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

October 14, 2009

Mr. Preston D. Swafford
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
3R Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2 - REQUEST FOR ADDITIONAL INFORMATION REGARDING GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS" (TAC NOS. MC4717 AND MC4718)

Dear Mr. Swafford:

By letter dated February 23, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML090540857), Tennessee Valley Authority (TVA or 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 Sequoyah Nuclear Plant (SQN), Units 1 and 2.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal. 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 "Content Guide for Generic Letter 2004-02 Supplemental Responses" (ADAMS Accession No. ML073110389). Based on these reviews, the NRC 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 SQN, Units 1 and 2. The enclosed document describes these requests for additional information (RAIs). These requests were discussed with Mr. Fred Mashburn of your staff on September 30, 2009, and it was agreed that a response would be provided by January 7, 2010. The NRC staff would like to receive only one response letter for all RAIs. If more time is required to respond to the RAIs, the licensee should request additional time, including a basis for why the extension is needed.

If TVA 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 staff strongly suggests that the licensee discuss such plans with the staff before formally transmitting an extension request.

If you have any questions regarding this matter, I can be reached at 301-415-1564.

Sincerely,

Siva P. Lingam

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

Docket No. 50-327 and 50-328

Enclosure: Request for Additional Information

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REQUEST FOR ADDITIONAL INFORMATION

REGARDING GENERIC LETTER 2004-02

SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-327 AND 50-328

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Head Loss and Vortexing

The staff believes that the responses to the following requests for additional information (RAIs) in the licensee's submittal dated February 23, 2009, did not demonstrate that a thin bed of debris is precluded for the design basis debris loading. The staff's underlying concern is that the nonprotypical testing may lead the licensee to the conclusion that SQN has a margin to sump blockage that is significantly larger than actually exists.

RAI 1 The staff requested that the licensee provide the test protocol used for head loss testing and a justification that shows the aspects of the testing were conservative or prototypical. The licensee's response did not fully address the issues as discussed below.

RAI 1A The staff requested that the licensee provide information that justified that addition of debris to the test flume prior to the starting of the recirculation pump resulted in realistic or conservative test conditions. In response to this RAI, the licensee described the test methodology in greater detail than in the original supplemental response. The licensee stated that the debris (mixed with water) was added to the flume with the water level at about 6 inches. The debris was added 3 to 15 feet (ft) from the strainer, which was intended to minimize agglomeration and maximize transport. Reflective metallic insulation (RMI) was added first in an attempt to prevent it from impeding transport of other debris. The flume was then filled using overhead nozzles intended to keep the debris mixture in suspension. The debris was also manually stirred prior to starting the recirculation pump. The staff believes that these test

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methods resulted in nonconservative head loss for the same reasons documented in the Watts Bar Audit Report (ADAMS Accession No. ML062120469). The licensee should provide additional information that shows that the head loss determined by the testing was prototypical or realistic or the licensee should retest using prototypical or conservative procedures.

RAI 1B The staff requested that the licensee provide information that justified that the concentration of debris in the test flume did not result in excessive agglomeration and settling of debris during the head loss testing. The licensee stated that the heavier debris was added to the test flume prior to the lighter debris. This would result in less likelihood of the lighter debris being trapped by the heavier. In addition, the licensee conducted a test where all of the debris was added at or near the test strainer module. The staff considers these points are valid for the aspects stated except that stirring the debris could allow the larger debris to trap some of the smaller debris that was previously on top of it. Also, agglomeration of debris can occur with a single type of debris and may not depend on relative density.

For example, the staff has observed agglomeration of apparently fine fibrous debris into clumps that behave as single large pieces rather than individual fibers. In this example, dumping an agglomerated mass of fiber onto the screen would not be expected to have the same effect on head loss as allowing the individual fibers to transport and collect on the strainer, as would be more likely in the plant. The staff believes that the test methodology used resulted in a nonconservative head loss because the debris preparation and addition practices, higher than prototypical debris concentration, lower than prototypical flume flow rates, and addition of debris prior to starting the recirculation pump have been observed in testing for other plants to contribute to non-prototypical agglomeration and settling of debris. The licensee should provide additional information that shows that the head loss determined by the testing was prototypical or realistic, or the licensee should retest using prototypical or conservative procedures.

