



SAFETY INVESTIGATION REPORT

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The Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011 prescribe that the sole objective of marine safety investigations carried out in accordance with the regulations, including analysis, conclusions, and recommendations, which either result from them or are part of the process thereof, shall be the prevention of future marine accidents and incidents through the ascertainment of causes, contributing factors and circumstances.

Moreover, it is not the purpose of marine safety investigations carried out in accordance with these regulations to apportion blame or determine civil and criminal liabilities.

NOTE

This report is not written 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 report may therefore be misleading if used for purposes other than the promulgation of safety lessons.

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MV ALGARVE **Fatality of shipyard worker** **In Rijeka** **21 July 2011**

SUMMARY

At about 1246 on 21 July 2011, a shipyard worker sustained fatal injuries on board the Maltese registered general cargo *Algarve*, while the vessel was in dry-dock. His corpse was removed from the emergency fire pump space about four hours later. He was declared dead on the scene of the accident.

Although a safety investigator was deployed to the accident site and assisted by the crew members and owners representatives, the safety investigation was hampered during the collection of evidence and could not come to a clear conclusion as to what could have caused the fire inside the space.

The hypotheses on the cause of the fire were built around the acetylene torch and/or hoses which were inside the space. Whilst it could not be ascertained as to what had started the fire, it was possible that the fire started as a result of acetylene leakage coming in contact with an ignition source, oxygen coming in direct contact with oil and grease, or oxygen enrichment inside the emergency fire pump space.

In view of the actions taken by the vessel's managers, no recommendations have been made.



FACTUAL INFORMATION

Vessel, crew and environment

Algarve, a 25,719 GT general cargo vessel, was built by Bohai Shipyard, China in 1998 and is registered in Valletta. She is owned by Algarve Shipping Company Ltd., managed by F. H. Bertling Reederei GmbH, Germany, and classed by Det Norske Veritas. The vessel has an overall length of 189.70 m and a beam of 27.74 m.

Algarve was operated in international trade with her last port of call before dry-docking being Monfalcone, Italy. Her crew were Polish and Sri Lankan nationals. With a total of 24 crew members, *Algarve* was manned in accordance with the Minimum Safe Manning Certificate. The working language on board was English.

The deceased was a 52 year old Croatian. The information available suggested that he was not directly employed with the shipyard. The shore worker was a local sub-contractor, and the yard normally outsourced the servicing of valves to him. The information made available to the MSIU indicated that the sub-contractor owned a company, which was involved in the repairs of electronic and optical equipment.

At the time of the accident, it was very hot considering the summer heat in the Adriatic region. As expected, the situation on board was significantly busy with simultaneous repairs and other tasks in many parts of the vessel.

The shipyard

Victor Lenac Shipyard is advertised as one of the leading yards in the Mediterranean, with a long tradition of ship repair and conversion. The Shipyard had two floating dry-docks and approximately 1,000 m of berthing space. *Algarve* was dry docked in no. 5 dry-dock, which was built by Allied Shipyard in Norway in 1968.

Narrative

Algarve arrived at Victor Lenac Shipyard from Monfalcone, Italy to undergo special and dry-dock surveys. The vessel dry-docked on 17 July 2011 at about 1701 (Figure 1) and shore power eventually connected at around 1935. Whilst no shore security measures were discussed between the ship and the Yard, port facilities were maintained at security level 1.



Figure 1: MV *Algarve* in Dock no. 5

Every morning, a meeting was held on board between the Shipyard and the vessel. It was normal that the meeting included *Algarve*'s superintendent, the master, chief mate, chief engineer, the repair manager, engine and deck foremen, and the coating and safety supervisors.

Deck officers were maintaining a six-on six-off watch arrangement along with the deck ratings.

On the day of the accident, the chief mate was notified by the project manager that work had to be carried out in the emergency fire pump spaces (Figure 2). However, he did not request additional details.

At noon, the deck watch was taken over by the second mate whilst the deck rating was relieved by the deck officer cadet. The deck cadet was assigned maintenance tasks on the main deck and the forecabin together with the bosun and another deck rating.

