Marine Safety Investigation Unit

Transport Malta

MARINE SAFETY INVESTIGATION REPORT

Safety investigation into a fatality on board the Maltese registered oil tanker

SEAPRINCESS

in TK Tuzla Shipyard, Türkiye on 14 August 2023

202308/012

MARINE SAFETY INVESTIGATION REPORT NO. 11/2024

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 14 August 2023. Its sole purpose is confined to the promulgation of safety lessons and therefore may be misleading if used for other purposes.

The findings of the safety investigation are not binding on any party and the conclusions reached and recommendations made shall in no case create a presumption of liability (criminal and/or civil) or blame. It should be therefore noted that the content of this safety investigation report does not constitute legal advice in any way and should not be construed as such.

© Copyright TM, 2024.
Source and copyright of front page photograph: Thenamaris Ships Management Inc.

This document/publication (excluding the logos) may be re-used free of charge in any format or medium for education purposes. It may be only re-used accurately and not in a misleading context. The material must be acknowledged as TM copyright.

The document/publication shall be cited and properly referenced. Where the MSIU would have identified any third party copyright, permission must be obtained from the copyright holders concerned.

MARINE SAFETY INVESTIGATION UNIT
No. 2, Level 1
Notabile Road
Fleur-de-Lys
Birkirkara BKR 1876
Malta

CONTENTS

LIST OF REFERENCES AND SOURCES OF INFORMATION iv

GLOSSARY OF TERMS & ABBREVIATIONS v

SUMMARY vii

1 FACTUAL INFORMATION 1
1.1 Vessel, Voyage and Marine Casualty Particulars 1
1.2 Description of Vessel 2
1.2.1 Cargo and slop tanks 4
1.2.2 Gas freeing of tanks 6
1.3 Crew members 8
1.4 Riding Repair Team 8
1.4.1 Welder 1 9
1.4.2 Welder 2 9
1.5 Safety Management System 9
1.5.1 General 9
1.5.2 Procedures 10
1.6 TK Tuzla Shipyard 10
1.7 Environment 10
1.8 Narrative 10
1.8.1 Events prior to Tuzla anchorage 10
1.8.3 Emergency response 15
1.8.4 Injuries sustained 15
1.8.5 Damage to the port slop tank 16

2 ANALYSIS 17
2.1 Purpose 17
2.2 Limitations of the Safety Investigation 17
2.3 Fatigue and Alcohol 17
2.4 Cause of the Explosion Inside the Slop Tank 17
2.5 Was the Slop Tank Gas Free? 19
2.6 Dry-dock Procedures 20
2.7 Introduction of an Oily-water Mixture into an Enclosed Space 22
2.8 Management of Contractors 23

3 CONCLUSIONS 26
3.1 Immediate Cause of the Accident 26
3.2 Conditions and other Safety Factors 26
3.3 Other Findings 27

4 RECOMMENDATIONS 28

LIST OF REFERENCES AND SOURCES OF INFORMATION

Crew members and Company – MT *Seaprincess*

GLOSSARY OF TERMS AND ABBREVIATIONS

°C	Degree Celsius
%	Percent
ABS	American Bureau of Shipping
DNV	Det Norske Veritas
DOC	Document of Compliance
CCR	Cargo control room
CO	Carbon monoxide
H_2S	Hydrogen sulphide
HSEQ	Health, safety, environment, and quality
ISM Code	International Safety Management Code
ISO	International Organization for Standardization
kW	Kilowatt
LEL	Lower explosive limit
m	Metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MSIU	Marine Safety Investigation Unit
MT	Motor tanker
m^3	Cubic metres
mt	Metric tonnes
O_2	Oxygen
OOW	Officer in charge of the watch
PPE	Personal protective equipment
ppm	Parts per million
rpm	Revolutions per minute
SMS	Safety Management System
SRM	Ship repair manager

STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TM	Transport Malta
UTC	Coordinated Universal Time
VOC	Volatile organic compound

SUMMARY

Seaprincess entered TK Tuzla Shipyard, Türkiye, for its planned dry-docking on 29 July 2023. At the time of arrival in the dry-dock, all cargo and slop tanks had been washed, cleaned and dried, and declared gas free. The compartments were tested on a daily basis and while they had been declared to be gas free, they were only suitable for entry provided a personal gas monitor was worn. Moreover, the compartments' environment was declared unsafe for hot work.

On 14 August, two welders from the repair riding team were told that they had to repair several stanchions in the port side slop tank. The damaged stanchions had been identified on 06 August, during a survey. After setting up the welding set and preparing the area, one of the welders, who had just started welding, noticed a ball of fire rising from the bottom of the slop tank, followed by a rush of air. He immediately shouted to his colleague to exit the slop tank and to head to the nearby vertical ladder. The force of the explosion ejected him to a height of about 12 m in the air. A second explosion cushioned his fall on deck, as he descended.

The explosion caused a small fire inside the slop tank which, however, was immediately extinguished. After the slop tank was declared safe for entry, the body of the second welder was extracted from the slop tank.

Although the slop tank had been tested at 0800 and found to be gas free, the safety investigation concluded that in all probability, the cause of the explosion was the ignition of a small gas pocket that had built up at the lower levels of the tank and which must have escaped detection when the atmosphere was te4sted by the shipyard in the morning.

Two recommendations have been issued by the Marine Safety Investigation Unit (MSIU), aimed to address communication in the shipyard.

