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Subject: Duke Energy Carolinas, LLC
William States Lee III Nuclear Station - Docket Nos. 52-018 and 52-019
AP1000 Combined License Application for the
William States Lee III Nuclear Station Units 1 and 2
Response to Request for Additional Information
Ltr# WLG2010.10-09

References:

(1) Letter from Sarah Lopas (NRC) to Bryan Dolan (Duke Energy), Request for Additional Information Regarding the Supplement to the Environmental Report for the William States Lee III Nuclear Station, Units 1 and 2 Combined License Application, dated June 22, 2010 (ML101370398)

(2) Letter from Sarah Lopas (NRC) to Bryan Dolan (Duke Energy), Follow-Up Requests for Additional Information Regarding the Supplement to the Environmental Report for the William States Lee III Nuclear Station, Units 1 and 2 Combined License Application, dated September 14, 2010 (ML102371173)

This letter provides the Duke Energy response to the Nuclear Regulatory Commission's request for additional information (RAI) included in References 1 and 2.

RAI 128, Alternatives
RAI 216, Alternatives

The responses to the NRC information requests described in Reference 1 and Reference 2 are addressed in separate enclosures, which identify associated changes to the Combined License Application for the Lee Nuclear Station, when appropriate.

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

Bryan J. Dolan
Vice President
Nuclear Plant Development

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Enclosures:

1) RAI 128, Alternatives
2) RAI 216, Alternatives

AFFIDAVIT OF BRYAN J. DOLAN

Bryan J. Dolan, being duly sworn, states that he is Vice President, Nuclear Plant Development, Duke Energy Carolinas, LLC, that he is authorized on the part of said Company to sign and file with the U. S. Nuclear Regulatory Commission this supplement to the combined license application for the William States Lee III Nuclear Station and that all the matter and facts set forth herein are true and correct to the best of his knowledge.

Bryan J. Dolan

Bryan J. Dolan

Subscribed and sworn to me on October 29, 2010

Vickie M Prenatt

Notary Public

My commission expires: May 11, 2011

SEAL

VICKIE M PRENATT
NOTARY PUBLIC
Mecklenburg County
North Carolina
My Commission Expires May 11, 2011

xc (w/o enclosures):

Loren Plisco, Deputy Regional Administrator, Region II
Robert Schaaf, Branch Chief, DSER

xc (w/ enclosures):

Sarah Lopas, Project Manager, DSER
Brian Hughes, Senior Project Manager, DNRL
Mickie Chamness, PNNL

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

RAI Letter Dated: June 22, 2010

Reference NRC RAI Number: ER RAI 128, Alternatives

NRC RAI:

Provide details of the quantitative analyses used to evaluate hybrid wet-dry tower options for cooling of the proposed Lee Nuclear Plant during periods of low river flow. Include alternatives considered for cooling water sources and cooling system technologies. Include in the metrics of the analyses foregone net power due to parasitic energy losses, reduced generation efficiency, and frequency of outages due to loss of water supply.

Duke Energy Response:

Before addressing the specific questions in this RAI, a broad overview is presented of the overall water management strategy for Lee Nuclear Station, including discussion of how this strategy is supported and integrated with the selected heat dissipation system (wet cooling towers) and selected alternative for supplemental cooling water (Make-Up Pond C). This overview provides context for the topic of cooling water required to support station operations and enables meaningful comparisons of alternatives evaluated for cooling system technologies and cooling water sources. Quantitative analyses of cooling system technologies and respective cooling water requirements are presented for both wet cooling towers and hybrid cooling towers so as to substantiate and validate the selections previously made of the heat dissipation system and alternative for supplemental cooling water for Lee Nuclear Station. Finally, a review and comparison of environmental impacts and other considerations are presented to support and substantiate a conclusion regarding the environmentally preferable and the most practicable alternative for a heat dissipation system and for supplemental cooling water.

Lee Nuclear Station and its selected heat dissipation system consume a minimal amount of the mean annual flow of the Broad River. As stated in Subsection 5.2.2.1.1 of the Supplement to Revision 1 of the Environmental Report (ER Supplement), based on the mean annual flow of approximately 2,500 cubic feet per second (cfs) at the Lee Nuclear Site approximately 2 percent of the mean annual flow of the Broad River will be consumed by the plant. (Approximately 3 percent of the mean annual river flow at the Lee Nuclear Site is expected to be withdrawn for plant use and the plant will return 1 percent of the mean annual river flow as discharge of cooling tower blowdown and screen wash.) Consumptive losses of this magnitude are expected to be barely discernible under normal circumstances (typical flows).

The overall water management strategy being deployed by Duke Energy for Lee Nuclear Station also mitigates water availability impacts of station operations during both normal operations and during low flow conditions on the Broad River. Lee Nuclear Station would withdraw make-up cooling water from Make-Up Ponds B and C during low flow conditions on the Broad River as outlined in Subsection 5.2.1 of the ER Supplement. The Federal Energy Regulatory Commission (FERC) has jurisdiction over the Ninety-Nine Islands Reservoir, and the FERC license minimum release from the Ninety-Nine Islands Reservoir is 483 cfs, for low flow conditions. Normally (98 percent of the time), Broad River flows are well above this level. However, during significant droughts, flows fall below 483 cfs. If the river flow drops below 538 cfs (FERC minimum release of 483 cfs + Lee Nuclear Station average consumptive use for two-unit operation of 55 cfs) Lee Nuclear Station would begin to draw proportionally from the river and Make-Up Ponds B and C to in order to preserve the 483 cfs minimum release from the Ninety-Nine Islands Reservoir. If the river flow is at or below 483 cfs, Lee Nuclear Station would suspend withdrawals from the Broad River for consumptive use and rely on Make-Up Ponds B and C to provide cooling water needs. The volume of Make-Up Pond A would be maintained for station shutdown cooling water needs. Cooling water would be withdrawn from Make-Up Pond B until Make-Up Pond B is drawn down 30 feet (ft) below full pond (from 570 ft mean sea level (msl) to 540 ft msl). Cooling water then would be withdrawn from Make-Up Pond C until Make-Up Pond C is drawn down approximately 45 ft below full pond (from 650 ft msl to 605 ft msl), as allowed by permit conditions. Once flow in the river exceeds 538 cfs, Lee Nuclear Station would resume operating from the river and use any excess flow (> 538 cfs) to refill the ponds, within permit conditions. Make-Up Pond B would be refilled first, followed by Make-Up Pond C, if necessary, when river flows are higher and outside the peak entrainment period (i.e., when fish larvae are less likely to be present). Operating in this manner not only uses Make-Up Ponds B and C to support station needs but also maintains maximum flow in the Broad River downstream of the Ninety-Nine Islands Reservoir during drought conditions to maintain the biological, chemical, and physical integrity of the river, taking into account the needs of downstream users. As stated in ER Supplement Subsection 5.2.2.2.1, the impact of Lee Nuclear Station operations during low flow conditions on downstream future water availability is considered SMALL.

Selected Heat Dissipation System – Wet Mechanical-Draft Cooling Towers

Wet mechanical-draft cooling towers are the selected heat dissipation system for Lee Nuclear Station as described in Subsection 9.4.1.1 of the ER. The Circulating Water System uses three wet mechanical-draft cooling towers per unit to dissipate heat. The wet mechanical-draft cooling towers use fans to force heat transfer within the wet cooling towers. Water from the wet cooling towers is discharged to the plant outfall structure on the upstream side of the Ninety-Nine Islands Dam through a blowdown pipe/diffuser. The Broad River is used to supply make-up water to support operations of the wet cooling towers and for refilling Make-Up Ponds A, B, and C within permit limitations when flows are above threshold limits as described above. If Broad River flow is below the threshold limits, make-up water for station operations would be supplemented by water stored in Make-Up Ponds B and C. If flow in the Broad River is below 483 cfs Lee Nuclear Station would suspend withdrawals from the Broad River for consumptive use and rely on water stored in Make-Up Ponds B and C.

Quantitative Analysis of Wet Mechanical-Draft Cooling Towers

To determine how often low flow conditions in the Broad River would result in the need for Lee Nuclear Station to withdraw from Make-Up Ponds B or C for supplemental cooling water, a water model was developed to analyze water balance needs to support station operations with wet mechanical-draft cooling towers. A summary of water model inputs along with stage-volume data, stage-area data, and daily evaporation rates for Make-Up Ponds A, B, and C are provided in Duke Energy's response to RAI 216 (Enclosure 2 of this letter). United States Geological Survey (USGS) stream flow gauge data for the Broad River was available for an 83-year period of record, 1926 through 2008. This data was used to establish daily average flows for the Broad River at the Lee Nuclear site. The water model was then used to analyze the daily average flow data for the Broad River as if Lee Nuclear Station was operating during this timeframe.

Results of the water model analyses identified 2002 as the most severe drought year and determined that the Broad River flow dropped below 483 cfs for an 112-day period (from 6/11/2002 through 9/30/2002) during this year. During this extended drought, all of the usable volume in Make-Up Pond B (3,156 acre-feet (ac-ft)) would have been depleted to support operations of the wet cooling towers and Make-Up Pond B would have been at its maximum drawdown level for 69 days. Calculations described in Duke Energy's response to RAI 206 (Reference 1) reflect that approximately 11,000 ac-ft of usable storage is needed in Make-Up Pond C to support continued station operations. Additional supplemental water storage to support approximately 20 days of station operations (approximately 2,500 ac-ft) was applied as design margin in the sizing of Make-Up Pond C due to the uncertainty of the length/severity of a future drought. This design margin provides a reasonable buffer to prevent forced outages in the future as a result of loss of cooling water supply.

Daily water consumption data, Broad River daily flows, and water balance model results using wet cooling towers for 2002 are provided in Duke Energy's response to RAI 216 (Enclosure 2 of this letter). Figure 5.2-1 of the ER Supplement illustrates the number of times Make-Up Pond B or Make-Up Pond C would have been used during the 83-year period of record as well as the magnitude of the drawdowns assuming Lee Nuclear Station was operating during this timeframe. The water available in Make-Up Pond B would have been insufficient five times during the 83-year period of record and the station would have drawn additional water from Make-Up Pond C. Supplemental water from Make-Up Pond C would have been used in 1954, 1956, 2002, 2007, and 2008 with drawdown magnitudes of 5 to 19 ft.

Associated changes to ER Supplement Subsection 5.2.1 and ER Supplement Tables 5.2-3 and 5.2-4 to reflect minor changes resulting from an enhancement that was made to the water balance model are provided as Attachments 128-01, 128-02, and 128-03, respectively. Changes to this text and these tables do not affect any conclusions. ER Supplement Figures 5.2-2 through 5.2-6 will not be changed because the changes are so small that they are not discernible in these figures.

Evaluation of Hybrid (Wet-Dry) Cooling Towers – Alternative to Selected Heat Dissipation System

Screening of Alternatives for Heat Dissipation System

Screening of alternatives to the selected heat dissipation system is outlined in ER Subsection 9.4.1.2. Hybrid (wet-dry) cooling towers were evaluated in this screening of alternatives for a preferred heat dissipation system as noted in Subsection 9.4.1.2.4 of the ER. Additional cooling technologies were also included in the alternatives evaluation, as discussed later in this response.

Evaluation of Alternatives for Supplemental Water

Duke Energy also considered hybrid cooling as an option in the evaluation of cooling water alternatives for providing supplemental water required to support station operations during periods of low flow in the Broad River. This evaluation concluded that hybrid cooling would not support sufficient reduction in the volume of supplemental cooling water required so as to obviate the need for Make-Up Pond C; therefore, this alternative was eliminated from further consideration at that time.

Feasibility Evaluation of Hybrid (Wet-Dry) Cooling Towers

Additional review of a hybrid (wet-dry) cooling system was conducted by way of a detailed feasibility evaluation of hybrid cooling; this evaluation was performed to determine if sufficient consumptive water savings could be realized such that the usable storage in Make-Up Pond B would support station operations during low flow periods in the Broad River, thereby eliminating the need for Make-Up Pond C.

The feasibility evaluation (described in further detail below) has reaffirmed the conclusion that hybrid cooling would not support sufficient reduction in the volume of supplemental cooling water required so as to obviate the need for Make-Up Pond C. This evaluation also concludes that hybrid cooling in addition to Make-Up Pond C is neither environmentally preferable to the selected heat dissipation system nor practicable. Associated changes to ER Subsection 9.4.1.2.4 to clarify why wet-dry or hybrid cooling is not considered superior to the selected heat dissipation system for Lee Nuclear Station are provided as Attachment 128-05.

Hybrid Cooling System Sizing

The feasibility evaluation considered a hybrid cooling system comprised of 50% indirect dry cooling towers in series with 100% wet mechanical-draft cooling towers as shown in Figure 1 (Attachment 128-07). The dry cooling towers are assumed to be sized to reject 50% of the heat load at the design dry bulb temperature for the Lee Nuclear site of 92°F (1% exceedance). The wet cooling towers would be sized to reject 100% of the heat load. The dry cooling towers (3 per unit) would be very large (100 ft wide by 935 ft long by 100 ft high) owing to the significant surface area required for heat transfer to support the selected range of heat dissipation. A summary of the equipment footprint for the dry cooling towers is provided in Table 1 (Attachment 128-08). Land in the vicinity of the dry cooling towers would have to be cleared and maintained devoid of vegetation to avoid impacts to air flow and performance of the equipment.