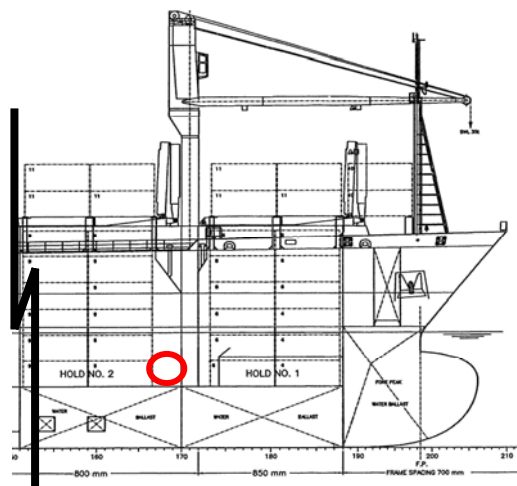


Figure 2: The Emergency fire pump space where the accident happened

At about 1446, the chief mate received a call from the project manager. He was informed that an accident had just happened in the emergency fire pump room. The chief mate relayed the call to the master by VHF.

Later, other crew members also became aware that something had happened on their ship. The second mate was on the bridge when he noticed firemen approaching at about 1440. The deck cadet, who was working on the forecastle, also noticed an ambulance approaching the ship and a rescue team was being transferred on board by the shore crane to the port side deck.

The deck cadet also observed light ash and coloured smoke coming out of the emergency fire pump space but no open flames. Soon after, officials from the fire brigade arrived on board, accompanied by other shore personnel.

The crew members were not allowed to approach the emergency fire pump space. However, they soon became aware that one of the shore workers had sustained fatal burn injuries whilst inside the space. Eventually, the chief mate arranged for all the crew members to muster inside the accommodation space. The body was recovered by the rescue team at about 1825.

Following the accident, the vessel remained in dry-dock to finish the pending repair jobs. She was refloated on 27 July 2011 at about 1815.

The emergency fire pump space and reported damage

The emergency fire pump space was a very tight space, located between frames 166.5 and 170. The frame spacing was 850 mm and measured 1.52 m by 1.37 m and was 2.44 m high (Figure 3).

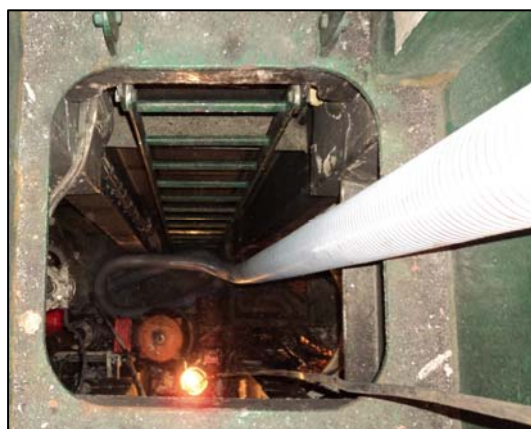


Figure 3: The restricted space where the accident happened

There were no structural damages reported as a result of the fire inside the emergency fire pump space. However, smoke damage was visible, with scorched paint and ashes in the space bilges (Figure 4). Most of the scorched paint was localised in the lower areas of the emergency fire pump space.



Figure 4: Fire damage inside the emergency fire pump space

Several units of the ship's equipment, such as the fire pump and pressure gauges, were also affected by the fire. An oxy-acetylene cutting

torch had also sustained fire damage. A melted red hard hat was found in the space together with a partially damaged yellow hard hat, a pair of burned protective gloves, and several burned rags.

A ribbed hose pipe extended from the upper open space down to the lower floors of the emergency fire pump space. The pipe served as a forced ventilation duct when the work was being carried out in the emergency fire pump space.

ANALYSIS

Access to evidence

The MSIU had a significant challenge to try and establish the dynamics of the accident in order to determine the contributing factors to this accident in an accurate manner.

The deployment of a safety investigator on board the ship provided important information, and the managers of the vessel were extremely cooperative from the day the notification of the accident was received. However, the safety investigation did not identify the direct contributing factors to this accident. A thorough analysis only led to several hypotheses which, after being assessed in detail, were reduced to three.

During the on-site deployment and following several discussions with the managers, it became evident that cooperation from the Shipyard was not forthcoming. No interviews were allowed with the shore workers.

The absence of any crew members from the proximity of the accident site made it extremely difficult to ascertain the sequence of events. It also meant that the data gaps had to be filled in by the Shipyard which, however, did not materialise.

