Exelon Generation.

RS-14-070
RA-14-016

10 CFR 50.54(f)

March 31, 2014

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

Oyster Creek Nuclear Generating Station
Renewed Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Exelon Generation Company, LLC, Seismic Hazard and Screening Report (Central and Eastern United States (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

References:

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012
2. NEI Letter, Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, dated April 9, 2013
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
4. Exelon Generation Company, LLC letter to the NRC, 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 12, 2013
5. 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
6. NRC Letter, Endorsement of Electric Power Research Institute Final Draft Report 1025287, "Seismic Evaluation Guidance," dated February 15, 2013
7. EPRI Technical Report 3002000704, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," dated May 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 located in the Central and Eastern United States (CEUS) to submit a Seismic Hazard Evaluation and Screening Report within 1.5 years from the date of Reference 1.

In Reference 2, the Nuclear Energy Institute (NEI) requested NRC agreement to delay submittal of the final CEUS Seismic Hazard Evaluation and Screening Reports so that an update to the Electric Power Research Institute (EPRI) ground motion attenuation model could be completed and used to develop that information. NEI proposed that descriptions of subsurface materials and properties and base case velocity profiles be submitted to the NRC by September 12, 2013, with the remaining seismic hazard and screening information submitted by March 31, 2014. NRC agreed with that proposed path forward in Reference 3. In Reference 4, Exelon Generation Company, LLC (EGC) provided the description of subsurface materials and properties and base case velocity profiles for Oyster Creek Nuclear Generating Station.

Reference 5 contains industry guidance and detailed information to be included in the Seismic Hazard Evaluation and Screening Report submittals. NRC endorsed this industry guidance in Reference 6.

The enclosed Seismic Hazard Evaluation and Screening Report for Oyster Creek Nuclear Generating Station provides the information described in Section 4 of Reference 5 in accordance with the schedule identified in Reference 2. As described in Enclosure 1, Oyster Creek Nuclear Generating Station meets the requirements of SPID Sections 3.2 and 7 (Reference 5) and therefore screens out and no Seismic Risk Assessment or Spent Fuel Pool evaluation is needed. Oyster Creek Nuclear Generating Station will prepare an Expedited Seismic Evaluation Process (ESEP) Report limited to low frequency susceptible structures, systems, or components (SSCs) as allowed by the Augmented Approach (Reference 7) Section 2.2.1.1, by December 31, 2014. Additionally, Oyster Creek Nuclear Generating Station will perform a High Frequency Confirmation evaluation, and evaluation of safety significant low frequency susceptible SSCs as required by SPID (Reference 5) Section 3.2.1.1 special screening considerations, as determined by NRC prioritization following submittal of all nuclear power plant Seismic Hazard Re-evaluations per Reference 1.

EGC is continuing to evaluate the risk benefits of implementing the above NTTF 2.1: Seismic risk evaluation actions considering the limited remaining duration of plant operating life for Oyster Creek Nuclear Generating Station and may request further relief from these actions based on the results of this evaluation.

A list of regulatory commitments contained in this letter is provided in Enclosure 2. If you have any questions regarding this report, please contact Ron Gaston at (630) 657-3359.

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

Respectfully submitted,

James Barstow
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosures:

1. Oyster Creek Nuclear Generating Station, Seismic Hazard and Screening Report
2. Summary of Regulatory Commitments

cc: Director, Office of Nuclear Reactor Regulation
Regional Administrator - NRC Region I
NRC Senior Resident Inspector – Oyster Creek Nuclear Generating Station
NRC Project Manager, NRR – Oyster Creek Nuclear Generating Station
Ms. Jessica A. Kratchman, NRR/JLD/PMB, NRC
Mr. Eric E. Bowman, NRR/DPR/PGCB, NRC or Ms. Eileen M. McKenna, NRO/DSRA/BPTS, NRC
Manager, Bureau of Nuclear Engineering - New Jersey Department of Environmental Protection
Mayor of Lacey Township, Forked River, NJ

Enclosure 1

Oyster Creek Nuclear Generating Station

Seismic Hazard and Screening Report

(49 pages)

SEISMIC HAZARD AND SCREENING REPORT

IN RESPONSE TO THE 50.54(f) INFORMATION REQUEST REGARDING FUKUSHIMA NEAR-TERM TASK FORCE RECOMMENDATION 2.1: SEISMIC

for the
OYSTER CREEK NUCLEAR GENERATING STATION Unit 1
Route 9 South, P.O. Box 388, Forked River, NJ 08731
Facility Operating License No. DPR-16
NRC Docket No. 50-219
Correspondence No.: RS-14-070, RA-14-016

Exelon

Exelon Generation Company, LLC (Exelon)
PO Box 805398
Chicago, IL 60680-5398

Prepared by:
Enercon Services, Inc.
500 Townpark Lane, Kennesaw, GA 30144

Report Number: EXLNOC111-PR-001, Revision 0

	Printed Name	Signature	Date
Preparer:	Natalie Doulgerakis	[signature]	03/13/2014
Reviewer:	Benjamin Kosbab	[signature]	3/13/14
Approver:	Paul Hansen	[signature]	3/13/14
Lead Responsible Engineer:	Wing Ho	[signature]	3/17/14
Risk Management Engineer: (Section 5.4 only)	Phil Tarpinian	[signature]	3/18/14
Branch Manager:	Robert Csillag	[signature]	3/18/14
Senior Manager Design Engineering:	F.H. Ray	[signature]	3/19/14
Corporate Acceptance:	Jeffrey Clark	[signature]	3/19/14

RECORD OF REVISIONS

Revision	Affected Pages	Description
0	All	Initial issue.

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Purpose

Following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the Nuclear Regulatory Commission (NRC) issued a 50.54(f) letter (Reference 1) requesting information in response to NRC Near-Term Task Force (NTTF) recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. The 50.54(f) letter (Reference 1) requests that licensees and holders of construction permits under Title 10 Code of Federal Regulations Part 50 (Reference 2) reevaluate the seismic hazards at their sites using updated seismic hazard information and present-day regulatory guidance and methodologies. This report provides the information requested in items (1) through (7) of the "Requested Information" in Enclosure 1 of the 50.54(f) letter (Reference 1), pertaining to NTTF Recommendation 2.1: Seismic for Oyster Creek Nuclear Generating Station (OCNGS) in accordance with the documented intention of Exelon Generation Company, LLC transmitted to the NRC via letter dated April 29, 2013 (Reference 17).

Scope

In response to the 50.54(f) letter (Reference 1) and following the Screening, Prioritization, and Implementation Details (SPID) industry guidance document (Reference 3), a seismic hazard reevaluation for OCNGS was performed to develop a Ground Motion Response Spectrum (GMRS) for comparison with the plant-level seismic capacity. The new GMRS represents an alternative seismic demand determined using recently developed techniques. The new GMRS does not constitute a change in the plant design or licensing basis as described in the NRC letter dated February 20, 2014 (Reference 15). Section 1 provides an introduction. Section 2 provides a summary of the OCNGS regional and local geology and seismicity, other major inputs to the seismic hazard reevaluation, and detailed seismic hazard results including definition of the GMRS. Seismic hazard analysis for OCNGS, including site response evaluation and GMRS development (Sections 2.2, 2.3, and 2.4 of this report) was performed by the Electric Power Research Institute (Reference 19). A more in-depth discussion of the calculation methods used in the seismic hazard reevaluation can be found in References 3, 6, 7, 8, and 18. Section 3 describes the characteristics of the plant design basis for OCNGS. Section 4 provides a GMRS screening evaluation for OCNGS. Sections 5 and 6 discuss interim actions and conclusions, respectively, for OCNGS.

Conclusions

The seismic hazard reevaluation and screening comparison demonstrate that OCNGS is a low seismic hazard site (peak 5% of critical damping spectral acceleration less than the low hazard threshold of 0.4g) with GMRS exceedances of the Safe Shutdown Earthquake limited to low- and high-frequency exceedances. Due to the low- and high-frequency exceedances identified, low frequency evaluations and high frequency confirmations are

prescribed in accordance with the SPID (Reference 3) through evaluation of structures, systems, and components (SSC) potentially susceptible to damage from spectral accelerations at frequencies below 1.9 Hz and between 18 and 70 Hz. As an interim action/assessment prior to low frequency evaluations and high frequency confirmations, evaluations in support of a low frequency limited Expedited Seismic Evaluation Process (ESEP) will be performed for OCNGS in conformance with the "Augmented Approach" guidance document (Reference 4). Given the remaining life of OCNGS, Exelon will continue to evaluate the benefits of pursuing NTTF 2.1: Seismic risk evaluation actions and may request further relief where appropriate. Actions to address NTTF 2.1: Seismic for central and eastern United States nuclear plants are outlined in the schedule provided in the April 9, 2013 letter from the industry to the NRC (Reference 5), as agreed to by the NRC in the May 7, 2013 letter to the industry (Reference 29).

1

Introduction

Following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the Nuclear Regulatory Commission (NRC) established a Near Term Task Force (NTTF). The NTTF was tasked with conducting a systematic review of NRC processes and regulations to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 50.54(f) letter requesting information to assure these recommendations would be addressed by all U.S. nuclear power plants (Reference 1). The 50.54(f) letter (Reference 1) requests that licensees and holders of construction permits under Title 10 Code of Federal Regulations Part 50 (10CFR50) (Reference 2) reevaluate the seismic hazards at their sites using updated seismic hazard information and present-day regulatory guidance and methodologies. Depending on the outcome of the comparison between the reevaluated seismic hazard and the current site-specific design basis, performance of a seismic risk assessment may be necessary. Risk assessment approaches acceptable to the NRC staff include a seismic probabilistic risk assessment (SPRA), or a seismic margin assessment (SMA). Based upon the risk assessment results, the NRC staff will determine whether additional regulatory actions are necessary to provide additional protection against the updated hazards.

This report provides the information requested in items (1) through (7) of the "Requested Information" in Enclosure 1 of the 50.54(f) letter (Reference 1), pertaining to NTTF Recommendation 2.1: Seismic for Oyster Creek Nuclear Generating Station (OCNGS), located in Ocean County, New Jersey in accordance with the documented intention of Exelon Generation Company, LLC (Exelon) transmitted to the NRC via letter dated April 29, 2013 (Reference 17). In providing this information, Exelon followed the Screening, Prioritization, and Implementation Details (SPID) industry guidance document (Reference 3). The "Augmented Approach" guidance document (Reference 4) defines interim actions/evaluations for addressing a higher seismic hazard relative to the plant's current design/licensing basis prior to completion of the seismic risk assessments to demonstrate additional seismic margin. This short term aspect of the Augmented Approach is referred to as the Expedited Seismic Evaluation Process (ESEP). In response to NTTF Recommendation 2.3, seismic walkdowns for OCNGS have been performed as initially documented and supplemented in Exelon Correspondence Numbers RS-12-177 and RS-13-065 (References 12 and 13), respectively, to satisfy the 50.54(f) letter (Reference 1).

Several geological investigations have been performed on and near the Oyster Creek site, including investigations for the original plant construction as well as those for a potential additional unit (Reference 9, Section 2.5). OCNGS structures, systems, and components (SSC) important to safety are designed to withstand effects of the most severe natural phenomena specific to the site, including earthquakes, in compliance with General Design Criterion 2 in Appendix A to 10CFR50 (Reference 9, Section 3.1). The OCNGS Safe Shutdown Earthquake (SSE) ground motions are used for the design of seismic Category

I SSCs. See Section 3 of this report for further discussion on the development of the OCNGS SSE.

In response to the 50.54(f) letter (Reference 1) and following the guidance provided in the SPID (Reference 3), a seismic hazard reevaluation was performed for OCNGS. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed.

2

Seismic Hazard Reevaluation

OCNGS is located on the coastal pine barrens of New Jersey in Lacey and Ocean Townships, Ocean County, with the plant site bounded on the north by the South Branch of Forked River, on the east by Barnegat Bay, and on the south by Oyster Creek. The site is approximately 35 miles north of Atlantic City, New Jersey and 45 miles east of Philadelphia, Pennsylvania. (Reference 9, Section 2.1.1) The Oyster Creek site lies far out on the New Jersey Coastal Plain, which is underlain by a sequence of unconsolidated to semi consolidated deposits of Quaternary, Tertiary, and Cretaceous age. These sediments lie unconformably on a basement complex consisting of crystalline Precambrian, early Paleozoic rock, and Triassic rocks. The nearest known fault is approximately 40 miles from the site at Morrisville, Pennsylvania, and there is no evidence of faulting near the site. Buildings and structures are founded generally in the third stratum (Cohansey sand). (Reference 9, Section 2.5)

Small earthquakes have occurred in the general New Jersey area, and others can be expected to occur there in the future. The nearest large earthquakes were centered approximately 500 miles from the Oyster Creek site. The seismicity of the general region of the Oyster Creek site is so low that it would be expected to have a low intensity of ground motion. According to the seismic probability map used during plant licensing, New Jersey is located in Zone 1 (minor damage), with a corresponding spectrum intensity, $I_{0.2}$ = 0.67. The probable maximum intensity expected at the site during the life of the plant was defined as $I_{0.2}$ = 0.94, equating to an Operating Basis Earthquake and SSE peak ground acceleration (PGA) of 0.11g and 0.22g respectively. (Reference 9, Section 2.5 and 3.7)

2.1 Regional and Local Geology

The Oyster Creek site lies far out on the New Jersey Coastal Plain. It is an area of low relief extending from the Fall Zone some 40 miles west of the site to the Continental Shelf east of the site. Coast Plain sediments were deposited in a northwest trending coastal plain "basement depression" which extends from the vicinity of Raritan Bay, New Jersey to Virginia and westward to the Fall Zone. The sediments which were consolidated to form the basement rock in the area were deposited during the Precambrian and early Paleozoic eras. The soils to the depth investigated consist of sand, silt and clay with five distinct strata varying considerably in depth over the area investigated but quite consistent in the area where plant buildings and structures are located. The structure of the Coastal Plain formations is essentially homoclinal with gentle dips to the southwest. (Reference 9, Section 2.5)

OCNGS is located in Ocean County, approximately 35 miles north of Atlantic City, New Jersey and 45 miles east of Philadelphia, Pennsylvania. The power island of OCNGS is situated approximately midway between Oyster Creek and the South Branch of Forked River, approximately 1400 ft. west of Route 9. (Reference 9, Section 2.1.1) An eroded

plateau of Precambrian and early Paleozoic rocks extends below the Coastal Plain to form the bedrock below the unconsolidated sediments. The nearest known fault is approximately 40 miles from the site at Morrisville, Pennsylvania, and there is no evidence of faulting near the site. It is concluded that the probability of fault displacements occurring in the vicinity of the reactor structure is negligibly small. The development of the Triassic troughs represents the last major tectonic and igneous event in Eastern North America. The forces which caused the faulting and vulcanism have been quiescent for a period in excess of 140 million years. (Reference 9, Section 2.5)

2.2 Probabilistic Seismic Hazard Analysis

2.2.1 Probabilistic Seismic Hazard Analysis Results

In accordance with the 50.54(f) letter (Reference 1) and following the guidance in the SPID (Reference 3), a probabilistic seismic hazard analysis (PSHA) was completed using the recently developed Central and Eastern United States Seismic Source Characterization (CEUS-SSC) for Nuclear Facilities (Reference 6) together with the updated EPRI Ground-Motion Model (GMM) for the CEUS (Reference 7). For the PSHA, a lower bound moment magnitude cutoff of 5.0 was used, as specified in the 50.54(f) letter (Reference 1).

