



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

January 15, 2019

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Unit 1
Renewed Facility Operating License No. DPR-33
NRC Docket No. 50-259

Subject: **Licensee Event Report 50-259/2018-004-01**

Reference: Letter from TVA to NRC, "Licensee Event Report 50-259/2018-004-00,"
dated September 7, 2018

Pursuant to 10 CFR 50.73(a)(2)(v)(A), (B), and (D), Browns Ferry Nuclear Plant hereby submits supplemental Licensee Event Report (LER) 50-259/2018-004-01 which documents the inoperability of the Browns Ferry Nuclear Plant, Unit 1, High Pressure Coolant Injection system. The enclosed LER has been revised to document a revision of the Level 2 Apparent Cause Evaluation which was initiated at the time when the referenced report was submitted to the NRC.

There are no new regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact M. W. Oliver, Acting Nuclear Site Licensing Manager, at (256) 729-7874.

Respectfully,

A handwritten signature in blue ink, appearing to read "DLH", is written over the word "Respectfully,".

D. L. Hughes
Site Vice President

Enclosure: Licensee Event Report 50-259/2018-004-01 – High Pressure Coolant Injection
Declared Inoperable due to Steam Supply Valve Isolation

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cc (w/ Enclosure):

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

ENCLOSURE

**Browns Ferry Nuclear Plant
Unit 1**

Licensee Event Report 50-259/2018-004-01

High Pressure Coolant Injection Declared Inoperable due to Steam Supply Valve Isolation

See Enclosed



LICENSEE EVENT REPORT (LER)

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 Information Services Branch (T-2 F43), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by 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.

1. Facility Name

Browns Ferry Nuclear Plant, Unit 1

2. Docket Number

05000259

3. Page

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4. Title

High Pressure Coolant Injection Declared Inoperable due to Steam Supply Valve Isolation

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
07	09	2018	2018	004	01	01	15	2019	N/A	N/A
9. Operating Mode			11. This Report is Submitted Pursuant to the Requirements of 10 CFR §: (Check all that apply)							
1			<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)		<input type="checkbox"/> 50.73(a)(2)(ii)(A)		<input type="checkbox"/> 50.73(a)(2)(viii)(A)		
			<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)		<input type="checkbox"/> 50.73(a)(2)(ii)(B)		<input type="checkbox"/> 50.73(a)(2)(viii)(B)		
			<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)		<input type="checkbox"/> 50.73(a)(2)(iii)		<input type="checkbox"/> 50.73(a)(2)(ix)(A)		
			<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)		<input type="checkbox"/> 50.73(a)(2)(iv)(A)		<input type="checkbox"/> 50.73(a)(2)(x)		
10. Power Level			<input type="checkbox"/> 20.2203(a)(2)(ii)		<input type="checkbox"/> 50.36(c)(1)(ii)(A)		<input checked="" type="checkbox"/> 50.73(a)(2)(v)(A)		<input type="checkbox"/> 73.71(a)(4)	
100			<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)		<input checked="" type="checkbox"/> 50.73(a)(2)(v)(B)		<input type="checkbox"/> 73.71(a)(5)		
			<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)		<input type="checkbox"/> 50.73(a)(2)(v)(C)		<input type="checkbox"/> 73.77(a)(1)		
			<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)		<input checked="" type="checkbox"/> 50.73(a)(2)(v)(D)		<input type="checkbox"/> 73.77(a)(2)(i)		
			<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)		<input type="checkbox"/> 50.73(a)(2)(vii)		<input type="checkbox"/> 73.77(a)(2)(ii)		
			<input type="checkbox"/> 50.73(a)(2)(i)(C)		<input type="checkbox"/> OTHER		Specify in Abstract below or in NRC Form 366A			

12. Licensee Contact for this LER

Licensee Contact

Justin Garner, Licensing Engineer

Telephone Number (Include Area Code)

