

Commonwealth Edison Company  
Byron Generating Station  
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February 10, 2000

LTR: BYRON 2000-0017  
File: 3.03.0800

United States Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Byron Station, Unit 2  
Facility Operating License No. NPF-66  
NRC Docket No. STN 50-455

Subject: Licensee Event Report (LER) 2000-001-00

Enclosed is an LER concerning the Byron Station Unit 2 automatic reactor trip on January 13, 2000. This event is reportable to the NRC in accordance with 10 CFR 50.73 (a)(2)(iv).

If you need any additional information concerning this report, please contact Mr. Brad Adams, Regulatory Assurance Manager, at (815) 234-5441, extension 2280.

Sincerely,

A handwritten signature in black ink, appearing to read "W Levis".

William Levis  
Site Vice President  
Byron Station

WL/JL/dpk

Enclosure: Byron Station Unit 2 LER 2000-001-00

cc: Regional Administrator – NRC Region III  
NRC Senior Resident Inspector – Byron Station

Handwritten initials in black ink, possibly "JED".

**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. 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

FACILITY NAME (1) Byron, Unit 2

DOCKET NUMBER (2) STN 05000455

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TITLE (4) Automatic Reactor Trip System Actuation Due to Off-Site Power Line Fault and Failed Air Circuit Breaker Load Rejection Contact

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 NUMBER
01	13	2000	2000 - 001 - 00			02	10	2000	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	MODE 1	<b>THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §:</b> (Check one or more) (11)	
POWER LEVEL (10)	100		
<input type="checkbox"/> 20.2201(b) <input type="checkbox"/> 20.2203(a)(3)(i) <input type="checkbox"/> 50.73(a)(2)(iii) <input type="checkbox"/> 73.71(b)			
			<input type="checkbox"/> 20.2203(a)(1) <input type="checkbox"/> 20.2203(a)(3)(ii) <input checked="" type="checkbox"/> 50.73(a)(2)(iv) <input type="checkbox"/> 73.71(c)
			<input type="checkbox"/> 20.2203(a)(2)(i) <input type="checkbox"/> 20.2203(a)(4) <input type="checkbox"/> 50.73(a)(2)(v) <input type="checkbox"/> OTHER
			<input type="checkbox"/> 20.2203(a)(2)(ii) <input type="checkbox"/> 50.36(c)(1) <input type="checkbox"/> 50.73(a)(2)(vii)
			<input type="checkbox"/> 20.2203(a)(2)(iii) <input type="checkbox"/> 50.36(c)(2) <input type="checkbox"/> 50.73(a)(2)(viii)(A)
		<input type="checkbox"/> 20.2203(a)(2)(iv) <input type="checkbox"/> 50.73(a)(2)(i) <input type="checkbox"/> 50.73(a)(2)(viii)(B)	
		<input type="checkbox"/> 20.2203(a)(2)(v) <input type="checkbox"/> 50.73(a)(2)(ii) <input type="checkbox"/> 50.73(a)(2)(x)	

(Specify in Abstract below and in Text, NRC Form 366A)

**LICENSEE CONTACT FOR THIS LER (12)**

NAME (Include Position Title)	TELEPHONE NUMBER (Include Area Code)
Brad Adams, Regulatory Assurance Manager	(815) 234-5441 X2280

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
X	FK	RLY	X999	Y					

**SUPPLEMENTAL REPORT EXPECTED (14)**

YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
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ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines 16)

At 0059 hours on January 13, 2000, Byron Station Unit 2 received an offsite transmission line 0622 trip alarm due to a phase B fault. A static line from another offsite line fell onto phase B of line 0622 causing the fault and direct transfer trip. As designed, the direct transfer trip opened oil circuit breakers (OCBs) 11-12 and 12-13 to isolate the line fault in the Byron Station switchyard. Unit 2 next received an unexpected main generator load rejection trip signal. The load rejection circuit provided a signal to actuate a main generator lockout relay, which opened air circuit breaker (ACB) 10-11 and tripped the Unit 2 turbine and reactor. The turbine and reactor trip occurred as designed and the unit was safely shut down.

