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

CNL-16-069

April 14, 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 11, Responses 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 April 7, 2016 (ML16091A071)

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. During the technical review of the LAR, the Nuclear Regulatory Commission (NRC) identified the need for additional information. The Reference 2 letter provided NRC Requests for Additional Information (RAI) related to reactor vessel and internals integrity. The due date for the responses to the NRC RAIs provided by the Reference 2 letter is April 15, 2016. The enclosure to this letter provides the responses to the RAIs 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 14th day of April 2016.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure: Responses to NRC Requests for Additional Information EVIB-RAI 1, EVIB-RAI 2, EVIB-RAI 3, EVIB-RAI 4, EVIB-RAI 5, EVIB-RAI 6, EVIB-RAI 7, and EVIB-RAI 8.

cc:

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

ENCLOSURE

Responses to NRC Requests for Additional Information
EVIB-RAI 1, EVIB-RAI 2, EVIB-RAI 3, EVIB-RAI 4, EVIB-RAI 5, EVIB-RAI 6, EVIB-RAI 7, and EVIB-RAI 8

ENCLOSURE

EVIB-RAI 1

Section 2.1.1 of Attachment 6[1] (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.*

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.

TVA Response:

Tennessee Valley Authority (TVA) agrees that the correct terminology for this Final Safety Analysis Report (FSAR) statement (FSAR 4.2.6) should be *transition temperature shift* (ΔRT_{NDT}) rather than *adjusted reference temperature*. This conclusion is based on a review of 10 CFR 50, Appendix H and American Society for Testing and Materials (ASTM) E185-82. Guidance in ASTM E185-82 with respect to a surveillance program design and withdrawal schedule bases the number of required capsules and their withdrawal schedule on the transition temperature shift rather than the adjusted reference temperature.

The FSAR will be revised to read as follows: Since the predicted ~~adjusted reference temperature~~ [transition temperature shift] 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.

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

ENCLOSURE

The BWRVIP ISP surveillance capsules designated for the Browns Ferry Nuclear Plant units, including their withdrawal schedule, will continue to meet the requirements of 10 CFR Part 50, Appendix H, and ASTM E185-82.

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.*

TVA Response:

A reconstituted capsule is available for withdrawal from Browns Ferry Nuclear Plant (BFN) Unit 2, but no plans for such withdrawal have been made at this time. Lead factors determined from previous capsule analyses (Reference 1) and fluence calculations supporting the Boiling Water Reactor Vessel and Internals Project (BWRVIP) Integrated Surveillance Program (ISP) (Reference 2) indicate that the fourth capsule is accumulating fluence at approximately the same rate as the vessel ID, i.e., lead factor ~1. Thus at the end of the current license, this capsule will have accumulated approximately the same fluence as the vessel wall. This capsule can be considered a backup for the third capsule, part of the BWRVIP ISP, or to support operation beyond 60 years in satisfaction of the Generic Aging Lessons Learned (GALL) recommendation.

The BWRVIP ISP, as currently constituted and approved by Nuclear Regulatory Commission (NRC), does not require additional BFN capsule withdrawals beyond the third BFN Unit 2 capsule scheduled for 2026 in Table 7-1 of BWRVIP-86. However, the BWRVIP ISP recognizes that some uncertainty exists in the projections for the exact year plants will reach the target EFPY; therefore, the BWRVIP closely coordinates with the ISP plants and informs the NRC of any schedule changes that exceed two years of the scheduled removal. BFN Unit 2 is currently scheduled to withdraw the third capsule in early 2027 coinciding with a planned refueling outage. The BFN Unit 2 stand-by capsule, as well as reserved capsules from BFN Units 1 and 3, represent reactor vessel material surveillance resources that could be employed to support further license extensions. BFN is committed to the BWRVIP ISP program and will support the program through additional capsule withdrawals as deemed appropriate by the BWRVIP and NRC.

References

1. BWRVIP-271NP: BWR Vessel and Internals Project, Testing and Evaluation of the Browns Ferry Unit 2 120° Capsule, Table 3-4, EPRI, Palo Alto, CA, 2013.

2. BWRVIP-86, Revision 1-A: BWR Vessel and Internals Project, Updated BWR Integrated Surveillance Program (ISP) Implementation Plan, Table 7-2, EPRI, Palo Alto, CA, 2012.

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.

TVA Response:

The Request for Additional Information (RAI) requests that information from the Integrated Surveillance Program (ISP) be incorporated into Tables 2.1-1b (Unit 2) and 2.1-1c (Unit 3). The following discussion addresses that request.