256-729-7955

13. Complete One Line for each Component Failure Described in this Report

Cause	System	Component	Manufacturer	Reportable to ICES	Cause	System	Component	Manufacturer	Reportable to ICES
B	BJ	PS	S382	Y	N/A	N/A	N/A	N/A	N/A
14. Supplemental Report Expected					15. Expected Submission Date				
<input type="checkbox"/> Yes (If yes, complete 15. Expected Submission Date) <input checked="" type="checkbox"/> No					Month Day Year				
					N/A N/A N/A				

Abstract (Limit to 1400 spaces, i.e., approximately 14 single-spaced typewritten lines)

On July 9, 2018, during performance of surveillance procedure 1-SR-3.3.6.1.2(3B), High Pressure Coolant Injection System Steam Supply Low Pressure Functional Test, an unexpected High Pressure Coolant Injection (HPCI) isolation occurred. The isolation was discovered at 1111 Central Daylight Time (CDT) during a walkdown of the Unit 1 Control Room when the Unit Operator identified that the inboard and outboard HPCI steam supply valves were closed.

It was determined that the valves had closed at approximately 0958 CDT during performance of 1-SR-3.3.6.1.2(3B). Unit 1 entered Technical Specifications (TS) Limiting Condition for Operation (LCO) 3.5.1, ECCS - Operating, Condition C, at approximately 1111 CDT, which required restoring HPCI to operable status within 14 days and verification that Reactor Core Isolation Cooling (RCIC) is operable by administrative means. Following successful completion of the functional test, HPCI was placed in standby readiness lineup. The HPCI system was declared operable on July 10, 2018, at 1342 CDT. During the period of Primary Containment Isolation, the HPCI system was unable to perform its safety function. However, in an emergency, sufficient systems were available to provide the required safety functions.

The most likely cause of the unexpected HPCI isolation during performance of the HPCI test was determined to be past operation of the HPCI steam supply low pressure switches at an electrical current level near the manufacturer's rating, which resulted in degradation of the switch electrical contacts. The degradation eventually resulted in momentary arcing during functional testing of an adjacent switch, which energized the downstream logic relays causing Unit 1 HPCI to isolate. The corrective action for this event is to revise procedures 1/2/3-SR-3.3.6.1.2(3B) to lift a wire for the pressure switch under test and then re-land the wire prior to moving to the next pressure switch.

**LICENSEE EVENT REPORT (LER)
CONTINUATION SHEET**

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1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Browns Ferry Nuclear Plant, Unit 1	05000259	2018	- 004	- 01

NARRATIVE**I. Plant Operating Conditions Before the Event**

At the time of discovery, Browns Ferry Nuclear Plant (BFN), Unit 1, was in Mode 1 at approximately 100 percent rated thermal power.

II. Description of Event**A. Event Summary**

On July 9, 2018, at approximately 0920 Central Daylight Time (CDT), BFN Instrumentation and Control Maintenance personnel (MIG) commenced a scheduled High Pressure Coolant Injection (HPCI)[BJ] System Steam Line Supply Low Pressure Functional Test [WO 118568097/1-SR-3.3.6.1.2(3B)]. This Surveillance Requirement (SR) involves closing Pressure Switches (PS)[PS] 1-PS-073-0001A and 1-PS-073-0001C, which are in the logic circuit for automatic low-pressure induced closure of HPCI isolation valves [ISV].

At approximately 1111 CDT during a walkdown of the Unit 1 Control Room, the HPCI Steam Line inboard and outboard isolation valves (1-FCV-73-0002 and 1-FCV-73-0003)[FCV] were found closed. Operations personnel entered Abnormal Operating Instruction 1-AOI-64-2B, Group 4 HPCI Isolation. After investigation, it was found that the valves closed at 0958 CDT during performance of Surveillance Functional Test; therefore, HPCI was declared inoperable retroactive to 0958 CDT. The Primary Containment Isolation System (PCIS) Group 4 Isolation was subsequently determined to be caused by a deficiency on the PS which allowed the circuit to complete while another PS was taken closed for testing.

