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

April 27, 2015

Mr. Kelvin Henderson
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4800 Concord Road
York, SC 29745

SUBJECT: CATAWBA NUCLEAR STATION, UNITS 1 AND 2 - STAFF ASSESSMENT OF INFORMATION PROVIDED PURSUANT TO TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* PART 50, SECTION 50.54(f), SEISMIC HAZARD REEVALUATIONS RELATING TO RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NOS. MF3965 AND MF3966)

Dear Mr. Henderson:

By letter dated 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 31, 2014, Duke Energy Carolinas, LLC (the licensee, Duke) responded to this request for Catawba Nuclear Station, Units 1 and 2 (Catawba).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for Catawba and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to Enclosure 1, Items (1) – (3), (5), (7) and screening review portion of Item (4) of the 50.54(f) letter. Further, the staff concludes that the licensee's reevaluated seismic hazard is suitable for other actions associated with Near-Term Task Force Recommendation 2.1 "Seismic".

Contingent upon the NRC's review and acceptance of Duke's expedited seismic evaluation process and seismic risk evaluation including the high frequency and spent fuel pool evaluations (i.e., Items (4), (6), (8), and (9)) for Catawba, 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 Nos. 50-413 and 50-414

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

CATAWBA NUCLEAR STATION, UNIT S. 1 AND 2

DOCKET NOS. 50-413 AND 50-414

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,

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

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

(4) Comparison of the GMRS and SSE for screening purposes. High-frequency evaluation (if necessary),

(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, 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), the 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 referred to as 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, 2013), industry proposed a six-month extension to March 31, 2014, for submitting the SHSR. Industry also proposed that licensees perform an expedited assessment, 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 (ESEP) and (2) a seismic risk evaluation. By letter dated May 7, 2013 (NRC, 2013a), the NRC determined that the modified schedule was acceptable and by letter dated August 28, 2013 (NRC, 2013c), the NRC determined that the updated GMM (EPRI, 2013) is an acceptable GMMI for use by CEUS plants in developing a plant-specific GMRS.

By letter dated September 11, 2013 (Waldrep, 2013), Duke Energy Carolinas, LLC (Duke, the licensee), submitted partial site response information for Catawba Nuclear Station, Units 1 and 2 (Catawba). By letter dated March 31, 2014 (Henderson, 2014), Duke submitted its SHSR.

2.0 REGULATORY EVALUATION

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." 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 the 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) ground motion models. 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 31, 2014 (Henderson, 2014), Duke provided the SHSR for Catawba, Units 1 and 2. The licensee's SHSR indicates that the site GMRS exceeds the SSE for Catawba, Units 1 and 2 over the frequency range of 1 to 10 Hertz (Hz). Therefore, the licensee will perform a risk evaluation. Further, the licensee indicated that since the SSE also exceeds the GMRS above 10 Hz, that a high frequency confirmation and a SFP evaluation will be performed.
On May 9, 2014 (NRC, 2014), the staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. As indicated in the letter, the staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS, developed by the staff, exceed the SSE for Catawba over the frequency range of 6 to 100 Hz. As such, a plant seismic risk evaluation, SFP evaluation and high frequency confirmation are merited.

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 33 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 3.1 of the SHSR, the licensee described its seismic design bases for Catawba. The licensee stated that the SSE for Catawba is based on a postulated earthquake producing surface intensity of VII-VIII MMI occurring adjacent to the site. Based on this earthquake, the Catawba SSE is defined in terms of a PGA of 0.15 g (15 percent of the acceleration due to earth's gravity) and a Newmark-type spectrum shape.

The licensee specified that the SSE control point is located at the top of the sound rock. However, due to the 100 ft (30.4 m) variation in the elevation of sound rock across the site, the licensee selected elevation 544 ft (166 m) at the Catawba site, coinciding with the base of the reactor building mat foundations. The licensee stated that this approach is consistent with the guidance provided in Section 2.4.2 of the SPID to define the control point.