Conceptual Layout

A conceptual layout of the hybrid cooling system including placement of the dry cooling towers on the Lee Nuclear Station site is provided as Figure 2 (Attachment 128-09). Owing to the large footprint and manufacturer's spacing requirements of this equipment, many other facilities on the site shown in ER Supplement Figure 3.1-1 would have to be relocated (e.g., wet cooling towers, 230 kV and 525 kV switchyards, waste water retention basins, construction office building and parking, receiving warehouse, etc.). The meteorological tower for the site would also have to be relocated to avoid being in close proximity of any tall structures, systems, or components.

Design Margin

The hybrid cooling system feasibility evaluation considered temperature data for 2002, the most severe drought year on record for the Lee Nuclear Station site. The conceptual design of the hybrid cooling system, and in particular the dry cooling towers, includes a 25% design margin to the theoretical maximum heat transfer to account for degradation in performance (e.g., interior fouling of tubing, exterior fouling of heat transfer fins, and wind and recirculation effects from adjacent cooling towers). The potential for higher temperatures in future years (i.e., potential for temperatures in excess of the data used from the most severe drought year) and issues associated with "first-of-a-kind" engineering also contribute to uncertainty in this system, but are conservatively not included in the design margin.

Generation Efficiency

Because the hybrid cooling system uses the wet cooling towers to keep the Circulating Water System temperature from exceeding 91°F during the hot summer conditions, there would be no negative impact to the generation efficiency of the nuclear units.

Control Strategies

Hybrid cooling towers can be operated under various control philosophies. For completeness, Duke Energy performed evaluations under a maximum "water savings" control strategy as well as under a "power savings" control strategy. These evaluations are presented below.

Quantitative Analysis of Hybrid Cooling Towers – Maximum "Water Savings" Evaluation

For the maximum "water savings" evaluation, the dry cooling towers were assumed to operate year-round with the wet cooling towers being placed in and out of service as required based on ambient dry bulb temperatures. For ambient dry bulb temperatures below 69°F, the dry cooling towers would reject 100% of the heat dissipation duty and the wet cooling towers could be shut down. As the ambient dry bulb temperature increases, the wet cooling towers would be placed into service one tower at a time as required to support heat dissipation. The control philosophy (on a per-unit basis) for the maximum "water savings" hybrid cooling system is shown on Figure 3 (Attachment 128-10).

The hybrid cooling system evaluation calculated the consumptive water demand on an hourly basis for the 50% indirect dry cooling towers in series with the 100% wet cooling towers for the year 2002. These hourly results were converted to daily water consumption for the "water savings" evaluation and are summarized in a table provided with Duke Energy's response to RAI 216 (Enclosure 2 of this letter). Duke Energy then applied the daily water consumption data for the "water savings" evaluation of the hybrid cooling system in the water model for Lee Nuclear Station to determine the volume of supplemental water required to support station operations during 2002, the most severe drought year on record. The water model results show that Make-Up Pond B usable storage was depleted on 08/12/2002 and 2,778 ac-ft of additional supplemental water would be required to support station operations. Broad River daily flows and water balance model results with hybrid cooling towers for 2002 (under the "water savings" evaluation, where dry cooling towers are assumed to run year-round) are provided in Duke Energy's response to RAI 216 (Enclosure 2 of this letter).

The hybrid cooling system would result in an overall reduction in the water consumption to support heat dissipation; however, these savings come at a loss of generation output from the plant due to higher parasitic loads. The additional parasitic load to power the large fans on the dry cooling towers is approximately 23 to 24 megawatts per unit as shown in Figure 4 (Attachment 128-11). The variation in parasitic load is a consequence of the variation in air density which is a function of the dry bulb temperature.

Quantitative Analysis of Hybrid Cooling Towers – "Power Savings" Evaluation

A "power savings" evaluation for the hybrid cooling system was also considered. Noting that flows in the Broad River are normally (98 percent of the time) well above the minimum flow release for the Ninety-Nine Islands Reservoir of 483 cfs and dry cooling towers have a generation penalty on plant output (parasitic loads of fans), a separate evaluation considered limiting the operation of the dry towers to periods of significant drought. Figure 5.2-1 of the ER

Supplement illustrates the number of times Make-Up Pond B or Make-Up Pond C would have been used during the 83-year period of record as well as the magnitude of the drawdowns, assuming Lee Nuclear Station was operating during this timeframe. Over 90% of the drawdowns on Make-Up Pond B are less than 6 ft; therefore, a 6-ft drawdown on Make-Up Pond B was selected for this evaluation as the threshold to place the dry cooling towers into operation (i.e., selected as the indicator of a significant drought). Once placed into operation, the dry cooling towers would remain in service until both Make-Up Ponds B and any additional required supplemental water storage had been restored to full pond elevation.

The daily water consumption for the "power savings" evaluation is based on the consumptive water required for operation of the wet cooling towers until Make-Up Pond B is drawn down 6 ft and the dry cooling towers are placed into service. The daily water consumption is then based on the hybrid cooling system evaluation (i.e., same as "water savings" evaluation). When Make-Up Ponds B and any additional required supplemental water storage are refilled, the dry cooling towers are then removed from service and the daily water consumption reverts back to being based on the consumptive water required for operation of the wet cooling towers. The daily water consumption data for 2002 corresponding to the "power savings" evaluation are summarized in a table provided with Duke Energy's response to RAI 216 (Enclosure 2 of this letter). Duke Energy then applied the daily water consumption data for the "power savings" evaluation of the hybrid cooling system to the water model to determine the volume of supplemental water required to support station operations during 2002, the most severe drought year on record. The water model results indicate that Make-Up Pond B usable storage would have been depleted on 08/04/2002 and 3,263 ac-ft of additional supplemental water would be required to support station operations. Broad River daily flows and water balance model results with hybrid cooling towers for 2002 (under the "power savings" evaluation, where dry cooling towers are placed in service only after Make-Up Pond B is drawn down 6 ft) are provided in Duke Energy's response to RAI 216 (Enclosure 2 of this letter).

As would be expected, the "power savings" scenario results in a less significant loss in generation from parasitic load as the "water savings" scenario. Based on the water balance model results for the "power savings" evaluation, the dry cooling towers would have been placed into service on 06/18/2002 when drawdown in Make-Up Pond B reached a 6 ft drawdown, and removed from service on 10/29/2002 when Make-Up Ponds B and C would have returned to full pond levels (for the purposes of the water model analysis to support this evaluation, Make-Up Pond C was assumed to be the additional required supplemental water storage). With a more limited period of dry cooling tower operation, the generation losses from the "power savings" scenario are approximately 37% of the losses experienced in the "water savings" scenario. In years with no significant drought, there would be no appreciable generation losses under the "power savings" scenario beyond those associated with the selected heat dissipation system (i.e., for running the wet cooling towers).

Make-Up Pond C Requirements Using Hybrid (Wet-Dry) Cooling Towers

The maximum "water savings" evaluation of hybrid cooling towers identified that 2,778 ac-ft of additional supplemental water would be required to support station operations under this control strategy. To provide a reasonable buffer to prevent forced outages in the future as a result of loss of cooling water supply, additional supplemental water storage to support approximately 20 days of station operations (approximately 2,500 ac-ft) should be applied as a design margin.

Therefore, the overall volume of additional supplemental water that would be required for the maximum "water savings" evaluation of hybrid cooling towers is 5,278 ac-ft.

The "power savings" evaluation of hybrid cooling towers identified that 3,263 ac-ft of additional supplemental water would be required to support station operations under this control strategy. Adding the 20-day buffer as discussed above (approximately 2,500 ac-ft) yields an overall volume of additional supplemental water that would be required for the "power savings" evaluation of hybrid cooling towers of 5,763 ac-ft.

Make-Up Pond C is a viable alternative for providing storage for the additional supplemental water required to support station operations with hybrid cooling towers. The sizing of Make-Up Pond C to support hybrid cooling towers should average the storage needs of both the maximum "water savings" evaluation and the "power savings" evaluation since the required storage volumes are very similar in magnitude (i.e., 5,278 ac-ft and 5,763 ac-ft, respectively).

In calculating the size of Make-Up Pond C, an average storage volume of approximately 5,500 ac-ft is assumed. With the floor of the intake in Make-Up Pond C at elevation 545 ft and 10 ft of submergence for the pump intake, dead storage is 147 ac-ft. Adding this dead storage volume to the 5,500 ac-ft of required usable storage yields 5,647 ac-ft which corresponds to a Make-Up Pond C elevation of approximately 610 ft. Adding 20 ft to this elevation based on compliance with CWA §316(b) requirements [40 CFR §125.84(b)(3)(ii)] as described in Duke Energy's response to RAI 206 (Reference 1) results in a full pond elevation of 630 ft msl.

The full pond elevation of Make-Up Pond C required to support 100% wet cooling towers as indicated in the ER Supplement is 650 ft msl. Refer to Figure 5 (Attachment 128-12) for a footprint and water depths of Make-Up Pond C at this full pond elevation. Both the maximum "water savings" evaluation and the "power savings" evaluation of a hybrid cooling system with 100% wet cooling towers and 50% indirect dry cooling towers determined that additional supplemental water would be required to support station operations. A smaller Make-Up Pond C with a full pond elevation of 630 ft msl would support station operations with hybrid cooling towers as noted above. Refer to Figure 6 (Attachment 128-13) for a footprint and water depths of Make-Up Pond C at a full pond elevation 630 ft msl.

Additional Alternatives to Selected Heat Dissipation System

Additional cooling technology alternatives to the selected heat dissipation system that were evaluated are Dry Cooling Towers and Wet-Dry Cooling Towers (i.e., hybrid towers) as summarized in ER Supplement Subsection 9.4.1.2.3 and ER Subsections 9.4.1.2.3 and 9.4.1.2.4, respectively.

Air-Cooled Condenser

The most common type of dry cooling tower technology deployed at power generation facilities is the air-cooled condenser (ACC). However, as noted in ER and ER Supplement Subsection 9.4.1.2.3, the ACC technology would require large-scale changes to the standardized AP1000 design. The ACC is not compatible with the condenser and turbine design described in the AP1000 certified design and would require extensive revision to fundamental design elements of the main steam, feedwater, and heater drains systems. Essential elements of the turbine building foundation, structure, and turbine missile evaluation would also require revision. Therefore, this system does not meet the need for heat dissipation supporting operation of the Lee Nuclear Station.

Indirect Dry Cooling

The other type of dry cooling tower technology is the indirect dry tower. Duke Energy performed a feasibility evaluation of a 100% indirect dry cooling system. This evaluation, based on 2002 temperature data for the site, concluded that this type of cooling technology is not feasible for use at Lee Nuclear Station since the system cannot maintain Circulating Water System temperature within standard plant design limits for the AP1000 for most days in the months of June, July, and August. Accordingly, this type of system does not meet the need for heat dissipation supporting operation of the Lee Nuclear Station.

Associated changes to ER and ER Supplement Subsection 9.4.1.2.3 to clarify why dry cooling towers are not feasible for Lee Nuclear Station are provided in Attachment 128-04.

As noted in ER Subsection 9.4.1.2.4, wet-dry or hybrid cooling towers use a combination of wet and indirect dry cooling technologies. Hybrid cooling towers can be one of two configurations: a design that uses the combination of separate wet cooling towers and dry cooling towers (air-cooled heat exchangers), or a single cooling tower equipped with integrated wet and dry cooling sections.

The configuration consisting of a combination of separate wet and dry cooling towers is thoroughly evaluated and addressed in this RAI response.

Single Cooling Tower with Wet and Dry Cooling Sections

The single cooling tower with wet and dry cooling capability operates in a manner similar to a wet cooling tower. Plume abatement is the most common reason for selecting this technology. The decrease in tower consumptive water use is limited by the size of the dry cooling section; accordingly, this configuration does not save as much water as the hybrid cooling system with separate wet and dry cooling towers. As discussed in ER Subsection 5.3.3, the design and environmental impacts from cooling tower plumes are considered SMALL or non-existent. Therefore, the selection of a plume abatement technology is not warranted for the Lee Nuclear site.

Supplemental Water Alternatives Considering Hybrid Cooling System

ER Supplement Subsection 9.4.2.2.5 evaluated several alternatives for providing the additional supplemental water required to support station operations during extended periods of low flow in the Broad River. The quantitative analyses of hybrid cooling towers in this response concluded that, even if hybrid towers were deployed, approximately 5,500 ac-ft of additional supplemental water would be required.

