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

June 3, 2016

Mr. Joseph W. Shea
Vice President, Nuclear Licensing
Tennessee Valley Authority
1101 Market Street, LP 3R-C
Chattanooga, TN 37402-2801

SUBJECT: BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 - REQUEST FOR ADDITIONAL INFORMATION RELATED TO LICENSE AMENDMENT REQUEST REGARDING EXTENDED POWER UPRATE (CAC NOS. MF6741, MF6742, AND MF6743)

Dear Mr. Shea:

By letter dated September 21, 2015, as supplemented by letters dated November 13, December 15 (2 letters), and December 18, 2015, Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) for the Browns Ferry Nuclear Plant, Units 1, 2, and 3. The proposed amendment would increase the authorized maximum steady-state reactor core power level for each unit from 3,458 megawatts thermal (MWt) to 3,952 MWt. This LAR represents an increase of approximately 20 percent above the original licensed thermal power level of 3,293 MWt, and an increase of approximately 14.3 percent above the current licensed thermal power level of 3,458 MWt.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the licensee's submittals and determined that additional information is needed. On March 21, 2016, the NRC staff forwarded, by electronic mail, a draft request for additional information (RAI) to TVA. On March 31, 2016, the NRC staff held a conference call to provide the licensee with an opportunity to clarify any portion of the draft RAI and discuss the timeframe for which TVA may provide the requested information.

In addition, from April 19, to April 21, 2016, the NRC staff conducted an audit of the licensee's draft responses to support the review of the extended power uprate LAR regarding the structural adequacy of the steam dryers. Subsequent to the audit, the NRC staff deleted 2.5 draft RAIs (deleted 2 draft RAIs and part of another RAI) and added 1.5 draft RAIs. As agreed to by the NRC and TVA staff, TVA will respond to the enclosed RAI items according to the dates proposed in Enclosure 1.

The NRC staff has determined that its documented RAI (Enclosure 2) contains proprietary information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 2.390, "Public inspections, exemptions, requests for withholding." Accordingly, the NRC staff has prepared a redacted, nonproprietary version (Enclosure 3). However, the NRC will delay

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placing the nonproprietary RAI in the public document room for a period of 10 working days from the date of this letter to provide TVA the opportunity to comment on any proprietary aspects. If you believe that any information in Enclosure 3 is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390. After 10 working days, the nonproprietary RAI will be made publicly available.

If you have any questions, please contact me at 301-415-1447 or Farideh.Saba@nrc.gov.

Sincerely,

Farideh E. Saba

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, and 50-296

Enclosures:
1. TVA Proposed Response Schedule
2. Request for Additional Information (Proprietary Information)
3. Request for Additional Information (Nonproprietary Information)

cc with Enclosures 1 and 3: Distribution via Listserv (10 days after issuance of the letter)

TVA PROPOSED RESPONSE SCHEDULE

Request for Additional Information (RAI) Question Number	Due Date
EMCB-RSD-RAI-1	July 29, 2016
EMCB-RSD-RAI-2	June 17, 2016
EMCB-RSD-RAI-3	June 17, 2016
EMCB-RSD-RAI-4	July 29, 2016
EMCB-RSD-RAI-5	July 29, 2016
EMCB-RSD-RAI-6	July 29, 2016
EMCB-RSD-RAI-7	July 29, 2016
EMCB-RSD-RAI-8	July 29, 2016
EMCB-RSD-RAI-9	June 17, 2016
EMCB-RSD-RAI-10	June 17, 2016
EMCB-RSD-RAI-11	June 17, 2016
EMCB-RSD-RAI-12	July 29, 2016
EMCB-RSD-RAI-13	June 17, 2016
EMCB-RSD-RAI-14	August 26, 2016
EMCB-RSD-RAI-15	August 26, 2016
EMCB-RSD-RAI-16	August 26, 2016
EMCB-RSD-RAI-17	June 17, 2016
EMCB-RSD-RAI-18	August 26, 2016
EMCB-RSD-RAI-19	June 17, 2016
EMCB-RSD-RAI-20	July 29, 2016
EMCB-RSD-RAI-21	August 26, 2016
EMCB-RSD-RAI-22	June 17, 2016
EMCB-RSD-RAI-23	July 29, 2016

