



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

March 21, 2012

10 CFR 21  
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 50-259/2011-002-01**

**Reference:** Letter from TVA to NRC, "Licensee Event Report 50-259/2011-002-00,"  
dated June 27, 2011

On June 27, 2011, the Tennessee Valley Authority (TVA) submitted Revision 0 to Licensee Event Report (LER) 50-259/2011-002. In Revision 0, TVA indicated that it was evaluating the Unit 1/2 C Emergency Diesel Generator (EDG) for past inoperability, and if there was a past inoperability issue identified, TVA would revise the LER for the loss of safety function that resulted from the loss of power from the Unit 1/2 C EDG due to an oil leak.

TVA is submitting this supplemental LER in accordance with 10 CFR 21.2(c), reporting of defects; 10 CFR 50.73(a)(2)(i)(B), as an operation or condition that is prohibited by the plant's Technical Specifications; 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.

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

cc: See Page 2

TE22  
NRC

U.S. Nuclear Regulatory Commission  
Page 2  
March 21, 2012

Enclosure: Licensee Event Report 259/2011-002-01 - Loss of Safety Function (SDC)  
Resulting from Loss of Power from Unit 1/2 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  
Units 1, 2, and 3**

**Licensee Event Report 259/2011-002-01**

**Loss of Safety Function (SDC) Resulting from Loss of Power from Unit 1/2 C EDG  
Due to Oil Leak**

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**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.

<b>1. FACILITY NAME</b> Browns Ferry Nuclear Plant (BFN) Unit 1	<b>2. DOCKET NUMBER</b> 05000259	<b>3. PAGE</b> 1 of 12
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**4. TITLE:** Loss of Safety Function (SDC) Resulting from Loss of Power from Unit 1/2 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	01	03	21	2012	BFN Unit 2	05000260
									FACILITY NAME	DOCKET NUMBER
									BFN Unit 3	05000296

<b>9. OPERATING MODE</b>  4	<b>11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §:</b> <i>(Check all that apply)</i> <table style="width:100%; border:none;"> <tr> <td><input type="checkbox"/> 20.2201(b)</td> <td><input type="checkbox"/> 20.2203(a)(3)(i)</td> <td><input type="checkbox"/> 50.73(a)(2)(i)(C)</td> <td><input type="checkbox"/> 50.73(a)(2)(vii)</td> </tr> <tr> <td><input type="checkbox"/> 20.2201(d)</td> <td><input type="checkbox"/> 20.2203(a)(3)(ii)</td> <td><input type="checkbox"/> 50.73(a)(2)(ii)(A)</td> <td><input type="checkbox"/> 50.73(a)(2)(viii)(A)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(1)</td> <td><input type="checkbox"/> 20.2203(a)(4)</td> <td><input type="checkbox"/> 50.73(a)(2)(ii)(B)</td> <td><input type="checkbox"/> 50.73(a)(2)(viii)(B)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(i)</td> <td><input type="checkbox"/> 50.36(c)(1)(i)(A)</td> <td><input type="checkbox"/> 50.73(a)(2)(iii)</td> <td><input type="checkbox"/> 50.73(a)(2)(ix)(A)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(ii)</td> <td><input type="checkbox"/> 50.36(c)(1)(ii)(A)</td> <td><input checked="" type="checkbox"/> 50.73(a)(2)(iv)(A)</td> <td><input type="checkbox"/> 50.73(a)(2)(x)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(iii)</td> <td><input type="checkbox"/> 50.36(c)(2)</td> <td><input type="checkbox"/> 50.73(a)(2)(v)(A)</td> <td><input type="checkbox"/> 73.71(a)(4)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(iv)</td> <td><input type="checkbox"/> 50.46(a)(3)(ii)</td> <td><input checked="" type="checkbox"/> 50.73(a)(2)(v)(B)</td> <td><input type="checkbox"/> 73.71(a)(5)</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(v)</td> <td><input type="checkbox"/> 50.73(a)(2)(i)(A)</td> <td><input type="checkbox"/> 50.73(a)(2)(v)(C)</td> <td><input checked="" type="checkbox"/> OTHER - Part 21</td> </tr> <tr> <td><input type="checkbox"/> 20.2203(a)(2)(vi)</td> <td><input checked="" type="checkbox"/> 50.73(a)(2)(i)(B)</td> <td><input type="checkbox"/> 50.73(a)(2)(v)(D)</td> <td><small>Specify in Abstract below or in NRC Form 366A</small></td> </tr> </table>	<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)	<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 checked="" type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	<small>Specify in Abstract below or in NRC Form 366A</small>
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<b>10. POWER LEVEL</b>  000																																					

