2.5.2 VIBRATORY GROUND MOTION

The U.S. EPR FSAR includes the following COL Item for Section 2.5.2:

> A COL applicant that references the U.S. EPR design certification will review and investigate site-specific details of the seismic, geophysical, geological, and geotechnical information to determine the safe shutdown earthquake (SSE) ground motion for the site and compare site-specific ground motion to the Certified Seismic Design Response Spectra (CSDRS) for the U.S. EPR.

This COL item is addressed as follows:

{This section provides a detailed description of the vibratory ground motion assessment that was carried out for the Callaway Plant Unit 2 Site to develop the Callaway Plant Unit 2 Ground Motion Response Spectra (GMRS). This is the first step to define the final Site Safe Shutdown Earthquake (SSE) response spectra, as defined in Regulatory Guide 1.208, Regulatory Position 5.4.

The basic information and regulatory guidance for this assessment is provided by:

- U. S. NRC Regulatory Guide 1.206: Combined License Applications for Nuclear Power Plants (LWR Edition) (NRC, 2007c).
- US NRC Regulatory Guide 1.208: A Performance Based Approach to Define the Site-Specific Ground Motion (NRC, 2007a);
- The United States Geological Service (USGS) documentation of the studies for the 2002 national seismic hazard maps (USGS, 2002);
- The EPRI-SOG probabilistic seismic hazard analysis (PSHA) methodology outlined in EPRI NP-4726-A 1988 (EPRI, 1988);
- The Early Site Permit (ESP) Application for the Clinton NPP (EGC, 2006) submitted to the NRC on April 16, 2006 by Exelon Generation Company (EGC);

Regulatory Framework

The applicable USNRC regulations and guidelines are summarized as follows:

10 CFR Part 52 governs the issuance of Early Site Permits (ESPs), Standard Design Certifications, and COL Applications for nuclear power facilities licensed under Section 103 or 104b of the Atomic Energy Act of 1954, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242). Part 52 refers to Part 50 for information that is required for the COL application, and refers to Part 100 for information on compliance on site characteristics.

10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," states that on or after January 10, 1997, stationary power reactor applicants shall comply with the earthquake engineering criteria in Appendix S of this Part. Previously, seismic and geologic siting criteria for nuclear power plants were specified in Appendix A of 10 CFR Part 100, Reactor Site Criteria, which established the criteria for determining the SSE ground motions for all currently existing nuclear power plants in the USA using a deterministic approach. 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," pursuant to the seismic and geologic basis requirements of 10 CFR Part 100, Section 100.23, defines two levels of vibratory ground motion - Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE).

In 2007, the USNRC published Regulatory Guide (RG)1.206: Combined License Applications for Nuclear Power Plants (LWR Edition) to provide guidance on the information to be submitted in a COL Application for a nuclear power plant (NRC, 2007c). RG 1.206 addresses many of the application options allowed by 10 CFR Part 52.

Also in 2007, the USNRC issued Regulatory Guide 1.208: A Performance Based Approach to Define the Site-Specific Ground Motion. This document provides an alternative to Regulatory Guide 1.165 for satisfying the requirements set forth in 10 CFR100.23, "Geologic and Seismic Siting Criteria," of 10 CFR Part 100, Reactor Site Criteria.

The vibratory ground motion analysis for the Callaway Plant Unit 2 Site is performed in accordance with Regulatory Guide 1.208 (RG 1.208). In RG 1.208, alternative guidance is provided for incorporating recent developments in ground motion models; models for earthquake sources; estimates of site response; and defining the Site SSE or GMRS. The Callaway Plant Unit 2 analysis has followed RG 1.208 and is based on the findings of the site-specific field geologic, geotechnical and geophysical investigations, on seismicity data described in EPRI SOG studies (1986-1989), USGS 2002 and 2008 documentation, updated information and assessments from the Clinton Early Site Permit (ESP) Application, Rev. 4, and studies to assess the potential of paleoseismicity in the Callaway Plant Unit 2 Site Area and Region.

The Callaway Plant Unit 2 GMRS ground motion is based on the risk-consistent/ performance-based approach of RG 1.208 (NRC, 2007a), with reference to NUREG/CR-6728 (NRC, 2001), NUREG/CR-6769 (NRC, 2002), and ASCE/SEI 43-05 (ASCE 2005). Horizontal ground motion amplification factors are developed using site-specific data and estimates of near-surface soil and rock properties. These amplification factors are then used to scale the hard rock spectra to develop Uniform Hazard Spectra accounting for site-specific conditions using Approach 2B of NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002). Horizontal GMRS spectra are developed from these soil Uniform Hazard Spectra using the performance-based approach of ASCE/SEI 43-05 (ASCE 2005), as implemented in Regulatory Guide 1.208 (NRC, 2007a). The GMRS motion is defined at the free ground surface of a hypothetical outcrop at the base of the Nuclear Island foundation (RG 1.208).

As defined in Regulatory Postion 5.4 of RG 1.208, the final SSE is 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 SSE for the Site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. RG 1.208 prescribes procedures to arrive at a site-specific Ground Motion Response Spectra (GMRS) that satisfies the requirements of 10 CFR 100.23 with respect to developing the SSE. The GMRS are based on site-specific Uniform Hazard Response Spectra (UHRS) at the free-field ground surface modified by a design factor to obtain the performance-based site-specific response spectrum.

The SSE spectra described herein are considered performance goal-based (risk-informed) site-specific Safe Shutdown Earthquake response spectra. The method specifies the level of conservatism and rigor in the seismic design process such that the performance of structures, systems, and components (SSC) of the plant achieve a uniform seismic safety performance consistent with the NRC's safety goal policy statement (NRC, 1986; NRC, 2001). The SSE spectra, and its specific location at a free ground surface, reflects the seismic hazard in terms of the Probalistic Seismic Hazard Analysis (PSHA) and the geologic characteristics of the site and represents the site-specific (GMRS) of Regulatory Guide 1.208 (NRC, 2007a). These spectra are subject to modification as appropriate to develop ground motion for design considerations. The Site SSE developed in this section meets the requirements of paragraph (d) of 10 CFR 100.23 (CFR, 2007).

The steps to develop the final SSE are decribed in Chapter 3 (Section 3.7.1). "Design of Structures, Components, Equipment, and Systems," of NUREG-0800, "Standard Review Plan." Two options are discussed. The first option is for COL applicants using a standard design nuclear power plant which uses broad-band smooth response spectra, referred to as Certified Seismic Design Response Spectra (CSDRS). The CSDRS are site-independent seismic design response spectra scaled to a peak ground motion value. Under this first option, the GMRS are used to determine the adequacy of the CSDRS for the site. If adequate, the CSDRS becomes the SSE for the Site. Under the second option an applicant would develop a site-specific nuclear power plant design based on a Site SSE. The GMRS developed for the Callaway Plant Unit 2 Site is an initial site-specific SSE. The Site final SSE for Callaway Plant Unit 2 is further defined in Section 3.7.1.1.1 after reconciliation with the CSDRS curves.

Site Investigations

RG 1.208 provides guidance for the recommended level of investigation at different distances from a proposed Site for a nuclear facility as follows:

- The Site Region is that area within 200 miles (320 km) of the Site location,
- The Site Vicinity is that area within 25 miles (40 km) of the Site location,
- The Site Area is that area within 5 miles (8 km) of the Site location,
- The Site is that area within 0.6 mile (1 km) of the Site location.

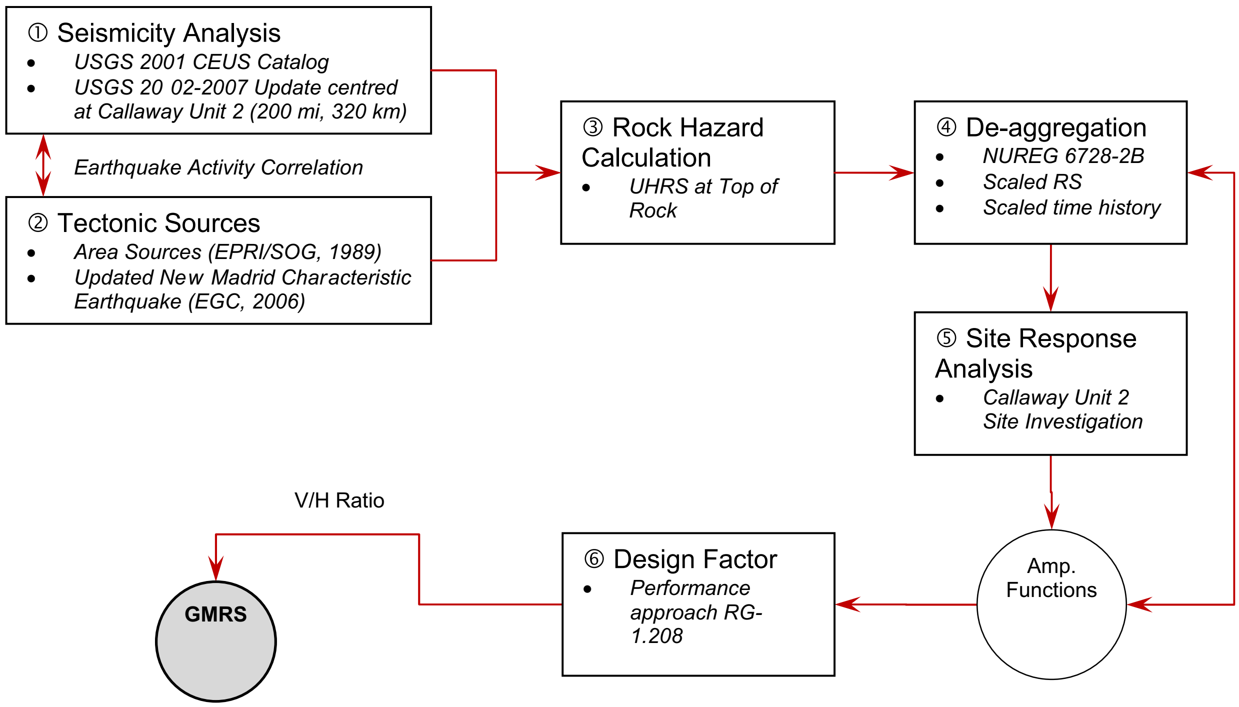
The depth and detail of field investigations increases from the Region to the Site levels. For the Site Vicinity and Site Area levels, a field reconnaissance and investigation was performed to identify potential zones of surface faulting and paleoliquefaction features. No associated historical earthquakes or alignments of seismicity exist to suggest the presence of a capable tectonic source in the Site Area.

In October of 2008 a field reconnaissance effort was performed with the objective of identifying potential paleoliquefaction features. None of the observed sites within the Callaway Plant Site Area yielded evidence of earthquake derived paleoliquefaction. The Site Area Paleoliquefaction and Surface Faulting Investigations provided in COLA Part 11G provides additional detail related to the paleoliquefaction field investigation.

Site Seismic Hazard Process

As described in RG 1.208, the PSHA can be conducted as shown below.

Site Seismic Hazard Process Flowchart



The PSHA begins with the selection of an updated seismic catalog, follows with the definition of tectonic sources and then proceeds with the rock hazard calculation. For each hazard level, (10^{-4} and 10^{-5}), the Uniform Hazard Response Spectra (UHRS) at hard rock is derived as well as their corresponding de-aggregation results. The low frequency controlling event, 1 to 2.5 hertz, and the high frequency controlling event, 5 to 10 hertz, can be identified from the de-aggregation results. These controlling events are prescribed in terms of magnitude (M) and distance (R) pairs. From the M-R pair defining each controlling event, the rock motion time histories are selected.

For each controlling event, a spectral shape is adopted from the shapes for the Central and Eastern United States (CEUS) site according to the corresponding magnitude and distance pair (NUREG 6728). Then, the response spectrum is scaled to match the rock UHRS at the spectral frequencies of 1.75 hertz (low frequency controlling event) and 7.5 hertz (high frequency controlling event). Next, the rock motion time histories are scaled to match the corresponding scaled controlling response spectrum. These scaled time histories are utilized as input to the Site Response Analyses.

A best estimate soil profile, with best estimate shear-wave velocity and material stiffness, density, and damping curves, is developed based on field measurements, laboratory testing and appropriate generic information (Section 2.5.4). The site response analysis uses randomized material properties and layer thicknesses based on the best estimate values and their variability. The results are expressed as mean site amplification functions corresponding to each controlling event. These factors are used to calculate the mean soil UHRS. In turn, the mean site amplification functions and the mean soil UHRS are used to derive the design factors with the application of the performance approach defined by RG 1.208. Vertical to horizontal ratios are subsequently used to calculate the vertical GMRS.

The following subsections summarize the content of this section related to the vibratory ground motion studies that were carried out for Callaway Plant Unit 2.

- Section 2.5.2.1 provides information related to the seismicity analysis (Step 1 of Site Seismic Hazard Process Flow Chart). The 2002 earthquake catalog compiled by the USGS in terms of body wave magnitude (m_b), up to the end of 2001 has been adopted. At the time of the PSHA for Callaway Plant Unit 2 that catalog constituted the most recently updated list that considers body wave magnitude units. The 2002-2007 seismicity has been incorporated into a sensitivity analysis for the Site Region (200 mi (320 km)).

- Section 2.5.2.2 provides information related to the geologic and tectonic characteristics of the Site and Region, with special attention to the EPRI-SOG seismic source zones and the characterization of the New Madrid Seismic Zone (NMSZ) (Step 2 of Site Seismic Hazard Process Flow Chart).

- Section 2.5.2.3 describes the correlation between recorded earthquake activity and seismic source zones. (Steps 1 and 2 of Site Seismic Hazard Process Flow Chart).

- Section 2.5.2.4 is a key component of the PSHA calculation process (Steps 3 and 4 of Site Seismic Hazard Process Flow Chart). The Section describes the applied theory and the development of the area sources hazard contribution and the New Madrid characteristic earthquake.

- Section 2.5.2.5 summarizes information about the seismic wave transmission characteristics of the Callaway Plant Unit 2 Site with reference to more detailed discussion of all engineering aspects of the Site subsurface in Section 2.5.4. (Step 5 of Site Seismic Hazard Process Flow Chart).

- Section 2.5.2.6 describes the development of the horizontal GMRS ground motion for the Callaway Plant Unit 2 Site (Step 6 of Site Seismic Hazard Process Flow Chart).

The development of the PSHA for Callaway Plant Unit 2 utilized a Senior Seismic Hazard Analysis Committee (SSHAC) for review of the input parameters and overall approach. The overall goal of the SSHAC process is to provide a representation of the informed scientific community's view of the important components and issues related to the PSHA. NUREG/CR-6372 provides guidance on PSHA uncertainty and use of experts to incorporate different interpretations and diversity of expert judgment. The SSHAC process focuses on the parameters used as input and the methodologies applied for the calculation of the seismic hazard. Members of the Callaway Plant Unit 2 SSHAC are:

- Dr. Paul C. Rizzo - Technical Integrator,

- Dr. Robert Herrmann - Resource Expert in CEUS seismicity,

- Dr. Robert Kennedy - Resource Expert in PSHA and earthquake design basis, and

- Dr. Richard Lee - Resource Expert in site amplification analysis and geophysical data interpretation.

2.5.2.1 Seismicity

Seismicity input data consists of:

- Earthquake catalogs, which reflect recorded seismicity in the Central and Eastern United States (CEUS),
- Prehistoric seismicity, postulated from the presence of paleoliquefaction features within the Site Region,
- EPRI Seismic source zones.

Discussions related to the earthquake catalog, prehistoric seismicity and EPRI Seismic Source Zones are provided in the following subsections. Seismic source zones are shown in figures depicting the 200 mi (320 km) Region around the Callaway Plant Site and the recorded seismicity. The Guttenberg-Richter (G-R) parameters ‘a’ and ‘b’, and Maximum magnitude for each seismic source are discussed in Section 2.5.2.2.

2.5.2.1.1 Recorded Seismicity: Earthquake Catalog

Current probabilistic hazard methodologies consider that the activity in area seismic sources can be adequately represented by the Guttenberg-Richter (G-R) recurrence equation in terms of body wave magnitude, m_b. A quantitative derivation of the G-R parameters is based on historical seismicity, i.e., on catalogs of seismic events. The seismic hazard analysis conducted by EPRI as delineated in NP-6395-D 1989 (EPRI, 1989a) relied, in part, on an analysis of historical seismicity in the CEUS to estimate seismicity parameters (rates of activity, a, and slope b-values of the Guttenberg-Richter equation) for individual seismic sources. The historical earthquake catalog used in the EPRI analysis was complete through 1984.

As recognized in NRC Regulatory Guide 1.208 (NRC, 2007a), the United States Geological Survey (USGS) maintains a large database of seismic sources for the Central and Eastern United States, as part of their efforts to develop National Seismic-Hazard Maps (USGS, 1997, 2002, 2008). In Open-File Report 96-532, entitled “National Seismic-Hazard Maps: Documentation June 1996 (USGS, 1996), the USGS states that their CEUS catalog was primarily based on a catalog by Seeber (1991), who conducted a refinement of the EPRI 1986 catalog (EPRI, 1986). The 2002 USGS catalog uses mainly: (1) the National Center for Earthquake Engineering Research (NCEER) NCEER91 catalog which lists about 3,630 events (m_{bLg} 2.5 or greater) in the CEUS and southeastern Canada from 1627 to 1985, with consistent treatment of pre-instrumental earthquakes; (2) events for Central and Eastern North America (CENA) compiled by various groups listed by USGS; and (3) the Decade of North American Geology project. The NCEER91 catalog constitutes an improvement and update to the 1986 EPRI catalog as does the USGS 2002 catalog.

USGS updated catalogs are compiled by examining and combining events listed in several CEUS source catalogs (Mueller and others, 1997). In this effort, the USGS intent is to develop a catalog dominated by entries from the best-researched sources and then use this priority to choose the best location and magnitude from among multiple source catalogs for each earthquake. In addition, secondary events have been filtered as explained in a recent USGS publication (USGS, 2008) as follows:

> “Foreshocks and aftershocks are deleted using the declustering methodology of Gardner and Knopoff (1974); this simple algorithm requires no tuning parameters (that is, prejudgments about what are or are not aftershocks), and results are easily reproducible. Man-made seismic events are deleted if they are associated with a transient process that is no longer active (for example, earthquakes caused by deep fluid injection at the Rocky Mountain Arsenal near Denver), or if the process is ongoing but we have no reason to expect that future large, hazardous events will be associated with the activity (for example, earthquakes caused by fluid injection in the Paradox

Valley of western Colorado, mining-related events in Colorado and Utah, and events related to oil production at the Dagger Draw field in New Mexico)."

The 2002 USGS catalog was used to provide the seismicity data required for the PSHA at the Callaway Plant Unit 2 Site. This catalog is a significant update to the EPRI-SOG 1984 seismic catalog.

There are numurous seismic networks that record earthquakes in the CEUS. The USGS routinely examines and combines available data on historical earthquakes to develop a homogeneous earthquake catalog that contains all recorded earthquakes for the region. "Homogeneous" means that estimates of body-wave magnitude, m_b, for all earthquakes are consistent, duplicate earthquakes have been eliminated, non-earthquakes (e.g., mine blasts and sonic booms) have been eliminated, and significant events in the historical record have not been missed. Thus, the USGS catalog forms a strong basis on which to estimate seismicity parameters. Foreshock and aftershock events are removed as recommended by the USGS. Consequently, seismic events are only counted once in the USGS catalog. Thus, the catalog compiled by the USGS up to the end of 2001, has been used in the determination of G-R parameters for the area seismic sources that affect Callaway Plant Unit 2. Table 2.5.2-1 provides the complete CEUS catalog through the year 2001. This catalog constitutes the most recently updated list in terms of m_b units.

Regulatory Guide 1.206 specifies that earthquakes of a Modified Mercalli Intensity (MMI) greater than or equal to IV or of a magnitude greater than or equal to 3.0 should be listed for seismic sources, "any part of which is within a radius of 200 miles (320 km) of the site (the Site Region)." The USGS catalog and methodology for determining seismicity parameters consider precisely the minimum magnitude of m_b equal to 3.0.

The seismic events recorded in the 2002 USGS catalog are accounted for in the calculation of the G-R parameters for a given area source if any portion of the area source is within the 200 mi (320 km) region.

RG 1.206 also requires the incorporation of large earthquakes outside the region that could impact the GMRS. For the Callaway Plant PSHA, portions of the New Madrid Zone and Wabash Valley Seismic Zone fall within this category. The entire New Madrid Zone was included in the PSHA. Earthquakes outside the 200-mile region that affect the Callaway Plant Unit 2 seismic hazard have been accounted for up to present date, either by a general area source hazard calculation or by the New Madrid characterisitc earthquake analysis.

Earthquake Catalog Update

For performing the Callaway Plant PSHA calculation, the USGS 2002 catalog constituted the most up to date published catalog in terms of m_b units. To assess the potential effects of more recent events, a sensitivity analysis has been performed with a catalog update for years 2002-2007. The seismicity for these years marginally affects the outcome of the PSHA by slightly reducing the ground motion levels, which yields less conservative results. Since the initial analysis based on the 2002 catalog update resulted in higher site response (i.e. more conservative ground motion levels) the G-R parameters have not been updated with the 2002 to 2007 data. The results of the sensitivity analyses are discussed in detail in Section 2.5.2.4. For the sensitivity analysis an earthquake catalog search for years 2002-2007 was performed using the following criteria:

- Use of a circular area (200 mi (320 km) radius), centered at the Callaway Plant Site (38.76 (N), -91.78 (W)) for the USGS earthquake database; selection of the USGS/NEIC (PDE)

'1973 – Present' database for magnitudes from 3.0 to 10.0 between the year 2002 and 2007 (USGS, 2008a);

- Use of a rectangular boundary zone with limits from 35.86N to 41.66N (latitude) and -88.06 (W) to -95.50 (W) (longitude) for the Advanced National Seismic System (ANSS) earthquake database for magnitude 3.0 to 10.0 between years 2002 to 2007 (ANSS, 2008);
- The magnitude of the earthquake databases is considered in m_{bLg} (m_b) units;
- For the same event, if the magnitude between databases differs, the larger magnitude is selected;
- Consider only those earthquakes within the 200 mi (320 km) radius resulting from either database query.

There are 18 events in the 200 mi (320 km) circular area centered at the Callaway Plant Unit 2 Site with magnitude larger than 3.0 m_b from 2002 to 2007. A search was also performed with the Center for Earthquake Research and Information (CERI), specifically with the New Madrid Earthquake Catalog Search. The events provided by the search of the CERI catalog have been confirmed as being included in the PDE and ANSS databases and were utilized in the Sensitivity Studies.

The new event data is incorporated into the Table 2.5.2-2 catalog and is shown within the Region and within the context of the EPRI source zones by Figure 2.5.2-1 through Figure 2.5.2-6:

- Figure 2.5.2-1 – Earthquake Catalog and Bechtel Group EPRI Source Zones
- Figure 2.5.2-2 – Earthquake Catalog and Dames & Moore Group EPRI Source Zones
- Figure 2.5.2-3 – Earthquake Catalog and Law Engineering Group EPRI Source Zones
- Figure 2.5.2-4 – Earthquake Catalog and Rondout Group EPRI Source Zones
- Figure 2.5.2-5 – Earthquake Catalog and Weston Group EPRI Source Zones
- Figure 2.5.2-6 – Earthquake Catalog and Woodward-Clyde Group EPRI Source Zones

In conclusion, the earthquake catalog used for the Callaway Plant Unit 2 PSHA considers recorded seismicity from 1534 to 2007. A sensitivity analysis for the catalog update from 2002 through 2007 has been performed and the new events are not incorporated into the Site PSHA and GMRS calculations since they would slightly reduce the seismic hazard. Other regions with evidence of prehistoric earthquake activity that could potentially affect the outcome of the PSHA are also discussed in Section 2.5.2.1.2.

2.5.2.1.2 Prehistoric Seismicity

In the Central and Eastern United States (CEUS), seismogenic faults are uncommon or difficult to identify. Strain rates are generally low, and recurrence intervals for large earthquakes are usually longer than the historic record. In this tectonic environment, the identification of paleoliquefaction features that result from strong ground motion has proven to be an effective tool in identifying and characterizing seismogenic sources that generate moderate-to-large magnitude earthquakes in prehistoric time.

Earthquake induced liquefaction is a process through which saturated, granular sediment temporarily loses its strength in response to earthquake ground shaking. Sediment with low cohesion that is water saturated and loosely packed will tend to compact, leading to an increase in pore water pressure. If pore water pressure increases to the point that it approximately equals overburden pressure, the sediment can behave as a viscous liquid. Under conditions such as lateral spreading, the resulting slurry of sediment and water will tend to flow toward the ground surface along zones of weakness or cracks formed by lateral spreading, forming a number of distinctive sedimentary features; including sand blows, dike, and sills.

Site borings and reconnaissance field investigations did not reveal any caves or significant open cavities in the Site Area. No evidence of earthquake induced landsliding, spreading, and lurching was found, which is expected in the absence of steep slopes.

Field and literature investigations confirmed that the Site Area exhibits little evidence of faulting; all of it is non-capable and none is within the Site Area. In addition, a targeted field investigation discovered no evidence of paleoliquefaction features in the Site Area. The investigation took place in October 2008 and was performed by geologists and engineers to assess the presence of paleoliquefaction features along waterways within the Site Vicinity, and also to ground-truth the presence and surface expression of nearby Ordovician to Pennsylvanian-age faults.

At a regional scale the paleoseismicity of the New Madrid Seismic Zone, the Wabash Valley Zone, and the St. Louis-Eastern Illinois Region are of particular importance.

2.5.2.1.2.1 New Madrid Seismic Zone

Documentation for the 2008 Update of the United States National Seismic Hazard Maps by the USGS (USGS, 2008) asserts that their CEUS fault model includes four finite fault sources (New Madrid, Mo. and adjacent States; Charleston, S.C.; Meers, Okla.; and Cheraw, Colo.), adding that these four sources are the only ones in the CEUS that have paleoseismic data to constrain large-earthquake recurrence rates.

Liquefaction investigations have been conducted to infer the occurrence of prehistoric earthquakes in the Central and Eastern United States. One of the most significant findings is the very large magnitude (**M** > 7.6) earthquakes, similar to those in 1811-1812 are believed to have occurred around A.D. 1450 ± 150 yr and A.D. 900 ± 100 yr (Tuttle et al., 2002). These findings have been considered in the Callaway Plant Unit 2 PHSA by an updated characterization of clustered New Madrid large earthquakes and are discussed in Section 2.5.2.2.2.

2.5.2.1.2.2 Wabash Valley

Evidence from recent paleoliquefaction studies and seismic reflection data suggests that significant earthquakes may occur in parts of the Illinois basin where there are no obvious faults or folds at the surface (EGC, 2006). The location, size, and recurrence of such events are not well defined by available data. The presence of paleoliquefaction features, however, suggests that the range of maximum magnitudes assigned to a random background (that is, not associated with a specific source) earthquake must include events comparable to that estimated for the postulated Springfield earthquake (that is, **M** 6.2 to 6.8). In addition, it is estimated that a **M** 7.5 magnitude for the Vincennes-Bridgeport earthquake occurred 6,011 ± 200 years ago.

The maximum magnitude distribution for the Wabash Valley-Southern Illinois Source Zone has been updated based on recent analysis of paleoliquefaction features in the vicinity of the lower

Wabash Valley of Southern Illinois and Indiana. Details of the update in maximum magnitude distribution are discussed in Section 2.5.2.2.3.

2.5.2.1.2.3 St. Louis Region

In a study focused in the area east of St. Louis, two generations of sand dikes, were found along the Kaskaskia River and its tributary Shoal Creek (McNulty and Obermeier, 1999). The study concluded that a **M** > 6 earthquake occurred near the lower portion of Shoal Creek during the Middle Holocene about 6,500-7,000 radiocarbon years B.P. The age of the event was estimated from the weathering characteristics of sand dikes and dating of deposits cut by the dikes. The earthquake source area was inferred from the local distribution of liquefaction features. The magnitude of the earthquake was derived from the relationship between earthquake magnitude and maximum epicentral distance to surface evidence of liquefaction (e.g., Ambraseys, 1988).

In a regional paleoseismology study conducted for the U.S. Nuclear Regulatory Commision, more than 250 mile (400 km) of rivers and creeks were surveyed across southeastern Missouri and southwestern Illinois for evidence of Quaternary faulting or folding and earthquake-induced liquefaction (Tuttle et al., 1998 and 1999). At least two generations of liquefaction features, including two sand blows and many sand and silt dikes and sills, were found along the Big Muddy, Cache, Castor, Marys, Meramec and Kaskaskia Rivers and Mud, Shoal, and Silver Creeks. The sand blows, as well as a few truncated sand dikes, provided minimum age constraints, in addition to maximum age constraints. Thus, age estimates were narrowly constrained for several liquefaction features, and thus for their causative earthquakes. Sand dikes at two sites on the Meramec River appeared to have formed during the 1811-1812 earthquakes and two sand blows and several sand dikes on the Kaskaskia River and Shoal Creek were estimated to have formed in 4520 B.C. ± 160 yr or 6,500 B.C. (also 5,670 ± 80 radiocarbon yr B.P.). Although they were assigned to general age classes (e.g., Late Holocene, Middle Holocene, Holocene, or Late Wisconsin-Holocene), most of the other liquefaction features have poor age constraints, making regional correlation problematic. On the basis of the analysis, it was proposed that several different earthquake scenarios could explain the observed distribution of liquefaction features.

As reported by Crone (2000), paleoliquefaction features have been systematically examined in an area extending approximately 31 to 56 miles (50 to 90 km) west and east of the Mississippi River, between the St. Louis area on the northwest and the Cape Girardeau area on the southeast. When the Crone report was published (2000), these features were interpreted as produced by an earthquake of magnitude **M** > 6, and perhaps exceeding 7, occurring approximately 6,500 years ago, roughly 38 miles (60 km) east of St. Louis. The identification of this type of event relies only on locations and age estimates of liquefaction. No associated surface ruptures or deformations have been identified. Thus, causative faults were neither identified nor characterized.

More recently, Tuttle (2005) has undertaken a study aiming to constrain the age estimates of earthquakes that induced liquefaction in the St. Louis region. The study consisted of identifying and examining features along rivers and creeks in the St. Louis region. Thirty additional sand and silt dikes along several rivers and creeks were identified and documented, including radiocarbon aging estimates. Despite this significant effort, Tuttle (2005) concludes that "additional study and dating of liquefaction features is needed to further constrain the timing of paleoearthquakes and to make regional correlations of similar-age liquefaction features. A more complete picture of the size and spatial distributions of liquefaction features is needed to interpret the source areas and magnitudes of prehistoric earthquakes with greater confidence." Thus, correlation and dating of the liquefaction features near St. Louis, other than those clearly related to New Madrid seismic zone, remain uncertain.

For the Callaway Plant Unit 2 PSHA, the updated and increased maximum magnitude for the background seismicity and EPRI source zones affected by the Wabash Valley paleoliquefaction studies adequately cover the epistemic uncertainty related to earthquakes near the St. Louis liquefaction features. This is later explained in Section 2.5.2.4.7, which details the PSHA process and related sensitivity analyses.

2.5.2.2 Geologic and Tectonic Characteristics of Site and Region

As described in Section 2.5.1, a comprehensive review of available geological, seismological, and geophysical data has been performed for the Callaway Plant Unit 2 Site Area and surrounding Site Vicinity and Region. In addition, the floors and walls of excavations for safety-related structures for Callaway Plant Unit 2 facilites will be mapped in detail, and the NRC will be notified immediately if previously unknown geologic features that could represent a hazard to the proposed factilites are identified. Any potential deformation feature identified in the excavations will be characterized to assess surface deformation or ground motion generating potential.

The seismo-tectonic characteristics of the region form the basis for defining the seismic source zones that affect the Callaway Plant Unit 2 Site seismic analysis. Seismic sources may be general area source regions as defined by the EPRI-SOG study or distinctive features such as the New Madrid Seismic Zone (NMSZ). Features, such as the NMSZ, due to their tectonic setting or the magnitude and relevance of the reported seismicity, receive a distinct treatment in the form of a "characteristic earthquake". The contribution in the PSHA from characteristic earthquakes is added to hazard contributions of the general area sources and the "background" seismicity, (a term used to define seismic activity that has not been directly correlated to a specific area source or tectonic feature).

The following sources are considered for the PSHA at the Callaway Plant Unit 2 Site:

- EPRI general area source zones extracted from the 1989 EPRI-SOG study,
- Updated New Madrid Seismic Zone (NMSZ) characteristic model earthquake,
- Background seismicity (general area source),
- St. Louis Region, prehistoric earthquake studies (sensitivity study).

The two major contributors to the PSHA completed for the Callaway Plant Unit 2 Site are:

- The New Madrid Seismic Zone (NMSZ), evaluated as a characteristic earthquake,
- The Wabash Valley Seismic Zone (WVSZ) in Southern Illinois and Southern Indiana, evaluated as a non-general area source.

2.5.2.2.1 EPRI Seismic Sources

In the 1986 EPRI study (EPRI, 1986), six independent Earth Science Teams (ESTs) evaluated geological, geophysical, and seismological data to develop seismic sources in the CEUS. These sources were used to model the occurrence of future earthquakes and evaluate earthquake hazards at nuclear power plant sites across the CEUS. The six ESTs involved in the EPRI project were:

- Bechtel Group,
- Dames & Moore,

- Law Engineering,
- Rondout Associates,
- Weston Geophysical Corporation, and
- Woodward-Clyde Consultants.

Each team produced a report, included in EPRI NP-4726 (EPRI, 1986), that provides detailed descriptions of how they identified and defined seismic sources. Figure 2.5.2-1 through Figure 2.5.2-6 present the geometry of the seismic sources selected to estimate the hazard for Callaway Plant Unit 2. These figures also show plots of earthquakes with body wave magnitude (m_b) equal to or higher than 3.0 in the updated earthquake catalog. The EST figures illustrate the spatial relationships between seismicity and seismic sources.

Evaluations of new information examined in previously approved Early Site Permits (ESPs) (EGC, 2006, NRC, 2005) concluded that the EPRI-SOG seismic sources remain appropriate for assessing seismic hazards in CEUS. The PSHA development team and the SSHAC team reviewed the EPRI-SOG source zones and concluded that no new or additional information exists that would necessitate material changes or adjustments to the EPRI-SOG seismic source zones. Therefore, the seismic sources defined in the 1989 EPRI-SOG study have been adopted for performing the Callaway Plant Unit 2 PSHA. However, it is noted that updates and adjustments are required for the maximum magnitude distribution of the area sources and that a characteristic earthquake model must be used to properly account for more recent information on the seismic activity in the New Madrid Fault System. EPRI has published updated models of ground motion attenuation in the CEUS (EPRI, 2004).

The EPRI-SOG ESTs determined recurrence parameters and maximum magnitudes for each source in body wave or seismic moment magnitude (m_b or M) units, including their corresponding weights. These models were incorporated into a PSHA reported in EPRI NP-6395-D (EPRI, 1989a). EPRI NP-6452-D (EPRI, 1989b) summarized the parameters used in the final PSHA calculations, and this reference is the primary source for defining the geometry of area seismic sources for the Callaway Plant Unit 2 PSHA presented herein. For the Callaway Plant Unit 2 PSHA (based on the USGS 2002 catalog) an equal weight is given to each of the geometries for the determination of mean hazard and hazard percentile curves.

The following sections list the seismic source interpretations in the 1989 EPRI PSHA study (EPRI, 1989a), relevant post-EPRI seismic source characterization studies, and updated interpretations provided by the more recent data.

Field and literature investigations confirmed that the Site Area exhibits little evidence of faulting; all of it is non-capable and none is within the Site Area. In addition, a targeted field investigation discovered no evidence of paleoliquefaction features in the area of Site and the geometry of the EPRI source zones is considered appropriate for the Callaway Plant Unit 2 PSHA.

2.5.2.2.1.1 Maximum Magnitude Updates

The upper magnitude, M_{max}, utilized in the magnitude recurrence equation significantly affects the low probability seismic hazard, in particular the near field events. If this parameter is increased, even if there are no earthquakes recorded with such magnitude, the PSHA calculation will take into account higher magnitudes occurring in the low probability range. In the 1989 EPRI-SOG study each EST developed alternative values of M_{max} for each seismic source in m_b units. More recent studies, however, have revised M_{max} for the Wabash Valley, New Madrid, and local sources. It has been recognized that large historical events have occurred at the New Madrid Fault System that cannot be adequately modeled by the G-R equation. Instead, the concept of characteristic earthquakes has been introduced to more appropriately represent the seismic activity at New Madrid. As described in Section 2.5.2.2.2, the characteristic earthquake concept was adopted in this PSHA for Callaway Plant Unit 2 considering moment magnitudes between 7.0 and 8.1.

To avoid double counting the impact of large earthquakes, the maximum magnitude for the New Madrid area source was reduced to m_b 7.0. For the Wabash Valley, revised assessments of the maximum magnitude are as high as **M** 7.8. For the local source, the updated estimates of maximum magnitude are up to **M** 6.8 (EGC, 2006). The New Madrid Earthquakes with magnitudes above 7.0 are not analyzed as an area source but as a characteristic earthquake (Section 2.5.2.2.2).

Table 2.5.2-4 through Table 2.5.2-9 list revised maximum magnitudes and their corresponding weights for the seismic sources selected for the Callaway Plant Unit 2 PSHA. The tables provide the zones for which the maximum magnitude was revised from the original EPRI studies.

2.5.2.2.1.2 Recurrence Parameter ‘b’ Updates

Following the 1989 EPRI study and the 1996, 2002 and 2008 USGS studies, the recurrence parameters for area seismic sources were computed for each one-degree latitude and longitude cell that intersects any portion of a seismic source.

The source recurrence relationships have been described employing the Guttenberg-Richter (G-R) equation. This equation was modified to the exponential magnitude distribution truncated at maximum magnitude, M_{max}. The ‘a’ and ‘b’ parameters characterizing the potential of seismic sources have been updated. As noted previously, each EPRI-SOG EST developed G-R parameters ‘a’ and ‘b’ for each of their seismic sources identifying their selected smoothing options and their corresponding weights. Smoothing allows incorporation of the variation of the G-R parameters ‘a’ and ‘b’ within the seismic source. The smoothing approach developed by USGS (2008) which considers only the variation of the parameter ‘a’ for prescribed constant values of the parameter ‘b’, has been utilized. The constant values of ‘b’ have been taken as the averages of the ‘b’-values adopted for each seismic source by each EPRI-SOG EST, along with the corresponding weights for each smoothing option. Table 2.5.2-4 through Table 2.5.2-9 present the average seismic parameter ‘b’ used as input to the Callaway Plant Unit 2 PSHA.

2.5.2.2.1.3 Recurrence Parameter ‘a’ Updates

Four smoothing options are considered for characterizing the recurrence parameter ‘a’ in the adopted USGS 2008 approach. Each of the first three smoothing options is based on an incompleteness magnitude, a minimum incompleteness magnitude, and a smoothing correlation distance. The fourth option is considered only for the background seismic source since it has negligible effect on main sources such as New Madrid that have a much smaller area than the background source.

2.5.2.2.1.4 Magnitude Conversion

The EPRI-SOG ESTs have defined maximum magnitude for each of their seismic sources using either body wave magnitude, m_b, or seismic moment magnitude, **M**. Furthermore, the G-R parameters ‘a’ and ‘b’ are derived in terms of m_b, while the equations for ground motion models are functions of **M**. Therefore, conversions from body wave magnitude into moment magnitude are required. The three magnitude-conversion relationships shown in Table 2.5.2-3 were used in the Callaway Plant Unit 2 PSHA and each of them were assigned equal weight.

2.5.2.2.1.5 Earth Science Teams (EST) Source Zones

The following paragraphs describe the seismic source zones developed by the six different ESTs in the EPRI-SOG study. The EST source zone data tables discussed for each team below show updates to the parameters that were applied for the Callaway Plant Unit 2 PSHA. Discussions on the relevance of the source zones for the Callaway Plant Unit 2 Site are provided.

As noted previously, liquefaction evidence has been found in the St. Louis region suggesting strong ground shaking at least twice during the past 6,500 years (Tuttle et al., 1999). Some of these features were likely formed during the 1811-1812 New Madrid Earthquake series. However, it is possible that some features are related to earthquake activity near the St. Louis region. Sand dikes at the Meramec River suggest the possibility of a moderate to large earthquake centered in St. Louis and a very large earthquake located 50 miles (80 km) to 63 miles (100 km) east of St. Louis (Tuttle, 2005). These assumptions are still uncertain and the resulting epistemic uncertainty is taken into account by the PSHA as described in Section 2.5.2.4. In addition, for all EPRI zones, the background seismicity zone has been updated to a maximum magnitude entered at **M** 7.0.

2.5.2.2.1.6 Sources Used for EPRI PSHA – Bechtel Group

The seismic sources and recurrence parameters identified by the Bechtel Group EPRI-SOG EST that are within 200 mile (320 km) of the Callaway Plant Unit 2 are listed in Table 2.5.2-4. Figure 2.5.2-1 illustrates the geometry of the seismic sources defined by the Bechtel EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). The figure shows the elevated earthquake activity in the New Madrid seismic zone, which is separately treated as a characteristic source.

The background seismicity zone (BGZ) provides an update to M_{max} as shown in Table 2.5.2-4 that increases the maximum magnitude in a region that encompasses the paleofeatures. This increase assigns M_{max} above 7.0 with a weight of 0.7 and covers the postulated pre-historic seismicity within the St. Louis region. The influence of the update of M_{max} in the Wabash Valley area is incorporated within the Southern Illinois area (Zone K).

2.5.2.2.1.7 Sources Used for EPRI PSHA – Dames & Moore

The seismic sources and recurrence parameters identified by the Dames & Moore EPRI-SOG EST that are within 200 mi (320 km) of Callaway Plant Unit 2 are listed in Table 2.5.2-5. Figure 2.5.2-2 illustrates the geometry of the seismic sources defined by the Dames & Moore EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). The St. Louis Arm zone, which is about 50 mi (80 km) east of the Callaway Plant Unit 2 Site incorporates an updated M_{max} up to 7.8 (USGS, 2008). This area source is the most significant within the Dames & Moore interpretation.

2.5.2.2.1.8 Sources Used for EPRI PSHA – Law Engineering

The seismic sources and recurrence parameters identified by the Law Engineering EPRI-SOG EST that are within 200 mi (320 km) of Callaway Plant Unit 2 are listed in Table 2.5.2-6. Figure 2.5.2-3 illustrates the geometry of the seismic sources defined by the Law Engineering EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). The St. Louis arm and the New Madrid Rift Complex is a significant portion of the contribution to the hazard from the area sources. The M_{max} of this zone was increased from the original EPRI study to a distribution centered at 7.4 and with a minimum of 7.0 (USGS, 2008).

2.5.2.2.1.9 Sources Used for EPRI PSHA – Rondout Associates

The seismic sources and recurrence parameters identified by the Rondout Associates EPRI-SOG EST that are within 200 mi (320 km) of Callaway Plant Unit 2 are listed in Table 2.5.2-7. Figure 2.5.2-4 illustrates the geometry of the seismic sources defined by the Rondout Associates EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). Both Zones 2 and 4, the New Madrid Rift Complex and the Southern Illinois Zone have updated M_{max}. For the Rondout EST the Callaway Plant Unit 2 Site is in the Precambrian Craton, Background Zone, with a USGS M_{max} centered at 7.0. In this configuration, the Ozark Uplift has a lower than 7.0 M_{max}. The influence of the update of M_{max} in the Wabash Valley area is incorporated within the Southern Illinois area and the New Madrid Rift Complex.

2.5.2.2.1.10 Sources Used for EPRI PSHA – Weston Geophysical

The seismic sources and recurrence parameters identified by the Weston Geophysical EPRI-SOG EST that are within 200 mi (320 km) of Callaway Plant Unit 2 are listed in Table 2.5.2-8. Figure 2.5.2-5 illustrates the geometry of the seismic sources defined by the Weston Geophysical EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). Most of the region covered by the Weston area sources has been updated by either a USGS higher background seismicity or by Wabash Valley updates in the St. Louis Arm.

2.5.2.2.1.11 Sources Used for EPRI PSHA – Woodward-Clyde Consultants

The seismic sources and recurrence parameters identified by the Woodward-Clyde Consultants EPRI-SOG EST that are within 200 mi (320 km) of Callaway Plant Unit 2 are listed in Table 2.5.2-9. Figure 2.5.2-6 illustrates the geometry of the seismic sources defined by the Woodward-Clyde Consultants EPRI-SOG EST along with plots of USGS earthquakes with m_b equal to or higher than 3.0 between 1534 and 2007 (activity in the Site Region between 2002 and 2007 is shown for information only). In this configuration, the Callaway Plant Unit 2 Site is located within the Background Zone. Most of the region has been updated with M_{max}, except for the Kansas/Nebraska Offset, which is engulfed by the Great Plains Crustal Block background zone.

2.5.2.2.1.12 Conclusions Related to Update of EPRI Source Zones

The ‘a’ and ‘b’ parameters characterizing the potential of seismic sources have been updated and seismic sources within the Callaway Plant Unit 2 Site Region have been updated with higher M_{max} to account for the epistemic uncertainty related to the possible maximum magnitude of earthquakes in the CEUS (USGS, 2008).

Extensive research of paleoliquefaction earthquake scenarios have suggested the occurrence of ancient earthquakes near St. Louis (Tuttle, 2005). However, it remains uncertain if the St. Louis paleoliquefaction evidence is related to the New Madrid events or to earthquakes that originated near St. Louis, closer to the Callaway Plant Site Vicinity. This epistemic uncertainty is addressed by the calculated recurrence rates, higher M_{max}, and proximity of other seismic areas, including the background seismicity.

2.5.2.2.2 Characterization of the New Madrid Fault System

As reported by the USGS and illustrated on Figure 2.5.2-7, significant seismic activity occurs in the area of the New Madrid Fault System (NMFS). In the winter of 1811 and 1812, four large magnitude earthquakes, two of which are grouped into one event (USGS, 2008), and having estimated magnitudes of **M** 7 to 8 occurred in the New Madrid Region. Several strong aftershocks were recorded as well.

These larger magnitude earthquakes are thought to have ruptured the Reelfoot Fault and fault segments to the south and the north. The precise locations of these four large events are not entirely known. The only evidence of surface rupture appears along the Reelfoot Fault and earthquake locations are generally constrained only by intensity and paleoseismic data. However, the available information indicates that the seismic activity at the NMFS can be attributed to the following three sources:

- New Madrid South (NS) Fault;
- New Madrid North (NN) Fault; and
- Reelfoot Fault (RF).

Paleoliquefaction investigations have made it possible to recognize the occurrence of prehistoric earthquakes. In the CEUS, these studies are the basis for estimating the timing and magnitudes of earthquake activity from source areas or a fault zone such as New Madrid. As previously noted, seismologic, geologic, and geophysical studies have postulated faults within the New Madrid region associated with the large-magnitude historical earthquakes that occurred during 1811 and 1812. In particular, paleoliquefaction studies indicate that large-magnitude events have occurred on these faults more frequently than the seismicity rates specified in the EPRI-SOG source characterizations. Thus, the updated seismic source evaluations focus on the characteristic large-magnitude events along the New Madrid Fault System.

A correlation between historical and prehistoric features and the contemporary NMFS provides good evidence that the NMFS was the source for two prehistoric events, as well as the 1811-1812 earthquake sequence (Tuttle, 2002). The spatial distribution of sand blows thought to have formed about A.D. 1450 is only slightly less extensive than the distribution of those features attributed to the 1811-1812 events. The spatial distribution of sand blows that formed about A.D. 900 is also similar to the 1811 sequence. Other features north of New Madrid have also been attributed to the A.D. 900 and 1811-1812 events.

The logic tree used to represent the uncertainty in the model for the NMFS characteristic events is based on the Clinton ESP (EGC, 2006) and is shown on Figure 2.5.2-8. The first two levels of the logic tree take into account the uncertainty in the location and extent of the faults that can rupture in an earthquake sequence, by considering alternative geometries for the NS, RF and NN Faults. The considered fault locations are displayed on Figure 2.5.2-9. Distances to Callaway Plant Unit 2 for the various options are listed in Table 2.5.2-10.

Two alternatives are considered for the New Madrid South fault arm:

- Blytheville arch/Bootheel lineament (BA/BL); weight 0.6, length 82 miles (132 km), and
- Blytheville arch/Blytheville fault (BA/BFZ); weight 0.4, length 72 miles (116 km).

Two alternative total lengths are considered for the New Madrid North fault arm:

- With a weight of 0.7, rupture of the NN 37 miles (60 km) segment, and
- The 60 miles (97 km) length including the NN and NNE is given a 0.3 weight.

Two possible alternatives are considered for the Reelfoot arm:

- A full length segment including the northwest part, with weight 0.7, and

- A central segment, excluding the northwest part, with 0.3 weight.

2.5.2.2.2.1 New Madrid Characteristic Earthquake Magnitude

Table 2.5.2-11 contains expected moment magnitudes for characteristic earthquake ruptures for each fault within the New Madrid Fault System along with their corresponding weights. The size of the next characteristic earthquake is assumed to vary randomly about the expected value following a uniform distribution over a range of ±0.25 moment magnitude units, to represent the aleatory variability in the size of individual characteristic earthquakes.

Constraints on recurrence of characteristic NMFS events were derived from paleoliquefaction and paleoseismic investigations of the Reelfoot fault scarp and associated fold (EGC, 2006). It was concluded that the NMFS has generated temporally clustered large earthquakes in AD 900±100, AD 1450±150 years and in 1811 to 1812 (Tuttle, 2002); the time between clustered events may be from 200 to 800 years, with an estimated average of 500 years. Thus, a quantitative assessment of the uncertainty in the dates for prehistoric New Madrid earthquakes was developed, using a Monte Carlo simulation of constraints on the possible dates for the prehistoric earthquakes. The time intervals between these simulated dates were then fit with poissonian and renewal recurrence models. Table 2.5.2-16 lists the discrete distribution for equivalent annual frequency for characteristic New Madrid earthquakes. In Table 2.5.2-11, for Model A, all ruptures are similar in size to the 1811 and 1812 earthquakes. In Model B, 1/3 of the sequences consider a smaller (lower magnitude) rupture of the New Madrid North fault and 1/3 of the sequences assume a smaller rupture of the New Madrid South fault. The difference in magnitude from the 1811 and 1812 ruptures was set to be no more than 1/2 magnitude, and no magnitude ruptures are considered to be less than **M** 7. Model A and Model B were assigned weights of 2/3 and 1/3, respectively.

2.5.2.2.2.2 New Madrid Characteristic Earthquake Recurrence

The recurrence estimates, based on the Poissonian and renewal models, used to represent the occurrence of characteristic New Madrid earthquakes are summarized in Table 2.5.2-16. Since the site is affected by three dependent events, the frequency of exceedance, $\nu(z)$, of a spectral value z from a characteristic earthquake sequence is:

$$\nu(z)_{\text{characteristic}} = \lambda_{\text{rate of cluster}}\,(1-(1-P_1)(1-P_2)(1-P_3))$$

Where:

$\nu(z)_{\text{characteristic}}$ → Probability of exceeding ground motion z,

$\lambda_{\text{rate of cluster}}$ → Equivalent mean annual rate of occurrence of the event cluster (Table 2.5.2-16),

and

P1, P2, and P3 → Probabilities of exceeding the ground motion level z, when an earthquake of specified magnitude and distance occurs.

Regarding large earthquake recurrence for the NMFS, the USGS 2008 study has used paleoliquefaction data indicating a 500 year recurrence. Three large earthquake sequences have occured as indicated by cross-cutting relationships and radiometric dating of sand blows (liquefaction effects). These dates agree with a 500-year mean recurrence. However, citing lack of certainty on whether or not the northern portion of the fault system ruptured in the 1450 A.D. sequence, the USGS considered the possibility of 750-year and 500-year recurrences, equally weighted, for the northern arm of New Madrid (Figure 2.5.2-7). The 500 year recurrence for the southern and central sections remained unchanged in view of the fact that Tuttle and others (2002) published evidence that all three of the sequences affected those arms. As a result, a 500 year return period is used for the Callaway Plant Unit 2 PSHA.

2.5.2.2.2.3 Conclusions Related to the New Madrid Fault System Characteristic Event

The New Madrid zone earthquake recurrence is modeled as a characteristic earthquake, and a separate hazard analysis is conducted to account for its contribution. Since 1996, the USGS considered the occurrence of large events in the New Madrid as a characteristic rupture model with a characteristic moment magnitude **M** of 8.0, similar to the estimated magnitudes of the largest events in 1811-12 (USGS, 1996). The geometry of the New Madrid source is modeled as three S-shaped parallel faults encompassing the area of highest historic seismicity. For the Callaway Plant Unit 2 PSHA, the large characteristic earthquakes on the central faults of the NMSZ (**M**>7.0) are characterized with improved logic trees to account for updated assessments of magnitude, location, and return periods, as discussed within this section. Section 2.5.2.4 provides details related to the ground motion attenuation models that are used for the Callaway Plant Unit 2 PSHA.

2.5.2.2.3 Updated Wabash Valley Model

As previously discussed, evidence from recent paleoliquefaction studies and seismic reflection data suggests that significant earthquakes may occur in parts of the Illinois basin where there are no obvious faults or folds at the surface. The location, size, and recurrence of such events are not well constrained by available data. Liquefaction features suggest that the range of maximum magnitudes assigned to a random background (that is, not associated with a specific source) earthquake must include events comparable to that estimated for the postulated Springfield, Illinois earthquake (i.e., **M** 6.2 to 6.8).

Based on interpretations of the size of the prehistoric earthquakes, the following maximum magnitude probability distribution was proposed to capture the uncertainty in the magnitude of the largest prehistoric earthquakes in the lower Wabash Valley region:

- **M** 7.0- Weight (0.1),
- **M** 7.3 - Weight (0.4),
- **M** 7.5- Weight (0.4),
- **M** 7.8- Weight (0.1).

The highest weight is given to the range from **M** 7.3 to 7.5 where most of the magnitude estimates lie.

2.5.2.2.4 Background Seismicity

Between 1996 and 2008, the USGS produced seismic hazard maps for the Central and Eastern United States based on updated seismological, geophysical, and geological information (USGS, 1996, 2002, and 2008). Each map reflects changes to the source models used to construct the previous version of the national seismic hazard maps. Among the most significant modifications to the CEUS portion of the source models are changes in the recurrence, maximum magnitude (M_{max}), and geometry of the Charleston and New Madrid sources. Unlike the EPRI models that incorporate many local sources, the USGS source model in the Callaway Plant Unit 2 Site Region 200 mi (320 km) radius includes three sources that are important to the site hazard: the Extended Margin background, Stable Craton background, and New Madrid. Except for the New Madrid zone, where earthquake recurrence is modeled as characteristic earthquakes, the hazard for the large background or “maximum magnitude” zones is largely based on historical seismicity and the variation of that seismicity. Even though no direct correlation with seismic activity exists, such as the Springfield Earthquake/Wabash Valley case, the PSHA for Callaway Plant Unit 2 considers an updated maximum magnitude for the background zones with the following distribution:

- **M** 6.6- Weight (0.10),
- **M** 6.8 - Weight (0.20),
- **M** 7.0- Weight (0.50),
- **M** 7.2- Weight (0.20).

The selection of this distribution is designed to account for epistemic uncertainty in the maximum magnitude that is postulated for the Central and Eastern United States.

2.5.2.3 Correlation of Earthquake Activity with Seismic Sources

Following Regulatory Guide 1.208 and 10 CFR 100.23 (CFR, 2007), a PSHA was conducted to determine the GMRS and to account for uncertainties in the seismological and geological evaluations for Callaway Plant Unit 2. The probabilistic approach was based on the PSHA conducted by EPRI for CEUS in the mid-to-late 1980s (EPRI, 1989a) with changes to incorporate updated earthquake catalog data through 2001. Expert opinion was incorporated following a SSHAC2 approach (NRC, 1997b).

The USGS 2002 catalog, covering events from 1534 through 2001, along with sensitivity analyses for events through 2007 has been used for assessing the Callaway Plant Unit 2 seismic hazard. This catalog is a refinement of the EPRI SOG catalog that listed earthquakes between 1534 and 1984 (EPRI, 1988). Figure 2.5.2-1 through Figure 2.5.2-6 show the distribution of earthquake epicenters from both the EPRI and updated 2007 USGS earthquake catalogs in comparison to the seismic sources identified by each of the EPRI ESTs. The USGS catalog, including the Preliminary Determination of Epicenters (PDE) is relied upon to locate earthquake epicenters and earthquakes. The comparison of earthquake distributions from both catalogs supports the following conclusions:

- The updated catalog does not show any earthquakes within the Site Region that can be associated with a known geologic or tectonic structure.
- The updated catalog does not show a unique cluster of seismicity that would suggest a new seismic source outside of the EPRI seismic source model (EPRI, 1986).
- The updated catalog does not show a pattern of seismicity that would require significant revision to the EPRI seismic source geometry.
- No reported historical earthquake epicenters have been associated with bedrock faults or other tectonic features within the 25 mile (40 km) radius of the Callaway Plant Site.

The following updates are incorporated into the analysis:

- A new characterization of the New Madrid Seismic Zone and related large-magnitude historical earthquakes that occurred during 1811 and 1812. The New Madrid Seismic Zone and the 1811-1812 events are clearly correlated.These events are modeled as characteristic large-magnitude events along the New Madrid Fault System (Section

2.5.2.2.2). The location of the New Madrid earthquakes is well documented and it is accounted for by the updated New Madrid characteristic model.

- An increase in maximum magnitude for the Wabash Valley seismic source zone, as detailed in Section 2.5.2.2.3.

- Updated maximum magnitude for the background seismicity (USGS, 1996) in Section 2.5.2.2.4.

- A sensitivity analysis is performed to evaluate the impact of possible earthquakes near the St. Louis Region. The location of these events is uncertain and it is still not determined if the paleoliquefaction features in the region are attributed to the New Madrid events. Section 2.5.2.4 provides the results of this sensitivity analysis.

The following conclusions are derived from recent vicinity and area field reconnaissance efforts:

The Site is located in a region that has experienced only infrequent minor earthquake activity (3.0 to 3.9 m_b), with the closest epicentral location situated approximately 38 miles (61 km) southwest of the Callaway Plant Site, west of Cole County.

There has been only one other cataloged earthquake (3.0 to 3.9 m_b) within 50 miles (80 km) of the Callaway Plant Site, approximately 45 miles (72 km) south-southeast of the Site, that occurred on July 8, 2003 as noted in the catalog update.

There is no evidence of potential faults or other tectonic features, correlated with earthquakes or other seismicity, within a 25 mile (40 km) radius of the Callaway Plant Unit 2 Site.

2.5.2.4 Probabilistic Seismic Hazard Analysis and Controlling Earthquakes

Sections 2.5.2.4.1 through 2.5.2.4.8 are added as a supplement to the U.S. EPR FSAR. The PSHA was performed consistent with RG 1.208 and the guidance of NUREG/CR-6372 was followed by the development of a SSHAC 2 process.

The objective of the PSHA is to define the Uniform Hazard Response Spectra for hard rock conditions, by combining the spectral hazard curves for the spectral ordinates specified in RG 1.208.

2.5.2.4.1 Methodology

The total rock hazard at Callaway Plant Unit 2 is the addition of the hazard from the area sources plus the contribution of the New Madrid characteristic earthquake. Therefore, the PSHA rock hazard analysis is divided into two independent parts:

- Area source hazard integration;

- New Madrid Fault System characteristic clustering event.

To avoid double counting the impact of large earthquakes, the maximum magnitude for the New Madrid area source was reduced to m_b 7.0. The events with magnitudes larger than 7.0 are incorporated within the characteristic earthquake model (Section 2.5.2.2.2). This section presents the mean total hazard from both area sources and characteristic events.

Using the original EPRI EST area sources, plus the New Madrid characteristic earthquake, and with the updated ground motion model and aleatory uncertainty model, the seismic hazard was calculated for Callaway Plant Unit 2. This calculation was first made for hard rock conditions, and these results were then modified to account for local site conditions.

The analysis of the seismic hazard consists of calculating annual frequencies of exceeding different amplitudes of ground motion for all combinations of seismic sources, seismicity parameters, maximum magnitudes, ground motion equations, and ground motion aleatory uncertainties. This calculation is made separately for the New Madrid Zone and for the seismic sources defined by each of the six EPRI EST teams and results in a family of seismic hazard curves. The alternative assumptions on seismic sources, seismicity parameters, maximum magnitudes, ground motion equations, and ground motion aleatory uncertainties are weighted, resulting in a combined weight associated with each hazard curve. From the family of hazard curves and their weights, the mean hazard (and the distribution of hazard) is then calculated.

The quantification of the probabilistic seismic hazard in hard rock utilizes Pro-Hazard (Version 1.1) software. This code uses the definition of site area seismic sources, the seismic potential of these sources in terms of generating future earthquakes, and the ground motion models, to estimate the annual exceedence probabilities for various levels of spectral accelerations at different spectral frequencies.

The technical methodology utilized in Pro-Hazard follows the approach implemented in the 1989 Electric Power Research Institute study for Nuclear Power Plant Sites in the Central and Eastern United States (EPRI, 1989a). This methodology integrates the product of the conditional probability that a ground motion measure will be exceeded given the earthquake magnitude and distance, and the probability distribution of magnitude and distance over all sources that can significantly contribute to the site seismic ground motion. This is expressed as:

$$\nu(z) = \Sigma\alpha_{n(m_o)}\int f(m)[\int f(r\backslash m)P(Z > z\backslash m,r)dr]dm$$

Where:

$\nu(z)\rightarrow$	Frequency of exceeding a given value z, such as spectral acceleration.
$Z\rightarrow$	Peak ground acceleration or the spectral pseudo-acceleration at prescribed natural frequencies.
$P(Z>z \mid m,r)\rightarrow$	Conditional probability that Z will exceed a value z, given the earthquake magnitude, m, and distance, r.
$f(m)\rightarrow$	Probability density function in terms of magnitude.
$f(r)\rightarrow$	Probability density function in terms of distance.
$\alpha_n (m_o)\rightarrow$	Number of earthquakes per year above a prescribed minimum magnitude m_o, in the n-th seismic source.

The integration over magnitude is performed from m_o to an upper bound magnitude m_u, and the integration over distance is performed over a prescribed radius from the site, typically larger than 200 mi (320 km). The seismic events recorded in the catalog are accounted for in the calculation of the G-R parameters for a given area source if any portion of the area source is within the 200 mi (320 km) region. The probability density function for distance assumes that earthquakes can occur randomly over the source areas or faults. The functions f(m) and $\alpha(m_o)$ define the recurrence relationships for the respective source zones.

The conditional probability in the above equation represents the random uncertainties in the natural phenomenon (aleatory). Pro-Hazard addresses epistemic uncertainties in sources and recurrence parameters and the ground motion attenuation resulting from limitations in the available data and alternative interpretations of this data. Alternative assumptions on seismic sources, seismicity parameters, maximum magnitudes, ground motion equations, and ground motion aleatory uncertainties are weighted, resulting in a combined weight associated with each hazard curve. The mean hazard and the distribution of hazard (i.e., median and fractiles) are obtained from the resulting family of hazard curves and the associated weights.

The PSHA relies upon seismic source zone characterizations that define their geometry and their seismicity parameters. This information is discussed in Section 2.5.2.2 and summarized below in Section 2.5.2.4.2.

To calculate the conditional probability that the spectral acceleration exceeds a given value z for a source with given distance and magnitude, the use of ground motion models in the form of attenuation relationships is required. Attenuation relationships introduce both epistemic and aleatory uncertainties that need to be accounted for with the use of more than one approach or specific equation. Various models are grouped in the form of logic trees. Section 2.5.2.4.3 provides the ground motion models and logic trees used for the Callaway Plant Unit 2 PSHA.

2.5.2.4.2 Seismic Source Characterizations

A new characteristic earthquake New Madrid source model has been adopted to reflect updated estimates of the possible geometries of seismic sources in the NMFS. The Guttenberg-Richter (G-R) equation has been used to describe recurrence in area seismic sources. This equation was truncated at the maximum magnitude, M_{max}. The ‘a’ and ‘b’ parameters characterizing the potential of seismic sources have been updated as well as their maximum earthquake magnitude. As discussed in Section 2.5.2.2.1, each EPRI-SOG EST developed G-R parameters ‘a’ and ‘b’ for each of their seismic sources, identifying their selected smoothing options and their corresponding weights. Smoothing allows incorporation of the variation of the G-R parameters ‘a’ and ‘b’ within the seismic source. For the Callaway Plant Unit 2 PSHA, the smoothing approach developed by USGS (2002, 2008) has been used. This approach considers only the variation of the intercept parameter ‘a’ for prescribed constant values of the slope parameter ‘b’. The constant values of ‘b’ have been taken as the averages of the ‘b’-values adopted for each seismic source by each EPRI-SOG EST, along with the corresponding weights for each smoothing option. Table 2.5.2-4 through Table 2.5.2-9 present the values of the average seismic parameter ‘b’ used as input to the Callaway Plant Unit 2 PSHA.

