June 27, 2006

Mr. Rick A. Muench
President and Chief Executive Officer
Wolf Creek Nuclear Operating Corporation
Post Office Box 411
Burlington, KS 66839

SUBJECT: WOLF CREEK GENERATING STATION - REQUEST FOR ADDITIONAL INFORMATION (RAI) RELATED TO LICENSE AMENDMENT REQUEST (LAR) TO REVISE THE STEAM GENERATOR PROGRAM (TAC NO. MD0197)

Dear Mr. Muench:

By the application dated February 21, 2006 (ET 06-0004), Wolf Creek Nuclear Operating Corporation (the licensee) submitted an LAR to revise Technical Specification (TS) 5.5.9, "Steam Generator (SG) Program." Enclosed is an RAI based on the Nuclear Regulatory Commission (NRC) staff review of the application. The questions in the RAI were provided to your staff by email and discussed in a conference call on June 22, 2006. The enclosed RAI may have editorial differences with respect to that provided in the email; however, the questions are technically the same.

In the call, your staff stated that it could not submit the requested information before the upcoming refueling outage, but it would be able to submit the information no later than December 31, 2006. Additionally, your staff stated that it would be submitting an additional license amendment request (LAR) very soon to address SG tube inspections for the upcoming outage. In response, the NRC staff stated that this delay in responding to the enclosed RAI would preclude the staff from completing its review of the application before the outage, and that the anticipated schedule for completing the review would be late 2007. For the new LAR, the NRC staff agreed that an expedited review of the LAR is needed for the upcoming outage. In response, your staff indicated that this schedule was acceptable and would support your spring 2008 refueling outage when the amendment would be needed.

Sincerely,

/RA/

Jack Donohew, Senior Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-482

Enclosure: Request for Additional Information

cc w/encl: See next page

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REQUEST FOR ADDITIONAL INFORMATION (RAI)

RELATED TO LICENSE AMENDMENT REQUEST SUBMITTED ON FEBRUARY 21, 2006

TO REVISE STEAM GENERATOR (SG) TUBE SURVEILLANCE PROGRAM

WOLF CREEK NUCLEAR OPERATING CORPORATION

WOLF CREEK GENERATING STATION (WCGS)

DOCKET NO. 50-482

In its application letter dated February 21, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML060600456), Wolf Creek Nuclear Operating Corporation (the licensee) proposed changes to the Technical Specifications (TSs) for WCGS. The proposed changes are to revise Technical Specification 5.5.9, "Steam Generator Tube Surveillance Program," to exclude portions of the SG tube below the top of the tubesheet in the SGs from periodic tube inspections based on the application of structural analysis and leak rate evaluation results to re-define the primary-to-secondary pressure boundary.

Based on its review of the licensee's application, the Nuclear Regulatory Commission (NRC) staff has the following RAI:

1. Enclosure 1 of the application, Sections 6.1 and 6.2: What were the actual yield strengths and wall thicknesses of the tube specimens used for pullout and leakage testing? How do these values compare to minimum values of these parameters at Wolf Creek? Discuss the effect of tube yield strength and wall thickness on contact pressure between the tube and tubesheet after the tube expansion process (i.e., ignoring pressure and temperature loads). Discuss why the test specimen strengths and wall thicknesses were conservative from the standpoint of minimizing the contact pressures between the tube and tubesheet, or discuss what adjustments need to be made to the test results to allow for the variability of yield strength and tube wall thickness.

2. Enclosure 1, Section 6.2.1: The section states that the leak test program utilized tubesheet simulants (collars) with the nominal tubesheet hole diameter. Was this also the case for the pullout tests? What were the diameters of the tube specimens used in the pullout and leakage tests? Discuss the effect that the field tolerances on these parameters can have on contact pressure between the tube and tubesheet after the tube expansion process (i.e., ignoring pressure and temperature loads). Discuss why the parameter values used for the test specimens were conservative from the standpoint of minimizing the contact pressures between the tube and tubesheet, or discuss what adjustments need to be made to test results to allow for the variability of these parameters.

3. Enclosure 1, Section 6.1, page 27 of 127: Why was the pullout data evaluated at the lower 95th percentile? Discuss how this supports the ability of all tubes to sustain pullout loads, versus using an absolute lower bound value? Given the limited number of tests performed (and the thousands of tubes in the SGs), should not the lower bound value be evaluated to a high confidence value?

