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December 11, 2008

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 Nos. 701, 702, 703, and 704)
Ltr # WLG2008.12-19

Reference: Letter from Ravindra Joshi (NRC) to Peter Hastings (Duke Energy), *Request for Additional Information Letter Nos. 013 Related to SRP Section 11.02 for the William States Lee III Units 1 and 2 Combined License Application*, dated September 16, 2008.

This letter provides the Duke Energy 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.

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

Bryan J. Dolan
Vice President
Nuclear Plant Development

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NRO

Enclosures:

1) Duke Energy Response to Request for Additional Information Letter 013, RAI 11.02-001
2) Duke Energy Response to Request for Additional Information Letter 013, RAI 11.02-002
3) Duke Energy Response to Request for Additional Information Letter 013, RAI 11.02-003
4) Duke Energy Response to Request for Additional Information Letter 013, RAI 11.02-004

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

Subscribed and sworn to me on December 11, 2008

Phoebe P. Elliott
Notary Public

My commission expires: June 26, 2011

SEAL

xc (w/o enclosures):

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

xc (w/enclosures):

Brian Hughes, Senior Project Manager, DNRL
Ravindra Joshi, Project Manager, DNRL

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

RAI Letter No. 013

NRC Technical Review Branch: Health Physics Branch (CHPB)

Reference NRC RAI Number(s): 11.02-001

NRC RAI:

FSAR Sections 11.2.3.5.2 and 11.2.5.2 (including WSL COL Item 11.2-2) reference draft NEI Template 07-11 as the basis of the cost-benefit analysis for justifying, in part, the design of the Liquid Waste Management System (LWMS). The NEI template proposed a bounding envelope of population doses associated with liquid effluent releases, which, if met, would demonstrate compliance with ALARA cost-benefit requirements of Section II.D of Appendix I to Part 50. However, NEI Template 07-11 was withdrawn from further consideration by NEI. Accordingly, please explain how the applicant intends to develop a plant and site-specific cost-benefit analysis demonstrating compliance with Section II.D of Appendix I to Part 50 with respect to the LWMS, and provide sufficient information for the staff to evaluate the bases and assumptions used in the analysis against the applicable NRC regulations and guidance.

Duke Energy Response:

A plant-specific cost-benefit analysis has been developed demonstrating compliance with Section II.D of Appendix I to Part 50 with respect to the LWMS. This cost-benefit analysis replaces use of NEI 07-11; thus, reference to NEI 07-11 will be removed from the FSAR. The total annual costs of the liquid radwaste system augments listed in Regulatory Guide 1.110 were developed using the methodology and parameters provided in the regulatory guide. Conservative values were chosen for parameters not specified in the regulatory guide. The following variable parameters were used:

- Capital Recovery Factor (CRF) – This factor is taken from Table A-6 of Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year is assumed in this analysis, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). A CRF of 0.0806 was obtained from Table A-6.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. It is assumed that the radwaste system for this analysis is a unitized system at a 2-unit site, which equals an ICF of 1.625.
- Labor Cost Correction Factor (LCCF) – This factor takes into account the differences in relative labor costs between geographical regions and is taken from Table A-4 of Regulatory Guide 1.110. A LCCF of 1.0 (the lowest value) is assumed in this analysis.

Appendix I to 10 CFR Part 50 prescribes a criterion of $1,000 per person-rem as the threshold to determine if the total body exposure-related costs per person-rem are cost beneficial.

The lowest-cost option for liquid radwaste treatment system augments is a 20 gpm Cartridge Filter at $11,140 per year, which yields a threshold value of 11.14 person-rem total body or thyroid dose from liquid effluents. For AP1000 sites with population dose estimates less than 11.14 person-rem total body or thyroid dose from liquid effluents, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR 50, Appendix I Section II.D.

The total body and thyroid population doses for liquid effluents given in revised Table 11.2-204 (See response to RAI 11.02-002) are a small fraction of the threshold dose of 11.14 person-rem. Thus, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR 50, Appendix I Section II.D.

The attached FSAR markups will be incorporated into a future revision of the FSAR.

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

FSAR Subsections 11.2.3.5.2, 11.2.3.5.3, 11.2.3.5.4, 11.2.5.2, and 11.2.6

FSAR Table 11.2-204 (See response to RAI 11.02-002, this letter)

Attachments:

1) Revision to Subsections 11.2.3.5.2, 11.2.3.5.3, 11.2.3.5.4, 11.2.5.2, and 11.2.6

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

Attachment 1 to RAI 11.02-001

Revision to FSAR Subsections 11.2.3.5.2, 11.2.3.5.3, 11.2.3.5.4, 11.2.5.2, and 11.2.6

COLA Part 2. FSAR, Chapter 11, Subsection 11.2.3.5.2, will be revised as follows:

The population dose is based on the fraction of the 50-mile population that will be exposed to the evaluated pathways. These pathways are drinking water, recreational activities, and sport fishing.

The sport fishing harvest is estimated to be 15,000 lb/yr using data from the State of South Carolina.

Recreational activities considered are swimming, boating, and hunting, fishing and wildlife water use. The annual usage for each of these activities is assumed to be 1.93E+7 person-hours.

The population doses are shown in Table 11.2-204.

