July 25, 2008

Mr. Thomas D. Walt, Vice President
H. B. Robinson Steam Electric Plant,
Unit No. 2
Carolina Power & Light Company
3581 West Entrance Road
Hartsville, South Carolina 29550-0790

SUBJECT: H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2 – REQUEST FOR ADDITIONAL INFORMATION REGARDING SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED WATER REACTORS" (TAC NO. MC4709)

Dear Mr. Walt:

By letter dated March 7, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080730290), Carolina Power & Light Company, now doing business as Progress Energy Carolinas, Inc. (PEC, the licensee), submitted a supplemental response to Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," for the H.B. Robinson Steam Electric Plant, Unit No. 2 (HBRSEP).

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal. The process involved detailed review by a team of 10 subject matter experts, with focus on the review areas described in the NRC's "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 HBRSEP. 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 except the last. 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.

If the licensee concludes, based on its review of the RAIs, that additional corrective actions are needed for GL 2004-02, the licensee should request additional time to complete such corrective actions as needed. Criteria for such extension requests are contained in SECY-06-0078 (ADAMS Accession No. ML053620174), and examples of previous requests and approvals can be found on the NRC's sump performance website, located at: http://www.nrc.gov/reactors/operating/ops-experience/pwr-sump-performance.html.

Any extension request should also include results of contingency planning that will result in near term identification and implementation of any and all modifications needed to fully address GL 2004-02. The NRC strongly suggests that the licensee discuss such plans with the staff before formally transmitting an extension request.

The exception to the above response timeline is the last RAI in the enclosure (RAI No. 25). The NRC staff considers in-vessel downstream effects to not be fully addressed at HBRSEP, as well as at other pressurized water reactors. HBRSEP'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-NP.

The licensee may demonstrate that in-vessel downstream effects issues are resolved for HBRSEP 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 also resolve this item by demonstrating, without reference to WCAP-16793 or the NRC staff SE, that in-vessel downstream effects have been addressed at HBRSEP.

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-NP. The NRC staff is currently 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, "Assessment of Debris Accumulation on PWR Sump Performance."

Please contact me at 301-415-3178 if you have any questions on this issue, would like to participate in a conference call, or if you require additional time to submit your responses.

Sincerely,

/RA/

Marlayna Vaaler, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-261

Enclosure: As stated

cc w/enclosure: See next page

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Marlayna Vaaler, Project Manager
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REQUEST FOR ADDITIONAL INFORMATION

H.B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

SUPPLEMENTAL RESPONSE TO GENERIC LETTER 2004-02:

“POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION

DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED WATER REACTORS”

DOCKET NO. 50-261

The NRC staff has determined that it needs responses to the following questions in order to continue its review of the subject document:

1. Please provide justification for the assumption that 50 percent of small fines of fiber and 50 percent of fine particulate will be retained in the upper containment rather than being washed down into the containment pool.

   The licensee’s position that 50 percent of fine fibrous and particulate debris is retained in upper containment is a deviation from the baseline guidance in the Nuclear Energy Institute’s (NEI) Guidance Report 04-07, “Pressurized Water Reactor Sump Performance Evaluation Methodology.” The staff further considers this position non-conservative because it is contrary to existing conclusions based on testing evidence. For instance, regarding fibrous debris, a reference discussed in the licensee’s submittal (NUREG/CR-6369, V2, “Drywell Debris Transport Study: Experimental Work”) to support its position actually concludes that “all finer debris that are smaller than the grating, but are captured on the grating as a result of inertial capture, would be washed down when subjected to break and/or containment sprays. A transport factor of 1.0 should be assigned for such fragments.” This conclusion seemingly applies equally for fine particulate.

2. Please provide justification to support the assumptions of zero percent erosion of large fibrous debris pieces and zero percent transportability for large fibrous debris pieces.

