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GNRO-2014/00027

March 31, 2014

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

SUBJECT: Entergy Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCES:

1. NRC Letter, *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2012

2. NEI Letter, *Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations*, dated April 9, 2013, ADAMS Accession No. ML13101A379

3. NRC Letter, *Electric Power Research Institute Final Draft Report XXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," as an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations*, dated May 7, 2013, ADAMS Accession No. ML13106A331

4. EPRI Report 1025287, *Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic*, ADAMS Accession No. ML12333A170

5. NRC Letter, *Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance,"* dated February 15, 2013, ADAMS Accession No. ML12319A074

6. Entergy letter to NRC, *Entergy's Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident - 1.5 Year Response for CEUS Sites,* dated September 12, 2013, ADAMS Accession No. ML13254A311, GNRO-2013/00068

Dear Sir or Madam:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to all power reactor licensees and holders of construction permits in active or deferred status. Enclosure 1 of Reference 1 requested each addressee located in the Central and Eastern United States (CEUS) to submit a seismic hazard evaluation within 1.5 years from the date of Reference 1.

In Reference 2, the Nuclear Energy Institute (NEI) requested NRC agreement to delay submittal of the final CEUS seismic hazard evaluation so that an update to the Electric Power Research Institute (EPRI) ground motion attenuation model could be completed and used to develop that information. NEI proposed that descriptions of subsurface materials and properties and base case velocity profiles be submitted to the NRC by September 12, 2013 (Reference 6), with the remaining seismic hazard and screening information submitted by March 31, 2014. NRC agreed with that proposed path forward in Reference 3.

Reference 4 contains industry guidance and detailed information to be included in the Seismic Hazard Evaluation and Screening Report submittals. NRC endorsed this industry guidance in Reference 5.

The attached Seismic Hazard Evaluation and Screening Report for Grand Gulf Nuclear Station Unit 1 (GGNS) provides the information described in Section 4 of Reference 4 in accordance with the schedule identified in Reference 2.

This letter contains no new regulatory commitments.

If you have any questions or require additional information, please contact Jeffery A. Seiter at 601-437-2344.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 31, 2014.

Sincerely,

KJM/jas

Attachment: GGNS Seismic Hazard and Screening Report (CEUS Sites)

cc: (see next page)

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Attachment to

GNRO-2014/00027

GGNS Seismic Hazard and Screening Report (CEUS Sites)

Seismic Hazard and Screening Report for Grand Gulf Nuclear Station

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1.0 Introduction

Following the accident at the Fukushima Daiichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the Nuclear Regulatory Commission (NRC) established a Near-Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 50.54(f) letter (U.S. NRC, 2012) that requests information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter (U.S. NRC, 2012) requests that licensees and holders of construction permits under 10 CFR Part 50 reevaluate the seismic hazards at their sites against present-day NRC requirements. Depending on the comparison between the reevaluated seismic hazard and the current design basis, the result is either no further risk evaluation or the performance of a seismic risk assessment. Risk assessment approaches acceptable to the staff include a Seismic Probabilistic Risk Assessment (SPRA), or a Seismic Margin Assessment (SMA). Based upon the risk assessment results, the NRC staff will determine whether additional regulatory actions are necessary.

This report provides the information requested in items (1) through (7) of the "Requested Information" section and Attachment 1 of the 50.54(f) letter (U.S. NRC, 2012) pertaining to NTTF Recommendation 2.1 for the Grand Gulf Nuclear Station (GGNS), located in Claiborne County, Mississippi. In providing this information, Entergy followed the guidance provided in the *Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI, 2013a). The Augmented Approach, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI, 2013b), has been developed as the process for evaluating critical plant equipment as an interim action to demonstrate additional plant safety margin prior to performing the complete plant seismic risk evaluations.

The original geologic and seismic siting investigations for GGNS were performed in accordance with Appendix A to 10 CFR Part 100 and meet General Design Criterion 2 in Appendix A to 10 CFR Part 50. The Safe Shutdown Earthquake (SSE) Ground Motion was developed in accordance with Appendix A to 10 CFR Part 100 and used for the design of seismic Category I systems, structures and components.

In response to the 50.54(f) letter (U.S. NRC, 2012) and following the guidance provided in the SPID (EPRI, 2013a), a seismic hazard reevaluation for GGNS was performed. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed.

Based on the results of the screening evaluation, no further evaluations will be performed.

2.0 Seismic Hazard Reevaluation

The Grand Gulf Nuclear Station is located in Claiborne County, Mississippi. The plant site is located near the east bank of the Mississippi River, approximately 25 miles south of Vicksburg and 37 miles northeast of Natchez. The community of Grand Gulf is approximately 1-1/2 miles to the north. The town of Port Gibson is about 6 miles southeast of the plant site. This area is in the Loess or Bluff Hills and Mississippi Alluvial Valley subprovinces of the Gulf Coastal Plain physiographic province. The site is underlain by approximately 13,000 ft of Cretaceous and Cenozoic sands, gravels, clays, marls, claystones, sandstones, and limestones. The Catahoula Formation of Miocene age is the foundation-bearing stratum for the major plant structures. It consists primarily of hard-to-very-hard silty-to-sandy clay, clayey silt, and locally indurated or cemented clay, sand and silt layers. (Entergy, 2013)

The site lies within the Gulf Coast Basin tectonic province which is the major geologic and tectonic region along the Gulf Coast. The province is bounded on the north by the Monroe uplift and Jackson dome about 60 miles north of the site. The northern most fault zone in the province is the Baton Rouge fault zone, located 110 miles south of the site. No seismic activity has been recorded on the Baton Rouge fault zone. (Entergy, 2013)

Infrequent earthquakes have occurred randomly in this province; however, they are not known to be associated with any specific geologic structure. Faults in the Gulf Coast Basin originate, so far as is known, within the sedimentary pile, and, therefore, resemble large-scale slumping more than tectonic faulting. Lack of any known association with earthquakes indicates these faults are not potential sources of vibratory ground motion large enough to be of engineering concern. The maximum historical intensity in the tectonic province is intensity VI on the Modified Mercalli Intensity Scale of 1931, which was recorded near Donaldsonville, Louisiana, about 140 miles south of the site. (Entergy, 2013)

The Mississippi Embayment tectonic province is a structurally distinct region in the central Mississippi Valley area. It extends from the Monroe uplift and Jackson dome northward to southern Illinois. The closest approach of the Mississippi Embayment tectonic province is about 60 miles north of the site. Within this province, the New Madrid fault zone, which trends south-southwest from the head of the Mississippi Embayment, possibly as far south as about 15 miles northwest of Memphis, offsets embayment sediments and is considered capable. Detailed investigations have established that the fault zone does not extend farther south than Memphis, Tennessee, 220 miles north of the site. South of Memphis scarcely any seismic activity has been recorded. Therefore, there is no reason to assume that the maximum event associated with the New Madrid seismic zone (Intensity XII on the Modified Mercalli Intensity Scale of 1931) could occur south of Memphis, Tennessee. Further study indicates that no other earthquakes associated with either the Mississippi Embayment or the Gulf Coast tectonic province, or any other tectonic province, are as important to the site as are the New Madrid or Donaldsonville earthquakes. Also, no surface faults exist within 5 miles of the site. Consequently, based on the seismicity of both the Gulf Coast Basin tectonic province and Mississippi Embayment tectonic province (New Madrid seismic zone), the SSE is conservatively selected at 0.15g at foundation grade on the Catahoula Formation. (Entergy, 2013)

2.1 Regional and Local Geology

The Grand Gulf Nuclear Station is located near the east bank of the Mississippi River in Claiborne County, Mississippi. The site is located within an extensive structural and depositional province known as the Gulf Coast Basin. The sediments contained within the basin form the subdued terrain that is characteristic of the Gulf Coastal Plain physiographic province, which includes nearly all of the region within 200 miles of the site. The basin is filled by a series of sedimentary formations composed chiefly of fine sand, silt, clay, marl, limestone and chalk, which range in age from Jurassic to Holocene and are mainly unconsolidated. (Entergy, 2013)

In the site region, two major tectonic provinces, the Gulf Coast Basin and Mississippi Embayment tectonic provinces, occur within the Gulf Coastal Plain. The site is located in the Gulf Coast Basin tectonic province. The northern boundary of the province corresponds approximately with the latitude of the northern flanks of the Monroe uplift and Jackson dome. To the west and east, the northern boundary of the province is assumed to occur at the landward limits of exposed Upper Cretaceous strata. The Gulf Coast Basin merges with the Atlantic Coastal Plain in south Georgia and Florida. (Entergy, 2013)

The Mississippi Embayment tectonic province extends northward from the Monroe uplift and Jackson dome into southern Illinois. The province corresponds to the region flanking the Mississippi River covered by Cenozoic sediments. The structural grain is generally northeast-southwest, although several major buried features trend northwest-southeast. (Entergy, 2013)

There is no evidence to suggest that surficial or subsurface materials at the site have been affected by prior earthquake activity. No faults were encountered by the numerous site borings or exposed in any of the excavations. (Entergy, 2013)

The depth to the Paleozoic basement bedrock at the site is reportedly 13,000 ft. The materials above the basement surface are not well lithified and can be expected to yield plastically to any applied stress. No evidence of stresses in the overlying materials was discovered during the investigation of the site or the surrounding area. (Entergy, 2013)

2.2 Probabilistic Seismic Hazard Analysis

2.2.1 Probabilistic Seismic Hazard Analysis Results

In accordance with the 50.54(f) letter (U.S. NRC, 2012) and following the guidance in the SPID (EPRI, 2013a), a Probabilistic Seismic Hazard Analysis (PSHA) was completed using the recently developed Central and Eastern United States Seismic Source Characterization (CEUS-SSC) for Nuclear Facilities (CEUS-SSC, 2012) together with the updated Electric Power Research Institute (EPRI) Ground-Motion Model (GMM) for the Central and Eastern United

States (CEUS) (EPRI, 2013c). For the PSHA, a lower-bound moment magnitude of 5.0 was used, as specified in the 50.54(f) letter (U.S. NRC, 2012). (EPRI, 2014)

For the PSHA, the CEUS-SSC background seismic sources out to a distance of 400 miles (640 km) around GGNS were included. This distance exceeds the 200 mile (320 km) recommendation contained in Reg. Guide 1.208 (U.S. NRC, 2007) and was chosen for completeness. Background sources included in this site analysis are the following (EPRI, 2014):

1. Extended Continental Crust—Atlantic Margin (ECC_AM)
2. Extended Continental Crust—Gulf Coast (ECC_GC)
3. Gulf Highly Extended Crust (GHEX)
4. Mesozoic and younger extended prior – narrow (MESE-N)
5. Mesozoic and younger extended prior – wide (MESE-W)
6. Midcontinent-Craton alternative A (MIDC_A)
7. Midcontinent-Craton alternative B (MIDC_B)
8. Midcontinent-Craton alternative C (MIDC_C)
9. Midcontinent-Craton alternative D (MIDC_D)
10. Non-Mesozoic and younger extended prior – narrow (NMESE-N)
11. Non-Mesozoic and younger extended prior – wide (NMESE-W)
12. Oklahoma Aulacogen (OKA)
13. Paleozoic Extended Crust narrow (PEZ_N)
14. Paleozoic Extended Crust wide (PEZ_W)
15. Reelfoot Rift (RR)
16. Reelfoot Rift including the Rough Creek Graben (RR-RCG)
17. Study region (STUDY_R)

For sources of large magnitude earthquakes, designated Repeated Large Magnitude Earthquake (RLME) sources in NUREG-2115 (CEUS-SSC, 2012) modeled for the CEUS-SSC, the following sources lie within 1,000 km of the site and were included in the analysis (EPRI, 2014):

1. Charleston
2. Commerce
3. Eastern Rift Margin Fault northern segment (ERM-N)
4. Eastern Rift Margin Fault southern segment (ERM-S)
5. Marianna
6. Meers
7. New Madrid Fault System (NMFS)
8. Wabash Valley

The Grand Gulf Nuclear Station is located within the gulf region of the CEUS approximately 87 miles (140 km) from the mid-continent region border. For each of the above background sources, the Gulf version of the updated CEUS EPRI GMM are used to model the seismic wave travel path. For the NMFS, Commerce, ERM-N, ERM-S, Marianna, Meers, and Wabash RLMEs, a combination of Gulf (50%) and mid-continent (50%) GMMs are used based on the relative fraction of the seismic wave travel paths through these regions from source to site. For the Charleston RLME source, a combination of Gulf (17%) and mid-continent (83%) GMMs are created based on the relative travel path from the center of the Charleston Local zone to the site. (EPRI, 2014)

2.2.2 Base Rock Seismic Hazard Curves

Consistent with the SPID (EPRI, 2013a), base rock seismic hazard curves are not provided as the site amplification approach referred to as Method 3 has been used. Seismic hazard curves are shown below in Section 2.3.7 at the SSE control point elevation.

