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

September 7, 2012

10 CFR 50.73

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

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Licensee Event Report 50-259/2012-007-01**

Reference: Letter from TVA to NRC, "Licensee Event Report 50-259/2012-007-00," dated July 31, 2012

On July 31, 2012, the Tennessee Valley Authority (TVA) submitted Revision 0 to Licensee Event Report 50-259/2012-007. The TVA subsequently completed additional reviews which identified another cable routing error in the Appendix R separation analysis. The TVA is submitting this supplement in accordance with Title 10 of the Code of Federal Regulations (10 CFR) 50.73(a)(2)(ii)(B) and 10 CFR 50.73(a)(2)(v)(A).

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,

K. J. Polson
Vice President

Enclosure: Licensee Event Report 50-259/2012-007-01 - Cable Routing Errors Found in the Appendix R Separation Analysis

cc: See Page 2

IE22
NRR

cc (w/ Enclosure):

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

ENCLOSURE

Browns Ferry Nuclear Plant
Units 1, 2, and 3

Licensee Event Report 50-259/2012-007-01

Cable Routing Errors Found in the Appendix R Separation Analysis

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 (BFN), Unit 1	05000259	1 of 8

4. TITLE: Cable Routing Errors Found in the Appendix R Separation Analysis

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
									BFN, Unit 2	05000260
06	01	2012	2012	007	01	09	07	2012	FACILITY NAME: BFN, Unit 3	DOCKET NUMBER: 05000296

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)*
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

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 June 1, 2012, at 0900 hours Central Daylight Time (CDT), during the National Fire Protection Association (NFPA) 805 transition review, it was discovered that a cable routing error would result in failure of direct current control power to credited 4kV Shutdown Board 3EA during an Appendix R fire in Fire Area 23.

On July 11, 2012, at 1520 hours CDT, during the NFPA 805 transition review, it was discovered that an Appendix R cable was routed in Fire Zone 03-02. However, the Appendix R computerized separation analysis does not recognize the Appendix R cable as being routed in Fire Zone 03-02.

The root cause was determined to be the lack of an effective program for technical human performance tools during the performance of the Appendix R separation analysis.

The corrective action to prevent recurrence is to implement a technical human performance procedure for knowledge worker human performance tools for all programs/calculations performed by engineering.

I. PLANT CONDITION(S)

On June 1, 2012, at 0900 hours Central Daylight Time (CDT) when the first condition was identified, Browns Ferry Nuclear Plant (BFN), Units 1 and 2, were in Mode 1 at approximately 100 percent power. The BFN, Unit 3, was in Mode 4 at zero percent power.

On July 11, 2012, at 1520 hours CDT when the second condition was identified, BFN, Units 1, 2, and 3, were in Mode 1 at approximately 100 percent power.

II. DESCRIPTION OF EVENT

A. Event

Condition 1: Cable Routed in Fire Area (FA) 23

On June 1, 2012, at 0900 hours CDT, during the National Fire Protection Association (NFPA) 805 transition review, it was discovered that a cable routing error would result in failure of direct current (DC) control power to credited 4kV Shutdown Board [EB] 3EA during an Appendix R fire in FA 23.

Cable [CBL] 3B181 provides alternate DC control power to the 4kV Shutdown Board 3EA from Battery Board [BYBD] 2 and is routed in FA 23. However, cable 3B181 is not identified as being in FA 23 in the BFN Appendix R computerized separation analysis. This error allowed the analysis to credit alternate DC control power to the 4kV Shutdown Board 3EA. The normal DC control power to 4kV Shutdown Board 3EA via cable 3B180 would not be available for a FA 23 Appendix R fire because cable 3B180 is also routed through FA 23. Therefore, the separation analysis error results in the credited 4kV Shutdown Board 3EA being unable to perform its function for FA 23 Appendix R fires and could result in a loss of power to the credited safe shutdown equipment which would challenge the ability to provide adequate core cooling during the performance of the BFN Safe Shutdown Instructions.

Condition 2: Cable Routed in Fire Zone 03-02

On July 11, 2012, at 1520 hours CDT, during the NFPA 805 transition review, it was discovered that Appendix R cable PP698-IB was routed in Fire Zone 03-02. However, the Appendix R computerized separation analysis does not recognize Appendix R cable PP698-IB as being routed in Fire Zone 03-02.

