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) |
|---|---|---|
| Arkansas Nuclear One, Unit One | 0 5 0 0 0 3 1 3 | 1 OF 0 5 |

TITLE (4)
Emergency Diesel Generator Failure

| 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 1 | 1 3 | 8 6 | 8 6 | -- 0 0 1 | -- 0 0 | 0 2 | 1 4 | 8 6 | | 0 5 0 0 0 |
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OPERATING MODE (9): 1

POWER LEVEL (10): 4 3

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) | __ 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 |
| __ 20.405(a)(1)(iii) | X 50.73(a)(2)(i) | __ 50.73(a)(2)(viii)(A) | Abstract below and |
| __ 20.405(a)(1)(iv) | __ 50.73(a)(2)(ii) | __ 50.73(a)(2)(viii)(B) | in Text, NRC Form |
| __ 20.405(a)(1)(v) | __ 50.73(a)(2)(iii) | __ 50.73(a)(2)(x) | 366A) |

LICENSEE CONTACT FOR THIS LER (12)

| Name | Telephone Number (Area Code) |
|---|---|
| Dwight J. Johnson, Licensing Engineer | 5 0 1 9 6 4 - 3 1 1 0 0 |

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 |
|---|---|---|---|---|---|---|---|---|---|
| E | E K | E N G | E 1 4 7 | Y | | | | | |
| | | | | | | | | | |

SUPPLEMENT REPORT EXPECTED (14)

| | EXPECTED SUBMISSION DATE (15) | Month | Day | Year |
|---|---|---|---|---|
| X Yes (If yes, complete Expected Submission Date) | | 0 1 | 0 7 | 8 7 |
| __ No | | | | |

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

On 1/13/86, at 0628 hours, during the performance of the diesel generator monthly surveillance test for the #1 Emergency Diesel Generator (K4A), the diesel engine tripped on high crankcase pressure. The reactor plant was operating at 43% power to allow for maintenance of the 'A' main feedwater pump control system. The failure of the diesel did not impact unit operations. Maintenance activities commenced immediately to repair and determine the cause of the trip. The cause was determined to be the failure of piston wristpin bearings for cylinders #1, 5, 11, and 14. An Arkansas Power and Light engineering evaluation team was assembled to determine root cause of the failure and make recommendations to prevent recurrence. This evaluation concluded that the event was caused by a long term metal on metal contact of the wristpin bearings due to inadequate lube oil film. The ultimate initiation and propagation of the failure occurred as a result of 3 factors (or combinations thereof): 1) previous history of water in the lube oil; 2) excessive fast starts; 3) extended operation of the diesel at low or no load condition. On 1/15/86, when the extent of necessary repair indicated an overhaul of K4A should be initiated, the plant staff determined that it would be prudent to shut the unit down to cold shutdown conditions. The unit was shut down on 1/15/86. An evaluation of the redundant diesel generator (K4B) showed the existence of possible common failure precursors and the plant staff decided that K4B should also be overhauled. On 1/24/86 maintenance activities commenced on overhauling the #2 emergency diesel generator after the #1 emergency diesel was restored to operable status. Maintenance activities and operational checks of the diesel were completed on 1/31/86 and the plant was returned to power operation. Long term corrective actions have been identified by the engineering evaluation team and will be addressed by the plant staff. A supplemental report on this event will be issued 1/7/87. .This event resulted in no technical specification violation and the health and safety of the general public was not degraded. There have been no similar occurrences.

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

I. Description of Event

A. Unit Status

The unit was operating at 43% power while maintenance was being performed on the "A" main feedwater pump control system. A power reduction had been performed on 1/12/86 to allow the "A" main feedwater pump to be isolated for the corrective maintenance.

B. Component Identification

Emergency Diesel Generator: EIIS Identifier = EK-ENG-K4A

The Engine for the Emergency Diesel Generators used to supply onsite emergency AC power at Arkansas Nuclear One, Unit One, are General Motors Corp. Electromotive Division (EMD) Model EMD 645E4, 20 cylinder, 2 cycle, turbo-charged diesels rated at 3600 brakehorsepower (at 900 rpm). The engine is used to drive a 2750 kw electric generator. These packaged units (2) were supplied by Stewart and Stevenson to Arkansas Power & Light in 1972. The units were subsequently modified to include a prelube/prewarm oil system per the manufacturer's recommendations.

C. Sequence of Events

At 0530 hours on 1/13/86 a licensed control room operator started the #1 Emergency Diesel Generator (K4A) to perform the monthly surveillance test. As part of this surveillance, the service water supply valve to the diesel engine cooling water system must be verified to have opened automatically. Upon checking the control room indicator of the valve's position, it was noted by the licensed control room operator to be in an intermediate position. Another operator was immediately dispatched to the valve to verify actual position. The valve was found to be approximately half open. The operator at the valve manually opened the valve to full opened position. At this point, the licensed control room operator decided to unload the diesel and initiate the surveillance again. During the unloading sequence the diesel was inadvertently tripped on generator anti-motoring. At 0548 hours the diesel generator was restarted from the control room and the service water supply valve opened fully.