~~This section adopts NEI 07-11 (Reference 201) which is currently under review by the NRC staff. The application of the methodology of NEI 07-11 satisfies the cost-benefit analysis requirements of 10 CFR Part 50, Appendix I, Section II.D. The augments provided in NEI 07-11 were reviewed and were found not to be cost beneficial due to the low BLN population doses.~~

COLA Part 2. FSAR, Chapter 11, will be revised to add new Subsection 11.2.3.5.3 as follows:

11.2.3.5.3 Liquid Radwaste Cost Benefit Analysis Methodology

STD COL 11.2-2 The application of the methodology of Regulatory Guide 1.110 was used to satisfy the cost benefit analysis requirements of 10 CFR Part 50, Appendix I, Section II.D. The parameters used in calculating the Total Annual Cost (TAC) are fixed and are given for each radwaste treatment system augment listed in Regulatory Guide 1.110, including the Annual Operating Cost (AOC) (Table A-2), Annual Maintenance Cost (AMC) (Table A-3), Direct Cost of Equipment and Materials (DCEM) (Table A-1), and Direct Labor Cost (DLC) (Table A-1).

The following variable parameters were used:

- Capital Recovery Factor (CRF) – This factor is taken from Table A-6 of Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year is assumed in this analysis, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). A CRF of 0.0806 was obtained from Table A-6.
- Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of Regulatory Guide 1.110. It is assumed that the radwaste system for this analysis is a unitized system at a 2-unit site, which equals an ICF of 1.625.
- Labor Cost Correction Factor (LCCF) – This factor takes into account the differences in relative labor costs between geographical regions and is taken from Table A-4 of Regulatory Guide 1.110. A LCCF of 1.0 (the lowest value) is assumed in this analysis.

Appendix I to 10 CFR Part 50 prescribes a $1,000 per person-rem criterion for determining the cost benefit of actions to reduce radiation exposure.

The analysis used a conservative assumption that the respective radwaste treatment system augment is a "perfect" system that reduces the effluent and dose by 100%. The liquid radwaste treatment system augments annual costs were determined and the lowest annual cost considered a threshold value. The lowest-cost option for liquid radwaste treatment system augments is a 20 gpm Cartridge Filter at $11,140 per year, which yields a threshold value of 11.14 person-rem total body or thyroid dose from liquid effluents.

For AP1000 sites with population dose estimates less than 11.14 person-rem total body or thyroid dose from liquid effluents, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR 50, Appendix I Section II.D.

COLA Part 2. FSAR, Chapter 11, will be revised to add new Subsection 11.2.3.5.4 as follows:

11.2.3.5.4 Liquid Radwaste Cost Benefit Analysis

WLS COL 11.2-2 The total body and thyroid population doses for liquid effluents given in Table 11.2-204 are a small fraction of the threshold dose of 11.14 person-rem. Thus, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR 50, Appendix I Section II.D.

COLA Part 2. FSAR, Chapter 11, Subsection 11.2.5.2, will be revised as follows:

STD COL 11.2-2 This COL Item is addressed in Subsection 11.2.3.5.3.

WLS COL 11.2-2 This COL Item is addressed in Subsections 11.2.3.3, 11.2.3.5, 11.2.3.5.1, ~~and~~ 11.2.3.5.2, and 11.2.3.5.4.

COLA Part 2. FSAR, Chapter 11, Subsection 11.2.6, will be revised to delete the subsection in its entirety.

~~11.2.6 REFERENCES~~

~~201. NEI 07-11, "Generic FSAR Template Guidance for Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," Rev. 0, September 2007~~

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

RAI Letter No. 013

NRC Technical Review Branch: Health Physics Branch (CHPB)

Reference NRC RAI Number(s): 11.02-002

NRC RAI:

Please explain how the application demonstrates that the site can meet the general environmental radiation standard in 40 CFR Part 190 (per 10 CFR 20.1301(e)), and provide sufficient information for the staff to evaluate the bases and assumptions used in the applicant's analysis. Please incorporate this analysis into the FSAR or justify its exclusion.

Duke Energy Response:

Plant and site-specific offsite dose analyses have been developed for normal release of both liquid and gaseous effluents that demonstrate compliance with applicable federal regulations, including 40 CFR Part 190. 40 CFR Part 190 requires that the annual dose equivalent to any member of the public does not exceed 25 mrem to the total body, 75 mrem to the thyroid, and 25 mrem to any other organ as the result of exposures to planned discharges of radioactive materials to the general environment or operation of uranium fuel cycle facilities. There are no other uranium fuel cycle facilities within 20 miles of the site which would contribute significantly to the dose received by the maximally exposed individual. Also, no other fuel cycle facility is located within 50 miles upstream or downstream on the Broad River. Thus, only the dose from effluent released from the site and direct radiation from the site need be considered.

Offsite doses resulting from normal releases through the liquid pathway were recently recalculated to incorporate more realistic population data and recreational population usage of the Broad River. Consistent with the guidance provided in Regulatory Guide 1.206 and Standard Review Plan 11.2, inputs and methodology are described in revised FSAR Subsections 11.2.3.3 and 11.2.3.5 and revised FSAR Tables 11.2-201 and 11.2-202 (Attachments 1 and 2). New results are presented in revised FSAR Tables 11.2-203 through 11.2-208 (Attachments 2 and 3). Maximum individual doses from revised FSAR Table 11.2-203 are multiplied by two (2) for comparison with 40 CFR Part 190 limits which are based on all units at the site. The maximum liquid pathway doses calculated for the site are: a whole body dose of 1.22E-01 mrem/yr, 1.06E-01 mrem/yr to the thyroid, and 1.55E-01 mrem/yr to the maximum organ as presented in new FSAR Table 11.2-205 (Attachment 3).

