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# Marine Risk Management in the 21st Century – friend or foe?

## Preamble

Changes in the marine insurance market in the late 1990's have given rise to an increase in risk management activities where commercial shipping is concerned. Shipowners sometimes view this with suspicion and feel that it is just another level of regulation which they have to deal with. The shipping industry has never been more subjected to rules and regulation than it is today and the feelings of shipowners are entirely justified.

The reasons for marine insurers taking a greater interest in risk management are numerous. Large losses in the marine market in the 1990's resulted in the demise of many marine insurers who felt that writing volume business would give sufficient premium income to deal with any claims that might arise. Writing business on this basis proved fateful for many and the number of marine insurers declined as a result.

Those that have survived have done so by using a more analytical approach to the risks they write. There is a new breed of underwriter who thinks carefully about the risks they are insuring rather than purely the amount of premium.

The FSA rules and regulations have had an impact and insurers need to show that their actions in insuring a particular risk are justified. Some insurers have particular risk profiles that they have to remain within, such as vessel age and type but occasionally have to stray outside of these boundaries and use risk management to give some degree of protection.

One way of addressing these concerns is to require surveys of the vessels and fleets which are being considered for insurance, particularly where the track record may not be known or the client has a poor loss record.

The London market has always been strong and among the varied insurance companies it has the capacity to insure any tonnage for a price, which is somewhat different to other markets which specifically avoid certain high risk areas.

The London market is however tempering their risk exposure with the requirement for risk management surveys.

At Inserve, we have tried to respond to the needs of the market in these changing times. We have tailored our surveys to meet the needs of the insurers. In the past, the survey companies which were supported by the London market carried out condition surveys, and this is still evident today. In conjunction with underwriters wishes, we now carry out risk based surveys. The basis for this comes from the experiences of the 1990's where it was found that most of the marine casualties arose from the way in which ships are operated, managed, maintained and manned rather than their physical condition.

Inserve take the view that there is no point going on board a ship and commenting solely upon condition. Structural failures are thankfully quite rare. The ship itself might be fine, but the crewing, management, mode of operation and types of cargoes for example might give rise for concern.

All of our survey products look at these more important areas, particularly the management. Often we combine a visit to the management with a survey of a ship or ships. This shows if the intentions of the management ashore are reflected on board.

However, they are risk based and as such look at areas which other surveyors, flag state inspectors, charterers, classification societies etc. do not deal with.

The reports are quite thorough and often contain a lot of recommendations, which can come as a shock, but we stress that these are risk reduction recommendations and not just a list of defects. As such they do address high risk areas and recommend ways to reduce them.

The purpose of this paper is to bring shipowners and insurers together in understanding these surveys more easily. They are intended to be of service to the shipowner who after all, does not want his ship breaking down and not able to earn freight. They are also intended to develop and strengthen the link between the insurer and his client on a technical level, which is now considered to be crucial to a long term relationship.

## Introduction

The shipping industry has never been more regulated than it is today, but unfortunately this has not resulted in a reduction of breakdowns, accidents, casualties and claims. It is not surprising when you consider the areas which the current regulators concentrate upon. Flag state, classification societies, charterers, P&I and port state control inspections typically focus upon rules and regulations such as ships certificates, crew qualifications, crew certificates, bridge publications and safety equipment being in date.

We take the view that a ship doesn't sink because a certificate is out of date or a fire extinguisher has not been serviced. The reasons for major casualties go far beyond that. In the overall risk profile of a ship, the current regulatory inspections all focus on similar areas at the lower end of the risk profile. There then exist large gaps in the risk profile through which all the hull and machinery claims fall, such as fires and machinery failures.

It is this gap or gaps in the risk profile which aren't covered by rules, regulations and the other surveys mentioned above that Inserve concentrate on. Our risk based approach has proven effective in reducing claims and casualties to the extent that all fleets surveyed have seen a reduction in claims activity and some have seen a complete elimination of claims altogether after having gone through the "Inserve process".

Does this result in a reduction in premiums? Yes it does. Insurers do not necessarily respond to an improvement in the loss record in the short term, but they do in the long term. More importantly the shipowners benefit from an improvement in reliability and in the current freight climate this is of enormous value.

Of course, some of the comments we make in this paper might refer to shipowners but to a great extent it involves the managers.

## Methodology

The risk management process that we use, is risk based not condition based or rules based. It draws upon a body of machinery failure data built up over the last 10 years, it looks at the present risk exposure and it is also forward looking. We try to predict where failures could occur in the future or where there is a propensity to failure such as a lack of redundancy – single point failures.

## Typical high risk areas

### Fires

Fires are still the greatest category of loss for insurers in terms of cost, albeit they account for around 10 to 15% of claims in terms of numbers – insurers have slightly differing statistics. In our view all fires can be avoided, given sufficient attention to the risks. Shipboard fires are generally caused in the machinery spaces where there is an escape of fuel or oil which ignites upon contact with a hot surface. An escape of fuel or oil can come from the most unlikely places and it is difficult to foresee this. However, it is quite within the capabilities of crew and management to eliminate hot surfaces and ignition points. SOLAS goes some way to address this but doesn't really explain how.

In our view, thermal imaging of engines, machinery and switchboards is a tool which all serious shipowners have at their disposal. We would encourage its use on a regular basis, during superintendent inspections and prior to drydocks and repair periods.

Around 95% of ships we survey have exposed hot surfaces on machinery, such as deficient insulation and lagging on exhaust pipes, exposed indicator cocks, and other hot spots.

