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

April 21, 2015

Mr. Fadi Diya
Senior Vice President and Chief
Nuclear Officer
Ameren Missouri
Callaway Plant
P.O. 620
Fulton, MO 65251

SUBJECT: CALLAWAY PLANT, UNIT 1 - STAFF ASSESSMENT OF INFORMATION PROVIDED PURSUANT TO TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* PART 50, SECTION 50.54(f), SEISMIC HAZARD REEVALUATIONS RELATING TO RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NO. MF3739)

Dear Mr. Diya:

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The purpose of that request was to gather information concerning, in part, seismic hazards at each operating reactor site and to enable the NRC staff, using present-day NRC requirements and guidance, to determine whether licenses should be modified, suspended, or revoked.

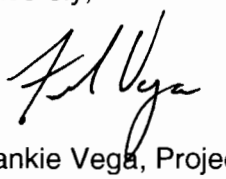
By letter dated March 28, 2014, Union Electric Company, doing business as Ameren Missouri (UE, the licensee), responded to this request for Callaway Plant, Unit 1 (Callaway).

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

Contigent upon the NRC's review and acceptance of the UE expedited seismic evaluation process, and seismic risk evaluation including the high frequency and spent fuel pool evaluations (i.e., Items (4), (6), (8), and (9)) for Callaway, 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. 50-483

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

CALLAWAY PLANT, UNIT 1

DOCKET NO. 50-483

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), 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,

---

[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 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) that the licensee provide a Seismic Hazard and Screening Report (SHSR) by 1.5 years after issuance of the 50.54(f) letter. However, in order to complete its update of the EPRI seismic ground motion models (GMM) for the CEUS (EPRI, 2013), industry proposed a six-month extension to March 31, 2014, for submitting the SHSR. Industry also proposed that licensees perform an expedited assessment, referred to as the Augmented Approach, for addressing the requested interim evaluation (Item (6) above), which would use a simplified assessment to demonstrate that certain key pieces of plant equipment for core cooling and containment functions, given a loss of all alternating current power, would be able to withstand a seismic hazard up to two times the design-basis. Attachment 2 to the April 9, 2013, letter (Pietrangelo, 2013) provides a revised schedule for plants needing to perform (1) the Augmented Approach by implementing the Expedited Seismic Evaluation Process (ESEP) and (2) a seismic risk evaluation. By letter dated May 7, 2013 (NRC, 2013a), the NRC determined that the modified schedule was acceptable and by letter dated August 28, 2013 (NRC, 2013c), the NRC

determined that the updated GMM (EPRI, 2013) is an acceptable 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 (Reasoner, 2013), Union Electric Company, doing business as Ameren Missouri (UE, the licensee) submitted partial site response information for Callaway Plant, Unit 1 (Callaway). By letter dated March 28, 2014 (Neterer, 2014), UE submitted its SHSR for Callaway.

2.0 REGULATORY EVALUATION

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

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that had been historically reported for the site and surrounding area. The design bases also considered limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The seismic design bases for currently operating nuclear power plants were either developed in accordance with, or meet the intent of GDC 2 and 10 CFR Part 100, Appendix A. Although the regulatory requirements in Appendix A to 10 CFR Part 100 are fundamentally deterministic, the NRC process for determining the seismic design-basis ground motions for new reactor applications after January 10, 1997, as described in 10 CFR 100.23, requires that uncertainties be addressed through an appropriate analysis such as a probabilistic seismic hazard analysis (PSHA).

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. On March 12, 2012, the NRC staff issued requests for licensees to reevaluate the seismic hazards at their sites using present-day NRC requirements and guidance, and identify actions planned to address plant-specific vulnerabilities associated with the updated seismic hazards.