The liquid effluent doses per site presented in Table 11.2-205 were added to the gaseous effluent doses per site presented in Table 11.3-207 (attached to response to RAI 11.03-002 transmitted as enclosure 1 to Ltr# WLG2008.10-11 on 10-17-2008). Results are presented in new FSAR Table 11.2-206 (Attachment 3). Direct radiation from containment and other plant buildings is negligible based on information presented in the AP1000 DCD, Tier 2, Chapter 12, Subsection 12.4.2.1.

The maximum individual total doses determined for liquid and gaseous effluents for all units at the site are: whole body dose of 2.76 mrem/yr., thyroid dose of 27.9 mrem/yr., and maximum organ dose of 8.67 mrem/yr. These annual doses are below 40 CFR Part 190 limits.

The attached FSAR markups will be incorporated in a future FSAR revision.

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

FSAR Subsections 11.2.3.3 and 11.2.3.5.2

FSAR Tables 11.2-201, 11.2-202, 11.2-203 and 11.2-204

New FSAR Tables 11.2-205, 11.2-206, 11.2-207 and 11.2-208

Attachments:

1) Revision to FSAR Subsections 11.2.3.3 and 11.2.3.5.2.
2) Revision to FSAR Tables 11.2-201, 11.2-202, 11.2-203 and 11.2-204
3) New FSAR Tables 11.2-205, 11.2-206, 11.2-207 and 11.2-208

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

Attachment 1 to RAI 11.02-002

Revision to FSAR Subsections 11.2.3.3 and 11.2.3.5.2

COLA Part 2, FSAR. Chapter 11, Subsection 11.2.3.3, second paragraph, will be revised as follows:

~~The dilution factors used for the maximum exposed individual and the population dose are calculated by the LADTAP II code in accordance with Regulatory Guide 1.113.~~ A diffuser pipe upstream of the Ninety-~~nine~~ Nine Islands Dam is the discharge point for the plant liquid radiological effluent. The diffuser pipe mixes the effluent with the ~~Broad River~~Ninety-Nine Islands Reservoir, which acts as an impoundment, as described in Regulatory Guide 1.113. The annual average flowrates for the liquid radwaste effluent and the ~~the~~ Broad River at the Ninety-~~nine~~ Nine Islands Dam are used in the dose calculations. The dilution factors for points downstream of the dam are set at one. This conservatively assumes that no additional dilution occurs other than the dilution that takes place upstream of the dam.

COLA Part 2, FSAR. Chapter 11, Subsection 11.2.3.5.2, will be revised as follows:

The population dose is based on the fraction of the 50-mile population that will be exposed to the evaluated pathways. These pathways are drinking water, recreational activities, and sport fishing.

The sport fishing harvest given in Table 11.2-202 is estimated using observations of usage and South Carolina Department of Natural Resources harvest limits for the number and size applicable to the Broad River in the vicinity of the Lee Nuclear Station site.

Recreational activities considered are swimming, boating, and ~~hunting, fishing and wildlife water~~shoreline use. The annual usage for each of these activities, ~~is assumed to be 1.93E+7 person-hours.~~ which is given in Table 11.2-202, is based on consideration of the recreational value of the Broad River, the population in the vicinity of the Broad River downstream of Lee Nuclear Station, and the average shoreline exposure time per person for each age group taken from Table E-4 of Regulatory Guide 1.109. The population doses are shown in Table 11.2-204.

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

Attachment 2 to RAI 11.02-002

Revision to FSAR Tables 11.2-201, 11.2-202, 11.2-203 and 11.2-204

COLA Part 2, FSAR, Chapter 11, Table 11.2-201 will be revised as follows:

TABLE 11.2-201
IMPOUNDMENT MODEL PARAMETERS

Parameter	Average Annual Condition
Impoundment Model	Fully Mixed
Plant Discharge Rate (cfs)	13.4~~37~~
Impoundment Volume (cubic feet)	1,746,300
Impoundment Blowdown Rate (cfs)	2,538

COLA Part 2, FSAR. Chapter 11, Table 11.2-202 will be revised as follows:

TABLE 11.2-202
LADTAP II INPUT ~~FOR INDIVIDAUL DOSE RATES~~ PARAMETERS [a]

Input Parameter	Value
Freshwater Site	Selected
Discharge Flowrate (cfs)	13.~~374~~
50-mile Population	3,455,395 (Tables 2.1-203 and 2.1-204, Year 2036~~56~~) [b]
Source Term	DCD Table 11.2-7
Impoundment Model	Table 11.2-201
Shore Width Factor	0.2
Dilution Factors	1.0
Transit Time – Drinking Water (hr)	14.2
Transit Time – Fish and Recreational Uses (hr)	0
Sport Fish Annual Harvest (lb/yr)	15,000
Commercial Fish Annual Harvest (lb/yr)	0
~~Hunting, Fishing, Wildlife Water~~Shoreline Use (person-hrs/yr)	6,620,364~~19,293,442~~ [c]
Swimming Exposure (person-hrs/yr)	6,620,364~~19,293,442~~ [c]
Boating Exposure (person-hrs/yr)	6,620,364~~19,293,442~~ [c]
Drinking Water Intake	Union, SC
Distance	21 miles
Projected 2036 Population	24,725

a. Input parameters not specified use LADTAP II default values.

b. The population is conservatively projected to 2036; a date more than five years beyond the date of commercial operation of Unit 2.

c. Annual use is based on consideration of the recreational value of the Broad River, the population in the vicinity of the Broad River downstream of Lee Nuclear Station, and the average shoreline exposure time per person for each age group taken from Table E-4 of Regulatory Guide 1.109. Fifteen percent of the 50-mile 2036 population is assumed to access Broad River recreational area annually.

