Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

June 12, 2012

10 CFR 50.46
10 CFR 50.73

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

Browns Ferry Nuclear Plant, Units 2 and 3
Facility Operating License Nos. DPR-52 and DPR-68
NRC Docket Nos. 50-260 and 50-296

Subject: **Licensee Event Report 50-260/2012-001-00**

The enclosed Licensee Event Report provides details of Browns Ferry Nuclear Plant's failure to accurately maintain design control regarding single-failure assumptions for the Emergency Core Cooling System and to perform sufficiently bounding analyses to ensure that the calculated maximum fuel element cladding temperature of 2200 degrees Fahrenheit would not be exceeded in the event of a small break Loss of Coolant Accident. The Tennessee Valley Authority is submitting this report in accordance with 10 CFR 50.73(a)(2)(ii)(B), as any event or condition that results in the nuclear power plant being in an unanalyzed condition that significantly degraded plant safety, and 10 CFR 50.46(a)(3)(ii), the calculated maximum fuel element cladding temperature shall not exceed 2200 degrees Fahrenheit.

There are no new regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact J. E. Emens, Jr., Nuclear Site Licensing Manager, at (256) 729-2636.

Respectfully,

K. J. Polson
Vice President

Enclosure: Licensee Event Report 50-260/2012-001-00 – Browns Ferry Nuclear Plant, Units 2 and 3, Inappropriate LOCA Modeling of Core Spray for Limiting LOCA Event with Manual Actuation of Automatic Depressurization System

IE22
NRR

cc (w/ Enclosure):

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

ENCLOSURE

Browns Ferry Nuclear Plant
Units 2 and 3

Licensee Event Report 50-260/2012-001-00

Browns Ferry Nuclear Plant, Units 2 and 3, Inappropriate LOCA Modeling of Core Spray for Limiting LOCA Event with Manual Actuation of Automatic Depressurization System

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See Enclosed

NRC FORM 366 (10-2010) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 10/31/2013

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to FOIA/Privacy Section (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Browns Ferry Nuclear Plant (BFN), Unit 2	05000260	1 of 7

4. TITLE: Browns Ferry Nuclear Plant, Units 2 and 3, Inappropriate LOCA Modeling of Core Spray for Limiting LOCA Event with Manual Actuation of Automatic Depressurization System

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									BFN, Unit 3	05000296
04	13	2012	2012	- 001 -	00	06	12	2012	FACILITY NAME	DOCKET NUMBER

9. OPERATING MODE

1

10. POWER LEVEL

100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☒ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☒ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER *(Include Area Code)*
Mark Acker, Licensing Engineer	256-729-7533

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR
N/A	N/A	N/A

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On April 13, 2012, the Nuclear Regulatory Commission (NRC) notified Browns Ferry Nuclear Plant (BFN) of a NRC-identified non-cited violation. This violation was formally issued in the NRC Integrated Inspection Report for BFN, dated April 27, 2012. The violation was issued due to BFN's failure to accurately maintain design control regarding single-failure assumptions for the Emergency Core Cooling System (ECCS) and to perform sufficiently bounding analyses to ensure that the calculated maximum fuel element cladding temperature of 2200 degrees Fahrenheit would not be exceeded in the event of a small break Loss of Coolant Accident (LOCA). Due to this condition, there was a potential that the Peak Clad Temperature limit of fuel rods in BFN, Units 2 and 3, could have been exceeded starting March 30, 2004 for BFN Unit 3 and April 16, 2005 for BFN, Unit 2 and ending May 20, 2011.

The cause of this condition was sufficient barriers were not in place to require the appropriate reviews for design document control associated with ECCS availability in a LOCA scenario.

Corrective actions are established to correct the flawed barriers to prevent this condition.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Browns Ferry Nuclear Plant, Unit 2	05000260	2012	-- 001	-- 00	2 of 7

NARRATIVE

I. PLANT CONDITION(S)

At the time of discovery, Browns Ferry Nuclear Plant (BFN), Unit 2, was in Mode 1 at approximately 100 percent rated thermal power and BFN, Unit 3, was in Mode 5 for a scheduled refueling outage.

