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

January 7, 2016

Mr. Mano Nazar
President and Chief
Nuclear Officer
Nuclear Division
NextEra Energy
P.O. Box 14000
Juno Beach, FL 33408-0420

SUBJECT: ST. LUCIE PLANT, UNITS 1 AND 2 - STAFF ASSESSMENT AND CLOSURE 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" (CAC NOS. MF3940 AND MF3941)

Dear Mr. Nazar:

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, Florida Power and light Company (the licensee), responded to this request for the St. Lucie Plant, Units 1 and 2 (St. Lucie).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for St. Lucie 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 St. Lucie. This closes out the NRC's efforts associated with Phase 1 and 2 of NTTF Recommendation 2.1 "Seismic" (CAC Nos. MF3940 and 3941).

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

Sincerely,

Nicholas [signature] for

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

Docket Nos. 50-335 and 50-389

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

ST LUCIE PLANT, UNITS 1 AND 2

DOCKET NOS. 50-335 AND 50-389

1.0 INTRODUCTION

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

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

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

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

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

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

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

---

[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 Seismic Hazard and Screening Report (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 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 agreed to follow the SPID to develop the SHSR for existing nuclear power plants. By letter dated, September 12, 2013 (Jensen, 2013), Florida Power and Light (the licensee) submitted at least partial site response information for St. Lucie Plant, Units 1 and 2 (St. Lucie). By letter dated March 31, 2014 (Jensen, 2014), the licensee submitted its SHSR.

2.0 REGULATORY BACKGROUND

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

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The design bases for 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) GMMs. The SPID provides further guidance regarding the appropriate use of GMMs for the CEUS. Specifically, Section 2.3 of the SPID recommends the use of the updated GMM (EPRI 2013) and, as such, licensees used the NRC-endorsed updated EPRI GMM instead of the older EPRI (2004, 2006)

GMM to develop PSHA base rock hazard curves. Finally, Attachment 1 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 (Jensen, 2014), the licensee provided the SHSR for St. Lucie. The licensee's SHSR indicates that the site GMRS is bounded by the SSE for St. Lucie over the frequency range of 1 to 10 Hertz (Hz). As such, St. Lucie screens out of performing both a seismic risk evaluation and a SFP evaluation. The GMRS is also bounded by the SSE at frequencies above 10 Hz. As such, the licensee indicated that a high-frequency confirmation was not merited.

On May 9, 2014 (NRC, 2014), the NRC staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. As indicated in the letter, the NRC staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS, developed by the NRC staff, are bounded by the SSE in the frequency range of 1 to 100 Hz. Therefore, a seismic risk evaluation, SFP evaluation and a HF confirmation are not merited for St. Lucie.

3.0 TECHNICAL EVALUATION

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

3.1 Plant Seismic Design-Basis

Enclosure 1 of the 50.54(f) letter requests the licensee provide the SSE ground motion values, as well as the specification of the control point elevation(s) for comparison to the GMRS. For operating reactors licensed before 1997, the SSE is the plant licensing basis earthquake and is characterized by (1) a Peak Ground Acceleration (PGA) value which anchors the response spectra at high frequencies (typically at 33 Hz for the existing fleet of nuclear power plants); (2) a response spectrum shape which depicts the amplified response at all frequencies below the PGA; and (3) a control point where the SSE is defined.

In Section 3.1 of its SHSR, the licensee described its seismic design-basis for St. Lucie. The licensee stated that the SSE for St. Lucie is anchored at a PGA of 0.10g and has a RG 1.60 (NRC, 1973) design response spectrum shape. To comply with the minimum accepted acceleration specified by 10 CFR 100, Appendix A, the licensee designed St. Lucie for a PGA of 0.10g, which exceeds the maximum acceleration for the maximum earthquake that has occurred in the same seismotectonic province at the site in the last 200 years. In addition, the licensee specified that the control point is located at the ground surface at elevation 18.5 ft (5.6m).

