

David R. Vineyard  
Vice President - Hatch

Southern Nuclear  
Operating Company, Inc.  
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October 13, 2016

Docket No.: 50-366

NL-16-2107

U. S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, D. C. 20555-0001

Edwin I. Hatch Nuclear Plant Unit 2  
Licensee Event Report 2016-003-00  
2C Emergency Diesel Generator Inoperable Due to Low Lube Oil Pressure

Ladies and Gentlemen:

In accordance with the requirements of 10 CFR 50.73(a)(2)(i)(B), 10 CFR 50.73(a)(2)(v)(D), and 10 CFR 21.21(d)(1)(ii) Southern Nuclear Operating Company (SNC) hereby submits the enclosed Licensee Event Report.

This letter contains no NRC commitments. If you have any questions, please contact Greg Johnson (912) 537-5874.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "D. R. Vineyard".

D. R. Vineyard  
Vice President – Hatch

DRV/jcb

Enclosures: LER 2016-003-00

cc: Southern Nuclear Operating Company  
Mr. S. E. Kuczynski, Chairman, President & CEO  
Mr. D. G. Bost, Executive Vice President & Chief Nuclear Officer  
Mr. D. R. Vineyard, Vice President – Hatch  
Mr. M. D. Meier, Vice President – Regulatory Affairs  
Mr. D. R. Madison, Vice President – Fleet Operations  
Mr. B. J. Adams, Vice President – Engineering  
Mr. G. L. Johnson, Regulatory Affairs Manager - Hatch  
RTYPE: CHA02.004

U. S. Nuclear Regulatory Commission  
Ms. C. Haney, Regional Administrator  
Mr. M. D. Orenak, NRR Project Manager – Hatch  
Mr. D. H. Hardage, Senior Resident Inspector – Hatch

**Edwin I. Hatch Nuclear Plant Unit 2**

**LER 2016-003-0**

**2C Emergency Diesel Generator Inoperable Due to Low Lube Oil Pressure**



**LICENSEE EVENT REPORT (LER)**

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an 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.

|  |                                      |                          |
|--|--------------------------------------|--------------------------|
| <b>1. FACILITY NAME</b><br>Edwin I. Hatch Nuclear Plant Unit 2 | <b>2. DOCKET NUMBER</b><br>05000 366 | <b>3. PAGE</b><br>1 OF 6 |
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**4. TITLE**  
2C Emergency Diesel Generator Inoperable Due to Low Lube Oil Pressure

| 5. EVENT DATE |     |      | 6. LER NUMBER |                   |         | 7. REPORT DATE |     |      | 8. OTHER FACILITIES INVOLVED |               |
|---------------|-----|------|---------------|-------------------|---------|----------------|-----|------|------------------------------|---------------|
| MONTH         | DAY | YEAR | YEAR          | SEQUENTIAL NUMBER | REV NO. | MONTH          | DAY | YEAR | FACILITY NAME                | DOCKET NUMBER |
| 08            | 18  | 2016 | 2016          | - 003 -           | 00      | 10             | 13  | 2016 | FACILITY NAME                | DOCKET NUMBER |
|               |     |      |               |                   |         |                |     |      | FACILITY NAME                | DOCKET NUMBER |