The staff reviewed the licensee's description of its SSE for Catawba, Units 1 and 2 in the SHSR. To further confirm the SSE, the staff also reviewed the Catawba Updated Final Safety Analysis Report (UFSAR), (Duke Energy Carolinas, 2012). The staff performed its screening evaluation for Catawba based on a comparison of the GMRS with the licensee's current design basis SSE, which is a Newmark-shape design spectrum anchored at 0.15 g. Finally based on review of the SHSR and the UFSAR, the staff confirmed that the licensee's control point elevation for the Catawba SSE is consistent with the guidance provided in the SPID.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of the 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, 2004, 2006, 2013). For its PSHA, the licensee used a minimum moment magnitude (M_w) of 5.0 as specified in the 50.54(f) letter. The licensee further stated that it included CEUS-SSC background sources out to a distance of 400 miles [640 km] and included the Charleston, Charlevoix and Wabash Valley repeated large magnitude earthquake (RLME) sources, which lie within 621 miles [1,000 km] of the site. The RLME sources are those source areas or faults for which more than one large magnitude ($M_w >= 6.5$) earthquake has occurred in the historical or paleoearthquake (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 base rock seismic hazard curves because it performed a site response analysis to determine the control point seismic hazard curves. The licensee provided its control point seismic hazard curves in Section 2.3.7 of its SHSR. 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 staff performed PSHA calculations for the Catawba site. As input, the staff used the CEUS-SSC model as described in NUREG-2115 (NRC, 2012b) along with the updated EPRI GMM (EPRI, 2013). Consistent with the guidance provided in the SPID the staff included all CEUS-SSC background seismic sources within a 310 mi [500 km] radius of the Catawba site. In addition, the staff included all of the RLME sources falling within a 620 mi [1000 km] radius of the site, which includes the Charleston, Charlevoix and Wabash Valley RLME sources. For each of the CEUS-SSC sources used in the PSHA, the staff used the mid-continent version of the updated EPRI GMM (EPRI, 2013). The 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. The licensee provided its seismic hazard curves at the control point elevation in SHSR Section 2.3.7. The staff's review of the licensee's results is provided in Section 3.3 of this staff assessment.

Based on review of the SHSR, the staff concludes that the licensee appropriately followed the guidance provided in the SPID for selecting the 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 licensees 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 ground motion models used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that licensees perform a site response analysis.

Detailed site response analyses were not typically performed for many of older the 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 will occur as a result of 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

The licensee provided detailed site profile descriptions in Sections 2.3.1 and 2.3.2 of its SHSR based on information provided in the Catawba, Units 1 and 2 UFSAR (Duke Energy Carolinas, 2012) and an AMEC (2012) report that provide supporting data for the licencee's site amplification calculations (AMEC, 2012). The licensee stated that the site is underlain by approximately 60.5 ft [18.4 m] of partially weathered firm rock, including fill concrete, overlying hard metamorphic basement rock.

Geophysical investigations for the Catawba site consisted of borehole geophysical measurements. The licensee provided a brief description of the subsurface materials in terms of geologic units and thicknesses in its SHSR. Seismic velocities for the approximately 60.5 ft [18.4 m] of partially weathered firm rock beneath the site increase from 1,347 feet per second (fps) [411 meters per second (m/s)] to 8,868 fps [2,702 m/s].

