UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

PRE-FILED REBUTTAL TESTIMONY OF
DR. GEORGE C. HOWROYD
REGARDING SALT EMISSIONS AND SALT DEPOSITION FROM COOLING TOWERS, AND CLIMATE CHANGE

I. BACKGROUND

Q1. Please state your name and business address.

A1. My name is Dr. George C. Howroyd. My business address is 1000 Abernathy Rd., Suite 1600, Atlanta, Georgia 30328.

Q2. Have you previously submitted testimony in this proceeding?

A2. Yes. I submitted Pre-Filed Direct Testimony in this proceeding, which presented the results of calculations performed by me and by my team at CH2M HILL of cooling tower salt drift emissions and the rate of deposition of those emissions that will result from operation of Progress Energy Florida Inc.'s ("PEF") proposed Levy County Nuclear Plant, Units 1 and 2 ("LNP"). PEF500.

Q3. What is the purpose of your rebuttal testimony?

A3. The purpose of my Rebuttal Testimony is to respond to certain issues raised by the pre-filed direct testimony of Dr. Sydney Bacchus (INT301R) regarding salt drift emissions and deposition.[1] My rebuttal testimony also responds to claims raised by various of the Intervenors' witnesses regarding the extent to which the Final Environmental Impact Statement ("FEIS") (NRC001), prepared in this proceeding by the NRC Staff should have considered the impacts of climate change.

[1] PEF507 is a list of acronyms used in my Rebuttal Testimony.

II. SALT DEPOSITION

Q4. On page 21 of her Testimony (INT301R), Dr. Bacchus states that the discussion regarding Cooling System Impacts on pages 5-85 and 5-86 of the FEIS (NRC001) discusses the average salt content of the world's oceans. Dr. Bacchus comments that this is not relevant because ocean salinity is approximately twice the salinity of water in the Cross Florida Barge Canal ("CFBC"). Do you have any comments or observations regarding her statement?

A4. Yes. The salinity of the water in the Gulf of Mexico (ocean water) was relevant for calculating what the salinity of the water in the CFBC will be when the LNP becomes operational and cooling water is pumped from the CFBC intake structure. Since LNP cooling water from the CFBC will be comprised of both salt water from the Gulf of Mexico and fresh water that infiltrates the CFBC from various sources, it was necessary to know the salinity of the Gulf of Mexico (ocean water), the salinity of the fresh water infiltrating the CFBC, and the relative amounts of each. The salinity of the LNP cooling water was used to calculate the amount of salt in cooling tower drift emissions. These emissions and their salt content were used as a basis for calculating maximum salt deposition rates as described in FEIS Section 5.7.2 *Cooling-System Impacts* (NRC001 at pp. 5-85 – 5-86).

Q5. On page 41 of Dr. Bacchus's Testimony (INT301R), she states that "[t]he FEIS assumed, without any adequate, scientifically based analysis, that the impact associated with salt drift and salt deposition would be negligible." Do you agree with this statement?

A5. No. The analysis of cooling tower drift and salt deposition, as performed under my direction at CH2M HILL (on behalf of Progress Energy) as well as by the NRC Staff (as described in the FEIS), was based on state-of-the-art dispersion modeling tools (specifically the American Meteorological Society/Environmental Protection Agency Regulatory Model ("AERMOD")) and procedures that are accepted in the scientific and engineering communities, including the U.S. Environmental Protection Agency. The results of these analyses, which documented the maximum predicted rates of salt deposition both on and off the LNP site, were compared by the NRC with potential injury thresholds for various crops, ornamental plants, and native plant species as described in NRC NUREGs 1555 (NRC013) and 1437 (NRC057). NRC001 at p. 5-21. The information on sensitivity thresholds as described in those documents was obtained from the scientific literature. In addition, contrary to Dr. Bacchus's claim, FEIS Section 10.2.2 *Unavoidable Adverse Impacts During Operation* does not conclude that the impacts of salt drift and deposition will be "negligible," rather it concludes that there will be "minor impacts to vegetation

from salt deposition near the mechanical draft cooling towers" (NRC001 at p. 10-9), which is consistent with the results of the analyses described in the FEIS.

