UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 18, 2015

Mr. Benjamin C. Waldrep
Site Vice President
Shearon Harris Nuclear Power Plant
5413 Shearon Harris Rd.
M/C HNP01
New Hill, NC 27562-0165

SUBJECT: SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1 - STAFF ASSESSMENT OF INFORMATION PROVIDED PURSUANT TO TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* PART 50, SECTION 50.54(f), SEISMIC HAZARD REEVALUATIONS FOR RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NO. MF3952)

Dear Mr. Waldrep:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The purpose of that request was to gather information concerning, in part, seismic hazards at each operating reactor site and to enable the NRC staff, using present-day NRC requirements and guidance, to determine whether licenses should be modified, suspended, or revoked.

By letter dated March 27, 2014, Duke Energy Progress, Inc. (Duke, the licensee), responded to this request for Shearon Harris Nuclear Power Plant, Unit 1 (HNP).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for HNP and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to Requested Information Items (1) – (3), (5) - (9) and the comparison portion to Item (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the NRC staff concludes that the licensee's reevaluated seismic hazard is suitable for other actions associated with Near-Term Task Force Recommendation 2.1, "Seismic".

Contigent upon the NRC's review and acceptance of Duke's high frequency confirmation (Item 4) for HNP, the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter will be completed.

If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

Frankie Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-400

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO SEISMIC HAZARD AND SCREENING REPORT

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-400

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), the U.S. Nuclear Regulatory Commission (NRC or Commission) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) "Conditions of license" (hereafter referred to as the "50.54(f) letter"). The request and other regulatory actions were issued in connection with implementing lessons-learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the "Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident" (NRC, 2011b).[1] In particular, the NRC Near-Term Task Force (NTTF) Recommendation 2.1, and subsequent Staff Requirements Memoranda (SRM) associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), instructed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

Enclosure 1 to the 50.54(f) letter requests that addressees perform a reevaluation of the seismic hazards at their sites using present-day NRC requirements and guidance to develop a ground motion response spectrum (GMRS).

The required response section of Enclosure 1 requests that each addressee provide the following information:

(1) Site-specific hazard curves (common fractiles and mean) over a range of spectral frequencies and annual exceedance frequencies,

(2) Site-specific, performance-based GMRS developed from the new site-specific seismic hazard curves at the control point elevation,

(3) Safe Shutdown Earthquake (SSE) ground motion values including specification of the control point elevation,

(4) Comparison of the GMRS and SSE. A high-frequency (HF) evaluation, (if necessary),

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[1] Issued as an enclosure to Commission Paper SECY-11-0093 (NRC, 2011a).

Enclosure

(5) Additional information such as insights from NTTF Recommendation 2.3 walkdown and estimates of plant seismic capacity developed from previous risk assessments to inform NRC screening and prioritization,

(6) 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 (if necessary),

(7) Statement if a seismic risk evaluation is necessary,

(8) Seismic risk evaluation (if necessary), and

(9) Spent fuel pool (SFP) evaluation (if necessary).

Present-day NRC requirements and guidance with respect to characterizing seismic hazards use a probabilistic approach in order to develop a risk-informed performance-based GMRS for the site. Regulatory Guide (RG) 1.208, A Performance-based Approach to Define the Site- Specific Earthquake Ground Motion (NRC, 2007), describes this approach. As described in the 50.54(f) letter, if the reevaluated seismic hazard, as characterized by the GMRS, is not bounded by the current plant design-basis SSE, further seismic risk evaluation of the plant is merited.

By letter dated November 27, 2012 (Keithline, 2012), Nuclear Energy Institute (NEI) submitted Electric Power Research Institute (EPRI) report "Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 Seismic"(EPRI, 2012), hereafter called the SPID. The SPID supplements the 50.54(f) letter with guidance necessary to perform seismic reevaluations and report the results to NRC in a manner that will address the Requested Information Items in Enclosure 1 of the 50.54(f) letter. By letter dated February 15, 2013 (NRC, 2013b), the staff endorsed the SPID.

The required response section of Enclosure 1 to the 50.54(f) letter specifies that Central and Eastern United States (CEUS) licensees provide their Seismic Hazard and Screening Report (SHSR) by 1.5 years after issuance of the 50.54(f) letter. However, in order to complete its update of the EPRI seismic ground motion models (GMM) for the CEUS (EPRI 2004, 2006, 2013), industry proposed a six-month extension to March 31, 2014 for submitting the SHSR. In addition, industry developed guidance, referred to as the Augmented Approach, for addressing the requested interim evaluation (Item (6) above), which would use a simplified assessment to demonstrate that certain key pieces of plant equipment for core cooling and containment functions, given a loss of all alternating current power, would be able to withstand a seismic hazard up to two times the design-basis. Attachment 2 to the April 9, 2013, letter (Pietrangelo, 2013)provides a revised schedule for plants needing to perform (1) the Augmented Approach by implementing the Expedited Seismic Evaluation Process and (2) a seismic risk evaluation. By letter dated May 7, 2013 (NRC, 2013a), the NRC determined that the modified schedule was acceptable and in a letter dated August 28, 2013 (NRC, 2013c), the NRC determined that the updated GMM (EPRI, 2013) is an acceptable GMM for use by CEUS plants in developing a plant-specific GMRS.