2.3 Site Response Evaluation

Following the guidance contained in Seismic Enclosure 1 of the 50.54(f) Request for Information (U.S. NRC, 2012) and in the SPID (EPRI, 2013a) for nuclear power plant sites that are not founded on hard rock (defined as 2.83 km/sec), a site response analysis was performed for GGNS. (EPRI, 2014)

2.3.1 Description of Subsurface Material

The GGNS is located in west-central Mississippi about 25 miles (40 km) south of Vicksburg near the east bank of the Mississippi River in Claiborne County. This area is in the Loess or Bluff Hills and Mississippi Alluvial Valley subprovinces or the Gulf Coastal Plain physiographic province. The site is underlain by approximately 13,000 ft (4,000 m) of Cretaceous and Cenozoic sands, gravels, clays, marls, claystones, sandstones, and limestones Precambrian basement rocks are at a depth of about 27,000 ft (8,200 m). (Entergy, 2013)

The information used to create the site geologic profile at the GGNS is shown in Table 2.3.1-1. This profile was developed using information documented in (Entergy, 2013). As indicated in Table 2.3.1-1, the SSE Control Point is defined at elevation 87 ft at the top of the Catahoula clay formation.

Table 2.3.1-1 Summary of Geotechnical Profile at GGNS. (Entergy, 2013)

Elevation (feet)	Depth Range (feet)	Soil Description	Compression Wave Velocity (fps)	Shear Wave Velocity (fps)	Density (pcf)	Poisson's Ratio	Young's Modulus (ksf)	Shear Modulus (ksf)	Bulk Modulus (ksf)
197 to 127	70	Loess – Silt	1,400	670	105	0.35	3,950	1,460	4,390
127 to 107	20	Terrace – Silty Clay	4,600	1,100	119	0.47	13,200	4,470	73,000
107 to 87	20	Terrace – Sand	6,000	1,600	125	0.46	29,000	9,940	121,000
87	-	SSE Control Point at base mat of structures	-	-	-	-	-	-	-
87 to 67	20	Catahoula – Clay	6,560	1,600	120	0.47	28,000	9,540	156,000
67 to 17	50	Catahoula – Clay and Silt with Silty Sand Layers	6,560	1,640	120	0.47	29,500	10,000	164,000
17 to -33	50	Catahoula – Clay and Silt with Silty Sand Layers	6,400	1,720	120	0.46	32,200	11,000	134,000
-33 to -103	70	Catahoula – Clay and Silt with Silty Sand Layers	6,730	1,715	120	0.47	32,200	11,000	179,000

The following description of the general geology of the site is taken directly from plant-specific information (Entergy, 2013):

> "The Grand Gulf Nuclear Station is located near the east bank of the Mississippi River in Claiborne County, Mississippi, about 25 mi south of Vicksburg and 37 mi northeast of Natchez. [...] This area is in the Loess or Bluff Hills and Mississippi Alluvial Valley subprovinces or the Gulf Coastal Plain physiographic province. The site is underlain by approximately 13,000 ft of Cretaceous and Cenozoic sands, gravels, clays, marls, claystones, sandstones, and limestones."
>
> "The Quaternary sediments in the site vicinity consist of sands, gravels, silts, and clays of Holocene and Pleistocene ages. In the site area, fluvial material occurring within the Mississippi Alluvial Valley and its tributaries, ranges in thickness from 22 to 182 ft. The average thickness is approximately 93 ft. In the bluff area, the older fluvial sediments range in thickness from 0 to 151 ft and are overlain by 22 to 82 ft of loess."
>
> "The Holocene Series consists of alluvium and colluvial deposits with in the Loess Hills and the Mississippi Alluvial Valley. [...] Borings near the foot of the bluff and in the tributary valleys that drain the bluff area encountered colluvial deposits up to 47 ft thick. Along the bluff the colluvium generally consists of a brown silt, clayey silt, or silty clay, which is derived from the Loess bluff."
>
> "The bluffs adjacent to the Alluvial Valley are composed of Pleistocene loess. The average preconstruction thickness at the site is 65 feet, with extremes of 22 and 82 ft. The upper 10 to 15 feet of loess consists of a moist clayey silt. Below this depth the loess consists of a dry, homogeneous layer of unstratified silt which generally occurs along old drainage channels or areas where impermeable terrace clays form shallow basins in which infiltrating water accumulates."
>
> "Underlying the loess are unnamed, "pre-loess," terrace deposits comprised primarily of clayey silt, silty clay and sand. [...] Where penetrated, the thickness ranged from 8 to 151 ft and averaged 51 ft."
>
> "Most deep site borings encountered the Miocene age Catahoula Formation. The Catahoula consists of a hard-to-very-hard, gray-to gray-green, silty-to-sandy clay, and clayey silt and sand, with some locally indurated or cemented clay, sand, and silt seams. [...] The maximum estimated thickness of the Catahoula Formation at the site is 320 ft."
>
> "Unconformably underlying the Catahoula Formation is the Vicksburg Group, a sequence of four formations of Oligocene age. These formations, from youngest to oldest, are the Bucatunna, the Byram, the Glendon, and the Mint Spring. [...] The Bucatunna is a 53-ft thick layer of stiff-to hard greenish-black-to-black clay with a thin, gray, fine sand seams. [...] The Byram Marl, underlying the Bucatunna, is hard-to-very-hard, green-to-gray, fine sandy, calcareous clay approximately 5 ft thick. [...]

Comformably underlying the Byram Marl is the Glendon Formation. It consists of a series of interbedded, light gray, fossiliferous limestones and hard-to-partly-indurated, grayish-green, fine sandy, calcareous clays. Total thickness is about 46 ft. [...] Underlying the Glendon is the Mint Spring Marl. Forty feet of the Mint Spring Marl was penetrated at the site; however, the total thickness of the formation was not determined. The formation consists of hard, grayish green fossiliferous, glauconitic sand and clay."

"The Catahoula Formation of Miocene age is the foundation-bearing stratum for the major plant structures. It consists primarily of hard-to-very-hard silty-to sandy clay, clayey silt, and locally indurated or cemented clay, silt and sand layers. The in-situ shear wave velocity of the Catahoula Formation is 1700 to 1800 fps and the compressional wave velocity is 6400 to 6700 fps."

The GGNS site consists of a layer of Holocene Alluvium (145 ft) consisting of clay, silt, sand and gravel. Next is a thin layer of Pleistocene Loess (82 ft) consisting of silt and Terrace Deposits (151 ft) consisting of clay, sand and gravel. This is followed by a deposit of Miocene Catahoula Clay (320 ft) consisting of silty fine sandy clay, partly indurated. Below the Catahoula Clay is deposits for Oligocene (Vicksburg Group) consisting of Bucatunna (53 ft of stiff-hard black clay/fine sand), Byram Marl (5 ft of Hard Sandy Clay), Glendon Limestone (46 ft of Interrended Fossiliferous Limestone and Hard Calcareous Clay), Mint Spring Marl (40 ft of Hard Calcareous Clay) and Forest Hill (60 ft of Silty Micaceous Clay, Sandstone, and Silts). (Entergy, 2013)

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

Table 2.3.1-1 shows the recommended shear-wave velocities and unit weights versus depth and elevation for the best estimate single profile to an elevation of -103 ft (-31 m). This elevation is at a depth of 190 ft (58 m) below the SSE Control Point. In-situ shear and compressional-wave velocity measurements at the site were made in the Catahoula clay formation (Entergy, 2013). Recommended shear-wave velocities listed in Table 2.3.1-1 were taken as the mean base-case profile (P1) in the top 190 ft (58 m). Beneath this depth the profile was extended to a depth of 4,000 ft (1,219 m) using the Vs30 270 m/sec (886 ft/s) profile template from the SPID (EPRI, 2013a). The depth of 4,000 ft (1,219 m) was considered adequate to reflect amplification over the lowest frequency of interest, about 0.5 Hz (EPRI, 2013a). (EPRI, 2014)

Lower (P2)- and upper (P3)- range profiles were developed with a scale factor of 1.25 reflecting uncertainty in measured velocities to a depth of 190 ft (58 m). To accommodate increased epistemic uncertainty below a depth of 190 ft (58 m) reflecting assumed shear-wave velocities, a scale factor of 1.57 was used. To alleviate the development of a low velocity zone in the softer profile (P2) below 190 ft (58 m), the discontinuity in profile P2 at 190 ft (58 m) was smoothed to a depth of about 400 ft (122 m), where the full scale factor of 1.57 was reached. The scale factors of 1.25 and 1.57 reflect a $\sigma_{\mu ln}$ of about 0.2 and about 0.35 respectively based on the SPID (EPRI, 2013a) 10^{th} and 90^{th} fractiles which implies a scale factor of 1.28 on $\sigma_{\mu ln}$. Depth to Precambrian basement was taken at 4,000 ft (1,219 m) randomized ±1,200 ft (366 m).

The three shear-wave velocity profiles are shown in Figure 2.3.2-1 and listed in Table 2.3.2-1 (EPRI, 2014)

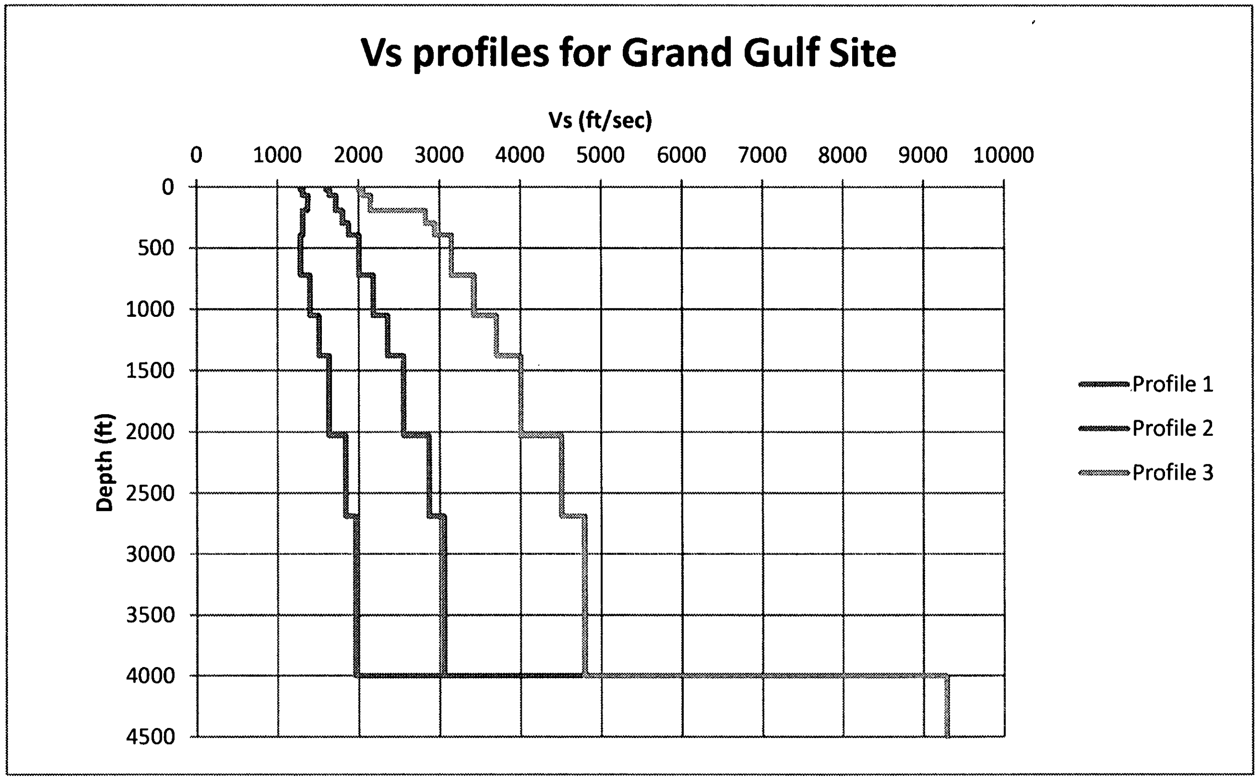


Figure 2.3.2-1 Shear-wave velocity profiles for the GGNS. (EPRI, 2014)

