Bryan J. Dolan
VP, Nuclear Plant Development

Duke Energy
EC09D/ 526 South Church Street
Charlotte, NC 28201-1006

Mailing Address:
P.O. Box 1006 – EC09D
Charlotte, NC 28201-1006

704-382-0605

Bryan.Dolan@duke-energy.com

November 12, 2009

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
(RAI No. 2686)
Ltr# WLG2009.11-05

Reference: Letter from Brian Hughes (NRC) to Peter Hastings (Duke Energy), Request for Additional Information Letter No. 073 Related to SRP 02.04.13 for the William States Lee III Units 1 and 2 Combined License Application, dated July 17, 2009

This letter provides the Duke Energy response to the Nuclear Regulatory Commission's requests for additional information (RAIs) included in the referenced letter.

The response to the NRC information requests described in the referenced letter are addressed in separate enclosures, which also identify associated changes, when appropriate, that will be made in 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

D093
NRO

Enclosures:

1) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-019
2) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-020
3) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-021
4) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-022
5) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-023
6) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-024
7) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-025
8) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-026
9) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-027
10) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-028
11) Duke Energy Response to Request for Additional Information Letter 073, RAI 02.04.13-029

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 November 12, 2009

K N Slays

Notary Public

My commission expires: April 19, 2010

SEAL

xc (w/o enclosures):

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

xc (w/ enclosures):

Brian Hughes, Senior Project Manager, DNRL

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-019

NRC RAI:

In its independent review of alternative pathways, the staff determined that several alternative pathways were not evaluated. The applicant did not evaluate the impact of a failure of the dams associated with make-up ponds A and B (such an event could increase the hydraulic gradient substantially and therefore decrease travel times). The applicant did not evaluate alternative geohydrologic features such as continuous partially weathered rock along all pathways (which would decrease travel times). The applicant did not evaluate the potential for preferential flow paths (e.g., buried pipes, or coarse bedding material beneath them) created by Cherokee construction activities (which would decrease travel times). Because the pathways described above are plausible, the applicant should evaluate each pathway, or justify why each is not plausible and therefore should not be evaluated further.

Duke Energy Response:

Evaluation of Geohydrologic Features Along All Pathways

In its response to RAI 2.4.12-015 (RAI Letter No. 070, Reference 1), Duke stated that groundwater exists at the Lee Site as a single undifferentiated aquifer, comprised of soils, saprolite, partially weathered bedrock (PWR), competent bedrock, and to a limited extent fill soils. Typical of Piedmont terrain, the relative thicknesses and characteristics of each of these zones vary across the site. All of these materials are exposed in the existing excavation. Duke thoroughly characterized the site through an extensive program of borings, wells, test pits, geophysical testing, in-situ and laboratory testing and analyses of soil and geologic material, and assessment of groundwater conditions. These investigations have shown that the aquifer is principally comprised of saprolite and PWR zones. Site-specific hydraulic conductivity test results and available literature from hydrogeological studies conducted in similar Piedmont soil and rock environments demonstrate that transport characteristics of the PWR, where such conditions occur, can produce higher groundwater flow velocities than for the saprolite zone.

Although the aquifer has been shown to be comprised of a mixture of weathered materials, Duke re-calculated hypothetical contaminant transport velocities at the site using the more conservative hydraulic conductivity and effective porosity values of PWR for all evaluated release pathways. The release pathways assume PWR up to the base of the building. The results of this re-analysis identified Pathway 1 (Lee Unit 2 to Hold-Up Pond A) as the limiting pathway. The radionuclide transport model (RESRAD-OFFSITE) was then re-evaluated using this limiting pathway and conservative PWR values where appropriate. The results of this re-evaluation are included in the response to RAI 02.04.13-029 (Enclosure 11 to this letter).

Impact of Failure of Make-Up Pond A and Make-Up Pond B Dams

An evaluation was performed to determine the impact of potential failures of the dams impounding Make-Up Pond A, Make-Up Pond B, and Hold-Up Pond A on groundwater transport. In the event of dam failure, water levels in the corresponding impoundment would decline to the stream baseflow elevation downstream of the dam and surface drainage of the pond areas would revert to the former stream channel networks (FSAR Figure 2.1-204). Under these drained equilibrium conditions, groundwater would be discharged to the stream network and the water table gradient would shift to this new discharge point, lower in elevation and more distant from the hypothetical point of release. The two alternative pathways with potential points of exposure at Make-Up Ponds A and B (Pathways 3 and 5, respectively, in FSAR Subsection 2.4.12.3.1) were re-evaluated assuming dam failures. Even with the changes in transport characteristics with dam failure, the limiting pathway continues to be from Unit 2 to Hold-Up Pond A (assuming the use of effective porosity and hydraulic conductivity values of PWR in the analysis as discussed previously). This analysis is further supported by groundwater flow divides located between the power block and Make-Up Pond A and between the power block and Make-Up Pond B (RAI Letter No. 017, Reference 2). Based on the documented geohydrology of the site, the dominant influence of these flow boundaries would not be substantially affected by the hypothetical dam failures considered in this scenario.

To address potential impacts of failure of the dams impounding Make-Up Pond A, Make-Up Pond B, or Hold-Up Pond A on resulting nuclide concentrations in the Broad River, a sensitivity analysis was performed on gradient. The groundwater gradients determined at the Lee site for the initial case analysis ranged from 0.006 to 0.035 ft/ft. A slightly more conservative gradient value of 0.04 ft/ft was derived for the initial case using the highest projected post-dewatering, post-construction groundwater level in the vicinity of the Lee reactors, coupled with lowest pond levels observed during the 2006-2007 investigation. The RESRAD-OFFSITE sensitivity analysis varied gradient ±50% of the 0.04 ft/ft value. Although the resultant upper limit value of 0.06 ft/ft used for this analysis is not plausible for the Lee site, it is a suitable upper limit for the purposes of sensitivity assessments. Radionuclide concentrations in the Broad River with this extreme gradient increased less than 10% from the base analysis, but still remained below both the 10 CFR 20 Appendix B, Table 2, Column 2 limits and the total sum of fractions limit of one. Based on these results, the postulated dam failure scenarios do not change the conclusions reached in FSAR Subsection 2.4.13.6. Additional information on the sensitivity analysis is included in the response to RAI 02.04.13-029 (Enclosure 11, this letter).

Evaluation for Potential Preferential Flow Paths

As discussed in FSAR Subsection 2.4.12.2.3, Duke evaluated the potential for preferential flow paths to affect groundwater movement at Lee through a review of the historic Cherokee earthwork and drainage grading plans. Manhole and catch basin designs identified the depths of the piping corridor outlets, which were compared with the projected water table elevation map (FSAR Figure 2.4.12-204, Sheet 8). The piping corridor that runs from the power block area to Hold-Up Pond A was identified as the only Cherokee stormwater piping segment located downgradient from the radwaste tank source areas at depths that potentially intercept the water table. As discussed in responses to RAI 02.04.12-017 and -018 (Enclosures 3 and 4, Reference

1), Duke is committed to the removal of this piping system and associated bedding materials by over-excavation and the backfilling of the trench with native soil materials, compacting the backfill to a condition less permeable than the surrounding soils.

Piping corridors identified more than 500 feet south (upgradient) of the power block, along the north edge of the switchyard area, could potentially divert shallow groundwater toward Make-Up Pond A. However, based on their upgradient position and distance from the power block area, coupled with the predominant south to north groundwater flow at the Lee site, these piping corridors do not cause a condition that affects the postulated accidental release scenario.

FSAR Changes

FSAR Subsection 2.4.12.2.3 will be revised to clarify the preferential flow path analysis. Changes shown as bold-face type in Attachment 1 pertain to Duke's commitment regarding the removal of stormwater piping mentioned above. These FSAR changes were stated in Duke's response to RAI 02.04.12-018 (Enclosure 4, RAI Letter No. 070), submitted July 31, 2009 (Reference 1). These changes have been repeated in this response for clarity, since RAI 02.04.12-018 and RAI 02.04.13-019 overlap in their requested information. See Attachment 1.

FSAR Subsection 2.4.13.4 will be revised, as appropriate, to discuss the modeling of transport using parameters associated with PWR. FSAR Subsection 2.4.13.5 will be revised to provide a summary of additional sensitivity analyses related to the impacts of Make-Up Pond A or B dam failure. These changes to the FSAR Subsection 2.4.13 are provided as attachments to the response to RAI 02.04.13-029 (Enclosure 11 to this letter).

These FSAR changes will be incorporated into a future revision of the Final Safety Analysis Report.

References:

1) Duke Energy Letter, dated July 31, 2009, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information (RAI No. 2685, Letter No. 070) (ADAMS Accession No. ML092170378).
2) Duke Energy Letter, dated May 12, 2009, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Supplemental Response to Request for Additional Information (RAI No. 826, Letter No. 017, Supplemental Response) (ADAMS Accession No. ML091340410).

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

FSAR 2.4.12.2.3

FSAR 2.4.13.4

FSAR 2.4.13.5

Attachments:

1) FSAR 2.4.12.2.3

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

Attachment 1 to RAI 02.04.13-019

Revision to FSAR Subsection 2.4.12.2.3

COLA Part 2, FSAR Chapter 2, Subsection 2.4.12.2.3. The next to final paragraph will be changed as follows:

Based on site observations, a network of storm drains and buried piping was partially installed during the Cherokee project to manage surface water runoff. While no as-built drawings for the existing storm drain system for the former Cherokee Nuclear Station exist, a review of stormwater plans was conducted to assess the drain system's potential affect on groundwater movement. Storm drains located more than 500 ft. upgradient (south) of the ~~excavation~~ power block ~~appear to~~ could potentially intercept the water table and allow shallow groundwater movement ~~of water~~ towards ~~the make-up ponds~~Make-Up Pond A; these drains do not affect groundwater movement in the power block area-. Other storm drains appear to be above the water table and would not affect the movement of groundwater. One exception is a storm drain originally designed to transfer stormwater from the Cherokee power block area to Hold-Up Pond A. The depth of this storm drain pipe appears to be below the projected water table. Therefore ~~and, thus,~~, if left ~~as is could locally affect groundwater movement~~ in place~~,~~ this conduit could potentially cause a preferential groundwater pathway from the power block area downgradient to Hold-Up Pond A ~~when~~ once groundwater recovers from the construction dewatering activities. ~~The potential effect on groundwater movement can be mitigated by engineering controls or by removal and replacement with less permeable material.~~ **The existing storm drain and bedding materials will be removed by over-excavation. The remaining void will then be plugged with low-permeability backfill material,** and **compacted to density sufficient to assure no short-circuiting can occur.**

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-020

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted that the plume dimension did not account for porosity. Using a PWR porosity value of 0.44 (FSAR Revision 0) and assuming the same vertical dimension of 2 m, the plume length and width would have to be 9.81 m to accommodate the leak volume of 22,400 gallons. Because the plume dimension is important to the RESRAD analysis, the applicant should correct the plume dimension for porosity, or justify why such a correction is inappropriate.