Q6. On page 41 of her Testimony (INT301R), Dr. Bacchus states that the salt drift deposition model relied on in the FEIS uses wind directions from Tampa to calculate the rate of salt deposition from the LNP's cooling towers, and that those wind directions do not correlate closely enough with data from the LNP site. Do you agree with her statement?

A6. No, I do not agree with Dr. Bacchus's statement. As I pointed out in my Direct Testimony, Tampa meteorological data were not used in the analysis to predict cooling tower drift and salt deposition. PEF500 at p. 8. The dispersion modeling analysis that was performed under my direction at CH2M HILL, as well as the modeling analysis that was performed independently by the NRC Staff, to calculate maximum onsite and offsite salt deposition rates used five years (2001 through 2005, 43,800 hours) of hourly surface meteorological data from Gainesville, Florida (in conjunction with upper air soundings -- to determine mixing heights -- from the nearest upper air weather observing station at Jacksonville, Florida). PEF505 at p.2 of 75; NRCTEST at p. 153. The data from Gainesville were used because that is the location of the nearest and most representative first-order National Weather Service weather station to the LNP site, at approximately 76 km (47 mi) north-northeast of the LNP. PEF503 at p. 2-623. The Gainesville meteorological data were compared with meteorological data collected at the LNP site and found to be very similar in terms of both wind speed and wind direction. PEF503 at p. 2-636. The NRC Staff's Direct Testimony also describes in detail the Staff's comparison of data from Gainesville and the LNP site. For example, in Answer A87 of the NRC Staff testimony (NRCTEST at pp. 83-84), two figures are referenced (NRC038) that graphically illustrate that wind speed and wind direction observations at the LNP site and the Gainesville weather station do in fact correlate well with each other.

In addition, the NRC Staff testified that they performed AERMOD salt deposition modeling analyses using meteorological data from both Gainesville and the LNP site. The results of the two analyses were nearly identical, although the use of the onsite LNP data actually resulted in slightly *lower* maximum predicted offsite salt deposition rates than the Gainesville data. NRCTEST at p. 84. More specifically, the NRC Staff's maximum predicted rate of salt deposition using the Gainesville data was 10.75 kg/ha/mo (identical to what was predicted by my team and documented in the LNP's Environmental Report ("ER")), whereas the maximum predicted rate of deposition using the onsite data was

9.95 kg/ha/mo (NRCTEST at p. 84), which is below the minimum threshold range for foliar injury to plant species as published by the NRC in NUREG-1555. PEF603 at p. 5.3.3.2-4; NRC013 at p. 5.3.3.2-4.

Q7. On page 41 of her Testimony (INT301R), Dr. Bacchus states that prevailing wind directions at the LNP site are from the east-northeast and the west which, according to Dr. Bacchus, means that significant amounts of salt will be deposited to the southwest of the LNP, not the west, where the FEIS says the highest salt deposition rate will be. Do you agree?

A7. Dr. Bacchus is correct in her interpretation of the prevailing wind directions, since there is effectively a bimodal distribution of wind directions at the LNP site that is consistent with typical onshore and offshore sea breeze effects. However, the AERMOD dispersion model relied upon by my team and the NRC Staff was used to conservatively predict the *maximum monthly* salt deposition rate at onsite and offsite locations, as opposed to the *total* amount of deposition at those locations over the 5-year period of meteorological data. Calculating the maximum monthly deposition rate was more conservative than calculating the total deposition over a longer period because the average deposition rates over a longer period (at any location) would necessarily be *lower* than the maximum monthly rates that we predicted. Calculating total deposition using a longer period would likely have resulted in the highest total depositions at a location to the southwest of the LNP consistent with the prevailing wind directions. However, the average monthly deposition rate over that longer period would necessarily have been even less than what we predicted. Using our approach, and that of the NRC Staff, the model conservatively selected the worst case meteorological data for one month that resulted in the maximum predicted rate of salt deposition, which happened, for that month, to be at a location due west of the cooling towers for the offsite maximum and northeast of the cooling towers for the onsite maximum.

Q8. On page 42 of Dr. Bacchus's Testimony (INT301R), she states that "computer modeling in the FEIS for salt drift and deposition inaccurately portrays salt deposition rates and locations and underestimates the ensuing effects." Do you agree with Dr. Bacchus's statement?

