



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

July 20, 2015

Mr. Thomas D. Gatlin, Vice President  
Nuclear Operations  
South Carolina Electric and Gas Company  
Virgil C. Summer Nuclear Station  
Post Office Box 88, Mail Code 800  
Jenkinsville, SC 29065

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, 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. MF3831)

Dear Mr. Gatlin:

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 26, 2014, South Carolina Electric and Gas Company (SCE&G, the licensee), responded to this request for Virgil C. Summer Nuclear Station (VCSNS), Unit 1.

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

Contingent upon the NRC's review and acceptance of SCE&G's 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 VCSNS, the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter will be completed.

T. Gatlin

- 2 -

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

Sincerely,

A handwritten signature in black ink, appearing to read 'Frankie Vega'.

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

Docket No. 50-395

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

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1

DOCKET NO. 50-395

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).<sup>1</sup> In particular, the NRC Near-Term Task Force (NTTF) Recommendation 2.1, and subsequent Staff Requirements Memoranda (SRM) associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), instructed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

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

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

- (1) Site-specific hazard curves (common fractiles and mean) over a range of spectral frequencies and annual exceedance frequencies,
- (2) Site-specific, performance-based GMRS developed from the new site-specific seismic hazard curves at the control point elevation,
- (3) Safe Shutdown Earthquake (SSE) ground motion values including specification of the control point elevation,
- (4) Comparison of the GMRS and SSE. A high-frequency evaluation (if necessary),

---

<sup>1</sup> 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 the NRC in a manner that will address the Requested Information Items in Enclosure 1 of the 50.54(f) letter. By letter dated February 15, 2013 (NRC, 2013b), the staff endorsed the SPID.

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

By letter dated April 9, 2013 (Pietrangelo, 2013), industry agreed to follow the SPID to develop the SHSR for existing nuclear power plants. By letter dated September 11, 2013 (Gatlin, 2013), South Carolina Electric and Gas Company (SCE&G, the licensee) submitted partial site response information for Virgil C. Summer Nuclear Station (VCSNS), Unit 1. By letter dated March 26, 2014 (Gatlin, 2014a), SCE&G submitted its SHSR. By letter dated November 12, 2014 (Gatlin, 2014b), SCE&G supplemented its SHSR with additional information.

## 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, tsunamis, 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 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 26, 2014 (Gatlin, 2014a), the licensee provided the SHSR for VCSNS. The licensee's SHSR indicates that the site GMRS exceeds the SSE for VCSNS over the frequency range of 1 to 10 Hertz (Hz). As such, a seismic risk evaluation and SFP evaluation are merited. Additionally, due to exceedances above 10 Hz, the licensee indicated that a high-frequency confirmation would be performed for VCSNS.

On May 9, 2014 (NRC, 2014a), 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 confirmatory GMRS, developed by the staff, exceed the SSE for VCSNS over the frequency range of approximately 5 to 100 Hz. Therefore, a seismic risk evaluation, SFP evaluation, and a high-frequency confirmation are merited for VCSNS.

## 3.0 TECHNICAL EVALUATION

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

### 3.1 Plant Seismic Design-Basis

Enclosure 1 of the 50.54(f) letter requests the licensee provide the SSE ground motion values, as well as the specification of the control point elevation(s) for comparison to the GMRS. For operating reactors licensed before 1997, the SSE is the plant licensing basis earthquake and is characterized by 1) a peak ground acceleration (PGA) value which anchors the response spectra at high frequencies (typically at 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 bases for VCSNS. The licensee stated that the SSE for VCSNS is based on a postulated Intensity VII earthquake occurring near the site. This earthquake is assumed similar to the 1913 Union County, SC earthquake, which occurred 35 miles (56 km) from the site. Based on this earthquake, the response spectral shape is anchored at a PGA of 0.15 g (15 percent of the acceleration due to earth's gravity). The licensee provided the design spectral shape in the SHSR.

The licensee specified that the SSE control point is located at the top of competent rock at a mean sea level elevation of 350 ft (107 m) approximately 85 ft (26 m) below plant grade elevation.