“Hot work” is perhaps the next most common cause of fires, and the incidence of fire caused by cutting and welding while under repair in a shipyard or during routine onboard maintenance is increasing, and this is a particularly worrying trend. Despite the introduction of ISM and more formal safety management procedures there is still a fundamental lack of awareness of the risks by those on board and ashore. In a shipyard environment the ships staff often take their eye off the ball and assume that the yard are in charge of hot work and are taking the necessary precautions, whereas the yard assume that the ship’s staff are aware of what’s happening and are taking the necessary precautions. Seldom do the two work together harmoniously.

Maintenance work on board continues to involve hot work and while a permit to work system might be followed, it is often seen to be a paper work exercise without any real benefit. We find hot work taking place in the presence of large amounts of combustible materials even though a hot work permit might have been issued.

## Crankshaft bearings

In terms of claims frequency, crankshaft bearing damages remain the greatest category. These are most common on medium speed four stroke engines used as main propulsion on certain types of ship and more commonly as diesel generator engines on most ship types. High speed diesel engines as used on high performance ferries and yachts also fall into this category but they have a much greater propensity to failure.

There seems to be a widespread misunderstanding of how susceptible four stroke engines are to crankshaft bearing failures. Nearly all shipping companies that we visit do not pay sufficient attention to this area and have suffered failures as a result.

## Navigation

The next most prominent high risk area is with navigation. It is much harder to prevent navigation related losses which are often caused by a momentary lack of concentration or a genuine mistake. Fatigue has been blamed on occasions and this is something which is attracting more attention in recent years. There is also a general lack of navigational skills in today's seafarers and a greater reliance on electronic aids, which when considered collectively, goes some way to explain why such losses should still be occurring and not showing any sign of reducing.

Of course there are and always will be unavoidable losses caused by accidents, for which the insurance companies are required to respond, and indeed this is the whole purpose of seeking insurance. Heavy weather related losses are fortunately quite rare, but are often looked upon as preventable. In our view there have been various losses caused by adverse weather which insurance practitioners would never understand without having experienced such conditions themselves. While we endeavour to reduce losses wherever possible, we have to ensure that we do not become too cosy in our semi-office environments, that we forget what it is like to experience a storm at sea.

While we look at the entire spectrum of risk to a ship during our surveys, we stress to our surveyors that if they look at nothing else other than the risks of fire and crankshaft bearing failures, they will have made a huge improvement for the client and for the insurer. Hopefully, we always go beyond that and give added value, but to repeat my earlier words, the most significant risk reductions come from the most basic measures to prevent fires and crankshaft bearing failures.

## Watertight integrity

Another high risk area which seems to worsening is the crusty old issue of watertight doors on passenger ships and the need to keep them closed. Too any ships are still being lost due to progressive flooding of underdeck spaces when the hull has been breached, even though the rate of water ingress may be quite low.

## Risk reduction measures

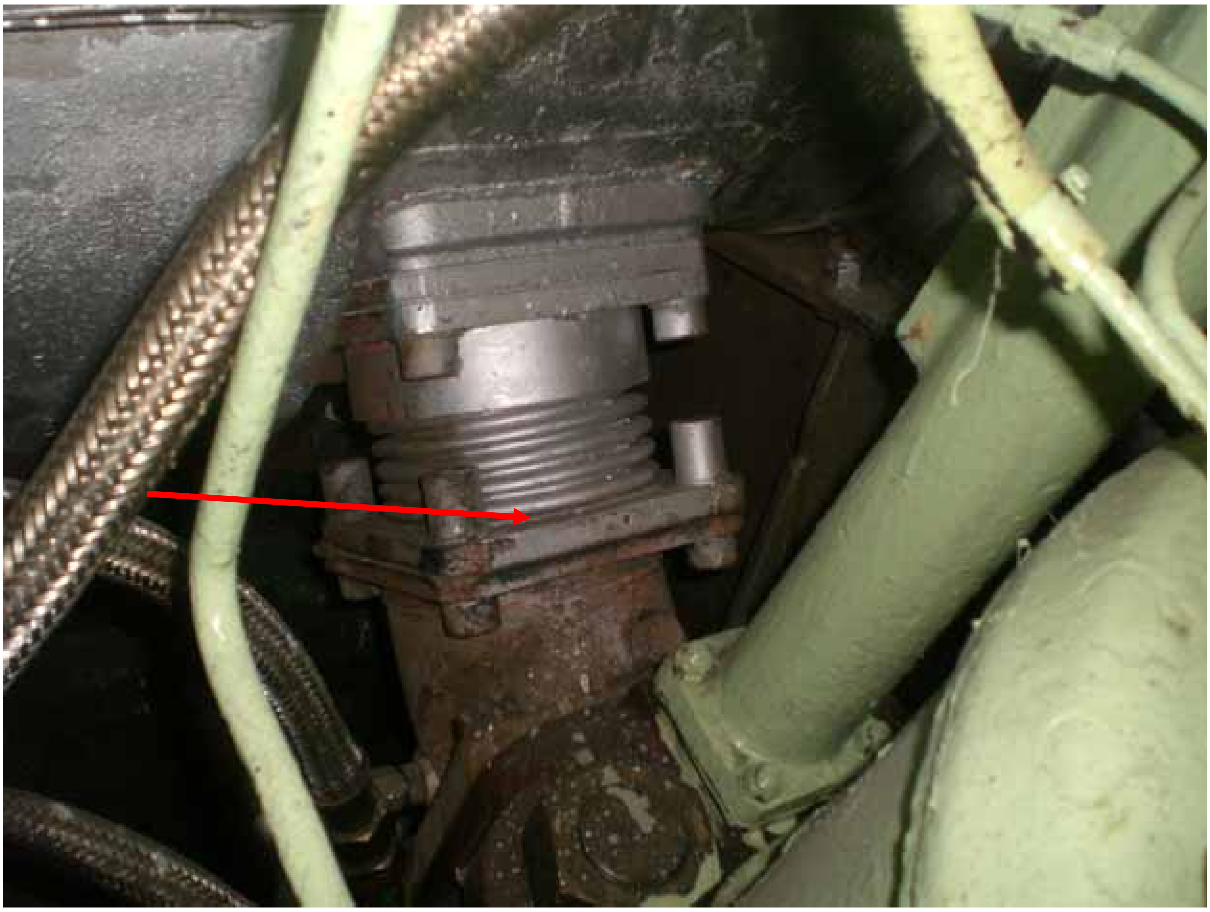
Having identified some of the most important high risk areas, what can we do to reduce risk and prevent losses?

