PERSPECTIVES

MARINE CASUALTY INVESTIGATION:

Engineering and Forensic Accounting Risks and Hazards

JS|HELD

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Introduction

The following case study is a hypothetical scenario based on broad and varied investigation and attendance experience. Any resemblance to ongoing or previous incidents is entirely unintended and purely coincidental.

The hypothetical case described in this article involves a well-established ship owner with an in-house managed fleet of around 100 vessels, trading internationally. The matter under discussion is a fire on board one of those vessels as it sailed from Europe to East Asia.

The fire immobilised the Vessel in the Red Sea, which required towage to a safe port where the cargo could be trans-shipped for onward carriage. As could be expected, there were various claims in relation to towage, machinery damage, cargo degradation, and delays.

This article will examine this hypothetical marine casualty case, as well as the various claims and investigations involved. We will also discuss the importance of proper investigation and the value of owners' diligence, good maintenance practices and preventative forensic insights.

Marine Risk Context: Engine Room Fire Aboard a Commercial Vessel

The Vessel, a containership, was registered in an IMO and Paris MOU Whitelist country, classed with an IACS member without condition, and operated by a renowned and respected ship owner/manager. These factors should have ameliorated the risks generally associated with shipping and provided reassurance to those with an interest in the voyage.

Having loaded cargo, the Vessel departed her berth and proceeded toward the Suez Canal. The transit through the Canal was without problem and the Red Sea passage subsequently commenced.

The geopolitical situation in the Red Sea required increased vigilance by the crew and an acute awareness of potential piracy or attacks from hostile regional actors. The ngine room was maintained in a manned condition, and the passage continued without a notable event.

At around 03:45, as the Vessel entered the Gulf of Aden, the watchkeeping engineer carried out rounds and smelled fuel oil in the vicinity of the Number 3 auxiliary engine. To investigate the source of the odour, the watchkeeper removed a heatshield from the engine and, in doing so, observed a fuel oil leak in way of one of the engine's six high-pressure fuel pumps.

Given the geographically hazardous location of the Vessel and deeming the fuel leak to be of little immediate risk, as it was not a spray but seepage, the watchkeeper did not initiate any action at that time. The engine was left in operation but without the heatshield allowing the leak to be monitored. The engineer returned to the engine control room to complete record-keeping and to prepare for the watch change at 04:00.

At 04:05, with the watch handover in progress, a heat alarm was activated in the engine room, quickly followed by smoke detectors in the funnel space. The engineers investigated the alarms and approached the generator space which housed the Numbers 3 and 4 auxiliary engines. It was clear to the engineers that a fire was well established above the Number 4 auxiliary engine. Dense smoke was also being generated. This and the excessive heat made entry impossible without firefighting suits.

The engineers promptly returned to the control room, and one of them advised the Master of the situation. Another shut the quick-closing valves and stopped the ventilation to control the fire. The fire and smoke continued to spread, and it was decided to abandon the engine room.

With all crew mustered and their procedures followed, the fixed firefighting system was activated, and the engine room was flooded with carbon dioxide. Boundary cooling of the engine room was carried out. By then, main power had been lost, and, consequently, the Vessel drifted.

Once the crew deemed it safe, a ship's fire team entered the engine room in breathing apparatuses. Among other matters, they found that the nature and extent of damage was such that main power and propulsion could not be restored. Rather, permanent repairs would be required at a shipyard.

The Vessel drifted in the Gulf of Aden pending the arrival of a tug and subsequent towage to a safe port. By the time the tug arrived, the Vessel had no power as the emergency generator had overheated and failed within an hour of operation.

The Vessel arrived in port three days later, and cargo was discharged there for trans-shipment and onward carriage to East Asia. There were significant delays in the arrival of the cargo at the destination ports.

Expert Attendance

J.S. Held was initially instructed by Owners' interests to attend the Vessel upon its arrival in Oman. Our remit was to investigate the cause of the fire and related aspects of Owners' diligence which should (or could) have prevented, controlled, and/or extinguished the fire. As our attendance progressed, our instructions evolved to assist the Owner in defining future loss prevention activities.

Having attended various marine casualties, our engineer acted proactively and sought to cover all aspects which could have contributed to the fire, including those directly relevant to causation, as well as those that, while appearing unconnected, may be leveraged by opponents. This approach was to protect Owners' interests and to furnish its legal team with encompassing, robust technical advice.

Our attendance in Oman spanned several days and included our engineer assisting other interests' surveyors with their "without prejudice inspections" which were carried out within legally binding confines and subject to indemnities. In this article, we do not discuss joint inspections with other parties' experts or surveyors, only focusing on the technical aspects of the matter.