COLA Part 2, FSAR. Chapter 11, Table 11.2-203 will be revised as follows:

TABLE 11.2-203
ANNUAL DOSE TO A MAXIMALLY EXPOSED INDIVIDUAL FROM LIQUID EFFLUENTS~~INDIVIDUAL DOSE RATES~~[a]
(PER UNIT)

Dose (mrem/yr)

~~Age Group~~	~~Skin~~	~~Bone~~	~~Liver~~	~~Total Body~~	~~Thyroid~~	~~Kidney~~	~~Lung~~	~~GI-LLI~~
~~Adult~~	~~4.72E-05~~	~~3.20E-02~~	~~7.54E-02~~	~~6.08E-02~~	~~3.21E-02~~	~~3.88E-02~~	~~2.61E-02~~	~~2.86E-02~~
~~Teenager~~	~~2.64E-04~~	~~3.38E-02~~	~~7.12E-02~~	~~3.75E-02~~	~~2.49E-02~~	~~3.34E-02~~	~~2.15E-02~~	~~2.07E-02~~
~~Child~~	~~5.51E-05~~	~~4.28E-02~~	~~7.74E-02~~	~~3.59E-02~~	~~4.76E-02~~	~~4.33E-02~~	~~3.24E-02~~	~~3.12E-02~~
~~Infant~~	~~0.00E+00~~	~~2.11E-03~~	~~2.82E-02~~	~~2.61E-02~~	~~5.32E-02~~	~~2.69E-02~~	~~2.61E-02~~	~~2.80E-02~~

Adult

Pathway	Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Fish		3.13E-02	5.50E-02	4.06E-02	4.17E-03	1.88E-02	6.48E-03	4.38E-03
Drinking		7.00E-04	2.04E-02	2.02E-02	2.79E-02	2.00E-02	1.96E-02	2.42E-02
Shoreline	4.72E-05	4.03E-05	4.03E-05	4.03E-05	4.03E-05	4.03E-05	4.03E-05	4.03E-05
Total	4.72E-05	3.20E-02	7.55E-02	6.09E-02	3.21E-02	3.88E-02	2.61E-02	2.86E-02

Teenager

Pathway	Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Fish		3.29E-02	5.64E-02	2.32E-02	3.82E-03	1.90E-02	7.46E-03	3.30E-03
Drinking		6.75E-04	1.46E-02	1.41E-02	2.09E-02	1.42E-02	1.38E-02	1.72E-02
Shoreline	2.64E-04	2.25E-04	2.25E-04	2.25E-04	2.25E-04	2.25E-04	2.25E-04	2.25E-04
Total	2.64E-04	3.38E-02	7.13E-02	3.75E-02	2.50E-02	3.34E-02	2.15E-02	2.07E-02

Child

Pathway	Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Fish		4.08E-02	4.92E-02	9.19E-03	3.90E-03	1.60E-02	5.89E-03	1.45E-03
Drinking		1.94E-03	2.82E-02	2.67E-02	4.37E-02	2.73E-02	2.65E-02	2.97E-02
Shoreline	5.51E-05	4.71E-05	4.71E-05	4.71E-05	4.71E-05	4.71E-05	4.71E-05	4.71E-05
Total	5.51E-05	4.28E-02	7.75E-02	3.60E-02	4.77E-02	4.34E-02	3.25E-02	3.12E-02

Infant

Pathway	Skin	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
Fish		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Drinking		2.11E-03	2.82E-02	2.61E-02	5.32E-02	2.69E-02	2.61E-02	2.80E-02
Shoreline	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	0.00E+00	2.11E-03	2.82E-02	2.61E-02	5.32E-02	2.69E-02	2.61E-02	2.80E-02

COLA Part 2, FSAR. Chapter 11, Table 11.2-204 will be revised as follows:

TABLE 11.2-204
ANNUAL POPULATION DOSE FROM LIQUID EFFLUENTS
(PER UNIT)
Dose (person-rem per yr.)

	~~Annual Dose (person-rem)~~
~~Total Body~~	~~0.34~~
~~Thyroid~~	~~0.44~~

Pathway	Skin	Total Body	Thyroid	Kidney	Lung	GI-LLI	Liver	Bone
Fish	-	1.25E-02	9.58E-04	6.90E-03	2.45E-03	1.31E-03	2.05E-02	1.25E-02
Drinking	-	2.60E-01	3.69E-01	2.59E-01	2.54E-01	3.06E-01	2.66E-01	1.15E-02
Shoreline	2.60E-02	2.23E-02	2.23E-02	-	-	-	-	-
Swimming	-	5.39E-04	5.39E-04	-	-	-	-	-
Boating	-	2.69E-04	2.69E-04	-	-	-	-	-
Total	2.60E-02	2.96E-01	3.93E-01	2.66E-01	2.56E-01	3.07E-01	2.87E-01	2.40E-02

