DUKE ENERGY.

CHRISTOPHER M. FALLON
Vice President
Nuclear Development

Duke Energy
EC12L/526 South Church Street
Charlotte, NC 28201-1006

Mailing Address:
EC12L / P.O. Box 1006
Charlotte, NC 28201-1006

o: 704.382.9248
c: 704.519.6173
f: 980.373.2551

christopher.fallon@duke-energy.com

October 22, 2014

10 CFR 52.79

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Duke Energy Carolinas, LLC (Duke Energy)
William States Lee III Nuclear Station - Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the William States Lee III Nuclear Station Units 1 and 2
Supplemental Response to Request for Additional Information Letter No. 121 (eRAI 7571)
Ltr#: WLG2014.10-02

References:

1. Letter from Brian Hughes (NRC) to Robert Kitchen (Duke Energy), Request for Additional Information Letter No. 121, Related to SRP Section 03.08 Foundations for the William States Lee III Units 1 and 2 Combined License Application, dated July 15, 2014 (ML14196A303)

2. Letter from Christopher M. Fallon (Duke Energy) to the Document Control Desk, Response to Request for Additional Information Letter No. 121 (eRAI 7571), Ltr# WLG2014.08-05, dated August 14, 2014 (ML14227A706)

This letter provides Duke Energy's supplemental response to the Nuclear Regulatory Commission's request for additional information (RAI) included in Reference 1. Supplemental information in response to RAI 03.08.05-7 is presented in a separate enclosure. This supplemental information provides additional detail on the assessment of Seismic Category II buildings for potential sliding and overturning. The corresponding information for the Nuclear Island and the associated updates to the Final Safety Analysis Report are unchanged from Reference 2. If you have questions or require additional information, please contact Robert H. Kitchen, Nuclear Development Licensing Director, at (704) 382-4046.

I declare under penalty of perjury that the forgoing is true and correct. Executed on October 22, 2014.

Sincerely,

Christopher M Fallon

Christopher M. Fallon
Vice President
Nuclear Development

D093
NRD

Enclosure:

1) Lee Nuclear Station Units 1 and 2 Supplemental Response to Request for Additional Information (RAI) Letter No. 121, RAI 03.08.05-7 (eRAI 7571)

xc (w/o enclosure):

Frederick Brown, Deputy Regional Administrator, Region II

xc (w/ enclosure):

Brian Hughes, Senior Project Manager, DNRL

Enclosure 1

Lee Nuclear Station Units 1 and 2

Supplemental Response to Request for Additional Information (RAI)

RAI Letter No. 121

RAI 03.08.05-7 (eRAI 7571)

Lee Nuclear Station Supplemental Response to Request for Additional Information (RAI)

RAI Letter No. 121

NRC Technical Review Branch: Seismic System Analysis

Reference NRC RAI Number(s): 03.08.05-7 (eRAI 7571)

NRC RAI:

Staff reviewed Figures 3.7-201 and 3.7-202 and finds that there are Lee site-specific FIRS exceedances of the AP1000 and HRHF and CSDRS. Due to these exceedances, staff requests the applicant to provide additional information relating to the factors of safety on sliding and overturning for the nuclear island and the seismic Category II structures. The response should also address factors of safety to resist beyond design basis demands (1.67 x WLS GMRS). Staff reviews the effects of sliding and overturning in accordance with SRP Section 3.8.5 and seismic margin in accordance with SRP Section 19.0.

Duke Energy Supplemental Response

Duke Energy letter WLG2014.08-05 (Reference 1) provided the initial response to this request. The portion of that response addressing the potential for sliding and overturning of the Nuclear Island (NI) is unchanged from Reference 1. Similarly, the proposed update to FSAR Subsection 3.7.2.8.4 is also unchanged from Reference 1. The information below supplements Reference 1, providing additional detail about the evaluations of adjacent Seismic Category II structures for potential sliding and overturning.

Seismic Category II Adjacent Structures Sliding and Overturning Evaluation:

The seismic interaction of the Lee Seismic Category (SC) II adjacent structures and NI was evaluated as part of the Lee SCII soil-structure interaction (SSI) analysis described in report WLG-1000-S2R-804 (FSAR Section 3.7 Reference 205). In this report relative displacements between the SCII Annex Building and Turbine Building First (1st) Bay were shown to be less than the gap provided between the adjacent structures and the NI. Also, bearing demand of the Lee SCII adjacent structures was shown to be less than the site-specific dynamic bearing capacity of the underlying engineered backfill material.

