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

April 21, 2015

Mr. Bryan Hanson
Senior Vice President
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President and Chief Nuclear Officer
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4300 Winfield Road
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SUBJECT: LASALLE COUNTY 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 FOR RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NOS. MF3881 AND MF3882)

Dear Mr. Hanson:

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, Exelon Generation Company, LLC (Exelon), previously as Constellation Energy Nuclear Group, LLC responded to this request for LaSalle County Station, Units 1 and 2 (LaSalle).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for LaSalle 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 NTTF Recommendation 2.1, "Seismic".

Contingent upon the NRC's review and acceptance of Exelon's expedited seismic evaluation process, and seismic risk evaluation including the high frequency confirmation and spent fuel pool evaluations (i.e., Items (4), (6), (8), and (9)) for LaSalle Units 1 and 2, 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. 50-373 and 50-374

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

LASALLE COUNTY STATION, UNITS 1 AND 2

DOCKET NOS. 50-373 AND 50-374

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), the U.S. Nuclear Regulatory Commission (NRC) 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), Part 50, Section 50.54(f) "Conditions of license" (hereafter referred to as the "50.54(f) letter"). The request and regulatory actions were issued in connection with implementing lessons-learned and taking regulatory action as a result of the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the "Near-Term Task Force [NTTF] Review of Insights from the Fukushima Dai-ichi Accident" (NRC, 2011b).[1] In particular, the NRC NTTF Recommendation 2.1, and subsequent Staff Requirements Memoranda (SRMs) 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,

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

(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 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 AC 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 ground motion model 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 (NPPs). By letter dated September 12, 2013 (Kaegi, 2013), Exelon Generation Company, LLC (Exelon, the licensee) submitted partial site response information for LaSalle County Station, Units 1 and 2 (LaSalle). By letter dated March 31, 2014 (Kaegi, 2014), Exelon 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." 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-basis 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-basis 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-basis also considered limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The seismic design-basis for currently operating NPPs 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 (Kaegi, 2014), Exelon provided the SHSR for the LaSalle. The licensee's SHSR indicates that the site GMRS exceeds the SSE for LaSalle 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. Also, 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 staff's confirmatory GMRS, exceed the SSE for LaSalle over the frequency range of approximately 5 to 100 Hz. As such, LaSalle screens in for conducting a risk evaluation. Additionally, a SFP evaluation and a high-frequency confirmation for LaSalle 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 that licensees' 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 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 the SHSR, the licensee described its seismic design-basis for LaSalle and states that the SSE is defined in terms of a PGA and a design response spectrum. The response spectral shape is anchored at a PGA of 0.20 g (20 percent of the acceleration due to earth's gravity). The licensee stated that the original LaSalle SSE is based on the Atomic Energy Commission (AEC, now NRC) criteria in effect at the time of the LaSalle County Station construction permit.

In Section 3.2 of the SHSR, the licensee specified that the SSE control point is located at the bottom of the reactor building basemat (located in the concrete mud mat under the foundation) at a mean sea level (MSL) elevation of 666 ft [203 m]. In absence of a control point definition in the

Updated Final Safety Analysis Report (UFSAR; Exelon, 2012) the licensee relied on the LaSalle County Station Design Analysis Calculation 67A, "Soil Structure Interaction/Horizontal Excitation" analysis and UFSAR Figure 3.7-39 (Exelon, 2012), which showed that the elevation 666 ft [203 m] MSL is the appropriate location of the SSE control point, along with 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 LaSalle in the SHSR. With regard to the SSE for LaSalle, based on its review of the SHSR and UFSAR (Exelon, 2012), the staff confirmed that the licensee's SSE is a RG 1.60, Design Response Spectra for Seismic Design at Nuclear Power Plants, spectrum anchored at 0.2 g. This spectral shape is based on the NRC seismic design criteria in effect at the time of the LaSalle construction permit. Finally, based on review of the SHSR and the UFSAR (Exelon, 2012), the staff confirmed that the licensee's control point elevation for LaSalle 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 states 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 states that it included the CEUS-SSC background sources out to a distance of 400 miles (640 km) around the site and included the Commerce, Eastern Rift Margin Fault northern segment (ERM-N), Eastern Rift Margin Fault southern segment (ERM-S), Marianna, New Madrid Fault System (NMFS), and Wabash Valley repeated large magnitude earthquake (RLME) sources, which lie within 621 mi (1,000 km) of the site. 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 provides 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 its own PSHA calculations for base rock site conditions at the LaSalle 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 staff included all CEUS-SSC background seismic sources within a 310 mi (500 km) radius of the LaSalle site. In addition, the staff included all the RLME sources mentioned above which lie within 621 mi (1,000 km) of the site. 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.

