March 31, 2014

NRC 2014-0024
10 CFR 50.54(f)

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

Point Beach Nuclear Plant, Units 1 and 2
Docket 50-266 and 50-301
Renewed License Nos. DPR-24 and DPR-27

NextEra Energy Point Beach, LLC 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

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 (ML12073A348)
(2) NEI Letter to NRC, Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, dated April 9, 2013 (ML13107B386)
(3) NRC Letter, EPRI Final Draft Report XXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of 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 ([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, dated February 2013 (ML12333A170)
(5) NRC Letter, Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance," dated February 15, 2013 (ML12319A074)

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.

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 NextEra Energy Point Beach, LLC 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 and no revisions to existing Regulatory Commitments.

If you have any questions please contact Mr. Michael Millen, Licensing Manager, at 920/755-7845.

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

Very truly yours,

NextEra Energy Point Beach, LLC

Eric McCartney
Site Vice President

Enclosure

cc: Director, Office of Nuclear Reactor Regulation
Administrator, Region III, USNRC
Resident Inspector, Point Beach Nuclear Plant, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
Ms. Sue Perkins-Grew, NEI

ENCLOSURE

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

SEISMIC HAZARD AND SCREENING REPORT
FOR THE POINT BEACH NUCLEAR PLANT
UNITS 1 AND 2

MARCH 31, 2014

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 NRC Commission 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 that requests information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter 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 pertaining to NTTF Recommendation 2.1 for the Point Beach Nuclear Plant (PBNP), located in the Town of Two Creeks, Manitowoc County, Wisconsin. In providing this information, PBNP 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 PBNP were performed in accordance with the PBNP updated final safety analysis report (UFSAR), section 1.3 and meet the PBNP definition of General Design Criterion 2 in the PBNP UFSAR, section 1.3.

The PBNP general design criteria were developed as stated below:

> "Regarding the origin of these criteria, the Atomic Energy Commission (AEC) published proposed GDCs for public comment in 1967. The Atomic Industrial Forum (AIF) reviewed these proposed criteria and recommended changes. The Point Beach GDCs documented in this FSAR are similar in content to the AIF version of the Proposed 1967 GDCs.
>
> Appendix A of 10 CFR 50 contains a different set of GDCs which were published in 1971 (After Point Beach construction permits were issued). Note that the GDCs found in 10 CFR 50 Appendix A differ both in numbering and content from the GDCs adopted herein for PBNP." (UFSAR page 1.3-1 of 30)

From PBNP UFSAR Section 2.9, *Seismology, Descriptive Seismology*:

> "The northcentral United States is a relatively inactive earthquake area. The Coast and Geodetic Survey, <u>Seismic Probability Map of the United States</u> assigns the area to Zone 0 - no damage. There is no instrumental or verifiable record of large intensity shocks (above MM VII) within 200 miles of the site, and there is no record of damaging earthquakes with epicenters within 100 miles of the site. Appendix D of the Unit 1 Preliminary Safety Analysis Report, Docket No. 50-266 contains a listing of the seismic history of the regions.
>
> None of the maps presently available, including the Tectonic Map of the United States, shows the presence of faults on which the earthquakes of eastern Wisconsin may have originated. It seems highly unlikely that a regional zone of fracture of any magnitude is present but as yet unmapped. There is a strong possibility that local earthquakes are manifestations of the release of residual stresses remaining in the rock since the glacial periods. The Wisconsin drift sheet is the youngest of these, having occurred only a few thousands of years ago.
>
> Neither the seismic history of the site nor the regional tectonics indicates that a large intensity earthquake is to be expected near the proposed site, and the large earthquakes which have occurred at great distances have had but little effect at the site.
>
> Because the constantly operating stress-relieving mechanism suggested above may produce a small shock anywhere in the affected region, a small intensity earthquake very close to the proposed site is postulated.
>
> A horizontal ground acceleration at the site of 0.06g combined with a vertical acceleration of 0.04g are used for the earthquake design criteria. These accelerations are considered as acting simultaneously.
>
> The hypothetical earthquake [that is the Safe Shutdown Earthquake, SSE] is twice the magnitude of the design earthquake [that is the Operating Basis Earthquake, OBE]; the horizontal and vertical accelerations are considered as acting simultaneously. Components that are essential to safety are designed such that there is no loss of function due to seismic effects."

The SSE is described in the PBNP UFSAR, Appendix A.5, as follows:

> "The spectrum response curves for the equipment inside the building are generated by the time history technique of seismic analysis. The sample earthquake utilized is that recorded at Olympia, Washington 45N-120W on April 13, 1949. The originally recorded earthquake is scaled to that of .06g. Essentially, the curves are generated by applying the recorded earthquake to a single degree of freedom system, for which the values for damping and natural frequency are varied. Some averaging of the curves is provided to smooth out the erratic response of the earthquake's random behavior. At the high frequency end of the curve, the acceleration levels converge to the peak input value at the location inside the building. Table A.5-2 gives the damping factors used in the design of components and structures. The 2% and 5% damping values given in the table for the containment structure include the soil-structure interaction damping."

In response to the 50.54(f) letter 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; PBNP screens in for risk evaluation, a Spent Fuel Pool evaluation, and a High Frequency Confirmation.

2.0 Seismic Hazard Reevaluation

PBNP is located approximately 30 miles (48 km) southeast of Green Bay and about 90 miles (145 km) north-northeast of Milwaukee adjacent to Lake Michigan. PBNP is near the western border of the Michigan Basin, a symmetrical depression developed in Paleozoic rocks.

Earthquake activity in historic time of north central United States was used to develop estimates of the maximum earthquake which could affect the site. The original investigation of historical seismic activity in the region included all recorded earthquakes that had an MMI (Modified Mercalli Scale) intensity of V or greater. Three local quakes with MMI of less than V were also considered: two local quakes with MMI of IV and one with an MMI of III. (UFSAR pg. 2.9-1 of 3)

PBNP had John A. Blume and Associates (JABA), (JAB 1966) review the field investigations performed by Dames and Moore. Based on their review, JABA was of the opinion that the possibility of damaging earthquakes is relatively minor. It is estimated that the maximum earth shock would produce a peak ground acceleration of less than 0.06 g, which was increased to 0.12 g for the SSE. (UFSAR pg. 2.9-1 of 3)

2.1 Regional and Local Geology

The geologic structure of the region is essentially very simple. Gently dipping sedimentary rock strata of Paleozoic age outcrop in a horseshoe pattern around a shield of Precambrian

crystalline rock which occupies the western part of the region. The site is located on the western flank of the Michigan Basin, which is a broad downwarp ringed by discontinuous outcrops of more resistant formations. The bedrock formations are principally limestones, dolomites, and sandstones with subordinate shale layers. The Maquoketa shale is the only formation in which shale predominates. The rocks form a succession of extensive layers that are relatively uniform in thickness. The bedrock strata dip very gently towards Lake Michigan at from 15 to 35 feet per mile. (FSAR pg. 2.8-1 of 6)

The principle PBNP structures are founded on deposits of glacial till, outwash, and lacustrine sediments, approximately 85 ft. deep (varies from 70 ft. to 100 ft.), which overlay bedrock, Niagara Dolomite. Exceptions to this are the containment structures and Spent Fuel Pool (SFP) which are founded on piles driven to refusal into bedrock.

2.2 Probabilistic Seismic Hazard Analysis

2.2.1 Probabilistic Seismic Hazard Analysis Results

In accordance with the 50.54(f) letter 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 EPRI Ground-Motion Model (GMM) for the CEUS (EPRI, 2013b). For the PSHA, a lower-bound moment magnitude of 5.0 was used, as specified in the 50.54(f) letter.

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

1. Illinois Basin Extended Basement (IBEB)
2. Mesozoic and younger extended prior – narrow (MESE-N)
3. Mesozoic and younger extended prior – wide (MESE-W)
4. Midcontinent-Craton alternative A (MIDC_A)
5. Midcontinent-Craton alternative B (MIDC_B)
6. Midcontinent-Craton alternative C (MIDC_C)
7. Midcontinent-Craton alternative D (MIDC_D)
8. Non-Mesozoic and younger extended prior – narrow (NMESE-N)
9. Non-Mesozoic and younger extended prior – wide (NMESE-W)
10. Paleozoic Extended Crust wide (PEZ_W)
11. St. Lawrence Rift, including the Ottawa and Saguenay grabens (SLR)
12. Study region (STUDY_R)

For sources of large magnitude earthquakes, designated Repeated Large Magnitude Earthquake (RLME) sources in CEUS-SSC (2012), the following sources lie within 620 miles (1,000 km) of the site and were included in the analysis:

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

For each of the above background and RLME sources, the mid-continent version of the updated CEUS EPRI GMM was used.

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 (see subsection 2.3.7 for definition of Method 3) has been used. Seismic hazard curves are shown below in Section 3 at the SSE Control Point elevation.

2.3 Site Response Evaluation

Following the guidance contained in Seismic Enclosure 1 of the 3/12/2012 50.54(f) Request for Information and in the SPID (EPRI, 2013a) for nuclear power plant sites that are not sited on hard rock (defined as rock with a shear wave velocity of 2.83 km/sec (1.76 miles/sec)), a site response analysis was performed for PBNP.

