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RLB-92-106

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U. S. Nuclear Regulatory Commission
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Reference: Quad Cities Nuclear Power Station
Docket Number 50-265, DPR-30, Unit Two

Enclosed is Licensee Event Report (LER) 92-011, Revision 00, 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). The licensee shall report any event or condition that resulted in manual or automatic actuation of any Engineered Safety Feature.

Respectfully,

COMMONWEALTH EDISON COMPANY
QUAD CITIES NUCLEAR POWER STATION

R. L. Bax
Station Manager

RLB/TB/plm

Enclosure

cc: J. Schrage
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INPO Records Center
NRC Region III

STMGR 364

IE22

LICENSEE EVENT REPORT (LER)

Form Rev 2.0

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Title (4)

Loss Of Transforme/ 22 And Security Violation Due To Inadvertent Deluge Actuation

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 Names	Docket Number(s)
									Quad Cites Unit 1	0 5 0 0 0 2 5 4
0 4	0 2	9 2	9 2	0 1 1 1	0 0	0 5	0 4	9 2		0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)			
		20.402(b)	20.405(c)	X 50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)	1 0 0 0	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 (Specify in Abstract below and in Text)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		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
	AREA CODE
Jay Rolfes Ext 2160	3 0 9 6 5 4 - 2 2 4 1

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

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS

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 fifteen single-space typewritten lines) (16)

ABSTRACT:

On April 2, 1992 at 0037 hours, Unit Two was in the SHUTDOWN mode with Primary Containment [NH] in effect when the Reserve Auxiliary Transformer [EK,XFMR] (T22) tripped, causing a loss of normal AC power to the Unit and subsequent trip of Shutdown Cooling [BO] (SDC). The T22 trip occurred during an inadvertent deluge from the Fire Protection [KP] system.

Unit One was in the RUN mode at full power. The fault on T22 caused a voltage perturbation, resulting in air operated (AO) valves [NH,ISV] 1-220-44 and 45 to auto-close. The root cause of this event could not be determined. Two inappropriate actions or failures were identified: the inadvertent deluge actuation and the trip of T22.

The corrective actions include an assessment of the removal of automatic deluge capability for transformers, enhancement of the HLA program,assessment of the surveillances for flushing the deluge systems, and Operating Management will emphasize that Fire Protection work has the potential of impacting the equipment it protects.

This report is being submitted in accordance with 10CFR50.73(a)(2)(iv).

PLANT AND SYSTEM IDENTIFICATION:

General Electric - Boiling Water Reactor - 2511 MWt rated core thermal power.

EVENT IDENTIFICATION: Loss of Transformer 22 and security violation due to inadvertent deluge actuation.

A. CONDITIONS PRIOR TO EVENT:

Unit: Two Event Date: April 2, 1992 Event Time: 0037
Reactor Mode: 1 Mode Name: SHUTDOWN Power Level: 00%

This report was initiated by Deviation Report D-4-2-92-048.

SHUTDOWN Mode (1) - In this position, a reactor scram is initiated, power to the control rod drives is removed, and the reactor protection trip systems have been deenergized for 10 seconds prior to permissive for manual reset.

B. DESCRIPTION OF EVENT:

At 0005 hours on April 2, 1992 Equipment Operators (EO) were continuing with an Out-Of-Service (OOS) from the previous shift which would isolate and drain a section of the main Fire Suppression Header [KP] which serves 13 separate deluge valves [KP,V]. At 0032 hours the Control Room annunciator for Fire Header low pressure and auto-start of the Diesel Fire Pumps [KP, P] was received. At approximately the same time one of the EO's noticed the Transformer 22 [EK,XFMR] (T22) deluge valve had actuated. However, the Control Room had not received the "T22 Fire" alarm nor the "T22 Trouble" (indicative that cooling fans have tripped) alarm. The EO's immediate reaction was to divert the deluge valve overflow to the appropriate drain to stop the valve from spraying near 4KV Bus 24. The Control Room personnel questioned the fire pump auto-start and paged the operators performing the OOS by radio. When the second EO called the Control Room he was told to check Transformer 22. Upon arrival at T22, the EO witnessed a flash and heard a loud pop on the Transformer.

At 0037 hours, Unit One was in the RUN mode at 99 percent of rated core thermal power, and Unit Two was in the SHUTDOWN mode with all Control Rods [AA] inserted and Primary Containment in effect. At this time, T22 tripped, which resulted in a loss of normal AC power to Unit Two. The Integrated Primary Containment Leak Rate Test (IPCLRT) was in progress on Unit Two with the Primary Containment and reactor at 50 psig. Also as part of the IPCLRT, the reactor water level was stable at approximately 93 inches (30 inches normal level) and 131 degrees F. The "A" loop of Shutdown Cooling [BO] (SDC) was in operation maintaining a constant reactor water temperature.

