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RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 90-033-00:on 901219,failed piston pin bushing found on right cylinder of D EDG.Caused by improper fit-up between piston pin bushing & piston bore.Insp performed to determine extent of damage.W/910118 ltr.

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Pennsylvania Power & Light Company
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January 18, 1991

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

SUSQUEHANNA STEAM ELECTRIC STATION
LICENSEE EVENT REPORT 90-033-00
FILE R41-2
PLAS -468

Docket No. 50-387
License No. NPF-14

Attached is Licensee Event Report 90-033-00. This event is being voluntarily reported to provide information related to a failed piston pin bushing which was found on the 'D' Emergency Diesel Generator during a post maintenance inspection.

H.G. Stanley
Superintendent of Plant - Susquehanna

RRW/mjm

cc: Mr. T.T. Martin
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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Susquehanna Steam Electric Station - Unit 1	0 5 0 0 0 3 8 7	1 OF 0 6

TITLE (4)

Diesel Generator 'D' Piston Pin Bushing 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)
1 2	1 9	9 0	9 0	0 3 3	0 0	0 1	1 8	9 1	SSES - Unit 2	0 5 0 0 0 3 8 8
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

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)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	Voluntary
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
	AREA CODE
Richard R. Wehry - Compliance Engineer	7 1 7 5 4 2 - 3 6 6 4

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)

		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

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

On December 19, 1990, with Unit 1 and Unit 2 operating at 100% power, a failed piston pin bushing was found on the No. 7 Right cylinder of the 'D' Emergency Diesel Generator (EDG) while performing a maintenance inspection. This inspection was being performed after approximately 43 hours of engine operating time following major engine work which had been completed in October 1990. The inspection is a manufacturer's recommended practice following any work which disturbs a piston bolt attachment. The root cause investigation for the bushing failure included an Installation Review, Metallurgical Analyses and Manufacturer's Evaluation. It was determined that the most probable causes for the bushing failure was either an improper fit-up between the piston pin bushing and piston bore during an earlier piston refurbishing by the manufacturer or a restriction to lubricating oil flow to the piston pin/bushing. The bushing failure was determined by the manufacturer and PP&L to be a unique and isolated type of failure and not indicative of any generic concerns. This event is being voluntarily reported for information purposes. There were no safety consequences or compromise to public health and safety. Corrective actions included inspections to determine extent of damage and debris distribution, repair work, debris cleanup and retesting and re-inspection. The manufacturer will include piston pin bushing bore measurement checks on all future piston refurbishings.

DESCRIPTION OF EVENT

On December 19, 1990, with Unit 1 and Unit 2 operating at 100% power, a failed piston pin bushing was found on the No. 7 Right cylinder of the 'D' Emergency Diesel Generator (EDG; EIIS Code: EK) while performing a post maintenance inspection. This inspection was being performed after approximately 43 hours of engine operating time following major engine work which had been completed in October 1990. The inspection is a manufacturer's recommended practice following any work which disturbs a piston bolt attachment.

The inspection consisted of a topside cylinder wall borescope inspection and an underside visual inspection at each cylinder. A torque check of piston pin bolts and crankshaft end anticulating rod bolts was also performed. The bronze piston pin bushing for the No. 7 Right piston was found in several pieces. These pieces, ranging from approximately 1/4 inch square to approximately 2 x 3 inches, were found in the crankcase. Bronze shavings were distributed in the crankcase primarily below the No. 7 Right and No. 7 Left cylinders. After piston removal, the pin and bushing were removed. The pin was blackened from overheated lubricating oil. The bushing came out in pieces and showed evidence of rotating within the piston as well as melting and hammering damage. The appearance of the bushing pieces indicated that they had migrated out of the piston pin area and contacted the cylinder walls. The No. 7 Right cylinder liner was not damaged. A replica check of the liner confirmed proper porosity of the chrome and dimensional checks were within specifications. No other failed piston pin bushings were found during the inspection.

