



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

April 7, 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, and December 18, 2015 (ADAMS Accession Nos. ML15317A361, ML15351A113, and ML15355A413, respectively), 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. By electronic mail dated February 4 and March 21, 2016, the NRC staff forwarded a draft requests for additional information (RAI) to TVA. On February 23 and March 25, 2016, the NRC staff held conference calls 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 the NRC and TVA staff during the conference calls, TVA will respond to the enclosed RAI by April 15, 2016. In addition, the TVA staff confirmed that the enclosed RAI does not contain any sensitive information.

J. Shea

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

Sincerely,

A handwritten signature in black ink, appearing to read "Farideh Saba", with a long horizontal flourish extending to the right.

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

The U.S. Nuclear Regulatory Commission (NRC) staff from the Vessels & Internals Integrity Branch (EVIB), Division of Engineering, 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.

EVIB-Request for Additional Information (RAI) 1

Section 2.1.1 of Attachment 6¹ (NEDE-33860P, Revision 0), "Safety Analysis Report for Browns Ferry Nuclear Plant Units 1, 2, and 3 Extended Power Uprate," to the September 21, 2015, EPU submittal provides the status of the capsule withdrawal for the three units and states, "Browns Ferry Units 1, 2, and 3 are part of the BWR [Boiling-Water Reactor] Vessel and Internals Project (BWRVIP) Integrated Surveillance program (ISP) ... and will comply with the withdrawal schedule specified for representative or surrogate surveillance capsules that now represent each unit." This is the basis for your conclusion that implementation of EPU has no adverse effect on the BWRVIP withdrawal schedule. Since this statement is too general to demonstrate that the BWRVIP ISP surveillance capsules designated for the BFN units, including their withdrawal schedule, meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix H, and ASTM E185-82, the NRC staff reviewed the current BFN Updated Final Safety Analysis Report, Amendment 26 (BFN-26), for additional information and found the following supporting statement:

Since the predicted adjusted reference temperature [ART] of the reactor vessel beltline steel is less than 100°F at end-of-life, the use of the capsules per the ISP meets the requirements of 10 CFR 50, Appendix H, and ASTM E185-82.

¹ Attachment 7 contains a non-proprietary version of Attachment 6.

Note that “adjusted reference temperature” in the quote may be incorrect. The correct terminology per ASTM E185-82, “Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels,” is “transition temperature shift,” which is further explained in Article 4.15 of this standard as “ ΔRT_{NDT} ,” consistent with the terminology in Regulatory Guide (RG) 1.99, Revision 2, “Radiation Embrittlement of Reactor Vessel Materials.” However, ART has a different meaning, as defined in RG 1.99, Revision 2:

$$ART = \text{initial } RT_{NDT} + \Delta RT_{NDT} + \text{Margin}$$

This definition has been adopted by almost all licensees. The NRC staff asks the licensee to ensure that the quote in BFN-26 is consistent with the information in Table 2.1-2a (Unit 1), Table 2.1-2b (Unit 2), and Table 2.1-2c (Unit 3) of Attachment 6 to the submittal.

EVIB-RAI 2

Regarding the scheduled date of the third capsule withdrawal for BFN, Unit 2, BFN-26, indicated that the third capsule of BFN, Unit 2, is currently scheduled for removal in the refueling outage closest to, without exceeding, 40 effective full power years (EFPYs) of operation. This is consistent with the BWRVIP ISP schedule and the American Society for Testing and Materials (ASTM) E185-82 requirement to have the third capsule withdrawn between 32 EFPYs and 64 EFPYs of the reactor pressure vessel (RPV) operation. Therefore, for BFN units, the BWRVIP ISP meets the requirements of 10 CFR 50, Appendix H, and ASTM E185-82 until 2026. Confirm that the withdrawal date for the third capsule in 2026 will not be changed due to higher neutron fluence under EPU. Also, explain how the withdrawal date will be determined for the remaining standby capsule (the fourth capsule) in BFN, Unit 2, so that the BWRVIP ISP is consistent with the following guidance in NUREG-1801, “Generic Aging Lessons Learned (GALL) Report,” Chapter XI, “Aging Management Programs (AMPs),” XI.M31, “Reactor Vessel Surveillance”:

The plant-specific or integrated surveillance program shall have at least one capsule with a projected neutron fluence equal to or exceeding the 60-year peak reactor vessel wall neutron fluence prior to the end of the period of extended operation.

EVIB-RAI 3

Table 2.1-1a of Attachment 6 indicates that the upper-shelf energy (USE) decrease for the limiting beltline weld 406L44 of Unit 1 is based on surveillance weld data of the same heat number. Table 2.1-1b indicates that the USE decrease for the limiting beltline weld, electroslag weld (ESW) of Unit 2, is not based on the surveillance data, even though the surveillance data for ESW is available. Table 2.1-1c indicates that the USE decrease for the limiting beltline weld ESW of Unit 3 is not based on the surveillance data because this table did not identify the surveillance weld. However, the current pressure-temperature (P-T) limits approved on February 2, 2015, for Unit 1; June 2, 2015, for Unit 2; and January 7, 2016, for Unit 3, which are applicable to the P-T limits under EPU conditions, indicate that surveillance data from the BWRVIP ISP is available for the limiting ESW for Units 2 and 3. Update your Tables 2.1-1b and 2.1-1c for Units 2 and 3 to include estimation of USE decrease based on ESW surveillance

data. Also, discuss applicability of the plate surveillance data in the USE evaluation for BFN, Units 1, 2, and 3.

