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December 15, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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
Cherokee Nuclear Station Final Foundation Geologic Map Record
Ltr#: WLG2011.12-04

Reference: Letter from Bryan Dolan (Duke Energy) to U.S. Nuclear Regulatory Commission Document Control Desk, Geological Mapping, Ltr# WLG2011.03-07, dated March 17, 2011 (ML110800599)

This letter provides the Duke Energy geologic mapping project report documenting the acceptability of the Lee Nuclear Station site, as well as a technical summary of that report. The technical summary and project report are included in separate enclosures to this letter.

If you have any questions or need any additional information, please contact James R. Thornton, Nuclear Plant Development Licensing Manager (Acting), at (704) 382-2612.

Sincerely,

Ronald A. Jones
Senior Vice President
Nuclear Development

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NRO

Enclosures:

1) Lee Nuclear Station Summary of Final Foundation Geological Mapping Assessment

2) Lee Nuclear Station Technical Summary of Final Foundation Geological Mapping

3) Project Report DUK-001-PR-01, Rev. 2, Cherokee Nuclear Station Final Foundation Geologic Map Record (CD-ROM)

xc (w/out enclosure):

Charles Casto, Deputy Regional Administrator, Region II

xc (w/ enclosure):

Brian Hughes, Senior Project Manager, DNRL

AFFIDAVIT OF RONALD A. JONES

Ronald A. Jones, being duly sworn, states that he is Senior Vice President, Nuclear 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 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.

Ronald A. Jones, Senior Vice President
Nuclear Development

Subscribed and sworn to me on December 15, 2011

Freda K. Crump
Notary Public

My commission expires: August 17, 2016

SEAL

FREDA K CRUMP
NOTARY
PUBLIC
LINCOLN COUNTY, NC

Lee Nuclear Station Summary of Final Foundation Geological Mapping Assessment

During the period of July 12-14, 2011, NRC representatives conducted an independent technical assessment of William States Lee Nuclear Station (WLS) project records documenting site geologic relationships. The assessment included review of the recently-completed Cherokee Nuclear Station (CNS) final foundation geologic maps and report, review of selected CNS zone reports including petrographic analysis, and visual inspection of exposed rock at the WLS site.

The reviews included evaluations of CNS-era structural features (e.g., shear zone fabric) including geochronology (e.g., Potassium – Argon (K-Ar) and Rubidium – Strontium (Rb – Sr) radiometric age dating) studies that are used to constrain the minimum age of tectonic deformation at the site. The CNS geologic maps document macro-structural features within the foundation level rock, whereas detailed CNS zone reports and associated petrographic analysis document micro-structural relationships including crystallization of key mineral associations that post-date and are used to constrain the most recent tectonic deformations at the site.

During the independent technical assessment, NRC representatives had the opportunity to:

- Review CNS final foundation level geologic mapping and exposed rock within Lee Unit 1 / Cherokee Unit 1,
- Evaluate exposed rock and previously studied areas within Cherokee Unit 2,
- Evaluate exposed rock and CNS-era foundation maps within CNS Unit 2, which included inspections of area of comparison to assess similarities between WLS era mapping geology (e.g., lithology and structural elements) and CNS era mapping), and
- Inspect Cherokee Unit 3/Lee Unit 2 intermediate level rock (e.g., above CNS final foundation grade) to confirm that no observed features conflicted with the geologic interpretations documented in Lee Unit 1 / CNS Unit 1 and CNS Unit 2 foundation level geology.

At the conclusion of the visit, NRC representatives suggested areas in which the WLS project report could be improved to more fully document the acceptability of the Lee Nuclear Station site. Duke Energy has updated its report in response to those suggestions. Enclosure 2 contains a technical summary of the information presented in that report. Enclosure 3 is an electronic copy of the updated report (Reference 1).

Reference:

1. Fugro Consultants Inc., Project Report DUK-001-PR-01, Rev. 2, Cherokee Nuclear Station Final Foundation Geologic Map Record, October 2011 (CD-ROM)

Lee Nuclear Station Technical Summary of Final Foundation Geologic Mapping

Background

The Cherokee Nuclear Station (CNS) Final Foundation Geologic Map Record Report (Reference 1) documents the procedures and methodologies used to develop the CNS final foundation map record and other detailed evaluations used to constrain the minimum age of tectonic deformation at the William States Lee Nuclear Station (WLS). The CNS as-built final foundation geologic map record was not completed before that project's cancelation. The CNS geologic field maps were qualified for use as inputs using a project specific record qualification procedure described in Reference 1. The foundation level geologic maps were reproduced digitally. The report presents the results of CNS mapping, comparisons of CNS and WLS mapping, and also evaluates the microstructural kinematic and geochronologic constraints documented during CNS PSAR and construction activities.

Summary of Report and Key Conclusions

Evaluation of the CNS era geologic records consists mainly of a comparison between CNS (PSAR and Construction Observations) and WLS (COLA) field studies. Direct comparison and evaluations of lithologic and structural features were performed as a means to corroborate geologic map records and interpretations performed as part of CNS construction.