Request for Additional Information (RAI) Question Number	Due Date
EMCB-RSD-RAI-24	June 17, 2016
EMCB-RSD-RAI-25	July 29, 2016
EMCB-RSD-RAI-26	June 17, 2016
EMCB-RSD-RAI-27	June 17, 2016
EMCB-RSD-RAI-28	July 29, 2016
EMCB-RSD-RAI-29	June 17, 2016
EMCB-RSD-RAI-30	June 17, 2016
EMCB-RSD-RAI-31	Withdrawn
EMCB-RSD-RAI-32	June 17, 2016
EMCB-RSD-RAI-33	July 29, 2016
EMCB-RSD-RAI-34	Withdrawn
EMCB-RSD-RAI-35	July 29, 2016
EMCB-RSD-RAI-36	June 17, 2016
EMCB-RSD-RAI-37	June 17, 2016
EMCB-RSD-RAI-38	July 29, 2016
EMCB-RSD-RAI-39	July 29, 2016
EMCB-RSD-RAI-40	July 29, 2016
EMCB-RSD-RAI-41	July 29, 2016
EMCB-RSD-RAI-42	July 29, 2016
EMCB-RSD-RAI-43	July 29, 2016

REQUEST FOR ADDITIONAL INFORMATION

LICENSE AMENDMENT REQUEST REGARDING EXTENDED POWER UPRATE

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

DOCKET NOS. 50-259, 50-260, AND 50-296

By letter dated September 21, 2015 (Reference 1), as supplemented by letters dated November 13, December 15 (2 letters), and December 18, 2015 (References 2, 3, 4, and 5, respectively), Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) for the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3. The proposed amendment would increase the authorized maximum steady-state reactor core power level for each unit from 3,458 megawatts thermal (MWt) to 3,952 MWt. This LAR represents an increase of approximately 20 percent above the original licensed thermal power level of 3,293 MWt, and an increase of approximately 14.3 percent above the current licensed thermal power (CLTP) level of 3,458 MWt.

The Nuclear Regulatory Commission (NRC) staff notes that the BFN units' replacement steam dryer (RSD) analysis submitted by the licensee is based on main steamline (MSL) strain gage (SG) data collected in 2007 and 2008 for Unit 1, in 2010 for Unit 3, and in 2011 for Unit 2 (Section 4.1.1.2 on page 4-3 of Reference 6) when the steam dryers were original equipment dryers (OEDs). The NRC staff also notes that the OEDs will be replaced with new dryers of curved hood design for all three BFN Units. The staff further notes that new set of MSL SGs will be installed at the three BFN Units. The lead BFN unit (Unit 3) RSDs will have on-dryer instrumentation.

The NRC staff from the Civil Engineering Branch (EMCB), Division of Engineering, Office of Nuclear Reactor Regulation, has reviewed the information the licensee provided that supports the proposed LAR and requests for additional information (RAIs) related to the RSDs to complete its review.

Steam Dryer RAIs related to Design and Fabrication

EMCB-RAI 1

In Section 3.2.2.2 of NEDC-33824P (Reference 6), the licensee discusses the design improvements made in the BFN RSDs to increase fatigue margins.

a. Describe the types of welds introduced by these improvements.

b. Describe if any of these welds connect more than two components and have heat-affected zones that may be susceptible to fatigue cracking.

c. Also discuss if any of these welds require testing of the weld samples.

d. Address if these welds receive solution heat treatment or annealing.

EMCB-RAI 2

MSLs A and D appear to have **[[ ]]**,[1] according to Appendix B (Reference 7), pages B-16 and 17, and Figure 2.2-5. However, the image from Figure 4.1-26 on page 4-44 (Reference 6) appears to show that the dead legs are on MSLs B and C. Also, Figure 4.1-13 on page 4-16 (Reference 6) shows peak loads adjacent to the B and C MSL inlets. Clarify which MSLs have the dead legs, and confirm that the **[[ ]]** analyses performed to date are associated with the proper MSL inputs.