1 FACTUAL INFORMATION

1.1 Vessel, Voyage and Marine Casualty Particulars

Name	*Seaprincess*
Flag	Malta
Classification Society	ABS
IMO Number	9373668
Type	Oil tanker
Registered Owner	Dolphin Maritime Services Limited
Managers	Thenamaris (Ships Management) Inc.
Construction	Steel (Double bottom)
Length overall	248.96 m
Registered Length	240.63 m
Gross Tonnage	61,248
Minimum Safe Manning	15
Authorised Cargo	Liquids in bulk
Port of Departure	Gdansk, Poland
Port of Arrival	Tuzla, Türkiye
Type of Voyage	International
Cargo Information	In ballast
Manning	23
Date and Time	14 August 2023 at approximately 09:40 (LT)
Type of Marine Casualty	Very Serious Marine Casualty
Place on Board	Slop tank (port side)
Injuries/Fatalities	One fatality and one serious injury
Damage/Environmental Impact	None
Ship Operation	Normal Service – Maintenance
Voyage Segment	Arrival
External & Internal Environment	Daylight and good visibility. Westerly, gentle breeze, and an air temperature of 29 °C.
Persons on Board	65

1.2 Description of Vessel

Seaprincess was a 61,248 gt, Maltese-registered oil tanker (**Figure 1**). The vessel was built in 2008 at the Samsung Shipyard, in Koje, Republic of Korea. The vessel was owned by Dolphin Maritime Services Limited, and was managed by Thenamaris (Ships Management Inc.), of Liberia, with an office in Greece (the Company). The vessel was classed with American Bureau of Shipping (ABS). Det Norske Veritas (DNV) acted as the recognised organisation, in terms of the International Safety Management (ISM) Code.

The vessel had an overall length of 248.96 m, a moulded breadth of 43.80 m, and moulded depth of 21.0 m (**Figure 2**). It had a summer draught of 13.60 m, which corresponded to a summer deadweight of 115,948.70 metric tonnes (mt).

Propulsive power was provided by a two-stroke, MAN-B&W 6S60MC-C, low speed, marine diesel engine, producing 13,560 kW at 105 rpm. The main engine drove a single fixed-pitch propeller, which enabled the vessel to reach a service speed of 15.0 knots.