II. DESCRIPTION OF EVENT

A. Event:

On April 13, 2012, the Nuclear Regulatory Commission (NRC) notified BFN of a NRC-identified non-cited violation. This violation was formally issued in the NRC Integrated Inspection Report for BFN, dated April 27, 2012.

This violation was issued due to BFN's failure to accurately maintain design control regarding single-failure assumptions for the Emergency Core Cooling System (ECCS) [BJ][BO][BM][SB] and perform sufficiently bounding analyses to ensure that the calculated maximum fuel element cladding temperature of 2200 degrees Fahrenheit (F) would not be exceeded in the event of a small break Loss of Coolant Accident (LOCA).

On January 5, 2010, it was discovered that a single failure vulnerability of the Automatic Depressurization System (ADS) [SB] existed on all three BFN Units. Upon discovery of this issue, the BFN LOCA analysis was revised to reflect a manual actuation of ADS 10 minutes into the event. This revised analysis was used as the LOCA basis for BFN, Units 2 and 3, from April 8, 2010 until May 20, 2011, at which time the NRC raised concerns related to the appropriateness of the application of credit for spray cooling with the manual actuation of ADS.

The NRC concluded that the application of credit for spray cooling was inappropriate for the limiting LOCA event with manual ADS actuation and subsequent event behavior. As a result, an operability assessment was developed, which modeled the limiting LOCA event with a 10 minute manual actuation of ADS, coupled with a modified treatment of spray cooling. The combination of the delayed ADS and the modified spray cooling treatment resulted in a Peak Clad Temperature (PCT) in excess of 2200 degrees F, which was calculated to have violated the limit in 10 CFR 50.46(a)(3)(ii). The operability assessment provided thermal limit penalties as a compensatory action to ensure the PCT limit would not be violated.

However, these thermal limit penalties were not in place for BFN, Units 2 and 3, during the period from April 8, 2010 to May 20, 2011. The thermal limits used during that time would not have protected the PCT limit. This is true not just from the point of discovery of the ADS single failure vulnerability, but for a time period going back to the first introduction of AREVA fuel to BFN in BFN, Unit 3, Cycle 12, March 30, 2004.

B. Inoperable Structures, Components, or Systems that Contributed to the Event:

There were no inoperable structures, components, or systems that contributed to this event.

C. Dates and Approximate Times of Major Occurrences:

March 30, 2004	AREVA fuel loaded into BFN, Unit 3. AREVA LOCA analysis becomes the analysis of record for BFN, Unit 3
April 16, 2005	AREVA fuel loaded into BFN, Unit 2. AREVA LOCA analysis becomes the analysis of record for BFN, Unit 2.
January 5, 2010	Discovered single failure vulnerability of the ADS for all three BFN Units.
April 8, 2010	LOCA analyses revised to reflect manual actuation of ADS.
May 20, 2011	NRC concluded that the application of credit for spray cooling was inappropriate for the limiting LOCA event with manual actuation of ADS and the subsequent event behavior. Thermal limit penalties implemented as a compensatory action.
April 13, 2012	NRC notified BFN of a NRC-identified non-cited violation resulting from 10 CFR 50.46(a)(3)(ii) non-compliance.
April 27, 2012	Violation for failure to ensure ECCS design calculation does not exceed Maximum Clad Temperature formally issued in NRC Integrated Inspection Report for BFN.

D. Other Systems or Secondary Functions Affected

There were no other systems or secondary functions affected.

E. Method of Discovery

The issue was identified by the NRC.

F. Operator Actions

There were no operator actions.

G. Safety System Responses

There were no safety system responses.

NARRATIVE

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause of this issue was the inappropriate application of spray cooling for the limiting LOCA event, with a 10 minute delay for manual actuation of ADS.

B. Root Cause

The cause of this condition was sufficient barriers were not in place to require the appropriate reviews for design document control associated with ECCS availability in a LOCA scenario. Inadequate review of the AREVA LOCA analysis was based on reliance upon information in the Updated Final Safety Analysis Report (UFSAR) and the fact that the AREVA LOCA evaluation methodology is an NRC-approved method. Based on the barriers in place, the reviewer would not have considered that the single failure scenarios listed in the UFSAR were incomplete or that the previously applied NRC-approved LOCA evaluation model may not be applicable to the specific BFN plant configuration.