Duke Energy Response:

The contaminated zone had previously been defined as a water volume only, as a conservative measure and as an analytical convenience. (See FSAR Subsection 2.4.13.3.) The RESRAD-OFFSITE transport analysis has been revised, as discussed in response to RAI 02.04.13-029 (Enclosure 11 in this letter). The revised analysis models the contaminated zone as a volume of soil saturated with contaminated water, released from the postulated tank failure event.

In addition, the zone dimensions were previously based on a rectangular volume having a 2-m vertical dimension. The revised RESRAD-OFFSITE analysis models the contaminated zone as a cubic volume.

The volume of the contaminated zone is increased to uniformly distribute the release volume of contaminated water into the portion of the soil pore volume represented by effective porosity. Effective porosity, rather than total porosity, was chosen for adjusting the water volume in the contaminated zone. In general, total porosity represents the total volume not occupied by solid material. Effective porosity is that portion of the pore volume that is not occupied by tightly held pore water, and that is relatively available for transmission of fluids. Effective porosity is, therefore, the more appropriate and conservative parameter for adjusting the volume of the contaminated zone.

Additionally, the initial source term concentrations are reduced to reflect the dry bulk density of the contaminated zone soil, thus preserving the initial total radionuclide inventory of the postulated liquid release.

Related discussion relevant to this question is contained in the response to RAI 02.04.13-029 (Enclosure 11 to this letter).

FSAR 2.4.13 will be revised to reflect the revised definition of the contaminated zone using PWR effective porosity, as provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter). Revisions to FSAR 2.4.13 will be incorporated into a future revision of the FSAR.

References:

None

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

FSAR 2.4.13

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-021

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted that total porosity was lowered and set equal to the effective porosity value of 0.08. Rather than lead to a conservative result, the lowered total porosity value increases the travel time of retarded contaminants in the RESRAD analysis. Because setting the total porosity value lower than it really is results in a less conservative estimate of contaminant travel time, the applicant should repeat the RESRAD analysis using a more appropriately conservative value of total porosity, or justify why the value of 0.08 is conservative for contaminants that sorb to the sediments.

Duke Energy Response:

Changes were made to FSAR Subsection 2.4.12.2.4.1, in response to RAI 02.04.12-016 (Attachment 1 to Enclosure 2, Reference 1). These changes provide appropriate site-specific values for total porosity and effective porosity for partially weathered rock materials of 27 percent and 8 percent, respectively. These values were used as input in revised RESRAD-OFFSITE transport analyses.

Additional discussion on input, the revised analyses, and results are provided in the response to RAI 02.04.013-029 (Enclosure 11 to this letter).

References:

1) Duke Energy Letter, dated July 31, 2009, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information (RAI 2685, Letter No. 070) (ADAMS Accession No. ML092170378).

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

None

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-022

NRC RAI:

In its review of the applicant response to RAI 2.4.13-03, the staff noted the use of the phrase "maximum conservative" value of 1.4E-03 cm/s. This value is the same as the "conservative estimate" described in Section 2.4.12. The staff considers the use of the term "maximum" in this context to potentially be misleading. The applicant should modify the text in the FSAR, or justify why using the term "maximum" is justified.

Duke Energy Response:

The phrase "maximum conservative" could be misleading as used in referring to the hydraulic conductivity value of 1.4E-03 cm/s for partially weathered rock (PWR) materials. As discussed in response to RAI 02.04.12-016 (Enclosure 2, Reference 1), this value was derived from a scientifically sound and defensible data set based on an extensive hydrogeologic assessment of the Lee Site. Based on its analysis and review of hydrogeologic characteristics of the site, Duke asserts that 1.4E-03 cm/s is an appropriate and conservative hydraulic conductivity (K) value for the PWR zone.

The text of FSAR Subsection 2.4.13.4 will be revised to delete the term "maximum" when it appears in the phrase "maximum conservative" and refers to PWR hydraulic conductivity. This change to FSAR Subsection 2.4.13.4 is included with other changes to FSAR Subsection 2.4.13, as provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter).

References:

1) Duke Energy Letter, dated July 31, 2009, from B.J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information (RAI 2685, Letter No. 070) (ADAMS Accession No. ML092170378).

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

FSAR 2.4.13.4

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-023

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted applicant's use of the phrase "lowest uncertainty corrected K_d values." Given that only three samples (one from fill material, two from soil/saprolite) were analyzed, it is highly unlikely that the uncertainty in K_d values can be quantified with confidence. The applicant should explicitly describe the K_d values as mean values minus one standard deviation, or else justify the terminology "lowest uncertainty corrected values."

Duke Energy Response:

Due to the small population of samples, a statistical analysis of the distribution of K_d values could not be performed; therefore, the lowest laboratory reported value was used as described below.

The term "uncertainty corrected" does not pertain to the number of samples or the variance of the data reported for the population of samples. Rather, the context of uncertainty here refers to the quality, accuracy, and precision of the analytical results for individual samples as reported by the laboratory.

An explanation of how distribution coefficient (K_d) results were processed and applied is provided as follows. Site-specific K_d values for nine specific radionuclides were developed by Argonne National Laboratory for representative soil/saprolite materials. For each of these radionuclides the lowest result from the three samples analyzed was selected, regardless of which sample it originated from (Table 2.4.13-201). The result selected was then adjusted further to the lower value of the laboratory reporting range for that result, prior to input to the RESRAD-OFFSITE model. For example, the reported values for the three samples of Cs-137 were 3,704 +/- 524, 2,117 +/- 299, and 1,156 +/- 163 cm^3/g. The lowest reported value of 1,156 +/- 163 cm^3/g was selected, and adjusted to the lower limit of the reporting range, 993 cm^3/g.

According to Argonne National Laboratory's report, its laboratory procedure specifies that uncertainty is determined from calibration check standards used in its analytical methods. This laboratory procedure uncertainty is the basis for the reporting range provided by Argonne for its results. Hence, the correction does not address statistical variance of the data results, but rather certainty in the results from the laboratory method for a particular sample.

The term "uncertainty corrected" could be misinterpreted. To avoid future confusion, FSAR Subsection 2.4.13.1 will be revised to provide the explanation of data handling described above. This change to FSAR Subsection 2.4.13.1 is included with other changes to FSAR Subsection 2.4.13, as provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter). This revision will be incorporated into a future revision of the FSAR.

FSAR Table 2.4.13-201 presents results of laboratory analyses of K_d properties and indicates that samples were taken from both fill and soil/saprolite geo-media zones. Upon re-examination of boring logs, it has been determined that all three samples analyzed for K_d were collected from representative soil/saprolite zones. Specifically, the MW-1208 boring log indicates the sample collected from a depth of 45 to 46 ft bgs came from saprolite material and not fill, as indicated in FSAR Table 2.4.13-201. This boring log also indicates the sample collected from MW-1208 at a depth of 58.5 to 59 ft bgs came from deep saprolite, immediately above partially weathered rock. According to the re-examination of the boring logs, none of the samples analyzed were collected from fill material.

FSAR Table 2.4.13-201 will be revised to show updated K_d sample zone identification. This change to FSAR Table 2.4.13-201 is included with other changes to FSAR Subsection 2.4.13, as provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter). This revision will be incorporated into a future revision of the FSAR.

References:

None

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

FSAR Subsection 2.4.13.1

FSAR Table 2.4.13-201

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-024

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted that parameters used in RESRAD-OFFSITE effectively yielded a recharge rate of 7.68 in/yr, which is lower than estimates of 10-15 in/yr in FSAR Section 2.4.1.2.4 and 10.7 to 16.0 in/yr in ER Section 2.3.1.1.5. Recharge is used in RESRAD to leach contaminants from the contaminated zone into the groundwater. Because recharge affects the leach rate in the RESRAD analysis, the applicant should choose runoff and evaporation factors for RESRAD that yield conservative estimates of recharge, or justify why the recharge rate used (7.68 in/yr) is conservative.

Duke Energy Response:

In the prior transport analyses, RESRAD-OFFSITE input parameters for precipitation, runoff coefficient, and evapotranspiration resulted in a recharge rate of 7.68 in/yr, as noted in the RAI. This recharge rate was considered reasonable in representing a post-construction site. The completed site will have extensive buildings, parking lots, and roads resulting in a large net area of impervious or semi-pervious surfaces. As a result the site will exhibit a high degree of runoff (high curve number (CN)) and correspondingly lower recharge per unit area.

However, to provide a conservative value used by RESRAD-OFFSITE in the FSAR Section 2.4.13 supporting analyses, the input value for annual precipitation was updated to 1.27 meters (i.e., approximately 50 inches per FSAR Subsection 2.3.1.1) and evapotranspiration coefficient was revised to a value of 0.64, based on regional information (Reference 1). To generate the maximum recharge rate, the runoff coefficient was adjusted to a value of zero (0). As a result of changes to these three parameters, the effective recharge rate used in RESRAD-OFFSITE is approximately 18 in/yr and is considered appropriately conservative for these analyses.

Revisions to FSAR Table 2.4.13-203 will provide the revised values for the above stated RESRAD-OFFSITE input parameters. FSAR Subsection 2.4.13.3 will be revised to reflect the conservative treatment of runoff in determining the recharge rate. These revisions are provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter). These revisions to FSAR Table 2.4.13-203 and Subsection 2.4.13.3 will be incorporated into a future revision of the FSAR.

References:

1) A Comparison of Six Potential Evapotranspiration Methods for Regional Use in the Southeastern United States, Jianbiao Lu, Ge Sun, Steven G. McNulty, and Devendra M. Amatya, Journal of the American Water Resources Association Paper No. 03175, June 2005.

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

FSAR Subsection 2.4.13.3

FSAR Table 2.4.13-203

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-025

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted that there were no measurements of K_d for the PWR material, which is the material considered in the most conservative pathway. Because K_d values are important to the transport of retarded contaminants, the applicant should use K_d values for the PWR material that are measured on site samples or justify why the existing values are conservative.

