

Improving seal reliability

BUSINESS WHITE PAPER



CONTENTS

Introduction.....	2
External factors	3
Design factors	3
Wärtsilä Enviroguard M: evolved reliability...	4
Wärtsilä Airguard: environmental reliability...	5
Reliability backed by global capacity	6
Designed for reliable operation	7

Introduction

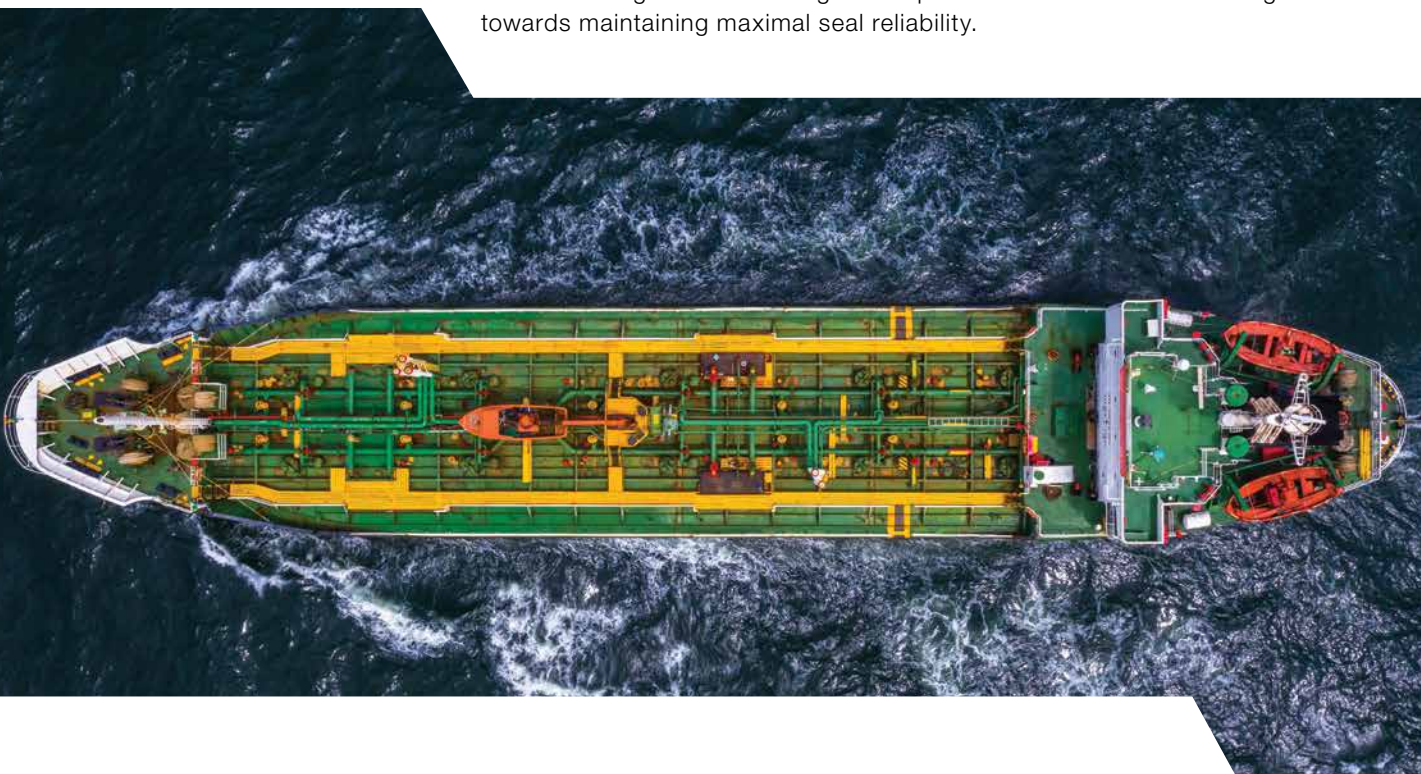
— The stern tube seal is fundamental to safe sailing.

