

## LICENSEE EVENT REPORT (LER)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)

McGuire Nuclear Station, Unit 1

DOCKET NUMBER (2)

05000 369

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TITLE (4) Concurrent Inoperability Of Both Unit 1 Emergency Diesel Generators

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 NAME	DOCKET NUMBER(S)
06	18	96	96	03	1	11	07	96	N/A	05000
OPERATING MODE (9) 1 POWER LEVEL (10) 100% THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)										
			20.402(b)			20.405(c)			50.73(a)(2)(iv)	
			20.405(a)(1)(i)			50.36(c)(1)			X 50.73(a)(2)(v)	
			20.405(a)(1)(ii)			50.36(c)(2)			50.73(a)(2)(vii)	
			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)(ix)	
									73.71(b)	
									73.71(c)	
									OTHER (Specify in Abstract below and in Text, NRC Form 366A)	

LICENSEE CONTACT FOR THIS LER (12)

NAME

J. W. Pitesa, Safety Review Manager

TELEPHONE NUMBER

AREA CODE

(704)

875-4788

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
B2b	EEB	ENGINE	N152	YES					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE)

X

NO

EXPECTED SUBMISSION DATE (15)

MONTH

DAY

YEAR

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

**This report also satisfies the special reporting requirements of Technical Specification (TS) 3.8.1.1.**

**Unit Status:** Unit 1 was in Mode 1 (Power Operation) at 100 percent power.

**Event Description:** On June 18, 1996, during the performance of a scheduled operability test of Emergency Diesel Generator (EDG) 1A, the EDG was declared inoperable because of a voltage regulator problem. Subsequently, during TS required operability testing of EDG 1B on June 19, 1996, a fuel oil leak developed which necessitated shutdown of the EDG and it was also declared inoperable. Concurrent inoperability of both EDGs resulted in inability to meet TS requirements for supplying emergency power to both vital buses. As a result, Operations personnel began a shutdown of Unit 1 while efforts to repair the failures were in progress. An Unusual Event was declared due to having both EDGs inoperable for greater than 2 hours. The fuel oil leak was repaired and, after appropriate testing, EDG 1B was declared operable. The Unusual Event was then terminated and shutdown of Unit 1 was halted.

**Event Cause:** This event is assigned causes of Unknown, Possible Equipment Failure/Malfunction for EDG 1A and Equipment Failure, Manufacturing Process Deficiency for EDG 1B respectively. The EDG 1A failure is attributed to a failure of either the PC Board or Motor Operated Potentiometer associated with the Voltage Regulator. The EDG 1B failure is attributed to failure of a fuel injection tubing connection.

**Corrective Action:** Corrective actions included shutdown of the EDGs, replacement of the failed components, further evaluation, and improved swaging for susceptible fuel oil line tubing connections.

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**EVALUATION:****Description of Event**

**This report also satisfies the special reporting requirements of Technical Specification (TS) 3.8.1.1.**

**On June 18, 1996, Unit 1 was in Mode 1(Power Operation) at 100 percent power.**

- Operations (OPS) personnel were running procedure PT/1/A/4350/02A, Diesel Generator (EDG) [EIIS:DG] 1A Operability Test.
- All initial portions of the test had been completed satisfactorily and the EDG was loaded to 3100 KW.
- During the performance of the portion of the procedure requiring loading of the EDG locally, the EDG voltage was being lowered. At that time the power factor (pf) indication dropped low in the lead direction, the Volt Amp Reactive (VARs) indication dropped off scale low, and the Amps indication began to increase above 600.
- The OPS person at the local control panel [EIIS:PL] stopped the voltage adjustment and began to clear Maintenance personnel from the area. He observed all indications return to normal.
- Upon observing normal indications, the OPS person attempted to lower the voltage a second time. Once more the pf indication dropped low in the lead direction, the VARs indication dropped to 0, and the Amps indication began to increase above 600.
- At that time, the OPS person left the control panel and instructed Maintenance personnel to move clear of the EDG to a safe area. While doing so the EDG 1A Emergency Breaker [EIIS:BKR] tripped open, unloading the EDG to an idling condition. Simultaneously, OPS Control Room [EIIS:NA] personnel received annunciator [EIIS:ANN] alarms [EIIS:ALM] for "EDG 1A 125 VDC Control Power Trouble", and "Battery Charger 1EDGA Trouble".
- Engineering personnel were notified in order to begin the Failure Investigation Process prior to any conditions changing with the EDG.