ACB 10-11 was closed at the time of the load rejection alarm which indicated one of the ACB 10-11 auxiliary contacts must have been closed at that time to complete the required load rejection trip logic. It was verified during subsequent troubleshooting that the ACB 10-11 phase A load rejection 'b' contact was found closed when the breaker was closed. The 'b' contact should have been open. The root cause of the switch failure is unknown.

The immediate corrective action was to replace the defective contacts and verify proper operation. Also, a preventive maintenance activity will be developed to test these switches for both Byron Station Units. There were no actual safety consequences impacting plant or public safety. At 0155 hours on January 13, 2000, a NRC Emergency Notification System telephone call was initiated in accordance with 10 CFR 50.72.

**LICENSEE EVENT REPORT (LER)**  
TEXT CONTINUATION

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**A. Plant Conditions Prior to Event:**

Event Date/Time: January 13, 2000/0059 hours

Unit 2 - Mode 1 - Power Operation, Reactor Power - 100%

Reactor Coolant System [AB] Temperature/Pressure: Normal operating temperature and pressure.

At the time of the event, the Unit 2 Boron Dilution Protection System (BDPS) was inoperable as described in Byron Station Licensee Event Report (LER) 454-98-20-00. BDPS is required by Technical Specifications to be operable in Mode 3 (i.e., Hot Standby) through Mode 5 (i.e., Cold Shutdown). No other structures, systems or components (SSCs) were inoperable at the start of the event that contributed to the event.

**B. Description of Event:**

The two Units at Byron Station have a common 345 Kv switchyard that is configured into two ring busses to afford reliability and redundancy of offsite power supplies. Figure 1 depicts a line diagram of Byron Station's switchyard. Two 345 Kv offsite transmission lines are connected to each unit's ring bus. The Unit 1 lines are numbered 0621 and 15501 and the Unit 2 lines are numbered 0622 and 0624. Line 0621 and 0622 are routed on the same transmission towers from the Cherry Valley substation into the Byron Station switchyard. Each line is provided with fault isolation capability from the ring bus through use of switchyard circuit breakers.

At 0059 hours on January 13, 2000, a static line on line 0621 broke and fell across the B phase of line 0622 thereby causing an electrical fault. Unit 2 received a line 0622 direct transfer trip alarm due to a phase B fault on line 0622. The direct transfer trip signal opened Oil Circuit Breakers (OCBs) 11-12 and 12-13 to isolate the line fault in the Byron Station switchyard. Due to the redundant offsite power supply (i.e., line 0624) the event should have terminated at this time without further interruption to unit operations. However, Unit 2 also received an unexpected Main Generator [TB] (MG) load rejection trip signal. The load rejection circuit provided a signal to actuate MG lockout relay 86G2A, which opened Air Circuit Breaker (ACB) 10-11 and automatically tripped the Unit 2 turbine [TA]. A turbine trip automatically generates a reactor trip above 30% power.

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**B. Description of Event, cont.:**

A reactor trip signal (RTS) also automatically generates a main feedwater [SJ] (FW) isolation signal. The turbine trip, reactor trip, and FW isolation functions occurred as designed. Licensed operators responded to the event using appropriate reactor trip response procedures. A reactor trip from power operations also causes an immediate entry into Mode 3 and as a result, operators entered the Technical Specification action requirement for BDPS inoperability. This required isolation of unborated water sources and verification that shutdown margin was within limits. These actions were accomplished by 0155 hours on January 13, 2000.