Based on review of the SHSR, the staff concludes that the licensee followed the 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 model.

3.3 <u>Site Response Evaluation</u>

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 provides detailed site profile descriptions in Sections 2.3.1 and 2.3.2 of its SHSR based on information provided in the LaSalle UFSAR (Exelon, 2012), summarized in SHSR Table 2.3.1-1, and the guidance in Appendix B of the SPID. According to the licensee, the upland portion of the site where the main power block structures are located consists of approximately 170 ft (52 m) of Pleistocene till resting on about 4,200 ft (1280 m) of firm to hard sedimentary rock with Precambrian basement at a depth of about 4,400 ft (1341 m). Additionally, the licensee describes the hard sedimentary rock units at the site as including nearly flat-lying Pennsylvanian cyclothem sequences (limestones, shales, sandstones, coals) overlying Ordovician limestones, shales, dolomites, and sandstones.

In Table 2.3.1-1 of the SHSR, the licensee provides a brief description of the subsurface materials in terms of the geologic units and layer thicknesses. In Table 2.3.2-1 of the SHSR, the licensee provided the shear-wave velocities determined from seismic refraction and shear wave velocity surveys that it performed during the original site investigation. These geophysical surveys indicated that the shear-wave velocity in the upper 4,400 ft (1341 m) range from 400 to 4,800 ft/sec (122 to 1463 m/sec). The licensee states that the top elevation of its site response is at an elevation of 666 ft (203 m) MSL, which is within the Pleistocene Wisconsinan Wedron Formation and is located at the bottom of the reactor building basemat (located in the concrete mud mat under the foundation).

The licensee developed three base-case shear-wave velocities for the LaSalle site. The licensee used a natural log standard deviation of 0.35 to calculate the lower and upper base case shear-wave velocity profiles with one variation. The licensee varied the upper base case profile to increase the shear-wave velocity between 616 ft (188 m) and 4,400 ft (1341 m) to 9,285 ft/sec (2,830 m/s). Table 2.3.2-1 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.

The licensee states that no site-specific dynamic material properties were determined in the initial siting of LaSalle County Station. Therefore, the licensee stated that it followed the SPID guidance for soil sites and selected two alternative characterizations of nonlinear dynamic material behavior. In one characterization, the licensee used the EPRI (1993) soil shear modulus reduction and hysteretic damping curves over the upper 155 ft (47 m), EPRI (1993) rock shear modulus reduction and hysteretic damping curves between 155 ft (47 m) to a depth of 500 ft (152 m), and modeled linear behavior with 1.25 percent damping below 500 ft (152 m). In the second characterization, the licensee used the Peninsular Range shear modulus reduction and hysteretic damping curves over the upper 155 ft (47 m), linear behavior with damping from EPRI rock shear modulus reduction and hysteretic damping curves between 155 ft (47 m) to a depth of 500 ft (152 m), and linear behavior with 1.25 percent damping below 500 ft (152 m). The licensee assigned equal weights to the two characterizations.

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 the LaSalle site, the licensee provided estimates of kappa in Table 2.3.2-2 of the SHSR, which the licensee calculated using the EPRI soil, EPRI rock, and Peninsular Range curves' low strain damping values, shear-wave velocities, and layer thicknesses to estimate the damping accounted for explicitly in the damping properties discussed above. The licensee also added an additional kappa of 0.006 sec to account for the damping in the underlying base rock material. However, in order to be consistent with the SPID guidance, the licensee limited the depth range of the EPRI rock curves in order to keep kappa equal to or less than the imposed upper value of 0.04 sec for each of the three base case shear-wave velocity profiles. Total profile kappa values for the best estimate, upper, and lower base case velocity profiles are 0.034, 0.040, 0.012 sec, respectively.