   The supplemental response did not explicitly address the transportability and erosion of larger pieces of fibrous debris (although erosion was addressed in an NRC staff RAI for the licensee’s September 2005 GL 2004-02 response (ADAMS Accession No. ML052490343)). However, based upon other information in the submittal, it may be deduced that zero percent erosion was considered for large pieces, and that zero percent transport was considered for large pieces. The staff’s safety evaluation (SE) on NEI 04-07 specifically noted that licensees should consider erosion of large pieces and transport of large pieces when using the baseline guidance.

3. Please provide justification to support the assumption that 15 percent of the debris in the containment pool during pool fill up will be trapped in inactive pool volumes.

The licensee assumed that 15 percent of the debris in the containment pool during pool fill up would be trapped in inactive containment pool volumes. The staff's SE on NEI 04-07 considers 15 percent to be the recommended maximum limit that licensees should assume for debris trapped in inactive volumes, but the staff intended that this reduction in debris reaching the strainer should only be taken if an adequate technical basis exists to support it. No such basis was provided in the supplemental response.

4. Please provide justification to support the position that only 10 percent of fine particulate debris will be blown into the upper containment.

   The licensee assumed that only 10 percent of fine particulate debris would be blown into the upper containment based on "multiple levels of grating above the break location and the small flow area around the steam generator at Elevation 275 ft." Underestimate of this scenario would result in an unrealistic amount of fine particulate debris being considered captured in inactive containment pool volumes. It appears counterintuitive that grating and a small flow area around a steam generator would be sufficient to cause 90 percent of fine particulate debris to blow down to the containment pool.

5. Please provide the size distribution of fibrous debris used in head loss testing. Please compare this distribution with the sizes of fibrous debris predicted to reach the strainer by the plant debris transport evaluation.

   The submittal states that 60 percent of the fibrous material was considered small fines and 40 percent large pieces. In the debris characteristics section, a table states that 60 percent of the fibrous insulation types are fines. It is unclear what percentage of the fibrous debris added to the testing was actually fines. In general, the licensee's strainer test vendor has tested with a generic fiber mix that consists of fibrous debris that is shredded and mixed with water prior to addition. This may result in the size distribution of fibrous debris reaching the strainer not matching the assumptions made in the transport and debris characteristics evaluations. The amount of truly fine fiber added to a test can have a significant impact on how the debris bed forms and the resulting head loss. In addition, the use of a fiber size mixture that is coarser than that predicted by the other evaluations can result in the lack of a thin bed forming during testing when one may actually occur in the plant.

6. Please provide justification that testing was conducted with a debris mix and flow conditions that resulted in prototypical or conservative head loss values.

   In general, NRC guidance expects that in some cases (especially for thin bed testing) only fine fibrous debris will transport to the strainer unless a plant specific evaluation shows transport of larger debris to be prototypical. Transport of coarser fiber would likely be delayed (or not occur at all) due to its lower transportability. Non-prototypical stirring can drive larger fibrous debris onto the strainer, resulting in non-prototypical non-homogeneities in the debris bed and thereby causing lower head loss.

7. Please provide details on the debris introduction techniques used during testing (e.g., where was debris added, what was the concentration of debris when added). Justify

that the debris introduction did not result in non-prototypical agglomeration of debris or non-prototypical deposition of debris on the strainer.

8. Please provide documentation of how much debris, and to the extent possible, what types of debris, settled during testing.

9. Please provide details on any extrapolations that were conducted using the NUREG-6224, “Head Loss Correlation,” correlation. In addition, for any extrapolation, except to higher temperatures, please provide justification for why the extrapolation is prototypical or conservative. Please provide details on any vertical loop testing that was performed to support or inform these extrapolations.

10. Please provide details on the vortex testing that was completed to show where vortex suppressors needed to be installed (e.g., approach velocity, submergence, strainer size, and orientation). Please provide the criteria that were used (e.g., margin to vortexing) to determine which strainer modules required a vortex suppressor.

