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

Subject: Duke Energy Carolinas, LLC
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
Response to Request for Additional Information
Ltr# WLG2009.09-10

Reference: Letter from J.M. Muir (NRC) to B.J. Dolan (Duke Energy), *Request for Additional Information Regarding the Environmental Review of the Combined License Application for William States Lee III Nuclear Station, Units 1 and 2*, dated August 21, 2008

Letter from B.J. Dolan to Document Control Desk, Duke Energy Carolinas, LLC, 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, Response to Request for Additional Information*, Ltr# WLG2008.10-13, dated October 28, 2008

This letter provides supplemental information to the Duke Energy response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) included in the referenced letter:

RAI 63, Aquatic Ecology

Responses to these NRC requests are addressed in the enclosures which also identify any associated changes that will be made in a future revision of the William States Lee III Nuclear Station application.

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NRO

If you have any questions or need any additional information, please contact Peter S. Hastings, Nuclear Plant Development Licensing Manager, at 980-373-7820.

Bryan J. Dolan
Vice President
Nuclear Plant Development

Enclosure:

1) Supplemental Response to RAI 63, Aquatic Ecology

AFFIDAVIT OF BRYAN J. DOLAN

Bryan J. Dolan, being duly sworn, states that he is Vice President, Nuclear Plant Development, Duke Energy Carolinas, LLC, that he is authorized on the part of said Company to sign and file with the U. S. Nuclear Regulatory Commission this supplement to the combined license application for the William States Lee III Nuclear Station and that all the matter and facts set forth herein are true and correct to the best of his knowledge.

Bryan J. Dolan

Bryan J. Dolan

Subscribed and sworn to me on September 24, 2009

K N Slays

Notary Public

My commission expires: April 19, 2010

KIM N. SLAYS
NOTARY PUBLIC
NEW HANOVER COUNTY, N.C.

SEAL

xc (w/o enclosure):

Loren Plisco, Deputy Regional Administrator, Region II
Stephanie Coffin, Branch Chief, DNRL
Robert Schaaf, Branch Chief, DSER

xc (w/ enclosure):

Michelle Moser, Project Manager, DSER
Brian Hughes, Senior Project Manager, DNRL

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

RAI Letter Dated: August 21, 2008

Reference NRC RAI Number: ER RAI-63 Supplement

NRC RAI:

Duke is requested to conduct further modeling of low flow events focusing on temperature increases during low flow periods and the predicted durations of these elevated temperature events to help ecologists determine the level of impacts to the small mouth bass population below the Ninety - Nine Islands dam. Modeling should include a re - evaluation of the CORMIX modeling results downstream of the dam, considering smallmouth bass thermal tolerances as an input.

Duke Energy Response:

Duke Energy is supplementing the previous response to this RAI.

Duke Energy conducted three-dimensional modeling of the Lee Nuclear Station thermal discharge using the Computational Fluid Dynamic (CFD) model developed by Geosyntec. The model used the maximum design discharge temperature of 91°F and average design discharge flow of 18 cfs. Scenarios were modeled for the estimated Broad River mean annual flow of 2500 cfs and low flow of 483 cfs. The model predicted a maximum area for the $\Delta T > 1^{\circ}F$ plume of 0.08 ac. during low flow. The model predicted that the maximum water temperature at the Ninety-Nine Islands Hydroelectric Station intakes would be 88.2°F, also during low-flow. This temperature would be a < 1°F increase above ambient temperatures.

The Lee Nuclear Station COLA Environmental Report will be revised, as indicated below, to reflect the updated results from the CFD study. The revisions will be submitted in a future revision to the Lee Nuclear Station COLA.

Associated Revisions to the Lee Nuclear Station Combined License Application:

1. Revise COLA Part 3, ER Chapter 5, Subsection 5.2.3.1, Paragraphs 1-3, as follows:

   Under NPDES regulations, waste heat is regarded as thermal pollution and is regulated in the same way as chemical pollutants. In addition to modeling performed at Clemson University to determine the impact of waste heat on the receiving water (Reference 9), a three-dimensional model using computational fluid dynamics (CFD) (Reference 10) was undertaken to examine behavior of the thermal plume under various flow regimes. The CFD model incorporates equations to express the laws of conservation of mass, momentum, and energy. ~~A computer program, CORMIX (Version 4.3), was used to simulate the thermal plumes above and below the Ninety-Nine Islands Dam (Reference 13). CORMIX is widely used and recognized for discharge mixing-zone analyses (Reference 10). The model has been validated in numerous applications (Reference 9)~~. A mass balance also was performed to determine expected temperature of water discharged by Lee Nuclear Station after mixing with Broad River water in the hydroelectric station turbines.