The NRC staff reviewed the licensee's description of its SSE for the St. Lucie site in the SHSR. To confirm the SSE, the NRC staff reviewed the St. Lucie Updated Final Safety Analysis Report

(UFSAR) Florida Power and Light, 2012). Section 3.0 of the SHSR states that the SSE, as shown in Figure 3.7-4 of the St. Lucie UFSAR, has a RG 1.60 shape. However, UFSAR Figure 3.7-4 depicts the spectra from the synthetic time history used for design rather than the SSE. Based on the staff's review, the SSE is shown in Figure 3.7-2 of the St. Lucie UFSAR and has a Housner shape. Therefore, the NRC staff based its screening evaluation for the St. Lucie site on a comparison of the GMRS with the licensee's design-basis SSE, which has a Housner shape and is lower than a RG 1.60 spectrum in the 1 to 10 Hz range. As stated above in Section 2.1, the staff's screening review indicates that the GMRS is bounded by the SSE over the entire frequency range. In addition, based on review of the SHSR and the UFSAR, the NRC staff confirmed that the licensee's control point elevation is consistent with the guidance provided in the SPID.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of its SHSR, the licensee stated that, in accordance with the 50.54(f) letter and the SPID, it performed a PSHA using the CEUS-SSC model and the updated EPRI GMM for the CEUS (EPRI, 2013). The licensee used a minimum magnitude of **M** 5.0, as specified in the 50.54(f) letter. The licensee further stated that it included the CEUS-SSC background sources out to a distance of 400 miles (640 km) around the site and included the Charleston RLME source, which lies within 620 mi (1,000 km) of the site. The RLME sources are those source areas or faults for which more than one large magnitude (**M** ≥ 6.5) earthquake has occurred in the historical or paleo-earthquake (geologic evidence for prehistoric seismicity) record. The licensee used the Gulf version of the updated EPRI GMM (EPRI, 2013) for each of the CEUS- SSC sources and a combination of 66 percent Gulf and 34 percent mid-continent for the Charleston RLME source. 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 its own PSHA calculations for base rock conditions at the St. Lucie site. As input, the NRC staff used the CEUS-SSC model as documented in NUREG-2115 (NRC, 2012b) along with the updated EPRI GMM (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 St. Lucie site. In addition, the NRC staff included all of the RLME sources falling within a 620 mi (1000 km) radius of the site, which includes the Charleston RLME source. For each of the CEUS-SSC sources used in the PSHA, the NRC staff used the Gulf 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 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 the licensee provide a GMRS developed from the site-specific seismic hazard curves at the control point elevation. In addition, the 50.54(f) letter specifies that the subsurface site response models, for both soil and rock sites, should extend to sufficient depth to reach the generic or reference rock conditions as defined in the GMMs used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that the licensee perform a site response analysis.

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

The purpose of the site response analysis is to determine the site amplification that 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

In its SHSR, the licensee indicated that the site is located on an offshore sandbar along the east coast of Florida at an elevation of 18.5 ft (5.6 m). The subsurface profile consists of about 80 ft (24 m) of fill overlying about 700 ft (213 m) of soils underlain by about 13,000 ft (3,960 m) of Jurassic through Tertiary age carbonate rocks above a Paleozoic crystalline basement. Table 2.3.1-1 of the SHSR summarizes the subsurface profile for the St. Lucie site, including description of the geologic units, thickness and shear wave velocity.

The licensee stated that the shear wave velocities for its best-estimate (P1) base case model are based on measurements at St. Lucie, Units 1 and 2 over the upper 160 ft (48.8 m). The measured shear wave velocities beneath the site range from about 800 ft/sec (244 m/s) at the control point elevation to a velocity of 1200 ft/sec (366 m/s) at an elevation of 151 ft (46 m). The licensee extended this velocity gradient to a depth of 178 ft (54 m) and then used the 270 m/s velocity profile from the SPID to a depth of about 740 ft (226 m). The licensee estimated the depth of carbonate rock to be at 740 ft (226 m) beneath the control point elevation and assigned a shear wave velocity of 5000 ft/sec (1524 m/sec) for the top of this layer. For the carbonate rock layer, the licensee used the velocity gradient of 0.5 m/sec/m recommended in the SPID and extended its best estimate base case profile to a velocity of 7,400 ft/sec (2,255 m/sec) at a depth of 5,079 ft (1,548 m).