When T22 tripped, the 1/2 Diesel Generator [EK] (DG) auto-started and loaded to Bus 23-1. The Unit 2 DG auto-start function was unavailable due to modification work but was available for a manual start throughout the event. The four supply breaker control switches from the transformer were immediately placed in the pull-to-lock position. The running Residual Heat Removal [BO] (RHR) and RHR service water pumps providing SDC tripped when their respective 4KV emergency buses received under-voltage trips. Also, the Reactor Building Ventilation [NG,VLR] isolated and Standby Gas Treatment System [BH] automatically started.

On Unit One, the Primary Containment Isolation (PCI) air operated (AO valves [NH,V] AO 1-220-44 and 45 auto closed. Also, a number of Unit One equipment trips occurred as a result of the fault on T22 which propagated through the switchyard and into the Reserve Auxiliary Transformer on Unit One (T12). All the Unit One equipment trips were attributed to a depressed voltage at T12. All the equipment trips on Unit One were resolved by 0310 hours, except for the Reactor Building Ventilation which was restarted at 0745 hours.

The immediate corrective action on Unit 2 was to restore power to the 4KV [EA] and 480V [EC] safety system buses. Before each electrical bus was re-energized it was checked for possible fault indicators to assure that the running DG would not be closed into a damaged electrical bus. At 0112 hours the 4KV cross-tie for Bus 14-1 to Bus 24-1 was closed and supplying normal AC power to Division II equipment. The Unit 2 DG was available for a manual start, if needed. By 0250 hours some non-essential loads were removed and other loads were transferred to their Unit One feed. At 0256 hours SDC was established on the "A" RHR loop which is powered from the 1/2 DG. During the period of time that SDC was off, hourly recordings of reactor vessel temperature data were made in accordance with QCOP 1000-17 to monitor thermal stratification while both Recirculation Pumps [AD,P] were off as part of the IPCLRT. The reactor water temperature increased 8 degrees Fahrenheit (131°F to 139°F). The IPCLRT was aborted and Primary Containment depressurization was initiated at 0430 hours. This depressurization was completed at 2130 hours.

C. APPARENT CAUSE OF EVENT:

This report is being submitted in accordance with 10CFR50.73(a)(2)(iv), which states the licensee shall report any event or condition that resulted in manual or automatic actuation of any Engineered Safety Feature

An investigation team was assembled on April 2, 1992 consisting of key plant personnel and experienced corporate personnel. There were two inappropriate actions or failures which the team determined to be contributing factors to this event: actuation of the deluge valve and the trip of Reserve Auxiliary Transformer 22.

The root cause of the deluge valve actuation and subsequent deluge of the transformer was undetermined. Below is a summary of the results of investigation into the various means by which the transformer deluge could have occurred.

Emergency Manual Pull Station - The tamper seal on the pull station was found to be intact immediately after the event by a Shift Foreman resetting the valve.

Mechanical Failure of the Valve - A representative from the Grinnell Corp. performed the inspection of the valve in question and determined that the valve was in perfect working order and the valve, in particular the diaphragm, had not failed.

The Start of Two Fire Pumps or Other Pressure Fluctuations - The deluge valve was designed with a restricting orifice and a check valve to compensate for these types of events by maintaining constant pressure on the latch diaphragm to prevent unlatching of the clapper due to pressure surges in the supply header. These components were inspected and were found to be working properly. Also, previous events involving the starting of both fire pumps have not resulted in the actuation of these valves.

Transformer Inputs - It was verified that the sudden pressure relays and differential current relays had not picked up and the "86 device" lockout relays did not have to be reset. Therefore, the deluge valve did not receive a signal to operate from the fault on the transformer. The transformer was also tested for any abnormalities and none were found.

Electrical Pull Stations - Neither pull station had to be reset after the event and the glass tamper rods, which secure the pull station covers, were intact.

Heat Detectors - The electrical leads for the detection circuit on Transformer 22 had been lifted from the actuation circuit for maintenance purposes prior to the event and therefore could not have initiated the deluge system.

Wiring - The local and remote actuation circuit, including the end of line resistor, was physically traced and compared to the existing wiring and schematic drawings. It was determined that the circuit would function as intended and would not create an inadvertent actuating signal.

System Grounds - No system grounds were recorded on the Station ground recorder at the time of this event, which could have spuriously actuated the deluge system.

Personnel Error - The actions of the operators involved with the ongoing fire protection QOS and in the Control Room were recreated through information gathered from interviews. The recreation did not identify any proper or improper actions taken by the operators which could have actuated the system.

