Marine Safety Investigation Unit

Transport Malta

MARINE SAFETY INVESTIGATION REPORT

Safety investigation into the engine-room fire on board the Maltese registered ro-ro cargo vessel

EUROCARGO TRIESTE

following departure from the port of Livorno on 21 November 2019

201911/027

MARINE SAFETY INVESTIGATION REPORT NO. 21/2020

FINAL

Investigations into marine casualties are conducted under the provisions of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011 and therefore in accordance with Regulation XI-I/6 of the International Convention for the Safety of Life at Sea (SOLAS), and Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009, establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Council Directive 1999/35/EC and Directive 2002/59/EC of the European Parliament and of the Council.

This safety investigation report is not written, in terms of content and style, with litigation in mind and pursuant to Regulation 13(7) of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011, shall be inadmissible in any judicial proceedings whose purpose or one of whose purposes is to attribute or apportion liability or blame, unless, under prescribed conditions, a Court determines otherwise.

The objective of this safety investigation report is precautionary and seeks to avoid a repeat occurrence through an understanding of the events of 21 November 2019. Its sole purpose is confined to the promulgation of safety lessons and therefore may be misleading if used for other purposes.

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LIST OF REFERENCES AND SOURCES OF INFORMATION

Documentary evidence collected from the vessel and received from the Company and the Italian Ministry of Infrastructure and Transport.

Data retrieved from the vessel's Voyage Data Recorder.

International Labor Organization (ILO). (2006). *Maritime Labour Convention*. Genève: Author.

International Maritime Organization (IMO). (2018). *International convention for the safety of life at sea, 1974* (Consolidated ed.). London: Author.

IMO. (2010). *International convention on standards of training, certification and watchkeeping for seafarers, 1978, (STCW code)*. London: Author.

Statements and interviews with the crew members of *Eurocargo Trieste.*

GLOSSARY OF TERMS AND ABBREVIATIONS

A60	An "A" class division, which complies with the relevant criteria prescribed in Chapter II-2 of the SOLAS Convention
AB	Able seafarer (deck)
AIS	Automatic identification system
CO_2	Carbon Dioxide
DPA	Designated person ashore
ETA	Estimated time of arrival
gt	Gross tonnage
kW	Kilowatt
LOA	Length overall
LT	Local time
m	Metres
MSIU	Marine Safety Investigation Unit
mt	Metric tonnes
nm	Nautical miles
OOW	Engine-room officer of the watch
PA	Public address
PVC	Polyvinyl Chloride
QCV	Quick-closing valve
RO	Recognized organisation
RPM	Revolutions per Minute
SMS	Safety management system
SOLAS	International Convention for the Safety of Life at Sea, as amended
STCW	International Convention on Standards of Training, Certification and Watchkeeping of Seafarers, 1978, as amended
TSS	Traffic separation scheme
UPS	Uninterruptable power supply
UTC	Coordinated universal time
VDR	Voyage data recorder
VHF	Very high frequency

SUMMARY

At around 0123 on 21 November 2019, ro-ro cargo, motor vessel *Eurocargo Trieste* Livorno, Italy, for Savona, Italy. There were 25 crew members on board and the vessel was laden with trailers.

At around 0220, shortly after dropping off the outbound pilot, a fire broke out around the starboard main engine. The engine-room crew initially tried to fight the fire but soon had to vacate the space. The crew members were then mustered, and the fire-fighting team tried to enter the engine-room to fight the fire. Due to thick smoke and difficulties to enter the space, the fire-fighting team retreated, and the master decided to flood the engine-room with CO_2. The gas was released at 0230.

The vessel contacted Livorno's port authorities at 0240 requesting fire-fighting assistance. At 0304, the first pilot boarded the vessel and at 0320, a tugboat started the deck boundary cooling. The Livorno Fire Department personnel boarded the vessel at 0410 and at around 1200, the fire-fighters reported that the fire was under control. However, the vessel lost all power and was subsequently re-berthed at 1720, with the assistance of tugs.

None of the crew members were injured and no pollution occurred, but the vessel's engine-room sustained heavy damage.

The safety investigation concluded that the fire was most likely caused by fuel spilling accidentally onto a hot surface, near the entrance to the purifier room. Once the fire started, it spread quickly due to the presence of combustible material, leaking heavy fuel oil and lubricating oil around the engine and its bilges.

Based on the investigation findings, Valiant Shipping S.A., is recommended to review its procedures with a view of improving fire safety on board vessels under its fleet.

1 FACTUAL INFORMATION

1.1 Vessel, Voyage and Marine Casualty Particulars

Name	*Eurocargo Trieste*
Flag	Malta
Classification Society	RINA
IMO Number	9131515
Type	Ro-ro cargo
Registered Owner	Malta Motorways of the Sea Limited
Managers	Valiant Shipping S.A.
Construction	Steel (Double bottom)
Length overall	185.00 m
Registered Length	147.60 m
Gross Tonnage	26,536
Minimum Safe Manning	15
Authorised Cargo	Trailers and cars
Port of Departure	Livorno, Italy
Port of Arrival	Savona, Italy
Type of Voyage	Short International
Cargo Information	127 cars and 213 trailers
Manning	25
Date and Time	21 November 2019 at 02:20 (LT)
Type of Marine Casualty	Serious Marine Casualty
Place on Board	Engine-room (Starboard aft side)
Injuries/Fatalities	None
Damage/Environmental Impact	Material damage affecting the operational characteristics of the vessel. No environmental damages were reported.
Ship Operation	Normal Service – In passage
Voyage Segment	Transit
External & Internal Environment	Night, visibility: 10 nm, wind: Southwesterly 10 knots, Southeasterly swell 0.3 m, sea temperature: 19 ^{o}C
Persons on Board	25

1.2 Description of *Eurocargo Trieste*

1.2.1 Vessel overview

Eurocargo Trieste was 26,536 gt ro-ro cargo vessel, built by Fincantieri Cantieri Navali S.p.A, Italy, in 1997. Primarily, she was designed to carry 213 trailers and 127 cars but could also carry up to 12 passengers. The vessel was owned by Malta Motorways of the Sea Ltd. and managed by Valiant Shipping S.A., Greece. Registro Italiano Navale (RINA) performed the functions of the classification society as well as the recognised organisation (RO) of the vessel.

The vessel had a length overall of 185.00 m, a moulded breadth of 25.20 m, a moulded depth of 13.25 m and a summer draught of 7.70 m, which corresponded to a summer deadweight of 11,600 mt. At the time of the accident, the vessel was reported to have been drawing a forward draft of 6.50 m and an aft draft of 7.30 m.

1.2.2 The engine-room and machinery spaces

Eurocargo Trieste was propelled by two MAN B&W "9L 58/64" 9-cylinder, four-stroke, medium speed diesel engines, each developing 12,510 kW at 428 RPM to give a total available power of 25,020 kW. Each main engine was coupled to a sperate propeller shaft, which drove a controllable pitch propeller through a RANK HSN-1120 reduction gearbox.

