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

September 8, 2015

Mr. Oscar A. Limpias
Vice President-Nuclear and CNO
Nebraska Public Power District
Cooper Nuclear Station
72676 648A Avenue
P.O. Box 98
Brownville, NE 68321

SUBJECT: COOPER NUCLEAR STATION - 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. MF3734)

Dear Mr. Limpias:

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 31, 2014, and February 11, 2015, Nebraska Public Power District (NPPD, the licensee), responded to this request for Cooper Nuclear Station (CNS).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for CNS 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 the comparison portion of Item (4) 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".

Contingent upon the NRC staff's review and acceptance of the licensee's expedited seismic evaluation process and seismic risk evaluation including the high frequency confirmation and spent fuel pool evaluation (i.e., Items (4), (6), (8), and (9)) for CNS, 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,

Michael L Markley for

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

Docket No. 50-298

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO SEISMIC HAZARD AND SCREENING REPORT

COOPER NUCLEAR STATION

DOCKET NO. 50-298

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 evaluation (if necessary),

---

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

(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), 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 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, 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 power, would be able to withstand a seismic hazard up to two times the design-basis. Attachment 2 to the April 9, 2013, letter 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 GMM for use by CEUS plants in developing a plant-specific GMRS. By letter dated April 9, 2013 (Pietrangelo, 2013), industry agreed to follow the SPID to develop the SHSR for existing nuclear power plants.

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 12, 2013 (Pope, 2013), Nebraska Public Power District (NPPD or the licensee) submitted at least partial site response information for Cooper Nuclear Station (CNS). By letter dated March 31, 2014 (Limpias, 2014), the licensee submitted its SHSR for CNS. The licensee submitted a revised SHSR by letter dated February 11, 2015 (Limpias, 2015). On June 22, 2015 (Higginbotham, 2015), the licensee responded to the staff request for additional information, which were issued on May 4, 2015 (NRC, 2015a).

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 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) GMMss. 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 requested 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 letters dated March 31, 2014 (Limpias, 2014), February 11, 2015 (Limpas, 2015), and supplemented on June 22, 2015 (Higginbothan, 2015), NPPD, provided its SHSR for CNS. The licensee's updated SHSR (Limpas, 2015) indicated that the site GMRS exceeds the SSE over the frequency range of approximately 5 to 100 Hertz (Hz). However, the licensee provided an assessment of its Individual Plant Examination of External Events (IPEEE) program to allow the GMRS to be compared to the IPEEE High Confidence Low Probability of Failure (HCLPF) Spectra (IHS) for screening. The licensee determined that the IHS bounds the GMRS in the frequency range of 5 to 15 Hz. The GMRS exceeds the IHS in the frequency range above 15 Hz. As such, the licensee stated that CNS screens-out of performing a seismic risk evaluation. Because the IPEEE program did not include the SFP, the licensee will perform a SFP evaluation. Also, the licensee indicated that a HF confirmation will be performed.

In response to the updated SHSR, the NRC staff issued a request for additional information (RAI) on May 4, 2015 (NRC, 2015a), related to the plant's IPEEE evaluation to the SPID criteria, to support the final screening determination. By letter dated June 22, 2015 (Higginbothan, 2015), the licensee provided a response to the NRC staff's RAI. Based on the NRC staff's review of information provided in the SHSR and in the RAI response, the NRC staff concluded that CNS's IPEEE review did not meet SPID Section 3.3 criteria. As such, the NRC staff compared the licensee's GMRS, as well as the confirmatory GMRS developed by the NRC staff, to the SSE. The licensee's GMRS, as well as the NRC staff's confirmatory GMRS, exceeds the SSE for CNS at frequencies greater than 5 Hz. Therefore, the staff determined that a seismic risk evaluation, SFP evaluation, and high frequency (HF) 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 20 to 30 Hz for the existing fleet of nuclear power plants (NPPs); 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 its SHSR, the licensee described its seismic design bases for CNS. The licensee stated that the PGA value for the SSE for CNS was developed assuming a local earthquake of Modified Mercalli intensity (MMI) VII. From this earthquake the licensee estimated a PGA value of 0.20 g both at the rock surface and base of structures. The licensee also stated that the spectral shape of the CNS SSE is based on a recording of the 1952 Kern County, California earthquake.