MSIU requested the assistance of Transport Malta's Merchant Shipping Directorate, following the receipt of information from the managers that port State Control had also boarded the ship. A document in Croatian was eventually provided and this was translated into English.

The document revealed that at the time of the accident, the deceased shore worker was accompanied by another worker. It was also stated that both were working on the cleaning and servicing of fire fighting system valves in the emergency fire pump space.

Whilst MSIU was not provided with any details of the second shore worker, it can be stated with almost complete certainty that considering the size of the space and the (flash) fire, the deceased shore worker must have been on his own inside the space, at the time of the accident.

Leaking acetylene

One of the analysed hypotheses was the possibility of acetylene leaking in the space and eventually igniting by some ignition source. The limited information available indicated that at the time of the accident, the acetylene torch was not being used by the deceased shore worker. However, a torch was found at the accident site.

It was not excluded that since the gas bottles were located on the deck, acetylene could have potentially leaked into the space either from the hose pipes or from the torch itself during the temporary suspension of the works inside the space.

Unofficial and unconfirmed information indicated that the space was declared gas free before access was allowed. What was certain, however, was that the emergency fire pump room was not gas free at the time of the accident. Whether the gas was oxygen, acetylene, a combination of both or a different gas altogether, is another matter.

Whilst acetylene is less dense than air, it also becomes unstable and explosive when compressed or liquefied. Therefore, during the manufacturing process, the gas is dissolved in acetone, which is further absorbed into a porous substance (such as pumice).

This means that acetylene dissolved in acetone now becomes heavier than air. Any leak would therefore tend to sink into depressions, bilges, and inside toolboxes. As such, this can create a fire and/or explosion hazard at a concentration as low as 2.4% (STP conditions).

This was a plausible possibility; however, it had to be appreciated that several of the crew members only became aware of the accident when they saw the rescue personnel approaching the vessel. None of them mentioned an explosion on board; and indeed the damage sustained in the emergency fire pump space did not indicate that an explosion had actually occurred at any time.

Oxygen in direct contact with grease and oil

A second possibility was that of oxygen coming in contact with oil/grease inside the space. A Safety Notice issued by the UK's Health and Safety Executive, gives a clear warning that oxygen behaves differently to air, nitrogen and other inert gases, since it is very reactive.

It is also remarked that pure oxygen at high pressure (such as from a cylinder used with acetylene), can react violently with common materials such as oil and grease and may also catch fire spontaneously if it were to come in contact with incompatible materials.

Oxygen enrichment of the emergency fire pump space

Oxygen enrichment is the term used to describe situations where the oxygen is greater in the space than in air. It was not excluded that oxygen enrichment resulted from the use of oxygen to cool the hot air in the confined space, hence contaminating clothing and hair.

The Safety Notice mentioned earlier warned that nearly all materials including textiles, rubber, and even metals will burn vigorously in the presence of oxygen. A small increase in the oxygen level in the air can create a dangerous situation – more easy for a fire to start, which will then burn hotter and more fiercely than in normal air. A leaking valve or hose in a poorly ventilated room or confined space can quickly increase the oxygen concentration to a dangerous level¹.

Missing defences

The probability of a fire in any part of the ship is higher during any dry-docking period. However, during the course of the safety investigation, it did not transpire that the master was fully aware of all the arrangements made by the Yard regarding fire-watchers.

It has to be stated that whilst in the dry-dock, it was regular for the ship to have between 20 and 30 areas where hot work was being carried out simultaneously, including welding, cutting and grinding. Although the Shipyard had arranged for fire and safety officers, the crew members had specific jobs

¹ This is not intended to mean that part of the equipment was faulty. MSIU was aware that the acetylene and oxygen bottles were pressure tested at 30 bar and 13 bar respectively by the maintenance section of the Shipyard on 31 March 2011. Moreover, the valves for the acetylene and oxygen bottles were also tested and calibrated by a competent person (not a Shipyard employee) during the month of June 2011. MSIU did not have access to the equipment *per se* or the results of any tests, which were conducted after the accident as part of the judicial investigation held in Rijeka.

to do and therefore were not solely engaged in overseeing the Shipyard workers.