|                          |  |   |   |   |
|--------------------------|--|---|---|---|
| <b>9. OPERATING MODE</b> | <b>11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)</b> |   |   |   |
| 1                        | <input type="checkbox"/> 20.2201(b)  | <input type="checkbox"/> 20.2203(a)(3)(i)             | <input type="checkbox"/> 50.73(a)(2)(i)(C)            | <input type="checkbox"/> 50.73(a)(2)(vii)     |
|                          | <input type="checkbox"/> 20.2201(d)  | <input type="checkbox"/> 20.2203(a)(3)(ii)            | <input type="checkbox"/> 50.73(a)(2)(ii)(A)           | <input type="checkbox"/> 50.73(a)(2)(viii)(A) |
|                          | <input type="checkbox"/> 20.2203(a)(1)   | <input type="checkbox"/> 20.2203(a)(4)                | <input type="checkbox"/> 50.73(a)(2)(ii)(B)           | <input type="checkbox"/> 50.73(a)(2)(viii)(B) |
|                          | <input type="checkbox"/> 20.2203(a)(2)(i)  | <input type="checkbox"/> 50.36(c)(1)(i)(A)            | <input type="checkbox"/> 50.73(a)(2)(iii)             | <input type="checkbox"/> 50.73(a)(2)(ix)(A)   |
| 100                      | <input type="checkbox"/> 20.2203(a)(2)(ii)   | <input type="checkbox"/> 50.36(c)(1)(ii)(A)           | <input type="checkbox"/> 50.73(a)(2)(iv)(A)           | <input type="checkbox"/> 50.73(a)(2)(x)       |
|                          | <input type="checkbox"/> 20.2203(a)(2)(iii)  | <input type="checkbox"/> 50.36(c)(2)                  | <input type="checkbox"/> 50.73(a)(2)(v)(A)            | <input type="checkbox"/> 73.71(a)(4)          |
|                          | <input type="checkbox"/> 20.2203(a)(2)(iv)   | <input type="checkbox"/> 50.46(a)(3)(ii)              | <input type="checkbox"/> 50.73(a)(2)(v)(B)            | <input type="checkbox"/> 73.71(a)(5)          |
|                          | <input type="checkbox"/> 20.2203(a)(2)(v)  | <input type="checkbox"/> 50.73(a)(2)(i)(A)            | <input type="checkbox"/> 50.73(a)(2)(v)(C)            | <input checked="" type="checkbox"/> OTHER     |
|                          | <input type="checkbox"/> 20.2203(a)(2)(vi)   | <input checked="" type="checkbox"/> 50.73(a)(2)(i)(B) | <input checked="" type="checkbox"/> 50.73(a)(2)(v)(D) | 10 CFR 21.21(d)                               |

**12. LICENSEE CONTACT FOR THIS LER**

|  |   |
|--|---|
| LICENSEE CONTACT<br>Edwin I. Hatch / Carl James Collins – Licensing Supervisor | TELEPHONE NUMBER (Include Area Code)<br>912-537-5900 ext 2342 |
|--|---|

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**


| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|-------|--------|-----------|---------------|--------------------|-------|--------|-----------|---------------|--------------------|
| B     | EK     | DG        | F010          | Y                  |       |        |           |               |                    |

|  |  |
|--|--|
| <b>14. SUPPLEMENTAL REPORT EXPECTED</b><br><input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE) <input checked="" type="checkbox"/> NO | <b>15. EXPECTED SUBMISSION DATE</b><br>MONTH: _____ DAY: _____ YEAR: _____ |
|--|--|

**ABSTRACT** (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On August 18, 2016 at 1006, while performing the monthly Emergency Diesel Generator (EDG) surveillance, the 2C EDG tripped on low lube oil pressure. The station entered a 72 hour Required Action Statement (RAS) for Unit 2 Limiting Condition of Operation (LCO) 3.8.1.b. The other four EDGs were successfully started for surveillance testing in accordance with Tech Specs to preclude a common cause failure mode. Further inspections were performed and the cross drive shaft between the pump flexible drive gear and the engine driven lube oil pump was found sheared. The cross drive shaft assembly was replaced and the 2C EDG was declared operable on August 24, 2016 after subsequent functional and post maintenance testing.

Investigations into the failure revealed that the initial cross drive shaft fracture existed prior to the monthly surveillance performed on August 18. The time frame for which the 2C EDG was able to perform its safety function for its 7-day mission time is indeterminable due to the failure mechanism of the cross drive shaft. A loss of safety function is being reported due to the 2C EDG being potentially inoperable during a time in which either the 1B swing EDG was inhibited from Unit 2 or the 1B/2A EDG was inoperable due to normal equipment maintenance and testing. Additionally, this report constitutes a Part 21 notification per 10 CFR 21.21(d).

|   |   |  |
|---|---|--|
| <p><b>NRC FORM 366A</b><br/>(02-2014)</p>  | <p><b>U.S. NUCLEAR REGULATORY COMMISSION</b></p> <p><b>LICENSEE EVENT REPORT (LER)<br/>CONTINUATION SHEET</b></p> | <p><b>APPROVED BY OMB: NO. 3150-0104</b>      <b>EXPIRES: 1/31/2017</b></p> <p>Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA, Privacy and Information Collections Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to <a href="mailto:Infocollects.Resource@nrc.gov">Infocollects.Resource@nrc.gov</a>, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an 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.</p> |
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| Edwin I. Hatch Nuclear Plant Unit 2 | 05000 366 | YEAR              | SEQUENTIAL NUMBER | REV. NO. | 2 OF 6  |
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**NARRATIVE**

