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

August 31, 2010

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Unit 3
Facility Operating License No. DPR-68
NRC Docket No. 50-296

Subject: **Licensee Event Report 50-296/2009-003 - Revision 2**

On May 24, 2010, The Tennessee Valley Authority (TVA) submitted Revision 0 to Licensee Event Report (LER) 50-296/2009-003 which contained a commitment to provide additional details of the condition prohibited by Technical Specifications involving an inoperable Reactor Core Isolation Cooling System. Revision 1 to the LER was submitted July 15, 2010, and indicated a supplemental report was expected. TVA is providing the enclosed LER revision which contains an expanded timeline and additional data from high speed data sources.

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

Respectfully,

K. J. Polson
Vice President

Enclosure: Licensee Event Report - Reactor Core Isolation Cooling System Inoperable Longer Than Allowed By the Technical Specifications
cc (w/ Enclosure):

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

IE22
NRR

Enclosure

Browns Ferry Nuclear Plant
Unit 3

Licensee Event Report
Reactor Core Isolation Cooling System Inoperable Longer Than Allowed By The Technical Specifications

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SEE ATTACHED

NRC FORM 366 (9-2007) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 08/31/2010

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 the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@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 Unit 3	05000296	1 of 7

4. TITLE: Reactor Core Isolation Cooling System Inoperable Longer Than Allowed By the Technical Specifications

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
									N/A	N/A
08	26	2009	2009	003	02	08	31	2010	FACILITY NAME N/A	DOCKET NUMBER N/A

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

NAME	TELEPHONE NUMBER *(Include Area Code)*
Steve Austin, Licensing Engineer	256-729-2070

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
NA	NA	NA

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

On February 13, 2007, and again on August 26, 2009, during post scram reviews, Browns Ferry Nuclear Plant personnel identified an unexpected level of instability in the Reactor Core Isolation Cooling (RCIC) system flow and turbine response following reactor scrams that occurred on February 9, 2007, and on August 24, 2009. Following each event, site engineering personnel reviewed the RCIC response and concluded the RCIC system was capable of performing its design function and determined that RCIC was operable. On February 12, 2007, and again on August 26, 2009, the unit entered Mode 2, commencing startup operations. Following the second event on August 24, 2009, Unit 3 was returned to service and remained at power until September 12, 2009, when Unit 3 was removed from service for scheduled maintenance activities. During the September outage the RCIC Electric Governor-Remote (EG-R) was replaced and successfully tested. On March 25, 2010, in response to questions from the Nuclear Regulatory Commission (NRC), the Tennessee Valley Authority (TVA) notified the NRC via conference telephone call that Unit 3 RCIC was inoperable since March 22, 2006, after the EG-R had been installed and when Unit 3 exceeded 150 psig while in Mode 2. This reflected RCIC inoperability longer than allowed by Technical Specification 3.5.3 and mode changes not allowed by LCO 3.0.4. A failure analysis determined the oscillations were caused by a missing buffer piston and springs within the EG-R. BFN personnel replaced the Unit 3 RCIC system EG-R hydraulic actuator on September 14, 2009.

I. PLANT CONDITION(S)

At the time TVA determined RCIC had been previously inoperable, Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3 were at approximately 100 percent power.

II. DESCRIPTION OF EVENT

A. Event:

On March 14, 2006, during Unit 3 refueling outage 12, BFN installed a replacement Electric Governor-Remote (EG-R) on the Reactor Core Isolation Cooling (RCIC) [BM] system as a scheduled preventative maintenance activity. Post maintenance surveillance testing was satisfactorily completed. On March 22, 2006, Unit 3 exceeded 150 psig while in Mode 2 commencing restart operations.

On February 9, 2007, Unit 3 received an automatic reactor scram from 100 percent power following a loss of condensate flow. RCIC auto initiated and injected into the reactor vessel in response to the low water level resulting from the loss in condensate flow. On February 12, 2007, Operations personnel commenced restart operations with Unit 3 entering Mode 2. Specific details on the reactor scram can be found in LER 50-296/2007-001, Reactor Scram due to Low Reactor Water Level Caused by Loss of Feedwater, submitted to the Nuclear Regulatory Commission (NRC) on April 10, 2007.

