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Exelon Nuclear

October 01, 2001

SVP-01-099

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: 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," for Quad Cities Nuclear Power Station.

This report is submitted in accordance with the requirements of the Code of Federal Regulations, Title 10, Part 50.73(a)(2)(iv)(A), which requires reporting of any event or condition that resulted in a manual or automatic actuation of any Engineered Safety Feature.

We are committing to the following action:

The root cause determination for this event is in progress but has not been finalized. Upon completion of the root cause investigation, a revised report will be issued .

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.

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

Respectfully,

George P. Barnes for

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

NRC FORM 366 (1-2001)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001

Estimated burden per response to comply with this mandatory information collection request: 50 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, and 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.

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TITLE (4) Reactor Scram due to Failure of Main Power Transformer

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
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 -	00	10	01	01	FACILITY NAME N/A	DOCKET NUMBER N/A

OPERATING MODE (9): 1

POWER LEVEL (10): 100

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

☐ 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)	☒ 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
☐ 20.2203(a)(2)(iii)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	Specify in Abstract below or in NRC From 366A
☐ 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)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Wally Beck, Regulatory Assurance Manager	(309) 227-2800

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		12	07	01

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

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, 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 transformer 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 preliminary root cause of the transformer failure is internal damage due to a lightning strike on a high-voltage line away from the plant. The preliminary root cause of the loss of normal offsite power is a switchyard breaker relay with an excessive time delay reset. Final root causes will be provided in a revised report to be submitted upon completion of the root cause analysis.

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

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

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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

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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 preliminary root cause of the transformer failure is internal damage due to a lightning strike on a high-voltage line away from the plant. A final root cause will be provided in a revised report to be submitted upon completion of the root cause analysis.

The preliminary root cause of the loss of normal offsite power is a switchyard breaker relay with an excessive time delay reset. A final root cause will be provided in a revised report to be submitted upon completion of the root cause analysis.

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 Corrective 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.

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Corrective Actions to be Completed:

Further corrective actions will be provided in a revised report to be issued following completion of the root cause evaluation.

F. PREVIOUS OCCURRENCES

No similar events at Quad Cities Nuclear Power Station were identified during the last five years.

G. COMPONENT FAILURE DATA

The Unit 2 Main Transformer is a 17.1/345 kV GSU Transformer made by ABB, serial number GBM22471. If necessary, further component failures will be identified in the revised report to be submitted upon completion of the root cause evaluation.