The main engines were fitted inside the propulsion engine-room, at the main floor level which lay at level 3000[1] (Figure 1), below the main vehicle deck (frames 27-69). The propulsion shafts penetrated the aft bulkhead and the stern tube terminated at frame 20; however, the propeller shaft in way of the stern tube and the propeller itself were supported by an "A" frame. A fuel oil modules' room, with forward and aft accesses on its port side, lay to the starboard side of the propulsion room.

The generator room floor was at level 5200, located aft of the propulsion room (Figure 2). A remotely operated hydraulic watertight door separated the propulsion room from the generator room. The engine control room (ECR) and the main switchboard room were located at 5750 mm above the keel. A watertight door to ECR's starboard side allowed access to the main switchboard room, while a

[1] All levels mentioned in this safety investigation report refer to the height of levels above the keel in millimetres.

watertight door to its port side provided access to the generator room and the propulsion room. The main switchboard room could also be accessed from the generator room through a conventional A60 door. A separator room, with forward and aft accesses on its port side, lay forward of the main switchboard room and directly above the fuel oil modules room.

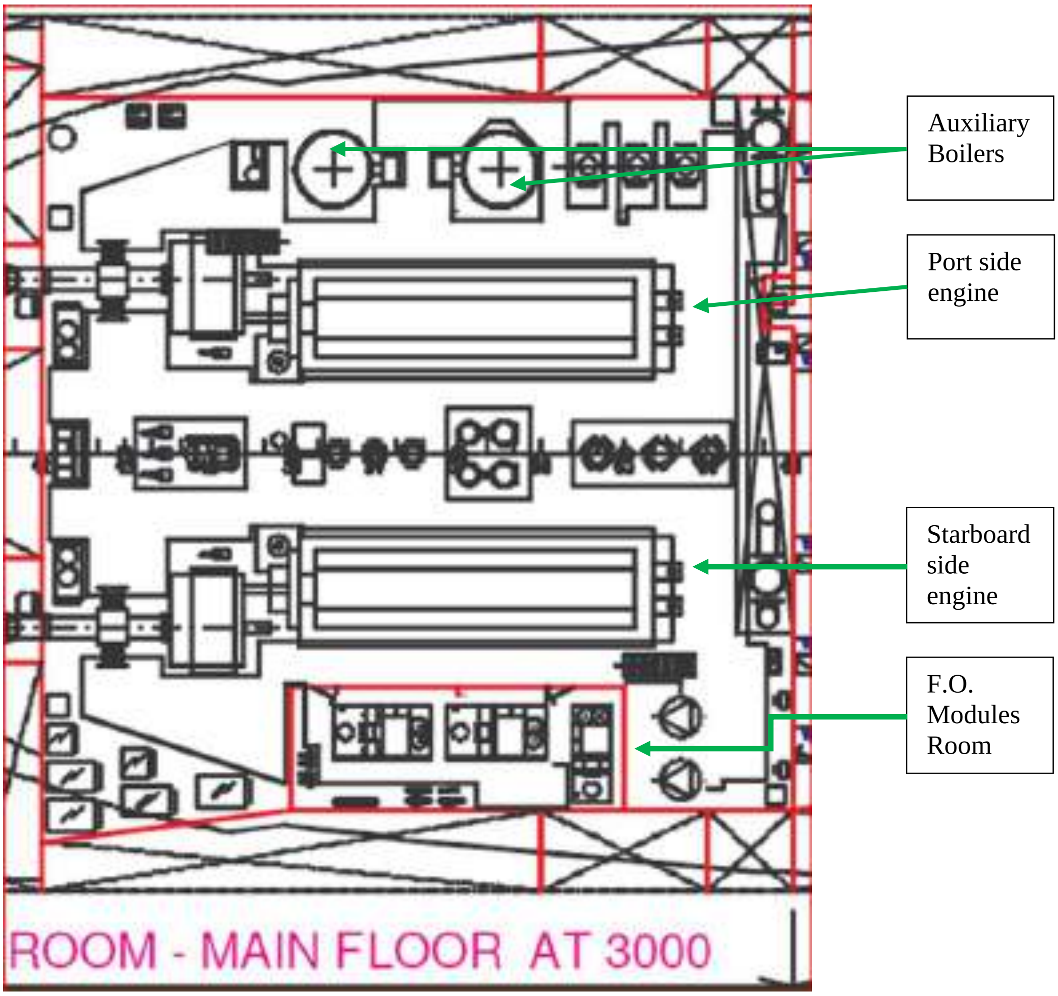

Figure 1: Layout of propulsion room at main floor level

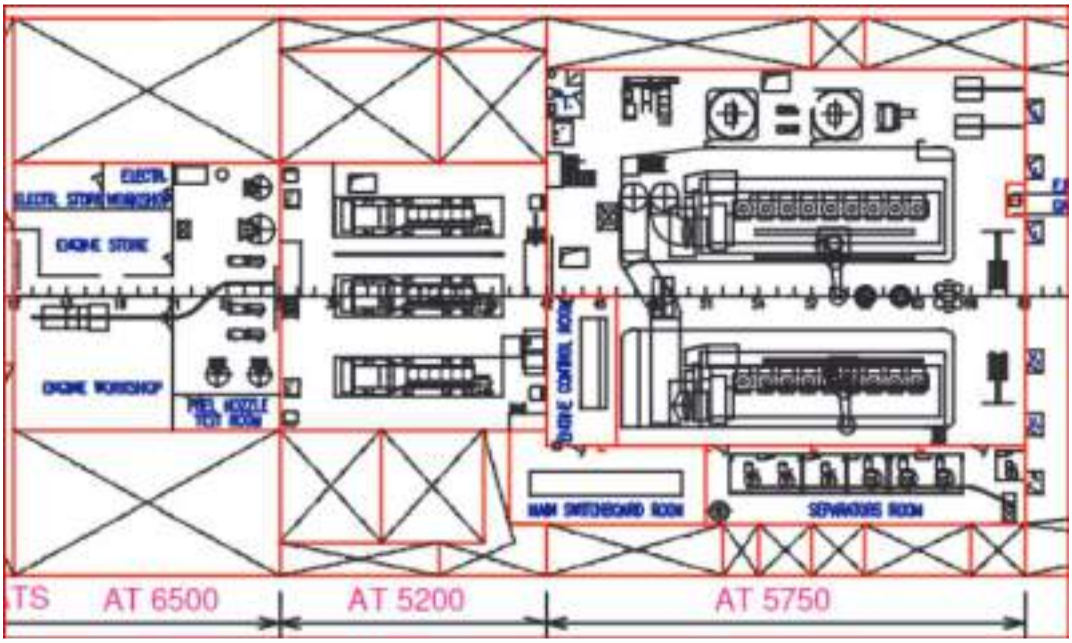

Figure 2: Layout of the engine room at about 5200 mm above the keel

The normal access to the machinery spaces was from the main vehicle deck, located at frame 27 (Figure 3). A vertical ladder led downwards to the aft of the generator room, through which access was provided to the propulsion room and ECR.