Duke Energy Response:

The Piedmont Aquifer at Lee Nuclear Site is comprised of soils, saprolite, partially weathered bedrock (PWR), and to a limited extent, fill soils. The relative thicknesses and characteristics of each of these materials vary significantly across the site. The soil, saprolite, and PWR mediums are present in the geologic profile at most locations of the site, including the existing excavation. Therefore, for the accidental release scenario the groundwater transport and contaminant attenuation characteristics for each of these geologic mediums were considered. Although the physical arrangement of mineral particles varies for the saprolite, fill, and PWR materials, their geochemistry is similar. Saprolite is weathered in place from underlying parent rock. The PWR medium is an intermediate (or "partially weathered") condition that manifests the properties of both the saprolite, and the underlying parent rock. Although the PWR does exhibit somewhat higher hydraulic conductivities than the saprolite, the interstices between rock fragments are often substantially or partially filled with saprolitic materials eluviated from above or weathered in place. The fill, comprising portions of the aquifer at some site locations, is a mixture of soil and saprolite materials resulting from the removal, remixing, placement, and compaction of site regolith.

Distribution coefficient (K_d) is an estimate of the propensity of a contaminant to sorb onto the solid phase of a soil or geologic medium. Laboratory determination of site-specific distribution coefficient (K_d) values, using generally accepted methodologies, enhances estimation of contaminant transport conditions. However, the challenges of establishing site-specific K_d values in an aquifer comprised of variable soil and rock materials are well documented. EPA specifically acknowledged that analysis of K_d on materials having coarse fragments (particles larger than 2-mm size fraction) can produce misleading results (Reference 1). Therefore, commonly accepted methods for analysis of K_d call for crushing aggregates larger than 2-mm to provide a uniform sample for analysis (Reference 2).

Based on its review of the published guidance on determination of K_d values (References 1, 2 and 3), and in consideration of the unique character of the Piedmont aquifer at the Lee Site, Duke determined that crushing the coarse particles (gravel and rock fragments) was not an appropriate practice and may result in non-representative analytical results. Duke asserts for the geo-media present at the Lee Site, the weathered geologic materials (saprolite and fill soil) provide the optimal materials for analysis of physical-chemical properties critical to interpreting retardation dynamics. Since these geo-media comprise a major portion of the aquifer across the site, and are manifestations of a gradational weathering sequence derived from the underlying parent rock, these materials are considered to accurately reflect the physical-chemical character of the aquifer, including the PWR zone.

Duke's approach to establishing reasonable estimates of K_d values for the Lee Site was to collect and analyze representative materials from three site locations. These samples were taken from depths of 45 to73 feet below grade, in the saturated zone. All samples were obtained from the soil/saprolite zone. (See additional discussion below regarding K_d sample source media.) The deeper sample collected from MW-1208 (i.e., 58.5 to 59 ft bgs) is generally near the center of the Pathway 1 from Lee Unit 2 toward Hold-Up Pond A and is located in the deep saprolite zone, immediately above the saprolite-PWR interface (see Figure 1 in Attachment 1). These samples were analyzed by Argonne National Laboratory for determination of media-specific K_d values.

In the absence of K_d data specific to PWR, samples were collected and the K_d values were determined based on saprolite, as representative and characteristic of aquifer materials. As a conservative measure, for those radionuclides evaluated for K_d, the RESRAD-OFFSITE analysis used the lowest measured K_d values (i.e., the lowest measured value for each radionuclide from the three samples). All other radionuclides used the conservative K_d value of zero. Duke has concluded that, given the wide range of hydrogeological characteristics exhibited within the Piedmont Aquifer at this site, the samples collected from the site and analyzed for K_d are representative and appropriate for the accidental release analysis.

The relative significance and sensitivity of K_d values in this particular transport analysis should also be considered. For the accidental release analysis for the Lee Site, tritium accounts for over 99% of the 10 CFR 20 Appendix B, Table 2, Column 2 radionuclide sum of fractions total, both in Hold-Up Pond A and in the Broad River, which is the ultimate surface water receptor. Tritium also represents over 99% of the total activity for all radionuclides predicted by the RESRAD model in both Hold-Up Pond A and the Broad River. Given that tritium moves with the groundwater, the practical influence of PWR material in terms of K_d is generally inconsequential to the determination of concentrations and activities in Hold-Up Pond A or in the Broad River.

Overall, the selection of samples and use of resulting K_d values in the transport analysis is considered conservative and appropriate for the Lee site.

As indicated earlier, in response to RAI 02.04.13-023 (Enclosure 5 to this letter), a re-examination of boring logs determined that the source geo-media for one K_d sample was incorrectly described in FSAR Table 2.4.13-201 as originating in the fill zone. Boring logs indicated this sample (MW-1208, depth 45 to 46 ft) was obtained from the soil/saprolite zone; therefore, each of the three K_d samples were obtained from soil/saprolite media.

Associated with this re-examination of boring logs, the general elevation of the saprolite-PWR interface in the immediate area of the Unit 2 to Hold-Up Pond A flow path was reassessed and is now interpreted to be at a higher elevation. The conceptual model of site aquifer conditions and lithostratigraphy (Figure 1, Attachment 1 to this response) reflects the results of that reassessment. This figure also depicts the locations of the two geo-media samples collected from

MW-1208 for site-specific K_d analysis. FSAR Figure 2.4.12-205 will be updated in a future revision of the FSAR.

FSAR Table 2.4.13-201 will be revised to update the source location of K_d sample media. This change is included with other changes to FSAR Subsection 2.4.13, as provided in response to RAI 02.04.13-029 (Enclosure 11 to this letter) and will be incorporated into a future revision of the FSAR.

References:

1) U.S. Environmental Protection Agency (USEPA), "Understanding Variation in Partition Coefficient K_d Values," EPA-402-R99-004, August 1999.
2) ASTM, "Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments," ASTM D-4646-03, Reapproved 2008.
3) C. Yu, C. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace, Environmental Assessment and Information Sciences Division, Argonne National Laboratory, *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil*, 1993.

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

FSAR Table 2.4.13-201

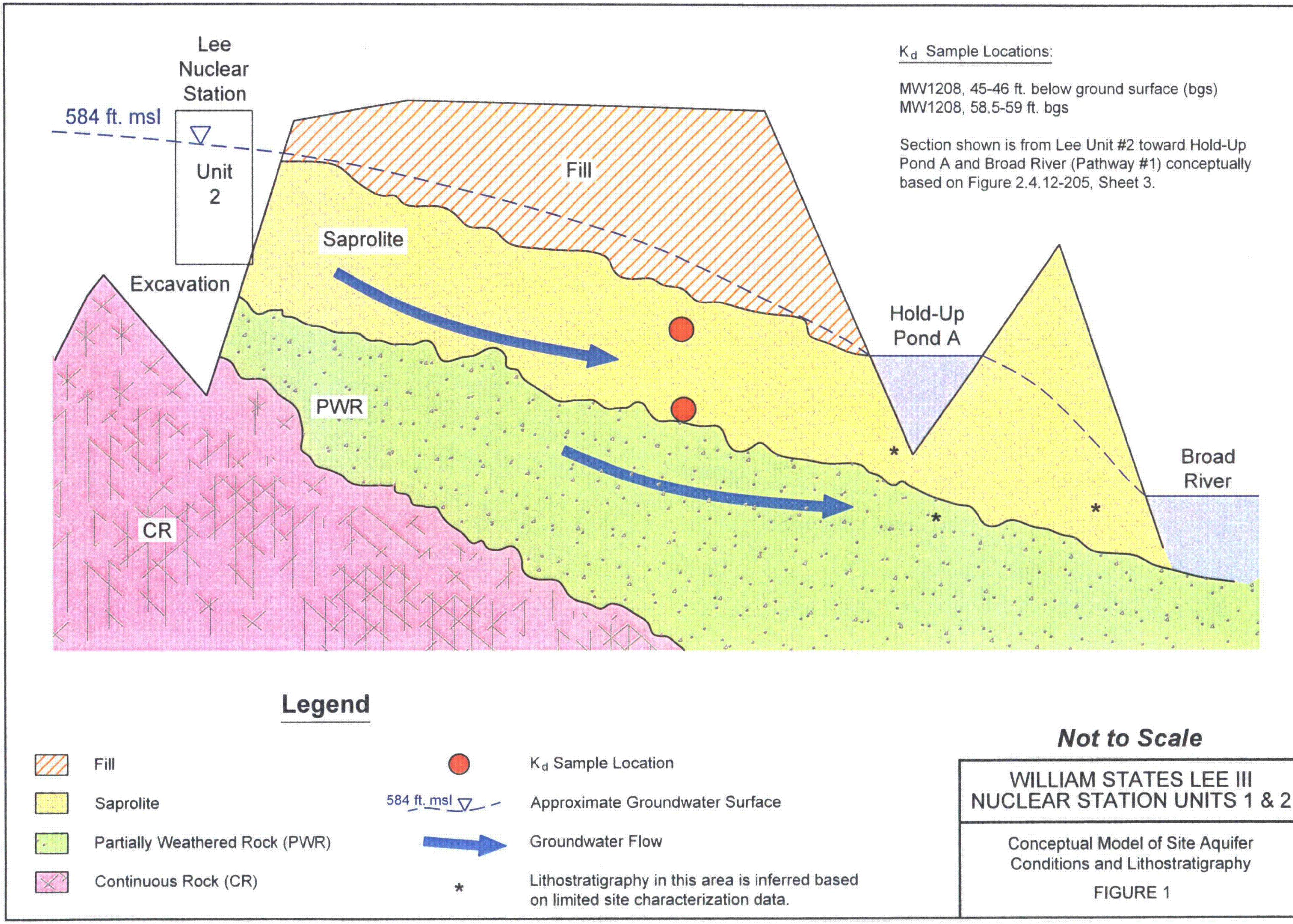
Attachment:

1) Figure 1 (Conceptual Model of Site Aquifer Conditions and Lithostratigraphy)

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

Attachment 1 to RAI 2.4.13-025

Figure 1 (Conceptual Model of Site Aquifer Conditions and Lithostratigraphy)



Not to Scale

WILLIAM STATES LEE III
NUCLEAR STATION UNITS 1 & 2

Conceptual Model of Site Aquifer Conditions and Lithostratigraphy

FIGURE 1

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-026

NRC RAI:

In its review of FSAR Section 2.4.13 and the response to RAI 2.4.13-11, the staff noted that the applicant discussed correcting the DCD concentrations by the factor 0.12/0.25. This correction is recommended by the NRC in BTP 11-6. However, the uncorrected DCD values were used in the RESRAD analysis. The staff noted that the applicant also adjusted concentrations by a factor of 1.01, but no reason was given and a basis for such an adjustment was not found in BTP 11-6. The staff also noted that the Xe-133 concentration in the RAI response was 1.2E-2 uCi/g, whereas the DCD value is 1.2E2 uCi/g. Because it is important to be clear about methodology, the applicant should a) use the 0.12/0.25 corrected concentrations, or justify why not, b) not use the 1.01 correction, or justify why it is needed, and c) confirm the Xe-133 concentration used in the analysis and update the analysis if appropriate.