The diesel was loaded to 2750 kilowatts (rated load) at 0548 hours. At 0628 hours the diesel generator tripped after running for 40 minutes under full load. An investigation by operations personnel found oil leaking from gaskets above the oil cocks, the oil dip stick (engine oil sump level indication) was noted as being almost blown from the crankcase. The "low oil pressure" and "low oil pressure shutdown" annunciators were in alarm at the local panel and the crankcase high pressure trip button was in the tripped condition. Note: the high crankcase pressure trip device functions by dumping oil pressure sensed by the "low oil pressure trip" pressure switches. Disassembly of K4A was initiated on 1/14/84 to inspect and repair the cause of the trip. At this time it was discovered that cylinders 1, 5, 11 and 14 had excessive piston-to-cylinder head clearances. Upon examination of these cylinders and pistons assemblies (power packs) it was discovered that these four cylinders had heavily scored and burned wristpin bearings. On January 15, it was decided by ANO maintenance personnel to overhaul K4A and install new power packs on all 20 cylinders and a replacement main oil pump. When the decision was made to overhaul K4A the plant staff determined that the required duration of maintenance would exceed the applicable technical specification limiting condition for operation time allowance (7 days) therefore on 1/15/86 the unit was shutdown. An inspection of the redundant diesel generator, K4B, indicated that the same failure mechanism precursors may have existed and maintenance activities were initiated to overhaul K4B on 1/24/86. Maintenance activities and operability checks were completed 1/31/86 and the unit was returned to power operations.

II. EVENT CAUSE

A. Event Analysis

An anaiysis of this event was conducted by a team of Arkansas Power & Light Co. (AP&L) employees and a consultant from MPR Associates. Included in this team was a mechanical engineer, a metallurgical engineer and two diesel maintenance specialists. This teams evaluation consisted of: 1) a visual inspection of the power packs during the engine overhaul; 2) a nondestructive examination of the failed components (wristpin bearings); 3) a review of the operational history for both K4A and K4B; 4) a review of industry experience with this make and model of diesel engine; 5) a review of the

II. Event Cause Cont'd:

manufacturer's recommendations for operation of this diesel engine; 6) a review of the lube oil analysis performed after the K4A failure. The following conclusions were drawn from the evaluations performed by this team:

1. Based on the inspection of the diesel components the failure of K4A cylinders 1,5,11 and 14 wristpin bearings were noted as being the only major failures. The other 16 cylinders of the diesel showed normal wear patterns however, the wristpin bearings on several of the other pistons did show some significant signs of wear as did several of the wristpin bearings in K4B. There was no sign of crankshaft, piston, or cylinder wall scoring which would indicate a lube oil system failure or lube oil breakdown. Additionally, the lube oil pump was inspected on 1/17/86 and found to meet established operational criteria.

2. The nondestructive examination of the wristpin bearings indicated that the failure of this component was due to progressive long term degradation as opposed to a sudden failure mechanism. This conclusion is borne out by the fact that the wristpin bearing failure involved a localized wear mechanism that propagated through successive stages (as evidenced by examining several bearings).

3. A review of the operational history of both diesels showed three significant items of interest:

   a. Water in the lube oil (1979)
   b. Excessive fast starts (as high as 90/year/diesel) and excessive operation at rated speed under low or no load conditions.
   c. Cylinder #13 power pack for K4A was removed and replaced during October 1984 due to excessive head to piston clearance and abnormal wear (this problem did not cause the diesel to malfunction, but later inspection of the piston assembly indicated the wristpin bearing had failed).

4. Industry experience with this make of diesel has generally been good. A sampling of ten other nuclear utilities that have EMD Model 645EA diesels indicated that none had witnessed failures of the type seen at ANO. A review of Nuclear Power Experience reports, Electric Power Research Institute reports, INPO database and NPRDS showed no failures involving connecting rod or wristpin bearing failures. The operational data from other nuclear utility owners of EMD diesels provided a basis for comparison of operational experience and practices at Arkansas Nuclear One.

5. A review of the current manufacturer's recommendations for diesel operation and also discussions with the manufacturer concerning the failed wristpins were performed. The recent manufacturers recommendations concerning operation of these diesel engines shows that operation at low or no load condition will increase wear. Conversations with the manufacturer concerning the failed wristpin bearings provided concurrence with the Arkansas Power and Light's metallurgical engineer findings and supported these, but also included as a potential precursor event the cooling water in the lube oil event recorded in 1979 (reference LER's 50-313/79-016, 79-017).

6. The lube oil analysis showed no abnormalities except for elevated levels of lead, iron and silver in the K4A lube oil (post failure). These findings would be expected since the components found are the balance of materials used in the wristpin bearings.

