TENNESSEE VALLEY AUTHORITY

1101 Market Street, Chattanooga, Tennessee 37402

CNL-25-014

January 8, 2025

10 CFR 54

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: **Browns Ferry Nuclear Plant, Units 1, 2, and 3 – Response to Request for Additional Information, Set #2 (EPID: L-2024-SLE-0000)**

Reference:
1. Letter from TVA to NRC, CNL-24-001, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 – Application for Subsequent Renewed Operating Licenses," dated January 19, 2024 (ML24019A010)
2. Letter from TVA to NRC, CNL-24-077, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 – Application for Subsequent Renewed Operating Licenses, Response to Request for Additional Information, Set #1 (EPID L-2024-SLE-0000)," dated October 9, 2024 (ML24283A091)
3. NRC electronic mail to TVA, "Browns Ferry SLRA – Request for Additional Information – Set #2," dated December 11, 2024 (ML24347A248)

By Reference 1, the Tennessee Valley Authority (TVA) submitted a subsequent license renewal application (SLRA) for the Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, Renewed Facility Operating Licenses in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." By Reference 2, TVA provided the first response to a Nuclear Regulatory Commission (NRC) request for additional information (RAI) regarding the BFN SLRA. By Reference 3, TVA received a second NRC RAI regarding the BFN SLRA. The TVA RAI response is provided in the enclosure to this letter.

There are no new regulatory commitments in this letter. Should you have any questions regarding this submittal, please contact Peter J. Donahue, Director, Subsequent License Renewal, at pjdonahue@tva.gov.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 8th day of January 2025.

Respectfully,

Digitally signed by Edmondson, Carla
Date: 2025.01.08 11:55:48 -05'00'

Kimberly D. Hulvey
General Manager, Nuclear Regulatory Affairs and Emergency Preparedness

Enclosure:

Response to Request For Additional Information by the Office Nuclear Reactor Regulation, Set #2

cc:

NRC Regional Administrator – Region II
NRC Branch Chief – Region II
NRC Senior Resident Inspector – Browns Ferry Nuclear Plant
NRC Project Manager, License Renewal Projects Branch (Safety)
State Health Officer, Alabama Department of Public Health (w/o Enclosure)

Enclosure

Response to Request For Additional Information by the Office of Nuclear Reactor Regulation, Set #2

Background

Background is provided separately in each of the two RAIs.

NVIB RAI 3.5.2.2.2.6-1

Background

SLRA Section 3.5.2.2.2.6 states that NUREG-1509 is a resource for addressing the potential effects of irradiation on the steel elements of the concrete biological shield (CBS) wall. Therefore, the applicant used the guidance in NUREG-1509 to evaluate potential irradiation embrittlement effects of the steel elements of the CBS wall.

Issue

The staff noted that before any analysis on the effects of irradiation embrittlement of the steel elements is performed, the guidance in NUREG-1509 states that the existing physical condition of the structure or components (in this case the steel structural elements of the CBS wall) must be assessed. Information from the operating experience element of existing aging management programs of the BFN units, such as the Structures Monitoring AMP (SLRA Section B.2.1.33), may be credited for assessing the existing physical condition of the steel structural elements of the CBS wall. However, the applicant did not provide specific operating experience on the structural steel elements of the CBS wall in the existing aging management programs of the BFN units, such as the Structures Monitoring AMP (SLRA Section B.2.1.33).

Request

Describe operating experience from existing aging management programs of the BFN units, such as the Structures Monitoring AMP (SLRA Section B.2.1.33), that provides information on the physical condition of the structural steel elements of the CBS walls of the BFN units.

TVA Response

Implementing procedures for the existing Browns Ferry Nuclear Plant (BFN) Structures Monitoring Aging Management Program (AMP) require inspections of each unit's CBS structural steel for deterioration such as, but not limited to, deformation, alteration, wear, pitting, loss of material due to corrosion, and cracked welds. Degradation is documented in the BFN Corrective Action Program in accordance with Element 7 of the Structures Monitoring AMP and documented in the BFN Maintenance Rule Program to ensure the intended functions of components associated with the CBS are maintained.

