VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

March 31, 2014

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

Serial No.	14-134
NL&OS/WDC	R0
Docket Nos.	50-280/281
License Nos.	DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY SURRY POWER STATION UNITS 1 AND 2 RESPONSE TO MARCH 12, 2012 INFORMATION REQUEST SEISMIC HAZARD AND SCREENING REPORT (CEUS SITES) FOR RECOMMENDATION 2.1

References:

1. NRC Letter, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 12, 2012
2. NEI letter to NRC, Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, dated April 9, 2013
3. NRC Letter, Electric Power Research Institute Final Draft Report 3002000704, "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
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
5. NRC Letter, Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance," dated February 15, 2013

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 in the Central and Eastern United States (CEUS) to submit a Seismic Hazard 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 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.

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

The attached Seismic Hazard and Screening Report for Surry Power Station provides the information described in Section 4 of Reference 4 in accordance with the schedule identified in Reference 2.

If you have any questions regarding this information, please contact Gary D. Miller at (804) 273-2771.

Sincerely,

David A. Heacock
President and Chief Nuclear Officer
Virginia Electric and Power Company

VICKI L. HULL
Notary Public
Commonwealth of Virginia
140542
My Commission Expires May 31, 2014

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by David A. Heacock, who is President and Chief Nuclear Officer of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 31st day of March, 2014.

My Commission Expires: May 31 2014

Vicki L. Hull
Notary Public

Commitments made in this letter: No new regulatory commitments

Attachment: Seismic Hazard and Screening Report

cc: U.S. Nuclear Regulatory Commission, Region II
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Surry Power Station

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Serial No. 14-134
Docket Nos. 50-280/281

ATTACHMENT

SEISMIC HAZARD AND SCREENING REPORT

March 2014

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
SURRY POWER STATION UNITS 1 AND 2

EXECUTIVE SUMMARY

Following the accident at the Fukushima Daiichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established a Near Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. Subsequently, the NRC issued a 10 CFR 50.54(f) letter (Reference 7.1) that requests information to assure that selected recommendations from the NTTF are addressed by U.S. nuclear power plants. Recommendation 2.1: Seismic involves reevaluation of the seismic hazard at plant sites consistent with present-day NRC requirements. The 10 CFR 50.54(f) letter requests licensees to re-evaluate the seismic hazard for applicable reactor units. Depending on the comparison of the re-evaluated seismic hazard and the current design basis, a risk assessment may be required. Based upon the results of risk evaluations, where performed, the 10 CFR 50.54(f) letter indicates that NRC staff will determine whether additional regulatory actions are necessary.

This report provides the information requested in items (1) through (7) of the Enclosure 1 section titled "Requested Information" of the 50.54(f) letter for Surry Power Station. In providing this information, Dominion followed the guidance provided in 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* (Reference 7.2).

In response to the 50.54(f) letter, and following the guidance provided in Reference 7.2, a seismic hazard reevaluation was performed. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed. The comparison of the GMRS with the design basis earthquake (DBE) (also referred to as safe shutdown earthquake – SSE) indicates that Surry Power Station screens out from a risk evaluation, along with a high-frequency confirmation and Spent Fuel Pool evaluation, in accordance with the guidance in EPRI Report 1025287 (SPID).

Seismic core damage frequency (CDF) calculations have been performed by the EPRI for plants in the Central and Eastern United States (CEUS) using the plant capacities from the Individual Plant Examination of External Events (IPEEE) program and the recently updated seismic hazard curves. The results of these calculations for Surry Power Station Units 1 and 2 support the conclusion of the NRC GI-199 Safety/Risk Assessment (Reference 7.3) that "Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement..." and "...the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis" as indicated in NEI letter to NRC dated March 12, 2014 (Reference 7.4).

Based on the results of the screening evaluation and consistent with the NRC endorsed guidance in the SPID, no further actions related to the Fukushima NTTF Recommendation 2.1 in the March 12, 2012 10 CFR 50.54(f) letter are required for Surry Power Station.

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1.0 INTRODUCTION

Following the accident at the Fukushima Daiichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established a Near Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 10 CFR 50.54(f) letter (Reference 7.1) 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. The comparison between the reevaluated seismic hazard and the current design basis will result in either no further risk evaluation or the performance of a seismic risk assessment. Risk assessment approaches acceptable to the NRC staff include a seismic probabilistic risk assessment (SPRA) or a seismic margin assessment (SMA). Based upon this information, the NRC staff will determine whether additional regulatory actions are necessary.

This report provides the information requested in items (1) through (7) of the Enclosure 1 section titled "Requested Information" of the 50.54(f) letter for Surry Power Station, located in Surry County, Virginia. In providing this information, Virginia Electric and Power Company (Dominion) followed the guidance provided in 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* (Reference 7.2).

In response to the 50.54(f) letter and following the guidance provided in Reference 7.2, a seismic hazard reevaluation was performed. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed.

2.0 SEISMIC HAZARD REEVALUATION

The Surry Power Station site is located in the Atlantic Coastal Plain, Physiographic Province. In Virginia, the province is bounded on the east by the Atlantic Ocean and on the west by the Fall Line and the Piedmont Physiographic Province. The crystalline basement rock crops out near the Fall Zone about 50 miles west of the site. From the Fall Zone, the basement surface slopes gently to the southeast, and is overlain by Cretaceous and Tertiary sediments that are about 1,300 feet thick at the site.

The tectonics of the region are largely dependent on the study of the Appalachian Highlands, especially that of the Blue Ridge and Piedmont provinces. East of the Piedmont is the Atlantic Coastal Plain. The Atlantic Coastal Plain is essentially an irregular, thick, dissected, eastward-facing wedge of unconsolidated to semi-consolidated sediments. The basement of this wedge consists of Paleozoic-age Piedmont-type rocks. They are largely igneous and low- to high-grade metamorphic rocks.

The Atlantic Coastal Plain sediments effectively mask the crystalline basement rock so that no faulting can be identified in the area. However, the available regional data and the geologic studies at the site indicate that the overlying Cretaceous and Tertiary sediments are essentially underformed in the site area. The absence of folding and faulting in the exposed sedimentary strata of the Atlantic Coastal Plain in the vicinity of the site indicates that any displacements along possible unknown faults have been negligible.

The Surry Power Station design-basis earthquake (DBE) (also referred to as the Safe Shutdown Earthquake (SSE)) response spectrum was developed by conservatively assuming a magnitude as large as 5 to 5.5 (Richter scale; epicentral intensity-VII Modified Mercalli scale shock), originating in the basement rock close to the site. An occurrence of a shock of the same size as the largest of the 1886 Charleston shocks at a distance of 200 miles or so would result in significantly lower accelerations at the site. It was estimated that the maximum horizontal particle acceleration at foundation levels at the site, due to the design-basis earthquake, would be no more than about 15% of gravity.

2.1 REGIONAL AND LOCAL GEOLOGY

The Surry Power Station (SPS) is located adjacent to the James River on Gravel Neck in Surry County, Virginia, within the Atlantic Coastal Plain physiographic province, approximately half way between the Atlantic Ocean and the Fall Line forming the boundary between the Piedmont and Atlantic Coastal Plain. The site is south of and adjacent to the Hog Island State Wildlife Management Area. It is bordered by the James River on either side of the peninsula. The site is 4.5 miles west-north-west of Fort Eustis, 7 miles south of Colonial Williamsburg, and 8 miles east north east of the town of Surry.

In Virginia, the Atlantic Coastal Plain has a stair-step character composed of a series of plains that are successively lower from west to east and are separated from one another by scarps. In the site vicinity, four plains are recognized. From the highest to the lowest they are the 120-foot plain, 90-foot plain, 70-foot plain, and 45-foot plain. Also, three prominent scarps are present. They are the Surry scarp, the Peary scarp, and the Chippokes scarp.

In the immediate site area, surface inspection and subsurface investigations show no evidence of structural deformation. Borings indicate no offsets or folding of strata. There is no surface or subsurface evidence of prior landslides, cratering, or fissures that may be indicative of prior intense earthquake effects.

2.2 PROBABILISTIC SEISMIC HAZARD ANALYSIS

The probabilistic seismic hazard analysis results provided in Sections 2.2.1 through 2.4 were developed for EPRI in an industry-wide effort by Lettis Consultants International (LCI) (Reference 7.5).

2.2.1 PROBABILISTIC SEISMIC HAZARD ANALYSIS RESULTS

In accordance with the 50.54(f) letter and following the guidance in the SPID (Reference 7.2), 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 7.6) together with the updated EPRI Ground-Motion Model (GMM) for the CEUS (Reference 7.7). 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 around SPS were included. This distance exceeds the 200 mile recommendation contained in Reference 7.8 and was chosen for completeness. Background sources included in this site analysis are the following:

1. Atlantic Highly Extended Crust (AHEX)
2. Extended Continental Crust—Atlantic Margin (ECC_AM)
3. Extended Continental Crust—Gulf Coast (ECC_GC)
4. Mesozoic and younger extended prior – narrow (MESE-N)
5. Mesozoic and younger extended prior – wide (MESE-W)
6. Midcontinent-Craton alternative A (MIDC_A)
7. Midcontinent-Craton alternative B (MIDC_B)
8. Midcontinent-Craton alternative C (MIDC_C)
9. Midcontinent-Craton alternative D (MIDC_D)
10. Non-Mesozoic and younger extended prior – narrow (NMESE-N)
11. Non-Mesozoic and younger extended prior – wide (NMESE-W)
12. Paleozoic Extended Crust narrow (PEZ_N)
13. Paleozoic Extended Crust wide (PEZ_W)

14. St. Lawrence Rift, including the Ottawa and Saguenay grabens (SLR)
15. Study region (STUDY_R)

For sources of large magnitude earthquakes, designated Repeated Large Magnitude Earthquake (RLME) sources in CEUS-SSC (Reference 7.6), the following sources lie within 620 miles of the site and were included in the analysis:

1. Charleston
2. 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 industry report template, base rock seismic hazard curves are not provided. Seismic hazard curves are provided in Section 2.3.7 at the control point elevation.

2.3 SITE RESPONSE EVALUATION

Following the guidance contained in Seismic Enclosure 1 of the 50.54(f) Request for Information letter and in the SPID for nuclear power plant sites that are not sited on hard rock (shear wave velocity ≥ 9,200 ft/sec [SPID]), a site response analysis was performed for Surry Power Station.

2.3.1 DESCRIPTION OF SUBSURFACE MATERIAL

The information used to create the site geologic profile at the Surry Power Station is shown in Table 2.3.2-1. As indicated in Table 2.3.2-1, the SSE Control Point is assumed to be at the surface. The Surry Power Station site consists of about 1,600 ft of soils (clays, sands and marl) overlying about 100 ft of firm rock. Hard rock (crystalline igneous and metamorphic rock) is estimated to be at a depth of 1,700 ft beneath the surface.

The top 140 ft was selectively explored, sampled and tested with laboratory or geophysical methods.

The site consists of Pleistocene Epoch Norfolk Estuarine Formation deposits to depths ranging from 50 to 80 feet. Layers of brown to mottled brown sand, silty sand, organic and inorganic silts and clays, interlayered with iron-oxide cemented sands comprise the upper 20 to 35 feet of this formation, while layers of gray sand, silty sand, and organic to inorganic clays and silts with decayed vegetation and shell fragments comprise the lower portion of this formation.

The Norfolk Formation deposits lie above Miocene Epoch Chesapeake Group sediments comprising very stiff, green to dark gray clays containing shell fragments with occasional compact sand and silt layers. This Miocene deposit is estimated to be about 240 feet thick at the site. Underlying the Miocene sediments are Eocene, Paleocene, and Cretaceous deposits estimated to be about 45 feet, 55 feet, and at least 800 feet, respectively, in thickness, based upon wells drilled in the general area. Metamorphic and igneous crystalline bedrock is estimated to be roughly 1,300 feet deep at the site based upon seismic investigations conducted about 2 miles southeast of the site.

Upper portions of the Pleistocene deposits were excavated and replaced with compacted granular fill to support shallow foundations at the plant, while the lower Miocene deposits support deep mat foundations, driven piles and sheet pile cutoffs. The pertinent soil profile varies from the top of Miocene clay to the top of the granular fill replacement material.

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

Table 2.3.2-1 shows the recommended shear-wave velocities and unit weights along with depths and corresponding stratigraphy. The SSE control point is at the surface on compacted granular fill with an estimated shear-wave velocity of 1,000 ft/s (305 m/s). Additional shear-wave velocities were based on the N-value from sampler penetration tests (SPT) in the upper 140 ft (Reference 7.9). Depth to Crystalline basement of about 1,700 ft was estimated (Table 2.3.2-1), likely based on seismic investigations, regional geology, or available nearby deep boreholes. (Reference 7.5)

Uncertainty in shear-wave velocities was taken as 1.57 based on the type of measurement and the early time frame for the measurements (Reference 7.5). The scale factor of 1.57 reflects a σ_{ln} of about 0.35 respectively, based on the SPID 10th and 90th fractiles which implies a 1.28 scale factor on σ_{μ}.

TABLE 2.3.2-1 (Reference 7.9, 7.11):
Surry Power Station Site Geotechnical Profile Data

Depth Range (feet)	Soil Description	Density (pcf)	Shear Wave Velocity, Vs (fps)
0 (El. 26.5)	**Emergency Condensate Storage Tank**	---	---
0 (El. 26.5)	**SSE Control Point Elevation**	---	---
0-16	Compacted Granular Fill to 95% Modified (ASTM D1557)	130(1)	1000 (1)
16-27	Pleistocene Upper Clay	94	790
27-40	Pleistocene Sand A	99	950
40-52	Pleistocene Lower Medium Clay	84	710
52-67	Pleistocene Sand B	102	830
67 (El. -41)	**Containment Foundation**	---	---
67-96	Miocene Chesapeake dark blue to gray Clay, shell Marl	87	940
96 (El. -70)	**Pile tips below Spent Fuel Pool, Main Steam Valve House, and Refueling Water Storage Tank**	---	---
67-307	Miocene Chesapeake dark blue to gray Clay, shell Marl	87	940
307-362	Eocene gray Marl, Glauconitic and Quart Sand, Pyritic Marl, Limestone beds	120 (2)	1200 (2)
362-407	Paleocene Mattaponi mottled Clay, Glauconitic Sand and Marl, Quartz Sand	130 (2)	1000 (2)
407-1600	Cretaceous Potomac Group Sand and Clay beds	140 (2)	2000 (2)
1600 - 1700	Crystalline Igneous and Metamorphic Rock	160 (2)	7000 (2)
1700+ (2)	"Hard Rock" - Crystalline Igneous and Metamorphic Rock	170 (2)	9200 (2) (3)

(1) Estimated; considered typical for compacted granular fill material.
(2) Rough estimates / Approximation for analysis purposes; no data readily available.
(3) Definition of Hard Rock Position C, Section 4 in Reference 7.8.

Using the shear-wave velocities specified in Table 2.3.2-1, three base-case profiles were developed using the scale factor of 1.57 for the 1,600 ft of soil and 100 ft of firm rock. The specified shear-wave velocities were taken as the mean or best estimate base-case profile (P1) with lower and upper range base-cases profiles P2 and P3 respectively. Profiles extended to a depth (below the SSE control point) of 1,700 ft, randomized ± 510 ft. The base-case profiles (P1, P2, and P3) are shown in Figure 2.3.2-1 and listed in Table 2.3.2-2. The depth randomization reflects ± 30% of the depth and was included to provide a realistic broadening of the fundamental resonance at deep sites rather than reflect actual random variations to basement shear-wave velocities across a footprint.