Figure 3: Access to the main machinery spaces from the main vehicle deck

The propulsion room deckhead was formed by the main vehicle deck, and the space below was divided into two levels by the top floor at level 5200. This level had two large openings over the main engines from which it was possible to view each engine. Various items of ancillary machinery were located on this level. Casings extending upwards to the funnel provided space for the uptakes from the two main engines, the two boilers, diesel generators and the ventilation. The propulsion room and the lower vehicle deck were separated by a bulkhead, which extended up to the main vehicle deck. An emergency exit was provided at the forward bulkhead, leading up to the main vehicle deck.

Air for the main engines was supplied by fans from intakes on the upper deck, ducted down through ventilation trunks to the propulsion and diesel generator rooms. Each main engine and diesel generator had an exhaust trunk extending up through the casing on the appropriate side to emerge separately at the funnel top, along with the incinerator and the boilers' flue uptakes. All the air outlets and inlets were protected by louver-type fire dampers, which could be remotely operated. A General Arrangement of the vessel is produced in Figure 4.

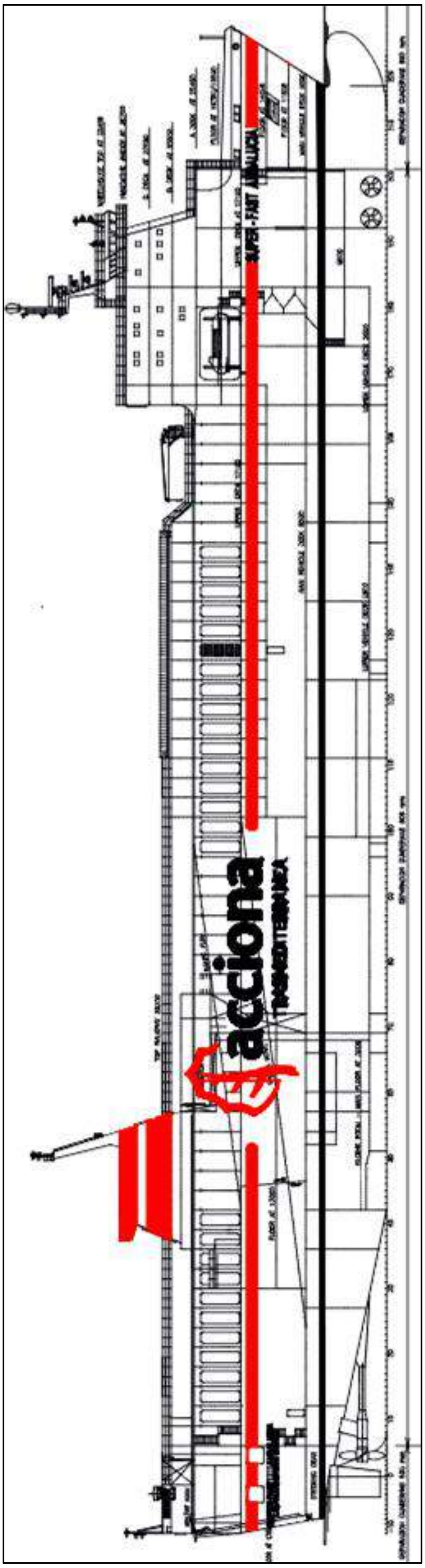

Figure 4: ***Eurocargo Trieste*** **General Arrangement Plan**

1.2.3 Fire detection and extinguishing system

Fire detection within the engine-room was provided by a comprehensive system of smoke, heat detectors, and manual call points. The propulsion room was fitted with smoke detectors. The fire detection system alarms on the bridge, which was manned continuously at sea, were fitted in a central panel. From this panel, it was possible to identify the location of any activated point. A printer provided a permanent record of all generated alarms. A repeater panel for the fire detection system was in the ECR.

The engine-room was fitted with a fixed CO_2 fire extinguishing system, which consisted of a battery of 90 cylinders of 45 kg each. The CO_2 room was located on the upper deck (extreme aft, port side). The fuel oil service tanks were all equipped with quick closing valves (QCVs), operated from a cabinet outside the machinery spaces. In accordance with the relevant SOLAS regulations, when activated, these valves closed instantly and cut off fuel oil supply to the engines. The last annual service of the system was carried out on 15 June 2019 and everything was reported to have been satisfactory.

1.2.4 Fuel oil supply system

Fuel oil supply to each of the main engines was treated in the separator room and then pumped into the service tanks, from which, fuel oil was supplied to the main engines through fuel oil modules.

1.3 Manning of the Vessel

At sea, the engine-room was manned on a 24-hour basis. The engine-room officer of watch (OOW) was a certificated marine engineer. The watches were based on the conventional 4-on, 8-off watch system. The chief engineer was assisted by the second engineer, who looked after the routine day-to-day planned maintenance. The engine-room compliment comprised of a third engineer, fourth engineer, an oiler and two wipers.

At the time of the fire, the OOW was the third engineer, although the chief engineer and the electrical engineer were also in the engine-room to oversee the manoeuvring of the vessel.

The bridge was manned by the master, chief mate, second mate (who had just returned from the mooring station) and an AB, who was serving as a helmsman and look-out.

All crew members were certified in accordance with the relevant requirements of the STCW Convention. The number of crew members exceeded the minimum number stipulated on the Minimum Safe Manning Certificate, which was issued on 18 June 2015 by the flag State Administration.

1.3.1 Chief engineer

The vessel's chief engineer was a 44-year old Bulgarian national, with 16 years of seafaring experience. He held a chief engineer's STCW III/2 Certificate of Competence, issued by the Bulgarian authorities in 2008. He had served as chief engineer since 2009; however, this was his first contract with the Company. He had joined the vessel on 23 September 2019 and, following a hand-over, had taken over as the vessel's chief engineer on 27 September.

1.3.2 Second engineer

The vessel's second engineer was a 55-year old Bulgarian national, with about six years of experience at sea in various ranks, including six months as a chief engineer on board *Eurocargo Trieste*. He had been with the Company since 2014 and had sailed on Company ships as a third engineer up to rank of a chief engineer. He had joined the vessel a week before the accident. He held a chief engineer's STCW III/2 Certificate of Competence, issued in 2017 by the Bulgarian authorities.

1.4 Safety Management System

Eurocargo Trieste complied with the International Management Code for the Safe Operation of Ships and for Pollution (ISM Code), and had been issued with a Safety Management Certificate, valid until 26 November 2019. The last shipboard ISM audit by RINA was carried out on 18 December 2018.

The annual internal audit was carried out by the vessel's DPA 23 August 2019. The audit identified three vessel-related non-conformities, two of which were attributed to marine operations and the other to the engineering department. The auditor also raised one observation that related to the marine operations of the vessel.

1.5 Narrative[2]

1.5.1 Events leading up to the fire and firefighting

At around 0123 on 21 November 2019, *Eurocargo Trieste* departed Livorno with 115 trailers and containers on board, bound for Savona (Figure 5). After dropping the pilot at 0154, the master ordered the engines' speed to be increased to full sea speed (Full Away) at 0200. At a speed of 20 knots, the estimated time of arrival at Savona was 0640 on 21 November.

