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

December 15, 2015

Mr. David A. Heacock
President and Chief Nuclear Officer
Virginia Electric and Power Company
5000 Dominion Blvd.
Glen Allen, VA 23060-6711

SUBJECT: SURRY POWER STATION, UNIT NOS. 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 FOR RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE (NTTF) REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT AND STAFF CLOSURE OF ACTIVITES ASSOCIATED WITH NTTF RECOMMENDATION 2.1, "SEISMIC" (TAC NOS. MF3953 AND MF3954)

Dear Mr. Heacock:

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, Virginia Electric and Power Company (Dominion, the licensee), responded to this request for Surry Power Station, Unit Nos, 1 and 2 (Surry).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for Surry and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to Enclosure 1, Items (1) - (9) of the 50.54(f) letter.

The NRC staff concludes that the licensee responded appropriately and has completed its response to Enclosure 1, of the 50.54(f) letter. Furthermore, the NRC staff review concluded that the reevaluated seismic hazard is bounded by the plants existing design-basis safe shutdown earthquake. As such, the NRC staff concludes that no further responses or regulatory actions associated with Phase 2 of Near-Term Task Force (NTTF) Recommendation 2.1 "Seismic" are requiered for Surry. This closes out the NRC's efforts associated with Phase 1 and 2 of NTTF Recommendation 2.1 "Seismic" (TAC Nos. MF3953 AND MF3954).

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. 50-280 and 50-281

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

SURRY POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-280 AND 50-281

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] 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),

---

[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), 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 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 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 committed to following the SPID to develop the SHSR for existing nuclear power plants. By letter dated September 12, 2013 (Grecheck, 2013), Virginia Electric and Power Company (Dominion, the licensee) submitted partial site response information for Surry Power Station, Unit Nos. 1 and 2 (Surry). By letter dated March 31, 2014 (Heacock, 2014), Dominion 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 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 described 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 provided further guidance regarding the appropriate use of GMMs for the CEUS. Specifically, Section 2.3 of the SPID recommended 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 letter dated March 31, 2014 (Heacock, 2014), the licensee provided the SHSR for Surry. The licensee's SHSR indicates that the site GMRS exceeds the SSE for Surry by a negligible amount in a narrow frequency band within the frequency range of 1 to 10 Hertz (Hz). As such, Surry screens out of performing a seismic risk evaluation. In addition, the licensee indicated that a SFP evaluation and HF confirmation will not be performed.

On May 9, 2014 (NRC, 2014a), the NRC staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. In the letter, the NRC staff characterized the Surry site as conditionally screened-in, because additional time was needed to support the NRC staff review of the licensee's GMRS. The NRC staff held a public meeting on June 25, 2014 (NRC, 2014b), with the licensee to discuss apparent differences in the analyses. Based on the information gathering during that meeting, the NRC staff was able to make a final screening determination. By letter dated October 3, 2014 (NRC, 2014c), the NRC staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS developed by the NRC staff, are essentially bounded by the SSE over the frequency range of 1 to 10 Hz. Therefore, the NRC staff confirmed the licensee's conclusion that a seismic risk evaluation and SFP evaluation are not merited for Surry. In addition, the NRC staff confirmed that the licensee's GMRS is either equal to or below the SSE for frequencies above 10 Hz. As such, the NRC staff concluded that a HF confirmation is not merited for Surry.

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 re-evaluated 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 3.1 of its SHSR, the licensee described the seismic design bases for Surry stating that the SSE is anchored at a PGA of 0.15 g (15 percent of the acceleration due to earth's gravity) and has a Housner response spectrum shape. The licensee stated that the original Surry SSE is based on the Atomic Energy Commission (AEC, now NRC) criteria in effect at the time of the Surry construction permit.

In Section 3.2 of its SHSR, the licensee specified that the control point elevation for the SSE is defined at the elevation of the highest safety related, soil supported structure. For Surry, the highest safety related, supported structure is the Emergency Condensate Storage Tank, which is founded at elevation 26.5 ft. [8.1 m] on compacted fill placed after the power block was excavated to 7 ft. [2.1 m] during construction.