By letter dated April 9, 2013 (Pietrangelo, 2013), industry committed to following the SPID to develop the SHSR for existing nuclear power plants. By letter dated September 11, 2013 (Waldrep, 2013), Duke Energy Progress, Inc. (Duke, the licensee) submitted at least partial site response information for the Shearon Harris Nuclear Power Plant, Unit 1 (HNP, Harris). By letter dated March 27, 2014 (Kapopoulos, 2014), the licensee submitted its SHSR.

2.0 REGULATORY BACKGROUND

The structures, systems, and components (SSCs) important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2: "Design Bases for Protection Against Natural Phenomena;" and Appendix A to 10 CFR Part 100, "Reactor Site Criteria." The GDC 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The design bases for SSCs reflect appropriate consideration of the most severe natural phenomena that had been historically reported for the site and surrounding area. The design bases also considered limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The seismic design bases for currently operating nuclear power plants were either developed in accordance with, or meet the intent of GDC 2 and 10 CFR Part 100, Appendix A. Although the regulatory requirements in Appendix A to 10 CFR Part 100 are fundamentally deterministic, the NRC process for determining the seismic design-basis ground motions for new reactor applications after January 10, 1997, as described in 10 CFR 100.23, requires that uncertainties be addressed through an appropriate analysis such as a probabilistic seismic hazard analysis (PSHA).

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. On March 12, 2012, the NRC staff issued requests for licensees to reevaluate the seismic hazards at their sites using present-day NRC requirements and guidance, and identify actions planned to address plant-specific vulnerabilities associated with the updated seismic hazards.

Attachment 1 to Enclosure 1 of the 50.54(f) letter describes an acceptable approach for performing the seismic hazard reevaluation for plants located in the CEUS. Licensees are expected to use the CEUS Seismic Source Characterization (CEUS-SSC) model in NUREG- 2115 (NRC, 2012b) along with the appropriate EPRI (2004, 2006) GMMs. The SPID provides further guidance regarding the appropriate use of GMMs for the CEUS. Specifically, Section 2.3 of the SPID recommends the use of the updated GMM (EPRI 2013) and, as such, licensees used the NRC-endorsed updated EPRI GMM instead of the older EPRI (2004, 2006)

GMM to develop PSHA base rock hazard curves. Finally, Attachment 1 requests that licensees conduct an evaluation of the local site response in order to develop site-specific hazard curves and GMRS for comparison with the plant SSE.

2.1 Screening Evaluation Results

By letter dated March 27, 2014 (Kapopoulos, 2014), the licensee provided the SHSR for HNP. The licensee's SHSR indicates that the site GMRS is bounded by the SSE for HNP over the frequency range of 1 to 10 Hertz (Hz). As such, HNP screens out of performing a seismic risk evaluation. Also, a SFP evaluation will not be performed. However, the GMRS exceeds the SSE at frequencies above 10 Hz. Therefore, the licensee indicated that it will perform a HF confirmation.

On May 9, 2014 (NRC, 2014), the NRC staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. As indicated in the letter, the NRC staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS, developed by the NRC staff is bounded by the SSE for HNP over the frequency range of 1 to 25 Hz, and also beyond 40 Hz. Therefore, a seismic risk evaluation and SFP evaluation are not merited. However, since the licensee's GMRS as well as the confirmatory GMRS, developed by the NRC staff, exceed the SSE for frequencies between approximately 25 to 40 Hz, a HF confirmation is merited for HNP.

3.0 TECHNICAL EVALUATION

The NRC staff evaluated the licensee's submittal to determine if the provided information responded appropriately to Enclosure 1 of the 50.54(f) letter with respect to characterizing the reevaluated seismic hazard.

3.1 Plant Seismic Design-Basis

Enclosure 1 of the 50.54(f) letter requests the licensee provide the SSE ground motion values as well as the specification of the control point elevation(s) for comparison to the GMRS. For operating reactors licensed before 1997, the SSE is the plant licensing basis earthquake and is characterized by (1) a peak ground acceleration (PGA) value which anchors the response spectra at high frequencies (typically at 20 to 30 Hz for the existing fleet of nuclear power plants); (2) a response spectrum shape which depicts the amplified response at all frequencies below the PGA; and (3) a control point where the SSE is defined.

