# Loss Prevention Case Studies

MSMI

MARINE SHIPPING MUTUAL INSURANCE COMPANY LIMITED

# Contents

# Introduction

Accidents and incidents may never be totally avoided, but their frequency can perhaps be reduced significantly. One way to understand why incidents occur, and as a consequence what can be done to prevent them happening again, is to learn from the mistakes of others.

MSMI handles many claims involving accidents and incidents every year. Selected ones are used for case studies from which the entire Membership can learn useful lessons. Each study is based on an actual incident, accident or claim, but is written so that the identities of the actual ships, companies or people involved are not revealed.

Each case study is kept brief and to the point, and examines what happened, what went wrong and, most important of all, what lessons can be learnt so that steps can be taken to ensure that it does not happen to us!

Case Study 001

## Main Engine Damage

# Bolt failure causes catastrophic damage

The ship was at sea when she suffered a massive failure of her main engine, a Sulzer 8ZL 40/48. The ship managed to anchor safely and was considered not to be in danger; she was eventually towed to Rotterdam on a fixed-rate contract of US$10,000.

### What happened?

The ship was underway and proceeding into port when excessive vibration was noted. Initial investigations considered the source to be a flexible coupling that was due for renewal at that port. Simultaneously, the crankcase oil mist detector alarm and the main lubrication oil pressure alarm sounded. The engine stopped with a loud bang some two minutes later.

A detailed inspection, including attendance by an MSMI surveyor, discovered initially that a crankshaft counterweight had passed through Number 3 starboard crankcase door. A main bearing jacking device had passed through Number 3 port crankcase door.

Severe damage also occurred to Numbers 3 and 4 bottom ends, as well as major damage to pistons, liners, a cylinder head crankcase, entablature and engine block. Damage was so severe that a complete engine replacement was considered. Because of technical difficulties, it was not possible to replace the engine and the more expensive option of a complete rebuild was required. The engine was removed from the ship. The final cost of repairs was US$1.5 million.

### What went wrong?

The cause of this catastrophic incident was the failure of a single counterweight bolt on Number 3 counterweight. It was reported that the bolts were not subject to any planned maintenance other than routine testing of their correct tensioning.

### What can we learn from this incident?

The correct inspection procedures and tensioning of bottom end bolts and crankshaft counterweight bolts should be completed in strict accordance with manufacturers' instructions. If such inspections are not identified in engine instruction manuals, advice should be obtained from the engine builder.

Any locking arrangements should be carefully fitted by a competent person.

The use of non-destructive testing is strongly recommended when checking these components.

Case Study 002

Main Engine Damage

# Poor maintenance results in major failure

The main engine of this ship (a MAN 14V 52/55 A) suffered major failure and the ship was diverted for repairs and an investigation into the cause of the incident.

## What happened?

Whilst the ship was entering port and under "stand by" manoeuvring conditions, smoke was seen coming from the crankcase seal at the flywheel end of the main engine. With the vessel safely berthed, the engine was allowed to cool alongside, before a crankcase inspection was undertaken. The inspection identified debris and metal particles beneath Numbers 6 and 7 units. A more detailed investigation identified the problem unit to be 6A.

It was decided to investigate further and Number 6A unit was opened. The vessel's crew found damage to the cylinder liner and, on pulling the piston, found damage to piston skirt, piston crown and piston rings. The piston and liner were replaced and the vessel continued on passage. One month later, the main engine automatic lubricating oil filter was found to be blowing down excessively due to heavy carbonaceous deposit build-up. Investigation found that several pistons had seized and revealed badly broken piston rings.

After these repairs were completed, it was discovered that oil was coming from between the piston skirt and crown of yet another piston. The gap was checked and found to be excessive and beyond acceptable limits. Used spares were fitted to facilitate this repair. Over the following months, the engine suffered similar problems.

Finally, specialist MAN service engineers were called in. They advised that the engine be completely stripped down, with all units to be checked, calibrated and overhauled.

Eventual repairs included the replacement of ten pistons, ten liners and all the additional parts associated with such a major renewal of components.

The final cost of these repairs was in the region of US$300,000.

## What went wrong?

The general condition of the engine and machinery spaces was considered by specialists to be very poor. The turning gear was inoperable, while the engine had several major oil leaks, water leaks and exhaust gas leakages. The crankcase was found to be excessively pressurised. There were no spares available and "used but good spares" were being fitted. Major engine components were found to be wrongly assembled and beyond manufacturers recommended limits. The fuel timing was wrong, fuel pumps and injection valves were in a very poor condition, and several cooling water pipes were partially blocked. The watchkeeping practices were also the subject of criticism, particularly regarding a build-up of water in the bunker tanks regularly, as they were not being sludged.

It was concluded that the damage could be divided into three principal causation categories, damage to pistons due to incorrect assembly of crowns and skirts, damage due to excessively high ignition pressures, and general wear and tear and poor maintenance.

## What can we learn from this incident?

Good maintenance and general upkeep of ship's plant is vital. It is essential that sufficient spares are carried and that maintenance is completed correctly, on time, by fully competent staff and in accordance with manufacturers' instructions.

The use of "used but good" spares is to be actively discouraged.

In this case, a repair yard had been involved in some of the repairs. This case supports the view that shore repair staff should be closely supervised by ship's engineers and attending surveyors. In order to achieve this, it is essential that seagoing engineers and superintendents are fully conversant with engine maintenance schedules and procedures. If necessary, engineers should attend manufacturers' courses.

Conscientious, correctly completed maintenance programmes using competent engineers will prevent many major incidents and claims.

## FOOTNOTE:

The managers of this vessel are no longer Members of MSMI.

Case Study 003

## Main Engine Damage

# Lubricating oil problems

The ship was on passage from North America to the Far East when the main engine lubricating oil pressure suddenly dropped and the engine, a Mitsubishi 6 UEC37H-11B, stopped on low lubricating oil pressure trip.

### What happened?

After the emergency shutdown, the engine was allowed to cool before the crankcase was opened to facilitate inspection. This inspection revealed traces of white metal in the crankcase and the engine sump. It was subsequently discovered that the white metal had come from Number 1 main bearing, which had turned in the bearing pocket. Lesser damage of a similar nature was found to Number 2 main bearing.

Repairing the damage required machining of the crankshaft and the fitting of oversized bearings, as well as line-boring of the bearing pockets. These repairs were then the subject of extensive testing, including trueness and magnaflux testing.

### What went wrong?

A combination of factors were put forward as the possible root cause of this incident:

- Fluctuating lubricating oil pressure.
- Dirty lubricating oil.
- Poor temperature control of the lubricating oil.
- Incorrect onboard treatment of lubricating oil.

The result was an insurance claim in the region of US$450,000.

### What can we learn from this incident?

This claim was the result of serious damage to engine bearings. Many insurance claims submitted to MSMI are for this type of failure and often causation is never established. However, in this case causation was firmly due to the condition of the lubricating oil.

Lubricating oil is the "life blood" of any piece of machinery and if it is not correctly treated and looked after on board ship, then engine failures similar to those above will occur. On board treatment of lubricating oil is a vital part of the operation of the plant. Purifiers, clarifiers, heaters, filters, etc. all have a part to play in the onboard condition of lubricants.

Oil should be treated in accordance with lubricant, manufacturers' instructions and stored, used, analysed and replenished as and when required. System temperatures and pressures should be maintained as per engine manufacturers' instructions. Low oil pressure alarms and shutdown should be carefully set and regularly tested. Pressure gauges and thermometers should be calibrated and maintained in good order.

The oil suppliers all have test programmes and these should be adopted, to allow continuous monitoring of the oils condition. Sumps should be maintained at working levels, being replenished regularly and often (little by little) rather than allowing levels to drop to minimum levels and then topping up. Filters should be regularly cleaned, if possible on pressure differentials, and cleaning should be done by competent staff to ensure that all components are correctly reassembled.

The correct care of lubricating oil and lubricating oil system components is extremely important in the care of engines - it will help to prevent incidents and claims.

Case Study 004

# Main Engine Damage

## Incorrect assembly causes cracks

During a routine overhaul of both Ruston 8RK270M main engines on this ship, two connecting rods from each engine were found to have suffered cracking in the joint face serrations.

### What happened?

The vessel was undergoing routine drydock maintenance when the cracks were identified. Both engines had completed 43,000 hours of service and were undergoing repair under a planned maintenance programme. The cracks were initially identified by dye penetration detection methods. The existence of the cracks was confirmed by subsequent magnetic particle testing methods.

After metallurgical analysis by Ruston Diesels on both the cap and rod serrations, it was established that the cracks originated from within the root of the serrations.

### What went wrong?

Comprehensive testing of the components identified no metallurgical defect in the manufacture of the connecting rods. However, it was established that failure was due to incorrect assembly after manufacture.

Failure was considered to be as a result of misalignment between rod and cap introducing abnormal stresses across the serrations.

The high stress concentrations within the serrations could well have been sufficient to initiate fatigue cracks.

### What can we learn from this incident?

It is essential that during engine overhauls the correct assembly procedures outlined in the engine builder's manuals are closely followed.