The wristpin bearing failure appears from analysis to occur in a succession of steps; first the lead babbit metal wears down to the silver substrate, second the silver substrate begins to flake (due to mechanical action), and finally catastrophic failure of the bearing occurs. Each of these stages was witnessed in the wristpin bearings of K4A and the initial failure precursors were observed in K4B.

B. Root Cause

The cause of the K4A malfunction is a wear failure of 4 wristpin bearings due to metal to metal contact as a result of insufficient lube oil film. The installed prelube system provides initial lubrication of diesel component metal surfaces by maintaining the lube oil supply header full of oil prior to the engine start phase. This system also supplies direct lubrication of the crankshaft surfaces and turbo-charger bearings. There is no direct application of lube oil to the wristpin bearing by the

prelube system, however, the manufacturer has indicated that this is not a critical concern since the time to initiation of wristpin lubrication has been minimized by filling the lube oil header via the prelube system. There is no evidence to suggest that there was a loss of lube oil or insufficient lubrication of these bearings once the diesel was operating at full speed and under loaded conditions. The root cause appears to be long term wear initiated and propagated by each of the following or a combination thereof:

1. Water in the lube oil event (1979)
2. Fast starts
3. Unloaded or Low load operation at rated speed.

This conclusion was based on the facts presented by the AP&L team of investigators and the manufacturers representative. Also, these conclusions seem to be borne out by the current industry and NRC concerns about fast starts and other diesel engine related operating conditions (i.e., Reg. Guide 84-15 and 83-41, NUREG/CR0660, etc.).

C. Basis for Reportability

Arkansas Nuclear One, Unit One, Technical Specification 3.7.2.C. allows one diesel generator to be inoperable for up to 7 days. When the extent of the failure of K4A was determined and a course of maintenance action decided upon the plant staff realized that the planned maintenance activities and therefore diesel generator inoperability would exceed the time allowed in the units technical specification. Based on this an orderly shutdown of the unit to cold shutdown conditions was initiated on 1/15/86. This report is being submitted in accordance with 10CFR50.73(a)(2)(i) based on the guidance given in NUREG 1022 Supplement 1, Page 3 Question 1.3. Since the unit was shutdown due to the potential for exceeding the limiting condition for operation time limits, the plant staff acted prudently in placing the plant in cold shutdown. There was no violation of the units technical specifications, and the health and safety of the general public was not degraded.

III. CORRECTIVE ACTIONS

A. Immediate

Immediate corrective actions included an operational check of offsite AC power sources to the unit. As directed by the units Technical Specification the redundant diesel generator was immediately proven operable and subsequently surveilled on a daily basis. Maintenance activities to determine and repair the cause of the diesel engine failure were also initiated. An engineering evaluation team was assembled to review this event, determine root cause, and make engineering recommendations to the plant staff.

B. Subsequent

Based on the maintenance evaluation of the failure, K4A was disassembled and completely overhauled (20 new power packs, new bearings, rebuilt oil pump, etc.). Since the failure mechanism observed in K4A was progressive an evaluation of K4B was undertaken. When this investigation showed the same precursors to failure as witnessed in K4A, K4B was overhauled (1/24/86) as a precaution against common mode failure. Both diesels were subsequently proven operable and the unit was returned to power operation.

C. Future

Since this failure was a progressive event that developed over a long period of time and the precursors have been identified, adequate assurance has been provided to prevent recurrence through evaluation and implementation of recommendations provided by the evaluation team. The recommendations identified by the team include:

1. Increased visual and mechanical surveillance of diesel engine components on a regular frequency.

2. Review and revision of the diesel generator operating and test procedures.

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3. Increased diesel lube oil sampling with emphasis on lead and silver content and trending.

4. Improved monitoring of diesel engine parameters during operation.

5. Design changes to diesel engine auxiliaries that will improve operations and reliability and reduce stress induced wear.

IV. Additional Information

A. Supplemental Information

An initial revision to this report is scheduled for 1/7/87. This future report will include the results of the scheduled inspections to be performed during the next refueling outage. Also included in this supplemental report will be a description of the corrective actions taken or planned as a result of this event as summarized in III.C above (Items 1-5).

B. Similar Events

There have been no similar events of wristpin bearing failure; however, LER's 50-313/79-016 and 79-017 were implicated as initiators to the event described in this report.

ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

February 14, 1986

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

Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Licensee Event Report
No. 86-001-00

Gentlemen:

In accordance with 10CFR50.73(a)(2)(i), enclosed is the subject report concerning a diesel generator trip on high crankcase pressure during the performance of the diesel generator monthly surveillance test for the #1 emergency diesel generator, K4A. The cause of the trip was subsequently determined to be due to failed wristpin bearings on four cylinders.

Very truly yours,

J. Ted Enos, Manager
Nuclear Engineering
and Licensing

JTE:RJS:lw

Enclosure

cc: Mr. James M. Taylor, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, DC 20555

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