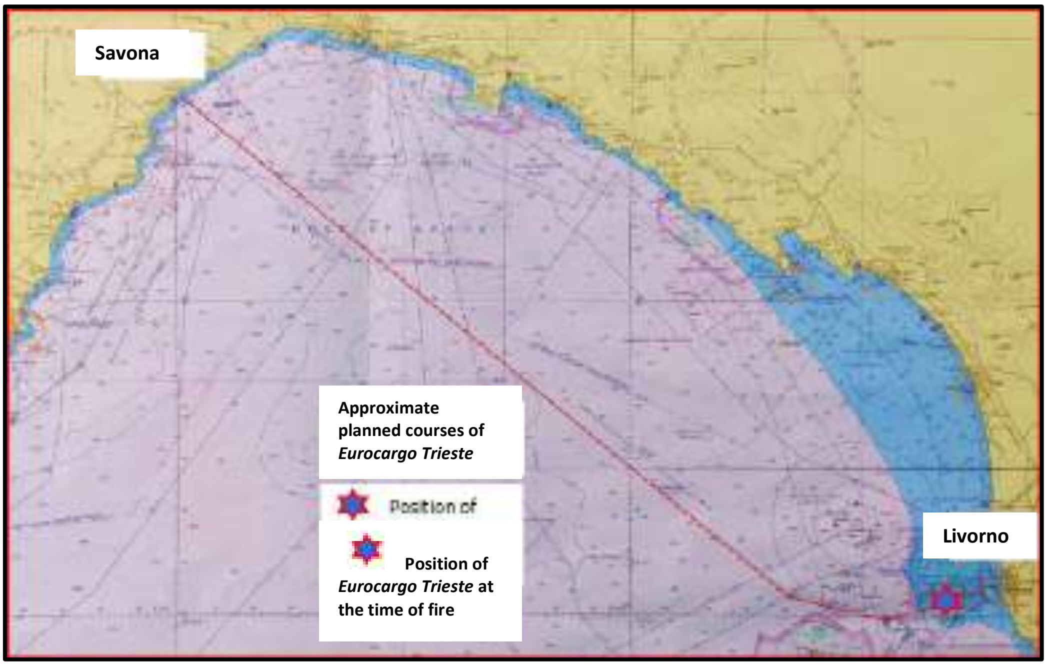

Figure 5: Route of *Eurocargo Trieste* and the position where the fire occurred

At about 0220, both propulsion engines were running at full sea speed. In the meantime, the third engineer left the ECR through the port side door to read off the fuel oil flowmeter, fitted in the fuel oil modules room on the main floor of the propulsion room.

2 Unless otherwise stated, all times are in local time (UTC+1) and are as contained in the vessel's logs.

As the third engineer left the ECR, whilst still at level 5200, he noticed flames emanating from the aft of the starboard engine, on its port side, where the engine's turning gear motor was situated. At around the same time, a fire alarm was activated. He rushed back to the ECR and informed the chief engineer who was there that there was a fire in the propulsion room. The chief engineer proceeded out of the ECR and observed the location of the fire to be between the starboard engine's flywheel and reduction gear.

1.5.2 Emergency response

The chief engineer reportedly contacted the bridge and advised the master that the starboard propulsion engine was on fire[3]. The master advised the chief engineer that the vessel was still in a traffic separation scheme (TSS) and it would be risky if both engines were to stop. The chief engineer transferred the engines' control from 'Bridge' to 'Engine-Room' and stopped the starboard propulsion engine using the emergency stop button on the ECR's control console. At the same time, the master activated the general alarm, announced that there was a fire in the engine-room and asked everyone to muster at the fire muster station.

In the meantime, based on the chief engineer's directions, the third engineer tried to extinguish the fire, using a portable foam extinguisher which was located outside the ECR. Due to dense smoke and the flame's height, the third engineer abandoned his attempt. The chief engineer advised the master of their inability to fight the fire and the master ordered him to evacuate the engine-room. The chief engineer, electrical engineer and the third engineer left the engine-room through its main entrance whilst the port propulsion engine and two diesel generators were still running.

After evacuating the engine-room, the master decided to send a fire-fighting team into the engine-room to fight the fire, using a water jet. Two crew members wearing the fireman's outfit entered the engine room through the main entrance on the main deck (Figure 6).

Due to thick smoke in the generator room and a sharp angle of descent (Figure 6) into the engine-room from the main deck, the fire-fighting team found it very difficult to

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[3] This time of fire recorded by the vessel's documents was 0220, whereas the VDR's and fire alarm's records indicated that the fire started at about 0159.

proceed. The master ordered the fire-fighting-team to withdraw and decided to release CO_2 into the propulsion room to extinguish the fire.

Figure 6: Stairs leading to the generator room from the engine-room entrance on the main deck

Prior to the release of CO_2, the QCVs for the fuel oil service and settling tanks were tripped to stop the fuel supply to the main engines and the generators. This resulted in a loss of electrical power, following which, the emergency generator automatically started[4] and supplied emergency electrical power to the emergency consumers. At this stage, the vessel started to drift. All engine-room and funnel flaps, ventilation ducts and covers were closed by the crew members. Whilst the ECR's port side watertight door was reportedly closed, the crew members, however, could not confirm whether the watertight door of the ECR's starboard access had been closed when the engine room was vacated.

Following confirmation that all the crew members were accounted for, the master authorised the release of the CO_2 into the propulsion room, which was executed by the chief engineer and the electrical engineer at around 0230. However, after releasing the CO_2, they noted that the main CO_2 line within the compartment was leaking. Soon after, the smoke detector of the CO_2 room was activated, but there were no signs

[4] VDR data indicated that the emergency generator started at around 0215.

of a fire within that compartment. During this time, boundary cooling of the main deck (in way of the propulsion room) and funnel's outer surface was started, using the water supplied by the emergency fire pump.

1.5.3 Post-fire events

At 0240, the master informed Livorno's Port Control of the situation on board *Eurocargo Trieste* and requested for assistance.

At 0304, the first pilot boarded the vessel, following which it was decided to have the vessel towed back towards the port of Livorno. The first fire-fighting tug arrived at 0320 to assist with boundary cooling and, at 0349, the second pilot boarded the vessel. During the second pilot's boarding, it was reported that the lowermost spreader of the pilot ladder was damaged.

At 0410, members of the Livorno's fire brigade boarded the vessel to assess the fire in the propulsion room. The fire brigade entered the generator room at 0514 and, following an assessment of the (high) temperature of the propulsion room's aft bulkhead, concluded that the fire may have not been extinguished. At 0523, the fire brigade left the generator room and decided to continue with the boundary cooling of the bulkheads and decks affected by the fire.

At 0537, the third pilot/harbour master boarded the vessel, followed by a port State control officer, for an assessment of the situation. Thereafter, it was decided to have the vessel drift outside the harbour until the situation was brought under control. At 0549, all crew members were ordered to muster at the muster station, and the vessel's lifeboats were prepared for launching. The lifeboats were lowered to the embarkation deck by 0610. Meanwhile, the vessel was drifting outside the harbour.

At 0809, an assessment by the fire brigade indicated that the fire was spreading again; however, after re-evaluating the situation, at 0825, it appeared to have been extinguished. Nonetheless, as a precaution, the crew members were advised to standby at the lifeboat station in case the vessel had to be abandoned.