Table 2.3.2-1 Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, GGNS (EPRI, 2014)

Profile 1			Profile 2			Profile 3		
thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)
	0	1600		0	1280		0	2000
10.2	10.2	1600	10.2	10.2	1280	10.2	10.2	2000
10.2	20.3	1600	10.2	20.3	1280	10.2	20.3	2000
12.5	32.8	1640	12.5	32.8	1312	12.5	32.8	2050
12.5	45.3	1640	12.5	45.3	1312	12.5	45.3	2050
4.6	49.9	1640	4.6	49.9	1312	4.6	49.9	2050
7.9	57.7	1640	7.9	57.7	1312	7.9	57.7	2050
12.5	70.2	1640	12.5	70.2	1312	12.5	70.2	2050
12.5	82.7	1720	12.5	82.7	1376	12.5	82.7	2150
12.5	95.1	1720	12.5	95.1	1376	12.5	95.1	2150
12.5	107.6	1720	12.5	107.6	1376	12.5	107.6	2150
12.5	120.1	1720	12.5	120.1	1376	12.5	120.1	2150
14.1	134.2	1715	14.1	134.2	1372	14.1	134.2	2144
14.1	148.3	1715	14.1	148.3	1372	14.1	148.3	2144

Table 2.3.2-1 Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, GGNS (EPRI, 2014)

Profile 1			Profile 2			Profile 3		
thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)
14.1	162.4	1715	14.1	162.4	1372	14.1	162.4	2144
14.1	176.5	1715	14.1	176.5	1372	14.1	176.5	2144
14.1	190.6	1715	14.1	190.6	1372	14.1	190.6	2144
17.7	208.3	1800	17.7	208.3	1312	17.7	208.3	2826
17.7	226.0	1800	17.7	226.0	1312	17.7	226.0	2826
17.7	243.8	1800	17.7	243.8	1312	17.7	243.8	2826
6.2	250.0	1800	6.2	250.0	1312	6.2	250.0	2826
44.0	294.0	1800	44.0	294.0	1312	44.0	294.0	2826
32.8	326.8	1873	32.8	326.8	1312	32.8	326.8	2941
32.8	359.6	1873	32.8	359.6	1312	32.8	359.6	2941
32.8	392.4	1873	32.8	392.4	1312	32.8	392.4	2941
40.0	432.4	2005	40.0	432.4	1283	40.0	432.4	3147
40.0	472.4	2005	40.0	472.4	1283	40.0	472.4	3147
27.6	500.0	2005	27.6	500.0	1283	27.6	500.0	3147
52.5	552.5	2005	52.5	552.5	1283	52.5	552.5	3147
40.0	592.5	2005	40.0	592.5	1283	40.0	592.5	3147
42.7	635.2	2005	42.7	635.2	1283	42.7	635.2	3147
42.7	677.8	2005	42.7	677.8	1283	42.7	677.8	3147
42.7	720.5	2005	42.7	720.5	1283	42.7	720.5	3147
65.6	786.1	2182	65.6	786.1	1396	65.6	786.1	3425
65.6	851.7	2182	65.6	851.7	1396	65.6	851.7	3425
65.6	917.3	2182	65.6	917.3	1396	65.6	917.3	3425
65.6	982.9	2182	65.6	982.9	1396	65.6	982.9	3425
65.6	1048.6	2182	65.6	1048.6	1396	65.6	1048.6	3425
65.6	1114.2	2359	65.6	1114.2	1510	65.6	1114.2	3704
65.6	1179.8	2359	65.6	1179.8	1510	65.6	1179.8	3704
65.6	1245.4	2359	65.6	1245.4	1510	65.6	1245.4	3704
65.6	1311.0	2359	65.6	1311.0	1510	65.6	1311.0	3704
65.6	1376.6	2359	65.6	1376.6	1510	65.6	1376.6	3704
131.2	1507.9	2552	131.2	1507.9	1634	131.2	1507.9	4007
131.2	1639.1	2552	131.2	1639.1	1634	131.2	1639.1	4007
131.2	1770.3	2552	131.2	1770.3	1634	131.2	1770.3	4007
131.2	1901.6	2552	131.2	1901.6	1634	131.2	1901.6	4007
131.2	2032.8	2552	131.2	2032.8	1634	131.2	2032.8	4007
131.2	2164.0	2871	131.2	2164.0	1837	131.2	2164.0	4507
131.2	2295.3	2871	131.2	2295.3	1837	131.2	2295.3	4507
131.2	2426.5	2871	131.2	2426.5	1837	131.2	2426.5	4507
131.2	2557.7	2871	131.2	2557.7	1837	131.2	2557.7	4507
131.2	2689.0	2871	131.2	2689.0	1837	131.2	2689.0	4507

Table 2.3.2-1 Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, GGNS (EPRI, 2014)

Profile 1			Profile 2			Profile 3		
thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)
164.0	2853.0	3054	164.0	2853.0	1955	164.0	2853.0	4795
164.0	3017.1	3054	164.0	3017.1	1955	164.0	3017.1	4795
164.0	3181.1	3054	164.0	3181.1	1955	164.0	3181.1	4795
164.0	3345.1	3054	164.0	3345.1	1955	164.0	3345.1	4795
164.0	3509.2	3054	164.0	3509.2	1955	164.0	3509.2	4795
490.5	3999.7	3054	490.5	3999.7	1955	490.5	3999.7	4795
3280.8	7280.5	9285	3280.8	7280.5	9285	3280.8	7280.5	9285

2.3.2.1 Shear Modulus and Damping Curves

Site-specific nonlinear dynamic material properties were not available for the soils at the GGNS. The soil material over the upper 500 ft (150 m) was assumed to have behavior that could be modeled with either EPRI cohesionless soil or Peninsular Range (PR) G/G_{max} and hysteretic damping curves (EPRI, 2013a). Consistent with the SPID (EPRI, 2013a), the EPRI soil curves (model M1) were considered to be appropriate to represent the more nonlinear response likely to occur in the materials at this site. The PR curves (EPRI, 2013a) for soils (model M2) was assumed to represent an equally plausible alternative more linear response across loading level. (EPRI, 2014)

2.3.2.2 Kappa

Base-case kappa estimates were determined using Section B-5.1.3.1 of the SPID (EPRI, 2013a) for a deep, greater than 3,000 ft (1,000 m), CEUS soil site. Kappa for a soil site with greater than 3,000 ft (1 km) was assumed to have maximum value of 0.04 s (Table 2.3.2-2). Epistemic uncertainty in profile damping (kappa) was considered to be accommodated at design loading levels by the multiple (2) sets of G/G_{max} and hysteretic damping curves. (EPRI, 2014)

Table 2.3.2-2 Kappa Values and Weights Used for Site Response Analyses. (EPRI, 2014)

Velocity Profile	Kappa(s)
P1	0.040
P2	0.040
P3	0.040
Velocity Profile	Weights
P1	0.4
P2	0.3
P3	0.3
G/G_{max} and Hysteretic Damping Curves	
M1	0.5
M2	0.5

2.3.3 Randomization of Base Case Profiles

To account for the aleatory variability in dynamic material properties that is expected to occur across a site at the scale of a typical nuclear facility, variability in the assumed shear-wave velocity profiles has been incorporated in the site response calculations. For GGNS, random shear wave velocity profiles were developed from the base case profiles shown in Figure 2.3.2-1. Consistent with the discussion in Appendix B of the SPID (EPRI, 2013a), the velocity randomization procedure made use of random field models which describe the statistical correlation between layering and shear wave velocity. The default randomization parameters developed in (Toro, 1997) for United States Geological Survey "A" site conditions were used for this site. Thirty random velocity profiles were generated for each base case profile. These random velocity profiles were generated using a natural log standard deviation of 0.25 over the upper 50 ft and 0.15 below that depth. As specified in the SPID (EPRI, 2013a), correlation of shear wave velocity between layers was modeled using the footprint correlation model. In the correlation model, a limit of ± 2 standard deviations about the median value in each layer was assumed for the limits on random velocity fluctuations. (EPRI, 2014)

2.3.4 Input Spectra

Consistent with the guidance in Appendix B of the SPID (EPRI, 2013a), input Fourier amplitude spectra were defined for a single representative earthquake magnitude (M 6.5) using two different assumptions regarding the shape of the seismic source spectrum (single-corner and double-corner). A range of 11 different input amplitudes (median Peak Ground Accelerations (PGAs) ranging from 0.01 to 1.5g) were used in the site response analyses. The characteristics of the seismic source and upper crustal attenuation properties assumed for the analysis of GGNS were the same as those identified in Tables B-4, B-5, B-6 and B-7 of the SPID (EPRI, 2013a) as appropriate for typical CEUS sites. (EPRI, 2014)

2.3.5 Methodology

To perform the site response analyses for the GGNS, a random vibration theory approach was employed. This process utilizes a simple, efficient approach for computing site-specific amplification functions and is consistent with existing NRC guidance and the SPID (EPRI, 2013a). The guidance contained in Appendix B of the SPID (EPRI, 2013a) on incorporating epistemic uncertainty in shear-wave velocities, kappa, non-linear dynamic properties and source spectra for plants with limited at-site information was followed for the GGNS. (EPRI, 2014)

2.3.6 Amplification Functions

The results of the site response analysis consist of amplification factors (5% damped pseudo absolute response spectra) which describe the amplification (or de-amplification) of hard reference rock motion as a function of frequency and input reference rock amplitude. The amplification factors are represented in terms of a median amplification value and an associated standard deviation (sigma) for each oscillator frequency and input rock amplitude. Consistent with the SPID (EPRI, 2013a) a minimum median amplification value of 0.5 was employed in the present analysis. Figure 2.3.6-1 illustrates the median and ±1 standard deviation in the predicted amplification factors developed for the eleven loading levels parameterized by the median reference (hard rock) peak acceleration (0.01g to 1.50g) for profile P1 and EPRI soil G/G_{max} and hysteretic damping curves (EPRI, 2013a). The variability in the amplification factors results from variability in shear-wave velocity, depth to hard rock, and modulus reduction and hysteretic damping curves. To illustrate the effects of more linear response at the GGNS deep soil site, Figure 2.3.6-2 shows the corresponding amplification factors developed with PR curves for soil (model M2). Between the more nonlinear and more linear analyses, Figures 2.3.6-1 and Figure 2.3.6-2 respectively show little difference across structural frequency as well as loading level. Tabular data for Figure 2.3.6-1 and Figure 2.3.6-2 is provided For Information Only in Appendix A. (EPRI, 2014)