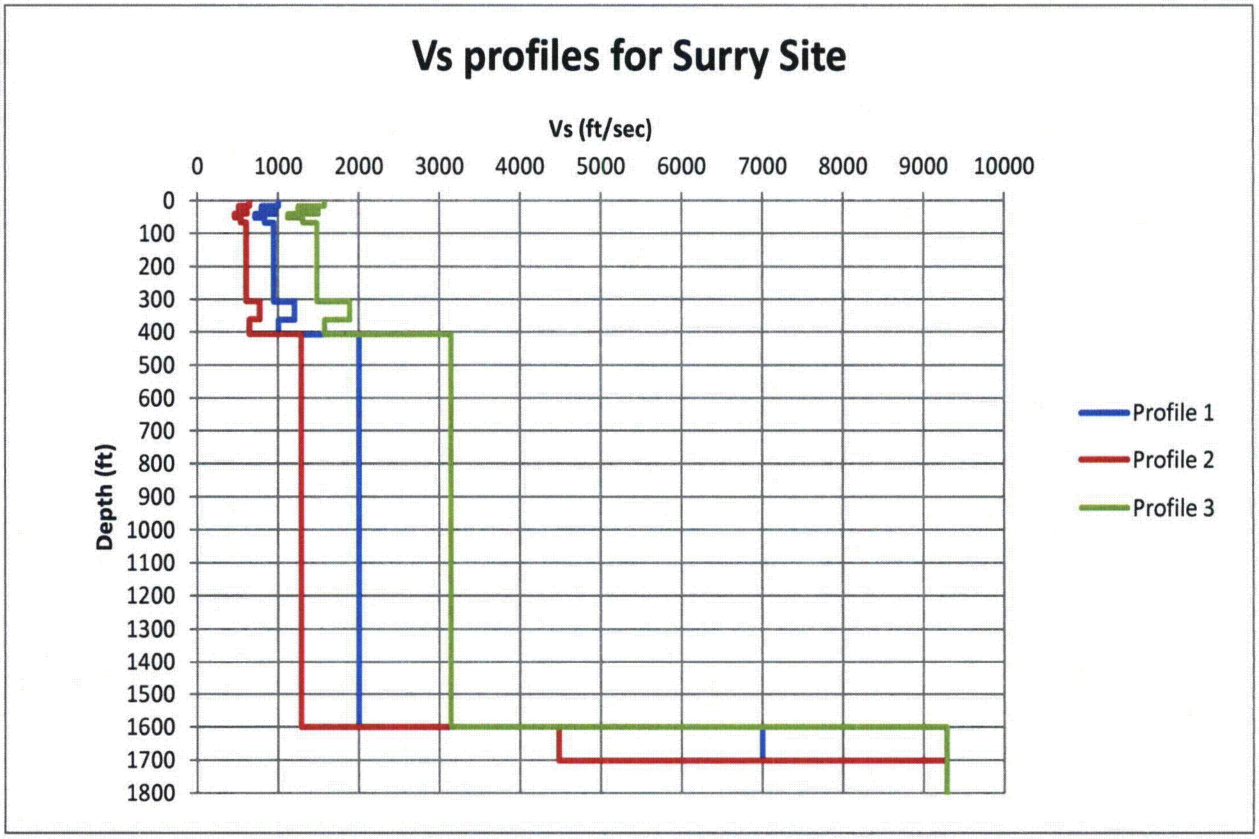

Figure 2.3.2-1Shear-wave velocity profiles for SPS

Table 2.3.2-2
Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, SPS

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	1000		0	640		0	1570
8.0	8.0	1000	8.0	8.0	640	8.0	8.0	1570
8.0	16.0	1000	8.0	16.0	640	8.0	16.0	1570
4.0	20.0	790	4.0	20.0	506	4.0	20.0	1240
7.0	27.0	790	7.0	27.0	506	7.0	27.0	1240
6.5	33.5	950	6.5	33.5	608	6.5	33.5	1492
6.5	40.0	950	6.5	40.0	608	6.5	40.0	1492
6.0	46.0	710	6.0	46.0	454	6.0	46.0	1115
6.0	52.0	710	6.0	52.0	454	6.0	52.0	1115
7.5	59.5	830	7.5	59.5	531	7.5	59.5	1303
7.5	67.0	830	7.5	67.0	531	7.5	67.0	1303
5.0	72.0	940	5.0	72.0	602	5.0	72.0	1476
5.0	77.0	940	5.0	77.0	602	5.0	77.0	1476
5.0	82.0	940	5.0	82.0	602	5.0	82.0	1476
5.0	87.0	940	5.0	87.0	602	5.0	87.0	1476
5.0	92.0	940	5.0	92.0	602	5.0	92.0	1476
5.0	97.0	940	5.0	97.0	602	5.0	97.0	1476
5.0	102.0	940	5.0	102.0	602	5.0	102.0	1476
5.0	107.0	940	5.0	107.0	602	5.0	107.0	1476
5.0	112.0	940	5.0	112.0	602	5.0	112.0	1476
5.0	117.0	940	5.0	117.0	602	5.0	117.0	1476
3.0	120.0	940	3.0	120.0	602	3.0	120.0	1476
7.0	127.0	940	7.0	127.0	602	7.0	127.0	1476
5.0	132.0	940	5.0	132.0	602	5.0	132.0	1476
5.0	137.0	940	5.0	137.0	602	5.0	137.0	1476
5.0	142.0	940	5.0	142.0	602	5.0	142.0	1476
5.0	147.0	940	5.0	147.0	602	5.0	147.0	1476
5.0	152.0	940	5.0	152.0	602	5.0	152.0	1476
5.0	157.0	940	5.0	157.0	602	5.0	157.0	1476
5.0	162.0	940	5.0	162.0	602	5.0	162.0	1476
5.0	167.0	940	5.0	167.0	602	5.0	167.0	1476
5.0	172.0	940	5.0	172.0	602	5.0	172.0	1476
5.0	177.0	940	5.0	177.0	602	5.0	177.0	1476
5.0	182.0	940	5.0	182.0	602	5.0	182.0	1476
5.0	187.0	940	5.0	187.0	602	5.0	187.0	1476
5.0	192.0	940	5.0	192.0	602	5.0	192.0	1476
5.0	197.0	940	5.0	197.0	602	5.0	197.0	1476
5.0	202.0	940	5.0	202.0	602	5.0	202.0	1476
5.0	207.0	940	5.0	207.0	602	5.0	207.0	1476
5.0	212.0	940	5.0	212.0	602	5.0	212.0	1476
5.0	217.0	940	5.0	217.0	602	5.0	217.0	1476
5.0	222.0	940	5.0	222.0	602	5.0	222.0	1476
5.0	227.0	940	5.0	227.0	602	5.0	227.0	1476
5.0	232.0	940	5.0	232.0	602	5.0	232.0	1476
5.0	237.0	940	5.0	237.0	602	5.0	237.0	1476
5.0	242.0	940	5.0	242.0	602	5.0	242.0	1476

Table 2.3.2-2
Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, SPS

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)
5.0	247.0	940	5.0	247.0	602	5.0	247.0	1476
3.0	250.0	940	3.0	250.0	602	3.0	250.0	1476
7.0	257.0	940	7.0	257.0	602	7.0	257.0	1476
5.0	262.0	940	5.0	262.0	602	5.0	262.0	1476
5.0	267.0	940	5.0	267.0	602	5.0	267.0	1476
5.0	272.0	940	5.0	272.0	602	5.0	272.0	1476
5.0	277.0	940	5.0	277.0	602	5.0	277.0	1476
5.0	282.0	940	5.0	282.0	602	5.0	282.0	1476
5.0	287.0	940	5.0	287.0	602	5.0	287.0	1476
5.0	292.0	940	5.0	292.0	602	5.0	292.0	1476
5.0	297.0	940	5.0	297.0	602	5.0	297.0	1476
5.0	302.0	940	5.0	302.0	602	5.0	302.0	1476
5.0	307.0	940	5.0	307.0	602	5.0	307.0	1476
5.0	312.0	1200	5.0	312.0	768	5.0	312.0	1884
5.0	317.0	1200	5.0	317.0	768	5.0	317.0	1884
5.0	322.0	1200	5.0	322.0	768	5.0	322.0	1884
5.0	327.0	1200	5.0	327.0	768	5.0	327.0	1884
5.0	332.0	1200	5.0	332.0	768	5.0	332.0	1884
5.0	337.0	1200	5.0	337.0	768	5.0	337.0	1884
5.0	342.0	1200	5.0	342.0	768	5.0	342.0	1884
5.0	347.0	1200	5.0	347.0	768	5.0	347.0	1884
5.0	352.0	1200	5.0	352.0	768	5.0	352.0	1884
5.0	357.0	1200	5.0	357.0	768	5.0	357.0	1884
5.0	362.0	1200	5.0	362.0	768	5.0	362.0	1884
5.0	367.0	1000	5.0	367.0	640	5.0	367.0	1570
5.0	372.0	1000	5.0	372.0	640	5.0	372.0	1570
5.0	377.0	1000	5.0	377.0	640	5.0	377.0	1570
5.0	382.0	1000	5.0	382.0	640	5.0	382.0	1570
5.0	387.0	1000	5.0	387.0	640	5.0	387.0	1570
5.0	392.0	1000	5.0	392.0	640	5.0	392.0	1570
5.0	397.0	1000	5.0	397.0	640	5.0	397.0	1570
5.0	402.0	1000	5.0	402.0	640	5.0	402.0	1570
5.0	407.0	1000	5.0	407.0	640	5.0	407.0	1570
5.0	412.0	2000	5.0	412.0	1280	5.0	412.0	3140
5.0	417.0	2000	5.0	417.0	1280	5.0	417.0	3140
5.0	422.0	2000	5.0	422.0	1280	5.0	422.0	3140
5.0	427.0	2000	5.0	427.0	1280	5.0	427.0	3140
5.0	432.0	2000	5.0	432.0	1280	5.0	432.0	3140
5.0	437.0	2000	5.0	437.0	1280	5.0	437.0	3140
5.0	442.0	2000	5.0	442.0	1280	5.0	442.0	3140
5.0	447.0	2000	5.0	447.0	1280	5.0	447.0	3140
5.0	452.0	2000	5.0	452.0	1280	5.0	452.0	3140
5.0	457.0	2000	5.0	457.0	1280	5.0	457.0	3140
5.0	462.0	2000	5.0	462.0	1280	5.0	462.0	3140
5.0	467.0	2000	5.0	467.0	1280	5.0	467.0	3140
5.0	472.0	2000	5.0	472.0	1280	5.0	472.0	3140

Table 2.3.2-2
Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, SPS

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)
5.0	477.0	2000	5.0	477.0	1280	5.0	477.0	3140
5.0	482.0	2000	5.0	482.0	1280	5.0	482.0	3140
5.0	487.0	2000	5.0	487.0	1280	5.0	487.0	3140
5.0	492.0	2000	5.0	492.0	1280	5.0	492.0	3140
5.0	497.0	2000	5.0	497.0	1280	5.0	497.0	3140
3.0	500.0	2000	3.0	500.0	1280	3.0	500.0	3140
7.0	507.0	2000	7.0	507.0	1280	7.0	507.0	3140
5.0	512.0	2000	5.0	512.0	1280	5.0	512.0	3140
5.0	517.0	2000	5.0	517.0	1280	5.0	517.0	3140
5.0	522.0	2000	5.0	522.0	1280	5.0	522.0	3140
5.0	527.0	2000	5.0	527.0	1280	5.0	527.0	3140
5.0	532.0	2000	5.0	532.0	1280	5.0	532.0	3140
5.0	537.0	2000	5.0	537.0	1280	5.0	537.0	3140
5.0	542.0	2000	5.0	542.0	1280	5.0	542.0	3140
5.0	547.0	2000	5.0	547.0	1280	5.0	547.0	3140
5.0	552.0	2000	5.0	552.0	1280	5.0	552.0	3140
5.0	557.0	2000	5.0	557.0	1280	5.0	557.0	3140
5.0	562.0	2000	5.0	562.0	1280	5.0	562.0	3140
5.0	567.0	2000	5.0	567.0	1280	5.0	567.0	3140
103.3	670.3	2000	103.3	670.3	1280	103.3	670.3	3140
103.3	773.6	2000	103.3	773.6	1280	103.3	773.6	3140
103.3	876.9	2000	103.3	876.9	1280	103.3	876.9	3140
103.3	980.2	2000	103.3	980.2	1280	103.3	980.2	3140
103.3	1083.5	2000	103.3	1083.5	1280	103.3	1083.5	3140
103.3	1186.8	2000	103.3	1186.8	1280	103.3	1186.8	3140
103.3	1290.0	2000	103.3	1290.0	1280	103.3	1290.0	3140
103.3	1393.3	2000	103.3	1393.3	1280	103.3	1393.3	3140
103.3	1496.6	2000	103.3	1496.6	1280	103.3	1496.6	3140
103.3	1599.9	2000	103.3	1599.9	1280	103.3	1599.9	3140
33.3	1633.3	7000	33.3	1633.3	4480	33.3	1633.3	9285
33.3	1666.6	7000	33.3	1666.6	4480	33.3	1666.6	9285
33.3	1699.9	7000	33.3	1699.9	4480	33.3	1699.9	9285
3280.8	4980.8	9285	3280.8	4980.8	9285	3280.8	4980.8	9285

2.3.2.1 SHEAR MODULUS AND DAMPING CURVES

No site-specific nonlinear dynamic material properties are available for SPS for the soils. The firm soil material over the upper 500 ft was assumed to have behavior that could be modeled with either EPRI cohesionless soil or Peninsular Range G/G_{max} and hysteretic damping curves (Reference 7.5). Consistent with the SPID, 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 (Reference 7.2) 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 for sites with less than 3,000 ft of soil. Per the SPID, for soil sites with depths less than 3,000 ft to hard rock, a mean base-case kappa may be estimated based on total soil thickness with the addition of the hard basement rock value of 0.006s conditioned with an upper bound of 0.04s. For the SPS site, with about 1,600 ft of soil, the total kappa value was 0.034s (Table 2.3.2-3). Epistemic uncertainty in profile damping (kappa) was considered to be accommodated at design loading levels by the multiple (2) sets of G/G_{max} and hysteretic damping curves.

Table 2.3.2-3
Kappa Values and Weights Used for Site Response Analyses

Velocity Profile	Kappa(s)
P1	0.034
P2	0.034
P3	0.034
	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 was incorporated in the site response calculations. For the SPS site, random shear wave velocity profiles were developed from the base case profiles shown in Figure 2.3.2-1. Consistent with the discussion in Appendix B of the SPID, 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 Reference 7.12 for U.S. Geological Survey "A" site conditions were used for the SPS 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, 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, 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 1.5g) were used in the site response analyses. The characteristics of the seismic source and upper crustal attenuation properties assumed for the analysis of the SPS site were the same as those identified in Tables B-4, B-5, B-6 and B-7 of the SPID as appropriate for typical CEUS sites.

2.3.5 METHODOLOGY

To perform the site response analyses for the SPS 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. The guidance contained in Appendix B of the SPID 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 SPS 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, a lower bound median amplification factor value of 0.5 was applied for the seismic hazard 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 and rock G/G_{max} and hysteretic damping curves. 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 SPS deep soil and firm rock site, Figure 2.3.6-2 presents the corresponding amplification factors developed with Peninsular Range G/G_{max} and hysteretic damping curves for soil (model M2). Comparison of Figure 2.3.6-1 and Figure 2.3.6-2 indicates only a minor difference for all frequencies and all loading levels. Tabulated values of selected site response amplification functions are provided in the attached Appendix A (Tables A2, A2-b1 and A2-b2) for comparison purposes.