In Section 3.0 of its SHSR, the licensee described its seismic design-basis for the HNP site and stated that the SSE is defined in terms of a PGA and a design response spectrum. The licensee stated that the SSE for HNP is based on a postulated Intensity VII event resulting in a maximum horizontal ground acceleration at the site of 0.15 g (15 percent the acceleration of earth's gravity). In Section 3.1 of its SHSR, the licensee stated that the SSE spectral shape is a Regulatory Guide 1.60 (NRC, 1973) shape. In Section 3.2 of its SHSR, the licensee stated that the SSE control point is located at a depth of 16 ft. (4.9 m), corresponding to the top of firm rock. The NRC staff reviewed the licensee's description of its SSE for HNP in the SHSR. With regard to the SSE for HNP, based on its review of the SHSR and the Updated Final Safety Analysis

Report (UFSAR) (Progress Energy, 2014), the NRC staff confirmed that the licensee's SSE is defined by a Regulatory Guide 1.60 spectral shape with a PGA anchored at 0.15 g. Finally, based on review of the SHSR and the UFSAR (Progress Energy, 2014), the NRC staff confirmed that the licensee's control point for HNP SSE is consistent with the guidance provided in the SPID.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of its SHSR, the licensee stated that, in accordance with the 50.54(f) letter and the SPID, it performed a PSHA using the CEUS-SSC model and the updated EPRI GMM for the CEUS (EPRI, 2013). The licensee used a minimum magnitude of **M** 5.0, as specified in the 50.54(f) letter. The licensee further stated that it included the CEUS-SSC background sources out to a distance of 400 miles (640 km) around the site and included the Charleston and New Madrid RLME sources, which lie within 620 miles (1,000 km) of the site. The RLME sources are those source areas or faults for which more than one large magnitude (**M** ≥ 6.5) earthquake has occurred in the historical or paleo-earthquake (geologic evidence for prehistoric seismicity) record. The licensee used the mid-continent version of the updated EPRI GMM (EPRI, 2013) for each of the CEUS-SSC sources. Consistent with the SPID, the licensee did not provide its base rock seismic hazard curves in SHSR Section 2.2.2, as it used the site amplification approach referred to as Method 3. The licensee provided its control point seismic hazard curves in SHSR Section 2.3. The staff's review of the licensee's control point seismic hazard curves is provided in Section 3.3 of this staff assessment.

As part of its confirmatory analysis of the licensee's GMRS, the NRC staff performed its own PSHA calculations for base rock site conditions beneath the HNP site. As input, the NRC staff used the CEUS-SSC model, as documented in NUREG-2115 (NRC, 2012b), along with the updated EPRI GMM model (EPRI, 2013). Consistent with the guidance provided in the SPID, the NRC staff included all CEUS-SSC background seismic sources within a 310 miles (500 km) radius of the HNP site. In addition, the NRC staff included the RLME sources, which lie within 621 mi (1,000 km) of the site. For each of the CEUS-SSC sources used in the PSHA, except for the Extended Continental Crust – Gulf Coast (ECC-GC), the NRC staff used the mid-continent version of the updated EPRI GMM (EPRI, 2013). The NRC staff used the Gulf version of the updated EPRI GMM (EPRI, 2013) for the ECC-GC source. The NRC staff used the resulting base rock seismic hazard curves together with a confirmatory site response analysis, described in the next section, to develop control point seismic hazard curves and a GMRS for comparison with the licensee's results.

Based on its review of the SHSR, the NRC staff concludes that the licensee appropriately followed guidance provided in the SPID for selecting PSHA input models and parameters for the site. This includes the licensee's use and implementation of the CEUS-SSC model and the updated EPRI GMM.

3.3 Site Response Evaluation

After completing PSHA calculations for reference rock site conditions, Attachment 1 to Enclosure 1 of the 50.54(f) letter requests that the licensee provide a GMRS developed from the site-specific seismic hazard curves at the control point elevation. In addition, the 50.54(f) letter specifies that the subsurface site response model, for both soil and rock sites, should extend to sufficient depth to reach the generic rock conditions as defined in the GMMs used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that the licensee perform a site response analysis.

Detailed site response analyses were not typically performed for many of the older operating plants; therefore, Appendix B of the SPID provides detailed guidance on the development of site-specific amplification factors (including the treatment of uncertainty) for sites that do not have detailed, measured soil and rock parameters to extensive depths.

The purpose of the site response analysis is to determine the site amplification that occurs as a result of base rock or bedrock ground motions propagating upwards through the soil/rock column to the surface. The critical parameters that determine what frequencies of ground motion are affected by the upward propagation of bedrock motions are the layering of soil and/or soft rock, the thicknesses of these layers, the shear-wave velocities and low-strain damping of the layers, and the degree to which the shear modulus and damping change with increasing input bedrock amplitude.