The sequence of the Out-Of-Service was determined to be adequate to successfully perform the job. The original Out-Of-Service was subsequently successfully completed on April 2, 1992 at 1320.

The reason for the Transformer 22 trip was a fault which occurred on the high voltage side of the transformer. The fault was an "A" phase to ground fault which lasted for five cycles at ground potential. The duration was the result of expected equipment response time to isolate the fault.

The root cause of the transformer fault is unknown. A possible contributing factor to this event, however, may have been a cloud of water mist collecting between the transformer and the north wall. This mist could have created a conductive medium possibly leading to the phase to ground fault.

On April 3, 1992, the "as built" configuration of the deluge system, including piping and nozzle placement, was compared to the vendor design drawings. One discrepancy involving the alignment of a nozzle was identified during this comparison. In an effort to determine the significance of this alignment discrepancy, Station personnel decided to perform a full discharge test of the T22 deluge system in the as-found condition. The alignment discrepancy did not adversely affect the discharge of water from the nozzles on T22. The spray pattern did not directly impinge on the bushings and a continuous curtain of water surrounded the transformer. Though the spray pattern was acceptable, the misaligned nozzle was repositioned after the initial discharge test to the angle specified on the drawing. The realignment of the nozzle had no effect on the spray patterns in subsequent discharge tests.

The investigation team identified the Quad-Cities Heightened Level Awareness (HLA) program as an additional barrier which may prevent similar events in the future. The HLA program is designed to place additional controls on critical or infrequently performed activities to increase the sensitivity of the personnel involved to the importance of their actions to ensure proper completion of the task. Much planning and thought went into the preparation of the fire system Out-Of-Service. Although T22 had been identified as a Shutdown Risk, and no work was to be done on the transformer, the potential impact of taking the deluge system Out-Of-Service on T22 was not recognized. Had the fire system Out-Of-Service been considered in the HLA program, the impact of the deluge system on the transformer may have been identified and the increased attention may have reduced the possibility of the event.

During the fault on T22 on the 345KV side of the "A" phase bushing, several events occurred simultaneously which affected Unit One equipment.

The cause of PCI valves AO 1-220-44 and 45 failing closed is as follows. The fault which occurred on April 2, 1992 on T22 was sensed by the protective relays in the 345KV yard and was quickly isolated to limit damage. An analysis of the oscillograph recordings of the fault was performed by the System Operational Analysis Department (SOAD) which showed the "A" phase potential dropped to zero volts for 5 cycles (.083 seconds). SOAD determined that all protective relaying functioned correctly and the fault was isolated within the design limits. The depressed voltage was transferred to the 345KV yard and resulted in a momentary degradation of the Unit One Division I Electrical Supply System (ESS) which is supplied by the Unit One Reserve Auxiliary Transformer (T12). Each of the equipment trips which occurred on Unit One can be traced to the abnormal voltage on Division I ESS. The power for the control solenoid for valves AO 1-220-44 and 45 is supplied by Division I ESS via the 120VAC Instrument Bus [EE]. When the Division I ESS voltage had degraded, the control solenoid for AO 1-220-44 and 45 deenergized, allowing both valves to close, which is the safety function for these valves.

D. SAFETY ANALYSIS OF EVENT:

The safety significance of this event for Unit Two, which is related to the ability to cool the irradiated fuel in the reactor, was minimal. During this event, the SDC system was not in operation for two hours and twenty minutes. The reactor water temperature was being monitored every hour by the Control Room Operator as part of the IPCLRT, and water temperature increased from 131 degrees F to 139 degrees F without SDC. The rate of increase of reactor water temperature without SDC operation at the time of the event was approximately 3.5 degrees per hour. Therefore, reactor water temperature would not have exceeded 212 degrees for approximately 23 hours had SDC not been reestablished. In addition, since reactor pressure and Primary Containment pressure were 50 psig for the performance of the IPCLRT, saturation temperature at the time of the event was 297 degrees instead of 212 degrees under normal atmospheric conditions.

All 4 RHR pumps and all 4 RHR Service Water pumps were available at the time of the event; however, none of the pumps were "operable" due to the fact that the room coolers were not available and full operability surveillance testing, which includes room cooler operability verification, had not been performed. Both Core Spray systems were inoperable at the time of the event. However, the inoperable status was limited to the pump control switches in the pull-to-lock position and the motor operated suction valves in the closed position. These conditions were required for the performance of the IPCLRT and could have readily been corrected from the Control Room should the need for Core Spray actuation become necessary. The U2 DG was available for manual start at the time of the event. The auto start capability for the DG had been disabled for the performance of modification work. Had the Bus 14-1 to 24-1 cross-tie failed to operate, the U2 DG could have been manually started and utilized to supply power to Division II electrical loads on Unit Two. The Bus 14-1 to 24-1 cross-tie was available during the event. In order to assure adequate cooling under these conditions, one RHR pump and one associated RHR Service Water pump must function in the Shutdown Cooling (SDC) Mode of RHR. At the time of the event, all four RHR pumps and all four RHR Service Water pumps were available. Additional redundancy is provided in the event of RHR Service Water pump failure since each loop of the RHR Service Water can be supplied by the RHR Service Water pumps from the other unit through a manual cross-tie line.

