Entergy

Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61N
St. Francisville, LA 70775

March 26, 2014

RBG-47453

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
11555 Rockville Pike,
Rockville. MD 20852

Subject: Entergy Operations Inc. Seismic Hazard and Screening Report (CEUS Sites), Response 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
River Bend Station – Unit 1
Docket No. 050-458
License No. NPF-47

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

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 and Screening Report within 1.5 years from the date of Reference 1.

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In Reference 2, the Nuclear Energy Institute (NEI) requested NRC agreement to delay submittal of the final CEUS Seismic Hazard Evaluation and Screening Reports 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, 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 River Bend Station 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 regarding this report, please contact Joseph A. Clark at 225-381-4177.

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 26, 2014.

Respectfully,

W. F. Mashburn

Willis F. Mashburn
Director – Engineering

WFM/dhw

Enclosure: Seismic Hazard Report and Screening Report for River Bend Station

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Seismic Hazard and Screening Report for River Bend 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, 2012a) 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, 2012a) requests that licensees and holders of construction permits under 10 CFR Part 50 revaluaterevaluate the seismic hazards at their sites against present-day NRC requirements. Depending on the comparison between the revaluated 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, 2012a) pertaining to NTTF Recommendation 2.1 for River Bend Station (RBS), located in West Feliciana Parish, Louisiana. 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 RBS 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, 2012a) and following the guidance provided in the SPID (EPRI, 2013a), a seismic hazard reevaluation 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 Revaluation

The RBS site in West Feliciana Parish is located approximately 3 miles southeast of St. Francisville, Louisiana, and approximately 24 miles northwest of Baton Rouge. The site lies within the Southern Hills section of the Gulf Coastal Plain physiographic province approximately 85 miles from the Gulf of Mexico. The site is underlain by sediments consisting of loess, silts, clays, sands, Citronelle buried channel deposits, and Pascagoula clays. No faults have been identified within the sedimentary sequence within 5 miles of the site to a depth of about 13,500 feet. There are no shears, joints, fractures, or folds in the sediments immediately beneath or in the area surrounding the plant area. There are no natural features (e.g., tectonic depressions or cavernous or karstic terrain) which could cause subsidence at this site. In addition, investigations have determined that no capable faults exist at RBS. (Entergy, 1987)

The RBS site is located in an area of infrequent and low seismicity, typified by shallow focus earthquakes. The maximum historical earthquake in the Gulf Coast Basin tectonic province, for design purposes, is considered to be the Donaldsonville earthquake of epicentral Modified Mercalli Intensity Scale of 1931 Intensity VI. The Donaldsonville and New Madrid earthquakes are considered to be the only earthquakes important to the site and were felt at the site with Intensity IV and IV-V on the Modified Mercalli Intensity Scale of 1931, respectively. No surface faulting was found within a 5 mile radius of the site. Since the underlying soil conditions at the site are average to good, as evidenced by the average seismic shear wave velocity values of 1,000 ft./sec to 1,220 ft./sec (increase with depth) at the site, the resulting ground motion is estimated for RBS to be 0.07g. This acceleration is essentially due to body-wave motion, associated with high frequencies of about several cycles per second or more and should be of short duration, on the order of several seconds. The maximum horizontal ground acceleration value for the SSE is assumed to be 0.10g for design purposes, which is the minimum value as established by the NRC 10 CFR Part 100. (Entergy, 1987)

2.1 Regional and Local Geology

The RBS site is located in the Southern Hills section of the Gulf Coastal Plain physiographic province. This province extends 500 miles inland from the coast to include the Mississippi Embayment Section north of the site. The physiographic provinces nearest the site are the Ouachita province located 250 miles to the northwest and the Appalachian Plateaus, Valley and Ridge, and Piedmont provinces located approximately 275 miles to the northeast. Coastal Plain sediments, which unconformably overlie the Paleozoic rocks, consist of unconsolidated deposits of Mesozoic and Cenozoic age. The predominant physiographic feature is the Mississippi River. The site is situated in southern Louisiana near the axis of the Mississippi Structural Trough, which trends essentially north-south through the Gulf Coastal Plain near the present Mississippi River course. Deposition is continuing in the Gulf Coast basin, particularly near the axis of the Gulf Coast geosyncline which extends along the coastal area of Louisiana and Texas. The sedimentary thickness exceeds 50,000 ft. along the geosynclinal axis. Significant structural features within the site region include the Sabine, Monroe, Jackson, and Wiggins Uplifts, the Mississippi Embayment, and the Desha Basin. (Entergy, 1987)

The plant area is situated on the uplands adjacent to the Mississippi Alluvial Valley. These uplands are composed of the fluvial deposits of the Pliocene-Pleistocene Citronelle Formation and the Pleistocene Port Hickey Terrace Formation with a thin blanket of overlying loess. The Citronelle Formation is underlain by hard Pascagoula clay. The site is underlain by approximately 27,000 ft. of predominantly unindurated sand, clay, gravel, and marl of Mesozoic and Cenozoic age, unconformably overlying Paleozoic rocks. The site is situated within the Gulf Coast Basin tectonic province. As defined in 10 CFR 100, Appendix A, no zone has been identified requiring detailed faulting investigations at the site; however, investigations have determined that no capable faults exist at the site. (Entergy, 1987)

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, 2012a) 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, 2012a). (EPRI, 2014)

For the PSHA, the CEUS-SSC background seismic sources out to a distance of 400 miles (640 km) around RBS 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

RBS is located within the Gulf region of the CEUS approximately 260 km from the mid-continent region border. For each of the above background sources, the Gulf version of the updated CEUS EPRI GMM was 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 (60%) and mid-continent (40%) GMMs were used to model the seismic wave travel path. These percentages represent conservative estimates of the relative fraction of the travel path through these regions from source to site. For the Charleston RLME source, a combination of Gulf (30%) and mid-continent (70%) GMMs were 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 in Section 2.3.7 at the Safe Shutdown Earthquake (SSE) control point elevation. (EPRI, 2014)

2.3 Site Response Evaluation

Following the guidance contained in Seismic Enclosure 1 of the 50.54(f) Request for Information (U.S. NRC, 2012a) 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 RBS. (EPRI, 2014)

2.3.1 Description of Subsurface Material

RBS is located about 24 miles (39 km) northwest of Baton Rouge, Louisiana on the Uplands complex adjacent to the Mississippi alluvial valley. The site is in the Southern Hills physiographic section of the Gulf Coastal Plain physiographic province. The plant area is situated 1.9 miles (3.3 km) northeast of the east bank of the Mississippi River adjacent to the Deltaic physiographic province. In the site vicinity, the Uplands are composed of Pliocene-Pleistocene fluvial deposits with an overlying blanket of loess. (Entergy, 1987)

The basic information used to create the site geologic profile at RBS is shown in Tables 2.3.1-1 and 2.3.1-2. This profile was developed using information documented in (Entergy, 1987). The SSE Control Point for the Reactor building is defined at elevation 65 ft. (20 m) in sand and clay layers. Paleozoic basement rocks are at about 27,000 ft. (8,200 m). (EPRI, 2014)

The following description of the general geology of the site is taken from the Updated Safety Analysis Report (USAR) (Entergy, 1987):

The near surface stratigraphy consists of about 8 ft. (2.4 m) of loess over the Pleistocene Port Hickey Top Stratum and terrace deposits 60 ft. (18 m) thick. Beneath these strata are silty sands, sands, clays, and gravels of the Pliocene Citronelle Formation and the hard clay of the Pascagoula Formation. The Pascagoula Formation was the oldest formation encountered by borings in the site area. The Grand Gulf – Fleming Group is approximately 6,500 ft. (2,000 m) thick at the site. The strata underlying the site consist of a thick and stratigraphically complex sequence of relatively flat lying sediments that are part of the Gulf Coast geosyncline. These sediments are about 20,000 ft. (6,000 m) thick and unconformably overlie a sequence or rocks composed mainly of Mesozoic limestone. The Paleozoic basement rock was estimated to be at a depth of about 27,000 ft. (8,200 m).

Table 2.3.1-1 Summary of Geotechnical Profile for RBS. (Entergy, 1987)

Elevation, (ft. above mean sea level)	Soil Description	Density, (lb./cu ft.)	"P" wave velocity, (ft./sec)	"S" wave velocity, (ft./sec)	Poisson's Ratio
108 to 100	Loess	130	1,100		
100 to 90	Port Hickey Top Stratum Silts and Clays	130	2,000		
90 to 40 (water table at el 57)	Sands and Clayey Sands	130	5,500 (values measured at el. 48)	1,000	0.483
40 to 20	Citronelle Sands and Gravelly Sands	130	5,600	1,050	0.482
20 to -40	Citronelle Buried Channel Deposits Sands and Gravelly Sands	130	5,970	1,170	0.480
-40 to -102	Pascagoula Clays	130	5,970	1,220	0.478

FROM: Updated Safety Analysis Report (USAR) Table 2.5-11 (Entergy, 1987), Summary of Average Velocity and Moduli Data Corresponding to Geologic Zones for Borings 113, 135, 136, 137, 138, and 109.

