UNITED STATES
NUCLEAR REGULATORY COMMISSION
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May 10, 2017

Mr. George Lippard III, Vice President
Nuclear Operations
South Carolina Electric & 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 REVIEW OF SPENT FUEL POOL EVALUATION ASSOCIATED WITH REEVALUATED SEISMIC HAZARD IMPLEMENTING NEAR-TERM TASK FORCE RECOMMENDATION 2.1 (CAC NO. MF3831)

Dear Mr. Lippard:

The purpose of this letter is to inform South Carolina Electric and Gas Company (SCE&G, the licensee) of the results of the U.S. Nuclear Regulatory Commission (NRC) staff's review of the spent fuel pool (SFP) evaluation for Virgil C. Summer Nuclear Station (VCSNS), Unit 1, which was submitted in response to Item 9 of Enclosure 1 of the NRC's March 12, 2012, request for information (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340) issued under Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The NRC staff concludes that the licensee's assessment was performed consistent with the NRC-endorsed SFP Evaluation Guidance Report and that the licensee has provided sufficient information to complete the response to Item 9 of the 50.54(f) letter.

BACKGROUND

On March 12, 2012, the NRC issued a 50.54(f) letter as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 1 to the 50.54(f) letter requested that licensees reevaluate seismic hazards at their sites using present-day methodologies and guidance. Enclosure 1, Item 4, of the 50.54(f) letter requested that licensees perform a comparison of the ground motion response spectrum (GMRS) and the safe shutdown earthquake (SSE). The staff's assessment of the information provided in response to Items 1-3 and 5-7 and the comparison portion of Item (4) of the 50.54(f) letter is provided by letter dated July 20, 2015 (ADAMS Accession No. ML15194A055). Enclosure 1, Item 9, of the 50.54(f) letter requested that, when the GMRS exceeds the SSE in the 1 to 10 Hertz frequency range, a seismic evaluation be made of the SFP. More specifically, plants were asked to consider "...all seismically induced failures that can lead to draining of the SFP."

By letter dated February 23, 2016 (ADAMS Accession No. ML16055A021), the Nuclear Energy Institute (NEI) staff submitted Electric Power Research Institute (EPRI) Report No. 3002007148 entitled, "Seismic Evaluation Guidance: Spent Fuel Pool Integrity Evaluation" (SFP Evaluation Guidance Report). The SFP Evaluation Guidance Report provides criteria for evaluating the seismic adequacy of an SFP to the reevaluated GMRS hazard levels. This report supplements the guidance in EPRI Report 1025287, "Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID)" (ADAMS Accession No. ML12333A170), for plants where the GMRS peak spectral acceleration is less than or equal to 0.8g (low GMRS sites). The NRC endorsed the SFP Evaluation Guidance Report by letter dated March 17, 2016 (ADAMS Accession No. ML15350A158), as an acceptable method for licensees to use when responding to Item 9 in Enclosure 1 of the 50.54(f) letter.

By letter dated October 27, 2015 (ADAMS Accession No. ML15194A015), the NRC staff stated that SFP evaluation submittals for low GMRS sites are expected by December 31, 2016.

REVIEW OF LICENSEE SPENT FUEL POOL EVALUATION

By letter dated March 30, 2017 (ADAMS Accession No. ML17089A578), the licensee submitted its SFP evaluation for VCSNS for NRC review. The NRC staff assessed the licensee's implementation of the SFP Evaluation Guidance Report through the completion of a reviewer checklist, which is included as an enclosure to this letter.

TECHNICAL EVALUATION

Section 3.0 of the SFP Evaluation Guidance Report develops SFP evaluation criteria for plants with GMRS peak spectral acceleration less than or equal to 0.8g. These criteria address SFP structural elements (e.g., floors, walls, and supports); non-structural elements (e.g., penetrations); seismically-induced SFP sloshing; and water losses due to heat-up and boil-off. Section 3.0 also provides applicability criteria, which enables licensees to determine if their site-specific conditions are within the bounds considered in developing the evaluation criteria for this report. The staff's review consists of confirming that these SFP site-specific conditions are within the bounds considered for the evaluation criteria specified in the SFP Evaluation Guidance Report.

1.1 Spent Fuel Pool Structural Evaluation

Section 3.1 of the SFP Evaluation Guidance Report provides a SFP structural evaluation approach used to demonstrate that the SFP structure is sufficiently robust against the reevaluated seismic hazard. This approach supplements the guidance in Section 7 of the SPID and follows acceptable methods used to assess the seismic capacity of structures, systems, and components (SSCs) for nuclear power plants as documented in EPRI NP-6041, "A Methodology for Assessment of Nuclear Plant Seismic Margin, Revision 1." Table 3-2 of the SFP Evaluation Guidance Report (reproduced from Table 2.3 of EPRI NP-6041) provides the structural screening criteria to assess the SFPs and their supporting structures.

