Technology. Creativity. Fun.

Volume 3 Issue 9

Entertainment Engineering

GIANT FERRIS WHEEL

relies on proactive maintenance

Home Makeover's Eclectic Chair

Tape-Less Broadcasting

Giant Ferris Wheel Relies on Proactive Maintenance

Park management turns to SKF Reliability Systems for its expertise in providing early maintenance on the biggest tourist attraction in Chicago — the Navy Pier Ferris Wheel.

Worker ascending wheel for maintenance.

The Navy Pier® Ferris wheel (presented by McDonald's) is literally the biggest tourist attraction in Chicago. It stands as the centerpiece of the Navy Pier entertainment complex that draws more than 8.5 million visitors a year. From a vantage point 15 stories above the ground at the wheel's top, riders in 40 passenger gondolas, capable of holding six people in each gondola, can enjoy spectacular views of Lake Michigan and the Chicago skyline.

The view is a bit different for the wheel's maintenance team. The wheel (like the Pier) operates year-round and rotates 363 days per year and is occupied by visitors weather permitting. Proactive maintenance is essential to minimize the impact from a potential shutdown on Navy Pier operations and dollars. "Keeping the wheel operating and well-maintained is imperative for us," confirms Mike Kenny, Navy Pier Director of Maintenance and Operations. "It's important that we get a handle on what repair and maintenance procedures are required to allow them to be scheduled to ensure ride reliability, minimize downtime and be cost effective."

Aerial view of Navy Pier.

A case in point: the wheel's bearings. The wheel operates with two SKF® spherical roller bearings installed at the time of its construction in 1995. If bearing replacement were ever required, the necessary disassembly of the wheel would sideline the attraction for months.

Aiming to gain the longest possible bearing life and provide an accurate view on the future timetable for repair or replacement, Navy Pier turned to SKF Reliability Systems for an ongoing predictive/preventive maintenance program. Key technologies in play include SKF vibration testing and grease analysis, providing "early indicators" of possible problems for remedial action.

Getting Access

Many machinery problems manifest as vibration, which is widely considered the best operating parameter to judge a machine's condition. Vibration can detect machine fault conditions such as unbalance, misalignment, oil film bearing instabilities, bearing degradation, mechanical looseness, structural resonance, soft foundation, misalignment, rotor bow, and cracked rotors, as well as many other fault conditions. Vibration measurements are also quick and fairly non-intrusive since the operating equipment is undisturbed.

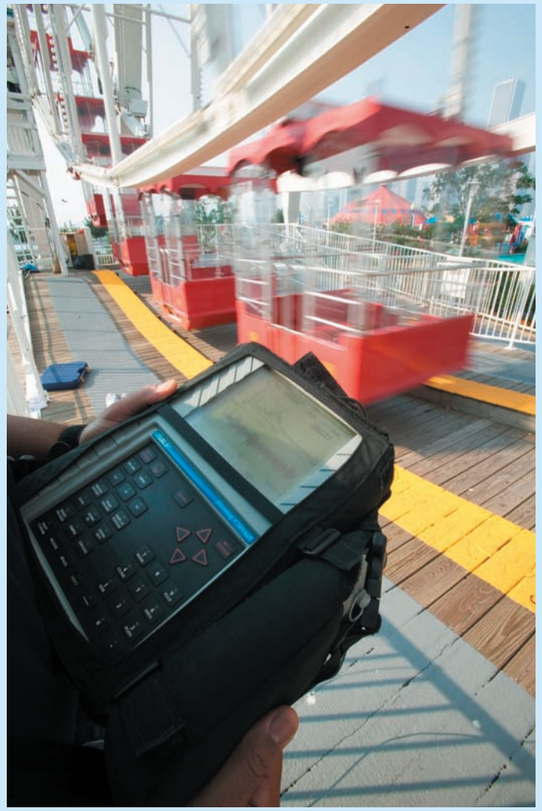
For the Navy Pier Ferris wheel, a daunting challenge arose at the outset relating to access to the out-of-the-way bearings for vibration testing. Located 75 feet off the ground, the bearings can only be reached by climbing a ladder to a platform next to the housing at the center of the wheel. And a visual inspection was immediately ruled out, because the bearing housing cannot be removed without disassembling the wheel.