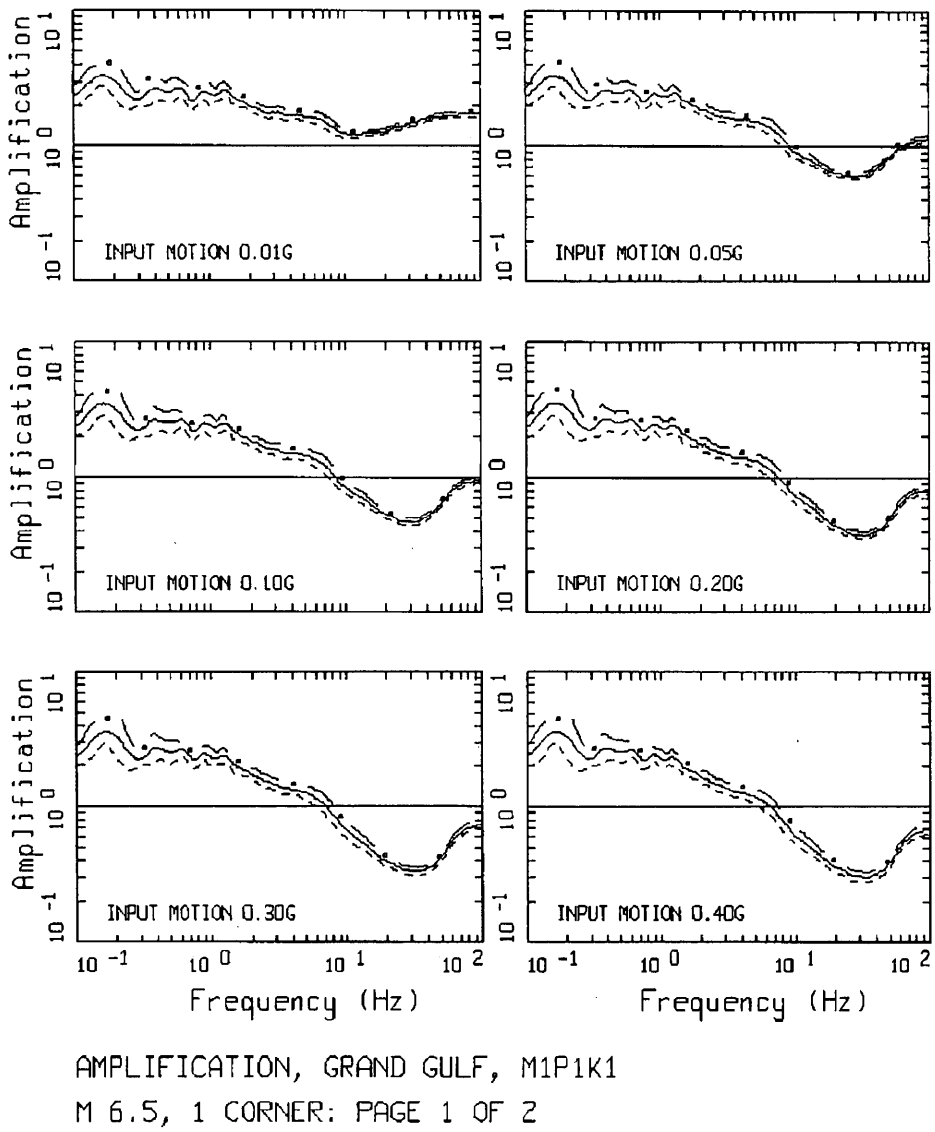
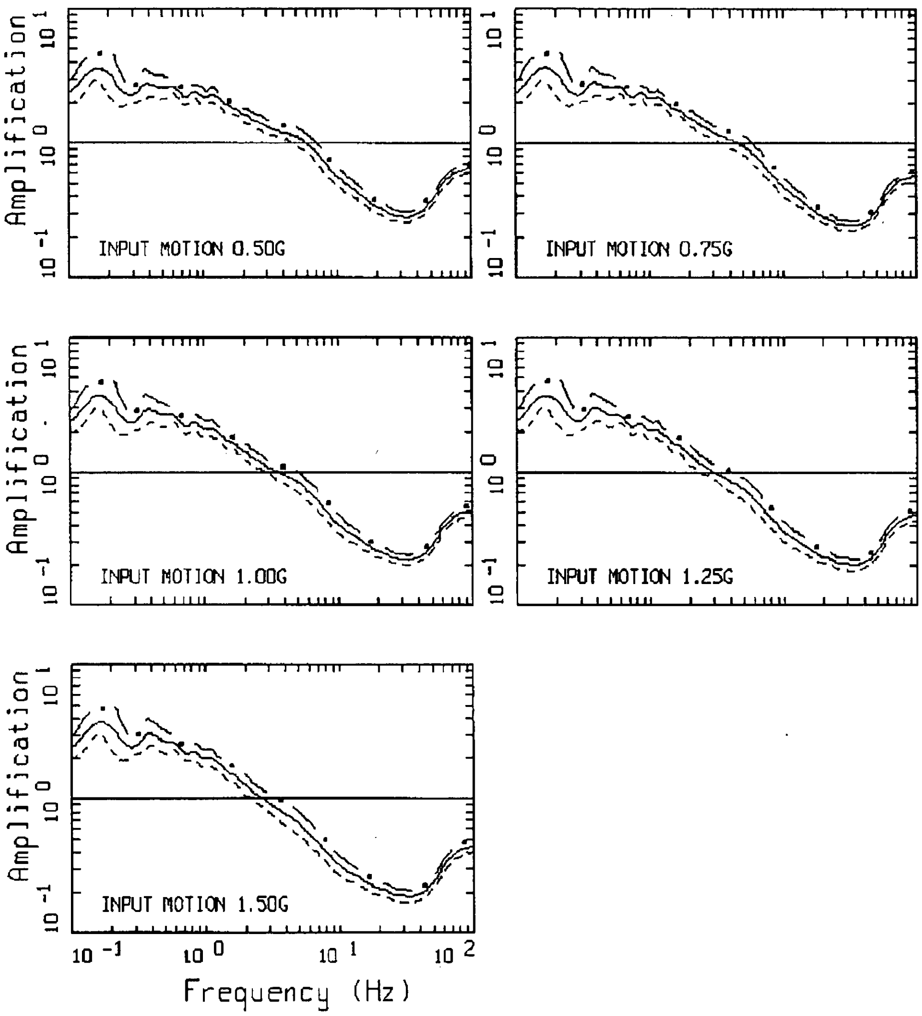


Figure 2.3.6-1 Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI soil modulus reduction and hysteretic damping curves (model M1), and base-case kappa at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g. M 6.5 and single-corner source model. (EPRI, 2013a) (EPRI, 2014)



AMPLIFICATION, GRAND GULF, M1P1K1

M 6.5, 1 CORNER: PAGE 2 OF 2

Figure 2.3.6-1 (cont.)

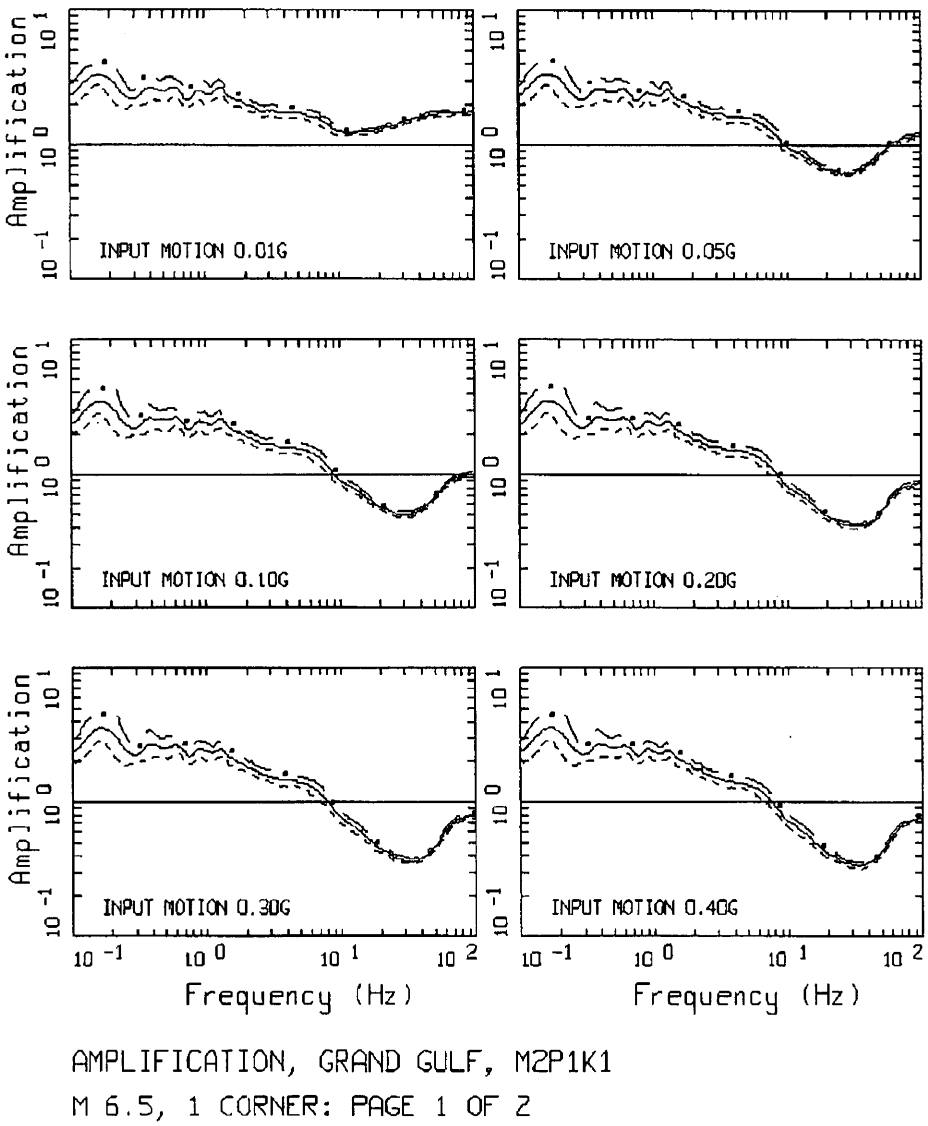
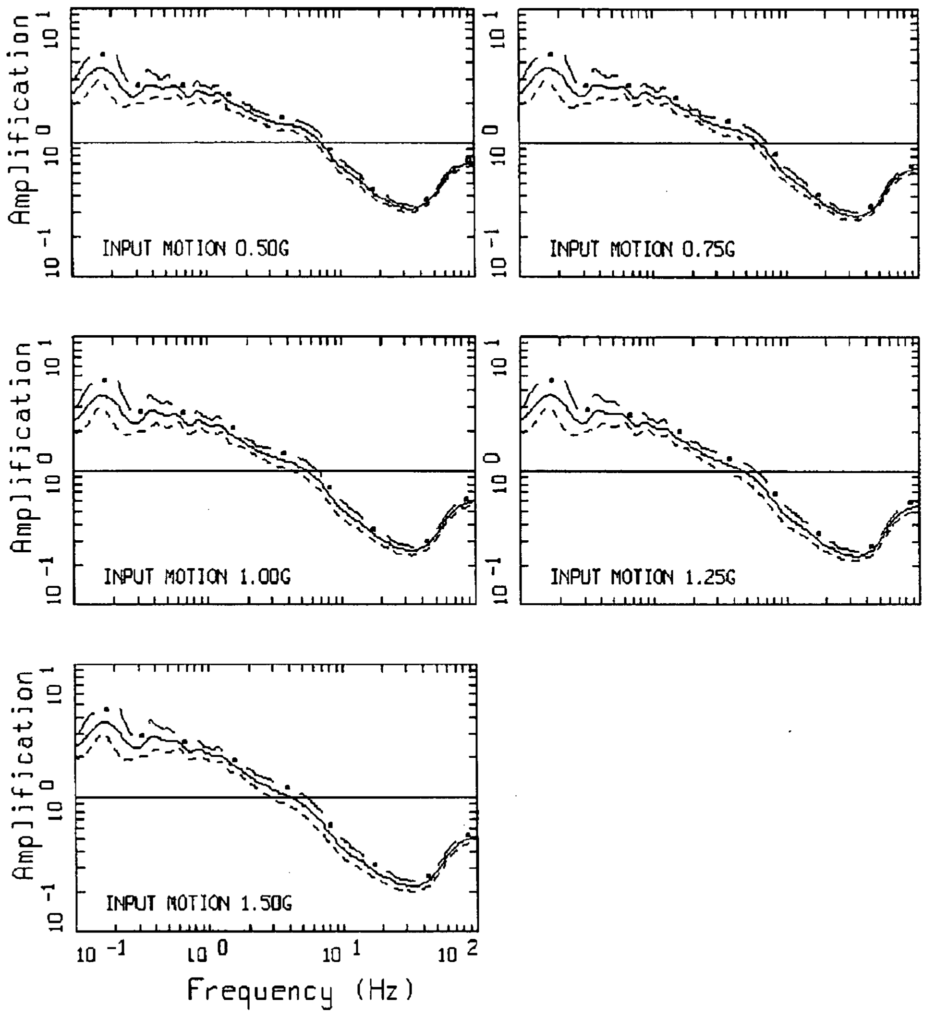


Figure 2.3.6-2 Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), Peninsular Range curves for soil (model M2), and base-case kappa at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g. M 6.5 and single-corner source model. (EPRI, 2013a) (EPRI, 2014)



AMPLIFICATION, GRAND GULF, M2P1K1
M 6.5, 1 CORNER: PAGE 2 OF 2

Figure 2.3.6-2 (cont.)

