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

April 22, 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: BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2 – REQUEST FOR ADDITIONAL INFORMATION FOR EXTENDED POWER UPRATE - ROUND 23 (TAC NOS. MD5262 AND MD5263) (TS-431 AND TS-418)

Dear Mr. Swafford:

By letter dated June 24, 2004, the Tennessee Valley Authority (TVA, the licensee) submitted an amendment request for Browns Ferry Nuclear Plant (BFN), Units 1 and 2, as supplemented by letters dated August 23, 2004, February 23, April 25, June 6, and December 19, 2005, February 1 and 28, March 7, 9, 23 and 31, April 13, May 5 and 11, June 12, 15, 23, and 27, July 6, 21, 24, 26, and 31, December 1, 5, 11 and 21, 2006, January 31, February 16, and 26, and April 6, 18, and 24, March 6, July 27, August 13, and 21, September 24, November 15 and 21, and December 14, 2007; January 25, February 11 and 21, March 6, April 4 and 9, May 1, June 16, August 15, September 2 and 19, and October 3 ,11, 17, and 31, November 12 and 14, December 15, 2008, January 9, 16, and 23, February 18 and 24, March 12 and 27, and April 2 and 10, 2009. The proposed amendment would change the BFN operating licenses for Units 1 and 2 to increase the maximum authorized power level by approximately 14 percent.

A response to the enclosed Request for Additional Information (RAI) is needed before the Nuclear Regulatory Commission (NRC) staff can complete the review. This request was discussed with Mr. James Emens of your staff on April 6, 2009, and it was agreed that TVA would respond by May 4, 2009. The NRC staff notes that responses to RAI EMCB 201./162 through EMCB 204./168 SRXB-78 were provided in letters dated January 9, 16, and 23, February 18 and 24, and March 12 and 27, 2009.

If you have any questions, please contact me at (301) 415-2315.

Sincerely,

/RA/

Eva A. Brown, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259 and 50-260

Enclosures: 1. RAI - Non-Proprietary
2. RAI - Proprietary

cc w/enclosure 1: Distribution via Listserv

REQUEST FOR ADDITIONAL INFORMATION

EXTENDED POWER UPRATE

ROUND 23

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50- 259 AND 50-260

EMCB

(Units 1 and 2 only)

201./162. In Enclosure 6 to a letter dated October 31, 2008, Tennessee Valley Authority (TVA) presented a response to EMCB.RAI 199/156 in the Structural Integrity Associates Calculation Package 0006982.304, *Comparison Study of Substructure and Submodel Analysis Using ANSYS*. The Nuclear Regulatory Commission (NRC) staff finds the TVA's use of terms "substructure" and "submodel" confusing. For clarification, the NRC understands that the term "substructure" in the response implies a typical submodel as mentioned in the request for additional information (RAI), and the term "submodel" implies TVA's submodel.

TVA's response presents full-model and submodel analyses of a two-plate structure, with a horizontal plate welded to a vertical plate at the mid-height. The dynamic analysis of these plates with harmonic forces acting at the free end of the horizontal plate is presented in Section 6. Based on the analyses results presented in Sections 6.4.2 and 6.5.2, TVA concludes that the typical submodel analyses are invalid because they do not include inertia forces. Therefore, a justifiable stress reduction factor for the stresses at the weld during the dynamic analysis cannot be determined. Because of this, the accuracy of the stress reduction factors determined using the TVA's submodeling approaches (which are different from the typical submodeling approach) cannot be assessed. To address this concern, TVA is requested to provide the following:

a. A full solid finite element analyses for the two dynamic load cases listed in Section 4.2 of the Structural Integrity Associates (SIA) Calculation Package;

b. A comparison of resulting weld stresses with the corresponding stresses from the full shell finite element analyses presented in Sections 6.4.1 and 6.5.1 of the SIA Calculation Package and determination of stress reduction factors;

c. Submodel analyses for the two dynamic load cases considered in (a) using the approach presented in Appendix A of the Continuum Dynamics, Incorporated (CDI) Report 08-20P. Provide a comparison of the resulting stress reduction factors with those obtained in (b). This

d. A comparison of stress reduction factors obtained in (b) with those reported in Sections 6.4.4 and 6.5.4 of the SIA Calculation Package. This should include an assessment of the validity of the two TVA's submodeling approaches used in the stress analyses of Units 1 and 2 steam dryers.

