February 9, 2006

Mr. David A. Christian
Senior Vice President
and Chief Nuclear Officer
Virginia Electric and Power Company
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: NORTH ANNA POWER STATION, UNITS 1 AND 2, REQUEST FOR ADDITIONAL INFORMATION RE: RESPONSE TO GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS" (TAC NOS. MC4696 AND MC4697)

Dear Mr. Christian:

On September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," as part of the NRC's efforts to assess the likelihood that the emergency core cooling system (ECCS) and containment spray system (CSS) pumps at domestic pressurized water reactors (PWRs) would experience a debris-induced loss of net positive suction head margin during sump recirculation. The NRC issued this GL to all PWR licensees to request that addressees (1) perform a mechanistic evaluation using an NRC-approved methodology of the potential for the adverse effects of post-accident debris blockage and operation with debris-laden fluids to impede or prevent the recirculation functions of the ECCS and CSS following all postulated accidents for which the recirculation of these systems is required, and (2) implement any plant modifications that the above evaluation identifies as being necessary to ensure system functionality. Addressees were also required to submit information specified in GL 2004-02 to the NRC in accordance with Title 10 of the *Code of Federal Regulations* Section 50.54(f). Additionally, in the GL, the NRC established a schedule for the submittal of the written responses and the completion of any corrective actions identified while complying with the requests in the GL.

By letter dated March 4, 2005, as supplemented by letter dated September 1, 2005, Virginia Electric and Power Company provided responses to the GL. The NRC staff is reviewing and evaluating your responses along with the responses from all PWR licensees. The NRC staff has determined that responses to the questions in the enclosure to this letter are necessary in order for the staff to complete its review. Please note that the Office of Nuclear Reactor Regulation's Division of Component Integrity is still conducting its initial reviews with respect to coatings. Although some initial coatings questions are included in the enclosure to this letter, the NRC might issue an additional request for information regarding coatings issues in the near future.

Please provide your response within 60 days from the date of this letter. If you have any questions, please contact me at (301) 415-1544.

Sincerely,

/RA/

Stephen Monarque, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-338 and 50-339

Enclosure:
Request for Additional Information

cc w/encl: See next page

Please provide your response within 60 days from the date of this letter. If you have any questions, please contact me at (301) 415-1544.

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GL 2004-02 RAI Questions

Plant Materials

1. Identify the name and bounding quantity of each insulation material generated by a large-break loss-of-coolant accident (LBLOCA). Include the amount of these materials transported to the containment pool. State any assumptions used to provide this response.

2. Identify the amounts (i.e., surface area) of the following materials that are:

   (a) submerged in the containment pool following a loss-of-coolant accident (LOCA),

   (b) in the containment spray zone following a LOCA:

   - aluminum
   - zinc (from galvanized steel and from inorganic zinc coatings)
   - copper
   - carbon steel not coated
   - uncoated concrete

   Compare the amounts of these materials in the submerged and spray zones at your plant relative to the scaled amounts of these materials used in the Nuclear Regulatory Commission (NRC) nuclear industry jointly-sponsored Integrated Chemical Effects Tests (ICET) (e.g., 5x the amount of uncoated carbon steel assumed for the ICETs).

3. Identify the amount (surface area) and material (e.g., aluminum) for any scaffolding stored in containment. Indicate the amount, if any, that would be submerged in the containment pool following a LOCA. Clarify if scaffolding material was included in the response to Question 2.

4. Provide the type and amount of any metallic paints or non-stainless steel insulation jacketing (not included in the response to Question 2) that would be either submerged or subjected to containment spray.

Containment Pool Chemistry

5. Provide the expected containment pool pH during the emergency core cooling system (ECCS) recirculation mission time following a LOCA at the beginning of the fuel cycle and at the end of the fuel cycle. Identify any key assumptions.

6. For the ICET environment that is the most similar to your plant conditions, compare the expected containment pool conditions to the ICET conditions for the following items: boron concentration, buffering agent concentration, and pH. Identify any other significant differences between the ICET environment and the expected plant-specific environment.

7. For a LBLOCA, provide the time until ECCS external recirculation initiation and the associated pool temperature and pool volume. Provide estimated pool temperature and pool volume 24 hours after a LBLOCA. Identify the assumptions used for these estimates.

Plant-Specific Chemical Effects

8. Discuss your overall strategy to evaluate potential chemical effects including demonstrating that, with chemical effects considered, there is sufficient net positive suction head (NPSH) margin available during the ECCS mission time. Provide an estimated date with milestones for the completion of all chemical effects evaluations.

