Commonwealth Edison
Zion Generating Station
101 Shiloh Blvd.
Zion, Illinois 60099
Telephone 708 / 746-2084

May 3, 1994

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

Dear Sir:

The enclosed Licensee Event Report number 94-005-00, Docket No. 50-295/DPR-39 from Zion Generating Station is being transmitted to you in accordance with the requirements of 10CFR50.73(a)(2)(iv), which requires a 30 day written report when any event or condition occurs that resulted in a manual or automatic actuation of any Engineered Safety Feature (ESF), including the Reactor Protection System (RPS).

Very truly yours,

DBWozniak for/

E. A. Broccolo
Station Manager
Zion Generating Station

EAB/sks

Enclosure: Licensee Event Report

cc: NRC Region III Administrator
NRC Resident Inspector
INPO Record Center
CECo distribution List

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LICENSEE EVENT REPORT (LER)

Form Rev 3.0

Facility Name (1)	Docket Number (2)	Page (3)
Zion Unit 1	0 5 0 0 0 2 9 5	1 of 0 5

Title (4) Unit 1 Main Reactor Trip and Subsequent Start of 1A Auxiliary Feedwater Pump Following a Generator Fire and Isophase Bus Duct Fault

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)
0 4	0 3	9 4	9 4	--- 0 0 5 ---	0 0	0 5		9 4	Zion Unit 2	0 5 0 0 0 3 0 4

OPERATING MODE (9)	1
POWER LEVEL (10)	0 2 5

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)
___ 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
Cary B. Jozefiak, System Engineering	2048	AREA CODE 7 0 8
Herman G. Shelton, Operating	ext. 3078	7 4 6 - 2 0 8 4

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 L	X F M R	W 1 2 0	Yes	X	T B	G E N	W 1 2 0	Yes
X	E L	B U	W 1 2 0	No	E				No

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		0 5	0 1	9 5

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

On 04/03/94, at 0430, Unit 1 was synchronized to the electrical distribution system following refueling outage Z1R13. At 0618, a loud noise was heard in the control room, and a subsequent generator trip and reactor trip occurred. At 0619, operating personnel reported that a fire was emanating from the main generator lead box. A Generating Site Emergency Plan (GSEP) was activated and the appropriate notifications were made. At 0905, the fire was extinguished and the GSEP was terminated. At 1456, during isolation of the main generator, incorrect fuses were pulled creating a two of four reactor coolant pump bus undervoltage signal and the 1A turbine driven auxiliary feedwater (AFW) pump autostarted. The fuses were reinstalled and the 1A AFW pump was secured.

The cause of the main generator fire is not known. The cause of the 1A AFW pump autostart is management deficiency. All reactor protection, engineered safeguards, and auxiliary power systems functioned normally throughout this event.

Corrective actions include replacing the Unit 1 west main transformer, inspecting and repairing the Unit 1 main generator, inspecting the Unit 2 main generator, and submitting a supplemental report.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)					Page (3)
		Year	///	Sequential Number	///	Revision Number	
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TEXT Energy Industry Identification System (EIIS) codes are identified in the text as [XX]

A. CONDITION PRIOR TO EVENT

MODE 1 - Power Operation RX Power 25% RCS [AB] Temperature/ Pressure 549°F / 2235 psig

B. DESCRIPTION OF EVENT

On 04/03/94, at 0430, Unit 1 was synchronized to the electrical distribution system after the completion of refueling outage Z1R13. The unit was stabilized at 25% reactor power at 0511. At 0613, a 3% load increase was initiated as required by fuel conditioning guidelines. At 0618, a loud noise was heard in the control room which appeared to emanate from the vicinity of the main generator. Almost simultaneously, a main generator lockout trip and subsequent turbine and reactor trips occurred with the main generator tripping on differential current. Emergency Operating Procedure (EOP) E-0 "Reactor Trip or Safety Injection" was entered at this time to verify proper response of the automatic protection systems.