3.3.1 Site Base Case Profiles

In its SHSR, the licensee indicated that it performed a site response analysis for HNP. The licensee stated that the site consists of about 15 ft. (4.9 m) of residual soils and weathered rock overlying approximately 5,000 ft. (1,524 m) of Triassic sedimentary rocks. In SHSR Table 2.3.1-1 describes the subsurface materials in terms of the geologic units and thicknesses, as well as the shear and compression wave velocites and densites. The shear wave velocity was estimated at 500 ft./sec (152 m/s) in the residual soils in the upmost 8 ft. (2.4 m), 2,500 ft. /sec (762 m/s) in the weathered and fractured rock from 8 to 16 ft. (2.4 to 4.9 m) below the surface, and 5,600 ft. /sec (1,700 m/s) in the sound Triassic sedimentary bedrock below 16 ft. (4.9 m). The licensee stated that the top elevation of its site response is at 16 ft. (4.9 m) from the surface and corresponds to the top of the sound Triassic sedimentary rocks.

The licensee used the estimated shear-wave velocities, information on the regional geologic profile (summarized in SHSR Table 2.3.1-1), and the guidance in Appendix B of the SPID to develop three base-case shear-wave velocity profiles for the HNP site. The licensee used the shear wave velocities from measurements of compressional wave velocities and assumed a Poisson's ratios which was confirmed by more recent downhole testing. To develop the best estimate or base case shear-wave velocity profile, the licensee set the initial shear-wave velocity at the surface to 5,600 ft./sec (1,707 m/s) and then increased it with depth at a rate of 0.5 m/m/s, resulting in a mean base-case shear wave velocity of 8,000 ft./sec (2,438 m/sec) at a depth of 5,000 ft. (1,524 m). Based on the SPID, the licensee used a scale factor of 1.57, reflecting a natural log standard deviation of 0.35, to estimate the lower and upper base case shear-wave velocity profiles. Table 2.3.2-1 and Figure 2.3.2-1 of the SHSR provide the licensee's shear-wave velocity profiles for each of the three cases.

The licensee stated that no site-specific dynamic material properties were determined in the initial siting of HNP. Therefore, the licensee assumed the behavior of the rock material in the upper 500 ft. (152 m) could be modeled as either linear or non-linear. In one characterization, the licensee used the EPRI rock curves to represent the upper range of nonlinearity. To model more linear behavior, the licensee assumed that the site could be modeled as linear with a constant damping value that corresponds to the low-strain damping value in the EPRI rock curves over the upper 500 ft. (152 m).

The licensee also considered the impact of kappa, or small strain damping, on site response. Kappa is measured in units of seconds (sec), and is the damping contributed by both intrinsic hysteretic damping and scattering due to wave propagation in a heterogeneous material. For the HNP site, the licensee applied the guidance in the SPID for sites with greater than 3,000 ft. (914 m) of firm rock to estimate kappa values of 0.013, 0.022, and 0.008 sec for the best-estimate, lower and upper base cases respectively.

To account for randomness in material properties across the plant site in its site response calculations, the licensee stated that it randomized its base case shear-wave velocity profiles following the guidance in Appendix B of the SPID. In addition, as stated in Section 2.3.2 of the SHSR, the licensee randomized the depth to bedrock by ±1,500 ft. (±457 m), which corresponds to 30-percent of the total profile thickness. The licensee stated that this randomization did not represent actual uncertainty in the depth to bedrock, but was used to broaden spectral peaks.

3.3.2 Site Response Method and Results

In Section 2.3.4 of its SHSR, the licensee stated that it followed the guidance in Appendix B of the SPID to develop input ground motions for the site response analysis, and in Section 2.3.5 of its SHSR, the licensee described its implementation of the random vibration theory (RVT) approach to perform its site response calculations. Finally, Section 2.3.6 of the SHSR shows the resulting amplification function and associated uncertainties for eleven input loading levels for the base case profile and the EPRI rock shear modulus reduction and damping curves.

In order to develop the probabilistic site-specific control point hazard curves requested in Requested Information Item 1 of the 50.54(f) letter, the licensee used Method 3, which is described in Appendix B of the SPID. The licensee's use of Method 3 involved computing the site-specific control point hazard curve for a broad range of spectral accelerations given the site-specific bedrock hazard curve and the site-specific estimates of soil or soft-rock responses and associated uncertainties. The licensee provided its resulting control point hazard curves for the seven specified oscillator frequencies in SHSR Figure 2.3.7-1 and Appendix A.

3.3.3 Staff Confirmatory Analysis

To confirm the licensee's site response analysis, the NRC staff performed its own site response calculations for the HNP site. The NRC staff adapted the base case shear wave velocity profile from the Combined License (COL) FSAR (Progress Energy, 2012), noting this was appropriate because the operating unit is close to the COL site and the site geology is relatively uniform. However, because the COL FSAR indicates that the shear wave velocities in the upper sections vary laterally, the NRC staff used three base case profiles rather than just one profile. The NRC staff modeled the upper 14 ft. (4.3 m) with a best-estimate velocity of 4050 ft./sec (1234 m/s), and used information in the COL FSAR (Progress Energy, 2012) to extend the profile to a total depth of 5255 ft. (1601 m). To estimate the upper and lower base case profiles, the NRC staff used a natural log standard deviation of 0.17. This value, while lower than that used by the licensee, is consistent with the amount and quality of data available near the HNP site. The NRC staff randomized the depth to reference rock by ±10 percent to allow for additional uncertainty in the depth to base rock. Figure 3.3-1 of this assessment shows a comparison of the three velocity profiles developed by the licensee with those developed by the NRC staff. The profiles developed by the licensee cover a wider range of shear wave velocities from those of the NRC staff but both follow a similar trend as they extend to base rock.

