Entergy

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NL-14-042

March 31, 2014

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11545 Rockville Pike, TWFN-2 F1
Rockville, MD 20852-2738

SUBJECT: Entergy Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident
Indian Point Unit No. 2
Docket No. 50-247
License No. DPR-26

REFERENCES:

1. NRC letter to Entergy, 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 (ML12053A340).
2. NEI Letter to NRC, Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, dated April 9, 2013 (ML13101A345)
3. NRC Letter, Electric Power Research Institute Final Draft Report XXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," as an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations, dated May 7, 2013, (ML13106A331)
4. EPRI Report 1025287, Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic (ML12333A170)
5. NRC Letter, Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance," dated February 15, 2013 (ML12319A074)

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6. Entergy Letter (NL-13-118), Entergy's Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident - 1.5 Year Response for CEUS Sites, dated September 13, 2013

Dear Sir or Madam:

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

In Reference 2, the Nuclear Energy Institute (NEI) requested NRC agreement to delay submittal of the final CEUS Seismic Hazard Evaluation 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 for EPRI Report 300200704.
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Reference 4 contains industry guidance and detailed information to be included in the seismic hazard evaluation submittal. NRC endorsed this industry guidance in Reference 5.

Entergy Nuclear Operations, Inc. submitted the descriptions of subsurface materials and properties and base case velocity profiles for Indian Point in Reference 6.

The attached Seismic Hazard Evaluation and Screening Report for Indian Point Unit No 2 provides the information described in Section 4 of Reference 4 in accordance with the schedule identified in Reference 2.

This letter contains no new regulatory commitments.

If you have any questions or require additional information, please contact Robert Walpole, Regulatory Assurance, at (914) 254-6710.

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

Respectfully,

JAV/sp

Attachment: IP2 Seismic Hazard and Screening Report (CEUS Sites)

cc: Mr. Douglas V. Pickett, Senior Project Manager, NRC NRR DORL
Mr. William M. Dean, Regional Administrator, NRC Region 1
NRC Resident Inspectors Office
Mr. Francis J. Murray, Jr., President and CEO, NYSERDA
Ms. Bridget Frymire, New York State Dept. of Public Service

ATTACHMENT TO NL-14-042

IP2 SEISMIC HAZARD AND SCREENING REPORT (CEUS SITES)

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NO. 2
DOCKET NO. 50-247

Seismic Hazard and Screening Report for Indian Point Unit 2

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1.0 Introduction

Following the accident at the Fukushima Daiichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the Nuclear Regulatory Commission (NRC) established a Near-Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 50.54(f) (U.S. NRC, 2012) letter that requests information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter (U.S. NRC, 2012) requests that licensees and holders of construction permits under 10 CFR Part 50 reevaluate the seismic hazards at their sites against present-day NRC requirements. Depending on the comparison between the reevaluated seismic hazard and the current design basis, the result is either no further risk evaluation or the performance of a seismic risk assessment. Risk assessment approaches acceptable to the staff include a seismic probabilistic risk assessment (SPRA), or a seismic margin assessment (SMA). Based upon 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 "Requested Information" section and Attachment 1 of the 50.54(f) letter (U.S. NRC, 2012) pertaining to NTTF Recommendation 2.1 for Indian Point Unit 2, located in upper Westchester County, New York. In providing this information, Entergy followed the guidance provided in the *Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI, 2013a). The Augmented Approach, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI, 2013c), has been developed as the process for evaluating critical plant equipment as an interim action to demonstrate additional plant safety margin prior to performing the complete plant seismic risk evaluations.

The original geologic and seismic siting investigations for Indian Point Unit 2 were performed in accordance with Appendix A to 10 CFR Part 100 as it existed prior to the original site construction permits used in November 1966. To the extent discussed in the Final Safety Analysis Report (FSAR) (Entergy, 2010), Indian Point Unit 2 meets General Design Criterion 2 in Appendix A to 10 CFR Part 50 which was not part of the original licensing basis. The Safe Shutdown Earthquake (SSE) ground motion was subsequently evaluated against criteria in Appendix A to 10 CFR Part 100 and found to be acceptable. This SSE was used for the design of seismic Category I systems, structures and components.

In response to the 50.54(f) letter (U.S. NRC, 2012) and following the guidance provided in the SPID (EPRI, 2013a), a seismic hazard reevaluation for Indian Point Unit 2 was performed. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed. Based on the results of the screening evaluation, Indian Point Unit 2 screens-in for a risk evaluation, a Spent Fuel Pool evaluation, and a High Frequency Confirmation.

2.0 Seismic Hazard Reevaluation

Indian Point Energy Center, which includes two adjacent units, namely Indian Point Unit 2 and Indian Point Unit 3, is located approximately 24 miles northeast of the New York City boundary line and approximately two miles southwest of the city of Peekskill, Westchester County, New York, on the east bank of the Hudson River. The rocks in the vicinity of the Indian Point generating stations belong to three geologic provinces, the Hudson Highlands, the Manhattan Prong and the Newark Basin. Rocks that outcrop within the provinces range in age from Precambrian through Triassic. Geologically, the site consists of a hard limestone in a jointed condition that provides a solid bed for the plant foundation. The bedrock is sufficiently sound to support any loads that could be expected up to 50 tons/ft^2, which is far in excess of any load that may be imposed by the plant. (Entergy, 2010)

The site is located in Zone I of the Uniform Building Code with intensities limited to V and VI on the Modified Mercalli Intensity Scale of 1931 and only slight earthquake activity can be expected. However, the Indian Point Energy Center facility was built per requirements of Zone 2 of the Uniform Building Code, i.e., corresponding to an intensity VII on the Modified Mercalli Intensity Scale of 1931. The range of expected horizontal acceleration of ground motion for earthquakes of this intensity is 70-150 cm/sec^2 near the epicenter or about 0.15g max. At a distance of 100 miles from the epicenter, the acceleration drops to 50%. (Entergy, 2010) (Entergy, 2011a)

The nearest event larger than intensity VII on the Modified Mercalli Intensity Scale of 1931 occurred near Cape Ann, Massachusetts, a distance of more than 200 miles from the site, in 1755. This event was classified as intensity VIII on the Modified Mercalli Intensity Scale of 1931. It was believed, therefore, that the plant's structural design, allowing for safe shutdown in the event of an earthquake of intensity VII on the Modified Mercalli Intensity Scale of 1931, was adequate. (Entergy, 2010)(Entergy, 2011a)