At 1015, the fire brigade was relieved by a new team. At 1124, a second attempt was made by the fire brigade and the second engineer to enter the generator room to assess the temperature of the bulkheads and the state of the fire.

At 1200, the fire was declared to be under control but, as the vessel's propulsion power had not been restored, she was towed by two tugboats. At 1214, the fire brigade team re-entered the generator room. At 1219, it was concluded that the fire was out. The lower part of the bulkheads' temperatures indicated that there was no chance of re-ignition.

At 1314, the fire brigade disembarked from the vessel. As the engine-room fire was declared to have been extinguished, Livorno's port authorities allowed the vessel to berth. At 1530, another pilot boarded the vessel, and the vessel was towed into port. The vessel finally came alongside at 1720.

1.5.4 Damages sustained

The main fire lasted about 30 minutes, although it continued to burn at a lower intensity for several hours. Nonetheless, due to the loss of electrical supply cables in the fire, the damage to the machinery was serious enough to prevent its use.

Heat and smoke, which reached the engine-room ceiling (*i.e.* the vessel's main deck) and funnel casing, led to damage of the electrical supply cables, lighting fixtures, fire detection and alarm system, general alarm, exhaust manifolds for the propulsion engines and boilers, forced ventilation ducts, and the main switchboard.

The starboard propulsion system's damage could only be determined by a complete overhaul of its units and the turbocharger. The port propulsion engine appeared to have been unaffected. An electrical control sub-station unit, located immediately forward of the ECR's windows, was completely destroyed (Figure 7).

Although the emergency generator started automatically when the vessel suffered the first power failure, it subsequently failed. During the occasional survey by Class, following the accident, the emergency generator and the emergency switchboard were noted to have been damaged.

Neither did the fire nor the fire-fighting activities lead to any pollution or injuries to personnel.

Figure 7: Burnt out electrical / control panel forward of the ECR and modules room bulkhead

The port side pilot ladder was found damaged, namely: its lowermost spreader was broken (Figure 8).

Figure 8: Damaged port side pilot ladder

Furthermore, paint scratches were observed on the port shell plating of the vessel, around the area where the pilot ladder was rigged up (Figure 9).

Figure 9: Paint scratches on the vessel's hull (circled in yellow)

2 ANALYSIS

2.1 Purpose

The purpose of a marine safety investigation is to determine the circumstances and safety factors of the accident as a basis for making recommendations, to prevent further marine casualties or incidents from occurring in the future.

2.2 Fatigue and Alcohol

Analysis of the crew members' records of rest hours showed that they were in excess of those required by the STCW Code and the Maritime Labour Convention, 2006 (as amended). Although there were no records on the quality of rest hours, the safety investigation had no evidence which would have attributed fatigue as a contributing factor to this accident.

Alcohol tests were carried out on all crew members, who were on duty at the time, shortly after the accident. As all tests returned negative results and consumption of alcohol was not considered to have contributed to this accident.

2.3 Limitations of the Safety Investigation

When the MSIU attended the vessel in the port of Livorno, the vessel was a 'dead ship' *i.e.*, there was no lighting available throughout the vessel. The inspections of the machinery spaces were carried out in complete darkness using a handheld torch light. The photographs were taken with the aid of the camera's flashlight.

While the ECR was not fitted with an alarm printer for the machinery spaces, the engine alarm data and other valuable information were reported to have been lost during the fire, although the ECR was not affected by the fire. The electronic data was reported to have been lost when the vessel's power was lost and the UPS systems, located within the engine-room, were found burnt in the fire[5]. Similarly, the telegraph logger was reported to have developed a fault on 16 November 2019, and engine

[5] This was observed during an inspection of the system carried out on 27 November by shore technicians, which also revealed that two of the four UPS systems' hard disks were missing, and the alarm history could not be retrieved from the remaining two.

movements and events were recorded in the bridge bell book. However, the recorded times of the engine movements and events neither tallied with the witness recollection nor the VDR replay, and the safety investigation was unable to verify the reason for this discrepancy.

2.4 Timing and Seat of the Fire

According to the fire alarm system's printer data, smoke detector 0105 (Figure 10) located on the starboard side of the starboard engine, above the main deck level, was the first smoke detector in the machinery space that was activated by the fire.

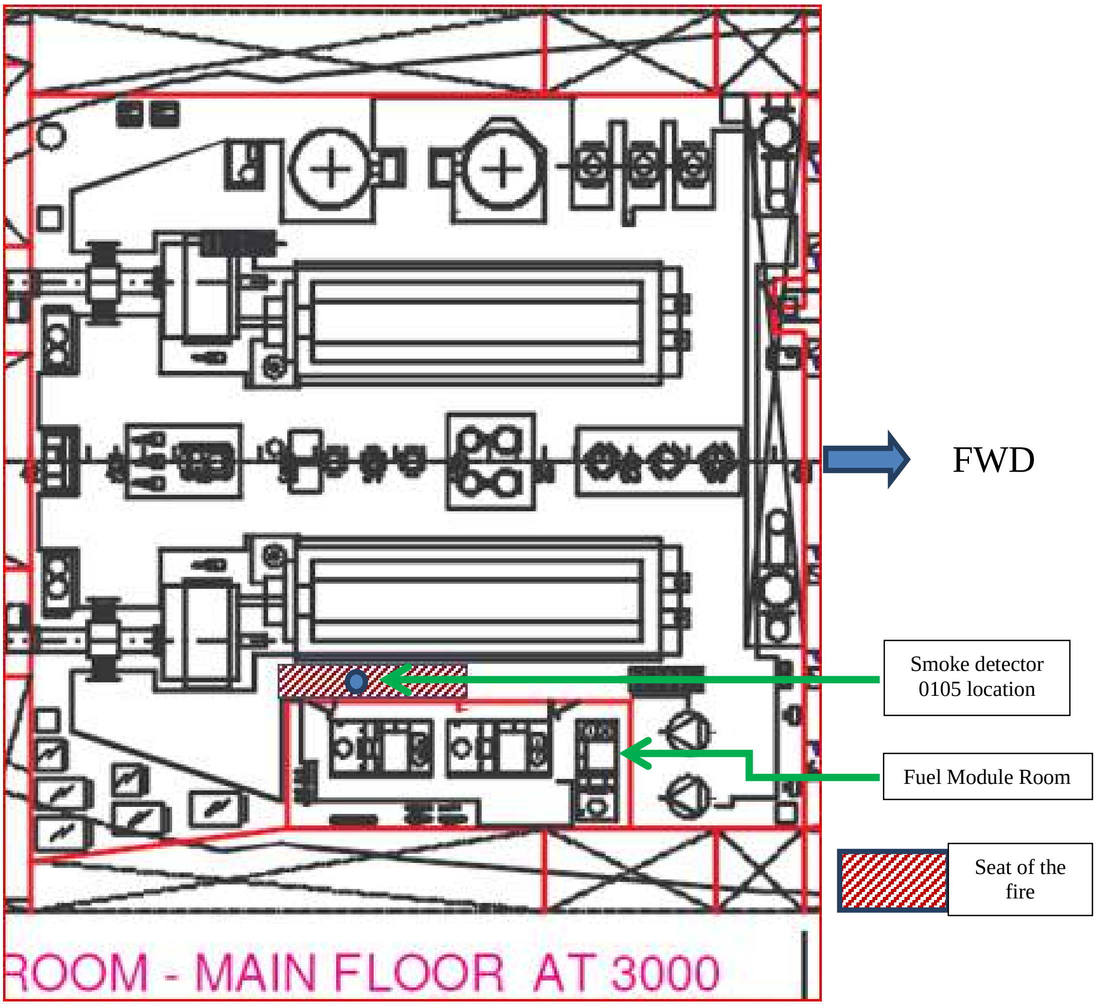

Figure 10: Seat of the fire on the main floor

A comparison between the VDR data and the time at which the alarm was recorded on the printer, revealed that the time settings on the fire alarm system were about 82 minutes behind the vessel's local time[6]. Therefore, the first fire detector had activated at around 0159, on 21 November 2019. The location of the detector corresponded to the seat of the fire identified during the safety investigation.