The SKF solution: Attach two 500-millivolt per G accelerometers to each bearing. Once a year, Navy Pier maintenance professionals climb the tower and attach wires to the sensors. The wires run down to the ground, where they are connected to an SKF Microlog® portable data collector/analyzer. The collected vibration-testing data then is evaluated by SKF technicians using waveform analysis. This is a method developed for slow-speed machinery and ideally suited for a wheel that takes 7 1/2 minutes to make one revolution.

According to Mike Barnett, SKF Reliability Maintenance Specialist, most industrial machinery rotates at very high RPMs and the analysis can be performed with easier-to-analyze spectrum or amplitude/frequency methods. This situation suggested the need for a different analysis approach. "The Navy Pier Ferris wheel has an extremely slow rotation," he adds. "We did the analysis at just 1 RPM. In this case the defect signal has to go through the bearing materials to the outer housing and that causes the signal to dissipate. Waveform analysis enables us to evaluate the vibration data, despite a fainter signal."

Portable data collectors/analyzers have evolved into sophisticated instruments with the capability to collect and store machinery vibration data over a broad and

Maintenance workers at the wheel's hub.



An SKF Microlog® portable data collector, which collects vibration data from sensors attached to the Ferris Wheel's bearings.

high frequency range (typically up to 20 kHz.) and display high resolution FFT frequency spectra and time domain waveforms on an LCD screen. Collected vibration measurements can be analyzed on the spot or downloaded to a host computer's database management program for analysis and long term trending. Portable data collectors/analyzers can be used both to detect vibration problems and diagnose specific machinery faults.

During each predictive/preventive maintenance site visit in Chicago, SKF technicians further obtain grease samples, which are sent to a special lab for study. "The grease can tell us much about what's happening with the bearing," Barnett reports. "Sometimes it calls our attention to a new problem and other times it corroborates the conclusions we reach through our vibration analysis."

Early Diagnosis

The first round of tests at the wheel underscored how vibration and grease analysis can serve as predictors of potential problems. Technicians found that vibration readings indicated wear on the bearing raceways. An SKF specialist was dispatched up the ladder to inspect the bearing using a "hand analysis scratch test." A metal probe was inserted into the bearing housing and, by rubbing it across the raceway, the extent of the wear could be determined.

The cause was found to be small particles, most likely blown into the bearing by the windy Lake Michigan environment. A grease analysis confirmed the diagnosis, showing a high ferrous content. "Bits of debris get into the bearing and, when the rollers go over the particles, dents form in the outer ring," Barnett says. "The grease analysis supported the vibration analysis."

Over the years at the wheel, SKF grease analyses have pinpointed other small issues, including an elevated water content resulting from environmental factors and a high copper content, possibly indicating minor bearing cage wear. Each time, a grease sample is taken and grease is added, if necessary. Additionally, worn seals are repaired or replaced and other preventive measures are taken to keep wear to a minimum.

These larger robust bearings (bore sizes greater than 17 in.) are designed with two rows of symmetrical rollers with a common sphered raceway in the outer ring. The inner ring has retaining flanges and the two inner ring raceways are inclined at an angle to the bearing axis. These types of bearings are self-aligning and can accommodate radial loads and axial loads acting in both directions to promote very high load-carrying capacity. Self-guiding rollers reduce friction and minimize heat generation.

All the predictive analysis work performed so far indicates that the wheel's bearings are experiencing normal wear, according to Barnett. "That's really what predictive maintenance is all about," he observes. "It allows the operator to maintain an awareness of where things stand and properly plan for and schedule repair or replacement downtime with minimal interruption."

From the perspectives of Kenny and Navy Pier, the SKF predictive/preventive maintenance program has contributed to peace of mind. "The ability to know exactly how the wheel's bearings are performing and to have the data necessary to properly plan for maintenance is critical for us."

Footnote: **The SKF bearings have been in continuous service since the wheel was installed at the Navy Pier more than a decade ago.**

For More Information:

SKF Home: http://www.skfusa.com
SKF Products: http://www.skf.com/portal/skf_us/home/products?contentId=056001&lang=en
SKF Applications: http://www.skf.com/portal/skf_us/home/applications?contentId=055994&lang=en
SKF Services: http://www.skf.com/portal/skf_us/home/services?contentId=056002&lang=en