Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-16-100

June 20, 2016

10 CFR 50.90

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU) - Supplement 21, Response to Requests for Additional Information**

References:
1. Letter from TVA to NRC, CNL-15-169, "Proposed Technical Specifications (TS) Change TS-505 - Request for License Amendments - Extended Power Uprate (EPU)," dated September 21, 2015 (ML15282A152)
2. Letter from NRC to TVA, "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)," dated June 3, 2016 (ML16145A158)

By the Reference 1 letter, Tennessee Valley Authority (TVA) submitted a license amendment request (LAR) for the Extended Power Uprate (EPU) of Browns Ferry Nuclear Plant (BFN) Units 1, 2 and 3. The proposed LAR modifies the renewed operating licenses to increase the maximum authorized core thermal power level from the current licensed thermal power of 3458 megawatts to 3952 megawatts. The Reference 2 letter provided Nuclear Regulatory Commission (NRC) Balance of Plant Branch Request for Additional Information (RAI) SBPB-RAI 4 with a due date of June 24, 2016. The enclosure to this letter provides the response to the RAI included in the Reference 2 letter.

TVA has reviewed the information supporting a finding of no significant hazards consideration and the environmental consideration provided to the NRC in the Reference 1 letter. The supplemental information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the supplemental information in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed license amendment. Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter to the Alabama State Department of Public Health.

There are no new regulatory commitments associated with this submittal. If there are any questions or if additional information is needed, please contact Edward D. Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 20th day of June 2016.

Respectfully,

for

J. W. Shea
Vice President, Nuclear Licensing

Enclosure: Response to NRC Request for Additional Information SBPB-RAI 4

cc:

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
State Health Officer, Alabama Department of Public Health

ENCLOSURE

Response to NRC Request for Additional Information SBPB-RAI 4

ENCLOSURE

SBPB-RAI 4

<u>Regulatory Bases:</u>

The following regulations and requirements are applicable to this RAI:

- *Section 50.67, "Accident Source Term," of Title 10 of Code of Federal Regulations (10 CFR)*

- *Regulatory Guide 1.183 "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Regulatory Position 1.5 "Submittal Requirements" as summarized below:*

  According to 10 CFR 50.90, an application for an amendment must fully describe the changes desired and should follow, as far as applicable, the form prescribed for original applications. Regulatory Guide 1. 70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR [Light-Water Reactor] Edition)" (Ref. 16), provides additional guidance. The NRC staff's finding that the amendment may be approved must be based on the licensee's analyses, since it is these analyses that will become part of the design basis of the facility. The amendment request should describe the licensee's analyses of the radiological and non-radiological impacts of the proposed modification in sufficient detail to support review by the NRC staff.

<u>Plant Specific Technical Specification (TS) proposed change:</u>

Current Surveillance Requirement (SR):

> *SR 3.6.3.1.1 "Verify ~ 2500 gal (gallons] of liquid nitrogen are contained in each nitrogen storage tank." (Frequency: 31 days).*

Proposed SR:

> *SR 3.6.3.1.1 "Verify ~ 2615 gal of liquid nitrogen are contained in each nitrogen storage tank." (Frequency: 31 days).*

The staff notes that the BFN Updated Final Safety Analysis Report (UFSAR) (BFN-26) Chapter 5, Section 5.2.6 "Combustible Gas Control in Primary Containment" and Chapter 14, Section 14.6.3.5 "Fission Product Release From Primary Containment" and Section 14.6.3.6 "Fission Product Release to Environs" provides two different values for containment exhaust flow rates for the containment atmosphere dilution (CAD) system. Chapter 5 provides a flow rate of 100 ft^3/min (cubic feet per minute (cfm)), whereas Chapter 14 provides a flow rate of 139 cfm. In particular, Section 14.6.3.6d reads "The Containment Atmospheric Dilution (CAD) system operates for a period of 24 hours at a flow rate of 139 cfm at 10 days, 20 days, and 29 days post-accident. This flow is filtered via the SGTS [Standby Gas Treatment System] filters."

The staff reviewed Section 2.6.4 "Combustible Gas Control in Containment" and Figures 2.6-1 through 2.6-4 of LAR Attachments 8 (proprietary) and 9 (non-proprietary). Attachment 9 reads in part:

> *Technical Specification (TS) 3.6.3.1 "Containment Atmospheric Dilution (CAD)*

> *System," requires that 2500 gallons of liquid nitrogen (191,000 scf [standard cubic feet]) be stored in each of two tanks to meet the CAD system inerting requirements. As a result of increased production rate of radiolytic gas following EPU [extended power uprate], the required 7-day volume of nitrogen to satisfy TS 3.6.3.1 increases to 2615 gallons (200,000 scf) from 2108 gallons (161,200 scf) under CLTP [current licensed thermal power] conditions, which exceeds the available 2500 gallons (191,000 scf) supply required by TS 3.6.3.1. Analysis of the containment pressure buildup as a result of continuing CAD operation, under EPU conditions, shows that the containment repressurization limit of 30 psig (pounds per square inch gauge] is reached 15 days post-LOCA [loss-of-coolant accident], compared to 18 days under CLTP conditions.*

The NRC staff could not determine from the information contained in the LAR submittal of September 21, 2015, the BFN Alternate Source Term LAR, or the subsequent license amendment, whether the increase in required liquid nitrogen volume (i.e., from 2500 to 2615 gal) per SR 3.6.3.1.1 factored into the Chapter 14 CAD system flowrate of 139 cfm to the SGTS and ultimately to the plant environs via the plant stack.