Attachment 1 to Enclosure 1 of the 50.54(f) letter describes an acceptable approach for performing the seismic hazard reevaluation for plants located in the CEUS. Licensees are expected to use the CEUS Seismic Source Characterization (CEUS-SSC) model in NUREG-2115 (NRC, 2012b) along with the appropriate EPRI (2004, 2006) 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 28, 2014 (Neterer, 2014), UE provided the SHSR for Callaway, Unit 1. The licensee's SHSR indicated that the site GMRS exceeds the SSE over the frequency range of 1 to 10 Hertz (Hz). As such, Callaway screens in for conducting a plant seismic risk evaluation. A SFP evaluation will also be performed. In addition, due to exceedances above 10 Hz, the licensee indicated that a high-frequency confirmation would be performed for Callaway as part of the plant seismic risk evaluation.

On May 9, 2014 (NRC, 2014), the staff issued a letter providing the outcome of the 30-day screening and prioritization evaluation. As indicated in the letter, the staff confirmed the licensee's screening results. The licensee's GMRS, as well as the confirmatory GMRS developed by the staff, exceeds the SSE for Callaway over the frequency range of 1 to 10 Hz. Therefore, Callaway screens in for conducting a seismic risk evaluation. A SFP evaluation is also merited. The staff also confirmed the licensee's conclusion that a high-frequency confirmation for Callaway is merited because the GMRS exceeds the SSE for frequencies above 10 Hz.

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

In Section 3.1 of the SHSR, the licensee described the seismic design-basis for Callaway. The licensee stated that according to the updated final safety Analysis report (FSAR), the SSE response spectra was defined as a horizontal ground acceleration at foundation level of 0.20g, equivalent to a Modified Mercalli intensity VIII event. The licensee defined the SSE in terms of a PGA and RG 1.60 design response spectral shape anchored to a 0.20g PGA, as shown in Figure

3.1-1 and Table 3.1-1 of the SHSR. The licensee specified the SSE control point at the free field at finished grade which is at an elevation of 840 ft (256 m).

The staff reviewed the licensee's description of the SSE for Callaway in the SHSR. To further confirm the SSE, the staff also reviewed the FSAR for Callaway, Unit 1 (Callaway, 2013). Based on its review, 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 a PGA of 0.20 g. In addition, based on review of the SHSR and the FSAR, the staff confirmed that the licensee's control point elevation for the Callaway SSE is consistent with the guidance provided in the SPID.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of the SHSR, the licensee stated that, in accordance with the 50.54(f) letter and the SPID, it performed a PSHA using the CEUS-SSC model and the updated EPRI GMM for the CEUS (EPRI, 2013). The licensee used a minimum earthquake 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 Meers and New Madrid Fault System repeated large magnitude earthquake (RLME) sources, which lie within 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 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 staff performed PSHA calculations for base rock site condition at the Callaway site. As input, the 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, and licensee's approach, the staff included all CEUS-SSC background seismic sources within a 310 mi (500 km) radius of the Callaway site. In addition, similar to the licensee's calculations the staff included the RLME seismic sources within 1000 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).

Based on review of the SHSR, the staff concludes that the licensee appropriately followed the guidance provided in the SPID for selecting the PSHA input models and parameters for the site. This includes the licensee's use and implementation of the CEUS-SSC model and the updated EPRI GMM.

3.3 Site Response Evaluation

After completing PSHA calculations for reference rock site conditions, Attachment 1 to Enclosure 1 of the 50.54(f) letter requests that 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 model, for both soil and rock sites, should extend to sufficient depth to reach the generic or base rock conditions as defined in the ground motion models used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that licensees perform a site response analysis.

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

The purpose of the site response analysis is to determine the site amplification that will occur as a result of bedrock ground motions propagating upwards through the soil/rock column to the surface. The critical parameters that determine what frequencies of ground motion are affected by the upward propagation of bedrock motions are the layering of soil and/or soft rock, the thicknesses of these layers, the shear-wave velocities and low-strain damping of the layers, and the degree to which the shear modulus and damping change with increasing input bedrock amplitude.