In order to have adequate electrical power for SDC operation, one of the two emergency 4160 volt buses (23-1 or 24-1) must have power. This bus will power the RHR pump being used for SDC and will provide power to the associated RHR Service Water pump by back feeding the associated 4160 volt bus (23 or 24). During the event, the 1/2 DG, the U2 DG and the Bus 14-1 to Bus 24-1 cross-tie were available to provide the power necessary for SDC with T22 deenergized. The safety significance of this event for Unit One was also minimal. The PCI valves AO 1-220-44 and 45 auto closed, which is the fail safe position for these valves. The closure of these valves had no adverse effect on Unit One operation.

E. CORRECTIVE ACTIONS:

The following corrective actions were deemed appropriate to provide additional margin to preclude a similar event from occurring. These corrective actions are provided as follows:

Operating Management will emphasize through a tailgate training session or memo that Fire Protection work has the potential of impacting the equipment it protects. The importance of this concept when preparing, scheduling, as well as performing Out-Of-Services, Return-To-Services and surveillances of Fire Protection equipment, will be emphasized (NTS #2652009204801).

The HLA procedure will be revised to include evolutions which have already been recognized as having shutdown risk potential (NTS #2652009204802).

The Station will have a study performed by Production Services Department Fire Protection personnel to assess the removal of the automatic deluge function from the transformer protection logic and evaluate the recommendations from the study. (NTS #2652009204803)

The damage to T22 was assessed on April 3, 1992 by SQAD. The only damage that occurred to the transformer, consisted of slight damage to the "A" phase bushing. Only minor repairs to the bushing were required, which were completed April 3, 1992. The transformer was tested and returned to service on April 4, 1992 at 0540 hours.

The immediate correction action for the fault on T22 was to verify that the spray pattern for the deluge system did not impinge on the bushings. To potentially reduce the possibility of creating a conductive medium, the station will re-evaluate the methods of periodic flushing of the transformer deluge systems (NTS #2652009204804).

The Station aborted the IPCLRT and depressurized Primary Containment. The Station successfully performed the test after power was restored to T22.

F. PREVIOUS EVENTS:

A similar event occurred May 7, 1985 which was documented in LER 265/85-011. During this event, a sudden "A" phase to ground fault occurred on the 345KV side of Transformer 22 when an extension cord was lowered too close to the T22 "A" phase 345KV line. This caused a trip of T22 as well as a depressed voltage in the 345KV yard which affected the Unit One Reserve Auxiliary Transformer (T12) and resulted in several trips of Unit One equipment powered by the Division I Electrical Supply System (ESS). The effects on Unit One during this event were consistent with the April 2, 1992 event.

In the industry, there have been thirteen events in the past seven years involving the loss of main and auxiliary power transformers during inadvertent Fire Protection deluge actuations. These events were described in SER 17-91. The most recent event occurred at Zion Station on March 21, 1991 when the System Auxiliary Transformer tripped during an inadvertent deluge. During the Zion event, the deluge actuation was determined to be caused by a mechanical disturbance to the deluge valve, an Automatic Sprinkler Model C valve which is activated by the release of a dead weight. The transformer trip occurred because the deluge nozzles sprayed directly onto the phase bushing, causing a fault to occur.

The factors which led to the Zion event were specifically considered during the investigation of the April 2, 1992 Quad Cities event. However, the means of actuation of the Zion deluge valve were not possible on the Grinnell Multimatic valve. Also, during the discharge test that was performed to evaluate the deluge spray patterns on the transformer, the nozzle orientation yielded an acceptable spray pattern which was not directed at the bushings.

G. COMPONENT FAILURE DATA:

The Fire Protection System for T22 is an open-head deluge system manufactured by Grinnell Fire Systems. It is actuated by a Grinnell 4 inch model A-4 Multimatic valve equipped with a solenoid valve, hydraulic and electric manual pull stations, and a relay panel which controls supervision and operation of the deluge system.

The Unit Two Reserve Auxiliary Transformer is a General Electric power transformer having a voltage rating of 345/4.16KV. The serial number is D590598.