2.3.7 Control Point Seismic Hazard Curves

The procedure to develop probabilistic site-specific control point hazard curves used in the present analysis follows the methodology described in Section B-6.0 of the SPID (EPRI, 2013a). This procedure (referred to as Method 3) computes a site-specific control point hazard curve for a broad range of spectral accelerations given the site-specific bedrock hazard curve and site-specific estimates of soil or soft-rock response and associated uncertainties. This process is repeated for each of the seven spectral frequencies for which ground motion equations are available. The dynamic response of the materials below the control point was represented by the frequency and amplitude-dependent amplification functions (median values and standard deviations) developed and described in the previous section. The resulting control point mean hazard curves for GGNS are shown in Figure 2.3.7-1 for the seven spectral frequencies for which ground motion equations are defined. Tabulated values of mean and fractile seismic hazard curves and site response amplification functions are provided in Appendix A. (EPRI, 2014)

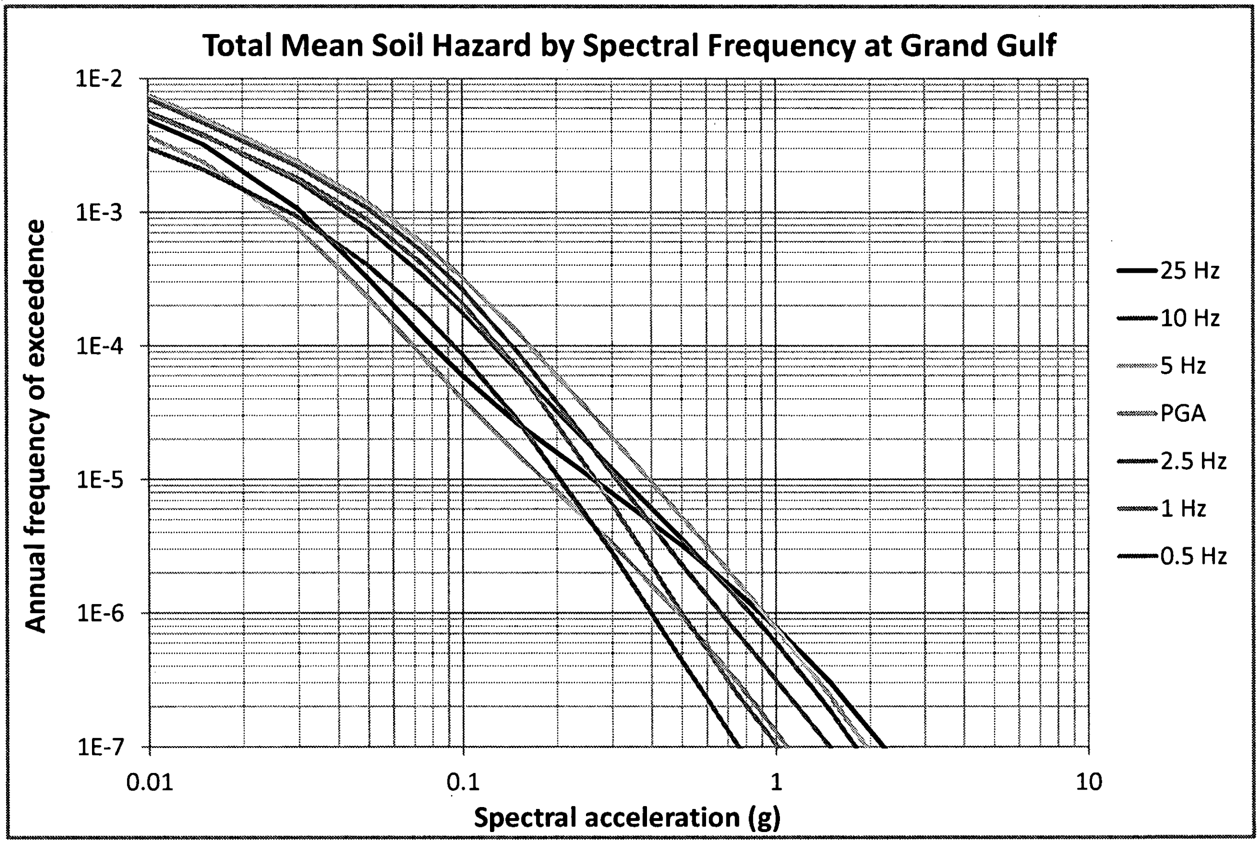


Figure 2.3.7-1 Control point mean hazard curves for spectral frequencies of 0.5, 1.0, 2.5, 5.0, 10, 25 and PGA (100) Hz at GGNS. (EPRI, 2014)

2.4 Control Point Response Spectrum

The control point hazard curves described above have been used to develop Uniform Hazard Response Spectra (UHRS) and the GMRS. The UHRS were obtained through linear interpolation in log-log space to estimate the spectral acceleration at each spectral frequency for the 10^{-4} and 10^{-5} per year hazard levels. Table 2.4-1 shows the UHRS and GMRS accelerations for a range of frequencies. (EPRI, 2014)

Table 2.4-1 UHRS and GMRS for GGNS. (EPRI, 2014)

Frequency (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS (g)
100	6.96E-02	1.82E-01	9.03E-02
90	6.98E-02	1.86E-01	9.17E-02
80	7.01E-02	1.90E-01	9.34E-02
70	7.05E-02	1.95E-01	9.55E-02
60	7.09E-02	2.01E-01	9.79E-02
50	7.16E-02	2.09E-01	1.01E-01
40	7.29E-02	2.20E-01	1.06E-01
35	7.41E-02	2.29E-01	1.10E-01
30	7.62E-02	2.41E-01	1.15E-01
25	8.01E-02	2.62E-01	1.24E-01
20	8.59E-02	2.66E-01	1.27E-01
15	1.00E-01	2.89E-01	1.40E-01
12.5	1.12E-01	3.09E-01	1.51E-01
10	1.26E-01	3.25E-01	1.61E-01
9	1.35E-01	3.42E-01	1.70E-01
8	1.47E-01	3.66E-01	1.83E-01
7	1.55E-01	3.85E-01	1.92E-01
6	1.59E-01	3.92E-01	1.96E-01
5	1.65E-01	3.94E-01	1.98E-01
4	1.62E-01	3.75E-01	1.90E-01
3.5	1.62E-01	3.63E-01	1.85E-01
3	1.57E-01	3.44E-01	1.76E-01
2.5	1.45E-01	3.10E-01	1.60E-01
2	1.50E-01	3.19E-01	1.65E-01
1.5	1.46E-01	3.03E-01	1.57E-01
1.25	1.43E-01	2.94E-01	1.53E-01
1	1.30E-01	2.65E-01	1.38E-01
0.9	1.34E-01	2.73E-01	1.42E-01
0.8	1.19E-01	2.53E-01	1.31E-01
0.7	1.12E-01	2.37E-01	1.23E-01
0.6	1.13E-01	2.40E-01	1.24E-01
0.5	9.40E-02	2.05E-01	1.05E-01

Table 2.4-1 UHRS and GMRS for GGNS. (EPRI, 2014)

Frequency (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS (g)
0.4	7.52E-02	1.64E-01	8.41E-02
0.35	6.58E-02	1.43E-01	7.36E-02
0.3	5.64E-02	1.23E-01	6.30E-02
0.25	4.70E-02	1.02E-01	5.25E-02
0.2	3.76E-02	8.18E-02	4.20E-02
0.15	2.82E-02	6.14E-02	3.15E-02
0.125	2.35E-02	5.12E-02	2.63E-02
0.1	1.88E-02	4.09E-02	2.10E-02

The 10^{-4} and 10^{-5} UHRS are used to compute the GMRS at the control point and are shown in Figure 2.4-1.

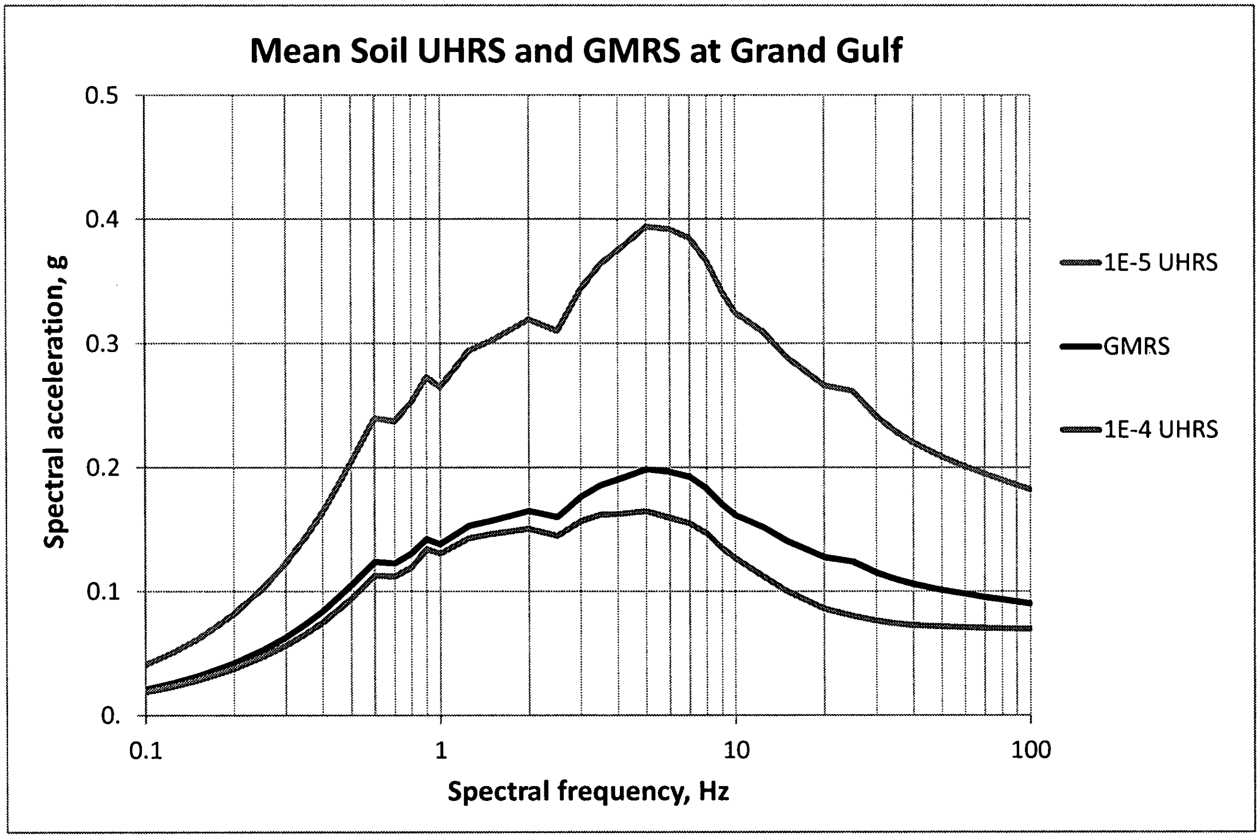


Figure 2.4-1 UHRS for 10^{-4} and 10^{-5} and GMRS at control point for GGNS (5% damped response spectra). (EPRI, 2014)

3.0 Plant Design Basis and Beyond Design Basis Evaluation Ground Motion

The design basis for Grand Gulf is identified in the Updated Final Safety Analysis Report (FSAR) (Entergy, 2013) and other pertinent documents.

3.1 SSE Description of Spectral Shape

The SSE is based on the seismicity of both the Gulf Coast Basin tectonic province and the zone of tectonism in the Mississippi Embayment tectonic province which is referred to as the New Madrid seismic zone. The maximum vibratory ground motion at GGNS is associated with the Gulf Coast Basin maximum potential earthquake for frequencies greater than about 1 to 2 cycles per second. The peak horizontal acceleration at the site due to this event does not exceed 0.1g. However, for additional conservatism an SSE of 0.15g was selected. The maximum vibratory ground motion at the site for low frequencies is associated with the New Madrid seismic zone maximum potential earthquake. (Entergy,2013)

The SSE is defined in terms of a PGA and a design response spectrum. Table 3.1-1 shows the Spectral Acceleration (SA) values as a function of frequency for the 5% damped horizontal SSE. (Entergy, 2013)

Table 3.1-1 SSE for GGNS. (Entergy, 2013)

Frequency (Hz)	SA (g)
100	0.15
33	0.15
25	0.15
22	0.15
10	0.30
6.7	0.40
5.0	0.40
2.5	0.40
2.0	0.40
1.0	0.20
0.50	0.10
0.26	0.036
0.10	0.009

The original SSE spectrum tabulation was augmented with additional spectral points to better define the spectrum in the frequency range of interest.

3.2 Control Point Elevation

Section 2.5, Page 2.5-2 of the GGNS FSAR (Entergy, 2013) states that "the safe shutdown earthquake (SSE) is conservatively selected at 0.15g at foundation grade on the Catahoula formation." As such, the SSE control point elevation is defined at elevation 87 ft, which is the top of the Catahoula Formation (Entergy, 2013). The bottom of the foundation of the highest safety-related structure is 3'-6" below, at Elev. 83'-6".

3.3 IPEEE Description and Capacity Response Spectrum

The Individual Plant Examination of External Events (IPEEE) was performed as a reduced scope. Because GGNS screens-out from performing any further evaluations, the IPEEE was not reviewed.