The NRC staff reviewed the licensee's description of its SSE and the control point in the SHSR. To confirm the SSE, the staff reviewed the VCSNS Updated Final Safety Analysis Report (UFSAR) (SCE&G, 2012). Based on its review, the NRC staff confirmed that both the SSE spectrum and control point elevation are consistent with information in the UFSAR, as well as guidance provided in the SPID.

### 3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of its 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). For its PSHA, the licensee used a minimum moment magnitude (**M**) of 5.0 as specified in the 50.54(f) letter. The licensee further states that it included CEUS-SSC background sources out to a distance of 400 miles [640 km] and included the Charleston, Commerce, Eastern Rift Fault segments, Marianna, New Madrid Fault System, and Wabash Valley repeated large magnitude earthquake (RLME) sources, which lie within 620 miles [1,000 km] of the site. The RLME sources are those source areas or faults for which more than one large magnitude ( $M \geq 6.5$ ) 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.

Rather than implement the CEUS-SSC model as published for its PSHA, the licensee stated in its SHSR that it performed a site-specific review of the CEUS-SSC seismic catalog with regard to two issues: (1) identification of additional reservoir induced seismicity (RIS) earthquakes in the southeastern U.S. and (2) locations of earthquakes in South Carolina near the time of the 1886 Charleston, SC earthquake sequence. The purpose of the licensee's review was to determine if the magnitude recurrence parameters for the southeastern U.S., as determined in the CEUS-SSC model, needed to be adjusted.

Concerning the first issue, the licensee noted that in developing the CEUS-SSC catalog, earthquakes identified as RIS were removed from the final earthquake catalog. Taking into consideration the proximity of each earthquake to a reservoir, timing of the earthquake versus the filling of the reservoir, magnitude of the earthquake, and proximity to a nuclear power plant, the licensee further evaluated the CEUS-SSC seismic catalog to determine if there were additional RIS earthquakes that had not been previously identified in the CEUS-SSC seismic catalog. As a result of its review, the licensee identified and removed an additional 30 earthquakes from the CEUS-SSC catalog that it considered to be RIS.

Concerning the second issue, the licensee noted that in developing the CEUS-SSC catalog earthquakes identified as aftershocks of the large Charleston, SC 1886 main shock were removed from the final catalog. Prior to using the CEUS-SSC source model, the licensee evaluated 20 earthquakes in the CEUS-SSC catalog located at a sufficient distance from Charleston to not be identified as aftershocks of the 1886 main event. Of these 20 earthquakes, the licensee identified several that it considered to be duplicates, mislocated, or to have incorrect magnitudes and therefore, they were modified as appropriate.

After reviewing the licensee's CEUS-SSC catalog changes, the staff issued a Request for Additional Information (RAI). In its RAI, the NRC staff noted that Enclosure 1 to the 50.54(f)

letter states that regional and local refinements of the CEUS-SSC are not necessary for this evaluation and that Section 2 of the SPID states that the use of the CEUS-SSC model as published is appropriate. The NRC staff further noted that Section 6 of NUREG-2117 (NRC, 2012c) recommends that viable regional probabilistic hazard studies, such as the CEUS-SSC, should be updated with at least a Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 study. As such, the NRC staff requested that the licensee either provide the SSHAC Level 2 study supporting the licensee's changes to the CEUS-SSC catalog or re-do the PSHA for VCSNS using the CEUS-SSC model as published. In response to the RAI, dated November 12, 2014 (Gatlin, 2014), the licensee stated that it would perform a SSHAC Level 2 study to ensure that the modified CEUS-SSC catalog represents the center, body, and range of technically defensible interpretations.

By letter dated April 28, 2015 (Gatlin, 2015), the licensee submitted its SSHAC Level 2 study on the topics of RIS and the Charleston earthquake locations. The SSHAC study developed the technical basis for the removal of RIS and the relocation of earthquakes located near the Charleston RLME source near the time of the 1886 earthquake sequence. In addition, the SSHAC study included the technical comments provided by two independent reviewers and the authors' response and resolution of the technical comments. Finally, the SSHAC study included a closure letter from the independent reviewers confirming that the technical comments had been resolved and the SSHAC level 2 process was followed.

