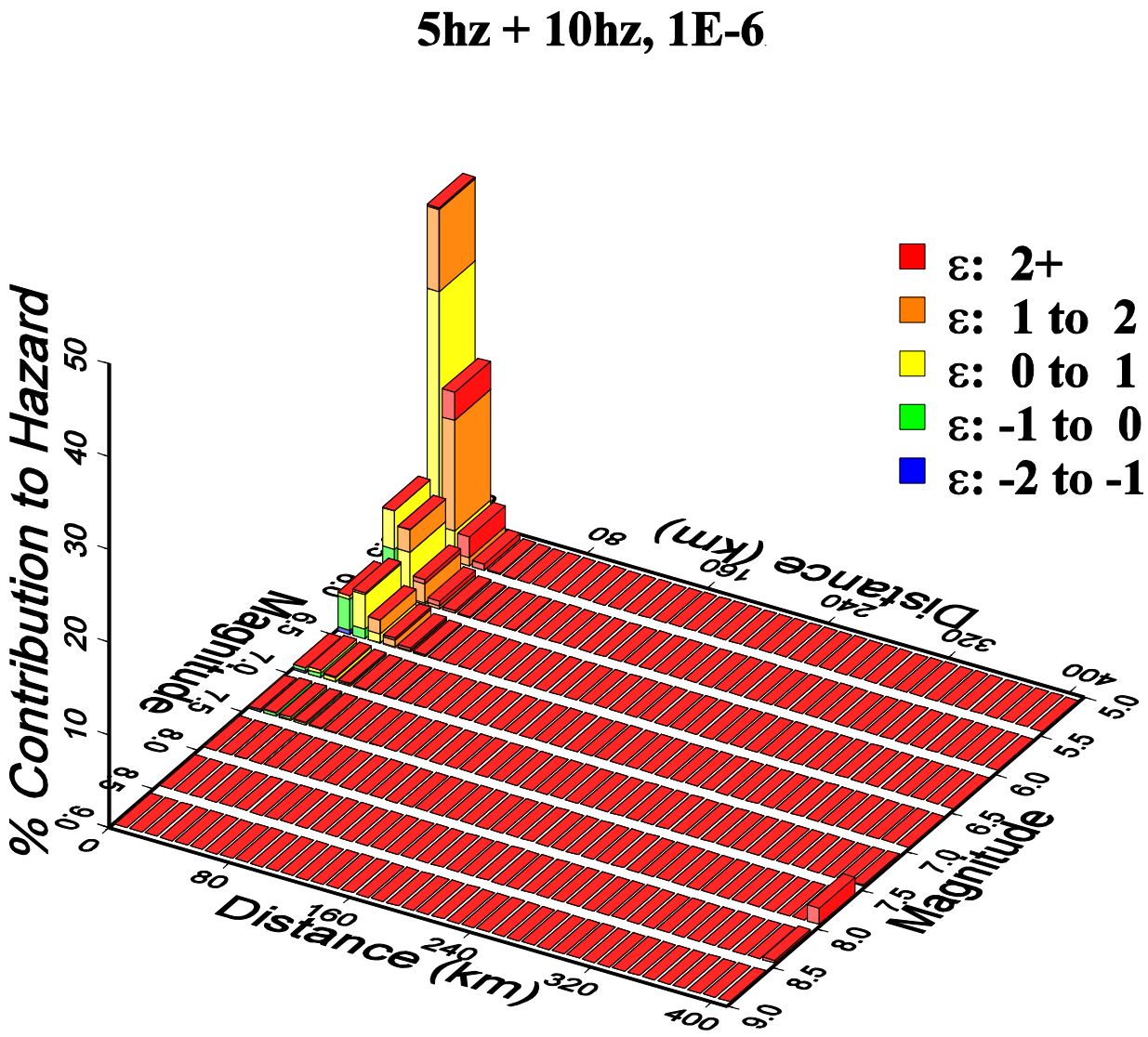


**Figure 2.5S.2-32 M and R Deaggregation for 5 and 10 Hz at $10^{-6}$ Annual Frequency of Exceedence**

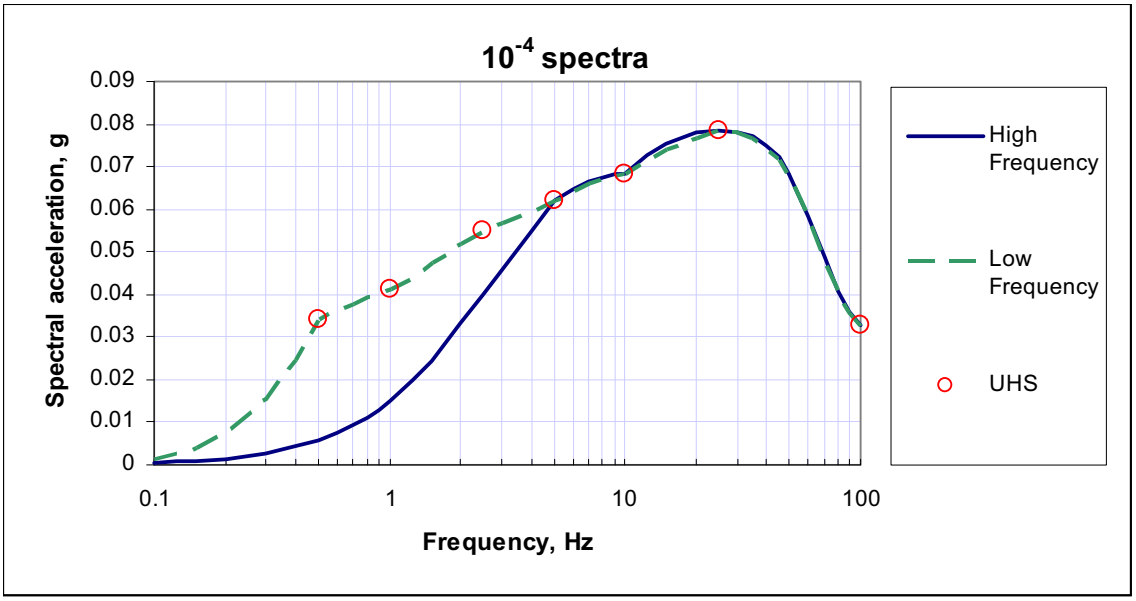


**Figure 2.5S.2-33 Smooth $10^{-4}$ ~~r~~Rock UHRS for HF and LF Earthquakes**

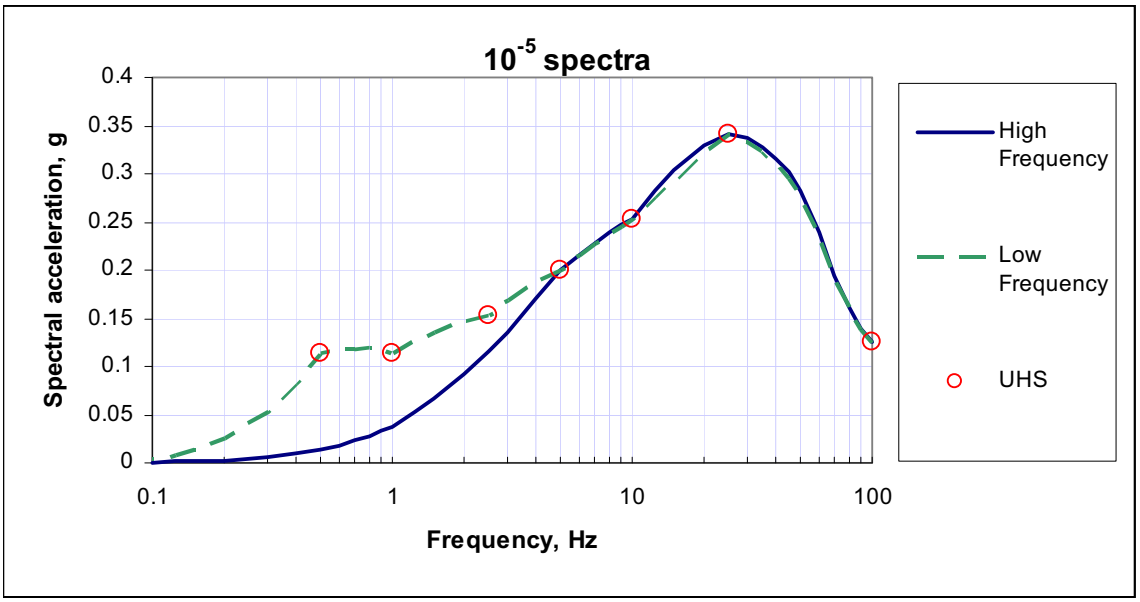


**Figure 2.5S.2-34 Smooth $10^{-5}$ ~~r~~Rock UHRS for HF and LF Earthquakes**

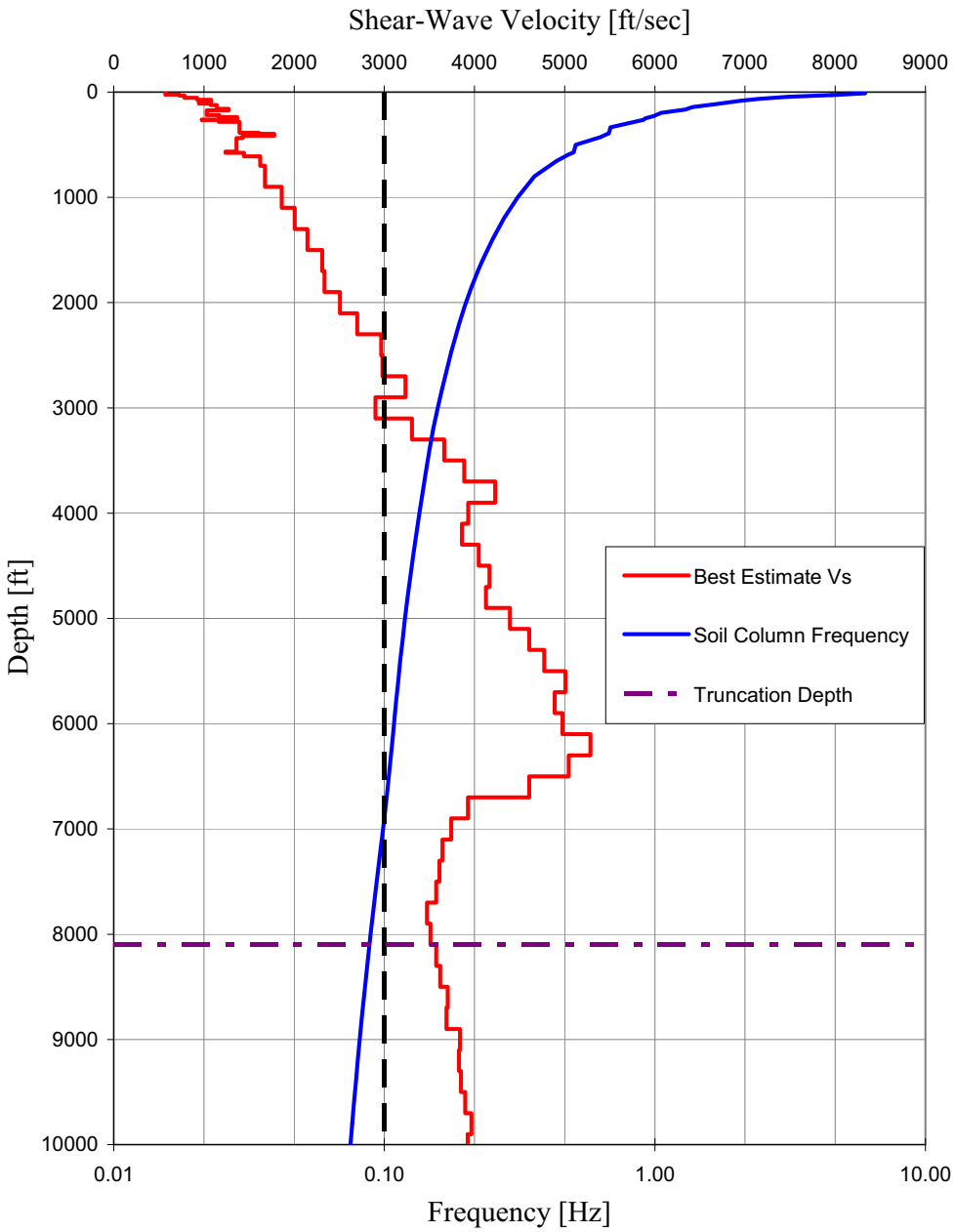


