



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

April 30, 2013

10 CFR 50.4
10 CFR 50.46

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: Title 10 of the Code of Federal Regulations (10 CFR) 50.46 Annual Report for Browns Ferry Nuclear Plant, Unit 1, and 10 CFR 50.46 30-Day and Annual Report for Browns Ferry Nuclear Plant, Units 2 and 3

- Reference:**
1. Letter from TVA to NRC, "10 CFR 50.46 Annual Report for Browns Ferry Nuclear Plant, Unit 1," dated April 30, 2012 (ML12123A708)
 2. Letter from TVA to NRC, "10 CFR 50.46 30-Day and Annual Report for Browns Ferry Nuclear Plant, Units 2 and 3," dated April 18, 2012 (ML12114A003)
 3. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 1," dated January 4, 2013 (ML13010A016)
 4. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 2," dated August 20, 2012 (ML12235A478)
 5. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 3," dated May 30, 2012 (ML12153A053)
 6. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 2 and 3 - Issuance of Amendments Regarding Deletion of Low Pressure Coolant Injection Motor-Generator Sets for Browns Ferry Plant, Units 2 and 3 (TAC Nos. ME9176 and ME9177)," dated February 15, 2013 (ML13018A342)

A002
NRC

The purpose of this letter is to provide the annual report, as required by Title 10 of the Code of Federal Regulations (10 CFR) 50.46, of changes or errors discovered in the Emergency Core Cooling System (ECCS) evaluation model for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3. In accordance with 10 CFR 50.46, "Acceptance Criteria for ECCS for Light-Water Nuclear Power Reactors," paragraph (a)(3)(ii), Enclosures 1, 2, and 3 describe the nature and the estimated effect on the limiting ECCS analysis of changes or errors discovered since submittal of Reference 1 for BFN, Unit 1, and Reference 2, as supplemented by References 4 and 5, for BFN, Units 2 and 3.

Enclosure 1 to this letter contains a summary of changes to the calculated peak cladding temperature (PCT) made to the BFN, Unit 1, ECCS-Loss of Coolant Accident (LOCA) analysis of record (AOR), including changes described in the letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 1," dated January 4, 2013 (Reference 3). The baseline GE14 fuel PCT for BFN, Unit 1, is 1760°F. The baseline ATRIUM-10 fuel PCT for BFN, Unit 1, is 1926°F.

Enclosure 2 to this letter contains a summary of changes to the calculated PCT made to the BFN, Unit 2, ECCS-LOCA AOR, including changes described in the letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 2," dated August 20, 2012 (Reference 4).

Enclosure 2 also serves as the 30-day report of a significant change to the BFN, Unit 2, ECCS-LOCA AOR. As described in Reference 6, the NRC has approved the application of a modified version of AREVA's EXEM BWR-2000 methodology. A new ECCS-LOCA AOR was implemented on April 15, 2013, for BFN, Unit 2, with a baseline PCT of 1926°F. This results in a 66°F change from the previously reported baseline PCT of 1992°F.

Enclosure 3 to this letter contains a summary of changes to the calculated PCT made to the BFN, Unit 3, ECCS-LOCA AOR, including changes described in the letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 3," dated May 30, 2012 (Reference 5).

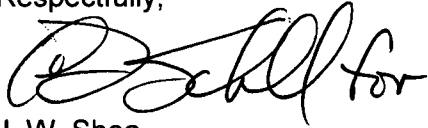
Enclosure 3 also serves as the 30-day report of a significant change to the BFN, Unit 3, ECCS-LOCA AOR. As described in Reference 6, the NRC has approved the application of a modified version of AREVA's EXEM BWR-2000 methodology. A new ECCS-LOCA AOR was implemented on April 15, 2013, for BFN, Unit 3, with a baseline PCT of 1926°F. This results in a 66°F change from the previously reported baseline PCT of 1992°F.