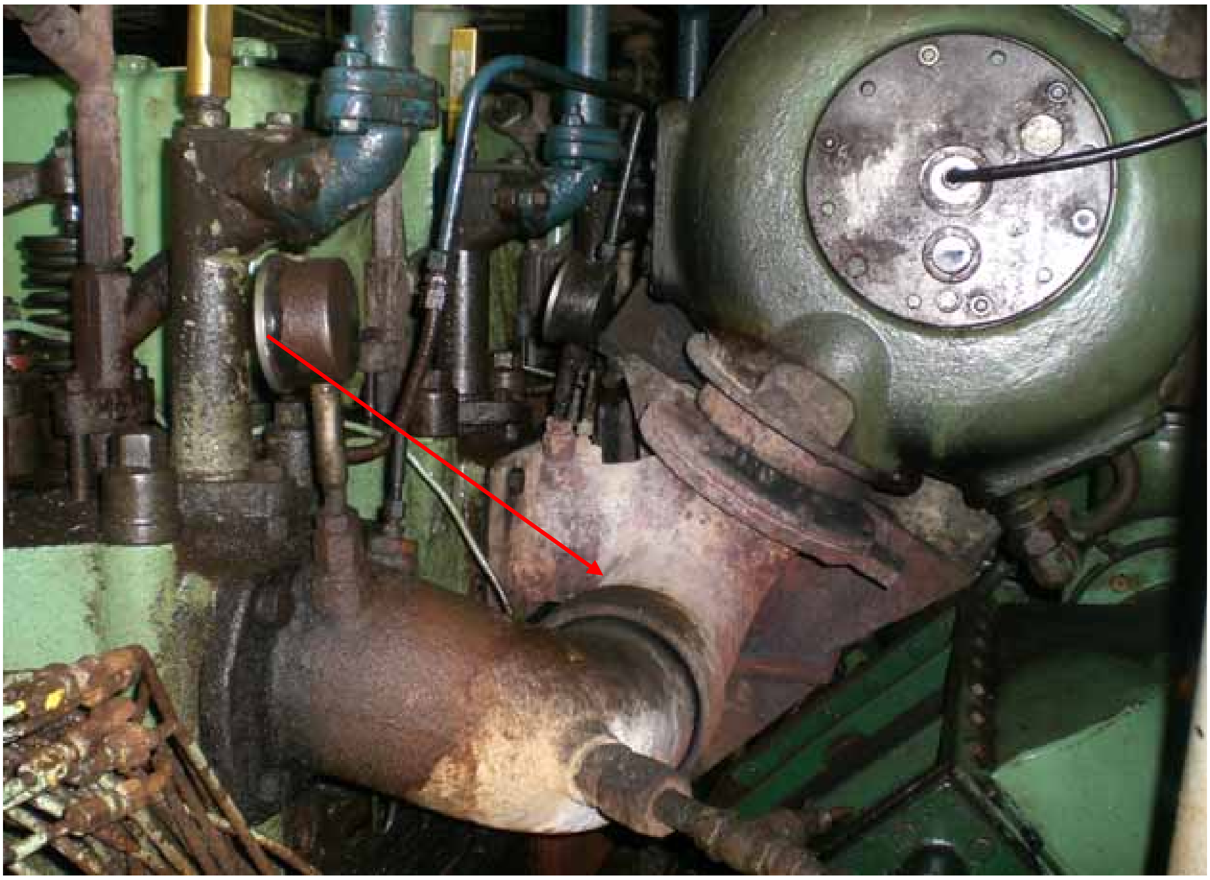
## Fires

With machinery space fires, shipowners are to a great extent at the mercy of the engine manufacturers. Marine engine manufacturers continue to produce engines which have exposed hot surfaces sufficient to cause fires if there is an escape of combustible liquid such as fuel or lubricating oil. Classification societies continue to approve marine engine designs and installations which are inherently unsafe. SOLAS has gone some way to try to redress this by saying that there should be no exposed hot surfaces greater than 220 C, but it is the classification societies that have been given the responsibility for applying these rules and they rarely do this effectively.

Naturally, shipowners feel that they have complied with all rules, regulations and class requirements, yet we come onboard and find significant high risk areas, which often come as an unnecessary inconvenience to say the least and our requirements to provide additional lagging and insulation is seen as unfair.