Four smoothing options are considered for characterizing the recurrence parameter in the USGS 2008 approach. Each of the first three smoothing options is based on an incompleteness period, a minimum incompleteness magnitude, and a smoothing correlation distance. The fourth option is considered only for the background seismic source since it has negligible effect on main sources such as New Madrid that have a much smaller area than the background source. The information for each smoothing model is listed in Table 2.5.2-17.

2.5.2.4.3 Ground Motion Models

Once the earthquake sources are defined, attenuation relations relate the source characteristics of the earthquake and the propagation path of the seismic waves to the ground motion at the Site. Predicted ground motions are typically quantified in terms of a median value (a function of magnitude, distance, site condition, and other factors) and a probability density function of peak horizontal ground acceleration or spectral accelerations.

The estimation of strong ground motion for specified magnitude, distance, and site conditions in the CEUS is difficult due to the limited physical data, since ground motion models are mostly developed based on recorded seismicity. Most of the available data correspond to **M** < 5.8 and distances exceeding about 31 miles (50 km). Considerable effort has been directed to developing appropriate attenuation relations for the CEUS conditions. In general the attenuation relationships utilize standard forms to regress on recorded data in the Region, augmented by data from other similar tectonic regimes and stochastic time histories tied to source type and style of faulting.

2.5.2.4.3.1 Ground Motion Models for General Area Sources

Since publication of the 1989 EPRI study (EPRI, 1989a), much work has been done to evaluate strong earthquake ground motion in the CEUS. In 2004, EPRI completed a study on strong ground motion prediction in the CEUS following the SSHAC (Budnitz , 1997) guidelines for a Level III Analysis. A panel of six ground motion experts was reconvened during several workshops to provide advice to a Technical Integrator (TI) on the adequacy of available CEUS ground motion relationships. On this basis, the TI developed a representation of the current scientific understanding on the subject, consisting of "clusters" of ground motion relationships with associated weights to represent the uncertainty in predicting the median ground motion in terms of moment magnitude. Each cluster corresponds to relationships based on a similar approach for ground motion modeling. The uncertainty in the median model for each ground motion cluster is defined by two additional models: one representing the 5^{th} percentile of the median uncertainty distribution and the other corresponding to the 95^{th} percentile.

The attenuation relationships developed in 2004 by EPRI for the CEUS have been incorporated into in Pro-Hazard. This model was the outcome of several workshops that convened a panel of six ground motion experts who developed a consensus-based ground motion model consisting of weighting of several attenuation relationships. The ground motion model relates spectral accelerations at frequencies of 100 Hz (equivalent to Peak Ground Acceleration (PGA)), 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1 Hz, and 0.5 Hz for generic hard rock conditions to moment magnitude and distance to a given source. In accordance with RG 1.208 (NRC, 2007a), hazard curves from the PSHA need to be defined for generic hard rock conditions characterized by a shear wave velocity (Vs) of about 9200 ft/sec (2800 m/sec). Thus, the 2004 EPRI model has been implemented in the rock hazard calculation for Callaway Plant Unit 2. This ground motion model provides a total of twelve median ground motion equations, representing the epistemic uncertainty. However, the EPRI (2006a) updated estimates of aleatory uncertainties have been used in lieu of the original aleatory uncertainties (EPRI, 2004). Epistemic uncertainty is represented using multiple ground motion equations and multiple estimates of aleatory uncertainty (sigma), all with associated weights. Further, EPRI (2006a) corrects the excessive aleatory uncertainties in the 2004 study, particularly for low frequencies.

EPRI TR-1014381 (EPRI, 2006a) was used in lieu of the Regulatory Guide 1.208 cited document, i.e. EPRI Report 1013105 (EPRI, 2006b). EPRI Report 1013105 (EPRI, 2006b) was an Update Report while EPRI TR-1014381 (EPRI, 2006a) is the final report. For the purposes of revised estimates of aleatory uncertainty in the CEUS, there is no technical difference between the documents. The "Recommended CEUS Sigma" values and "Conclusions" of both reports are identical.

The above uncertainties are incorporated into Pro-Hazard in the analysis utilizing logic trees. The logic trees represent discrete alternatives of models and model parameters and assign relative weights to the alternatives. The weighting is developed from statistical analysis of the data and represent the best judgment of experts. Thus, several analyses reflecting various scenarios quantitatively assess the modeling uncertainties.

In summary, the EPRI 2004 equations have been adopted for median ground motion estimates, and the EPRI 2006 log-sigma model is used to incorporate aleatory variability. Within this context, Figure 2.5.2-10 shows the logic tree for general area sources such as background or local sources. Figure 2.5.2-11 shows the logic tree for non-general sources such as New Madrid and Wabash Valley.

Earthquakes occurring within the area seismic sources were treated as point sources. Thus, the adjustments to the ground motion equations developed in EPRI (2004) to account for this point-source representation were incorporated in the hazard calculations.

2.5.2.4.3.2 New Madrid Characteristic Earthquake Ground Motion Assessment

Consistent with the hazard calculation for area sources, the contribution of the New Madrid characteristic events was calculated using the CEUS ground motions developed by EPRI (2004). Figure 2.5.2-11 shows the logic tree structure defined by EPRI to represent the uncertainty in the median ground motion equation and in the aleatory variability about the median. As noted in the previous sections for area sources, the EPRI 2004 Report defines four clusters of median ground motion models to represent the alternative modeling approaches. All four clusters have been used for assessing the hazard from the New Madrid characteristic earthquakes, as illustrated in Figure 2.5.2-11. The rift option was selected for the fourth cluster, instead of the non-rift option that is used for area sources.

The three branches of the second level of the logic tree in Figure 2.5.2-11 represent the epistemic uncertainty in the median attenuation relationship for each cluster. The branches incorporate a three-point discrete distribution with weights of 0.63, 0.185 and 0.185 for the median, the 5^{th} and the 95^{th} percentiles, respectively. The third branching level addresses the uncertainty in the model for the aleatory variability in ground motions about the median attenuation relationship. Models 1A and 1B, as well as their weights, are those proposed by Abrahamson (EPRI, 2006a, b) to account for inter-event and intra-event variability for events with distances greater than 12.5 miles (20 km) (termed σ1 by Abrahamson). The additional standard deviation, σ2, developed by Abrahamson to incorporate additional variability at short distances, is not applicable for the distances between the Callaway Plant Unit 2 and any of the arms of the New Madrid faults.

The EPRI 2004 ground motion attenuation relationships use either closest distance to the rupture plane or closest distance to the surface projection of the rupture plane (Joyner-Boore distance). Thus, the EPRI 2004 document also presents adjustments for use when the hazard integration is conducted based on point-source distances. These adjustments were unnecessary in the hazard calculations for the New Madrid characteristic events since the specific closest or Joyner-Boore distance was calculated for each fault arm, for input to the EPRI ground motion models.

2.5.2.4.4 Updated EPRI Probabilistic Seismic Hazard Analysis De-aggregation, and 1 Hz, 2.5 Hz, and 10 Hz Spectral Accelerations Incorporating Significant Increases Based on the Above Sensitivity Studies

Figure 2.5.2-12 and Figure 2.5.2-13 are plots of the resulting updated probabilistic seismic hazard hard rock curves for the seven spectral ordinates [100 Hz (equivalent to PGA), 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1 Hz, and 0.5 Hz]. The mean and fractile (5%, 16%, 50% (median), 84% and 95%) hazard curves are indicated as required by RG 1.208 (NRC, 2007a). As expected, the mean hazard is above the median for all probabilities and all spectral ordinates.

The combination of the hazard curves results in Figure 2.5.2-14, which shows mean and median uniform hazard spectra at hard rock for 1E-4, 1E-5 and 1E-6 annual frequencies of exceedance. The results are presented at the seven structural frequencies at which ground motion equations are available. Numerical values of these spectra are documented in Table 2.5.2-15. Smooth spectra is later developed in Section 2.5.2.5.

The mean rock hazard has been de-aggregated for the 1E-4, 1E-5 and 1E-6 levels of probability of exceedance. The magnitude and distance bins for the de-aggregation table were taken from RG 1.208 (NRC, 2007a). The results have been plotted in Figure 2.5.2-15, for the required low frequency (1 and 2.5 Hz) and the high frequency (5 and 10 Hz) ranges. These figures depict the percent contribution of each magnitude-distance bin to the total hazard.

The de-aggregation plots reflect the dominance of the New Madrid characteristic earthquake. At low frequencies, events with magnitudes higher than 7.0 and distances beyond 185 miles (300 km), such as the characteristic earthquake, contribute to more than 90% of the hazard at the site. At high frequencies, the dominance of the New Madrid events is still significant, though lower than 90%. Other meaningful contributors are the background seismicity represented by the low distance and low magnitude bins and the seismic source zones with updated maximum magnitudes and distances of 62 to 124 miles (100 to 200 km), such as the Southern Illinois Area and St. Louis Arm.

2.5.2.4.5 Controlling Events

Approach 2B of NUREG-6728 (NRC, 2001) was used to derive the controlling events for Callaway Plant Unit 2. First, the controlling events were identified using the de-aggregation results. Table 2.5.2-12 lists the de-aggregated controlling events. Each de-aggregated earthquake (DE) is prescribed as a distance and magnitude pair and its associated contribution to a high frequency (HF) or low frequency (LF) response. DEL indicates the low end of the distance range, while DEM and DEH refer to the middle and high ends, respectively. Using the magnitude-distance pairs for each sub-controlling event, DEL, DEM, and DEH, the CEUS single corner spectral shapes from NUREG-6728 (NRC, 2001) were adopted to develop the corresponding spectral shapes. Then, the response spectra of each sub-controlling event were scaled to match the rock UHRS at 1.75 or 7.5 Hz for low frequency and high frequency events, respectively. Results for scaling and smoothing from controlling events are presented in Section 2.5.2.5.3.

The de-aggregation of the total hazard indicates that the New Madrid characteristic earthquakes control the hazard for Callaway Plant Unit 2. The influence of local earthquakes is more appreciable in the HF motion, but the most significant contribution still results from the large, distant earthquakes in the New Madrid region.

2.5.2.4.6 Sensitivity Analysis including 2002-2007 Seismicity Data

As discussed in Section 2.5.2.1 the 2002 USGS catalog forms the basis on which to estimate seismicity parameters. The catalog compiled by the USGS up to the end of 2001 (Table 2.5.2-1), has been used in the determination of G-R parameters for the area seismic sources that affect Callaway Plant Unit 2. At the time of the calculation of the Callaway Plant Unit 2 seismic hazard, this catalog constituted the most recently updated list in terms of m_b units.

The sensitivity analysis extended the 2001 catalog through the year 2007 (Table 2.5.2-2). The update methodology adopted the approach described in the USGS Open File Report 2008-1128 “The 2008 Update of the United States National Seismic Hazard Maps” that USGS uses for catalog updates to reduce the additional epistemic uncertainty related to the magnitude conversion. Magnitude may be adopted from the reported values. Differences resulting from unit conversion are negligible for small magnitude earthquakes. If more than one magnitude is listed in the original source-catalog record for an earthquake, a preferred magnitude is selected. Only about 10 percent of the earthquakes do not have a listed m_{bLg} or m_b (USGS, 2008); in these cases, the preferred magnitude is assumed to be m_{bLg}.

The sensitivity analysis was performed using the same calculation methodology that was used for the final PSHA, based upon the USGS 2002 catalog. Results presented in Figure 2.5.2-16 and Figure 2.5.2-17 show that the 2002-2007 seismicity does not have a significant effect on the b-parameter, seismic occurrence rate at zero magnitude, or the PSHA completed for the Callaway Plant Unit 2 Site using data through 2001. The use of the 2002-2007 data results in a less conservative prediction of seismic occurrence rates when compared to results using the USGS 2002 catalog. The resulting UHRS ground motion levels are marginally lower.

The G-R parameters from the USGS 2002 catalog have been adopted as the parameters of choice for the Callaway Unit 2 PSHA since:

- The G-R parameters resulting from the catalog update through 2007 are equivalent to those obtained with the USGS 2002 catalog. As an example, a plot of the resulting G-R parameters is provided in Figure 2.5.2-16. The plot compares the cases with catalog data through 2001 and through 2007 for some of the seismic sources and one of the ESTs.

- The effect on the seismic hazard using the 2002-2007 data is a marginal reduction in the UHRS ground motion levels, which is less conservative than results using USGS 2002 catalog data. The reduction is verified by comparison of the Uniform Hazard Response Spectra (UHRS) at top of rock (Figure 2.5.2-17) for the cases using data through 2001 and 2007.

- Recent studies, such as that completed for the Clinton ESP, have reached similar conclusions related to the catalog updates that go back to 1984 (ECG, 2006).

2.5.2.4.7 Sensitivity Analysis on Postulated Events near St. Louis

Section 2.5.2.1.2 describes some recent discoveries related to paleoliquefaction features near St. Louis, Mo. Researchers have concluded that a **M** > 6 earthquake occurred near the lower portion of Shoal Creek during the Middle Holocene about 6,500-7,000 radiocarbon yr B.P. The age of the event was estimated from the weathering characteristics of sand dikes and dating of deposits cut by the dikes. The earthquake location related to the features remains unclear. However, the paleoliquefaction patterns suggest that ground motion could have originated near St. Louis.

For the Callaway Plant Unit 2 PSHA, it has been determined that the updated and increased maximum magnitude in the background seismicity and in the EPRI source zones adequately cover the epistemic uncertainty related to earthquakes near the St. Louis liquefaction features. However, in view of the uncertainties in location and magnitude, the PHSA conducted for Callaway Plant Unit 2 considers the potential effects of paleoearthquakes in the vicinity of St. Louis by performing a sensitivity analysis with the following two cases:

Case 1 - Consider the background zone maximum magnitude of the Clinton ESP study (M_{max} centered at 6.4), and add the contribution of an event with either of the following magnitude-distance pairs (USGS, 2000):

- **M** 5.2, 70 miles (112 km), 4000 years;

- **M** 7.0, 107 miles (171 km), 6500 years.

Case 2 - Consider the updated M_{max} as used in the Callaway Plant Unit 2 PSHA.

There is virtually no difference in the hazard between both cases. Figure 2.5.2-18 compares the results from both cases at the 1E-4 and 1E-5 annual frequencies of exceedance, with a semi-logarithmic scale. From this comparison, it is concluded that the current PSHA from Case 2 covers the hazard contribution from St. Louis earthquakes in the noted range of probability of exceedance. The increased maximum magnitude of the background zone constitutes a conservative approach for considering the effects of repetition of paleoearthquakes such as the ones postulated in the St. Louis region.

2.5.2.4.8 Conclusions from the Callaway Plant Unit 2 PSHA

A PSHA has been completed for the Callaway Plant Unit 2 in accordance with RG 1.208. The PSHA incorporated the following items:

- An update of the EPRI-SOG seismic catalog with the use of USGS 2002 catalog data and sensitivity analysis after adding the seismicity from 2002-2007,
- The EPRI-SOG seismic source zones developed by six EST teams (EPRI, 1989a),
- Updated M_{max} for the background zones,
- USGS 2008 incompleteness and smoothing models,
- An updated NMFS model and characteristic event (EGC, 2006, USGS, 2008). The NMFS is the most significant seismic hazard at Callaway Plant Unit 2 Site. An updated logic-tree representation of the clustered characteristic earthquakes at the NMFS has been incorporated into the PSHA. This NMFS characterization is consistent with that provided in the Clinton ESP application (EGC, 2006) and verified with USGS modeling of the New Madrid Faults. The PSHA for Callaway Plant Unit 2 makes use of a decision tree approach with appropriate weighting factors that are based on the most up-to-date information and relative confidence in alternative characterizations for each seismic source.
- Updated models of ground motion attenuation in the CEUS (EPRI, 2006a),
- Determination of hazard curves and UHRS at hard rock,
- De-aggregation of the hazard and determination of controlling events for the definition of time histories,
- SSHAC expert review, and concurrence with PSHA approach and associated sensitivity analyses.

2.5.2.5 Seismic Wave Transmission Characteristics of the Site

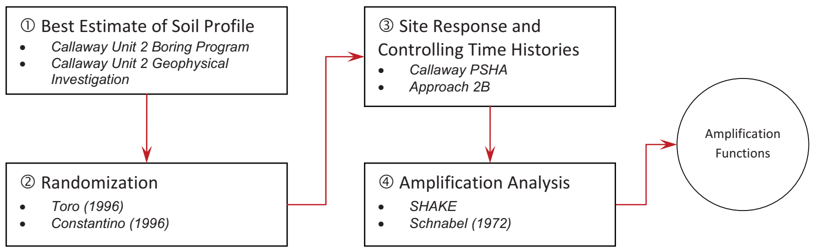
The uniform hazard spectra described in Section 2.5.2.4 and displayed on Figure 2.5.2-14 are defined on hard rock (shear-wave velocity of 9200 ft/sec (2804 m/sec)). Rock layers with shear-wave velocities of such value are located more than 2200 ft (670 m) below the current ground surface at Callaway Plant Unit 2.

To determine the GMRS at the ground surface, it is necessary to adjust the uniform hazard spectra for amplification or de-amplification as the vibratory ground motion propagates through the soil media. The adjustment was made by conducting Site Response Analyses following Approach 2B described in NUREG-6728 (NRC, 2001). These analyses consist of defining the shear wave velocity and material damping characteristics in the soil and rock profile between the ground surface and the depth of hard rock. Uni-dimensional site analyses are then conducted using an equivalent linear procedure (Schnabel, 1972). The results are used to derive site amplification factors for modifying the response spectra at rock on account of the seismic wave transmission characteristics of the soil layers.

This section describes the various steps involved in the calculation and application of the site amplification factors. The seismic wave transmission characteristics and effects of this thick soil column on hard rock ground motions are also described in this section.

The purpose of the seismic wave transmission analysis is to obtain the amplification functions between hard rock and free-field ground motion at a hypothetical outcrop. This is accomplished with the following steps shown in the process flowchart below:

Seismic Wave Transmission Analysis Process Flowchart



1. Section 2.5.2.5.1 describes development of a best estimate soil and rock column in which mean low-strain shear wave velocities and material damping values, and strain-dependencies of these properties, are estimated for relevant layers from the surface to the hard rock horizon. At the Callaway Plant Site, hard rock (V_S = 9,200 ft/sec (2804 m/sec) is at a depth of approximately 2,200 ft (670 m). (Step 1 in the Seismic Wave Transmission Analysis Process Flowchart)

2. Section 2.5.2.5.2 describes development of a probabilistic model that describes the uncertainties in the above properties, locations of layer boundaries, and correlation between the velocities in adjacent layers, and generate a set of 60 artificial “randomized” profiles. (Step 2 in the Seismic Wave Transmission Analysis Process Flowchart)

3. For each of the sub-controlling earthquakes (DEL, DEM, and DEH) of 1E-4 and 1E-5 annual frequencies of exceedance for both LF and HF earthquakes, Section 2.5.2.5.3 discusses use of the corresponding controlling time histories for input into dynamic response analysis as the outcrop motion at the hard rock elevation. (Step 3 in the Seismic Wave Transmission Analysis Process Flowchart)

4. Section 2.5.2.5.4 discusses use of an equivalent linear time history site response formulation to calculate the dynamic response of the site for each of the 60 artificial profiles, and calculate the mean of site response. This step is repeated for each de-aggregated earthquake of the four input motions (1E-4 and 1E-5 annual frequencies, HF and LF events). (Step 4 in the Seismic Wave Transmission Analysis Process Flowchart)

2.5.2.5.1 Best Estimate Soil/Rock Profile Callaway Plant Unit 2

Development of a best estimate soil/rock column is described in detail in Section 2.5.4. Discussion and laboratory test results for bulk densities, soil index properties, shear modulus and damping are also provided in Section 2.5.4. Summaries of the best estimate of low strain shear wave velocity, material damping, and strain-dependent properties of the materials are provided here in Section 2.5.2.5.1. These parameters are used in the site response analyses.

The upper 350 ± ft (107 m) of the Callaway Plant Unit 2 soils were investigated using test borings and geophysical methods. The geotechnical investigation is described in detail in Section 2.5.4. Site Boring Logs are provided in COLA Part 11F. Information on subsurface conditions below this depth was assembled from available geologic information discussed later in this section.

The subsurface layer in the upper 350 ft (107 m) of the site is divided into the following stratigraphic units:

- Overburden Soils
  - Modified Loess
  - Accretion-Gley
  - Glacial Till
- Rock Formations
  - Graydon Chert Conglomerate
  - Burlington Formation, Bushberg Formation
  - Snyder Creek Formation, Callaway Formation
  - Cotter-Jefferson City Formation

The compression and shear-wave velocities are taken from geophysical field tests using three different techniques:

- Five sets of downhole tests,
- Five sets of P-S suspension logging tests, and
- Three sets of crosshole tests (from one crosshole array).

Three borings, R-1, R-3 and R-13, provide the deepest site-specific soil information collected during the geotechnical investigation for the Callaway Plant Unit 2. One of them, boring R-1, was used to obtain the deepest suspension velocity profile and downhole seismic velocity profile at the Site.

The downhole profiles consist of average compression and shear-wave velocities for thicknesses varying from 30 ft (9.1 m) to 150 ft (45.7 m). The suspension logging profiles provide detailed discrete compressional and shear-wave velocities for thickness of approximately 1.5 ft (0.5 m). The crosshole profiles consist of discrete compressional and shear-wave velocities for thicknesses varying from 3 to 10 ft (0.9 to 3.1 m).

The geologic investigation included a review of the Callaway Plant Unit 1 FSAR, as well as bibliographic research of the Missouri Department of Natural Resources (MoDNR) database (MoDNR, 2007), specifically related to deep borings for water exploration and production. There are no records of oil and gas exploration wells in Callaway County. The closest are found 30 miles (48 km) from the Site, in the northwest quadrant in Boone County. No deep borings with shear or compressional wave velocities were identified in the area. The only information found relates to shallow tests performed in unconsolidated sediments near St. Louis.

As discussed in Section 2.5.1, the geologic column below the Cotter-Jefferson City formation shows a sequence of Ordovician, Cambrian and Pre-Cambrian rocks. A series of dolomite formations, belonging to the Ordovician System, was identified, presumably of slightly higher shear-wave velocities than those from the Cotter-Jefferson City formation due to the increasing confining pressure. Below these formations, at depths varying from 1,617 ft to 2,818 ft (493 m to 859 m) from the ground surface, Pre-Cambrian granitic rocks are identified. Velocities for granitic rocks typically range from 9,700 to 14,900 ft/sec (2,960 to 4,540 m/sec) (Cholach and others, 2005, Rao, 2003, and Winkler, 1995).

A value of 8,300 ft/s (2,530 m/s) is assigned to the best estimate shear wave velocity for the Cotter-Jefferson City Formation over approximately 175 ft (53 m) explored in the geotechnical investigation. Since Regulatory Guide 1.208 (NRC, 2007a) assigns a shear wave velocity of 9,200 ft/s (2,804 m/s) to hard rock, which is about 10% higher than the shear wave velocity estimate for the Cotter-Jefferson City Formation, the same parameters from this formation are assigned to the deep rock formation starting at the bottom of borings: 350 ft (107 m) from ground surface to the top of the hard rock.

Resonant Column, Torsional Shear (RCTS) and Unconfined Resonant Column ("Free-Free") Laboratory Tests were performed on soil and rock samples. The complete set of results from these tests is reported in Section 2.5.4.2.3. Generic soft rock curves (Silva and others, 1996) were adopted to describe the strain dependencies of shear modulus and damping for the Graydon Chert Conglomerate based on available results from the site investigation. Below 350 ft (107 m), the same parameters from the Cotter-Jefferson City Formation are assigned to the deep rock formation down to the top of the hard rock.

For the site response analyses, the sedimentary rocks below the Graydon Chert Conglomerate are assumed to behave linearly during earthquake shaking. "Free-Free" Direct arrival tests were performed on undisturbed rock samples by the University of Texas. The tests provided material velocity and damping values associated with shear-waves as well as those associated with compression waves.

The average of the laboratory test results for damping ratio in the Cotter-Jefferson City Formation, 1.41 percent, was assigned to the deep rock column above the hard rock horizon.

The best estimate of the shear wave velocity is shown by Figure 2.5.2-19 for the upper 350 ft (107 m) with the median shear wave velocity value as a function of depth. The Figure also shows a profile with the complete soil site amplification model, from the ground surface to the hard rock base at a depth of 2,200 ft (670 m).

2.5.2.5.2 Site Properties Representing Uncertainties, Correlations and Randomization

To account for variations in shear-wave velocity across the site, 60 artificial profiles were generated using the stochastic model developed by Toro (1996), with some modifications to account for conditions at the Callaway Plant Unit 2 Site. These artificial profiles represent the soil column from the top of the Graydon Chert Conglomerate to the top of bedrock (with a bedrock shear-wave velocity of 9,200 ft/sec (2,804 m/sec)). This model uses as inputs the following values and/or assumptions:

- The median shear-wave velocity profile, equal to the best estimate soil and rock profiles described above and in Figure 2.5.2-19.
- The site amplification model ends at the bottom of a hypothetical outcrop that will exist after excavation; in the case of Callaway Plant Unit 2, this outcrop is positioned at the top of the Graydon Chert Conglomerate. The overburden clays above bedrock are not included in the site amplification model.
- The standard deviation of ln(V_s) (the natural logarithm of the shear-wave velocity) as a function of depth, developed using available site data.

- Correlation coefficients between V_s in adjacent layers, determined using the available measured shear-wave velocities.

- The probabilistic characterization of layer thickness as a function of depth, computed assuming a normal distribution.

- The depth to bedrock, which is randomized assuming a normal distribution to account for epistemic uncertainty in the bedrock-depth data described in Section 2.5.4.

The coefficient of variation of shear wave velocities calculated from the best estimate soil/rock column is used as the standard deviation of $\ln(V_s)$ as a function of depth. The Callaway Plant Unit 2 soil data in the Cotter-Jefferson City formation results in a value of 0.06. Toro (1996) reports standard deviations for a number of sites where many shear-wave velocity profiles were obtained. These results suggest values of standard deviation of $\ln(V_s)$ on the order of 0.30 near the surface decreasing with increasing depth to about of 0.05. The variability in shear wave velocity typically decreases with increasing depth. On the basis of the data presented in Toro (1996), a standard deviation of $\ln(V_s)$ of 0.1 is judged appropriate and selected to represent the variability in shear wave velocity in the Cotter-Jefferson City formation.

Below 350 ft (107 m), the same parameters from the Cotter-Jefferson City Formation are assigned to the deep rock formation down to the top of the hard rock.

Figure 2.5.2-19 shows the coefficient of variation (equivalent to the logarithmic standard deviation) of shear wave velocity, which were used to generate multiple profiles. The correlation coefficients between shear wave velocities in adjacent layers were determined using the available measured shear-wave velocities. The 0-depth, as shown in Figure 2.5.2-20, is placed at the top of the Graydon Chert Conglomerate, which is considered as the surface of the site amplification model.

The randomly generated "thicknesses of layer" was computed assuming a normal distribution using the site-specific standard deviation for thickness of each layer observed from the 71 boring logs. For consistency with the site-specific data, the generated ln-velocities and the generated thicknesses were truncated at $\pm 2\sigma$ according to the recommendations of Toro (1996). However, for the Cotter-Jefferson City Formation and the underlaying deep rock formation above the bedrock, the generated ln-velocities were truncated at $\pm\sigma$ due to the proximity between the shear wave velocity of this formation, 8,300 ft/sec (2,530 m/sec), and the shear wave velocity of the hard bedrock 9,200 ft/sec (2,804 m/sec).

The shear-wave velocity of 9,200 ft/sec (2,804 m/sec) (for bedrock) is estimated to occur at a depth of approximately 2,200 ft (670 m). This value is taken as the base case or median depth. This information on bedrock depth is based on boreholes located tens of miles away from the Site (Section 2.5.2.5.1). The uncertainty associated with depth to bedrock is characterized by a normal distribution over the depth range.

Figure 2.5.2-20 illustrates the V_s profiles generated for profiles 1 through 60, using the median, logarithmic standard deviation, and correlation model described. The figure shows the upper 400 ft (122 m) and the complete profiles down to bedrock. These profiles include uncertainty in depth to bedrock. In total, 60 profiles were generated. The 0-depth is referenced at the foundation level or top of Graydon Chert Conglomerate.

Figure 2.5.2-21 compares the mean of these 60 V_s profiles to the median V_s profile described in the previous section, indicating very good agreement. This figure also shows the +1 standard deviation values of the 60 profiles, reflecting the standard deviations indicated on Figure 2.5.2-19.

Median values of shear stiffness (G/G_{MAX}) and damping for each geologic unit are described in Section 2.5.4. Uncertainties in the properties for each soil unit are characterized using the values obtained by Constantino (1996). Figure 2.5.2-22 illustrates the shear stiffness and damping curves generated for one of the geologic units, the Graydon Chert Conglomerate, that is present at the depth range from approximately 37.5 ft (11.4 m) to 68.9 ft (21.0 m). The sedimentary rocks below the Graydon Chert Conglomerate are assumed to behave linearly during earthquake shaking and were not subjected to random variation.

This set of 60 profiles, consisting of V_S 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.

As required by Regulatory Guide 1.208 (NRC, 2007a) the damping curves for soils were truncated at 15 percent for the site response analysis.

2.5.2.5.3 Site Response Analysis

The calculation of site effects was performed with the computer program SHAKE (Schnabel et. al, 1972). This program computes the response in a system of viscous-elastic, horizontally layered, soil/rock materials, over a uniform half-space, subjected to transient, vertical travelling shear waves.

The analytical method implemented in SHAKE is based on the solution of the wave equation and the Fast Fourier Transform algorithm. The nonlinearity of the shear modulus and damping is accounted for by the use of equivalent linear soil properties within an iterative procedure to obtain values for modulus and damping compatible with the effective strains in each layer. Therefore, for any set of layer properties, SHAKE performs a linear analysis.

The motion used as basis for the analysis (i.e., the motion that is considered to be known) can be applied to any layer in the system. An iterative procedure is used to account for the nonlinear behavior of the soils. The object motion can be specified at the top of any sublayer within the soil profile or at the corresponding outcrop.

It is noted that the solution of a particular soil profile requires use of realistic ground motions (loading), modeling site dynamics (response), and the interpretation and prediction of soil behavior subject to dynamic loading (analysis). To facilitate conducting and verifying these tasks, the following modifications were incorporated into the SHAKE program:

- The number of sub-layers was increased to up to 500 to allow a more accurate representation of deeper and/or softer soil deposits;
- Modulus reduction and damping relationships can be specified by the user, up to 13 different curves;
- User specified periods are allowed for calculating spectral ordinates;
- The code can accept input data to generate random soil/rock columns by utilizing best estimates of the mean and the standard deviation along with prescribed probabilistic distributions for material properties (stiffness, mass and damping) and for layer thickness.

2.5.2.5.3.1 Development of Smooth Uniform Hazard, Controlling, and Reference Response Spectra

In order to derive smooth spectra corresponding to the 1E-4 and 1E-5 amplitudes, the magnitude and distance pairs of both controlling and reference earthquakes summarized in Table 2.5.2-12 were used as described below.

The magnitudes and distances were applied to spectral shape equations from NUREG CR-6728 (NRC, 2001) to determine realistic spectral shapes for the four representative earthquakes (at spectral frequency 0.5, 1.75, 7.5, and 25 Hz) of 1E-4 and 1E-5 events.

To calculate smooth UHRS, the 25 Hz smooth shapes were utilized and scaled to the Uniform Hazard Spectra mean values for 1E-4 or 1E-5 between 25 Hz and 100 Hz. The 7.5 Hz smooth shapes were utilized and scaled to the Uniform Hazard Spectra mean values for 1E-4 or 1E-5 between 5 Hz and 25 Hz. The 1.75 Hz smooth shapes were utilized and scaled to the Uniform Hazard Spectra mean values for 1E-4 or 1E-5 between 0.5 Hz and 5 Hz. Below 0.5 Hz, the 0.5 Hz smooth shapes were scaled and utilized without any modification. The smooth UHRS at hard rock is provided in tabulated form by Table 2.5.2-19 and the smooth UHRS are presented on Figure 2.5.2-23.

For the reference response spectra, the HF reference spectra shapes for 1E-4 or 1E-5 at the spectral frequency above 5 Hz were the same as the smooth UHRS. The spectral shape at frequency 7.5 Hz was extrapolated from 5 Hz without regard to Uniform Hazard Spectra amplitudes at lower frequencies. The LF reference spectra shapes were scaled to the smooth UHRS values for 1E-4 or 1E-5 for frequency less than 2.5 Hz. Above 2.5 Hz the spectral shape was extrapolated from 2.5 Hz, without regard to Uniform Hazard Spectra amplitudes at higher frequencies by using the smooth spectral shape at frequency 1.75 Hz.

Creation of smoothed 1E-4 and 1E-5 reference spectra in this way ensures that the HF spectra match the 1E-4 and 1E-5 Uniform Hazard Spectra values at high frequencies (5 Hz and above), and ensures that the LF spectra match the 1E-4 and 1E-5 Uniform Hazard Spectra values at low frequencies (2.5 Hz and below). In between calculated values, the spectra have smooth and realistic shapes that reflect the magnitudes and distances dominating the seismic hazard, as reflected in Table 2.5.2-12. The smooth reference spectra are presented on Figure 2.5.2-24.

For controlling response spectra, the smooth spectra shapes for 1E-4 and 1E-5 events, LF and HF, and sub-event DEL, DEM, and DEH were developed directly from the NUREG CR-6728 (NRC, 2001) using the magnitudes and distances in Table 2.5.2-12 without any modification. These smooth spectra were then scaled to match the smooth UHRS at 1.75 Hz for LF events and at 7.5 Hz for HF events. The smooth controlling response spectra are presented on Figure 2.5.2-25.

2.5.2.5.3.2 Controlling Time Histories

Time histories were selected from the rock time histories database from NUREG CR-6728 (NRC, 2001) for sub controlling earthquakes (DEL, DEM, and DEH) for the 1E-4 and 1E-5 levels and for both LF and HF events according to their de-aggregated magnitudes and distances. These time histories were then modified according to the spectral matching criteria set for time histories in Appendix F of Regulatory Guide 1.208 (NRC, 2007a) to match their target smooth controlling response spectra. The selected time histories are listed in Table 2.5.2-18.

For each hazard level (1E-4 and 1E-5) the rock Uniform Hazard Response Spectra (UHRS) is derived as well as the corresponding de-aggregation results. The low frequency controlling event, 1 to 2.5 Hertz, and the high frequency controlling event, 5 to 10 Hertz, can be identified from the de-aggregation results. These controlling events are prescribed in terms of magnitude (M) and distance (R) pairs. From the M-R pair defining each controlling event, the rock motion time histories whose epicenter distance and magnitude are close to the ones of the controlling event are selected.

For each controlling event, a spectral shape is adopted from the shapes for the Central and Eastern United States (CEUS) site according to the corresponding magnitude and distance pair. Then, the response spectrum is scaled to match the rock UHRS at the spectral frequencies of 1.75 Hertz (low frequency controlling event) and 7.5 Hertz (high frequency controlling event). The rock motion time histories are scaled to match the corresponding scaled controlling response spectrum. Each of the controlling earthquakes (DEL, DEM, and DEH) of both LF and HF were taken as input for the seismic site amplification analyses as described in the following section. For each sub-controlling event, all selected time histories have been scaled and modified to match their calculated response spectra with the target scaled response spectrum. As an example, Figure 2.5.2-26, compares the target response spectrum with the response spectra of selected time histories, after performing the spectral matching for the 1E-4 hazard low frequency controlling event of the sub-controlling DEL and DEH.

2.5.2.5.4 Amplification Analysis

The amplification response analysis performed for Callaway Plant Unit 2 used a time history-based procedure in conjunction 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.

Sixty response analyses were performed with a modified version of the program SHAKE (Schnabel and others, 1972) to calculate the site amplification function for each de-aggregation earthquake. The 60 randomized velocity profiles were paired with the 60 sets of randomized modulus reduction and damping curves (one profile with one set of modulus reduction and damping curves) to define 60 soil columns, each characterized by a set of shear wave velocities, modulus reduction curves, and material damping curves. Each of the four scaled time histories corresponding to a de-aggregated earthquake was used to compute the response of fifteen profile-soil property curve sets.

For each analysis, the response spectrum for the computed motion at the top of the Graydon Chert Conglomerate was divided, frequency by frequency, by the response spectrum for the input motion at the hard rock to obtain a site amplification function. The arithmetic mean of these 60 individual response spectral ratios was taken as the mean site amplification function for each de-aggregated earthquake.

Figure 2.5.2-27 describes the site amplification factors for the high and low frequencies and 1E-4 and 1E-5 input motions. Figure 2.5.2-28 provides plots of maximum strain versus depth for 1E-4 and 1E-5 ground motion levels and low and high frequency motion.

The amplification functions, which are the purpose of the seismic wave transmission analysis, are provided by the amplification factors for 1E-4 and 1E-5 input motions and HF and LF rock spectra shown by Table 2.5.2-13 and Table 2.5.2-14.}

2.5.2.6 Ground Motion Response Spectra

The U.S. EPR FSAR includes the following COL Item in Section 2.5.2.6:

> A COL applicant that references the U.S. EPR design certification will verify that the site-specific seismic parameters are enveloped by the CSDRS (anchored at 0.3 g PGA)

and the 10 generic soil profiles discussed in Section 2.5.2 and Section 3.7.1 and summarized in Table 3.7.1-6.

This COL Item is addressed as follows:

{As described in Section 2.5.2.4, the end results of the site response analysis are weighted average site amplification factors. In this Section these factors are used to develop the Ground Motion Response Spectra (GMRS) by modifying the spectra at rock. The GMRS was developed in accordance with the performance-based approach described in Regulatory Position 5 of Regulatory Guide 1.208 (NRC, 2007a): "The horizontal and vertical GMRS are determined in the free field on the ground surface. For sites with soil layers near the surface that will be completely excavated to expose competent material, the GMRS are specified on the outcrop or hypothetical outcrop that will exist after excavation. Motions at this hypothetical outcrop should be developed as a free surface motion, not as an in-column motion."

The Site GMRS was developed starting from the 1E-4 and 1E-5 rock Uniform Hazard Spectra. At high frequencies, the appropriate (1E-4 or 1E-5) HF mean amplification factor was applied to the 1E-4 or 1E-5 HF smooth rock spectrum, to calculate site spectral amplitudes for 1E-4 and 1E-5 annual frequencies of exceedance. At low frequencies, a similar technique was used with the LF mean amplification factors. At intermediate frequencies the larger of the HF and LF site spectral amplitudes was used.

Figure 2.5.2-29 illustrates the resulting site spectra. At high frequencies the HF spectral amplitudes are always greater, and at low frequencies the LF spectral amplitudes are always greater.

This procedure adopts Approach 2B in NUREG/CR-6728 (NRC, 2001) and NUREG/CR-6769 (NRC, 2002), wherein the rock Uniform Hazard Spectra (for example, at 1E-4) is multiplied by a mean amplification factor at each frequency to estimate the 1E-4 site Uniform Hazard Spectra. Note that the amplification factors plotted on Figure 2.5.2-27 are mean logarithmic amplification factors. The amplification factors used to prepare Figure 2.5.2-29 are arithmetic mean of the mean factors displayed in those figures.

The Callaway Plant Unit 2 GMRS is developed at a hypothetical outcrop that will exist after excavation. The GMRS is defined at the top horizon of the Graydon Chert Conglomerate. No overburden materials, in this case the modified loess, accretion gley, glacial till, or engineered fill, are considered in the site amplification model.

The low-frequency character of the spectra on Figure 2.5.2-29 reflects the low-frequency amplification of the Site, as shown in the amplification factors of Figure 2.5.2-27. That is, there is a fundamental Site resonance at about 0.22 Hz, with a dip in Site response at about 0.4 Hz, 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 1E-4and 1E-5 at 0.4 Hz that reflects the Site characteristics.

The RG 1.208 (NRC, 2007a) performance-based approach was used to derive a Site GMRS from the 1E-4 and 1E-5 site spectra. The Site GMRS (or site SSE) spectrum is derived at each structural frequency as follows:

$$\mathrm{AR} = \frac{\mathrm{SA}(1 \cdot \mathrm{E}-5)}{\mathrm{SA}(1 \cdot \mathrm{E}-4)}$$

$$\mathrm{DF} = 0.6 \bullet \mathrm{A_R}^{0.8}$$

$$\mathrm{SSE} = \max\{\mathrm{SA}(1 \cdot \mathrm{E}-4) \bullet \max\{1, \mathrm{DF}\} 0.45 \bullet \mathrm{SA}(1 \cdot \mathrm{E}-5)$$

The last term in the above equation was not published in this form in ASCE (ASCE, 2005) but is a supplemental modified form, as presented in NRC Regulatory Guide 1.208 (NRC, 2007a). The resulting Design Factors are provided in Table 2.5.2-20. The resulting horizontal Site GMRS (SSE) spectrum is plotted on Figure 2.5.2-30.

A vertical Site GMRS (SSE) spectrum was constructed from the horizontal Site GMRS spectrum following the approach described in NUREG/CR-6728 (NRC, 2001) by deriving vertical-to-horizontal (V:H) ratios and applying them to the horizontal Site GMRS (SSE). As background and for comparison purposes, V:H ratios were obtained by the following methods:

The vertical Site GMRS (SSE) spectrum was constructed from the horizontal DRS spectrum using vertical to horizontal (V/H) response spectral ratios appropriate for Callaway Plant Unit 2. The V/H ratios are developed following the approach described in NUREG/CR-6728 (NRC, 2001). Figure 2.5.2-31 shows the V/H ratios recommended for CEUS rock sites as a function of spectral frequency and the level of peak ground acceleration (PGA) for the horizontal component. Figure 2.5.2-31 shows the weighted average of these V/H ratios based on the PGA for the de-aggregated earthquakes (DE's) that make up the high-frequency (HF) and low-frequency (LF) mean 1E-4 reference earthquakes (RE's). The weights assigned to the DE are listed in Table 2.5.2-12. The weighted V/H ratios are essentially the same for the HF and LF mean 1E-4 DE.

The rock V/H ratios represented by the dotted line in Figure 2.5.2-31 must be adjusted for soil sites. Two recently developed models (Abrahamson, 1997; and Campbell, 2003) provide relationships for both vertical and horizontal motions for both soil and rock conditions for the Western United State (WUS). The average V/H ratios for both rock and soil sites for the WUS from these two attenuation models are first calculated. Then, the ratio of the V/H ratios of the soil site respect to rock site are obtained and represented with the dashed line in Figure 2.5.2-31. These ratios correspond to earthquakes of magnitude **M** 6.5 and **M** 7.7 at source-to-site distances of 10.5 and 30 miles (17 and 45 km), respectively. A magnitude **M** 6.5 earthquake was chosen to correspond to the magnitude for the HF RE (m_b 6.6) and a magnitude **M** 7.7 earthquake was chosen to correspond to the LF RE (m_b 7.2). The distances of 17 and 45 km were chosen so that the WUS attenuation relationships produce a horizontal PGA on rock comparable to that for the mean 1E-4 HF and LF RE, respectively. From Figure 2.5.2-31, the resulting V/H ratios for soil sites are greater than those for rock sites at high frequencies and lower at low frequencies. The ratio of V/H spectral ratio for the soil to rock site in WUS is then shifted to have the peak of the spectrum occurs at the same frequency as at the Callaway Plant Site as represented by the dash-dotted line in Figure 2.5.2-31. This shifted soil to rock V/H ratio is then multiplied by the CEUS V/H ratio for the rock site to obtain the recommended V/H ratio for the soil site as represented by the solid line in Figure 2.5.2-31.

The vertical Site GMRS (SSE) is obtained by scaling the horizontal spectrum by the soil V/H ratios shown on Figure 2.5.2-31. The resulting vertical Site GMRS (SSE) is shown on Figure 2.5.2-30 and is tabulated in Table 2.5.2-20 along with the horizontal Site GMRS (SSE) spectrum. The final site SSE for Callaway Plant Unit 2 is further defined in Section 3.7.1.1.1 after reconciliation of Figure 2.5.2-30 curves with the CSDRS curves.

2.5.2.6.1 Seismic Reconciliation

Reconciliation of the Callaway Plant Unit 2 site-specific seismic parameters with the U.S. EPR certified seismic design response spectra (CSDRS) and the 10 generic soil profiles used for the U.S. EPR is addressed in Section 3.7.1. The evaluation guidelines in U.S. EPR FSAR Section 2.5.2.6 are used to perform the reconciliation.

The steps and conclusions of the seismic reconciliation are summarized below. Summaries of select U.S. EPR structures, systems, and components evaluations which confirm they are adequate for the Callaway Plant Unit 2 Site are also provided as required by Step 9.

The seismic reconciliation steps and conclusions:

- Step 1 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the peak ground acceleration for GMRS is less than 0.3g. The Callaway Plant Unit 2 site-specific GMRS are described in Section 3.7.1. The peak ground acceleration for the Callaway Plant Unit 2 site-specific GMRS is confirmed to be less than 0.3g.

- Step 2 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the low strain, best estimate value of the shear wave velocity at the bottom of the NI Common Basemat Structures is 1000 fps, or greater. The low strain, best estimate value of the Callaway Plant Unit 2 site-specific shear wave velocity at the bottom of the NI Common Basemat Structures is confirmed to be greater than 1000 fps.

- Step 3 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the foundation input response spectra (FIRS) are enveloped by the certified seismic design response spectra (CSDRS). Comparison of the Callaway Plant Unit 2 site-specific GMRS/FIRS with the U.S. EPR CSDRS is described in Section 3.7.1. The site-specific horizontal GMRS/FIRS exceeds the envelope of the U.S. EPR CSDRS ground motions for frequencies below approximately 0.4 Hz and frequencies above approximately 10 Hz. The site-specific vertical GMRS/FIRS exceed the envelope of the U.S. EPR CSDRS ground motions for frequencies below approximately 0.25 Hz and frequencies above approximately 14.5 Hz. The Callaway Plant Unit 2 design ground motion response spectra are as described in Section 3.7.1, instead of the CSDRS, because the GMRS/FIRS exceed the CSDRS. This represents a departure from the U.S. EPR FSAR, as described in Section 3.7.1.

- Step 4 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the site-specific soil profile is laterally uniform. Horizontal soil layering is confirmed for Callaway Plant Unit 2 site-specific soil profile.

- Step 5 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the idealized site soil profile is similar to or bounded by the 10 generic soil profiles used for the U.S. EPR. The Callaway Plant Unit 2 idealized site soil profile is described in Section 3.7.1. The Callaway Plant Unit 2 idealized site soil profile is not considered bounded by the U.S. EPR 10 generic soil profiles. This represents a departure from the U.S. EPR FSAR, as described in Section 3.7.1.

- Step 6 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is confirmation that the conditions of Steps 1 through 5 are met. The conditions of Steps 3 and 5 are not met for the Callaway Plant Unit 2 Site because the Callaway Plant Unit 2 site-specific GMRS/FIRS exceed the envelope of the U.S. EPR CSDRS and the Callaway Plant Unit 2 site-specific idealized site soil profile is not bounded by the 10 generic soil profiles used for the U.S. EPR. Because the conditions of Steps 3 and 5 are not met for the Callaway Plant Unit 2 Site, seismic reconciliation guidelines Step 7 is performed.

- Step 7 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is performance of intermediate-level studies, such as evaluation of the site-specific motion at the top of the basemat, to demonstrate that the site is bounded by the design of the U.S. EPR. Callaway Plant Unit 2 site-specific response spectra are developed at the center of the NI Common Basemat Structures basemat and the footprints of the EPGB and ESWB and compared to the corresponding U.S. EPR design certification spectra. The Callaway Plant Unit 2 site-specific spectra exceed the envelope of the U.S. EPR certified design spectra; therefore, seismic reconciliation guideline Step 8 is performed.

- Step 8 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is performance of site-specific soil-structure interaction (SSI) analyses, development of instructure response spectra (ISRS), and confirmation that the Callaway Plant Unit 2 site-specific ISRS do not exceed the ISRS for the U.S. EPR design certification by more than 10% at the building locations specified in the guideline step. Callaway Plant Unit 2 site-specific SSI analyses are performed and site-specific ISRS are developed at the building locations identified in U.S. EPR FSAR Section 2.5.2.6 Step 8 for comparison to the U.S. EPR design certification ISRS. The U.S. EPR design certification SSI analysis methodology is used to perform the site-specific SSI analyses. The site-specific SSI analysis of the EPGB utilizes a new finite element model with refined meshing. Performance of the SSI analyses and comparison of the Callaway Plant Unit 2 site-specific ISRS with the U.S. EPR design certification ISRS is described in Section 3.7.1. The Callaway Plant Unit 2 site-specific ISRS exceed the envelope of the U.S. EPR certified design ISRS by more than 10% at some of the building locations identified in U.S. EPR FSAR Section 2.5.2.6 Step 8. This represents a departure from the U.S. EPR FSAR, as described in Section 3.7.1. Therefore, seismic reconciliation guideline Step 9 is performed.

- Step 9 of the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines is performance of additional evaluations to confirm that safety-related structures, systems, and components of the U.S. EPR at the building locations where Callaway Plant Unit 2 site-specific ISRS exceed the ISRS for the U.S. EPR design certification by more than 10% are not affected. These evaluations, summarized below, confirm that the safety-related structures, systems and components of the U.S. EPR are not affected.

2.5.2.6.2 Reactor Coolant System (RCS)

The RCS is evaluated by comparing the RCS seismic loading resulting from the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles with the U.S. EPR design certification RCS seismic loads. Site-specific RCS seismic loads are developed from the site-specific GMRS/FIRS time histories for the site-specific best estimate, lower bound, and upper bound soil profiles; using the same model, modal weighted damping values, and methodology used to develop the U.S. EPR design certification RCS seismic loads. Callaway Plant Unit 2 site-specific time history analyses are performed to approximately 40 seconds using input at 0.005 second intervals. Sensitivity evaluation confirms the integration time step used, 0.005 seconds, is adequate.

Callaway Plant Unit 2 site-specific RCS seismic loads are compared to the U.S. EPR design certification RCS seismic loads at key locations:

- Reactor Pressure Vessel (RPV) support pads (all loops)
- Steam Generator vertical column supports (all loops)
- Steam Generator upper lateral supports (all loops)
- Reactor Coolant Pump vertical column supports (all loops)

- Pressurizer lower bracket support
- Steam Generator snubbers (all loops)
- Steam Generator bumper (all loops)
- Reactor Coolant Pump upper lateral supports (all loops)
- Pressurizer upper horizontal bumper
- Primary piping (all nozzles, all loops)

The Callaway Plant Unit 2 site-specific RCS seismic loads, except some components of the RPV outlet nozzle loads, are confirmed to lie within the standard U.S. EPR design certification RCS seismic loads envelope. Stress analysis of the RPV outlet nozzles confirms the nozzles are acceptable for the Callaway Plant Unit 2 site-specific RCS seismic loads.

2.5.2.6.3 RPV Internals

The RPV internals are evaluated by the RCS load comparison described above and by comparing the RB internal structures response at elevation 5.15 m resulting from the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles to the U. S. EPR design certification spectra at the same elevation. This elevation is the primary source of seismic excitation for the RPV because the base of the RPV support pad is located at approximately the same elevation. The Callaway Plant Unit 2 site-specific spectra are enveloped by the U.S. EPR design certification spectra at all frequencies and directions except for slight breakthroughs in the vertical direction in the 20-22 Hz range. The vertical spectra breakthroughs are minor in comparison to other excitations affecting the RPV internals and are considered insignificant.

Some RPV excitation also feeds through the RPV nozzles from the RCS. The Callaway Plant Unit 2 site-specific RPV nozzle loads are enveloped by the U.S. EPR design certification RPV loads in all components except some moments about the vertical axes, which would induce horizontal loading in the RPV. The influence of these moments is slight, as can be seen in the RPV support pad loads, both horizontal and vertical, where the Callaway Plant Unit 2 site-specific loads are enveloped by design certification loads.

The Callaway Plant Unit 2 site-specific RPV internals seismic loads are confirmed to lie within the U.S. EPR design certification RPV internals seismic loads envelope based on these spectra and load comparisons.

2.5.2.6.4 Control Rod Drive Mechanisms (CRDMs)

The CRDMs are evaluated by comparing the RPV nozzle centerline response spectra resulting from the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles with the U.S. EPR design certification RPV nozzle centerline response spectra. The Callaway Plant Unit 2 nozzle centerline response spectra are enveloped at all frequencies and directions except for slight breakthroughs in the 10-12 Hz range for the vertical acceleration case. Because the lowest natural frequencies in the vertical direction are approximately 51 Hz and the breakthrough is not close to the natural frequency, the breakthrough is considered insignificant.

2.5.2.6.5 Fuel

Fuel is evaluated by comparing the fuel seismic impact loads resulting from the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles with the U.S. EPR design certification fuel seismic impact loads. Site-specific displacement time histories at the core plates are developed from the site-specific GMRS/FIRS and the site-specific best estimate, lower bound, and upper bound soil profiles. Callaway Plant Unit 2 site-specific fuel seismic impact loads are developed from these time histories using the same model parameters used to develop the U.S. EPR design certification fuel seismic impact loads; except the time histories are extended to approximately 40 seconds. The Callaway Plant Unit 2 site-specific fuel seismic impact loads are confirmed to lie within the U.S. EPR design certification fuel seismic impact loads envelope.

2.5.2.6.6 Leak Before Break (LBB)

Callaway Plant Unit 2 site-specific application of LBB to the main coolant loop, surge line, and main steam line is evaluated by comparing the loads resulting from the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles combined with normal operating loads with the U.S. EPR LBB allowable range of loadings.

Main coolant loop loads are compared at the RPV inlet nozzle, RPV outlet nozzle, steam generator inlet nozzle, steam generator outlet nozzle, reactor coolant pump outlet nozzle, reactor coolant pump inlet nozzle, hot leg piping, cold leg piping, and crossover leg piping. The most highly loaded locations are the RPV outlet nozzle region and steam generator inlet nozzle region; with maximum moments of approximately 30,000 in-kips and 23,000 in-kips, respectively. The Callaway Plant Unit 2 site-specific main coolant loop loads are confirmed to lie within the U.S. EPR design certification allowable load limit LBB curves.

Main steam line loads are compared at the steam generator outlet nozzle and main steam line piping. The most highly loaded location is in the main steam line piping, with a maximum moment of approximately 33,500 in-kips. The Callaway Plant Unit 2 site-specific main steam line loads are confirmed to lie within the U.S. EPR design certification allowable load limit LBB curves.

Surge line loads are compared at the pressurizer nozzle, hot leg nozzle, and surge line piping. Loads at the pressurizer nozzle, hot leg nozzle, and most highly loaded location of surge line piping are approximately 4,100 in-kips, 4,000 in-kips, and 4,600 in-kips, respectively. The Callaway Plant Unit 2 site-specific surge line loads are confirmed to lie within the U.S. EPR design certification allowable load limit LBB curves.

Callaway Plant Unit 2 site-specific application of LBB to the main coolant loop, surge line, and main steam line is confirmed because the site-specific main coolant loop, surge line, and main steam line loads are confirmed to lie within the U.S. EPR design certification allowable load limit LBB curves.

2.5.2.6.7 Piping

Design of Callaway Plant Unit 2 piping and pipe supports is performed using the Callaway Plant Unit 2 design ground motion response spectra described in Section 3.7.1 and ISRS provided in Section 3.7.2. U.S. EPR FSAR Table 1.8-2 specifies that the design of piping and pipe supports are actions performed by the COL Holder. Confirmation of the completion of piping and pipe support design is addressed by the piping design ITAAC contained in U.S. EPR FSAR Tier 1.

2.5.2.6.8 Seismic Qualification of Equipment

Callaway Plant Unit 2 seismic qualification of equipment is performed using the Callaway Plant Unit 2 design ground motion response spectra described in Section 3.7.1 and ISRS provided in Section 3.7.2. The seismic qualification methods, criteria, and process for mechanical and electrical equipment described in U.S. EPR FSAR Section 3.10 are used for Callaway Plant Unit 2 seismic qualification of equipment.

2.5.2.6.9 Seismic Category I Structures

Seismic Category I structures are evaluated for the Callaway Plant Unit 2 site-specific GMRS/FIRS and site-specific soil profiles. Evaluations performed for the Reactor Containment Building, Reactor Building internal structures, other Seismic Category I structures, and Seismic Category I foundations are described in Sections 3.8.1.3, 3.8.3.3, 3.8.4.3, and 3.8.5.5, respectively, and confirm that these structures are adequate for the Callaway Plant Unit 2 Site.

2.5.2.6.10 Conclusion (Seismic Reconciliation)

Completion of the Callaway Plant Unit 2 seismic reconciliation and confirmation of the acceptability of the U.S. EPR for the Callaway Plant Unit 2 site is demonstrated in accordance with the U.S. EPR FSAR Section 2.5.2.6 seismic reconciliation guidelines. This provides justification for the departures from the U.S. EPR FSAR described in Section 3.7.1 for the site specific soil profile, and site specific In-Structure Response Spectra (ISRS).

2.5.2.7 Conclusions

AmerenUE has conducted an updated evaluation of the vibratory ground motion for Callaway Plant Unit 2. A Probabilistic Seismic Hazard Analysis (PSHA) was selected as the appropriate basis for evaluating the vibratory ground motion accounting for all credible alternative seismic sources. AmerenUE considers that the alternative seismic sources identified by the Electric Power Research Institute (EPRI) for the Central and Eastern United States (CEUS), Seismic Hazard Methodology for the Central and Eastern United States, (EPRI, 1986) issued in 1986 still constitute an adequate definition of seismic area sources. However, updated information available from databases maintained by the United States Geological Survey and other sources has been used to determine recurrence parameters and maximum magnitudes for each source. Since the New Madrid Fault System (NMFS) constitutes the most significant source of seismic hazard at Callaway Plant Unit 2, an updated logic-tree representation of the clustered characteristic earthquakes at the NMFS has been incorporated into the PSHA. This NMFS characterization is that provided in the Clinton ESP application (EGC, 2006) after verification with USGS modeling of the New Madrid Faults. The PSHA for Callaway Plant Unit 2 makes use of a decision tree approach with appropriate weighting factors that are based on the most up-to-date information and relative confidence in alternative characterizations for each seismic source.

The guidance of Regulatory Guide 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion," (NRC, 2007a) was used to develop the Ground Motion Response Spectrum (GMRS) at Callaway Plant Unit 2 that is to be used for the development of the Safe Shutdown Earthquake (SSE). This GMRS adequately represents the regional and local seismic hazards and accurately includes the effects of the local soils subsurface properties at the Callaway Plant Unit 2 Site.

It is concluded that the performance-based approach outlined in Regulatory Guide 1.208 (NRC, 2007a) is advancement over the solely hazard-based reference probability approach recommended in Regulatory Guide 1.165 (NRC, 1997a) in the determination of the GMRS. The performance-based approach uses not only the seismic hazard characterization of the Site from the PSHA but also basic seismic fragility SSC modeling in order to obtain a Site SSE that directly targets a structural performance frequency value. AmerenUE concludes that the application for Callaway Plant Unit 2 is acceptable from a geologic and seismologic standpoint and meets the requirements of 10 CFR 100.23(d) (CFR, 2007). Deviations from the NRC guidance in Regulatory Guide 1.165 (NRC, 1997a), Regulatory Guide 1.208 (NRC, 2007a), or review criteria in Standard Review Plan 2.5.2 (NRC, 2007b) have been identified and acceptable alternatives, including technical justification have been provided.