A8. No, I do not agree with Dr. Bacchus's statement. As I describe in my Rebuttal Testimony above, Dr. Bacchus does not provide a scientific basis for claiming that the computer modeling resulted in inaccurate deposition rates and locations. The modeling analysis relied upon by my team and the NRC Staff was performed to determine the maximum predicted rate of salt deposition on a monthly basis, using a widely recognized and accepted dispersion model (the AERMOD), a long-term (5 years) record of representative meteor-

ological data, and conservative estimates of maximum cooling tower drift loss and salt emissions from the LNP.

Q9. On pages 42-43 of her Testimony (INT301R), Dr. Bacchus states: "Neither PEF nor the DEIS appears to have even a single year of air concentration and vertical deposition data or sedimentation measurements from a comparable site as support for allegations that drift from the proposed LNP cooling towers would not result in significant adverse environmental impacts." Do you have any observations or comments regarding this statement?

A9. The assessments of potential salt drift and salt deposition impacts on vegetation from cooling towers in PEF's ER and the FEIS were based primarily on information contained in NRC's NUREG-1555 (NRC013) and NUREG-1437 (NRC057). NRCTEST at pp. 161-163. More specifically, Table 4.2 of NUREG-1437 (NRC057 at p. 4-37) was used as a source of information to establish a range of thresholds for foliar damage to crops, ornamental plants, and native species. The information contained in this document is based on information obtained from the scientific literature (as cited in the document), as well as from annual reports of environmental monitoring for vegetation damage at 18 nuclear plants, some of which use brackish water for plant cooling at inland locations. NRC057 at pp. 4-35 – 4-42. Information from the scientific literature (summarized in Table 4.2 of NRC057) was used to identify a range of thresholds for potential damage to sensitive plant species. The annual environmental monitoring reports (summarized in Table 4.3 of NRC057) indicated that there have been no reports of visible damage to vegetation or reduction in crop yield attributable to salt emissions or deposition at any of the facilities. The only reports of damage to vegetation at any of these operating plants were associated with ice damage in the immediate vicinity of the cooling towers.

Since the LNP is not yet an operational facility, my team and the NRC Staff used the most current and accepted dispersion modeling tools and modeling procedures to predict maximum potential rates of salt deposition at both onsite and offsite locations surrounding the LNP cooling towers, and to compare those predictions with the range of thresholds for foliar damage obtained from NUREG-1555 (NRC013), the technical basis of which is drawn from data set forth in NUREG-1437 (NRC057). NRCTEST at pp. 161-163.

Q10. On page 43 of her Testimony (INT301R), Dr. Bacchus states: "[N]either PEF nor the FEIS quantified or assessed the combined and cumulative impacts of salt drift from operating cooling towers similar to the LNP cooling towers *combined* with naturally occurring airborne salt deposition

from the coast in the vicinity of the proposed LNP site." Do you agree that this cumulative impact should have been studied?

A10. No, I do not. First, there is no reason to quantify emissions of salt drift based on operating cooling towers "similar to the LNP" since the LNP's salt drift emissions are simple to quantify. Emissions from the LNP's proposed mechanical draft cooling towers were calculated based on the design specifications for the specific cooling towers that will be installed at the facility, including the high performance mist eliminators that will be used on the towers. The manufacturer guarantees that total drift loss emissions will be no greater than 0.0005 percent of the circulating water flow rate (consistent with the LNP's air permit requirements (PEF504 at p. 4 of 5)) in the towers when using these mist eliminators. Since the circulating water flow rate is a known quantity, the maximum potential liquid drift emissions (which will include salt drift particulates) are easily quantified. The calculations of drift emissions (including salt) are described in my direct testimony (PEF500 at p. 6) and in the Direct Testimony of the NRC Staff (NRCTEST at pp. 82-83).

