Attachment 11 – Affidavit of Dr. Howroyd

August 17, 2010

**UNITED STATES OF AMERICA**
**NUCLEAR REGULATORY COMMISSION**

Before the Atomic Safety and Licensing Board

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| In the Matter of | ) | | |
| | ) | Docket Nos. | 52-029-COL |
| Progress Energy Florida, Inc. | ) | | 52-030-COL |
| | ) | | |
| (Combined License Application for | ) | | |
| Levy Nuclear Plant, Units 1 and 2) | ) | ASLBP No. | 09-879-04-COL |

AFFIDAVIT OF GEORGE CLARION HOWROYD IN SUPPORT OF PROGRESS ENERGY'S MOTION FOR SUMMARY DISPOSITION OF JOINT INTERVENERS CONTENTION 4

GEORGE CLARION HOWROYD states as follows under penalties of perjury:

1. I am a Vice President and Technology Fellow with CH2M HILL, Inc., an engineering company representing Progress Energy Florida, Inc. (PEF) for the proposed Levy Nuclear Plant, Units 1 and 2 (LNP).
2. My professional and educational experience is summarized in my curriculum vitae, which is included as Attachment 1 to this affidavit. I hold a Doctorate degree in Mechanical Engineering, a Master of Science degree in Mechanical Engineering, and a Bachelor of Science degree in Mechanical Engineering, all of which were earned from the University of Waterloo, in Ontario, Canada. I am a licensed Professional Engineer (PE) in Georgia and Mississippi and I am certified by the American Meteorological Society as a Certified Consulting Meteorologist (CCM) and by the Institute of Professional Practice as a Qualified Environmental Professional (QEP).
3. In my capacity as the Task Lead for Air Quality and Meteorology for the Combined License Application (COLA) and the Environmental Report (ER) for the proposed LNP project, I was responsible for the evaluation and documentation of potential impacts on ambient air quality that could result from the construction and operation of the LNP, including but not limited to the evaluation of the facility's two banks of mechanical draft cooling towers. This evaluation, which was performed under my direction, included consideration of normal and extreme meteorological

conditions to determine the range of potential impacts, including "worst-case" impacts that could occur during extreme and unlikely occurrences. I have over 30 years of experience performing comprehensive air quality evaluations and assessments of industrial facilities, including nuclear and fossil fueled power plants. These evaluations include numerous and extensive air quality modeling studies of air pollution from a variety of air emission sources, including salt drift and particulate matter emissions from natural and mechanical draft cooling towers used for process cooling. I am knowledgeable of the ambient air quality and meteorological aspects of the LNP COLA and ER. I have prepared and reviewed the analysis of these issues as presented in the ER, and I have provided advice and input on its preparation to PEF and its Counsel. Specifically, I am knowledgeable of and have provided advice and input on the air quality impacts, including the dispersion and deposition of salt and salt drift from the proposed facility's mechanical draft cooling towers as proposed in the COLA and evaluated in the ER. I have also reviewed the Draft Environmental Impact Statement (DEIS) as prepared and published by the U.S. Nuclear Regulatory Commission (NRC).

4. I am familiar with Joint Interveners Contention 4, which was raised by the Joint Interveners in the NRC licensing proceeding for the LNP new plant licensing. As admitted into the proceeding by the Atomic Safety and Licensing Board (Board) and clarified by the Commission, Contention 4 asserts that the LNP ER is deficient, in part, because it fails to adequately address, and inappropriately characterizes as SMALL, certain specific environmental impacts resulting from salt drift and salt deposition on vegetation and freshwater wetland areas at the Levy site. Also, the Board narrowed the submitted Contention 4 from the broad, non-specific discussion of "wetlands, floodplains, special aquatic sites, and other waters" to (a) the aquifer system underlying the project area and (b) the Outstanding Florida Waters (OFWs) such as the Withlacoochee and Waccasassa Rivers.

