

Using Acceleration Enveloping on Sleeve Bearings

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Introduction

SKF has a long history of using enveloping as part of a multi-parameter condition monitoring approach. The multi-parameter approach typically includes vibration velocity, acceleration and enveloped acceleration measurements, along with temperature measurements. Traditionally, enveloped acceleration measurements are performed on rolling element bearings, gearboxes and other components that tend to generate impulsive type fault signals.

Sleeve bearings have not typically fallen into this category, and vibration monitoring on machinery using these types of bearings normally employs non-contact eddy current probes, especially in the machinery protection arena.

However, Dragan Trivanovic, a Senior Reliability Engineer with Teckcominco, has experienced cases where he successfully detected failed sleeve bearings prior to what would have been a catastrophic failure using a CMVA 60 SKF Microlog and enveloped acceleration measurements.

For detection purposes, enveloping filter Band 3 was employed for almost all of the measurements, using 1 600 lines of resolution and an F_{max} of 100 kCPM. Upon detection, if a measurement started to indicate a developing problem, then analysis would continue with higher resolution measurements.

This Application Note will present two of the four cases that Dragan has submitted for this study. In the first case, a failed sleeve bearing was detected on an absorption fan, and with the second case, a failed sleeve bearing was detected on a bypass fan.



Figure 1. The SKF Microlog CMVA 60 portable data collector / analyzer.

Case 1: absorption fan bearing failure

This case involved an absorption fan driven by a 1 250 HP motor. The variable speed motor drives 87 × 26 in. fan runners on 4-7/16 in. shaft Dodge sleeve bearings. Operating speed is typically 940 RPM.

Fig. 2 shows the fan's enveloped acceleration waterfall spectrum. We observe signs of looseness indicated by 1/2X harmonics. The drive end bearing was indeed damaged and was replaced after the 12/1/2002 measurement.

Vibration velocity and temperature were also measured. The velocity readings did not indicate any bearing problems, although there was a slightly elevated 1X. Engineering suspected that there was dirt on the runners.

The temperature trend on the failed bearing never reached alarm setpoints. In fact, temperature values remained relatively stable throughout the entire period shown in the waterfall spectrum. The bearing probably would have been lost completely if only temperature readings were used.

In **fig. 3** and **fig. 4**, the pictures illustrate the damaged bearing and the scraping damage to the shaft.

As seen in the pictures, both the bearing and the shaft were damaged. The bearing wear was 8 mils and the shaft wear was 12 mils. In this case, sanding the shaft down using 600 grade sandpaper and scraping the bearing allowed both to be salvaged, and took only six hours to perform. Had this bearing completely failed, the estimated downtime would have been seven days and would have resulted in more than \$700 000 USD in lost revenue.

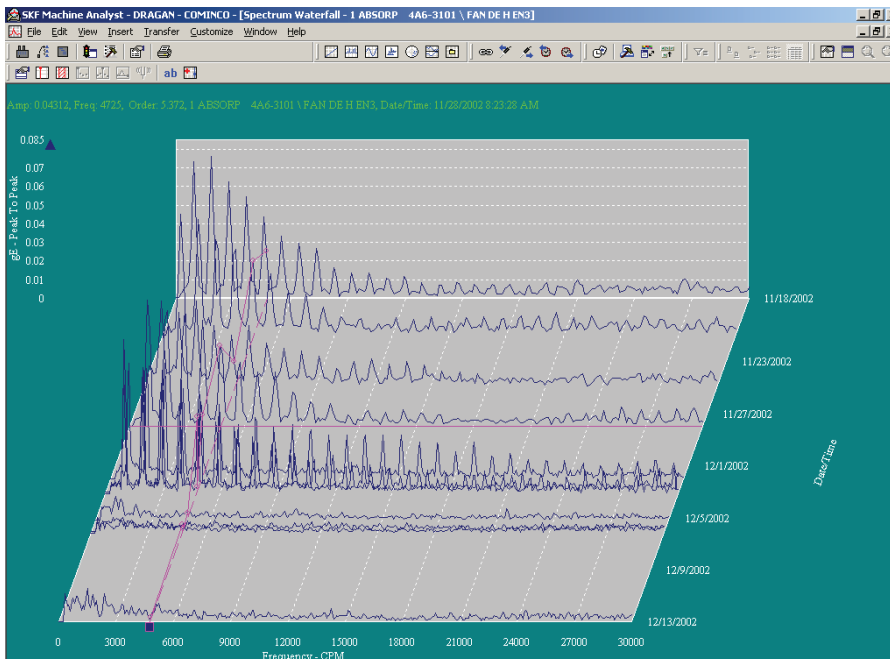


Figure 2. Absorption fan enveloped acceleration waterfall plot.



Figure 3. Absorption fan, bearing damage.