**12. LICENSEE CONTACT FOR THIS LER**

FACILITY NAME Eric Bates, Licensing Engineer	TELEPHONE NUMBER <i>(Include Area Code)</i> 256-614-7180
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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	Y					

<b>14. SUPPLEMENTAL REPORT EXPECTED</b> <input type="checkbox"/> YES <i>(If yes, complete 15. EXPECTED SUBMISSION DATE)</i> <input checked="" type="checkbox"/> NO	<b>15. EXPECTED SUBMISSION DATE</b>						
	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th>MONTH</th><th>DAY</th><th>YEAR</th> </tr> <tr> <td style="text-align:center;">N/A</td><td style="text-align:center;">N/A</td><td style="text-align:center;">N/A</td> </tr> </table>	MONTH	DAY	YEAR	N/A	N/A	N/A
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**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 4-kV shutdown buses by onsite emergency diesel generators (EDGs), Browns Ferry Nuclear Plant personnel performed a shutdown of the Unit 1/2 C EDG. The Unit 1/2 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 4-kV shutdown board C, which was being powered by the Unit 1/2 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 4-kV 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 Unit 1/2 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 2338 hours Central Daylight Time (CDT)], BFN Units 1, 2, and 3 were in Mode 4 (Cold Shutdown) with shutdown 4-kV buses supplied by seven of eight onsite emergency diesel generators (EDG) [EK].

**II. DESCRIPTION OF EVENT**

**A. Event**

On April 28, 2011, at 2338 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 Unit 1/2 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 Unit 1/2 C EDG. Upon loss of the Unit 1/2 C EDG, the C 4-kV 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 4-kV 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 Unit 1/2 C EDG was out of service, the failed fitting was replaced with a like-for-like fitting. The failed fitting was sent to an offsite laboratory for failure analysis.

As a result of performing a past operability evaluation on the Unit 1/2 C EDG, it was determined the Unit 1/2 C EDG would have been unable to perform its specified safety function from April 1, 2011, at 1526 hours CDT until April 30, 2011, at 1047 hours CDT, when the failed fitting was replaced and post maintenance testing was successfully completed. In addition, it has been determined, as a result of performing a separate past operability evaluation on the Unit 1/2 A EDG, that the Unit 1/2 A EDG would have also been unable to perform its specified safety function during this time period. The Unit 1/2 A EDG inoperability is addressed in LER 50-259/2011-003-01.

**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**

April 5, 2011, at 2208 hours CDT

Unit 2 enters Mode 2 from refueling outage that started on February 26, 2011, at 0001 hours Central Standard Time.

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**NARRATIVE**

April 24, 2011, at 2003 hours CDT	3B EDG declared inoperable due to planned maintenance outage.
April 27, 2011, at 1636 hours CDT	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.)
April 28, 2011, at 0243 hours CDT	Unit 3 entered Mode 4.
April 28, 2011, at 0545 hours CDT	Unit 2 entered Mode 4.
April 28, 2011, at 1337 hours CDT	Unit 1 entered Mode 4.
April 28, 2011, at 2330 hours CDT	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.
April 28, 2011, at 2338 hours CDT	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.
April 28, 2011, at 2342 hours CDT	Unit 2 SDC restored by starting 2D RHR pump.
April 29, 2011, at 0025 hours CDT	Unit 1 SDC restored by resetting PCIS signal and establishing SDC.
April 30, 2011, at 1047 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 2010 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**

There were no other systems or secondary functions affected.

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**NARRATIVE**

**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 Unit 1/2 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**

During the loss of SDC event, the Technical Specifications (TS) required Emergency Core Cooling System (ECCS) subsystems were Operable to ensure adequate core cooling.

**III. CAUSE OF THE EVENT**

This LER addresses the cause of the failure of the Unit 1/2 C EDG. The cause of the failure of the Unit 1/2 A EDG is addressed in LER 50-259/2011-003-01.

**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.

**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) [JC] 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 4-kV 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 (SGT) System [BH], automatic initiation of one train of Control Room Emergency Ventilation (CREV) System [VI], a trip of the

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**NARRATIVE**

Reactor Water Cleanup System [CE] (due to loss of suction on PCIS isolation), and loss of the A Control Air System [LE] compressor occurred.

