



COMPAC PROPELLER SHAFT BEARINGS

THORDON

ZERO POLLUTION | HIGH PERFORMANCE | BEARING SYSTEMS

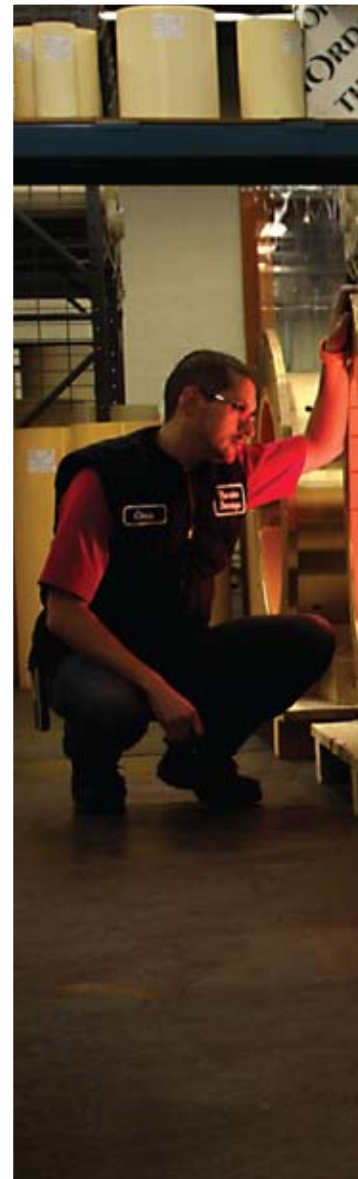
PIONEERS IN SEAWATER LUBRICATED BEARING TECHNOLOGY

Over fifty years ago, ship owners and managers made the conversion from seawater lubricated *lignum vitae* (wood) bearings to oil lubricated white metal stern tube bearings. Concern over the continued supply of quality *lignum vitae*, and improvements in lip seal technology creating a controlled environment, facilitated this development. Today, the majority of commercial ocean-going ships operate with a propulsion system using a propeller shaft supported by oil lubricated metal bearings with the oil contained in the stern tube by forward and aft shaft seals. According to seal manufacturers, the seal must leak (aft-into the sea or forward-into the ship's bilge) at the shaft/seal interface in order for the seal to function properly. As well, simple fishing net or rope caught on a ship's rotating shaft can also damage the aft seal allowing stern tube oil to flow out into the sea.