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

Attachment 3 to RAI 11.02-002

New FSAR Tables 11.2-205, 11.2-206, 11.2-207 and 11.2-208

COLA Part 2, FSAR. Chapter 11, new Table 11.2-205 will be added as follows:

TABLE 11.2-205
LIQUID PATHWAY DOSES COMPARED
TO 40 CFR PART 190 LIMITS

Dose (mrem/yr, per site)

Dose	40 CFR 190 Requirements	Assessment of Both Units
Whole Body Dose Equivalent	25	1.22E-01 [a]
Thyroid Dose	75	1.06E-01 [b]
Dose to Another Organ	25	1.55E-01 [c]

a. an adult receives the maximum individual whole body dose
b. an infant receives the maximum thyroid dose
c. a child receives the maximum individual organ dose which is to the liver

COLA Part 2, FSAR. Chapter 11, new Table 11.2-206 will be added as follows:

TABLE 11.2-206
LIQUID AND GASEOUS PATHWAY DOSES COMPARED
TO 40 CFR PART 190 LIMITS

Dose (mrem/yr, per site) [a]

Dose	40 CFR 190 Requirements	Assessment of Both Units
Whole Body Dose Equivalent	25	2.76E+00 [b]
Thyroid Dose	75	2.79E+01 [c]
Dose to Another Organ	25	8.67E+00 [d]

a. Direct radiation from containment and other plant buildings is negligible based on information presented in the AP1000 DCD, Tier 2, Chapter 12, Subsection 12.4.2.1.
b. This value was conservatively calculated by summing the maximum whole body dose due to the liquid pathway (to an adult) and the maximum whole body dose due to the gaseous pathway (to a child).
c. An infant receives the maximum thyroid dose.
d. A child receives the maximum individual organ dose which is to the bone.

COLA Part 2, FSAR. Chapter 11, new Table 11.2-207 will be added as follows:

TABLE 11.2-207
LIQUID PATHWAY COMPARISON OF MAXIMUM INDIVIDUAL DOSE TO 10 CFR PART 50, APPENDIX I CRITERIA

Dose (mrem/yr, per unit)

Dose	Appendix I Objective	Unit 1 or 2 Assessment
Total Body		
Shoreline		4.03E-05
Drinking		2.02E-02
Fish		4.06E-02
Total	3	6.09E-02 [a]
Maximum Organ		
Shoreline		4.71E-05
Drinking		2.82E-02
Fish		4.92E-02
Total	10	7.75E-02 [b]

a. An adult receives the maximum individual total body dose.
b. A child receives the maximum individual organ dose which is to the liver.

COLA Part 2, FSAR. Chapter 11, new Table 11.2-208 will be added as follows:

TABLE 11.2-208
LIQUID PATHWAY COMPARISON OF MAXIMUM INDIVIDUAL DOSE
TO 10 CFR PART 20.1301 CRITERIA

Dose (mrem/yr, per unit)

Dose	10 CFR 20.1301 Objective	Unit 1 or 2 Assessment
Total Body	-	6.09E-02 [a]
Thyroid Dose	-	5.32E-02 [b]
TEDE	100	6.25E-02 [c]
Maximum dose in any hour (mrem/hr)	2	7.13E-06

a. An adult receives the maximum individual total body dose.
b. An infant receives the maximum thyroid dose.
c. Per the guidance of Regulatory Guide 1.183, the total effective dose equivalent (TEDE) is approximated by the sum of the total body dose and 3% of the thyroid dose.

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

RAI Letter No. 013

NRC Technical Review Branch: Health Physics Branch (CHPB)

Reference NRC RAI Number(s): 11.02-003

NRC RAI:

Please provide detailed information to enable the staff to validate and verify the estimated doses in FSAR section 11.2.3.5 with respect to the dose objectives of Appendix I to 10 CFR Part 50 and the dose limits in 10 CFR 20.1301(e); please revise the FSAR to include this information, or justify its exclusion. The information should include the following:

- a complete description of how the applicant derived all the values listed in Tables 11.2-201 and 11.2-202, including all assumptions made citations to any reference material used (for documents not publicly available please provide a copy for staff's use)
- detailed breakdown of individual doses by pathway and organ
- detailed breakdown of population doses by pathway and organ

Duke Energy Response:

The requested basis material required to enable the staff to validate and verify the estimated doses in FSAR Subsection 11.2.3.5 is provided in the annotated Tables given in Attachment 1. These annotated tables provide additional information regarding how the values in FSAR Tables 11.2-201 and 11.2-202 were derived. The tables provide the input parameters, the values used in the analysis, and the basis for each value. A reference is provided for each value with supporting discussion about how the value was determined if it is not found directly from the reference.

Regulatory Guide 1.206, Revision 0, and Standard Review Plan 11.2, Revision 3, require the parameters used to determine estimated doses from the liquid effluent system to be provided in the FSAR, but neither require the FSAR to provide a detailed basis for each parameter. Therefore, the annotated Tables provided in Attachment 1 are not part of the FSAR.

Offsite doses resulting from normal releases through the liquid pathway were recently recalculated. Revised inputs, methodology and detailed breakdown of results as well as comparisons with the dose objectives of Appendix I to 10 CFR Part 50 and the dose limits in 10 CFR 20.1301(e) are provided in the response and attachments to RAI 11.02-002 (included in this letter).