For the ~~CORMIX~~ CFD model, river temperature data collected from ~~1996 to~~ December 2006 to July 2008 (Subsection 2.3.3.1.2) ~~at~~ in the Broad River at various locations were used to establish ambient river conditions ~~low, mean, and high ambient temperatures~~ (~~Table 2.3-3~~). Long-term daily flow records in the river were obtained from the USGS Station No. 02153551, located on the Broad River below Cherokee Falls, South Carolina (just below Ninety-Nine Islands Dam), downstream of the Lee Nuclear Site. The flow records were combined with the temperature data to establish the model inputs provided in Table 5.2-1~~used to synthesize a 10-year record of monthly low and mean flows at the Lee Nuclear Site (Table 2.3-3)~~.

While in the normal intake/discharge mode, the cooling system is expected to operate at four cycles of concentration. ~~Blowdown discharge flow rates and temperatures were provided as input to CORMIX for four-cycle operation.~~ Results of these simulations (Table 5.2-1) predict a small thermal plume that dissipates quickly. In addition, as discussed under discharge design in this subsection, placing the discharge structure in the Ninety-Nine Islands Reservoir just in front of the dam should facilitate enhanced mixing. Results of the ~~heat~~ mass balance calculation indicate that the maximum temperature change downstream of the hydroelectric station is expected to be less than 1.4°F while the results of CFD and the Clemson University study indicate, under normal operating conditions, the temperatures at the turbine inlets should be less than 1°F higher than ambient. Therefore, impacts from discharge temperature from the Lee Nuclear Station are SMALL and do not warrant mitigation. Additional information from the simulation is provided in the discharge design discussion below and in Subsection 5.3.2.1.

2. Revise COLA Part 3, ER Chapter 5, subsection 5.2.3.1, Paragraph 5, as follows:

The SCDHEC regulations for issuing NPDES permits give the agency the authority to allow a mixing zone for surface waters. A mixing zone defines a limited area or volume of the receiving water where the initial dilution of a discharge is allowed to occur. In practice, discharge dilution may occur close to (e.g., near-field) or far from (e.g., far-field) the actual location of a hydrodynamic mixing process and therefore, the definition of a specific mixing zone depends on source, ambient, and regulatory constraints ~~(Reference 4)~~.

3. Revise COLA Part 3, ER Chapter 5, Subsection 5.2.3.1, Paragraphs 7-9, as follows:

Discharge Design
~~An analysis of discharge above and below the dam was used in evaluating the thermal plumes. The analysis was performed for conditions of (1) low river temperature at mean annual flow; (2) high river temperature at mean annual flow; and (3) high river temperature at low (7Q10) downstream flow (Subsection 5.3.2.1).~~ A discharge flow rate of 18.3 cfs (8216 gpm) was used ~~as well as the maximum rate of 64 cfs (28,778 gpm)~~ for the ~~CORMIX~~ CFD runs. The discharge flows represent the total expected blowdown volume, plus other miscellaneous effluents, from the Lee Nuclear Station under normal conditions. Thermal plumes were modeled for normal flow, low flow and an extreme low flow ~~The flows represent the total expected blowdown volume, plus other miscellaneous effluents, from the Lee Nuclear Station under normal conditions. A plume model was developed for each case above and below the dam to determine the plume characteristics~~ (see Table 5.2-1). Low flow conditions (< 483 cfs) occur only 2% of the time. The extreme low flow represents a condition where the Ninety-Nine Islands Hydroelectric Station is cycling discharge in accordance with its FERC license conditions.

The ~~CORMIX~~ CFD results in Table 5.2-1 demonstrate that, for an expected operational discharge of 18.3 cfs, the 5°F isotherm covers an area of less than ~~75 sq.ft.~~0.02 ac for ~~both~~ mean annual flows. ~~and~~ For low (~~7Q10~~) flows (483 cfs), a 5°F isotherm was considered negligible. For the unusual condition of ~~maximum blowdown discharge under minimum ambient temperatures~~ extreme low flow (157 cfs), the 5°F isotherm would cover an area of ~~less than 400 sq.ft~~ approximately 0.01 ac. Because the aerial extent of this isotherm is small, the impact of the thermal discharge is expected to be SMALL.