**Figure 2.5S.2-35a Best Estimate Soil Column Frequency**

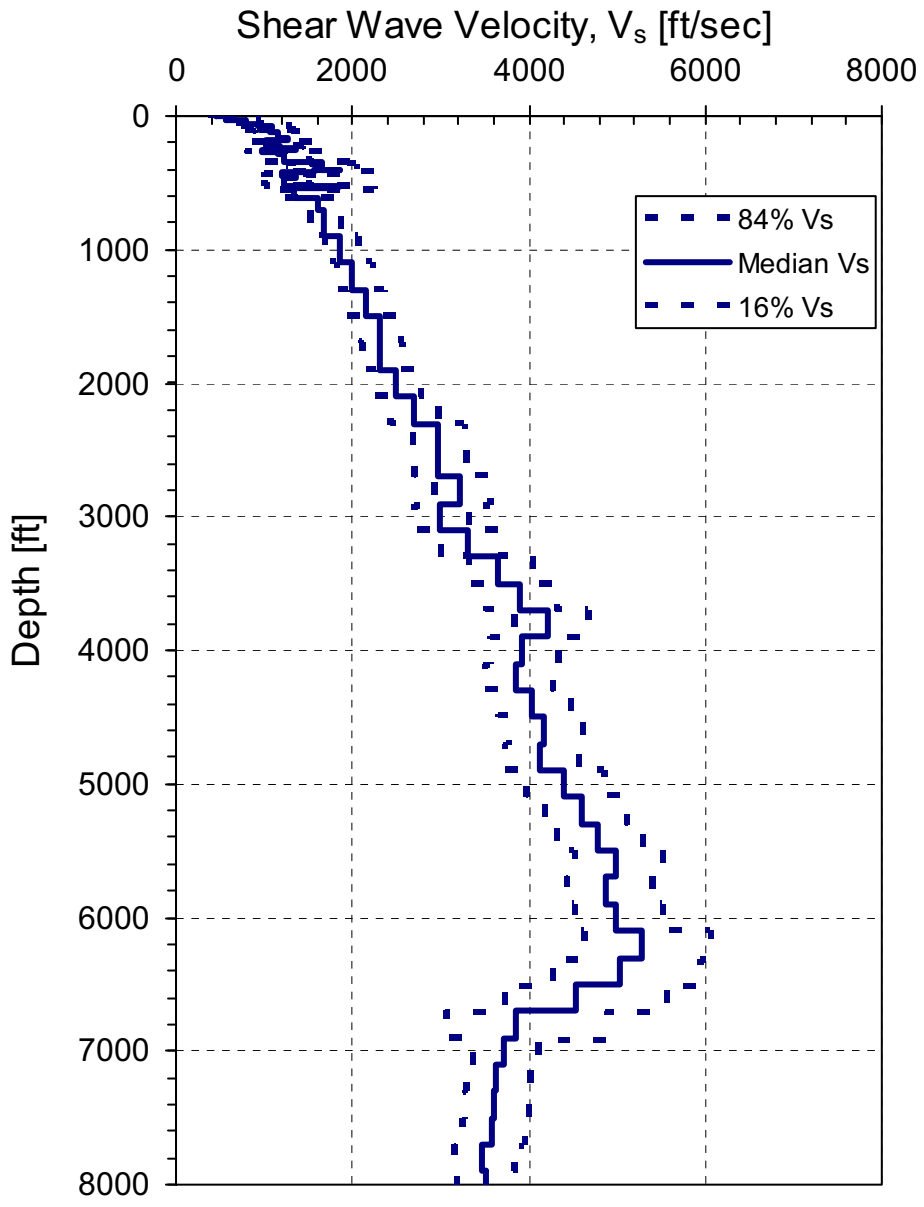


**Figure 2.5S.2-35b ~~Figure 2.5S.2-35~~Input Median Shear Wave Velocity Profile (+/- One Standard Deviation) for Randomization Process**

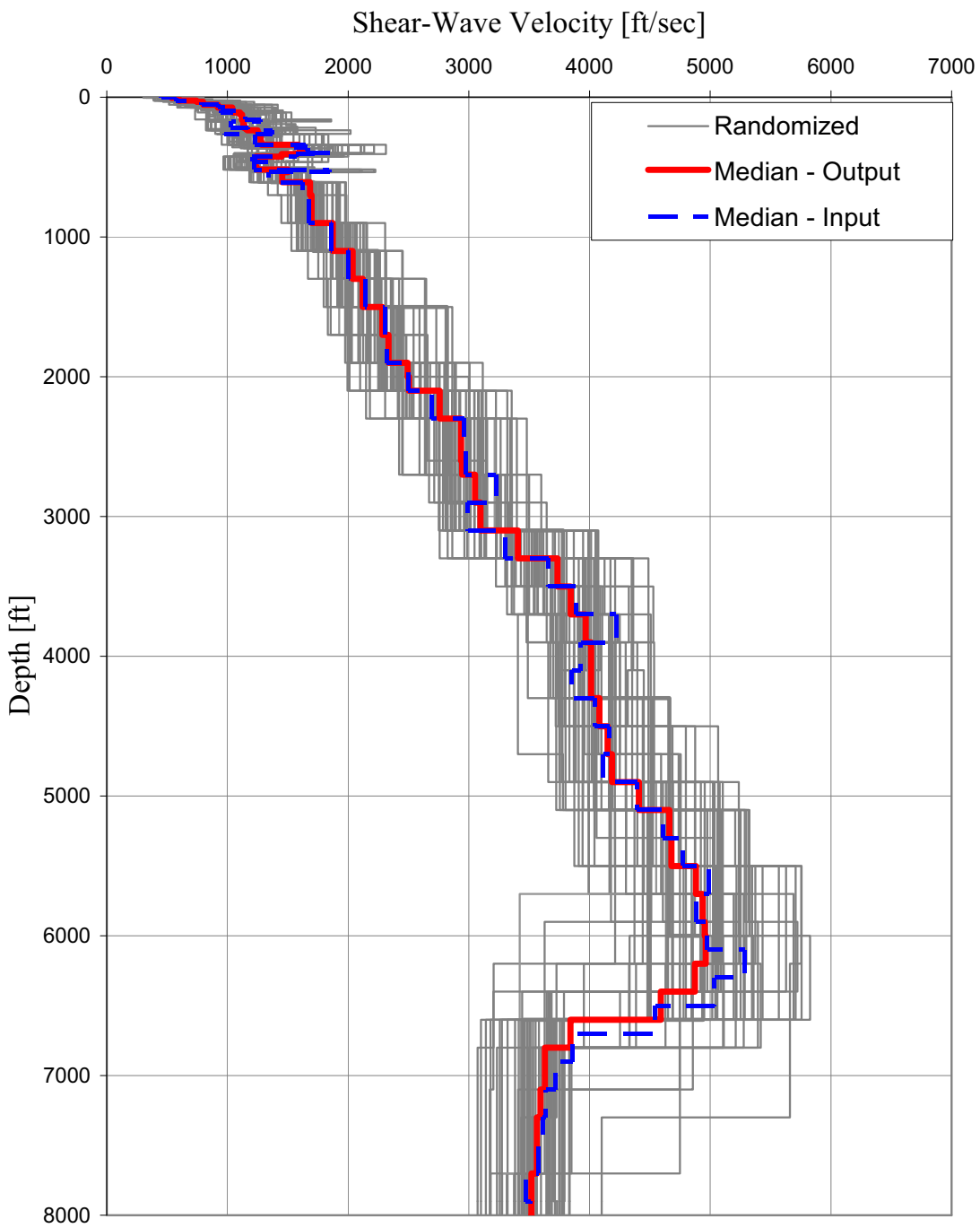


**Figure 2.5S.2-36 Randomized Shear Wave Velocity Profiles, Median (~~Log Average~~Output) Shear Wave ~~Velocuty~~Velocity Profile and the Median (Input) Profile Used For Randomization**

