NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	1 OF 0 5

TITLE (4)

Auxiliary Transformer Failure and Reactor Scram

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)
1 1	0 4	8 4	8 4	— 0 4 0	— 0 0	1 2	0 4	8 4	None	0 5 0 0 0
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OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 5 6	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 (Specify in Abstract below and in Text, NRC Form 366A)
		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
James C. Smith, Technical Support Engineer	AREA CODE 3 1 9 — 8 5 1 - 7 3 0 8

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	E A	X F M R	W 1 2 0	Yes							

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)

During normal operation at 56% power on November 4, 1984, the Auxiliary Transformer through which onsite power is fed to the nonessential busses catastrophically failed, causing the Main Generator breakers as well as the Auxiliary Transformer breakers to the nonessential busses to open. The Main Turbine tripped and the Reactor scrammed from Turbine Stop Valve closure as designed. The failure also caused damage and carbon deposits on two 161 KV line insulator strings and bushings of the adjacent Startup Transformer primary. The deluge systems for both transformers initiated. The carbon deposits caused the Startup transformer to trip on a phase to ground fault. When the Startup Transformer tripped, the essential loads transferred to the Standby Transformer but all nonessential loads were lost. Given these conditions, the scram and recovery proceeded as expected (some communication and equipment problems are detailed in the text). Reactor water level dropped from a collapse of steam voids and reached a minimum level of approximately 140 inches above the top of active fuel. High Pressure Coolant Injection and later Reactor Core Isolation Cooling were started manually to recover coolant level. Approximately 18 minutes after the scram, operators closed the Main Steam Isolation Valves in anticipation of a loss of Main Condenser vacuum. At the same time Reactor recovery actions were being performed, the Fire Brigade was dispatched. Primarily as a result of deluge operation, the fire was reported as under control approximately 15 minutes after the transformer failure. There were no injuries. Repairs to the Startup Transformer were completed within 15 hours and nonessential loads were brought on line. The Auxiliary Transformer manufacturer's preliminary finding was that the failure was caused from a short circuit between turns in the high voltage winding of the "C" phase coil.

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

Description of Event

At 0134 hours on November 4, 1984, the plant was in run mode at approximately 56% power when the Auxiliary Transformer (EIIS component code EA-XFMR-1X2) catastrophically failed. As a result, the Auxiliary Transformer differential power relay (87 device) operated which tripped the unit back-up lock out relay (86 device) causing the Main Turbine to trip and the Reactor to scram from Turbine Stop Valve closure as designed. A resulting fireball from the transformer failure reached as high as the electrical high voltage lines (161 KV) connected to the Startup Transformer (EA-XFMR-1X3) causing damage and carbon deposits on two line insulator strings for the Startup Transformer primary. In addition, the 161 KV primary bushings on the Startup Transformer received heavy carbon deposits. The deluge systems for both the Startup and Auxillary Transformers initiated. The carbon deposits and insulator damage on the Startup Transformer caused the Startup Transformer to trip on a phase-to-ground fault (51 device). When the Startup Transformer tripped, the essential loads switched to the Standby Transformer and both Diesel Generators auto-started but were not loaded due to the successful transfer from the Startup to Standby Transformers. The Diesel Generators were secured within 30 minutes.

The transfer of essential loads to the Standby (from the Startup) Transformer was accomplished in approximately 4 to 6 cycles so the Reactor Protection System (EIIS system code JC) Motor-Generator Set flywheel maintained stability long enough to prevent the Electrical Protection Assembly breakers from tripping. All nonessential loads were lost when the Startup Transformer tripped. Given these conditions, the scram proceeded as expected and the equipment performed consistent with design and design intent except for some minor difficulties. The ENS/NRC hotline was inoperable due to the loss of nonessential power. Operation of the PABX telephones was unreliable. An onsite "direct line" phone was used to make NRC and other offsite notifications. Other effects of the loss of nonessential power are detailed as they occurred below.

Immediately after the Main Turbine trip, the bypass valves to the Main Condenser opened as designed. Reactor pressure peaked at approximately 1009 psig immediately after the turbine trip and scram. Reactor water level began dropping from a collapse of steam voids and reached a minimum level of approximately 140 inches above the top of active fuel within one minute (normal operating level is 193"). High Pressure Coolant Injection (BJ) was manually started and injected to recover coolant inventory. The Residual Heat Removal System (BO) was manually started and placed in Torus Cooling mode. Per design, containment isolation Groups II through V and the Standby Gas Treatment System actuated at the 170 inch level. In addition, several spurious Reactor Water Cleanup isolation signals were received during the course of the transient.

Approximately 4 minutes after the scram, Operators attempted to reset the Startup Transformer power to nonessential busses. The attempt was unsuccessful because of the insulator damage and carbon deposits. Operators secured the Control

Rod Drive Pump at 0319 in an effort to control the Reactor Vessel bottom head cooldown rate. The vessel bottom head cooldown rate (less than 200°F/hr) exceeded the normal cooldown rate of 100 degrees/hour during the transient.