To account for randomness in material properties across the plant site, the licensee states in Section 2.3.3 of its SHSR that it randomized its base case shear-wave velocity profiles using parameters developed in Toro (1997), in accordance with Appendix B of the SPID. In addition, as stated in Section 2.3.2 of its SHSR, the licensee randomized the depth to bedrock by ±1,320 ft (±402 m), which corresponds to 30 percent of the total profile thickness. The licensee states that this randomization did not represent the actual uncertainty in the depth to bedrock, but was used to broaden the spectral peaks.

3.3.2 Site Response Method and Results

In Section 2.3.4 of its SHSR, the licensee states 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 describes 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 two of the eleven input loading levels for the base case profile 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 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 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 staff performed site response calculations for the LaSalle site. The staff reviewed the licensee's site response analysis and performed confirmatory calculations to independently test the licensee's calculation following the guidance in Appendix B of the SPID.

The staff conducted three confirmatory calculation tests of the licensee's site response analysis. For its first confirmatory analysis, the staff calculated the site response using all of the licensee's inputs. For its second analysis, the staff calculated the site response using all of the licensee's inputs, except the staff determined both the upper and lower base case shear-wave velocity profiles using a natural log standard deviation of 0.35 and did not, as the licensee did, increase the shear-wave velocity of the upper base case profile to 9,285 ft/sec (2,830 m/s) over the profile depths between 616 ft (188 m) and 4,400 ft (1341 m). Finally for its third analysis, the staff used a lower natural log standard deviation of 0.20 to calculate the lower and upper shear-wave velocity profiles for all layers less than 616 ft (188 m) in the profile and a natural log standard deviation of 0.35 for the layers below 616 ft (188 m). Similar to the licensee, the staff randomized its lower, base, and upper case shear-wave velocity profiles using the guidance provided in the Appendix B of the SPID in order to account for aleatory variability. In addition, to capture the uncertainty in the depth to base rock, the staff randomized the depth to bedrock by ±1,320 ft (±402 m), which corresponds to 30 percent of the total profile thickness and is consistent with the licensee's analyses. In Figure 3.3-1 of this assessment, the staff compared the licensee's base case profiles to those modified by the staff during confirmatory analysis tests.

In the absence of any site-specific dynamic material property measurements, the staff also used the SPID guidance to characterize the dynamic material behavior of the site response profile. The staff used the two alternative characterizations used by the licensee, as described above in Section 3.3.1 of this assessment.

To determine kappa for its final case profiles, the 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 0.033, 0.039, 0.011 sec, respectively, which are similar to the licensee's.

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 two of the eleven input loading levels. The staff's median site amplification factors are similar to the licensee's but somewhat below the licensee's amplification factors between 0.8 and 100 Hz. Below 0.8 Hz, the staff's amplification factors are higher than the licensee's. However, at frequencies below 0.8 Hz, both the staff and licensee's final GMRS are approximately equal to or lower than the site SSE spectrum.

As described above, the staff conducted multiple confirmatory sensitivity tests to evaluate the licensee's characterization of the site subsurface properties, as well as the uncertainties associated with the soil/rock properties. Based on these sensitivity analyses, the staff concludes that the licensee's evaluation for the LaSalle site adequately captures the site amplification occurring as a result of bedrock ground motions travelling upward through the soil/rock column to the control point elevation.

Overall, the licensee's approach to modeling the subsurface rock properties and their uncertainty results in somewhat higher site amplification factors, than did the staff's analysis. However, as shown in Figure 3.3-3 of this assessment, the staff notes that these 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, various 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 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 LaSalle County Station site.

3.4 Ground Motion Response Spectra

In Section 2.4 of the 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} (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 of this assessment, the licensee's GMRS is very similar to the staff's confirmatory GMRS. The staff concludes that the small differences between the two GMRS are acceptable because the licensee followed the guidance provided in the SPID with respect to both the PSHA and site response analysis for the LaSalle site for the response to the 50.54(f) letter.

