July 19, 2006

Mr. Karl W. Singer
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 1 — REQUEST FOR ADDITIONAL INFORMATION FOR EXTENDED POWER UPRATE - ROUND 7 (TS-431) (TAC NO. MC3812)

Dear Mr. Singer:

By letter dated June 28, 2004, 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, 11, 15, and 16, and June 2, 2006, the Tennessee Valley Authority submitted to the U.S. Nuclear Regulatory Commission (NRC) an amendment request for Browns Ferry Nuclear Plant, Unit 1. The proposed amendment would change the Unit 1 operating license to increase the maximum authorized power level from 3293 to 3952 megawatts thermal. This change represents an increase of approximately 20 percent above the current maximum authorized power level for Unit 1. The proposed amendment would also change the Unit 1 licensing bases and associated Technical Specifications to credit 3 pounds per square inch gauge (psig) for containment overpressure following a loss-of-coolant accident and increase the reactor steam dome pressure by 30 psig.

The request for additional information was informally provided to your staff on June 15, 2006. A response to the enclosed request for additional information is needed before the NRC staff can complete the review. If you have any questions, please contact me at (301) 415-4041.

Sincerely,

/RA/

Margaret H. Chernoff, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-259

Enclosures:
1. Redacted Request for Additional Information
2. Proprietary Request for Additional Information

cc w/enclosure 1 only: See next page

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SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNIT 1 — REQUEST FOR ADDITIONAL INFORMATION FOR EXTENDED POWER UPRATE - ROUND 7 (TS-431) (TAC NO. MC3812)

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REDACTED REQUEST FOR ADDITIONAL INFORMATION

EXTENDED POWER UPRATE

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-259

EEEB

12. In a letter dated October 3, 2005, in question EEIB-B-4, the NRC staff requested detailed information on the modification to the isophase bus cooling. As the December 19, 2005, response did not contain a sufficiently detailed discussion, address the modifications planned for the isophase bus cooling and the replaced transformers. With regards to the transformers, clarify what modification will be made to increase the rating of the main transformers and when the new transformers will be installed.

13. Since higher capacity recirculation, condensate, and condensate booster pumps are going to be installed, clarify if any modification to the cabling and protective relaying would be required because of the higher load current and provide the status and schedule for those modifications.

14. Discuss how the main generator breaker rating is modified from the current 36 kA to 37 kA and short circuit rating of 346989 amperes to support operation at extended power uprate conditions for Unit 1.

EEMB (Previously EMEB-B)

15. Describe the power ascension monitoring plan for steam dryer and main steam lines (MSL).

16. Enclosure 1 of the letter dated April 13, 2006, contained the General Electric (GE) report, GE-NE-0000-0049-6652-01P, Revision 0, General Electric Boiling Water Reactor Steam Dryer Scale Model Test Based Fluctuating Load Definition Methodology, dated March 2006 (SMT Report). [[redacted]]

    Explain the modeling of surface roughness, edges, and other geometric parameters at the small scale of 1/17; potential distortions and their consequences; and the range of uncertainty in replicating the existence of the excitation mechanisms, their magnitudes, and their frequency content. Include a discussion of why, when and how 1/6 th scale models are used for modeling the safety/relief valves (S/RVs).

17. [[redacted]]because they cannot be accurately modeled at 1/17 scale. Discuss what, if any, flow-induced vibration (FIV) excitation mechanisms are precluded by this distortion.

18. As mentioned on pages 71, 74, and 114 of the SMT Report, [ ]. Explain how the waterline is modeled, changes that are planned, and the effects of potential distortions on pressures and acoustic mode shapes. The response should take into account that acoustic circuit analysis (ACA) has shown that this water-steam interface's damping significantly affects pressure predictions.

19. As mentioned on pages 70 and 75 of the SMT Report, [ ], which the report states will attenuate fluid flow oscillations. Elaborate on how this distortion will affect SMT pressures and what changes could be made to model more prototypic conditions. The reply should take into account that ACA analysis has shown that the steam dome and MSL steam damping significantly affects pressure predictions.

20. As mentioned on pages 70, 71, and 74 of the SMT Report, the array of steam separators in the reactor are described to act like a muffler and the vane bundles which provide some attenuation to acoustic waves. [ ]. Explain how these boundary conditions are represented in the SMT. Also, explain how the differences between the actual boundary conditions and those modeled in the SMT affect the pressures and acoustic mode shapes.

