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DUKE ENERGY.

10 CFR 50.54(f)

March 27, 2014
Serial: HNP-14-035

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

Duke Energy Progress, Inc. (Duke Energy)
Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400

Subject: Seismic Hazard and Screening Report (CEUS Sites), Response to NRC 10 CFR 50.54(f) 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

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, ADAMS Accession No. ML12053A340
2. Electric Power Research Institute (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
3. NRC Letter, *Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance,"* dated February 15, 2013, ADAMS Accession No. ML12319A074
4. NEI Letter, *Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations*, dated April 9, 2013, ADAMS Accession No. ML13101A379
5. NRC Letter, *Electric Power Research Institute 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, ADAMS Accession No. ML13106A331
6. EPRI Final Report No. 3002000704, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic", May 2013

Ladies and Gentlemen:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) staff issued Reference 1 to all power reactor licensees and holders of construction permits in active or deferred status.

A010
NRR

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.

The Nuclear Energy Institute (NEI) submitted Reference 4 requesting NRC agreement to delay submittal of the CEUS Seismic Hazard Evaluation and Screening Report 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.

Industry guidance and detailed information to be included in the Seismic Hazard Evaluation and Screening Report submittals is provided by Reference 2. The industry guidance was endorsed by the NRC in a letter dated February 15, 2013, (Reference 3).

The attachment provides the Seismic Hazard Evaluation and Screening Report for Shearon Harris Nuclear Power Plant, Unit 1, as directed by Section 4 of Reference 2 and in accordance with the schedule provided in Reference 4.

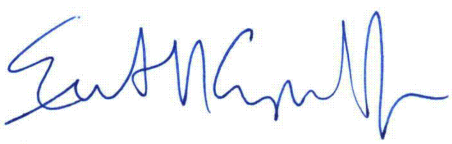
Based on the results documented in the attachment, Shearon Harris Nuclear Power Plant, Unit 1, screens in for only a High Frequency Confirmation per Section 3.2 of Reference 2 and screens out of the Expedited Seismic Evaluation Process (ESEP) per Section 2.2 of Reference 6.

There are no regulatory commitments associated with this letter.

If you have any questions regarding this report, please contact Dave Corlett, Regulatory Affairs Manager, at (919) 362-3137.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on March 27, 2014.

Sincerely,



Ernest J. Kapopoulos, Jr.

Attachment:
Seismic Hazard Evaluation and Screening Report, Shearon Harris Nuclear Power Plant, Unit 1, Docket No. 50-400

cc: Mr. J. D. Austin, NRC Sr. Resident Inspector, HNP
Mr. A. Hon, NRC Project Manager, HNP
Mr. V. M. McCree, NRC Regional Administrator, Region II

Attachment

Seismic Hazard Evaluation and Screening Report

Shearon Harris Nuclear Power Plant, Unit 1

Docket No. 50-400

Seismic Hazard Evaluation and Screening Report

for

Shearon Harris Nuclear Plant (HNP) Unit 1

1.0 Introduction

Following the accident at the Fukushima Dai-ichi 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 on March 12, 2012 (Reference 1) 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 Shearon Harris Nuclear Plant (HNP) site, located in southwest Wake County and southeast Chatham County, North Carolina. In providing this information, HNP 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 1025287, 2013) (Reference 2). The Augmented Approach, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI 3002000704, 2013) (Reference 3), 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 design response spectra used for all Seismic Category I structures, systems, and components (SSCs), except dams and dikes, were developed in accordance with Regulatory Guide (RG) 1.60 (Reference 4). Those SSCs, including their foundations and supports, that are designed to remain functional in the event of a safe shutdown earthquake (SSE) are designated Seismic Category I and are listed in Table 3.2.1-1 of the HNP Updated Final Safety Analysis Report (UFSAR) (Reference 5). The applicable codes, standards and specifications used in the design of seismic Category I SSCs are listed in Section 3.8.1 of the HNP UFSAR (Reference 5).

In response to the 50.54(f) letter and following the guidance provided in the SPID (Reference 2), 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, HNP screens in for only a High Frequency Confirmation.

2.0 Seismic Hazard Reevaluation

The HNP site is located in southwest Wake County and southeast Chatham County, North Carolina. The site is approximately 35 miles southwest of Raleigh, North Carolina and is located near the eastern edge of the Cape Fear River drainage basin. The site is underlain by gently dipping rocks of the Upper Triassic Sanford formation. The bedrock is mostly siltstone and fine-grained sandstone interbedded with subordinate shale, claystone, and conglomerate. Beds range in thickness from less than an inch to a maximum of 20 ft. They interfinger and overlap into compact masses with no structural weakness. A minor fault uncovered in the plant excavation trends nearly east-west across the site. The fault is a minor tensional normal fault with downthrow on the south and the last movement was more than 150 million years ago. Since the Late Jurassic, the site area has been remarkably stable. The Triassic rocks have not been further faulted, and no faults offsetting strata younger than Miocene have been found in the site region.

The plant site lies in an aseismic area; and no earthquakes have been reported within 40 miles of the site. The original investigation of historical seismic activity in the region indicated that a design intensity of VII (Modified Mercalli Scale) is adequately conservative for the site. HNP determined that the Intensity VII, with margin added, corresponds to peak ground acceleration of 0.150 g for the SSE.

2.1 Regional and Local Geology

Regional Geology

The HNP site is located in the Deep River Triassic Basin, a trough-like topographic lowland located mostly within the Piedmont Plateau Physiographic Province. The upland area elevations of the Piedmont Plateau range from 300 ft to 600 ft above sea level along the eastern border of the plateau and increase to about 1500 ft above sea level at the bottom of the Blue Ridge Scarp. The lowland elevations in the Plateau are 50 ft to 200 ft lower than the upland regions. Elevations along the Cape Fear River range from less than 160 ft above sea level to more than 500 ft in the northern part of the basin. Underlying the Piedmont Plateau is igneous and metamorphic rock. This rock can be divided into several broad northeast-southwest trending belts on the basis of the differences in metamorphic rock grade. The Deep River Triassic Basin is a sediment-filled trough located between the Carolina Slate Belt on the west and the Raleigh Belt on the east. The Carolina Slate Belt rocks form a section that is believed to be at least 30,000 ft thick in North Carolina. This section of the belt consists mostly of metavolcanic rocks and metasediments, of Late Precambrian and Cambrian age with intrusions of granitic plutons.

The geologic history of the central and eastern Piedmont region is poorly known because fossil-bearing strata are extremely rare and geochronology is based largely on radiometric dating of igneous events. The geologic record suggests that island arc volcanism was the dominant activity from Late Precambrian through Cambrian time. A period of major deformation of early volcanogenic deposits around 600 million years ago formed the major folds of the Carolina Slate Belt.

In the Deep River Basin, normal fault movement along segments of the Jonesboro fault system and the resulting differential subsidence caused eastward tilting of sedimentary strata. Accumulation of the sedimentary wedge was followed by continued movements in the Jonesboro fault zone and development of cross-basin faults. Emplacement of diabase sills and dikes followed formation of the cross faults and continued into Jurassic time. Final movement of the Jonesboro fault during late Triassic-early Jurassic time was followed by widespread zeolite mineralization related either to low-grade burial metamorphism or to high heat flow and hydrothermal activity. Little is known of late Mesozoic and Tertiary history. The region apparently has been relatively stable tectonically since late Mesozoic time. Crustal movement has largely been limited to vertical isostatic adjustments possibly related to periodic uplift of the Appalachians to the west and subsidence of the Coastal Plain to the east.

Local Geology

The HNP site is located near the eastern edge of the Cape Fear River drainage basin. Elevation of hill tops and ridge crests are mostly between 250 ft and 275 ft and local relief is generally less than 60 ft. Drainage from the site is southeast through Tom Jack Creek and Thomas Creek to Whiteoak Creek, which flows southwestward into Buckhorn Creek, which in turn flows southward and empties into the Cape Fear River about a quarter mile below Buckhorn Dam. The soils around the site are mostly residual soils derived from sedimentary rocks and diabase dikes underlying the area. Soil depth ranges from 0 to 15 ft., but is commonly between 5 ft and 10 ft. The soil is generally thinnest over sandstone and thickest over diabase dikes. Most residual soil is silty clay in texture, but silty sand may be found along streams and in limited areas overlying sandstone. Residual soils observed in trench excavations were medium stiff to hard. Permeability values of most soils are extremely low, resulting in rapid precipitation runoff.

The site is underlain by gently dipping rocks of the Upper Triassic Sanford formation. The bedrock is mostly siltstone and fine-grained sandstone interbedded with subordinate shale, claystone, and conglomerate. These rocks consist mostly of alluvial fan, stream channel and floodplain deposits and are characterized by abrupt changes in composition and texture, both horizontally and vertically. A minor fault uncovered in the plant excavation trends nearly east-west across the site. The fault is a normal fault with downthrow on the south. The fault surface is somewhat undulatory with dips ranging from vertical to 55° southward. Drag folding of Triassic beds is present on the hanging wall of the fault. Investigation has determined that the fault is a minor tensional normal fault whose last movement was prior to 150 million years ago. Several small, non-capable faults were found in the foundations of Main Dam structures. No other significant structural features were found.

Historical records of earthquake activity indicate that the site is aseismic. There is little history of felt earthquakes in the site area and no historical accounts of the behavior of the site during the few earthquakes which have been felt. The geologic history of the site through Paleozoic time is poorly known, since the only Paleozoic rocks exposed in the plant area are Raleigh Belt gneisses and schists exposed in the Main Dam foundation south of the plant.

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 (Reference 2), 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 (Reference 6) together with the updated EPRI Ground-Motion Model (GMM) for the CEUS (Reference 7). For the PSHA, a lower-bound (minimum) moment magnitude of 5.0 was used, as specified in the 50.54(f) letter.

For the PSHA, the CEUS-SSC background seismic source zones out to a distance of 400 miles (640 km) around the HNP site were included. This distance exceeds the 200 mile (320 km) recommendation. Background sources included in this site analysis are the following:

1. Atlantic Highly Extended Crust
2. Extended Continental Crust—Atlantic Margin
3. Extended Continental Crust—Gulf Coast
4. Mesozoic and younger extended prior – narrow
5. Mesozoic and younger extended prior – wide
6. Midcontinent-Craton alternative A
7. Midcontinent-Craton alternative B
8. Midcontinent-Craton alternative C
9. Midcontinent-Craton alternative D
10. Non-Mesozoic and younger extended prior – narrow
11. Non-Mesozoic and younger extended prior – wide
12. Paleozoic Extended Crust narrow
13. Paleozoic Extended Crust wide
14. Reelfoot Rift including the Rough Creek Graben
15. Study region

For sources of large magnitude earthquakes, designated Repeated Large Magnitude Earthquake (RLME) sources in CEUS-SSC (Reference 6), the following sources lie within 625 miles (1,000 km) of the site and were included in the analysis:

1. Charleston
2. Commerce
3. Eastern Rift Margin Fault northern segment
4. Eastern Rift Margin Fault southern segment
5. New Madrid Fault System
6. 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 (Reference 2), base rock seismic hazard curves are not provided as the site amplification approach referred to as Method 3 has been used. Seismic hazard curves are shown below in Section 3 at the SSE control point elevation.