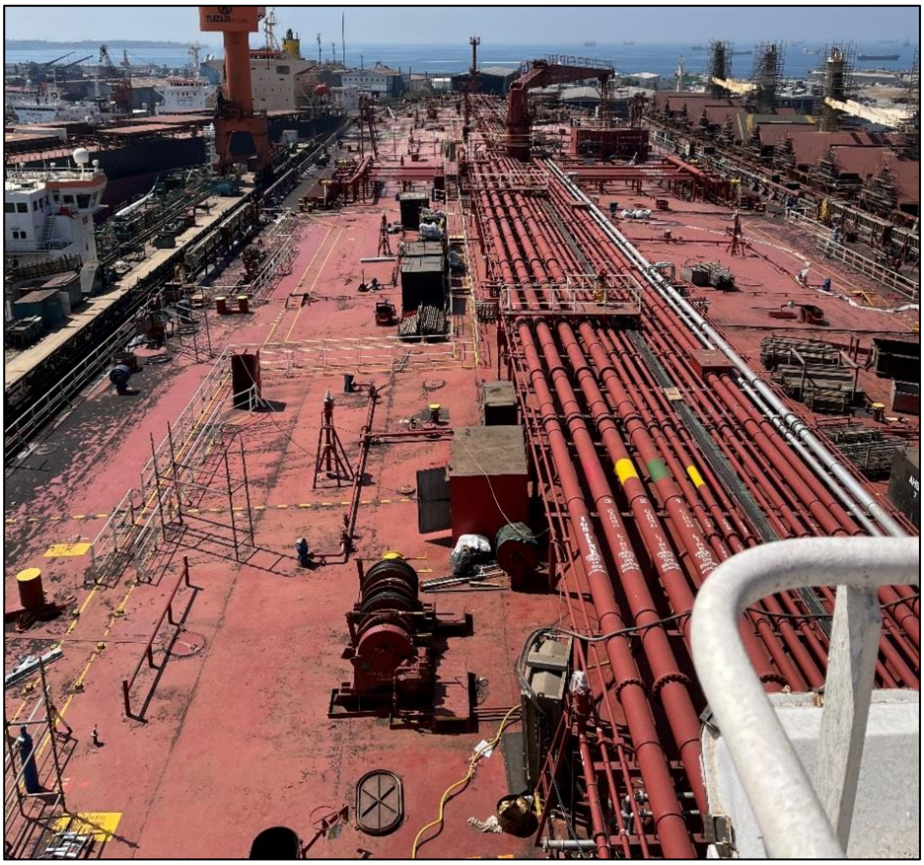

Figure 1: MT *Seaprincess*' main deck

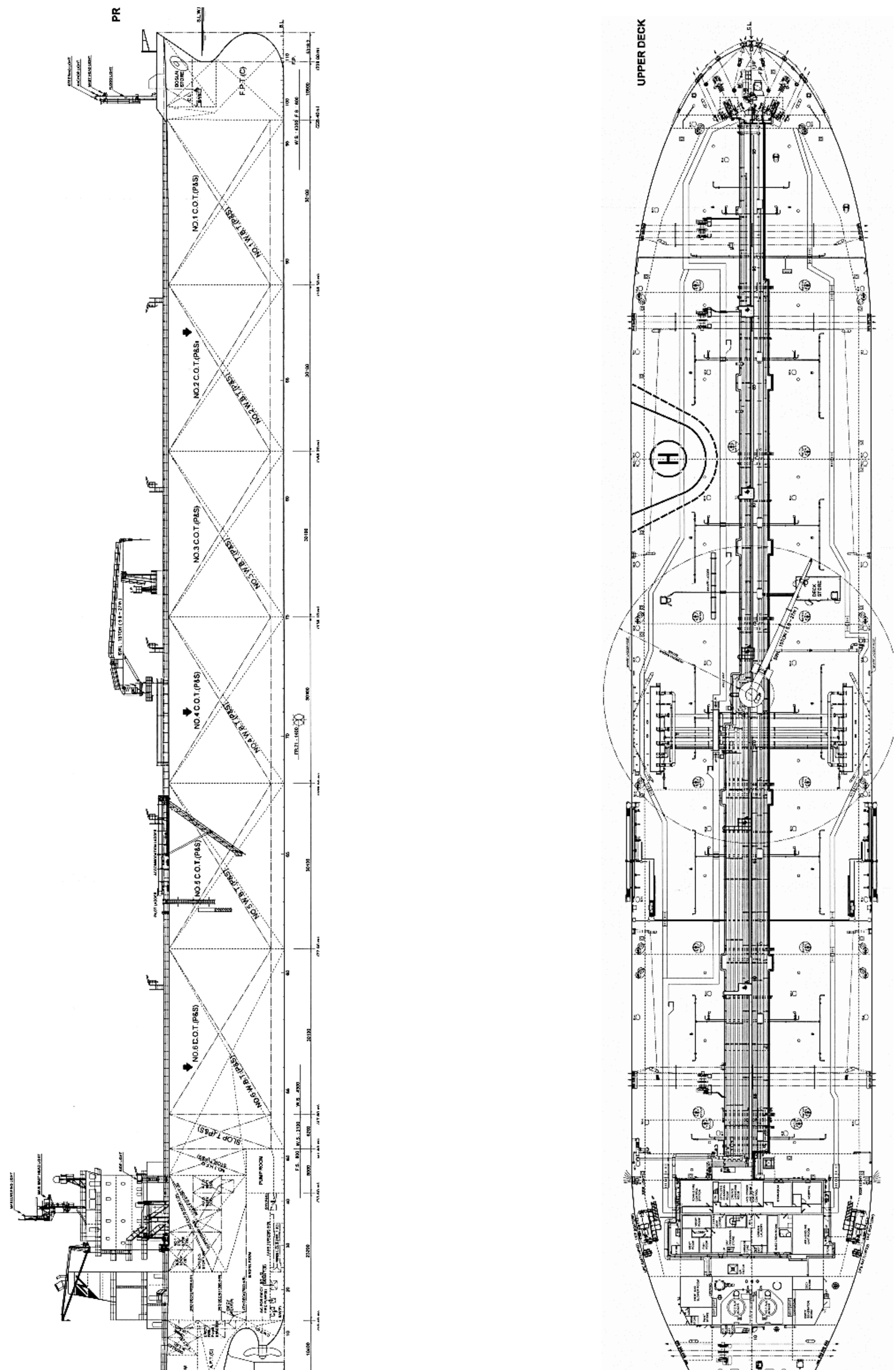

Figure 2: ***Seaprincess*** **General Arrangement plan**

1.2.1 Cargo and slop tanks

Seaprincess was fitted with six pairs of cargo oil tanks, with a total capacity of 126,164.8 m^3 and numbered from 1 to 6 (port and starboard). In addition, the vessel had two slop tanks (port and starboard), located aft of the main cargo oil tanks but forward of the pump room (**Figure 3**). Each slop tank had a capacity of 1,973.8 m^3.

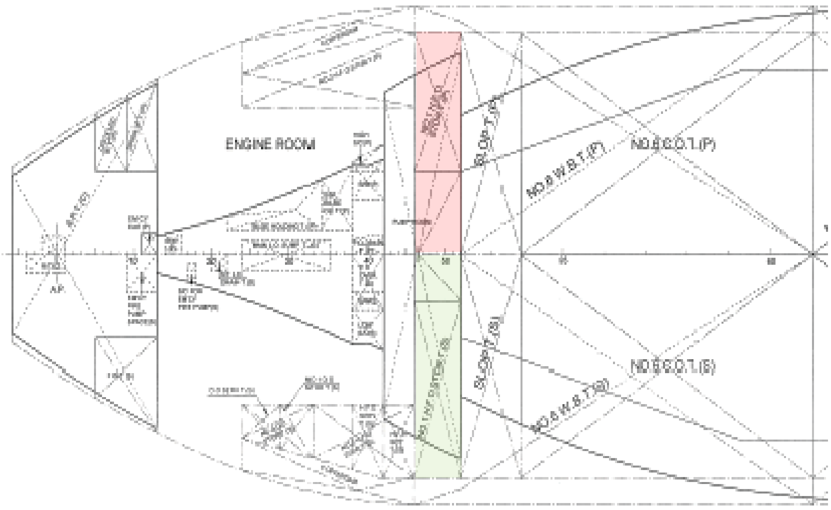

Figure 3: Layout of the port and starboard slop tanks

At the time of the accident, the cargo tanks were empty and had been cleaned and washed during the ballast passage from Gdansk to Tuzla. The port side slop tank was designated as the dirty tank and the starboard side slop tank was the clean tank. The slop tanks were interconnected through a decanting line[1] (**Figure 4**).