2.1 Regional and Local Geology

The general landscape of the region consists of bedrock-supported ridges following generally northeasterly structural trends and rather steep and broad swampy valleys. The highest elevation in the region is 1,000 ft, and elevations range from 50 to 300 ft above mean sea level in low-lying areas. At the plant site the ground is level, about 15 ft above sea level and is covered with fill. The surface is artificially leveled and bedrock lies very close to the surface. (Entergy, 2010)(Entergy, 2011a)

The eastern part of the United States has gone through tectonism since the Precambrian age and is known as the Appalachian Orogen. Indian Point Energy Center is situated within the Manhattan Prong of the Appalachian Mountains. It is estimated that the earliest tectonic activity in the Appalachian Orogen was in Precambrian age and was a result of continental rifting and associated intrusive activity. A striking characteristic of the region is the high degree of metamorphism exhibited by the rocks. This has resulted from their long and complex history (Precambrian through the mid- Ordovician time) which included extensive thrust faulting, folding, instrusion, etc. The Taconic Orogeny was intense in the Manhattan Prong region and produced most of the structures evident in the map today. Essentially, the rocks in the plant site area belong to three tectonic provinces, e.g., the Hudson Highlands, the Manhattan Prong and the Newark Basin. (Entergy, 2010)(Entergy, 2011a)

The Hudson Highlands are a part of the much larger Blue Ridge – New Jersey Highlands Province. Here the northeast trending ridges are underlain by complexly folded granitoid gneisses and schists. These also involve granodioritic intrusives. Prevailing dips in the entire region are steep towards the southeast. The bulk of the Highland rocks represent a sequence of Precambrian aged miogeosynclinal and engeosynclinal deposits, however those in the areas of concern are in faulted and in-folded strata of Cambro - Ordovician age. It was recognized that a mappable sequence of five rock units exists in the Lake Carmel, New York, area of the Highlands. These rocks were metamorphosed to granulite facies, and were multiply deformed in the Greenville Orogeny. There was recrystallization to amphibolite facies accompanied by folding during the Taconic Orogeny (mid-Ordovician). The Ramapo Fault Zone separates the Highlands from the Manhattan Prong and the Newark Basin. (Entergy, 2010)(Entergy, 2011a)

The Manhattan Prong is bounded on the east by Cameron's line, on the west by the Newark Basin border fault and the Hudson River. It covers the geographic areas of New York City (Manhattan), Westchester County, New York and parts of Fairfield County, Connecticut. The uppermost formation of sedimentary origin is called a Phyllite or Schist known as the Manhattan Schist. This is the most recent geologic formation. In order of increasing age and depth are the Inwood Marble, the Lowerre Quartzite, the Yonkers-Pound Ridge Granite and the Fordham Gneiss. Due to the extremely complicated nature of the region's geology this stratigraphy varies with location. (Entergy, 2010)(Entergy, 2011a)

The Manhattan Formation was deposited in a miogeosyncline. It was metamorphosed, deformed and intruded during the Taconic and the Acadian episodes. The Inwood Marble, consisting of dolomite and calcite marbles with interlayed calc – silicate schists, were deposited during the Cambrian – Ordovician period. It is widespread in the Appalachian Orogen. (Entergy, 2010)(Entergy, 2011a)

The Lowerre Quartzite underlies the Inwood Marble. It is a relatively thin, discontinuous unit representing an arkosic sandstone. The Lowerre consists mainly of quartz with potassium feldspar and biotite. It is always found underlying the Cambro-Ordovician aged rocks. (Entergy, 2010)(Entergy, 2011a)

The Yonkers and Fordham formations are Precambrian in age and are separated from the Lowerre. Inwood and Manhattan formations are joined by an angular unconformity. The Fordham formation was deformed and metamorphosed to granulite facies during the Greenville Orogeny. The Yonkers – Pound Ridge Granite, emplaced during the opening of the Proto-Atlantic in late Precambrian age, is mostly a metamorphosed rhyolite. (Entergy, 2010)(Entergy, 2011a)

The Newark Basin formation, west of the Hudson River, extends from York County, Pennsylvania to Rockland County, New York. The northern tip of this basin very closely approaches the Indian Point Energy Center site on the opposite side of the Hudson River near Stony Point. This is an assemblage of conglomerates, sandstones and shales with their intercalated beds of basaltic lava and the well-known intrusive sill of the "Palisades". Deposition was continuous from the late Triassic through the upper Jurassic ages. The boundary fault between this basin and older crystalline rocks is the well-known Ramapo Fault. (Entergy, 2011a)

2.2 Probabilistic Seismic Hazard Analysis

2.2.1 Probabilistic Seismic Hazard Analysis Results

In accordance with the 50.54(f) letter (U.S. NRC, 2012) and following the guidance in the SPID (EPRI, 2013a), a probabilistic seismic hazard analysis (PSHA) was completed using the recently developed Central and Eastern United States Seismic Source Characterization (CEUS-SSC) for Nuclear Facilities (CEUS-SSC, 2012) together with the updated Electric Power Research Institute (EPRI) Ground-Motion Model (GMM) for the CEUS (EPRI, 2013b). For the PSHA, a lower-bound moment magnitude of 5.0 was used, as specified in the 50.54(f) letter (U.S. NRC, 2012). (EPRI, 2013d)

For the PSHA, the CEUS-SSC background seismic source zones out to a distance of 400 miles (640 km) around the site were included. This distance exceeds the 200 mile (320 km) recommendation contained in Reg. Guide 1.208 (U.S. NRC, 2007) and was chosen for completeness. Background sources included in this site analysis are the following (EPRI, 2013d):

1. Atlantic Highly Extended Crust (AHEX)
2. Extended Continental Crust—Atlantic Margin (ECC_AM)
3. Great Meteor Hotspot (GMH)
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. Northern Appalachians (NAP)
11. Non-Mesozoic and younger extended prior – narrow (NMESE-N)
12. Non-Mesozoic and younger extended prior – wide (NMESE-W)
13. Paleozoic Extended Crust narrow (PEZ_N)
14. Paleozoic Extended Crust wide (PEZ_W)
15. St. Lawrence Rift, including the Ottawa and Saguenay grabens (SLR)
16. Study region (STUDY_R)

