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February 2, 2004
BW040010

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Unit 2
Facility Operating License No. NPF-77
NRC Docket No. STN 50-457

Subject: Submittal of Licensee Event Report Number 2003-004-00, "Unit 2 Reactor Trip and Auxiliary Feedwater Emergency Safeguards Actuation Due to Cascading Feedwater Pump Trips Caused by a Lack of Preventative Maintenance."

The enclosed Licensee Event Report (LER) is being submitted in accordance with 10 CFR 50.73, "Licensee event report system", paragraph (a)(2)(iv)(A). 10 CFR 50.73(a) requires an LER to be submitted within 60 days after discovery of the event; therefore, this report is being submitted by February 2, 2004.

Should you have any questions concerning this submittal, please contact Ms. Kelly Root, Regulatory Assurance Manager, at (815) 417-2800.

Respectfully,

Thomas P. Joyce

Thomas P. Joyce
Site Vice President
Braidwood Station

Enclosure: LER Number 2003-004-00

cc: Regional Administrator - Region III
NRC Braidwood Senior Resident Inspector

JE22

NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004
LICENSEE EVENT REPORT (LER)	Estimated burden per response to comply with this information collection request: 50.0 hrs. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NOEB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose 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
Braidwood, Unit 2	STN 05000457	1 of 5

4. TITLE
Unit 2 Reactor Trip and Auxiliary Feedwater Emergency Safeguards Actuation Due to Cascading Feedwater Pump Trips Caused by a Lack of Preventative Maintenance

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEA	SEQUENTIAL NUMBER	REV NO	MONTH	DAY	YEAR	FACILITY NAME N/A	DOCKET NUMBER N/A
12	03	2003	2003-004-00			02	02	2004	FACILITY NAME N/A	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)	☐ 73.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 73.73(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

NAME	TELEPHONE NUMBER (Include Area Code)
Gary Dudek, Operations Manager	(815) 417-2200

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO epix	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
E	JK	Tach-Pak 075-636-1 X 11	Airpax Electronics	Yes	N/A	N/A	N/A	N/A	N/A

14. SUPPLEMENTAL REPORT EXPECTED			15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ Yes (If yes, complete EXPECTED SUBMISSION DATE).	✓	NO				

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

At 0336 on 12/03/03, the Unit 2 reactor tripped on 2D Steam Generator low-low water level due to the cascading trip of the 2C and 2B turbine driven feedwater pumps during 2C feedwater pump testing. While testing the 2C feedwater pump stop valves, the high pressure stop valve did not reopen as expected during the test due to a piece of age degraded tie wrap lodged in the relay contacts. The 2C feedwater pump subsequently tripped. The suspected reason for the trip of the 2C feedwater pump is believed to be a simultaneous closed signal from the low pressure and high pressure stop valves. During the start of the 2A motor driven feedwater pump, the 2B feedwater pump tripped on overspeed due to high flow demand when the 2C feedwater pump tripped and failure of the 2B feedwater pump speed feedback control circuit to limit the pump speed below the mechanical overspeed trip setpoint. The 2A motor driven feedwater pump could not provide sufficient flow to maintain the Unit 2 Steam Generator water levels above the automatic reactor trip setpoint.

This event is the result of equipment failures and not due to human performance error. The significance of this event is an automatic Reactor Protection System actuation when the reactor tripped on low-low Steam Generator water level and subsequent Engineered Safety Feature actuation when the auxiliary feedwater pumps started.

This report is being made in accordance with 10 CFR 50.73(a)(2)(iv)(A).

A. **Plant Operating Conditions Before The Event:**

Unit: 2 Event Date: December 3, 2003 Event Time: 0336

MODE: 1 Reactor Power: 100 percent

Reactor Coolant System (RCS)[AB] Temperature: 580 degrees F, Pressure: 2235 psig

B. **Description of Event:**

There were no additional systems or components inoperable at the beginning of this event that contributed to the severity of the event.

On shift 1, 12/03/03, Operations was scheduled to perform a routine 2B and 2C turbine driven main feedwater(FW)[SJ] pump stop valve surveillance. The test involves depressing a pushbutton and observing the proper light indications. A Non-Licensed Operator(NLO) was dispatched to the field to locally monitor the stroking of the 2B and 2C FW pump stop valves during the testing.