The ISP, as defined in Boiling Water Reactor Vessel and Internals Project (BWRVIP)-135 Revision 3 (see pages 2-4 and 2-5), identifies two Browns Ferry Nuclear Plant (BFN) Unit 2 surveillance capsules that are applicable to the Unit 2 weld material. The salient information is included in the Unit 2 weld evaluation in the upper portion of the weld evaluation in Table 2.1-1b.

BWRVIP-135 (see page 2-7) also states that the Unit 2 capsule weld information is not the same heat as that in the Unit 3 vessel, and therefore should not be considered in Table 2.1-1c. Therefore, the Unit 2 capsule weld information should not be included in the Unit 3 Upper Shelf Energy Equivalent Margin Analysis (USE/EMA) evaluation, consistent with the guidance contained in BWRVIP-135.

In summary, in accordance with BWRVIP-135 guidance, Table 2.1-1b correctly incorporated the ISP weld data and Table 2.1-1c correctly did not incorporate the ISP surveillance weld data. Therefore, Tables 2.1-1b and 2.1-1c require no further changes.

It is agreed that the ISP information was included in the Unit 1, Unit 2, and Unit 3 P-T curve reports for EPU operating conditions for the calculation of Adjusted Reference Temperature (ART). The footnotes to the ART tables identify that the information for the weld material for Unit 2 is applied to the development of the P-T curves, but Unit 3 information is not used in the development of the P-T curves and is provided for information only as it is not applicable, in accordance with the BWRVIP-135 guidance stated above.

With respect to the plate surveillance data portion of the RAI:

The Unit 1 plate material surveillance data is represented by Unit 2 in the ISP (see page 2-2 of BWRVIP-135, Revision 3). However, this surveillance plate is not the same as the Unit 1 target plate and is therefore not included in the Unit 1 USE/EMA evaluation, per BWRVIP-135 guidance.

The Unit 2 plate material is identified in BWRVIP-135 (see page 2-4) as being representative for Unit 2. However, this plate material is not the "target" plate heat and would not normally be considered in the USE/EMA evaluation. However, as this heat is in the Unit 2 vessel, it is considered in the plate section of Table 2.1-1b, per BWRVIP-135 guidance.

The Unit 3 plate material, per BWRVIP-135 (see page 2-6), is not the same heat number as the target vessel plate and is not in the Unit 3 vessel. Therefore, the surveillance data should not be considered in the Unit 3 evaluation.

The plate material USE/EMA evaluations contained in Tables 2.1-1a, 2.1-1b, and 2.1-1c have been evaluated consistent with the guidance provided in BWRVIP-135 and require no further changes.

ENCLOSURE

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. ML0400660361) 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.*

TVA Response:

a. Projections of future generation, using actual plant performance through 2014 outages (2013 for Unit 2), confirm that the revised End of Life (EOL) Effective Full Power Years (EFPY) values reported in Table 2.1-3 of Browns Ferry Nuclear Plant (BFN) Extended Power Uprate (EPU) License Amendment Request (LAR), Attachment 6 (i.e., 38 EFPYs, 48 EFPYs, and 54 EFPYs, respectively, for the three BFN units) are correct. Future cycles were projected with 30 day outages and 95% capacity during operation. In addition, in response to a License Renewal commitment, Pressure-Temperature (P-T) curves were submitted to the Nuclear Regulatory Commission (NRC) for the entire Period of Extended Operation (PEO) with an expiration value of 38 EFPY for Unit 1, 48 EFPY for Unit 2, and 54 EFPY for Unit 3. These revised P-T curves were approved by the NRC in letters dated February 2, 2015, for BFN Unit 1 (Reference 1), June 2, 2015, for Unit 2 (Reference 2), and January 7, 2016, for BFN Unit 3 (Reference 3).

b. A relief request from inspecting the BFN Unit 1 Reactor Pressure Vessel (RPV) circumferential welds for the extended license period was submitted by TVA in the letter dated June 26, 2015 (ML15181A448) and supplemented by letters dated October 27, 2015 and November 18, 2015. The relief request was approved by NRC letter dated February 17, 2016 (ML16020A115). BFN stated in its relief request and

NRC reiterated in its approval letter that, "the licensee will continue to implement operator training and procedures to limit the frequency of cold overpressure events to the amount specified in the NRC staff's SE for the BWRVIP-05 report." TVA's relief request used projected fluence and ΔRT_{NDT} values consistent with EPU as found in BFN EPU LAR, Attachment 6, Table 2.1-3. Similar relief requests for BFN Units 2 and 3 will be submitted by TVA later in 2016.