CAUSE OF EVENT

The root cause investigation for failure of the piston pin bushing proceeded along three parallel paths:

1) Installation Review
2) Materials Analysis
3) Manufacturer's Evaluation

1) Installation Review

The piston assembly in the No. 7 Right position had been installed in the engine in October 1990. A review was performed on the as-found conditions and installation records for any abnormalities that could have lead to the bushing failure. Lubrication passages were all found to be unrestricted within the piston pin and bushing areas. The pin bolts were found to be properly torqued. Examination of rings, piston walls and liner walls showed no signs of lubrication starvation. No signs of excessive piston to liner drag forces were

evident. In October 1990 checks had been made for piston pin straightness and diameter and bushing to pin clearance and contact (blue check) had been determined to be satisfactory.

Straightness checks of the master rod found the rod to be straight by examination of the lubrication bore. However, checks for the rod to be centered in the cylinder found the rod off centerline by 0.030 inch. Review of this condition by the manufacturer, however, concluded that the rod condition could not have caused the bushing failure. The rod condition was within specification and a review of the manufacturing records revealed that the condition existed since original time of manufacture.

2) Materials Analysis

A metallurgical review of the failed bushing found no material abnormalities. Although severely damaged and overheated, the bushing appeared to have normal composition. There were no observable structural defects. Examinations for surface contaminations found nothing other than elements associated with lubricating oil decomposition from the heat generated by the failure.

3) Manufacturer's Evaluation

The No. 7 Right piston was a Susquehanna piston which had been refurbished by the manufacturer following the August 1990 engine sand intrusion event described in Licensee Event Report 90-018-00. The manufacturer's evaluation concluded that either some problem existed in the fit-up of the bushing to the refurbished piston or a restriction to lubricating oil flow to the piston pin/bushing assembly occurred. Either cause could have resulted in the bushing moving within the piston, resulting in rapid failure. The manufacturer's piston refurbishment proceeds as follows:

1. Clean old piston to remove all dirt, carbon, etc.,
2. Magnaflux inspect to detect any cracking.
3. Perform a 100% dimensional inspection.
4. Remove old pin bushing and visually inspect piston pin bore.
5. Install new pin bushings and precision bore to size. Check for proper pin clearance and blue (contact area) pattern.
6. Strip tin plating from outer diameter and re-tin to specification.
7. Thoroughly clean and check cleanliness with a fibrescope.
8. Final inspect for shipment.

The manufacturer reviewed the refurbishment process for the No. 7 Right piston. They observed that the dimensional check did not include the inside diameter of the piston pin bore or bore straightness without the bushing. The manufacturer's rationale for not making this dimension check was that it was checked when originally manufactured and no mechanism to change this dimension during engine operation normally exists. A field measurement of the actual .

bore in the No. 7 Right piston at several locations after the event found diameters ranging from 5.7491 to 5.7498 inches. The bore was found arched up to 0.005 inch at the center of the piston. The diameters were all within the specified 5.749 to 5.750 limits, however, the variances may have lead to movement of the bushing within the piston bore.

The manufacturer and PP&L believe that the piston pin bushing failure was due to distress between the piston pin and bushing caused either by an improper fit-up of the bushing to the piston or by a restriction to lubricating oil flow to the piston pin/bushing assembly. In either case, failure would occur rapidly. A review of the lube oil analyses performed following the installation of the refurbished pistons on the 'D' EDG to the present showed an increase in the Wear Particle Count from a normal 10.9 parts/ml to 32.2 parts/ml after the 12 hour post maintenance test following that installation in October 1990. Discussions with the manufacturer at that time, however, concluded that the increase in Wear Particle Count could be attributed to the break-in of new components and was not considered abnormal. No evidence of a blockage in lube oil passages was found after this event, however, such a blockage could have washed out after the failure had occurred. A single piece of debris large enough to restrict flow will not pass through the main lube oil filter and lube oil strainer.