2.5.2.8 References

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Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
6.3	-70.1	47.7	0	1534	1	1	0	0	0	DNAG
6.5	-71.8	44.4	0	1638	6	11	19	0	0	Ebel
7	-70.1	47.6	0	1663	2	5	22	30	0	Ebel
3.5	-71.5	42.5	0	1668	12	19	0	0	0	Ebel
3.5	-70.8	42.8	0	1685	2	18	21	0	0	Ebel
3	-70.8	42	0	1697	2	20	11	15	0	Ebel
3.3	-73.5	41.4	0	1702	1	1	0	0	0	NCEER
3.3	-71.1	42.4	0	1705	6	27	0	0	0	NCEER
5.1	-70.6	42.8	0	1727	11	10	3	40	0	NCEER
3.3	-70.6	42.8	0	1728	5	16	0	0	0	NCEER
3.3	-70.6	42.8	0	1728	7	30	15	0	0	NCEER
3.5	-70.6	42.8	0	1729	2	10	14	0	0	NCEER
3.3	-70.6	42.8	0	1729	3	30	19	0	0	NCEER
3.3	-73.5	41.4	0	1729	8	6	0	0	0	NCEER
3.3	-70.6	42.8	0	1729	9	19	20	30	0	NCEER
3.3	-70.6	42.8	0	1729	10	10	21	30	0	NCEER
3.3	-70.6	42.8	0	1729	11	25	13	0	0	NCEER
3.3	-70.6	42.8	0	1730	2	20	1	0	0	NCEER
3.3	-70.6	42.8	0	1730	4	24	1	0	0	NCEER
3.3	-70.6	42.8	0	1730	12	7	1	20	0	NCEER
3.3	-70.6	42.8	0	1731	1	13	0	0	0	NCEER
3.3	-70.6	42.8	0	1731	7	16	10	0	0	NCEER
3.3	-70.6	42.8	0	1731	10	13	4	0	0	NCEER
3.3	-70.6	42.8	0	1732	2	19	0	0	0	NCEER
5.8	-73.6	45.5	0	1732	9	16	16	0	0	NCEER
3.3	-70.6	42.8	0	1734	11	23	5	0	0	NCEER
3.3	-70.6	42.8	0	1736	2	13	22	45	0	NCEER
3.3	-70.6	42.8	0	1736	10	12	6	30	0	NCEER
3.3	-70.6	42.8	0	1736	11	23	7	0	0	NCEER
3.3	-71	42.4	0	1737	2	17	21	30	0	NCEER
3.3	-70.6	42.8	0	1737	9	20	15	20	0	NCEER
5.2	-74	40.8	0	1737	12	19	3	45	0	NCEER
3.3	-70.6	42.8	0	1739	8	13	7	30	0	NCEER
3.3	-70.6	42.8	0	1741	2	5	20	50	0	NCEER
3.3	-71.2	46.8	0	1744	5	27	0	0	0	NCEER
4.6	-70.9	42.5	0	1744	6	14	15	15	0	NCEER
3.6	-76.3	40	0	1752	12	17	23	30	0	SRA
5.8	-70.3	42.7	0	1755	11	18	9	12	0	NCEER
3.3	-71.1	42.3	0	1757	7	8	19	15	0	NCEER
3.5	-76.5	38.9	0	1758	4	25	2	30	0	NCEER
3.3	-71	42.35	0	1759	2	2	7	0	0	NCEER
4.3	-71	42.5	0	1761	3	12	7	15	0	NCEER
3.3	-71.5	43.1	0	1761	11	2	1	0	0	NCEER
3.5	-66	45.3	0	1764	9	30	0	0	0	NCEER
3.3	-70.3	43.7	0	1766	1	23	10	0	0	NCEER
3.3	-70.77	43.07	0	1766	3	2	8	0	0	NCEER
3.3	-70.8	43.1	0	1766	12	17	11	48	0	NCEER
3.3	-70.3	43.7	0	1769	10	19	0	0	0	NCEER
4.6	-77.4	37.2	0	1774	2	21	19	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-78.8	37.7	0	1775	3	16	19	15	0	NCEER
4	-82	39.9	0	1776	1	1	0	0	0	NCEER
3.3	-83	35.2	0	1776	11	5	0	0	0	NCEER
3.3	-84	36	0	1777	11	16	7	0	0	NCEER
3.8	-87.2	30.4	0	1780	2	6	0	0	0	NCEER
3.3	-70.9	42.5	0	1780	11	29	0	0	0	NCEER
4.9	-74.5	41	0	1783	11	30	3	50	0	NCEER
3.3	-71.2	46.8	0	1784	1	2	10	0	0	NCEER
3.3	-78.8	37.7	0	1791	1	13	9	0	0	NCEER
3.3	-77.5	37.5	0	1791	1	15	10	0	0	NCEER
4.5	-72.4	41.5	0	1791	5	16	13	22	0	NCEER
6	-70.5	47.4	0	1791	12	6	20	0	0	NCEER
3.3	-72.5	41.5	0	1792	8	29	3	0	0	NCEER
3.3	-72.5	41.5	0	1794	3	6	19	0	0	NCEER
3.4	-89.9	39	0	1795	1	8	9	0	0	NCEER
4	-79	42.9	0	1796	12	26	11	0	0	NCEER
4.4	-80	32.9	0	1799	4	11	8	20	0	NCEER
3.9	-76.39	40.12	0	1800	11	20	5	0	0	NCEER
3.3	-72.3	43.7	0	1800	12	20	0	0	0	NCEER
3.3	-71.1	41.9	0	1800	12	25	0	0	0	NCEER
3.3	-70.8	43.1	0	1801	3	1	20	30	0	NCEER
3.5	-79.1	37.4	0	1802	8	23	10	0	0	NCEER
3.3	-70.9	42.5	0	1803	1	18	14	50	0	NCEER
4.4	-87.8	42	0	1804	8	20	20	10	0	USHIS
4.2	-89	42	0	1804	8	24	20	10	0	NCEER
3.3	-70.9	42.5	0	1805	4	25	0	0	0	NCEER
3.3	-69	44.5	0	1805	6	12	12	30	0	NCEER
3.3	-72.5	41.5	0	1805	12	30	11	0	0	NCEER
3.3	-71.1	43	0	1807	1	14	4	0	0	NCEER
3.5	-79.1	37.4	0	1807	5	1	9	0	0	NCEER
3.3	-70.5	43.5	0	1807	5	6	18	0	0	NCEER
3.5	-69	44.4	0	1808	6	26	2	50	0	NCEER
3.9	-70.9	43	0	1810	11	10	2	15	0	NCEER
3.3	-80.2	36.1	0	1811	11	27	8	0	0	NCEER
3.3	-77.4	37.6	0	1812	2	2	9	30	0	NCEER
7.4	-89.6	36.5	0	1812	2	7	9	45	0	NCEER[Note 1]
3.3	-77.5	37.5	0	1812	4	22	4	0	0	NCEER
4	-70.3	43.7	0	1814	11	29	0	14	0	NCEER
3	-89.5	36.6	0	1816	7	25	15	0	0	NCEER
5.2	-73.6	45.5	0	1816	9	9	0	0	0	NCEER
5	-80	32.9	0	1817	1	8	9	0	0	USHIS
4.7	-67.2	45	0	1817	5	22	20	0	0	NCEER
4.2	-71.2	42.5	0	1817	10	5	16	45	0	NCEER
3.1	-84.5	38.5	0	1817	12	11	0	0	0	NCEER
3	-90.2	38.6	0	1818	4	11	20	0	0	NCEER
3.3	-71.2	46.9	0	1818	10	11	0	0	0	NCEER
3.3	-76.5	44	0	1818	12	7	0	0	0	NCEER
3.4	-89.7	37.7	0	1819	9	2	8	0	0	NCEER
3.1	-89.8	38.1	0	1819	9	17	4	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3	-89.5	36.6	0	1820	1	1	0	0	0	NCEER
3.3	-79.3	33.4	0	1820	9	3	8	30	0	NCEER
3.4	-89.5	37.3	0	1820	11	9	22	0	0	NCEER
3.8	-68.8	44.8	0	1821	5	5	12	30	0	NCEER
3.3	-70	43.9	0	1823	3	7	15	0	0	NCEER
3.5	-68.8	44.8	0	1823	6	10	17	0	0	NCEER
3.8	-70.6	42.9	0	1823	7	23	11	55	0	NCEER
3.5	-66.5	46.5	0	1824	7	9	0	0	0	NCEER
4.1	-80.5	39.7	0	1824	7	15	16	20	0	NCEER
3.3	-81.56	30.08	0	1826	2	26	14	0	0	NCEER
3.3	-81.2	36.1	0	1827	5	11	0	0	0	NCEER
4.8	-87.5	38	0	1827	7	5	11	30	0	NCEER
4.8	-88	38	0	1827	8	7	4	30	0	NCEER
4	-85.8	38.3	0	1827	8	7	7	0	0	NCEER
3.3	-72.1	41.4	0	1827	8	23	0	0	0	NCEER
4.8	-80	37	0	1828	3	9	0	0	0	NCEER
3.3	-70	43.9	0	1828	7	25	11	0	0	NCEER
3.3	-69.8	44.2	0	1829	8	27	21	45	0	NCEER
5.2	-70.5	47.3	0	1831	5	8	0	0	0	NCEER
5	-70.1	47.6	0	1831	7	14	0	0	0	NCEER
4	-85.6	42.3	0	1833	2	4	0	0	0	NCEER
3.3	-70.17	47.65	0	1833	3	1	0	0	0	NCEER
3.3	-70.2	47.7	0	1833	4	1	0	0	0	NCEER
4.6	-78	37.7	0	1833	8	27	11	0	0	NCEER
3.8	-76.14	39.85	0	1834	2	5	22	30	0	NCEER
3.4	-86	38	0	1834	11	20	19	40	0	NCEER
3.1	-81.7	41.5	0	1836	7	9	2	15	0	NCEER
3.3	-70.9	42.5	0	1837	1	15	7	0	0	NCEER
3.5	-72.7	41.7	0	1837	4	12	0	0	0	NCEER
5	-88	38.5	0	1838	6	9	14	45	0	NCEER
3.1	-83.8	38.6	0	1839	9	5	0	0	0	NCEER
3.7	-75	43	0	1840	1	16	20	0	0	NCEER
3.7	-72.9	41.5	0	1840	8	9	20	30	0	NCEER
4	-79.85	43.2	0	1840	9	10	0	0	0	NCEER
3.3	-74.25	40.79	0	1841	1	25	5	30	0	NCEER
4.2	-89.2	36.6	0	1841	12	28	5	50	0	NCEER
3.1	-89.2	36.6	0	1842	5	28	5	0	0	NCEER
3.4	-89.2	36.6	0	1842	11	4	6	30	0	NCEER
3.8	-73.2	46	0	1842	11	9	0	0	0	NCEER
5.4	-89.6	35.5	0	1843	1	5	2	45	0	NCEER
3.1	-90.3	38.8	0	1843	2	16	0	0	0	NCEER
4.4	-90.5	35.5	0	1843	2	17	5	0	0	NCEER
3.3	-72.5	44.4	0	1843	3	14	0	0	0	NCEER
4.1	-87.1	35.6	0	1843	8	9	0	0	0	NCEER
3.3	-71.2	41.1	0	1843	10	24	0	0	0	NCEER
3.5	-78.33	43.05	0	1844	10	22	7	0	0	NCEER
3.3	-73.6	45.5	0	1844	11	1	0	0	0	NCEER
3.6	-83.27	35.79	0	1844	11	28	8	0	0	NCEER
3.8	-73.67	41.22	0	1845	10	26	23	15	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 4 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-70.3	42.7	0	1846	5	30	18	30	0	NCEER
4.1	-70.8	42.5	0	1846	8	25	9	45	0	NCEER
3.3	-69.1	44.2	0	1847	2	2	0	0	0	NCEER
4.2	-70.1	41.7	0	1847	8	8	15	0	0	NCEER
3.7	-82.53	39.65	0	1848	4	6	0	0	0	NCEER
4.4	-73.85	41.11	0	1848	9	9	0	0	0	NCEER
3.4	-89.2	36.6	0	1849	1	24	0	0	0	NCEER
4.3	-88	37	0	1850	4	5	2	5	0	NCEER
3.1	-81.7	41.5	0	1850	10	1	10	25	0	NCEER
3.3	-78.4	37.3	0	1850	10	17	0	0	0	NCEER
3.3	-69.6	44.6	0	1851	1	4	4	30	0	NCEER
3.3	-71.4	41.2	0	1852	1	10	11	40	0	NCEER
4.9	-81.6	36.6	0	1852	4	29	18	0	0	NCEER
3.3	-82	33.48	0	1852	8	25	2	40	0	NCEER
4.4	-78.6	37.6	0	1852	11	2	23	35	0	NCEER
3.7	-70.9	43	0	1852	11	28	4	45	0	NCEER
4.5	-75.5	43.7	0	1853	3	12	7	0	0	NCEER
3.3	-79.4	43.1	0	1853	3	13	10	0	0	NCEER
4.4	-79.5	38.5	0	1853	5	2	14	20	0	NCEER
4	-81.96	33.49	0	1853	5	20	5	10	0	NCEER
3.3	-70.2	43.5	0	1853	7	17	10	30	0	NCEER
3.3	-71.9	43	0	1853	11	28	0	0	0	NCEER
4.1	-89.2	36.6	0	1853	12	12	0	0	0	NCEER
3	-83.8	37.2	0	1854	2	12	0	0	0	NCEER
3.6	-84	37.6	0	1854	2	28	0	0	0	NCEER
3.1	-85.2	38.2	0	1854	3	8	0	0	0	NCEER
3.3	-83.62	32.82	0	1854	3	20	6	15	0	NCEER
3.3	-72.3	42.9	0	1854	10	24	0	0	0	NCEER
3.4	-70.8	43	0	1854	12	11	5	30	0	NCEER
4	-71	44	0	1855	1	16	23	0	0	NCEER
3.9	-78.6	37	0	1855	2	2	8	0	0	NCEER
3.3	-69.6	44.6	0	1855	2	19	0	0	0	NCEER
3.1	-89.2	37	0	1855	5	3	3	33	0	NCEER
3.3	-71.6	44.7	0	1855	5	29	10	0	0	NCEER
3.3	-65.5	44.7	0	1855	6	1	0	0	0	NCEER
3.3	-73.7	43.3	0	1855	12	17	19	0	0	NCEER
3.3	-78.2	39.2	0	1856	1	16	8	0	0	NCEER
3.3	-72.6	41.4	0	1856	3	13	3	0	0	NCEER
4.1	-89.5	36.6	0	1856	11	9	10	0	0	NCEER
3.1	-74.75	40.08	0	1857	2	10	23	30	0	NCEER
3.9	-81.05	42.22	0	1857	2	27	20	30	0	NCEER
3.3	-80.6	41.8	0	1857	3	1	1	40	0	NCEER
3.4	-83.18	33	0	1857	3	1	22	45	0	NCEER
5.1	-89.2	38.7	0	1857	10	8	10	0	0	NCEER
4	-78.97	42.74	0	1857	10	23	20	15	0	NCEER
3.3	-68	46.7	0	1857	12	8	20	0	0	NCEER
4.1	-80.73	32.78	0	1857	12	19	8	50	0	NCEER
3.9	-70.2	44.1	0	1857	12	23	18	30	0	NCEER
3.3	-78.5	42.9	0	1858	1	1	7	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 5 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-81.3	41.7	0	1858	4	10	11	30	0	NCEER
3.3	-72.1	45.5	0	1858	5	17	20	0	0	NCEER
3.3	-73	41.3	0	1858	7	1	3	45	0	NCEER
4	-89.2	36.5	0	1858	9	21	0	0	0	NCEER
3.1	-81.5	37.1	0	1859	3	22	0	0	0	NCEER
4.5	-94.8	46	0	1860	1	1	0	0	0	NCEER
4.3	-80.57	33.68	0	1860	1	19	18	0	0	NCEER
3.3	-70.5	42.2	0	1860	3	17	2	30	0	NCEER
4	-83.64	35.08	0	1860	4	24	20	0	0	NCEER
4.3	-87.5	37.5	0	1860	8	7	15	30	0	NCEER
6	-70.1	47.5	0	1860	10	17	11	15	0	NCEER
3.2	-82.64	34.13	0	1860	10	22	5	0	0	NCEER
4.3	-83.36	35.09	0	1861	1	3	16	30	0	NCEER
5	-75.4	45.4	0	1861	7	12	0	0	0	NCEER
5.2	-82.3	36.18	0	1861	8	31	5	0	0	NCEER
3.5	-73.7	45.6	0	1861	10	1	0	0	0	NCEER
3.3	-72.5	41.5	0	1862	2	3	1	0	0	NCEER
3.3	-73	44.5	0	1863	6	9	21	30	0	NCEER
3.8	-71.2	46.9	0	1864	4	20	18	15	0	NCEER
3.3	-73.6	45.5	0	1864	10	21	9	10	0	NCEER
4.6	-89.5	36.5	0	1865	8	17	15	0	0	NCEER
3.3	-71.2	46.8	0	1866	11	9	16	10	0	NCEER
5.2	-96.3	39.2	0	1867	4	24	20	22	0	NCEER
3.1	-95.8	40.7	0	1867	4	28	0	0	0	NCEER
4.7	-75.15	44.65	0	1867	12	18	8	0	0	NCEER
3.3	-80	32.9	0	1869	1	1	0	0	0	NCEER
3.4	-84.5	38.1	0	1869	2	20	0	0	0	NCEER
5.1	-67.2	45	0	1869	10	22	11	0	0	NCEER
4	-70.5	47.5	0	1869	12	1	0	0	0	NCEER
3.3	-69.8	44.1	0	1870	2	8	0	0	0	NCEER
3.3	-66.5	45.5	0	1870	3	17	11	0	0	NCEER
6.5	-70.5	47.4	0	1870	10	20	16	30	0	NCEER
3	-89.2	36.6	0	1870	12	14	0	0	0	NCEER
3.5	-74.6	45.6	0	1871	1	3	0	0	0	NCEER
3.3	-71.2	46.8	0	1871	5	20	7	0	0	NCEER
3.3	-71.5	43.2	0	1871	7	20	0	0	0	NCEER
3.4	-90	38.5	0	1871	7	25	6	40	0	NCEER
3.8	-75.5	39.7	0	1871	10	9	14	40	0	NCEER
3.4	-83.8	43.5	0	1872	2	6	14	0	0	NCEER
3	-89.2	37	0	1872	2	8	11	0	0	NCEER
3.7	-78	37.7	0	1872	6	5	3	0	0	NCEER
3	-83.22	33.06	0	1872	6	17	14	30	0	NCEER
3.1	-93.5	39.8	0	1872	7	9	2	30	0	NCEER
3	-73.8	40.9	0	1872	7	11	10	25	0	NCEER
3.6	-97	42.7	0	1872	10	9	16	0	0	NCEER
3.4	-71.6	43.2	0	1872	11	18	19	0	0	NCEER
3	-84.2	39.7	0	1873	4	23	4	14	0	NCEER
3.5	-74.2	44.8	0	1873	4	25	19	0	0	NCEER
3.1	-79.9	43.3	0	1873	4	30	0	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 6 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-74.7	45	0	1873	4	30	0	0	0	NCEER
3	-97.7	30.2	0	1873	5	1	4	30	0	NCEER
3.7	-89.6	36	0	1873	5	3	21	0	0	NCEER
4	-78.94	42.69	0	1873	7	6	0	0	0	NCEER
3.3	-73.2	45.5	0	1873	9	30	11	50	0	NCEER
3.3	-76	46.5	0	1873	9	30	11	50	0	NCEER
3.6	-78.2	37.2	0	1873	10	3	12	45	0	NCEER
3.2	-83.9	33	0	1873	10	4	0	0	0	NCEER
3.3	-71.2	43.6	0	1874	1	6	0	0	0	NCEER
3.3	-71.4	42.6	0	1874	1	25	17	0	0	NCEER
3.3	-71.5	43	0	1874	1	26	7	0	0	NCEER
3.3	-82.1	35.7	0	1874	2	22	0	0	0	NCEER
3.7	-67.28	45.18	0	1874	2	28	3	40	0	NCEER
3.3	-82.1	35.7	0	1874	3	17	0	0	0	NCEER
3.3	-82.1	35.7	0	1874	4	14	0	0	0	NCEER
3	-89.2	37	0	1874	7	9	22	0	0	NCEER
3.3	-69.1	48.6	0	1874	7	31	9	0	0	NCEER
3	-70.9	42.7	0	1874	11	24	0	0	0	NCEER
3.4	-73.8	40.9	0	1874	12	11	3	25	0	NCEER
3.4	-82.51	35.29	0	1875	4	10	0	0	0	NCEER
4.7	-84	40.2	0	1875	6	18	13	43	0	NCEER
3.4	-73	41.9	0	1875	7	28	9	10	0	NCEER
4.1	-89.6	36.1	0	1875	10	7	0	0	0	NCEER
3.1	-90	35.1	0	1875	10	28	3	0	0	NCEER
4.8	-82.9	33.49	0	1875	11	1	22	30	0	NCEER
3.8	-95.7	39	0	1875	11	8	10	40	0	NCEER
3.6	-84	36	0	1875	11	12	7	0	0	NCEER
3.3	-72.3	42.9	0	1875	12	1	9	0	0	NCEER
4.8	-78.5	37.6	0	1875	12	23	4	45	0	NCEER
3.4	-84.2	40.4	0	1876	6	1	0	0	0	NCEER
3.1	-99.6	44.1	0	1876	8	17	5	25	0	NCEER
3.6	-71.3	41.5	0	1876	9	22	4	30	0	NCEER
4.7	-87	38.5	0	1876	9	25	6	15	0	NCEER
3.3	-80	32.9	0	1876	12	12	0	0	0	NCEER
3.3	-77.5	37.4	0	1876	12	23	4	45	0	NCEER
3.4	-83.5	38.8	0	1877	1	23	21	0	0	NCEER
3.6	-84	36	0	1877	5	25	0	0	0	NCEER
3	-87.9	38.2	0	1877	5	26	21	0	0	NCEER
4.2	-89.7	36.8	0	1877	7	15	0	40	0	NCEER
3.1	-83.3	42.3	0	1877	8	17	16	50	0	NCEER
3.3	-74.9	40.3	0	1877	9	10	14	59	0	NCEER
4.7	-73.9	45.2	0	1877	11	4	0	0	0	NCEER
5	-97	41	0	1877	11	15	17	45	0	NCEER
3.7	-84	35.5	0	1877	11	16	7	38	0	NCEER
3	-89.2	37	0	1877	11	19	11	10	0	NCEER
3.5	-76.85	45.7	0	1877	12	18	10	0	0	NCEER
3	-89.2	37	0	1878	1	9	4	30	0	NCEER
3.9	-89.1	36.8	0	1878	3	12	10	0	0	NCEER
3.4	-74	41.5	0	1878	10	4	7	30	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 7 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
5.2	-90.7	35.5	0	1878	11	19	5	52	0	NCEER
3.3	-99.1	39.6	0	1879	3	1	0	0	0	NCEER
3.3	-75.5	39.2	0	1879	3	26	0	30	0	NCEER
3.3	-73.6	45.6	0	1879	6	11	0	0	0	NCEER
3.3	-79.2	43.2	0	1879	8	21	8	0	0	NCEER
3.7	-90.3	35.3	0	1879	9	26	3	10	0	NCEER
3.3	-71.5	43	0	1879	10	26	2	30	0	NCEER
3.1	-81.08	34.37	0	1879	10	26	20	0	0	NCEER
3.6	-97.3	42.9	0	1879	12	29	6	30	0	NCEER
3.4	-71	42.7	0	1880	5	12	12	45	0	NCEER
3.3	-75.3	45.2	0	1880	5	31	0	0	0	NCEER
3.7	-90.3	35.3	0	1880	7	14	2	30	0	NCEER
3.3	-71.5	43	0	1880	7	20	0	0	0	NCEER
3.3	-73.8	45.2	0	1880	9	6	5	30	0	NCEER
3.3	-70.5	47.45	0	1880	11	28	13	30	0	NCEER
3	-97.2	49	0	1880	12	28	7	15	0	NCEER
3.3	-70	44	0	1881	1	21	2	40	0	NCEER
3.1	-85.8	41.6	0	1881	4	20	0	0	0	NCEER
4	-89.1	41.3	0	1881	5	27	0	0	0	NCEER
3.3	-70.2	47.6	0	1881	10	1	6	40	0	NCEER
3.3	-71.6	43.2	0	1881	10	6	5	3	0	NCEER
3.1	-90	35.1	0	1881	10	7	16	52	0	NCEER
3.1	-84.2	40.4	0	1882	2	9	20	0	0	NCEER
3.3	-71.7	43.2	0	1882	4	17	0	0	0	NCEER
3.4	-89.2	36.9	0	1882	7	20	10	0	0	NCEER
3.9	-90.6	37.6	0	1882	7	28	0	0	0	NCEER
3.3	-67.4	49.3	0	1882	8	15	15	30	0	NCEER
4.4	-89.5	38.7	0	1882	9	27	10	20	0	NCEER
4.8	-95.6	33.6	0	1882	10	22	22	15	0	NCEER
6.2	-105.5	40.5	0	1882	11	8	1	30	0	USHIS
3.1	-79.25	43	0	1882	11	27	23	30	0	NCEER
3.6	-71.4	43.2	0	1882	12	19	22	24	0	NCEER
3.5	-67	45	0	1883	1	1	2	55	0	NCEER
3.3	-67.7	44.6	0	1883	1	1	7	58	0	NCEER
4.7	-88.5	37	0	1883	1	11	7	12	0	NCEER
4.7	-85.6	42.3	0	1883	2	4	11	0	0	NCEER
3.3	-71.2	43.6	0	1883	2	4	20	5	0	NCEER
3.6	-71.3	41.5	0	1883	2	28	3	30	0	NCEER
3.1	-76.4	39.5	0	1883	3	11	23	57	0	NCEER
3.3	-74.5	45.1	0	1883	3	12	0	0	0	NCEER
4.5	-89.2	37	0	1883	4	12	8	30	0	NCEER
3.1	-82.6	38.4	0	1883	5	23	4	30	0	NCEER
4	-90	35.1	0	1883	6	11	18	16	0	NCEER
3.7	-89.1	37	0	1883	7	14	7	30	0	NCEER
3.1	-90.2	38.7	0	1883	11	15	3	14	0	NCEER
4	-91.2	35.7	0	1883	12	5	15	20	0	NCEER
3.3	-71.7	43.2	0	1884	1	18	7	0	0	NCEER
3.7	-77.59	34.59	0	1884	1	18	8	0	0	NCEER
3.1	-100.7	41.1	0	1884	3	17	20	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 8 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.6	-83.05	32.8	0	1884	3	21	4	30	0	NCEER
5.2	-74	40.6	0	1884	8	10	19	7	0	NCEER
3.3	-83.83	36.07	0	1884	8	24	19	45	0	NCEER
4.8	-84.1	40.7	0	1884	9	19	20	14	0	NCEER
3.7	-71.7	43.2	0	1884	11	23	5	30	0	NCEER
3.5	-89.7	35.5	0	1884	11	30	5	0	0	NCEER
3.3	-71.5	43.7	0	1884	12	17	7	0	0	NCEER
3.9	-77.5	39.2	0	1885	1	3	2	12	0	NCEER
3.4	-73.9	41.3	0	1885	1	4	11	6	0	NCEER
3.5	-81.6	41.16	0	1885	1	18	10	30	0	NCEER
3.3	-81.1	36.9	0	1885	2	2	12	10	0	NCEER
3.3	-66.1	45.1	0	1885	6	1	0	0	0	NCEER
3.4	-81.83	36.12	0	1885	8	6	9	0	0	NCEER
4.4	-78.8	37.7	0	1885	10	10	4	35	0	NCEER
3.6	-82.71	33.17	0	1885	10	17	18	20	0	NCEER
3.3	-71.5	42.9	0	1886	1	6	0	10	0	NCEER
3.3	-73.8	41.6	0	1886	1	25	0	4	0	NCEER
3.5	-88	32.8	0	1886	2	5	1	0	0	NCEER
3.3	-81.52	35.93	0	1886	2	5	2	0	0	NCEER
3	-85.5	39	0	1886	3	1	16	0	0	NCEER
4.2	-89.2	37	0	1886	3	18	5	59	0	NCEER
3.8	-82.24	39.36	0	1886	5	3	3	0	0	NCEER
3.3	-67.4	49.3	0	1886	5	18	19	30	0	NCEER
3.3	-74	46	0	1886	8	12	0	0	0	NCEER
3	-86.1	39.7	0	1886	8	14	0	0	0	NCEER
3.8	-80.14	33.38	0	1886	8	27	8	30	0	NCEER
3.3	-81.7	30.4	0	1886	9	1	0	0	0	NCEER
6.8	-80	32.9	0	1886	9	1	2	51	0	NCEER
4.4	-81.94	33.93	0	1886	9	1	8	55	0	NCEER
4.2	-82.86	34.3	0	1886	9	1	9	45	0	NCEER
4.3	-81.56	33.41	0	1886	9	1	23	50	0	NCEER
3.6	-81.23	34.72	0	1886	9	2	23	0	0	NCEER
3.3	-72.5	41.5	0	1886	9	5	0	0	0	NCEER
4.1	-80.97	33.05	0	1886	9	7	11	42	0	NCEER
4.3	-80.68	32.7	0	1886	9	7	17	0	0	NCEER
3.7	-80.96	32.23	0	1886	9	19	0	0	0	NCEER
3.2	-80.05	36.7	0	1886	9	25	2	0	0	NCEER
3.4	-81.62	34.7	0	1886	9	27	22	0	0	NCEER
4.1	-81.66	34.71	0	1886	10	22	0	0	0	NCEER
5.2	-81.01	33.87	0	1886	10	22	14	45	0	NCEER
3.9	-80.39	33.9	0	1886	10	31	14	20	0	NCEER
5.3	-80.42	33.4	0	1886	11	5	12	25	0	NCEER
3.8	-81.06	33.04	0	1886	12	2	2	20	0	NCEER
3.6	-82.06	34.18	0	1886	12	11	16	0	0	NCEER
3.6	-97.06	30.15	0	1887	1	5	17	57	0	SRA
3.1	-82.42	34.35	0	1887	1	12	6	0	0	NCEER
4.5	-88.5	39	0	1887	2	6	22	15	0	NCEER
3.1	-80	45.35	0	1887	2	19	0	0	0	NCEER
3.3	-67.4	49.3	0	1887	2	22	22	59	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-70.5	47.5	0	1887	3	11	0	0	0	NCEER
3.7	-80.37	33.9	0	1887	5	22	20	45	0	NCEER
4	-70.5	47.45	0	1887	5	27	6	15	0	NCEER
3.6	-81	34	0	1887	6	3	8	45	0	NCEER
3.3	-71.5	43.2	0	1887	6	30	22	0	0	NCEER
3.7	-80.77	33.74	0	1887	7	10	13	5	0	NCEER
3.8	-78.83	34.41	0	1887	8	2	1	0	0	NCEER
4.6	-88.5	37.2	0	1887	8	2	18	36	0	NCEER
3.9	-79.95	33.83	0	1887	8	10	7	1	0	NCEER
4.2	-80.62	32.49	0	1887	8	26	23	45	0	NCEER
4	-81.22	33.52	0	1887	8	27	4	56	0	NCEER
3.9	-80.86	33.66	0	1887	8	28	22	57	0	NCEER
3.3	-77.1	45.8	0	1888	1	11	9	0	0	NCEER
4.4	-80.17	34.18	0	1888	1	12	9	55	0	NCEER
3.3	-70.1	44.65	0	1888	2	1	0	0	0	NCEER
3	-82.5	36.4	0	1888	3	17	0	0	0	NCEER
3.3	-70.5	47.45	0	1888	4	19	5	30	0	NCEER
3.3	-70	44.3	0	1888	8	15	1	15	0	NCEER
3.1	-81.08	34.37	0	1888	8	15	18	30	0	NCEER
3.5	-83.35	33.42	0	1888	9	17	21	30	0	NCEER
3.1	-90.4	35.4	0	1888	11	3	0	0	0	NCEER
3.3	-68.7	48.5	0	1888	12	7	14	25	0	NCEER
3.9	-79.2	33.16	0	1889	2	5	19	40	0	NCEER
3.3	-71.6	43.5	0	1889	3	8	0	0	0	NCEER
4.1	-76	40	0	1889	3	8	23	40	0	NCEER
3.7	-88.1	35.9	0	1889	6	6	16	25	0	NCEER
4.4	-80.33	32.4	0	1889	7	11	21	47	0	NCEER
4	-90	35.2	0	1889	7	20	1	32	0	NCEER
3.3	-73.7	43.4	0	1889	8	10	0	0	0	NCEER
3.5	-84.87	35.03	0	1889	9	29	0	0	0	NCEER
3.1	-82.6	34.72	0	1889	10	24	10	0	0	NCEER
3.8	-95.2	31.7	0	1891	1	8	6	0	0	NCEER
3	-90	35.1	0	1891	1	14	0	0	0	NCEER
3.7	-71.6	43.2	0	1891	5	2	0	10	0	NCEER
4.2	-87.5	37.9	0	1891	7	27	2	28	0	NCEER
5.5	-88.5	38.3	0	1891	9	27	4	55	0	NCEER
3.3	-80	32.9	0	1891	10	13	5	55	0	NCEER
3.3	-71.7	44.3	0	1892	12	11	16	30	0	NCEER
3.3	-74	40.6	0	1893	3	9	5	30	0	NCEER
3.3	-72.7	42.3	0	1893	3	14	0	0	0	NCEER
3.3	-81.7	30.4	0	1893	6	21	7	7	0	NCEER
3.3	-80	32.9	0	1893	7	5	8	10	0	NCEER
3.3	-80	32.9	0	1893	9	19	7	5	0	NCEER
3.3	-80	32.9	0	1893	11	8	4	40	0	NCEER
5.2	-73.3	45.5	0	1893	11	27	16	50	0	NCEER
3.3	-80	32.9	0	1893	12	27	6	51	0	NCEER
3.3	-66.8	49.7	0	1894	1	11	9	0	0	NCEER
3.3	-80	32.9	0	1894	1	30	4	5	0	NCEER
3.3	-72.5	41.6	0	1894	4	10	0	0	0	NCEER

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 10 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-80	32.9	0	1894	6	16	2	16	0	NCEER
4.3	-106.3	42.9	0	1894	6	25	0	0	0	NCEER
3.3	-80	32.9	0	1894	12	11	5	27	0	NCEER
3.3	-73.8	42.5	0	1894	12	17	0	0	0	NCEER
3.3	-80	32.9	0	1895	1	8	5	40	0	NCEER
3.3	-80	32.9	0	1895	4	27	7	40	0	NCEER
3.3	-80	32.9	0	1895	7	25	4	1	0	NCEER
3	-88.2	35.2	0	1895	7	27	0	0	0	NCEER
4.3	-74.3	40.46	0	1895	9	1	11	9	0	NCEER
3.3	-80	32.9	0	1895	10	6	6	25	0	NCEER
3.5	-77.5	35.9	0	1895	10	7	4	30	0	NCEER
3.5	-103.3	43.9	0	1895	10	11	23	55	0	NCEER
5.4	-89.4	37	0	1895	10	31	11	8	0	NCEER
3.3	-80	32.9	0	1895	11	12	23	33	0	NCEER
3.3	-78.6	36.3	0	1896	2	11	1	45	0	NCEER
3.1	-84.2	40.3	0	1896	3	15	7	0	0	NCEER
3.3	-80	32.9	0	1896	3	19	8	22	0	NCEER
3.8	-67.2	45.2	0	1896	3	23	0	56	0	NCEER
3.3	-66.6	45.9	0	1896	5	16	4	0	0	NCEER
3.3	-80	32.9	0	1896	8	11	5	58	0	NCEER
3.3	-71.8	44.3	0	1896	10	22	10	30	0	NCEER
3.3	-80	32.9	0	1896	11	14	8	15	0	NCEER
3.3	-66.8	44.5	0	1897	1	28	0	0	0	NCEER
3.1	-79.2	43.1	0	1897	3	7	0	0	0	NCEER
5	-73.6	45.5	0	1897	3	23	23	7	0	NCEER
3.7	-89.6	35.8	0	1897	4	26	4	0	0	NCEER
3.3	-89	37	0	1897	5	1	4	0	0	NCEER
4.5	-73.5	44.5	0	1897	5	28	3	16	0	NCEER
5	-80.7	37.3	0	1897	5	31	18	58	0	NCEER
3.3	-71.6	43.7	0	1897	7	1	9	20	0	NCEER
3.3	-72.5	41.5	0	1897	9	5	0	0	0	NCEER
4.1	-68.7	44.7	0	1897	9	25	18	5	0	NCEER
4.1	-81.1	36.9	0	1897	10	22	3	20	0	NCEER
4.5	-106.3	42.9	0	1897	11	14	0	0	0	NCEER
3.3	-77.5	37.7	0	1897	11	27	20	56	0	NCEER
4	-97.7	37.7	0	1897	12	2	7	10	0	NCEER
4.6	-77.5	37.7	0	1897	12	18	23	45	0	NCEER
3.3	-74.3	45.1	0	1898	1	7	6	0	0	NCEER
3.3	-66.8	44.7	0	1898	1	11	9	0	0	NCEER
3.1	-90.6	34.6	0	1898	1	27	1	35	0	NCEER
4.3	-81	37	0	1898	2	5	20	0	0	NCEER
3.3	-72.6	42.8	0	1898	6	11	6	45	0	NCEER
4	-88.7	36.5	0	1898	6	14	15	6	0	NCEER
3.1	-97.3	42.6	0	1898	9	16	9	59	0	NCEER
4.3	-81	37	0	1898	11	25	20	0	0	NCEER
4.4	-81	37	0	1899	2	13	9	30	0	NCEER
3.3	-76.3	36.9	0	1899	3	3	0	0	0	NCEER
3.3	-80	32.9	0	1899	3	10	5	45	0	NCEER
4.6	-87.4	38.5	0	1899	4	30	2	5	0	NCEER