Second, with regard to the cumulative impacts of naturally occurring salt deposition, the modeling analyses performed by my team and the NRC Staff assumed that the amount of salt deposition from naturally occurring airborne salts would be very small or negligible. This assumption is consistent with the observations of Moser (1979) (INT391) as cited by Dr. Bacchus. The Moser study focused on the measurements of salt impingement and sedimentation rates in the near-shore environment, in which the author noted that: "Sedimentation rates were high near the surf and dropped off rapidly with distance inland." INT391 at p. 1003. The author graphically illustrated the very significant reduction in deposition rate in Figure 3 *Sedimentation Rates of Airborne Sea Salt as Affected by Distance Inland from the Surf* of his publication (i.e., an approximate 90 percent reduction in only 500 meters). (INT391 at p. 1003). Given that the LNP cooling towers will be approximately 15 km (15,000 meters) from the Gulf of Mexico (NRCTEST at p. 157), it is reasonable to assume that naturally occurring salt drift originating from the shoreline of the Gulf of Mexico will be minimal, with correspondingly low potential for cumulative impacts. The NRC Staff reached this same conclusion, and excluded deposition of naturally occurring salt from their analysis. NRCTEST at p. 157.

Q11. On page 43 of her Testimony (INT301R), Dr. Bacchus states: "Dispersal of airborne salt is not consistent from day to day or even within the same season." She cites an example from Moser (1979) (INT391) indicating that, during two consecutive days of onshore winds, salt deposition

rates were three times higher than at other times during the same summer season. Do you have any comments or observations regarding these statements?

A11. It would not be unreasonable to observe this kind of variation in drift and deposition rates, particularly in the near-field zone, from an uncontrolled seashore environment as observed by Moser (1979) (INT391). The generation of liquid drift at a shoreline is a function of a variety of meteorological and physical conditions, such as wind speed, wind direction relative to shoreline, ambient temperature, water temperature, wave height, wave angle, and tidal influences. In contrast, for the mechanical draft cooling towers that will be used at the LNP, the generation of liquid drift and salt drift emissions will be much more controlled and consistent, due to the consistency of cooling tower operation. Those emissions will, therefore, be much more predictable, albeit with some degree of variability due to outside influences, such as wind speed and temperature. In order to account for this potential variability, as explained above, and in my Direct Testimony and the Direct Testimony of the NRC Staff, comprehensive dispersion modeling analyses were performed to predict the maximum potential rate of salt deposition using five years of hourly meteorological data and an accepted dispersion model.

Q12. On page 44 of her Testimony (INT301R), Dr. Bacchus states: "The FEIS relies heavily on the CREC salt drift monitoring reports, however, the methodology used at CREC was flawed because during the 13 years of reporting, the cooling towers were not all in operation, as described on page 1-1 of the Crystal River Salt Drift Study, and the monitoring sites were moved periodically." Do you agree with Dr. Bacchus's statements?

A12. No, I do not. There is no indication that the Crystal River Energy Center ("CREC") study was flawed. The CREC study was performed to evaluate potential vegetation impacts due to operation of all the salt water cooling towers at the CREC complex, not just the mechanical draft helper cooling towers that did in fact operate for approximately one year prior to discontinuing the study that Dr. Bacchus refers to in her statements. The CREC study, including the annual reports that were prepared and submitted to the Florida Department of Environmental Protection ("FDEP"), found no appreciable damage to vegetation during the study period attributable to cooling tower operation, and the FDEP ultimately authorized discontinuation of the study. Furthermore, Dr. Bacchus is incorrect when she claims that the FEIS relied "heavily" on the results of the CREC salt drift monitoring study. The results of the CREC study were simply used to anecdotally "support" the Staff's conclusions in the FEIS, which "rely primarily" on the Staff's evaluation of

the AERMOD results against NRC guidance as set forth in its NUREGs. NRCTEST at p. 169.

Q13. On page 46 of her Testimony (INT301R), Dr. Bacchus states: "[T]he salt intercepted by the canopy of the trees ultimately will reach the ground, either via rainfall during the rainy season or following the droughts or as the salt-encrusted dead leaves fall from the trees. The rain then will carry the salt directly to the shallow roots of these trees combining chronic salt stress with the chronic stress of hydroperiod alterations referenced in my testimony in response to previous questions. This is the nature of cumulative adverse impacts that were not addressed in the FEIS." Can you comment on Dr. Bacchus's statements?