[1] Decanting is a common practice on board tankers and is considered to be a very important procedure following pipe flushing of oil residues and cargo tank water washing. With two slop tanks fitted on board, one of the tanks is normally designated as the primary slop tank and the other is the secondary slop tank. Collected in the designated primary slop tank, the oily-mixture is allowed to settle over a period of time, leading to the separation of oil and water. Water is then drained via the decanting line into the secondary slop tank, until it is discharged either to the sea or to a shore reception facility, in accordance with the applicable provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL).

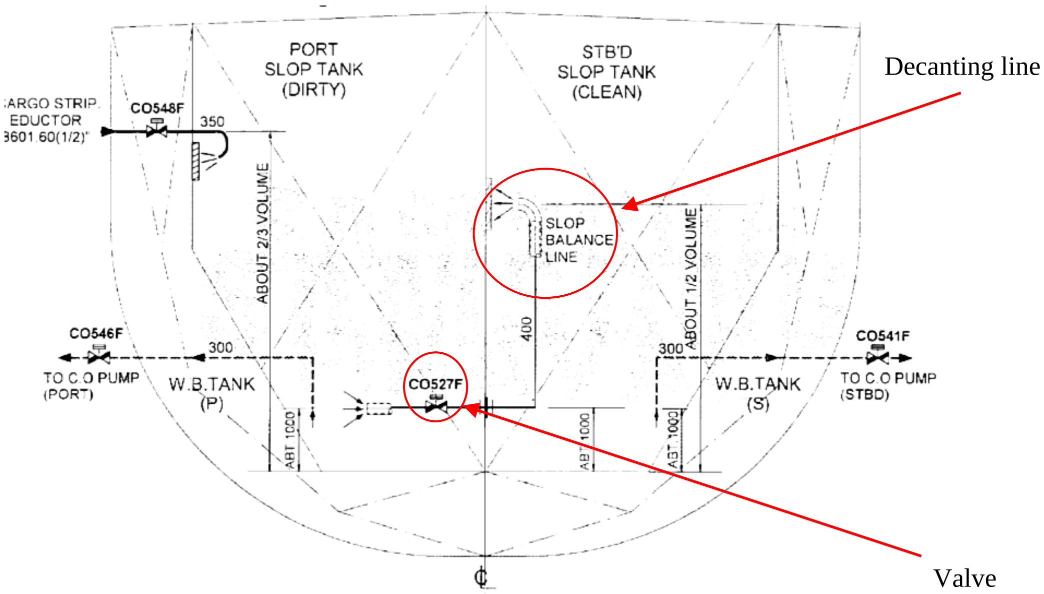

Figure 4: Cross-section through the slop tanks, showing the decanting line

Prior to the accident, all the cargo tanks had been cleaned following which, the slop tanks were cleaned. All slops were pumped out to a slop barge on 24 July, at Piraeus anchorage. By the time the vessel arrived in the dry-dock, the slop tanks had been cleared of all oily-water and carbon residue (**Figure 5**).

Figure 5: Photograph of the clean and dry slop tank

1.2.2 Gas freeing of tanks

The cargo and slop tanks were initially certified gas free on 28 July by the shipyard's chemists, while the vessel was at Tuzla anchorage, awaiting instructions to enter the dry-dock. The shipyard had established a series of categories for the entry into enclosed spaces and safety, based on the gas measurement of the space (**Table 1**).

Table 1: Enclosed space and safety categories as established by the shipyard

Enclosed Space Categories	Safety Categories
I. *First category*: compartments in which hazardous air conditions that cause medical emergency situations may, or do occur	1. Unsafe for person, unsafe for hot work
II. *Second category*: compartments in which air conditions do not cause medical emergency situation but are expected to be hazardous	2. Unsafe for person without protective equipment, unsafe for hot work
III. *Third category*: compartments in which air conditions are hazardous or possible to be hazardous to some degree that do not cause medical emergency situation	3. Unsafe for entrance of person, safe for hot work from outside
IV. *Fourth category*: compartments that have 20-21% concentration of oxygen and potential risks lower than the abovementioned categories	4. Unsafe for person, safe for hot work from outside
	5. Safe for person, safe for hot work

Following the vessel's dry-docking on 29 July, the tanks were certified gas free by the shipyard chemists on a daily basis, at around 0800. On completion of the daily measurements, the chief mate was provided with a gas free certificate and a notice to each and every enclosed space was attached at the entrance, showing the enclosed space and safety category of entry (**Figure 6**). The information on the port side slop tank label, dated 14 August 2023, confirmed that the enclosed space was designated as *Category IV*, with an assigned Safety Category 2. These categories were based on the gas measurements made on the side, which returned the following values:

