



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

June 27, 2011

10 CFR 50.73

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

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

Subject: Licensee Event Report 50-259/2011-002-00

On April 27, 2011, severe weather in the Tennessee Valley Service Area caused grid instability and loss of all 500-kV offsite power sources that resulted in a scram of all three Browns Ferry Nuclear Plant (BFN) units. On April 28, 2011, with all three BFN units in cold shutdown and power supplied by onsite emergency diesel generators (EDGs), BFN Operations personnel performed an emergency shutdown of the Unit 1/2 C EDG. This resulted in a Primary Containment Isolation System actuation which caused the loss of Shutdown Cooling for BFN Units 1 and 2.

The Tennessee Valley Authority (TVA) is submitting this report in accordance with 10 CFR 21.2(c), reporting of defects; 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 10 CFR 50.73(a)(2)(iv)(B); and 10 CFR 50.73(a)(2)(v)(B), as an event that could have prevented the fulfillment of a safety function for systems needed to remove decay heat.

JE2
MRK

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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 259/2011-002 - Loss of Safety Function (SDC)
Resulting from Loss of Power from C EDG Due to Oil Leak

cc (w/ Enclosure):

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

Enclosure

**Browns Ferry Nuclear Plant
Unit 1**

**Licensee Event Report 259/2011-002
Loss of Safety Function (SDC) Resulting from Loss of Power from C EDG
Due to Oil Leak**

See Attached

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 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.

1. FACILITY NAME Browns Ferry Nuclear Plant (BFN) Unit 1	2. DOCKET NUMBER 05000259	3. PAGE 1 OF 8
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4. TITLE
Loss of Safety Function (SDC) Resulting from Loss of Power from C EDG Due to Oil Leak

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
04	28	2011	2011	002	00	06	27	2011	BFN Unit 2	05000260
									FACILITY NAME	DOCKET NUMBER
									N/A	05000

9. OPERATING MODE 4	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)											
	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> 50.73(a)(2)(vii)								
10. POWER LEVEL 000	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)								
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)								
	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)								
	<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)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)								
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)								
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input checked="" type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)								
<input type="checkbox"/> 20.2203(a)(2)(v)	<input type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input checked="" type="checkbox"/> OTHER - Part 21									
<input type="checkbox"/> 20.2203(a)(2)(vi)	<input type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A									

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME James W. Davenport, Licensing Engineer	TELEPHONE NUMBER (Include Area Code) 256-729-2690
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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	EK	DG	E147	Yes					

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
<input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE)	<input checked="" type="checkbox"/> NO	N/A	N/A	N/A

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On April 28, 2011, at 2338 hours Central Daylight Time, with all three units in cold shutdown and power supplied to the 4kV shutdown buses by onsite emergency diesel generators (EDGs), Browns Ferry Nuclear Plant performed a shutdown of the Unit 1/2 C EDG. The C EDG was shutdown due to a hydraulic oil leak in piping for the EDG governor that was causing voltage and frequency fluctuations. Following shutdown of the Unit 1/2 C EDG, the 4kV shutdown board C, which was being powered by the C EDG, de-energized. This resulted in a loss of power to the 1B Reactor Protection System causing a Primary Containment Isolation System (PCIS) actuation. The PCIS isolation (Group 2) caused the loss of Shutdown Cooling on Unit 1 for 47 minutes. In addition, the loss of power to the 4kV shutdown board C also caused the loss of the 2B Residual Heat Removal (RHR) pump leading to a momentary suspension of Shutdown Cooling for Unit 2. Shutdown Cooling for Unit 2 was immediately restored using the 2D RHR pump. The root cause of the oil leak was determined to be a less than adequate design of the C EDG governor oil piping to compensate for vibration loading.

This report also constitutes a 10 CFR 21 notification.

LICENSEE EVENT REPORT (LER)
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NARRATIVE

I. PLANT CONDITION(S)

On April 27, 2011, severe weather in the Tennessee Valley Service Area caused grid instability and a loss of all 500-kV offsite power sources that resulted in a scram of all three Browns Ferry Nuclear Plant (BFN) units. At the time of the event being reported [April 28, 2011, at 23:38 hours Central Daylight Time (CDT)], BFN Units 1, 2, and 3 were in Mode 4 (Cold Shutdown) with shutdown 4kV buses supplied by seven of eight onsite emergency diesel generators (EDG) [EK].