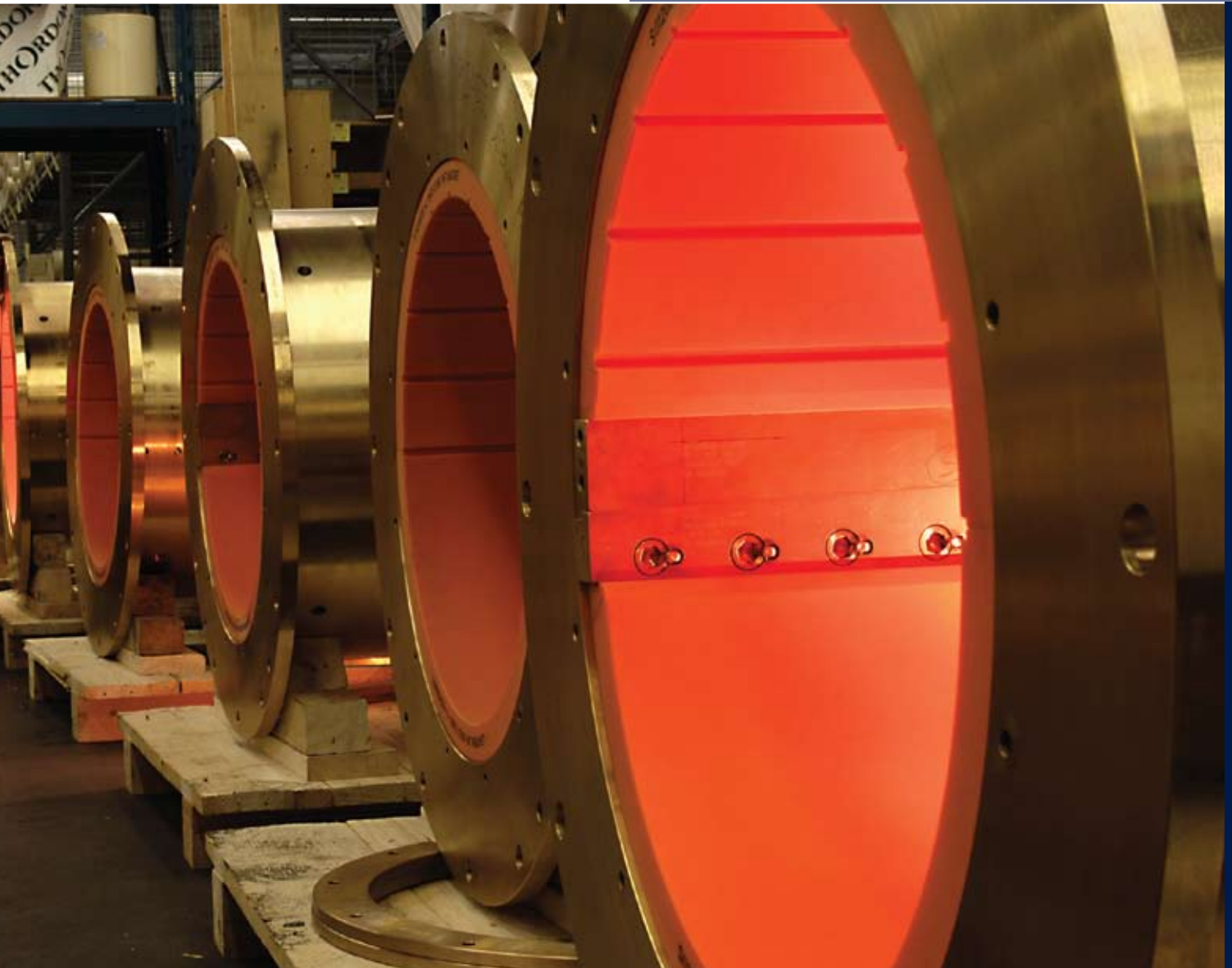
Violations of international, national and local environment laws are resulting in numerous penalties - criminal (such as large fines or jail terms), civil and judicial or administrative (such as loss of government contracts or permits). These penalties can be applicable to any company or individual such as the captain, the chief engineer, the owner, the operator, the charterer of the ship and the Classification Society.

Using a proven, available technology, there is an alternative to an oil lubricated sealed system that completely eliminates stern tube oil pollution and the risks associated with it. A Thordon seawater lubricated COMPAC bearing system uses seawater as the lubrication medium in place of oil. The seawater is taken from the sea, pumped through COMPAC elastomeric shaft bearings and returns to the sea. No stern tube oil is needed.

With over 30 years of bearing experience using the proven principles of seawater lubrication, Thordon's COMPAC stern tube bearing system is a simple, reliable and oil-free system.



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Thordon seawater lubricated COMPAC bearings replaced oil lubricated metal stern tube bearings on the 74,000 dwt bulk carrier, CSL Acadian in 2006 at Shan Hai Guan Shipyard in China.

"It's pretty clear that the end game will be no discharges allowed at all, and we have bought into a process that is externally audited by Lloyd's Register. The initiative with water lubricated stern tube bearings is an example of that commitment. If anyone asks what we've done for the environment, well, we can say 'this'."

*Al Davies, SMT Director, Operations
SMT Ship Management & Transport, Canada*

"Spills always come at times when you do not need them, and they must be resolved as soon as possible. Prior to the switch to these seawater lubricated bearings, Flinter, like others, had been fined for oil pollution, especially in US ports."

*Martijn Berends, Newbuildings Manager
Flinter Management BV, Netherlands*



"The Thordon system is the perfect choice for BP because its pollution free characteristics are consistent with the design philosophy of the ships. The first vessel is due to launch in Spring of 2004 and because of a dedication to protecting the environment, these ships will carry oil by sea, safely, for decades to come."

**Stan Taylor, Technical Manager
BP Shipping, U.S.A.**

"NOAA specified the Thordon bearing because of its experience showing that Thordon has a low acoustic signature. We had Thordon modify the standard offering to allow for sustained hydrodynamic operation at very low shaft RPM."