2.3.1 Description of Subsurface Material

PBNP is located in east central Wisconsin on the west shore of Lake Michigan approximately 30 miles (48 km) southeast of Green Bay and about 90 miles (145 km) north-northeast of Milwaukee. The site is near the western border of the Michigan Basin, a symmetrical depression developed in Paleozoic rocks. The basic information used to create the site geologic profile at PBNP is shown in Table 2.3.1-1. This profile was developed using information documented in Table 2.3.1-1 footnotes. The site consists of about 83 ft (25m) of glacial till and lake deposits overlying bedrock (Niagara Dolomite) of Paleozoic age and taken as hard reference rock (Table 2.3.1-1).

Per the SPID (EPRI, 2013a) guidance, the SSE was taken to be at the elevation of the highest foundation of key structures, which is elevation +8 ft. (+2.4 m).

The following is a description of the site geology and Paleozoic bedrock:

> As a result of geologically recent succession of glaciations, bedrock at the site is covered by deposits of glacial till, outwash, and lacustrine sediments. Glacial overburden soils consist essentially of an upper layer of till underlain by lacustrine deposits, and by a deeper layer of till and glacial outwash. The thickness of the glacial overburden is on the order of 100 feet. All glacial soils present at the site show evidence of having been highly over-consolidated due to the weight of the overlying ice sheets during the various stages of the most recent glaciation (Dames & Moore 1966). This area is near the western border of the Michigan Basin, a remarkably symmetrical subsurface depression developed in Paleozoic rocks. The uppermost rocks of the basin's flank in this area consist of magnesian limestone known as the Niagara dolomites of Silurian age. The rudely stratified glacial sediments lie directly on the dolomite. These sediments, of Pleistocene age, were deposited some 348 million years after the deposition and consolidation of the Niagara dolomite. (JAB 1966).

Table 2.3.1-1 Geologic profile and estimated layer thicknesses for PBNP

Elevation [1]	**Soil / Rock** [5] **Description**	**Density** [4] **(pcf)**	**Poisson's Ratio** [5]	**Modulus of Elasticity** [5] **(psf)**	**Shear Modulus** [5] **(psf)**	**Damping Percent** [2, 5]	**Shear Wave Velocity** [4] **(fps)**
+26' to +10'	Glacial till	130	0.45	3.0 x 10E7	1.0 x 0E7	20	900
+10' to -5'	Lake deposits Lacustrine[4]	125	0.49	1.5 x 10E6[3]	1.5 x 10E6[3]	30	900
-5' to -25'							
-25' to -35'	Glacial till and glacial outwash	130	0.45	3.0 x 0E7	1.0 x 0E7	20	960
-35' to -50'							1,000
-50' to -75'							1,030
below -75'	Bedrock (Niagara Dolomite)	175	0.25	1.8 x 0E9	7.5 x 0E8	--	12,000

1. Reference elevation 0' is the City of Milwaukee Datum.
2. Expressed as a percentage of critical damping.
3. The moduli for the Lake Deposits should be decreased by 10% for dynamic loads which will be acting on the soil for a large number of repetitions such as an SSE.
4. GEI (1995). Shear wave velocities are recommended 'Best Estimate' Values.
5. Dames & Moore (1966).

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 along with elevations and corresponding stratigraphy. Per the SPID (EPRI 2013a) guidance, the SSE Control Point was taken to be at the elevation of the highest foundation of key structures, which is elevation +8 ft (+2.4 m). Velocity values listed in Table 2.3.1-1 are recommended "Best Estimate" values, but the measurement type is not listed.

Velocity measurement extends to a depth below the SSE Control Point of about 83 ft (25m). The mean base-case profile (P1) was based on the specified shear-wave velocities in Table 2.3.1-1 and is shown as profile P1 in Figure 2.3.2-1. Based on the uncertainty in shear-wave velocities due to the age and type of measurement (Table 2.3.1-1), a scale factor of 1.57 was adopted to reflect upper and lower range base-cases. The scale factor of 1.57 reflects a σ_{μ}ln of about 0.35 based on the SPID (EPRI 2013a) 10th and 90th fractiles which implies a 1.28 scale factor on σ_{μ}. Lower (P2) - and upper (P3) - range profiles were developed with scale factors of 1.57. Depth to Precambrian basement was taken at 83 ft (25m) randomized ± 16 ft (5.0m). The three shear-wave velocity profiles are shown in Figure 2.3.2-1 and listed in Table 2.3.2-2.

Table 2.3.2-1. Not Used.

Table 2.3.2-2. Geologic profile and estimated layer thicknesses for PBNP.

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	900		0	573		0	1413
3.0	3.0	900	3.0	3.0	573	3.0	3.0	1413
5.0	8.0	900	5.0	8.0	573	5.0	8.0	1413
5.0	13.0	900	5.0	13.0	573	5.0	13.0	1413
5.0	18.0	900	5.0	18.0	573	5.0	18.0	1413
2.0	20.0	900	2.0	20.0	573	2.0	20.0	1413
8.0	28.0	900	8.0	28.0	573	8.0	28.0	1413
5.0	33.0	900	5.0	33.0	573	5.0	33.0	1413
5.0	38.0	1000	5.0	38.0	637	5.0	38.0	1570
5.0	43.0	1000	5.0	43.0	637	5.0	43.0	1570
5.0	48.0	1000	5.0	48.0	637	5.0	48.0	1570
2.0	50.0	1000	2.0	50.0	637	2.0	50.0	1570
8.0	58.0	1000	8.0	58.0	637	8.0	58.0	1570
5.0	63.0	1000	5.0	63.0	637	5.0	63.0	1570
5.0	68.0	1000	5.0	68.0	637	5.0	68.0	1570
5.0	73.0	1000	5.0	73.0	637	5.0	73.0	1570
5.0	78.0	1000	5.0	78.0	637	5.0	78.0	1570
5.0	83.0	1000	5.0	83.0	637	5.0	83.0	1570
3280.8	3363.8	9285	3280.8	3363.8	9285	3280.8	3363.8	9285

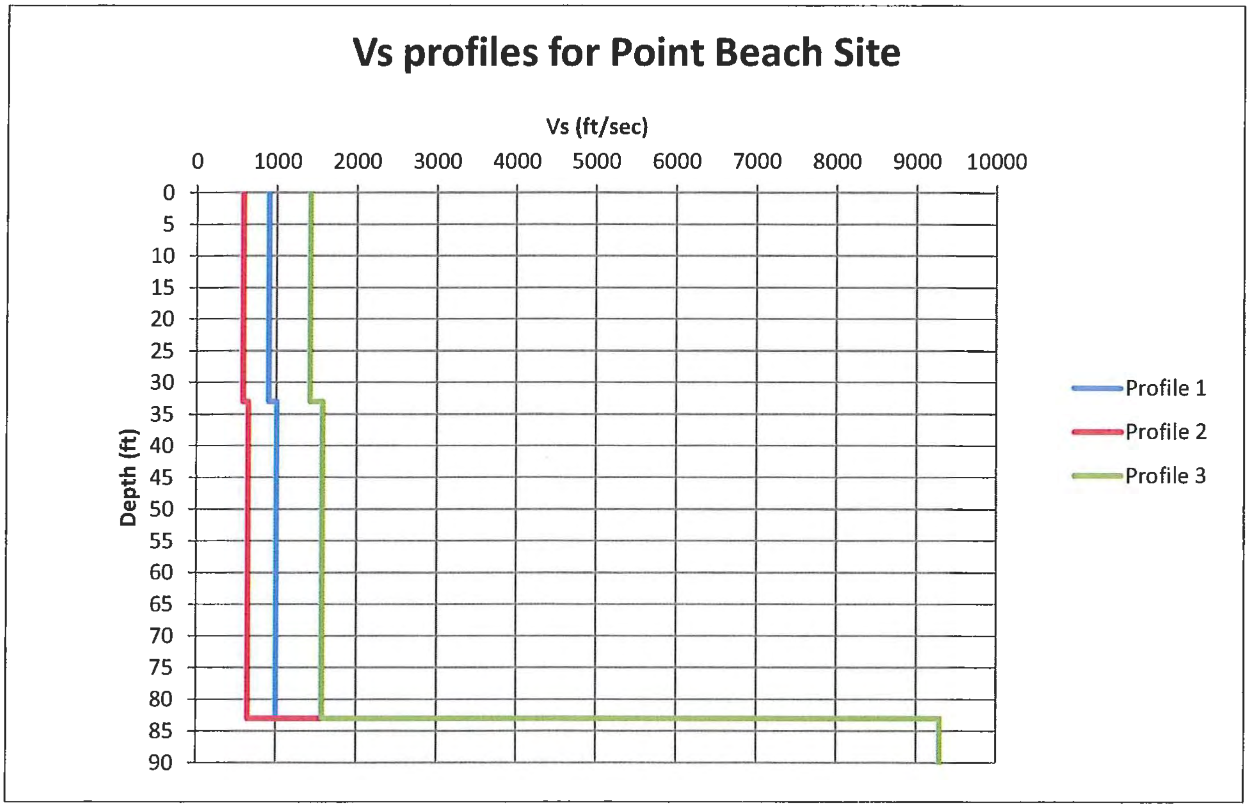


Figure 2.3.2-1. Shear wave velocity profile used in site response calculations for PBNP

2.3.2.1 Shear Modulus and Damping Curves

No site-specific nonlinear dynamic material properties were available for PBNP for the soils. The soil material over the upper 83 ft (25 m) was assumed to have behavior that could be modeled with either EPRI cohesionless soil or Peninsular Range G/Gmax 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.