II. DESCRIPTION OF EVENT

A. Event:

On April 28, 2011, at 23:38 hours CDT, seven of eight EDGs were in service to provide AC power for emergency core cooling loads. Operations personnel observed a small leak on the governor hydraulic oil system piping for the Unit 1/2 C EDG. When the piping was found leaking, Operations personnel began to switch Residual Heat Removal (RHR) [BO] pumps to unload the C EDG. The leak rapidly progressed from 1 drop per minute to a steady stream/spray and upon witnessing worsening voltage and frequency fluctuations; Operations personnel initiated an emergency shutdown of the C EDG. Upon loss of the C EDG, the C 4kV Shutdown Board [EB] de-energized. This resulted in a loss of Shutdown Cooling (SDC) on Units 1 and 2. Unit 1 SDC was lost due to a Group 2 Primary Containment Isolation System (PCIS) [JE] actuation from the loss of the C 4kV shutdown board. SDC was restored to Unit 1 in 47 minutes after the PCIS actuation and SDC was restored to Unit 2 four minutes after the failure. While the C EDG was out of service, the failed fitting was replaced with a like-for-like. The failed fitting was sent to an offsite laboratory for failure analysis.

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

Loss of offsite power was a contributor to this event.

C. Dates and Approximate Times of Major Occurrences:

- | | |
|---|--|
| <p>April 27, 2011, at 16:36 hours CDT</p> | <p>Loss of all 500-kV offsite power sources. Scram of all 3 BFN units and 7 of 8 EDGs started. (3B EDG, was inoperable and unavailable due to planned maintenance.)</p> |
| <p>April 28, 2011, at 23:30 hours CDT</p> | <p>Unit 1/2 C EDG governor hydraulic oil piping leak observed by Operations personnel. Maintenance personnel notified to prepare to add oil. Operations personnel prepared to switch from 2B to 2D RHR pump.</p> |
| <p>April 28, 2011, at 23:38 hours CDT</p> | <p>Operations personnel performed emergency shutdown of Unit 1/2 C EDG due to hydraulic oil piping leak on governor. SDC lost to Unit 1 and Unit 2.</p> |

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April 28, 2011, at 23:42 hours CDT	Unit 2 SDC restored by starting 2D RHR pump.
April 29, 2011, at 00:25 hours CDT	Unit 1 SDC restored by resetting PCIS signal and establishing SDC.
April 30, 2011, at 10:47 hours CDT	Unit 1/2 C EDG operable after replacement of failed hydraulic oil piping fitting and successful post maintenance testing.
May 2, 2011, at 20:10 hours CDT	All shutdown boards are powered from qualified 161-kV offsite power sources, and all EDGs are shutdown and in standby readiness.

D. Other Systems or Secondary Functions Affected:

None

E. Method of Discovery:

Operations personnel were continuously monitoring the EDGs for leaks, abnormal noises, and vibration. Operations personnel observed a small leak (1 drop per minute) on the governor hydraulic oil system piping for the Unit 1/2 C EDG.

F. Operator Actions:

The C EDG oil leak rapidly progressed from 1 drop per minute to a steady stream/spray. Upon witnessing worsening voltage and frequency fluctuations, Operations personnel initiated an emergency shutdown of the Unit 1/2 C EDG.

G. Safety System Responses:

All onsite safe shutdown equipment was available with the exception of the 3B EDG, which was inoperable and unavailable due to planned maintenance.

III. CAUSE OF THE EVENT

A. Immediate Cause:

The immediate cause of this event was a leaking 1/8-inch threaded brass fitting on the governor-to-governor booster pump hydraulic oil piping of the Unit 1/2 C EDG.

B. Root Cause:

The root cause was determined to be less than adequate design of the Unit 1/2 C EDG governor hydraulic oil piping to compensate for vibration loading. As a result, the 1/8-inch threaded brass fitting failed due to fatigue from cyclic vibration loads transmitted from the EDG governor.