**PLANT AND SYSTEM IDENTIFICATION**

General Electric – Boiling Water Reactor  
 Energy Industry Identification System codes appear in the text as (EIS Code XX)

**DESCRIPTION OF EVENT**

On August 18, 2016 at 1006 with Unit 2 at approximately 100 percent thermal power, the 2C Emergency Diesel Generator (EDG) (EIS Code DG) tripped due to low lube oil pressure about 30 minutes into the surveillance run. The station entered a 72 hour Required Action Statement (RAS) for Limiting Condition of Operation (LCO) 3.8.1.b of Hatch Unit 2 Technical Specifications, which requires two (2) Unit 2 EDGs to be operable. The other four (4) EDGs were successfully started in accordance with Tech Specs to preclude a common cause failure mode, and no issues were identified. All four EDGs were also successfully loaded, which exceeded the requirement of the required action. The 1B EDG was inhibited from automatically aligning to Unit 1 on August 19, 2016 at 1157 in order to allow 14 days to restore the 2C EDG to operable status. Further inspections of the 2C EDG were performed and the cross drive shaft between the pump flexible drive gear and the engine driven lube oil pump was found sheared. As part of further troubleshooting and inspection, the cross drive assembly was inspected and excessive bearing wear was identified in the cross drive indicated by excessive movement in the shaft.

Upon the installation of a new cross drive assembly, as well as the replacement of associated damaged parts, the 2C EDG was declared operable on August 24, 2016 at 2334 following successful completion of post maintenance testing.

**CAUSE OF EVENT**

Based on physical indications and failure analysis taken from the damaged cross drive shaft, associated drive gears, and cylindrical roller bearing, the shaft failed due to rotational bending fatigue caused by premature bearing failure. The most likely cause of bearing failure was due to an overload condition such that the bearing was no longer able to adequately support the shaft to reduce rotational friction and support radial and axial loads. The overloaded bearing condition most likely existed from the EDG manufacturer. All preventative maintenance activities have been appropriately completed in accordance with vendor recommendations. Additionally, as-found failure analyses did not find indications of foreign material or inadequate lubrication. A search through Southern Nuclear Operating Company (SNC) maintenance records has not revealed any maintenance performed on the cross drive assembly by SNC beyond the vendor recommended visual inspection since the 2C EDG was installed. Therefore, based on the aforementioned information, this event is also reportable per 10 CFR 21.21(d) for reporting manufacturing defects that could create a substantial safety hazard. Premature wear of the cylindrical roller bearing located on the cross drive shaft initiated and propagated the cross drive shaft failure. Bearing life expectancy is dependent upon the load and speed imposed on the bearing. Based on the maximum speeds seen by Fairbanks Morse 38TD 8-1/8 Opposed Piston Diesel Engines and the amount of run-time hours accumulated by the 2C EDG, the bearing failed prematurely due to being overloaded. This overload caused fatigue on the bearing inner and outer races and on the bearing rollers, such that the shaft was no longer adequately supported. This resulted in the bending of the shaft and initiated cracks at multiple locations on the outer diameter. The cracks then continued to propagate inward towards the center of the shaft due to continued bending fatigue. When the remaining cross-sectional area of the shaft could no longer support the applied bending and torsional loads, the shaft failed.

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(02-2014)**LICENSEE EVENT REPORT (LER)  
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U.S. NUCLEAR REGULATORY COMMISSION

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**NARRATIVE****REPORTABILITY AND SAFETY ASSESSMENT**

This event is reportable per 10 CFR 50.73(a)(2)(i)(B) due to being a condition prohibited by Technical Specifications and per 10 CFR 50.73(a)(2)(v)(D) as an event or condition that could have prevented fulfillment of a safety function of a system that is needed to mitigate the consequences of an accident. The time frame for which the 2C EDG was able to perform its safety function for its 7-day mission time is indeterminable due to the failure mechanism of the cross drive shaft. There is a loss of safety function due to a potential loss of onsite emergency power since the 2C EDG was potentially inoperable for a time period in which either the 1B swing EDG was inhibited from Unit 2 or the 1B/2A EDG was inoperable due to normal equipment maintenance and testing. Additionally, this report constitutes a Part 21 notification in accordance with 10 CFR 21.21(d)(1)(ii) for reporting manufacturing defects that could create a substantial safety hazard.