2.3.2.2 Kappa

Base-case kappa estimates were determined using Section B-5.1.3.1 of the SPID (EPRI, 2013a) for sites with less than 3,000 ft (1,000m) of soil. For soil sites with depths less than 3,000 ft (1,000m) to hard rock, a mean base-case kappa may be estimated based on total soil thickness of 83 ft (25 m) with the addition of the hard basement rock value of 0.006s (SPID EPRI, 2013a). For base-case profiles P1, P2, and P3 the kappa contributions from the profiles was 0.002s, 0.003s, and 0.001s respectively. The total kappa values, after adding the

hard reference rock value of 0.006s, were 0.008s, 0.009s, and 0.007s respectively (Table 2.3.2-3). Epistemic uncertainty in profile damping (kappa) was considered to be accommodated at design loading levels by the range of damping (kappa) provided by the multiple (2) sets of G/Gmax and hysteretic damping curves.

Table 2.3.2-3.
Kappa Values Used for Site Response Analyses

Velocity Profile	Kappa(s)
P1	0.008
P2	0.009
P3	0.007
	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 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 PBNP, random shear wave velocity profiles were developed from the base case profiles as 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 USGS 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 USGS A 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.

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 (PGA) ranging from 0.01 to 1.5 g) were used in the site response analyses. The characteristics

of the seismic source and upper crustal attenuation properties assumed for the analysis of the PBNP site 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.

2.3.5 Methodology

To perform the site response analyses for the PBNP site, a random vibration theory (RVT) 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 PBNP site.

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/Gmax 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 PBNP 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 only minor differences across structural frequency as well as loading level caused by the thin layer of soil [only 83 ft (25 m)]. See Attachment A, Tables A2-b1 through A2-b2, for tabulated information.

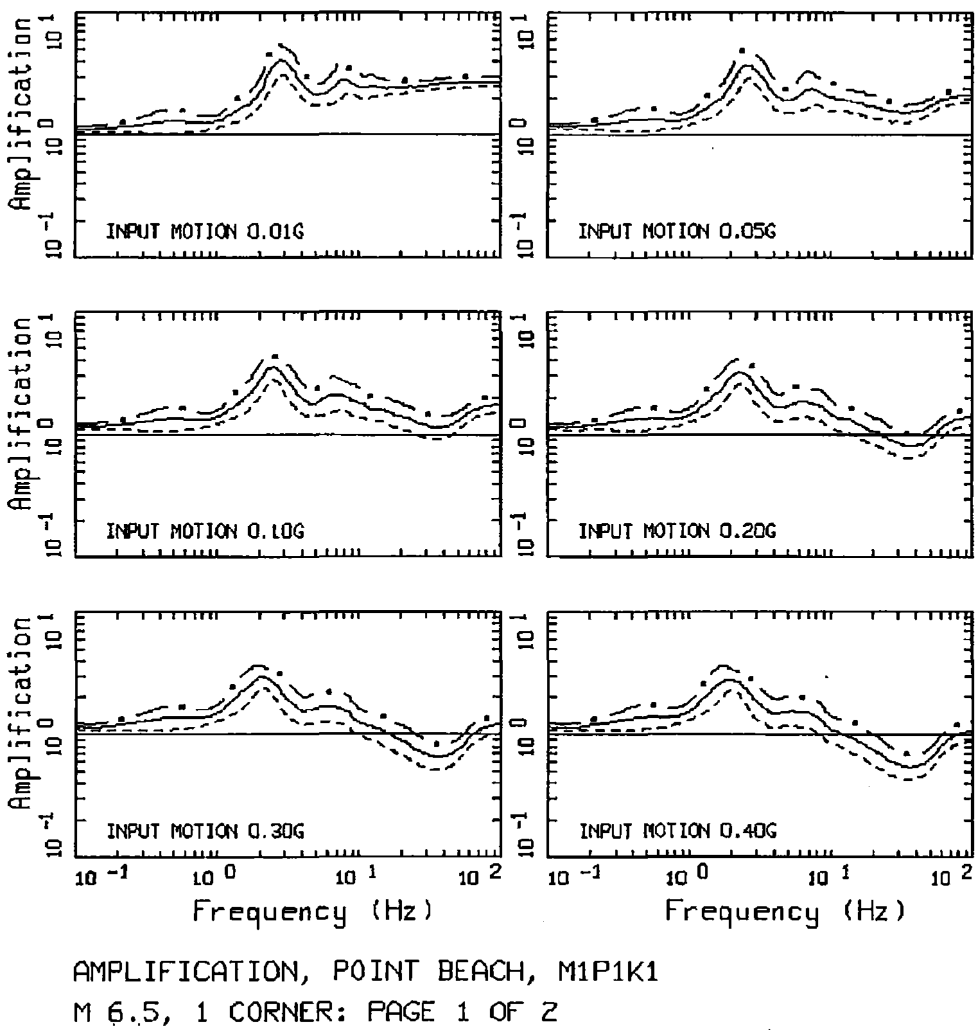
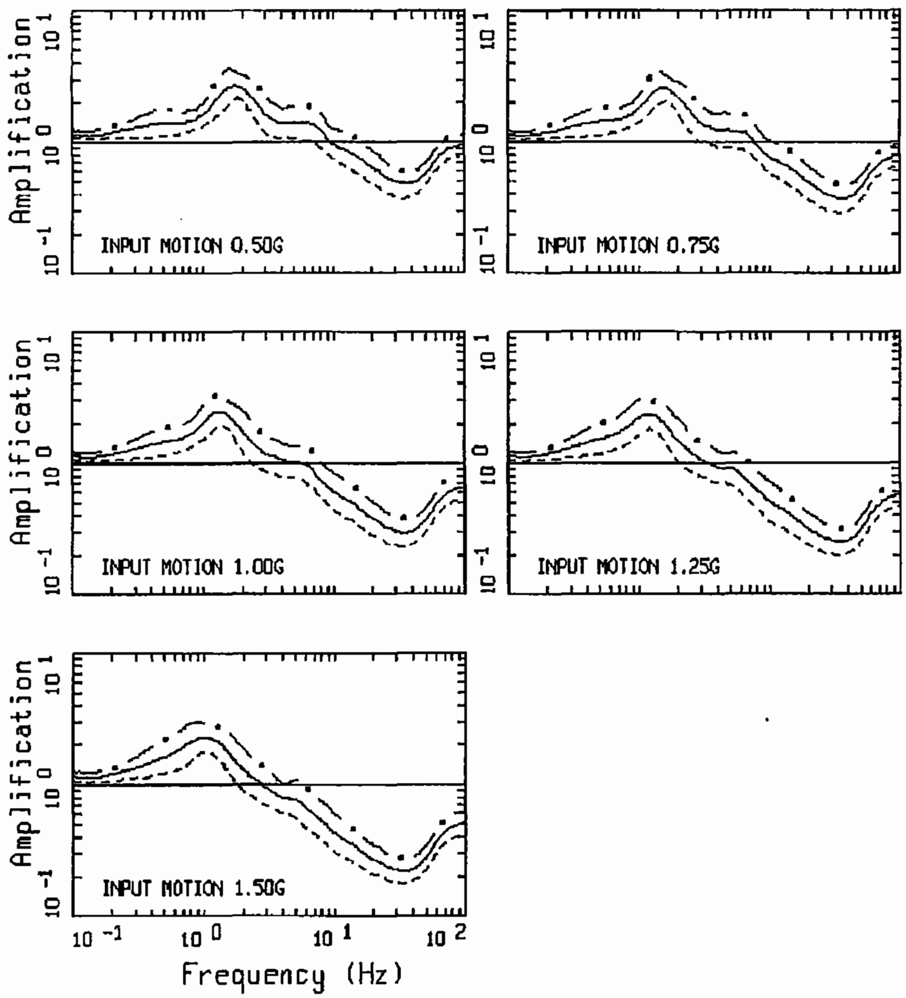


Figure 2.3.6-1. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI rock modulus reduction and hysteretic damping curves (model M1), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration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



AMPLIFICATION, POINT BEACH, M1P1K1
M 6.5, 1 CORNER: PAGE 2 OF 2

Figure 2.3.6-1. (Continued)