21. As mentioned on pages 72, 73, 75, and 104 of the SMT Report, [ ]. Also, the piping layouts between the S/RVs and the main steam isolation valves (MSIVs) are not prototypic. [ ]. Elaborate on the sensitivity of the turbulence noise excitation mechanism created by these model distortions. Include in the response similar considerations for the turbine control valves (TCVs) and turbine stop valves (TSVs). Discuss the adequacy of the modeling of these components.

22. In reference to the discussion on page 46 of the SMT Report, discuss potential periodicities created in the flow resulting from the multiple jets emanating from the top of the dryer into the steam dome.

23. In reference to the discussion on page 49 and in Appendix A of the SMT Report, explain the potential excitation mechanisms within the steam dome and their significance in term of the need to understand their source and impact. Address the dependence of these mechanisms on Reynolds number (Re) and their possible distortion in the SMT.

24. In reference to the discussion on page 138 of the SMT Report, address how the time shifts are formulated in the stress analyses using an SMT load definition [ ] emergency relief valves (ERV) and S/RV peaks observed in the Quad Cities Unit 2 (QC2) at different frequencies.

25. In reference to the discussion on page 140 of the SMT Report, address how the SMT and the prototype are correlated, so that normal modes are adequately modeled at all the frequencies of interest.

26. The comparison of the operating mode shapes for the pressure data in the SMT and QC2 as presented on pages beginning with page 144 is not clear. Discuss this comparison in more detail.

27. a) Address why a 1:17.3 small scale model was chosen in lieu of a larger scale model (e.g.,1:8). Address the possibility of error propagation being excessive due to the scaling of the model.

    b) Discuss whether there are any friction effects that cause additional ambient noise in the plant using a saturated water vapor compared to the scaled model that uses purely dry air. Discuss whether fouling and buildup on the inside of the plant MSLs considered. Discuss whether those potential friction effects can be neglected and assumed small in the model.

    c) The pressure of air is dependent on the temperature and density where treated as an ideal gas. Discuss what temperature of air was chosen for the model, since pressure is linearly dependent on temperature. Address how the model accounts for steam at given pressures and temperatures in the plant.

28. When calculating the Re for internal flow in a circular pipe on pages A20/A30 of the SMT Report, the diameter of the pipe in the scale model should be that of the plant MSL (1.5 ft) divided by the scale of 17.3, which is 0.0867 ft. [.] Discuss what purpose the boundary layer calculation serves. Discuss whether the entry length should be found to determine where in the pipe the flow becomes turbulent.

29. In Section 4.3.2 (4), the MSIV internals were modeled and included in the overall scale model; however, the TCV internals were not. Address why were they not modeled. Confirm whether and how the main steam line flow restrictor is included in the model.

30. a) Address how the steam colliding with the long radius elbows does not create additional noise in the pipes, which increases the frequency towards resonance, where straight pipes would not. Discuss at what minimum angle can noise generated from steam colliding with the pipe walls be neglected.

    b) Considering pipe bends create non-fully developed flow, provide the basis for assuming that the flow is fully developed throughout the entire model. While this effect can be neglected if the pipe length is much larger than the pipe bend radius, provide the minimum pipe radius for this assumption.

31. Section 7.1 - Table 11 of the SMT Report shows the RMS and peak pressures for the SMT prediction and the plant measurement in the 150-162 Hz band. If sensors P1, P2, and P3 are on one side of the steam dryer and sensors P9, P10, and P11 are in a similar location on the other side of the dryer, discuss why the trends in Table 11 are not similar for the groups. Discuss why there are not similar pressure trends for sensors in symmetric locations.

32. Discuss the potential effects on the S/RVs from possible resonant frequencies that could occur, leading to valve failures. Effects due to vortex shedding were examined for the steam dryer; discuss whether this anomaly would exist in the valves.

33. Regarding uncertainty analysis, discuss whether the uncertainties in the venturi calculation from the manufacturer taken into account (accuracy, resolution, and propagated errors). For the exponential pressure/velocity relationship, discuss the basis for the exponent [ ].

34. The SMT Report indicates that the SMT [ ]. In some cases, the SMT data trended in the opposite direction from the QC2 plant data. See, e.g., Table 11 (75 percent underprediction from 150-162 Hz) and Figures 75 to 98, 109, 112, 117, and 120. Discuss the basis for reliance on the SMT in predicting steam dryer loading in the Browns Ferry Nuclear Plant (BFN) in light of these [ ].