Following the approach recommended by the SPID, the NRC staff assumed both linear and non-linear behavior for the materials beneath the HNP site in response to a range of input motions. Similar to the licensee, the NRC staff used the EPRI rock curves over the upper 500 ft. (152 m) to model the upper limit of nonlinearity at the site. For the linear approach the NRC staff assumed that the rock has a constant damping value of 1.25 percent and behaves linearly under all loading levels. This is in contrast to the licensee's more linear model that assumes a constant damping value of over 3 percent.

To determine kappa for its three profiles, the NRC staff used the guidance in the SPID for sites with greater than 3,000 ft. (914 m) of firm rock to determine kappa values of 0.013, 0.011, and 0.017 sec for its best-estimate, upper, and lower base cases, respectively. These values include the 0.006 sec contribution from the base rock. To model uncertainty in kappa, the NRC staff used a natural log standard deviation of 0.35 to calculate upper and lower kappa values for each profile. This approach results in nine kappa values for the staff's site response analysis, which range from 0.007 to 0.027 sec.

Figure 3.3-2 of this assessment shows a comparison of the staff's and the licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. Peaks in the amplification functions occur at approximately 1 and 5 Hz in the licensee's analysis, while the staff's analysis resulted in relatively constant amplification functions below 2 Hz, and a modest decrease between 2 and approximately 10 Hz. There are large differences in uncertainties at high frequencies due to the NRC staff using greater uncertainties in both kappa and damping parameters. Differences in site amplification curves developed by the NRC staff and the licensee are due to differences in site velocities, kappa values, and damping parameters.

The licensee's approach to modeling the subsurface soil and rock properties and their uncertainties results in amplification factors that are broadly similar to those produced by the NRC staff, with the exceptions noted above. As shown in Figure 3.3-3 of this assessment, these differences in site response have a minor impact on control point seismic hazard curves and the resulting GMRS, discussed below. Appendix B of the SPID provides guidance for performing site response analyses, including capturing the uncertainty for sites with less subsurface data; however, the guidance is neither entirely prescriptive nor comprehensive. As such, various approaches in performing site response analyses, including the modeling of uncertainty, are acceptable for the 50.54(f) response.

In summary, the NRC staff concludes that the licensee's site response was conducted using present-day guidance and methodology, including the NRC-endorsed SPID. The NRC staff performed independent calculations which confirmed that the licensee's amplification factors and control point hazard curves adequately characterize the site response, including the uncertainty associated with the subsurface material properties, for the HNP site.

3.4 Ground Motion Response Spectra

In Section 2.4 of its SHSR, the licensee stated that it used the control point hazard curves, described in SHSR Section 2.3.7, to develop the 10^{-4} and 10^{-5} (mean annual frequency of exceedance) uniform hazard response spectra (UHRS) and then computed the GMRS using the criteria in RG 1.208.

The NRC staff independently calculated the 10^{-4} and 10^{-5} UHRS using the results of its confirmatory PSHA and site response analyses, as described in Sections 3.2 and 3.3 of this staff assessment, respectively. Figure 3.4-1 of this assessment shows a comparison of the GMRS determined by the licensee to that determined by the NRC staff.

As shown in Figure 3.4-1, the licensee's GMRS is similar to the staff's confirmatory GMRS. However, the NRC's GMRS is slightly higher than the licensee's GMRS at frequencies above 15 Hz. As described above in Section 3.3, the NRC staff notes that these differences are the result of differences in the site response analyses performed by the licensee and the NRC staff.

The NRC staff confirms that the licensee used the present-day guidance and methodology outlined in RG 1.208 and the SPID to calculate the horizontal GMRS, as requested in the 50.54(f) letter. The NRC staff performed both a PSHA and site response confirmatory analysis and achieved results consistent with the licensee's horizontal GMRS. As such, the NRC staff concludes that the GMRS determined by the licensee adequately characterized the reevaluated hazard for the HNP site. Therefore, this GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the HNP site. Based on its review, the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance, it appropriately characterized the site given the information available, and met the intent of the guidance for determining the reevaluated seismic hazard. Based upon the preceding analysis, the NRC staff concludes that the licensee provided an acceptable response to Requested Information Items (1) – (3), (5) – (7), and the comparison portion of Item (4) identified in Enclosure 1 to the 50.54(f) letter. Further, the licensee's reevaluated seismic hazard is acceptable to address other actions associated with NTTF Recommendation 2.1: "Seismic".