The licensee specified that the SSE control point is located at Elevation 869.5 ft [265 m]. Several control points are specified in the CNS Updated Safety Analysis Report (USAR) and the licensee selected the higher elevation to be consistent with guidance provided in Section 2.4.2 of the SPID to define the control point.

The NRC staff reviewed the licensee's description of its SSE in the SHSR. To confirm the SSE, the NRC staff reviewed the CNS USAR (NPPD, 2013). Based on its review, the staff confirmed both the SSE spectrum and control point are consistent with the UFSAR and 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). 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, among others, the Meers, New Madrid Fault System and Wabash Valley repeated large magnitude earthquake (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_w >= 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 base rock seismic hazard curves in SHSR Section 2.2.2 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 NRC 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 base rock site conditions at the CNS site. As input, the 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 mi [500 km] radius of the CNS 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 Meers, New Madrid Fault System and Wabash Valley RLME sources. For each of the CEUS-SSC sources used in the PSHA, the NRC staff used the mid-continent version of the updated EPRI GMM (EPRI, 2013). 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 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 or base 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 licensees 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 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 CNS USAR (NPPD, 2013) and recent measurements made using a suspension logging system and downhole seismic measurements. The licensee stated that the site is underlain by approximately 49.5 ft [15 m] of fill and compacted alluvium overlying 3,450 ft [1,052 m] of firm sedimentary rock.

The licensee provided a brief description of the subsurface materials in terms of geologic units and thickness in its SHSR. Seismic shear wave velocities range from 600 to 1,120 feet per second (fps) [183 to 341 meters per second (m/s)] for the fill and alluvium, and increase from 1,620 to 2,750 fps [494 to 838 m/s] for the firm sedimentary rock.

To characterize the subsurface geology, the licensee developed three site base case profiles. For the middle, or best estimate, profile, the licensee estimated a value of 7,292 ft/s [2,223 m/s] for the firm rock layers below a depth of 128 ft [39 m] based on the lithology of the rock. To develop the upper and lower base case profiles, the licensee used a scale factor of 1.25 for the upper 49.5 ft (15 m) and 1.57 below to reflect increased uncertainty for assumed shear wave velocities. Figure 3.3-1 of this assessment shows the licensee's three shear-wave velocity base case profiles.

To model the potential non-linear behavior of the soil and rock layers, the licensee used two sets of shear modulus and damping curves. In the first model, the licensee applied EPRI soil and rock shear modulus degradation and damping curves. In the second model, the licensee assumed that the site would behave more linearly under all loading levels and, as such, used the Penninsular Range (PR) curves for the soil combined with a linear analyses for the rock with a low strain damping value of approximately 3 percent. The licensee weighted these alternative material behaviors equally, assigning 50 percent to each case.

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 CNS, with about 50 ft [15.2 m] of soils overlying 3,450 ft [1,052 m] of firm rock below the SSE control point, the licensee estimated kappa based on the low-strain damping over the upper 500 ft [152 m] and a constant damping value of 1.25 percent for the rock below. In addition, the licensee added a kappa of 0.006 sec to account for the underlying base or reference rock. The resulting kappa values for the three profiles are 0.021 sec, 0.030 sec, and 0.008 sec.

To account for aleatory variability or randomness in material properties across the plant site in its site response calculations, the licensee stated that it randomized its base case profiles, consistent with the SPID. The licensee also randomized the depth to reference rock ±1050 ft [±320 m], which corresponds to 30 percent of the total profile thickness for the middle and lower base case profiles. For the upper profile, the licensee assume a depth to reference rock of 97 ft [30 m].

