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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
Updated Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage
Ltr# WLG2010.06-01

Reference: Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Supplemental Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage, Ltr# WLG2009.07-05, dated July 31, 2009 (ML092170268)

This letter provides updated information to the Nuclear Regulatory Commission addressing the potential for reservoir-induced seismicity (RIS) associated with off-site supplemental water storage, as previously discussed in the referenced letter. The updated information is addressed in a separate enclosure, which also identifies associated changes, when appropriate, that will be incorporated into a future revision of the Final Safety Analysis Report for the Lee Nuclear Station.

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

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Enclosure:

1) Updated Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage

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 June 8, 2010

Jimmie O. Stroud

Notary Public

My commission expires: October 31, 2013

SEAL

xc (w/o enclosure):

Loren Plisco, Deputy Regional Administrator, Region II
Jeffrey Cruz, Branch Chief, DNRL

xc (w/ enclosure):

Brian Hughes, Senior Project Manager, DNRL

Lee Nuclear Station Updated Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage

Description of Update:

As discussed in Reference 1, Duke Energy plans to construct an additional off-site make-up pond as a source of supplemental water. The new pond will be formed by impounding London Creek. The resulting pond will be designated "Make-Up Pond C" and will be located to the west of the existing Make-Up Pond B.

In Reference 1, Duke Energy proposed changes to Final Safety Analysis Report (FSAR), Section 2.5, "Geology, Seismology, and Geotechnical Engineering," to address the potential for reservoir-induced seismicity (RIS) based on the results of an evaluation described in the response. These FSAR changes were incorporated in FSAR Revision 2 submitted in Reference 2. Duke Energy has updated the evaluation discussed in Reference 1 to incorporate additional research conducted to include consideration of how the maximum horizontal compressive stress orientation (S_{Hmax}) within the Carolina Piedmont metamorphic terrane of N50°E, lithology, and reservoir depth affect the potential for RIS.

This updated evaluation demonstrates that the potential for RIS associated with the Make-Up Pond C impoundment is considered low with a negligible risk to safe operations for Lee Nuclear Station Units 1 and 2. If RIS associated with Make-Up Pond C occurs, it is unlikely the induced magnitudes would have a maximum RIS magnitude of **M** > 4, a value well below the short period controlling earthquake for the Lee Nuclear Site. Ground motions associated with RIS events (**M** < 4) typically display high frequency, modest peak ground acceleration with low energy. The current short-period design is controlled by a local **M** 5.05. Therefore, the construction of Make-Up Pond C will not have an adverse impact on the ability of any safety-related system, structure, or component in performing its design function.

Lee Nuclear Station FSAR Subsections 2.5.2.1.3 and 2.5.2.8 are revised to include the results of the updated evaluation of the potential for RIS associated with the configuration and operating parameters of Make-Up Pond C. Mark-ups of the FSAR are provided as attachments to this enclosure, and will be incorporated into a future revision of the Final Safety Analysis Report.

References:

1. Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Supplemental Information Addressing the Potential for Reservoir Induced Seismicity Associated with Off-Site Water Storage, Ltr# WLG2009.07-05, dated July 31, 2009 (ML092170268)
2. Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Update for William States Lee III Nuclear Station Units 1 and 2 Combined License Application, Ltr# WLG2010.02-07, dated February 25, 2010 (ML100620211)

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

FSAR Subsection 2.5.2.1.3

FSAR Subsection 2.5.2.8

Attachments:

1) Mark-up of FSAR Subsection 2.5.2.1.3
2) Mark-up of FSAR Subsection 2.5.2.8

Lee Nuclear Station
Updated Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage

Attachment 1

Mark-up of FSAR Subsection 2.5.2.1.3

COLA Part 2, FSAR, Chapter 2, Subsection 2.5.2.1.3, third paragraph is revised as follows:

These evaluations consider RIS potential associated with the configuration and operating parameters for Make-Up Pond C and include an extensive review of RIS literature and scientific understanding of the potential for RIS based on crustal (e.g., underlying geologic and tectonic) properties and reservoir operations. The evaluations also include a review of past worldwide cases of RIS associated with reservoirs with similar or greater hydraulic heights to Make-Up Pond C, an analysis of seismicity associated with ~~similar~~ reservoirs operated in the Carolina Piedmont, and an analysis of U.S. Bureau of Reclamation dams and reservoirs located in metamorphic terranes with historic hydraulic height and operating configurations comparable to or exceeding Make-Up Pond C hydraulic height or hydraulic height variation operating parameters.

COLA Part 2, FSAR, Chapter 2, Subsection 2.5.2.1.3, beginning with the eleventh paragraph is revised as follows:

Based on the review of the Carolina Reservoirs, it appears that ~~three~~five conditions are needed for RIS to occur:

(1) Rock stressed close to failure conditions (a situation more likely to occur in felsic-crystalline rock rather than felsic to intermediate metavolcanic and metasedimentary crystalline rock underlying Make-Up Pond C),

(2) Through-going fractures favorably oriented relative to the maximum horizontal stress direction,~~and~~

(3) Hydraulic diffusivity in the range of 0.1 to 10 m^2/s as determined by Talwani et al. (2007) (Reference 303)~~.~~,

(4) A maximum reservoir depth greater than 140 feet, and

(5) A site dominated by medium to coarse grained felsic rocks.