At 0619, a report of a fire emanating from the generator lead box was received by operating personnel. The station fire alarm was sounded and the fire brigade was dispatched to extinguish the fire. The Shift Engineer was notified at 0630 that the fire could not be contained by the fire brigade. Offsite fire department assistance was requested. A Generating Station Emergency Plan (GSEP) Unusual Event, Emergency Activation Level (EAL) HU5, "Fire in the protected area not extinguished in < 15 minutes", was declared at this time. Emergency Notification System (ENS), Nuclear Accident Reporting System (NARS) and GSEP notifications were made within the required 15 minute time frame. In addition, the Nuclear Regulatory Commission (NRC) Resident Inspector and the duty Operating Engineer were notified. At 0645, it was determined that the fire was being fueled by a hydrogen leak near the generator C phase bushing. The Unit 1 generator was depressurized and a carbon dioxide purge was initiated. Fire fighters continued to use water to cool the area around the fire while the generator was being purged. At 0905, the generator fire was extinguished. The GSEP Unusual Event was terminated and outside fire department assistance had left the site.

Due to the visible damage to the main generator conductors, the decision was made to electrically isolate the equipment. System Operating Instruction (SOI) 63T, "Main Generator and System Auxiliary Transformer Outage Hold Points", was used to initiate the out of service (OOS) 41-019 for isolating the main generator. Because of the significant concern surrounding the destruction to the generator conductors, management asked the Operational Analysis Department (OAD) to review the OOS to ensure that it was adequate for this situation. The OAD Engineer asked for additional isolation points to be included in the OOS.

These additional isolation points were the neutral ground link, the ground strap, and the 120 volt secondary fuses of the X and Y windings. This request was given verbally. The operating personnel wanted to ensure that the correct terminology for the equipment was used for the OOS so both licensed and non-licensed operating personnel reviewed the electrical drawings and inspected the field installation. Four different sets of fuses, (bus potential transformer 3 amp fuses, line potential transformer 3 amp fuses, bus undervoltage fuses, and bus underfrequency fuses) were identified. Based on the OAD request for the X and Y winding fuses, shift personnel concluded that the bus potential transformer fuses for non-essential service (non-ESS) buses 143 and 145 were the correct fuses to add to the OOS request.

The equipment operator was dispatched to begin isolating the main generator per OOS 41-019. The control room personnel noticed that the voltage indication light for non-ESS bus 143 unexpectedly extinguished. They realized that this was a result of the equipment operator pulling the non-ESS bus 143 potential transformer fuses. They immediately attempted to contact the equipment operator in the field to stop him from continuing with the OOS. Before they were able to contact him, the equipment operator pulled the potential transformer fuses for non ESS bus 145. The control room personnel noticed that the voltage indication light for non-ESS bus 145 extinguished, and subsequently the 1A turbine driven auxiliary feedwater (AFW) pump autostarted. The control room personnel verified that the pump was operating properly, and instructed the equipment operator to reinstall the potential transformer fuses for non ESS buses 143 and 145. Once the fuses were reinstalled, the 1A turbine driven AFW pump was secured.

An assessment of the damage to the main generator and associated bus ducts was performed following the termination of the fire. The A and B phase isophase bus ducts showed signs of excessive arcing. The corners of the 90 degree turns on both phase housings were blown outward and aluminum spatter covered the general area of the fault. Large amounts of white powder were also found in the A and B phase duct work. The conductors on both phases were also damaged. The bus duct cooling boundaries for the A and B phases, at the insulator penetration on the generator end, were blown inward. The retaining clamps for the A and B phase housings, located at the generator end, appeared to have separated. One broken and several damaged stand-off insulators were also found. The C phase bus duct sustained only minor damage in this event. An internal inspection of the C phase duct found an oil film on the first and second stand off insulators from the generator end.