The NRC staff reviewed the SSHAC Level 2 study, the reviewer comments, and the comments resolution. The staff's review focused on the technical bases for the removal of events near the plant sites identified as RIS and the relocation of seismicity near Charleston. On the issue of RIS, the staff notes that a substantial effort was made to remove RIS from the CEUS-SSC catalog, however, the potential that some RIS remains in the published catalog cannot be ruled out. The issue of induced seismicity, and its effect on hazard, is one of importance to the broader seismic hazard community. Based on the NRC staff's review of the SSHAC Level 2 study and the recent literature related to RIS, the staff finds that the licensee's removal of additional RIS from the catalog on a site-specific basis for the limited purpose of responding to Recommendation 2.1, to be acceptable. The magnitudes of the 30 earthquakes identified as RIS and removed from the catalog range from **M** 2.32 – 3.64. Earthquakes of this size have a limited impact on the calculation of recurrence parameters for the CEUS-SSC model but the removal of a large number of small events in a concentrated area may impact the overall hazard for a nearby site.

On the issue of relocating earthquakes potentially associated with the Charleston earthquake sequence, the NRC staff reviewed the SSHAC Level 2 study and the technical comments made by the reviewers. The location of historical seismicity is made difficult by the lack of instrumental data, requiring that scientists rely on historical reports of felt motions, most often recorded in contemporaneous newspaper accounts. The NRC staff notes that significant effort went into locating events near Charleston during the CEUS-SSC study using the most up to date methods and available reports at the time of the study. The licensee's technical judgement is based on additional reviews of historical newspaper accounts and evidence that some earthquake times may have been misinterpreted in the original catalog. The NRC staff agrees that additional review of earthquake locations, times, and magnitudes is warranted when new information is made available (i.e. additional historical data becomes available), but notes that



locating historical seismicity remains a subject of intense debate within the broader technical community.

Overall, the NRC staff finds that the licensee followed applicable guidance in conducting a Senior Seismic Hazard Analysis Committee (SSHAC) Level 2 study when modifying the CEUS-SSC catalog for its site-specific PSHA. However, because the issues addressed by the study are subjects of significant discussion within the broader scientific community, the NRC staff regards the site-specific modifications conducted by the licensee to be applicable to only the licensee's response to the 50.54(f) request for information. As such, the NRC staff does not consider these site specific refinements to the hazard inputs of the CEUS-SSC model to constitute an official update of the CEUS-SSC model. In order for these changes to the model to be considered as an official update, all of the stakeholders of the CEUS-SSC would need to agree on their merits.

As part of its confirmatory analysis of the licensee's GMRS, the NRC staff performed PSHA calculations for base rock conditions at the VCSNS 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 VCSNS 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, Commerce, Eastern Rift Fault segments, New Madrid Fault System, and Wabash Valley RLME sources. With the exception of one background source located along the Gulf Coast, the NRC staff used the mid-continent version of the updated EPRI GMM (EPRI, 2013). For the Gulf Coast seismic source, the NRC staff used the Gulf Coast version of the updated EPRI GMM (EPRI, 2013).

Figure 3.2-1 of this assessment shows the hazard curves developed by the licensee using the modified CEUS-SSC, the hazard curves developed by the licensee using the original CEUS-SSC, and the hazard curves developed by the NRC staff for three of the seven spectral frequencies. The hazard curves developed by the licensee using the original CEUS-SSC model without the catalog revisions are, as expected, the same as the curves developed by the NRC staff. The hazard curves developed by the licensee using the modified CEUS-SSC are consistently lower than those developed using the original CEUS-SSC by about 6 to 16 percent, which indicates that the licensee's revisions to the catalog for the southeastern U.S. had a modest but not insignificant impact.

### 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 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.

The licensee stated that the rocks underlying the VCSNS site are composed primarily of crystalline metamorphic rock with igneous intrusives. These rocks have a measured shear wave velocity greater than 8,000 ft/s (2,438 m/s), which is considered hard rock according to guidance in the SPID. Therefore, the licensee did not perform a site response analysis for the VCSNS site. As such, the licensee used the hard rock hazard curves from the PSHA as its control point hazard curves for determining the GMRS for the VCSNS site.