Associated Revision to the Lee Nuclear Station Final Safety Analysis Report

None

Attachment:

1) Annotated FSAR Tables 11.2-201 and 11.2-202

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Attachment 1 to RAI 11.02-003

Annotated FSAR Tables 11.2-201 and 11.2-202
(Annotated tables are provided for information only.)

TABLE 11.2-201 (annotated)
IMPOUNDMENT MODEL PARAMETERS

Parameter	Average Annual Condition	Basis
Impoundment Model	Fully Mixed	Regulatory Guide 1.113, Rev. 1
Plant Discharge Rate (cfs)	13.4	Note 1
Impoundment Volume (cubic feet)	1,746,300	Note 2
Impoundment Blowdown Rate (cfs)	2,538	Note 3

Notes:

1. The plant discharge rate is calculated using the 1,925 gal/day effluent discharge rate and the cooling tower blowdown rate of 6,000 gpm provided in Subsection 11.2 of Revision 16 of the AP1000 DCD.
2. The assumed volume of the WLS impoundment is the volume immediately above the spillway and powerhouse of the Ninety-Nine Islands dam. The Lee Nuclear Station 65 ft effluent diffuser extends across this volume. [Dr. Abdul Khan, et. al., "Final Report - Hydrodynamic Assessment of Discharge from Cooling Tower Blowdown to Broad River, Lee Nuclear Station, Cherokee County, South Carolina", dated 13 September 2007]
3. Yearly average effluent releases from Ninety-Nine Islands Dam result in an average annual reconcentration in the impoundment that accounts for high and low flow conditions. The average discharge flow rate from Ninety-Nine Islands Reservoir is 2,538 ft^3/s [William States Lee Nuclear Station COLA, Part 3, Environmental Report, Chapter 2, "Environmental Description", Revision 0].

TABLE 11.2-202 (annotated)
LADTAP II INPUT PARAMETERS [(a)]

Input Parameter	Value	Basis
Freshwater Site	Selected	LADTAP II Job Control Option
Discharge Flowrate (cfs)	13.4	Table 11.2-201
50-mile Population	3,455,395	Tables 2.1-203 and 2.1-204, Year 2036
Source Term	DCD Table 11.2-7	Source term multiplier equals 1
Impoundment Model	Table 11.2-201	Regulatory Guide 1.113, Rev. 1
Shore Width Factor	0.2	LADTAP II shore width factor for a River.
Dilution Factors	1.0	Discharge from a completely mixed impoundment model
Transit Time – Drinking Water (hr)	14.2	Note 1
Transit Time – Fish and Recreational Uses (hr)	0	Conservative assumption
Sport Fish Annual Harvest (lb/yr)	15,000	Note 2
Commercial Fish Annual Harvest (lb/yr)	0	Note 3
Shoreline Use (person-hrs/yr)	6,620,364	Note 4
Swimming Exposure (person-hrs/yr)	6,620,364	Note 4
Boating Exposure (person-hrs/yr)	6,620,364	Note 4
Drinking Water Intake	Union, SC	Note 5
Distance	21 miles	
Projected 2036 Population	24,725	

Other input parameters not specified use LADTAP II default values.

Notes:

1. The nearest possible source of drinking water that was identified is associated with the City of Union, South Carolina. The linear distance from the Lee Nuclear Site to this location is approximately 21 mi [William States Lee Nuclear Station COLA, Part 3, Environmental Report, Chapter 2, "Environmental Description", Revision 0, Table 2.3-13]. Between the Ninety-Nine Islands dam and the Kings Creek confluence, the mean flow velocity is 0.95 ft/s, and below the Kings Creek confluence the mean flow velocity was determined to be 2.22 ft/s [Duke Lee Nuclear Station Combined License Application Project, DUK010-PR-023,"Bathymetry Study for the COL Application", Revision 0, Attachment 1, Transect 4]. The distance from the dam to the Kings Creek confluence is approximately 2,194 ft. These values are used to determine the transit time for the drinking water pathway for the maximally exposed individual as follows:

$$\text{Transit Time} = \left[\frac{2194\text{ ft}}{0.95\text{ ft/sec}} + \frac{(5280\text{ ft/mi})(21\text{mi}) - 2194\text{ ft}}{2.22\text{ ft/sec}}\right] \times \frac{1\text{ hour}}{3600\text{ sec}} = 14.2\text{ hours}$$

2. No actual creel census data was available for the Broad River; therefore, environmental scientists familiar with the area and the WLS application made conservative estimates based on observations. It was estimated that there were approximately 2,500 person-days per year of fishing on the Broad River within 50 miles of

the WLS site. Assuming each person collected a total of six fish at an average weight of one pound and that the entire fish was consumed, a total sport fish consumption value of 15,000 lb (6,818 kg) was determined.

