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

November 20, 2009

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Unit 2
Facility Operating License No. DPR-52
NRC Docket No. 50-260

Subject: **Licensee Event Report 50-260/2009-007, "Manual Scram During Removal of a Reactor Feedwater Pump from Service"**

The submittal provides Licensee Event Report (LER) 260/2009-007. The LER provides the details of a manual reactor scram that was inserted during work activities associated with removing a reactor feedwater pump from service. TVA is reporting this occurrence in accordance with 10 CFR 50.73(a)(2)(iv)(A).

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

Respectfully,

R. G. West
Vice President

Enclosure
cc (Enclosure):

NRC Regional Administrator - Region II

NRC Senior Resident Inspector - Browns Ferry Nuclear Plant

IE22
NRR

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
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4. TITLE: Manual Scram During Removal of a Reactor Feedwater Pump from Service

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
									None	N/A
09	29	2009	2009	- 007 -	00	11	20	2009	FACILITY NAME: None	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)*
B. C. Morris, Licensing Engineer	256-729-7909

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

ABSTRACT

At 2321 hours on September 29, 2009, with Unit 2 at 100 percent power, operators were in the process of removing reactor feedwater pump 2B from service for scheduled maintenance. At the time, condensate pump 2B and condensate booster pump 2C had been previously removed from service for maintenance. When feedwater pump 2B speed was lowered to where flow was below the minimum flow setpoint, the pump 2B minimum flow valve automatically opened. This action increased total condensate flow, which lowered feedwater and condensate booster pump suction pressures. Feedwater pump 2A and condensate booster pump 2A subsequently tripped on low pump suction pressure signals. Feedwater pump 2C automatically increased speed to maintain reactor vessel level and tripped on overspeed. Operators manually scrammed the reactor due to decreasing vessel water level. Decreasing vessel level also resulted in the auto-initiation of High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC). HPCI successfully started and in combination with feedwater pump 2B restored water level to normal. RCIC started, but failed to achieve sufficient speed to inject. A separate LER is being submitted on the RCIC malfunction.

The event investigation determined that the operating instructions for removing a feedwater pump from service were inadequate for the operating configuration (with less than a full complement of condensate and condensate booster pumps in operation). The subject operating instructions have been revised to require that feedwater flow be below that needed for 85 percent power prior to removing a feedwater pump from service if a condensate/condensate booster pump is not in service. A new tool for assessing the risk of online activities was implemented. The risk review process for performing online feedwater/condensate system maintenance is also being reviewed.

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME)	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
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NARRATIVE

I. PLANT CONDITION(S)

Prior to the event, Unit 2 was in Mode 1 operating at 100 percent power. Units 1 and 3 were also at 100 percent power. Units 1 and 3 were unaffected by this event.

II. DESCRIPTION OF EVENT

A. Event:

On September 29, 2009, with Unit 2 at 100 percent power, control room operators were in the process of removing reactor feedwater [SJ] pump 2B from operation for scheduled maintenance. As feedwater pump 2B was being removed from service, reactor feedwater pump 2A and condensate [SD] booster pump 2A tripped on low suction pressure followed by the trip of reactor feedwater pump 2C on overspeed. As a result, reactor vessel water level began to decrease and the reactor operator manually scrammed the reactor at +15 inches. As reactor water level further decreased, the High Pressure Coolant Injection (HPCI) system [BG] and the Reactor Core Isolation Cooling (RCIC) system [BN] initiated on Reactor Vessel Low Low, Level 2 (-45 inches). HPCI and feedwater pump 2B operation restored reactor water level to normal within approximately 45 seconds after the scram.

Safety systems responded as expected. RCIC started but failed to successfully inject. Details of the RCIC problem will be provided in LER 050-260/2009-008.

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

One condensate pump and one condensate booster pump were out-of-service for scheduled maintenance at the time of the event.

C. Dates and Approximate Times of Major Occurrences:

September 29, 2009 at 2321 hours	Activities were in progress to remove reactor feedwater pump 2B from service.
2321 hours	As pump 2B speed was lowered, the pump's minimum flow valve opened, which increased total condensate flow.
2321 hours	Feedwater pump 2A tripped on low suction pressure.
2322 hours	Condensate booster pump 2A tripped on low suction pressure soon followed by the trip of feedwater pump 2C on overspeed.
2323 hours	Unit operator manually scrammed the reactor due to decreasing vessel water level at +15 inches.
2323 hours	Reactor water level decreased to -45 inches, which is the HPCI and RCIC initiation point.
2323 hours	HPCI successfully started and injected. RCIC started but failed to inject.
2324	Reactor water level was returned to normal by operation of HPCI and reactor feedwater pump 2B.

NARRATIVE

D. Other Systems or Secondary Functions Affected

None.

E. Method of Discovery

Operators observed low pump suction pressure alarms, pump trips, and decreasing reactor vessel water level.

F. Operator Actions

Operator actions in response to the scram were in accordance with applicable operating procedures.

G. Safety System Responses

Safety systems operated as designed. The RCIC system, although not a safety system, did not operate as designed.

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause of the event was the successive trips of reactor feedwater pump 2A, condensate booster pump 2A, and reactor feedwater pump 2C.

B. Root Cause

The cause investigation determined that the condensate/feedwater system operating instructions had been previously revised to allow operation at 100 percent power in a reduced pump configuration. The basis for the procedure change was the misapplication of a steady-state hydraulic design calculation.

