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

October 16, 2012

10 CFR 50.73

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
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 50-260/2012-004-00**

The enclosed Licensee Event Report provides details of the High Pressure Coolant Injection System that was rendered inoperable due to an inadvertent actuation of the Primary Containment Isolation System. The Tennessee Valley Authority is submitting this report in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(v)(B) and 10 CFR 50.73(a)(2)(v)(D).

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,

for K. J. Polson

K. J. Polson
Vice President

Enclosure: Licensee Event Report 50-260/2012-004-00 - High Pressure Coolant Injection System Rendered Inoperable Due to an Inadvertent Actuation of Primary Containment Isolation System

cc (w/ Enclosure):

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

IE22
NRR

ENCLOSURE

Browns Ferry Nuclear Plant
Unit 2

Licensee Event Report 50-260/2012-004-00

High Pressure Coolant Injection System Rendered Inoperable Due to an Inadvertent Actuation of Primary Containment Isolation System

---

See Attached

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, Unit 2	05000260	1 of 8

4. TITLE: High Pressure Coolant Injection System Rendered Inoperable Due to an Inadvertent Actuation of Primary Containment Isolation 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
									N/A	05000
08	17	2012	2012	- 004 -	00	10	16	2012	FACILITY NAME: N/A	DOCKET NUMBER: 05000

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)*
Christopher Bennett, Licensing Engineer	256-729-2475

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	BJ	TS	F081	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 August 17, 2012, at approximately 0445 hours Central Daylight Time (CDT), the Browns Ferry Nuclear Plant (BFN), Unit 2, High Pressure Coolant Injection (HPCI) System unexpectedly received a Group 4, Primary Containment Isolation System signal during the performance of surveillance procedure 2-SR-3.3.6.1.3(3DFT), HPCI Steam Line Space High Temperature Functional Test. On August 17, 2012, at approximately 0450 hours CDT, Operations personnel declared the HPCI System inoperable and entered Technical Specification 3.5.1 Condition C and Abnormal Operating Instruction 2-AOI-64-2B, Group 4 High Pressure Coolant Injection Isolation.

The root cause of the event was the use of incorrect wire bending practices to assemble steam line space high temperature switches.

The corrective action to prevent recurrence is to replace the BFN, Units 1, 2, and 3, HPCI and Reactor Core Isolation Cooling steam line space high temperature switches with switches that are designed by EGS and are supplied with Rockbestos switchboard wire, ensuring the correct wire bending practices specified in Special Instrument Instruction SII-0-TS-00-320, EGS Corporation/Fenwal Environmental Qualified Temperature Switch Assembly and Repair, have been used.

I. PLANT CONDITION(S)

At the time of the event, Browns Ferry Nuclear Plant (BFN), Unit 2, was in Mode 1 at approximately 100 percent rated thermal power.

II. DESCRIPTION OF EVENT

A. Event

On August 17, 2012, at approximately 0445 hours Central Daylight Time (CDT), the BFN, Unit 2, High Pressure Coolant Injection (HPCI) [BJ] System unexpectedly received a Group 4, Primary Containment Isolation System (PCIS) [BD] signal during the performance of surveillance procedure 2-SR-3.3.6.1.3(3DFT), HPCI Steam Line Space High Temperature Functional Test. After a review of data for the HPCI steam line space high temperature channel B2, it was determined that channel B2 was spuriously actuating and clearing prior to the functional test. When the HPCI steam line space high temperature channel A1 was actuated for the test, the HPCI steam line space high temperature channel B2 was spuriously actuated. With both HPCI steam line high temperature channels A1 and B2 actuated, a full BFN, Unit 2, HPCI steam line isolation occurred. On August 17, 2012, at approximately 0450 hours CDT, Operations personnel verified that the Reactor Core Isolation Cooling (RCIC) [BN] System was Operable by administrative means, declared the HPCI System inoperable, and entered Technical Specification (TS) 3.5.1 Condition C and Abnormal Operating Instruction 2-AOI-64-2B, Group 4 High Pressure Coolant Injection Isolation.

On August 18, 2012, at approximately 0342 hours CDT, following the replacement of all four HPCI steam line space high temperature channel B2 switches [TS] and successful completion of 2-SR-3.3.6.1.3(3D), HPCI Steam Line Space High Temperature Calibration, for the channel B2 switches, Operations personnel returned the HPCI System to service.