An analysis of sliding and overturning stability to determine the corresponding factors of safety was performed, which evaluated both the design basis and beyond design basis (seismic margin) cases of the Lee SCII Annex Building and Turbine Building 1st Bay adjacent structures. The evaluation was conducted using a simplified conservative pseudo-static analysis.

Sliding stability factors of safety for the Lee SC II adjacent structures were determined as the ratio of the resisting friction force (Ff), using a conservative static coefficient of friction (μ) = 0.55, and the site specific maximum horizontal base shear force at the center of mass, i.e., base of the SCII stick model of the respective adjacent structure. Similarly, overturning stability factors of safety for the Lee SCII adjacent structures were determined as the ratio of the resisting moment (Mr) and site-specific overturning moment at the center of mass/base of the SCII structure stick model.

The maximum groundwater condition is at elevation (El.) 584 feet. The bottoms, i.e., underside of the 3-foot thick foundation for the Annex Building and 6-foot thick foundation for the Turbine Building 1st Bay are at El. 590 feet and El. 587 feet, respectively. Therefore, the maximum groundwater level is below the bottom of the foundations and buoyancy is non-effective. The computer program SASSI2000 was used to perform STRESS analyses for extracting seismic

horizontal base shear forces, overturning moments, and vertical soil stresses at the base of the Annex Building and Turbine Building 1st Bay stick models.

The maximum horizontal base shear forces and overturning moments were obtained as the maximum of the Lee best estimate (BE), lower bound (LB) and upper bound (UB) soil cases forces and moments. The site-specific beyond design basis seismic margin case is reflective of a review level earthquake (RLE) and is defined herein as 1.67 times the Lee SCII adjacent structures design basis forces, moments and stresses.

Annex Building Sliding and Overturning Stability – Design Basis and Beyond Design Basis

Time history analysis was performed for the evaluation of seismic stability of the Lee SCII Annex Building. The analysis results are summarized below. The results are derived from the maximum reaction forces and moments at the base of the stick model located at El. 593 feet (AP1000 El. 100 feet) and exactly under the center of mass of the Annex Building.

Summarized below are the maximum site-specific horizontal base shear (toward the Nuclear Island), overturning moment and vertical seismic force, as well as the resisting friction force, conservatively utilizing a friction coefficient, $\mu = 0.55$, and resisting moment for the Annex Building.

Annex Building Maximum Horizontal Base Shear, Overturning Moment and Vertical Force

Lee Annex Building Maximums: BE, LB and UB Backfill Soil Cases

	Design Basis		Beyond Design Basis	
Horizontal Base Shear	8510	kips	14212	kips
Overturning Moment	520252	kip-feet	868822	kip-feet
Vertical Seismic Force	14022	kips	23417	kips

Annex Building Resisting Friction Force

(Weight of Annex Building and Foundation – Max Vertical Seismic Force) * 0.55 friction coefficient.

- Resisting Friction Force ($\mu = 0.55$) Ff = 22179 kips (Design Basis)
- Resisting Friction Force ($\mu = 0.55$) Ff = 17012 kips (Beyond Design Basis)

Annex Building Resisting Overturning Moment

(Weight of Annex Building and Foundation – Max Vertical Seismic Force) * 29.3-foot distance from Annex stick model to foundation edge toward Nuclear Island.

- Resisting Overturning Moment Mr = 1181534 kip-feet (Design Basis)
- Resisting Overturning Moment Mr = 906265 kip-feet (Beyond Design Basis)

As shown below, the site-specific Lee Annex Building sliding and overturning factors of safety for the design basis case are greater than the allowable factor of safety of 1.1. The beyond design basis seismic margin sliding and overturning factors of safety are greater than or equal to a factor of safety of 1.0.