The NRC staff reviewed the licensee's description of its SSE for Surry in the SHSR. With regard to the SSE for Surry, based on its review of the SHSR and the Updated Final Safety Report (UFSAR) (Virginia Electric and Power Company, 2010), the NRC staff confirmed that the licensee's SSE is based on a Housner shape response spectrum with a PGA of 0.15g. Finally, based on review of the SHSR and the UFSAR (Virginia Electric and Power Company, 2010), the NRC staff confirmed that the licensee's control point elevation for the SSE at Surry 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 (**M**) of 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. The licensee included the following Repeated Large Magnitude Earthquakes (RLME) within 621 mi (1,000 km) of the site: Charleston and Wabash Valley. 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 since a site response analysis is necessary 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 NRC staff performed PSHA calculations for the Surry site. As input, the staff used the CEUS-SSC model in NUREG-2115 (NRC, 2012b) along with the 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 Surry site. In addition, the NRC staff included RLME sources, which lie within 621 mi (1,000 km) of the site. For each of the CEUS-SSC sources used in the PSHA, the NRC staff used the mid-continent version of the 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 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 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 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 site profile descriptions in Sections 2.3.1 and 2.3.2 of its SHSR based on information provided in the Surry UFSAR (Virginia Electric and Power Company, 2010), Surry Dames and Moore Report (1966), regional geology and available nearby deep boreholes (U.S. Geological Survey Professional Papers No. 1612 and 1731), and the guidance in Appendix B of the SPID. The licensee stated that the site is underlain by approximately 1600 ft. [488 m] of soils (clay, sand and silty sand) overlying about 100 ft. [30 m] of firm rock. Bedrock consisting of crystalline igneous and metamorphic rock is estimated to be at a depth of 1700 ft. [518 m] beneath the surface. The top 140 ft. [42.7 m] was selectively explored and tested with laboratory methods.

To estimate the shear wave velocities for its best estimate or middle base case profile for the upper 140 ft. [42.7 m], the licensee used the blow count values from Standard Penetration Testing. For the deeper soil layers to a depth of 1600 ft. [488 m], the licensee estimated the shear wave velocities based on the soil type and its depth beneath the site. Finally, for the metamorphic rock between 1600 ft. [488 m] and 1700 ft. [518 m], the licensee assumed a shear wave velocity of 7000 feet per second (fps) [2130 meters per second (m/s)]. At a depth of 1700 ft. [518 m], the licensee assumed the reference or base rock shear wave velocity of 9200 fps [2800 m/s]. Due to the large uncertainty in the shear wave velocity estimates for the best estimate base case profile, the licensee calculated lower and upper base case profiles using a scale factor of 1.57, reflecting a natural log standard deviation of 0.35. Table 2.3.1-2 and Figure 2.3.2-1 of the SHSR provide the licensee's shear-wave velocity profile for each of the three base cases. Figure 3.3-1 of this assessment shows the licensee's three shear-wave velocity base case profiles.

In Section 2.3.2.1 of its SHSR, the licensee states that no site-specific nonlinear dynamic material properties are available for the Surry site. Therefore, the licensee followed the guidance in the SPID and assumed that the site could be modeled with two alternative models of hysteretic damping and shear modulus reduction curves, representing varying levels of nonlinearity. For the more nonlinear case, the licensee selected the EPRI soil damping and shear modulus reduction curves over the upper 500 ft (152 m). For the more linear case, the licensee selected the Peninsular Range 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, as well as scattering due to wave propagation in heterogeneous material. The licensee provides estimates of kappa for its three base case velocity profiles in Table 2.3.2-3 of the SHSR. For the Surry site, with about 1,600 ft. [488 m] of soil, the licensee estimated a total kappa value of 0.034 sec for all three profiles.

To account for randomness in material properties across the plant site, the licensee stated in Section 2.3.3 of the SHSR that it randomized its base case shear-wave velocity profiles following guidance in Appendix B of the SPID. In addition, the licensee randomized the depth to bedrock by ±510 ft. [155 m], which corresponds to ±30 percent of the total profile thickness. The licensee stated that this randomization did not represent the 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, 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 for the single-corner and double-corner seismological models.