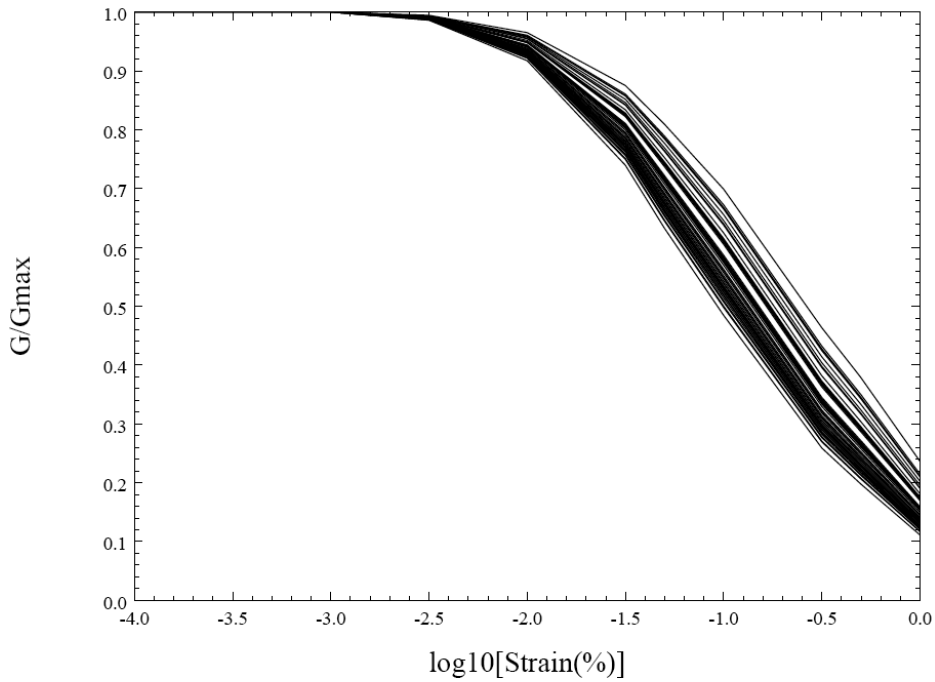


**Figure 2.5S.2-37 Strain Dependent Degradation Curves for Stratum C~~M~~**

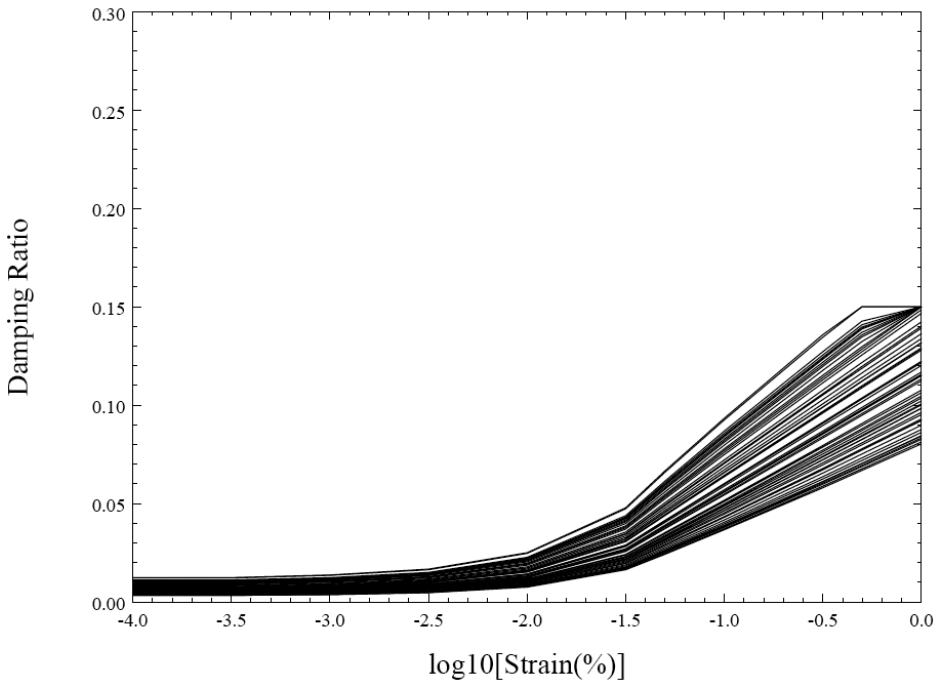


**Figure 2.5S.2-38 Strain Dependent Damping Ratio Properties for Stratum C~~M~~**

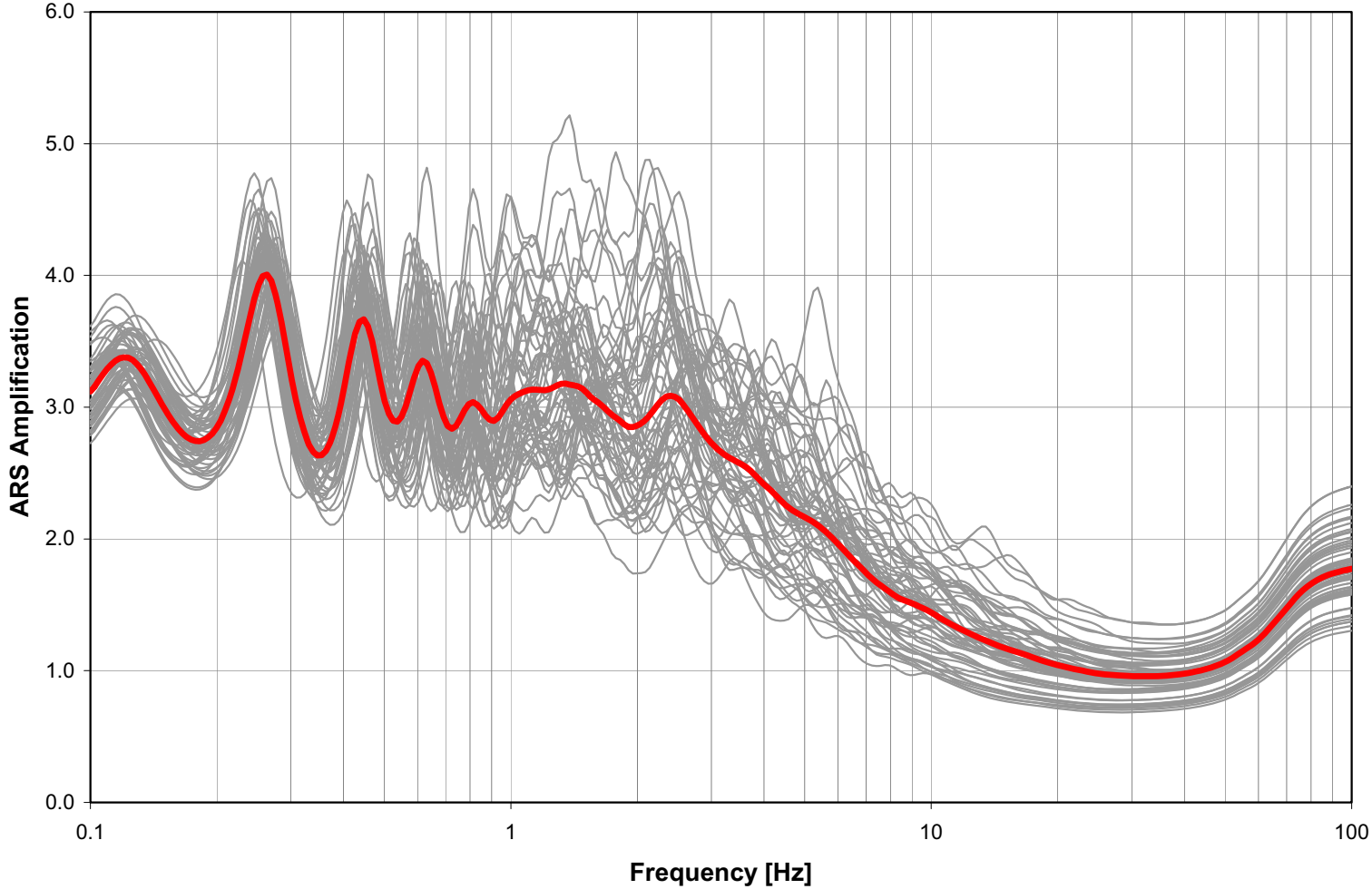


**Figure 2.5S.2-39 Logarithmic Mean and Standard Deviation of Site Amplification Factors at Ground Surface from ~~Analyses~~Analysis of the 60 Modified Random Profiles with the $10^{-4}$ LF Input Motion**