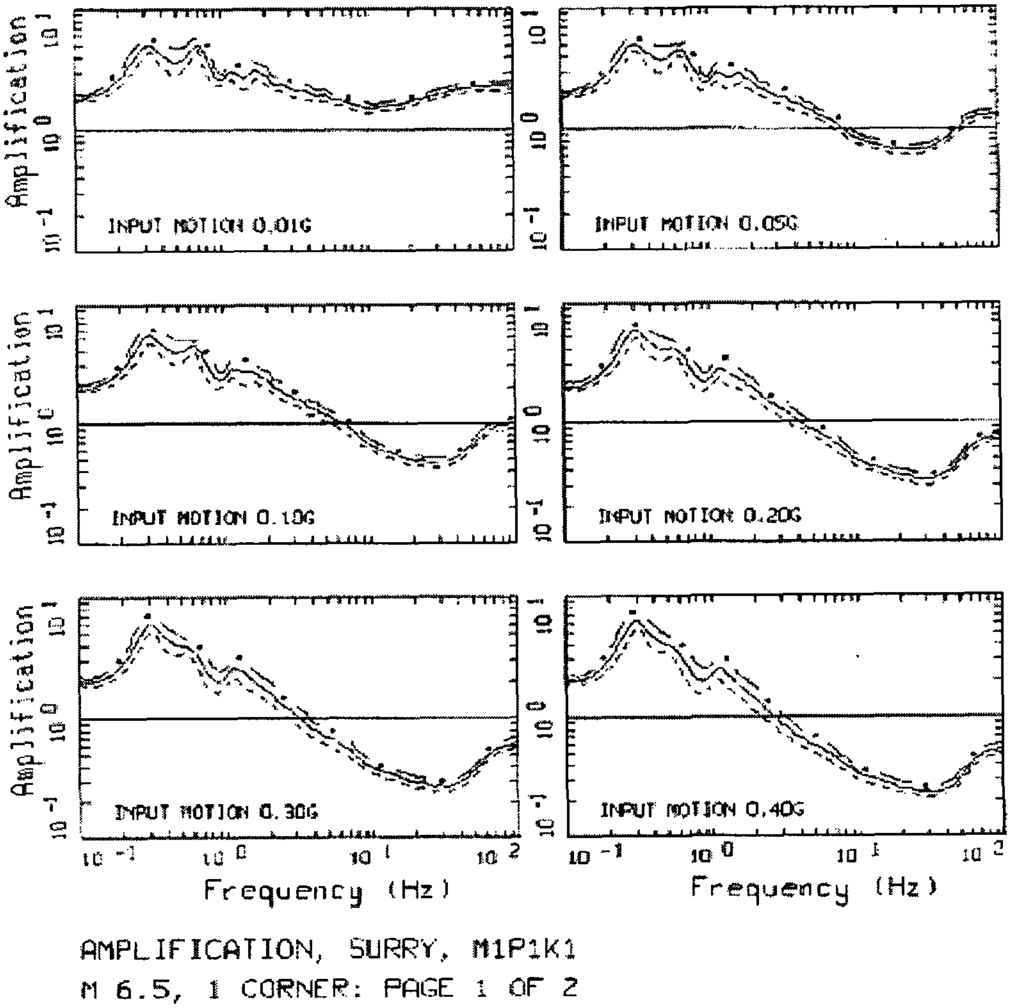

Figure 2.3.6-1 Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI soil modulus reduction and hysteretic damping curves (model M1), and base-case kappa at eleven loading levels of hard rock median peak acceleration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

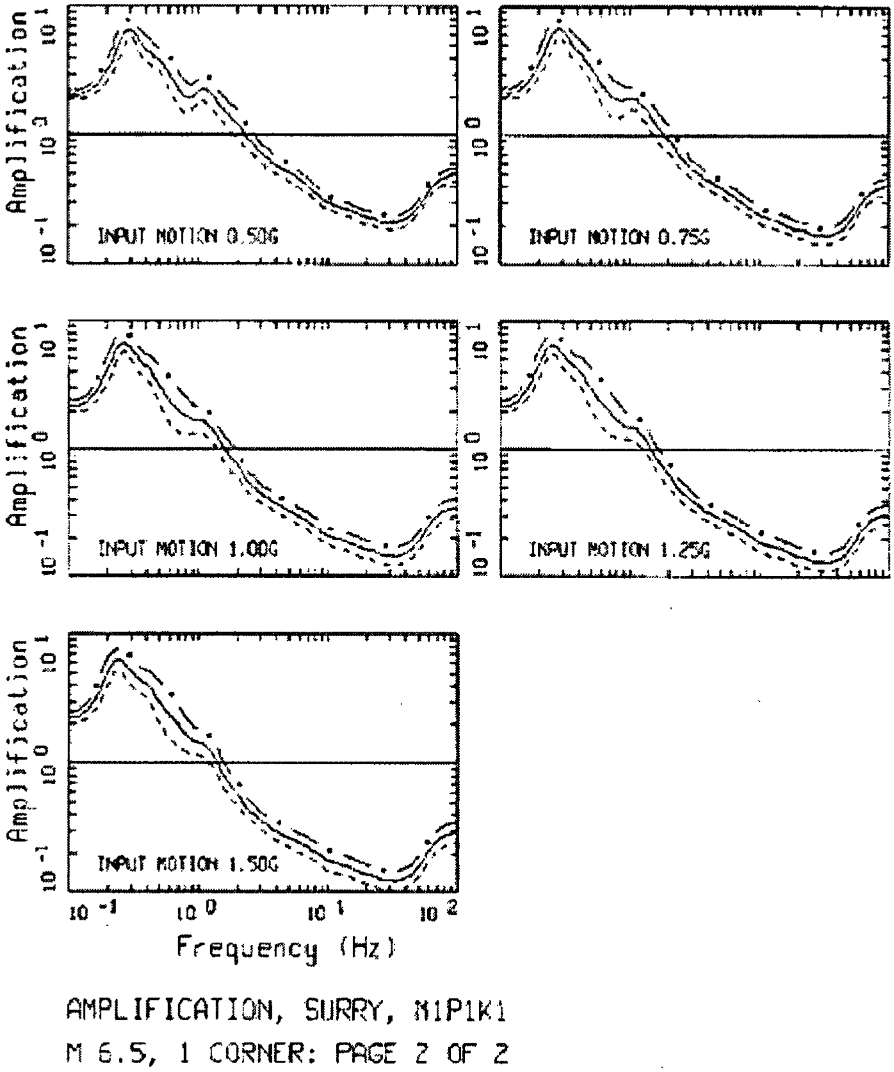

Figure 2.3.6-1 (continued from previous)

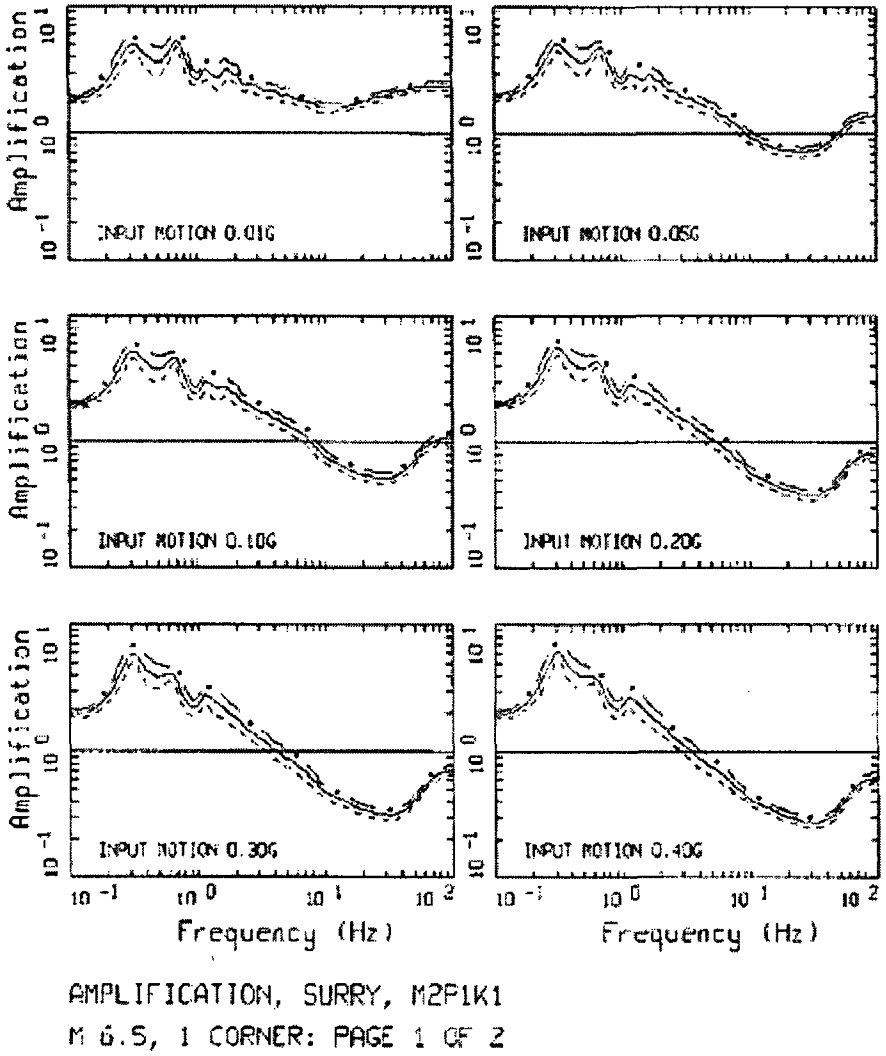

Figure 2.3.6-2 Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), Peninsular Range modulus reduction and hysteretic damping curves for soil (model M2), and base-case kappa at eleven loading levels of hard rock median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

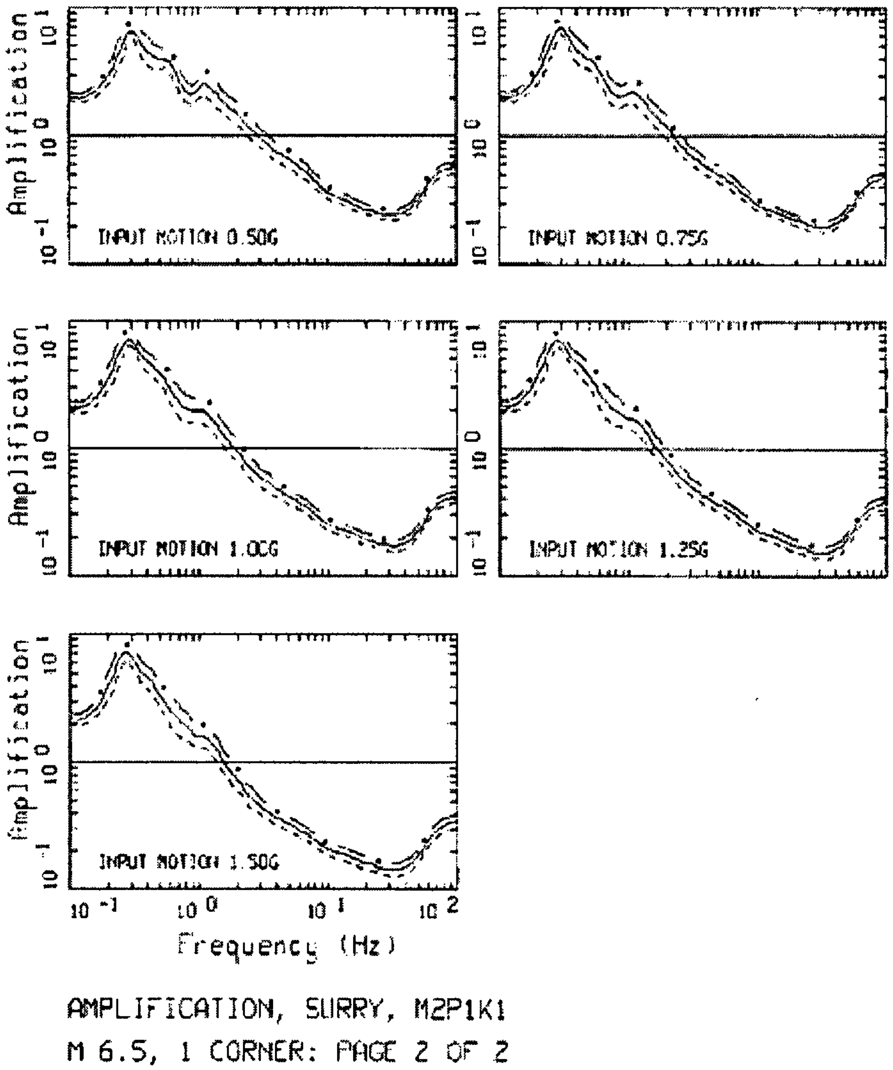

Figure 2.3.6-2 (continued from previous)

2.3.7 CONTROL POINT SEISMIC HAZARD CURVES

The procedure to develop probabilistic site-specific control point hazard curves follows the methodology described in Section B-6.0 of the SPID. 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 along with application of the minimum median amplification factor of 0.5. The resulting control point mean hazard curves for the SPS 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 the attached Appendix A (Tables A-1a through A-1g).

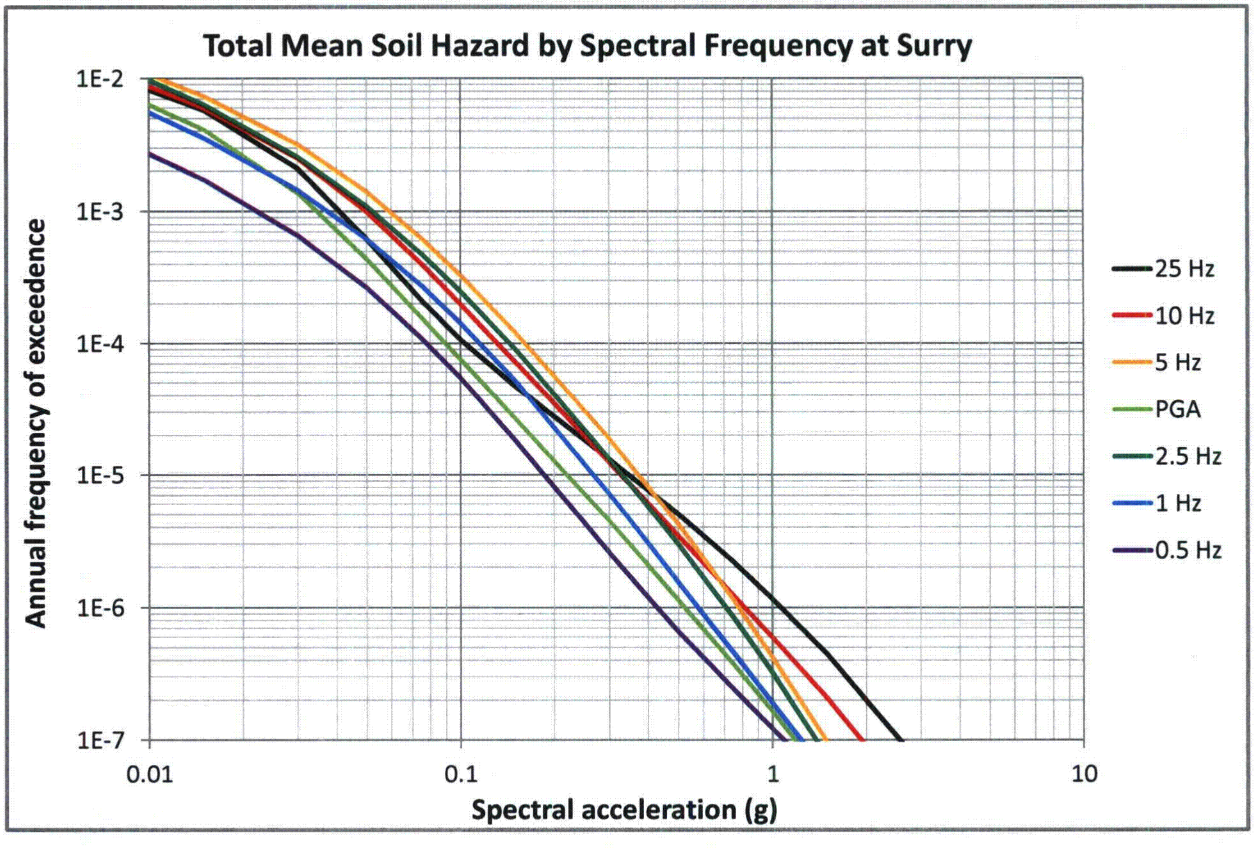

Figure 2.3.7-1 Control point mean hazard curves for spectral frequencies of 0.5, 1, 2.5, 5, 10, 25 and 100 (PGA) Hz at SPS.

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 ground motion response spectrum (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.

The 1E-4 and 1E-5 UHRS, along with a design factor (DF), are used to compute the GMRS at the control point using the criteria in Regulatory Guide 1.208. Table 2.4-1 provides the UHRS and GMRS spectral accelerations data, and these data are plotted in Figure 2.4-1.