For sources of large magnitude earthquakes (designated Repeated Large Magnitude Earthquake (RLME) sources), in NUREG-2115 (CEUS-SSC, 2012) modeled for the CEUS-SSC, the following sources lie within 1,000 km of the site and were included in the analysis (EPRI, 2013d):

- Charleston
- Charlevoix

For each of the above background and RLME sources, the mid-continent version of the updated CEUS EPRI GMM was used. (EPRI, 2013d)

2.2.2 Base Rock Seismic Hazard Curves

Indian Point Unit 2 is a hard-rock site. To be consistent with the SPID (EPRI, 2013a), hard-rock seismic hazard curves are provided shown below in Section 2.3.7 at the SSE control point elevation. (EPRI, 2013d)

2.3 Site Response Evaluation

Based on information describing the Indian Point Unit 2 site presented in Section 2.3.1, the geologic layers underlying the foundation of the plant consist of hard rock (Vs $\geq$ 9280 fps). Therefore no site-specific evaluation of site amplification was performed for the Indian Point Unit 2 site. (EPRI, 2013d)

2.3.1 Description of Subsurface Material

The rocks in the vicinity of the Indian Point Unit 2 belong to three geologic provinces, the Hudson Highlands, the Manhattan Prong and the Newark Basin. Rocks that outcrop within the provinces range in age from Precambrian through Triassic (possibly Jurassic). (EPRI, 2013d)

The landscape consists of northeast trending ridges and rather broad swampy valleys. Ridges are supported by bedrock and tend to follow prominent generally northeast, structural trends. Valley walls tend to be steep, the result of modification by Pleistocene glaciation. Elevations in the area reach a maximum of 1,000 ft, and range from 50 to 300 ft above sea level in low lying areas. (EPRI, 2013d)

The Hudson Highlands outcrop in a northeast (040°) trending belt, approximately 10- miles wide, north, northwest and west of the Indian Point Unit 2 site. Four major rock types are present in the vicinity of Dunderburg Mountain, across the Hudson River from Indian Point. They are quartzo-feldspathic ± calc-silicate hornblende gneiss; migmatitic quartzo-feldspathic biotite ± gamet gneiss; calc-silicate bearing quartzite; and gneissic hornblende granite. Granite probably intruded the gneisses during Precambrian time. (EPRI, 2013d)

The Manhattan Prong is a sequence of highly deformed metamorphic rocks, trending north-northeast, from New York City through Westchester County and western Fairfield County, Connecticut. The prong is bounded on the east by Cameron's Line, a complicated structure possibly representing a suture between two crustal blocks. On the west, the prong is bounded by the Newark Basin border fault and the Hudson River. (EPRI, 2013d)

The third geologic province in the area is the Newark-Gettysburg Basin. The basin extends 140-miles from York County, Pennsylvania, to Rockland County, New York. The basin, a down dropped crustal block, formed during Mesozoic time. Deposition was continuous from the late Triassic through the upper Jurassic (Dames & Moore, 1977). Intrusion of the Palisades sill apparently occurred during deposition of sediments in latest Triassic-earliest Jurassic. The extrusion of the Watchung basalt flows followed later in the Jurassic. Rocks of the Newark series are in contact with the crystalline rocks of both the Manhattan and Reading Prongs, but the nature of the contact varies. At the northeastern edge of the basin, Triassic sediments unconformably lie over the Highland rocks, while the northeastern edge of the basin is in contact with the rocks of the Highlands. (EPRI, 2013d)

Interpretations documented in site-specific information in the FSAR indicate that rock supporting reactor structures have shear-wave velocities exceeding 9,200 fps. Therefore the Indian Point Unit 2 site is treated as a hard-rock site. (Entergy, 2010)

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

This section is not needed because this site is a hard rock site.

2.3.3 Randomization of Base Case Profiles

This section is not needed because this site is a hard rock site.

2.3.4 Input Spectra

This section is not needed because this site is a hard rock site.

2.3.5 Methodology

This section is not needed because this site is a hard rock site.

2.3.6 Amplification Functions

This section is not needed because this site is a hard rock site.

2.3.7 Control Point Seismic Hazard Curves

The procedure to develop probabilistic seismic hazard curves for hard rock follows standard techniques documented in the technical literature (e.g., McGuire, 2004). Separate seismic hazard calculations are conducted for the 7 spectral frequencies for which ground motion equations are available (100 Hz=peak ground acceleration or PGA, 25 Hz, 10 Hz, 5.0 Hz, 2.5 Hz, 1.0 Hz, and 0.5 Hz). As discussed in Section 2.2.1, ground motion equations from the updated EPRI GMM for the CEUS (EPRI, 2013b) were used for the calculation of rock hazard. All spectra accelerations presented herein correspond to 5% of critical damping. Figure 2.3.7-1 shows the mean hard-rock seismic hazard curves for the 7 spectral frequencies. The digital values for the mean and fractile hazard curves are provided in Appendix A. (EPRI, 2013d)