Since ship propulsion shifted from sails to propellers, preventing seawater from getting into the hull via the stern tube has been one of the most fundamental engineering challenges of designing and operating vessels. Without reliable sealing, even the simplest marine operation can become time consuming, costly and complex. Today there are new challenges to reliability, including greater forces at play and an environmental focus on preventing fluids from escaping the hull as well as getting in. But the stern tube seal remains a basic building block of safe and secure sailing.

Beyond the need for vessels to be seaworthy, the drivers of reliability differ depending on the nature of the operation. For commercial vessels, time is money. At a low level, unreliable seals can place an excessive burden on the vessel crew by increasing the demand for day-to-day maintenance and inspection, driving up manpower and maintenance costs. More serious reliability issues can result in reduced availability or failure to meet charter conditions alongside significant expense.

For naval vessels, availability for missions and the ability to complete missions is the overriding factor. A ship that unexpectedly has to return to dock for repairs can jeopardise the success of a mission. Likewise, with limited capacity spread across a wide theatre of operations, redeployment of vessels from other areas to cover essential missions can cause significant delay. Vessel systems that are robust, reliable and easy to maintain in the field are therefore critical.

With decades of experience in the design, servicing and integration of stern tube seals, bearings and shaft lines, Wärtsilä Shaft Line Solutions has extensive insight into the design and operational considerations that go towards maintaining maximal seal reliability.



External factors

— The most important factors – friction, corrosion and shock.

The harsh conditions in which vessels operate provide multiple challenges to the reliability and durability of seals. Three of the most important factors include friction, corrosion and shock.

Friction is a factor whenever rotating components meet static components. In the case of stern tube seals, the seal interfaces are the points of friction that require lubrication to prevent overheating and excessive wear. The lubrication can be provided by seawater, mineral oil or environmentally acceptable lubricants. The risk of wear on the shaft line and the seal itself means that the integrity of the lubricating layer and shaft line temperatures should be controlled and monitored carefully to detect friction.

As well as controlling friction, stern tube seals need to be resistant to corrosion. Prolonged exposure to seawater can cause some materials to degrade, resulting in excessive leakage. When lubricants other than water are used, care also needs to be taken to ensure that seal materials are appropriate and that seals are not at risk of corrosion by the lubricant as well as seawater.

Corrosion can be minimised both by seal material selection and by a seal construction design that includes corrosion-resistant housing. A third factor in seal reliability is resistance to shock. Either direct impacts or the surges of water pressure associated with nearby explosions can damage the seal between the shaft line and the hull if it is not of a robust design and materials. Shock resistance is particularly important in naval applications, where strict standards are applied. It is also important for commercial vessels to minimise the chance of flooding and other damage during impacts such as groundings or collisions.

Design factors

— Seals need to be designed to ensure minimal maintenance.

As well as resisting those external threats to reliability through material selection and design, stern tube seals must also be easy to maintain. Critical factors in the design of any seal are therefore ease of service, simple inspection and monitoring, and redundancy.

While at sea with limited time and resources to effect repairs, poor serviceability can be as much a hindrance to reliability as low resistance to friction, corrosion or shock. Seals must be designed first to require minimal maintenance, so if maintenance is required, core components are easily accessible and replaceable by ship crew.

Where day-to-day maintenance is not enough to keep seals functioning properly, seal assemblies must also offer the redundancy to enable either substantial repairs at sea, or safe return to port where a drydocking is required. This redundancy is traditionally provided by secondary seals within the assembly.

The ability to monitor the condition of seals and the shaft line is also imperative in order to identify issues at an early stage. Monitoring can be conducted by visual inspection or by deploying digital technologies that can sense wear, temperature and other variables. Ideally operators will use a combination of traditional inspection and continuous monitoring to ensure that seals are in working order.

Wärtsilä Enviroguard M: evolved reliability

— Wärtsilä Enviroguard M –
designed for reliability.

The latest iteration of the best-selling seawater-lubricated seal series for naval applications, Wärtsilä Enviroguard M, shows how continuous evolution in the design of the various seal elements has resulted in market-leading reliability. Wärtsilä Enviroguard M is a face seal, and the materials used for the stationary and rotating faces that press together to form the primary seal are important considerations. Especially where water replaces oil lubrication, the face material needs to be able to cope with higher levels of abrasion, particularly in waters containing sediment or other contaminants. The faces of Wärtsilä Enviroguard M seals are made from an aromatic polyamide or 'aramid' composite material from the same family as the bullet-proof fibre Kevlar®. This material has been specially developed to enable the seal to perform in all environments, including brown water conditions with high sediment loads.