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

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the LaSalle Site. Based on its review, the staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance, 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 (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the licensee's reevaluated seismic hazard is suitable for other activities associated with NTTF recommendation 2.1, "Seismic".

In reaching this determination, staff confirmed the licensee's conclusion that the licensee's GMRS exceeds the SSE for LaSalle over the frequency range of 1 to 10 Hz. As such, the licensee will perform a seismic risk evaluation, which will include a high-frequency confirmation, and a SFP evaluation. NRC review and acceptance of Exelon's ESEP interim evaluation and seismic risk evaluation with the high frequency and spent fuel pool evaluations (i.e., Items (4), (6), (8), and (9)) for LaSalle Units 1 and 2 will complete the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter.

REFERENCES

Note: ADAMS Accession Nos. refer to documents available through NRC's Agencywide Document 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), 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 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), 2012c. "Japan Lessons-Learned Project Directorate Interim Staff Guidance JLD-ISG-2012-04; Guidance on Performing a Seismic Margin Assessment in Response to the March 2012 Request for Information Letter", ADAMS Accession No. ML12286A028.

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 Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, 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 D. L. Skeen (NRC) 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) Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants."

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

Other References

Electric Power Research Institute (1993). "Guidelines for determining design basis ground motions." Palo Alto, Calif: Electric Power Research Institute, vol. 1-5, EPRI TR-102293.

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, Priorization 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.

Exelon Generation Company, LLC, Updated Final Safety Analysis Report (UFSAR), Revision 19, April 12, 2012, ADAMS Accession No. ML121580191.

LaSalle County Station Design Analysis Calc 67 A, Soil Structure Interaction/Horizontal Excitation, Revision 0.

Kaegi, G., 2013, Letter from G. Kaegi (Exelon Generation Company, LLC) 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. ML13256A070.

Kaegi, G., 2014, Letter from G. Kaegi (Exelon Generation Company, LLC) 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. ML14091A013.

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.

Figure 3.3-1: Plot of Staff's and Licensee's Base Case Shear-Wave Velocity Profiles for LaSalle County Station