Cable PP698-IB is associated with the 4kV Shutdown Board B cross-tie breaker [BKR] 1828 differential lockout contacts. Breaker 1828 is normally open and required to be open for a fire in Fire Zone 03-02. Fire damage to cable PP698-IB may cause a spurious closure of breaker 1828. This condition could impact the ability for the 4kV Shutdown Board B to perform its Appendix R function to power credited Appendix R loads for fires in Fire Zone 03-02 which would challenge the ability to provide adequate core cooling during the performance of BFN Safe Shutdown Instructions.

Breaker 1848 on 4kV Shutdown Board 3EB is also vulnerable to spurious closure in the event of an Appendix R fire in Fire Zone 03-02, as control cable 3ES2071-IB for

this breaker is routed through Fire Zone 03-02. In accordance with the applicable BFN Safe Shutdown Instruction, breaker 1848 is isolated and tripped locally prior to connecting Emergency Diesel Generator (EDG) [EK] 3B to 4kV Shutdown Board 3EB. If offsite power was lost and 4kV Shutdown Board B and 4kV Shutdown Board 3EB were powered from EDG B and EDG 3B respectively, and fire damage occurred to breaker 1848 control cable 3ES2071-IB and cable PP698-IB for the breaker 1828 differential lockout contacts, which are both routed in Fire Zone 03-02, prior to the completion of Safe Shutdown Instruction steps to isolate and trip breaker 1848, then the potential to parallel EDG B and EDG 3B out of phase would exist which could damage either EDG and challenge the ability to provide adequate core cooling during the performance of BFN Safe Shutdown Instructions.

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

There were no inoperable structures, components, or systems that contributed to these conditions.

C. Dates and Approximate Times of Major Occurrences

1987 to 1991	Appendix R separation analysis performed for BFN, Unit 2.
1991 to 1995	Appendix R separation analysis performed for BFN, Unit 3, which included BFN, Unit 2, Appendix R separation analysis.
2003 to 2007	Appendix R separation analysis performed for BFN, Unit 1, which included BFN, Units 2 and 3, Appendix R separation analysis.
June 1, 2012, at 0900 hours CDT	A cable routing error was identified that would result in failure of DC control power to credited 4kV Shutdown Board 3EA during an Appendix R fire in FA 23.
June 1, 2012, at 1626 hours CDT	The BFN reported the cable routed in FA 23 condition to the NRC.
July 11, 2012, at 1520 hours CDT	A cable associated with 4kV Shutdown Board B cross-tie breaker 1828 differential lockout contacts was identified to be routed in Fire Zone 03-02 which is not routed in accordance with the Appendix R separation analysis.
July 11, 2012, at 1818 hours CDT	The BFN reported the cable routed in Fire Zone 03-02 condition to the NRC.

D. Other Systems or Secondary Functions Affected

There were no other systems or secondary functions affected.

E. Method of Discovery

These conditions were discovered during NFPA 805 transition reviews.

F. Operator Actions

There were no operator actions.

G. Safety System Responses

There were no safety system responses.

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause was an error within the 4kV Shutdown Board cable block diagram that was created for Appendix R analyses.

B. Root Cause

The root cause was the lack of an effective program for technical human performance tools during the performance of the Appendix R separation analysis.

C. Contributing Factors

There were no contributing factors.

IV. ANALYSIS OF THE EVENT

The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 50.73(a)(2)(ii)(B), as any event or condition that resulted in the nuclear power plant being in an unanalyzed condition that significantly degraded plant safety, and 10 CFR 50.73(a)(2)(v)(A), 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.

Condition 1

The inadequate separation of the normal and alternate DC control power cables in FA 23 may result in the 4kV Shutdown Board 3EA potentially becoming unable to fulfill its function in the event of an Appendix R fire in this area. The DC control power allows for remote operation of various breakers required for safe shutdown, including the emergency diesel generator feeder breaker and the residual heat removal pump breakers. If the DC control power is lost during an Appendix R fire in FA 23, there is no assurance that the 4kV Shutdown Board 3EA will be able to be connected to provide power to the required loads. To mitigate the potential chances of this potential unavailability, a continuous fire watch has been stationed in FA 23 in order to reduce the probability that a fire has the opportunity to grow into an Appendix R event.