C. Contributing Factors

The risk review process did not adequately identify the aggregate risk (reduction in operating margin) of removing a reactor feedpump from service with other condensate system pumps out-of-service.

IV. ANALYSIS OF THE EVENT

There are three pairs of electric condensate and condensate booster pumps, which provide flow and pressure head to the three steam driven reactor feedwater pumps on each BFN unit. During normal operation, all nine pumps are in service. On Units 1 and 2 the original pumps have been replaced with larger capacity pumps to support extended power uprate (EPU) operation.

Prior to this event, condensate pumps 2A and 2C, condensate booster pumps 2A and 2B, and all three reactor feedwater pumps were operating. Condensate pump 2B and condensate booster pump 2C had been previously removed from service for scheduled maintenance. At 2321 hours, operators were in process of reducing speed and flow on feedwater pump 2B to take it off line for scheduled maintenance. As feedwater pump 2B speed was being lowered, reactor feedwater pumps 2A and 2C automatically increased speed and flow to maintain rated feedwater flow to the reactor. When the speed of feedwater pump 2B was lowered to where pump flow was below the minimum flow setpoint, feedwater pump 2B minimum flow valve automatically opened, which opened a flow path back to the condenser. This resulted in increasing total condensate flow, which reduced the head pressure being supplied to the operating reactor feedwater pumps and condensate booster pumps.

NARRATIVE

This was directly evidenced by the receipt of low pump suction pressure alarms. The low header pressure also initiated the low pump suction pressure trip logic that provides trips to the feedwater pumps and condensate booster pumps after staggered time delays.

Operators attempted to recover suction head by manually increasing the speed of feedwater pump 2B, which would cause the 2B minimum flow valve to reclose, and by decreasing reactor power by reducing recirculation pump speed. However, the low pump suction pressure trip logic timed out and feedwater pump 2A and condensate booster pump 2A tripped. Feedwater pump 2C attempted to maintain reactor water level and tripped on overspeed shortly after booster pump 2A tripped.

With decreasing reactor vessel water level, operators manually scrammed the reactor at approximately +15 inches above instrument zero on the normal operating range water level instrumentation. The automatic scram setpoint on reactor water level is at +2 inches. As reactor water level continued to decrease because of the feedwater pump trips and due to the prompt water level decrease from the scram, the HPCI and RCIC systems auto-initiated on Reactor Vessel Low Low, Level 2 (-45 inches). HPCI and feedwater pump 2B operation restored reactor water level to normal within approximately 45 seconds after the scram. RCIC started, but failed to achieve sufficient speed and discharge pressure to inject.

The post-event evaluation determined that the reactor control systems and feedwater/condensate systems responded as would be expected for the circumstances.

The cause investigation determined that the condensate/feedwater system operating instructions had been previously revised to allow plant operation at 100 percent power in a reduced pump configuration status (with a condensate, a condensate booster pump, and a feedwater pump out-of-service). The basis for the procedure change was a misapplication of a hydraulic flow calculation performed for EPU. The EPU calculation was a steady-state analysis that showed 100 percent power could be achieved with the reduced pump configuration; however, the calculation did not address the transient effects of establishing the reduced pump configuration. In this case, the revised operating instructions did not account for the additional condensate system flow expected when a feedwater pump minimum flow valve opens. The cause investigation also determined that risk review process for conducting online feedwater/condensate system maintenance did not adequately identify the risk (reduction in operating margin) associated with removing a feedwater pump from service for maintenance with other condensate system pumps out-of-service.

V. ASSESSMENT OF SAFETY CONSEQUENCES

The trip of the feedwater pumps and condensate booster pump resulted in an unplanned scram and the initiation of high pressure injection systems. The HPCI system responded to the transient and reactor water level was restored to a safe condition by the operation of HPCI and feedwater pump 2B, which remained in service during the entire event. As noted previously, RCIC failed to inject. The main condenser remained in service throughout and served as the heat sink for the reactor. The event is categorized as a partial loss-of-feedwater event. The plant is analyzed for a complete loss-of-feedwater event.

VI. CORRECTIVE ACTIONS

A. Immediate Corrective Actions

The operating instructions were revised to require that feedwater flow be below that needed for 85 percent power prior to removing a feedwater pump from service if a condensate or condensate booster is not in service. With the lower feedwater flow, adequate pump suction head

would be maintained during the removal of a reactor feedwater pump from service. Additionally, a new tool for assessing the risk of online activities was implemented.

B. **Corrective Actions to Prevent Recurrence** - The corrective actions are being managed by the Browns Ferry Nuclear Plant corrective action program.

The risk review process for performing online maintenance on the feedwater/condensate system with a reduced complement of pumps in service will also be reviewed.

VII. ADDITIONAL INFORMATION

A. Failed Components

None.

B. Previous LERs on Similar Events

None identified.

C. Additional Information

The primary corrective action documents for this event are Problem Evaluation Report (PER) 203538 (scram event) and PER 171722 (evaluate risk process).

D. Safety System Functional Failure Consideration:

This event did not result in a safety system functional failure according to NEI 99-02.

E. Scram With Complications Consideration:

This event was not a complicated scram according to NEI 99-01.

VIII. COMMITMENTS

None.