On August 19, 2012, at approximately 0107 hours CDT, surveillance procedure 2-SR-3.3.6.1.3(3DFT) was completed satisfactorily.

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

The inoperable component that contributed to the event was the BFN, Unit 2, HPCI steam line space high temperature switch in channel B2.

C. Dates and Approximate Times of Major Occurrences

Between July 11, 2011, and August 17, 2012	After a review of historical data for the HPCI steam line space high temperature channel B2, it was determined that the channel had spuriously actuated approximately forty-one times ranging in duration from one minute to several hours.

August 17, 2012, at 0445 hours CDT	During the performance of surveillance procedure 2-SR-3.3.6.1.3(3DFT), a HPCI isolation occurred.
August 18, 2012, at 0342 hours CDT	Following the replacement of all four HPCI steam line space high temperature channel B2 switches and successful completion of 2-SR-3.3.6.1.3(3D), for the channel B2 switches, Operations personnel returned the HPCI System to service.
August 19, 2012, at 0107 hours CDT	Surveillance procedure 2-SR-3.3.6.1.3(3DFT) was completed satisfactorily.

D. Other Systems or Secondary Functions Affected

There were no other systems or secondary functions affected by this event.

E. Method of Discovery

This event was self revealing during the performance of surveillance procedure 2-SR-3.3.6.1.3(3DFT) when an inadvertent Group 4, PCIS signal was received.

F. Operator Actions

Operations personnel verified that the RCIC System was Operable by administrative means, declared the HPCI System inoperable, and entered TS 3.5.1 Condition C and 2-AOI-64-2B.

G. Safety System Responses

There were no safety system responses in response to this event.

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause was the degraded wire insulation internal to temperature switch BFN-2-TS-073-0002S.

B. Root Cause

The root cause of the event was determined to be the use of incorrect wire bending practices to assemble steam line space high temperature switches.

C. Contributing Factors

The HPCI steam line space high temperature channel B2 output was not being periodically monitored by the system engineer.

IV. ANALYSIS OF THE EVENT

The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 50.73(a)(2)(v)(B) and (D), any event or condition that could have prevented the fulfillment of the safety function of structures or systems that are needed to remove residual heat and mitigate the consequences of an accident.

The HPCI steam line space high temperature switches are connected in one-out-of-four logic feed relays [RLY] and are connected in one-out-of-two-taken-twice logic. When the logic is made up, this signal indicates a leak or break in the HPCI steam supply line. Redundant instrumentation is used for detection of high steam supply line area temperature with a logic to protect against spurious actuation. The HPCI steam line isolation occurs when a steam leak has occurred and is diverse to the high flow instrumentation. The HPCI steam line space high temperature switches are designed to isolate the HPCI steam line by closing the HPCI inboard steam isolation valve and the HPCI outboard steam isolation valve in the event of a steam line break.

High temperature switch actuations are initiated from bimetallic temperature switches that are appropriately located to protect the system that is being monitored. Four switches monitor each area. The high temperature switches are also grouped electrically such that one group of four switches are in parallel and each one can actuate a hinged armature auxiliary relay and is monitored by a computer point. The HPCI System has sixteen total switches available to detect high area temperature. The TS 3.3.6.1, Primary Containment Isolation Instrumentation, covers HPCI area temperature isolation instrumentation and requires that sixteen switches to be Operable to ensure that no single instrument failure can preclude the isolation function. A past operability evaluation was performed on the switches and it was determined that the switches would have performed their required function of causing a HPCI isolation at their set point.

It was determined from July 11, 2011, to August 17, 2012, that the HPCI steam line space high temperature channel B2 spuriously actuated approximately forty-one times. When the HPCI steam line space high temperature channel A1 was actuated during performance of 2-SR-3.3.6.1.3(3DFT), a Group 4, PCIS signal was received due to the make up of the one-out-of-two-taken-twice logic. The HPCI inboard steam isolation valve and the HPCI outboard steam isolation valve both closed as designed and the HPCI steam line depressurized, causing a full BFN, Unit 2, HPCI steam isolation. Operations personnel declared the HPCI System inoperable and entered TS 3.5.1 Condition C.