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- Upon arrival at EDG 1A, the Engineering personnel noted EDG voltage was indicating 2100 VAC, Battery Charger output current was at the high current limit of 27 Amps, Battery Charger output voltage was low (120 VDC), and EDG frequency was 61 Hz.
- Based on these indications, Engineering personnel requested that OPS personnel shut down the EDG.
- Accordingly, OPS personnel shut down EDG 1A at 0959, on June 18, 1996.
- OPS personnel then entered procedure PT/1/A/4350/25, Essential Auxiliary Power System Source Verification, and EDG 1A was declared inoperable due to an apparent equipment failure.
- The Failure Investigation Process was continued with Engineering personnel as lead.

Technical Specification (TS) 3.8.1.1, action d. states that when an EDG becomes inoperable because of a failure, the opposite train EDG is required to be demonstrated operable within 24 hours.

- Accordingly, testing to verify operability of EDG 1B was initiated per procedure PT/1/A/4350/02B, EDG 1B Operability Test.
- While performing the test, a fuel oil leak developed on the tubing from the fuel oil injection pump [EIIS:P] to the injector for the 4R cylinder.
- As a result, EDG 1B was shutdown and declared inoperable at 0430, on June 19, 1996.
- With both EDGs inoperable, the operability of the offsite power supplies must be demonstrated. This was done successfully at 0435.

TS 3.7.1.2, Auxiliary Feedwater [EIIS:BA], requires that each of the Motor [EIIS:MO] Driven Auxiliary Feedwater Pumps must be capable of being powered from an emergency bus.

- Since both EDGs were declared inoperable, this requirement could not be met.

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- Consequently, the 1A and 1B Motor Driven Auxiliary Feedwater Pumps were declared inoperable at 0430 on June 19, 1996.

TS 3.7.1.2, also requires that with two Auxiliary Feedwater Pumps inoperable, the unit must be in HOT STANDBY within 6 hours, and in HOT SHUTDOWN within the following 6 hours.

- As a result, OPS personnel initiated shutdown of Unit 1 at 25 percent per hour, starting at 0530.
- An Unusual Event was declared at 0630, due to having both EDGs inoperable for greater than 2 hours.
- All required NRC notifications were made in accordance with applicable procedures.
- Additional actions were taken in a conservative manner to protect the available essential power source and backup safety systems. These included securing a second set of Switchyard Gates, placing signs on the Standby Shutdown Facility (SSF) [EIIS:NB], and 6900v Switchgear Room doors to restrict access.
- The fuel oil leak on EDG 1B was determined to be due to failure of a tubing [EIIS:TBG] connection.
- The section of tubing involved was replaced and, after testing, EDG 1B was declared operable at 0932.
- The Unusual Event was then terminated and OPS personnel halted the Unit 1 shutdown.

**Conclusion**

This event did not result in any uncontrolled releases of radioactive material, personnel injuries, or radiation overexposures. The event as associated with the EDG 1B, Cylinder 4R fuel injection line tubing connection failure is Nuclear Plant Reliability Data System (NPRDS) reportable.

This event is assigned causes of Unknown, Possible Equipment Failure/Malfunction for EDG 1A and Equipment Failure, Manufacturing Process Deficiency for EDG 1B, respectively. Capability to supply



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emergency power from the Unit 1 EDGs was lost during the time period in which both EDGs were actually tagged out concurrently (2 hours and 1 minute); however, both EDGs were concurrently logged as inoperable for a period of 5 hours and 2 minutes.