In reaching this determination, the NRC staff confirms the licensee's conclusion that its GMRS for the HNP site is bounded by the SSE in the 1 to 15 Hz range and above 40 Hz range, but exceeds the SSE in a portion of the frequency range from approximately 15 to 40 Hz. As such, a seismic risk evaluation (Item 8) and SFP evaluation (9) are not merited. However, a HF confirmation (Item 4) is merited. The NRC review and acceptance of Duke's HF confirmation (i.e. Item (4)) for HNP will complete the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter.

REFERENCES

Note: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U.S. Nuclear Regulatory Commission), 2007, A Performance-based Approach to Define the Site-Specific Earthquake Ground Motion, Regulatory Guide (RG) 1.208, March 2007.

NRC (U.S. Nuclear Regulatory Commission), 1973, Design Response Spectra for Seismic Design of Nuclear Power Plants, Regulatory Guide (RG) 1.60, December 1973.

NRC (U.S. Nuclear Regulatory Commission), 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011c, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

NRC (U.S. Nuclear Regulatory Commission), 2011d, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011, Adams Accession No. ML11272A111.

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Figure 3.3-1 Plot of Licensee's Base Case Shear-Wave Velocity Profiles for the HNP site

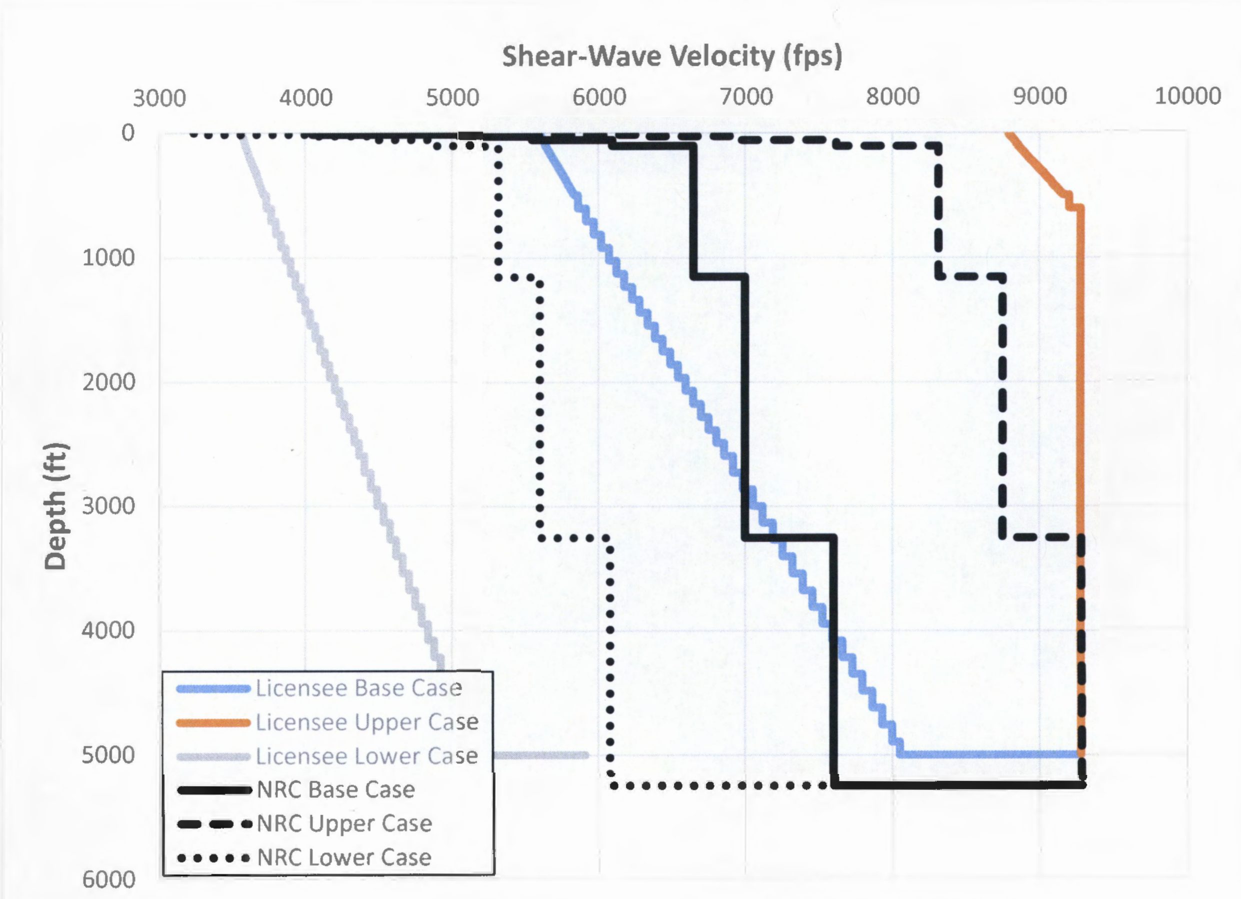


Figure 3.3- 1 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for the HNP site