An inspection of the generator lead box and surrounding areas was also performed. The C phase bushing was severely damaged at the isophase shorting plate and internal to the lead box. The A and B phase bushings sustained damage external to the lead box. Molten metal was found in the area where the C Phase bushing exits the lead box. The micarta cleats which separate the generator from the lead box were blown upward into the generator. Evidence of arcing between the top flange of the C phase bushing and the structural ribbing of the lead box was discovered. Soot covered the inside of the lead box and appeared to cover the lower third of the generator stator. Evidence of arcing was also found on the neutral bus enclosure in the vicinity of the generator lead box.

B. DESCRIPTION OF EVENT (Continued)

The Unit 1 West Main Power Transformer (MPT) also sustained damage. Oil was observed to be leaking at the A and B phase low side bushings. These bushings also appeared to be displaced. Gas in oil samples taken showed traces of acetylene and other combustible gases, confirming that an internal fault had occurred. The Operational Analysis Department (OAD) performed various electrical tests on this transformer which also showed coil damage. The results of these tests prompted an internal inspection of the transformer. There was evidence of a through fault induced turn to turn winding failure on the upper region of the A phase low voltage winding. Evidence of insulation burning was discovered at the location of the short. A more detailed inspection, which requires disassembly, must be performed to adequately access the damage and failure mode.

A review of the record of relay actuations and digital fault recorder output indicated that the failure started as a single phase to ground fault which rapidly evolved into a three phase to ground fault. The fault condition continued for a duration of four cycles (.07 seconds). A transformer deluge was prevented by the actuation of the sudden pressure inhibit relay. A large residual current was also detected on the transformer's high side neutral ground.

C. APPARENT CAUSE OF EVENT

The cause of the electrical fault is not known. Two scenarios have been developed which correspond to the physical evidence documented subsequent to the event.

The first scenario assumes that the initiating event was a fault of the main generator C phase bushing. This resulted in a low current flashover to ground. This flashover increased the A and B phase generator bus voltages increasing the potential difference between the conductors and the ductwork. This increased potential alone was not large enough to allow an arc to be generated from the bus to the corner of the duct on both phases. The flashover had to occur as a result of either a decrease in the dielectric strength of the air or a mechanical agitation of the system causing the distance between the duct and the conductor to decrease. At this point, the event became a three phase to ground fault which generated the currents necessary to create the damage found on the A and B phase bus ducts and the generator C phase bushing and lead box. The high current arc from the C phase to the lead box resulted in the rupture of the bushing internal and external to the lead box. This allowed hydrogen to escape to atmosphere. The hydrogen was ignited by the flashover and started to burn. The fault currents generated were significant enough in magnitude to cause the through fault damage observed on the A phase winding of the west MPT.

Although this scenario matches the majority of the physical evidence, it cannot readily support the residual current detected on the Unit 1 West MPT high side neutral ground. The neutral ground normally detects current in the event of a phase imbalance, which would be indicative of a high side winding fault. The results of the initial inspection of this transformer did not identify any indication of a high side fault.

The second scenario assumes that a high to low side fault within the west MPT initiated the event. This condition would have imposed a high voltage on the generator conductors. This increased voltage would have elevated the potential difference between the bus and the bus duct causing the A and B phases to arc to ground. The C phase found its ground path at the generator bushing and arced to the lead box. The arcing of the C phase resulted in bushing damage both internal and external to the lead box resulting in a hydrogen leak. The escaping hydrogen was ignited by the arc resulting in a fire.

Although this second scenario provides an explanation for the high side neutral residual current recorded during the event, the physical damage observed during the internal inspection of the transformer is not of the magnitude seen on other documented failures of this nature.

A thorough inspection of the fire scene was conducted by a consultant to the root cause team. His diagnosis was that the damage sustained to the bushing and the area around the fire origin was a result of intense heat. This analysis would attribute the loud noise heard at the beginning of this event to an electrical fault and eliminate the possibility of a hydrogen initiated explosion.