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.6	-72.6	41.6	0	1899	5	17	1	15	0	NCEER
3.3	-69.5	44	0	1899	10	5	11	30	0	NCEER
3.2	-86.5	42.1	0	1899	10	11	4	0	0	NCEER
3.1	-83	39.3	0	1899	11	12	14	0	0	NCEER
3.1	-94.4	36.8	0	1899	12	1	18	50	0	NCEER
3.3	-80	32.9	0	1899	12	4	12	48	0	NCEER
3.5	-99	44.5	0	1899	12	6	12	0	0	NCEER
3	-89.5	45.5	0	1900	3	14	3	0	0	NCEER
4	-81.8	41.4	0	1900	4	9	13	0	0	NCEER
3.5	-81.7	30.4	0	1900	10	31	16	15	0	NCEER
3.1	-96.8	36	0	1900	12	1	0	0	0	NCEER
3.5	-94	37.8	0	1901	1	4	3	12	0	NCEER
3.8	-90	36	0	1901	2	15	0	15	0	NCEER
4.3	-82.66	38.95	0	1901	5	17	7	0	0	NCEER
3.3	-80	32.9	0	1901	12	2	0	26	0	NCEER
4.3	-89	42.3	0	1902	1	24	10	18	0	NCEER
3	-85.2	39.9	0	1902	3	10	6	0	0	NCEER
3.4	-80.6	37.3	0	1902	5	18	4	0	0	NCEER
4.2	-85.3	35.1	0	1902	5	29	7	30	0	NCEER
3.3	-81.4	40.3	0	1902	6	14	7	0	0	NCEER
4.2	-97.5	42.5	0	1902	7	28	18	0	0	NCEER
3.6	-97.6	30.1	0	1902	10	9	19	0	0	SRA
3.2	-85.3	35	0	1902	10	18	22	0	0	NCEER
4.1	-80	32.9	0	1903	1	24	1	0	0	NCEER
4.8	-89.3	37.8	0	1903	2	9	0	21	0	NCEER
3	-89.5	39.1	0	1903	3	17	11	50	0	NCEER
3	-71	42.7	0	1903	4	24	12	30	0	NCEER
3.1	-86.3	39.4	0	1903	9	20	0	0	0	NCEER
3.1	-88.1	38.7	0	1903	9	21	0	0	0	NCEER
3.7	-90.2	38.3	0	1903	10	5	2	56	0	NCEER
3	-89.3	37.8	0	1903	11	3	18	0	0	NCEER
4.9	-89.8	36.5	0	1903	11	4	19	14	0	NCEER
3.9	-89.5	37	0	1903	11	27	7	0	0	NCEER
3.5	-75.5	44.7	0	1903	12	25	12	30	0	NCEER
3.4	-83.5	35.7	0	1904	3	5	0	30	0	NCEER
5	-67.2	45	0	1904	3	21	6	4	0	NCEER
3.5	-100.2	37.5	0	1904	10	28	4	30	0	NCEER
3.4	-91.1	30.5	0	1905	2	3	0	0	0	NCEER
3.4	-87.7	45.1	0	1905	3	13	16	30	0	NCEER
3.6	-91.6	40.4	0	1905	4	13	16	30	0	NCEER
4.4	-70	44.2	0	1905	7	15	10	10	0	NCEER
4.5	-88.4	47.3	0	1905	7	27	0	20	0	NCEER
5.2	-89.3	37.2	0	1905	8	22	5	8	0	NCEER
3.4	-70.7	43.1	0	1905	8	30	22	40	0	NCEER
3.3	-72.2	44.9	0	1905	10	22	0	0	0	NCEER
3.3	-71.3	41.5	0	1905	11	26	0	30	0	NCEER
4.9	-96.5	39.2	0	1906	1	8	0	15	0	NCEER
3.1	-91.4	39.7	0	1906	3	6	0	0	0	NCEER
3.4	-83.6	40.7	0	1906	4	23	7	12	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 12 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.6	-85.8	39.5	0	1906	5	8	6	58	0	NCEER
3.3	-72.5	41.5	0	1906	5	8	13	30	0	NCEER
3	-75.7	38.7	0	1906	5	8	17	41	0	NCEER
3.1	-85.9	39.2	0	1906	5	9	6	38	0	NCEER
4.2	-101.3	43	0	1906	5	10	0	27	0	NCEER
3.3	-87.2	38.5	0	1906	5	11	6	15	0	NCEER
3.4	-88.4	38.7	0	1906	5	21	19	0	0	NCEER
3.3	-88.4	47.3	0	1906	5	26	14	42	0	NCEER
3.2	-81.6	40.4	0	1906	6	27	21	10	0	NCEER
3.7	-88.4	47.3	0	1906	8	8	0	0	0	NCEER
3.1	-86.8	39.7	0	1906	8	13	13	19	0	NCEER
3.8	-87.7	38.2	0	1906	9	7	16	33	0	NCEER
4	-70.5	43.5	0	1906	10	20	16	0	0	NCEER
3.3	-75.41	45.61	0	1906	11	17	14	0	0	NCEER
3.3	-77.1	41.2	0	1907	1	10	9	45	0	NCEER
3.1	-97	37.1	0	1907	1	11	7	45	0	NCEER
3.4	-86.6	39.5	0	1907	1	30	5	30	0	NCEER
3.6	-89.5	38.9	0	1907	1	31	5	30	0	SRA
4	-78.3	37.7	0	1907	2	11	13	22	0	NCEER
3.9	-80	32.9	0	1907	4	19	8	30	0	NCEER
3.3	-70.5	43.5	0	1907	6	29	0	0	0	NCEER
3.2	-90.4	37.8	0	1907	7	4	9	0	0	NCEER
3.3	-70.16	47.65	0	1907	8	5	12	43	0	NCEER
3.5	-71	42.8	0	1907	10	16	0	10	0	NCEER
3.3	-76.68	45.47	0	1907	11	14	5	0	0	NCEER
3.1	-89.8	42.3	0	1907	11	28	16	30	0	NCEER
3.1	-90.2	38.6	0	1907	12	11	4	32	0	NCEER
3.3	-70.5	47.45	0	1908	3	10	0	0	0	NCEER
3.1	-75.5	40.6	0	1908	5	31	17	42	0	NCEER
3.5	-74.8	45.1	0	1908	6	16	20	41	0	NCEER
3.3	-76.35	45.43	0	1908	7	17	7	10	0	NCEER
3.5	-67.6	46.3	0	1908	8	8	12	0	0	NCEER
3.5	-77.9	37.5	0	1908	8	23	9	30	0	NCEER
3.5	-89.6	36.6	0	1908	9	28	19	34	0	NCEER
3.6	-89.2	37	0	1908	10	28	0	27	0	NCEER
3.8	-93.2	38.7	0	1908	11	12	12	0	0	SRA
3.3	-71.7	43.5	0	1908	11	23	13	0	0	NCEER
3.7	-88	37.5	0	1908	12	27	21	15	0	NCEER
3.4	-88.6	47.2	0	1909	1	23	3	15	0	NCEER
3.3	-97.8	42.3	0	1909	1	26	20	15	0	NCEER
3.3	-73.57	45.51	0	1909	2	1	8	20	0	NCEER
3.5	-78	39.4	0	1909	4	2	7	25	0	NCEER
3.3	-74.3	46.1	0	1909	5	10	1	20	0	NCEER
5.5	-104	49	0	1909	5	16	4	15	0	NCEER
5	-88.1	41.6	0	1909	5	26	14	42	0	USHIS
3.3	-74.28	46.05	0	1909	6	8	8	25	0	NCEER
4.3	-90.7	40.3	0	1909	7	19	4	34	0	NCEER
3.8	-90.1	38.3	0	1909	8	16	22	45	0	NCEER
3.7	-86.5	38.7	0	1909	9	22	0	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 13 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.8	-87.4	39.5	0	1909	9	27	9	45	0	NCEER
3.3	-85	34.9	0	1909	10	8	10	0	0	NCEER
3.1	-90.6	37.6	0	1909	10	22	22	0	0	NCEER
3.3	-89.7	41.8	0	1909	10	22	22	30	0	NCEER
4.3	-89.5	37	0	1909	10	23	7	10	0	NCEER
3.9	-87.8	39	0	1909	10	23	9	47	0	NCEER
3.3	-75.6	45.4	0	1909	12	10	6	24	10	NCEER
3.8	-70	48	0	1910	2	1	0	0	0	NCEER
3.2	-78.7	38.8	0	1910	2	8	14	0	0	NCEER
3.1	-79.8	43.2	0	1910	2	25	0	0	0	NCEER
3.8	-97.4	41.4	0	1910	2	26	8	0	0	NCEER
3.5	-78.4	37.7	0	1910	5	8	21	10	0	NCEER
3.2	-96	30.1	0	1910	5	12	0	0	0	NCEER
4.3	-109.3	41.5	0	1910	7	26	1	30	0	DNAG
3.3	-71.1	42.7	0	1910	8	21	18	45	0	NCEER
3.3	-72.1	43.4	0	1910	8	30	14	30	0	NCEER
3.3	-68.8	44.3	0	1910	10	20	21	50	0	NCEER
4	-69.8	47.6	0	1910	10	25	9	30	0	NCEER
3.3	-79.4	36.6	0	1911	2	10	10	22	0	NCEER
3.1	-90.3	38.7	0	1911	2	28	9	0	0	NCEER
3.3	-71.5	43.2	0	1911	3	2	21	30	0	NCEER
4.6	-91.8	34	0	1911	3	31	16	57	0	NCEER
3.5	-92.2	33.8	0	1911	3	31	18	10	0	NCEER
3.3	-75.5	38.3	0	1911	4	8	1	0	0	NCEER
3.5	-82.7	35.1	0	1911	4	20	22	0	0	NCEER
4.2	-98.2	44.2	0	1911	6	2	22	34	0	NCEER
3.3	-87.6	41.8	0	1911	7	29	0	0	0	NCEER
4.7	-89	42.3	0	1912	1	2	16	21	0	NCEER
3.4	-79.7	43.2	0	1912	5	27	12	52	0	NCEER
4.9	-80	32.9	0	1912	6	12	10	30	0	NCEER
3.5	-81	32	0	1912	6	20	0	0	0	NCEER
3.3	-78.4	37.7	0	1912	8	8	1	0	0	NCEER
3	-89.1	42.3	0	1912	9	25	0	0	0	NCEER
3.3	-68	49.5	0	1912	10	23	0	0	0	NCEER
3.3	-83.5	32.7	0	1912	10	23	1	15	0	NCEER
3.3	-80	32.9	0	1912	11	17	12	30	0	NCEER
3.3	-81.7	34.7	0	1912	12	7	19	10	0	NCEER
5	-81.7	34.7	0	1913	1	1	18	28	0	NCEER
3.3	-85	34.5	0	1913	3	13	5	0	0	NCEER
4	-83.7	36.2	0	1913	3	28	21	50	0	NCEER
3.7	-84.2	35.3	0	1913	4	17	16	30	0	NCEER
4.4	-75.33	44.87	0	1913	4	29	0	28	57	NCEER
3.3	-74.4	45.68	0	1913	6	8	6	30	0	NCEER
3.7	-88.9	35.8	0	1913	6	9	15	30	0	NCEER
3.8	-84	36	0	1913	8	3	16	45	0	NCEER
3.4	-74	44	0	1913	8	10	5	15	0	NCEER
3.7	-89.7	41.8	0	1913	10	17	2	15	0	NCEER
3.3	-71.5	41.5	0	1913	11	3	14	30	0	NCEER
3.1	-85.8	38.2	0	1913	11	11	14	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-67.2	45.1	0	1914	1	13	8	0	0	NCEER
3.5	-84.5	35.6	0	1914	1	24	3	24	0	NCEER
5.5	-75	46	0	1914	2	10	18	31	0	NCEER
3.5	-73.6	46.4	0	1914	2	14	9	34	0	NCEER
3.8	-70.5	45	0	1914	2	22	19	15	0	NCEER
4.6	-83.5	33.5	0	1914	3	5	20	5	0	NCEER
3.3	-79.8	34.2	0	1914	3	7	1	20	0	NCEER
3.3	-67.61	49.31	0	1914	4	12	0	0	0	NCEER
3.3	-80	32.9	0	1914	7	14	1	53	0	NCEER
4.3	-80	32.9	0	1914	9	22	7	4	0	NCEER
3.1	-89.4	43.1	0	1914	10	7	21	0	0	NCEER
3.5	-95.9	30.5	0	1914	12	30	1	0	0	NCEER
3.6	-82.2	36.6	0	1915	1	14	9	20	0	NCEER
3.1	-88.6	37.7	0	1915	2	5	6	55	0	NCEER
3.1	-89.2	37.1	0	1915	2	19	4	35	0	NCEER
3.5	-71.4	42.7	0	1915	2	21	1	20	0	NCEER
3.3	-73.4	44.7	0	1915	2	21	23	41	0	NCEER
3	-88.4	47.3	0	1915	3	3	7	45	0	NCEER
3.7	-88.1	38.7	0	1915	4	15	13	20	0	NCEER
3.1	-89.5	36.5	0	1915	4	28	23	40	0	NCEER
3.1	-103.6	48.1	0	1915	8	8	15	15	0	NCEER
3	-99.3	42.8	0	1915	9	16	19	0	0	NCEER
3.3	-88.4	47.3	0	1915	10	4	14	2	0	NCEER
3.7	-95.3	35.7	0	1915	10	8	16	50	0	NCEER
3.8	-101.5	43.8	0	1915	10	23	6	5	0	NCEER
3.4	-88.6	36.7	0	1915	10	26	7	40	0	NCEER
4.4	-90	36	0	1915	12	7	18	40	0	NCEER
4	-73.7	43.7	0	1916	1	5	13	56	0	NCEER
3.7	-87	39.1	0	1916	1	7	19	45	0	NCEER
3.8	-74	43	0	1916	2	3	4	26	0	NCEER
5.2	-83.55	35.62	0	1916	2	21	22	39	0	Chapman
3.3	-70.9	46.8	0	1916	2	29	5	15	0	NCEER
3.3	-82.7	34.5	0	1916	3	2	5	2	0	NCEER
4	-77	47	0	1916	4	24	16	7	45	NCEER
3.6	-89.5	36.6	0	1916	5	21	18	24	0	NCEER
3.3	-73.8	41	0	1916	6	8	21	15	0	NCEER
3.5	-89.2	37	0	1916	8	24	9	0	0	NCEER
3.6	-81	36	0	1916	8	26	19	36	0	NCEER
5.2	-86.2	33.5	0	1916	10	18	22	3	40	NCEER
3.5	-73.7	43.3	0	1916	11	2	2	32	0	NCEER
3.7	-89.2	36.6	0	1916	12	19	5	42	0	NCEER
3.4	-83.5	36.1	0	1917	1	25	21	15	0	NCEER
3.5	-74.5	46.8	0	1917	1	26	19	35	0	NCEER
3.1	-95	47.9	0	1917	2	6	17	26	0	NCEER
3.3	-72.5	41.5	0	1917	2	16	9	0	0	NCEER
3.4	-84	36	0	1917	3	5	2	7	0	NCEER
3.6	-83.5	36.1	0	1917	3	25	19	15	0	NCEER
3.8	-101.3	35.3	0	1917	3	27	19	56	0	NCEER
4.9	-90	37	0	1917	4	9	20	52	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-90.2	38.1	0	1917	4	9	23	38	0	NCEER
3.9	-90.4	36.8	0	1917	5	9	9	0	0	SRA
3.9	-75.6	45.1	0	1917	5	22	9	0	26	NCEER
3.8	-89.4	36.8	0	1917	6	9	13	14	0	NCEER
4	-68	49	0	1917	6	12	2	0	0	NCEER
3.8	-83	36	0	1917	6	21	0	0	0	NCEER
3.4	-87.5	32.7	0	1917	6	30	1	23	0	NCEER
4.2	-94.8	46.3	0	1917	9	3	21	30	0	NCEER
3	-97.7	35.5	0	1918	1	1	0	0	0	NCEER
3.3	-83.9	35.9	0	1918	1	16	15	45	0	NCEER
3.7	-89.2	37	0	1918	2	17	8	10	0	NCEER
3.1	-84.2	42.8	0	1918	2	22	0	0	0	NCEER
4.7	-78.4	38.7	0	1918	4	10	2	9	0	NCEER
3.5	-84.1	36.1	0	1918	6	22	1	0	0	NCEER
3.1	-91.4	39.7	0	1918	7	1	19	2	0	NCEER
3.3	-71.35	46.85	0	1918	7	23	12	0	0	NCEER
4.2	-70.5	44.2	0	1918	8	21	4	11	54	USHIS
3.6	-98	35.5	0	1918	9	10	16	30	0	NCEER
4	-91.1	35	0	1918	10	4	9	21	0	NCEER
3.5	-91	36.1	0	1918	10	13	9	30	0	NCEER
4.2	-90	36	0	1918	10	16	2	15	0	NCEER
3.5	-87.5	37.8	0	1919	2	11	3	37	0	NCEER
3	-91.3	36.2	0	1919	4	8	12	30	0	NCEER
3.7	-89.2	36.6	0	1919	5	23	12	30	0	NCEER
3.8	-87.5	38.3	0	1919	5	25	9	45	0	NCEER
3.7	-97.3	37.7	0	1919	5	27	4	0	0	NCEER
3.7	-89.5	36.4	0	1919	5	28	13	45	0	NCEER
3.3	-70	43.9	0	1919	7	11	1	40	0	NCEER
3.3	-70.3	43.7	0	1919	7	23	11	50	0	NCEER
3.6	-97.3	37.7	0	1919	7	26	13	55	0	NCEER
3.8	-78.2	38.8	0	1919	9	6	2	46	0	NCEER
3.3	-70	47.6	0	1919	10	26	10	28	0	NCEER
3.6	-91	36.3	0	1919	11	3	20	40	0	NCEER
3.3	-69.71	48.15	0	1920	2	6	0	0	0	NCEER
3.9	-93.3	37.2	0	1920	2	29	3	5	0	NCEER
3.7	-88.2	36.3	0	1920	4	7	20	45	0	NCEER
3.5	-89.1	38.6	0	1920	4	30	15	12	0	NCEER
3.9	-89.6	38	0	1920	5	1	15	15	0	NCEER
3.3	-71.5	43.1	0	1920	5	23	8	0	0	NCEER
3.3	-70.5	43.5	0	1920	6	7	8	0	0	NCEER
3.5	-103.2	43.2	0	1920	7	14	23	0	0	NCEER
3.3	-78.4	38.7	0	1920	7	24	0	0	0	NCEER
3.7	-94.3	38.6	0	1920	10	3	14	15	0	NCEER
3.4	-73.43	46.01	0	1920	11	8	0	0	0	NCEER
3.3	-67.1	45	0	1920	11	9	0	40	0	NCEER
3.4	-85	36	0	1920	12	24	7	30	0	NCEER
3.3	-89.5	36.4	0	1921	1	9	21	54	0	NCEER
3.2	-74.91	40.01	0	1921	1	26	23	40	0	NCEER
3.7	-89.2	37	0	1921	2	27	22	16	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 16 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4	-88	40	0	1921	3	14	12	15	0	NCEER
3	-96.7	43.5	0	1921	3	16	23	45	0	NCEER
3.1	-87.8	37.9	0	1921	3	31	20	3	0	NCEER
3.3	-70.4	42.5	0	1921	7	29	21	14	0	NCEER
3.8	-78.4	37.8	0	1921	8	7	6	30	0	NCEER
3.4	-76	47	0	1921	8	27	8	12	16	NCEER
3.5	-90.1	38.3	0	1921	9	9	3	0	0	NCEER
3.1	-98.7	43.7	0	1921	9	24	0	30	0	NCEER
3.5	-88.6	37.7	0	1921	10	1	9	0	0	NCEER
3.7	-90.1	38.3	0	1921	10	9	7	50	0	NCEER
3.3	-67	44.8	0	1921	10	10	13	0	0	NCEER
3.4	-84.6	35.8	0	1921	12	15	13	20	0	NCEER
4	-99.3	43.8	0	1922	1	2	14	50	0	NCEER
3.7	-87.8	37.9	0	1922	1	11	3	42	0	NCEER
4.6	-88.4	37.9	0	1922	3	22	22	30	0	NCEER
4.6	-89.4	37.4	0	1922	3	23	2	22	0	USHIS
3.8	-88.9	37	0	1922	3	23	21	45	0	NCEER
3.8	-90.4	36.7	0	1922	3	28	16	42	0	NCEER
3.1	-86.7	35.5	0	1922	3	30	1	20	0	NCEER
3.3	-82.3	36.8	0	1922	3	30	3	21	0	NCEER
3.9	-89.6	36.1	0	1922	3	30	16	53	0	NCEER
3.3	-82.2	36.5	0	1922	3	30	22	20	0	NCEER
3.3	-71.4	43.4	0	1922	5	7	22	40	0	NCEER
3.5	-66.6	46.5	0	1922	7	2	22	25	35	NCEER
3.4	-88.5	43.8	0	1922	7	7	0	0	0	NCEER
4.6	-88.2	37.4	0	1922	11	27	3	31	0	NCEER
3.5	-75.1	44.4	0	1922	12	8	21	24	0	NCEER
3.9	-89.4	38.9	0	1923	3	9	2	45	0	SRA
3.7	-89.7	34.6	0	1923	3	27	8	0	0	NCEER
3.7	-89.2	37	0	1923	5	6	7	50	0	NCEER
3	-96.2	41.7	0	1923	9	10	6	30	0	NCEER
4.1	-90	35.3	0	1923	10	28	17	10	0	NCEER
3.3	-89.9	40	0	1923	11	10	4	0	0	NCEER
3.6	-90.4	35.5	0	1923	11	26	23	25	0	NCEER
3.1	-89.2	37	0	1923	11	29	23	20	0	NCEER
3.3	-82.5	34.8	0	1923	12	31	20	6	0	NCEER
4.3	-90	36	0	1924	1	1	3	5	0	NCEER
3.3	-78.1	39.1	0	1924	1	5	0	0	0	NCEER
3.5	-70.2	47.8	0	1924	3	4	19	15	0	NCEER
4	-88.8	37	0	1924	4	2	11	15	0	NCEER
3.7	-89.8	36.5	0	1924	6	7	5	42	0	NCEER
3.7	-76.5	45.7	0	1924	7	15	0	10	0	NCEER
3.4	-104.5	36	0	1924	8	13	4	23	0	NCEER
3.1	-100.1	40.9	0	1924	9	24	11	0	0	NCEER
4.4	-82.6	35	0	1924	10	20	8	30	0	NCEER
4	-82.2	36.6	0	1924	11	13	10	30	0	NCEER
3.3	-76.3	45.5	0	1924	11	14	1	32	0	NCEER
3.5	-79.9	37.3	0	1924	12	26	4	30	0	NCEER
3.6	-103.5	43.5	0	1924	12	30	22	10	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}
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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.9	-70.6	42.6	0	1925	1	7	13	7	0	NCEER
3.6	-91.7	36.2	0	1925	1	27	22	42	0	NCEER
6.6	-69.84	47.76	9	1925	3	1	2	19	14.7	NCEER
3.3	-71.5	42.9	0	1925	3	9	0	0	0	NCEER
3.4	-83.9	39.5	0	1925	3	27	4	6	0	NCEER
3.6	-70.8	41.7	0	1925	4	24	7	56	0	NCEER
4.9	-88.2	38	0	1925	4	27	4	5	0	NCEER
3.3	-70.9	42.5	0	1925	5	4	17	51	0	NCEER
3.6	-88.6	36.7	0	1925	5	13	12	0	0	NCEER
3.5	-77.5	37.3	0	1925	5	16	1	30	0	NCEER
3.5	-93.2	36.2	0	1925	7	8	16	0	0	NCEER
3.8	-90	38.8	0	1925	7	13	0	0	0	NCEER
3.3	-77.5	37.6	0	1925	7	14	21	20	0	NCEER
3.1	-101.2	34.5	0	1925	7	29	11	30	0	NCEER
3.4	-100.3	34.5	0	1925	7	30	8	0	0	NCEER
4.8	-101.3	35.4	0	1925	7	30	12	17	0	NCEER
3.1	-97.4	42.8	0	1925	8	25	6	27	0	NCEER
4.5	-87.2	37.9	0	1925	9	2	11	55	0	NCEER
3.3	-71.22	46.82	0	1925	10	9	5	0	0	NCEER
4	-71.1	43.7	0	1925	10	9	13	55	0	NCEER
3.3	-70.2	44.1	0	1925	10	18	21	30	0	NCEER
3.5	-73	47	0	1925	10	19	12	5	17	NCEER
3.4	-72.4	41.7	0	1925	11	14	13	4	0	NCEER
3.3	-72.7	41.8	0	1925	11	16	6	20	0	NCEER
4.3	-107	44.6	0	1925	11	18	1	50	0	NCEER
3.3	-71.8	41.6	0	1926	1	4	0	0	0	NCEER
4	-94.9	35.6	0	1926	1	20	0	0	0	NCEER
3.5	-75	40	0	1926	1	26	23	40	0	NCEER
3.3	-74.1	44.3	0	1926	1	27	0	0	0	NCEER
3.3	-71	47.7	0	1926	2	19	20	20	0	NCEER
3.5	-71.8	42.8	0	1926	3	18	21	9	0	NCEER
3.5	-88.6	37.8	0	1926	3	22	14	30	0	NCEER
3.9	-89	36.2	0	1926	4	28	2	16	0	SRA
3	-73.9	40.9	0	1926	5	12	3	30	0	NCEER
4	-94.9	35.6	0	1926	6	20	14	20	0	NCEER
3.5	-82.1	35.9	0	1926	7	8	9	50	0	NCEER
3.3	-71.5	47	0	1926	7	18	6	0	0	NCEER
3.3	-77.1	45.8	0	1926	8	23	16	40	0	NCEER
3.4	-70	44.7	0	1926	8	28	21	0	0	NCEER
3.5	-90.4	36.7	0	1926	10	27	16	22	0	NCEER
3.4	-83.6	41.7	0	1926	10	28	8	42	0	NCEER
3.8	-82.1	39.1	0	1926	11	5	16	53	0	USHIS
3.3	-67.5	45	0	1926	11	24	19	30	0	NCEER
3.7	-89.4	36.7	0	1926	12	13	23	3	0	NCEER
3.5	-89.5	36.4	0	1926	12	17	0	0	0	NCEER
3.6	-97.7	38.3	0	1927	1	7	9	30	0	NCEER
3.9	-89.7	37.4	0	1927	2	2	1	30	0	SRA
3.8	-90.4	36.7	0	1927	2	3	8	0	0	SRA
3.1	-82.5	40.7	0	1927	2	17	5	30	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.4	-71.4	43.3	0	1927	3	9	4	8	0	NCEER
3.3	-75.2	44.6	0	1927	3	12	22	12	0	NCEER
3.9	-95.3	39.9	0	1927	3	18	17	25	0	NCEER
3.3	-72.8	41.7	0	1927	3	30	0	0	0	NCEER
3.5	-89.5	36.3	0	1927	4	18	10	30	0	NCEER
4.7	-90.2	36	0	1927	5	7	8	28	0	NCEER
3.9	-74	40.3	0	1927	6	1	12	23	0	NCEER
3.6	-79	38	0	1927	6	10	7	16	0	NCEER
3.6	-86	34.7	0	1927	6	16	12	0	0	NCEER
4	-71	47.3	0	1927	7	25	0	56	0	NCEER
4.1	-89.5	36.4	0	1927	8	13	16	10	0	NCEER
3.3	-85.3	35.1	0	1927	10	8	4	30	0	NCEER
3.1	-98.9	41.6	0	1927	10	14	16	10	0	NCEER
3.3	-73.8	44.7	0	1927	10	24	11	0	0	NCEER
3.3	-76.2	36.3	0	1927	10	27	0	0	0	NCEER
3.4	-81.2	40.9	0	1927	10	29	0	0	0	NCEER
3.1	-79.06	43.1	0	1927	11	13	0	50	0	NCEER
3.4	-90.2	32.3	0	1927	11	13	16	21	0	NCEER
3.3	-78	33.9	0	1927	11	23	0	50	0	NCEER
3.5	-89.4	28.9	0	1927	12	15	4	30	0	NCEER
3.3	-71.6	41.2	0	1928	1	13	19	50	0	NCEER
3.1	-90	42	0	1928	1	23	9	19	0	NCEER
3.3	-70.2	48	0	1928	1	27	0	0	0	NCEER
3.5	-69	45.3	0	1928	2	8	0	0	0	NCEER
3.5	-87	35.6	0	1928	3	7	2	45	0	NCEER
3.3	-90.2	38.6	0	1928	3	17	21	15	0	NCEER
4	-74.3	44.5	0	1928	3	18	15	25	0	NCEER
3.3	-69	45.3	0	1928	3	22	13	30	0	NCEER
3.1	-89.5	36.6	0	1928	4	15	11	0	0	NCEER
3.1	-89.5	37.3	0	1928	4	15	15	5	0	NCEER
3.1	-89.2	36.5	0	1928	4	23	11	0	0	NCEER
3.8	-71.2	44.5	0	1928	4	25	23	38	0	NCEER
3.1	-89.5	36.6	0	1928	5	31	22	40	0	NCEER
3	-84.1	40.4	0	1928	10	27	0	0	0	NCEER
3.4	-77.5	37.5	0	1928	10	30	11	45	0	NCEER
4.6	-82.83	36.11	0	1928	11	3	4	2	49.8	NCEER
3.1	-89.1	39.5	0	1928	11	8	14	15	0	NCEER
3.1	-91.1	36.1	0	1928	11	10	6	20	0	NCEER
3.5	-103.7	44.1	0	1928	11	16	13	45	0	NCEER
3.2	-67.2	45	0	1928	11	20	2	30	0	NCEER
3.7	-82.3	35.8	0	1928	11	20	3	45	0	NCEER
4	-81.5	50	0	1928	12	1	0	0	0	NCEER
3.3	-80.3	35.3	0	1928	12	23	2	30	0	NCEER
3.1	-93.9	47.6	0	1928	12	23	6	10	0	NCEER
3.1	-91.1	36.1	0	1928	12	26	3	25	0	NCEER
3.3	-80.3	33.9	0	1929	1	3	12	5	0	NCEER
3.3	-70.3	44	0	1929	2	5	19	9	0	NCEER
3.2	-87.6	38.3	0	1929	2	14	20	12	0	NCEER
3.1	-90.6	37.6	0	1929	2	26	8	15	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.7	-84.2	40.4	0	1929	3	8	9	6	0	NCEER
3.3	-71.9	45.4	0	1929	5	11	9	30	0	NCEER
3.5	-89.5	36.4	0	1929	5	13	3	50	0	NCEER
3.4	-89.4	28.9	0	1929	7	28	17	0	0	NCEER
5.2	-78.4	42.91	9	1929	8	12	11	24	48.7	NCEER
3.9	-96.6	39	0	1929	9	23	11	0	0	NCEER
3.4	-97.4	42.8	0	1929	10	6	12	30	0	NCEER
3.3	-82.4	34.3	0	1929	10	28	2	15	0	NCEER
3.1	-99.8	37.2	0	1929	11	26	16	20	0	NCEER
3.4	-96.6	39.2	0	1929	12	7	8	2	0	NCEER
3.6	-78.5	38.1	0	1929	12	26	2	56	0	NCEER
4	-97.9	35.5	0	1929	12	28	0	30	0	NCEER
4.6	-65.83	46.73	0	1930	1	4	14	30	38	NCEER
3.1	-91.1	36.1	0	1930	1	26	21	0	0	NCEER
3	-90.2	37	0	1930	2	25	12	45	0	NCEER
3.3	-71.6	43.3	0	1930	3	19	0	15	0	NCEER
3.5	-90	35.1	0	1930	3	26	8	56	0	SRA
3.1	-89.7	36.1	0	1930	4	2	9	39	0	NCEER
3.6	-71.22	45.73	0	1930	6	19	12	6	56	NCEER
3.2	-84	40.5	0	1930	6	26	21	45	0	NCEER
3.1	-83.2	40.6	0	1930	7	11	0	15	0	NCEER
3.1	-69.83	47.5	0	1930	7	13	4	52	39.3	NCEER
3.1	-70.8	41.5	0	1930	8	1	2	0	0	NCEER
3.1	-91.4	39.7	0	1930	8	8	18	31	0	NCEER
3.5	-89.1	37	0	1930	8	29	6	26	54	NCEER
3.5	-84.4	35.9	0	1930	8	30	9	28	0	NCEER
3.7	-89.4	36.6	0	1930	9	1	20	27	24	NCEER
3.5	-84.3	40.3	0	1930	9	30	20	40	0	NCEER
3.9	-68.7	48.93	0	1930	10	8	1	8	41	NCEER
3.6	-83.9	36	0	1930	10	16	21	50	0	NCEER
4.2	-91	30.1	0	1930	10	19	12	12	0	NCEER
3.3	-76.5	39.1	0	1930	11	1	1	34	0	NCEER
3.3	-92.8	34.3	0	1930	11	16	12	30	0	NCEER
3.5	-70.17	47.65	0	1930	12	13	23	18	23.7	NCEER
3.2	-90.7	38.5	0	1930	12	23	14	44	0	NCEER
3.1	-80.3	34.5	0	1930	12	26	3	0	0	NCEER
3.5	-87	39	0	1931	1	6	2	51	0	SRA
5.4	-70.4	47.3	0	1931	1	8	0	13	0.3	NCEER
3.1	-98.7	43.7	0	1931	1	17	18	45	0	NCEER
3	-84.2	40.4	0	1931	3	21	15	48	0	NCEER
3.5	-88.3	36.9	0	1931	4	1	23	20	9	NCEER
3.1	-89	36.8	0	1931	4	6	15	37	3	NCEER
4.8	-73.78	43.47	5	1931	4	20	19	54	30.6	NCEER
3.1	-78.9	42.9	0	1931	4	22	0	0	0	NCEER
4.2	-86.6	33.7	0	1931	5	5	12	18	0	NCEER
3	-73.4	41.6	0	1931	7	1	2	45	0	NCEER
3.3	-89.5	36.6	0	1931	7	18	14	52	0	NCEER
3.3	-65.77	44.62	0	1931	8	7	0	0	0	NCEER
3.8	-94.7	39.1	0	1931	8	9	6	18	37	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.7	-84.27	40.43	5	1931	9	20	23	4	54	NCEER
4.5	-76.07	47	0	1931	9	23	22	47	37	NCEER
3.4	-70.17	47.33	0	1931	11	14	14	2	29.5	NCEER
3.3	-89.9	35.9	0	1931	12	10	8	11	36	NCEER
4.7	-89.8	34.1	0	1931	12	17	3	36	0	NCEER
3.1	-78.4	37.6	0	1932	1	5	4	5	0	NCEER
3.1	-81.6	41.1	0	1932	1	21	0	0	0	NCEER
3.8	-99.6	39	0	1932	1	29	0	15	0	NCEER
3.8	-74.67	46.47	0	1932	3	9	5	23	38.8	NCEER
3.6	-96.4	31.7	0	1932	4	9	10	15	0	NCEER
3.4	-90.2	36	0	1932	11	22	7	56	42	NCEER
3.2	-74.1	44.4	0	1932	12	7	3	15	0	NCEER
3.2	-70.5	47.45	0	1933	1	11	23	32	0	NCEER
3.8	-74.65	45.3	0	1933	1	21	16	4	39.5	NCEER
3.3	-74.7	40.2	0	1933	1	25	2	0	0	NCEER
3.8	-99.9	39.8	0	1933	2	20	17	0	0	NCEER
3.3	-84.2	40.3	0	1933	2	23	3	20	0	NCEER
3.4	-69.93	47.43	0	1933	2	25	9	43	2.7	NCEER
3.1	-90.4	36.7	0	1933	3	11	12	48	0	NCEER
3.4	-83.7	38.6	0	1933	5	28	15	10	0	NCEER
3.3	-83.5	33.3	0	1933	6	9	11	30	0	NCEER
3	-73.8	41	0	1933	6	26	14	10	0	NCEER
3.3	-89.9	37.9	0	1933	7	13	14	42	39	NCEER
3.9	-75.7	45.42	0	1933	7	14	4	48	40	NCEER
3.1	-89.9	37.9	0	1933	8	4	4	34	15	NCEER
3.3	-103.7	41.9	0	1933	8	8	0	0	0	NCEER
3.4	-98	35.5	0	1933	8	19	19	30	0	NCEER
3.1	-73.7	43	0	1933	10	29	0	0	0	NCEER
3.3	-90.6	38.6	0	1933	11	16	9	29	1	NCEER
3.1	-89.2	42.9	0	1933	12	7	5	55	0	NCEER
4	-90.2	35.8	0	1933	12	9	8	50	0	NCEER
3.5	-80	32.9	0	1933	12	23	9	40	0	NCEER
3.1	-97.7	45.9	0	1934	1	29	12	30	0	NCEER
3.3	-72.6	41.8	0	1934	1	30	10	30	0	NCEER
3.6	-72.7	44	0	1934	4	11	3	0	0	NCEER
3.9	-95.5	33.9	0	1934	4	12	1	40	0	SRA
3.9	-73.8	44.7	0	1934	4	15	2	58	0	NCEER
3.3	-74.3	44.8	0	1934	4	15	18	5	0	NCEER
3.2	-98.7	41.5	0	1934	5	11	10	40	0	NCEER
3	-89.9	37.9	0	1934	5	15	14	28	0	NCEER
3.1	-90	35.2	0	1934	7	3	3	10	41	NCEER
4.3	-103	42.7	0	1934	7	30	7	20	0	NCEER
3.2	-70.3	43.7	0	1934	8	2	14	59	0	NCEER
4.3	-89.2	36.9	0	1934	8	20	0	47	0	NCEER
3	-67	44.9	0	1934	8	26	11	36	0	NCEER
3.1	-99.1	43.4	0	1934	8	30	3	50	0	NCEER
3.2	-80.2	42	0	1934	10	29	20	7	0	NCEER
3.3	-88.5	37.5	0	1934	10	30	2	25	47	NCEER
3.4	-100.2	42.6	0	1934	11	8	4	45	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.9	-90.5	41.5	0	1934	11	12	14	45	0	NCEER
3.3	-80	32.9	0	1934	12	9	9	0	0	NCEER
3.4	-83.6	35.1	0	1935	1	1	8	15	0	NCEER
3	-90.6	41.5	0	1935	1	5	18	40	0	NCEER
3.3	-77.4	37.2	0	1935	2	10	23	45	0	NCEER
4.8	-96.2	40.3	0	1935	3	1	10	59	44	NCEER
3.3	-70.2	42.2	0	1935	4	24	1	24	0	NCEER
3.1	-89.5	36.4	0	1935	7	24	1	38	0	NCEER
6.2	-79.07	46.78	0	1935	11	1	6	3	40	NCEER
3.3	-78.9	38.9	0	1935	11	1	8	30	0	NCEER
4.9	-78.17	47.23	0	1935	11	2	14	31	58	NCEER
3.3	-81.7	29.6	0	1935	11	14	3	30	0	NCEER
3.1	-83.2	41.2	0	1936	1	31	19	30	0	NCEER
3.1	-89.7	36.2	0	1936	2	17	5	5	8	NCEER
3.4	-95.2	34	0	1936	3	14	17	20	0	NCEER
4	-70.25	47.33	0	1936	3	29	0	49	23.4	NCEER
3.4	-71.5	43.5	0	1936	6	14	5	40	0	NCEER
4.4	-100.77	35.31	5	1936	6	20	3	24	3.5	NCEER
3.3	-74.2	44.7	0	1936	6	21	4	20	0	NCEER
3	-102.9	36.9	0	1936	7	12	0	23	0	NCEER
3.9	-89	36.7	0	1936	8	2	22	16	25	NCEER
3.3	-84.4	39.3	0	1936	10	8	16	30	0	NCEER
3.1	-103.5	43.5	0	1936	10	30	10	30	0	NCEER
3.3	-71.4	43.6	0	1936	11	10	2	46	0	NCEER
3.2	-71.7	44.7	0	1936	11	10	4	2	0	NCEER
3.3	-89.7	36.2	2	1937	1	30	8	57	9	NCEER
3.6	-78.7	37.7	0	1937	2	3	1	26	0	NCEER
4.9	-84.27	40.49	2	1937	3	2	14	47	33.3	NCEER
3.3	-75.2	44.6	0	1937	3	10	5	29	0	NCEER
4	-90.6	36.1	0	1937	5	17	0	49	46	NCEER
3.2	-96.9	35.3	0	1937	6	8	14	26	0	NCEER
3.5	-73.71	40.72	0	1937	7	19	3	51	0	NCEER
4.5	-65.43	47.8	5	1937	9	30	7	58	3.4	NCEER
4	-75.82	46.78	24	1937	11	6	14	31	20.6	NCEER
3.7	-74.47	46.1	1	1937	11	12	16	57	31.3	NCEER
4	-89.1	38.6	0	1937	11	17	17	4	0	NCEER
3.5	-98.2	44.5	0	1938	1	2	17	5	0	NCEER
3.2	-75.18	44.9	0	1938	1	6	13	28	42.2	NCEER
3	-76.27	45.57	0	1938	1	24	5	29	2	NCEER
3.8	-87	41.6	0	1938	2	12	6	27	0	NCEER
3.2	-75.4	46.38	0	1938	2	23	17	56	35.7	NCEER
3.1	-83.2	42.4	0	1938	3	13	16	10	0	NCEER
3.3	-103.4	42.7	0	1938	3	24	13	11	0	NCEER
3.6	-83.5	35.6	0	1938	3	31	10	10	0	NCEER
3.2	-79.08	46.72	0	1938	4	12	18	55	47	NCEER
3.1	-93.5	34.2	0	1938	4	26	5	42	0	NCEER
3	-74.5	45.37	0	1938	5	5	0	33	0.3	NCEER
3.9	-68	49	0	1938	5	17	18	32	0	NCEER
3	-66.8	46.5	0	1938	6	15	5	7	43	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-78.43	40.68	1	1938	7	15	22	46	12	NCEER
3.1	-73.7	41.08	0	1938	8	2	9	2	30	NCEER
3.8	-68.79	44.89	5	1938	8	22	12	48	9.4	NCEER
3.8	-74.36	40.05	21	1938	8	23	5	4	53.4	NCEER
3	-74.9	45.87	0	1938	9	7	23	18	18.9	NCEER
4.8	-90.254	35.413	1	1938	9	17	3	34	28.3	USHIS
3.2	-72.2	41.5	0	1938	9	20	0	0	0	NCEER
4.1	-69.58	48.78	0	1938	9	28	4	33	16	NCEER
3.8	-99.3	43.8	0	1938	10	1	22	15	0	NCEER
3.8	-96.7	43.5	0	1938	10	11	9	37	0	NCEER
3.3	-98.9	43.2	0	1938	11	4	22	10	0	NCEER
3.5	-75.25	44.75	0	1938	11	18	22	19	6	NCEER
4.2	-76.2	47.03	0	1938	11	26	7	47	57.5	NCEER
3.9	-75.4	47.6	0	1938	12	25	7	46	0	NCEER
3.3	-79.85	43.25	0	1939	1	14	8	10	16	NCEER
3.6	-95.8	46.8	0	1939	1	28	17	55	0	NCEER
3	-78.3	42.9	0	1939	2	24	0	20	0	NCEER
3.6	-77.5	46.4	0	1939	3	16	20	21	0	NCEER
3.3	-84	40.4	0	1939	3	18	14	3	0	NCEER
3.2	-89.4	36.8	0	1939	4	15	17	25	0	NCEER
3.3	-85.8	33.7	0	1939	5	5	2	45	0	NCEER
3.9	-96.4	35	0	1939	6	1	7	30	0	NCEER
3.1	-98.9	43	0	1939	6	10	18	30	0	NCEER
3.1	-84	40.3	0	1939	6	18	3	20	0	NCEER
4.1	-92.6	34.1	0	1939	6	19	21	43	12	NCEER
3.4	-86.6	34.7	0	1939	6	24	10	27	0	NCEER
4.5	-69.98	47.59	14	1939	6	24	17	20	18.3	NCEER
5.6	-69.8	47.8	15	1939	10	19	11	53	58	NCEER
4.1	-70.5	47.8	0	1939	11	7	2	40	32	NCEER
3.8	-75.05	39.58	3	1939	11	15	2	53	48.7	NCEER
4.9	-90.14	38.18	0	1939	11	23	15	14	52	NCEER
3.5	-76.6	39.5	0	1939	11	26	5	20	0	NCEER
3.6	-71.4	47.97	0	1939	12	8	1	17	47	NCEER
3	-79.08	46.72	0	1940	1	5	0	34	14	NCEER
3.4	-70.8	41.6	0	1940	1	28	23	12	0	NCEER
4	-76.83	46.5	0	1940	2	10	20	57	17.3	NCEER
3.5	-78.5	38.8	0	1940	3	26	0	1	0	NCEER
3.8	-70.73	47.73	0	1940	4	13	8	13	34	NCEER
3.6	-73.2	45.8	0	1940	5	16	14	0	17.1	NCEER
3.4	-88.6	37.1	0	1940	5	31	19	3	0	NCEER
3.1	-82.3	40.9	0	1940	6	16	4	30	0	NCEER
3.1	-74.78	46.25	0	1940	8	4	16	20	52	NCEER
3	-74.83	45.77	0	1940	8	7	23	57	35.3	NCEER
3.5	-71.13	47	0	1940	9	11	1	6	55.4	NCEER
4.7	-69.8	47.8	0	1940	10	13	19	50	51	NCEER
3.3	-85.1	34.7	0	1940	10	19	5	54	0	NCEER
5	-90.1	38.2	0	1940	11	23	21	15	0	NCEER
3.1	-94	33	0	1940	12	2	16	16	0	NCEER
5.5	-71.37	43.87	10	1940	12	20	7	27	26.2	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-82.9	35.9	0	1940	12	25	6	5	0	NCEER
3.6	-87.3	37.9	0	1940	12	29	2	30	0	SRA
3.4	-83.9	36	0	1941	3	4	6	15	0	NCEER
3	-75.5	46.27	0	1941	3	5	7	29	23.2	NCEER
3.3	-73.92	44.73	0	1941	4	4	8	10	43.7	NCEER
3.3	-82.6	35.6	0	1941	5	10	11	12	0	NCEER
3.7	-103.5	43.5	0	1941	5	25	6	25	0	NCEER
3	-70.34	47.39	0	1941	6	22	9	59	31	NCEER
4.1	-76.83	47.4	0	1941	6	26	4	5	44.9	NCEER
3	-90.8	32.3	0	1941	6	28	18	30	0	NCEER
3.7	-67.9	46.1	0	1941	8	30	10	21	0	NCEER
3	-85.3	35	0	1941	9	8	9	45	0	NCEER
4	-70.73	47.63	0	1941	10	6	16	34	27.6	NCEER
3.3	-89.7	36.2	0	1941	10	8	7	51	0	NCEER
3	-72.3	42.3	0	1941	10	11	8	15	0	NCEER
3.2	-99	35.4	0	1941	10	18	7	48	0	NCEER
3.3	-74.8	44.77	0	1941	10	21	6	10	41	NCEER
3.3	-89.1	37	0	1941	10	21	16	53	0	NCEER
3.6	-74.3	45.7	0	1941	10	24	14	13	59.3	NCEER
3.1	-90	35.1	0	1941	11	15	3	7	0	NCEER
4.2	-89.7	35.5	0	1941	11	17	3	8	0	NCEER
3.3	-90.3	38.4	0	1942	1	14	18	5	0	NCEER
3.3	-81	26.5	0	1942	1	19	0	0	0	NCEER
3.1	-74.77	46.83	0	1942	2	18	7	55	12	NCEER
3.6	-89.7	41.2	0	1942	3	1	14	43	10	NCEER
3.2	-70.4	44.2	0	1942	3	8	23	37	0	NCEER
3	-103.5	44.4	0	1942	3	11	16	55	0	NCEER
3	-88.6	37.7	0	1942	3	29	12	43	0	NCEER
4.4	-74.67	45.77	0	1942	5	20	12	19	22.8	NCEER
3.9	-73.8	44.7	0	1942	5	24	11	33	0	NCEER
3.5	-97.9	36.4	0	1942	6	12	4	50	0	NCEER
3.7	-77.5	46.8	0	1942	8	26	17	54	0	NCEER
3.1	-89.2	37	0	1942	8	31	9	28	0	NCEER
3.1	-71.5	46.97	0	1942	9	5	14	30	24.1	NCEER
3.4	-99.3	38.8	0	1942	9	10	9	0	0	NCEER
3.7	-67.4	49.22	0	1942	9	11	11	5	13	NCEER
3.3	-76	46.78	0	1942	9	15	22	32	46	NCEER
3	-73.8	42.57	0	1942	10	2	22	29	50.5	NCEER
3.3	-78.4	37.6	0	1942	10	7	2	15	0	NCEER
3.4	-75.25	40.97	0	1942	10	24	17	27	3.6	NCEER
3.6	-75.05	46.42	0	1942	11	16	0	13	29.4	NCEER
3	-90.2	38.6	0	1942	11	17	18	18	0	NCEER
4.2	-76.07	46.97	0	1942	12	5	21	10	51.2	NCEER
4.4	-69.33	45.16	0	1943	1	14	21	32	38	NCEER
3.7	-75.77	46.5	0	1943	2	28	16	40	1.2	NCEER
4.4	-81.31	41.63	7	1943	3	9	3	25	24.9	NCEER
3.9	-71.6	43.7	0	1943	3	14	14	2	0	NCEER
3.1	-85.8	38.3	0	1943	4	13	17	0	0	NCEER
3.2	-73.83	44.77	0	1943	5	9	11	3	12.5	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-103.5	43.5	0	1943	5	16	19	40	0	NCEER
3	-90.4	38.6	0	1943	6	8	19	50	0	NCEER
4	-105	48.5	0	1943	6	25	4	25	0	NCEER
3.8	-73.03	44.84	22	1943	7	6	22	10	16	NCEER
3.3	-70.65	47.55	0	1943	9	25	5	52	36.1	NCEER
3.8	-70.4	47.27	0	1943	9	28	16	30	25.2	NCEER
3.9	-70.08	47.38	0	1943	11	6	0	6	40.5	NCEER
3.2	-74.87	47.68	0	1943	12	6	7	19	40	NCEER
3	-69.6	44.6	0	1943	12	19	9	0	44	NCEER
3.3	-80.2	33	0	1943	12	28	10	25	0	NCEER
3.2	-89.7	37.5	0	1944	1	7	5	18	0	NCEER
4.2	-75.5	39.8	0	1944	1	8	0	0	0	DNAG
4.3	-76.78	45.83	0	1944	1	22	21	55	9.1	NCEER
3.3	-80	32.9	0	1944	1	28	17	30	0	NCEER
4	-70.5	47.4	0	1944	2	5	12	37	52.5	NCEER
3.7	-76.2	40.8	0	1944	2	5	16	22	0	NCEER
4.1	-78.9	46.7	0	1944	3	8	12	49	0	NCEER
4.9	-67.4	49.9	0	1944	4	9	12	44	0	NCEER
3.7	-70.28	47.3	0	1944	6	9	15	19	8.7	NCEER
5.1	-67.75	49.42	0	1944	6	23	6	37	53	NCEER
3.7	-74.25	46	0	1944	6	24	23	48	38.5	NCEER
5.8	-74.72	44.96	12	1944	9	5	4	38	45.7	NCEER
5	-107.5	39	0	1944	9	9	4	12	20	DNAG
3.9	-90	37.9	0	1944	9	25	11	37	23	NCEER
4.2	-67	48.5	0	1944	10	14	13	26	17	NCEER
4.4	-80.8	48.7	0	1944	11	5	19	7	0	NCEER
4.1	-84.4	40.4	0	1944	11	13	11	52	0	NCEER
3.1	-87.1	45.7	0	1944	12	10	11	0	0	NCEER
3.6	-72.8	41.6	0	1944	12	14	3	15	0	NCEER
3.1	-89.7	36.2	0	1944	12	23	7	23	0	NCEER
3.2	-90.2	37.8	0	1945	1	16	2	0	0	NCEER
3.3	-80	32.9	0	1945	1	30	20	20	0	NCEER
3.7	-90.2	38.6	0	1945	3	28	1	45	58	NCEER
3.1	-76.4	43	0	1945	4	15	13	15	0	NCEER
3.3	-89.7	36.5	0	1945	5	2	11	22	0	NCEER
3.1	-90.2	38.6	0	1945	5	21	7	51	0	NCEER
4.3	-75.4	47.08	0	1945	6	12	7	58	15.1	NCEER
3.6	-84.5	35	0	1945	6	14	3	25	0	NCEER
4.7	-71.09	47.34	5	1945	6	18	15	20	4.7	NCEER
3.9	-76.8	48.47	0	1945	7	2	13	29	52.1	NCEER
3.3	-67	44.9	0	1945	7	15	10	44	0	NCEER
4	-81.38	33.75	5	1945	7	26	10	32	16.4	NCEER
3.1	-89.8	37	0	1945	9	23	6	22	0	NCEER
4.7	-69.81	47.99	5	1945	10	9	13	18	42	NCEER
3.3	-78.5	37.5	0	1945	10	12	19	0	0	NCEER
3.1	-97.9	43	0	1945	11	10	8	0	0	NCEER
3.7	-89.2	37	0	1945	11	13	8	21	0	NCEER
3	-74.9	45	0	1945	12	2	15	22	32	SRA
4.3	-68.7	49.4	0	1946	1	17	8	4	52	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-89.1	38.6	0	1946	2	25	0	52	0	NCEER
3.8	-84.9	35.2	0	1946	4	7	5	0	0	NCEER
3.6	-73.43	45.73	0	1946	4	21	5	5	55.5	NCEER
4	-90.8	36.6	0	1946	5	15	6	10	0	NCEER
3	-74.53	44.65	0	1946	6	27	21	6	22	NCEER
4	-98.6	44.1	0	1946	7	23	6	45	0	NCEER
3.3	-71.47	47.33	0	1946	9	1	4	39	41	NCEER
3	-74.88	44.9	0	1946	9	4	19	30	0	NCEER
3.2	-75	47.72	0	1946	9	19	0	53	28.8	NCEER
3.4	-72.15	46.43	0	1946	9	26	21	19	8.2	NCEER
4	-90.6	37.5	0	1946	10	8	1	12	2	NCEER
3.1	-103.6	48.1	0	1946	10	26	20	37	0	NCEER
3.6	-76.6	41.5	0	1946	10	28	20	36	0	NCEER
3.1	-77.45	42.87	0	1946	11	10	11	41	23.1	NCEER
3	-74.9	45	0	1946	11	11	10	20	47	SRA
3.1	-74.68	45.17	0	1946	11	24	10	20	47.2	NCEER
3	-74.9	44.9	0	1946	12	25	4	48	3	NCEER
3.3	-73.6	41	0	1947	1	4	18	51	0	NCEER
3.9	-76.7	46.8	0	1947	1	19	0	45	1.7	NCEER
4.2	-70.53	47.67	0	1947	2	2	16	50	32.3	NCEER
3.1	-88.3	42.1	0	1947	3	16	15	30	0	NCEER
4	-88.4	37	0	1947	3	26	0	0	0	NCEER
4	-70.23	47.37	0	1947	3	29	12	28	52.4	NCEER
3.5	-87.9	43	0	1947	5	6	21	27	0	NCEER
3.1	-100.9	46	0	1947	5	14	5	2	0	NCEER
3	-100.3	44.4	0	1947	5	16	5	45	0	NCEER
3.4	-84	36	0	1947	6	6	12	55	0	NCEER
4.2	-90.2	38.4	0	1947	6	30	4	23	53	NCEER
4.4	-81.1	46.5	0	1947	8	8	5	39	0	NCEER
4.5	-85	41.93	2	1947	8	10	2	46	41.3	NCEER
3.1	-98.9	43.1	0	1947	8	25	14	0	0	NCEER
4.3	-81.3	47	0	1947	9	14	19	29	0	NCEER
3.3	-92.6	31.9	0	1947	9	20	21	30	0	NCEER
3.8	-70.72	47.55	0	1947	10	22	9	36	38.3	NCEER
3.3	-80	32.9	0	1947	11	2	4	30	0	NCEER
4.5	-81.2	45.7	0	1947	11	3	19	51	0	NCEER
3.7	-90.6	36.7	0	1947	12	1	7	47	33	NCEER
4	-90.1	35.6	0	1947	12	16	3	27	0	SRA
3.2	-85.3	35	0	1947	12	27	19	0	0	NCEER
3.8	-69.2	45.2	0	1947	12	28	19	58	0	NCEER
4.5	-70.4	47.3	0	1948	1	1	18	33	45.3	NCEER
3.3	-78.3	37.7	0	1948	1	5	2	45	0	NCEER
3.5	-78.5	37.5	0	1948	1	5	3	20	0	NCEER
3.1	-89.1	38.6	0	1948	1	6	1	34	0	NCEER
3.1	-89.7	43.1	0	1948	1	15	17	40	0	NCEER
3.7	-69	50	0	1948	1	16	6	2	56	NCEER
3.4	-84.1	36.4	0	1948	2	10	0	4	0	NCEER
4.6	-102.48	36.22	5	1948	3	12	4	29	6.3	NCEER
3.1	-97.3	37.7	0	1948	4	3	3	0	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-91.8	41.7	0	1948	4	20	14	17	0	NCEER
3.2	-71.8	41.4	0	1948	5	4	2	23	0	NCEER
4	-73.69	45.86	3	1948	5	7	12	2	27.3	NCEER
3.7	-73.87	45.23	0	1948	6	9	3	4	12.2	NCEER
3.3	-82.2	26.5	0	1948	11	8	17	44	0	NCEER
3.5	-70.3	46.7	0	1948	11	13	16	49	56.6	NCEER
3	-69.2	45.2	0	1948	11	29	4	56	0	NCEER
3.5	-89.7	36.4	0	1949	1	14	3	49	0	NCEER
3.3	-80	32.9	0	1949	2	2	10	52	0	NCEER
3.6	-77.6	37.6	0	1949	5	8	11	1	0	NCEER
3.3	-99	42.5	0	1949	5	13	4	15	0	NCEER
3.1	-100	45	0	1949	6	3	0	0	0	NCEER
3.3	-80	32.9	0	1949	6	27	6	53	0	NCEER
3.2	-83	36.7	0	1949	9	17	9	30	0	NCEER
4.7	-70.58	44.84	20	1949	10	5	2	33	47.8	NCEER
4.2	-74.9	45.49	14	1949	10	16	23	33	45.4	NCEER
3.4	-72.12	46.47	0	1949	10	30	20	51	13.7	NCEER
5	-109.5	35.7	0	1950	1	17	0	51	0	DNAG
5.3	-110.5	40.5	0	1950	1	18	1	55	51	USHIS
3.7	-92.7	37.7	0	1950	2	8	10	37	0	NCEER
3.3	-95.2	46.1	0	1950	2	15	10	5	0	NCEER
4	-74.5	46	0	1950	3	6	16	14	11.8	NCEER
3.1	-97.1	33.5	0	1950	3	20	13	24	0	NCEER
3.3	-75.8	41.5	0	1950	3	20	22	55	11.5	NCEER
4.9	-75.5	47.83	0	1950	4	14	18	20	48.5	NCEER
3.1	-84.2	39.8	0	1950	4	20	0	0	0	NCEER
3.5	-84	35.8	0	1950	6	19	4	19	0	NCEER
4.3	-68.1	49.9	0	1950	6	29	9	13	33	NCEER
3.2	-70.25	47.33	0	1950	8	4	6	45	21	NCEER
4	-74.72	45.2	0	1950	8	4	14	29	28.7	NCEER
3	-89.9	35.7	0	1950	9	17	5	48	0	NCEER
3	-77.12	45.82	0	1950	10	29	5	59	26	NCEER
3.3	-78.3	37.7	0	1950	11	26	7	45	0	NCEER
3.2	-72.5	41.5	0	1951	1	26	3	27	0	NCEER
3.3	-80	32.9	0	1951	3	4	2	55	0	NCEER
3.5	-77.6	37.6	0	1951	3	9	7	0	0	NCEER
3.7	-71.53	41.52	5	1951	6	10	17	20	37.7	NCEER
4.3	-103.04	35.22	1	1951	6	20	18	37	11.1	NCEER
4.2	-67.5	50	0	1951	6	28	1	3	57	NCEER
3.3	-71.37	47.2	0	1951	7	25	0	22	51.5	NCEER
3.3	-74.67	45.93	0	1951	8	8	9	36	24.1	NCEER
3.6	-73.86	41.35	18	1951	9	3	21	26	24.8	NCEER
4.3	-66.25	49.3	0	1951	9	19	8	19	38	NCEER
3.3	-89.9	38.7	0	1951	9	20	2	38	0	NCEER
3.7	-75.37	46.22	0	1951	9	25	15	45	0	NCEER
3.8	-74.73	45.27	0	1951	10	25	7	7	52.8	NCEER
3.9	-73.55	44.92	31	1951	11	6	17	54	45.9	NCEER
3.3	-75.5	40.6	0	1951	11	23	6	45	0	NCEER
3.3	-80	32.9	0	1951	12	30	7	55	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-73.2	44.5	0	1952	1	30	4	0	0	NCEER
3.3	-69.38	46.33	0	1952	2	18	20	56	7	NCEER
3.9	-89.5	36.4	0	1952	2	20	22	34	39	NCEER
3.7	-70.2	46.8	0	1952	2	26	0	56	0	NCEER
3.8	-76.17	47.1	0	1952	3	17	4	14	41	NCEER
4.1	-69.88	47.83	0	1952	3	30	13	11	7	NCEER
5.1	-97.85	35.52	10	1952	4	9	16	29	28.4	NCEER
3.8	-70.58	47.47	0	1952	4	19	2	50	52.8	NCEER
3.7	-78.5	47	0	1952	4	26	4	59	0	NCEER
3.3	-89.7	36.6	0	1952	5	28	9	54	14	NCEER
3.3	-82.3	36.3	0	1952	6	11	20	20	0	NCEER
3.9	-82.02	39.64	9	1952	6	20	9	38	8.6	NCEER
4	-89.6	36.2	0	1952	7	16	23	48	10	NCEER
4.3	-75.84	46.87	1	1952	7	19	1	16	17.2	NCEER
3.2	-74.5	43	0	1952	8	25	0	7	0	NCEER
3.1	-96.5	35.1	0	1952	10	8	4	15	0	NCEER
4.3	-74	41.7	0	1952	10	8	21	40	0	DNAG
4.9	-69.8	47.8	0	1952	10	14	22	3	44.8	NCEER
3.1	-89.6	36.2	0	1952	10	17	4	16	18	NCEER
3.1	-93.7	30.1	0	1952	10	17	15	48	0	NCEER
3.1	-103.5	44.1	0	1952	11	15	0	0	0	NCEER
3.3	-84.6	30.6	0	1952	11	18	20	12	0	NCEER
3.1	-80	32.9	0	1952	11	19	0	0	0	NCEER
3.1	-81	43.8	0	1952	12	25	0	0	0	NCEER
3.6	-89.8	35.9	0	1952	12	25	4	23	24	NCEER
4.6	-66	49.07	0	1953	1	24	9	58	37	NCEER
3.1	-89.5	36	0	1953	1	26	23	18	0	NCEER
3.3	-78.1	37.7	0	1953	2	7	7	5	0	NCEER
3.3	-89.5	36.5	0	1953	2	11	10	50	54	NCEER
3.1	-89.8	36.1	0	1953	2	17	11	45	0	NCEER
3.5	-74.43	48.07	0	1953	2	28	6	24	2.5	NCEER
4.2	-98	35.6	0	1953	3	17	14	25	0	NCEER
3.3	-81.4	28.6	0	1953	3	26	0	0	0	NCEER
3	-73.5	41.1	0	1953	3	27	8	50	0	NCEER
3.6	-73	43.7	0	1953	3	31	2	50	0	NCEER
3	-73.5	44.7	0	1953	4	26	1	17	0	NCEER
3.1	-90.3	35.6	0	1953	5	12	18	50	0	NCEER
3.1	-96.7	34.7	0	1953	6	6	17	40	0	NCEER
3.5	-83.6	41.7	0	1953	6	12	0	0	0	NCEER
4.3	-110.163	38.997	0	1953	7	30	5	45	0	DNAG
3.1	-74	41	0	1953	8	17	4	22	50	NCEER
3.9	-90.1	38.8	0	1953	9	11	18	26	28	NCEER
4.4	-65.2	49.1	0	1953	9	14	22	52	57	NCEER
3.3	-83.9	36	0	1953	10	11	4	0	0	NCEER
3	-102.9	45.2	0	1953	12	21	22	43	0	NCEER
3.3	-89.1	38.6	0	1953	12	30	22	0	0	NCEER
3.1	-99.3	43.1	0	1953	12	31	20	30	0	NCEER
3.8	-83.2	37.3	0	1954	1	1	2	30	0	NCEER
4.4	-83.7	36.6	0	1954	1	2	3	25	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 28 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-76	40.3	0	1954	1	7	7	25	0	NCEER
3.1	-68.23	49.17	0	1954	1	10	21	4	30	NCEER
3.1	-89.4	36	0	1954	1	17	7	15	0	NCEER
3.4	-105.5	41.5	0	1954	1	20	20	50	1	NCEER
3.1	-84.4	35.3	0	1954	1	23	1	0	0	NCEER
3.1	-77.3	42.9	0	1954	1	31	12	30	0	NCEER
3.3	-76.65	43.03	0	1954	2	1	0	37	50	NCEER
4.3	-90.3	36.7	0	1954	2	2	16	53	0	NCEER
3.8	-70.25	47.6	0	1954	2	7	20	24	16	NCEER
3.5	-70.62	47.67	0	1954	2	21	9	0	37	NCEER
3.1	-96.4	35	0	1954	4	11	0	0	0	NCEER
4.3	-76.12	47	6	1954	4	12	21	22	0.1	NCEER
3.1	-73.5	44.7	0	1954	4	21	15	45	0	NCEER
4.1	-79.2	43.1	0	1954	4	27	2	14	8	NCEER
3.9	-90	35.1	0	1954	4	27	4	9	0	NCEER
3	-74.2	45	0	1954	5	20	22	0	0	NCEER
3.7	-70.12	47	0	1954	6	30	7	41	7	NCEER
3.5	-70.7	42.81	1	1954	7	29	19	56	56	NCEER
3.1	-87.3	38.5	0	1954	8	9	0	0	0	NCEER
3.3	-76	40.3	0	1954	8	11	3	40	0	NCEER
3.6	-68.37	49.03	0	1954	9	8	1	29	53	NCEER
4.6	-75.66	47.18	28	1954	9	11	18	55	55.6	NCEER
3	-74.6	44.6	0	1954	12	13	3	53	0	NCEER
3.1	-88.4	47.3	0	1955	1	5	20	0	0	NCEER
3.1	-82.2	36.6	0	1955	1	6	20	30	0	NCEER
3.4	-88.6	47.1	0	1955	1	7	5	0	0	NCEER
3.3	-78.4	37.3	0	1955	1	17	12	37	0	NCEER
4	-73.8	43	0	1955	1	21	8	40	0	DNAG
4.3	-89.83	36.07	8	1955	1	25	7	24	39.1	NCEER
3.1	-83.9	36	0	1955	1	25	19	34	0	NCEER
4	-70.5	47.67	0	1955	2	1	12	40	27	NCEER
4.1	-89.1	30.4	0	1955	2	1	14	45	0	NCEER
4.3	-107	40.5	0	1955	2	10	17	30	0	NCEER
3.3	-98.6	41.3	0	1955	2	25	1	45	0	NCEER
4.3	-89.78	38.23	11	1955	4	9	13	1	23.3	NCEER
3.2	-81.4	41.3	0	1955	5	26	18	9	0	NCEER
3.1	-81.4	41.3	0	1955	6	29	1	16	33	NCEER
3	-79.63	43.77	0	1955	6	29	1	17	40	NCEER
3.5	-78.3	42.9	0	1955	8	16	7	35	0	NCEER
3.4	-89.5	36	0	1955	9	6	1	45	0	NCEER
3.1	-89.5	36.4	0	1955	9	24	18	45	0	NCEER
3.5	-81.3	36.6	0	1955	9	28	7	1	41.5	NCEER
3.5	-73.9	45.22	0	1955	10	7	18	9	52	NCEER
3.4	-70.2	48.93	0	1955	10	20	21	31	6	NCEER
3.5	-75.87	46.5	0	1955	11	1	7	45	52	NCEER
3.4	-89.5	36	0	1955	12	13	7	43	0	NCEER
3.3	-82.4	34.3	0	1956	1	5	8	0	0	NCEER
4	-98.35	37.58	29	1956	1	6	11	58	7.4	NCEER
3.8	-94.8	29.3	0	1956	1	7	23	30	0	SRA

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}
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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-75.47	45.67	0	1956	1	10	12	8	18	NCEER
3.7	-84	40.5	0	1956	1	27	11	3	27	NCEER
3.9	-89.8	35.76	16	1956	1	29	4	44	15.5	NCEER
3.7	-71.17	47.05	0	1956	1	30	9	43	13	NCEER
3.1	-74.82	45.45	0	1956	2	2	19	24	16	NCEER
3.9	-97.3	35.4	0	1956	2	16	23	30	0	NCEER
3.1	-75.38	44.85	0	1956	3	6	23	38	10	NCEER
3.7	-90.4	40.5	0	1956	3	13	15	5	0	SRA
3.5	-95.6	34.2	0	1956	4	2	16	3	18	NCEER
3.3	-82.4	34.3	0	1956	5	19	19	0	0	NCEER
3.9	-76.43	47.1	0	1956	6	15	0	53	37	NCEER
3.1	-87.7	43.6	0	1956	7	18	21	30	0	NCEER
3.4	-73.78	44.7	0	1956	7	27	1	34	44	NCEER
3.6	-66.17	49.42	0	1956	8	3	12	52	9	NCEER
4	-83.79	36.44	5	1956	9	7	13	35	50.8	NCEER
4.2	-84	35.5	0	1956	9	7	13	49	29	NCEER
3.2	-86.7	35.8	0	1956	9	9	22	45	0	SRA
3.8	-88.4	31.9	0	1956	9	27	14	15	0	NCEER
3.1	-87.9	42.9	0	1956	10	13	0	0	0	NCEER
3.4	-69	48.25	0	1956	10	27	14	40	6	NCEER
3.4	-89.7	36.1	0	1956	10	29	9	23	44	NCEER
4	-95.8	36.2	0	1956	10	30	10	36	21	USHIS
4	-75.42	45.96	1	1956	11	4	11	53	29.2	NCEER
4.3	-90.39	36.91	1	1956	11	26	4	12	43.3	NCEER
3	-88.8	43.5	0	1957	1	8	16	0	0	NCEER
4	-83.7	36.6	0	1957	1	25	18	15	0	NCEER
3.5	-69.93	48.4	0	1957	2	19	5	18	33	NCEER
3.3	-74.9	44.9	0	1957	2	20	15	45	0	NCEER
4	-94.7	32.6	0	1957	3	19	16	37	38	NCEER
3.5	-74.8	40.6	0	1957	3	23	19	2	0	NCEER
3.1	-88.4	37	0	1957	3	26	8	27	6	NCEER
4.3	-86.72	33.77	5	1957	4	23	9	23	39	NCEER
3.3	-72	44.42	0	1957	4	24	0	41	59	NCEER
4.4	-70.25	43.53	5	1957	4	26	11	40	8.6	NCEER
4.1	-82.14	35.8	5	1957	5	13	14	24	51.1	NCEER
3.3	-84.1	35.95	5	1957	6	23	6	34	16	NCEER
3.1	-81.3	42.9	0	1957	6	29	11	25	9	NCEER
3.9	-82.7	35.6	0	1957	7	2	9	33	1	NCEER
3.7	-67.08	46.58	0	1957	8	4	12	40	58	NCEER
4	-70.42	47.48	0	1957	8	6	23	50	38	NCEER
3.3	-70.12	46.73	0	1957	8	17	1	30	7	NCEER
3.1	-89.5	36.2	0	1957	8	17	23	0	0	NCEER
3	-76.17	44.8	0	1957	8	21	2	40	33	NCEER
3.1	-69.9	48.42	0	1957	10	9	14	16	58	NCEER
3.2	-78.75	46.38	0	1957	10	27	8	48	27	NCEER
3.3	-84	36	0	1957	11	7	17	15	0	NCEER
3.5	-69.55	48.67	0	1957	11	13	20	49	19	NCEER
3.9	-83.5	35	0	1957	11	24	20	6	17	NCEER
3.1	-98.2	43.8	0	1957	12	3	7	30	0	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.5	-87.9	38.4	0	1958	1	8	2	41	43	DNAG
3.3	-74.9	44.9	0	1958	1	11	16	36	0	NCEER
3.5	-81.3	45	0	1958	1	24	17	10	0	NCEER
3.8	-89.7	36.1	0	1958	1	26	16	55	37	NCEER
3.9	-89.2	37.1	0	1958	1	28	5	56	40	NCEER
3.9	-76.03	46.9	0	1958	3	1	17	41	49	NCEER
3.4	-77.8	34.2	0	1958	3	5	11	53	43	NCEER
3.1	-77.13	46	0	1958	3	19	6	39	25	NCEER
3.4	-67.12	45.55	0	1958	3	23	22	4	17	NCEER
3.4	-89.2	36.3	0	1958	4	8	22	25	33	NCEER
3.2	-89.5	36.4	0	1958	4	26	7	30	0	NCEER
3.1	-81.8	41.5	0	1958	5	1	22	46	31	NCEER
3.7	-70.32	48.57	0	1958	5	6	16	2	49	NCEER
5	-76.82	47.09	1	1958	5	14	17	41	16.7	NCEER
3.3	-82.6	35.6	0	1958	5	16	22	30	0	NCEER
3.1	-90.4	35.5	0	1958	5	20	1	25	0	NCEER
3.2	-71.4	46.7	0	1958	7	18	23	56	27	NCEER
4.4	-79.5	43	0	1958	7	22	1	46	40	NCEER
3.8	-75.8	46.57	0	1958	7	25	3	45	11	NCEER
3	-70.3	47.32	0	1958	7	27	8	58	0	NCEER
3.8	-80	43.13	0	1958	8	4	20	25	58	NCEER
3.1	-106	41.1	0	1958	8	7	0	46	43	NCEER
3.6	-70.38	47.93	0	1958	8	8	22	15	3	NCEER
3.9	-69.38	48.6	0	1958	8	12	3	22	12	NCEER
3.6	-79	43	0	1958	8	22	14	25	5	NCEER
3	-70.2	43.6	0	1958	9	19	17	45	0	NCEER
3.3	-69.27	48.38	0	1958	9	29	10	45	29	NCEER
3.7	-73.73	45.18	0	1958	9	30	0	13	58	NCEER
3.5	-82.7	34.5	0	1958	10	20	6	16	0	NCEER
4.1	-68	49.6	0	1958	10	21	9	32	51	NCEER
3	-81.9	37.2	5	1958	10	23	2	29	44.3	NCEER
3.1	-90.1	29.9	0	1958	11	6	23	8	0	NCEER
4.4	-88.01	38.44	5	1958	11	8	2	41	12.6	NCEER
3.3	-91.2	30.5	0	1958	11	19	18	15	0	NCEER
3.3	-71.7	44	0	1958	11	21	23	30	0	NCEER
3.7	-69.82	46.98	0	1958	12	23	23	14	16	NCEER
3.1	-98.1	44.9	0	1959	1	12	13	0	0	NCEER
3.1	-89.5	36.3	0	1959	1	21	15	35	0	NCEER
3.1	-81	43	0	1959	2	9	0	0	0	NCEER
4.2	-100.9	35.5	0	1959	2	10	20	5	0	NCEER
3.2	-89.5	36.1	0	1959	2	13	8	37	0	NCEER
3.4	-73.27	41.92	0	1959	4	13	21	20	19	NCEER
3.5	-70.33	47.12	0	1959	4	16	16	36	25	NCEER
3.7	-80.68	37.39	1	1959	4	23	20	58	39.5	NCEER
3.9	-76.45	46.55	0	1959	5	21	9	38	51	NCEER
3.5	-79.2	48.8	0	1959	5	24	10	52	0	NCEER
3.6	-84.3	35.4	0	1959	6	13	1	0	0	SRA
3.7	-96.7	34.7	0	1959	6	15	12	45	0	NCEER
4.1	-98.06	34.64	5	1959	6	17	10	27	10.6	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-80.7	37.3	0	1959	7	7	23	17	0	NCEER
4.1	-68.32	48.42	0	1959	8	1	13	52	49	NCEER
4.6	-80.13	33.05	1	1959	8	3	6	8	36.8	NCEER
3.9	-86.56	34.79	5	1959	8	12	18	6	1.4	NCEER
3.2	-80.7	37.3	0	1959	8	21	17	20	0	NCEER
3.2	-70.78	46.95	0	1959	8	22	3	52	30	NCEER
3.4	-93.1	29.8	0	1959	10	15	15	45	0	NCEER
4	-80.2	34.5	0	1959	10	27	2	7	28	NCEER
3.4	-89.34	36.03	5	1959	12	21	16	23	39.6	NCEER
4.3	-106.2	41.1	0	1959	12	25	9	50	0	NCEER
3.7	-75.67	46.97	0	1960	1	20	20	7	40	NCEER
3.4	-75.5	41.5	0	1960	1	22	20	53	22	SRA
3.2	-89.5	36	0	1960	1	28	21	38	0	NCEER
3.3	-70.38	47.8	0	1960	2	6	0	44	2	NCEER
4.2	-80.12	33.07	9	1960	3	12	12	47	44	NCEER
3.5	-84	35.8	0	1960	4	15	10	10	10	NCEER
3.4	-89.5	36	0	1960	4	21	10	45	0	NCEER
4	-70.34	47.88	5	1960	4	23	11	47	47.1	NCEER
3.1	-92	34.2	0	1960	5	4	16	31	32	NCEER
3.7	-80	32.9	0	1960	7	24	3	37	30	NCEER
3.3	-79.3	37.4	0	1960	9	4	18	40	0	NCEER
5.5	-107.6	38.3	49	1960	10	11	8	5	30.5	USHIS
3.6	-95.5	34.9	0	1961	1	11	1	40	0	NCEER
3.8	-66.93	46.38	0	1961	1	29	0	49	39	NCEER
3.7	-83.3	41.2	0	1961	2	22	9	45	3	NCEER
3.2	-75.28	45.17	0	1961	3	13	10	55	45	NCEER
3.6	-99.77	39.98	1	1961	4	13	21	14	55.2	NCEER
3.2	-74.8	45	0	1961	4	20	13	13	0	NCEER
3.6	-95	34.6	0	1961	4	26	7	5	0	NCEER
3.8	-95.3	34.9	0	1961	4	27	7	30	0	NCEER
3.4	-70.5	47.33	0	1961	8	22	18	55	51	NCEER
3.8	-90.19	35.96	5	1961	9	9	22	42	55	NCEER
4.3	-75.5	40.8	0	1961	9	15	2	16	56	DNAG
3.1	-74.9	44.9	0	1961	9	29	6	30	0	NCEER
3.8	-76.58	48.67	0	1961	10	7	22	36	51	NCEER
3.9	-94.24	39.32	9	1961	12	25	12	58	16.8	NCEER
3.3	-74.8	40.5	0	1961	12	27	17	6	0	NCEER
4	-100.72	44.25	23	1961	12	31	16	36	5.8	NCEER
3.8	-74.85	45.92	0	1962	1	27	12	11	17	NCEER
3.5	-67.13	47.5	0	1962	1	31	14	32	38	NCEER
4.3	-89.51	36.37	4	1962	2	2	6	43	30	NCEER
3	-88.7	37	0	1962	2	16	0	0	0	NCEER
3.3	-69.47	47.18	0	1962	3	23	2	2	21	NCEER
4	-66.02	47.57	0	1962	3	25	5	15	5	NCEER
3	-79.3	43	0	1962	3	27	6	35	0	NCEER
4.3	-72.97	44.11	5	1962	4	10	14	30	45.2	NCEER
3.3	-98.6	35.3	0	1962	4	28	6	9	11	NCEER
3	-89.5	36.5	0	1962	5	24	0	0	0	NCEER
3.2	-90.39	35.38	1	1962	6	1	11	23	38.6	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-72.64	45.44	1	1962	6	21	2	6	47	NCEER
5.4	-88.64	37.9	0	1962	6	27	1	28	59.3	NCEER
3.2	-89.82	36.56	1	1962	7	14	2	23	44	NCEER
3.6	-89.4	36.04	8	1962	7	23	6	5	15.7	NCEER
3.9	-70.67	47.25	0	1962	7	27	17	56	57	NCEER
3.2	-97.4	34.8	0	1962	8	10	20	47	19	SRA
3.6	-70.05	47.53	0	1962	8	11	3	5	16	NCEER
3.3	-77.7	39.5	0	1962	9	4	23	40	0	NCEER
3.3	-78.2	39.7	0	1962	9	7	14	0	0	NCEER
3.1	-110.89	39.2	7	1962	9	7	16	50	23.8	SRA
3.2	-98.4	34.7	0	1962	9	7	22	53	44	SRA
3.3	-74.3	44.8	0	1962	10	2	23	45	0	NCEER
3	-69.13	45.57	0	1962	12	1	21	29	23	NCEER
3.4	-110.42	39.36	7	1962	12	11	10	28	13.5	SRA
3	-71.7	42.8	0	1962	12	29	6	19	0	NCEER
3.3	-80.1	37.3	0	1963	1	17	14	26	50.8	NCEER
3	-75.9	44	0	1963	1	30	14	50	0	NCEER
3.4	-92.1	34.4	0	1963	2	7	21	18	36	NCEER
4.3	-109.2	42.6	33	1963	2	25	18	45	16.5	SRA
3	-79.57	43.2	0	1963	2	27	6	0	0	NCEER
3.4	-75.73	41.51	0	1963	3	2	20	24	32	NCEER
4.8	-90.05	36.64	15	1963	3	3	17	30	10.6	NCEER
3.1	-95.9	34.6	0	1963	3	13	9	33	34	NCEER
3.9	-109.8	45.1	33	1963	4	3	9	55	12.6	SRA
3.1	-89.58	36.46	6	1963	4	6	8	12	22.7	NCEER
3.1	-89.54	36.67	10	1963	5	2	1	9	21.4	NCEER
3.3	-80.19	32.97	5	1963	5	4	21	1	50.3	NCEER
3	-96.4	34.3	0	1963	5	7	20	3	29	SRA
3.5	-75.2	43.5	0	1963	5	19	19	14	0	NCEER
4.4	-104	39.3	0	1963	6	5	0	13	50.6	NCEER
4	-104.4	36.6	0	1963	6	6	8	5	33	SNMX
3.3	-73.75	42.37	0	1963	7	1	19	59	12	NCEER
3.1	-90.47	36.97	0	1963	7	8	23	51	42.1	NCEER
3	-66.5	46.8	0	1963	8	1	6	34	16	NCEER
4.4	-88.77	36.98	7	1963	8	3	0	37	49.1	NCEER
3.5	-73.95	45.18	0	1963	8	26	16	29	35	NCEER
4.3	-111.22	38.1	7	1963	9	30	9	17	39.3	SRA
3.2	-82.5	33.9	0	1963	10	8	6	1	43.4	SRA
3.6	-78.197	39.655	0	1963	10	10	14	59	52.3	SRA
4.5	-108.3	42.2	30	1963	10	14	8	31	23	SRA
4.2	-77.47	46.37	8	1963	10	15	13	59	50.8	NCEER
3.8	-70.42	42.4	14	1963	10	16	15	30	59.7	NCEER
3.7	-81	36.7	0	1963	10	28	22	38	0.3	NCEER
3.4	-70.8	42.7	0	1963	10	30	22	36	57.9	NCEER
3.2	-71.6	43.6	9	1963	12	4	21	32	34.8	NCEER
3.2	-86.97	37.15	1	1963	12	5	6	51	0.5	NCEER
3.4	-104.133	35.133	0	1963	12	19	16	47	28	SNMX
3.9	-77.53	46.23	0	1964	1	8	10	3	26	NCEER
3.3	-89.46	36.84	0	1964	1	16	5	9	58	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-70.7	46.92	27	1964	1	20	18	57	45.3	NCEER
3	-89.5	36.5	0	1964	1	25	19	54	10	NCEER
3.4	-99.7	35.1	0	1964	2	2	8	23	0	NCEER
3.3	-77.96	40.38	1	1964	2	13	19	46	40.8	NCEER
3.3	-85.4	34.7	0	1964	2	17	22	47	0	SRA
3.3	-82.39	33.72	5	1964	3	7	18	2	58.6	NCEER
3.9	-83.31	33.19	1	1964	3	13	1	20	17.5	NCEER
3.5	-89.6	36.2	0	1964	3	17	2	16	6	NCEER
3.5	-103.5	43.5	0	1964	3	24	6	12	0	NCEER
3.4	-104.1	42.7	0	1964	3	28	3	0	0	NCEER
4.5	-101.8	43	30	1964	3	28	10	8	46.5	NCEER
4.3	-74.9	44.9	0	1964	3	29	9	16	0	NCEER
3.1	-71.5	43.6	0	1964	4	1	11	21	34	NCEER
3.8	-81.1	46.4	0	1964	4	5	13	21	0	NCEER
3.7	-81.1	33.84	3	1964	4	20	19	4	44.1	NCEER
3.6	-93.81	31.42	5	1964	4	24	7	33	51.9	NCEER
3.2	-76.41	40.3	1	1964	5	12	6	45	10.7	NCEER
3.9	-90.02	36.58	3	1964	5	23	11	25	34.5	NCEER
4.2	-94	31.3	0	1964	6	2	23	0	0	SRA
3	-94	31	0	1964	6	3	9	37	0	NCEER
3.3	-74.3	40.9	0	1964	6	16	0	0	0	NCEER
3.8	-71.68	43.4	1	1964	6	26	11	4	49	NCEER
3.7	-79.2	47.8	0	1964	6	27	19	17	0	NCEER
3.8	-67.42	49.43	0	1964	7	1	21	41	30	NCEER
3.4	-71.41	46.72	0	1964	7	12	0	0	41	NCEER
3.3	-76.25	46.65	0	1964	7	24	10	34	11	NCEER
3	-83.9	36	0	1964	7	28	0	0	0	NCEER
4	-106	39.7	0	1964	8	4	11	13	25.2	NCEER
3	-110.92	38.95	7	1964	8	5	15	17	56.2	SRA
3	-93.8	31.4	0	1964	8	16	11	35	31	NCEER
4.5	-104.7	42.9	0	1964	8	22	3	28	11	NCEER
3	-102.25	43.77	20	1964	8	26	16	58	55.1	NCEER
3.1	-73.87	48.4	0	1964	9	9	6	16	26	NCEER
4.1	-107.8	41.9	33	1964	9	10	6	19	50.7	SRA
4	-109.7	50	33	1964	9	19	20	51	5	DNAG
3	-91.1	37.1	0	1964	9	24	8	9	34	NCEER
3.4	-96.4	44	0	1964	9	28	15	41	0	NCEER
3	-89.8	47.4	0	1964	10	10	8	30	0	NCEER
3	-90.3	47.3	0	1964	10	10	11	30	0	NCEER
3.2	-83.9	36	0	1964	10	13	16	30	0	NCEER
3.9	-67.25	47.67	0	1964	10	17	14	13	7	NCEER
3.1	-73.7	41.2	0	1964	11	17	17	8	0	NCEER
3.6	-81.698	37.394	6	1964	11	25	2	50	6.4	SRA
3.1	-110.916	38.923	7	1964	12	16	21	39	25.2	DNAG
3	-72	43.5	0	1965	1	3	17	5	1	NCEER
3.5	-78.5	48	0	1965	1	8	12	29	45	NCEER
3.3	-110.35	39.44	7	1965	1	14	12	30	10.8	SRA
3.4	-103.8	35.1	0	1965	2	3	11	32	34	SNMX
3	-103	31.9	0	1965	2	3	19	59	32	SRA