To characterize the subsurface geology, the licensee developed three site base case profiles. The middle, or best estimate, profile was developed using shear-wave velocity data from downhole measurements at the site, which extended to a depth of 103 ft (31.4 m). The licensee extrapolated shear-wave velocities below this depth. Although Section 3.1 of the SHSR states that the SSE corresponds to foundations on closely jointed rock and slightly weathered rock, the licensee also included 12 ft [3.7 m] of fill concrete at the top of the site response profile.
The licensee estimated the shear-wave velocity of concrete based on unit weight, unconfined compressive strength, and assumed Poisson's ratio provided in the SHSR. Upper and lower

base case profiles were developed by the licensee using a natural log deviation of 0.2. Figure 3.3-1 of this assessment shows the licensee's three shear-wave velocity base case profiles. As the SPID recommends that a site's control point elevation should be at the top of competent rock, the staff asked the licensee to justify including the fill concrete in its site response profile. In a letter dated January 8, 2015, 2015 (Henderson, 2015), the licensee responded to the staff's request for additional information by stating that the concrete fill was considered an extension of the underlying rock and was used to restore the foundation elevation. The licensee further stated that in at a few locations across the site the top of continuous rock is below the design bottom of the substructure mat of significant structures such as the Reactor Building. As such, at these locations, fill concrete was placed to extend the top of continuous rock up to the foundation grade level. As described below, the staff evaluated the licensee's inclusion of about 12 ft [3.7 m] of concrete fill in its site profile by performing a confirmatory site response analysis. The staff's results show that the licensee's inclusion of the fill concrete had a negligible impact on the resulting hazard curves and GMRS.

In Section 2.3.2.1 of the SHSR, the licensee assumed that the rock material over the upper 60.5 ft [18.4 m] could be modeled as either linear or non-linear. To model the potential non-linear behavior of the rock, the licensee used the generic EPRI rock (model M1) shear modulus reduction and hysteretic damping curves over the upper 60.5 ft [18.4 m]. To model the linear behavior of the rock over the upper 60.5 ft [18.4 m], the licensee used the low strain damping values (approximately 3 percent) from the EPRI rock curves as the constant damping values in the upper 60.5 ft [18.4 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 as well as scattering due to wave propagation in heterogeneous material. For Catawba, the licensee determined that the hard rock kappa value of 0.006s dominates the profile. Total profile kappa values for the best estimate, upper, and lower base case velocity profiles are 0.0065, 0.0066, and 0.0064 sec, respectively.

To account for randomness in material properties across the plant site, the licensee randomized its base case shear-wave velocity profiles using a natural log standard deviation of 0.25 over the upper 50 ft (15.2 m) and a natural log standard deviation of 0.15 below that depth. As specified in the SPID, the licensee correlated the shear wave velocity between layers using the footprint correlation model and assumed a random velocity fluctuation limit of +/- 2 standard deviations about the median value in each layer.

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, 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 functions and associated uncertainties for the eleven input loading levels for the base case profile and EPRI rock shear modulus and damping curves.

In order to develop probabilistic site-specific control point hazard curves, as requested in Requested Information Item 1 of the 50.54(f) letter, the licensee used Method 3, described in Section B-6.0 of the SPID. The licensee's use of Method 3 involved computing the site-specific control point elevation hazard curves for a broad range of spectral accelerations by combining the site-specific bedrock hazard curves, determined from the initial PSHA (Section 3.2), and the amplification functions and their associated uncertainties, determined from the site response analysis.

3.3.3 Staff Confirmatory Analysis

To confirm the licensee's site response analysis, the staff performed site response calculations for the Catawba site. The staff independently developed shear-wave velocity profiles, damping values, and modeled the potential behavior of the rock using measurements and geologic information provided in the Catawba, Units 1 and 2 UFSAR (Duke Energy Carolinas, 2012) and Appendix B of the SPID. For its site response calculations, the staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