The supplemental water alternatives of groundwater, treated wastewater, increasing the size of Make-Up Pond B, and release of water from upstream reservoirs were previously evaluated as summarized in ER Supplement Subsections 9.4.2.2.5.1, 9.4.2.2.5.2, 9.4.2.2.5.3, and 9.4.2.2.5.4, respectively, to determine if any were viable alternatives for providing the required 11,000 ac-ft of supplemental water to support wet cooling towers. None were viable alternatives. For completeness, each of these supplemental water alternatives is reevaluated below to determine if any is a viable alternative for providing approximately 5,500 ac-ft of supplemental water required to support a hybrid cooling system alternative to the selected heat dissipation system.

Groundwater

Groundwater is not a viable alternative for providing 5,500 ac-ft of supplemental water as groundwater yields in the vicinity of the Lee Nuclear site will not supply sufficient water and the site is not large enough to support the required number of wells.

Treated Wastewater

Two wastewater treatment facilities are currently located in Cherokee County, South Carolina. The Clary Wastewater Treatment Plant discharges treated wastewater into Thicketty Creek which flows into the Broad River downstream of the Ninety-Nine Islands Reservoir. The Broad River Wastewater Treatment Plant discharges treated wastewater into the Broad River upstream of the river water intake structure for Lee Nuclear Station. However, the combined utilization rates from both the Clary and Broad River Wastewater Treatment Plants as shown in ER Table 2.5-19 are insufficient to provide the required supplemental water; therefore, treated wastewater is not a viable alternative.

Increasing the Size of Make-Up Pond B

The full pond elevation of Make-Up Pond B is 570 ft msl. Draining, dredging, blasting and excavating to lower the entire bottom of Make-Up Pond B by 15 ft would increase the usable storage by 2,569 ac-ft. Significant additional environmental impacts to open water, streams, and wetlands would result from implementing these changes and the changes would not result in adequate storage for additional supplemental water. In addition to lowering the bottom of Make-Up Pond B by 15 ft, the dam could be raised 15 ft to support raising the full pond elevation to 585 ft msl. Raising the dam 15 ft would result in significant additional environmental impacts to land use, open water, streams, and wetlands. This change would also result in significant site flooding concerns for Lee Nuclear Station, whose plant grade elevation is 589.5 ft (i.e., flooding concerns from Probable Maximum Flood (PMF) and Probable Maximum Precipitation (PMP)). These concerns would have to be addressed by adding safety-related flood protection walls and other features to protect safety-related structures, systems, and components (SSCs) of the plant from flooding. However, the addition of dry cooling towers present a significant challenge to overall land use on the Lee Nuclear site as shown on Figure 2 (Attachment 128-09), and the site layout and overall land use cannot support the addition of both dry cooling towers and safety-related flood protection walls and other features to protect safety-related SSCs from flooding.

The combination of both of these changes to Make-Up Pond B could increase usable storage by 5,645 ac-ft, which would satisfy the required 5,500 ac-ft of supplemental water in support of the use of hybrid cooling. But as discussed above, layout and land use do not support this combination of options, and increasing the size of Make-Up Pond B also results in significant additional environmental impacts to open water, streams, and wetlands. Considering these site layout/land use issues and environmental impacts, increasing the size of Make-Up Pond B is not a viable alternative for providing 5,500 ac-ft of supplemental water.

Release of Water from Upstream Reservoirs

ER Supplement Subsection 9.4.2.2.5.4 states that the maximum dependable storage from upstream reservoirs is 4,900 ac-ft. Noting that the upstream reservoirs are a long distance from the Lee Nuclear site and there is no guarantee that released water would actually reach the site in extended droughts (i.e., owing to the potential for released water to be consumed by upstream users), reliance on release of water from upstream reservoirs is considered to be high risk. Therefore, release of water from upstream reservoirs is not a viable alternative for providing the required 5,500 ac-ft of supplemental water.

None of these alternatives is viable for providing the supplemental water that is required to support a hybrid cooling system. Make-Up Pond C is still the preferred alternative for supplemental water, even considering the possible use of a hybrid cooling system.

Associated changes to ER Supplement Subsection 9.4.2.2.5.3 to clarify the evaluation of increase in storage volume from increasing the size of Make-Up Pond B are provided in Attachment 128-06.

Environmental Impacts Considering a Hybrid Cooling System

Guidance provided in NUREG-1555 (Sections 9.4.1 and 9.4.2) was used to identify key screening factors for evaluating environmental impacts associated with alternatives for heat dissipation systems and for supplemental water supply (i.e., land use impacts, aquatic ecology impacts, and water use impacts). Environmental impacts from other discriminators between hybrid cooling towers and wet cooling towers were also evaluated (i.e., noise, atmospheric emissions).

Duke Energy has evaluated the environmental impacts associated with construction and operation of Lee Nuclear Station with hybrid cooling towers (addition of dry cooling towers) and Make-Up Pond C with a full pond elevation of 630 ft msl. These impacts are compared below to the environmental impacts documented in the ER Supplement and Revision 1 of the ER associated with construction and operation of Lee Nuclear Station with round mechanical-draft wet cooling towers and Make-Up Pond C with a full pond elevation of 650 ft msl. Comparisons were made of environmental impacts resulting from: increased plant equipment footprint on the Lee Nuclear site from hybrid cooling towers compared to wet cooling towers; decreased footprint from Make-Up Pond C at full pond elevation 630 ft msl to support hybrid cooling towers, versus Make-Up Pond C at full pond elevation 650 ft msl to support wet cooling towers; decreased water use to support station operations with a hybrid cooling system compared to wet cooling towers; increased noise from hybrid cooling system compared to wet cooling towers; and increased atmospheric emissions (CO_2, SO_2, and NO_X) resulting from purchase of replacement power due to higher parasitic loads associated hybrid cooling towers compared to wet cooling towers.

Impacts on the Lee Nuclear Site

A review of the Lee Nuclear site equipment footprint from hybrid cooling towers (layout of dry cooling towers and relocation of other SSCs on the site) results in a land use impact of approximately 370 ac. Land use impacts of approximately 270 ac result from construction at the Lee Nuclear site with wet cooling towers, as summarized in ER Table 4.3-1. Ecological cover types impacted of each alternative are summarized on Table 2 (Attachment 128-14). Impacts to land use within the Lee Nuclear site are discussed in ER Subsection 4.1.1.1 and are considered SMALL with the use of wet cooling towers. Land use impacts associated with the deployment of a hybrid cooling system are larger, considering the additional area disturbed from the larger footprint of plant equipment (addition of dry cooling towers), but are also considered SMALL.

For the purpose of analyzing impacts to wetlands, streams, and open water, delineation data for the Lee Nuclear site that became available after issuance of Revision 1 of the ER was used. The impacts to wetlands, streams, and open water on the Lee Nuclear site from a hybrid cooling system increase to approximately 3 ac, 1400 ft, and 6 ac, respectively, as compared to the impacts from use of wet cooling towers of approximately 0 ac, 0 ft, and 1 ac, respectively. Environmental impacts are summarized on Table 2 (Attachment 128-14). Considering the use of wet cooling towers, the impacts from construction to aquatic communities on the Lee Nuclear site, which are discussed in Subsection 4.3.2 of the ER, were found to be SMALL. The impacts to aquatic communities are also SMALL on the Lee Nuclear site when considering the additional impacts from deployment of a hybrid cooling system.

Impacts at Make-Up Pond C

Land use associated with construction of Make-Up Pond C at full pond elevation 630 ft msl (i.e., to support a hybrid cooling system) impacts approximately 900 ac. Land use impacts of approximately 1,100 ac result from construction of Make-Up Pond C to full pond elevation 650 ft msl as summarized in Duke Energy's response to RAI 157 (Reference 2) for wet cooling towers. Ecological cover types impacted of each heat dissipation system alternative are summarized on Table 2 (Attachment 128-14). Impacts to land use at Make-Up Pond C are described in ER Supplement Subsection 4.1.2.2 and are considered MODERATE within the area of Make-Up Pond C and on a site and vicinity scale. While a 630-ft msl elevation constitutes a reduction in land use impacts, the associated land use impacts are still considered MODERATE within the area of Make-Up Pond C and on a site and vicinity scale.

Impacts to wetlands, streams, and open water for Make-Up Pond C at elevation 630 ft msl decrease to approximately 4 ac, 57,000 ft, and 14 ac respectively, as compared the impacts for Make-Up Pond C at elevation 650 ft msl of 4 ac, 68,000 ft and, 14 ac. Stream impacts reflect updated information provided in Duke Energy's response to RAI 164 (Reference 3). The results of this comparison are outlined in Table 2 (Attachment 128-14). Impacts from construction of Make-Up Pond C to full pond elevation 650 ft msl to aquatic communities are discussed in ER Supplement Subsection 4.3.2. As noted in ER Supplement Subsection 4.3.2.2.3, these impacts are LARGE at the London Creek watershed scale and MODERATE at the site and vicinity scale. Considering the decrease in impacted streams associated with a smaller Make-Up Pond C required to support a hybrid cooling system, the impacts to aquatic communities remain LARGE at the London Creek watershed scale and MODERATE at the site and vicinity scale.

Impacts to Water Use

Duke Energy has previously evaluated existing and future water supply needs in the Broad River to ensure that Lee Nuclear Station has sufficient water supply during operation and will not affect the water supply of downstream users. Impacts to water supply resulting from the operation of Lee Nuclear Station are discussed in Subsections 5.2.1.7 and 5.2.2 of the ER and ER Supplement. As stated in ER Supplement Subsection 5.2.2.2.1, Lee Nuclear Station uses Make-Up Ponds B and C to supply make-up water if river flow drops below 538 cfs; therefore, the impact of Lee Nuclear Station operations during low flow conditions on downstream future water availability is considered SMALL. Because a hybrid cooling system would require less consumptive water than wet cooling towers, this impact would also be considered SMALL for a hybrid cooling system. Environmental impacts are summarized on Table 2 (Attachment 128-14).

Impacts from Noise

ER Subsection 5.8.1.5 describes the potential impacts from noise. The main sources of continuous noise on the site are the cooling towers. The hybrid cooling system would consist of three dry cooling towers per unit with 48 large fans each, and three wet cooling towers with 12 large fans each, for a total of 180 large fans per unit. Therefore, the number of large fans required for a hybrid cooling system is five times the number of large fans required to support heat dissipation from a wet cooling tower system. Environmental impacts are summarized on Table 2 (Attachment 128-14). Projected noise from Lee Nuclear Station operations is considered to be of SMALL significance to workers and the public for a heat dissipation system with wet cooling towers. Owing to a significant increase in the projected noise from Lee Nuclear Station operations with a hybrid cooling system, noise impact would be considered to be SMALL to MODERATE to workers and would remain SMALL to the public.

Impacts to Air Quality from Atmospheric Emissions

Due to the higher parasitic loads from operating the high number of large fans on the dry cooling towers, deployment of the hybrid cooling system will result in higher atmospheric emissions (CO_2, SO_2, and NO_X) resulting from purchase of replacement power than experienced from the use of wet cooling towers. Environmental impacts are summarized on Table 2 (Attachment 128-14). Impacts to air quality from atmospheric emissions impact would be considered to be SMALL for hybrid cooling towers and for wet cooling towers.

In consideration of the relative impacts of a hybrid (wet-dry) cooling system at the Lee Nuclear Station site, such a technology would not be an environmentally preferable alternative.

Other Considerations Associated With a Hybrid Cooling System

40 CFR 230.10(a)(2) states that "an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes." Other considerations beyond the environmental impacts discussed above make the alternative of deploying a hybrid cooling system impracticable for Lee Nuclear Station. These considerations include: higher capital costs of a hybrid cooling system; higher replacement power costs due to higher parasitic loads; higher O&M costs due to additional equipment and more moving parts; and uncertainty associated with the evaluated technology not operating anywhere in the world at a comparable scale.

Capital Costs

Incremental costs (i.e., those costs above and beyond those associated with providing wet cooling towers) were estimated for deploying a hybrid cooling system at Lee Nuclear Station in accordance with the conceptual layout shown on Figure 2 (Attachment 128-09). The overall incremental costs are approximately $1 billion for both units. Additional details on the incremental costs are provided on Table 3 (Attachment 128-15). These incremental costs are disproportionate when compared to the estimated costs of deploying wet cooling towers and constructing Make-Up Pond C to support the operations of Lee Nuclear Station, particularly given that hybrid towers would not obviate the need to construct Make-Up Pond C.

Replacement Power Costs

Deployment of a hybrid cooling system would result in higher replacement power costs due to the higher parasitic loads associated with operating the high number of large fans on the dry cooling towers. Approximate replacement power costs for the first year of station operation (both units) are shown on Table 3 (Attachment 128-15) for the hybrid "water savings" option and the hybrid "power savings" option. Note that the replacement power cost for the hybrid "power savings" option varies from $0 (in years with no significant drought periods, the dry cooling towers would not operate, thus there would be no replacement power costs associated with the dry towers) to $11 million.

Higher O&M Costs

Higher O&M costs would be anticipated for a hybrid cooling system due to significantly more equipment and moving parts (i.e., five times as many fans on the hybrid cooling system that was evaluated as compared to wet cooling towers).