EMCB-RAI 3

Table 4.1-23 (page 4-88 of Reference 6) shows flow velocity in the BFN MSL of **[[ ]]**, while Table 4.1-6 (page 4-52) in Reference 6 lists MSL flow velocities of **[[ ]]**. Explain why the MSL flow velocity at extended power uprate (EPU) conditions listed in the two tables are not consistent, and which one is used in the steam dryer evaluations.

EMCB-RAI 4

Section 5.1.1 (page 5-1 of Reference 6) lists the materials used in the manufacture of the steam dryer assembly: **[[ ]]**. Provide information on the heat treatment and fabrication techniques employed for the RSDs to improve resistance to Intergranular Stress Corrosion cracking (IGSCC) and fatigue cracking. Address the following items.

a. Describe whether there are any areas of the RSDs with crevices. If there are any, please provide the locations and their impact on IGSCC, and the corresponding alternating stress ratios (ASRs).

b. Describe any measures implemented in the fabrication of the RSDs to minimize residual stresses.

c. Describe the solution annealing or other heat treatments applied to the materials prior to and subsequent to manufacturing.

d. Describe whether any cold forming is introduced during fabrication. In case cold forming is introduced, discuss any mitigation measures.

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[1] The text between bolded brackets **[[ ]]** contains proprietary information.

EMCB-RAI 5

Confirm that the weld pass thickness, which is discussed in Section 4.2 of NEDC-33824P, Appendix A (Reference 8), will be smaller than the critical flaw size. In addition, the licensee is requested to have a requirement that the root and final passes of dryer welds are inspected using a liquid penetrant test during the fabrication of the replacement steam dryers for the three Browns Ferry Units.

Steam Dryer related to Finite Element Modeling

EMCB-RAI 6

In Section 5.1.3, **[[** **]]** page A30 (Reference 8), the following constraints are imposed on the water volume surrounding the bottom of the skirt:

a. **[[** **]]**, although there are gaps between the steam separator tubes which allow the water to move radially.

b. **[[**

]] Explain what is meant by "most nodes."

The above constraints increase the water loading on the immersed portion of the skirt and, therefore, may impose unrealistic reduction of the skirt vibration response. Demonstrate the conservatism of these constraints with respect to the dynamic response and alternating stresses of the skirt.

EMCB-RAI 7

[[

]] effectively includes damping in addition to the 1.0 percent structural damping in Section 4.2.1.4 of NEDC-33824P (Reference 6). Estimate the additional damping added to the dryer modes by **[[**

]]. Please also provide the properties (density, sound speed, damping, others) applied to the **[[** **]]**. Also, per Regulatory Guide 1.20, applying damping in addition to the usual allowable 1 percent requires justification. Provide full 120-second time histories of the Boiling–Water Reactor (BWR)/4 benchmark on-dryer SGs at EPU conditions in Matlab format, so that an independent assessment may be made to confirm the reasonableness of the added hydrodynamic damping caused by **[[**

]]

EMCB-RAI 8

Figure 4.2-17 shows **[[** **]]** curves for **[[**

]] structural analyses. **[[**

]]. Since in this frequency range critical excitation frequencies associated with [[ ]] loading are present, it is nonconservative to have damping greater than 1 percent in these ranges.

a. Redefine the anchor points such that the damping is 1 percent or less over the entire frequency range of [[ ]]. Please provide the corresponding Minimum Alternating Stress Ratio (MASR) for the lead-in BFN RSD. Also explain how the [[ ]] is applied in the BWR/4 prototype dryer stress analyses.

b. Confirm that the Bias/Uncertainty (B/U) correction process accounts for excessive [[ ]]

i. The licensee applies [[ ]] to their time domain analysis results per the procedures described in Section 4.2.5. Please confirm or clarify as appropriate the following staff's understanding of the approach.