9. Identify, if applicable, any plans to remove certain materials from the containment building and/or to make a change from the existing chemicals that buffer containment pool pH following a LOCA.

10. If bench-top testing is being used to inform plant specific head loss testing, indicate how the bench-top test parameters (e.g., buffering agent concentrations, pH, materials, etc.) compare to your plant conditions. Describe your plans for addressing uncertainties related to head loss from chemical effects including, but not limited to, use of chemical surrogates, scaling of sample size and test durations. Discuss how it will be determined that allowances made for chemical effects are conservative.

Plant Environment Specific

11. Provide a detailed description of any testing that has been or will be performed as part of a plant-specific chemical effects assessment. Identify the vendor, if applicable, that will be performing the testing. Identify the environment (e.g., borated water at pH 9, deionized water, tap water) and test temperature for any plant-specific head loss or transport tests. Discuss how any differences between these test environments and your plant containment pool conditions could affect the behavior of chemical surrogates. Discuss the criteria that will be used to demonstrate that chemical surrogates produced for testing (e.g., head loss, flume) behave in a similar manner physically and chemically as in the ICET environment and plant containment pool environment.

12. For your plant-specific environment, provide the maximum projected head loss resulting from chemical effects (a) within the first day following a LOCA, and (b) during the entire ECCS recirculation mission time. If the response to this question will be based on testing that is either planned or in progress, provide an estimated date for providing this information to the NRC.

ICET 1 and ICET 5 Plants

13. Results from the ICET #1 environment and the ICET #5 environment showed chemical products appeared to form as the test solution cooled from the constant 140 ^{o}F test temperature. Discuss how these results are being considered in your evaluation of chemical effects and downstream effects.

Trisodium Phosphate (TSP) Plants

14. (Not Applicable).

15. (Not Applicable).

16. (Not Applicable).

Additional Non-Coatings Questions

17. (Not Applicable).

18. (Not Applicable).

19. (Not Applicable).

20. (Not Applicable).

21. (Not Applicable).

22. (Not Applicable).

23. (Not Applicable).

24. (Not Applicable).

Coatings

Generic - All Plants

25. Describe how your coatings assessment was used to identify degraded qualified/acceptable coatings and determine the amount of debris that will result from these coatings. This should include how the assessment technique(s) demonstrates that qualified/acceptable coatings remain in compliance with plant licensing requirements for design-basis accident (DBA) performance. If current examination techniques cannot demonstrate the coatings' ability to meet plant licensing requirements for DBA performance, licensees should describe an augmented testing and inspection program that provides assurance that the qualified/acceptable coatings continue to meet DBA performance requirements. Alternately, assume all containment coatings fail and describe the potential for this debris to transport to the sump.

Plant Specific

26. (Not Applicable).

27. (Not Applicable).

28. (Not Applicable).

29. Your GL response indicates that you may pursue a reduction in the radius of the ZOI for coatings. Identify the radius of the coatings ZOI that will be used for your final analysis. In addition, provide the test methodology and data used to support your proposed ZOI. Provide justification regarding how the test conditions simulate or correlate to actual plant conditions and will ensure representative or conservative treatment in the amounts of coatings debris generated by the interaction of coatings and a two-phase jet. Identify all instances where the testing or specimens used deviate from actual plant conditions (i.e., irradiation of actual coatings vice samples, aging differences, etc.). Provide justification regarding how these deviations are accounted for with the test demonstrating the proposed ZOI.

30. The NRC staff's safety evaluation (SE) addresses two distinct scenarios for formation of a fiber bed on the sump screen surface. For a thin bed case, the SE states that all coatings debris should be treated as particulate and assumes 100% transport to the sump screen. For the case in which no thin bed is formed, the staff's SE states that the coatings debris should be sized based on plant-specific analyses for debris generated from within the ZOI and from outside the ZOI, or that a default chip size equivalent to the area of the sump screen openings should be used (Section 3.4.3.6). Describe how your coatings debris characteristics are modeled to account for your plant-specific fiber bed (i.e. thin bed or no thin bed). If your analysis considers both a thin bed and a non-thin bed case, discuss the coatings debris characteristics assumed for each case. If your analysis deviates from the coatings debris characteristics described in the staff-approved methodology, provide justification to support your assumptions.

