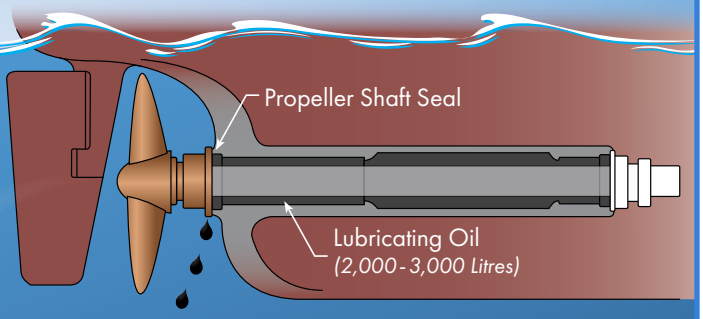
OIL EMISSIONS FROM PROPULSION SYSTEMS OF COMMERCIAL SHIPS

The sustainability of our oceans is under severe threat. As the shipping industry implements changes to reduce the impact on the seas, eliminating oil emissions from propulsion systems is a viable initiative going hand in hand with the United Nation's Sustainable Development Goal #14: *Life Below Water* as well as the IMO's World Maritime Theme for 2022 *New Technologies for Greener Shipping*. Vessels that operate with a sealed oil lubricated propeller shaft or podded propulsion system routinely leak oil into our oceans and seas and this document offers proof. Many ship owners are acting now and have equipped their ships with alternatives to eliminate oil emissions from propulsion systems forever. When we think about Green Ships, we need a holistic view with considerations below the waterline.

There are two main types of oil emissions that can occur from stern tubes:

- **Operational** oil emissions are the day-to-day oil that leaks from the AFT seal of a stern tube in order for the seal to work properly.
- **Accidental** emissions happen when there is damage to the seal, like getting tangled in fishing nets.



Both types of oil emissions can be prevented with an open seawater lubricated system that ELIMINATES the need for an AFT seal.

Much research has been done on the topics of oil emissions from commercial shipping propulsion systems with some key findings presented inside.

Propeller shafts can be a substantial contributor to the operational oil spills from shipping, as they can leak between two and six litres of oil daily. When the oil begins to run out in the bearing, oil is refilled in the tank. It is no simple operation to repair a seal or replace a propeller shaft bearing; this most often has to be performed when the ship is dry docked. Then it may take up to years before the leakage can be stopped. The annual global additions of oil from propeller shafts are estimated to range between 30,000-100,000 m^3.

Andersson, Karin, et al. Chalmers University of Technology,
"Discharges to the Sea" Shipping and the Environment:
Improving Environmental Performance in Marine Transportation, 2016.

The issue of oil leakage from stern tubes, once considered a part of normal "operational consumption" of oil, has become an issue of concern and is now being treated as oil pollution with full legal consequences. The study results indicate that each year in over 1.7 million vessel port visits, 4.6 to 28.6 million litres of lubricating oil leaks from stern tubes, and 32.3 million litres of oil is input to marine waters from other operational discharges and leaks. If the same rates of discharge occur at sea as they do in port, the estimated worldwide annual inputs of lubricants to marine waters both in ports and harbours and at sea might be estimated to be about four times the port estimate. This assumes that each vessel spends, on average, three days at sea for every day in port. Total worldwide of lubricants from operational leaks and discharges would then be about 130 to 244 million litres annually.

Etkin, Dagmar Schmidt. Environmental Research Consulting
"Worldwide Analysis of In-Port Vessel Operational Lubricant,"
Arctic and Marine Oilspill Program Technical Seminar of Environment Canada, 8 June 2010, Halifax, Canada.

There exist several alternatives to stern tube oil, such as water lubrication... but as long as mineral oil lubricants are allowed to be used it will continue to be a source of oil pollution to the Baltic Sea. Most of the stern tube oil leaks occur in the Baltic Sea proper and there is a maximum during the summer months. Dry-cargo ships are the largest source, over 3 times larger than the contribution from any other ship type.