    The submittal states that HBRSEP installed vortex suppressors over strainer sections where vortexing was predicted. The submittal does not state which strainer modules had vortex suppressors installed and what margin to vortexing was achieved for the modules that do not require vortex suppressors.

11. Please provide the size distributions for the particulate debris used during testing. Discuss how these size distributions compare with the guidance in NEI 04-07 and justify any differences with that guidance.

12. Please provide a revised response to NRC RAI No. 41 contained in an NRC letter dated February 8, 2006 (ADAMS Accession No. ML060370460).

    Specifically, on page 4 of the licensee’s September 1, 2005, GL 2004-02 response (ADAMS Accession No. ML052490343) it was stated that “the result of the water level calculation shows that the most limiting case, which is the small break LOCA [loss of coolant accident] of the pressurizer spray line, results in a depth of at least 1.2 feet above the containment floor, and the applicable emergency operating procedures ensure that at least 1.5 feet is available at the start of containment sump recirculation. The ECCS [emergency core cooling system] sump design will be such that the water level will completely submerge the screens.”

    Information on pages 29 and 39 of the March 7, 2008, supplemental response, taken together, show that at a level of 229.5 feet (18 inches or 1.5 feet above the containment building floor) there are 3.5 inches of water above the strainers. However, it is unclear how a level of 1.5 feet above the containment floor is assured by operating procedures. Please clarify this point.

13. The head loss plot on page 79 of the March 7, 2008, supplemental response shows little or no effect from the last few chemical precipitate additions to the test loop. There appears to be a debris bed redistribution after chemical addition number 2H, possibly due to calcium silicate dissolution.

Given the small remaining net positive suction head (NPSH) margin for HBRSEP, please indicate whether the head loss plot shown on page 79 of the March 7, 2008, supplemental response provides the maximum integrated head loss test result or only the integrated head loss test data for a specific break scenario. Please provide the other head loss plots if additional head loss tests were performed.

14. Based on the gradual increase in turbidity associated with the addition of chemical precipitate surrogate depicted by the figure on page 79 of the March 7, 2008, supplemental response, the staff considers it possible that boreholes or other openings may have been present in the debris bed. Specifically, the turbidity at the end of the test apparently exceeded the turbidity just prior to thin-bed formation. The relative flatness of the head loss trace over the majority of the chemical addition sequence is also indicative of bed disruptions driven by the differential pressure across the debris bed.

    Please provide the basis for using temperature scaling in light of these indications that bed disturbances caused by differential pressure may have occurred (since the bed disruptions may not have occurred at higher temperatures).

15. Please provide a description of the system configuration and assumptions that provide the basis for the flow rate (3820 gallons per minute (gpm)) used to compute the "minimum NPSH margin" in the limiting NPSH margins calculation, including an explanation of which pumps are running and their flow rates.

16. A single-train sump design flow rate of 3820 gpm was used in the NPSH and head loss calculations as the flow rate that would result in the most limiting NPSH margin. Although the use of this value for computing NPSH margin with a clean strainer may be conservative (based on the discussion in the March 7, 2008, supplemental response), there is no basis provided to conclude that this single-train flow rate is conservative when debris bed head loss is factored in. In fact, based on the significant increase in head loss during the flow sweep in the head loss plot on page 79 of the March 7, 2008, submittal, it appears that increased flow due to dual-train operation could result in a significant increase in debris bed head loss, which could potentially overwhelm any benefit from a higher flow rate that is associated with the other terms in the clean strainer NPSH margin.

    Please identify the maximum sump flow rate for dual-train operation and provide a basis that 3820 gpm is the bounding flow rate when both NPSH and debris bed head loss are considered. The basis should include a description of the results of any head loss testing performed at flow rates above 3820 gpm.

17. Please provide a summary of structural qualification results and design margins for the various components of the sump strainer structural assembly. This summary should include interaction ratios and/or design margins for structural members, welds, concrete anchorages, and connection bolts as applicable.