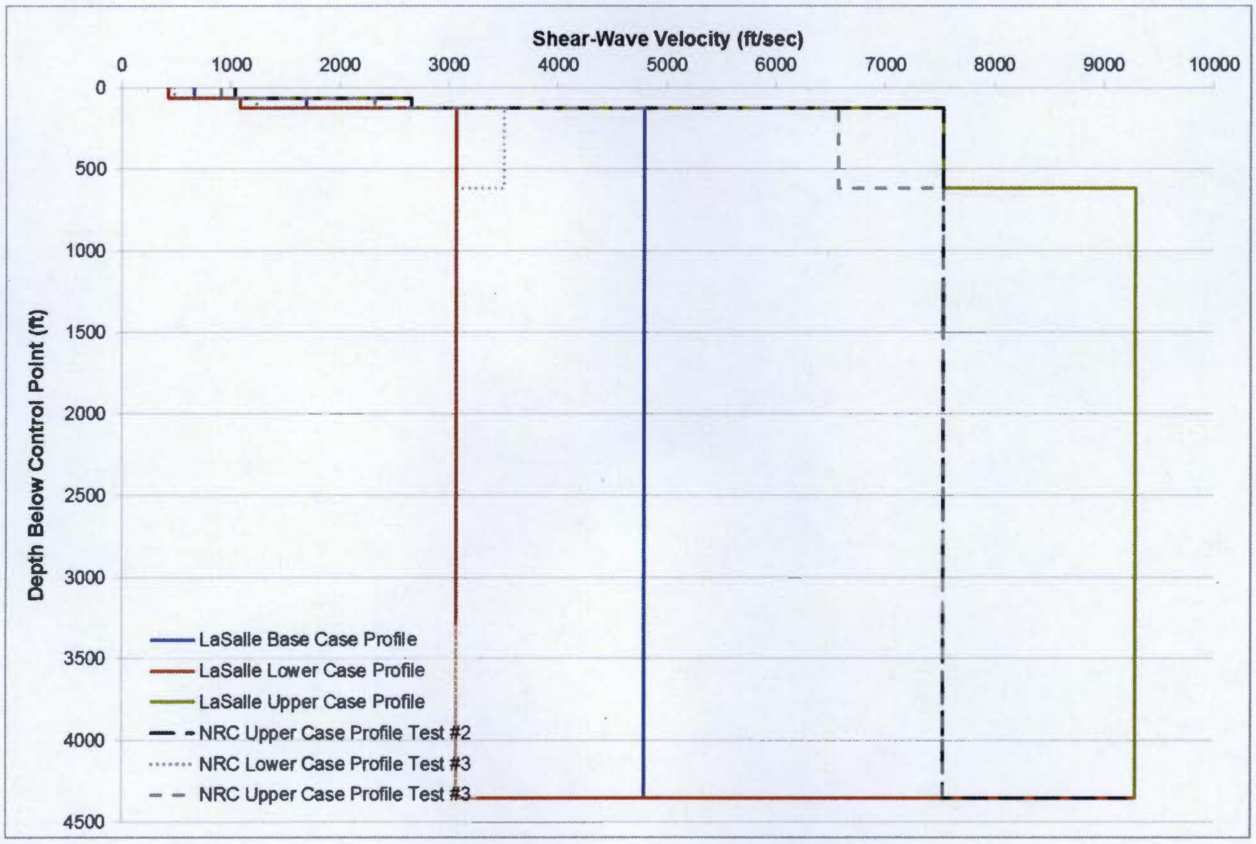


Figure 3.3-2 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for two input loading levels for LaSalle County Station