The Unit 2 electrically powered safety loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed. The essential loads are divided between essential 4160-V buses 2E, 2F, and 2G. The availability of any two of these buses is sufficient to meet any accident condition. Unit 2 onsite standby AC power supply consists of three diesel generator units (2A, 2C, and 1B EDG). In the event of an emergency such that normal AC power is unavailable, the EDGs supply standby power to the essential 4160-V buses. Diesel generators 2A and 2C supply essential buses 2E and 2G, respectively. Diesel generator 1B is a shared diesel and can supply either Unit 1 essential bus 1F or Unit 2 essential bus 2F. Therefore, each load group has connections to a single EDG. There are a total of five EDGs furnishing the essential loads for HNP-1 and HNP-2, such that any four out of five diesel generators are adequate to supply the engineered safety features (ESF) loads of one unit concurrent with the emergency shutdown loads of the other unit. Therefore, the failure of any one diesel and its associated bus does not prevent safe shutdown, regardless of which bus fails.

Based on failure analysis, it is indeterminate when the 2C EDG could last meet its 7-day mission time due to the failure mechanism of the cross drive shaft. The 2C EDG successfully passed its 24 hour surveillance in January 2016. However, there were two subsequent periods of time in which the 1B EDG was declared inoperable due to maintenance activities, thus potentially causing two EDGs to be inoperable simultaneously. The most extensive of these periods of time, and therefore the most limiting, was when the 1B "swing" EDG was in a system outage in April 2016 and declared inoperable for approximately 109 hours. The limiting accident in which two EDGs would be necessary to ensure Unit 2 is maintained in safe shutdown conditions would be a dual unit Loss of Site Power (LOSP) simultaneous with a Loss of Coolant Accident (LOCA) on Unit 2 only. The 2C EDG successfully passed its monthly surveillances in April, May, June and July of 2016 and ran for 30 minutes fully loaded in August 2016 prior to failure. This represents approximately 4.5 hours of run time. If a station LOSP concurrent with a Unit 2 LOCA event would have occurred during April 2016, the 2C and the 2A EDG would have started and carried essential emergency loads for at least 4.5 hours into the accident, at which time the 2C EDG would have failed. Upon initiation of the LOSP/LOCA event, appropriate priority would have been placed on returning the 1B EDG to service. Qualified diesel mechanics approximate this return to service time to be 18 hours. Therefore, the approximate time period for which Unit 2 would have had only one fully operable EDG would be approximately 13.5 hours. Unit 1 would have been shutdown at this point and not needed the additional EDG.

Four and a half hours into a LOCA/LOSP event, the core has been reflooded and one loop of suppression pool cooling is removing decay and sensible heat from the containment. Upon the loss of the 2C EDG, the remaining 2A EDG would be available to continue vessel injection and core cooling using Core Spray or RHR. Due to the loss of the 2C EDG and suppression pool cooling, containment would begin to heat up along with a pressure increase. Operators would continue to monitor containment parameters and take appropriate actions in accordance with Emergency Operating Procedures. These actions would include spraying containment and ultimately venting

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containment as necessary. Venting containment would not result in offsite radiation levels being elevated since fuel failure during a LOCA is not postulated. Upon returning the 1B EDG to service, approximately 18 hours into the event, RHRSW pumps would be started to assist in containment cooling, thus restoring containment temperature and pressure. The use of proceduralized and trained operator actions available to mitigate the effects of the reduction in containment cooling ensures containment protection would have been accomplished.

The likelihood of having a station LOSP concurrent with a Unit 2 LOCA is very low. Therefore, based on the ability of the station to mitigate the consequences of a potential loss of two EDGs combined with the unlikely occurrence these EDGs would be inoperable during a LOCA/LOSP event, there was no significant impact to the health and safety of the public for this event.

**CORRECTIVE ACTIONS**

The associated gears, bearings, and shaft were replaced and the cross drive assembly on the 2C EDG was rebuilt per approved vendor procedure requirements. Additionally, the lube oil pump gear, the engine driven jacket coolant pump gear, scavenging air coolant pump gear, and flexible drive gear were replaced. Engine inspections were also conducted to ensure damage was limited to the cross drive assembly and interfacing components.