As already mentioned, in our view 95% of vessels surveyed are found to be deficient in this area and have exposed hot surfaces on machinery exhaust systems which can cause a fire. The following are a few examples. All are IACS classed vessels, and more worryingly, some are passenger ships.





Before above, after below.

These examples are quite extreme but it does show what in our opinion is a complete ignorance of these issues by the bodies which are responsible for overseeing the SOLAS regulations. Hence, from a common sense point of view, when we find these high risk areas we require that shipowners apply more lagging and insulation. We feel that the protection of hot surfaces in this way should be considered a minimum requirement of the London insurance market and I am sure that most shipowners would agree.

Often, shipowners argue that they are at the mercy of the engine manufacturers, and we sympathise with this. Some engine manufacturers show complete disregard for the protection of hot surfaces and manufacture engines which are inherently unsafe from day one. Caterpillar is a good example of this and generally it is the four stroke medium speed engine manufacturers which are to blame.

Two stroke slow speed engines do not suffer from the same level of vibration as four stroke engines, and their exhaust temperatures are lower, around 350 C. The design of the engines means that the exhaust lagging and insulation is rarely interfered with during maintenance, so it tends to remain in good condition and fire risks are generally low. They burn heavy fuel and even in the event of an oil or fuel escape there is rarely a fire.

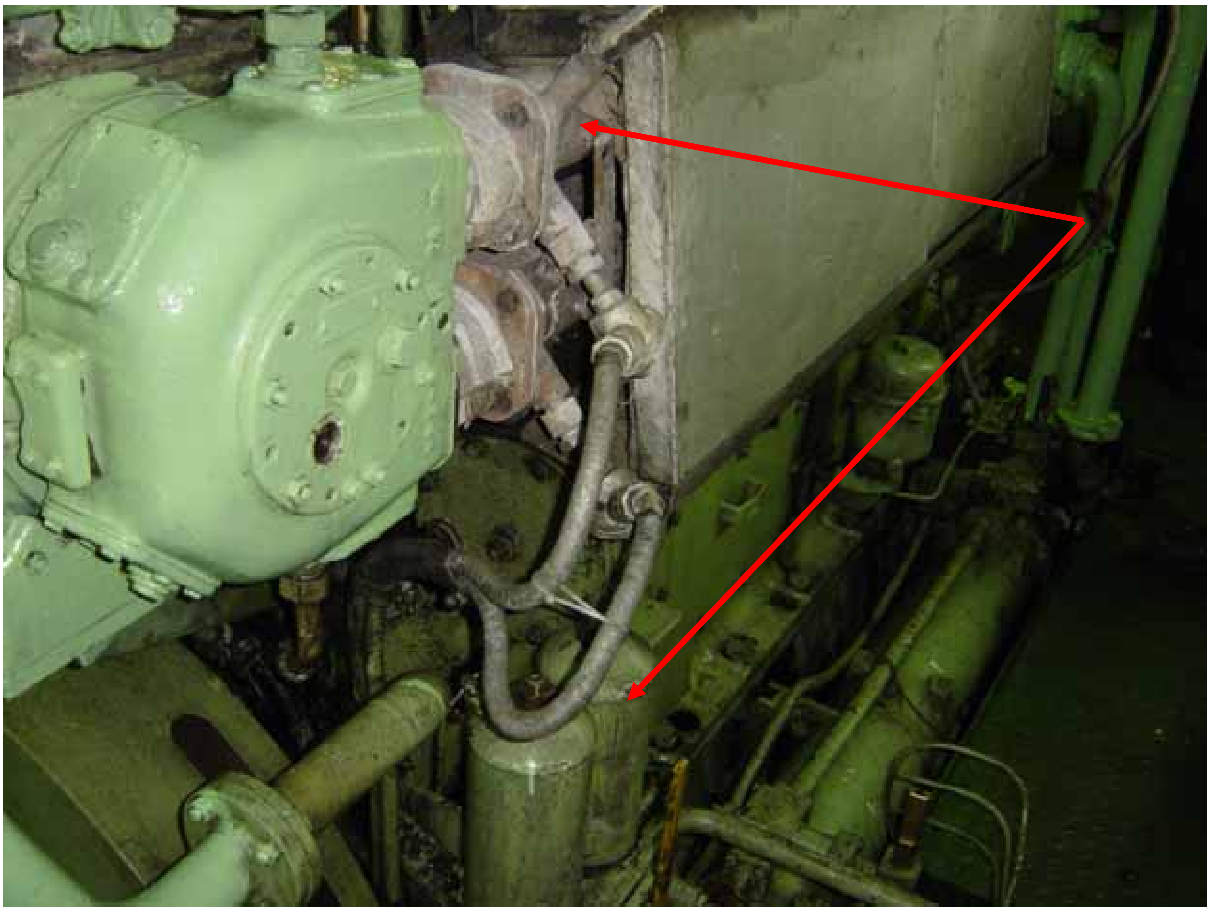
The majority of serious engine room fires occur on medium speed engines where the vibration levels are higher and there is a greater risk of a pipe failure through fatigue, rubbing, chafing or other means. The exhaust temperatures are higher, 400 C and above. Maintenance is difficult to achieve without disturbing the exhaust insulation around the cylinder head outlet or turbocharger inlet. Of course, generator engines fall into this category and they are present on nearly all vessel types often burning diesel or gas oil which is more combustible.