To capture the uncertainty in the site subsurface geology, the staff developed three base case shear-wave velocity profiles. The upper and lower base case shear-wave velocity profiles are based on the downhole measurements obtained from Borings A-61 and A-63, which are presented in Figures 2-98 and 2-99, respectively, of the Catawba, Units 1 and 2 UFSAR (Duke Energy Carolinas, 2012). The middle or best estimate base case profile represents the geometric mean of the shear wave velocities for the upper and lower base case profiles. The staff's base case profiles are similar to the licensee's profiles above the depth of 25 ft [7.6 m]. Below this depth the shear wave velocities for the licensee's lower base case profile are lower than the staff's velocities for its lower base case profile. In addition to the differences in the lower base case profile, the licensee's and staff's profiles also differ for the upper layer because the staff did not include the 12 ft [3.7 m] of fill concrete in its site response profile. As described below, these differences between the staff's and licensee's profiles did not have a significant impact on the final hazard curves or GMRS for the site. Figure 3.3-1 of this assessment shows the staff velocity profile compared to the base case profiles developed by the licensee.

In contrast to the approach used by the licensee, the staff assumed only linear behavior for the rock beneath Catawba in response to the range of input loading motions. To model the linear behavior of the rock, the staff used a low strain dampings value of 2 to 3 percent depending upon the depth and shear-wave velocities of the three profiles.

To account for the impact of small strain damping or kappa, the staff only accounted for the contribution from the basement rock (0.006 sec) since the amount of small strain damping from each of the three base case profiles is negligible.

Figure 3.3-2 of this assessment shows a comparison of the staff's and licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. Due to the use of low damping values and modeling of the rock behavior as linear, the staff's confirmatory amplification factors are essentially one for the frequency range below approximately 10 Hz. Amplification functions calculated by the licensee are also fairly close to one, varying between 0.8 to 1.3 for frequencies above 20 Hz. In addition, the staff's calculated amplification factor uncertainties are very similar to those of the licensee's.

Overall, the licensee's approach to modeling the subsurface rock properties and their uncertainty results in amplification factors that vary more than those developed by the staff. However, as shown in Figure 3.3-3 of this assessment, these small differences in the site response analysis do not have a large impact on the control point seismic hazard curves or the resulting GMRS, as 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, alternative approaches in performing site response analyses, including the modeling of uncertainty, are acceptable for this application.

In summary, the staff concludes that the licensee's site response was conducted using present-day guidance and methodology, including the NRC-endorsed SPID. The staff performed independent calculations to confirm 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 Catawba site.

3.4 Ground Motion Response Spectra

In Section 2.4 of the 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 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 staff.

As shown in Figure 3.4-1, the licensee's GMRS is similar to the staff's confirmatory GMRS. However, NRC staff's confirmatory GMRS is higher than the licensee's at frequencies above 20 Hz. As described above in Section 3.3, the staff concludes that these differences over the higher frequency range are primarily due to the differences in the site response analyses performed by the licensee and staff. The staff concludes that these differences are acceptable for the response to the 50.54(f) letter because the licensee followed the guidance provided in the SPID with respect to both the PSHA and site response analysis for the Catawba site.

The 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. As such, the staff concludes that the GMRS determined by the licensee adequately characterizes the reevaluated hazard for the Catawba site. Therefore, this GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter. The staff performed both a PSHA and site response confirmatory analysis and achieved results consistent with the licensee's horizontal GMRS.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the Catawba site. Based on its review, the 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 screening review portion of Item (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the licensee's reevaluated seismic hazard is suitable for other actions associated with NTTF recommendation 2.1 "Seismic".

In reaching this determination, the staff confirmed the licensee's conclusion that the GMRS for the Catawba site exceeds the SSE for Catawba Nuclear Station, Units 1 and 2 in the 6 to 100 Hz range. As such, the licensee will perform a plant seismic risk evaluation, which will include a high-frequency confirmation, and a SFP evaluation. NRC review and acceptance of Duke's seismic risk evaluation including the high-frequency confirmation, an ESEP interim evaluation, and a SFP evaluation (i.e., Items (4), (6), (8), and (9)) for Catawba, Units 1 and 2 will complete the items requested 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), 1978, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants." NUREG/CR-0098, May 1978.

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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.

