ROOT CAUSE OF FAILURE REPORT

PVNGS UNIT 3 DIESEL "B"

No. 9 LEFT WRIST PIN

ROOT CAUSE OF FAILURE DATA SHEET

EQUIP. I.D. No.: 3-M-DGB-H01	RCF No.: 87-DG-193

COMPONENT I.D./MFG No.: #9L Piston wrist Pin

UNIT: 3	SYSTEM: DG	LOCATION: 100' Diesel Gen Bldg unit 3

INITIATOR: Robert Powell	EXT.: 2835	INITIATION DATE: 7-10-87

METHOD OF INITIATION: Diesel Gen Trip

FAILURE TIME/DATE: RP 7-10-87 2330 June 30, 1987	RESTORATION TIME/DATE: 1116 July 5, 1987

I N I T I A T I O N

EQUIP/COMPONENT DESCRIPTION: #9Left Cylinder

FAILURE DESCRIPTION: Piston wrist Pin siezed in Piston Bushing.

METHOD OF DETECTION: Crank case High pressure Trip

EFFECT ON SYSTEM: Diesel Gen 'D' Inoperable

EFFECT ON PLANT: Suspended Testing of 'B' Diesel And Procedure 73PE-3PE01

ASSIGNED TO: OPS ENG Mech / Robert Powell / 7-10-87 (Group / System Engr. / Date)	DUE DATE:
	EXT. DATE:
TRANSFER TO: ___ / ___ / ___ (Group / System Engr. / Date)	Extension Approved By: ___ / ___ DATE

ROOT CAUSE OF FAILURE DATA SHEET

RESOLUTION RCF NO.: 87-DG-193

[X] ROOT CAUSE ANALYSIS PERFORMED

[ ] ROOT CAUSE ANALYSIS NOT REQUIRED (If Checked, explain below)

ROOT CAUSE OF FAILURE:

SEE PAGES 3 Through 6

RECOMMENDATIONS:

Perform Installation of wrist pins and Bushings as directed by Vendor Tech manual to ensure correct loading between pin and Bushing.

ANALYSIS PERFORMED BY: Robert Powell / 7-10-87
DATE

APPROVED BY: Thomas P. Engler / 7/10/87
LEAD OR SUPERVISOR SIGNATURE DATE

ACTION TAKEN TO IMPLEMENT RECOMMENDATIONS:

Copy of This Report to be sent to Mech maint. and OMD to enforce compliance with Vendor Tech manuals.

Cooper-Bessemer Reciprocating
Ref: QCG-3630
July 3, 1987

REPORT

Arizona Nuclear Power Project (ANPP)
Diesel Generator IIIB, S.N.7187
No. 9 Left - Piston/Liner Scuffing

1.0 INTRODUCTION

1.1 The rebuilding of the above unit, following the December 23, 1986 rod failure, was completed May 31, 1987 and the engine restarted June 2, 1987.

1.2 On June 8, 1987 an attempted restart was not completed due to a head crack which allowed cooling water to enter cylinder 8 right. Between June 12 and June 23, the engine was shut down three times by a bearing overtemperature device on the number 2 main bearing.

1.3 Following the repolishing of the number 2 journal and approximately 50 hours of successful engine running, the engine was shut down by the turbocharger bearing wear detector. No problem with the bearings were found and so the engine was started again.

1.4 During the night of June 30, the engine was shut down by the crankcase overpressure safety device. A subsequent inspection of the inside of the engine revealed a heavy scuff mark on the thrust (left) side of the number 9 left cylinder.

2.0 OBSERVATIONS

2.1 When the 9 left piston and liner were removed from the engine, a heavy scuffing of the liner on the thrust side was readily observable. It was approximately 10 inches around the circumference by about 12 inches high. This was a classic scuffing in which all clearance had been taken up by the expansion of the piston. Heavy "dragging" of the piston against the liner walls was evident for the balance of the area which was not discolored by the heavy loading in the scuffed area.

2.2 The piston evidenced distress commensurate with that of the liner. The area of heaviest contact was "heat-checked" due to the high temperature of friction following loss of the oil film. All rings were free to move in their grooves and had suffered no damage beyond that which arose from the expansion of the piston.

2.3 When the piston and its articulated rod were removed from the engine it was not possible to move the piston pin in its bushing. (The bushing is made from bronze and is an interference fit in the piston). Seizure of the piston pin was such that the piston had to be cut apart in order to remove the pin and bushing together. Subsequently, the bushing was suitably cut in order to remove it from the piston without further damage to the distressed area.

2.4 The piston pin is approximately 5 inches in diameter and 11½ inches long. It is made from an AISI 1050 or equivalent steel, is induction hardened and is made with a 10 RMS finish. Oil holes conduct oil from the top of the articulated rod, through the pin to grooves on the upper surface of the pin for lubrication of the pin and bushing. In addition, the same oil supply is fed into the piston for purposes of piston crown cooling. The bronze bushing is chilled prior to assembly in the piston with an interference fit. Upon assembly to the engine it is required that the pin to bushing clearance of .005 to .006 inches be checked with a feeler guage and that a "blue" pattern of 80% contact area be established by scraping the bushing as necessary.