Condition 2

In the event of an Appendix R fire in Fire Zone 03-02, fire damage could occur to cables associated with 4kV Shutdown Board B cross-tie breaker 1828 and the 4kV Shutdown Board 3EB cross-tie breaker 1848. A fire induced hot short could cause the spurious

closure of breaker 1828. Fire damage to cable PP698-IB which is associated with 4kV Shutdown Board B cross-tie breaker 1828 differential lockout contacts could also result in the loss of the breaker trip function. This condition may result in the following two failures:

1) If breaker 1828 on 4kV Shutdown Board B spuriously closed, it could close onto a fault, since the cross-tie power cables from breaker 1828 on 4kV Shutdown Board B to breaker 1848 on 4kV Shutdown Board 3EB are routed through Fire Zone 03-02 and would be subject to a fire induced fault, if energized. This could result in the trip of EDG B output breaker 1822 and deenergization of the 4kV Shutdown Board B.

2) Breaker 1848 on 4kV Shutdown Board 3EB is also vulnerable to spurious closure in the event of an Appendix R fire in Fire Zone 03-02, as control cable 3ES2071-IB for this breaker is routed through Fire Zone 03-02. In accordance with the applicable BFN Safe Shutdown Instruction, breaker 1848 is isolated and tripped locally prior to connecting EDG 3B to 4kV Shutdown Board 3EB. If offsite power was lost and 4kV Shutdown Board B and 4kV Shutdown Board 3EB were powered from EDG B and EDG 3B respectively, and fire damage occurred to breaker 1848 control cable 3ES2071-IB and cable PP698-IB for the breaker 1828 differential lockout contacts, which are both routed in Fire Zone 03-02, prior to the completion of Safe Shutdown Instruction steps to isolate and trip breaker 1848, then the potential to parallel EDG B and EDG 3B out of phase would exist. Either paralleling EDG B and EDG 3B out of phase with each other or paralleling out of phase with offsite power poses the potential to damage either EDG.

From 1987 to 1991, the Appendix R separation analysis for BFN, Unit 2, was conducted using manual evaluations/drawings for cable separation analysis. The Appendix R separation analysis for BFN, Unit 3, was conducted from 1991 to 1995 and was prepared using block diagrams and a computer program. This BFN, Unit 3, Appendix R separation analysis also incorporated the previous BFN, Unit 2, Appendix R separation analysis. The BFN, Unit 1, Appendix R separation analysis was conducted from 2003 to 2007 using the System Assurance and Fire Protection Engineering (SAFE) program and the Integrated Cable and Raceway Design System (ICRDS) for cable routing data and combined BFN, Units 1, 2, and 3, data into the SAFE program.

Subsequent to the time periods of the performance of the BFN Appendix R separation analyses, lessons learned have been implemented throughout the industry on the use of technical human performance tools to mitigate/prevent documentation errors. In 2005, the Institute of Nuclear Power Operations (INPO) released INPO 05-002, Human Performance Tools for Engineers and Other Knowledge Workers, and INPO 05-006, Engineering Organization Success Factors. These two documents incorporated industry lessons learned to provide guidance for technical human performance tools.

The BFN has implemented human performance program improvements to ensure that human errors are minimized. The station maintains a human performance program and individuals are trained on the use of human performance tools.

Extent of Condition

The extent of condition is limited to all Appendix R Safe Shutdown Boards normal and alternate DC control power feeds as well as the normal and alternate AC power feeds.

Extent of Cause

The extent of cause was determined to include other programs/calculations that are dated, knowledge intensive, and comparable to the significance of the Appendix R separation analysis.

V. ASSESSMENT OF SAFETY CONSEQUENCES

Condition 1

The normal and alternate DC control power cables to the 4kV Shutdown Board 3EA are both routed in FA 23. An Appendix R fire in FA 23 would result in the unavailability of 4kV Shutdown Board 3EA, which impacts the operator's ability to shutdown the plant using the credited components in the BFN Appendix R Safe Shutdown Instructions. The total ignition frequency for the fires for the scenarios of interest is 1.31E-3/year. However, this fire ignition frequency is based on time to damage of the closest target to the source. Consideration of the plant cable routing configuration of the subject cable allows credit for additional mitigation of fire damage effects. In accordance with the guidance provided in NUREG/CR-6850, Fire Probabilistic Risk Assessment Methods Enhancements, dated September 2010, these mitigation factors include fire propagation time due to the location of the associated cable tray in the cable tray stack relative to the postulated fire source and the probability of manual suppression success. In addition, the probability of manually aligning normal control power, which is not impacted by the fires of interest, to the shutdown board was also considered. Inclusion of these additional mitigation factors reduces the fire impacts to below 1.00E-4/year, which is less than the defined threshold for a scenario of interest.