5. My declaration and the statements provided herein are intended to address claims or allegations made by the Joint Interveners in Contention 4 concerning the emissions, dispersion, and deposition of salt and salt drift from the LNP's proposed mechanical draft cooling towers. The statements that follow are representative of the key elements of the analysis, as directed or performed by me, of salt-drift

emissions and salt-drift deposition, including the assumptions, analysis methods, general and specific observations, results and findings, and conclusions as they may relate to the issues that are raised in Contention 4.

6. A detailed account of my assessment of the potential impacts of salt drift and salt deposition attributable to the operation of the LNP mechanical draft cooling towers was documented in a detailed Technical Memorandum entitled *LNP Cooling Tower Plume Deposition Analysis*. This memorandum, which was prepared under my direction using multi-disciplinary CH2M HILL engineering staff, was used as the basis of the information and conclusions presented in LNP ER Section 5.3.3.2.1 *Salt Drift*, and is referenced therein. The NRC relied on the information provided in ER Section 5.3.3.2.1 (including the referenced Technical Memorandum) in their preparation of DEIS Section 5.3.1.1 *Terrestrial Resources – Site and Vicinity* (sub-heading: *Impacts of Cooling Tower Operations*, pages 5-19 through 5-23).

7. The LNP ER was also submitted as part of Progress Energy's request for site certification to the Florida Siting Board (SCA). My role in the preparation of the SCA included evaluations of the site and regional meteorological conditions that could affect dispersion in the vicinity of the site, and the potential for air pollution impacts during facility operation, including those attributable to salt and salt-drift emissions from the proposed mechanical draft cooling towers. I was also responsible for responding to specific questions raised by the Siting Board during the SCA review process. Finally, I testified before the Administrative Law Judge during the hearing process with respect to the analyses and conclusions that were prepared under my direction and presented in the SCA and the LNP ER.

## Basic Design and Background Information Used in the Analysis

8. The LNP will be a nominally rated 2200-megawatt electric (MWe) nuclear fueled power generating facility, with steam condensers that will be water cooled using a non-contact, closed-loop, cooling system. Heat rejection will be to the atmosphere and will be accomplished using two banks of mechanical draft evaporative cooling towers.

9. The source of cooling water that will be used in the LNP cooling towers will be water pumped from the Cross Florida Barge Canal (CFBC). The majority of this water is expected to be saltwater from the Gulf of Mexico, with varying amounts of freshwater that can enter the CFBC by various means. The salinity of the water in the CFBC at the point where the LNP cooling water will be withdrawn will be less than or equal to the salinity of the water in the Gulf of Mexico. For the purpose of my analysis of salt drift and salt deposition from the cooling towers, all water was conservatively assumed to be saltwater, as a worst-case scenario, with a saline content consistent with the maximum expected saline content of the CFBC at the point where the LNP will withdraw makeup water from the canal. The two banks of cooling towers will each circulate up to 531,000 gallons per minute (gpm) during normal maximum operation, with a capacity of up to 600,000 gpm for short periods of time. The characteristics of the cooling tower and its water use are described in ER Section 5.3.3 *Heat Dissipation System*, and in DEIS Section 3.2.2.2 *Cooling System*.

10. Cooling towers of the type being proposed for the LNP will emit water vapor (as a result of the heat rejection process) as well as a very small quantity of what is often referred to as "drift." Cooling tower drift consists of water droplets that are entrained into the air stream exiting the cooling tower.