For operators of high speed ferries and similar type vessels the situation is often much worse, with exhaust temperatures of + 500 C often to the point where the exhaust pipes are seen to glow cherry red where the insulation has been disturbed, a clear indication of a very high risk of fire should there be an oil or fuel leak.

The following pictures are taken of a high speed passenger ferry with a normal camera, not a thermal imaging camera, with Caterpillar main engines.

Any kind of oil leak would immediately result in a fire. The exhaust lagging was in a poor state and the exhaust temperatures, heat and vibration had caused this deterioration.

The following two pictures show engines which are designed with fuel and lubricating oil filter modules in close proximity with the exposed exhaust pipes.



Prevention is better than cure, and the only real solution is to apply better lagging and insulation until the exhaust system is fully covered and surface temperatures have reduced to safe levels.

Engine manufacturer's could do a lot more to improve the situation. Water jacketed exhaust systems are the answer but most seem reluctant to introduce these.

Smaller engines sometimes have water jacketed exhaust systems, but MTU are perhaps the only manufacturer where watercooled exhaust systems are an integral part of the design on engines over 5000 KW. As a consequence, an oil on hot surfaces type of fire on an MTU engine is just about impossible.

As for the cure, most ships are fitted with CO2 smothering for the engine room which is fine in theory, but casualty investigations have shown how ineffective it can be. Before it can be used, the engine room should ideally be evacuated of personnel, the machinery stopped, ventilation fans stopped and fire dampers closed. This can take some time particularly on complicated ships such as passenger vessels, ROROs, cruise ships where the dampers are numerous and in different locations. Numbering or colour coding can help to speed up the process but the delays can be costly in terms of structural damage being caused by the fire.

Some CO2 systems have failed to activate due to seized mechanisms (they cannot easily be function tested and seized valves and activation cylinders are only discovered when the system is needed in an emergency).

The CO2 once injected, does not have a cooling effect and re-ignition is quite common, particularly if the concentration has become diluted from a damper left open or if premature entry has been attempted.

Foam systems are no better. Most commonly the engine room foam nozzles are situated in the bilge areas, boiler flat, purifier room, generator flat and are seemingly intended to smother oil fires and fill the engine room from the bottom up. This arrangement is no use for the majority of fires where the seat of the fire will be on the main engine or generator engine exhaust manifold, quite high up in the engine room.

It has always been puzzling to us why greater use is not made of water spray for engine room fire extinguishing. It can be applied immediately, protects the lives of any personnel trapped in the engine room, can be applied without stopping the engine, stopping ventilation, closing dampers etc and it has a cooling effect as well as an extinguishing effect. Most importantly there is an unlimited supply.

Thankfully it is now becoming more common on passenger ships where it has been found to be very effective and considered the primary system when fitted in conjunction with CO2 for example. Hopefully, it will be more widely adopted throughout shipping in the future.

One of the most fundamental issues which has a huge impact on fire safety is the closure of fire doors at the engine room boundary. Around 70% of vessels surveyed have fire doors gagged open, closers removed or doors removed to the extent that it would allow the fire to spread and reduce the effectiveness of the extinguishing medium. Most notable of these is the fire door between the engine room and the steering flat. This is commonly found gagged open sometimes to the extent that proper hooks have been tailor made and fitted which must have taken some effort!


Unfortunately the gagging open of this single fire door can be fatal. The foam system and emergency fire pump are often fitted in the steering flat and in the event of an engine room fire, they would be rendered useless. Where CO2 is concerned, the steering flat is not a machinery space for the purpose of calculating the volume / amount of gas needed, leaving this door open will have a diluting effect and reduce its effectiveness.

The other most blatant disregard for fire safety is the gagging open of sight glass valves on oil tanks. Similar to fire doors, it appears that the whole purpose of these has been forgotten. When these are gagged open, any engine room fire will melt the sight glass and instead of just the content of the sight glass escaping, the entire tank contents will spill out, feeding the fire and in a lot of cases, making it impossible to extinguish by any means. Gagging of sight glass isolating valves is found in perhaps 80% of ships we survey. Similar to hold backs fitted to fire doors, sight glass gags are often found to have been fashioned out of brass or copper plate and in some cases, proudly polished.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Similar to the spring loaded oil tank sight glass valves, it is also seemingly forgotten why double bottom tank sounding pipes are fitted with self closing weighted cocks, and these are also found gagged open or disconnected.

These last few issues are a matter of training and awareness. They are “housekeeping” issues or seamanship. Good housekeeping is about reducing oil leaks, keeping bilges clean, keeping fire doors shut, watertight doors closed, sounding pipe cocks shut and sight glass valves closed.

Far more education is needed where hot work is concerned. The industry continues to experience too many fires caused by cutting and welding in the vicinity of flammable substances. The permit to work system doesn’t really have any effect in reducing risk. Often it is seen as unnecessary paperwork signed off by personnel who haven’t even visited the work place.

Hot work in shipyards is often a cause of fire, and only afterwards is it found that nobody was really overseeing the operation. The ship’s staff assume that the yard are keeping an eye on things. The yard assumes the ship’s staff are aware of the work taking place and have made the site safe. The reality is that neither is taking the matter seriously.

Sadly it is very often only after a fire has been experienced that seafarers become more aware of the dangers. Superintendents also. With large fleets, where we find fire risks to be too high, we might recommend thermal imaging once per year so that the ship’s staff and the superintendents can clearly see the risks for themselves. It is amazing how many companies that haven’t experienced a fire will argue against the need for this. Those that have experienced a serious fire are often doing it already.