During the performance of the 2C FW pump stop valve surveillance, the low pressure(LP) stop valve was completed first with no problems noted.

The Unit 2 NSO then depressed the 2C FW pump high pressure(HP) stop valve test pushbutton per the surveillance procedure. The valve moved to the closed position. The Unit 2 NSO observed the OPEN light extinguished and the CLOSED light lit. The TEST light did not come ON as expected per the procedure. Additionally, the HP stop valve remained closed and did not reopen as expected.

The 2C FW pump tripped at 0335:26. The 2B FW pump speed increased and the 2B FW pump discharge flow high alarm was received at 0335:27. The 2B FW pump responded as expected. With the trip of the 2C FW pump, several feedwater flow mismatch alarms were received for all Unit 2 Steam Generators(SG). The Unit 2 Supervisor initiated entry into 2BwOA SEC-1, Secondary Pump Trip, abnormal operating response procedure.

The 2C FW pump recirculation valve was immediately closed in preparation for starting the 2A motor driven FW pump. Simultaneously, the auxiliary oil pump for the 2A FW pump was started. The oil pump started and the oil pressure available light on the FW pump control panel lit. When the 2C FW pump recirculation valve was closed, the 2A FW pump was started. The 2A FW pump discharge valve is preset to 25% open for rapid start. Positive flow for the 2A FW pump was observed and 2A FW pump flow began to increase.

The Unit 2 NSO continued to increase flow from the 2A FW pump. At this time, the SG narrow range water levels were observed to be about 45% (reactor trip setpoint is 36.3%). At 0335:33 (seven seconds after the 2C FW pump tripped), the 2B FW pump tripped.

The Unit 2 Supervisor directed a turbine runback from the turbine control panel. The fourth condensate-condensate booster pump was started to provide more NPSH for the 2A FW pump as directed by 2BwOA SEC-1.

At 0336:06, the 2A FW pump discharge flow high alarm was received as the NSO continued to increase flow to try and match steam flow. The NSO observed a 500 kilo-pound mass (KLB) difference between FW flow and steam flow in each SG. At this time, the SG narrow range water levels were observed to be 40%. At 0336:20, Unit 2 tripped on low-low 2D SG water level and the auxiliary FW(AF)[BA] pumps automatically started coincident with the 2D SG low-low water level before the NSO could manually initiate a reactor trip.

The Unit 2 operators and supervisor immediately entered emergency procedure 2BwEP-0, Reactor Trip or Safety Injection, due to the Unit 2 reactor trip.

After the Unit 2 reactor trip, investigations and troubleshooting were performed to identify the cause of the 2C FW pump trip. A small piece of age and heat degraded tie wrap was found lodged in the R-PB-SVT relay contacts for 2C FW pump HP stop valve test circuit that blocked contact closure. The piece of tie wrap in the relay contact did not cause the 2C FW pump to trip. However, since the piece of tie wrap prevented the relay contact from closing, the HP stop valve remained closed and made up one series contact in the FW pump trip circuit. Subsequent investigation for extent of condition was conducted and entered into the correction action process to document the findings.

The trip of the 2C FW pump was believed to be caused by both the HP stop valve and LP stop valve closed signals being present at the same time. Both HP and LP stop valves closed is a turbine driven FW pump trip signal. The cause of the LP stop valve closure signal was not conclusive. A NLO slipped and grabbed the LP closed limit switch case (not the limit switch actuating arm) and attached flexible conduit, to prevent his fall. The NLO actions were simulated at the 2C FW pump. Based on the simulation, the NLO actions were discounted as a cause of the 2C FW pump trip.

The trip of the 2B FW pump was the result of a failed Tach-Pak (an electronic feedback loop to the speed control circuit). The 2B FW pump troubleshooting included a calibration check of its speed circuit and found the Tach-Pak was unable to achieve proper output voltage. Review of the Tach-Pak circuitry indicated that the Tach-Pak failed in a manner that would allow the 2B FW pump to overspeed during the system transient following the 2C FW pump trip. The Tach-Pak signal was attenuated and provided an erroneously low input signal to the speed controller so that the 2B FW pump speed increase continued until an overspeed condition was reached and the mechanical overspeed trip actuated.