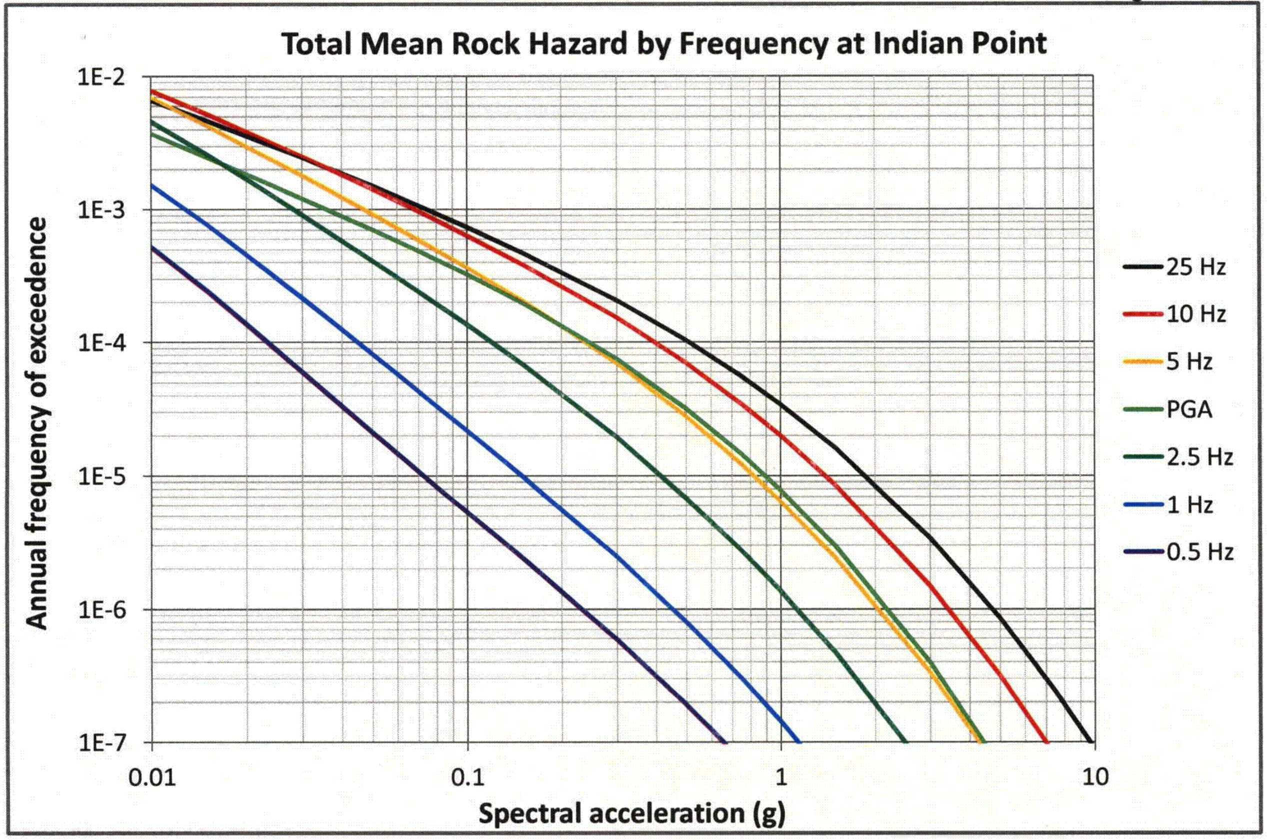

Figure 2.3.7-1. Control point mean hazard curves for spectral frequencies of 0.5, 1.0, 2.5, 5.0, 10, 25 and PGA (100 Hz) at Indian Point Unit 2. (EPRI, 2013d)

2.4 Control Point Response Spectrum

The hard-rock hazard curves described in Section 2.3.7 were used to develop uniform hazard response spectra (UHRS) and the GMRS. The UHRS were calculated through log-log interpolation of mean seismic hazard curves for a range of spectral frequencies, for annual frequencies of exceedance of 10^{-4} and 10^{-5}. Table 2.4-1 shows the UHRS and GMRS for a range of spectral frequencies. (EPRI, 2013d)

Table 2.4-1. UHRS and GMRS for Indian Point Unit 2. (EPRI, 2013d)

Freq. (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS
100	2.43E-01	8.91E-01	4.12E-01
90	2.63E-01	9.62E-01	4.46E-01
80	2.98E-01	1.09E+00	5.04E-01
70	3.51E-01	1.28E+00	5.94E-01
60	4.17E-01	1.52E+00	7.04E-01
50	4.78E-01	1.74E+00	8.06E-01
45	5.00E-01	1.82E+00	8.42E-01
40	5.14E-01	1.87E+00	8.66E-01
35	5.21E-01	1.89E+00	8.77E-01
30	5.20E-01	1.89E+00	8.75E-01
25	5.11E-01	1.85E+00	8.58E-01
20	4.97E-01	1.78E+00	8.28E-01
15	4.64E-01	1.65E+00	7.67E-01
12.5	4.36E-01	1.54E+00	7.17E-01
10	3.97E-01	1.39E+00	6.48E-01
9	3.70E-01	1.29E+00	6.04E-01
8	3.41E-01	1.19E+00	5.55E-01
7	3.09E-01	1.07E+00	5.02E-01
6	2.75E-01	9.52E-01	4.46E-01
5	2.38E-01	8.21E-01	3.85E-01
4	1.94E-01	6.69E-01	3.14E-01
3	1.46E-01	5.04E-01	2.36E-01
2.5	1.20E-01	4.13E-01	1.94E-01
2	9.90E-02	3.39E-01	1.59E-01
1.5	7.38E-02	2.49E-01	1.17E-01
1.25	5.96E-02	2.00E-01	9.42E-02
1	4.49E-02	1.49E-01	7.04E-02
0.9	4.12E-02	1.35E-01	6.40E-02
0.8	3.71E-02	1.20E-01	5.71E-02
0.7	3.28E-02	1.05E-01	4.99E-02
0.6	2.82E-02	8.91E-02	4.25E-02
0.5	2.33E-02	7.27E-02	3.48E-02
0.4	1.87E-02	5.82E-02	2.78E-02
0.3	1.40E-02	4.36E-02	2.09E-02
0.2	9.33E-03	2.91E-02	1.39E-02
0.167	7.79E-03	2.43E-02	1.16E-02
0.125	5.83E-03	1.82E-02	8.69E-03
0.1	4.67E-03	1.45E-02	6.95E-03

The 10^{-4} and 10^{-5} UHRS and GMRS are plotted in Figure 2.4-1. (EPRI, 2013d)