Table 2.3.1-2 Summary of Geotechnical Profile for RBS Geotechnical Profile 2. (Entergy, 1987)

Elevation, (ft. above mean sea level)	Soil Description	Density, (lb./cu ft.)	"P" wave velocity, (ft./sec)	"S" wave velocity, (ft./sec)	Poisson's Ratio
108 to 100	Loess	130	1,400		
100 to 90	Port Hickey Top Stratum Silts and Clays	130	2,000		
90 to 39 (water table at el 57)	Sands and Clayey Sands	130	5,500 (values measured at el 49)	1,050	0.481
39 to 20	Citronelle Sands and Gravelly Sands	130	5,750	1,050	0.483
20 to -40	Citronelle Buried Channel Deposits Sands and Gravelly Sands	130	6,080	1,170	0.481
-40 to -91	Pascagoula Clays	130	5,970	1,125	0.482

FROM: USAR Table 2.5-12 (Entergy, 1987), Summary of Average Velocity and Moduli Data Corresponding to Geologic Zones for Borings 280, 251, 252, 253, and 254.

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

Tables 2.3.1-1 and 2.3.1-2 show the recommended shear-wave velocities and unit weights versus elevation for the best estimate single profile to an elevation of -102 ft. (-31 m). This elevation is at a depth of 165 ft. (50 m) below the SSE Control Point. Geophysical measurements, including seismic refraction, downhole, uphole and cross-hole were performed. The deepest boring shear-wave velocities around 1200 ft./s (365 m/s) in the Pascagoula clay were measured (Entergy, 1987). Recommended shear-wave velocities listed in Table 2.3.1-1 were taken as the mean base-case profile (P1) in the top 165 ft. (50 m). Beneath this depth the profile was extended to a depth of 4,000 ft. (1,219 m) using the SPID (EPRI, 2013a) profile where Vs30 equals 270 m/sec (886 ft./s). Epistemic uncertainty taken over the roughly 4,000 ft. (1,219 m) of the profile was considered to reflect an adequate range in period for the amplification calculation. (EPRI, 2014)

Lower (P2)- and upper (P3)- range profiles were developed with scale factors of 1.25 reflecting uncertainty in measured velocities to a depth of 165 ft. (50 m). Beneath these depths a factor of 1.57 was assumed to reflect increased epistemic uncertainty from the assumed shear-wave velocities. 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) 10th and 90th 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. (366m). The three shear-wave velocity profiles are shown in Figure 2.3.2-1 and listed in Table 2.3.2-1. (EPRI, 2014)

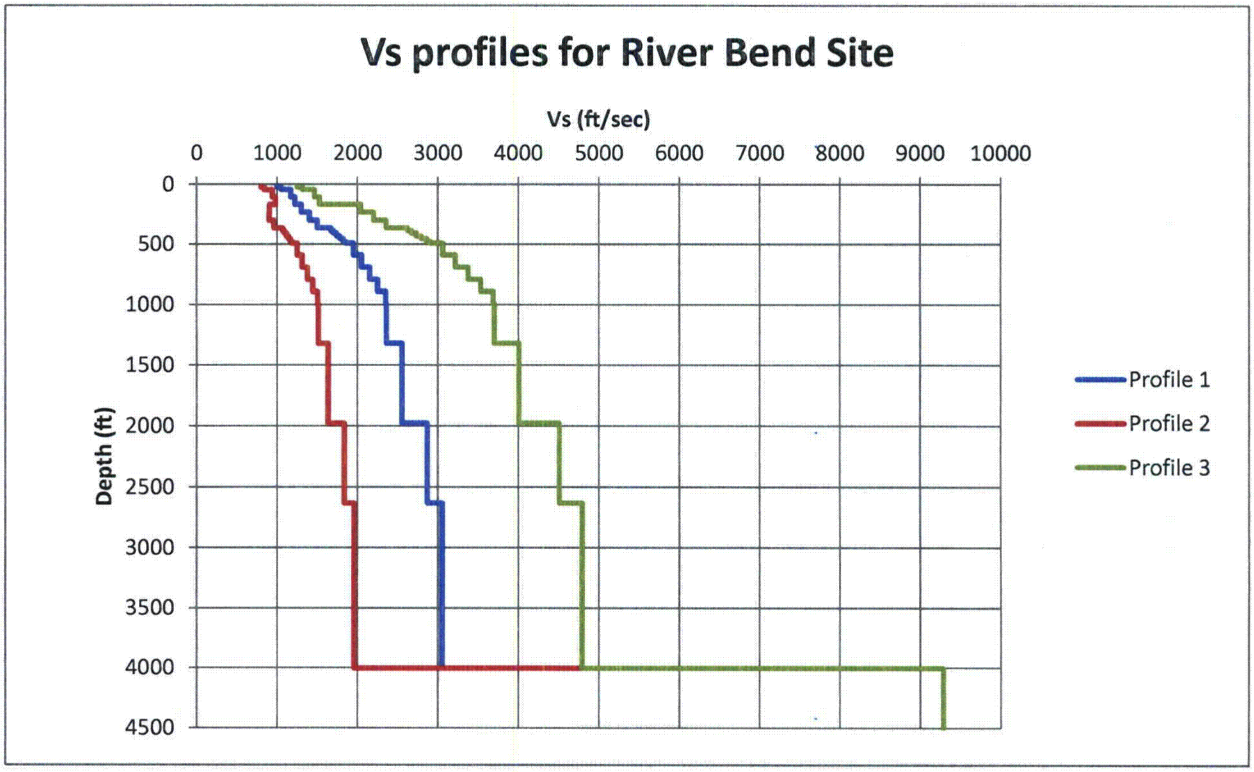


Figure 2.3.2-1. Shear-wave velocity profiles for RBS. (EPRI, 2014)

Table 2.3.2-1. Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, RBS. (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	1,000		0	800		0	1,250
5.0	5.0	1,000	5.0	5.0	800	5.0	5.0	1,250
10.0	15.0	1,000	10.0	15.0	800	10.0	15.0	1,250
5.0	20.0	1,000	5.0	20.0	800	5.0	20.0	1,250
5.0	25.0	1,000	5.0	25.0	800	5.0	25.0	1,250
10.0	35.0	1,050	10.0	35.0	840	10.0	35.0	1,312
10.0	45.0	1,050	10.0	45.0	840	10.0	45.0	1,312
5.0	50.0	1,170	5.0	50.0	936	5.0	50.0	1,462
15.0	65.0	1,170	15.0	65.0	936	15.0	65.0	1,462
10.0	75.0	1,170	10.0	75.0	936	10.0	75.0	1,462
10.0	85.0	1,170	10.0	85.0	936	10.0	85.0	1,462
10.0	95.0	1,170	10.0	95.0	936	10.0	95.0	1,462
10.0	105.0	1,170	10.0	105.0	936	10.0	105.0	1,462
10.3	115.3	1,220	10.3	115.3	976	10.3	115.3	1,525
4.7	120.0	1,220	4.7	120.0	976	4.7	120.0	1,525
16.0	136.0	1,220	16.0	136.0	976	16.0	136.0	1,525
10.3	146.3	1,220	10.3	146.3	976	10.3	146.3	1,525
10.3	156.6	1,220	10.3	156.6	976	10.3	156.6	1,525
10.3	167.0	1,220	10.3	167.0	976	10.3	167.0	1,525
13.1	180.1	1,299	13.1	180.1	902	13.1	180.1	2,040
13.1	193.2	1,299	13.1	193.2	902	13.1	193.2	2,040
13.1	206.3	1,299	13.1	206.3	902	13.1	206.3	2,040
13.1	219.5	1,299	13.1	219.5	902	13.1	219.5	2,040
13.1	232.6	1,299	13.1	232.6	902	13.1	232.6	2,040
13.1	245.7	1,401	13.1	245.7	897	13.1	245.7	2,199
4.3	250.0	1,401	4.3	250.0	897	4.3	250.0	2,199
22.0	272.0	1,401	22.0	272.0	897	22.0	272.0	2,199
13.1	285.1	1,401	13.1	285.1	897	13.1	285.1	2,199
13.1	298.2	1,401	13.1	298.2	897	13.1	298.2	2,199
13.1	311.3	1,499	13.1	311.3	960	13.1	311.3	2,354
13.1	324.5	1,499	13.1	324.5	960	13.1	324.5	2,354
13.1	337.6	1,499	13.1	337.6	960	13.1	337.6	2,354
13.1	350.7	1,499	13.1	350.7	960	13.1	350.7	2,354
13.1	363.8	1,499	13.1	363.8	960	13.1	363.8	2,354
22.0	385.9	1,670	22.0	385.9	1,069	22.0	385.9	2,622
22.0	407.9	1,700	22.0	407.9	1,088	22.0	407.9	2,669
22.9	430.8	1,740	22.9	430.8	1,114	22.9	430.8	2,732