To accommodate epistemic uncertainty in shear wave velocities, the licensee selected a scale factor of 1.57, reflecting both the age and sparseness of shear wave velocity measurements at the site, to develop lower (P2) and upper (P3) base case velocity profiles. For the upper profile, the licensee assumed that the reference rock velocity of 9,285 ft/sec (2,890 m/sec) is reached at a depth of 2,323 ft (708 m) below the control point elevation. Figure 3.3-1 of this assessment shows the licensee's three shear-wave velocity profiles.

Recent laboratory testing results for nonlinear dynamic material properties were not available for the soils or firm rock materials at the St. Lucie site. Therefore, the licensee selected two sets of modulus reduction and hysteretic damping curves to accommodate a realistic range in soil nonlinearity over the top 500 ft (152 m) of the three profiles. Consistent with the SPID, the licensee considered the EPRI soil curves (model M1) to be appropriate to represent the upper range of nonlinearity in the materials at the site. The licensee assumed that the Peninsular Range (PR) curves (model M2) represent an equally plausible less nonlinear alternative response.

The licensee determined base-case kappa estimates using Appendix B-5.1.3.1 of the SPID. 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 estimated values of kappa 0.033 sec, 0.040 sec and 0.017 sec for the base case, lower and upper base case profiles, and concluded that this range of kappa reflects a reasonable assessment of epistemic uncertainty.

To account for randomness in material properties across the plant site in its site response calculations, the licensee stated that it randomized its three base case shear-wave velocity profiles. The licensee also randomized the total thickness of profiles P1 and P2 by about ±30 percent of the depth, which the licensee stated provides a realistic broadening of the fundamental resonance at the site rather than actual random variations to basement shear wave velocities across the site footprint.

3.3.2 Site Response Method and Results

In Section 2.3.5 of its SHSR, the licensee stated that it employed a random vibration theory (RVT) approach to perform its site response calculations. The licensee stated that this approach is consistent with present-day guidance and methodology. Furthermore, the licensee stated that its site response approach is also consistent with the SPID in terms of incorporating epistemic uncertainty in shear-wave velocities, non-linear dynamic material properties, and source spectra for sites with limited at-site information.

In order to develop probabilistic site-specific control point hazard curves requested in Requested Information Item 1 of the 50.54(f) letter, the licensee used Method 3, which is described in Appendix B-6.0 of the SPID. The licensee's use of Method 3 involved computing the site-specific control point hazard curve for a broad range of spectral accelerations given the site-specific bedrock hazard curve and the site-specific estimates of soil or soft-rock response and associated uncertainties. The licensee provided its resulting control point hazard curves for the seven specified oscillator frequencies in SHSR Figure 2.3.7-1 and Appendix A.

3.3.3 Staff Confirmatory Analysis

To confirm the licensee's site response analysis, the NRC staff performed site response calculations for the St. Lucie site. The NRC staff independently developed shear-wave velocity profiles, damping values, and modeled the potential nonlinear behavior of the soil and rock using measurements and geologic information provided in the St. Lucie UFSAR (Florida Power and Light, 2012), geophysical information provided in the Crystal River (Duke Energy, 2014) and the Levy County (Duke Energy, 2014) UFSARs, and Appendix B of the SPID. For its site response calculations, the staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