Flushing is an important element of mechanical seals in naval applications to cool rotating components. In seals that are lubricated with water rather than oil, another important function of flushing is to prevent the accumulation of sediment or organic matter within the seal assembly. The latest Wärtsilä Enviroguard M design includes direct flushing to the composite running face.

The temperature included in the renewed Wärtsilä Enviroguard M seals enable real-time monitoring of the condition of the sealing interfaces. This optimises maintenance scheduling by telling operators how much running time they have left until an overhaul is needed. In many cases monitoring can alert operators of a condition which can be corrected to prevent premature seal failure. This lessens the risk of unexpected downtime and lowers maintenance costs due to the simplified procedure.

To improve redundancy, the back-up inflatable seal has been doubled in the new design. The first inflatable seal allows for the shaft to continue operating at reduced speed, even after main seal failure for a safe return to port; the second provides extra redundancy. Either of the seals can be used to keep the vessel moving or, when the shaft line is locked, to enable repairs and maintenance to be carried out afloat without the aid of divers. Minor overhauls of worn parts can also be managed in this way, which reduces the cost and complexity of maintenance by eliminating the need for dry dock.

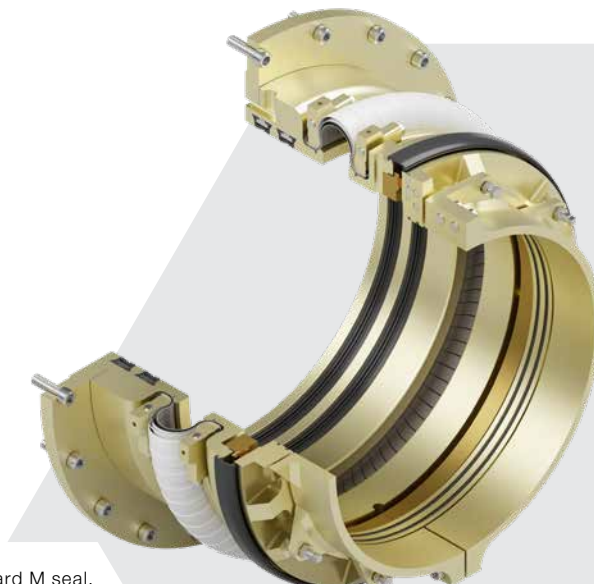


Fig.1 Wärtsilä Enviroguard M seal.

Wärtsilä Airguard: environmental reliability

— Wärtsilä Airguard –
designed to prevent oil
leakage.

Highlighting the evolution of seal reliability to accommodate environmental regulations, the Wärtsilä Airguard is designed for applications that require extra security against the leakage of oil into seawater. The US Vessel General Permit (VGP) forbids the leakage of mineral oil into seawater, requiring operators to use either an environmentally acceptable lubricant or an air seal. The Wärtsilä Airguard has a barrier of air (which is harmless to the environment) that completely separates the stern tube oil from the seawater, preventing both seawater ingress inboard and lube oil leakage outboard.

The Wärtsilä Airguard can have either three or four seal rings. The failure of a seal ring will not lead to the leakage of oil into the sea or the failure of another main component. The air chamber or void space between the seal rings is one of the reasons behind the effectiveness of the Wärtsilä Airguard seal, physically separating the seawater and oil.

The air barrier in the Wärtsilä Airguard is regulated by a control unit which includes air filters, pressure regulators, flow meters, flow controllers, air relays and a pressure switch. The flow controller provides a constant flow of compressed air into the void space between the seal rings at a pressure higher than that of seawater, depending on the vessel's draft condition. A small amount of pressurised air is forced out into the seawater through a clearance under the lip of the aft seal ring.

