UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 22, 2009

Mr. Mano Nazar
Senior Vice President, Nuclear and
Chief Nuclear Officer
Florida Power & Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE UNIT 1 - GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED WATER REACTORS," REQUEST FOR ADDITIONAL INFORMATION (TAC NO. MC4710)

Dear Mr. Nazar:

By letters dated February 27, 2008 and June 30, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML080650560 and ML081840513), Florida Power & Light Company (the licensee) submitted the supplemental responses to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," for the St. Lucie, Unit 1.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittals. The process involved detailed review by a team of approximately 10 subject matter experts, with a focus on the review areas described in the NRC's "Revised Content Guide for Generic Letter 2004-02 Supplemental Responses" (ADAMS Accession No. ML073110389). Based on these reviews, the staff has determined that additional information is needed in order to conclude there is reasonable assurance that GL 2004-02 has been satisfactorily addressed for St. Lucie, Unit 1. The enclosed document describes these requests for additional information (RAIs).

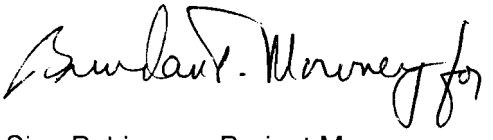
The NRC requests that the licensee respond to these RAIs within 90 days of the date of this letter. However, the NRC would like to receive only one response letter for all RAIs with exceptions stated below. If the licensee concludes that more than 90 days are required to respond to the RAIs, the licensee should request additional time, including a basis for why the extension is needed.

The exception to the above response timeline is RAI 12 in the enclosure. The NRC staff considers in-vessel downstream effects to not be fully addressed at St. Lucie, Unit 1, as well as at other pressurized-water reactors (PWRs). The licensee's submittal refers to draft WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." At this time, the NRC staff has not issued a final safety evaluation (SE) for WCAP-16793.

The licensee may demonstrate that in-vessel downstream effects issues are resolved for St. Lucie, Unit 1, by showing that the licensee's plant conditions are bounded by the final WCAP-16793 and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. The licensee may also resolve RAI 12 by demonstrating, without reference to WCAP-16793 or the NRC staff SE, that in-vessel downstream effects have been addressed at St. Lucie, Unit 1. The specific issues raised in RAI 12 should be addressed regardless of the approach the licensee chooses to take.

The licensee should report how it has addressed the in-vessel downstream effects issue and the associated RAI referenced above within 90 days of issuance of the final NRC staff SE on WCAP-16793. The NRC staff is currently developing a Regulatory Issue Summary to inform licensees of the staff's expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue 191, "Assessment of Debris Accumulation on PWR Sump Performance."

Sincerely,



Siva P. Lingam, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-335

Enclosure: As stated

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ST. LUCIE PLANT, UNIT 1

REQUEST FOR ADDITIONAL INFORMATION

SUPPLEMENTAL RESPONSES TO GENERIC LETTER 2004-02

DATED FEBRUARY 27 AND JUNE 30, 2008

1. Identify the size jet used in the testing documented in WCAP-16851-P and describe the comparability of the demonstrated destruction zone of influence with what would be expected with the large diameter jets that could occur with a large break loss-of-coolant accident (LOCA). At issue, in part, is that the radial decay of pressure for a small size nozzle will occur much more rapidly (particularly at close range) than for a ruptured reactor coolant system pipe.

2. Page 13 of the supplemental response dated June 30, 2008, states that the fiberglass debris used for head loss testing was assumed to be divided into a two category size distribution: (1) large pieces sized 6"x3"x1" and (2) small pieces sized 1"x1"x1". Page 16 of this same submittal indicates that 40% of the fiberglass is considered to be large pieces, and 60% is considered to be small pieces. However, the staff's review could not identify information as to the quantity of individual fibrous fines assumed to be generated during a LOCA. Provide this information to the staff and also provide a technical basis for any debris characteristics assumptions that were made but that are not consistent with approved guidance in the Nuclear Regulatory Commission (NRC) staff's approved safety evaluation on Nuclear Energy Institute document (NEI) 04-07.

