ANPP

METALLURGICAL INVESTIGATION REPORT

PVNGS

EMERGENCY DIESEL GENERATOR 3B

NO. 9L PISTON PIN

PREPARED BY D.E. Sachs 9/24/87

REVIEWED BY RPMdap 9/24/87

APPROVED BY D.B. Hansen 9-24-87

SUMMARY

This report describes the metallurgical investigation undertaken to determine the cause of failure of the number 9L piston pin in emergency diesel generator 3B.

No metallurgical abnormalities or pitting was found, and the pin had the correct surface finish.

It was concluded that the piston pin overheated because of an error during assembly (see Cooper-Bessemer Reference QCG-3630, dated July 3, 1987).

INTRODUCTION

On July 1, 1987, during a full power run, a crankcase high pressurization event (crankcase explosion) occurred. After engine shutdown, a visual examination identified an overheated piston and cylinder liner at the number 9L location. The piston and piston pin were removed from the engine for further examination and testing.

RESULTS

During disassembly, no loose or stretched bolting was found. This indicated that the piston pin did not actually seize in its bushing, but it could not be moved by hand in the piston. After cutting through the bottom of the piston, the pin was easily removed. A discolored area was observed on a portion of the upper (loaded) surface of the pin. The bluish black color was an obvious sign of an overheated pin. The finish on the pin was smooth, but numerous fine scratches were present. A visual examination of all of the spare pins in the warehouse was performed. All of these (6 or 7) had mirror finishes with very few scratches. Subsequent testing of the overheated pin determined that the actual surface finish was 8-10 RMS, which met the manufacturers requirement of a 12 RMS or better. The surface hardness also met the requirements of RC54 minimum, and chemical analysis met all requirements for AISI 1046 steel.

It was also observed that small (approximately 1/16" max.) black "chips" or debris were inside an oil hole that was drilled through the pin. Chemical analysis of several of these chips identified them as iron based. The chips were not flushed out of the hole because pressurized oil is present on both sides of the hole, resulting in little actual flow from the hole. These chips were most likely left in the hole during manufacture or resulted from debris generated during engine repairs. Regardless, they were much too large to have migrated between the rubbing surfaces of the pin and bushing. This clearance was measured during field assembly as .005" Additional checking of assembly work documents indicated that a requirement to "hand scrape" the bronze bushing to provide a minimum of 80% contact area (blueing check) between the upper pin surface and the upper bushing surface was not performed.

RESULTS (Cont'd.)

This fitting step is required in order to spread out the firing load from what is essentially a line contact developed by the .005" difference in diameters between the pin and bushing. While the .005" is required for oil film thickness and heat removal, the required hole in the hand scraped bushing will not be round, but must be elongated in the direction of piston movement. Thus, the requirement for adequate oil flow clearance combined with at least 80% contact area on the loaded side of the pin and bushing.

The omission of this step resulted in very high pressures between the pin and bushing during each firing stroke while the engine was fully loaded. The fact that the discolored area is not directly at the top of the pin is due to the connecting rod angularity as the piston descends.

Subsequent checks of all other field fitted pin bushings indicated that only the 3B engine, 9L bushing had been omitted from this step.

CONCLUSIONS

The omission of a critical hand scraping step during field assembly of the 9L piston pin to its bushing resulted in higher than intended pressures and friction. The resulting friction raised the temperature of the affected areas above the auto-ignition temperature of the crankcase vapors, resulting in the crankcase overpressurization event.