C. Contributing Factors

A contributing factor to this condition developed when issues previously identified by the NRC, and communicated to TVA, related to the application of credit for spray cooling in the AREVA LOCA evaluation methodology were not entered into TVA's corrective action system. Thus, when the new LOCA analysis was performed to address the ADS single failure vulnerability, the NRC's concerns regarding this aspect of the methodology were not taken into account. Current Licensing procedures did not classify this issue as significant or require it to be addressed within the corrective action program. To address this issue, procedures are being updated and BFN and Corporate Nuclear Power Group supervision and management personnel will be trained on the significance and importance of compliance with regulations.

IV. ANALYSIS OF THE EVENT

TVA is submitting this report in accordance with 10 CFR 50.73(a)(2)(ii)(B), as any event or condition that results in the nuclear power plant being in an unanalyzed condition that significantly degraded plant safety, and 10 CFR 50.46(a)(3)(ii), the calculated maximum fuel element cladding temperature shall not exceed 2200 degrees F.

This event is the result of BFN's failure to accurately maintain design control regarding single-failure assumptions for the ECCS and to perform a sufficiently bounding analysis to ensure that the calculated maximum fuel element cladding temperature of 2200 degrees F would not be exceeded in the event of a small break LOCA.

Based on the information available in the UFSAR, it was reasonable for TVA and AREVA reviewers to assume that the stated equipment availability for a battery [BTRY] failure applied to all battery failure scenarios, rather than only the scenario determined to be limiting for the GE (fuel vendor prior to AREVA) analysis. A table was copied essentially verbatim from the GE analysis by TVA personnel and placed in Table 6.5-3 of the

NARRATIVE

UFSAR. TVA engineering personnel failed to recognize that the change to the UFSAR table made the single failures listed specific to one fuel vendor's methodology, and that the other battery failure scenarios would need to be reconsidered if another fuel vendor's methodology was applied. Specifically, the 250 Volt (V) Direct Current (DC) Board B failure, which resulted in failure of the ADS, was not included in the table. Thus, the failure to include the ADS single failure vulnerability in the initial AREVA LOCA analyses can be attributed to inadequate technical rigor in the UFSAR update related to ECCS availability for a LOCA scenario.

Once the issue was identified, the failure to provide a sufficiently bounding LOCA analysis allowed the continued potential for the PCT to be exceeded. The AREVA LOCA analysis states, Boiling Water Reactor (BWR) small break LOCA phenomena will differ from large break LOCA behavior because ADS operation is needed to reduce the reactor system pressure and achieve maximum ECCS delivery. This implies that the performance of the model for small break LOCAs is dependent upon the automatic ADS. A careful review of the AREVA LOCA analysis methodology might have led TVA to further scrutinize the application of the methodology for a small-break LOCA without automatic ADS.

The ADS single failure vulnerability combined with the flawed AREVA LOCA analysis created the potential for the PCT to exceed the PCT limit of 2200 degrees F starting March 30, 2004 for BFN Unit 3 and April 16, 2005 for BFN, Unit 2 and ending May 20, 2011. Once the issue was identified, the failure to provide a sufficiently bounding LOCA analysis allowed the condition to continue from April 8, 2010 until May 20, 2011.

Extent of Condition

The design control issue affects all three BFN Units. Based on the extent of condition review, no other evaluations or analyses were identified that assumed ADS to be single failure proof and no other types of equipment or processes were identified that required review. TVA personnel have also validated all other parameters and single failure assumptions provided to the fuel vendors (GE and AREVA) for the LOCA and transient analyses that those vendors perform. No deficiencies were identified.

The failure to provide a sufficiently bounding analysis affects the small break LOCA analysis for AREVA fuel in BFN, Units 2 and 3. BFN, Unit 1, is not affected, as it does not currently contain any fuel manufactured by AREVA, and therefore does not include the affected analysis in its current licensing basis. The BFN, Unit 1, license amendment to transition to AREVA fuel was issued on April 27, 2012, and included NRC approval of revised LOCA analyses that did not credit application of spray cooling.

