

## How to prevent equipment failures

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**WHEN equipment fails, often the biggest concern is how to get it running again. However, equally important is discovering the cause and how that can be prevented in the future. Often, managers and their employees are ill equipped to identify the cause, ultimately leading to a recurrence.**

Preventive maintenance is defined as the regular performance of equipment maintenance practices in order to avoid future equipment problems.

An important first step in any preventive maintenance program is learning to identify the causes of equipment failure. By providing managers and service technicians with the knowledge to identify causes of gearbox failure (a crucial link in the power transmission chain), they can establish an effective preventive maintenance program.

### Analyzing problems

Effective lubrication is extremely critical to all gearboxes and will help prevent gear and bearing failures. Many gear and bearing failures result from insufficient or interrupted lubrication.

Maintaining proper lubrication includes using the appropriate lubricant, keeping oil clean and free of foreign materials, and maintaining a sufficient supply of lubricant.

Since selecting a lubricant is based on many independent factors including gear type, load type, speed, operating temperatures, input power and reduction ratio – choosing a lubricant should be left up to a gear lubrication specialist. This is especially true considering the technical sophistication found in gearing today, along with increased speeds and loads, and the specialized lubricants and additives now available.

When lubrication problems occur, they can cause several gear problems. Failures, like scoring and galling, are generally caused by oil film breakdown resulting in metal-to-metal contact, and high temperatures resulting in tooth surface damage.

If a gear continues to operate without adequate lubrication, damage will progress until the gear's tooth profiles are degraded to the point where replacement is the only remedy. Further, foreign materials present in the lubricant can cause abrasive wear.

Maintenance professionals have several important tools at their disposal for diagnosing gearbox lubrication problems, including oil analysis. By analyzing particulate content and concentration in the oil, engineers are able to monitor the condition of an operating gearbox. Further analysis of the oil yields vital information about the condition of the lubricant used in the equipment.

Analysis of the oil used for lubrication could alert engineers to possible problems within the lubrication system.

Lubrication problems can also be detected by examining wear patterns on gears.

Gear tooth "pitting" is characterized by a large number of very small pits, distributed evenly over the working surface of a gear. The appearance of such pitting is usually an indication of gear overload, but may also be indicative of lubrication problems caused either by some corrosive medium within a lubricant or by improper lubricant additives.

Vibration – the motion of a body about a reference point caused by an undesirable mechanical force – is another key indicator in the diagnosis of machine faults. Each machine fault generates a specific vibration profile, and a single vibration measurement provides information concerning multiple components. The frequency of the vibration is determined by the machine geometry and operating speed.

By analyzing shaft vibration, engineers are able to determine whether the cause of the machine fault is imbalance, misalignment, general looseness or wear, bearing defects, gear defects or some other unforeseen problem.

Imbalance is the force created by a rotating body when its center of mass is offset from its center of rotation. Imbalance can cause other faults to appear. Misalignment is the deviation from a common centerline during operation and can occur as offset (shafts are meeting square, but not on a centerline), angular (shafts are meeting at an angle from one another) or both.

Gear damage caused by misalignment is visible as a fracture originating at one end of a gear tooth, occurring on a diagonal line. Misalignment is also a common cause of broken teeth on helical and bevel gears.

Wear is another fault determined by vibration analysis and can cover a broader range of gear damage – from scoring and galling to abrasive wear to plastic yielding.

Left alone, any of these machine faults can do enough damage to necessitate shutting down a process, making a shaft vibration analysis even more important.

### Establishing a preventative maintenance program

While identifying the cause of equipment failure can sometimes be as simple as looking closely at the damage, discovering the root cause of such a problem is often considerably more difficult.

Most mines do not have the sophisticated equipment needed to identify shaft vibration anomalies or analyze oil samples for foreign materials. Without these resources, how then can they establish a preventive maintenance program?

Outsourcing preventive maintenance functions to an outside service provider is certainly an option. Outsourcing these duties allows mines to focus on their own core competencies, letting experts, with access to both a strong knowledge base and a wide range of necessary equipment, handle maintenance and repair duties.

When selecting a preventive maintenance provider, several key services should be included in any agreement. Any agreement should cover breakdowns, scheduled maintenance, parts reconditioning, service upgrades, reverse engineering, alignment and balancing, and on- or off-site diagnostic services. Providers should be thoroughly skilled in performing gearbox failure root cause analysis.

Troubleshooting is another necessary service, as part of a comprehensive preventive maintenance program. Such troubleshooting duties include engineering assistance in the identification, and swift resolution of operational problems. Other important services that were covered previously include vibration and oil analysis.

These two monitoring techniques are paramount in identifying equipment anomalies before they become a problem.

Any good preventive maintenance contract should include a strong warranty on all equipment serviced.

Such warranties often offer many of the services already mentioned, and are ultimately a benefit to the refurbished equipment. Also, as important as any warranty is the proper installation of a gearbox, which can assure years of trouble-free operation, if adequate preventive maintenance procedures are performed.

While identifying the cause of equipment failure is only the first step in establishing an overall preventive maintenance program, it is an important step. The information gathered will ultimately serve as the foundation for planning future preventive maintenance – a particular necessity when working with critical equipment. Such information will also help service technicians avoid making the same mistakes after initial equipment repairs.

– By Philadelphia Gear vice president of engineering Jules DeBaecke