35. On page 175, the SMT Report states that the SMT amplitude measurements associated with S/RV resonances [ ]. Discuss the reliability of this effort based on the significant underprediction of the QC2 plant data by the SMT and the nonlinearity of the data.

36. On page 175 of the SMT Report, the vendor recommends power ascension monitoring in light of the error in the SMT load prediction. Discuss the plans to address this recommendation.

37. Page 19 of the SMT Report states that additional work is on-going to improve the accuracy of the load predictions. Discuss the status and success of this additional work.

38. As Browns Ferry Unit 1 has been shut down since March 1985 and remained in a long term lay-up condition, provide a discussion of the program established to implement NRC IE Bulletin No. 79-14, Seismic Analyses for As-built Safety-related Piping Systems, for restart, consistent with the plant design basis code of record. Discuss with examples the evaluation of the impact of extended power uprate (EPU) conditions on the recovery activities that include ongoing replacement of piping in the reactor coolant, reactor water cleanup, and feedwater (FW) systems; and reinstallation of balance-of-plant piping and new small and large bore pipe supports.

39. Section 3.3.5, Flow Induced Vibration, of Enclosure 4 of the June 28, 2004, submittal, NEDC-33101P, DRF 0000-0010-9439, Browns Ferry Unit 1 Safety Analysis Report for Extended Power Uprate, or the PUSAR, states that the safety-related thermowells and sample probes in the piping for the main steam (MS), FW and Reactor Recirculation (RRS) systems were evaluated, and found to be adequate for the increased MS, FW and RRS flows as a result of EPU. Provide a summary of evaluation and technical basis for the acceptability of this conclusion regarding safety-related thermowells and sample probes in the EPU condition.

40. Section 3.3.5 of the PUSAR states that for the proposed EPU operation for Unit 1, the components in the upper zone of the reactor, such as the moisture separators and dryer, are mostly affected by the increased steam flow. The adverse effects of

increased steam flow on the steam dryer is evaluated in a separate analysis. Provide a summary of the evaluation for the effects of FIV on steam separators for the proposed EPU condition.

41. In reference to Table 3-8 and Section 3.3.4, Reactors Internals Structural Evaluation, of the PUSAR, the reactor internal components such as shroud, core plate, top guide, fuel channel, jet pump, core spray line and sparger, incore housing and guide tube, were evaluated qualitatively for the EPU condition. Provide a quantitative evaluation by comparing the key parameters and design transients, loads and load combinations that are used in the design basis analysis report for stresses and fatigue usage factors (CUFs) in each component, against the EPU condition. Confirm whether and how the design basis parameters envelop those of the EPU condition.

42. Section 3.4, Reactor Recirculation System (RRS), of the PUSAR states that RRS components (e.g., pumps and valves) will be evaluated at EPU conditions to ensure that safety and design objectives are met. Provide a summary of the evaluation for the RRS piping and components regarding the structural and pressure boundary integrity. Also, provide a summary of the calculated maximum stress and fatigue usage factor for critical components at the EPU condition. The components should include recirculation pumps and valves and their supports, which may require a modification after the EPU.

43. Section 3.5, Reactor Coolant Pressure Boundary (RCPB) Piping, of the PUSAR states that the pressure, temperature, and flow changes due to EPU were incorporated into the TPIPE analysis computer model for the affected RCPB piping systems. It also states that the analysis effort included changes due to NRC IEB 79-14 walkdown data, seismic design criteria and spectra changes, and piping and piping component replacement design changes. Confirm whether the computer code TPIPE has been reviewed and approved by NRC for use of piping analysis for Unit 1. Provide a summary of TPIPE analysis and applied loads and load combinations for normal, upset, emergency and faulted conditions. Discuss changes in seismic design criteria and spectra for EPU that deviate from the design basis analysis of record for Unit 1. Also, discuss American Society of Mechanical Engineers Code, Section XI Editions and Addenda or other Codes you used for piping and component modifications and replacements in the affected piping system as a result of EPU.

44. Section 3.5.1, Pipe Stresses, of the PUSAR states that the Unit 1 piping analyses effort stress results, including EPU as well as the other changes, involving the RCPB systems were checked against the USAS-B31.1.0, 1967 Code stress criteria and found acceptable. The report also indicates that all CUFs satisfy the code requirements. Provide the calculated maximum stress and fatigue usage factors at the most critical locations for each of evaluated RCPB piping systems.