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 3.2 of this assessment), 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 Surry site. The NRC staff independently developed a shear-wave velocity profile, damping values, and modeled the potential nonlinear behavior of the site using measurements and geologic information provided in the Surry UFSAR (Virginia Electric and Power Company, 2010) and Appendix B of the SPID. For its site response calculations, the

NRC staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

To develop its best estimate base case velocity profile over the upper 200 ft. [61 m], the NRC staff assumed the same values as the licensee. Below 200 ft. [61 m], the NRC staff assumed a constant velocity gradient down to the base of the profile at a depth of 1,500 ft (457 m). To capture the uncertainty in the shear wave velocities, the NRC staff used a scale factor of 1.21 to calculate upper and lower base case velocity profiles, which is consistent with a natural log standard deviation of 0.15. 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 NRC staff are similar to those developed by the licensee, but have higher velocities at depths greater than 200 ft (61 m). In addition, the NRC staff assumed a somewhat shallower depth to metamorphic rock beneath the site and that the shear wave velocity for this rock is the reference rock value of 9200 fps (2800 m/s). The NRC staff randomized the depth to reference rock by ±300 ft (91 m) to allow for additional uncertainty.

Similar to the approach used by the licensee, the NRC staff assumed that the site would behave in either a more linear or nonlinear way. To model the more nonlinear case, the NRC staff used the EPRI soil dynamic material property curves over the upper 500 ft (152 m). To model the more linear case, the NRC staff used the Peninsular Range curves over the upper 500 ft (152 m). Also similar to the licensee, the NRC staff considered the effect of kappa on its site response analysis. To determine kappa for its base case profiles, the NRC staff used the low strain damping values, shear wave velocities, and layer thicknesses for each layer to arrive at kappa values for the best estimate, upper, and lower base case velocity profiles of 0.040, 0.031, 0.023 sec, respectively.

Figure 3.3-2 of this assessment shows a comparison of the staff's and licensee's median site amplification factors and uncertainties (±1 standard deviation) for 2 of the 11 input loading levels. The staff's median site amplification factors are similar to the licensee's amplification factors. In addition, the staff's and licensee's uncertainties are similar at frequencies below 2 Hz. At higher frequencies the staff's uncertainties are slightly higher than the licensee's.

The licensee's approach to modeling the subsurface rock properties and their uncertainty results in similar site amplification factors. As shown in Figure 3.3-3, the control point seismic hazard curves developed by the licensee and NRC staff are also similar. Appendix B of the SPID provides guidance for performing site response analyses, including capturing the uncertainty for sites with less subsurface data. As such, alternative 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 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 Surry site.

3.4 Ground Motion Response Spectra

In Section 2.4 of its SHSR, the licensee states that it used the control point hazard curves, described in SHSR Section 2.3.7, to develop the 10^{-4} and 10^{-5} 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 below, the licensee's GMRS shape is similar to that calculated by the NRC staff at frequencies less than 10 Hz. However, the staff's confirmatory GMRS is somewhat higher than the licensees at frequencies above 10 Hz. As described above in Section 3.3, the NRC staff concludes that these minor differences over the higher frequency range are primarily due to the differences in the site response analyses performed by the licensee and 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 Surry 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 Surry 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) and (5) – (7) and the comparison portion of Item (4) identified in Enclosure 1 of the 50.54(f) letter.

In reaching this determination, the NRC staff confirmed the licensee's conclusion that the licensee's GMRS for the Surry site is bounded by the SSE in the 1 to 10 Hz range. A comparison of the SSE with GMRS shows overlap in the 9 – 10 Hz range. As such, the NRC staff determined that a seismic risk evaluation and SFP evaluation (i.e., Requested Information Items (8) and (9)) are not necessary for Surry. Further, the NRC staff also concluded that the GMRS and SSE overlap at frequencies greater than 10 Hz, and as such, the NRC staff determined that a HF confirmation (i.e., Requested Information Item (4)) is not merited. Based upon the preceding analysis, the NRC staff concludes that the licensee responded appropriately and has completed its response to 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), 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 most easily 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) 2014. 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 M. Balazik (NRC) to Virginia Electric and Power Company, Summary of the June 25, 2014, Category 1 Public Meeting with Dominion Nuclear And Virginia Electric And Power Company to Discuss Seismic Hazard Reevaluations Associated with Implementation Of Japan Lessons-Learned Near-Term Task Force Recommendation 2.1, August 11, 2014, ADAMS Accession No. ML14210A021.

NRC (U.S. Nuclear Regulatory Commission) 2014c. Letter from D. H. Dorman (NRC) to Select Operating Power Reactor Licensees, Screening and Prioritization Results Regarding Seismic Hazard Reevaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, October 3, 2014, ADAMS Accession No. ML14258A043.