4.0 Screening Evaluation

In accordance with SPID Section 3 (EPRI, 2013a), a screening evaluation was performed as described below.

4.1 Risk Evaluation Screening (1 to 10 Hz)

In the 1 to 10 Hz part of the response spectrum, the SSE exceeds the GMRS. Therefore, a risk evaluation will not be performed. Additionally, based on the SSE and GMRS comparison, GGNS will screen-out of the expedited seismic evaluation described in EPRI 3002000704 (EPRI, 2013b) as proposed in a letter to the NRC (ML13101A379) dated April 9, 2013 (NEI, 2013) and agreed to by the NRC (ML13106A331) in a letter dated May 7, 2013 (U.S. NRC, 2013).

4.2 High Frequency Screening (> 10 Hz)

Above 10 Hz, the SSE exceeds the GMRS. Therefore, the High Frequency Confirmation will not be performed.

4.3 Spent Fuel Pool Evaluation Screening (1 to 10 Hz)

In the 1 to 10 Hz part of the response spectrum, the SSE exceeds the GMRS. Therefore, a Spent Fuel Pool evaluation will not be performed.

5.0 Interim Actions

Based on the screening evaluation, the expedited seismic evaluation described in EPRI 3002000704 will not be performed.

Consistent with NRC letter (ML14030A046) dated February 20, 2014, (U.S. NRC, 2014) the seismic hazard reevaluations presented herein are distinct from the current design and licensing bases of GGNS. Therefore, the results do not call into question the operability or functionality of Structures, Systems, and Components and are not reportable pursuant to10 CFR 50.72, "Immediate notification requirements for operating nuclear power reactors," and10 CFR 50.73, "Licensee event report system".

The NRC letter also requests that licensees provide an interim evaluation or actions to demonstrate that the plant can cope with the reevaluated hazard while the expedited approach and risk evaluations are conducted. In response to that request, NEI letter dated March 12, 2014 (NEI, 2014), provides seismic core damage risk estimates using the updated seismic hazards for the operating nuclear plants in the Central and Eastern United States. These risk estimates continue to support the following conclusions of the NRC GI-199 Safety/Risk Assessment (U.S. NRC, 2010):

> Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency. The GI-199 Safety/Risk Assessment, based in part on information from the U.S. Nuclear Regulatory Commission's (NRC's) Individual Plant Examination of External Events (IPEEE) program, indicates that no concern exists regarding adequate protection and that the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis.

GGNS is included in the March 12, 2014 risk estimates. Using the methodology described in the NEI letter, all plants were shown to be below 10^{-4}/year; thus, the above conclusions apply (NEI, 2014).

In accordance with the Near-Term Task Force Recommendation 2.3, GGNS performed seismic walkdowns using the guidance in EPRI Report 1025286 (EPRI, 2012). The seismic walkdowns were completed and captured in Fukushima Seismic Walkdown Report GNRO-2012/00141 (Entergy, 2012). The goal of the walkdowns was to verify current plant configuration with the existing licensing basis, to verify the current maintenance plans, and to identify any vulnerabilities. The walkdown also verified that any vulnerabilities identified in the IPEEE (Entergy, 1995) were adequately addressed. The results of the walkdown, including any identified corrective actions, confirm that GGNS can adequately respond to a seismic event.

6.0 Conclusions

In accordance with the 50.54(f) request for information (U.S. NRC, 2012), a seismic hazard and screening evaluation was performed for GGNS. A GMRS was developed solely for the purpose of screening for additional evaluations in accordance with the SPID (EPRI, 2013a). Based on the results of the screening evaluation, no further evaluations will be performed.

7.0 References

10 CFR Part 50. Title 10, Code of Federal Regulations, Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington DC.

10 CFR Part 50.72. Title 10, Code of Federal Regulations, Part 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, Washington DC.

10 CFR Part 50.73. Title 10, Code of Federal Regulations, Part 50.73, "Licensee Event Report System," U.S. Nuclear Regulatory Commission, Washington DC.

10 CFR Part 100. Title 10, Code of Federal Regulations, Part 100, "Reactor Site Criteria," U.S. Nuclear Regulatory Commission, Washington, DC.

CEUS-SSC (2012). "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," U.S. Nuclear Regulatory Commission Report, NUREG-2115; EPRI Report 1021097, 6 Volumes; DOE Report# DOE/NE-0140.

Entergy (1995). "Grand Gulf Nuclear Station Engineering Report for IPEEE Reduced Scope Seismic Margin Assessment (SMA)," GGNS-94-0053, Revision 0, dated January 5, 1995.

Entergy (2012). "Seismic Walkdown Report – Entergy's Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident; Grand Gulf Nuclear Station, Unit No. 1; Docket No. 50-416; License No. NPF-29," GNRO-2012/00141, dated November 27, 2012.

Entergy (2013). "Grand Gulf Nuclear Station Updated Final Safety Analysis Report," Docket No. 50-416, 2013.

EPRI (2012). "Seismic Walkdown Guidance for Resolution of Fukushima Near-Term Task Force Recommendation 2.3: Seismic," EPRI 1025286, Draft 7 Report, May 2012.

EPRI (2013a). "Seismic Evaluation Guidance Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," EPRI 1025287, February 2013.

EPRI (2013b). "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 – Seismic," EPRI 3002000704, Final Report, May 2013.

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NEI (2014). NEI Letter to NRC, "Seismic Risk Evaluations for Plants in the Central and Eastern United States," March 12, 2014.

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U.S. NRC (2007). "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," U.S. Nuclear Regulatory Commission Reg. Guide 1.208.

U.S. NRC (2010). "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," GI-199, September 2, 2010.

U.S. NRC (2012). NRC (E Leeds and M Johnson) Letter to All Power Reactor Licensees et al., "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3 and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012.

U.S. NRC (2013). NRC Letter, Eric J. Leeds to Joseph E. Pollock, NEI "Electric Power Research Institute Final Draft Report XXXXXX, Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic, As an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluation," dated May 7, 2013.

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Appendix A

Tabulated Data

Table A-1a. Mean and Fractile Seismic Hazard Curves for PGA at GGNS.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.69E-02	1.87E-02	3.42E-02	4.63E-02	6.17E-02	7.13E-02
0.001	2.90E-02	1.07E-02	1.95E-02	2.72E-02	4.01E-02	4.98E-02
0.005	6.92E-03	2.53E-03	3.95E-03	6.26E-03	9.51E-03	1.46E-02
0.01	3.70E-03	9.93E-04	1.67E-03	3.19E-03	5.66E-03	8.23E-03
0.015	2.37E-03	4.77E-04	8.35E-04	1.87E-03	3.95E-03	6.09E-03
0.03	7.53E-04	9.11E-05	1.64E-04	4.13E-04	1.29E-03	2.64E-03
0.05	2.31E-04	2.10E-05	4.07E-05	1.05E-04	3.14E-04	8.72E-04
0.075	8.28E-05	6.93E-06	1.46E-05	3.95E-05	1.08E-04	2.96E-04
0.1	4.02E-05	3.47E-06	7.77E-06	2.13E-05	5.66E-05	1.32E-04
0.15	1.55E-05	1.42E-06	3.37E-06	9.51E-06	2.42E-05	4.83E-05
0.3	3.29E-06	2.72E-07	6.93E-07	2.13E-06	5.50E-06	1.01E-05
0.5	9.35E-07	6.00E-08	1.67E-07	5.75E-07	1.60E-06	3.01E-06
0.75	3.07E-07	1.46E-08	4.31E-08	1.74E-07	5.20E-07	1.07E-06
1.	1.30E-07	4.50E-09	1.42E-08	6.73E-08	2.19E-07	4.77E-07
1.5	3.54E-08	7.23E-10	2.53E-09	1.49E-08	5.66E-08	1.51E-07
3.	2.77E-09	1.29E-10	1.98E-10	8.00E-10	3.90E-09	1.49E-08
5.	3.07E-10	1.11E-10	1.21E-10	1.82E-10	5.05E-10	1.90E-09
7.5	4.34E-11	1.11E-10	1.21E-10	1.72E-10	1.95E-10	4.01E-10
10.	9.80E-12	1.11E-10	1.11E-10	1.72E-10	1.72E-10	2.04E-10

Table A-1b. Mean and Fractile Seismic Hazard Curves for 25 Hz at GGNS.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.06E-02	2.46E-02	3.95E-02	5.05E-02	6.36E-02	7.34E-02
0.001	3.28E-02	1.44E-02	2.35E-02	3.14E-02	4.19E-02	5.50E-02
0.005	8.78E-03	3.57E-03	5.20E-03	7.89E-03	1.16E-02	1.90E-02
0.01	4.86E-03	1.57E-03	2.46E-03	4.31E-03	7.03E-03	1.05E-02
0.015	3.20E-03	8.23E-04	1.34E-03	2.64E-03	5.05E-03	7.55E-03
0.03	1.06E-03	1.67E-04	2.80E-04	6.54E-04	1.84E-03	3.42E-03
0.05	3.22E-04	3.68E-05	6.64E-05	1.60E-04	4.63E-04	1.21E-03
0.075	1.17E-04	1.20E-05	2.39E-05	6.00E-05	1.51E-04	4.13E-04
0.1	5.97E-05	6.36E-06	1.32E-05	3.47E-05	8.12E-05	1.92E-04
0.15	2.62E-05	3.05E-06	6.73E-06	1.82E-05	4.07E-05	7.34E-05
0.3	7.90E-06	9.37E-07	2.32E-06	6.26E-06	1.31E-05	2.01E-05
0.5	3.21E-06	3.57E-07	9.51E-07	2.57E-06	5.42E-06	8.23E-06
0.75	1.45E-06	1.46E-07	3.95E-07	1.11E-06	2.49E-06	3.84E-06
1.	7.80E-07	7.34E-08	1.98E-07	5.83E-07	1.32E-06	2.16E-06
1.5	2.96E-07	2.42E-08	6.64E-08	2.10E-07	5.05E-07	8.98E-07
3.	4.23E-08	2.25E-09	6.45E-09	2.49E-08	7.23E-08	1.55E-07
5.	7.73E-09	3.42E-10	8.85E-10	3.73E-09	1.32E-08	3.14E-08
7.5	1.68E-09	1.49E-10	2.39E-10	7.55E-10	2.88E-09	7.55E-09
10.	5.19E-10	1.21E-10	1.62E-10	2.92E-10	9.93E-10	2.42E-09

Table A-1c. Mean and Fractile Seismic Hazard Curves for 10 Hz at GGNS. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.88E-02	3.57E-02	4.77E-02	5.83E-02	7.13E-02	8.00E-02
0.001	4.01E-02	2.10E-02	3.01E-02	3.95E-02	5.05E-02	5.91E-02
0.005	1.04E-02	4.90E-03	6.73E-03	9.79E-03	1.36E-02	1.90E-02
0.01	5.57E-03	2.25E-03	3.23E-03	5.12E-03	7.89E-03	1.04E-02
0.015	3.81E-03	1.29E-03	1.95E-03	3.42E-03	5.66E-03	7.66E-03
0.03	1.70E-03	3.90E-04	6.17E-04	1.29E-03	2.84E-03	4.43E-03
0.05	7.53E-04	1.25E-04	2.07E-04	4.56E-04	1.29E-03	2.39E-03
0.075	3.37E-04	4.56E-05	8.00E-05	1.82E-04	5.27E-04	1.15E-03
0.1	1.76E-04	2.16E-05	3.95E-05	9.51E-05	2.53E-04	5.91E-04
0.15	6.61E-05	7.45E-06	1.51E-05	3.84E-05	9.24E-05	2.07E-04
0.3	1.21E-05	1.31E-06	3.01E-06	8.23E-06	1.92E-05	3.42E-05
0.5	3.58E-06	3.42E-07	8.47E-07	2.53E-06	6.17E-06	1.02E-05
0.75	1.30E-06	1.07E-07	2.80E-07	8.85E-07	2.25E-06	3.90E-06
1.	6.01E-07	4.25E-08	1.18E-07	3.95E-07	1.05E-06	1.87E-06
1.5	1.84E-07	1.01E-08	2.96E-08	1.13E-07	3.33E-07	6.09E-07
3.	1.86E-08	5.50E-10	1.77E-09	8.98E-09	3.23E-08	7.34E-08
5.	2.85E-09	1.62E-10	2.57E-10	1.11E-09	4.70E-09	1.31E-08
7.5	5.71E-10	1.20E-10	1.53E-10	2.64E-10	1.02E-09	2.88E-09
10.	1.69E-10	1.11E-10	1.21E-10	1.72E-10	3.79E-10	1.01E-09

