Commonwealth Edison Company
Braidwood Generating Station
Route #1, Box 84
Braceville, IL 60407-9619
Tel 815-458-2801

ComEd

May 8, 1995
BW/95-0055

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

The enclosed Licensee Event Report from Braidwood Generating Station is being transmitted in accordance with the requirement of 10 CFR 50.73(a)(2)(iv), which requires a 30-day written report.

This report is number 95-004-00, Docket No. 50-456.

Yours truly,

T. J. Tulon
Station Manager
Braidwood Nuclear Station

TJT/BJM/dla
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Encl: Licensee Event Report
No. 456-95-004-00

cc: NRC Region III Administrator
NRC Resident Inspector
INPO Record Center
CECo Distribution Center
I.D.N.S.

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NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

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

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Braidwood Unit 1	05000456	1 OF 6

TITLE (4) Reactor trip due to a failed capacitor in a firing card causing the loss of Vital AC Instrument Bus 111

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBERS
04	09	95	95	-- 004 --	00	05	02	95	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.402(b)		20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
	20.405(a)(1)(i)		50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
	20.405(a)(1)(ii)		50.36(c)(2)	50.73(a)(2)(vii)	OTHER
	20.405(a)(1)(iii)		50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)		50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
	20.405(a)(1)(v)		50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
M. Olson, Root Cause Team	(815)458-2801 x2028

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
X	EBK	GENERA	W120	Y						

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

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

At 0310 on 04/09/95, with unit 1 at 99% power, Instrument Inverter 111 failed, causing a loss of the Vital AC Instrument Bus 111 and failure of twenty-five 7300 Process Control Cabinet cards. Two of the 7300 card failures, FT-510 for 1A Steam Generator feedwater flow and PT-508 for Main Feed header pressure, resulted in the 1A Steam Generator feedwater regulating valve failing open and the master feedwater pump speed controller failing to maximum demand. The NSO took manual control of the 1A feedwater regulating valve but was unable to prevent the Steam Generator from reaching the P-14 trip setpoint. A Turbine trip above P-8 Reactor Trip occurred from the 1A Steam Generator level above the P-14 setpoint.

At 0326 the Instrument Bus was energized from it's associated Constant Voltage Transformer (CVT). Subsequent investigation revealed a blown fuse in Instrument Inverter 111 caused by a failed firing card. The 7300 cards failed due to a voltage spike from the inverter prior to the fuse blowing.

The unit was stabilized in Mode 3 and remained in Mode 3 at NOT/NOP while the Instrument Inverter was repaired and all failed 7300 cards that failed were repaired or replaced.

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Braidwood Unit 1	05000456	95	-- 004 --	00	2 OF 6

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

A. PLANT CONDITIONS PRIOR TO EVENT:

UNIT: Braidwood 1 EVENT DATE: 04/09/95
EVENT TIME: 0311
MODE: 1 RX POWER: 100%
RCS [AB] TEMPERATURE/PRESSURE: NOT/NOP

B. DESCRIPTION OF EVENT:

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

At 0310 on 04/09/95, with unit 1 at 99% power, Instrument Inverter 111 failed, causing a loss of the Vital AC Instrument Bus 111 and failure of twenty-five 7300 Process Control Cabinet cards. The C2 capacitor that failed is used for filtering AC ripple and voltage spikes from the gating board 20 VDC power supply circuit. The C2 capacitor failed open, becoming a high resistance which shifted the tuning frequency of the oscillator RC time constant to a higher frequency. This caused the gating signals to increase resulting in a shift of the output voltage from 120 volts to about 180 volts. Two of the 7300 card failures, FT-510 for 1A Steam Generator feedwater flow and PT-508 for Main Feed header pressure, resulted in the 1A Steam Generator feedwater regulating valve failing open and the master feedwater pump speed controller failing to maximum demand. The NSO took manual control of the 1A feedwater regulating valve but was unable to prevent the Steam Generator from reaching the P-14 trip setpoint. At 0311, approximately 40 seconds after the initiation of the event, 2 of 4 channels of Steam Generator level above the P-14 setpoint of 81.4% actuated a Main Turbine trip and Feedwater Isolation. Because Reactor power was above 30%, A Turbine trip above P-8 Reactor trip occurred immediately. Steam Generator levels decreased to below the low-low level setpoint initiating a start of the Auxiliary Feedwater Pumps.