Regular maintenance such as that carried out in this case is essential and this should include, as a matter of routine, crack detection and testing of engine components. If cracks such as those identified in this incident had remained undetected, the results would have been a catastrophic failure and a major insurance claim.

This advice is relevant to all engines incorporating this type of bottom end serration arrangement.

Case Study 005

## Main Engine Damage

# 'Off-spec' bunkers damage engine

The ship stemmed "off-spec" bunkers in a northern European port prior to undertaking a voyage to Australia via the Panama Canal. As soon as the ship's main engine started consuming the "off-spec" fuel oil, the engine performance began to suffer. The engines subsequently suffered serious damage and the ship was delayed.

### What happened?

The vessel stemmed some 2,000 tonnes of heavy fuel oil of viscosity 380 Centistokes (Cst) at 50ºC in northern Europe. The ship had sufficient bunkers on board for the first ten days of her voyage and then changed over fuel oil to begin burning the "off spec" bunkers.

Almost immediately the main engines, medium-speed trunk piston engines, began to suffer problems. Both main engine turbochargers began surging, and exhaust temperatures were variable and higher than normal. The overall plant performance fell away. Soft waxy carbonaceous deposits began to form on the cylinder head valves. The fuel pumps and injectors also suffered extensive damage.

As a matter of necessity, additional bunkers were purchased prior to the Panama Canal transit, which enabled the ship to reach her port of destination. The "off-spec" bunkers were landed at the destination port, and new bunkers were purchased and loaded onboard.

### What went wrong?

Although a bunker pre-load survey was conducted prior to the bunker stem being lifted, NO samples were taken during the bunker loading. It subsequently transpired that the 380 Cst fuel oil had an extremely high brackish water content and it was this that led to the major engine problems. Later it was discovered that because the water was held in suspension and the fuel oil emulsified, the water could not be removed in the conventional manner.

As a result of attempting to burn the "off-spec" fuel, damage was sustained by the main engines and their turbochargers, which formed the basis of a hull and machinery claim under the terms of the shipowner's Hull policy.

Because the ship's technical staff had no bunker samples, no technical information and no guidance on the best treatment and consumption of these bunkers, they were left to try to burn the fuel in the ship's engines. As a consequence, the plant sustained damage.

### What can we learn from this incident?

Whenever bunker fuel oil is loaded, it is essential that a thorough bunker pre-load survey is conducted, accurate representative samples are taken at the time of loading and an analysis of the sample is obtained, preferably before using the fuel.

The importance of good onboard practices and bunker sampling can not be over- emphasised. It is also critical that owners make all ship's staff aware of the importance 0of collecting contemporaneous evidence to support any claims that may follow.

Correctly labelled representative samples are probably the single most important piece of evidence available to the shipowner in the event of a bunker quality dispute arising. However, additional supporting evidence is essential if a shipowner is to see a successful conclusion to a bunker dispute claim.

Further information relating to bunker disputes and their successful resolution is available from the loss prevention department at MSMI.

Case Study 006

Main Engine Damage

# Sediment build-up during lay-up

The main engines on this small coastal tanker suffered loss of power and excessive exhaust temperatures as well as major overheating of the turbochargers, which meant that the vessel had to be operated at reduced power and speed.

## What happened?

The vessel had recently been laid up but was reactivated prior to going on trials and resuming trading. Major maintenance work was undertaken to ensure that both medium-speed V12 main engines were fully operational and in good condition.

Both main engines performed to expected performance levels on trials but, on the vessel's first major voyage after reactivation, serious problems were experienced. The vessel encountered severe weather conditions in the Caribbean which led to severe rolling of the vessel through an arc of some 80°.

## What went wrong?

The severe weather conditions led to the sediment in the vessel's fuel tanks - which had built up in the daily service tanks during the period of lay-up, to pass to the main engine fuel system. The main engine fuel system and fuel filters, together with main engine fuel parts including fuel pumps and injectors, were affected by this contamination.

The engine, which was of a V-design, struggled to maintain power but the engineers increased the power by loading up the engine until maximum exhaust temperatures were achieved. It eventually became apparent that one bank of each engine was running correctly while the other had blocked fuel filters, which meant that one bank of each engine was carrying full power. With a centrally sited exhaust temperature probe indicating acceptable average exhaust temperatures, things were thought to be in reasonable condition. However, it quickly became apparent that the turbochargers were experiencing major overheating hidden behind lagging and the exhaust temperatures were above safe levels.

All fuel pipes and fuel filters were removed and cleaned of sludge and sediment before acceptable operating levels were once again achieved.

## What can we learn from this incident?

It is vitally important that all duty engineers actively inspect the engineroom on a regular basis and do not necessarily rely on automation. In this incident, a centrally mounted turbocharger exhaust uptake manifold thermo-couples indicated that exhaust temperatures were acceptable, whilst six cylinders attempted to do the work of the 12. A basic and fundamental problem like blocked fuel filters led to major performance concern but fortunately, on this occasion, major engine damage was averted.

Sometimes a problem arises that appears to be complex, yet the cause of these problems can often be very basic. All fuel filters and fuel systems should be checked to ensure that they are clean and ready for use and ship's staff are reminded that vessels susceptible to heavy rolling and pitching may encounter such problems on a more frequent basis than with larger, more stable, vessels.

Case Study 007

Main Engine Damage

# Incompatible piston rings

The ship had recently left drydock when she encountered serious main engine lubricating oil consumption problems. At one stage the main engine, a medium-speed diesel engine, was consuming some 950 litres of lubricating oil per day.

## What happened?

The vessel had been experiencing problems with main engine lubricating oil consumption but immediate repairs had been deferred until the vessel entered drydock.

Whilst in drydock, the main engine had undergone a major overhaul in which seven of the main engine pistons were exchanged and all the cylinder liners were honed. In drydock, the piston rings, which were the same type as the original supply, were replaced with plasma- coated piston rings as per the engine builder's revised instructions.

The chief engineer was justifiably concerned about the increase in lubricating oil consumption and the vessel diverted to port for further investigation.

An inspection undertaken by both ship's engineers and engine builder representatives revealed that major and accelerated cylinder liner wear had occurred, so that significant main engine component exchange was needed.

## What went wrong?

It would appear that the plasma-coated piston rings, which were fitted during the engine overhaul in dry-dock, were significantly harder than the cylinder liner itself. This led to excessive cylinder liner wear causing blow-past of combustion gases which further reduced cylinder lubrication, resulting in the massively accelerated liner wear.

In this case, the shipowner followed the advice of the engine manufacturer, which led to this serious problem with consequential damage to the main engine. The managers of the vessel held the engine manufacturer responsible for all damages and are seeking recovery from the engine builders.

## What can we learn from this incident?

As with all engine damage problems, it is important that the shipowners and their technical representatives discuss their concerns with the engine manufacturer. However, it is not unknown to find that an engine designer or manufacturer uses different components or component designs to an authorised licensee. This problem of incompatible piston rings and liners has arisen before in very similar circumstances and is known to have occurred on both medium and slow-speed marine diesel engines.

If any engine component or spare part is changed, it is vitally important to verify with component suppliers and engine builders that all components are fully compatible.

Case Study 008

Main Engine Damage

# Bolt fails after maintenance

The ship suffered serious damage to its Pielstick main engine whilst at sea, which meant that it was not possible to continue on passage. The ship was towed to a port of refuge, where it was established that the crankshaft was damaged and beyond repair.

## What happened?

The vessel left port in ballast bound for South America. A scheduled stop for bunkers at Algeciras was completed without delay and the ship departed without incident and resumed passage.

During the 8 to 12 watch, the duty engineer heard loud bangs coming from the main engine. The engine was immediately stopped and after a period of time to allow the engine to cool down, an inspection revealed that Number 4 connecting rod was fractured, with the bottom end bearing and keeps badly damaged. The lower parts of Number 4 and 10 cylinder liners were smashed and the Geislinger coupling was leaking oil and air.

It was initially thought that the ship's engineers could isolate Number 4 and 10 cylinders and that the ship would be able to return to Algeciras.

However, due to the extent of the damage this was not possible and the shipowners engaged a tug to tow the vessel to Algeciras, where closer inspection revealed further extensive damage to the engine.

## What went wrong?

The damage survey concluded that the cause of engine damage was failure of a bottom end bolt.

In the weeks preceding the incident, the ship's engineers had completed maintenance on the main engine.

The survey report offered three reasons why the bottom end bolt may have failed:

1. A latent defect.
2. Over tightening of bolt by crew.
3. A combination of 1 and 2 above.

The surveyors were of the opinion that the damage was not the result of normal wear and tear.

Surveyors concluded that, on the balance of probability, the bolt failed because of over- tightening during maintenance work.

## What can we learn from this incident?

Where maintenance work requires critical processes such as specified torque settings, the work needs rigorous and conscientious supervision.

It was perhaps fortunate that the main engine failure occurred only one day out of Algeciras and that the Atlantic weather was good. If the weather had been worse and the ship mid-ocean, the implications of this incident could have been more serious.

All maintenance must be conducted professionally and in full accordance with manufacturers' instructions.

It is critically important all torque settings are applied correctly. Both hydraulic tensioning devices and torque wrenches should be carefully maintained and all related equipment should be calibrated and certificated to ensure accuracy.