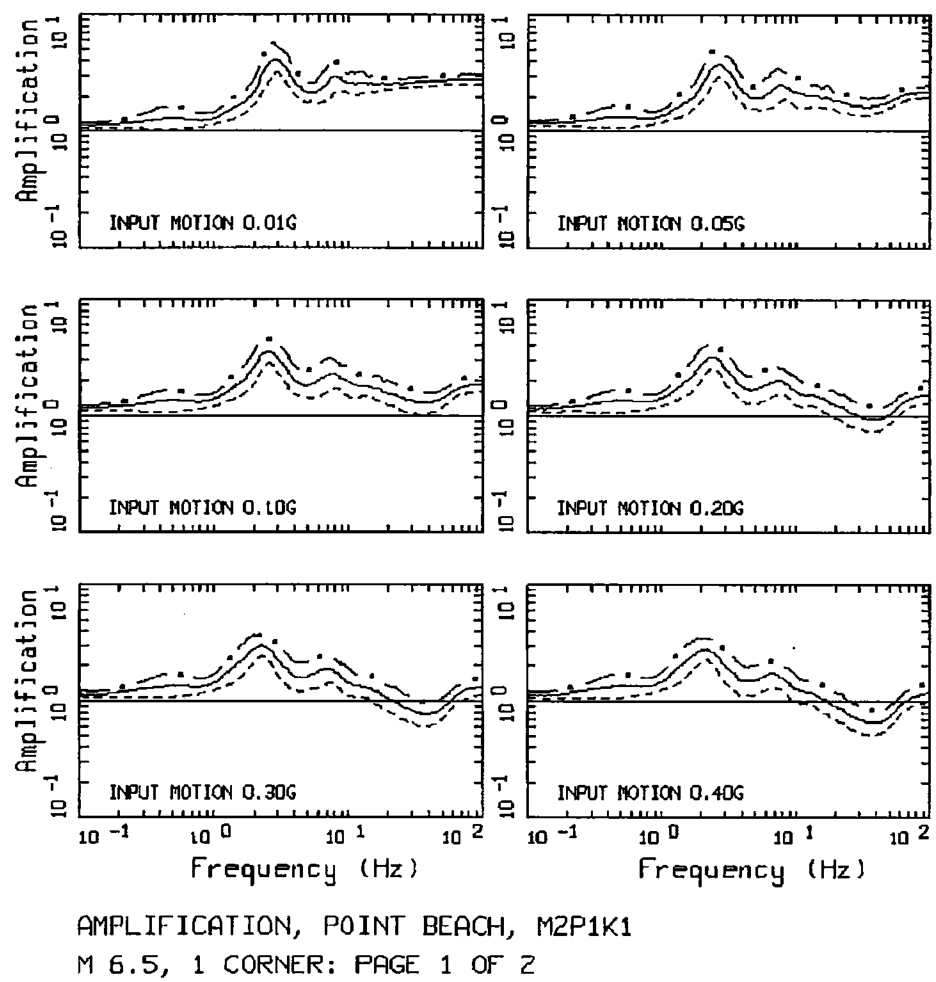


Figure 2.3.6-2. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), linear site response (model M2), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g.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

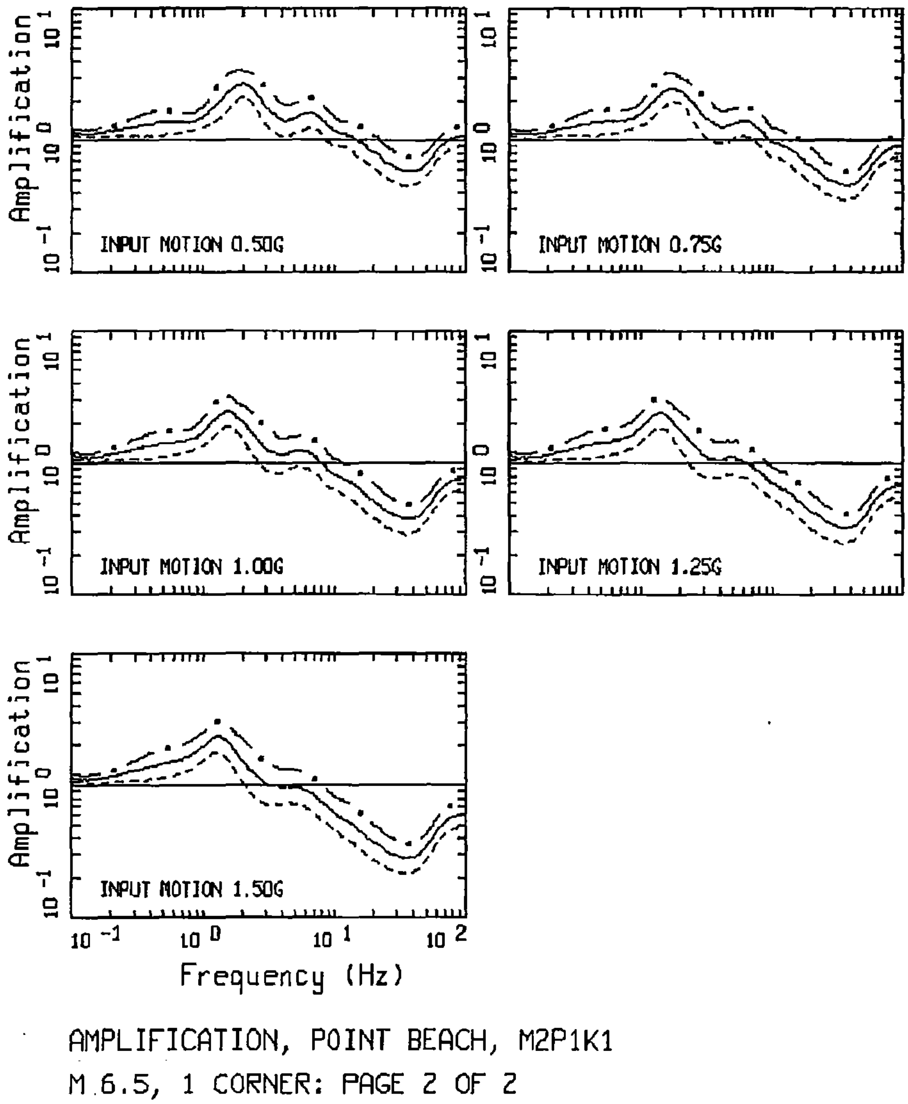


Figure 2.3.6-2. (Continued)

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 specified oscillator frequencies. 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 the PBNP site are shown in Figure 2.3.7-1 for the seven oscillator frequencies for which the GMM is defined. Tabulated values of the Control Point hazard curves are provided in Appendix A, Tables A1-a through A1-g.

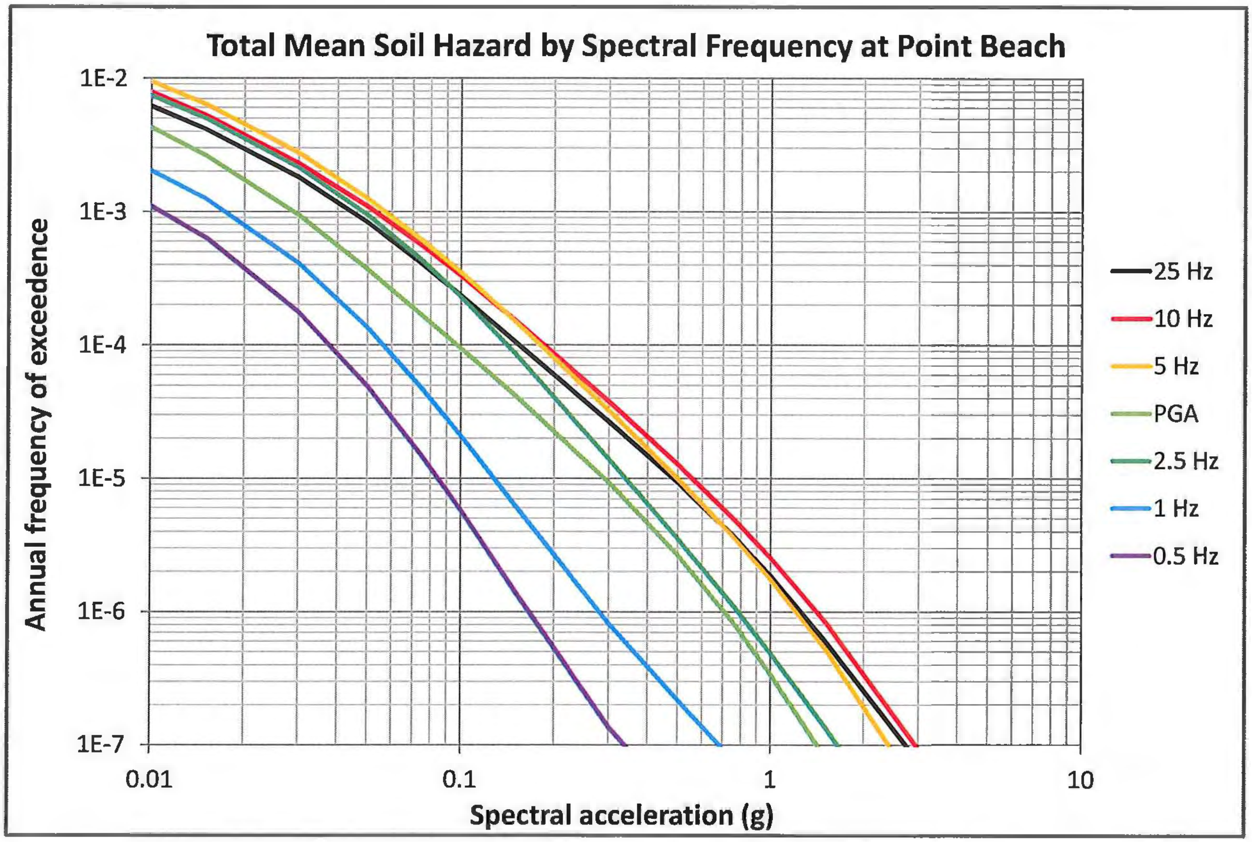


Figure 2.3.7-1. Control Point mean hazard curves for spectral frequencies of 0.5, 1, 2.5, 5, 10, 25 and 100 Hz at the PBNP site.

2.4 Control Point Response Spectra

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 oscillator frequency for the 1E-4 and 1E-5 per year hazard levels. Table 2.4-1 shows the UHRS and GMRS spectral accelerations.

