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 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15282A152), 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.

By letter dated January 28, 2016, the U.S. Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) (ADAMS Accession No. ML16020A111). The licensee, by letter dated February 16, 2016 (ADAMS Accession No. ML16049A248), responded to the staff's requested information.

The NRC staff reviewed the licensee's submittals and determined that additional information is needed. By electronic mail dated March 30, 2016, the NRC staff forwarded a draft RAI to TVA. On April 12, 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 to by the NRC and TVA staff during the conference calls, TVA will respond to the enclosed RAI by June 10, 2016. In addition, TVA staff confirmed that the enclosed RAI does 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

cc w/enclosure: Distribution via Listserv

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 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15282A152), as supplemented by letters dated November 13, December 15 (2 letters), and December 18, 2015 (ADAMS Accession Nos. ML15317A361, ML15351A097, ML15351A113, and ML15355A413, 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.

By letter dated January 28, 2016, the U.S. Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) (ADAMS Accession No. ML16020A111). The licensee, by letter dated February 16, 2016 (ADAMS Accession No. ML16049A248), responded to the staff's requested information.

The NRC staff from the Electrical Engineering Branch (EEEB), Division of Engineering, Office of Nuclear Reactor Regulation, reviewed Attachment 43 and Section 2.3, "Electrical Engineering," of Attachments 6 and 7 of the letter dated September 21, 2016. The staff has also reviewed the licensee's supplemental information and responses to the staff's RAIs provided in letters dated December 18, 2015, and February 16, 2016. Based on its review, the staff determined that the following additional information is needed to complete its detailed review.

Section 2.3.1, "Environmental Qualification of Electrical Equipment"

EEEB-RAI 5[1]

In Section 2.3.1 of Attachment 7 (ADAMS Accession No. ML15282A181) of the LAR, the licensee identified changes to existing environmental qualification (EQ) parameters (temperatures, pressures, radiation and humidity) for electrical equipment in some areas inside and outside primary containment due to the extended power uprate (EPU). However, the licensee did not specify if these changes (also shown in Tables 2.3-1, 2.3-2, 2.3-3, and 2.3-5, Figure 2.3-1, and Figure 2.3-2) apply to all three BFN units.

[1] Refer to TVA letter dated February 16, 2016, for EEEB-RAI 1 through 4.

Confirm if these changes in Section 2.3.1 and above mentioned tables and figures are applicable to all three BFN units. If not, provide unit-specific evaluation, tables, and figures for EQ parameters.

EEEB-RAI 6

On page 2-130 of Attachment 7 of the LAR, in the BFN Current Licensing Basis section, the licensee stated that the BFN EQ program for electrical equipment is described in the BFN Updated Final Safety Analysis Report (UFSAR), Section 8.9, "Safety Systems Independence Criteria and Bases for Electrical Cable Installation." However, Section 8.9 of the UFSAR does not contain the description of the BFN EQ program.

Provide the current licensing basis (include the history) for the BFN EQ of electrical equipment, and a mark-up of the UFSAR's relevant sections showing the requested information.

EEEB-RAI 7

In Figure 2.3-1 of Attachment 7 of the LAR, the licensee provided the worst case drywell EQ accident temperature profiles for current licensed thermal power (CLTP) and EPU for 100 days. On page 2-132 of Attachment 7, the licensee stated that the profiles were developed by combining the bounding curves for both the steamline break and loss-of-coolant accident (LOCA) design-basis accidents. Based on the figure, the staff noted that the EPU drywell temperature profile exceeds the existing drywell temperature profile over the entire 100 days. Note 1 of Table 2.3-1 states: "Current component qualification testing bounds the temperature increases."

Provide the current component qualification temperature profile of EQ electrical equipment (considering the qualified temperature of worst case components) inside primary containment to confirm that it bounds the EPU drywell temperature profile shown in Figure 2.3-1. Also, discuss how the temperature margins in the Institute for Electrical and Electronics Engineers Standard 323-1974 will be maintained under EPU conditions.