The BFN, Unit 2, TS Limiting Condition for Operation 3.5.1 requires each Emergency Core Cooling System [BJ][BO][BM] injection/spray subsystem and the Automatic Depressurization System (ADS)[SB] function of six safety/relief valves to be Operable in Mode 1, and in Modes 2 and 3, except HPCI and ADS valves are not required to be Operable with reactor steam dome pressure less than or equal to 150 pound-force per square inch gauge (psig). With the HPCI System inoperable, TS 3.5.1 Required Action C.1 requires that RCIC System to be immediately verified Operable by administrative

NARRATIVE

means and Required Action C.2 requires the HPCI System to be restored to Operable status in 14 days.

The four switches on the HPCI steam line space high temperature channel B2 were removed from the plant on August 17, 2012, and bench tested at BFN to determine if any abnormalities existed. The switches passed their "as-found testing" satisfactorily.

The switches were then sent to the TVA Central Laboratories for detailed analysis. The contacts and struts of all four switches appeared to be in satisfactory condition and there was no loss of hermetic seal or contact damage. The laboratory testing identified an issue with the insulation on Fenwal temperature switch 2-TS-073-0002S and examination of the switch identified wear on the wire insulation internal to the switch.

Fenwal no longer supplies temperature switches to the nuclear industry; therefore, BFN has been purchasing replacement switches from EGS. The switches are still manufactured by Fenwal; however, they are manufactured using the EGS design specifications. The EGS switches include some improved design changes in comparison to the older Fenwal switches. One change to the design was the change of the lead wires from a Teflon insulated nickel clad copper wire to a more robust Rockbestos switchboard type nuclear wire.

A subject matter expert on the fabrication of the switches from EGS was contacted to assist in the investigation. EGS advised that a spurious actuation could only be caused by one the following: a problem with the struts, a problem with the contacts, or a problem with the wiring.

Some of the Fenwal designed switches and all of the EGS designed switches have a mechanical stress relief attached to the end that prevents the wire from being pulled out of the switch. There is a loop of wire that causes a tight wire bending radius immediately following the stress relief. While this loop is beneficial for the switches designed by EGS, it proved to be detrimental to the switches designed by Fenwal. The wire insulation of the Fenwal switch is not capable of withstanding the stress from bending over time and is susceptible to fraying when in contact with the switch housing.

The subject matter expert from EGS advised that degradation of the wiring insulation could result in spurious actuation each time the wire completes the circuit due to any slight vibration or thermal expansion. Degraded wire insulation would show more of an effect late in life compared to early in life due to the repeated handling during surveillances of the temperature switch which causes more opportunities for wire repositioning and degradation.

It was determined that the wire insulation degraded slowly over multiple years until it exposed the wire and slight vibration and/or slight thermal expansion caused spurious actuation of the HPCI steam line space high temperature channel B2. After a review of historical data for the HPCI steam line high temperature channel B2, it was determined that this condition repeated itself numerous times between July 11, 2011, and August 17, 2012, and resulted in an isolation when the HPCI steam line space high temperature channel A1 was actuated during performance of 2-SR-3.3.6.1.3(3DFT).

NARRATIVE

The cause of the spurious actuation of the HPCI steam line space high temperature channel B2 was degraded wire insulation internal to the temperature switch as a result of undue stress placed on the insulation of the lead wires due to lack of wire bending guidance during assembly of the Fenwal designed switches.

Extent of Condition

The extent of condition is limited to HPCI and RCIC steam line space high temperature switches on BFN, Units 1, 2, and 3.

V. ASSESSMENT OF SAFETY CONSEQUENCES

The consequences of the actions identified in this report resulted in a Group 4, PCIS signal being received. This resulted in closure of the HPCI inboard steam isolation valve and the HPCI outboard steam isolation valve and a full BFN, Unit 2, HPCI steam isolation, rendering the HPCI System inoperable.

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 operation or Core Spray (CS) System operation can maintain core cooling. If a Loss of Coolant Accident occurs, the reactor scrams upon receipt of a low-water-level signal or a high-drywell-pressure signal. The HPCI System starts when the water level reaches a preselected height above the core, or if high pressure exists in the primary containment (drywell).