Table 2.4-1 Horizontal Direction, 5% Damped UHRS for 1E-4 and 1E-5 and GMRS at control point for SPS

Freq. (Hz)	1E-4 UHRS (g)	1E-5 UHRS (g)	GMRS (g)
100	8.94E-02	2.19E-01	1.10E-01
90	9.00E-02	2.26E-01	1.13E-01
80	9.06E-02	2.35E-01	1.16E-01
70	9.15E-02	2.45E-01	1.21E-01
60	9.25E-02	2.57E-01	1.26E-01
50	9.38E-02	2.72E-01	1.32E-01
40	9.59E-02	2.92E-01	1.40E-01
35	9.75E-02	3.06E-01	1.46E-01
30	9.99E-02	3.23E-01	1.53E-01
25	1.04E-01	3.47E-01	1.64E-01
20	1.06E-01	3.31E-01	1.58E-01
15	1.13E-01	3.22E-01	1.57E-01
12.5	1.21E-01	3.26E-01	1.60E-01
10	1.31E-01	3.27E-01	1.63E-01
9	1.37E-01	3.33E-01	1.67E-01
8	1.45E-01	3.44E-01	1.74E-01
7	1.50E-01	3.57E-01	1.80E-01
6	1.56E-01	3.67E-01	1.85E-01
5	1.61E-01	3.72E-01	1.88E-01
4	1.62E-01	3.66E-01	1.87E-01
3.5	1.58E-01	3.62E-01	1.84E-01
3	1.52E-01	3.50E-01	1.78E-01
2.5	1.44E-01	3.29E-01	1.67E-01
2	1.40E-01	3.24E-01	1.64E-01
1.5	1.21E-01	2.76E-01	1.40E-01
1.25	1.24E-01	2.73E-01	1.40E-01
1	1.15E-01	2.67E-01	1.35E-01
0.9	1.03E-01	2.43E-01	1.23E-01
0.8	1.03E-01	2.30E-01	1.17E-01
0.7	1.06E-01	2.29E-01	1.18E-01
0.6	9.08E-02	2.18E-01	1.10E-01
0.5	7.77E-02	1.85E-01	9.34E-02
0.4	6.21E-02	1.48E-01	7.47E-02
0.35	5.44E-02	1.30E-01	6.54E-02
0.3	4.66E-02	1.11E-01	5.60E-02
0.25	3.88E-02	9.26E-02	4.67E-02
0.2	3.11E-02	7.41E-02	3.74E-02
0.15	2.33E-02	5.56E-02	2.80E-02
0.125	1.94E-02	4.63E-02	2.33E-02
0.1	1.55E-02	3.70E-02	1.87E-02

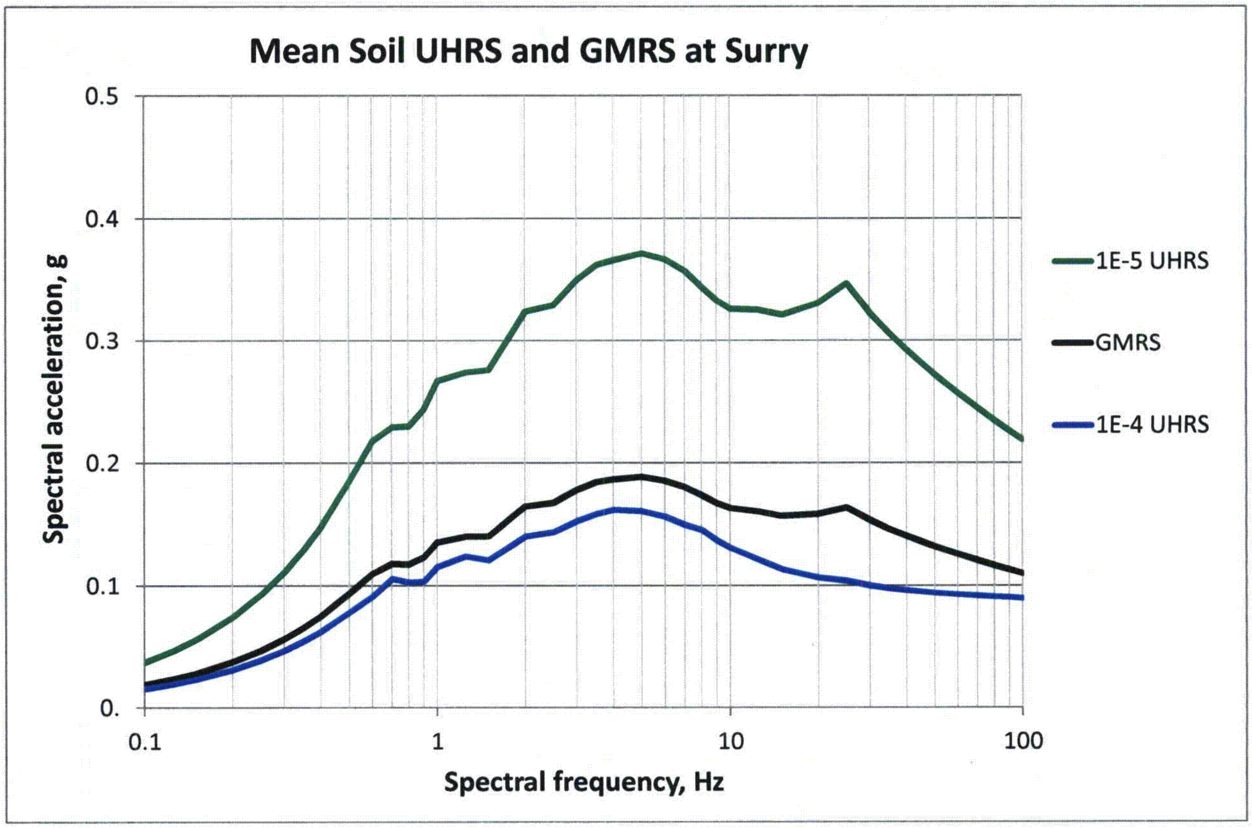

Figure 2.4-1 UHRS for 1E-4 and 1E-5 and GMRS at control point for SPS (Horizontal Direction, 5%-damped response spectra).

The elevated acceleration "peak" in the 1E-5 UHRS curve at a frequency of 25 Hz in Figure 2.4-1 was characterized in Reference 7.5 as unrealistic given the deep soil characteristics of the Surry Power Station site. This peak causes a similar peak in the calculated GMRS at 25 Hz. A sensitivity analysis (Reference 7.13) was performed to determine the influence of the application of a lower bound median amplification factor value and the results are described in Appendix B.

3.0 DESIGN BASIS EARTHQUAKE

The design basis for Surry Power Station is identified in the Updated Final Safely Evaluation Report (UFSAR) (Reference 7.10).

3.1 SSE DESCRIPTION OF SPECTRAL SHAPE

The Surry Power Station UFSAR Section 2.5.6 describes the development of SSE; UFSAR Figure 2.5-6 presents the SSE response spectrum. The SSE is based on a Housner shape with a PGA of 0.15g as described below.

For frequencies higher than about 2 cycles per second, the Housner spectra were followed and normalized to a horizontal ground acceleration of 7% of gravity for the operating-basis earthquake, and 15% of gravity for the design basis earthquake.

In the frequency range between 0.3 cycles per second and 2 cycles per second, Housner's average spectra were normalized to a maximum ground velocity of about 4 in/sec for the operating-basis earthquake, and 9 in/sec for the design-basis earthquake.

For frequencies lower than about 0.3 cycles per second, the spectra were prepared using data suggested by Drs. Newmark and Hall.

Figure 3.3-1 provides the Surry Power Station SSE response spectra. Data for the response spectra are given in Table 3.3-1.

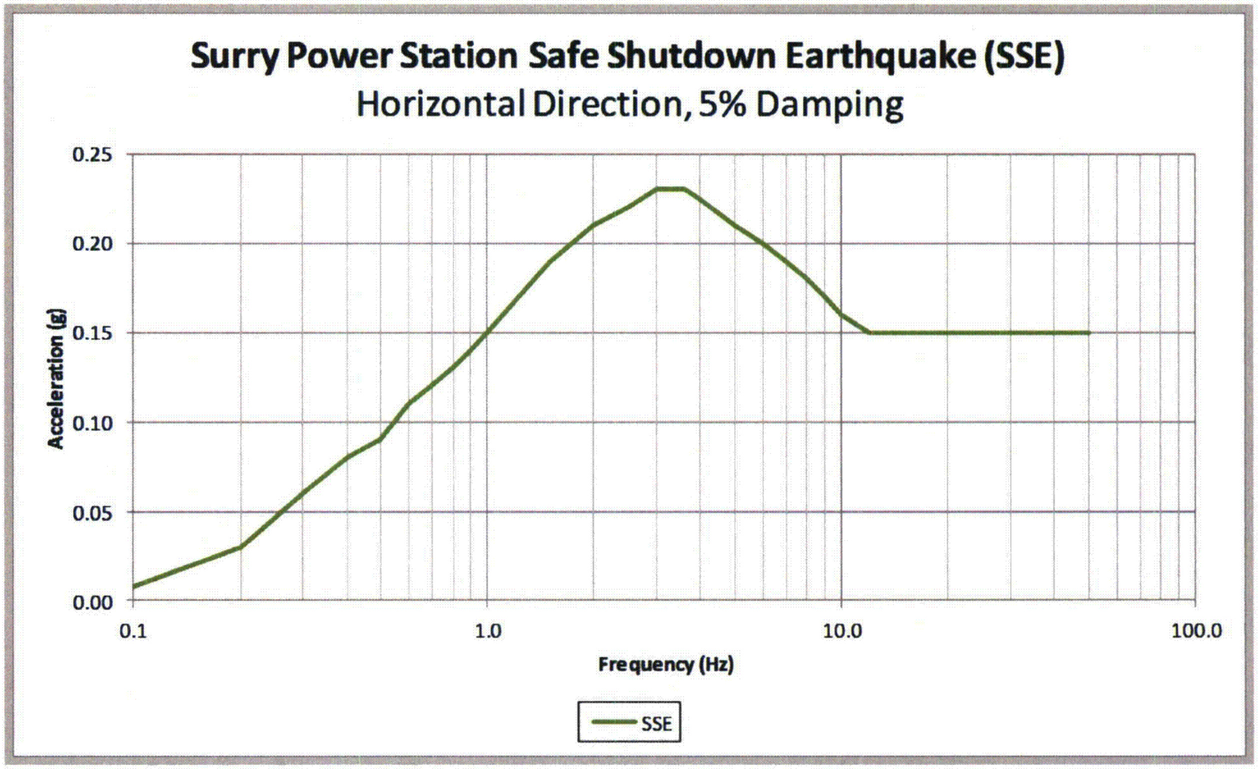

Figure 3.3-1 Horizontal SSE for SPS (5%-damped response spectrum).

Table 3.3-1 SSE for SPS – Digitized Data

Freq (Hz)	Accel (g)	Freq (Hz)	Accel (g)
0.1	0.008	3.6	0.230
0.2	0.030	4.0	0.225
0.3	0.060	5.0	0.210
0.4	0.080	6.0	0.200
0.5	0.090	7.0	0.190
0.6	0.110	8.0	0.180
0.7	0.120	9.0	0.170
0.8	0.130	10.0	0.160
0.9	0.140	12.0	0.150
1.0	0.150	15.0	0.150
1.5	0.190	20.0	0.150
2.0	0.210	33.0	0.150
2.5	0.220	50.0	0.150
3.0	0.230		

3.2 CONTROL POINT ELEVATION

In accordance with the SPID, Surry Power Station has been designated as a soil supported site. In the case of a plant designated as a soil site where the UFSAR does not specifically define the SSE elevation, the SSE control point is defined as the foundation bearing elevation of the highest soil supported, safety related structure. The safety related structure at Surry Power Station bearing at the highest elevation is the Emergency Condensate Storage Tank which bears at elevation 26.5 feet on compacted fill placed after the critical power block area was excavated to approximately elevation 7 feet during construction. The SSE control point elevation is assumed to be at the surface, as indicated in Table 2.3.2-1.

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)

A comparison of the SSE to the GMRS in the 1 to 10 Hz range of the response spectrum shows that the GMRS exceeds the SSE by a negligible amount in a narrow frequency band within that range. The maximum exceedance at any frequency in the 1 to 10 Hz part of the response spectrum is 0.003g.

As discussed in Section 2.4, an unrealistic, high acceleration value (peak) is evident in the GMRS at a frequency of 25 Hz when a lower bound median amplification factor value of 0.5 is used in accordance with the methodology described in SPID Section B-5.1.4.1. A sensitivity analysis (Reference 7.13) performed with a lower limit on the median amplification factor reduced by 10% (i.e., with a lower bound of 0.45) shows a reduced spectral peak at 25 Hz. The GMRS from this sensitivity-case is completely enveloped by the SSE in the 1 to 10 Hz range. The sensitivity analysis is described in Appendix B to this report.

In addition, the special screening considerations of SPID Section 3.2.1 for the acceptance of narrow band exceedances were reviewed. The applicable criteria are met, as described in Appendix C.

Based on the above considerations, Surry Power Station screens-out and a risk evaluation will not be performed.

4.2 HIGH FREQUENCY SCREENING (> 10 HZ)

Above 10 Hz, in the 10 to 30 Hz frequency band, the GMRS minimally exceeds the SSE. The largest exceedance occurs at 25 Hz (0.014g) and is less than 10% of the SSE. With this small SSE exceedance in the high frequency range, a concern for effects on potentially high-frequency sensitive components is not considered to be warranted.

Further, as described in Section 2.4, Appendix B provides the results of a sensitivity analysis that was performed to determine the influence of the lower bound median amplification factor value on the GMRS for Surry Power Station. The GMRS determined by this sensitivity analysis is essentially enveloped by the SSE in the > 10 Hz frequency range.

Based on the above considerations, a high-frequency confirmation will not be performed for Surry Power Station.

4.3 SPENT FUEL POOL EVALUATION SCREENING (1 TO 10 HZ)

Based on the screening results described in Section 4.1, a spent fuel pool evaluation will not be performed.

5.0 INTERIM ACTIONS

Based on the screening evaluation for Surry Power Station, no further actions are required.

6.0 CONCLUSIONS

In accordance with the 10 CFR 50.54(f) request for information, a seismic hazard and screening evaluation was performed for Surry Power Station. A GMRS was developed solely for the purpose of screening for additional evaluations in accordance with the SPID.

Based on the results of the screening evaluation and consistent with the NRC endorsed guidance in the SPID, no further actions in response to the Fukushima NTTF Recommendation 2.1: Seismic, related to the information requested in the 10 CFR 50.54(f) letter, are required for Surry Power Station.

It is noted that, as discussed in the NEI letter to NRC dated March 12, 2014 (Reference 7.4), seismic core damage frequency (CDF) calculations were performed by EPRI for plants in the Central and Eastern United States using the plant capacities from the Individual Plant Examination of External Events (IPEEE) program and the recently updated seismic hazard curves. The results of these calculations for Surry Power Station Units 1 and 2 support the conclusion of the NRC GI-199 Safety/Risk Assessment (Reference 7.3) that "Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement..." and "...the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis."

7.0 REFERENCES

7.1 U. S. Nuclear Regulatory Commission (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.

7.2 Electric Power Research Institute (EPRI) Report No. 1025287, "Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," February 28, 2013.

7.3 NRC Information Notice 2010-18, 'Generic Issue (GI) 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants,"' and NRC Memorandum from Patrick Hiland to Brian Sheron, "Safety/Risk Assessment Results for GI-199," September 2, 2010.

7.4 Anthony R. Pietrangelo, NEI letter to Eric J. Leeds, NRC, "Seismic Risk Evaluations for Plants in the Central and Eastern United States," dated March 12, 2014.

7.5 Lettis Consultants International Report, "Surry Seismic Hazard and Screening Report," LCI Project 1041, January 14, 2014 via EPRI Supplemental Project Seismic Attenuation and GMRS Project, CF 18139-30157 (Project ID No. 073272) letter.

7.6 Technical Report, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," U.S. Nuclear Regulatory Commission Report, NUREG-2115; EPRI Report 1021097, DOE Report# DOE/NE-0140, 2012.

7.7 EPRI Report No. 3002000717, "EPRI (2004, 2006) Ground-Motion Model (GMM) Review Project," June 13, 2013.

7.8 NRC Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," March 2007.

7.9 Dominion, Seismic Screening GMRS Subsurface Profile for Surry Power Station, ETE-CCE-2013-0002, Revision 0.

7.10 Surry Power Station Updated Final Safety Analysis Report (UFSAR), Revision 45.

7.11 Virginia Electric and Power Company Letter S/N 13-244C, Eugene S. Grecheck to NRC Document Control Desk, Surry Power Station Units 1 and 2 Surry Power Station Units 1 and 2 Response to March 12, 2012 Information Request Regarding Seismic Aspects of Recommendation 2.1 – 1.5 Year Response for CEUS Sites, September 12, 2013.