The 2B RHR pump is fed by the C 4-kV 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 shutdown.

Based on the following, TVA is also reporting this event in accordance with 10 CFR 50.73(a)(2)(i)(B), as an operation or condition that is prohibited by the plant's TS.

As a result of performing a past operability evaluation on the Unit 1/2 C EDG, it was determined the Unit 1/2 C EDG would have been unable to perform its specified safety function from April 1, 2011, at 1526 hours CDT until April 30, 2011, at 1047 hours CDT, when the failed fitting was replaced and post maintenance testing was successfully completed. The determination was based on the results of an evaluation of the Unit 1/2 C EDG operating history and the cause of the failure. In addition, it has been determined, as a result of performing a separate past operability evaluation on the Unit 1/2 A EDG, that the Unit 1/2 A EDG would have also been unable to perform its specified safety function during this time period. The Unit 1/2 A EDG inoperability is addressed in LER 50-259/2011-003-01. Based on the results of these past operability evaluations, two Unit 1/2 EDGs were inoperable concurrently.

During this time period, the status of the three BFN units was as follows.

- Unit 1 was in Mode 1 until the unit automatically scrammed on April 27, 2011, at 1636 hours CDT (entering Mode 3) as a result of the loss of all 500-kV offsite power sources. Unit 1 subsequently entered Mode 4 on April 28, 2011, at 1337 hours CDT.
- Unit 2 was in a refueling outage and started up from this refueling outage and transitioned from Mode 4 to Mode 2 on April 5, 2011, at 2208 hours CDT. Unit 2 subsequently transitioned to Mode 1 and remained there until the unit automatically scrammed on April 27, 2011, at 1636 hours CDT (entering Mode 3) as a result of the loss of all 500-kV offsite power sources. Unit 2 subsequently entered Mode 4 on April 28, 2011, at 0545 hours CDT.
- Unit 3 was in Mode 1 until the unit automatically scrammed on April 27, 2011, at 1636 hours CDT (entering Mode 3) as a result of the loss of all 500-kV offsite power sources. Unit 3 subsequently entered Mode 4 on April 28, 2011, at 0243 hours CDT.

BFN Units 1 and 2 TS Limiting Condition for Operation (LCO) 3.8.1, "AC Sources - Operating," requires, in part, that Unit 1/2 EDGs be Operable in Modes 1, 2, and 3. The Unit 1/2 EDGs consist of the A, B, C, and D EDGs. If two or more Unit 1/2 EDGs are inoperable, TS 3.8.1 Required Action H.1 requires all but one EDG to be restored to Operable status within 2 hours. If this TS 3.8.1 Required Action is not met within 2 hours, then both Units 1 and 2 are required to be in Mode 3 within 12 hours and in Mode 4 within 36 hours. Since it was not recognized that the two Unit 1/2 EDGs were inoperable concurrently until the completion of the two past



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**NARRATIVE**

operability evaluations, BFN Units 1 and 2 operated with inoperable EDGs longer than allowed by the TS.

In addition, BFN Unit 2 started up from a refueling outage and transitioned from Mode 4 to Mode 2 on April 5, 2011, at 2208 hours CDT while the Unit 1/2 A EDG and Unit 1/2 C EDG were inoperable. LCO 3.0.4 prohibits Mode changes when a LCO is not met except under certain conditions that were not applicable to this event. Therefore, BFN Unit 2 entered the applicability of TS LCO 3.8.1 without the required EDGs Operable contrary to the requirements of LCO 3.0.4.

BFN Units 1 and 2 TS LCO 3.8.1, also requires, in part, that two qualified circuits between the offsite transmission network and the onsite Class 1E AC Electrical Power Distribution System be Operable in Modes 1, 2 and 3. Upon loss of all required offsite power sources concurrent with the two inoperable Unit 1/2 EDGs, TS 3.8.1 Required Action J.1 requires immediate entry into LCO 3.0.3. LCO 3.0.3 requires action be initiated within 1 hour to place the unit in Mode 2 within 10 hours, Mode 3 within 13 hours, and Mode 4 within 37 hours. These requirements were satisfied as a result of the automatic scrams that occurred on April 27, 2011, at 1636 hours CDT, placing each unit in Mode 3, and subsequent cooldown of each of the units to Mode 4 within the required time periods.