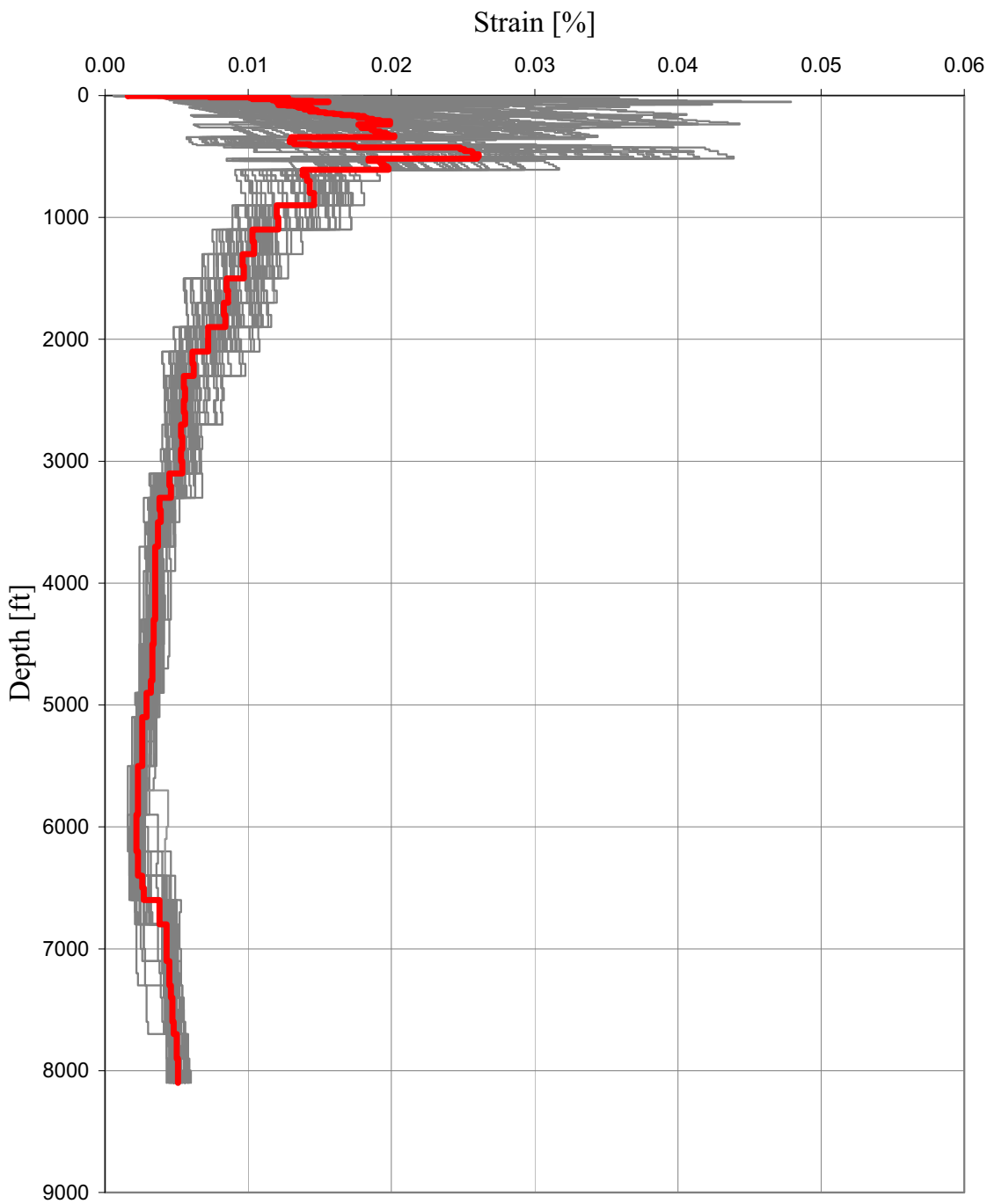


**Figure 2.5S.2-40 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the $10^{-4}$ LF Input Motion**

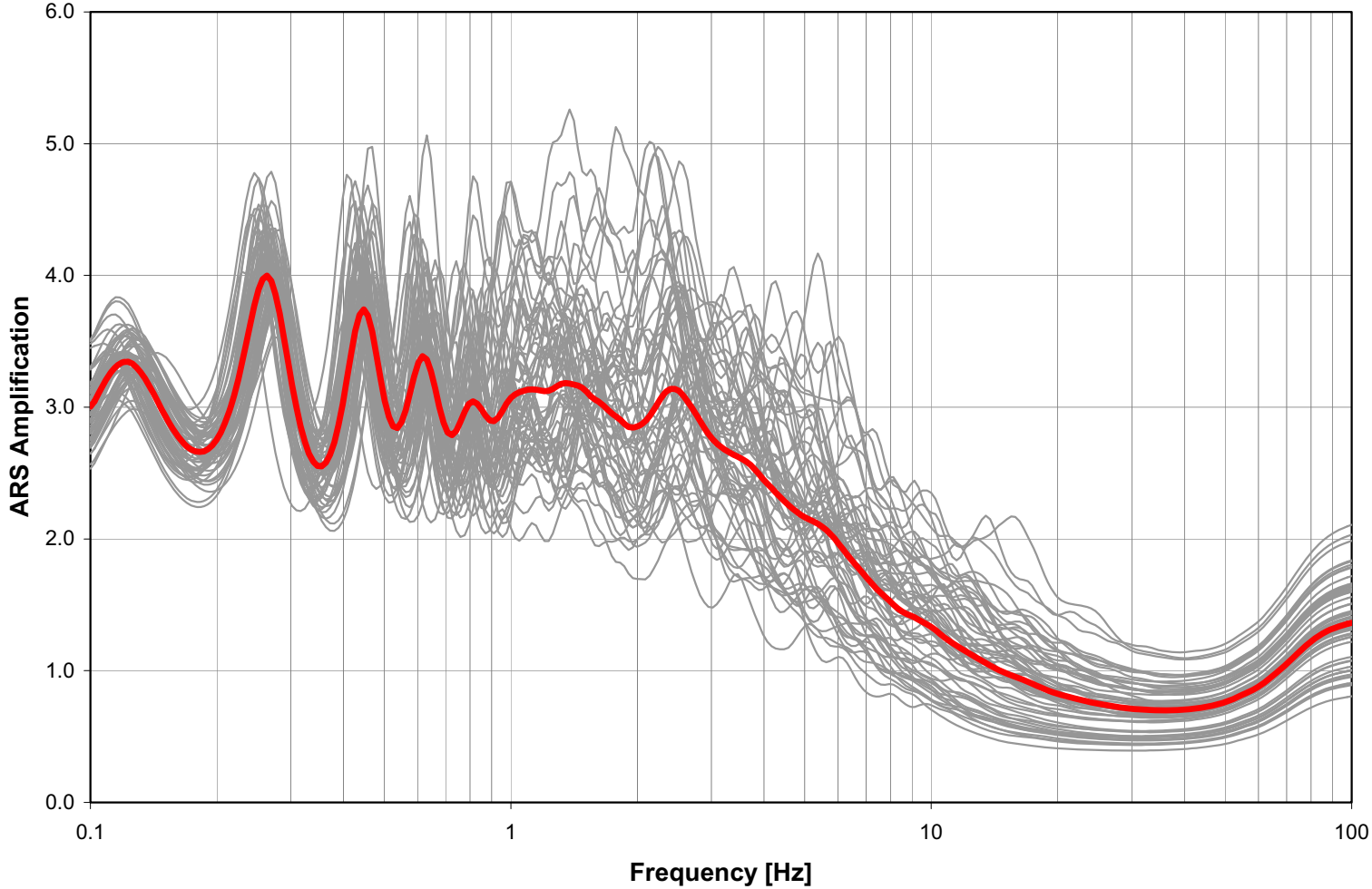


**Figure 2.5S.2-41 Logarithmic Mean of Site Amplification Factors at Ground Surface from ~~the Analyses~~Analysis of the 60 Modified Random Profiles ~~W~~with the $10^{-4}$ HF Input Motion**

