Progress Energy

Serial: NPD-NRC-2008-065
November 24, 2008

10CFR52.79

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 2 AND 3
DOCKET NOS. 52-022 AND 52-023
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 026 RELATED TO LIQUID RADWASTE MANAGEMENT SYSTEM

Reference: Letter from Ravindra G. Joshi (NRC) to James Scarola (PEC), dated October 6, 2008, "Request for Additional Information Letter No. 026 Related to SRP Section 11.02 for the Harris Units 2 and 3 Combined License Application"

Ladies and Gentlemen:

Progress Energy Carolinas, Inc. (PEC) hereby submits our response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A response to each NRC request is addressed in the enclosure. The enclosure also identifies changes that will be made in a future revision of the Shearon Harris Nuclear Power Plant Units 2 and 3 application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (919) 546-6107.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 24, 2008.

Sincerely,

Garry D. Miller
General Manager
Nuclear Plant Development

Enclosure

cc : U.S. NRC Director, Office of New Reactors/NRLPO
U.S. NRC Office of Nuclear Reactor Regulation/NRLPO
U.S. NRC Region II, Regional Administrator
U.S. NRC Resident Inspector, SHNPP Unit 1
Mr. Manny Comar, U.S. NRC Project Manager

Progress Energy Carolinas, Inc.
P.O. Box 1551
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NRO

Shearon Harris Nuclear Power Plant Units 2 and 3
Response to NRC Request for Additional Information Letter No. 026 Related to SRP Section 11.02 for the Combined License Application, dated October 6, 2008

NRC RAI #	Progress Energy RAI #	Progress Energy Response
11.02-1	H-0131	Response enclosed – see following pages
11.02-2	H-0132	Response enclosed – see following pages
11.02-3	H-0169	Response enclosed – see following pages
11.02-4	H-0133	Response enclosed – see following pages
11.02-5	H-0134	Response enclosed – see following pages
11.02-6	H-0135	Response enclosed – see following pages
11.02-7	H-0136	Response enclosed – see following pages

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-1

Text of NRC RAI:

FSAR Sections 11.2.3.5.2 and 11.2.5.2 (including HAR 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.

PGN RAI ID #: H-0131

PGN Response to NRC RAI:

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, Revision 0 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). Using this after-tax rate of return on capital is considered conservative for new plants at HAR. While the North and South Carolina utility regulators have not yet approved a rate of return on capital for this project, Progress expects the approved rate will be comparable, if not higher. 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) for Region III will be assumed in the 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. This criterion is utilized within Regulatory Guide 1.110. While NRC guidance considers $2,000 per person-rem the criterion applicable in other situations, the criterion of $1,000 per person-rem is specifically applicable to cost-benefit evaluations of effluent treatment augments. The $1,000 per person-rem criterion is the long-standing NRC guidance for these evaluations, preserved through revisions of the NRC regulations governing new reactor designs, including a revision as recent as 2007. Therefore, a criterion of $1,000 per person-rem is considered appropriate for this analysis.

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.

The population doses are given in new FSAR Table 11.2-208 (see response to NRC-RAI 11.2-3) which shows population exposures of 6.65 person-rem total body and 1.89 person-rem thyroid. As discussed above, the lowest cost liquid radwaste system augment is $11,400. Assuming 100% efficiency of this augment, the minimum possible cost per person rem is determined by dividing the cost of the augment by the population dose. This is $1,675 per person-rem total body ($11,400/6.65 person-rem) and $5,894 per person-rem thyroid ($11,140/1.89 person-rem). These costs per person-rem reductions exceed the $1,000 per person-rem criterion prescribed in Appendix I to 10 CFR 50 and are therefore not beneficial.

Associated HAR COL Application Revisions:

1. Add new FSAR Chapter 11 Subsection 11.2.3.5.3 to read:

11.2.3.5.3	Liquid Radwaste Cost Benefit Analysis Methodology
STD COL 11.2-2	The guidance for performing cost-benefit analysis for the liquid radwaste system is provided in Regulatory Guide 1.110. 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.

2. Add new FSAR Chapter 11 Subsection 11.2.3.5.4 to read:

11.2.3.5.4	Liquid Radwaste Cost Benefit Analysis
HAR COL 11.2-2 HAR COL 11.5-3	As shown in FSAR Section 11.2.3.5.2 and Table 11.2-208, the HAR liquid population doses are 6.65 person-rem total body and 1.89 person-rem thyroid which does not exceed the 11.14 person-rem threshold value.

