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

May 19, 2014

10 CFR 50.73

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

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

Subject: **Licensee Event Report 50-296/2014-001-00, Automatic Reactor Scram due to a Turbine Trip on High Moisture Separator Level**

The enclosed Licensee Event Report provides details of a Browns Ferry Nuclear Plant (BFN) Unit 3 automatic reactor scram due to a turbine trip that resulted from a high moisture separator level. The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 50.73(a)(2)(iv)(A), as any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B), reactor protection and containment isolation systems.

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

Respectfully,

S. BONO FOR K. Polson

K. J. Polson
Site Vice President

Enclosure: Licensee Event Report 50-296/2014-001-00 – Automatic Reactor Scram due to a Turbine Trip on High Moisture Separator Level.

cc (w/ Enclosure):

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

JE22
NRR

ENCLOSURE

Browns Ferry Nuclear Plant
Unit 3

Licensee Event Report 50-296/2014-001-00

Automatic Reactor Scram due to a Turbine Trip on High Moisture Separator Level

See Enclosed

NRC FORM 366 (01-2014) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 01/31/2017

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 and Information Collections Branch (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
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4. TITLE: Automatic Reactor Scram due to a Turbine Trip on High Moisture Separator Level

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
03	18	2014	2014	001	00	05	19	2014	N/A	05000
									FACILITY NAME: N/A	DOCKET NUMBER: 05000

9. OPERATING MODE

1

10. POWER LEVEL

035

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)*
Eric Bates, Licensing Engineer	256-614-7180

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
B	SB	LIC	F180	Y					

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 March 18, 2014, the Browns Ferry Nuclear Plant (BFN) Unit 3 reactor automatically scrammed due to a turbine trip from a high main turbine moisture separator level. Initial indications show the level controller for 3B2 Moisture Separator failed to maintain level in automatic. Additionally, local manual control attempts failed to restore moisture separator level. Following the turbine trip Main Steam Isolation Valves remained open with main turbine bypass valves controlling reactor pressure.

At approximately 2232, Central Daylight Time (CDT) the 3B2 Moisture Separator Level High Alarm was received and an operator was dispatched to investigate. In accordance with the alarm response procedure the 3B2 Moisture Separator Water Level Controller was placed in manual. Attempts to control the Moisture Separator Reservoir 3B2 High Level Dump Valve manually were ineffective. At approximately 2252 CDT, the Unit 3 reactor automatically scrammed due to a turbine trip from a high moisture separator level.

The root cause was a failure to prevent the introduction of foreign material during the manufacturing process of the Moisture Separator Level Controller. The manufacturing defect was a legacy issue dating back to 1971 when the controller body was originally machined. The corrective actions to prevent recurrence requires the removal, cleaning of air passages, replacement of control relays, for similar controllers and upgrading the calibration procedure to include cleaning guidance.

NARRATIVE

I. Plant Operating Conditions Before the Event

Browns Ferry Nuclear Plant (BFN), Unit 3, was in Mode 1 at approximately 35 percent power.

II. Description of Events

A. Event:

On March 18, 2014, at 2252 Central Daylight Time (CDT), an automatic reactor [RCT] scram occurred on BFN Unit 3. The unit was at approximately 35 percent power while performing Scram Time testing. The automatic reactor scram was caused by a turbine [TRB] trip that resulted from a high 3B2 Moisture Separator [MSR] Level.

System Description (Refer to Figure 1)

Figure 1 shows the drain [DRN] system for Moisture Separators 3A1 & 3A2. The drain systems for Moisture Separators 3B1 & 3B2 and 3C1 & 3C2 are similar.

The BFN Unit 3 Moisture Separator Drain System [SB] consists of six separators [SEP] that collect excessive moisture from the steam exhausted from the High Pressure Turbine. The drains collect in the moisture separators, drain to corresponding Level Control Reservoirs [RVR], and flow through the drain lines. From there the water can be sent through the high level dump valves [LCV] (LCV 6-61A and 6-61B) to the Main Condenser or through the normal level control valves (LCV 6-62A and 6-62B) to the number two feedwater [SJ] heaters [HX].

When reactor thermal power is 40 percent or greater, differential pressure will allow Moisture Separators to drain through the normal level control valves to the number 2 feedwater heaters. Below 40 percent reactor thermal power, the Moisture Separator drains will be operated on their high level dumps. The feedwater heaters and the moisture separators are normally placed in service at greater than 40 percent reactor thermal power.