202/163. In the response to EMCB 200./157., TVA states that the coherence between the upper and lower strain gage arrays is modified by removing electrical interference check (EIC) signals from the individual strain gage autospectra (step 1). Then, notch filters are applied to remove tones from the signals that are unrelated to dryer loads (step 2). In step 3, the coherence between the modified upper and lower strain gage array signals is computed. The coherence between two spectra is:

$$\gamma^2=|G_{12}|^2/(G_{11}{}^*G_{22}),$$

where G12 is the cross-spectrum between the two signals, and G11 and G22 are the autospectra of the individual signals. Explain how G12 is modified after using EIC signals and notch filters prior to being used in the coherence calculation. This explanation should include how both the magnitude and phase of G12 are modified.

203/164. In response to EMCB.200./157., TVA presents detailed discussion of signal conditioning in six steps. Provide plots of strain gage signals (autospectra, cross spectra, coherence, and phase) and computed [[______________________________ ________]] throughout the procedure described in the RAI response (prior to step 1, after step 1, after step 2, after step 4 and after step 6), for current license thermal power (CLTP) and Low Flow (LF) signals, for Units 1 and 2.

(Unit 2 Only)

165. In EMCB.159, TVA was asked to compare filtered signals for lines A and D to substantiate strain gage signal substitution in Unit 2. Provide a comparison of the following:

a. The power spectral density (PSD) of $(\text{CLTP} - \text{EICCLTP})_{\text{A-upper}}$ with the PSD of $(\text{CLTP} - \text{EICCLTP})_{\text{D-upper}}$;

b. The PSD of $(\text{LF} - \text{EICLF})_{\text{A-upper}}$ with the PSD of (LF – EICLF); and

c. The filtered [[______________________________]] for the available measurements of lines A and D (e.g., at CLTP).

166. In Section 6.1 of the CDI Report 08-20P, "Stress Assessment of Browns Ferry Nuclear Unit 2 Steam Dryer with Outer Hood and Tie-Bar Reinforcements," TVA reports that the lowest alternating stress ratio calculated at extended power uprate (EPU) without considering filtering of the plant noise is 1.97. The corresponding location is a weld between the dam plate and the new gusset (referred to as Dam Plate/New Gusset in Table 9c). For a more accurate estimate of the stresses at the weld, TVA considers typical submodeling for this location and determines that the stress reduction factor is 0.82 (see Appendix A

of the CDI Report 08-20P). Application of this factor increases the alternating stress ratio from 1.97 to 2.40.

In the submodeling analysis mentioned above, TVA uses the known stresses from the global shell analysis to determine the forces and moments acting on the submodel boundary. In addition it simulates the acoustic pressures and inertial forces acting on the submodel by linearly varying body force. These forces and moments are applied to both shell submodel and the solid submodel, in which the welds are also modeled. The stress results from the analyses of these two submodels are used to determine the stress reduction factor. This submodeling approach is based on technically sound principles and is supported by the computer codes such as ANSYS and ABAQUS.

a. The global shell analysis is a dynamic analysis whereas the submodel analysis is a static analysis. Explain which instant of the global transient analysis is analyzed by the submodel analyses and why that instant is chosen for the analysis.

b. Explain whether the forces and moments acting on the submodel boundary were determined manually or by using the ANSYS Code capabilities.

c. Clarify the last two sentences in the third paragraph on p. 82 of the CDI report.

d. Table 10 in Appendix A of the CDI report provides the alternating stress intensity results for the global shell model. Discuss whether these stresses are related to those presented in the report.

e. Clarify the last two sentences in the fourth paragraph on p. 112 of the CDI report.