"First of a Kind" Technology Rather Than Existing Technology

The hybrid cooling system evaluated as an alternative heat dissipation system is comprised of 50% indirect dry cooling towers in series with 100% wet mechanical-draft cooling towers as shown in Figure 1 (Attachment 128-07). The dry cooling towers evaluated would be twice as large as any similar towers currently installed worldwide. Deployment of this hybrid cooling system would be "first of a kind" technology with uncertainties and questions about the system's operational capability that would put a substantial generating and capital asset at risk of not performing adequately. Wet mechanical-draft cooling towers are in use at many operating power generation facilities in the United States and the world. Wet cooling towers are considered "existing technology" rather than "first of a kind" technology.

The EPA rejected dry cooling as the best technology available for a national requirement because the technology carries costs that are sufficient to pose a barrier to its entry to the marketplace for some projected new facilities (Reference 4).

Accordingly, in addition to not being environmentally preferable, other considerations dictate that a hybrid (wet-dry) cooling system also would not be a practicable alternative for Lee Nuclear Station.

Conclusion

The development of Make-Up Pond C supports the overall water management strategy established by Duke Energy for Lee Nuclear Station. This strategy provides for management of water resources and minimizes water availability impacts that station operations might otherwise have on downstream ecology and water users during low flow conditions on the Broad River. Make-Up Pond C is sized to ensure adequate storage in anticipation of the most severe drought conditions. Permitting for Make-Up Pond C is expected to respect existing minimum release requirements in the FERC licensing for the Ninety-Nine Islands Reservoir, satisfy conditions in the South Carolina Water Withdrawal Permitting, Use, and Reporting Act, and minimize impacts to downstream resources and communities along the Broad River. Implementation of the preferred water management strategy allows the purpose and need for the project to be met, while minimizing the potential for downstream impacts.

Based on the alternatives evaluation performed in support of the ER Supplement, Duke Energy concludes that, pursuant to the guidance in NUREG-1555 (Subsections 9.4.1 and 9.4.2), no environmentally preferable option exists to wet mechanical-draft cooling towers (the selected heat dissipation system) and to the development of Make-up Pond C (the selected supplemental water alternative in support of the Circulating Water System) to support Lee Nuclear Station operation during potential extended periods of low flow in the Broad River.

Duke Energy also concludes that the selected water management strategy and cooling systems, consisting of wet mechanical-draft cooling towers and Make-Up Ponds A, B, and C constitute the Least Environmentally Damaging Practicable Alternative (pursuant to 40 CFR 230.10(a)) for achieving the overall project purpose.

References:

1. Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information, Ltr# WLG2010.10-04 dated October 14, 2010.
2. Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information, Ltr# WLG2010.07-03 dated July 9, 2010 (ML101950207).
3. Letter from Bryan J. Dolan (Duke Energy) to Document Control Desk, U.S. Nuclear Regulatory Commission, Response to Request for Additional Information, Ltr# WLG2010.07-06 dated July 16, 2010 (ML102100214).
4. United States Environmental Protection Agency (EPA). 2001. National Pollutant Discharge Elimination System: Regulations Addressing Cooling Water Intake Structures for New Facilities; Final Rule. [40 CFR Parts 9, 122, 123, 124, and 125] December 18, 2001. 66 Federal Register 65256, 65281.

Associated Revisions to the Lee Nuclear Station Combined License Application:

ER Supplement Subsection 5.2.1

ER Supplement Table 5.2-3

ER Supplement Table 5.2-4

ER and ER Supplement Subsection 9.4.1.2.3

ER Subsection 9.4.1.2.4

ER Supplement Subsection 9.4.2.2.5.3

Attachments:

Attachment 128-01	Mark-up of ER Supplement Subsection 5.2.1
Attachment 128-02	Mark-up of ER Supplement Table 5.2-3
Attachment 128-03	Mark-up of ER Supplement Table 5.2-4
Attachment 128-04	Mark-up of ER and ER Supplement Subsection 9.4.1.2.3
Attachment 128-05	Mark-up of ER Subsection 9.4.1.2.4

Attachment 128-06	Mark-up of ER Supplement Subsection 9.4.2.2.5.3
Attachment 128-07	Figure 1 – Indirect Dry Cooling Towers in Series with Wet Cooling Towers
Attachment 128-08	Table 1 – Equipment Footprint for Dry Cooling Towers
Attachment 128-09	Figure 2 – Conceptual Layout of Hybrid Cooling System on the Lee Nuclear Station Site
Attachment 128-10	Figure 3 – Control Philosophy for Hybrid Cooling System to Maximize Water Savings
Attachment 128-11	Figure 4 – Parasitic Load for Dry Cooling Towers (Per Unit)
Attachment 128-12	Figure 5 – Make-Up Pond C Full Pond Elevation 650 Ft. MSL – Footprint and Water Depths
Attachment 128-13	Figure 6 – Make-Up Pond C Full Pond Elevation 630 Ft. MSL – Footprint and Water Depths
Attachment 128-14	Table 2 – Environmental Impacts Considering a Hybrid Cooling System
Attachment 128-15	Table 3 – Other Considerations Associated with a Hybrid Cooling System

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

Attachment 128-01

Mark-up of ER Supplement Subsection 5.2.1

COLA Part 3, ER Supplement, Subsection 5.2.1, Hydrologic Alterations and Plant Water Supply, next to last paragraph, is revised as follows:

Figure 5.2-3 shows the two Make-Up Pond C drawdown events that would have hypothetically occurred in 1954 and 1956, where Make-Up Pond C would have supplied supplemental water for 25 and 21 days, respectively. In both of these drawdown events, Make-Up Pond C would have drawn down approximately 5 feet and would have taken between 78 and 89 days to fully recover. During the 2002 event (Figure 5.2-4), Make-Up Pond C would have been used for supplemental water for 75 days, resulting in a drawdown of approximately 19 ft. Refill operations would have taken 3436 days. During the 2007 event (Figure 5.2-5), Make-Up Pond C would have been used for supplemental water for 5756 days, resulting in a drawdown of approximately 1312 ft. Refill operations would have taken approximately 28 days. The remaining hypothetical event for Make-Up Pond C is shown graphically in Figure 5.2-6. Beginning in June 2008, Make-Up Pond C would have provided supplemental water for 52 days, which would have resulted in a drawdown of approximately 13 ft. Due to fluctuations in Broad River flows the refill operations would have taken 112113 days (Table 5.2-4). Table 5.2-6 provides the relationship between water surface elevation, area, and volume in Make-Up Pond B, and Make-Up Pond C.

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

Attachment 128-02

Mark-up of ER Supplement Table 5.2-3

Table 5.2-3

Make-up Pond B Drawdown Occurrences (January 1926 - April 2009) [a]

Histogram Breakouts	Magnitude of Drawdown Event (ft)	# Days to Lowest Elevation Reached[c]	# Days at Lowest Elevation	# Days to Refill Pond B from Lowest Elevation Reached[d]	Total # Days in Drawdown Event	Start Date	End Date
0 - 0.5 ft[b]	0.5	1	1	1	2	12/31/2001	1/1/2002
0.5 - 1 ft[b]	1.0	2	1	1	3	9/4/1954	9/6/1954
1 - 2 ft[b]	2.0	3	1	1	4	10/11/1930	10/14/1930
2 - 3 ft[b]	3.0	5	1	1	6	7/8/2000	7/13/2000
3 - 4 ft[b]	3.5	8	1	2	10	8/31/1999	9/9/1999
4 - 5 ft[b]	4.8	7	1	2	9	9/4/2008	9/12/2008
5 - 6 ft[b]	5.3	19	1	8	27	10/29/2001	11/24/2001
6 - 20 ft	6.1	7	1	5	12	9/20/2008	10/1/2008
6 - 20 ft	6.4	7	1	2	9	7/17/2000	7/25/2000
6 - 20 ft	6.7	9	1	2	11	9/14/2000	9/24/2000
6 - 20 ft	8.1	11	1	11	22	10/3/2000	10/24/2000
6 - 20 ft	10.0	15	1	3	18	9/13/1999	9/30/1999
6 - 20 ft	11.4	12	1	5	17	8/10/1999	8/26/1999
6 - 20 ft	14.0	17	1	19	36	8/18/2001	9/22/2001
6 - 20 ft	17.3	49	1	13	62	10/13/2008	12/13/2008
20- 30 ft	20.3	21	1	6	27	8/12/2000	9/7/2000
20- 30 ft	21.4	22	1	17	39	7/6/1986	8/13/1986
20- 30 ft	30.0	33	3	26 ~~27~~	61 ~~62~~	7/31/1956	9/29 ~~30~~/1956
20- 30 ft[5]	30.1	33	13	28	73	9/8/1954	11/19/1954
20- 30 ft[5]	30.1	30	10	53	92	6/2/2008	9/1/2008
20- 30 ft[5]	30.2	69 ~~68~~	27 ~~28~~	44	139	7/21/2007	12/6/2007
20- 30 ft[5]	30.8	29	69	15	112	6/11/2002	9/30/2002

Notes:

a Provisional USGS data ~~(12/23/2008-4/30/2009)~~ was not used in this analysis.

b Only the largest drawdown event in Figure 5.2-2 is shown.

c Number of days to lowest pond elevation includes the first day at the lowest elevation which results in this day being counted twice. As a result, the # days to the lowest elevation reached + # days at the lowest elevation + # days to refill Pond B do not equal the total # of days in the drawdown event (i.e., off by one day).

d Number of days to refill Pond B from lowest elevation begins on the first day that water can be pumped from the Broad River (1 to 251.1 ~~225~~ cfs) into Pond B until the full pond elevation (570 ft msl) is reached.

e Magnitude of drawdown event exceeds 30 ft due to evaporation losses during periods when Pond B had no usable storage.

ft = feet

ft msl = feet above mean sea level

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

Attachment 128-03

Mark-up of ER Supplement Table 5.2-4

Table 5.2-4

Make-up Pond C Drawdown Occurrences (January 1926 - April 2009) [a]

Drawdown Event	Magnitude of Drawdown Event (ft)	# Days of Evaporation Loss Prior to Lee Nuclear Station Alignment to Pond C[c]	# Days ~~Lee Nuclear Station Aligned to~~ Make-up Withdrawn from Pond C[d]	# Days at Lowest Elevation	# Days to Refill Pond C from Lowest Elevation Reached[e]	Total # Days in Drawdown Event	Start Date	End Date
2001 [b,f]	0.4	35 ~~36~~	0	1	2 ~~1~~	37	8/18/2001	9/23/2001
1986 [g,f]	0.5	38	0	1	2	40	7/6/1986	8/14/1986
1954	4.7	32 ~~31~~	25	1	8 ~~7~~	80 ~~78~~	9/8 ~~9~~/1954	11/26 ~~25~~/1954
1956	4.9 ~~5.0~~	32	21	2 ~~1~~	9 ~~8~~	69	7/31/1956	10/7/1956
2007	12.3 ~~12.5~~	68 ~~67~~	56 ~~57~~	2 ~~1~~	28	166 ~~165~~	7/21/2007	1/2 ~~1~~/2008
2008	12.9	29	52	1	113 ~~112~~	204 ~~203~~	6/2/2008	12/22 ~~21~~/2008
2002	19.3 ~~19.2~~	28	75	1	36 ~~34~~	147 ~~145~~	6/11/2002	11/4 ~~2~~/2002

Notes:

a Provisional USGS data ~~(12/23/2008 - 4/30/2009)~~ was not used in analysis.

b Only the largest drawdown event less than 0.5 ft in Figure 5.2-2 is shown.

c Period when Lee Nuclear Station would have withdrawn supplemental cooling water from Pond B and flows in the Broad River are below pumping threshold.

d Number of days that ~~Lee Nuclear Station aligned to~~ make-up withdrawn from Pond C are not necessarily consecutive days because Lee Nuclear Station pumped from Broad River as flow was available. As a result, the # days of evaporation loss prior to Lee Nuclear Station alignment to Pond C + # days ~~Lee Nuclear Station aligned to~~ make-up withdrawn from Pond C + # days at the lowest elevation + # days to refill Pond C do not equal the total # of days in the drawdown event.

e Number of days to refill Pond C from lowest elevation begins on the first day that water can be pumped (1 to ~~225~~ 200 cfs) from the Broad River into Pond C until the full pond elevation (650 ft msl) is reached.

f These events are not drawdowns to supply make-up water; Make-Up Pond C was drawn down from evaporative losses.

g Only the largest drawdown event between 0.5 ft and 1 ft from Figure 5.2-2 is shown.

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

Attachment 128-04

Mark-up of ER and ER Supplement Subsection 9.4.1.2.3

COLA Part 3, ER and ER Supplement Subsection 9.4.1.2.3, is revised as follows:

9.4.1.2.3 Dry Cooling Towers

Dry cooling is an alternative cooling method in which heat is dissipated directly to the atmosphere using a tower. This tower transfers the heat to the air by conduction and convection rather than by evaporation. Heat transfer is then based on the dry-bulb temperature of the air and the thermal transport properties of the piping material. A natural- or mechanical-draft configuration can be used to move the air.