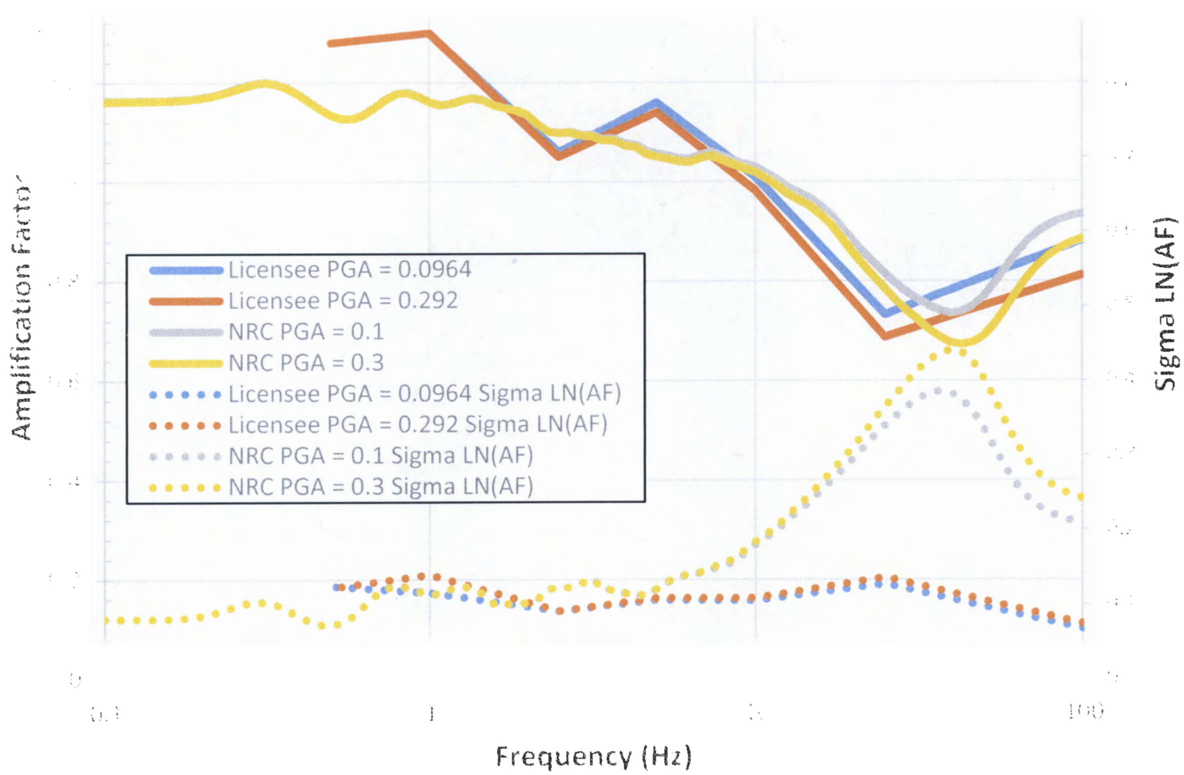


Figure 3.3-2 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at t a Variety of Frequencies for the HNP site