On February 13, 2007, a post scram review of the RCIC operating parameters revealed the unexpected level of instability in the system flow and turbine control system response that was experienced on February 9, 2007. During the injection sequence RCIC system flow oscillated between approximately 300 and 900 gpm. However, because the RCIC system only operated approximately 2 minutes and automatically shut down when the reactor pressure vessel high water was attained, the instability was not noted by the Operations crew and therefore, no review of the system response was conducted prior to the startup of Unit 3. On February 15, 2007, a functional evaluation concluded that the RCIC system was operable and capable of performing its design function.

On March 18, 2008, BFN entered Unit 3 refueling outage 13. On May 15, 2008, following the completion of outage activities, Operations commenced restart activities for Unit 3 Cycle 14 operation, entering Mode 2.

On August 24, 2009, Unit 3 was manually scrammed from 100 percent power due to the lowering of the water level in the reactor pressure vessel. Following the manual reactor scram, RCIC auto initiated and injected into the reactor vessel. On August 26, 2009, Operations personnel, commenced startup operations, with Unit 3 entering Mode 2. Unit 3 was returned to service on August 28, 2009, and remained at power until September 12, 2009. Specific details of the Unit 3 manual reactor scram can be found in Licensee Event Report 50-296/2009-001, Reactor Scram Due to Loss of Condensate Booster Pumps, submitted to the NRC on October 23, 2009.

On August 26, 2009, as part of a post scram review and prior to restart, site engineering personnel again identified an unexpected level of instability in the RCIC system flow and turbine response. During the injection sequence, the RCIC system flow oscillated between approximately 230 and 970 gallons per minute (gpm). A functional evaluation dated

August 26, 2009, concluded that the RCIC system was capable of performing its design function and, thus, it was determined the RCIC system was operable.

Following each event, BFN Engineering personnel evaluated the RCIC system response and concluded the RCIC system was capable of performing its design function and determined that the RCIC system was operable.

On September 12, 2009, BFN Unit 3 was removed from service for scheduled maintenance activities not associated with the RCIC system. During the September maintenance outage the RCIC Electric Governor-Remote (EG-R) was replaced and successfully tested. A failure analysis of the removed EG-R determined the oscillations were caused by a missing buffer piston and springs within the EG-R.

On March 25, 2010, in response to questions from the NRC, the Tennessee Valley Authority (TVA) notified the NRC via conference telephone call that the RCIC system was inoperable since Unit 3 exceeded 150 psig while in Mode 2 on March 22, 2006, based on reevaluation of the impact of the non-conforming EG-R. Technical Specification (TS) 3.5.3 requires that the RCIC pump develop a flow rate greater than or equal to 600 gpm against a system head corresponding to reactor pressure. A determination of operability with respect to the applicable TS requirements could not be concluded as a result of the observed instability.

TVA has determined the RCIC system was inoperable from March 22, 2006, after the defective EG-R was installed on the RCIC system through September 12, 2009, when Unit 3 was shut down and the defective EG-R was replaced.

TVA is submitting this report in accordance with 10 CFR 50.73(a)(2)(i)(B), as an operation or condition prohibited by the plant's Technical Specifications.

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

None

C. Dates and Approximate Times of Major Occurrences:

March 14, 2006	BFN installs replacement EG-R and it is successfully tested.
March 22, 2006	Unit 3 enters Mode 2, commencing restart activities.
February 9, 2007	Unit 3 received an automatic reactor scram. RCIC pump starts and injects into the reactor vessel on low water level.
February 12, 2007	Unit 3 Enters Mode 2, commencing restart activities.
February 13, 2007	BFN personnel noted an unexpected level of instability during reactor pressure vessel (RPV) injection on February 9, 2007.
March 18 thru May 15, 2008	BFN conducts Unit 3 Refueling Outage 13.
August 24, 2009	Unit 3 Operations personnel insert a manual scram on Unit 3. RCIC pump starts and injects into the reactor vessel on low water level.