3. Delete FSAR Subsection 11.2.6 in its entirety:

~~11.2.6 REFERENCES~~

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

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-2

Text of 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.

PGN RAI ID #: H-0132

PGN Response to NRC RAI:

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 whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public 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 in the vicinity of the site, other than the on-site operation of Unit 1, which would contribute to the dose received by the maximally exposed individual. Thus, only the radiation dose from effluents released and direct radiation emanating from the Harris site need be considered.

Offsite doses resulting from normal releases through the liquid pathway were calculated as described in FSAR Sections 11.2.3.3 and 11.2.3.5 and are presented in FSAR Table 11.2-203. This table has been revised as part of the update in response to NRC RAI No. 11.02-3. Offsite doses resulting from the normal releases through the gaseous pathway were calculated as described in FSAR Sections 11.3.3.4 and are presented in FSAR Table 11.3-206. The total effective dose equivalent (TEDE) for the whole body due to both liquid and gaseous releases was determined using the adult dose values given in the tables and the applicable organ dose weighting factor. The calculated liquid effluent doses per unit were added to the gaseous effluent doses per unit and the resulting maximum doses to whole body, thyroid, and organ multiplied by two (2) to account for the operation of the Harris Units 2 & 3 at the site.

In addition to the exposures from Unit 2 & 3, the liquid and gaseous doses due to the operation of Unit 1 contribute to the total public dose. Unit 1 doses, based on actual plant effluent radioactive releases during the 1999 – 2006 period, are: 0.53 mrem/yr (whole body), 0.54 mrem/yr (thyroid) and 0.54 mrem/yr (maximum organ). Direct radiation exposure from containment and other plant buildings is negligible based on information presented in the AP1000 DCD, Tier 2, Chapter 12 Section 12.4.2.1

The sum of these annual doses discussed above are below the 40 CFR Part 190 limits for whole body dose equivalent, thyroid, and maximum organ and are presented in a new FSAR Table 11.2-206.

Associated HAR COL Application Revisions:

1. Revise FSAR Section 11.2.3.5.1 to add the following paragraphs after the last sentence.

   In order to demonstrate compliance with the requirements of 40 CFR 190 (per 10 CFR 20.1301(e)), the liquid and gaseous effluent doses presented in Tables11.2-203 and 11.3-206 were adjusted to reflect the whole body dose equivalent. The total effective dose equivalent (TEDE)

for the whole body was determined using the adult dose values given in the tables and the applicable organ dose weighting factor. The calculated liquid effluent doses per unit and the calculated gaseous effluent doses per unit were multiplied by a factor of two (2) to determine the total dose contribution from operation of Harris Units 2 & 3 at the site.

In addition to the exposures from Unit 2 & 3, the liquid and gaseous doses due to the operation of Unit 1 contribute to the total public dose. Unit 1 doses are based on an average of actual plant effluent releases during the period 1999 to 2006. Direct radiation exposure from containment and other plant buildings is negligible based on information documented in AP1000 DCD, Tier 2, Chapter 12, Section 12.4.2.1.

The sum of the annual doses due to the releases of liquid and gaseous radioactive materials from all units at the Harris site are presented in Table 11.2-206 and are below the 40 CFR Part 190 limits for whole body dose equivalent, thyroid, and maximum organ.

2. Revise FSAR Section 11.2 to add new FSAR Table 11.2-206 "Comparison of Maximum Exposed Individual Doses from the HAR Site with the 40 CFR Part 190 Criteria" with the table shown below.

Table 11.2-206
Comparison of Maximum Exposed Individual Doses from the HAR Site with the 40 CFR Part 190 Criteria (mrem/yr)

Type of Dose	Dose Limit (40 CFR 190)	Unit 1 Total Liquid and Gaseous Dose[a]	Unit 2 & 3 Calculated Liquid Dose (Total for two units)	Unit 2 & 3 Calculated Gaseous Dose (Total for two units)	Total Dose (All Pathways)
Whole Body Dose Equivalent[b]	25	0.53	5.08[b]	1.68[b]	7.3
Dose to Thyroid	75	0.54	0.11	3.30	4.0
Dose to Any Other Organ	25	0.54	6.14	3.72	10.4

Notes:

(a) HNP operating data

(b) Whole body dose equivalent assumed equal to TEDE

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-3

Text of NRC RAI:

Please provide detailed information to enable the NRC staff to validate and verify the estimated doses in the applicant's FSAR, Section 11.2.3.5, "Estimated Doses," 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 the NRC staff's use);
- a detailed breakdown of individual doses by pathway and organ; and
- a detailed breakdown of population doses by pathway and organ.