For the PSHA, the CEUS-SSC background seismic sources out to a distance of 400 miles (640 km) around Oyster Creek were included. This distance exceeds the 200 mile (320 km) recommendation contained in NRC Reg. Guide 1.208 (Reference 18) 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. 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 CEUS-SSC (Reference 6), the following sources lie within 1,000 km of the Oyster Creek site and were included in the analysis:

1. Charleston
2. Charlevoix

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

2.2.2 *Base Rock Seismic Hazard Curves*

Consistent with the SPID, Section 2.5.3 (Reference 3), base rock seismic hazard curves are not provided as the site amplification approach referred to as Method 3 has been used. Seismic hazard curves are shown below in Section 2.3.7 at the SSE control point elevation.

2.3 SITE RESPONSE EVALUATION

Following the guidance contained in Enclosure 1 of the 50.54(f) letter (Reference 1) and the SPID, Section 2.4 (Reference 3) for nuclear power plant sites that are not founded on hard rock (considered as having a shear-wave velocity of at least 9285 fps), a site response analysis was performed for OCNGS.

2.3.1 *Description of Subsurface Material*

OCNGS is located in the New Jersey Coastal Plain. The Coastal Plain is underlain by a thick wedge of unconsolidated sediment ranging from Cretaceous to recent in age. The plain extends about 40 miles (65 km) west of the site. The profile consists of about 4,000 ft. (1,219m) of Coastal Plain sediments with the SSE control point at the surface. Bedrock (Precambrian basement) is estimated to be at a depth of about 4,000 ft. (1,219m) (Reference 22).

The following description of the site properties is taken directly from the SGH Review of Existing Site Response Parameter Data (Reference 22):

> "The soils in the site area are relatively homogeneous deposits of sands and silty sands with some gravel. The sands become courser with increasing depth. The soils (to the depth investigated) consist of five distinct strata; these strata vary considerably in depth over the area investigated but are quite consistent in the area where plant buildings and structures are located. The buildings and structures are founded generally on the third stratum (Cohansey Sand).
>
> "The Cape May Formation starts are the surface in the area of the plant buildings and structures (El. 23 ft. MSL). It consists of approximately 17 ft. of generally yellow, fine to medium textured, sand of medium density; lenses of silt and silty clay are also present. The Cape May Formation is believed to represent an interglacial, warm water beach and terrace deposit along the coast, and a fluvial marsh deposit inland of the Late Pleistocene Epoch (Quaternary Period).
>
> "The second stratum, Upper Clay, is of the Late Pleistocene to Late Miocene Epoch (Quaternary to Tertiary Period). It starts at El. 6 ft. MSL and consists of alternating layers or bands of stiff to very stiff organic clay, silty clay, and clayey silt with lenses of thin fine sand that extend approximately 17 ft. to an elevation of -11 ft. MSL. Approximately 50% of the material examined fell in the clay or colloid range. This stratum varies in thickness over the area investigated and slopes generally downward toward Barnegat Bay to the east, and upward to the north so that the stratum generally thins out and disappears along the South Branch of the Forked River, which forms

the northern boundary of the site. The clay is overconsolidated by desiccation caused by groundwater fluctuation.

"The Cohansey Formation is generally believed to represent a transitional marine environment which existed along the coast of New Jersey during Late Miocene time (Tertiary Period), and was apparently deposited by fluvial processes. The Cohansey Formation at the plant location is a dense sand stratum about 65 ft. in thickness of generally yellow sand of medium to course texture. The sand grains in the upper formation range from well-rounded to very angular in shape and are about 95% quartz. The penetration resistance in borings at the site increases significantly below the interface of the Upper and Lower Cohansey Formations. This is indicative of a higher relative density in the deeper Lower Cohansey Formation. The higher density may be attributed to wave action associated with a beach or barrier bar depositional environment. The sand grains in the lower formation are subangular to angular and are about 99% quartz.

"The fourth stratum at the plant location, Lower Clay, is another stratum of layers that consists primarily of medium to fine sand containing traces of organic silt layers or inclusions of very stiff to hard organic clay. This stratum is 8 ft. thick at the plant location. The particle size analysis of this material indicated about 50% clay or colloids. This stratum appears to underlie all of the area investigated, varying in thickness from 6 to 30 ft., and starting at elevations from -63 to -98 ft. MSL. The clay layers are overconsolidated, apparently by groundwater fluctuation.

"The Kirkwood Formation from -84 ft. MSL down consists primarily of fine to medium sand of a uniformly gray color. The borings showed some local areas with fine and medium to coarse gravel intermingled with the sand. This formation extends to a depth of about 350 ft. The Oyster Creek documentation reviewed in this study contains very little information on the rocks underlying the Kirkwood formation."

Table 2.3.1-1 shows the geotechnical properties for OCNGS (reproduced from Reference 22).

Table 2.3.1-1 Summary of site geotechnical profile for OCNGS (Reference 22)

Elevations of Layer Boundaries Under Reactor Buildings (ft., MSL)	Range in Thickness Across Site (ft.)	Soil/Rock Description and Age	Density (pcf)	Shear-Wave Velocity (fps)	Compressional Wave Velocity (fps)	Poisson's ratio
23[a] to 20	17-18	Late Pleistocene Cape May Formation, medium density fine sand	120	270-360	Saturated: 5000-5200[c] Not saturated: 1400[c]	0.39
20 to 13				520-690		
13 to 5				570-760		
5 to -3	16-17	Late Pleistocene to Late Miocene Upper Clay, alternating clay, silt, and fine sand	115	640-845	5200-5900	0.49
-3 to -11				700-930		
-11 to -20	65-66	Late Miocene Cohansey Formation, dense fine to coarse sand	125	810-1070	5200-5900	0.49
-20 to -29[b]				860-1130		
-29 to -32				1020-1350		
-32 to -39				1100-1460		
-39 to -45				1000-1320		
-45 to -55				980-1300		
-55 to -57				1100-1450		
-57 to -63				1230-1630		
-63 to -71				1260-1670		
-71 to -77				1220-1610		
-77 to -85	8	Lower Clay, alternating clay, silt, and fine sand	125	1030-1360	5200-5900	N/A
-85 to -330	245	Kirkwood Formation, dense fine to medium sand	125	1350-1780	5200-5900	N/A
-330 to N/A	3700	Quaternary, Tertiary and Cretaceous sediments	N/A	N/A	N/A	N/A
N/A	N/A	Precambrian, early Paleozoic and Triassic rocks	N/A	N/A	N/A	N/A

[a] Finish grade elevation is nominally 23 ft. MSL, corresponding to the SSE control point.

[b] Bottom of the deepest foundation is at El. -29 ft. MSL, within Cohansey Formation.

[c] Different compressional wave velocities are reported for saturated and not-saturated soils. At the time of a 1989 geotechnical investigation by Weston Geophysical Corporation, the soils below a depth of 15 ft. were found to be saturated, and those above were not saturated. The ISFSI geotechnical investigation found groundwater at depths between 10 and 13 ft.

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

Table 2.3.1-1 (Reference 22) shows the recommended shear-wave velocities and unit weights along with elevations and corresponding stratigraphy. The OCNGS SSE control point is defined as the ground surface at El. +23 ft. (+7.0 m) MSL, as further discussed in Section 3.2. The SSE control point location, at the surface, has an average shear-wave velocity from Standard Penetration Test (SPT) measurements of about 315 fps (96 m/s). The source for deeper velocity estimates were also from SPT measurements that extended to a depth of about 300 ft. (91 m) (Table 2.3.1-1).

For sites with shear-wave velocities available over only a limited depth range, a suite of nine shear-wave velocity profile templates has been assumed appropriate to guide extrapolations to basement depths, as documented in the SPID (Reference 3). The template profiles were parameterized with V_{S30} (time averaged shear-wave velocity over upper 100 ft. (30 m) of the profile) ranging from 620 fps to 6,670 fps (190 m/s to 2,032 m/s). For the Oyster Creek site, the profile with the closest velocities (average shear-wave velocities in Table 2.3.1-1) over the appropriate depth range was the 590 fps (180 m/sec) profile. This profile was adopted and adjusted by stripping off material (50 ft., 15.2 m) and scaled to match the shallow velocity estimates provided at the site. The base-case profile consisted of the original specified profile (average shear-wave velocities in Table 2.3.1-1) with the adjusted template added to extend the profile to crystalline basement at a depth of about 4,000 ft. (1,219 m).

To accommodate epistemic uncertainty in shear-wave velocities a scale factor of 1.57 was assumed at the site due to the shallow SPT measurements extending to a depth of about 300 ft. (91 m). The epistemic uncertainty taken over the roughly 4,000 ft. (1,219 m) of the profile was considered to reflect an adequate range in amplification. The scale factor of 1.57 reflects a $\sigma_{\mu ln}$ of about 0.35, based on the SPID (Reference 3) 10^{th} and 90^{th} fractiles which implies a 1.28 scale factor on σ_{μ}. Using the shear-wave velocities specified in Table 2.3.1-1 along with the template velocities, three base-profiles were developed using the scale factor of 1.57 for the entire profile above hard rock.

The specified shear-wave velocities augmented at depth with a velocity template were taken as the mean or best estimate base-case profile (P1) with lower and upper range base-case profiles, P2 and P3 respectively. Profiles extended to a depth (below the SSE control point) of 4,000 ft. (1,219 m), randomized ± 1,200 ft. (± 365.7 m). 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.

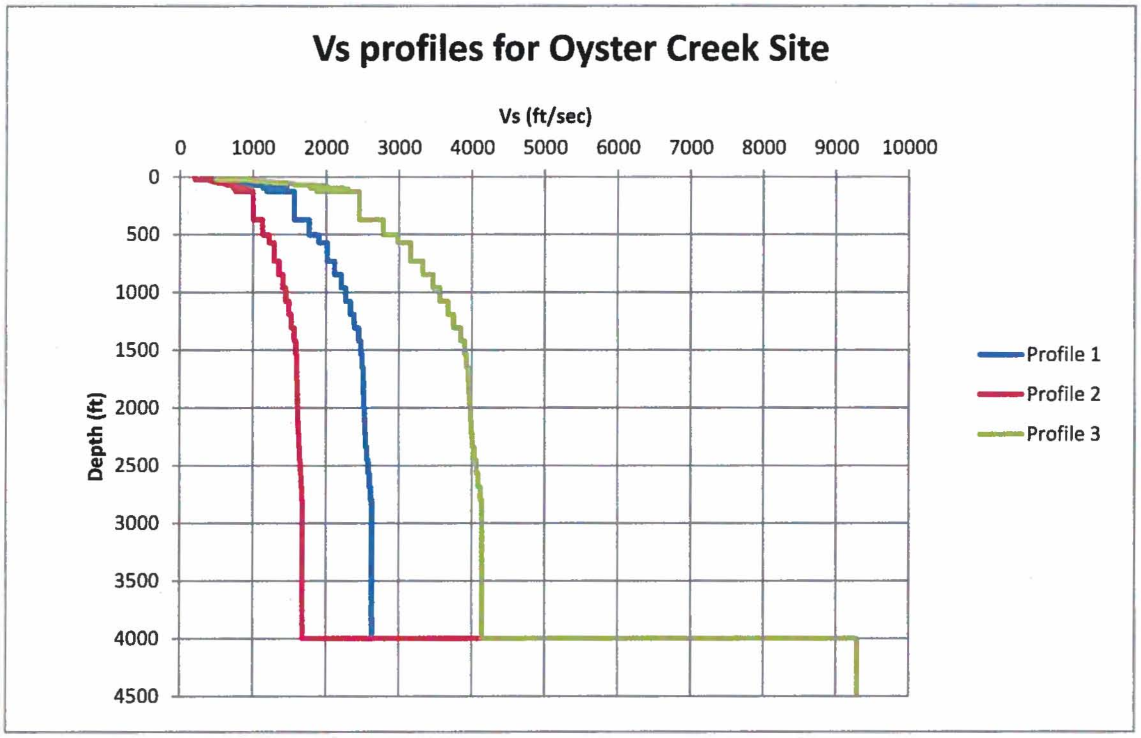


Figure 2.3.2-1 Shear-wave velocity profiles for the Oyster Creek site

Table 2.3.2-2 Layer thicknesses, depths, and shear-wave velocities (V_s) for three profiles, the Oyster Creek site