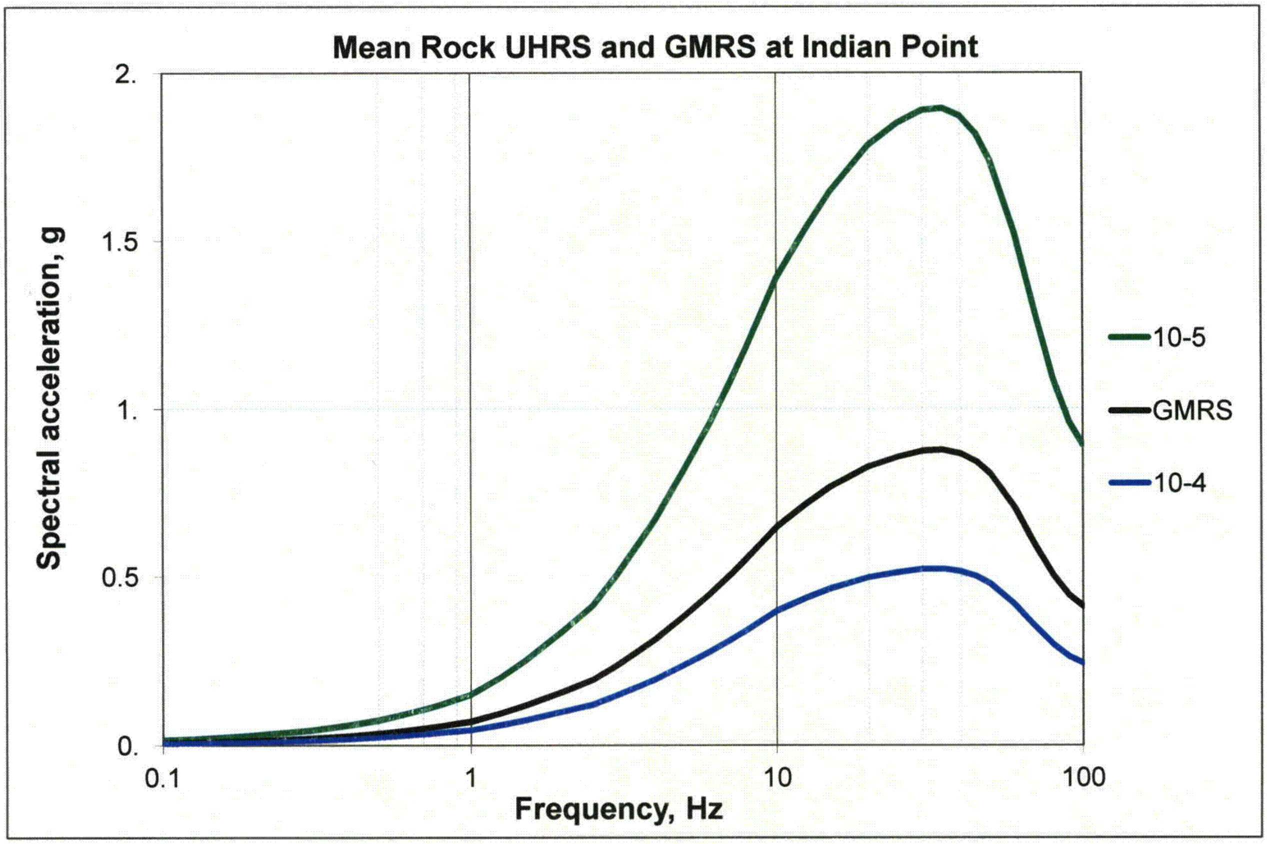

Figure 2.4-1. UHRS for 10^{-4} and 10^{-5} and GMRS at control point for Indian Point Unit 2 site (5%-damped response spectra). (EPRI, 2013d)

3.0 Plant Design Basis and Beyond Design Basis Evaluation Ground Motion

The design basis for Indian Point Unit 2 is identified in the Updated Final Safety Analysis Report (Entergy, 2010), and other pertinent documents.

3.1 Safe Shutdown Earthquake Description of Spectral Shape

The SSE was developed in accordance with 10 CFR Part 100, Appendix A that existed at the time of the construction permit through an evaluation of the maximum earthquake potential for the region surrounding the site. Subsequently, the Atomic Safety Licensing Board (ASLB), considering the historic seismicity of the site region, ruled "in accordance with Appendix A to 10 CFR 100, neither the Cape Ann earthquake nor any historic event required the assumption of a safe shutdown earthquake for the Indian Point site of greater than a Modified Mercalli intensity VII" (ASLB, 1977). It was believed, therefore, that the plant's structural design, allowing for safe shutdown in the event of an earthquake of intensity VII on the Modified Mercalli Intensity Scale of 1931, was adequate. ((Entergy, 2010)(Entergy, 2011a)).

The SSE is defined in terms of a peak ground acceleration (PGA) and a design response spectrum. Table 3.1-1 shows the spectral acceleration (SA) values as a function of frequency for the 5%-damped horizontal SSE. (Entergy, 2010)

Table 3.1-1. SSE for Indian Point. (Entergy, 2010)

Freq. (Hz)	100	25	10	5.0	2.5	1.0	0.5
SA (g)	0.15	0.15	0.168	0.228	0.234	0.127	0.075

3.2 Control Point Elevation

In accordance with the guidance provided in the SPID (EPRI, 2013a) Section 2.4.2 for rock sites, the SSE control point elevation is defined at the top of hard-rock and is applicable at grade in the free field as well as the various foundations elevations. (EPRI, 2013d)

3.3 IPEEE Description and Capacity Response Spectrum

For the Indian Point Unit 2, the Individual Plant Examination of External Events (IPEEE) (Entergy, 1995) was not reviewed as the Indian Point Unit 2 will not be screening-out of performing a risk evaluation.

4.0 Screening Evaluation

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

4.1 Risk Evaluation Screening (1 to 10 Hz)

In the 1 to 10 Hz part of the response spectrum, the GMRS exceeds the SSE. Therefore, Indian Point Unit 2 screens-in for a risk evaluation.

4.2 High Frequency Screening (> 10 Hz*)*

For the range above 10 Hz, the GMRS exceeds the SSE. Therefore, Indian Point Unit 2 screens-in for a High Frequency Confirmation.

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

In the 1 to 10 Hz part of the response spectrum, the GMRS exceeds the SSE. Therefore, Indian Point Unit 2 screens-in for a Spent Fuel Pool evaluation.

5.0 Interim Actions

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

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

bases of Indian Point Unit 2. Therefore, the results do not call into question the operability or functionality of SSCs and are not reportable pursuant to 10 CFR 50.72, "Immediate notification requirements for operating nuclear power reactors," and 10 CFR 50.73, "Licensee event report system".