7.12 Appendix of: Silva, W.J., Abrahamson, N., Toro, G., and Costantino, C. (1997). "Description and validation of the stochastic ground motion model," Report Submitted to Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973, Contract No. 770573.

7.13 Lettis Consultants International Report, "Surry Soil Hazard Sensitivity Report," LCI Project 1041, February 21, 2014 via EPRI Supplemental Project Seismic Attenuation and GMRS Project, CF 18139-30157 (Project ID No. 073272) letter.

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NOTE: 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 1E-4 and 1E-5 mean annual frequency of exceedance. **These factors are unverified and are provided for information only**. The figures should be considered the governing information.

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.74E-02	1.98E-02	3.09E-02	3.84E-02	4.50E-02	4.83E-02
0.001	2.97E-02	1.40E-02	2.25E-02	3.01E-02	3.79E-02	4.19E-02
0.005	1.12E-02	4.77E-03	7.55E-03	1.07E-02	1.49E-02	1.98E-02
0.01	6.34E-03	2.39E-03	3.79E-03	5.83E-03	8.60E-03	1.27E-02
0.015	4.12E-03	1.42E-03	2.19E-03	3.63E-03	5.66E-03	9.24E-03
0.03	1.37E-03	3.52E-04	5.27E-04	1.07E-03	2.01E-03	3.84E-03
0.05	4.36E-04	6.45E-05	1.15E-04	2.76E-04	6.64E-04	1.46E-03
0.075	1.57E-04	1.44E-05	2.92E-05	8.35E-05	2.42E-04	5.83E-04
0.1	7.50E-05	5.27E-06	1.21E-05	3.68E-05	1.15E-04	2.84E-04
0.15	2.66E-05	1.55E-06	4.13E-06	1.32E-05	4.07E-05	9.79E-05
0.3	4.44E-06	1.90E-07	7.03E-07	2.42E-06	7.45E-06	1.53E-05
0.5	1.13E-06	4.01E-08	1.57E-07	6.45E-07	1.90E-06	3.84E-06
0.75	3.71E-07	1.02E-08	4.01E-08	1.98E-07	6.36E-07	1.32E-06
1.	1.64E-07	3.28E-09	1.34E-08	8.00E-08	2.80E-07	6.17E-07
1.5	4.81E-08	5.12E-10	2.49E-09	1.92E-08	7.89E-08	1.98E-07
3.	4.33E-09	8.85E-11	1.42E-10	1.15E-09	6.26E-09	2.04E-08
5.	5.30E-10	4.70E-11	8.12E-11	1.42E-10	7.23E-10	2.80E-09
7.5	8.13E-11	4.01E-11	5.05E-11	9.11E-11	1.51E-10	4.83E-10
10.	1.95E-11	4.01E-11	4.01E-11	8.60E-11	9.11E-11	1.60E-10

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.84E-02	2.29E-02	3.28E-02	3.90E-02	4.50E-02	4.83E-02
0.001	3.12E-02	1.67E-02	2.49E-02	3.14E-02	3.79E-02	4.25E-02
0.005	1.32E-02	6.45E-03	9.11E-03	1.25E-02	1.69E-02	2.29E-02
0.01	8.22E-03	3.63E-03	5.27E-03	7.66E-03	1.08E-02	1.55E-02
0.015	5.79E-03	2.35E-03	3.37E-03	5.27E-03	7.89E-03	1.16E-02
0.03	2.10E-03	6.45E-04	9.51E-04	1.77E-03	3.09E-03	4.90E-03
0.05	6.20E-04	1.44E-04	2.29E-04	4.63E-04	9.51E-04	1.67E-03
0.075	2.13E-04	3.90E-05	6.64E-05	1.49E-04	3.28E-04	6.45E-04
0.1	1.08E-04	1.60E-05	3.01E-05	7.23E-05	1.64E-04	3.47E-04
0.15	4.70E-05	5.27E-06	1.20E-05	3.14E-05	7.55E-05	1.49E-04
0.3	1.32E-05	1.18E-06	3.28E-06	9.11E-06	2.13E-05	3.79E-05
0.5	5.02E-06	3.79E-07	1.21E-06	3.57E-06	8.60E-06	1.44E-05
0.75	2.19E-06	1.38E-07	4.83E-07	1.57E-06	3.90E-06	6.36E-06
1.	1.17E-06	6.26E-08	2.39E-07	8.23E-07	2.10E-06	3.42E-06
1.5	4.42E-07	1.95E-08	7.66E-08	3.01E-07	8.12E-07	1.34E-06
3.	6.48E-08	1.90E-09	7.34E-09	3.68E-08	1.16E-07	2.22E-07
5.	1.23E-08	2.92E-10	9.79E-10	5.58E-09	2.13E-08	4.83E-08
7.5	2.81E-09	9.79E-11	1.98E-10	1.08E-09	4.63E-09	1.20E-08
10.	8.99E-10	8.00E-11	9.79E-11	3.19E-10	1.42E-09	4.07E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.09E-02	3.01E-02	3.57E-02	4.13E-02	4.63E-02	4.90E-02
0.001	3.44E-02	2.29E-02	2.84E-02	3.47E-02	4.07E-02	4.43E-02
0.005	1.46E-02	8.00E-03	1.05E-02	1.42E-02	1.87E-02	2.25E-02
0.01	8.67E-03	4.25E-03	5.83E-03	8.23E-03	1.15E-02	1.46E-02
0.015	5.98E-03	2.72E-03	3.79E-03	5.58E-03	8.00E-03	1.07E-02
0.03	2.49E-03	9.51E-04	1.36E-03	2.22E-03	3.52E-03	5.05E-03
0.05	9.79E-04	3.01E-04	4.37E-04	8.23E-04	1.46E-03	2.25E-03
0.075	3.96E-04	8.47E-05	1.40E-04	3.05E-04	6.17E-04	1.02E-03
0.1	1.97E-04	3.14E-05	5.91E-05	1.42E-04	3.19E-04	5.42E-04
0.15	7.11E-05	8.60E-06	1.74E-05	4.70E-05	1.20E-04	2.10E-04
0.3	1.24E-05	1.05E-06	2.68E-06	8.23E-06	2.16E-05	3.84E-05
0.5	3.42E-06	2.25E-07	7.34E-07	2.32E-06	5.91E-06	1.04E-05
0.75	1.23E-06	6.83E-08	2.42E-07	8.23E-07	2.16E-06	3.73E-06
1.	5.92E-07	2.60E-08	1.01E-07	3.79E-07	1.05E-06	1.87E-06
1.5	2.05E-07	6.45E-09	2.60E-08	1.18E-07	3.63E-07	6.93E-07
3.	2.77E-08	4.56E-10	1.92E-09	1.23E-08	4.83E-08	1.07E-07
5.	5.11E-09	9.79E-11	2.68E-10	1.74E-09	8.60E-09	2.13E-08
7.5	1.16E-09	7.89E-11	9.37E-11	3.42E-10	1.84E-09	5.12E-09
10.	3.73E-10	5.05E-11	8.12E-11	1.31E-10	5.91E-10	1.72E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.31E-02	3.42E-02	3.79E-02	4.31E-02	4.83E-02	5.12E-02
0.001	3.85E-02	2.72E-02	3.23E-02	3.90E-02	4.50E-02	4.83E-02
0.005	1.84E-02	9.79E-03	1.31E-02	1.82E-02	2.39E-02	2.72E-02
0.01	1.07E-02	5.20E-03	7.34E-03	1.05E-02	1.42E-02	1.69E-02
0.015	7.31E-03	3.28E-03	4.83E-03	7.03E-03	9.93E-03	1.20E-02
0.03	3.17E-03	1.29E-03	1.92E-03	2.96E-03	4.50E-03	5.75E-03
0.05	1.39E-03	5.20E-04	7.66E-04	1.23E-03	2.01E-03	2.76E-03
0.075	6.23E-04	2.04E-04	3.01E-04	5.35E-04	9.37E-04	1.36E-03
0.1	3.26E-04	8.85E-05	1.36E-04	2.68E-04	5.05E-04	7.77E-04
0.15	1.20E-04	1.95E-05	3.52E-05	8.98E-05	2.01E-04	3.28E-04
0.3	1.87E-05	1.04E-06	2.60E-06	1.07E-05	3.42E-05	6.26E-05
0.5	4.20E-06	1.67E-07	5.05E-07	1.95E-06	7.55E-06	1.57E-05
0.75	1.14E-06	3.42E-08	1.15E-07	4.70E-07	2.01E-06	4.50E-06
1.	4.19E-07	9.11E-09	3.42E-08	1.74E-07	7.45E-07	1.67E-06
1.5	9.55E-08	1.08E-09	5.50E-09	4.13E-08	1.74E-07	3.63E-07
3.	9.80E-09	9.11E-11	2.13E-10	2.10E-09	1.62E-08	4.43E-08
5.	2.22E-09	5.05E-11	8.23E-11	2.25E-10	3.14E-09	1.08E-08
7.5	6.67E-10	4.01E-11	5.05E-11	9.11E-11	8.60E-10	3.28E-09
10.	2.76E-10	4.01E-11	5.05E-11	9.11E-11	3.37E-10	1.40E-09

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.29E-02	3.42E-02	3.79E-02	4.31E-02	4.77E-02	5.05E-02
0.001	3.81E-02	2.72E-02	3.14E-02	3.84E-02	4.43E-02	4.77E-02
0.005	1.75E-02	9.37E-03	1.21E-02	1.69E-02	2.32E-02	2.68E-02
0.01	9.73E-03	4.70E-03	6.45E-03	9.37E-03	1.32E-02	1.57E-02
0.015	6.36E-03	2.88E-03	4.07E-03	6.09E-03	8.72E-03	1.08E-02
0.03	2.56E-03	9.93E-04	1.46E-03	2.35E-03	3.68E-03	4.83E-03
0.05	1.08E-03	3.73E-04	5.66E-04	9.51E-04	1.60E-03	2.25E-03
0.075	4.78E-04	1.46E-04	2.29E-04	4.07E-04	7.23E-04	1.07E-03
0.1	2.48E-04	6.83E-05	1.08E-04	2.04E-04	3.84E-04	5.83E-04
0.15	8.98E-05	1.92E-05	3.28E-05	7.03E-05	1.44E-04	2.32E-04
0.3	1.31E-05	1.07E-06	2.32E-06	8.12E-06	2.29E-05	4.25E-05
0.5	2.96E-06	6.26E-08	1.98E-07	1.38E-06	5.27E-06	1.10E-05
0.75	8.42E-07	6.17E-09	3.28E-08	2.88E-07	1.46E-06	3.52E-06
1.	3.21E-07	1.44E-09	1.01E-08	8.47E-08	5.35E-07	1.42E-06
1.5	7.33E-08	2.49E-10	1.40E-09	1.32E-08	1.16E-07	3.37E-07
3.	4.74E-09	5.05E-11	9.11E-11	5.35E-10	6.00E-09	2.22E-08
5.	6.66E-10	4.01E-11	5.35E-11	9.24E-11	6.64E-10	3.01E-09
7.5	1.46E-10	4.01E-11	5.05E-11	9.11E-11	1.53E-10	6.64E-10
10.	4.83E-11	4.01E-11	4.01E-11	9.11E-11	9.11E-11	2.46E-10

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.72E-02	2.39E-02	2.96E-02	3.79E-02	4.43E-02	4.77E-02
0.001	2.96E-02	1.57E-02	2.10E-02	3.01E-02	3.79E-02	4.25E-02
0.005	1.06E-02	4.13E-03	6.17E-03	1.01E-02	1.51E-02	1.84E-02
0.01	5.55E-03	1.79E-03	2.88E-03	5.20E-03	8.23E-03	1.07E-02
0.015	3.58E-03	9.79E-04	1.67E-03	3.23E-03	5.50E-03	7.34E-03
0.03	1.44E-03	2.72E-04	5.12E-04	1.18E-03	2.39E-03	3.47E-03
0.05	6.17E-04	8.47E-05	1.69E-04	4.50E-04	1.05E-03	1.72E-03
0.075	2.74E-04	2.84E-05	6.09E-05	1.82E-04	4.77E-04	8.47E-04
0.1	1.43E-04	1.20E-05	2.68E-05	8.72E-05	2.49E-04	4.63E-04
0.15	5.13E-05	3.05E-06	7.34E-06	2.80E-05	8.98E-05	1.79E-04
0.3	7.14E-06	2.07E-07	6.00E-07	3.05E-06	1.21E-05	2.80E-05
0.5	1.54E-06	2.10E-08	7.55E-08	5.20E-07	2.49E-06	6.45E-06
0.75	4.54E-07	2.76E-09	1.31E-08	1.21E-07	6.93E-07	1.92E-06
1.	1.90E-07	6.26E-10	3.33E-09	4.07E-08	2.76E-07	8.35E-07
1.5	5.51E-08	1.13E-10	4.77E-10	8.00E-09	7.34E-08	2.53E-07
3.	6.45E-09	5.05E-11	9.11E-11	3.68E-10	5.75E-09	2.88E-08
5.	1.27E-09	4.01E-11	5.05E-11	9.11E-11	7.66E-10	5.05E-09
7.5	3.28E-10	4.01E-11	5.05E-11	9.11E-11	1.72E-10	1.16E-09
10.	1.19E-10	4.01E-11	4.01E-11	9.11E-11	9.11E-11	3.90E-10

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

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.64E-02	1.55E-02	2.04E-02	2.64E-02	3.23E-02	3.63E-02
0.001	1.79E-02	9.37E-03	1.31E-02	1.77E-02	2.25E-02	2.64E-02
0.005	5.23E-03	1.98E-03	3.09E-03	4.90E-03	7.34E-03	9.65E-03
0.01	2.70E-03	7.34E-04	1.29E-03	2.42E-03	4.13E-03	5.66E-03
0.015	1.72E-03	3.63E-04	6.83E-04	1.46E-03	2.80E-03	3.95E-03
0.03	6.56E-04	8.35E-05	1.84E-04	4.83E-04	1.13E-03	1.82E-03
0.05	2.62E-04	2.29E-05	5.50E-05	1.67E-04	4.63E-04	8.23E-04
0.075	1.09E-04	7.23E-06	1.82E-05	6.00E-05	1.92E-04	3.73E-04
0.1	5.39E-05	2.96E-06	7.66E-06	2.72E-05	9.51E-05	1.92E-04
0.15	1.82E-05	7.55E-07	2.04E-06	7.89E-06	3.14E-05	6.83E-05
0.3	2.55E-06	5.66E-08	1.74E-07	7.77E-07	4.01E-06	1.10E-05
0.5	6.55E-07	6.54E-09	2.42E-08	1.42E-07	8.72E-07	3.09E-06
0.75	2.41E-07	1.07E-09	4.90E-09	3.79E-08	2.88E-07	1.20E-06
1.	1.21E-07	2.96E-10	1.51E-09	1.49E-08	1.32E-07	6.00E-07
1.5	4.57E-08	9.51E-11	3.09E-10	3.95E-09	4.25E-08	2.22E-07
3.	8.00E-09	5.05E-11	9.11E-11	3.47E-10	5.20E-09	3.63E-08
5.	1.99E-09	4.01E-11	5.50E-11	9.65E-11	9.11E-10	7.89E-09
7.5	6.03E-10	4.01E-11	5.05E-11	9.11E-11	2.29E-10	2.10E-09
10.	2.43E-10	4.01E-11	4.01E-11	9.11E-11	1.11E-10	7.77E-10