Under normal operating conditions, no oil or seawater will enter the air chamber. However, if it does, the air pressure in the system forces it downwards and out through the drain collection pipe. This system ensures that all leakages will be drained inboard, preventing oil leaking outboard or seawater entering the stern tube. It also means that if a seal ring is damaged, any leakage of oil or seawater will still be safely drained away.

In the Wärtsilä Airguard system, which has three- or four-lipped versions, only the second seal ring from inboard rubs directly on the liner and is lubricated by the oil. The other seal rings operate under a floating condition due to the air and oil films. Effectively, the third seal ring acts as a spare second seal ring. In instances where the second seal ring is damaged – the valve to the oil chamber can be closed and the system works using just the first and third rings, providing additional safety and reliability.

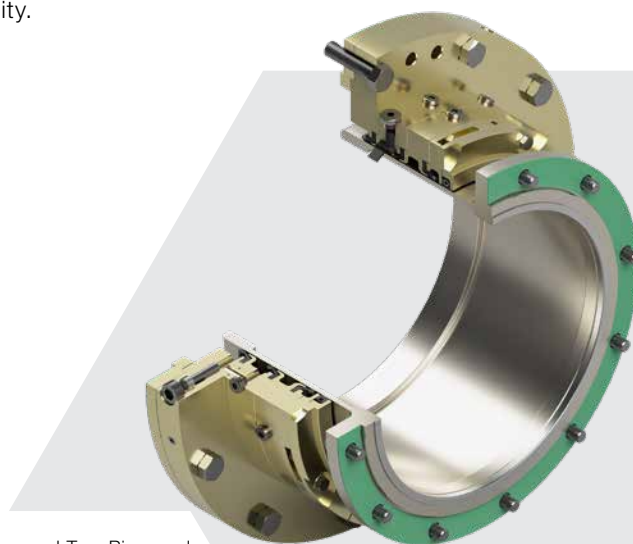


Fig.2 Wärtsilä Airguard Two Pipe seal.