Case Study 009

# Main Engine Damage

## Pre-sailing problem ignored

A freight ferry on a regular scheduled run between UK and France suffered main engine gearbox failure after indications that something was amiss were ignored and the sailing went ahead.

### What happened?

The procedures for readying the ship for sailing from the UK went ahead without any problems.

During preparation of the main engines for departure, engineers reported hearing a significant and unusual noise from the port side reduction gear.

A brief inspection by shipboard engineers was carried out but nothing "unusual" was discovered. The ship departed for France, where a more detailed inspection with shoreside assistance was planned.

### What went wrong?

The later inspection by shore-based specialists discovered that the lube oil filter elements had collapsed and white metal particles were found in and around the filter. Serious bearing damage was identified.

The oil filter element was found to be choked with white bearing metal cuttings.

The probable cause of the bearing damage was a failure of the lubricating oil supply to the gearbox bearing leading to overheating and eventual collapse of the bearing.

The bearing failure led to excessive vibration, which in turn fractured the gearbox casing.

### What can we learn from this incident?

Testing of ship's gear prior to sailing is a longstanding part of pre-sailing checks with which all seafarers are familiar.

In this case, over-familiarity led to complacency. All too often, pre-sailing checks identify problems which are not traced correctly and suitable corrective action is not taken.

Whether due to commercial or other pressures, simple errors of judgment can lead to very serious incidents and claims.

The importance of correct and careful pre-sailing checks cannot be over-emphasised.

Aside from pre-sailing checks, the existing planned maintenance procedures should include analysis of the gearbox lube oil and monitoring of oil filter cleanliness.

All procedures (existing and newly modified) should be carefully monitored to ensure that they are effective.

A more effective and prudent course of action would have been to delay sailing and investigate the "noise" whilst alongside in the UK.

Case Study 010

Auxiliary Engine Damage

# Bolt fails after maintenance

The ship was at anchor when she suffered failure of Number 1 diesel alternator prime mover, a Daihatsu PSHT-26H.

## What happened?

The engine was running on full ship's load when it suffered failure and stopped. When power was recovered using another diesel alternator, the failure was investigated. An initial survey found the cause to be failure of a connecting rod bottom end bolt. The bolt failure led to damage to the crankshaft, piston, liner, connecting rod and bearings. The most serious damage was to the engine frame/block and the bedplate.

The damage to the engine structure proved to be the most serious problem and was the reason behind the very high cost of this case. The engine builders advised that the parts required complete renewal.

The components were eventually replaced and the total cost of the claim was in the region of US$850,000.

## What went wrong?

A full investigation of the damage showed that the bottom end bolt had failed and it was strongly suspected that incorrect tightening procedures had been adopted by the vessel's crew.

## What can we learn from this incident?

The tightening and inspection of bottom end bolts is vitally important. Whether bearings and bolts are opened for survey or planned maintenance, it is vital that the correct tightening procedures are adopted. In many cases this is by using a correctly calibrated torque wrench but other methods include the use of hydraulic jacks, dial test indicators and gauges. Indeed, Daihatsu has adopted the use of a gauge as a revised torque setting method on several of its engines. Thus the bolt tensioning method varies from engine to engine and the manufacturer's recommendations should be adopted.

However, an area that warrants particular mention is the non-destructive testing of bottom end bolts. These bolts have suffered numerous failures in the shank/bolt head. A three-can spray test kit will enable detection of such cracks and the kit may also be used to test connecting rod serrations for early signs of problems.

The correct fitting, arrangement and securing of bottom end bolt locking systems is vital and must be undertaken by a competent person.

Case Study 011

Auxiliary Engine Damage

# Poor cleaning after maintenance

The ship was operating as a floating storage unit when damage occurred to her Number 1 alternator prime mover, a trunk piston diesel engine.

## What happened?

The engine was operating on full ship's load when a gradual fall in lubricating oil pressure was identified. The engine continued in service until some hours later when it was shut down by the ship's engineers in response to the low lubricating oil pressure alarm.

Initial investigation identified heavy scoring of crankpins as well as damage to main and crankpin white metal bearings. The connecting rod bottom ends were also found to be oval.

During engine strip-down, two sharp projections of metal were lifted from the main journals. The repairs were carried out as necessary at a cost of some US$200,000.

## What went wrong?

The crankshaft had recently been reconditioned by a specialist shore-based engineering workshop. The discovery of metal particles and swarf by attending engineer surveyors indicated that the cause of failure was due to insufficient flushing and cleaning of components after reconditioning. Oil paths in the crankshaft were partially blocked and this was exacerbated during engine operation.

## What can we learn from this incident?

Whenever any type of engine is undergoing maintenance, extreme care must be taken to ensure that engine cleanliness is given high priority. This is particularly relevant when working on fuel or lubricating oil systems. The seriousness is amplified when machining of components has occurred.

All passage ways, sumps and journals should be protected from particle damage during machining. On completion of machining, all components should be cleaned and sumps cleaned and flushed.

This flushing process should be done with equipment other than pumps, etc., used for normal operation of the plant, to ensure that engine components are not contaminated. A full inspection should be completed prior to engine rebuild and subsequent engine trials.

In this particular case, ship's staff were heavily involved in post-machining clean-up. This can seriously affect the owner's ability to claim from shore-based repair squads. It is vital that ship's staff record instructions given by contractors in such cases.

Engine cleanliness, post-maintenance flushing and inspections and good engineering practice are vital. Correctly employed, these practices will help to avoid such claims.

Case Study 012

## Auxiliary Engine Damage

# Lack of maintenance procedures

The ship suffered major damage to her port diesel alternator, an Allen 6BCS 12D, six-cylinder, in line, single acting, four stroke, turbocharged diesel engine.

### What happened?

With the engine running on load, the engine suffered serious failure. An investigation by an attending surveyor revealed damage to piston, cylinder liner and connecting rod. The crankshaft, entablature and bedplate also suffered serious damage. The surveyor advised that the damage necessitated complete engine stripdown, with all parts cleaned, examined and calibrated.

The engine was rebuilt and the following new parts fitted: bedplate, crankshaft, bearings, entablature, crankcase doors, relief valve and internal lubrication pipework. A new piston, connecting rod, piston rings and gudgeon pins were fitted. The total cost was in the region of US$370,000.

### What went wrong?

A full investigation of the damage was inconclusive as to the cause of the failure. However, the surveyors suggested that excessive wear of major components was a probable factor.

### What can we learn from this incident?

The long-term maintenance and general upkeep of an engine is very important. All maintenance should be completed in accordance with manufacturer's instructions. It is vital that all components are calibrated and gauged and only reused if they are within manufacturer's limits of use and renewal is not appropriate.

It must be remembered that a component just within limits may only just be within reusable limits and once refitted, it may not be inspected for many more running hours.

All maintenance should be completed correctly and carefully, by a competent person.

It is also imperative that spares are ordered in good time so as to avoid the use of worn or previously used components - known in some quarters as "used but good" spares.

Case Study 013

Auxiliary Engine Damage

# Lack of maintenance procedures

During a ballast passage, one of the auxiliary engines suffered mechanical failure. There was substantial damage to the engine block and it was established that it would take approximately ten weeks to procure the spare parts. Consequently, a portable generator was hired as an interim measure to allow the ship to continue to trade.

## What happened?

The engine was running on full load when the second engineer heard an abnormal noise and noted water being forced out of Number 4 unit indicator cock. The engine was immediately stopped.

## What went wrong?

Subsequent investigations identified that Number 4 unit had previously been dismantled by ship's crew because of sticking piston rings.

The ship did not carry a spare piston, so the sticking piston rings were machined out ashore.

The surveyor was of the opinion that the piston ring groove wear tolerances were already at or near maximum when this operation was carried out. He concluded that machining may have increased the groove sizes beyond acceptable limits, which eventually led to the failure.

The surveyor also mentioned that a piston gudgeon pin circlip was missing.

The ship operators believed that a missing circlip was the cause of the unit failure, but the surveyor was of the opinion that damage was inconsistent with this being the sole cause.

## What can we learn from this incident?

No damage/accident reports were available from the ship. Without this type of feedback, it becomes very difficult to analyse what went wrong and the lessons to be learnt. However, all engine maintenance must be carried out in accordance with manufacturers' instructions and maintenance manuals.

Procedures for stripping and rebuilding ship's equipment require careful and methodical accounting of components.

All maintenance work must be supervised by responsible and accountable ship's personnel.

All maintenance records must be updated and damage/accident reports kept accurately for future reference.

Engine manufacturers or class should be consulted before critical components are "refurbished" or machined.

Shipowners/operators should ensure that all spare parts carried meet class requirements and should carefully consider which critical components should be carried.

Case Study 014

Ancillary Equipment

# Seal failure causes steering problems

The ship, a feeder car carrier built in Japan in 1993 and fitted with a Japanese electronic autopilot, a Norwegian rotary vane steering gear and a high-lift rudder (capable of helm angles of up to 70°), encountered unexpected and random alteration of helm.

## What happened?

The vessel was underway on passage when the rudder altered to 50° to starboard, causing the vessel to sheer some 100° off course. The master immediately reduced speed and he and the chief engineer initiated an onboard investigation. Nothing obvious was found and the shipboard engineers were unable to identify problems in either the steering gear or the autopilot system.