## Crankshaft bearings

Crankshaft bearing failures are most prevalent on medium and high speed diesel engines. The slow speed two stroke direct drive main engine remains a very reliable form of propulsion even though combustion pressures and power to weight ratios have increased in recent years. We can never understand why anybody would have wanted to install a Vee 16 Pielstick PC3 or a Vee 12 MAN 52/55 medium speed main engine / gearbox arrangement in a large bulk carrier where there is plenty of room in the machinery space for a 6 cylinder slow speed direct drive two stroke engine.

Of course, smaller ships and those of a particular design where there is a lack of headroom such as passenger ships, ROROs, some reefers, are more suited to medium speed main engines, although nearly all vessels have them installed as generators to provide electrical power.

There is essentially one fundamental difference between the slow speed two stroke and four stroke medium speed engine which affects reliability and that is cylinder liner/piston ring lubrication. On the two stroke the cylinder liner is lubricated by oil injected into the liner / piston ring pack. Having fulfilled its purpose of lubricating the piston rings and cylinder liner and neutralizing the products of combustion, it is drained from the under piston scavenge space and disposed of. On the four stroke engine, the cylinder liner / piston ring pack is lubricated by oil from the crankcase, sometimes by pumping it into the piston or spraying it on the cylinder liner walls. The purpose is the same, but instead of disposing of it, the oil falls down into the crankcase taking with it the products of wear such as iron, and products of combustion such as acids and soot.

It is these combustion products which have the most detrimental effect on the oil and despite measures to remove them they can and do build up and affect bearing lubrication.

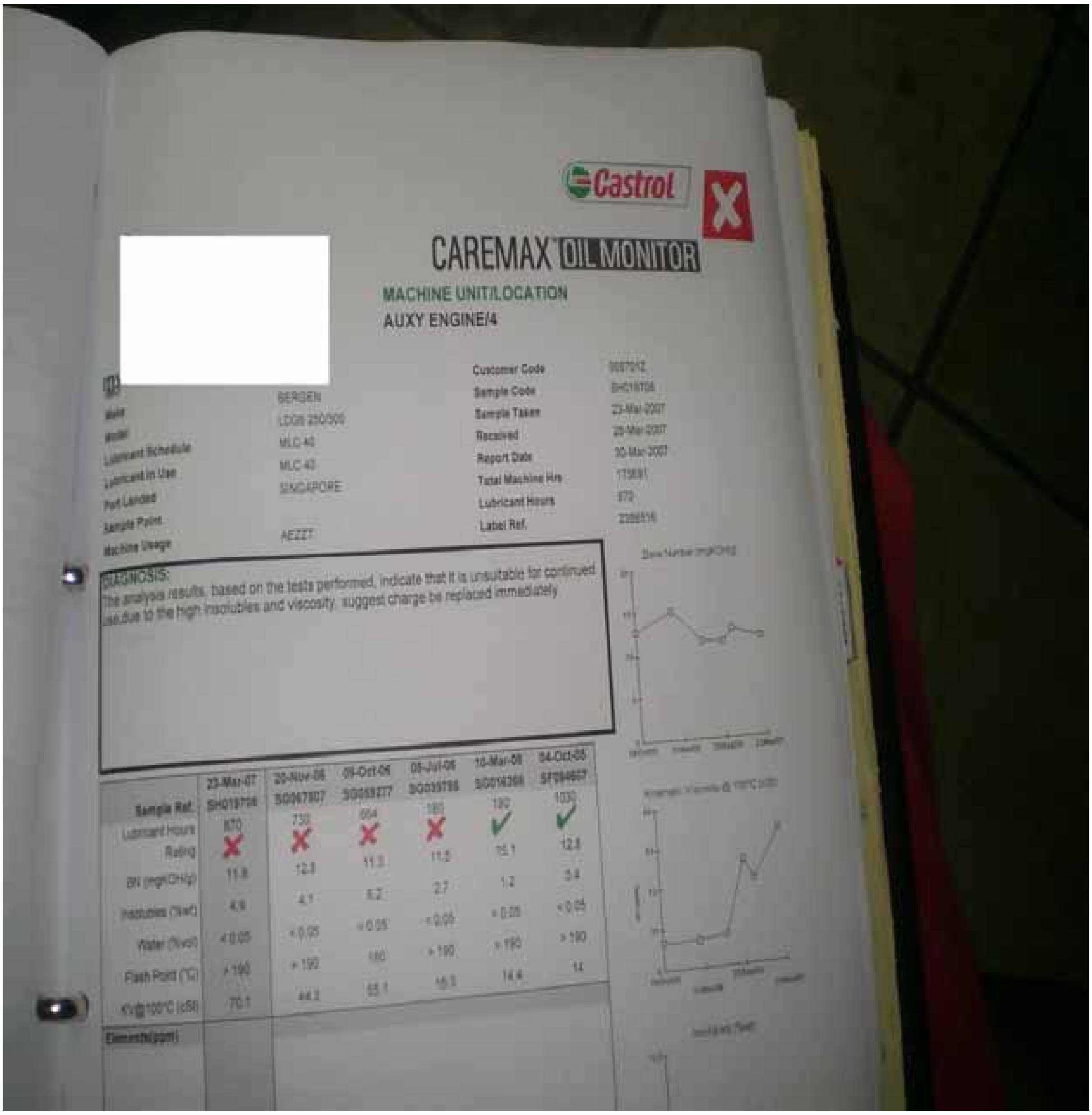
Other contributory factors include the higher rotational speeds and higher bearing loads which give rise to ovality of the connecting rod bearing housings and the crankshaft bearing surfaces, the deterioration of the connecting rod mating surfaces and the fatigue of connecting rod bolts. During overhauls ovality is commonly overlooked.

