**Shearon Harris Nuclear Power Plant Units 2 and 3
Response to NRC Request for Additional Information for the Environmental Review of the Combined License Application, dated January 13, 2011**

NRC RAI #	Progress Energy RAI #	Progress Energy Response
1.1.7-1	H-0655	NPD-NRC-2011-030; March 31, 2011
8.0-1	H-0656	NPD-NRC-2011-030; March 31, 2011
8.3-1	H-0657	NPD-NRC-2011-030; March 31, 2011
8.3-2	H-0658	NPD-NRC-2011-030; March 31, 2011
8.3-3	H-0659	NPD-NRC-2011-030; March 31, 2011
9.4-3	H-0660	Response enclosed – see following pages
3.1-1	H-0661	NPD-NRC-2011-070; September 29, 2011

NRC Letter No.: ER Supplemental

NRC Letter Date: January 13, 2011

NRC Review of Environmental Report

NRC RAI #: 9.4-3

Text of NRC RAI:

Provide an evaluation of following system alternatives, conditions, and associated combinations:

- Pool elevation changes: 20 ft rise; 15 ft rise;10 ft rise; 5 ft rise; 0 ft rise
- Release strategies: High; medium; low; and normative (based on Buckhorn IFIM)
- Timing of withdrawal from Cape Fear; High flow only; in excess of monthly median flow; lower flow (based on Cape Fear IFIM). High flow is defined as flow greater than the maximum of the monthly median flows.
- Cooling water demand: conventional wet tower for proposed nuclear; hybrid tower for proposed nuclear; dry tower with proposed nuclear; and an equivalent MWe output combined cycle plant water demand using conventional wet tower

Evaluation of these alternatives requires a time series of various metrics for two extended periods of record. These extended periods of records should be at least the license period of forty years:

- The first extended period of record will reflect streamflow conditions in the Cape Fear River and the inflows into Harris Reservoir at the beginning of operation.
- The second period of record will reflect streamflow conditions at the end of the license period.

The time series of the following metrics are to be provided. Time increments should be a minimum of monthly. The maximum (or minimum) values to be provided are those that occur within the monthly increment.

- Pool elevation
- Maximum tritium concentration in Harris Reservoir outside the mixing zone and wherever the maximum occurs in Harris Reservoir for each time increment
- Normalized Cape Fear water quality response. The normalization is to be with respect to the 0 ft rise condition with existing inflows and existing consumptive uses. Variability of Cape Fear River water quality is to be included at a monthly time interval, as supported by the available data.
  - For total phosphorus, total nitrogen, and a conservative tracer, provide a maximum of the volumetric-weighted average concentrations for Harris Reservoir for each time increment.

- For chlorophyll a, provide the maximum concentration wherever it occurs outside the mixing zone in Harris Reservoir for each time increment.
- For dissolved oxygen, provide the minimum surface layer concentration wherever it occurs in Harris Reservoir.

For the specified system alternatives, conditions, and associated combinations:

- Quantify the amount and type of aquatic, wetland, and terrestrial habitats that would be temporarily or permanently lost under each operating pool elevation.
- Evaluate the temporary and permanent loss of aquatic, wetland, and terrestrial habitat that would result from construction of the specified system alternatives.
- Evaluate the magnitude and periodicity of expected water level fluctuations along the reservoir shoreline
- Evaluate the magnitude and timing of cooling tower drift and salt deposition
- Evaluate potential impacts to wildlife resulting from 1) collisions with structures and cooling towers, 2) noise, and 3) lighting.

PGN RAI ID #: H-0660

PGN Response to NRC RAI:

This response follows the structure of the NUREG 1555 – Environmental Standard Review Plan (ESRP), Section 9.4. Feasible alternatives were evaluated based on impacts requested by the NRC for the proposed action, then compared with impacts of the preferred cooling system.

Feasibility and Preferred Alternative

The RAI requests environmental evaluation of the following cooling water alternatives:

- Conventional wet tower
- Hybrid tower
- Dry tower
- Combined cycle

A dry cooling system was not evaluated because it was determined that it would not conform to the Westinghouse AP1000 standard design. The dry cooling system would have high cooling water inlet temperature (>105 degrees for 2,000 hours per year) and is therefore considered not feasible as an alternative (Reference RAI 9.4-3 01). The environmental evaluation requested is presented below for the remaining three cooling water alternatives, which are considered feasible for construction and operation at the proposed plant site.

Progress Energy's preferred cooling water alternative is the conventional wet tower (also referred to in this response as a Natural Draft Tower [NDT]) based on land use; water use; operation and maintenance; capital, maintenance, and operating costs; generating efficiency;

thermal and physical effect; atmospheric effect; operating noise level; and aesthetic effect considerations as discussed in HAR ER Section 5.3. The environmental considerations evaluated herein will be measured against this preferred alternative.

Cooling Water Demands

Cooling water demands for the NDT, hybrid tower, and combined cycle cooling water alternatives were estimated by parametric comparison to similar projects.

The first option, an NDT system, uses evaporation and natural convection to extract heat from a plant's cooling water. The second option, a hybrid system, runs the cooling water through a radiator farm, which uses mechanical fans to extract some of the heat before passing it through an NDT. The third option is the replacement of the nuclear plant and cooling systems with an equivalent hypothetical natural gas combined cycle generation facility and its associated cooling system. An estimate of the monthly water use for each of these cooling water alternatives is provided in RAI 9.4-3 Table 1.