August 26, 2009	BFN personnel noted an unexpected level of instability during RPV RCIC injection on August 24, 2009.
August 26, 2009	BFN Operations personnel commence restart activities on Unit 3. Place the mode switch in Startup position.
September 2009	RCIC EG-R replaced and the RCIC system successfully tested.
March 25, 2010	TVA informs NRC that RCIC was inoperable longer than allowed by TS.

D. Other Systems or Secondary Functions Affected

None

E. Method of Discovery

BFN personnel noted the instability in RCIC system operation during post scram reviews of the RCIC system operating parameters.

F. Operator Actions

None

G. Safety System Responses

None

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause for the inoperable RCIC pump was the EG-R actuator non-conformance and the resulting reduced stability of the RCIC governor control system during RPV injection. The EG-R was absent critical parts that would keep the RCIC pump from oscillating during RPV injection.

B. Root Cause

A failure analysis performed by Engine Systems Incorporated determined the oscillations seen during RPV injection were caused by a missing buffer piston and springs within the EG-R. However the missing parts did not affect stable operation during the periodic surveillance testing, and therefore, inoperability was not detectable by routine surveillance testing of the RCIC system. TVA postulates that these parts were omitted either during the original manufacturing or during repair of the EG-R unit by Woodward Governor.

C. Contributing Factors

None

IV. ANALYSIS OF THE EVENT

On February 9, 2007, and again on August 24, 2009, following the Unit 3 reactor scram the RCIC system, along with the High Pressure Coolant Injection [BJ] (HPCI) system, auto-initiated and

injected into the RPV restoring water level. Both the HPCI and the RCIC systems auto-stopped as expected on high RPV water level.

Subsequent review of the RCIC System operating flow parameters for both scrams revealed an unexpected level of instability in the RCIC system flow and turbine control system response. In both cases, the instability was not noted by the BFN Operations personnel in the main control room due to the short time the system operated (approximately 2.0 and 2.5 minutes respectively). With regard to the oscillations that occurred on February 13, 2007, a review of RCIC system operation was not conducted prior to Unit 3 restart.

The following discussion is specific to the August 24, 2009 event; however, the data is consistent with data from the event that occurred on February 9, 2007. During the injection event on August 24, 2009, flow data obtained from a high resolution source (100 samples per second from the plant Integrated Computer System (ICS) [ID]) indicated RCIC pump output flow was oscillating between 230 gpm and 970 gpm. A least-squares fit analysis of this event indicated that the RCIC system was providing an average flow rate of approximately 620 gpm.

The highest recorded speed of the turbine was 4610 rpm which is well below the over-speed setpoint of 5625 RPM. Therefore, while the turbine speed was oscillating, the turbine did not approach the over-speed setpoint.

Another flow rate estimate was performed using a flow totalization method. The evaluation used high speed data (Dataware Program) to estimate the total injection during the 2 minute 29 second time period. The total volume obtained was 1573 gallons, which corresponded to 630 gpm during the injection period. A similar flow totalization estimate was performed using high resolution Integrated Computer System data. This estimate calculated an average flow rate of approximately 623 gpm during the injection period.

Normal RCIC system flow testing is performed taking suction from the condensate header and discharging back to the Condensate Storage Tank. During the RCIC system testing activities, perturbations are introduced into the control system by operating the system with the flow controller in the manual mode and then placing the controller in the automatic mode with a flow setpoint different than the existing system flow rate. This method limits the severity of the perturbation. Additionally, due to the hydraulic difference between the Condensate Storage Tank to Condensate Storage Tank mode of operation and injection into a pressurized RPV, the instability on the Unit 3 governor control system during RPV injection was not detected until the RPV injection occurred.

V. ASSESSMENT OF SAFETY CONSEQUENCES

The safety consequences of this event were not significant.

The applicability statement for BFN TS Limiting Condition for Operation 3.5.3 requires the RCIC system be operable when the reactor is in Mode 1 and in Modes 2 and 3 with the reactor dome pressure greater than 150 psig. TS 3.5.3 Condition A and Required Actions A.1 and A.2 require immediate verification by administrative means that the High Pressure Coolant Injection System (HPCI) is operable and restoration of the RCIC system to operable status in 14 days. These Required Actions were not met. The HPCI system was inoperable during the time that the RCIC system was inoperable for short periods which are discussed below. BFN also performed reactor Mode changes with the RCIC system inoperable.