Table 2.3.2-1. Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, RBS. (Continued) (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)
22.9	453.8	1,780	22.9	453.8	1,139	22.9	453.8	2,795
22.9	476.7	1,820	22.9	476.7	1,165	22.9	476.7	2,857
14.8	491.5	1,850	14.8	491.5	1,184	14.8	491.5	2,905
8.5	500.0	1,950	8.5	500.0	1,248	8.5	500.0	3,062
58.4	558.4	1,950	58.4	558.4	1,248	58.4	558.4	3,062
33.3	591.7	1,950	33.3	591.7	1,248	33.3	591.7	3,062
33.3	625.0	2,050	33.3	625.0	1,312	33.3	625.0	3,219
33.3	658.4	2,050	33.3	658.4	1,312	33.3	658.4	3,219
33.3	691.7	2,050	33.3	691.7	1,312	33.3	691.7	3,219
33.3	725.0	2,150	33.3	725.0	1,376	33.3	725.0	3,376
33.3	758.4	2,150	33.3	758.4	1,376	33.3	758.4	3,376
33.3	791.7	2,150	33.3	791.7	1,376	33.3	791.7	3,376
33.3	825.0	2,250	33.3	825.0	1,440	33.3	825.0	3,533
33.3	858.4	2,250	33.3	858.4	1,440	33.3	858.4	3,533
33.3	891.7	2,250	33.3	891.7	1,440	33.3	891.7	3,533
33.3	925.0	2,350	33.3	925.0	1,504	33.3	925.0	3,690
33.3	958.4	2,350	33.3	958.4	1,504	33.3	958.4	3,690
33.3	991.7	2,350	33.3	991.7	1,504	33.3	991.7	3,690
65.6	1,057.3	2,359	65.6	1,057.3	1,510	65.6	1,057.3	3,704
65.6	1,122.9	2,359	65.6	1,122.9	1,510	65.6	1,122.9	3,704
65.6	1,188.6	2,359	65.6	1,188.6	1,510	65.6	1,188.6	3,704
65.6	1,254.2	2,359	65.6	1,254.2	1,510	65.6	1,254.2	3,704
65.6	1,319.8	2,359	65.6	1,319.8	1,510	65.6	1,319.8	3,704
131.2	1,451.0	2,552	131.2	1,451.0	1,634	131.2	1,451.0	4,007
131.2	1,582.3	2,552	131.2	1,582.3	1,634	131.2	1,582.3	4,007
131.2	1,713.5	2,552	131.2	1,713.5	1,634	131.2	1,713.5	4,007
131.2	1,844.7	2,552	131.2	1,844.7	1,634	131.2	1,844.7	4,007
131.2	1,976.0	2,552	131.2	1,976.0	1,634	131.2	1,976.0	4,007
131.2	2,107.2	2,871	131.2	2,107.2	1,837	131.2	2,107.2	4,507
131.2	2,238.4	2,871	131.2	2,238.4	1,837	131.2	2,238.4	4,507
131.2	2,369.7	2,871	131.2	2,369.7	1,837	131.2	2,369.7	4,507
131.2	2,500.9	2,871	131.2	2,500.9	1,837	131.2	2,500.9	4,507
131.2	2,632.1	2,871	131.2	2,632.1	1,837	131.2	2,632.1	4,507
164.0	2,796.2	3,054	164.0	2,796.2	1,955	164.0	2,796.2	4,795
164.0	2,960.2	3,054	164.0	2,960.2	1,955	164.0	2,960.2	4,795
164.0	3,124.3	3,054	164.0	3,124.3	1,955	164.0	3,124.3	4,795

Table 2.3.2-1. Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, RBS. (Continued) (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	3,288.3	3,054	164.0	3,288.3	1,955	164.0	3,288.3	4,795
164.0	3,452.3	3,054	164.0	3,452.3	1,955	164.0	3,452.3	4,795
552.5	4,004.8	3,054	552.5	4,004.8	1,955	552.5	4,004.8	4,795
3280.8	7,285.7	9,285	3,280.8	7,285.7	9,285	3,280.8	7,285.7	9,285

2.3.2.1 Shear Modulus and Damping Curves

Site-specific nonlinear dynamic material properties were not available for RBS. 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 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 Peninsular Range (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 CEUS deep-soil (greater than 3,000 ft. (1,000 m)) site. Kappa for a soil site with greater than 3,000 ft. (1 km) is assumed to be the maximum kappa 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 RBS, 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 RBS 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 RBS, 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 RBS. (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 RBS 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)

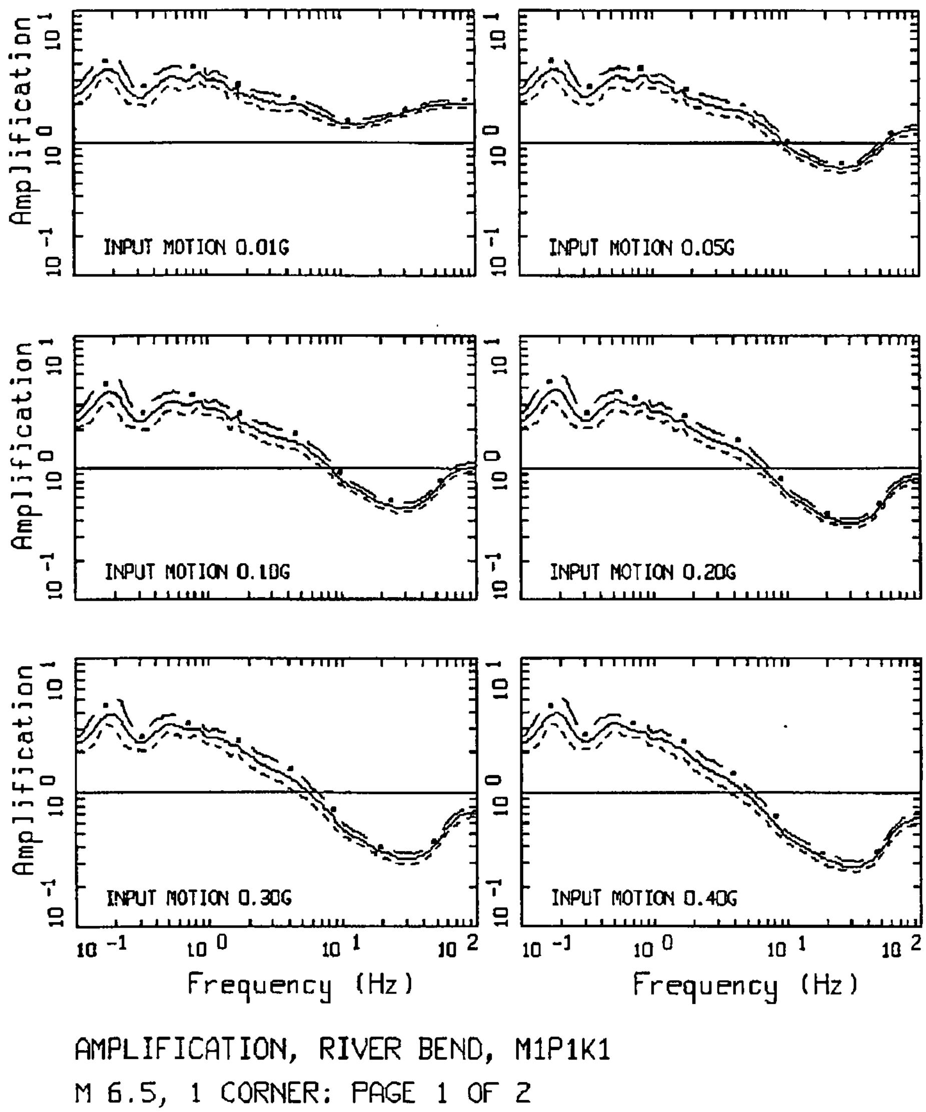
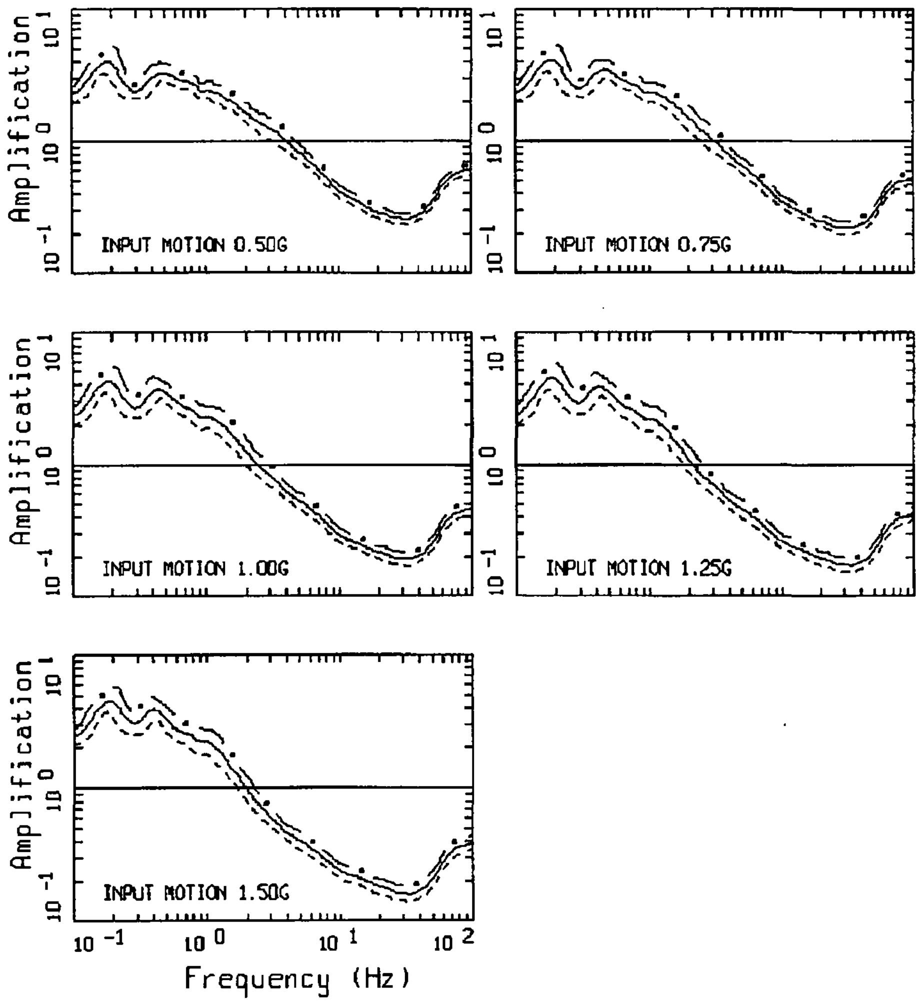


Figure 2.3.6-1. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI soil modulus reduction and hysteretic damping curves (model M1), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g. M 6.5 and single-corner source model (EPRI, 2013a). (EPRI, 2014)



AMPLIFICATION, RIVER BEND, M1P1K1
M 6.5, 1 CORNER: PAGE 2 OF 2

Figure 2.3.6-1.(cont.)