PGN RAI ID #: H-0169

PGN Response to NRC RAI:

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.

The requested basis information is provided in the attached annotated FSAR Tables 11.2-201 and 11.2-202 (see pages 15 through 17). These annotated tables provide additional information on how the values in revised FSAR Tables 11.2-201 and 11.2-202 were derived. These annotated tables are not part of the FSAR and are not included in the revisions to the COLA. These tables provide a reference for each value with supporting discussion about how the value was determined if it is not found directly from the reference.

FSAR Table 11.2-201 has been revised to reflect the use of updated information in terms of down stream water use, determination of the dilution factors used, and the consolidated use of projected (2020) populations in the dose analyses. FSAR Table 11.2-202 has been revised to include new line items reflecting the LADTAP input for recreational activities and liquid path usage and consumption data that has been added via new FSAR Table11.2-207.

In the response to NRC RAI Number 11.02-2, FSAR Table 11.2-206 is being added to list the individual dose to a member of the public due to the release of both liquid and gaseous effluent relative to the limits contained in 40 CFR 190 as required by 10 CFR 20.1301(e).

FSAR Table 11.2-203 has been revised to show a detailed breakdown of the calculated individual doses by pathway and organs.

A detailed breakdown of the calculated population doses by pathway and organs is provided in new FSAR Table 11.2-208. In addition to the drinking water pathway, this table provides the 50 mile annual

population dose in person rem/yr by pathways and organs. This population dose determination includes consideration of site workers (refer to response to NRC RAI Number 11.02-6). The revised population doses are based upon 2020 projected population figures, updated estimates of recreational exposures (shoreline usage, swimming and boating activities), and updated sport fish consumption data.

Associated HAR COL Application Revisions:

1. Revise the last paragraph of FSAR Section 11.2.3.5, Estimated Doses, from:

   The nearest drinking water takeoff downstream of the Harris site is approximately seventeen miles downstream at the town of Lillington.

   To read:

   Table 11.2-201 contains dilution factors and related site and population data used in dose rate calculations. Table 11.2-202 contains LADTAP II input data used for individual and population dose rate calculations

2. Revise FSAR Section 11.2.3.5.1, Estimated Individual Dose Rates, from:

   Dose rates to individuals are calculated for drinking water, fish consumption, and recreational activities.

   Drinking water produced a maximum dose rate to a single organ of 1.41E-1 mrem/yr to a child's liver. The maximum total body dose rate was calculated to be 1.35E-1 mrem/yr to a child. Fish consumption assumes that fish are caught at the plant discharge. LADTAP II default fish consumption values are used in lieu of site-specific fish consumption data. The estimated maximum dose rate to a single organ is 3.04 mrem/yr to a teenager's liver. The maximum total body dose rate is calculated to be 1.98 mrem/yr to an adult.

   Shoreline recreation results in a maximum dose rate to a single organ of 2.44E-2 mrem/yr to a teenager's skin. The maximum total body dose rate is calculated to be 2.1E-2 mrem/yr to a teenager.

   The maximum dose rate to any organ considering all pathways was calculated to be 3.14 mrem/yr to a teenager's liver. The maximum total body dose rate is calculated to be 2.09 mrem/yr to an adult.

   Table 11.2-202 contains LADTAP II input data for dose rate calculations. Table 11.2-203 contains total organ dose rates based on age group.

   To read:

   Dose rates to individuals are calculated for drinking water, fish consumption, and recreational activities. Table 11.2-203 gives the individual dose rates by age group, pathway and organ. Table 11.2-207 lists the liquid pathways consumption factors that were used in determining the dose to the maximum exposed individual.

3. Revise FSAR Section 11.2.3.5.2, Estimated Population Dose, from:

   The pathway for the population dose to the 81 km (50 mile) residents is for the several downstream municipal water intakes at Lillington, Erwin, and Fayetteville (Subsection 2.4.1.2.7). The municipal populations are listed in Table 11.2-201.

   The estimated population dose within 81 km (50 miles) is calculated as 6.8 person-rem whole body and 6.6 person-rem thyroid.

To read:

The population dose is based on the fraction of the 81 km (50 mile) resident population that may be exposed to the evaluated pathways. These pathways are drinking water and recreational activities. The drinking water pathways include the residents in the towns of Lillington, Dunn and Fayetteville who receive their drinking water supply from the Cape Fear River downstream of Harris Lake and an estimated 1000 site workers who may receive their drinking water supply directly from the Harris Lake. Harris Lake offers recreational activities to area residents which include sport fishing, swimming, boating, and shoreline use. Estimated recreational usage data is given in Table 11.2-202.

