December 19, 2005

U.S. Nuclear Regulatory Commission 10 CFR 50.73
ATTN: Document Control Desk
Mail Stop OWFN, P1-35
Washington, D. C. 20555-0001

Dear Sir:

TENNESSEE VALLEY AUTHORITY - BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 3 - DOCKET 50-296 - FACILITY OPERATING LICENSE DPR - 68 - LICENSEE EVENT REPORT (LER) 50-296/2005-003-00

The enclosed LER provides details of an October 31, 2005, automatic scram as a result of a main turbine trip on Unit 3, which occurred during a 500-kV breaker switching operation.

In accordance with 10 CFR 50.73(a)(2)(iv)(A), TVA is reporting this event as the valid actuation of the reactor protection system and of containment isolation valves in more than one system. There are no commitments contained in this letter.

Sincerely,

Original signed by

Brian O'Grady

cc: See page 2

Enclosure
cc (Enclosure):

Ms. Eva Brown, Project Manager
U.S. Nuclear Regulatory Commission
(MS 08G9)
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

Mr. Stephen J. Cahill, Branch Chief
U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-8931

NRC Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611-6970

WDC:DTL:BCM:BAB
Enclosure
cc (Enclosure):
B. M. Aukland, POB 2C-BFN
A. S. Bhatnagar, LP 6A-C
J. C. Fornicola, LP 6A-C
R. G. Jones, NAB 1A-BFN
R. F. Marks, PAB 1C-BFN
G. W. Morris, BR 4X-C
K. W. Singer, LP 6A-C
E. J. Vigluicci, ET 11A-K
LEREvents@inpo.org
NSRB Support, LP 5M-C
EDMS WT CA-K

S:lic/submit/lers/296-2005-03.doc

NRC FORM 366 (6-2004)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2007
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)		Estimated burden per response to comply with this mandatory collection request:: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@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	2. DOCKET NUMBER	3. PAGE
Browns Ferry Unit 3	05000296	1 OF 6

4. TITLE
Reactor Scram from Main Turbine Trip During Switching Operation

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
									Browns Ferry Unit 2	05000260
10	31	2005	2005-03-00			12	19	2005	FACILITY NAME none	DOCKET NUMBER N/A

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)	X	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

NAME	TELEPHONE NUMBER *(Include Area Code)*
B. C. Morris Senior Licensing Engineer	256-729-7909

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		15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ **YES** (*if yes, complete 15. EXPECTED SUBMISSION DATE*)	■ **NO**				

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

On October 31, 2005, while Unit 3 was in steady state operation at 100% power, a main turbine trip and resultant reactor scram occurred. At the time, operators were in the process of returning 500-kV switchyard Bus-2, Section 2 to service using a switching order. When the Power Circuit Breaker (PCB) to the 500-kV Trinity 2 transmission line was closed, the PCB immediately tripped back open. The post-scram investigation subsequently determined that this was due to a closed ground switch at an offsite substation on this transmission line. The PCB properly tripped open to clear the Trinity 2 line ground; however, the electrical power transient resulting from the ground and its clearing caused speed perturbations on the Unit 3 main turbine. The rate of speed change seen on the turbine was slightly greater than the maximum rate anticipated by the turbine control system logic and, therefore, the turbine speed feedback signals were designated as invalid by the turbine control logic. With all turbine speed feedback signals designated as invalid, a main turbine trip on loss of speed feedback occurred in accordance with the system design and a reactor scram occurred due to the turbine trip.

This event was an uncomplicated plant scram with major plant safety systems responding as expected and in accordance with the plant design. The event cause was that actual turbine speed change exceeded that anticipated as possible by the turbine control logic, causing valid speed signals to be designated as invalid. Additionally, the switching order was deficient in that instructions to open the closed ground switch were in a separate switching order and were not performed. Corrective actions include modifying the Unit 3 turbine control logic and strengthening the process used by the transmission system organization for switching activities.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Browns Ferry Nuclear Plant Unit 3	05000296	2005	-- 003	-- 00	2 OF 6

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A) (17)*

I. PLANT CONDITION(S)

Prior to the Unit 3 turbine trip/reactor scram, Unit 2 and Unit 3 were in Mode 1 at nominal 100 percent reactor power (3458 megawatts thermal). Unit 1 was shutdown and defueled and was unaffected by the event. Unit 2 experienced a small decrease in reactor power due to a recirculation pump speed reduction as a result of the electrical disturbance, but otherwise was not affected by this event.