All combinations of steering gear pump and steering gear control systems were checked and interchanged, yet no problems were encountered. The vessel proceeded to port, where a steering gear technician and autopilot technician attended the vessel. Once again, nothing significant was found. During the technician's inspection, the oil condition was verified as good, all filters were cleaned and, apart from some threads of cotton waste being found in a filter, no further problems were found.

On leaving the vessel, the technicians identified the cotton waste as the cause of the problem but the owner felt there was some other source of concern and appointed a technician to the vessel to further assess problems.

The vessel once again sailed and after a few days the problems recurred, first on one watch and then twice on the next watch. Eventually, during one of these random yet highly dangerous alterations to the helm angle, problems were observed that indicated that the fault lay with the hydraulics rather than electronic/electrical controls.

The rudder was of a balanced type, hydraulic pressures gave no indication as to the potential problems and the owner sought the assistance of a tug to escort the vessel into port. Once alongside, the vessel underwent major tests which revealed that over a period of time the rudder would drift from 0° to some 50° to starboard of its own accord.

## What went wrong?

Eventually, and after considerable investigation and inspection, the rubber seals for the rotor were found to have shrunk some 5 mm over the entire length of the seals. Consequently, oil leakage from the main rotor seals was identified as the source of the problem. All of the seals in the steering gear hydraulic system were renewed, as were the pressure control valves, which were found to be of an old design that did not incorporate modifications recommended by the manufacturer.

It later became apparent that the manufacturer was aware of seal problems and had indeed revised and renewed the seal material but had not advised owners.

## What can we learn from this incident?

It is vitally important that any changes to the steering gear, technical specification of equipment or spares made by manufacturers is brought to the attention of all shipowners. Shipowners using this equipment should notify their superintendents and shipboard staff to ensure that potential problems are not allowed to develop into serious problems which may jeopardise the safety of the vessel, her crew and passengers.

As in this case, if owners are concerned as to the safety of a vessel, they should seek assistance and eliminate the problem before the vessel goes to sea.

Case Study 015

Ancillary Equipment

# Incorrect oil causes compressor problems

The ship was trading between Europe and South America when she experienced severe problems with the refrigeration plant compressor units. The forward refrigeration plant compressor unit was shut down due to excessive noise and vibration. Considerable damage was found to major component parts, including gearing arrangements, shafting arrangements, bearings and the lubricating oil pump.

## What happened?

The vessel was on passage to South America when problems with the refrigeration plant compressor units were first encountered. The compressor had recently undergone routine maintenance during which the lubricating oil was changed and the compressor had run without incident for several days prior to problems becoming apparent.

The refrigeration compressor which was vibrating excessively and operating noisily, was stopped for investigation. The compressor was stripped down for inspection and all damaged and worn components were changed in accordance with manufacturer's recommendations as found in the manufacturer's manuals.

The compressor unit was then completely rebuilt and returned to service without further incident. After running for a few days, the compressor once, experienced severe problems and eventually failed resulting in very similar damages to the previous incident.

## What went wrong?

The cause of this serious incident and the consequential damage to the compressor was identified as incorrect lubricating oil having been used in the compressor. Samples of the lubricating oil from the compressor were sent for full analysis at a local testing laboratory and it was concluded that the oil that had been used was not suitable for use in refrigeration equipment.

Indeed, further investigation revealed that as well as the damaged components, many parts of the compressor were fouled with lubricating oil. Comprehensive inspection revealed that the compressor had been correctly maintained and rebuilt. However, when the lubricating oil was changed, a mineral lubricating oil was used rather than the synthetic lubricating oil which had been supplied and specifically developed for use in refrigeration compressors.

## What can we learn from this incident?

It is vitally important that shipboard engineers who are involved in maintenance and component exchange are fully conversant with the equipment and consumables to be used.

In this case, the correct lubricating oil was available on board the ship but the engineer involved did not check which lubricating oil should be used in the refrigeration compressor and used oil from a drum which was stored adjacent to the compressor, rather than the correct oil.

Clearly this serious machinery damage could have been easily averted and we are all reminded of the importance of diligent, conscientious maintenance as well as the importance of adopting industry best practices and common sense.

Case Study 016

Grounding

# Tidal conditions cause grounding

The ship, a fully laden 90,000 dwt tanker, was approaching the berth to discharge her cargo of fuel oil when she grounded.

## What happened?

Many of the officers had served on the ship previously. The ship had transited the Malacca Straits without incident and anchored at the working anchorage in Singapore. After a few hours at the anchorage, the local pilot boarded and the ship proceeded towards her berth.

Many of the storage tank facilities in Singapore are located on the small islands upon which the industry is based. On this occasion, the entered ship grounded during an approach and navigational turn while attempting to berth at one of these facilities.

The grounding was considered to be minor. After additional support from tugs and a rise in the tide, the ship refloated without further incident, major damage or pollution. The ship returned to the anchorage for an underwater survey prior to berthing and discharging her cargo.

## What went wrong?

At the time of the incident, the bridge team consisted of the master, third officer and helmsman, as well as the Singaporean pilot. On boarding the vessel, the pilot was fully briefed about the ship and the MSMI Pilot Card was completed and discussed. However, the master passed the navigational control of the vessel to the pilot. The bridge team failed to correctly assess the tidal data available to them and did not monitor the vessel's progress towards the berth. The pilot is on board as a navigational advisor with local knowledge but on this occasion the master seemed to allow the pilot complete control. The ship was technically sound and was under full manoeuvring condition standby.

## What can we learn from this incident?

The bridge team should have fully researched local tidal conditions and monitored progress. It is vital that the master retains full control of all manoeuvring and navigational decisions. The pilot is only an advisor.

Voyage planning and bridge teamwork are vital if incidents such as this are to be avoided.

Case Study 017

Grounding

# Main engines not ready

The ship was fully loaded and due to berth in an Atlantic port to discharge her cargo. With the berth unavailable, the ship anchored without incident in a designated anchorage area. The main engine was shut down and the main engine and engineroom placed on 30 minutes' notice of readiness by the master.

## What happened?

In the late evening and with the ancillary plant running properly, the master retired to his bed, having left his standing orders at 2115 on the bridge. At this time, the engineroom was unmanned.

The weather conditions were good and the wind was approximately force 3.

The weather conditions gradually deteriorated throughout the night but the officer of the watch failed to notify the master, or the duty engineer, of the worsening conditions. When the chief officer went to the bridge to take the 4 to 8 watch, he expressed serious concerns regarding the weather and sought to clarify the ship's position. However, it was some 30 minutes before the chief officer completed this task and the ship's position was verified.

The master awoke due to the deteriorating weather conditions, lashing rain and the increasing wind forces. He arrived on the bridge just as the chief officer completed his checks regarding the ship's position and confirmed that the ship was indeed dragging her anchor.

The master immediately called the chief engineer and asked that the main engines be started as soon as possible. The duty engineer was not notified at this stage. The chief engineer attended the engine room in his civilian clothing and, as he entered the engineroom, the boiler level alarm sounded.

Despite the master's instructions to start the main engine, the chief engineer decided to return to his cabin to change into his working clothes he began to try to rectify the boiler problems. He believed the problems would lead to a main engine running problem at a later time if they were not rectified, due to the future difficulties of heating the fuel oil. At no time did the chief engineer consider changing the main engine fuel supply over to diesel oil.

He was eventually joined in the engineroom by the second engineer, who was the duty engineer, and was responding to the UMS boiler alarms. The chief engineer believed that he was only the person capable of rectifying the problems and starting the engine and did not delegate any tasks to the second engineer.

The main engine was eventually started some 42 minutes after the master had first telephoned the chief engineer in his cabin. Consequently, the ship grounded a few minutes later and was seriously damaged. The eventual claim against MSMI was finally settled in the region of US$6 million.

## What went wrong?

The officer of the watch on the bridge failed to notify the master at an appropriate time of the weather deterioration.

The chief officer took some 30 minutes to determine the vessel's position and confirm that the anchor was indeed dragging.

The master called the chief engineer in his cabin and did not emphasise the serious and imminent nature of the situation the ship was facing.

The chief engineer arrived in the engineroom inappropriately dressed and concentrated his efforts on rectifying the boiler problems rather than starting the main engine as requested by the master.

The chief engineer did not suitably prioritise the tasks or delegate responsibility to his subordinates.

## What can we learn from this incident?

The importance of accurately forecasting weather conditions and, perhaps more importantly, the ability to recognise changing weather conditions. In this case, the weather altered very dramatically and very quickly due to the influences of a hurricane. But whatever the circumstances, the vessel and particularly the engine notice period should allow sufficient time for the plant to be prepared for all eventualities.

The officer of the watch should routinely monitor the position of the ship and always be prepared to call the master. The master should lay down specific guidelines as to when he should be called.

The vessel could have anchored further offshore but the master decided that he was happy to be only 1.2 cables offshore. As the weather conditions deteriorated, another vessel which had been anchored nearby shifted to a revised anchor position, although it was believed this guidance was given by the local port authority. It may have been that they were monitoring the weather conditions from other sources.