The non-conservatism is confined to EXEM BWR-2000 LOCA analysis methodology. This methodology is not used to analyze any other plant operating modes, events, or accidents.

V. ASSESSMENT OF SAFETY CONSEQUENCES

TVA performed an evaluation of operating history between January 1, 2008, and May 31, 2011, to determine the most limiting MAPLHGR experienced by BFN, Units 2

and 3, during that time frame (i.e., 11.35 kW/ft, equivalent to a Maximum Average Planar Ratio (MAPRAT) value of 0.908). AREVA performed a LOCA assessment using the limiting MAPLHGR value from the operating history evaluation, a Minimum Critical Power Ratio (MCPR) operating limit of 1.45, a conservative top-peaked power shape, and no credit for spray cooling. Statepoints were also identified in BFN, Unit 3, Cycle 13, and BFN, Unit 3, Cycle 14, that had MCPR values less than 1.45. For these cases, the limiting MAPRAT values were determined (i.e., 0.812 for BFN, Unit 3, Cycle 13, and 0.846 for BFN, Unit 3, Cycle 14). AREVA performed a LOCA assessment using the limiting MAPRAT values and a MCPR operating limit of 1.40 using the same approach as described above.

Based on the evaluations and assessments, it is not expected that past operation of BFN, Units 2 and 3, would have resulted in a PCT greater than 2200 degrees F for the limiting small break LOCA. In addition, it is not expected that the maximum peak cladding oxidation and core wide metal water reaction would have exceeded the limits of 10 CFR 50.46.

Therefore, this condition is of low safety significance and posed little risk to public health and safety.

VI. CORRECTIVE ACTIONS - The corrective actions are being managed by TVA's corrective action program.

A. Immediate Corrective Actions

1) After the discovery of the failure of the LOCA analysis to consider the single failure vulnerability of ADS (PER 213060), GE and AREVA supplied revised LOCA analysis to match the plant configuration. A Functional Evaluation (FE) was performed and imposed thermal limit penalties on all three BFN Units.

2) After the NRC raised concerns related to the appropriateness of the application of credit for spray cooling with the manual actuation of ADS in the AREVA LOCA analyses (PERs 372764 and 527811), FEs were performed to revise the imposed thermal limits on BFN, Units 2 and 3. Actions are currently in place (PER 527811) to ensure the BFN, Units 2 and 3, revised LOCA analyses are submitted to the NRC for approval as the analysis of record.

B. Corrective Actions

1) Revise the licensing procedure regarding the TVA interface with the NRC to include guidance for addressing significant regulatory issues using the corrective action program.
2) Revise Nuclear Fuel procedures to require a review of all relevant Licensing Topical Reports and their associated NRC Safety Evaluation Reports prior to their application for analyses at any TVA site.
3) Revise the BFN UFSAR Division of Responsibility such that Nuclear Safety Analysis is the lead organization for all sections related to ECCS and LOCA analyses.

4) Revised TVA procurement procedures to ensure vendor analyses work utilized correct input and the vendor's work had proper TVA reviews.
5) Develop and deliver a presentation to communicate the lessons learned from the Root Cause Analysis on PER 369800, "Undetected Failure of 1-FCV-74-66," including the significance and importance of compliance with regulations, to BFN and Corporate Nuclear Power Group supervision and management personnel.
6) Actions (PER 213060) are in place to implement design changes to each BFN Unit to remove the single failure vulnerability of ADS. The ADS design change was implemented on the BFN, Unit 3, ADS during the recent refueling outage (U3R15).

VII. ADDITIONAL INFORMATION

A. Failed Components

There were no failed components.

B. Previous Similar Events

A search of BFN LERs for Units 1, 2, and 3, for approximately the past five years did not identify any similar events.

A search was performed on the BFN corrective action program. Similar PERs include 40564, 54163, and 53676. Issues related to this condition are detailed in PERs 213060, 372764, 504005, and 527811.

C. Additional Information

The corrective action document for this report is PER 539468.

D. Safety System Functional Failure Consideration:

In accordance with NEI 99-02, this issue is not considered a safety system functional failure.

E. Scram With Complications Consideration:

This condition did not include a reactor scram.

VIII. COMMITMENTS

There are no commitments.