2.3 Site Response Evaluation

A site response analysis was performed for HNP following the guidance contained in Seismic Enclosure 1 of the March 12, 2012 50.54(f) Request for Information (Reference 1) and in the SPID (Reference 2) for nuclear power plant sites that are not sited on hard rock (defined as 2.83 km/sec).

2.3.1 Description of Subsurface Material

The HNP site is located in the Deep River Triassic Basin of North Carolina. The general site conditions consist of about 15 ft (4.6 m) of residual soils and weathered rock overlying about 5,000 ft of sound Triassic sedimentary rocks with a basement of hard crystalline rocks.

Table 2.3.1-1 provides a brief description of the subsurface material in terms of the geologic units and layer thicknesses.

Table 2.3.1-1. Geologic profile and estimated layer thicknesses for HNP.

Depth Range (feet)	Soil/Rock Description	Density (pcf)	Shear Wave Velocity (fps)	Compressional Wave Velocity (fps)	Poisson's Ratio
0-8	Residual Soil	130	500*	1500	0.44
8-16	Weathered and Fractured Rock	160	2500	5500	0.37
Below 16	Sound Bedrock (SSE Control Point)	160	5600	12000	0.35

* Estimated values.

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 verses depth for the profile. Based on Table 2.3.1-1 and the location of the SSE at a depth of 16 ft (4.9 m), the profile consists of 5,000 ft (1524 m) of firm rock overlying hard crystalline basement rock.

Shear-wave velocities for the profile were based on measurements of compressional-wave velocities and assumed Poisson ratios. More recent downhole testing at the nearby proposed new nuclear plant site generally confirmed the firm rock shear-wave velocities (Reference 8).

To develop the mean or best-estimate base-case firm rock profile, the shear-wave velocity of 5,600 ft/s (1,707 m/s) was assumed to reflect the shallow portion of the profile. Provided the materials to basement depth reflect similar sedimentary rocks and age, the shear-wave velocity gradient for sedimentary rock of 0.5m/m/s (Reference 2) was assumed to be appropriate for the site. The shallow shear-wave velocity of 5,600 ft/s (1,707 m/s) was taken at the surface of the profile with the velocity gradient applied at that point, resulting in a mean base-case shear-wave velocity of about 8,000 ft/s (2,438 m/s) at a depth of 5,000 ft (1,524 m). The mean or best estimate base-case profile is shown as profile P1 in Figure 2.3.2-1.

Based on the specified shear-wave velocities, reflecting measured compressional-wave velocities and assumed Poisson ratios, a scale factor of 1.57 was adopted to reflect upper and lower range base-cases. The scale factor of 1.57 reflects a $\sigma_{\mu ln}$ of about 0.35 based on the SPID (Reference 2) 10^{th} and 90^{th} fractiles which implies a 1.28 scale factor on σ_{μ}.

Using the best-estimate or mean base-case profile (P1), the depth independent scale factor of 1.57 was applied to develop lower and upper range base-case profiles P2 and P3 respectively, with the stiffest profile (P3) reaching reference rock velocities at a depth of about 600 ft (183 m). Base-case profiles P1 and P2 have a mean depth below the SSE of 5,000 ft (1,524 m) to hard reference rock, randomized ± 1,500 ft (± 457 m). The base-case profiles (P1, P2, and P3) are shown in Figure 2.3.2-1 and listed in Table 2.3.2-1. The depth randomization reflects ± 30% of the depth to provide a realistic broadening of the fundamental resonance rather than reflect actual random variations to basement shear-wave velocities across a footprint.

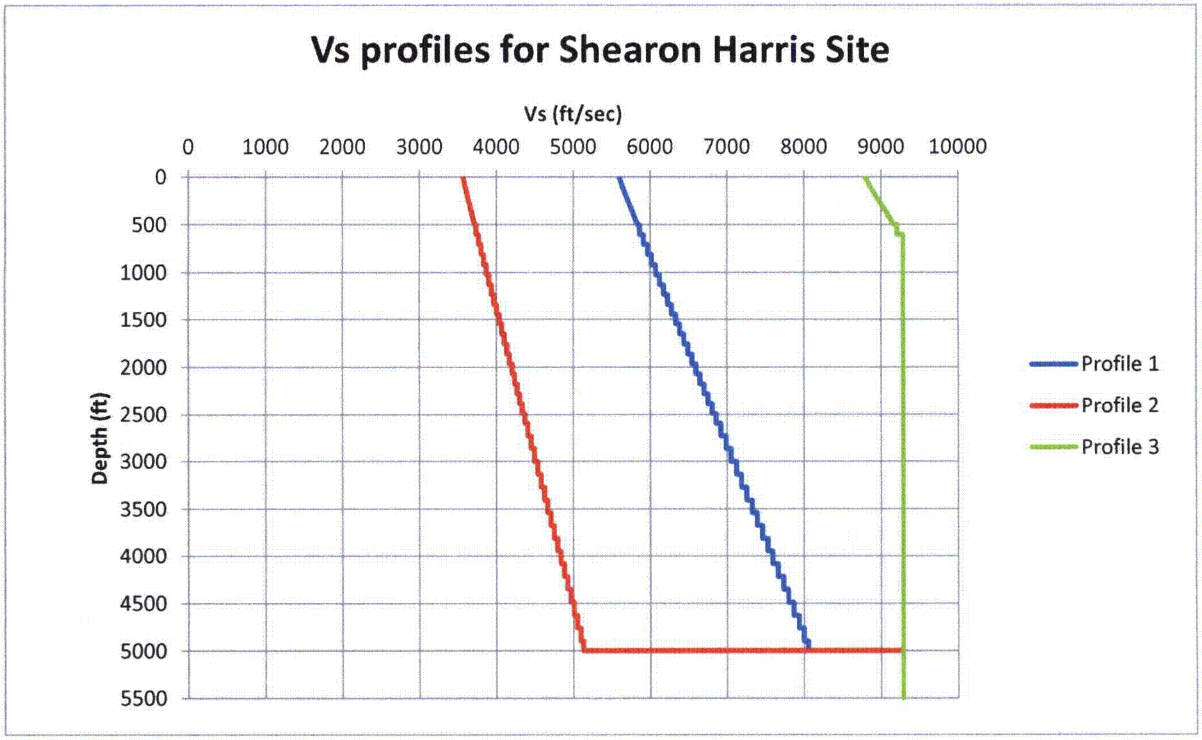


Figure 2.3.2-1. Shear-wave velocity profiles for the HNP Site.

Table 2.3.2-1. Geologic profile and estimated layer thicknesses for the HNP Site.

Profile 1			**Profile 2**			**Profile 3**		
Thicknes s (ft)	**Depth (ft)**	**Vs (ft/s)**	**Thickness (ft)**	**Depth (ft)**	**Vs (ft/s)**	**Thickness (ft)**	**Depth (ft)**	**Vs (ft/s)**
	0	5600		0	3567		0	8792
5.0	5.0	5600	5.0	5.0	3567	5.0	5.0	8792
5.0	10.0	5601	5.0	10.0	3568	5.0	10.0	8794
5.0	15.0	5603	5.0	15.0	3569	5.0	15.0	8797
5.0	20.0	5606	5.0	20.0	3571	5.0	20.0	8801
5.0	25.0	5608	5.0	25.0	3573	5.0	25.0	8805
5.0	30.0	5611	5.0	30.0	3574	5.0	30.0	8809
5.0	35.0	5613	5.0	35.0	3576	5.0	35.0	8813
5.0	40.0	5616	5.0	40.0	3577	5.0	40.0	8817
5.0	45.0	5618	5.0	45.0	3579	5.0	45.0	8821
5.0	50.0	5621	5.0	50.0	3581	5.0	50.0	8825
5.0	55.0	5623	5.0	55.0	3582	5.0	55.0	8829
5.0	60.0	5626	5.0	60.0	3584	5.0	60.0	8833
5.0	65.0	5628	5.0	65.0	3585	5.0	65.0	8837
3.0	68.0	5630	3.0	68.0	3586	3.0	68.0	8839
6.0	74.0	5631	6.0	74.0	3587	6.0	74.0	8841

Table 2.3.2-1. (cont.)

6.0	80.0	5632	6.0	80.0	3588	6.0	80.0	8843
6.0	86.0	5634	6.0	86.0	3589	6.0	86.0	8845
6.0	92.0	5635	6.0	92.0	3589	6.0	92.0	8847
7.0	99.0	5639	7.0	99.0	3592	7.0	99.0	8852
7.0	106.0	5642	7.0	106.0	3594	7.0	106.0	8858
7.0	113.0	5645	7.0	113.0	3596	7.0	113.0	8863
7.0	120.0	5649	7.0	120.0	3598	7.0	120.0	8869
6.0	126.0	5652	6.0	126.0	3600	6.0	126.0	8874
4.0	130.0	5654	4.0	130.0	3602	4.0	130.0	8877
5.0	135.0	5657	5.0	135.0	3603	5.0	135.0	8881
5.0	140.0	5659	5.0	140.0	3605	5.0	140.0	8885
5.0	145.0	5662	5.0	145.0	3606	5.0	145.0	8889
5.0	150.0	5664	5.0	150.0	3608	5.0	150.0	8892
5.0	155.0	5667	5.0	155.0	3610	5.0	155.0	8896
5.0	160.0	5669	5.0	160.0	3611	5.0	160.0	8900
4.0	164.0	5671	4.0	164.0	3612	4.0	164.0	8903
5.0	169.0	5672	5.0	169.0	3613	5.0	169.0	8905
5.0	174.0	5675	5.0	174.0	3615	5.0	174.0	8909
5.0	179.0	5677	5.0	179.0	3616	5.0	179.0	8913
5.0	184.0	5680	5.0	184.0	3618	5.0	184.0	8917
5.0	189.0	5682	5.0	189.0	3620	5.0	189.0	8921
5.0	194.0	5685	5.0	194.0	3621	5.0	194.0	8925
5.0	199.0	5687	5.0	199.0	3623	5.0	199.0	8929
5.0	204.0	5690	5.0	204.0	3624	5.0	204.0	8933
5.0	209.0	5692	5.0	209.0	3626	5.0	209.0	8937
5.0	214.0	5695	5.0	214.0	3628	5.0	214.0	8941
5.0	219.0	5697	5.0	219.0	3629	5.0	219.0	8945
5.0	224.0	5700	5.0	224.0	3631	5.0	224.0	8949
5.0	229.0	5702	5.0	229.0	3632	5.0	229.0	8953
5.0	234.0	5705	5.0	234.0	3634	5.0	234.0	8956
5.0	239.0	5707	5.0	239.0	3636	5.0	239.0	8960
5.0	244.0	5710	5.0	244.0	3637	5.0	244.0	8964
6.0	250.0	5713	6.0	250.0	3639	6.0	250.0	8969
6.3	256.3	5716	6.3	256.3	3641	6.3	256.3	8974
6.3	262.7	5719	6.3	262.7	3643	6.3	262.7	8979
6.3	269.0	5722	6.3	269.0	3645	6.3	269.0	8984
10.0	279.0	5727	10.0	279.0	3648	10.0	279.0	8992
10.0	289.0	5732	10.0	289.0	3651	10.0	289.0	9000
10.0	299.0	5737	10.0	299.0	3655	10.0	299.0	9007
10.0	309.0	5742	10.0	309.0	3658	10.0	309.0	9015

Table 2.3.2-1. (cont.)