Profile 1			Profile 2			Profile 3		
Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)
	0	315		0	202		0	494
7.0	7.0	315	7.0	7.0	202	7.0	7.0	494
7.0	14.0	315	7.0	14.0	202	7.0	14.0	494
7.0	21.0	315	7.0	21.0	202	7.0	21.0	494
6.9	27.9	605	6.9	27.9	387	6.9	27.9	950
7.9	35.7	665	7.9	35.7	426	7.9	35.7	1044
7.9	43.6	742	7.9	43.6	475	7.9	43.6	1166
7.9	51.5	815	7.9	51.5	522	7.9	51.5	1279
8.9	60.3	940	8.9	60.3	602	8.9	60.3	1476
8.9	69.2	995	8.9	69.2	637	8.9	69.2	1562
3.0	72.2	1185	3.0	72.2	758	3.0	72.2	1861
3.5	75.7	1280	3.5	75.7	819	3.5	75.7	2009
3.5	79.2	1280	3.5	79.2	819	3.5	79.2	2009
6.0	85.2	1160	6.0	85.2	742	6.0	85.2	1821
4.0	89.2	1140	4.0	89.2	730	4.0	89.2	1790
6.0	95.2	1140	6.0	95.2	730	6.0	95.2	1790
2.0	97.2	1275	2.0	97.2	816	2.0	97.2	2002
6.0	103.2	1430	6.0	103.2	915	6.0	103.2	2245

Profile 1			Profile 2			Profile 3		
Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)
4.0	107.2	1465	4.0	107.2	938	4.0	107.2	2300
4.0	111.2	1465	4.0	111.2	938	4.0	111.2	2300
6.0	117.2	1415	6.0	117.2	906	6.0	117.2	2222
2.0	119.2	1195	2.0	119.2	765	2.0	119.2	1876
6.0	125.2	1195	6.0	125.2	765	6.0	125.2	1876
6.4	131.6	1565	6.4	131.6	1002	6.4	131.6	2457
6.4	138.0	1565	6.4	138.0	1002	6.4	138.0	2457
6.4	144.4	1565	6.4	144.4	1002	6.4	144.4	2457
6.4	150.8	1565	6.4	150.8	1002	6.4	150.8	2457
6.4	157.2	1565	6.4	157.2	1002	6.4	157.2	2457
6.4	163.6	1565	6.4	163.6	1002	6.4	163.6	2457
6.4	170.0	1565	6.4	170.0	1002	6.4	170.0	2457
6.4	176.4	1565	6.4	176.4	1002	6.4	176.4	2457
6.4	182.8	1565	6.4	182.8	1002	6.4	182.8	2457
6.4	189.2	1565	6.4	189.2	1002	6.4	189.2	2457
6.5	195.7	1565	6.5	195.7	1002	6.5	195.7	2457
6.5	202.2	1565	6.5	202.2	1002	6.5	202.2	2457
6.5	208.7	1565	6.5	208.7	1002	6.5	208.7	2457
6.5	215.2	1565	6.5	215.2	1002	6.5	215.2	2457
6.5	221.7	1565	6.5	221.7	1002	6.5	221.7	2457
6.5	228.2	1565	6.5	228.2	1002	6.5	228.2	2457
6.5	234.7	1565	6.5	234.7	1002	6.5	234.7	2457
6.5	241.2	1565	6.5	241.2	1002	6.5	241.2	2457
6.5	247.7	1565	6.5	247.7	1002	6.5	247.7	2457
6.5	254.2	1565	6.5	254.2	1002	6.5	254.2	2457
6.5	260.7	1565	6.5	260.7	1002	6.5	260.7	2457
6.5	267.2	1565	6.5	267.2	1002	6.5	267.2	2457
6.5	273.7	1565	6.5	273.7	1002	6.5	273.7	2457
6.5	280.2	1565	6.5	280.2	1002	6.5	280.2	2457
6.5	286.7	1565	6.5	286.7	1002	6.5	286.7	2457
6.5	293.2	1565	6.5	293.2	1002	6.5	293.2	2457
6.5	299.7	1565	6.5	299.7	1002	6.5	299.7	2457
6.5	306.2	1565	6.5	306.2	1002	6.5	306.2	2457
6.5	312.7	1565	6.5	312.7	1002	6.5	312.7	2457
6.5	319.2	1565	6.5	319.2	1002	6.5	319.2	2457
6.4	325.6	1565	6.4	325.6	1002	6.4	325.6	2457
6.4	331.9	1565	6.4	331.9	1002	6.4	331.9	2457
6.4	338.3	1565	6.4	338.3	1002	6.4	338.3	2457
6.4	344.7	1565	6.4	344.7	1002	6.4	344.7	2457
6.4	351.1	1565	6.4	351.1	1002	6.4	351.1	2457
6.4	357.4	1565	6.4	357.4	1002	6.4	357.4	2457
6.4	363.8	1565	6.4	363.8	1002	6.4	363.8	2457
6.4	370.2	1565	6.4	370.2	1002	6.4	370.2	2457
15.9	386.1	1773	15.9	386.1	1135	15.9	386.1	2784
114.8	500.9	1773	114.8	500.9	1135	114.8	500.9	2784

Profile 1			Profile 2			Profile 3		
Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)	Thickness (ft.)	Depth (ft.)	V_s (fps)
68.2	569.2	1901	68.2	569.2	1217	68.2	569.2	2985
161.4	730.5	2014	161.4	730.5	1289	161.4	730.5	3162
114.8	845.4	2120	114.8	845.4	1357	114.8	845.4	3329
114.8	960.2	2209	114.8	960.2	1414	114.8	960.2	3469
114.8	1075.0	2271	114.8	1075.0	1453	114.8	1075.0	3565
114.8	1189.9	2339	114.8	1189.9	1497	114.8	1189.9	3673
114.8	1304.7	2387	114.8	1304.7	1528	114.8	1304.7	3748
114.8	1419.5	2449	114.8	1419.5	1567	114.8	1419.5	3845
114.8	1534.4	2483	114.8	1534.4	1589	114.8	1534.4	3899
114.8	1649.2	2500	114.8	1649.2	1600	114.8	1649.2	3926
114.8	1764.0	2514	114.8	1764.0	1609	114.8	1764.0	3947
114.8	1878.8	2521	114.8	1878.8	1613	114.8	1878.8	3958
114.8	1993.7	2528	114.8	1993.7	1618	114.8	1993.7	3969
114.8	2108.5	2535	114.8	2108.5	1622	114.8	2108.5	3979
114.8	2223.3	2541	114.8	2223.3	1627	114.8	2223.3	3990
114.8	2338.2	2552	114.8	2338.2	1633	114.8	2338.2	4006
114.8	2453.0	2569	114.8	2453.0	1644	114.8	2453.0	4033
114.8	2567.8	2586	114.8	2567.8	1655	114.8	2567.8	4060
114.8	2682.6	2603	114.8	2682.6	1666	114.8	2682.6	4087
114.8	2797.5	2620	114.8	2797.5	1677	114.8	2797.5	4114
85.1	2882.6	2634	85.1	2882.6	1686	85.1	2882.6	4135
1117.0	3999.7	2634	1117.0	3999.7	1686	1117.0	3999.7	4135
3280.8	7280.5	9285	3280.8	7280.5	9285	3280.8	7280.5	9285

2.3.2.1 Shear Modulus and Damping Curves

No site-specific nonlinear dynamic material properties were determined in the initial siting of OCNGS for soils or deeper layers. The soil material over the upper 500 ft. (150 m) was assumed to have behavior that could be modeled with either EPRI cohesionless soil or Peninsular Range G/G_{max} and hysteretic damping curves (Reference 3). Consistent with the SPID (Reference 3), 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 3) for soils (model M2) were assumed to represent an equally plausible alternative exhibiting a more linear response across loading levels.

2.3.2.2 Kappa

Base-case kappa estimates were determined using Section B-5.1.3.1 of the SPID (Reference 3) for a deep (> 3000 ft. (1000 m)) CEUS soil site. For soil sites with depths exceeding 3,000 ft. (1,000 m) to hard rock, a mean base-case kappa of 0.04s should be assumed based upon observed average values for deep soil sites and low loading levels (Reference 3). Hence for the Oyster Creek site, with about 4,000 ft. (1219 m) of soil, a value of kappa of 0.040s was considered appropriate (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)	Weights
P1	0.040	0.4
P2	0.040	0.3
P3	0.040	0.3
G/G_{max} and Hysteretic Damping Curves		
M1		0.5
M2		0.5

2.3.3 Randomization of Base Case Profiles

To account for the aleatory variability in dynamic material properties that is expected to occur across a site at the scale of a typical nuclear facility, variability in the assumed shear-wave velocity profiles has been incorporated in the site response calculations. For the Oyster Creek 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 (Reference 3), 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 8 for USGS "A" site conditions were used for this site. Thirty random velocity profiles were generated for each base case profile. These random velocity profiles were generated using a natural log standard deviation of 0.25 over the upper 50 ft. and 0.15 below that depth. As specified in the SPID (Reference 3), correlation of shear-wave velocity between layers was modeled using the footprint correlation model. In the correlation model, a limit of +/- 2 standard deviations about the median value in each layer was assumed for the limits on random velocity fluctuations.

2.3.4 Input Spectra

Consistent with the guidance in Appendix B of the SPID (Reference 3), 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 PGA ranging from 0.01g 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 Oyster Creek site were the same as those identified in Tables B-4, B-5, B-6 and B-7 of the SPID (Reference 3) as appropriate for typical CEUS sites.

2.3.5 Methodology

To perform the site response analyses for the Oyster Creek site, a random vibration theory (RVT) approach was employed. This process utilizes a simple, efficient approach for computing site-specific amplification functions and is consistent with existing NRC guidance and the SPID (Reference 3). The guidance contained in Appendix B of the SPID (Reference 3) 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 Oyster Creek site.

2.3.6 *Amplification Functions*

The results of the site response analysis consist of amplification factors (5% of critical damping pseudo absolute response spectra) which describe the amplification (or de-amplification) of hard reference rock motion as a function of frequency and input reference rock amplitude. The amplification factors are represented in terms of a median amplification value and an associated standard deviation (sigma) for each oscillator frequency and input rock amplitude. Consistent with the SPID (Reference 3) a minimum median amplification value of 0.5 was employed in the present analysis. Figure 2.3.6-1 illustrates the median and +/- 1 standard deviation in the predicted amplification factors developed for the eleven loading levels parameterized by the median reference (hard rock) peak acceleration (0.01g to 1.50g) for profile P1 and EPRI soil G/G_{max} and hysteretic damping curves. 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 Oyster Creek soil site, Figure 2.3.6-2 shows the corresponding amplification factors developed with Peninsular Range G/G_{max} and hysteretic damping curves for soil (model M2). Figure 2.3.6-1 and Figure 2.3.6-2 respectively show some differences for the amplification factors across all frequencies and loading levels. Tabulated values of the amplification factors are provided in Appendix A.