As an expected response to a reactor trip from 100% reactor power, the Steam Generator water levels dropped below the low level setpoint for an automatic Auxiliary Feedwater [BA] (AF) actuation. This resulted in the automatic initiation of both trains of the AF system. This is considered an Engineered Safety Feature (ESF) actuation. However, not expected, were containment ventilation isolation signals for both Unit 1 and Unit 2 and a start signal for the Unit Common B (i.e., 0B) train of the Fuel Handling (FH) Charcoal Booster Ventilation Train. These were attributable to momentary voltage transients on the radiation monitors that generate these ESF actuation signals. Both Unit 1 and Unit 2 containment ventilation isolation valves were closed prior to receiving the isolation signal and consequently, no equipment actuated. The OB FH charcoal booster fan started as designed. After verification that these signals were not valid, the containment ventilation isolation signals were reset and the OB FH charcoal booster fan was secured. The OA Main Control Room Ventilation Train did not receive an ESF switchover signal as originally believed and reported in the Emergency Notification System (ENS) telephone notification. This train was already operating in its ESF alignment for surveillance testing prior to the reactor trip.

At 0127 hours on January 13, 2000, Licensed operators exited the reactor trip response procedure and entered the normal unit shutdown procedure.

At 0155 hours on January 13, 2000, a NRC ENS telephone call was completed in accordance with 10 CFR 50.72 (b) (2) (ii). This reporting criterion requires a NRC four hour notification for any event or condition that results in a manual or automatic actuation of any engineered safety feature, including the reactor protection system. In addition, this event is reportable as an LER in accordance 10 CFR 50.73 (a) (2) (iv).

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**B. Description of Event, cont.:**

A prompt investigation into the root cause of the reactor trip was initiated. This investigation revealed the following sequence of events:

- 1) Red System (Unit 2) Transfer Trip Alarm received at 0059.06.326 hours on January 13, 2000

This alarm was caused by the phase B line 0622 fault. The line 0622 System I and II direct transfer trip (DTT) targets from transmission substation 156 (Cherry Valley) were received. The DTT caused an OCB 11-12 and OCB 12-13 trip as expected. All relay targets and relay actuations were as expected and accounted for based on breaker operation.

- 2) Line 0622 Faulted Alarm received at 0059.06.339

This alarm was caused by the phase B line 0622 fault. Line relay targets 21G, 21GX, and SLA-T1 were received. This condition also causes an OCB 11-12 and OCB 12-13 trip. All relay targets and relay actuations were as expected and accounted for based on breaker operation.

- 3) OCB 12-13 Trip Alarm received at 0059.06.360

The DTT, 21G, 21GX and SLA-T1 relay actuations caused this alarm. OCB 12-13 tripped and opened as expected. All relay targets and relay actuations were as expected and accounted for based on breaker operation.

- 4) OCB 11-12 Trip Alarm at 0059.06.360

The DTT, 21G, 21GX and SLA-T1 relay actuations caused this alarm. OCB 11-12 tripped and opened as expected. All relay targets and relay actuations were as expected and accounted for based on breaker operation.

The event should have terminated at this point following the isolation of the faulted line. The following alarms and events were unexpected for a line 0622 fault and subsequent isolation.

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**B. Description of Event, cont.:**

5) Load Rejection Generator Trip Alarm at 0059.06.364

This alarm occurs when all the following conditions are satisfied:

- a. Any phase of OCB 11-12 is open,
- b. Any phase of ACB 10-11 is open,
- c. Unit 2 Main Power Transformer disconnect is closed, and
- d. Any Unit Auxiliary Transformer feed breaker is closed.

Conditions c. and d. are satisfied during the normal full power unit operation electrical lineup. Condition a. was satisfied when OCB 11-12 opened due to the line 0622 fault. The remaining permissive to complete the logic was the position of the ACB 10-11 load rejection auxiliary contacts. The Unit 2 Sequence of Event Recorder (SER) indicated ACB 10-11 was closed at the time of the load rejection alarm which indicated one of the ACB 10-11 auxiliary contacts must have been closed at that time to complete the logic. It was verified during subsequent troubleshooting that the ACB 10-11 phase A load rejection 'b' contact was found closed when the breaker was closed. The 'b' contact should have been open with the breaker closed to prevent the load rejection trip signal.

