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# THRILL RIDE

**Bearing reliability  
keeps big wheel turning**

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# THRILL RIDE

## Bearing reliability keeps **big wheel** turning

BY MIKE G. BARNETT



**H** **heavy loading, extremely slow rotation, remoteness and constant exposure to the wind and rain create special problems for the bearings of a large Ferris wheel at Chicago's Navy Pier Amusement Complex.** A preventive maintenance (PM) and predictive maintenance (PdM) program deals with these problems and gives peace of mind to the wheel's operators.

The Ferris wheel is the Navy Pier's centerpiece attraction and can be seen from miles away. It's hard not to notice a big, slowly rotating wheel, two supporting pylon structures and two rather large bearings. Now take another look. The bearings are 75 feet off the ground, reached by climbing a ladder, and both are fully exposed to the prevailing winds and inclement outdoor weather.

A visual inspection isn't possible because the bearing housing can't be removed without disassembly of the wheel. In addition to the bare weight of the wheel structure, the 440-mm diameter axle transmits to the bearings the additional load of passenger cars (each holding several people), and the wheel rotates at just one revolution every seven and a half minutes.

**ABOVE:** The wheel's bearings can only be reached by climbing a ladder to a platform located 75 feet off the ground.

**LEFT:** Sensors attached to the wheel's bearings send vibration data to an SKF Microlog, where it's collected and analyzed.

PHOTOS: SKF/MINNETT MEDIA

## Preventing bearing failure

A worst-case scenario for the Navy Pier maintenance team is a bearing failure. This means that complete disassembly of the Ferris wheel would put the ride out of action for three to four months. As a result, having a well-maintained wheel is of paramount importance to the team.

The team's goal is to prevent breakdown and equipment downtime. They keep on top of repair and maintenance needs and schedule them into planned stoppages. It's this awareness that has kept the two spherical-roller bearings in good working order since they were first installed in 1995.

After five years of trouble-free bearing operation, however, the Navy Pier maintenance team decided in 2000 it needed to use a PM and PdM program. Turning to SKF Reliability Systems for help, the Navy Pier maintainers wanted to ensure longer possible bearing life and implement a future timetable for the repair or replacement of the bearings.

## Vibration testing

After a detailed inspection of the Ferris wheel, SKF suggested a PM and PdM program be used that was based on routine vibration testing and grease analysis. For vibration testing, two 500 millivolt per G accelerometers were permanently attached to each bearing housing. The arrangement on the bearings was the same—one accelerator in the horizontal direction and the other vertical.

Wires were attached to the accelerometers by a Navy Pier technician and lowered to the ground where they were plugged into a portable SKF CMV60 Microlog data collector/analyzer. Having the accelerometers mounted permanently rather than magnetically gave an improved dynamic range, which enabled the collected data to be analyzed by SKF technicians.

To do this, they used waveform analysis—a special method necessary for slow-speed equipment. Most industrial machinery rotates at high speed, which makes it much easier to analyze using spectrum or amplitude/frequency methods.

*During the first visit to the Ferris wheel, vibration readings indicated that something was causing wear on the bearing raceways.*

Because the Ferris wheel rotates so slowly, the analysis was made at just one revolution per minute. In this situation, the defect signal has to go through the bearing materials to the outer housing. This causes the signal to dissipate. Waveform analysis made it possible to check the vibration data, despite the fainter signal.

Impending failure is detected by monitoring the vibration signatures over a period of time. The analysis will identify frequencies that match known bearing defect signatures. For example, if a frequency in the vibration spectrum should match that of an outer-race-defect-frequency, the outer race of the bearing may be damaged.

## Grease sampling

As part of the PM and PdM program, the vibration testing procedure is carried out three times annually. During each visit, the SKF technician also obtains a sample of grease from the bearings. The samples are sent to a specialist laboratory for analysis. In the laboratory, the sample is tested for wear particles where each particle found is identified and the quantity determined.



**The size and location of the bearing makes maintenance planning an absolute necessity for the Navy Pier team. If bearing replacement is eventually needed, the wheel must be disassembled. This puts it out of operation for several months.**

In addition, an analytical ferrography test is conducted where the size of the particle is determined and photographed. A surprising feature of this analysis is how much it can reveal about what's happening with the bearing. Often, it confirms what the SKF technician has found with the vibration testing.

During the first visit to the Ferris wheel, vibration readings indicated that something was causing wear on the bearing raceways. An SKF specialist climbed the ladder to inspect the bearing by means of a "hand-analysis scratch test." A metal probe was inserted into the bearing housing. By rubbing it across the raceway, the specialist was able to determine the extent of wear.

He found that small particles had been blown into the bearing by the gusty winds off Lake Michigan. This was confirmed by the grease analysis, which showed a high ferrous content. Bits of debris get into the bearing, and when the rollers go over the particles, it causes dents in the outer ring. The grease analysis supported the vibration analysis.

Since the first visit, further grease sampling and analysis revealed a number of other small issues. For example, elevated water content and high copper content were detected during one visit. This indicated the possibility of minor cage wear. Any worn seals are now quickly repaired or replaced to keep wear to a minimum.

Recent visits by SKF specialists have shown that the bearings are experiencing normal wear and give every indication that they will exceed their life expectancy. Navy Pier operators can now feel more confident when they switch on the Ferris wheel and its 16,000 lights. When you're next in Chicago, buy a ticket and go for a thrilling ride. You will have a must-see view of the city and Lake Michigan. **PEM**

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