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, 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 50-259/2011-001-00**

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 automatic scrams of all three units at the Browns Ferry Nuclear Plant. The Tennessee Valley Authority is submitting the enclosed Licensee Event Report in accordance with 10 CFR 50.73(a)(2)(iii), any natural phenomenon or other external condition that posed an actual threat to the safety of the nuclear power plant or significantly hampered site personnel in the performance of duties necessary for the safe operation of the nuclear power plant. Additionally, TVA is reporting this event in accordance with 10 CFR 50.73(a)(2)(iv)(A), any event or condition that resulted in manual or automatic actuation of systems named in 10 CFR 50.73(a)(2)(iv)(B) - (1) Reactor Protection System including: reactor scram or reactor trip.

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

IE22
NRR

Enclosure: Licensee Event Report - Three-Unit Scram Caused By Loss of All 500-kV Offsite Power Sources

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 - Three-Unit Scram Caused By Loss of All 500-kV Offsite Power Sources

SEE ATTACHED

NRC FORM 366 (10-2010) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 10/13/2013

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 7

4. TITLE

Three-Unit Scram Caused By Loss of All 500-kV Offsite Power Sources

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
04	27	2011	2011	- 001	- 00	06	27	2011	FACILITY NAME: BFN Unit 3	DOCKET NUMBER: 05000296

9. OPERATING MODE

1

10. POWER LEVEL

075

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)*
Mike Oliver, Licensing Engineer	256-729-7874

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 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 automatic scrams of all three units.

All three units were in Mode 1 at the time of the event. All scram systems were actuated, all actuations were complete, and required systems started and functioned successfully with the exception of an indeterminate position indication for the Unit 3 B Inboard Main Steam Isolation Valve. All onsite safe shutdown equipment was available with the exception of the 3B Emergency Diesel Generator (EDG), which was inoperable and unavailable due to planned maintenance.

After the event, only one 161-kV line remained available for offsite power - all (seven) 500-kV lines and one (of two) 161-kV line were lost. All three units immediately entered Mode 3 (Hot Shutdown) with their respective 4-kV busses supplied by the onsite EDGs.

On April 27, 2011, at 1701 hours, a Notification of Unusual Event (NOUE) was declared due to the loss of normal and alternate supply voltage to all unit-specific 4-kV shutdown boards for greater than 15 minutes and at least two EDGs supplying power to unit-specific 4-kV shutdown boards. On May 2, 2011, at 2050 hours, the NOUE was terminated following restoration of qualified offsite power sources.

NARRATIVE

I. PLANT CONDITION(S)

At the time of the event, Browns Ferry Nuclear Plant (BFN) Units 1 and 2 were at approximately 75 percent power (Mode 1) and Unit 3 was at approximately 100 percent power (Mode 1).

II. DESCRIPTION OF EVENT

A. Event:

On April 27, 2011, following offsite power grid oscillations (due to severe weather including high winds and tornadoes) and subsequent Unit 1 and 2 power reductions from 100 percent to 75 percent to attempt to correct the condition, BFN experienced a complete loss of the 500-kV offsite power system. This resulted in automatic scrams of Units 1, 2, and 3.

All three units were in Mode 1 at the time of the event. All scram systems were actuated, all actuations were complete, and required systems started and functioned successfully with the exception of an indeterminate position indication for the Unit 3 B Inboard Main Steam Isolation Valve (MSIV)[SB]. All onsite safe shutdown equipment was available with the exception of the 3B Emergency Diesel Generator (EDG)[EK], which was inoperable and unavailable due to planned maintenance.

After the event, only one 161-kV line remained available for offsite power - all (seven) 500-kV lines and one (of two) 161-kV line were lost. All three units immediately entered Mode 3 (Hot Shutdown) with their respective 4-kV[EB] busses supplied by the onsite EDGs.

On April 27, 2011, at 1701 hours, Central Daylight Time, a Notification of Unusual Event (NOUE) was declared due to the loss of normal and alternate supply voltage to all unit-specific 4-kV shutdown boards for greater than 15 minutes and at least two EDGs supplying power to unit-specific 4-kV shutdown boards. On May 2, 2011, at 2050 hours, the NOUE was terminated following restoration of qualified offsite power sources.

The Tennessee Valley Authority (TVA) is submitting this LER in accordance with 10 CFR 50.73(a)(2)(iii), any natural phenomenon or other external condition that posed an actual threat to the safety of the nuclear power plant or significantly hampered site personnel in the performance of duties necessary for the safe operation of the nuclear power plant. Additionally, TVA is reporting this event in accordance with 10 CFR 50.73(a)(2)(iv)(A), any event or condition that resulted in manual or automatic actuation of systems named in 10 CFR 50.73(a)(2)(iv)(B) - (1) Reactor Protection System including: reactor scram or reactor trip.