To develop its best estimate base case velocity profile, the NRC staff used the measured on- site velocity information over the upper 160 ft (48.8 m). Below this depth, the NRC staff developed a velocity profile based on the soil type and rock lithologies for the region. The staff's best estimate base case profile generally demonstrates similar behavior as the licensee's profile except the staff's profile shear-wave velocity increases gradually below the depth of 600 ft (182.9 m) from 4000 ft/sec (1,219 m/sec) to 7800 ft/sec (2377 m/sec) at the presumed bedrock depth of 8000 ft (2438 m). To capture the uncertainty in the site subsurface geology, the NRC staff developed three base case shear-wave velocity profiles using a scale factor of 1.57, which corresponds to a natural log standard deviation of 0.35. Figure 3.3-1 of this assessment shows the NRC staff velocity profile compared to the base case profiles developed by the licensee. The profiles developed by the NRC staff have lower seismic velocities and have a deeper depth to base rock than those developed by the licensee. The NRC staff randomized the depth to base rock by ±20 percent to allow for additional uncertainty.

Consistent with guidance in the SPID, the NRC staff assumed that the upper 500 ft (152 m) of soil could behave either in a nonlinear or linear manner to the range of input loading. To model the nonlinear behavior, the NRC staff used the EPRI soil shear modulus and damping material curves and to model the linear response the NRC staff used a constant small strain damping value consistent with the Peninsular curves.

To determine kappa for its profiles, the NRC staff used the low strain damping values, shear wave velocities, Q-values, 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, 0.016, 0.040 sec, respectively. Figure 3.3-2 of this assessment shows a comparison of the NRC staff's and licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. Due to the differences in shear-wave velocity profiles the staff's amplification functions are slightly lower than those of the licensee's. In addition, the staff's amplification factor uncertainties are somewhat higher than the licensee's for the two loading levels.

As shown in Figure 3.3-3 of this assessment, 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. Figure 3.3-3 shows that between the 10^{-4} and 10^{-5}, the staff's and licensee's control point hazard curves are similar. Appendix B of the SPID provides guidance for performing site response analyses, including capturing the uncertainty for sites with less subsurface data; however, the guidance is neither entirely prescriptive nor comprehensive. As such, various approaches in performing site response analyses, including the modeling of uncertainty, are acceptable for the response to the 50.54(f) letter.

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 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 St. Lucie 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 the GMRS using the criteria in RG 1.208.

The NRC staff independently obtained the 10^{-4} and 10^{-5} UHRS using the results of its confirmatory PSHA and site response calculations described in Sections 3.2 and 3.3 of this NRC 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 of this staff assessment, the licensee's GMRS shape is similar to the staff's GMRS across the entire frequency range, although the licensee's GMRS has a flatter profile at high frequencies than the NRC's GMRS. The NRC staff also noted that the NRC's SSE differs from that of the licensee in both shape and spectral acceleration. The NRC's SSE is also a smoother curve than the licensee's with a lower spectral acceleration.

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 St. Lucie site. Therefore, this GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) lettter.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the St. Lucie 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) – (9), identified in Enclosure 1 of the 50.54(f) letter.

In reaching this determination, the NRC staff confirmed the licensee's conclusion that its GMRS for the St. Lucie site is bounded by the SSE in the 1 to 100 Hz frequency range. As such, a seismic risk evaluation, HF confirmation, and SFP evaluation are not merited. Based upon the preceding analysis, the NRC staff concludes that the licensee responded appropriately 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), 1973, Design Response Spectra for Seismic Design of Nuclear Power Plants, Regulatory Guide (RG) 1.60, December 1973.

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

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

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

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

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.

<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.

Duke Energy, 2014. Crystal River UFSAR, Revision 34.

Duke Energy, 2014. Levy County FSAR, Revision 7.

Florida Power and Light (FPL), 2012. FPL St. Lucie Unit 2 UFSAR, Amendment No. 21, Section 3.7 "Seismic Design" and Section 2.5 "Geology, Seismology".

Jensen, J., 2013, Florida Power and Light (FPL) Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) , Regarding the Seismic Aspects of Recommendation 2.1of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident -1.5 Year Response September 12, 2013, Letter, ADAMS Accession No. ML13263A245.

