Exelon Generation Company, LLC
Quad Cities Nuclear Power Station
22710 206th Avenue North
Cordova, IL 61242-9740

www.exeloncorp.com

Exelon Nuclear

April 10, 2002

SVP-02-010

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

Quad Cities Nuclear Power Station, Unit 2
Facility Operating License No. DPR-30
NRC Docket No. 50-265

Subject: Revision 01 of Licensee Event Report 265/01-001, "Reactor Scram due to Failure of Main Power Transformer"

Enclosed is Licensee Event Report (LER) 265/01-001, "Reactor Scram due to Failure of Main Power Transformer," Revision 01, for Quad Cities Nuclear Power Station. LER 265/01-001 has been revised to include the root cause and corrective actions from the completed root cause report.

This submittal includes the following commitment:

A comprehensive transformer monitoring strategy will be implemented utilizing the number of through-fault conditions to evaluate when internal inspections of transformers are required.

Any other actions described in the submittal represent intended or planned actions by Exelon Generation Company (EGC), LLC. They are described for the NRC's information and are not regulatory commitments.

Should you have any questions concerning this report, please contact Mr. W. J. Beck at (309) 227-2800.

Respectfully,

Timothy J. Tulon
Site Vice President
Quad Cities Nuclear Power Station

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station

IE22

NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB NO. 31[illegible]104 EXPIRES 7-31-2004

Estimated burden per response to comply with this mandatory information 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 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, NEOB-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
Quad Cities Nuclear Power Station Unit 2	05000265	1 of 5

4. TITLE Reactor Scram Due to Failure of Main Power Transformer

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
									Quad Cities Nuclear Power Station, Unit 1	05000254
08	02	01	01	- 001 -	01	04	10	02	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)(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)
Wally Beck, Regulatory Assurance Manager	(309) 227-2800

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

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)

On August 2, 2001, at 0813 hours, lightning struck a 345 kV line that connected to the Quad Cities switchyard. This resulted in failure of the Unit 2 Main Power Transformer (MPT), an automatic reactor scram on Unit 2 and loss of normal offsite power to Unit 2. An Unusual Event was declared, the Unit 2 and 1/2 Emergency Diesel Generators started, and the Reactor Core Isolation Cooling system and the Safe Shutdown Makeup Pump were manually started to maintain reactor vessel level. The MPT fire was extinguished at 0845 hours and normal offsite power was restored to Unit 2 at 1047 hours.

The safety significance of this event was minimal. All safety systems operated as designed to shut the Unit 2 reactor down and maintain it in a safe shutdown condition. Offsite power was available to Unit 2 from the Unit 1 Reserve Auxiliary Transformer through the emergency bus crosstie throughout the event.

The root cause of the MPT failure was mechanical failure of the bus bar clamps due to original equipment manufacturer design and construction errors. The root cause of the loss of normal offsite power was age degradation in a Static Breaker Failure (SBF) relay.

The SBF relay was replaced and the preventive maintenance program has been upgraded concerning local breaker backup schemes. The MPT Specification Development Lessons Learned Review Checklist has been upgraded and a comprehensive transformer monitoring strategy will be implemented.

PLANT AND SYSTEM IDENTIFICATION

General Electric - Boiling Water Reactor, 2511 Megawatts Thermal Rated Core Power

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

EVENT IDENTIFICATION

Reactor Scram Due to Failure of Main Power Transformer

A. CONDITION PRIOR TO EVENT

Unit: 1	Event Date: August 2, 2001	Event Time: 0813 hours
Reactor Mode: 1	Mode Name: Power Operation	Power Level: 100%
Unit: 2	Event Date: August 2, 2001	Event Time: 0813 hours
Reactor Mode: 1	Mode Name: Power Operation	Power Level: 100%

Power Operation (1) - Mode switch in the RUN position with average reactor coolant temperature at any temperature.

B. DESCRIPTION OF EVENT

On August 2, 2001, at 0813 hours, Quad Cities Nuclear Power Station's Unit 2 Main Power Transformer (MPT) (T2) [XFMR] [EL] ruptured and caught fire. This caused an automatic shutdown of the Unit 2 Reactor [JC]. During the event additional breakers in the switchyard that should have stayed closed also opened. This resulted in a loss of feed from the Unit 2 Reserve Auxiliary Transformer (RAT) to Unit 2.