At 0147 hours, an Unusual Event A-26 was declared. Offsite notifications were completed (slightly in excess of 15 minutes because of the noted telephone problems). At 0158 hours, the Reactor Core Isolation Cooling System (BN) was manually started and then the High Pressure Coolant Injection System was secured. HPCI and/or RCIC were used manually by Operators throughout the rest of the event for vessel level and pressure control.

Operators closed the Main Steam Isolation Valves at 0152 in anticipation of automatic isolation on loss of condenser vacuum.

Recovery operations proceeded as expected although problems were noted as follows:

1. Normal radiation air sampling capability within the power block was lost. Battery powered samplers were placed at two locations, one each in the Turbine and Reactor Buildings. Samples were taken hourly and all were normal. Upon loss of their power sources, Area Radiation Monitors alarmed. Health Physics technicians conducted surveys to determine actual conditions in the areas of the alarmed monitors. These monitor alarms were indicative of momentary loss of power and not abnormal radiation. Included in these monitors were the high range accident monitors which tripped on the momentary loss of vital power. These monitors could have been reset quickly by Health Physics technicians if necessary.

2. Per design, normal Control Room Reactor Conductivity indication and Radwaste panel indications were lost until 1015 hours, when equipment was moved to the Post-Accident Sampling System lab and grab samples were taken every hour thereafter. (Normal conductivity monitoring was restored when nonessential power was restored.)

Metal siding in the area of the fire resulting from the transformer failure was damaged such that fires were reported both at the transformer and in the Turbine Building where the siding was damaged. While Reactor recovery actions were being performed, the Fire Brigade was dispatched to the area. The fires were extinguished by 0149 hours. The deluge system at the transformer operated as designed and the Fire Brigade activities were mostly of a clean-up nature. A fire wall between Auxiliary and Startup Transformers limited damage to the Startup Transformer to that previously described.

Repairs to the Startup Transformer insulators were completed at approximately 1600 hours and nonessential loads were brought on line.

Cause of the Event

A preliminary study was conducted by the transformer manufacturer (Westinghouse Electric Corporation). The preliminary finding was that the failure resulted from a short circuit between turns in the high voltage winding of the "C" phase coil. The exact cause of the short circuit is still under investigation. When the short circuit occurred, arcing was introduced which generated gas at a rapid rate. Pressure built up in the transformer tank too quickly for the pressure relief device to release enough gas to prevent tank rupture.

Test records were reviewed. Westinghouse noted that the six-month test schedule followed at DAEC was more than adequate for proper preventive maintenance. They stated that the most informative test is gas-in-oil chromatography analysis and oil condition testing. Samples had been taken on October 31, 1984. When these results were compared with the results of the November, 1983 and March, 1984 tests, it was found that levels of methane, carbon dioxide, ethane and ethylene had increased slightly. Westinghouse feels this is an indication of possible insulation breakdown. However, the amount by which dissolved gas levels had increased would not normally be considered a precursor to the type of failure encountered during this event.

Corrective Actions

1. Transformer testing at DAEC will be reviewed in order to ensure our program uses the best applicable oil and gas-in-oil analysis in an attempt to anticipate transformer problems. In addition, we are reviewing our other transformer maintenance procedures for adequacy.

2. Auxiliary Transformer repairs will be completed. In the interim, the Startup Transformer is capable of performing the function of the Auxiliary Transformer. (The two offsite feeds to the vital busses are via the Startup and Standby Transformers. The Auxiliary Transformer by design supplies power only to the nonvital busses.)

3. A complete checkout of remaining transformers and the Main Generator was performed to ensure no damage occurred during the event.

4. Because of recent Diesel Generator problems at DAEC (see LER 84-021), a check of scavenging air blower clearances was conducted because the diesels ran unloaded. No decrease of clearances was found.

5. The reliability of the various telephone systems during a loss of offsite power is being evaluated. In the interim, Operations personnel have been briefed in means of making offsite emergency notifications and restoring communications given the present systems.

6. Our review indicates the power supplies and operation of the Reactor water chemistry monitoring equipment, Area Radiation monitoring equipment and Radwaste equipment will ensure that functions essential to plant safety can be performed during a loss of non-vital power.

7. Power supplies to several administrative areas are being evaluated for possible improvement in power supply reliablity.

8. An engineering evaluation was conducted on the effects of the Reactor Vessel bottom head cooldown rate. The conclusion of Iowa Electric and General Electric was that the 100°F per hour cooldown rate applies to normal cooldowns and not transients. General Electric stated that the cooldown rate was acceptable.

Conclusion

Although the failure of the Auxiliary Transformer and its consequences caused some problems in recovering from this event, safety equipment and personnel responded as expected. As part of long term corrective actions, procedural and design changes will be taken as deemed necessary to overcome the minor problems experienced.

Iowa Electric Light and Power Company

December 4, 1984
DAEC-84-775

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

Subject: Duane Arnold Energy Center
Docket No. 50-331
Op. License DPR-49
Licensee Event Report No. 84-040

Gentlemen:

In accordance with 10 CFR 50.73 please find attached a copy of the subject Licensee Event Report.

Very truly yours,

Daniel L. Mineck
Plant Superintendent - Nuclear
Duane Arnold Energy Center

DLM/JCS/kp

attachment

cc: Mr. James G. Keppler
Regional Administrator
Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

NRC Resident Inspector - DAEC

File A-118a

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