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 cases analyzed. Amplification functions are shown for eleven input loading levels for the median reference (hard rock) peak acceleration (0.01g to 1.50g) for profile P1 and EPRI soil and 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 Appendix 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 2.3.7), 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 NRC staff performed site response calculations for the CNS site. The NRC staff independently developed three base case shear-wave velocity profiles, damping values, and modeled the potential non-linear behavior of the site using the geologic information provided in the CNS UFSAR and information gathered at other NPP sites in the region. 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 characterize the uncertainty in the subsurface material properties, the NRC staff developed three separate profiles. The NRC staff's shear wave velocity profiles are very similar to those submitted by the licensee in the upper 80 ft, but differ somewhat below 80 ft. The differences are due to the NRC staff's use of the shear wave velocities for similar rock units at other nuclear sites in the region while the licensee used a generic velocity profile from the SPID. The NRC staff's base case shear-wave velocity profiles along with the licensee's base case profiles are shown in Figure 3.3-1 of this assessment.

Similar to the approach used by the licensee, the NRC staff used the SPID guidance to characterize the dynamic material behavior of the base case profiles. The NRC staff assumed that the material in the upper 500 ft [152 m] could behave both linearly and non-linearly under alternate loading conditions. For the soil layers, the staff used the EPRI soil curves to model the non-linear response and the Penninsular curves to represent linear behavior. For the rock layers in the upper 500 ft [152 m], the NRC staff used the EPRI rock curves to model the non-linear response and a constant small strain damping value of about 3 percent to model the linear behavior. Below 500 ft, the staff assumed that the rock would behave with a constant damping value of 1.25 percent.

To determine the kappa value for each of the three profiles, the NRC staff used the small strain damping value for each layer, as described above. The kappa values for the middle, lower, and upper profiles are 0.018 sec, 0.025 sec and 0.007 sec, respectively. The NRC staff also added additional uncertainty in the kappa value for each of the three profiles by applying an upper and lower bound based on a lognormal standard deviation of 0.35. Finally, to account for aleatory variability in material properties across the plant site, the NRC staff randomized its base case shear-wave velocity profiles following the guidance in the SPID.

Figure 3.3-2 of this assessment shows a comparison of the NRC staff's and licensee's median site amplification functions and uncertainties for two of the eleven input loading levels for profiles used in the licensee's SHSR submittal. As shown in Figure 3.3-2, the differences between the NRC staff's and licensee's amplification functions and uncertainties are very minor. Figure 3.3-3 of this assessment compares the control point hazard curves at 1 Hz, 10 Hz, and PGA developed by the NRC staff with those developed by the licensee in its SHSR. Again the licensee's and NRC staff's control point hazard curves are very similar. 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.

In summary, the NRC staff notes that the licensee's site response was conducted using present-day guidance and methodology, including the NRC-endorsed SPID, which the licensee used for its site response calculations using a range of input parameters. 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 CNS 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 very similar to that determined by 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 characterizes the reevaluated hazard for the CNS 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 CNS 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 to Item (4), identified in Enclosure 1 of 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 confirmed the licensee's GMRS for the CNS site exceeds the SSE in the frequency range of approximately 5 to 100 Hz. As such, a seismic risk evaluation, SFP evaluation, and HF confirmation are merited for CNS. The NRC staff review and acceptance of the NPPD's plant seismic risk evaluation, interim ESEP evaluation, SFP evaluation, and HF confirmation (i.e., Items (4), (6), (8), and (9)) for CNS will complete 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

AEC (U.S. Atomic Energy Commission), 1963, "Nuclear Reactors and Earthquakes," TID-7042, August 1963.

NRC (U.S. Nuclear Regulatory Commission), 1978, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants." NUREG/CR-0098, May 1978.

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), 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.

NRC (U.S. Nuclear Regulatory Commission), 2012a, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, March 12, 2012, ADAMS Accession No. ML12053A340.

NRC (U.S. Nuclear Regulatory Commission), 2012b, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities", NUREG-2115, ADAMS stores the NUREG as multiple ADAMS documents, which are accessed through the web page http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2115/.

NRC (U.S. Nuclear Regulatory Commission), 2013a. Letter From Eric J. Leeds, to Joseph Pollock, Executive Director NEI, Acceptance Letter for NEI Submittal of Augmented Approach, Ground Motion Model Update Project, and 10 CFR 50.54(f) Schedule

Modifications Related to the NTTF Recommendation 2.1, Seismic Reevaluations, May 7, 2013, ADAMS Accession No. ML13106A331.