Event Description

On March 18, 2014, at 2232 CDT, the 3B2 Moisture Separator Reservoir high level alarm [LA] was received. The associated Alarm Response Procedure (ARP) was entered directing the operators to dispatch personnel to the Moisture Separator Reservoir 3B2 High Level controller [LIC], to place the controller in manual and control level as required for present plant conditions. Upon arrival, the operators noted that both the 3B2 Moisture Separator Normal level Controller and High Level Dump Controller indicated off-scale high level and observed that the other Moisture Separators all had normal levels. The controller was placed in "manual" and an attempt was made to raise the controller output to 100 percent but the controller did not respond.

At 2252 CDT, on March 18, 2014, the high level in the moisture separator caused a turbine trip, resulting in the reactor protection system (RPS) initiating an automatic reactor scram.

Prior to the automatic scram, the controller status was relayed to the control room personnel, who were following the alarm response procedure awaiting confirmation of the ability to take manual control. With reactor power at 35%, no other available method to reduce power, indicated level off-scale high, no method to control moisture separator water level, and the potential for an automatic scram existing, the need to manually scram had been reached. The unit supervisor recognized the need to manually scram the reactor but before operator action could be implemented, the automatic scram occurred.

B. Status of structures, components, or systems that were inoperable at the start of the event and that contributed to the event:

There were no structures, components, or systems that were inoperable at the start of the event and that contributed to the event.

C. Dates and approximate times of occurrences:

circa 1971	Moisture Separator Level Controller manufactured, installed in Unit 1
2004	Moisture Separator Level Controller removed from Unit 1, rebuilt, and installed in Unit 3
March 17, 2014, at 1738 CDT	BFN Unit 3 enters MODE 1, recovering from a refueling outage.
March 18, 2014, at 2232 CDT	Received 3B2 Moisture Separator Level Control Reservoir Level High Alarm
March 18, 2014, at 2252 CDT	BFN Unit 3 Automatic Scram due to Turbine Trip on High Moisture Separator Reservoir Level

D. Manufacturer and model number (or other identification) of each component that failed during the event:

The component that failed was a Foxboro Model 52A-SM2 Pneumatic Indicating Controller (BFN-3-LIC-006-0072B).

E. Other systems or secondary functions affected:

There were no other systems or secondary functions affected.

NARRATIVE

F. Method of discovery of each component or system failure or procedural error:

During the plant startup from the refueling outage, the control room received the Moisture Separator Level Control Reservoir 3B2 Level High alarm.

G. The failure mode, mechanism, and effect of each failed component, if known:

During the inspection performed for the Root Cause Analysis, the Maintenance Instrument Group (MIG) personnel found a metallic shaving wedged in the control arm of the control relay on Moisture Separator Level Controller. The metallic shaving prevented movement of the control arm thereby resulting in 0 pounds per square inch (psi) output in both the automatic and manual modes of operation, preventing opening of the Moisture Separator Reservoir high level dump valve.

H. Operator actions:

In accordance with the alarm response procedure, an operator was dispatched to the controller. The operator took manual control of the Moisture Separator Level Controller and raised the manual control to provide a 100 percent demand output. Indication on the controller for air output signal did not change.

I. Automatically and manually initiated safety system responses:

The high level in the 3B2 Moisture Separator Reservoir caused a turbine trip. In response to the turbine trip, the reactor protection system provided an automatic reactor scram. The reactor scram caused an automatic recirculation pump speed runback.

In addition, the reactor pressure vessel low level setpoint was reached. This caused the Primary Containment Isolation System Groups 2, 3, 6, and 8, to isolate. The reactor pressure vessel low level also caused Control Room Emergency Ventilation system actuation and Standby Gas Treatment system actuation. All systems responded as designed.

III. Cause of the event

A. The cause of each component or system failure or personnel error, if known:

Direct Cause

The direct cause of the Unit 3 automatic reactor scram on March 18, 2014, was the output from 3B2 Moisture Separator Water Level Controller did not respond in both automatic and manual operation.

Root Cause

The root cause was a failure to prevent the introduction of foreign material during the manufacturing process. The manufacturing defect was a legacy issue dating back to

1971 when the controller was manufactured.

Contributing Causes

1. A BFN organizational weakness in procedural guidance created a condition with less than adequate mitigating strategy.
2. Operators were slow to recognize the need to insert a manual scram of the reactor upon validation of an existing high level in the moisture separator with no other method available for reducing reactor power or controlling moisture separator water level.

B. The cause(s) and circumstances for each human performance related root cause:

There was no human performance related root cause.

IV. Analysis of the event:

The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 50.73(a)(2)(iv)(A), as any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B), reactor protection and containment isolation systems.