II. DESCRIPTION OF EVENT

A. Event:

On Monday, October 31, 2005, while Unit 3 was in steady state operation at 100% power, a main turbine [TA] trip and resultant reactor scram occurred at 1318 hours Central Standard Time (CST). All expected safety system responses occurred. Actuation of primary containment isolation system (PCIS) [JM] Groups 2, 3, 6, and 8 occurred due to the expected temporary lowering of reactor water level below the first low actuation setpoint. This logic isolates shutdown cooling [BO] (if in service), isolates the reactor water cleanup (RWCU) [CE] system, isolates the normal reactor building ventilation [VA], initiates the standby gas treatment (SGT) [BH] system, initiates the control room emergency ventilation (CREV) [VI] system, and retracts Traversing Incore Probes [IG] (if inserted). The normal heat rejection path from the reactor to the main condenser via the steam lines with reactor water make-up provided by the condensate/feedwater systems [SD/SJ] remained in service throughout the event. Reactor water level was quickly recovered to the normal operating range by the feedwater system using the normal reactor water level control system. Neither the high pressure coolant injection (HPCI) [BJ] nor the reactor core isolation cooling (RCIC) [BN] systems automatically initiated or were manually operated. Several main steam safety-relief valves (SRV) [SB] actuated during the pressurization transient and reclosed. The post-trip review confirmed SRV actuations were consistent with the observed transient reactor pressure caused by the turbine trip.

Prior to the event, operators were in the process of returning 500-kV switchyard Bus-2, Section 2 to service. This activity was conducted using a prepared switching order, which had been coordinated with the load dispatcher, and included the testing of a number of 500-kV switchyard Power Circuit Breakers (PCB) and transmission line tests. When PCB 5298, which is the connection to the 500-kV Trinity 2 transmission line, was closed, the PCB immediately tripped back open. The post-scram investigation subsequently determined that the Trinity 2 transmission line had a closed ground switch at the offsite NUCOR Steel substation that should have been opened by the load dispatcher as part of this switching order.

PCB 5298 properly tripped open in to clear the Trinity 2 line ground; however, the electrical power transient resulting from the ground and its clearing caused speed perturbations on the Unit 3 main turbine. The rate of speed change seen on the Unit 3 main turbine was slightly greater than the maximum rate anticipated by the turbine control system logic and, therefore, the turbine speed feedback signals, while valid, were designated as invalid by the logic. With all turbine speed feedback signals designated as invalid, a main turbine trip on loss of speed feedback occurred in accordance with the system design and a reactor scram occurred due to the turbine trip.

Because this event involved the valid, automatic actuation of the Reactor Protection System (RPS) [JC] and the operation of containment isolation valves in more than one system, and because the scram was not part of a pre-planned sequence, this event is reportable in accordance with 10 CFR 50.73 (a) (2) (iv) (A).

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

None.

C. Dates and Approximate Times of Major Occurrences:

October 31, 2005	1318 hours CST	As part of an activity to return Section 2 of the 500-kV Bus 2 to service, operators closed PCB 5298.
	1318	PCB 5298 immediately tripped back open due to a closed ground switch on the Trinity 2 500-kV transmission line.
	1318:16	Resulting grid disturbance caused a Unit 3 main turbine speed change to exceed setpoint and all speed channels were designated as invalid by the control logic. Main turbine tripped, which caused Unit 3 scram.
	1319	Following a brief reactor water level drop caused by the turbine trip and scram, water level was recovered to normal range.

D. Other Systems or Secondary Functions Affected

Several auxiliary plant system breakers tripped due to the electrical disturbance. The electrical transient also resulted in a small recirculation pump speed reduction on Unit 2 with an accompanying decrease (~ 2%) in reactor power.

E. Method of Discovery

The turbine trip/reactor scram event was immediately apparent to the control room staff through numerous indications and alarms.

F. Operator Actions

This event was an uncomplicated scram. Operator actions taken in response to the scram and in the recovery from the event were appropriate. These actions included the verification that the reactor had been successfully shut down, the expected system isolations and initiations had occurred, and accomplishing the subsequent restoration of these systems to normal alignments.

G. Safety System Responses

Safety system equipment operated in accordance with the plant design during this event. The RPS logic responded to the main turbine trip condition per design to initiate the reactor scram. All control rods fully inserted into the core.

The PCIS logic responded per design to the expected lowered reactor water level by actuating the following isolation groups:

- Group 2 - Residual Heat Removal shutdown cooling function isolation (not in service at the time of the event)
- Group 3 - RWCU system isolation
- Group 6 - primary and secondary containment isolation, including the isolation of the normal reactor building ventilation and the initiation of the SGT and CREV systems
- Group 8 - withdrawal and isolation of the Traversing Incore Probes (the probes were not inserted at the time of this event)

Reactor water level was maintained by the condensate/feedwater systems and the normal water level control systems such that no automatic or manual operation of the HPCI or RCIC systems occurred during this event. No diesel generators started.

The turbine trip results in a pressurization transient and seven main steam SRVs actuated in response. The peak reactor pressure was measured at about 1140 psig during the pressurization transient. The post-trip review confirmed SRV actuations were consistent with the observed transient reactor pressure caused by the turbine trip.