REPORTABILITY/ANALYSIS

This is a voluntary report to provide information on the 'D' EDG failed piston pin bushing.

The 'E' EDG, which is a fifth and spare EDG, had been substituted for the 'D' EDG prior to performing the maintenance inspection. As such, four EDG's remained OPERABLE during the time that the 'D' EDG was removed from service, the pin bushing problem identified and repairs made. The 'D' EDG had been run successfully for OPERABILITY surveillance testing in accordance with Technical Specification Table 4.8.1.1.2-1 from October 1990 until its removal for this maintenance inspection. Had the piston pin bushing failure resulted in a failure of the 'D' EDG to perform its design function, if it had been called upon to do so, three EDG's would still have remained OPERABLE as required by the SSES Safety Analysis to perform their design function. Based on evaluations performed both by PP&L and the manufacturer, the bushing failure was determined to be an isolated incident and not indicative of any generic problem. Improper fit-up of the bushing to the piston or a restriction to lubricating oil flow to the piston pin/bushing assembly would lead to distress between the piston pin and bushing resulting in rapid failure. A visual inspection of all refurbished pistons on the 'D' EDG did not disclose any other problems. The 'D' EDG was the only Susquehanna EDG to have refurbished pistons installed which had earlier experienced a stress event (i.e., these refurbished

pistons originally had been on the 'B' EDG which, along with the 'D' EDG, had experienced the sand intrusion event described in LER 387/90-18-01). Recent similar inspections of the 'A', 'B' and 'C' EDG's did not uncover any other bushing failures. Lube oil analyses for 'A', 'B', 'C' and 'E' were all normal. As such, there were no safety consequences or compromise to public health or safety as a result of this event.

CORRECTIVE ACTIONS

Corrective actions included inspections to determine extent of damage and debris distribution, repair work, debris cleanup and retesting/re-inspection. Several components and locations in the lubricating oil system were inspected for both evidence of bronze bushing debris and damage. The following components were inspected:

Main lube oil and turbo oil filters
Lube oil suction piping
Prelube Pump
Engine Driven Lube Oil Pump
Lube Oil Heat Exchanger
Lube Oil Filter
Lube Oil Strainer
Crankcase oil supply header
7 Right master rod bearing
7 Right articulating rod bearing
7 Left and 4 Right piston pin bushings
Several camshaft bearings
7 Right, 7 Left and 4 Right heads and rocker assemblies
Selected head lube oil drain orifices
Selected rocker arm areas and crevices
Turbo lube oil piping
Turbo lube oil air separator

The inspections confirmed no component damage had occurred from the bronze bushing debris.

Repair work consisted of replacement of the 7 Right piston, piston rings, piston pin, master rod bearing and master rod. After manually cleaning the crankcase and lube oil system, a flush was performed using heated 10W weight lube oil. Special 5 micron screen type filters were used for the flush. New lubricating oil, main lube oil filter elements and turbo lube oil filter elements were installed after the flush.

A 12 hour post maintenance run was performed following the repairs and flushing. An underside inspection of all piston pins and bushings performed

after the 12 hour run disclosed no further anomalies. Lube oil analysis of samples taken after the 12 hour run and after a 4 hour Operability run confirmed no problems within the engine.

The manufacturer's inspection procedure for refurbished pistons did not include a pin bushing bore measurement or straightness check. As a result of this bushing failure, however, these checks will now be an acceptance criteria by the manufacturer prior to refurbishing pistons. PP&L and the manufacturer are also performing these checks on selected refurbished pistons in the warehouse to determine if any other fit-up problems exist.

To aid in earlier detection of engine material degradation or failures, PP&L will now perform a lubricating oil sample and analysis following all EDG runs. A new enhanced main lube oil filter design is also being evaluated to further minimize the chances of foreign debris migrating to critical parts of the engine.

ADDITIONAL INFORMATION

Failed Component Identification: None listed in IEEE Std. 803A-1983.
Manufacturer: Cooper Energy Services

Previous Similar Events: None.