TVA Response:

The calculation that provided the basis for the wording used in the FSAR Sections 14.6.3.5 and 14.6.3.6 intended to describe the post-accident vent path in simplified terms for conservative radiological considerations. The wording provided by this calculation also described the effects of containment pressure control (venting) necessary to compensate for CAD system inlet flow rates over a 30-day period. The assumed flowrate for containment venting maximizes the release of activity from the containment establishing a bounding activity release. Venting containment is not performed simultaneously with CAD system operation, so there is no particular link between the venting and diluting operations or flows. Under post-accident conditions, the higher EPU power level increases the radiolysis of water in containment, which increases the rate of oxygen and hydrogen production. The analysis indicates that containment venting does not become necessary until well after 10 days post-LOCA and therefore the total vent release volume required over the 30 day period following the accident remains within the value assumed for radiological projections in the FSAR Sections 14.6.3.5 and 14.6.3.6.

The flow rate of 139 ft^3/minute (cfm), in FSAR Sections 14.6.3.5 and 14.6.3.6, is provided as a means of establishing radiological conditions for three releases over a 30-day period and misleadingly refers to the vent path as “CAD flow.” Operators procedurally vent containment at 100 cfm for a period necessary to maintain containment pressure under the 30 psig limit and venting is restricted to periods when nitrogen inlet flow is secured. The CAD system inlet design flow rate is 100 cfm and will remain unchanged with EPU. Similarly, the vent flow rate is unchanged with EPU. Attachment 1 provides markups of FSAR Sections 14.6.3.5 and 14.6.3.6 that clarify the description of the vent flow path used for reducing containment pressure by stating, “The containment vent system flow path is operated for a period of 24 hours at a flow rate of 139 cfm at 10 days, 20 days, and 29 days post-accident. This flow is filtered via the Standby Gas Treatment System (SGTS) filters.”

For both CLTP and EPU conditions, the volume of nitrogen needed to maintain the percentage of oxygen at less than 5% in containment for the first seven days is supplied by the two 4000 gallon CAD nitrogen tanks. The liquid capacity of each CAD tank is 3400 gallons, which is sufficient to store the increased nitrogen volume needed for EPU. The effect of EPU will be an increased frequency of nitrogen deliveries to account for normal use and evaporation. Each CAD tank is maintained at or above the levels that satisfy TS 3.6.3.1 (CLTP-2500 gallons, EPU-2615 gallons). The tank volumes have been designed to provide adequate nitrogen for a seven day period following a LOCA in order to ensure that a reasonable period for replenishment has been accounted for. Subsequent need for CAD system operation throughout the 30 day post LOCA period will require additional tank refills.

Attachment 1

UFSAR Section 14.6.3.5 and 14.6.3.6 Mark-up

d. The core inventory release fractions, timing, and chemical form are those specified in Regulatory Guide 1.183. Table 14.6-7 gives the bounding core inventory of each isotope .

14.6.3.5 Fission Product Release From Primary Containment

Fission products are released from the primary containment to the secondary containment via primary containment penetration leakage at the Technical Specification leakage limit. Primary containment atmosphere is released via main steam isolation valve leakage to the high and low pressure turbines and the condenser. Primary containment atmosphere is released directly to the Standby Gas Treatment System during operation of the Containment Atmospheric Dilution (CAD) System. Primary containment atmosphere is released to the top of the stack via leakage of the hardened wetwell vent isolation valves. The Emergency Core Cooling Systems (ECCS) leak into the secondary containment. The following assumptions were used in calculating the amounts of fission products released from the primary containment:

a. The primary containment minimum free volume (drywell and wetwell) is 278,400 ft^3. The drywell volume is 159,000 ft^3 and the torus gas space volume is 119,400 ft^3. The drywell torus gas space volumes are treated as separate volumes until after the activity release to the containment is complete and then these volumes are assumed to be well mixed. The activity release is entirely to the drywell.

b. The primary to secondary containment leak rate was taken as two percent volume per day (232 cfh).

c. The four main steam lines are assumed to leak a total of 150 scfh which is the Technical Specification limit.

d. ~~CAD system flow rate is 139 cfm for 24 hours at 10 days, 20 days, and 29 days.~~

e. The hardened wetwell vent isolation valves leak a total of 10 scfh to the top of the offgas stack. This leakage is assumed to begin at 8 hours.

f. Twenty gpm ECCS leakage into secondary containment in accordance with NUREG-0800, Section 15.6.5, Appendix B.

g. No credit is taken for spray removal in the containment.

h. Natural removal rates for particulates in the drywell are based on the correlations of NUREG-CR-6604. For elemental iodine, the natural removal coefficients for removal of plateout are based on the expressions of SRP 6.5.2.