Duke Energy Response:

The DCD Fuel Failure Correction Factor of 0.12/0.25 was inadvertently omitted in the original Lee site-specific RESRAD-OFFSITE analysis. In accordance with the supporting Westinghouse analysis related to the evaluation of a liquid radwaste tank failure, the subject factor should have been applied for isotopes other than tritium and corrosion products (Cr-51, Mn-54, Mn-56, Fe-55, Fe-59, Co-58, and Co-60). In the revised RESRAD-OFFSITE analysis, the factor is appropriately applied to isotopes other than tritium and corrosion products. This revised RESRAD-OFFSITE analysis is further discussed in the response to RAI 02.04.13-029 (Enclosure 11 to this letter).

The 101% adjustment factor is a conservative adjustment applied in accordance with the supporting Westinghouse analysis related to the evaluation of a liquid radwaste tank failure. The factor is used to show that overall tank activity considered in the analysis could be, on average, 101% of the reactor coolant activity. This adjustment was applied to all isotopes.

The presentation of Xe-133 concentration in response to RAI 02.04.13-014 (Reference 1) was a typographical error and should have been shown as 1.2E2 uCi/g, consistent with the NRC RAI and DCD Table 11.1-2. However, since Xe-133 is a gaseous state nuclide and not used as input into the RESRAD-OFFSITE analysis, it has no effect on the analysis results.

References:

1) Duke Energy Letter, dated November 25, 2008, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Partial Response to Request for Additional Information (RAI No. 828, Letter No. 017) (ADAMS Accession No. ML083360506).

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

None

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-027

NRC RAI:

In its review of FSAR Section 2.4.13, the staff noted DCD Table 11.1-2 does not list tritium explicitly but says that the concentration will not exceed 3.5 uCi/g in the design basis coolant. For their RESRAD analysis, the applicant used a tritium concentration of 1.0 uCi/g, which is the activity listed under Realistic Reactor Coolant (DCD Table 11.1-8). Because the RESRAD analysis should be initialized to be consistent with the DCD, the applicant should conduct the RESRAD analysis using only "design basis" concentrations or "realistic" concentrations, or justify why a mix of the two is conservative.

Duke Energy Response:

Source term input for the RESRAD-OFFSITE analyses, as listed in FSAR Subsection 2.4.13.3 is based on supporting Westinghouse information, provided specifically for the liquid tank failure evaluation. In that supporting information, Westinghouse recognized that DCD Table 11.1-2 (Design Basis Reactor Coolant Activity) did not list tritium and indicated that the best available value for tritium was in DCD Table 11.1-8, Realistic Source Terms. Following Westinghouse's guidance, the tritium reactor coolant activity value of 1.0 uCi/g from DCD Table 11.1-8 is used as the source term input value to RESRAD-OFFSITE.

References:

None

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

None

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-028

NRC RAI:

In its review of FSAR Section 2.4.13, the staff examined the rationale for using the default reservoir mixing volume in RESRAD-Offsite and determined that it is insufficient. Default values are placeholders only, to be replaced by values representative of the situation being modeled. The choice of a mixing volume should be independently determined using site-specific characteristics. The concentrations of radionuclides in the groundwater just prior to entry into the Broad River may provide the basis for a conservative estimate of exposure without the need to define a mixing volume. An alternative approach would be to define a mixing volume based on site-specific river flow conditions. The applicant should identify and use parameters that can be related to site-specific characteristics, or justify the use of default values.

Duke Energy Response:

The use of the default reservoir volume in the RESRAD-OFFSITE analysis is not representative of the site-specific conditions being modeled. A site-specific volume of 856,036 cubic meters, based on the volume of the Broad River reservoir from the postulated release point downstream to the Ninety-Nine Islands Dam, is used in the revised RESRAD-OFFSITE analysis. In addition, a site-specific residence time of radionuclides in the reservoir is calculated by assuming only 50% of the Federal Energy Regulatory Commission (FERC) license requirement for minimum flow (483 cfs) through the Ninety-Nine Islands Dam generating facility. The calculated residence time of 0.00397 years (1.5 days) is used as an input into the RESRAD analysis.

See Response to RAI 02.04.13-029 (Enclosure 11 to this letter) for additional discussion on the revised analysis, including the modeling approach, assumptions, and results.

References:

None

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

None

Attachments:

None

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

RAI Letter No. 073

NRC Technical Review Branch: Hydrology

Reference NRC RAI Number(s): 02.04.13-029

NRC RAI:

In its review of FSAR Section 2.4.13, the staff examined the method used to initialize the contaminant concentrations in RESRAD. The staff determined that this method was incorrect for two reasons.

First, RESRAD assumes that the initial concentrations are in terms of activity per unit dry weight of soil (pCi/g) rather than per unit volume of water (pCi/cm^3). However, the applicant entered values based on the initial source-term concentrations, which are for water, not soil. RESRAD automatically multiplies the quantity entered by the bulk soil density, in this case $1.59g/cm^3$, to give the total activity per unit volume of soil (pCi/cm^3). The total activity is therefore 1.59 times too large.

Second, the applicant defined the dimensions of the contaminated volume in RESRAD so that its volume is the same as that of the fluid released, 22,400 gallons. RESRAD assumes, however, that the contaminated volume contains both soil particles and water, and that the portion occupied by water is defined by the porosity, in this case 0.08. RESRAD thus calculated the concentration in the contaminated zone by placing the total inventory of radionuclides in the 22,400 gallons of leaked fluid into a water volume that is smaller by a factor of (1/0.08), or 12.5 times.

The result is that the concentration in water in the contaminated volume is too large by a factor of (1.59/0.08), or 19.9 times. The applicant's method of initializing the radionuclide concentrations in RESRAD is very conservative, but it is based on erroneous input values rather than reasoned conservative assumptions. Because conservatism must be based on a reasonable rationale that accounts for system characteristics of the subsurface at the site, the applicant should repeat the RESRAD analysis using a well-defined method for initiating reasonable and appropriate contaminant concentrations, or provide a more defensible justification for the approach used in the FSAR.

Duke Energy Response:

The RESRAD-OFFSITE analysis has been re-evaluated using the following approach.

As discussed in response to RAI 02.04.13-020 (Enclosure 2 to this letter), the contaminated zone was analyzed as a volume of soil for which the effective porosity is saturated with contaminated water, released from the postulated tank failure event. For conservatism, the surrounding soils were assumed to have the effective porosity and hydraulic conductivity properties of partially weathered rock (PWR); also, the release pathway assumes PWR up to the base of the building. Use of the effective porosity of PWR (0.08) enables contaminant transport under the conservative assumption that contaminated water filled that portion of the void space primarily available for transport of fluids. The affected zone was assumed to be a cube, with equal sides. The initial source term concentrations were converted to a soil mass basis by using the dry bulk density (1.98 g/cm^3) of PWR, for a final concentration input to RESRAD-OFFSITE in picocuries per gram.

Duke analyzed five potential contaminant pathways to identify the limiting pathway for groundwater transport to surface water receptors. This analysis is discussed in FSAR Subsection 2.4.12.3.2 and in response to RAI 02.04.12-015 (Reference 1). The limiting pathway is defined as that which allows the radionuclides to reach the surface water receptor at the fastest rate, assuming a release to groundwater. The Piedmont aquifer at the site is comprised of variable thicknesses of soil, saprolite, PWR, bedrock, and, to a limited extent, fill soils. For conservatism, Duke evaluated the travel times using the hydraulic conductivity and effective porosity values of PWR for all pathways. Using these conservative values, the limiting flow path was from Unit 2 to Hold-Up Pond A. Conservative PWR characteristics were used throughout the analysis and as inputs to RESRAD-OFFSITE as appropriate; model input parameters are in FSAR Table 2.4.13-203 (Attachment 7 to this response).

Because the Broad River is the closest surface water receptor, and since surface water in Hold-Up Pond A can quickly travel to the Broad River via its spillway, a two step approach was implemented in RESRAD-OFFSITE. The release was first modeled from Unit 2 to the edge of Hold-Up Pond A. Radionuclide concentrations were obtained through the modeling of a hypothetical groundwater well, with a screen located in the middle of the saturated zone at the edge of Hold-Up Pond A; this analysis represented concentrations at the point of entry into the surface water body. In the second step, the concentrations were modeled as if the release occurred directly into the surface water receptor, not allowing for any additional retardation, hold-up, or restriction to transport between Hold-Up Pond A and the Broad River. This analysis included the dilution of the radionuclides in the surface water receptor upstream of the Ninety-Nine Island Dam.

The volume of the surface water receptor used in the model is 856,036 cubic meters, which is the volume of water from the postulated release point downstream to the Ninety-Nine Islands Dam. The nearest potable water supply in an unrestricted area is the City of Union, located approximately 21 miles downstream from the modeled point of release (FSAR Subsection 2.4.13.6). Input flow in the Broad River for this revised analysis was assumed to be 50% of the Federal Energy Regulatory Commission licensing condition for minimum flow (483 cfs) through the Ninety-Nine Islands Dam generating facility.

Concentrations for source term and progeny radionuclides were determined using the RESRAD-OFFSITE model for both the Hold-Up Pond A hypothetical well and the Broad River reservoir surface water receptor. For both of these receptor points, radionuclide concentrations were below the limits in 10 CFR 20, Appendix B, Table 2, Column 2. The resulting total sum of fractions was also less than unity for both the hypothetical well (approximately 0.8) and the surface water analyses (approximately 4E-05).