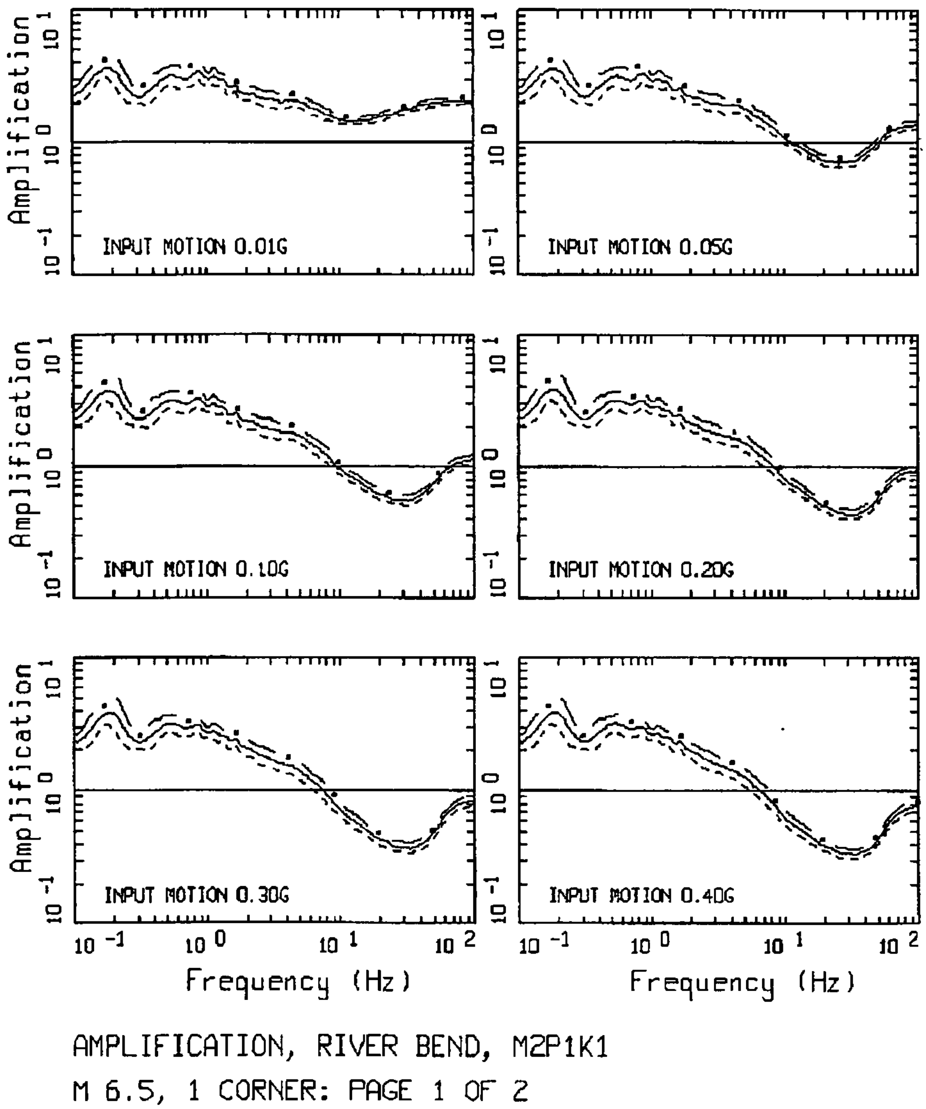
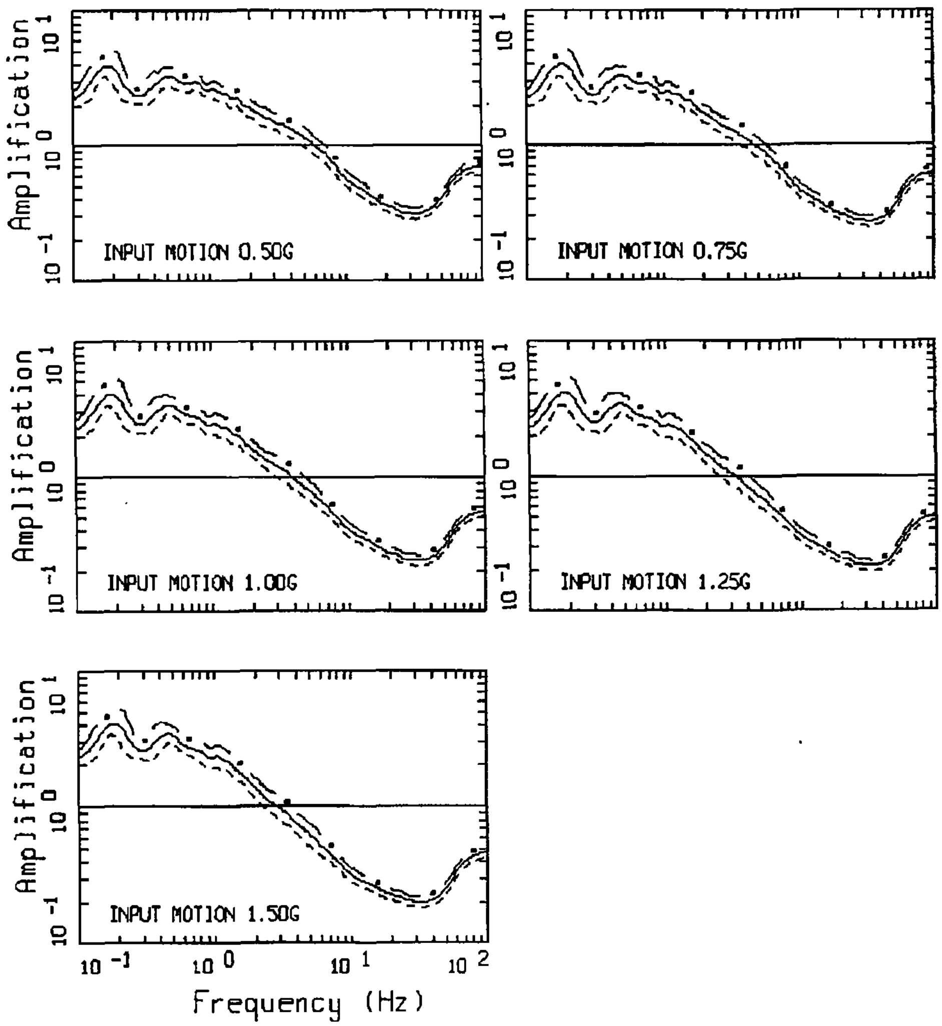


Figure 2.3.6-2. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), Peninsular Range curves for soil (model M2), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g. M 6.5 and single-corner source model (EPRI, 2013a). (EPRI, 2014)



AMPLIFICATION, RIVER BEND, 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 RBS 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)