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

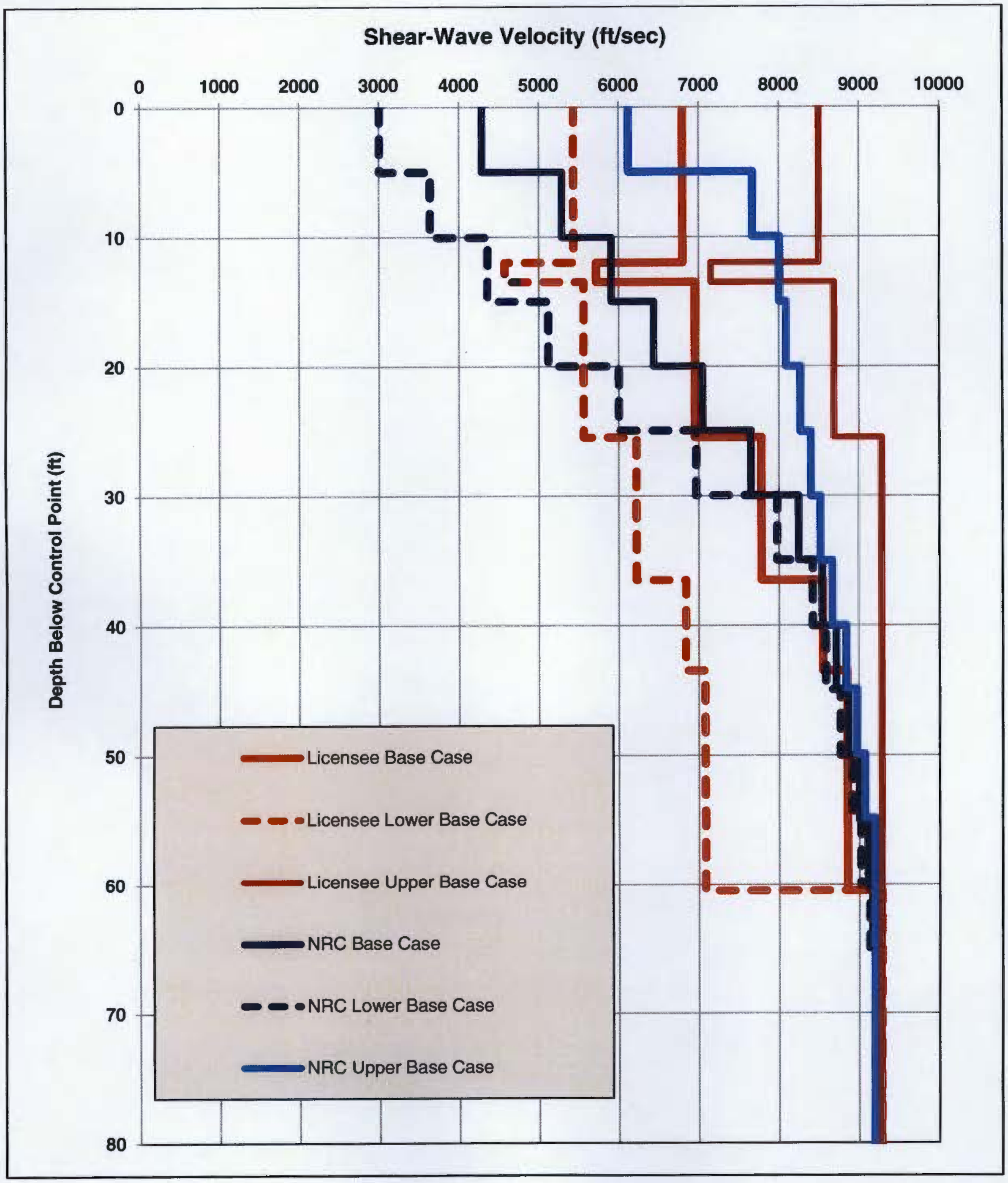


Figure 3.3- 2 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for two input loading levels for the Catawba site