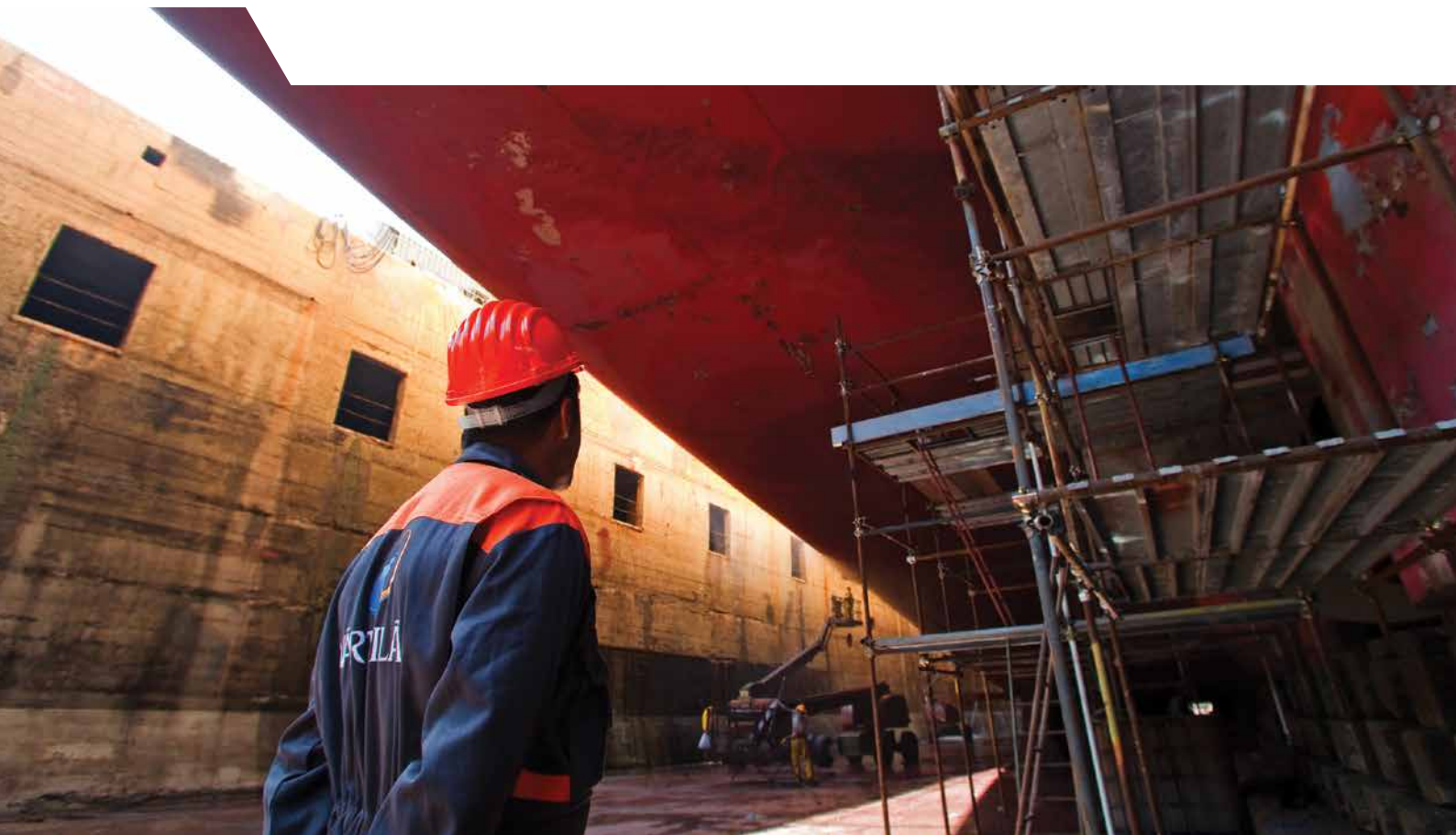
Reliability backed by global capability

— Wärtsilä Shaft Line Repair Services – expert help whenever you need us, wherever you are.

The reliability built in to Wärtsilä's stern tube seal solutions is supported by a global end-to-end service offering. With a network of global service centres, specialist project management and rapid access to customised replacement parts, Wärtsilä Shaft Line Solutions can assist customers in both scheduled and non-scheduled service to keep seals and shaft lines in optimal condition.

Scheduled maintenance offerings include alignment services, ensuring the vessel shaft line is correctly configured to optimise propulsion efficiency and maximise component lifetimes. Checking alignment regularly during dry docks can prevent problems such as premature wear and breakdown, extensive component failure and large-scale damage to engines, shafts, struts and hulls.

For emergency support, Wärtsilä's Shaft Line Repair Services brings together project managers, alignment and measurement specialists and field service engineers to provide a fully integrated service. This cross-disciplinary team of experts can tap into dedicated manufacturing facilities around the world as well as a wide inventory of OEM parts, making sourcing replacements much quicker and project management more streamlined. With unique insight into all aspects of shaft line repair, Wärtsilä can act as the main point of contact, liaising with owner, shipyard and service teams - making the difference between a tightly coordinated, on-schedule repair and one that takes excessive time and cost.



Designed **for reliable operation**

— To maintain reliability, regular inspections are required.

Ensuring the reliability of a vessel is one of the most important responsibilities of any operator, and the stern tube seals are an essential element of seaworthiness. Crew should make regular visual inspections of seals to assess for signs of leakage, damage or overheating. In modern installations, these inspections can be supported by continuous digital monitoring of wear, temperature and water/oil quality to provide early detection of potential issues. And seal assemblies should be thoroughly vetted and wearable parts replaced during periodic surveys (typically every five years on commercial vessels).

Backed by a responsible maintenance routine, Wärtsilä's stern tube seals are designed to provide optimal reliability across the lifecycle of the vessel – leaving ship owners and ship operators to focus on making the best use of their assets.





An industry leader in shaft line components Wärtsilä Shaft Line Solutions delivers a portfolio of end-to-end services and integrated solutions for the marine markets that builds on our core values: lifecycle efficiency, risk reduction, environmental leadership and design excellence. As an original equipment manufacturer operating in 75 countries, we have the capabilities to support customers on a global scale, and remain committed to providing in-country and round-the-clock expertise.

wartsila.com/shaft-line-solutions

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