4. Enclosure 1, Section 6.2.1.2: The section states that the hydraulic expansion pressure was approximately [proprietary information]. Was hydraulic expansion pressure a measured parameter during SG fabrication that was used for acceptance of each joint? Was the lower limit of the acceptance standard the same as the lower limit of the assumed [proprietary information]? If the answer to either of these questions is no, what is the basis for the assumed [proprietary information]?

5. How does pressure and temperature cycling affect the pullout and leakage resistance of the joints? Cite the available data on this topic, and why it is appropriate that the proposed inspection depths need not specifically account for such cycling.

6. Pullout resistance per unit length associated with the tube expansion process (residual pullout resistance) was determined on the basis of pullout tests and on the assumption that pullout resistance is uniform along the length of the joint. The axial force in the tube is maximum at the top of the tubesheet and decreases as joint friction incrementally picks up some of the load with increasing distance into the tubesheet. As axial force in the tube declines, with increasing distance in the tubesheet, the Poisson's contraction of the tube diameter decreases causing contact pressure to increase until it reaches a constant value at the location where axial force in the tube has been reduced to zero. At the pullout load, the pullout resistance per unit length near the bottom of the joint will be higher than the average pullout resistance along the entire joint. The pullout resistance over the upper portion of the joint will be less than the average resistance. Referring to Tables 7-6 to 7-10 in Enclosure 1, would not consideration of the actual distribution of the residual pullout resistance as a function of distance below the top of the tubesheet lead to larger H* values than shown on these tables? If not, explain why not.

7. The models used to develop the H* lengths are complex. Describe how these models have been verified to yield conservative H* values. Have these models been verified by test? For example, how well do these models predict the actual residual pullout loads for joint test samples with typical H* lengths (i.e., provide comparative data)?

8. Enclosure 1, Section 6.2.2: The section states that room-temperature leakage tests were performed on all test specimens at test pressures of 1900, 2650, and 3100 pounds per square inch (psi) (presumably applied on the primary side with nothing more than atmospheric pressure at the top of the joint). However, Table 6-2 only presents room temperature data for a differential pressure of 1000 psi. Where is this latter data discussed? Why aren't the room temperature data for the tests described in Section 6.2.2 included in Table 6-2 and Figure 6-6?

9. Enclosure 1: Section 6.2.2-1 states that the elevated temperature tests were performed following the room temperature tests. Section 6.2.2-2 states that the room temperature tests were performed following the elevated temperature tests. Clarify this apparent inconsistency.

10. Enclosure 1, Section 6.2.2-2: The section states that a 1900 psi test pressure was used (simulating normal operating pressure) to keep the pressurizing fluid above saturation pressure. As the staff understands the report, the pressure at the upper end of the test

joint is at atmospheric pressure which is not prototypic for normal operating conditions. As the test leakage goes from the bottom of the joint to the top, pressure at some point drops to less than saturation. Why would the test be expected to show as much leakage through the joint as would be the case under prototypic normal operating conditions?

11. The plot of Model F loss coefficient versus contact pressure in Figure 6-6 of Enclosure 1 exhibits a higher slope than is the case for Model D5. The difference appears attributable to lower loss coefficients at lower contact pressures for Model F than for Model D5. Discuss the differences between the Model F and D5 SG designs that explain their different behaviors. If no significant design differences can be identified, discuss the credibility of the loss coefficient data.

12. Enclosure 1, Section 6.2.2.1: The section states that the leak test results averaged 16 drops per minute (dpm) per joint at 1900 psi compared to 59 dpm at higher pressures. This is a factor of 3.7 difference. Discuss why this difference is so high compared to the factor of 2 which, under the bellwether principle, is assumed to bound the increase in leakage going from normal operating to accident conditions.

13. Enclosure 1, Section 7.1.2, page 45 of 127: Was the primary pressure unit load applied only to the primary face of the tubesheet, and not to the side of the tubesheet bore holes? Was the secondary pressure unit load applied only to the secondary face of the tubesheet, and not to the side of the tubesheet bore holes? Was the tube end cap pressure load (due to primary and secondary pressures) included in the finite element analyses?

14. Enclosure 1, Section 7.1.2, page 45 of 127: The 500 °F unit loads represent which of the following: heating up from 70 to 500 °F, or from 70 to 570 °F? If the former, why isn't the 70 °F subtracted from 500 °F in the radial deflection scaling factors in Enclosure 1, Section 7.1.3 (page 46 of 127)?

15. Enclosure 1: Regarding the equation for ΔR^{pr}_{TS} at the top of page 48 of 127, should not P_i be P_o to be consistent with the last equation appearing on page 48? If not, why not?