The NRC staff reviewed information in the SHSR and the VCSNS, Unit 1 UFSAR (SCE&G, 2012), as well as information available in the VCSNS, Unit 2 and 3 FSAR (SCE&G, 2014) and confirmed that the VCSNS site is characterized by hard rock and no site response analysis is required. The SSE control point is located on sound rock, which has a shear wave velocity of approximately 9,185 fps (2,800 m/s) according to Table 2.5-5 of the VCSNS Unit 1 UFSAR. Additionally, VCSNS, Units 2 and 3, which were licensed following the issuance of RG. 1.208, and have very similar subsurface conditions, were not required to perform a site response analysis during licensing. The NRC staff concludes that based on the shear wave velocity of the subsurface at the VCSNS site, the guidance in the SPID, and recent licensing decisions at the site based on modern methods and regulations, a site response analysis is not necessary for this application.

### 3.4 Ground Motion Response Spectra

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

The NRC staff independently calculated the  $10^{-4}$  and  $10^{-5}$  UHRs using the results of its confirmatory PSHA, as described in Section 3.2 of this staff assessment. Figure 3.4-1 of this assessment shows a comparison of the GMRS determined by the licensee to that determined by the NRC staff.

As shown in Figure 3.4-1, the licensee's GMRS shape is generally similar to that calculated by the NRC staff at all frequencies. However, the NRC staff's confirmatory GMRS is slightly higher than the licensee's. As described in Section 3.2, the NRC staff concludes that these differences are due to changes the licensee made to the published CEUS-SSC catalog when conducting the PSHA.

Based on the NRC staff's review of the licensee's SHSR, RAI response and SSHAC report, the staff confirms that the licensee used the present-day guidance and methodology outline in RG 1.208 and the SPID to calculate the horizontal GMRS, as requested in the 50.54(f) letter. The NRC staff performed a PSHA confirmatory analysis and achieved results consistent with the licensee's base rock hazard curves developed with the CEUS-SSC as published. As such, the NRC staff concludes that the GMRS determined by the licensee adequately characterizes the reevaluated hazard for the VCSNS site for the purposes of screening. Because the NRC staff accepted the licensee's SSHAC Level 2 study justifying modifications for the limited purpose of response to the 50.54(f) letter, the staff concludes that the GMRS determined by the licensee adequately characterizes the reevaluated hazard for the VCSNS site. Therefore, this

GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter.

#### 4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the VCSNS site. Based on its review, the NRC 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), and (7) and the comparison portion to Item (4) identified in Enclosure 1 of the 50.54(f) letter. Further, the licensee's reevaluated seismic hazard is acceptable to address other actions associated with NTTF Recommendation 2.1: Seismic.

Additionally, as described above, the NRC staff finds that the licensee followed applicable guidance in conducting a SSHAC Level 2 study when modifying the CEUS-SSC catalog for its site-specific PSHA. However, because the issues addressed by the study are subjects of significant discussion within the broader scientific community, the staff regards the site-specific modifications conducted by the licensee to be applicable to only the licensee's response to the 50.54(f) request for information.

In reaching this determination, the NRC staff confirmed the licensee's conclusion that the licensee's GMRS for the VCSNS site exceeds the SSE over the frequency range of approximately 5 to 100 Hz. As such, a seismic risk evaluation, SFP evaluation, and a high-frequency confirmation are merited. The licensee indicated that it would perform the high frequency confirmation as part of its seismic risk evaluation. The NRC review and acceptance of the seismic risk evaluation with the high-frequency confirmation, interim ESEP evaluation, and SFP evaluation (i.e., Items (4), (6), (8), and (9)) for VCSNS will complete the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter.

## REFERENCES

Note: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through <http://www.nrc.gov/reading-rm/adams.html>.

### U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U.S. Nuclear Regulatory Commission), 2007, A Performance-based Approach to Define the Site-Specific Earthquake Ground Motion, Regulatory Guide (RG) 1.208, March 2007.

