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

Subject: Duke Energy Carolinas, LLC.
William States Lee III Nuclear Station - Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the William States Lee III Nuclear Station Units 1 and 2
Partial Response to Request for Additional Information (RAI No. 828)
Ltr # WLG2008.11-07

Reference: Letter from Brian Hughes (NRC) to Peter Hastings (Duke Energy), *Request For Additional Information Letter No. 012 {sic} [017] Related To SRP Section 2.3.4 {sic} [2.4] for the William States Lee III Units 1 and 2 Combined License Application*, dated September 22, 2008.

Dolan to NRC Document Control Desk, Partial Response to Request For Additional Information, (RAI Nos. 820, 821, 822, 823, 824, and 825), Ltr# WLG2008.10-14, Dated October 27, 2008.

Dolan to NRC Document Control Desk, Response to Request for Additional Information, (RAI No. 818), Ltr# WLG2008.11-10, Dated November 18, 2008.

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

Responses 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. This letter addresses responses to RAIs 02.04.13-003 through 02.04.13-018. The responses to RAIs for FSAR sections 2.4.1 through 2.4.11 were provided in the Duke Energy responses referenced above. The remaining RAIs from the referenced letter will be the subject of future correspondence from Duke Energy.

This letter contains, as an attachment to the response to RAI 02.04.13-013, a computer disk to address specific information related to model inputs and outputs. The data is provided electronically as a native file per the staff's request.

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NRO

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

Bryan J. Dolan
Vice President
Nuclear Plant Development

Enclosures:

1) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-003
2) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-004
3) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-005
4) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-006
5) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-007
6) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-008
7) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-009
8) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-010
9) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-011
10) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-012
11) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-013
12) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-014
13) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-015
14) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-016
15) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-017
16) Duke Energy Response to Request for Additional Information Letter 017, RAI 02.04.13-018

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 25, 2008

Phoebe P. Elliott

Notary Public

My commission expires: June 26, 2011

SEAL

xc (w/o enclosures):

Michael Johnson, Director, Office of New Reactors
Gary Holahan, Deputy Director, Office of New Reactors
David Matthews, Director, Division of New Reactor Licensing
Scott Flanders, Director, Site and Environmental Reviews
Glenn Tracy, Director, Division of Construction Inspection and Operational Programs
Charles Ader, Director, Division of Safety Systems and Risk Assessment
Michael Mayfield, Director, Division of Engineering
Luis Reyes, Regional Administrator, Region II
Loren Plisco, Deputy Regional Administrator, Region II
Thomas Bergman, Deputy Division Director, DNRL
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. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-003

NRC RAI:

The applicant needs to describe the process followed to determine the conceptual models for surface and subsurface pathways and for the site characteristics that affect transport of radioactive liquid effluents in ground and surface waters to ensure that the most conservative of plausible conceptual models has been identified.

Duke Energy Response:

The process of identifying the conceptual model for estimating dose resulting from an accidental release began with determining the most appropriate method for data collection and evaluation. This process was initiated through discussions involving subject matter experts (SMEs) in several disciplines, including, but not limited to, geologists, engineers, health physicists, and regulatory specialists. The goal of these discussions was to define the objectives and methods used in performing the evaluation of the accidental release scenario. These initial discussions led to the eventual decision to use the RESRAD-OFFSITE Version 2.0 code for this evaluation as opposed to a more manual method using spreadsheets and data tables. The NRC has previously approved the use of the RESRAD-OFFSITE Version 2.0 code for evaluations of this type.

Subsequent discussions centered on identifying appropriately conservative parameters to be used as input values to the RESRAD-OFFSITE model. These discussions aided in determining the origin of various data including when it was appropriate to use RESRAD-OFFSITE default values, when region-specific values were appropriate, and when site-specific data were required. During the conceptual model evolution, numerous parameters were determined to have no effect on the outcome and subsequently remained as the RESRAD-OFFSITE default value or were disabled, as appropriate.

Collection of site-specific hydrogeologic data deemed relevant to the accident scenario was carried out under the direction of the geologist SME during the site groundwater investigation. These data were compiled and provided to the health physicist SME for inclusion in the RESRAD-OFFSITE model. The data compilation aided in defining the most appropriate pathway using the hydrogeological conditions at the proposed Lee Nuclear Site. Five distinct flow paths were evaluated to determine the limiting flow path for an effluent release. Of the five paths, the most limiting pathway was from Unit 2 to the Broad River. Additional detail on the flowpaths is included in response to FSAR RAI 02.04.13-018 (Enclosure 16).

NUREG-0800, Standard Review Plan, Branch Technical Position 11-6 directs that the accident evaluation be performed for the nearest potable water source within an unrestricted area. The Broad River was identified during the site investigation process as that potable water source. The nearest downstream withdrawal for potable water from the Broad River is for the City of

Union public supply at a linear distance of 21 miles. For conservatism, the release is evaluated in a partial volume of the Broad River at a point adjacent to the plant site.

Choosing the environmental parameters for use in the RESRAD-OFFSITE model began with identifying parameter values that contributed to the most rapid groundwater transport to the Broad River, which subsequently provides the greatest concentration of radionuclides in the receptor body. Individual parameter values were selected using the following hierarchy until such a point where an available, appropriate, and conservative individual parameter value was identified:

1. A single, appropriate site-specific parameter value,
2. A conservative parameter value from a site-specific range,
3. A single, appropriate region-specific parameter value,
4. A conservative parameter value from a region-specific range,
5. A conservative parameter value from appropriate published values , or
6. The RESRAD-OFFSITE default parameter value.

Using this ordered list assured the selection of the most appropriate, yet conservative, parameter values available were selected as input to the RESRAD-OFFSITE model.

Sensitivity analyses were performed on numerous parameters to determine that the chosen value for each parameter was appropriate. The sensitivity analyses also demonstrated that under varying conditions that may affect those parameter values, the radionuclide concentration in the receptor body remains within the comparison values.

Throughout the process, independent reviews of the RESRAD-OFFSITE model were carried out by a reviewer equally proficient with the RESRAD-OFFSITE code to confirm a conservative plausible evaluation was being performed. Additional discussions between the SMEs upon completion of the RESRAD-OFFSITE model identified the method for documenting the results and preparing the final description of the analysis results.

Associated Revision 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. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-004

NRC RAI:

Explain why the travel distance in Section 2.4.12 is 1935 ft (589.8 m) and it is 1847 ft (562.86 m) in Table 2.4.13-203.

Duke Energy Response:

The distance of 562.86 meters reflects a previous version of the analysis and is incorrect. The travel distance from the assumed Unit 2 release point to the nearest surface water body that eventually contributes to a potable drinking water source (the Broad River) is 583.28 meters. This distance is equal to the total travel distance (589.79 meters) minus the length of the contaminated zone around the Unit 2 release point (6.51 meters). FSAR Table 2.4.13-203 (Sheet 7) has been revised to reflect the travel distance discussed here.

The entire markup for FSAR Subsection 2.4.13 and associated tables are included with this response. Responses to other questions will also refer to these attachments.

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

FSAR Table 2.4.13-203

Attachments:

1) Revision to FSAR Subsection 2.4.13
2) Revision to FSAR Table 2.4.13-203
3) Revision to FSAR Table 2.4.13-204

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

Attachment 1 to RAI 2.4.13-004

Revision to FSAR Section 2.4.13

WLS COL 2.4-5

2.4.13 ACCIDENTAL RELEASES OF RADIOACTIVE LIQUID EFFLUENTS IN GROUND AND SURFACE WATERS

2.4.13.1 Groundwater

This section provides a conservative analysis of a postulated accidental liquid effluent release to the environment at the Lee Nuclear Site. The following sections describe the scenario and conceptual model used to evaluate the transport pathways to the nearest potable water supply in an unrestricted area. RESRAD-OFFSITE Version 2.0 is used to model the transport and provide resulting radionuclide concentration values in the potable water receptor body.