It was therefore not possible for the crew to accurately determine the efficiency of fire-watchers. As such, this prevented them from taking all the necessary precautions. It also prevented a thorough assessment for the prevention of a fire on board.

A risk assessment, for instance, could have revealed the need for a permit to work - entry in enclosed spaces. It could also have revealed that in view of the use of flammable gases and the fact that the equipment may have been left unattended for a period of time, a permit to work - hot work would have been necessary before work inside the space was resumed.

There seemed to be another factor indicating the lack of preparation for the job and which stemmed from the fact that two dangerous gases were being used in a confined space. Notwithstanding the space being confined, there was no evidence which indicated that an oxygen level monitoring meter or gas detector were in use at the time. There was no indication that a risk assessment was conducted in order to address this matter.

Communication between the yard and the ship was not optimal and the lack of information available to the crew members after the accident was a clear indication of this. As for the factors mentioned above, the crew members were not in a position to confirm whether ventilation was maintained in the space during the break. Moreover, the crew members were not aware of the exhaust and air inlet arrangements in order to prevent an accumulation of gases inside the space.

Risk acceptance

The work in a shipyard involves a certain degree of risk. Although risk needs to be accepted for any task to be carried out, one

has to question whether the risk is actually acceptable or not. This is important because depending on the context, the perception of risk varies – even if risk *per se* may not have been reduced.

It is clear that the level of risk increases when repairs are being affected in a shipyard. However, this awareness does not necessarily mean that uncertainty about risk is overcome; one of the main causes of uncertainty being the nature of the task in the shipyard.

Considering the multiple and simultaneous tasks conducted in the ship yard, one can only speculate on the actual risks involved; which was not necessarily straight forward especially when communication between the yard and the ship was not optimal.

In other words, true risk was not known but approaching the actual value was more difficult when communication was broken. Notwithstanding, in view of the context within a ship yard, risk tends to be accepted – even if this is not normally the case when the ship is at sea.

The point raised above on communication and discussion on risk is important since although the level of risk will remain the same, communication may change the perception of risk. Thus, if the crew members had the chance to know more on the risks involved, than risk would have been further understood appreciated.

CONCLUSIONS

1. The shore worker involved in the accident was alone in the space at the time of the fire.
2. Whilst it cannot be ascertained as to what has started the fire, it is possible to claim that the fire started as a result of three possibilities; acetylene leakage coming in contact with an ignition source, oxygen coming in direct contact with oil and grease, or oxygen enrichment inside the emergency fire pump space.
3. Communication between the yard and the ship was not optimal – a factor which had a significant bearing on the fact that a thorough risk assessment was not carried out.
4. Lack of communication had also led to a situation where a gap was created between actual and perceived risk.

SAFETY ACTIONS TAKEN DURING THE COURSE OF THE SAFETY INVESTIGATION²

Following the accident, the ship managers have taken the necessary steps to start their internal review process of the safety management system manuals for dry-docks and external repair supervision. It is envisaged that new procedures will be in place in the short term and communicated to all the ships.

² Safety actions and recommendations should not create a presumption of blame and/or liability.

SHIP PARTICULARS

Vessel Name:	<i>Algarve</i>
Flag:	Malta
Classification Society:	Det Norske Veritas
IMO Number:	9170638
Type:	General Cargo
Registered Owner:	Algarve Shipping Co. Ltd.
Managers:	F. H. Bertling Reederei GmbH
Construction:	Steel
Length Overall:	189.70 metres
Registered Length:	179.00 metres
Gross Tonnage:	25719
Minimum Safe Manning:	16
Authorised Cargo:	In dry-docks

VOYAGE PARTICULARS

Port of Departure:	Monfalcone
Port of Arrival:	Rijeka
Type of Voyage:	International
Cargo Information:	In ballast
Manning:	24

MARINE OCCURRENCE INFORMATION

Date and Time:	21 July 2011 at 12:46
Classification of Occurrence:	Very Serious Marine Casualty
Location of occurrence:	Rijeka, Croatia
Place on board	Emergency fire pump space
Injuries / fatalities:	One
Damage/environmental impact:	None
Ship Operation:	In dry-docks
Voyage Segment:	NA
External & Internal Environment:	Hot and confined space. Vessel in dry-dock
Persons on board:	Unknown