The controller was originally installed in BFN Unit 1 and was inactive from 1985 until 2004. In 2004, the controller was removed from Unit 1, rebuilt, and installed in Unit 3. The instrument operated per design from 2004 until March 18, 2014 when the failure occurred. There were possible indications of imminent failure in 2011 as evidenced by erratic behavior, but testing did not identify the problem. During the inspection personnel found a metallic shaving wedged in the control arm of the control relay in the Moisture Separator Level Controller. The metallic shaving prevented movement of the control arm thereby resulting in no output response in both the automatic and manual modes of operation.

The controller design is such that contaminant entry into the controller via the air system is prevented. Strainers are screwed into the inlet and outlet connections and were intact with no physical defects. The investigation identified a machining defect on the controller where the control relay mounts. The defect matches in size and configuration to the metallic shaving found in the control arm of the relay.

Based on the internal configuration of the controller, there is no internal pathway for the metal shaving to travel from its origin to the inlet hole for the control relay. Therefore, the only path for intrusion is through the inlet port to the control relay. The shaving had to have been cut from the block during initial machining and fallen into the inlet port to the relay. The shaving apparently became trapped in the internals of the controller block

and remained there until it finally worked its way out of the block and came to rest in the control relay.

V. Assessment of Safety Consequences

Nuclear Safety was challenged by the need for a reactor scram. However, Nuclear Safety was maintained by the automatic protective functions in the circuitry that resulted in the scram followed by appropriate operator actions based on procedural requirements.

A. Availability of systems or components that could have performed the same function as the components and systems that failed during the event:

Steam exits the high-pressure turbine through six exhaust lines. Each of the exhaust lines goes to one of the six moisture separators. Two moisture separators feed each of the three low-pressure turbines. Because each moisture separator removes liquid from one of the six exhaust lines there is no other component that would perform the same function as the failed 3B2 Moisture Separator water level controller.

B. For events that occurred when the reactor was shut down, availability of systems or components needed to shutdown the reactor and maintain safe shutdown conditions, remove residual heat, control the release of radioactive material, or mitigate the consequences of an accident:

The BFN, Unit 3, was not shut down when this event occurred.

C. For failure that rendered a train of a safety system inoperable, an estimate of the elapsed time from discovery of the failure until the train was returned to service:

This event did not render a train of a safety system inoperable.

VI. Corrective Actions

Corrective Actions are being managed by TVA's corrective action program under Problem Evaluation Report (PER) 860625.

Immediate Corrective Actions

The Moisture Separator Level Controller was replaced, and the removed controller quarantined until the investigation was completed.

Interim Corrective Actions

1. Operations will issue a shift order for reactor startup requiring cycling of the Moisture Separator Dump Valves to verify operation prior to rolling the turbine.

2. On-shift Operations personnel will be briefed on the need to maintain heightened awareness during abnormal plant configurations and the need to recognize when a manual scram may be required.

Corrective Actions to Prevent Recurrence or to Reduce Probability of Similar Events Occurring in the Future

1. Implement Work Orders to remove similar control relays, clean out the air passages, install replacement control relays, and perform a functional check with as-left data on the controllers.
2. Incorporate step-by-step instructions for the rebuild of the Foxboro 52A Controllers to include guidance for clearing the machined portion of the controller of foreign material potentially remaining from the manufacturing process.

VII. Additional Information:

A. Previous similar events at the same plant:

A search was performed on the BFN corrective action program for the past five years using various related search criteria. The most applicable issue identified was BFN PER 588183 "Current Transformer (CT) Reverse Polarity Causes Unit 3 Scram. This event was related because a non-quality, non-safety related component with a manufacturer's defect resulted in a scram. Although this event seems similar in nature, the CT scram could have been prevented through a more rigorous receipt inspection and testing program. The moisture separator water level trip with scram would not have been identified by testing.

B. Additional Information:

There is no additional information.

C. Safety System Functional Failure Consideration:

In accordance with Nuclear Energy Institute (NEI) NEI 99-02, "Regulatory Assessment Performance Indicator Guideline," this event is not considered a safety system functional failure.

D. Scram with Complications Consideration:

This event did not result in an unplanned scram with complications because:

1. RPS actuation established a shutdown rod pattern for a cold clean core;
2. Pressure control was able to be established following the initial transient;
3. Power was not lost to any Class 1E Emergency / Engineered Safety Feature bus;
4. A Level 1 Injection signal was not received;

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5. Main Feedwater was available or recoverable using approved plant procedures during the scram response; and
6. Following initial transient, stabilization of reactor pressure/level and drywell pressure did not require remaining in the Emergency Operating Procedures.

VIII. COMMITMENTS

There are no commitments.

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NARRATIVE

Figure 1