Jensen, J., 2014,Florida Power and Light (FPL) Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Re: Recommendation 2.1of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident , March 31, 2014, Letter, ADAMS Accession No. ML14099A106.

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.

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

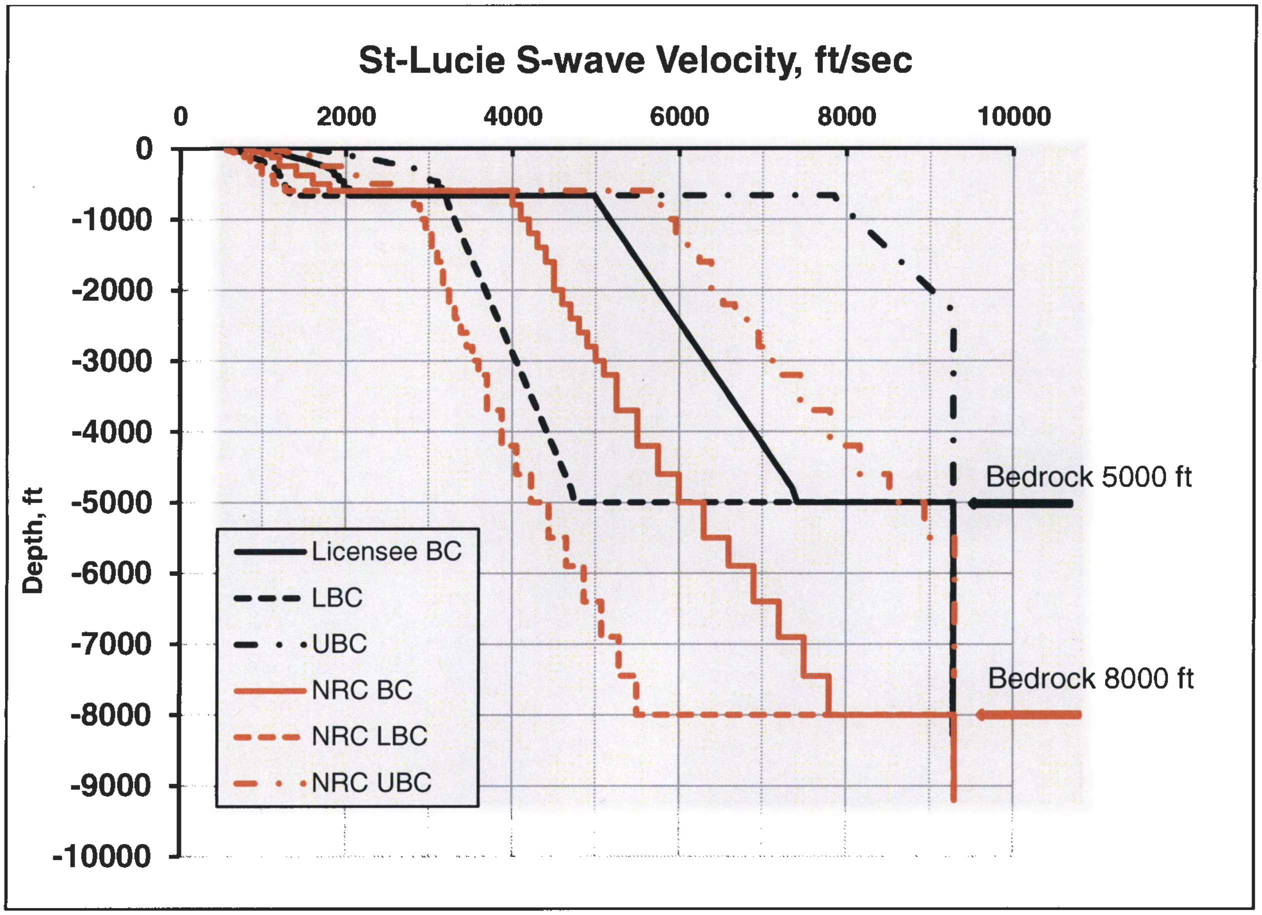


Figure 3.3-1 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties

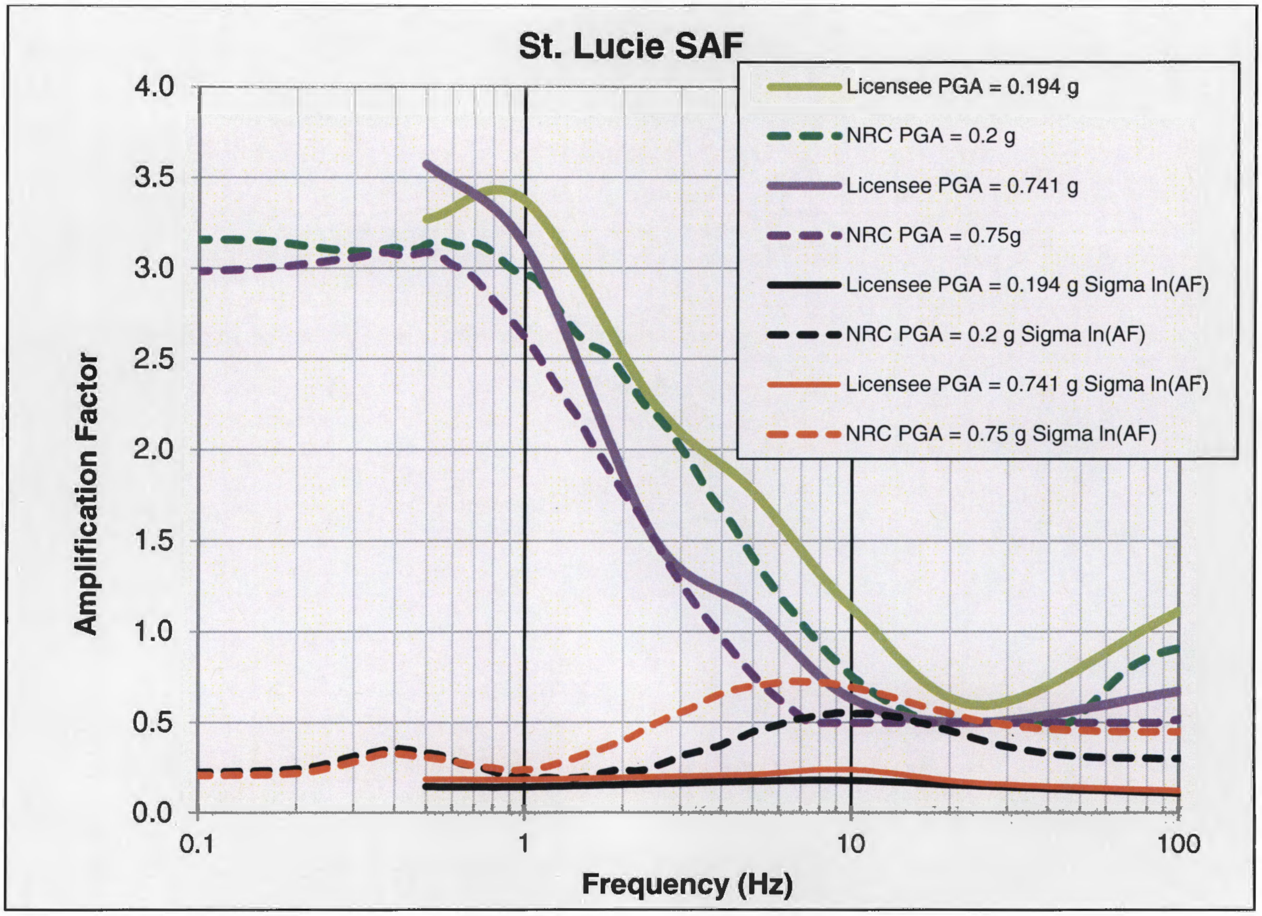


Figure 3.3-2 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at t a Variety of Frequencies