RAI 1C The staff requested information regarding the fibrous debris preparation and introduction with respect to prototypical sizing (transport and bed formation), including justification that the testing was performed prototypically or conservatively. The licensee, in the response to RAI 1.C, stated that finely shredded NUKON™ was used as a surrogate for latent fiber. However, the term finely shredded has little quantitative information associated with it. During staff observations of testing (prior to 2008) at Alden labs, it was noted that the fibrous debris used in the testing was larger than considered prototypical. (The licensee's testing was performed at Alden Labs prior to December 31, 2007.) The staff considers fibers in size classes 1-3 as defined in section 3 of NUREG/CR-6808 to be adequate as a surrogate for fine fiber. Use of larger debris sizes would result in nonconservative test results. The licensee also stated that the fibers were mixed with water prior to introduction to the flume. The response does not provide an adequate description of the concentration of fibrous debris in the test nor compare it with what would be

expected in the plant. The staff could not determine that the concentration of debris added to the flume was justified. The licensee should show that the debris preparation and introduction methods resulted in a test head loss that was prototypical or conservative.

RAI 1D The staff requested information regarding the test flume velocity and turbulence. The licensee provided the calculated flume velocity and flume turbulence. However, these were not compared to the plant condition. It was noted that the flume velocity is much lower (by factors of about 2 to 10 times) than velocities used by other plants that attempt to model the flow in the near field of the strainer. In addition, the licensee confirmed that the Reynolds number (Re) for the flume was in the transitioning regime. Although it was not discussed in the response, the staff believes that the plant Re, due to significantly higher temperatures, larger hydraulic diameter, and higher flow velocities, is almost certainly in fully turbulent region, with an estimated Re likely more than one order of magnitude higher than the flume condition. Thus, even setting aside the concerns on debris preparation, sequencing, etc., from strictly a flow perspective, it is almost certain that the transport of fine debris in the test flume underrepresented the plant condition. Because adequate agitation to maintain debris suspended was not provided throughout the test and the flume velocity was likely nonconservative, it is probable that the head loss was affected nonconservatively. The licensee should provide additional information that justifies that the test was conducted using prototypical or conservative procedures or should perform additional testing using prototypical or conservative procedures.

RAI 1E The staff requested the licensee to quantify any near-field settling that occurred during the test. The licensee stated that test 6, which placed all debris on or in the immediate vicinity of the strainer, accounted for any near-field effects that could have altered the outcomes of the other tests. Because the head loss from test 6 was slightly higher than the other test head losses, it was selected as the limiting debris head loss. However, placing debris directly onto a strainer is not likely to result in a conservative or even realistic head loss. Based on staff observations of similar tests, tests 1-5 probably had considerable near-field settlement. The licensee should provide additional information that justifies that the test was conducted using prototypical or conservative procedures, or should perform additional testing using prototypical or conservative procedures.

RAI 1F The staff requested that the licensee provide additional information regarding test scaling, including debris amounts and strainer flow velocity. The licensee provided the scaling for flow and debris amounts. The scaling was based on the ratio of flow areas between the plant strainer and the test strainer. This scaling factor was applied to both the flow rate and the debris quantities. However, the scaling factor generally includes a term for the miscellaneous debris assumed in the design basis for the strainer. Had the miscellaneous debris term of 850 ft^2 (multiplied by the 0.75 factor) been included in the scaling, the flow rate and debris amounts would have been considerably

higher. The licensee did adjust the scaling factor by subtracting about 70 ft^2 from the plant strainer area, but the adjustment should have been 637 ft^2 based on the licensee's calculated miscellaneous debris area. The licensee should justify the use of the lower area assigned to miscellaneous materials.

RAI 1G The staff requested additional information on how partial submergence of the strainer affects the scaling of flow and debris amounts. The licensee stated that the test program was based on a large break loss-of-coolant accident (LOCA) that would result in a fully submerged strainer, and that scaling for a partially submerged strainer was not considered. Because a small break LOCA would probably result in a lower debris load, this might be considered acceptable. However, the critical debris component for this strainer is the latent fiber, which could be present for both large and small break LOCAs in an equal amount. Based on the response to RAI 3 (minimum pool submergence = 9.06 ft), it appears that the design of the strainer did not account for the possibility of partial submergence. However, the licensee did recognize that partial submergence was possible for a small break LOCA in its supplemental response, section 3.f.2. The licensee should provide information that justifies that the strainer will perform adequately under partially submerged conditions considering the reduced strainer area available for debris deposition.