- The cause of the EDG 1A failure is attributed to an Unknown, possible failure of either the Printed Circuit (PC) Board or Motor Operated Controller (MOC) associated with the Voltage Regulator [EIIS:RG]. The Voltage Regulator components were supplied by Basler Electric.
- No problems were found with either component during initial inspection or troubleshooting following the failure on EDG 1A, nor were attempts to recreate a similar failure during subsequent testing successful. However, upon further analysis and consultation with the manufacturer it was determined that the most likely cause of the EDG failure was a failure of one of these components.
- Consequently, as a conservative measure, both components were replaced.
- Procedure PT/1/A/4350/19A, EDG 1A Governor and Voltage Regulator Benchmark Comparison Test, was performed on June 19, 1996, to verify that the EDG would respond satisfactorily to an Engineered Safety Features (ESF) type loading transient. Also, procedure PT/1/A/4350/02A, EDG 1A Operability Test, was completed satisfactorily on June 19, 1996, at 1839, and EDG 1A was declared operable on June 19, 1996, at 1859.
- The EDG 1B failure is attributed to failure of a fuel injection line tubing connection. The section of tubing involved was supplied by NAK Engineering Inc.
- The EDG 1B, Cylinder 4R fuel injection line tubing connection failure resulted in the loss of adequate fuel injection to the affected cylinder. This fuel injection line had been installed during 1EOC10, when all 32 lines on the Unit 1 engines were replaced (conversion from single wall to double wall lines).
- Upon disassembly and inspection, the ferrule sleeve at the connection holding the fuel line into the fuel pump was found to

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have come loose from the fuel line. This eliminated the fuel connection seal and allowed fuel to leak from the connection.

- Initial failure root cause analysis indicates that internal pressure pushed the tubing connection apart, resulting in the ferrule sleeve stripping tube material from the outer diameter of the fuel line. This can only have been caused by an overpressure condition (due to fuel injector blockage or malfunction) or by insufficient crimping force in the ferrule sleeve.
- Metallurgical Laboratory analysis indicates that the amount of material removed from the tubing during the pullout failure was less in size than the amounts removed during testing. This supports insufficient crimping force applied during the manufacturing process as the most probable cause. This failure mode would be expected to occur soon after installation, as with this failure.
- No other failures of this type have occurred at McGuire, nor is there indication of degradation of similar tubing connections to the other EDG cylinders on either Unit EDGs.
- This was the first Valid Failure in the last 20 Valid Tests and the second Valid Failure in the last 100 Valid Tests of EDG 1A. On a Unit basis, this was the second Valid Failure in the last 100 Valid Tests of EDGs 1A and 1B combined.
- Based on a torsional analysis evaluation performed by Failure Analysis Associates (FAA) on the McGuire Nordberg EDG crankshafts, EDG 1B could have operated during an emergency situation on 15 cylinders with crankshaft safety factors within the limits as recommended by International Association of Classification Societies (IACS) rules. Operation on 15 cylinders has been performed previously at McGuire with no problems. Since the EDG 1B could have performed in an emergency on 15 cylinders, this test run is classified as an Invalid test. Although the FaAA states that any cylinder except 1R may be shutoff without exceeding IACS safety factors, they do not recommend running continuously without cylinders 1 through 4 (right or left bank) unless analysis results are confirmed by torsionograph testing. EDG 1B was secured as a conservative measure at the time of the event and the fuel leak repaired immediately.

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- Surveillance testing remains monthly per the requirements of TS 4.8-1, Diesel Generator Test Schedule.

Review of the Operating Experience Program (OEP) and Problem Investigation Process (PIP) data bases for the past 24 months revealed that there have been no events involving concurrent inoperability of both EDGs due to these causes, nor have there been any events involving failures of these components. Therefore, this event is not considered to be recurring.

