Selecting the right drivetrain inspection technology

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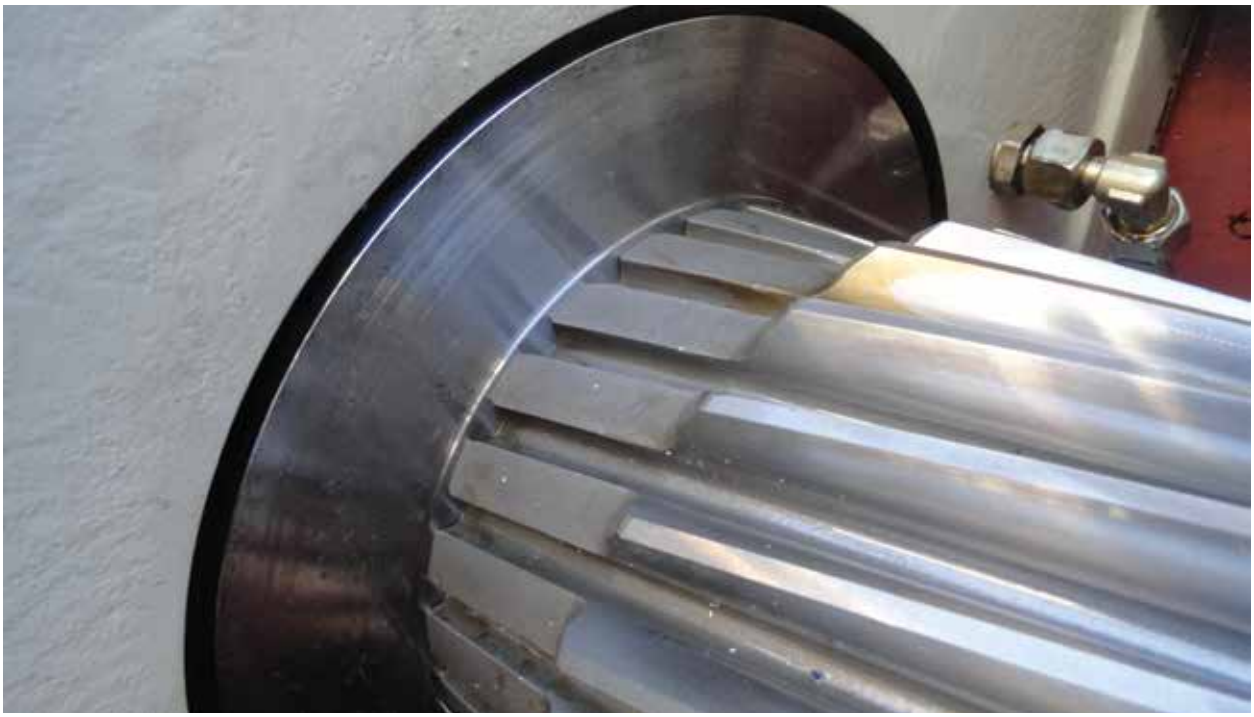


Vibration frequency analysis can be a powerful tool for diagnosing mechanical and electrical problems in wind turbine drive trains. However, it seems that some people are still skeptical about the accuracy of the technology. Perhaps those people have had bad experiences with vibration analysis in the past. Poor vibration analysis could yield false positives or worse, missing damage in a major component entirely. To avoid this situation some wind farm owners may rather perform a visual inspection via a bore scope camera. However, turbine owners may not realize that bore scope inspections have many limitations of their own. This article will review the two inspection types: vibration analysis and bore scope inspections.