A review of the BFN Maintenance Rule Program records from 2012 to present identified no defects related to the physical condition of the structural steel elements of the BFN CBS walls. Inspections performed in 2012 identified a residue on two localized areas of the Unit 3 CBS wall. A VT-3 inspection concluded no base metal loss, weld metal loss, or recordable indications. No other relevant operating experience was identified.

NVIB RAI 3.5.2.2.2.6-2

Background

SLRA Section 3.5.2.2.2.6 states that the "bottom and top portions of the shield wall are comprised of standard density concrete with limestone aggregate. The central portion of the CBS is comprised of high-density concrete with hematite aggregate." The staff noted during the audit that increased gamma heating of the concrete-hematite infill due to hematite activation was not considered in SLRA Section 3.5.2.2.2.6.

Issue

The increased gamma dose and gamma heating could result in a potential unaccounted for volumetric expansion resulting in pressure on the double steel shell of the CBS wall and exertion of additional stresses to the overall structural steel assembly, including its welds, that could lead to cracking of the welds. Since increased gamma heating of the concrete-hematite infill due to hematite activation was not considered in SLRA Section 3.5.2.2.2.6, there is no aging management review (AMR) line item in SLRA Table 3.5.2-1 that specifically addresses the thermal and mechanical loading of the welded connections (due to thermal expansion of the concrete-hematite infill) as a result of increased gamma dose/gamma heating on the structural steel of the CBS wall, including its welds.

Request

Respond to one of the following. Either:

- *Identify an existing AMR line item(s) in the SLRA (revised with plant-specific notes as needed) that addresses the aging effect of thermal and mechanical loading (and/or loss of intended function) of welded connections of the CBS wall steel liner plates that could lead to cracking of the associated welds, as a result of current licensing basis loading including thermal expansion of the concrete-hematite infill; or*

- *Provide an AMR (or more) line item(s) in SLRA Table 3.5.2-1 that specifically address(es) the aging effect of thermal and mechanical loading (and/or loss of intended function) of welded connections of the CBS wall steel liner plates that could lead to cracking of the associated welds, as a result of current licensing basis loading including thermal expansion of the concrete-hematite infill; or*

- *Explain how the thermal expansion of the concrete-hematite infill has no significant aging effect on the steel liner plates that could lead to cracking of their associated weldments.*

TVA Response

TVA elects to respond to the third bullet.

An evaluation was performed of the BFN Plant CBS. This evaluation considered radiation effects on both high-density hematite aggregate concrete (approximately 223 lb/ft3) and normal density concrete (approximately 150 lb/ft3), as per American Concrete Institute 122R. The results showed that the higher density concrete has a higher thermal conductivity (both initial and irradiated), which is the key parameter in the amount of heat that will transfer through the wall. The evaluation determined the greater heat transfer results in less heat accumulation and lower temperatures.

Thermal conductivity is expected to decrease with radiation exposure. NUREG/CR-7171 states that, based on the available test data, the thermal conductivity of irradiated concrete can be a fraction of the unirradiated concrete with a reduction in the range of 30 percent (%). Available test data for thermal conductivity change in concrete resulting from irradiation are for fluence levels significantly higher than the expected levels at BFN for the subsequent license renewal (SLR) period. To account for the radiation exposure, thermal conductivity values were conservatively reduced by 50%. Thus, resulting temperatures are conservative for the end of the SLR 80-year period.

The results of the evaluation show the peak CBS wall temperatures experienced, including the effects of age-related degradation, are approximately 1 °F above the peak temperature in the CBS wall from normal environmental heating. The temperature differential across the CBS, that is inner wall temperature versus outer wall temperature, was found to be 125 °F and 120 °F, respectively. Furthermore, it was found that the use of hematite aggregate mix resulted in a reduced concrete temperature throughout the plant life when compared to normal weight concrete. The resulting temperature rise is attributed to age-related degradation from radiation effects. However, based on the magnitude of temperature rise, it is concluded that temperature effects in the CBS wall are not significantly affected by long-term aging. Based on this analysis, the operational temperatures of the BFN CBS concrete containing hematite will have little to no effect on the stress state of the steel liners and would reduce stress as compared to a similarly configured Mark I boiling water reactor containing normal weight aggregates. Accordingly, aging management is not required for this phenomenon.