3.3.1 Site Base-case Profiles

The licensee provided detailed site profile descriptions in Sections 2.3.1 and 2.3.2 of its SHSR based on information provided in the Callaway, Unit 1 FSAR (Callaway, 2013) and the Callaway, Unit 2 FSAR (Unistar Nuclear Services, 2009). According to the licensee, the site consists of 30.5 feet of fill layer, underlain by approximately 2,174 ft (662 m) of sedimentary rocks with Precambrian basement at a depth of about 2,204 ft (672 m). In SHSR Figures 2.3.2-1 and 2.3.2-2, the licensee provided a brief description of the subsurface materials in terms of the geologic units and layer thicknesses. SHSR Figure 2.3.2-1 shows the recommended shear wave velocities determined from compressional wave refraction surveys at the site. The calculated shear wave velocities are similar to those observed at the Callaway, Unit 2 Combined License Application (COL) site obtained from downhole, cross hole, and suspension logging.

The licensee used the shear-wave velocities, the information on the regional geologic profile (summarized in SHSR Figures 2.3.2-1 and 2.3.2-2), and the guidance in Appendix B-3.0 of the SPID to develop three base-case shear-wave velocities for the Callaway site. To develop the best estimate or base-case shear-wave velocity profile, the licensee extended the deepest velocity of 8,333 ft/s (2,540 m/s) to the Precambrian basement at a depth of 2,204 ft (672 m) for the mean base-case profile. The licensee developed the lower and upper range profiles with a scale factor of 1.25 for the entire profile, which reflects a natural log standard deviation of 0.2. Table 2.3.2-1 and Figure 2.3.2-3 of the SHSR provide the licensee's shear-wave velocity profile for each of the three base-cases.

The licensee stated that no site-specific dynamic material properties were determined in the initial siting of Callaway. Therefore, consistent with the SPID the licensee considered the EPRI (1993) soil and firm rock curves (model M1) appropriate to represent the more nonlinear response likely to occur in the site materials, and the Peninsular Range curves for soils combined with linear analysis for firm rock were considered (model M2) equally plausible across loading level.

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 estimated the site kappa using Appendix B-5.1.3.1 of the SPID for a firm CEUS rock site. The licensee used the low strain damping values from the EPRI (1993) soil and rock curves over the upper 500 ft [152 m] and assumed a damping value of 1.25 percent (corresponding to a Q value of 40) for the rock layers below 500 ft in order to calculate a kappa value for each of the three base case profiles. The licensee determined kappa values 0.016 s, 0.009s and 0.020s corresponding to each of the base case velocity profiles reflecting epistemic uncertainties in low strain damping for the profile.

The licensee described the development of its random velocity profiles in Section 2.3.3 of the SHSR and stated that its approach is consistent with Appendix B of the SPID guidance. To account for randomness in material properties across the plant site, the licensee randomized its base case shear-wave velocity profiles, consistent with Appendix B of the SPID. In addition, the licensee randomized the depth to bedrock by about ±530 ft (±162 m), which corresponds to 24 percent of the total profile thickness.

3.3.2 Site Response Method and Results

In Section 2.3.4 of the 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 of the SHSR, the licensee described its implementation of the random vibration theory (RVT) approach to perform the site response calculations. Finally, Section 2.3.6 of the SHSR shows the resulting amplification functions and associated uncertainties for the eleven input loading levels for the base-case profile and EPRI and Peninsular Range shear modulus and damping curves. In order to develop probabilistic site-specific control point hazard curves, as requested in Requested Information Item (1) of the 50.54(f) letter, the licensee used Method 3, described in Appendix B-6.0 of the SPID. The licensee's use of Method 3 involved computing the site-specific control point elevation hazard curves for a broad range of spectral accelerations by combining the site-specific bedrock hazard curves, determined from the initial PSHA (Section 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 Callaway site. The staff independently developed a shear-wave velocity profile, damping values, and modeled the potential nonlinear behavior of the rock using measurements and geologic information provided in the Callaway FSAR and the Callaway, Unit 2 COL FSAR. For its

site response calculations, the staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