The population doses from liquid effluents by pathway and organ are given in Table 11.2-208.

4. FSAR Tables 11.2-201, 11.2-202 and 11.2-203 will be replaced with the revised tables shown on the following pages (see pages 9 through 12).

5. New FSAR Tables 11.2-207 "Liquid Pathway Consumption Factors" and 11.2-208 "Population Doses from Liquid Effluents" are added as shown on the following pages (see pages 13 & 14).

Attachments/Enclosures:

None.

HAR COL 11.2-2

Table 11.2-201

Dilution Factors and Population Data

Parameter	Average Annual Condition
Discharge Flow From Harris Lake to Cape Fear River (cfs)	20
Annual Average Flow in Cape Fear River at Lillington (cfs)	3363
Distance to Nearest Drinking Water Extraction (mi.)	17(Lillington)
Dilution Factor for Drinking Water	168 (Lillington)[a] 1 (Site Workers)[b]
Dilution Factor for Recreational Activities	1
Dilution Factor for Fish	1
Lillington Population[c]	4,328
Dunn Population[c]	13,654
Fayetteville Population[c]	133,084
50-Mile Residential Population[c]	3,003,458 (Table 2.1.3-203 and Table 2.1.3-204)

a) Dilution Factor for Lillington conservatively used for Dunn and Fayetteville even though both are further downstream with more dilution and longer transit times.

b) Site worker population conservatively estimated at 1,000 for Units 2 and 3.

c) Population data projected to year 2020.

HAR COL 11.2-2

Table 11.2-202

LADTAP II Input

Input Parameter	Value
Freshwater Site	Selected
Discharge Flow Rate from two AP1000 units to Harris Lake (gpm)	12,000
Source Term	DCD Table 11.2-7
Reconcentration Model	Partial Mixing
Harris Lake Storage Capacity (acre-ft)	177,563
Shore Width Factor	0.3
Dilution Factors	Table 11.2-201
Transit Time – Drinking (hr)	1.0
Transit time – Fish and Recreational Uses (hr)	0
Liquid Pathway Consumption Factors	Table 11.2-207
Recreational Exposure for Shoreline, Swimming, and Boating (person-hrs/yr)	1,379,591
Sport Fish Catch at Harris Reservoir (kg/yr)	53,710

HAR COL 11.2-2

Table 11.2-203

Individual Dose Rates (mrem/year)

Adult

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	1.98E+00	9.35E-02	2.04E+00	2.94 E+00	1.02 E+00	3.55E-02	3.62E-01	-
Drinking Water	837E-03	8.22E-03	2.27E-04	8.47E-03	8.27E-03	8.17E-03	8.20E-03	-
Shoreline	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	4.38E-03
Swimming	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	9.09E-06	-
Boating	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	3.79E-05	-
Total	2.00E+00	1.06E-01	2.04E+00	2.95E-00	1.03E+00	4.75E-02	3.74E-01	4.38E-03

Teenager

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	1.11E+00	7.15E-02	2.18E+00	3.04E+00	1.05E+00	2.73E-02	4.23E-01	-
Drinking Water	5.86E-03	5.79E-03	2.20E-04	6.04E-03	5.85E-03	5.76E-03	5.79E-03	-
Shoreline	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	2.10E-02	-
Swimming	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	5.07E-05	2.44E-02
Boating	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	2.54E-05	-
Total	1.14E+00	9.83E-02	2.20E+00	3.07E+00	1.07E+00	5.41E-02	4.50E-01	2.44E-02

Table 11.2-203

Individual Dose Rates (mrem/year)

Child

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	4.38E-01	4.01E-02	2.73E+00	2.74E+00	9.03E-01	2.26E-02	3.39E-01	-
Drinking Water	1.11E-02	1.11E02	6.36E-04	1.17E-02	1.13E-02	1.11E-02	1.11E-02	-
Shoreline	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	4.38E-03	5.11E-03
Swimming	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	-
Boating	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	5.30E-06	-
Total	4.54E-01	5.56E-01	2.74E+00	2.75E+00	9.19E-01	3.81E-02	3.55E-01	5.11E-03

Infant

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Drinking Water	1.09E-02	1.09E-02	6.47E-04	1.16E-02	1.11E-02	1.09E-02	1.09E-02	-
Shoreline	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-
Total	1.09E-02	1.09E-02	6.47E-04	1.16E-02	1.11E-02	1.09E-02	1.09E-02	-

