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

May 6, 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 16, 2016, the NRC staff forwarded, by electronic mail, draft requests for additional information (RAIs) to TVA. On April 7, 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. As agreed by NRC and TVA staff during the conference call, TVA will respond to the enclosed RAIs by May 23, 2016. In addition, TVA staff confirmed that the enclosed RAIs do not contain any sensitive information.

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

Sincerely,

Siva P. Lingam for

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

Enclosure:
Request for Additional Information

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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 level of 3,458 MWt.

The U.S. Nuclear Regulatory Commission (NRC) staff from the Nuclear Performance and Code Review Branch (SNPB), Division of Safety Systems, Office of Nuclear Reactor Regulation, reviewed the information the licensee provided and determined that the following additional information is required in order to complete the evaluation.

The NRC staff reviews are based on the following regulatory and technical requirements, and review criteria:

1. As established by 10 CFR 50.36, "Technical Specifications," regulatory requirements related to the content of the Technical Specifications include: (1) Safety limits, limiting safety system settings, and limiting control settings; (2) Limiting conditions for operation; (3) Surveillance requirements; (4) Design features; and (5) Administrative controls.

2. General Design Criterion (GDC) 10, "Reactor Design," in part, ensures that the specified acceptable fuel design limits are not exceeded during any condition of normal operation, including anticipated operating occurrences (AOOs).

3. GDC 27, "Combined reactivity control system capability," requires the reactivity control systems to be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes under postulated accident conditions.

4. GDC 35, "Emergency core cooling," requires a system to provide abundant emergency core cooling to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented, and (2) clad metal-water reaction is limited to negligible amounts.

5. NUREG-0800, "Standard Review Plan (SRP)," Chapters 4.2, 4.3, 4.4 and 15.

A few of the following RAIs may be similar to those requested during the BFN units' fuel transition LAR that was approved in 2013. However, these RAIs are related to the extended power uprate (EPU) operating conditions.

SNPB-RAI 1

SRP Chapter 4.2 stipulates, "Dimensional changes, such as rod bowing or irradiation growth of fuel rods, fuel assemblies, control rods, and guide tubes, should be limited to prevent fuel failures or a situation in which the thermal-hydraulic limits established in Section 4.4 are exceeded."

Section 3.3.5 of Attachment 24 of the LAR (ANP-3386P) (Reference 6) states that "Rod bow is calculated using approved model described in Reference 4." Reference 4 in Attachment 24 is XN-NF-75-32(P)(A) (Reference 7 in this document) Supplements 1 through 4. Reference 4 indicates that "Base document not approved."

a. Justify the use of the methodology in XN-NF-75-32(P)(A) for evaluation of the ATRIUM-10 and ATRIUM 10XM fuel designs, which were developed after the approval of the XN-NF-75-32(P)(A). Also, justify the application of this methodology for EPU conditions.

b. Provide details of the results of the rod bow analysis that produced sufficient margins for the ATRIUM-10 and ATRIUM 10XM under EPU conditions.

SNPB-RAI 2

SRP Section 4.4 indicates "Problems affecting DNBR [Departure from Nucleate Boiling Ratio] or CPR [Critical Power Ratio] limits, such as fuel densification or rod bowing, are accounted for by an appropriate design penalty which is determined experimentally or analytically."

Section 3.4 of ANP-3327P (Reference 8) discusses the impact of rod bow on thermal margins. Provide the procedure and results from the assessment of the impact of rod bow on thermal margin. Also provide quantitative results of the CPR penalty as a function of the exposure and fractional rod closure during the EPU conditions.

SNPB-RAI 3

Section 3.4.4 of ANP-3386P (Reference 6) summarizes the evaluations performed for the fuel under combined seismic/loss-of-coolant accident (LOCA) loadings for structural integrity.

a. Provide details of the model used for the ATRIUM-10 and ATRIUM 10XM assemblies with and without a fuel channel, acceleration used in the calculations, uncertainty allowances in the calculations, and results with margin to established limits under the EPU conditions.

b. Provide details of the evaluation of both fuel assemblies structural response to externally applied forces during seismic and LOCA during the EPU conditions and show how the acceptance criteria in SRP Chapter 4.2, Appendix A, Section IV are satisfied.

SNPB-RAI 4

Section 3.1 of ANP-3385P (Reference 9) describes a method to determine the Gadolinia power history.

a. Provide a basis for the process used for the determination of the gadolinia power history.

b. Why the process described in ANP-3385P is limited to peaking factors calculated for the central lattices of the fuel assembly? Explain.

SNPB-RAI 5

Section 3.2.4 of ANP-3385P (Reference 9) states that "the fuel centerline temperature is evaluated using the RODEX2A code for both normal operating conditions and AOOs."

RODEX2A code is a legacy code that does not explicitly treat fuel thermal conductivity as a function of burnup (TCD) and is less conservative above ~35 GWd/MTU burnup. Provide justification for using RODEX2A code for evaluating fuel centerline temperature. Also, please describe whether any modification/augmentation of RODEX2A have been done in order to correct this deficiency of the lack of TCD treatment.