NRC (U.S. Nuclear Regulatory Commission), 2013b, letter from David L. Skeen, Director, Japan Lessons-Learned Directorate, to Joseph E. Pollock, Executive Director, Nuclear Energy Institute, Endorsement of Electric Power Research Institute Draft Report 1025287, “Seismic Evaluation Guidance,” February 15, 2013, ADAMS Accession No. ML12319A074.

NRC (U.S. Nuclear Regulatory Commission) 2013c. Letter from D. L. Skeen (NRC) to K. A. Keithline (NEI), Approval of Electric Power Research Institute Ground Motion Model Review Project Final Report for Use by Central and Eastern United States Nuclear Power Plants, August 28, 2013 ADAMS Accession No. ML13233A102.

NRC (U.S. Nuclear Regulatory Commission) 2014a. Letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation to All Power Reactor Licensees and holders of Construction Permits in Active or Deferred Status, Seismic Screening and Prioritization Results Regarding Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazard Reevaluations for Recommendations 2.1 of the Near-Term Task Force Review of Insights, May 9, 2014, ADAMS Accession No. ML14111A147.

NRC (U.S. Nuclear Regulatory Commission) 2014b. Letter from W. Dean (NRC) to O. Limpias (NPPD), Cooper Nuclear Station - Seismic Screening and Prioritization Results Regarding Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazard Reevaluations for Recommendations 2.1 of the Near-Term Task Force Review of Insights, October 28, 2014, ADAMS Accession No. ML14273A259.

NRC (U.S. Nuclear Regulatory Commission) 2015a, Letter from Frankie G. Vega to O.Limpias (NPPD), Cooper Nuclear Station - Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Seismic Hazard And Screening Report, May 4, 2015, ADAMS Accession No. ML15107A254.

<u>Other References</u>

Electric Power Research Institute (EPRI), 2004. EPRI Report 1009684, "CEUS Ground Motion Project Final Report." Palo Alto, CA, 2004.

Electric Power Research Institute (EPRI), 2006. EPRI Report 1014381, "Truncation of the Lognormal Distribution and Value of the Standard Deviation for Ground Motion Models in the Central and Eastern United States." Palo Alto, CA, 2006.

Electric Power Research Institute (EPRI), 2012. 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” November 27, 2012, ADAMS Accession No. ML12333A170.

Electric Power Research Institute (EPRI), 2013. EPRI Ground Motion Model Review Final Report, June 3, 2013, ADAMS Accession No. ML13155A553.

Higginbotham, 2015, Letter from Kenneth Higginbotham (Nebraska Public Power District), Nebraska Public Power District's Response to Request for Additional Information Associated with the Near-term Task Force Recommendation 2.1, Seismic Hazard and Screening Report, June 22, 2015, ADAMS Accession No. ML15177A097.

Keithline, 2012, Letter from Kimberly Keithline, Senior Project Manager, NEI, to David L. Skeen, Director, Japan Lessons Learned Project Directorate, NRC, Final Draft of Industry Seismic Evaluation Guidance (EPRI 1025287), November 27, 2012, ADAMS Accession No. ML12333A168.

Limpias, O., 2014, Letter from O. Limpias (Nebraska Public Power District) to NRC, Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, March 31, 2014, ADAMS Accession No. ML14094A040.

Limpias, O., 2015, Letter from O. Limpias (Nebraska Public Power District) to NRC, Revision to Nebraska Public Power District's 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, February 11, 2015, ADAMS Accession No. ML15050A165.

Nebraska Public Power District (NPPD), 2013, Cooper Nuclear Station Updated Safety Analysis Report (USAR) Revision 26, May 16, 2013, ADAMS Accession No. ML15127A351.

Pietrangelo, 2013. Letter from A. R. Pietrangelo (NEI) to D. L. Skeen (NRC), Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, April 9, 2013, ADAMS Accession No. ML13101A379.

Pope P., 2013, Letter from P. Pope (Nebraska Public Power District) to 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, September 12, 2013, ADAMS Accession No. ML13260A255.

