November 10, 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) 50-296/2005-002-00

The enclosed report provides details of an automatic scram which occurred on Unit 3. During the performance of a maintenance activity on a secondary plant feedwater heater level control valve, an air in-leakage path to the main condenser developed such that condenser vacuum decreased to the main turbine trip point. This trip then occurred in accordance with the plant design, and, also in accordance with the plant design, the turbine trip from greater than 30% power directly resulted in a reactor scram.

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
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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
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4. TITLE
Reactor Scram from Main Turbine Trip on Low Condenser Vacuum

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
									none	N/A
9	17	2005	2005-002-00			11	10	2005	FACILITY NAME none	DOCKET NUMBER N/A

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*							
1		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)
10. POWER LEVEL		20.2203(a)(2)(ii)		50.36(c)(1)(ii)(A)	X	50.73(a)(2)(iv)(A)		50.73(a)(2)(x)
73		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)*
Paul S. Heck, Nuclear Engineer, Licensing and Industry Affairs	256-729-3624

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
X	SN	VLV	Fisher	Y						

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 9/17/05 Unit 3 was in steady state operation at approximately 73% power. A maintenance activity was in progress to repair a level control valve on a high pressure feedwater heater. During the work on the valve, an air in-leakage pathway to the main condenser was created, and due to an unanticipated mechanical failure of the valve internals, the valve could not be readily reassembled to isolate the in-leakage path. Over a period of approximately 10 minutes, the main condenser vacuum decreased to the low vacuum trip setpoint for the main turbine, and a main turbine trip and subsequent reactor scram occurred at 1129 hours CDT. All expected system responses occurred. Actuation of primary containment isolation system Groups 2, 3, 6, and 8 occurred due to the expected temporary lowering of reactor water level below the actuation setpoint. This logic isolates shutdown cooling (if in service), isolates the reactor water cleanup system, isolates the normal reactor building ventilation, initiates the standby gas treatment system, initiates the control room emergency ventilation system, and retracts traversing incore probes (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 remained in service. Neither the high pressure coolant injection nor reactor core isolation cooling systems were used during this event. No safety-relief valve (SRV) operation occurred during the trip transient, and post-trip review confirmed that peak reactor pressures remained below the nominal SRV lift setpoints.

The event was caused by the unanticipated failure mode of the valve's internals, and the work control process was not effectively managed to assess all possible failure modes. Corrective actions include revisions to operating procedures and the provision of training to managers/supervisors on effective operational decision making.

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

I. PLANT CONDITION(S)

Prior to the subject turbine trip/reactor scram event, Unit 3 was in Mode 1 operating at approximately 73 percent reactor power (approximately 2518 megawatts thermal). Unit 2 was in Mode 1 operating at 100 percent reactor power and was unaffected by this event. Unit 1 was shutdown and defueled and was also unaffected by the event.

II. DESCRIPTION OF EVENT

A. Event:

On Saturday, September 17, 2005, Unit 3 was in steady state operation at approximately 73% power. A maintenance activity was in progress to repair a level control valve (LCV) on a high pressure feedwater heater [SN]. During the work on the valve, an air in-leakage pathway to the main condenser [SG] was created, and due to an unanticipated mechanical failure of the valve internals, the valve could not be readily reassembled to isolate the in-leakage path. Over a period of approximately 10 minutes, the main condenser vacuum decreased to the low vacuum trip setpoint for the main turbine [TA], and a main turbine trip and subsequent reactor scram occurred at 1129 hours CDT. All expected 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 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 (TIP) [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. Reactor water level was recovered to the normal operating range by the normal reactor water level control system. Neither the high pressure coolant injection (HPCI) [BJ] nor reactor core isolation cooling (RCIC) [BN] systems were used during this event. Reactor water level did not drop to the auto-initiation point for these systems, and they were not manually placed in service by the control room staff. No safety-relief valve (SRV) [SB] operation occurred during the trip transient, and post-trip review confirmed that peak reactor pressures remained below the nominal SRV lift setpoints.

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:

September 16, 2005 2200 hours	Unit 3 power reduction commenced in support of control rod pattern adjustment and planned maintenance activities

September 17, 2005	0842 hours	Pre-job brief held on the LCV maintenance activity
	1120 hours	alarm received in the main control room on high off-gas system flow
	1125 hours	alarm received in the main control room on main condenser low vacuum
	1129 hours	main turbine trip and reactor scram occurred when the low vacuum turbine trip setpoint was reached

D. **<u>Other Systems or Secondary Functions Affected</u>**

None

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. All 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.

The control room crew was specifically monitoring main condenser vacuum during the work activity on the LCV, however, differences in the sensing locations of the instrumentation providing control room indication and the instrumentation providing the turbine trip function caused these instruments' outputs to differ. Some mitigative actions planned to compensate for decreasing condenser vacuum, including scramming the reactor manually if necessary, did not occur because this instrumentation difference masked the remaining margin to the automatic trip setpoint. See Section III.C below for further details.

G. **Safety System Responses**

All equipment operated in accordance with the plant design during this event. The RPS logic responded to the 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 TIPs (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. With the reactor operating at a reduced power at the time of the trip, the initial reactor pressure was consequently lower as well. The expected transient reactor pressure increase immediately following closure of the turbine stop and control valves did not reach a magnitude high enough for SRV actuation. No SRV actuation occurred.

III. CAUSE OF THE EVENT

A. Immediate Cause

The immediate cause of this event was the designed response of the main turbine protection logic to initiate a main turbine trip when a low vacuum condition occurs in the main condenser.

B. Root Cause

1) An unanticipated failure mode of level control valve internals resulted in the inability to restore system integrity in a timely manner. The valve's failure mode prevented the installation of a compensatory flange and resulted in a decreasing vacuum condition.
2) The work planning process was not effectively managed to assess all possible failure modes prior to proceeding with the subject work activity.