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

> Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency. The GI-199 Safety/Risk Assessment, based in part on information from the U.S. 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.

Indian Point Unit 2 is included in the March 12, 2014 risk estimates (NEI, 2014). Using the methodology described in the NEI letter, all plants were shown to be below 10^{-4}/year; thus, the above conclusions apply. It is worthwhile noting that the largest differences are in the 10 Hz range while differences between the SSE and GMRS are less for significant structures which are in the 6 to 8 Hz range and for tanks which are below 2 Hz.

In accordance with the Near-Term Task Force Recommendation 2.3, Indian Point Unit 2 performed seismic walkdowns using the guidance in EPRI Report 1025286 (EPRI, 2012). The seismic walkdowns were completed and captured in Fukushima Seismic Walkdown Report IP-RPT-12-00037 (Entergy, 2012a). The goal of the walkdowns was to verify current plant configuration with the existing licensing basis, to verify the current maintenance plans, and to identify any vulnerabilities. The walkdown also verified that any vulnerabilities identified in the IPEEE (Entergy, 1995) are adequately addressed. The results of the walkdown, including any identified corrective actions, confirm that Indian Point Unit 2 can adequately respond to a seismic event.

Furthermore, as part of the Fukushima Near-Term Task Force (NTTF) considerations, Entergy reduced the height of the plant stack from Elevation 390 feet to Elevation 202 feet, a 188 feet height reduction, with the new stack configuration resulting in a stack median capacity and HCLPF in excess of the values established to screen out components (Entergy, 2011b). The plant stack was a high Indian Point Unit 2 risk contributor. In the original IPEEE submittal (Entergy, 1995), the stack failure contributed 46% to the top Seismic Damage States (SDSs), which in turn contributed 45% to the total seismic core damage frequency of 1.45E-5 per year (prior to upgrading the Component Cooling Water (CCW) Surge Tank hold down bolts). Thus, the stack failure contributed 1.45E-5 x .45 x .46 = 3E-6 per year to the SCDF at Indian Point Unit 2. After upgrading the hold down bolts, the CCW contribution was essentially eliminated, giving a revised seismic CDF of 1.1E-5 per year. Eliminating the stack as a significant seismic risk contributor reduces the seismic core damage frequency reported in the revised IPEEE results to 1.1E-5 per year - 3E-6 per year = 8.3E-6 per year.

6.0 Conclusions

In accordance with the 50.54(f) request for information (U.S. NRC, 2012), a seismic hazard and screening evaluation was performed for Indian Point Unit 2. A GMRS was developed solely for purpose of screening for additional evaluations in accordance with the SPID (EPRI, 2013a). Based on the results of the screening evaluation, Indian Point Unit 2 screens-in for a risk evaluation, a Spent Fuel Pool evaluation, and a High Frequency Confirmation.

7.0 References

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Appendix A

Tabulated Data

Table A-1a. Mean and Fractile Seismic Hazard Curves for 100 Hz (PGA) at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.01E-02	1.79E-02	3.09E-02	4.07E-02	4.98E-02	5.66E-02
0.001	2.81E-02	1.10E-02	2.04E-02	2.76E-02	3.68E-02	4.37E-02
0.005	7.39E-03	3.23E-03	4.56E-03	6.73E-03	9.51E-03	1.57E-02
0.01	3.73E-03	1.53E-03	2.16E-03	3.33E-03	4.70E-03	8.98E-03
0.015	2.47E-03	8.98E-04	1.32E-03	2.13E-03	3.28E-03	6.17E-03
0.03	1.20E-03	3.19E-04	5.35E-04	9.93E-04	1.79E-03	3.09E-03
0.05	7.04E-04	1.34E-04	2.68E-04	5.66E-04	1.10E-03	1.79E-03
0.075	4.52E-04	6.45E-05	1.60E-04	3.57E-04	7.23E-04	1.16E-03
0.1	3.25E-04	3.73E-05	1.11E-04	2.60E-04	5.27E-04	8.35E-04
0.15	1.97E-04	1.72E-05	6.45E-05	1.57E-04	3.23E-04	5.12E-04
0.3	7.45E-05	4.07E-06	2.16E-05	5.83E-05	1.23E-04	1.92E-04
0.5	3.17E-05	1.31E-06	8.23E-06	2.42E-05	5.35E-05	8.60E-05
0.75	1.45E-05	4.43E-07	3.28E-06	1.05E-05	2.46E-05	4.13E-05
1.	7.79E-06	1.98E-07	1.53E-06	5.42E-06	1.32E-05	2.29E-05
1.5	2.93E-06	5.58E-08	4.31E-07	1.84E-06	4.90E-06	9.37E-06
3.	3.94E-07	4.13E-09	2.96E-08	1.98E-07	6.17E-07	1.57E-06
5.	6.52E-08	4.25E-10	2.57E-09	2.42E-08	9.24E-08	3.14E-07
7.5	1.25E-08	1.05E-10	3.19E-10	3.42E-09	1.57E-08	6.73E-08
10.	3.40E-09	6.73E-11	1.11E-10	7.66E-10	4.01E-09	2.01E-08