EEEB-RAI 8

On page 2-132 of Attachment 7 of the LAR, the licensee states:

> The maximum normal and maximum abnormal temperatures [inside primary containment] will increase by 0.12 °F [degrees farhenheit], which will be rounded to 1 °F. This small temperature increase will have a minor effect on thermal qualified life and will be addressed as part of normal EQ maintenance replacement.

Also, on page 2-133 of Attachment 7, the licensee states:

> The Steam Tunnel (EQ room 7) bulk temperature [outside primary containment] at EPU conditions will increase by 0.37 °F and is conservatively rounded up to a 1 °F increase for the EPU evaluation. This temperature increase has a minor effect on thermal qualified life and is addressed as part of normal EQ maintenance replacement.

a. Provide the EPU maximum normal and abnormal temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment inside the primary containment preferably in a tabular form. Also, provide the EPU temperatures, the qualification temperature limits, and the thermal qualified life for electrical equipment in the steam tunnel preferably in a tabular form.

b. Discuss the effects of the increased temperatures on the equipment thermal qualified life and how the equipment will be maintained during its lifetime to ensure that it remains qualified and capable of performing its intended design function under EPU conditions.

EEEB-RAI 9

On page 2-133 of Attachment 7 of the LAR, the licensee stated that the reactor water cleanup (RWCU) high-energy line break (HELB) outside primary containment will change peak temperatures in some EQ rooms at EPU conditions. Table 2.3-1 indicated that RWCU HELB peak temperatures will increase 5 to 20 °F in EQ rooms 6B, 8, 9A, 9D, 12, 13, 16, 19 and 20, and will decrease in EQ room 18 due to the EPU. In Table 2.3-5, the licensee provided a listing of the EQ components affected by the increase in RWCU LOCA/HELB peak-accident temperatures and their qualification limits for rooms 6B, 8, 9D, 12, and 16, but not for rooms 9A, 13, 18, 19 and 20.

a. Provide the RWCU HELB temperature evaluation as shown in Table 2.3-5 for rooms 9A, 13, 18, 19 and 20; and identify the information that pertains to RWCU HELB (differentiate from LOCA) for rooms 6B, 8, 9D, 12, and 16 in Table 2.3-5. Also, explain why there is a temperature decrease in EQ room 18 (cleanup demineralizer valve room per Table 2.3-4) during an RWCU HELB at EPU conditions.

b. In Table 2.3-1, the licensee states:

> LOCA - All but a few EQ locations will fractionally increase in temperature. The Torus Room and NE [northeast] Pump Room will increase by 6.3 °F and 1.2 °F, respectively.

Specify the EQ location(s) of the LOCA, and provide the LOCA temperature evaluation, preferably in a tabular form similar to Table 2.3-5, for all EQ locations affected by the LOCA outside primary containment.

EEEB-RAI 10

In Table 2.3-3 of Attachment 7 of the LAR, the licensee provided the radiation qualification doses and the EPU total integrated doses (normal plus accident) for equipment located inside and outside primary containment. The radiation qualification doses for some cables, solenoids, splices, and motor operated valves' components are less than the EPU total integrated doses. Note 3 of Table 2.3-3 stated that these components have a limited life of less than 60 years due to EPU radiation, and they will be replaced periodically as part of the normal EQ maintenance program.

Provide the radiation qualified life for the above components. Also, describe the approach for assessing the effects of radiation aging and determining the periodic replacement for these components. Also, explain why certain splices of Raychem, such as NPkV, NPKC, etc., have been listed twice with different qualified doses.

EEEB-RAI 11

On page 2-134 of Attachment 7 of the LAR, the licensee states:

> The HELB pressure profiles [outside primary containment] for CLTP conditions were determined to be bounding for EPU conditions.