- The individual stress time histories [[ ]]
- The amplitudes of important peaks in the resulting [[ ]] are combined with [[ ]] to compute weighted overall B/U corrections.
- The [[ ]] are applied to the original peak values extracted from the time histories.

ii. Given that the licensee uses a [[ ]] frequency resolution, quantitatively prove that bias corrections at the [[ ]] are conservative, considering that 1 percent damping implies a [[ ]] half-power bandwidth (which is much smaller than the [[ ]] resolution used). This proof may be based on demonstrating the procedure on simplified representative structural models.

iii. Also, for the benchmark BWR/4 and BFN plants, the dead leg lengths are different [[ ]]. Provide:

- The actual dead leg resonance frequencies at finer frequency resolution, including variability of these frequencies over time
- The actual peak amplitudes at those frequencies and their variability over time

EMCB-RAI 9

Section 4.2.3.1 (page 4-125 of Reference 6) mentions using 1 percent structural damping and table 4.1-24 (p. 4-89) in Section 4.1.7.3 shows [[ ]]. In addition to these, describe if there is any other damping utilized in the RSD evaluations. Clarify if the [[ ]] is a percentage of critical damping.

EMCB-RAI 10

In Section 4.2.1.3, the licensee describes the use of [[ ]]. The licensee has identified the [[ ]]. Explain whether these Masters properly represent the [[ ]]. Show that the Masters preserve the natural frequencies [[ ]] and mode shapes of the corresponding [[ ]].

EMCB-RAI 11

In Figure 4.2-2 of NEDC-33824P, Appendix A, Revision 0, it is stated that the range for applicability of [[ ]]. Please discuss the significance of this statement and any impact on the stress concentration associated with an undersized weld. Explain if this condition of [[ ]] is satisfied for BFN RSD fillet welds.

EMCB-RAI 12

In Section 4.2.1.7 of NEDC-33824P (page 4-119) it is stated that, [[ ]] Provide the value for the coefficient of friction and the magnitude of the friction force during heat-up and cooldown. Justify [[ ]] in the dryer stress analysis.

EMCB-RAI 13

Section 4.2.3.3 of NEDC-33824P, page 4-126, states that: [[ ]]. This means that both the mesh size and nodes [[ ]]. Provide additional details on the acoustic and structural mesh size and explain [[ ]]

Steam Dryer RAIs related to SRV Loading

EMCB-RAI 14

In Section 4.1.4 of NEDC-33824P (Reference 6), General Electric Hitachi Nuclear Energy (GEH) has estimated dryer [[ ]] of the BFN dryers based on previous data from other plants. GEH describes the measures taken to ensure the [[ ]] are conservative. However, GEH's procedures do not appear to guarantee that conservative loading is applied to the BFN RSD models. Please repeat the [[ ]], but using dryer stress as a metric instead of [[ ]]. One possible approach is to perform this calculation in the frequency domain since the SRV loading is deterministic, saving significant computational time.

EMCB-RAI 15

In Section 4.1.4.4.1 of NEDC-33824P (Reference 6) the [[ ]]. The table below shows the main features of the MSLs in both of these plants. There are several important differences between the plants, including the number of safety relief valves on each MSL, their locations along the MSLs and the acoustic resonance frequencies. In addition, the dead legs in BFN piping are not present in the RP. Given these differences, it is not clear why it is reasonable to assume that the response of the target plant (BFN) [[ ]]. Since the acoustic resonance mechanism of the SRVs is basically a non-linear phenomenon, the conservatism of the approach used to scale the resonance peak from the RP to the target plant needs to be substantiated.

Plant data of SRVs

Plant	Browns Ferry (BFN)	Reference Plant (RP)
Resonance Frequency.	[[	]]
Dead legs	YES	NO
(d/D)*	≈ 0.22	≈ 0.32
SRVs on MSL A	3	2
SRVs on MSL B	2	2
SRVs on MSL C	1	2
SRVs on MSL D	3	2
Total No. of SRVs exposed to steam flow	9	8

*d is the standpipe diameter and D is the MSL diameter

The RP has additional valves other than the SRVs (e.g., electromatic relief valves (ERVs) and target rock relief valves (TRVs)) that exhibited resonant response below EPU conditions, [[ ]] for BFN may be used [[ ]] in the RP at their resonant operating conditions. Such an approach may validate the effects due to differences in number and location of valves as well as differences in the resonance frequencies. The conservatism of using [[ ]] can also be validated by means of this approach. The licensee is thus requested to substantiate/validate the [[ ]] used to estimate the [[ ]].