Because there are no evaporative or drift losses in this type of system, many of the problems of conventional cooling systems are eliminated. For example, there are no problems with blowdown disposal, chemical treatment, fogging, or icing when dry cooling towers are utilized. Although elimination of such problems is beneficial, most currently available dry tower technologies require condenser and turbine designs outside the scope of the AP1000 standardized design.

While a wet tower uses the processes of evaporation, convection and conduction to reject heat, a dry tower is dependent on conduction and convection only. As a result, heat rejection is limited by the dry bulb temperature at the site. The higher the ambient temperature at the site, the higher the steam saturation pressure, and consequently, the higher the turbine backpressure will be.

Since dry towers do not rely on the process of evaporative cooling as does the wet tower, larger volumes of air must be passed through the tower compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and must be larger in size than comparable wet towers.

The U.S. Environmental Protection Agency (EPA) rejects dry cooling as the best available technology for a national requirement because the technology carries costs that are sufficient to pose a barrier to its entry to the marketplace for some projected new facilities. Dry cooling technology also poses some detrimental effects on electricity production by reducing the energy efficiency of steam turbines.

The increased exhaust gas emissions of dry cooling tower systems as compared with wet cooling tower systems provide additional support for EPA's rejection of dry cooling as the best available technology. Dry cooling technology results in a performance penalty for electricity generation that is likely to be significant under certain climatic conditions. A performance penalty is applied by the EPA to any technology (i.e., dry cooling) that requires the power producer to use more energy than would be required by another available technology (i.e., recirculating wet cooling) to produce the same amount of energy. Therefore, EPA does not consider dry cooling technology as the best available technology for minimizing adverse environmental impacts.

Two technologies are used in dry coolers: the air-cooled condenser and the indirect dry cooling tower.

The most common form of dry cooling tower technology is the air-cooled condenser (ACC). In this design, steam from the turbine exhaust is piped through large ducts to a separate air-cooled condenser located next to the turbine building. Fans draw air through cooling coils to reject heat from the exhaust steam. As the steam loses its heat, it condenses to water and is returned as steam generator feedwater.

Incorporation of the ACC technology (Reference 5) would require large-scale changes to the standardized design. The ACC is not compatible with the condenser and turbine design described in the certified design and would require extensive revision to fundamental design elements of the main steam, feedwater and heater drains systems. Essential elements of the turbine building foundation, structure and turbine missile evaluation would require revision.

The cooling units for an ACC must be located in immediate proximity to the turbine building and the size of the units requires extensive land use. As stated previously, dry towers require much larger heat transfer surfaces and are much larger in size than comparable wet towers. Extensive changes to the AP1000 turbine building footprint would be required to accommodate this design.

Because of the larger volume of air required for heat rejection, fan horsepower requirements for the ACC are typically 3 to 4 times higher than wet towers. This will significantly decrease the net electrical output of the unit. In addition, the AP1000 standardized electrical distribution design is not sized to accommodate these additional loads.

In addition to the impact on the AP1000 design, an ACC is not as thermally efficient as a wet cooling tower system, which would have a negative impact on plant performance. Dry cooling designs are unable to maintain design plant thermal performance during the hottest months of the year. Depending on weather conditions and the design heat rate, a plant can experience capacity reductions of up to 10 to 25 percent on the steam side alone, because of increased turbine backpressure.

As previously stated, the AP1000 turbine low pressure stage design requires operation at an average condenser backpressure of 3 inches (in.) Hg absolute to maintain design electrical output and has operational limits at 5 inches Hg absolute. State-of-the-art ACC designs can not operate within these parameters during the summer temperature conditions expected at the Lee Nuclear Station. ~~This would increase the probability of forced down powers and turbine trips.~~ Under typical summer temperature conditions at the site, plant operators would be required to decrease electrical output numerous times during the day to reduce the heat load on the ACC and maintain the turbine within specified operating limits. It is important to note that ACC designs in current use in the United States are combined with turbines specially designed to operate at these higher backpressures.

Incorporation of the ACC technology at the Lee Nuclear Station would extensively revise the AP1000 design reviewed during the 10CFR 52 Design Certification process. The revisions would impact safety-related design attributes, such as the offsite dose analysis. An ACC can not be integrated with the standardized turbine generator design without greatly increasing the probability of plant transients during summer operation. Therefore, this system is inferior to the selected heat dissipation system.

The second type of dry cooling tower technology is the indirect dry tower. In this design, the wet tower in the AP1000 standardized design is replaced with a large air-water heat exchanger. Circulating water from the condenser is piped through metal-finned tubes and fans force air over the tubes to reject heat to the air and atmosphere.

The advantages of indirect dry cooling towers are the same as the ACC design. The requirement for cooling water is eliminated and there are no problems with blowdown disposal, chemical treatment, icing or fogging.

~~The most significant disadvantage of indirect dry cooling towers is the size of the units. Indirect dry cooling is much less efficient than air cooled condensers because heat rejection is dependent on two thermal interfaces (steam/CWS/air), rather than the single interface used in the ACC (steam/air). Since indirect cooling has never been utilized at a 1000 MWe fossil or nuclear unit in the United States, establishing the actual size of the unit is difficult. However, based on relative efficiencies, an indirect dry cooling tower would require much more space than an ACC and would dwarf the footprint of a wet cooling tower.~~ An indirect dry cooling design, sized to reject 100% of the heat load would exceed the available space on the Lee Nuclear Station site. A system sized to fit in the available space, would not be capable of maintaining the circulating water temperatures required by the AP1000 standard plant design during typical summer temperature conditions.

~~Because of the loss of efficiency, the indirect dry cooling tower requires an even larger volume of air for heat rejection than the ACC. Therefore, fan horsepower requirements would increase beyond the ACC design, which is already 3 to 4 times greater than wet towers. An indirect cooling tower would decrease the plant net electrical output even more than an ACC. And as stated previously, the standardized electrical distribution design for the AP1000 is not sized to accommodate either the ACC or indirect dry cooling tower fan horsepower requirements.~~ Because an indirect dry cooling system uses the surrounding air to cool heat rejected from the condenser, it requires a large number of fans to circulate air through the cooling coils. The parasitic electrical requirement for these fans is very high; approximately 5 times the fan power requirements for a similarly sized wet tower system. The standardized electrical distribution design for the AP1000 is not sized to accommodate these fan horsepower requirements.

~~The ACC and indirect dry cooling towers both rely upon sensible heat rejection for cooling, so the turbine backpressure limitations in the ACC technology discussion are applicable to the indirect dry cooling design. Like the ACC, indirect dry cooling towers in current use are combined with turbines specially designed to operate at higher backpressures than the AP1000 standard design.~~

Incorporation of the indirect dry cooling tower technology at the Lee Nuclear Station is not possible because the site cannot provide the land usage ~~required~~ for ~~the~~ towers sized to maintain the circulating water temperatures required by the AP1000 standard design. The tower fan horsepower requirements greatly exceed the AP1000 standardized electrical distribution design and would substantially decrease the net electrical output of the plant. The indirect dry cooling towers would also require changes to the AP1000 design that would impact the 10CFR 52 certification of the plant design and negatively impact utility efforts towards plant standardization. Therefore, this system is inferior to the selected heat dissipation system.

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

Attachment 128-05

Mark-up of ER Subsection 9.4.1.2.4

COLA Part 3, ER Subsection 9.4.1.2.4, is revised as follows:

9.4.1.2.4 Wet Dry Cooling Towers

Wet-dry or hybrid cooling towers use a combination of wet and dry cooling technologies. If a hybrid design is used in conjunction with the AP1000 design, it will need to be a wet and indirect dry cooling combination to satisfy the design requirements for the turbine/condenser package specified in the Design Control Document certified by the NRC, because the AP1000 design has a surface condenser.

Hybrid cooling technologies that combine wet and indirect dry cooling technologies are composed of two configurations: a single tower equipped with integrated wet and dry cooling sections and a design that uses the combination of a separate wet tower and air-cooled heat exchangers.

The single tower with wet and dry cooling capability operates in a manner similar to that of a wet cooling tower. The additional dry section, typically located in the upper part of the cooling tower, transfers heat from the circulating water into an air stream that is then mixed with the moist air exiting the wet tower section. This increases the temperature and lowers the humidity of the air leaving the tower, suppressing formation of a visible plume. The plume abatement feature is the primary reason for selecting this technology as the decrease in tower consumptive water use is limited by the size of the dry cooling section. Consumptive water savings from this design are achieved through the decreased heat load on the wet section of the tower due to sensible heat rejection in the dry section. In addition, sensible heat rejection is dependent on the temperature of the ambient air, and during summer conditions, the heat rejection (and therefore consumptive water savings) decreases substantially. Therefore, these towers are not a good choice for sites with high ambient conditions during the summer, like those experienced at the Lee Nuclear Station.

Further reductions in consumptive water use would require increasing the size of the dry section. However, because the tower structure must support both wet and dry sections, there is a physical limitation to the size of the dry cooling sections that can be housed in a single tower arrangement. ~~For decreased consumptive water use, a second wet-dry cooling tower design that utilizes a separate wet tower and air-cooled heat exchangers is available. In this design, circulating water is routed to the wet and dry systems in a series or parallel flow arrangement to provide operating flexibility. Because the indirect dry cooling section can be located at a significant distance away from the wet tower, it can be sized large enough to accommodate a significant portion of the heat rejection requirements for the station.~~

<u>As discussed in ER Subsection 5.3.3, the design and environmental impacts from cooling tower plumes are considered SMALL or non-existent. Therefore, the selection of a plume-abatement technology is not indicated for the Lee site. The desired reductions in consumptive water use for the Lee Nuclear Station exceed the capabilities of a single tower with wet and dry cooling capability. Therefore, this hybrid cooling design was not selected.</u>

For decreased consumptive water use, a second wet-dry cooling tower design is available. This design utilizes wet towers and separate indirect dry cooling towers. Because the indirect dry cooling tower is a separate component, its size (and the attendant consumptive water savings) is not limited by the wet tower structure and can be sized large enough to accommodate a significant portion of the heat rejection requirements for the station. The indirect dry and wet towers are typically arranged in a series configuration. Hot circulating water from the condenser passes through the indirect dry cooling towers, where forced draft air circulation rejects heat to the atmosphere. Under low ambient temperature conditions, the indirect dry cooling towers can cool circulating water to the temperature requirements of the standard plant design and the wet towers are not used. As ambient temperatures increase, the wet cooling towers can be sequentially placed into operation to maintain the required circulating water temperature.

Like the integrated wet-dry tower, consumptive water use savings from the separate tower design are still dependent on the temperature of the ambient air. During hot weather conditions, heat rejection from the air-cooled heat exchangers decreases substantially, with the wet tower rejecting most of the heat load and a limited decrease in consumptive water usage.

Wet-dry cooling technologies have higher capital costs, land use, and consumptive power requirements than other technologies, such as wet mechanical draft cooling towers.

As discussed in ER Subsection 5.3.3, the design and environmental impacts from cooling tower plumes are considered SMALL or non-existent. Therefore, the selection of a plume-abatement technology is not indicated for the Lee site.

Although the average flow on the Broad River will support station operation with minimal effects on the downstream environment or users, the flow is subject to seasonal variations. As described in ER Subsection 5.2.1.3, the station plans to limit withdrawal from the Broad River during low flow conditions, utilizing water stored in on-site impoundments to supplement or replace withdrawals on the river.

The Lee Nuclear Station has evaluated the use ofwet-dry towers a hybrid system that utilizes separate indirect dry and wet towers, based on their its ability to reduce consumptive water use at the site and extend the availability of the water stored in on-site impoundments during extended periods of low-flow conditions on the river. The evaluated hybrid system utilized the largest indirect dry cooling towers that could be feasibly accommodated by the site layout. However, the watersavingwater saving features of the wet-dry technologies decrease markedly during hot weather operation, which is the time when low-flow conditions occur on the Broad River. During the months that favor operation of the wet-dry technologies for consumptive water savings, ample flow is available in the Broad River to support station operation with minimal effects on the downstream environment or users. While wet-dry tower technologies have the ability to reduce consumptive water use, the timing of the water conservation feature does not align with the need for this feature at the Lee Nuclear Site. Specifically, a hybrid tower configuration sized to conserve enough water to preclude shutdown during all historical low-flow) river conditions would require a footprint that would be prohibitive for the site as it currently exists. Based on this discussion, and giving due consideration to the higher capital costs and consumptive power

~~requirements of the wet-tower technologies, the systems are considered inferior to the selected heat dissipation system.~~

The hybrid cooling system results in an overall reduction in the water consumption to support heat dissipation; however, these savings come at a loss of generation output from the plant due to higher parasitic loads. The larger footprint of the hybrid system will require additional clearing and grading, which will negatively impact land use. Based on this discussion, and giving due consideration to the higher capital costs of the wet-dry tower technologies, the systems are considered inferior to the selected heat dissipation system.