10.0	319.0	5747	10.0	319.0	3661	10.0	319.0	9023
12.0	331.0	5753	12.0	331.0	3665	12.0	331.0	9033
10.0	341.0	5758	10.0	341.0	3668	10.0	341.0	9040
10.0	351.0	5763	10.0	351.0	3671	10.0	351.0	9048
10.0	361.0	5768	10.0	361.0	3674	10.0	361.0	9056
10.0	371.0	5773	10.0	371.0	3678	10.0	371.0	9064
10.0	381.0	5778	10.0	381.0	3681	10.0	381.0	9072
12.0	393.0	5784	12.0	393.0	3685	12.0	393.0	9081
7.0	400.0	5788	7.0	400.0	3687	7.0	400.0	9087
10.0	410.0	5790	10.0	410.0	3688	10.0	410.0	9091
10.0	420.0	5795	10.0	420.0	3692	10.0	420.0	9099
10.0	430.0	5800	10.0	430.0	3695	10.0	430.0	9106
10.0	440.0	5805	10.0	440.0	3698	10.0	440.0	9114
10.0	450.0	5810	10.0	450.0	3701	10.0	450.0	9122
10.0	460.0	5815	10.0	460.0	3704	10.0	460.0	9130
10.0	470.0	5820	10.0	470.0	3707	10.0	470.0	9138
10.0	480.0	5825	10.0	480.0	3711	10.0	480.0	9146
10.0	490.0	5830	10.0	490.0	3714	10.0	490.0	9153
10.0	500.0	5837	10.0	500.0	3718	10.0	500.0	9164
104.7	604.7	5863	104.7	604.7	3735	104.7	604.7	9205
104.7	709.5	5916	104.7	709.5	3768	104.7	709.5	9285
104.7	814.2	5968	104.7	814.2	3802	104.7	814.2	9285
104.7	919.0	6020	104.7	919.0	3835	104.7	919.0	9285
104.7	1023.7	6073	104.7	1023.7	3868	104.7	1023.7	9285
104.7	1128.4	6125	104.7	1128.4	3902	104.7	1128.4	9285
104.7	1233.2	6177	104.7	1233.2	3935	104.7	1233.2	9285
104.7	1337.9	6230	104.7	1337.9	3968	104.7	1337.9	9285
104.7	1442.7	6282	104.7	1442.7	4002	104.7	1442.7	9285
104.7	1547.4	6335	104.7	1547.4	4035	104.7	1547.4	9285
104.7	1652.2	6387	104.7	1652.2	4068	104.7	1652.2	9285
104.7	1756.9	6439	104.7	1756.9	4102	104.7	1756.9	9285
104.7	1861.7	6492	104.7	1861.7	4135	104.7	1861.7	9285
104.7	1966.4	6544	104.7	1966.4	4169	104.7	1966.4	9285
104.7	2071.1	6596	104.7	2071.1	4202	104.7	2071.1	9285
104.7	2175.9	6649	104.7	2175.9	4235	104.7	2175.9	9285
104.7	2280.6	6701	104.7	2280.6	4269	104.7	2280.6	9285
104.7	2385.4	6754	104.7	2385.4	4302	104.7	2385.4	9285
104.7	2490.1	6806	104.7	2490.1	4335	104.7	2490.1	9285
104.7	2594.9	6858	104.7	2594.9	4369	104.7	2594.9	9285
135.2	2730.1	6918	135.2	2730.1	4407	135.2	2730.1	9285

Table 2.3.2-1. (cont.)

135.2	2865.3	6986	135.2	2865.3	4450	135.2	2865.3	9285
135.2	3000.6	7054	135.2	3000.6	4493	135.2	3000.6	9285
135.2	3135.8	7121	135.2	3135.8	4536	135.2	3135.8	9285
135.2	3271.1	7189	135.2	3271.1	4579	135.2	3271.1	9285
135.2	3406.3	7256	135.2	3406.3	4622	135.2	3406.3	9285
135.2	3541.6	7324	135.2	3541.6	4665	135.2	3541.6	9285
135.2	3676.8	7392	135.2	3676.8	4708	135.2	3676.8	9285
135.2	3812.0	7459	135.2	3812.0	4752	135.2	3812.0	9285
135.2	3947.3	7527	135.2	3947.3	4795	135.2	3947.3	9285
135.2	4082.5	7594	135.2	4082.5	4838	135.2	4082.5	9285
135.2	4217.8	7662	135.2	4217.8	4881	135.2	4217.8	9285
135.2	4353.0	7730	135.2	4353.0	4924	135.2	4353.0	9285
135.2	4488.3	7797	135.2	4488.3	4967	135.2	4488.3	9285
135.2	4623.5	7865	135.2	4623.5	5010	135.2	4623.5	9285
135.2	4758.7	7933	135.2	4758.7	5053	135.2	4758.7	9285
135.2	4894.0	8000	135.2	4894.0	5096	135.2	4894.0	9285
105.8	4999.7	8053	105.8	4999.7	5130	105.8	4999.7	9285
3280.8	8280.6	9285	3280.8	8280.6	9285	3280.8	8280.6	9285

2.3.2.1 Shear Modulus and Damping Curves

No site-specific nonlinear dynamic material properties were determined in the initial siting of the HNP site for sedimentary rocks. The rock material over the upper 500 ft (150 m) was assumed to have behavior that could be modeled as either linear or non-linear. To represent this potential for either case in the upper 500 ft of sedimentary rock at the HNP site, two sets of shear modulus reduction and hysteretic damping curves were used. Consistent with the SPID (Reference 2), the EPRI rock curves (model M1) were considered to be appropriate to represent the upper range nonlinearity likely in the materials at this site and linear analyses (model M2) were assumed to represent an equally plausible alternative rock response across loading level. For the linear analyses, the low strain damping values from the EPRI rock curves were used as the constant damping values in the upper 500 ft (150 m).

2.3.2.2 Kappa

For the HNP site, kappa estimates were determined using Section B-5.1.3.1 of the SPID (Reference 2) for a firm CEUS rock site. Kappa for a firm rock site with at least 3,000 ft (1 km) of sedimentary rock may be estimated from the average S-wave velocity over the upper 100 ft (V_{s100}) of the subsurface profile while for a site with less than 3,000 ft (1 km) of firm rock, kappa may be estimated with a Qs of 40 below 500 ft combined with the low strain damping from the EPRI rock curves, and an additional kappa of 0.006 s for the underlying hard rock. For the HNP site, with 5,000 ft (1,524 m) of firm sedimentary rock below the SSE, kappa estimates were based on the average shear-wave velocity over the top 100 ft (30 m) of the three base-case profiles P1, P2, and P3. For the three profiles the corresponding shear-wave velocities were: 5,620 ft/s (1,713 m/s), 3,567 ft/s (1,087 m/s), and 8,792 ft/s (2,680 m/s) with corresponding kappa estimates of 0.013 s, 0.022 s, and 0.008 s. The range in kappa about the best estimate base-case value of 0.013 s (profile P1) is roughly 1.6 and was considered to adequately reflect epistemic uncertainty in low strain damping (kappa) for the profile. Table 2.3.2-2 shows the kappa values and weights used for HNP site response analyses.

Table 2.3.2-2. Kappa Values and Weights Used for HNP Site Response Analyses.

Velocity Profile	**Kappa(s)**
P1	0.013
P2	0.022
P3	0.008
	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 the HNP site, random shear wave velocity profiles were developed from the base case profiles shown in Figure 2.3.2-1. 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 (Reference 2), 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.

2.3.4 Input Spectra

Consistent with the guidance in Appendix B of the SPID (Reference 2), input Fourier amplitude spectra were defined for a single representative earthquake magnitude 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 g to 1.50 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 HNP site were the same as those identified in Tables B-4, B-5, B-6 and B-7 of the SPID (Reference 2) as appropriate for typical CEUS sites.

2.3.5 Methodology

To perform the site response analyses for the HNP 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 (Reference 2). The guidance contained in Appendix B of the SPID (Reference 2) 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 HNP 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 (Reference 2) 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 (0.01 g to 1.50 g) for profile P1 and EPRI rock G/G_{max} and hysteretic damping curves (Reference 9). 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 nonlinearity at the HNP site, Figure 2.3.6-2 shows the corresponding amplification factors developed with linear analyses (model M2). Tabulated values of the amplification factors are provided in Appendix A.

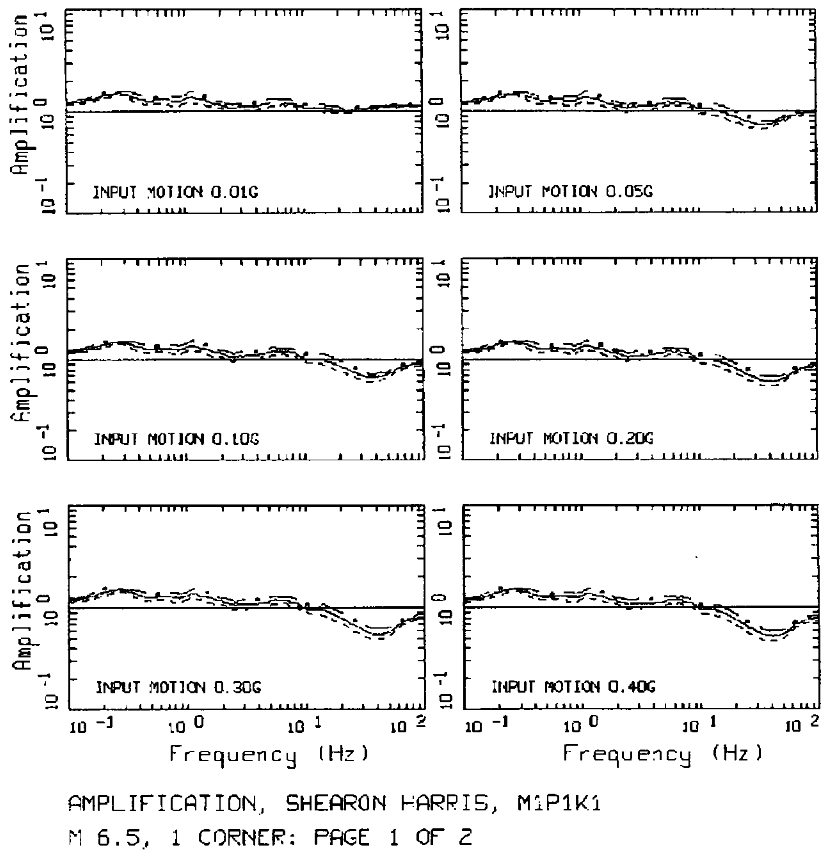


Figure 2.3.6-1. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI rock modulus reduction and hysteretic damping curves (model M1), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g. **M** 6.5 and single-corner source model (Reference 2). Curves show median and +/- 1 standard deviation.