RIS has been shown to not occur when one of these conditions does not exist. ~~(e.g.~~As an example, Bad Creek is a deep reservoir with primarily felsic rocks (condition 5), but the lack of RIS at Bad Creek shows that RIS does not occur when one of the first three conditions (condition 3 for Bad Creek) does not exist ~~Reservoir) (Schaeffer et al. (1991); Talwani et al. (1990a and 1990b); and Widdowson et al. (1991)~~ (References 309, 311, 312, and 313)~~)~~. The lack of RIS at most of the deepest Carolina Piedmont reservoirs is consistent with condition (5). The two deepest Carolina Piedmont Reservoirs lacking RIS with maximum depths > 200 ft (Murray and Badin Lake) share similarities with the Make-Up Pond C metavolcanic site geology, with Murray having metasedimentary rocks with locally interbedded intermediate to felsic fragmental metavolcanic rocks, and felsic to intermediate crystal-lapilli tuff with lenticular lenses of metasedimentary rocks, and Badin Lake having crystal and lithic tuffs of rhyolitic to rhyodacitic compostion with minor ash flow tuffs and tuff breccias and siltstone and siltstone/mudstone; siltstone and argillite with minor tuff beds; graywacke, sandstone and minor siltstone; and mafic and intermediated metavolcanic rocks, primarily tuffs and flows with hypabyssal intrusives (References 317, 318 and 319). The three other non-RIS Carolina Piedmont reservoirs with maximum depths greater than the Lake Keowee maximum depth are Hartwell, Richard Russell, and W. Scott Kerr, which also are comprised of more intermediate metamorphic rocks than the four felsic rock Carolina reservoirs with RIS (References 320, 321 and 322). Thus, while condition 5 is empirical, the occurrence of RIS at a dominantly fine-grained felsic metavolcanic site like Make-Up Pond C would be without precedent.

For a large region that contains Make-Up Pond C, the dominant joint orientation is N47°E-vertical (Schaeffer (1981) (Reference 314)), and the predominant large-scale shear zone strike northeast (Horton and Dicken (2001) (Reference 315)). Zoback and Zoback (1980) (Reference 316) find that the Atlantic coastal plain that encompasses Make-Up Pond C is dominated by northwest-southeast oriented compressive stress. Thus, the dominant joint and fault orientations are orthogonal to the maximum compressive stress, which would minimize fracture hydraulic diffusivities on these dominant through-going structures. Secondary joints are oriented nearly vertical and normal to the minimum compressive stress direction of Zoback and Zoback (1980) (Reference 316) based on Schaeffer (1981) (Reference 314) and would be optimally oriented to maximize fracture hydraulic diffusivities. Consequently, RIS on large through-going faults and fractures is inhibited in the current stress regime and the second condition above is not satisfied if the regional fracture results of Schaeffer (1981) apply to the Make-Up Pond C site. Instead, it appears that any RIS that may occur in Make-Up Pond C would be associated with secondary, nonthrough-going joints, which are likely to place strong limits on maximum RIS magnitude of **M** < 5 and possibly **M** < 3.

There is a NE-striking joint set at at the William State Lee site that is optimally oriented to maximize seismic diffusivity. At Make-Up Pond B the dominant shears are oriented about 30° oblique to S_{Hmax}, with the dominant shear set at existing Make-Up Pond B striking N19°E and dipping 61° SE. Despite this, there have been no documented cases of RIS at Make-Up Pond B since it was impounded.

Geologic mapping demonstrates a more easterly structural orientation in the impoundment area of Make-Up Pond C. Dominant schistosity at Make-Up Pond C strikes N47°E and dips 55° SE (Reference 323). This mean orientation is subparallel to S_{Hmax}. Detailed shear orientation measurements have not been made in the vicinity of Make-Up Pond C but it is reasonable to expect that shears would be parallel the overall structural fabric (which is best indicated by the schistosity data). Thus, condition (2) is not met at Make-Up Pond C.

At Make-Up Pond B and possibly Make-Up Pond C, there are a small number of northwest-striking shears that dip 48°-62° NE that are reasonably oriented to accommodate shallow reverse-faulting consistent with condition (2). However, these dips are relatively steep in relation to the more optimally oriented shallow dipping shears observed at Monticello Reservoir (Reference 324). Thus, if RIS were to occur at Make-Up Pond C, it is most likely to be associated with **M** < 3 shallow reverse-faulting similar to that observed at Monticello Reservoir.