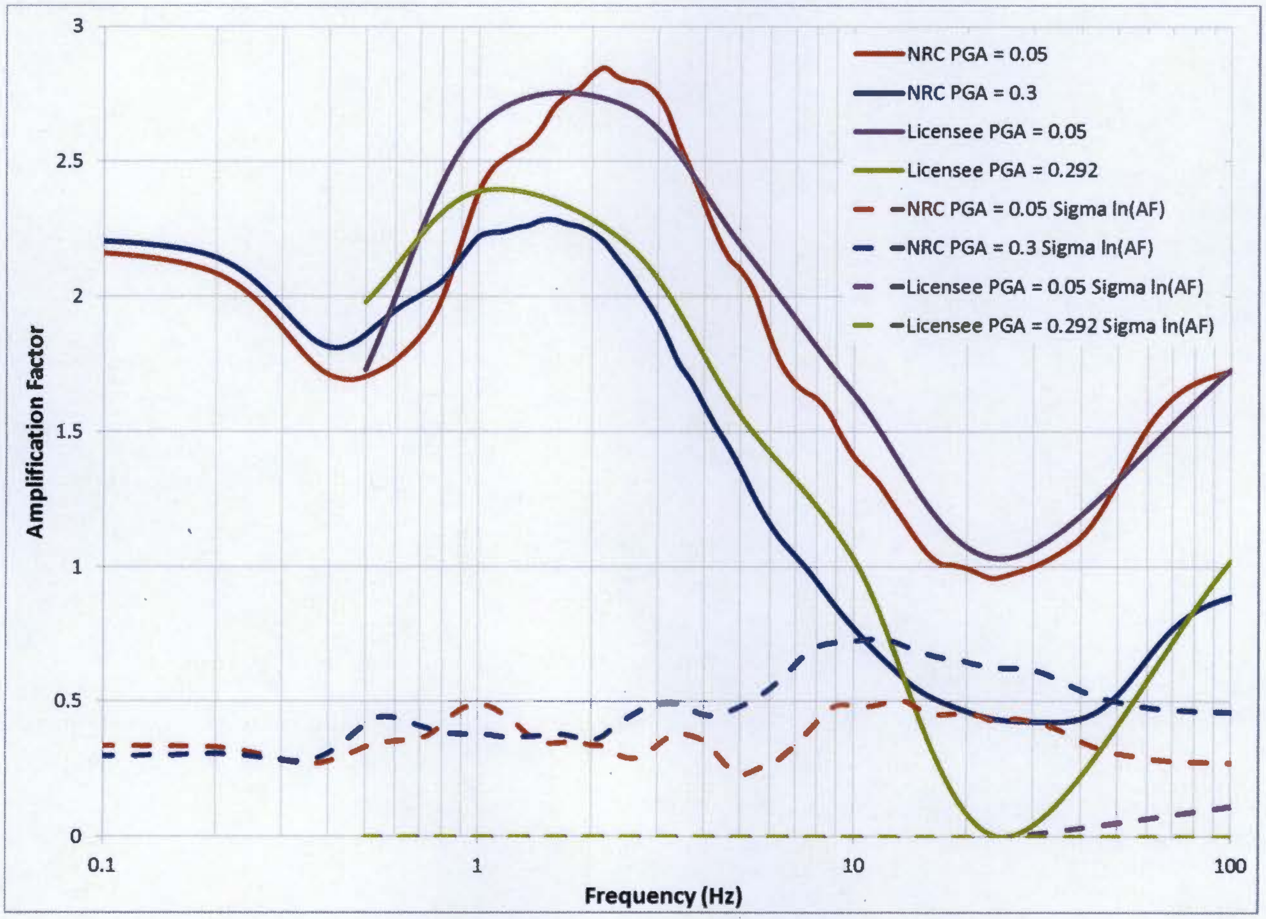


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for LaSalle County Station

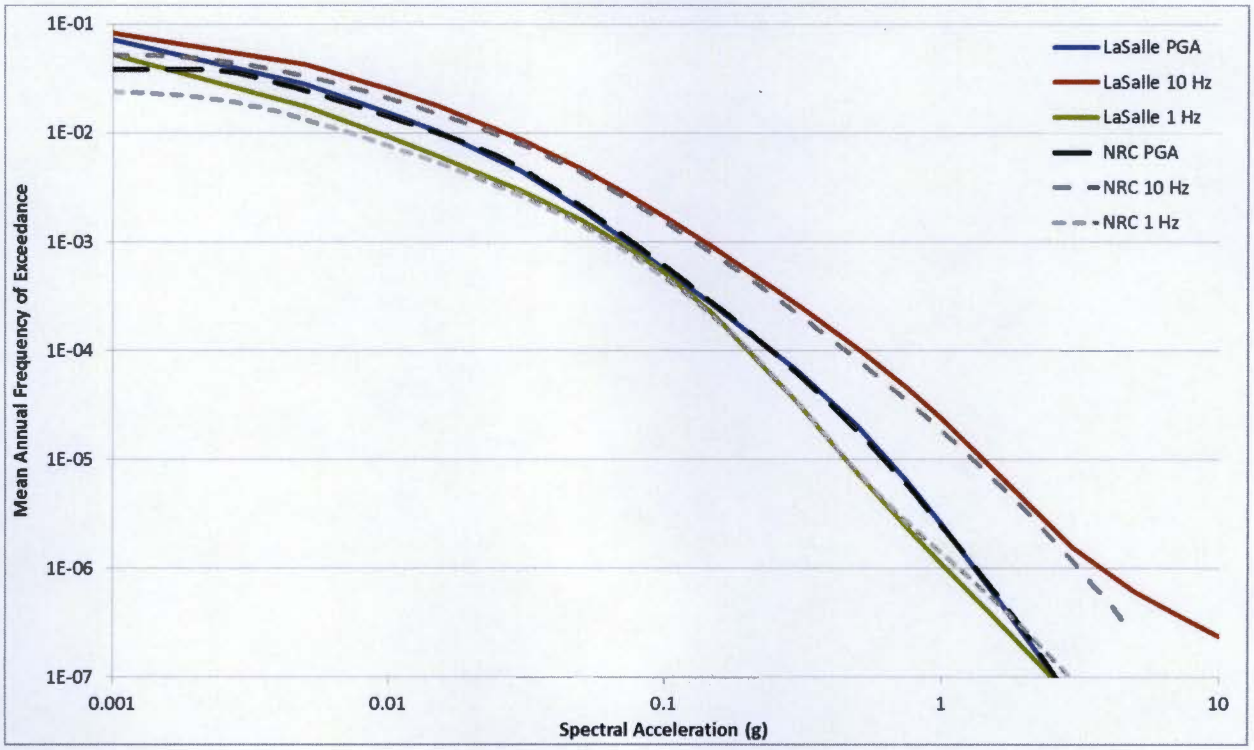
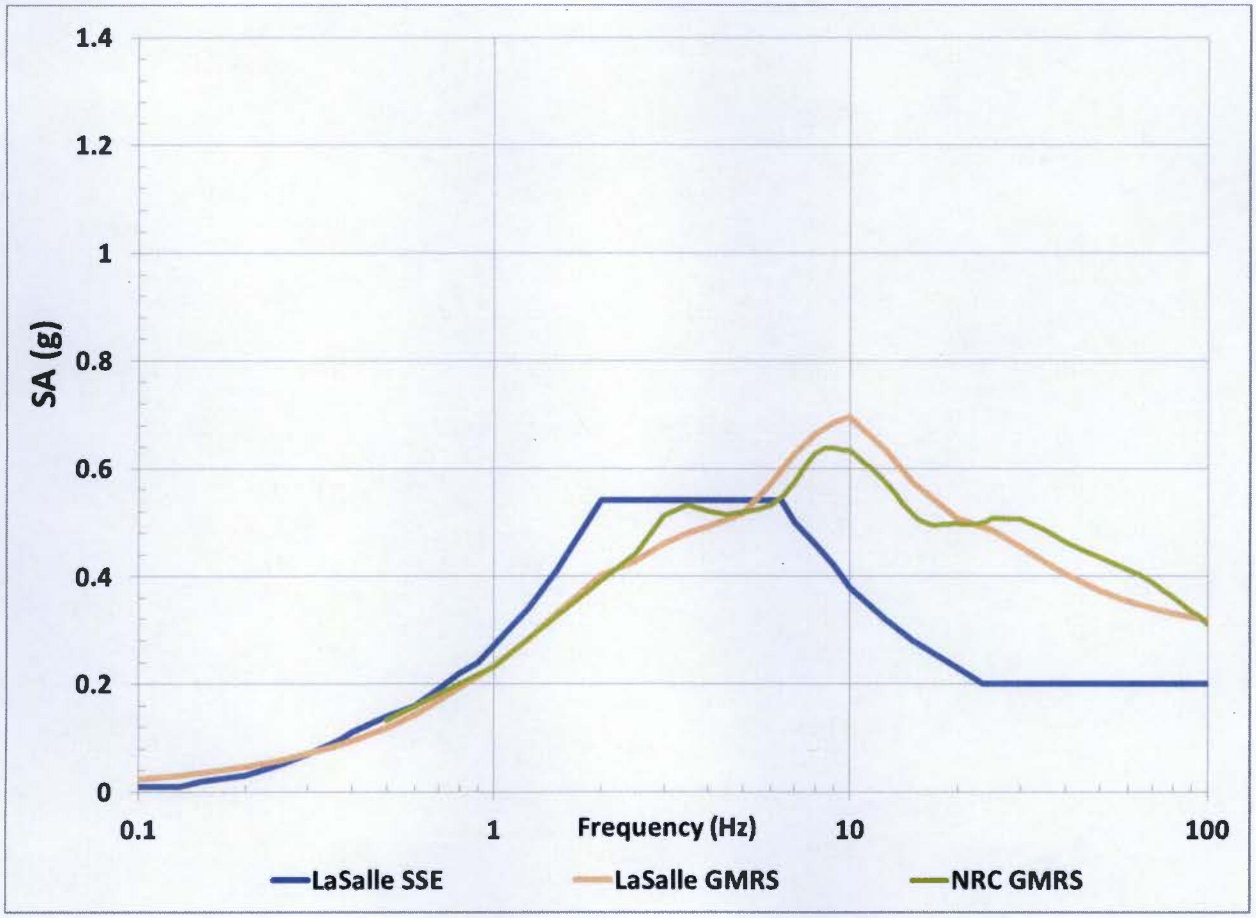


Figure 3.4-1 Comparison of the Staff's GMRS, Licensee's GMRS, and the SSE for LaSalle County Station



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. 50-373 and 50-374

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