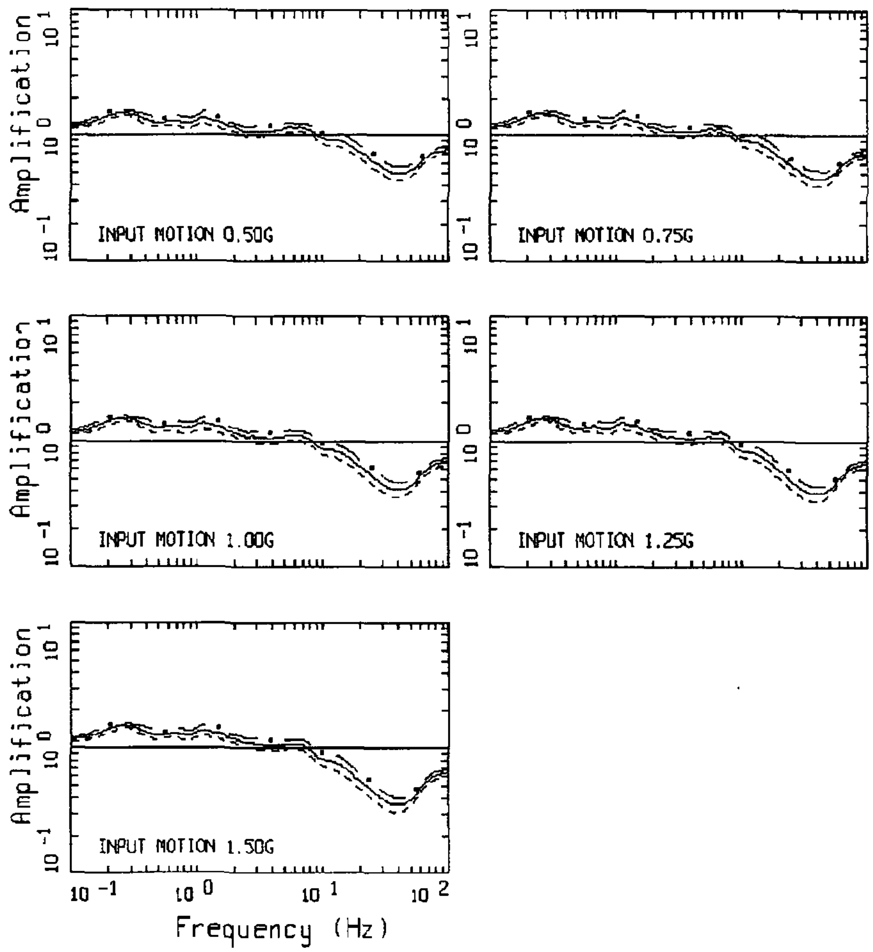


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Figure 2.3.6-1.(cont.)

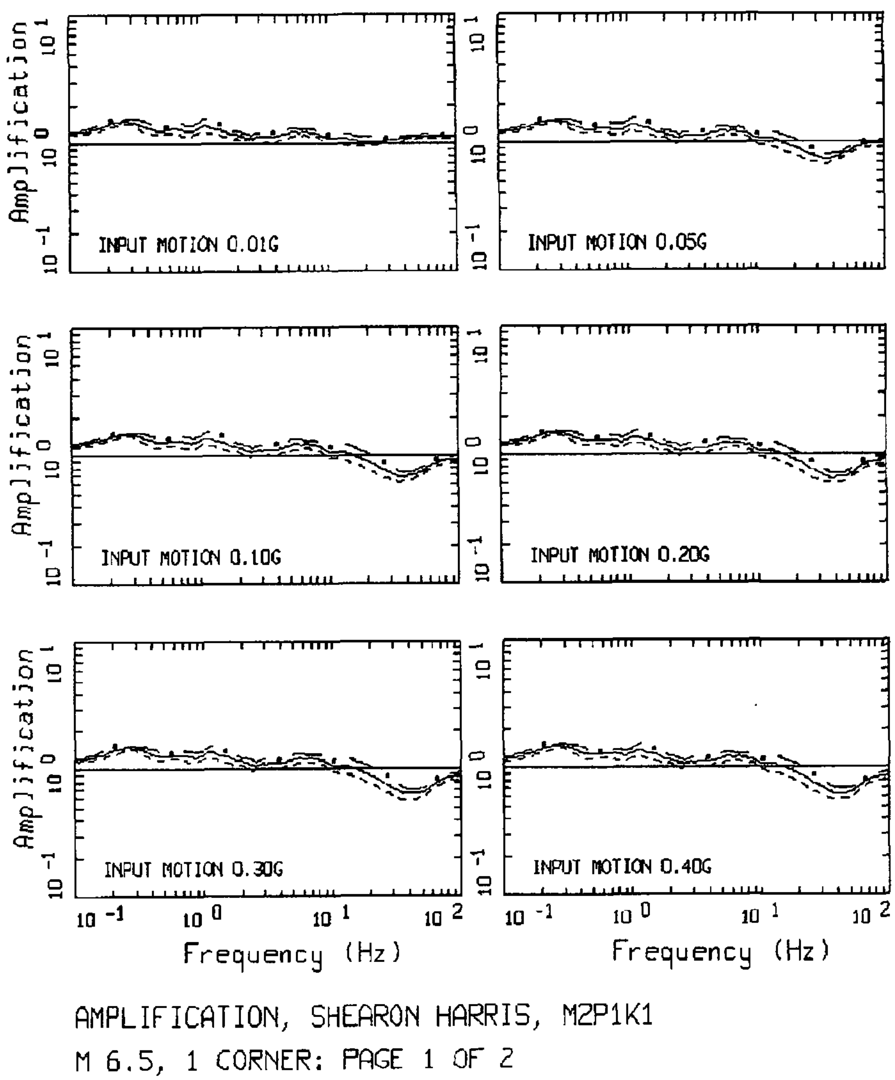
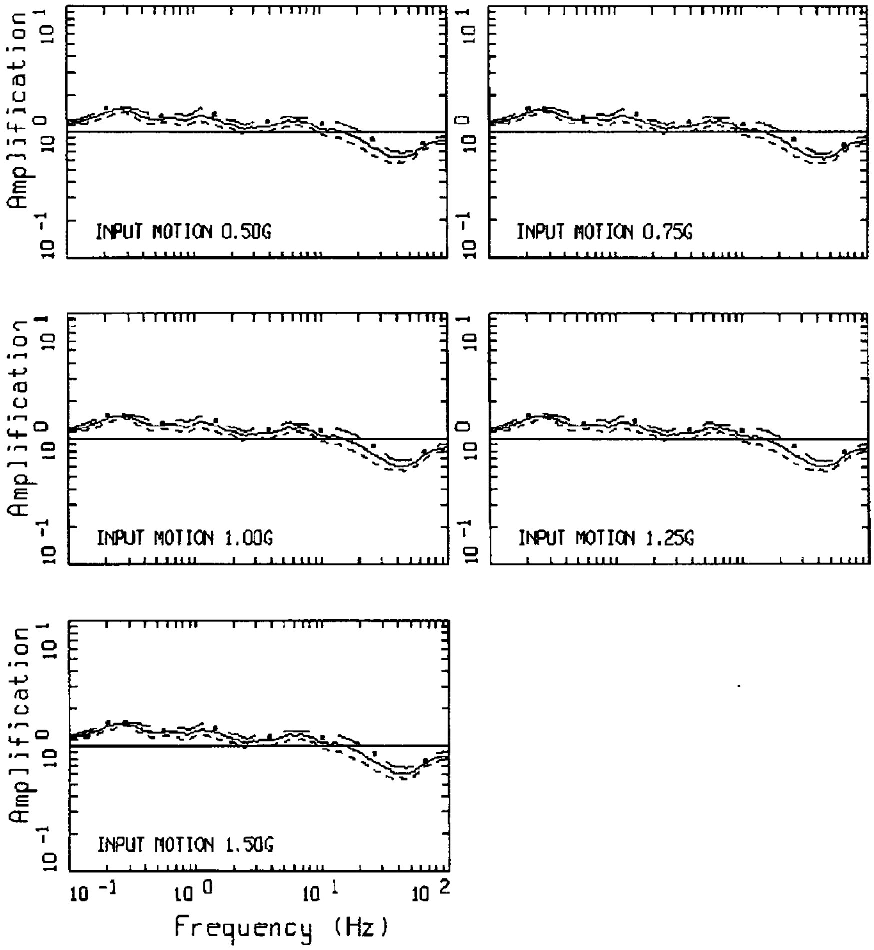


Figure 2.3.6-2. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), linear site response (model M2), and base-case kappa (K1) at eleven loading levels of hard rock median peak acceleration values from 0.01 g to 1.50 g. **M** 6.5 and single-corner source model (Reference 2). Curves show median and +/- 1 standard deviation.



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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 (Reference 2). 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 HNP are shown in Figure 2.3.7-1 for the seven spectral frequencies for which ground motion equations are defined. Tabulated values of the control point hazard curves are provided in Appendix A.