RAI 9.4-3 Table 1

Total Normal Consumptive Water Usage (mgd)

	Natural Draft Tower	**Hybrid**	**Combined Cycle Equivalent**
January	57.7	42.1	30.0
February	57.7	42.7	30.0
March	57.7	43.5	30.0
April	58.1	45.8	30.2
May	58.1	47.4	30.2
June	58.4	49.3	30.4
July	58.7	49.4	30.5
August	58.4	48.7	30.4
September	58.4	47.9	30.4
October	58.1	46.0	30.2
November	57.7	44.3	30.0
December	57.7	42.5	30.0
Average (mgd)	58.1	45.8	30.2

Note:
mgd = million gallons per day

Pool Elevation Changes

Progress Energy has performed hydrologic analyses to determine the optimum operating water level of the Harris Reservoir. The results are documented in a technical memorandum (338884-TMEM-107, Rev 3). It was determined that a reservoir level of 240 feet (ft.) National Geodetic Vertical Datum of 1929 (NGVD29) is necessary to provide sufficient cooling water storage and ensure reliable operation of Shearon Harris Nuclear Power Plant Unit 1 (HNP), Unit 2 (HAR 2), and Unit 3 (HAR 3) during extreme drought. Evaluations of reservoir levels of 220 ft. NGVD29, 236 ft. NGVD29, 238 ft. NGVD29, and 240 ft. NGVD29 were included as part of the analyses. Operating levels of 220 ft., 236 ft., and 238 ft. do not support the purpose and need of the project, which is to provide continued reliable power generation from the three units while minimizing impacts to water resources in the Cape Fear River Basin. It was determined that reservoir levels fall below 224 ft. NGVD29, which is the minimum engineering level below which the intake pumps can no longer function, during an extreme drought for the 238 ft. NGVD29 scenario and consistently for the 220 ft. NGVD29 scenario.

Aquatic, Wetland, and Terrestrial Habitat Impacts

A detailed evaluation of jurisdictional wetlands was performed to support the HAR ER. The information collected during the wetlands assessment was used to quantify the amount of wetlands that would be impacted at different reservoir elevations. The delineated pond, fringe, and emergent wetlands were overlain with elevation contours to calculate the amount that would be lost for each 2-ft. change in reservoir elevation. As shown in RAI 9.4-3 Table 2, the majority of the wetlands occur in the first 4 ft. of elevation above 220 ft. NGVD29. This is due to the fact that the wetlands that would be impacted are primarily emergent, fringe, and pond wetlands that occur at the current operating level of the reservoir.

The difference in impacts to wetland areas from each of the alternatives is estimated to be small. Approximately 600.2 acres of wetlands, 96.9 percent of the total wetland impacts, may be impacted if the reservoir operating level is 228 ft. NGVD29, the minimum requirement for any of the alternatives. An increase of 0.6 percent (3.3 acres) of wetland impacts is associated with a reservoir level of 230 ft. NGVD29, which would be the minimum reservoir level required to meet water demands for the hybrid system. Approximately 15.5 acres of additional wetland impacts, an increase of 2.4 percent, is associated with increasing the reservoir level from 230 ft. NGVD29 to 240 ft. NGVD29.

The impacts to terrestrial habitats associated with the reservoir were calculated by determining the total inundated area and subtracting the Wetland Pond acreage. The results of this analysis are provided in RAI 9.4-3 Table 3. While the acreage of terrestrial impacts is larger than the wetlands impacts, much of the area surrounding the reservoir is gamelands and the areas inundated would be converted from terrestrial habitat to aquatic habitat so the loss of potential habitat is SMALL.

The difference in impacts to terrestrial areas on the plant site from each of the alternatives is assumed to be equivalent since the alternatives would be built on the existing plant site. A more detailed determination of other impacts associated with the combined cycle alternative, such as a new gas pipeline, is not possible at this conceptual level.

These findings support the conclusion that raising the current operating pool (220 ft. NGVD29) by 5 ft. to 225 ft. NGVD29, by 10 ft. to 230 ft. NGVD29, by 15 ft. to 235 ft. NGVD29, or by 20 ft. to 240 ft. NGVD29 would have approximately equivalent impacts to aquatic, terrestrial, and wetlands. Raising the operating pool by 20 ft. to 240 ft. NGVD29 is required to allow for uninterrupted operation, and is therefore the preferred alternative based on plant operational considerations.

RAI 9.4-3 Table 2

Comparison of Jurisdictional Wetland Habitat Impacts versus Reservoir Elevation

Elevation Range	Wetland Pond Acreage	Wetland Fringe Acreage	Wetland Emergent Acreage	Total Wetland Acreage	Cumulative Area	Percentage
Various (associated with intake structure)	7.2			7.2	7.2	1.2%
<220			340.5	340.5	347.7	55.0%
220 - 222	97.2	63.9		161.1	508.8	82.1%
222 - 224	56.6			56.6	565.4	91.3%
224 - 226	25.5			25.5	590.9	95.4%
226 - 228	9.3			9.3	600.2	96.9%
228 - 230	3.3			3.3	603.6	97.5%
230 - 232	3.1			3.1	606.6	98.0%
232 - 234	4.6			4.6	611.2	98.7%
234 - 236	3.2			3.2	614.4	99.2%
236 - 238	2.8			2.8	617.2	99.7%
238 - 240	1.8			1.8	619.0	99.9%
>240	0.3			0.33	619.3	100.0%

Note:

Wetland areas presented in this table may differ slightly from those used in the jurisdictional determination due to rounding errors which were introduced when the computer-aided design files containing the wetlands delineations were converted to GIS shapefiles and overlain with elevation contours.