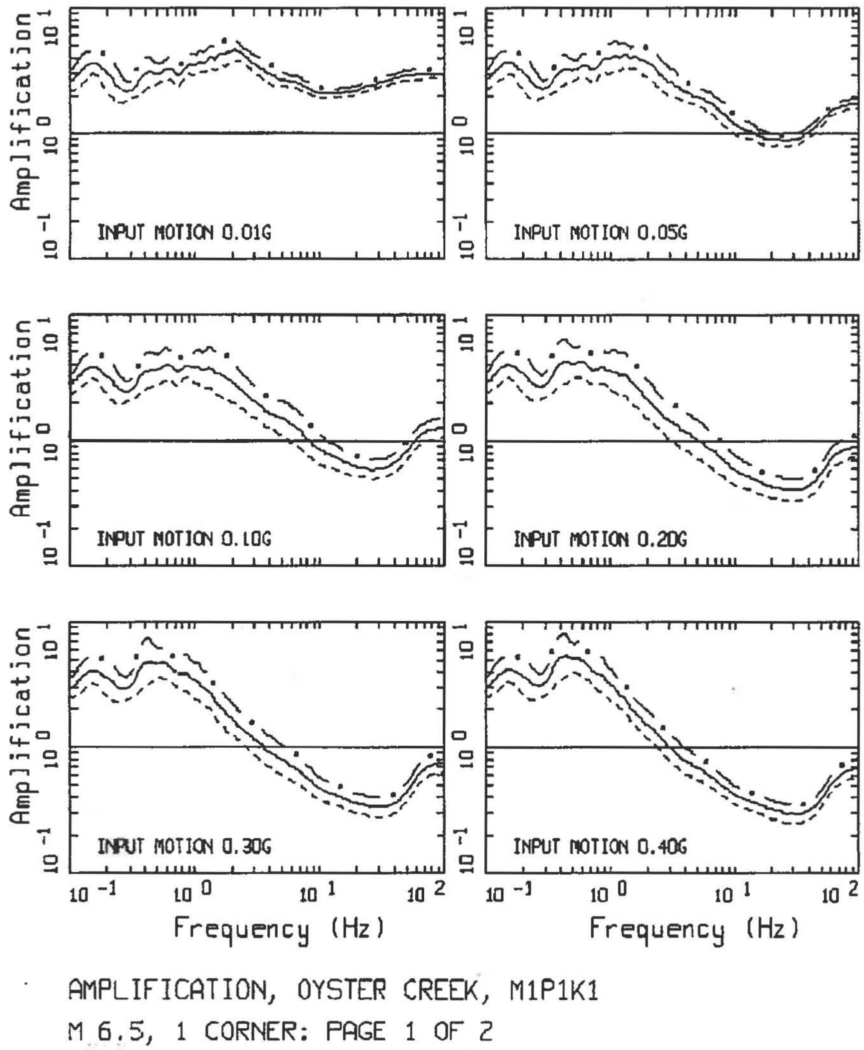
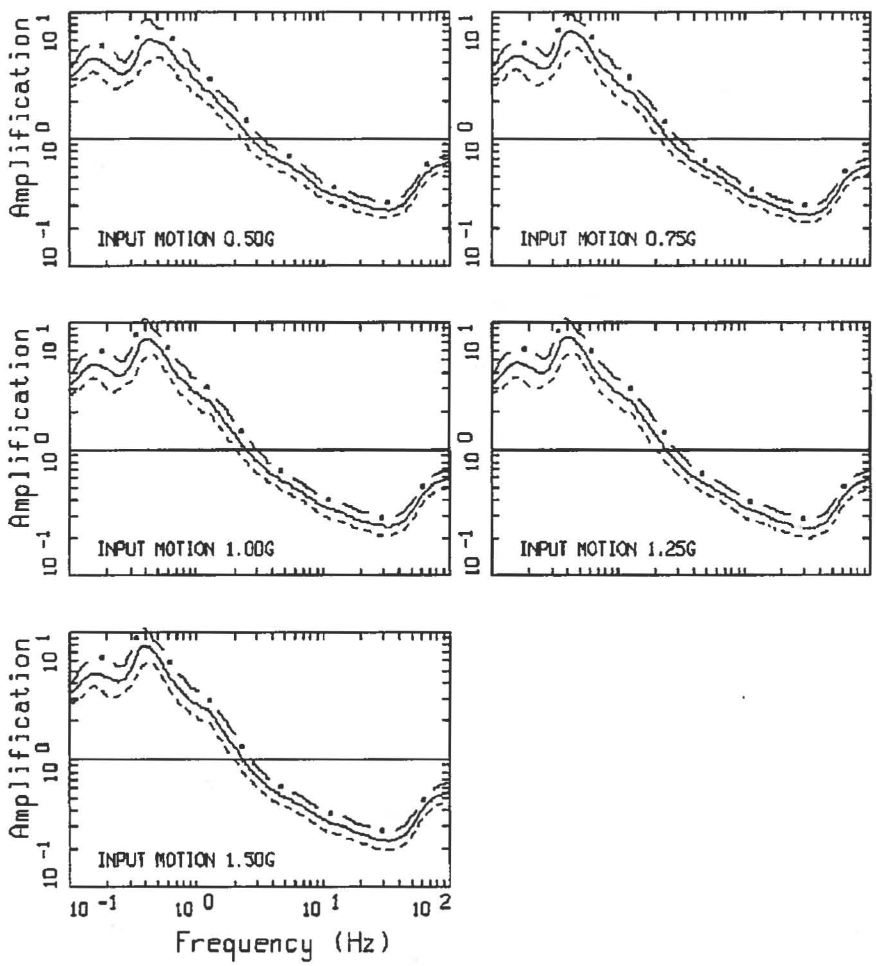


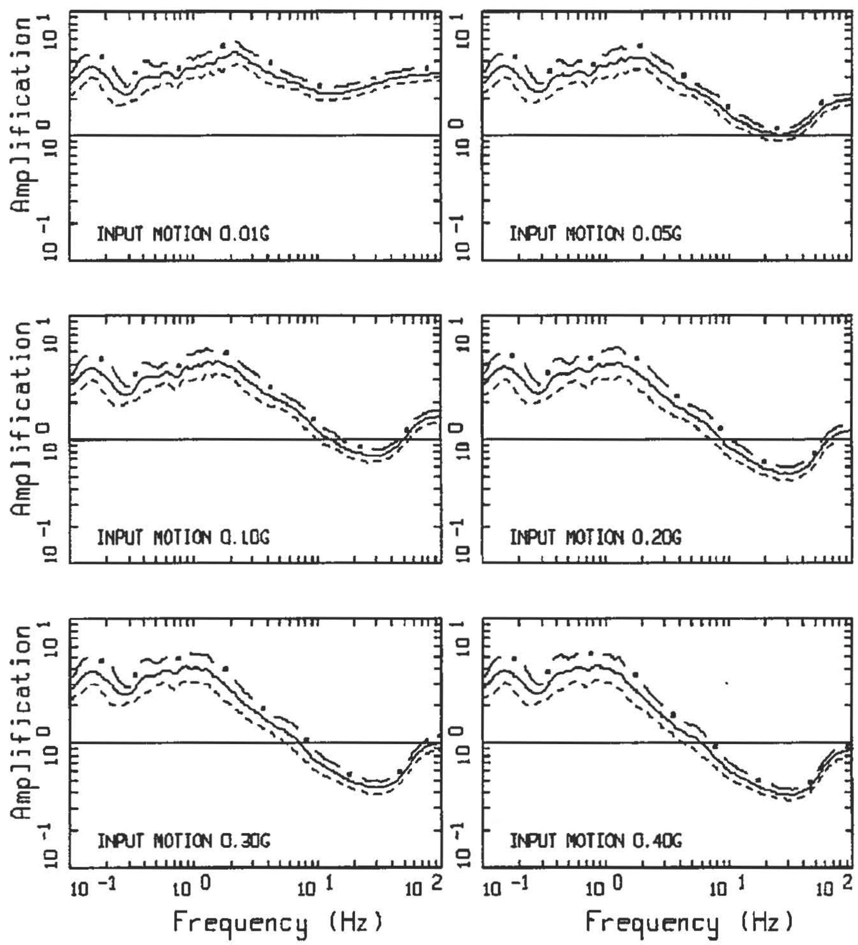
Figure 2.3.6-1 Example suite of amplification factors (5% of critical damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI soil and rock modulus reduction and hysteretic damping curves (model M1), and base-case kappa at eleven loading levels of hard rock median peak acceleration values from 0.01g to 1.50g; **M** 6.5 and single-corner source model (Reference 3)



AMPLIFICATION, OYSTER CREEK, M1P1K1

M 6.5, 1 CORNER: PAGE 2 OF 2

Figure 2.3.6-1 continued



AMPLIFICATION, OYSTER CREEK, M2P1K1

M 6.5, 1 CORNER: PAGE 1 OF 2

Figure 2.3.6-2 Example suite of amplification factors (5% of critical damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), Peninsular Range modulus reduction and hysteretic damping curves for soil and linear site response for rock (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 (Reference 3)

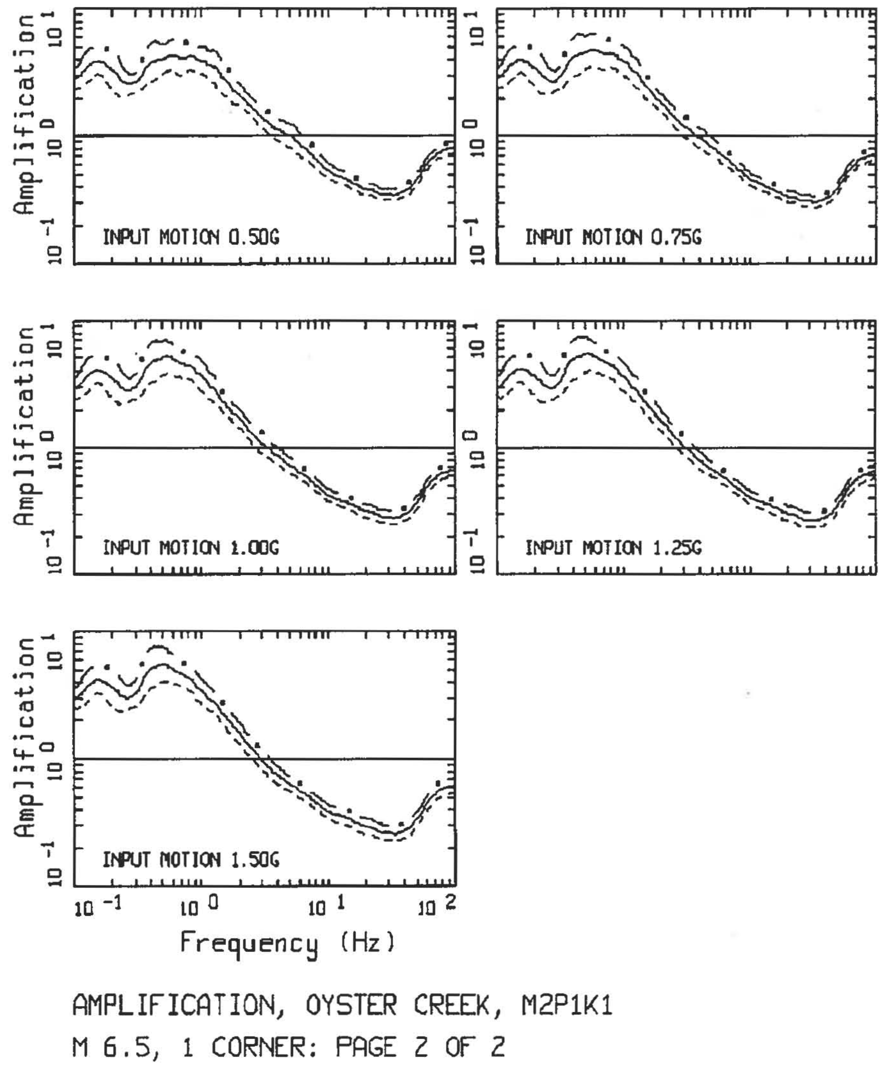


Figure 2.3.6-2 continued

2.3.7 Control Point Seismic Hazard Curves

The procedure to develop probabilistic site-specific control point hazard curves used in the present analysis follows the methodology described in Section B-6.0 of the SPID (Reference 3). This procedure (referred to as Method 3) computes a site-specific control point hazard curve for a broad range of spectral accelerations given the site-specific bedrock hazard curve and site-specific estimates of soil or soft-rock response and associated uncertainties. This process is repeated for each of the seven spectral frequencies for which ground motion equations are available. The dynamic response of the materials below the control point was represented by the frequency- and amplitude-dependent amplification functions (median values and standard deviations) developed and described in the previous section. The resulting control point mean hazard curves for OCNGS are shown in Figure 2.3.7-1 for the seven spectral frequencies for which ground motion equations are defined. Tabulated values of mean and fractile seismic hazard curves and site response amplification functions are provided in Appendix A.

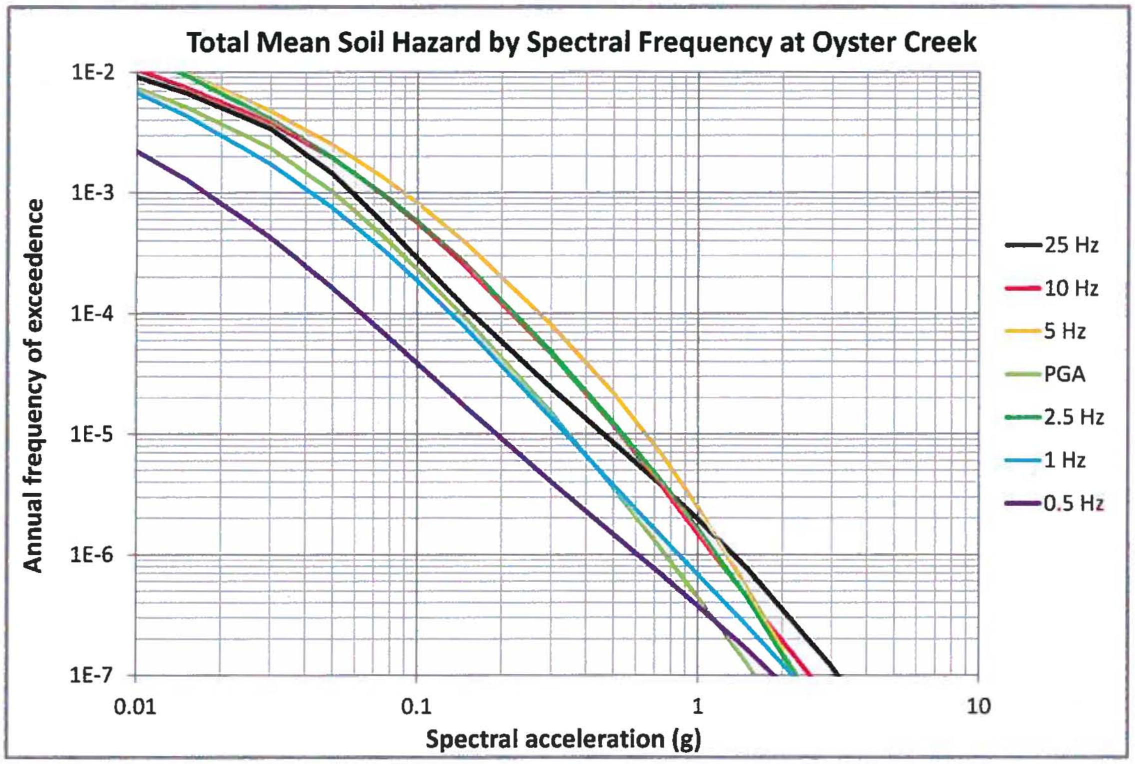


Figure 2.3.7-1 Control point mean hazard curves for spectral frequencies of 0.5, 1, 2.5, 5, 10, 25 and 100 Hz (PGA) at OCNGS (5% of critical damping)

2.4 Control Point Response Spectra (UHRS & GMRS)

The control point hazard curves described above have been used to develop geometric mean horizontal uniform hazard response spectra (UHRS) and the GMRS. The UHRS were obtained through linear interpolation in log-log space to estimate the spectral acceleration at each spectral frequency for the 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 NRC Reg. Guide 1.208 (Reference 18). The GMRS developed herein represents an alternative seismic demand determined using recently developed techniques. Table 2.4-1 shows the UHRS and GMRS accelerations for a range of spectral frequencies. Figure 2.4-1 shows the UHRS and GMRS at the control point.

