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November 20, 2003

U. S. Nuclear Regulatory Commission
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Subject: Licensee Event Report 50-458 / 03-008-00
River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

File Nos. G9.5, G9.25.1.3

RBG-46200
RBF1-03-0215

Ladies and Gentlemen:

In accordance with 10CFR50.73, enclosed is the subject Licensee Event Report.

Sincerely,

D N Lorfing

For Joseph W. Leavines
JWL/dhw
enclosure

IE22

cc: U. S. Nuclear Regulatory Commission
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Arlington, TX 76011

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NRC FORM 366 (7-2001)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104	EXPIRES 7-31-2004

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE
Automatic Reactor Scram During Main Turbine Control Valve Testing Due to Control System Malfunction

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
09	22	2003	2003	- 008 -	00	11	20	2003	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE	1
10. POWER LEVEL	078

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)	X	50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
J.W. Leavines, Manager - Licensing	225-381-4642

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	TG	VT	GE	Y					

14. SUPPLEMENTAL REPORT EXPECTED				15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

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

At 10:43 p.m. CDT on September 22, 2003, with the plant operating at approximately 78 percent power, an automatic reactor scram occurred during scheduled testing of the main turbine control valves. The scram signal originated from reactor steam pressure instruments following a malfunction of the main turbine control system which caused the control valves to move toward the closed position. A containment isolation signal initiated due to the expected reactor low water level alarm, which caused the isolation of the suppression pool cooling system, as designed. This event is being reported in accordance with 10CFR50.73(a)(2)(iv) as a valid actuation of the reactor protection system and the containment isolation logic circuitry. Modifications are being considered to prevent recurrence of this condition. Turbine control valve testing has been suspended pending further corrective actions. This event was of very low safety significance, as the response of the plant to the scram signal was bounded by the safety analysis.

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REPORTED CONDITION

At 10:43 p.m. CDT on September 22, 2003, with the plant operating at approximately 78 percent power, an automatic reactor scram occurred during scheduled testing of the main turbine (**TRB**) control valves (**SCV**). There were no safety systems out of service at the time of the scram, and the reactor protection system functioned as designed. No emergency core cooling system initiation setpoints were exceeded, nor did any reactor safety/relief valves actuate. A containment isolation signal initiated due to the expected reactor low water level (Level 3) alarm, which caused the isolation of the suppression pool cooling system, as designed. The main generator tripped on reverse power, as designed, approximately nine seconds following the scram. The turbine bypass valves modulated to control reactor pressure. This event is being reported in accordance with 10CFR50.73(a)(2)(iv) as a valid actuation of the reactor protection system and the containment isolation logic circuitry.

INVESTIGATION

Prior to the scram, main turbine control valve testing was being conducted in accordance with plant procedures. When the no. 1 control valve was tested, it closed as expected and the other three control valves opened as expected to control reactor pressure. Control valve no. 1 fully closed, and a half-scram signal actuated as designed. When the "test" button for no. 1 control valve was released, all the control valves began to move back to their pre-test positions. At this point, the reactor scram occurred.

When plant computer data was analyzed, rapid transients in the turbine speed, speed error, and steam flow reference signal were found. The speed control system sensed a false high acceleration rate signal, causing a "close" signal to the turbine control valves. This caused reactor steam pressure to rise to a maximum of 1108 psig. The computer data confirmed that the steam pressure control and generator load control circuits operated correctly throughout the transient. The steam flow reference signal transient caused the pressure control system to open the turbine bypass valves, but their flow capacity was not enough to prevent the rise in reactor pressure.

During the shutdown, the no. 1 and 2 bearing vibration probes (**VT**) were removed from their wells, and the no. 1 bearing probe was found to have babbit material on it. The discovery of babbit on the vibration probe tip of the no. 1 bearing after the 2003 event (similar to that found on the no. 2 bearing vibration probe tip after a similar event in 2001 – see Previous Occurrence Evaluation) strongly suggests that arcing (electrolysis) was occurring during the 2003 event. Plans are being made to inspect no. 1 turbine bearing during the 2004 refueling outage to confirm this condition.

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Following the September 2003 event, mockup testing confirmed that the turbine speed probe was sensitive to electromagnetic frequencies produced by electrical arcing. The cable alone did display some sensitivity, but not as much as when the probe was connected.

The origin of an electrostatic potential sufficient to produce arcing is not well understood. High pressure end arcing during steam transients on partial arc turbines has been observed by vendor specialists. It is known that electrostatic charge buildup is most prevalent under conditions of high relative velocity and wet steam. It is theorized that, during control valve testing, significantly higher steam velocities are occurring within the high pressure turbine. The wet, high-velocity steam rapidly builds up a large electrostatic potential on the rotor, which exceeds the capacity of the grounding brushes at the generator end. Because of their tight clearances, the high pressure turbine bearings become the path of least resistance, where arcing then occurs.