Analysis of the Tach-Pak unit by a testing lab found the R17 voltage input load resistor failed (i.e., shorted). This failure allowed full input voltage to zener diodes CR10 and CR9 causing extreme heating of these components and failure of CR10. Filter capacitor C3 was also damaged due to age degradation. The lab concluded that the failure of the components in the Tach-Pak was due to age degradation.

C. Cause of Event

The root cause for the Unit 2 reactor trip is a cascading trip of the 2C and the 2B Feedwater (FW) pumps caused by a lack of preventative maintenance(PM). The 2C FW pump tripped first while testing the turbine stop valves. A piece of age degraded tie wrap was found in the test relay. The actual cause of the 2C FW pump trip is not known but is suspected to be the result of the simultaneous low pressure (LP) stop valve closed signal and the high pressure (HP) stop valve closed signal. The 2B FW pump subsequently tripped on overspeed due to age degradation of the speed feedback Tach-Pak module. Neither of the FW pump local control cabinets were inspected or cleaned on a routine basis per any PM process. Although the speed control circuits for the turbine driven FW pumps are calibrated on a two-year frequency, the Tach-Pak modules are not replaced on a routine basis per any PM process.

D. **Safety Consequences:**

There were no safety consequences impacting plant or public safety as a result of this event. The reactor trip system responded as intended to the low SG level condition and shut down the reactor without incident. The AF system functioned as intended to provide decay heat removal. The fourth quarter 2003 Unit 2 NRC Performance Indicator for Unplanned Scrams per 7,000 Critical Hours is well within the green band (i.e., low safety significance) at a value of 0.8.

There were no safety system functional failures associated with this event.

E. **Corrective Actions:**

The piece of age degraded tie wrap in the relay contact did not cause the 2C FW pump to trip. However, since the piece of age degraded tie wrap prevented the relay contact from closing, the HP stop valve remained closed and made up one series contact in the FW pump trip circuit. The closure of the LP stop valve contact in the closed limit switch or a ground in the LP closed limit switch would result in the second series contact to cause the 2C FW pump to trip. The trip of the 2C FW pump was the initiating event and resulted in a challenge to the 2B FW pump and subsequent trip. Although the 2C FW pump trip resulted in a reduction in FW flow to the SGs, the Operator's timely action of starting the 2A FW pump would have prevented an automatic reactor trip if the 2B FW pump had not tripped.

Some FW pump control panels have been inspected for missing or damaged tie-wraps with inspection activities scheduled for the remaining FW pump control panels. Damaged tie-wraps were replaced with a tefzel equivalent. The use of tefzel tie-wraps is being evaluated in panels or control cabinets where prolonged exposure to heat may degrade standard use tie-wraps for securing electrical/electronic components.

The Tach-Paks in the Braidwood turbine driven FW pumps are original equipment. The 2B FW pump Electro-Hydraulic(EH) speed controller, which includes the Tach-Pak module, is calibrated on a two-year frequency. Other PM actions were created to replace or refurbish the circuit cards in these controllers; but, no PM actions were established for the replacement of the Tach-Pak modules. Failure of the Tach-Pak was analyzed and it was identified that the voltage load input resistor failed (i.e., shorted) causing extreme heating and subsequent failure of two zener diodes inside of the unit. The cause was determined to be age degradation.

The failure of electronic speed control circuits is applicable to the industry and all electronic speed control systems. Corrective actions are to replace the Tach-Paks in the short-term, in each of the Braidwood turbine driven FW pumps and create a PM action to replace the Tach-Paks on a 10-year frequency. Procedure enhancements will monitor Tach-Pak operation and initiate actions to test the Tach-Paks during turbine driven FW pump startup and during routine testing of the Tach-Paks.

F. **Previous Occurrences:**

There have been no similar events at Braidwood Station.

G. **Component Failure Data:**

Manufacturer	Nomenclature	Model	Mfg. Part Number
Airpax Electronics	Tach-Pak	075-636-1 X 11	075-636-1 X 11