- On November 30, 2007, between 1052 and 1445 hours Central Standard Time (CST), during a controlled reactor shutdown, Unit 3 HPCI system was declared inoperable when a steam leak on a HPCI system condensate inboard drain valve increased. Details on the HPCI system inoperability can be found in LER 50-296/2007-004, Manual Isolation of High Pressure Coolant Injection Due to a Steam Leak, submitted to the NRC on January 28, 2008.
- On July 24, 2007, at 1645 hours, Central Daylight Time (CDT), the Unit 3 HPCI system was declared inoperable when the Division II Emergency Core Cooling Systems [AD] Analog Trip Unit failed due to a cleared fuse. On July 25, 2007, at approximately 0018 CDT hours the HPCI system was declared operable. Details on the HPCI system inoperability can be found in LER 50-296/2007-002, Unplanned Inoperability of the Unit 3 High Pressure Coolant Injection System Due to Loss of 120 V-AC Instrument Power, submitted to the NRC on September 24, 2007.
- There was approximately 6.58 hours of Maintenance Rule unplanned unavailability for the HPCI system during the period from March of 2006 thru September of 2009. Additional planned unavailability of the HPCI system occurred during the performance of surveillance tests and other maintenance activities. However, these instances would typically be less than a shift in duration.

To be considered operable in accordance with the applicable Technical Specification requirements, the RCIC system is assumed to deliver a minimum of 600 gpm to the RPV. Although the RCIC system was inoperable, during the period discussed in this LER, it was functional. That is, the RCIC system was capable of starting and injecting into the RPV delivering an average flow rate greater than or equal to 600 gpm to the RPV. During the RPV injection on February 9, 2007, and again on August 24, 2009, the RCIC system along with the HPCI system injected for approximately 2.0 and 2.5 minutes and injected an average of approximately 620 gpm for the period. For long term operation such as maintaining water level with the RPV isolated, Operating Instruction, 3-OI-71, "Reactor Core Isolation Cooling System," provides instructions for operating the RCIC system in a manual mode upon malfunction of the flow controller. Therefore, TVA concludes that there was no significant reduction in the health and safety of the public by this event.

VI. CORRECTIVE ACTIONS

A. Immediate Corrective Actions

On September 14, 2009, BFN replaced the Unit 3 RCIC system EG-R hydraulic actuator. Following the replacement of the Unit 3 RCIC system EG-R hydraulic actuator, a RPV injection test was conducted on September 21, 2009. The hydraulic actuator exhibited stable RCIC turbine speed and flow during the RPV injection. The hydraulic actuator that was in place during the period was sent to the vendor for failure analysis and refurbishment.

B. Corrective Actions to Prevent Recurrence

TVA relies on the vendor, Engine Systems Inc. (ESI) to provide a fully dedicated EG-R for use at BFN. Implementation of the vendor's Appendix B Quality Assurance Program is expected to provide TVA with a fully dedicated EG-R and prevent the recurrence of this event.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A) (17)*

The current vendor used by TVA for dedication of the EG-R, ESI, is not the vendor that dedicated failed the EG-R for use at BFN.

ESI stated that they have serviced and or sold more than 50 EG-Rs with the majority being used in being used in safety related nuclear applications. All new governors and or actuators are subject to retesting while at ESI using the same test specifications as the manufacturer. All of the test specifications have steps that assure proper operation of the compensation system. If the test sheets are followed as written this issue would have been found.

In addition ESI stated, to date, no other EG-Rs have been found without the subject parts being installed (either new or those returned for rebuild) which would lead one to conclude that this was an isolated incident.

VII. ADDITIONAL INFORMATION

A. Failed Components

None

B. PREVIOUS LERS ON SIMILAR EVENTS

None

C. Additional Information

Corrective action document for this report is Problem Evaluation Reports 200183 and 119628.

D. Safety System Functional Failure Consideration:

This event is not classified as a safety system functional failure according to NEI 99-02.

E. Scram With Complications Consideration:

This LER does not describe a complicated scram according to NEI 99-02.

VIII. COMMITMENTS

None