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

February 3, 2009

Mr. Jeffery B. Archie
Vice President, Nuclear Plant Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
Post Office Box 88
Jenkinsville, SC 29065

SUBJECT: V. C. SUMMER NUCLEAR STATION – REQUEST FOR ADDITIONAL INFORMATION FOR GENERIC LETTER 2004-02 (TAC NO. MC4721)

Dear Mr. Archie:

By letter dated February 29, 2008, the licensee for Virgil C. Summer Nuclear Station (VCSNS) 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." The cognizant 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" (Agencywide Documents Access and Management System (ADAMS), Accession No. ML073110389). Based on these reviews, the NRC staff has determined that a request for additional information (RAI), as requested in the enclosure, is needed for NRC staff to conclude there is reasonable assurance that GL 2004-02 has been satisfactorily addressed for VCSNS.

The NRC staff requests that a response be provided within ninety (90) days of the date of this letter. However, we wish to receive only one response letter for all RAIs except for No. 23. If the licensee concludes that more than 90 days is needed to respond to the RAIs, the licensee should request additional time, including a basis for why such time is needed.

The exception to the above response timeline is RAI No. 23 in the enclosure. The NRC staff considers in-vessel downstream effects to not be fully addressed at VCSNS. The licensee's submittal refers to draft Westinghouse Commercial Atomic Power (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 safety evaluation (SE) for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for VCSNS 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 VCSNS. 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 NRC staff's expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue -191.

Sincerely,

Robert Martin

Robert E. Martin, Senior Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure: Request for Additional Information

cc w/enclosure: Distribution via ListServ

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V.C. SUMMER NUCLEAR STATION, UNIT 1 (VCSNS)

REQUEST FOR ADDITIONAL INFORMATION

RELATED TO FEBRUARY 29, 2008, RESPONSE TO GENERIC LETTER 2004-02

1. Identify which reactor coolant loop was used to evaluate the postulated crossover leg break and describe how it was ensured that the break selection maximized the generation of Temp-Mat debris.

2. Identify the insulating materials installed on the reactor vessel. If the material is other than reflective metal insulation, provide the amount of material damaged by various breaks and size distribution for the damaged insulation.

3. Provide the following additional information needed to support the assumption of 10 percent erosion of fibrous debris pieces in the containment pool.

   a. Demonstrate the similarity of the flow conditions (velocity and turbulence), chemical conditions, and fibrous material present in the erosion tests to the analogous conditions applicable to the plant condition.

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

4. Provide the methodology used to calculate the tumbling velocity metrics used for paint chips that are listed in Table 8 of the supplemental response. Also, identify the test data from NUREG/CR-6916 from which the velocity metrics are derived, and justify how the methodology used to derive the calculated velocity metrics accounts for the differences between the paint chips that were tested and the paint chips predicted to be formed under actual post-loss-of-coolant accident (LOCA) conditions for the plant.

5. Transport testing performed for Unresolved Safety Issue A-43 was used as a basis for the tumbling velocity metrics assumed for small and large pieces of Temp-Mat. Provide the following information concerning the assumed velocity metrics:

   a. Identify the specific tests from NUREG/CR-2982 that were used as a basis.

   b. Identify the sizes of the test debris pieces for which these metrics were derived and justify why they are conservative or prototypical.

   c. Justify using regularly shaped, scissor-cut debris pieces for representing debris that is likely to be shredded by a LOCA jet into irregular shapes that would typically experience lower frictional forces against the containment floor and offer increased vertical cross-sectional area to promote tumbling.

Enclosure

6. It was not clear that the testing covered the full range of potential fibrous debris loading for the strainer. Provide information that shows that the following issues were considered in the evaluation and shows how the issues were bounded by the head-loss testing that was conducted.

   a. The surge line break that results in fine Kaowool debris was not tested.

   b. It was not clear that Test 2 included any fibrous debris to represent the Temp-Mat prior to the introduction of the "additional fiber loading."