In response to HPCI system inoperability, BFN, Unit 1, entered Technical Specifications (TS) Limiting Condition for Operation (LCO) 3.5.1, Emergency Core Cooling Systems (ECCS) - Operating, which requires each ECCS injection/spray subsystem and the Automatic Depressurization System (ADS) function of six safety/relief valves to be operable in reactor Modes 1, 2, and 3. Condition C was entered due to HPCI inoperability, with required actions to immediately verify Reactor Core Isolation Cooling (RCIC)[BN] operable by administrative means and restore HPCI to operable status within 14 days. RCIC was verified operable by Operations personnel.

On July 9, 2018, at 1310 CDT, MIG completed the HPCI System Steam Supply Low Pressure Functional Test satisfactorily. At 1342 CDT on July 10, 2018, Operations personnel declared HPCI operable and exited TS LCO 3.5.1 Condition C.

The Tennessee Valley Authority (TVA) is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(v)(A), (B), and (D), as any event or condition that could have prevented the fulfillment of the safety function of structures or systems that are needed to shut down the reactor and maintain it in a safe shutdown condition, remove residual heat, or mitigate the consequences of an accident.

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NARRATIVE**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, systems, or components (SSCs) whose inoperability contributed to this event.

C. Dates and approximate times of occurrences

<u>Dates & Approximate Times</u>	<u>Occurrence</u>
July 9, 2018, 0920 CDT	MIG commenced 1-SR-3.3.6.1.2(3B) - HPCI System Steam Supply Low Pressure Functional Test.
July 9, 2018, 0958 CDT	Isolation valves closed.
July 9, 2018, 1111 CDT	Isolation valves were found closed. HPCI declared inoperable and determined to have been inoperable since 0958 CDT. Entered TS LCO 3.5.1 Condition C.
July 9, 2018, 1253 CDT	HPCI declared available, but inoperable. Exited 1-AOI-64-2B.
July 9, 2018, 1310 CDT	MIG satisfactorily completed 1-SR-3.3.6.1.2(3B) - HPCI System Steam Supply Low Pressure Functional.
July 10, 2018, 1342 CDT	HPCI declared operable. Unit 1 exited TS LCO 3.5.1 Condition C.

D. Manufacturer and model number of each component that failed during the event

Two PSs were identified as the potential points of failure (1-PS-073-0001A and 1-PS-073-0001C). Both were manufactured by Static-O-Ring (SOR). The manufacturer part number is 5N6-B3-U8-C1A-JJTTNQ. The electrical portion of the SOR PS used in the HPCI steam supply low pressure logic is a Honeywell Micro Switch brand microswitch, part number 11SM244.

E. Other systems or secondary functions affected

No other systems or secondary functions were affected by this event.

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

The unexpected Unit 1 HPCI system isolation was discovered by the Unit Operator on observation of the Control Room panel. Light indications in the Control Room include the position indication lights for the HPCI inboard steam isolation valve and the HPCI outboard steam isolation valve. Additionally, the lamps for Group 4 of the Containment Isolation Status System would have illuminated when the isolation signal was present.

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NARRATIVE**G. The failure mode, mechanism, and effect of each failed component**

The failure mechanism was determined to be electrical contact degradation due to loading near the manufacturer's rated values for the microswitch in the HPCI steam supply low PS. This resulted in momentary arcing during functional testing of an adjacent switch, which energized the logic relays and caused Unit 1 HPCI to isolate.

H. Operator actions

Upon receipt of the BFN, Unit 1, PCIS Group 4 Isolation:

- Entered Abnormal Operating Instruction 1-AOI-064-0002B, Group 4 High Pressure Coolant Injection Isolation.
- Declared BFN, Unit 1, HPCI inoperable and unavailable and entered TS LCO 3.5.1, ECCS - Operating Condition C.
- Verified RCIC was operable.