16. Enclosure 1: The tube inside and outside radii within the tubesheet after expansion shown on page 49 of 127 appears not to be entirely consistent with the numbers on page 44 of 127. Explain this inconsistency or, alternatively, show that this inconsistency does not significantly affect the outcome of the overall analysis.

17. Enclosure 1: Near the top of page 50 of 127, it is stated that the secondary pressure is conservatively assumed to act on the outside of the tube and the inside of the tubesheet hole. The NRC staff agrees that this is conservative from the standpoint of maximizing leakage under normal operating conditions, but it is concerned that it may be non-conservative from the standpoint of determining conservative ratios of accident leakage to normal operating leakage. Would not the assumption of no secondary pressure yield a lesser value of normal operating leakage, leading to a higher ratio of accident to normal operating leakage? What is the basis for describing the assumption on secondary pressure as conservative?

18. Enclosure 1: The ligament tearing discussion in Section 8.2 (starting on page 75 of 127) only addresses circumferential cracks. Provide a corresponding discussion for axial cracks.

19. The structural and leakage assessments supporting the proposed technical specification amendment are for tubes with no degradation in the proposed inspection zone. The proposed inspection depths make no allowance for degradation which may occur within this zone prior to the next scheduled inspection. Assess the potential impact of degradation in the inspection zone on (1) contact pressures between the tube and tubesheet, (2) tube pullout capacity, and (3) leakage under normal and accident conditions. Although flaws in this zone will be plugged on detection, this question is relevant to satisfying the tube integrity performance criteria with respect to condition monitoring and operational assessments. This assessment should address potential axial and circumferential stress corrosion cracks (SCC) and volumetric intergranular attack (IGA) flaws.

20. Describe the methodology to be employed for performing condition monitoring and operational assessments for the tubesheet inspection zone (for pullout and accident leakage) assuming that SCC and/or IGA mechanisms have started to be active.

21. Enclosure 1: The development of the B* distances assumes that crack leakage resistance is not significant relative to the tube-to-tubesheet joint resistance. Discuss the conservatism of the B* distances given the assumption that crack leakage resistance is the dominant resistance to leakage under normal operating conditions. To the extent this discussion relies on assumptions about contact pressure between the tube and tubesheet local to the crack, justify assumptions relative to the influence of the crack on local contact pressure.

22. Describe the methodology for performing condition monitoring and operational assessments for accident-induced leakage stemming from locations below the specified tubesheet inspection depths.

23. By letter dated March 28, 2006 (ADAMS Accession No. ML060940425), the licensee provided revisions to the proposed TSs in accordance with Technical Specification Task Force (TSTF)-449, Revision 4, to include the following additional sentence into TS 5.5.9 c.1: "All tubes with degradation identified in the portion of the tube within the region from the top of the hot leg tubesheet to 17 inches below the top of the tubesheet shall be removed from service." Describe the plans for revising these words to reflect the February 21, 2006, license amendment and for submitting revisions to this amendment.

24. Discuss the plans to revise TS 5.6.10 to include reporting requirements applicable to the implementation of the tubesheet inspection and alternate repair criteria. For example:

- A breakout of indications detected within the tubesheet inspection depths with respect to their location, orientation, and measured size. (The only difference here relative to proposed changes associated with TSTF-449, Rev. 4, is that the indications in the tubesheet region would be listed separately from those elsewhere.)

- The operational primary-to-secondary leakage rate observed in each SG during the cycle preceding the inspection, which is the subject of the report, and the calculated accident leakage rate for each steam generator from the portion of tubing below the tubesheet inspection depths for the most limiting accident. If the calculated accident leakage rate for any SG is less than 2 times the total observed operational primary-to-secondary leakage rate, the 12-month report should describe how it was determined.

25. Enclosure 1, Section 7.1.3, page 46 of 127: The tubesheet bow analysis takes credit for resistance against bow provided by the divider plate. Cracks in the welds connecting the tubesheet and divider plate have been found by inspection at certain foreign steam generators. Describe what actions you are taking to ensure that the divider plates can perform their function, including providing the assumed resistance against tubesheet bow.

26. This is an observation by the NRC staff that does not require a response. On page 24 of 127 of Enclosure 1 to the application, it appears that an item 3 should be added as follows:

    Calculated primary-to-secondary side leak rate during postulated events should:

    (1) ...
    (2) ...
    (3) not exceed 1 gallon per minute (gpm) per SG.

cc:
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