Table 11.2-207

Liquid Pathways Consumption Factors for the Maximum Exposed Individual

Pathway	Adult	Teen	Children	Infant
Drinking Water[a] (L/yr)	730	510	510	330
Fish consumption[a] (kg/yr)	21	16	6.9	N/A
Shoreline usage[a] (hr/yr)	12	67	14	N/A
Swimming exposure (hr/yr) (assumed same as shoreline)	12	67	14	N/A
Boating (hr/yr)	100 (assumed)	67	14	N/A

Notes:
a) LADTAP default values

FSAR Table 11.2-208

Population Doses from Liquid Effluents

(person rem /yr)

Pathway	Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Fish Consumption	4.82E+00	2.44E-01	6.50E+00	8.70E+00	2.99E+00	9.66E-02	1.09E+00	-
Drinking Water [(a)]	1.39E+00	1.37E+00	2.56E-02	1.42E+00	1.38E+00	1.36E+00	1.37E+00	-
Hydrosphere Tritium	7.70E-03	7.70E-03	-	7.70E-03	7.70E-03	7.70E-03	7.70E-03	
Shoreline	4.31E-01	-	-	-	-	4.31E-01		5.03E-01
Swimming	1.04E-03		-	-	-	1.04E-03		
Boating	5.22E-04	-	-	-	-	5.22E-04		
Total	6.65E+00	1.62E+00	6.53E+00	1.01E+01	4.37E+00	1.89E+00	2.46E+00	5.03E-01

Note: (a) Drinking water pathway doses reflect 1000 site workers as well as downstream residents in the towns of Lillington, Dunn, and Fayetteville.

Annotated FSAR Table 11.2-201
Dilution Factors and Population Data

Parameter	Average Annual Condition	Basis
Discharge Flow From Harris Lake to Cape Fear River (cfs)	20	Note 1
Annual Average Flow in Cape Fear River at Lillington (cfs)	3363	Note 2
Distance to Nearest Drinking Water Extraction (mi.)	17 (Lillington)	SHNPP ODCM, Rev. 19, Note 3
Dilution Factor for Drinking Water	168 (Lillington)[a]	Note 4
	1 (Site Workers)	Conservative assumption
Dilution Factor for Recreational Activities	1	Conservative assumption
Dilution Factor for Fish	1	Conservative assumption
Lillington Population[b]	4328	Note 5
Dunn Population[b]	13,654	Note 5
Fayetteville Population[b]	133,084	Note 5
50-Mile Residential Population[b]	3,003,458	Table 2.1.3-203
		Table 2.1.3-204

a) Dilution Factor for Lillington conservatively used for Dunn and Fayetteville even though both are further downstream with more dilution and longer transit times.

b) Population data projected to year 2020.

Annotated Table Notes

1. Minimum average annual overflow value for the Harris Lake that will be maintained by Progress Energy.
2. Annual mean discharge in Cape Fear River at Lillington, NC (1982-2005). The flow is regulated in the river since September 1981. (USGS North Carolina Water Resource Data Report water year 2005).
3. Distance as given in SHNPP ODCM, Rev. 19, page 4-6, for Sample Point 40, Water Treatment Plant Intake Building in Lillington, NC.
4. The dilution factor associated with the drinking water pathway is based on the minimum average annual discharge flow from the Harris Reservoir of 20 cfs and the average annual flow in the Cape Fear River at the nearest downstream withdrawal location at Lillington of 3363 cfs (1/20/3363) or 168. The dilution factor specified for site workers drinking water supply and for aquatic foods (fish) is conservatively set equal to 1. No dilution is assumed for shoreline or recreation activities consistent with the value selected for aquatic foods.
5. Municipalities down stream of the Harris Reservoir discharge having surface water intakes for drinking water are listed in FSAR Table 2.4.12-204 and shown on ER Figure 2.3-10 include: Lillington, Dunn, and Fayetteville. Population values given for these towns are 2020 projected populations based upon the 2000 data for Lillington (2,915), Dunn (9,196), and Fayetteville (121,015) provided in FSAR Table 2.1.3-206 that have been updated to 2020 via basis in North Carolina State Demographics, "County Population Growth 2000 - 2030," Website, demog.state.nc.us