EMCB-RAI 16

In the [[ ]], Section 4.1.4.4.1 of NEDC-33824P (Reference 6), the [[ ]] between EPU and CLTP conditions in Browns Ferry Plant [[ ]]. The staff does not agree with this approach because the resonance frequency is not the same in both plants. The licensee is, therefore, requested to utilize an approach such as the one considering Strouhal number similarity to convert the Browns Ferry's EPU [[ ]] to that of the RP.

EMCB-RAI 17

In the [[ ]], Equation 4.1-14 on page 4-67 of NEDC-33824P (Reference 6) is used to account for differences between the [[ ]] of both plants (BFN and RP). In this equation, the [[ ]]. This seems to be inconsistent with the text given above equation 4.1-14, stating [[

]]. According to this statement, Group (RMS1) should be multiplied by the [[ ]]. Explain the reasons for dividing, instead of multiplying, [[ ]].

EMCB-RAI 18

The plant data comparisons provided in Figures 4.1-56 and 4.1-57 of NEDC-33824P (pages 4.104 and 4-105 of Reference 6) include plants with different diameters (D) of the MSLs and different diameters (d) of the SRV standpipes, MSL flow velocity (V), and Strouhal frequency (f). Therefore, the comparison between the BFN and the [[ ]] plants, which is used for [[ ]] Additionally, the Strouhal number for acoustic resonances of the SRV standpipes depends on the ratio d/D, which is different for these plants (see the table in RAI-15). Therefore, the licensee is requested to provide a comparison between BFN and the reference plant based on the similarity of Strouhal number.

EMCB-RAI 19

Clarify whether the [[ ]] comparison at test condition [[ ]] in Figure 4.1-56 and 4.1-57 (pages 4.104 and 4-105 of Reference 6) is at previous CLTP conditions or current EPU conditions.

EMCB-RAI 20

The [[ ]]. As illustrated in NEDC-33824P on page 4-54 (Reference 6), the dryer load amplitude is very sensitive to changes in the frequency or phase of the SRV acoustic sources. The licensee is requested to explain how the [[ ]] during the dryer stress computation.

EMCB-RAI 21

In Section 4.1.4.4.2 of NEDC-33824P (Reference 6), the [[ ]] used in estimating the [[ ]] of BFN at EPU conditions is based on [[ ]]. However, BFN and the RP have fundamental differences in the arrangement and resonance frequency of the SRVs. It is not clear why the [[ ]]. The licensee is requested to demonstrate that [[ ]]. Since the RP has additional valves other than the SRVs (e.g., ERV and TRV) which exhibited resonant response below EPU conditions, the resonant response of these other valves in the RP can be used to validate the [[ ]] which is used in BFN.

EMCB-RAI 22

Section 4.1.2.2 (page 4-17 of Reference 6) discusses how [[
]]. Please explain if this [[ ]] is coherent (a sum over complex numbers), or incoherent (a sum over the absolute values of the differential pressures). If the sum is coherent, the [[ ]] may not be conservative, as it effectively filters the circumferentially varying loading which excites the low frequency dryer modes most likely to contribute to peak stresses. Provide an assessment of the impact on MASR, if a coherent sum was inappropriately chosen as the basis for [[ ]], and for computing [[ ]].

Steam Dryer RAIs related to Acoustics

EMCB-RAI 23

In Section 4.1.4.2 of NEDC-33824P (page 4-42 of Reference 6), it is noted that previous testing and analysis has indicated that High Pressure Coolant Injection, Reactor Core Isolation Cooling, and vent lines are [[ ]]. Explain, if the first valve (from the MSL) on any of the three lines is closed (an off-normal event), why that line [[ ]]. Provide a history of such off-normal events at BFN plants, and the impact of those events on steam dryer analysis.

EMCB-RAI 24

The [[ ]] that are plotted in Figures 3.2-2 to 3.2-7 (pages C-50 to C-52) of Appendix C (Reference 9) of NEDC-33824P are obtained from [[
]]. The degree of variability between these plants can be evaluated by comparing the individual [[ ]] of the plants. Please provide overlaid plots comparing the values of each coefficient obtained from the three plants.

