CONTENTS

Introduction ........................................Page 2

Causes and effects ...............................Page 3

Conventional methods .........................Page 3

The Wärtsilä PCBM system ..................Page 4

Pre-warning of possible breakdowns .......Page 5

Example – identifying a failure .............Page 5

Conclusion .........................................Page 6
Introduction

While efficiency is being highlighted more than ever before for all aspects of a ship’s operations, tail shaft alignment is seldom at the top of the priority list. Nevertheless, it is important for eliminating the vibration and unnecessary frictional losses that can create considerable inefficiencies. Wasted energy not being converted into thrust diminishes performance and harms the overall efficiency of the vessel.

What is even more serious, however, is the often overlooked fact that misalignment can eventually cause serious damage to the shaft line equipment. This can result in costly and time consuming repairs to be carried out, especially if the ship has to be taken out of service for any length of time.

In this paper we shall compare the conventional and traditional methods for checking tail shaft alignment with Wärtsilä’s state-of-the-art Portable Condition Based Monitoring (PCBM) system. The positive effect that modern dynamic monitoring of a vessel’s equipment can have on overall operational efficiency will also be highlighted. Efficiency represents a critical element in lowering operating costs and, by extension therefore, in improving its profitability. Correct alignment of the tail shaft is an important contributing factor in achieving full efficiency.
Causes and effects

There are many causes of shaft line misalignment.

Today’s vessel designs increasingly utilise shorter shaft lines with the engine(s) located further aft, thus allowing the hull to accommodate additional cargo. While this enables more cargo to be transported, it can also open the door to a new set of problems.

With heavier and more efficient propellers now being used, the shorter shaft line has a greater tendency to bend, which not only negatively affects the alignment, but can also cause possibly serious damage to the rest of the shaft line equipment. Furthermore, ships are often running at slower speeds in order to save fuel, which creates a higher friction coefficient on the wearing parts and therefore a greater possibility of faults occurring.

There are numerous other factors that can influence shaft alignment and cause damage. These include, for example, the way in which cargo is loaded, changes in speed and rpm, engine de-rating, shallow water running, the fitting of a new optimised propeller, switching to EAL lubricating oil, or hull deflection occurrences.

Hull deflections are the result of stress placed on the hull structure of the vessel, which in turn affects the bearings supporting the propulsion shafting. One major cause of such stress is the effect of different loading conditions and ballasting arrangements. It is increasingly apparent with the longer ship designs that have emerged in recent years, since longer hulls are inevitably more flexible than shorter ones.

Therefore, correct alignment is of prime importance, both for optimal propulsion performance as well as for extending the life of the shaft line equipment. Should serious damage occur because of misalignment issues, it could mean taking the vessel out of service for repairs with obvious cost repercussions.

Conventional methods

Traditional methods of alignment are no longer up to the standard required.

Ships are generally designed to serve specific operational profiles. The necessary calculations for the design are made based, for the most part, on data supplied by the equipment manufacturers, the owner’s requested specifications, and on experience.

However, the life of a ship can last for decades and during this time its ownership may be changed, and the operational profile can alter significantly from that for which the vessel was designed. Because operational changes can have an impact on various hull deflection effects, misalignment of the shaft may cause, and has in some cases led to extensive wear on the bearings, leaking seals, and even major breakdowns.
The Wärtsilä PCBM System

Until now, the traditional and conventional way of checking the shaft line alignment has been by static checks. This involves checking the bearing loads and using piano wire or laser beams to determine the line of sight among the relevant points. Because of the limited accuracy the available tools have been able to provide, root cause investigations of misalignments have often been based on the visual inspection of parts after a failure has occurred. Such investigations have, not surprisingly, frequently resulted in inconclusive or incorrect assumptions.

Static alignment measurements can, at best, only give a view of the static shaft. They cannot, therefore, measure the different forces impacting the shaft during ‘real-life’ day-to-day operations. Nor can they indicate all the various operational effects on the hull. For true accuracy in detecting any vertical or horizontal misalignment, and to know exactly how the equipment is performing under daily operating conditions, modern dynamic measuring is necessary.

To overcome the shortcomings resulting from inadequate measuring tools and practices, Wärtsilä has developed the Portable Condition-based Monitoring System (PCBM) system. This offers a dynamic approach to measuring tail shaft alignment using state-of-the-art technology. It delivers detailed root cause information on vibration levels, temperatures, shaft runout, whirling, movement, torque, stress, and on the position of the equipment. These parameters and more are given while the ship is operating under differing conditions and speeds.