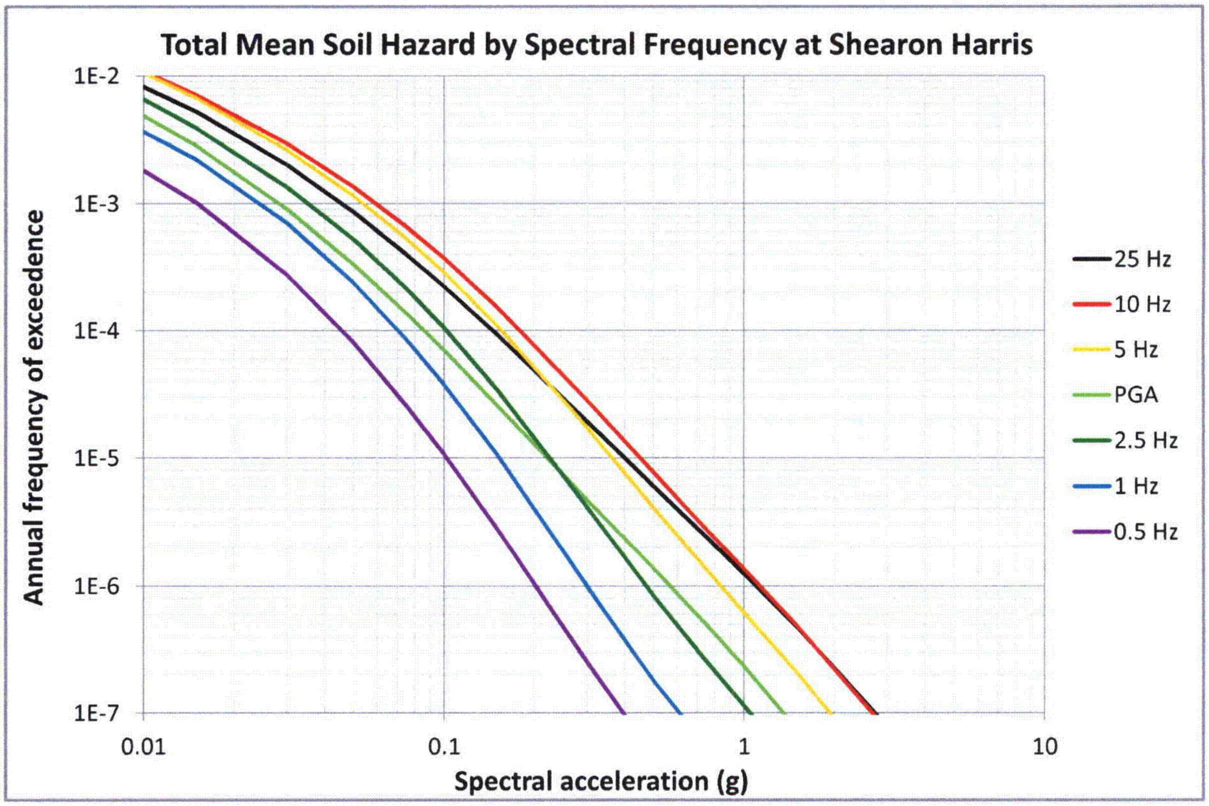

Figure 2.3.7-1. Control point mean hazard curves for spectral frequencies of 0.5, 1, 2.5, 5, 10, 25 and PGA (100 Hz) at the HNP site.

2.4 Control Point Response Spectra

The control point hazard curves described above were used to develop uniform hazard response spectra (UHRS) and the ground motion response spectrum (GMRS). The UHRS were obtained through linear interpolation in log-log space to estimate the spectral acceleration at each spectral frequency for the 1E-4 and 1E-5 per year hazard levels. The 1E-4 and 1E-5 UHRS along with the design factor (DF) are used to compute the GMRS at the control point using the criteria in Regulatory Guide 1.208 (Reference 10). Table 2.4-1 and Figure 2.4-1 show the UHRS and GMRS spectral accelerations.

Table 2.4-1. UHRS and GMRS at control point for HNP.

Freq, Hz	1E-4 UHRS (g)	1E-5 UHRS (g)	GMRS
100	8.58E-02	2.21E-01	1.10E-01
90	8.56E-02	2.21E-01	1.10E-01
80	8.58E-02	2.23E-01	1.11E-01
70	8.69E-02	2.28E-01	1.13E-01
60	9.03E-02	2.41E-01	1.19E-01
50	1.01E-01	2.78E-01	1.36E-01
40	1.18E-01	3.32E-01	1.62E-01
35	1.26E-01	3.55E-01	1.73E-01
30	1.37E-01	3.82E-01	1.87E-01
25	1.45E-01	4.00E-01	1.96E-01
20	1.60E-01	4.31E-01	2.12E-01
15	1.73E-01	4.53E-01	2.24E-01
12.5	1.79E-01	4.61E-01	2.29E-01
10	1.79E-01	4.51E-01	2.25E-01
9	1.78E-01	4.43E-01	2.22E-01
8	1.76E-01	4.32E-01	2.16E-01
7	1.71E-01	4.15E-01	2.09E-01
6	1.65E-01	3.92E-01	1.98E-01
5	1.56E-01	3.64E-01	1.84E-01

Table 2.4-1. (cont.)

4	1.37E-01	3.13E-01	1.59E-01
3.5	1.28E-01	2.90E-01	1.48E-01
3	1.16E-01	2.59E-01	1.32E-01
2.5	1.02E-01	2.25E-01	1.15E-01
2	9.74E-02	2.14E-01	1.10E-01
1.5	8.57E-02	1.88E-01	9.65E-02
1.25	8.04E-02	1.76E-01	9.02E-02
1	7.04E-02	1.53E-01	7.86E-02
0.9	6.58E-02	1.44E-01	7.37E-02
0.8	6.22E-02	1.36E-01	7.00E-02
0.7	5.84E-02	1.29E-01	6.60E-02
0.6	5.22E-02	1.16E-01	5.93E-02
0.5	4.56E-02	1.02E-01	5.21E-02
0.4	3.65E-02	8.17E-02	4.17E-02
0.35	3.19E-02	7.15E-02	3.65E-02
0.3	2.74E-02	6.13E-02	3.13E-02
0.25	2.28E-02	5.11E-02	2.61E-02
0.2	1.83E-02	4.08E-02	2.09E-02
0.15	1.37E-02	3.06E-02	1.56E-02
0.125	1.14E-02	2.55E-02	1.30E-02
0.1	9.13E-03	2.04E-02	1.04E-02

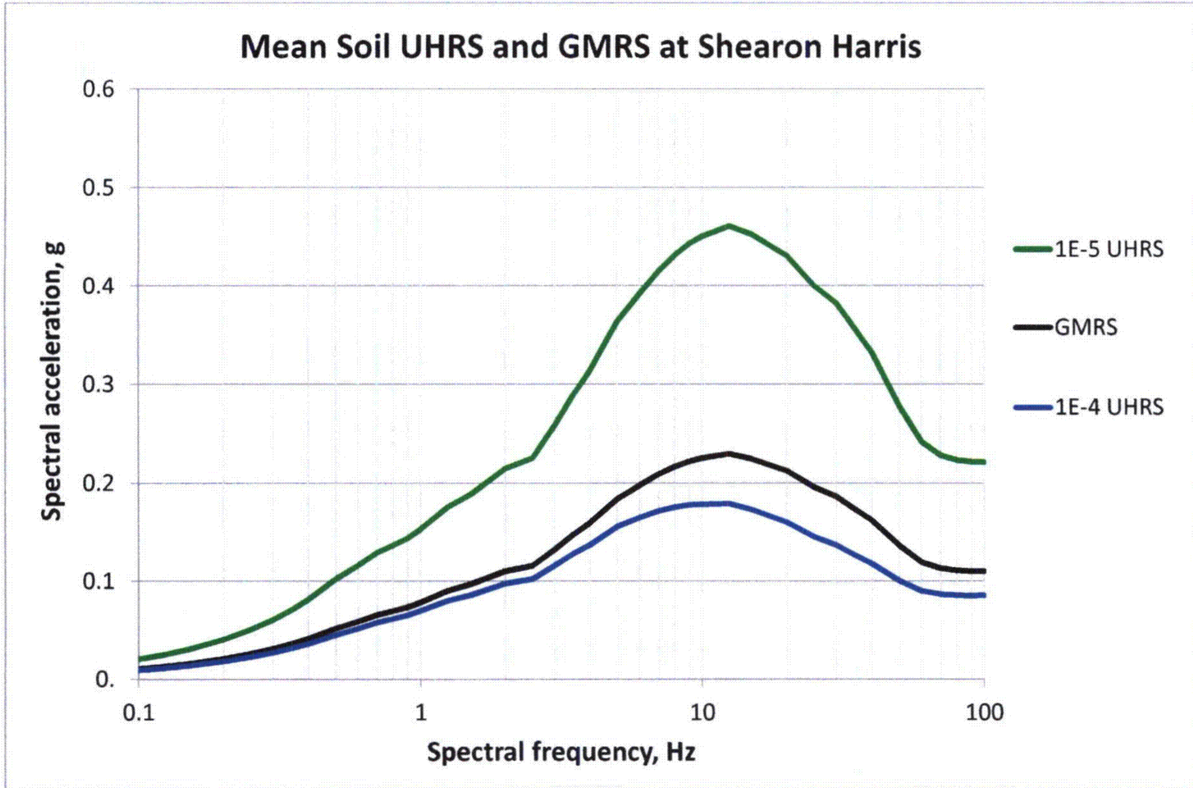

Figure 2.4-1. UHRS for 1E-4 and 1E-5 and GMRS at control point for HNP (5%-damped response spectra).

3.0 Plant Design Basis

The design basis for HNP is identified in the Updated Final Safety Analysis Report (Reference 5) and other pertinent documents.

3.1 SSE Description of Spectral Shape

The SSE for the purpose of seismic hazard screening is defined in terms of a Peak Ground Acceleration (PGA) at 5% critical damping. The horizontal and vertical response spectra for the SSE were prepared in accordance with NRC Regulatory Guide 1.60 (Reference 4). Considering the historic seismicity of the site region, the maximum potential earthquake selected was an intensity VII (Modified Mercalli Scale) event. Table 3.1-1 presents the tabulated horizontal SSE spectra that are used for the purposes of the seismic hazard screening. The points in Table 3.1-1 represent the log-linearly interpolated accelerations between the control points listed in Table 1 of Regulatory Guide 1.60. The control points are taken at 0.25, 2.5, 9, and 33 Hz and they are calculated by scaling the amplification factors from Table 1 of Regulatory Guide 1.60 to the SSE earthquake of 0.15 g. The frequencies that are used are the same frequencies as in Table 2.4-1, except for the use of 33 Hz instead of 35 Hz. Figure 3.1-1 shows the SSE for HNP.

Table 3.1-1. SSE for HNP at 5% Damping.

Freq. (Hz)	SSE (g)
0.1	0.0113
0.125	0.0177
0.15	0.0254
0.2	0.0452
0.25	0.0707
0.3	0.0821
0.35	0.0932
0.4	0.1041
0.5	0.1250
0.6	0.1452
0.7	0.1648
0.8	0.1840
0.9	0.2027
1	0.2210
1.25	0.2655
1.5	0.3085
2	0.3908
2.5	0.4695
3	0.4575
3.5	0.4476
4	0.4392
5	0.4255
6	0.4147
7	0.4057
8	0.3981
9	0.3915
10	0.3622
12.5	0.3072
15	0.2685
20	0.2171
25	0.1841
30	0.1609
33	0.1500
40	0.1500
50	0.1500
60	0.1500
70	0.1500
80	0.1500
90	0.1500
100	0.1500