The master should have emphasised the seriousness of the situation and the potential for a serious incident. He did not impress upon the chief engineer the imperative need to start the main engine at the earliest opportunity.

The chief engineer should have made the engines available to the master at the earliest opportunity. Clearly he failed to do so and was distracted by the perceived importance of the boiler problems. Clear and concise communication throughout the vessel, even in very serious situations, is critically important.

If officers or crew have any concerns regarding the capabilities of colleagues, these should be raised with the master. The master should notify the owner/company immediately to avoid a difficult situation whereby senior officers do not feel confident in the abilities of junior personnel to deal with serious problems in time of crisis.

The notice of readiness period should be determined on a case-by-case basis by the master in conjunction with the chief engineer. It is essential that the main engine should be made available for full service power within the notice period identified.

During notice of readiness periods of less than one hour, the engineroom should perhaps remain manned and, if necessary, the main engine should be maintained on full readiness and given a kick ahead/astern if necessary.

Case Study 018

Grounding

# Grounding during collision avoidance

The ship a 5,700 GT aggregates dredger, was leaving port early in the morning bound for her regular dredging grounds, at the same time as a fleet of fishing vessels. In an effort to avoid an incident, the vessel grounded and sustained minor hull damage.

## What happened?

The entered dredger was leaving port and the officer of the watch was monitoring the position of his own ship and that of the fishing vessels as they all proceeded.

The officer of the watch alerted the master that the vessel was moving too far to starboard and, in his opinion, was likely to run into the shallows. The master attempted to correct the vessel's position, but due to concerns about the close proximity of another fishing vessel, was unable to do so with immediate effect and correction was undertaken too late. As a result, the vessel grounded. Fortunately, no significant damage was done. The master manoeuvred the vessel to a safe position and instructed that all double bottom tanks should be sounded to ensure that no breach of the hull had occurred. When he was satisfied that no serious damage had been sustained, the vessel returned to port and a subsequent diver inspection confirmed minimal damage.

## What went wrong?

A thorough investigation into this incident by the vessel's owners revealed that the master was well rested and that fatigue was not a factor in the incident.

The master admitted that he had not made sufficient allowance for the speed of the vessel when giving the helmsman his orders and that the vessel had gone too far over and had touched bottom.

The master made an error of judgment which could have been avoided by delaying departure until the exit from the port was clear of normal traffic.

The incident was initially reported to the owner as a near miss, when in fact there had been a grounding. The fact that no damage was caused to the dredger, was due solely to good fortune. Clearly, a much more significant and serious incident could have resulted had the vessel grounded on a rocky seabed and sustained serious hull damage or the hull been breached.

## What can we learn from this incident?

The corrective action taken by the master was basically too little too late and although there was significant fishing traffic, this was considered to be normal for the time of day and year and the owner's investigation concluded that the master had been complacent.

Alternatively, the vessel's speed could have been reduced to match that of the fishing vessels until all vessels were clear and free to proceed on their voyages.

Complacency was a major factor in this incident. The master was highly experienced and had undertaken this particular voyage on many occasions. However, it is vitally important that all voyages are carefully reviewed and passage planning, which should be detailed and comprehensive in its nature, is essential.

If and when a vessel encounters difficulty, it is essential that effective and positive action is taken immediately.

Case Study 019 Grounding

# Grounding during heavy weather

The ship suffered extensive damage to the rudder stocks, bow thruster, steering gear and bottom plating following a grounding in heavy weather.

## What happened?

The ro-ro freight ferry left port at 2200 with an ETA for the next port of 0325. The weather forecast was force 8-9.

After departure, the master decided the weather was not as bad as expected and at 0100 he left the bridge, giving instructions to the second mate to call him 45 minutes prior to arrival. This would have meant a call at 0240.

After the master left the bridge, the weather deteriorated very quickly and the second mate made a succession of small alterations of course to port to ease the rolling of the ship. After passing a buoy marking a sand bank, he started to alter course to starboard. The ship did not respond and the second mate, realising they were aground called the master at 0315.

## What went wrong?

The second mate was on the bridge on his own when he made a succession of small alterations of course but did not:

- Monitor the ship's position relative to the course laid down on the chart.
- Advise the master of the deteriorating weather or when he deviated from the passage plan.
- Call the master as required by the master's night orders.

## What can we learn from this incident?

The master completed an MAIB incident report form. In response to the question "please state how you think the incident happened?" he wrote "I don't know". This would seem to indicate that the master was reluctant to acknowledge failings in bridge team management or was unwilling to conduct an accident investigation. Lessons can be learnt from accident investigation.

Masters must regularly review and appraise the conduct and actions of junior watchkeeping officers during their navigational watches.

An essential part of good leadership and bridge team management is to assess the capabilities of each member of the bridge team as well as the number and composition of the team for all circumstances.

The passage plan for a regular route can be considered as standard only to the extent that it is a starting point for assessing each passage according to the prevailing circumstances.

The master's standing and night orders need to be specific on the extent of the permitted deviation from the passage plan.

Case Study 020

Grounding

# Grounding following navigational error

The ship, an 8,250 GT bulk carrier was navigating in confined waters in an established traffic separation scheme (TSS) which was bounded by both islands and rocks. Due to a navigational error, the vessel grounded and suffered serious structural damage. Fortunately, a major pollution incident was avoided.

## What happened?

The vessel was full away on passage, having previously sailed from its load port where the ship had loaded a cargo of grain some seven days earlier.

The incident took place on the 8 to 12 evening watch when the third officer was the officer of the watch. With the ship transiting a traffic separation scheme, the master had remained on the bridge for some considerable time. However, he finally left the bridge, leaving the third officer and a lookout on duty, when he was satisfied that everything was in order and he had no concerns regarding other shipping or the navigational safety of his ship in the TSS. Visibility was good, although dark due to no moon and there was very little shipping traffic in the region.

The officer of the watch saw a set of lights apparently on a steady bearing and crossing to port. He took the opportunity to check the radar but there was no shipping obvious on the radar screen. He decided to alter the course to starboard to pass around the stern of the target. Having manoeuvred his own vessel, the third officer was concerned that the lights still appeared to indicate a collision threat and, as a result, he altered yet more to starboard.

Some 20 minutes after the last course alteration, the vessel hit an island and firmly grounded. Considerable damage was sustained to the entered ship in the bow region and ship's bottom but a major pollution incident was avoided. The vessel was eventually refloated by salvors and towed to a repair yard, where considerable steel and structural repairs were required.

## What went wrong?

The master had remained on the bridge during the early part of the 8 to 12 watch as the vessel entered the traffic separation scheme. However, having ensured that the vessel was safely in the separation scheme, he entrusted the navigation to a relatively inexperienced third officer.

The third officer became disorientated in the darkness and confused lights on land with those of the accommodation of a ship, which he had taken to be crossing his own vessel.

He was unable to confirm the situation on the radar or on electronic charts but he failed to call the master. The third officer made an initial alteration of course but, fearing that this was insufficient to avoid a collision, he attempted a second more significant course alteration and did not take into account the safe navigation of the ship, the depth of water or proximity of land before completing the manoeuvre.

## What can we learn from this incident?

It is, of course, essential that any officer left with sole responsibility for the navigation of the vessel is experienced, technically capable and confident that he can safely undertake the tasks ahead. The master should ensure that he is satisfied with the competence of his officers and, if any doubt exists, he should take all reasonable steps to ensure the safety of the vessel.

The Master should have left clear, detailed yet concise night orders which would have left no doubt in the third officer's mind at which point he should call the master.

Any navigating officer making alterations to course should familiarise himself with the prevailing conditions and ensure that it is safe to manoeuvre having considered the depth of water and the proximity of land and other vessels.

Case Study 021

Contact

# Fast approach causes damage

This incident relates to serious hull damage sustained by an entered ship when she made contact with a jetty. The ship, a fully ballasted 30,000 GT product tanker, was manoeuvring on to her loading berth in the Middle East when the incident occurred.

## What happened?

The approach to the berth was to be made with the assistance of two harbour tugs, which were to push the vessel on to the berth.

The vessel was equipped with bow thrusters and had performed the same berthing operation numerous times before. However, on this occasion the approach to the berth was made too fast and the vessel was unable to stop in time. The port bow made contact with the jetty forward of the port anchor spurling pipe.

The hull was punctured and the vessel had to undergo gas freeing and hull repairs prior to loading her cargo. The damage was not excessively expensive on this occasion but as the final cost fell below deductible, the owners paid all costs incurred.

## What went wrong?

It was the opinion of the attending surveyors that a little complacency crept into this incident. The ship regularly berthed at the load port and had had no previous problems.

However, on this occasion the approach to the berth was not fully discussed by the master and his bridge team. The vessel was attended by two tugs which were unable to arrest the ship's momentum in time to avoid contact with the jetty.

## What can we learn from this incident?

Even when repeating manoeuvres completed on numerous previous occasions, the berthing should be fully discussed by the bridge team. Where possible, the full range of ship's equipment should be employed to ensure that such contact damages are avoided. Ship's officers must be fully conversant with their navigation aids, low-speed doppler logs and the like. The use of versatile tugs and careful use of mooring equipment can help to avoid incidents such as this.