Jalkanen, Jukka-Pekka, et al. Finnish Meteorological Institute, Chalmers University of Technology,
Lovén Center of Marine Sciences, Tallinn Technical University, Swedish Environmental Research Institute
"Modelling of discharges from Baltic Sea shipping" 28 May 2021.

Oil pollution from shipping accidents tends to be catastrophic, capturing much of the public attention; however, cumulatively oil pollution stemming from day-to-day activities ("operational discharges") contributes a higher rate of input into marine environments than pollution from shipping accidents. When considered cumulatively, oil pollution from operational discharges is likely to have a big effect on marine ecosystems as these discharges occur at a much higher frequency and are extensive spatially. It is generally difficult to model occurrence and estimate the impact of smaller oil spills because they are far more likely to go unreported and undetected.

Bertazzon, Stefania, et al. University of Calgary, Institute of Ocean Sciences, University of Victoria,
"Geospatial analysis of oil discharges observed by the National Aerial Surveillance Program
in the Canadian Pacific Ocean", August 2014.

The unregulated leak of lubrication oil from stern tube bearing systems may represent a significant oil quantity compared to the actual legal discharge of bilge oil and slop oil. It is difficult to make an accurate estimate of the leak to sea because the leak rate is dependent on several parameters like propulsion power, age and type of arrangement, wear, operational profile, etc. Currently no authorized quantity estimates exist, but assumptions are in the range of 6 litres of oil per ship per day, of course depending on vessel type and size.

Det Norske Veritas,
"Regular operational emissions and discharges from shipping in polar areas - particular environmental aspects", 02 July 2010.

Even though regulations have been made regarding discharge of bilge water and the prevention of accidental oil spills, the undocumented oil leakage that occur daily through stern tubes seems to go unnoticed. The wear and tear of the stern tube seal can differ depending on the environment the ship is working in and how clean the water is. If the water is contaminated with particles, then the wear on the seal could increase and thus increase the leakage rate.

Lundberg, Johan. Linnaeus University,
"Undocumented oil leakages; A study about stern tube seals and leakages", 2021.

"In a simple oil lubricated stern tube system oil will inevitably be lost to the sea, as, to an extent, 'all shaft seals leak'. This is the case because, in order to function satisfactorily and give a long operational life a seal must operate with a fluid film between the static and dynamic sealing surfaces. Some of this lubricating fluid will be pushed out into the sea. The Exxon Valdez oil spill which occurred in the Prince William Sound, Alaska, on March 24, 1989, was 41.6 million litres (IMO 2008). Clearly equipment specification which knowingly contributes to putting the equivalent of nearly two Exxon Valdez oil spills per year into our Oceans is not sustainable."

Mr. John Thornhill BSc (Hons) CEng FIMechE, General Manager of Seals, Wärtsilä UK Ltd.
Thornhill, John. "The Challenge of Stern Tube Bearings and Seals", 2015.

Q&A with Wärtsilä Shaft Line Solutions Team

Q: How many emergency seal repairs do you perform in a year?