Table 2.4-1, UHRS for 1E-4 and 1E-5 and GMRS at SSE Control Point for PBNP

Freq, Hz	1E-4 UHRS	1E-5 UHRS	GMRS
100	9.70E-02	2.90E-01	1.40E-01
90	9.73E-02	2.91E-01	1.40E-01
80	9.79E-02	2.93E-01	1.41E-01
70	9.92E-02	2.99E-01	1.44E-01
60	1.02E-01	3.11E-01	1.49E-01
50	1.10E-01	3.41E-01	1.63E-01
40	1.23E-01	3.92E-01	1.86E-01
35	1.32E-01	4.19E-01	2.00E-01
30	1.43E-01	4.49E-01	2.14E-01
25	1.54E-01	4.84E-01	2.31E-01
20	1.68E-01	5.14E-01	2.47E-01
15	1.82E-01	5.56E-01	2.67E-01
12.5	1.91E-01	5.71E-01	2.75E-01
10	1.84E-01	5.55E-01	2.67E-01
9	1.78E-01	5.37E-01	2.58E-01
8	1.78E-01	5.20E-01	2.52E-01
7	1.75E-01	4.97E-01	2.42E-01
6	1.72E-01	4.89E-01	2.38E-01
5	1.79E-01	4.99E-01	2.44E-01
4	1.74E-01	4.71E-01	2.32E-01
3.5	1.62E-01	4.32E-01	2.13E-01
3	1.52E-01	3.73E-01	1.87E-01
2.5	1.41E-01	3.39E-01	1.71E-01
2	1.19E-01	2.89E-01	1.45E-01
1.5	1.03E-01	2.25E-01	1.15E-01
1.25	7.82E-02	1.81E-01	9.19E-02
1	5.61E-02	1.28E-01	6.50E-02
0.9	5.11E-02	1.16E-01	5.89E-02
0.8	4.75E-02	1.07E-01	5.45E-02
0.7	4.47E-02	1.00E-01	5.11E-02

Freq, Hz	1E-4 UHRS	1E-5 UHRS	GMRS
0.6	4.18E-02	9.36E-02	4.78E-02
0.5	3.75E-02	8.43E-02	4.30E-02
0.4	3.00E-02	6.74E-02	3.44E-02
0.35	2.63E-02	5.90E-02	3.01E-02
0.3	2.25E-02	5.06E-02	2.58E-02
0.25	1.88E-02	4.22E-02	2.15E-02
0.2	1.50E-02	3.37E-02	1.72E-02
0.15	1.13E-02	2.53E-02	1.29E-02
0.125	9.38E-03	2.11E-02	1.08E-02
0.1	7.50E-03	1.69E-02	8.60E-03

The 1E-4 and 1E-5 UHRS are used to compute the GMRS at the Control Point elevation and are shown in Figure 2.4-1. Figure 2.4-1 shows the Control Point UHRS and GMRS.

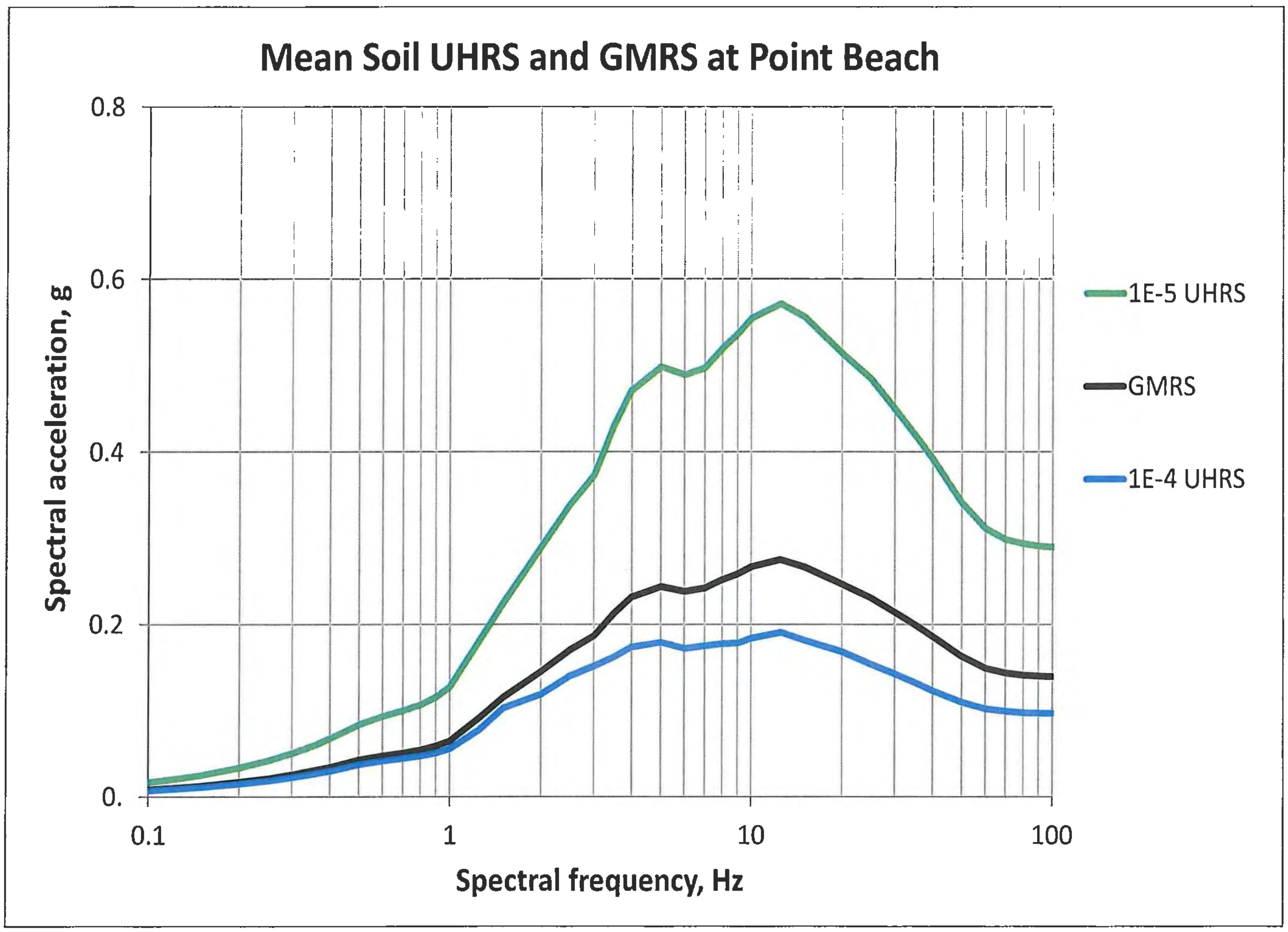


Figure 2.4-1. UHRS for 1E-4 and 1E-5 and GMRS at Control Point for PBNP (5%-damped response spectra).

3.0 Plant Design Basis and Beyond Design Basis Evaluation Ground Motion

The design basis for PBNP is identified in the PBNP UFSAR.

3.1 SSE Description of Spectral Shape

The SSE was developed in accordance with PBNP General Design Criterion 2. A review of historical earthquakes in the regional and immediate vicinity of the PBNP was performed in the late 1960's as part of the Construction Permitting process. There is no instrumental or verifiable record of large intensity shocks (above MM VII) within 200 miles of the site, and there is no record of damaging earthquakes with epicenters within 100 miles of the site.

Neither the seismic history of the site nor the regional tectonics indicates that a large intensity earthquake is to be expected near the proposed site, and the large earthquakes which have occurred at great distances have had but little effect at the site.

The SSE is defined in terms of a Peak Ground Acceleration (PGA) and a design response spectrum. A horizontal ground acceleration at the site of 0.06g combined with a vertical acceleration of 0.04g are used for the earthquake design criteria. These accelerations are considered as acting simultaneously. The hypothetical earthquake (that is the Safe Shutdown Earthquake) is twice the magnitude of the design earthquake (that is the Operating Basis Earthquake); the horizontal and vertical accelerations are considered as acting simultaneously.

Table 3.1-1 shows the spectral acceleration values as a function of frequency for the 5% damped horizontal SSE.

Table 3.1-1, SSE for PBNP
(NextEra, 2012)

Freq. (Hz)	SA (g)
35.71	0.120
25.00	0.120
16.67	0.120
12.50	0.120
10.00	0.140
5.00	0.200
2.50	0.180
1.67	0.160
1.25	0.130
1.00	0.110
0.50	0.064
0.33	0.045

3.2 Control Point Elevation

The SSE Control Point elevation was taken to be at the elevation of the highest foundation of key, safety-related structures, which is elevation + 8.0 ft.

The PBNP UFSAR does not designate a specific Control Point. Guidance is provided in the SPID (EPRI, 2013a), section 2.4.2, *Horizons and SSE Control Point* for determination of the Control Point when it is not defined in the PBNP UFSAR. PBNP is classified as a soil site with generally uniform, horizontally layered stratigraphy. Key, safety-related structures are containments, spent fuel pool, control building and primary auxiliary building (PAB).

Although both containments and the spent fuel pool are supported by piles driven to refusal in bedrock, with regard to SSE Control Point, PBNP considers these structures to be founded on soil. The Control Building is supported by spread footings and the PAB is supported by slab-on-grade. With regard to the SSE Control Point, the Control Building and PAB are founded on soil. The turbine buildings and facades are not safety-related structures, and therefore were not considered in determination of the SSE Control Point elevation.

4.0 Screening Evaluation

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

4.1 Risk Evaluation Screening (1 to 10 Hz)

In the 1 to 10Hz part of the response spectrum, the GMRS exceeds the SSE. Therefore, PBNP screens in for a risk evaluation.

4.2 High Frequency Screening (> 10 Hz)

For the range above 10 Hz, the GMRS exceeds the SSE. The high frequency exceedences can be addressed in the risk evaluation discussed in 4.1, above.