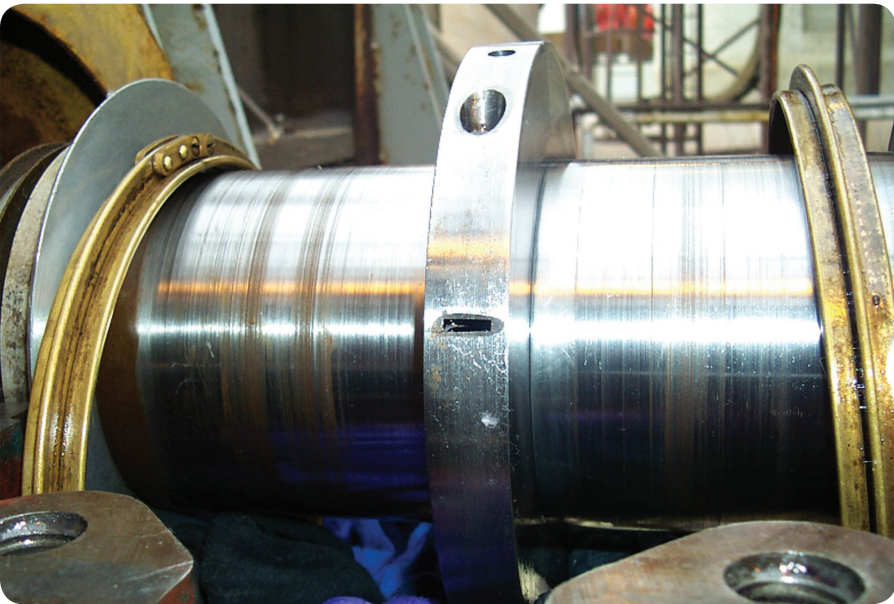


Figure 4. Absorption fan, shaft damage.

Case 2: bypass fan bearing failure

This case involves a bypass fan driven by a 600 HP, 1 798 RPM motor. The variable speed clutch drives a Sheldon fan with 50 × 18 in. runners on 3-7/16 × 100 in. shaft. Dodge sleeve bearings were being used, and typical operating speeds were between 450 to 800 RPM.

Fig. 5 shows the enveloped acceleration measurement's overall trend, with some relatively high readings going in and out of alert. The last two readings were taken before and after the bearing was replaced. The day before the bearing was replaced, the value was about 2,3 gE, which dropped to 0,4296 gE after the bearing was replaced.

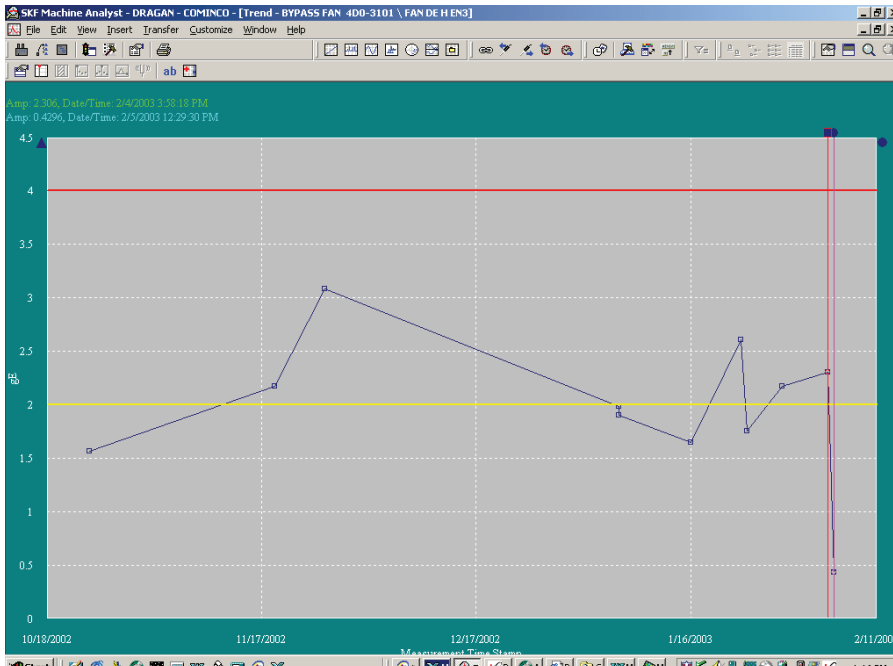


Figure 5. Bypass fan, enveloped acceleration overall trend.