RAI 9.4-3 Table 3

Comparison of Jurisdictional Wetland Habitat Impacts versus Reservoir Elevation

Minimum Elevation	Inundated Area (ac)	Difference by Elevation (ac)	Terrestrial Area (ac)
< 220	4075.0	-	-
220 - 222	4197.7	122.7	25.5
222 - 224	4580.4	382.7	326.1
224 - 226	4958.3	377.9	352.4
226 - 228	5330.6	372.3	363.0
228 - 230	5692.0	361.5	358.2
230 - 232	6065.0	372.9	369.8
232 - 234	6468.1	403.1	398.5
234 - 236	6887.4	419.4	416.2
236 - 238	7324.8	437.4	434.6
238 - 240	7562.8	238.0	236.2

Notes:

The Aquatic or Terrestrial Area value is calculated by subtracting Wetland Pond acreage (non-emergent or fringe wetlands) from the total inundated area.

ac = acre

Release, Withdrawal, and Demand Scenarios

Release flows, withdrawal timing, and cooling water demand all have an impact on long-term reservoir levels. Both cooling water demand and releases from the reservoir can draw down water level, with higher demand and release rates increasing drawdown. Likewise, the timing and rate of withdrawals from the Cape Fear River can affect the ability to maintain the reservoir near the desired operating level. Each of these factors was evaluated using the Cape Fear River Basin Hydrological Model (CFRBHM) to evaluate the potential impact. The CFRBHM simulates the water balance among water users, rivers, and reservoirs within the Cape Fear River Basin. The model was calibrated based on historical data, specifically the period from 1930 to 2010. The model was then used to evaluate changes in release flows, withdrawal timing, and cooling water demand. The model can also incorporate the future demands by other users in the basin at the beginning of operation (Year 2025) and at the date closest to the end of the licensing period (Year 2065). Future demands have been developed through 2050 by the North Carolina Division of Water Resources. These future demands were extrapolated to 2065 and applied to the entities in the model; however, the model was run with the historical basin inflows for which the model was calibrated. Therefore, the time periods reported in the charts and tables in the CFRBHM Results section of this document are shown as the period from 1930 to 2010 but include either 2025 or 2065 demands.

Progress Energy performed an instream flow incremental methodology (IFIM) study on Buckhorn Creek and the Cape Fear River. An IFIM study integrates information on depth, velocity, substrate, or other habitat attributes and habitat requirements for specific aquatic species and life stages of interest to the amount of fish habitat available at various flows in a river.

The results of this study are being used to evaluate the impacts on habitat in Buckhorn Creek and the Cape Fear River that are associated with various operating scenarios. Based on the Buckhorn Creek IFIM, a high-release flow rate and a low-release flow rate were developed for each month (RAI 9.4-3 Table 4). The 20-cubic feet per second (cfs) (12.9-million gallons per day [mgd]) release rate used in previous analyses was not used because the IFIM study made this generalized estimate unnecessary.

The withdrawal rate from the Cape Fear River is constrained for this analysis by the proposed design, which uses three constant rate pumps, each with a capacity of 44.6 cfs (28.8 mgd). Withdrawal timing, however, can be adjusted. Three constraints were used to determine when flow was available in the river: flow greater than the maximum of the monthly medians (i.e., high flow); monthly medians; and the U.S. Army Corps of Engineers (USACE) Jordan Reservoir Rules, which maintain a target flow of 600 cfs at the U.S. Geological Survey (USGS) gage at Lillington, North Carolina, under normal conditions (Reference RAI 9.4-3 02).

RAI 9.4-3 Table 4

Monthly Low- and High-Release Rates
Based on Buckhorn Creek IFIM Study

	Proposed Low Release (cfs)	Proposed High Release (cfs)
January	14	30
February	8	30
March	8	30
April	8	25
May	8	17
June	6	17
July	4	17
August	4	17
September	4	17
October	4	17
November	8	25
December	14	30

Notes:

cfs = cubic feet per second
IFIM = instream flow incremental methodology

The average daily flow in the river at the USGS gage near Lillington (USGS02102500) was used to determine whether pumping could occur each day during the 80-year simulation period under each of these three constraints. The flow requirements in the Cape Fear River based on the IFIM were not included in the evaluation since they were below the 600-cfs target flow specified in the USACE's Jordan Reservoir Rules and would be less protective of downstream water quality.

A summary of the scenarios evaluated is provided in RAI 9.4-3 Table 5.

RAI 9.4-3 Table 5
Alternative Reservoir Management Scenarios

Cooling Type	Release	Withdrawal
Combined Cycle	High[a]	High[b]
Combined Cycle	Low[c]	High[b]
Combined Cycle	High[a]	Median[d]
Combined Cycle	Low[c]	Median[d]
Combined Cycle	High[a]	600 cfs
Combined Cycle	Low[c]	600 cfs
Natural Draft Tower	High[a]	High[b]
Natural Draft Tower	Low[c]	High[b]
Natural Draft Tower	High[a]	Median[d]
Natural Draft Tower	Low[c]	Median[d]
Natural Draft Tower	High[a]	600 cfs
Natural Draft Tower	Low[c]	600 cfs
Hybrid Tower	High[a]	High[b]
Hybrid Tower	Low[c]	High[b]
Hybrid Tower	High[a]	Median[d]
Hybrid Tower	Low[c]	Median[d]
Hybrid Tower	High[a]	600 cfs
Hybrid Tower	Low[c]	600 cfs

Notes:
[a] High-release rate based on high release in IFIM (RAI 9.4-3 Table 4).
[b] High-withdrawal rate based on flows greater than the maximum of the monthly medians.
[c] Low-release rate based on low release in IFIM (RAI 9.4-3 Table 4).
[d] Median-withdrawal rate based on flows in excess of monthly median flow.
cfs = cubic feet per second

Each scenario in RAI 9.4-3 Table 5 was run twice, once based on projected basinwide demands at the beginning of operation (Year 2025) and once based on projected basinwide demands at the end of the licensing period (Year 2065). Of critical interest was whether each alternative met the purpose and need of the project, providing continued reliable power generation from the three units while minimizing impacts to water resources in the Cape Fear River Basin. This was in part measured by whether the reservoir level fell below the engineering design minimum water level of 224 ft. NGVD29, based on the minimum level that the pumps can operate, at any time. RAI 9.4-3 Table 6 summarizes the lowest reservoir levels calculated for each scenario over the 1930 through 2010 simulation period. Shaded cells correspond to scenarios where the reservoir level remained above the minimum engineering design requirement (224 ft. NGVD29).