Review of the Lee Nuclear Station site conditions indicates that all threethe Make-Up Pond C site properties are not conducive to satisfying conditions are not present(1), (2), (3), (4) and (5). Specifically, it is concluded that the first condition is not met and that Thus **M** > 3 RIS is not expected to be associated with the Make-Up Pond C impoundment,. and the second condition is not likely to be satisfied based on regional and site geologic evaluations described in this subsection Specifically, it is concluded that condition (1) is not met for depths greater than 0.5 km based on Carolina Piedmont in situ stress measurements (Reference 325), and that condition (2) is only partially satisfied at depths greater than 0.5-1.0 km because a 60° shear-plane dip is not optimal for predominant strike-slip faulting due to the rotation of the maximum principal stress toward vertical with increasing depth observed by Moos and Zoback (Reference 325). Thise conclusion that **M** > 3 RIS is not expected to be associated with the Make-Up Pond C impoundment is further supported by the fact that no known recorded RIS is associated with the Lee Nuclear Station Make-Up Pond B impoundment or other Carolina Piedmont reservoirs with similar geologic conditions. Furthermore, there are no documented instances of RIS for reservoirs of similar sizemaximum depth in rocks of similar lithologies (e.g., primarily felsic to intermediate mostly fine-grained metavolcanic and metasedimentary rock types).

In the event that RIS associated with Make-Up Pond C occurs, it is unlikely the induced magnitudes would exceed **M** > 4, a value well below the short-period controlling earthquake. Ground motions associated with RIS events (**M** < 4) typically display high frequency~~,~~ and ~~high~~modest peak ground accelerations with low energy. The potential for RIS associated with the Make-Up Pond C impoundment is considered low with a negligible risk to safe operations for Lee Nuclear Station Units 1 and 2.

Lee Nuclear Station
Updated Information Addressing the Potential for Reservoir-Induced Seismicity Associated with Off-Site Water Storage

Attachment 2

Mark-up of FSAR Subsection 2.5.2.8

COLA Part 2, FSAR, Chapter 2, Subsection 2.5.2.8, is revised as follows:

314. ~~Schaeffer, M.F., Polyphase Folding in a Portion of the Kings Mountain Belt, North-Central South Carolina, in Geological Investigations of the Kings Mountain Belt and Adjacent Areas in the Carolinas, Carolina Geological Society Field Trip Guidebook, 1981.~~Deleted.

315. ~~Horton, J.W. Jr. and Dicken, C.L., Preliminary Digital Geologic Map of the Appalachian Piedmont and Blue Ridge, South Carolina Segment, U.S. Geological Survey Open-File Report 01-298, 1:500,000 scale, 2001.~~Deleted.

316. ~~Zoback, M.L., and M. Zoback, State of Stress in the Conterminous United States, Journal of Geophysical Research, vol. 85, p. 6113-6156, 1980.~~Deleted.

317. Secor, D.T., Jr., and Snoke, A.W., Stratigraphy, structure and plutonism in the central South Carolina Piedmont, p. 65-123, in, Snoke, A.W., ed., Geological investigations of the eastern Piedmont, southern Appalachians (with a field trip guide on the bedrock geology of central South Carolina): Carolina Geological Society Field Trip Guidebook, 123 p., October 7-8, 1978.

318. Secor, D.T., Jr., Geology of the eastern Piedmont in South Carolina, p. 204-225, in, Secor, D.T., Jr., ed., Southeastern Geological Excursions – Guidebook for Geological Excursions: Geological Society of America Southeastern Section Annual Meeting, Columbia, South Carolina, 350 p. April 4-10, 1988.

319. Goldsmith, R., Milton, D.J. and Horton, J.W., Jr., Geologic map of the Charlotte 1° x 2° Quadrangle, North Carolina and South Carolina: United States Geological Survey, Miscellaneous Investigations Series, Map I-2175, 1:250,000, 1988.

320. Nelson, A.E., Horton, J.W., Jr., and Clarke, J.W., Geologic map of the Greenville 1° x 2° Quadrangle, Georgia, South Carolina, and North Carolina and South Carolina: United States Geological Survey, Miscellaneous Investigations Series, Map I-1251-E, 1:250,000, 1998.

321. Bryant, B. and Reed, J.C., Jr., Geology of the Grandfather Mountain Window and vicinity, North Carolina and Tennessee: United States Geological Survey Professional Paper 615, 190 p., 1:62,500, 1970.

322. North Carolina Geological Survey, Geologic map of North Carolina: Department of Natural Resources and Community Development, Division of Land Resources, North Carolina Geological Survey, 1:500,000, 1985.

323. Nystrom, P., Jr., 2008, Geologic map of the Blacksburg South quadrangle, Cherokee County, South Carolina (draft): South Carolina Department of Natural Resources, S.C. Geological Survey, Map GQM-XX.

324. Zoback, M.D., and Hickman, S., In situ study of the physical mechanisms controlling induced seismicity at Monticello Reservoir, South Carolina, Journal of Geophysical Research, vol. 87, p. 6959-6974, 1982.

325. Moos, D., and Zoback M.D., Near-surface, "Thin Skin" reverse faulting stresses in the Southeastern United States, International Journal of Rock Mechanics and Mining Science & Geomechanics Abstracts, vol.30, No.7, p. 965-971, 1993.