7. The licensee did not verify that the fibrous debris that was added to the testing was prepared sufficiently. Because most fibrous debris for this plant is latent, and the majority of the other fibrous debris that transports is fine, almost all fibers should have been individual or easily suspendable. The use of fibrous shreds for the VCSNS test cases could prevent the potential formation of a thin bed because sufficient fines would not be available to cover the strainer. Because the fibrous debris predicted to arrive at the strainer is a relatively small amount and it is added directly on top of the strainer, the results of the test are likely strongly dependent upon the preparation and introduction of the debris. Provide information that shows that the size distribution of debris in each test matches the debris size predicted to reach the strainer by the transport calculation for that case. Alternately verify that the debris was prepared conservatively fine.

8 It was not clear that the debris was diluted sufficiently to prevent agglomeration of debris during testing. Provide information that shows that non-conservative agglomeration of debris did not occur during testing.

9. The supplemental response stated that the test results were viscosity corrected based on the decrease of water viscosity with increasing temperature. The presence of bore holes or lack of a continuous bed could result in turbulent flow conditions across at least part of the strainer that would invalidate the use of a straight viscosity correction for head-loss. State whether flow sweeps were conducted to ensure that bore holes or other pressure driven phenomenon did not occur during testing. Provide the results of the flow sweeps. Provide the methodology used for the viscosity correction. If flow sweeps were not conducted, justify the method used to perform the viscosity correction.

10. The basis for combining the head-loss results for one paint chip addition (from Test 3) with the results of the head-loss from the fiber and particulate case (Test 2) was not clear. If it is anticipated that paint chips will transport to the strainer, thereby, reducing the effective area for debris to collect, the chips should be added to the limiting case. A simple addition of the results may not produce a conservative result. Provide a justification for combining the two test results instead of performing an integrated test.

11. The section of the supplemental response that describes bypass fraction testing states that samples for bypass fraction were taken for all three tests at 2-hour intervals. The supplemental response also states that the quantity of fiber bypass decreased exponentially over time. It is not clear when the first grab sample was taken. It also appears that more frequent sampling near the beginning of the test may be appropriate.

Provide the schedule upon which samples were taken. Considering that the bypass decreases exponentially with time, provide the methodology used to determine the total bypass.

12. It was not clear that the properties of Marinite sawdust were equivalent to the predicted crushed Marinite. Provide a justification for the use of Marinite sawdust instead of crushed Marinite.

13. It was not stated that the test results were extrapolated to the strainer mission time. Results were not provided in a format that showed that the head-loss was steady or decreasing at test termination. Provide any extrapolation of test results to the mission time. If the results were not extrapolated provide a justification for the lack of extrapolation. Provide head-loss graphs for tests 2 and 3 showing debris additions, test termination, and noting other significant events during the tests.

14. It was not clear that the refueling water storage tank (RWST) volume credited in the water level evaluation was based on a technical specification (TS) minimum RWST level. Please verify that the mass of water credited from the RWST is based on a minimum TS level.

15. The amount of holdup in the refueling canal was not clearly specified. Specify the amount of holdup in the refueling canal and its drain line. Provide a justification for the assumption that the refueling canal cannot be blocked by debris (as stated in the Upstream Section of the supplemental response).

16. A technical basis for the pump flow rates was not provided. Provide the basis for the flow rates used in the net positive suction head (NPSH) evaluation. For example, are the flow rates based on pump runout or are they based on a calculated value? If the value was calculated, provide the methodology, assumptions, and inputs used in the evaluation.

17. A technical basis for the NPSH required (NPSHr) for each pump was not provided. Please provide the basis for the NPSHr values used in the evaluation (e.g., is the NPSHr based on a 3 percent decrease in discharge head or some other acceptance criterion?).

18. An evaluation of NPSH margin during hot-leg recirculation was not provided. If the maximum flow rate is not based on pump runout, provide the maximum flow rate during hot-leg recirculation. Include the methodology, assumptions, and inputs used to determine the flow rate.

19. The 2004 Edition of the American Society of Mechanical Engineers (ASME) Code is not currently endorsed in the Title 10 of the *Code of Federal Regulations* (10 CFR). Provide justification and/or re-evaluation for discrepancies, if any, between the applicable portions of the 2004 Edition of the ASME Code which were used in the analysis and the respective Code Editions which are currently endorsed by the NRC in 10 CFR 50.55a.