I. Automatically and manually initiated safety system responses

During this event, momentary arcing of a PS resulted in a PCIS Group 4 isolation of the HPCI system. PCIS Group 4 isolation closes the steam supply valves to HPCI in the event of high steamline space temperature, high steam flow, or low steamline pressure. These signals are indicative of a line break in the HPCI system steamline to the turbine or high pressure between the diaphragm rupture discs on the HPCI Turbine Exhaust. At the time of the event, these conditions did not exist.

III. Cause of the event**A. Cause of each component or system failure or personnel error**

The most likely cause of the unexpected Unit 1 HPCI isolation during performance of the HPCI steam supply low pressure functional test was operation of the switch near the manufacturer's electrical contact current ratings. This was a result of a design change that added logic relays to the isolation circuit, increasing the current flow through the circuit.

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

No human performance related root causes were identified.

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		2018	- 004	- 01

NARRATIVE**IV. Analysis of the event**

The HPCI system is provided to assure that the reactor is adequately cooled to limit fuel cladding temperature in the event of a small break in the nuclear system and loss of coolant which does not result in rapid depressurization of the reactor vessel. The HPCI system permits the nuclear plant to be shut down, while maintaining sufficient reactor vessel water inventory until the reactor vessel is depressurized. The HPCI system continues to operate until the reactor vessel pressure is below the pressure at which Low Pressure Coolant Injection (LPCI)[BO] operation or Core Spray System operation maintains core cooling. Due to the isolation of the HPCI system, this system would have been unable to perform its safety function.

The design discrepancy that resulted in the unexpected isolation is the addition of logic relays to the HPCI steam supply low pressure isolation circuit. The design configuration that has been evaluated in Tab C-3 of EQ Binder BFN0EQ-IPS-003 as acceptable for the PS electrical contacts includes two GE HFA type relays in parallel being energized by the PS contact closure. Since the time that the initial evaluation was performed, an Agastat EGP type relay was added to the Unit 1 circuit, and two GE HGA type relays were added to the Units 2 and 3 circuits. The additional current demanded on the circuit to energize the relays has resulted in approaching the switch electrical contact rating. Electrical contacts degrade in repeated "make" and "break" cycles by pitting, which can affect contact performance and reliability. The pitting is a result of material transfer across contacts that occurs from arcing on either contact make or break. In DC circuits, the pitting can be more severe than in AC circuits, as one contact is always positive and the other is always negative. This pitting is exacerbated in inductive loading applications by the counter electromotive force which causes high break currents.

The electrical portion of the SOR switch used in the HPCI steam supply low pressure logic is a Honeywell Micro Switch brand microswitch, part number 11SM244. The switch is robust enough to continue to operate acceptably with some contact degradation; however, the two instances of unexpected HPCI isolations during the PS functional testing demonstrates that the degradation has affected the switches in a manner that can occasionally result in momentary spurious closure. A voltmeter used in the functional testing procedure detects that the switch contacts are open, but the voltmeter test voltage across the contacts is very low. However, when approximately 280VDC is applied across the contacts, a momentary arc across the air gap of the contacts, which can be affected by the pitting, can result in momentary circuit completion and energization of the logic relays. The failure mechanism has been difficult to detect because of the intermittent and unpredictable frequency.

The potential for spurious system isolation with the HPCI steam supply low PSs in standby is low based on the logic configuration (one-out-of-two-taken-twice). The configuration is changed during quarterly functional testing as one-half of the one-out-of-two-taken-twice logic is satisfied while each switch is being tested. This can be changed by a minor modification to the testing procedure to lift a wire for the switch under test to isolate it from the logic circuit. This is acceptable because TS Table 3.3.6.1-1, Primary Containment Isolation Instrumentation, provides

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NARRATIVE

in Function 3.b for the HPCI Steam Supply Line Pressure - Low, that only 3 channels out of 4 are required to remain operable.

