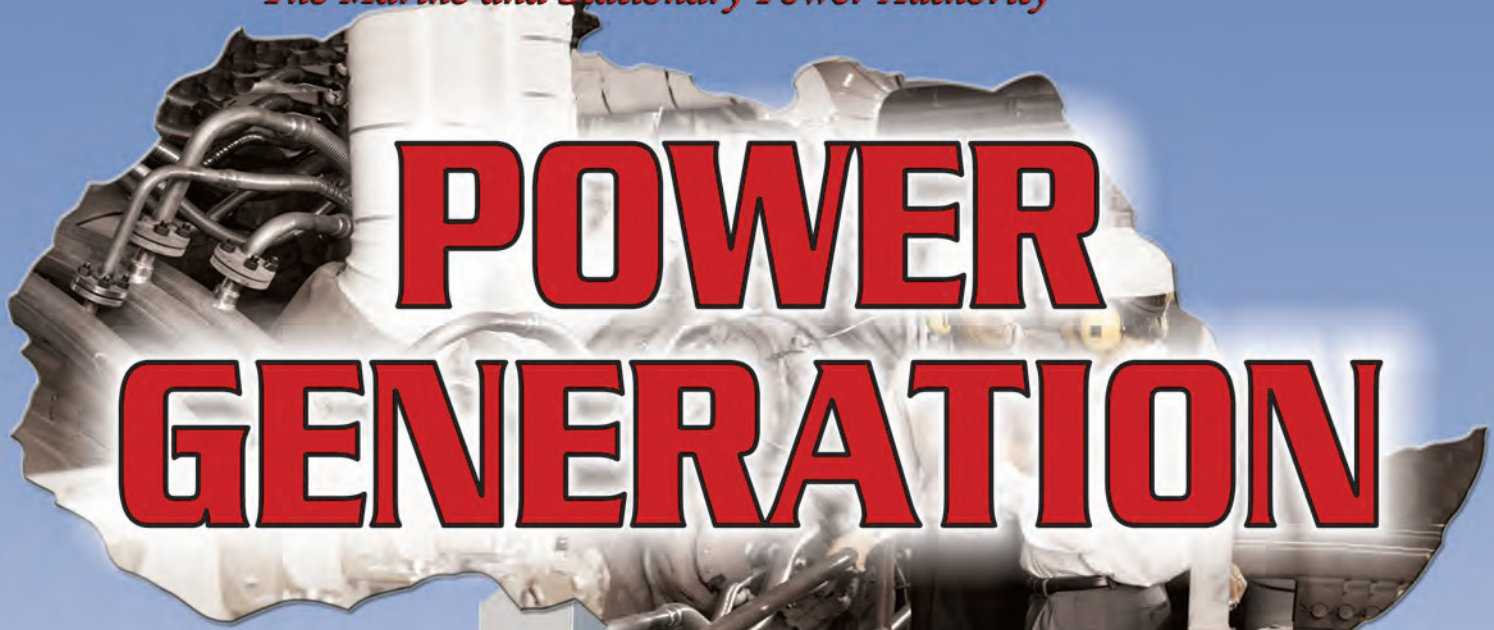
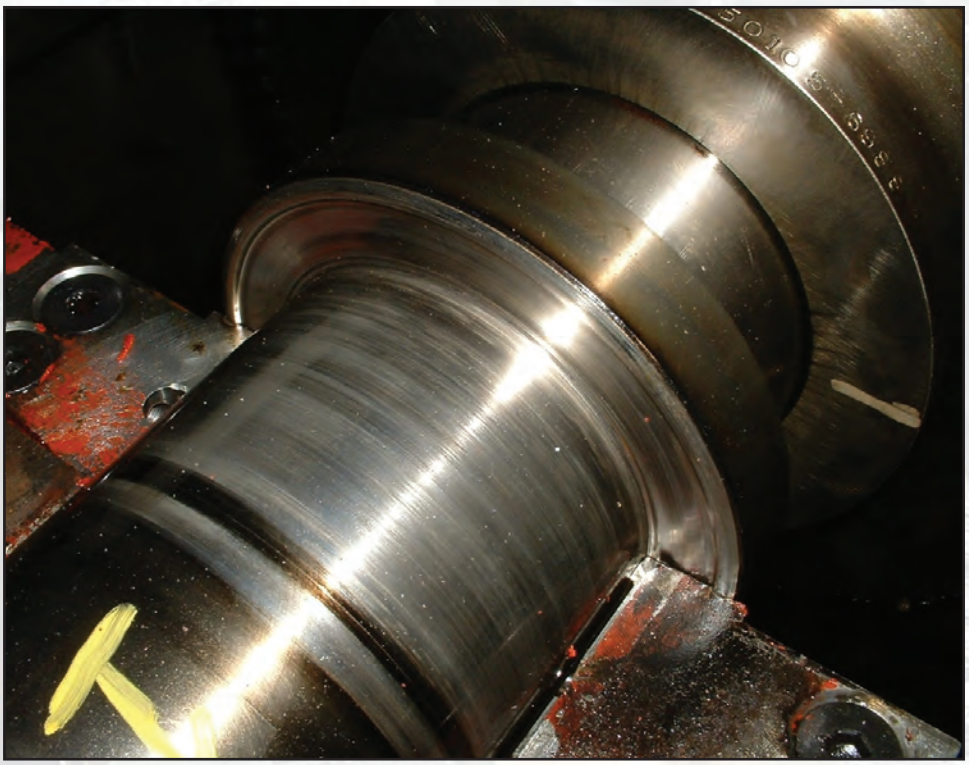
DIESEL & GAS TURBINE WORLDWIDE