The four stroke engine connecting rod experiences a stress reversal during the induction stroke which the two stroke engine does not. The effect of this stress reversal is to expose the connecting rod bolts to cyclic stress such that they can suffer from fatigue. Most bolted fastenings in this region have a finite life, often around 20,000 hours or five years, but this is not always disclosed by the engine manufacturers.

There are other factors behind the poorer reliability of four stroke engines when compared to two stroke engines, particularly when considering high speed engines such as those on fast ferries, but if we just consider the main points above we will be dealing with the majority of them.

Risk reduction measures include the sampling and testing of the lubricating oil on a regular basis. Most companies use the oil testing services provided by the oil supplier, and it is customary to sample and analyse the important lubricating oils every three months. Better still if the vessel has an onboard test kit where the staff can check the important lubricating oils every week, even if it is only for the basic parameters such as viscosity and water content. This is also useful for the stern tube bearing where it is oil lubricated, as this is a typical single point failure item and reliability can be improved by regular monitoring of oil quality and temperature.

Laboratory results are generally sent to the management for onward transmission to the ship. Very often the superintendents are too busy to scrutinize the results and rely on the laboratory to flag a warning or alert. Unfortunately the laboratory work to industry norms and do not have any intimate knowledge of the machinery, so can sometimes pass an oil as being fit for further service whereas for a particular engine it would be considered poor. Levels of insolubles and levels of wear metals are examples of this.




Maintenance and reliability of safety and protection devices such as low oil pressure alarms and trips, high cooling water alarms and trips can have a mitigating effect in the event of a crankshaft bearing failure by alerting the operator and slowing or stopping the engine. Other more sensitive devices exist such as metal particle detectors in the oil circuit more often found on aviation engines but occasionally found on marine.

One misconception is the role of the oil mist detector. The oil mist detector was installed on marine engines to help identify and warn of an impending crankcase explosion. A crankcase explosion occurs when a bearing starts to fail, overheats, and the hot oil vapour which is created forms a mist in the crankcase, which when it comes into contact with the overheating bearing, ignites.

By the time the oil mist detector has detected this explosive mist in the crankcase, damage will have been sustained. In fact, some damage has to be present for the overheating to occur in the first place. But by the time the oil mist detector sounds and the engine is slowed or stopped, very often serious damage has been sustained by the bearing shell and the crankshaft.

In extreme circumstances this will involve the renewal of the crankshaft and/or bedplate.

So, accepting that an oil mist detector is there to protect the lives of those in the engine room and not to prevent physical damage to an engine, what can we do to help reduce the high number of crankshaft bearing failures?

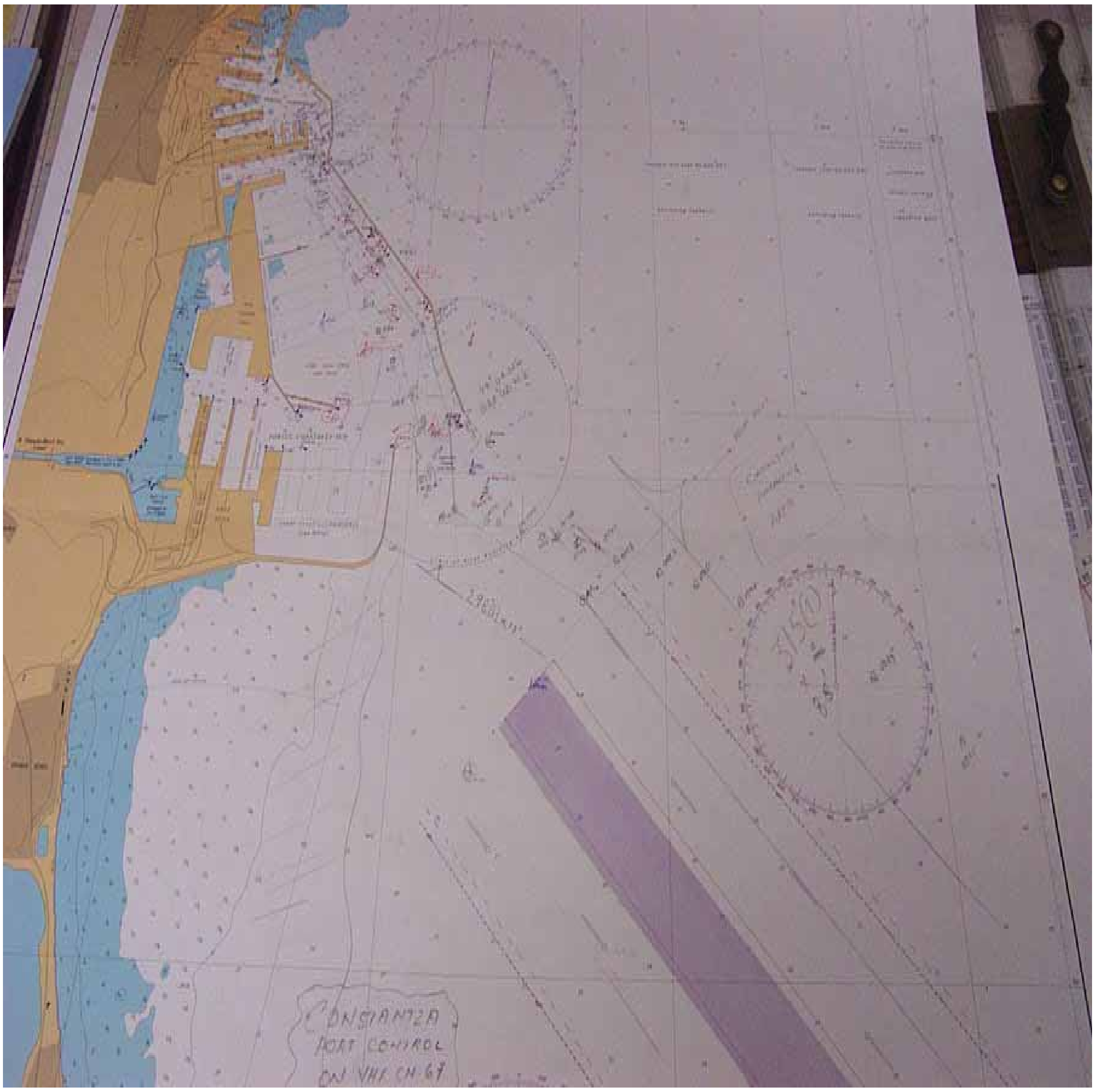
Bearing temperature monitoring has been available for years, but is only just coming back into fashion. On the slow speed two stroke engines it has been more common, having been fitted as an optional extra since the early 1970's on all crankcase bearings, crossheads, connecting rod bottom ends and main bearings.