45. Section 3.5.1, of the PUSAR, states that for high energy lines, the postulated break/crack locations were identified and evaluated based on the analyses results. The higher EPU pressure effects on the pipe whip restraints have been evaluated and found acceptable. Confirm whether the determination of the postulated high energy line break (HELB) locations is based on the NUREG -800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants LWR Edition (SRP) Section 3.6.2, MEB 3-1 criteria. Identify HELB locations resulting from analyses for EPU conditions

that are different from the original locations specified in the UFSAR for Unit 1. Provide a summary of the evaluation regarding the higher EPU pressure effects on the pipe whip restraints and the jet impingement loads on affected components.

46. Section 3.5.2, Pipe Supports, of the PUSAR states that the TSV closure transient affects on the MS piping increased due to the EPU pressure and flow changes. The MS analysis included the TSV transient and the stresses from this event were found acceptable. All existing RCPB piping supports were qualified as-is or were modified as required to meet design criteria. New added supports were qualified based on the new analyses loads. Provide the maximum calculated stress at the critical locations for the evaluated supports and include a comparison against the Code allowable limits. Also, identify supports that were required to be modified or added in each of RCPB piping systems for the EPU for Unit 1. Provide the schedule for completion of all support modifications, and piping repair and replacement. Confirm whether RCPB piping analyses were performed based on the final configuration after the modification.

47. Section 3.11, Balance-of-plant Piping Evaluation, of the PUSAR noted that balance-of-plant (BOP) piping analyses were performed for changes due to NRC IEB 79-14 walkdown data, seismic design criteria and spectra changes, piping and piping component replacement design changes, the increased post-loss of coolant accident (LOCA) temperatures in the torus, turbine stop valve closure transient and the increased EPU pressure, temperature and flow changes. Provide the calculated maximum stress and CUFs for each of the evaluated BOP piping and supports at the EPU condition including a comparison with the code allowable limits. Provide a summary of the modification in piping and supports for each of the BOP systems due to the impact of the proposed EPU operation.

48. Section 3.11, Balance-of-plant Piping Evaluation, of the PUSAR notes that the design basis accident (DBA) / LOCA dynamic loads, including the pool swell loads vent thrust loads, condensation oscillation (CO) loads and chugging loads were re-evaluated and found acceptable. Provide a summary of the evaluation and the basis for your acceptance conclusion. Also, confirm whether other applicable dynamic loads such as relief valve discharging loads and annulus asymmetric pressurization loads are also evaluated. Confirm whether these evaluations conclude the acceptability of BOP piping in comparison with those of the Unit 1 design basis analyses.

49. Enclosure 1 of the April 13, 2006 submittal contained the GE report, GENE-0000-0052-3661-01-P, Test Report # 1 Browns Ferry Nuclear Plant, Unit 1 Scale Model Test, Class III, dated April 2006 (Test Report #1). Discuss which specific polymer was used to construct the Unit 1 dryer model using stereolithography.

50. If the acoustic Finite Element Model (FEM) of the RPV volume referenced in Test Report #1 is used to define the loading and/or response of the steam dryer, the corresponding document should be submitted for review.

51. a) The acoustic FEM characterization testing in Section 6.1 of Test Report #1 apparently [__________]. Previous scale model test reports indicate that [__________]. Address the effects [__________] acoustic FEM model.

b) Figures 77 to 84 of Test Report #1 purport to show that graphically operating acoustic mode shapes on the surface of the RPV are not understandable. Discuss the significance of these shapes for the RPV. Address whether acoustic modes and pressures will be extrapolated to the surface of the dryer.

52. a) Table 4 on page 51 of Test Report #1 defines the increments of the adjustments made to the S/RV cavity heights (if any). [____]. Also, Ziada and Shine (Ziada, S. and Shine, S., "Strouhal Numbers of Flow-Excited Acoustic Resonance of Closed Side Branches," Journal of Fluids and Structures, Vol. 13, pages 127-142, 1999) point out that valves in tandem can induce higher loads than individual valves. Discuss whether adjustments were made on adjacent valves simultaneously over a matrix of positions to truly maximize excitation. For example, discuss whether an adjustment on Valve 1 of MSL A of [___]" was combined with an adjustment on Valve 4 of [___]".

b) Provide the basis for using [____], considering that only microphone M10 measurements show an S/RV acoustic resonant excitation. Address whether microphone locations have shown different, more conservative sensitivities.

53. The amplitude units in Figures 50-61 of Test Report #1 should be clarified. Discuss whether they are spectra over a specific frequency bandwidth, or spectral densities.