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

In the 1 to 10 Hz part of the response spectrum, the GMRS exceeds the SSE. Therefore, PBNP screens in for a spent fuel pool evaluation.

5.0 Interim Actions

Based on the screening evaluation, the expedited seismic evaluation described in EPRI 3002000704 will be performed as proposed in a letter to NRC dated April 9, 2013, (ML13101A379) and agreed to by NRC in a letter dated May 7, 2013, (ML13106A331).

Consistent with NRC letter dated February 20, 2014, (ML14030A046), the seismic hazard reevaluations presented herein are distinct from the current design and licensing bases of

PBNP. 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," 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:

> 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.

PBNP is included in the March 12, 2014 (NEI 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.

The NTTF Recommendation 2.3, seismic walkdowns, determined that PBNP, Units 1 and 2 are in compliance with their seismic license basis.

Seismic walkdowns have been completed at PBNP in accordance with the NRC endorsed walkdown methodology. All potentially degraded, nonconforming, or unanalyzed conditions identified as a result of the seismic walkdowns were entered into the corrective action program (CAP).

Evaluations of the identified conditions are complete and documented within the CAP. These evaluations determined the Seismic Walkdowns resulted in no adverse anchorage conditions, no adverse seismic spatial interactions, and no other adverse seismic conditions associated with the items on the Seismic Walkdown Equipment List (SWEL). Similarly, the Area Walk-Bys resulted in no adverse seismic conditions associated with other structures, systems or components located in the vicinity of the SWEL items.

All follow-on activities identified in the November 2013 report submittal have been completed.

All previously made seismic related IPEEE commitments involving plant improvement have been completed.

6.0 Conclusions

In accordance with the 50.54(f) request for information, a seismic hazard and screening evaluation was performed for PBNP. 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, PBNP screens in for a risk evaluation, a Spent Fuel Pool evaluation, and a High Frequency Confirmation.

7.0 References

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NEI (2014). *Seismic Risk Evaluations for Plants in the Central and Eastern United States*, dated March 12, 2014, prepared by Nuclear Energy Institute.

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Appendix A

Table A1-a. Mean and Fractile Seismic Hazard Curves for PGA at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.90E-02	1.57E-02	2.13E-02	2.88E-02	3.73E-02	4.19E-02
0.001	2.38E-02	1.02E-02	1.62E-02	2.35E-02	3.19E-02	3.68E-02
0.005	8.51E-03	2.32E-03	4.70E-03	7.89E-03	1.23E-02	1.64E-02
0.01	4.28E-03	1.04E-03	1.98E-03	3.68E-03	6.45E-03	9.79E-03
0.015	2.62E-03	6.00E-04	1.07E-03	2.10E-03	4.01E-03	6.83E-03
0.03	9.36E-04	1.69E-04	3.09E-04	6.64E-04	1.38E-03	2.92E-03
0.05	3.69E-04	5.35E-05	9.93E-05	2.42E-04	5.58E-04	1.20E-03
0.075	1.67E-04	1.84E-05	3.57E-05	1.01E-04	2.64E-04	5.50E-04
0.1	9.41E-05	8.23E-06	1.72E-05	5.35E-05	1.51E-04	3.14E-04
0.15	4.14E-05	2.60E-06	6.26E-06	2.19E-05	6.64E-05	1.42E-04
0.3	9.28E-06	3.05E-07	1.01E-06	4.37E-06	1.53E-05	3.28E-05
0.5	2.66E-06	5.27E-08	2.10E-07	1.13E-06	4.56E-06	1.01E-05
0.75	8.43E-07	1.11E-08	5.42E-08	3.23E-07	1.44E-06	3.37E-06
1.	3.36E-07	3.42E-09	1.82E-08	1.16E-07	5.66E-07	1.40E-06
1.5	8.07E-08	5.12E-10	2.92E-09	2.35E-08	1.32E-07	3.52E-07
3.	5.89E-09	9.11E-11	1.21E-10	1.02E-09	8.23E-09	2.68E-08
5.	7.95E-10	7.77E-11	9.11E-11	1.36E-10	9.37E-10	3.73E-09
7.5	1.44E-10	7.13E-11	8.12E-11	9.11E-11	1.98E-10	7.34E-10
10.	3.93E-11	7.13E-11	8.12E-11	9.11E-11	1.05E-10	2.53E-10

Table A1-b. Mean and Fractile Seismic Hazard Curves for 25 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.02E-02	1.87E-02	2.25E-02	3.01E-02	3.84E-02	4.25E-02
0.001	2.59E-02	1.36E-02	1.87E-02	2.57E-02	3.33E-02	3.84E-02
0.005	1.10E-02	3.90E-03	6.64E-03	1.04E-02	1.51E-02	2.01E-02
0.01	6.19E-03	1.90E-03	3.23E-03	5.58E-03	8.85E-03	1.31E-02
0.015	4.14E-03	1.16E-03	1.95E-03	3.52E-03	6.09E-03	9.79E-03
0.03	1.81E-03	4.19E-04	7.13E-04	1.40E-03	2.64E-03	5.05E-03
0.05	8.33E-04	1.60E-04	2.80E-04	6.09E-04	1.23E-03	2.49E-03
0.075	4.05E-04	6.45E-05	1.15E-04	2.80E-04	6.26E-04	1.21E-03
0.1	2.34E-04	3.01E-05	5.83E-05	1.55E-04	3.79E-04	7.03E-04
0.15	1.05E-04	9.51E-06	2.10E-05	6.54E-05	1.79E-04	3.28E-04
0.3	2.66E-05	1.42E-06	3.84E-06	1.46E-05	4.63E-05	8.98E-05
0.5	9.35E-06	4.01E-07	1.25E-06	4.98E-06	1.64E-05	3.23E-05
0.75	3.77E-06	1.53E-07	5.05E-07	2.04E-06	6.54E-06	1.34E-05
1.	1.85E-06	6.93E-08	2.46E-07	1.01E-06	3.19E-06	6.64E-06
1.5	6.08E-07	1.90E-08	7.45E-08	3.28E-07	1.08E-06	2.19E-06
3.	7.61E-08	9.65E-10	5.27E-09	3.42E-08	1.46E-07	2.88E-07
5.	2.00E-08	1.21E-10	4.77E-10	4.25E-09	3.47E-08	9.37E-08
7.5	7.91E-09	9.11E-11	1.10E-10	7.03E-10	1.23E-08	4.13E-08
10.	4.19E-09	8.12E-11	9.11E-11	2.32E-10	6.17E-09	2.29E-08

Table A1-c. Mean and Fractile Seismic Hazard Curves for 10 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.19E-02	2.16E-02	2.42E-02	3.14E-02	3.95E-02	4.37E-02
0.001	2.87E-02	1.82E-02	2.13E-02	2.84E-02	3.63E-02	4.07E-02
0.005	1.37E-02	6.45E-03	8.85E-03	1.32E-02	1.84E-02	2.29E-02
0.01	7.83E-03	2.96E-03	4.43E-03	7.34E-03	1.11E-02	1.44E-02
0.015	5.24E-03	1.74E-03	2.72E-03	4.77E-03	7.66E-03	1.05E-02
0.03	2.28E-03	6.09E-04	1.01E-03	1.92E-03	3.42E-03	5.35E-03
0.05	1.09E-03	2.49E-04	4.31E-04	8.60E-04	1.62E-03	2.76E-03
0.075	5.54E-04	1.13E-04	1.95E-04	4.19E-04	8.35E-04	1.49E-03
0.1	3.29E-04	6.09E-05	1.07E-04	2.46E-04	5.12E-04	8.98E-04
0.15	1.51E-04	2.35E-05	4.25E-05	1.10E-04	2.46E-04	4.19E-04
0.3	3.73E-05	3.79E-06	8.00E-06	2.49E-05	6.45E-05	1.10E-04
0.5	1.27E-05	8.47E-07	2.16E-06	7.77E-06	2.25E-05	4.01E-05
0.75	5.05E-06	2.35E-07	6.93E-07	2.80E-06	9.11E-06	1.72E-05
1.	2.49E-06	8.98E-08	2.92E-07	1.29E-06	4.50E-06	8.98E-06
1.5	8.32E-07	2.16E-08	8.00E-08	3.84E-07	1.49E-06	3.19E-06
3.	9.23E-08	1.49E-09	6.45E-09	3.47E-08	1.62E-07	3.84E-07
5.	1.48E-08	1.74E-10	5.91E-10	4.37E-09	2.57E-08	6.26E-08
7.5	3.37E-09	9.11E-11	1.20E-10	8.12E-10	5.75E-09	1.51E-08
10.	1.24E-09	8.12E-11	9.11E-11	2.57E-10	1.98E-09	5.91E-09