Acceptable results are those that are less than the effluent concentrations listed in 10 CFR 20 Appendix B, Table 2, Column 2. Individual radionuclide concentration results and the sum of fractions value are compared against these limits. The sum of fractions (i.e., unity value) is a comparison of the ratio of known radionuclides to their limit. This unity value may not exceed "1". As applied through Branch Technical Position 11-6, these criteria apply to the nearest potable water supply in an unrestricted area.

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. Due to the higher groundwater velocity and faster travel time in partially weathered bedrock, ~~this~~ the flow path from the Unit 2 effluent holdup tank to the Broad River is assumed to be the bounding pathway of radionuclide migration. This pathway represents the most rapid transport for water released by a liquid tank failure. 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 ~~by adsorption~~ 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 groundwater pathways 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 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. Included in that table are default K_d values found in literature for comparison. For conservatism, those radionuclides which have been evaluated for distribution coefficients use the lowest uncertainty corrected K_d values in the evaluation. All other radionuclides use the most conservative K_d value of 0.

2.4.13.2 Accident Scenario

The limiting postulated failure of a Unit 2 effluent holdup tank, located in the Unit 2 auxiliary building, was analyzed to estimate the resulting concentration of radioactive contaminants entering the Broad River. This 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 effluent holdup tank were conservatively assumed to enter the ~~groundwater~~environment instantaneously, allowing radionuclides to be transported in the direction of groundwater flow.

It is noted that no outdoor tanks contain radioactivity. In particular, the AP1000 does not require boron changes for load follow and so does not recycle boric acid or water; therefore, the boric acid tank is not radioactive.

The spent resin tanks are excluded from consideration, because most of their activity is bound to the spent resins; they have minimal free water that would be capable of migrating from the tank in the event of a tank failure. Tanks inside the containment building were not considered because the containment building, a seismic Category I structure, is a freestanding cylindrical steel containment vessel (DCD Subsection 1.2.4.1). Credit is taken for the steel liner to mitigate the effect of a postulated tank failure.

The Liquid Radwaste System (WLS) monitor tanks located in the radwaste building extension are considered because of their location in a non-seismic building. These tanks have a maximum capacity of 15,000 gallons each. They receive fluid that has been processed and must be monitored prior to discharge. The radwaste building has a well sealed, contiguous basemat with integral curbing that can hold the maximum liquid inventory of any tank. Floor drains in the area lead to the liquid radwaste system. The foundation for the entire building is a reinforced concrete mat on grade. Liquid spilled due to failure of any one of these tanks would be contained within the building, and would involve low activity liquids being held for discharge. Any release to the environment would be leakage through cracks in the concrete. The radiological consequences of such leakage are bounded by the analysis for the effluent holdup tanks. Therefore, these monitor tanks are not the limiting fault.

The remaining four tank applications were considered - the effluent holdup tanks, waste holdup tanks, monitor tanks (located in the auxiliary building), and chemical waste tanks. Of these tanks, the effluent holdup tanks have both the highest potential radioactive isotope inventory and the largest volume. The other tanks need not be considered further because they have lower isotopic inventory and, with the exception of one of the monitor tanks, because the rooms in which they are located are not on the lowest level of the auxiliary building (and thus intervening interior floors would mitigate the uncontrolled release of a ruptured tank). Therefore, an effluent holdup tank is limiting for the purpose of calculating the effects of the failure of a radioactive liquid-containing tank.

The effluent holdup tanks are located in an unlined room on the lowest level of the auxiliary building. This level is 33 feet 6 inches below the existing surface grade elevation of the plant. Each unit has two effluent holdup tanks, one of which is postulated to fail.

The analysis considers the tank liquid level, decay of the tank contents, potential paths of spilled liquid to the environment, and other pertinent factors.

The total volume of each effluent holdup tank is 28,000 gallons. Since credit can not be taken for liquid retention by unlined building foundations; a conservative analysis assumes that the tank content (80 percent of capacity, or 22,400 gallons) is immediately released through cracks in the auxiliary building walls and floor into the surrounding sub-surface soil. These assumptions follow the position in Branch Technical Position 11-6, March 2007.

2.4.13.3 Source Term

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.

WLS COL 2.4-5 Analysis of failure of the effluent holdup tank of Unit 2 rather than Unit 1 is conservative. As discussed in Subsection 2.4.12.3.1, groundwater transport is in a northerly direction. ~~Two~~Five groundwater flow paths were evaluated~~, to Hold-Up Pond A and to the Broad River. Travel times for water to migrate to the Broad River are significantly shorter than those to Hold-Up Pond A. Thus, migration to the Broad River is evaluated~~. The pathway from the Unit 2 effluent holdup tank to the Broad River has the shortest travel duration 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 ended, and no dewatering wells will exist.

The conceptual model of radionuclide transport through groundwater is shown in Figure 2.4.13-201. 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 mass of soil equivalent in size to the volume of 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 ~~then~~ released to the ~~groundwater~~ environment and transported through the partially weathered rock to the Broad River. The overburden soils continually receive the average annual onsite precipitation. The precipitation that does not runoff or is lost to evapotranspiration infiltrates through the overlying unsaturated zone and contributes to groundwater transport to the Broad River.

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 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 as the City of Union public water supply. 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.

This conceptual model is conservative~~. It~~ because it provides for the shortest travel time 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. ~~in the Broad River and~~ The analysis uses conservative estimates for parameters that are not developed from site data. A straight line flow path is considered the most conservative as the actual groundwater pathways are expected to be more tortuous, transport times much longer, and hydraulic conductivities of the fractures/joints lower. Due to the lower hydraulic conductivities in the soil and deeper bedrock, the ~~majority of~~ 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 K_d 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 assumed partial volume of the Broad River reservoir upstream of the Nine-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 saprolite soils and partly weathered rock.

The highest measuredmaximum 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.

Radionuclide concentrations in the Broad River are modeled using RESRAD-Offsite (Reference 212). The groundwater pathway mechanism is a first order release model that considers the effects of different transport rates for radionuclides and progeny nuclides, while allowing 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 decay.

No credit is taken for dilution of radionuclides in the Broad River 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-OffsiteOFFSITE (Reference 212) and concentrations were calculated on a periodic interval of approximately 70 daysmodeled for an evaluation period of 501,000 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.

The radiological consequences of a postulated failure of the effluent holdup tank as the limiting fault do not exceed 10 CFR 20 Appendix B Table 2 Column 2 limits at the nearest potable surface water supply (Broad River) located in an unrestricted area.

The maximum radionuclide concentration for each isotope calculated to be in the Broad River during a 50 year evaluation period was compared to 10 CFR 20 Appendix B Table 2 Column 2. The maximum concentration for each radionuclide is less than 10 CFR 20 Appendix B Table 2 Column 2 limits. Table 2.4.13-204 provides the concentration of the source term radionuclides calculated to be in the Broad River.

The maximum radionuclide concentration for each isotope calculated to be in the Broad River during the 50 year period was used to calculate a fraction of effluent concentration. The fraction of effluent concentration using all maximum isotope concentrations is well below a value of 1.0. Table 2.4.13-204 provides the fraction of effluent concentration for each radionuclide. The evaluation is conservative since the maximum concentration of each radionuclide occurs at a different time due to variations in transport time to the Broad River.

2.4.13.5 Sensitive Parameters

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.