BFN Units 1 and 2 TS LCO 3.8.2, "AC Sources - Shutdown," requires, in part, two of the four Unit 1/2 EDGs each capable of supplying one 4-kV shutdown board of the onsite Class 1E AC electrical power distribution subsystems required by LCO 3.8.8, "Distribution Systems - Shutdown," to be Operable. LCO 3.8.8 requires the necessary portions of the AC and DC electrical power distribution subsystems to be Operable to support equipment required to be Operable in Modes 4 and 5 and during movement of irradiated fuel assemblies in the secondary containment. In the event, one or more required Unit 1/2 EDGs are inoperable, TS 3.8.2 Required Actions B.1.1, B.1.2, B.1.3, and B.1.4 require immediate suspension of Core Alterations, suspension of movement of irradiated fuel assemblies in secondary containment, initiation of action to suspend operations with the potential for draining the reactor vessel (OPDRVs), and initiation of action to restore the required Unit 1/2 EDGs to Operable status.

During the time period that Unit 2 was in Mode 4 at the end of its refueling outage (April 1, 2011, to April 5, 2011), it is likely that either the Unit 1/2 A EDG and/or Unit 1/2 C EDG were credited with satisfying the requirements of LCO 3.8.2. However, no Core Alterations, no movement of irradiated fuel assemblies in secondary containment, and no OPDRVs were in progress. Therefore, the associated TS 3.8.2 Required Actions were satisfied. Because the inoperability of the Unit 1/2 A EDG and Unit 1/2 C EDG was not recognized, the TS 3.8.2 Required Action B.1.4 to immediately initiate action to restore the required Unit 1/2 EDGs to Operable status was not satisfied.

After BFN Units 1 and 2 automatically scrammed on April 27, 2011, and Mode 4 was entered for each of the units, no Core Alterations, no movement of irradiated fuel assemblies in secondary containment, and no OPDRVs occurred. Therefore, the

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associated TS 3.8.2 Required Actions were satisfied. Because the inoperability of the Unit 1/2 A EDG and Unit 1/2 C EDG was not recognized, the TS 3.8.2 Required Action B.1.4 to immediately initiate action to restore the required Unit 1/2 EDGs to Operable status was not satisfied.

BFN Unit 3 TS LCO 3.8.1 requires, in part, that Unit 3 EDGs be Operable and the Unit 1/2 EDGs capable of supplying the Unit 1 and 2 4-kV shutdown boards required by LCO 3.8.7, "Distribution Systems - Operating," be Operable in Modes 1, 2, and 3. Unit 3 TS LCO 3.8.7.g requires the Unit 1 and 2 AC and DC boards required by LCO 3.6.4.3, "Standby Gas Treatment (SGT) System," and LCO 3.7.3, "Control Room Emergency Ventilation (CREV) System," to be Operable (i.e., the Unit 1/2 A EDG and Unit 1/2 D EDG are required to be Operable). The Unit 3 EDGs consist of the 3A, 3B, 3C, and 3D EDGs. If one Unit 3 EDG is inoperable, TS 3.8.1 Required Action B.4, applicable at the time of this event, required the Unit 3 EDG to be restored to Operable status within 7 days. The 3B EDG was declared inoperable for a planned maintenance outage on April 24, 2011, at 2003 hours CDT. If this TS 3.8.1 Required Action is not met, then Unit 3 is required to be in Mode 3 within 12 hours and in Mode 4 within 36 hours. For the 3B EDG, the TS 3.8.1 Required Actions were satisfied as a result of the automatic scram that occurred on April 27, 2011, at 1636 hours CDT, placing the unit in Mode 3, and subsequent cooldown of the unit to Mode 4 within the required time periods. However, with one or more required Unit 1/2 EDGs inoperable (in this case, the Unit 1/2 A EDG), TS 3.8.1 Required Action K.2 requires the affected SGT and CREV subsystems to be declared inoperable within 30 days. Since it was not recognized that the Unit 1/2 A EDG was inoperable until the completion of the past operability evaluation, BFN Unit 3 operated with an inoperable required Unit 1/2 EDG (i.e., Unit 1/2 A EDG) longer than allowed by the TS.