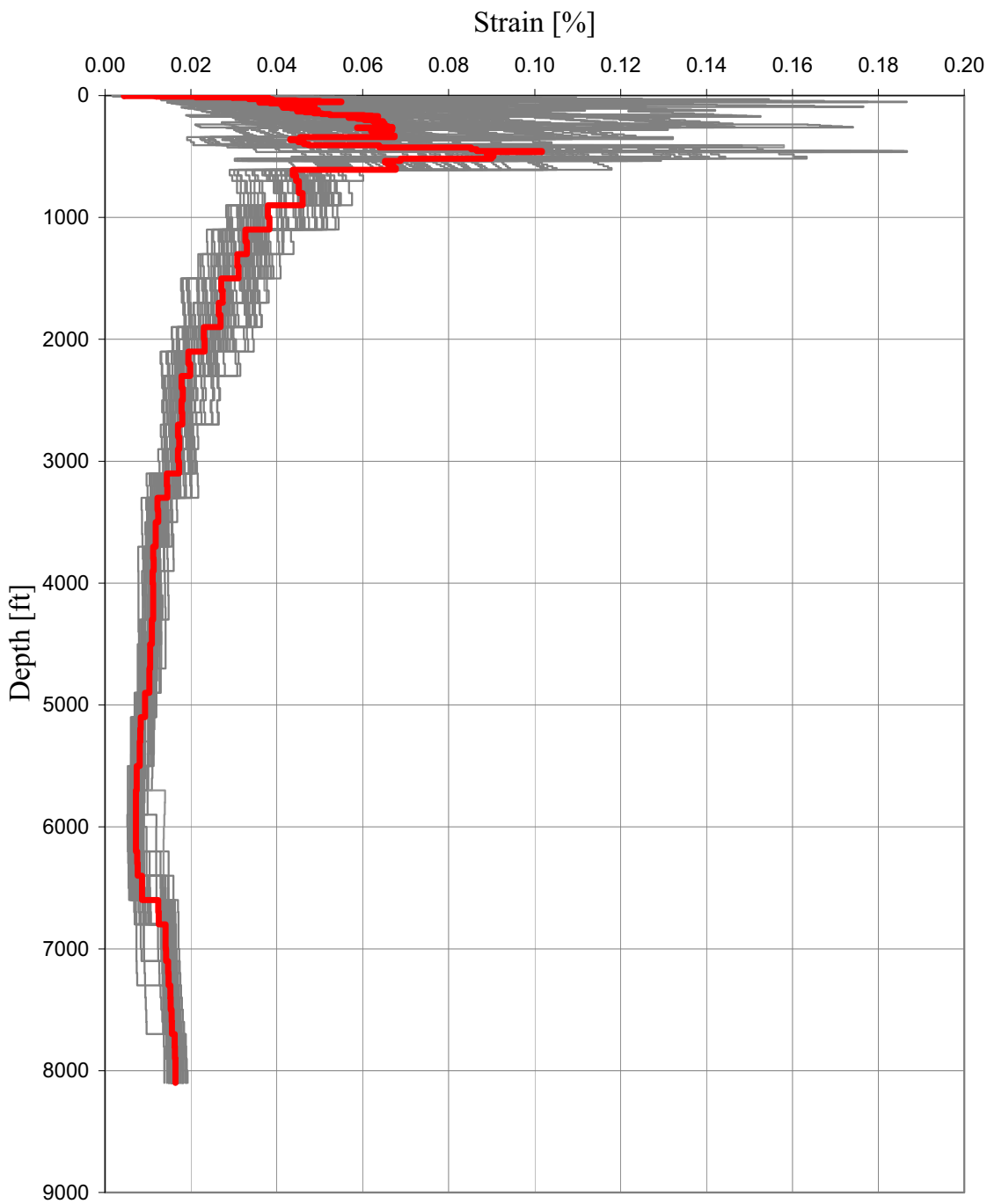


**Figure 2.5S.2-42 Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the $10^{-4}$ ~~LF~~HF Input Motion**

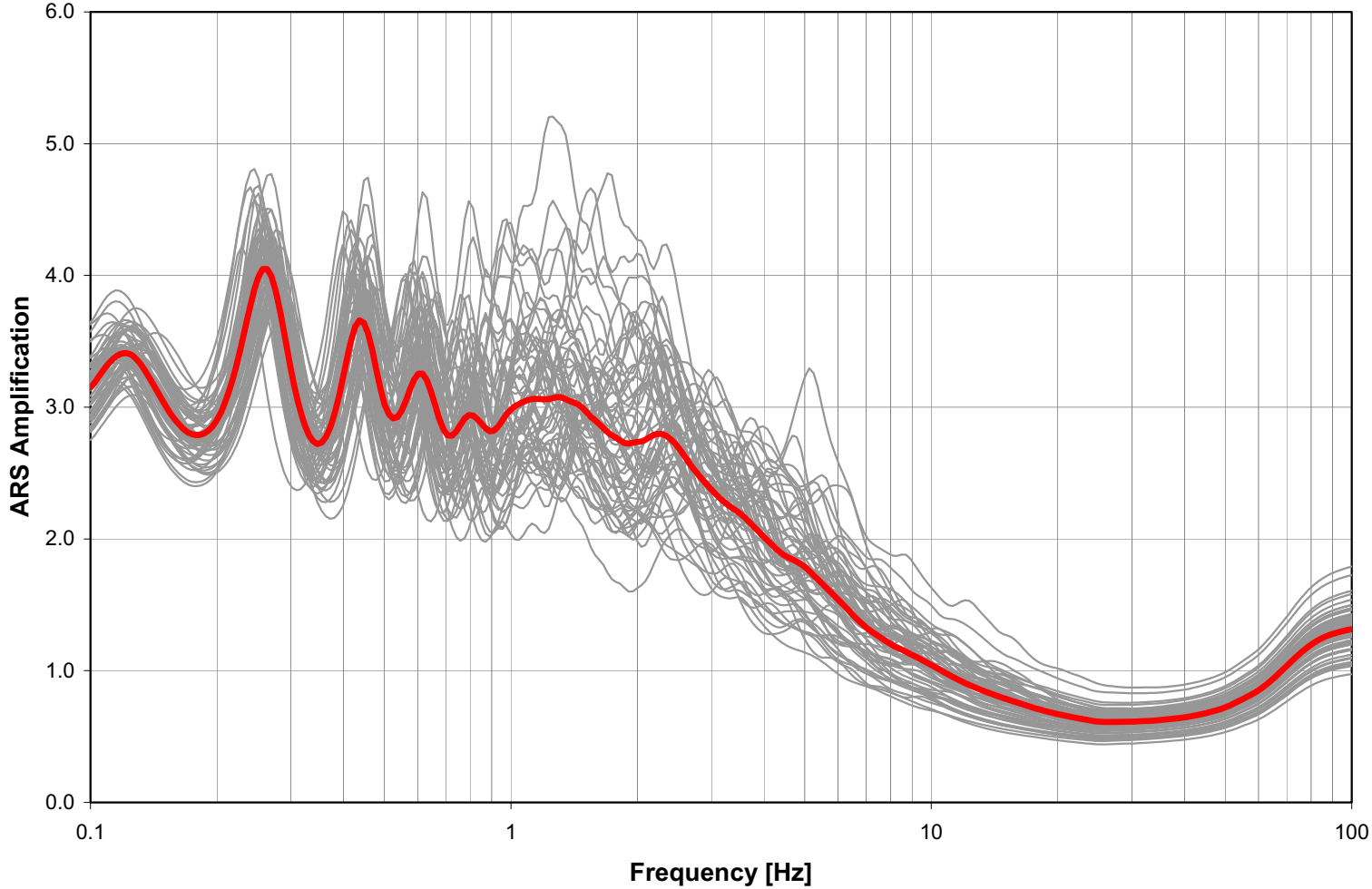


**Figure 2.5S.2-43** Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the $10^{-5}$ LF Input Motion~~ARS Amplifications—$10^{-5}$ LF Motion~~

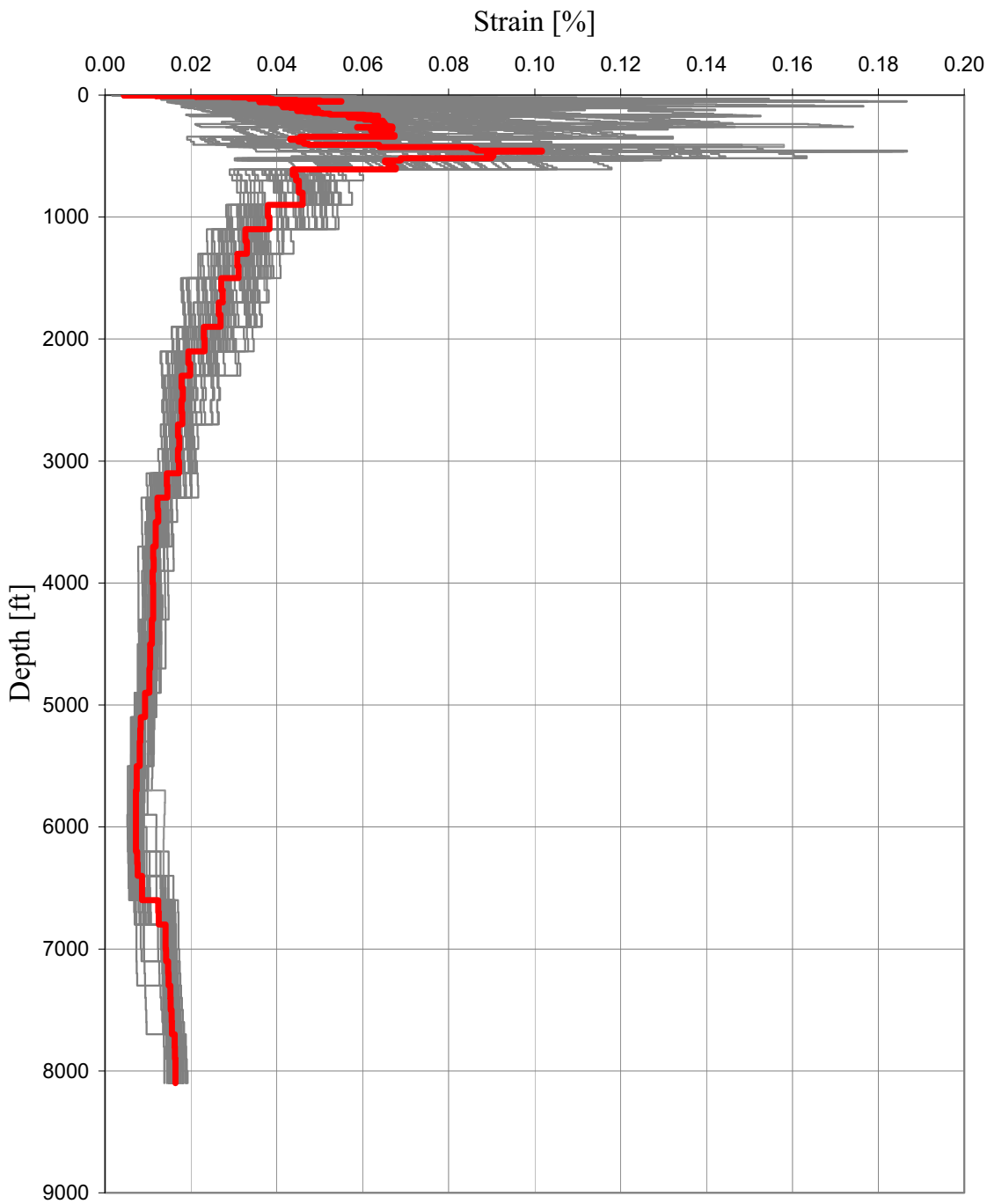


**Figure 2.5S.2-44** Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the $10^{-5}$ LF Input Motion~~Maximum Strains – $10^{-5}$ LF Motion~~

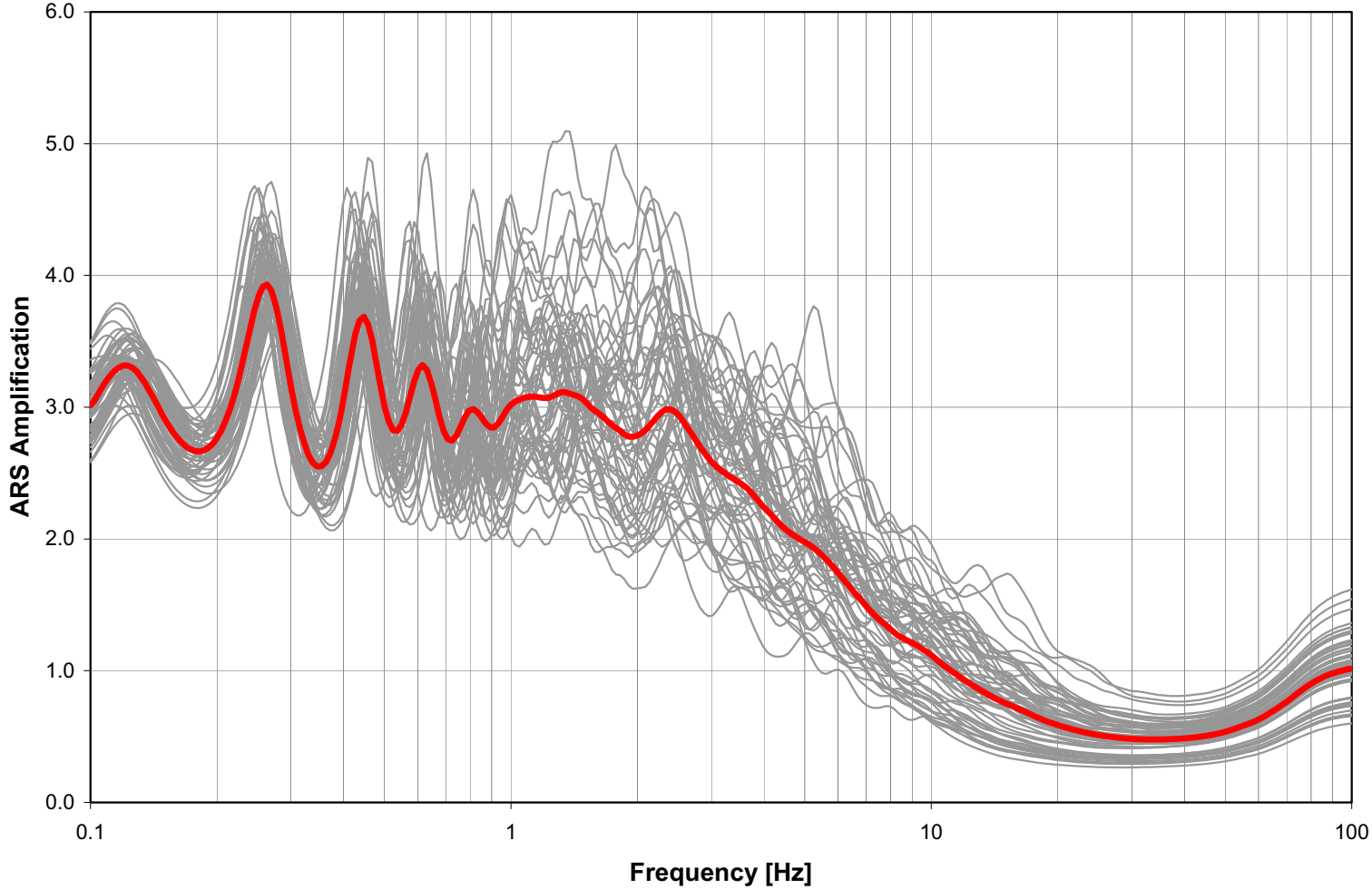


**Figure 2.5S.2-45** Logarithmic Mean of Site Amplification Factors at Ground Surface from Analysis of the 60 Modified Random Profiles with the $10^{-5}$ HF Input Motion~~ARS Amplifications – $10^{-5}$ LF Motion~~