The sensitivity analyses indicated that no variation in any single parameter has sufficient impact to cause the concentrations to exceed 10 CFR 20 Appendix B, Table 2, Column 2 limits or a sum of fractions calculation.

2.4.13.6 Regulatory Compliance

WLS COL 2.4-5 10 CFR 20 Appendix B states, "The columns in Table 2 of this appendix captioned "Effluents," "Air," and "Water," are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of §20.1302. The concentration values given in Columns 1 and 2 of Table 2 are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.05 rem (50 millirem or 0.5 millisieverts)." Thus, meeting the concentration limits of 10 CFR 20 Appendix B, Table 2 Column 2 results in a dose of less than 0.05 rem and therefore demonstrates that the requirements of 10 CFR 20.1301 and 10 CFR 20.1302 are met.

The radiological consequences of a postulated failure of the Unit 2 effluent holdup tank as the limiting fault were 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.

The maximum radionuclide concentration for each isotope calculated to be in 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 below a value of 1. Table 2.4.13-204 provides the fraction of effluent concentration for each 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 2 to RAI 2.4.13-004

Revision to FSAR Table 2.4.13-203

WLS COL
2.4-5

TABLE 2.4.13-203 (SHEET 1)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Silver Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	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	~~1,103~~985[2]	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.
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.

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~OFFSITE.

[2] Site-specific distribution coefficients use the measured value minus the applicable uncertainty

WLS COL
2.4-5

TABLE 2.4.13-203 (SHEET 2)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Cesium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	~~1,156~~993	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.
Iron Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	~~1,689~~1,450	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.
Tritium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default value is 0, which assumes no retardation during transport.
Iodine Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	~~0.07~~0.06	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.
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.

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~OFFSITE.

WLS
COL 2.4-5

TABLE 2.4.13-203 (SHEET 3)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Niobium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default value is 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 value is 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	~~73~~64	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.
Technetium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	~~0.04~~0.03	A radionuclide-specific K_d value was measured by Argonne National Laboratory using Lee soil.

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~OFFSITE.

WLS COL 2.4-5

TABLE 2.4.13-203 (SHEET 4)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Tellurium Transport K_d Coefficient (cm^3/g)	Radionuclide-specific retardation coefficient	0	The model default value is 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	~~1.01E00~~1.23	~~On-Site data collected at Lee~~Highest precipitation value for the region was used
Area of contaminated zone (square meters)	Area containing liquids released by the tank failure	4.238E+01	The contaminated soil area 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).
Evapotranspiration coefficient	Describes the fraction of precipitation and irrigation water penetrating the topsoil that is lost to evaporation and by transpiration by vegetation	0.74	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 model uses the conservative ratio of the average annual evaporation rate divided by the annual precipitation, disregarding the water lost through transpiration by vegetation.

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~OFFSITE.

WLS COL
2.4-5

TABLE 2.4.13-203 (SHEET 5)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Runoff coefficient (unitless)	Coefficient (fraction) of precipitation that runs off the surface and does not infiltrate into the soil	~~3.6E-01~~<u>0.39</u>	<u>The most conservative </u>~~S~~<u>s</u>ite-specific value was ~~determined to be 0.36~~<u>used</u>
Contaminated zone total porosity (unitless)	Total porosity of the contaminated sample, which is the ratio of the soil pore volume to the total volume	~~4.1E-01~~<u>8.0E-02</u>	On-site data <u>was </u>collected at Lee<u>.</u>
Density of contaminated zone (g/cm^3)	Density of the contaminated soil impacted by the liquid tank failure	1.59E+00	On-site data <u>was </u>collected at Lee<u>.</u>
Contaminated zone hydraulic conductivity (meters per year)	Flow velocity of groundwater through the contaminated zone under a hydraulic gradient	~~4.415E+02~~<u>4.418E+02</u>	The hydraulic conductivity was calculated from on-site data collected at Lee<u>.</u>
Unsaturated zone soil density (g/cm^3)	Density of the unsaturated overburden soil	1.59E+00	On-site data <u>was </u>collected at Lee<u>.</u>
Unsaturated zone hydraulic conductivity (meters per year)	Hydraulic conductivity that the unsaturated zone would have if saturated and subjected to a hydraulic gradient	~~4.415E+02~~<u>4.418E+02</u>	The hydraulic conductivity was calculated from on-site data collected at Lee<u>.</u>

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~<u>OFFSITE</u>.

WLS COL
2.4-5

TABLE 2.4.13-203 (SHEET 6)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Density of saturated zone (g/cm^3)	Density of the saturated zone soil that transmits groundwater	1.51E+00	On-site data was collected at Lee.
Saturated zone total porosity (unitless)	Total porosity of the saturated zone soil, which is the ratio of the pore volume to the total volume	4.4E-01 8.0E-02	On-site data was collected at Lee.
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.	4.4E-01 8.0E-02	The value is conservatively selected by setting the effective porosity equal to the saturated water content to achieve maximum groundwater movement On-site data was collected at Lee.
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.	3.6E-02 3.8E-02	The value is conservatively selected as the hydraulic gradient for the shortest travel time to the nearest off-site surface water body (Broad River).
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.	6.51E-02	Follows recommendations in the RESRAD-OFFSITE User Manual.

[1]Parameter values are provided in metric units as used with RESRAD-Offsite OFFSITE.

WLS COL
2.4-5

TABLE 2.4.13-203 (SHEET 7)
LISTING OF LEE NUCLEAR STATION DATA AND MODELING PARAMETERS SUPPORTING THE EFFLUENT HOLDUP TANK FAILURE

Soil Parameter	Parameter Description	Parameter Value [1]	Parameter Justification
Lateral (horizontal) dispersivity to surface water body (meters)	Describes the ratio between the horizontal lateral dispersion coefficient and the pore water velocity.	6.51E-03	Follows recommendations in the RESRAD-OFFSITE User Manual.
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.	6.51E-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	~~562.86~~583.28	~~The value is conservatively selected by measuring the distance from the Unit 2 auxiliary building to the nearest point on the Broad River.~~ The selection is conservative because this distance results in the shortest travel time to the nearest off-site surface water body.

[1]Parameter values are provided in metric units as used with RESRAD-~~Offsite~~OFFSITE.

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

Attachment 3 to RAI 2.4.13-004

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	10 CFR 20 Appendix B Table 2 Column 2	Sum of Fractions Contribution[1]
	microcuries/ml	microcuries/ml	
Ag-110m	6.25E-10	6.00E-06	1.04E-04
Ce-144	3.09E-10	3.00E-06	1.03E-04
H-3	1.07E-04	1.00E-03	1.07E-01
Mn-54	2.40E-09	3.00E-05	8.01E-05
Pr-144	3.09E-10	2.00E-05	1.55E-05
			Sum of Fraction Unity Rule Value
			1.08E-01
~~H-3~~	~~2.44E-05~~	~~1.00E-03~~	~~2.44E-02~~
			~~Sum of Fraction Unity Rule Value~~
			~~2.44E-02~~

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

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-005

NRC RAI:

In Table 2.4.13-203, effective porosity is set equal to saturated porosity in the calculation of contaminant transport within RESRAD. In contrast, in Section 2.4.12, the actual effective porosity (not the saturated porosity) is used to calculate travel time. Explain why different values are used in each section and, if for conservativeness, explain why each is conservative. If each is conservative for a different reason (e.g., in one case, to maximize volume; in the second, to minimize travel time), evaluate and present the results of both cases.