Annotated FSAR Table 11.2-202
LADTAP II Input

Input Parameter	Value	Basis
Freshwater Site	Selected	None required.
Discharge Flow Rate from two AP1000 units to Harris Lake (gpm)	12,000	DCD Section 11.2.3.3
Source Term	DCD Table 11.2-7	Radionuclides per DCD Table 11.2-7
Reconcentration Model	Partial Mixing	Note 1
Harris Lake Storage Capacity (acre-ft)	177,563	Storage capacity associated with normal water level of the main reservoir at elevation 240 ft.
Shore Width Factor	0.3	LATAP recommended factor for a lake shore site.
Dilution Factors	Table 11.2-201	Refer to Note 4 for Annotated Table 11.2-201
Transit Time – Drinking (hr)	1	Conservative assumption Note 2
Transit time – Fish and Recreational Uses (hr)	0	Conservative assumption
Liquid Pathway Consumption Factors	Table 11.2-207	Default values used excepted as noted.
Recreational Exposure for Shoreline, Swimming, and Boating (person-hrs/yr)	1,379,591	Note 3
Sport Fish Catch at Harris Reservoir (kg/yr)	53,710	Note 4

Annotated Table Notes:

1. The Partially Mixed Reconcentration Model from USNRC Regulatory Guide 1.113 is used based on the design where a significant part of the flow is due to both blowdown and plant pumping into a body of water. The LADTAP computer code defines the partially mixed model as linear flow through the impoundment with partial recirculation through the reactor.

2. As documented in the ODCM, Rev. 19, Section 2.2.1 the average transport time to reach point of exposure is specified as 12 hours based on the more limiting decay time for the drinking water and fish exposure pathways (Reg. Guide 1.109, Appendix A, Rev. 1).

3 Recreation exposure is estimated based on multiplying the average daily attendance for Harris Lake County Park of 293 people per day and an estimated average annual exposure period of 12.9 hours (293 persons/day x 365 days/yr x 12.9 hours = 1,379,591 person hours per year).

4. The sport fish catch at the Harris Lake is based upon an estimated number of 188,313 anglers visiting the HAR area in North Carolina out of a total count of 1,263,000 state-wide. The number of anglers visiting the HAR Region was estimated by distributing the total number of anglers by the percent of land that is occupied within the 50 mile region. The HAR region is estimated to occupy approximately 14.9 % of the land area within the state. The average daily amount of bass caught by each angler in a bass tournament is estimated at 5.24 pounds/angler-day. The amount of fish caught each year in the HAR Region was estimated based on the average fish catch per angler-day multiplied by the total number of anglers estimated in the HAR Region per year. The amount of fish caught each year in Harris Lake was estimated based on the ratio of Harris Lake to other large water bodies within the HAR Region. Estimating 12% of the recreational fish catch in the HAR Region results in an estimated catch of 118,411 pounds/year for Harris Lake.

   188,313 anglers/year x 5.24 lbs/angler x 0.12 (fractional catch in HAR) = 118,411 lbs or 53,710 kg

   This is considered conservative since the average catch weight provided is based on professional angler catch rates which provides an over estimation of the average catch rate for a recreational angler.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-4

Text of NRC RAI:

Section 11.2.3.5 states that the irrigation pathway was not evaluated because no irrigation of crops was identified downstream of the Harris Units. Please discuss whether this approach to irrigation considers 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.

PGN RAI ID #: H-0133

PGN Response to NRC RAI:

Calculation of the doses to man from routine release of liquid reactor effluents from Harris Units 2 and 3 was done in accordance with Regulatory Guide 1.109 (Reference. 1). 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 represents 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 (Reference 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 Harris 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 the public from routine release of liquid reactor effluents from Harris Units 2 and 3. The basis for this conclusion and further justification are provided below. The computer code LADTAP II (Reference 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 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, no irrigation of crops was identified downstream of the Harris 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 contaminated irrigation. An individual with a garden irrigated with 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. Population dose was not considered since crop irrigation was not found to occur in the vicinity of HAR.

The dose to the maximally exposed individual from this pathway was calculated assuming the use of public drinking water originating from Lillington, the closest drinking water diversion location downstream of the Harris plant discharge. The transit time of 12 hours used for the drinking water is also used in irrigation evaluation. The dilution factor of 168 to Lillington is also used in the irrigation evaluation.

