# Still bearing up

## A tale of water lubrication

Tim Findley reveals the alternative to the oil-filled stern tube – good for the environment, good for boats. Welcome back to water lubrication.

HMNZS *Te Mana* at sea.

Last month's story was a stage-setter. In it we examined why on earth perfectly competent design engineers were abandoning a proven 100-year-old propeller shaft support system. If you missed it, we were looking at the oil-filled stern tube, which is standard to steel ships.

Increasingly, harbour authorities around the world are moving toward zero tolerance of oil spillage. And as they realise what a good source of revenue fines can be, they'll pursue each tiny teaspoonful, spreading to a widening and tell-tale slick.

Of all the shipboard regimes introduced to comply with "clean seas" requirements, stern tube oil leakage is the most irritating and most difficult to deal with. It has become such a huge issue that new buildings at shipyards everywhere are being equipped with water lube propeller shaft systems. But while water lube bearings have been round forever, none of them have offered the reliability and longevity of the sealed oil filled stern tube.

Without a driver, there's been no incentive for developments, so the phenolic resin cotton or asbestos reinforced, the so-called "Cutlass" rubber of today's polyurethane equivalent bearings, have been on the shelves since great-grandad's day.

The driver for development is there now, though, with environmental issues to the fore. As a consequence Thordon's COMPAC bearing, which for years had been caught in the inertia of existing classification rules, has emerged as front-runner in the water lube stakes, in as much as classification societies have recognised the material and design criteria as different.

### Really magic plastic

First, an apology for my blatant commercialism. It's very likely there's a competitive elastomeric bearing made by another company. If there is, I'm not aware of it, which is why I'm referring to Thordon and their COMPAC product exclusively.

Sure, there are any amount of magic plastics and all sorts of claims made for them, but Thordon's material is an elastomer. Accordingly, any comparison should be with another elastomeric product, not with nylon, teflon, polyester, acetyl or any of their derivatives.

It's a really rocky road, sorting out magic plastics. They've promised so much, and failed so often, that the marine industry is gun-shy. Nylon, for instance, absorbs water like a camel drinking, resulting in the bearing swelling and seizing. Polyester melts, if cooling is disabled, and so on.

Elastomers are different and here's a story to illustrate the advantages of that difference for propeller shaft bearing. It involves *Te Mana*, one of our Navy's Anzac-class frigates, and it's quite compelling.

*Te Mana* is built to the German MEKO 200 class design. She doesn't enjoy the stealth features of later buildings, but her speed, range, and multi-purpose capability, make her a formidable opponent. Her propulsion system is an example of her versatility. There's a pair of MTU diesels which give her a range of 6000 miles at 18 knots. When

she really needs to move, she can light up a gas turbine, putting out over three times the horsepower of the two V12 MTUs. Gearing and controllable pitch propellers take care of the difference in power availability, the turbine returning around 30 knots.

As regards armaments, it's interesting to note that First and Second World War ships were categorised by number and calibre of guns mounted. Today's ships are most likely fitted with only one large calibre gun. In *Te Mana*'s case it's a single fully automatic 5-inch, and it delivers way more firepower with much greater accuracy then her multiple-gunned elder sisters.

For air defence, *Te Mana* mounts NATO Seasparrow missiles and for close in protection, employs a Phalanx system. Phalanx integrates high frequency radar with anti-aircraft weaponry so accurately that it will defeat air or sea launched anti-ship missiles.

There are also a couple of torpedo tubes, but probably *Te Mana*'s best weapons asset is her Super Seasprite helicopter, which can launch all sorts of fire-and-forget weapons, from torpedoes and depth charges, to missiles. She's certainly not a warship to be trifled with.

Last year, *Te Mana* did a duty tour in the Persian Gulf. It's a dangerous area with several unfriendly states sharing the Gulf's coastline, and ships of all flags plying its waters. *Te Mana* was tasked with ensuring these many vessels were going about peaceful and legitimate business, be they fishing boats, tankers or cargo ships.

Lots of folks up there enjoy shooting each other and constructing car bombs. The UN had determined that cutting off the supply of armaments might be helpful in limiting such activities. What's really dangerous about that? A fully armed, battle ready warship stopping anything from Arab sailing dhows to tankers and verifying their bona fides?

Quite dangerous, actually. A high-speed launch, packed with explosives, disabled a top-of-the-line US warship a few years back.

Then there's the guy sitting in his little boat, fishing. Don't go too close, there's a chance he might just stand up with a shoulder launched anti-tank weapon. If one of those will knock out an Abrams main battle tank, it could certainly leave *Te Mana* dead in the water.

## Beware the fisherman

But it was neither of these violent scenarios that *Te Mana* was faced with. It was fisherfolk. It appears the locals' indiscipline with firearms and explosives extends to the laying of nets. The rationale seems to

Lower haft of a damaged COMPAC bearing (not from *Te Mana*) showing hydrolysis in centre of bearing due to lack of coolant. This bearing was used for another 10,000 miles after damage occurred.

be that there must be lots of fish in the shipping lanes, where fishing is forbidden. As a consequence, there's the nightmare of nets almost anywhere.