Appendix A

Table A-2. GMRS Amplification Functions for SPS

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	2.00E+00	9.38E-02	1.30E-02	1.55E+00	9.47E-02	1.90E-02	1.35E+00	1.14E-01	2.09E-02	1.87E+00	1.48E-01
4.95E-02	1.15E+00	9.89E-02	1.02E-01	5.89E-01	1.02E-01	9.99E-02	8.53E-01	1.35E-01	8.24E-02	1.48E+00	1.59E-01
9.64E-02	9.02E-01	9.96E-02	2.13E-01	5.00E-01	1.03E-01	1.85E-01	7.03E-01	1.38E-01	1.44E-01	1.28E+00	1.60E-01
1.94E-01	7.01E-01	9.95E-02	4.43E-01	5.00E-01	1.03E-01	3.56E-01	5.50E-01	1.41E-01	2.65E-01	1.05E+00	1.63E-01
2.92E-01	5.99E-01	1.01E-01	6.76E-01	5.00E-01	1.04E-01	5.23E-01	5.00E-01	1.46E-01	3.84E-01	9.09E-01	1.66E-01
3.91E-01	5.32E-01	1.03E-01	9.09E-01	5.00E-01	1.06E-01	6.90E-01	5.00E-01	1.51E-01	5.02E-01	8.05E-01	1.69E-01
4.93E-01	5.00E-01	1.06E-01	1.15E+00	5.00E-01	1.08E-01	8.61E-01	5.00E-01	1.55E-01	6.22E-01	7.27E-01	1.72E-01
7.41E-01	5.00E-01	1.13E-01	1.73E+00	5.00E-01	1.15E-01	1.27E+00	5.00E-01	1.64E-01	9.13E-01	5.89E-01	1.81E-01
1.01E+00	5.00E-01	1.23E-01	2.36E+00	5.00E-01	1.24E-01	1.72E+00	5.00E-01	1.71E-01	1.22E+00	5.00E-01	2.00E-01
1.28E+00	5.00E-01	1.29E-01	3.01E+00	5.00E-01	1.30E-01	2.17E+00	5.00E-01	1.73E-01	1.54E+00	5.00E-01	2.07E-01
1.55E+00	5.00E-01	1.36E-01	3.63E+00	5.00E-01	1.37E-01	2.61E+00	5.00E-01	1.73E-01	1.85E+00	5.00E-01	2.12E-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	2.31E+00	1.70E-01	1.27E-02	3.34E+00	1.76E-01	8.25E-03	3.74E+00	2.39E-01			
7.05E-02	2.03E+00	1.69E-01	3.43E-02	3.13E+00	1.55E-01	1.96E-02	3.47E+00	2.25E-01			
1.18E-01	1.86E+00	1.63E-01	5.51E-02	2.98E+00	1.48E-01	3.02E-02	3.36E+00	2.15E-01			
2.12E-01	1.61E+00	1.56E-01	9.63E-02	2.75E+00	1.63E-01	5.11E-02	3.27E+00	2.00E-01			
3.04E-01	1.44E+00	1.56E-01	1.36E-01	2.59E+00	1.79E-01	7.10E-02	3.24E+00	1.91E-01			
3.94E-01	1.30E+00	1.62E-01	1.75E-01	2.45E+00	1.90E-01	9.06E-02	3.21E+00	1.90E-01			
4.86E-01	1.18E+00	1.69E-01	2.14E-01	2.33E+00	2.00E-01	1.10E-01	3.21E+00	1.94E-01			
7.09E-01	9.72E-01	1.85E-01	3.10E-01	2.10E+00	2.14E-01	1.58E-01	3.19E+00	2.00E-01			
9.47E-01	8.22E-01	2.00E-01	4.12E-01	1.96E+00	2.17E-01	2.09E-01	3.16E+00	2.10E-01			
1.19E+00	7.23E-01	2.14E-01	5.18E-01	1.87E+00	2.18E-01	2.62E-01	3.12E+00	2.18E-01			
1.43E+00	6.92E-01	2.14E-01	6.19E-01	1.81E+00	2.19E-01	3.12E-01	3.09E+00	2.24E-01			

Appendix A

Table A2-b1. Median AFs and Sigmas for Model 1, Profile 1, for 2 PGA Levels.
These factors are unverified and are provided for information only.

M1P1K1	Rock PGA=0.0964			M1P1K1	PGA=0.391		
Freq. (Hz)	Soil_SA	Med. AF	Sigma ln (AF)	Freq. (Hz)	Soil_SA	Med. AF	Sigma ln (AF)
100.0	0.097	1.004	0.090	100.0	0.215	0.550	0.110
87.1	0.097	0.984	0.090	87.1	0.215	0.534	0.110
75.9	0.097	0.951	0.090	75.9	0.215	0.506	0.110
66.1	0.097	0.888	0.090	66.1	0.215	0.458	0.110
57.5	0.097	0.782	0.090	57.5	0.215	0.384	0.110
50.1	0.097	0.665	0.090	50.1	0.215	0.317	0.110
43.7	0.097	0.567	0.090	43.7	0.215	0.268	0.110
38.0	0.098	0.511	0.090	38.0	0.215	0.246	0.110
33.1	0.098	0.477	0.090	33.1	0.216	0.235	0.110
28.8	0.098	0.473	0.091	28.8	0.216	0.237	0.110
25.1	0.099	0.467	0.093	25.1	0.216	0.238	0.110
21.9	0.101	0.490	0.096	21.9	0.217	0.253	0.110
19.1	0.103	0.499	0.099	19.1	0.217	0.259	0.111
16.6	0.105	0.524	0.101	16.6	0.219	0.274	0.112
14.5	0.108	0.557	0.100	14.5	0.220	0.291	0.113
12.6	0.113	0.589	0.097	12.6	0.223	0.305	0.116
11.0	0.118	0.628	0.096	11.0	0.228	0.321	0.119
9.5	0.125	0.688	0.109	9.5	0.233	0.346	0.122
8.3	0.135	0.799	0.135	8.3	0.241	0.390	0.126
7.2	0.146	0.913	0.139	7.2	0.253	0.439	0.139
6.3	0.154	1.016	0.127	6.3	0.268	0.498	0.155
5.5	0.159	1.096	0.110	5.5	0.283	0.553	0.161
4.8	0.171	1.192	0.118	4.8	0.298	0.598	0.161
4.2	0.184	1.317	0.124	4.2	0.316	0.656	0.157
3.6	0.198	1.450	0.167	3.6	0.338	0.724	0.174
3.2	0.207	1.595	0.145	3.2	0.363	0.828	0.172
2.8	0.211	1.705	0.145	2.8	0.402	0.968	0.193
2.4	0.219	1.914	0.158	2.4	0.421	1.103	0.197
2.1	0.225	2.151	0.161	2.1	0.455	1.315	0.228
1.8	0.226	2.402	0.176	1.8	0.466	1.510	0.231
1.6	0.216	2.642	0.219	1.6	0.466	1.746	0.213
1.4	0.187	2.650	0.254	1.4	0.468	2.042	0.257
1.2	0.178	2.848	0.183	1.2	0.479	2.383	0.245
1.0	0.142	2.500	0.146	1.0	0.432	2.389	0.191
0.91	0.121	2.320	0.180	0.91	0.328	2.002	0.218
0.79	0.140	2.949	0.271	0.79	0.303	2.055	0.278
0.69	0.170	4.000	0.198	0.69	0.334	2.555	0.302
0.60	0.160	4.290	0.123	0.60	0.374	3.301	0.248
0.52	0.127	3.967	0.209	0.52	0.369	3.837	0.170
0.46	0.105	3.929	0.236	0.46	0.332	4.153	0.198
0.10	0.002	2.022	0.062	0.10	0.007	2.110	0.077

Table A2-b2. Median AFs and Sigmas for Model 2, Profile 1, for 2 PGA Levels.

These factors are unverified and are provided for information only.

M2P1K1	PGA=0.0964			M2P1K1	PGA=0.391		
Freq. (Hz)	Soil_SA	Med. AF	Sigma ln (AF)	Freq. (Hz)	Soil_SA	Med. AF	Sigma ln (AF)
100.0	0.105	1.088	0.090	100.0	0.249	0.636	0.091
87.1	0.105	1.066	0.090	87.1	0.249	0.617	0.091
75.9	0.105	1.030	0.090	75.9	0.249	0.586	0.091
66.1	0.105	0.963	0.090	66.1	0.249	0.530	0.091
57.5	0.105	0.848	0.090	57.5	0.249	0.445	0.091
50.1	0.105	0.721	0.091	50.1	0.249	0.367	0.091
43.7	0.106	0.615	0.091	43.7	0.249	0.310	0.091
38.0	0.106	0.555	0.091	38.0	0.250	0.285	0.091
33.1	0.107	0.520	0.092	33.1	0.250	0.272	0.091
28.8	0.108	0.517	0.094	28.8	0.251	0.275	0.091
25.1	0.109	0.514	0.098	25.1	0.251	0.276	0.091
21.9	0.112	0.542	0.102	21.9	0.253	0.294	0.092
19.1	0.114	0.555	0.108	19.1	0.254	0.303	0.094
16.6	0.118	0.585	0.108	16.6	0.257	0.322	0.096
14.5	0.122	0.626	0.110	14.5	0.262	0.346	0.099
12.6	0.128	0.667	0.104	12.6	0.268	0.366	0.102
11.0	0.135	0.716	0.102	11.0	0.276	0.390	0.107
9.5	0.144	0.793	0.123	9.5	0.286	0.425	0.111
8.3	0.155	0.919	0.145	8.3	0.301	0.487	0.120
7.2	0.168	1.053	0.153	7.2	0.319	0.554	0.139
6.3	0.177	1.171	0.135	6.3	0.340	0.632	0.158
5.5	0.182	1.250	0.133	5.5	0.362	0.708	0.159
4.8	0.196	1.366	0.128	4.8	0.384	0.770	0.165
4.2	0.206	1.470	0.132	4.2	0.409	0.848	0.160
3.6	0.222	1.623	0.172	3.6	0.439	0.940	0.175
3.2	0.221	1.707	0.153	3.2	0.465	1.060	0.160
2.8	0.228	1.844	0.144	2.8	0.500	1.205	0.166
2.4	0.233	2.033	0.140	2.4	0.515	1.349	0.155
2.1	0.236	2.259	0.173	2.1	0.542	1.564	0.167
1.8	0.238	2.531	0.173	1.8	0.539	1.747	0.195
1.6	0.223	2.729	0.207	1.6	0.532	1.995	0.197
1.4	0.191	2.704	0.242	1.4	0.524	2.287	0.249
1.2	0.185	2.959	0.176	1.2	0.526	2.618	0.201
1.0	0.146	2.576	0.143	1.0	0.457	2.531	0.186
0.91	0.130	2.506	0.153	0.91	0.350	2.136	0.154
0.79	0.160	3.376	0.234	0.79	0.354	2.402	0.198
0.69	0.191	4.511	0.130	0.69	0.422	3.229	0.206
0.60	0.159	4.264	0.152	0.60	0.449	3.963	0.140
0.52	0.121	3.803	0.220	0.52	0.385	4.000	0.184
0.46	0.103	3.821	0.245	0.46	0.324	4.047	0.231
0.10	0.002	2.008	0.055	0.10	0.007	2.066	0.070

Appendix B

Sensitivity Analysis for the GMRS

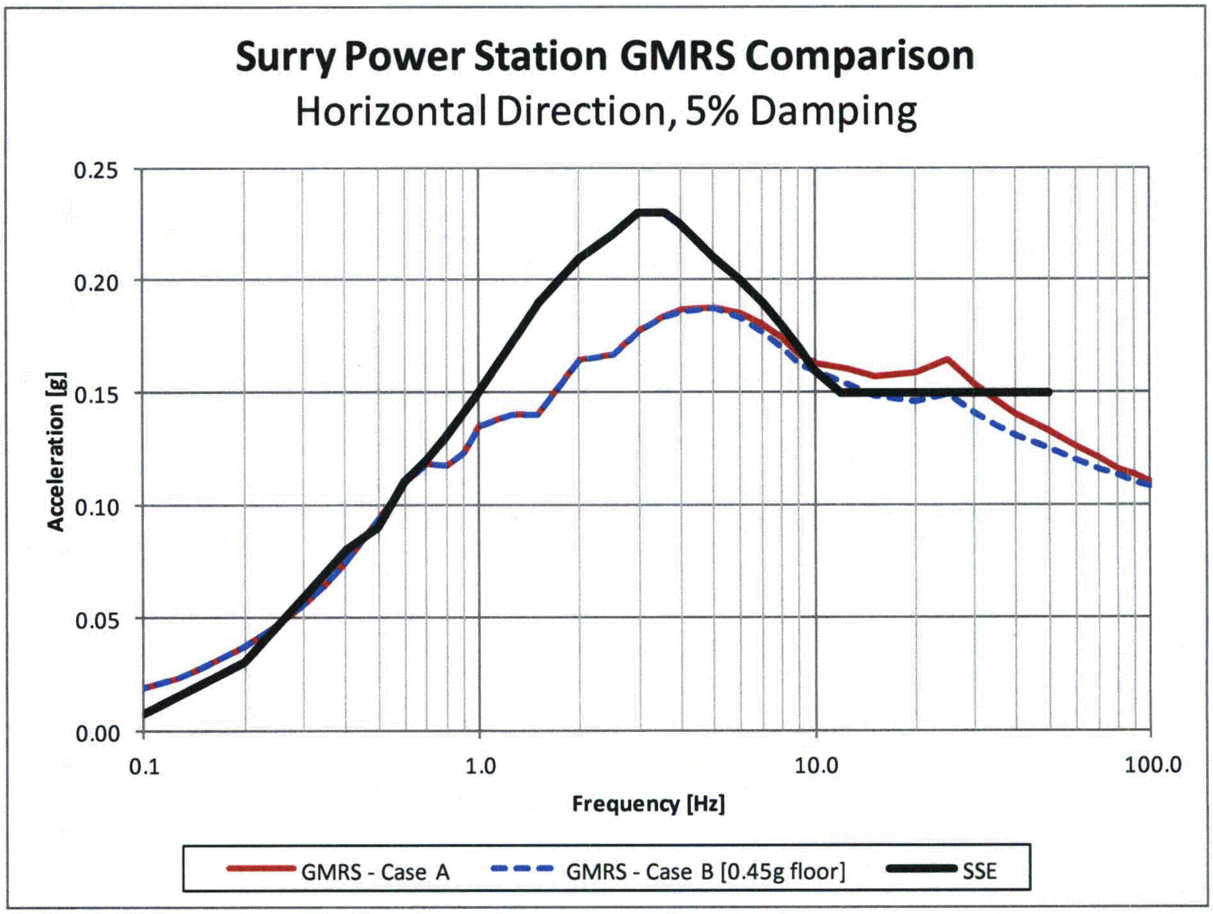

Figure B-1 – Sensitivity Plot

Figure 2.4-1 shows the SPID compliant 1E-4 and 1E-5 horizontal UHRS and the GMRS developed for this report. Note the peak in the 1E-5 UHRS at 25 Hz in this figure, which is characterized in Reference 7.5 as unrealistic given the deep soil characteristics of the Surry Power Station site. This peak results in a similar peak in the calculated GMRS at 25 Hz. To determine the influence of the lower bound median amplification factor value on the UHRS and GMRS, a sensitivity analysis (Reference 7.13) was performed with a reduced lower bound value on the median amplification value taken as 0.45 (i.e., 10% lower than the SPID guidance). The SPID compliant GMRS described in Section 2.4 is referred to as Case A and the GMRS created as a result of the sensitivity analysis is referred to as Case B.

Figure B-1 plots the SPID compliant GMRS (Case A), the sensitivity case (Case B) and the Surry Power Station SSE.

This sensitivity analysis shows that the GMRS amplitude starts decreasing at about 7 Hz in comparison to Case A and the peak at 25 Hz is reduced. The Case B GMRS is completely enveloped by the SPS SSE in the 1 to 10 Hz frequency range.

Appendix B

For completeness of the Case B data, the following information is included in this Appendix:

The resulting control point mean hazard curves for Case B are shown in Figure B-2 for the seven spectral frequencies for which ground motion equations are defined.

Figure B-3 shows the Case B 1E-4 and 1E-5 horizontal UHRS and the GMRS for this calculation. Tabular values are shown in Table B-1. Tabulated values of mean and fractile seismic hazard curves and site response amplification functions for Case B is provided below in Tables B-2(a-g) and B-3.