Table A1-d. Mean and Fractile Seismic Hazard Curves for 5 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.23E-02	2.19E-02	2.46E-02	3.19E-02	4.01E-02	4.43E-02
0.001	2.98E-02	1.90E-02	2.22E-02	2.92E-02	3.73E-02	4.25E-02
0.005	1.59E-02	6.83E-03	9.65E-03	1.53E-02	2.22E-02	2.76E-02
0.01	9.43E-03	3.23E-03	4.98E-03	8.72E-03	1.38E-02	1.79E-02
0.015	6.37E-03	1.84E-03	3.05E-03	5.83E-03	9.79E-03	1.29E-02
0.03	2.73E-03	6.00E-04	1.05E-03	2.29E-03	4.43E-03	6.36E-03
0.05	1.24E-03	2.25E-04	4.07E-04	9.51E-04	2.07E-03	3.23E-03
0.075	6.06E-04	9.37E-05	1.72E-04	4.37E-04	1.01E-03	1.67E-03
0.1	3.46E-04	4.70E-05	8.98E-05	2.42E-04	5.75E-04	9.79E-04
0.15	1.48E-04	1.64E-05	3.37E-05	9.79E-05	2.53E-04	4.37E-04
0.3	3.20E-05	2.35E-06	5.66E-06	1.92E-05	5.66E-05	1.02E-04
0.5	9.93E-06	5.20E-07	1.40E-06	5.50E-06	1.82E-05	3.37E-05
0.75	3.71E-06	1.42E-07	4.25E-07	1.87E-06	6.93E-06	1.32E-05
1.	1.73E-06	5.05E-08	1.67E-07	8.12E-07	3.23E-06	6.45E-06
1.5	5.25E-07	1.01E-08	3.79E-08	2.16E-07	9.79E-07	2.07E-06
3.	4.56E-08	4.43E-10	1.87E-09	1.34E-08	7.77E-08	1.98E-07
5.	5.77E-09	9.79E-11	1.95E-10	1.23E-09	8.85E-09	2.60E-08
7.5	1.07E-09	8.12E-11	9.11E-11	2.10E-10	1.40E-09	4.83E-09
10.	3.25E-10	7.13E-11	8.85E-11	1.02E-10	4.01E-10	1.49E-09

Table A1-e. Mean and Fractile Seismic Hazard Curves for 2.5 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.07E-02	1.98E-02	2.32E-02	3.01E-02	3.84E-02	4.31E-02
0.001	2.70E-02	1.49E-02	1.92E-02	2.64E-02	3.52E-02	4.07E-02
0.005	1.29E-02	4.43E-03	6.64E-03	1.20E-02	1.92E-02	2.49E-02
0.01	7.41E-03	1.92E-03	3.23E-03	6.64E-03	1.16E-02	1.55E-02
0.015	4.98E-03	1.05E-03	1.87E-03	4.37E-03	8.12E-03	1.11E-02
0.03	2.13E-03	3.01E-04	5.75E-04	1.64E-03	3.73E-03	5.58E-03
0.05	9.42E-04	9.93E-05	2.01E-04	6.26E-04	1.69E-03	2.88E-03
0.075	4.29E-04	3.79E-05	7.89E-05	2.60E-04	7.55E-04	1.40E-03
0.1	2.28E-04	1.82E-05	3.84E-05	1.32E-04	3.95E-04	7.45E-04
0.15	8.53E-05	6.00E-06	1.31E-05	4.70E-05	1.49E-04	2.84E-04
0.3	1.39E-05	7.66E-07	1.84E-06	7.23E-06	2.49E-05	4.90E-05
0.5	3.53E-06	1.51E-07	4.07E-07	1.72E-06	6.36E-06	1.31E-05
0.75	1.14E-06	3.73E-08	1.11E-07	5.20E-07	2.04E-06	4.31E-06
1.	4.86E-07	1.29E-08	4.19E-08	2.07E-07	8.72E-07	1.87E-06
1.5	1.36E-07	2.53E-09	8.98E-09	4.98E-08	2.35E-07	5.50E-07
3.	1.37E-08	1.64E-10	4.63E-10	2.80E-09	2.04E-08	6.26E-08
5.	2.45E-09	8.98E-11	1.01E-10	2.84E-10	2.88E-09	1.18E-08
7.5	5.94E-10	7.13E-11	8.47E-11	1.01E-10	5.66E-10	2.72E-09
10.	2.06E-10	7.13E-11	8.12E-11	9.11E-11	2.04E-10	9.24E-10

Table A1-f. Mean and Fractile Seismic Hazard Curves for 1 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.01E-02	9.11E-03	1.27E-02	1.95E-02	2.76E-02	3.33E-02
0.001	1.37E-02	5.27E-03	7.89E-03	1.29E-02	1.95E-02	2.46E-02
0.005	3.94E-03	8.35E-04	1.62E-03	3.57E-03	6.26E-03	8.35E-03
0.01	2.03E-03	2.29E-04	5.27E-04	1.62E-03	3.63E-03	5.20E-03
0.015	1.25E-03	9.11E-05	2.29E-04	8.47E-04	2.35E-03	3.79E-03
0.03	4.08E-04	1.51E-05	4.13E-05	1.87E-04	7.55E-04	1.55E-03
0.05	1.35E-04	3.28E-06	9.37E-06	4.70E-05	2.25E-04	5.66E-04
0.075	4.73E-05	8.98E-07	2.72E-06	1.40E-05	7.03E-05	1.98E-04
0.1	2.09E-05	3.52E-07	1.11E-06	5.91E-06	2.96E-05	8.60E-05
0.15	6.20E-06	9.24E-08	3.09E-07	1.77E-06	8.72E-06	2.49E-05
0.3	8.22E-07	8.72E-09	3.73E-08	2.42E-07	1.27E-06	3.52E-06
0.5	2.19E-07	1.44E-09	7.89E-09	6.09E-08	3.47E-07	9.51E-07
0.75	7.96E-08	3.73E-10	2.16E-09	1.95E-08	1.20E-07	3.42E-07
1.	3.80E-08	1.67E-10	8.60E-10	8.35E-09	5.42E-08	1.67E-07
1.5	1.27E-08	9.93E-11	2.57E-10	2.22E-09	1.67E-08	5.66E-08
3.	1.70E-09	8.23E-11	9.11E-11	2.25E-10	1.69E-09	7.34E-09
5.	3.39E-10	7.13E-11	8.12E-11	9.93E-11	2.96E-10	1.36E-09
7.5	8.51E-11	7.13E-11	8.12E-11	9.11E-11	1.15E-10	3.47E-10
10.	2.99E-11	7.13E-11	8.12E-11	9.11E-11	1.01E-10	1.57E-10

Table A1-g. Mean and Fractile Seismic Hazard Curves for 0.5 Hz at Point Beach

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	1.05E-02	4.83E-03	6.83E-03	1.01E-02	1.40E-02	1.74E-02
0.001	6.59E-03	2.64E-03	3.90E-03	6.26E-03	9.24E-03	1.16E-02
0.005	2.14E-03	2.76E-04	5.91E-04	1.77E-03	3.79E-03	5.27E-03
0.01	1.10E-03	6.00E-05	1.57E-04	7.03E-04	2.13E-03	3.47E-03
0.015	6.37E-04	2.10E-05	6.09E-05	3.19E-04	1.27E-03	2.25E-03
0.03	1.75E-04	2.60E-06	8.85E-06	5.50E-05	3.14E-04	7.45E-04
0.05	4.88E-05	4.90E-07	1.77E-06	1.16E-05	7.45E-05	2.19E-04
0.075	1.47E-05	1.21E-07	4.43E-07	3.05E-06	1.95E-05	6.73E-05
0.1	5.72E-06	4.31E-08	1.57E-07	1.15E-06	6.93E-06	2.64E-05
0.15	1.39E-06	8.98E-09	3.47E-08	2.76E-07	1.67E-06	6.54E-06
0.3	1.36E-07	4.77E-10	2.46E-09	2.16E-08	1.77E-07	6.45E-07
0.5	3.58E-08	1.08E-10	3.37E-10	3.73E-09	3.73E-08	1.62E-07
0.75	1.45E-08	9.11E-11	1.10E-10	9.51E-10	1.23E-08	6.36E-08
1.	7.78E-09	8.47E-11	9.11E-11	3.79E-10	5.75E-09	3.28E-08
1.5	3.12E-09	8.12E-11	9.11E-11	1.40E-10	1.90E-09	1.23E-08
3.	5.40E-10	7.13E-11	8.12E-11	9.11E-11	2.80E-10	1.84E-09
5.	1.22E-10	7.13E-11	8.12E-11	9.11E-11	1.10E-10	4.07E-10
7.5	3.25E-11	7.13E-11	8.12E-11	9.11E-11	1.01E-10	1.51E-10
10.	1.18E-11	7.13E-11	8.12E-11	9.11E-11	1.01E-10	1.01E-10