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

None

C. Dates and Approximate Times of Major Occurrences:

April 27, 2011, at 1401 hours	Operations personnel were notified that BFN was under a Tornado Warning. The actions of procedure 0-AOI-107, Severe Weather, were addressed.
at 1539 hours	The first 500-kV line was lost. Others followed with the last (seventh) line lost at 1636 hours.
at 1622 hours	The first 161-kV line was lost. The other 161-kV line did not trip and provided the only sustained source of offsite power to the station during the event and recovery from it.
at 1636 hours	Units 1, 2, and 3 automatically scrammed due to loss of all 500-kV offsite power sources. Units 1, 2, and 3 entered Mode 3 (Hot Shutdown).
at 1701 hours	BFN declared a Notification of Unusual Event (NOUE) in accordance with EPIP-1, Emergency Classification Procedure, Emergency Action Level 5.1-U - Loss of normal and alternate supply voltage to all unit-specific 4-kV shutdown boards for greater than 15 minutes and at least two EDGs supplying power to unit-specific 4-kV shutdown boards.
April 28, 2011, at 0243 hours	Unit 3 entered Mode 4 (Cold Shutdown).
April 28, 2011, at 0545 hours	Unit 2 entered Mode 4 (Cold Shutdown).
April 28, 2011, at 1337 hours	Unit 1 entered Mode 4 (Cold Shutdown).
May 2, 2011, at 2010 hours	All shutdown boards are powered from qualified 161-kV offsite power sources, and all EDGs are shutdown and in standby readiness.
May 2, 2011, at 2050 hours	The NOUE was terminated.
May 20, 2011	Unit 1 returned to service with main generator breaker closure.
May 25, 2011	Unit 2 returned to service with main generator breaker closure.
May 31, 2011	Unit 3 returned to service with main generator breaker closure.

D. Other Systems or Secondary Functions Affected:

None

E. Method of Discovery:

The event was self-revealing. Severe weather in the Tennessee Valley Service Area caused grid instability and loss of all 500-kV offsite power sources that resulted in automatic scrams of all three units.

F. Operator Actions:

Following the automatic scrams, Operations personnel used the applicable post-scram procedures. Unit-specific emergency operating procedures were also used as the scrams were complicated by the loss of normal power to balance of plant systems.

G. Safety System Responses:

All scram systems were actuated, all actuations were complete, and required systems started and functioned successfully with the exception of an indeterminate position indication for the Unit 3 B Inboard MSIV. All onsite safe shutdown equipment was available with the exception of the 3B EDG, which was inoperable and unavailable due to planned maintenance.

After the event, only one 161-kV line remained available for offsite power - all (seven) 500-kV lines and one (of two) 161-kV lines were lost due to extensive damage to the area grid. All three units immediately entered Mode 3 (Hot Shutdown) with the respective shutdown 4-kV busses supplied by onsite EDGs.

III. CAUSE OF THE EVENT

A. Immediate Cause:

The immediate cause for this condition was loss of all 500-kV offsite power sources that resulted in a scram of all three units from automatic turbine trips when power load unbalance signals were detected.

B. Root Cause:

The TVA Transmission/Distribution system was subjected to severe wind speeds and wind induced forces which resulted in multiple failures of transmission towers and conductor elements. This resulted in the eventual loss of all 500-kV lines servicing the station and automatic shutdowns of all three units.

IV. ANALYSIS OF THE EVENT

On April 27, 2011, at approximately 1636 hours, all three BFN units automatically scrammed with a first out signal of Power Load Unbalance. Problem Evaluation Report (PER) 364318 was initiated for this event. Required plant systems and components responded as expected except for an indeterminate Main Control Room position indication for the Unit 3 B Inboard MSIV.

Evaluation of Plant Systems / Components

Based on review of plant system records (including scram reports), operating logs, and transmission/distribution system data, BFN plant systems responded as designed to facilitate shutdown of all three units.

Safety systems actuations following the initial scrams include:

- Reactor Protection System (RPS)[JC] for Units 1, 2, and 3 due to offsite power losses,
- Primary Containment Isolation System (PCIS)[JE][JM] Groups 2, 3, 6, and 8 isolations for Units 1 and 3 due to loss of A and B RPS power and for Unit 2 due to low reactor water level,
- PCIS Group 1 (e.g., MSIVs) isolations for Units 1 and 3 due to loss of A and B RPS power. The Unit 2 MSIVs did not close because the remaining 161-kV line continued to supply power to the Unit 2 RPS,
- EDGs A, B, C, D, 3A, 3C, and 3D (EDG 3B was out of service for maintenance), and
- High Pressure Coolant Injection (HPCI)[BJ] for Unit 1 only. Unit 1 HPCI auto-initiated on low reactor water level (less than minus 45 inches). Unit 1 Reactor Core Isolation Cooling (RCIC) [BN] had been manually initiated earlier in the event for level control and was already running when the low reactor water level signal was received.