RAI 9.4-3 Table 6

Lowest Water Elevation in Harris Reservoir for Alternative Operational Scenarios

Withdrawal Scenarios	Release Scenarios	Cooling Water Demand Scenarios: Natural Draft (NDT)	Hybrid	Combined Cycle
2025 Demand		**Minimum Elevation (ft.)**	**Minimum Elevation (ft.)**	**Minimum Elevation (ft.)**
High Flow only	Low-release pattern	191.0	218.6	233.2
High Flow only	High-release pattern	191.0	191.0	225.7
Median Flow only	Low-release pattern	218.5	231.4	235.6
Median Flow only	High-release pattern	199.0	222.2	233.6
600 cfs Flow	Low-release pattern	231.5	233.4	235.6
600 cfs Flow	High-release pattern	230.1	231.9	234.3
2065 Demand		**Minimum Elevation (ft.)**	**Minimum Elevation (ft.)**	**Minimum Elevation (ft.)**
High Flow only	Low-release pattern	191.0	217.7	233.1
High Flow only	High-release pattern	191.0	191.0	225.2
Median Flow only	Low-release pattern	216.1	230.3	235.3
Median Flow only	High-release pattern	191.0	220.2	233.2
600-cfs Flow	Low-release pattern	231.5	233.3	235.6
600-cfs Flow	High-release pattern	227.7	231.9	234.3

Notes:
cfs = cubic feet per second
ft. = feet

RAI 9.4-3 Table 6 shows a consistent pattern between the lowest reservoir levels for the 2025 and 2065 demand years for each of the scenarios. The greatest difference in reservoir level between the 2025 and 2065 demand years is approximately 2.4 ft. for the viable alternatives (NDT, 600 cfs, high-release scenario). These differences occur due to the predicted increased use of the basin water supply in the future.

CFRBHM Results

A comparison of the withdrawal above 600 cfs, high-release pattern, and conventional NDT cooling option for the 2025 and 2065 demands is provided graphically in Attachment RAI 9.4-3A. The complete set of model results for the 18 scenarios for the 2025 demand are provided in Attachment RAI 9.4-3B. The demand comparison provided in Attachment RAI 9.4-3A indicates that the reservoir is maintained at similar water levels for both demand years with the main exception occurring during the extreme low-flow periods when basin water availability is impacted by upstream users. For the majority of the time, instream flow is great enough that the increase in demand in the future does not affect the availability of water supply. Since water supply planning and evaluations must focus on long-term availability, the remainder of the discussion will focus on the 2065 scenario.

RAI 9.4-3 Table 6 demonstrates that flow withdrawal above 600 cfs is the only option for withdrawals from the Cape Fear River that provides sufficient water supply for all the cooling water alternatives. This withdrawal restricts flows above the level determined by the IFIM study while providing sufficient flow to protect downstream water supply and water quality. An approximate 2.4-ft. difference in lowest reservoir level is estimated between the use of the combined cycle equivalent system and the proposed nuclear plant expansion with a hybrid system. An approximate 4.2-ft. difference in lowest reservoir level is seen between the hybrid cooling system and a conventional NDT system.

A set of daily time series of reservoir levels comparing each cooling water alternative for each set of withdrawal and release rates were plotted for the 2065 demand period and are provided in Attachment RAI 9.4-3C. The complete set of model results for the 18 scenarios for the 2065 demand are provided in Attachment RAI 9.4-3B.

As noted, withdrawal at 600-cfs flow is preferred since it provides the most flexibility in meeting cooling water demands while meeting instream flow requirements. The comparison of the three cooling water alternatives for the withdrawal above 600 cfs and high-release rate is provided in Attachment RAI 9.4-3C, Figure C-1. This figure shows that the water levels are similar for the three cooling options during periods when water availability is not limited. Water levels decrease at a quicker rate and reach a lower level for the hybrid system and NDT when compared with the combined cycle equivalent, due to the higher water demands and more restrictive pumping conditions. As noted in RAI 9.4-3 Table 6, the maximum difference in minimum water level for the 2065 demand period is 6.6 ft. between the 600-cfs/high-release scenarios.

While the combined cycle equivalent system uses less water and could result in a higher minimum reservoir water level elevation than the hybrid and NDT options, it would have other environmental impacts. As described in HAR ER Chapter 9, the carbon footprint of a combined cycle equivalent system is approximately 100 times that of a nuclear power generation facility. In addition, the combined cycle equivalent system would require large amounts of natural gas to generate electricity. A natural gas pipeline would need to be built to supply the plant. The construction of the pipeline and permanent right-of-way (ROW) could potentially cause additional impacts to wetlands and terrestrial habitat. The trade-off in cost between an NDT and combined cycle system has been calculated as approximately $2,352 per acre-foot (ac-ft) of reduced water use.