The Callaway, Unit 2 COL application site and the Callaway operating plant site are relatively close and the site geology is relatively uniform. As such, the NRC shear-wave velocity profile is based on the information provided in the Callaway, Unit 2 COL FSAR, except for the fill material which was assigned an average velocity of 1,000 fps (304 m/s). The staff used just a single base-case shear wave velocity profile to represent the site conditions, as significant data exist controlling the velocities and other properities at the site. Potential uncertainties in rock layer velocities are taken into account during the randomization process employed in site response calculations. In contrast, the licensee used three base-case profiles to represent velocity uncertainties at the site with recognition that even though the operating and proposed new sites are in close proximity, the site conditions are not identical. To capture the uncertainty in the depth to base rock beneath the site, the staff used a sigma of ln 0.15, resulting in a basement uncertainty of about ± 300 feet. Figure 3.3-1 of this assessment shows the staff's velocity profile compared to the three base-case profiles developed by the licensee. Even though the licensee used three base-case profiles, the range between the lower and upper profiles is relatively small since the licensee used a natural log standard deviation of 0.2. As such, the velocity profile used by NRC and the three base-case profiles used by the licensee do not differ substantially.

There are also some differences in the dynamic properties used by the licensee and the staff. The licensee used the EPRI (1993) soil and rock curves along with the Peninsular curves and linear rock option, as described in the SPID document, while the staff used the dynamic properties described in the Callaway, Unit 2 COL FSAR with specific kappa values calculated using the SPID guidance. Using the proposed shear wave velocities and layer thicknesses, the staff calculated a kappa value of 0.015 sec which includes the 0.006 sec contribution from the base rock. The licensee's kappa estimate for the mean profile is 0.016 sec. To model the uncertainty in the kappa value, the staff used upper and lower range values of 0.016 and 0.014 sec, respectively. Below the depth of base rock conditions, the staff assumed linear behavior for the rock with a damping value of 0.1 percent.

Figure 3.3-2 of this assessment shows a comparison of the staff's and licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. Both the staff's and the licensee's result indicate that there is strong site amplification between about 3 and 20 Hz.

Even though there are some variations in site amplifications due to differing input model parameters, overall the licensee's approach to modeling the subsurface rock properties and their uncertainty results in similar amplification factors as those developed by the staff. In addition, as shown in Figure 3.3-3 of this assessment, when calculated using these amplification functions the staff's and licensee's control point seismic 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 this application.

In summary, the staff concludes that the licensee's site response was conducted using present-day guidance and methodology, including the NRC-endorsed SPID. The staff performed independent calculations to confirm that the licensee's amplification factors and control point hazard curves adequately characterize the site response, including the uncertainty associated with the subsurface material properties, for the Callaway site.

3.4 Ground Motion Response Spectra

In Section 2.4 of the SHSR, the licensee stated that it used the control point hazard curves described in SHSR Section 2.3.7 to develop the 10^{-4} and 10^{-5} (mean annual frequency of exceedance) uniform hazard response spectra (UHRS) and then computed the GMRS using the criteria in RG 1.208.

The staff independently 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 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 below, the licensee's GMRS shape is generally similar to that calculated by the staff. The staff concludes that the small differences between the two GMRS are due to the differences in base-cases, with the licensee using three base-cases and the staff using one base-case profile. The staff concludes that these differences are acceptable for this application because the licensee followed the guidance provided in the SPID with respect to both the PSHA and site response analysis for the Callaway site.

The staff confirms that the licensee used the present-day guidance and methodology outlined in RG 1.208 and the SPID to calculate the horizontal GMRS, as requested in the 50.54(f) letter. As such, the staff concludes that the GMRS determined by the licensee adequately characterizes the reevaluated hazard for the Callaway site. Therefore, this GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter. The staff performed both a PSHA and site response confirmatory analysis and achieved results consistent with the licensee's horizontal GMRS.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the Callaway Plant, Unit 1 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 Item (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the staff concludes that the licensee's reevaluated seismic hazard is acceptable to address other actions 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 the Callaway site over the frequency range of approximately 3 Hz and above. As such, a seismic risk evaluation, SFP evaluation and a high-frequency confirmation are merited. The licensee indicated the high frequency confirmation would be performed as part of the seismic risk evaluation. NRC review and acceptance of UE's ESEP interim evaluation with the high-frequency SFP evaluations (i.e., Items (4), (6), (8), and (9)) for Callaway, Unit 1 will complete the items requested 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, ADAMSs 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), 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 David L. Skeen, Director, Japan Lessons-Learned Project 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) 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

Callaway, 2013. Callaway Energy Center Final Safety Analysis Report (FSAR), Rev. OL-20, December 2013.