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

Attachment 128-06

Mark-up of ER Supplement Subsection 9.4.2.2.5.3

COLA Part 3, ER Supplement Subsection 9.4.2.2.5.3, is revised as follows:

9.4.2.2.5.3 Increase the Size of Make-Up Pond B

This alternative includes dredging out several arms of Make-Up Pond B that were filled in during the original construction activities; dredging out remnants of a cofferdam that was used during construction of the main Make-Up Pond B dam; dredging out the entire bottom of Make-Up Pond B by 5 ft, 10 ft, and 15 ft; and increasing the height of the dam 10 ft and 15 ft.

During construction of the earthen dam, virtually all available material from the impounded area was used as fill material in the dam. Therefore, in order to increase the usable volume in the Make-Up Pond B, the pond would need to be dewatered and then a combination of excavation/ripping and blasting would be required. Increasing the Make-Up Pond B dam height would provide additional capacity but also invalidate the probable maximum flood (PMF) calculation for the Lee Nuclear Station and jeopardize the safety of the Lee Nuclear Station during the PMF. Even if these obstacles could be overcome, this alternative only increases the available supplemental water by 5,645 to 8,800 ac-ft which is 5,355 2,200 ac-ft less than the supplemental water requirement.

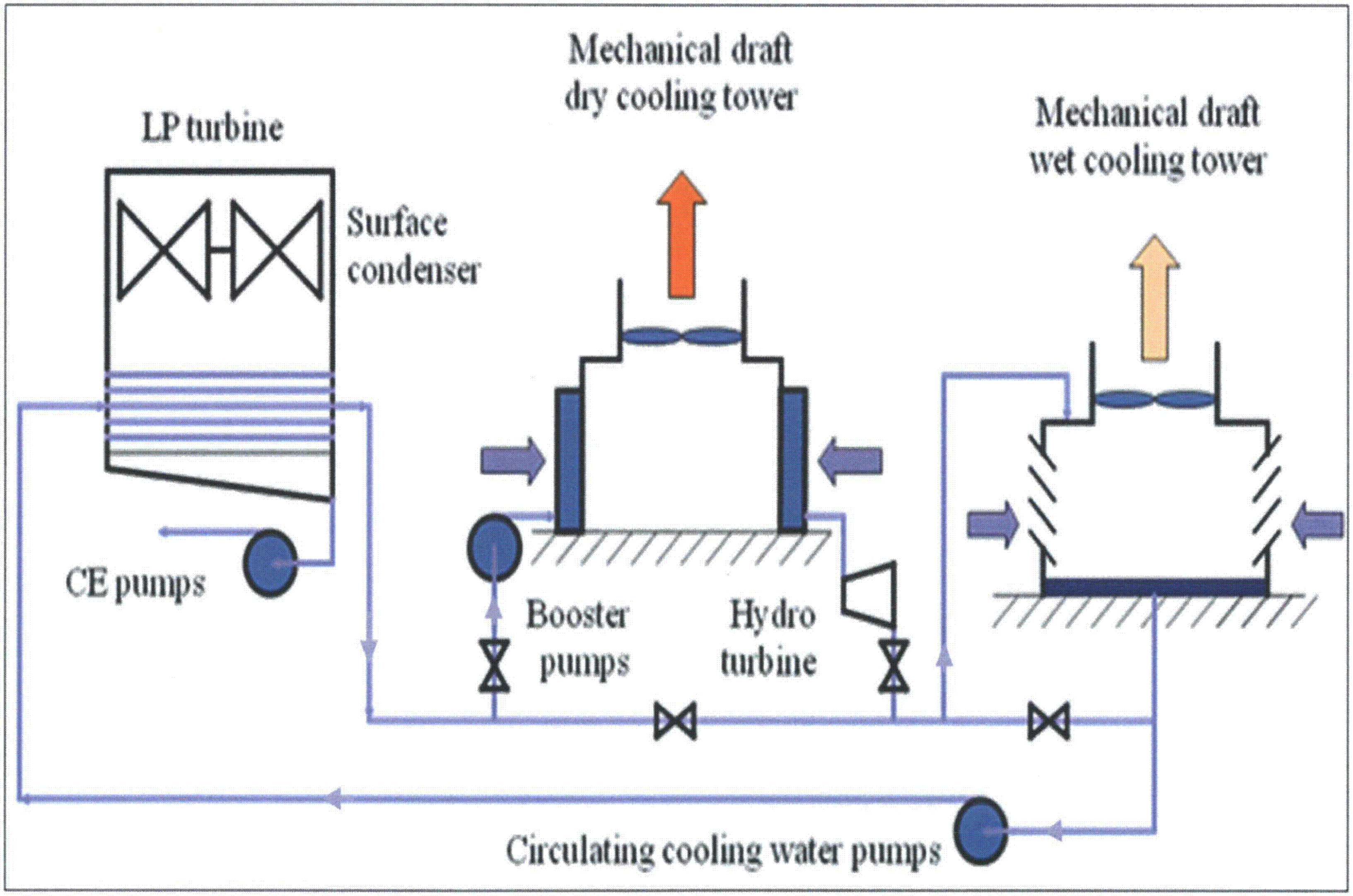
Consequently, this alternative was rejected as not meeting the need for supplemental water.

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

Attachment 128-07

Figure 1 – Indirect Dry Cooling Towers in Series with Wet Cooling Towers

Figure 1 – Indirect Dry Cooling Towers in Series with Wet Cooling Towers



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

Attachment 128-08

Table 1 – Equipment Footprint for Dry Cooling Towers

Table 1 – Equipment Footprint for Dry Cooling Towers

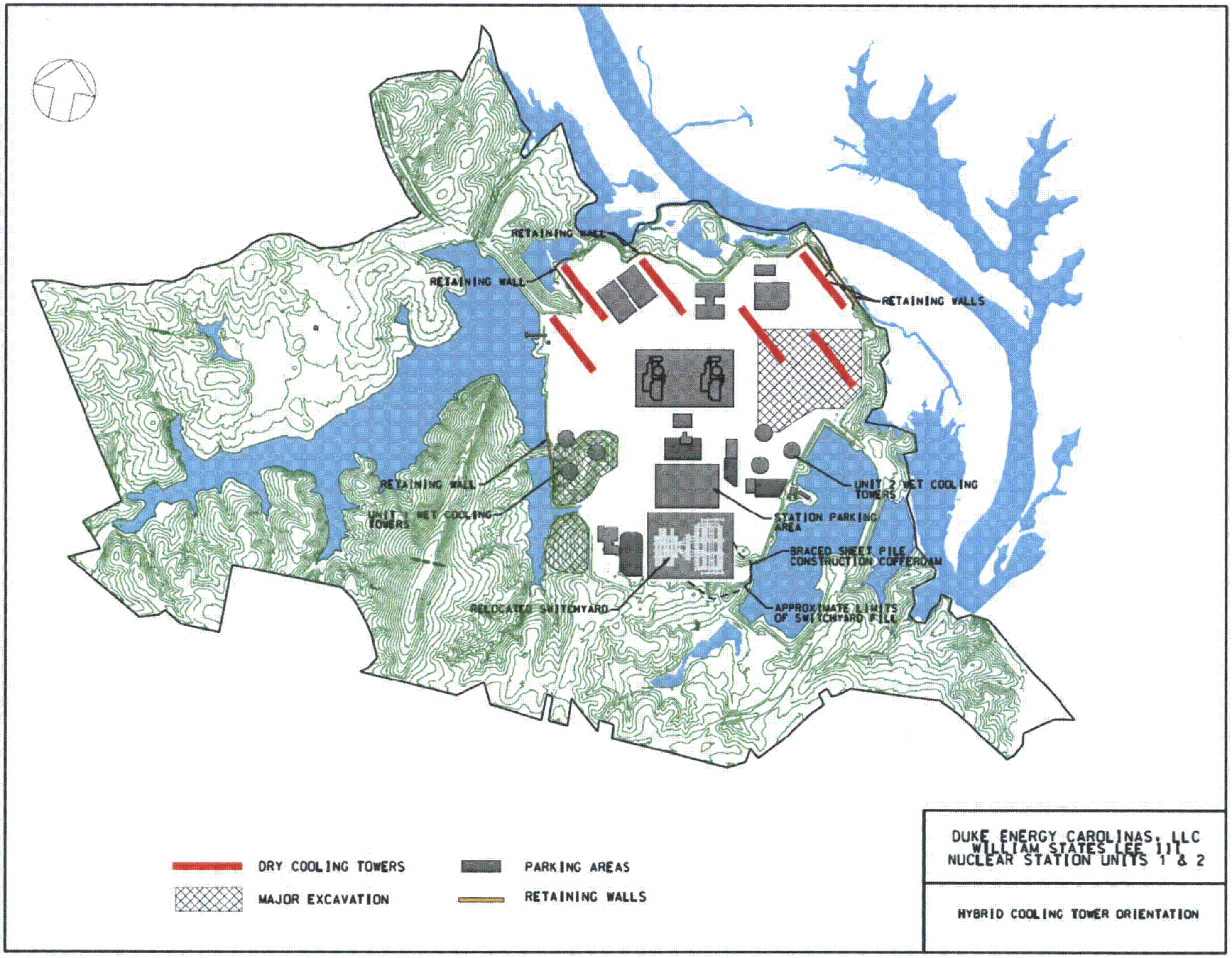
Parameter	Value
Total Number of Cells per unit	72
Total Number of Fans per unit	144
Number of fans per cell	2
Motor Rating per fan	200 HP
Number of towers per unit	3
Number of cells per tower	24
Tower length	935 ft
Cell dimensions (W x L)	100 ft x 39 ft
Tower width	100 ft
Tower height	100 ft

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

Attachment 128-09

Figure 2 – Conceptual Layout of Hybrid Cooling System on the Lee Nuclear Station Site

Figure 2 – Conceptual Layout of Hybrid Cooling System on the Lee Nuclear Station Site

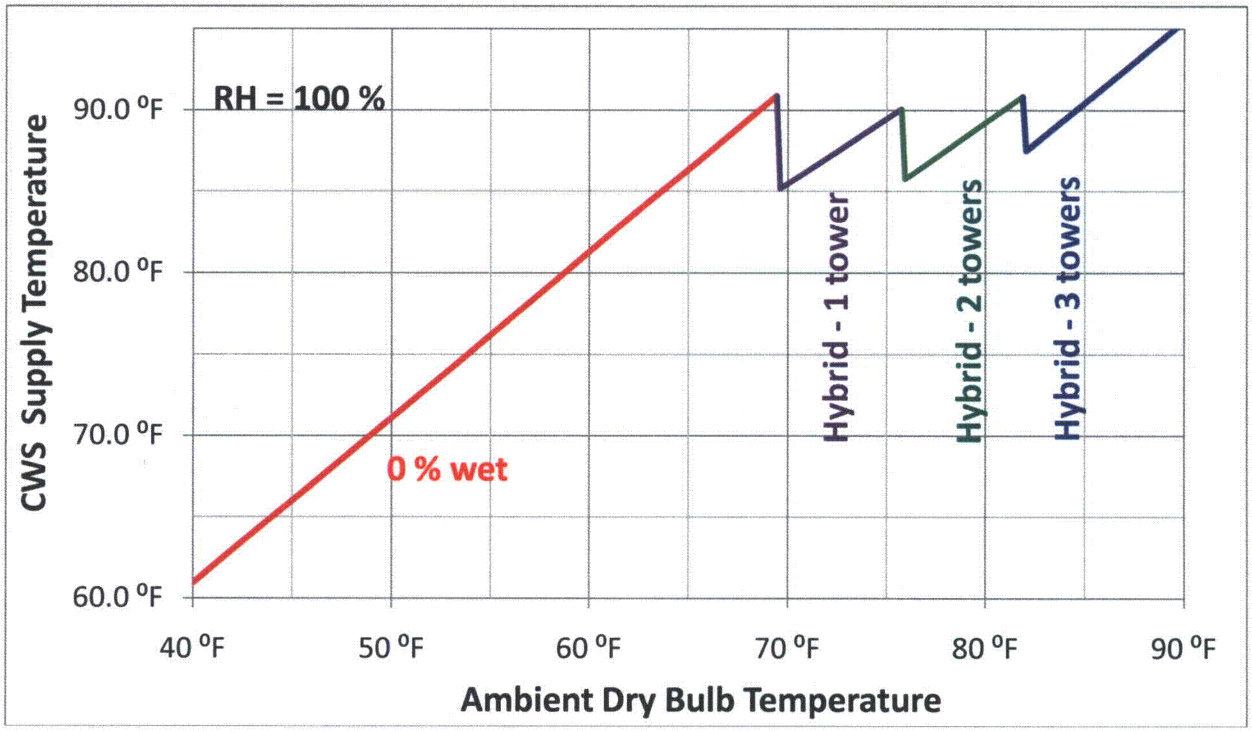


Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 128-10

Figure 3 – Control Philosophy for Hybrid Cooling System to Maximize Water Savings

Figure 3 – Control Philosophy for Hybrid Cooling System to Maximize Water Savings