A wide variety of vegetables are grown in the Southeast. Recommended water requirements for these vegetables when commercially grown are given in Alabama Cooperative Extension System, Basics of Vegetable Crop Irrigation (Reference 4). Depending on the vegetable type, water requirements range from one inch in five days to one inch in 21 days where 1 inch of precipitation equals 25.4 liters/m^2/month. A rate of one inch in 12 days (64 liters/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 the Harris site were investigated to determine irrigation needs not typically met by normal rainfall. Per FSAR Table 2.3.2-259, the minimum average monthly rainfall occurring during the growing season (March – October) in Charlotte, Greensboro or Raleigh-Durham based on 30 years of data is 2.8 in/month (71 liters/m^2/month). This historical, minimum average rainfall rate in itself would meet the average water requirement for the individual garden given above. Regardless, an irrigation rate of one inch per 12 days (64 liters/m^2/month) was conservatively 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 the vegetable dose and the leafy vegetable dose to the maximally exposed individual as 0.012 and 0.0008 mr/yr, respectively. The total for both vegetable pathways is 0.0128 mrem/yr to the total body of an adult. When summed with the total body dose of 2.00 mrem/yr due to the fish consumption, recreational exposure, and drinking water pathways, an adult total body dose of 2.01 mrem/yr is calculated. The adult age group results in the maximum total body dose due to liquid effluent releases. Therefore, the total body dose due to the vegetable irrigation/consumption pathway contributes just 0.5% of the total body dose due to all liquid effluent pathways.

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. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Doses 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.

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. Alabama Cooperative Extension System, ACES Publications: Basics of Vegetable Crop Irrigation, ANR-1169, April 2000.

Associated HAR COL Application Revisions:

No COLA revisions have been identified associated with this response.

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-5

Text of NRC RAI:

Based on the Environmental Site Audit the staff learned that the applicant did not include sport fishing and recreational usage of Harris Lake in estimating population doses for the FSAR. During this audit the staff observed over 100 cars parked at the various boat launching ramps around the lake and extensive recreational use of the county park on the lake. Given the fact that the lake is used extensively for sport fishing and recreation, these exposure pathways should be included in the dose estimation.
Please revise the FSAR to include these pathways or provide detailed information to justify their exclusion. If the applicant intends to use the licensing basis for Unit One to justify the exclusion of sport fishing and recreational usage, please provide the factual information that supported that justification.

PGN RAI ID #: H-0134

PGN Response to NRC RAI:

FSAR Section 11.2 population doses estimates have been revised to include consideration of sport fishing and recreational usage of Harris Lake. FSAR Table 11.2-201 (Dilution Factors and Population Data) and Table 11.2-202 (LADTAP Input) have been revised to identify updated data and list the estimated annual sport fish catch and person-hours per year associated with the recreational activities, (i.e. shoreline, swimming and boating). FSAR Table 11.2-208 provides a breakdown by affected organ of the estimated population doses by each pathway that includes fish consumption, drinking water, shoreline, swimming and boating usage.

Associated HAR COL Application Revisions:

As part of the response to NRC RAI Number 11.02-3, FSAR Section 11.2.3.5.2 has been revised to delete the current description and to include a revised description of the bases for the dose determination and to provide cross references to revised FSAR Table 11.2-202 and new FSAR Table 11.2-208 (Population Doses from Liquid Effluents).

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-6

Text of NRC RAI:

The applicant states in the ER that the potable water for the site will be from Harris Lake. Based on the Environmental Site Audit the staff learned that the applicant did not include site workers in the population dose estimate. Please revise the FSAR to include these workers or provide detailed information to justify their exclusion.

PGN RAI ID #: H-0135

PGN Response to NRC RAI:

FSAR Section 11.2.3.5.2 provides the estimated population dose for residents within 50 miles that use water from the downstream municipal water intakes at Lillington, Dunn, and Fayetteville. The estimated population doses are based on the municipal populations listed in Table 11.2-201 and the drinking water pathway. As noted in the response to NRC RAI Number 11.02-3, the estimated population doses given in new FSAR Table 11.2-208 conservatively include the drinking water pathway dose to an estimated 1000 site workers.

Associated HAR COL Application Revisions:

FSAR Section 11.2.3.5.2 has been revised as part of the response to NRC RAI Number 11.02-3 to include the site workers in the population dose estimate. No additional action is required.

Attachments/Enclosures:

None.

NRC Letter No.: HAR-RAI-LTR-026

NRC Letter Date: October 6, 2008

NRC Review of Final Safety Analysis Report

NRC RAI #: 11.02-7

Text of NRC RAI:

The applicant used the mixed impoundment model in LADTAP II to calculate radionuclide concentrations in Harris Lake with no justification as to why this dilution model is appropriate. The applicant needs to justify, in the FSAR, the dilution model used and explain how the model accounts for the facts that the plant discharge is well downstream near the outfall of the dam possibly causing a non-uniform distribution of radionuclide concentration, and the intermittent flow over the dam outfall complicating the dilution calculation for the Cape Fear River.