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.

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.

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.

Neterer, 2014, Transmittal of Seismic Hazard and Screening Report (CEUS Sites), Ameren Missouri, March 28, 2014 Letter, ADAMS Accession No. ML14090A448.

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.

Reasoner, 2013, Callaway, Unit 1, Response to NRC Request For Information Pursuant to 10CFR50.54(f) Regarding Seismic Aspects Of Recommendation 2.1 Of The Near-Term Task Force Review Of Insights From Fukushima Dai-Ichi Accident - 1.5 Year Responses For CEUS Sites, September 12, 2013 Letter, ADAMS Accession No. ML13256A067.

UniStar Nuclear Services, 2009. *FSAR Callaway Unit 2, Revision 2.*

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

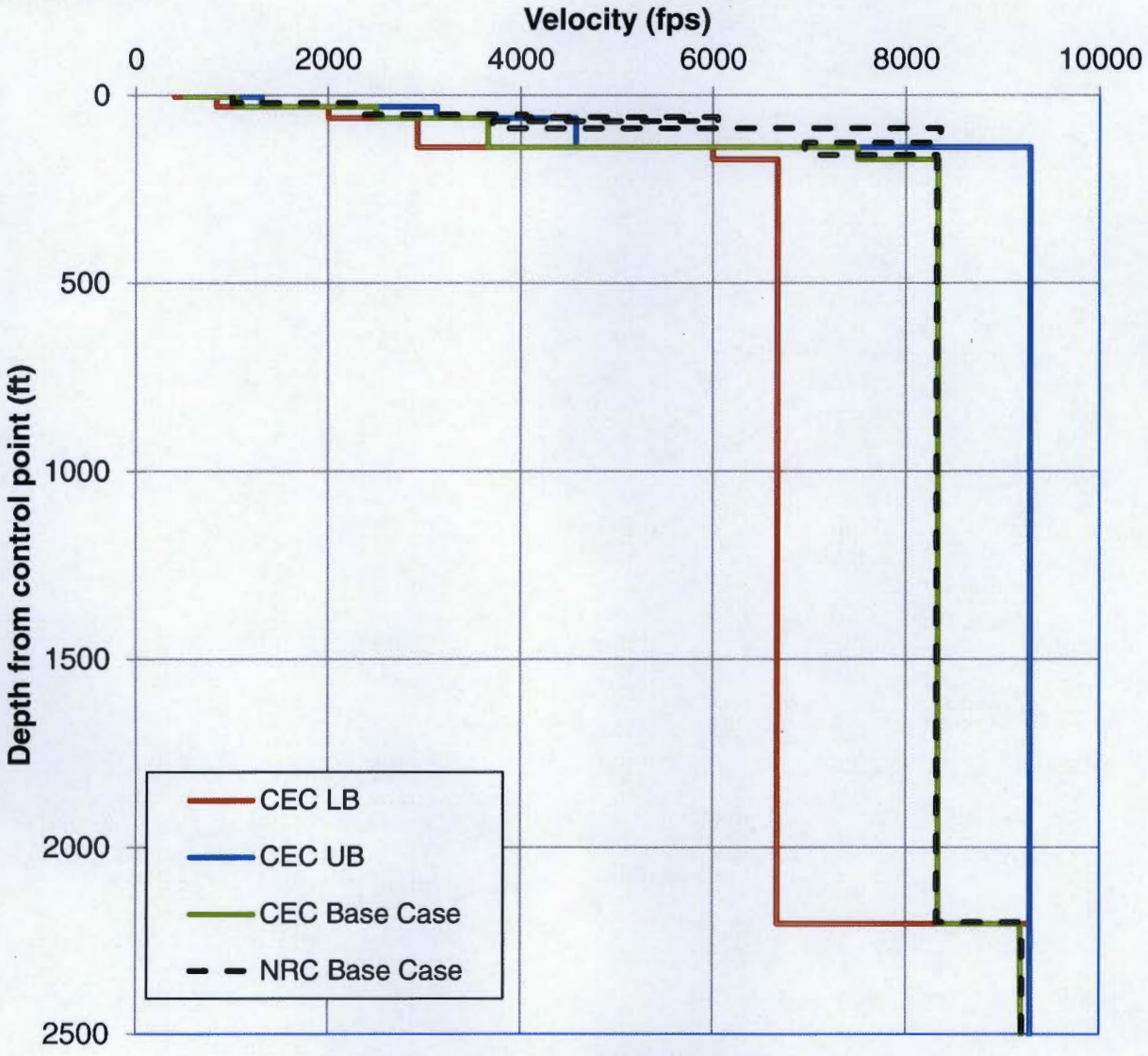


Figure 3.3-1 Plot Comparing the Staff's and the Licensee's Median Amplification Functions and Uncertainties for the Callaway site