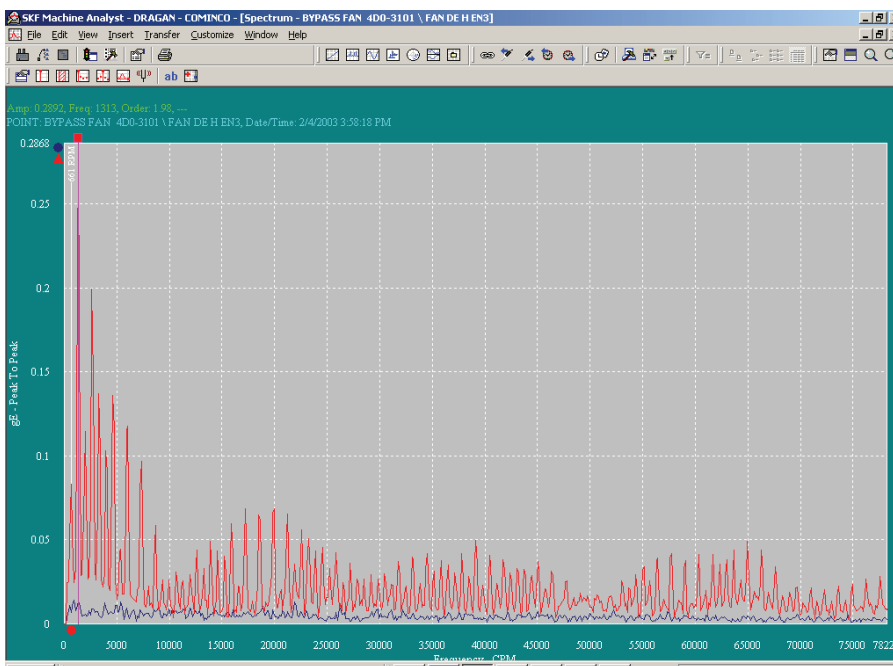


Figure 6. Bypass fan, overlaid enveloped acceleration spectra for last two measurements.

Fig. 6 shows the overlaid spectra of the last two readings: one before (shown in red), and one after bearing replacement. The red spectrum shows signs of looseness, with 2X being the highest peak, which was caused by shaft movement due to wear.

As with the previous case, the velocity trend did not show much. However, the velocity spectrum did have some activity (→fig. 7 and fig. 8). The velocity spectrum has high peaks that belong to motor speed and 1X, 2X and 3X components caused by misalignment. Fan speed harmonics (660 RPM), shown in red, are very low in the velocity spectrum.

In addition to collecting vibration data with the SKF Microlog, a Foxboro DCS was monitoring velocity and temperature readings. However, the trends shown in the DCS were flat and did not indicate any problems.

In **fig. 9**, the left part of the trend shows the velocity readings before the bearing was replaced, and the far right side shows the readings after the bearing was replaced. The spikes created between the two were created during the repair.

An interesting observation is that the far right part of the trend actually shows higher velocity readings than before the bearing was replaced. This is because the new bearing was installed on the same damaged shaft. It turns out that the shaft was worn by 22 mils, and to replace it would have been a four day job. It was decided that we should wait until the next planned shut down to make repairs, and in the meantime investigate the feasibility of performing a repair “in place” using a Belzona or similar product instead of replacing the entire shaft.

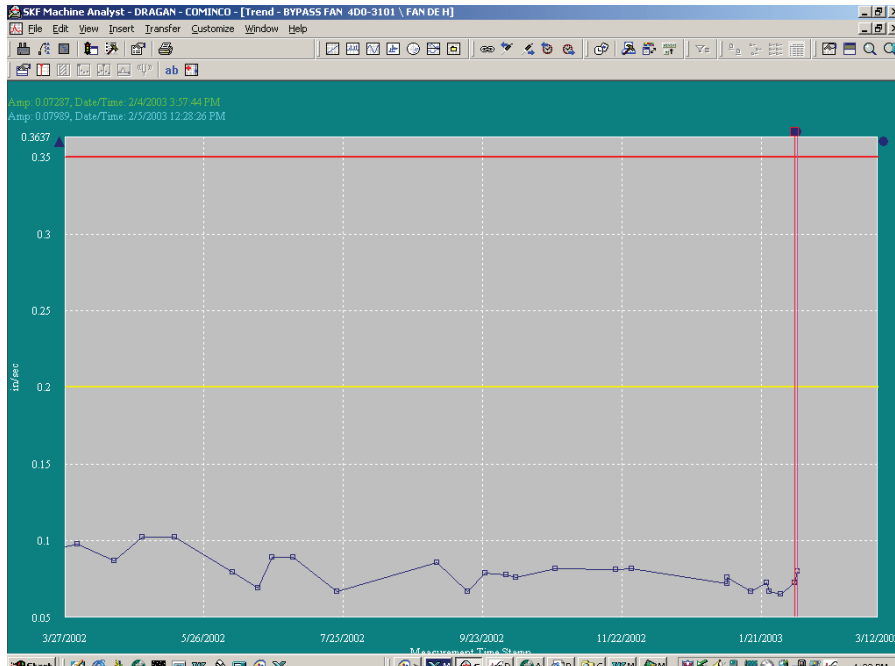


Figure 7. Bypass fan, velocity trend.