For the above condition, a continuous fire watch has been established in order to decrease the probability of a serious fire.

Condition 2

Cable PP698-IB associated with 4kV Shutdown Board B cross-tie breaker 1828 differential lockout contacts was routed in Fire Zone 03-02 which is not routed in accordance with the Appendix R separation analysis. Breaker 1828 is normally open and required to be open for a fire in Fire Zone 03-02. In the event of an Appendix R fire in Fire Zone 03-02, fire damage could occur to cables associated with 4kV Shutdown Board B cross-tie breaker 1828 and the 4kV Shutdown Board 3EB cross-tie breaker 1848. A fire induced hot short could cause the spurious closure of breaker 1828. Fire damage to cable PP698-IB which is associated with 4kV Shutdown Board B cross-tie breaker 1828 differential lockout contacts could also result in the loss of the breaker trip function. This condition could result in the deenergization of the 4kV Shutdown Board B and the potential to parallel EDG B and EDG 3B out of phase with each other or parallel out of phase with offsite power, which poses the potential to damage either EDG. As a

result, the operator's ability to shutdown the plant using the credited components in the BFN Appendix R Safe Shutdown Instructions could be impacted.

A probabilistic risk assessment evaluation was performed to determine the fires in Fire Zone 03-02 which affect cable PP698-IB. The fires which impact cable PP698-IB were evaluated using the following approach.

The issue was first evaluated to determine the impacts of the issue. If individual targets were assigned to the listed issue, these targets were queried in the SAFE program to determine the applicable fires that could damage the subject targets. These identified source ignition frequencies were then taken from the scoping fire modeling calculation performed in support of the BFN fire probabilistic risk assessment. This evaluation was limited to the fire zones where the subject issue adversely impacts the credited Appendix R safe shutdown strategy.

There was only one fire scenario that was identified that impacted cable PP698-IB and the frequency of this fire is 1.59E-6/year, which is less than the defined threshold for a scenario of interest.

For the above condition, a roving fire watch has been established in order to decrease the probability of a serious fire.

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

A. Immediate Corrective Actions

A continuous fire watch in FA 23 was established and a roving fire watch in Fire Zone 03-02 was established.

B. Corrective Actions

1. A design change will be implemented to correct the routing of the normal and alternate DC control power cables that are both routed through FA 23.
2. A comprehensive cable routing verification of the normal and alternate control power for the Safe Shutdown Board feeds will be performed.
3. An assessment will be performed to determine the overall condition of the programs/calculations.
4. A design change will be implemented to correct the non-conformance of cable PP698-IB that is routed in Fire Zone 03-02.

C. Corrective Actions to Prevent Recurrence

Implement a technical human performance procedure for knowledge worker human performance tools for all programs/calculations performed by engineering.

VII. ADDITIONAL INFORMATION

A. Failed Components

There were no failed components.

B. Previous Similar Events

A search of BFN, Units 1, 2, and 3, LERs for approximately the past five years did identify LER 50-259/2010-001-00, Unit 1, 2, and 3 Appendix R Safe Shutdown Instruction Procedures Contain Incorrect Operator Manual Actions, and LER 50-259/2012-003-00, Reactor Protection System Circuit Could Potentially Remain Energized During An Appendix R Fire, as similar events that were discovered during NFPA 805 transition.

A search was performed on the BFN corrective action program. The previous problem evaluation reports (PERs) associated with the similar LERs are PERs 243955 and 503304. The similar PERs related to this condition are PERs 358612, 405118, 409312, 422371, 493807, and 499047.

C. Additional Information

The corrective action documents for this report are PERs 561101 and 577583.

D. Safety System Functional Failure Consideration

In accordance with NEI 99-02, these conditions are considered a safety system functional failure for BFN, Units 1, 2, and 3, because they could challenge the ability to provide adequate core cooling during the performance of the BFN Safe Shutdown Instructions.

E. Scram With Complications Consideration

These conditions did not include a scram.

VIII. COMMITMENTS

There are no commitments.