11. The amount of cooling tower "drift" from the LNP cooling towers will be limited by the conditions incorporated by the State of Florida in approving LNP's Site Certification. In accordance with the Florida Power Plant Siting Act, the Florida Governor and Cabinet (as the Florida Siting Board), approved the *Final Order on Certification for the Progress Energy Levy Nuclear Power Plant Units 1 & 2* on August 26, 2009. The Final Order included various Conditions of Certification (COCs). These COCs, in conjunction with the state-issued permit for the Prevention of Significant Deterioration (PSD), Federal Air Permit No. PSD-FL-403 (issued February 18, 2009), specifically limit the amount of drift that can be emitted from the LNP cooling towers to a maximum of 0.0005 percent of the circulating water flow rate by using high efficiency drift eliminators on the towers. Based on a maximum normal operating water flow rate of 531,000 gpm in each cooling tower, up to 2.66 gpm of entrained water droplets or "drift" could be emitted by each cooling tower during normal maximum

operation as described in ER Section 5.3.3 *Atmospheric Heat Dissipation System* and DEIS Section 5.7.2 *Cooling System Impacts*. These entrained water droplets will contain both suspended and dissolved solids, including salts. For the purpose of the analysis conducted, all suspended and dissolved solids (including inert material) have been conservatively assumed to be salts.

12. Salt drift represents only a small fraction of the total cooling tower drift and is dependent on the concentration of salts in the total cooling tower drift leaving the cooling towers.

13. Salt drift is not a unique concern to either fresh- or saltwater-based cooling towers. It was one of the design considerations used in designing and orienting the cooling towers on the project site. The design parameters that were considered included operational parameters such as the optimal number of cycles of concentration and the rate of cooling water blowdown necessary to maintain water quality in the water circulating system, meteorological conditions such as wind speed and predominant wind directions, and distance to the nearest property boundaries. These parameters have been evaluated and considered in the design process to facilitate compliance with environmental parameters, including air quality and deposition rate.

14. The source of salt drift from the LNP cooling tower will be naturally occurring salts that are contained in the water circulated in the basins beneath the cooling towers. As the water is circulated, the concentration of solids (including salts) in the water tends to increase due to the constant release of water vapor from the cooling towers. The concentrations of the dissolved and suspended solids in the cooling tower basins will be controlled to acceptable levels to maintain cooling tower performance and to reduce the potential for salt and particle drift to the atmosphere. The control of suspended and dissolved solids (including salts) in the cooling tower basins will be accomplished by maintaining a constant "blowdown" of water from the basin by removing a portion of the water from the cooling tower basins and adding makeup water from the CFBC. The LNP cooling towers are being designed to operate with a maximum concentration of total dissolved solids (TDS) in the circulating water, based on the number of "cycles of concentration," with a design operating range of 1.5 to 2.0 cycles of concentration. Therefore, the concentration of TDS in the circulating water will

not be controlled or limited by the TDS in the incoming makeup water from the CFBC, rather it will be monitored and controlled by the plant operators by balancing makeup water and blowdown water flow rates to ensure that the circulating water is within the desired range of cycles of concentration. Blowdown from the LNP cooling towers will be conveyed by dedicated pipelines to the Crystal River Energy Complex (CREC) Gulf of Mexico discharge canal approximately 15.5 kilometers (km) (9.6 miles) south of the LNP project site.

**Assessment Methodology for Evaluating Drift Emissions and Drift Deposition**

15. Dispersion modeling of salt-drift emissions from the LNP cooling towers was performed using a U.S. Environmental Protection Agency (EPA) dispersion model and EPA-recommended modeling procedures. The purpose of the modeling analysis was to conservatively estimate the maximum potential (worst-case) deposition rate of total particulate emissions (including inert solids and dissolved salts) that could occur in the immediate vicinity of or in the area surrounding the LNP. The results of this analysis were used to predict potential deposition rates for comparison with published NRC guidance.

16. To be conservative, all particulate matter emissions in the cooling water were assumed to be salts; however, some of the particulate matter in the cooling water is inert material. The actual emissions of dissolved salts from the cooling towers should therefore be less than what has been assumed in the impact analysis conducted.

17. The estimate of salt drift emissions used in the drift deposition modeling analysis was conservatively based on the maximum possible short-term circulating flow rate of 600,000 gpm, a maximum TDS of 25,000 parts per million (ppm) in the incoming makeup water, and the maximum number of cycles of concentration that will be used during operation (2.0).