**CORRECTIVE ACTION:****Immediate:**

1. Engineering and Maintenance personnel began investigation and troubleshooting of the circuitry associated with EDG 1A to determine the cause for the failure.

**Subsequent:**

1. Testing to verify operability of EDG 1B was initiated.
2. The operability of offsite power supplies was verified.
3. Actions were taken in a conservative manner to protect the available essential power source and backup safety systems.
4. OPS personnel initiated shutdown of the Unit at 25 percent per hour.
5. The section of tubing involved in the EDG 1B leak was replaced, the EDG was tested, and EDG 1B was declared operable.
6. Both the PC Board and the MOC associated with the Voltage Regulator for EDG 1A were replaced, the EDG was tested, and EDG 1A was declared operable.
7. Metallurgical analysis was performed on the failed tubing connection removed from EDG 1B.
8. Additional testing was performed to determine the torque value required to optimally swage the ferrule sleeve onto the tubing for this type tubing connection.

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9. Engineering personnel conducted partial analysis of the PC Board and the MOC which were removed in an effort to determine the exact cause of failure.
10. Tubing containing connections of this type were checked and the connections re-crimped to the optimal torque value as necessary on all four EDGs.
11. An independent assessment of EDG reliability has been performed and Engineering personnel have and will continue to evaluate the results.

Planned:

None

**SAFETY ANALYSIS:**

**Based on this analysis, this event is not considered to be significant. At no time were the health and safety of the public or plant personnel affected as a result of this event.**

The EDGs are required to operate at the necessary loading to support ESF loads in order to mitigate an accident involving a Loss Of Offsite Power (LOOP). FSAR Chapter 15 contains the analysis of several accidents assuming the LOOP event. The primary event of interest is the LOOP event as an initiating event.

- The existing MNS PRA assumes the frequency of LOOP events to be 0.07 per year.
- Based on industry data, LOOP to more than one unit occurs in only 17% of all LOOP events. At MNS, there is an additional margin of safety since there are two shared 4160V auxiliary transformers which can power the essential 4160V busses from either unit.
- With both EDGs unavailable, the dominant core damage sequence involves a LOOP initiating event, an induced seal Loss Of Coolant Accident (LOCA) failure, and failure of injection. This sequence probability is multiplied by the probability of failure to recover power from the other unit. Finally, the result is multiplied by an additional factor to convert from an annual basis to a five hour basis. The analysis yields an increase in core damage probability of approximately  $4.3E-8$ , which is well below the precursor



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threshold of  $1E-6$ . Therefore, this event is not significant from a risk perspective.

- Assuming both EDGs had been unavailable and a LOOP had occurred concurrent with failure of power from the other unit, power run back, or recovery of offsite power, the unit could still have been maintained in a safe shutdown condition with the use of the Standby Shutdown Facility (SSF), which can supply the Reactor Coolant Pump seal injection and provide Steam Generator cooling by means of the Turbine Driven [EIIIS:TRB] Auxiliary Feedwater pump. Thus a variety of means were available to mitigate a LOOP event even with both EDGs unavailable.
- During this event both EDG 1A and EDG 1B were functional and would have been able to respond in an emergency situation except for the time periods when each EDG was inoperable due to having control power tagged associated with the implementation of repairs.
- Also, during this period of reduced reliability of the McGuire emergency AC power system, no event requiring the use of the EDGs occurred at the McGuire site nor was there any challenge to safety systems.

**ADDITIONAL INFORMATION:**

As a result of the Unknown/Possible Equipment failure associated with the components removed from EDG 1A, a planned corrective action was created for Engineering personnel to conduct analysis of the PC Board and the MOC which were removed.