A13. Dr. Bacchus appears to be suggesting that the LNP salt drift modeling did not account for the fact that salt intercepted by the tree canopy may eventually reach the ground. She is incorrect. The drift deposition analysis relied upon by my team and the NRC Staff was based on the conservative assumption that all of the salt emissions would eventually be deposited at the surface and available for ingestion by plants. The Rebuttal Testimony of Dr. Blancher (PEF608) addresses the potential cumulative impacts alleged by Dr. Bacchus.

Q14. The Testimony submitted by the NRC Staff (NRCTEST at pp. 81-85 and pp. 151-157) describes in detail the analysis that the NRC Staff performed when calculating the LNP's projected salt deposition rates. Do you have any comments regarding that testimony?

A14. I have reviewed the NRC Staff's Testimony as it relates to their analysis, as described in the FEIS, of salt drift and salt deposition resulting from the operation of the LNP cooling towers. In my opinion, the NRC Staff has performed a thorough and independent analysis of potential salt drift and deposition from the LNP. I consider that analysis to be both appropriate and representative of best practices for this type of study. The NRC Staff's analysis even included some additional salt drift and deposition modeling that was not included in the ER. More specifically, the NRC Staff performed an AERMOD modeling analysis of salt drift and salt deposition using one year of the onsite meteorological data obtained from the LNP onsite meteorological monitoring tower. As I explained above, using onsite meteorological data actually resulted in a slightly *lower* predicted rate of salt deposition than my team predicted using Gainesville meteorological data.

III. CLIMATE CHANGE

Q15. Please describe your experience and qualifications in the area of meteorology.

A15. In addition to being a Professional Engineer, I am certified as a Consulting Meteorologist by the American Meteorological Society (Certified Consulting Meteorologist Number 342, date of certification June 1983). I am certified as a Consulting Meteorologist on the basis of my education in the field of meteorology (extensive graduate level studies in meteorological science while obtaining M.S. and Ph.D. degrees in Mechanical Engineering) and extensive practical experience in the field. As a practicing meteorologist, I routinely provide consultation and support on a variety of matters related to meteorology and air pollution, including the design and installation of meteorological monitoring and measurement programs, meteorological data analysis, forensic meteorological evaluations, air pollution meteorology for industrial facilities and fossil fueled power generating facilities, air quality and meteorological evaluations for nuclear facilities, air pollution dispersion modeling (using long term meteorological records), ambient air quality monitoring studies and evaluations, greenhouse gas studies and evaluations, climate change evaluations, air pollution research, and a variety of other related topics. In the field of climate change, I have experience identifying and quantifying greenhouse gases and greenhouse gas reductions, developing monitoring and verification protocols designed to quantify the beneficial reductions of greenhouse gases, and identifying projects that will reduce emissions from large industrial fossil fueled facilities (including power plants) that would otherwise contribute to high level ozone depletion. I also have experience evaluating meteorological data in terms of climate change impacts.

Q16. On page 58 of her Testimony (INT301R), Dr. Bacchus states that the FEIS contains "no analysis of the impacts of climate change on ANY aspect of the LNP." Is that correct?

A16. No. The FEIS does in fact address climate change and its potential for impacts on the LNP and surrounding environment, specifically in Sections 2.9.1 *Climate* (NRC001 at pp. 2-180 – 2-183); 7.1 *Land-Use Impacts* (NRC001 at p. 7-9); 7.2 *Water Use and Quality* (NRC001 at pp. 7-12 – 7-20); 7.3 *Ecology* (NRC001 at pp. 7-20 – 7-34); 7.6 *Air Quality* (NRC001 at pp. 7-42 – 7-44), and 7.7 *Nonradiological Health* (pp. 7-44 – 7-47). However, it is important to understand that the impacts of the current cycle of climate change are highly speculative, and the ability to predict what those changes or their impacts will be with any accuracy is not feasible with current scientific tools and theories. As described in ER Section 2.7.3.6 *Effects of Global Climate Change on Regional Climatology* (PEF508 at p. 2-635), which I prepared, global trends in various meteorological and geophysical parameters are currently the subject of much discussion in both the scientific community and in the media. While it may be evident (and expected) that changes

in the *averages* of certain meteorological parameters are occurring over time (such as temperature and precipitation), it is also evident and generally acknowledged that the amount of any such changes are difficult, if not impossible, to reliably predict. Even the most advanced climate change models are not capable of accurately predicting design basis extremes in weather patterns. A discussion of public concerns or speculations about climate change in the FEIS would not add to the resolution of these issues, nor would a discussion of changes in average global trends, because these data cannot be reviewed on a site-specific basis with any degree of accuracy or reliability**.**