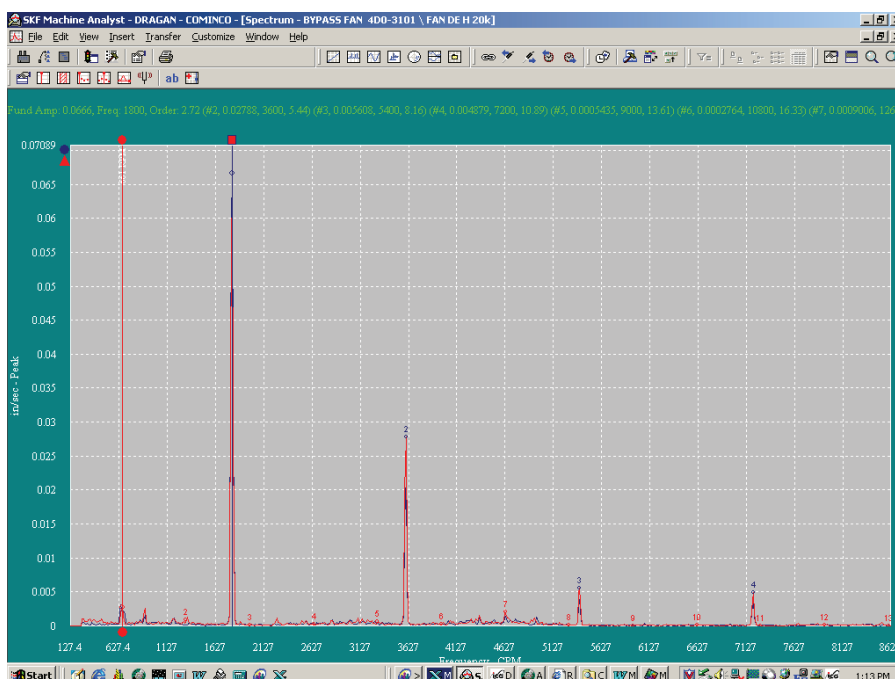


Figure 8. Bypass fan, velocity spectrum.

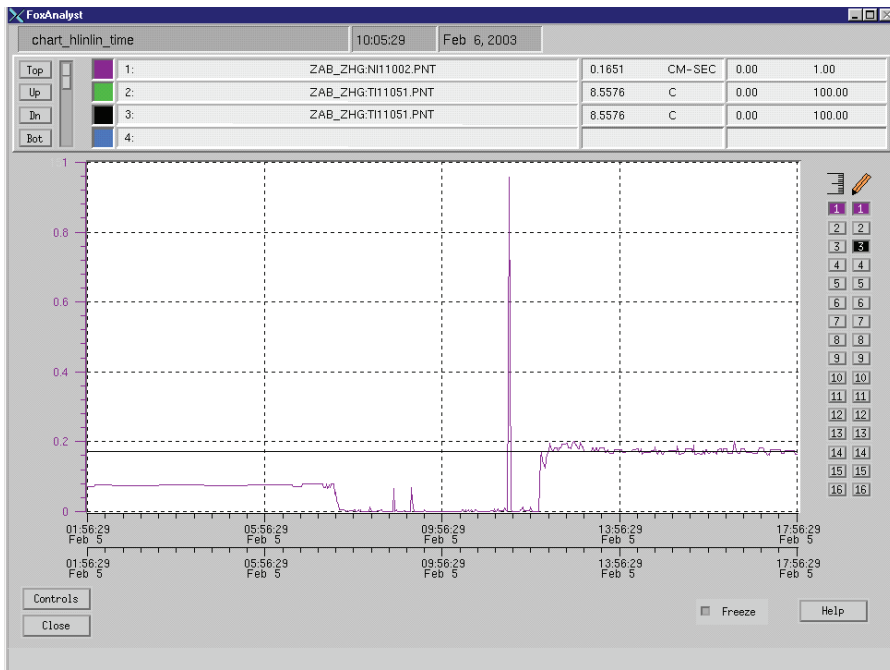


Figure 9. Bypass fan, DCS trend.

Conclusion

Since the shaft and sleeve bearings were repaired, both the machines and the bearings have run without incident. In the case of the bypass fan, the sleeve bearing was replaced with a rolling element bearing.

Although seldom used in sleeve bearing applications, enveloped acceleration measurements have proven to be a useful tool for early detection of sleeve bearing equipment problems. In this case, metal-to-metal contact provided a clear indication of a problem. From an economic standpoint, the case studies show that catastrophic and unplanned shutdowns were diverted, saving both time and money, and minimizing the risk to safety.

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