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IV. ANALYSIS OF THE EVENT

The Tennessee Valley Authority (TVA) is reporting this event 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 10 CFR 50.73(a)(2)(iv)(B). This event is also reportable in accordance with 10 CFR 50.73(a)(2)(v)(B), as an event that could have prevented the fulfillment of a safety function for systems needed to remove decay heat. The Unit 1/2 C EDG is a common EDG which feeds Unit 1 and Unit 2 equipment. Loss of the Unit 1/2 C EDG also caused a loss of the 1B Reactor Protection System (RPS) because the 1B RPS is fed from the 480V Reactor Motor Operated Valve Board [ED] 1B, which is fed from the 480V Shutdown Board [ED] 1B, which is fed from the C 4kV Shutdown Board. Loss of power to the 1B RPS caused PCIS Group 2, 3, 6, and 8 isolations. Unit 1 SDC was lost due to the Group 2 PCIS isolation. SDC was restored 47 minutes later for Unit 1 in accordance with Abnormal Operating Instruction (AOI) 1-AOI-74, Loss of Shutdown Cooling. In addition to the loss of SDC, automatic initiation of the three trains of Standby Gas Treatment System [BH], one train of Control Room Emergency Ventilation System [VI], a Reactor Water Cleanup System [CE] trip (due to loss of suction on PCIS isolation), and loss of the A Control Air System [LE] compressor.

The 2B RHR pump is fed by the C 4kV Shutdown Board, so that pump was lost resulting in a momentary suspension of SDC to Unit 2. The 2D RHR pump was used to restore SDC to Unit 2 four minutes after the Unit 1/2 C EDG was shut down.

TVA is currently evaluating the potential that this condition may have resulted in past inoperability of the C EDG. If this is found to be the case, a revision to this LER will be submitted.

TVA is also submitting this report in accordance with 10 CFR 21 due to the root cause determination of inadequate design of the Unit 1/2 C EDG governor-to-governor booster pump hydraulic oil line. See Part VII.F of this report for details.

V. ASSESSMENT OF SAFETY CONSEQUENCES

This event could have been significant from a nuclear safety standpoint. The EDGs are one of the most important BFN systems as determined by the plant's Probability Risk Assessment. Loss of an EDG limits the capability for the unit to respond to an accident or transient when accompanied by a loss of offsite power. The Unit 1/2 C EDG operated for approximately 31 hours prior to Operations personnel performing an emergency shutdown. The 31 hours of operation did not meet the 7-day mission time of the C EDG. If multiple EDGs had experienced the same failure under the same event scenario, BFN could have lost its ability to provide power to components essential for heat removal from the reactor vessel.

However, since the remaining three Unit 1/2 EDGs remained operable and all of the Emergency Core Cooling Systems were operable, there was sufficient redundancy to support the core cooling requirements for Units 1 and 2. Therefore, this event was of minimal safety significance.

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The oil leak caused a loss of the Unit 1/2 C EDG and subsequent loss of SDC on Unit 1 and Unit 2. Unit 1 restored SDC in 47 minutes after the failure and SDC was restored on Unit 2 four minutes after the failure. This information is relevant because the time to boil Spent Fuel Pool Water (airborne radioactive contamination risk) was approximately 2 hours for each unit. In addition, TS 3.4.8, Residual Heat Removal (RHR) Shutdown Cooling System - Cold Shutdown, contains provisions that allow both RHR Shutdown Cooling subsystems to be out of service for up to one hour. Therefore, while this event could have been significant from a radiological safety standpoint, in actuality it had minimal safety significance.

In addition, the equivalent 1/8-inch threaded brass fittings for the Unit 1/2 A, B, and D EDGs were removed and submitted for laboratory analysis to determine if there was any evidence of cracking as identified on the Unit 1/2 C EDG. A Liquid Penetrant (PT) nondestructive examination was performed on each of the fittings and no indication of cracking was identified. The Unit 1/2 A, B, and D EDGs ran for approximately 5 days following the loss of offsite power event that began on April 27, 2011. Based on the approximate 5-day run time of these EDGs and the laboratory analysis that found no cracking of the fittings, it can be concluded that the 7-day mission time for these EDGs would most likely have been met.

VI. CORRECTIVE ACTIONS

Corrective actions are being managed within TVA's Corrective Action Program.

A. Immediate Corrective Actions:

The following immediate corrective actions were taken:

- Operations personnel performed an emergency shutdown of the Unit 1/2 C EDG and all loads were transferred to an operating EDG.
- Replaced failed 1/8-inch brass threaded fitting (like-for-like) on the Unit 1/2 C EDG governor hydraulic oil system.
- The failed fitting was recovered and sent to Alstom TTTM Laboratory, Chattanooga, Tennessee, for failure analysis.
- Performed vibration testing on all four Unit 1/2 EDG governor oil piping.

