1101 Market Street, Chattanooga, Tennessee 37402

CNL-15-172

September 14, 2015

10 CFR 50.90

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

Watts Bar Nuclear Plant, Unit 1
Facility Operating License Nos. NFP-90
NRC Docket No. 50-390

Subject: **Application to Revise Technical Specification 4.2.1, "Fuel Assemblies" (WBN-TS-15-03) (TAC No. MF6050) - Response to NRC Request for Additional Information - Reactor Systems Branch**

Reference:

1. Letter From TVA to NRC, CNL-15-001, "Application to Revise Technical Specification 4.2.1, "Fuel Assemblies," (WBN-TS-15-03)," dated March 31, 2015 (ADAMS Accession No. ML15098A446)

2. Letter from TVA to NRC, CNL-15-077, "Correction to Application to Revise Technical Specification 4.2.1, "Fuel Assemblies" (WBN-TS-15-03)," dated April 28, 2015 (ADAMS Accession No. ML15124A334)

3. Letter From NRC to TVA, "Watts Bar Nuclear Plant, Unit 1 - Supplemental Information Needed for Acceptance of Requested Licensing Action Regarding Application to Increase Tritium Producing Absorbing Rods (TAC NO. MF6050)," dated May 14, 2015 (ADAMS Accession No. ML15127A250)

4. Letter from TVA to NRC, CNL-15-092, "Response to NRC Request to Supplement the Application to Revise Technical Specification 4.2.1, "Fuel Assemblies" (WBN-TS-15-03)," dated May 27, 2015 (ADAMS Accession No. ML15147A611)

5. Letter from TVA to NRC, CNL-15-093, "Response to NRC Request to Supplement Application to Revise Technical Specification 4.2.1, "Fuel Assemblies" (WBN-TS-15-03) - Radiological Protection and Radiological Consequences," dated June 15, 2015 (ADAMS Accession No. ML15167A359)

6. Electronic Mail from Jeanne Dion (NRC) to Clinton Szabo (TVA), Gordon Arent (TVA), and Robert H. Bryan, Jr. (TVA), "Request for Additional Information Regarding Tritium production License Amendment (TAC No. MF6050)," dated August 14, 2015

By letter dated March 31, 2015 (Reference 1), Tennessee Valley Authority (TVA) submitted a license amendment request (LAR) to revise Watts Bar Nuclear Plant (WBN), Unit 1 Technical Specification (TS) 4.2.1, "Fuel Assemblies," to increase the maximum number of Tritium Producing Burnable Absorber Rods (TPBARs) that can be irradiated per cycle from 704 to 1,792. The proposed change also revises TS 3.5.1, "Accumulators," Surveillance Requirement (SR) 3.5.1.4 and TS 3.5.4, "Refueling Water Storage Tank (RWST)," SR 3.5.4.3 to delete outdated information related to the Tritium Production Program. TVA provided a correction letter on April 28, 2015 (Reference 2).

By letter dated May 14, 2015 (Reference 3), the Nuclear Regulatory Commission (NRC) requested that TVA provide additional information to supplement the LAR. TVA provided the requested supplemental information in TVA letters dated May 27, 2015, and June 15, 2015 (References 4 and 5, respectively).

By electronic mail dated August 14, 2015 (Reference 6), the Nuclear Regulatory Commission (NRC) requested that TVA provide additional information to support the NRC review of the LAR. The response to the request for additional information (RAI) is due September 14, 2015.

Enclosure 1 to this letter provides TVA's RAI responses. Enclosure 2 to this letter provides a list of regulatory commitments containing one revised regulatory commitment. The revision to the commitment provided in Enclosure 2 is indicated by a revision bar to the right of the change. Enclosure 2 provides a complete updated commitment list that supersedes the previous commitment list provided in the Reference 1 letter.

Consistent with the standards set forth in Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50.92(c), TVA has determined that the additional information, as provided in this letter, does not affect the no significant hazards consideration associated with the proposed application previously provided in Reference 1.

Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and the enclosures to the Tennessee Department of Environment and Conservation.