In general, the information presented and evaluated in the FEIS is properly focused on extreme meteorological conditions, since it is these conditions that need to be considered, in conjunction with the plant's applicable design basis operating limits, in order to ensure that the plant can operate within its design basis safety limits. This is accomplished in the FEIS by identifying historical extremes and projecting, in a scientifically defensible manner, the potential effects that weather will (or could) have on the safety and operation of the LNP.

Q17. On page 62 of her Testimony (INT301R), Dr. Bacchus states: "In addition to assuming average precipitation, weather conditions and water withdrawals, the FEIS fails to address the cumulative impacts of the construction and operation of the proposed LNP combined with the impacts of climate change. In my professional opinion, this failure is a fatal flaw; the FEIS admits climate change could have significant effects on the LNP besides dewatering, including an 'increase in average temperature and a decrease in precipitation in the area of interest' (FEIS, p. 7-46, paragraph 2)." Do you agree with Dr. Bacchus's assessment of the treatment of climate change in the FEIS?

A17. No, I do not agree with Dr. Bacchus's assessment. The FEIS does not state that changes in climatological parameters (such as temperature and precipitation) due to global climate change "could have significant effects on the LNP." Rather, the FEIS simply *acknowledges* that current projections indicate there could be an increase in average temperature and a decrease in precipitation in the region surrounding the LNP, without regard to the magnitude of those potential changes. The FEIS further acknowledges that a *potential* impact on the LNP of such climatological changes could include reduced cooling system efficiency, which would be true for all power plants. However, it is important to understand that the magnitude of any changes in parametric climatological averages resulting from global climate changes cannot be quantified with any accuracy or reliability, as discussed in ER Section 2.7.3.6 *Effects of Global Climate Change on Regional Climatology*. PEF507 at p. 2-635. The FEIS therefore properly identifies the *potential* for impacts that

could occur, since accurately quantifying the magnitude of future climatological parameters resulting from climate change is not feasible using current science.

Q18. The Testimony of Dr. Bacchus (INT301R at p. 57) and Mr. Davies (INT001R at pp. 19-20) both claim that changes in sea level resulting from climate change should have been considered in the FEIS. The Testimony of Dr. Hazlett (INT101R at p. 9) similarly states that the effects of sea level rise due to climate change should have been included in the LNP's groundwater modeling. What is your opinion regarding those claims?

A18. The FEIS acknowledges that one of the potential effects of climate change is a rise in sea level. *See*, for example, NRC001 at p. 7-9. However, the FEIS adds that a key issue in any assessment of global climate change is the *accuracy* of any projections for climatological parameters, including sea level rise, since the scientific community acknowledges that the science used to make such projections is not accurate, reliable, or proven. The FEIS does not provide any definitive indication of changes in temperature, precipitation, or sea level changes (NRC001 at p. 7-9) since there are no scientifically supportable theories for making those quantifications.

These obvious limitations aside, the projection for sea level rise in the Testimony of Mr. Davies (INT001 at p. 20) is 7 meters over the next 60 *thousand* years (attributable in Mr. Davies's Testimony to Bowen [2010]). The projected life of the LNP is on the order of 60 years, which represents only 0.1 percent of the time period for the projected 7 meter sea level rise referenced in Mr. Davies's testimony. Based on this single projection, a simple linear interpolation of sea level rise over the projected life of the LNP (no definitive information exists to make a more definitive estimate) would, therefore, be only 0.0070 meters, or 0.7 centimeters. This corresponds to approximately ¼ inch over the life of the plant. Considering the lack of accuracy of the science upon which these projections are made, it is not reasonable to expect that the projected sea-level rise of 0.7 cm over the life of the plant would be either significant or relevant.

In simple terms, any projection for sea level rise at this point in time is essentially conjecture that cannot be quantifiably substantiated by either science or fact.