Although the vessel's records indicated that the engine-room fire started at 0220 on 21 November 2019, an analysis of the VDR data indicated that the vessel's speed dropped suddenly from 10.0 to 8.0 knots at 0158, followed by the fire alarm at 0159. The vessel's speed drop was due to the manual stoppage of the starboard propulsion engine by the chief engineer, as mentioned earlier in this safety investigation report.

The bridge bell book indicated that the sea passage commenced at 0200. However, it was reported that the third engineer left the control room to read the fuel oil flowmeter. As a general practice, flowmeter readings are usually taken after the commencement of the sea passage. This suggested that, if the bridge bell book's information was reliable, the fire started somewhere around 0159, which is in line with the VDR data.

The location of the seat of the fire[7] was just outside the fuel oil modules room, on the main floor, in front of its aft access door (Figures 10 and 11). All fuel supply equipment to the engines such as pumps, heaters, fuel filters and gauges are in the modules room. Signs of heat and smoke damages were observed in the modules room, as well as in the separator room, indicating that these rooms were partly affected by flames, even though the seat of the fire was not within any of these rooms. This led the safety investigation to believe that at least one of the access doors to each of these rooms were open during the fire.

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6 On seeking clarification from the Company, it was revealed that the vessel's electrical officer had performed routine checks on the vessel's fire detection system, during the port stay at Livorno. Reportedly, when restarting the system after his checks, it had slipped his mind to synchronize the system with the vessel's clocks.

7 As stated further on, the actual point of fuel oil spray/spillage appeared to be above the seat of the fire in line with the separator room.

Figure 11: Seat of the fire on the main floor in the propulsion room

A propulsion engine's fuel pumps and its associated piping are the likely cause of most engine-room fires. On board *Eurocargo Trieste*, these were located on the port side of the engine. Therefore, the safety investigation could not draw a connection between the starboard propulsion engine and the start of the fire. Consequently, leakages from the high-pressure fuel lines were not considered as the source of fire.

2.5 Cause of the Fire

With poor lighting inside the engine-room and without an obvious source of fuel leakage to failure of equipment, a clear picture of the fire scene was compromised during the collection stage of the evidence. Under these circumstances, the safety investigation did not rule out accidental spillage of fuel oil on an exposed hot surface. This is being stated in the light that the inspection of the space after the fire revealed that all the fuel pipes were protected and located on the port side of the engine entablature.

The safety investigation also considered an accidental spillage of fuel onto a hot surface from around the entrance to the separator room. The aft entrance to the separator room was right above the starboard engine’s turbocharger. Spillage or spray of fuel oil occurring at this level would have directed the oil downwards on to the bottom floor and onto the turbocharger, possibly serving as the seat of the fire. Once the fire would have started, it would have quickly spread to the aft of the starboard propulsion engine due to the presence of combustible material, such as leaking heavy fuel and lubricating oil around the engine entablature and into the bilges, immediately beneath the flywheel.

The safety investigation was also made aware of at least one plastic container, which was used to collect the starboard engine’s fuel pumps’ leaking fuel oil. This container, which is very common in many engine-rooms, was hanging on the aft/port side of the engine. It was clear that it had caught fire, as the bottom of the charred container was found in the bilge exactly below its original position.

The safety investigation did not rule out that the fire spread due to the presence of combustible materials at and around the starboard propulsion engine, and in the bilges. The electrical cables at the aft of the starboard propulsion engine under the plates and in the bilges were found covered by PVC braided pipes, most probably to protect them from the oily water in the bilges. Some PVC braided pipes were used to direct leaked oil and fuel from the engine into the bilges or collection containers. A similar arrangement was used on the port side engine (Figure 12).

The floor plates at and around the seat of the fire were severely heated and deformed. The main engine’s foundation resin chocks (in way of the seat of the fire) were affected by the fire which indicated the existence of a substantial quantity of burning substances (oil and fuel) around the base of the engine. The path and direction of the smoke / flame flow was easily identified, being mainly dictated by the flow path of the air towards the funnel casing, where the bulk of the exhaust air was discharged. Due to the air circulation within the propulsion room, upper structural parts above the machinery within the engine-room were affected by the heat.

Figure 12: PVC braided pipes used to direct leaking oil from the port engine

2.6 Cause of the Damages Sustained

While all damages within the engine-room were noted to have been caused by the fire and the heat generated through it, the safety investigation hypothesized that the emergency generator was damaged during the fire-fighting efforts. It is highly likely that water, sprayed for boundary cooling, entered the emergency generator through its air intakes.

The paint scratches on the port side shell plating of the vessel, in the vicinity of the area where the port side pilot ladder was rigged up, seemed to indicate that the damages to the pilot ladder and the paint scratches were caused by the fire-fighting tugs, whilst they were engaged in boundary cooling, and/or the boats used to transfer the pilots. It should be noted that the pilot ladder was reported as damaged when the second pilot was boarding the vessel, after the accident. Neither were any reports of damages made by the pilots engaged in taking the vessel out of Livorno harbour, prior to the fire, nor was the damage observed when the first pilot embarked onto the vessel, after the fire.

2.7 The Combustible Materials and Oils

It was highly likely that the use of plastic materials, braided PVC and the leaked oil on and around the starboard propulsion engine (Figure 13) exasperated the situation and allowed the fire to develop further; in particular, a hanging plastic container which had been used on the aft/port side of the starboard engine, to collect the leaked fuel oil from the engine's fuel oil pumps.

Figure 13: Propulsion engine's fuel pumps tray showing leaked fuel

The estimated position of the plastic container is shown in Figure 14 (red dotted box), while Figure 15 shows the plan view of the plastic container's position in relation to the starboard engine.