The containment vent system flow path is operated for a period of 24 hours at a flow rate of 139 cfm at 10 days, 20 days, and 29 days post-accident. This flow is filtered via the Standby Gas Treatment System (SGTS) filters.

i. For the purpose of suppression pool pH control, the accident is assumed to be a recirculation line break.

Additionally, an analysis evaluated the suppression pool pH in the event of a DBA LOCA involving fuel damage. The objective of the analysis was to demonstrate that the suppression pool pH remains at or above 7.0; thus, ensuring that the particulate iodine (Cesium Iodide - CsI) deposited into the suppression pool during this event does not re-evolve and become airborne as elemental iodine.

The calculation methodology was based on the approach outlined in NUREG-1465 and NUREG/CR-5950. Specifically, credit was taken for sodium pentaborate solution addition to the suppression pool water as a result of SLCS operation.

The initial effects on suppression pool pH come from rapid fission product transport and formation of cesium compound, which would result in increasing the suppression pool pH. As radiolytic production of nitric acid and hydrochloric acid proceeds and these acids are transported to the suppression pool over the first days of the event, the suppression pool water would become more acidic. The buffering effect of SLCS injection within several hours is sufficient to offset the effects of these acids that are transported to the pool. Sufficient sodium pentaborate solution is available to maintain the suppression pool pH at or above 7.0 for 30 days post-accident.

14.6.3.6 Fission Product Release to Environs

Secondary Containment Releases

The fission product activity in the secondary containment at any time (t) is a function of the leakage rate from the primary containment, the volumetric discharge rate from the secondary containment and radioactive decay. During normal power operation, the secondary containment ventilation rate is 75 air changes per day; however, the normal ventilation system is turned off and the Standby Gas Treatment System (SGTS) is initiated as a result of low reactor water level, high drywell pressure, or high radiation in the Reactor Building. Any fission product removal effects in the secondary containment such as plateout are neglected. The fission product activity released to the environs is dependent upon the fission product inventory airborne in the secondary containment, the volumetric flow from the secondary containment, and the efficiency of the various components of the SGTS.

The following assumptions were used to calculate the fission product activity released to the environment from the secondary containment:

a. The primary containment atmosphere leakage to secondary containment mixes instantaneously and uniformly within the secondary containment.

b. The effective mixing volume of the secondary containment is 1,311,209 ft^3.

c. The SGTS removes fission products from secondary containment. If only two of the SGTS trains are in operation (i.e., SGTS flow of 16,200 cfm), a short period exists at the start of the accident during which the secondary containment becomes pressurized relative to the outside environment. However, negative pressure would be re-established in secondary containment prior to fission product release times specified by Regulatory Guide 1.183. Once the secondary containment pressure is reduced below atmospheric pressure, all releases from secondary containment to the environment are through the SGTS filters via the plant stack. If all three trains of SGTS are in operation (i.e., SGTS flow of 24,750 cfm), all releases to the environment from secondary containment are through the SGTS filters via the plant stack. The case with three trains in operation is the limiting condition.

The containment vent system flow path is operated

d. ~~The Containment Atmospheric Dilution (CAD) system operates~~ for a period of 24 hours at a flow rate of 139 cfm at 10 days, 20 days, and 29 days post-accident. This flow is filtered via the SGTS filters.

e. The ECCS systems leak reactor coolant directly to the secondary containment. The maximum water temperature is less than 212°F. The volume available for mixing is 1.31E5 ft^3. Ten percent of the iodine in the ECCS leakage is assumed to become airborne.

f. Filter efficiency for the SGTS was taken as 90 percent for organic and 0% inorganic (elemental) iodine.

g. Release to the environment from the plant stack is composed of three flow paths. A continuous ground level release of 20 cfm occurs at the base of the stack. This flow results from SGTS leakage through the backdraft dampers in the base of the stack. Subsection 5.3.3, "Secondary Containment System Description" describes the backdraft dampers. The 20 cfm leakage mixes uniformly within the rooms at the base of the stack (50% of the room volume of 69,120 ft^3). The remaining SGTS flow exits the stack at a height of 183 meters above ground elevation. The hardened wetwell vent isolation valves leak a total of 10 scfh to the top of the offgas stack with a delay of 8 hours for the leakage to reach the stack. The hardened wetwell vent isolation valve leakage enters the stack above the divider deck and exits the top of the stack.

h. Fumigation conditions exist for 30 minutes when the post-accident control room accumulated dose rate is the maximum.

i. Atmospheric dispersion coefficients, X/Q, for elevated releases under fumigation conditions, elevated releases under normal atmospheric conditions and ground level releases at the base of the stack are used. X/Q