There is one revised regulatory commitment and no new regulatory commitments associated with this submittal. Please address any questions regarding this request to Edward D. Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 14th day of September 2015.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosures:
1. TVA Response to NRC Request for Additional Information
2. List of Regulatory Commitments

Enclosures
cc (Enclosures):

NRC Regional Administrator - Region II
NRC Resident Inspector – Watts Bar Nuclear Plant
NRC Project Manager – Watts Bar Nuclear Plant
Director, Division of Radiological Health - Tennessee State Department of Environment and Conservation

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT, UNIT 1

TVA Response to NRC Request for Additional Information

Request for Additional Information (RAI) 1

As part of the review of the license amendment approved for loading of 2,304 tritium producing burnable absorber rods (TPBARs) in 2002, TVA indicated that they planned to use TPBARs in key peripheral locations to suppress power. The intent of doing so was to ensure that the vessel fluence remains bounded by the projected value used in the design basis evaluation for 10 CFR 50.61 compliance. Please confirm that the expected vessel fluence for cores with 1,792 TPBARs will continue to be less than the value assumed in the design basis pressurized thermal shock evaluation for Watts Bar Unit 1.

TVA Response

One of the Tennessee Valley Authority (TVA) core design goals is to ensure that fluence remains within previously analyzed values to preserve the expected lifetime of the reactor pressure vessel and include the effect on reactor vessel pressure-temperature limits. This goal has been incorporated into TVA's core design procedure and design guidelines. The procedure requirements apply to all Watts Bar Nuclear Plant (WBN), Unit 1 reload core designs.

The 1,792 TPBAR design radial power distribution was compared with the radial power distribution used to assess the reactor pressure vessel lifetime in WCAP-16760-NP, "Analysis of Capsule Z from Watts Bar Unit 1 Reactor Vessel Radiation Surveillance Program." The 1,792 TPBAR equilibrium cycle design exhibits lower assembly powers at the core locations important to the fluence for the limiting reactor pressure vessel location. Given this power distribution, it was not necessary to load additional absorbers to suppress the fluence.

The 1,792 TPBAR design exhibits higher and lower assembly powers at core locations near the periphery that do not contribute to the fluence at the current limiting location for reactor pressure vessel fluence. Because the fluence may be increased at reactor pressure vessel locations that were not previously identified as limiting, TVA is evaluating the reactor pressure vessel fluence accumulation using the 1,792 TPBAR design power distribution for future cycles. TVA's objective is to identify the power distribution limits needed to preserve the reactor pressure vessel lifetime.

If additional power distribution constraints are required, TVA anticipates choosing the core design option that achieves the design goal at the lowest cost. The lowest cost core design option may use TPBARs, but it is also possible that discrete burnable absorbers would be used.

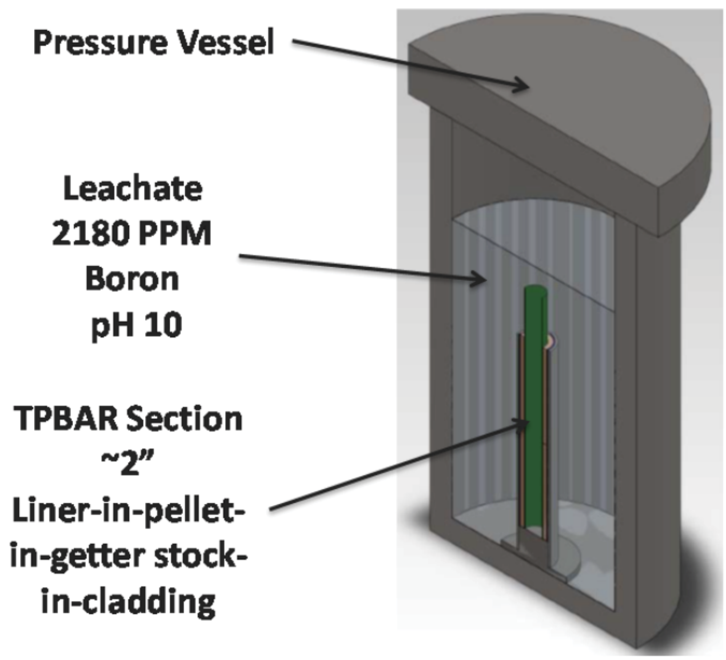
RAI 2

The post-Loss of Coolant Accident (LOCA) subcriticality assessment was performed using revised assumptions for leaching of lithium from the core due to TPBAR failures. A series of Pacific Northwest National Laboratory (PNNL) tests are used as justification for the new assumptions. However, little information is provided about the PNNL tests other than the experiment durations and the temperature at which the tests were conducted. Provide the following information:

a. A description of the test conditions, including ambient fluid conditions, fluid flow, installation configuration for the TPBAR, and mechanical loads.

TVA Response

The tested configuration consisted of a sample TPBAR section in a pressure vessel as shown in the figure below. Each sample TPBAR section was fabricated with uncoated cladding and getter stock, production inner material, and two irradiated lithium aluminate pellets ($LiAlO_2$). A buffered, pH-adjusted borated test solution (2180 ppm boron and pH of 10) was used to simulate the sump water. The test solution was periodically sampled and replaced with fresh solution.