The normal sources of offsite power to Unit 2 are the Unit 2 RAT and the Unit 2 Unit Auxiliary Transformer (UAT). The UAT is lost whenever the unit scrams, and its loads are automatically transferred to the RAT. With a unit scram and loss of the RAT, the normal source of offsite power to the unit is lost. The second source of offsite power required by the Technical Specifications is the RAT on the opposite unit feeding through the emergency bus crosstie [EB]. This power source was available from Unit 1 for Unit 2 throughout this event.

An Unusual Event was declared in accordance with the station's Emergency Plan. The Unit 2 and 1/2 Emergency Diesel Generators (EDGs) [DG] [EK] started as required, and the Station Blackout (SBO) diesel generators were manually started as required by station procedures. The Reactor Core Isolation Cooling (RCIC) system [BN] and the Safe Shutdown Makeup Pump (SSMP) [P] were also manually started and used to maintain reactor vessel level. Reactor water level did not go below approximately 130 inches above the top of active fuel. The T2 transformer fire was extinguished at approximately 0845 hours by the automatic actuation of the transformer's fire protection deluge system [IC], the station fire brigade, and the local fire department.

Reactor pressure was controlled with the Main Steam Relief Valves. Reactor water level fluctuated within the control band of the emergency operating procedures such that the reactor vessel level dropped below the scram setpoint again at

approximately 0930 hours, but returned above the scram setpoint within 10 minutes.

Power to Unit 2 emergency busses from the Unit 2 RAT was restored at approximately 1047 hours. Unit 2 was in a seven-day Technical Specification (TS) Limiting Condition for Operation (LCO) 3.8.1, Condition A, "One required offsite circuit inoperable," from 0813 hours to 1047 hours.

Unit 1 continued to operate with normal power. The train of offsite power to Unit 1 comprising the Unit 2 RAT feeding through the emergency bus crosstie was not available as required by the Technical Specifications. Normal power to the unit from the Unit 1 RAT and from the Unit 1 UAT were not affected. Unit 1 was in the seven-day TS LCO 3.8.1, Condition A, from 0813 hours to 1047 hours. Also, Unit 1 was in the seven-day TS LCO 3.8.1, Condition B, "One required DG inoperable," from 0855 hours to 1051 hours while the Unit 1/2 EDG was dedicated to Unit 2. Finally, Unit 1 was in the 12-hour TS LCO 3.8.1, Condition D, "One required offsite circuit inoperable AND One required DG inoperable," from 0855 hours to 1047 hours.

The event began when lightning struck the "A" phase conductor of transmission line 0401 on the Iowa side of the Mississippi River. (This section of line 0401 is not owned or maintained by Exelon.) The resulting voltage surge caused a flash-over on an insulator [INS] located in Iowa on the second transmission tower to the west of the river. The flashover shorted "A" phase to ground through the tower frame. The "A" phase voltage on the entire ring bus was reduced from 345 KV to 52 KV.

The protective relaying at Quad Cities' switchyard detected this fault, and switchyard breakers '4-6' and '6-7' opened within 60 milliseconds of the lightning hit. This is well within the design standards for the switchyard. This isolated the 0401 line fault from the switchyard ring bus. The voltage spike from the lightning was substantially shorted to ground by the insulator flash-over. There were no discharges by any of the flash arrestors connected to the ring bus.

Sixty-nine milliseconds after the lightning strike to line 0401, the sequence of events recorder noted an overpressure condition within the transformer. Accounting for the time response of the measuring devices, the phase to phase fault started at 44 milliseconds after the lightning strike.

At 85 milliseconds after the lightning strike, the protective relaying initiated a generator trip. The switchyard breakers opened at 125 milliseconds, which isolated T2 from the switchyard ring bus. The generator field breaker opened after 191 milliseconds. Due to the generator coastdown, it takes up to 5 seconds for the magnetic fields in the exciter and generator to stop producing current to the main power transformer. Thus the arcing within the transformer did not stop immediately when the breakers opened.

At 439 milliseconds after the lightning strike to line 0401, the sudden pressure relay [RLY] reset. This reset indicates that the pressure within the transformer had sufficiently vented to atmosphere. While some arcing may have still have been occurring within the transformer, the rate of gas production was within the capacity of the vent paths opened in the top of the transformer (broken bushings).