**Dave Rickman, Chief Mechanical Engineer
VT Halter Marine, Inc., U.S.A.**



HMCS Halifax patrol frigate installed with seawater lubricated COMPAC bearings

COMPAC SEAWATER LUBRICATED STERN TUBE BEARING SYSTEM

COMPAC Elastomeric Polymer Stern Tube Bearings

The bearing wear surface is Thordon COMPAC, a non-metallic, elastomeric polymer alloy. To reduce start-up friction and eliminate stick-slip, COMPAC's formulation includes special lubricants to provide a low coefficient of friction. To promote early formation of a hydrodynamic film between the shaft and bearing, the lower (loaded) portion of the bearing is smooth, while the upper half of the bearing incorporates grooves for flow of the water for lubrication and cooling. COMPAC bearings are approved by all major Classification Societies. The L/D ratio for COMPAC can be as low as 2:1 for the bearing adjacent to the propeller and 1:1 for all others depending upon the load and operational requirements. Options are available if the bearings are to be aligned and resin chocked into position. A Thordon tapered keyset can be provided to allow the bearing to be removed for inspection or replacement without removing the shaft. The COMPAC bearing is split and the key is comprised of two parts sliding on a taper – a fixed section and a removable sliding section.

Thordon Water Quality Package

A steady supply of seawater with the significant abrasives removed is an important element in ensuring long, predictable, bearing wear life. The Thordon Water Quality Package is a self contained, conditioning and monitoring package to ensure that an adequate supply of clean water is consistently being delivered to both the forward seal and the stern tube bearings.

Shaft Liners

Since bearing "clearance" is the sum of both bearing wear, and wear of the shaft liner, a high quality shaft liner is an important component of a COMPAC bearing system. Thordon Bearings recommends shaft liners made from a bronze, stainless steel or Inconel alloys. Weld clad Inconel or others acceptable to Classification Society Rules are also possible.

Thor-Coat Shaft Coating

In a COMPAC seawater lubricated bearing system, clean seawater is used as the lubricant. Where the shaft is exposed to salt water, the shaft must be protected by a corrosion-resistant coating. Thor-Coat is a modified epoxy coating having enhanced flexibility. Thor-Coat is designed to provide 10 years or more of corrosion protection - potentially eliminating the need for the 5 year shaft withdrawal and inspection.

Forward Seal

Thordon recommends a face seal or lip seal for use with the COMPAC seawater lubricated stern tube bearing system.