Case Study 022

Contact

# Engine control problems

The incident involved a passenger / ro-ro ferry which sustained substantial damage to the bow and caused superficial damage to another berthed vessel and substantial quay damage during berthing manoeuvres.

## What happened?

During the final approach to the berth the master intended to operate the main engine controls from the bridge wing and he selected half astern to reduce the vessel's headway. On detecting little response, he then selected full astern.

The second officer checked the main engine consul in the wheel house and, noticing the engine still showing half ahead, informed the master. Control of the main engines was then transferred to the bridge wing.

Full astern was again selected by the master with bow thrusters set to full port thrust in an attempt to clear the situation. Subsequent measures to resume control and manoeuvre the vessel to safety were unsuccessful and she struck a glancing blow to the berthed vessel and collided heavily with the quay, causing substantial damage.

## What went wrong?

Subsequent investigation identified the following points.

Neither the voyage plan nor the master's standing orders identified a defined point for pre-arrival checks to be completed.

The lack of any pre-arrival briefing made it impossible for the officer on watch to monitor immediately the actions of the master, reducing significantly the capability of the bridge team.

Use of bridge control panel dimmer switches had made it difficult for the master to visually confirm that the change-over procedure of engine controls from the bridge to bridge wing had been successful.

## What can we learn from this incident?

Routine and over-familiarisation with any procedure can have a detrimental effect on the manner and effectiveness of any preparations carried out.

Effective bridge procedures, including clear guidance and communication instigated by the master, re-affirms each team member's responsibilities and provides an appropriate forum for any deviations from the original passage plan to be highlighted and discussed.

The berthing plan for this incident seems to have been unclear and not documented. There was no written procedure within the vessel's safety management system for any pre-arrival briefing, nor any indication of a contingency plan for this type of incident.

Good bridge discipline can alleviate the likelihood of any distractions. The important role of all bridge team members in monitoring others cannot be over-emphasised.

Case Study 023

Contact

# Damage to propeller

The ship suffered damage to her propeller as a consequence of impact with flotsam.

## What happened?

The vessel had completed cargo discharge and was preparing to set sail towards her next load port. The master had given one hour's notice and the duty deck officer and engineer were preparing the vessel for sea. Completed pre-departure tests included testing of the steering gear and preparing the main engine. Having warmed through the main engine, the duty engineer requested clearance to test the main engine. Clearance was given by the duty deck officer and the duty engineer kicked the main engine ahead and astern on air.

On kicking the main engine astern, the direct drive propeller made contact with a large piece of floating wood, which became lodged in the blades of the propeller and caused sufficient damage to necessitate an emergency drydocking.

The final cost of this damage ran into many thousands of dollars.

## What went wrong?

The cause of this serious incident was the failure of the duty officer to check that the stern was clear of all floating objects and potential hazards prior to authorising the duty engineer to test the main engine ahead and astern.

## What can we learn from this incident?

It is essential that whenever vessels are preparing to depart port and undergoing pre- sailing checks, the ship's officers and crew closely follow the ship's instructions and procedures. It is vitally important whenever testing main engines that the stern of the vessel is clear of any small craft, floating objects, ropes and other potential hazards. Authorisation to test the engines should only be given when the duty officer has satisfied himself that no hazards exist.

This failure to undertake a basic check reaffirms the view that the failure of ship's staff to follow rudimentary procedures often leads to major and serious incidents.

Once again we are reminded that many incidents can be avoided by following basic procedures.

Case Study 024

Contact

# Diversion from voyage plan

A freight ro-ro vessel struck an uncharted underwater obstruction and sustained damage to her starboard rudder, propeller, stern tube seal and gear box coupling. The shell plating was also badly set in.

## What happened?

The vessel left port at 1400 and diverted from the voyage plan by altering course along the coast to undertake in crew drills and what was described as a coastal training exercise. During the course of the exercise, the vessel was manoeuvred close to the shore and hit a submerged object.

## What went wrong?

The vessel made an unplanned diversion from the voyage plan.

This resulted in "blind navigation" taking the vessel outside the area covered by the largest scale chart available. The local hydrographic department identified only 30% of the coastline as being surveyed to an acceptable standard in this area.

## What can we learn from this incident?

Irrespective of the nature or purpose of a voyage, the significance of a detailed voyage plan is critical.

A voyage appraisal would have highlighted:

- Navigational hazards associated with conducting a training exercise in these waters.
- Navigation warnings and chart notes regarding the incomplete nature of the survey date.

Reference should also be made to voyage planning requirements identified in:

SOLAS Chapter V, Reg 34 - "Safe Navigation and Avoidance of Dangerous Situations"

Chapter V, Annex 25 - "Guidelines for Voyage Planning" IMO Resolution A.893(21), which states:

*"Most accidents happen because of simple mistakes in use of navigational equipment and interpretation of the available information."*

Voyage planning includes a process of appraisal, planning, executing and monitoring.

Appraisal is the process of gathering all information relevant to the proposed voyage, including ascertaining risks and assessing its critical areas.

Planning should be detailed and cover the whole voyage, from berth to berth.

During execution the master should take into account any special circumstances which may arise and require the plan to be reviewed or altered. Any deviation from the original plan must be wholly appraised.

Monitoring of the vessel's progress along the pre-planned course is a continuous process. The officer of the watch, whenever in any doubt, should immediately call the master.

Case Study 025

Fire

# Switchboard fire causes extensive damage

The vessel, a jack-up accommodation platform, sustained extensive damage as a result of an electrical fire in the switchboard room.

Damage extended to distortion of steel plating and destruction of most of the electrical wiring.

## What happened?

During routine testing of a foam monitor system the chief engineer ordered Number 1 fire pump to be started. The pump immediately tripped and Number 2 pump was started in order to continue with the exercise.

The chief engineer noticed a pungent smell and discovered smoke coming from the back of the switchboard at Number 1 fire pump circuit breaker. The fire doors were closed, alarms activated and the area immediately evacuated.

The C02 system was activated and the fire extinguished.

## What went wrong?

There was confusion over firefighting procedures when dealing with such an incident.

Access to the control room fixed smothering system activation point was prevented by the fire.

## What can we learn from this incident?

Accident investigation identified weaknesses within the safety management system on board this vessel.

Effective debriefing on completion of drills, as required by the ISM Code Chapter 8, should identify deficiencies within a programme of training.

Case Study 026

Fire

# Soot build-up causes fire

This large product tanker suffered an exhaust gas boiler uptake fire as a consequence of a failure to operate soot blowers during and after a period of slow steaming.

## What happened?

The vessel, which was in ballast, received orders from charterers to proceed at reduced speed to her next load port. The master and chief officer calculated the projected voyage speed and the ship was manoeuvred out to sea. At full-away on passage, the engine power output was reduced to approximately 60% MCR.

After an extended period at reduced power, an uptakes fire was discovered by the duty engineer when the engine output was increased to full power. Considerable damage to boiler tubes and the exhaust trunking itself resulted.

## What went wrong?

It is inevitable that even modern, slow-speed diesel engines operating on heavy fuel oils at greatly reduced power outputs will generate soot in the exhaust uptakes. If cylinder lubrication is not adjusted accordingly, this may worsen the situation by effectively reducing the ignition temperatures of carbonaceous deposits.

Neither the chief engineer nor the shipboard procedures manuals initiated procedures for "slow steaming" and the routine operation of soot blowers - therefore, carbonaceous and soot build-up remained unchecked. When the main engines were increased to full power, the greatly increased exhaust temperatures caused the carbonaceous build-up to ignite. It is likely that the failure to adjust cylinder lubrication flow rates contributed to the lower ignition temperatures.

## What can we learn from this incident?

Whenever slow-speed diesel engines are operated at reduced power for an extended period, the economiser and exhaust gas uptakes should be routinely cleaned. Engine manufacturers should also be contacted to ensure that their guidelines are followed.

On vessels fitted with soot blowers, these should be routinely operated in accordance with both chief engineer and shipowner instructions. On vessels without soot blowers the washing of boiler uptakes and economisers should form part of the engineroom maintenance programme. It is quite normal to increase from slow steaming to full power and back again over a one-hour period on a daily basis to help prevent similar occurrences.

## Note

If an uptake fire is detected, the soot blower should not be operated in an attempt to extinguish the fire. This course of action may lead to a hydrogen fire, which is likely to be both more severe and more damaging than the original uptake fire.

Case Study 027

Fire

# Maintenance undertaken in unmanned engine room

The vessel, a small multipurpose tanker operating with twin medium-speed main engines driving two propellers, was under way on passage at sea with both engines running when the duty engineer undertook basic and routine maintenance which led to a fire in the engineroom. Fortunately, the fire was extinguished quickly with no major machinery or engineroom damage and, more importantly, no injuries or loss of life.

## What happened?

Whilst undertaking afternoon UMS engineroom rounds, the duty engineer noticed that the port main engine duplex fuel oil filter attached to the diesel oil supply to the port main engine was indicating that the filter was dirty. The duty engineer changed over the duplex filters to operate on one filter only and began to change the dirty filter. Whilst reassembling the filter unit, he was distracted by an engineroom alarm. He dealt with the alarm problem and returned to complete his task on the running port main engine. Having reassembled the filter, he then changed over the duplex filter to put two filters on line. Almost immediately, the filter bowl seal blew out and fuel sprayed on to the hot surfaces of the exhaust manifold. The fire began on the port main engine exhaust manifold. The engineer had the presence of mind to stop the port main engine and isolate the fuel supply and, with the assistance of attending engineers, the fire was extinguished.