With the implementation of the changes to the BFN, Units 2 and 3, Technical Specifications approved in Reference 6, the new baseline PCT values described above became effective on April 15, 2013. The 66°F change in the baseline PCT for BFN, Units 2 and 3, meets the criteria of 10 CFR 50.46 (a)(3)(i) as a significant change. As such, in accordance with 10 CFR 50.46 (a)(3)(ii), this 30-day report is required to be submitted by May 15, 2013.

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There are no new regulatory commitments in this letter. Please direct questions concerning this issue to Tom Hess at (423) 751-3487.

Respectfully,

A handwritten signature in black ink, appearing to read "J. W. Shea for".

J. W. Shea
Vice President, Nuclear Licensing

Enclosures:

1. 10 CFR 50.46 Annual Report for Browns Ferry Nuclear Plant, Unit 1
2. 10 CFR 50.46 30-Day and Annual Report for Browns Ferry Nuclear Plant, Unit 2
3. 10 CFR 50.46 30-Day and Annual Report for Browns Ferry Nuclear Plant, Unit 3

cc (w/Enclosure):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Browns Ferry Nuclear Plant

ENCLOSURE 1
10 CFR 50.46 ANNUAL REPORT
FOR
BROWNS FERRY NUCLEAR PLANT, UNIT 1

The Browns Ferry Nuclear Plant (BFN), Unit 1, core contains both the ATRIUM™-10 and GE14 fuel designs. This report establishes new baseline peak cladding temperature (PCT) values for both fuel types, as described below.

ATRIUM™-10 Fuel Evaluation

The Reference 1 letter established References 2 and 3 as the Emergency Core Cooling System (ECCS)-Loss of Coolant Accident (LOCA) analysis of record (AOR) for ATRIUM™-10 fuel in BFN, Unit 1. These analyses were reviewed by the NRC and approved for application to BFN, Unit 1, in Reference 4. The baseline PCT for ATRIUM™-10 fuel is 1926°F.

No new changes or errors have been discovered in the AREVA LOCA analyses since the issuance of Reference 1.

Table 1 details the accumulated PCT effect due to errors and changes in the LOCA analyses since Reference 3 was established as the AOR.

Table 1: Cumulative Effect of PCT Changes - BFN, Unit 1 (ATRIUM™-10)	
Baseline PCT	1926°F
Thermal Conductivity Degradation (previously reported in Reference 1 of this enclosure)	+ 0°F
Accumulated changes since baseline analysis	+ 0°F
New licensing PCT	1926°F
Absolute value of accumulated changes	0°F

ENCLOSURE 1
10 CFR 50.46 ANNUAL REPORT
FOR
BROWNS FERRY NUCLEAR PLANT, UNIT 1

GE14 Fuel Evaluation

The Reference 1 letter established Reference 5 as the LOCA AOR for GE14 fuel, with a baseline PCT of 1760°F. The applicability of this analysis to the current plant configuration was confirmed by GE-Hitachi in Reference 6. Reference 5 provided PCT results for both Current Licensed Thermal Power (CLTP) and Extended Power Uprate (EPU) conditions. The Tennessee Valley Authority has elected to use the CLTP results for 10 CFR 50.46 reporting, because EPU has not been approved for BFN, Unit 1, and all GE14 fuel is scheduled to be discharged prior to the planned EPU implementation date. The baseline PCT for GE14 fuel at CLTP conditions is 1760°F.

No new changes or errors have been discovered in the GE14 LOCA analysis since the issuance of Reference 1.

Table 2 details the accumulated PCT effect due to errors and changes in the GE14 LOCA analyses since Reference 5 was established as the AOR.