Duke Energy Response:

Subsequent revisions to the accident scenario calculation have used updated porosity values. Revised FSAR Table 2.4.13-203 reflects this change. Specifically, the most conservative (i.e., the lowest) measured value (0.08) has been used regardless of the media from which it was collected. As an additional conservative measure, the porosity values are set to the lowest value regardless of whether it is total porosity (i.e., saturated porosity) or effective porosity (i.e., the values used for total porosity and the effective porosity are equal and use the most conservative site-specific value). Using the lowest porosity values has the effect of decreasing travel time of the contaminated liquid from the liquid effluent tank to the receptor water body, thereby providing the highest concentration of radionuclides in the receptor water body which provides a conservative result.

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

Revisions to FSAR are provided in the response to FSAR RAI 2.4.13-004 as Attachment 2 (Revised Table 2.4.13-203, Sheet 6) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-006

NRC RAI:

The contaminated zone hydraulic conductivity is set equal to 441.5 m/yr, which is 1.4 E-3 cm/s, which suggests the contaminated zone is PWR. This value is called the conservative value in Table 2.4.12-204. FSAR text on p. 2.4-67 says the highest measured hydraulic conductivity in the weather rock is used. From Table 2.4-12-204, the highest value for PWR is 9.89E-3 cm/s. Explain which value was intended.

Duke Energy Response:

While the value of 9.89E-03 cm/s for partially weathered rock (PWR) is the maximum recorded value, the mean value for the recorded data is 1.54E-04 cm/s. Based on the nature of the evaluation, the use of a constant value of 1.4E-03 cm/s results in a conservative analysis. Revised text of FSAR Subsection 2.4.13.4 paragraph 7 reflects this discussion.

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

Revisions to FSAR are provided in the response to FSAR RAI 2.4.13-004 as Attachment 1 (Revised FSAR Subsection 2.4.13.4 paragraph 7) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-007

NRC RAI:

The value for the porosity of the contaminated zone in Table 2.4.12-204 is 0.41, which suggests the material is fill. The conductivity value is 441.5 m/yr (1.4 E-3 cm/s), which suggests the material is PWR, which has a porosity of 0.44. Define the nature of the contaminated zone.

Duke Energy Response:

The most conservative measured value of 0.08 for both total porosity and effective porosity of the saturated zone has been used in the FSAR. This value is applicable to the PWR. The use of the lowest porosity value is conservative because it allows for the fastest transport of radionuclides to the nearest potable water source not in the restricted area. This is reflected in the markup of FSAR Table 2.4.13-203.

The contaminated zone is a postulated mass of contaminated water that is assumed to be released into the surrounding groundwater. The contaminated zone is assumed to have the characteristics of the saturated zone immediately outside the Auxiliary Building which is essentially partially weathered rock with some portions of residual soils and fill. The parameter values were selected from the available soil media types to provide the most conservative results. The conceptual model assumes that one of the 28,000 gallon liquid effluent tanks, located at the lowest level of the Auxiliary Building and containing 80% of its total capacity, ruptures. 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 the floor drains. The sump pumps are conservatively assumed to be inoperable. The liquid then enters the environment outside the Auxiliary Building via gradual infusion into the saturated zone, i.e. the groundwater. Therefore, as the existing groundwater moves in its normal flow, the contaminated water gradually mixes in and is transported to the receptor body. The consequence is a release of 22,400 gallons of contaminated liquid into the soil and subsequent transport via groundwater flow to the nearest potable water source in an unrestricted area.

As noted above, the volume of water in the liquid effluent tank at failure is selected to be 80% of the total tank capacity of 28,000 gallons, per Branch Technical Position 11-6 guidance, for a total release volume of 22,400 gallons. Water from the failed effluent holdup tank was assumed to be a volume configuration of rectangular shape 2 meters in height and 6.51 square meters, which is a sufficient volume to account for the 22,400 gallons of water from the effluent holdup tank.

Groundwater impact occurs by failure of the effluent holdup tank discharging radionuclide-impacted water into the sub-surface at an elevation of 66 feet 6 inches below the at-grade DCD reference elevation of 100 feet (590 ft MSL for Lee), i.e., the effluent holdup tank is located 33 feet 6 inches below the at-grade surface of the plant.

The postulated scenario is conservative in that the release point is below the water table and the model does not take credit for engineered containment systems or water-proof membranes that would drastically slow or stop the contaminated liquid from reaching the groundwater.

The markup of FSAR Subsection 2.4.13.4, which will be incorporated in a future revision of the FSAR, contains this description.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 as Attachment 1 (Revised Subsection 2.4.13.4) and Attachment 2 (Revised Table 2.4.13-203, Sheets 5 and 6) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: **Hydrologic Engineering Branch (RHEB)**

Reference NRC RAI Number(s): **02.04.13-008**

NRC RAI:

Table 2.4.13-203 states that the bulk density of the contaminated zone is 1.59 g/cm^3. The data in Table 2.4.12-203 suggest that the bulk density of PWR is 1.80 g/cm^3 (e.g., (140/62.4)-0.44 = 1.80). Explain how and from what data bulk density was calculated.

Duke Energy Response:

The RESRAD-OFFSITE model uses the most conservative values for numerous parameters. The dry bulk density of the contaminated zone was calculated as the average dry bulk density of the four primary media types present; fill (1.58 g/cm^3), residual soil (1.44 g/cm^3), saprolite (1.51 g/cm^3), and partially weathered rock (PWR) (1.80 g/cm^3). This yields an average dry bulk density of 1.59 g/cm^3. Using an average dry bulk density is conservative relative to the density of PWR because the lower density allows for shorter travel duration to the receptor water body, both in the model and in reality. Because the postulated release occurs in the unsaturated zone (i.e., below the water table), the higher density materials in that zone would have the effect of slowing the travel velocity, thus increasing the travel duration. Using a dry bulk density of 1.59 g/cm^3 is therefore a conservative evaluation.

Associated Revision 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. 017

NRC Technical Review Branch: **Hydrologic Engineering Branch (RHEB)**

Reference NRC RAI Number(s): **02.04.13-009**

NRC RAI:

Section 2.4.13 mentions dispersion coefficients, but Table 2.4.13-203 does not show dispersion coefficient values. Provide the dispersion coefficients used for each material type.

Duke Energy Response:

The RESRAD-OFFSITE model does not define dispersion coefficient values based on media types, but rather by zone. The saturated zone (i.e., the zone within the groundwater), is the applicable zone in the accident scenario calculation in which dispersion coefficient values are used. There are three dispersion coefficient values which are applicable to the RESRAD-OFFSITE model: 1) longitudinal dispersivity; 2) horizontal dispersivity; and 3) lateral dispersivity. Using the guidance contained in NUREG/CR-6937, Volume 2 (i.e., the RESRAD-OFFSITE user manual), the longitudinal dispersivity of the saturated zone is equal to one-hundredth of the length of the contaminated zone or 0.0651 meters. The horizontal dispersivity is 0.00651 meters. The lateral dispersivity is 0.00651 meters. These are each equal to one tenth the longitudinal dispersivity, also using the guidance in NUREG/CR-6937, Volume 2. These values were chosen to demonstrate infusion, rather than injection, of the contaminant into the groundwater through normal flow. Using higher dispersion coefficient values would have the unrealistic effect of radionuclides reaching the receptor surface water body prior to the groundwater reaching the receptor body, due to the contaminated water traveling at a greater velocity than the surrounding groundwater.

New FSAR Subsection paragraph 8 and revised FSAR Table 2.4.13-203, which will both be incorporated in a future revision of the Final Safety Analysis Report, reflect this discussion and now include dispersivity values.