V. Assessment of Safety Consequences

This event resulted in inoperability and unavailability of the single train of the BFN, Unit 1, HPCI system resulting in the inability of the HPCI system to perform its safety functions for shutting down the reactor and maintaining it in a safe shutdown condition, mitigation of the consequences of an accident, and the removal of residual heat in the event that the reactor was shut down. In the event of an emergency, the RCIC system remained operable, and all ADS systems were available during this event to facilitate core cooling by low pressure ECCS systems. Based on the above, during the time period that the HPCI system was inoperable, sufficient systems were available to provide the required safety functions to protect the health and safety of the public. There was no significant reduction to the health and safety of the public or plant personnel for this event.

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

During this event, RCIC was verified as operable by Operations personnel. Additionally, all other ECCS and ADS systems remained operable.

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

This event did not occur when the reactor was shutdown.

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

The event resulted in isolation of the BFN, Unit 1, HPCI system at 0958 CDT on July 9, 2018. The event was discovered at 1111 CDT on July 9, 2018, at which point Unit 1 was retroactively declared inoperable by Operations personnel. However, HPCI remained inoperable until 1342 CDT on July 10, 2018. The lapsed time for inoperability of the HPCI system was 27 hours and 44 minutes.

VI. Corrective Actions

Corrective Actions are being managed by TVA's corrective action program under Condition Reports (CRs) 1429497 (1-FCV-73-2 found closed during board walkdown) and 1437895 (Discrepancy in HPCI PS contact rating).

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NARRATIVE**A. Immediate Corrective Actions**

The immediate corrective actions related to this event were to replace the two Unit 1 pressure switches that could have failed, resulting in spurious isolation. Based on the one-out-of-two-taken-twice logic configuration, it was not determined which Unit 1 PS actually failed, but it was narrowed down to two of the four switches. Work orders were also initiated to replace the other two Unit 1 PSs, as well as Unit 2 PSs and Unit 3 PSs.

B. Corrective Actions to Prevent Recurrence or to reduce the probability of similar events occurring in the future

The PS functional test procedures for all three units, 1/2/3-SR-3.3.6.1.2(3B), have been revised to reduce the chances of inadvertent isolation by lifting a wire for the PS under test and then re-landing the wire prior to moving on to the next PS. Lifting a wire for the PS under test eliminates the purposeful making up of one-half of the one-out-of-two-taken-twice logic, such that a single failure will not result in spurious actuation. In addition to lifting the wires, CR 1437895 was initiated to document the discrepancy identified with the electrical contact rating for the SOR brand PSs used in the HPCI steam supply low pressure isolation circuit. CR Action 1429497-05 is being used to monitor the corrective actions of CR 1437895 to ensure resolution of the nonconforming condition related to the HPCI steam supply low pressure isolation switches.

VII. Previous Similar Events at the Same Site

A search of BFN Licensee Event Reports (LERs) for Units 1, 2, and 3, identified five LERs similar to this issue within the last six years.

- BFN LER 260/2012-004-00 -- High Pressure Coolant Injection Rendered Inoperable Due to an Inadvertent Actuation of Primary Containment Isolation System (PER 596706)
- BFN LER 259/2013-007-00 -- High Pressure Coolant Injection Declared Inoperable Due to an Inadvertent Actuation of the Primary Containment Isolation System (PER 794807)
- BFN LER 296/2015-004-00 -- High Pressure Coolant Injection Inoperable Due to Failed Pressure Switch (CR 1024825)
- BFN LER 296/2016-006-00 -- High Pressure Coolant Injection Found Inoperable During Testing (CR 1179483)
- BFN LER 259/2016-002-00 -- High Pressure Coolant Injection Safety System Functional Failure due to Inoperability of Primary Containment Isolation Valve (CR 1193943)

A review of the corrective actions for the CRs associated with the LERs concluded that the corrective actions associated with these CRs would not have prevented this event from occurring.



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NARRATIVE

VIII. Additional Information

There is no additional information.

IX. Commitments

There are no new commitments.