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-89.59	36.52	3	1965	2	11	3	40	24.8	NCEER
3	-93.3	36.9	0	1965	2	14	20	3	20	NCEER
3.1	-71.25	47.5	0	1965	3	1	2	22	8	NCEER
3.2	-78.83	47.72	0	1965	3	5	12	11	1	NCEER
4	-91.03	37.4	7	1965	3	6	21	8	50.3	NCEER
3.1	-83	45	0	1965	3	6	21	13	0	NCEER
3.1	-67.53	49.77	0	1965	3	18	12	9	5	NCEER
3.7	-89.52	36.46	3	1965	3	25	12	59	27.7	NCEER
3.4	-80.5	46	0	1965	4	1	6	30	20	NCEER
3.5	-81.6	37.32	5	1965	4	26	15	26	19.7	NCEER
3.3	-89.9	36.1	0	1965	5	25	7	15	43	NCEER
4.3	-106.3	39.4	33	1965	5	30	17	31	4.1	SRA
3	-89.5	36.5	0	1965	6	1	7	24	57	NCEER
4.7	-106.5	43.6	33	1965	6	3	19	30	25.8	SRA
3.3	-89.5	36.5	0	1965	7	8	7	3	50	NCEER
3	-78.08	43.04	18	1965	7	16	11	6	57	NCEER
3.1	-109.9	39.5	33	1965	7	18	3	55	51.4	SRA
3.9	-109.8	44.7	33	1965	8	6	15	39	49.2	SRA
3.8	-89.31	37.23	1	1965	8	14	13	13	56.9	NCEER
3.3	-110.6	42.3	33	1965	8	22	17	54	33.3	SRA
3.1	-78.1	43	0	1965	8	28	1	55	0	SRA
3.5	-102.3	32.1	0	1965	8	30	5	17	38	NCEER
3.2	-65.28	46	0	1965	8	31	8	38	44	NCEER
3.2	-81.2	34.7	0	1965	9	9	14	42	20	NCEER
3.8	-79.05	46.72	0	1965	9	15	17	56	28	NCEER
3.3	-74.4	41.4	0	1965	9	29	20	57	0	NCEER
3.9	-67.66	49.78	0	1965	10	5	14	36	55	NCEER
3.3	-79.75	40.08	0	1965	10	8	2	17	27	NCEER
3.1	-97.7	36.1	0	1965	10	10	23	51	33	NCEER
4.9	-90.94	37.48	5	1965	10	21	2	4	39.1	NCEER
3	-70.1	41.3	0	1965	10	24	17	45	0	NCEER
3.4	-90.92	37.03	4	1965	11	4	7	43	37.9	NCEER
4.2	-76.36	47.25	10	1965	11	7	20	57	41.8	NCEER
3.3	-83.2	33.2	0	1965	11	8	12	58	1	SRA
3.7	-76.28	46.93	0	1965	11	24	21	28	1	NCEER
3.2	-71.4	41.7	0	1965	12	8	3	2	0	NCEER
4.1	-70.6	47.83	0	1965	12	16	13	53	19	NCEER
3.8	-89.76	36.03	1	1965	12	19	22	19	12	NCEER
3.9	-78.25	42.84	2	1966	1	1	13	23	39	NCEER
3.9	-67.47	48.9	0	1966	1	14	15	29	25	NCEER
3.6	-89.87	35.95	1	1966	2	12	4	32	12.8	NCEER
3.5	-87	33.6	0	1966	2	13	6	29	43	SRA
3.6	-90.9	37.04	6	1966	2	13	23	19	37.8	NCEER
3	-90	36.2	0	1966	3	13	14	24	42	NCEER
3.2	-76.16	46.5	0	1966	3	20	23	45	33	NCEER
3.4	-103.333	35.283	0	1966	4	21	14	14	19	SNMX
3.3	-71.9	44.1	0	1966	4	28	12	2	0	NCEER
4.3	-78.13	37.66	2	1966	5	31	6	18	59.5	NCEER
3.1	-88.2	38.6	0	1966	6	22	11	27	53	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.4	-73.83	45.16	0	1966	6	25	0	5	51	NCEER
3.1	-103.43	44.3	2	1966	6	26	11	59	43.1	NCEER
3.3	-66	49.5	0	1966	7	12	1	6	38	NCEER
3.7	-101.33	35.64	3	1966	7	20	9	4	58.8	NCEER
3.2	-70	47.75	0	1966	7	20	20	8	29	NCEER
3	-67.6	44.5	0	1966	7	24	1	59	0	NCEER
3.7	-68.55	49.63	0	1966	7	24	22	19	46	NCEER
3.1	-110.36	39.44	7	1966	7	30	3	25	31	SRA
4.3	-102.339	32.115	3	1966	8	14	15	25	53.7	USHIS
3	-84	35.8	0	1966	8	24	6	0	0	NCEER
4.2	-107.6	38.3	33	1966	9	4	9	52	34.5	SRA
3.1	-98.81	41.3	27	1966	9	9	9	50	34.2	NCEER
3.1	-80.3	39.3	0	1966	9	28	0	0	0	NCEER
3.2	-65.25	46.92	0	1966	9	28	20	11	35	NCEER
3	-70.33	47.66	0	1966	10	1	17	23	55	NCEER
4.5	-104.1	37.4	0	1966	10	3	2	26	2.3	NCEER
3	-104.6	39.3	0	1966	10	13	0	33	0	SRA
3.2	-71.8	43	0	1966	10	23	23	5	0	NCEER
3.9	-106.9	40.2	33	1966	11	1	7	40	28	SRA
3.6	-76.3	47	0	1966	11	13	15	43	0	NCEER
3	-92.8	38.9	0	1966	12	6	8	0	47	NCEER
3.4	-68.17	49	0	1966	12	12	21	4	12	NCEER
3.7	-107.017	36.983	0	1966	12	16	2	0	40	SNMX
3.3	-106.5	39	5	1966	12	19	20	52	33.3	SRA
4.4	-107.51	38.98	33	1967	1	12	3	52	6.2	SRA
4.1	-107.86	37.67	33	1967	1	16	9	22	45.9	SRA
3.8	-107.05	40.05	33	1967	1	18	6	12	0.6	SRA
3.6	-109.77	44.74	33	1967	1	21	0	18	16	SRA
3.1	-84.6	42.7	0	1967	2	2	6	30	0	NCEER
3.3	-71.4	41.4	0	1967	2	2	13	40	9	NCEER
3	-110.1	39.55	33	1967	2	5	10	7	16.6	SRA
3.1	-90	36	0	1967	2	12	0	0	0	SRA
3.4	-110.37	39.27	5	1967	2	15	15	2	16.5	SRA
3.1	-110.28	42.05	7	1967	3	10	2	20	33.2	SRA
3.6	-109.9	45.16	33	1967	3	28	20	31	35.4	SRA
3	-107.75	38.32	33	1967	4	4	22	53	39.5	SRA
3.7	-82.53	39.65	1	1967	4	8	5	40	30.5	NCEER
3	-89.7	36.1	0	1967	4	11	23	44	45	NCEER
4.7	-108.77	43.41	5	1967	4	26	10	17	59.4	SRA
4.8	-105.9	43.66	0	1967	5	11	21	15	6.6	NCEER
3.2	-69.9	42.3	0	1967	5	15	22	47	12	NCEER
4.3	-90.84	33.55	6	1967	6	4	16	14	12.6	NCEER
3.7	-75.03	46.58	0	1967	6	11	1	49	39	NCEER
3.9	-78.23	42.84	1	1967	6	13	19	8	55.5	NCEER
3.8	-69.9	44.4	0	1967	7	1	16	11	18.9	SRA
3.4	-90.4	35.8	0	1967	7	6	16	43	51	NCEER
4.6	-90.44	37.44	15	1967	7	21	9	14	48.8	NCEER
3.1	-91.1	37.1	0	1967	8	25	19	15	18	NCEER
3.4	-70.7	46.93	0	1967	9	23	16	27	55	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.7	-65.63	49.44	15	1967	9	30	22	39	48	NCEER
3	-89.5	36.5	0	1967	10	18	5	8	36	NCEER
3.4	-80.22	32.8	19	1967	10	23	9	4	2.5	NCEER
3.2	-73.8	41.2	0	1967	11	22	22	10	0	NCEER
3.5	-99.6	43.56	1	1967	11	23	6	23	42.1	NCEER
3.5	-81.6	37.36	2	1967	12	16	12	23	33.4	NCEER
3.1	-95.55	34.85	0	1968	1	4	22	30	0	NCEER
3.8	-106.8	42.7	33	1968	1	9	2	16	39.3	SRA
3.3	-89.8	36.2	0	1968	1	23	16	16	0	NCEER
3.8	-89.86	36.52	7	1968	2	10	1	34	30.6	NCEER
3.2	-110.61	41.72	7	1968	2	20	6	34	26.4	SRA
3.4	-80.77	37.28	8	1968	3	8	5	38	15.7	NCEER
3.1	-70.49	47.94	18	1968	3	30	15	28	59	NCEER
4.5	-89.85	38.02	1	1968	3	31	17	58	9.6	NCEER
3.5	-70.4	47.6	0	1968	4	11	9	18	0	NCEER
3.8	-102.1	37.8	0	1968	4	21	7	8	7	NCEER
3.3	-66.66	46.9	18	1968	5	27	19	21	56	NCEER
3.5	-89.5	36.5	0	1968	5	30	1	59	33	NCEER
3.3	-110.45	39.21	7	1968	6	2	18	59	23.2	SRA
3	-110.47	41.93	7	1968	6	14	21	11	15.3	SRA
3.8	-107.41	39.31	33	1968	6	23	20	16	13	SRA
3.7	-100.74	46.59	27	1968	7	8	16	50	14.7	NCEER
3.1	-89.5	36.5	0	1968	7	14	4	21	25	SRA
3	-90.8	35.7	0	1968	7	15	4	21	25	NCEER
3.1	-71.3	47.01	18	1968	7	24	23	16	37	NCEER
3	-84.2	40.4	0	1968	7	26	15	2	53.7	SRA
3.1	-81.48	34.11	1	1968	9	22	21	41	18.2	NCEER
3.3	-69.45	45.17	18	1968	9	23	15	38	50	NCEER
3.4	-81.66	45.8	18	1968	10	10	20	10	41	NCEER
3.5	-96.8	34	0	1968	10	14	14	42	54	NCEER
3.2	-74.1	45.3	0	1968	10	19	10	37	0	NCEER
3.6	-70.6	47.5	0	1968	10	20	2	36	0	NCEER
3.7	-83	43	0	1968	10	31	0	0	0	NCEER
3.3	-72.5	41.4	0	1968	11	3	8	33	0	NCEER
3.1	-76.3	46.17	18	1968	11	3	20	50	49	NCEER
5.5	-88.37	37.91	21	1968	11	9	17	1	40.5	NCEER
3.3	-77.9	34.1	0	1968	11	25	20	0	0	NCEER
3.2	-74.6	39.7	0	1968	12	10	9	12	0	NCEER
3.4	-87.6	37.8	0	1968	12	11	15	0	0	NCEER
3	-85.8	38.3	0	1968	12	11	16	0	0	NCEER
4.4	-92.69	34.99	7	1969	1	1	23	35	38.7	NCEER
3.4	-90.4	37.8	0	1969	1	20	19	25	0	NCEER
3.5	-96.3	34.2	0	1969	4	13	6	27	51	NCEER
3.3	-96.31	35.29	8	1969	5	2	11	33	21.7	NCEER
3.6	-70.65	47.47	18	1969	5	10	18	43	29	NCEER
3.5	-82.58	33.95	0	1969	5	18	0	0	0	NCEER
3.1	-78.245	39.61	0	1969	5	22	14	59	51.6	SRA
3.5	-104.4	40.4	0	1969	5	26	1	30	8.6	NCEER
3	-97.8	34.8	0	1969	5	30	14	8	5	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-81.45	49.67	18	1969	6	4	9	36	2	NCEER
3	-97	37.4	0	1969	7	1	3	36	58	NCEER
4.1	-83.69	36.12	1	1969	7	13	21	51	9.8	NCEER
3.8	-70.09	47.83	18	1969	7	14	3	6	59	NCEER
3.1	-89.5	36.5	0	1969	7	27	0	0	0	SRA
3.5	-71.4	43.8	0	1969	8	6	16	2	0.5	NCEER
3.2	-70.07	47.49	18	1969	8	31	7	20	27	NCEER
3.3	-74.6	41.1	0	1969	10	6	0	0	0	NCEER
3.1	-106.58	48.29	18	1969	10	6	20	24	53	NCEER
4.5	-75.06	46.31	2	1969	10	10	0	7	4.9	NCEER
4.6	-80.93	37.45	5	1969	11	20	1	0	9.3	NCEER
3.6	-77.67	37.84	1	1969	12	11	23	44	37.4	NCEER
3.7	-82.85	35.04	6	1969	12	13	10	19	29.7	NCEER
3.1	-89.9	35.2	0	1970	1	7	17	45	0	NCEER
3.8	-103.417	35.9	0	1970	1	12	11	21	15	SNMX
3.1	-97	31	0	1970	2	3	0	0	0	NCEER
4	-108.31	37.92	33	1970	2	3	5	59	35.6	SRA
3.4	-90.6	37.9	0	1970	2	6	4	53	2	NCEER
3.1	-77.78	48.24	18	1970	2	27	8	8	36	NCEER
3.3	-89.54	36.6	5	1970	3	27	3	44	29.2	NCEER
3.1	-81.22	49.7	18	1970	4	25	0	46	27	NCEER
3.2	-78.275	39.619	0	1970	5	27	17	59	41.4	SRA
3.7	-82.206	36.99	12	1970	7	30	15	15	16.9	SRA
3.5	-83.4	37.7	0	1970	7	31	0	31	0	SRA
3.3	-66.12	45.8	18	1970	8	8	0	10	30	NCEER
3.2	-82.05	38.23	10	1970	8	11	6	14	25.5	NCEER
3.2	-70.3	47.92	18	1970	9	7	21	39	27	NCEER
3.1	-81.42	36.02	1	1970	9	10	1	41	5.2	NCEER
3	-71.03	48.72	18	1970	10	9	16	35	1	NCEER
3.3	-76.25	47.07	18	1970	10	15	18	56	11	NCEER
3	-90	36	0	1970	11	5	10	25	35	NCEER
4.4	-89.95	35.86	16	1970	11	17	2	13	54.1	NCEER
3	-89.5	36.3	0	1970	11	30	4	46	53	NCEER
3	-89	36	0	1970	12	8	23	16	0	NCEER
4.9	-107.55	43.96	15	1970	12	12	15	57	19.1	SRA
3.4	-89.55	36.71	15	1970	12	24	10	17	56.8	NCEER
3	-75.96	47.17	18	1971	1	6	6	22	8	NCEER
3.8	-107.31	39.49	33	1971	1	7	20	39	52.1	SRA
3.1	-75.18	46.92	18	1971	1	19	13	44	25	NCEER
3.1	-87.85	38.5	15	1971	2	12	12	44	27.5	NCEER
3	-83.2	37.1	0	1971	2	19	23	11	42	NCEER
3.6	-87.84	33.18	12	1971	3	14	17	27	54.6	NCEER
3.7	-88.3	32.8	0	1971	3	16	2	37	28	NCEER
4.4	-106.97	40.7	10	1971	3	18	9	8	59.9	SRA
3	-81.6	37.4	0	1971	4	1	5	5	11	NCEER
3	-90.1	35.8	0	1971	4	13	14	0	51	NCEER
3.2	-73.37	45.1	18	1971	5	14	6	20	9	NCEER
3.7	-80.66	33.36	1	1971	5	19	12	54	3.6	NCEER
4.1	-74.48	43.9	2	1971	5	23	6	24	27.9	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3	-76.28	46.55	18	1971	7	6	17	47	49	NCEER
3.1	-81.2	46.74	18	1971	7	9	5	5	26	NCEER
3.7	-109.6	40.24	7	1971	7	10	17	22	36.8	SRA
3.4	-84	36	0	1971	7	13	2	3	0	SRA
3.4	-84.3	36	0	1971	7	13	3	3	0	NCEER
3.6	-83	34.8	0	1971	7	13	11	42	26	NCEER
3.3	-75.6	39.7	0	1971	7	14	0	0	0	NCEER
3.6	-103.17	31.64	5	1971	7	30	1	45	51.4	NCEER
3.8	-80.63	33.34	4	1971	7	31	20	16	55	NCEER
3.6	-77.59	38.15	5	1971	9	12	0	6	27.6	NCEER
3.2	-70.24	47.56	18	1971	9	12	8	31	43	NCEER
3	-103.2	31.6	0	1971	9	24	1	1	54	SRA
3.2	-75.17	45.71	18	1971	9	27	8	47	23	NCEER
4.1	-90.49	35.77	9	1971	10	1	18	49	38.5	NCEER
3.7	-83.37	35.8	8	1971	10	9	16	43	32.7	NCEER
3	-89.6	36.7	0	1971	10	18	6	39	31	NCEER
3.7	-101.26	43.69	17	1971	10	19	21	7	37.4	NCEER
3.4	-71.2	42.7	0	1971	10	21	0	54	0	NCEER
3.3	-83	36	0	1971	10	22	21	55	0	SRA
3	-67.13	49.23	18	1971	10	27	7	13	24	NCEER
4	-108.68	38.91	5	1971	11	12	9	30	44.6	SRA
3	-73.87	45.06	18	1971	11	15	10	38	55	NCEER
3	-76.28	47.24	18	1971	11	22	5	29	7	NCEER
3	-76.62	45.83	18	1971	11	23	16	32	30	NCEER
4.1	-110.34	42.49	7	1971	12	3	7	44	59.2	SRA
4	-74.67	46.01	13	1971	12	18	15	36	24.5	NCEER
3.3	-75.6	39.7	0	1971	12	29	0	0	0	NCEER
3.7	-81.6	37.4	0	1972	1	9	23	24	29	NCEER
3.7	-90.85	36.37	3	1972	2	1	5	42	9.5	NCEER
4.5	-80.58	33.31	2	1972	2	3	23	11	9.7	NCEER
3.3	-75.6	39.7	0	1972	2	11	0	16	0.3	NCEER
4.3	-105.12	44.29	0	1972	2	18	11	43	38.1	NCEER
3.7	-89.74	36.12	7	1972	3	29	20	38	31.7	NCEER
3.3	-75.99	46.67	18	1972	4	25	3	24	25	NCEER
3.4	-89.97	35.93	1	1972	5	7	2	12	8.7	NCEER
3.9	-82.2	37	0	1972	5	20	19	39	6	NCEER
3.1	-90.37	37.62	12	1972	6	9	19	15	18.9	NCEER
4.5	-89.08	37	13	1972	6	19	16	15	18.8	NCEER
3	-77.86	47.9	18	1972	7	17	1	58	46	NCEER
4.3	-104.93	49.35	5	1972	7	26	3	58	19	NCEER
3.1	-104.033	32.65	0	1972	7	26	4	35	40	SNMX
3.3	-75.6	39.7	0	1972	8	14	1	9	0	NCEER
3	-81.4	33.2	0	1972	8	14	15	5	19	NCEER
3.9	-66.47	49.54	18	1972	8	22	19	17	48	NCEER
3.4	-77.7	37.6	0	1972	9	5	16	0	0	NCEER
3.2	-77.56	46.18	18	1972	9	12	9	15	38	NCEER
4.4	-89.37	41.64	10	1972	9	15	5	22	15.9	NCEER
3.7	-99.6	42.3	0	1972	10	16	5	47	33	NCEER
3	-74.56	44.76	0	1972	11	2	5	15	8.8	SRA

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.3	-112.74	49.12	18	1972	11	21	6	8	46	DNAG
3.5	-76.24	40.14	2	1972	12	8	3	0	33.3	NCEER
4.1	-108.39	43.65	20	1972	12	8	18	47	39.4	SRA
3.9	-75.1	45.64	10	1972	12	16	19	1	37.2	NCEER
3.2	-87.22	37.4	14	1973	1	7	22	56	6.2	NCEER
3.5	-90.6	33.8	0	1973	1	8	9	11	37	NCEER
3.2	-90.48	37.89	17	1973	1	12	11	56	56.2	NCEER
3.1	-70	47.98	10	1973	1	28	13	7	50	NCEER
3.2	-110.425	36.43	5	1973	2	9	17	38	37	SRA
3	-70	44.5	0	1973	2	26	13	42	0	SRA
3.8	-75.43	39.69	12	1973	2	28	8	21	33.2	NCEER
3.4	-77.7	37.3	0	1973	4	9	23	11	0	NCEER
4.8	-107.85	42.64	33	1973	4	22	6	7	12.4	SRA
3.4	-90.8	33.9	0	1973	5	25	14	40	14	NCEER
3.1	-66.5	49.48	18	1973	6	14	15	9	55	NCEER
4.8	-71.12	45.31	12	1973	6	15	1	9	5.1	NCEER
3.3	-75.7	39.7	0	1973	7	10	4	38	0.2	NCEER
3.5	-74.47	43.87	2	1973	7	15	8	20	30.7	NCEER
3.1	-66.96	49.56	18	1973	7	20	17	6	39	NCEER
4.2	-104.57	37.15	5	1973	9	23	3	58	54.9	NCEER
3.4	-90.05	35.87	6	1973	10	3	3	50	19.8	NCEER
3.8	-89.62	36.49	3	1973	10	9	20	15	26.5	NCEER
3.5	-80.65	28.48	5	1973	10	27	6	21	2	NCEER
3.5	-84.12	35.76	1	1973	10	30	22	58	39	NCEER
3.1	-69.01	49.6	18	1973	11	15	17	31	35	NCEER
3.1	-70.29	47.55	10	1973	11	16	1	36	34	NCEER
3.1	-94.7	35	0	1973	11	18	10	3	53	NCEER
4.6	-83.99	35.89	12	1973	11	30	7	48	40.5	NCEER
3	-80.27	32.97	6	1973	12	19	10	16	8.7	NCEER
3.1	-89.69	36.14	10	1973	12	20	10	45	0.9	NCEER
3.1	-98.3	29	0	1973	12	25	2	46	0	NCEER
3.9	-89.47	36.18	7	1974	1	8	1	12	38.1	NCEER
4.5	-100.69	36.4	0	1974	2	15	13	33	49.2	NCEER
3.8	-93.04	34.03	10	1974	2	15	22	49	4.4	NCEER
3	-67.09	49.54	18	1974	2	17	12	57	28	NCEER
3	-90.41	35.69	5	1974	3	4	14	24	28.1	NCEER
3.2	-89.8	35.64	5	1974	3	12	12	30	29.2	SRA
3.5	-107.05	40.7	5	1974	3	31	11	58	47.1	SRA
4.7	-88.07	38.55	15	1974	4	3	23	5	2.8	NCEER
3	-98	29	0	1974	4	20	23	46	10	SRA
3.2	-75.907	40.974	0	1974	4	27	14	45	39.9	SRA
3.3	-75.6	39.8	0	1974	4	28	14	19	0	NCEER
3.8	-89.36	36.74	4	1974	5	13	6	52	18.7	NCEER
3.6	-80.54	37.46	5	1974	5	30	21	28	35.3	NCEER
3.2	-84.75	38.48	10	1974	6	5	0	16	40.2	NCEER
3.2	-89.91	38.65	12	1974	6	5	8	6	10.7	NCEER
3.4	-98	29	0	1974	6	24	18	3	10	SRA
3.4	-67.22	49.58	10	1974	7	2	4	46	51	NCEER
3	-98	29	0	1974	8	1	13	33	10	SRA

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.1	-82.53	33.91	4	1974	8	2	8	52	11.1	NCEER
3.2	-76.08	45.93	18	1974	8	8	11	55	33	NCEER
3.2	-91.16	36.93	6	1974	8	11	14	29	45.4	NCEER
4.4	-107.38	44.11	10	1974	9	19	15	36	11.4	SRA
3	-83.49	41.21	1	1974	9	29	2	26	19.1	NCEER
3.1	-82.4	33.9	0	1974	10	8	23	22	28	NCEER
3.8	-81.61	39.06	4	1974	10	20	15	13	55.6	NCEER
3.2	-75.48	46.08	10	1974	10	23	22	52	57	NCEER
3	-81.92	33.79	0	1974	10	28	11	33	0	NCEER
3.2	-75.03	46.07	10	1974	11	2	13	47	56	NCEER
3.7	-82.22	33.73	0	1974	11	5	3	0	0	NCEER
4.3	-80.16	32.92	6	1974	11	22	5	25	56.7	NCEER
3.3	-79.11	43.33	0	1974	11	27	10	28	51.7	SRA
4	-104.017	32.633	0	1974	11	28	3	35	20	SNMX
3.5	-75.5	46.25	10	1974	12	2	10	58	5	NCEER
3.6	-82.5	33.95	0	1974	12	3	8	25	0	NCEER
3.2	-87.46	31.23	18	1974	12	10	6	1	35	NCEER
3.1	-91.86	34.49	3	1974	12	13	5	3	55.5	NCEER
3	-69.8	42.37	0	1974	12	22	20	46	48.7	SRA
3.5	-67.44	49.14	18	1974	12	27	0	50	12	NCEER
3.7	-103.11	30.92	5	1974	12	30	8	5	27.1	NCEER
3	-90.9	34.9	0	1975	1	2	9	19	0	NCEER
3.1	-74.6	44.9	0	1975	1	15	19	16	0	NCEER
4.1	-108.65	39.27	5	1975	1	30	14	48	40.3	SRA
3	-103.1	35.067	0	1975	2	2	20	39	23	SNMX
3.3	-83.2	41.3	0	1975	2	3	10	31	0	NCEER
3.4	-89.59	36.55	3	1975	2	13	19	43	58	NCEER
3	-82.35	38.88	4	1975	2	16	23	21	34.4	NCEER
3.5	-87.98	33.55	18	1975	3	1	11	50	0.2	NCEER
3	-80.48	37.32	5	1975	3	7	12	45	13.5	NCEER
4.8	-108.1	42.67	10	1975	3	25	14	59	58	SRA
3.1	-74.24	45.73	5	1975	4	3	19	3	17	NCEER
3	-80.22	33	10	1975	4	28	5	46	52.6	NCEER
3.3	-98.5	42.07	1	1975	5	13	7	53	40	NCEER
3.1	-103.7	43.2	0	1975	5	16	5	57	1	NCEER
3.2	-75.19	47.23	18	1975	5	29	21	19	16	NCEER
3.7	-108.8	41.91	5	1975	6	7	4	36	21.7	SRA
3.5	-73.65	44.87	11	1975	6	9	18	39	22.7	NCEER
3.9	-89.68	36.54	9	1975	6	13	22	40	27.5	NCEER
3.5	-89.44	36.21	7	1975	6	20	7	29	6.6	DNAG
3.7	-87.84	33.7	4	1975	6	24	11	11	36.6	NCEER
3	-79.77	43.4	10	1975	6	30	20	15	23	NCEER
4.6	-96.1	45.5	8	1975	7	9	14	54	21.3	NCEER
4.2	-76.31	46.54	17	1975	7	12	12	37	13.8	NCEER
3.1	-66.81	49.16	18	1975	7	18	4	21	6	NCEER
3.1	-70.18	47.44	5	1975	8	21	4	29	37	NCEER
3.6	-78.118	48.123	1	1975	8	21	21	42	51.1	PDE
3	-89.84	36.05	11	1975	8	25	7	11	8	NCEER
3	-65.34	46.8	18	1975	8	27	22	28	22	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.4	-86.59	33.66	4	1975	8	29	4	22	52.1	NCEER
3.3	-69.74	48.29	2	1975	9	2	6	21	17	NCEER
3.8	-104.38	48.37	0	1975	9	5	20	47	40.7	NCEER
3	-89.3	30.7	0	1975	9	9	11	52	44	NCEER
3.2	-97.22	34.13	5	1975	9	13	1	25	5.6	NCEER
3.2	-97.7	35.5	5	1975	10	12	2	58	11.5	NCEER
3.1	-65.89	45.11	18	1975	10	15	3	26	17	NCEER
3.3	-83	34.9	0	1975	10	18	4	31	0	NCEER
3.1	-68.13	49.13	18	1975	10	21	20	50	2	NCEER
4.1	-68.62	49.83	2	1975	10	23	21	17	48.7	NCEER
4	-74.65	43.91	5	1975	11	3	20	54	55.3	NCEER
3.5	-87.33	33.31	4	1975	11	7	23	39	31.7	NCEER
3.2	-80.89	37.22	1	1975	11	11	8	10	37.6	NCEER
3.2	-82.9	34.93	10	1975	11	25	15	17	34.8	NCEER
3.5	-97.42	34.68	14	1975	11	29	14	29	44.9	NCEER
3.3	-94.62	38.24	0	1975	12	4	18	59	59.9	SRA
3.6	-78.89	47.01	0	1975	12	19	15	25	0.1	NCEER
3.5	-107.65	42.85	0	1975	12	19	23	26	19.5	SRA
4.6	-108.212	35.817	0	1976	1	5	6	23	33.9	SNMX
3.4	-92.16	35.9	7	1976	1	16	19	42	56.9	NCEER
3.3	-103.1	31.9	0	1976	1	19	4	3	30	NCEER
3.8	-83.86	36.87	1	1976	1	19	6	20	39.6	NCEER
3.3	-100.087	31.9	4	1976	1	25	4	48	28.5	SRA
3.4	-83.73	41.88	5	1976	2	2	21	14	2.3	NCEER
3.6	-84.7	34.97	14	1976	2	4	19	53	53	NCEER
3.5	-71.21	41.56	0	1976	3	11	8	29	32.2	NCEER
3.1	-69.97	41.66	0	1976	3	14	23	12	24.6	NCEER
3.1	-95.6	35.43	5	1976	3	16	7	39	45.3	NCEER
3.5	-104.27	49.39	5	1976	3	25	0	12	16	NCEER
4.9	-90.48	35.58	17	1976	3	25	0	41	20.8	NCEER
3.3	-67.86	49.34	18	1976	3	29	21	23	27	NCEER
3	-86.7	39.3	0	1976	4	8	7	38	53	NCEER
3.2	-74.03	40.8	0	1976	4	13	15	39	12.9	NCEER
3.3	-87.31	37.38	4	1976	4	15	7	3	34.4	NCEER
3.5	-99.79	36.04	8	1976	4	19	4	42	46.9	NCEER
3.5	-109.1	35.39	5	1976	4	19	23	35	45.5	SRA
3	-103.14	32.27	0	1976	5	1	11	13	40.8	SRA
3.1	-73.9	49.56	18	1976	5	5	3	1	4	NCEER
3.1	-79.9	39.6	0	1976	5	6	18	46	8.1	NCEER
3.3	-68.62	49.84	3	1976	5	15	21	6	52	NCEER
3.2	-89.83	36.03	9	1976	5	22	7	40	46.1	NCEER
3	-104.02	37.41	5	1976	5	30	1	43	37.3	SRA
3.3	-81.6	37.34	1	1976	6	19	5	54	13.4	NCEER
3	-103.283	35.617	0	1976	6	24	15	27	32	SNMX
3.1	-74.1	45.18	9	1976	7	13	3	51	14	NCEER
3.1	-110.3	40.75	7	1976	7	30	22	19	0.2	SRA
3	-103.02	31.57	0	1976	8	5	18	53	9	SRA
3.1	-74.98	49.77	18	1976	8	7	7	50	11	NCEER
3.4	-106.57	45.03	5	1976	8	10	13	54	57.5	SRA

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.5	-106.15	44.04	10	1976	9	3	4	18	16.2	SRA
4.3	-80.77	36.62	9	1976	9	13	18	54	38	NCEER
3	-103.1	32.21	0	1976	9	17	2	47	45.4	SRA
3.1	-102.5	31.4	0	1976	9	17	3	56	29	DNAG
3.4	-67.1	49.36	18	1976	9	18	0	40	32	NCEER
3.5	-90.47	35.58	8	1976	9	25	14	6	55.8	NCEER
3.5	-106.57	45.03	0	1976	10	8	13	54	0	SRA
3	-97.06	35.38	5	1976	10	22	17	15	50.5	NCEER
3	-78.05	48.16	18	1976	10	22	18	50	56	NCEER
3.1	-88.98	32	10	1976	10	23	0	40	59.2	NCEER
4.2	-69.78	47.82	18	1976	10	23	20	58	18	NCEER
3	-75.96	47.11	18	1976	11	6	6	9	29	NCEER
4.2	-91.04	38.1	0	1976	12	11	7	5	1.1	NCEER
3.5	-90.26	37.81	9	1976	12	13	8	35	55.1	NCEER
3.7	-82.5	32.06	14	1976	12	27	6	57	15.2	NCEER
3.6	-89.71	37.58	5	1977	1	3	22	56	48.5	NCEER
3	-80.17	33.06	1	1977	1	18	18	29	14.1	NCEER
4.5	-66.73	46.88	18	1977	2	6	9	1	19	DNAG
3.1	-70.42	47.54	8	1977	2	14	0	35	4.1	NCEER
3.4	-78.63	37.9	0	1977	2	27	20	5	34.6	NCEER
3.1	-109.903	44.608	1	1977	3	2	18	7	24.2	DNAG
3.8	-107.15	41.24	5	1977	3	3	17	50	28	SRA
4.2	-108.222	35.748	0	1977	3	5	3	0	55.8	SNMX
3.7	-107	44.6	0	1977	3	24	8	55	0	DNAG
3.3	-103.1	31.9	0	1977	4	26	9	3	7	NCEER
3.3	-88.44	31.96	0	1977	5	4	2	0	24.3	NCEER
3.6	-94.17	34.56	10	1977	6	2	23	29	10.6	NCEER
3.2	-84.71	40.71	1	1977	6	17	15	39	46.9	NCEER
3.1	-70.16	47.77	8	1977	6	20	5	5	54.7	NCEER
3.4	-74.38	46.04	4	1977	7	14	7	39	29.8	NCEER
3	-102.7	31.8	0	1977	7	22	4	1	10	DNAG
3.5	-84.41	35.42	5	1977	7	27	22	3	20.8	NCEER
3.1	-80.7	33.37	9	1977	8	4	4	20	7.7	NCEER
3.9	-67.05	49.77	18	1977	8	8	23	8	40	NCEER
3.1	-80.69	33.39	0	1977	8	25	4	20	7	NCEER
3.5	-107.31	39.31	5	1977	9	24	11	16	48.4	SRA
4.8	-110.47	40.47	6	1977	9	30	10	19	20.4	USHIS
3	-73.82	46.52	1	1977	10	16	21	29	19.1	NCEER
3	-67.05	47	18	1977	10	24	18	9	12	NCEER
3.4	-89.173	33.928	16	1977	11	4	11	21	10.2	SRA
3	-75.15	46.27	5	1977	11	7	20	48	52.7	NCEER
3	-75.86	46.69	1	1977	11	25	18	47	24.4	NCEER
3.1	-92.91	34.39	10	1977	11	26	4	18	18.1	NCEER
3	-80.18	32.88	9	1977	12	15	19	16	43.1	NCEER
3.1	-70.68	41.79	0	1977	12	20	17	44	23.8	NCEER
3.5	-76.91	46.84	11	1977	12	22	14	57	1.3	NCEER
3.2	-71.64	43.2	0	1977	12	25	15	35	53.5	NCEER
3.2	-70.55	44.07	9	1978	1	4	19	28	10.8	NCEER
3.1	-88.21	32.7	1	1978	1	8	11	34	23.4	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.8	-81.6	28.1	0	1978	1	12	21	10	0	DNAG
3	-105.31	42.43	5	1978	1	16	3	50	3.1	SRA
3	-88.01	38.244	5	1978	1	28	16	40	58.8	DNAG
3.3	-109.7	42.5	30	1978	2	7	5	3	10.4	SRA
4.1	-74.11	46.35	7	1978	2	18	14	48	25	NCEER
3.5	-102.5	31.55	1	1978	3	2	10	4	53	NCEER
3.1	-90	36.63	9	1978	4	3	12	24	21.5	NCEER
3	-69.89	47.751	22	1978	4	8	8	21	45	PDE
3.1	-78.24	39.7	15	1978	4	26	19	30	23.3	SRA
3.6	-101.95	42.26	38	1978	5	7	16	6	23	NCEER
3.2	-69.99	47.72	3	1978	5	26	2	31	0.4	NCEER
3	-107.32	39.28	5	1978	5	29	16	45	18	SRA
3.2	-88.46	38.41	20	1978	6	2	2	7	28.9	NCEER
3.8	-107.83	43.63	5	1978	6	6	21	23	34.7	SRA
3.3	-88.595	32.042	2	1978	6	9	23	15	19.6	SRA
3.4	-101.94	31.05	0	1978	6	29	20	58	45.1	DNAG
3.2	-68.39	48.75	18	1978	6	30	0	17	0	NCEER
3.1	-76.22	39.9	0	1978	7	16	6	39	29.7	NCEER
3.1	-105.04	34.68	0	1978	7	21	5	2	36.2	SNMX
3.4	-65.61	49.3	18	1978	7	29	13	56	43	NCEER
3.6	-74.44	45.68	7	1978	7	30	10	54	44	NCEER
3	-70.22	47.669	18	1978	8	14	22	55	58	PDE
3.1	-74.51	44.52	0	1978	8	21	8	47	0	NCEER
3	-76.43	47.17	5	1978	8	26	3	54	34.1	NCEER
3.5	-111.48	48.49	5	1978	8	30	16	33	21.2	SRA
3.5	-89.44	36.09	1	1978	8	31	0	31	0.6	NCEER
3	-90.28	38.58	1	1978	9	20	12	24	8.9	NCEER
3.1	-91.92	33.96	33	1978	9	23	7	34	3.7	NCEER
3	-76.15	40.08	0	1978	10	6	19	25	47.4	NCEER
3.8	-82.65	30.2	0	1978	11	6	23	0	0	DNAG
3.3	-67.62	48.96	18	1978	12	2	8	36	44	NCEER
3.5	-88.37	38.56	23	1978	12	5	1	48	2	NCEER
3.5	-88.47	31.91	3	1978	12	11	2	6	50.1	NCEER
3.3	-107.86	40.82	5	1979	1	20	6	59	8.4	SRA
3	-74.26	40.32	0	1979	1	30	16	30	52	NCEER
3.2	-90.1	35.84	10	1979	2	5	5	31	9.4	NCEER
3.3	-113.299	49.233	5	1979	2	24	15	49	15.5	PDE
3.4	-91.2	35.96	10	1979	2	27	22	54	54.8	NCEER
3.2	-74.5	40.72	0	1979	3	10	4	49	39.6	NCEER
3	-76.46	45.84	18	1979	3	18	16	31	12	NCEER
3.1	-108.9	40.18	2	1979	3	19	14	59	29.7	SRA
3.2	-70.1	47.69	10	1979	3	23	22	53	5	NCEER
3.2	-112.41	48.59	5	1979	4	14	9	39	6.4	SRA
3.1	-95.54	46.7	20	1979	4	16	6	40	16.7	SRA
4	-69.79	43.97	17	1979	4	18	2	34	15.3	NCEER
3.2	-66.03	45.24	18	1979	4	20	10	32	49.2	NCEER
3.1	-71.24	43.04	0	1979	4	23	0	5	45.7	NCEER
3.8	-111.02	37.88	7	1979	4	30	2	7	10.3	SRA
3.3	-75.68	46.18	1	1979	5	26	21	58	32.8	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3	-74.99	45	2	1979	5	29	20	48	49.1	NCEER
3.3	-67.54	49.37	18	1979	6	5	8	58	20	NCEER
3	-99.76	35.22	2	1979	6	7	7	39	36.3	NCEER
3.1	-73.86	44.43	0	1979	6	7	13	45	53.3	NCEER
3.8	-89.64	36.15	15	1979	6	11	4	12	17.1	NCEER
3	-110.904	37.861	7	1979	6	16	1	8	44.7	DNAG
3	-74.38	41.35	0	1979	6	20	19	20	17.8	SRA
3	-90.45	35.56	7	1979	6	25	17	11	13.8	NCEER
3	-97.29	39.92	7	1979	6	30	20	46	42.3	NCEER
3.8	-76.6	46.87	18	1979	7	8	1	29	18	NCEER
3.1	-89.31	36.91	2	1979	7	8	12	35	15.5	NCEER
3.7	-74.65	46.54	18	1979	7	9	8	16	26	NCEER
3.2	-100.32	40.18	4	1979	7	16	0	3	48.4	NCEER
3.1	-110.591	37.592	7	1979	7	25	23	56	11.7	DNAG
3.5	-70.44	43.29	11	1979	7	28	23	29	12	NCEER
3	-81.358	34.333	3	1979	8	7	19	32	17.2	SRA
3.8	-111.47	48.49	5	1979	8	9	17	12	55.4	SRA
3.7	-84.36	35.21	10	1979	8	13	5	18	56.8	NCEER
4.6	-69.9	47.67	10	1979	8	19	22	49	30.4	NCEER
3.7	-82.956	34.916	1	1979	8	26	1	31	45	USHIS
3.8	-91.5	36.3	0	1979	8	26	11	28	0	DNAG
3.2	-83.24	35.3	10	1979	9	6	20	38	16.3	NCEER
3.2	-83.91	35.58	12	1979	9	12	6	24	4	NCEER
3.4	-99.47	35.19	1	1979	9	13	0	49	21.5	NCEER
3.6	-82.08	36.44	5	1979	10	8	8	53	52.8	SRA
3.5	-110.93	37.89	7	1979	10	23	4	17	19.9	SRA
3.2	-91.04	36.46	6	1979	11	5	16	35	25.9	NCEER
3.6	-82.81	38.49	1	1979	11	9	21	29	59.8	NCEER
3.3	-98.41	35.63	5	1979	11	27	9	10	36.7	NCEER
3.8	-66.72	49.43	18	1979	12	19	18	58	10	NCEER
3.5	-91.22	49.62	18	1980	2	27	6	13	41	NCEER
3.1	-74.2	42.58	12	1980	2	29	5	53	56.1	SRA
3.7	-71.87	46.79	18	1980	3	11	4	15	55	NCEER
3.3	-75.09	40.15	0	1980	3	11	6	0	26.9	NCEER
3	-88.44	37.89	20	1980	3	13	2	23	13	NCEER
3.3	-86.76	37.6	9	1980	3	23	21	38	16.2	NCEER
4	-67.95	48.77	18	1980	4	3	16	57	24	NCEER
3.2	-68.36	44.71	0	1980	4	10	15	36	43.8	NCEER
4.1	-81.64	49.64	18	1980	4	13	22	40	23	NCEER
3.6	-112.34	48.79	5	1980	4	14	3	27	33.8	SRA
3	-81.324	34.329	3	1980	4	24	6	16	57.2	SRA
3	-75	40.3	0	1980	5	2	19	2	0	NCEER
3	-75.25	45.26	19	1980	5	19	23	40	50	DNAG
3.4	-74.55	44.89	0	1980	5	23	8	39	44	NCEER
3.5	-75.23	43.56	1	1980	6	6	13	15	51.9	NCEER
3.4	-101.01	35.48	1	1980	6	9	22	37	12.3	NCEER
3	-82.81	35.46	1	1980	6	10	23	47	32.2	NCEER
3.3	-84.03	35.73	1	1980	6	25	18	2	1.6	NCEER
3.4	-70.75	47.56	10	1980	7	1	3	6	38	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-70.33	47.3	10	1980	7	2	7	50	33	NCEER
3.5	-89.6	36.56	4	1980	7	5	8	54	40.1	NCEER
3.2	-99.7	35.18	5	1980	7	18	14	29	46.8	NCEER
3.1	-74.17	45.14	5	1980	7	25	6	22	34	NCEER
3.1	-87.44	33.94	0	1980	7	25	15	30	12.5	SRA
5.2	-83.89	38.19	16	1980	7	27	18	52	21.4	NCEER
3.2	-81.364	34.351	1	1980	7	29	1	10	22.7	SRA
3	-82.04	49.9	18	1980	7	31	10	10	4	NCEER
3.1	-74.15	40.43	8	1980	8	2	17	20	59.7	SRA
3.3	-75.16	43.54	0	1980	8	11	14	54	46.1	NCEER
3.2	-82.99	41.99	1	1980	8	20	9	34	53.4	NCEER
3.1	-84.87	37.98	1	1980	8	23	3	49	3.7	NCEER
3	-74.9	39.8	0	1980	8	30	9	19	0	NCEER
3.2	-73.78	41.11	13	1980	9	4	4	30	55.8	SRA
3.2	-69	44.67	8	1980	9	8	5	59	55.2	NCEER
3.2	-105.12	41.18	0	1980	9	12	22	33	55.4	SRA
3.2	-74.02	43.63	0	1980	9	21	20	52	45.1	DNAG
3	-69.9	47.67	6	1980	9	30	18	26	1	NCEER
3.4	-80.57	43.15	5	1980	10	14	0	58	56.4	NCEER
3.1	-72.9	41.3	0	1980	10	24	17	27	38.2	NCEER
3	-97.76	35.46	1	1980	11	2	10	0	48.9	NCEER
3	-79.9	38.18	4	1980	11	5	21	48	14.7	NCEER
3.8	-89.43	36.17	5	1980	12	2	8	59	29.7	NCEER
3.4	-78.44	37.72	6	1981	2	11	13	44	16.4	NCEER
3.8	-91.8	30	0	1981	2	13	2	15	0	DNAG
3.3	-74.93	45.96	18	1981	2	19	7	7	10	NCEER
4.3	-104.96	39.91	8	1981	4	2	16	10	6.4	NCEER
3.5	-89.38	38.87	1	1981	4	8	1	53	13	SRA
3.3	-82.05	35.51	0	1981	4	9	7	10	31.2	NCEER
3.7	-65.7	45.93	18	1981	4	13	17	31	38	NCEER
3.5	-82.42	35.33	10	1981	5	5	21	21	56.7	NCEER
3	-91.63	36.76	1	1981	5	25	22	50	18.2	SRA
3	-110.37	36.83	1	1981	5	29	3	9	2.2	SRA
3	-81.67	36.18	1	1981	6	3	20	54	22.4	SRA
3.2	-94.32	31.99	5	1981	6	9	1	46	32.7	NCEER
3.4	-89.03	37.82	19	1981	6	9	14	15	47.8	NCEER
3.8	-89.9	43.9	0	1981	6	12	15	30	0	DNAG
3.7	-70	47.47	8	1981	6	16	17	55	4	NCEER
3.5	-90.07	35.85	9	1981	6	26	8	33	27	NCEER
3.1	-71.55	43.57	0	1981	6	28	22	42	35	NCEER
3.7	-74.62	45.14	13	1981	7	4	23	16	32	NCEER
3.5	-97.73	34.85	5	1981	7	11	21	9	21.8	NCEER
3.7	-66.8	49.82	18	1981	7	13	4	48	4	NCEER
3	-110.31	36.82	0	1981	7	14	19	29	51	SRA
4	-89.18	36.03	11	1981	8	7	11	53	44	NCEER
3	-73.54	44.07	1	1981	8	10	23	6	59.3	DNAG
3.3	-72.24	48.66	5	1981	8	23	23	17	20	NCEER
3.3	-80.59	43.15	1	1981	8	28	10	51	33	NCEER
3	-85.17	34.63	3	1981	9	4	17	21	44.5	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-81.41	42.8	9	1981	9	5	5	49	21	NCEER
3.1	-100.52	42.89	5	1981	9	7	0	38	9.1	SRA
3.1	-110.56	37.5	2	1981	9	10	7	55	9	SRA
3.4	-101.85	43.04	5	1981	9	13	22	16	29.7	NCEER
3.1	-66.11	49.53	18	1981	9	18	2	24	11	NCEER
3.5	-75.02	46.11	0	1981	9	18	7	16	7	NCEER
3.5	-75.56	46.37	0	1981	9	30	23	41	39	NCEER
3.3	-98.54	41.17	5	1981	10	9	21	54	27.8	NCEER
3	-112.92	49.29	18	1981	10	20	3	47	36	DNAG
3.7	-72.57	41.14	5	1981	10	21	16	49	6.9	NCEER
3.9	-65.25	49.83	18	1981	10	28	19	56	14	NCEER
3.2	-95.26	32.02	5	1981	11	6	12	36	40.5	NCEER
3	-89.39	36.09	12	1981	11	8	17	11	19	NCEER
3.4	-77.04	46.98	18	1981	11	12	18	40	14	NCEER
3.7	-66.61	47.03	5	1981	11	28	5	12	3	NCEER
3.3	-72.64	45.38	3	1981	12	6	16	11	27	NCEER
3.1	-86.43	35.18	13	1982	1	2	2	0	26.2	NCEER
3.9	-102.49	31.18	5	1982	1	4	16	56	8.1	NCEER
5.7	-66.6	47	5	1982	1	9	12	53	52	NCEER
4.7	-71.62	43.51	7	1982	1	19	0	14	42.6	NCEER
4.3	-92.22	35.22	0	1982	1	24	3	22	44.4	NCEER
3.3	-70.38	47.45	6	1982	1	27	1	35	56	NCEER
3	-70.94	41.87	0	1982	1	27	18	50	4.6	NCEER
3.4	-81.39	32.98	7	1982	1	28	4	52	51.9	SRA
3	-67.48	49.18	18	1982	1	30	15	44	35	DNAG
3.1	-90.06	35.92	10	1982	2	2	9	26	46.3	NCEER
3.3	-104.03	48.51	18	1982	3	9	13	10	50.1	NCEER
3	-82.48	46.65	1	1982	3	13	4	34	32	NCEER
3.1	-103.27	35.36	5	1982	3	16	11	3	2.7	NCEER
3	-79.88	46.3	18	1982	3	19	16	48	13	NCEER
3.4	-113.25	49.07	18	1982	3	21	21	43	21	DNAG
3	-98.46	29.85	5	1982	3	28	23	24	32.9	NCEER
3	-82.04	36.51	3	1982	4	13	13	4	13.3	NCEER
3	-111.3	38.22	9	1982	4	17	6	0	12.5	SRA
3.5	-92.24	35.18	0	1982	4	21	21	17	55	NCEER
3.1	-96.47	33.99	5	1982	5	3	7	54	48.6	NCEER
3.4	-109.7	44.64	11	1982	5	9	21	7	36.5	SRA
3	-77.96	40.41	0	1982	5	12	18	29	33	SRA
3.5	-92.23	35.2	2	1982	5	31	18	21	19.7	NCEER
3.5	-76.95	47.38	18	1982	6	23	0	22	0	NCEER
3.5	-92.21	35.22	6	1982	7	5	4	13	52	NCEER
3.6	-96.72	44.01	5	1982	7	11	19	42	28.4	NCEER
3.8	-74.55	46.09	17	1982	7	13	2	18	49	NCEER
3	-69.02	46.08	6	1982	7	15	7	27	55.4	SRA
3.1	-81.55	34.32	2	1982	7	16	14	16	2.9	SRA
3.7	-75.46	45.89	19	1982	8	6	6	29	10	NCEER
3.2	-92.24	35.19	4	1982	8	9	11	12	31.6	SRA
3.1	-88.73	37.25	5	1982	8	11	10	32	38.8	NCEER
3.7	-78.61	46.67	18	1982	8	13	1	6	42	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.3	-105.38	49.06	18	1982	8	17	4	49	25	NCEER
3.4	-70.38	47.37	20	1982	8	29	2	7	11	NCEER
3	-74.19	43.2	5	1982	8	31	10	16	28.4	NCEER
3.2	-108.85	42.72	5	1982	8	31	22	2	18.5	SRA
3	-82.9	34.96	3	1982	9	2	21	52	45.5	SRA
3.7	-76.61	45.67	12	1982	9	3	23	14	3	NCEER
3.2	-84.51	35.19	13	1982	9	5	10	11	9.4	NCEER
3.4	-84.25	35.68	8	1982	9	24	22	19	16.9	NCEER
3.5	-92.23	35.21	5	1982	9	25	23	17	5.5	SRA
3	-73.057	43.125	8	1982	9	28	22	24	12.5	DNAG
3.9	-102.57	36.1	5	1982	10	14	12	52	46.3	NCEER
3.3	-65.3	49.82	18	1982	10	29	21	50	57	NCEER
3.1	-84.89	32.64	0	1982	10	31	3	12	12.2	NCEER
3.3	-108.695	35.305	0	1982	11	3	17	54	1.9	SNMX
3.1	-100.2	35.2	0	1982	11	7	0	4	19	SRA
4.3	-97.85	43.01	5	1982	11	15	2	58	22.9	NCEER
3.5	-92.08	35.25	0	1982	11	21	16	35	31	NCEER
3	-73.43	45.34	5	1982	11	24	7	34	39	PDE
3	-71.52	43.62	6	1982	12	1	22	52	22.9	SRA
3.9	-70.22	47.54	16	1982	12	4	16	8	32	NCEER
3	-83.53	32.85	0	1982	12	11	0	25	0	NCEER
3.3	-78.83	46.82	18	1983	1	10	21	31	27	NCEER
4.1	-67.06	49.11	18	1983	1	17	19	35	52	NCEER
3.9	-92.16	35.28	0	1983	1	19	2	30	42	NCEER
3.1	-83.45	48.72	18	1983	1	20	9	16	45	NCEER
3.1	-67.86	47.46	15	1983	1	20	14	17	21	NCEER
3.3	-81.02	41.75	10	1983	1	22	7	46	58	NCEER
3.5	-83.56	32.85	0	1983	1	26	14	7	44.7	NCEER
3.1	-83.63	36.06	13	1983	1	27	22	9	35.1	NCEER
3.3	-110.674	37.778	7	1983	1	27	23	37	11.8	SRA
3.2	-88.31	34.73	0	1983	2	5	13	8	19	NCEER
3.5	-68.33	48.98	18	1983	2	11	15	46	56	NCEER
4	-105.729	42.232	5	1983	2	13	13	44	44	SRA
3.5	-112.373	48.539	14	1983	2	16	6	22	9.3	SRA
3.6	-89.6	36.19	1	1983	2	23	8	51	27	NCEER
3	-73.66	41.55	7	1983	2	26	19	59	35.4	NCEER
4.4	-99.41	44.21	5	1983	3	4	6	32	18.6	NCEER
3.4	-71.72	42.96	1	1983	3	24	14	27	20.4	NCEER
3.3	-82.46	35.33	12	1983	3	25	2	47	11.1	NCEER
3.2	-92.15	35.2	0	1983	3	30	4	15	26	NCEER
3.4	-102.38	35.32	5	1983	4	3	4	55	24.2	NCEER
3	-66.98	49.34	18	1983	4	13	16	6	53	DNAG
3	-110.633	38.305	2	1983	5	3	12	43	37.7	SRA
3.3	-102.198	42.955	5	1983	5	6	6	14	46.9	SRA
3.9	-66.6	47	5	1983	5	13	23	40	57	NCEER
4.3	-89.57	38.77	0	1983	5	15	5	16	22	NCEER
3.8	-69.89	47.7	11	1983	5	16	2	1	57	NCEER
3	-92.36	38.48	0	1983	5	16	14	3	4	NCEER
3.7	-69.46	45.54	10	1983	5	27	23	4	35.2	NCEER

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 48 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.4	-70.4	44.49	3	1983	5	29	5	45	49.9	NCEER
3.4	-70.22	47.45	10	1983	6	2	6	30	23	NCEER
3	-69.65	47.46	10	1983	6	4	5	0	23	NCEER
3.5	-66.68	47.04	5	1983	6	28	8	5	49	NCEER
3	-90.94	37.1	0	1983	7	8	9	41	40	NCEER
3.4	-84.15	35.55	10	1983	7	8	19	29	5.9	NCEER
3	-74.91	46.06	18	1983	7	17	22	47	45	NCEER
3	-70.95	46.53	10	1983	7	23	3	25	38	NCEER
3.4	-98.131	28.743	5	1983	7	23	15	24	38.2	SRA
3.7	-67.68	44.97	12	1983	8	12	14	8	47.6	NCEER
3.5	-82.77	38.47	10	1983	8	17	14	3	15	NCEER
3.4	-104.314	37.469	5	1983	8	17	15	3	27.6	SRA
3.1	-83.82	36.68	18	1983	8	28	22	45	7.4	NCEER
3.1	-104.43	34.922	0	1983	9	15	23	25	37.5	SNMX
4.1	-108.837	40.789	5	1983	9	24	16	57	45.7	SRA
3.1	-79.79	43.44	2	1983	10	4	17	18	40	NCEER
5.2	-74.31	44.03	7	1983	10	7	10	18	47	NCEER
4.2	-75.77	45.21	15	1983	10	11	4	10	55	NCEER
3.1	-75.05	45.62	11	1983	10	16	3	0	47	NCEER
3.8	-93.39	30.24	5	1983	10	16	19	40	50.8	NCEER
3.2	-66.31	47.21	5	1983	10	17	22	58	56	NCEER
3.1	-77.97	48.14	1	1983	10	24	1	0	6	NCEER
3.5	-73.9	45.68	18	1983	11	1	10	16	52	NCEER
3.3	-80.16	32.94	10	1983	11	6	9	2	19.8	NCEER
3	-105.955	43.016	5	1983	11	15	12	33	12.1	SRA
3.8	-66.6	47	5	1983	11	17	15	32	18	NCEER
3.3	-69.16	45.19	2	1983	12	4	10	48	33.6	NCEER
3	-67.17	45.11	7	1983	12	8	12	23	5	NCEER
3	-92.704	33.183	5	1983	12	9	20	52	10.5	SRA
3.2	-76.29	46.69	18	1983	12	14	1	52	3	NCEER
3.1	-73.97	45.24	18	1983	12	21	15	4	44	NCEER
3.4	-76.33	47.01	18	1983	12	28	12	24	21	NCEER
3	-89.75	37.59	2	1984	1	12	2	48	15.7	SRA
3.5	-67.16	44.88	18	1984	1	14	9	9	32	NCEER
3	-83.43	41.65	0	1984	1	14	20	14	31	NCEER
3.3	-110.845	47.149	5	1984	1	16	19	50	25.2	SRA
3.1	-75.12	45.56	19	1984	1	17	19	4	46	NCEER
3.2	-89.92	36.61	1	1984	1	28	21	29	22.1	SRA
3.2	-97.36	34.67	5	1984	2	3	4	38	28	NCEER
3.6	-83.74	36.13	10	1984	2	14	20	54	30.9	NCEER
3.6	-89	37.21	0	1984	2	14	22	56	10	NCEER
3.7	-66.6	47	5	1984	2	24	3	17	14	PDE
3.2	-108.638	41.539	2	1984	3	1	18	13	0.9	SRA
3.8	-98.461	28.852	5	1984	3	3	1	3	26.5	SRA
3	-84.05	35.83	7	1984	3	17	23	26	11.4	NCEER
3	-66.49	46.91	5	1984	3	27	22	56	24	DNAG
3.2	-66.46	49.61	18	1984	3	29	22	52	50	DNAG
3.4	-102.4	35.32	0	1984	4	3	4	55	24	SRA
3.8	-67.52	49.3	18	1984	4	11	19	7	42	DNAG

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-66.6	47	5	1984	4	13	15	35	51	DNAG
3.4	-88.44	38.38	0	1984	4	17	4	44	44	NCEER
3.1	-107.19	39.281	5	1984	4	22	17	30	56.7	SRA
4.1	-76.37	39.95	4	1984	4	23	1	36	0	NCEER
3.2	-107.228	39.322	5	1984	5	14	10	14	17.2	SRA
3.4	-102.4	35.4	0	1984	5	21	13	30	14	SRA
3.1	-102.228	35.067	5	1984	5	21	13	31	13.5	SRA
3.6	-102.155	39.22	5	1984	5	27	23	30	19.3	SRA
3.2	-66.33	49.6	18	1984	5	28	21	4	52	DNAG
3.5	-80.78	46.63	1	1984	6	20	16	10	22	PDE
3.2	-89.39	36.1	12	1984	6	26	15	15	19.9	NCEER
3.1	-75.68	46.23	0	1984	6	28	3	8	49	DNAG
3.8	-88.47	37.7	2	1984	6	29	7	58	29.3	NCEER
3	-66.6	47	5	1984	7	2	5	24	54	DNAG
4.1	-81.17	46.53	1	1984	7	6	17	24	52	PDE
3	-89.53	36.5	7	1984	7	16	3	50	53.5	NCEER
4	-87.07	39.22	10	1984	7	28	23	39	27.4	NCEER
3	-90.92	37.82	7	1984	7	30	7	33	46.5	NCEER
3	-67.05	45.32	18	1984	8	3	13	41	11	DNAG
3	-98.362	29.133	5	1984	8	8	1	31	27.3	SRA
3.2	-86.3	34.62	8	1984	8	9	2	42	35.8	NCEER
4.2	-78.324	37.868	8	1984	8	17	18	5	46.9	SRA
3.2	-73.48	44.875	11	1984	8	20	10	58	17	SRA
3.1	-87.45	39.11	10	1984	8	29	6	50	59.5	NCEER
3.1	-84.34	35.57	13	1984	8	30	16	26	28.4	NCEER
5	-106.11	44.138	15	1984	9	8	0	59	31.1	USHIS
3.2	-100.697	31.991	5	1984	9	11	14	47	33.5	SRA
3.2	-108.582	41.61	2	1984	9	14	19	4	26.3	SRA
3.4	-92.21	35.25	5	1984	9	27	13	3	6	NCEER
3	-91.7	35.72	5	1984	9	27	13	16	22.9	NCEER
4.2	-85.2	34.75	12	1984	10	9	11	54	26.9	NCEER
3	-66.59	47.08	5	1984	10	13	1	45	15	DNAG
3.3	-65.66	44.72	18	1984	10	13	12	53	45	DNAG
5.4	-105.735	42.317	22	1984	10	18	15	30	22	USHIS
3.2	-81.68	36.36	11	1984	10	22	18	58	41.7	NCEER
3.5	-73.93	43.59	0	1984	10	23	6	26	21.9	NCEER
4.7	-108.919	42.534	5	1984	11	3	9	30	8.4	USHIS
3.1	-97.41	34.71	5	1984	11	20	10	57	31.9	NCEER
3.2	-75.05	45.19	14	1984	11	26	9	3	49	PDE
3.7	-66.58	46.98	14	1984	11	30	5	54	22	PDE
3	-89.7	36.16	11	1984	12	3	11	55	44.6	NCEER
3.6	-66.04	47.52	1	1984	12	9	18	12	21	DNAG
3.5	-82.6	46.5	0	1984	12	17	9	38	36	PDE
3	-70.25	47.4	19	1984	12	22	12	46	30	DNAG
3	-89.91	35.93	9	1985	1	30	9	35	12.4	SRA
3.1	-89.51	36.29	7	1985	2	7	23	44	35.3	NCEER
3	-87.5	38.42	3	1985	2	13	10	22	24	SRA
3.3	-89.34	37.23	6	1985	2	15	15	56	9.9	NCEER
3.2	-70.48	47.39	14	1985	3	3	12	15	17	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-105.85	38.558	5	1985	3	16	21	55	2.4	SRA
3.1	-69.96	47.52	12	1985	4	10	5	52	57	DNAG
3.1	-70.704	45.364	2	1985	4	12	5	27	30.5	SRA
3.2	-80.4	41.59	18	1985	4	14	11	39	54	DNAG
3.4	-108.92	35.26	0	1985	4	14	21	48	2.9	SNMX
3.1	-90.77	36.27	9	1985	5	4	7	7	12.5	SRA
3.2	-75.9	46.83	18	1985	5	16	13	39	7	DNAG
3.2	-80.485	37.248	11	1985	6	10	12	22	38.3	SRA
3.6	-82.038	37.222	1	1985	6	19	22	28	8.9	SRA
3	-85.156	35.198	3	1985	7	12	18	20	28.4	SRA
3.3	-92.202	35.219	5	1985	8	3	4	23	11	DNAG
3.5	-108.649	41.817	5	1985	8	13	20	57	0.8	SRA
4.3	-108.06	42.813	10	1985	8	16	6	5	22.6	SRA
3.1	-67.67	49.3	0	1985	8	16	22	48	37	DNAG
3	-110.232	46.109	5	1985	8	22	2	12	5	SRA
3.1	-76.64	45.67	18	1985	8	24	6	4	2	PDE
3.6	-93.118	35.809	10	1985	9	6	22	17	2.8	SRA
3	-88.014	41.848	5	1985	9	9	22	6	31	SRA
3.3	-97.051	33.548	5	1985	9	18	15	54	4.6	SRA
4	-66.6	47	5	1985	10	5	5	34	14	PDE
3	-109.498	40.407	21	1985	10	7	20	33	40.1	SRA
3.1	-71.471	42.528	13	1985	10	15	20	0	38.4	SRA
3.9	-73.829	40.983	6	1985	10	19	10	7	40.3	USHIS
3.3	-73.45	45.29	5	1985	11	1	23	33	39	PDE
3.3	-92.188	35.223	4	1985	11	8	19	56	48.5	SRA
3.2	-113.36	49.18	18	1985	12	4	8	38	14	DNAG
3.8	-89.99	35.88	5	1985	12	5	22	59	41.2	SRA
3	-104.665	35.437	0	1985	12	15	7	14	52.6	SNMX
3.1	-66.6	47	5	1985	12	21	6	3	11	DNAG
3.3	-83.72	35.701	13	1985	12	22	0	56	5	SRA
3.5	-88.965	38.552	5	1985	12	29	8	56	56.3	SRA
3.2	-84.762	35.609	22	1986	1	7	1	26	43.3	SRA
3.3	-77.32	45.8	18	1986	1	10	9	59	48	PDE
4	-70.18	47.7	18	1986	1	11	13	30	28	PDE
3.3	-100.693	32.066	5	1986	1	30	22	26	37	SRA
4.9	-81.162	41.65	2	1986	1	31	16	46	42.3	USHIS
3.5	-82.907	34.793	5	1986	2	13	11	35	45.3	SRA
3.1	-102.514	35.308	5	1986	3	3	11	45	17.4	SRA
3.5	-66.6	47	5	1986	3	6	8	34	51	PDE
3	-85.51	35.187	27	1986	4	19	7	40	53	SRA
4.4	-87.347	33.335	1	1986	5	7	2	27	0.4	SRA
3.3	-66.14	46.54	18	1986	5	9	9	4	33	PDE
3.2	-110.319	37.294	8	1986	5	14	15	2	55.7	SRA
3	-92.217	35.178	5	1986	5	24	8	16	1.5	SRA
3.4	-89.88	36.58	10	1986	5	24	12	48	13.5	SRA
3.4	-98.289	43.937	5	1986	5	25	7	13	22.1	SRA
3.4	-66.6	47	5	1986	6	1	14	53	14	PDE
3	-99.781	39.344	5	1986	6	2	4	4	5.2	SRA
3.3	-75.09	46.34	8	1986	6	5	12	13	22	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}
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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3	-105.694	42.397	20	1986	6	12	15	14	34	SRA
3.8	-84.987	34.937	13	1986	7	11	14	26	14.8	USHIS
4.5	-84.371	40.537	10	1986	7	12	8	19	37.9	USHIS
3.4	-68.198	46.17	9	1986	7	12	20	32	48.4	SRA
3.5	-75.22	46.37	18	1986	8	6	11	19	36	PDE
3.3	-74.246	45.131	24	1986	8	13	4	55	18.4	PDE
4	-110.574	37.42	5	1986	8	22	13	26	33.3	SRA
3.7	-89.79	38.32	5	1986	8	26	16	41	24.8	SRA
3.1	-105.17	35.12	0	1986	8	27	18	6	58	SNMX
3.5	-107.09	38.912	5	1986	9	3	6	20	50.9	SRA
4.2	-70.32	47.3	22	1986	9	19	15	53	1	PDE
4.1	-66.6	47	5	1986	10	17	14	47	59	PDE
3	-101.372	37.918	5	1986	10	20	4	32	49	SRA
3.9	-71.59	43.399	5	1986	10	25	17	16	38.4	SRA
3.3	-108.896	41.922	5	1986	11	3	0	23	45	SRA
3	-110.297	37.43	1	1986	11	7	1	31	53.7	SRA
3	-82.88	34.898	9	1986	12	11	14	7	11.5	SRA
3.5	-89.58	36.42	14	1986	12	30	7	15	19.1	SRA
3.5	-103.482	42.788	5	1987	1	1	8	2	24	PDE
3	-89.978	35.893	5	1987	1	16	3	25	35.7	PDE
3.1	-98.097	35.828	5	1987	1	24	16	8	17	PDE
3.8	-110.616	40.442	1	1987	3	5	3	2	50.4	PDE
4.2	-84.229	35.567	19	1987	3	27	7	29	30.4	USHIS
5.2	-87.954	38.713	10	1987	6	10	23	48	54.8	USHIS
4.1	-89.686	36.605	5	1987	6	13	21	17	12.8	PDE
3.6	-89.173	36.839	5	1987	7	7	19	19	5.7	PDE
3	-98.292	44.332	10	1987	7	9	22	6	45.4	PDE
3.4	-83.817	36.103	25	1987	7	11	0	4	29.4	PDE
3.8	-80.767	41.896	5	1987	7	13	5	49	17.4	PDE
3.4	-79.472	43.491	6	1987	7	23	9	32	28.5	PDE
3.1	-89.688	38.308	5	1987	8	31	17	12	35.5	PDE
3.3	-84.311	35.623	19	1987	9	22	17	23	50.1	PDE
3.7	-74.517	44.375	10	1987	9	26	17	44	6.9	PDE
4.5	-89.21	36.84	5	1987	9	29	0	4	57.2	USHIS
3.6	-107.381	45.771	5	1987	10	5	18	54	49.3	PDE
3.8	-88.793	37.049	5	1987	10	14	15	49	39.5	PDE
3	-98.599	44.472	5	1987	10	15	10	54	33.8	PDE
3.5	-83.099	36.848	14	1987	11	27	18	58	29.5	PDE
3.7	-98.024	36.055	5	1987	12	8	1	42	40.3	PDE
3	-82.628	34.244	5	1987	12	12	3	53	28.7	PDE
3.3	-84.201	35.275	12	1988	1	9	1	7	40.7	PDE
3.6	-89.621	46.559	5	1988	1	14	17	23	36.5	PDE
3.3	-80.157	32.935	7	1988	1	23	1	57	16.3	PDE
4.9	-65.58	48	18	1988	1	28	8	38	28	PDE
3.5	-90.465	35.681	10	1988	1	31	0	12	43.4	PDE
3.3	-108.532	40.626	5	1988	2	14	18	32	40.5	PDE
3.2	-82.304	36.561	5	1988	2	16	15	26	54.5	PDE
3.5	-83.853	35.366	5	1988	2	18	0	37	45.9	PDE
3.3	-66.6	47	5	1988	3	6	18	13	18.1	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.9	-75.716	46.341	18	1988	3	10	14	42	55.2	PDE
3.4	-99.155	39.093	5	1988	4	14	9	39	31.4	PDE
4.1	-81.987	37.238	0	1988	4	14	23	37	31.1	PDE
3.4	-66.6	47	5	1988	5	9	1	23	3.6	PDE
3.5	-75.58	45.17	7	1988	5	15	6	10	5.6	PDE
3.3	-92.77	37.288	5	1988	5	20	23	6	22.6	PDE
3.3	-110.448	36.374	5	1988	7	15	0	38	9.5	PDE
3.5	-74.955	44.995	10	1988	8	9	13	57	26.9	PDE
5.4	-110.869	39.128	10	1988	8	14	20	3	3.9	USHIS
3.8	-66.59	46.99	5	1988	8	26	5	59	10.2	PDE
4.6	-83.878	38.143	10	1988	9	7	2	28	9.5	USHIS
3.5	-87.931	38.69	5	1988	10	5	0	38	52.2	PDE
3.9	-71.158	44.539	5	1988	10	20	13	9	50.1	USHIS
3.8	-70.386	44.424	5	1988	11	14	6	15	43.1	PDE
5.8	-71.183	48.117	28	1988	11	25	23	46	4.5	PDE
3.3	-92.702	34.189	13	1988	12	25	15	57	57.7	PDE
3.5	-69.342	44.514	10	1988	12	28	6	28	44.4	PDE
3.5	-89.428	36.185	5	1988	12	31	14	24	20.5	PDE
3.8	-67.357	49.264	18	1989	1	1	17	55	53.6	PDE
3.1	-112.862	49.056	5	1989	1	4	18	50	9.7	PDE
3.4	-104.103	35.183	0	1989	1	29	5	7	15.6	SNMX
3.8	-101.898	42.685	5	1989	2	9	5	15	45.8	PDE
3.5	-87.092	33.643	0	1989	2	28	17	31	50.8	PDE
4.4	-69.9	47.7	18	1989	3	11	8	31	52.1	PDE
3.5	-71.144	44.511	5	1989	4	6	2	35	51.3	PDE
3.7	-105.602	47.716	5	1989	4	7	8	26	48.9	PDE
3	-89.711	36.557	5	1989	4	15	16	39	51.1	PDE
4.4	-89.768	36.006	10	1989	4	27	16	47	49.8	USHIS
3.7	-89.71	36.74	2	1989	5	14	0	16	9.5	PDE
3.9	-99.477	39.165	5	1989	6	8	18	18	43.3	PDE
3.1	-83.569	38.607	10	1989	7	15	0	8	2.6	PDE
3.1	-98.876	36.434	5	1989	7	20	6	7	50.4	PDE
3.3	-79.53	43.21	18	1989	8	5	21	7	59.1	PDE
3.5	-65.82	46.65	18	1989	8	10	21	17	43.5	PDE
3.4	-87.086	33.632	0	1989	8	13	20	16	2.9	PDE
3.9	-87.645	34.736	10	1989	8	20	0	3	17.8	USHIS
3	-70.899	41.614	5	1989	8	24	15	56	59.3	PDE
3	-108.948	47.547	5	1989	8	31	4	2	38.3	PDE
3.4	-89.62	36.545	11	1989	9	14	17	31	28	PDE
3	-107.027	41.207	5	1989	11	2	6	23	56.2	PDE
4	-76.59	46.57	18	1989	11	16	9	24	52	PDE
3	-107.767	38.055	5	1989	11	19	3	21	13.6	PDE
3.3	-99.908	45.317	5	1989	11	26	1	6	14.6	PDE
3.2	-90.744	35.245	5	1989	12	25	8	29	26.9	PDE
3.9	-86.434	38.133	5	1990	1	24	18	20	24.4	PDE
4	-102.504	43.313	5	1990	1	28	4	59	59.1	PDE
3.6	-89.219	38.868	10	1990	3	2	7	1	47.7	PDE
3	-91.49	36.72	5	1990	3	18	16	22	33	PDE
3.5	-68.23	47.28	18	1990	3	30	1	54	9	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 53 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.1	-112.37	48.717	6	1990	4	4	21	42	33.6	PDE
3.5	-109.519	40.082	3	1990	4	7	15	37	54.8	PDE
3	-84.852	40.46	5	1990	4	17	10	27	34.7	PDE
3	-88.23	39.556	10	1990	4	24	9	41	24.3	PDE
3	-110.828	38.952	11	1990	6	25	17	15	33.5	PDE
3	-98.954	41.507	5	1990	7	18	2	47	3.9	PDE
3	-89.24	36.85	6	1990	8	7	5	5	56.4	PDE
3.8	-83.34	36.794	10	1990	8	17	21	1	17.9	PDE
3.5	-89.66	35.83	13	1990	8	29	19	34	59.9	PDE
3.3	-83.731	38.061	5	1990	9	8	0	3	57.4	PDE
3	-106.206	39.701	5	1990	9	12	21	38	57.6	PDE
4.9	-89.577	37.165	12	1990	9	26	13	18	51.3	PDE
3	-101.505	41.815	5	1990	9	30	0	6	24	PDE
3.9	-75.19	46.32	17	1990	10	7	8	47	30.5	PDE
4.9	-75.59	46.47	13	1990	10	19	7	1	57.4	PDE
3	-75.506	39.512	10	1990	10	23	1	34	48.2	PDE
3.3	-88.99	38.31	5	1990	10	24	8	20	4.3	PDE
3.9	-98.472	43.794	5	1990	10	25	6	25	25.5	PDE
3.5	-89.62	36.54	8	1990	11	9	3	39	15.9	PDE
3.2	-80.136	32.947	3	1990	11	13	15	22	13	PDE
3.8	-97.59	34.76	5	1990	11	15	11	44	41.4	PDE
4.1	-76.219	47.128	18	1990	11	15	13	47	15.7	PDE
3.5	-66.6	47	5	1990	12	12	5	15	7.1	PDE
3.2	-87.044	40.068	10	1990	12	17	5	24	59.1	PDE
3.6	-86.671	39.57	10	1990	12	20	14	4	17.1	PDE
4.3	-72.556	47.579	18	1990	12	31	3	53	58.3	PDE
3	-88.86	37.946	5	1991	1	23	9	25	23.5	PDE
3	-97.3	36.378	5	1991	1	24	5	0	26.9	PDE
3.3	-81.453	41.536	5	1991	1	26	3	21	22.6	PDE
3.4	-111.429	37.681	9	1991	1	26	21	49	38	PDE
3	-89.95	35.98	14	1991	2	11	0	0	6.1	PDE
3.3	-109.483	40.091	1	1991	3	2	8	41	37.4	PDE
3.9	-76.874	46.282	18	1991	3	6	5	26	53.6	PDE
3.8	-77.916	37.746	17	1991	3	15	6	54	8.2	PDE
3.9	-66.594	49.698	18	1991	3	21	4	10	59.3	PDE
3	-106.857	42.031	5	1991	4	13	19	8	5.1	PDE
3.5	-80.207	37.941	14	1991	4	22	1	1	20.2	PDE
3.6	-66.6	47	5	1991	4	23	3	19	19	PDE
4.7	-89.823	36.564	5	1991	5	4	1	18	54.9	PDE
3.6	-74.4	45.5	18	1991	5	17	18	8	47	PDE
3.5	-99.4	39.2	5	1991	5	30	22	7	44	PDE
3.6	-112.007	48.374	5	1991	6	5	9	24	7.6	PDE
4.3	-76.7	47	18	1991	6	16	16	46	53	PDE
4	-74.678	42.63	5	1991	6	17	8	53	16.7	PDE
3	-110.358	37.209	1	1991	6	25	21	2	13.6	PDE
3.2	-81.668	38.276	5	1991	6	28	18	34	51.9	PDE
3.3	-91.71	37.49	5	1991	7	2	3	49	1.7	PDE
3.8	-73.896	45.232	18	1991	7	5	1	47	36.7	PDE
3.9	-91.643	36.658	5	1991	7	7	21	24	2.6	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