3. The debris characteristics discussion in the supplemental response dated June 30, 2008, provided neither a debris size distribution nor size characteristics for calcium silicate debris, as was requested in the NRC's Revised Content Guide. Provide the assumed debris size distribution and characteristic sizes of the debris pieces for calcium silicate debris generated during a LOCA. Provide a technical basis for any debris characteristics assumptions were made but that are not consistent with approved guidance in the NRC staff's approved safety evaluation on NEI 04-07.

4. Describe the statistical methodology used to compute the sample mass used in the estimates of total latent debris mass.

5. Provide the accuracy of the individual sample mass measurements and the influence of the uncertainty on the total computed mass of latent debris.

6. Describe in more detail the methodology used to estimate the total area of tapes, stickers, and miscellaneous debris. Include any assumptions that would reduce the quantity of material transported to the sump screen.

7. The staff considers the technical basis supporting the transport fraction of 0.3417 calculated for Nukon and Thermal Wrap fibrous debris to lack an adequate supporting technical basis. The method used by the licensee appears to be a simplified hand calculation that is a variation on the nodal network approach that was considered reasonable by the safety evaluation (SE) on NEI 04-07 only if supported by experimental data. The transport

methodology used for St. Lucie Unit 1 is not consistent with the approved guidance on debris transport in the SE on NEI 04-07, and the technical basis provided in the supplemental response is not adequate to justify the alternate approach (hand calculation) chosen. Address the following staff concerns:

a. It is unclear how blowdown, washdown, and pool-fill transport were analyzed.

b. The supplemental response identifies only three distinct velocities in the entire containment pool: 0.113 ft/s inside the bioshield, 0.14 ft/s for 26.4% of the area outside the bioshield and 0.07 ft/s for the other 73.6% of the area outside the bioshield. The resolution (number of nodes in the licensee's calculation) does not appear sufficiently fine to provide a prototypical or conservative representation of actual flows in the containment pool.

c. Based on the information provided, it is unclear how 20.6% of the sump pool was calculated to be a "turbulent zone" for large pieces and 30.6% was calculated to be a "turbulent zone" for small pieces. Furthermore, it is not clear that turbulence is the controlling parameter for the tumbling of small and large pieces of debris across the containment floor (e.g., versus velocity), or how a hand calculation can provide a reasonable estimate of the turbulence in the containment pool.

d. It is unclear how the kinetic energy of the break flow and containment sprays was modeled. This flow splashing down into the containment pool can have a significant impact on the velocity and turbulence distributions in the containment pool. For St. Lucie Unit 1 the licensee assumed uniform containment spray drainage. However, the drainage from containment sprays frequently is not at the containment pool elevation due to non-uniformities in the structures at higher elevations that can result in concentrated drainage (e.g., refueling canal drains, hatch openings, gaps in curbs, etc.).

e. The calculation appears to assume that all flow enters the physically nearest strainer module. This assumption is not likely to be valid for modules nearest the bioshield exits carrying the majority of the break flow (note that many licensees have seen significant tangential velocity components or swirling flow patterns near such modules). Neglecting tangential or swirling flow patterns leads to an under-prediction of the velocities throughout the containment pool and local to the strainer modules. Furthermore, without internal strainer flow control, it is not clear that modules nearest the sump suction pipes would not preferentially draw flow, particularly in light of the potential for the clean strainer head losses to result in non-uniform flow.

f. No experimental data was provided to support the simplified analytical hand calculations.

8. Provide the following additional information needed to support the assumption of 10% erosion of fibrous debris in the containment pool:

a. Demonstrate the similarity of the flow conditions (velocity and turbulence), chemical conditions, and fiberglass material present in the erosion tests to the corresponding conditions applicable to St. Lucie Unit 1.

b. Identify the length of the erosion tests and how the results were extrapolated to the sump performance mission time.

c. Clarify how the erosion test results were applied for the different "zones" or computational nodes in the containment pool that were assigned in the transport calculation.