Sensitivity analyses were performed on a number of input parameters to determine the sensitivity of the RESRAD-OFFSITE model to a range of input values. A parameter was considered "sensitive" if the resulting effect on the evaluated radionuclide concentration was greater than 10%. Sensitivity analyses for K_d were performed based on specific concentrations on a nuclide by nuclide basis. All other sensitivity analyses were evaluated using a total sum of fractions computation that was based only on changes in H-3 concentration. Base case analyses showed that H-3 accounted for more than 99% of both the resultant activity and the total sum of fractions for the hypothetical well and surface water receptor scenarios. Given the dominance of the H-3 nuclide, the sensitivity analyses computed a new sum of fractions using the resultant H-3 value summed with limiting concentration fractions for all other nuclides from the base case. Such an approach was considered appropriate for these analyses.

Input parameters evaluated in the sensitivity analyses included:

- Hydraulic gradient of the saturated zone (varied by a factor of 1.5);
- Well pump intake depth (varied by a factor of 2);
- Volume of the surface water receptor (varied by a factor of 2); and
- K_d values in the saturated zone for site-specific (non-zero) radionuclides (varied by a factor of 10).

Overall, the sensitivity analyses indicated that variations in the single parameters analyzed had no significant impact on the resulting model concentrations; in no case did the resulting concentrations exceed 10 CFR 20, Appendix B, Table 2, Column 2 limits or a total unity value of one. Of particular note:

- When surface water receptor volume was reduced by a factor of 2, the total unity value doubled but remained in the E-05 range. This expected outcome confirmed that even with a significant reduction in available volume, the sum of fractions remained within the unity value. Similar results were noted with a doubling of residence time.
- Duke also considered potential changes in hydraulic gradient which may occur in the case of a catastrophic failure of either of the dams impounding Make-Up Pond A, Make-Up Pond B, or Hold-Up Pond A as discussed in RAI Response 02.04.13-019 (this letter). The sensitivity analyses indicated that even at a high gradient (0.06 ft/ft, considered not plausible for this site), increases in radionuclide concentrations and the sum of fractions were less than 10%.

This revised analysis was conducted using conservative but reasonable assumptions. Key aspects of the analysis include: (1) the use of the shortest (i.e., most rapid), most direct pathway to the nearest surface water feature (Hold-Up Pond A); (2) direct communication from Hold-Up Pond A to the Broad River with no further reduction in radionuclide activity; and (3) the use of PWR characteristics as the transport media. Hydrogeologic investigation of the site shows that the Piedmont aquifer is, in fact, comprised of a mixture of soils, including saprolite, PWR, and fill soil.

The analysis evaluated concentrations at both a hypothetical well at the edge of Hold-Up Pond A, representing radionuclide concentrations just prior to entry into the surface water body receptor, and in the Broad River. Radionuclide concentrations in both the hypothetical well (see the following table) and the Broad River (see Attachment 8 of this enclosure) are within 10 CFR Part 20 limits and below the total unity value of one. It follows, therefore, that concentrations at the Ninety-Nine Islands Dam, as well as those downstream at the nearest potable water supply (approximately 21 miles from the postulated release point, per FSAR Subsection 2.4.13.4), would also be below 10 CFR Part 20 limits and less than unity.

Radionuclide Concentrations in a Hypothetical Well Located at the Edge of Hold-Up Pond A Due to Effluent Holdup Tank Failure			
Detected Radionuclide	Radionuclide Concentration (microcuries/ml)	10CFR20 App B Table 2 Column 2 (microcuries/ml)	Sum of Fractions Contribution [(a)]
Ag-110m	1.07E-08	6.00E-06	1.79E-03
Ce-144	4.38E-09	3.00E-06	1.46E-03
H-3	7.58E-04	1.00E-03	7.58E-01
I-129	4.94E-12	2.00E-07	2.47E-05
Mn-54	6.25E-08	3.00E-05	2.08E-03
Te-127	1.04E-09	1.00E-04	1.04E-05
Te-127m	1.06E-09	9.00E-06	1.17E-04
		Sum of Fractions [(b)]:	7.64E-01

The excavation surrounding the nuclear islands will be backfilled with a granular fill; however, design specifications for the granular fill have not been finalized, and potential sources of materials have not yet been identified. Overall, granular fill comprises a relatively small portion of the geo-media in the limiting pathway. The granular material selected as fill will not change the limiting pathway (Unit 2 to Hold-Up Pond A), and will not significantly affect analysis conclusions presented in this response; i.e., concentrations less than 10 CFR Part 20 limits in the Broad River reservoir system upstream of the Ninety-Nine Islands Dam.

<u>FSAR Changes</u>

FSAR 2.4.13.1 will be revised as discussed in response to (1) RAI 02.04.13-019 (Enclosure 1 to this letter) to discuss use of PWR parameters and (2) RAI 02.04.13-023 (Enclosure 5 to this letter) to clarify K_d values from laboratory analyses. In addition, the subsection will be revised to indicate the limiting transport pathway. See Attachment 1.

FSAR 2.4.13.2 will be revised to clarify the description of the limiting transport path and route to the surface water receptor, i.e., the Ninety-Nine Islands reservoir on the Broad River. See Attachment 2.

FSAR 2.4.13.3 will be revised as discussed in response to (1) RAI 02.04.13-020 (Enclosure 2 to this letter) regarding adjustments to initial source term concentrations using dry bulk density and (2) RAI 02.04.13-019 (Enclosure 1 to this letter) to discuss the use of PWR parameters. The subsection will also be revised to (3) indicate nuclides removed from consideration in the RESRAD-OFFSITE analyses, (4) clarify the description of the limiting transport pathway, (5) update the definition and approach to determining the contaminated zone, and (6) clarify the approach to the RESRAD-OFFSITE input for "recharge," in that runoff is assumed to be zero. See Attachment 3.

FSAR 2.4.13.4 will be revised as discussed in response to (1) RAI 02.04.13-020 (Enclosure 2 to this letter) related to the revised contaminated zone and (2) RAI 02.04.13-022 (Enclosure 4 to this letter) to delete the term "maximum" regarding PWR hydraulic conductivity. The subsection will also be revised to (3) reflect changes in the modeling of the surface water receptor, (4) clarify the description of the limiting transport pathway, and (5) expand the discussion of analysis method, utilizing two stages of RESRAD-OFFSITE analyses. See Attachment 4.

FSAR 2.4.13.5 will be revised as discussed in response to RAI 02.04.13-019 (Enclosure 1 to this letter) to discuss the sensitivity analysis associated with the failure of dams associated with Make-Up Pond A, Make-Up Pond B, or Hold-Up Pond A, and impacts on radionuclide concentrations. The subsection will also be revised to update the parameters subjected to sensitivity analyses, as well as summary discussion, specifically, on the analysis of surface water receptor water volume and residence time. See Attachment 5.

FSAR 2.4.13.6 will be revised to reflect changes in the modeling of the surface water receptor. See Attachment 6.

FSAR Table 2.4.13-203 will be revised to reflect changes in selected RESRAD-OFFSITE input parameters associated with the revised analysis. This table will be revised as discussed in response to RAI 02.04.13-024 (Enclosure 6 to this letter) to update values associated with recharge rate (i.e., precipitation, runoff coefficient, and evapotranspiration). See Attachment 7.

FSAR Table 2.4.13-204 will be revised to reflect the summary results of the revised RESRAD-OFFSITE analyses. See Attachment 8.

FSAR Figure 2.4.13-201 will be deleted to avoid confusion when compared with the more detailed representation of the Unit 2 to Hold-Up Pond A pathway (i.e., Pathway 1) in FSAR Figure 2.4.12-205, Sheet 3. FSAR Subsection 2.4.13.3 will be revised to refer, instead, to FSAR Figure 2.4.12-205, Sheet 3. See Attachment 9.

FSAR Table 2.4.13-201 will be revised as discussed in response to RAI 02.04.13-023 (Enclosure 5 to this letter) and RAI 02.04.13-025 (Enclosure 7 to this letter) to update the source location of K_d sample media. The table will also be revised to remove engineering properties associated with the general sample zones noted in the table. The properties are not sample-specific and are not relevant to the table's purpose, i.e., to provide analytical K_d results. Therefore, this information will be removed. In addition several editorial changes are also made. See Attachment 10.

The above described FSAR changes will be incorporated into a future revision of the Final Safety Analysis Report.

References:

1) Duke Energy Letter, dated July 31, 2009, from B. J. Dolan to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information (RAI No. 2685, Letter No. 070) (ADAMS Accession No. ML092170378).

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

FSAR 2.4.13.1

FSAR 2.4.13.2

FSAR 2.4.13.3

FSAR 2.4.13.4

FSAR 2.4.13.5

FSAR 2.4.13.6

FSAR Table 2.4.13-201

FSAR Table 2.4.13-203

FSAR Table 2.4.13-204

FSAR Figure 2.4.13-201

Attachments:

1) FSAR 2.4.13.1
2) FSAR 2.4.13.2
3) FSAR 2.4.13.3
4) FSAR 2.4.13.4
5) FSAR 2.4.13.5
6) FSAR 2.4.13.6
7) FSAR Table 2.4.13-203
8) FSAR Table 2.4.13-204
9) FSAR Figure 2.4.13-201 (Figure deleted)
10) FSAR Table 2.4.13-201

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

Attachment 1 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.1

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.1, beginning with the third paragraph, will be revised as follows:

Historical and projected groundwater flow paths were evaluated in Subsection 2.4.12 to characterize groundwater movement from the nuclear island area to a point of exposure. Groundwater at the Lee Site exists as a single, undifferentiated aquifer, comprised of soil, saprolite, partially weathered rock (PWR), competent bedrock, and, to a limited extent, fill soils. Although the projected groundwater flow paths travel through zones with saprolite, fill, and PWR, the more conservative hydrogeologic characteristics of PWR were used in both the determination of the limiting groundwater flow path and as inputs, where appropriate, into the RESRAD-OFFSITE model. Using the PWR characteristics for hydraulic conductivity , bulk density, and effective porosity, ~~Due to the higher groundwater velocity and faster travel time in partially weathered bedrock,~~ the flow path from the Unit 2 effl~~e~~uent holdup tank to ~~the Broad River~~ Hold-Up Pond A is assumed to be the limiting ~~bounding~~ pathway of radionuclide migration, with the shortest (i.e. most rapid) travel time to a surface water body. ~~This pathway represents the most rapid transport for water released by a liquid tank failure.~~ For purposes of this analysis, because the spillway and dam of Hold-Up Pond A are proximal to the Broad River, entry concentrations at Hold-Up Pond A are assumed to be entry concentrations at the Broad River. This direct conveyance to the Broad River thus provides for no additional retardation, hold-up, or restrictions to transport between Hold-Up Pond A and the Broad River. Figures 2.4.12-204, Sheet 8 and 2.4.12-205, Sheet 3 depict subsurface conditions that control the movement of groundwater beneath the Lee Nuclear Station.