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

Revisions to FSAR are provided in the response to FSAR RAI 2.4.13-004 as Attachment 1 (New FSAR Subsection 2.4.13.4 paragraph 8) and Attachment 2 (Revised Table 2.4.13-203, Sheets 6 and 7) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-010

NRC RAI:

Section 2.4.13 describes Kd values as being dependent on the texture of soils (sand, loam, clay, organic soils), the organic matter content, pH, soil solution ratio, pore water concentration, and the presence of competing cations and complexing agents. The section goes on to say that, because of its dependence on many soil properties, the Kd value for a specific radionuclide can range over several orders of magnitude. Describe the geochemical conditions in the groundwater, the chemical conditions in the effluent holdup tank, and the conditions under which the Kd was measured for the three soil samples. Describe how well the lab measurements ought to represent field behavior during and after the leak event. Quantify the likely variation in Kd that should be expected given the range of conditions that might be encountered, including the variability in soil and rock properties along the flow pathways.

Duke Energy Response:

The site groundwater is consistent with Piedmont province groundwaters: slightly acidic, calcium carbonate-type waters.

The effluent holdup tanks contain reactor coolant which has been processed through the chemical and volume control system (CVS) mixed bed demineralizer and filter, and the Liquid Radwaste System (WLS) degasifier. The water chemistry is described by DCD Table 5.2-2. The content of the effluent holdup tanks is water, with a low concentration of boric acid resulting in a slightly acidic pH. The contents are miscible with groundwater (not buoyant) and the total dissolved solids are in the sub-ppm (less than 1 ppm) range.

The chemical conditions of the postulated released effluent will not vary significantly from ambient groundwater conditions in pH, salts, metals, or organics. As such, the released effluent would not affect the general subsurface water and soil chemistry under which the distribution coefficients (K_d) function. Therefore, the evaluated model is realistic, and no additional conservatism is required.

K_d was measured according to methods described by Argonne National Laboratory (ANL) in Argonne Chemistry Laboratory Standard Operating Procedure 264 (ACL SOP-264), "Standard Operating Procedure: Determination of the Distribution Coefficient (K_d) in Soil Samples." The chemical conditions under which ANL conducted their sampling were designed to mimic conditions in the field to the extent practicable, using samples of soil and groundwater from the site. As such, lab measurements should represent field behavior during and after the postulated release.

It would not be practical to quantify the variation of K_d for the range of *in-situ* conditions which may exist because of the amount and method (i.e., injection of radionuclides into the local environment) of data collection that would be required. However, the range of K_d values for specific radioisotopes determined at the Lee Nuclear Site are presented in FSAR Table 2.4.13-201. This range is generally representative of the values within the alternative flow pathways.

Duke Energy's evaluation is bounding because the lowest measured K_d values were used regardless of the media from which they were taken. Additionally, the RESRAD-OFFSITE model used a K_d of 0 for Tritium (H^3), which is the radionuclide that accounts for greater than 99% of the dose contribution. Additionally, a sensitivity analysis on K_d parameters was conducted within the RESRAD-OFFSITE model in order to demonstrate the affect of K_d on the radionuclide concentrations in the receptor water body following the postulated release. The sensitivity analysis is further discussed in the response to FSAR RAI 02.04.13-012.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 as Attachment 1 (New Subsection 2.4.13.4 Paragraph 4) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-011

NRC RAI:

Section 2.4.13 states that the precipitation that is not lost to runoff or evapotranspiration infiltrates and contributes to groundwater transport. Table 2.4.13-203 identifies that the runoff coefficient is 0.36. Explain how this value was determined. The table lists annual precipitation as 101 cm/yr. That suggests that annual runoff is 36.4 cm (about 14.3 inches). State whether this value is consistent with observations. Table 2.4.13-203 does not identify the value of evapotranspiration, which is needed to understand how much infiltrates. Explain how much infiltration is estimated to occur and the basis for the assumption.

Duke Energy Response:

The original runoff coefficient value listed in FSAR Table 2.4.13-203 (0.36) has been updated to 0.39 based on the latest revision of the postulated release analysis, as discussed below.

The Soil Conservation Service (SCS) Curve Number (CN) method was used to estimate runoff coefficients using the average monthly rainfall. Rainfall data is based on the Gaffney, South Carolina monthly rainfall data from the Gaffney 6 E station. The period of record is from 1944 through 2007. The average rainfall for each month was determined by summing the total rainfall for each month and dividing by the number of years. The average annual rainfall based on the monthly averages is 48.41 inch (in.) which is 123 cm/year. A composite CN value of 81 was used for the Make-Up Pond A and Hold-Up Pond A watersheds based on developed site conditions. A composite CN value of 73 was used for the Make-Up Pond B watershed based on developed site conditions. Composite CN values are based on average antecedent moisture conditions (AMC II).

Rainfall runoff is determined using the SCS CN method to account for infiltration losses. The formulas for the SCS CN method are identified below.

$$Pe = (P - 0.2 * S)^2 / (P + 0.8 * S)$$

where;

P = accumulated precipitation (in.)
Pe = precipitation excess (in.)
S = potential maximum retention of the soil (in.)

$$S = 1000 / CN - 10$$

where;

S = potential maximum retention of the soil (in.)
CN = SCS runoff curve number (dimensionless)

The average monthly precipitation is used with the appropriate CN value to calculate the average monthly precipitation excess using the formula identified above. The results are provided in following table:

Average Monthly Precipitation Excess and Losses.

		Make-Up Pond A and Hold-Up Pond A (CN = 81, S = 2.35)		Make-Up Pond B (CN = 73, S = 3.70)	
Month	Average Precipitation[a] (in.) (1)	Precipitation Excess (in.) (2)	Precipitation Losses (in.) (3)	Precipitation Excess (in.) (4)	Precipitation Losses (in.) (5)
Jan.	4.13	2.23	1.90	1.62	2.51
Feb.	4.01	2.13	1.88	1.53	2.48
Mar.	4.99	2.97	2.02	2.27	2.72
Apr.	3.63	1.81	1.82	1.27	2.36
May	3.78	1.94	1.84	1.37	2.41
June	4.14	2.24	1.90	1.63	2.51
July	4.33	2.40	1.93	1.77	2.56
Aug.	4.56	2.60	1.96	1.94	2.62
Sept.	4.04	2.15	1.89	1.56	2.48
Oct.	3.58	1.77	1.81	1.23	2.35
Nov.	3.34	1.58	1.76	1.07	2.27
Dec.	3.88	2.02	1.86	1.44	2.44
Sum	48.41	25.84	22.57	18.70	29.71

$(2) = [(1) - 0.2 * 2.35]^2 / [(1) + 0.8 * 2.35]$

$(3) = (1) - (2)$

$(4) = [(1) - 0.2 * 3.70]^2 / [(1) + 0.8 * 3.70]$

$(5) = (1) - (4)$

(a) Rainfall data from Gaffney 6 E station

The average annual runoff for the Make-Up Pond A and Hold-Up Pond A watersheds is 53 percent of the average annual rainfall (25.84 / 48.41 = 0.53). The average annual runoff for the Make-Up Pond B watershed is 39 percent of the average annual rainfall (18.70 / 48.41= 0.39). Therefore, a runoff coefficient of 0.53 is calculated for Make-Up Pond A and Hold-Up Pond A and a runoff coefficient of 0.39 is calculated for Make-Up Pond B.

Using a lower runoff coefficient rate in the RESRAD-OFFSITE model is a conservative approach. Therefore, a runoff coefficient of 0.39 is used for Make-Up Pond A, Make-Up Pond B and Hold-Up Pond A.

The South Carolina State Climatology Office website indicates that:

"*Average annual precipitation is heaviest in northwestern South Carolina, and annual totals vary directly with elevation, soil type, and vegetation. In the Mountains, between 70 to 80 inches of rainfall occur at the highest elevations, with the highest annual total at Caesars Head (79.29"). Across the Foothills, average annual precipitation ranges from 60 to more than 70 inches. In the eastern and southern portions of the Piedmont, the average annual rainfall ranges from 45 to 50 inches.*"

The project site lies within the eastern and southern portions of the Piedmont. These regional data are consistent with the site-specific data analysis that was performed and are consistent with an average annual rainfall range of 45 to 50 in. (1.14 to 1.27 meters). Therefore the use of 48.41 inches per year is appropriate for groundwater modeling.