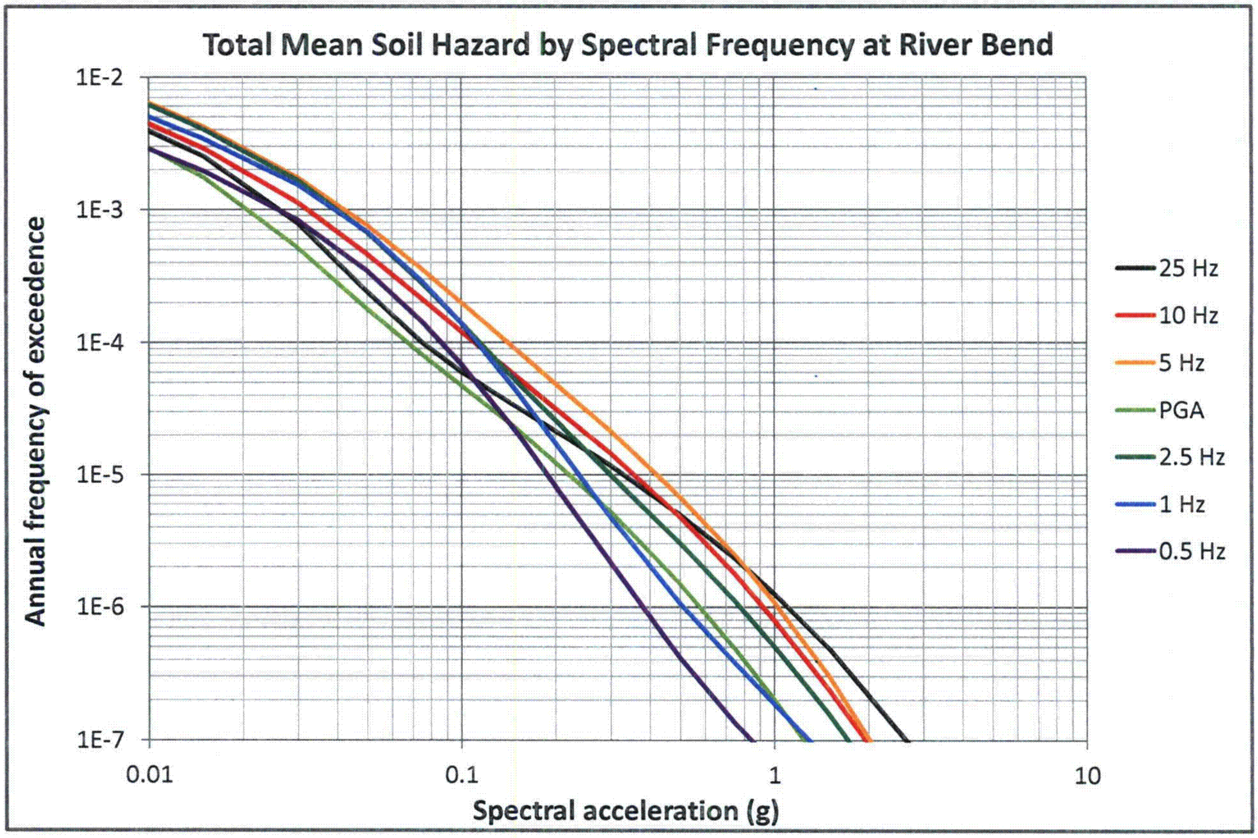


Figure 2.3.7-1. Control point mean hazard curves for spectral frequencies of 0.5, 1.0, 2.5, 5.0, 10, 25 and PGA (100) Hz at RBS. (EPRI, 2014)

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 RBS. (EPRI, 2014)

Frequency (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS (g)
100	6.76E-02	2.22E-01	1.05E-01
90	6.77E-02	2.27E-01	1.07E-01
80	6.78E-02	2.34E-01	1.09E-01
70	6.80E-02	2.41E-01	1.12E-01
60	6.83E-02	2.51E-01	1.16E-01
50	6.87E-02	2.62E-01	1.20E-01
40	6.96E-02	2.79E-01	1.27E-01
35	7.05E-02	2.90E-01	1.31E-01
30	7.21E-02	3.06E-01	1.38E-01
25	7.51E-02	3.30E-01	1.49E-01
20	7.92E-02	3.23E-01	1.46E-01
15	8.97E-02	3.31E-01	1.53E-01
12.5	9.89E-02	3.49E-01	1.63E-01
10	1.11E-01	3.58E-01	1.70E-01
9	1.17E-01	3.69E-01	1.76E-01
8	1.23E-01	3.85E-01	1.84E-01
7	1.31E-01	3.97E-01	1.91E-01
6	1.38E-01	4.15E-01	2.00E-01
5	1.41E-01	4.22E-01	2.03E-01
4	1.35E-01	3.87E-01	1.88E-01
3.5	1.31E-01	3.66E-01	1.79E-01
3	1.24E-01	3.35E-01	1.65E-01
2.5	1.15E-01	3.00E-01	1.49E-01
2	1.21E-01	3.00E-01	1.50E-01
1.5	1.18E-01	2.78E-01	1.41E-01
1.25	1.18E-01	2.63E-01	1.35E-01
1	1.13E-01	2.38E-01	1.23E-01
0.9	1.13E-01	2.37E-01	1.23E-01
0.8	1.10E-01	2.36E-01	1.21E-01
0.7	1.01E-01	2.19E-01	1.12E-01
0.6	9.44E-02	2.04E-01	1.05E-01
0.5	8.65E-02	1.89E-01	9.69E-02

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

Frequency (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS (g)
0.4	6.92E-02	1.51E-01	7.75E-02
0.35	6.06E-02	1.32E-01	6.78E-02
0.3	5.19E-02	1.13E-01	5.81E-02
0.25	4.33E-02	9.44E-02	4.85E-02
0.2	3.46E-02	7.55E-02	3.88E-02
0.15	2.60E-02	5.66E-02	2.91E-02
0.125	2.16E-02	4.72E-02	2.42E-02
0.1	1.73E-02	3.78E-02	1.94E-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. (EPRI, 2014)

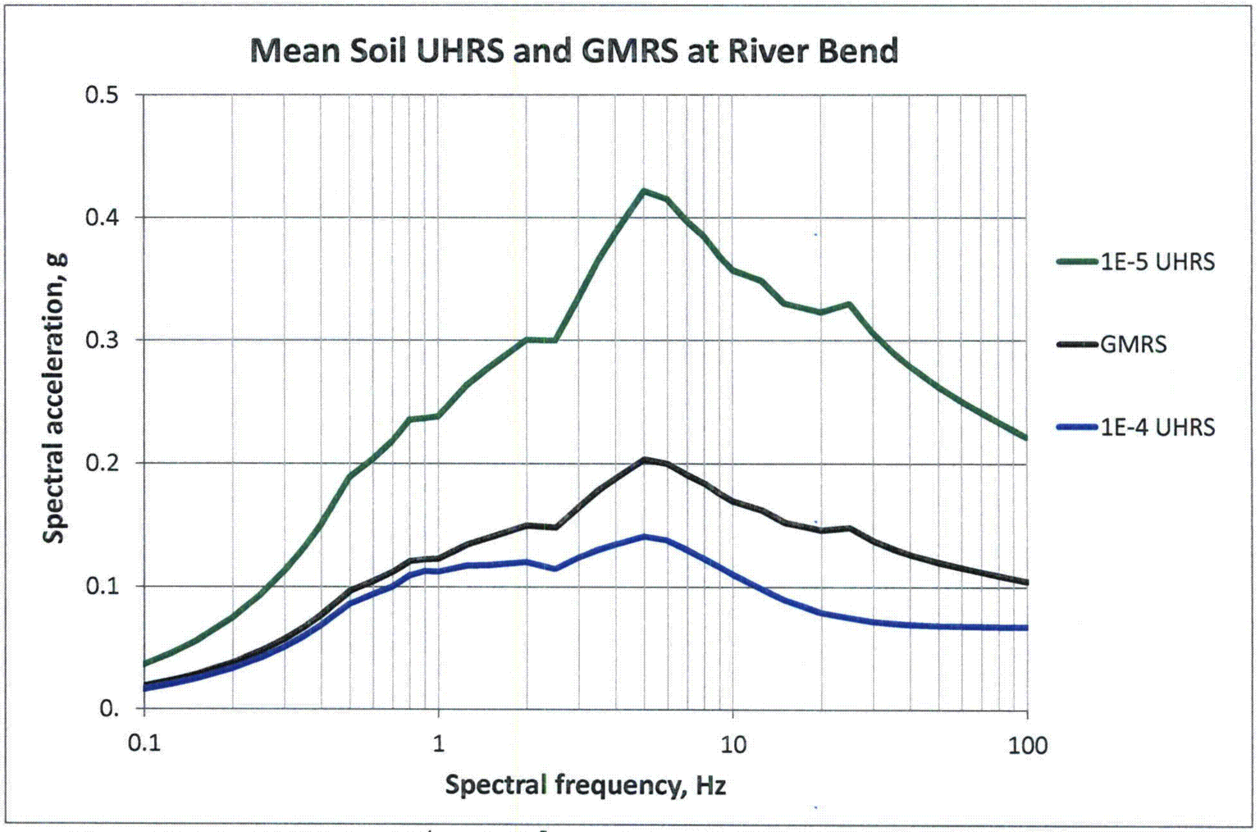


Figure 2.4-1. UHRS for 10^{-4} and 10^{-5} and GMRS at control point for RBS (5%-damped response spectra). (EPRI, 2014)

3.0 Plant Design Basis and Beyond Design Basis Evaluation Ground Motion

The design basis for RBS is identified in the Updated Safety Analysis Report (Entergy, 1987) and other pertinent documents.

3.1 SSE Description of Spectral Shape

The maximum horizontal ground acceleration value for the SSE of VI on the Modified Mercalli Intensity Scale of 1931 at the foundations of RBS is 0.07g. The maximum horizontal ground acceleration value for the SSE is assumed to be 0.10g for design purposes, which is the minimum value as established by the NRC 10 CFR Part 100. (Entergy, 1987)

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, 1987)

Table 3.1-1. SSE for RBS (Entergy, 1987)

Frequency (Hz)	100	33	25	10	9	5	2.5	1	0.5
SA (g)	0.1	0.1	0.14	0.24	0.25	0.29	0.31	0.16	0.084

3.2 Control Point Elevation

The SSE control point elevation is defined at elevation 65 ft. This represents the elevation of the bottom of the foundations for the Auxiliary, Control, and Diesel Generator Building, which are the highest safety-related buildings at RBS (EPRI, 2013a).

3.3 IPEEE Description and Capacity Response Spectrum

The Individual Plant Examination of External Events (IPEEE) was performed as a reduced scope. As discussed below, RBS screens-out from performing further risk evaluations. Therefore, 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, RBS 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)

For a portion of the range above 10 Hz, the 5% damping GMRS exceeds the 5% damping SSE spectrum by less than 7%. The maximum accelerations in the GMRS exceedance frequency range are 0.15g or less. Furthermore, the 5% damping spectrum of the time history used to derive seismic responses for all safety related SSCs, envelopes with some margin the SSE 5% spectrum in the exceedance frequency range as shown in Figure 3.7A-15 of the USAR (Entergy, 1987). It is also noted that the RBS soil-spring systems have natural frequencies in the 1.6 Hz to 2.0 frequency range, with the highest mode participating in the response being at 10 Hz. As shown in Attachment E of "Peak Spread ARS for Seismic Events Including Curves with N-411-1 Damping (Entergy, 1989)," the floor response spectra become quasi-steady state above 10 Hz. Thus, the seismic high frequency content is filtered out by the soil-structure systems.