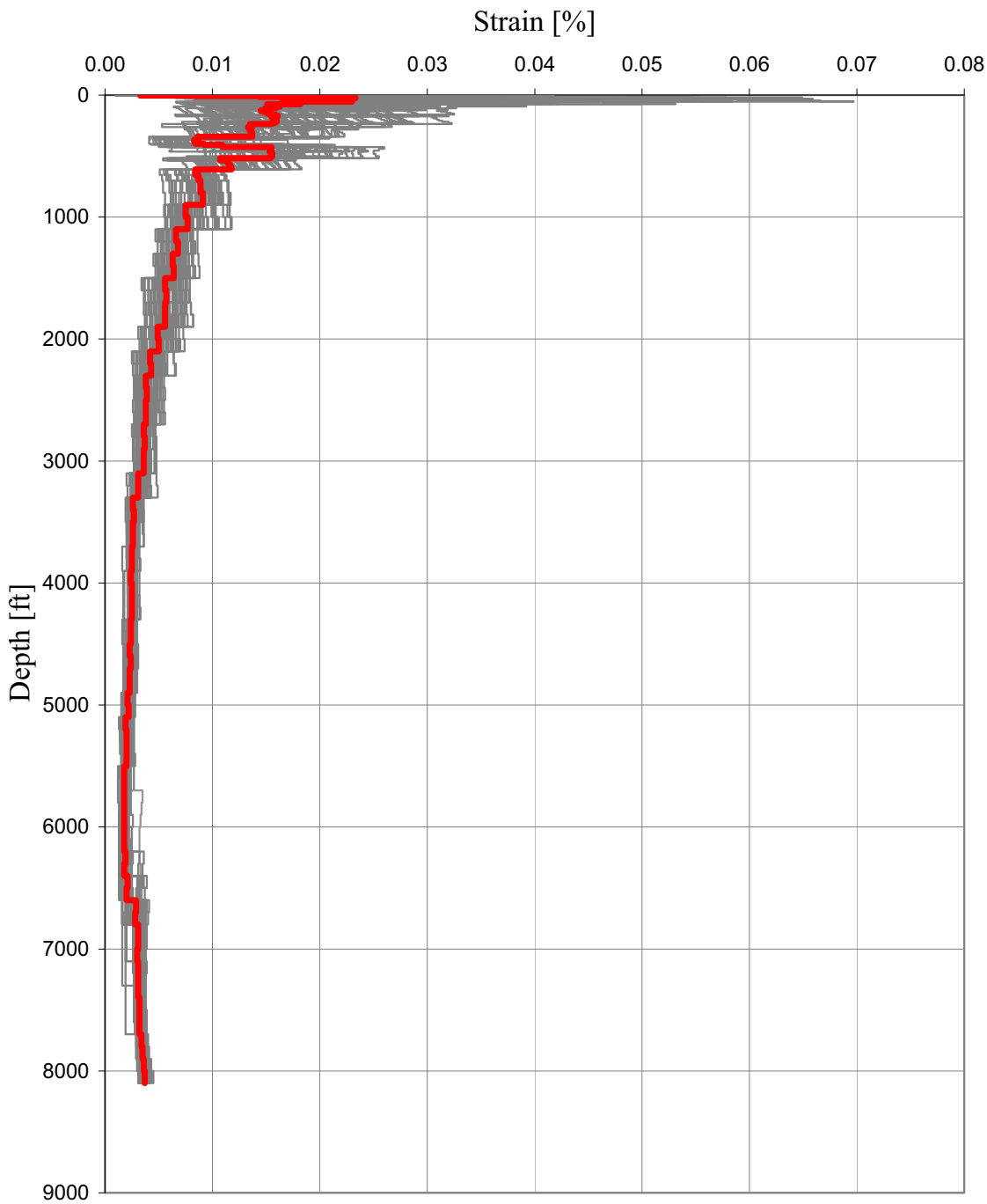


**Figure 2.5S.2-46** Maximum Strains Versus Depth that are Calculated for the 60 Profiles and their Logarithmic Mean (Thick Red Line) with the $10^{-5}$ HF Input Motion~~Maximum Strains – $10^{-5}$ HF Motion~~