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

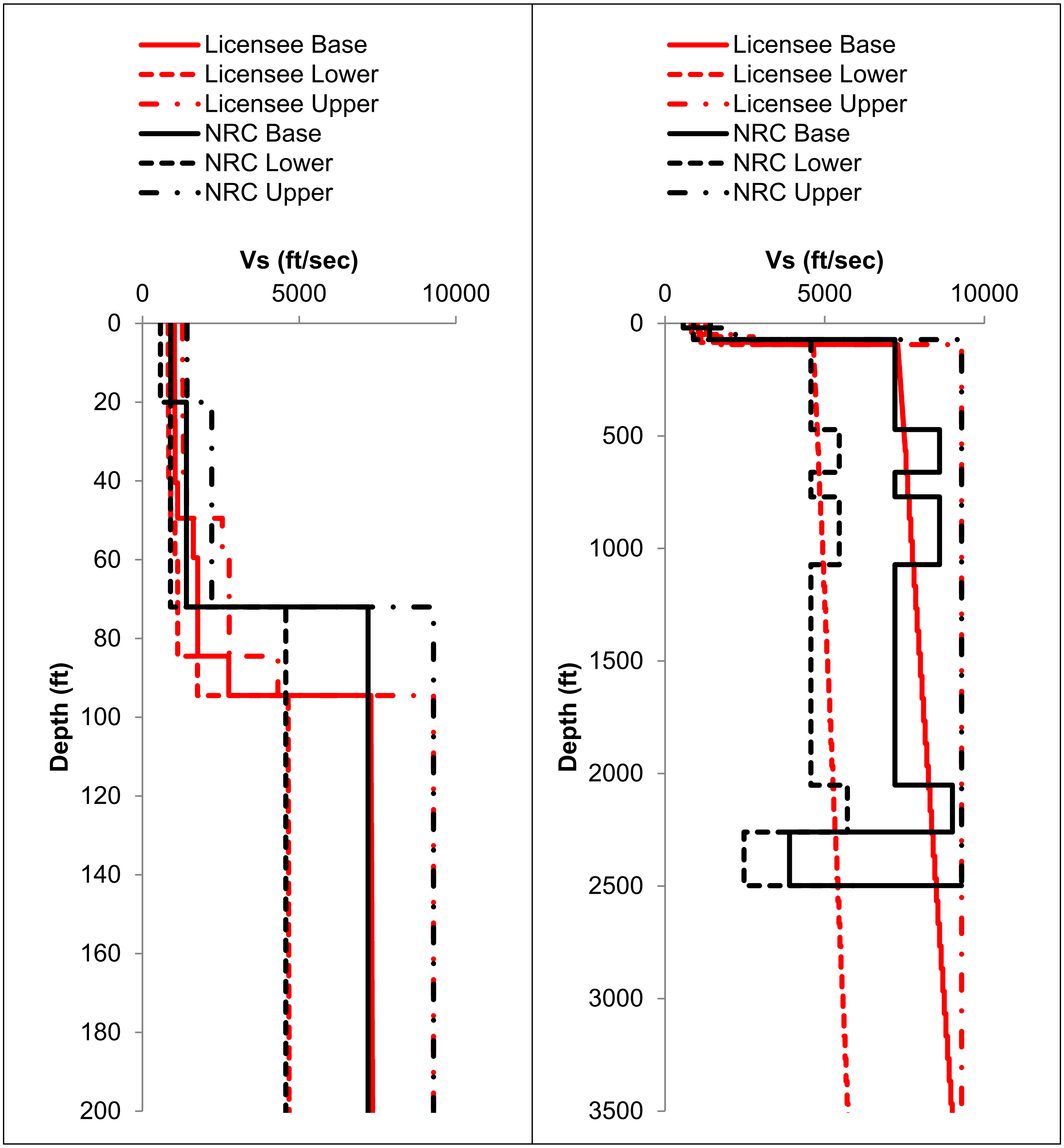


Figure 3.3-2 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for two input loading levels for the Cooper Nuclear Station site