As we hold clear and timely client communications as critical, during his attendance, our surveyor provided our principals with daily updates by email and telephone/cell. As far as was possible on site, he remained readily contactable, aware of our instructing interest's time zones.

Having provided technical assistance to a solicitor appointed for Owners' interests in interviewing the crew, it quickly became apparent to our engineer that the cause of the auxiliary engine fuel leak may be of direct interest to the investigation.

Onboard Investigation

A forensic inspection of the engine room and affected machinery was carried out, with the scene thoroughly and accurately documented. Various evidence was collated and considered, including documents, contemporaneous video, photographs, and machinery operating records.

As part of his investigation, the attending J.S. Held engineer identified a fractured and parted high-pressure fuel pipe coupling in the vicinity of where the watchkeeper had reported the fuel leak.

With the heatshield having been removed before the fire, upon the coupling failure, high-pressure fuel had sprayed onto various machinery in the vicinity. Despite the heat damage, there remained clear evidence of the fuel spray and unburnt fuel residues. The fractured coupling and fittings were subsequently removed from the engine and preserved for possible materials analysis.

It was also observed by our engineer that the fire damage appeared to have centered on the auxiliary engine adjacent to the engine with the fuel leak. The evidence indicated that fuel had sprayed onto the exhaust side of that engine.

The outer metal cladding surrounding the exhaust manifold of the Number 4 Engine was found to be affected by heat and had buckled and melted because of the fire. Upon closer inspection, our engineer observed that the heatshield had not been correctly fitted prior to the fire, with short, twisted lengths of wire having been used to secure it, rather than the original fittings specified by the manufacturer.

The remains of metal cladding were removed, and it was apparent that large sections of the manifold below it had not been properly insulated. The combination of the poorly secured heatshield and lack of lagging had allowed the sprayed fuel to directly impinge on the hot exhaust surface, leading to ignition.

Firefighting System Performance and Safety Equipment Deficiencies

In terms of the Vessel's fire response, the quick-closing valves, fire dampers, and fixed firefighting system were also inspected. From these inspections, it was determined that while these systems had been operated by the crew, not all quick-closing valves or fire dampers had closed, nor had all carbon dioxide bottles operated.

Upon closer examination:

a) It was identified that several carbon dioxide bottles remained fitted with their related shipping safety pins. These had prevented their operation.
b) Hydraulic oil leaks were identified in way of three lubricating oil tank quick-closing valves which had prevented their operation.
c) Two machinery space ventilation damper actuators were found jammed open with wooden wedges. This prevented the dampers from being closed.

Initial Investigation Findings

The preliminary findings from our attendance included:

a) Fuel had sprayed from a failed high-pressure pipe coupling and likely had been ignited by the hot surface of the adjacent engine's exhaust.
b) In terms of Owners' diligence, the poor insulation and cladding in way of the adjacent engine's exhaust placed the Vessel in violation of SOLAS and probably provided the ignition source for the fire.

c) The heatshield removed by the watchkeeper (when the fuel leak was first identified) was not replaced. Had it been refitted, the spray of fuel would have been contained, which may have prevented the fire.

d) The watchkeeper appeared reluctant to stop the Number 3 auxiliary engine when the fuel leak was first identified. As well as considering the location of the Vessel in a high-risk area, it transpired that the watchkeeper decided to leave the incident engine in operation as their watch was near to an end. The watchkeeper felt that stopping it and starting another would have kept them in the engine room past their watchkeeping hours. The watchkeeper was keen to finish on time. At interview, the watchkeeper stated that they had intended to ask the next watch to stop the engine, but the fire had already started before the handover was completed. While the leak was deemed minor by the watchkeeper, had the engine been stopped with load transferred to another auxiliary engine, it appeared likely that the fire could have been prevented.

e) The fixed carbon dioxide system did not fully operate. Safety pins were found in the way of several bottles, preventing their operation. The system had last been serviced by a shore contractor 12 months before the fire. Despite the crew reportedly carrying out routine inspections since that service and an intervening satisfactory Port State Control inspection, the presence of the safety pins had not been identified.

f) While not contributing to the cause or extent of the fire, three lubricating oil quick-closing valves had not operated. It was identified that the hydraulic connections to these valves were loose, with evidence of leaking hydraulic oil. These valves had reportedly been routinely tested without problem and within a month of the fire occurring. Since that last test, maintenance records indicated that the system had been bled of air following a pipeline repair. It was therefore concluded that the couplings had not been properly reconnected after this work, and that the system was not tested after those works.

g) The two machinery space fire dampers that were found held open with wooden wedges had been subject to maintenance at the last port. The relevant pneumatic actuators had reportedly been found defective during a Port State Control inspection at that port and had been removed for repair. It was reported that the crew's intention had been to overhaul and refit these actuators during working hours on the incident Red Sea passage.