Table 2.4-1 UHRS and GMRS at control point for OCNGS (5% of critical damping response spectra)

Freq. (Hz)	1E-4 UHRS (g)	1E-5 UHRS (g)	GMRS (g)
100	1.43E-01	3.47E-01	1.74E-01
90	1.43E-01	3.53E-01	1.77E-01
80	1.43E-01	3.61E-01	1.80E-01
70	1.44E-01	3.70E-01	1.84E-01
60	1.44E-01	3.81E-01	1.88E-01
50	1.45E-01	3.95E-01	1.94E-01
40	1.47E-01	4.13E-01	2.01E-01
35	1.48E-01	4.24E-01	2.06E-01
30	1.51E-01	4.39E-01	2.13E-01
25	1.56E-01	4.61E-01	2.22E-01
20	1.62E-01	4.62E-01	2.25E-01
15	1.79E-01	4.76E-01	2.35E-01
12.5	1.95E-01	4.98E-01	2.48E-01
10	2.17E-01	5.30E-01	2.66E-01
9	2.26E-01	5.46E-01	2.75E-01
8	2.37E-01	5.67E-01	2.86E-01
7	2.46E-01	5.90E-01	2.97E-01
6	2.59E-01	6.17E-01	3.11E-01
5	2.73E-01	6.50E-01	3.28E-01
4	2.72E-01	6.32E-01	3.20E-01
3.5	2.67E-01	6.15E-01	3.12E-01
3	2.48E-01	5.85E-01	2.96E-01
2.5	2.21E-01	5.38E-01	2.70E-01
2	2.09E-01	5.09E-01	2.56E-01
1.5	1.78E-01	4.39E-01	2.20E-01
1.25	1.54E-01	3.95E-01	1.96E-01
1	1.32E-01	3.39E-01	1.68E-01
0.9	1.22E-01	3.20E-01	1.58E-01
0.8	1.07E-01	2.94E-01	1.44E-01
0.7	9.36E-02	2.63E-01	1.28E-01
0.6	8.30E-02	2.37E-01	1.15E-01
0.5	6.33E-02	1.92E-01	9.22E-02
0.4	5.06E-02	1.53E-01	7.38E-02
0.35	4.43E-02	1.34E-01	6.45E-02
0.3	3.80E-02	1.15E-01	5.53E-02
0.25	3.17E-02	9.59E-02	4.61E-02
0.2	2.53E-02	7.67E-02	3.69E-02
0.15	1.90E-02	5.75E-02	2.77E-02
0.125	1.58E-02	4.80E-02	2.30E-02
0.1	1.27E-02	3.84E-02	1.84E-02

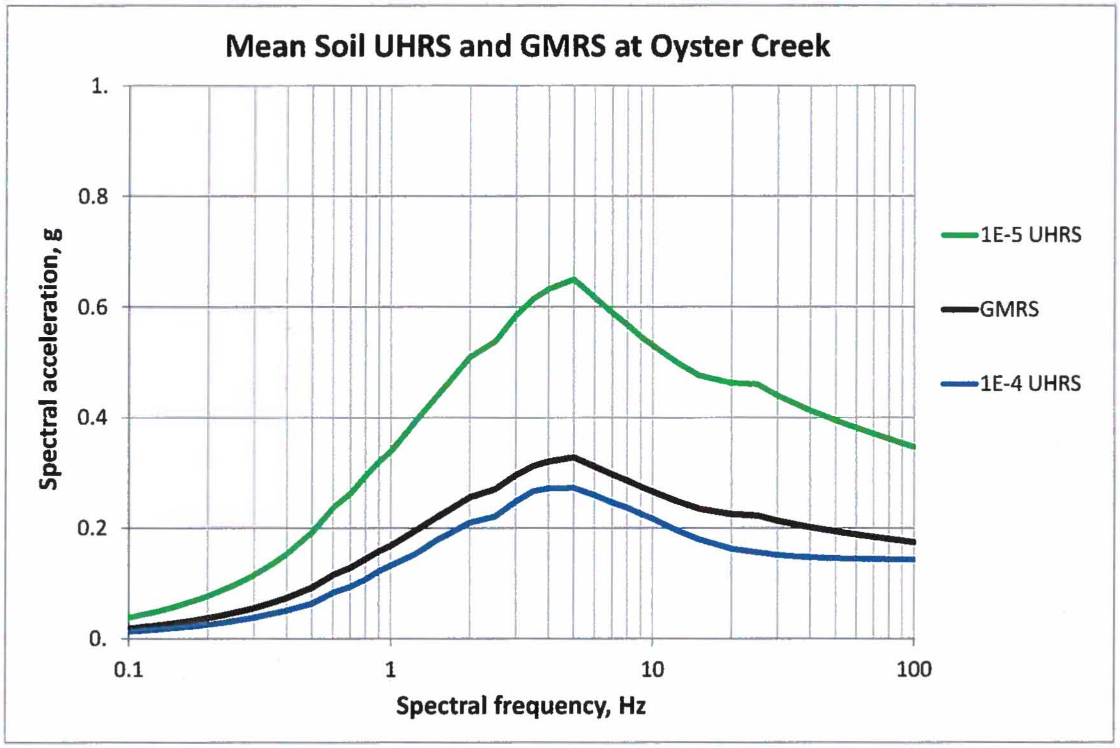


Figure 2.4-1 Plots of 1E-4 and 1E-5 UHRS and GMRS at control point for OCNGS (5% of critical damping response spectra)

3 Plant Design Basis Ground Motion

The design basis for OCNGS is identified in the Updated Final Safety Analysis Report (UFSAR) (Reference 9). The original seismic design of Class I structures and major pieces of equipment at OCNGS was based on a Housner-shaped ground response spectrum (Reference 9, Figure 3.7-1). This response spectrum is based on a peak ground acceleration of 0.22g derived from the El Centro ground acceleration scaled to account for the seismic probability and associated spectrum intensity appropriate for New Jersey (Reference 9, Section 2.5.2.3). In 1992, new site-specific design input response spectra were generated. The peak ground accelerations associated with the SSE for these spectra were obtained from the 84% non-exceedance probability of the data and are equal to 0.184g horizontal and 0.0952g vertical (Reference 9, Section 2.5.2.3). These spectra were used to evaluate components on the Safe Shutdown Equipment List (SSEL) as part of the A-46 program (Reference 20) and have been the SSE response spectra for design of equipment, components, supports and structural subsystems since 1995 (Reference 9, Section 3.7.1.1).

For seismic hazard screening purposes in response to NTTF 2.1: Seismic, the most recent site-specific horizontal response spectrum (anchored to 0.184g PGA) is selected to represent the plant SSE. While the OCNGS Class I structures are designed and evaluated to the original Housner-shaped spectra, this most recent, site-specific spectra is the design basis SSE for the majority of equipment, components, and sub-structures at OCNGS. Based on beyond-design-basis seismic evaluations performed during the Individual Plant Examination of External Events (IPEEE) program, OCNGS structures have been found to be generally more rugged (median fragility capacity no less than 0.69g PGA) than "weak-link" equipment (median fragility capacity as low as 0.30g PGA) (Reference 10, Section 3.1). Therefore, the SSE response spectrum for equipment and components (site-specific response spectra anchored to 0.184g horizontal PGA) represents a lower bound capacity earthquake for plant safe shutdown, and is thus appropriate for NTTF 2.1: Seismic screening.

3.1 SSE Description of Spectral Shape

The SSE is defined in terms of a PGA and a design response spectrum. Considering a suite of 67 horizontal and 34 corresponding vertical earthquake time history records used to generate the input response spectra, the maximum horizontal ground acceleration is defined as the 84% non-exceedance value equal to 0.184g for the SSE anchor point (Reference 9, Section 2.5.2.3). The spectral shape is site-specific based on the input time history records.

Table 3.1-1 shows the spectral acceleration values as a function of frequency for the 5% of critical damping horizontal SSE based upon tabulated values in the OCNGS USI A-46 Seismic Evaluation Report (Reference 20) and linear interpolation between points, which

match the graphical values from UFSAR Figure 3.7-18 (Reference 9). The horizontal SSE (5% of critical damping) for OCNGS is shown in Figure 3.1-1.

Table 3.1-1 Horizontal SSE for OCNGS (5% of critical damping response spectrum)

Frequency (Hz)	Spectral Acceleration (g)
0.5	0.03
0.6	0.05
0.7	0.06
0.8	0.08
0.9	0.09
1	0.11
1.25	0.15
1.5	0.19
2	0.27
2.5	0.29
3	0.36
3.5	0.39
4	0.41
5	0.44
6	0.43
7	0.42
8	0.39
9	0.37
10	0.36
12.5	0.31
15	0.26
20	0.22
25	0.20
50	0.18
100/PGA	0.18

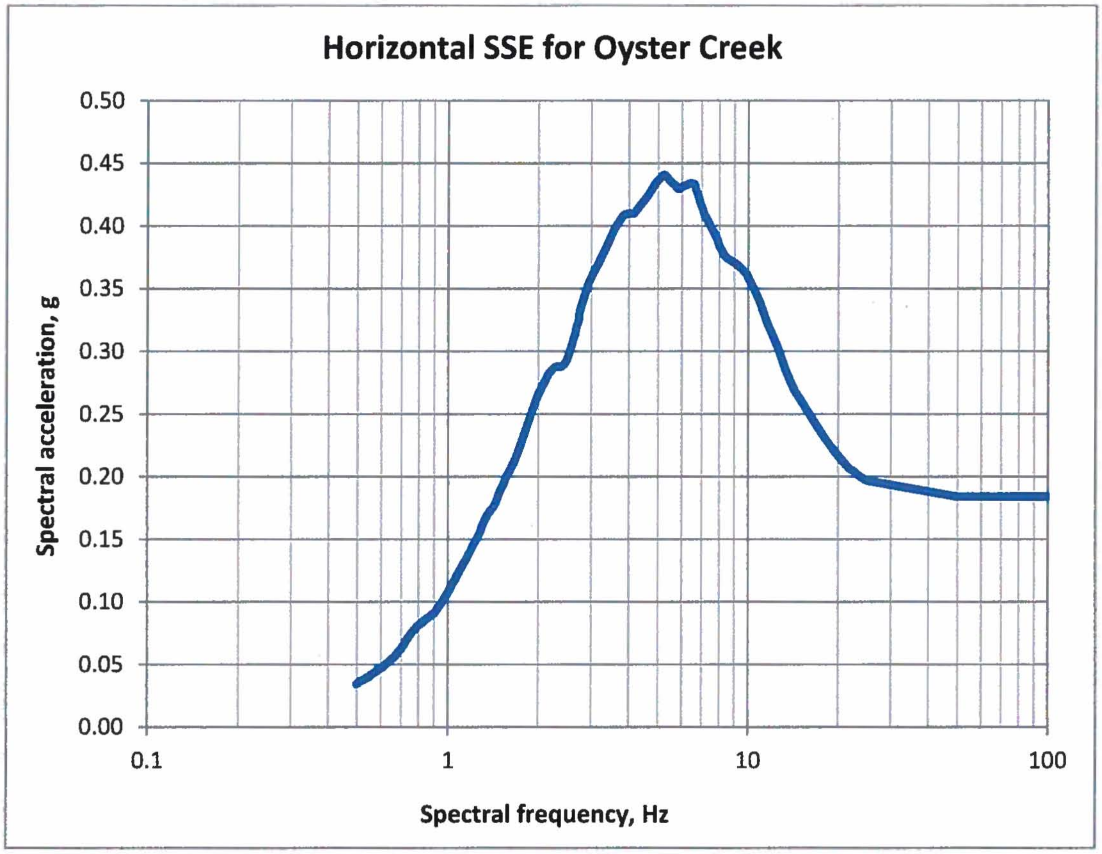


Figure 3.1-1 Horizontal SSE for OCNGS (5% of critical damping response spectrum)

3.2 CONTROL POINT ELEVATION

The OCNGS UFSAR (Reference 9) does not define an SSE control point. The site is layered with several soil strata and is classified as a soil site (Reference 9, Section 2.5.1.4). Buildings and structures are founded generally in the third stratum (Cohansey sand) (Reference 9, Section 2.5.3.1). However, the control point associated with the site-specific response spectra anchored to 0.184g horizontal PGA is defined in the Oyster Creek analysis, "Design Basis Seismic Response Analyses for the Oyster Creek Nuclear Generating Station Reactor, Intake, and Turbine Buildings" (Reference 21) which describes soil-structure interaction (SSI) analysis of Oyster Creek structures for generation of in-structure response spectra. The site-specific SSE is defined therein as the ground surface response spectrum or freefield input motion. Consequently, the control point for the SSE used for screening is considered the free-field ground surface, with the site nominal grade elevation equal to 23 ft. MSL. While the Exelon 1.5 year response to the 50.54(f) letter (Reference 27) did not model the soil profile up to the ground surface, the control point at El. 23 ft. MSL represents the location at which the SSE is defined and the appropriate location to define the GMRS. Therefore, the SSE control point elevation has been revised from the Exelon 1.5 year response to the 50.54(f) letter (Reference 27) and is located at the grade elevation of El. 23 ft. MSL, consistent with application of the SSE in Oyster Creek structural modeling (Reference 21).

4 Screening Evaluation

Following completion of the seismic hazard reevaluation, as requested in the 50.54(f) letter (Reference 1), a screening evaluation is performed in accordance with the SPID, Section 3 (Reference 3). The horizontal GMRS determined from the hazard reevaluation is used to characterize the amplitude of the alternative seismic hazard at each of the nuclear power plant sites. The screening evaluation is based upon a comparison of the GMRS with the established plant-level seismic capacity (either the SSE or IPEEE HCLPF Spectrum (IHS), where HCLPF is defined as high-confidence-of-low-probability-of-failure), in accordance with the SPID (Reference 3). For OCNGS, the plant-level seismic capacity is based on the SSE.