References

1. Letter from F. Saba (NRC) to J. Shea (TVA), Browns Ferry Nuclear Plant, Unit 1 - Issuance of Amendment Revising Pressure and Temperature Limit Curves (TAC NO. MF3260), dated February 2, 2015 (ML14325A501)

2. Letter from F. Saba (NRC) to J. Shea (TVA), Browns Ferry Nuclear Plant, Unit 2 - Issuance of Amendment Revising Pressure and Temperature Limit Curves (TAC NO. MF4303), dated June 2, 2015 (ML15065A049)

3. Letter from F. Saba (NRC) to J. Shea (TVA), Browns Ferry Nuclear Plant, Unit 3 - Issuance of Amendment Regarding Modification of Technical Specification 3.4.9, "RCS Pressure and Temperature (P/T) Limits" (CAC NO. MF5659), dated January 7, 2016 (ML15344A321)

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 [irradiation-assisted stress-corrosion cracking], 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 EFPY values in the quote should be corrected to 38, 48, and 54 EFPYs for Units 1, 2, and 3.

TVA Response:

In March 2004, General Electric (GE) issued a Time Limited Aging Analysis (TLAA) for the Reactor Vessel and Internals (GE-NE-0000-0016-2112-02R1) in support of License Renewal Application (LRA) for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3. The report used 54 Effective Full Power Years (EFPY) (Unit 1) and 52 EFPY (Units 2 and 3). These values are conservative when used in calculations projecting total fluence for license extension because they assume the entire 60-year BFN Units 1, 2 and 3 license period.

As documented in GE-NE-0000-0016-2112-02R1 the following values apply:

Shroud:
Unit 1 = 5.34e21 n/cm^2
Units 2 and 3 = 5.15e21 n/cm^2

Top Guide:
Unit 1 = 2.06e22 n/cm^2
Units 2 and 3 = 1.98 e22 n/cm^2

Core Plate:
Unit 1 = 7.33e20 n/cm^2
Units 2 and 3 = 7.07 e20 n/cm^2

Although the fluence values for these three components were developed in an effort related to the LRA for the end of the period of extended operation fluence values at 54 EFPY for Unit 1 and 52 EFPY for Units 2 and 3, they bound the corresponding fluence values under the Extended Power Uprate conditions.

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.

TVA Response:

<u>Summary of core shroud cracking in the Browns Ferry Nuclear Plant (BFN) units:</u>

Unit 1

Unit 1 Core Shroud Inspection Results

Weld ID	Percentage of Weld Examined		Percentage of Examined Length Containing Indications
	Upper	Lower	
H1	83.0%	82.1%	2.1% (lower)
H2	81.8%	88.7%	0.4% (upper)
H3	88.7%	79.2%	5.1% (lower)
H4	90.0%	89.6%	20.1% (upper), 2.6% (lower)
H5	91.3%	91.3%	1.2% (upper)
H6	91.9%	91.9%	11.2% (lower)
H7	91.4%	78.0%	12.0% (upper)

Unit 2

Unit 2 Core Shroud Inspection Results

Weld ID	Percentage of Weld Examined		Percentage of Examined Length Containing Indications
	Upper	Lower	
H1	N/A	77.1%	1.7% (lower)
H2	62.4%	82.7%	0.8% (upper)
H3	80.8%	82.1%	15.0% (lower)
H4	98.6%	98.6%	0%
H5	89.6%	98.6%	1.6% (upper)
H6	98.6%	91.7%	9.3% (lower)
H7	63.3%	53.8%	11.5% (upper)
V5	100%	100%	0%
V6	100%	100%	0%

Unit 3

Unit 3 Core Shroud Inspection Results

Weld ID	Percentage of Weld Examined		Percentage of Examined Length Containing Indications
	Upper	Lower	
H1	N/A	83.6%	5.6% (lower)
H2	75.4%	82.8%	1.7% (upper)
H3	82.6%	82.9%	0.6% (lower
H4	98.9%	99.2%	4.5% (upper)
H5	99.2%	99.2%	29.2% (upper)
H6	99.2%	99.7%	0%
H7	62.8%	62.8%	3.2% (upper)
V5	84%	84%	1.3%
V6	84%	84%	0%

<u>BFN Plant-Specific Deviations from Boiling Water Reactor Vessel and Internals Project (BWRVIP)-76</u>