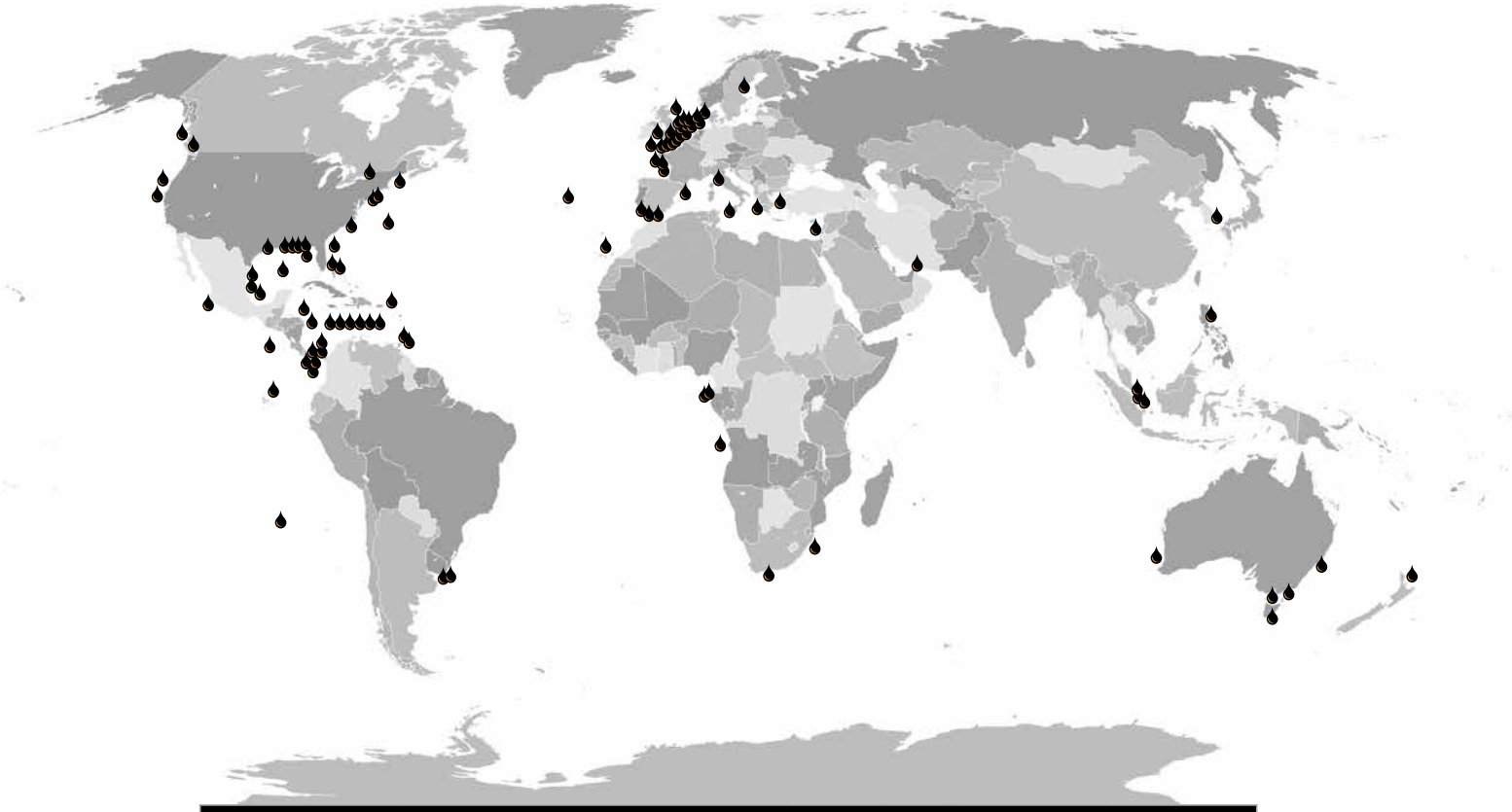
A: Good question... Several hundred I would say.

A: It is a tricky question and from the top of my head I cannot give an exact figure for emergency seal repairs. There are a good number of emergency repairs coming from fishing lines, ropes and some are done dockside and some underwater.

"Reducing maintenance and operational costs through integrated shaft line solutions"
Webinar hosted by Riviera Maritime Media, 25 Feb. 2021

ACCIDENTAL OIL LEAKAGE REPORTED IN THE PRESS

Shaft Seals Repaired due to Oil Discharges (since 2006)



Types of Vessels					
Anchor Handling Vessel	1	Dredger	2	Pipe Laying Vessel	1
Bulker	9	Excavation Vessel	1	Research Vessel	1
Container Ship	15	Ferry	2	RORO	6
Cruise Ship	5	General Cargo Ship	7	Tanker	13
Dive Support Vessel	1	Offshore Supply Vessel	2	Unknown	43

Source: Factual News Reports of Oil Leaking from Shaft Seals Dec 2022
available from Thordon Bearings at www.thordonbearings.com