Table 2.3-1 indicates that "there will be no change" in accident pressure outside primary containment as a result of the EPU.

a. Provide:

   i. the HELB pressure profiles for CLTP and EPU conditions to show that the HELB pressure profiles are bounding for EPU conditions; and

   ii. the component qualification pressure profile for electrical equipment outside primary containment to show that it bounds the HELB pressure profiles at EPU conditions.

b. Explain why the pressure considered for EQ of electrical equipment remains the same for CLTP and EPU conditions.

Section 2.3.2, "Offsite Power System"

EEEB-RAI 12

In Table 2.3-6 of Attachment 7 of the LAR, the licensee provided the megavolts amperes (MVA) ratings of the Unit Station Service Transformers (USSTs) and the Common Station Service Transformers (CSSTs) of the offsite power system and their respective EPU duties.

a. The CLTP duties and margins for the USSTs and CSSTs are not provided in Table 2.3-6. Provide the missing parameters or justify their omission.

b. The loadings/duties of USSTs are provided at normal loading. Provide maximum loadings of USSTs under the accident/shutdown conditions also.

EEEB-RAI 13

On page 2-138 of Attachment 7 of the LAR, the licensee stated that the main generators have been rewound to increase their maximum ratings to 1,330 MVA for Unit 1 and 1,332 MVA for Units 2 and 3; and the generator step-up transformers (GSUTs) have been replaced and upgraded at a rating of 1,500 MVA at 65 °C to support the increase in generator output. On page 2-136, the licensee stated that no changes are required for the protective relaying for the main generator for operation at EPU.

Provide a summary of the evaluation performed to determine that the settings of the protective relays, which are described in Section 8.2 of BFN UFSAR, for the rewound generator and the upgraded GSUTs remain adequate to protect the equipment at EPU conditions.

EEEB-RAI 14

On page 2-138 of Attachment 7 of the LAR, the licensee stated that the existing 500 kilovolts (KV) switchyard components (i.e., bus, breakers, switches, transformers, and lines) are adequate for the increased generator output associated with the EPU.

Provide a summary of the evaluation for the above components, including ratings and margins under CLTP and EPU duties, to confirm that the above components remain adequate under EPU conditions. Also, provide a discussion for the adequacy of the 161 KV switchyard components to support operation at EPU conditions.

EEEB-RAI 15

By letter dated December 18, 2015, the licensee provided the interconnection system impact study (SIS) and a revised transmission system stability evaluation, which was originally provided in Attachment 43 of the LAR, to supplement the LAR per request of the EEEB staff.

The transmission system stability evaluation, revision 1, provided the results of the transmission system study (TSS)-grid voltage study and the evaluation of the impacts of the transmission system upgrades identified by the SIS on the results of the TSS. The TSS evaluated the impact of BFN operation at EPU conditions on its continued compliance with Title 10 of Code of Federal Regulation, Part 50, Appendix A, General Design Criterion (GDC) 17. In the TSS, the licensee stated that each BFN unit will be uprated to provide a maximum power (winter) output of 1,318 megawatts (MW) and approximately 1,260 MW during the summer months post-EPU. The TSS assumed all three units operation at the winter output of 1,318 MW and used base cases from summer 2015 (pre-EPU) and summer 2019 (post-EPU) peak system loads.

Explain why the study was performed using the generators' winter maximum power output with the system summer peak load cases instead of winter peak load cases.

EEEB-RAI 16

The SIS identified three upgrades on the TVA transmission system that are required for the BFN, Units 1, 2, and 3 EPU. The upgrades include installing of 774 megavolts amperes reactive capacitor banks at four locations throughout the TVA transmission system to meet all reactive power requirements for the incremental increase in MW output from each BFN unit.

Discuss the actions the licensee will take, such as reduction in BFN unit power output prior to the capacitor bank installations.