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

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

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

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

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

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

NRC (U.S. Nuclear Regulatory Commission), 2013a. Letter From Eric J. Leeds, to Joseph Pollock, Executive Director NEI, Acceptance Letter for NEI Submittal of Augmented Approach, Ground Motion Model Update Project, and 10 CFR 50.54(f) Schedule Modifications Related to the NTTF Recommendation 2.1, Seismic Reevaluations, May 7, 2013, ADAMS Accession No. ML13106A331.

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

- NRC (U.S. Nuclear Regulatory Commission) 2013c. Letter from D. L. Skeen (NRC) to K. A. Keithline (NEI), Approval of Electric Power Research Institute Ground Motion Model Review Project Final Report for Use by Central and Eastern United States Nuclear Power Plants, August 28, 2013 ADAMS Accession No. ML13233A102.
- NRC (U.S. Nuclear Regulatory Commission) 2014a. Letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation to All Power Reactor Licensees and holders of Construction Permits in Active or Deferred Status, Seismic Screening and Prioritization Results Regarding Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazard Reevaluations for Recommendations 2.1 of the Near-Term Task Force Review of Insights, May 9, 2014, ADAMS Accession No. ML14111A147.
- NRC (U.S. Nuclear Regulatory Commission) 2014b, Letter from N. J. DiFrancesco (NRC) to Virgil C Summer Nuclear Station, Request for Additional Information Associated with near-Term Task Force Recommendation 2.1, Seismic Re-Evaluations Related to Southeastern Catalog changes, October 23, 2014, ADAMS Accession No. ML14268A516.

#### Other References

- Electric Power Research Institute (EPRI), 2004. EPRI Report 1009684, "CEUS Ground Motion Project Final Report." Palo Alto, CA, 2004.
- Electric Power Research Institute (EPRI), 2006. EPRI Report 1014381, "Truncation of the Lognormal Distribution and Value of the Standard Deviation for Ground Motion Models in the Central and Eastern United States." Palo Alto, CA, 2006.
- Electric Power Research Institute (EPRI), 2012. EPRI Report 1025287 "Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details [SPID] for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic" November 27, 2012, ADAMS Accession No. ML12333A170.
- Electric Power Research Institute (EPRI), 2013. EPRI Ground Motion Model Review Final Report, June 3, 2013, ADAMS Accession No. ML13155A553.
- Gatlin, T. D., 2013, Letter from Thomas Gatlin (SCE&G) 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 11, 2013 ADAMS Accession No. ML13256A100.
- Gatlin T. D. 2014a, Letter from Thomas Gatlin (SCE&G) to NRC, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, March 26, 2014, ADAMS Accession No. ML14092A250.

Gatlin T. D., 2014b, Letter from Thomas Gatlin (SCE&G) to NRC, Response to NRC Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Seismic Re-Evaluations, November 12, 2014, ADAMS Accession No ML14318A314.

Gatlin, T. D., 2015, Letter from Thomas Gatlin (SCE&G) to NRC, Response to NRC Request for Additional Information Regarding Seismic Evaluations Related to Southeastern Catalog changes, April 28, 2015, ADAMS Accession No ML15124A596.