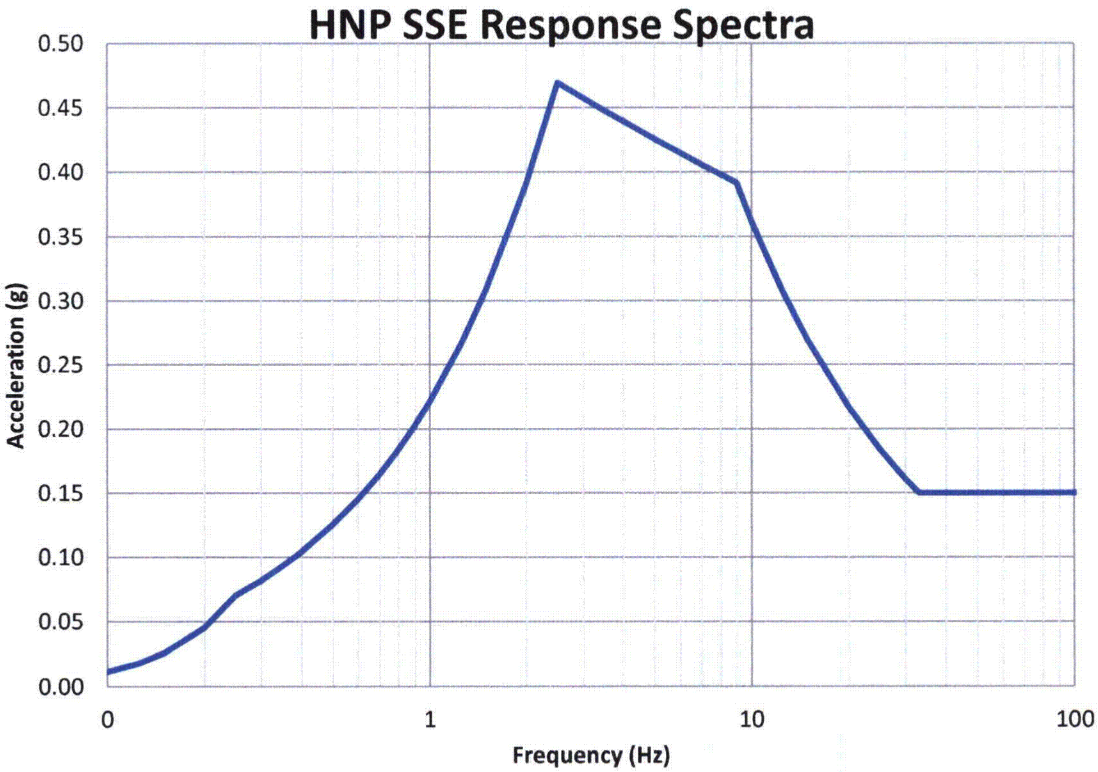

Figure 3.2-1. SSE for HNP.

3.2 Control Point Elevation

Based on the information presented in Table 2.3.1-1, the SSE control point elevation is defined at a depth of 16 ft at the top of sound bedrock. The control point was selected following guidance of Section 2.4.2 of the SPID (Reference 2).

4.0 Screening Evaluation

In accordance with SPID (Reference 2) Section 3, a screening evaluation was performed and the results are 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 is not required.

4.2 High Frequency Screening (> 10 Hz)

For a portion of the range above 10 Hz, the GMRS exceeds the SSE. Therefore, the plant screens in for a High Frequency Confirmation.

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

In the 1 to 10 Hz range of the response spectrum, the SSE exceeds the GMRS. Therefore, a spent fuel pool evaluation is not required.

5.0 Interim Actions

As discussed in Section 4.2, the GMRS only exceeds the SSE for high frequencies. This motion is considered to be non-damaging to components and structures that have strain or stress based potential failures modes. NRC letter dated February 15, 2013 (Reference 15) endorses a program to provide guidance for identifying and evaluating potentially high-frequency sensitive components. This High Frequency Confirmation is expected to address the exceedance described in Section 4.2.

Consistent with NRC letter dated February 20, 2014, (Reference 13) the seismic hazard reevaluations presented herein are distinct from the current design and licensing bases of HNP. 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 address the higher seismic hazard relative to the design basis while the expedited approach and risk evaluations are conducted. In response to that request, NEI letter dated March 12, 2014, (Reference 14) 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.

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

6.0 Conclusions

In accordance with the 50.54(f) request for information, a seismic hazard and screening evaluation was performed for HNP. A GMRS was developed solely for the purpose of screening for additional evaluations in accordance with the SPID (Reference 2).

Based on the results of the screening evaluation, HNP screens in for a High Frequency Confirmation.

Based on the results of the screening evaluation, and in accordance with the criteria in the expedited seismic evaluation described in EPRI 3002000704 (Reference 3) proposed in a letter to the NRC dated April 9, 2013 (Reference 11) and agreed to by the NRC in a letter dated May 7, 2013 (Reference 12), HNP screens out of the expedited seismic evaluation under EPRI 30020000704 (Reference 3).

7.0 References

1. United States Nuclear Regulatory Commission (USNRC), 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.

2. Electric Power Research Institute (EPRI), Final Report 1025287, "Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic", February 2013.

3. Electric Power Research Institute (EPRI), Final Report No. 3002000704, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic", May 2013.

4. United States Nuclear Regulatory Commission (USNRC), Regulatory Guide (RG) 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants", Revision 1, December 1973.

5. Progress Energy, "Shearon Harris Nuclear Power Plant Updated Final Safety Analysis Report", through Amendment No. 59.

6. United States Nuclear Regulatory Commission (USNRC), NUREG-2115, Department of Energy/Office of Nuclear Energy (DOE/NE)-0140, EPRI 1021097, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities", 6 Volumes, 2012.

7. Electric Power Research Institute (EPRI), Final Report No. 3002000717, "EPRI (2004, 2006) Ground-Motion Model (GMM) Review Project", June 2013.

8. Progress Energy Harris Nuclear Units 2 & 3 COLA (Final Safety Analysis Report), Rev. 4, September 12, 2012 (ML12122A656).

9. Electric Power Research Institute (EPRI) (1993). "Guidelines for determining design basis ground motions." Palo Alto, Calif: Electric Power Research Institute, vol. 1-5, EPRI TR-102293.

10. United States Nuclear Regulatory Commission (USNRC), Regulatory Guide (RG) 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion", March 2007.

11. Nuclear Energy Institute (NEI), A. Pietrangelo, Letter to D. Skeen of the USNRC, "Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations", April 9, 2013 (ML13101A379).

12. United States Nuclear Regulatory Commission (USNRC), E. Leeds, Letter to J. Pollock of NEI, "Electric Power Research Institute Final Draft Report XXXXXX, 'Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,' as an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations", May 7, 2013.

13. United States Nuclear Regulatory Commission (USNRC), E. Leeds, Letter to All Power Reactor Licensees and Holders of Construction Permits, "Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazard Reevaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights From the Fukushima Dai-Ichi Accident", February 20, 2014 (ML14030A046).

14. Nuclear Energy Institute (NEI), A. Pietrangelo, Letter to Mr. Eric J. Leeds of the USNRC, "Seismic Risk Evaluations for Plants in the Central and Eastern United States", March 12, 2014.

15. United States Nuclear Regulatory Commission (USNRC), E. Leeds, Letter to All Power, Reactor Licensees and Holders of Construction Permits, "Endorsement of Electric Power Research Institute Final Draft Report 1025287, Seismic Evaluation Guidance", February 15, 2013 (ML 12319A074).

Table A-1a. Mean and Fractile Seismic Hazard Curves for PGA at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.35E-02	2.42E-02	3.68E-02	4.43E-02	5.12E-02	5.50E-02
0.001	3.38E-02	1.57E-02	2.68E-02	3.37E-02	4.19E-02	4.70E-02
0.005	1.05E-02	3.79E-03	6.45E-03	9.65E-03	1.36E-02	2.19E-02
0.01	4.84E-03	1.42E-03	2.42E-03	4.25E-03	6.54E-03	1.25E-02
0.015	2.81E-03	6.54E-04	1.15E-03	2.29E-03	4.01E-03	8.23E-03
0.03	9.03E-04	1.08E-04	2.07E-04	5.58E-04	1.38E-03	3.52E-03
0.05	3.31E-04	2.13E-05	4.37E-05	1.44E-04	4.83E-04	1.55E-03
0.075	1.37E-04	5.50E-06	1.21E-05	4.70E-05	1.84E-04	6.93E-04
0.1	6.99E-05	2.07E-06	5.20E-06	2.13E-05	8.98E-05	3.47E-04
0.15	2.60E-05	5.50E-07	1.79E-06	7.77E-06	3.37E-05	1.20E-04
0.3	4.70E-06	4.98E-08	3.33E-07	1.57E-06	7.34E-06	1.92E-05
0.5	1.37E-06	8.47E-09	8.47E-08	4.83E-07	2.25E-06	5.58E-06
0.75	5.01E-07	1.92E-09	2.42E-08	1.67E-07	8.00E-07	2.07E-06
1	2.36E-07	7.23E-10	8.60E-09	7.23E-08	3.68E-07	9.79E-07
1.5	7.51E-08	2.16E-10	1.69E-09	1.90E-08	1.11E-07	3.19E-07
3	8.01E-09	1.21E-10	1.55E-10	1.27E-09	1.04E-08	3.47E-08
5	1.15E-09	9.11E-11	1.21E-10	1.92E-10	1.32E-09	5.05E-09
7.5	2.01E-10	8.12E-11	9.11E-11	1.23E-10	2.72E-10	9.51E-10
10	5.21E-11	8.12E-11	9.11E-11	1.21E-10	1.40E-10	3.09E-10

Table A-1b. Mean and Fractile Seismic Hazard Curves for 25 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.65E-02	3.05E-02	4.07E-02	4.70E-02	5.27E-02	5.66E-02
0.001	3.84E-02	2.16E-02	3.23E-02	3.90E-02	4.50E-02	5.05E-02
0.005	1.54E-02	6.73E-03	1.07E-02	1.46E-02	1.92E-02	2.88E-02
0.01	8.19E-03	3.14E-03	4.90E-03	7.45E-03	1.05E-02	1.84E-02
0.015	5.21E-03	1.72E-03	2.76E-03	4.56E-03	6.93E-03	1.29E-02
0.03	2.01E-03	4.25E-04	7.34E-04	1.55E-03	3.01E-03	5.75E-03
0.05	8.53E-04	1.08E-04	2.04E-04	5.50E-04	1.38E-03	2.88E-03
0.075	3.98E-04	3.14E-05	6.54E-05	2.07E-04	6.54E-04	1.53E-03
0.1	2.22E-04	1.25E-05	2.80E-05	9.93E-05	3.57E-04	8.98E-04
0.15	9.31E-05	3.52E-06	8.72E-06	3.52E-05	1.42E-04	3.90E-04
0.3	1.93E-05	4.77E-07	1.57E-06	6.73E-06	2.92E-05	7.66E-05
0.5	6.00E-06	9.65E-08	4.90E-07	2.25E-06	9.65E-06	2.39E-05
0.75	2.40E-06	2.49E-08	1.87E-07	9.37E-07	4.01E-06	9.65E-06
1	1.25E-06	9.79E-09	8.98E-08	4.90E-07	2.13E-06	5.05E-06
1.5	4.81E-07	2.64E-09	2.96E-08	1.79E-07	8.12E-07	2.01E-06
3	7.78E-08	3.01E-10	3.09E-09	2.35E-08	1.25E-07	3.28E-07
5	1.64E-08	1.34E-10	4.83E-10	4.01E-09	2.39E-08	6.93E-08
7.5	4.12E-09	1.21E-10	1.62E-10	8.60E-10	5.58E-09	1.77E-08
10	1.42E-09	1.08E-10	1.23E-10	3.01E-10	1.84E-09	6.26E-09