167. Explain why the submodeling approach discussed in Appendix A of the CDI Report 08-20P was not used for a more refined stress analysis of the two locations evaluated in Structural Integrity Associates Calculation package, 0006982.301.

204./168. TVA utilized CDI Acoustic Circuit Model (ACM), Revision 4, for the steam dryer analyses. This model was provided in CDI Report 07-09P, Methodology to Predict Full Scale Steam Dryer Loads from In-Plant Measurements, with Inclusion of a Low Frequency Hydrodynamic Contribution. Based on comparisons to Quad Cities' measurements, it is recognized by the NRC staff that ACM Rev. 4 [[________________________________________ ]]

Use of this negative bias is acceptable provided there are no significant loads, or no significant dryer stress components in [[________________________________________

]] There are also strong loads on the Unit 2 dryer (see Figure 4.6 of CDI Report 08-05P, Revision. 3, Acoustic and Low Frequency Hydrodynamic Loads at CLTP Power Level on Browns Ferry Unit 2 Steam Dryer to 250 Hertz (Hz) and at least one critical location with high stresses between 60 and 70 Hz (node 101376, shown in Figure 15a of CDI Report 08-20P, Revision. 0, Stress Assessment of Browns Ferry Nuclear Unit 2 Steam Dryer with Outer Hood and Tie-Bar Reinforcements).

Provide justification for the application of the [[ ]] on the dryer stresses is not significant.

(Unit 1 Only)

205. CDI Technical Note No. 07-30P, Rev. 2, March 2009, states:

Limit curves were generated from the in-plant CLTP strain gage data collected on Unit 1 and reported in CDI Report No. 08-04 [1]. These data were filtered across the frequency ranges shown in Table 5 to remove noise and extraneous signal content, as suggested in SIA Letter Report No. KKF-07-012 [16]. The resulting PSD curves for each of the eight strain gage locations were used to develop the limit curves, shown in Figures 1 to 4. Level 1 limit curves are found by multiplying the main steam line pressure PSD base traces by the square of the corrected limiting stress ratio ($2.80^2 = 7.84$)

[[ ]]

206. In a letter dated March 11, 2009, TVA presented the Unit 1 steam dryer support beam analysis in Enclosure 1. The submittal indicates the support beams are the secondary structural members because they play no role in providing structural integrity to steam dryer. As such the main concern related to partially unattached support beams is the generation of loose parts. TVA claims that the generation of loose parts is not a concern because the stresses in the remaining attached welds on the support beams are acceptable. Therefore, the NRC staff requests TVA to show that galloping of the unattached portion due to cross flow of the support beams is not a problem. Additionally, the licensee should address whether these welds are/will be included in the Browns Ferry inspection program.

EMCB

(Unit 1 only)

207. In Enclosure 1 to the letter dated April 3, 2009, TVA responded to EMCB 206. The response considers the possibility of galloping of the unattached portion of the beam to demonstrate that galloping is not a problem. Although the analysis approach used by TVA appears reasonable, the questions regarding the initial assumptions remain. It was expected that the response would address the worst case scenario, especially if the stitch weld of the beam is not to be included in the inspection program. This worst case scenario should consider that the stitch weld is inactive along the whole base plate of the innermost dryer vane bank and, therefore, the beam would be cantilevered on the base plate of the adjacent vane bank.

In this case, the length of the free end of the beam appears to be substantially longer than the 14.5 inches assumed in the galloping analysis and the frequency would be substantially lower. The relevant vibration mode and the relevant flow direction appear to be different from those assumed in the galloping analysis.

Provide an assessment of the worst case loose section length for galloping/flutter with more appropriate assumptions of the length of the unattached portion of the beam, the relevant vibration mode, and the relevant direction of the cross flow.