Table A-1d. Mean and Fractile Seismic Hazard Curves for 5.0 Hz at GGNS. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	7.06E-02	4.77E-02	5.75E-02	7.03E-02	8.35E-02	9.24E-02
0.001	5.35E-02	2.96E-02	4.01E-02	5.35E-02	6.73E-02	7.66E-02
0.005	1.52E-02	6.83E-03	9.93E-03	1.46E-02	2.07E-02	2.49E-02
0.01	7.54E-03	3.33E-03	4.70E-03	7.23E-03	1.04E-02	1.27E-02
0.015	5.03E-03	1.98E-03	2.88E-03	4.77E-03	7.13E-03	8.98E-03
0.03	2.40E-03	6.54E-04	1.04E-03	2.07E-03	3.79E-03	5.35E-03
0.05	1.19E-03	2.32E-04	3.84E-04	8.47E-04	2.01E-03	3.23E-03
0.075	5.85E-04	8.98E-05	1.53E-04	3.52E-04	9.51E-04	1.90E-03
0.1	3.26E-04	4.37E-05	7.66E-05	1.79E-04	4.98E-04	1.15E-03
0.15	1.28E-04	1.49E-05	2.76E-05	6.54E-05	1.74E-04	4.56E-04
0.3	2.08E-05	2.29E-06	4.77E-06	1.23E-05	2.92E-05	6.45E-05
0.5	5.25E-06	5.42E-07	1.27E-06	3.57E-06	8.47E-06	1.51E-05
0.75	1.74E-06	1.49E-07	3.73E-07	1.16E-06	3.01E-06	5.27E-06
1.	7.76E-07	4.98E-08	1.29E-07	4.70E-07	1.40E-06	2.49E-06
1.5	2.34E-07	7.03E-09	2.13E-08	1.16E-07	4.37E-07	8.47E-07
3.	2.47E-08	2.01E-10	5.66E-10	7.34E-09	4.43E-08	1.07E-07
5.	3.96E-09	1.21E-10	1.72E-10	7.55E-10	6.17E-09	1.84E-08
7.5	8.28E-10	1.11E-10	1.23E-10	2.04E-10	1.18E-09	4.01E-09
10.	2.57E-10	1.11E-10	1.21E-10	1.72E-10	4.01E-10	1.34E-09

Table A-1e. Mean and Fractile Seismic Hazard Curves for 2.5 Hz at GGNS. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	7.03E-02	4.83E-02	5.66E-02	7.03E-02	8.35E-02	9.37E-02
0.001	5.30E-02	3.09E-02	3.90E-02	5.20E-02	6.83E-02	7.66E-02
0.005	1.48E-02	6.93E-03	9.51E-03	1.40E-02	2.01E-02	2.46E-02
0.01	7.09E-03	3.09E-03	4.31E-03	6.73E-03	9.93E-03	1.21E-02
0.015	4.64E-03	1.77E-03	2.57E-03	4.37E-03	6.73E-03	8.47E-03
0.03	2.19E-03	5.35E-04	8.72E-04	1.87E-03	3.57E-03	5.05E-03
0.05	1.07E-03	1.74E-04	3.05E-04	7.55E-04	1.84E-03	2.96E-03
0.075	5.04E-04	6.17E-05	1.11E-04	2.88E-04	8.60E-04	1.69E-03
0.1	2.63E-04	2.80E-05	5.05E-05	1.34E-04	4.31E-04	9.79E-04
0.15	9.08E-05	8.35E-06	1.55E-05	4.19E-05	1.34E-04	3.57E-04
0.3	1.11E-05	9.37E-07	2.01E-06	5.42E-06	1.64E-05	3.79E-05
0.5	2.30E-06	1.79E-07	4.31E-07	1.32E-06	3.68E-06	7.03E-06
0.75	7.11E-07	4.56E-08	1.20E-07	4.19E-07	1.20E-06	2.35E-06
1.	3.15E-07	1.55E-08	4.37E-08	1.72E-07	5.50E-07	1.11E-06
1.5	9.79E-08	2.84E-09	8.85E-09	4.37E-08	1.72E-07	3.79E-07
3.	1.13E-08	1.90E-10	4.01E-10	2.80E-09	1.82E-08	5.12E-08
5.	1.94E-09	1.21E-10	1.64E-10	3.63E-10	2.64E-09	9.24E-09
7.5	4.21E-10	1.11E-10	1.21E-10	1.72E-10	5.66E-10	2.04E-09
10.	1.32E-10	1.11E-10	1.21E-10	1.72E-10	2.46E-10	7.23E-10

Table A-1f. Mean and Fractile Seismic Hazard Curves for 1.0 Hz at GGNS. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.60E-02	2.88E-02	4.01E-02	5.66E-02	7.13E-02	8.12E-02
0.001	3.83E-02	1.64E-02	2.53E-02	3.79E-02	5.12E-02	6.00E-02
0.005	1.05E-02	4.13E-03	6.26E-03	9.93E-03	1.46E-02	1.84E-02
0.01	5.47E-03	1.87E-03	2.92E-03	5.12E-03	8.12E-03	1.02E-02
0.015	3.72E-03	1.01E-03	1.72E-03	3.42E-03	5.75E-03	7.55E-03
0.03	1.80E-03	2.60E-04	5.27E-04	1.46E-03	3.14E-03	4.56E-03
0.05	8.75E-04	7.55E-05	1.67E-04	5.83E-04	1.60E-03	2.64E-03
0.075	4.06E-04	2.42E-05	5.66E-05	2.22E-04	7.45E-04	1.38E-03
0.1	2.08E-04	9.93E-06	2.39E-05	9.79E-05	3.68E-04	7.66E-04
0.15	6.79E-05	2.72E-06	6.54E-06	2.68E-05	1.11E-04	2.72E-04
0.3	6.56E-06	2.46E-07	5.91E-07	2.35E-06	9.11E-06	2.68E-05
0.5	9.95E-07	3.57E-08	9.37E-08	3.79E-07	1.51E-06	3.90E-06
0.75	2.50E-07	7.03E-09	2.10E-08	9.11E-08	4.07E-07	9.93E-07
1.	1.05E-07	2.16E-09	6.73E-09	3.52E-08	1.67E-07	4.43E-07
1.5	3.42E-08	4.50E-10	1.36E-09	8.72E-09	5.12E-08	1.57E-07
3.	4.90E-09	1.31E-10	1.84E-10	7.34E-10	5.91E-09	2.32E-08
5.	1.01E-09	1.11E-10	1.25E-10	2.01E-10	1.07E-09	4.70E-09
7.5	2.54E-10	1.11E-10	1.21E-10	1.72E-10	3.09E-10	1.21E-09
10.	8.84E-11	1.11E-10	1.21E-10	1.72E-10	1.92E-10	4.77E-10

Table A-1g. Mean and Fractile Seismic Hazard Curves for 0.5 Hz at GGNS. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.99E-02	1.49E-02	2.16E-02	2.92E-02	3.84E-02	4.56E-02
0.001	1.83E-02	8.72E-03	1.25E-02	1.77E-02	2.39E-02	3.01E-02
0.005	5.34E-03	1.72E-03	2.80E-03	4.98E-03	7.89E-03	1.02E-02
0.01	3.02E-03	5.75E-04	1.13E-03	2.68E-03	4.90E-03	6.64E-03
0.015	2.08E-03	2.57E-04	5.75E-04	1.72E-03	3.63E-03	5.20E-03
0.03	9.23E-04	4.70E-05	1.29E-04	5.66E-04	1.74E-03	3.01E-03
0.05	4.01E-04	1.07E-05	3.28E-05	1.74E-04	7.55E-04	1.55E-03
0.075	1.73E-04	2.88E-06	9.37E-06	5.58E-05	2.96E-04	7.45E-04
0.1	8.61E-05	1.11E-06	3.57E-06	2.25E-05	1.32E-04	3.95E-04
0.15	2.78E-05	2.76E-07	8.60E-07	5.58E-06	3.68E-05	1.34E-04
0.3	2.83E-06	2.19E-08	6.93E-08	4.25E-07	2.96E-06	1.25E-05
0.5	4.39E-07	2.88E-09	1.04E-08	6.54E-08	4.83E-07	1.82E-06
0.75	1.05E-07	5.83E-10	2.25E-09	1.46E-08	1.20E-07	4.70E-07
1.	4.18E-08	2.49E-10	7.77E-10	5.20E-09	4.56E-08	2.01E-07
1.5	1.32E-08	1.60E-10	2.35E-10	1.31E-09	1.20E-08	6.73E-08
3.	2.04E-09	1.11E-10	1.27E-10	2.07E-10	1.32E-09	9.51E-09
5.	4.59E-10	1.11E-10	1.21E-10	1.72E-10	3.05E-10	1.92E-09
7.5	1.25E-10	1.11E-10	1.21E-10	1.72E-10	1.79E-10	5.42E-10
10.	4.59E-11	1.11E-10	1.11E-10	1.72E-10	1.72E-10	2.76E-10

Table A-2. Amplification Functions for GGNS. (EPRI, 2014)

PGA	Median AF	Sigma ln(AF)	25 Hz	Median AF	Sigma ln(AF)	10 Hz	Median AF	Sigma ln(AF)	5 Hz	Median AF	Sigma ln(AF)
1.00E-02	1.53E+00	5.75E-02	1.30E-02	1.19E+00	5.74E-02	1.90E-02	1.14E+00	8.61E-02	2.09E-02	1.60E+00	1.08E-01
4.95E-02	1.02E+00	6.60E-02	1.02E-01	5.44E-01	6.87E-02	9.99E-02	9.16E-01	1.12E-01	8.24E-02	1.49E+00	1.18E-01
9.64E-02	8.72E-01	6.94E-02	2.13E-01	5.00E-01	7.34E-02	1.85E-01	8.47E-01	1.18E-01	1.44E-01	1.42E+00	1.22E-01
1.94E-01	7.51E-01	7.36E-02	4.43E-01	5.00E-01	7.89E-02	3.56E-01	7.65E-01	1.25E-01	2.65E-01	1.34E+00	1.27E-01
2.92E-01	6.87E-01	7.78E-02	6.76E-01	5.00E-01	8.37E-02	5.23E-01	7.09E-01	1.30E-01	3.84E-01	1.27E+00	1.33E-01
3.91E-01	6.43E-01	8.10E-02	9.09E-01	5.00E-01	8.71E-02	6.90E-01	6.64E-01	1.35E-01	5.02E-01	1.21E+00	1.38E-01
4.93E-01	6.09E-01	8.36E-02	1.15E+00	5.00E-01	9.01E-02	8.61E-01	6.26E-01	1.39E-01	6.22E-01	1.16E+00	1.43E-01
7.41E-01	5.49E-01	8.72E-02	1.73E+00	5.00E-01	9.34E-02	1.27E+00	5.52E-01	1.46E-01	9.13E-01	1.06E+00	1.54E-01
1.01E+00	5.05E-01	9.22E-02	2.36E+00	5.00E-01	9.85E-02	1.72E+00	5.00E-01	1.52E-01	1.22E+00	9.79E-01	1.65E-01
1.28E+00	5.00E-01	9.62E-02	3.01E+00	5.00E-01	1.02E-01	2.17E+00	5.00E-01	1.58E-01	1.54E+00	9.07E-01	1.74E-01
1.55E+00	5.00E-01	1.00E-01	3.63E+00	5.00E-01	1.05E-01	2.61E+00	5.00E-01	1.61E-01	1.85E+00	8.52E-01	1.83E-01
2.5 Hz	**Median AF**	**Sigma ln(AF)**	**1 Hz**	**Median AF**	**Sigma ln(AF)**	**0.5 Hz**	**Median AF**	**Sigma ln(AF)**			
2.18E-02	1.76E+00	1.13E-01	1.27E-02	2.33E+00	1.75E-01	8.25E-03	2.25E+00	1.85E-01			
7.05E-02	1.68E+00	1.14E-01	3.43E-02	2.26E+00	1.70E-01	1.96E-02	2.23E+00	1.80E-01			
1.18E-01	1.64E+00	1.15E-01	5.51E-02	2.23E+00	1.67E-01	3.02E-02	2.23E+00	1.80E-01			
2.12E-01	1.58E+00	1.17E-01	9.63E-02	2.18E+00	1.63E-01	5.11E-02	2.23E+00	1.81E-01			
3.04E-01	1.53E+00	1.19E-01	1.36E-01	2.15E+00	1.59E-01	7.10E-02	2.23E+00	1.82E-01			
3.94E-01	1.49E+00	1.21E-01	1.75E-01	2.12E+00	1.57E-01	9.06E-02	2.23E+00	1.83E-01			
4.86E-01	1.45E+00	1.23E-01	2.14E-01	2.09E+00	1.54E-01	1.10E-01	2.23E+00	1.84E-01			
7.09E-01	1.37E+00	1.25E-01	3.10E-01	2.04E+00	1.51E-01	1.58E-01	2.23E+00	1.87E-01			
9.47E-01	1.30E+00	1.29E-01	4.12E-01	2.02E+00	1.50E-01	2.09E-01	2.23E+00	1.88E-01			
1.19E+00	1.24E+00	1.35E-01	5.18E-01	2.00E+00	1.51E-01	2.62E-01	2.23E+00	1.89E-01			
1.43E+00	1.21E+00	1.37E-01	6.19E-01	1.98E+00	1.51E-01	3.12E-01	2.23E+00	1.90E-01			

Tables A-3a and A-3b are tabular versions of the typical amplification factors provided in Figures 2.3.6-1 and 2.3.6-2. Values are provided for two input motion levels at approximately 10^{-4} and 10^{-5} mean annual frequency of exceedance. These factors are unverified and are provided For Information Only. The figures should be considered the governing information.