C. Contributing Factors

It was recognized during the planning process that the work activity would result in air in-leakage and lowering condenser vacuum. It was not realized by the plant staff, however, that the difference in the specific monitoring location in the condenser system between the instrumentation which initiates a turbine trip and that which provides control room indication was significant under these conditions.

During the maintenance activity, the condenser vacuum was being monitored by the control room crew using an indicator that monitors the "A" condenser vacuum. The lowest observed reading in the control room was approximately 24.3 inches of mercury (Hg) vacuum. The low vacuum turbine trip switches have a setpoint of 21.8 inches of Hg vacuum. The sensing tap for the instrumentation the operations crew was monitoring during the evolution is located just above the condenser tubes. The sensing tap for the instrumentation that provides the low vacuum turbine trip signal is located very near the low pressure turbines' exhaust, at a point about 25 feet higher than the indication instrumentation sensing tap. Shape and volume differences in the condenser between these two different locations and the steam flow direction from top to bottom causes the sensed vacuum to be greater at the lower sensing tap. The control room indication therefore displayed a vacuum value greater than what was being sensed by the turbine trip instrumentation. This unrealized instrumentation characteristic caused the indicated margin to the trip setpoint to be greater than the actual margin. As such, the turbine trip occurred at an indicated value of 24.3 inches of Hg vacuum, rather than at the nominal 21.8 inches of Hg vacuum where it was expected. This unexpected premature trip preempted the completion of some planned mitigating steps.

IV. ANALYSIS OF THE EVENT

The maintenance activity to repair the feedwater heater LCV was initially planned using an equipment alignment which would have completely isolated the affected feedwater heater. However, when this

equipment alignment was attempted, it was discovered that some of the isolation valves leaked through at a rate too great to allow the maintenance to be performed as originally planned. The plan was then revised to allow the opening of a heater bypass drain line to the condenser, such that the isolation boundary valve leak-through was effectively negated by being pulled through this bypass line to the condenser. It was recognized that taking this approach would result in a decreasing condenser vacuum when the subject LCV body was opened to accomplish the repair work. To mitigate this anticipated decreasing vacuum condition, two compensatory actions were pre-established:

- the work intrusive to the valve body would be accomplished expeditiously, and a blind flange was prestaged at the valve location to allow the valve body to be quickly closed in the event condenser vacuum decreased too far toward the turbine trip setpoint.
- in the event that the condenser vacuum approached too close to the trip setpoint, the heater drain bypass valve would be closed. Closing this valve would isolate the air in-leakage flow path to the condenser, even if the valve body integrity had not been re-established. Taking this action would allow recovery of condenser vacuum, and therefore provide additional time for subsequent continuation of the valve repair work.

When the LCV repair work was begun and the valve body opened, an existing failure in the valve internals (the stem and plug had separated) resulted in a portion of these internals becoming wedged in the valve body. The valve body's integrity could then not be readily restored. Control room personnel monitoring the condenser vacuum directed that the workers leave the area and that the drain bypass valve be closed to allow the condenser vacuum to be recovered. However, because of the instrumentation differences discussed in paragraph III.C above, the turbine trip occurred at an indicated vacuum greater than what had been expected, prior to the drain bypass valve closure having an effect on the vacuum decrease.

To protect the turbine and the condenser, upon sensing a condition where the main condenser vacuum may not be sufficient to condense the steam exhausting from the turbine stages, the main turbine control logic initiates a turbine trip by immediately closing the stop and control valves. The RPS logic is designed such that a main turbine trip with reactor power above approximately 30% reactor power will directly scram the reactor. These trip actions occurred in accordance with the plant design.

This event was an uncomplicated plant scram. Such turbine trip/reactor scram events are addressed in detail by the plant Updated Final Safety Analysis Report (UFSAR), and the plant conditions assumed in the UFSAR for analyzing this type 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.

Equipment response following the reactor scram and turbine trip was also in accordance with the plant design. All control rods fully inserted. Post-trip reactor pressure control was handled by operation of the turbine bypass valves. The operation of other systems post-scram (e.g., containment isolation, start-up of SGT and CREV, isolation of normal reactor building ventilation, RWCU isolation, TIP isolation, etc.) also occurred in accordance with the plant design. The main condenser continued to function as the heat sink following the scram.

V. ASSESSMENT OF SAFETY CONSEQUENCES

UFSAR sections 14.5.2.1 through 14.5.2.6 address main turbine trip events. These analyses assume initial conditions more limiting that those in effect during the subject event, and situations such as total loss of condenser vacuum and main turbine bypass valve failure are considered. No safety limits are exceeded in any of these transient scenarios. The subject event is fully bounded by these analyses. The health and safety of the public were not affected by the subject scram event.

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

VI. CORRECTIVE ACTIONS

A. Immediate Corrective Actions

The alarm response procedures for Unit 2 and for Unit 3 on low condenser vacuum were revised to highlight the difference between control room indication and automatic trip actuation.

B. Corrective Actions to Prevent Recurrence[1]

1. Training will be provided to all managers and supervisors to improve effective operational decision making.
2. Improvements will be made in the Unit 2 and Unit 3 loss of condenser vacuum abnormal operating procedures.

VII. ADDITIONAL INFORMATION

A. Failed Components

high pressure feedwater heater level control valve 3-LCV-006-0073A (Fisher Controls)

B. Previous LERs on Similar Events

None

C. Additional Information

Browns Ferry corrective action document PER 89506

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 balance-of-plant conditions. All safety-related equipment performed in accordance with design in response to the event.

E. Loss of Normal Heat Removal Consideration:

The main condenser vacuum was sufficient with ample margin to allow the condenser to continue 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

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