Schematic of the Pellet Leaching Test Configuration

The leach tests were performed in unstirred stainless steel pressure vessels at 120°C and as-generated pressures. An actual TPBAR cladding breach creates a tortuous path that does not allow for free flowing coolant interaction with the pellet material. Therefore, no continuous flow past the TPBAR sections was used in the leach testing. Leaching of $LiAlO_2$ within a breached TPBAR occurs in stagnant conditions within the TPBAR. However, to conservatively bound the breach configuration relative to coolant interaction with the pellets, an open ended cladding section was used in the pellet leach test. The test included the mechanical loads due to temperature effects, thermal expansion and pressure. The test was conducted at bounding post-LOCA temperature and pressure conditions.

b. The pellet leach rates observed during the tests.

TVA Response

Samples were taken at one day and 14 days. The average lithium leaching seen at one day with a 95 percent (%) confidence upper bound was 2.05 weight percent (wt%) per day. The total lithium leached after 14 days with a 95% confidence upper bound was 8.73 wt%, or an overall average of 0.62 wt% per day.

c. The projected maximum temperature for the TPBARs during post-LOCA conditions.

TVA Response

The maximum TPBAR temperature after reflood (post-LOCA) is <248°F (<120°C) based on post-LOCA coolant temperature (see the TVA response to RAI 2.d, below).

d. Technical justification for the applicability of the test results to the post-LOCA environment that would be experienced by the TPBARs, including fluid flow/turbulence, mechanical vibrations, thermal contraction/expansion, and coolant chemistry.

TVA Response

A burst TPBAR would result in about a two inch long fish-mouthed breach that clogs with a deformed mass of TPBAR components (getter, liner, pellets, and clad) and guide tube, resulting in a tortuous, obstructed path for fluid migration into a TPBAR. Full scale TPBAR burst testing has shown that an average of less than 12 inches of TPBAR pellet material is ejected as a result of a TPBAR breach. The safety analysis assumes that no pellet material remains near the breach location. During reflood, the TPBARs may fill with coolant, but the potential for circulation of coolant past TPBAR pellet material is limited. Water stagnation in the TPBAR is the expected condition. When pellets are wet, swelling due to conversion to lower density phases further restricts the potential for coolant circulation. Thermal expansion and contraction of the TPBAR materials after reflood is otherwise minimal. Coolant would circulate outside a TPBAR, but the small quantity of coolant that gets to the TPBAR interior would not readily be exchanged.

The tested geometry consisted of a two inch long open ended TPBAR section containing irradiated pellets in a pressure vessel. The open end simulates a guillotine breach, which exposes the entire cross section to the test solution. Tests were conducted in stagnant test solution as that was the expected condition in the TPBAR and it facilitated testing protocols with irradiated samples. The results from the two inch section are conservatively applied to the entire length of the TPBAR, even though the TPBAR geometry does not facilitate communication of the remaining pellets with the coolant. Although post-LOCA conditions would have high volumes of fresh coolant outside of the TPBAR, transfer of the small quantity of coolant present in the interior of the TPBAR would not occur in post-LOCA conditions due to the highly tortuous path at the post LOCA breach, the small pellet/getter/liner gaps and the expected pellet swelling.

Use of irradiated pellets accounted for pellet irradiation damage and swelling. Past pellet leach tests show that initial pellet Li leaching occurred via the conversion of $LiAlO_2$ into $LiAl_2(OH)_7 \cdot 2H_2O$ and LiOH with significant pellet swelling due to the formation of the lower density phases. High boron concentrations and a high pH both simulate the expected post-LOCA coolant condition. Large test solution/pellet ratios were used and when the test solutions were sampled they were replaced with fresh solution. These conditions bounded the expected, stagnant condition.

The low Reynolds number post-LOCA coolant flows would cause only low energy vibration of the TPBAR. Vibration would have minimal effect on fluid exchange given the expected breach geometry.

The maximum Emergency Core Cooling System (ECCS) water temperature at any time post-LOCA is the saturation temperature at the bounding high post-LOCA containment pressure. This peak pressure is maintained for less than 24 hours and results in a maximum ECCS water temperature of 239°F (115°C). TPBARs generate little heat as they have no fission products and are not significantly hotter than the ECCS water. The test vessel contents were maintained at 248°F (120°C) and as-generated pressures for the full duration of the test. As leaching increases with increasing temperature, testing at higher than expected temperatures for longer than expected times, provides margin to the expected condition.