Table 2: Cumulative Effect of PCT Changes - BFN, Unit 1 (GE14)	
Baseline PCT	1760°F
Input coefficient database error (previously reported in Reference 1 of this enclosure)	+25°F
Revised gamma heat deposition formulation (previously reported in Reference 1 of this enclosure)	+15°F
Pellet thermal conductivity degradation (previously reported in Reference 1 of this enclosure)	+0°F
Accumulated changes since baseline analysis	+40°F
New licensing PCT	1800°F
Absolute value of accumulated changes	40°F

ENCLOSURE 1
10 CFR 50.46 ANNUAL REPORT
FOR
BROWNS FERRY NUCLEAR PLANT, UNIT 1

References

1. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 1," January 4, 2013
2. ANP-3015(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA Break Spectrum Analysis," AREVA NP Inc., September 2011
3. ANP-3016(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA-ECCS Analysis MAPLHGR Limit for ATRIUMTM-10 Fuel," AREVA NP Inc., December 2011
4. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Unit 1 – Issuance of Amendments Regarding the Transition to AREVA Fuel (TAC No. ME3775) (TS-473)," April 27, 2012
5. NEDC-32484P Revision 6, "Browns Ferry Nuclear Plant Units 1, 2, and 3: SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis," GE Nuclear Energy, February 2005
6. NEDC-32484P Rev. 6, Supplement 2 Revision 0, "Browns Ferry Nuclear Plant Unit 1: Supplementary Report Regarding ECCS-LOCA Evaluation Additional Single Failure Evaluation at Current Licensed Thermal Power," GE-Hitachi Nuclear Energy, September 2012

ENCLOSURE 2

10 CFR 50.46 30-DAY AND ANNUAL REPORT FOR BROWNS FERRY NUCLEAR PLANT, UNIT 2

The Browns Ferry Nuclear Plant (BFN), Unit 2, core contains only the ATRIUM™-10 fuel design.

Description of Changes and Errors Relative to the Previous Report

The previous 10 CFR 50.46 report for BFN, Unit 2, was submitted on August 20, 2012 (Reference 1). This report cites References 2 and 3 as the analysis of record (AOR) with a baseline Peak Cladding Temperature (PCT) of 1992°F.

A modification to the Automatic Depressurization System (ADS) was completed during the spring 2013 refueling outage, which restored the automatic initiation capability of the ADS in the event of a single failure. AREVA has prepared new Emergency Core Cooling System (ECCS)-Loss of Coolant Accident (LOCA) analyses to reflect the updated plant configuration (References 4 and 5). This letter establishes References 4 and 5 as the new ECCS-LOCA AOR for BFN, Unit 2, with a baseline PCT of 1926°F. Reference 4 utilizes a modified version of AREVA's EXEM BWR-2000 methodology, which was approved by the NRC for application to BFN, Unit 2, in Reference 6. With the implementation of the changes to the BFN, Unit 2, Technical Specifications approved in Reference 6, the new baseline PCT values described above became effective on April 15, 2013.

On June 28, 2012, AREVA issued Reference 7, which notified the Tennessee Valley Authority (TVA) of a change relative to the AOR in References 4 and 5. As discussed in Reference 7, Reference 8 indicates that burnup degradation of fuel thermal conductivity over the approved burnup range was not supported by experimental data when older generation codes, like RODEX2, were approved. In recent evaluations of this phenomenon, it appears that the use of the RODEX2 code (which provides inputs to RELAX and HUXY in the LOCA analysis methodology) results in conservatively high temperatures at low burnup (less than 15 Giga-Watt Days per Metric Ton Uranium), but underpredicts pellet temperatures at higher exposures.

For BFN, Unit 2, the current analysis (Reference 5) shows that the limiting PCT occurs at beginning of life (BOL). As discussed in Reference 7, the effects of thermal conductivity degradation at higher burnups result in a zero degree change in the limiting PCT, which occurs at BOL. Therefore, there is no change in the reported PCT due to thermal conductivity degradation for BFN, Unit 2.

Table 1 details the accumulated PCT effect due to errors and changes in the ATRIUM™-10 LOCA analyses since References 4 and 5 were established as the AOR.