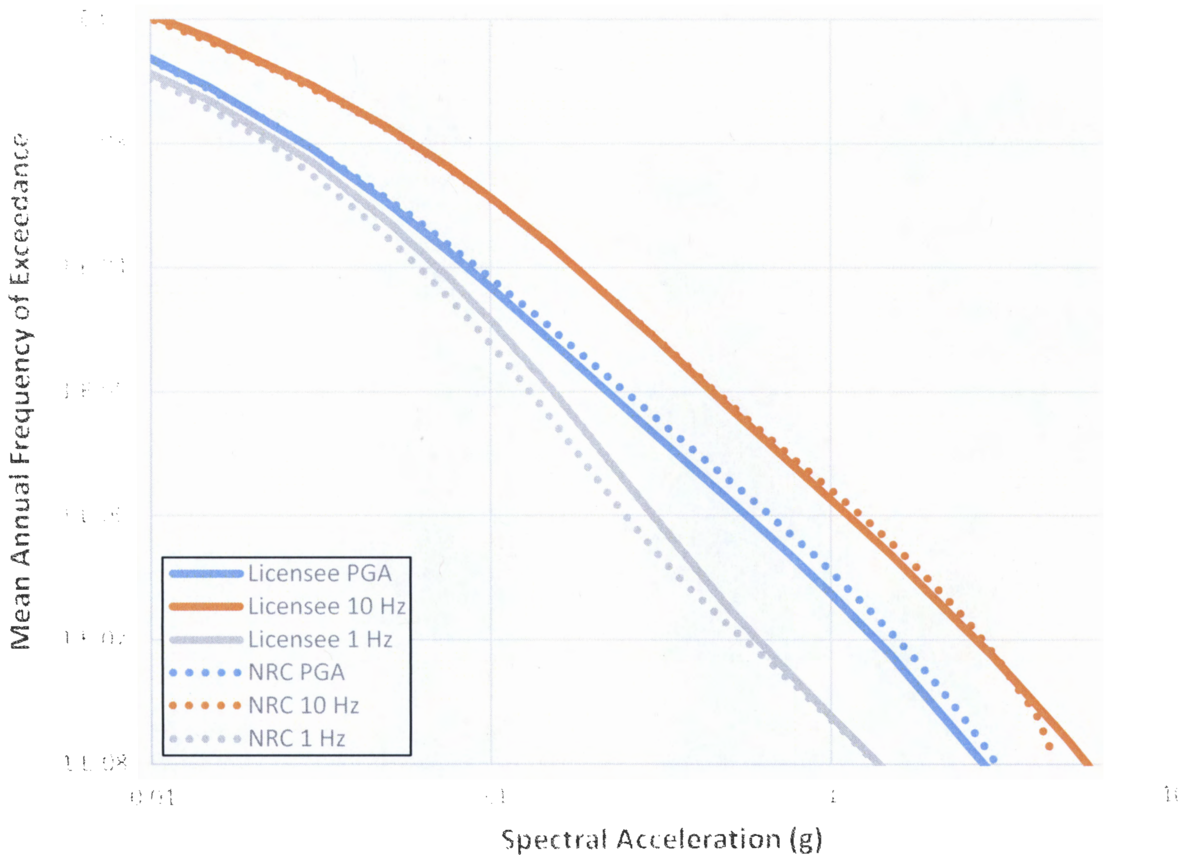
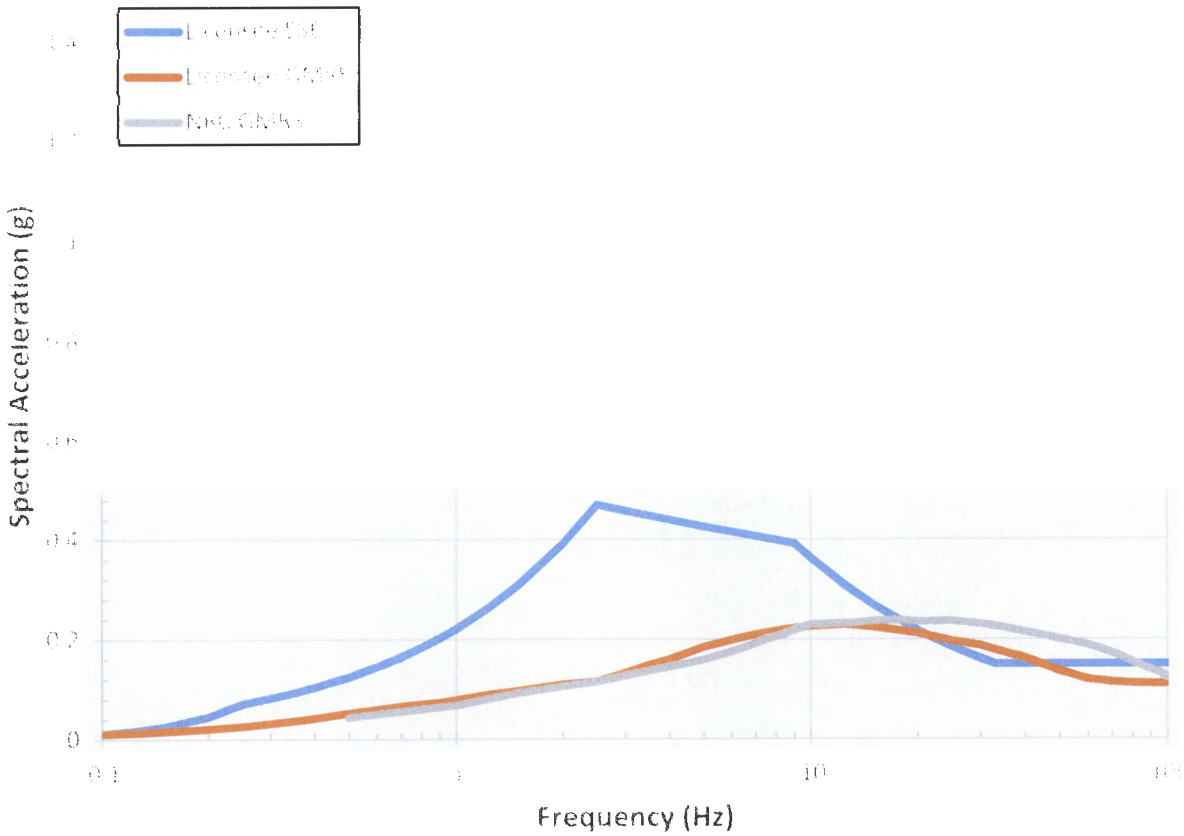


Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the SSE for the HNP site



If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

/RA/

Frankie Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-400

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