SCVB (formerly ACVB)

71./69. For the Appendix R to Title 10 to the *Code of Federal Regulations* (Appendix R) fire event, the March 12, 2009, letter states that there are three other residual heat removal (RHR) pump/heat exchanger combinations that would be available after 72 hours, if needed, in case the RHR pump operating up to that time could not function after 72 hours.

a. Provide the basis for the assumption that at least one of the other RHR pump and heat exchanger combinations will be available at 72 hours following the fire.

b. Address the circumstances that would need to occur and the operator manual action(s) necessary to switch to another RHR pump.

c. Specify the procedures in place to ensure that another RHR pump or pumps can be restored to operable status, if necessary following a significant fire.

d. Paragraph III.G and, by extension, III.L of Appendix R allows for cold shutdown repairs. Discuss what repairs might be necessary and the equipment maintained onsite to make these repairs.

72./70. Provide a calculation demonstrating that the maximum relative humidity that could exist without exceeding the unidentified leakage limit of 5 gallons per minute is 40 percent.

73./71. For the special event associated with a significant fire in accordance with Appendix R:

a. The NRC staff is aware that revisions have/will occur to the operator actions associated with safe shutdown of the plant in the event of a significant fire. Address any modifications, related to securing the non-safety-related fan coolers within two hours of the initiation of an Appendix R Fire. Identify those fire areas where this action is required.

b. Address the feasibility and reliability of this operator manual action. Include a discussion on the means used to train operators to successfully perform this action.

c. Address the effects that termination of non-safety-related fan coolers following the Appendix R Fire will have on equipment (i.e., neutron monitoring cables, main steam safety/relief valves control cables, actuating solenoids, etc.) necessary to safely shutdown the plant.

74./72. Specify whether the fact that the RHR and core spray pumps are high suction energy pumps is considered in the choice of the 3-percent head loss criterion for required net positive suction head. Otherwise explain why not.

SRXB

77. In a letter dated December 15, 2008, TVA provided information regarding expected plant response to a load reject event from EPU power level at Browns Ferry Unit 1. TVA also stated that the potential for the high pressure coolant injection (HPCI) system to automatically start on low reactor water level following a load rejection from EPU power level would be entered in the plant corrective action program.

The Level 2 acceptance criteria for the turbine trip and generator load rejection test performed as part of the startup test program included the following:

The feedwater controller must prevent a low-level initiation of the HPCI and MSIVs [main steam isolation valves] as long as feedwater remains available.

After the startup test program, TVA had lowered the setpoint for main steam line isolation to the reactor vessel water level L1 setpoint. However, HPCI and reactor core isolation cooling continue to startup at the reactor vessel water level L2 setpoint, which may be reached following a load rejection from EPU power level. As TVA described, if HPCI is not secured by operators, HPCI would shutdown automatically on high reactor vessel level. The high level isolation would also shut down the main feed pumps, resulting in a complete loss of feedwater flow.

Clarify the criteria to be employed in the corrective action program to ensure that a load rejection from EPU power level would not routinely progress to an HPCI start and potential high reactor water level event necessitating operator action.

Also, describe how the reactor water level margin to an automatic HPCI start and subsequent potential high level isolation would be evaluated, and explain why the margin is sufficient to preclude the need for load rejection testing from the EPU power level.

78. Provide a discussion summarizing how Unit 1 will meet the specified conditions/limitations numbered 12, 14, and 17 in the NRC's safety evaluation report (SER) related to licensing topical report NEDC-33173P "Applicability of GE Methods to Expanded Operating Domains."

For limitation 14, specifically address the measures intended for Unit 1 in relation to Appendix F of the SER for NEDC-33173P to reduce the critical pressure by 350 pounds per square inch in order to ensure that the no-clad-liftoff criterion of Standard Review Plan Section 4.2 is met.

April 22, 2009

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Docket Nos. 50-259 and 50-260

Enclosures: 1. RAI - Non-Proprietary
2. RAI - Proprietary

cc w/enclosure 1: Distribution via Listserv Package: ML091110480
ADAMS Accession No.: ML091000283 Enclosure 2: ML091100186 NRR-106

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