6) Generator Lockout Relay Trip Alarm First Out at 0059.06.383

The load rejection circuit actuates MG lockout relay 86G2A, which opened ACB 10-11 and tripped the Unit 2 turbine and reactor. All relay actuations resulting from the actuation of relay 86G2A were reviewed and verified through the SER. The drawings, SER, and relay targets were also reviewed to verify only the load rejection circuit caused the 86G2A actuation.

7) ACB 10-11 Trip at 0059.06.410

This alarm was caused by the actuation of the 86G2A lockout relay. ACB 10-11 tripped and opened as expected. All potential ACB 10-11 trips were reviewed and were excluded as a cause of the breaker trip with the exception of the 86G2A and 86G2B relays.

All additional relay targets were expected based on the line 0622 fault and subsequent switchyard actuations. These relays would not cause any breaker trips since these relays need a synchronizing permissive to cause a breaker trip. The backup generator lockout relay (86G2B) also actuated as designed during this event.

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**C. Cause of Event:**

The cause of the static line breaking on Line 0621 was determined to be excessive wear of the rubber grommet inside the armor grip support unit causing damage to the static wire strands. This was a previously identified deficiency discovered through periodic inspections and awaiting a scheduled line outage to implement repairs.

The ACB 10-11 phase A load rejection 'b' contact was found closed when the breaker was closed instead of in its expected open position. ACB 10-11 was operated several times and the contact position did not change with breaker position.

A failure analysis of the ACB 10-11 phase A 'b' contact was performed at Commonwealth Edison Company's Components Laboratory. The failed contact (switch) was a Gessman auxiliary switch on a Brown Boveri 345 Kv type DLFK circuit breaker. This particular switch is mechanically interlocked with a lower switch that contains a plunger assembly and a roller assembly that rides against a cam. The rotation of the cam provides the motive force to change contact (switch) position. The failure analysis report concluded the following:

- 1) Based on the test performed on the switch at the Components Laboratory and in accordance with the written test plan, the switch was verified to open at approximately .080 inches of travel as expected. Furthermore, even though the evidence gathered in the field would indicate a possible problem with the switch, there was no conclusive evidence found during the testing of the switch to indicate sticking of the contacts or binding in the mechanical portion of the switch. The most likely failure mechanism would be insufficient travel of the switch plunger, which could allow the contacts to remain closed.
  
- 2) A single mode of failure is undetermined at this time. It is possible that cam positioning due to the linkages, switch alignment, cam alignment and switch to frame rail position could all be contributing factors. These factors could not be validated at this time, as the cam assembly into which this switch is mounted must be field verified and was therefore not part of this portion of the failure analysis. Testing at the Components Laboratory further substantiated the minimum distances for switch travel to actuation, reset, full travel, and at rest. It was found that the plunger could be observed to move without the switch actually changing state. This is what was believed to have been seen in the field at the time of failure.

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**C. Cause of Event, cont.:**

An investigation was performed to determine the last time the load rejection contacts were tested. Maintenance Department personnel reviewed all switchyard breaker contacts and verified all contacts were periodically tested with the exception of the load rejection contacts. These contacts would not be checked during plant operation or shutdown since the operation of the plant electrical system does not normally allow all load rejection logic contacts to be made up at once. It was determined line 0622 last tripped and opened OCBs 11-12 and 12-13 on July 25, 1996. This would have been the last time that the load rejection logic would have been challenged during a line fault. All five Byron Station ACBs have the same contacts but only ACB 10-11 has the load rejection contacts. It should also be noted the OCB contacts are not the same model or design as the ACB contacts.

Action taken in response to Transmission and Distribution Maintenance and Operations Alert and Awareness Notices (MOAAN) #19, "Auxiliary Switch Modifications on Brown Boveri 345 kV and 765kV Type DLFK Circuit Breakers," June 11, 1999 may have contributed to the cause.