54. a) [____]. The [___________] used as inputs to the LIA and ACM models are different, presumably because the input locations are different for the two models and the most conservative increments were chosen as inputs. Explain why different increments were chosen for the two models.

b) Explain how the pressures on the dryer will be generated with LIA or ACM analysis.

c) Figures 87-90 of Test Report #1 show that the pressure spectral levels computed using the chosen [________] increments exceed those of spectra computed using the full time records, but are consistently lower than those computed using a peak-hold average. The tonal levels near the S/RV singing frequencies, as well as the broad-band levels of the 2.5 second increments are lower than the peak-hold levels. However, no bias error is assigned to the choice of the 2.5-second increment in the uncertainty analysis. Explain why these bias errors for the dryer loading frequency ranges (A-E) in representative 2.5 second increment selections relative to the peak-hold spectra are not estimated and included in the total correction factors.

d) Discuss what assurances there are that the time history segments chosen for the load definitions are bounding, when they are based on pressures measured at essentially only two locations on the dryer faces.

55. The plant conditions for the QC2 data in Figures 62-67 should be clarified. Address whether they are at OLTP or EPU.

56. The SMT data shows that at EPU [ ] (lock-in excitation of acoustic modes within valve standoff pipes by flow instabilities over the pipe openings) [ ] (prior to mitigation by Acoustic Side Branches - ASBs). The blind flanges, S/RVs, and MS relief valves have been modeled geometrically at a very small 1/17 scale. Some provisions have been made to vary the length of their standpipes, to account for fabrication tolerances established by BFN. However, other parameters affect the occurrence and strength of the lock-in excitation mechanisms (such as surface roughness, sharpness of edges, valve internal geometry, etc., all of which are hard to simulate in a small scale model). Discuss what other steps or larger scale tests have been made to evaluate the excitation mechanisms observed in the model and assure that the 1/17 scale model is an adequate representation of the excitation mechanisms that will occur. Assuming the model is correct, discuss those plans being made to avoid operating the reactors at lock-in conditions, where feedback between the flow instabilities and the acoustic modes can nonlinearly cascade into strong FIV excitation mechanisms that are hard to simulate or predict.

57. Section 10.3, A BFN1 SMT Load Definition Process, of Test Report #1, is unclear. Explain the process.

58. In Section 3.5 of Test Report #1, discuss how the unknown absorptivity of the rigid flange at the steam/water interface between the RPV and the steam dryer will affect the model. Discuss how choosing [ ] maximize reflected amplitude.

59. In Section 3.5.1 of Test Report #1, discuss why the outlet of the [ ] if the model is scaled 1:17.3. Discuss how this approximation more accurately models the resonating chamber of the steam dryer for plant scale.

60. Discuss whether the pipe sizing (error of 0.5 percent on page 22 of Test Report #1) was considered in the March 2006 benchmark report.

61. Section 3.5.3.5 of Test Report #1 states that rounded edges at the entrance of a cavity have been shown to attenuate the amplitude of a cavity resonance. The GE SMT uses sharp edges. Address what edges are present in the plant.

62. The acoustic frequencies calculated in Table 1 of Test Report #1 are not in the range evaluated in the SMT Report, [ ]. Discuss whether the frequencies in Table 1 are scaled frequencies. Discuss what this demonstrates in relation to the plant frequencies.

63. Describe the microphone arrangement (i.e., placement for minimal ambient noise, temperature compensation, etc.).

64. Address why microphones [ ]. Discuss how the locations for the microphones on the steam dryer were chosen, outside of being symmetrically spaced on the dryer.

65. Section 6.1 of Test Report #1, references “the Acoustic Finite Element Modeling Report for BFN1.” Indicate whether this document been submitted for review.

66. Address how variations in length sensitivities affect the uncertainty analysis.

67. In Figures 73, 74, and 75 of Test Report #1, [________________________________]. Discuss the physical phenomena causing the data to be as collected. Address why the data is so different from the data at the other sensors.

68. Figures 63 to 65 indicate that the BFN SMT steam dryer loading data [_______________ _______________]. Discuss the evaluation of the steam dryer loading at BFN in light of the QC2 SMT data [____].

69. Discuss the source of the specific resonance peaks in the frequency spectra indicated in the BFN SMT data. See Figures 62 to 67 of Test Report #1.

70. Discuss the ability to correct the [____ ____________________] shown in Figures 69 to 76 of Test Report #1.

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