18. HBRSEP has taken credit for silica inhibition of aluminum corrosion. On page 77 of the March 7, 2008, submittal, the licensee stated that when credit is taken for silica

inhibition, chemical precipitate load is maximized when calcium silicate debris input is reduced to 40 percent of that predicted to reach the screen.

Please state whether there are plausible break locations containing less than 40 percent calcium silicate debris that would result in a greater chemical precipitate load than tested due to insufficient silica to reach the threshold silica concentration for inhibition. If so, please discuss why the actual debris tested resulted in a more conservative head loss test compared to an alternate test.

19. Please provide the amounts of time needed for sufficient calcium silicate insulation dissolution to reach the 50 parts per million (ppm) silica and 100 ppm silica concentration in the containment pool and the basis for these calculated times.

20. Please provide details concerning how aluminum oxyhydroxide (AlOOH) solubility was credited during the chemical effects evaluation. Please explain whether the approximately 13 percent reduction in chemical debris load was based on temperatures above 140 ^{o}F. Also, please explain whether additional precipitate was added to the test loop at a point representing when the pool temperature reaches 140 ^{o}F.

21. Please provide the basis for why the chemical effects evaluation remains conservative when crediting aluminum inhibition by silica and AlOOH solubility.

22. Please provide additional information regarding the likelihood of blockage at the refueling canal drain and the potential adverse consequences of blockage at this drain.

    The supplemental response states that a trash rack will not be installed around the refueling canal drain because (1) sufficient water would reach the containment floor during a large-break LOCA to initiate recirculation, and (2) blockage was considered by the licensee to be unlikely. However, the staff generally does not consider blockage of a 3-inch drain to be unlikely, since a very small quantity of debris (e.g., a single piece) could be sufficient to result in blockage.

    An adequate technical basis was not provided in the supplemental response to support the conclusion that blockage of the refueling canal drain is unlikely at HBRSEP. The staff considers blockage at this drain to be of potential concern because (1) for a large-break LOCA, if the sprays are run in recirculation mode, a large quantity of water may eventually be held up in the refueling canal if the drain is blocked, and (2) for a small-break LOCA, the drain may be credited as passing flow during the injection phase of the LOCA.

23. The supplemental response states that the licensee did not consider trash racks necessary for floor drains at the depressions below the steam generator platforms, and it notes that 2 of the 3 drains are credited with passing flow post-LOCA. Given the proximity of these drains to the reactor coolant system and the apparent potential for debris to accumulate at these drains via blowdown and/or washdown, the basis for crediting flow through these drains is unclear.

To support the conclusion that the drains would not become blocked following a LOCA, please provide the following information: (1) the diameter of the floor drains, (2) a description of any cover grating installed over the drains, (3) the basis for considering blockage at 2 of the 3 drains unlikely, and (4) a description of any potential adverse consequences that would occur if all 3 drains became blocked following a LOCA.

24. The supplemental response states that debris blockage would not occur at the 2 foot wide openings in the crane wall where steel bars have been installed in place of the previous coarse mesh screens.

    Please provide the following information in support of this conclusion: (1) the number of openings, (2) the height of the openings and their elevation above the containment floor, (3) the size of the openings between the steel bars, and (4) the basis for considering blockage at these openings to be unlikely.

25. The NRC staff considers in-vessel downstream effects to be not fully addressed at HBRSEP as well as at other PWRs. HBRSEP's March 7, 2008, GL 2004-02 submittal refers to draft WCAP-16793-NP. The NRC staff has not issued a final SE for WCAP-16793-NP, nor is the staff aware that satisfactory testing for a problem bed of debris at the core inlet has been performed for HBRSEP plant conditions and fuel type.

    The licensee may demonstrate that in-vessel downstream effects issues are resolved for HBRSEP by verifying that the plant conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC staff SE (not yet issued), and by addressing the conditions and limitations in the final SE. The licensee may also resolve this item by demonstrating, without reference to WCAP-16793 or the NRC staff SE, that in-vessel downstream effects have been appropriately addressed at HBRSEP.