## What went wrong?

The duty engineer should not have undertaken routine maintenance without assistance in the engine room and without a more structured plan.

The vessel was on passage and it would have been both safer and easier to undertake the maintenance when the engine room was fully manned and the port main engine stopped.

Onboard investigation showed that it had become routine for filters to be changed while the engine was still in operation and that this had become an accepted practice.

The potential problems and hazards of undertaking such maintenance whilst the engineroom was unmanned, were not fully appreciated by the engineer responsible for this maintenance. The potential for a serious incident was underestimated.

## What can we learn from this incident?

The real cause of this incident was a combination of complacency and inexperience, which led to an unsafe practice creating what could have been a very serious incident. Any task of this nature should, however minor it may appear, be fully planned and assessed and should not be undertaken while the engineroom is in an UMS condition or indeed, while the engine is running.

Routine cleaning of fuel filters should be part of a planned maintenance schedule and if fitters need cleaning outside this schedule, this should be carefully planned. All maintenance should be subject to prior work planning and approval by the chief engineer.

If it becomes necessary to stop the main engine for such maintenance, this should be approved by the officer of the watch or, preferably, by the chief engineer and master during daily work planning meetings. Had a realistic work planning assessment been undertaken, it is almost certain that this incident would have been avoided.

The inexperience of the engineer involved was perhaps a contributory factor in allowing the filter seal to blow out. However, he should be commended for his actions in ensuring that the engine and fuel supply were shut down as quickly as possible, thus avoiding a more serious incident.

Case Study 028

Miscellaneous

# Carriage of sulphur causes damage

The ship, a 26,000 GT bulk carrier, loaded a cargo of sulphur at Long Beach, US on 24 May and discharged at two ports in India on 16 July and 1 August respectively. On completion of discharge, numerous small holes and severe pitting were found in several holds. It appeared that the damage to the steelwork was the result of the corrosive nature of the sulphur cargo.

## What happened?

The ship arrived at Long Beach on 18 May and all her holds were cleaned using high- pressure water washing equipment prior to a hold inspection. The holds were then lime- washed to the expected cargo height and declared fit for the intended cargo. The vessel encountered no rain or delays and completed loading cargo on 27 May. During the load period, it is believed that the sulphur was dampened with fresh water to avoid cargo dust forming. The vessel proceeded to India via Singapore without incident and bilge levels were recorded at a constant level of 700-1,100 mm. The vessel discharged part of her cargo between 7 and 16 July and then completed discharge at a second port on 1 August, some 65 days after loading the cargo.

On completion of discharge, pitting - in some areas severe - was detected. The owner thought this pitting might be the result of sulphur corrosion and contacted MSMI which made the necessary arrangements for surveyors to attend the vessel.

Temporary repairs, including doublers, were made and fitted prior to sailing and the vessel then proceeded for drydocking.

In drydock, the following principal damage was found:

- Areas in Number 1 starboard wing tank found damaged and holed.
- Areas in Number 3 hold damaged, pitted and holed.
- Areas in Number 5 hold damaged, pitted and holed. Scattered areas in port and starboard hoppers found corroded, pitted and holed.
- Areas in Number 6 hold with scattered corrosion, pitted and holed. The aft bulkhead was also damaged and holed.

Class insisted on steel inserts being fitted, with the exception of Number 6 aft bulkhead, which was repaired with doubler pads.

The final cost of steel repairs, ultrasonic survey, paintwork and staging was in the region of US$1 million.

## What went wrong?

The attending chemist who was instructed by MSMI took samples from cargo remains and confirmed that the damage could have resulted from corrosive action instigated by sulphur reducing bacteria. The survey and chemist's reports suggested that lime-washing may not have been effective, due to poor application and insufficient thickness; however, this was disputed, as the surveyor in the load port had approved the lime wash. 180 cu $m^3$ of water was drained from the cargo during the voyage and no ventilation of the cargo took place.

## What we can learn from this incident?

The problems of corrosion while carrying sulphur cargoes are well documented and if correct procedures are not followed then serious problems may result, as in this case. Hold corrosion may occur especially if sulphur is loaded wet and in holds which have not been sufficiently prepared; this corrosive action may increase in high temperatures and over extended periods.

Correct procedures must be followed, prior to loading:

- All residues from previous cargoes must be removed.
- All loose scale, rust and/or paint must be removed.
- All traces of chlorides must be removed, especially those remaining after seawater washing of holds.
- The holds should be thoroughly fresh water washed.
- The holds should be "grain clean", i.e. meeting the equivalent cleanliness requirements as for grain cargoes.
- The holds must be inspected and approved and hatches must be weathertight.

Preventative measures include placing a barrier between sulphur and steel. This helps prevent corrosion, particularly when steel is unpainted, rusty or in a generally poor condition.

Suitable barriers would be paint or, more commonly, coating the holds with lime wash. If a lime wash barrier is to be applied, it must be sufficiently thick and allowed to dry. The lime wash solution should be of specific strength, typically 60 kg of lime to 200 litres of fresh water. Recommended thickness will be notified by attending surveyors.

Case Study 028 (continued)

## Miscellaneous

When loading the cargo, shippers' instructions should be followed.

During the voyage, all holds and hatches should be secured weathertight to avoid water ingress. All potential sources of ignition in the holds, lighting, etc., must be isolated. Bilges should be regularly pumped to avoid water accumulation.

It may be possible for hydrogen sulphide gas to be present, thus all holds must be fully ventilated and tested to ensure the atmosphere can support human life safely in the event of entry by personnel.

It is important to realise that corrosive action may continue if holds are not sufficiently cleaned after a sulphur cargo and if residues remain after discharge. Accordingly, the holds should be thoroughly cleaned after discharge and fresh water washed to prevent future problems. After pumping out bilges, the bilge wells, systems and pumps should be flushed through with a lime wash solution to help protect the system.

Extreme caution must be exercised when sulphur cargoes are carried.

Case Study 029

Miscellaneous

# Total loss in heavy weather

A handysize bulk carrier that was on a loaded voyage in the north Pacific during the northern winter months broke in two during heavy weather and sank with the loss of six lives.

## What happened?

The vessel loaded a cargo of copper and zinc concentrate in South America and was on passage for discharge in Japan.

The ship encountered heavy weather which was so serious that the crew abandoned ship 20 minutes before the vessel sank. Interviews with the surviving crew members reveal that the vessel probably broke in two somewhere in the area of holds 4, 5 and 6.

There was no indication of any shock or sound to suggest that the vessel hit another object or vessel. Six crewmen lost their lives. The remaining crew were rescued by the Japanese Coast Guard and taken to Tokyo before being repatriated.

## What went wrong?

The ship sank in an area about which weather information was broadcast from Japan. There is no record of the ship taking any steps to avoid the deteriorating weather nor reference to obtaining weather forecasts when making passage planning decisions.

Statements made after the incident appear to reveal that the ship had found itself in the centre of extremely bad weather. However, it was noted that recollections offered by the crew differed between watchkeepers at the time.

The weather in the days leading up to the incident was recorded as deteriorating from force 7 (ship rolling moderately) to gale force 9 with 8 metre waves (ship pitching and rolling very heavily, shipping seas forward).

On the morning of the incident, the chief officer stated that at an unspecified time the ship reduced speed to 4.5 knots. At 0400 the ship went to hand steering. At 0411 the ship suffered structural failure and she sank at 0630.

The EPIRB distress signal from the ship was recorded at approximately 0600.

## What can we learn from this incident?

Good seamanship practice would be to avoid a known area of extreme winter weather.

Once in such conditions, the only option may be to heave to in heavy seas which are so bad that progress can no longer be made safely.

With all the modern technology and weather forecasting systems that are available, it is imperative that all possible information is collated and any weather routing and avoidance measures are taken in order to protect the ship and the lives of her crew. This should be part of the voyage planning progress.

Close monitoring of weather conditions is essential.

Case Study 030

Miscellaneous

# Fuel transferred to duct keel

The ship was undergoing post-purchase refit when she suffered an internal oil spill of some 84 tonnes of heavy fuel oil. A bunker fuel oil transfer pipe failed in service and flooded into the duct keel.

## What happened ?

The Member had recently purchased the vessel and had carried out a pre-purchase inspection. The vessel was subsequently dry docked in northern Europe. A company superintendent attended the vessel for the duration of the drydock to oversee the repair work and modifications required by owners.

One of the tasks to be undertaken was the conversion of one of the ship's bunker fuel oil tanks so as to enable it to carry vegetable oils. Obviously this necessitated the tank being completely drained and fully cleaned.

At the time the vessel was handed over to her new owner, it was estimated that the tank in question contained approximately 400 tonnes of heavy fuel oil (HFO).

Arrangements were made to transfer the tank contents to waiting road tankers. The HFO was heated to 55°C prior to transfer. The process was both complex and time-consuming and, due to the small capacity of the transfer pump, was to take four days to complete.