(Page 54 of 60)

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3	-89.44	36.14	12	1991	7	8	23	49	7.4	PDE
3.5	-98.042	28.908	10	1991	7	20	23	38	19.2	PDE
3.5	-108.861	43.502	5	1991	8	7	12	49	16.6	PDE
3	-77.657	40.786	1	1991	8	15	7	16	7.1	PDE
3.4	-100.533	42.162	5	1991	8	26	11	49	15.4	PDE
3.1	-84.095	35.711	5	1991	9	24	7	21	6.4	PDE
3.1	-89.432	36.841	5	1991	10	3	11	46	4.8	PDE
3	-73.578	41.07	10	1991	10	28	20	58	26.1	PDE
3.8	-87.894	38.713	10	1991	11	11	9	20	47.4	PDE
3	-90.27	35.72	9	1991	11	13	9	43	15.9	PDE
3	-108.895	47.952	10	1991	12	5	10	10	0.7	PDE
4	-69.8	47.7	18	1991	12	8	3	0	30	PDE
3.1	-106.917	41.936	5	1991	12	18	21	36	47.9	PDE
3.4	-106.715	45.82	5	1991	12	23	20	32	27.2	PDE
5	-103.187	32.302	0	1992	1	2	11	45	35.3	SNMX
3.2	-82.465	33.946	5	1992	1	3	4	21	22.2	PDE
3	-74.341	40.363	7	1992	1	9	8	50	45.2	PDE
3.5	-81.245	41.911	5	1992	3	15	6	13	55.2	PDE
3.3	-89.479	35.828	12	1992	4	3	3	6	3.9	PDE
3.2	-104.773	37.335	5	1992	4	15	22	46	5	PDE
3.1	-90.41	36.92	5	1992	4	30	0	1	30.9	PDE
3.2	-70.407	47.446	2	1992	5	1	0	37	51.4	PDE
3.1	-104.778	37.378	5	1992	5	2	10	19	29.8	PDE
3.7	-74.964	46.444	18	1992	5	19	5	59	41	PDE
3.3	-99.549	38.76	5	1992	7	15	2	56	40.7	PDE
4.2	-80.116	33.05	10	1992	8	21	16	31	55.1	PDE
3	-102.708	32.173	5	1992	8	26	3	24	52.6	PDE
3.3	-89.68	37.63	5	1992	8	26	5	41	38.4	PDE
3.6	-107.041	43.825	5	1992	8	31	1	40	14.2	PDE
3.4	-71.578	43.324	5	1992	10	6	15	38	4	PDE
4	-108.242	42.819	5	1992	10	10	15	40	56.2	PDE
3	-104.389	42.74	5	1992	11	2	6	54	10.3	PDE
3.3	-112.611	49.001	5	1992	11	17	3	37	22.9	PDE
4.2	-74.862	45.764	18	1992	11	17	3	58	0.9	PDE
3.5	-97.581	34.744	5	1992	12	17	7	18	4.2	PDE
3.2	-89.63	37.5	5	1992	12	27	10	12	58.9	PDE
3	-82.09	35.877	3	1993	1	1	5	8	5.3	PDE
3.3	-112.19	48.897	5	1993	1	1	15	57	41.9	PDE
3.5	-90.03	35.83	21	1993	1	8	13	1	18.8	PDE
3.1	-98.275	36.595	5	1993	1	14	17	6	10.4	PDE
3.1	-84.974	35.075	1	1993	1	15	2	2	51.8	PDE
3	-89.617	36.222	13	1993	1	21	19	46	19.3	PDE
3.4	-112.403	49.212	5	1993	1	22	6	2	32.7	PDE
3.2	-89.04	39.038	5	1993	1	29	13	56	23.2	PDE
3.5	-89.73	36.66	7	1993	2	6	2	9	45.5	PDE
3.5	-101.461	42.83	5	1993	2	20	13	8	10.1	PDE
3.7	-106.062	44.932	5	1993	2	25	3	44	15.5	PDE
3.1	-89.49	36.67	8	1993	3	2	0	29	11.8	PDE
3.2	-106.617	43.399	5	1993	3	10	3	54	31.1	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}
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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.2	-90.55	35.67	10	1993	3	16	7	38	10.2	PDE
3	-104.438	35.15	0	1993	3	24	2	32	5.9	SNMX
3.3	-89.42	36.79	5	1993	3	31	20	23	21.2	PDE
4.2	-98.124	28.811	5	1993	4	9	12	29	19.1	PDE
3.6	-89.44	36.19	7	1993	4	28	22	40	1.9	PDE
3.5	-75.5	46.3	18	1993	5	6	1	23	25.9	PDE
3.8	-107.575	42.304	5	1993	6	1	21	33	22.9	PDE
4.1	-96.293	45.674	10	1993	6	5	1	24	53	PDE
3	-105.373	42.985	5	1993	6	30	6	50	57.8	PDE
3.1	-106.715	39.227	5	1993	7	8	4	3	52.2	PDE
3.7	-88.341	31.747	5	1993	7	16	10	54	32.8	PDE
3.7	-105.703	42.478	5	1993	7	23	6	30	23.8	PDE
3.9	-74.12	45.26	8	1993	7	30	22	30	54	PDE
3	-89.88	36	11	1993	8	5	7	21	37.4	PDE
3.2	-81.595	33.633	5	1993	8	8	9	24	31.1	PDE
3	-109.921	43.576	5	1993	8	23	5	29	47.6	PDE
3	-106.837	42.033	5	1993	8	23	13	12	13.8	PDE
3.3	-90.36	38.09	16	1993	8	27	0	8	34	PDE
3.5	-75.05	46.457	15	1993	8	30	5	15	28.5	PDE
3.7	-74.605	46.065	18	1993	9	23	6	45	28.4	PDE
3	-103.56	35.568	0	1993	9	29	2	1	28.5	SNMX
3.7	-105.868	42.421	5	1993	10	10	4	17	46.7	PDE
3.5	-81.012	41.698	5	1993	10	16	6	30	5.3	PDE
3.5	-107.384	43.884	5	1993	11	16	7	26	4	PDE
4.2	-73.495	45.182	17	1993	11	16	9	31	44.2	PDE
3.3	-103.157	35.808	0	1993	11	30	3	7	36.3	SNMX
3.5	-70.06	47.53	8	1993	12	1	12	47	15	PDE
3.5	-105.499	42.333	5	1993	12	13	14	51	3	PDE
4.3	-75.606	46.506	18	1993	12	25	16	44	22.3	PDE
4.7	-110.132	43.483	8	1993	12	28	21	2	28.7	PDE
3.8	-70.367	47.453	7	1993	12	30	23	1	47.5	PDE
4.6	-76.037	40.33	5	1994	1	16	1	49	16.2	PDE
3.3	-100.141	42.627	5	1994	1	25	2	44	39.8	PDE
4.2	-89.18	37.37	16	1994	2	5	14	55	37.7	PDE
3.1	-95	45	5	1994	2	9	8	45	35.5	PDE
3.2	-82	36.8	5	1994	2	12	2	40	24.5	PDE
3.5	-77.876	42.782	1	1994	3	12	10	43	15.7	PDE
3.6	-65.74	48.99	18	1994	3	28	16	28	23	PDE
3.2	-85.493	34.961	5	1994	4	5	22	21	59	PDE
3.1	-89.27	38.123	10	1994	4	6	17	38	55.8	PDE
3	-87.174	34.198	5	1994	5	4	9	12	2.7	PDE
3.2	-92.671	33.013	5	1994	6	10	23	34	2.9	PDE
4	-66.6	47	5	1994	7	14	12	41	52	PDE
3.7	-76.751	35.067	5	1994	8	6	19	54	9.9	PDE
4.1	-111.333	48.489	5	1994	8	16	11	3	41.7	PDE
3.5	-91.058	36.136	5	1994	8	20	10	45	44.6	PDE
3.5	-84.604	42.798	5	1994	9	2	21	23	6.5	PDE
3	-69.232	43.861	5	1994	9	5	14	13	52.2	PDE
4.5	-107.976	38.151	10	1994	9	13	6	1	23	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.6	-68.223	45.306	5	1994	9	16	4	22	42.5	PDE
4.2	-69.96	47.77	17	1994	9	25	0	53	28	PDE
3.6	-88.935	36.929	5	1994	9	26	14	23	22	PDE
3.6	-72.277	42.347	10	1994	10	2	11	27	22.5	PDE
3.4	-108.269	40.04	5	1994	11	3	11	40	10.1	PDE
4	-104.811	39.29	10	1994	12	25	19	6	7.5	PDE
4.1	-97.596	34.774	5	1995	1	18	15	51	39.4	PDE
5.2	-109.64	41.529	1	1995	2	3	15	26	10.6	PDE
3.1	-94.952	40.505	5	1995	2	11	5	54	10.1	PDE
3.5	-75.04	45.9	18	1995	2	15	15	53	57	PDE
3.6	-83.47	39.12	10	1995	2	19	12	57	6	PDE
3	-74.426	44.233	4	1995	3	2	5	33	51.4	PDE
3.3	-112.35	48.65	10	1995	3	5	12	17	11.5	PDE
3.3	-84.922	35.425	17	1995	3	18	22	6	21	PDE
3.3	-104.212	35	5	1995	3	19	18	36	43.9	PDE
4.1	-108.925	40.179	5	1995	3	20	12	46	16.3	PDE
3.9	-80.068	32.947	10	1995	4	17	13	45	57.8	PDE
3.3	-67.73	49.15	15	1995	4	20	4	37	5	PDE
3.9	-66.6	47	5	1995	5	6	7	51	35	PDE
3.5	-89.43	36.17	6	1995	5	27	19	51	10.4	PDE
3.4	-87.827	33.191	1	1995	5	28	15	28	36.9	PDE
3	-96.732	34.287	5	1995	6	1	4	49	29.3	PDE
3.6	-76.29	47.02	18	1995	6	3	22	44	32	PDE
3.8	-71.915	44.286	5	1995	6	16	12	13	11.4	PDE
3.5	-81.452	36.747	5	1995	6	26	0	36	17	PDE
3.8	-104.814	36.246	5	1995	7	4	3	59	4.5	PDE
3.7	-84.212	35.366	10	1995	7	5	14	16	44.4	PDE
3	-81.873	36.515	11	1995	7	7	21	1	2.8	PDE
3.3	-87.665	33.478	1	1995	7	15	1	3	28.3	PDE
3	-89.632	36.528	5	1995	7	20	2	10	34.4	PDE
3	-74.953	46.168	20	1995	7	28	5	47	37.1	PDE
3.1	-89.409	36.102	5	1995	8	17	23	18	50.8	PDE
3	-73.28	45.41	18	1995	8	20	16	15	26	PDE
3.7	-74.43	45.61	18	1995	9	12	3	59	5	PDE
3.9	-98.69	36.87	5	1995	9	15	0	31	33.2	PDE
3.1	-74.21	45.08	18	1995	9	21	23	3	27	PDE
3.3	-78.77	46.42	18	1995	10	10	7	19	20	PDE
3.7	-96.864	45.788	5	1995	10	20	15	57	18.7	PDE
3.6	-104.917	38.732	5	1995	12	23	6	51	48.8	PDE
4.2	-110.878	39.12	0	1996	1	6	12	55	58.6	PDE
3.6	-97.542	42.513	5	1996	2	6	15	10	28.2	PDE
3.7	-103.729	43.981	5	1996	2	6	16	8	36.7	PDE
4.3	-74.43	45.99	18	1996	3	14	10	42	26	PDE
3.1	-71.242	41.69	11	1996	3	22	20	22	12.5	PDE
3.3	-102.601	35.61	5	1996	3	25	6	43	46.8	PDE
3.3	-88.671	32.131	5	1996	3	25	14	15	50.5	PDE
3.7	-104.102	43.069	5	1996	4	9	2	48	8.1	PDE
3.3	-91.162	34.969	5	1996	4	11	21	54	57.6	PDE
4	-81.95	37.187	1	1996	6	29	19	30	42.6	PDE

FSAR: Tables 2.5.2

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.8	-104.247	37.398	5	1996	8	1	5	44	22.7	PDE
3.4	-90.874	33.577	10	1996	8	11	18	17	49.8	PDE
3.5	-112.405	49.076	5	1996	8	15	20	7	29.9	PDE
3.6	-82.92	49.21	18	1996	8	16	4	56	46	PDE
3.7	-71.352	44.184	10	1996	8	21	7	54	14	PDE
4.2	-106.056	43.09	5	1996	10	19	13	27	57.9	PDE
3.7	-109.27	42.549	5	1996	10	21	13	51	39.5	PDE
3.2	-104.232	37.349	5	1996	11	1	3	9	28.3	PDE
3	-100.504	35.04	5	1996	11	23	10	54	18.5	PDE
4.2	-89.927	35.919	20	1996	11	29	5	41	33.6	PDE
3.6	-89.37	36.29	5	1996	11	29	10	47	9	PDE
3.4	-107.693	42.369	5	1996	12	11	3	55	44	PDE
3.1	-87.4	39.5	5	1996	12	16	1	58	31.3	PDE
3	-100.89	34.947	5	1997	2	12	23	53	10.7	PDE
3.2	-100.569	34.973	5	1997	2	15	9	8	55.4	PDE
3.4	-93.435	34.209	5	1997	3	16	19	7	27.9	PDE
3.8	-98.054	27.717	5	1997	3	24	22	31	34.5	PDE
3.5	-72.33	45.98	5	1997	4	3	4	44	12	PDE
3.1	-108.732	42.683	5	1997	4	25	10	39	6.7	PDE
3.7	-112.65	49.13	5	1997	5	1	21	38	36	PDE
3.1	-87.4	31	5	1997	5	4	3	39	12.9	PDE
4.1	-74.421	45.978	10	1997	5	24	18	52	6.3	PDE
3.4	-95.966	33.182	5	1997	5	31	3	26	41.3	PDE
3.5	-84.808	35.056	10	1997	7	19	17	6	34.3	PDE
3.8	-83.509	36.436	5	1997	7	30	12	29	23.3	PDE
3.2	-75.37	43.624	5	1997	7	31	7	15	29.7	PDE
3.4	-97.185	41.795	5	1997	8	9	17	46	3.9	PDE
3.7	-70.29	47.53	18	1997	8	20	9	12	4	PDE
4.3	-96.435	34.66	5	1997	9	6	23	38	0.9	PDE
3.8	-90.457	35.619	5	1997	9	17	18	16	31.6	PDE
3.1	-90.924	37.179	5	1997	9	20	5	55	50.4	PDE
3.2	-89.817	36.545	5	1997	9	24	4	20	24.8	PDE
3	-89.484	36.201	5	1997	9	27	12	14	9.3	PDE
3	-74.968	44.36	4	1997	10	13	23	6	40.2	PDE
4.9	-87.339	31.118	10	1997	10	24	8	35	17.8	PDE
4.7	-69.91	47.67	11	1997	10	28	11	44	18	PDE
4.9	-71.41	46.8	22	1997	11	6	2	34	33	PDE
3	-76.252	40.146	5	1997	11	14	3	44	11	PDE
4	-87.306	33.466	1	1997	12	12	8	42	20.2	PDE
3.4	-103.408	37.828	5	1998	1	2	15	47	16.4	PDE
3	-89.712	36.123	10	1998	2	12	9	37	49.5	PDE
3	-107.513	44.333	5	1998	2	13	2	28	4	PDE
3.6	-76.36	46.07	18	1998	2	26	14	20	31	PDE
3.9	-81.07	46.49	1	1998	3	9	5	5	58	PDE
3.1	-111.35	38.25	3	1998	3	29	12	12	42	PDE
3.2	-89.02	36.94	13	1998	4	8	18	16	49	PDE
3.8	-80.466	34.61	5	1998	4	13	9	56	11.3	PDE
3.9	-74.99	45.57	18	1998	4	18	16	22	52	PDE
3.2	-102.383	35.453	5	1998	4	27	15	22	46.2	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

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m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.2	-98.416	34.782	5	1998	4	28	14	13	1.6	PDE
3.7	-81.174	46.457	1	1998	5	25	15	47	2	PDE
3.2	-80.821	35.479	5	1998	6	5	2	31	1.9	PDE
3.4	-73.72	44.75	4	1998	6	9	8	53	51	PDE
3.6	-84.405	35.926	10	1998	6	17	8	0	23.4	PDE
3.4	-103.003	42.622	5	1998	6	18	16	26	38.3	PDE
3.4	-87.954	32.501	5	1998	6	24	15	20	1.3	PDE
3.2	-97.589	34.719	5	1998	7	7	18	44	44.4	PDE
3.1	-101.111	43.554	5	1998	7	12	16	28	49.6	PDE
3.1	-89.52	36.69	13	1998	7	15	4	24	51	PDE
4	-66.61	47.02	5	1998	7	15	7	8	4	PDE
3.6	-104.706	48.37	5	1998	7	29	3	31	58.9	PDE
4.1	-74.73	46.16	10	1998	7	30	8	57	22	PDE
3.6	-107.19	41.953	10	1998	8	6	18	22	7.1	PDE
4.9	-80.388	41.495	5	1998	9	25	19	52	52	PDE
3.4	-111.091	36.033	5	1998	10	18	7	13	10.6	PDE
3.5	-78.367	37.381	13	1998	10	21	5	56	47.2	PDE
4.1	-66.88	49.34	18	1998	10	22	9	43	35	PDE
3.5	-97.6	36.8	5	1998	10	30	17	41	22.2	PDE
3.3	-104.032	48.548	5	1998	11	11	11	59	37.6	PDE
3.3	-77.93	43.83	18	1998	12	25	13	30	26	PDE
3	-99.378	38.674	5	1999	1	7	5	16	26.9	PDE
3	-70.98	42.84	2	1999	1	10	10	52	16.1	PDE
3	-83.691	36.854	5	1999	1	17	18	38	4.7	PDE
4.3	-87.255	33.405	1	1999	1	18	7	0	53.4	PDE
3.4	-80.939	49.267	18	1999	2	1	22	22	5.6	PDE
3.8	-69.52	44.48	3	1999	2	26	3	38	43	PDE
4	-104.63	32.591	1	1999	3	14	22	43	17.9	PDE
4.8	-66.32	49.61	18	1999	3	16	12	50	48	PDE
4.3	-107.741	41.451	10	1999	4	6	0	41	9.5	PDE
3	-94.7	39.1	5	1999	5	13	14	18	22.7	PDE
3.9	-104.664	32.575	10	1999	5	30	19	4	25.6	PDE
3.1	-108.459	42.559	5	1999	7	21	2	36	6.9	PDE
3.1	-89.503	36.264	9	1999	8	23	12	12	41.1	PDE
3.5	-89.433	41.721	5	1999	9	2	16	17	29.7	PDE
3.8	-91.02	36.49	19	1999	10	21	8	18	0	PDE
3	-99.659	36.846	26	1999	10	25	23	19	58.3	PDE
3.9	-74.32	45.85	18	1999	10	31	20	14	10	PDE
3.5	-105.467	45.512	10	1999	11	3	13	28	52	PDE
3.1	-107.477	43.479	5	1999	11	9	8	17	41.1	PDE
3.6	-78.997	43.71	12	1999	11	26	22	33	1.4	PDE
3.8	-87.253	33.416	1	1999	11	28	11	0	9.3	PDE
3	-69.37	44.94	5	1999	12	25	0	21	41	PDE
5	-78.93	46.888	18	2000	1	1	11	22	57	PDE
3.5	-70.17	44.31	9	2000	1	3	21	5	50	PDE
3	-110.34	42.1	12	2000	1	8	22	43	37	PDE
3.5	-70.44	44.57	16	2000	1	17	8	16	20	PDE
3.5	-83.214	32.993	5	2000	1	18	22	19	31.9	PDE
3	-71.18	43	1	2000	1	27	14	49	40	PDE

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
4.4	-109.679	41.464	1	2000	1	30	14	46	51.3	PDE
3	-106.732	42.24	5	2000	2	1	22	15	45.3	PDE
3	-106.666	40.601	5	2000	2	7	17	24	54.3	PDE
3.3	-105.813	42.409	5	2000	4	13	18	17	31.7	PDE
3.6	-86.75	39.76	5	2000	4	14	3	54	20	PDE
3.9	-74.257	43.949	5	2000	4	20	8	46	55.4	PDE
3.1	-79.099	43.806	18	2000	5	24	10	22	46.2	PDE
4	-107.57	42.196	5	2000	5	26	21	58	46.6	PDE
3	-87.82	33.809	5	2000	5	28	11	32	7	PDE
3.7	-69.81	47.67	10	2000	6	15	9	25	54	PDE
3.3	-72.82	42.1	9	2000	6	16	4	2	53	PDE
3	-109.31	40.69	1	2000	6	20	17	55	46	PDE
3.8	-92.75	35.8	0	2000	6	27	1	28	45	PDE
3	-88.87	37.13	4	2000	6	27	6	2	57	PDE
4.2	-71.1	47.52	10	2000	7	12	15	1	49	PDE
4.1	-74.97	46.19	18	2000	8	6	8	52	24	PDE
3.9	-101.814	35.39	5	2000	8	17	1	8	5.4	PDE
3.2	-108.26	42.554	5	2000	8	19	2	55	43.7	PDE
3.9	-91.106	36.492	8	2000	8	22	20	12	14	PDE
3.2	-69.382	44.355	5	2000	9	7	10	7	40.7	PDE
3.8	-74.02	45.13	18	2000	10	6	13	59	4	PDE
3	-107.693	43.437	5	2000	11	8	2	16	49.9	PDE
3.7	-109.23	40.28	5	2000	11	11	21	17	53	PDE
3.9	-87.66	37.973	5	2000	12	7	14	8	49.4	PDE
3.9	-101.8	35.4	5	2000	12	16	22	8	54	PDE
4.3	-80.802	41.942	5	2001	1	26	3	3	20	PDE
3.2	-77.394	42.345	0	2001	2	3	20	15	15	PDE
3	-92.66	33.19	5	2001	3	3	10	46	13	PDE
3.2	-84.81	35.51	6	2001	3	7	17	12	25	PDE
3.9	-76.28	47.05	18	2001	3	19	10	40	17	PDE
3.2	-85.439	34.857	3	2001	3	21	23	35	35	PDE
3.1	-93.327	37.933	5	2001	3	30	17	13	55.6	PDE
3	-83.34	36.53	0	2001	4	13	16	36	20.7	PDE
4.5	-92.194	35.205	10	2001	5	4	6	42	12.6	PDE
3.3	-103.141	32.334	5	2001	6	2	1	55	53.7	PDE
3.2	-80.767	41.905	5	2001	6	3	22	36	46.4	PDE
3	-89.396	36.279	14	2001	7	7	20	45	42.7	PDE
3.1	-105.129	39.022	5	2001	7	22	19	22	45.5	PDE
3	-97	37.7	5	2001	7	24	14	2	35	PDE
3.2	-83.575	35.932	5	2001	7	26	5	26	44.7	PDE
3.1	-93.213	34.292	5	2001	8	4	1	13	25.3	PDE
4	-107.378	39.66	5	2001	8	9	22	38	54.5	PDE
4.5	-104.618	37.143	5	2001	9	5	10	52	7.8	PDE-W
4.3	-110.051	43.459	5	2001	9	27	22	5	21.7	PDE-W
3.2	-68.67	45.2	9	2001	10	25	0	24	29.8	PDE-W
3.4	-107.384	38.851	1	2001	11	5	8	34	23	PDE-W
3.3	-100.208	39.996	5	2001	11	13	1	56	13.1	PDE-W
3.1	-102.631	31.786	5	2001	11	22	0	7	8	PDE-W
3.1	-107.374	38.813	1	2001	12	4	18	20	9.1	PDE-W

Table 2.5.2-1—{USGS Earthquake Catalog for the CEUS with m_b >= 3.0}

m_b	Longitude (degree)	Latitude (degree)	Depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.9	-86.245	34.735	5	2001	12	8	1	8	21.5	PDE-W
3.3	-104.797	36.859	5	2001	12	15	7	58	31.3	PDE-W
3.8	-76.49	46.87	18	2001	12	24	16	58	21	PDE-W

Note 1. The New Madrid events occurred in a cluster of four events. The event shown in the catalog is determined by USGS as the New Madrid event for the 1811-1812 cluster set. Three other events are considered as the foreshock/aftershock events and are filtered out from the catalog by USGS. The event shown in the catalog is not considered in the general area source hazard integration since its magnitude is above the maximum magnitude limit considered. This New Madrid event is accounted for in the PSHA in the New Madrid Characteristic Cluster events. The following events are also part of the characteristic earthquake analysis:

Longitude (degree)	Latitude (degree)	m_b	Year	Month	Day	Hour	Minute	Event Group
-90	36	7.2	1811	12	16	8	15	1
-90	36	7.0	1811	12	16	14	15	
-89.6	36.3	7.1	1812	1	23	15	0	2
-89.6	36.5	7.4	1812	2	7	9	45	3

Table 2.5.2-2—{USGS and ANSS 2002-2007 Catalog Update}

m_b	Longitude (degree)	Latitude (degree)	depth (km)	Year	Month	Day	Hour	Minute	Second	Catalog Reference
3.6	-89.96	37.17	5	2002	3	12	8	30	48	PDE
3.0	-89.68	36.73	1	2003	5	2	3	25	3	PDE
3.2	-88.65	37.96	0.6	2003	5	2	8	10	13	ANSS
3.1	-91.5	38.15	2.5	2003	7	8	5	55	5	ANSS
3.7	-91.61	36.81	5	2003	8	16	5	9	22	PDE
3	-90.17	38.14	5	2003	12	29	9	2	8	PDE
3.8	-89.68	36.73	4	2004	6	15	8	34	21	PDE
3.3	-89.69	36.73	3	2004	6	16	12	29	9	PDE
3.6	-89.18	36.86	4.4	2004	7	16	3	25	17	ANSS
3.3	-93.97	38.46	5	2005	5	18	19	59	43	PDE
3.6	-89	36.92	21	2005	6	20	12	21	42	PDE
3	-89.42	37.63	5	2005	6	27	15	46	52	PDE
3.3	-92.72	38.72	5	2005	7	31	7	7	8	PDE
3.6	-88.35	37.8	10	2006	1	2	21	48	57	PDE
3	-88.98	37.5	6	2006	3	1	17	42	42	PDE
3.4	-89.64	36.54	8	2006	10	18	20	59	21	PDE
3.1	-95.34	39.46	5	2007	3	23	8	15	50	PDE
3.1	-93.1	36.21	0	2007	9	7	10	40	47	PDE

Table 2.5.2-3—{Conversion Between Body-Wave (m_b) and Moment (M) Magnitude}

Conversion Model	m_b to M	M to m_b	Weight
Atkinson and Boore 1987	$M = 2.715 - 0.277 m_b + 0.127 m_b^2$	$m_b = -4.249 + 3.3935M - 0.3732M^2 + 0.0168M^3$	0.333
EPRI 1993	$M = 0.3281 + 1.9437 m_b - 0.4302 m_b^2 + 0.0419 m_b^3$	$m_b = -10.23 + 6.105M - 0.7632M^2 + 0.03436M^3$	0.334
Johnston 1996	$M = 1.14 + 0.24 m_b + 0.0933 m_b^2$	$m_b = -0.919 + 1.7864M - 0.1351M^2 + 0.0052M^3$	0.333

Notes:

m_b indicates body wave magnitude
M indicates moment magnitude}

Table 2.5.2-4—{Summary of Bechtel Group Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
30	New Madrid	0.950	1.00	m_b 7.0	1.00
31	Reelfoot Rift	0.670	0.67	m_b 5.7	0.10
				m_b 6.0	0.40
		0.810	0.33	m_b 6.3	0.40
				m_b 6.6	0.10
36	Ste. Genevieve	1.160	0.33	m_b 6.0	0.10
		1.450	0.67	m_b 6.3	0.40
				m_b 6.6	0.50
42	TN-MT Trend	1.050	1.00	m_b 5.4	0.10
				m_b 5.7	0.40
				m_b 6.0	0.40
				m_b 6.6	0.10
J	Ozark Area	0.810	0.67	m_b 6.0	0.10
		0.920	0.33	m_b 6.3	0.40
				m_b 6.6	0.50
K	South Illinois Area (Wabash Valley)	0.640	0.67	M 7.0	0.10
				M 7.3	0.40
		0.785	0.33	M 7.5	0.40
				M 7.8	0.10
BGZ	Background Zone	0.800	0.15	M 6.6	0.10
		0.840	0.15	M 6.8	0.20
		0.920	0.30	M 7.0	0.50
		0.950	0.40	M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

Table 2.5.2-5—{Summary of Dames & Moore Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
18	Southern Illinois / Southern Indiana / Fairfield Basin	0.900	0.15	M 7.0	0.10
		0.950	0.10	M 7.3	0.40
		1.000	0.75	M 7.5	0.40
				M 7.8	0.10
18A	Illinois Basin	1.000	1.00	m_b 5.9	0.77
				m_b 7.2	0.23
19	St. Louis Arm	0.950	0.13	M 7.0	0.10
		1.000	0.75	M 7.3	0.40
		1.050	0.12	M 7.5	0.40
				M 7.8	0.10
21	New Madrid Compression Zone	0.950	0.25	m_b 7.0	1.00
		1.000	0.75		
22	Reelfoot Rift	0.950	0.16	m_b 6.9	0.77
		1.000	0.84	m_b 7.2	0.23
23B	Eastern Ozark / Regional Source	1.000	1.00	m_b 6.4	0.75
				m_b 7.2	0.25
BGZ	Background Zone	1.000	1.00	M 6.6	0.10
				M 6.8	0.20
				M 7.0	0.50
				M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

Table 2.5.2-6—{Summary of Law Engineering Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
4A	Reelfoot Rift	0.850	1.00	m_b 6.2	0.50
				m_b 6.8	0.50
6	St. Louis Arm of the New Madrid Rift Complex	0.900	1.00	M 7.0	0.10
				M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
7	Wabash Valley Arm	0.840	1.00	M 7.0	0.10
				M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
15	Ozark Uplift	1.000	1.00	m_b 5.1	0.70
				m_b 5.7	0.30
18	Postulated Faults in Reelfoot Rift / New Madrid	0.900	1.00	m_b 7.0	1.00
BGZ	Background Zone	0.890	1.00	M 6.6	0.10
				M 6.8	0.20
				M 7.0	0.50
				M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

Table 2.5.2-7—{Summary of Rondout Associates Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
1	New Madrid	1.000	1.00	m_b 7.0	1.00
2	New Madrid Rift Complex	1.000	1.00	M 7.0	0.10
				M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
3	Ozark Uplift	1.000	1.00	m_b 5.2	0.30
				m_b 6.3	0.55
				m_b 6.5	0.15
4	Southern Illinois	1.000	1.00	M 7.0	0.10
				M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
15	Northern Illinois	1.000	1.00	m_b 5.2	0.30
				m_b 6.3	0.55
				m_b 6.5	0.15
BGZ	Background Zone	1.000	1.00	M 6.6	0.10
				M 6.8	0.20
				M 7.0	0.50
				M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

Table 2.5.2-8—{Summary of Weston Geophysical Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
31	New Madrid Fault Zone	0.910	1.00	m_b 7.0	1.00
32	Reelfoot Rift	0.850	1.00	m_b 7.2	1.00
33	Indiana Arm	0.83	1.00	M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
				M 7.0	0.10
34	St. Louis Arm	0.890	1.00	M 7.0	0.10
				M 7.3	0.40
				M 7.5	0.40
				M 7.8	0.10
BGZ	Background Zone	0.950	1.00	M 6.6	0.10
				M 6.8	0.20
				M 7.0	0.50
				M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

Table 2.5.2-9—{Summary of Woodward-Clyde Consultants Seismic Sources}

Code	Name	b	b weight	M_{max}	M_{max} weight
40	Central Reelfoot Rift / New Madrid	0.920	1.00	m_b 7.0	1.00
41	Reelfoot Rift	0.850	0.25	m_b 5.4	0.33
		0.91	0.25	m_b 6.8	0.34
		0.95	0.50	m_b 7.2	0.33
42	St. Louis Arm, New Madrid Rift	0.800	0.50	M 7.0	0.10
		0.850	0.25	M 7.3	0.40
		0.900	0.25	M 7.5	0.40
				M 7.8	0.10
43	South Indiana Arm, New Madrid Rift	0.750	0.50	M 7.0	0.10
		0.800	0.25	M 7.3	0.40
		0.850	0.25	M 7.5	0.40
				M 7.8	0.10
44	New Madrid Loading Zone	0.800	0.25	M 7.0	0.10
		0.850	0.25	M 7.3	0.40
		0.900	0.25	M 7.5	0.40
		0.950	0.25	M 7.8	0.10
47	Kansas / Nebraska Offset of Mid Continent Geophysical Abnormaly	0.800	0.33	m_b 5.4	0.33
		0.87	0.34	m_b 6.3	0.34
		0.95	0.33	m_b 7.2	0.33
BGZ	Background Zone	0.950	0.50	M 6.6	0.10
				M 6.8	0.20
		1.000	0.50	M 7.0	0.50
				M 7.2	0.20

Notes:

m_b indicates body wave magnitude

M indicates moment magnitude

b indicates Recurrence Parameter utilized in the Guttenberg-Richter (G-R) equation

FSAR: Tables 2.5.2

Table 2.5.2-10—{Alternative New Madrid Fault Locations}

Fault arm	New Madrid South		Reelfoot		New Madrid North		Combined Weight
Faults set	Distance to Site (km)	Weight	Distance to Site (km)	Weight	Distance to Site (km)	Weight	
1	305	0.6	301	0.7	287	0.7	0.294
2					289	0.3	0.126
3			268	0.3	287	0.7	0.126
4					289	0.3	0.054
5	335	0.4	301	0.7	287	0.7	0.196
6					289	0.3	0.084
7			268	0.3	287	0.7	0.084
8					289	0.3	0.036

Table 2.5.2-11—{Earthquake Frequencies for Repeating New Madrid Earthquake Sequences}

Rupture Set	Weight	Magnitude, M			Weight	Rupture Model	Weight	Combined Weight
		NMS	RF	NMN				
1	0.1667	7.8	7.7	7.5	1	A	0.667	0.1112
		7.8	7.7	7.5	0.333	B	0.333	0.0185
		7.3	7.7	7.5	0.333			0.0185
		7.8	7.7	**7.0**	0.333			0.0185
2	0.1667	7.9	7.8	7.6	1	A	0.667	0.1112
		7.9	7.8	7.6	0.333	B	0.333	0.0185
		7.4	7.8	7.6	0.333			0.0185
		7.9	7.8	**7.1**	0.333			0.0185
3	0.2500	7.6	7.8	7.5	1	A	0.667	0.1668
		7.6	7.8	7.5	0.333	B	0.333	0.0277
		7.1	7.8	7.5	0.333			0.0277
		7.6	7.8	**7.0**	0.333			0.0277
4	0.0833	7.2	7.4	7.2	1	A	0.667	0.0556
		7.2	7.4	7.2	0.333	B	0.333	0.0092
		7.0	7.4	7.2	0.333			0.0092
		7.2	7.4	7.2	0.333			0.0092
5	0.1667	7.2	7.4	7.0	1	A	0.667	0.1112
		7.2	7.4	7.0	0.333	B	0.333	0.0185
		7.0	7.4	7.0	0.333			0.0185
		7.2	7.4	**7.0**	0.333			0.0185
6	0.1667	7.3	7.5	7.0	1	A	0.667	0.1112
		7.3	7.5	7.0	0.333	B	0.333	0.0185
		7.0	7.5	7.0	0.333			0.0185
		7.3	7.5	7.0	0.333			0.0185

Notes:
Adapted from the Seismic Hazards Report for the EGC ESP Site (EGC, 2006)
NMS: New Madrid South Arm; RF: Reelfoot Arm; NMN: New Madrid North Arm

Table 2.5.2-12—{Controlling Earthquakes for Callaway Plant Unit 2 Site}

Hazard	Reference Earthquake (RE)		De-aggregation Earthquakes (DE)			
	Mag. (M)	Dist. (km)	Event	Mag. (M)	Dist. (km)	Weight
Mean 1E-4 1 and 2.5Hz	7.48	341.28	DEL	6.11	16.07	0.019
			DEM	7.01	119.31	0.054
			DEH	7.49	348.67	0.927
Mean 1E-4 5 and 10 Hz	7.34	268.19	DEL	5.72	15.16	0.074
			DEM	6.80	118.48	0.118
			DEH	7.49	347.91	0.808
Mean 1E-5 1 and 2.5Hz	7.49	343.07	DEL	6.25	13.52	0.047
			DEM	7.19	110.58	0.052
			DEH	7.50	349.31	0.901
Mean 1E-5 5 and 10 Hz	7.21	190.34	DEL	5.84	12.12	0.208
			DEM	7.04	110.35	0.105
			DEH	7.50	348.87	0.687

Note:

Distance range of each event
DEL: 0 to 50 km
DEM: 50 to 200 km
DEH: > 200 km

Table 2.5.2-13—{Amplification Factors for 1E-4 HF and LF Input Motions}

Freq (Hz)	1E-4 LF DEL 0.0133	1E-4 LF DEM 0.0387	1E-4 LF DEH 0.9481	Ave.	1E-4 HF DEL 0.0535	1E-4 HF DEM 0.0880	1E-4 HF DEH 0.8585	Ave.
0.1000	1.0120	1.0113	1.0056	**1.0060**	1.0198	1.0077	1.0075	**1.0084**
0.1269	1.0145	1.0035	1.0042	**1.0044**	1.0194	1.0092	1.0062	**1.0075**
0.1610	1.0257	1.0130	1.0091	**1.0096**	1.0215	1.0097	1.0080	**1.0092**
0.2043	1.0187	1.0147	1.0075	**1.0081**	1.0121	1.0094	1.0093	**1.0095**
0.2593	1.0160	1.0166	1.0188	**1.0187**	1.0290	1.0114	1.0177	**1.0178**
0.3290	1.0321	1.0229	1.0183	**1.0188**	1.0324	1.0231	1.0188	**1.0203**
0.4175	1.0386	1.0320	1.0336	**1.0336**	1.0356	1.0364	1.0375	**1.0372**
0.5000	1.0544	1.0533	1.0538	**1.0538**	1.0636	1.0517	1.0502	**1.0514**
0.6723	1.0693	1.0698	1.0661	**1.0664**	1.0724	1.0674	1.0682	**1.0684**
0.8532	1.0770	1.0835	1.0739	**1.0745**	1.0765	1.0805	1.0762	**1.0767**
1.0000	1.0635	1.0653	1.0676	**1.0674**	1.0753	1.0692	1.0695	**1.0699**
1.3738	1.0465	1.0432	1.0438	**1.0438**	1.0526	1.0539	1.0453	**1.0469**
1.7500	1.0310	1.0373	1.0302	**1.0306**	1.0325	1.0231	1.0261	**1.0262**
2.2122	1.0592	1.0498	1.0446	**1.0452**	1.0435	1.0471	1.0431	**1.0436**
2.5000	1.0822	1.0737	1.0671	**1.0677**	1.0740	1.0859	1.0678	**1.0704**
3.5622	1.1410	1.1122	1.0871	**1.0894**	1.1202	1.1028	1.0819	**1.0872**
4.5204	1.2006	1.1848	1.1539	**1.1565**	1.1507	1.1442	1.1518	**1.1508**
5.0000	1.3483	1.2549	1.2623	**1.2635**	1.2940	1.2608	1.2544	**1.2581**
7.5000	1.5080	1.4978	1.4851	**1.4862**	1.5032	1.4293	1.4659	**1.4643**
10.0000	1.8668	1.7644	1.7554	**1.7580**	1.7840	1.6815	1.8045	**1.7884**
11.7210	1.9196	1.9427	1.8970	**1.8999**	1.8489	1.8494	1.8403	**1.8420**
14.8735	1.6524	1.6521	1.7049	**1.7010**	1.6564	1.7564	1.7460	**1.7406**
18.8739	1.3796	1.4057	1.3430	**1.3471**	1.4049	1.4026	1.4374	**1.4308**
25.0000	1.1762	1.2013	1.1695	**1.1714**	1.2332	1.2107	1.2535	**1.2469**
30.3920	1.0049	1.0807	1.0388	**1.0405**	1.0532	0.9799	1.0758	**1.0628**
38.5662	0.8110	0.8777	0.9033	**0.9001**	0.8424	0.9120	0.9582	**0.9442**
48.9390	0.7369	0.7723	0.7598	**0.7600**	0.8055	0.7970	0.8341	**0.8276**
62.1017	0.7759	0.8593	0.8287	**0.8294**	0.8554	0.9114	0.8940	**0.8932**
78.8046	0.9665	1.0419	1.0180	**1.0183**	1.0326	1.0384	1.1027	**1.0899**
100.0000	1.1199	1.2152	1.1894	**1.1895**	1.1589	1.2827	1.2910	**1.2803**

Notes:
DEL: De-aggregated Earthquake 0-31 miles (0-50 km);
DEM: De-aggregated Earthquake 31-124 miles (50-200 km);
DEH: De-aggregated Earthquake > 124 miles (>200 km);

Table 2.5.2-14—{Amplification Factors for 1E-5 HF and LF Input Motions}

Freq (Hz)	1E-5 LF DEL 0.0332	1E-5 LF DEM 0.0370	1E-5 LF DEH 0.9297	Ave.	1E-5 HF DEL 0.1532	1E-5 HF DEM 0.0811	1E-5 HF DEH 0.7657	Ave.
0.1000	1.0153	1.0059	1.0036	**1.0043**	1.0288	1.0108	1.0081	**1.0127**
0.1269	1.0132	1.0210	1.0091	**1.0099**	1.0262	1.0131	1.0069	**1.0116**
0.1610	1.0152	1.0144	1.0086	**1.0093**	1.0163	1.0109	1.0079	**1.0099**
0.2043	1.0092	1.0153	1.0079	**1.0083**	1.0153	1.0121	1.0092	**1.0108**
0.2593	1.0255	1.0120	1.0164	**1.0166**	1.0286	1.0210	1.0178	**1.0204**
0.3290	1.0317	1.0214	1.0225	**1.0229**	1.0291	1.0217	1.0183	**1.0209**
0.4175	1.0413	1.0351	1.0329	**1.0334**	1.0464	1.0351	1.0375	**1.0391**
0.5000	1.0540	1.0510	1.0542	**1.0540**	1.0496	1.0536	1.0506	**1.0507**
0.6723	1.0707	1.0681	1.0676	**1.0678**	1.0727	1.0725	1.0673	**1.0689**
0.8532	1.0744	1.0768	1.0778	**1.0776**	1.0800	1.0846	1.0771	**1.0785**
1.0000	1.0742	1.0717	1.0644	**1.0652**	1.0750	1.0692	1.0701	**1.0710**
1.3738	1.0571	1.0474	1.0498	**1.0501**	1.0434	1.0479	1.0480	**1.0470**
1.7500	1.0402	1.0279	1.0247	**1.0256**	1.0422	1.0395	1.0280	**1.0321**
2.2122	1.0433	1.0556	1.0498	**1.0498**	1.0534	1.0553	1.0456	**1.0482**
2.5000	1.0931	1.0791	1.0693	**1.0710**	1.1006	1.0786	1.0720	**1.0787**
3.5622	1.1456	1.1020	1.1001	**1.1023**	1.1263	1.1235	1.0891	**1.1005**
4.5204	1.2518	1.1631	1.1780	**1.1807**	1.2035	1.1981	1.1666	**1.1776**
5.0000	1.4283	1.2894	1.2818	**1.2891**	1.3559	1.2901	1.2827	**1.2987**
7.5000	1.6712	1.5455	1.5078	**1.5174**	1.6282	1.5448	1.5201	**1.5452**
10.0000	1.9374	1.8407	1.8253	**1.8314**	1.9273	1.8137	1.8488	**1.8614**
11.7210	1.9234	1.9320	1.9728	**1.9683**	2.0424	1.9397	1.8559	**1.9035**
14.8735	1.5699	1.6721	1.6693	**1.6647**	1.6571	1.6017	1.6728	**1.6621**
18.8739	1.2729	1.2645	1.2763	**1.2755**	1.3036	1.3490	1.3757	**1.3579**
25.0000	1.0837	1.0955	1.0841	**1.0847**	1.1435	1.1504	1.1935	**1.1786**
30.3920	0.9229	0.9432	0.9500	**0.9484**	0.9259	1.0298	1.0365	**1.0128**
38.5662	0.8029	0.8173	0.8575	**0.8529**	0.7976	0.8604	0.9274	**0.8934**
48.9390	0.7114	0.7066	0.6902	**0.6921**	0.7053	0.7539	0.8112	**0.7832**
62.1017	0.8202	0.7741	0.7720	**0.7744**	0.7161	0.8306	0.8971	**0.8525**
78.8046	0.9826	0.9109	0.9520	**0.9513**	0.8580	1.0115	1.0587	**1.0120**
100.0000	1.1498	1.0979	1.1409	**1.1390**	1.0206	1.2234	1.2743	**1.2162**

Notes:
DEL: De-aggregated Earthquake 0-31 miles (0-50 km);
DEM: De-aggregated Earthquake 31-124 miles (50-200 km);
DEH: De-aggregated Earthquake > 124 miles (>200 km);

Table 2.5.2-15—{Uniform Hazard Response Spectra (Hard Rock Conditions)}

Frequency (Hz)	1E-4 SA, g		1E-5 SA, g		1E-6 SA, g	
	Mean	Median	Mean	Median	Mean	Median
0.5	0.0878	0.0590	0.2150	0.1293	0.4291	0.2567
1.0	0.1308	0.1007	0.2896	0.2037	0.5380	0.3689
2.5	0.2511	0.2003	0.5187	0.4010	0.9346	0.7204
5.0	0.3258	0.2614	0.6732	0.5280	1.2665	0.9993
10.0	0.3743	0.2967	0.8078	0.6164	1.6573	1.3236
25.0	0.4735	0.3366	1.1742	0.7368	2.6124	1.7164
100.0	0.1752	0.1355	0.3784	0.2776	0.8391	0.7038

Table 2.5.2-16—{Earthquake Frequencies for Repeating New Madrid Earthquake}

Model	Weight of model	Mean repeat time (years)	Equivalent annual frequency, $\lambda_{\text{rate of cluster}}$	Weight of $\lambda_{\text{rate of cluster}}$	Combined weight, wc	$\lambda_{\text{rate of cluster}}$ times wc
Poisson	0.5	161	6.20E-03	0.10108	0.05054	0.00031
		262	3.82E-03	0.24429	0.12215	0.00047
		410	2.44E-03	0.30926	0.15463	0.00038
		694	1.44E-03	0.24429	0.12215	0.00018
		1563	6.40E-04	0.10108	0.05054	0.00003
Renewal $\alpha = 0.3$	0.5x0.2 = 0.1	333	3.39E-03	0.10108	0.01011	0.00003
		410	1.07E-03	0.24429	0.02443	0.00003
		485	3.02E-04	0.30926	0.03093	0.00001
		574	5.95E-05	0.24429	0.02443	0.00000
		709	4.30E-06	0.10108	0.01011	0.00000
Renewal $\alpha = 0.5$	0.5x0.5 = 0.25	316	4.85E-03	0.10108	0.02527	0.00012
		440	2.18E-03	0.24429	0.06107	0.00013
		573	8.89E-04	0.30926	0.07732	0.00007
		746	2.58E-04	0.24429	0.06107	0.00002
		1032	2.97E-05	0.10108	0.02527	0.00000
Renewal $\alpha = 0.7$	0.5x0.3 = 0.15	325	4.45E-03	0.10108	0.01516	0.00007
		506	2.25E-03	0.24429	0.03664	0.00008
		719	1.02E-03	0.30926	0.04639	0.00005
		1011	3.37E-04	0.24429	0.03664	0.00001
		1521	4.49E-05	0.10108	0.01516	0.00000
sums	1.00				1.00	0.00199
				Average return period =	503	years

Note:

Adapted from the Seismic Hazards Report for the EGC ESP Site
See Figure 4.1-1 and Table 4.1-3 (EGC, 2006)

FSAR: Tables 2.5.2

Table 2.5.2-17—{USGS 2008 Seismicity Smoothing Models}

Model	Incompleteness Year	Minimum Magnitude, m_b	Correlation Distance (km)	Weight	
				Main Source	Background
1	1924	3.0	50	0.50	0.40
2	1860	4.0	75	0.25	0.20
3	1700	5.0	75	0.25	0.20
4	Uniformly distributed		-	-	0.20

Table 2.5.2-18—{Selected Controlling Rock Motion Time Histories}

(Page 1 of 2)

1E-4 Low Frequency event						
	Controlling event		Earthquake acceleration time history			
Hazard	Mag. (M)	Dist. (km)	Event	Station	M	Dist (km)
1E-4 Near field event, DEL	6.11	16.07	Mammoth Lakes	Long Valley Dam (L Abut)	6.0	19.7
					6.0	19.7
			Morgan Hill	Gilroy Array #6	6.2	11.8
					6.2	11.8
1E-4 Middle field event, DEM	7.01	119.31	San Fernando	Maricopa Array #3	6.6	113.0
					6.6	113.0
			Northridge	Riverside Airport	6.7	101.3
					6.7	101.3
1E-4 Far field event, DEH	7.49	348.67	Landers	San Gabriel - E Gran Ave	7.3	141.6
					7.3	141.6
			Landers	Sun Valley - Sunland	7.3	162.6
					7.3	162.6

1E-4 High Frequency event						
	Controlling event		Earthquake acceleration time history			
Hazard	Mag. (M)	Dist. (km)	Event	Station	M	Dist (km)
1E-4 Near field event, DEL	5.72	15.16	Coalinga	Palmer Ave.	5.8	12.2
					5.8	12.2
			Livermore	San Roamon - eastman Kodak	5.4	17.6
					5.4	17.6
1E-4 Middle field event, DEM	6.80	118.48	Borrego Mtn	San Onofre - So Cal Edison	6.8	124.7
					6.8	124.7
			San Fernando	San Onofre - So Cal Edison	6.6	122.0
					6.6	122.0
1E-4 Far field event, DEH	7.49	347.91	Tabas, Iran	Kashmar	7.4	199.1
					7.4	199.1
			Landers	San Gabriel - E Gran Ave	7.3	141.6
					7.3	141.6

Table 2.5.2-18—{Selected Controlling Rock Motion Time Histories}

(Page 2 of 2)

1E-5 Low Frequency event						
	Controlling event		Earthquake acceleration time history			
Hazard	Mag. (M)	Dist. (km)	Event	Station	M	Dist (km)
1E-5 Near field event, DEL	6.25	13.52	Morgan Hill	Gilroy - Gavilian Coll.	6.2	16.2
					6.2	16.2
				Gilroy Array #6	6.2	11.8
					6.2	11.8
1E-5 Middle field event, DEM	7.19	110.58	Landers	Duarte - Mel Canyon Rd	7.3	126.4
					7.3	126.4
				Villa Park - Serrano Ave	7.3	131.4
					7.3	131.4
1E-5 Far field event, DEH	7.50	349.31	Landers	Calabasas - N Las Virg	7.3	194.1
					7.3	194.1
				Sun Valley - Sunland	7.3	162.6
					7.3	162.6

1E-5 High Frequency event						
	Controlling event		Earthquake acceleration time history			
Hazard	Mag. (M)	Dist. (km)	Event	Station	M	Dist (km)
1E-5 Near field event, DEL	5.84	12.12	Fruili, Italy	San Rocco	5.5	17.9
					5.5	17.9
			Whittier Narrows	Garvey Res. - Control Bldg.	6.0	12.1
					6.0	12.1
1E-5 Middle field event, DEM	7.04	110.35	San Fernando	Maricopa Array #3	6.6	113.0
					6.6	113.0
			Northridge	Riverside Airport	6.7	101.3
					6.7	101.3
1E-5 Far field event, DEH	7.50	348.87	Tabas, Iran	Kashmar	7.4	199.1
					7.4	199.1
			Landers	San Gabriel - E Gran Ave	7.3	141.6
					7.3	141.6

Table 2.5.2-19—{Smooth Uniform Hazard Response Spectra at Hard Rock}

Frequency (Hz)	Mean 1E-4	Median 1E-4	Mean 1E-5	Median 1E-5	Mean 1E-6	Median 1E-6
0.100	0.0094	0.0063	0.0231	0.0139	0.0461	0.0276
0.127	0.0142	0.0096	0.0349	0.0210	0.0696	0.0416
0.161	0.0208	0.0140	0.0509	0.0306	0.1016	0.0608
0.204	0.0294	0.0198	0.0721	0.0434	0.1439	0.0861
0.259	0.0406	0.0273	0.0995	0.0598	0.1985	0.1188
0.329	0.0547	0.0368	0.1340	0.0806	0.2674	0.1600
0.418	0.0721	0.0485	0.1767	0.1062	0.3526	0.2110
0.500	0.0878	0.0590	0.2150	0.1293	0.4291	0.2567
0.672	0.1050	0.0730	0.2514	0.1567	0.4941	0.3041
0.853	0.1199	0.0874	0.2749	0.1823	0.5277	0.3429
1.000	0.1308	0.1007	0.2896	0.2037	0.5380	0.3689
1.374	0.1691	0.1314	0.3681	0.2650	0.6788	0.4789
1.750	0.2014	0.1578	0.4307	0.3175	0.7885	0.5726
2.212	0.2339	0.1850	0.4917	0.3711	0.8931	0.6680
2.500	0.2511	0.2003	0.5187	0.4010	0.9346	0.7204
3.562	0.2944	0.2354	0.6082	0.4724	1.1115	0.8635
4.520	0.3220	0.2554	0.6587	0.5141	1.2213	0.9562
5.000	0.3258	0.2614	0.6732	0.5280	1.2665	0.9993
7.500	0.3533	0.2815	0.7490	0.5781	1.4822	1.1779
10.000	0.3743	0.2967	0.8078	0.6164	1.6573	1.3236
11.721	0.3998	0.3079	0.8964	0.6482	1.8847	1.4203
14.874	0.4290	0.3215	0.9998	0.6876	2.1475	1.5471
18.874	0.4537	0.3310	1.0931	0.7171	2.3922	1.6465
25.000	0.4735	0.3366	1.1742	0.7368	2.6124	1.7164
30.392	0.4638	0.3337	1.1293	0.7233	2.5115	1.7058
38.566	0.4414	0.3217	1.0539	0.6903	2.3427	1.6491
48.939	0.3967	0.2930	0.9269	0.6221	2.0595	1.5067
62.102	0.3187	0.2388	0.7273	0.5014	1.6151	1.2320
78.805	0.2291	0.1744	0.5095	0.3618	1.1306	0.9025
100.000	0.1752	0.1355	0.3784	0.2776	0.8391	0.7038

Table 2.5.2-20—{Recommended Horizontal and Vertical GMRS Amplitudes, Design Factor and V/H Ratio}

Freq (Hz)	Design Factor	Horizontal GMRS (g)	Vertical GMRS (g)	V/H Ratio
0.1000	1.2289	0.0116	0.0074	0.6359
0.1269	1.2357	0.0176	0.0112	0.6359
0.1610	1.2297	0.0258	0.0164	0.6359
0.2043	1.2300	0.0365	0.0232	0.6359
0.2593	1.2276	0.0507	0.0323	0.6359
0.3290	1.2333	0.0687	0.0437	0.6359
0.4175	1.2289	0.0916	0.0582	0.6359
0.5000	1.2291	0.1137	0.0723	0.6359
0.6723	1.2079	0.1352	0.0860	0.6359
0.8532	1.1681	0.1504	0.0957	0.6359
1.0000	1.1313	0.1580	0.1005	0.6359
1.3738	1.1230	0.1983	0.1285	0.6483
1.7500	1.0980	0.2279	0.1499	0.6579
2.2122	1.0910	0.2667	0.1782	0.6682
2.5000	1.0746	0.2881	0.1942	0.6741
3.5622	1.0821	0.3471	0.2401	0.6918
4.5204	1.0815	0.4027	0.2886	0.7167
5.0000	1.0962	0.4512	0.3306	0.7327
7.5000	1.1290	0.5929	0.4691	0.7912
10.0000	1.1464	0.7674	0.6279	0.8182
11.7210	1.1592	0.8804	0.7512	0.8532
14.8735	1.1378	0.8497	0.7606	0.8952
18.8739	1.1628	0.7548	0.6974	0.9239
25.0000	1.1860	0.7003	0.7114	1.0159
30.3920	1.1765	0.5799	0.6341	1.0934
38.5662	1.1515	0.4799	0.5705	1.1888
48.9390	1.1320	0.3716	0.4787	1.2880
62.1017	1.1185	0.3184	0.4071	1.2786
78.8046	1.0715	0.2676	0.3223	1.2042
100.0000	1.0663	0.2391	0.2568	1.0739

Figure 2.5.2-1—{Earthquake Catalog and Bechtel Group EPRI Source Zones}

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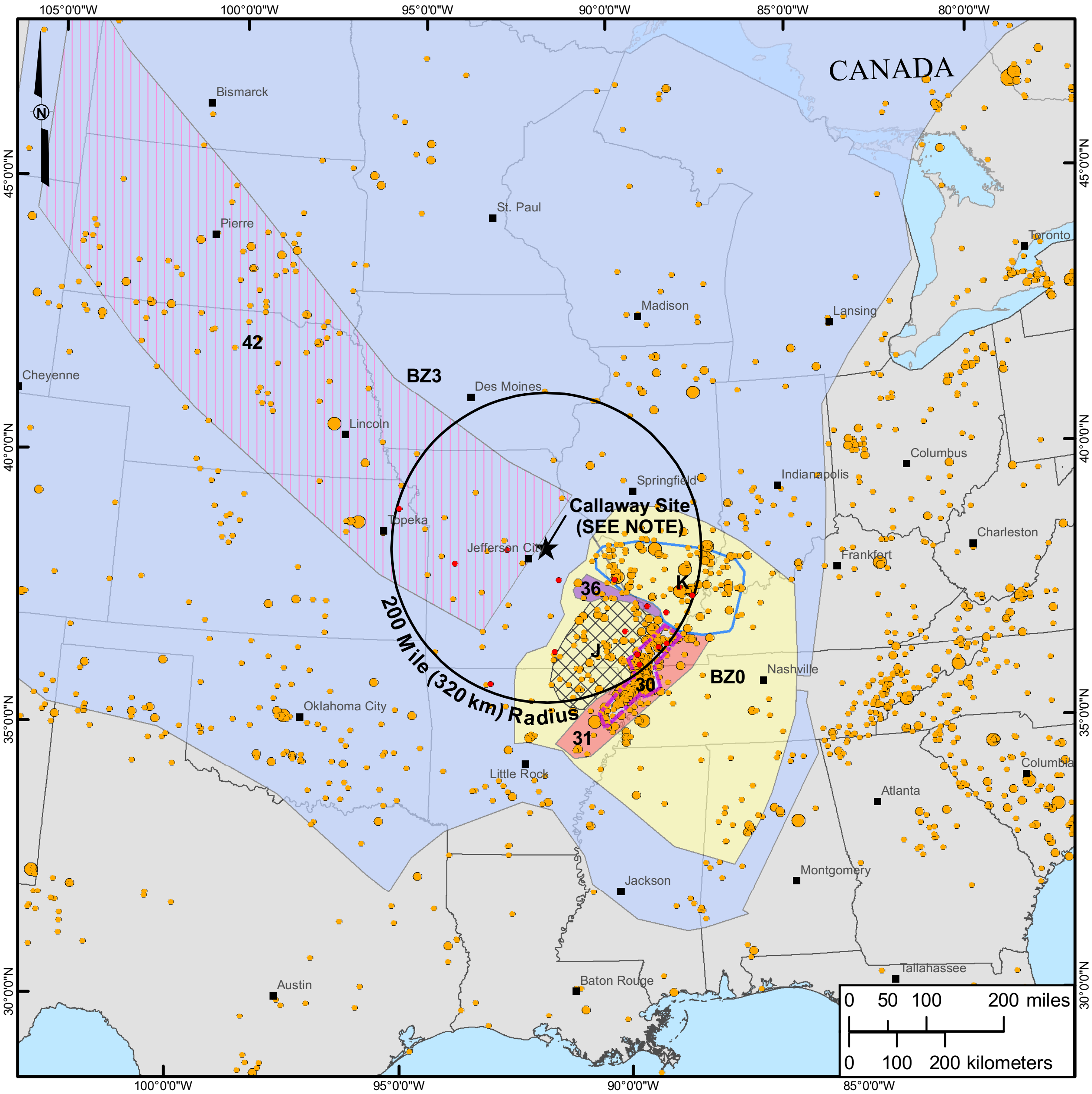


LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

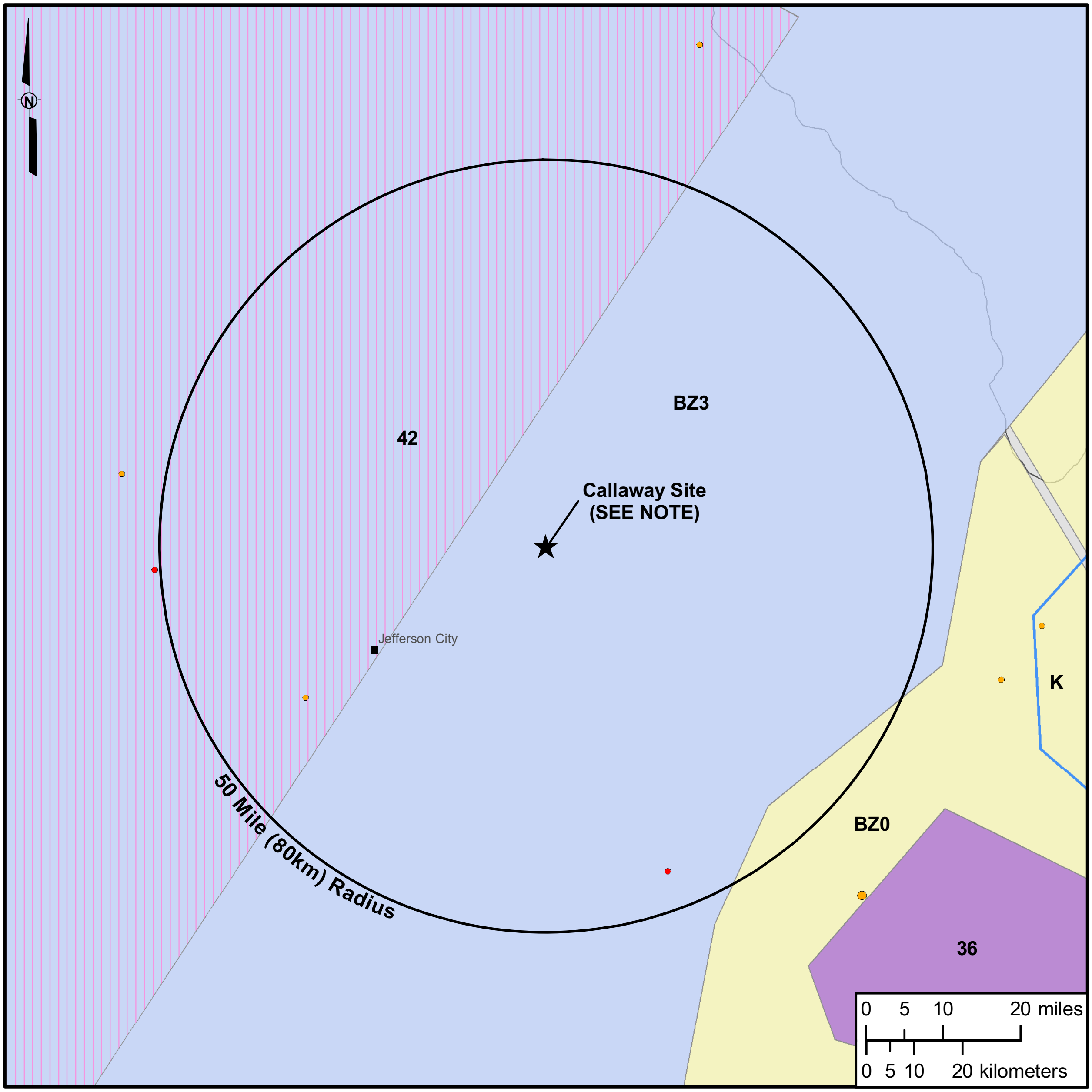
Bechtel Group Sources within 200 Mile (320 km) Radius

- 30 New Madrid
- 31 Reelfoot Rift
- 36 St. Genevieve
- 42 TN-MT Trend
- J Ozark Area
- K Southern Illinois Area
- BZ0 Background Zone 0
- BZ3 Background Zone 3

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume IX: Bechtel Group, 1986.