ENCLOSURE 2

**10 CFR 50.46 30-DAY AND ANNUAL REPORT
FOR
BROWNS FERRY NUCLEAR PLANT, UNIT 2**

Table 1: Cumulative Effect of PCT Changes - BFN, Unit 2	
Previously Reported Baseline PCT (References 2 and 3)	1992°F
Baseline PCT	1926°F
Thermal Conductivity Degradation (Reference 7)	+ 0°F
Accumulated changes since baseline analysis	+ 0°F
New licensing PCT	1926°F
Absolute value of accumulated changes	0°F

ENCLOSURE 2

10 CFR 50.46 30-DAY AND ANNUAL REPORT FOR BROWNS FERRY NUCLEAR PLANT, UNIT 2

References

1. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 2," August 20, 2012
2. ANP-2908(P) Revision 0, "Browns Ferry Units 1, 2, and 3 105% OLTP LOCA Break Spectrum Analysis," AREVA NP Inc., March 2010
3. ANP-2910(P) Revision 1, "Browns Ferry Units 1, 2, and 3 105% OLTP LOCA-ECCS Analysis MAPLHGR Limit for ATRIUM™-10 Fuel," AREVA NP Inc., November 2010
4. ANP-3015(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA Break Spectrum Analysis, AREVA NP Inc.," dated September 2011
5. ANP-3016(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA-ECCS MAPLHGR Limit for ATRIUM™-10 Fuel, AREVA NP Inc.," dated December 2011
6. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 2 and 3 - Issuance of Amendments Regarding Deletion of Low Pressure Coolant Injection Motor-Generator Sets for Browns Ferry Nuclear Plant, Units 2 and 3 (TAC Nos. ME9176 and ME9177)," dated February 15, 2013
7. FAB12-2249, "Transmittal of 10 CFR 50.46 PCT Error Reporting for Browns Ferry Units 1, 2, and 3," AREVA NP, June 28, 2012
8. Letter from P. Salas (AREVA) to USNRC Document Control Desk (DCD), "Response to NRC Letter Regarding Nuclear Fuel Thermal Conductivity Degradation Evaluation for Light Water Reactors Using AREVA Codes and Methods," NRC12:023, dated April 27, 2012

ENCLOSURE 3

10 CFR 50.46 30-DAY AND ANNUAL REPORT FOR BROWNS FERRY NUCLEAR PLANT, UNIT 3

The Browns Ferry Nuclear Plant (BFN), Unit 3, core contains only the ATRIUM™-10 fuel design.

Description of Changes and Errors Relative to the Previous Report

The previous 10 CFR 50.46 report for BFN, Unit 3, was submitted on May 30, 2012 (Reference 1). This report cites References 2 and 3 as the Analysis of Record (AOR), with a baseline Peak Cladding Temperature (PCT) of 1992°F.

A modification to the Automatic Depressurization System (ADS) was completed during the Spring 2012 refueling outage, which restored the automatic initiation capability of the ADS in the event of a single failure. The PCT effect of this modification relative to the Reference 3 analysis was described in Reference 1. AREVA has prepared new Emergency Core Cooling System (ECCS)-Loss of Coolant Accident (LOCA) analyses to reflect the updated plant configuration (References 4 and 5). This letter establishes References 4 and 5 as the new ECCS-LOCA AOR for BFN Unit 3, with a baseline PCT of 1926°F. Reference 4 utilizes a modified version of AREVA's EXEM BWR-2000 methodology, which was approved by the NRC for application to BFN, Unit 3, in Reference 6. With the implementation of the changes to the BFN, Unit 3, Technical Specifications approved in Reference 6, the new baseline PCT values described above became effective on April 15, 2013.