EMCB-RAI 25

In Section 4.1.7.4 of NEDC-33824P (pages 4-89 to 4-101 of Reference 6), several features of the dryer acoustic loading of BFN are compared with those of other plants, including the [[ ]]. In these comparisons, the acoustic pressure characteristics are [[
]]. This type of comparison between averages does not reflect the degree of local differences and may result in underestimating the maximum dryer stress. Since the [[ ]] is considered to be the prototype for the BFN plant, it would be appropriate to first validate this assumption by comparing the individual acoustic sources at the MSL nozzles of both plants. This comparison is needed to substantiate the [[
]]. Therefore, the licensee is requested to compare the acoustic sources at the MSL inlets for BFN and the prototype plant at CLTP conditions. These sources can be estimated by means of MSL data based plant based load evaluation [[

]] methodology. Please provide overlaid Power Spectral Density (PSDs) of the sources for each MSL separately.

EMCB-RAI 26

The licensee uses [[ ]] for estimating the pressures on the three BFN RSDs. [[ ]] is used to assess the projected MASRs at EPU for the proposed RSDs. [[ ]] will be applied for assessing the lead BFN unit (BFN Unit 3) (instrumented dryer) after on-dryer measurements are acquired. Finally, [[ ]] will be used to monitor the MASRs of the BFN Unit 1 and BFN Unit 2 RSDs during power ascension. However, [[ ]]. Explain the benefits of using [[ ]] to assess the MASRs of the first RSD during power ascension.

EMCB-RAI 27

The pressure PSD plots in Figures 4.1-56 and 4.1-57 (pages 4-104 and 4-105 of Reference 6) are in Pascals squared/Hz. Provide the pressure PSD plots in Figures 4.1-56 and 4.1-57 in English units (psid [pounds per square inch differential] squared/Hz) also.

Steam Dryer RAIs related to Instrumentation and Monitoring

EMCB-RAI 28

In Appendix E (Reference 10) of NEDC-33824P, Table 4.4-1 on Page E22 shows locations of the SGs that will be installed on the MSLs. The locations of the [[ ]]. However, the locations of the lower gages are different. Please explain the differences between the arrangements of the MSLs in the three units that preclude installing the lower gages at similar locations in the three units.

EMCB-RAI 29

Table C6-3 on page C-131 of Appendix C (Reference 9) specifies a pressure to microstrain conversion of about [[ ]]. However, no units are provided for this conversion. Clarify if the conversion is in Pascals (Pa)/microstrain or pounds per square inch (psi)/microstrain.

EMCB-RAI 30

In Attachment 45 (Reference 11) to the TVA Letter dated September 21, 2015 (Reference 1), the frequency range of valve monitoring is not indicated. Flow-excited resonances of the acoustic trapped modes inside the Main Steam Isolation valves (MSIVs) have been observed in other BWR plants consequent upon increasing the power beyond the CLTP value. The licensee should monitor the vibration of the MSIVs up to 1 kilohertz to assess the severity of acoustic resonances which may develop inside the MSIVs when the steam flow velocity is increased. Therefore, the licensee is requested to provide the frequency range for monitoring the vibration of MSIVs

EMCB-RAI 31

Deleted

Steam Dryer RAIs related to Stress Analysis

EMCB-RAI 32

GEH assesses the effects of Vane Passing Frequency (VPF) loads in **[[**

]] as described in Section 4.1.5.4 (Reference 6). Provide the following information regarding the VPF tones.

a. Considering how the VPFs vary throughout a fuel cycle:

   i. Discuss what SRV resonances might the VPF tones align with.

   ii. Address the potential impact of this interaction on the amplitude of the SRV resonance.

b. There are two reactor recirculation pumps:

   i. Address how the VPF tones between the two pumps interact.

   ii. Address amplification of loads due to 'beating' phenomena between the tones.

   iii. Provide any available data from the **[[** **]]** SGs to address this request.

EMCB-RAI 33

GEH has benchmarked the **[[**

]]. Provide the following additional information regarding the benchmarking.

Provide PSD plots for both **[[** **]]** based benchmarking that show that all peak strains at all measured SG locations are bounded by the upper envelope of the **[[**

]]. If any peak strains are not bounded, provide an assessment of the nonconservatism(s) on dryer fatigue life.

EMCB-RAI 34

Deleted.