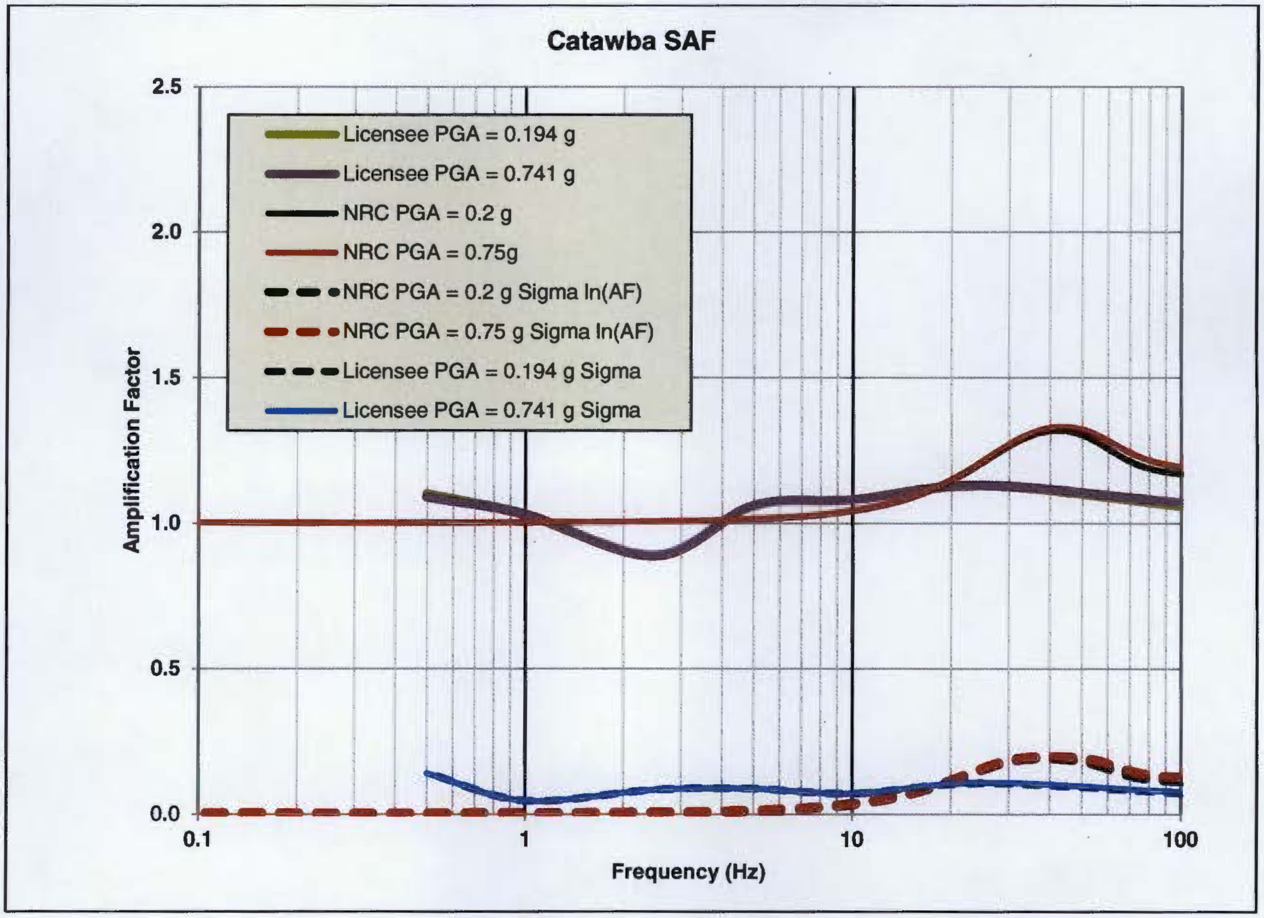


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for the Catawba site

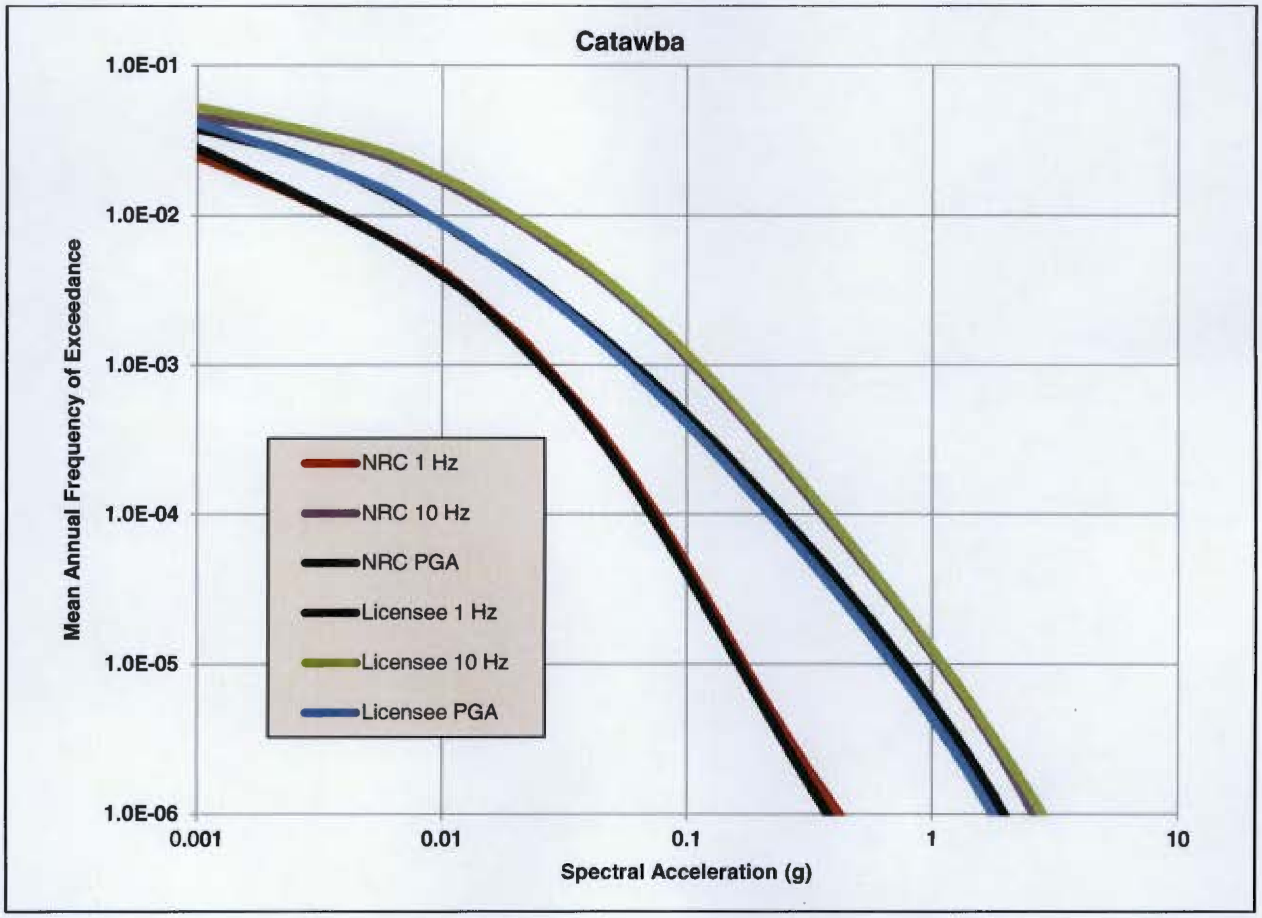