The hybrid system relies on mechanical fans to remove heat from the cooling water. This would result in parasitic energy losses to drive the fans and a resulting reduction in generation capacity. Besides the lost opportunity cost from driving fans versus providing power, hybrid towers are also significantly more expensive to construct and operate. The trade-off in cost between an NDT and hybrid system has been calculated as approximately $2,491 per ac-ft of reduced water use.

A review of the stage-storage relationship for the Harris Main Reservoir was done to determine approximate normal operating levels for the alternative cooling systems. These were done by determining the maximum drawdown for a scenario, estimating the associated volume, and determining the corresponding increase in stage from the current normal operating level of 220 ft. NGVD29 required to provide the same equivalent storage.

The hybrid system would require approximately 10 ft. of additional storage, when factoring in the reduced volume per change in elevation at lower elevations. Estimates for the 600 cfs, high release, hybrid scenario indicate a 231.9-ft. minimum elevation (see RAI 9.4-3 Table 6). The difference from 240 ft. to 231.94 ft. is approximately 50,000 ac-ft (180,000 ac-ft to 130,000 ac-ft). Starting at 220 ft., this is equivalent to approximately 10 ft. of additional storage. As described above, all three systems would have a similar impact on wetlands since 96.9 percent of current wetlands occur below 228 ft. NGVD29.

The combined cycle equivalent system uses the least water but still would require approximately 8 ft. of additional storage, when factoring in the reduced volume per change in elevation at lower elevations. Estimates for the 600 cfs, high release, combined cycle scenario indicate a 234.3-ft. minimum elevation (see RAI 9.4-3 Table 6). The difference from 240 ft. to 234.4 ft. is approximately 35,000 ac-ft (180,000 ac-ft to 145,000 ac-ft). Starting at 220 ft., this is equivalent to approximately 8 ft. of additional storage. As described below, all three systems would have a similar impact on wetlands since 96.9 percent of current wetlands occur below 228 ft. NGVD29.

Reservoir Level Fluctuation

Water level will generally be maintained close to the reservoir operating level. However, water level fluctuation will occur due to variability of supply such as storm events and restricted inflows during drought periods. The impacts of water level fluctuation on wetlands and biodiversity have been the focus of numerous studies. One such study, performed by the USGS, concluded that:

> "Low water levels can jeopardize fish spawning and reduce waterfowl nesting area; yet, they provide the opportunity for regeneration of the plant communities that are the foundation of the habitat. Water-level fluctuations promote the interaction of aquatic and terrestrial systems and result in higher quality habitat and increased productivity. When the fluctuations in water levels are removed through stabilization, shifting of vegetation types decreases, more stable plant communities develop, species diversity decreases, and habitat value decreases" (Reference RAI 9.4-3 04).

Middleton in *Flood Pulsing in the Regeneration and Maintenance of Species in Riverine Forested Wetlands of the Southeastern United States* concludes that the early life history of many plant species is dependent on flood pulse (variability) and that germination and recruitment will not occur without an extended drawdown during the growing season. (Reference RAI 9.4-3 05).

Reservoir level fluctuation was evaluated based on the relative change on a weekly basis. A count of the days that water level values were greater than 6 inches different, either in a negative or positive direction, compared to values from one week previous is presented in RAI 9.4-3 Table 7. This provides insight into the variability of reservoir level. For the withdrawal above 600 cfs and high-release scenarios, the weekly water level fluctuation greater than 6 inches occurred approximately 1 percent of the time more frequently for a conventional NDT than for an equivalent combined cycle plant, and 0.6 percent more frequently for a hybrid tower than for an equivalent combined cycle plant. This suggests that the impact from each of the alternatives would be SMALL.

RAI 9.4-3 Table 7

Percent of Time Weekly Water Level Changes More Than 6 Inches

Pumping	Release	Cooling Type	2025	2065
600 cfs	High	Combined Cycle	2.3	2.4
600 cfs	High	Natural Draft Tower	3.2	3.4
600 cfs	High	Hybrid Tower	2.9	3.0
600 cfs	Low	Combined Cycle	2.1	2.2
600 cfs	Low	Natural Draft Tower	2.9	3.1
600 cfs	Low	Hybrid Tower	2.5	2.7
High	High	Combined Cycle	3.7	3.7
High	High	Natural Draft Tower	35.6	36.1
High	High	Hybrid Tower	10.1	11.1
High	Low	Combined Cycle	2.9	3.0
High	Low	Natural Draft Tower	17.0	18.9
High	Low	Hybrid Tower	4.7	4.7
Medium	High	Combined Cycle	2.8	2.8
Medium	High	Natural Draft Tower	5.7	6.8
Medium	High	Hybrid Tower	3.6	3.9
Medium	Low	Combined Cycle	2.4	2.6
Medium	Low	Natural Draft Tower	3.9	4.2
Medium	Low	Hybrid Tower	3.1	3.2

Tritium Analysis

A model simulation was performed using the USACE's CE-QUAL-W2 model (Reference RAI 9.4-3 03) to calculate the change in tritium levels in the reservoir as a result of its increased release. Model predictions indicate that tritium levels will remain below the North Carolina water quality standard of 20,000 picocuries per liter (pCi/L) on an annual average basis, even during periods when inflows to the reservoir are limited due to drought.

A detailed spatial and temporal analysis was performed on the model results to identify the maximum tritium concentration in Harris Reservoir outside the mixing zone and wherever the maximum occurs in Harris Reservoir for each time increment. This analysis indicated that the highest levels would occur during drought periods at elevations below the thermocline in the reservoir segment where the blowdown discharge occurs. The highest estimated value at any single location and time was below 24,000 pCi/L. The annual average concentration at this elevation was highest in the 2008 period with a value of 18,323 pCi/L. It should be noted that these elevated levels occur at significant depth, approximately 8 meters below the surface. Concentrations in the surface layers and at all depths in the drinking water intake location remain below 20,000 pCi/L. A more detailed description of the analysis results is provided in Attachment RAI 9.4-3D.