The RESRAD-OFFSITE model uses an average annual precipitation rate of 48.41 inches as described above. The evapotranspiration coefficient used in the accident scenario calculation is 0.74. This value is calculated by dividing the corrected pan evaporation rate of 36 inches (0.914 meters) by the average annual precipitation rate (1.23 meters). The average annual pan evaporation rate for the region (1950 – 1992) is 51.8 inches (in.), with monthly averages ranging from 1.46 in. in January to 6.92 in. in July. Pan evaporation is usually greater than the actual evaporation from nearby land surfaces. A widely accepted correction coefficient of pan evaporation to the actual evaporation is approximately 0.7, thus an annual evaporation of approximately 36 in. is established. The data for the pan evaporation rate was gathered from the website of the South Carolina State Climatology Office, Pan Evaporation Records for the South Carolina Area (http://www.dnr.sc.gov/water/climate/sco/pan_evap.html, accessed April 1, 2007).

FSAR Table 2.4.13-203 will be revised to reflect the revised runoff coefficient and evapotranspiration coefficient in a future revision of the FSAR.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 as Attachment 2 (Revised Table 2.4.13-203 Sheet 5) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-012

NRC RAI:

Table 2.4.13-203 contains Kd values for one sample of fill and two of soil/saprolite. These materials contain high quantities of silt and clay, both of which could contribute to high Kd values. The primary transport pathway considered in Section 2.4.13 is through the PWR material, which is low in silt and clay. Explain why Kd values measured on fill and soil/saprolite can be used to represent PWR. Because of the uncertainty in Kd values, provide an evaluation of the sensitivity of the model results to Kd values.

Duke Energy Response:

No samples of partially weathered rock (PWR) were collected and submitted to Argonne National Laboratory (ANL) for K_d measurements, primarily because the measurement of K_d required the sample be pulverized, significantly altering it from in-situ conditions. The weathering profile within the Piedmont region suggests that continuous rock weathers in place to PWR, which weathers in place to saprolite, then to residual soil. The physical characteristics observed within the weathering profile appear to vary gradationally. Additional discussion of weathering profiles and soil stratigraphy is included in FSAR subsections 2.5.1.2.5.3 and 2.4.12.1.1.

The percentages of gravel, sand and fines in fill, residual soil, saprolite and PWR, respectively, are shown in FSAR Chapter 2, Table 2.5.4-211. These are summarized in Table 1 below. The weathering profile suggests a fining-upward sequence. PWR comprises more coarse-grained material than the saprolite, residual soil and fill materials, and it is anticipated that PWR represents the coarser fraction of this weathering profile.

Table 1 Material Characteristics

	Gravel	Sand	Fines
Partially Weathered Rock	9%	55%	36%
Saprolite	3%	52%	46%
Residual Soil	0%	46%	54%
Fill	4%	34%	62%

Chemical weathering processes are expected to degrade the continuous rock (parent rock) to create more chemically homogenous materials across the weathering profile. Thus, the chemical variances within the weathering profile are more subtle as weathering continues.

In the absence of K_d data specific to PWR, the K_d data collected for other materials within the weathering profile was used rather than assuming the worst case scenario in which the PWR K_d approaches unity. This decision is appropriate because observation of the variances in physical and chemical characteristics of soils within the weathering profile indicate the changes are generally gradational. As such, the use of Soil/Saprolite and Fill material K_d values in the RESRAD-Offsite model are reasonable and provide site-specific data for the analysis.

A sensitivity analysis was performed on the 18 radionuclides which appear in the receptor body and use a site-specific K_d value in the RESRAD-OFFSITE model. The K_d values for these radionuclides in the saturated zone were varied by a factor of 5 to determine the impact of the K_d on the transport. Of the 18 selected radionuclides, only two were affected by the variance of the K_d values. A factor of 5 decrease in the K_d for I-129 provided the greatest impact on the concentration in the receptor body, increasing its individual concentration by 10% from 1.69E-03 pCi/L to 1.86E-03 pCi/L. The receptor water body concentration for Tc-99 increased by 5.8% from 1.01E-03 pCi/L to 1.07E-03 pCi/L as a result of a factor of 5 decrease in the K_d value. The resulting increase in concentration for these two radionuclides is well below limits listed in 10 CFR 20 Appendix B Table 2 Column 2. This sensitivity analysis shows that even a factor of 5 decrease in K_d results in a concentration below comparison values.

Associated Revision 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. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number: 02.04.13-013

NRC RAI:

Provide input files and a summary of output results for each of the RESRAD analyses employed in the analysis of the accidental release of radioactive liquid effluent in groundwater and surface waters.

Duke Energy Response:

The RESRAD-OFFSITE input and output summary files are provided.

The input file is named "DUK010-FSAR-2_4-CALC-017R2D.ROF". The output summary file is included in two formats, the raw format is named "SUMMARY.REP" and a PDF version of the raw file is "SUMMARY.PDF".

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

None

Attachment:

1) Computer disc (CD format) with RESRAD-OFFSITE input and output summary files.

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-014

NRC RAI:

Make available the calculation package used to convert source concentration values in DCD Tables 11.1-2 and 11-1-8 to RESRAD input values (with units of pCi/g water).

Duke Energy Response:

The detailed calculation addressing the postulated tank rupture has been made available for NRC Staff review at the Duke Energy main offices in Charlotte, North Carolina and at Duke affiliate offices in Rockville, Maryland and Richmond, Washington.

The concentration of the radionuclides is listed in COL item 15.7.6 Table 11.1-2. The concentration is modified to account for fuel failure by multiplying the listed concentrations for non-corrosion products by 0.12/0.25 as recommended in DCD section 2.1. Corrosion product concentrations are taken directly from the table. Concentrations were then multiplied by the tank volume to achieve the total source term in microcuries per gram. All concentrations are then converted from microcuries per gram to picocuries per gram by multiplying by 1.00E+06 and further adjusted to 101% of the reactor coolant by multiplying the concentration (in picocuries per gram) by 1.01.

The conceptual model assumes that one of the liquid effluent tanks, located at the lowest level of the auxiliary building, ruptures 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 the floor drains. As a further conservative assumption, the sump pumps are assumed to be inoperable. 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 and subsequently transported via groundwater flow to the nearest potable water source in an unrestricted area. Five potential travel pathways exist. Evaluation of the five pathways indicates that the pathway from Unit 2 Effluent Holdup Tank to the Broad River is the shortest duration at 2.8 years travel time. These pathways are discussed further in the answer to FSAR RAI 2.4.13-16.

<u>Description of the Liquid Effluent Tank Release Conceptual Site Model</u>

AP1000 Design Control Document Revision 7 Section 15.7.3 states the following:

> Tanks containing radioactive fluids are located inside plant structures. In the event of a tank failure, the liquid would be drained by the floor drains to the auxiliary building sump. From the sump, the water would be directed to the waste holdup tank. The basemat of the auxiliary building is 6-feet thick, the exterior walls are 3-feet thick, and the building is seismic Category I. The exterior walls are sealed to prevent leakage. Thus, it

is assumed that there is no release of the spilled liquid waste to the environment. However, the Standard Review Plan states that credit cannot be taken for liquid retention by unlined building foundations. Analysis of the impact of this event is the responsibility of the Combined License applicant. This analysis should include consideration of tank liquid level, processing and decay of tank contents, potential paths of spilled waste to the environment, as well as other pertinent factors.