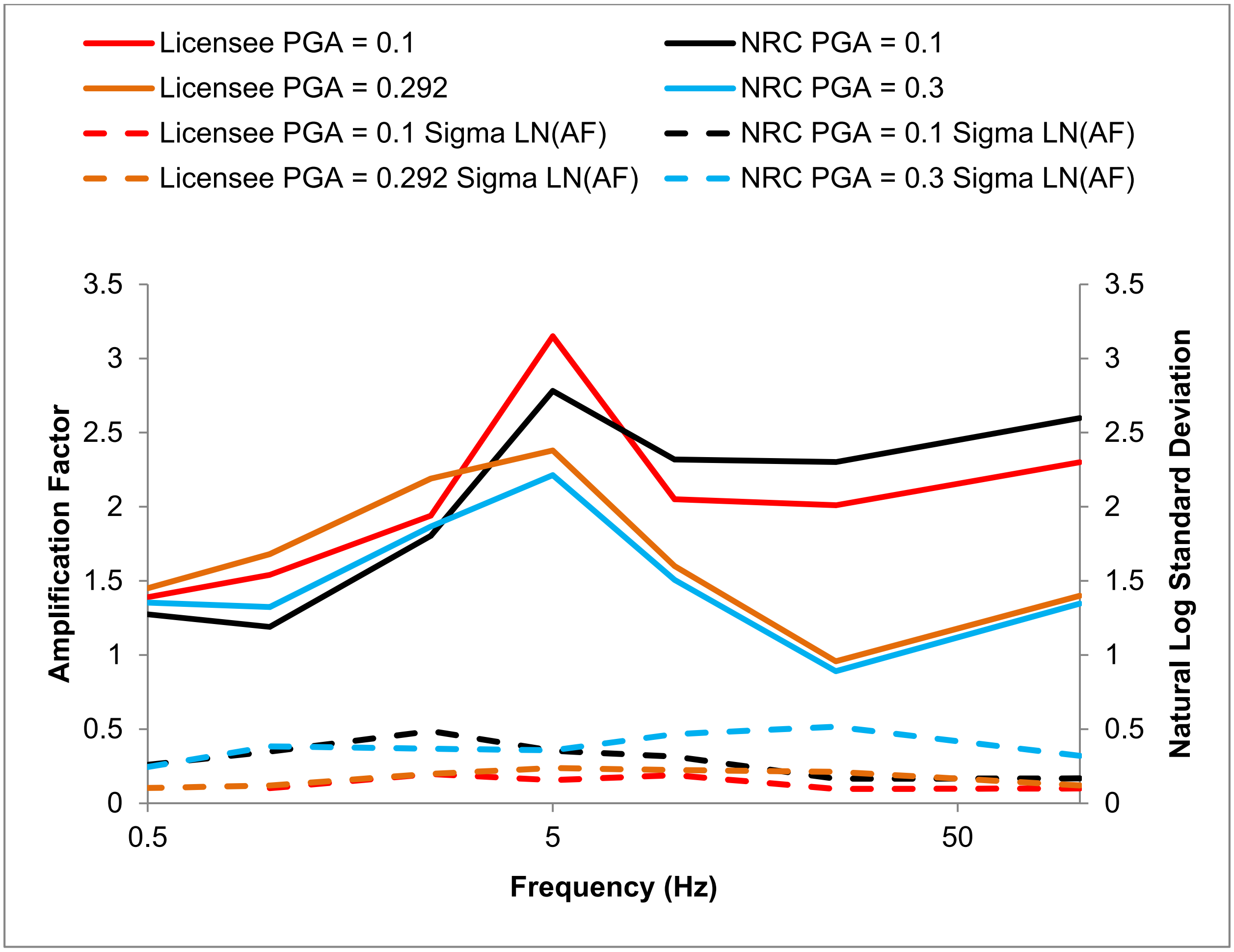


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for the Cooper Nuclear Station site