Table A2-a. Amplification Functions for Point Beach

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	2.72E+00	1.08E-01	1.30E-02	2.41E+00	1.17E-01	1.90E-02	2.33E+00	2.22E-01	2.09E-02	2.82E+00	2.62E-01
4.95E-02	2.03E+00	1.36E-01	1.02E-01	1.54E+00	1.95E-01	9.99E-02	1.91E+00	2.94E-01	8.24E-02	2.46E+00	2.62E-01
9.64E-02	1.72E+00	1.48E-01	2.13E-01	1.29E+00	2.25E-01	1.85E-01	1.73E+00	3.10E-01	1.44E-01	2.27E+00	2.70E-01
1.94E-01	1.41E+00	1.60E-01	4.43E-01	1.03E+00	2.54E-01	3.56E-01	1.49E+00	3.08E-01	2.65E-01	2.03E+00	2.83E-01
2.92E-01	1.24E+00	1.68E-01	6.76E-01	8.74E-01	2.72E-01	5.23E-01	1.34E+00	3.02E-01	3.84E-01	1.85E+00	2.89E-01
3.91E-01	1.12E+00	1.72E-01	9.09E-01	7.66E-01	2.79E-01	6.90E-01	1.22E+00	2.97E-01	5.02E-01	1.71E+00	2.90E-01
4.93E-01	1.02E+00	1.77E-01	1.15E+00	6.85E-01	2.86E-01	8.61E-01	1.13E+00	2.93E-01	6.22E-01	1.59E+00	2.96E-01
7.41E-01	8.63E-01	1.88E-01	1.73E+00	5.50E-01	3.05E-01	1.27E+00	9.57E-01	2.89E-01	9.13E-01	1.36E+00	3.10E-01
1.01E+00	7.49E-01	1.97E-01	2.36E+00	5.00E-01	3.15E-01	1.72E+00	8.34E-01	2.95E-01	1.22E+00	1.20E+00	3.15E-01
1.28E+00	6.66E-01	2.03E-01	3.01E+00	5.00E-01	3.25E-01	2.17E+00	7.41E-01	3.04E-01	1.54E+00	1.08E+00	3.20E-01
1.55E+00	6.05E-01	2.10E-01	3.63E+00	5.00E-01	3.36E-01	2.61E+00	6.68E-01	3.18E-01	1.85E+00	9.85E-01	3.30E-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	2.68E+00	3.50E-01	1.27E-02	1.52E+00	1.68E-01	8.25E-03	1.36E+00	2.18E-01			
7.05E-02	2.52E+00	2.89E-01	3.43E-02	1.60E+00	1.95E-01	1.96E-02	1.39E+00	2.18E-01			
1.18E-01	2.38E+00	2.53E-01	5.51E-02	1.65E+00	2.19E-01	3.02E-02	1.39E+00	2.19E-01			
2.12E-01	2.19E+00	2.47E-01	9.63E-02	1.74E+00	2.45E-01	5.11E-02	1.41E+00	2.26E-01			
3.04E-01	2.04E+00	2.62E-01	1.36E-01	1.78E+00	2.30E-01	7.10E-02	1.43E+00	2.39E-01			
3.94E-01	1.91E+00	2.79E-01	1.75E-01	1.79E+00	2.16E-01	9.06E-02	1.46E+00	2.59E-01			
4.86E-01	1.80E+00	2.93E-01	2.14E-01	1.77E+00	2.24E-01	1.10E-01	1.48E+00	2.74E-01			
7.09E-01	1.63E+00	3.14E-01	3.10E-01	1.72E+00	2.48E-01	1.58E-01	1.52E+00	3.29E-01			
9.47E-01	1.52E+00	3.21E-01	4.12E-01	1.71E+00	2.62E-01	2.09E-01	1.57E+00	3.32E-01			
1.19E+00	1.43E+00	3.09E-01	5.18E-01	1.71E+00	2.63E-01	2.62E-01	1.61E+00	3.10E-01			
1.43E+00	1.39E+00	3.02E-01	6.19E-01	1.72E+00	2.53E-01	3.12E-01	1.64E+00	3.09E-01			

Table A2-b1. Median AFs and sigmas for Model 1, Profile 1, for 2 PGA levels.

M1P1K1	Rock PGA=0.0495			M1P1K1	PGA=0.194		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.105	2.115	0.126	100.0	0.273	1.406	0.162
87.1	0.105	2.096	0.127	87.1	0.274	1.378	0.163
75.9	0.106	2.063	0.128	75.9	0.276	1.327	0.165
66.1	0.108	2.001	0.129	66.1	0.280	1.233	0.169
57.5	0.111	1.883	0.132	57.5	0.287	1.082	0.176
50.1	0.116	1.735	0.139	50.1	0.300	0.940	0.188
43.7	0.123	1.602	0.150	43.7	0.317	0.842	0.206
38.0	0.132	1.530	0.164	38.0	0.338	0.815	0.223
33.1	0.140	1.487	0.177	33.1	0.361	0.823	0.238
28.8	0.150	1.536	0.180	28.8	0.384	0.873	0.247
25.1	0.160	1.575	0.194	25.1	0.409	0.923	0.252
21.9	0.167	1.659	0.198	21.9	0.437	1.034	0.260
19.1	0.175	1.701	0.211	19.1	0.455	1.092	0.259
16.6	0.187	1.831	0.225	16.6	0.471	1.176	0.261
14.5	0.187	1.858	0.220	14.5	0.490	1.279	0.250
12.6	0.192	1.908	0.212	12.6	0.500	1.339	0.236
11.0	0.202	2.010	0.263	11.0	0.500	1.374	0.232
9.5	0.204	2.072	0.276	9.5	0.537	1.543	0.270
8.3	0.210	2.259	0.268	8.3	0.552	1.721	0.285
7.2	0.210	2.362	0.319	7.2	0.541	1.798	0.269
6.3	0.188	2.211	0.335	6.3	0.521	1.844	0.290
5.5	0.164	1.978	0.266	5.5	0.486	1.800	0.291
4.8	0.157	1.903	0.223	4.8	0.444	1.680	0.255
4.2	0.167	2.063	0.272	4.2	0.425	1.658	0.243
3.6	0.199	2.488	0.304	3.6	0.460	1.843	0.292
3.2	0.239	3.121	0.300	3.2	0.518	2.204	0.312
2.8	0.269	3.655	0.243	2.8	0.608	2.726	0.278
2.4	0.246	3.584	0.308	2.4	0.642	3.120	0.209
2.1	0.179	2.837	0.318	2.1	0.574	3.065	0.254
1.8	0.125	2.188	0.258	1.8	0.434	2.592	0.301
1.6	0.094	1.891	0.249	1.6	0.316	2.179	0.295
1.4	0.074	1.707	0.229	1.4	0.238	1.902	0.263
1.2	0.059	1.531	0.173	1.2	0.183	1.660	0.196
1.0	0.049	1.399	0.134	1.0	0.148	1.485	0.150
0.91	0.043	1.323	0.121	0.91	0.125	1.383	0.132
0.79	0.039	1.298	0.138	0.79	0.110	1.342	0.145
0.69	0.035	1.304	0.164	0.69	0.098	1.339	0.168
0.60	0.032	1.325	0.194	0.60	0.086	1.352	0.196
0.52	0.028	1.340	0.217	0.52	0.074	1.362	0.216
0.46	0.023	1.337	0.222	0.46	0.061	1.356	0.221
0.10	0.001	1.164	0.050	0.10	0.002	1.171	0.055

Table A2-b2. Median AFs and sigmas for Model 2, Profile 1, for 2 PGA levels.

M2P1K1	PGA=0.0495			M2P1K1	PGA=0.194		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.110	2.214	0.117	100.0	0.296	1.528	0.157
87.1	0.110	2.195	0.118	87.1	0.298	1.499	0.158
75.9	0.111	2.164	0.119	75.9	0.301	1.448	0.161
66.1	0.113	2.103	0.121	66.1	0.307	1.353	0.166
57.5	0.117	1.987	0.124	57.5	0.318	1.199	0.175
50.1	0.123	1.844	0.133	50.1	0.337	1.057	0.193
43.7	0.133	1.721	0.148	43.7	0.363	0.963	0.217
38.0	0.143	1.661	0.168	38.0	0.391	0.944	0.230
33.1	0.152	1.611	0.177	33.1	0.422	0.962	0.245
28.8	0.162	1.659	0.171	28.8	0.452	1.027	0.259
25.1	0.172	1.696	0.190	25.1	0.476	1.073	0.257
21.9	0.182	1.808	0.197	21.9	0.503	1.190	0.256
19.1	0.191	1.852	0.184	19.1	0.532	1.276	0.261
16.6	0.204	1.994	0.229	16.6	0.549	1.370	0.249
14.5	0.204	2.023	0.209	14.5	0.562	1.466	0.225
12.6	0.206	2.049	0.221	12.6	0.566	1.517	0.209
11.0	0.213	2.113	0.271	11.0	0.561	1.542	0.249
9.5	0.219	2.224	0.254	9.5	0.588	1.691	0.281
8.3	0.228	2.450	0.266	8.3	0.615	1.916	0.248
7.2	0.219	2.464	0.350	7.2	0.601	1.999	0.266
6.3	0.186	2.181	0.331	6.3	0.541	1.913	0.310
5.5	0.165	1.986	0.280	5.5	0.479	1.774	0.295
4.8	0.159	1.932	0.230	4.8	0.445	1.684	0.272
4.2	0.172	2.117	0.263	4.2	0.440	1.717	0.269
3.6	0.207	2.580	0.293	3.6	0.488	1.958	0.295
3.2	0.247	3.234	0.282	3.2	0.556	2.366	0.300
2.8	0.273	3.712	0.235	2.8	0.645	2.893	0.254
2.4	0.243	3.537	0.323	2.4	0.658	3.198	0.223
2.1	0.174	2.753	0.331	2.1	0.551	2.940	0.283
1.8	0.121	2.129	0.261	1.8	0.406	2.426	0.314
1.6	0.092	1.853	0.251	1.6	0.299	2.059	0.297
1.4	0.073	1.683	0.230	1.4	0.228	1.823	0.264
1.2	0.058	1.515	0.173	1.2	0.177	1.609	0.198
1.0	0.049	1.388	0.134	1.0	0.144	1.452	0.151
0.91	0.043	1.316	0.120	0.91	0.123	1.361	0.131
0.79	0.039	1.293	0.137	0.79	0.109	1.326	0.143
0.69	0.035	1.301	0.163	0.69	0.097	1.327	0.166
0.60	0.031	1.322	0.193	0.60	0.085	1.343	0.194
0.52	0.028	1.337	0.216	0.52	0.073	1.355	0.215
0.46	0.023	1.336	0.220	0.46	0.061	1.350	0.219
0.10	0.001	1.164	0.050	0.10	0.002	1.169	0.055