On the four stroke engine it has been quite common on the main bearings where a static probe is sufficient, but the connecting rod bottom end bearing is the most common to fail, and the misconception has been that the oil mist detector will give sufficient coverage, although we can see that this is not the case.

More recently, the four stroke medium and high speed engine manufacturers have shown greater interest in measuring the temperature of the connecting rod bearing either by collecting oil that is sprayed out from the bearing (splash oil monitoring) or (crank bay monitoring) or measuring the actual bearing temperature using a probe and a pick-up on the inside of the crankcase door. Either method works well and is very effective at detecting the first signs of a bearing failure. The system can be connected to a slow down or shut down to prevent damage. The only damages which have still occurred where such a system has been fitted are those where the operator has ignored or bypassed the alarm.

## Navigation

The diminution of skills and the over reliance on electronic aids seem to have gone hand in hand over recent years. Rarely do we find chart work at a level that we would describe as best practice, i.e. positions taken with reference to fixed objects, radar bearings, parallel indexing, no-go areas, abort points, safe anchorages etc.



A review of navigation related accidents shows a large number of them to have been caused by fundamental errors, failing to keep a proper watch (i.e. looking out of the windows), plotting a course over an area which is shallower than the draft of the vessel, not considering the effect of squat, failure to keep sufficient distance from targets and failure to follow accepted collision regulations.

From a loss prevention viewpoint it is difficult to improve navigation risks where they are seen to exist. The ICS Bridge Procedures Guide is one good book that should be available on board and along with others such as Risk Management in Shipping, Captain Swift (Nautical Institute) it is a matter of training, training and more training to try to improve navigational skills where weaknesses have been identified.

Identifying the weaknesses is not easy, as a shipping company superintendent would rarely go on board and assess the standard of navigation. Nor would an ISM audit necessarily identify poor navigational practices.

## Watertight integrity

The discussion over the correct use of watertight doors on passenger ships is always an emotive issue, and one that we encounter quite often because we sail on board the vessels during our surveys.

Similar to navigation, we rarely come across best practice being applied. In most cases we find the watertight doors being left open continuously in the knowledge that they can all be closed from the bridge in an emergency. Sadly, casualty investigations have shown that in a real emergency their closure is often overlooked, or they fail to operate when needed, are blocked with debris or damaged by the casualty.

It seems to be an awareness issue as much as anything. There may be an emergency checklist or procedures to follow in the event of a grounding. The closure of the watertight doors is often well down the list at item 6 or 7, whereas it should be item 1 in our opinion.

## Conclusion

We are privileged in having met so many shipping and shipmanagement companies and we always stress that there isn't a right way or a wrong way to manage ships. We learn a lot from whoever we visit and we try to take note of best practice and good ideas and try to spread these around for everybody's benefit.

We have highlighted a number of high risk areas and they may seem quite fundamental and basic, which they are, but they are still responsible for the majority of claims and casualties. As an industry it seems that the problems presented by crew shortages and crew quality mean that we have to concentrate on the fundamental issues and get these right, before we need look elsewhere for effective risk reduction and loss prevention.

Shipowning and ship management companies are finding it increasingly difficult to find good shore based technical staff. A good engineer superintendent is worth his weight in gold these days, but he needs to be much more hands on than ever before, giving advice and training to the crew as well as ensuring his ships pass through the barrage of rules and regulations in today's shipping environment to say nothing of keeping them reliable and reducing levels of risk.

The ratio of ships to superintendents is an interesting one and while most companies consider five ships per superintendent to be a reasonable number, it is evident that those who try to operate with as many as ten per superintendent do not enjoy such a good level of reliability. It is a very real indicator in our view.

Our examples of common high risk areas and the measures that can be taken to reduce them should be seen as helpful. We are a friend not a foe. We should not be seen as just another level of regulation or requirement. We do genuinely want to assist in reducing losses and as can be seen from the above, it should not be difficult to do so.

Simon Groves

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September 2011