The liquid effluent tank is a 28,000 gallon tank located in the Auxiliary Building. The volume of water in the liquid effluent tank at failure is selected to be 80% of the total tank capacity of 28,000 gallons, per Branch Technical Position 11-6 guidance, for a total release volume of 22,400 gallons. Water from the failed effluent holdup tank was assumed to be a volume configuration of rectangular shape 2 meters in height and 6.51 square meters, which is a sufficient volume to account for the 22,400 gallons of water from the effluent holdup tank. Source term radionuclides, listed below, are released into the unlined room.

Liquid Effluent Tank Source Term Inventory

Nuclide[(a)]	Half-Life[(a)]	Activity[(a)] (microcuries per gram)	Adjusted for Fuel Failures (microcuries per gram)	Total Source Term (microcuries per gram)	Source Term Concentration (picocuries per gram)
Ag-110m	249.8 days	4.00E-04	1.92E-04	1.63E+04	404.00
Ba-137m	2.55 minutes	4.70E-01	2.26E-01	1.91E+07	474700.00
Ba-140	12.75 days	1.00E-03	4.80E-04	4.07E+04	1010.00
Br-83	2.4 hours	3.20E-02	1.54E-02	1.30E+06	32320.00
Br-84	31.8 minutes	1.70E-02	8.16E-03	6.92E+05	17170.00
Br-85	2.87 minutes	2.00E-03	9.60E-04	8.14E+04	2020.00
Ce-141	32.5 days	1.60E-04	7.68E-05	6.51E+03	161.60
Ce-143	1.38 days	1.40E-04	6.72E-05	5.70E+03	141.40
Ce-144	284.6 days	1.20E-04	5.76E-05	4.88E+03	121.20
Co-58	70.88 days	1.90E-03	1.90E-03	1.61E+05	1919.00
Co-60	5.271 years	2.20E-04	2.20E-04	1.87E+04	222.20
Cr-51	27.7 days	1.30E-03	1.30E-03	1.10E+05	1313.00
Cs-134	2.065 years	6.90E-01	3.31E-01	2.81E+07	696900.00
Cs-136	13.16 days	1.00E+00	4.80E-01	4.07E+07	1010000.00
Cs-137	30.07 years	5.00E-01	2.40E-01	2.03E+07	505000.00
Cs-138	32.2 minutes	3.70E-01	1.78E-01	1.51E+07	373700.00
Fe-55	2.73 years	5.00E-04	5.00E-04	4.24E+04	505.00
Fe-59	44.51 days	1.30E-04	1.30E-04	1.10E+04	131.30
H-3	12.32 years	1.00E+00	1.00E+00	8.48E+07	1010000.00
I-129	1.57 E7 years	1.50E-08	7.20E-09	6.10E-01	0.015150
I-130	12.36 hours	1.10E-02	5.28E-03	4.48E+05	11110.00
I-131	8.02 days	7.10E-01	3.41E-01	2.89E+07	717100.00
I-132	2.28 hours	9.40E-01	4.51E-01	3.83E+07	949400.00
I-133	20.8 hours	1.30E+00	6.24E-01	5.29E+07	1313000.00
I-134	52.6 minutes	2.20E-01	1.06E-01	8.95E+06	222200.00
I-135	6.57 hours	7.80E-01	3.74E-01	3.17E+07	787800.00
Kr-83m	1.86 hours	1.80E-01	8.64E-02	7.33E+06	181800.00
Kr-85	10.76 years	3.00E+00	1.44E+00	1.22E+08	3030000.00
Kr-85m	4.48 hours	8.40E-01	4.03E-01	3.42E+07	848400.00

Nuclide[a]	Half-Life[a]	Activity[a] (microcuries per gram)	Adjusted for Fuel Failures (microcuries per gram)	Total Source Term (microcuries per gram)	Source Term Concentration (picocuries per gram)
Kr-87	1.27 hours	4.70E-01	2.26E-01	1.91E+07	474700.00
Kr-88	2.84 hours	1.50E+00	7.20E-01	6.10E+07	1515000.00
Kr-89	3.15 minutes	3.50E-02	1.68E-02	1.42E+06	35350.00
La-140	1.68 days	3.10E-04	1.49E-04	1.26E+04	313.10
Mn-54	312.1 days	6.70E-04	6.70E-04	5.68E+04	676.70
Mn-56	2.58 hours	1.70E-01	1.70E-01	1.44E+07	171700.00
Mo-99	2.75 days	2.10E-01	1.01E-01	8.55E+06	212100.00
Nb-95	34.97 days	1.60E-04	7.68E-05	6.51E+03	161.60
Pr-143	13.57 days	1.50E-04	7.20E-05	6.10E+03	151.50
Pr-144	17.28 minutes	1.20E-04	5.76E-05	4.88E+03	121.20
Rb-88	17.7 minutes	1.50E+00	7.20E-01	6.10E+07	1515000.00
Rb-89	15.4 minutes	6.90E-02	3.31E-02	2.81E+06	69690.00
Rh-103m	56.12 minutes	1.40E-04	6.72E-05	5.70E+03	141.40
Rh-106	29.9 seconds	4.50E-05	2.16E-05	1.83E+03	45.45
Ru-103	39.27 days	1.40E-04	6.72E-05	5.70E+03	141.40
Sr-89	50.52 days	1.10E-03	5.28E-04	4.48E+04	1111.00
Sr-90	28.78 years	4.90E-05	2.35E-05	1.99E+03	49.49
Sr-91	9.5 hours	1.70E-03	8.16E-04	6.92E+04	1717.00
Sr-92	2.71 hours	4.10E-04	1.97E-04	1.67E+04	414.10
Tc-99m	6.01 hours	2.00E-01	9.60E-02	8.14E+06	202000.00
Te-127m	109 days	7.60E-04	3.65E-04	3.09E+04	767.60
Te-129	1.16 hours	3.80E-03	1.82E-03	1.55E+05	3838.00
Te-129m	33.6 days	2.60E-03	1.25E-03	1.06E+05	2626.00
Te-131	25 minutes	4.30E-03	2.06E-03	1.75E+05	4343.00
Te-131m	1.35 days	6.70E-03	3.22E-03	2.73E+05	6767.00
Te-132	3.2 days	7.90E-02	3.79E-02	3.22E+06	79790.00
Te-134	42 minutes	1.10E-02	5.28E-03	4.48E+05	11110.00
Xe-131m	11.9 days	1.30E+00	6.24E-01	5.29E+07	1313000.00
Xe-133	5.24 days	1.20E-02	5.76E-03	4.88E+05	12120.00
Xe-133m	2.19 days	1.70E+00	8.16E-01	6.92E+07	1717000.00
Xe-135	9.1 hours	3.50E+00	1.68E+00	1.42E+08	3535000.00
Xe-135m	15.3 minutes	1.70E-01	8.16E-02	6.92E+06	171700.00
Xe-137	3.82 minutes	6.70E-02	3.22E-02	2.73E+06	67670.00
Xe-138	14.1 minutes	2.50E-01	1.20E-01	1.02E+07	252500.00
Y-90	2.67 days	1.30E-05	6.24E-06	5.29E+02	13.13
Y-91	58.5 days	1.40E-04	6.72E-05	5.70E+03	141.40
Y-91m	49.7 minutes	9.20E-04	4.42E-04	3.74E+04	929.20
Y-92	3.54 hours	3.40E-04	1.63E-04	1.38E+04	343.40
Y-93	10.2 hours	1.10E-04	5.28E-05	4.48E+03	111.10
Zr-95	64.02 days	1.60E-04	7.68E-05	6.51E+03	161.60

Notes:

tank volume (cc): 8.4784E+07
tank water weight (g): 8.4784E+07
picocuries per microcuries conversion: 1.00E+06
source term concentration adjusted to 101% of reactor coolant
[a] Reference 2 (COL Item 15.7.6) Revision 1

Associated Revision 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. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-015

NRC RAI:

Provide groundwater concentrations at the point just before entry into the Broad River. Explain how RESRAD dilutes groundwater concentrations as the groundwater mixes with the Broad River and why this approach is considered to be appropriate. Explain the meaning of the statement "no credit is taken for dilution in the river by water flow." If there is dilution in the river, how much is it and why was that value selected? What is the residence time in the river and why was this value selected?