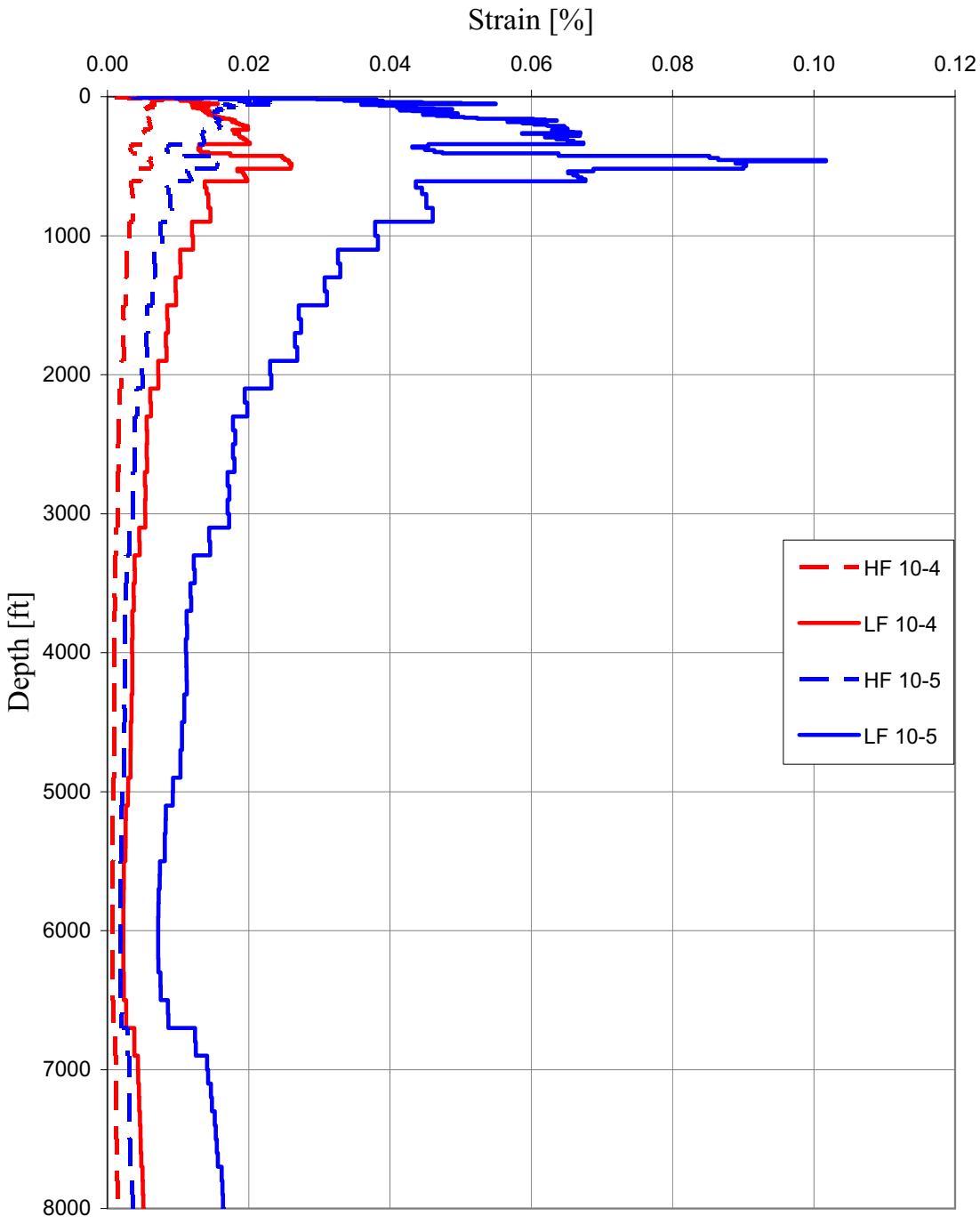


**Figure 2.5S.2-47 Logarithmic Mean Maximum Strain Profiles**

**Figure 2.5S.2-48 Logarithmic Mean Profiles of Strain-Compatible Soil Damping (Top 1000 ft)**

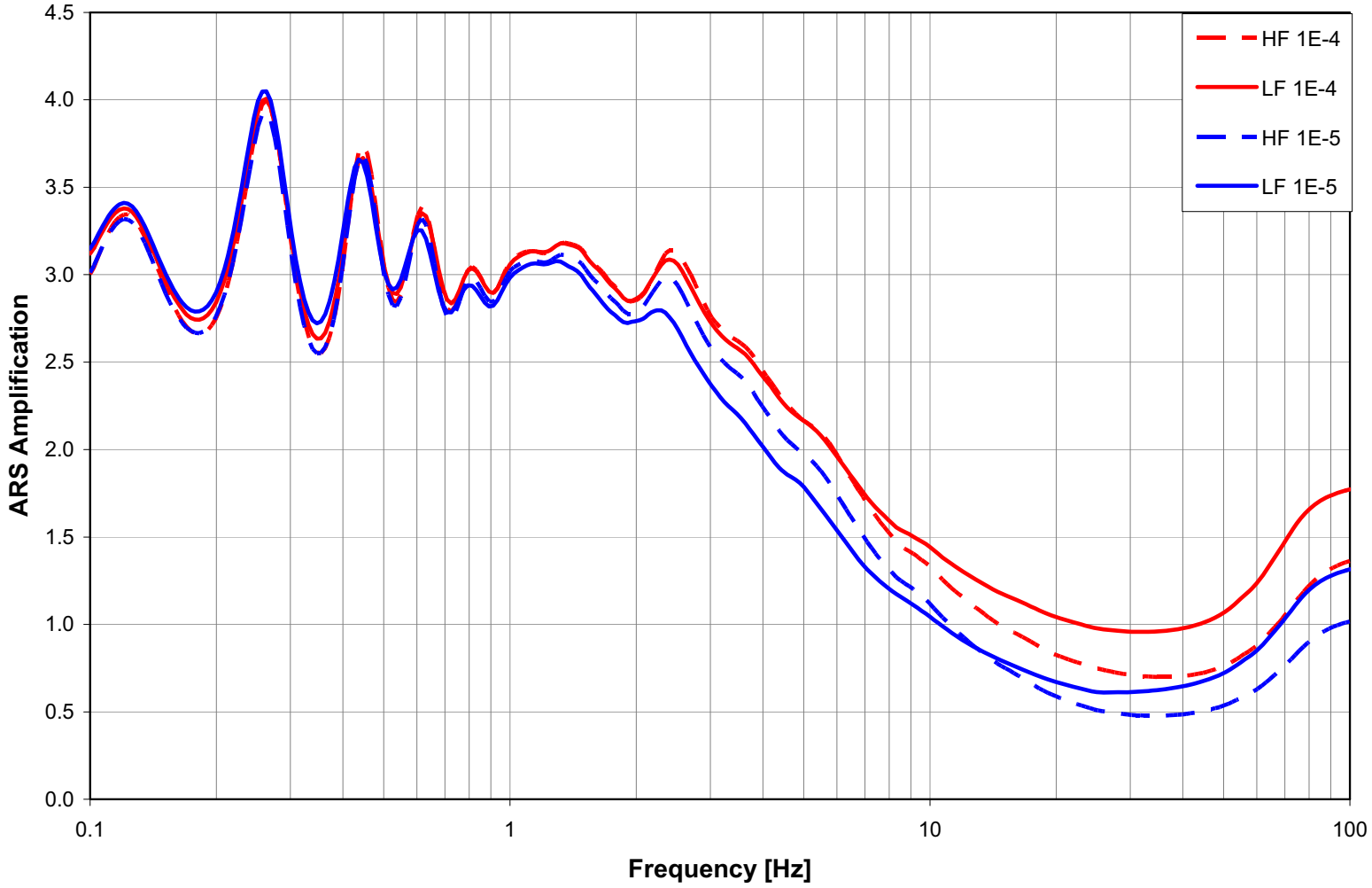


**Figure 2.5S.2-49a ~~2.5S.2-49~~Comparison of Log-Mean Soil amplification Factors at the Ground Surface Level for LF and HF $10^{-4}$ and $10^{-5}$ Input Motions**