The Marine and Stationary Power Authority



POWER GENERATION

BY DAN VNUK



Proper maintenance and periodic inspection are important to preventing a power plant's mission critical components such as gearboxes from failing. Shown is a damaged No. 1 shaft thrust collar on an accessory gearbox. To prevent this type of failure, axial movement checks are part of the plant's preventive maintenance.

Maintaining Mission Critical Equipment

Highly engineered, expertly machined and typically very expensive, gearboxes are among the many workhorses in modern power plants that are robustly built to run hard and go the distance, until they fail. When equipment fails, a plant manager's first concern is getting it back into service. After it is back online, the next concern should be why the equipment failed and how failures can be prevented in the future. To prevent disastrous downtime, gearboxes are designed to be easily inspected. And, through proper maintenance they can be kept running for years to come.

Although technically sophisticated, identifying the cause of a gearbox failure can be as simple as looking closely at the damage. However, uncovering the underlying factors of why it failed and how to prevent future failures is often considerably more difficult. Some power plants have neither the sophisticated equipment needed to identify vibration, excessive wear or other issues, nor are they able to analyze oil samples on-site. While other plants may have the equipment and expertise, maintenance personnel often do not have the time to perform preventive maintenance tasks due to other, more pressing issues. In either situation the cause of gearbox failures is not identified, ultimately leading to their recurrence.

The best course of action may be to contract with an outside service provider to provide gearbox preventive maintenance services. By outsourcing these duties, power plants can focus on their core competencies and let the experts — with access to both a strong knowledge base and a wide range of necessary equipment — handle maintenance and repair duties.

Philadelphia Gear, a privately owned company headquartered in King of Prussia, Pennsylvania, U.S.A., was founded over a century ago to provide expertise in power gear engineering and manufacturing of gear drives. Several years ago, Philadelphia Gear expanded its business model to better serve the power industry with the acquisition of WesTech and Western Gear and today operates five regional service and manufacturing facilities strategically located coast to coast. The company's motto is: *Local service. National support. Global expertise.*

In addition to the company's engineering and technical center in Pennsylvania, company-owned facilities in the U.S. states of Delaware, California, Texas, Illinois and Alabama offer comprehensive services including local repair, overhaul, parts and field service as well as technical sales and service teams. According to the company, the increase in aftermarket refurbishments and easier access to the user base drove the switch to