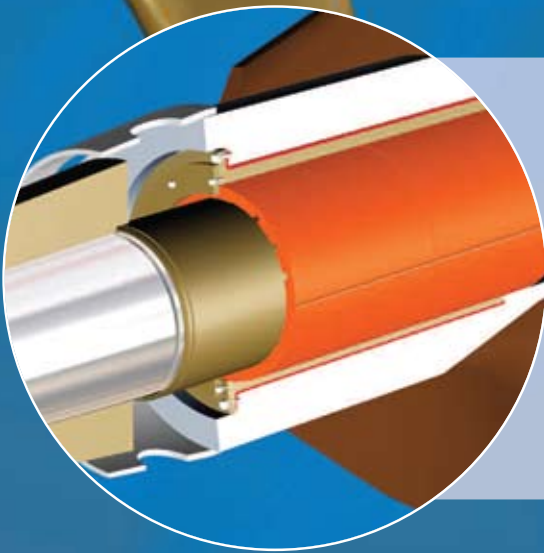
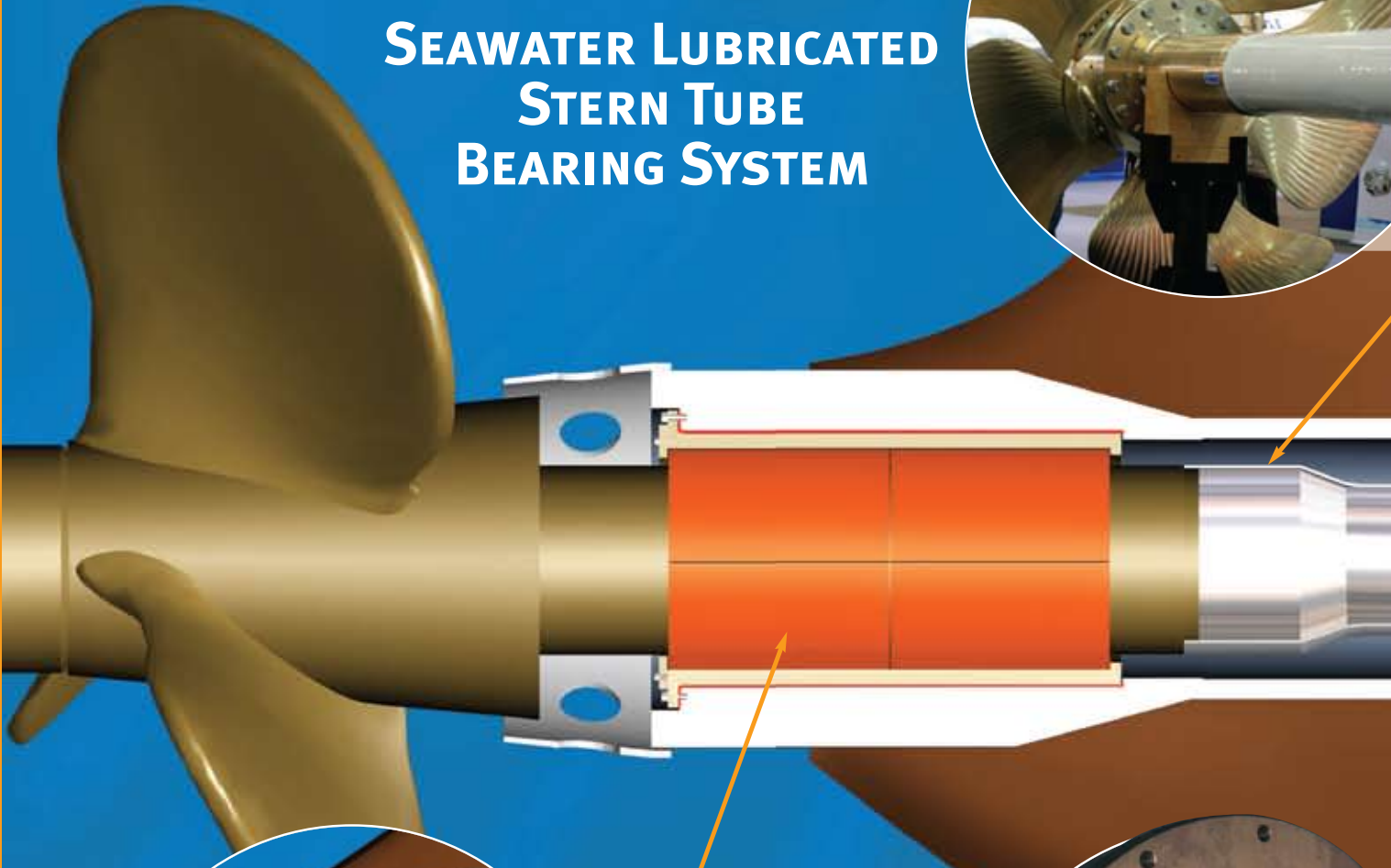


Thordon COMPAC is installed in all 12 Canadian Navy Halifax Class patrol frigates delivered between 1992 and 1994 (no bearings have been replaced to date). Over 40 of the world's Navies and Coast Guards use COMPAC seawater lubricated propeller shaft bearings for safety and non-catastrophic failure mode.

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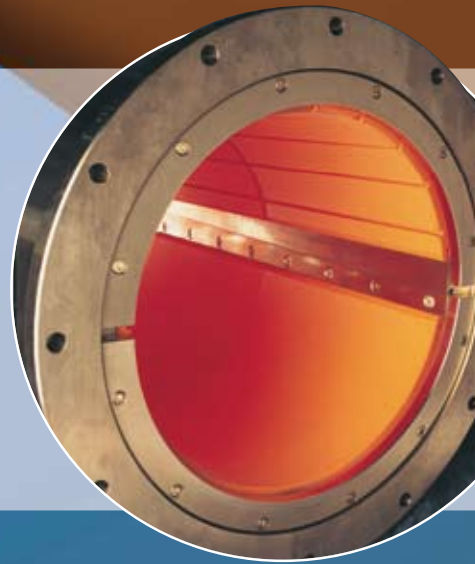
COMPAC

SEAWATER LUBRICATED STERN TUBE BEARING SYSTEM



AFT COMPAC BEARING SYSTEM

- COMPAC bearing in bearing carrier with retaining ring
- Thordon recommended shaft liner in way of the bearings
- No AFT seal required