3. There is no commercial fish harvest in this section of the Broad River [William States Lee Nuclear Station COLA, Part 3, Environmental Report, Chapter 2, "Environmental Description", Subsection 2.4.2.5.3, Revision 0]

4. There are many recreational waterways that are more accessible to the population within 50 miles of the Lee Nuclear Station than Ninety-Nine Islands Reservoir or the Broad River. The section of the river above Ninety-Nine Islands Reservoir is not an area of high recreational fishing interest due to turbidity, remoteness, and sand and gravel within the watershed. The Broad River below Ninety-Nine Islands Dam possesses a smallmouth bass fishery that is unique to Piedmont rivers in the state. Since the introduction of smallmouth in 1984, a small fishery has developed. [William States Lee Nuclear Station COLA, Part 3, Environmental Report, Chapter 2, "Environmental Description", Revision 0, Subsection 2.4.2.5.3] There are no state parks located on the Broad River within 50 mi. downstream of the site [South Carolina Department of Parks, Recreation & Tourism, http://www.southcarolinaparks.com]. Although approximately 30% of the population within 50 mi. of Lee Nuclear Station might have some access to the Broad River for recreational use, given its limited recreational value, 15% of the 50 mi. population is assumed to regularly visit.

   The total permanent population within fifty (50) miles of Lee Nuclear Station for 2036 is 3,455,395 [FSAR Tables 2.1-203 and 2.1-204]. Fifteen percent of this value is 518,309. Per Table E-4 of Regulatory Guide 1.109, the shoreline recreation exposure times for children, teenagers, and adults are 9.5 hrs/yr, 47 hrs/yr, and 8.3 hrs/yr, respectively. Multiplying these values by the fraction of the population represented by each age group (71% adults, 11% teens, and 18% children) and summing the values, yields an average total shoreline exposure time of 12.8 hrs/person/yr. The percentage of infants is conservatively included in that of children. The population shoreline usage time calculated for this location is 6,620,364 person-hr/yr. The same exposure times are also assumed for swimming and boating.

5. A review of water rights granted by the South Carolina Department of Health and Environmental Control showed that municipal water is not obtained from surface water in close proximity to Lee Nuclear Station. There are two permitted surface water intakes for public water supply downstream of Lee Nuclear Station. The closest is the city of Union, South Carolina which withdraws water from the Broad River 21 mi. downstream. The second is the Carlisle Cone Mills which is approximately 30 mi. downstream. The location of the closest diversion is conservatively assumed.

   The population using drinking water from the Broad River within 50 mi of Lee Nuclear Station is conservatively calculated based on the average annual intake for Union County and the average water usage of a person living in the state of South Carolina. The per capita water usage for the state of South Carolina is 179 gallons/day/person.

   Environmental Report Table 2.3-10 provides the public supplies water usage for Union County, SC in 2000 as 4.25 Mgd. This means that the number of people supplied in 2000, from public-supply is estimated at:

$$\frac{4.25\text{x}10^6 \text{ gallons / day}}{179 \text{ gallons / day / person}} = 23{,}728 \text{ persons}$$

   To determine the 2036 drinking water population growth, a ratio of the 2036 and 2000 populations (1.042) in the South & South-Southwest sectors between 10-40 km & 40-60 km where Union County is located is used [FSAR Figure 2.1-205]. Using this ratio, the total projected population considered for drinking water is determined to be 24,725 people.

$$(23{,}728 \text{ persons})(1.042) = 24{,}725 \text{ persons}$$

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RAI Letter No. 013

NRC Technical Review Branch: Health Physics Branch (CHPB)

Reference NRC RAI Number(s): RAI 11.02-004

NRC RAI:

Section 11.2.3.5 does not address the irrigation pathway. This overlooks the fact that individual users of public water that is withdrawn from downstream locations may use the water to irrigate their gardens. With respect to FSAR section 11.2.3.5, please explain whether the individual dose estimates should include this pathway and, if so, please include irrigation doses and provide calculations of sufficient detail for the staff to validate and verify the results.

Duke Energy Response:

Calculation of the doses to man from routine release of liquid reactor effluents from the proposed Lee Nuclear Station Units 1 and 2 was done in accordance with Regulatory Guide 1.109 (Ref. 4). Regulatory Guide 1.109 characterizes the maximum individual as "maximum" with regard to food consumption, occupancy, and other usage of the region in the vicinity of the plant site, and as such represent individuals with habits representing reasonable deviations from the average for the population in general. In addition, Regulatory Guide 1.109 identifies exposure pathways for estimating radiation exposure for maximum individuals and the population within 50 miles. Other exposure pathways that may arise due to unique conditions at a specific site should be considered if they are likely to provide a significant contribution to the total dose. A pathway is considered significant if a conservative evaluation yields an additional dose increment equal to or more than 10 percent of the total from all pathways considered in Regulatory Guide 1.109. Similar discussion is found in NUREG 1555, Section 5.4.1 (Ref. 2).

Consumption of most of an individual's annual intake of vegetables from a vegetable garden irrigated with public water was not regarded as either a pathway that fell within a reasonable deviation from the average for the population, or a pathway unique to the Lee Nuclear Station site that was likely to contribute a dose increment equal to or greater than 10 percent of the total from all pathways considered in Regulatory Guide 1.109. Therefore, individual use of public water for garden irrigation was not considered in the determination of doses to man from routine release of liquid reactor effluents from the proposed Lee Nuclear Station Units 1 and 2. The basis for this conclusion and further justification are provided below.