The following information is supplied to document the result of that analysis:

- On June 18, 1996, OPS personnel had started EDG 1A, paralleled the EDG to the grid (closed the breaker), and increased load to 3100 KW. When OPS personnel operated the Voltage Regulator Pistol Grip Controller in the lower direction (from 0.75 lagging to 0.90 lagging), pf and VARS indications dropped off-scale low, and the amperes indication was increasing. All indications then returned to normal. OPS personnel then attempted to lower pf again, and the pf and VARS indications again dropped off-scale low, the amperes indication increased above 600 Amps, and the Emergency Breaker tripped open on a 50DGT actuation (Instantaneous overcurrent). OPS personnel then allowed the diesel to idle, at which time the

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following parameters were recorded, 1) The EDG voltage was observed to be 2100 VAC (not the nominal 4160 VAC), 2) EDG frequency was 61 Hz, and 3) The EDG 1A Battery Charger output voltage and current were observed at 120 VDC and 27 ADC, respectively.

- The Voltage Regulator Manufacturer (Basler Electric) was contacted and concurred that failure of the Voltage Regulator PC Board or MOC was the most probable cause of the EDG event.
- The scenario could not be repeated successfully, and neither component was found to be failed, but, as a conservative measure, both were replaced.
- It should be noted that each time the EDG is shutdown, the MOC returns to its center reference position (4160 VAC) for the next EDG start. Therefore, EDG 1A would have been functional and would have been able to respond in an emergency situation since the MOC would have not been in the position which is suspected to have been failed. However, this also hindered troubleshooting efforts because it allowed the MOC wiper to move away from any possibly failed location (spot) on the assembly, clearing the as failed condition.
- At that time, the Voltage Regulator PC Board and MOC needed to be sent to the manufacturer for failure analysis; however, a purchase order (PO) and commercial grade package were required for this service to be performed.
- While documentation was being prepared, the MOC was sent to the McGuire Qualification and Test Lab for preliminary analysis. It was noted by the Test Lab that measured output for a region on the MOC around mid-range of travel was questionable.
- The Voltage Regulator PC Board and MOC were then sent to the Manufacturer, but there was miscommunication as to where to send the PO and it was not forwarded to the Manufacturer. It was sent instead to the local Manufacturer Representative (R.W. Chapman, Inc.). Consequently, due to this miscommunication, the Manufacturer did not receive the PO and; therefore, did not understand the need to perform a detailed failure analysis on the components. Instead a normal equipment return evaluation was performed.

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- The results of this evaluation found no faults on the Voltage Regulator PC board.
- Testing of the MOC revealed that, at approximately mid-range of travel, resistance would suddenly spike up and then return to normal. Resistance through all other parts of travel seemed normal.
- Since the Manufacturer only understood the need to perform a normal equipment return evaluation, the failed MOC was then discarded as a normal course of action. No further analysis was attempted to determine an exact failure mechanism.
- Consequently, the test results were documented and a new MOC was returned to McGuire.
- As a result, the exact location and cause of the resistance spiking noted in the operation of the failed MOC cannot be determined nor can any further investigation be performed.
- The Manufacturer has provided confirming information explaining the results that would be expected if the MOC would become electrically open. According to the Manufacturer, if the MOC would electrically open, there would be no positive side bridge voltage output from the regulator circuitry. This eliminates any control current to L1 of the Auto-Voltage Regulator (AVR) circuit board. This also causes maximum firing of Silicon Controlled Rectifiers (SCRs) CR10 and CR11 which in turn produces maximum control current to the saturable transformers T51, T52, and T53. Maximum control current to the saturables will cause the generator line voltage to go to a low level.
- Although the suspect MOC was discarded without performance of further failure analysis, given the scenario and observed operating conditions at the time of the event, results of the testing performed at the McGuire Qualification and Test Lab, results of the evaluation of the Voltage Regulator PC board and MOC performed by the manufacturer, and the explanation of expected results as supplied by the Manufacturer, it can be concluded that failure of the MOC is the most probable cause of the EDG 1A Emergency Breaker tripping at the time of the event.

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

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- The failure of the MOC as postulated would not have affected the ability of EDG 1A to respond as required to an emergency situation.