Table A-1c. Mean and Fractile Seismic Hazard Curves for 10 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.06E-02	4.01E-02	4.50E-02	5.12E-02	5.58E-02	6.00E-02
0.001	4.42E-02	3.19E-02	3.79E-02	4.43E-02	5.05E-02	5.42E-02
0.005	1.98E-02	1.02E-02	1.44E-02	1.95E-02	2.49E-02	3.05E-02
0.01	1.08E-02	4.90E-03	7.13E-03	1.04E-02	1.40E-02	1.90E-02
0.015	7.03E-03	2.92E-03	4.31E-03	6.64E-03	9.37E-03	1.34E-02
0.03	2.94E-03	9.51E-04	1.49E-03	2.60E-03	4.19E-03	6.45E-03
0.05	1.34E-03	3.23E-04	5.35E-04	1.10E-03	2.07E-03	3.42E-03
0.075	6.54E-04	1.16E-04	2.07E-04	4.77E-04	1.05E-03	1.90E-03
0.1	3.70E-04	5.12E-05	9.65E-05	2.42E-04	6.00E-04	1.20E-03
0.15	1.53E-04	1.51E-05	3.01E-05	8.72E-05	2.49E-04	5.42E-04
0.3	2.83E-05	1.67E-06	3.79E-06	1.32E-05	4.63E-05	1.08E-04
0.5	7.68E-06	2.96E-07	8.72E-07	3.47E-06	1.31E-05	2.96E-05
0.75	2.78E-06	6.73E-08	2.84E-07	1.21E-06	4.83E-06	1.07E-05
1	1.36E-06	2.16E-08	1.25E-07	5.83E-07	2.39E-06	5.27E-06
1.5	4.90E-07	4.31E-09	3.52E-08	2.01E-07	8.35E-07	1.95E-06
3	7.31E-08	3.33E-10	2.92E-09	2.39E-08	1.20E-07	3.05E-07
5	1.50E-08	1.32E-10	4.07E-10	3.68E-09	2.25E-08	6.45E-08
7.5	3.70E-09	1.21E-10	1.40E-10	7.34E-10	5.20E-09	1.64E-08
10	1.26E-09	9.24E-11	1.21E-10	2.64E-10	1.69E-09	5.66E-09

Table A-1d. Mean and Fractile Seismic Hazard Curves for 5 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.14E-02	4.13E-02	4.56E-02	5.20E-02	5.75E-02	6.09E-02
0.001	4.56E-02	3.28E-02	3.84E-02	4.63E-02	5.27E-02	5.66E-02
0.005	2.04E-02	9.93E-03	1.42E-02	2.01E-02	2.68E-02	3.09E-02
0.01	1.06E-02	4.56E-03	6.83E-03	1.02E-02	1.46E-02	1.77E-02
0.015	6.66E-03	2.68E-03	4.07E-03	6.36E-03	9.37E-03	1.16E-02
0.03	2.61E-03	8.35E-04	1.34E-03	2.39E-03	3.84E-03	5.12E-03
0.05	1.14E-03	2.72E-04	4.77E-04	9.79E-04	1.79E-03	2.60E-03
0.075	5.31E-04	9.37E-05	1.77E-04	4.07E-04	8.72E-04	1.40E-03
0.1	2.88E-04	4.07E-05	8.00E-05	2.01E-04	4.77E-04	8.47E-04
0.15	1.10E-04	1.13E-05	2.35E-05	6.54E-05	1.82E-04	3.68E-04
0.3	1.72E-05	1.07E-06	2.49E-06	8.23E-06	2.80E-05	6.26E-05
0.5	4.08E-06	1.67E-07	4.77E-07	1.84E-06	6.83E-06	1.53E-05
0.75	1.35E-06	3.33E-08	1.36E-07	5.83E-07	2.32E-06	5.27E-06
1	6.26E-07	9.93E-09	5.58E-08	2.64E-07	1.08E-06	2.49E-06
1.5	2.10E-07	1.79E-09	1.42E-08	8.35E-08	3.57E-07	8.35E-07
3	2.78E-08	1.92E-10	1.18E-09	8.85E-09	4.37E-08	1.16E-07
5	5.16E-09	1.21E-10	2.07E-10	1.29E-09	7.55E-09	2.22E-08
7.5	1.17E-09	1.05E-10	1.21E-10	2.84E-10	1.55E-09	5.12E-09
10	3.77E-10	8.98E-11	1.11E-10	1.42E-10	5.12E-10	1.69E-09

Table A-1e. Mean and Fractile Seismic Hazard Curves for 2.5 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.85E-02	3.68E-02	4.19E-02	4.90E-02	5.50E-02	5.91E-02
0.001	4.01E-02	2.64E-02	3.19E-02	4.01E-02	4.83E-02	5.27E-02
0.005	1.40E-02	6.54E-03	8.98E-03	1.34E-02	1.92E-02	2.32E-02
0.01	6.57E-03	2.64E-03	3.84E-03	6.17E-03	9.37E-03	1.18E-02
0.015	3.88E-03	1.36E-03	2.10E-03	3.57E-03	5.66E-03	7.45E-03
0.03	1.35E-03	3.23E-04	5.66E-04	1.16E-03	2.13E-03	3.01E-03
0.05	5.24E-04	8.47E-05	1.64E-04	4.01E-04	8.85E-04	1.38E-03
0.075	2.15E-04	2.42E-05	5.05E-05	1.42E-04	3.68E-04	6.64E-04
0.1	1.06E-04	9.24E-06	2.01E-05	6.09E-05	1.79E-04	3.52E-04
0.15	3.46E-05	2.10E-06	4.98E-06	1.67E-05	5.58E-05	1.25E-04
0.3	4.15E-06	1.44E-07	3.90E-07	1.55E-06	6.17E-06	1.53E-05
0.5	8.49E-07	1.69E-08	6.09E-08	2.92E-07	1.29E-06	3.23E-06
0.75	2.58E-07	2.80E-09	1.42E-08	8.47E-08	4.07E-07	1.05E-06
1	1.15E-07	8.12E-10	4.98E-09	3.52E-08	1.79E-07	4.83E-07
1.5	3.65E-08	2.13E-10	1.13E-09	9.65E-09	5.50E-08	1.55E-07
3	4.40E-09	1.21E-10	1.53E-10	8.23E-10	5.83E-09	1.92E-08
5	7.37E-10	9.11E-11	1.21E-10	1.72E-10	8.98E-10	3.23E-09
7.5	1.51E-10	8.12E-11	9.11E-11	1.21E-10	2.29E-10	7.03E-10
10	4.48E-11	8.12E-11	9.11E-11	1.21E-10	1.34E-10	2.68E-10

Table A-1f. Mean and Fractile Seismic Hazard Curves for 1 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.61E-02	2.01E-02	2.64E-02	3.68E-02	4.50E-02	5.05E-02
0.001	2.52E-02	1.20E-02	1.69E-02	2.49E-02	3.33E-02	3.90E-02
0.005	7.31E-03	2.64E-03	4.13E-03	6.93E-03	1.05E-02	1.32E-02
0.01	3.66E-03	9.65E-04	1.67E-03	3.28E-03	5.66E-03	7.66E-03
0.015	2.20E-03	4.37E-04	8.35E-04	1.84E-03	3.57E-03	5.12E-03
0.03	7.07E-04	7.89E-05	1.79E-04	5.12E-04	1.21E-03	2.01E-03
0.05	2.37E-04	1.64E-05	4.19E-05	1.44E-04	4.19E-04	7.89E-04
0.075	8.51E-05	3.95E-06	1.08E-05	4.31E-05	1.49E-04	3.09E-04
0.1	3.77E-05	1.32E-06	3.84E-06	1.67E-05	6.45E-05	1.44E-04
0.15	1.07E-05	2.64E-07	8.00E-07	3.90E-06	1.72E-05	4.25E-05
0.3	1.00E-06	1.40E-08	4.90E-08	2.80E-07	1.44E-06	4.13E-06
0.5	1.82E-07	1.46E-09	6.09E-09	4.19E-08	2.53E-07	7.77E-07
0.75	5.42E-08	2.88E-10	1.20E-09	9.93E-09	7.03E-08	2.39E-07
1	2.43E-08	1.46E-10	4.01E-10	3.57E-09	2.96E-08	1.08E-07
1.5	7.96E-09	1.21E-10	1.49E-10	8.72E-10	8.47E-09	3.42E-08
3	1.02E-09	8.47E-11	1.11E-10	1.42E-10	8.47E-10	4.01E-09
5	1.82E-10	8.12E-11	9.11E-11	1.21E-10	1.92E-10	7.34E-10
7.5	4.03E-11	8.12E-11	9.11E-11	1.21E-10	1.32E-10	2.13E-10
10	1.27E-11	8.12E-11	8.12E-11	1.21E-10	1.32E-10	1.34E-10

Table A-1g. Mean and Fractile Seismic Hazard Curves for 0.5 Hz at HNP.

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	1.97E-02	1.05E-02	1.44E-02	1.92E-02	2.49E-02	2.92E-02
0.001	1.24E-02	6.09E-03	8.47E-03	1.20E-02	1.62E-02	1.98E-02
0.005	3.77E-03	8.98E-04	1.62E-03	3.42E-03	5.91E-03	7.89E-03
0.01	1.81E-03	2.29E-04	5.05E-04	1.42E-03	3.14E-03	4.70E-03
0.015	1.02E-03	8.47E-05	2.07E-04	7.03E-04	1.84E-03	3.01E-03
0.03	2.75E-04	1.04E-05	3.05E-05	1.40E-04	4.90E-04	1.02E-03
0.05	8.02E-05	1.62E-06	5.50E-06	3.01E-05	1.36E-04	3.37E-04
0.075	2.58E-05	3.28E-07	1.20E-06	7.34E-06	4.07E-05	1.13E-04
0.1	1.07E-05	9.93E-08	3.84E-07	2.46E-06	1.57E-05	4.70E-05
0.15	2.84E-06	1.79E-08	7.23E-08	4.77E-07	3.68E-06	1.23E-05
0.3	2.54E-07	8.85E-10	3.68E-09	2.84E-08	2.64E-07	1.11E-06
0.5	4.63E-08	1.57E-10	4.50E-10	3.84E-09	4.13E-08	2.07E-07
0.75	1.37E-08	1.21E-10	1.51E-10	8.60E-10	1.02E-08	6.00E-08
1.	6.10E-09	9.65E-11	1.21E-10	3.23E-10	3.84E-09	2.53E-08
1.5	1.98E-09	8.35E-11	1.10E-10	1.42E-10	9.93E-10	7.55E-09
3.	2.53E-10	8.12E-11	9.11E-11	1.21E-10	1.60E-10	8.35E-10
5.	4.58E-11	8.12E-11	8.35E-11	1.21E-10	1.32E-10	2.01E-10
7.5	1.02E-11	8.12E-11	8.12E-11	1.21E-10	1.32E-10	1.32E-10
10	3.25E-12	8.12E-11	8.12E-11	1.21E-10	1.32E-10	1.32E-10

Table A-2. Amplification Functions for HNP.