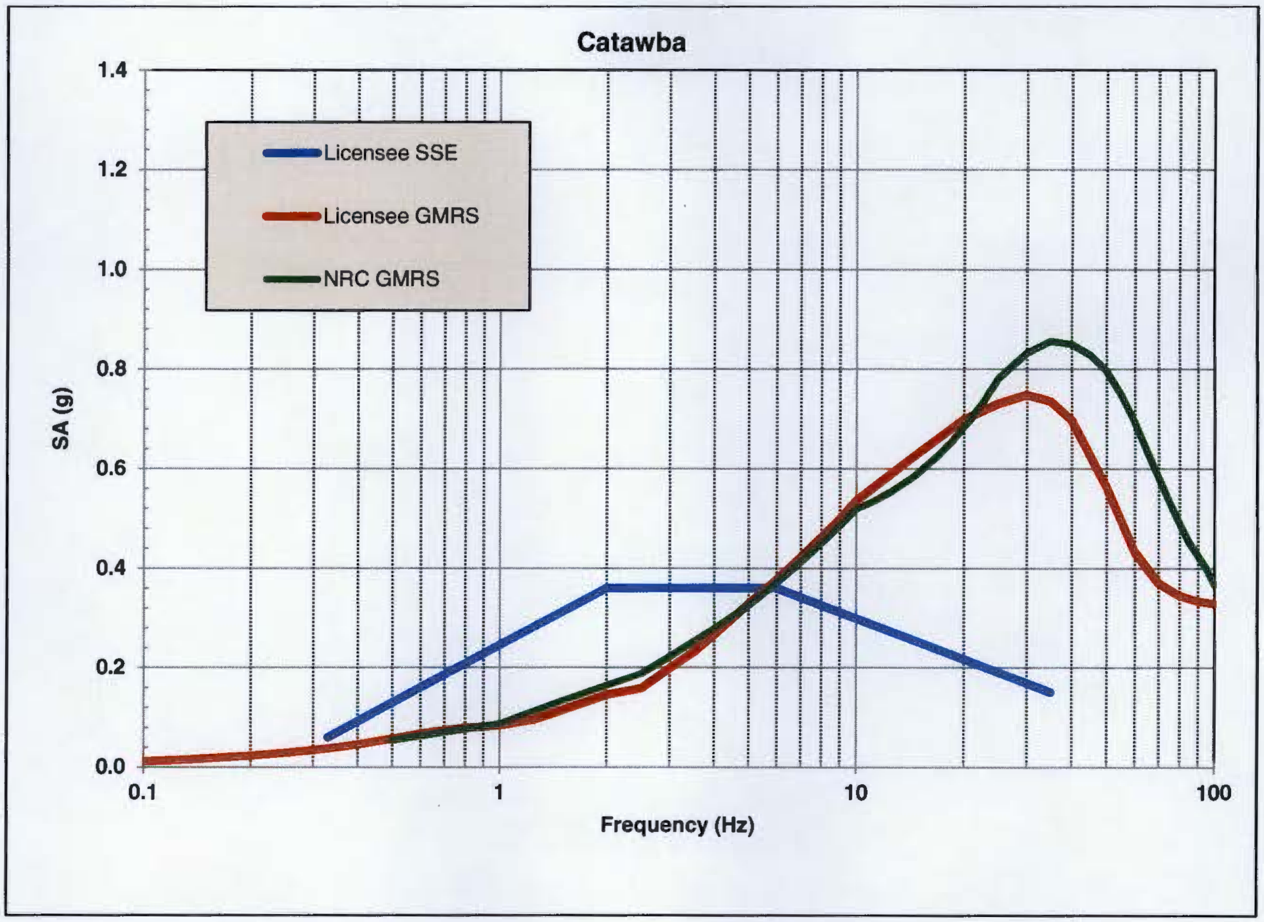


Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the SSE for the Catawba site



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 Nos. 50-413 and 50-414

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