Considering the very low accelerations in the high frequency range, the fact that high frequency susceptible components were designed/assessed for acceleration levels higher than the SSE accelerations in the high frequency range and frequency content above 10 Hz is filtered out by the soil-structure systems, no further high frequency assessments are considered to be required.

Therefore, a 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 (EPRI, 2013b) will not be performed.

Consistent with NRC letter (ML14030A046) dated February 20, 2014 (U.S. NRC, 2014), the seismic hazard revaluations presented herein are distinct from the current design and licensing bases of RBS. Therefore, the results do not call into question the operability or functionality of SSCs and are not reportable pursuant to10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors," and 10 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 revaluaterevaluated 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 Generic Issue (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.

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

In accordance with the Near-Term Task Force Recommendation 2.3 (U.S. NRC, 2014), RBS performed seismic walkdowns using the guidance in EPRI Report 1025286 (EPRI, 2012). The seismic walkdowns were completed and captured in Fukushima Seismic Walkdown Report RBS-CS-12-00001 (U.S. NRC, 2012b) (U.S. NRC, 2013b) (U.S. NRC, 2013c). 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 RBS can adequately respond to a seismic event.

6.0 Conclusions

In accordance with the 50.54(f) request for information (U.S. NRC, 2012a), a seismic hazard and screening evaluation was performed for RBS. 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.

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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.

Toro (1997). Appendix of: Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C. (1997). "Description and Validation of the Stochastic Ground Motion Model," Report Submitted to Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973, Contract No. 770573.

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U.S. NRC (2010). "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," ML100270598, GI-199, September 2, 2010.

U.S. NRC (2012a). 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 (2012b). "Entergy River Bend Station Seismic Walkdown Report for Resolution of Fukushima Near-Term Task Force Recommendation 2.3: Seismic," ML123420135, Revision 0, November 14, 2012.

U.S. NRC (2013a). NRC Letter from E. Leeds to J. Pollock, "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," May 7, 2013.

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Appendix A

Tabulated Data

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.26E-02	1.46E-02	2.25E-02	3.23E-02	4.31E-02	5.05E-02
0.001	2.14E-02	8.85E-03	1.38E-02	2.04E-02	2.92E-02	3.57E-02
0.005	5.82E-03	1.84E-03	3.19E-03	5.27E-03	8.35E-03	1.16E-02
0.01	2.94E-03	7.66E-04	1.29E-03	2.42E-03	4.56E-03	6.93E-03
0.015	1.75E-03	4.31E-04	6.73E-04	1.31E-03	2.76E-03	4.77E-03
0.03	5.20E-04	1.15E-04	1.82E-04	3.52E-04	7.13E-04	1.62E-03
0.05	1.80E-04	3.23E-05	5.75E-05	1.23E-04	2.60E-04	5.50E-04
0.075	8.15E-05	1.21E-05	2.42E-05	5.50E-05	1.31E-04	2.49E-04
0.1	4.80E-05	5.75E-06	1.34E-05	3.14E-05	8.00E-05	1.51E-04
0.15	2.26E-05	2.04E-06	5.91E-06	1.44E-05	3.79E-05	7.23E-05
0.3	5.30E-06	2.72E-07	1.16E-06	3.14E-06	8.60E-06	1.77E-05
0.5	1.50E-06	5.05E-08	2.72E-07	8.47E-07	2.39E-06	5.05E-06
0.75	4.86E-07	1.11E-08	6.54E-08	2.60E-07	7.89E-07	1.72E-06
1.	2.05E-07	3.19E-09	2.10E-08	1.01E-07	3.33E-07	7.55E-07
1.5	5.56E-08	5.12E-10	3.42E-09	2.29E-08	8.85E-08	2.19E-07
3.	4.45E-09	1.21E-10	2.13E-10	1.21E-09	6.26E-09	2.13E-08
5.	5.04E-10	1.11E-10	1.32E-10	2.10E-10	7.45E-10	2.84E-09
7.5	7.22E-11	1.11E-10	1.21E-10	1.72E-10	2.19E-10	5.35E-10
10.	1.64E-11	1.11E-10	1.21E-10	1.72E-10	1.72E-10	2.32E-10

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.46E-02	1.82E-02	2.57E-02	3.42E-02	4.43E-02	5.12E-02
0.001	2.36E-02	1.11E-02	1.62E-02	2.25E-02	3.14E-02	3.84E-02
0.005	7.21E-03	2.68E-03	4.07E-03	6.54E-03	1.01E-02	1.42E-02
0.01	3.93E-03	1.20E-03	1.87E-03	3.33E-03	5.91E-03	8.72E-03
0.015	2.52E-03	7.03E-04	1.08E-03	1.98E-03	3.95E-03	6.36E-03
0.03	7.91E-04	1.92E-04	2.96E-04	5.58E-04	1.15E-03	2.32E-03
0.05	2.42E-04	5.20E-05	8.98E-05	1.77E-04	3.42E-04	6.64E-04
0.075	1.00E-04	1.87E-05	3.68E-05	7.66E-05	1.57E-04	2.68E-04
0.1	6.05E-05	9.93E-06	2.22E-05	4.63E-05	9.93E-05	1.64E-04
0.15	3.28E-05	4.13E-06	1.18E-05	2.46E-05	5.35E-05	9.11E-05
0.3	1.17E-05	8.98E-07	4.13E-06	8.72E-06	1.84E-05	3.33E-05
0.5	4.99E-06	2.96E-07	1.69E-06	3.63E-06	7.66E-06	1.49E-05
0.75	2.31E-06	1.15E-07	7.23E-07	1.67E-06	3.52E-06	6.93E-06
1.	1.26E-06	5.20E-08	3.57E-07	8.85E-07	1.95E-06	3.79E-06
1.5	4.84E-07	1.72E-08	1.11E-07	3.19E-07	7.66E-07	1.46E-06
3.	7.04E-08	1.84E-09	1.01E-08	3.90E-08	1.20E-07	2.35E-07
5.	1.30E-08	3.14E-10	1.32E-09	6.00E-09	2.19E-08	4.90E-08
7.5	2.87E-09	1.40E-10	3.01E-10	1.18E-09	4.83E-09	1.21E-08
10.	8.94E-10	1.21E-10	1.77E-10	4.01E-10	1.51E-09	4.01E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.92E-02	2.39E-02	3.05E-02	3.90E-02	4.83E-02	5.50E-02
0.001	2.77E-02	1.51E-02	1.98E-02	2.68E-02	3.57E-02	4.19E-02
0.005	8.39E-03	3.73E-03	5.20E-03	7.89E-03	1.15E-02	1.49E-02
0.01	4.46E-03	1.67E-03	2.42E-03	4.01E-03	6.45E-03	8.72E-03
0.015	2.90E-03	9.79E-04	1.42E-03	2.46E-03	4.37E-03	6.36E-03
0.03	1.13E-03	3.37E-04	4.83E-04	8.60E-04	1.72E-03	2.88E-03
0.05	4.66E-04	1.27E-04	1.92E-04	3.47E-04	6.54E-04	1.21E-03
0.075	2.13E-04	5.05E-05	8.47E-05	1.62E-04	3.05E-04	5.42E-04
0.1	1.21E-04	2.46E-05	4.56E-05	9.37E-05	1.84E-04	3.05E-04
0.15	5.57E-05	8.85E-06	1.87E-05	4.19E-05	9.11E-05	1.51E-04
0.3	1.46E-05	1.34E-06	4.07E-06	1.02E-05	2.42E-05	4.37E-05
0.5	4.84E-06	3.19E-07	1.23E-06	3.14E-06	8.00E-06	1.46E-05
0.75	1.77E-06	8.47E-08	4.19E-07	1.13E-06	2.92E-06	5.35E-06
1.	7.99E-07	3.19E-08	1.77E-07	5.12E-07	1.32E-06	2.49E-06
1.5	2.38E-07	6.93E-09	4.25E-08	1.44E-07	3.95E-07	7.66E-07
3.	2.60E-08	3.95E-10	1.92E-09	1.15E-08	4.43E-08	9.93E-08
5.	4.48E-09	1.25E-10	2.39E-10	1.42E-09	7.45E-09	1.92E-08
7.5	9.76E-10	1.21E-10	1.64E-10	3.37E-10	1.60E-09	4.56E-09
10.	3.05E-10	1.11E-10	1.21E-10	1.90E-10	5.58E-10	1.53E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.72E-02	3.14E-02	3.79E-02	4.70E-02	5.66E-02	6.45E-02
0.001	3.67E-02	2.10E-02	2.68E-02	3.63E-02	4.63E-02	5.35E-02
0.005	1.21E-02	5.58E-03	7.66E-03	1.16E-02	1.67E-02	2.04E-02
0.01	6.39E-03	2.60E-03	3.79E-03	6.09E-03	8.98E-03	1.11E-02
0.015	4.20E-03	1.53E-03	2.29E-03	3.90E-03	6.09E-03	7.89E-03
0.03	1.75E-03	5.35E-04	8.00E-04	1.42E-03	2.68E-03	3.95E-03
0.05	7.61E-04	2.16E-04	3.19E-04	5.75E-04	1.11E-03	1.95E-03
0.075	3.56E-04	9.51E-05	1.46E-04	2.64E-04	4.98E-04	9.11E-04
0.1	2.01E-04	5.05E-05	8.12E-05	1.51E-04	2.80E-04	4.98E-04
0.15	8.87E-05	1.90E-05	3.42E-05	6.73E-05	1.32E-04	2.25E-04
0.3	2.15E-05	2.84E-06	6.73E-06	1.57E-05	3.52E-05	6.09E-05
0.5	6.84E-06	4.50E-07	1.34E-06	4.50E-06	1.16E-05	2.10E-05
0.75	2.45E-06	7.34E-08	2.80E-07	1.40E-06	4.37E-06	8.35E-06
1.	1.09E-06	1.87E-08	9.11E-08	5.27E-07	1.95E-06	3.95E-06
1.5	3.00E-07	2.49E-09	1.84E-08	1.08E-07	5.35E-07	1.21E-06
3.	2.37E-08	1.87E-10	6.09E-10	5.42E-09	3.84E-08	1.05E-07
5.	3.19E-09	1.21E-10	1.72E-10	6.09E-10	4.50E-09	1.42E-08
7.5	6.38E-10	1.11E-10	1.23E-10	1.95E-10	8.47E-10	3.01E-09
10.	1.99E-10	1.11E-10	1.21E-10	1.72E-10	3.19E-10	1.04E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.76E-02	3.23E-02	3.79E-02	4.70E-02	5.75E-02	6.45E-02
0.001	3.71E-02	2.19E-02	2.72E-02	3.68E-02	4.70E-02	5.50E-02
0.005	1.21E-02	5.66E-03	7.66E-03	1.15E-02	1.67E-02	2.04E-02
0.01	6.19E-03	2.57E-03	3.63E-03	5.83E-03	8.72E-03	1.10E-02
0.015	4.04E-03	1.44E-03	2.13E-03	3.73E-03	5.91E-03	7.66E-03
0.03	1.66E-03	4.37E-04	6.73E-04	1.34E-03	2.68E-03	3.95E-03
0.05	6.79E-04	1.53E-04	2.35E-04	4.77E-04	1.08E-03	1.87E-03
0.075	2.83E-04	5.91E-05	9.37E-05	1.92E-04	4.25E-04	8.47E-04
0.1	1.42E-04	2.88E-05	4.70E-05	9.79E-05	2.10E-04	4.25E-04
0.15	5.16E-05	9.93E-06	1.74E-05	3.63E-05	7.89E-05	1.46E-04
0.3	9.99E-06	1.31E-06	3.01E-06	7.03E-06	1.67E-05	2.84E-05
0.5	3.05E-06	2.19E-07	6.93E-07	1.95E-06	5.12E-06	9.37E-06
0.75	1.11E-06	4.31E-08	1.64E-07	6.17E-07	1.90E-06	3.73E-06
1.	5.10E-07	1.10E-08	4.70E-08	2.42E-07	8.72E-07	1.87E-06
1.5	1.58E-07	1.20E-09	5.50E-09	5.58E-08	2.72E-07	6.45E-07
3.	1.68E-08	1.21E-10	1.87E-10	2.64E-09	2.53E-08	7.77E-08
5.	2.67E-09	1.11E-10	1.46E-10	2.96E-10	3.23E-09	1.27E-08
7.5	5.55E-10	1.11E-10	1.21E-10	1.72E-10	6.00E-10	2.49E-09
10.	1.71E-10	1.11E-10	1.21E-10	1.72E-10	2.42E-10	8.12E-10