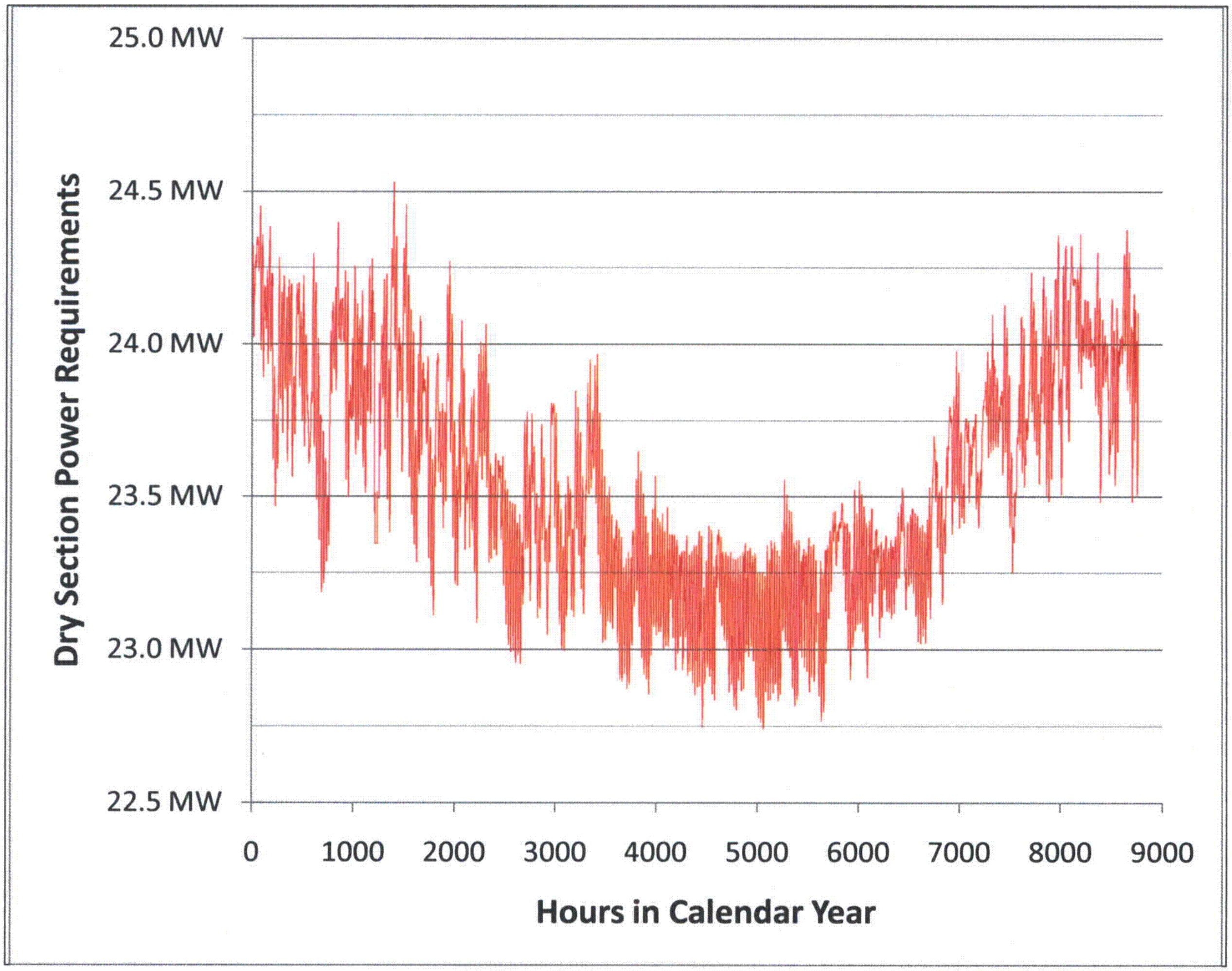


Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 128-11

Figure 4 – Parasitic Load for Dry Cooling Towers (Per Unit)

Figure 4 – Parasitic Load for Dry Cooling Towers (Per Unit)

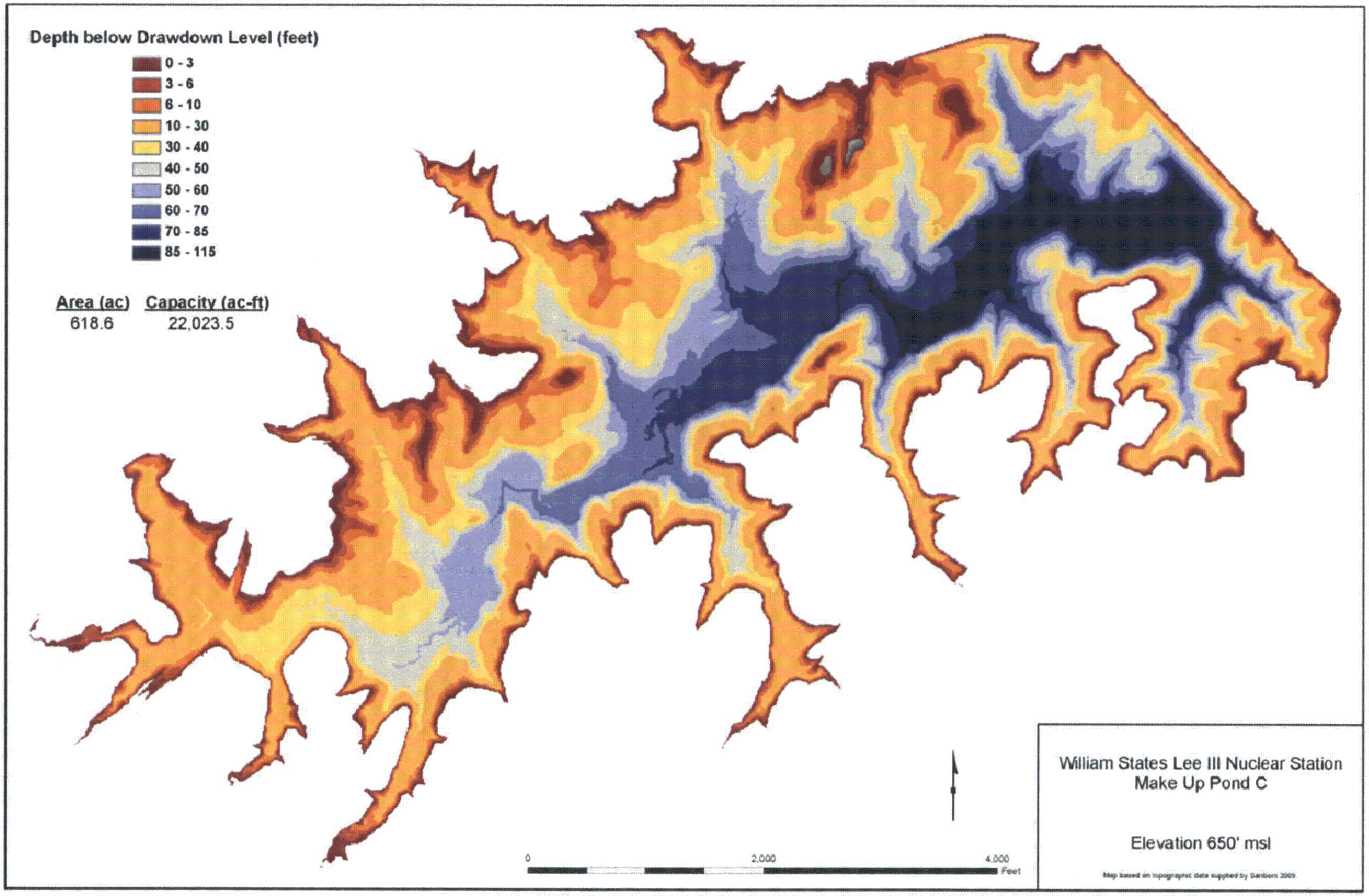


Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 128-12

Figure 5 – Make-Up Pond C Full Pond Elevation 650 Ft. MSL – Footprint and Water Depths

Figure 5 – Make-Up Pond C Full Pond Elevation 650 Ft. MSL – Footprint and Water Depths

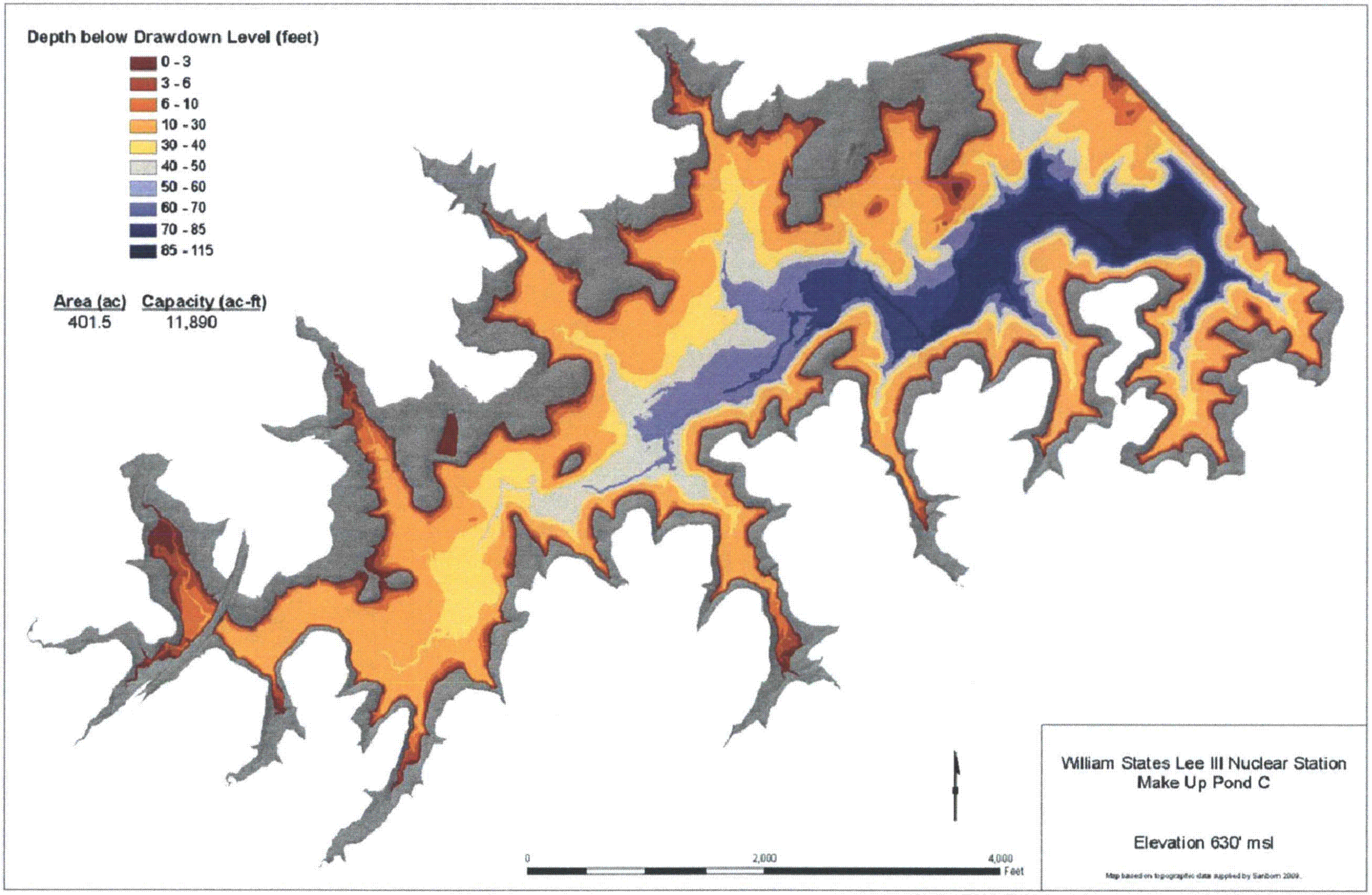


Lee Nuclear Station Response to Request for Additional Information (RAI)

Attachment 128-13

Figure 6 – Make-Up Pond C Full Pond Elevation 630 Ft. MSL – Footprint and Water Depths

Figure 6 – Make-Up Pond C Full Pond Elevation 630 Ft. MSL – Footprint and Water Depths



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

Attachment 128-14

Table 2 – Environmental Impacts Considering a Hybrid Cooling System

Table 2 – Environmental Impacts Considering a Hybrid Cooling System

SHEET 1 OF 2

	Land Use	Cover Type										
		MH	MHP	PMH	NJW	OFM	USC	AW	OW	OPMH	P	NAW
	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)	(Ac.)
Hybrid Cooling Towers												
Lee Nuclear Site	368.82	51.36	22.17	25.46	26.12	211.12	26.97	0.97	4.64	0	0	0
Make-Up Pond C (@ EL. 630) Impact	856.27	308.5	98.13	21.11	0	200.08	14.5	0.05	16	0.26	197.64	0
Total	**1225.09**	**359.86**	**120.3**	**46.57**	**26.12**	**411.2**	**41.47**	**1.02**	**20.64**	**0.26**	**197.64**	**0**
Wet Cooling Towers												
Lee Nuclear Site	270.13	4.49	17.75	10.75	32.54	192.12	16.67	0	0	0	0	
Make-Up Pond C (@ EL. 650) Impact	1114.69	412.02	147.96	34.3	0.03	253.84	15.13	0	15.99	6.12	229.22	0.08
Total	**1384.82**	**416.51**	**165.71**	**45.05**	**32.57**	**445.96**	**31.8**	**0**	**15.99**	**6.12**	**229.22**	**0.08**