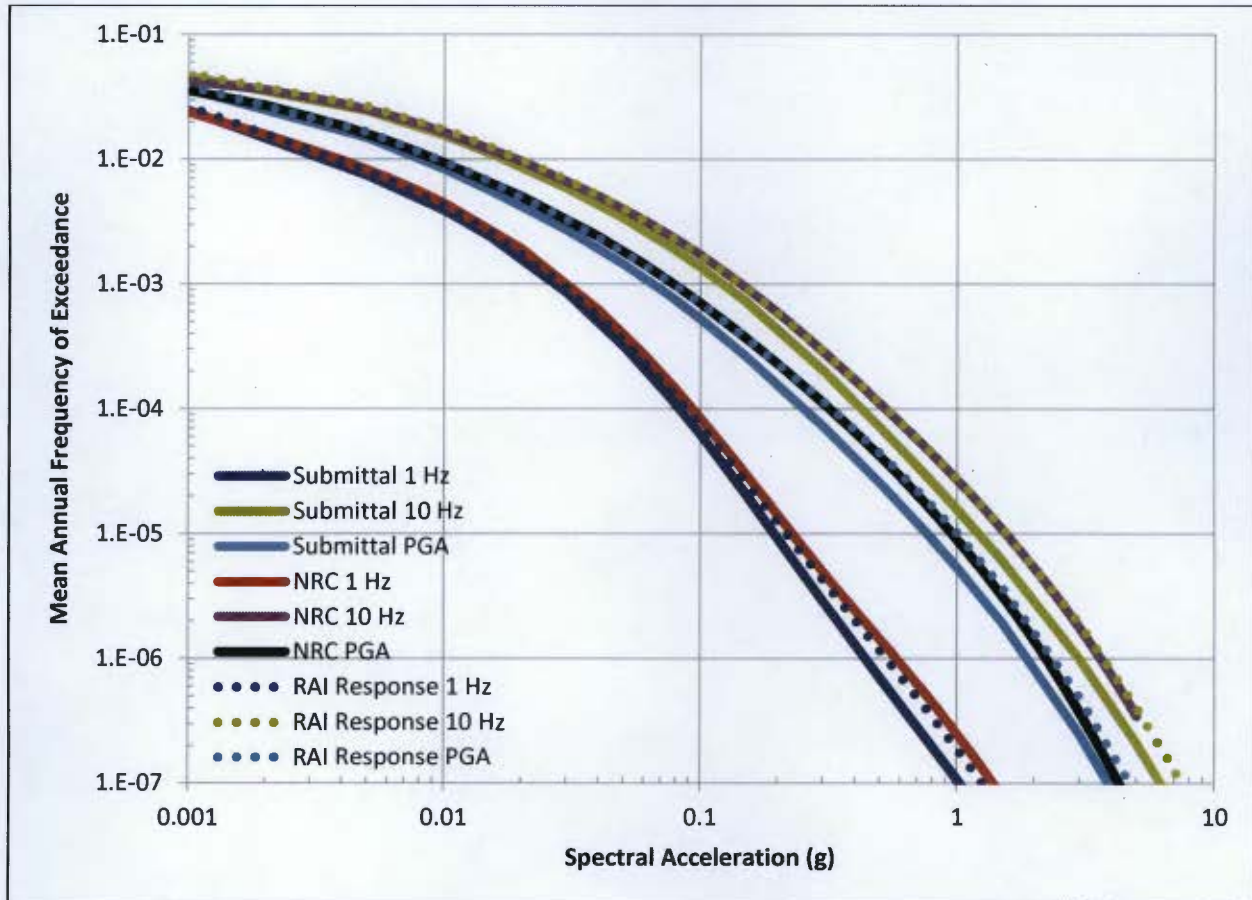
Keithline, 2012, Letter from Kimberly Keithline, Senior Project Manager, NEI, to David L. Skeen, Director, Japan Lessons Learned Project Directorate, NRC, Final Draft of Industry Seismic Evaluation Guidance (EPRI 1025287), November 27, 2012, ADAMS Accession No. ML12333A168.

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.