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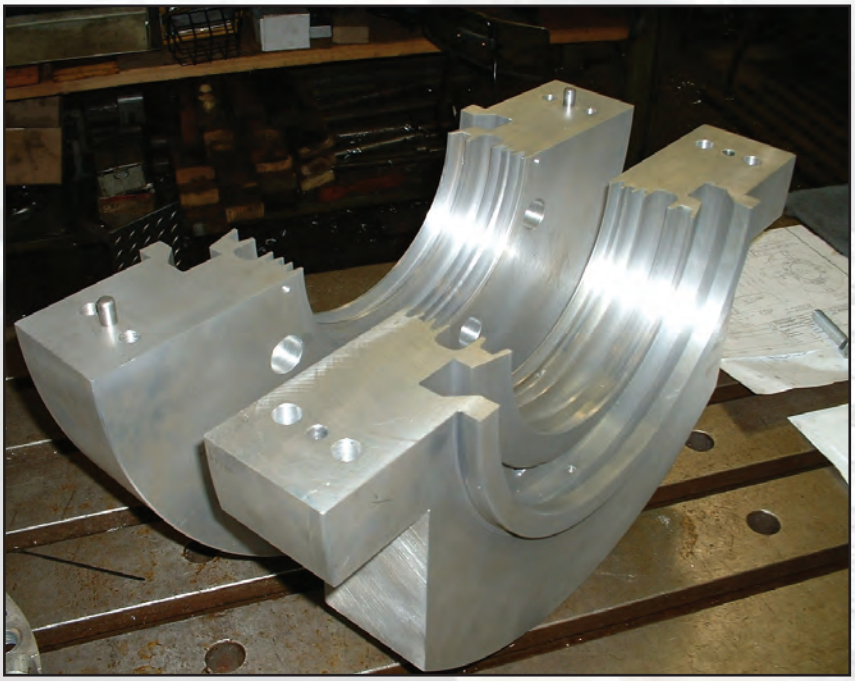


Other causes of gearbox failures can be attributed to oil leaks. To prevent this in one application, this "super" seal was developed by Philadelphia Gear engineers to solve leakage problems.

the new business model. Customers benefit by local availability to service, parts and expertise no matter where they are located across the country.

Bill McCloy is one of Philadelphia Gear's representatives for the northeastern United States. About 90% of his work week is spent visiting power plants to assess gear drive needs and concerns. McCloy's background includes decades of experience in geartrain and power plant operations.

"There's a solid base of 'legacy' gearboxes that have been in service 50 years or more and are still in daily use by power plants around the country," said McCloy. "These gearboxes are being used in applications such as gas turbines, accessory drives, load boxes, coal conveyor drives, pulverizer drives, cooling tower drives and more. Although part of my job is to provide expertise in the event of a major gearbox failure, another significant part of it is to educate the utility and its mechanics on how to prevent failures from happening in the future."

For his gas turbine customers in the U.S. states of New York and New Jersey, McCloy provides overhaul and repair services along with accessory drive and load box upgrades that minimize forced outage time and improve the overall operation at all of the sites.

One of McCloy's customers operates peak sharing power plants, producing a total of 1200 MW of power. Both sites had experienced accessory drive gearbox failures. The utility looked to Philadelphia Gear to not only repair gearbox drives, but to also develop a preventive maintenance program that would prevent failures in the future.

"The frame accessory drives not only serve to start up the gas turbines, but they also drive auxiliary equipment such as the atomizing air compressor, fuel and lube oil pumps," McCloy said. "During the initial inspection, our technicians discovered that the failures on the accessory drives were due to excessive axial movement on the No. 1 shaft toward the turbine, which caused thrust collar and bearing failures. The No. 1 shaft is designed to allow axial movement anywhere between 0.017 and 0.034 in. [0.432 and 0.864 mm]. As operating hours increase, the clearance on the No. 1 shaft also increases. When the clearance opens to 0.050 in. [1.270 mm], the drive begins losing its thrust face on the thin-wall, Babbitt-sleeve bearings. At 0.075 in. [1.905 mm], damage is done to both the thrust collars and housing shaft bores."