While groundwater functions as the transport media for fugitive radionuclides, interaction of individual radionuclides with the soil matrix can potentially delay their movement. The solid/liquid distribution coefficient, K_d, is, by definition, an equilibrium constant that describes the process wherein a species (e.g., a radionuclide) is partitioned between a solid phase (soil, by adsorption or precipitation) and a liquid phase (groundwater, by dissolution). Soil properties affecting the distribution coefficient include the texture of soils (sand, loam, clay, or organic soils), the organic matter content of the soils, pH values, the soil solution ratio, the solution or pore water concentration, and the presence of competing cations and complexing agents. Because of its dependence on many soil properties, the value of the distribution coefficient for a specific radionuclide in soils can range over several orders of magnitude under different conditions. The measurement of distribution coefficients of radionuclides within the ~~preferential~~ limiting groundwater pathway~~s~~ allows further characterization of the rate of movement of fugitive radionuclides in groundwater.

Soil and groundwater samples were collected from monitoring wells MW-1208 and MW-1210 located on the north and south sides of the nuclear island (Figure 2.4.12-205, Sheet 1). Three ~~saturated~~ soil samples were collected from the saturated zone at depths ranging from 45 to 73 ft. below ground level. The samples were submitted for laboratory analysis of soil distribution characteristics for specific radiological isotopes (~~i.e.,~~ Co-60, Cs-137, Fe-55, I-129, Ni-63, Pu-242, Sr-90, Tc-99, U-235). Results of these analyses are presented in Table 2.4.13-201, along with ~~. Included in that table are~~ default K_d values found in literature, for comparison. For conservatism, those radionuclides which had~~ave~~ been evaluated for site-specific distribution coefficients used the lowest ~~uncertainty~~

~~corrected~~measured K_d values in the evaluation, regardless of the media from which the samples were collected. The values are adjusted to the low limit of their reporting range, (e.g. for a reported Cs-137 value of 1156+/- 163 cm^3/g, a value of 993 cm^3/g was used in the analysis). All other radionuclides use the most conservative K_d value of 0.

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

Attachment 2 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.2

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.2, first paragraph will be revised as follows:

2.4.13.2 Accident Scenario

The limiting postulated failure of a Unit 2 effluent holdup tank, located in the Unit 2 auxiliary building, is~~was~~ analyzed to estimate the resulting concentration of radioactive contaminants entering Hold-Up Pond A via groundwater flow. Contaminant concentrations at this point are then assumed to represent entry concentrations to the surface water receptor, the Broad River, which is located proximal to Hold-Up Pond A.

The~~is~~ event is defined as an unexpected and uncontrolled release of radioactive water produced by plant operations from a tank rupture. The AP1000 tanks which normally contain radioactive liquid are listed in Table 2.4.13-202. ~~Based on groundwater flow directions (Figure 2.4.12-204, Sheet 8), Unit 2 was analyzed because its tanks are nearest the points of exposure: Hold-Up Pond A and the Broad River.~~ The contents ~~spilled~~ from ~~an~~ the effluent holdup tank are~~were~~ conservatively assumed to enter the environment instantaneously, allowing radionuclides to be transported in the direction of groundwater flow. The flow path from Unit 2 to Hold-Up Pond A is determined to be the limiting pathway based on travel time.

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

Attachment 3 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.3

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.3 will be revised as follows:

The radioactive source term is:

- Tritium source term concentration is 1.0 microcuries per gram taken from DCD Table 11.1-8;
- Corrosion product source terms Cr-51, Mn-54, Mn-56, Fe-55, Fe-59, Co-58, and Co-60 taken from DCD Table 11.1-2; ~~and~~
- Other isotope source terms taken from DCD Table 11.1-2 multiplied by 0.12/0.25 to adjust the radionuclide concentrations to the required 0.12 percent failed fuel fraction outlined in Branch Technical Position 11-6, March, 2007; and~~.~~
- Gaseous state nuclides and nuclides with short half-lives not included in the RESRAD default library are removed from consideration as they have no impact on the evaluation. These radionuclides include:

Ba-137m	Br-83	Br-85	I-131
I-133	Kr-83m	Kr-85	Kr-85m
Kr-87	Kr-88	Kr-89	Rh-106
Te-131	Te-131m	Xe-131m	Xe-133
Xe-133m	Xe-135	Xe-137	Xe-138

Analysis of failure of the effluent holdup tank of Unit 2 rather than Unit 1 is conservative in that~~. As discussed in Subsection 2.4.12.3.1, groundwater transport is in a northerly direction. Five groundwater flow paths were evaluated. T~~ the pathway from the Unit 2 effluent holdup tank to Hold-Up Pond A~~the Broad River~~ has the shortest (i.e. most rapid) travel duration, assuming conservative PWR characteristics along the entire flow path. ~~and is the bounding case. The distance from the Unit 2 auxiliary building to the Broad River is 1,935 feet. The location of the auxiliary building for Unit 1 and the corresponding groundwater transport of radionuclides for a tank failure in the auxiliary building of Unit 1 require a longer transport distance of 2,350 feet through similar soils. The shorter transport distance associated with a postulated failure of a Unit 2 tank is more limiting. The groundwater flow is assumed to be a straight transport line from the Unit 2 auxiliary building to the nearest point of the Broad River, minimizing the transport distance and time.~~

As discussed in Subsection 2.4.12, dewatering activities are currently occurring at the site. After construction is complete, dewatering activities will ~~be~~ end~~ed, and no dewatering wells will exist~~.

The conceptual model of radionuclide transport through groundwater, from Unit 2 to Hold-Up Pond A, is shown in Figure 2.4.12-205 (Sheet 3)~~2.4.13-201~~. As stated in Subsection 2.4.13.1, a direct conveyance between Hold-Up Pond A and the Broad River is assumed. With the failure of the effluent holdup tank and subsequent liquid release to the environment, radionuclides enter the subgrade soils at an elevation of 33 feet 6 inches below the surrounding grade. ~~The effluent liquid is assumed to completely fill the soil pore space in an area large enough to contain 22,400 gallons.~~ The contaminated zone is, therefore, a volume~~mass~~ of contaminated soil for which the effective porosity ~~equivalent in size to the volume of~~ is saturated with contaminated water released from the liquid effluent holdup tank. ~~The soil has the characteristics of the soil present outside the auxiliary building. As a~~

~~conservative evaluation, no consideration is made of the dilution potential for the liquid infusion into the soil. Radionuclides are released to the environment and transported through the partially weathered rock to the Broad River.~~The contaminated zone soil is assumed to exhibit PWR characteristics. Because RESRAD-OFFSITE considers soil at the source of the contamination, the liquid initial source term concentrations were converted to an equivalent concentration on a soil mass basis.

Currently, t~~T~~he overburden soils continually receive the average annual onsite precipitation. In general, t~~T~~he precipitation that does not runoff or is not lost to evapotranspiration infiltrates ~~through~~ the overlying unsaturated zone and contributes to groundwater ~~transport to the Broad River~~ as recharge. However, as an additional conservative measure in the model, runoff was assumed to be zero and precipitation not lost to evapotranspiration was treated by RESRAD-OFFSITE as recharge.

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

Attachment 4 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.4

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.4 will be revised as follows:

2.4.13.4 Conceptual Model

The conceptual model assumes that one of the liquid effluent tanks, located at the lowest level of the auxiliary building, ruptures while containing 80% of its total capacity. The liquid is assumed to be released in accordance with Branch Technical Position 11-6 of NUREG-0800. The liquid from the ruptured tank would flood the tank room and proceed to the auxiliary building radiologically controlled area sump by way of the floor drains. The sump pumps are assumed to be inoperable to create a bounding case. The liquid then enters the environment outside the auxiliary building. The consequence is a release of 22,400 gallons of contaminated liquid into the soil. The liquid is ~~subsequently~~ transported via groundwater flow to the surface water receptor, the Broad River. Because Hold-Up Pond A is the surface water body with the shortest (i.e. most rapid) groundwater transport time, assuming PWR characteristics, the model calculates radionuclide concentrations in a hypothetical well at the edge of this pond. The dam and spillway of Hold-Up Pond A are proximal to the Broad River. This model then assumes that concentrations in Hold-Up Pond A are immediately conveyed to the Broad River, without any additional intermediate retardation, hold-up, or transport restrictions between Hold Up-Pond A and the Broad River. The conceptual model then assumes the liquid is diluted in ~~a partial volume of~~ the Broad River reservoir upstream of the Ninety-Nine Islands Dam~~, and no further transport and dilution is assumed~~. This is conservative~~,~~ because ~~the Broad River from this assumed release point to a point downstream of the Ninety-Nine Islands Dam is within the exclusion area, and~~ the nearest potable water supply using the Broad River surface water is located ~~in the unrestricted area~~ approximately 21 ~~linear~~ miles downstream from the postulated release point, at~~as~~ the City of Union public water supply. Concentrations are modeled for an evaluation period of 1,000 years.~~Five potential travel pathways were evaluated. Evaluation of the five pathways indicates that the pathway from the Unit 2 effluent holdup tank to the Broad River is the shortest duration at 2.8 years travel time.~~

Th~~is~~e conceptual model is conservative because it provides for the shortest (i.e. most rapid) travel time to a surface water body, even though that surface water body is not the receptor body, and it also ~~to the Broad River,~~ includes faulting the limiting tank~~, and does not credit dilution for the water flow through the portion of the Broad River considered for the analysis~~. The analysis uses conservative estimates for parameters that are not developed from site-specific data. In addition, site-specific inputs to the model are also conservative, including the use of the lowest K_d values and the assumption that all groundwater pathways traveled through geo-media with the porosity and conductivity properties of PWR. Values used as inputs in the model are shown in Table 2.4.13-203. The ~~A~~ straight line flow path is used, which is also ~~is considered the most~~ conservative as ~~the~~ actual groundwater pathways are ~~expected to be~~ more tortuous, have longer transport times ~~much longer~~, and lower hydraulic conductivities for ~~of~~ the fractures~~/~~ and joints ~~lower. Due to the lower hydraulic conductivities in the soil and deeper bedrock, the groundwater flow is conservatively assumed to be within the partly weathered rock.~~

~~The surface water receptor body used in the model is 150,000 cubic meters, which is substantially less than the volume of water that flows annually through the potentially~~

impacted area of the Broad River. This assumed volume is conservative in that it provides less of a recipient volume for dilution. The volume of the Nine-Nine Islands reservoir from the calculated release point to the downstream Ninety-Nine Islands dam is estimated to be 856,036 cubic meters.