EVIB-RAI 4

Table 2.1-3 of Attachment 6 provides information on effects of radiation on BFN RPV circumferential weld properties for 38 EFPYs, 48 EFPYs, and 54 EFPYs, respectively, for the three BFN units, establishing the technical basis for not inspecting the RPV circumferential welds during the period of extended operation under EPU conditions. The NRC staff identified two issues that need further clarification:

- a. Page 4.2-9 of the BFN license renewal application (LRA) (ADAMS Accession No. ML040060361) indicated that 60-year operation means 54 EFPYs for BFN, Unit 1, and 52 EFPYs for BFN, Units 2 and 3. This interpretation was repeated several times in NUREG-1843, "Safety Evaluation Report Related to the License Renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3" (the safety evaluation report for the LRA). Confirm, with justification, that the end of the period of extended operation (PEO) for the three BFN units is no longer 54, 52, and 52 EFPYs, and the revised values under EPU conditions are now 38, 48, and 54 EFPYs.
- b. The previously approved reliefs from inspecting RPV circumferential welds covers 40 years of operation. A request for relief beyond 40 years is required if TVA plans not to inspect RPV circumferential welds during the specified 38, 48, and 54 EFPYs under EPU conditions. By letter dated February 17, 2016 (ADAMS Accession No. ML16020A115), the NRC authorized a relief pertaining to RV circumferential shell welds, for BFN, Unit 1, for the duration of the PEO. Confirm that TVA plans to submit relief requests for BFN, Units 2 and 3, covering operation beyond 40 years under EPU conditions and that the operator training and procedures to limit the frequency of cold over-pressure events implemented consistent with Generic Letter 98-05, "Boiling Water Reactor Licensees Use of the BWRVIP-05 Report to Request Relief from Augmented Examination Requirements on Reactor Pressure Vessel Circumferential Shell Welds," would remain in place post-EPU.

EVIB-RAI 5

Section 2.1.3 of Attachment 6 stated on page 2-9 that, "Three components [(top guide, shroud, and core plate)] have been identified as being potentially susceptible to IASCC, based upon the projected 54 EFPY fluence for Unit 1 ... Three components have been identified as being potentially susceptible to IASCC, based upon the projected 52 EFPY fluence for Units 2 and 3" Consistent with the response to EVIB-RAI 4, clarify with explanation, which of the following applies to BFN units:

- a. Although the fluence values for these three components were developed in an effort related to the LRA for the end of the PEO fluence values at 54 EFPY for Unit 1 and 52 EFPY for Units 2 and 3, these values bound the corresponding fluence values under the EPU conditions.

- b. The fluence values for these three components were developed for the EPU condition. The EPFY values in the quote should be corrected to 38, 48, and 54 EPFYs for Units 1, 2, and 3.

EVIB-RAI 6

Section 2.1.3 of Attachment 6 identified the core shroud as one of the three components being potentially susceptible to irradiation-assisted stress-corrosion cracking (IASCC) and identified BWRVIP-76 as the guidance document. However, no further discussion of the core shroud was given in this section. Provide a summary of core shroud cracking in the BFN units and describe any plant-specific deviations from the inspection in BWRVIP-76 and flaw evaluation guidelines in the past that could affect the units' effective management of intergranular stress-corrosion cracking and IASCC in the core shroud in the future under the EPU condition.

EVIB-RAI 7

Regarding management of IASCC in the core plate using guidance in BWRVIP-25, the only issue to be addressed is consideration of relaxation of the rim hold-down bolts as a Time Limiting Aging Analysis issue. Section 2.1.3 of Attachment 6 states, "Analysis of the core plate bolts was conducted as part of the Time Limiting Aging Analysis (TLAA) for the Browns Ferry license renewal, per Reference 25." Reference 25 of Attachment 6 is NEDC-33632P, "Browns Ferry (Units 1-3) Core Plate Bolt Analysis Stress Analysis Report," December 2010. Provide a brief summary of NEDC-33632P (non-proprietary: ADAMS Accession No. ML11171A038; proprietary: ADAMS Accession No. ML11171A039) relevant to the EPU conditions, and explain how the core plate bolting issue during the period of extended operation under EPU conditions is resolved in this report.

EVIB-RAI 8

On June 8, 2009, General Electric-Hitachi (GEH) issued Safety Communication (SC) 09-01, "Annulus Pressurization Loads Evaluation," related to annulus pressurization loads. The potential non-conservative evaluations may affect the corresponding stresses on the RPV, internals, and containment structures. The NRC staff also recently became aware of four other related GEH SCs, namely SC 09-03, Revision 1, related to core shroud recirculation line break loads; SC 11-07 related to a new load combination; and SC 12-20 related to acoustic load errors, all of which were issued on June 10, 2013. Additionally, SC 13-08 is related to SC 12-20, but its focus is on shroud support plate-to-vessel evaluation for alternating current loads.²

GEH identified that only SC 11-07, SC 12-20, and SC 13-08 are applicable to the BFN units. SC 11-07 recommends affected plants undertaking changes to the current licensing basis (e.g., EPU applicants), consider "re-evaluating the plant structural loads," based on revised annulus pressurization and acoustic loadings. SC 12-20 recommends affected plants perform an evaluation based on higher postulated loading and options if results from this evaluation are not

² The latest status of this topic was provided by the BWRVIP during a November 6, 2013, Category 2 meeting at NRC headquarters. The meeting summary is available at ADAMS Accession No. ML13312A177.

acceptable. SC 13-08 recommends affected plants perform evaluation for the shroud-to-RPV connections. Provide BFN plant-specific assessment of the impact to RVI integrity due to information in these three GEH SCs.

J. Shea

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

Sincerely,

/RA AHon 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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