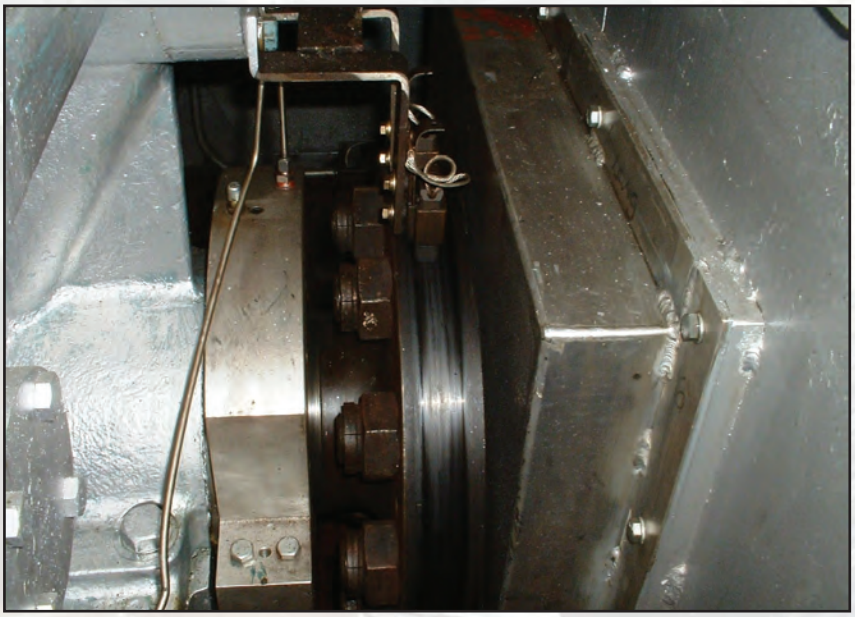
To prevent this from happening in the future, part of the plant's preventive maintenance program requires operations and maintenance personnel to perform annual axial movement checks. If the annual check finds shaft clearance to be 1.143 mm or more, the unit is removed from service and the No. 1 shaft is sent to Philadelphia Gear's regional service center where new thrust collars are installed and proper clearances reset. At the same time, new thin-wall Babbitt sleeve bearings could also be installed. The unit would then be reassembled and released for service. McCloy said the plant's preventive maintenance program reduced the number of catastrophic failures on accessory drives from two per year to zero.

In another instance, the No. 1 shaft axial clearance had grown to 1.905 mm, causing the No.1 shaft thrust collar and bearing on the accessory drive to fail, which overheated and cracked the housing shaft bores. Philadelphia Gear was able to fit a replacement sleeve, saving the housing for return to service.

Another of McCloy's experiences involved a constant oil leakage problem with the utility's Frame 5 load box coming from the area of the original 203.2 mm diameter LS shaft labyrinth seal. The load box reduces the turbine speed from 5100 r/min to 3600 r/min at the generator. Due to the design of the S-424-C5 load box, there is no internal oil deflector baffle plate on the LS shaft to prevent the oil from "rop-

ing" down the shaft to the outside during operation. To cure the leak, Philadelphia Gear's engineering group designed a "super" labyrinth seal (508 mm in diameter and 102 mm thick).

According to McCloy and other preventive maintenance experts, one of the best ways to keep a gearbox up and running for a long time is to have it inspected at least once during the year. "We've found that an annual, non-invasive inspection of the accessory drive through the inspection cover is essential to gearbox longevity," McCloy said. "After the inspection, our customers are given a report consisting of photos, base line data on the gearing, observations and guidelines to follow. I inspect the gears for scoring, unusual wear patterns and more. Philadelphia Gear also holds 'Gear 101' training seminars for our customers, which is a great addition to the scheduled training sessions for maintenance and engineering personnel who are directly involved in the operation, monitoring and maintenance of their facility's gear drives.



The new seal is shown here in service.

"We try to provide a lot of information, and offer additional expertise and skilled labor to our customers — many of whom have a workforce that's been slimmed down. These services are always appreciated."

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