18. The dispersion model used in the analysis was the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) dispersion model. AERMOD was developed by EPA for performing air quality impact evaluations of industrial facilities, including deposition analyses. AERMOD was used to predict the maximum potential (worst case, not likely to occur)

surface deposition of particulate matter (including salts) associated with cooling tower drift from LNP's proposed mechanical draft cooling towers during maximum potential power generation and cooling tower operation. The analysis predicted the maximum potential onsite and offsite deposition rates of particulate matter (including salt).

19. Data entered into the AERMOD dispersion model included 5 years of hourly meteorological data (43,800 hours of data) that were obtained from the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC), and the design parameters for the cooling towers. The design parameters of the cooling towers included the physical dimensions of the towers, the number of cooling tower cells, the circulating water flow rate, water temperature, heat rejection rate, number of cycles of concentration, vendor-specified drift removal efficiency, and the maximum allowable concentration of solids in the circulating water system.

**Prediction of Maximum Offsite Salt Drift Deposition Rate**

20. The dispersion modeling analysis as presented in the LNP ER demonstrates that the maximum predicted offsite deposition rate (assuming maximum power generation and cooling tower operation) is 6.81 kilograms/hectare/month (kg/ha/mo) (6.13 pounds/acre/month [lb/ac/mo]) of total solids (including salts) at a location due west of the cooling towers at the nearest site boundary. This is described in LNP ER Section 5.3.3.2.1 *Salt Drift*, and DEIS Section 5.7.2 *Cooling System Impacts*. It is noted that the maximum predicted offsite deposition rate is representative of a "worst case" since it is based on the simultaneous occurrence of maximum salt drift emissions (during maximum power generation and cooling tower operation) and the worst-case month of meteorological conditions that occurred during the 5-year period of meteorological data that was used as input to the model. The likelihood of this occurrence is low and it is not representative of a high frequency of occurrence.

21. The dispersion modeling analysis as presented in the LNP ER also demonstrates that the offsite deposition rate would decrease significantly with increasing distance from the plant. The analysis predicts that the maximum deposition rate at a distance of 1000 meters (3280 feet) from the site boundary would decrease to less than 2.3 kg/ha/mo (2.1 lb/ac/mo), or about one-third of the

maximum offsite deposition rate at the nearest site boundary. This is described in LNP ER Section 5.3.3.2.1 *Salt Drift*, and DEIS Section 5.7.2 *Cooling System Impacts*.

22. The dispersion modeling analysis was used to predict maximum potential salt deposition rates from the LNP cooling towers for the purpose of evaluating the potential for vegetation damage due to salt drift and deposition in the general vicinity of the plant. A threshold of 10 kg/ha/mo (9 lb/ac/mo) was used, consistent with guidance provided in NRC's *Environmental Standard Review Plan* (NUREG-155, Section 5.3.3.2, Paragraph III.1 at 5.3.3.2-5) ), as well as in NRC's *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437, Vol. 1, Section 4.3.4). This threshold was used as an indicator of a salt deposition rate that could cause leaf damage in some susceptible plants during the growing season. An example of a potentially susceptible plant (as described in NRC's Generic Environmental Impact Statement) is corn.

23. The analysis of salt drift and salt deposition that was performed under my direction demonstrates that, under conservative assumptions, including assuming all solid deposition from cooling towers is salt (as opposed to containing some portion of inert solids), the projected maximum salt deposition rates are found to be less than the NRC guidance value of 10 kg/ha/mo (9.68 lb/ac/mo) for evaluating the potential for leaf damage in some susceptible plants. This analysis is described in LNP ER Section 5.3.3.2.1 *Salt Drift*, and DEIS Section 5.7.2 *Cooling System Impacts*.