Evaluation of Maintenance Practices and Owners' Diligence

In terms of the fractured fuel pipe coupling, among other matters, our engineer investigated the related maintenance routines present on board.

It was established on board that the pipe coupling had been replaced around a month before the incident in response to a service letter issued by the engine builder. The available records indicated that work had been carried out by a certified second engineer officer using parts delivered to the Vessel before the incident. There was little evidence to doubt the Owners' diligence in this regard, as they had reacted promptly to the engine builder's service letter recommendations. In terms of the maintenance, the legal advice based on evidence collated on site was that the Owners had acted diligently, and there was limited scope for it to be argued that there was any incompetence or negligence in the maintenance.

However, given the failure of the coupling so soon after recommended maintenance, based on his experience, J.S. Held's engineer initially doubted the provenance or pre-existing

condition of the replacement coupling fitted at that maintenance.

As he was on board the Vessel and with evidence to hand, the purchase order and delivery note for those parts were immediately available to him. These were inspected, and they suggested that the coupling had been sourced from the Original Equipment Manufacturer (OEM), which further supported the Owner's diligence.

Our engineer remained concerned that an original coupling had failed after such limited service, and so he advised our principals accordingly, suggesting a way forward. Consequently, he went on to inspect other similar parts from the same and previous deliveries in the Vessel's stores. He noted that there were subtle variations in the visual appearance of the spare couplings and that the packaging and labelling were inconsistent.

Metallurgical Investigation and Failure Analysis

Considering the incident and his other observations, our engineer recommended that the failed coupling and exemplars be sent for materials analysis. This was both to investigate why the coupling had failed and so that Owners could consider the risk of similar failure across their other vessels, where similar reactive maintenance had been carried out, or was planned in response to the engine builder's service letter.

It was proposed that J.S. Held's materials laboratory and scientists carry out the materials analysis work. This was to ensure the continuity and unimpeded flow of information between the attending engineer and materials scientists. It also gave our principals the reassurance that the full suite of expected tests could be carried out by experienced personnel with the required equipment to hand.

A documented chain of custody was completed on board with the failed incident coupling and three exemplars sent for laboratory analysis. The exemplars included two of different appearances taken from the ship's stores and another from a non-incident engine.

The laboratory analysis was carried out in J.S. Held's materials laboratory in North Kingstown, Rhode Island. The analysis of the failed coupling included visual inspection, fractography of the fracture surface using light microscopy and a scanning electron microscope (SEM) with energy dispersive spectroscopy (EDS) capability, preparation of metallographic cross sections, hardness testing, and chemical analysis. The exemplar couplings were also examined for relevant comparisons.

The laboratory analysis of the failed coupling revealed that the material it was manufactured from contained an inclusion, which created a weak spot. Stresses present on the coupling during installation and operation of the fuel system had led to the initiation of a fatigue crack at the location of the inclusion. The hardness testing and chemical analysis of the couplings showed that the materials were in accordance with the intended specifications. The incident coupling was defective because it contained the inclusion, which was considered an isolated manufacturing defect.

Recurring Non-Compliances in Safety-Critical Systems

Despite the marine industry's longstanding awareness of hot surface ignition risk and the regulations designed to prevent it, we continue to attend fire casualties and vessels in general where hot surface protection is inadequate.

Fires caused by hot surface ignition are largely preventable by using known procedures and management policies. Shipowners, managers, and crews are typically aware of the required preventative measures, so it is distressing that such deficiencies remain a prominent cause of engine room fires.

This is a well-known, high-risk deficiency, and one we encounter on vessels in Class and with an apparently clean Port State Control history. In our experience, a vessel being in Class and without any recent causative Port State Control defect does not necessarily imply that the Owner is diligent or that an incident will not occur. In proceedings, the judgment of whether a vessel was seaworthy will consider significantly more evidence than simply Class status or Port State Control history.

Furthermore, we variously attend vessels and consider desktop cases proceeding to hearings where emergency equipment did not function correctly when needed. We have seen multiple occasions where this occurs, despite planned maintenance having reportedly been carried out. In our experience, the instances of emergency generator, quick-closing valve, ventilation, and fixed firefighting system defects are worryingly frequent.

While we find that maintenance procedures for these safety critical systems are generally in place, failures continue to occur. In those occasions, the attention to detail by the crew carrying the maintenance work, the thoroughness of those works, and/or the veracity of maintenance records are typically drawn into question.

Early Engineering Insight to Inform Legal Strategy

In our hypothetical scenario, the initial legal advice we received was that in any London proceedings, the Vessel was likely to be found unseaworthy due to the insulation defects. Owners' interests' lawyers also considered that a tribunal would likely look upon the general safety failings negatively, and this could prejudice the Owner's position. Ultimately, with our engineer on site, promptly feeding back his daily findings, the legal team could start to formulate preliminary views and guidance at the outset.