% LEL:	0 %
O_2 Volume:	20.9 %
H_2S ppm:	0
CO ppm:	0
VOC ppm:	20

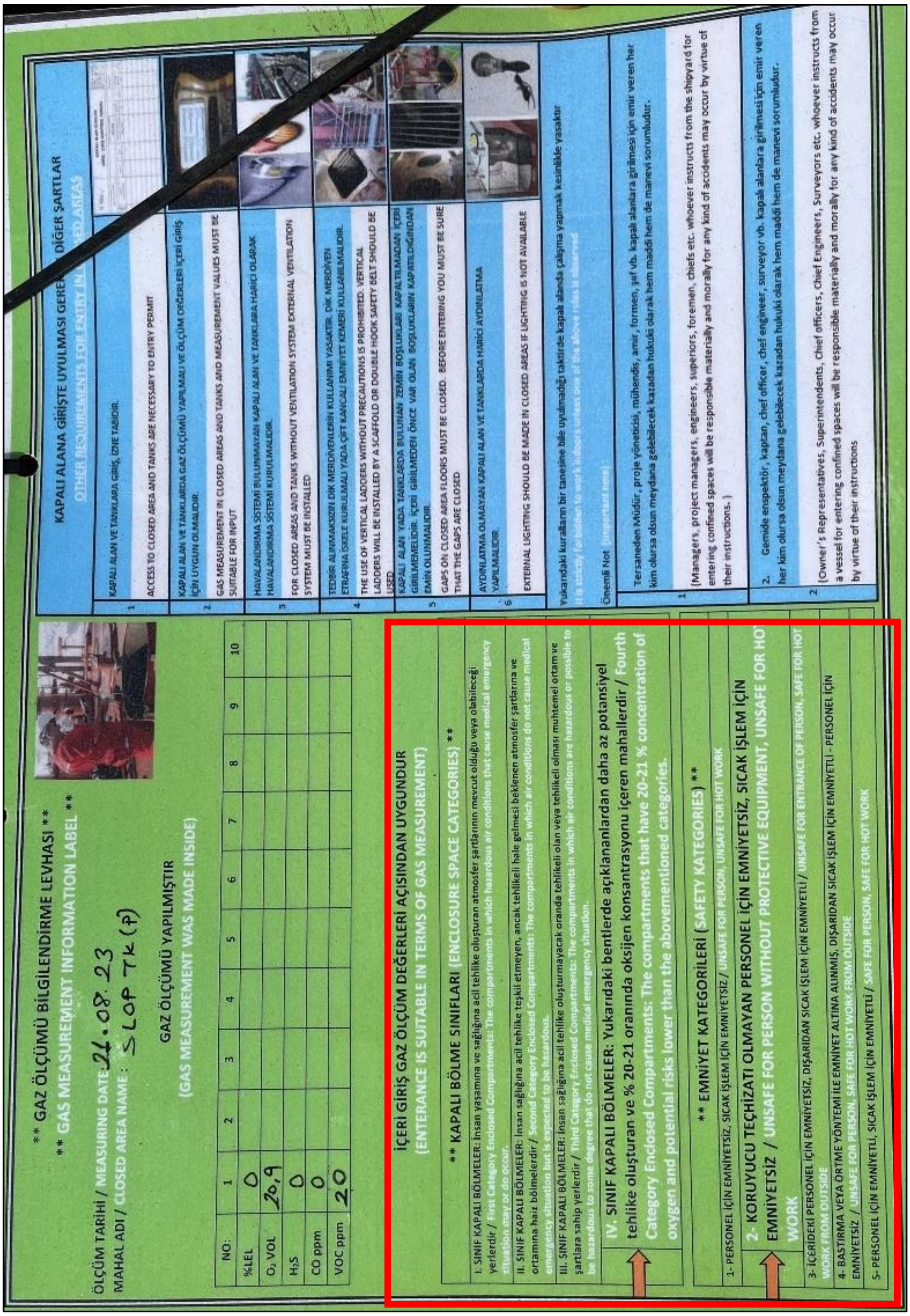

Figure 6: Gas measurement information label appended to the entrance of tanks

(Photo taken several days after the accident)

1.3 Crew members

All crew members were found to be duly certified in accordance with the relevant requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). The total number of crew members on board, when the vessel arrived at Tuzla anchorage, was 23. This exceeded the minimum number of 15, stipulated on the Minimum Safe Manning Certificate, issued by the flag State Administration on 21 November 2018. The crew comprised of Bulgarian and Filipino nationals. The working language on board was English.

On 29 July, soon after anchoring at Tuzla, seven additional Filipino wipers joined the vessel to assist with the dry-docking, bringing the total number of crew members to 30.

At the time of the accident, in addition to the existing crew, a further 35 persons were added to the crew list to assist with the dry-docking and repairs of the vessel. The list included superintendents, service engineers, technicians, surveyors, members of repair squads, and visitors. The safety investigation was informed that the 35 persons were added to the crew list because it would have facilitated access to the vessel and allowed them to work on board as contractors. The arrangement was acceptable to the shipyard. The additional persons were accommodated ashore and attended the vessel on a daily basis.

1.4 Riding Repair Team

The repair team consisted of a foreman and six welders, all of whom were Bulgarian nationals. Prior to joining the vessel, all members of the team participated in a familiarisation briefing at Varna, Bulgaria. During the briefing, the repair team members were informed of their roles and responsibilities, and the requirement to follow the vessel's procedures, as outlined in the Company's 'Safety Briefing for Riding Teams' Booklet.

The repair team members, who were accommodated in a local hotel, would arrive on board the vessel at about 0730, and work until about 1845, each day, with assigned breaks for lunch and refreshments. The task of the repair team was to assist in the facilitation of the dry-docking and work on a repair list, which was prepared in advance by the Company.

1.4.1 Welder 1

Welder 1 was 38 years old and, prior to working on board *Seaprincess*, he had been employed on board another of the Company's vessels between 16 and 28 July 2023. His evaluation report, compiled by the chief engineer and superintendent, was satisfactory. Welder 1 joined *Seaprincess* on 30 July in the dry-dock, together with the riding team foreman.

1.4.2 Welder 2

Welder 2 was 50 years old and joined the vessel on 08 August 2023, a few days after the vessel entered the dry-dock. He had completed several offshore courses in the past but had lapsed as they were not required for the position of a welder. He had about 20 years of experience on board ships at repair yards and dry-docks, as well as experience in industrial power plants.