4.1 Risk Evaluation Screening (1 to 10 Hz)

In the frequency range of 1 to 10 Hz, the OCNGS SSE spectral acceleration exceeds that of the GMRS except for frequencies below approximately 1.9 Hz. According to the SPID, Section 3.2.1.1 (Reference 3), the OCNGS SSE exceedances of the GMRS in the frequency range of 1 to 10 Hz are classified as low-frequency exceedances. Further, the GMRS spectral acceleration does not exceed the low hazard threshold of 0.4g peak spectral acceleration. For most SSCs, exceedances below 2.5 Hz are non-consequential as the fundamental frequency of these SSCs exceeds 2.5 Hz. Because of this and the low likelihood of any seismically designed SSC being damaged by ground motion with a peak spectral acceleration less than the low hazard threshold, the expected seismic risk at OCNGS is low (Reference 3). As a result, the SPID, Section 3.2.1.1 (Reference 3) limits the seismic risk assessment to evaluation of safety-significant SSCs that are potentially susceptible to ground motions at frequencies less than 1.9 Hz for OCNGS.

Examples of SSCs and failure modes potentially susceptible to damage from spectral accelerations at low frequencies are provided in the SPID, Section 3.2.1.1 (Reference 3) and reproduced below. Based upon further review of equipment natural frequencies, an additional component type was identified as potentially susceptible to low frequency acceleration: equipment mounted on vibration isolators. The SSC and failure mode types, along with examples of specific potentially safety-significant OCNGS SSCs, are listed below.

- Liquid sloshing in atmospheric pressure storage tanks
  - Diesel generator fuel oil storage tank, T-39-2
  - Condensate storage tank, T-11-1
- Very flexible distribution systems with frequencies less than 1.9 Hz
  - Cable tray raceways
  - Conduit raceways
  - Flexible piping systems
- Sliding and rocking of unanchored components
  - Emergency diesel generators, M-39-001 and M-39-002
  - Fire water pump house (controlling failure mode is sliding)
- Fuel assemblies inside the reactor vessel
- Soil liquefaction
  - Emergency diesel generator building
  - Turbine building
  - Fire water buried piping
- Equipment mounted on vibration isolators
  - Batt & M-G room exhaust and supply fans, EF-1-20 and SF-1-20
  - Switchgear room "A" main exhaust and supply fans, FN-56-4 and FN-56-7

Further, in accordance with the screening requirements in Section 2.2 of the "Augmented Approach" guidance document (Reference 4), OCNGS will perform evaluations in support of a low frequency limited ESEP as an interim action/assessment.

4.2 HIGH FREQUENCY SCREENING (> 10 Hz)

In the frequency range above 10 Hz, the OCNGS SSE spectral acceleration exceeds that of the GMRS up to a spectral frequency of 18 Hz. However, in the frequency range of approximately 18 to 70 Hz, the GMRS envelopes the SSE for OCNGS. Therefore, a high frequency confirmation is prescribed in accordance with the SPID guidance, Sections 3.2 and 3.4 (Reference 3).

As summarized in the SPID (Reference 3), EPRI Report NP-7498 (Reference 30) concludes that high-frequency vibration is not damaging, in general, to components with strain- or stress-based failure modes. However, components, such as relays, subject to electrical functionality failure modes have unknown acceleration sensitivity for frequencies above 16 Hz. EPRI Report 1015108 (Reference 28) provides evidence that supports the conclusion that high-frequency motions are not damaging to the majority of nuclear plant components, excluding relays and other electrical devices whose output signals may be affected by high-frequency vibration.

The types of SSCs which may be affected by high frequency ground motions include relays, contactors, and similar devices subject to electrical functionality failure modes such as inadvertent change of state, contact chatter, or change in output signal/set-point. EPRI has established a test program to develop data to support high frequency confirmation as described in the SPID, Sections 3.4.2 and 3.4.3 (Reference 3). The test program, which will evaluate the typical component types listed in Table 3-3 of the SPID (Reference 3), uses accelerations or spectral levels intended to be sufficiently high to address the high-frequency in-structure and in-cabinet responses of various plants. Reports from the EPRI high frequency testing program will serve as critical input to the OCNGS high frequency

confirmation. Example component types reproduced from Table 3-3 of the SPID (Reference 3) are:

- Electro-mechanical relays
- Circuit breakers
- Control switches
- Process switches and sensors
- Electro-mechanical contactors
- Auxiliary contacts
- Transfer switches
- Potentiometers

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

OCNGS is screened from performance of a full seismic risk assessment based on the special screening consideration in the SPID, Section 3.2.1.1 (Reference 3) for low seismic hazard sites. Therefore, a spent fuel pool integrity evaluation is not needed for OCNGS in accordance with the SPID, Section 7 (Reference 3).

5

Interim Actions

Based on the screening results described in Section 4 of this report, the GMRS spectral accelerations exceeds that of the SSE for frequencies below approximately 1.9 Hz and between 18 and 70 Hz at OCNGS. Therefore, low frequency evaluations and high frequency confirmations are prescribed in accordance with the SPID (Reference 3). Additionally, the "Augmented Approach" guidance document (Reference 4) prescribes expedited seismic evaluations be performed for key components, with the list of key components limited to those whose natural frequency is below 1.9 Hz.

5.1 Expedited Seismic Evaluation Process

Based on the screening results, evaluations in support of a low frequency limited ESEP will be performed for OCNGS as proposed in the April 9, 2013 letter from the industry to the NRC (Reference 5) and agreed to by the NRC in a letter dated May 7, 2013 (Reference 29).

Exelon has committed to follow the "Augmented Approach" guidance document (Reference 4), which introduces the ESEP as an interim action to augment the response to the NRC request for information. The ESEP addresses the part of the 50.54(f) letter (Reference 1) that requests "interim evaluation and actions taken or planned to address the higher seismic hazard relative to the design basis, as appropriate, prior to completion of the risk evaluation." Specifically, the ESEP focuses initial industry efforts on short term evaluations that will lead to prompt modifications to some of the most important components that could improve plant seismic safety.

5.2 Interim Evaluation of Seismic Hazard

Consistent with the NRC letter dated February 20, 2014 (Reference 15), the seismic hazard reevaluations presented herein are distinct from the current design and licensing bases of OCNGS. Therefore, the results do not call into question the operability or functionality of SSCs and are not reportable pursuant to 10CFR50.72, "Immediate notification requirements for operating nuclear power reactors" (Reference 2, Section 50.72) and 10 CFR 50.73, "Licensee event report system" (Reference 2, Section 50.73).

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, the NEI letter dated March 12, 2014 (Reference 25) provides seismic core damage risk estimates using the updated seismic hazards for the operating nuclear plants in the CEUS. These risk estimates continue to support the following conclusions of the NRC GI-199 Safety/Risk Assessment (Reference 26):

"Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency. The GI-199 Safety/Risk Assessment, based in part on information from the U.S. Nuclear Regulatory Commission's (NRC's) Individual Plant Examination of External Events (IPEEE) program, indicates that no concern exists regarding adequate protection and that the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis."

OCNGS is included in the March 12, 2014 risk estimates (Reference 25). Using the methodology described in the NEI letter, the seismic core damage risk estimates for all plants were shown to be below 1E-4/year; thus, the above conclusions apply.

5.3 Seismic Walkdown Insights

In response to NTTF 2.3, the 50.54(f) letter (Reference 1) also requested licensees to perform seismic walkdowns in order to, in the context of seismic response: 1) verify that the current plant configuration is consistent with the licensing basis; 2) verify the adequacy of current strategies, monitoring, and maintenance programs; and 3) identify degraded, nonconforming, or unanalyzed conditions. Exelon committed to and performed seismic walkdowns in accordance with the seismic walkdown guidance (Reference 16) as initially documented and supplemented in Exelon Correspondence Numbers RS-12-177 and RS-13-065 (References 12 and 13) respectively. A walkdown for the one remaining initially inaccessible equipment item is scheduled to be completed in the fourth quarter of 2014 and reported to the NRC by March 31, 2015 as committed in Exelon Correspondence Number RS-13-213 (Reference 14).

Based on the successful completion of seismic walkdowns for all but the one inaccessible item in response to NTTF 2.3, and the lack of adverse seismic conditions identified, Exelon has directly concluded that the OCNGS current plant configuration is consistent with the plant licensing basis and can safely shut down the reactor and maintain containment integrity following the design basis SSE event. Additionally, the findings of the seismic walkdown program indirectly verify that the current OCNGS strategies, monitoring, and maintenance programs are adequate for ensuring seismic safety consistent with the licensing basis.

Plant vulnerabilities and commitments identified in the OCNGS IPEEE (Reference 10) were reviewed as part of the NTTF 2.3 seismic walkdowns (References 12 and 13). The OCNGS seismic walkdown report verified the OCNGS IPEEE report did not identify any vulnerability, outlier, anomaly, or enhancement and confirmed all previously identified IPEEE commitments have been resolved (References 12 and 13).

5.4 Beyond-Design-Basis Seismic Insights

An evaluation of beyond-design-basis ground motions was performed for OCNGS as part of the IPEEE program. The OCNGS IPEEE analyzed seismic risk quantitatively via an SPRA. The IPEEE seismic evaluation included plant walkdowns, liquefaction analysis, review of relay chatter effects, and an evaluation of containment performance. The results of the OCNGS IPEEE showed there were no vulnerabilities to severe accident risk from external events, including seismic events (References 10 and 23). The final seismic core

damage frequency (SCDF) for OCNGS was found to be 4.74E-6/year (Reference 11), which is less than the Commission's Safety Goal subsidiary objective of 1E-4/year (Reference 26). Based on the sufficiently low SCDF value, it may be qualitatively concluded that the plant has significant seismic margin beyond the design basis (Reference 24, Section 2.3.4). As a result of the OCNGS IPEEE seismic evaluation, the combustion turbine fin-fan cooler bolts were added and torqued, as confirmed in the NTTF 2.3 seismic walkdown report (Reference 12), to further enhance the OCNGS seismic margin.

6 Conclusions

In accordance with the 50.54(f) letter (Reference 1), a seismic hazard and screening evaluation was performed for OCNGS. This evaluation followed the SPID guidance (Reference 3) in order to develop a site GMRS for the purpose of screening the plant in accordance with the SPID. The new GMRS does not constitute a change in the plant design or licensing basis as described in the NRC letter dated February 20, 2014 (Reference 15).

The screening evaluation comparison demonstrates that OCNGS is a low seismic hazard site with GMRS exceedances of the SSE limited to low- and high-frequency exceedances. Due to the low- and high-frequency exceedances identified, low frequency evaluations and high frequency confirmations are prescribed in accordance with the SPID (Reference 3) through evaluation of SSCs potentially susceptible to damage from spectral accelerations at frequencies below 1.9 Hz and between 18 and 70 Hz. As an interim action/assessment, evaluations in support of a low frequency limited ESEP will be performed for OCNGS in conformance with the "Augmented Approach" guidance document (Reference 4). This is an interim action to establish beyond-design-basis safety margin prior to further risk assessment. Given the remaining life of OCNGS, Exelon will continue to evaluate the benefits of pursuing NTTF 2.1: Seismic risk evaluation actions and may request further relief where appropriate. Actions to address NTTF 2.1: Seismic for CEUS nuclear plants are outlined in the schedule provided in the April 9, 2013 letter from the industry to the NRC (Reference 5), as agreed to by the NRC in the May 7, 2013 letter to the industry (Reference 29).

7 References

1. NRC (E. Leeds and M. Johnson) Letter to All Power Reactor Licensees et al., *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,* dated March 12, 2012.

2. Title 10 Code of Federal Regulations Part 50, *Domestic Licensing of Production and Utilization Facilities.*

3. EPRI 1025287, *Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,* Palo Alto, CA, February 2013.

4. EPRI 3002000704, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,* Palo Alto, CA, May 2013.

5. NEI Letter (A. R. Pietrangelo) to the NRC, *Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations,* dated April 9, 2013.

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7. EPRI 3002000717, *EPRI (2004, 2006) Ground-Motion Model (GMM) Review Project,* Palo Alto, CA, June 2013.

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14. Exelon Generation Company letter to the NRC, *Exelon Generation Company, LLC Proposed Resolution for Completion of the Seismic Walkdowns Associated with NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, RS-13-213, dated September 16, 2013.

15. NRC (E. Leeds) Letter to All Power Reactor Licensees et al., ML14030A046, *Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazard Reevaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated February 20, 2014.

16. EPRI 1025286, *Seismic Walkdown Guidance for Resolution of Fukushima Near-Term Task Force Recommendation 2.3: Seismic*, Palo Alto, CA, June 2012.

17. Exelon Generation Company letter to the NRC, *Exelon Generation Company, LLC 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*, RS-13-102, dated April 29, 2013.

18. NRC Regulatory Guide 1.208, *A performance-based approach to define the site-specific earthquake ground motion*, 2007.

19. EPRI RSM-121313-039, *Oyster Creek Seismic Hazard and Screening Report*, dated December 23, 2013.

20. EQE Engineering Consultants Report No. 42112-R-001, Revision 0, *Oyster Creek Nuclear Generating Station, USI A-46 Seismic Evaluation Report*, GPU Nuclear Corporation, March 1, 1996.

21. EQE Engineering Consultants Report No. 50069-R-001, Revision 0, *Design Basis Seismic Response Analysis for the Oyster Creek Nuclear Generating Station Reactor, Intake, and Turbine Buildings*, GPU Nuclear Corporation, September 1995.

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30. EPRI NP-7498, *Industry Approach to Seismic Severe Accident Policy Implementation,* Palo Alto, CA, November 1991.