EMCB-RAI 35

Link the five most stressed upper dryer locations and five most stressed lower dryer locations to specific on-dryer SGs. Show pictorially the gage and peak stress locations at the frequencies most responsible for peak stresses.

EMCB-RAI 36

Reconcile Figure 5.4.1 in Reference 10 (Appendix E to NEDC-32824P), where loading frequencies do not seem to [[ ]], with Figure 5.4.2 in Reference 10, where all [[ ]].

EMCB-RAI 37

Clarify whether the y-axes in Figures 5.4.1 and 5.4.3 in Appendix E of NEDC-32824P are microstrain or millistrain.

EMCB-RAI 38

The limits in Table 5.3.1 (time) and Appendix E-1 (frequency) appear to be nonconservative compared to strains observed in other instrumented dryers.

a. Compare the simulated on-dryer strains for the BFN dryer to those measured on the benchmark BWR/4 dryer.

b. Provide cumulative strain plots for sensors [[ ]] to complement the computing root mean square (RMS) values provided in Table 5.3-1.

c. SGs 6 and 9 have very high potential strains – up to [[ ]]. SGs have a finite life, particularly at high amplitude. Provide information on which frequency(s) contribute most strongly to the strain at these gage locations Describe the survivability (expected life or number of cycles) of the dryer SGs at these potential strain amplitudes.

d. Provide alternative procedures for RMS limits and frequency-dependent limit curves for on-dryer SGs based on new data acquired on the lead BFN dryer just prior to power ascension to CLTP. Note that since these methods would be based on data measured on the BFN dryer, [[ ]]. The current simulations of on-dryer strains may be used to demonstrate the procedure, but not used as actual limits during power ascension.

EMCB-RAI 39

GEH computes [[ ]]. The final alternating stress ratios (ASRs) at EPU shown in Table 4.4-1 on pages 4-152 and 4-153 (Reference 6) are above 2.0, and additional details of the five most highly stressed dryer regions are provided in Section 6 of Appendix D (Reference 10) of Attachment 40 (Ref. 6). However, not enough peak stress locations were addressed in the plots provided. Provide the following additional information.

a. Table 8.1-4 of Appendix-A (p. A-88 of Reference 8) states that a [[ ]]. Provide the numerical value of the [[ ]] used in the static analysis. Also, provide a justification for the magnitude of the [[ ]] value.

b. The instrument mast on BFN unit 3 RSD used for on-dryer instrumentation may influence the dryer stresses in the vicinity of the mast. Please clarify the following:

   i. Are the ASRs shown in Table 4.4-1 (pages 4-152 and 4-153 of Reference 6) based on a structural finite element model of the RSD with the instrumentation mast, without the instrumentation mast or an envelope of with and without the mast?

   ii. If the ASRs in Table 4.4-1 are based on a dryer model without the mast, provide ASRs for a model that includes the mast.

c. Based on Section 5.1 (page 5-1), and Section 4.1 (p. A-16) of Appendix A (Reference 8) it appears that the ASRs shown in Table 4.4-1 are [[ ]]. This issue is being discussed in the ASME Code committees, and has not been resolved. Therefore, provide adjusted Table 4.4-1 ASRs applying the [[ ]]

d. Provide spectra and stress accumulation plots for the five most highly stressed upper dryer and for the five most highly stressed lower dryer locations. Highlight the relative contributions to total stress of the [[ ]], the SRV resonance peak(s), and the VPF peak.

EMCB-RAI 40

To help ensure conservatism in the [[ ]], provide histograms of the summed BFN RSD loading [[ ]], along with histograms of the [[ ]] Also, provide histograms of the summed benchmark BWR/4 dryer loading, along with histograms of the simulated and measured on-dryer strains. Finally, provide histograms of the measured strains on the outer hood of the lead-in BFN RSD at EPU and include it in the 90-day EPU report. Provide a comparison of

these histograms with those for Grand Gulf Nuclear Station, [[
]] that were submitted earlier.

Steam Dryer RAIs related to Power Ascension

EMCB-RAI 41

In Section 6.5 of NEDC-33824P, Revision 0, the licensee discusses projecting [[
]]. If the projected loading leads to acceptance limit violations, Section 6.6.1 states that [[

]] Substantiate using [[ ]] to trend SRV loads that are highly nonlinear using examples from previous SRV resonance trending in other plants. Also, demonstrate with an example how SRV resonance loads will be trended (also at intermediate power hold points) using the method described in Section 6.6.1.