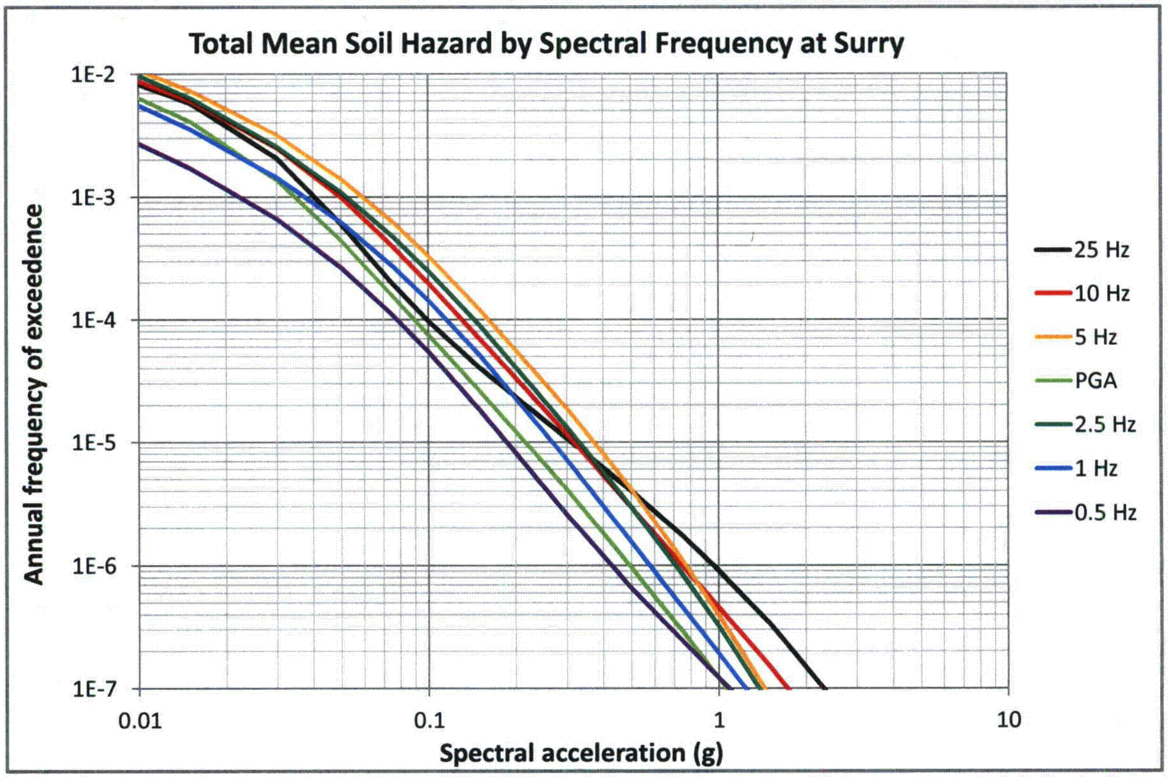

Figure B-2. Case B control point mean hazard curves for spectral frequencies of 0.5, 1, 2.5, 5, 10, 25 and 100 (PGA) Hz at Surry Power Station.

Appendix B

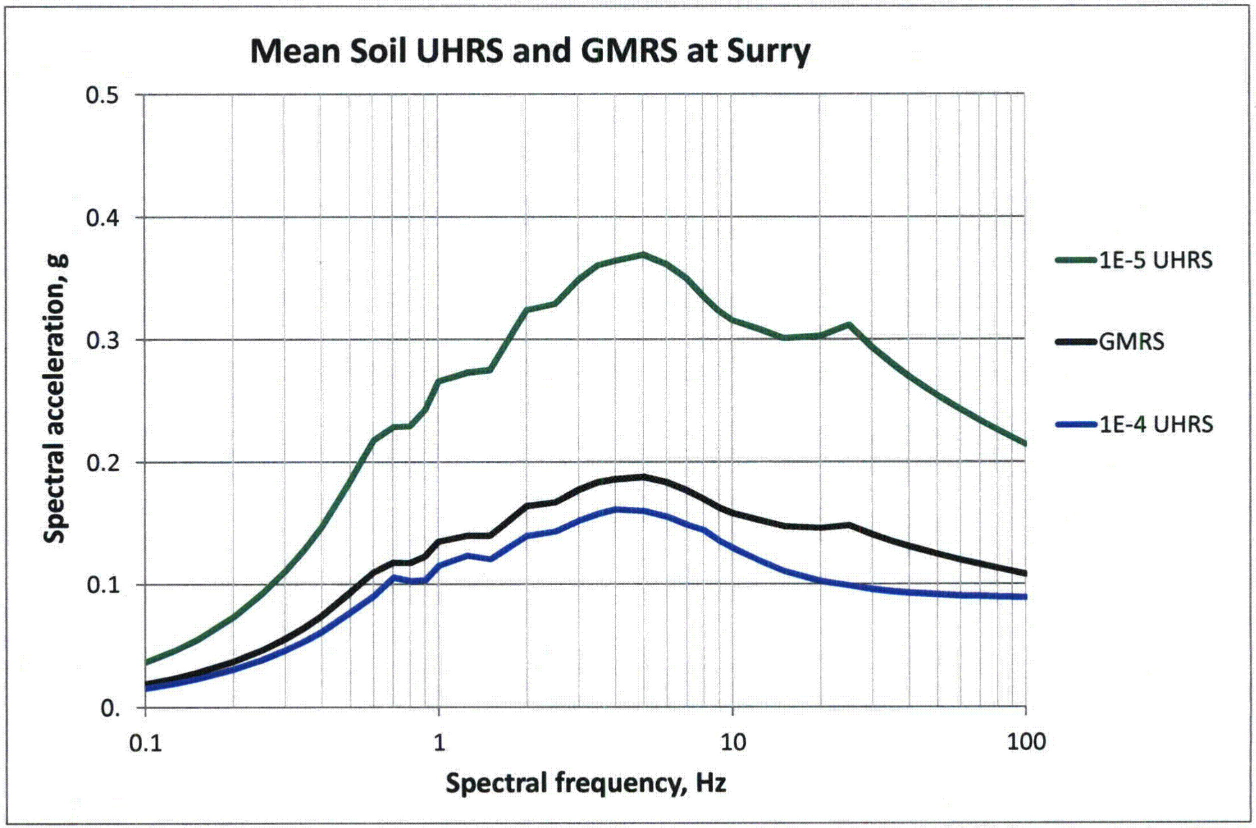

Figure B-3. Case B plots of 1E-4 and 1E-5 uniform hazard spectra and GMRS at control point for Surry Power Station (5%-damped response spectra).

Appendix B

Table B-1. Case B UHRS and GMRS for SPS

Freq. (Hz)	1E-4 UHRS (g)	1E-5 UHRS (g)	GMRS (g)
100	8.91E-02	2.15E-01	1.08E-01
90	8.94E-02	2.20E-01	1.10E-01
80	8.97E-02	2.27E-01	1.13E-01
70	9.01E-02	2.34E-01	1.16E-01
60	9.07E-02	2.43E-01	1.20E-01
50	9.14E-02	2.55E-01	1.25E-01
40	9.27E-02	2.70E-01	1.31E-01
35	9.39E-02	2.81E-01	1.35E-01
30	9.57E-02	2.94E-01	1.41E-01
25	9.88E-02	3.12E-01	1.49E-01
20	1.02E-01	3.03E-01	1.46E-01
15	1.10E-01	3.01E-01	1.48E-01
12.5	1.19E-01	3.08E-01	1.53E-01
10	1.30E-01	3.16E-01	1.59E-01
9	1.36E-01	3.23E-01	1.63E-01
8	1.44E-01	3.35E-01	1.70E-01
7	1.49E-01	3.51E-01	1.77E-01
6	1.56E-01	3.62E-01	1.84E-01
5	1.60E-01	3.70E-01	1.88E-01
4	1.62E-01	3.65E-01	1.86E-01
3.5	1.58E-01	3.61E-01	1.84E-01
3	1.52E-01	3.49E-01	1.78E-01
2.5	1.44E-01	3.29E-01	1.67E-01
2	1.40E-01	3.24E-01	1.64E-01
1.5	1.21E-01	2.76E-01	1.40E-01
1.25	1.24E-01	2.73E-01	1.40E-01
1	1.15E-01	2.67E-01	1.35E-01
0.9	1.03E-01	2.43E-01	1.23E-01
0.8	1.03E-01	2.30E-01	1.17E-01
0.7	1.06E-01	2.29E-01	1.18E-01
0.6	9.08E-02	2.18E-01	1.10E-01
0.5	7.77E-02	1.85E-01	9.34E-02
0.4	6.21E-02	1.48E-01	7.47E-02
0.35	5.44E-02	1.30E-01	6.54E-02
0.3	4.66E-02	1.11E-01	5.60E-02
0.25	3.88E-02	9.26E-02	4.67E-02
0.2	3.11E-02	7.41E-02	3.74E-02
0.15	2.33E-02	5.56E-02	2.80E-02
0.125	1.94E-02	4.63E-02	2.33E-02
0.1	1.55E-02	3.70E-02	1.87E-02

Appendix B

Table B-2a. Case B Mean and Fractile Seismic Hazard Curves for PGA at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.74E-02	1.98E-02	3.09E-02	3.84E-02	4.50E-02	4.83E-02
0.001	2.97E-02	1.40E-02	2.25E-02	3.01E-02	3.79E-02	4.19E-02
0.005	1.12E-02	4.77E-03	7.55E-03	1.07E-02	1.49E-02	1.98E-02
0.01	6.34E-03	2.39E-03	3.79E-03	5.83E-03	8.60E-03	1.27E-02
0.015	4.12E-03	1.42E-03	2.19E-03	3.63E-03	5.66E-03	9.24E-03
0.03	1.38E-03	3.52E-04	5.27E-04	1.07E-03	2.01E-03	3.84E-03
0.05	4.36E-04	6.45E-05	1.15E-04	2.76E-04	6.64E-04	1.46E-03
0.075	1.56E-04	1.42E-05	2.88E-05	8.35E-05	2.42E-04	5.83E-04
0.1	7.42E-05	4.98E-06	1.16E-05	3.57E-05	1.13E-04	2.80E-04
0.15	2.60E-05	1.36E-06	3.79E-06	1.25E-05	4.01E-05	9.51E-05
0.3	4.08E-06	1.60E-07	5.91E-07	2.16E-06	6.83E-06	1.42E-05
0.5	9.57E-07	3.14E-08	1.23E-07	5.20E-07	1.62E-06	3.33E-06
0.75	2.89E-07	7.03E-09	2.88E-08	1.49E-07	4.90E-07	1.05E-06
1.	1.20E-07	2.07E-09	8.85E-09	5.58E-08	2.04E-07	4.63E-07
1.5	3.31E-08	2.92E-10	1.40E-09	1.21E-08	5.35E-08	1.40E-07
3.	2.73E-09	7.77E-11	9.65E-11	6.17E-10	3.84E-09	1.34E-08
5.	3.15E-10	4.01E-11	6.36E-11	9.93E-11	4.37E-10	1.67E-09
7.5	4.63E-11	4.01E-11	4.70E-11	9.11E-11	1.11E-10	3.01E-10
10.	1.08E-11	4.01E-11	4.01E-11	8.12E-11	9.11E-11	1.18E-10

Table B-2b. Case B Mean and Fractile Seismic Hazard Curves for 25 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.84E-02	2.29E-02	3.28E-02	3.90E-02	4.50E-02	4.83E-02
0.001	3.12E-02	1.67E-02	2.49E-02	3.14E-02	3.79E-02	4.25E-02
0.005	1.32E-02	6.45E-03	9.11E-03	1.25E-02	1.69E-02	2.29E-02
0.01	8.23E-03	3.68E-03	5.27E-03	7.66E-03	1.08E-02	1.55E-02
0.015	5.79E-03	2.35E-03	3.37E-03	5.27E-03	7.89E-03	1.16E-02
0.03	2.07E-03	6.09E-04	8.98E-04	1.74E-03	3.09E-03	4.83E-03
0.05	5.99E-04	1.23E-04	2.04E-04	4.43E-04	9.37E-04	1.62E-03
0.075	1.99E-04	3.28E-05	5.75E-05	1.36E-04	3.14E-04	6.00E-04
0.1	9.69E-05	1.32E-05	2.64E-05	6.45E-05	1.53E-04	3.09E-04
0.15	4.04E-05	4.43E-06	1.01E-05	2.68E-05	6.45E-05	1.27E-04
0.3	1.08E-05	9.11E-07	2.72E-06	7.55E-06	1.77E-05	3.09E-05
0.5	4.03E-06	2.84E-07	9.37E-07	2.88E-06	7.03E-06	1.16E-05
0.75	1.73E-06	1.02E-07	3.73E-07	1.25E-06	3.09E-06	5.05E-06
1.	9.09E-07	4.56E-08	1.79E-07	6.45E-07	1.64E-06	2.68E-06
1.5	3.36E-07	1.40E-08	5.50E-08	2.22E-07	6.17E-07	1.04E-06
3.	4.68E-08	1.32E-09	4.90E-09	2.57E-08	8.35E-08	1.64E-07
5.	8.52E-09	2.04E-10	6.17E-10	3.73E-09	1.44E-08	3.42E-08
7.5	1.87E-09	9.11E-11	1.42E-10	6.83E-10	3.05E-09	8.12E-09
10.	5.82E-10	6.00E-11	9.11E-11	2.13E-10	9.51E-10	2.68E-09

Appendix B

Table B-2c. Case B Mean and Fractile Seismic Hazard Curves for 10 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.09E-02	3.01E-02	3.57E-02	4.13E-02	4.63E-02	4.90E-02
0.001	3.44E-02	2.29E-02	2.84E-02	3.47E-02	4.07E-02	4.43E-02
0.005	1.46E-02	8.00E-03	1.05E-02	1.42E-02	1.87E-02	2.25E-02
0.01	8.67E-03	4.25E-03	5.83E-03	8.23E-03	1.15E-02	1.46E-02
0.015	5.98E-03	2.72E-03	3.79E-03	5.58E-03	8.00E-03	1.07E-02
0.03	2.49E-03	9.51E-04	1.36E-03	2.22E-03	3.52E-03	5.05E-03
0.05	9.78E-04	2.96E-04	4.37E-04	8.23E-04	1.46E-03	2.25E-03
0.075	3.94E-04	8.23E-05	1.38E-04	3.05E-04	6.17E-04	1.02E-03
0.1	1.95E-04	2.92E-05	5.58E-05	1.40E-04	3.19E-04	5.42E-04
0.15	6.92E-05	7.66E-06	1.57E-05	4.43E-05	1.18E-04	2.07E-04
0.3	1.14E-05	9.11E-07	2.32E-06	7.23E-06	1.95E-05	3.63E-05
0.5	2.94E-06	1.79E-07	5.91E-07	1.95E-06	5.12E-06	9.24E-06
0.75	9.86E-07	4.98E-08	1.82E-07	6.54E-07	1.74E-06	3.05E-06
1.	4.55E-07	1.87E-08	7.23E-08	2.88E-07	8.00E-07	1.46E-06
1.5	1.51E-07	4.19E-09	1.69E-08	8.35E-08	2.68E-07	5.20E-07
3.	1.93E-08	2.35E-10	1.13E-09	7.77E-09	3.37E-08	7.66E-08
5.	3.44E-09	9.11E-11	1.62E-10	1.08E-09	5.66E-09	1.49E-08
7.5	7.56E-10	5.35E-11	9.11E-11	2.19E-10	1.21E-09	3.42E-09
10.	2.39E-10	4.01E-11	6.54E-11	1.01E-10	3.90E-10	1.16E-09

Table B-2d. Case B Mean and Fractile Seismic Hazard Curves for 5 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.31E-02	3.42E-02	3.79E-02	4.31E-02	4.83E-02	5.12E-02
0.001	3.85E-02	2.72E-02	3.23E-02	3.90E-02	4.50E-02	4.83E-02
0.005	1.84E-02	9.79E-03	1.31E-02	1.82E-02	2.39E-02	2.72E-02
0.01	1.07E-02	5.20E-03	7.34E-03	1.05E-02	1.42E-02	1.69E-02
0.015	7.31E-03	3.28E-03	4.83E-03	7.03E-03	9.93E-03	1.20E-02
0.03	3.17E-03	1.29E-03	1.92E-03	2.96E-03	4.50E-03	5.75E-03
0.05	1.39E-03	5.20E-04	7.66E-04	1.23E-03	2.01E-03	2.76E-03
0.075	6.23E-04	2.04E-04	3.01E-04	5.35E-04	9.37E-04	1.36E-03
0.1	3.26E-04	8.85E-05	1.36E-04	2.68E-04	5.05E-04	7.77E-04
0.15	1.20E-04	1.92E-05	3.47E-05	8.98E-05	2.01E-04	3.28E-04
0.3	1.85E-05	8.85E-07	2.29E-06	1.05E-05	3.42E-05	6.26E-05
0.5	4.11E-06	1.34E-07	4.31E-07	1.82E-06	7.45E-06	1.57E-05
0.75	1.09E-06	2.88E-08	9.65E-08	4.07E-07	1.92E-06	4.50E-06
1.	3.91E-07	7.23E-09	2.68E-08	1.42E-07	6.93E-07	1.64E-06
1.5	8.45E-08	6.83E-10	3.73E-09	3.23E-08	1.53E-07	3.42E-07
3.	7.79E-09	8.12E-11	1.42E-10	1.46E-09	1.27E-08	3.57E-08
5.	1.69E-09	4.07E-11	8.12E-11	1.62E-10	2.35E-09	8.35E-09
7.5	4.97E-10	4.01E-11	5.05E-11	9.11E-11	6.36E-10	2.53E-09
10.	2.02E-10	4.01E-11	5.05E-11	9.11E-11	2.57E-10	1.04E-09