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause of this event was the designed response of the main turbine Electro-Hydraulic Control (EHC) logic to initiate a main turbine trip when a condition occurs where no valid turbine speed signals are available.

B. Root Cause

The turbine speed changes occurred during an electrical disturbance when PCB 5298 was closed onto the grounded Trinity 2 transmission line. The rate of turbine speed change exceeded system design parameters such that the individual speed feedback channels were designated as invalid by the system logic. A contributing cause was a failure to ensure the grounding switches on the Trinity 2 transmission line were opened prior to or as part of the switching activities.

IV. ANALYSIS OF THE EVENT

This event was an uncomplicated plant scram with major plant safety systems responding in accordance with the plant design. The basic event (turbine trip) as it occurred is addressed in detail by the plant Updated Final Safety Analysis Report (UFSAR), and the plant conditions assumed in the UFSAR for analyzing this event are more severe than the actual conditions which were in existence at the time of this event. See Section V. below for further details.

LER 50-296/2004-02-00 describes a similar Unit 3 turbine trip and scram, which occurred on November 23, 2004. In that event, a lightning strike occurred on the West Point 500-kV transmission line approximately 40 miles from Browns Ferry causing a simultaneous phase-to-ground fault on all

three phases of the line. The current-voltage transient caused by the fault reduced the power demand seen by the Unit 2 and 3 main generators and initially caused an acceleration of both operating turbine-generators (TG).

As detailed in LER 50-296/2004-02-00, the EHC logic contains an algorithm that compares the turbine speed value reported by a speed channel to the average of all valid channels obtained at the last previous speed sensor scan. The purpose of this algorithm is to identify a failed speed channel as evidenced by a channel indicating a significant difference from the average of all the channels. A measured acceleration rate beyond a certain magnitude was deemed to be unlikely based on empirical industry-accepted data and was set to be discarded by the EHC logic as an invalid signal.

A post-event analysis of the November 23, 2004, turbine trip showed that the measured Unit 3 TG speed increase exceeded the speed value that was set as the rejection value. As each speed channel was scanned and reported the actual measured speed to the system computer, the algorithm described above designated the channel as invalid since the rpm difference relative to the previous value was too great. This resulted in the Unit 3 turbine trip due to the loss of all speed feedback. The Unit 2 EHC logic was configured identically; however, during the November 23, 2004, transient, the measured Unit 2 speed changes did not exceed the rejection value.

The October 31, 2005, electrical power transient resulting from the Trinity 2 line ground and its clearing caused a similar Unit 3 TG speed response and the same invalid speed trip logic tripped the turbine. As a result of LER 50-296/2004-02-00, the Unit 2 EHC logic was modified during the Spring 2005 refueling outage to avoid actuation of the turbine trip logic for these type circumstances. The Unit 3 EHC logic is scheduled to be likewise modified during the upcoming Spring 2006 refueling outage.

V. ASSESSMENT OF SAFETY CONSEQUENCES

UFSAR sections 14.5.2.4 and 14.5.2.5 specifically address the main turbine trip event. Turbine bypass valves are assumed to function in the discussion under section 14.5.2.4. Section 14.5.2.5, however, assumes that the main turbine bypass valves do not function and therefore is the more severe event. This analysis assumes the most limiting initial conditions of: end of cycle fuel exposure conditions, a core power of 100% of rated, a core flow of 105% of rated, and normal feedwater temperature. The analysis shows that no safety limits are exceeded for such a transient scenario. The actual plant conditions for this event were less limiting than those described in the UFSAR section 14.5.2.5 analysis, and the subject event is fully bounded by this analysis. The health and safety of the public were not affected by the subject scram event.

VI. CORRECTIVE ACTIONS[1]

1. Implement EHC logic changes on Unit 3 during Spring 2006 outage.
2. Transmission system organization will evaluate this event and strengthen the process used for offsite switching activities.

[1] TVA does not consider these corrective actions as regulatory commitments. The completion of the actions will be tracked in TVA's Corrective Action Program.

VII. ADDITIONAL INFORMATION

A. Failed Components

None.

B. Previous LERs on Similar Events

LER 50-296/2004-02-00.

C. Additional Information

Corrective action documents PER 91780 (scram) and PER 91811 (switching order).

D. Safety System Functional Failure Consideration:

This event does not involve a safety system functional failure which would be reported in accordance with NEI 99-02. The scram was caused by the response of non-safety related equipment to an off-site event. All safety-related equipment performed in accordance with design in response to the event.

E. Loss of Normal Heat Removal Consideration:

The main condenser was retained as the heat sink during this event, and the condensate/feedwater systems continued to provide reactor vessel inventory make-up. Neither HPCI nor RCIC operated during this event. This event does not constitute a scram with a loss of normal heat removal which would be reported in accordance with NEI 99-02.

VIII. COMMITMENTS

None.