FSAR: Figures 2.5.2

Figure 2.5.2-1—{Earthquake Catalog and Bechtel Group EPRI Source Zones}
50 mile (80 km) Closeup
Page 2 of 2



LEGEND

■ City

State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

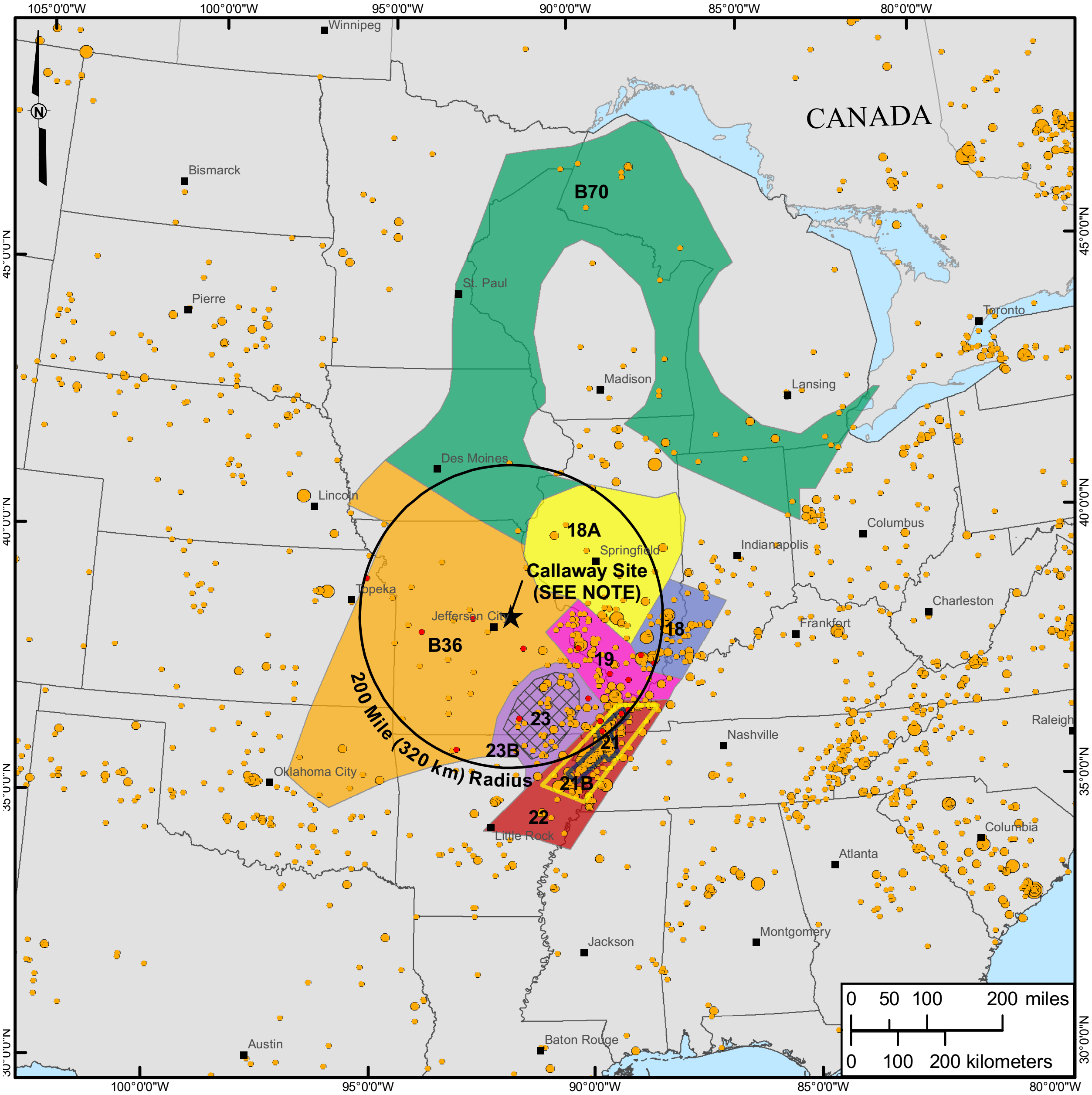
Bechtel Group Sources within 50 Mile (80 km) Radius

- 30 New Madrid
- 31 Reelfoot Rift
- 36 St. Genevieve
- 42 TN-MT Trend
- Ozark Area
- K Southern Illinois Area
- BZ0 Background Zone 0
- BZ3 Background Zone 3

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
• ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
• Updated USGS Catalog, 2007.
• EPRI Volume IX: Bechtel Group, 1986.

Figure 2.5.2-2—{Earthquake Catalog and Dames & Moore Group EPRI Source Zones}

Page 1 of 2



LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

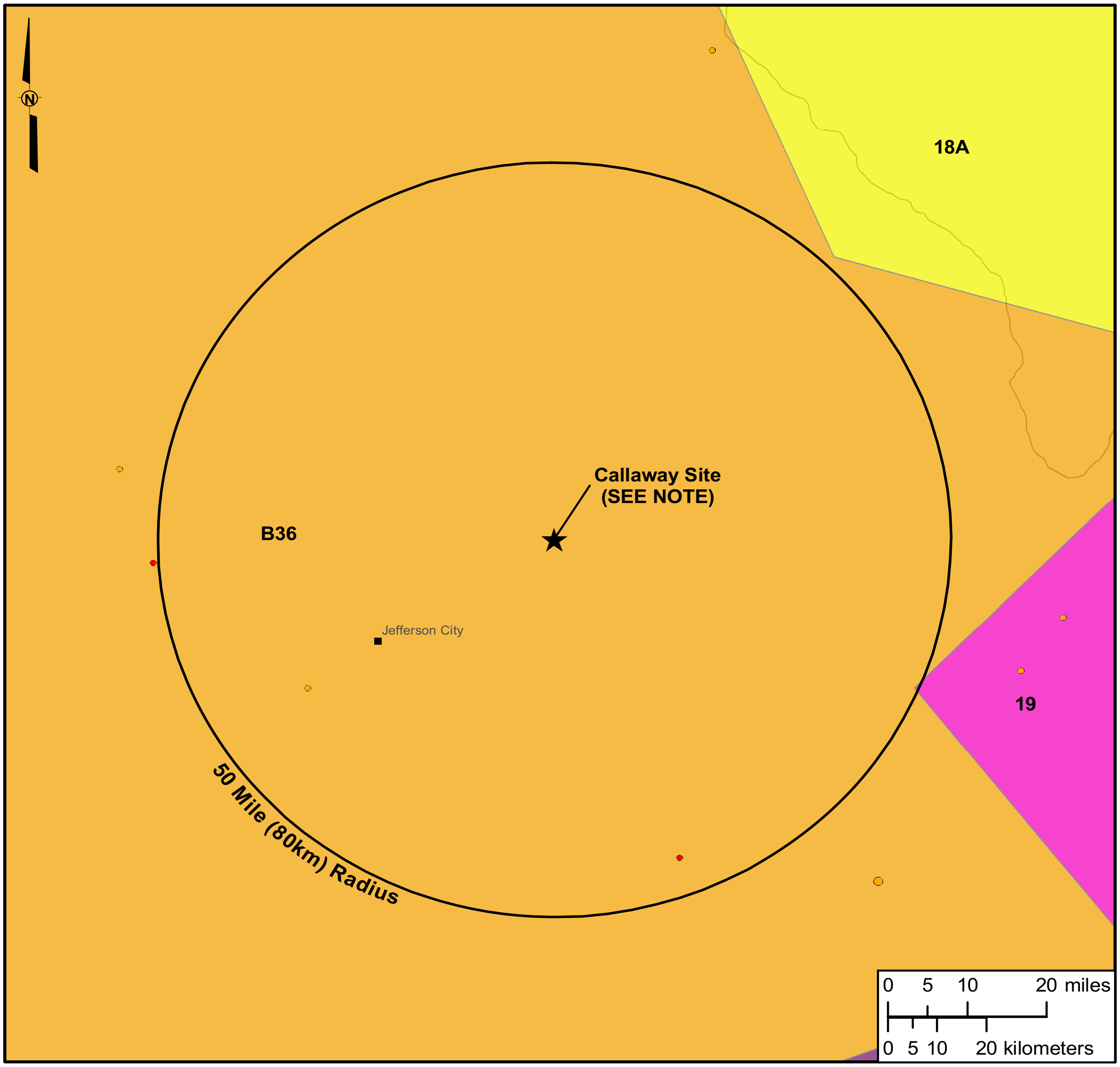
Dames and Moore Sources within 200 Mile (320 km) Radius

- 18 Southern Illinois/ Southern Indiana/ Fairfield Basin
- 18A Illinois Basin
- 19 St. Louis Arm
- 21 New Madrid Compression Zone
- 21B New Madrid Count Zone
- 22 Reelfoot Rift
- 23 Eastern Ozarks
- 23B Default (Regional Source)
- B36 Midcontinent Province
- B70 Wisconsin-Michigan Block

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.

REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume VI: Dames and Moore, 1986

Figure 2.5.2-2—{Earthquake Catalog and Dames & Moore Group EPRI Source Zones}
50 mile (80 km) Closeup
Page 2 of 2



LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

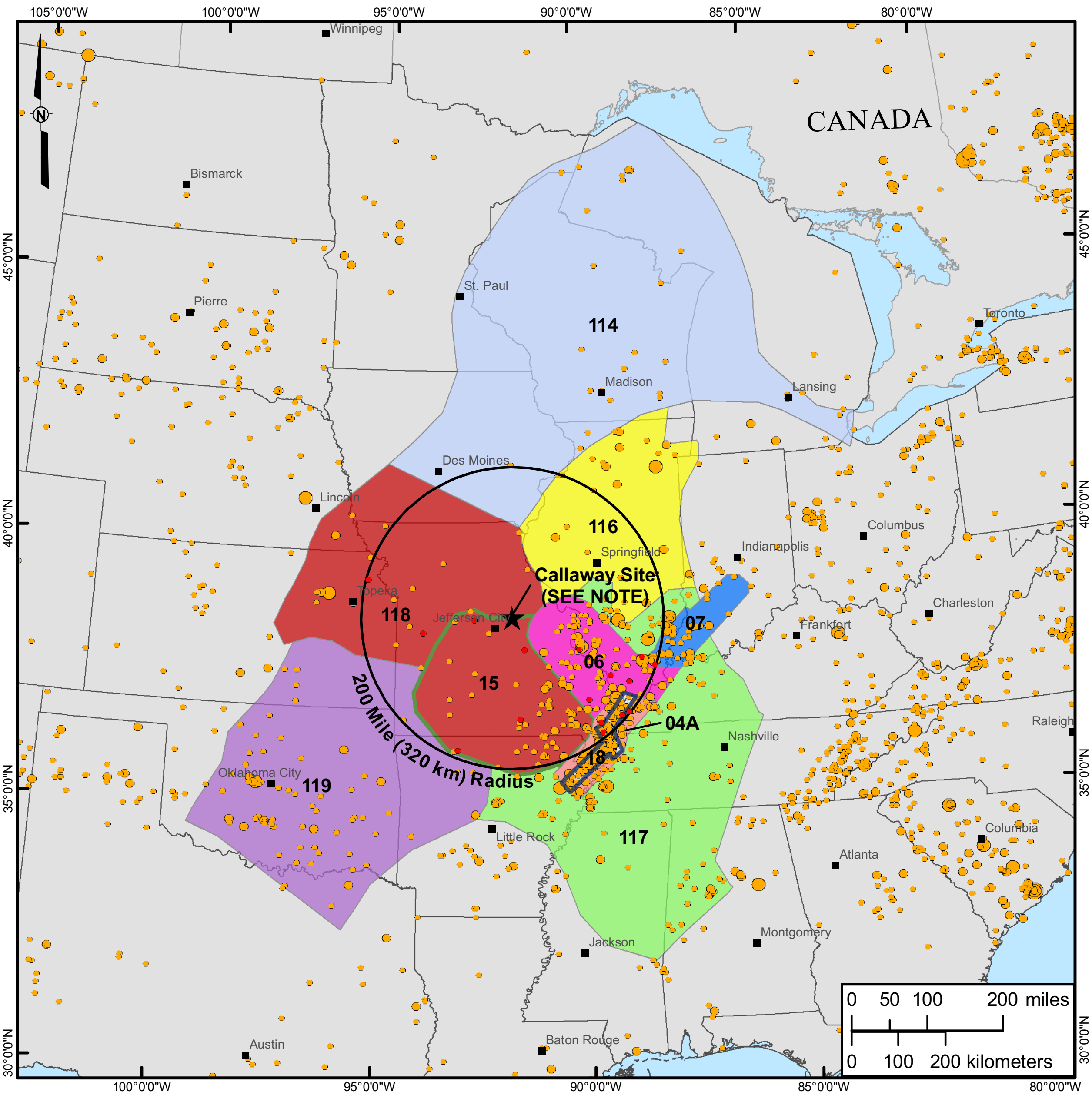
USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

Dames and Moore
Sources within 50 Mile (80 km) Radius

- 18 Southern Illinois/ Southern Indiana/ Fairfield Basin
- 18A Illinois Basin
- 19 St. Louis Arm
- 21 New Madrid Compression Zone
- 21B New Madrid Count Zone
- 22 Reelfoot Rift
- 23 Eastern Ozarks
- 23B Default (Regional Source)
- B36 Midcontinent Province
- B70 Wisconsin-Michigan Block

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
• ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
• Updated USGS Catalog, 2007.
• EPRI Volume VI: Dames and Moore, 1986.

Figure 2.5.2-3—{Earthquake Catalog and Law Engineering Group EPRI Source Zones}
Page 1 of 2



LEGEND

- City
- State/Privince Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

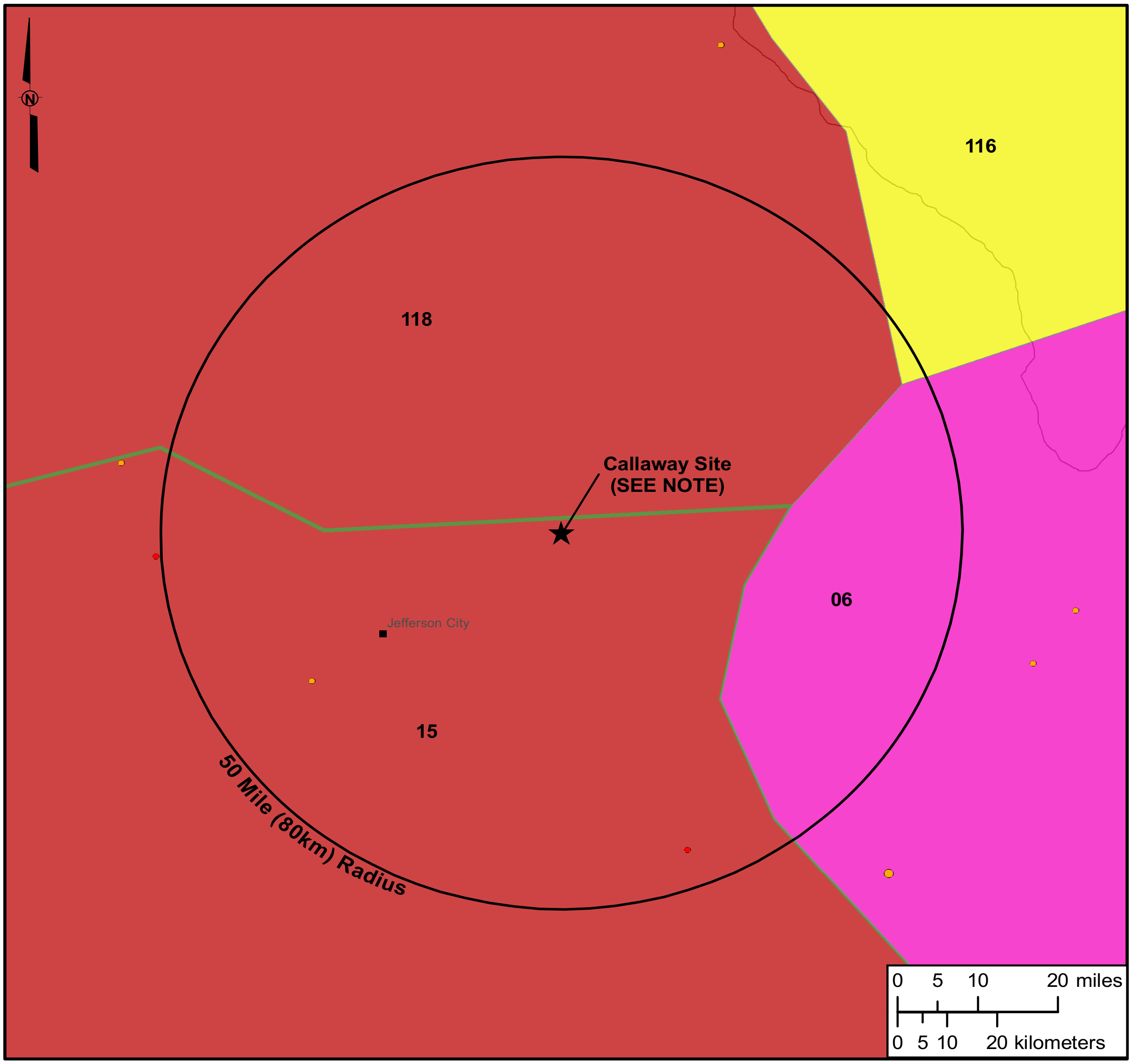
Law Engineering Sources within 200 Mile (320 km) Radius

- 04A Reelfoot Rift
- 06 St Louis Arm of the New Madrid Rift Complex
- 07 Wabash Valley Arm
- 15 Ozark Uplift
- 18 Postulated Faults in Reelfoot Rift
- 114 Wisconsin Block
- 116 Illinois Block
- 117 Mississippi Embayment
- 118 Missouri Block
- 119 Eastern Mid-Continent

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
• ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
• Updated USGS Catalog, 2007.
• EPRI Volume VII: Law Engineering, 1986.

Figure 2.5.2-3—{Earthquake Catalog and Law Engineering Group EPRI Source Zones} 50 mile (80 km) Closeup

Page 2 of 2



LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

Law Engineering Sources within 50 Mile (80 km) Radius

- 04A Reelfoot Rift
- 06 St Louis Arm of the New Madrid Rift Complex
- 07 Wabash Valley Arm
- 15 Ozark Uplift
- 18 Postulated Faults in Reelfoot Rift
- 114 Wisconsin Block
- 116 Illinois Block
- 117 Mississippi Embayment
- 118 Missouri Block
- 119 Eastern Mid-Continent

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
• ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
• Updated USGS Catalog, 2007.
• EPRI Volume VII: law Engineering, 1986.

Figure 2.5.2-4—{Earthquake Catalog and Rondout Group EPRI Source Zones}

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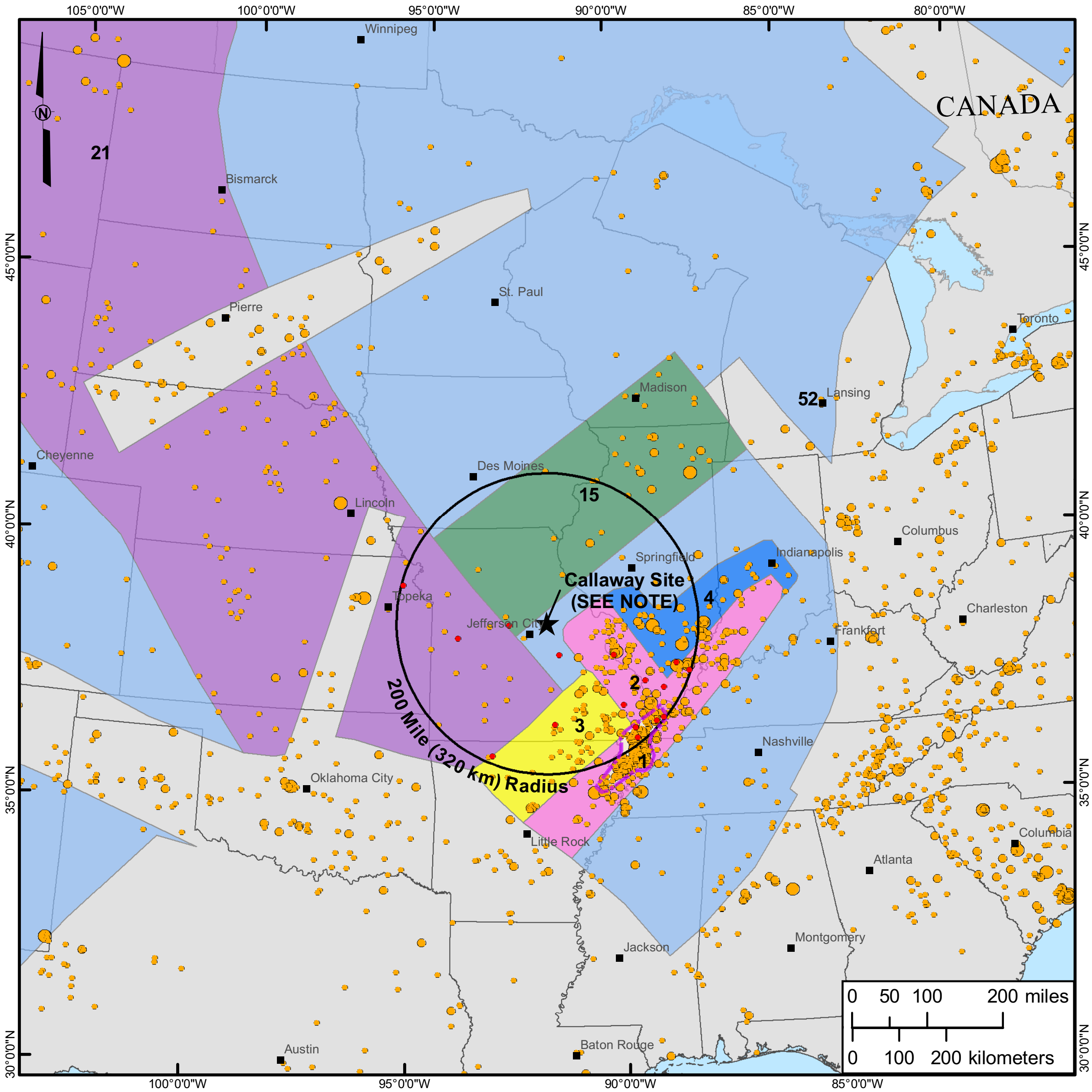


LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

Rondout Associates Sources within 200 Mile (320 km) Radius

- 1 New Madrid
- 2 New Madrid Rift Complex
- 3 Ozark Uplift
- 4 Southern Illinois
- 15 Northern Illinois
- 21 Great Plains
- 52 Pre-Grenville Precambiran Craton (Background Zone)

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume X: Rondout Associates, 1986.

Figure 2.5.2-4—{Earthquake Catalog and Rondout Group EPRI Source Zones}
50 mile (80 km) closeup
Page 2 of 2

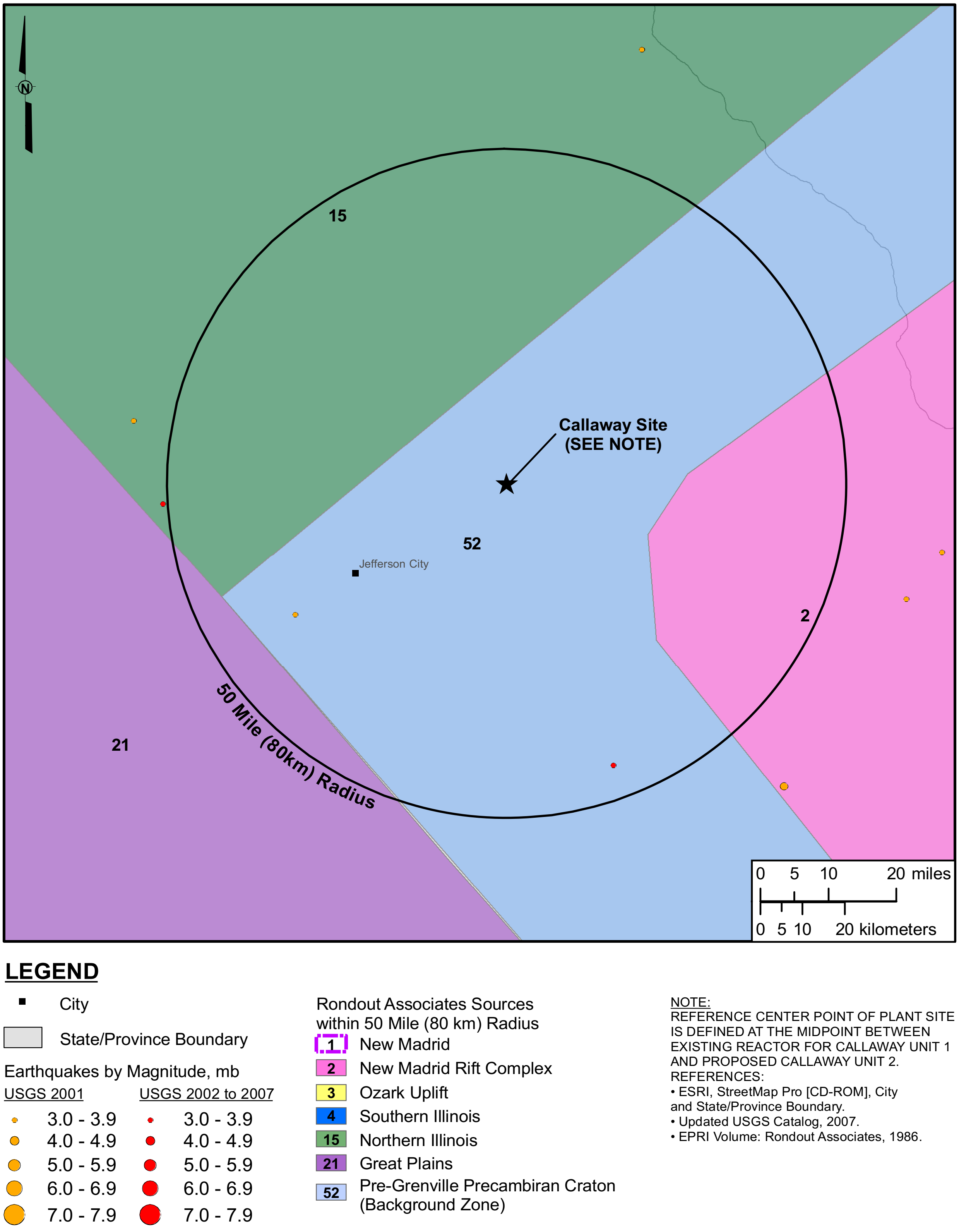


Figure 2.5.2-5—{Earthquake Catalog and Weston Group EPRI Source Zones}

Page 1 of 2

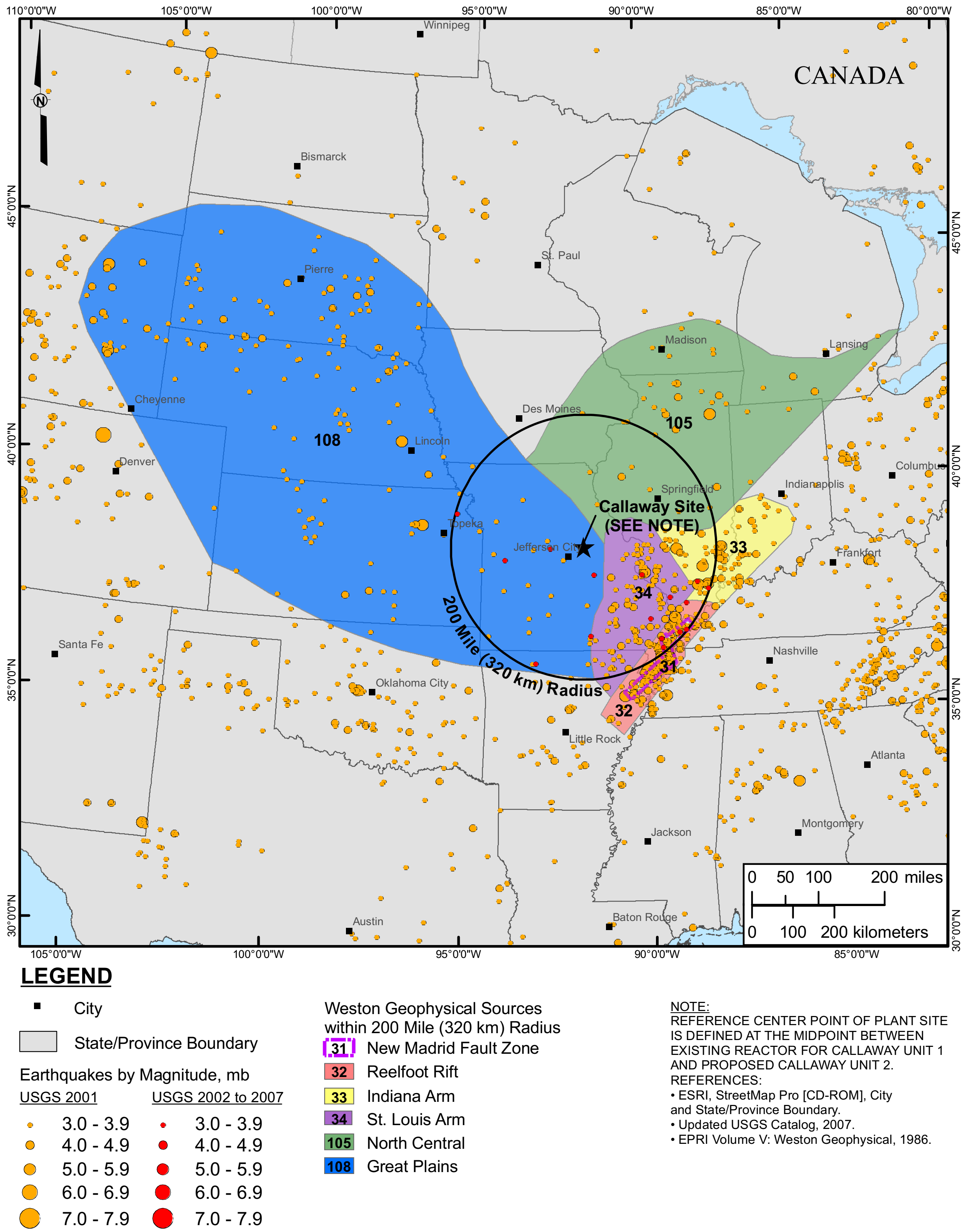
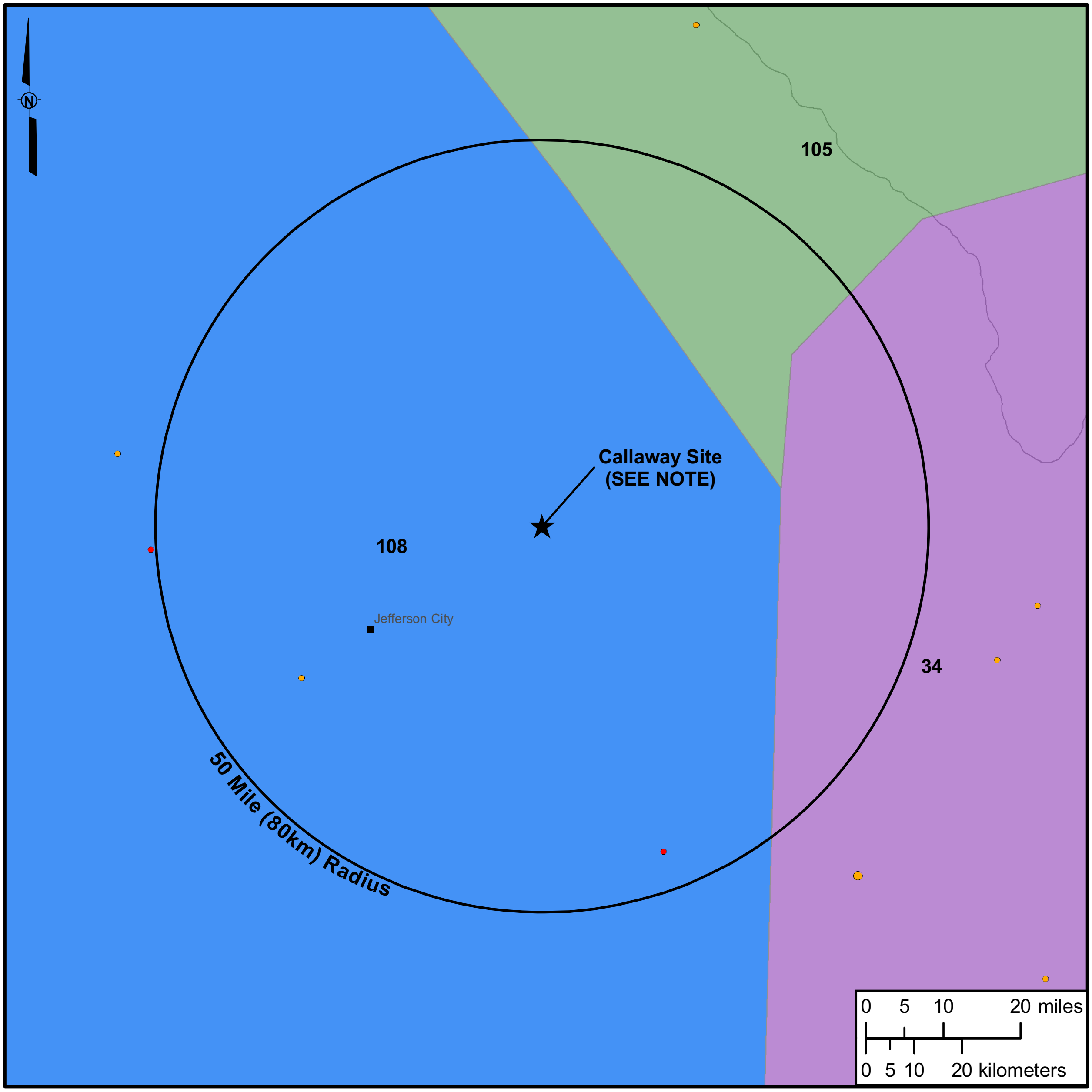


Figure 2.5.2-5—{Earthquake Catalog and Weston Group EPRI Source Zones}
50 mile (80 km) Closeup
Page 2 of 2



LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

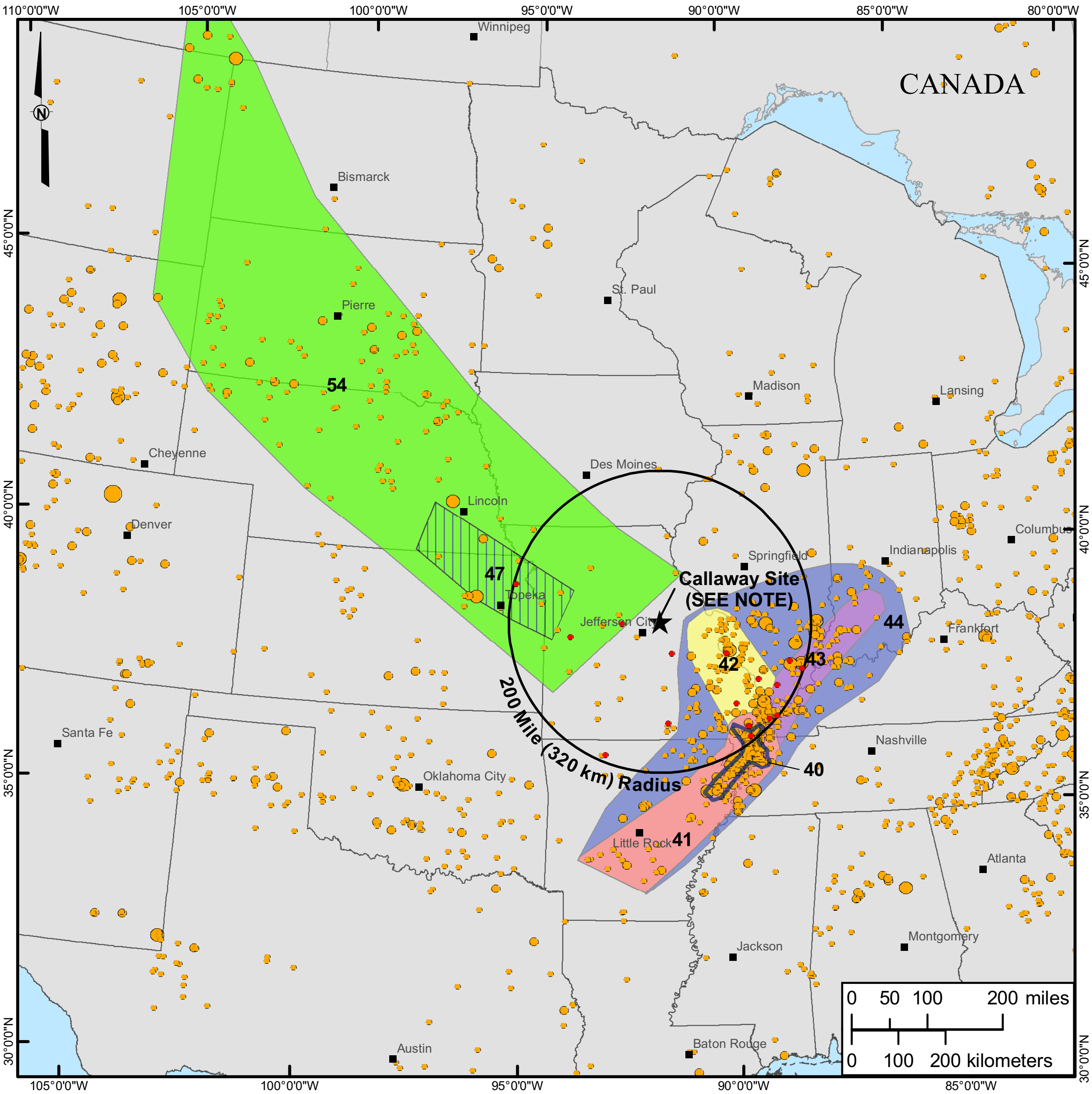
Weston Geophysical Sources within 50 Mile (80 km) Radius

- 31 New Madrid Fault Zone
- 32 Reelfoot Rift
- 33 Indiana Arm
- 34 St. Louis Arm
- 105 North Central
- 108 Great Plains

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume V: Weston Geophysical, 1986.

Figure 2.5.2-6—{Earthquake Catalog and Woodward-Clyde EPRI Source Zones}

Page 1 of 2



LEGEND

City

State/Province Boundary

Earthquakes by Magnitude, mb

USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

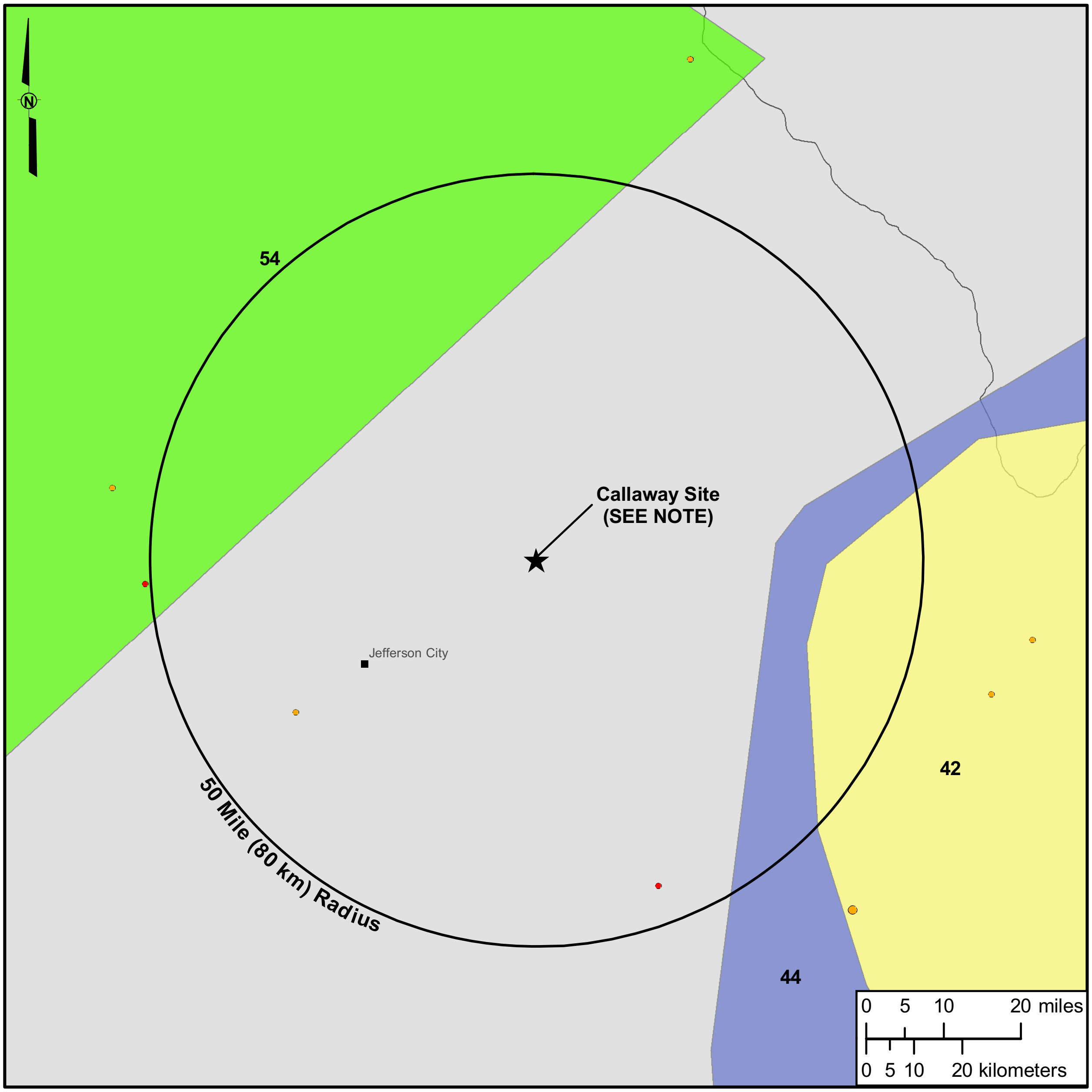
Woodward-Clyde Consultants Sources within 200 Mile (320 km) Radius

- 40 Central Reelfoot Rift
- 41 Reelfoot Rift
- 42 St Louis Arm, New Madrid Rift
- 43 South Indiana, New Madrid Rift
- 44 New Madrid Loading Zone
- 47 Kansas/Nebraska Offset of Mid-Continent Geophysical Anomaly
- 54 Great Plains Crustal Block

NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.

REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume VIII: Woodward-Clyde Consultants, 1986.

Figure 2.5.2-6—{Earthquake Catalog and Woodward-Clyde EPRI Source Zones}
50 mile (80 km) Closeup
Page 2 of 2



LEGEND

- City
- State/Province Boundary

Earthquakes by Magnitude, mb

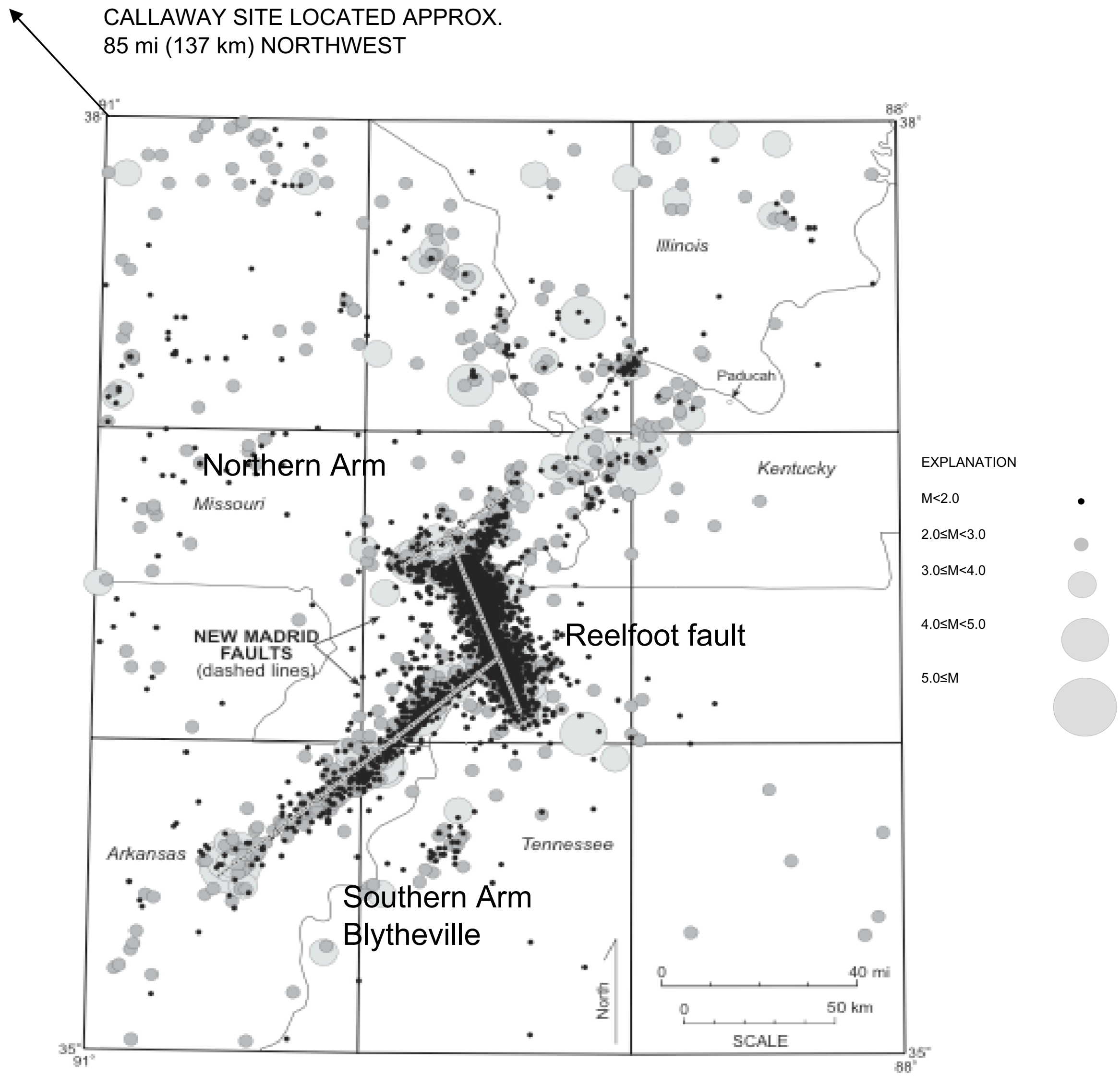
USGS 2001	USGS 2002 to 2007
3.0 - 3.9	3.0 - 3.9
4.0 - 4.9	4.0 - 4.9
5.0 - 5.9	5.0 - 5.9
6.0 - 6.9	6.0 - 6.9
7.0 - 7.9	7.0 - 7.9

Woodward-Clyde Consultants Sources within 50 Mile (80 km) Radius

- 40 Central Reelfoot Rift
- 41 Reelfoot Rift
- 42 St Louis Arm, New Madrid Rift
- 43 South Indiana, New Madrid Rift
- 44 New Madrid Loading Zone
- 47 Kansas/Nebraska Offset of Mid-Continent Geophysical Anomaly
- 54 Great Plains Crustal Block

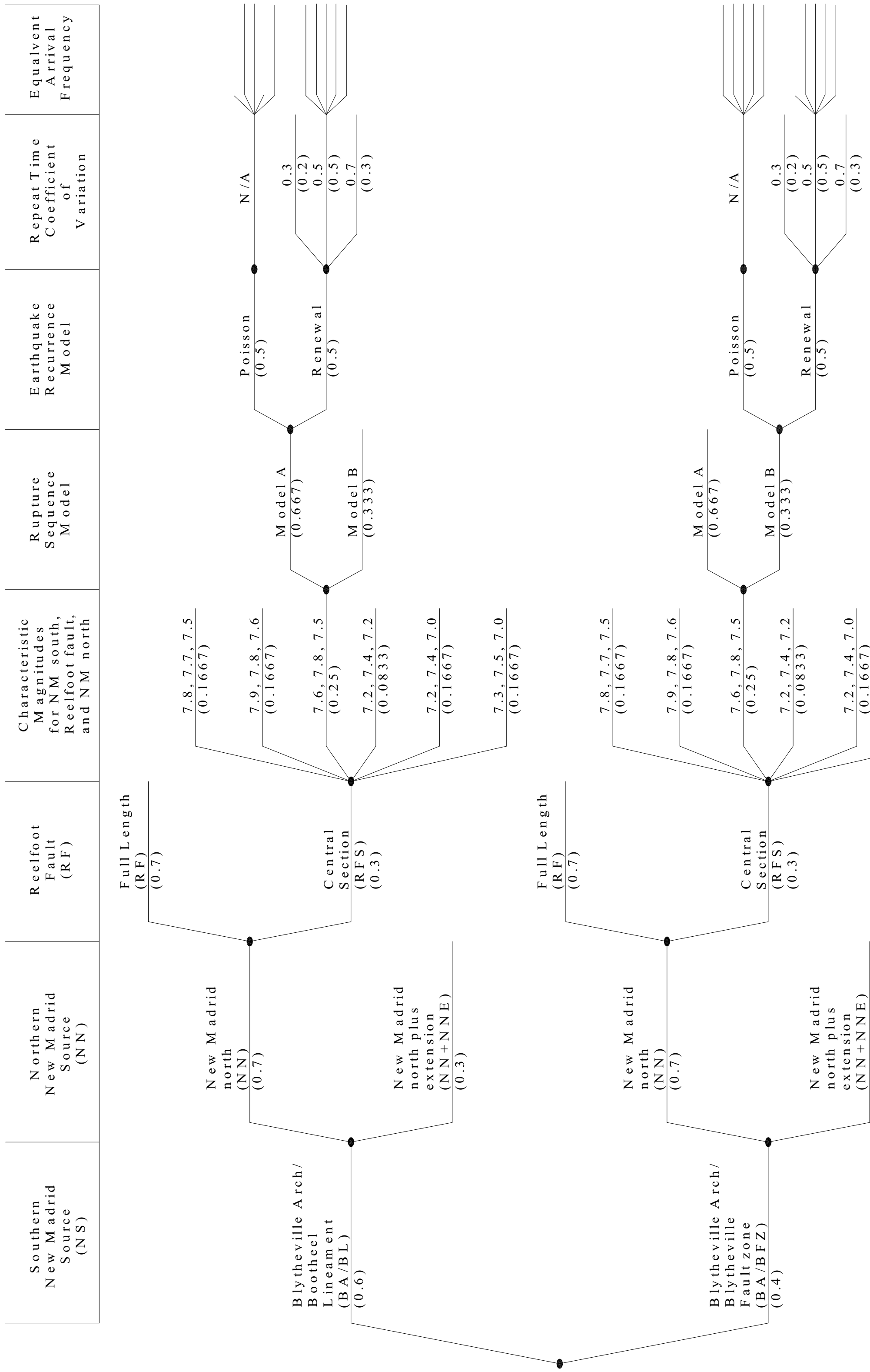
NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AT THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY UNIT 1 AND PROPOSED CALLAWAY UNIT 2.
REFERENCES:
- ESRI, StreetMap Pro [CD-ROM], City and State/Province Boundary.
- Updated USGS Catalog, 2007.
- EPRI Volume VIII: Woodward-Clyde Consultants, 1986.

Figure 2.5.2-7—{Seismic Activity at the New Madrid Fault System}



From USGS Preliminary Documentation for the 2007 Update of the US National Seismic (USGS 2007 Hazard Maps)

Figure 2.5.2-8—{Logic Tree for the New Madrid Fault System}



Adapted from the Seismic Hazards Report for the EGC ESP Site . See Figure 4.1-1 of Appendix B (EGC 2006)

FSAR: Figures 2.5.2

Figure 2.5.2-9—{Location of the Arms of the New Madrid Fault System}

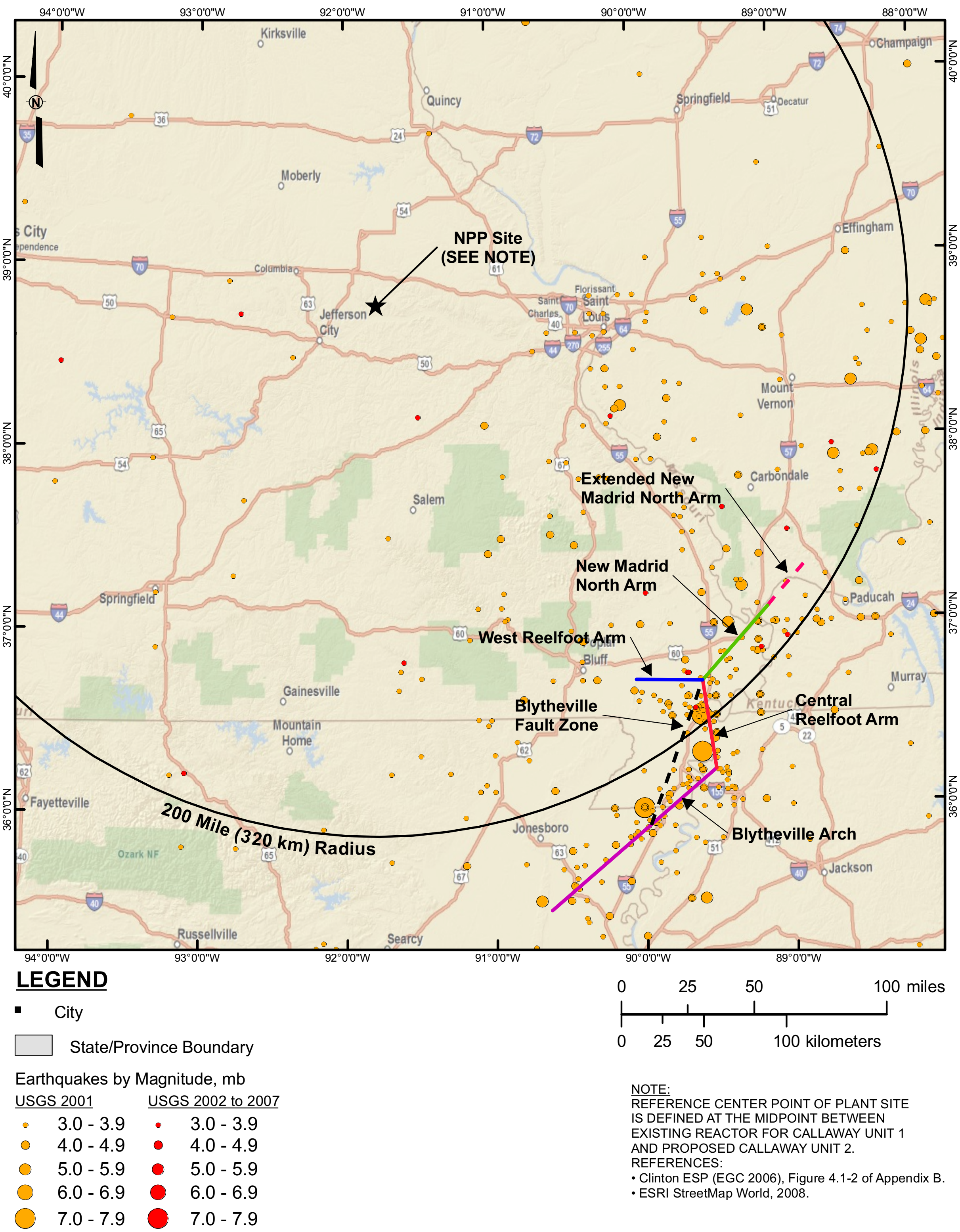
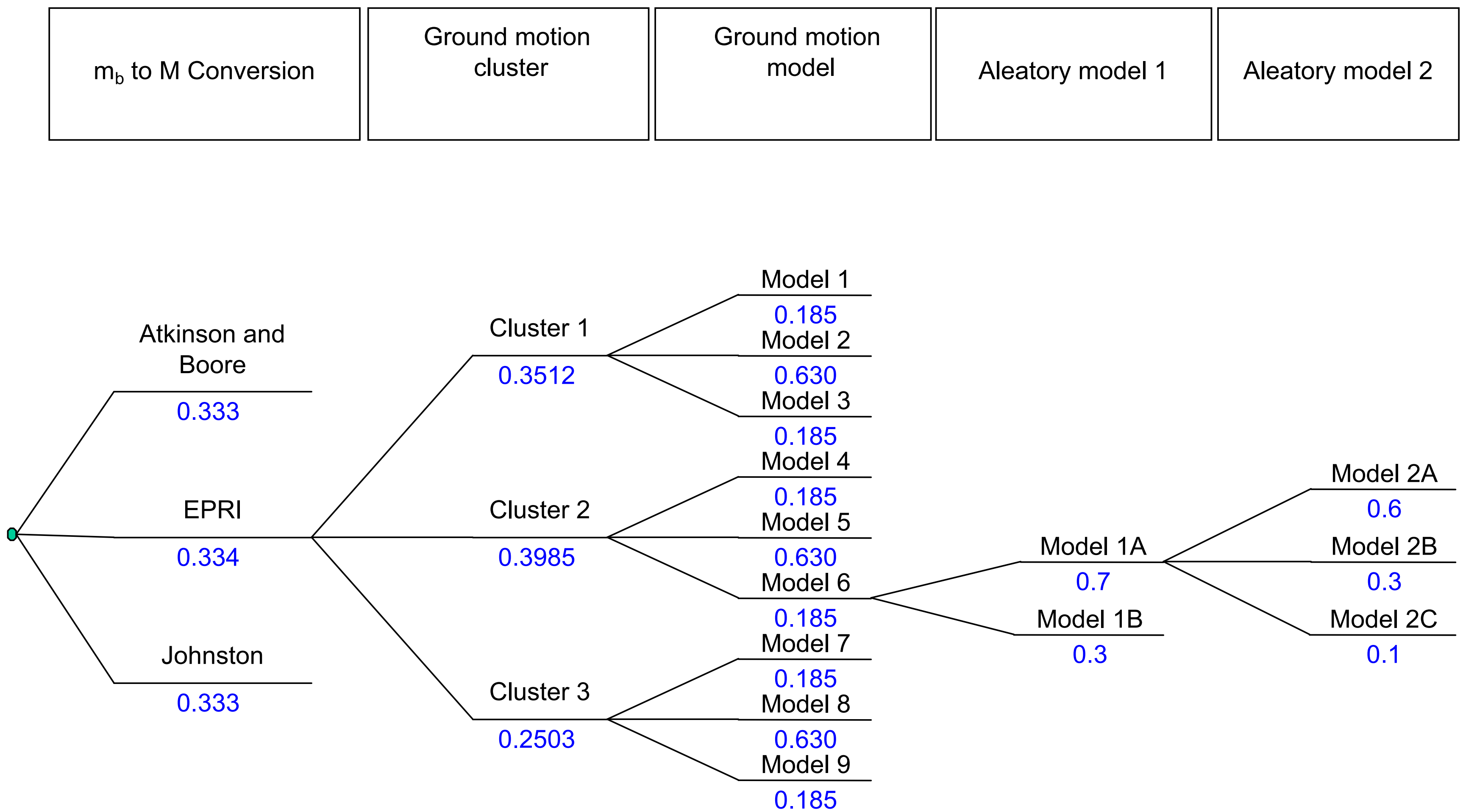
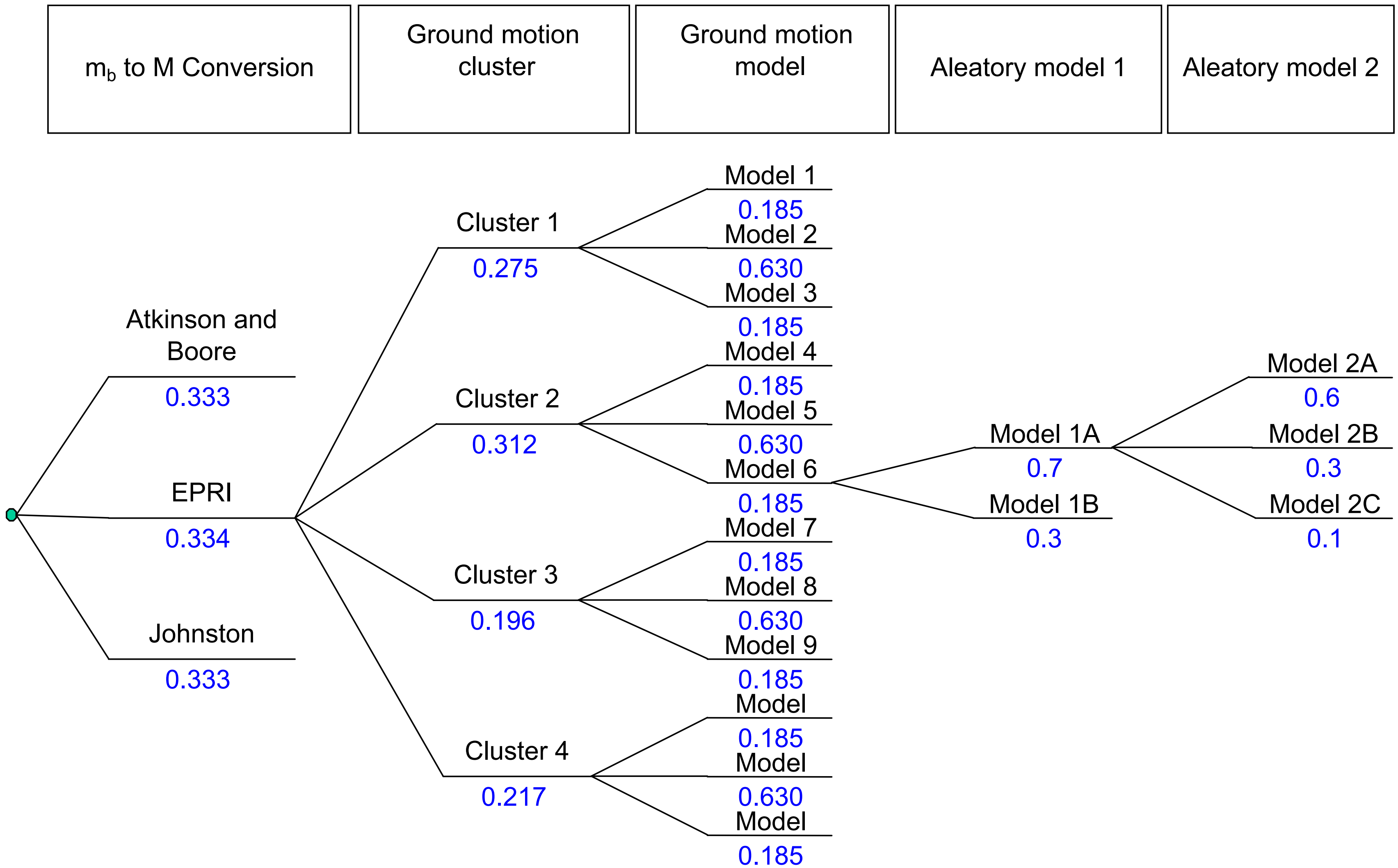