9. Identify whether the debris transport analysis considers the flow rate from a low pressure safety injection (LPSI) pump that fails to trip following switchover. If it does not, then provide the basis for concluding that a single failure of a LPSI pump to trip can be mitigated immediately after switchover during the high-stress period immediately following a LOCA, and that, therefore, the LPSI pump failure to trip flow regime need not be considered. The staff notes that, although the flow from a LPSI pump was analyzed in hot-leg recirculation mode, the LPSI pump flow rate for the hot-leg configuration appears to be significantly lower than for a single LPSI pump that fails to trip following switchover.

10. The extrapolation of test results to parameters other than tested conditions is discussed in the supplemental response. It states that the strainer sector test head loss was scaled to the full sized strainer system based on velocity, kinematic viscosity, and bed thickness differences. State all extrapolations or scaling that was performed for the head loss evaluation. Provide the methodology for all scaling including the inputs and assumptions used.

a. Provide the clean strainer head loss (CSHL) calculation methodology.

b. In the CSHL area the supplemental response stated that debris head loss is assumed to be directly proportional to bed thickness and flow rate through the bed. The concept of head loss proportional to bed thickness ignores the potential for thin bed formation and other bed morphology issues such as compression. It is unclear how this assumption relates to the CSHL calculation. If the current CSHL methodology is retained, provide information that explains how the debris bed thickness applies to the CSHL calculation and justifies the assumption that bed thickness is proportional to head loss. Note that recently the NRC staff has accepted CSHL calculations that assume that each module has an equal amount of in-flow. Alternatively, a licensee could determine how the CSHL value changes as the debris bed forms and provide a value based on such an evaluation.

c. It was implied that the debris was added to the sector test prior to starting the recirculation pump. Either verify that the pump was started before debris addition or provide details on the test sequence and justification that adding debris prior to starting the recirculation pump would result in prototypical or conservative head loss values.

d. Provide documentation of the testing methodology including:
   1. debris introduction sequences (debris type and size distribution) including time between additions
   2. description of test facility
   3. general procedure for conducting the tests
   4. debris introduction locations within the test flume

5. comparison of actual fibrous size distribution added during the test versus fibrous sizes predicted in the transport evaluation
6. particulate debris size distributions
7. amounts of each debris type added to each test
8. test strainer area
9. test flow rates
10. description of debris introduction procedures including debris mixes and concentrations showing that fibrous debris agglomeration did not occur
11. thin bed test debris introduction sequences
12. incremental amounts of fibrous debris added for thin bed tests

e. Provide documentation of the amount of debris that settled in the agitated and nonagitated areas of the test tank.

f. Provide information that shows how test results were extrapolated to emergency core cooling system mission times or provide a discussion of how the test results were determined to bound the head loss during the entire required mission time. If a mission time based net positive suction head (NPSH) margin evaluation was used, provide NPSH margin values for the entire mission time.

g. Provide the test termination criteria and sufficient data to show that the test was run in accordance with the termination criteria.

h. The flashing evaluation did not provide the margin to flashing through the strainer. The submittal stated that a small amount of air pressure is credited, but the amount of overpressure required was not provided, nor was the available margin. The total head loss, including chemical effects, was listed as 11.42 ft at 210 °F with a submergence of less than 1 ft. Provide information that shows that flashing will not occur within the strainer. Include the inputs and assumptions used to make this determination. Provide the margin to flashing at the limiting point during recirculation.

i. The strainer submergence and vortexing evaluation included the volume of the Safety Injection Tanks (SIT) for the small break LOCA. It is possible for some small breaks that this volume would not be available for sump pool inventory. Provide a justification for the crediting of SIT volumes for sump pool level for all required breaks.

j. The supplemental response stated that the vortexing evaluation was conducted with flow rates three times the average strainer module flow rate because modules near the pump suctions would have higher flow rates before a debris bed formed on the strainer. The submittal did not provide the actual flow rates through these modules under clean conditions. Provide the maximum flow through the limiting strainer module in the strainer array under clean conditions. Verify that the vortexing evaluation bounds the worst case strainer module flow rate.