*Te Mana* found one. Round and round the prop and shaft it went, melting and penetrating the water intakes for the strut-mounted propeller bearing. They aren't dumb, *Te Mana*'s German designers. They'd fitted a 'silver bullet', ahead of the strut, to deal with such eventualities. This defence, however, was breeched rendering the water lube system inoperable.

Ever caught a net around your prop? Bad enough with a conventional keel-mounted stern bearing, and heaps worse if the prop is strut supported, with bare shaft ahead of it. This last allows net entanglement both aft and, more particularly, forward of the prop – a double whammy. And the speed of the wrap-up can do untold damage before realisation the problem exists.

It's entirely possible that a net of the right consistency, picked up in the worst-case scenario, could drag *Te Mana*'s 30,000hp turbine to a shuddering stop, the quite awesome power and capability of this warship brought down by a humble fishperson's net.

I'm not saying that's what happened. Nobody will tell. What we do know is that there was in incident involving nets, the result of which was water lube denial to the propeller shaft strut bearing. We also know that the Persian Gulf is a long way from Godzone and Devonport Naval Base's dry dock.

Navy divers know what they are doing and carefully cleared away the net, clearing melted, compacted material from the water intakes. But that's about as far as one may go, working underwater. Damage control is something everyone aboard, no matter their speciality, is highly trained for.

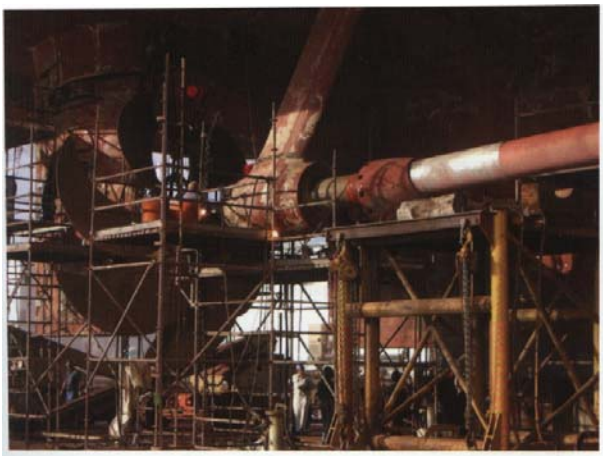
Brand new COMPAC bearing, showing the split-bearing system wiyh a single key allowing remove and replacement of hafts with shaft in place. Note that water-ways are cut in top half only; water is carried around by the spinning shaft to form a hydrodynamic seat.

## Let's go home

So, everything that could be done was done, and after consultation the decision was to steam for home. Pretty brave, that.

I have no idea what prompted this decision when the worst-case scenario is explored. That's when the bearing disintegrates and is washed away, allowing the shaft liner to contact the bearing shell – a not uncommon occurrence with water lube bearings. Of course, this ruins the liner, making shaft withdrawal necessary.

But that's not the worst, worst-case scenario. Imaging the rotating shaft, spinning inside the bearing housing, wearing though



Large A-bracket strut fitted with 25-inch Thordon COMPAC bearing. This isn't Te Mana's stern gear but is a similarly set-up, slightly larger, shaft on a different vessel.

the metal bearing shell that remains after the disintegrated bearing material has washed away. Imagine it wearing the shell right through at one point.

Interference fit of the shell is now released. It's not beyond the bounds of possibility that the shell turns, finds the now large gap above the shaft, and Murphy's Law doubles up to jam and wring the shaft. So there was a huge risk in turning south and steaming for home.

What may have prompted them was a clever measuring gauge that can be used under water to determine the extent of bearing wear. In this case, my understanding is the gauge recorded six millimetres between shaft and bearing. I'll bet any engineers reading this will say "Bearings totally stuffed". Yes, six mils is an awful lot. But it's within Thordon's tolerances for a 22-inch shaft!

Provided the water intakes to the bearing were clear, the COMPAC principle of the shaft spinning on a water seat, will prevail. And that's what happened. Back to Godzone at standard cruise, with bursts to full speed on "numerous occasions".

And here's the clincher for elastomeric bearings, revealed on disassembly. There was no discernable further wear occasioned by 10,400nm of steaming, after the incident. The shaft liner was unmarked. The bearing was replaced with the shaft 'in situ'. The saving to the Navy, and ultimately to us taxpayers, was enormous.

Drawing a 22-inch shaft is dramatic, elaborate, and enormously expensive. So is dry dock time. A several-week job was magically reduced to a several-day job.

Vic Demsey, the Thordon agency's man on the ground, comments "No-one, Navy engineers or civilian contractors, could believe how well the bearing performed after the damage it suffered. Everyone was expecting, and was prepared for, shaft withdrawal."

What escapes all of them is that if left unattended *Te Mana* could conceivably have circled the globe again, with no further stern bearing problem.

Anyway, she was back in service quick smart. And whether one agrees or disagrees as to whether we should have a blue-water Navy, the Anzac frigates mean our reach is far and our capability awesome – which is comforting for those of us who have business upon great waters.