Beyond Liability: Forensic Insights to Prevent Recurrence

Owners accepted the legal position, but, given our forensic approach to the investigation, they wanted J.S. Held to delve thoroughly into what had gone wrong on board. The Owner wanted to best protect their position, but also to proactively learn from it and to prevent other similar incidents across their fleet. With their profile, reputational harm was unpalatable to them, and a repeat incident had to be prevented.

In this context, as well as investigating incidents, J.S. Held can also provide valuable input to stakeholders based on our experience and lessons learned from other losses or incidents. In this scenario, and with our engineer on site, the Owner was keen to capitalize on this experience and knowledge.

Recognizing Red Flags and Tracing Root Causes

The possibility of fake or grey market spares is a frequent consideration in machinery failure investigations. While it is often considered, we have so far seen few losses directly related to it.

In this case, we considered the possibility of lower-quality or fake parts. Our awareness of this led to identifying possible red flags early in the investigation, such as variations in the appearance of parts and their packaging. However, it was concluded that the parts delivered to the Vessel were OEM supply but had been poorly manufactured by their sub-contractor. We are often involved with cases of latent or manufacturing defects, confirmed through laboratory analysis.

It was later determined that the inconsistencies in labelling and appearance reflected a change in the factory used by the OEM in making the parts. We concluded that the latent materials defect would and could not have been identified by the crew who diligently carried out the required maintenance. Owners had also ordered parts from the OEM in response to their service advice, which we considered prudent.

Furnished with our expert opinion, the Owner was able to promptly remove the potentially defective components from their stocks and replace any which had already been fitted in their fleet. Based on our findings and opinions, the Owner considered launching proceedings against the OEM for the supply of defective parts.

The Value of Early Expert Involvement in Casualty Response

In this scenario, Owners' interests appointed J.S. Held to attend the Vessel immediately after the fire and to carry out a thorough investigation as soon as possible. Among other matters, this enabled evidence to be secured and Owners' interests to be best protected.

In this case, our attending engineer was able to react to the dynamic situation on board and make decisions that otherwise may have been overlooked. His experience, foresight, and attention to detail were all key in this investigation and the outcome, even if it was not entirely positive for our clients. Being on board the Vessel, he was able to identify aspects of the investigation where we could further add client assistance, such as through materials analysis.

We are often instructed in cases where our experts are asked to provide an opinion based on incomplete or poor evidence obtained by a third party. In many of these cases, at the incident time the client believed that the matter may not escalate or that it was not attention-worthy. This elected approach can be costly and detrimental.

While we always support our clients as best possible, not being appointed at the outset to personally attend a casualty can greatly constrain later analysis and weaken clients' positions. In the longer term, it can also lead to caveats being required in our opinions and additional costs incurred where, had we attended, they could have been avoided. This is particularly the case when opposing parties rely on an expert who attended at the outset and therefore has firsthand knowledge.

Comprehensive On-Site and Laboratory Expertise Driving Effective Loss Resolution

In this hypothetical scenario, because of our forensic approach on board, our metallurgists were instructed to inspect various components of interest. In doing so, they were able to identify a materials defect in the failed and spare parts.

The evidence provided to them was subject to a robust chain of custody, driven by our attending engineer. The laboratory analysis was honed by our scientists, in attendance and thus positioned to make dynamic decisions based on findings as they became available in the laboratory.

There was no delay in analysis or loss of evidence which could have occurred had we not been involved at the outset and in the later laboratory processes. These factors all lent credibility to the investigation and added value to our findings. We too often come across cases where corners have been cut in the investigative process, leading to avoidable, detrimental outcomes.

Our experts frequently mobilise globally at short notice to serve our clients. We believe our international platform offers the best possible technical support in what can be challenging and distressing situations. Armed with rapid, professional, and robust feedback from our attendances, our clients can make informed decisions at all stages of an investigation. We ensure that all evidence, including that which may initially appear at the periphery, is collated and preserved.

The Role of Forensic Accountants in Marine Claims

While the scenario on marine engineering shows how essential it can be to retain an expert with marine experience, it is equally important to retain forensic accounting professionals with demonstrative experience handling complex marine claims.

The collection of the proper accounting data addressing the scope of work at the onset of the loss led to qualitative record-keeping of these significant recovery costs incurred early on the project. We were able to set expectations for all parties, ensuring the hourly/daily reporting was correctly occurring. In summary, our involvement in this claim scenario permitted us to ensure that the protocols for our review of this complex claim, with many moving parts, were in place, eventually leading to a successful resolution for all parties. Our involvement in the claims process could also be successfully used for other claims, such as tracking marine construction claim costs and evaluating economic damages relating to maritime ship allisions.

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