31. You indicated that you would be evaluating downstream effects in accordance with WCAP 16406-P. The NRC is currently involved in discussions with the Westinghouse Owner's Group (WOG) to address questions/concerns regarding this WCAP on a generic basis, and some of these discussions may resolve issues related to your particular station. The following issues have the potential for generic resolution; however, if a generic resolution cannot be obtained, plant-specific resolution will be required. As such, formal RAIs will not be issued on these topics at this time, but may be needed in the future. It is expected that your final evaluation response will specifically address those portions of the WCAP used, their applicability, and exceptions taken to the WCAP. For your information, topics under ongoing discussion include:

    ee. Wear rates of pump-wetted materials and the effect of wear on component operation
    ff. Settling of debris in low flow areas downstream of the strainer or credit for filtering leading to a change in fluid composition
    gg. Volume of debris injected into the reactor vessel and core region
    hh. Debris types and properties
    ii. Contribution of in-vessel velocity profile to the formation of a debris bed or clog
    jj. Fluid and metal component temperature impact
    kk. Gravitational and temperature gradients
    ll. Debris and boron precipitation effects
    mm. ECCS injection paths
    nn. Core bypass design features
    oo. Radiation and chemical considerations

pp. Debris adhesion to solid surfaces
qq. Thermodynamic properties of coolant

32. Your response to GL 2004-02 question (d)(viii) indicated that an active strainer design will not be used, but does not mention any consideration of any other active approaches (i.e., backflushing). Was an active approach considered as a potential strategy or backup for addressing any issues?

33. You stated that for materials for which no ZOI values were provided in the Nuclear Energy Institute (NEI) guidance report "Pressurized Water Reactor Sump Performance Evaluation Methodology," NEI 04-07, or the associated NRC staff SE, conservative ZOI values are applied. Please provide a listing of the materials for which this ZOI approach was applied and the technical reasoning for concluding the value applied is conservative.

34. You did not provide information on the details of the debris characteristics assumed in their evaluations other than to state that the NEI and SE methodologies were applied. Please provide a description of the debris characteristics assumed in these evaluations and include a discussion of the technical justification for deviations from the SE-approved methodology.

35. Has debris settling upstream of the sump strainer (i.e., the near-field effect) been credited or will it be credited in testing used to support the sizing or analytical design basis of the proposed replacement strainers? In the case that settling was credited for either of these purposes, estimate the fraction of debris that settled and describe the analyses that were performed to correlate the scaled flow conditions and any surrogate debris in the test flume with the actual flow conditions and debris types in the plant's containment pool.

36. Are there any vents or other penetrations through the strainer control surfaces which connect the volume internal to the strainer to the containment atmosphere above the containment minimum water level? In this case, dependent upon the containment pool height and strainer and sump geometries, the presence of the vent line or penetration could prevent a water seal over the entire strainer surface from ever forming; or else this seal could be lost once the head loss across the debris bed exceeds a certain criterion, such as the submergence depth of the vent line or penetration. According to Appendix A to Regulatory Guide 1.82, Revision 3, without a water seal across the entire strainer surface, the strainer should not be considered to be "fully submerged." Therefore, if applicable, explain what sump strainer failure criteria are being applied for the "vented sump" scenario described above.

37. What is the basis for concluding that the refueling cavity drain(s) would not become blocked with debris? What are the potential types and characteristics of debris that could reach these drains? In particular, could large pieces of debris be blown into the upper containment by pipe breaks occurring in the lower containment, and subsequently drop into the cavity? In the case that large pieces of debris could reach the cavity, are trash racks or interceptors present to prevent drain blockage? In the case that partial/total blockage of the drains might occur, do water hold-up calculations used in the

computation of NPSH margin account for the lost or held-up water resulting from debris blockage?

38. What is the minimum strainer submergence during the postulated LOCA? At the time that the re-circulation starts, most of the strainer surface is expected to be clean, and the strainer surface close to the pump suction line may experience higher fluid flow than the rest of the strainer. Has any analysis been done to evaluate the possibility of vortex formation close to the pump suction line and possible air ingestion into the ECCS pumps? In addition, has any analysis or test been performed to evaluate the possible accumulation of buoyant debris on top of the strainer, which may cause the formation of an air flow path directly through the strainer surface and reduce the effectiveness of the strainer?

39. The September 2005 GL response stated that Dominion performed computational fluid dynamics (CFD) analysis of which outputs included global (entire containment) and local (near sump pit) velocity contours, turbulent kinetic energy contours, path lines and flow distributions for various scenarios. Please explain how you used these outputs to determine the amount of debris that transports to the sump screen.

40. In GL 2004-02, item 2.d.iv, NRC requested licensees to provide the basis for concluding that the water inventory required to ensure adequate ECCS or Containment Spray System (CSS) recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths. North Anna responded that Dominion is planning to perform additional verification walkdowns during upcoming refueling outages. Is North Anna planning to write a supplemental response to this GL with the results of these walkdowns? If so, when will the NRC get the response?