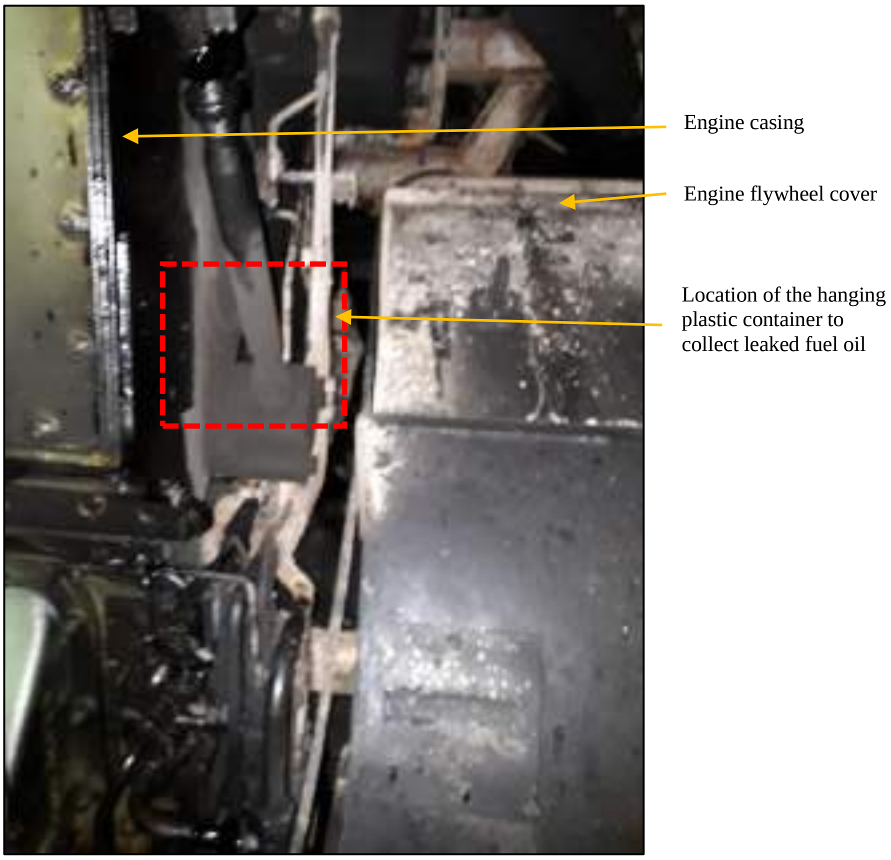

Figure 14: Position of the plastic container for collecting leaked oil

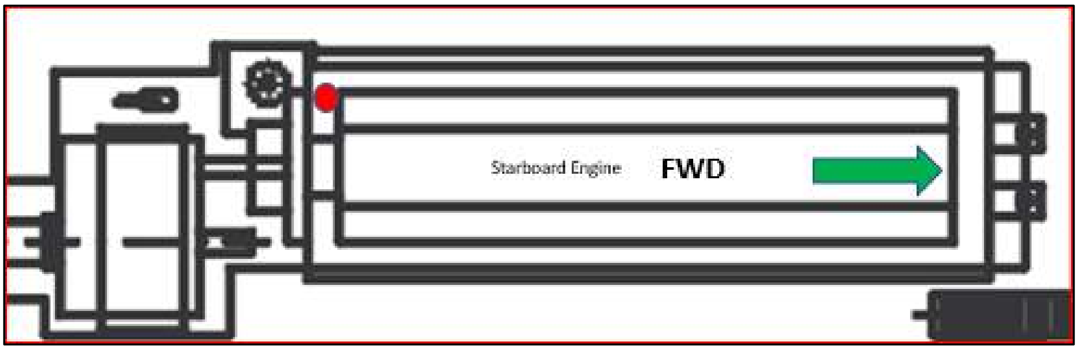

Figure 15: Red circle indicates the position of the plastic container in relation with the engine

Although the seat of the fire was on the starboard side of the engine, the direction of the supply air flow (forward to aft) to the engine may have directed the flames towards the plastic container that contained the leaking oil from the main engine. The leaking oil was directed into the plastic container through a braided PVC pipe (Figure 16).

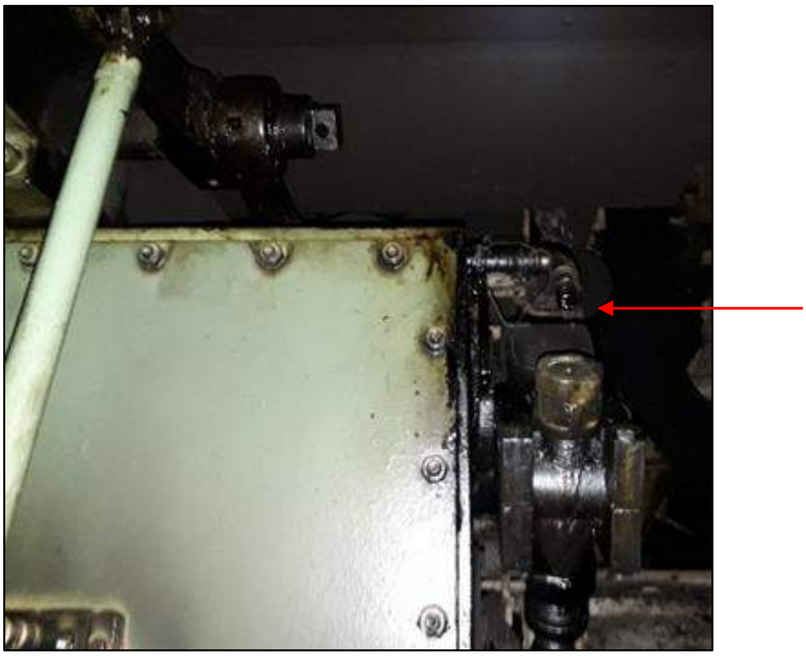

Figure 16: Starboard engine's leaked fuel drain position

Once the flames reached from the starboard side of the engine to the aft/port side (due to the direction of the air flow from the air supply duct to the main engine), the container caught fire and due to its shape and location, directed the flames upwards from the engine's turning gear position. The safety investigation hypothesized that this is what the third engineer witnessed as he left the ECR.

2.8 Absence of Fire Alarm

The engine-room crew members, who were present in the propulsion room at the time the fire started, could not provide a clear and consistent account of the sequence of events and the times at which each event took place. For instance, no one reported hearing a fire alarm or observing smoke and / or naked flames before the fire engulfed the aft of the starboard propulsion engine, in way of the flywheel, the starboard main floor and top floor, and in way of the separator room, fuel oil modules room and the starboard engine. The first fire alarm was captured by the VDR audio at 0159.

2.9 Fire-Fighting Efforts

2.9.1 Decisions on the bridge and in the engine-room

A fire on board a vessel is one of the most dangerous situations, which a crew can face at sea. If not mitigated correctly and in a timely manner, it can lead to dire consequences. It took the crew members time to control and extinguish the fire. This was because the vessel was in a TSS and the master thought it would be prudent to run the port propulsion engine (whilst the propulsion room was on fire) to allow the vessel to exit the separation zone.

It is evidently clear that the master may have had several options, other than the one which was selected. For instance, he could have stopped both main engines. This would have made it possible for the engine-room crew members to stop the ventilation supply to the engine-room. Moreover, had the master opted to stop both engines, the vessel would have gained a not under command status and the master could then have advised the coastal authorities of this situation, who would have taken steps to alert the surrounding vessels, if any, to keep clear.