The licensee stated that it followed the SFP structural evaluation approach presented in the SFP Evaluation Guidance Report and provided site-specific data to confirm its applicability. In addition, the licensee provided the results of a supplemental analysis performed to verify the SFP structural integrity for the site-specific GMRS. The results verified that the SFP structural integrity is acceptable and confirmed the SFP screening evaluation results.

The NRC staff reviewed the structural information provided, which included the requested site-specific data in Section 3.3 of the SFP Evaluation Guidance Report, and confirmed that the evaluation criteria are applicable to the VCSNS site. The staff concludes that SFP SSCs were appropriately evaluated and screened based on the seismic capacity criteria in EPRI NP-6041 and that the licensee has demonstrated that the SFP structure is sufficiently robust and can withstand ground motions with peak spectral acceleration less than or equal to 0.8g.

1.2 Spent Fuel Pool Non-Structural Evaluation

Section 3.2 of the SFP Evaluation Guidance Report provides criteria for evaluating the non-structural aspects of the SFP, such as piping connections, fuel gates, and anti-siphoning devices, as well as SFP sloshing and heat up and boil-off of SFP water inventory. Specifically, Table 3-4 of the SFP Evaluation Guidance Report provides a summary of the SFP non-structural evaluation criteria derived in Section 3.2, along with applicability criteria to demonstrate that site-specific conditions are suitable for applying the evaluation criteria.

The licensee stated that it followed the SFP non-structural evaluation approach presented in the guidance report and provided site-specific data to confirm its applicability. The staff reviewed the non-structural information provided, which included the requested site-specific data in Table 3-4 of the SFP Evaluation Guidance Report, and confirmed that the evaluation criteria are applicable to the VCSNS site. Therefore, the staff concludes that the licensee adequately evaluated the non-structural considerations for SSCs whose failure could lead to potential drain-down of the SFP due to a seismic event.

CONCLUSION

The NRC staff reviewed the licensee's SFP evaluation report. Based on its review, the NRC staff concludes that the licensee's implementation of the SFP integrity evaluation met the criteria of the SFP Evaluation Guidance Report for VCSNS and therefore, the licensee responded appropriately to Item 9 in Enclosure 1 of the NRC's 50.54(f) letter.

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

Sincerely,

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

Docket No. 50-395

Enclosure:
Technical Review Checklist

cc w/encl: Distribution via Listserv

TECHNICAL REVIEW CHECKLIST
BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO SPENT FUEL POOL EVALUATIONS FOR LOW GROUND MOTION RESPONSE SPECTRUM SITES
IMPLEMENTING NEAR-TERM TASK FORCE RECOMMENDATION 2.1 SEISMIC
VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1
DOCKET NO. 50-395

BACKGROUND

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), 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) (hereafter referred to as the "50.54(f) letter"). Enclosure 1 of the 50.54(f) letter requests addressees to reevaluate the seismic hazard at their site using present-day methods and guidance for licensing new nuclear power plants, and identify actions to address or modify, as necessary, plant components affected by the reevaluated seismic hazards. Enclosure 1, Item 4, of the 50.54(f) letter requested that licensees perform a comparison of the ground motion response spectrum (GMRS) with the safe shutdown earthquake (SSE). Enclosure 1, Item 9, requests that, when the GMRS exceeds the SSE in the 1 to 10 Hertz (Hz) frequency range, a seismic evaluation be made of the spent fuel pool (SFP). More specifically, plants were asked to consider "...all seismically induced failures that can lead to draining of the SFP."

Additionally, by letter dated February 23, 2016 (ADAMS Accession No. ML16055A021), the Nuclear Energy Institute (NEI) submitted Electric Power Research Institute (EPRI) Report No. 3002007148 entitled, "Seismic Evaluation Guidance: Spent Fuel Pool Integrity Evaluation" (SFP Evaluation Guidance Report). The SFP Evaluation Guidance Report supports the completion of SFP evaluations for sites with reevaluated seismic hazard exceedance in the 1 to 10 Hz frequency range. Specifically, the SFP Evaluation Guidance Report addressed those sites where the GMRS peak spectral acceleration (S_a) is less than or equal to 0.8g (low GMRS sites). The NRC endorsed the SFP Evaluation Guidance Report by letter dated March 17, 2016 (ADAMS Accession No. ML15350A158), as an acceptable method for licensees to use when responding to Item 9 in Enclosure 1 of the 50.54(f) letter. Licensee deviations from the SFP Evaluation Guidance should be discussed in their SFP evaluation submittal.