Q19. In his Testimony (INT201R), Mr. Still claims that the FEIS should not have relied on annual rainfall in Levy County of 53 inches because that information is based on old records rather than existing information and that "this statistic is no longer valid when the trend is toward less rainfall and higher temperatures, possibly due to climate change" (INT201R at p. 4). Dr. Bacchus similarly claims that the FEIS's assumption of 53 inches of annual rainfall relies only "on averages" (INT301R at p. 29). What is your view of those claims?

A19. The FEIS has characterized the region surrounding the LNP site as having a mean annual rainfall of 53 inches. NRC001 at p. 2-21. This value was derived from 13 weather observing stations in the region covering the period from 1892 to 2009 and is representative of the LNP site as indicated by the available record of climatological data. NRC001 at p. 2-21. However, the FEIS does not rely exclusively on this value, and that value can and will vary over time. More specifically, on page 5-22 of the FEIS (NRC001), it is stated:

> Mean annual precipitation for the region that includes the LNP site is approximately 53 in./yr (see Section 2.3.1.1 of the EIS); total rainfall recorded over a 1-year period (February 1, 2007 through January 31, 2008) at the LNP meteorological monitoring station was 43.0 in. (PEF 2009a). A review of salt deposition effects on soils by the NRC concluded that potential soil salinization problems at energy facilities are generally limited to arid regions with lower rainfall (NRC 1996). In humid environments such as Levy County, these effects were found to be transitory to undetectable. The projected changes in precipitation patterns for southwest Florida over the next 70 to 80 years, as reported by the U.S. Global Change Research Program (GCRP 2009), are for a decline in rainfall of between 20 to 25 percent in the spring and an increase of between 15 to 20 percent in the fall. Precipitation changes within these ranges would not be expected to alter the conclusion regarding the effects of soil salinization on vegetation (i.e., adverse effects would remain unlikely).

It should be further noted that the NRC Staff also specifically evaluated the impact of salinity in soils due to salt deposition during periods of drought rather than during a period of average annual rainfall. NRCTEST at pp. 159-160. The direct testimony of Dr. Blancher (PEF600 at pp. 6 through 9) also summarizes his evaluation of the impact of salinity in soils due to salt deposition during periods of drought.

With regard to Mr. Still's suggestion that the 53 inches of annual rainfall is no longer valid based on recent trends (he refers to the last six years and also the period since 1990 in INT201R at pp. 3-4), it is not reasonable to characterize the rainfall of the region using a short period of time, particularly when the LNP will be operational for 40 to 60 years. A detailed review of the rainfall data cited by Mr. Still (INT204) from the Southwest Florida Water Management District indicates that, through the end of 2011, the long term annual average rainfall has not substantially changed. The data show that there have been some gradual changes in annual precipitation (both increasing and decreasing) since the early part of the 20th century, as illustrated by the graphical representation of annual precipitation for Levy and Citrus counties in Exhibit PEF017. Two graphs, one for each of Levy and Citrus Counties, illustrate annual precipitation observations for the period 1915

through 2011. Also shown on each graph are the 5- and 10-year moving averages of annual precipitation, which are within the range of variability of annual rainfall amounts that have been recorded in Levy County since 1915. While the data illustrate that there has been a gradual decrease in precipitation in Levy County since 1980 from approximately 60 inches per year to 50 inches per year, during the preceding 40 years the annual precipitation in Levy County *increased* from approximately 50 inches per year to 60 inches per year. Similar observations are noted for Citrus County, although the range of annual precipitation is less, with observations that range between about 50 and 55 inches per year, on average. Accordingly, it is reasonable for the FEIS to rely on an annual mean rainfall of 53 inches because that is within the range of variation that one would expect for rainfall across the region for the duration of LNP operation. Mr. Still also suggests that the decreases in annual precipitation between 1980 and 2011 (and presumably the increases between 1940 and 1980) could be attributable to "climate change" (INT201R at p. 4). However, there is insufficient information available that would definitively support his suggestion.

Q20. Does this conclude your rebuttal testimony?

A20. Yes.

I, George C. Howroyd, swear under penalties of perjury that the foregoing testimony is true and correct to the best of my knowledge and belief.

George C. Howroyd
Signature

July 26, 2012
Date