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.00E-02	2.19E-02	2.88E-02	4.01E-02	5.05E-02	5.83E-02
0.001	2.88E-02	1.36E-02	1.92E-02	2.84E-02	3.79E-02	4.50E-02
0.005	9.19E-03	3.68E-03	5.50E-03	8.72E-03	1.29E-02	1.60E-02
0.01	5.04E-03	1.60E-03	2.60E-03	4.70E-03	7.45E-03	9.51E-03
0.015	3.43E-03	8.47E-04	1.46E-03	3.09E-03	5.35E-03	7.23E-03
0.03	1.55E-03	2.16E-04	4.19E-04	1.18E-03	2.72E-03	4.19E-03
0.05	6.83E-04	6.54E-05	1.32E-04	4.19E-04	1.25E-03	2.16E-03
0.075	2.91E-04	2.25E-05	4.70E-05	1.49E-04	5.20E-04	1.02E-03
0.1	1.41E-04	1.01E-05	2.13E-05	6.54E-05	2.39E-04	5.12E-04
0.15	4.38E-05	3.05E-06	6.45E-06	1.98E-05	6.73E-05	1.64E-04
0.3	4.80E-06	3.28E-07	7.45E-07	2.35E-06	7.55E-06	1.74E-05
0.5	1.07E-06	4.98E-08	1.42E-07	5.05E-07	1.84E-06	3.95E-06
0.75	3.80E-07	8.98E-09	3.37E-08	1.55E-07	6.36E-07	1.51E-06
1.	1.89E-07	2.42E-09	1.13E-08	6.64E-08	3.05E-07	7.89E-07
1.5	7.00E-08	4.43E-10	2.22E-09	1.82E-08	1.08E-07	3.19E-07
3.	1.14E-08	1.31E-10	2.16E-10	1.49E-09	1.42E-08	5.42E-08
5.	2.56E-09	1.15E-10	1.60E-10	2.88E-10	2.60E-09	1.21E-08
7.5	6.93E-10	1.11E-10	1.21E-10	1.72E-10	6.54E-10	3.14E-09
10.	2.55E-10	1.11E-10	1.21E-10	1.72E-10	2.92E-10	1.16E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.35E-02	1.21E-02	1.62E-02	2.29E-02	3.05E-02	3.68E-02
0.001	1.53E-02	7.34E-03	1.01E-02	1.46E-02	2.04E-02	2.49E-02
0.005	5.06E-03	1.38E-03	2.46E-03	4.70E-03	7.66E-03	9.79E-03
0.01	2.89E-03	4.37E-04	9.51E-04	2.53E-03	4.83E-03	6.64E-03
0.015	1.97E-03	1.90E-04	4.63E-04	1.55E-03	3.52E-03	5.12E-03
0.03	8.34E-04	3.57E-05	9.93E-05	4.63E-04	1.62E-03	2.84E-03
0.05	3.48E-04	8.85E-06	2.53E-05	1.36E-04	6.54E-04	1.40E-03
0.075	1.44E-04	2.72E-06	7.66E-06	4.31E-05	2.46E-04	6.36E-04
0.1	6.92E-05	1.15E-06	3.14E-06	1.79E-05	1.08E-04	3.09E-04
0.15	2.14E-05	3.19E-07	8.85E-07	4.77E-06	2.92E-05	9.37E-05
0.3	2.17E-06	2.96E-08	9.65E-08	4.90E-07	2.84E-06	8.98E-06
0.5	4.16E-07	4.01E-09	1.67E-08	9.51E-08	5.91E-07	1.84E-06
0.75	1.36E-07	7.77E-10	3.68E-09	2.64E-08	1.84E-07	6.54E-07
1.	6.67E-08	2.92E-10	1.27E-09	1.04E-08	8.23E-08	3.37E-07
1.5	2.55E-08	1.72E-10	3.19E-10	2.60E-09	2.60E-08	1.32E-07
3.	4.52E-09	1.21E-10	1.62E-10	3.01E-10	3.01E-09	2.19E-08
5.	1.09E-09	1.11E-10	1.21E-10	1.72E-10	5.66E-10	4.70E-09
7.5	3.13E-10	1.11E-10	1.21E-10	1.72E-10	2.22E-10	1.27E-09
10.	1.20E-10	1.11E-10	1.21E-10	1.72E-10	1.72E-10	4.90E-10