**Prediction of Maximum Onsite Salt Drift Deposition Rate**

24. The dispersion modeling analysis of salt drift and salt deposition that was performed under my direction and as described in the LNP ER and the DEIS demonstrates that the maximum potential onsite deposition of solids (inclusive of inert solids and salts) during maximum power generation and cooling tower operation is 10.75 kg/ha/mo (9.68 lb/ac/mo). This analysis is described in LNP ER Section 5.3.3.2.1 *Salt Drift*, and DEIS Section 5.7.2 *Cooling System Impacts*. Because all solids deposition has been conservatively assumed to be salts, with no reduction to account for inert solids, the results of this analysis represent a bounding upper estimate of salt deposition at any location. A best estimate of the *actual* deposition rate of salts would in fact be less than 10.75 kg/ha/mo (9.68

lb/ac/mo) if inert solids were to be excluded from the analyses. It is my opinion that the maximum predicted onsite deposition rate is therefore representative of a "worst case" since it is based on the simultaneous occurrence of maximum salt-drift emissions (during maximum power generation and cooling tower operation), maximum possible saline content of the cooling water from the CFBC, and the single worst-case month of meteorological conditions that occurred during the 5-year period of meteorological data that was used as input to the model. The likelihood of this occurrence is therefore predicted to be very low and it is not representative of a significant or likely occurrence. The dispersion modeling analysis described in this affidavit and as described in LNP ER Section 5.3.3.2.1 *Salt Drift* and DEIS Section 5.3.1.1 *Terrestrial Resources – Site and Vicinity* (sub-heading: *Impacts of Cooling-Tower Operations*) demonstrates that, while the potential exists for some isolated damage to vegetation at onsite locations, any such occurrences would be rare and infrequent and likely to be very minor in nature.

25. No onsite impacts to vegetative communities, including wetlands, are expected from salt deposition because the worst-case analysis of 10.75 kg/ha/mo would not exceed the NRC threshold range of 10 to 20 kg/ha/mo. Even if the maximum predicted onsite impact of salt drift and salt deposition were to occur, that rate of deposition might impact more sensitive species, such as corn, a plant identified by NRC in its Generic Environmental Impact Statement (NUREG-1437) as being a plant more susceptible to the impacts attributable to salt deposition. There is no corn or other similar crop presently grown on the project site and the entire project site has been used for over 50 years only for forestry and silvaculture. As noted in DEIS Section 5.3.1.1 *Terrestrial Resources – Site and Vicinity* (sub-heading *Impacts of Cooling-Tower Operations*, page 5-21), the potential for salt-drift impact on vegetation onsite would be further moderated by the frequent rainfall that occurs in the area, which would wash salt from leaves and limit the duration of exposure. I have therefore concluded that, even with the predicted upper bounding estimate of onsite deposition, it is unlikely that there would be any significant adverse or measurable impacts to onsite vegetation due to salt deposition from cooling tower operation.

26. Based on the analysis performed, leaf damage from onsite salt deposition is not expected. Additionally, other potential impacts from salt deposition are even more unlikely. For example, as noted in DEIS Section 5.3.1.1 *Terrestrial Resources – Site and Vicinity* (sub-section: *Impacts of Cooling Tower Operations*), adverse impacts on vegetation from soil salinization are not expected to be an issue on or near the LNP site because sufficient rainfall would be received on the site to leach salts from the predominantly sandy soil profile. My team did not further evaluate other potential impacts of salt deposition onsite because the levels predicted by a conservative bounding analysis indicated that such effects are not expected.

**Additional Information and General Conclusions Regarding the Impacts of Salt Drift**

27. My review of available literature and studies of drift and deposition (including salt) from various types of large power plant cooling towers has led me to conclude that the impacts of salt drift and deposition on vegetation have not been observed to be significant. This literature review included documents published by NRC that characterize the impact of cooling tower drift deposition on vegetation in the vicinity of operating nuclear plants, including plants that use saltwater for cooling, as SMALL. NRC has also noted that there have been no observations of significant impacts to vegetation at operating nuclear power plants (NUREG-1555, Supplement 1, Environmental Standard Review Plan for Operating License Renewal, October 1999).