Table A-1b. Mean and Fractile Seismic Hazard Curves for 25 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.56E-02	2.57E-02	3.79E-02	4.56E-02	5.42E-02	6.09E-02
0.001	3.50E-02	1.72E-02	2.76E-02	3.42E-02	4.37E-02	5.05E-02
0.005	1.19E-02	5.42E-03	7.77E-03	1.10E-02	1.51E-02	2.32E-02
0.01	6.62E-03	3.09E-03	4.13E-03	6.00E-03	8.23E-03	1.42E-02
0.015	4.65E-03	2.13E-03	2.84E-03	4.25E-03	5.83E-03	1.02E-02
0.03	2.47E-03	9.79E-04	1.40E-03	2.22E-03	3.28E-03	5.35E-03
0.05	1.50E-03	4.98E-04	7.77E-04	1.34E-03	2.10E-03	3.23E-03
0.075	9.97E-04	2.76E-04	4.70E-04	8.85E-04	1.46E-03	2.16E-03
0.1	7.37E-04	1.77E-04	3.23E-04	6.54E-04	1.11E-03	1.62E-03
0.15	4.73E-04	8.72E-05	1.92E-04	4.13E-04	7.34E-04	1.05E-03
0.3	2.07E-04	2.35E-05	7.89E-05	1.84E-04	3.28E-04	4.63E-04
0.5	1.03E-04	8.47E-06	3.73E-05	9.24E-05	1.67E-04	2.35E-04
0.75	5.55E-05	3.47E-06	1.90E-05	4.90E-05	8.98E-05	1.29E-04
1.	3.42E-05	1.84E-06	1.11E-05	2.96E-05	5.58E-05	8.00E-05
1.5	1.60E-05	6.54E-07	4.77E-06	1.32E-05	2.60E-05	4.07E-05
3.	3.39E-06	8.72E-08	7.55E-07	2.53E-06	5.58E-06	9.93E-06
5.	8.51E-07	1.57E-08	1.32E-07	5.75E-07	1.44E-06	2.88E-06
7.5	2.40E-07	3.37E-09	2.68E-08	1.44E-07	4.07E-07	8.98E-07
10.	8.89E-08	1.05E-09	7.45E-09	4.70E-08	1.49E-07	3.63E-07

Table A-1c. Mean and Fractile Seismic Hazard Curves for 10 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.04E-02	3.79E-02	4.31E-02	4.98E-02	5.83E-02	6.45E-02
0.001	4.12E-02	2.64E-02	3.33E-02	4.07E-02	4.98E-02	5.58E-02
0.005	1.48E-02	7.45E-03	1.02E-02	1.40E-02	1.92E-02	2.46E-02
0.01	7.87E-03	3.84E-03	5.12E-03	7.45E-03	1.02E-02	1.40E-02
0.015	5.26E-03	2.53E-03	3.37E-03	4.98E-03	6.83E-03	9.79E-03
0.03	2.54E-03	1.08E-03	1.55E-03	2.35E-03	3.37E-03	4.83E-03
0.05	1.44E-03	5.20E-04	7.89E-04	1.32E-03	2.04E-03	2.80E-03
0.075	9.04E-04	2.72E-04	4.43E-04	8.23E-04	1.32E-03	1.82E-03
0.1	6.43E-04	1.64E-04	2.92E-04	5.83E-04	9.65E-04	1.32E-03
0.15	3.90E-04	7.55E-05	1.62E-04	3.47E-04	6.09E-04	8.35E-04
0.3	1.54E-04	1.74E-05	5.66E-05	1.36E-04	2.46E-04	3.47E-04
0.5	7.02E-05	5.42E-06	2.39E-05	6.09E-05	1.15E-04	1.67E-04
0.75	3.48E-05	2.01E-06	1.08E-05	2.92E-05	5.66E-05	8.72E-05
1.	2.01E-05	9.65E-07	5.91E-06	1.64E-05	3.28E-05	5.20E-05
1.5	8.49E-06	3.14E-07	2.19E-06	6.64E-06	1.40E-05	2.32E-05
3.	1.49E-06	3.42E-08	2.72E-07	1.04E-06	2.53E-06	4.77E-06
5.	3.19E-07	5.27E-09	4.01E-08	1.95E-07	5.50E-07	1.18E-06
7.5	7.91E-08	1.01E-09	6.64E-09	4.13E-08	1.32E-07	3.23E-07
10.	2.66E-08	3.01E-10	1.69E-09	1.16E-08	4.37E-08	1.15E-07

Table A-1d. Mean and Fractile Seismic Hazard Curves for 5.0 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.09E-02	3.79E-02	4.31E-02	5.05E-02	5.91E-02	6.54E-02
0.001	4.20E-02	2.60E-02	3.28E-02	4.19E-02	5.12E-02	5.75E-02
0.005	1.43E-02	6.64E-03	9.51E-03	1.38E-02	1.95E-02	2.32E-02
0.01	6.93E-03	3.28E-03	4.43E-03	6.54E-03	9.51E-03	1.16E-02
0.015	4.30E-03	2.04E-03	2.72E-03	4.07E-03	5.83E-03	7.34E-03
0.03	1.81E-03	7.66E-04	1.10E-03	1.74E-03	2.46E-03	3.23E-03
0.05	9.31E-04	3.19E-04	4.98E-04	8.85E-04	1.34E-03	1.77E-03
0.075	5.44E-04	1.51E-04	2.60E-04	5.05E-04	8.23E-04	1.10E-03
0.1	3.67E-04	8.35E-05	1.62E-04	3.37E-04	5.66E-04	7.66E-04
0.15	2.07E-04	3.42E-05	8.35E-05	1.87E-04	3.28E-04	4.50E-04
0.3	6.97E-05	6.54E-06	2.46E-05	6.09E-05	1.13E-04	1.64E-04
0.5	2.78E-05	1.77E-06	8.60E-06	2.35E-05	4.63E-05	6.93E-05
0.75	1.22E-05	6.00E-07	3.33E-06	9.93E-06	2.10E-05	3.19E-05
1.	6.45E-06	2.57E-07	1.57E-06	5.05E-06	1.11E-05	1.77E-05
1.5	2.40E-06	7.13E-08	4.70E-07	1.72E-06	4.19E-06	7.13E-06
3.	3.35E-07	5.83E-09	3.84E-08	1.95E-07	5.83E-07	1.20E-06
5.	6.07E-08	6.54E-10	4.13E-09	2.72E-08	1.02E-07	2.39E-07
7.5	1.31E-08	1.40E-10	5.66E-10	4.43E-09	2.10E-08	5.58E-08
10.	4.01E-09	9.65E-11	1.69E-10	1.11E-09	6.00E-09	1.74E-08