By letter dated March 30, 2017 (ADAMS Accession No. ML17089A578), South Carolina Electric and Gas Company (SCE&G, the licensee), provided a SFP report in a response to Enclosure 1, Item 9, of the 50.54(f) letter for Virgil C. Summer Nuclear Station (VCSNS), Unit 1. The NRC staff performed its review of the licensee's submittal to assess whether the licensee responded appropriately to Item 9 in Enclosure 1 of the 50.54(f) letter. The NRC staff evaluated whether the site-specific parameters are within the bounds of the criteria considered in the SFP Evaluation Guidance Report, verified the SFP's seismic adequacy to withstand the reevaluated GMRS hazard levels, and confirmed that the requested information in response to Item 9 of the 50.54(f) letter was provided.

A review checklist was used for consistency and scope. The application of this staff review is limited to the SFP evaluation as part of the seismic review of low GMRS sites as part of the Near-Term Task Force (NTTF) Recommendation 2.1.

NTTF Recommendation 2.1 Spent Fuel Pool Evaluations
Technical Review Checklist for VCSNS, Unit 1

Site Parameters:

I. Site-Specific GMRS

The licensee: • Provided the site-specific GMRS consistent with the information provided in the Seismic Hazard and Screening Report (SHSR), or its update and evaluated by the staff in its staff assessment. • Stated that the GMRS peak S_a is less than or equal to 0.8g for any frequency.	Yes Yes
Notes from the reviewer: 1. The NRC staff confirmed that the site-specific peak S_a = 0.784g (SHSR - ADAMS Accession No. ML14092A250). **Deviation(s) or Deficiency(ies), and Resolution**: No deviations or deficiencies were identified.	
The NRC staff concludes: • The site-specific GMRS peak S_a at any frequency is less than 0.8g. • The licensee's GMRS used in this evaluation is consistent with the information provided in the SHSR.	Yes Yes

Structural Parameters:

II. Seismic Design of the SFP Structure

The licensee: • Specified the building housing the SFP. • Specified the plant's peak ground acceleration (PGA). • Stated that the building housing the SFP was designed using an SSE with a PGA of at least 0.1g.	Yes Yes Yes

Notes from the reviewer: 1. The NRC staff confirmed that the SFP is housed in the fuel handling building which is seismically designed to the site SSE with a PGA of 0.15g (SHSR Section 3.1 and Final Safety Analysis Report (FSAR) Sections 2.5 and 3.2). **Deviation(s) or Deficiency(ies), and Resolution:** No deviations or deficiencies were identified.	
The NRC staff concludes that: • The structure housing the SFP was designed using an SSE with a PGA of at least 0.1g.	Yes

III. Structural Load Path to the SFP

The licensee: • Provided a description of the structural load path from the foundation to the SFP. • Performed screening based on EPRI NP-6041 Table 2-3 screening criteria.	Yes Yes
Notes from the reviewer: 1. The staff verified the structural load path to the SFP. The staff confirmed that the structural load path from the pile foundation (exteneded to competent rock) to the SFP consists of reinforced concrete shear walls with a reinforced concrete slab (FSAR Section 3.8). **Deviation(s) or Deficiency(ies), and Resolution:** No deviations or deficiencies were identified.	
The NRC staff concludes that: • Licensee appropriately described the structural load path to the SFP. • Structures were appropriately screened based on the screening criteria in EPRI NP-6041.	Yes Yes

IV. SFP Structure Included in the Civil Inspection Program Performed in Accordance with Maintenance Rule

The licensee: • Stated that the SFP structure is included in the Civil Inspection Program performed in accordance with Maintenance Rule (10 CFR 50.65).	Yes
Notes from the reviewer: 1. The licensee stated that the SFP structure are included as part of VCSNS Procedure ES-0437, which implements the Maintenance Rule structural inspections program. **Deviation(s) or Deficiency(ies), and Resolution:** No deviations or deficiencies were identified.	
The NRC staff concludes that: • The SFP structure is included in the Civil Inspection Program performed in accordance with Maintenance Rule (10 CFR 50.65).	Yes

Non-Structural Parameters:

V. Applicability of Piping Evaluation

The licensee: • Stated that piping attached to the SFP is evaluated to the SSE.	Yes
Notes from the reviewer: 1. The licensee stated that piping attached to the SFP up to the first valve is Safety Class 2b and Seismic Category 1 and therefore, was designed to SSE (FSAR Section 3.2, Table 3.2-1) **Deviation(s) or Deficiency(ies), and Resolution:** No deviations or deficiencies were identified.	
The NRC staff concludes that: • The piping attached to the SFP is evaluated to the SSE. • Applicability criteria specified in Table 3-4 of SFP evaluation guidance have been met.	Yes Yes

VI. Siphoning Evaluation

The licensee:	
• Stated that anti-siphoning devices are installed on piping systems that could lead to siphoning inventory from the SFP.	Yes
• In cases where anti-siphoning devices were not included on the applicable piping, a description documenting the evaluation performed to determine the seismic adequacy of the piping is provided.	N/A
• Stated that the piping of the SFP cooling system cannot lead to rapid drain down due to siphoning.	No
• Stated that no anti-siphoning devices are attached to 2" or smaller piping with extremely large extended operators.	Yes
• Provided a seismic adequacy evaluation, in accordance with NP-6041, for cases where active siphoning devices are attached to 2" or smaller piping with extremely large extended operators.	N/A

Notes from the reviewer:

1. The licensee stated that anti-siphoning holes are present in attached piping that could lead to siphoning of water (FSAR Section 9.1.3.3).
2. Piping of the SFP cooling system is not likely to lead to rapid draindown due to siphoning.

Deviation(s) or Deficiency(ies), and Resolution:

No deviations or deficiencies were identified.

The NRC staff concludes:	
• Anti-siphoning devices exist in applicable piping systems that could lead to siphoning water from the SFP.	Yes
• Piping of the SFP cooling system is not likely to lead to rapid draindown due to siphoning.	Yes
• No active anti-siphoning devices are attached to 2" or smaller piping with extremely large extended operators.	Yes
• Applicability criteria specified in Table 3-4 of SFP evaluation guidance have been met.	Yes

VII. Sloshing Evaluation

The licensee:	
• Specified the SFP dimensions (length, width, and depth).	Yes
• Specified that the SFP dimensions are bounded by the dimensions specified in the report (i.e., SFP length and width <125ft.; SFP depth >36ft.).	Yes

• Stated that the peak Sa in the frequency range less than 0.3 Hz is less than 0.1g.	Yes

Notes from the reviewer:

1. SFP dimensions (FSAR Section 9.1.2.2)
   - SFP Length – 39 ft.
   - SFP Width – 28 ft.
   - SFP Depth – 38 ft. 10in.
2. The staff confirmed in the SHSR that the peak S_a in the frequency range less than 0.3 Hz is less than 0.1g (SHSR).

Deviation(s) or Deficiency(ies), and Resolution:

No deviations or deficiencies were identified.

The NRC staff concludes:	
• SFP dimensions are bounded by the dimensions specified in the report (i.e., SFP length and width <125ft.; SFP depth >36ft.).	Yes
• The peak S_a in the frequency range less than 0.3 Hz is less than 0.1g.	Yes
• Applicability criteria specified in Table 3-4 of SFP evaluation guidance have been met.	Yes

VIII. Evaporation Evaluation

The licensee:	
• Provided the surface area of the plant's SFP.	Yes
• Stated that the surface area of the plant's SFP is greater than 500 ft^2.	Yes
• Provided the licensed reactor core thermal power.	Yes
• Stated that the reactor core thermal power is less than 4,000 megawatt thermal (MW_t) per unit.	Yes

Notes from the reviewer:

1. Surface area of pool = 1092 ft^2
2. Reactor thermal power = 2,900 MW_t (FSAR Section 1.1.4)

Deviation(s) or Deficiency(ies), and Resolution:

No deviations or deficiencies were identified.

The NRC staff concludes:	
• The surface area of the plant's SFP is greater than 500 ft^2.	Yes

• The reactor core thermal power is less than 4,000 MW_t per unit. • Applicability criteria specified in Table 3-4 of SFP evaluation guidance have been met.	Yes Yes

Conclusions:

The NRC staff reviewed the licensee's SFP evaluation report. Based on its review, the NRC staff concludes that the licensee's implementation of the SFP integrity evaluation met the criteria of the SFP Evaluation Guidance Report for VCSNS and therefore the licensee responded appropriately to Item 9 in Enclosure 1 of the 50.54(f) letter.

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1 - STAFF REVIEW OF SPENT FUEL POOL EVALUATION ASSOCIATED WITH REEVALUATED SEISMIC HAZARD IMPLEMENTING NEAR-TERM TASK FORCE RECOMMENDATION 2.1 DATED May 10, 2017

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