The CFD model demonstrates that ~~In addition,~~ placing the discharge structure in the Ninety-Nine Islands Reservoir just in front of the dam should facilitate mixing. Directional flow of reservoir water toward Ninety-Nine Islands Reservoir Hydroelectric Facility will pull the plume toward the dam and into the hydroelectric station turbines where it will mix with ambient water from the reservoir. ~~The mass balance equation~~ Mass balance estimates predicts that the temperature of water discharged from the turbines under normal operating condition will be less than 1.4°F above ambient conditions. ~~The use of the CORMIX data~~ The CFD m~~M~~odeling and ~~the calculations for the mixed thermal criteria provide a good assumption~~verified that the proposed multi-port diffuser located at the dam penstocks will adequately meet the needs for the Lee Nuclear Station discharge~~outfall~~, and the temperature increase at this discharge ~~outfall are~~ is SMALL and does not warrant mitigation. See Subsection 5.3.2 for further details regarding the thermal plume's mixing zone. Additional details related to the plant discharge system are presented in Section 3.4.

4. Revise COLA Part 3, ER Chapter 5, Subsection 5.2.4, References, as follows:

4. ~~CORMIX, CORMIX Mixing Zone Glossary, Website, http://www.cormix.info/glossary.php, accessed March 19, 2007.~~ Removed.

9. ~~CORMIX, Independent CORMIX Validation Studies, Website, http://www.cormix.info/validations.php, accessed March 19, 2007.~~
Hargett, D., A. Khan, and B. Sill. 2007. *Hydrodynamic Assessment of Discharge from Cooling Tower Blowdown to Broad River, Lee Nuclear Station, Cherokee County, South Carolina*, Final Report, The Strom Thurmond Institute, Clemson University, Clemson, S.C.

10. ~~CORMIX, CORMIX Mixing Zone Applications, Website, http://www.cormix.info/applications.php, accessed March 19, 2007.~~
Geosyntec Consultants. 2009. Computational Fluid Dynamics Thermal Modeling Lee Nuclear Station Site: Cherokee County, South Carolina. Project Number GK4258.

13. ~~Jirka, Gerhard H., Doneker, Robert L., and Hinton, Steven W., *User's Manual for Cormix: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*, September 1996.~~ Removed.

5. Revise COLA Part 3, ER Chapter 5, Subsection 5.3.2.1, Paragraph 1, 2, and 3 as follows:

The effluent discharge from the new facility is located upstream of the Ninety-Nine Islands Dam at the hydroelectric facility. The station discharge has been analyzed using ~~CORMIX version 4.3~~ a variety of techniques, as discussed in the next paragraphs.

~~The mathematical modeling tool CORMIX (Reference 17) is a computer code for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. It is a U.S. Environmental Protection Agency (EPA) recommended analysis tool for the permitting of industrial, municipal, thermal, and other point-source discharges to receiving waters. The CORMIX system is used for prediction of subsurface multi-port discharges.~~

~~CORMIX analyzes unidirectional, staged, and alternation designs of multi-port diffusers and allows for arbitrary alignment of the diffuser structure within the ambient water body, and for arbitrary arrangement and orientation of the individual ports. For complex hydrodynamic cases, CORMIX uses the "equivalent slot diffuser" concept and thus neglects the details of the individual jets issuing from each diffuser port and their merging process, but rather assumes that the flow arises from a long slot discharge with equivalent dynamic characteristics.~~

Computational Fluid Dynamics (CFD) modeling is based on the Navier-Stokes equations for fluid motion, which are an expression of Newton's laws of motion with additionally viscous stress terms required to calculate fluid flow. For a geometrically complex model such as the Ninety-Nine Islands Reservoir, it is necessary to discretize the equations. In this process the geometry is subdivided into a large number of computational cells and the Navier-Stokes equations are re-formed to calculate the values of pressure, velocity, temperature, and turbulence in each cell. As these values in each computational cell are influenced by their neighboring cells, an iterative solution technique must be used. The result of appropriately refined CFD is a three-dimensional flow-map of the entire geometry, which can be interrogated to provide values of flow rate, temperature, chemical concentration, and other attributes throughout the domain, as appropriate to specific study objectives. (Reference 17)

The CFD model produced maximum temperature predictions at the turbine inlets for a variety of conditions. The results of this modeling indicated the maximum effect of thermal effluent would be expected during conditions of mean flow, low river temperature, and normal effluent release. However, even under those conditions, the maximum ΔT predicted by CFD for the turbine inlets would be 0.72°F. Increases in ambient water temperature above the 5°F detailed in SCDHEC water quality standards may be found in the winter months, but only in close proximity to the diffuser and only upstream of the turbines. Temperatures above the SCDHEC 90 °F maximum water quality Standards, were only predicted during the extreme low flow circumstances.