2.5 An area approximately 3 inches around the pin by 4 inches long exhibited very heavy contact with the bushing, and loss of oil film. As a result of this distress the bushing expanded (particularly radially), took up the clearance between the pin and bushing, and rubbed heavily to the point of metal transfer from the bush to the pin. This added heat was transferred to the piston skirt which in turn expanded until heavy contact with the cylinder wall resulted in "scuffing". This suffing generated more and more heat with the loss of oil film and would have been the source of ignition which resulted in a "puff" (minor crankcase explosion) which in turn caused the engine to shut down from a high crankcase pressure. It was noted that upon disassembly the pin was seized to the bushing. This seizure must have occurred following the shutdown because there was no evidence that the bush had turned (rotated) in the piston.

2.6 A closer look at the pin revealed two anomalies:

2.6.1 The surface finish appeared to be between 16 and 20 RMS (instead of 10).

2.6.2 Minor rust pitting was evident in an undamaged area.

2.7 The bushing generally exhibited some form of contact over its entire length, however, it is postulated that the majority of this contact arose during the cycle of distress. There was no evidence that the bushing had been scraped. A subsequent check of the work order records showed no requirement for this operation to be performed and it is therefore presumed that the "blueing" check for surface contact was not made. From observation of the failed bushing, it is evident that an adequate bearing area was not established at assembly.

3.0 ADDITIONAL INFORMATION

3.1 A new piston pin selected for the reassembly was visually checked for any surface abnormalities. There were none observed. It was also noted that the finish was far superior to that of the failed pin.

3.2 A further six pins in the ANPP warehouse were visually examined for surface finish and were also found to have superior finish to that of the failed pin.

3.3 A review of the records showed the following:

3.3.1 The clearance between the pin and bushing for the failed assembly was .005 inches (.005 to .006 inches required).

3.3.2 No reference to a "blueing" check for the failed 9 left.

3.3.3 No reference to a "blueing" check for the similarly assembled 9 right piston which was made with a new piston and pin. It should be noted that only "new" assemblies require the "blue" pattern check. It has, however, been established that the 9 right bushing was checked and scraped. All other piston/bushing/pin combinations with one exception (8 right which has been recorded and properly checked) were the original combination in the engine prior to the December 23, 1986 rod incident.

3.4 By rotating the engine on the turning gear, the lower portions of the other 19 liners were inspected for signs of scuffing or any other distress. None were found. From this inspection it is concluded that no other locations have a similar problem to the distressed number 9 left location.

3.5 Should, for some reason, a piston seize in a liner due to a combination of adverse circumstances between the piston and liner, it is most unusual to find that the piston pin and its bushing are also distressed. Invariably though, when the piston pin/bushing shows extreme distress it creates the circumstances which cause piston/liner scuffing.

4.0 CONCLUSION - ROOT CAUSE

4.1 The primary failure occurred between the piston pin and its bushings.

4.2 The primary reason for the failure is deduced to be one of poor pin finish possibly aggravated by rust pits. If any such pits did in fact exist in the damaged area, the evidence of them was destroyed during the failure.

4.3 It is also deduced that the failure mechanism was aggravated by the lack of contact between the piston pin and its bushing which led to high localized loading.

W. H. A. Lambert
Mgr., Quality Control
Cooper-Bessemer Reciprocating

WHA/dpr

cc:	W. Simko	ANPP	6077
	T. Engbring	ANPP	6077
	R. Powell	ANPP	2710
	R. Buckhalter	ANPP	6915
	P. Prescott	NRC - Vendor Branch	

Cooper-Bessemer:

D. T. Blizzard
W. Ferguson
T. Garrison
J. Horne
T. W. Kearns
M. Schleich
R. B. Sedelmyer
R. L. Spetka

File: SO 0391/P2A
5-1

212-00CA (9-84) 4190-900121 (BX/500)

Arizona Nuclear Power Project

COMPANY CORRESPONDENCE

ID#: 109-0124-RAK

DATE: September 24, 1987

TO: W. M. Simko
Sta. # 6077
Ext. # 2659

FROM: R. A. Kropp D B Hansen for
Sta. # 6086
Ext. # 2630

FILE: 87-001-404

SUBJECT: Failure Analysis of Number 9L Piston Pin from Emergency Diesel Generator 3B

Enclosed is the Failure Analysis Report of the subject piston pin.

Questions should be addressed to D. E. Sachs, ext. 2661.

RAK/dpr

cc:	T. Engbring	6077
	R. Powell	6086
	D. Hansen	6086
	D. Sachs	6086