PGN RAI ID #: H-0136

PGN Response to NRC RAI:

The mixed impoundment model was selected in performing the LADTAP II calculations for estimating liquid effluent doses and concentrations resulting from the release of radioactive liquids into Harris Lake. Mixing in the volume of the lake is consistent with the current licensing basis as documented in SHNPP U1 ER and SHNPP Unit 1 FSAR. Use of a well mixed lake is inherently conservative for calculating the maximum exposed individual (MEI) doses as discussed below.

As part of a Harris Nuclear Plant program for managing radioactive releases (Administrative Procedure (AP) 556, Effluent Management Program), SHNPP manages on a priority basis the following site level key performance indicators for liquid releases: 1) Harris Lake Tritium, 2) Liquid Tritium Activity, 3) Liquid Fission and Activation Activity and 4) Liquid Volume. Due to its higher priority, the tritium levels in Harris Lake are closely monitored and provide an indication of the degree of mixing that is occurring in the lake. Monitor location SW-26 is the surface water sample point located near the cooling tower blow down discharge which is the release point for liquid radioactive effluents and DW-51 is the monitor sample point located at the plant intake at the SHNPP Water Treatment Building. These locations are at opposite ends of the lake and would only be expected to have similar tritium activity concentrations in the event that essentially complete mixing of the lake volume were to be occurring.

Monthly tritium concentrations measured in the reservoir at the SW-26 and DW-51 locations indicate that except for some isolated spikes above 2.0 and below 1.0, the difference in the concentration at the two points since 1994 is between 1.0 and 2.0 with the 5 year period (2001 — 2005) being closer to an average value of about 1.25. This data indicates that in general the released tritium is well mixed in the Harris lake volume.

Even though the measurements are based on tritium, it is expected that other released radioactive materials such as cesium (Cs) will be similarly mixed. This is especially pertinent since the calculated doses and releases are based on average annual values. Using a well mixed lake is considered conservative in calculating the MEI dose. The majority of the calculated MEI dose (approximately 95 percent) is due to fish consumption with radioactive cesium being one of the primary dose contributors. As noted in SHNPP U1 ER for the reasons discussed therein, fish catching in the area of the discharge is expected to be poor and not productive. The area is not a favorable habitat for the fish to spend time. If it is assumed that, unlike tritium, the Cs isotope does not mix well in the lake and possibly concentrates at the discharge location, the population of sport fish in the lake would actually have a lower intake of Cs. Without mixing, the Cs would most likely migrate to the bottom sediment and only be included in a food chain source for species that are bottom feeders.

The predominant species of sport fish caught in the lake are largemouth bass and sunfish. These fish are not bottom feeders. Combined with the fact that the discharge area is not conducive to a productive fishing location, this would result in lower calculated doses for the Harris lake fish pathway. If the released Cs activity were concentrated in this area, this means the concentration in the remainder of the lake would be lower, thereby decreasing the other pathway doses (water ingestion, swimming, shoreline, etc.). Therefore, there are a number of qualitative considerations that support the conclusion that it is more conservative to use mixing in the entire lake volume.

The model assumes continuous outflow of 20 cfs from the Main Reservoir. It is PEC's plan to maintain a continuous flow from the Main Reservoir to Buckhorn Creek. Currently HAR ER section 2.3 and 5.4 describe an average annual minimum discharge of 20 cfs from the Main Reservoir to Buckhorn Creek. However, associated permitting has not been finalized. Future permits and analyses may change the flow assumptions; but in any case, PEC will continue to meet the requirements of 10 CFR 50 Appendix I.

Associated HAR COL Application Revisions:

Add a new FSAR Chapter 11 Subsection 11.2.3.3 to read:

> Add the following information at the end of DCD Subsection 11.2.3.3 Dilution Factor:
>
> Liquid radioactive releases are diluted by the cooling tower blowdown flow prior to being released to the Main Reservoir. For drinking water supply both at the plant site and for intakes downstream of Harris Lake the water is assumed to be well mixed. For the liquid radioactive releases from the plant to nearest drinking water intake at Lillington, NC (approximately 17 miles), the downstream dilution factor is based on the minimum average annual release from the Harris Lake to the Cape Fear river of 20 cfs and the average annual mean Cape Fear river flow at Lillington of 3363 cfs. Use of these values results in a dilution factor of 168. This dilution factor is also conservatively used for estimating population doses to towns downstream of Lillington even though longer transit times and more dilution results. No dilution is applied to the drinking water dose for site workers as part of the population dose estimate. Dilution factors are given in Table 11.2-201.

Attachments/Enclosures:

None.