Visual sightings confirmed that the tanks were empty but on completion of HFO transfer, the receivers advised owners of a shortage of 84 tonnes.

Initial investigations did not locate the missing fuel. Eventually it was located in the duct keel.

## What went wrong ?

The vessel was an ice-class ship built in the early 1980s and was designed to operate in temperatures as low as -50° C. Consequently, all the pipes in the duct keel were heavily lagged and fitted with trace steam heating. It is probable that leaking trace heating lines were not properly repaired and this led to corrosion of the steel pipework.

During pre-purchase inspections, HFO was detected in the duct keel but the source was neither identified nor repairs made prior to the system being used for fuel transfer. When it was decided to transfer the fuel from the tank to be converted, the lines were simply set and the pump started. The duct keel gradually filled with bunkers at a rate of approximately 1 tonne per hour.

## What can we learn from this incident ?

Even at particularly busy operational periods such as during the dry docking of a vessel, good practices should always be adopted and tasks carefully planned.

Before any fuel transfer, all visible sections of bunker transfer systems should be inspected and efforts should be made to confirm that the lines have been pressure-tested within the past 12 months. On any new or newly acquired ship, all oil transfer lines should be pressure-tested and their integrity proven prior to any fuel oil transfer. Tanks that are being filled or emptied should be carefully monitored, as should other system tanks, to ensure that fuel oil is going to the correct reception facility.

Tank soundings should be made on a regular basis and those readings should be recorded, as should the tank volumes. All bunker transfers should be carefully monitored and a permanent watch should always be maintained.

The duct keel should be sounded both forward and aft on a daily basis whether the vessel is at sea or not to ensure no flooding has occurred. If this had happened on board the ship in question, the spill would have been limited.

On many vessels Mobrey float alarms are fitted to indicate any flooding of the duct keel. This system would have prevented such a serious spill.

The clean-up costs and consequential losses incurred by Members cost MSMI many thousands of dollars.

Case Study 031

Miscellaneous

# Repairs undertaken in heavy weather

The vessel, a twin-engine passenger vessel with direct-drive propulsion plant, suffered engine failure, leaving it rolling heavily without main engines and with many very frightened passengers onboard.

## What happened?

Prior to leaving port, the chief engineer advised the master that there was a minor problem with the port main engine which would require shutdown to effect repairs. The engineer advised that the repairs were only expected to take a few minutes. However, the berth was exposed to difficult weather conditions and the master was reluctant to shut down the main engine in the conditions alongside the berth. Consequently, and following discussions with the engineer, the decision was taken to keep the engine running until she was full-away on passage and then shut down the port main engine in order to rectify the problem.

The vessel departed the port without incident but was steaming into heavy and difficult adverse weather conditions. The engineer shut down the engine to effect the repairs and left the starboard main engine running, which allowed the vessel to maintain a headway into the weather. Unfortunately, whilst the port main engine was shut down, the starboard main engine went into shutdown mode when a safety device was operated. The vessel was quickly left rolling and floundering in the heavy swell without main propulsion, which caused serious concerns on board ship and led to many frightened passengers.

The port main engine was quickly restarted after minor repairs. Shortly afterwards, the starboard main engine was also restarted and the voyage was completed without further incident.

## What went wrong?

The chief engineer made it clear to the master that repairs were needed to the port main engine but the potential for an incident was clearly underestimated in the rushed review of the situation before leaving port.

It later emerged that the original fault on the port main engine had been present for some time and although it was desirable that this be rectified, the fault did not affect the safe running and operation of the engine.

The heavy weather conditions meant that both main engines were required for full and safe operation in order to enable the vessel to make reasonable progress. Repairs on the port main engine could certainly have been delayed until there were better weather conditions.

## What can we learn from this incident?

It is essential that all maintenance should be carefully planned and organised at an effective work planning meeting undertaking any maintenance.

The decision to shut down at sea was ill advised, not least due to the difficult weather conditions at the time but also because there are more uncertainties at sea than when the vessel is at anchor or alongside.

The obvious benefits of having twin-engine propulsion plant with its inbuilt redundancy were not achieved, due to insufficient work planning and human error.

Subsequent company led enquiries concluded that the shutdown of the main engine had not been necessary and that the crew had not fully appreciated the potential consequences of a failure of the starboard main engine whilst the port main engine was shut down for repair at sea.

Case Study 032

Miscellaneous

# Navigational error causes damage

A ship ran over expensive sonar and seismic equipment being towed by a hydrographic vessel and damaged its own tailshaft.

## What happened?

The bulk carrier was proceeding on passage at a speed of 14.3 knots with following seas and swell in reduced visibility.

The navigation bridge was manned by the second officer and one lookout. The second officer failed to reduce speed in these conditions. He also failed to advise the master and the duty engineer.

The second mate, who had recently joined the vessel, found himself with a large backlog of uncorrected charts and had taken the opportunity to update the charts during the sea passage. As he was assisted on the bridge by a lookout, he felt that it would be possible to undertake the work during the watch.

The lookout requested permission to go to the ship's galley to prepare some food and permission was granted by the second officer. However, due to the need to catch up with chart corrections, he checked the radar, concluded that everything was in order, and resumed his chart corrections. The ARPA on board the ship was inoperative and the seas and swell were creating considerable clutter on the remaining 12 cm display. The radar was set on a range of 24 miles and the sea clutter setting was not properly adjusted.

Later in the watch, the second mate decided to check the radar and noticed a small vessel approximately 1.6 miles from the ship, fine on the starboard bow. The second mate eventually made visual contact with the craft which was showing lights for a vessel with restricted ability to manoeuvre. The second mate took the decision to alter course so as to pass around the stern of the vessel, which led to the bulk carrier seriously damaging expensive, submerged sensors and delicate equipment attached to the sonar and seismic equipment being towed 200 metres astern of the vessel, which was a hydrographic vessel.

Not only was the equipment seriously damaged as the bulk carrier passed over the tow but the tow wire became entangled in the ships propeller.

## What went wrong?

The master failed to issue proper and effective standing orders and ensure their compliance. He also failed to ensure that a proper bridge watch was being maintained, that the bridge equipment was fully operational, and that it was operated correctly.

The watchkeeper - the second mate - failed to:

- Maintain a proper lookout by all available means appropriate to the prevailing circumstances and make proper use of shipboard equipment to obtain early warning of the risk of collision.
- Ensure that the bridge was correctly manned - he allowed the lookout to leave the bridge without arranging for a replacement.
- Reduce speed and alert the master to the restricted visibility
- Assess properly the situation and identify the nature of the target vessel.
- Take early action to avoid a collision.

The hydrographic vessel was showing the lights of a vessel restricted in its ability to manoeuvre and this should have alerted the second officer to the potential hazards that lay ahead. Indeed, the hydrographic vessel also had a flashing amber light on the paravane attached to the equipment being towed but this was also missed by the second mate.

## What can we learn from this incident?

It is essential that a bridge watch is fully maintained at all times. This should at least meet minimum industry standards and comply with the company standing instructions and operational procedures.

The master of any ship should ensure that the watch is properly maintained and that all the watchkeepers are not distracted by additional workload or asked to undertake duties which mean they cannot undertake the bridge watch to their fullest capability.

Case Study 033

Miscellaneous

# Loss of rudder

The ship lost its rudder while in a rough following sea and heavy swell. The rudder sheared off at the palm plate. Several sister ships with the same rudder design subsequently suffered similar incidents.

## What happened?

The ship was on voyage heading north in the Arabian Sea during the height of the SW monsoon. A hydraulic oil leak developed in way of the steering gear but the source was not identified. Some time later, a crew member working in the steering flat heard two loud bangs. The ship immediately veered off course.

Although the steering gear appeared to function normally, there was no steerage and it was concluded that the rudder had been lost. Whilst awaiting a tow organised by the ship operator, the ship was able to head into the weather/swell by using the main engine and bow thrusters but was rolling up to 28°.

The first tug engaged for the tow had to return to port because of the severe monsoon weather conditions. A second tug arrived later and commenced towing. After about ten hours the towline parted. Whilst recovering the towing gear, the tug's starboard rudder and propeller were fouled by the bridle and the starboard engine was severely damaged. The second tug also returned to port. Eventually, a third tug arrived some ten days after the initial incident and successfully towed the ship to a port of refuge.

## What went wrong?

The final survey report concluded that the loss of rudder was probably due to a combination of problems, including the ingress of water into rudder. Increased stresses as seawater filled the rudder contributed to the rudder failure and the subsequent weld failure at the palm plate.

## What can we learn from this incident?

It is likely that the hydraulic oil leak was related to the increased stresses from a seawater-filled rudder.

The hydraulic leak should have been traced and it may have enabled engineers to identify more serious problems with the rudder.

Good watchkeeping is essential and its importance cannot be overstated.

Steering gear operating hydraulic pressure and electric motor loads should be closely monitored on a routine basis on each watch.

The first tug was unsuitable for the deepsea monsoon weather conditions, and the second tug was apparently reported as having defective towing gear when engaged.

It would have been prudent to seek immediate advice regarding the hydraulic leak.

The loss of rudder should have been notified immediately to sister ships to avoid any similar incidents.

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