The computer code LADTAP II (Ref. 3) was used in the determination of liquid effluent doses. LADTAP II implements the guidance of Regulatory Guide 1.109. The primary exposure pathways for the maximum individual considered in LADTAP II are consumption of aquatic food, ingestion of drinking water and shoreline recreational use. Where commercial irrigation using water obtained downstream of the plant effluent discharge is identified, LADTAP II also determines conservative individual doses associated with input parameters for irrigation rates and commercial production rates for milk, meat and vegetables. When vegetables are commercially grown in the vicinity of the site using potentially contaminated water, it is

reasonable to conclude that a maximally exposed individual could consume a significant portion of his annual intake of vegetables from these local sources. LADTAP II default parameters for individual consumption of vegetables (520 kg/yr for adult vegetable consumption and 64 kg/yr for adult leafy vegetable consumption) and time delay between harvest and ingestion (14 days for vegetables and 1 day for leafy vegetables) indicate ready availability. However, as identified in Section 11.2.3.5 of the Final Safety Analysis Report, no irrigation of crops was identified downstream of the Lee Nuclear Station Units. Therefore, it is not considered a reasonable deviation from average habits of the general population to assume that a maximally exposed individual could consume a significant portion of his annual intake of vegetables from local sources grown using potentially contaminated irrigation. An individual with a garden irrigated with contaminated public water would not produce the variety of vegetables associated with LADTAP II default individual consumption rates. In addition, preservation of vegetables from an individual garden would result in holdup times between harvest and consumption greater than LADTAP II default individual holdup times.

To provide further justification for exclusion of the irrigated vegetable pathway, the dose to an individual using public drinking water to irrigate a vegetable garden was conservatively estimated using LADTAP II and the input parameters described in the response to RAI 11.02-002 (included in this letter). Population dose was not considered since crop irrigation was not found to occur in the vicinity of Lee Nuclear Station.

The dose to the maximally exposed individual from this pathway was calculated assuming the use of public drinking water originating from the closest drinking water diversion location downstream of the Lee Nuclear Station plant discharge, Union, SC. The transit time calculated for the drinking water diversion location is 26.2 hours. This value includes the time required for the river water to travel from the plant discharge to the closest public drinking water diversion plus 12 hours for transport through the water purification and distribution system. These values are consistent with the recommendations of Regulatory Guide 1.109 for evaluation of the maximally exposed individual. The dilution factor for the closest drinking water diversion location downstream of Lee Nuclear Station is 1 because the plant discharge is assumed to be completely mixed in the impoundment above the Ninety-Nine Islands dam. Refer to the response to RAI 11.02-002 for the impoundment model parameters used in this analysis.

A wide variety of vegetables are grown in the Southeast. Recommended water requirements for these vegetables when grown on a large scale are given in North Carolina Cooperative Extension System, "Vegetable Crop Irrigation" (Ref. 1). Depending on the vegetable type, water requirements range from one inch in five days to one inch in 21 days. A rate of one inch in 12 days (64 L/m^2/month) represents a conservative, average water requirement for a wide range of vegetables grown in an individual garden. This value is also conservative given that the water requirements are recommended for commercial growers presumably using more economical, untreated water supplies.

Historical rainfall rates in the vicinity of Lee Nuclear Station were investigated to determine irrigation needs not typically met by normal rainfall. The minimum normal rainfall occurring for any one month in Greer, SC based on 30 years of data is 3.54 in/month (89.9 L/m^2/month) (Ref. 5). This historical, minimum normal rainfall rate would meet the average water requirement for an individual garden given above. Although rainfall is not uniform and irrigation may be required in during drought conditions, it is reasonable to conclude that irrigation would not normally be required in the region. This conclusion is supported by the fact that irrigation was

not found to occur in the area surrounding the Lee Nuclear Station site. However, an irrigation rate of one inch per month (25.4 L/m^2/month) was input to LADTAP II for consideration of this exposure pathway.

A vegetable production value of 1 kg/yr was selected so that LADTAP II would calculate the individual doses due to the irrigated vegetable pathway. Values of 60 days and 2.0 kg/m^2 were used for the growing period and crop yields, respectively, in accordance with the guidance of Table E-15 of Regulatory Guide 1.109.

Using the inputs described above, LADTAP II calculates a combined vegetable and leafy vegetable dose to the maximally exposed individual of 1.67×10^{-2} mrem/yr to the total body of an adult. When summed with the total body doses due to the fish consumption, shoreline exposure, and drinking water pathways, an adult total body dose of 7.76×10^{-2} mrem/yr is calculated. The adult age group results in the maximum total body dose due to liquid effluent releases. When the irrigated vegetable pathway exposure is summed with the total body doses of all exposure pathways considered in Regulatory Guide 1.109, an adult total body dose of 8.66×10^{-1} mrem/yr is calculated. The total body dose due to the vegetable irrigation/consumption pathway contributes less than 2% of the total body dose due to all pathways considered in Regulatory Guide 1.109.

Since the conservatively calculated dose associated with the irrigated, individual garden pathway does not have the potential for contributing 10% or more to individual or population doses, this pathway is not considered significant. Therefore, the doses to the maximally exposed individual associated with consuming vegetables watered by public drinking water are not included in the dose analysis.

References

1. D.C. Sanders, North Carolina Cooperative Extension System, North Carolina State University, "Vegetable Crop Irrigation", August 1997
2. NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", October 1999
3. LADTAP II - Technical Reference and User Guide, NUREG/CR-4013, PNL-5270, April 1986
4. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Does to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Rev. 1, October 1977
5. U. S Department of Commerce, National Oceanic & Atmospheric Administration, 2007 Local Climatological Data Annual Summary with Comparative Data, Greer, South Carolina (KGSP), ISSN 0198-4667

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

None

Attachments:

None