RAI 4 The staff requested that the licensee provide a basis for the statement that a thin bed cannot form on the strainer, considering the design basis debris loading and strainer size. The licensee responded that, although slightly more than 1/8-inch of fiber is available for thin bed formation, under expected plant conditions, non-uniform accumulation would occur, leading to large portions of clean area. The licensee stated that this effect was observed during strainer testing. The staff did not consider the licensee's strainer testing to have been performed in a prototypical manner and, despite the addition of extra fiber, does not have confidence that a thin bed would not form on the plant strainers. Strainers manufactured by Performance Contracting Incorporated are designed to encourage uniform debris bed accumulation, and testing performed at Alden Research Laboratory for U.S. pressurized water reactors using the revised protocol has indicated that uniform beds can be formed with relatively small quantities of fiber (precise amounts are unquantifiable due to settling). Strainer testing for other plants has also shown that debris beds thinner than 1/8-inch can lead to significant head losses. This again leads the staff to conclude that the licensee has not demonstrated a thin bed of debris is precluded for the design basis debris loading. The licensee should provide additional information that justifies that the thin bed testing was conducted using prototypical or conservative procedures, or should perform additional testing using prototypical or conservative procedures.

RAI 5 The staff requested that the licensee provide an evaluation of the performance of the strainer under partially submerged conditions. The licensee stated that, for a fully submerged strainer, vortex formation would be precluded due to the size of the perforations (0.095 inches) on the surface of the strainer. The RAI

response further stated that for a partially submerged strainer operating at a flow rate of 12,900 gallons per minute (gpm), a minimum sump level of 4.18 ft is required to prevent drawing the core tube level down to the level of the flow channel that connects the strainers to the emergency core cooling system suction. The minimum sump level was stated to be 5.04 ft. The response to the RAI did not state further assumptions or inputs for this calculation. It was not clear that the calculation considered whether a vortex could form within the core tube. The flow rate for the calculation was stated to be 12,900 gpm, but the design flow rate for the strainer is somewhat less than this so this input should be conservative. (Note that the response to RAI 6 states that the maximum flow rate is 18,750 gpm, but this appears to be an error. This should be verified to ensure that the evaluation was performed for limiting conditions. It also appears that small break LOCA flow rates would be significantly lower based on the initial supplemental response.) The RAI response also stated that numerous strainer qualification tests had been conducted for both fully and partially submerged strainers with acceptable results. However, these tests were not shown to be applicable or bounding for SQN. The strainer for the SQN test appeared to be very short (about three disks high), so it was not clear that a partially submerged test could have been conducted during the SQN testing. Further details of the calculations and testing performed for the partially submerged condition are needed. The licensee should provide information that justifies that the strainer will perform adequately under partially submerged conditions considering the reduced area for debris deposition on the strainer surface and other considerations contained in Regulatory Guide 1.82, Rev. 3.

RAI 6 The staff requested that the licensee provide an evaluation that shows that flashing across or within the strainer will not occur. The response to this RAI addressed only the large break LOCA case where the minimum strainer submergence is 1.91 ft. A more limiting case could be the small break LOCA case with lower strainer submergence. Flashing across a partially submerged strainer may be prevented due to equalization of the pressure both inside and outside of the strainer and also internal to the core tube during partial submergence. However, once the strainer is fully submerged, head loss may result in flashing if the fluid is close to saturation. It was noted that the maximum design post-LOCA pool temperature is 190 °F. If atmospheric pressure is maintained within the containment, this may provide adequate subcooling such that flashing is prevented. More realistically, the licensee could determine conservative margins to flashing by crediting the minimum predicted containment pressure and maximum sump temperature at various times throughout the event. The licensee should provide information that justifies that flashing will not occur for all postulated LOCA scenarios.

C. Chemical Effects

(New)
RAI 9 The February 2009 SQN supplemental response concludes that detailed chemical effects evaluations are not necessary due to the lack of a fiber bed

on the strainer surface. The staff accepts that maintaining sufficient bare strainer area will mitigate potential chemical effects on the sump strainer. Staff guidance provided in a March 28, 2008, letter (ADAMS Accession No. ML080380214) states, "Plants that plan to credit bare strainer area and perform a simplified chemical effect evaluation should demonstrate, for the maximum debris generation/transport break that the screen design allows for chemical precipitates to pass unimpeded due to the excess available bare strainer area. For the purpose of this simplified analysis, strainer area with a very thin layer of debris that covers the strainer flow area is considered to be different from bare strainer area." However, the bare strainer argument is contingent on NRC staff agreeing that a filtering fiber bed will not form on the entire strainer surface and the staff has not agreed that a filtering bed will not form for SQN. Therefore, unless the NRC staff is able to accept the maintenance of sufficient bare strainer area through the RAI resolution process, please address chemical effects on an alternate basis.

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 staff strongly suggests that the licensee discuss such plans with the staff before formally transmitting an extension request.

If you have any questions regarding this matter, I can be reached at 301-415-1564.

Sincerely,

/RA/

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

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