A
Additional Tables

Table A-1a Mean and fractile seismic hazard curves for PGA at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.07E-02	2.25E-02	3.47E-02	4.13E-02	4.83E-02	5.35E-02
0.001	3.43E-02	1.49E-02	2.68E-02	3.47E-02	4.25E-02	4.77E-02
0.005	1.32E-02	5.50E-03	8.85E-03	1.23E-02	1.79E-02	2.35E-02
0.01	7.36E-03	3.23E-03	4.56E-03	6.83E-03	9.65E-03	1.44E-02
0.015	5.12E-03	2.19E-03	3.05E-03	4.70E-03	6.64E-03	1.05E-02
0.03	2.34E-03	8.47E-04	1.23E-03	2.04E-03	3.23E-03	5.35E-03
0.05	1.01E-03	2.68E-04	4.19E-04	8.00E-04	1.51E-03	2.68E-03
0.075	4.43E-04	7.34E-05	1.32E-04	3.05E-04	7.13E-04	1.27E-03
0.1	2.32E-04	2.60E-05	5.27E-05	1.46E-04	3.90E-04	6.93E-04
0.15	8.88E-05	5.91E-06	1.42E-05	4.90E-05	1.46E-04	2.96E-04
0.3	1.50E-05	5.91E-07	1.98E-06	7.66E-06	2.46E-05	5.27E-05
0.5	3.54E-06	1.01E-07	4.31E-07	1.84E-06	6.00E-06	1.27E-05
0.75	1.06E-06	2.13E-08	1.04E-07	5.35E-07	1.82E-06	3.90E-06
1.	4.39E-07	6.00E-09	3.42E-08	2.07E-07	7.55E-07	1.64E-06
1.5	1.23E-07	8.60E-10	6.09E-09	4.90E-08	2.07E-07	4.90E-07
3.	1.13E-08	1.01E-10	2.39E-10	2.80E-09	1.67E-08	5.27E-08
5.	1.49E-09	5.05E-11	1.01E-10	2.84E-10	1.92E-09	7.66E-09
7.5	2.45E-10	4.01E-11	5.05E-11	1.01E-10	3.28E-10	1.40E-09
10.	6.14E-11	4.01E-11	4.83E-11	1.01E-10	1.29E-10	3.95E-10

Table A-1b Mean and fractile seismic hazard curves for 25 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.15E-02	2.60E-02	3.57E-02	4.13E-02	4.83E-02	5.35E-02
0.001	3.56E-02	1.82E-02	2.92E-02	3.57E-02	4.25E-02	4.77E-02
0.005	1.51E-02	6.93E-03	1.04E-02	1.42E-02	1.95E-02	2.72E-02
0.01	9.10E-03	4.31E-03	5.91E-03	8.47E-03	1.15E-02	1.82E-02
0.015	6.70E-03	3.09E-03	4.19E-03	6.26E-03	8.47E-03	1.36E-02
0.03	3.37E-03	1.36E-03	1.92E-03	3.09E-03	4.56E-03	6.73E-03
0.05	1.42E-03	4.31E-04	6.54E-04	1.21E-03	2.10E-03	3.01E-03
0.075	5.69E-04	1.23E-04	2.10E-04	4.43E-04	8.85E-04	1.38E-03
0.1	2.83E-04	4.83E-05	8.98E-05	2.10E-04	4.56E-04	7.45E-04
0.15	1.09E-04	1.38E-05	3.19E-05	7.77E-05	1.74E-04	3.09E-04
0.3	2.41E-05	2.19E-06	6.64E-06	1.87E-05	3.95E-05	6.54E-05
0.5	8.44E-06	6.17E-07	2.10E-06	6.54E-06	1.42E-05	2.29E-05
0.75	3.65E-06	2.16E-07	8.12E-07	2.76E-06	6.26E-06	1.02E-05
1.	1.96E-06	9.24E-08	3.95E-07	1.44E-06	3.42E-06	5.66E-06
1.5	7.60E-07	2.72E-08	1.31E-07	5.27E-07	1.34E-06	2.39E-06
3.	1.18E-07	2.42E-09	1.36E-08	6.93E-08	2.07E-07	4.19E-07
5.	2.33E-08	3.68E-10	1.82E-09	1.11E-08	4.07E-08	9.24E-08
7.5	5.49E-09	1.15E-10	3.37E-10	2.16E-09	9.24E-09	2.32E-08
10.	1.81E-09	9.11E-11	1.34E-10	6.17E-10	2.96E-09	8.12E-09

Table A-1c Mean and fractile seismic hazard curves for 10 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.37E-02	3.47E-02	3.79E-02	4.31E-02	4.98E-02	5.50E-02
0.001	3.90E-02	2.76E-02	3.33E-02	3.90E-02	4.56E-02	5.05E-02
0.005	1.79E-02	9.37E-03	1.31E-02	1.74E-02	2.29E-02	2.80E-02
0.01	1.04E-02	5.27E-03	7.13E-03	9.93E-03	1.34E-02	1.79E-02
0.015	7.38E-03	3.68E-03	4.90E-03	7.03E-03	9.51E-03	1.31E-02
0.03	3.76E-03	1.72E-03	2.32E-03	3.57E-03	4.98E-03	6.83E-03
0.05	1.92E-03	7.45E-04	1.07E-03	1.74E-03	2.72E-03	3.68E-03
0.075	9.72E-04	2.80E-04	4.37E-04	8.35E-04	1.49E-03	2.07E-03
0.1	5.59E-04	1.16E-04	2.01E-04	4.56E-04	8.85E-04	1.31E-03
0.15	2.38E-04	3.01E-05	6.09E-05	1.77E-04	3.95E-04	6.45E-04
0.3	4.66E-05	3.68E-06	9.11E-06	2.84E-05	8.12E-05	1.49E-04
0.5	1.19E-05	7.45E-07	2.13E-06	7.03E-06	2.13E-05	3.95E-05
0.75	3.60E-06	1.82E-07	6.26E-07	2.29E-06	6.36E-06	1.15E-05
1.	1.49E-06	6.45E-08	2.49E-07	9.93E-07	2.68E-06	4.56E-06
1.5	4.41E-07	1.31E-08	5.75E-08	2.68E-07	8.00E-07	1.46E-06
3.	6.03E-08	3.95E-10	2.57E-09	2.29E-08	1.15E-07	2.39E-07
5.	1.25E-08	1.01E-10	2.46E-10	3.23E-09	2.32E-08	5.35E-08
7.5	3.14E-09	5.27E-11	1.01E-10	6.17E-10	5.58E-09	1.42E-08
10.	1.09E-09	4.13E-11	9.11E-11	2.07E-10	1.87E-09	5.12E-09

Table A-1d Mean and fractile seismic hazard curves for 5 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.51E-02	3.68E-02	3.95E-02	4.43E-02	5.12E-02	5.58E-02
0.001	4.23E-02	3.23E-02	3.63E-02	4.19E-02	4.83E-02	5.35E-02
0.005	2.38E-02	1.25E-02	1.72E-02	2.35E-02	3.05E-02	3.52E-02
0.01	1.42E-02	6.73E-03	9.51E-03	1.38E-02	1.92E-02	2.29E-02
0.015	9.84E-03	4.56E-03	6.36E-03	9.37E-03	1.34E-02	1.62E-02
0.03	4.73E-03	2.16E-03	2.92E-03	4.50E-03	6.54E-03	8.12E-03
0.05	2.49E-03	1.07E-03	1.49E-03	2.35E-03	3.47E-03	4.50E-03
0.075	1.35E-03	5.12E-04	7.45E-04	1.23E-03	1.92E-03	2.60E-03
0.1	8.23E-04	2.60E-04	4.01E-04	7.34E-04	1.23E-03	1.72E-03
0.15	3.75E-04	7.55E-05	1.32E-04	3.14E-04	6.09E-04	8.85E-04
0.3	8.09E-05	5.35E-06	1.27E-05	5.50E-05	1.49E-04	2.35E-04
0.5	2.18E-05	8.60E-07	2.42E-06	1.15E-05	4.25E-05	7.66E-05
0.75	6.53E-06	2.16E-07	6.83E-07	2.76E-06	1.29E-05	2.60E-05
1.	2.46E-06	7.23E-08	2.42E-07	9.37E-07	4.70E-06	1.04E-05
1.5	5.17E-07	1.01E-08	3.90E-08	1.98E-07	9.65E-07	2.07E-06
3.	3.34E-08	1.60E-10	8.47E-10	1.07E-08	6.09E-08	1.40E-07
5.	5.90E-09	5.83E-11	1.01E-10	9.37E-10	1.02E-08	2.80E-08
7.5	1.51E-09	4.01E-11	7.55E-11	1.62E-10	2.49E-09	7.34E-09
10.	5.46E-10	4.01E-11	5.05E-11	1.01E-10	9.11E-10	2.76E-09

Table A-1e Mean and fractile seismic hazard curves for 2.5 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.49E-02	3.68E-02	3.95E-02	4.37E-02	5.05E-02	5.58E-02
0.001	4.18E-02	3.19E-02	3.57E-02	4.13E-02	4.83E-02	5.35E-02
0.005	2.33E-02	1.23E-02	1.60E-02	2.25E-02	3.09E-02	3.63E-02
0.01	1.39E-02	6.36E-03	8.60E-03	1.31E-02	1.92E-02	2.35E-02
0.015	9.37E-03	3.95E-03	5.50E-03	8.72E-03	1.34E-02	1.69E-02
0.03	4.08E-03	1.51E-03	2.19E-03	3.68E-03	6.00E-03	8.00E-03
0.05	1.93E-03	6.54E-04	9.65E-04	1.72E-03	2.88E-03	3.95E-03
0.075	9.81E-04	3.01E-04	4.63E-04	8.60E-04	1.51E-03	2.13E-03
0.1	5.77E-04	1.57E-04	2.53E-04	4.98E-04	8.98E-04	1.29E-03
0.15	2.52E-04	5.42E-05	9.51E-05	2.10E-04	4.07E-04	6.09E-04
0.3	4.82E-05	5.20E-06	1.11E-05	3.42E-05	8.47E-05	1.42E-04
0.5	1.23E-05	5.75E-07	1.51E-06	7.03E-06	2.25E-05	4.19E-05
0.75	3.89E-06	8.35E-08	2.84E-07	1.77E-06	7.23E-06	1.49E-05
1.	1.64E-06	2.13E-08	8.72E-08	6.09E-07	3.01E-06	6.64E-06
1.5	4.34E-07	3.23E-09	1.60E-08	1.25E-07	7.55E-07	1.90E-06
3.	3.30E-08	1.51E-10	6.17E-10	6.17E-09	4.90E-08	1.51E-07
5.	4.41E-09	6.73E-11	1.01E-10	5.42E-10	5.12E-09	1.98E-08
7.5	9.09E-10	4.01E-11	6.64E-11	1.20E-10	8.47E-10	3.73E-09
10.	2.92E-10	4.01E-11	5.05E-11	1.01E-10	2.57E-10	1.16E-09

Table A-1f Mean and fractile seismic hazard curves for 1 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	3.89E-02	2.57E-02	3.14E-02	3.90E-02	4.63E-02	5.20E-02
0.001	3.18E-02	1.74E-02	2.29E-02	3.19E-02	4.07E-02	4.63E-02
0.005	1.26E-02	4.56E-03	6.83E-03	1.20E-02	1.82E-02	2.29E-02
0.01	6.76E-03	1.92E-03	3.09E-03	6.17E-03	1.04E-02	1.36E-02
0.015	4.35E-03	1.04E-03	1.77E-03	3.84E-03	6.93E-03	9.51E-03
0.03	1.73E-03	3.05E-04	5.50E-04	1.40E-03	2.92E-03	4.43E-03
0.05	7.44E-04	1.07E-04	2.04E-04	5.50E-04	1.27E-03	2.10E-03
0.075	3.42E-04	4.25E-05	8.60E-05	2.42E-04	5.83E-04	1.01E-03
0.1	1.87E-04	2.16E-05	4.43E-05	1.29E-04	3.19E-04	5.66E-04
0.15	7.44E-05	7.77E-06	1.67E-05	4.83E-05	1.27E-04	2.35E-04
0.3	1.36E-05	1.07E-06	2.49E-06	7.89E-06	2.32E-05	4.56E-05
0.5	3.76E-06	2.01E-07	5.27E-07	1.90E-06	6.36E-06	1.38E-05
0.75	1.38E-06	4.50E-08	1.36E-07	5.91E-07	2.25E-06	5.50E-06
1.	6.83E-07	1.40E-08	4.98E-08	2.53E-07	1.10E-06	2.84E-06
1.5	2.55E-07	2.60E-09	1.10E-08	7.34E-08	3.95E-07	1.11E-06
3.	4.51E-08	1.67E-10	6.54E-10	7.23E-09	6.00E-08	2.04E-07
5.	1.13E-08	9.11E-11	1.20E-10	1.10E-09	1.23E-08	5.12E-08
7.5	3.40E-09	5.05E-11	9.11E-11	2.42E-10	3.09E-09	1.46E-08
10.	1.36E-09	4.01E-11	6.17E-11	1.16E-10	1.10E-09	5.58E-09

Table A-1g Mean and fractile seismic hazard curves for 0.5 Hz at OCNGS, 5% of critical damping