Water Quality Analysis

A water quality modeling analysis of Harris Reservoir was performed to provide information necessary to address the specific questions pertaining to water quality impacts from the operation of HAR 2 and HAR 3. The modeling examined existing water quality conditions in Harris Reservoir to establish a baseline for normalization, and the predicted water quality impacts from both high and low release strategies and the Cape Fear River makeup water pumping scenarios associated with those two release regimes. The modeling analysis simulated conventional/eutrophication water quality parameters including, but not limited to: nutrients, phytoplankton, chlorophyll *a* and dissolved oxygen (DO). A detailed report of the modeling effort and results are provided in Attachment RAI 9.4-3E.

Model results for the segment nearest to the dam (Segment 13) indicate that total nitrogen concentrations are predicted to be significantly lower in the expanded lake, with Cape Fear River water introduced. The fluctuations of total phosphorus (TP) loads are altered and the TP graph appears to indicate a slight overall load reduction. Examination of the chlorophyll *a* time series clearly shows a reduction in peak levels throughout the simulation period, which would indicate an overall reduction in eutrophic productivity. Surface DO levels appear to remain relatively unchanged, with the potential for some lessening in severity of the minimum DO spikes. The conservative tracer is reduced to concentrations near zero at startup and increases gradually, and then fluctuates in a range of approximately 20 to 45 milligrams per liter (mg/L) for the high base flow release condition, and 15 to 40 mg/L for the low base flow release condition, by the end of the simulation period.

Salt Drift

A qualitative comparative evaluation of each of the three cooling water alternatives was performed, using as a basis the results of a detailed cooling tower plume analysis of Progress Energy's proposed cooling systems as described in HAR ER Subsections 5.1.1.1.3 *Cooling and Heat Dissipation System* and 5.3.3.1 *Heat Dissipation to the Atmosphere*. Deposition and salt drift impacts from the proposed cooling systems are described in HAR ER Subsections 5.3.3.1.3 *Solids Deposition* and 5.3.3.2.1 *Salt Drift*. As described in these subsections of the ER, the comprehensive drift and deposition modeling analysis that was previously performed by Progress Energy for the preferred NDT cooling system (HAR ER Subsection 5.3.3.2.1 *Salt Drift*) demonstrated that the maximum rate of deposition of salt drift attributable to the operation of two AP1000 generating units would be only 0.15 kilograms per hectare per year (kg/ha/yr) at any location. This is less than 1 percent of the threshold limit of 10 kilograms per hectare per month (kg/ha/mo) (9 pounds per acre per month [lb/ac/mo]) that is provided by the U.S. Nuclear Regulatory Commission (NRC) in NUREG-1555, which is represented as a threshold above which adverse impacts on vegetation could potentially occur. Drift and deposition of salt particles resulting from cooling tower operation can be expected to occur at all times during the year; however, the maximum predicted deposition rate of 0.15 kg/ha/yr can be expected to occur during the months when maximum cooling is required and when maximum water flow through the cooling towers occurs. Typically this would occur in the spring, summer, and fall months when electrical demand is highest. The predicted impacts of cooling tower drift from the preferred cooling system have previously been characterized as SMALL, as described in HAR ER Table 5.10-1 *Summary of Measures and Controls to Limit Adverse Impacts during Operation.*

A comparison of the basic operating characteristics of each system (including water use and maximum drift loss) is provided in RAI 9.4-3 Table 8. Also shown in RAI 9.4-3 Table 8 is an estimated "relative drift rate," which is expressed as a percentage of the drift rate expected for the preferred alternative of wet natural draft cooling towers. The results of this comparison indicate that all of the identified cooling system alternatives can be expected to result in lower drift losses to the atmosphere than the proposed wet natural draft cooling system, with impacts ranging from 7 percent (combined cycle) to 66 percent (Hybrid Cooling) of the impacts for the preferred system. These reductions in drift (and therefore drift deposition) are a direct result of lower water use and, in the case of the combined cycle generating option, greater mist eliminator efficiency as a result of the use of mechanical draft cooling towers. For this comparative analysis, it is assumed that the drift losses to the atmosphere (and drift deposition to the surface) will be a function of total water use (as evaporative losses) by each system, and mist eliminator performance. While the estimated drift and deposition rates for the identified cooling system alternatives are lower than for the preferred natural draft cooling systems, the predicted impacts for the preferred system have been shown in HAR ER Subsection 5.3.3.2.1 to be less than 1 percent of the NRC-recommended threshold limit for adverse impacts to vegetation. The impacts of drift and deposition for all cooling alternatives (including the preferred alternative) are therefore also expected to be SMALL, as has been characterized in HAR ER Section 5.10 for the preferred cooling system.

RAI 9.4-3 Table 8

Operating Parameters and Potential Drift Losses for Identified Cooling System Alternatives for HAR 2 and HAR 3

Cooling System Alternative	Relative Comparison of Potential Drift Losses for Cooling System Alternatives (single cooling tower)		
	Water Use (mgd)[a]	Maximum Drift Loss (% of circulating flow rate)[b]	Relative Drift Rate (%)[c]
Wet Natural Draft Cooling Tower (Preferred Alternative)	20.3	0.002	100%
Hybrid Cooling	13.3	0.002	66%
Combined Cycle Generation (mechanical draft towers)	5.5	0.0005	7%

Notes:

[a] Maximum daily water use for one AP1000 generating unit (or ~1220-megawatt [MW] equivalent generation for Combined Cycle Option). All water use results from evaporative losses to the atmosphere.