The following initiatives are currently being pursued in an attempt to pinpoint the exact cause of the fault. The bus duct cooling unit make up and in line air filters were sent to the System Material Analyses Department (SMAD) for examination. The intent of the inspection was to look for the presence of conductive materials, which may have contributed to the flashover of the A and B phases. The residue collected from the filters was separated into organic and inorganic portions. The organic portion of the residue was identified as oxidized turbine oil. The inorganic segment of the sample showed the presence of aluminum, calcium and silicon; minor amounts of iron and sulfur; and traces of magnesium potassium and sodium. The appearance of the majority of these inorganic compounds is believed to be a result of the fire fighting effort. A small percentage of water soluble material was found on the in line filters. This material when wetted, could decrease the dielectric strength of the air. It is important to note that a very minimal amount of this substance was identified on the stand-off insulators.

SMAD was also asked to analyze various samples of molten metal and fire residue obtained from the A and B phase bus ducts and the C phase lead box. The intent of this examination was to identify the presence of any foreign material. Nothing out of the ordinary was found in this investigation. The majority of the material examined was identified as aluminum. The white powder found in the ducts was identified as aluminum oxide. The aluminum deposits are a result of the arcing which occurred on the A and B phases, which are fabricated from aluminum.

C. APPARENT CAUSE OF EVENT (Continued)

An examination of the deposits on the C phase bushing and bus duct was also performed. The results of this inspection revealed large amounts of silicon. A portion of the damaged bushing was also analyzed. A mineral based oil resembling turbine oil was present on the bushing. Evidence of this type of oil was also found on the stand-off insulator in the C phase duct closest to the bushing. An analysis of the glass cleaner used to clean the stand-off insulators during the outage was examined for conductive material. The results of the inspection showed that the cleaner does not contain levels of conductive material which would contribute to a flash over. The C phase bushing has been sent to a laboratory for a forensic examination. The results of this examination will be documented in the supplemental report.

The Unit 1 west MPT will be sent to a remote facility for a complete disassembly. The windings from all three phases will be examined for additional evidence of damage. The results of this examination will be included in the supplemental report.

A mathematical analysis of the fault is being developed by a team of individuals representing the System Protection and System Planning Departments. Numerous cases are being developed by this team to attempt to simulate the voltage and current recorded during this event by the digital fault recorder. If a scenario can be developed which closely matches the physical evidence associated with this event, a better understanding of the initiating sequences of the fault may be provided.

The cause of the autostart of the 1A turbine driven AFW pump was management deficiency. Due to the uniqueness of the situation and the concern surrounding the destruction to the generator conductors, management wanted to ensure that the OOS for isolating the main generator was sufficient. It is now realized that the instructions from SOI-63T were sufficient. However, at that time it was decided that the SOI-63T instructions should be reviewed by OAD personnel due to their expertise and knowledge of the main generator system. He identified additional isolation points that he was used to having on a main generator OOS, but due to the fact that Zion's OOS for the main generator is taken in a different manner, these additional points were really not necessary. In addition, he verbally communicated this information to the Operating personnel using terminology that is not standard at Zion Station. Based on this non-standard terminology used in the verbal comunication from OAD to the Shift, the wrong fuses were identified on the OOS.

D. SAFETY ANALYSIS OF EVENT

As a result of the Hydrogen fire burning for a period greater than 15 minutes, a GSEP unusual event was declared. The fire was contained by trained members of the station's Fire Brigade and local fire fighters. The proper notifications were made and fire alarms sounded evacuating all non essential personnel from the area. All reactor protection, engineered safeguards systems and auxiliary power systems functioned normally throughout this event. Control room personnel responded to the reactor trip per appropriate Emergency Operating Procedures and all systems responded properly. At no time during this event was the health and safety of the public at risk.