Operators performed the first four steps of BwEP-0, "Reactor Trip or Safety Injection", and transitioned to BwEP ES-0.1, "Reactor Trip Recovery". The unit was stabilized in Mode 3 at 557 degrees and 2235 psig (NOT/NOP).

Unit 1 remained in Mode 3 at NOT/NOP while all Unit 1 Instrument Inverters and failed 7300 cards were replaced or repaired. As a conservative measure, the Reactor Coolant System was borated to the Cold Shutdown, Xenon free condition.

The appropriate NRC notification was made via the ENS phone system at 0537 pursuant to 10CFR50.72(b)(2)(ii).

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

B. DESCRIPTION OF EVENT (continued):

This event is being reported pursuant to 10CFR50.73(a)(2)(iv) - Any event or condition that resulted in manual or automatic actuation of any Engineered Safety Feature, including the Reactor Protection System.

C. CAUSE OF EVENT:

The cause of this event was equipment failure.

The cause of the Instrument Inverter failure was a blown fuse due to the C-2 capacitor within the firing board frequency control circuit failing open. When the C-2 capacitor failed open, frequency spiked from 60HZ to 90HZ. Since, for our Instrument Inverters, voltage follows frequency, when the frequency spiked, output voltage increased from 120V to 180V. This voltage spike caused twenty-five 7300 Process Instrumentation cards to overload and fail. One card was the selected controlling Feedwater Flow channel (1FT-510) feeding Feedwater Regulating valve 1FW510, which opened. One card provided input to the Master Feedwater Pump speed control circuitry (1PT-508), which went to maximum speed demand. This caused Main Feedwater flow to increase to all steam generators in addition to the increased flow to the 1A steam generator as a result of the 1A feedwater regulating valve failing open.

D. SAFETY ANALYSIS:

This event had no effect on the safety of the plant or the public. All systems operated as designed, except for the train A ESF equipment. Due to the loss of the Instrument Bus 111, train A ESF slave relays remain de-energized. Train A equipment was available and could have been manually started from the Main Control Room had the need occurred.

Three other Instrument Busses connected to their respective Instrument Inverters were operable and available to provide redundant Instrumentation. The instruments and controls powered from Inverter 111 have redundant power supplies, multiple coincidence logics, or otherwise fail to their ESF 'safe' configurations, as did the ESF instrumentation in this case.

In the Byron/Braidwood UFSAR Safety Analysis the resultant transient in this event is addressed by the analysis for a Feedwater System malfunction that results in an increase in Feedwater flow. The increase in Feedwater flow event (UFSAR Section 15.1.2) is a Condition II event, a fault of moderate frequency that, at worst, results in a reactor trip with the plant being capable of returning to operation.

D. SAFETY ANALYSIS (continued):

The analysis assumes that when the steam generator water level in the faulted loop reaches the high-high level setpoint, all feedwater isolation valves and feedwater pump discharge valves are automatically closed and the main feedwater pumps are tripped. This prevents the continuous addition of feedwater. In addition, a turbine trip and a reactor trip are initiated at that time. This is as the event occurred on 04/09/95.

The results of the analysis show that the DNBRs encountered for an excessive Feedwater addition at power are at all times above the limit value; hence, no fuel or clad damage is predicted. The reactivity addition rate as a result of the RCS cooldown are more severe at no load conditions than at full power as was the case for this event. The radiological consequences of this event are less than the steam line break accident analyzed in Subsection 15.1.5.3.

E. CORRECTIVE ACTIONS:

The firing board in the Instrument Inverter was replaced with a new one that includes an upgraded capacitor. This C-2 capacitor has failed previously on at least two other Inverters at Braidwood Station in 1993. A similar occurrence has also occurred at the Vogtle Nuclear Power station. These failures and subsequent analysis identified this capacitor as being undersized for the circuit application being used. Westinghouse has since upgraded the circuit design to include a larger size capacitor to increase operating margins.