Other corrective actions to be performed:

- Verify as-found torque values on the Unit 1/2 C EDG governor bolting. Perform analysis of the results.
- Review the small bore (<1/2-inch) tubing/piping connections on the High Pressure Coolant Injection System [BJ] and determine its acceptability for vibration loading considering tubing weight, dimensions, operating experience, and any available vibration data.
- Review the small bore (<1/2-inch) tubing/piping connections on the Reactor Core Isolation Cooling System [BN] and determine its acceptability for vibration loading considering tubing weight, dimensions, operating experience, and any available vibration data.
- Review the small bore (<1/2-inch) tubing/piping connections on all eight EDGs and determine acceptability for vibration loading considering tubing weight, dimensions, operating experience, and any available vibration data.

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B. Corrective Actions to Prevent Recurrence:

The governor-to-governor booster pump hydraulic oil lines were redesigned and replaced with flexible hose rather than hard tubing. The hard tubing was replaced on all four Unit 1/2 EDGs. In addition, the sister fittings on the Unit 1/2 A, B, and D EDGs were removed for lab analysis to determine if there was any evidence of cracking. A PT nondestructive examination was performed on each of the fittings and no indication of cracking was identified.

The four Unit 3 EDG governor-to-governor booster pump hydraulic oil lines were originally supplied with flexible hose. Therefore, no modifications were necessary for those components.

VII. ADDITIONAL INFORMATION

A. Failed Components:

Unit 1/2 C Emergency Diesel Generator

B. Previous LERS or Similar Events:

A search of BFN LERs for Units 1, 2, and 3 for approximately the past five years did not identify any similar issues involving cracked or failed tubing threaded fittings.

Review of BFN Work Orders (WO) concluded that numerous oil leaks have occurred on the EDGs. However, none of them appeared to be major leaks that caused the EDG to be declared inoperable. There were also no WOs that indicated the failed fitting for this event had ever been replaced. This indicates that the fitting is originally installed equipment (Unit 1/2 EDGs delivered in 1970).

A search of the BFN corrective action program was performed. There were several Problem Evaluation Reports (PERs) that documented oil leaks and oil level issues. None of the PERs reviewed were associated with fitting failures similar to the current event, in that there were no low stress high cycle fatigue cracks on the EDGs previously identified.

C. Additional Information:

The corrective action document for this report is PER 362395.

D. Safety System Functional Failure Consideration:

This event is a safety system functional failure in accordance with NEI 99-02.

E. Scram With Complications Consideration:

This event did not include a reactor scram.

F. 10 CFR Part 21 Reporting Requirements:

The following information is provided to meet the requirements of 10 CFR 21.21(d)(4)(i) thru (viii)

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- (i) Name and address of the individual or individuals informing the Commission.

K. J. Polson
 Site Vice President
 Tennessee Valley Authority
 Browns Ferry Nuclear Plant
 Post Office Box 2000
 Decatur, Alabama 35609-2000

- (ii) Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which fails to comply or contains a defect.

Facility: Browns Ferry Nuclear Plant

Basic component which contains a defect:

Unit 1/2 C Emergency Diesel Generator, Model 999-20, (Engine Model Number 20-645E4, order number 9464).

- (iii) Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect.

Basic component supplier:

General Motors, Electro-Motive Division, La Grange, Illinois

- (iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

Nature of the defect :

The root cause was determined to be less than adequate design of the Unit 1/2 C EDG governor hydraulic oil piping to compensate for vibration loading. As a result, the 1/8-inch brass threaded fitting failed due to fatigue from cyclic vibration loads transmitted from the EDG governor.

Safety hazard which could be created by such defect:

Loss of an EDG limits the capability for the unit to respond to an accident or transient when accompanied by a loss of offsite power.

- (v) The date on which the information of such defect or failure to comply was obtained.

BFN Site Engineering (Procurement Engineering Group) completed the Part 21 evaluation on June 21, 2011.

- (vi) In the case of a basic component which contains a defect or fails to comply, the number and location of all such components in use at, supplied for, or being supplied for one or more facilities or activities subject to the regulations in this part.

Other 1/8-inch brass threaded fittings of this type were used in designs supplied by the vendor for the BFN Unit 1/2 A, B, and D EDGs.

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(vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

As stated in Section VI.B of this report, the governor-to-governor booster pump hydraulic oil lines were redesigned and replaced with flexible hose rather than hard tubing. The hard tubing was replaced on all four of the Unit 1/2 EDGs.

The four Unit 3 EDG governor-to-governor booster pump hydraulic oil lines were originally supplied with flexible hose. Therefore, the failed component does not exist on the four Unit 3 EDGs.

VIII. COMMITMENTS

None