Table A-2. Amplification Functions for RBS. (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	1.78E+00	8.85E-02	1.30E-02	1.38E+00	8.84E-02	1.90E-02	1.29E+00	1.03E-01	2.09E-02	1.86E+00	1.46E-01
4.95E-02	1.14E+00	9.87E-02	1.02E-01	5.98E-01	1.01E-01	9.99E-02	9.66E-01	1.22E-01	8.24E-02	1.67E+00	1.58E-01
9.64E-02	9.50E-01	1.02E-01	2.13E-01	5.00E-01	1.05E-01	1.85E-01	8.58E-01	1.28E-01	1.44E-01	1.56E+00	1.62E-01
1.94E-01	7.86E-01	1.07E-01	4.43E-01	5.00E-01	1.09E-01	3.56E-01	7.29E-01	1.38E-01	2.65E-01	1.39E+00	1.66E-01
2.92E-01	6.99E-01	1.11E-01	6.76E-01	5.00E-01	1.13E-01	5.23E-01	6.47E-01	1.47E-01	3.84E-01	1.27E+00	1.68E-01
3.91E-01	6.40E-01	1.12E-01	9.09E-01	5.00E-01	1.14E-01	6.90E-01	5.86E-01	1.52E-01	5.02E-01	1.17E+00	1.66E-01
4.93E-01	5.95E-01	1.14E-01	1.15E+00	5.00E-01	1.16E-01	8.61E-01	5.37E-01	1.56E-01	6.22E-01	1.09E+00	1.67E-01
7.41E-01	5.20E-01	1.17E-01	1.73E+00	5.00E-01	1.19E-01	1.27E+00	5.00E-01	1.62E-01	9.13E-01	9.27E-01	1.68E-01
1.01E+00	5.00E-01	1.21E-01	2.36E+00	5.00E-01	1.23E-01	1.72E+00	5.00E-01	1.69E-01	1.22E+00	8.07E-01	1.82E-01
1.28E+00	5.00E-01	1.25E-01	3.01E+00	5.00E-01	1.27E-01	2.17E+00	5.00E-01	1.71E-01	1.54E+00	7.13E-01	2.01E-01
1.55E+00	5.00E-01	1.30E-01	3.63E+00	5.00E-01	1.31E-01	2.61E+00	5.00E-01	1.76E-01	1.85E+00	6.48E-01	2.11E-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	2.07E+00	1.33E-01	1.27E-02	2.84E+00	1.41E-01	8.25E-03	2.82E+00	1.49E-01			
7.05E-02	1.94E+00	1.43E-01	3.43E-02	2.72E+00	1.39E-01	1.96E-02	2.78E+00	1.38E-01			
1.18E-01	1.86E+00	1.48E-01	5.51E-02	2.66E+00	1.40E-01	3.02E-02	2.75E+00	1.38E-01			
2.12E-01	1.74E+00	1.56E-01	9.63E-02	2.57E+00	1.43E-01	5.11E-02	2.72E+00	1.45E-01			
3.04E-01	1.65E+00	1.61E-01	1.36E-01	2.50E+00	1.48E-01	7.10E-02	2.69E+00	1.51E-01			
3.94E-01	1.58E+00	1.66E-01	1.75E-01	2.44E+00	1.52E-01	9.06E-02	2.67E+00	1.56E-01			
4.86E-01	1.51E+00	1.72E-01	2.14E-01	2.40E+00	1.58E-01	1.10E-01	2.66E+00	1.58E-01			
7.09E-01	1.37E+00	1.80E-01	3.10E-01	2.33E+00	1.70E-01	1.58E-01	2.64E+00	1.61E-01			
9.47E-01	1.24E+00	1.83E-01	4.12E-01	2.29E+00	1.77E-01	2.09E-01	2.63E+00	1.67E-01			
1.19E+00	1.14E+00	1.89E-01	5.18E-01	2.26E+00	1.87E-01	2.62E-01	2.62E+00	1.75E-01			
1.43E+00	1.09E+00	1.92E-01	6.19E-01	2.24E+00	1.93E-01	3.12E-01	2.60E+00	1.82E-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=0.0495			M1P1K1	PGA=0.292		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.063	1.265	0.075	100.0	0.215	0.736	0.089
87.1	0.063	1.248	0.075	87.1	0.215	0.716	0.089
75.9	0.063	1.219	0.076	75.9	0.215	0.681	0.089
66.1	0.063	1.166	0.076	66.1	0.215	0.620	0.089
57.5	0.063	1.069	0.076	57.5	0.216	0.524	0.089
50.1	0.063	0.943	0.076	50.1	0.216	0.434	0.089
43.7	0.063	0.822	0.076	43.7	0.216	0.367	0.089
38.0	0.064	0.738	0.076	38.0	0.217	0.336	0.090
33.1	0.064	0.682	0.076	33.1	0.218	0.321	0.090
28.8	0.065	0.668	0.077	28.8	0.219	0.324	0.090
25.1	0.066	0.654	0.078	25.1	0.221	0.327	0.091
21.9	0.068	0.679	0.079	21.9	0.224	0.350	0.092
19.1	0.071	0.691	0.080	19.1	0.229	0.364	0.093
16.6	0.075	0.732	0.076	16.6	0.236	0.394	0.095
14.5	0.079	0.786	0.075	14.5	0.246	0.432	0.098
12.6	0.084	0.837	0.078	12.6	0.258	0.467	0.097
11.0	0.091	0.901	0.078	11.0	0.272	0.506	0.098
9.5	0.099	1.008	0.101	9.5	0.291	0.570	0.109
8.3	0.108	1.157	0.108	8.3	0.316	0.673	0.132
7.2	0.114	1.278	0.131	7.2	0.342	0.780	0.135
6.3	0.120	1.409	0.134	6.3	0.366	0.890	0.134
5.5	0.131	1.578	0.132	5.5	0.395	1.010	0.139
4.8	0.141	1.705	0.134	4.8	0.434	1.137	0.168
4.2	0.144	1.771	0.137	4.2	0.459	1.242	0.180
3.6	0.143	1.782	0.148	3.6	0.488	1.359	0.167
3.2	0.143	1.867	0.147	3.2	0.486	1.441	0.166
2.8	0.141	1.920	0.156	2.8	0.491	1.538	0.171
2.4	0.139	2.031	0.136	2.4	0.483	1.640	0.159
2.1	0.134	2.132	0.131	2.1	0.480	1.797	0.166
1.8	0.128	2.244	0.130	1.8	0.473	1.982	0.148
1.6	0.122	2.448	0.120	1.6	0.460	2.227	0.132
1.4	0.114	2.636	0.129	1.4	0.409	2.307	0.161
1.2	0.109	2.838	0.144	1.2	0.387	2.482	0.151
1.0	0.101	2.869	0.111	1.0	0.361	2.571	0.135
0.91	0.104	3.188	0.157	0.91	0.347	2.721	0.154
0.79	0.094	3.141	0.161	0.79	0.340	2.958	0.113
0.69	0.080	2.968	0.153	0.69	0.301	2.946	0.135
0.60	0.074	3.095	0.178	0.60	0.275	3.102	0.158
0.52	0.065	3.138	0.160	0.52	0.246	3.267	0.162
0.46	0.051	2.941	0.166	0.46	0.198	3.160	0.171
0.10	0.002	2.322	0.118	0.10	0.006	2.336	0.117

Table A-3b. Median AFs and sigmas for Model 2, Profile 1, for 2 PGA levels. For Information Only							
M2P1K1	PGA=0.0495			M2P1K1	PGA=0.292		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.067	1.348	0.075	100.0	0.247	0.847	0.086
87.1	0.067	1.330	0.075	87.1	0.248	0.824	0.086
75.9	0.067	1.300	0.075	75.9	0.248	0.784	0.086
66.1	0.067	1.244	0.075	66.1	0.248	0.714	0.087
57.5	0.067	1.141	0.075	57.5	0.248	0.604	0.087
50.1	0.067	1.006	0.075	50.1	0.249	0.500	0.087
43.7	0.068	0.878	0.075	43.7	0.250	0.424	0.087
38.0	0.068	0.790	0.075	38.0	0.251	0.390	0.088
33.1	0.069	0.733	0.076	33.1	0.253	0.373	0.089
28.8	0.070	0.720	0.076	28.8	0.256	0.380	0.091
25.1	0.072	0.709	0.078	25.1	0.261	0.386	0.093
21.9	0.074	0.739	0.081	21.9	0.268	0.420	0.098
19.1	0.078	0.760	0.083	19.1	0.278	0.443	0.100
16.6	0.083	0.810	0.077	16.6	0.293	0.488	0.105
14.5	0.088	0.874	0.086	14.5	0.309	0.542	0.106
12.6	0.094	0.938	0.086	12.6	0.329	0.596	0.118
11.0	0.102	1.017	0.086	11.0	0.352	0.656	0.115
9.5	0.112	1.137	0.106	9.5	0.383	0.750	0.118
8.3	0.120	1.294	0.118	8.3	0.418	0.890	0.139
7.2	0.126	1.416	0.134	7.2	0.445	1.015	0.144
6.3	0.132	1.551	0.136	6.3	0.467	1.137	0.139
5.5	0.143	1.726	0.133	5.5	0.502	1.283	0.144
4.8	0.153	1.853	0.116	4.8	0.540	1.414	0.151
4.2	0.154	1.899	0.129	4.2	0.557	1.507	0.137
3.6	0.151	1.886	0.146	3.6	0.565	1.574	0.140
3.2	0.152	1.990	0.156	3.2	0.559	1.657	0.137
2.8	0.148	2.020	0.151	2.8	0.556	1.739	0.160
2.4	0.148	2.155	0.126	2.4	0.542	1.843	0.148
2.1	0.140	2.220	0.127	2.1	0.531	1.987	0.133
1.8	0.132	2.318	0.139	1.8	0.505	2.119	0.149
1.6	0.126	2.519	0.122	1.6	0.490	2.373	0.130
1.4	0.119	2.736	0.120	1.4	0.441	2.490	0.149
1.2	0.113	2.935	0.146	1.2	0.412	2.641	0.142
1.0	0.104	2.946	0.106	1.0	0.383	2.730	0.121
0.91	0.106	3.268	0.155	0.91	0.373	2.927	0.149
0.79	0.094	3.160	0.173	0.79	0.352	3.063	0.141
0.69	0.080	2.955	0.154	0.69	0.299	2.932	0.139
0.60	0.074	3.090	0.184	0.60	0.274	3.089	0.176
0.52	0.064	3.120	0.157	0.52	0.240	3.187	0.153
0.46	0.051	2.915	0.168	0.46	0.190	3.029	0.171
0.10	0.002	2.321	0.119	0.10	0.006	2.323	0.120