SNPB-RAI 6

Table 3.2, "Design duty cycles for cyclic fatigue evaluation of ANP-3385P," lists Load Follow among other processes. Assuming that the licensee plans to implement the load following of the BFN Units, respond to the following request:

Provide a discussion of the impact of load follow at the BFN units on their operation due to the following:

a. Effect of change in moderator temperature and moderator flow on reactivity due to load follow,

b. Effect of change in fuel temperature on reactivity due to load follow,

c. Change in power distribution in the core due to load follow,

d. Impact of power changes on xenon distribution and the subsequent xenon induced reactivity changes due to load follow, and

e. Impact on fuel performance parameters such as pellet-cladding-interaction, stress corrosion cracking, dimensional changes in fuel pellets, fission gas release and rod internal pressure due to load following.

SNPB-RAI 7

It is stated in Section 1.0 of ANP-3388P (Reference 10) that "for equilibrium cycle and Cycle 19 of Unit 3, approximately 30 percent of the fuel assemblies in each reload batch are composed of BLEU (blended low enriched uranium)."

Is the 30 percent BLEU fuel that will be introduced into Unit 3 for Cycle 19 higher than the BLEU percent for the ATRIUM 10XM fuel transition for the Unit 3 in 2013 LAR? If this percentage is higher than the percentage of BLEU fuel in 2013 fuel transition, what is the impact on the buildup of various uranium isotopes during the depletion of the fuel? Also discuss the impact of the various uranium isotopes on reactivity.

SNPB-RAI 8

The licensee is using the ACE ATRIUM 10XM correlation (ANP-10298PA, Revision 0 (Reference 11) and ANP-3140P (Reference 12)) for the ATRIUM 10XM fuel design and the SPCB correlation (EMF-2209PA) (Reference 13) for the co-resident ATRIUM-10 fuel design. However, NRC has approved the ACE ATRIUM-10 correlation (ANP-10249PA (Reference 13) as revised) for the ATRIUM-10 fuel design with revised additive constants as per EMF-2209PA. Please provide justification for the use of SPCB correlation for ATRIUM-10 instead of the approved ACE ATRIUM-10 correlation with revised additive constants.

REFERENCES

1. Letter from TVA to NRC 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. ANP-3386, "Mechanical Design Report for Browns Ferry Units 1, 2 and 3 Extended Power Uprate (EPU) ATRIUM 10XM Fuel Assemblies," Attachment 24 (proprietary) and Attachment 25 (non-proprietary) to Reference 1 (ADAMS Accession Nos. ML15282A191 and ML15282A192, respectively).

7. XN-NF-75-32(P)(A) Supplements 1 through 4, "Computational Procedure for Evaluating Fuel Rod Bowing," Exxon Nuclear Company, October 1983.

8. ANP-3327, "Evaluation of AREVA Fuel Thermal-Hydraulic Performance for Browns Ferry at EPU," Attachment 30 (proprietary) and Attachment 31 (non-proprietary) to Reference 1 (ADAMS Accession Nos. ML15282A294 and ML15282A221, respectively).

9. ANP-3385, "Mechanical Design Report for Browns Ferry Units 1, 2 and 3 Extended Power Uprate (EPU) ATRIUM 10 Fuel Assemblies," Attachment 26 (proprietary) and Attachment 27 (non-proprietary) to Reference 1 (ADAMS Accession Nos. ML15282A292 and ML15282A193, respectively).

10. ANP-3388, "Fuel Rod Thermal-Mechanical Evaluation for Browns Ferry Extended Power Uprate," Attachment 28 (proprietary,) and Attachment 29 (non-proprietary) to Reference 1 (ADAMS Accession Nos. ML15282A293 and ML15282A194, respectively).

11. ANP-10298PA, Revision 0, "ACE/ATRIUM 10XM Critical Power Correlation," March 2010 (ADAMS Accession Nos. ML101190044 (non-proprietary) and ML101190045 (proprietary).

12. ANP-3140P, "Browns Ferry Units 1, 2, and 3 Improved K-factor Model for ACE/ATRIUM 10XM Critical Power Correlation," August 2012 (ADAMS Accession Nos. ML13070A324 (non-proprietary) and ML13070A321 (proprietary)).

13. EMF-2209PA, "SPCB Critical Power Correlation," Revision 3, September 2009 (ADAMS Accession Nos. ML093650235 (non-proprietary) and ML093650230 (proprietary)).

14. 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 (proprietary)," (ADAMS Accession No. ML15282A264), (Non-Proprietary (Attachment 7) ADAMS Accession No. ML15282A181)

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

Sincerely,

/RA by SLingam for/

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

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ADAMS Accession No. ML16119A133 * via memorandum

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NAME	FSaba	BClayton	JDean	BBeasley	FSaba (SLingam for)
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