Annex Building Sliding and Overturning Factors of Safety (FS)

Design Basis Case		FS	Allowable
Sliding	Fs = Resisting Friction Force / Max Base Shear =	2.6	1.1
Overturning	Fs = Resisting Moment / Max Base Moment =	2.3	1.1

Beyond Design Basis Case		FS	Allowable
Sliding	Fs = Resisting Friction Force / Max Base Shear =	1.2	1.0
Overturning	Fs = Resisting Moment / Max Base Moment =	>1.0	1.0

Turbine Building 1st Bay Sliding and Overturning Stability – Design Basis and Beyond Design Basis

Time history analysis was also performed for the evaluation of seismic stability of the Lee SCII Turbine Building 1st Bay. The analysis results are summarized below. The results are derived from the maximum reaction forces and moments at the base of the stick model located at El. 593 feet (AP1000 El. 100 feet) and exactly under the center of mass of the Turbine Building 1st Bay.

Summarized below are the maximum site-specific horizontal base shear (towards the Nuclear Island), overturning moment and vertical force, the resisting friction force, conservatively utilizing a friction coefficient, $\mu = 0.55$, and resisting moment for the Turbine Building 1st Bay. The weight of the non-seismic (NS) main Turbine Building common foundation is included in the resisting force and moment of the Turbine Building 1st Bay; however, the weight of the main Turbine Building structure and corresponding seismic shear forces and moments were not included since factors of safety would increase due to the inclusion of these effects.

Turbine Building 1st Bay Maximum Horizontal Base Shear, Overturning Moment and Vertical Force

Lee Turbine Building 1st Bay Maximums: BE, LB and UB Backfill Soil Cases

	Design Basis		Beyond Design Basis	
Horizontal Base Shear	6629	kips	11070	kips
Overturning Moment	382073	kip-feet	638062	kip-feet
Vertical Seismic Force	2589	kips	4324	kips

Turbine Building 1st Bay Resisting Friction Force

(Weight of Turbine Building 1st Bay and Common Foundation – Max Vertical Seismic Force) * 0.55 friction coefficient.

- Resisting Friction Force ($\mu = 0.55$) Ff = 22553 kips (Design Basis)
- Resisting Friction Force ($\mu = 0.55$) Ff = 20644 kips (Beyond Design Basis)

Turbine Building 1st Bay Resisting Overturning Moment

(Weight of Turbine Building 1st Bay and Common Foundation – Max Vertical Seismic Force) * 16.5-foot distance of Turbine Building 1st Bay stick model and NS foundation center of mass to foundation edge.

- Resisting Overturning Moment Mr = 5348853 kip-feet (Design Basis)
- Resisting Overturning Moment Mr = 5011535 kip-feet (Beyond Design Basis)

As shown below, the site-specific Lee Turbine Building 1st Bay sliding and overturning factors of safety for the design basis case are greater than the allowable factor of safety of 1.1. The beyond design basis seismic margin sliding and overturning factors of safety are greater than a factor of safety of 1.0.

Turbine Building 1st Bay Sliding and Overturning Factors of Safety (FS)

Design Basis Case		FS	Allowable
Sliding	Fs = Resisting Friction Force / Max Base Shear =	3.4	1.1
Overturning	Fs = Resisting Moment / Max Base Moment =	14.0	1.1

Beyond Design Basis Case		FS	Allowable
Sliding	Fs = Resisting Friction Force / Max Base Shear =	1.9	1.0
Overturning	Fs = Resisting Moment / Max Base Moment =	7.9	1.0

As required by DCD Section 3.7.2.8, SCII adjacent structures must be designed to prevent their collapse when subjected to their design earthquake. Therefore, the detailed design of the building elements making up the AP1000 standard SC II adjacent structures will be reviewed to confirm that they satisfy the acceptance criteria specified in AP1000 DCD Section 3.7.2 when subjected to the forces resulting from the site-specific foundation response spectra. As noted in FSAR Subsection 3.7.2.8.4, this review and any required design changes will be completed prior to start of construction of the SCII adjacent buildings at Lee Nuclear Station. This review will include sliding and overturning factors of safety and will be incorporated in FSAR Subsection 3.7.2.8.4 in a future revision of the Final Safety Analysis Report.

Reference

1. Letter from Christopher M. Fallon (Duke Energy) to the Document Control Desk, "Response to Request for Additional Information Letter No. 121 (eRAI 7571)", Ltr# WLG2014.08-05, dated August 14, 2014.

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report:

None. Updates to FSAR Subsection 3.7.2.8.4 were provided in Reference 1 and are unchanged by this supplemental response.

Attachment:

None