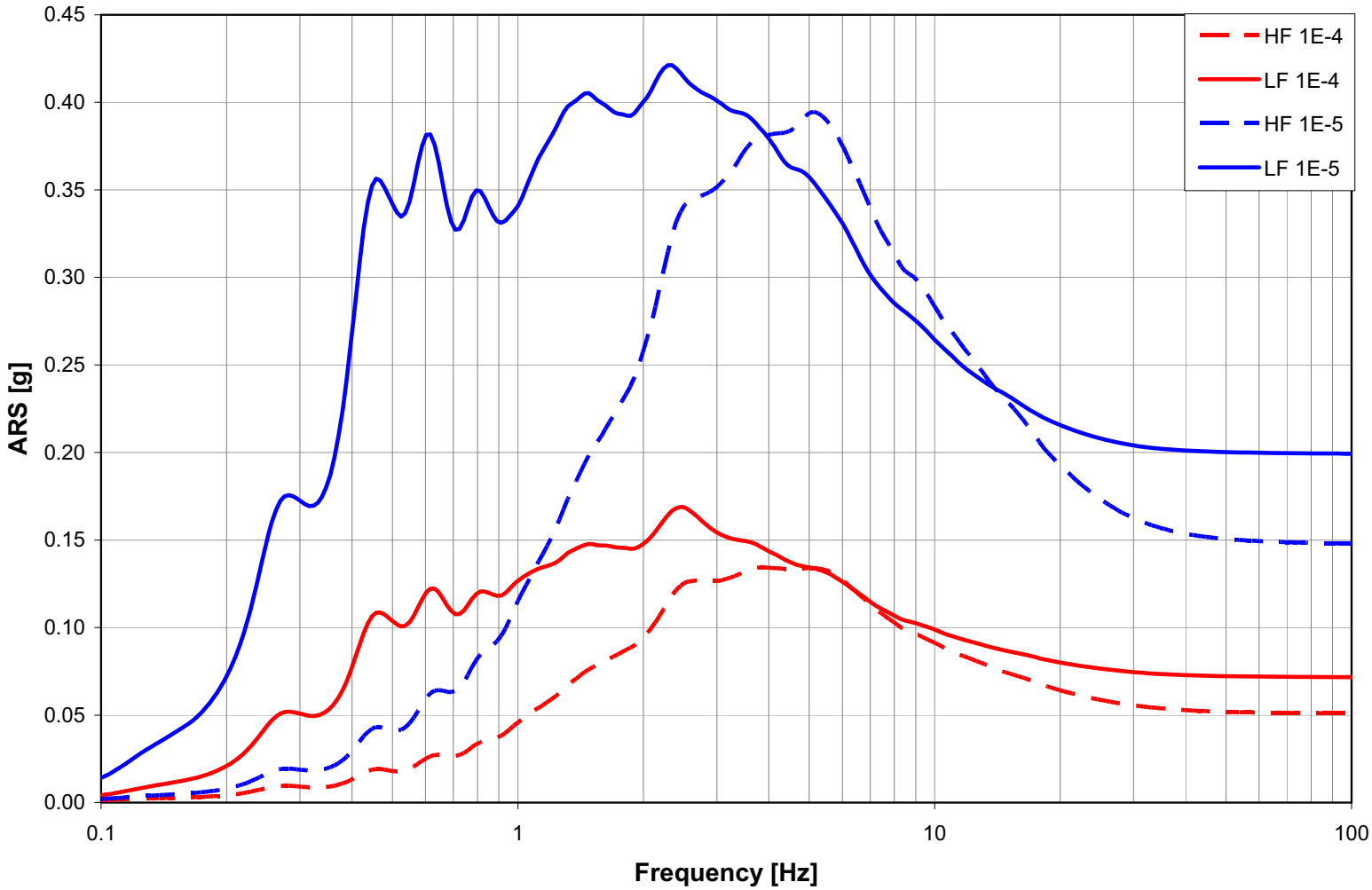


**Figure 2.5S.2-49b** Log-Mean ARS at the Ground Surface Level for LF and HF $10^{-4}$ and $10^{-5}$ Input Motions

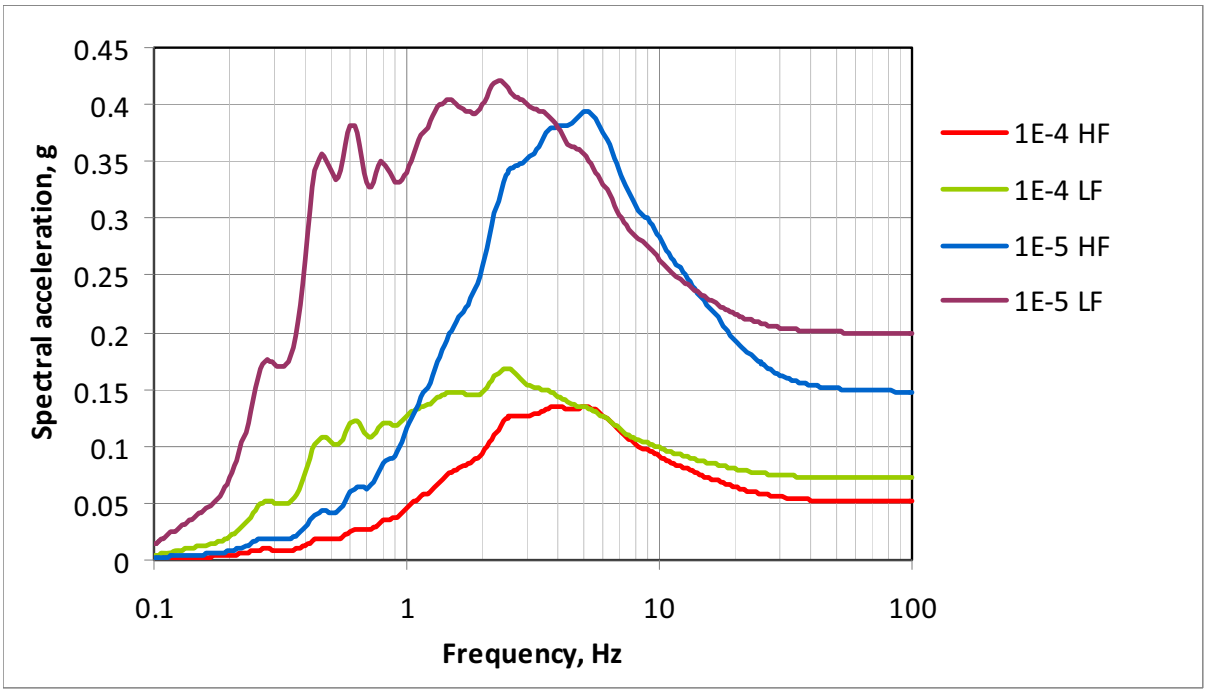


**Figure 2.5S.2-50 Raw $10^{-4}$ and $10^{-5}$ Ground Surface UHRS for HF and LF Earthquakes**

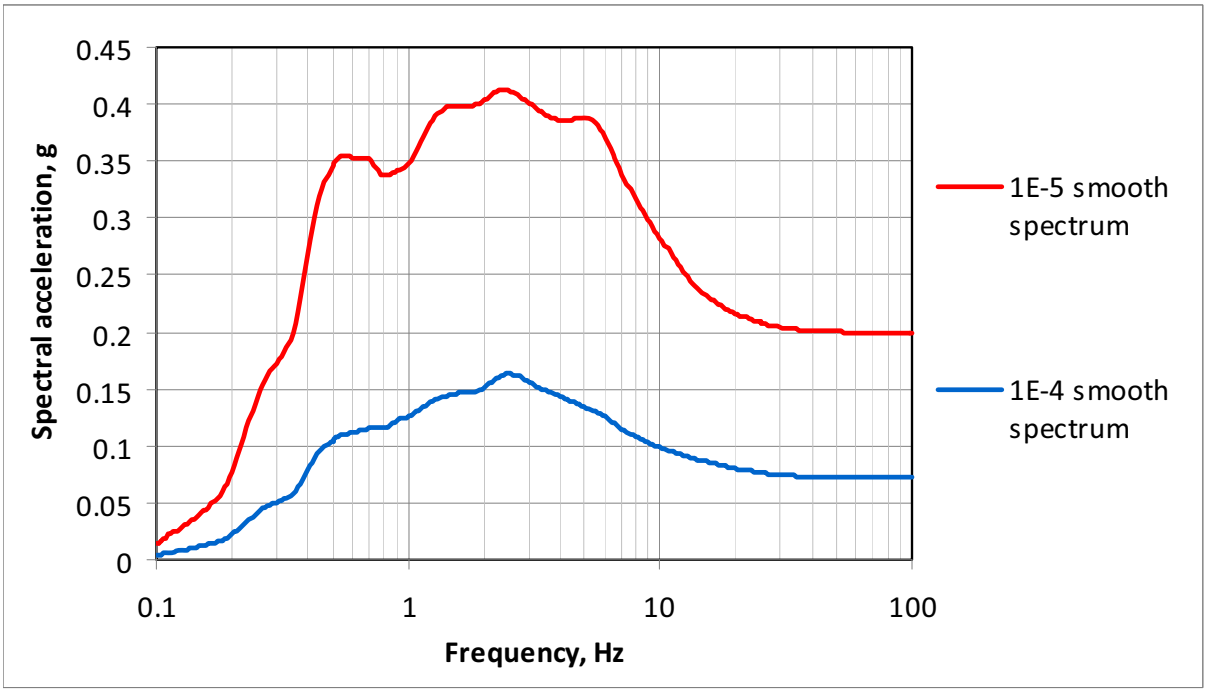


**Figure 2.5S.2-51 Enveloped Smooth $10^{-4}$ and $10^{-5}$ Ground Surface UHRS for HF and LF Earthquakes**

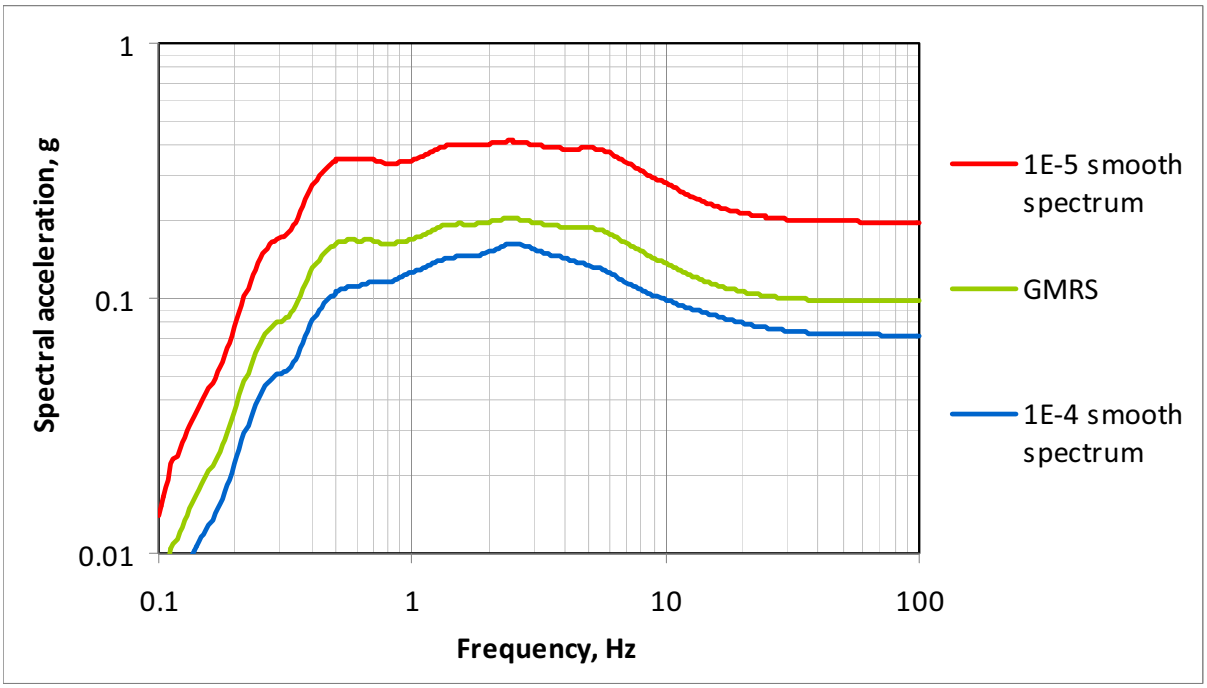


**Figure 2.5S.2-52 Smooth $10^{-4}$ and $10^{-5}$ Soil UHRS, and Resulting GMRS**

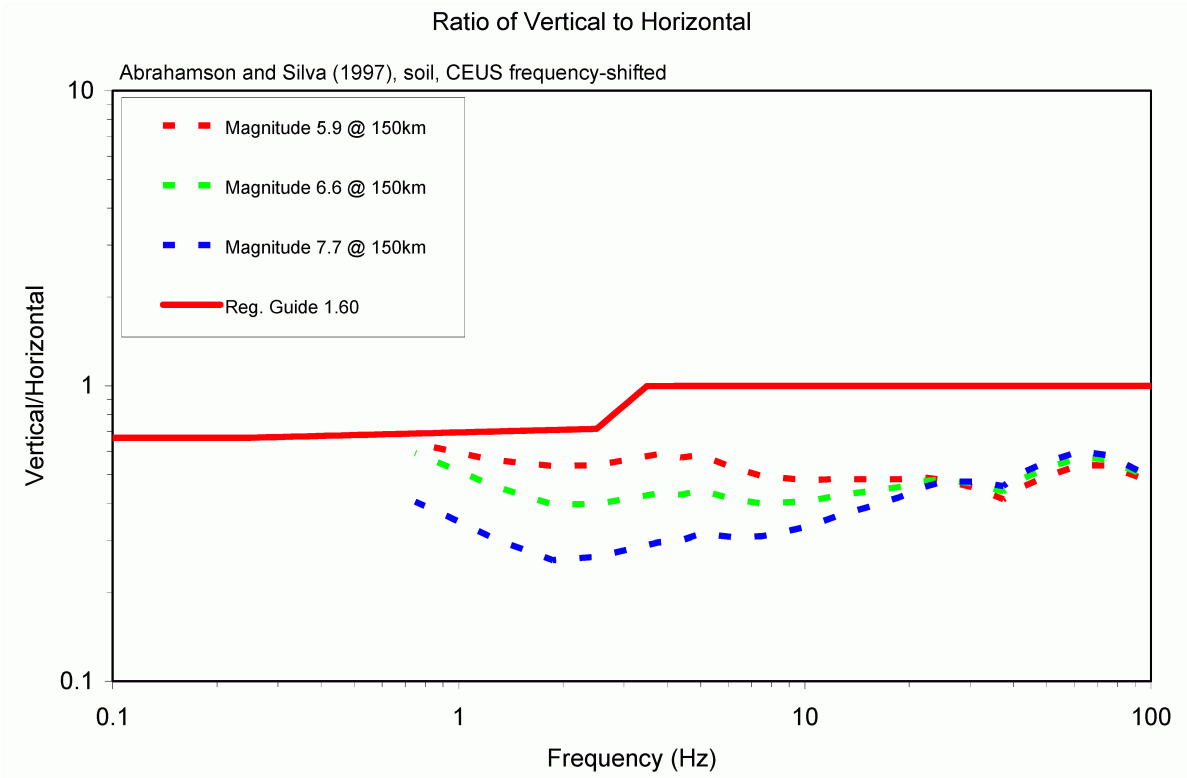


**Figure 2.5S.2-53 The WUS Soil V/H Ratios at 150km for Magnitudes 5.9, 6.6, and 7.7 with the Frequencies Shifted by a Factor of (62.5/16.7) to Approximate a WUS-to-CEUS Transformation**

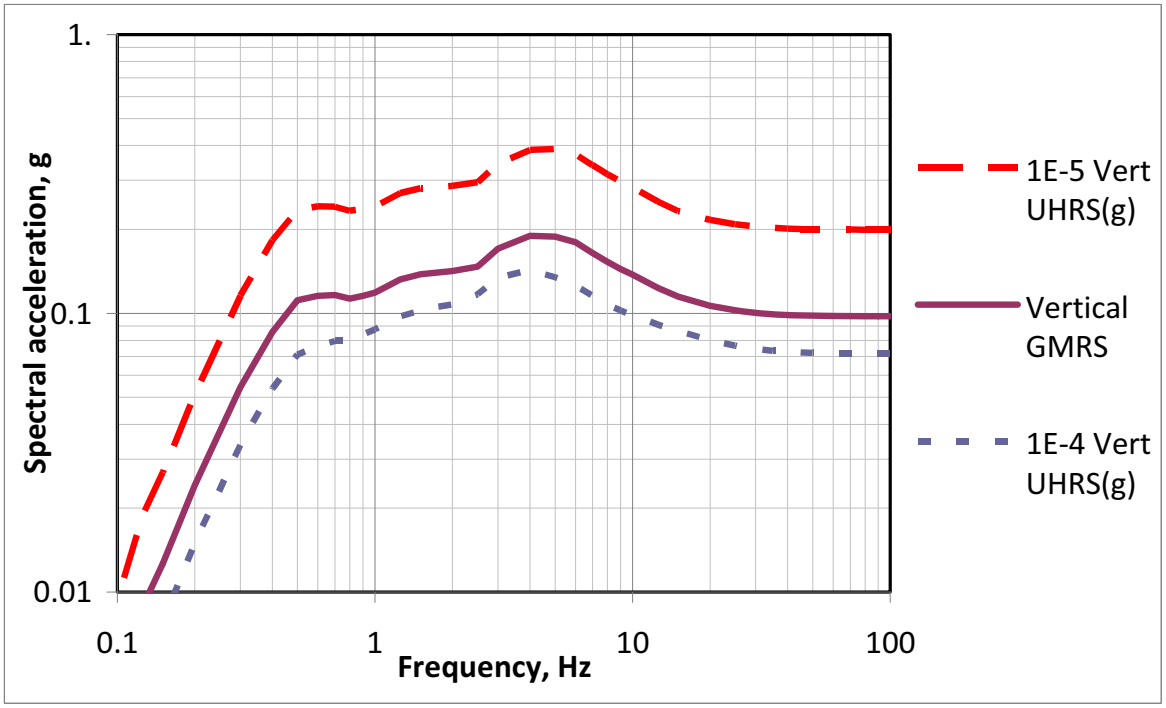


**Figure 2.5S.2-54 Vertical $10^{-4}$ and $10^{-5}$ UHRS, and Vertical DRS**