6. Revise COLA Part 3, ER Chapter 5, Subsection 5.3.5, References, as follows:

17. ~~Jirka, G.H., R.L. Doneker, and S.W. Hinton, User's Manual for CORMIX: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters, U.S. Environmental Protection Agency Office of Science and Technology, Washington, DC, 1996.~~
Geosyntec Consultants. 2009. Computational Fluid Dynamics Thermal Modeling Lee Nuclear Station: Cherokee County, South Carolina. Project Number GK4258.

7. Replace COLA Part 3, ER Chapter 5, Table 5.2-1, SUMMARY OF THERMAL PLUME ANALYSIS (Sheet 1 of 2) in its entirety with attached revised version.

8. Revise COLA Part 3, ER Chapter 6, Subsection 6.1.1, Preapplication Monitoring, paragraphs 3 and 4, as follows:

Modeling of the thermal data was performed using the ~~CORMIX model~~ computational fluid dynamics (CFD) model (References ~~2, 3, and 4~~). The CFD model incorporates equations to express the laws of conservation of mass, momentum, and energy. ~~This model is the standard for describing thermal geometries for discharges into a water body. The proposed facility diffuser was modeled with discharge to the Ninety-Nine Islands Dam forebay and the model demonstrated that the 5° F isotherm~~

~~met requirements of the SCDHEC NPDES regulation.~~ The details and results of this evaluation are provided in Sections 5.2 and 5.3.

~~The anticipated mixing of the Lee Nuclear Station discharge in the Ninety-Nine Islands Dam forebay was modeled by the South Carolina Water Resources Institute at Clemson University using the CORMIX model. The details and results of this evaluation are provided in Sections 5.2 and 5.3 along with the results of the CORMIX modeling in Table 5.2-1.~~

The SCDHEC is expected to independently review the modeling results associated with discharges from the Lee Nuclear Station ~~as detailed above~~ when establishing thermal monitoring locations as part of the NPDES permit.

9. Revise COLA Part 3, ER Chapter 6, Subsection 6.1.5, References, as follows:

2. ~~Jirka, G. H., R. L. Doneker, and S. W. Hinton, Cormix *User Manual: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*, Office of Science and Technology, U.S. Environmental Protection Agency, Washington, DC, September 1996~~.
Geosyntec Consultants. Computational Fluid Dynamics Thermal Modeling Lee Nuclear Station: Cherokee County, South Carolina. Project Number GK4258. 2009.

3. ~~CORMIX, CORMIX Mixing Zone Applications, Website, http://www.cormix.info/applications.php, accessed March 13, 2007~~. Removed.

4. ~~CORMIX, Independent CORMIX Validation Studies, Website, http://www.cormix.info/validations.php, accessed March 13, 2007.~~ Removed.

Associated Attachments:

Attachment 63S-1 Table 5.2-1, SUMMARY OF THERMAL PLUME ANALYSIS (Sheet 1 of 2)

Attachment 63S-2 Geosyntec Consultants. 2009. Computational Fluid Dynamics Thermal Modeling Lee Nuclear Station: Cherokee County, South Carolina. Project Number GK4258.

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

Attachment 63S-1

Table 5.2-1, SUMMARY OF THERMAL PLUME ANALYSIS (Sheet 1 of 2)

TABLE 5.2-1 (Sheet 1 of 2)
SUMMARY OF THERMAL PLUME ANALYSIS

(COMPUTATIONAL FLUID DYNAMICS
THERMAL MODELING)

						90°F Thermal Plume (2)			Themal Plume >5°F Above Ambient (2)		
Scenario	Description	River Flow (cfs)	Forebay Temp (1) (°F)	Discharge Flow (cfs / gpm)	Discharge Temp (°F)	Areal Extent (ac)	Volume (ac-ft)	Max. Depth (ft)	Areal Extent (ac)	Turbine in Operation	Max. Temp Increase at Turbine Inlet (°F)
1	Mean Annual Flow	2538	52.7	18.3 / 8216	91	(3)	(3)	(3)	0.02	2,3,4	0.72
2	Low Flow	483	88.2	18.3 / 8216	91	0.025	0.057	2.11	(3)	4	0.10
3	Extreme Low Flow	157	84.0	18.3 / 8216	91	(3)	(3)	(3)	0.01	4	0.38

(1) Based upon Lee Nuclear Station monitoring (Subsection 2.3.3.1.2).
(2) Based upon SCDHEC aquatic life maximum.
(3) None predicted.