1.5 Safety Management System

1.5.1 General

The vessel's Safety Management Certificate, valid until 17 March 2024, was issued by ABS on 04 February 2022. The last external audit (intermediate) was carried out on 30 January 2022 and found the vessel's safety management system (SMS) to be in compliance with the requirements of the ISM Code.

The vessel's last annual internal audit had been carried out on 17 November 2022 by the Company's lead auditor. The audit raised one non-conformity and two observations but found that there was continuous improvement in the implementation of the Company's systems as well as risk assessment practices.

The Company was issued a Document of Compliance (DOC) by DNV, on behalf of the flag State Administration, on 11 January 2022. The Company's DOC confirmed that the safety management system of the Company had been audited and it complied with the requirements of the ISM Code for chemical and oil tankers.

1.5.2 Procedures

Relevant to the accident, the vessel had the following procedures in its SMS:

- Management of Contractors;
- Permit to Work System;
- Hot Work and Enclosed Space Entry Permits;
- Risk Assessments; and
- Dry-docking Safety Checklist.

1.6 TK Tuzla Shipyard

TK Tuzla Shipyard is the largest ship repair facility in Tuzla Bay. The shipyard had a floating dock with a lifting capacity of 109,000 mt and 1,000 m of quayside for afloat repairs. The Yard provided a number of services, including dry-docking, ship repairs and conversion services. Tuzla Shipyard was certified to a number of industry standards including ISO 9001:2015 (Quality Management Systems) and ISO 45001:2018 (Occupational Health and Safety Management Systems).

1.7 Environment

The weather was fine with a Westerly, gentle breeze. The temperatures on 14 August varied from 29 °C to 33 °C. The temperatures remained generally stable since the vessel had arrived in the dry-dock.

1.8 Narrative[2]

1.8.1 Events prior to Tuzla anchorage

Seaprincess departed Gdansk, Poland on 10 July 2023, after discharging its cargo of light crude oil. The vessel was bound for dry-docking, scheduled at Tuzla, Türkiye.

On passing the Straits of Gibraltar, the charterers re-delivered the vessel to the owners and the cleaning of the cargo tanks commenced in preparation for the planned dry-docking. The vessel stopped at Piraeus anchorage on 24 July, to take on stores, transfer the oily-water mixture from the slops tanks into a slop barge, undergo an

[2] Unless otherwise stated, all times from this point are local (UTC +3).

underwater inspection of the hull, and embark additional personnel. On completion of all activities, the vessel departed the anchorage on 25 July.

During the passage to Tuzla, the slop tanks were cleaned. The collected sludge was removed from the tanks and landed *en route* at Bozcaada, Türkiye on 27 July. The port side slop tank was the last tank to be cleaned and all the oil and water residues were removed.

The vessel arrived at Tuzla anchorage on 28 July, where a number of service engineers and other personnel arrived on board. Two chemists from the shipyard boarded at 1124 on 28 July, and disembarked at 1248, after testing the tanks to confirm that they were gas free.

1.8.2 Tuzla anchorage to dry-docking

At 1242 on 29 July, the vessel heaved up its anchor and proceeded to the shipyard's floating dry-dock. By 1700, the vessel had been secured in the dry-dock.

During the dry-dock period, the operations were followed by the Company's Technical Superintendent and the HSEQ Superintendent. The scope of all the planned repairs and jobs, which were required to be undertaken by the shipyard, had been documented and agreed with the shipyard prior to the vessel's arrival at the dry-dock. A similar list of planned repairs that the riding team was expected to undertake, was also documented and provided to all parties concerned. Progress of repairs undertaken by the shipyard were discussed during daily morning meetings, held on board at 0930 with the shipyard's ship repair manager (SRM), the superintendents, vessel's senior officers, and the riding team foreman.

On or about 06 August, during the survey of the cargo and slop tanks, the ABS surveyor identified some stanchions railings on the sloping ladders inside cargo tank no. 4 starboard and the port side slop tank, which required repairs. The repair job was assigned to the riding team and recorded on a supplementary jobs list.

On 07 August, the chief officer and a service technician tested all the valve actuators located in the cargo and slop tanks, to identify any defective valves. Valve 'CO527F' (**Figure 4**) in the port side slop tank was also tested. During the opening and closing testing sequence of the valve, a quantity of oily-water mixture that had remained entrapped in the decanting line, spilled inside the slop tank, before the valve could be shut. The spillage was reported by the technician to the chief officer, as soon as he came out of the slop tank.

On 14 August, welders 1 and 2 arrived on board in the morning to start their work. Following the toolbox meeting, they were tasked to first complete the repair on the anchor lashing arrangements on the windlass that they had been working on during the previous day. After this task was completed, they reported back to the foreman who then showed them the two stanchions in the port side slop tank, advising them that the structure required alignment and welding. The foreman, along with welder 2, entered the slop tank (**Figure 7**) to explain and point out the work that had to be carried out.