The AFW system provides a reliable source of water to the steam generators for decay heat removal. The turbine-driven AFW pump is capable of meeting the decay heat removal demands for the unit during accident condition. During this event pulling the bus pot transformer fuses resulted in actuating the undervoltage relays for two of the four RCP buses. Subsequently, the 1A AFW pump started as designed from a valid signal. The station's margin of safety was not compromised at any time due to all safety systems functioning as designed.

E. CORRECTIVE ACTIONS

Since the root cause of this event is not known, the following immediate actions were taken to ensure a safe start up of Unit 2 and assure no unidentified damage existed on Unit 1.

1. An internal inspection of the Unit 2 Main Generator was performed. This inspection included internal and external examinations of all six bushings. A boroscopic inspection of the bushing ventilation passages was also conducted. The results of this inspection revealed a loose hydrogen blower retaining clip. Partial disassembly was performed to repair the loose part and inspect the blower. No additional problems were found.
2. A megger test of the Unit 2 Main Generator was performed. This was completed successfully.
3. The Unit 2 Main Generator stator coil was pressurized and leak tested. No leakage was observed.
4. The Unit 2 Main Generator Assembly was leak tested subsequent to reassembly and found to be acceptable.
5. An external inspection of the Unit 2 Bus Duct System was performed with no discrepancies identified.
6. The Unit 2 Bus Duct System in line filters were inspected and cleaned.
7. The Unit 2 East and West MPT cooling pumps were run for one hour and oil samples were taken. Combustible gases and water were within acceptable limits.

8. An internal inspection of the Unit 1 East Transformer was performed. Windings were found in good condition.

9. A full battery of electrical tests were completed on the Unit 1 East MPT. A low voltage exitation test, high-pot, power factor and turn to turn ratio tests were performed. The low voltage exitation test results were higher than historic values for this transformer. These tests will be reperformed after the transformer is filled with oil.

10. The Unit 1 West MPT was replaced.

11. A complete inspection of the Unit 1 Main Generator was performed. All identified discrepancies are scheduled for repair.

12. All equipment in the vicinity of the fire and flashover was inspected for damage. Necessary repairs are currently in progress.

13. A supplemental report will be issued after the bushing and transformer examinations have been completed. (295-180-94-00901)

As a result of the autostart of the 1A AFW pump, the following corrective action was identified:

14. The Operating Department has developed Zion Administrative Procedure (ZAP) 300-17, "Scheduling and Performing Work for Offsite Organizations". This new procedure is being tracked by CRML number A-94-0753, and will require review of OOS changes or requests by Zion Station System Engineering. (295-180-94-00902)

F. PREVIOUS EVENTS

On September 22, 1990, the Unit 2 West MPT experienced excessive mechanical damage as a result of a primary to secondary fault occurring on the C Phase winding. Damage to the C Phase Isophase Bus Duct occurred s a result of the fault. The cause of this failure was attributed to nitrogen break out. This evaluation was performed in Licensee Event Report 90-011. Corrective action implemented as a result of this failure was the installation of a transformer cooler bank sequencing modification. This change allows fans to start based on temperature demand. This modification significantly reduced the possibility of static electrification and nitrogen breakout by eliminating high oil flow velocity at low operating temperatures. Two additional changes were recommended as corrective actions. Modifications to install bus duct lightning arresters and separate bus duct grounding cables were initiated. These changes were pursued to mitigate the possibility of bus duct failures due to voltage surges and phase to ground faults. The changes are not fully implemented at this time.

LER 1-92-021 documented an autostart to the 1C AFW pump during Reactor Protection Testing. LER 1-92-021 was due to a personnel error because a procedure step was not followed correctly. The corrective actions from LER 1-92-021 would not have prevented LER 1-94-006.

G. COMPONENT FAILURE DATA

Manufacturer	Nomenclature
Westinghouse Power Transformer	FOA rated 567,000 KVA, 55°C rise, 3 Phase, 60hz, 23,700 volt secondary, 345,000 volt primary.
Westinghouse Electrical Bushing	
Westinghouse Isophase Bus Duct System	30,000 Ampere 23,000 Volts