EEEB-RAI 17

In response to EEEB-RAI-1, the licensee stated, in letter dated February 16, 2016, that the TSS study evaluated the performance of the 500 KV and 161 KV offsite power systems during a design-basis event under EPU conditions. Bus voltages observed during the simulation are compared to acceptance criteria to determine adequacy of the offsite power supply. The licensee provided the results for loss of the largest load, loss of the largest generator, and loss of the most critical 500 KV transmission line. The minimum voltage acceptance criteria for the 500 KV source were met in all cases.

a. Provide the voltages obtained for the 161 KV offsite source for the most critical 161 KV transmission line out-of-service scenarios to verify that the acceptance voltage criteria at 161 KV are met under EPU conditions.

b. The loadings provided for CSSTs A and B are different for three scenarios: (1) 161 KV Immediate Source for T = 0 to 2.5 seconds; (2) 161 KV Immediate Source for T = 2.5 second and beyond; (3) 161 KV Delayed Source. Provide a discussion of the CSSTs A and B loadings under the three scenarios.

Section 2.3.3, "AC [Alternating Current] Onsite Power System"

EEEB-RAI 18

On page 2-140 of Attachment 7 of the LAR, the licensee stated that equipment are operated at or below the nameplate ratings in both normal and emergency conditions at the EPU power level. Table 2.3-7 shows that the nameplate rating of the condensate booster pumps (CBPs) in all three units is 3,000 horsepower (hp), but the maximum transient load on the CBPs assuming a trip of one out of three CBPs or condensate pumps (CPs) is 3,720 brake hp. This shows that the CBPs are overloaded during the transient, and thus are operated above the nameplate ratings.

a. Identify the balance of plant buses/boards that power the CPs and CBPs, and provide the worst case loading of these buses/boards and margin available at CLTP and EPU conditions. Also, provide a copy of all the Single Line Diagrams listed on page E5-5 provided in response to EEEB-RAI-2.

b. Provide a summary of relay settings to show that CBPs and their associated boards remain adequately protected during transient loading. Also, provide a duration of the transient loading.

EEEB-RAI 19

On page 2-139 of Attachment 7 of the LAR, the licensee states:

> The AC onsite power system consists of equipment and systems required to provide AC power to safety-related and nonsafety-related loads as long as offsite power is available. This includes 500 KV transformers, 161 KV transformers, 22 KV transformers, 4.16 KV transformers, 4.16 KV switchgears, 480 V [volt]

transformers, 480 V load centers and motor control centers, 208/120 V distribution panels, and Uninterruptible Power Supply (UPS) systems.

In Table 2.3-6, the licensee provided the ratings, duties, and margins of offsite electrical equipment including the 500 KV (main GSUTs), 161 KV (CSSTs), and 22 KV (USSTs) transformers at CLTP and EPU conditions.

Provide the ratings, worst case loading and margins of the 4.16 KV transformers, 4.16 KV switchgears, 480 V transformers, 480 V load centers and motor control centers, 208/120 V distribution panels, and UPS systems at CLTP and EPU conditions to show that the above electrical distribution equipment and systems are adequately sized to support plant operation at EPU conditions.

Section 2.3.4, "DC [Direct Current] Onsite Power System"

EEEB-RAI 20

In Section 2.3.4 of Attachment 7 of the LAR, the licensee stated that the current licensing basis for BFN onsite DC power systems is based on the 1967 Atomic Energy Commission proposed GDC or draft-GDC 24 and 39. The licensee also stated in Sections 2.3.2 and 2.3.3 that the final GDC 17 is applicable to BFN offsite and onsite AC power systems, as described in UFSAR Section 8.3.

Explain to what extent the GDC 17 is applicable to the BFN DC power systems.

EEEB-RAI 21

On page 2-143 of Attachment 7 of the LAR, the licensee states:

> The results of the battery sizing calculation for the LOCA/LOOP [loss of offsite power] analysis scenario show that the existing batteries have adequate voltage at the end of the duty cycle. It also shows all required DC devices are within their design voltage range.

Provide a summary of the battery (identify the batteries) sizing calculation, including assumptions, voltages and margin, for the LOCA/LOOP scenario corresponding to EPU conditions.