<u>RAI 3</u>

In order to eliminate all unborated dilution sources, TVA has committed to replacing check valves on the lower compartment supply lines for the Component Cooling Water (CCW) System and Essential Raw Cooling Water (ERCW) System, as well as replacing the upper compartment cooler cooling coils. Chapter 9 of the UFSAR indicates that one of the CCW return lines has the same vulnerability; that is, the potential exists for backflow into the containment via check valve 1-CKV-70-698. Explain how backflow is precluded from occurring through this flow path, or incorporate this potential dilution source in the post-LOCA subcriticality assessment.

TVA Response

The scope design change replacing check valves on the lower compartment supply lines for the Component Cooling Water (CCW) System and Essential Raw Cooling Water (ERCW) System includes replacing check valve 1-CKV-70-698. TVA has revised Regulatory Commitment 1 to include replacing check valve 1-CKV-70-698 as shown in Enclosure 2 to this letter.

RAI 4

The LAR states that the RWST, ice mass, and accumulator fluid masses are assumed to be at a minimum value, while the Reactor Coolant System (RCS) fluid mass is assumed to be at a maximum. The intent is to conservatively select the fluid masses that will result in minimizing the boron concentration of the resulting mixture. For the hot leg switchover (HLSO) assessment, the sump boron concentration for all cases is lower than the minimum boron concentration for the ice mass (1,800 ppm). Therefore, assuming the minimum ice mass fluid mass is appropriate. However, for the long term assessments, this is not true. As a result, the ice mass would represent a boron dilution source and the maximum available fluid mass should be assumed. Provide an updated long term assessment that utilizes an appropriately conservative ice fluid mass.

TVA Response

The post-LOCA subcriticality long-term assessment described in TVA letter dated March 31, 2015, Enclosure 1 actually used an ice weight of 3,000,000 pounds, which is approximately 1.25 times greater than the minimum ice weight required by Technical Specifications (TS) Surveillance Requirement (SR) 3.6.11.2. Therefore, an updated long-term assessment is not required.

The statement, “For example, minimum RWST, ice mass, and accumulator fluid masses are assumed and a maximum RCS fluid mass is assumed (because the RCS, due to its low boron concentration, represents a dilution source),” that appears in TVA letter dated March 31, 2015, Enclosure 1, Section 4.1.2 is incorrect. The wording should have been, “For example, minimum RWST and accumulator fluid masses are assumed, and **maximum ice melt** [emphasis added] and RCS fluid masses are assumed (because the ice and RCS, due to their low boron concentrations, represent dilution sources).” Note that this statement only applies to the post-LOCA subcriticality assessment described in Section 4.1.2 of TVA letter dated March 31, 2015, Enclosure 1, and should not be interpreted as applying to the post-LOCA hot leg switchover (HLSO) analysis of record.

No changes to the post-LOCA HLSO analysis of record were required to support the proposed License Amendment Request (LAR). The fluid masses used in the post-LOCA HLSO analysis of record are appropriately biased to maximize the boron concentration of the resulting mixture. For example, the post-LOCA HLSO analysis of record used an ice weight of 1,750,000 pounds, which is approximately 0.73 times the minimum ice weight required by TS SR 3.6.11.2. In addition, the existing post LOCA HLSO analysis of record does not credit the 40 gpm unborated dilution sources described in TVA letter dated March 31, 2015, Enclosure 1.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT, UNIT 1

Watts Bar Nuclear Plant, Unit 1 Tritium Producing Burnable Absorber Rods
License Amendment Request Regulatory Commitment List

This Enclosure provides the Watts Bar Nuclear Plant (WBN), Unit 1 Tritium Producing Burnable Absorber Rods (TPBARs) License Amendment Request (LAR) updated List of Regulatory Commitments with the revised Commitment 1 change identified in this letter indicated by revision bars to the right of the revised commitment. The updated List of Regulatory Commitments provided in this Enclosure supersedes any previous WBN, Unit 1 TPBAR LAR List of Regulatory Commitments.

1. TVA will replace the containment isolation thermal relief check valves on the Watts Bar, Unit 1 supply lines to the containment for the Component Cooling Water System and Essential Raw Cooling Water System with simple relief valves and will replace one Watts Bar, Unit 1 Component Cooling Water System return line thermal relief check valve (1-CKV-70-698) with a simple relief check valve prior to increasing the number of TPBARs loaded in the reactor core above 704.

2. TVA will replace the WBN, Unit 1 upper compartment cooler cooling coils with fully qualified cooling coils to ensure ERCW System integrity during design basis events prior to increasing the number of TPBARs loaded in the reactor core above 704.