ZERO POLLUTION | HIGH PERFORMANCE

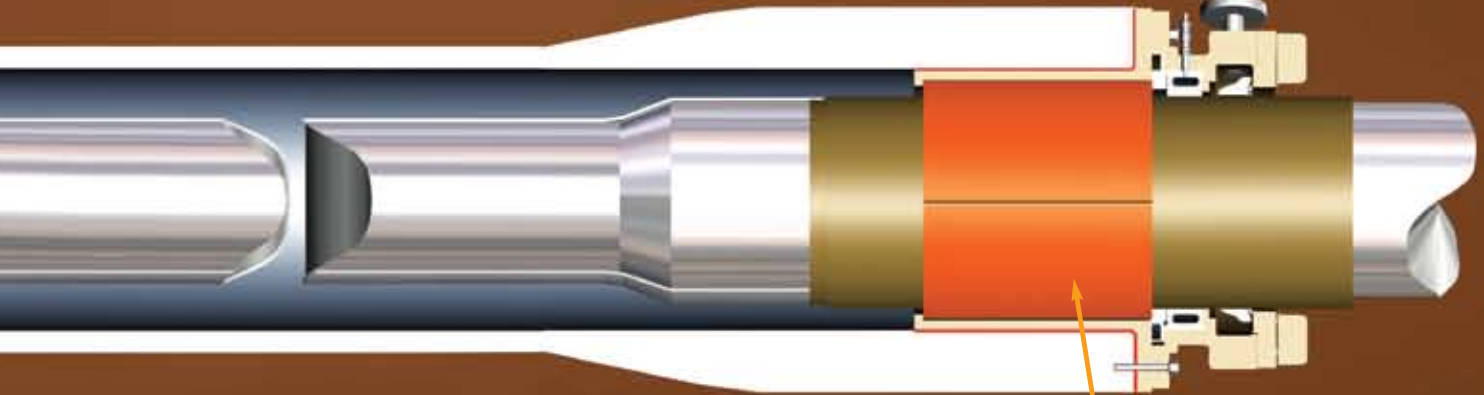
**THOR-COAT
SHAFT COATING**

- Thordon's tough new modified epoxy coating, designed to provide 10 year integrity against corrosion



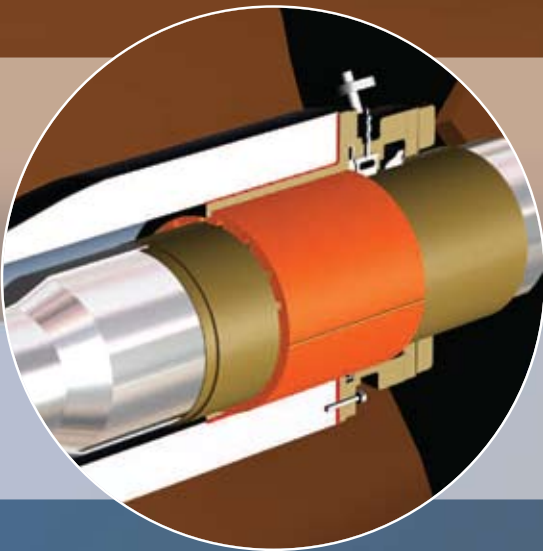
**THORDON WATER
QUALITY PACKAGE**

- A Thordon Water Quality Package delivers a consistent supply of conditioned water to both the FWD seal and all bearings. A separate detailed brochure on the Thordon Water Quality Package is available



**COMPAC SINGLE
TAPERED KEY DESIGN**

- COMPAC split bearing with a single tapered key allows bearings to be withdrawn, inspected and re-installed in a matter of hours with the shaft in place



**FWD COMPAC
BEARING SYSTEM**

- COMPAC bearing in bearing carrier
- Thordon recommended shaft liner in way of the bearings
- Face or lip type FWD shaft seal

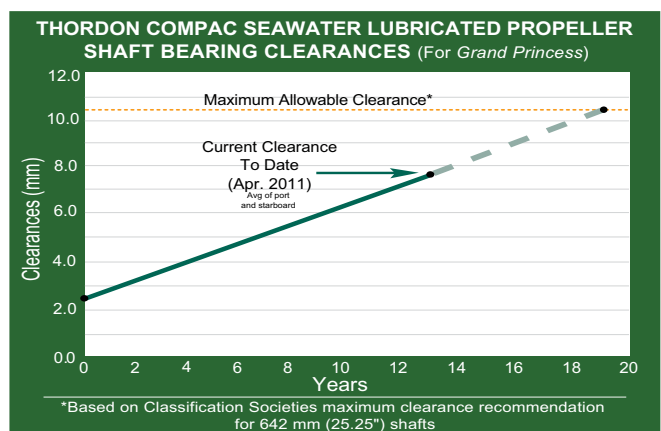


"Having water-lubricated sterntube bearings not only improves a company's environmental credentials but also eliminates the costs associated with maintaining an oil system and associated equipment."