[b] Engineering performance based on current mist eliminator design criteria.

[c] Relative Drift Rate is relative to the preferred alternative of a wet natural draft cooling tower

$$= \frac{\text{Water Use (MGD)}}{20.3^{d}} \times \frac{\text{Maximum Drift Loss (\%)}}{0.002^{e}}$$

[d] Water use for preferred alternative (natural draft cooling tower).

[e] Maximum drift loss for preferred alternative (percent of circulating water flow rate).

Impacts to Wildlife

The potential impacts to wildlife from the alternative cooling systems would likely occur from collisions with the towers and adverse effects from noise or lights. These impacts are evaluated below.

Collisions

The greatest potential for impacts for the proposed and alternative cooling systems is from the cooling towers. Associated structures would be lower in height and would pose a lower risk of collision. The impact from avian collisions with a single natural draft cooling tower per AP1000 unit is discussed in HAR ER Subsection 5.3.3.2.5 as follows:

> "The proposed natural draft cooling towers will be 183 m (600 ft.) high, moderately higher than the existing HNP cooling tower. Observations of avian collisions with the existing HNP cooling tower are rare; thus, collisions with the proposed HAR cooling tower are also expected to be minimal. NRC has also noted in NUREG-1437 that the occurrence of bird collisions with cooling towers at nuclear plants is minimal.
>
> Impacts to bird species from collisions with the proposed cooling tower will be SMALL and will not warrant mitigation."

Two natural draft cooling towers would slightly increase the possibility of avian collision. However, due to the rare occurrence of collisions, impacts would still be expected to be SMALL. Mechanical draft cooling towers for a combined cycle-equivalent system have a lower profile than the existing HNP cooling tower; impacts would therefore also be expected to be SMALL. Hybrid cooling towers would be of similar or lower height as the proposed cooling system and would also have similar SMALL impacts.

Noise

The alternative cooling systems would have approximately the same overall noise impacts as the proposed cooling towers, which are expected to be SMALL.

Noise impacts from operations of the cooling tower component of the alternative cooling systems will be similar to the proposed system. These impacts are described in HAR ER Chapter 5 as follows:

> "Natural-draft cooling towers emit noise of a broadband nature, and the frequencies with important intensities are 120, 240, 360, and 480 hertz (Hz). Because of the broadband character of the cooling towers, the noise associated with them is largely indistinguishable and less obtrusive than transformer noise or loudspeaker noise. Cooling tower and transformer noises do not change appreciably with time. Cooling towers generate approximately 55 dBA at a distance of 1000 ft. during operation (NUREG-1817)."

The operation of the fans for the hybrid systems may have a slightly higher impact due to the noise from the fans.

Noise impacts from construction are described in HAR ER Chapter 4 and are comparable to construction of the alternative heat dissipation systems:

> "The presence and operation of the HNP, near U.S. Highway 1, and ongoing timber stand improvement provide steady ambient noise levels. In addition, the construction of the HNP produced the same magnitude of noise as will occur with the construction of HAR 2 and HAR 3. Therefore, effects to wildlife will be no greater than those previously experienced.
>
> Typical equipment used in construction and clearing generate peak noise levels between 70 and 98 decibels (A-weighted scale) (dBA) at a distance of 15 m (50 ft.) from the equipment (ER Reference 4.3-008). Because multiple pieces of equipment are likely to be operating simultaneously, the total noise could exceed the peak noise level of any one piece of equipment by 1 to 3 dBA. Noise naturally attenuates over distance, typically decreasing by 3 dBA with every doubling of distance (ER Reference 4.3-009). Therefore, the actual noise levels experienced by wildlife after relocating from the construction area would be lower than the noise level at 15 m (50 ft.).
>
> Adverse effects have been observed in laboratory animals within a range of 72 and 101 dBA (ER Reference 4.3-010). Adverse effects beyond an initial startle response are more likely to result from continuous rather than intermittent loud noises. However, intermittent noises at lower noise levels may be more irritating.
>
> Peak construction noise would be intermittent, with the continuous noise level expected to be between 70 and 80 dBA at 15 m (50 ft.) (ER Reference 4.3-008). These thresholds, the natural attenuation of sound over distance, the short duration of preparation and

construction, and the consistent and historical presence of noise within the area create a small potential for short-term noise-related adverse effects on wildlife. These adverse effects would be limited to the duration of construction."

Lighting

Each of the alternatives would require lighting, particularly for towers, to meet Federal Aviation Administration (FAA) requirements. Therefore, the alternative cooling systems would have approximately the same light-associated impacts as the proposed cooling towers.

Lighting during construction would not be necessary, as construction is recommended to occur during daytime hours on days with good weather (HAR ER Subsection 4.3.1.1.2).

Conclusions

The environmental considerations evaluated herein are summarized in RAI 9.4-3 Table 9 for the three cooling water alternatives evaluated. The environmental considerations were evaluated against the preferred alternative, a conventional wet NDT cooling water system. As discussed in HAR ER Section 5.3, cooling water impacts are SMALL for both construction and operation. Parks and launch slips impacted by the increase in reservoir level will be rebuilt at the new reservoir pool elevation. Fluctuations in reservoir pool elevation are associated with drought periods and will therefore not significantly impact recreational uses of the Harris Reservoir.