This MOAAN was for breaker failures due to short circuits created at the auxiliary switches. The wires leaving the lower switch segments passed between long screws, which secured the upper row of piggybacked switch segments. The sharpness of the screw threads eventually wears through the wire insulation causing the breaker mis-operation and short circuits. The switches in ACB 10-11 were modified using the rail assembly as directed by the MOAAN on May 11, 1998. Additional contacts as discussed in the MOAAN were replaced on October 22, 1999. No load rejection contacts were changed at that time. These activities may have potentially affected switch operation and will be evaluated.

Further investigation into the root cause will continue and if significant additional information is determined involving the cause, a supplemental report will be issued.

**D. Assessment of Safety Consequences:**

There were no actual safety consequences impacting plant or public safety as a result of the event. Each Unit has redundant and separate offsite power lines to their respective switchyard ring bus. Normal offsite power to Unit 2 was always available through the redundant supply line 0624.

Though caused by an invalid main generator loss of load signal, the turbine trip functioned as designed and caused a reactor trip system actuation. The reactor is designed to withstand a trip from full power without challenging any safety limits.

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**D. Assessment of Safety Consequences, cont.:**

The current Byron Station Unit 2 NRC Performance Indicator for unplanned scrams per 7000 critical hours is in the green band (i.e., low safety significance) at a value of 0. It is estimated this reactor trip will change the indicators value to approximately 0.9 for first quarter 2000. This is still well within the green band.

**E. Corrective Actions:**

Immediate corrective actions include:

The static line for line 0621 was repaired on January 13, 2000.

The ACB 10-11 phase A, B, and C load rejection auxiliary contacts were replaced. A visual inspection of the remaining contacts was performed. The breaker was cycled to verify proper operation of the replaced contacts.

A failure analysis for ACB 10-11 phase A load rejection contact (switch) was performed and completed.

Corrective actions to prevent recurrence include:

A coordinated line outage plan will be executed to inspect other related switchyard breakers and repair deficiencies on the four offsite transmission lines.

Develop a procedure to test both units load rejection breakers' phase A, B, and C auxiliary contacts on a periodic basis.

Additional cause evaluation will continue and if significant additional information is determined a supplement to this report will be issued.

**F. Previous Occurrences:**

LER 454: 98-017

On August 4, 1998, Line 0621 tripped and a loss of off-site power subsequently occurred. The loss of off-site power was due to a 94X relay that failed to reset after the fault. The false trip signal from the failed relay in conjunction with other plant conditions caused a loss of off-site power to the Unit 1 System Auxiliary Transformers when the operator attempted reclosure of OCB 5-6. The failure mode in this event is not like the failure mode in this report.

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**F. Previous Occurrences, cont.:**

Problem Identification Form (PIF) B1998-01631 documented a pole disagreement on ACB 10-11. Work Request (WR) 980037569 replaced the pole disagreement contacts. The auxiliary contacts for pole disagreement are similar to the ones used for load rejection.

PIF B1999-00599 documented a pole disagreement on ACB 10-11. WR 990017572 replaced the pole disagreement contacts. The auxiliary contacts for pole disagreement are similar to the ones used for load rejection.

PIF B1999-00883 documented a problem with the ACB 3-7 phase B operations counter. WR 990027312 replaced the counter contact. The auxiliary contact for the counter is similar to the one used for load rejection.

PIF B1999-04106 documented a problem with pole disagreement for ACB 3-7. The pole disagreement was reset and the breaker was successfully closed. No corrective maintenance actions were performed. The auxiliary contacts for the pole disagreement are similar to the ones used for load rejection.

**G. Component Failure Data:**

<u>Manufacturer</u>	<u>Nomenclature</u>	<u>Model Number</u>
Brown Boveri	Circuit Breaker	DLFK

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FIGURE 1 - LINE DIAGRAM OF BYRON STATION'S SWITCHYARD