**John McMillan, Technical Director
Beltship Management Ltd., Monaco**

"The added advantage is that the COMPAC tapered key system allows inspection of the bearing and shaft journal without pulling the shaft. To date, our experience is that COMPAC bearings with Inconel journals will mean worry free shaft lines for the life of the vessel."

**Chris Joly, Principal Manager Marine Engineering
Carnival Corporation, United Kingdom**





SHIP OWNER BENEFITS

15 YEAR COMPAC STERN TUBE BEARING WEAR LIFE GUARANTEE*

In newbuild applications, the ship owner must clearly specify the complete COMPAC system (including Thordon Water Quality Package, Thor-Coat and approved shaft liners) to the ship yard in order to qualify for the 15 year wear life guarantee. The Thordon COMPAC Stern Tube Bearing System is guaranteed to meet Classification Society stern tube bearing wear specifications for 15 years or Thordon Bearings Inc. will supply new bearings free of charge. The guarantee is limited to the supply of replacement bearings delivered to the ship. It does not include replacement of any other Thordon supplied components nor any drydocking or installation costs. A copy of the specification is available from Thordon Bearings Inc.

The bearing guarantee is available for commercial newbuild vessels with shaft diameters of 300mm (12") or greater and COMPAC bearings enclosed in stern tubes. Standard operating parameters as specified by Thordon Bearings (for example – system maintenance, minimum water flows, etc.) must be provided and maintained by the ship owner. The guarantee is limited to the owner of the ship. Full details of the 15 year guarantee are available from Thordon Bearings Inc.

* The guarantee is subject to prior approval by Thordon Bearings Inc. and limited to the supply of replacement bearing(s).

Zero Pollution Risk

The COMPAC seawater lubricated stern tube bearing system eliminates stern tube oil, as the lubricant is seawater. There is no AFT seal, no storage of oil, no sampling of oil, no disposal of stern tube oil and no worry of ingressing seawater contaminating the oil. Expensive, multiple chamber AFT seals designed to 'trap' oil leakage and drain it inboard for further processing and disposal are not required. Thordon's COMPAC system ensures ship owners/operators that there will be no environmental violations resulting from stern tube oil leakage.

Lower Life Cycle Costs

Based on existing user experience of COMPAC seawater lubricated propeller shaft bearings, life cycle costs are significantly reduced compared to that of an oil lubricated system. Lower costs are from the elimination of aft seal maintenance and stern tube oil, plus additional benefits of no risk of stern tube oil pollution and the associated fines or emergency seal repair maintenance costs.

Proven Long Bearing Wear Life

Bearing wear data has been recorded for several ships with shaft diameters over 500 mm (20") that have been operating with the COMPAC bearing system for more than 10 years. Results have shown the bearings are expected to last 15 to 20 years as seen in the clearance chart for the *Grand Princess*.

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SHIP OWNER BENEFITS

Controlled Bearing Environment

Thordon's Water Quality Package ensures an adequate supply of clean water is consistently being delivered to both the forward seal and the stern tube bearings. Lubrication of the bearing is assured and a long predictable bearing wear life is achieved. A controlled supply of clean water allows Thordon to offer a 15 year bearing wear life guarantee.

Extensive References

Thordon seawater lubricated propeller shaft bearing systems are extensively used in over 2,000 commercial, naval and coast guard applications. Today, commercial ship owners and operators around the world have chosen COMPAC for its pollution-free simplicity and proven reliability. Reference lists and orders of commercial ships equipped with COMPAC seawater lubricated stern tube bearings are available from Thordon Bearings Inc.

Simple Design For Newbuilds and Conversions

The COMPAC system was developed from improvements in non-metallic materials and bearing design combined with the proven principles of water lubrication technology, that has existed since the earliest days of shaft driven propellers. The seawater is sourced from the ship's sea bay, pumped to the forward section of the stern tube just aft of the seal, through the forward and then aft bearings, and returns to the sea.