Duke Energy Response:

RESRAD-OFFSITE uses the surface water body volume as the receptor. Dilution occurs as a straight calculation from the input source (i.e., the groundwater) to the receptor (i.e., Broad River). The receptor volume used in the RESRAD-OFFSITE model is 150,000 m^3. An evaluation of the Broad River flow characteristics has shown the least available volume of water, and thereby most conservative value, would be a static pool of approximately 856,036 m^3, which is from the point of release to the Ninety-Nine Islands dam. By assuming it is a static pool, the volume is not increased by the constant flow of water through the evaluated area; thereby no credit is taken for dilution in the river by water flow. In reality, the volume which flows through the control volume and the associated dilution would be orders of magnitude greater.

The residence time in the river was selected to be 1 year to standardize the exposure duration to the accumulation duration. This is a very conservative value since flow through the potentially impacted portion of Broad River would reduce the actual residence time to, at most, a few hours.

Regarding radionuclide concentration just prior to entry into the Broad River, the analysis does not calculate the concentration of radionuclides as they emerge into the receptor water body. The model of record was developed to meet the regulatory guidance contained in BTP 11-6. Duke was unable to identify any additional regulatory guidance or other basis for requiring the calculation of an intermediate release point. Thus, the model was not reconfigured to perform such an evaluation.

As provided for in 10 CFR 50.2, the Lee Nuclear exclusion area includes a section of the Ninety-Nine Islands Reservoir, and expects to provide appropriate and effective arrangements to control traffic on the waterway, in case of emergency, to protect public health and safety. The Ninety-Nine Islands Dam and Reservoir are owned and operated by Duke Energy. This reservoir is a FERC-regulated water body associated with the FERC license of the Ninety-Nine Islands hydroelectric station. Accordingly, Duke is responsible for the control of public access to the reservoir from its property. A permit would have to be obtained from Duke in order to build permanent structures in the reservoir or to withdraw water from the reservoir. As such, Duke

Energy has sufficient control over the reservoir to protect public health and safety in the event of an accidental release.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 in Attachment 1 (New Subsection 2.4.13.4 paragraph 3) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-016

NRC RAI:

Explain more fully the conceptual model of the accidental release. Does the fluid drain from the tank and sink below the water table or does it travel horizontally and why? The text states that the fluid fills the pore space in an area large enough to contain the leaked fluid. Describe that "volume" in terms of length, width, and height. Confirm that this "volume" of soil accounts for the volume occupied by the soil matrix. Explain what becomes of the existing groundwater that is displaced. Explain how RESRAD treats the source term. Are the contaminants instantaneously distributed within the "volume" as if in the groundwater system or are they in a separate model compartment and released at a defined rate (e.g., diffusion-controlled)?

Duke Energy Response:

In an effort to evaluate an appropriate and conservative scenario, the contamination was assumed to be released directly into the environment and occupy a space equal to that of the defined contamination zone which is 6.51 meters long by 6.51 meters wide by 2 meters high. This volume accommodates the entire 22,800 gallons evaluated in the tank. Because of the relative elevations of the evaluated tank and groundwater, the liquid release is already within the groundwater zone, i.e. the saturated zone. Therefore, the contamination would travel in a roughly horizontal plane subject to the natural flow of the groundwater. The scenario evaluated in the RESRAD-OFFSITE model assumes the contamination is instantaneously released into the environment, but not injected into the environment via any hydraulic pressure except gravity. This is supported by the fact that there are no operable pumping mechanisms present to directly pump the contaminated liquid into the environment. In addition, the model does not take any credit for engineered containment systems or water-proof membranes that would drastically slow or stop the contaminated liquid from reaching the groundwater.

The above assumptions are more conservative than assuming the groundwater flows into the liquid effluent tank secondary containment, where it mixes and attains pressure equilibrium with the contaminated material, and is then transported into the environment. Even though the latter scenario might be more realistic, it would dilute and slow the travel time of the contamination to the potable water source, thus being less conservative. Consequently, the latter scenario was not selected as the evaluated model.

The approach used in the evaluation assumed the contaminated zone is a volume of soil with a density of 1.59 g/cm^3, rather than the more accurate density of 1.0 g/cm^3 for water. Thus, the total inventory of radioactive material released into the environment is artificially elevated, assuring conservative results.

No evaluation on the displacement of the existing groundwater was performed. As described above, the conceptual site model is based on a gradual infusion of the contaminated liquids into the saturated zone (i.e., the groundwater) rather than an injection, which would forcibly displace existing groundwater. Therefore, as the existing groundwater moves in its normal flow, the contaminated water gradually mixes in and is transported to the receptor body.

Associated Revision 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. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-017

NRC RAI:

Explain why the evaluation period was limited to 50 years and not to a period sufficient to capture major peak concentrations that may occur after 50 years.

Duke Energy Response:

In the latest revision of accident scenario calculation, the evaluation period was expanded to 1,000 years. This time period is sufficient to allow all radionuclides to either appear in the receptor body or be removed due to radioactive decay.

Text of revised FSAR Subsection paragraph 9 reflects this change.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 in Attachment 1 (Revised FSAR Subsection 2.4.13.4 paragraph 9) of Enclosure 2 of this letter.

Attachments:

None

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

RAI Letter No. 017

NRC Technical Review Branch: Hydrologic Engineering Branch (RHEB)

Reference NRC RAI Number(s): 02.04.13-018

NRC RAI:

Another consideration of the post-construction water table as described in RAI 2.4.12.-13 may indicate that a different groundwater flow path for radionuclide transport should be considered. Discuss the probability of such an alternative flow path, and whether it would be more conservative than the path considered in the FSAR. If such a path would be more conservative, discuss the changes that are required in RESRAD inputs, and the corresponding consequences for the analysis of accidental releases to groundwater.

Duke Energy Response:

Five distinct flow paths were considered as part of the revised accident scenario to identify the limiting case. The distances through the various aquifer materials in which groundwater movement occurs were estimated from cross-sections, allowing travel times for each alternative flow path to be determined.

Flow Paths

Pathway Number	Travel Path	Distance (meters)	Duration (years)
1	Unit 2 to Hold-up Pond A	383.44	7.2
2	Unit 2 to Broad River	589.79	2.8
3	Unit 2 to Make-up Pond A	594.66	23
4	Unit 1 to Non-jurisdictional Wetland area	338.63	53
5	Unit 1 to Make-up Pond B	496.52	9.8

Although the travel path from Unit 2 to the Broad River had the second greatest travel distance, it is the most conservative due to its significantly faster travel time. The short travel time is due to the hydraulic conductivity of the materials along this flow path.

In using the selected pathway, the model is bounding in that the most limiting case was evaluated and any pathway that may result due to construction activities would result in lower concentrations in the receptor water body.

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

Revisions to FSAR are provided in the response to FSAR RAI 02.04.13-004 in Attachment 1 (New Subsection 2.4.13.4 paragraph 1) of Enclosure 2 of this letter.

Attachments:

None