As part of extent of condition inspections, the existing cross drive assembly on the 2A EDG was replaced during its scheduled system outage. As-found backlash, axial thrust, and radial lift measurements were also taken and evaluated to be acceptable. Backlash, axial thrust, and radial lift measurements and a visual inspection of the gears will be taken at the location between the flex drive gear and the cross drive gear for all the Unit 1 EDGs (including the 1B swing EDG) on an expedited schedule. The 24 month routine maintenance procedure will also be revised to require the performance of gear backlash, axial thrust, and radial lift measurements.

**ADDITIONAL INFORMATION**

Other Systems Affected: None.

**Failed Components Information**

Master Parts List Number: 2R43S001C  
 Manufacturer: Fairbanks Morse  
 Model Number: 38TD 8-1/8  
 Type: Opposed Piston Diesel Engine  
 Manufacturer Code: F010  
 EIIS System Code: EK  
 Reportable to EPIX: Y  
 Root Cause Code: B  
 EIIS Component Code: DG

Commitment Information: This report does not create any new licensing commitments.

Previous Similar Events: None

NRC FORM 366A  
(02-2014)**LICENSEE EVENT REPORT (LER)  
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U.S. NUCLEAR REGULATORY COMMISSION

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**NARRATIVE****PART 21 REPORTING REQUIREMENTS**

To the best of the licensee's ability, the following information is provided to meet the requirements of 10 CFR Part 21.21(d)(4)(i) through (viii):

- (i) Name and address of the individual or individuals informing the Commission.

David R. Vineyard, Vice President - Hatch  
Southern Nuclear Operating Company, Inc.  
Edwin I. Hatch Nuclear Plant  
11028 Hatch Parkway North  
Baxley, Georgia 31513

- (ii) Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which fails to comply or contains a defect.

Facility: Edwin I. Hatch Nuclear Plant  
Component: Fairbanks Morse 38TD 8-1/8 Opposed Piston Diesel Engine

- (iii) Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect.

Fairbanks Morse

- (iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

An overload condition was created on the cylindrical roller bearing such that that the bearing was no longer able to adequately support the shaft to reduce rotational friction and support radial and axial loads. This resulted in premature bearing failure, leading to excessive bending of the cross drive shaft as it rotated. This excessive rotational bending caused crack initiation at multiple locations on the shaft due to rotational bending fatigue and led to eventual shaft fracture. The overloaded bearing condition most likely existed from the EDG manufacturer. All preventative maintenance activities have been appropriately completed in accordance with vendor recommendations. Additionally, as-found failure analyses did not find indications of foreign material or inadequate lubrication. A search through SNC maintenance records has not revealed any maintenance performed on the cross drive assembly by SNC beyond the vendor recommended visual inspection since the 2C EDG was installed.

Due to the fact that the identified condition resulted in the fracture of the cross drive shaft and therefore resulted in the loss of an EDG to respond to an accident or transient, a substantial safety hazard could have been created in the event of a station LOSP concurrent with a Unit 2 LOCA. Since the EDGs supply onsite emergency AC power to the essential 4160-V buses, a loss of two EDGs to any one unit would represent a loss of redundancy in essential safety related equipment necessary to mitigate the consequences of an accident.

- (v) The date on which the information of such defect or failure to comply was obtained.

10/11/2016



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(vi) In the case of a basic component which contains a defect or fails to comply, the number and location of these components in use at, supplied for, being supplied for, or may be supplied for, manufactured, or being manufactured for one or more facilities or activities subject to the regulations in this part.

All five EDGs installed at Hatch are Fairbanks Morse 38TD 8-1/8 Opposed Piston Diesel Engines.

(vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

Corrective actions have been completed to restore the 2C EDG to operable status. As part of the extent of condition review, the 24 month routine maintenance procedure will also be revised to require the performance of gear backlash, axial thrust, and radial lift measurements (see CORRECTIVE ACTIONS above).

(viii) Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.

Licensees who have been supplied with Fairbanks Morse 38TD 8-1/8 Opposed Piston Diesel Engines are advised to contact Fairbanks Morse concerning the existence of a similar condition. The backlash on pump gear drive trains should be inspected to ensure it is within acceptable tolerances per system specifications.