EMCB-RAI 42

In NEDC-33824P, Appendix E (Reference 11), page E-11, GEH states in the Power Ascension Test Plan that power levels will be chosen [[
]]. What test conditions will be evaluated that [[

]] may be assessed. Provide core flow sweep test results at EPU conditions to the NRC shortly after the test. The core flow sweep test results are also to be included in the 90-day steam dryer EPU report.

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Provide a quantitative justification that ANSYS shell elements used to model the steam dryer in the finite element structural analysis of the steam dryer adequately capture peak stresses.

REFERENCES

1. Letter from TVA dated September 21, 2015, "Proposed Technical Specifications Change TS-505 – Request for License Amendments – Extended Power Uprate" (Agencywide Document Access and Management System (ADAMS) Accession No. ML15282A152).

2. Letter from TVA dated November 13, 2015, "Proposed Technical Specifications Change TS-505 - Request for License Amendments - Extended Power Uprate - Supplemental Information" (ADAMS Accession No. ML15317A361).

3. Letter from TVA dated December 15, 2015, "Proposed Technical Specifications (TS) Change TS-505 – Request for License Amendments - Extended Power Uprate (EPU) - Supplement 1, Spent Fuel Pool Criticality Safety Analysis Information" (ADAMS Accession No. ML15351A097).

4. Letter from TVA dated December 15, 2015, "Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU) - Supplement 2, MICROBURN-B2 Information" (ADAMS Accession No. ML15351A113).

5. Letter from TVA dated December 18, 2015, "Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU) - Supplement 3, Interconnection System Impact Study Information" (ADAMS Accession No. ML15355A413).

6. NEDC-33824P, "Browns Ferry Replacement Steam Dryer Stress Analysis," Attachment 40 (ADAMS Accession No. ML15282A318) (non-public) to Reference 1. Attachment 41, NEDO-33824 (ADAMS Accession No. ML15282A236) to Reference 1 contains the public version of Attachment 40).

7. Appendix B, "Steam dryer Plant Based Load Evaluation Methodology PBLE01 Model Description," of NEDC-33824P/NEDO-33824.

8. Appendix A, "BWR Replacement Steam Dryer Structural Evaluation General Methodology," of NEDC-33824P/NEDO-33824.

9. Appendix C, "Steam Dryer Plant Based Load Evaluation Methodology PBLE02 Model Description," of NEDC-33824P/NEDO-33824.

10. Appendix D, "Supplemental Information," of NEDC-33824P/NEDO-33824.

11. Appendix E, "Power Ascension Test Plan Limit Curves (On-Dryer & MSL Based)," of NEDC-33824P/NEDO-33824.

12. Attachment 45, "Flow Induced Vibration analysis and Monitoring Program," to Reference 1 (ADAMS Accession No. ML15282A239).

13. Attachment 46, "Startup Test Plan," to Reference 1 (ADAMS Accession No. ML15282A240).

14. Attachment 47, "List and Status of Plant Modifications," to Reference 1 (ADAMS Accession No. ML15282A241).

15. Power Uprate Safety Analysis Report - Attachment 6 to Reference 1, "NEDC-33860P, Safety Analysis Report for Browns Ferry Nuclear Plant Units 1, 2, and 3 Extended Power Uprate" (ADAMS Accession No. ML15282A264) (non-public), (Attachment 7) ADAMS Accession No. ML15282A181) (public).

placing the nonproprietary RAI in the public document room for a period of 10 working days from the date of this letter to provide TVA the opportunity to comment on any proprietary aspects. If you believe that any information in Enclosure 3 is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390. After 10 working days, the nonproprietary RAI will be made publicly available.

If you have any questions, please contact me at 301-415-1447 or Farideh.Saba@nrc.gov.

Sincerely,
/RA/
Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, and 50-296

Enclosures:
1. TVA Proposed Response Schedule
2. Request for Additional Information (Proprietary Information)
3. Request for Additional Information (Nonproprietary Information)

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