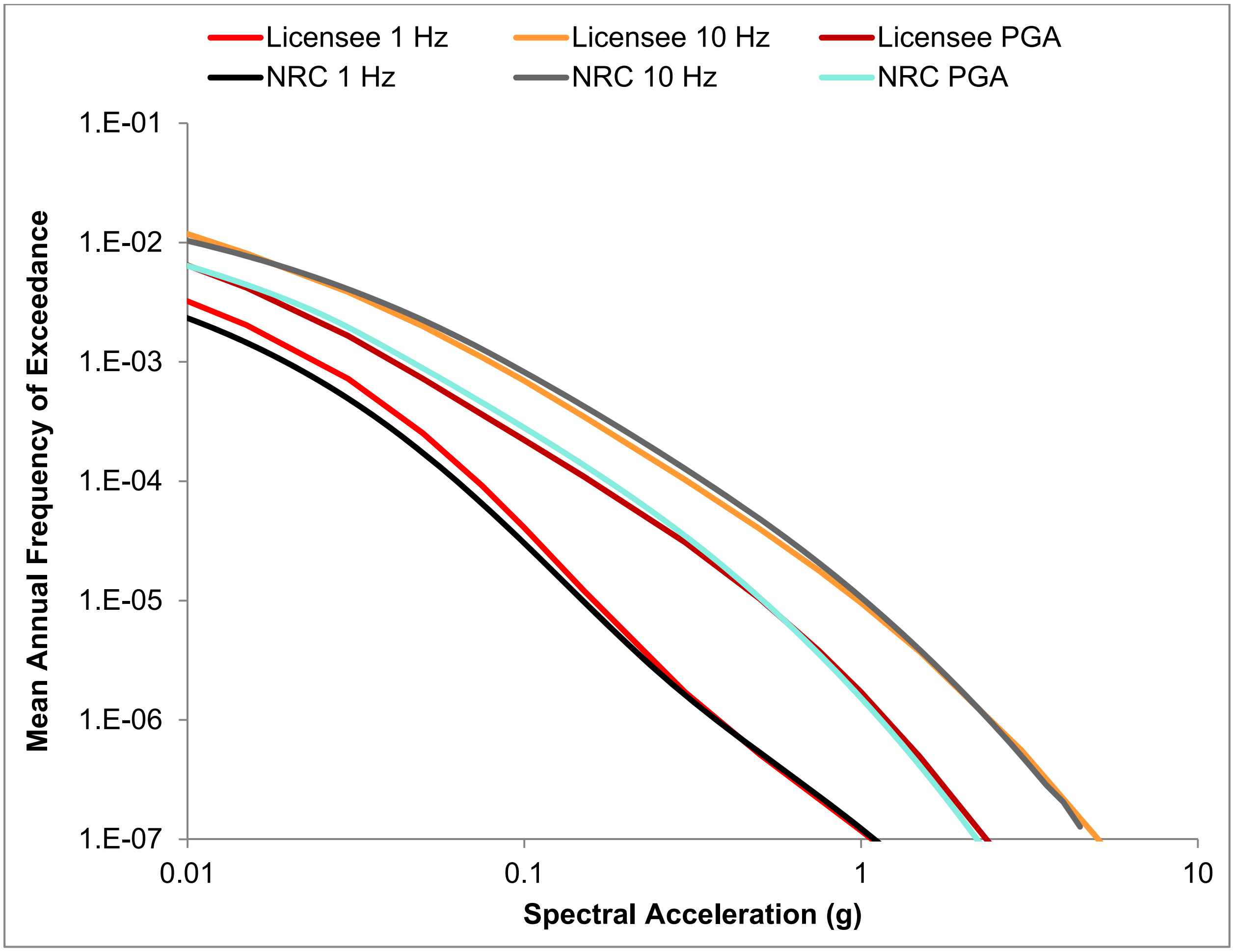
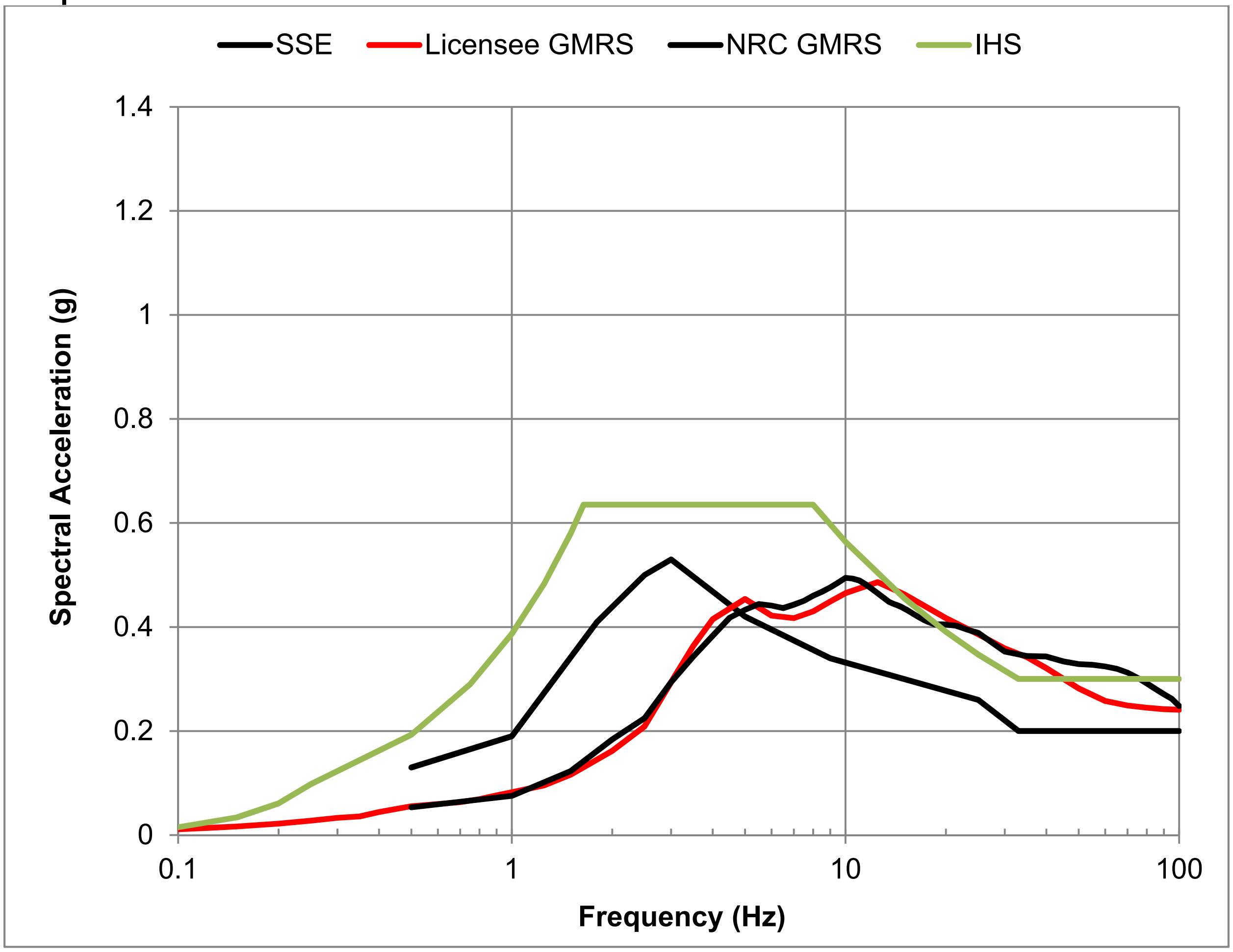


Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the SSE for the Cooper Nuclear Station site



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

Sincerely,

/RA by Michael Marshall for/

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

Docket No. 50-298

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:
PUBLIC
JHMB R/F
RidsNrrDorlLpl4-1 Resource
RidsNrrPMCooper Resource
RidsNrrLASLent Resource
RidsAcrsAcnw_MailCTR Resource
RidsRgn4MailCenter Resource
FVega, NRR
NDiFranceso, NRR
DJackson, NRO
MShams, NRR

ADAMS Accession No.: ML15240A030 ***via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RGS1/BC*
NAME	FVega	SLent	DJackson
DATE	09/02/15	09/02/15	08/25/15
OFFICE	NRRJLD/JHMB/BC	NRR/JLD/JHMB/PM	
NAME	MShams	FVega (MMarshall for)	
DATE	09/07/15	09/08/15	

OFFICIAL RECORD COPY