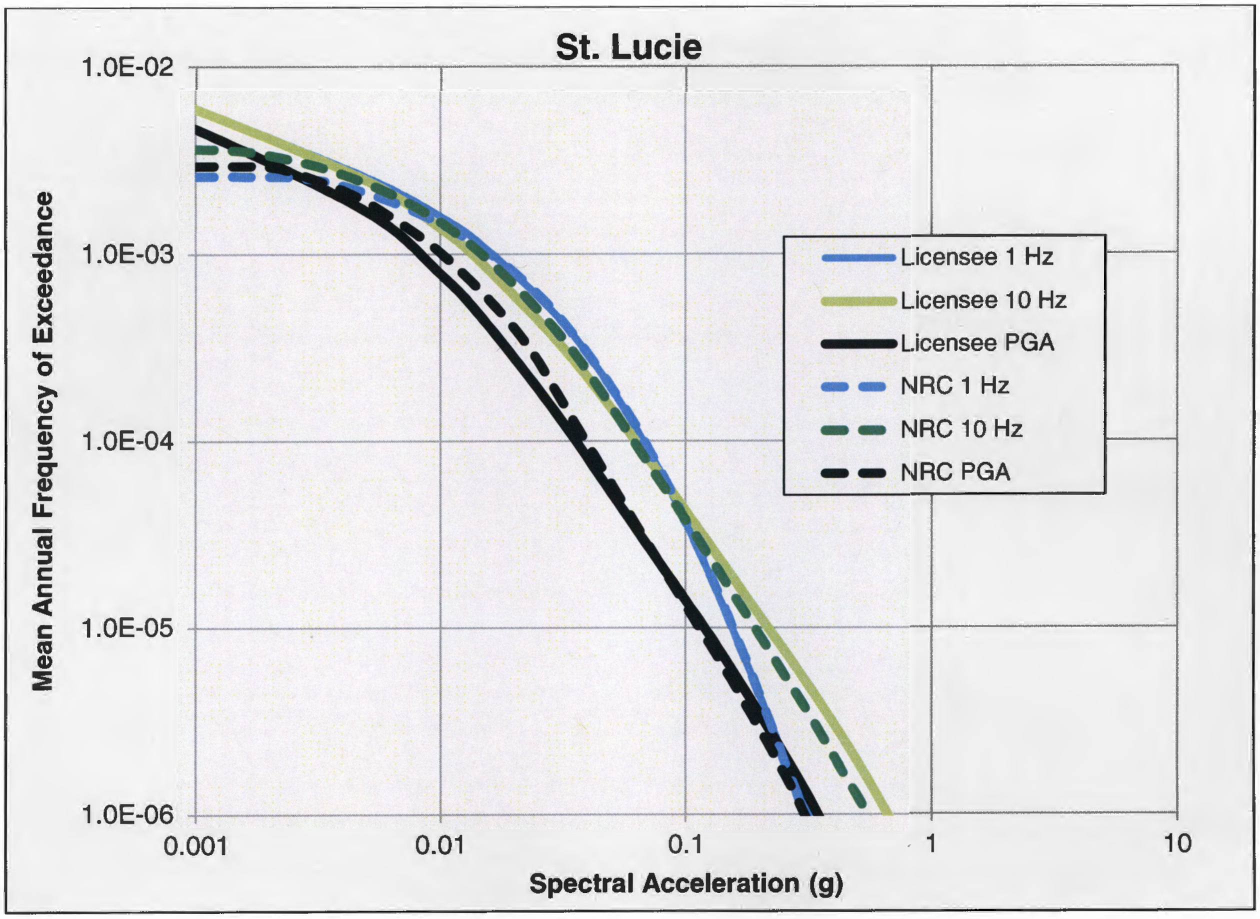
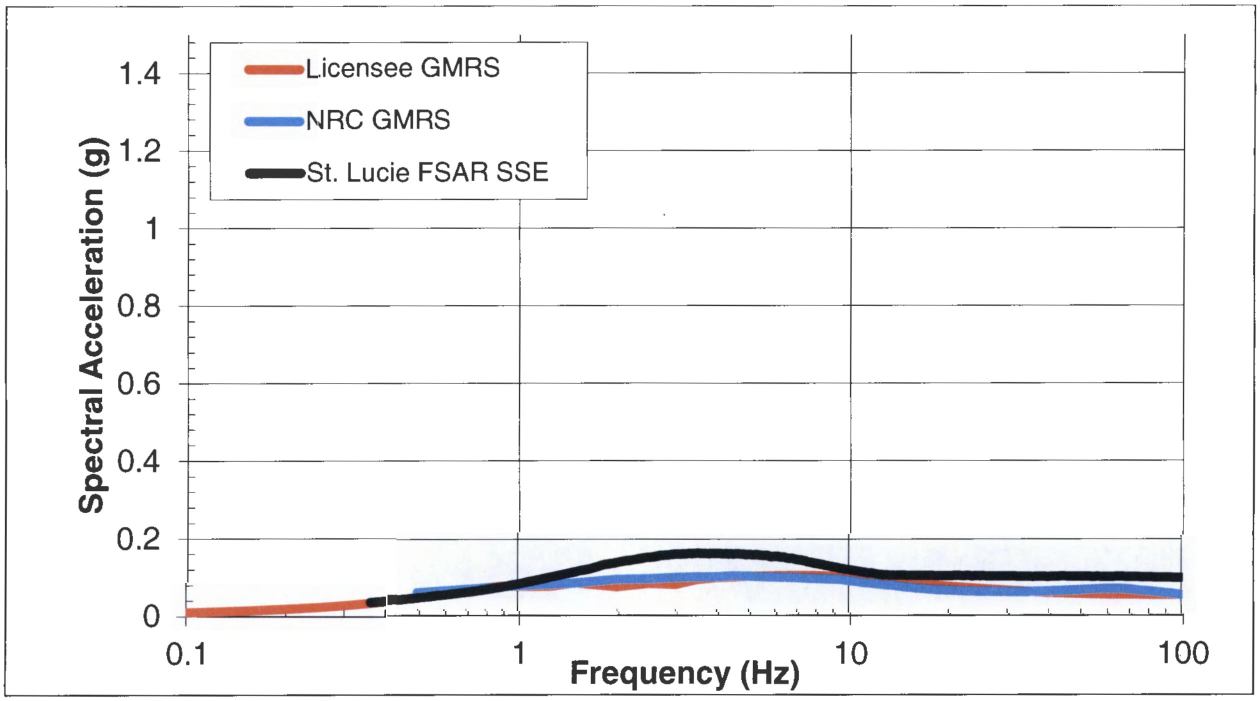


Figure 3.4-1 Comparison of the Staff's GMRS, Licensee's GMRS and the St. Lucie Unit Nos. 1 and 2 SSE.



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

Sincerely,

/RA Nicholas DiFrancesco Acting for/

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

Docket Nos. 50-335 and 50-389

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:
PUBLIC
JHMB R/F
RidsNrrDorlLPL2-2 Resource
RidsNrrPMStLucie Resource
RidsNrrLASLent Resource
RidsAcrsAcnw_MailCTR Resource
FVega, NRR
NDiFranceso, NRR
DJackson, NRO
MShams, NRR

ADAMS Accession No. ML15352A053 ***via email**

OFFICE	NRR/JLD/JHMB	NRR/JLD	NRO/DSEA/RGS*	JLD/JHMB	NRR/JLD/JHMB
NAME	FVega (NDiFrancesco for)	SLent	DJackson	MShams (MMarshall for)	FVega (NDiFrancesco for)
DATE	1/7/2016	12/29/2015	12/11/2015	1/3/2016	1/7/2016

OFFICIAL RECORD COPY