k. The supplemental response stated that the strainer sector test cases were observed and photographed to ensure that absence of bore holes. However, bore holes cannot be detected visually with assurance. Additionally, some post-test photos indicate that there was clean strainer area following the test. In order to assure that viscosity correction is applicable to test results, flow sweeps should be conducted for conditions on which

extrapolations are based (e.g., there should not be open screen area, nor should there be pre-existing bore holes). Provide information that provides additional justification that bore holes did not occur during testing. In addition, provide an evaluation of whether the clean strainer areas would affect the results of the extrapolation to higher temperatures.

l. The supplemental response stated that debris was prevented from settling using stirring. No information was provided to show that the stirring did not drive nonprototypical debris onto the bed or prevent debris from collecting naturally on the strainer. Provide information that verifies that the stirring did not result in non-prototypical bed formation.

11. Provide technical justification in support of the assumption of "no blockage of the refueling pool canal drains." Identify the type, physical characteristics (size, shape, etc.), and amounts of debris which may be blown into the refueling cavity during a LOCA. If it is determined that drainage from the refueling cavity could be blocked, specify the volume of water held up in the cavity and state the effect on minimum containment sump pool level.

12. The NRC staff considers in-vessel downstream effects to not be fully addressed at St. Lucie Unit 1 as well as at other pressurized-water reactors. The St. Lucie Unit 1 supplemental response refers to draft WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff has not issued a final SE for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for St. Lucie Unit 1 by showing that the licensee's plant conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. The licensee may alternatively resolve this item by demonstrating, without reference to WCAP-16793 or the staff SE, that in-vessel downstream effects have been addressed at St. Lucie Unit 1. In any event, the licensee should report how it has addressed the in-vessel downstream effects issue within 90 days of issuance of the final NRC staff SE on WCAP-16793. The NRC staff is developing a Regulatory Issue Summary to inform the industry of the staff's expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue-191.

13. On page 32 of the supplemental response dated June 30, 2008, the licensee made the statement that "the original St. Lucie Unit 1 strainer did not utilize redundant sump strainers." However, this statement does not appear fully consistent with Figure 6.2-40 in the Updated Final Safety Analysis Report (UFSAR) and the discussion on page 6.2-47, which explains that, while there is a common outer mesh with 1/2-inch openings, each suction line is encased by an individual screen capable of filtering down to 1/4 inch. Based upon the UFSAR description, it appears that the fine mesh layer of the former screen design actually did provide a measure of independence between the sump suction inlets, which is not present in the new single-barrier common strainer design. Since the new strainer traverses approximately 270 degrees of the containment, potential concerns associated with inadvertent damage to the strainer (e.g., during maintenance activities) or gaps due to improper installation appear to have increased compared to the previous smaller assembly with independent inner screens. Address the reduction in strainer redundancy that has occurred with the installation of the replacement strainer design and provide a technical basis to conclude that the potential for inadvertent damage and installation issues has been adequately addressed for the replacement strainer.

14. On page 35 of the supplemental response, the licensee stated that the original St. Lucie Unit 1 design did not have separate trash racks (although a two-layered screen assembly was in place prior to the installation of the replacement strainers). However, existing Technical Specification (TS) 4.5.2.d.2 refers to trash racks being present. The replacement strainer design clearly does not have trash racks. Submit an appropriate change to the St. Lucie Unit 1 TSs to be consistent with the new St. Lucie Unit 1 sump strainer configuration and analysis.

15. The NRC staff understands that the licensee has changed its test approach to evaluate chemical effects. Please submit the revised chemical effects test results and analyses to the NRC when they become available.

The licensee may demonstrate that in-vessel downstream effects issues are resolved for St. Lucie, Unit 1, by showing that the licensee's plant conditions are bounded by the final WCAP-16793 and the corresponding final NRC staff SE, and by addressing the conditions and limitations in the final SE. The licensee may also resolve RAI 12 by demonstrating, without reference to WCAP-16793 or the NRC staff SE, that in-vessel downstream effects have been addressed at St. Lucie, Unit 1. The specific issues raised in RAI 12 should be addressed regardless of the approach the licensee chooses to take.

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Sincerely,

**/RA/**

Siva P. Lingam, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-335

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