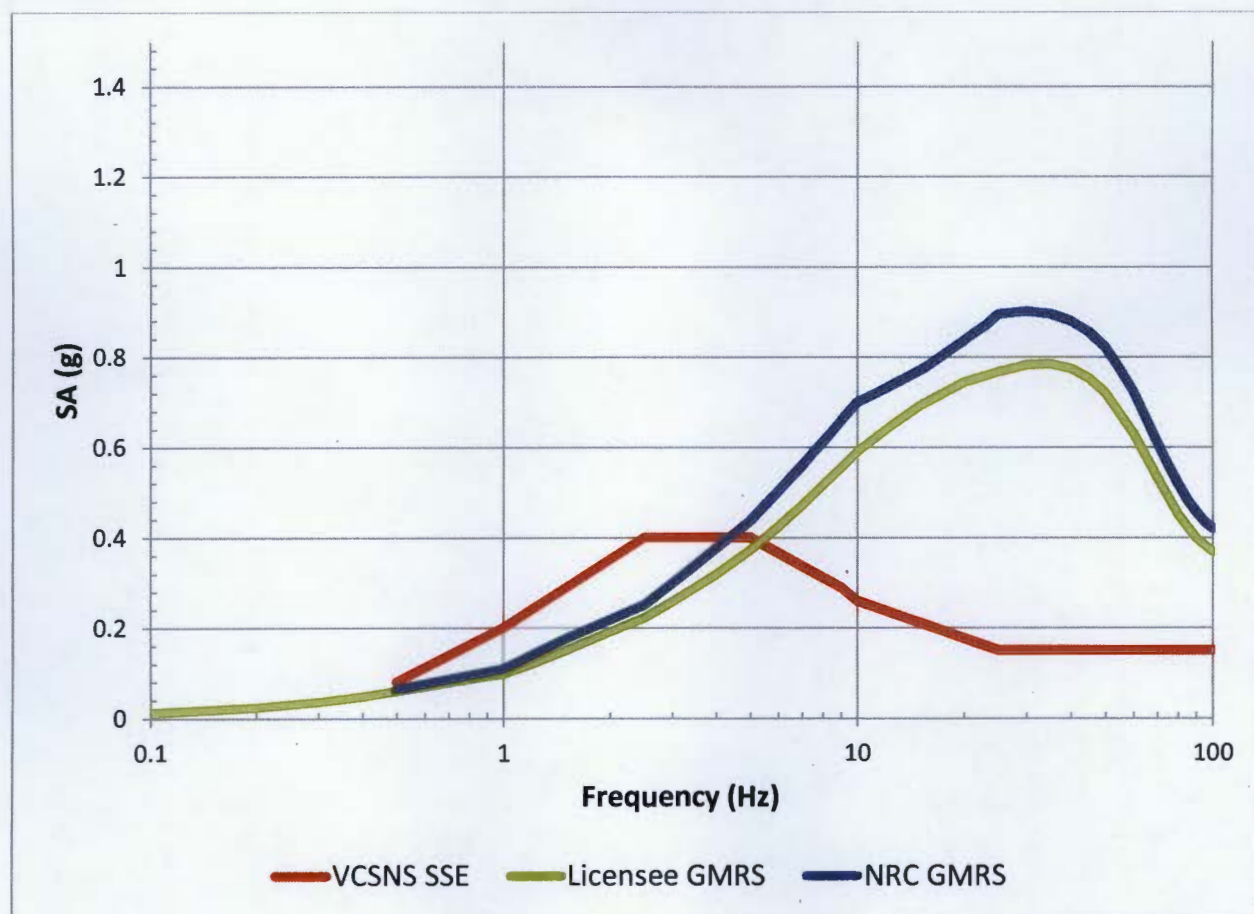
South Carolina Electric and Gas (SCE&G), 2012, Virgil C Summer Nuclear Station Unit 1 Final Safety Analysis Report (Updated) (UFSAR), Revision November 2012.

South Carolina Electric and Gas (SCE&G), 2014, Virgil C Summer Nuclear Station Units 2 & 3 Final Safety Analysis Report (Updated), Revision 2.

**Figure 3.2-1 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies. RAI Response Curves are Licensee Curves Developed Using the Currently Endorsed CEUS-SSC for the VCSNS site**



**Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the SSE for the VCSNS site**





T. Gatlin

- 2 -

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

Sincerely,

**/RA/**

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

Docket No. 50-395

Enclosure:  
Staff Assessment of Seismic  
Hazard Evaluation and Screening Report

cc w/encl: Distribution via Listserv

**DISTRIBUTION:**

PUBLIC	FVega, NRR
JHMB R/F	NDiFrancesco, NRR
RidsNrrDorlPl2-1Resource	DJackson, NRO
RidsNrrPMSummer Resource	MShams, NRR
RidsNrrLASLent Resource	
RidsAcrsAcnw_MailCTR Resource	

**ADAMS Accession No.: ML15194A055**

**\*via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RGS1/BC*
NAME	FVega	SLent	DJackson
DATE	07/13/15	07/13/15	07/08/15
OFFICE	NRR/JLD/JHMB/BC	NRR/JLD/JHMB/PM	
NAME	MShams	FVega	
DATE	07/19/15	07/20/15	

**OFFICIAL RECORD COPY**