Reduced Time In Dock With Single Key Design

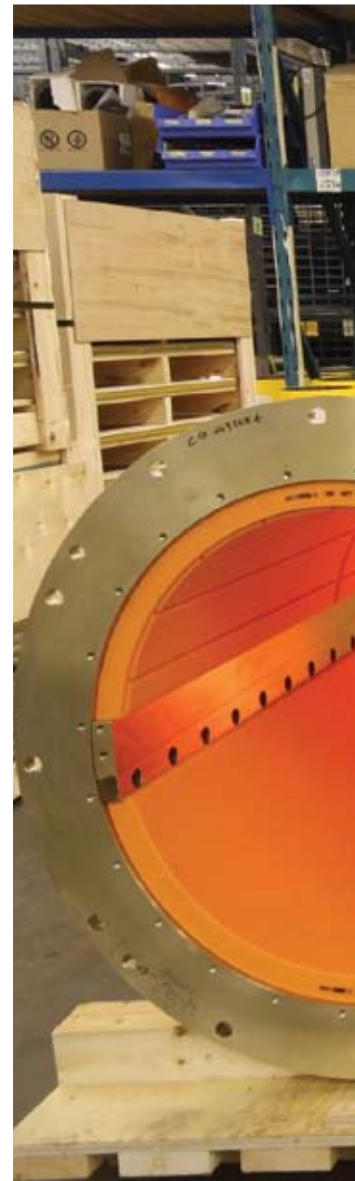
Thordon COMPAC's unique single tapered key design allows inspection or renewal of the bearings with the shaft in place. The split bearing design allows the bearings to be withdrawn, inspected and reinstalled in a few hours.

Survivability

If a serious bearing failure occurs with a white metal or reinforced plastic bearing, significant heat is often produced and there can be damage to the shaft as well as the bearing. As the Thordon COMPAC polymer softens at a lower temperature than metallic or other non-metallic bearing materials, excessive amounts of heat are not produced in failure mode and shaft damage is avoided.

Easily Machined and Fitted

Thordon COMPAC machines cleanly and produces no airborne machining debris. COMPAC is much lighter than white metal bearings and can be fitted quickly and easily by freezing in liquid nitrogen or dry ice.



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“Thordon’s approach and understanding of this project’s needs were first class and their expertise in this field contributed to a smooth and fast turnaround,”

*Louis Martel, V.P of Technical Operations
CSL International Inc., U.S.A.*

“Thordon does not get that high frequency squeal common with rubber bearings at low shaft RPM’s,” says Glass. But “no squeals” isn’t the only reason Donzi relies on Thordon. “When it comes to maintenance, “bearing replacement is not very often, indicating long bearing life.”

*Thomas Glass
Donzi Yachts, U.S.A.*

CUSTOMER FOCUSED TO QUICKLY MEET YOUR NEEDS

Quick and Responsive Service

It takes quality products to be globally successful in the marine bearing industry. It also takes great service to keep customers coming back.

Thordon Bearings Inc. is geared to respond quickly to new shipbuilding, repair and conversion projects. Thordon bearings arrive quickly, fit right and last!

Extensive Distribution Network

Thordon Bearings has an extensive distribution network to supply our global customers. More than 70 distributors in 100 countries carry extensive inventories of Thordon's common bearing sizes which are backed by large regional and head office inventories. Non-standard requests are met with responsive design, quick machining and speedy delivery.

Application Engineering

Thordon engineers work closely with customers to provide innovative bearing system designs and solutions. We offer in-house design, CAD and the proprietary Thordon Bearing Sizing Calculation Program to help correctly size our bearings.

Our decades of experience mean that we offer the right technical support during design, machining, installation and operation.

Manufacturing Quality

Thordon Bearings Inc. is a family-owned company that operates a state-of-the-art polymer processing plant and new product development facilities in Burlington, Ontario, Canada.

We manufacture to ISO 9001:2008 Quality System requirements. Contact us for references for our installations.

High Performance Bearings and Shaftline Products; Industry-Leading Service

Thordon Bearings is an industry leader in the design, manufacture, supply and installation of high performance, marine bearings systems.

Your Authorized Thordon Distributor

THORDON

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