	Wetlands	Streams	Open Water
	(Ac.)	(Ft.)	(Ac.)
Hybrid Cooling Towers			
Lee Nuclear Site	2.92	1408.26	5.24
Make-Up Pond C (@ EL. 630) Impact	4.03	56,719.00	13.68
Total	**6.95**	**58127.26**	**18.92**
Wet Cooling Towers			
Lee Nuclear Site	0	0	0.18
Make-Up Pond C (@ EL. 650) Impact	4.3	68,038	13.67
Total	**4.3**	**68038**	**13.85**

Table 2 – Environmental Impacts Considering a Hybrid Cooling System

SHEET 2 OF 2

		Hybrid Cooling Towers	Wet Cooling Towers
Land Use	Lee Nuclear Site	SMALL	SMALL
	Make-Up Pond C	MODERATE	MODERATE
Vegetative Cover Types	Lee Nuclear Site	SMALL	SMALL
	Make-Up Pond C	MODERATE	MODERATE
Wetlands, Streams, and Open Water	Lee Nuclear Site	SMALL	SMALL
	Make-Up Pond C	MODERATE	MODERATE
Water Use	Lee Nuclear Site	SMALL	SMALL
Noise	Lee Nuclear Site	SMALL - MODERATE	SMALL
Air Quality	Lee Nuclear Site	SMALL	SMALL
Cost	Lee Nuclear Site	LARGE	SMALL

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

Attachment 128-15

Table 3 – Other Considerations Associated with a Hybrid Cooling System

Table 3 - Other Considerations Associated With A Hybrid Cooling System

Incremental Capital Costs - Dry Cooling Towers for Hybrid Cooling System - 2 Units		
Total Costs		**$1,040,799,161**
Major Cost Components:		
Dry Cooling Tower Design and Supply		
Dry Cooling Tower Erection		
Excavation		
Foundations		
Piping		
Electrical		
Construction Services		
Project Office Services		
Allowances, Contingency, Overhead		
Replacement Power Costs for Higher Parasitic Loads Associated with Dry Cooling Towers (Annual Costs for First Year of 2 Unit Operation)		
Maximum "Water Savings" Option		**$30,000,000**
"Power Savings" Option	**Varies**	**$0 to $11,000,000**
Higher O&M Costs		
Hybrid Cooling System Has Much More Equipment Than Wet Cooling Towers		
Hybrid Cooling System - 180 Large Fans Per Unit Wet Cooling Towers - 36 Large Fans Per Unit		
"First of a Kind" Technology Rather Than Existing Technology		
Dry Cooling Towers Evaluated Would Be Twice As Large As Any Similar Operating Towers		

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

RAI Letter Dated: September 14, 2010

Reference NRC RAI Number: ER RAI 216, Alternatives

NRC RAI:

Provide the following information that will be cited in the response to RAI 128 (to be received by NRC in October 2010):

1. Table of stage-volume and stage-area data used to model Ponds B and C;
2. Water balance model results including daily stage, volume, surface area, inflow and outflow for Ponds A, B, and C;
3. Broad River daily flows used as input and the computed daily discharge from Ninety-Nine Islands Dam;
4. Daily evaporation rates for each pond; and
5. Any assumptions such as sources and sinks of water, and other initial and boundary conditions for these ponds or the Ninety-Nine Islands Reservoir.

The requested information is to be repeated for any alternative cooling scenario evaluated.

Duke Energy Response:

This response and the tables in Attachment 216-01 provide the water model inputs and output results for heat dissipation systems using 100% wet cooling towers and using hybrid cooling (combination of 100% wet and 50% indirect dry cooling towers in series) for the Lee Nuclear Station. For hybrid cooling, two separate evaluations were performed, a maximum "water savings" evaluation and a "power savings" evaluation. Duke Energy's response to RAI 128 provides an explanation of the evaluations performed for these cooling (heat dissipation) alternatives.

Table 1 provides stage-volume and stage-area data used to model Make-Up Ponds A, B and C.

Table 2 provides a summary of the water model inputs.

Table 3 provides Lee Nuclear Station withdrawals from the Broad River not considering make-up for pond evaporation that were used in the water model. Monthly variations shown are based on varying evaporative losses of the cooling towers (cooling tower evaporation is the lowest during the cooler months and the highest during the hotter months).

Table 4 provides Broad River monthly threshold flows (594 cfs to 606 cfs) used in the water model to support all consumptive water withdrawal from the Broad River. When flow in the Broad River is less than these monthly threshold flows in the water model, the amount above 543 cfs (483 cfs + 60 cfs future demand) is withdrawn from the Broad River and the additional amount needed for consumptive water use is withdrawn from the Make-Up Ponds B and C. When flow in the Broad River drops below 543 cfs in the water model, storage in the Make-Up Ponds B and C is relied on for all consumptive water make-up; no consumptive withdrawal is made from the Broad River. Blowdown and screen wash (23 cfs) will continue to be withdrawn from the Broad River because this water is returned to the Broad River and there is no net impact on downstream users.

Table 5 provides Broad River monthly threshold flows used in the water model to support maximum refill operations. The River Water Intake pumps have a design capacity of 125 cfs. The refill pumps have a design capacity of 200 cfs. The threshold flow to support maximum refill is based on maintaining minimum Broad River flow of 483 cfs + plant consumptive needs (which vary by month due to cooling tower evaporation) + refill rate for the Make-Up Ponds.

During the months of March through June, the refill pumps are not expected to be used, so as to minimize entrainment. For these months, only the 125-cfs pumps are expected to be used and the amount not needed for the plant will be used to refill the make-up ponds. The threshold flow in the water model for maximum refill during these months is 645 cfs (102 cfs + 483 cfs + 60 cfs). Blowdown and screen wash are not used to determine the threshold refill flow because they are always withdrawn from the Broad River regardless of the flow in the Broad River (given that they are returned to the Broad River resulting in no impact to downstream users). (125 cfs – 23 cfs = 102 cfs). While the threshold flow is constant, the refill rate to the make-up ponds varies because the plant consumptive use varies by month due to cooling tower evaporation (102 cfs – plant consumptive use which ranges from 55.2 cfs to 61.9 cfs = refill range of 46.8 cfs to 40.1 cfs).

During other months of the year, the 200 cfs refill pumps will be used in addition to the 125 cfs pumps. For these other months, threshold flow in the water model for maximum refill would be 845 cfs (102 cfs + 200 cfs + 483 cfs + 60 cfs future upstream demand). As above, blowdown and screen wash are not used to determine the threshold refill flow.

This table also shows the maximum refill rate by month for the Make-Up Ponds which varies due to cooling tower evaporation as discussed above. The Make-Up Ponds have different limits on how much can be pumped from the river to refill them. Make-Up Pond A has a maximum refill rate of 120.5 cfs (125 cfs – 4.5 cfs screen wash = 120.5 cfs). Make-Up Pond B has a maximum refill rate of 251.1 cfs. The refill pumps provide 200 cfs, and in January only 69.4 cfs of the 120.5 cfs is needed for the plant, so the remainder of 51.1 cfs can be pumped to Make-Up Pond B. This 51.1 cfs is first pumped into Make-Up Pond A and then pumped from Make-Up Pond A to Make-Up Pond B. Make-Up Pond C has a maximum refill rate of 213 cfs. The refill pumps provide 200 cfs and the pumping capability from Make-Up Pond B to Make-Up Pond C is limited to 13 cfs to provide the additional capacity not needed from the 125 cfs withdrawal. However, owing to this small amount of capacity (small pump designed to move water from Make-Up Pond B to Make-Up Pond C to replace evaporation losses), the model does not account for this additional 13 cfs during refill operations, so the maximum refill rate in the model for Make-Up Pond C is 200 cfs.

Table 6 provides daily evaporation rates for the Make-Up Ponds.

Table 7 provides daily evaporation rates for Make-Up Pond A assuming full pond elevation 547 ft msl.

Table 8 provides daily evaporation rates for Make-Up Pond B assuming full pond elevation 570 ft msl.

Table 9 provides daily evaporation rates for Make-Up Pond C assuming full pond elevation 650 ft msl.

The evaporation losses in Ponds A, B, and C were based on the Ninety-Nine Islands Reservoir evaporation rate due to its proximity to Lee Nuclear Station. The evaporation rate for the Ninety-Nine Islands Reservoir was calculated using data from multiple references. First, an annual pan evaporation estimate for the reservoir location was determined from Map 3 of National Oceanic and Atmospheric Administration (NOAA-TR33) Technical Report NWS 33, Evaporation Atlas for the Contiguous 48 United States (1982a) (Reference 1). The second step was to distribute the annual value to a monthly value using the monthly pan evaporation distribution data for the evaporation coefficients of data gathered at Clemson University (NOAA-TR34) Technical Report NWS 34, Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States (1982b) (Reference 2). The final step was to convert estimated monthly pan evaporation coefficients to free water surface using the average basin free water surface coefficient from NOAA-TR33.

The daily average make-up pond evaporation loss was calculated in feet per day based on each monthly evaporation coefficient described above. These evaporation rates were used to estimate the loss in all three ponds due to evaporation on a daily basis and are shown in Table 6. Evaporation has a more significant effect on Make-Up Pond C because of its full pond surface area being approximately four times larger than Make-Up Pond B and ten times larger than Make-Up Pond A. (The surface area of Make-Up Pond C at full pond elevation 650 ft msl is 618 acres; at a full pond elevation of 570 ft msl, the surface area of Make-Up Pond B is 152 acres; the surface area of Make-Up Pond A at full pond elevation 547 ft msl is 62 acres.) Daily evaporation losses are calculated for Make-Up Ponds A, B, and C for each month assuming full pond elevation (Tables 7, 8 and 9). The water model accounts for decreasing evaporation losses as a result of decreasing surface area as the ponds are drawn down.

Table 10 provides the daily water consumption for a heat dissipation system using 100% wet cooling towers during the year 2002 (most severe drought year on record). The information in Table 10 provides the inputs to the water model to evaluate the water storage needs based on this heat dissipation system.

Table 11 provides the daily water consumption for the maximum "water savings" evaluation using the hybrid cooling system during the year 2002 with the dry cooling towers operated year-round.

Table 12 provides the daily water consumption for the "power savings" evaluation using the hybrid cooling system during the year 2002 but the dry cooling towers are not operated until Make-Up Pond B is drawn down six feet; dry cooling towers are then operated through the drought until the make-up ponds are refilled.

Table 13 provides the water model results for a heat dissipation system evaluation using 100% wet cooling towers during the year 2002 including daily stage, volume, surface area, inflow and outflow for Make-Up Ponds A, B, and C. Table 13 also includes the Broad River daily flows used as input, and the Broad River flow at the Ninety-Nine Islands Dam.

Table 14 provides the water model results using the hybrid cooling system year-round during the year 2002 for the maximum "water savings" evaluation. Table 15 also includes the Broad River daily flows used as input, and the Broad River flow at the Ninety-Nine Islands Dam.

Table 15 provides the water model results using the hybrid system during the year 2002 for the "power savings" evaluation using wet towers only until Make-Up Pond B is drawn down six feet; dry cooling is then operated in combination with the wet cooling until the make-up ponds are refilled. Once the ponds are refilled, the dry cooling is shut down and only wet cooling is used. Table 14 also includes the Broad River daily flows used as input, and the Broad River flow at the Ninety-Nine Islands Dam.

References:

1. National Oceanic and Atmospheric Administration (NOAA-TR33) Technical Report NWS 33, Evaporation Atlas for the Contiguous 48 United States (1982a).
2. National Oceanic and Atmospheric Administration (NOAA-TR34) Technical Report NWS 34, Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States (1982b).

Associated Revisions to the Lee Nuclear Station Combined License Application:

None

Attachments:

Attachment 216-01 CD Containing Tables 1 through 15

Table 1	Stage-Volume and Stage-Area for Make-Up Ponds A, B and C
Table 2	Summary of the Water Model Inputs
Table 3	Lee Nuclear Station Withdrawals from the Broad River Not Considering Make-Up for the Pond Evaporation
Table 4	Broad River Monthly Threshold Flows in Water Model to Support All Consumptive Withdrawal from the Broad River
Table 5	Broad River Monthly Threshold Flows in Water Model to Support Maximum Refill Operations
Table 6	Daily Evaporation Rates for the Make-Up Ponds
Table 7	Daily Evaporation for Make-Up Pond A Assuming Full Pond Elevation
Table 8	Daily Evaporation for Make-Up Pond B Assuming Full Pond Elevation
Table 9	Daily Evaporation for Make-Up Pond C Assuming Full Pond Elevation
Table 10	Daily Water Consumption Using 100% Wet Cooling Towers For 2002