Table A-3a. Median AFs and sigmas for Model 1, Profile 1, for 2 PGA levels.

For Information Only

M1P1K1	Rock PGA=0.0964			M1P1K1	PGA=0.194		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.092	0.958	0.056	100.0	0.158	0.815	0.062
87.1	0.092	0.939	0.056	87.1	0.158	0.795	0.062
75.9	0.093	0.908	0.056	75.9	0.158	0.761	0.062
66.1	0.093	0.849	0.056	66.1	0.159	0.699	0.063
57.5	0.093	0.749	0.056	57.5	0.159	0.599	0.063
50.1	0.093	0.638	0.057	50.1	0.159	0.500	0.063
43.7	0.094	0.546	0.057	43.7	0.160	0.425	0.063
38.0	0.095	0.495	0.057	38.0	0.161	0.389	0.064
33.1	0.096	0.468	0.058	33.1	0.164	0.372	0.065
28.8	0.098	0.471	0.059	28.8	0.167	0.380	0.067
25.1	0.101	0.475	0.061	25.1	0.172	0.387	0.070
21.9	0.105	0.510	0.062	21.9	0.178	0.421	0.073
19.1	0.111	0.537	0.068	19.1	0.187	0.448	0.081
16.6	0.119	0.590	0.076	16.6	0.199	0.497	0.090
14.5	0.128	0.659	0.087	14.5	0.214	0.559	0.100
12.6	0.138	0.724	0.100	12.6	0.232	0.622	0.116
11.0	0.148	0.784	0.097	11.0	0.247	0.679	0.113
9.5	0.159	0.873	0.121	9.5	0.266	0.765	0.125
8.3	0.173	1.022	0.138	8.3	0.288	0.897	0.142
7.2	0.188	1.176	0.145	7.2	0.315	1.046	0.147
6.3	0.198	1.307	0.138	6.3	0.334	1.180	0.144
5.5	0.204	1.403	0.117	5.5	0.345	1.279	0.127
4.8	0.208	1.450	0.088	4.8	0.354	1.339	0.096
4.2	0.209	1.495	0.087	4.2	0.357	1.393	0.091
3.6	0.205	1.496	0.087	3.6	0.351	1.407	0.087
3.2	0.204	1.574	0.110	3.2	0.347	1.475	0.111
2.8	0.199	1.608	0.096	2.8	0.343	1.536	0.100
2.4	0.195	1.704	0.105	2.4	0.335	1.627	0.109
2.1	0.189	1.801	0.104	2.1	0.325	1.737	0.109
1.8	0.184	1.953	0.096	1.8	0.315	1.880	0.094
1.6	0.170	2.083	0.116	1.6	0.290	1.999	0.114
1.4	0.166	2.347	0.099	1.4	0.280	2.242	0.110
1.2	0.152	2.426	0.135	1.2	0.263	2.390	0.136
1.0	0.131	2.312	0.148	1.0	0.226	2.278	0.135
0.91	0.129	2.481	0.124	0.91	0.222	2.459	0.122
0.79	0.105	2.217	0.139	0.79	0.183	2.240	0.140
0.69	0.099	2.329	0.163	0.69	0.170	2.326	0.159
0.60	0.098	2.625	0.132	0.60	0.167	2.625	0.124
0.52	0.080	2.518	0.198	0.52	0.137	2.534	0.196
0.46	0.068	2.531	0.173	0.46	0.115	2.552	0.177
0.10	0.003	2.388	0.152	0.10	0.005	2.398	0.159

Table A-3b. Median AFs and sigmas for Model 2, Profile 1, for 2 PGA levels.

For Information Only

M2P1K1		PGA=0.0964		M2P1K1		PGA=0.194	
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.097	1.010	0.045	100.0	0.170	0.875	0.046
87.1	0.097	0.991	0.045	87.1	0.170	0.854	0.046
75.9	0.098	0.958	0.045	75.9	0.170	0.818	0.046
66.1	0.098	0.896	0.045	66.1	0.170	0.751	0.046
57.5	0.098	0.791	0.045	57.5	0.171	0.644	0.046
50.1	0.098	0.673	0.045	50.1	0.172	0.538	0.046
43.7	0.099	0.577	0.046	43.7	0.173	0.458	0.047
38.0	0.100	0.525	0.046	38.0	0.175	0.421	0.047
33.1	0.102	0.497	0.046	33.1	0.178	0.404	0.049
28.8	0.105	0.503	0.047	28.8	0.182	0.414	0.051
25.1	0.108	0.509	0.048	25.1	0.188	0.425	0.052
21.9	0.113	0.549	0.052	21.9	0.196	0.465	0.058
19.1	0.120	0.582	0.058	19.1	0.208	0.500	0.066
16.6	0.129	0.642	0.064	16.6	0.224	0.558	0.074
14.5	0.140	0.719	0.074	14.5	0.242	0.631	0.083
12.6	0.151	0.789	0.083	12.6	0.261	0.699	0.089
11.0	0.161	0.853	0.082	11.0	0.278	0.763	0.090
9.5	0.171	0.944	0.098	9.5	0.296	0.850	0.096
8.3	0.189	1.119	0.120	8.3	0.326	1.015	0.116
7.2	0.204	1.276	0.126	7.2	0.354	1.177	0.127
6.3	0.214	1.413	0.122	6.3	0.371	1.313	0.126
5.5	0.219	1.505	0.101	5.5	0.381	1.412	0.102
4.8	0.223	1.556	0.092	4.8	0.388	1.470	0.094
4.2	0.222	1.591	0.102	4.2	0.388	1.514	0.105
3.6	0.216	1.579	0.106	3.6	0.378	1.514	0.108
3.2	0.215	1.657	0.106	3.2	0.370	1.575	0.108
2.8	0.206	1.663	0.092	2.8	0.359	1.608	0.089
2.4	0.202	1.760	0.098	2.4	0.350	1.700	0.095
2.1	0.194	1.852	0.108	2.1	0.337	1.800	0.111
1.8	0.191	2.027	0.109	1.8	0.330	1.970	0.111
1.6	0.177	2.158	0.126	1.6	0.304	2.092	0.128
1.4	0.171	2.424	0.098	1.4	0.292	2.336	0.097
1.2	0.153	2.448	0.138	1.2	0.266	2.415	0.139
1.0	0.133	2.340	0.155	1.0	0.230	2.316	0.143
0.91	0.129	2.489	0.134	0.91	0.224	2.472	0.132
0.79	0.105	2.212	0.139	0.79	0.182	2.226	0.139
0.69	0.099	2.327	0.161	0.69	0.169	2.320	0.157
0.60	0.098	2.627	0.141	0.60	0.167	2.623	0.138
0.52	0.080	2.517	0.198	0.52	0.137	2.530	0.199
0.46	0.068	2.520	0.167	0.46	0.114	2.529	0.165
0.10	0.003	2.387	0.154	0.10	0.005	2.394	0.161

ATTACHMENT 9.4 **NRC SUBMITTAL REVIEW**

Sheet 1 of 2 *{Typical}*

Letter #: GNRO-2014/00027 **Response Due:** 3/31/2014

Subject: Entergy Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident

Date Issued for Review: 3/18/2014

Correspondence Preparer / Phone #: Tori Liggans-Robinson x6177

Section I **Letter Concurrence and Agreement to Perform Actions**

POSITION / NAME	Action (concurrence, certification, etc.)	Signature (sign, interoffice memo, e-mail, or telecom)
Design Engineering / Tori Liggans-Robinson	certification	Per EN-LI-106 Att. 9.5
Supervisor, Design Engineering / Fred Hopkins	certification/concurrence	Per EN-LI-106 Att. 9.5
Director Regulatory & Performance Improvement / Tom Coutu	concurrence	T. Coutu

COMMENTS

N/A

Section II **Correspondence Screening**

Does this letter contain commitments? **If "yes," identify the commitments with due dates in the submittal and in Section III. When fleet letters contain commitments, a PCRS LO (e.g., LO-LAR, LO-WT) should be initiated with a CA assigned to each applicable site to enter the commitments into the site's commitment management system.**	Yes No	☐ ☒
Does this letter contain any information or analyses of new safety issues performed at NRC request or to satisfy a regulatory requirement? **If "yes," reflect requirement to update the UFSAR in Section III.**	Yes No	☐ ☒
Does this letter require any document changes (e.g., procedures, DBDs, FSAR, TS Bases, etc.), if approved? **If "yes," indicate in Section III an action for the responsible department to determine the affected documents. (The Correspondence Preparer may indicate the specific documents requiring revision, if known or may initiate an action for review.)**	Yes No	☐ ☒
Does this letter contain information certified accurate? **If "yes," identify the information and document certification in an attachment. (Attachment 9.5 must be used.)**	Yes No	☒ ☐

ATTACHMENT 9.4 **NRC SUBMITTAL REVIEW**

Sheet 2 of 2

Section III **Actions and Commitments**

Required Actions *Note: Actions needed upon approval should be captured in the appropriate action tracking system*	**Due Date**	**Responsible Dept.**
N/A	N/A	N/A
Commitments *Note: When fleet letters contain commitments, a PCRS LO should be initiated with a CA assigned to each applicable site to enter the commitments into the site's commitment management system.*	**Due Date**	**Responsible Dept.**
N/A	N/A	N/A

Section IV **Final Document Signoff for Submittal**

Correspondence Preparer	Tori Liggans-Robinson / See EN-LI-106 Att. 9.5
Final Submittal Review *(optional)*	Fred Hopkins / See EN-LI-106 Att. 9.5
Responsible Department Head	Jeffery A. Seiter /

ATTACHMENT 9.5 **CERTIFICATION REFERENCE FORM**

Sheet 1 of 1

Letter Number: GNRO-2014/00027

Subject: **Entergy Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident**

Certifiable Statement(s): Use one of the following methods to identify certifiable statements in the table below:

1. Identify location in submittal (e.g., page 3, para 2, sentence 1) OR,
2. Paste in the exact words of the statement(s) OR,
3. State "see attachment" and attach a copy of the correspondence with the certifiable statements indicated (e.g., by redlining, highlighting, or underlining, etc.).

Each statement or section of information being certified should be uniquely numbered to correspond with the supporting documentation listed below.

Objective Evidence or Basis of Peer Review: List the supporting documents in the table below and attach a copy of the documents OR give basis of peer review. Large documents need not be attached.

Certifiable Statement(s)	Objective Evidence or Basis of Peer Review
GNRO-2014/00027 Attachment: GGNS Seismic Hazard and Screening Report (CEUS Sites)	Grand Gulf Seismic Hazard Report, AREVA Document Number 51-9218842-003

Individual certifying the statement(s): Certification may be documented using e-mail, telecom, "sign off" sheet, or inter-office memorandum. The form of documentation should specifically identify the information being certified.

Tori L. Robinson/ Tori L. Robinson	Design Engineering	3-21-14
Name	Department	Date

Peer Review: Prior to signing for certification, determine if a Peer Review is required per section 5.4[2](c). Indicate "N/A" if not required.

Fred Hopkins/ Fred Hopkins	Design Engineering	3-21-14
Name	Department	Date