28. I have reviewed the results of a 14-year vegetation study performed in the vicinity of the salt water cooling towers at PEF's Crystal River Energy Center. This study noted minor, infrequent leaf damage to vegetation. The results of that study also confirmed that there were no significant adverse impacts to vegetation caused by salt drift or salt deposition in the area surrounding the cooling towers. The Florida Department of Environmental Protection (FDEP) also reviewed this study and, in March 1996, after approximately 14 years of continuous vegetation monitoring, concluded that there were no significant adverse impacts to vegetation caused by salt drift or salt deposition from the facility's saltwater-based cooling towers. The Crystal River Energy Center is located approximately 15.5 km (9.6 miles) south of the LNP project site, has vegetation similar to that near the Levy site, and uses

the same water source (the Gulf of Mexico) for plant cooling as is proposed for the LNP. The Crystal River vegetation study is also described in LNP ER Section 5.3.3.2.1 *Salt Drift* and DEIS Section 5.3.1.1 *Terrestrial Resources* – Site and Vicinity (sub-heading: *Impacts of Cooling-Tower Operations*, pages 5-21 to 5-22).

29. The analysis described in this affidavit indicates no significant adverse onsite impacts are expected from salt deposition. These results are not inconsistent with the possibility of some isolated damage to vegetation at onsite locations because any such occurrences would be infrequent and very minor in nature.

30. In January 2009, after a review of PEF's SCA for the proposed LNP, FDEP concluded that particulate matter emissions associated with cooling tower drift from proposed LNP Units 1 and 2 were appropriately estimated, and that there would be no threat to any ambient air quality standard as a result of the operation of the LNP. This is described in FDEP's report entitled *Electric Power Plant Site Certification Staff Analysis Report* at 8-9 (January 12, 2009).

31. In August 2009, after reviewing PEF's air permit application for the proposed LNP, FDEP concluded that the design of the proposed mechanical draft cooling towers incorporated what is considered to be the "best available control technology" (BACT), which consists of the use of drift eliminators with a drift removal efficiency of 99.9995 percent. This method of control represents the "best available" and it is my opinion that there is no more efficient means of viably controlling drift from wet cooling towers. The determination regarding this point is provided in PEF's Air Permit for the LNP Facility (Air Permit Number PSD-FL-403 at D-1). See also LNP ER Section 5.3.3.1.3 *Solids Deposition* and DEIS Section 5.7.2 *Cooling-System Impacts*.

## Changes in Air Quality Due to Wildfires

32. The LNP project site consists of approximately 3,105 contiguous acres that have been used for more than 50 years for forestry and silvaculture purposes. During this time, the site has been unoccupied, with no structures on the property, and without day-to-day onsite management and oversight. When the LNP is constructed and operational, the site will become actively managed by numerous onsite

personnel who will be responsible for the routine surveillance, security, and safety of the site. Based on my experience with large industrial facilities, including those with large tracts of company-owned and actively managed lands, it is my opinion that there would be an effective decrease in the number and duration of wildfires on the site when compared to its present configuration and use. Air emissions from wildfires on the property are expected to decrease because the potential for wildfires will be routinely monitored, and there will be additional resources in the vicinity of the site to minimize the potential for and to put out any wildfires that do occur.

33. The foregoing is complete and accurate in all material respects to the best of my knowledge and belief.

George C. Howroyd

George C. Howroyd, Ph.D., P.E.
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Subscribed and sworn to before me this 17th day of August, 2010.

Dierdre T. Marsh Notary Public

DIERDRE T. MARSH
MY COMMISSION # DD811803
EXPIRES August 04, 2012
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My Commission expires: August 04, 2012