While the combined cycle equivalent system uses less water and could result in a higher minimum reservoir water level elevation than the hybrid and NDT options, it would have other environmental impacts including greenhouse gas and pipeline construction impacts. The hybrid system relies on mechanical fans to remove heat from the cooling water. This would result in parasitic energy losses to drive the fans and a resulting reduction in generation capacity. Besides the lost opportunity cost from driving fans versus providing power, hybrid towers are also significantly more expensive to construct and operate. As described above, all three systems would have a similar impact on wetlands since 96.9 percent of current wetlands occur below 228 ft. NGVD29. For these reasons, the NDT is the preferred cooling system option.

RAI 9.4-3 Table 9
Summary of Evaluated Cooling Water Alternatives

	Natural Draft Tower	Hybrid	Combined Cycle Equivalent
Average Water Use (mgd)	58.1	45.8	30.2
Harris Reservoir Normal Operating Pool Elevation (feet NGVD29)	240 ft.	230 ft.	228 ft.
Difference in Wetland Impacts (RAI 9.4-3 Table 2)	Preferred alternative	-15.7 acres	-19.1 acres
Difference in Aquatic and Terrestrial Impacts (RAI 9.4-3 Table 3)	Preferred alternative	-1855.3 acres	-2213.5 acres
Applicable Withdrawal Scenarios (RAI 9.4-3 Table 6)[a]	600 cfs	600 cfs, median (low release only)	600 cfs, median, high
Applicable Release Scenarios (RAI 9.4-3 Table 6)[b]	Low, high	Low, high	Low, high
Lowest Simulated Harris Reservoir Pool Elevation (feet NGVD29) (RAI 9.4-3 Table 6)[c]	Preferred Alternative	+4.2 ft.	+6.6 ft.
Harris Reservoir Pool Elevation Fluctuation Impacts (RAI 9.4-3 Table 1)[c]	Small (3.4%)	Small (decrease of 0.4%)	Small (decrease of 1%)
Water Quality Impacts	Small	Not available	Not available
Salt Drift Impacts	Small, <1% NRC threshold	66% of preferred alternative	7% of preferred alternative
Wildlife Impacts	Small	Small	Small (slightly lower profile than preferred alternative)
Noise Impacts	Small	Small (may be slightly higher than preferred alternative due to fans)	Small

RAI 9.4-3 Table 9

Summary of Evaluated Cooling Water Alternatives

	Natural Draft Tower	Hybrid	Combined Cycle Equivalent
Lighting Impacts	Same	Same	Same
Other Environmental Impacts	Preferred alternative	Reduction in generating capacity to run radiator fans	100x higher carbon footprint, natural gas needed to generate electricity, natural gas pipeline required
Cost	Preferred alternative	\$2,491/ac-ft of reduced water use	\$2,352/ac-ft of reduced water use

Notes:
mgd = million gallons per day
kg/ha/yr = killigrams per hectare per year
[a] High-withdrawal rate based on flows greater than the maximum of the monthly medians, median-withdrawal rate based on flows in excess of monthly median flow.
[b] High-release rate based on upper level of IFIM, low-release rate based on lower level of IFIM (RAI 9.4-3 Table 2).
[c] Based on 2065 Demand, 600 cfs withdrawal, high-release scenario.

References

Reference RAI 9.4-3 01 – Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle. Report No. HAG-G2-GER-001, Rev. 1. Sargent & Lundy. June 11, 2008.

Reference RAI 9.4-3 02 - Excerpts from the approved 1992 Water Control Manual for B. Everett Jordan project. U.S. Army Corps of Engineers. Accessed March 12, 2007. Website, http://epec.saw.usace.army.mil/jwcplan.txt.

Reference RAI 9.4-3 03 - CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.2. U. S. Army Corps of Engineers. Washington, DC. 2002.

Reference RAI 9.4-3 04 – Effects of Water-Level Fluctuations on Wetlands of the Great Lakes. U.S. Geological Society. 2008.

Reference RAI 9.4-3 05 - Flood pulsing in wetlands: Restoring the Natural Hydrological Balance. Middleton, B. A., editor. John Wiley and Sons. 2002.

Associated HAR COL Application Revisions:

No COLA changes have been identified associated with this response.

Attachments/Enclosures:

The following attachments are provided on the enclosed disk (Enclosure 2 to NPD-NRC-2011-072):

Attachment RAI 9.4-3A – Comparison of Main Reservoir Elevation for 2025 and 2065 Demands, Natural Draft Tower, High Release and 600 cfs withdrawal Scenarios

Attachment RAI 9.4-3B – Daily Water Level Estimates for the Main Reservoir from the Cape Fear River Basin Hydrologic Model for 2025 and 2065 Demands

Attachment RAI 9.4-3C – Comparison of Main Reservoir Elevation for 2065 Demands

Attachment RAI 9.4-3D – 338884-TMEM-122, Rev 1, Modeling of Long-term Tritium Levels in Harris Lake

Attachment RAI 9.4-3E – Water Quality Modeling: Scenarios to Address Nuclear Regulatory Commission RAI

Enclosure 3

Pre-Flight Report

for

Enclosure 2 to NPD-NRC-2011-072

[1 page following this cover page]

Progress Energy

This document serves as a pre-flight report for Enclosure 2 to letter NPD-NRC-2011-072. The following files do not pass pre-flight or do not meet NRC criteria, but text is word searchable and clarity/legibility is of high quality.

File Name	Preflight Status	Reason
Attachment RAI 9.4-3A	Error/Failed	Figure Resolution is less than 300 ppi
Attachment RAI 9.4-3C	Error/Failed	Figure Resolution is less than 300 ppi
Attachment RAI 9.4-3D	Error/Failed	Font not embedded due to OCR, <300 ppi due to logos and figures
Attachment RAI 9.4-3E	Error/Failed	Font not embedded due to OCR, <300 ppi due to logos and figures