On June 28, 2012, AREVA issued Reference 7, which notified the Tennessee Valley Authority (TVA) of two changes relative to the AOR in References 4 and 5. A summary of those changes is provided below:

- Reference 8 describes additional Core Spray line leakage for BFN, Unit 3. The leakage analysis indicated the core spray flow delivered inside the shroud is reduced by 136 gpm. The AREVA assessment of the BFN break spectrum calculations assumes a 150 gpm reduction in core spray. Based on an assessment of the BFN break spectrum calculations, Reference 7 reported that the effect of the 150 gpm additional leakage is 34°F.
- Reference 9 indicates that burnup degradation of fuel thermal conductivity over the approved burnup range was not supported by experimental data when older generation codes, like RODEX2, were approved. In recent evaluations of this phenomenon, it appears that the use of the RODEX2 code (which provides inputs to RELAX and HUXY in the LOCA analysis methodology) results in conservatively high temperatures at low burnup (less than 15 Giga-Watt Days per Metric Ton Uranium), but underpredicts pellet temperatures at higher exposures.

For BFN, Unit 3, the current analysis (Reference 5) shows that the limiting PCT occurs at beginning of life (BOL). As discussed in Reference 7, the effects of thermal conductivity degradation at higher burnups result in a zero degree change in the limiting PCT, which occurs at BOL. Therefore, there is no change in the reported PCT due to thermal conductivity degradation for BFN, Unit 3.

Table 1 details the accumulated PCT effect due to errors and changes in the ATRIUM™-10 LOCA analyses since References 4 and 5 were established as the AOR.

ENCLOSURE 3

**10 CFR 50.46 30-DAY AND ANNUAL REPORT
FOR
BROWNS FERRY NUCLEAR PLANT, UNIT 3**

Table 1: Cumulative Effect of PCT Changes - BFN, Unit 3	
Previously Reported Baseline PCT (References 2 and 3)	1992°F
Baseline PCT	1926°F
Increased core spray leakage from lower sectional replacement hardware modification analysis (Reference 7)	+ 34°F
Thermal Conductivity Degradation (Reference 7)	+ 0°F
Accumulated changes since baseline analysis	+ 34°F
New licensing PCT	1960°F
Absolute value of accumulated changes	34°F

ENCLOSURE 3

10 CFR 50.46 30-DAY AND ANNUAL REPORT FOR BROWNS FERRY NUCLEAR PLANT, UNIT 3

References

1. Letter from TVA to NRC, "10 CFR 50.46 30-Day Report for Browns Ferry Nuclear Plant, Unit 3," dated May 30, 2012
2. ANP-2908(P) Revision 0, "Browns Ferry Units 1, 2, and 3 105% OLTP LOCA Break Spectrum Analysis," AREVA NP Inc., March 2010
3. ANP-2910(P) Revision 1, "Browns Ferry Units 1, 2, and 3 105% OLTP LOCA-ECCS Analysis MAPLHGR Limit for ATRIUM™-10 Fuel," AREVA NP Inc., November 2010
4. ANP-3015(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA Break Spectrum Analysis, AREVA NP Inc.," dated September 2011.
5. ANP-3016(P) Revision 0, "Browns Ferry Units 1, 2, and 3 LOCA-ECCS MAPLHGR Limit for ATRIUM™-10 Fuel, AREVA NP Inc.," dated December 2011
6. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 2 and 3 - Issuance of Amendments Regarding Deletion of Low Pressure Coolant Injection Motor-Generator Sets for Browns Ferry Nuclear Plant, Units 2 and 3 (TAC Nos. ME9176 and ME9177)," dated February 15, 2013
7. FAB12-2249, "Transmittal of 10 CFR 50.46 PCT Error Reporting for Browns Ferry Units 1, 2, and 3," AREVA NP, June 28, 2012
8. SC 10-05, "Potential to Exceed Allowable Core Spray Leakage," 10 CFR 21 Communication, GE Hitachi, March 15, 2010
9. Letter from P. Salas (AREVA) to USNRC Document Control Desk (DCD), "Response to NRC Letter Regarding Nuclear Fuel Thermal Conductivity Degradation Evaluation for Light Water Reactors Using AREVA Codes and Methods," NRC12:023, dated April 27, 2012