Throughout the model, conservative values appropriate for the analysis are used. Site-specific Kd values have the associated uncertainty subtracted; the lowest site-specific porosity values are used and the maximum conservative hydraulic conductivity and hydraulic gradient values are used; and the highest annual precipitation rate is used. Each of these values provides for a conservative model.

Radionuclide concentrations in the hypothetical well at the edge of in the assumed partial volume of Hold-Up Pond A and in the Broad River at the reservoir upstream of the Ninety-Nine Islands Dam are modeled using RESRAD-OFFSITE (Reference 212). The groundwater pathway release model considers the effects of different transport rates for radionuclides and progeny nuclides, while allowing radioactive decay during the transport process. The concentration of each radionuclide transmitted to the Broad River is determined by the transport through the groundwater system, dilution by groundwater and infiltrating surface water from the overburden soils, adsorption, and radioactive decay.

Radionuclide decay during transport by groundwater occurs and is considered in the analysis. Radionuclide transport by groundwater is assumed to be affected by adsorption by the surrounding soils. As discussed in Subsection 2.4.12, the soils surrounding the auxiliary building at the elevation of the liquid release are modeled as having the porosity and hydraulic conductivity characteristics of PWRare saprolite soils and partly weathered rock.

The maximum conservative hydraulic conductivity in the partly weathered rock at the site is used (Subsection 2.4.12). Site-specific parameters such as unsaturated zone density, unsaturated zone porosity, saturated zone porosity, hydraulic conductivity, dispersion coefficients, flow velocities, and travel times are provided in Table 2.4.13-203.

The saturated zone dispersion values are set to mimic infusion, rather than injection, of the contaminated liquid into the groundwater flow by assigning a value to the longitudinal dispersivity equal to one-tenth the length of the contaminated zone. Horizontal lateral and vertical lateral dispersivity values are set at one-tenth the longitudinal dispersivity. These settings allow the contamination to move with the natural groundwater flow rather than be pushed through the groundwater and arrive over a longer time frame in a more dilute state.

No credit is taken for dilution of radionuclides caused by water flow through the potentially impacted portion of the Broad River. Radionuclides are assumed to remain in the Broad River near the groundwater discharge point for a period of one year. Individual radionuclide concentrations in the Broad River were modeled using RESRAD-OFFSITE (Reference 212) and concentrations were modeled for an evaluation period of 1,000 years. The radionuclides are diluted by the control volume selected for the analysis, which is 150,000 cubic meters. This volume is retained as a constant for a one year period and is not further diluted in the analysis by the normal river flow.

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

Attachment 5 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.5

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.5 will be revised as follows:

2.4.13.5 Sensitive Parameters

Sensitivity analyses were performed on a number of input parameters to evaluate the sensitivity of the RESRAD-OFFSITE model to a range of values for specific input factors. A parameter is considered sensitive if the resulting effect on the evaluated radionuclide concentration varied by more than 10%. Input parameters evaluated in the sensitivity analyses include:

- Hydraulic gradient of the saturated zone (varied by a factor of 1.5);
- Well pump intake depth (varied by a factor of 2);
- Volume of the surface water receptor (varied by a factor of 2); and
- K_d values in the saturated zone for site-specific (non-zero) radionuclides (varied by a factor of 10).

Analyses were performed on numerous parameters deemed sensitive to the concentration output. These parameters include:

1. Cover depth,
2. Total porosity of the saturated zone,
3. Effective porosity of the saturated zone,
4. Hydraulic conductivity of the saturated zone,
5. Hydraulic gradient of the saturated zone, and
6. K_d values in the saturated zone for those radionuclides for which site-specific values are used.

Overall, Tthe sensitivity analyses indicated that no variations in the any single parameters analyzed have no significant has sufficient impact on the resulting to cause the concentrations; in no case do the resulting concentrations to exceed 10 CFR 20 Appendix B, Table 2, Column 2 limits or a sum of fractions calculation. Of particular note:

- When the surface water volume is reduced by a factor of 2, concentrations doubled, but the sum of fractions remained in the E-05 range. This expected outcome confirmed that even with a significant reduction in available volume, the sum of fractions remained below the unity value of one.

- Even with a relatively high hydraulic gradient (0.06 ft/ft, considered not plausible for this site), increases in radionuclide concentrations varied by less than 10%, and the sum of fractions remained below 10 CFR 20 Appendix B, Table 2, Column 2 limits and unity standard.

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

Attachment 6 to RAI 02.04.13-029

Revision to FSAR Subsection 2.4.13.6

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13.6, 2nd and 3rd paragraphs will be revised as follows:

The radiological consequences of a postulated failure of the Unit 2 effluent holdup tank as the limiting fault ~~were~~is evaluated and ~~were~~ determined not to exceed 10 CFR 20 Appendix B, Table 2, Column 2 limits at the nearest waters adjoining the Lee site (Broad River). ~~This is conservative, because the Broad River,from this assumed release point to downstream of the Ninety-Nine Islands Dam is within the exclusion area, and the nearest potable water supply using the Broad River surface water is located in the unrestricted area approximately 21 linear miles downstream as the City of Union public water supply. The exclusion area boundary (EAB) crosses the Broad River upstream and downstream of the Ninety-Nine Islands dam. The water volume modeled in the analysis is confined within the EAB. The portion of the Broad River downstream of the Ninety-Nine Islands dam and outside of the EAB is unrestricted.~~ The analysis demonstrates that ~~in the event of the postulated release there are no downstream effects that would adversely impact the health and safety of the public~~radionuclide concentrations in both the hypothetical well located at the edge of Hold-Up Pond A and in the Broad River at the Ninety Nine Islands Dam are below 10 CFR 20 Appendix B, Table 2, Column 2 limits. Further, the nearest potable water supply located in an unrestricted area using the Broad River surface water is the City of Union public water supply located approximately 21 miles downstream of the Ninety-Nine Island Dam.

The maximum radionuclide concentration for each isotope sum of fractions of 10 CFR 20 Appendix B, Table 2, Column 2 limits calculated ~~to be in~~ for both the hypothetical well at the edge of Hold-Up Pond A and in the receptor body, ~~the assumed partial volume of~~ the Broad River during the 1,000-year period ~~was used to calculate a ratio of effluent concentration, which is well~~ are below a value of 1. Table 2.4.13-204 provides the fraction of effluent concentration for ~~each~~ the significant radionuclide. ~~The evaluation was conservative because the maximum concentration of each radionuclide occurred at a different time due to variations in radionuclide transport time to the Broad River.~~