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	1.08E+00	4.59E-02	1.30E-02	9.66E-01	6.08E-02	1.90E-02	1.05E+00	8.97E-02	2.09E-02	1.17E+00	1.01E-01
4.95E-02	9.36E-01	6.20E-02	1.02E-01	7.67E-01	1.15E-01	9.99E-02	1.02E+00	1.04E-01	8.24E-02	1.16E+00	1.05E-01
9.64E-02	8.82E-01	6.72E-02	2.13E-01	7.32E-01	1.27E-01	1.85E-01	1.01E+00	1.05E-01	1.44E-01	1.16E+00	1.06E-01
1.94E-01	8.37E-01	7.15E-02	4.43E-01	7.04E-01	1.33E-01	3.56E-01	9.95E-01	1.07E-01	2.65E-01	1.15E+00	1.08E-01
2.92E-01	8.12E-01	7.39E-02	6.76E-01	6.87E-01	1.36E-01	5.23E-01	9.82E-01	1.08E-01	3.84E-01	1.14E+00	1.08E-01
3.91E-01	7.95E-01	7.54E-02	9.09E-01	6.74E-01	1.38E-01	6.90E-01	9.71E-01	1.09E-01	5.02E-01	1.14E+00	1.08E-01
4.93E-01	7.82E-01	7.66E-02	1.15E+00	6.62E-01	1.39E-01	8.61E-01	9.62E-01	1.10E-01	6.22E-01	1.13E+00	1.08E-01
7.41E-01	7.58E-01	7.78E-02	1.73E+00	6.40E-01	1.42E-01	1.27E+00	9.41E-01	1.11E-01	9.13E-01	1.12E+00	1.05E-01
1.01E+00	7.40E-01	7.87E-02	2.36E+00	6.22E-01	1.44E-01	1.72E+00	9.24E-01	1.14E-01	1.22E+00	1.10E+00	1.03E-01
1.28E+00	7.25E-01	7.90E-02	3.01E+00	6.07E-01	1.46E-01	2.17E+00	9.08E-01	1.15E-01	1.54E+00	1.09E+00	1.03E-01
1.55E+00	7.12E-01	7.97E-02	3.63E+00	5.94E-01	1.47E-01	2.61E+00	8.94E-01	1.17E-01	1.85E+00	1.08E+00	1.03E-01
2.5 Hz	**Median AF**	**Sigma ln(AF)**	**1 Hz**	**Median AF**	**Sigma ln(AF)**	**0.5 Hz**	**Median AF**	**Sigma ln(AF)**			
2.18E-02	1.07E+00	9.15E-02	1.27E-02	1.31E+00	1.22E-01	8.25E-03	1.29E+00	1.30E-01			
7.05E-02	1.06E+00	9.12E-02	3.43E-02	1.31E+00	1.18E-01	1.96E-02	1.28E+00	1.26E-01			
1.18E-01	1.06E+00	9.09E-02	5.51E-02	1.30E+00	1.16E-01	3.02E-02	1.28E+00	1.24E-01			
2.12E-01	1.06E+00	9.10E-02	9.63E-02	1.30E+00	1.15E-01	5.11E-02	1.28E+00	1.23E-01			
3.04E-01	1.05E+00	9.12E-02	1.36E-01	1.30E+00	1.14E-01	7.10E-02	1.28E+00	1.22E-01			
3.94E-01	1.05E+00	9.13E-02	1.75E-01	1.31E+00	1.13E-01	9.06E-02	1.28E+00	1.22E-01			
4.86E-01	1.05E+00	9.15E-02	2.14E-01	1.31E+00	1.12E-01	1.10E-01	1.28E+00	1.22E-01			
7.09E-01	1.05E+00	9.16E-02	3.10E-01	1.31E+00	1.12E-01	1.58E-01	1.28E+00	1.22E-01			
9.47E-01	1.05E+00	9.24E-02	4.12E-01	1.31E+00	1.11E-01	2.09E-01	1.28E+00	1.22E-01			
1.19E+00	1.05E+00	9.36E-02	5.18E-01	1.32E+00	1.11E-01	2.62E-01	1.28E+00	1.22E-01			
1.43E+00	1.04E+00	9.42E-02	6.19E-01	1.32E+00	1.10E-01	3.12E-01	1.28E+00	1.22E-01			

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

M1P1K1	Rock PGA=0.0964			M1P1K1	PGA=0.292		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.088	0.917	0.050	100.0	0.240	0.821	0.057
87.1	0.089	0.906	0.051	87.1	0.242	0.806	0.058
75.9	0.090	0.887	0.051	75.9	0.246	0.779	0.059
66.1	0.093	0.848	0.052	66.1	0.253	0.728	0.062
57.5	0.097	0.782	0.055	57.5	0.267	0.650	0.070
50.1	0.105	0.719	0.069	50.1	0.294	0.591	0.093
43.7	0.116	0.678	0.084	43.7	0.330	0.561	0.113
38.0	0.126	0.661	0.088	38.0	0.359	0.558	0.112
33.1	0.138	0.671	0.105	33.1	0.391	0.577	0.123
28.8	0.150	0.722	0.115	28.8	0.427	0.634	0.129
25.1	0.161	0.759	0.125	25.1	0.457	0.677	0.134
21.9	0.171	0.829	0.121	21.9	0.479	0.748	0.125
19.1	0.184	0.891	0.127	19.1	0.511	0.815	0.127
16.6	0.190	0.944	0.129	16.6	0.526	0.878	0.128
14.5	0.194	0.999	0.127	14.5	0.536	0.939	0.128
12.6	0.196	1.025	0.107	12.6	0.536	0.970	0.111
11.0	0.193	1.025	0.098	11.0	0.522	0.972	0.102
9.5	0.193	1.063	0.085	9.5	0.517	1.011	0.088
8.3	0.195	1.155	0.067	8.3	0.522	1.110	0.071
7.2	0.189	1.186	0.083	7.2	0.505	1.151	0.085
6.3	0.181	1.199	0.069	6.3	0.480	1.169	0.067
5.5	0.176	1.211	0.086	5.5	0.463	1.182	0.086
4.8	0.166	1.156	0.098	4.8	0.433	1.133	0.097
4.2	0.158	1.127	0.086	4.2	0.410	1.111	0.086
3.6	0.150	1.099	0.092	3.6	0.391	1.088	0.092
3.2	0.142	1.094	0.098	3.2	0.367	1.088	0.099
2.8	0.135	1.091	0.077	2.8	0.348	1.089	0.077
2.4	0.123	1.075	0.088	2.4	0.317	1.076	0.089
2.1	0.118	1.125	0.082	2.1	0.301	1.126	0.081
1.8	0.109	1.164	0.078	1.8	0.278	1.166	0.076
1.6	0.101	1.238	0.112	1.6	0.256	1.239	0.111
1.4	0.091	1.282	0.085	1.4	0.228	1.283	0.082
1.2	0.084	1.348	0.113	1.2	0.210	1.347	0.111
1.0	0.076	1.347	0.097	1.0	0.189	1.346	0.095
0.91	0.065	1.255	0.094	0.91	0.160	1.255	0.092
0.79	0.059	1.255	0.105	0.79	0.144	1.254	0.102
0.69	0.055	1.298	0.091	0.69	0.132	1.296	0.089
0.60	0.048	1.290	0.072	0.60	0.114	1.288	0.071
0.52	0.040	1.259	0.062	0.52	0.095	1.258	0.060
0.46	0.034	1.273	0.087	0.46	0.080	1.271	0.085
0.10	0.001	1.198	0.026	0.10	0.003	1.192	0.027

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

M2P1K1	PGA=0.0964			M2P1K1	PGA=0.292		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.089	0.924	0.055	100.0	0.255	0.871	0.060
87.1	0.090	0.913	0.056	87.1	0.258	0.857	0.061
75.9	0.091	0.894	0.056	75.9	0.263	0.831	0.061
66.1	0.093	0.856	0.056	66.1	0.272	0.782	0.061
57.5	0.098	0.790	0.056	57.5	0.291	0.707	0.061
50.1	0.107	0.730	0.058	50.1	0.327	0.657	0.065
43.7	0.118	0.690	0.061	43.7	0.373	0.633	0.068
38.0	0.129	0.675	0.081	38.0	0.408	0.634	0.091
33.1	0.140	0.684	0.098	33.1	0.443	0.653	0.110
28.8	0.153	0.736	0.113	28.8	0.481	0.713	0.125
25.1	0.161	0.757	0.109	25.1	0.498	0.737	0.117
21.9	0.171	0.831	0.121	21.9	0.523	0.817	0.128
19.1	0.183	0.886	0.128	19.1	0.550	0.877	0.133
16.6	0.191	0.951	0.127	16.6	0.566	0.944	0.131
14.5	0.198	1.017	0.119	14.5	0.578	1.013	0.122
12.6	0.201	1.051	0.125	12.6	0.579	1.048	0.127
11.0	0.197	1.047	0.122	11.0	0.560	1.044	0.124
9.5	0.196	1.077	0.103	9.5	0.549	1.074	0.104
8.3	0.194	1.147	0.099	8.3	0.538	1.144	0.100
7.2	0.192	1.205	0.092	7.2	0.528	1.203	0.093
6.3	0.183	1.213	0.076	6.3	0.498	1.211	0.076
5.5	0.174	1.195	0.083	5.5	0.467	1.193	0.084
4.8	0.166	1.162	0.093	4.8	0.443	1.160	0.093
4.2	0.155	1.107	0.096	4.2	0.409	1.106	0.096
3.6	0.149	1.090	0.069	3.6	0.391	1.089	0.069
3.2	0.139	1.076	0.100	3.2	0.363	1.075	0.100
2.8	0.134	1.081	0.083	2.8	0.345	1.080	0.083
2.4	0.123	1.074	0.080	2.4	0.316	1.073	0.080
2.1	0.118	1.127	0.080	2.1	0.301	1.125	0.079
1.8	0.111	1.180	0.081	1.8	0.281	1.178	0.081
1.6	0.099	1.205	0.121	1.6	0.248	1.202	0.120
1.4	0.088	1.244	0.106	1.4	0.220	1.241	0.104
1.2	0.084	1.350	0.152	1.2	0.210	1.345	0.150
1.0	0.079	1.393	0.104	1.0	0.195	1.388	0.103
0.91	0.069	1.319	0.121	0.91	0.168	1.315	0.119
0.79	0.059	1.237	0.120	0.79	0.142	1.235	0.118
0.69	0.052	1.217	0.118	0.69	0.124	1.216	0.116
0.60	0.046	1.230	0.078	0.60	0.109	1.228	0.077
0.52	0.041	1.275	0.071	0.52	0.096	1.272	0.069
0.46	0.036	1.348	0.098	0.46	0.084	1.345	0.097
0.10	0.001	1.177	0.035	0.10	0.003	1.171	0.035

Tables A2-b1 and A2-b2 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.