The Unit 3 B Inboard MSIV indicated indeterminate (PER 361532).

Other significant, post-event failures or issues were identified as follows:

1. Failure of the diesel-driven Fire Pump [KP](PER 361542),
2. Failure of the Nuclear Security diesel-driven generator [IA](PER 364675),
3. Significant loss of the Alert Notification System (PER 364674),
4. Loss of power to the plant Chemistry Lab (to counting equipment) [LQ](PER 362839), and
5. Potential damage to all turbine generators [TB](PER 362890).

As shown, PERs were initiated for each of these items.

Evaluation of Personnel Performance

Personnel performance following the event and subsequent scrams was reviewed and evaluated. One issue was identified that had elements related to personnel performance. PER 335574 was initiated as result of a subsequent valid Unit 1 scram on low water level following the initial scram reported in this LER. The specific issues related to this scram will be reviewed and addressed in PER 335574 and a separate LER. Otherwise, no additional personnel performance issues were identified.

V. ASSESSMENT OF SAFETY CONSEQUENCES

The event discussed in this root cause did impact nuclear safety and resulted in a reduction in the defense-in-depth. The loss of all 500-kV offsite power sources (only one 161-kV line remained) reduced margins to nuclear safety by causing the automatic scrams of all three units and actuation of required safety systems. Although there was a reduction in defense-in-depth, safety systems and automatic protective functions all performed as designed. Individual component failures are addressed by separate PERs. Collectively, the identified conditions posed no significant risk or substantial degradation to the station's ability to respond to a design basis event. These conditions are under analysis by separate PERs, and actions to mitigate will be documented in those PERs.

The NOUE was reported in accordance with the Emergency Plan (Reference Event Notification 46793).

There was no change in radiological risk during or following the event. Therefore, safety margin was maintained and this event was of very low safety significance.

VI. CORRECTIVE ACTIONS

A. Immediate and Corrective Actions:

Qualified 161-kV offsite power sources were provided on May 2, 2011. The EDGs were shutdown and each unit entered a non-refueling outage awaiting restoration of sufficient 500-kV lines to support unit restart and power generation.

Corrective actions to improve severe weather preparedness and performance were developed. These include the following provisions:

1. Standardized source for use of predictive weather information,
2. Work activity risk management process that integrates the application of predictive weather products (i.e., 1, 3, and 5-day outlooks) based on weather thresholds relative to risks,
3. Action thresholds and protocols relative to risk due to weather for on-line and outage maintenance/modifications activities,
4. Site and TVA Fleet long-term strategy for EDG operation during recovery from prolonged offsite power losses,
5. Procedures that ensure anticipated disruptions in communications services are minimized and alternate communication methods are available for prolonged offsite power losses,
6. Guidelines and protocol for exiting emergency situations relative to 10 CFR 26 nuclear fatigue rule compliance,
7. Emergency procedures that include a review of 10 CFR 26 nuclear fatigue rule compliance procedures prior to termination,
8. Severe weather procedures that improve specific criteria for entry and exit conditions,
9. A backup diesel generator for maintaining fire operations during prolonged offsite power losses,
10. Procedures for installation and activation of temporary diesel generators for selected plant components, machinery, equipment, and
11. Operational readiness activity for all non safety-related diesel generators including those leased/rented to BFN.

B. Corrective Actions to Prevent Recurrence:

No practicable actions exist to prevent offsite power losses for the type of extensive, region-wide weather that caused this event.

VII. ADDITIONAL INFORMATION

A. Failed Components:

None

B. Previous LERS or Similar Events:

None

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Browns Ferry Nuclear Plant Unit 1	05000259	2011	- 001	- 00	7 OF 7

NARRATIVE

C. Additional Information:

The corrective action document for this report is PER 364318.

D. Safety System Functional Failure Consideration:

There were no safety system functional failures.

E. Scram With Complications Consideration:

Summaries for each unit's response to the event are as follows:

For Units 1 and 3, offsite power losses resulted in a loss of RPS power, which led to MSIV closure and subsequent loss of feedwater flow and main condenser vacuum. Decay heat was rejected to the primary suppression chamber (torus) via manual operation of Main Steam Relief Valves [SB] and HPCI in pressure control mode.

For Unit 2, there was no loss of normal heat removal capability.

Based on NEI 99-02 Revision 2 guidance, following the scram/shutdown transient, operator actions were beyond that of a normal scram. Therefore, the event scrams of Units 1 and 3 are considered as unplanned scrams with complications.

VIII. COMMITMENTS

None