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

Attachment 7 to RAI 2.4.13-029

Revision to FSAR Table 2.4.13-203

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value (a), (b)	Parameter Justification
Silver Transport K_d Coefficient (cm^3/g) (b)	Radionuclide-specific retardation coefficient	0	A value of 0 assumes no retardation. The model default value is 0, which is the most conservative selection since it assumes no retardation during transport.
Barium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Bromine Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Cerium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Cobalt Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	985 (b)	A rRadionuclide-specific K_d values wasare measured by Argonne National Laboratory using Lee soil. Lowerest value of the laboratory reporting range is used.
Chromium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value (a), (b)	Parameter Justification
Cesium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	993	~~A~~ Rradionuclide-specific K_d values ~~was~~are measured by Argonne National Laboratory using Lee soil. Lowerst value of the laboratory reporting range is used.
Iron Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	1,450	~~A r~~Radionuclide-specific K_d values ~~was~~are measured by Argonne National Laboratory using Lee soil. Lowerst value of the laboratory reporting range is used.
Tritium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	~~The model default value is 0~~, A value of 0 ~~which~~ assumes no retardation~~during transport.~~
Iodine Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0.06	~~A r~~Radionuclide-specific K_d values ~~was~~are measured by Argonne National Laboratory using Lee soil. Lowerest value of the laboratory reporting range is used.
Lanthanum Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 ~~was selected as most conservative since it~~ assumes no retardation ~~during transport~~.
Manganese Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 ~~was selected as most conservative since it~~ assumes no retardation ~~during transport~~.
Molybdenum Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 ~~was selected as most conservative since it~~ assumes no retardation ~~during transport~~.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value (a), (b)	Parameter Justification
Niobium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default A value is of 0, which is the most conservative selection since it assumes no retardation during transport.
Promethium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Rubidium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Rhodium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Ruthenium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default A value is of 0, which is the most conservative selection since it assumes no retardation during transport.
Strontium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	64	A rRadionuclide-specific K_d values wasare measured by Argonne National Laboratory using Lee soil. Lowerest value of the laboratory reporting range is used.
Technetium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0.03	A rRadionuclide-specific K_d values wasare measured by Argonne National Laboratory using Lee soil. Lowerst value of the laboratory reporting range is used.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value (a), (b)	Parameter Justification
Tellurium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default A value is of 0, which is the most conservative selection since it assumes no retardation during transport.
Yttrium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Zirconium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	A value of 0 was selected as most conservative since it assumes no retardation during transport.
Precipitation (meters per year)	Average quantity of precipitation annually	1.237	Based on the 50 inches per year typical annual precipitation for Cherokee countyHighest precipitation value for the region was used.
Area of contaminated zone (square meters)	Area containing liquids released by the tank failure	~4.238E+011 04	This is the area of a cube required to contain 80% of the effluent tank total capacity, distributed into that portion of the soil voids represented by the effective porosity (for PWR).The contaminated soilarea was assumed to be 2 meters in height, thus an area of 42.38 square meters is required to contain 80% of the liquid effluent tank(22,400 gallons).
Thickness of contaminated zone (meters)	Describes the thickness of the area considered to be the contaminated zone.	~10.2	The volume is assumed to be a cube. The area required to contain a volume with 80% of the liquid effluent tank (22,400 gallons), accounting for effective porosity of the contaminated zone.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [(a), (b)]	Parameter Justification
Length of Primary Contamination in X direction (meters)	Describes the X-axis length of the primary contamination	~10.2	The width of the area of soil saturated with water from the effluent tank failure. The shape is assumed to a cube.
Length of Primary Contamination in Y direction (meters)	Describes the Y-axis length of the primary contamination	~10.2	The length of the area of soil saturated with water from the effluent tank failure. The shape is assumed to a cube.
Evapotranspiration coefficient	Describes the fraction of precipitation and irrigation water penetrating the topsoil that is lost to evaporation and by transpiration by vegetation	0.~~7~~64	This is a parameter used by RESRAD-OFFSITE to determine the amount of available water obtained from either precipitation or irrigation that infiltrates to the saturated zone. The value, when used in conjunction with precipitation and runoff, creates a recharge rate of ~18 inches/yr. This value is suggested by a study of regional data and is conservative when considering conditions likely present following construction.~~The model uses the conservative ratio of the average annual evaporation rate divided by the annual precipitation, disregarding the water lost through transpiration by vegetation.~~
Runoff coefficient (unitless)	Coefficient (fraction) of precipitation that runs off the surface and does not infiltrate into the soil	0.~~39~~	~~The most conservative site-specific value was used.~~This is a parameter used by RESRAD-OFFSITE to determine the amount of available water obtained from either precipitation or irrigation that infiltrates to the saturated zone. The value, when used in conjunction with precipitation and evapotranspiration, creates a recharge rate of ~18 inches/yr. This value is suggested by a study of regional data and is conservative when considering conditions likely present following construction.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value (a), (b)	Parameter Justification
Contaminated zone total porosity (unitless)	Total porosity of the contaminated sample, which is the ratio of the soil pore volume to the total volume	~~8.0E-02~~2.7E-01	On-site data collected at Lee. A value representative of partially weathered rock is used for conservatism.
Density of contaminated zone (g/cm³)	Density of the contaminated soil impacted by the liquid tank failure	1.~~5~~98E+00	On-site data collected at Lee. A value representative of partially weathered rock is used for conservatism.
Contaminated zone hydraulic conductivity (meters per year)	Flow velocity of groundwater through the contaminated zone under a hydraulic gradient	~4.42~~18~~E+02	The hydraulic conductivity was calculated from on-site data collected at Lee. Based on a value representative of 1.40E-03 cm/s for partially weathered rock is used for conservatism, converted to m/y.
~~Unsaturated zone soil density (g/cm³)~~	~~Density of the unsaturated overburden soil~~	~~1.59E+00~~	~~On-site data was collect at Lee.~~
~~Unsaturated zone hydraulic conductivity (meters per year)~~	~~Hydraulic conductivity that the unsaturated zone would have if saturated and subjected to a hydraulic gradient~~	~~4.4 18E+02~~	~~The hydraulic conductivity was calculated from on-site data collected at Lee.~~
Density of saturated zone (g/cm³)	Density of the saturated zone soil that transmits groundwater	1.~~51~~98E+00	On-site data collected at Lee. A value representative of partially weathered rock is used for conservatism.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [(a), (b)]	Parameter Justification
Saturated zone total porosity (unitless)	Total porosity of the saturated zone soil, which is the ratio of the pore volume to the total volume	8.0E-022.7E-01	On-site data collected at Lee. A value representative of partially weathered rock is used for conservatism.
Saturated zone effective porosity (unitless)	Ratio of the part of the pore volume where water can circulate to the total volume of a representative sample.	8.0E-02	On-site data collected at Lee. A value representative of partially weathered rock is used for conservatism.
Saturated zone hydraulic gradient to surface water body (unitless)	Change in groundwater elevation per unit of distance in the direction of groundwater flow to a surface water body.	3.84.0E-02	The value is conservatively selected as theThe site-specific hydraulic gradient, representative of partially weathered rock, for the pathway having shortest (i.e., most rapid) travel time to the nearest off-site surface water body. Assumed to be nearest on-site surface water body (Hold-Up Pond ABroad River) for conservatism.
Longitudinal dispersivity to surface water body (meters)	Describes the ratio between the longitudinal dispersion coefficient and the pore water velocity., The parameter depends on the length of the saturated zone.	3.71E+006.51 E-02	Follows recommendations in the RESRAD-OFFSITE User Manual.
Lateral (horizontal) dispersivity to surface water body (meters)	Describes the ratio between the horizontal lateral dispersion coefficient and the pore water velocity.	3.71E-016.51E-03	Follows recommendations in the RESRAD-OFFSITE User Manual.

TABLE 2.4.13-203
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [(a), (b)]	Parameter Justification
Lateral (vertical) dispersivity to the surface water body (meters)	Describes the vertical dispersion. The user may either model (a) vertical dispersion in the saturated zone and ignore the effects of clean infiltration along the length of the saturated zone or (b) ignore vertical dispersion in the saturated and model the effects of clean infiltration along the length of the saturated zone.	3.71E-026.51E-03	Follows recommendations in the RESRAD-OFFSITE User Manual.
Distance to the nearest surface water body (meters)	Distance to the nearest off-site surface water body that contributes to a potable drinking water source	370.8583.28	The selection is conservative because this distance results in the shortest travel time to the nearest off-site surface water body. Site-specific value corresponding to the distance from the Unit 2 Auxiliary building to the "hypothetical" well location, i.e., the nearest edge of Hold-Up Pond A, minus the length of the contaminated zone.
Volume of the surface water body (m3)	Describes the size of the surface water body	856,036	Site-specific value corresponding to the volume of the Broad River reservoir from the postulated release point downstream to the Ninety-Nine Islands Dam.
Residence time (yrs)	The average time that water spends in the surface water body.	0.00397	Site-specific value obtained by dividing the volume of the surface water body by the volume of water that is extracted annually from it.

---

a) Parameter values are provided in metric units as used with RESRAD-OFFSITE
b) ~~Site-specific distribution coefficients use the measured value minus the applicable uncertainty.~~
b) K_d values reported in the laboratory analysis for nickel, plutonium, and uranium are not included in the liquid effluent source term and, therefore, are not listed in this RESRAD-OFFSITE input table.

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

Attachment 8 to RAI 02.04.13-029

Revision to FSAR Table 2.4.13-204

TABLE 2.4.13-204
RADIONUCLIDE CONCENTRATION AT NEAREST DRINKING WATER SOURCE IN AN UNRESTRICTED AREA DUE TO EFFLUENT HOLDUP TANK FAILURE

Detected Radionuclide	Radionuclide Concentration microcuries/ml	10 CFR 20 Appendix B Table 2 Column 2 microcuries/ml	Sum of Fractions Contribution [(a)]
~~Ag-110m~~	~~6.25E-10~~	~~6.00E-06~~	~~1.04E-04~~
~~Ce-144~~	~~3.09E-10~~	~~3.00E-06~~	~~1.03E-04~~
H-3	~~1.07~~3.35E-0~~4~~8	1.00E-03	~~1.07~~3.35E-0~~1~~5
~~Mn-54~~	~~2.40E-09~~	~~3.00E-05~~	~~8.01E-05~~
~~Pr-144~~	~~3.09E-10~~	~~2.00E-05~~	~~1.55E-05~~
			Sum of Fractions[(b)] ~~Unity Rule Value~~
			~~1.08~~3.38E-0~~1~~5

a) Those radionuclides with Sum of Fractions Contribution less than 1.0E-5 are negligible and not included in the table.

b) Total for all detected radionuclides.

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

Attachment 9 to RAI 02.04.13-029

Deletion of FSAR Figure 2.4.13-201

COLA Part 2, FSAR Chapter 2, Subsection 2.4.13 will be revised to remove FSAR Figure 2.4.13-201 from the FSAR, and revise the FSAR Chapter 2 List of Figures to delete FSAR Figure 2.4.13-201.

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

Attachment 10 to RAI 02.04.13-029

Revision to FSAR Table 2.4.13-201

WLS COL 2.4-5

TABLE 2.4.13-201 (Sheet 1 of 2)
DISTRIBUTION COEFFICIENTS (K_{dD})

	K_d Analytical Results per Argonne National Laboratory			Default K_d Values Used by RESRAD and Values From Other Sources [a]			
Sample Loc.	MW-1208	MW-1208	MW-1210				
Sample Depth ft bgs[b]	45-46 ft' bgs[b]	58.5-59 ft' bgs	69-73 ft' bgs				
Sample Zone	Fill Soil/Saprolite	Soil/Saprolite	Soil/Saprolite	Sheppard & Thibault	IAEA	NUREG/ CR-5512, Kennedy & Strenge	RESRAD (v. 5.62 & later)
Soil Sample Texture	Silty Sand/Sandy Silt (ML/SM) Sand, silty (SM)	Silty Sand/Sandy Silt (ML/SM) Sand, silty (SM)	Silty Sand/Sandy Silt (ML/SM) Silt, sandy (ML)	Loam	Loam	Sand	NIA[c]
Porosity	41%	45%	45%	NIA	NIA	NIA	NIA
Effective Porosity	31%	20%	20%	NIA	NIA	NIA	NIA
Hydraulic Cond.	1.95×10^2 m/yr	1.01×10^2 m/yr	1.01×10^2 m/yr	2.19×10^2 m/yr	NIA	NIA	NIA
pH	4.92	6.99	6.99	NIA	NIA	NIA	NIA
Element	cm^3/g	cm^3/g	cm^3/g	cm^3/g	cm^3/g	cm^3/g	cm^3/g
Co	1103 ± 118	1971 ± 214	>7714	1300	1300	60	1000
Cs	3704 ± 524	2117 ± 299	1156 ± 163	4600	4400	270	1000
Fe	1689 ± 239	5478 ± 775	3628 ± 513	800	810	160	1000

TABLE 2.4.13-201 (Sheet 2 of 2)
DISTRIBUTION COEFFICIENTS (K_{dD})

WLS COL 2.4-5

	K_d Analytical Results per Argonne National Laboratory			Default K_d Values Used by RESRAD and Values From Other Sources [(a)]			
I	1.4 ± 0.2	0.07 ± 0.01	2.5 ± 0.4	5	5	1	0.1
Ni	269 ± 38	167 ± 24	152 ± 22	300	300	400	1000
Pu-242	89 ± 13	>1921	987 ± 140	1200	1200	550	2000
Sr	739 ± 82	262 ± 33	73 ± 9	20	810	-	30
Tc-99	0.28 ± 0.04	0.04 ± 0.01	0.42 ± 0.06	0.1	-	0.1	0
U-235	>3159	1702 ± 241	>3636	15	-	15	50

~~NIA = No information available~~

a) References 209 and 210
b) Below ground surface
c) No information available