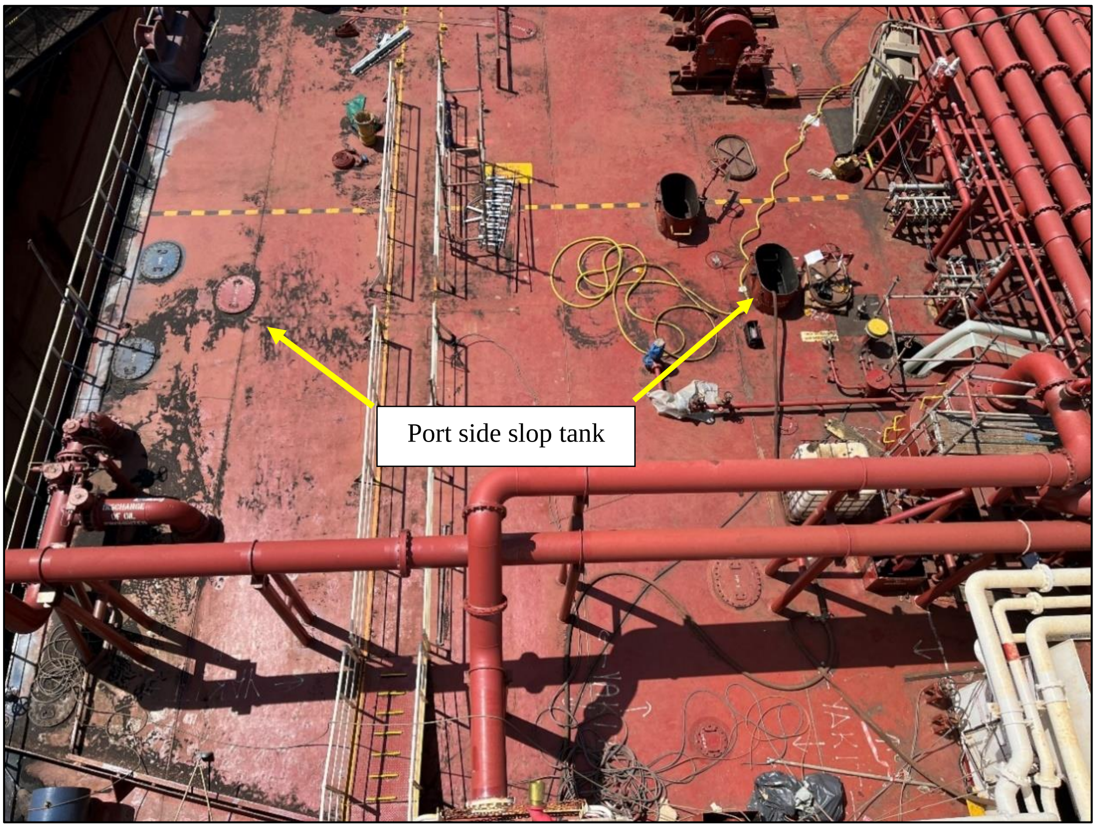

Figure 7: Overview of the port side slop tank's manhole and tank dome

The first and second stanchions on the sloping ladder were identified as the ones requiring attention (**Figure 8**). Whilst neither an entry permit nor a hot work permit was granted for the entry into the tank, the crew members were not informed that the foreman and welder 2 were entering the tank.

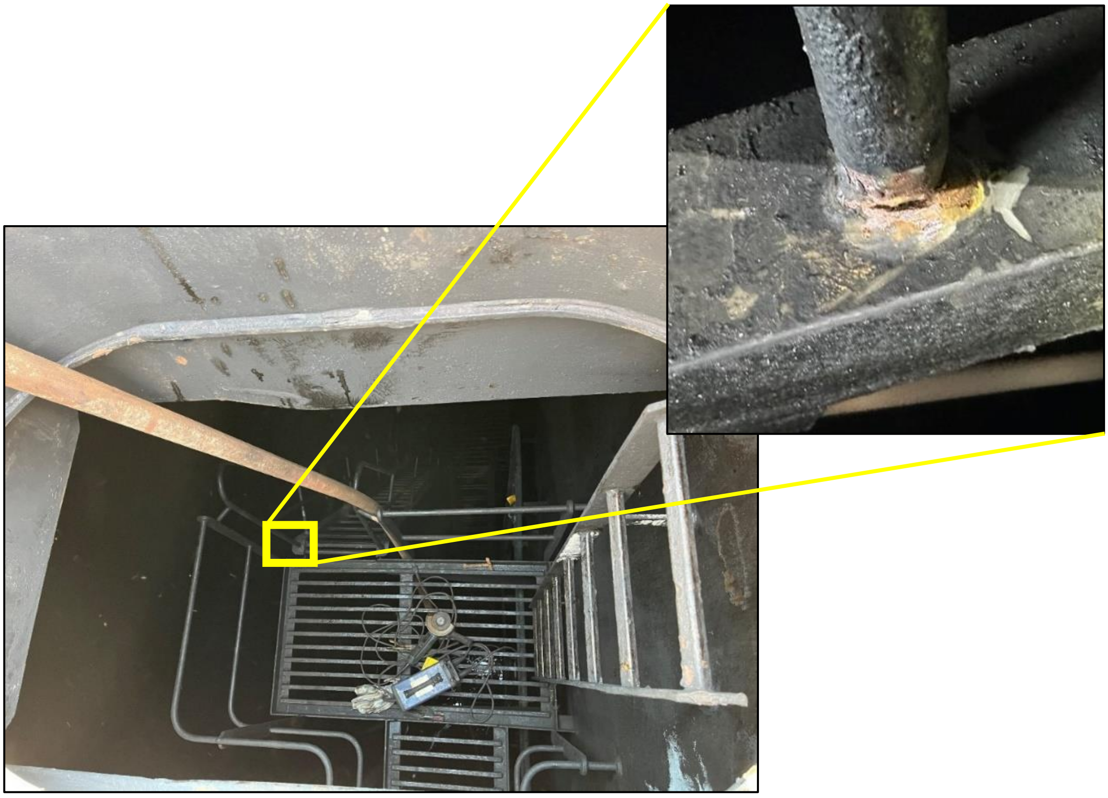

Figure 8: entrance to port side lope tank, showing the first stanchion that required repairs

The safety investigation was also informed that the master, the chief officer, the officer in charge of the watch (OOW), as well as the superintendents, were all unaware of this entry. Post-accident investigation also revealed that although both welders were wearing the appropriate personal protective equipment (PPE), including boiler suits, safety shoes, gloves, safety helmet and glasses, neither were equipped with a personal gas monitor. At about 0930, the daily meeting with the shipyard reconvened, attended by the vessel's senior officers, the two superintendents and the riding team foreman. The meeting was held in the cargo control room (CCR), located on deck A.