By comprehensively measuring all these parameters, the PCBM system is able to ensure that investigational conclusions are based on substantiated facts derived from the entire shaft line assembly. These measurements are all stored in the system’s data logger and can be extracted at any time.

The installation of the equipment can be performed by a single service engineer and the data logging is carried out while the ship is operating as normal. No operational downtime is imposed. The installation can be made while the ship is in port and the data collected for analysis at the next port-of-call.

The measurements are carried out using class-approved methodology, the analysis is made by senior technical specialists in accordance with classification society requirements, and the reporting procedure provides a record of the measurements along with a proposal for the corrective actions.
Pre-warnings of possible breakdowns

As indicated earlier in this paper, in addition to negatively impacting propulsion efficiency, shaft line misalignment can be a cause of equipment damage leading to serious breakdowns. Typical warning signs include the following:

- Leaking seals.
- High bearing temperatures.
- Excessive vibration.
- Extensive wear to parts.
- Contaminated oil.
- Ingress of water to the system.

Such symptoms should, in all cases, be taken seriously. Often, fairly minor adjustments can resolve the issue, but failure to act could result in major repairs becoming necessary.

Example – identifying a failure

A typical incidence of a fault being identified through the use of the Wärtsilä PCBM system would be the following hypothetical case:

**Issue:** A new stern tube seal is found to be leaking

**Detection:** By using the data produced by a Wärtsilä PCBM unit, analysts determine that there is significant runout on the propeller shaft. This is causing high levels of vibration.

**Cause:** The analysis identifies the cause of the runout as being misaligned shaft line bearings.

**Remedy:** With the shaft re-aligned and the replacement of the stern tube lip seals the cause of the problem is fixed and the seals are back to full functionality.

**Conclusion:** By measuring the tail shaft system under actual operating conditions, the Wärtsilä PCBM was able to quickly identify the reason for the seal leaking to occur, thereby enabling the repairs to be carried out before serious damage happened. A conventional static alignment check would have taken much longer and may have mis-diagnosed the cause of the problem.

**Note:** On rotating machinery, runout is defined as the degree to which a shaft or coupling deviates from true circular rotation. Every shaft or coupling has a center of rotation, or centerline. Any stray from concentricity is considered runout.
Full propulsion efficiency is essential for ships to achieve optimal operational costs, and to provide reliability, safety and onboard comfort. Such efficiency cannot be gained if there is misalignment of the shaft line equipment. Modern ship design, emphasising shorter shaft lines and often heavier, more efficient, propellers increases the challenge to maintain full alignment. However, whether the measurement service is for a modern vessel with a shorter shaft, or for an older ship with a more traditional length of shaft, full alignment is essential for efficient operation.

To enable a vessel to run at a consistently efficient level throughout its lifecycle, maintenance at all levels is required. This includes repairs and overhauls of the engines, regular inspection of the navigation system and other onboard equipment, and not least, shaft line alignment checks.

The conventional static method of checking alignment can be time-consuming and costly, can interrupt a ship’s sailing schedule, and cannot always be relied upon to deliver accurate assessments. In contrast, Wärtsilä’s Portable Condition-based Monitoring System dynamically detects faulty alignment, provides highly accurate data on the full assembly, and determines precisely the working condition of the equipment.

The portability aspect to the Wärtsilä system means that the PCBM can be quickly and easily installed and removed. It requires no vessel downtime as it carries out the measurements whilst the ship is in normal operation.

This innovation represents a state-of-the-art solution to achieving accurate measurements and full tail shaft alignment. The data produced is analysed by highly qualified specialists who then deliver a full report with any necessary recommendations. The Wärtsilä PCBM is a tool that brings shaft line alignment checks into the modern era.
Wärtsilä Seals & Bearings in brief

Wärtsilä provides integrated seals and bearings systems, packages and products that offer lifecycle efficiency, reduced risks through reliability and are environmentally sustainable.

As a truly global organisation, Wärtsilä has a broad product and services portfolio covering the whole lifecycle of the vessel. Looking ahead, Wärtsilä’s continuing development and technological leadership can ensure customers an environmentally sound solution that always complies with the latest regulations.

www.wartsila.com