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.44E-02	1.34E-02	1.74E-02	2.39E-02	3.14E-02	3.63E-02
0.001	1.64E-02	8.00E-03	1.08E-02	1.60E-02	2.19E-02	2.64E-02
0.005	4.67E-03	1.27E-03	2.19E-03	4.25E-03	7.13E-03	9.51E-03
0.01	2.20E-03	3.95E-04	7.66E-04	1.82E-03	3.63E-03	5.35E-03
0.015	1.28E-03	1.77E-04	3.68E-04	9.79E-04	2.19E-03	3.47E-03
0.03	4.23E-04	3.63E-05	8.35E-05	2.76E-04	7.45E-04	1.36E-03
0.05	1.62E-04	9.93E-06	2.46E-05	9.24E-05	2.88E-04	5.75E-04
0.075	7.08E-05	3.37E-06	8.72E-06	3.63E-05	1.25E-04	2.64E-04
0.1	3.87E-05	1.51E-06	4.07E-06	1.79E-05	6.83E-05	1.51E-04
0.15	1.65E-05	4.70E-07	1.40E-06	6.64E-06	2.88E-05	6.73E-05
0.3	4.02E-06	6.26E-08	2.32E-07	1.27E-06	6.54E-06	1.82E-05
0.5	1.48E-06	1.31E-08	5.83E-08	3.73E-07	2.19E-06	7.03E-06
0.75	6.67E-07	3.47E-09	1.87E-08	1.38E-07	9.11E-07	3.28E-06
1.	3.76E-07	1.36E-09	8.00E-09	6.73E-08	4.70E-07	1.87E-06
1.5	1.63E-07	3.52E-10	2.25E-09	2.25E-08	1.84E-07	8.00E-07
3.	3.44E-08	1.01E-10	2.53E-10	2.80E-09	3.14E-08	1.62E-07
5.	9.59E-09	6.36E-11	1.01E-10	5.05E-10	6.73E-09	4.25E-08
7.5	3.15E-09	4.37E-11	9.11E-11	1.62E-10	1.74E-09	1.25E-08
10.	1.35E-09	4.01E-11	5.12E-11	1.01E-10	6.54E-10	4.90E-09

Table A-2 Amplification functions for OCNGS, 5% of critical damping

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	2.77E+00	1.16E-01	1.30E-02	2.15E+00	1.15E-01	1.90E-02	1.97E+00	1.31E-01	2.09E-02	2.85E+00	1.59E-01
4.95E-02	1.61E+00	1.24E-01	1.02E-01	8.25E-01	1.26E-01	9.99E-02	1.25E+00	1.56E-01	8.24E-02	2.22E+00	1.81E-01
9.64E-02	1.25E+00	1.36E-01	2.13E-01	5.95E-01	1.39E-01	1.85E-01	1.01E+00	1.74E-01	1.44E-01	1.88E+00	2.12E-01
1.94E-01	9.52E-01	1.49E-01	4.43E-01	5.00E-01	1.53E-01	3.56E-01	7.71E-01	1.99E-01	2.65E-01	1.48E+00	2.48E-01
2.92E-01	8.05E-01	1.59E-01	6.76E-01	5.00E-01	1.65E-01	5.23E-01	6.41E-01	2.22E-01	3.84E-01	1.24E+00	2.69E-01
3.91E-01	7.15E-01	1.64E-01	9.09E-01	5.00E-01	1.70E-01	6.90E-01	5.57E-01	2.36E-01	5.02E-01	1.08E+00	2.79E-01
4.93E-01	6.54E-01	1.68E-01	1.15E+00	5.00E-01	1.74E-01	8.61E-01	5.00E-01	2.44E-01	6.22E-01	9.64E-01	2.88E-01
7.41E-01	5.61E-01	1.69E-01	1.73E+00	5.00E-01	1.74E-01	1.27E+00	5.00E-01	2.49E-01	9.13E-01	7.85E-01	2.74E-01
1.01E+00	5.07E-01	1.67E-01	2.36E+00	5.00E-01	1.71E-01	1.72E+00	5.00E-01	2.43E-01	1.22E+00	6.74E-01	2.62E-01
1.28E+00	5.00E-01	1.64E-01	3.01E+00	5.00E-01	1.67E-01	2.17E+00	5.00E-01	2.26E-01	1.54E+00	6.01E-01	2.47E-01
1.55E+00	5.00E-01	1.61E-01	3.63E+00	5.00E-01	1.64E-01	2.61E+00	5.00E-01	2.10E-01	1.85E+00	5.56E-01	2.37E-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	3.49E+00	1.71E-01	1.27E-02	3.88E+00	1.94E-01	8.25E-03	3.00E+00	1.91E-01
7.05E-02	2.88E+00	2.11E-01	3.43E-02	3.67E+00	2.67E-01	1.96E-02	3.17E+00	2.22E-01
1.18E-01	2.56E+00	2.28E-01	5.51E-02	3.47E+00	2.63E-01	3.02E-02	3.32E+00	2.75E-01
2.12E-01	2.13E+00	2.66E-01	9.63E-02	3.25E+00	2.83E-01	5.11E-02	3.50E+00	2.84E-01
3.04E-01	1.86E+00	3.05E-01	1.36E-01	3.15E+00	2.79E-01	7.10E-02	3.64E+00	2.72E-01
3.94E-01	1.67E+00	3.24E-01	1.75E-01	3.07E+00	2.59E-01	9.06E-02	3.78E+00	2.68E-01
4.86E-01	1.53E+00	3.19E-01	2.14E-01	3.00E+00	2.45E-01	1.10E-01	3.87E+00	2.68E-01
7.09E-01	1.29E+00	3.06E-01	3.10E-01	2.98E+00	2.56E-01	1.58E-01	4.01E+00	2.69E-01
9.47E-01	1.15E+00	2.91E-01	4.12E-01	2.99E+00	2.59E-01	2.09E-01	4.08E+00	2.70E-01
1.19E+00	1.06E+00	2.69E-01	5.18E-01	2.98E+00	2.57E-01	2.62E-01	4.12E+00	2.67E-01
1.43E+00	1.04E+00	2.58E-01	6.19E-01	2.96E+00	2.53E-01	3.12E-01	4.14E+00	2.64E-01

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 tables concentrate on the frequency range of 0.5 Hz to 25 Hz, with values up to 100 Hz included, and a single value at 0.1 Hz included for completeness. These factors are unverified and are provided for information only. The figures should be considered the governing information.

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

M1P1K1		Rock PGA=0.0964		M1P1K1		PGA=0.493	
Freq (Hz)	Soil SA	Median AF	Sigma ln(AF)	Freq (Hz)	Soil SA	Median AF	Sigma ln(AF)
100.0	0.123	1.272	0.172	100.0	0.319	0.648	0.143
87.1	0.123	1.247	0.172	87.1	0.319	0.629	0.143
75.9	0.123	1.204	0.172	75.9	0.319	0.596	0.143
66.1	0.123	1.126	0.172	66.1	0.319	0.537	0.143
57.5	0.123	0.991	0.173	57.5	0.320	0.448	0.143
50.1	0.123	0.842	0.173	50.1	0.320	0.368	0.143
43.7	0.123	0.718	0.174	43.7	0.320	0.312	0.143
38.0	0.124	0.647	0.174	38.0	0.320	0.287	0.144
33.1	0.124	0.605	0.176	33.1	0.320	0.274	0.144
28.8	0.125	0.599	0.178	28.8	0.320	0.278	0.144
25.1	0.126	0.591	0.182	25.1	0.321	0.279	0.144
21.9	0.127	0.618	0.187	21.9	0.321	0.297	0.144
19.1	0.130	0.629	0.195	19.1	0.322	0.305	0.144
16.6	0.133	0.663	0.205	16.6	0.323	0.322	0.145
14.5	0.138	0.709	0.217	14.5	0.324	0.342	0.145
12.6	0.144	0.755	0.234	12.6	0.326	0.357	0.146
11.0	0.152	0.809	0.255	11.0	0.330	0.372	0.148
9.5	0.160	0.883	0.276	9.5	0.335	0.399	0.151
8.3	0.169	0.999	0.295	8.3	0.343	0.447	0.157
7.2	0.181	1.132	0.316	7.2	0.354	0.495	0.164
6.3	0.195	1.293	0.326	6.3	0.368	0.551	0.172
5.5	0.207	1.421	0.321	5.5	0.385	0.606	0.181
4.8	0.218	1.520	0.305	4.8	0.401	0.650	0.184
4.2	0.225	1.612	0.288	4.2	0.421	0.706	0.187
3.6	0.237	1.730	0.290	3.6	0.437	0.756	0.183
3.2	0.253	1.955	0.290	3.2	0.466	0.860	0.204
2.8	0.268	2.168	0.306	2.8	0.502	0.980	0.228
2.4	0.284	2.480	0.323	2.4	0.546	1.160	0.220
2.1	0.292	2.791	0.358	2.1	0.579	1.358	0.215
1.8	0.291	3.100	0.395	1.8	0.598	1.574	0.238
1.6	0.279	3.414	0.427	1.6	0.598	1.822	0.219
1.4	0.252	3.566	0.363	1.4	0.599	2.126	0.234
1.2	0.226	3.611	0.334	1.2	0.597	2.420	0.232
1.0	0.215	3.794	0.312	1.0	0.614	2.770	0.249
0.91	0.199	3.836	0.228	0.91	0.644	3.207	0.285
0.79	0.173	3.663	0.209	0.79	0.665	3.684	0.299
0.69	0.153	3.613	0.280	0.69	0.676	4.231	0.259
0.60	0.147	3.963	0.277	0.60	0.710	5.131	0.282
0.52	0.118	3.693	0.277	0.52	0.665	5.670	0.264
0.46	0.096	3.593	0.309	0.46	0.578	5.932	0.321
0.10	0.003	2.832	0.166	0.10	0.013	3.191	0.172

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

M2P1K1		PGA=0.0964		M2P1K1		PGA=0.493	
Freq (Hz)	Soil SA	Median AF	Sigma ln(AF)	Freq (Hz)	Soil SA	Median AF	Sigma ln(AF)
100.0	0.149	1.548	0.113	100.0	0.401	0.814	0.104
87.1	0.149	1.517	0.113	87.1	0.401	0.790	0.104
75.9	0.149	1.466	0.113	75.9	0.401	0.748	0.104
66.1	0.150	1.370	0.113	66.1	0.401	0.674	0.104
57.5	0.150	1.208	0.113	57.5	0.402	0.563	0.105
50.1	0.150	1.026	0.114	50.1	0.402	0.463	0.105
43.7	0.150	0.876	0.114	43.7	0.402	0.392	0.105
38.0	0.151	0.791	0.114	38.0	0.403	0.361	0.105
33.1	0.152	0.742	0.114	33.1	0.403	0.346	0.105
28.8	0.154	0.738	0.115	28.8	0.404	0.351	0.106
25.1	0.156	0.734	0.116	25.1	0.405	0.353	0.106
21.9	0.160	0.775	0.118	21.9	0.407	0.377	0.108
19.1	0.165	0.799	0.122	19.1	0.410	0.389	0.109
16.6	0.172	0.856	0.125	16.6	0.415	0.414	0.113
14.5	0.182	0.934	0.136	14.5	0.423	0.446	0.118
12.6	0.194	1.017	0.142	12.6	0.435	0.475	0.127
11.0	0.206	1.092	0.148	11.0	0.449	0.507	0.137
9.5	0.223	1.230	0.161	9.5	0.467	0.556	0.148
8.3	0.243	1.438	0.182	8.3	0.490	0.637	0.161
7.2	0.256	1.601	0.171	7.2	0.519	0.725	0.176
6.3	0.272	1.801	0.142	6.3	0.552	0.826	0.197
5.5	0.284	1.955	0.137	5.5	0.593	0.933	0.218
4.8	0.298	2.080	0.136	4.8	0.632	1.023	0.201
4.2	0.311	2.225	0.180	4.2	0.657	1.102	0.195
3.6	0.328	2.396	0.207	3.6	0.680	1.177	0.192
3.2	0.348	2.683	0.221	3.2	0.726	1.340	0.190
2.8	0.359	2.905	0.229	2.8	0.776	1.516	0.186
2.4	0.380	3.315	0.215	2.4	0.829	1.760	0.177
2.1	0.391	3.732	0.207	2.1	0.858	2.012	0.200
1.8	0.374	3.975	0.209	1.8	0.873	2.296	0.248
1.6	0.343	4.195	0.216	1.6	0.887	2.701	0.284
1.4	0.289	4.082	0.228	1.4	0.893	3.173	0.284
1.2	0.247	3.942	0.259	1.2	0.876	3.551	0.277
1.0	0.222	3.919	0.242	1.0	0.862	3.890	0.251
0.91	0.195	3.753	0.233	0.91	0.815	4.062	0.248
0.79	0.159	3.365	0.168	0.79	0.762	4.217	0.248
0.69	0.136	3.196	0.228	0.69	0.654	4.090	0.311
0.60	0.127	3.419	0.184	0.60	0.599	4.329	0.276
0.52	0.102	3.188	0.158	0.52	0.482	4.114	0.255
0.46	0.085	3.171	0.225	0.46	0.384	3.941	0.315
0.10	0.003	2.742	0.169	0.10	0.011	2.868	0.177

Enclosure 2

SUMMARY OF REGULATORY COMMITMENTS

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE OR "OUTAGE"	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	PROGRAMMATIC (Yes/No)
1. Oyster Creek Nuclear Generating Station will prepare an Expedited Seismic Evaluation Process (ESEP) Report limited to low frequency susceptible structures, systems, or components in accordance with EPRI Report 3002000704 (Section 2.2.1.1).	December 31, 2014	Yes	No
2. Oyster Creek Nuclear Generating Station will perform a High Frequency Confirmation evaluation in accordance with EPRI Report 1025287, Section 3.4.	As determined by NRC prioritization following submittal of all nuclear power plant Seismic Hazard Re-evaluations, but no later than December 31, 2019.	Yes	No
3. Oyster Creek Nuclear Generating Station will perform an evaluation of safety significant low frequency susceptible structures, systems, or components in accordance with EPRI Report 1025287, Section 3.2.1.1	As determined by NRC prioritization following submittal of all nuclear power plant Seismic Hazard Re-evaluations, but no later than December 31, 2019.	Yes	No

Note: EGC is continuing to evaluate the risk benefits of implementing the above NTTF 2.1: Seismic risk evaluation actions considering the limited remaining duration of plant operating life for Oyster Creek Nuclear Generating Station and may request further relief from these actions based on the results of this evaluation.