The fault inside T2 vaporized the transformer oil in the vicinity of the arcing. The resulting high pressure combustion gases that were formed pushed the primary side terminals out of the primary bushings on top of the transformer and jetted gases into their respective iso-phase bus ducts [IPBU]. These gases then pressurized the iso-phase bus ducts and ruptured their enclosures. The top and sides of the transformer tank were bulged. The oil and gases that were discharged

from the transformer ignited and burned. The transformer fire was extinguished by the automatic actuation of the transformer's fire protection deluge system, the station fire brigade, and the local fire department.

During this event, line noise generated by the faults was not appropriately filtered, resulting in loss of relay communication on line 0402(not owned or maintained by Exelon). This caused breaker '9-10' to open. However, the time delay relay setting for breaker '9-10' (2 cycles rather than 0.6 cycles) was excessive. This was sensed as a "fail-to-open," and the ring bus protective logic caused breaker '8-9' to open. The combination of the excessive time delay, the 0401 fault, loss of relay communication, and the T2 failure, isolated the ring bus in such a way that there was one 345 KV breaker that connected Unit 1 to the grid. This caused the loss of normal off-site power to Unit 2.

C. CAUSE OF EVENT

The root cause of the transformer failure was original equipment manufacturer design and construction errors that allowed the mechanical failure of the bus bar clamps, due to undersized bus bars and bus bar clamp bolts, to create a phase-to-phase fault. Undersized low voltage bus bars caused excessive bus bar heating resulting in the loosening of the transformer bus bar support system. Undersized fiber bolting material with properly sized nuts caused excessive stress and wear on the threads leading to transformer bus bar support system failure.

The root cause of the loss of normal offsite power to Unit 2 was a transistor failure due to age degradation in a Static Breaker Failure (SBF) relay causing a slow relay reset time.

D. SAFETY ANALYSIS

The safety significance of this event was minimal. All safety systems operated as designed to shut the Unit 2 reactor down and maintain it in a safe shutdown condition. The EDGs supplied electrical power from the time of the event until normal offsite power was restored. The second TS-required source of offsite power to Unit 2 (the Unit 1 RAT feeding through the emergency bus crosstie) was also available. Reactor level was maintained by manual operation of RCIC and the SSMP, and pressure was maintained by manual operation of the Main Steam Relief Valves. On Unit 1, normal power was maintained from the Unit 1 RAT and from the Unit 1 UAT.

This report is being submitted in accordance with 10 CFR 50.73(a)(2)(iv)(A) as, "any event or condition that resulted in a manual or automatic actuation of any Engineered Safety Feature."

E. CORRECTIVE ACTIONS

Immediate Actions

The transformer fire was extinguished and normal offsite power for Unit 2 (and the second source of offsite power for Unit 1) was recovered.

Completed Corrective Actions:

The SBF time delay relay for breaker '9-10' was replaced with a newer SBF-1 relay and the Unit 2 MPT was replaced. Also, the cause for the loss of communication on line 0402 was fixed prior to startup.

Changes to the preventive maintenance program have been implemented, including testing of the reset function of the local breaker backup schemes.

The Electrical/Instrumentation and Control Transformer Specification Development Lessons Learned Review Checklist has been upgraded to ensure the potential for internal phase-to-phase faults in new, installed and spare transformers is minimized for all Exelon Nuclear sites.

Corrective Action to be Completed:

A comprehensive transformer monitoring strategy will be implemented utilizing the number of through-fault conditions to evaluate when internal inspections of transformers are required.

F. PREVIOUS OCCURRENCES

No previous occurrences at Quad Cities Station of the SBF relay failing to reset and therefore causing a loss of normal off-site power were identified.

The most recent transformer failure at Quad Cities Nuclear Power Station was in June of 1993 (LER 2-93-013). During that event the Unit 2 MPT failed due to an internal electrical fault, and the main turbine tripped resulting in a reactor scram. The transformer was replaced with the transformer involved in the August 2, 2001, event.

G. COMPONENT FAILURE DATA

The Unit 2 Main Transformer is a 17.1/345 kV GSU Transformer made by ABB, serial number GBM22471. The SBF relay is a Westinghouse, style 670B640A11, 1-4 amps, 125 volts, 60 hertz relay.