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Table B-2e. Case B Mean and Fractile Seismic Hazard Curves for 2.5 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.29E-02	3.42E-02	3.79E-02	4.31E-02	4.77E-02	5.05E-02
0.001	3.81E-02	2.72E-02	3.14E-02	3.84E-02	4.43E-02	4.77E-02
0.005	1.75E-02	9.37E-03	1.21E-02	1.69E-02	2.32E-02	2.68E-02
0.01	9.73E-03	4.70E-03	6.45E-03	9.37E-03	1.32E-02	1.57E-02
0.015	6.36E-03	2.88E-03	4.07E-03	6.09E-03	8.72E-03	1.08E-02
0.03	2.56E-03	9.93E-04	1.46E-03	2.35E-03	3.68E-03	4.83E-03
0.05	1.08E-03	3.73E-04	5.66E-04	9.51E-04	1.60E-03	2.25E-03
0.075	4.78E-04	1.46E-04	2.29E-04	4.07E-04	7.23E-04	1.07E-03
0.1	2.48E-04	6.83E-05	1.10E-04	2.04E-04	3.84E-04	5.83E-04
0.15	8.98E-05	1.92E-05	3.28E-05	7.03E-05	1.44E-04	2.32E-04
0.3	1.31E-05	1.05E-06	2.29E-06	8.12E-06	2.29E-05	4.25E-05
0.5	2.95E-06	5.75E-08	1.82E-07	1.36E-06	5.27E-06	1.10E-05
0.75	8.37E-07	4.98E-09	2.76E-08	2.80E-07	1.46E-06	3.52E-06
1.	3.18E-07	1.13E-09	8.35E-09	8.00E-08	5.35E-07	1.42E-06
1.5	7.22E-08	1.90E-10	1.20E-09	1.21E-08	1.13E-07	3.37E-07
3.	4.51E-09	5.05E-11	9.11E-11	4.77E-10	5.58E-09	2.10E-08
5.	6.09E-10	4.01E-11	5.05E-11	9.11E-11	5.83E-10	2.68E-09
7.5	1.29E-10	4.01E-11	4.98E-11	9.11E-11	1.34E-10	5.66E-10
10.	4.17E-11	4.01E-11	4.01E-11	8.72E-11	9.11E-11	2.13E-10

Table B-2f. Case B Mean and Fractile Seismic Hazard Curves for 1 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.72E-02	2.39E-02	2.96E-02	3.79E-02	4.43E-02	4.77E-02
0.001	2.96E-02	1.57E-02	2.10E-02	3.01E-02	3.79E-02	4.25E-02
0.005	1.06E-02	4.13E-03	6.17E-03	1.01E-02	1.51E-02	1.84E-02
0.01	5.55E-03	1.79E-03	2.88E-03	5.20E-03	8.23E-03	1.07E-02
0.015	3.58E-03	9.79E-04	1.67E-03	3.23E-03	5.50E-03	7.34E-03
0.03	1.44E-03	2.72E-04	5.12E-04	1.18E-03	2.39E-03	3.47E-03
0.05	6.17E-04	8.47E-05	1.69E-04	4.50E-04	1.05E-03	1.72E-03
0.075	2.74E-04	2.84E-05	6.09E-05	1.82E-04	4.77E-04	8.47E-04
0.1	1.43E-04	1.20E-05	2.68E-05	8.72E-05	2.49E-04	4.63E-04
0.15	5.13E-05	3.05E-06	7.34E-06	2.80E-05	8.98E-05	1.79E-04
0.3	7.14E-06	2.07E-07	6.00E-07	3.05E-06	1.21E-05	2.80E-05
0.5	1.54E-06	2.10E-08	7.55E-08	5.20E-07	2.49E-06	6.45E-06
0.75	4.54E-07	2.76E-09	1.31E-08	1.21E-07	6.93E-07	1.92E-06
1.	1.90E-07	6.26E-10	3.33E-09	4.07E-08	2.76E-07	8.35E-07
1.5	5.51E-08	1.13E-10	4.77E-10	8.00E-09	7.34E-08	2.53E-07
3.	6.45E-09	5.05E-11	9.11E-11	3.68E-10	5.75E-09	2.88E-08
5.	1.27E-09	4.01E-11	5.05E-11	9.11E-11	7.66E-10	5.05E-09
7.5	3.28E-10	4.01E-11	5.05E-11	9.11E-11	1.72E-10	1.16E-09
10.	1.19E-10	4.01E-11	4.01E-11	9.11E-11	9.11E-11	3.90E-10

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Table B-2g. Case B Mean and Fractile Seismic Hazard Curves for 0.5 Hz at SPS

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.64E-02	1.55E-02	2.04E-02	2.64E-02	3.23E-02	3.63E-02
0.001	1.79E-02	9.37E-03	1.31E-02	1.77E-02	2.25E-02	2.64E-02
0.005	5.23E-03	1.98E-03	3.09E-03	4.90E-03	7.34E-03	9.65E-03
0.01	2.70E-03	7.34E-04	1.29E-03	2.42E-03	4.13E-03	5.66E-03
0.015	1.72E-03	3.63E-04	6.83E-04	1.46E-03	2.80E-03	3.95E-03
0.03	6.56E-04	8.35E-05	1.84E-04	4.83E-04	1.13E-03	1.82E-03
0.05	2.62E-04	2.29E-05	5.50E-05	1.67E-04	4.63E-04	8.23E-04
0.075	1.09E-04	7.23E-06	1.82E-05	6.00E-05	1.92E-04	3.73E-04
0.1	5.39E-05	2.96E-06	7.66E-06	2.72E-05	9.51E-05	1.92E-04
0.15	1.82E-05	7.55E-07	2.04E-06	7.89E-06	3.14E-05	6.83E-05
0.3	2.55E-06	5.66E-08	1.74E-07	7.77E-07	4.01E-06	1.10E-05
0.5	6.55E-07	6.54E-09	2.42E-08	1.42E-07	8.72E-07	3.09E-06
0.75	2.41E-07	1.07E-09	4.90E-09	3.79E-08	2.88E-07	1.20E-06
1.	1.21E-07	2.96E-10	1.51E-09	1.49E-08	1.32E-07	6.00E-07
1.5	4.57E-08	9.51E-11	3.09E-10	3.95E-09	4.25E-08	2.22E-07
3.	8.00E-09	5.05E-11	9.11E-11	3.47E-10	5.20E-09	3.63E-08
5.	1.99E-09	4.01E-11	5.50E-11	9.65E-11	9.11E-10	7.89E-09
7.5	6.03E-10	4.01E-11	5.05E-11	9.11E-11	2.29E-10	2.10E-09
10.	2.43E-10	4.01E-11	4.01E-11	9.11E-11	1.11E-10	7.77E-10

Appendix B

Table B-3. Case B Amplification Functions for SPS

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	2.00E+00	9.38E-02	1.30E-02	1.55E+00	9.47E-02	1.90E-02	1.35E+00	1.14E-01	2.09E-02	1.87E+00	1.48E-01
4.95E-02	1.15E+00	9.89E-02	1.02E-01	5.89E-01	1.02E-01	9.99E-02	8.53E-01	1.35E-01	8.24E-02	1.48E+00	1.59E-01
9.64E-02	9.02E-01	9.96E-02	2.13E-01	4.50E-01	1.03E-01	1.85E-01	7.03E-01	1.38E-01	1.44E-01	1.28E+00	1.60E-01
1.94E-01	7.01E-01	9.95E-02	4.43E-01	4.50E-01	1.03E-01	3.56E-01	5.50E-01	1.41E-01	2.65E-01	1.05E+00	1.63E-01
2.92E-01	5.99E-01	1.01E-01	6.76E-01	4.50E-01	1.04E-01	5.23E-01	4.66E-01	1.46E-01	3.84E-01	9.09E-01	1.66E-01
3.91E-01	5.32E-01	1.03E-01	9.09E-01	4.50E-01	1.06E-01	6.90E-01	4.50E-01	1.51E-01	5.02E-01	8.05E-01	1.69E-01
4.93E-01	4.83E-01	1.06E-01	1.15E+00	4.50E-01	1.08E-01	8.61E-01	4.50E-01	1.55E-01	6.22E-01	7.27E-01	1.72E-01
7.41E-01	4.50E-01	1.13E-01	1.73E+00	4.50E-01	1.15E-01	1.27E+00	4.50E-01	1.64E-01	9.13E-01	5.89E-01	1.81E-01
1.01E+00	4.50E-01	1.23E-01	2.36E+00	4.50E-01	1.24E-01	1.72E+00	4.50E-01	1.71E-01	1.22E+00	4.92E-01	2.00E-01
1.28E+00	4.50E-01	1.29E-01	3.01E+00	4.50E-01	1.30E-01	2.17E+00	4.50E-01	1.73E-01	1.54E+00	4.50E-01	2.07E-01
1.55E+00	4.50E-01	1.36E-01	3.63E+00	4.50E-01	1.37E-01	2.61E+00	4.50E-01	1.73E-01	1.85E+00	4.50E-01	2.12E-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	2.31E+00	1.70E-01	1.27E-02	3.34E+00	1.76E-01	8.25E-03	3.74E+00	2.39E-01			
7.05E-02	2.03E+00	1.69E-01	3.43E-02	3.13E+00	1.55E-01	1.96E-02	3.47E+00	2.25E-01			
1.18E-01	1.86E+00	1.63E-01	5.51E-02	2.98E+00	1.48E-01	3.02E-02	3.36E+00	2.15E-01			
2.12E-01	1.61E+00	1.56E-01	9.63E-02	2.75E+00	1.63E-01	5.11E-02	3.27E+00	2.00E-01			
3.04E-01	1.44E+00	1.56E-01	1.36E-01	2.59E+00	1.79E-01	7.10E-02	3.24E+00	1.91E-01			
3.94E-01	1.30E+00	1.62E-01	1.75E-01	2.45E+00	1.90E-01	9.06E-02	3.21E+00	1.90E-01			
4.86E-01	1.18E+00	1.69E-01	2.14E-01	2.33E+00	2.00E-01	1.10E-01	3.21E+00	1.94E-01			
7.09E-01	9.72E-01	1.85E-01	3.10E-01	2.10E+00	2.14E-01	1.58E-01	3.19E+00	2.00E-01			
9.47E-01	8.22E-01	2.00E-01	4.12E-01	1.96E+00	2.17E-01	2.09E-01	3.16E+00	2.10E-01			
1.19E+00	7.23E-01	2.14E-01	5.18E-01	1.87E+00	2.18E-01	2.62E-01	3.12E+00	2.18E-01			
1.43E+00	6.92E-01	2.14E-01	6.19E-01	1.81E+00	2.19E-01	3.12E-01	3.09E+00	2.24E-01			

Appendix C

Narrow-band Exceedance Review

The seismic evaluation guidance for the resolution of Fukushima NTTF Recommendation 2.1 (Seismic) – Screening Prioritization and Implementation Details (SPID) (Reference 7.2) states:

"If the GMRS exceeds the SSE in narrow frequency bands anywhere in the 1 to 10 Hz range, the screening criterion is as follows: In the 1 to 10 Hz range, a point on the GMRS may fall above the SSE by up to 10% provided the average ratio of GMRS to SSE in the adjacent 1/3 octave bandwidth (1/6 on either side) is less than unity. There may be more than one such exceedance point above the SSE in the 1 to 10 Hz range provided they are at least one octave apart. If the GMRS meets the criteria, no SMA or SPRA is required for the NTTF Recommendation 2.1 seismic review."

The above criterion is checked for the Surry Power Station.

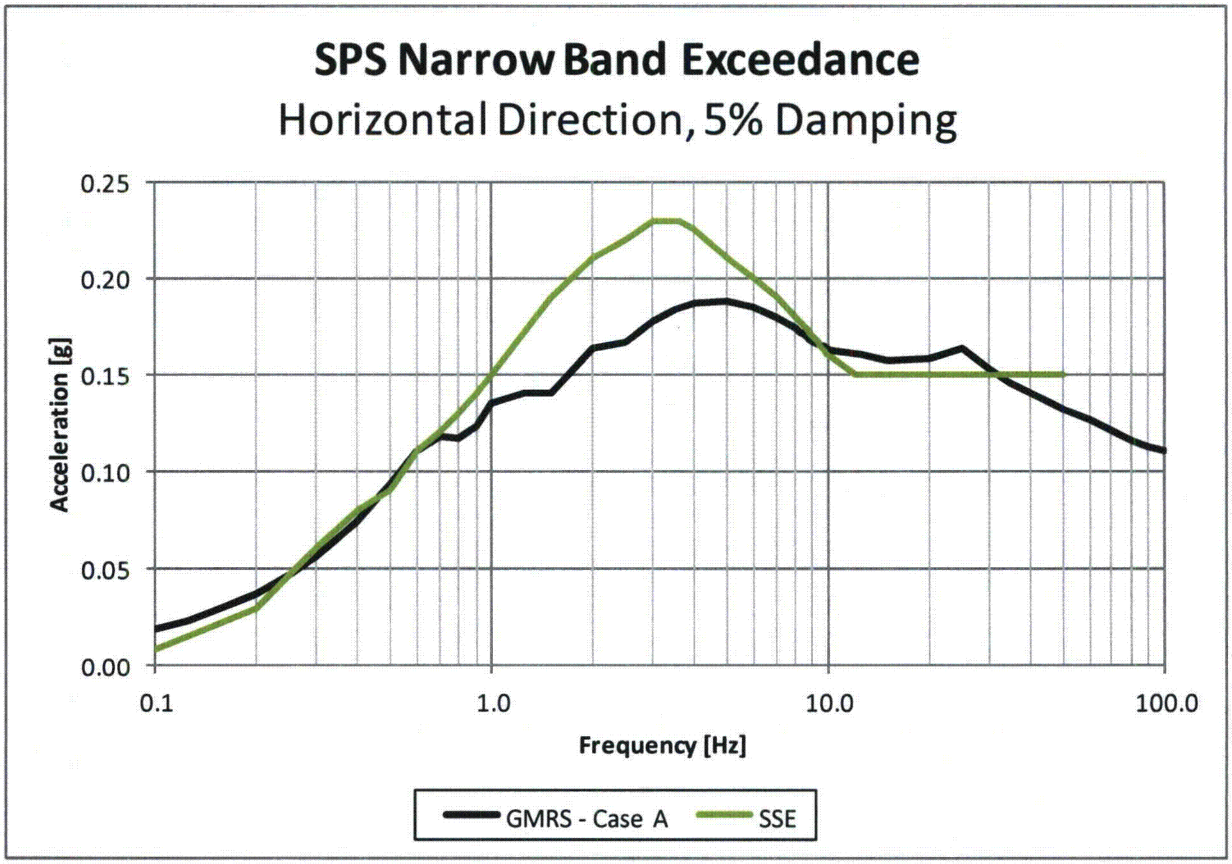

Figure C-1 - Comparison plot of SPS SSE and GMRS

The GMRS starts exceeding the SSE at about 9.5 Hz. The maximum exceedance of any point in the GMRS above the SSE between 9.5 Hz and 10 Hz is less than 10% and the average exceedance within the adjacent 1/3 octave bandwidth for a 9 Hz center frequency[1] is less than

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unity. Therefore, it is concluded that the GMRS for the Surry Power Station meets the narrow band screening criteria of the SPID.

Note 1: 9 Hz was selected as the center frequency in order to obtain a + 1/6th octave interval within the 10 Hz upper limit.