20. The licensee's submittal stated that current VCSNS LOCA dose calculations are required to assume the passive failure of a high-head safety injection (HHSI) pump seal at 24 hours after the event with isolation of the leak in 30 minutes. To eliminate the need for assuming a pump seal failure, Section 3p of the licensee's supplemental response stated that the licensee would be preparing an Alternate Source Term (AST) dose analysis and would be submitting an AST license amendment. The licensee stated that if it could avoid the assumption of a HHSI pump seal failure at 24 hours, there would be no need to replace the pump's carbon/graphite disaster bushing. A March 18, 2008, letter from South Carolina Electric & Gas Co. to the NRC, confirmed the licensee's commitment to submit the AST amendment, and the licensee's letter dated December 10, 2008, indicated that this submittal would be made in a projected time frame of February 2009. The licensee should either (1) obtain NRC approval of an AST amendment, or (2) satisfactorily address the radiological effects of failure of the high-head safety injection pump seal, potentially through replacement of that pump's carbon/graphite disaster bushing.

21. The licensee stated that the debris loading expected during post-LOCA conditions may cause the high-head safety injection (HHSI) pump seals to exceed the accepted 50 gallon per minute (gpm) leak rate and that the carbon/graphite disaster bushings in the pump seals may also not limit pump seal leakage to 50 gpm if the primary seal fails. The submittal stated that a more robust replacement pump seal assembly is not available.

    a. Confirm that the expected seal leakage does not diminish the pump(s) capacity below that required to accomplish the pumps design function.

    b. Confirm that the expected pump seal leakage is accounted for in the compartment flooding evaluation.

22. The licensee used coating abrasion data extracted from Westinghouse Commercial Atomic Power (WCAP)-16571-P, "Test of Pump and Valve Surfaces to Assess the Wear from Paint Chip Debris Laden Water," Rev. 0, to supplement erosion data in the erosion calculations. The NRC has not evaluated this WCAP. Submit data extracted from WCAP-16571-P pertinent to the wear evaluations, including information used to support the validity of the data.

23. The NRC staff considers in-vessel downstream effects to not be fully addressed at VCSNS, as well as at other pressurized water reactors. The licensee's supplemental response refers to WCAP-16406-P, which is not recognized by the NRC for addressing in-vessel downstream effects. Westinghouse has prepared WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid" to address in-vessel downstream effects. Further, the NRC staff has not issued a final safety evaluation (SE) for WCAP-16793-NP. Therefore, the licensee may demonstrate that in-vessel downstream effects issues are resolved for VCSNS 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-NP or the NRC staff SE, that in-vessel downstream effects have been addressed at VCSNS. 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 developing a Regulatory Issue Summary to inform the industry of the NRC staff's expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue -191.

24. Provide a detailed technical basis to support the conclusion that aluminum hydroxide is not expected to precipitate in the VCSNS sump water. This information should include the assumed post-LOCA temperature profile as a function of time. Indicate why the assumed temperature profile is the most limiting when considering the amount of dissolved aluminum in the sump water and the solubility of aluminum as a function of temperature at the assumed pH.

25. Provide a table showing, for each of the VCSNS plant-specific solubility cases evaluated, the following plant parameters: pH, temperature, amount of dissolved aluminum, and the assumed aluminum solubility.

26. To account for plant-specific chemical effects, licensees have used a number of approaches including: adding pre-mixed chemical precipitate to integrated head-loss tests; inducing precipitation in the head-loss test loop; or performing longer term tests in simulated post-LOCA environments. For those licensees using pre-mixed chemical precipitate, i.e., the WCAP-16530-NP methodology, the NRC staff has accepted the assumption of three specific precipitates based on the predicted amount and properties of these precipitates bounding other precipitates that could form following a LOCA. Given that the VCSNS analysis assumes no impact from chemical effects based solely on the assumption that aluminum hydroxide is not expected to form, provide the technical basis that shows why precipitates other than aluminum hydroxide could not form in a post-LOCA environment and affect head-loss across the sump strainer.

WCAP-16793. The NRC staff is developing a Regulatory Issue Summary to inform the industry of NRC staff's expectations and plans regarding resolution of this remaining aspect of Generic Safety Issue -191.

Sincerely,

/RA/

Robert E. Martin, Senior Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-395

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