CAUSAL ANALYSIS

The most probable cause of the erratic speed signals was electrostatic (DC voltage) discharging sensed by the primary and backup speed probe (**ST**). Due to increased monitoring since the 2001 event, more data was available to diagnose the 2003 conditions. Computer data indicates that the turbine speed signal decreased to 1775 RPM, then to 365 RPM. When the noise signal cleared and the backup speed probe again indicated 1800 rpm, the acceleration amplifier sensed a high acceleration rate and caused a large speed error. When the speed error signal reached approximately 25 percent, it began to close the control valves and intercept valves. The speed error signal continued to increase to 100 percent and remained there even after the noise signal cleared, due to the integration function of the acceleration amplifier.

CORRECTIVE ACTION TO PREVENT RECURRENCE

The following actions are being tracked by the station corrective action program, and are not considered to be regulatory commitments.

1. Modifications are being considered to install additional turbine shaft grounding devices and shaft voltage monitoring instruments, as well as to relocate the speed sensors.

2. Main turbine control valve testing has been suspended until additional modifications are installed and verified to be adequate to prevent recurrence. Control valve testing is not required by plant Technical Specifications.

3. Process enhancements in the corrective action program are being developed to strengthen management oversight of the root cause analysis process for any subsequent changes to the original approved root cause.

PREVIOUS OCCURRENCE EVALUATION

A similar event occurred on April 21, 2001, when an automatic scram occurred during turbine control valve testing. This event was reported in Licensee Event Report 50-458/01-001-00. The root cause analysis identified the most probable cause of that event as an upset in the rotor dynamics of the high pressure turbine during control valve testing. This generated a speed error signal causing an erratic turbine steam flow reference signal, resulting in a "close" signal to the intercept valves and control valves.

After the April 2001 event, control valve testing was suspended until a more definitive root cause could be determined and corrective actions taken. During the subsequent refueling outage, the no. 2 bearing was found to have extensive damage to the upper shell from electrolysis, which was repaired. Later, extensive damage was found on the backup speed sensor cable. The no. 1 bearing was also found to have electrolysis damage and residual magnetism. The bearing was repaired and demagnetized. An improved shaft grounding device was installed during the outage to prevent further electrolysis damage.

In light of the additional information described above, the root cause was revised to, "The damaged speed cables, possibly aggravated by electrolysis at the no.1 bearing and or lifting of the shaft, generated a false over speed signal during CV testing which closed the Turbine valves and led to the reactor scram." The decision was made to resume control valve testing after completion of the corrective actions. The basis for considering the actions as adequate to prevent recurrence was as follows:

1. The damaged speed cable had been repaired, including a modification which individually shielded the different speed cables and prevented future cable damage. It was believed to have addressed the electromagnetic interference (EMI) concern, because minor fluctuations which were detected by monitoring equipment prior to the outage were no longer detected after the modification. The cable damage was considered to be the primary cause of the April 2001 event.

2. The electrolysis concern was addressed in two ways. The no. 1 bearing had been demagnetized, and testing indicated that no AC potential was leaking through from the generator. A new shaft grounding system had been installed to bleed electromagnetic (AC) and electrostatic (DC) potentials to ground. These actions were deemed adequate to prevent the electrolysis.

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3. The turbine vendor had evaluated the potential for shaft lifting and concluded that lifting of more than 4 mils could not occur. In addition, River Bend conducted mockup testing which proved the speed probes to be insensitive to shaft movements within the possible range allowed by bearing clearances. Thus, the shaft lifting concern was no longer considered a valid contributor. That review of shaft lifting was re-evaluated and was determined to still be a valid conclusion.

These actions addressed each concern found in the revised root cause for the April 2001 scram. However, further investigation has found that the speed probes themselves are sensitive to electromagnetic interference associated with electrostatic arcing. Also, it has been learned that electrostatic potential can build up very rapidly on a rotor, such that even a properly operating grounding system at the generator end of the shaft may not be capable of providing adequate protection for the high pressure end of the shaft. The buildup of electrostatic potential on a turbine rotor is a known phenomenon in the industry, though not well understood.

The September 2003 recurrence of this event was caused by a breakdown in management oversight of the investigation of the previous event. The revised root cause analysis did not adequately address all possible sources of turbine speed error signals. This deficiency was not recognized during the management review. From a programmatic standpoint, the revised root cause lacked a systematic approach and the formal review process was not followed.

SAFETY SIGNIFICANCE

This event was of very low safety significance. The response of the plant to the initiating event was bounded by the safety analysis.

(NOTE: Energy Industry Component Identification codes are annotated as (**XX**).)