Despite the reduction in defense-in-depth due to the inoperability of the HPCI System, redundant systems such as the ADS, the CS System, and the Residual Heat Removal System remained Operable, as required by the TS, to respond to postulated accidents and maintain safe shutdown capability. In addition, as required by TS 3.5.1 Required Action C.1, Operations personnel verified that the RCIC System was Operable.

Main Control Room [NA] staff were aware of the spurious HPCI steam line isolation when it occurred, entered TS 3.5.1 Condition C and declared the HPCI System inoperable. The spuriously actuating channel by itself did not cause the HPCI System to lose its function nor did the spurious operation cause the channel to lose its function with respect to TS 3.3.6.1. The four switches that were replaced to correct the spurious operation all passed the required as-found calibration. Therefore, the switches would have performed their required function of causing a HPCI isolation at the required set point. The steam isolation logic is such that it can withstand spurious operation of one switch without an isolation. The isolation occurred during testing of one switch while a different switch was spuriously actuated. The HPCI System was inoperable from August 17, 2012, at approximately 0445 hours CDT, to August 18, 2012 at approximately 0342 hours CDT. This is within the required 14 day completion time.

Therefore, TVA concluded that there was no significant reduction to the health and safety of the public for this event.

NARRATIVE

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

A. Immediate Corrective Actions

1. Replaced the four temperature switches, connectors, and test coils associated with the BFN, Unit 2, HPCI steam line space high temperature channel B2 and satisfactorily performed 2-SR-3.3.6.1.3(3DFT).
2. Verified that none of the BFN, Unit 2, HPCI steam line space high temperature channels have spuriously tripped since the switches were replaced.
3. Verified that none of the Unit 1, 2, or 3, HPCI and RCIC channels have spuriously tripped over the last year other than BFN, Unit 2, HPCI channel B2.
4. Until the system monitoring plans have been revised to include the temperature channels, verify once per week that none of the BFN, Unit 1, 2, or 3, HPCI and RCIC channels have spuriously tripped.

B. Corrective Actions to Prevent Recurrence

The corrective action to prevent recurrence is to replace the BFN, Units 1, 2, and 3, HPCI and RCIC steam line space high temperature switches with switches that are designed by EGS and are supplied with Rockbestos switchboard wire, ensuring the correct wire bending practices specified in Special Instrument Instruction SII-0-TS-00-320, EGS Corporation/Fenwal Environmental Qualified Temperature Switch Assembly and Repair, have been used.

VII. ADDITIONAL INFORMATION

A. Failed Components

The failed component was temperature switch BFN-2-TS-073-0002S. This component was manufactured by Fenwal with a model number of 17023-6.

B. Previous Similar Events

A search was performed on the Browns Ferry Nuclear Plant's LER database for the past five years. Similar LER 50-260/2010-005-00, High Pressure Coolant Injection System Isolation Experienced During Performance of High Pressure Coolant Isolation Steam Supply Low Pressure Functional Test; LER 50-260/2010-004-00, HPCI Isolation During Time Delay Relay Calibration; and LER 50-260/2009-009-00, Inadvertent Isolation of the High Pressure Coolant Injection System During Testing Activities, were identified. These LERs are associated with HPCI System isolation events during performance of testing activities.

A search was performed on the BFN corrective action program. Problem Evaluation Reports (PERs) 75274 and 80014 were identified. These PERs are associated with degraded wire insulation. PER 80014 was written in response to a Group 1 isolation due to degraded wiring in the main steam line tunnel temperature switches. The extent of condition only encompassed switches designed by EGS and excluded switches designed by Fenwal. The extent of condition for PER 80014 did not

recognize that other similar Fenwal temperature switches, such as the steam line space high temperature switches referenced in this LER, should be included. If the temperature switches designed by Fenwal would have been included in the extent of condition for PER 80014, it is likely that this event could have been prevented. As such, PER 614099 has been initiated to address this condition.

C. Additional Information

The corrective action document for this report is PER 596706.

D. Safety System Functional Failure Consideration

In accordance with NEI 99-02, this event is considered a safety system functional failure because it could have prevented fulfillment of the HPCI System safety functions to remove residual heat and to mitigate the consequences of an accident.

E. Scram With Complications Consideration

This condition did not include a scram.

VIII. COMMITMENTS

There are no commitments.