Bore scope inspections have long been the go-to inspection technology for determining gearbox problems in the wind industry. Its biggest advantage is being able to capture pictures, which offer indisputable evidence of damage. However, these visual inspections are not cheap. Typically, if you are performing a full visual inspection of a gearbox it will take around six to eight hours to complete. Since there would need to be two technicians in the tower, this equals 12 to 16 labor hours that need to be compensated. Teams that gather vibration data need about two hours to complete their work, equaling a total of four man-hours. This option saves money and allows the vibration team to gather data from multiple towers in a day. The camera used with bore scope inspections has limited access to certain components. Depending on the gearbox type, a bore scope camera can generally only access around 90 percent of the gear teeth and only 30–40 percent of the bearing races and rollers. There are multiple reasons why gearbox bearings are difficult or not possible to inspect. Some of these reasons include:

- An oil dam plate could be installed in front of the bearing
- The bearing's cage is too close to the bearing race to allow camera access
- The bearing rollers are small and too close together for the camera to fit in-between
- The bearing is completely sealed off
- Large gears sit in front of the bearing, making it difficult to access

With vibration analysis, all gear teeth and bearings can be examined since it records the frequencies generated by all moving contact surfaces. This allows a more thorough inspection in about 30 percent of the time.

Borescope inspections on the generator and main bearings are not always

Photo taken during the up-tower gearbox repair to replace the intermediate speed shaft bearings.

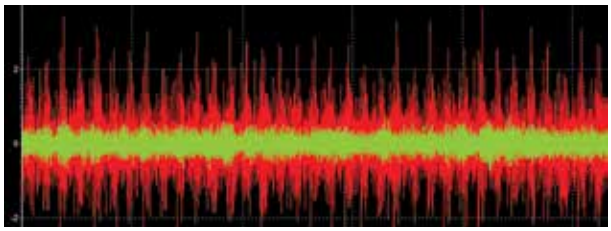
A picture of the damaged rotor side intermediate bearing inner race.

possible. Generator bearings and main bearings are usually packed with grease, and the bearing surfaces cannot be seen in this condition. Vibration analysis can easily pick up bearing fault frequencies in these components while also detecting other problems which cannot be detected during a visual inspection. These defects include blade unbalance, coupling misalignment, generator looseness, generator frame damage, generator stator and rotor electrical problems, and more.

While not dismissing the value of bore scope inspections, we highly recommend contacting Availon. Our engineers and technicians have vast experience in both—borescope inspections and vibration analysis—and can suggest the right technology for your particular application.

For example, we would recommend using the vibration analysis technology during End of Warranty inspections or when inspecting major components suspected to be damaged. Recently, Availon was contracted to perform end-of-warranty inspections on a wind farm of Vestas V80-1.8 MW turbines. As part of the scope of the inspection, vibration data was gathered from the wind turbine's drive train. During the analysis of the data it was found that one of the turbines had a large defect located on the inner race of the intermediate speed rotor side bearing in the gearbox. A bore scope inspection was attempted and an oil dam plate installed in front of the bearing prevented the inspectors from being able to access the inner race.

Although the bearing could not be visually inspected, the vibration data was enough evidence to claim the gearbox under the OEM's warranty. Shortly after finding the defective bearing an up-tower repair was ordered to replace the bearings on the intermediate speed shaft. During the gearbox repair the rotor side intermediate speed bearing was removed and the inner race found to be in very poor condition, just as the vibration analysis



Vibration waveform showing the intermediate speed bearing damage. The green signal shows the signal recorded from a good bearing. The red signal was recorded from the damaged bearing.

indicated. After two days the repair process was complete and the turbine returned to normal operation.

Due to the swiftness and accuracy of the vibration analysis, the owner of the wind farm was able to get a thorough drivetrain inspection at a low cost. If the owner had chosen to perform site-wide borescope inspections then the inspection cost would have been much higher and the damage bearing mentioned above would not have been found.

Let's be clear: This does not mean that there is no place for bore scope inspections. The most effective inspections are when vibration analysis and bore scope inspections are used together. The vibration analysis can be used to quickly locate and identify the problem while the bore scope can be used to gather visual evidence of the damage. This process is the perfect formula to get the most thorough inspection for the most economical price.

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