After identifying the sizing problem in May of 1994, a recommendation was made to install a new firing board with an upgraded 1000 uf, 50 VDC capacitor. All Unit 2 7.5 KVA Instrument Inverters' firing boards were replaced with the new capacitor during the A2R04 unit outage last fall. This component replacement was done during Electrical Maintenance Department preventative maintenance on the Instrument Inverters. The unit 1 firing boards with the upgraded capacitor were scheduled to be installed during A1R05 this fall as part of the same scheduled preventative maintenance on the Inverters. These boards were not replaced during the recently completed maintenance outage on Unit 1. The basis for this decision was that both trains of RHR were required to be operable for shutdown safety reasons, and thus no safety related buses were taken out of service. Braidwood Station management subsequently decided to not extend the maintenance outage to replace the firing boards, but to wait until the fall refueling outage as originally scheduled.

Instrument Inverter 111 has been repaired and returned to service. Also, the firing boards on all Unit 1 Instrument Inverters were replaced with the

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CORRECTIVE ACTIONS (continued):

Protection cards that failed have been replaced by the Instrument Maintenance Department. Each Inverter was also tested after the repairs were made. Testing consisted of "tuning" the Inverter by loading up the Inverter and adjusting voltages to ensure proper response was obtained.

F. PREVIOUS OCCURRENCES:

There have been three similar Instrument Inverter failures at Braidwood Station in the past:

1. (LER 20-1-89-001) On February 16, 1989, Unit 1 was in Mode 3 with all the control rods inserted and the reactor trip breakers closed. A momentary loss of output voltage on Instrument Bus 112 caused a reactor trip signal due to an Intermediate Range High Flux bistable from channel N36. The Unit 1 Instrument Inverters were inspected during the next outage. Radios were keyed with the inverter running and the door open, as Braidwood had experienced inadvertent actuations in the past due to keyed radios. The Inverter experienced no adverse effects. Westinghouse was consulted for corrective actions. New circuit boards and capacitors were installed and no definitive root cause was discovered.

2. On July 26,1993, Unit 1 was in Mode 1 at 100% power. The Instrument Inverter for Instrument Bus 112 tripped. As a result of the Inverter trip, approximately 10-20 7300 cards were damaged in the Process and Protection Control System which included one channel of Pressurizer Level Indication, (LI-460). The Pressurizer level channel failure caused a letdown isolation. LI-460 was de-selected as an input signal, letdown was re-established, and the unit was stabilized in Mode 1. The root cause of this Inverter failure was a capacitor that was observed to be damaged on the gating and sync board in the Inverter which raised output voltage and current before the Inverter tripped on overcurrent.

3. On November 18, 1993, Unit 2 was in Mode 1 at 100% power. The Instrument Inverter for Instrument Bus 212 failed but did not trip. Approximately 30 7300 cards in the Protection and Control System were damaged due to a suspected overvoltage condition developing on the output of the Inverter. The unit was stabilized in Mode 1 with seven LCOAR's entered for Inverter and other related instrumentation failures. A capacitor on the gating and sync board in the Instrument Inverter was found to be failed and was identical to the failure that occurred in July, 1993, on Unit 1. As a result of this second failure, Site Engineering had the capacitors in question sent to be analyzed to see if the failure mechanism could be determined.

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F . PREVIOUS OCCURRENCES (continued):

In July, 1994, component and system testing was completed by Parts Engineering on the two gating printed circuit boards that had failed in the Instrument Inverters at Braidwood Station in July and November of 1993. Each capacitor was carefully disassembled and revealed the same failure mode; total corrosion and separation of the positive electrode wire, and loss of dielectric film on the insulator between the circular plates. This caused the capacitors to operate as an abnormally high resistor, shifting the output frequency of the gating board higher and resulting in the increased output voltage. It was further determined that these capacitors, rated at 500 uf, 25 VDC, maximum ripple .484 A RMS, were marginal for this circuit design application. Westinghouse has since increased the circuit design requirement for a maximum ripple to 1.1 A RMS and a replacement C-2 capacitor which is rated at 1000 uf and 50 VDC. This replacement capacitor is twice the size and should provide adequate operating margin.

G. COMPONENT FAILURE DATA:

MANUFACTURER	NOMENCLATURE	MODEL	MFG PART NO.
Mallory	Capacitor	C-2	TT25X500