



BEARING FAILURE ANALYSIS

## Example Type B Report

### Electric Motor Bearing Failure

#### 1. INTRODUCTION

Two 6202 deep groove ball bearings retained at the ends of an electric motor shaft were supplied to us for inspection and report. See Fig 1.



Fig 1.

We understand that the bearings have been in service for only three to four months and that there was a complaint that the long shaft bearing was notchy. On the long shaft we understand that there was a steel impeller installed and that the end user acknowledges that this impeller was out of balance during service.

From information provided we are aware that the Accuracy Grade of the bearing is DIN P0 and that the radial clearance is CN (3  $\mu\text{m}$  to 18  $\mu\text{m}$ )

#### 2. INSPECTION

Prior to disassembly, it was confirmed that the long shaft bearing was indeed notchy.

The rotor was held securely and the fitted radial clearance of the bearings measured. Both bearing produced results of 10  $\mu\text{m}$  to 11  $\mu\text{m}$ , which is the expected range for the CN standard, as previously quoted.

##### 2.1 Long Shaft Bearing

Fig 2 shows the bearing as held on the long shaft. As can be seen, there is heavy bruising and damage on the shaft, it is not clear if this damage was caused during disassembly or present during service. Such damage could manifest itself in terms of out of balance running and vibration if it was present during service.



Fig 2

In order that the bearing could be removed without further damaging the raceways, the shaft was slightly relieved outboard of the bearing, cut 2mm from the inboard side and the centre of the shaft drilled out so that the interference between the bearing and the shaft could be relieved. See Fig 3.



Fig 3

Fig 4 shows the journal surface and the condition of the abutment surface. Both were considered normal with no fretting or rotation evident.



Fig 4

Fig 5 shows the removed bearing. Again no evidence of bore rotation or unusual fitting was noted.



Fig 5

The seal was carefully removed to reveal an ample grease fill inside the bearing. Fig 6 shows a relatively clean grease charge all around bearing cage which is intact and undamaged.



Fig 6

To disassemble the bearing it was necessary to cut the cage at one rivet and to peel the remaining rivets open. With the soft metal cage removed, the balls could be moved to one side and the bearing could be separated into its component parts.

Fig 7 and 8 show the inner ring raceway. It can be clearly seen that there is a slightly darker ring around the centre of the load bearing portion of the raceway. This line suggests a normal tracking with a slight thrust loading from one side. The track is also slightly marked with small crater like indentations. These marks are called pear skinning. This occurs when debris is trapped within the grease and gets rolled and crushed onto the surface of the raceways and balls.

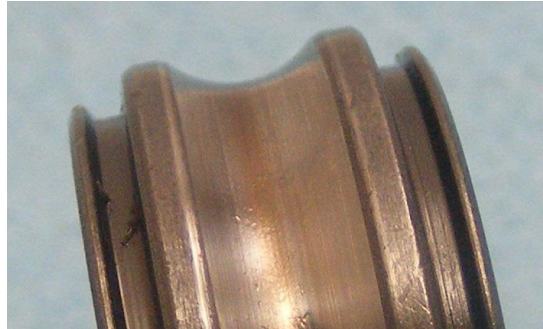


Fig 7



Fig 8

The ball bearings were inspected next. Fig 9 shows one of the slightly discoloured and pear skinned balls.



Fig 9

The discoloration suggests that the ball had been subject to a higher than normal temperature.

Temperature is generally elevated in a bearing with no lubricant(not the case with this bearing) or if the bearing is loaded excessively.

Fig 10 shows the raceway from the outer ring. Once again a darker ball path is seen in the centre of the raceway, however in addition to that there is also an area of fatigue where material has flaked from the surface. Flaking generally occurs when the sub surface stresses have reached a limit and the bearing reaches the end of its useful life.

Flaking of this type will occur at the end of a life cycle but will also occur if higher than designed stresses are imposed on the application during service.



Fig 10

Fig 11 shows a close up of the damaged area, as can be seen material at both ends of the mark are cracking and becoming dislodged. Such an effect is classical in a bearing when an abnormal load is being generated during rotation of the machine.

The metal debris from the damaged area will have mixed with the grease and will have caused the contaminant particles that have resulted in the pear skinning effect.

Although unlikely, a poor heat treatment process could result in the ring being more susceptible to induced stress during rotation.

To check this, hardness tests were undertaken on one side face. Values of approximately 57 to 59 HRC were recorded. This is within the range expected, ruling out poor heat treatment.



Fig 11

## 2.2 Splined Shaft Bearing

The bearing at the splined end was not felt to be notchy, see Fig 12

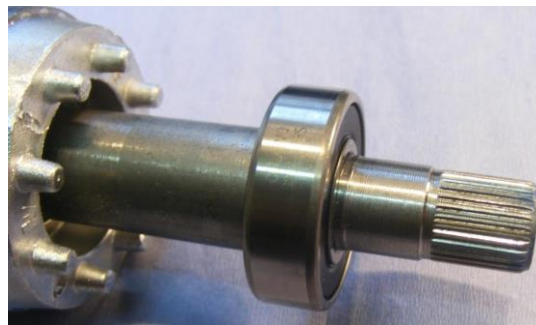


Fig 12

The bearing was not removed from the shaft and was disassembled in situ.

Fig 13 shows the inner raceway with a slightly discoloured contact mark.

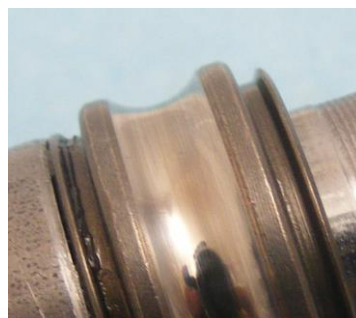


Fig 13

Fig 14 shows the outer ring with a similar contact mark. There was, however no evidence of flaking on this raceway.



Fig 14

Fig 15 shows a ball from this bearing; this ball is considered normal.



Fig 15

### 3 DISCUSSIONS AND CONCLUSIONS

The damage seen on the long shaft bearing is classic in nature and can generally be attributed to either a loss of radial clearance, a loss of lubricant or an abnormal loading condition.

The measured radial clearance prior to disassembly suggests there is no issue with fitting practice and resultant clearance loss.

The bearing is also clearly well lubricated and therefore a loss of lubricant fill can be discounted.

The hardness of the steel is also within the expected range, further discounting a material or process problem.

Even without the statement that the rotor had been running with an out of balance impeller we would have concluded that the bearing had been subject to some abnormal loading.

Out of balance forces can impose well over 50% to 100% more load on a bearing. This additional loading will have a cube effect on the reduction of service life, thus reducing bearing life dramatically.