BFN Unit 3 TS LCO 3.8.1 also requires, in part, that two qualified circuits between the offsite transmission network and the onsite Class 1E AC Electrical Power Distribution System be Operable in Modes 1, 2 and 3. Upon loss of required offsite power sources concurrent with one Unit 3 EDG inoperable, TS 3.8.1 Required Action J.1 requires immediate entry into LCO 3.0.3. LCO 3.0.3 requires action be initiated within 1 hour to place the unit in Mode 2 within 10 hours, Mode 3 within 13 hours, and Mode 4 within 37 hours. These requirements were satisfied as a result of the automatic scram that occurred on April 27, 2011, at 1636 hours CDT, placing the unit in Mode 3, and subsequent cooldown of the unit to Mode 4 within the required time periods.

BFN Unit 3 TS LCO 3.8.2 requires, in part, two of the four Unit 3 EDGs each capable of supplying one 4-kV shutdown board of the onsite Class 1E AC electrical power distribution subsystems required by LCO 3.8.8 to be Operable. LCO 3.8.8 requires the necessary portions of the AC and DC electrical power distribution subsystems to be Operable to support equipment required to be Operable in Modes 4 and 5 and during movement of irradiated fuel assemblies in the secondary containment. In the event, one or more required Unit 3 EDGs are inoperable, TS 3.8.2 Required Actions B.1.1, B.1.2, B.1.3, and B.1.4 require immediate suspension of Core Alterations,

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suspension of movement of irradiated fuel assemblies in secondary containment, initiation of action to suspend OPDRVs, and initiation of action to restore the required Unit 3 EDGs to Operable status. After BFN Unit 3 automatically scrammed on April 27, 2011, and Mode 4 was entered, no Core Alterations, no movement of irradiated fuel assemblies in secondary containment, and no OPDRVs occurred. In addition, actions continued to restore the 3B EDG to Operable status. Therefore, these associated TS 3.8.2 Required Actions were satisfied.

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 Probabilistic 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 Unit 1/2 C EDG. In addition, the Unit 1/2 A EDG operated for approximately 4 days and 13 hours prior to the output breaker trip. This period of operation did not meet the 7-day mission time of the Unit 1/2 A EDG. If multiple EDGs had experienced these failures concurrently, BFN could have lost its ability to provide power to components essential for core cooling, heat removal, and accident mitigation. However, in actuality the Unit 1/2 C EDG was returned to Operable status prior to the Unit 1/2 A EDG output trip breaker event. Based on this operating experience, it is reasonable to assume that both the Unit 1/2 A EDG and Unit 1/2 C EDG would not have been concurrently unavailable.

During the loss of SDC event, there was sufficient redundancy to support the core cooling requirements for Units 1 and 2 since the remaining two Unit 1/2 EDGs and the remaining three Unit 3 EDGs were Operable and the required ECCSs were Operable. In addition during the remainder of the time of concurrent EDG inoperabilities, the Unit 1/2 EDGs and the Unit 3 EDGs could have been paralleled, as shown in the Updated Final Safety Analysis Report Figure 8.5-24 (e.g., 4-kV shutdown board A to 4-kV shutdown board 3EA), to provide power to the necessary components to maintain adequate core cooling, heat removal capability, and SGT and CREV subsystem capabilities for each of the units. Therefore, this event was of minimal safety significance.

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 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.

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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 Testing (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 not been affected by this failure mode.

Evaluations of the risk associated with the separate unavailability of Unit 1/2 A EDG and the unavailability of the Unit 1/2 C EDG were also performed. The evaluation for the Unit 1/2 A EDG considered that this EDG was unavailable from May 2, 2011, at 0626 CDT until May 7, 2011, 0439 CDT. The evaluation for the Unit 1/2 C EDG considered that this EDG was unavailable from April 28, 2011, at 2338 CDT until April 30, 2011, at 1047 CDT. For the Unit 1/2 A EDG unavailability and Unit 1/2 C EDG unavailability, the risk impacts were determined to be small.

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

**VI. CORRECTIVE ACTIONS** - The corrective actions are being managed by TVA's corrective action program. The corrective actions addressed in this LER address the cause of the failure of the Unit 1/2 C EDG. The corrective actions that address the cause of the failure of the Unit 1/2 A EDG are addressed in LER 50-259/2011-003-01.

**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:

- 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

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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.

**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 EDG

**B. Previous 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 for EDGs.

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**

In accordance with NEI 99-02, this event is considered a safety system functional failure due to the loss of shutdown cooling on Unit 1 and Unit 2.

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**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)

- (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 EDG, 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.

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- (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.

- (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.

The individual responsible is K. J. Polson, Site Vice President of BFN.

The action was completed on June 27, 2011.

**VIII. COMMITMENTS**

There are no commitments.