Figure 2.5.2-10—{Logic Tree for the Ground Motion Models for General Area Sources}



Reference: 1. EPRI Report number 1009684 for the median ground motion (EPRI 2004)
2. EPRI Report number 1014381 for Aleatory model (EPRI 2006)

Figure 2.5.2-11—{Logic Tree for the Ground Motion Models for Non-General Area Sources}



Note: Non-rift cluster 4 for Wabash Valley and Rift cluster 4 for New Madrid

Reference: 1. EPRI Report number 1009684 for the median ground motion (EPRI 2004)
2. EPRI Report number 1014381 for Aleatory model (EPRI 2006)

**Figure 2.5.2-12—{Mean and Fractile Rock Hazard Curves }
(PGA, 25 Hz, 10 Hz, 5 Hz)**

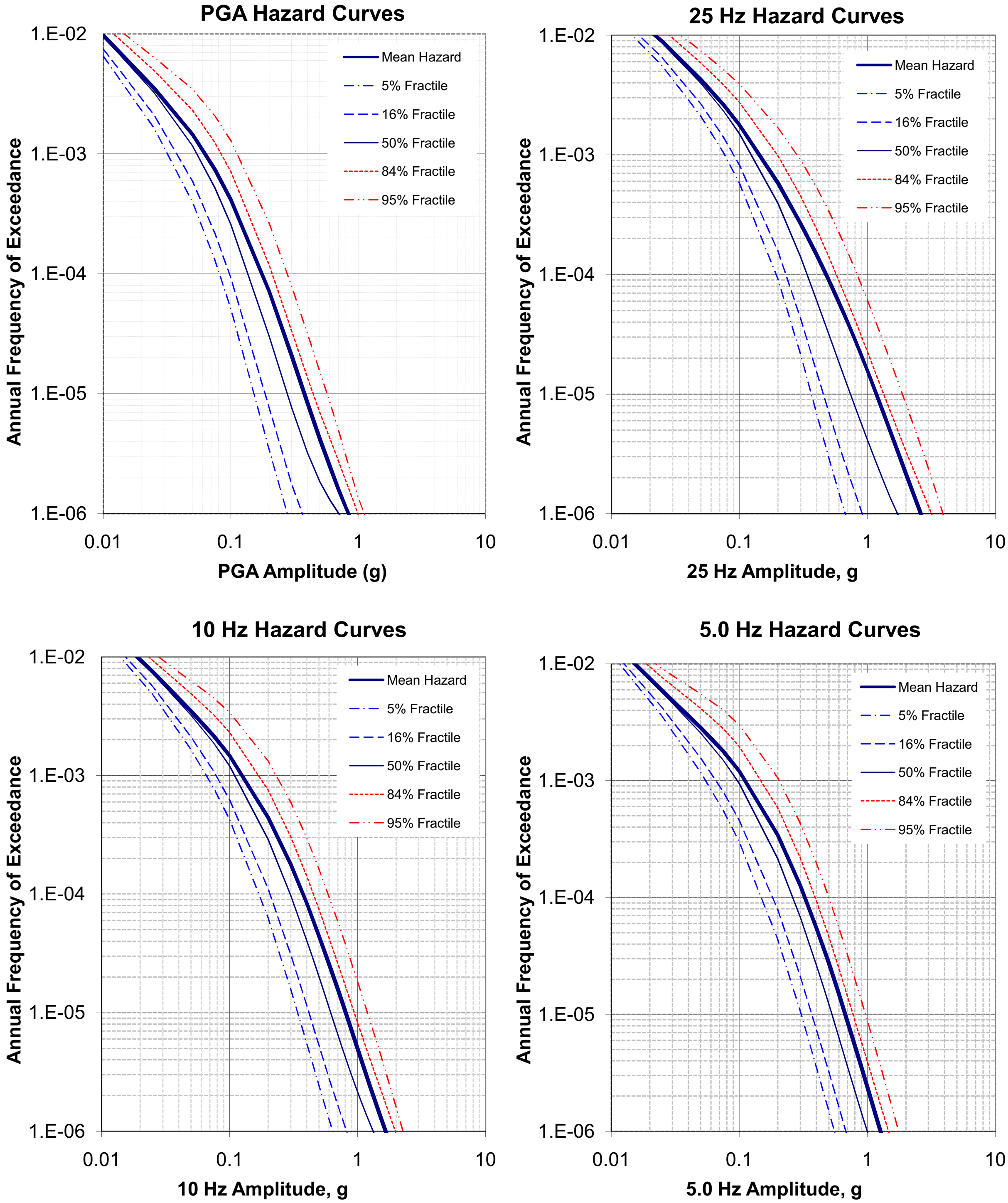


Figure 2.5.2-13—{Mean and Fractile Rock Hazard Curves }
(2.5 Hz, 1.0 Hz and 0.5 Hz)

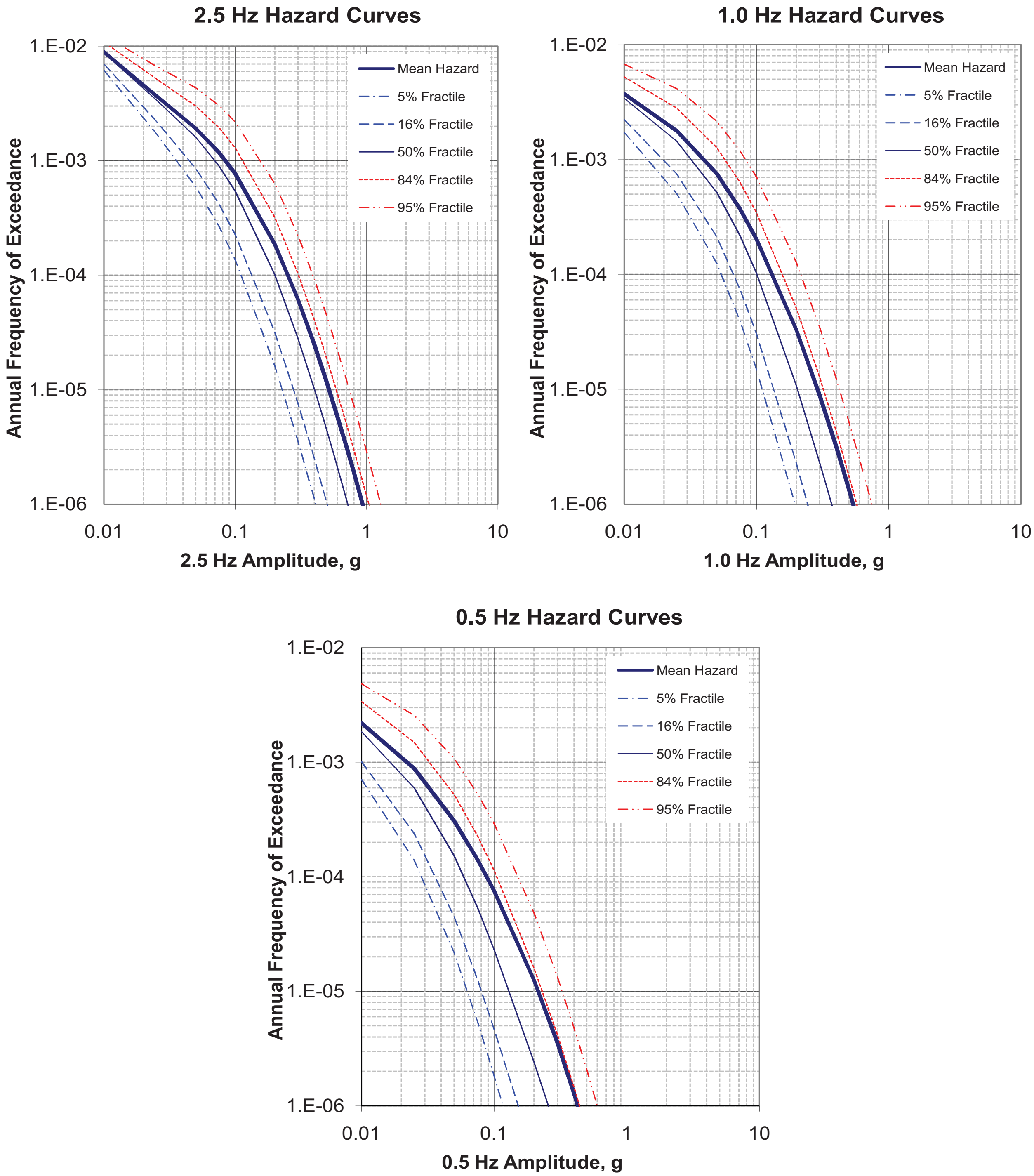


Figure 2.5.2-14—{Uniform Hazard Response Spectra for Hard Rock}

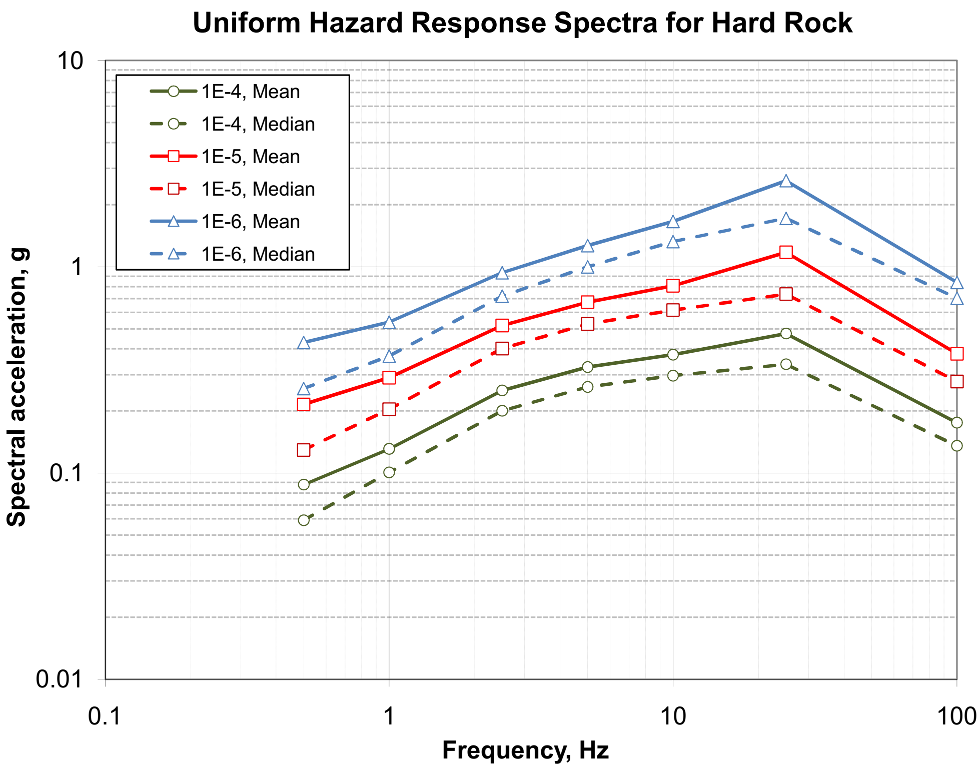


Figure 2.5.2-15—{Mean De-aggregation for 1E-4, 1E-5 and 1E-6}

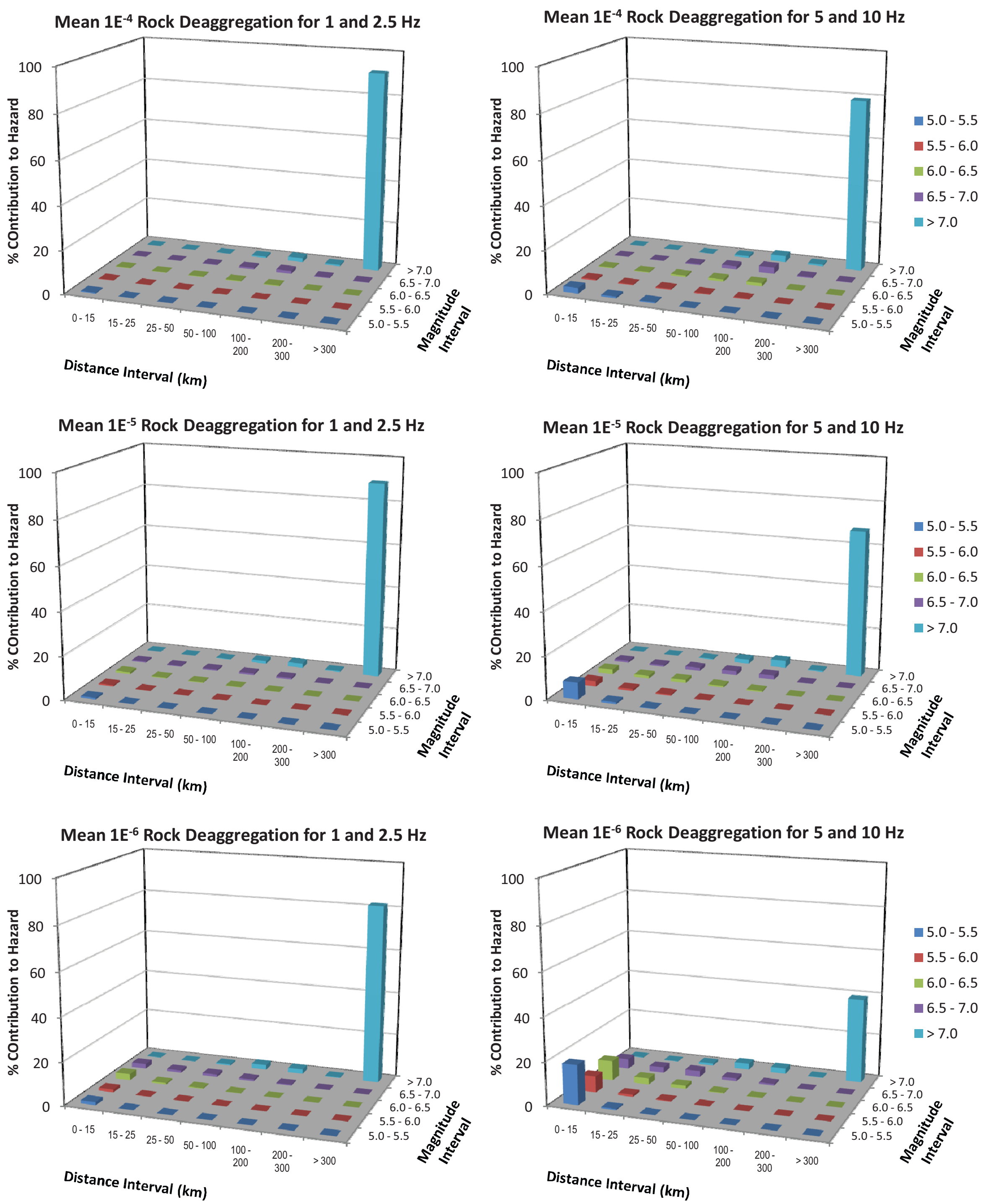


Figure 2.5.2-16—{Comparison of G-R Parameters, Bechtel EST Zones (USGS data through 2001 and 2007)}

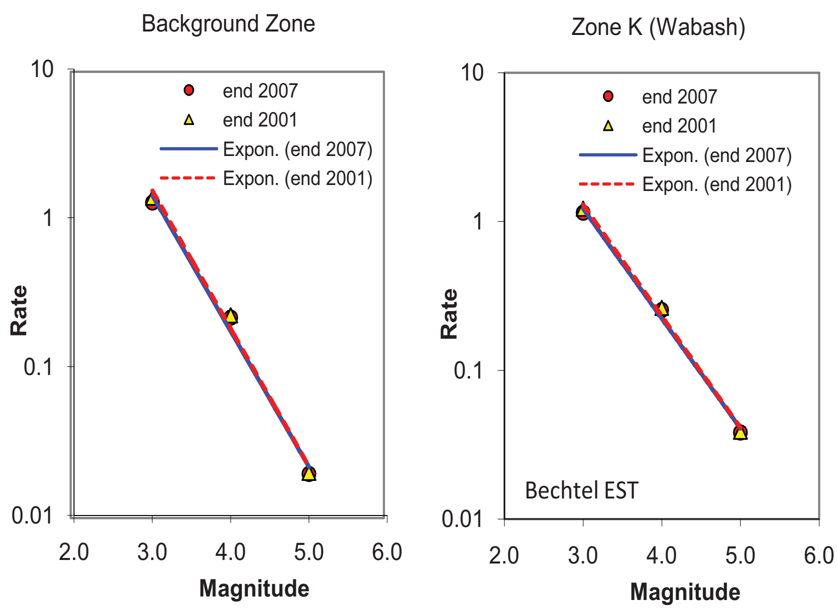


Figure 2.5.2-17—{Comparison of UHRS at Hard Rock for Callaway Plant Unit 2 Site (USGS data through 2001 and 2007)}

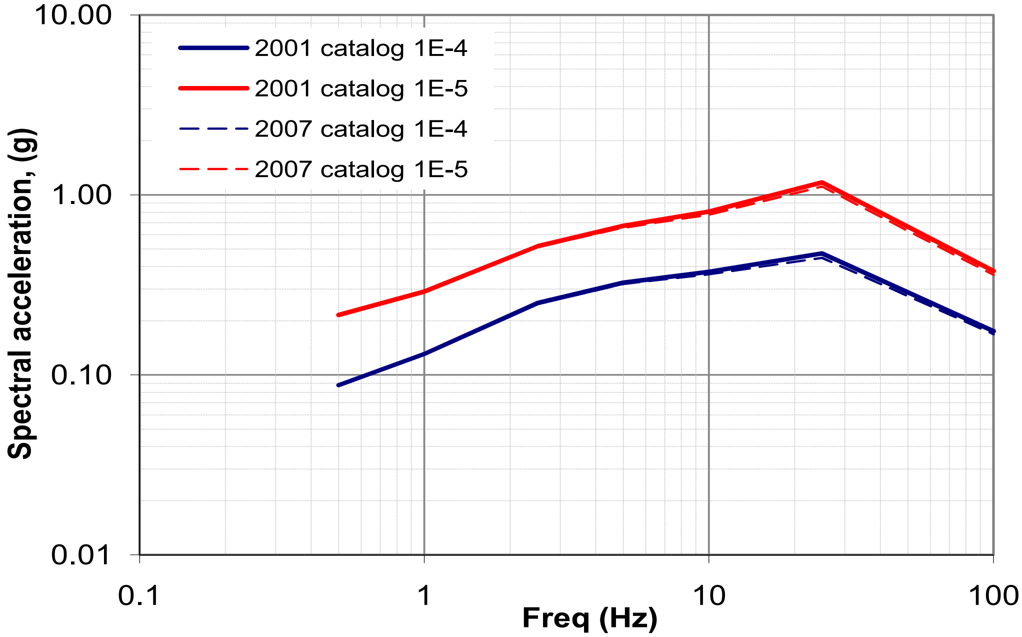


Figure 2.5.2-18—{Sensitivity Analysis of Postulated Events Near St. Louis}

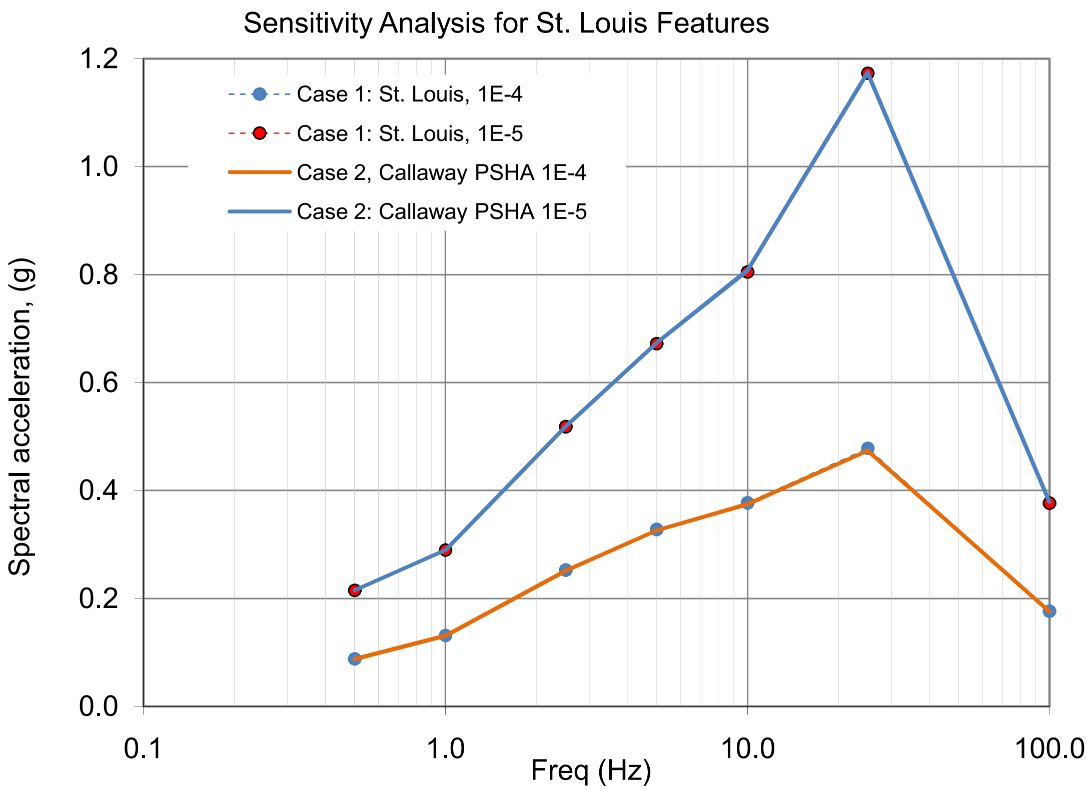
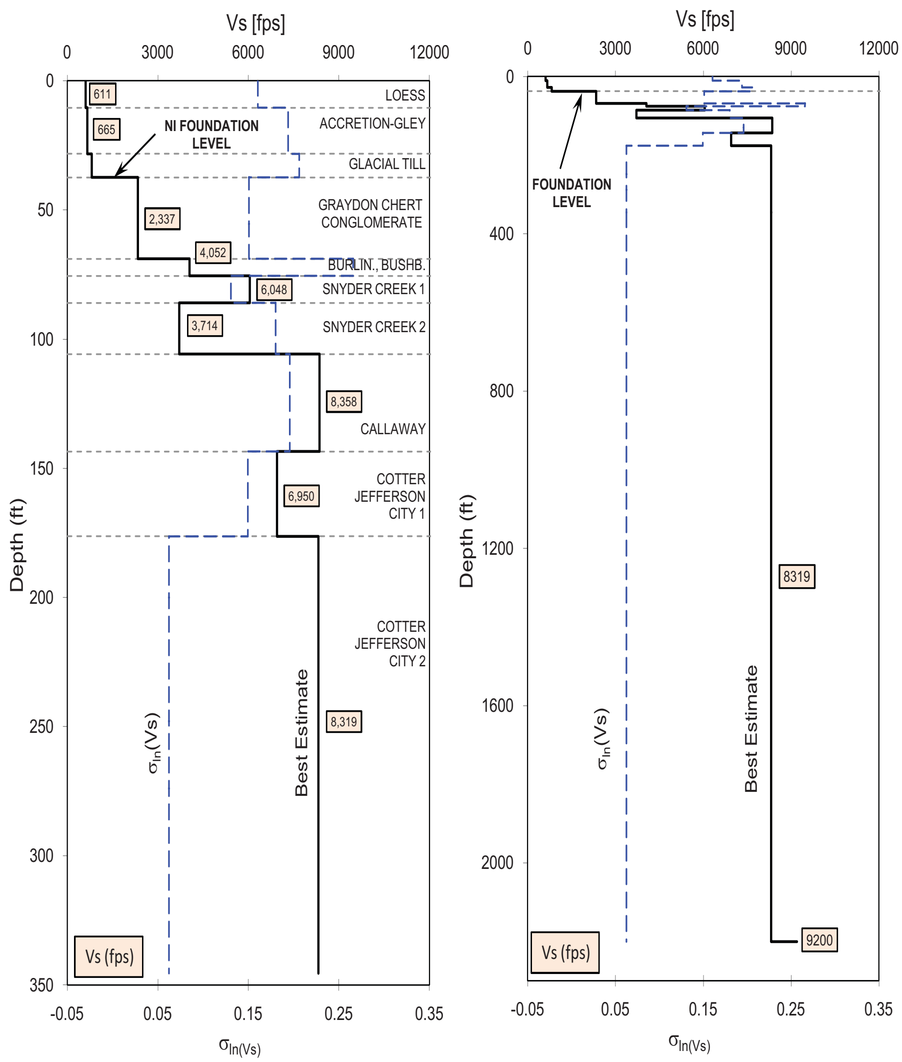


Figure 2.5.2-19—{Best Estimate of Shear Wave Velocity at the Callaway Plant Unit 2 Site}



Vs [fps] = Shear Wave Velocity of Soil or Rock Formation, in Feet per Second

$\sigma_{ln(Vs)}$ = Coefficient of Variation (Logarithimic Standard Deviation) of Shear Wave Velocity

Figure 2.5.2-20—{Randomization of Low Strain Shear Wave Velocity Profiles}

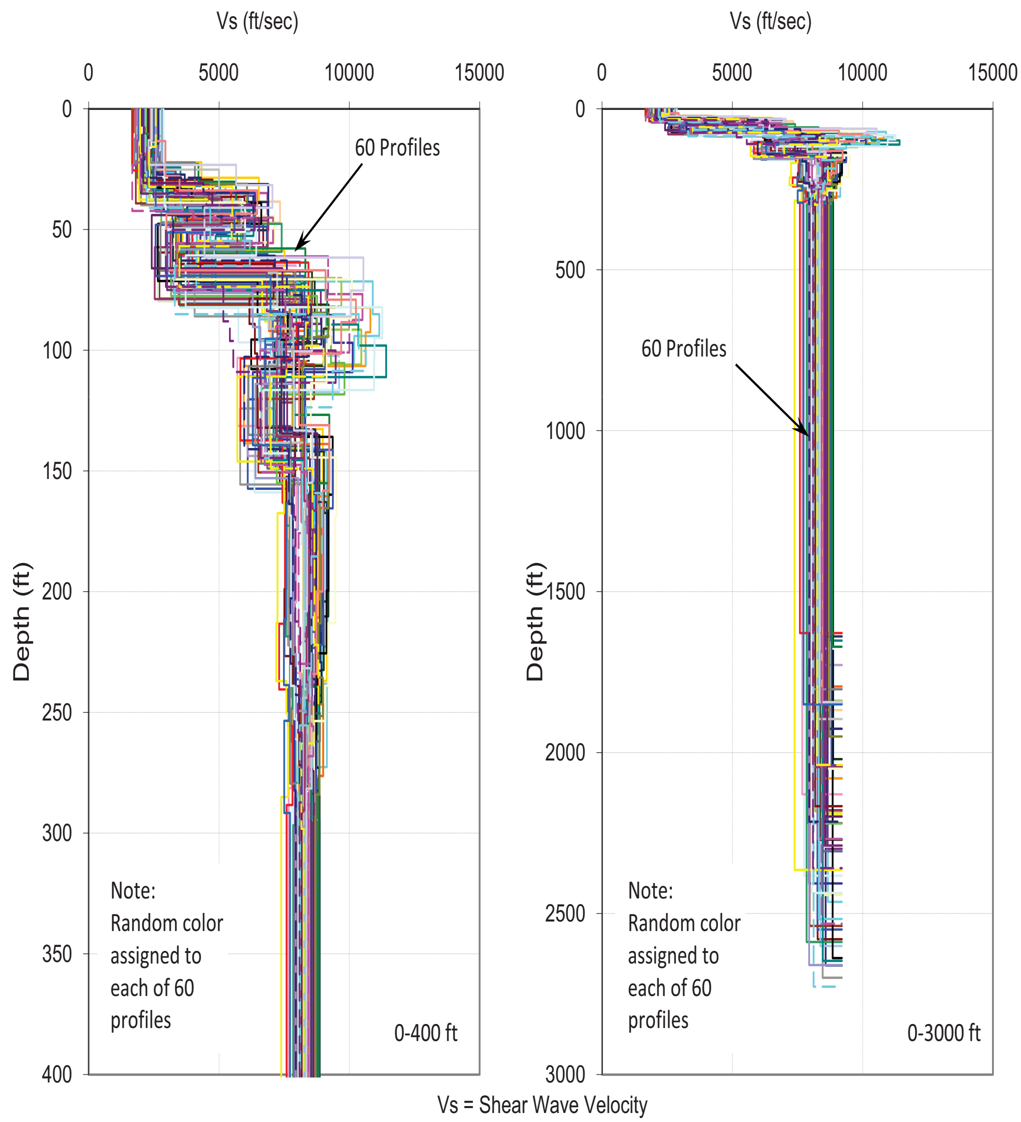


Figure 2.5.2-21—{Mean +/- Standard deviation for Shear Wave Velocity}

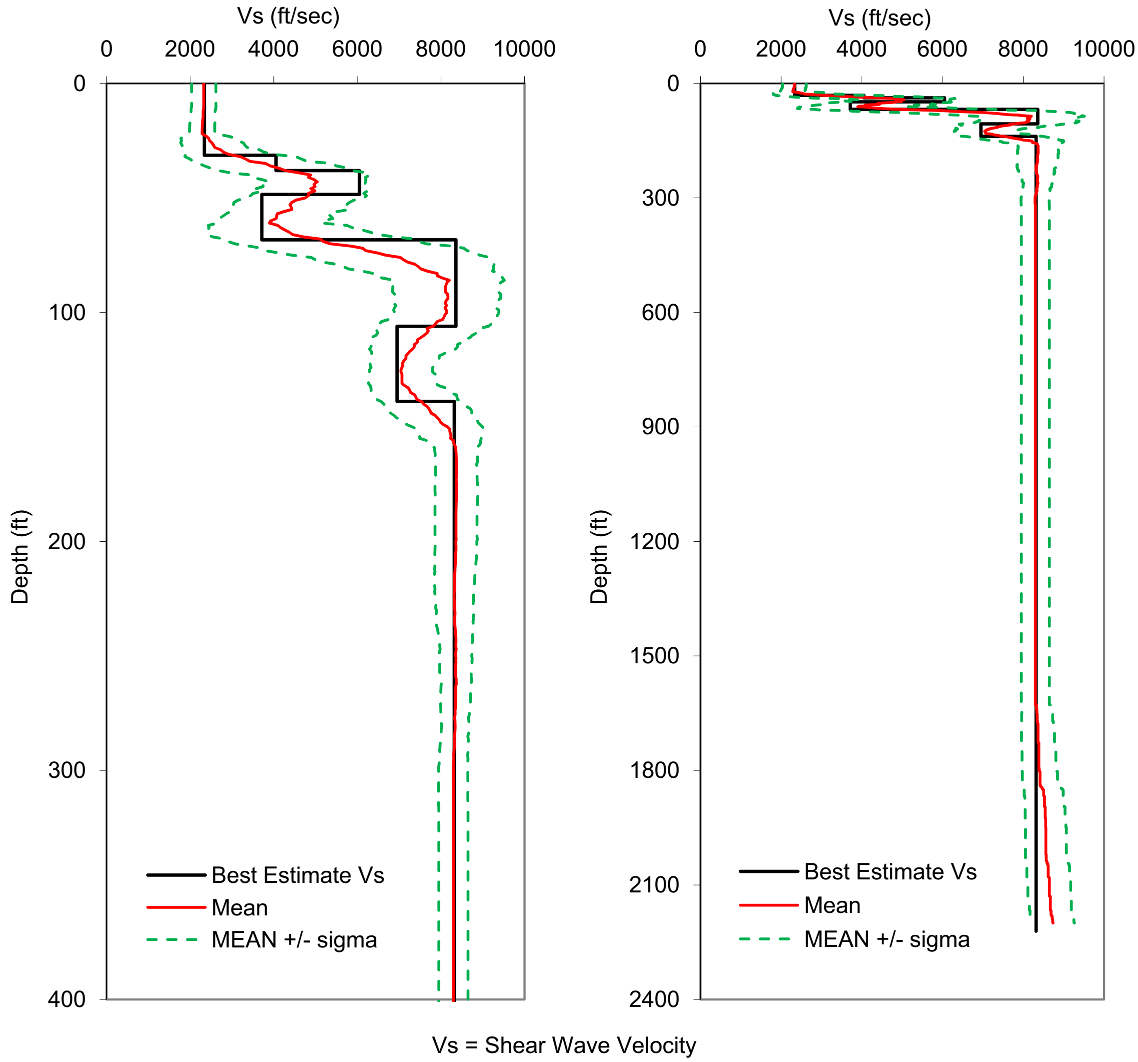


Figure 2.5.2-22—{Strain Dependent Properties and Randomization for Graydon Chert Conglomerate}

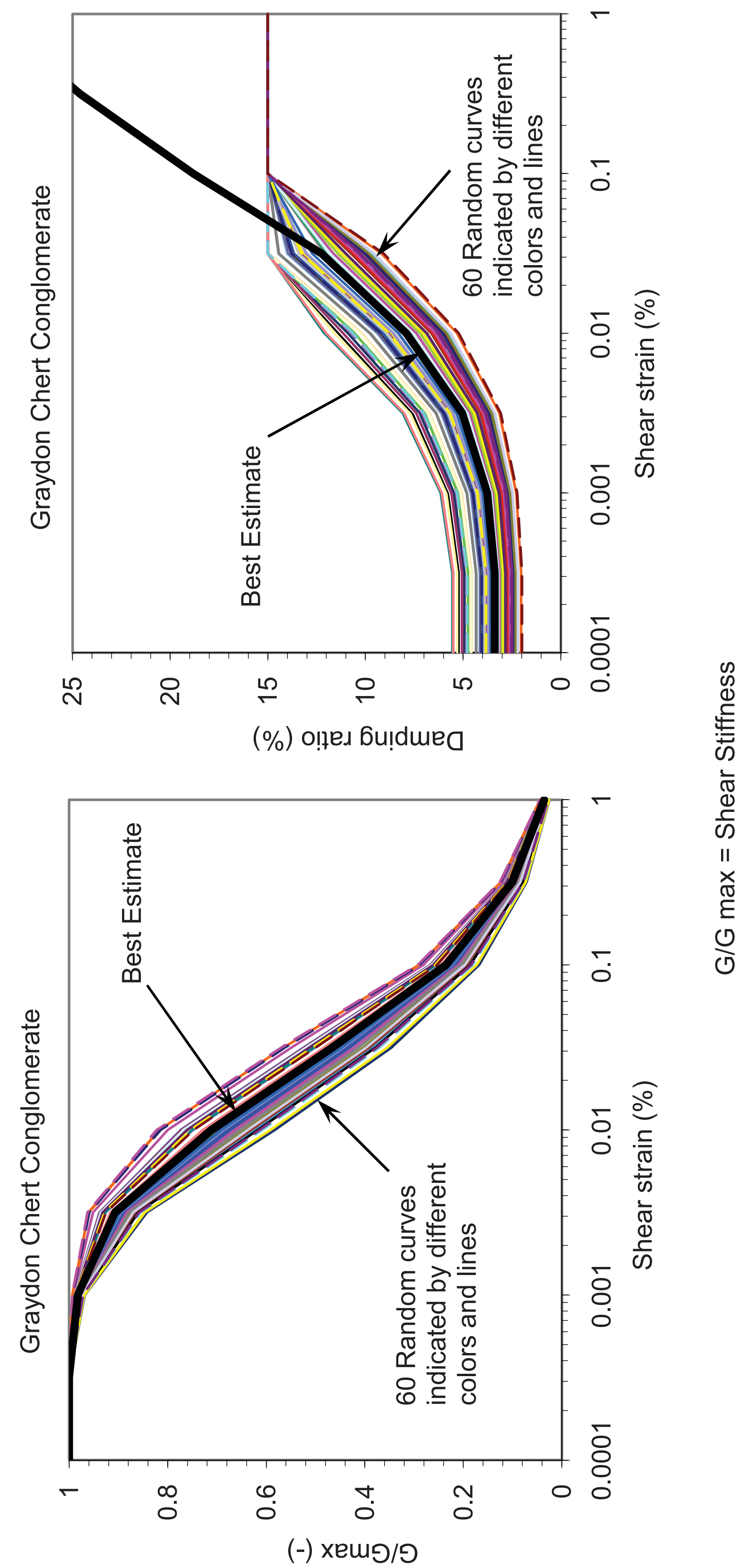


Figure 2.5.2-23—{Smooth Uniform Response Spectra for Hard Rock}

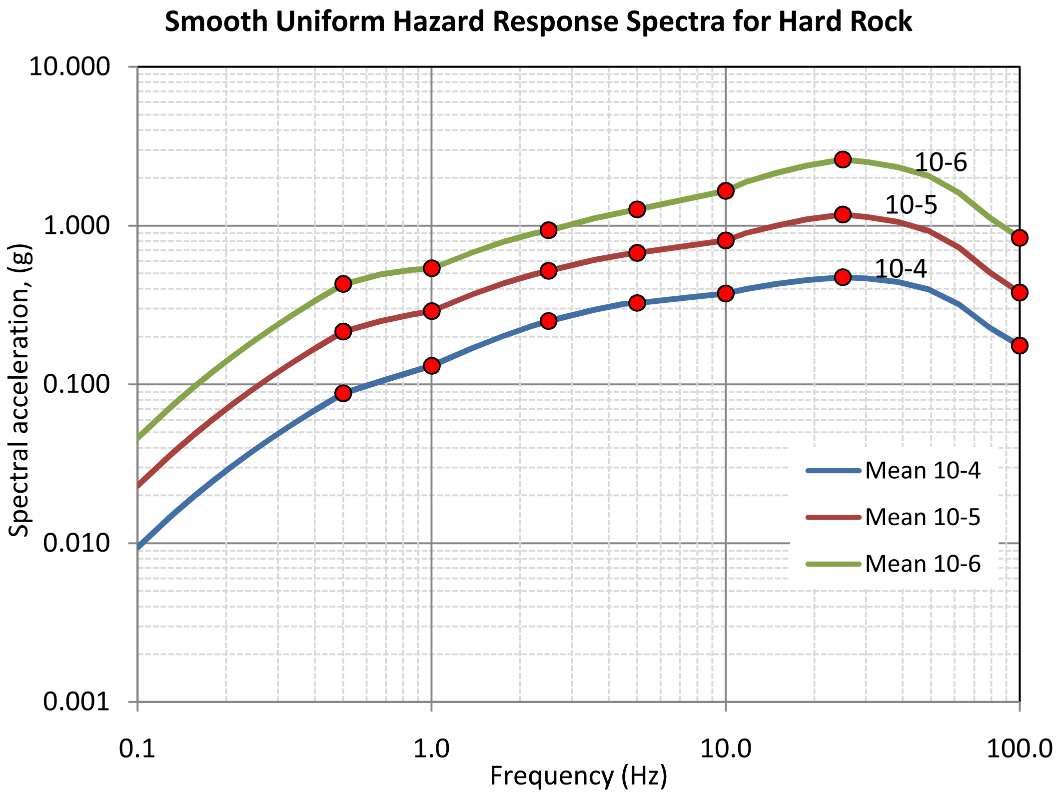


Figure 2.5.2-24—{Smooth Reference Spectra for Hard Rock Conditions}

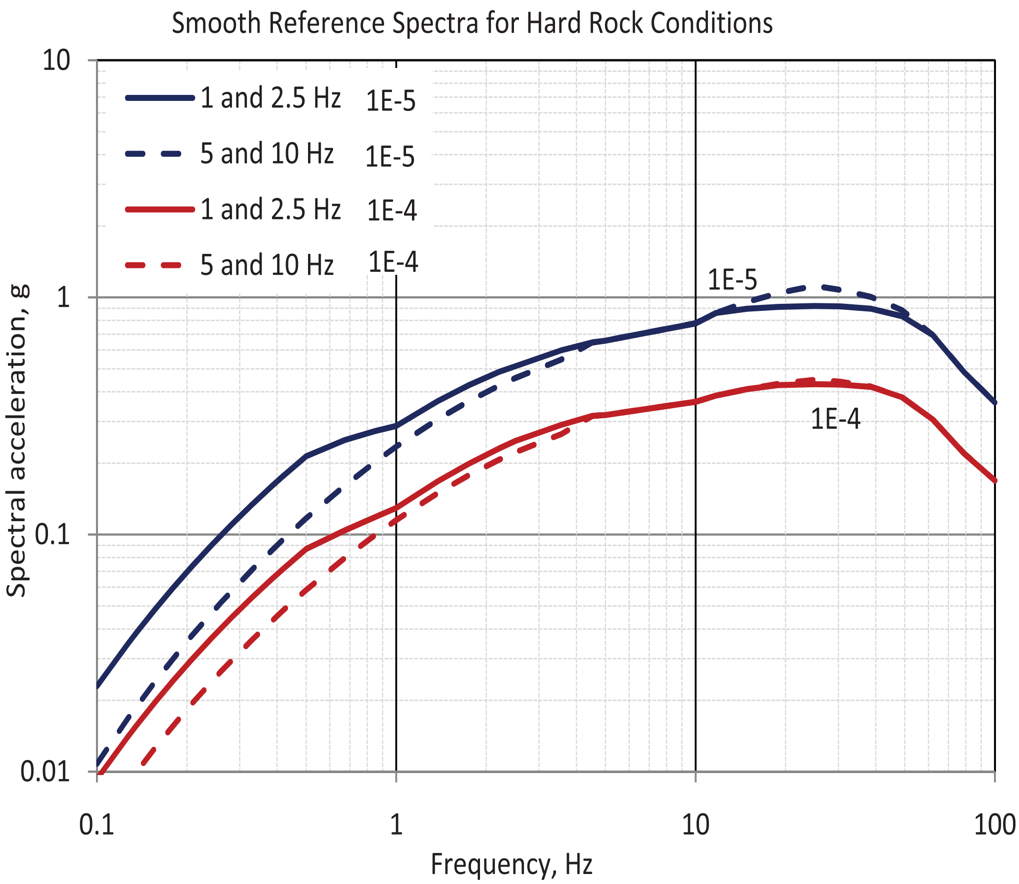


Figure 2.5.2-25—{Response Spectra for Controlling Events at the Callaway Plant Unit 2 Site}

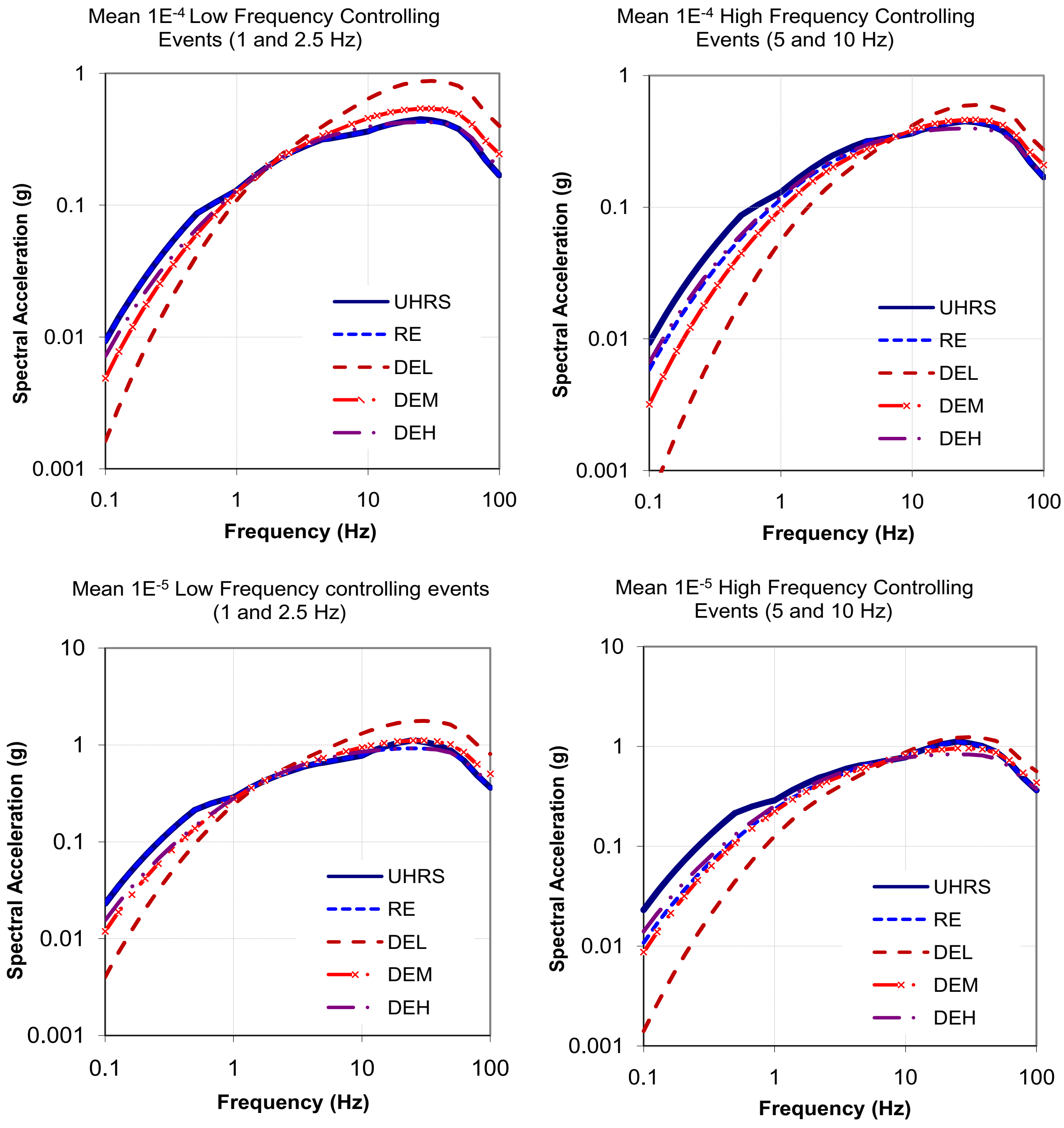


Figure 2.5.2-26—{Response Spectra of Selected Time Histories for 1E-4 Controlling Event LF, DEL and DEH after Spectral Matching}

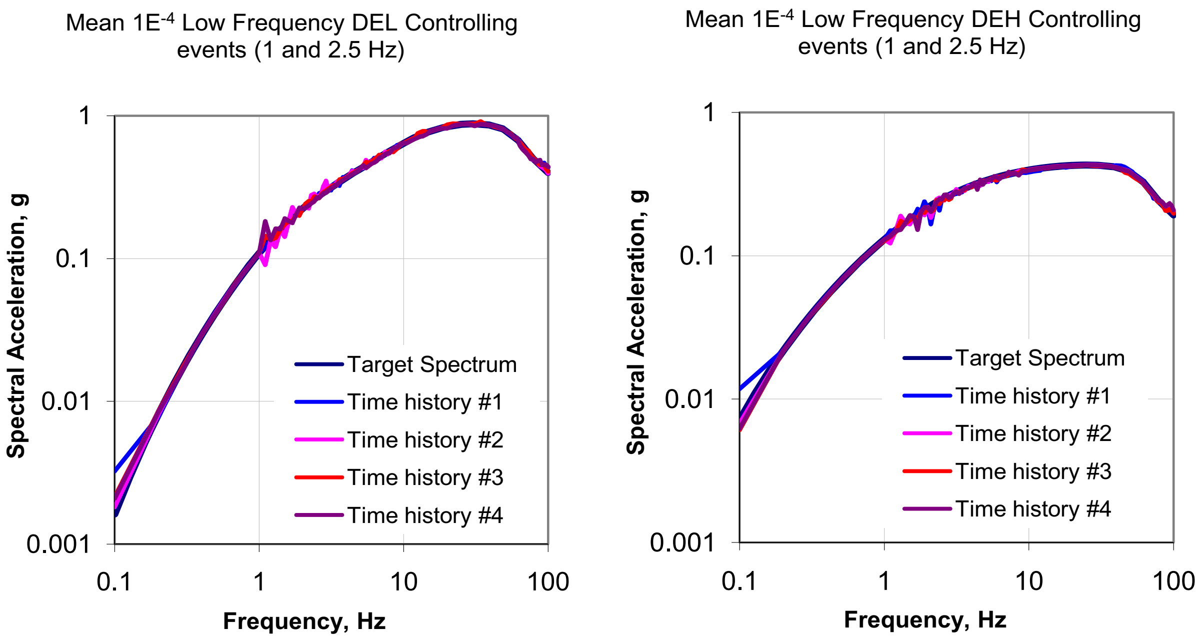


Figure 2.5.2-27—{Mean Site Amplification Factors and Coefficient of variation at 37.5 ft (11.4 m) Depth for 1E-4, 1E-5, LF and HF. DEM Input Motion}

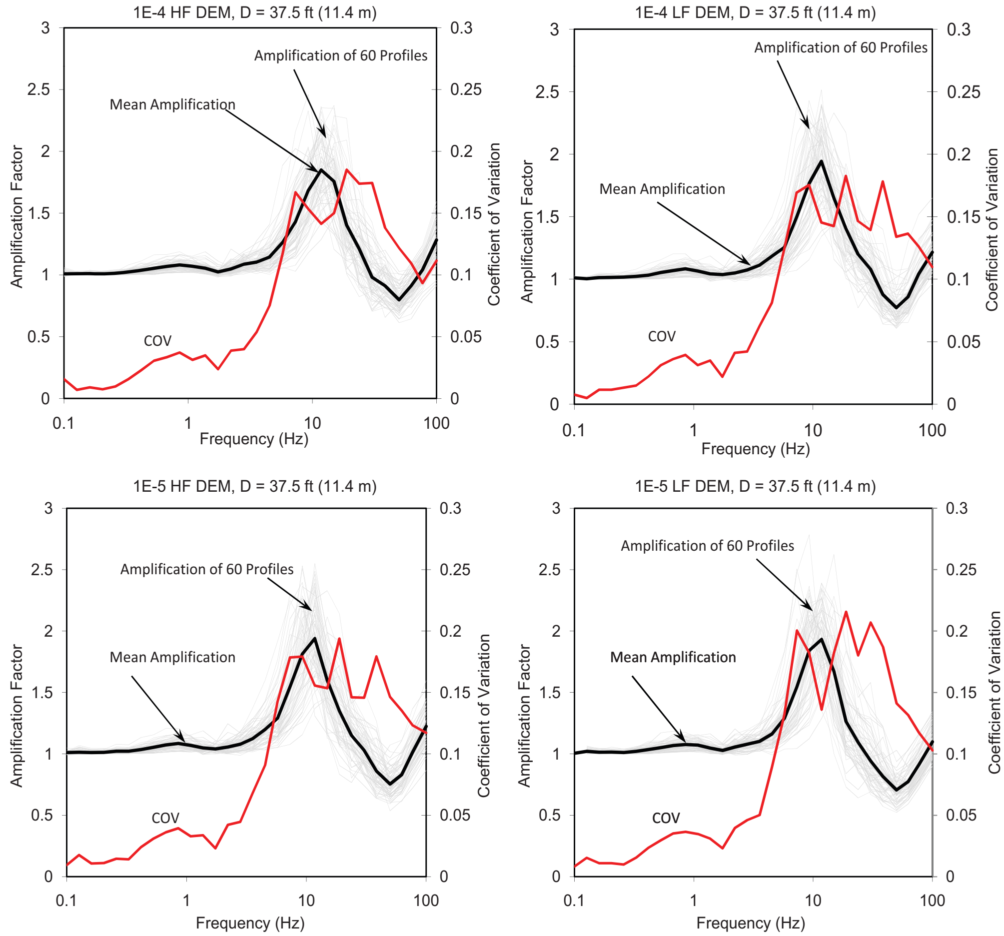


Figure 2.5.2-28—{Maximum Strains Vs. Depth for 1E-4, 1E-5, LF and HF. DEM Input Motion}

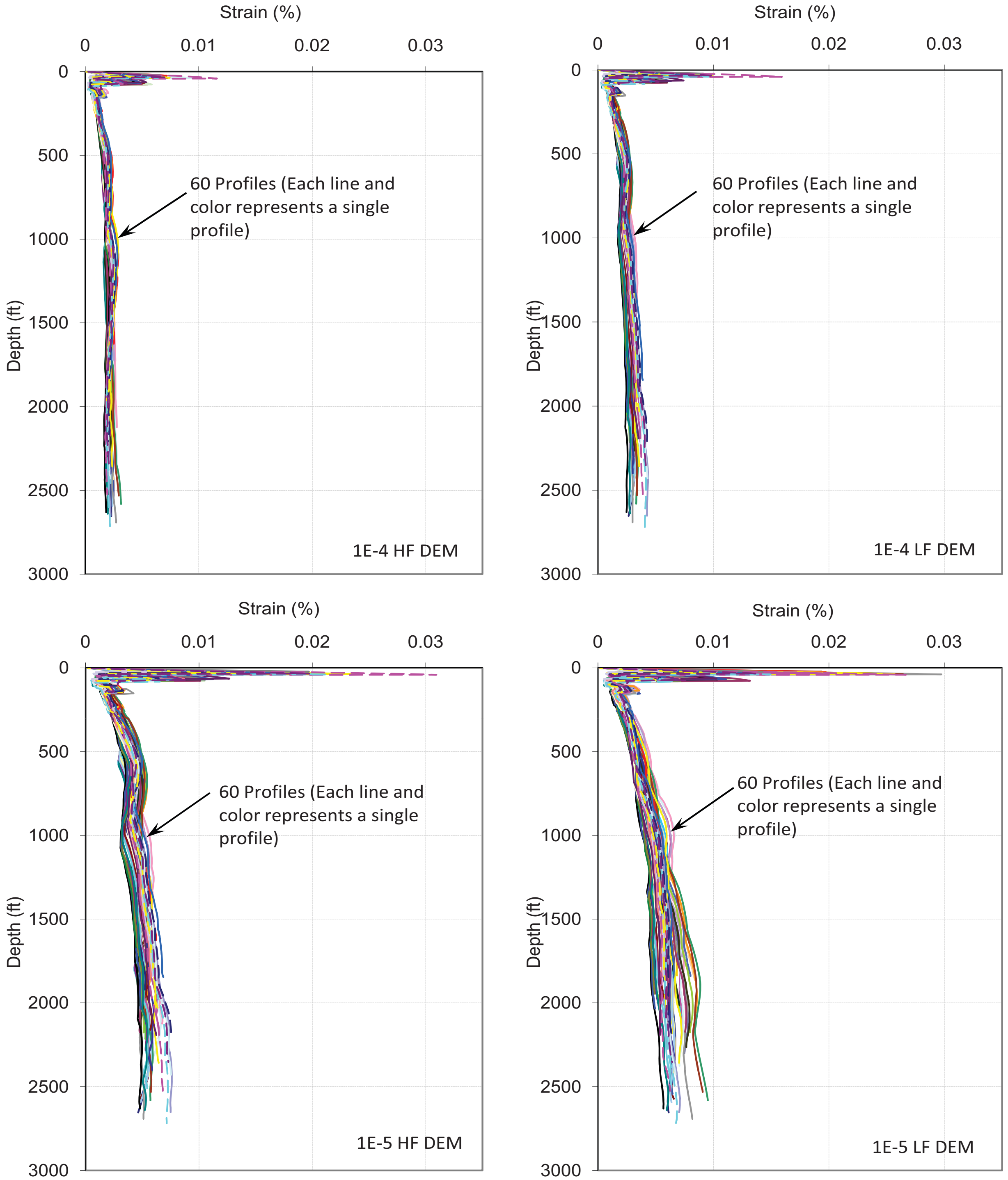


Figure 2.5.2-29—{HF and LF Spectra and Envelopes for 1E-4 and 1E-5}

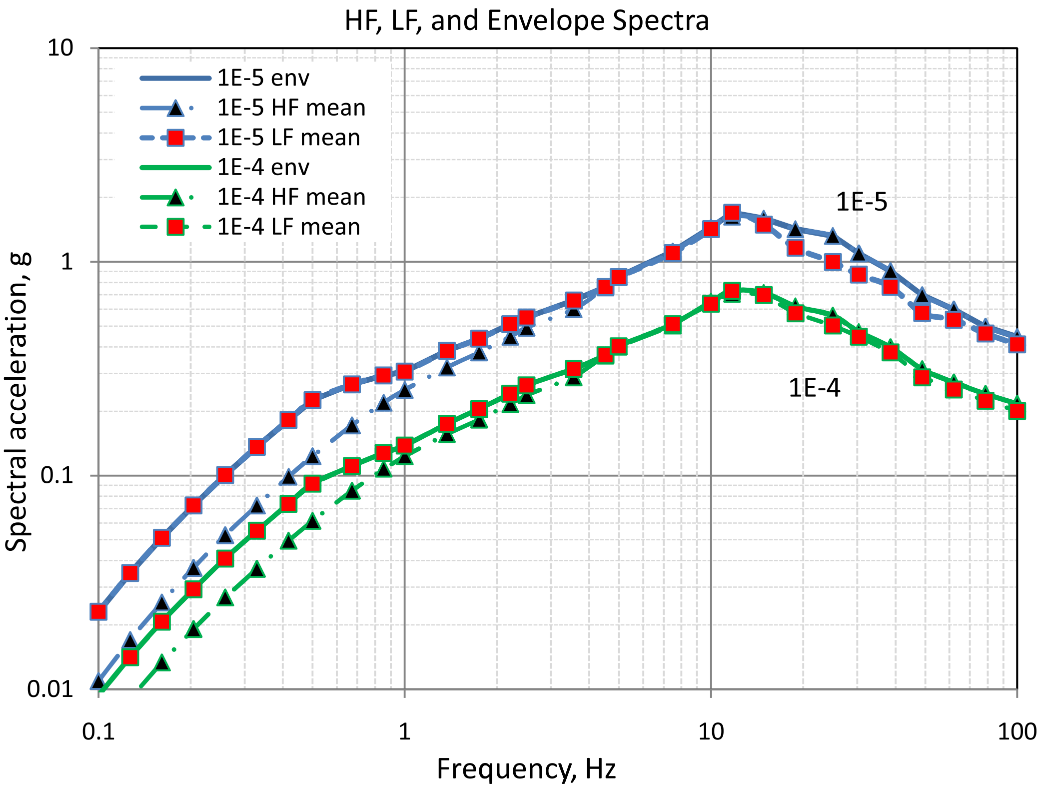


Figure 2.5.2-30—{Recommended Horizontal and Vertical SSE Spectra}

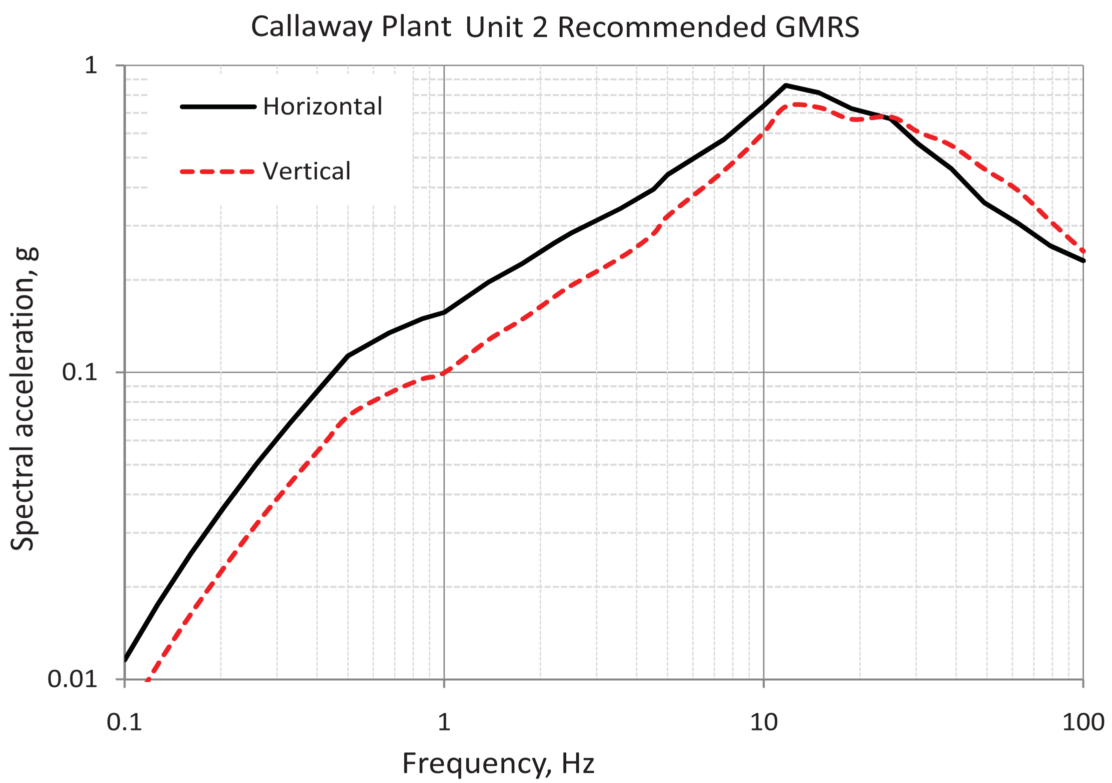
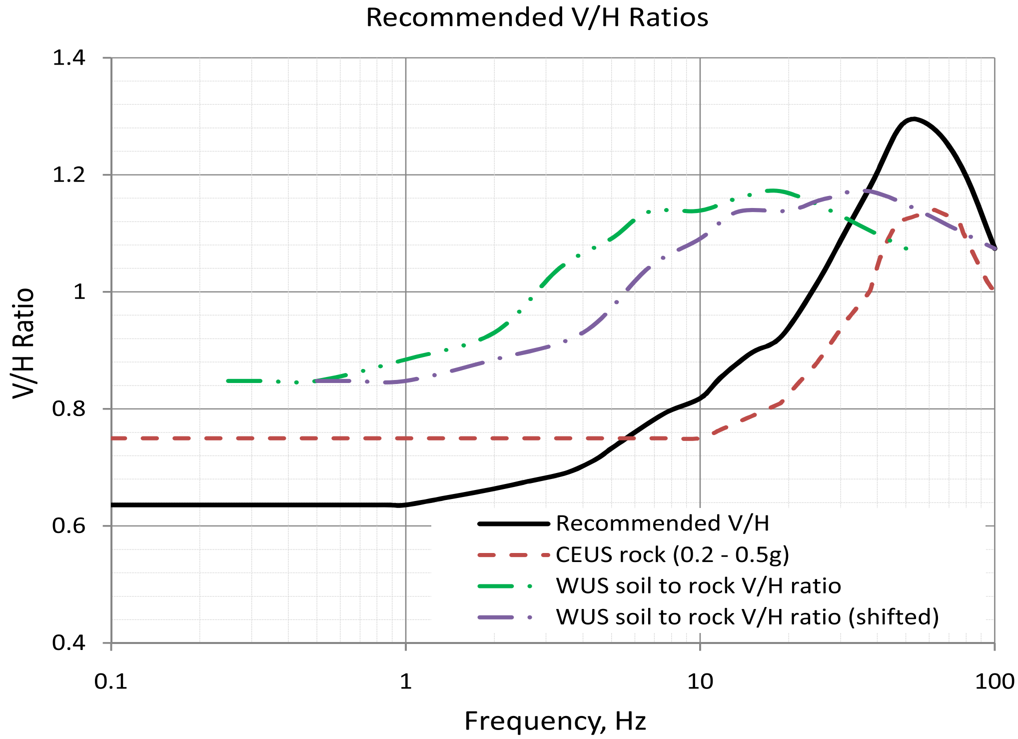


Figure 2.5.2-31—{Recommended V/H Ratios}



V/H Ratios = Vertical to Horizontal Response Spectra Ratio