Other References

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,

Heacock, G., 2013, Letter from G. Heacock (Virginia Electric and Power Company) to NRC, Response to March 12, 2012, Request 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. ML13259A041.

Heacock, G., 2014, Letter from G. Heacock (Virginia Electric and Power Company) 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, March 31, 2014, ADAMS Accession No. ML14092A414.

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.

Keithline, 2013, Submittal of EPRI (2004, 2006) Ground Motion Model Review Final Report, June 3, 2013, ADAMS Accession No. ML13170A378.

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.

Surry Dames & Moore Report. December 1966.

U.S. Geological Survey Professional Paper 1612 (2000). The effects of the Chesapeake Bay impact crater on the geological framework and correlation of hydrogeologic units of the lower York-James Peninsula, Virginia.

U.S. Geological Survey Professional Paper 1731 (2006). The Virginia Coastal Plain Hydrogeologic Framework, Reston.

Virginia Electric and Power Company, 2010. Surry Power Station Updated Final Safety Analysis Report (UFSAR), Revision 42, September 30, 2010.

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

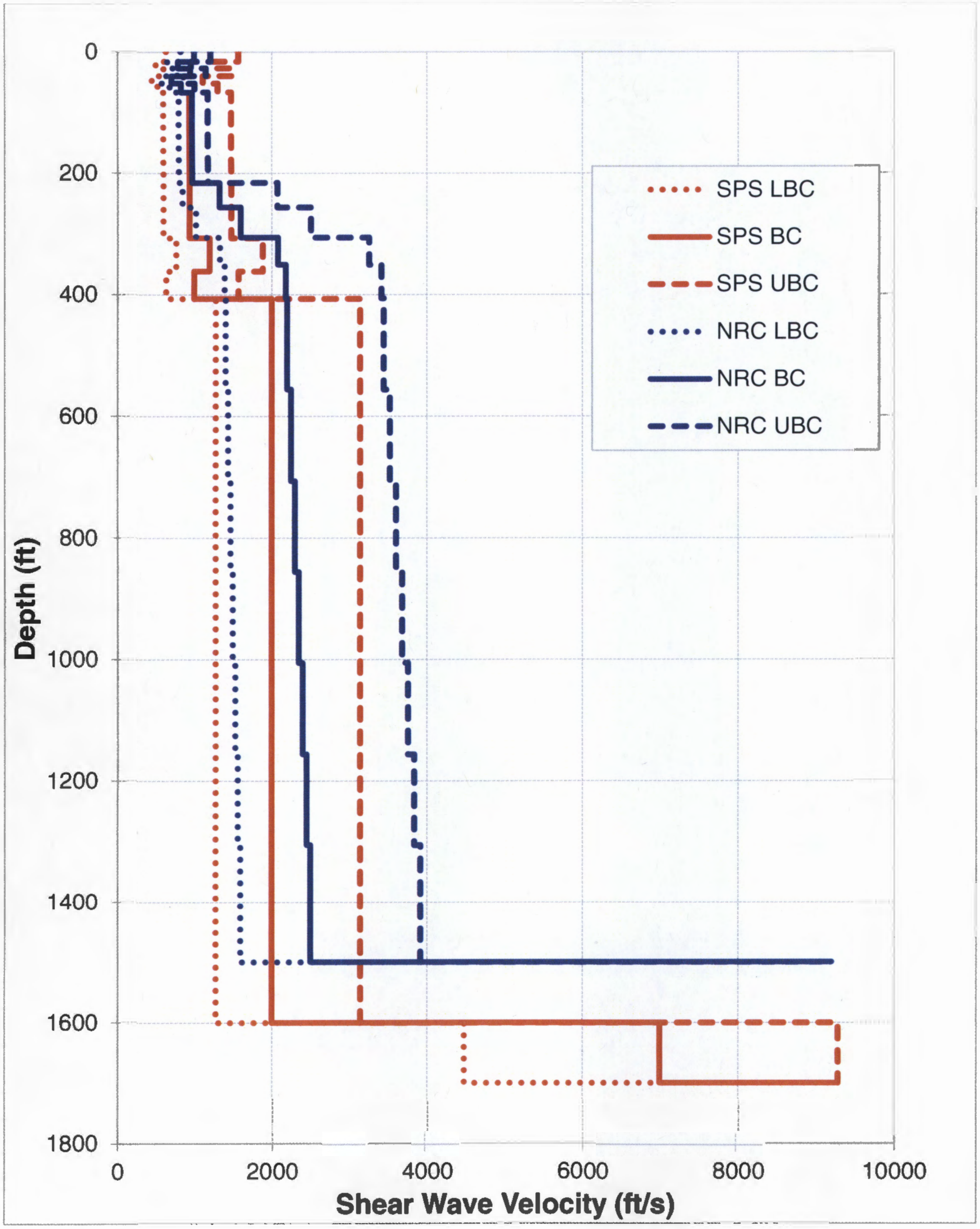


Figure 3.3-2 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for two input loading levels for the SPS site