Table A-1e. Mean and Fractile Seismic Hazard Curves for 2.5 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.80E-02	3.42E-02	3.95E-02	4.77E-02	5.66E-02	6.36E-02
0.001	3.75E-02	2.29E-02	2.80E-02	3.73E-02	4.70E-02	5.35E-02
0.005	1.07E-02	4.98E-03	6.93E-03	1.02E-02	1.49E-02	1.82E-02
0.01	4.58E-03	2.10E-03	2.80E-03	4.25E-03	6.36E-03	8.12E-03
0.015	2.59E-03	1.15E-03	1.57E-03	2.42E-03	3.63E-03	4.77E-03
0.03	9.12E-04	3.37E-04	5.05E-04	8.47E-04	1.31E-03	1.74E-03
0.05	4.11E-04	1.20E-04	1.98E-04	3.73E-04	6.17E-04	8.35E-04
0.075	2.16E-04	4.90E-05	9.24E-05	1.90E-04	3.37E-04	4.70E-04
0.1	1.36E-04	2.46E-05	5.27E-05	1.18E-04	2.16E-04	3.09E-04
0.15	6.85E-05	8.72E-06	2.32E-05	5.75E-05	1.13E-04	1.67E-04
0.3	1.93E-05	1.31E-06	5.05E-06	1.44E-05	3.33E-05	5.27E-05
0.5	6.78E-06	2.84E-07	1.36E-06	4.63E-06	1.18E-05	2.01E-05
0.75	2.73E-06	7.77E-08	4.19E-07	1.69E-06	4.83E-06	8.85E-06
1.	1.36E-06	2.88E-08	1.62E-07	7.66E-07	2.42E-06	4.70E-06
1.5	4.66E-07	6.45E-09	3.73E-08	2.22E-07	8.35E-07	1.79E-06
3.	5.64E-08	3.42E-10	2.01E-09	1.72E-08	9.65E-08	2.42E-07
5.	9.07E-09	1.01E-10	2.04E-10	1.77E-09	1.36E-08	4.07E-08
7.5	1.77E-09	5.05E-11	9.93E-11	2.80E-10	2.29E-09	8.12E-09
10.	5.03E-10	4.01E-11	5.66E-11	1.13E-10	6.00E-10	2.29E-09

Table A-1f. Mean and Fractile Seismic Hazard Curves for 1.0 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.11E-02	1.53E-02	2.16E-02	3.09E-02	4.07E-02	4.70E-02
0.001	2.00E-02	8.72E-03	1.32E-02	1.98E-02	2.68E-02	3.23E-02
0.005	4.13E-03	1.32E-03	2.22E-03	3.79E-03	6.00E-03	8.35E-03
0.01	1.52E-03	4.31E-04	7.23E-04	1.31E-03	2.32E-03	3.42E-03
0.015	7.72E-04	2.01E-04	3.37E-04	6.36E-04	1.21E-03	1.82E-03
0.03	2.16E-04	4.50E-05	8.00E-05	1.69E-04	3.63E-04	5.27E-04
0.05	8.15E-05	1.31E-05	2.57E-05	6.00E-05	1.38E-04	2.19E-04
0.075	3.76E-05	4.43E-06	9.93E-06	2.64E-05	6.36E-05	1.11E-04
0.1	2.17E-05	1.95E-06	4.98E-06	1.44E-05	3.68E-05	6.83E-05
0.15	9.92E-06	5.83E-07	1.82E-06	6.00E-06	1.69E-05	3.42E-05
0.3	2.45E-06	6.17E-08	2.64E-07	1.18E-06	4.25E-06	9.51E-06
0.5	7.96E-07	9.37E-09	4.98E-08	3.09E-07	1.34E-06	3.33E-06
0.75	3.01E-07	1.87E-09	1.10E-08	8.98E-08	4.83E-07	1.34E-06
1.	1.43E-07	5.58E-10	3.47E-09	3.33E-08	2.16E-07	6.64E-07
1.5	4.58E-08	1.38E-10	6.09E-10	6.93E-09	6.00E-08	2.22E-07
3.	4.99E-09	5.05E-11	1.01E-10	3.63E-10	4.56E-09	2.35E-08
5.	7.59E-10	4.01E-11	5.05E-11	1.01E-10	5.27E-10	3.28E-09
7.5	1.44E-10	4.01E-11	4.19E-11	1.01E-10	1.32E-10	5.91E-10
10.	4.03E-11	4.01E-11	4.01E-11	9.11E-11	1.01E-10	2.01E-10

Table A-1g. Mean and Fractile Seismic Hazard Curves for 0.5 Hz at Indian Point Unit 2. (EPRI, 2013d)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	1.60E-02	8.00E-03	1.15E-02	1.55E-02	2.07E-02	2.53E-02
0.001	9.40E-03	4.01E-03	6.09E-03	8.98E-03	1.27E-02	1.64E-02
0.005	1.61E-03	3.52E-04	6.64E-04	1.32E-03	2.60E-03	3.90E-03
0.01	5.23E-04	8.72E-05	1.69E-04	3.79E-04	9.11E-04	1.44E-03
0.015	2.45E-04	3.57E-05	6.83E-05	1.64E-04	4.43E-04	7.03E-04
0.03	6.01E-05	6.36E-06	1.32E-05	3.57E-05	1.13E-04	1.87E-04
0.05	2.11E-05	1.55E-06	3.68E-06	1.13E-05	3.79E-05	7.55E-05
0.075	9.41E-06	4.63E-07	1.27E-06	4.56E-06	1.62E-05	3.73E-05
0.1	5.35E-06	1.87E-07	5.83E-07	2.32E-06	8.85E-06	2.29E-05
0.15	2.41E-06	4.63E-08	1.87E-07	8.85E-07	3.84E-06	1.11E-05
0.3	5.88E-07	3.23E-09	1.95E-08	1.38E-07	8.12E-07	3.01E-06
0.5	1.91E-07	4.01E-10	2.84E-09	2.76E-08	2.22E-07	1.02E-06
0.75	7.29E-08	1.18E-10	5.58E-10	6.36E-09	6.93E-08	4.01E-07
1.	3.50E-08	9.93E-11	1.92E-10	2.07E-09	2.72E-08	1.84E-07
1.5	1.15E-08	5.05E-11	1.01E-10	4.13E-10	6.45E-09	5.75E-08
3.	1.32E-09	4.01E-11	5.05E-11	1.01E-10	4.13E-10	5.27E-09
5.	2.11E-10	4.01E-11	4.01E-11	1.01E-10	1.05E-10	7.45E-10
7.5	4.17E-11	4.01E-11	4.01E-11	9.11E-11	1.01E-10	1.79E-10
10.	1.20E-11	4.01E-11	4.01E-11	9.11E-11	1.01E-10	1.01E-10