Although the vessel's main engines would have been stopped, the master could have deployed the vessel's anchors if he felt that the vessel is likely to have run aground under the influence of the environment. Then, advising the coastal authorities soon after the fire was detected would have enabled the latter to alert the emergency services in an expedient manner. Although the fire ignited at around 0159, the master did not report the fire to coastal authorities until 0238 and only when the authorities requested clarifications on why the vessel had slowed down.

Whilst it was evidently clear that the master had at least one other option from where he could have chosen, it was imperative for the safety investigation to analyse his decision in perspective, rather than in a vacuum. The pivotal point to be analysed, was whether these various options, with a potential different outcome, were as clearly visible to the master, operating in a complex, dynamic environment as they are now after the accident has happened.

If the master would have been aware of the various options available, then it would not have been a simple exercise of comparing and determining the best option, with the most desirable outcome. Neither does this mean that the master would have had to rely on his intuition (at least not only). What is being submitted, however, is that the decision-making process of the master would have been very complex, involving at least cues (possibly conflicting), technological data, information from fellow crew members, interpretation of that data and a decision to act, either in one way or another.

It would have been only when the master was certain that the information being analysed was providing a consistent result that he would have decided on the way forward. Thus, the response of the master, whether seen as appropriate or not (with the benefit of hindsight) would not have been a deliberate choice from a number of available options but an act, based on his personal experience and understanding of the situation, and in a relatively short period of time.

In the meantime, the situation was equally challenging for the chief engineer in the machinery spaces. It was reported that the CO_2 was not released until 0230, which meant the fire had at least thirty minutes to take hold, spread and burn. Moreover, the chief engineer reportedly released the CO_2 bottles that were intended only to extinguish the fire in the propulsion room. However, although the fuel oil modules room and the separator room were separate compartments with their own protection system of CO_2 bottles, it seemed to the safety investigation that the entrances to these two rooms were open at the time of fire and that the chief engineer was not aware of the same. This would have led to a significant reduction in the effectiveness of the CO_2 installation.

The safety investigation has analysed the situation as documented and concluded that the situation corresponded to what academia defines as 'mode error'[8], *i.e.*, the chief engineer executed an action, when the status of the hardware was different from what it was believed to be. It was clear, however, that because of the significant amount of data which the chief engineer had to process in a relatively short period of time, the situation assessment which he had made did not reflect the actual status of the system. This was also reflected in the length of time which had been taken to activate the fixed fire-fighting system – suggestive that there was no awareness of the actual severity of the fire.

Then, the doors had no remote status indicators (open / close) and therefore, unless a local verification was made (*i.e.*, approaching the area where the fire was), the probability of a mode error would have increased significantly.

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[8] 'Mode errors' are normally attributed to automated systems.

2.9.2 Leakage of CO_2 from the main line

As mentioned earlier in this safety investigation report, once the CO_2 was released, it was found out that the main CO_2 line within the compartment was leaking. Most probably, it was the leak that had activated the smoke detector in the CO_2 room at 0227. The amount of CO_2 which was lost due to the leak was not known, but it was not excluded that it was substantial and most probably compromised the effectiveness of the CO_2 system.

A post-accident inspection of the system by a service company revealed that the release of CO_2 within the CO_2 room was due to an accidental closing of the main valve during its opening under discharge. This also resulted in ice formation on some of the pipes. The safety investigation could not determine why the valve was shut, however, it was not excluded that either this valve was operated accidently or, when the leakage occurred in the CO_2 compartment, the valve was manually shut off in an attempt to control / stop the leakage.

2.9.3 Access to the generator room

The stairway leading from the engine-room entrance to the generator room was fitted at a sharp angle (between 15° and 20° to the vertical). The time required preparing the fire-fighting team to investigate and fight the fire and then negotiating the access to the propulsion room through a very sharp-angled staircase was difficult and delayed the fire-fighting efforts of the crew members. It was not clear to the safety investigation whether this (design) issue had been identified during any of the fire drills held on board.

2.9.4 Shore assistance

A few hours after the fire started, the emergency generator stopped working. It was thought that when the crew were conducting boundary cooling with fire hoses in the area, they accidently sprayed seawater in the vent of the emergency generator intake. This resulted in the failure of the equipment and a total power failure on board. The vessel was close to the port of Livorno, and shore assistance could be provided in the form of tugs and a fire-fighting team, within a short period of time.

Apart from the port's fire fighters' efforts to enter the engine-room compartment in order to monitor the temperatures in the propulsion room, there was nothing more that could have been done. This is likely to have been because the crew restricted the fuel and oxygen supply to the propulsion room. It was then just a matter of keeping the boundary cool with water and wait for the fire to burn out. However, they provided support to the crew members and were an asset if the fire had eventually flared up again.

The crew members response to the fire were successful in that no crew member was injured during the fire and the engine-room crew members managed to evacuate the machinery space through its normal means of access.

THE FOLLOWING CONCLUSIONS, AND RECOMMENDATIONS SHALL IN NO CASE CREATE A PRESUMPTION OF BLAME OR LIABILITY. NEITHER ARE THEY BINDING NOR LISTED IN ANY ORDER OF PRIORITY.

3 CONCLUSIONS

Findings and safety factors are not listed in any order of priority.

3.1 Immediate Safety Factor

.1 The fire is likely to have occurred because of an accidental spill of oil onto a hot surface around the starboard propulsion engine;

.2 The fire spread from its original seat to other areas of the machinery space.

3.2 Latent Conditions and other Safety Factors

.1 The smoke detectors, although operational, failed to alert the crew of the existence of a fire immediately, as they probably had been silenced for a short period of time, while the vessel was in port.

.2 Combustible materials in the form of leaked fuel, leaked oil, braided PVC pipes (to direct the leaks), plastic containers to collect drained oils, oil in the bilges and the vicinity contributed to the propagation of the fire.

.3 It is highly likely that the leak in the CO_2 system compromised its effectiveness.

.4 Evidence indicated that the doors to the fuel oil modules and separator rooms were open. In addition to allowing the spread of the fire, this most probably would have further compromised the effectiveness of the CO_2 system, since each of these rooms had their own battery of CO_2 bottles for fire-extinguishing.

.5 The delay to stop the port main engine is likely to have contributed to the fire taking hold.

.6 The decision-making process of the master would have been very complex, involving at least cues (possibly conflicting), technological data, information from fellow crew members, interpretation of that data and a decision to act, either in one way or another.

.7 The leakage of CO_2 in the storage compartment is likely to have occurred when the main valve was accidently closed, soon after releasing the gas.

.8 There was a delay between the fire being detected and the port authorities being informed of the emergency on board.

3.3 Other Findings

.1 All four UPS systems for the main engine alarm data were affected by the fire, resulting in a loss of the alarm history.

.2 The emergency generator stopped working because, most probably, its air intake had accidently been sprayed with sea water during the boundary cooling.

.3 The design of the staircase from the engine-room entrance to the generator room made it difficult for the crew members to descend with a fireman's outfit and breathing apparatus.

4 RECOMMENDATIONS

In view of the conclusions reached and taking into consideration the safety actions taken during the safety investigation,

Valiant Shipping S. A. is recommended to:

21/2020_R1 Provide guidance in the vessel's SMS on good housekeeping practices with reference to monitoring of oil leaks.