Only one BWRVIP-76 deviation disposition was developed for BFN. Deviation Disposition No. DD-2006-01, "Deviation Disposition for Variance from BWRVIP Guidelines For Ultrasonic (UT) Examination of Core Shroud Horizontal Welds H6 & H7" for BFN Unit 3 provided the technical justification for demonstrating that adequate margin existed for continued operation with the H6 and H7 welds through the U3C13 Fuel Cycle. Ultrasonic Testing (UT) examination for the H6 and H7 welds was scheduled for the U3C12 Refueling Outage (RFO) in March 2006, which was the last RFO in which these welds could be inspected without exceeding the 10-year re-inspection interval. Due to vendor non-performance, no inspection data for the H6 and H7 welds was obtained during the U3C12 RFO. BFN resolved this issue by deferring UT examination of these welds until the U3C13 RFO in March 2008, at which time a two-sided UT examination was performed for both welds. Because the requisite inspections have been performed, this deviation does not affect the units' effective management of intergranular SCC and IASCC in the core shroud in the future under Extended Power Uprate conditions.

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.

TVA Response:

The Core Plate Bolt Analysis Stress Analysis Report (NEDC-33632P) is a plant-specific report that was performed as part of the Time Limiting Aging Analysis (TLAA) for the Browns Ferry Nuclear Plant (BFN) license renewal. The report documents that the core plate bolts in BFN Units 1, 2 and 3 meet American Society of Mechanical Engineers code allowable limits. The report also demonstrates that BFN core plate bolts can withstand normal, upset, emergency, and faulted loads considering the effects of stress relaxation on the bolts until the end of the 60-year period of extended operation and includes fluence considerations for Extended Power Uprate (EPU).

NEDC-33632P documented fluence calculations performed in support of BFN's TLAA in 2005 and included the 5% stretch power uprates implemented at that time as well as an assumed EPU occurring in 2007, and also added conservatism by including a factor of safety for flux uncertainty. The 60-year (54 Effective Full Power Years) fluence used in NEDC-33632P for Unit 2 also bounds Units 1 and 3.

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 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.

TVA Response:

GEH Safety Communications SC 11-07 (Reference 1), SC 12-20 (Reference 2), and SC 13-08 (Reference 3) were specifically considered in the development of the AC loads for Browns Ferry Nuclear Plant (BFN) at Extended Power Uprate (EPU) conditions and the subsequent application of EPU AC loads for the structural evaluation of the Reactor Pressure Vessel (RPV) and the reactor internals as presented in Sections 2.2.2.3 and 2.2.3.2 of EPU LAR Attachment 6, Power Uprate Safety Analysis Report (PUSAR).

As stated in Section 2.2.3.2.1 of the PUSAR, "The acoustic and flow-induced loads following a postulated recirculation line break were also evaluated using TRACG models (see Table 1-1). The methodology for determining the Browns Ferry acoustic and flow-induced loads at EPU rated thermal power is unchanged from that used for current rated thermal power and is unaffected by the issue identified in GEH Safety Communication 12-20 (Reference 50). The acoustic and flow-induced loads associated with the extension of the MELLLA and ICF domain to include EPU operation are bounded by the acoustic and flow-induced loads associated with reduced feedwater temperature operation at the minimum pump speed point on the MELLLA line (Point "C" of Figure 1-1)."

The BFN design and licensing basis does not include the application of AP loads in the structural evaluation of the RPV and the reactor internals. BFN is not a "new loads" plant as described in Reference 1. Therefore, the new load combination (AC+AP) as described in Reference 1 is not applicable to BFN. Because the BFN AC loads were found to be unaffected by the issue identified in Reference 2, the inertial load issue identified in Reference 1 was determined during the EPU evaluations as non-applicable to BFN.

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[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.

The RPV structural evaluation for the shroud support (shroud-to-RPV connection) incorporated the AC load as described in Reference 3. As noted above, BFN is unaffected by the AC load issue identified in Reference 2.

References

1. SC 11-07, Revision 0, “Impact of Inertial Loading and Potential New Load Combination from recirculation Suction Line Break Acoustic Loads,” June 10, 2013.

2. SC 12-20, Revision 1, “Error in Method of Characteristics Boundary Conditions Affecting Acoustic Loads Analyses,” December 8, 2014.

3. SC 13-08, Revision 0, “Shroud Support Plate-to-Vessel Evaluation for AC Loads,” December 15, 2014.