The shear zones contain an early ductile fabric that is composed primarily of elongated "polygonalized" polycrystalline quartz aggregates indicative of dynamic recrystallization and annealing recovery mechanisms. Potassium feldspar and plagioclase porphyroclasts are reported and this fabric is described as mylonitic. The feldspar fraction is highly altered to white mica and epidote. Iron staining of the shear planes is ubiquitous. Biotite in the protolith is reported to be "olive green" in color. In contrast, biotite reported in association with the shear zones is almost always reported to be "brown." This early ductile fabric is overprinted by a brittle fabric that contains fractured and broken plagioclase, quartz and quartz aggregates in a finer grained matrix of smaller clasts and fine-grained material.

Veins containing quartz, calcite, epidote, white mica, chlorite, pyrite and a low birefringent material identified as potassium feldspar (K-feldspar) (probably adularia; Weaver (1977) in Reference 1 pp. H96-H120) cut the ductile and brittle fabrics. Veins also occur that contain various mixtures of these minerals. These veins are in various states of deformation ranging from undeformed, to slightly deformed, to folded and bent. In addition, stringers of the vein material are reported sub-parallel to the dominant foliation. This indicates that these veins are both syn- and post-kinematic with respect to both the ductile and brittle phases of deformation.

The geochronologic database for the Cherokee site consists primarily of K-Ar ages with a few Rb–Sr ages. K–Ar ages in slowly cooled settings (regional metamorphic) is typically interpreted in the context of closure temperature intervals; that is the temperature intervals for which minerals become closed systems to argon volume diffusion. There are several potassium containing minerals in which the closure temperature interval is well characterized either experimentally or empirically, including hornblende, muscovite, biotite and K-feldspar. There are two important corollaries to the interpretation of K-Ar ages in the context of closure temperature intervals. One is that the K-Ar age records the time (date) at which a mineral passed through the closure interval as it cooled and therefore dates a temperature. The second, is that the K-Ar age is the minimum age for the mineral to have crystallized. In order to have confidence in the validity of these corollaries it is necessary that the K-Ar age is from a monomineralogic sample for which the K-Ar thermal systematics are well known. This criteria excludes whole rock samples in slowly cooled settings and minerals with little or no potassium in their composition. This also precludes the use of minerals whose structural state is unknown such as highly

deformed, weathered or altered samples or minerals that may have incorporated significant amounts of non-radiogenic ^{40}Ar from the environment.

The geochronologic database for the Cherokee site contains several samples that meet the above criteria. Sample B-28, 106 ft. with a K-Ar age of 290±9 Ma on undeformed hornblende. Sample BP-7, 59 ft. with a K-Ar age of 296±7 Ma on undeformed biotite. These ages are essentially the same and would indicate relatively rapid cooling of the terrane following emplacement of Late Paleozoic late - to post kinematic granitic intrusions nearby (i.e., Bald Rock, York, and Clover plutons). Also the K-Ar age reported for potassium feldspar from an undeformed vein in a dilatational feature that cross cuts one of the shear zones is an important constraint on the minimum age possible for the shear-breccia zones. This sample gives a mineral age of 219 ± 1 Ma (sample GTP-7). This result is significant in two respects: (1) because the feldspar is undeformed and cross-cuts the shear zone, and the feldspar is older than 219 Ma, the timing of deformation related to shear zone formation is constrained to be older than 219 Ma; (2) the temperature for closure to argon loss for potassium feldspar is about 250°C. These data indicate that the thermal environment at the site has probably not been sufficient to produce greenschist facies metamorphic effects (muscovite and biotite growth) since at least 219 Ma. However, the overgrowths of muscovite and biotite on both the ductile and brittle fabric components indicate that the fabric elements are significantly older since muscovite and biotite require thermal conditions above most of the closure interval of K-feldspar to grow. The K-Ar biotite age discussed above (i.e., Sample BP-7) indicate that these structural fabrics are 300 Ma or older. This conclusion is supported by the Rb-Sr age on biotite from sample B-51, 76 ft. of 291 ± 10 Ma, representing a minimum age constraint on biotite using an independent geochronologic dating technique.

Conclusion

The WLS mapping comparison confirms the CNS final foundation geology documented during CNS construction, including rock types and orientations of fractures and shear zones. Evaluation of CNS and WLS geologic mapping reveals identical geologic interpretations. CNS final foundation geologic mapping satisfies the requirements of Regulatory Guide 1.132, Site Investigations for Foundations of Nuclear Power Plants, Rev. 2, October 2003. The site geochronology developed as part of detailed CNS PSAR and construction evaluations was confirmed as part of WLS COLA investigations by using closure temperature – age relationships of undeformed minerals, as described above. This supports the conclusion of non-capability of tectonic structures at the William States Lee Nuclear Station site, since these data indicate the site has not experienced tectonic deformation since early Mesozoic, and possibly not since 219 Ma to 300 Ma (i.e., early Mesozoic to late Paleozoic).

Reference:

1. Fugro Consultants Inc., Project Report DUK-001-PR-01, Rev. 2, Cherokee Nuclear Station Final Foundation Geologic Map Record, October 2011 (CD-ROM)

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