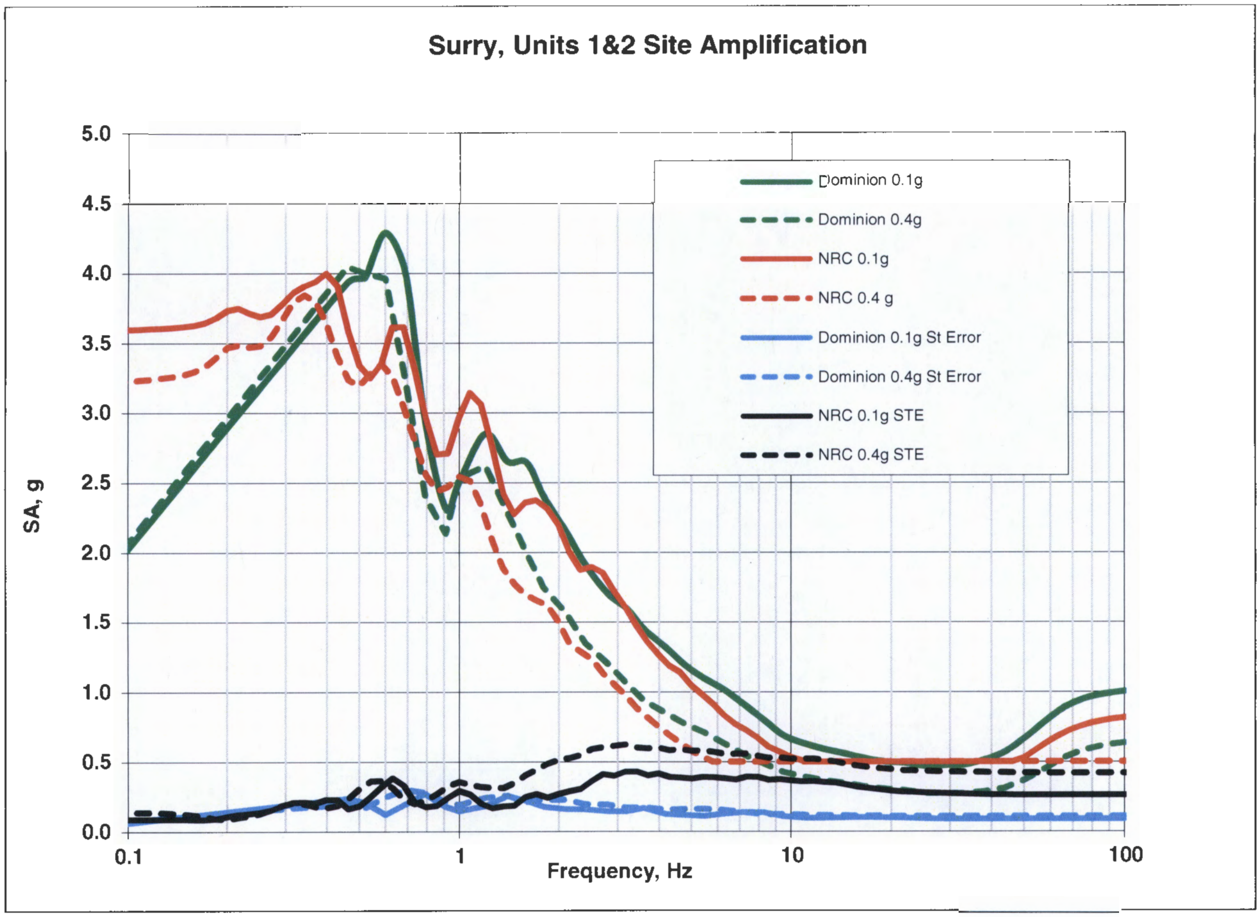


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for the SPS site

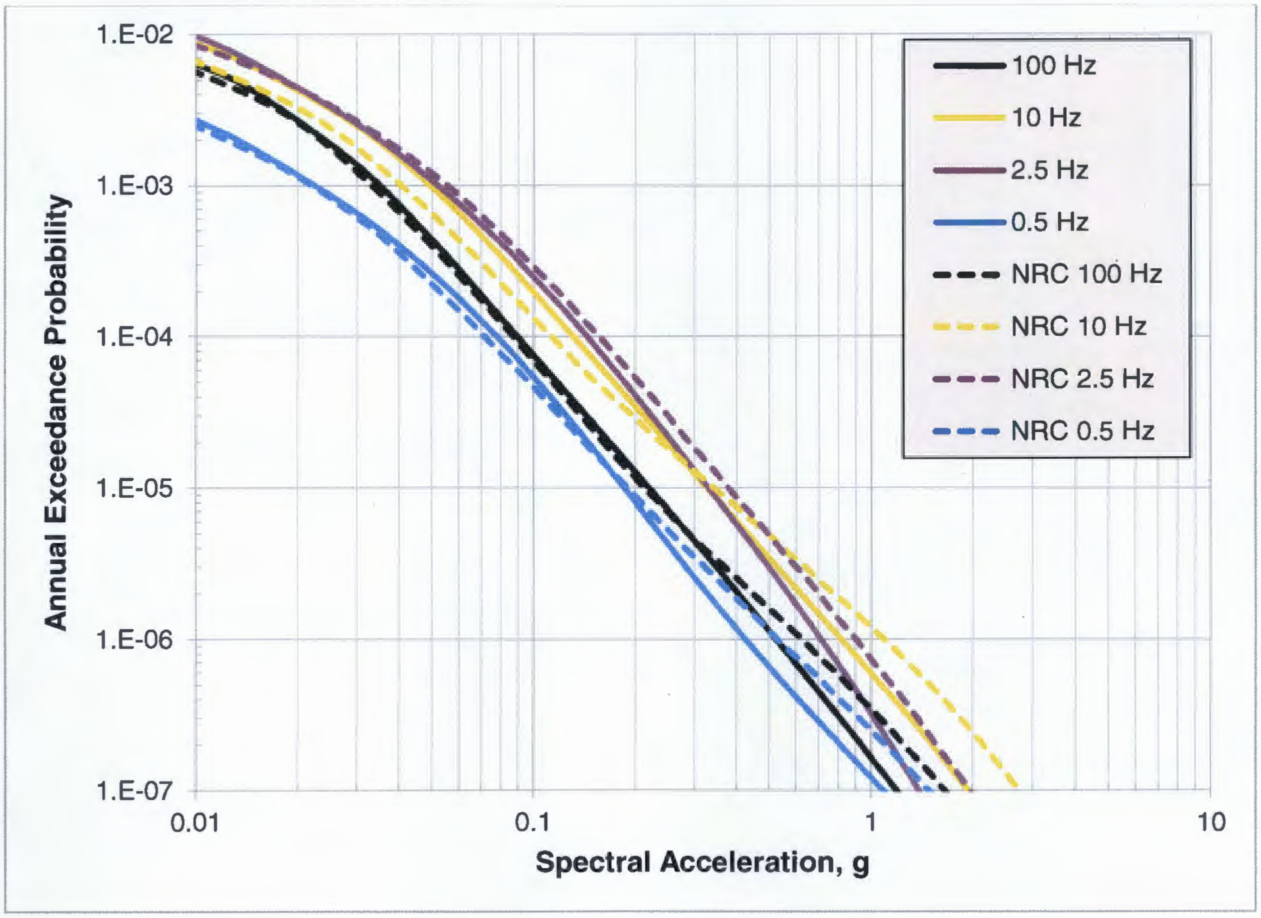
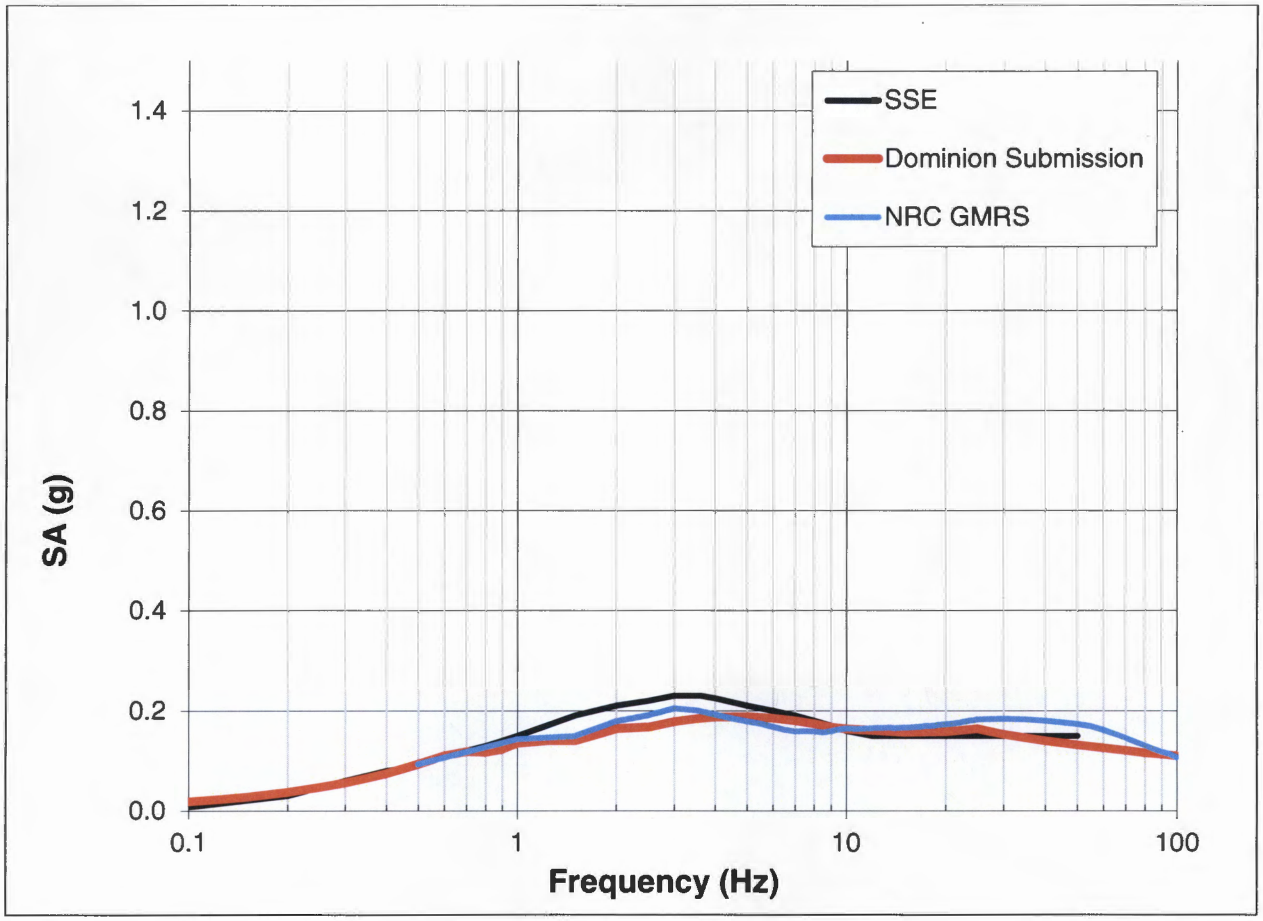


Figure 3.4-1 Comparison of the Staff's GMRS, Licensee's GMRS, and the SSE for the SPS site



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. 50-280 and 50-281

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:
PUBLIC
JHMB R/F
RidsNrrDorlLPL2-1 Resource
RidsNrrPMSurry Resource
RidsNrrLASLent Resource
RidsAcrsAcnw_MailCTR Resource
FVega, NRR
NDiFranceso, NRR
DJackson, NRO
MShams, NRR

ADAMS Accession No. ML15335A093 ***via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RGS/BC*	JLD/JHMB/BC	NRR/JLD/JHMB/PM
NAME	FVega	SLent	DJackson	MShams	FVega
DATE	12/07/2015	12/04/2015	11/18/2015	12/13/2015	12/15/2015

OFFICIAL RECORD COPY