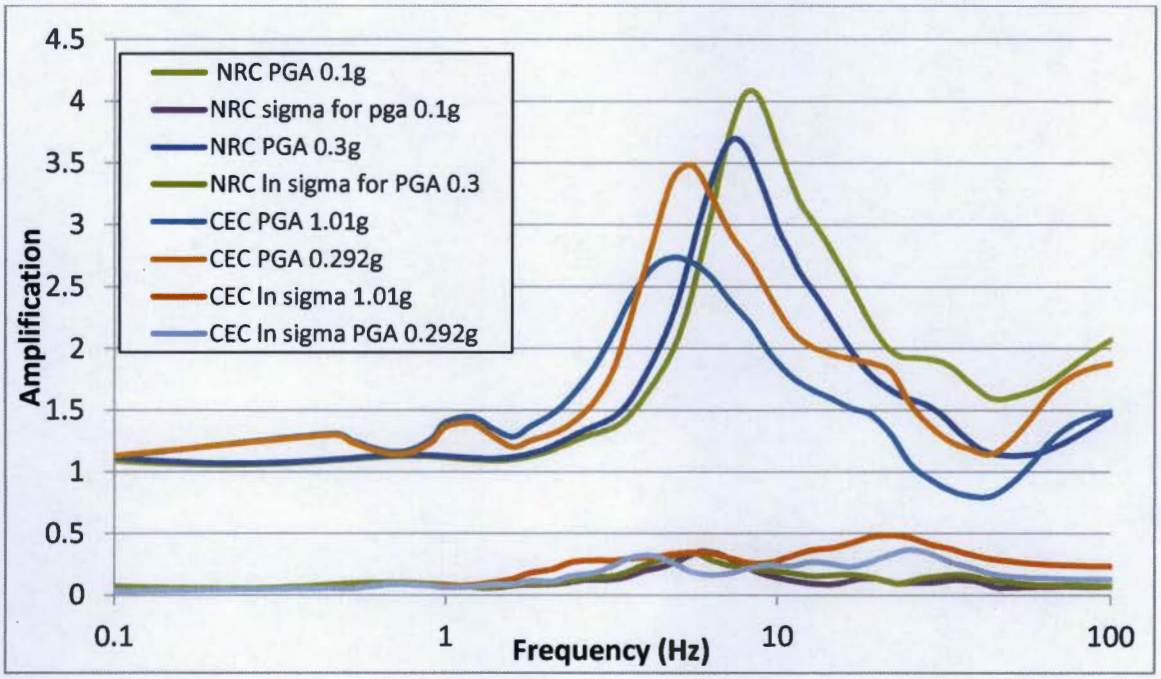


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for the Callaway Site

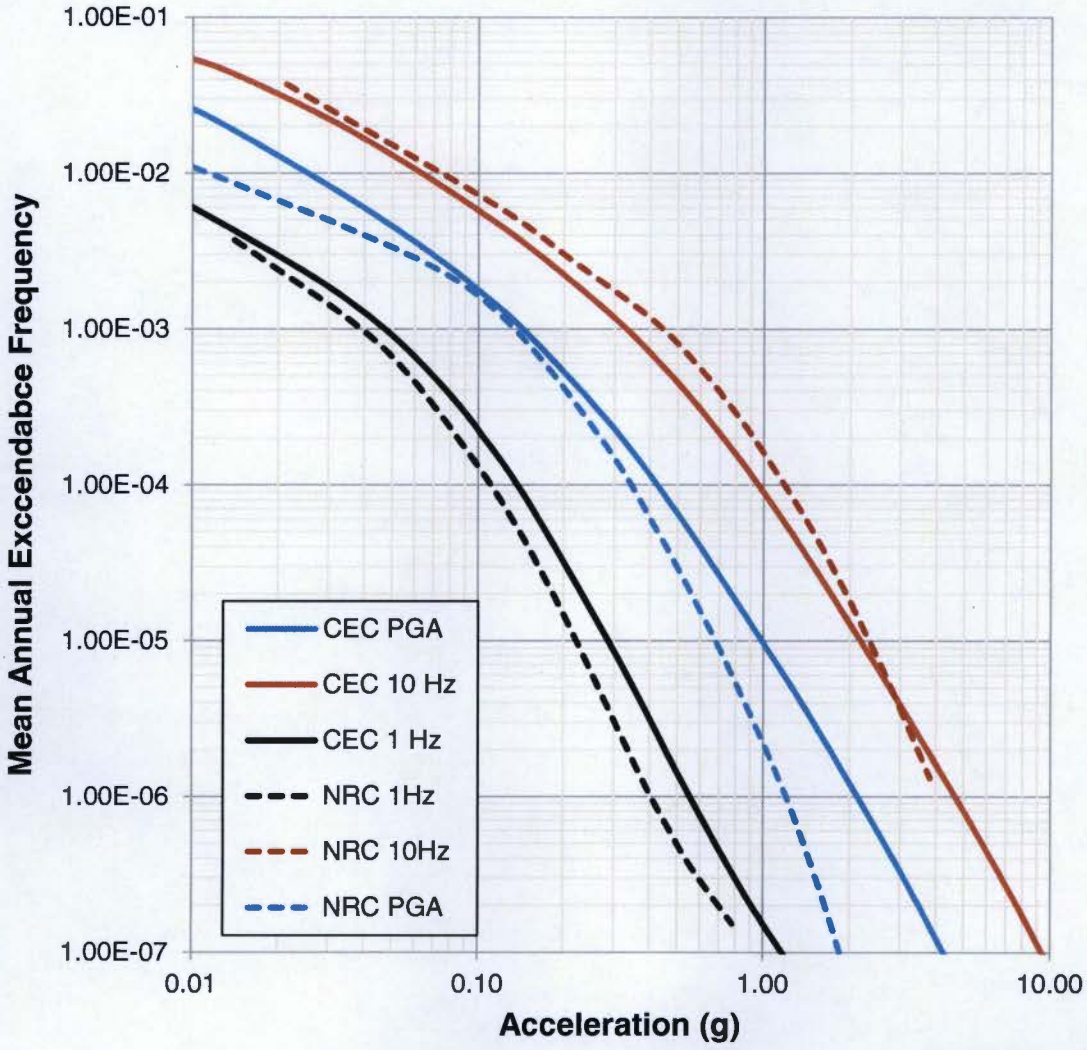
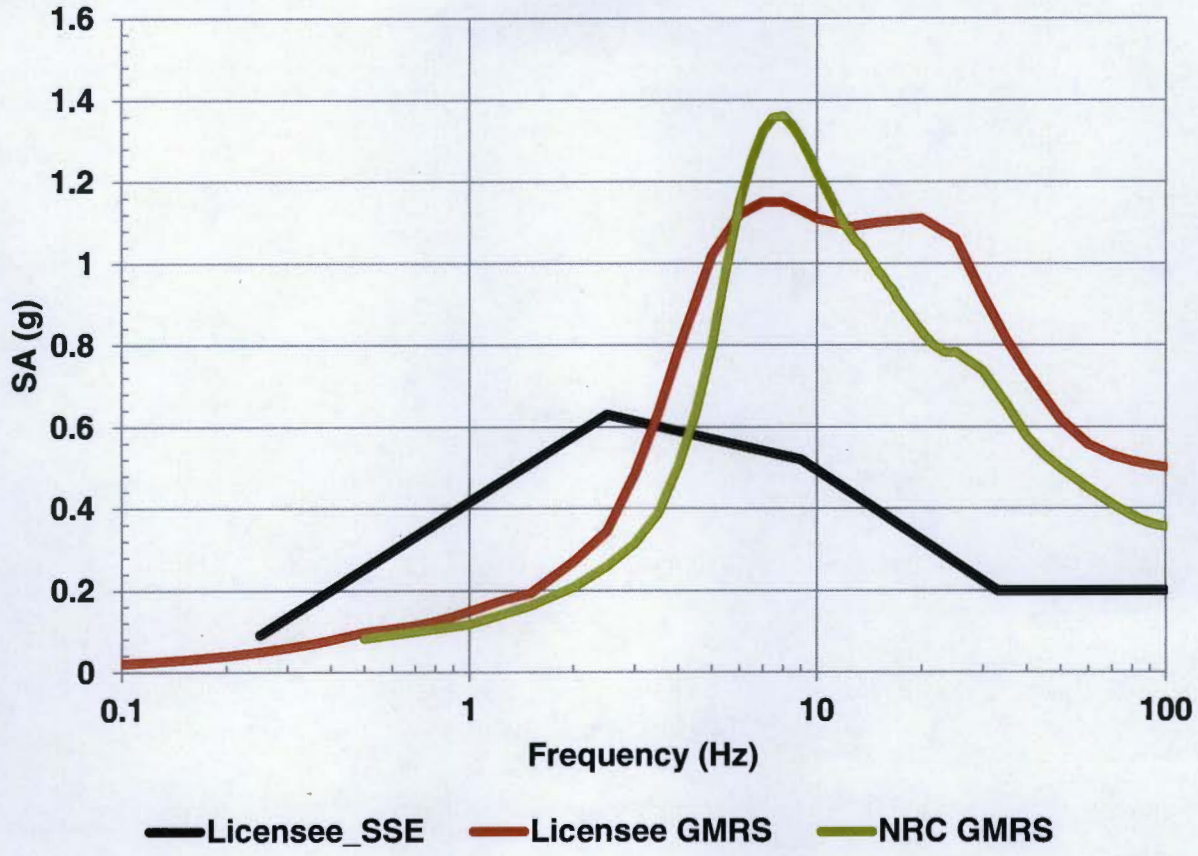


Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the Callaway Unit No 1 SSE



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. 50-483

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:
PUBLIC
JHMB R/F
RidsNrrDorlLpl4-1Resource
RidsNrrPMCallaway Resource
RidsNrrLASLent Resource
RidsAcrsAcnw_MailCTR Resource
FVega, NRR
NDiFranceso, NRR
DJackson, NRO
SWhaley, NRR

ADAMS Accession No.: ML15063A517 ***via email**

OFFICE	NRR/JLD/JHMB	NRR/JLD/JHMB	NRO/DSEA/RGS1*	NRR/DORL/LPL4-1*
NAME	FVega	SLent	DJackson	FLyon
DATE	03/09/15	03/06/15	03/03/15	03/08/15
OFFICE	OGC	NRR/JLD/JHMB*	NRR/JLD/JHMB	
NAME	BHarris	SWhaley	FVega	
DATE	03/13/15	03/17/15	04/21/15	

OFFICIAL RECORD COPY