EEEB-RAI 22

On page 2-143 of Attachment 7 of the LAR, the licensee stated that changes are not required to Class 1E DC power load for EPU implementation. As stated in UFSAR Section 8.6.3, the BFN 250 V DC power system supplies the engineered safeguards system and some nonsafety related loads.

Discuss changes, if any, required for the nonsafety related DC loads required for operation at EPU conditions.

Section 2.3.5, "Station Blackout"

EEEB-RAI 23

On page 2-146 of Attachment 7 of the LAR, the licensee also states:

> The battery capacity analysis of record is conservative in that it includes an assumption in the model that various HPCI [high pressure coolant injection] System loads, which are relatively large, operate for long periods during the SBO [station blackout] mitigation sequence. The CLTP mitigation sequence includes a single and relatively short HPCI cycle, and the resulting HPCI loads are bounded by the analysis. EPU does not significantly increase the HPCI loading, and similar to CLTP, only one relatively short HPCI cycle (approximately 7 minutes) is predicted by the EPU containment analysis analytical model (SHEX) model for SBO mitigation. Similarly, the number of required RCIC [reactor core isolation cooling] cycles in the CLTP and EPU mitigation sequence as predicted by the model is well below the RCIC initiations assumed in the analysis of record.

Table 2.3-8b, "Browns Ferry Station Blackout Sequence of Events," indicated that HPCI injection will last 6 minutes 14 seconds and RCIC injection will last 2 hours 22 minutes at EPU conditions. The licensee stated that the calculations were performed using the NRC-approved SHEX computer program.

a. Provide the HPCI and RCIC loads and their duration of operation as assumed in the battery capacity analysis for comparison with the HPCI and RCIC cycles calculated with the SHEX program. Also, discuss changes, if any, in the HPCI loading due to the EPU.

b. Provide a summary of the battery capacity analysis including assumptions, duty cycles, required voltages and available margin, for the 4-hour SBO mitigation at EPU conditions. Also, provide available battery capacity margin corresponding to CLTP conditions.

EEEB-RAI 24

On page 2-147 of Attachment 7 of the LAR, the licensee states:

> Outside the drywell, the SBO loss-of-ventilation evaluation for the Control Building Rooms, Reactor Building Shutdown Board Rooms/Electrical Board Rooms, RCIC Room, HPCI Room, Main Steam Tunnel, Reactor Building General Floor Area, and Torus Room determined that, compared to CLTP, equipment operability is maintained because the SBO environment is milder than the existing design and qualification bases.

Provide a summary of the evaluation showing the maximum temperatures calculated for the SBO conditions for the above areas versus the existing design and qualification temperatures of the equipment required for coping with the SBO.

EEEB-RAI 25

Provide an evaluation of any impacts of the EPU on reactor coolant inventory, procedures and training, plant modifications, quality assurance, and emergency diesel generator reliability program, considering the guidance provided in Regulatory Guidance 1.155, "Station Blackout," August 1988.

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

Enclosure:
Request for Additional Information

cc w/enclosure: Distribution via Listserv

DISTRIBUTION:
PUBLIC
LPL2-2 R/F
RidsNrrDorlLpl2-2
RidsNrrDorlDpr
RidsNrrLABClayton
RidsACRS_MailCTR
RidsRgn2MailCenter
RidsNrrDeEeeb
VGoel, NRR
RidsNrrPMBrownsFerry
AFoli, NRR
TMartinez-Nevado, NRR

ADAMS Accession No.: ML16119A440 *by e-mail

OFFICE	DORL/LPLII-2/PM	DORL/LPLII-2/LA	DE/EEEB/BC*	DORL/LPLII-2/BC	DORL/LPLII-2/PM
NAME	FSaba	BClayton	JZimmerman (SSwagata, for)	BBeasley	FSaba (SLingam for)
DATE	5/5/16	5/5/16	3/30/16	5/6/16	5/6/16

OFFICIAL RECORD COPY