In the meantime, welders 1 and 2 prepared the necessary tools and lowered an electrical extension cable along with an electric grinder and portable welding machine down to the first platform of the slop tank. The two welders discussed amongst themselves, on how to tackle the repair job. No light was rigged and there was no person stationed at the entrance of the tank.

On the platform, welder 1 prepared and cleaned the surface around the weld areas using an electric grinder – a process, which took approximately a minute to complete. Meanwhile, welder 2 prepared the welding machine and connected the ground lead near the stanchion. He then positioned himself on the first and second steps of the sloping ladder to strike the welding rod and start welding. Almost immediately, he observed a ball of fire rising from the bottom of the tank, followed by a rumbling noise. Heading for the exit, welder 2 shouted to welder 1, who was just below him, to get out of the tank. Welder 2 had just managed to reach and grab the vertical ladder (**Figure 8**), when he was ejected out of the tank's manhole, high into the air.

Persons on board, who witnessed the accident, stated that they saw welder 2 rise to an estimated height of about 12 m from the main deck (**Figure 9**); the OOW observed welder 2 from the bridge window. Falling back to the main deck, a second explosion[3] appeared to cushion his fall, slowing his free fall before landing on the deck.

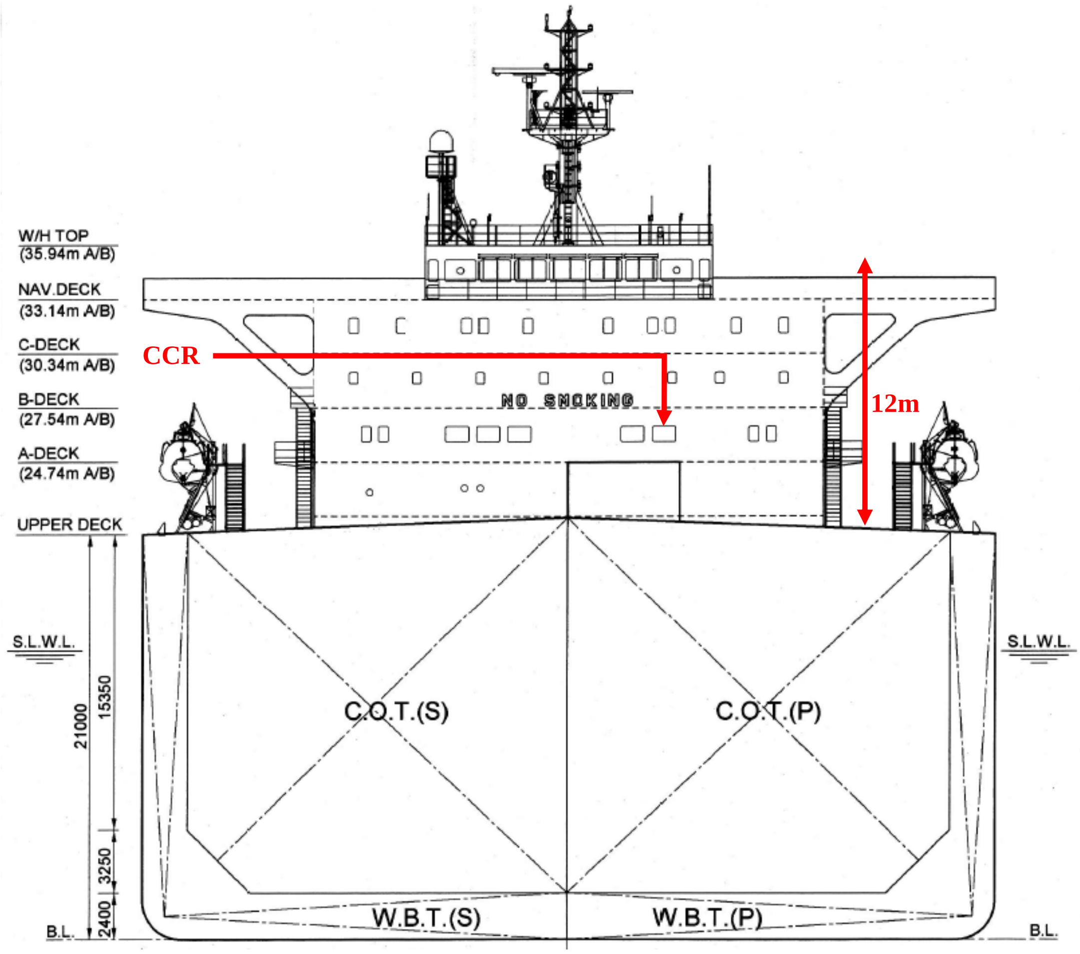

Figure 9: Approximate height from main deck

[3] Several witnesses reported hearing what they thought was a third explosion; however, they could not confirm this.

The explosion was heard by the CCR meeting participants, most of whom had also witnessed the ejection of welder 2 in the air and his landing on the deck.

1.8.3 Emergency response

As he landed on deck, welder 2 stood up and started walking aft, where he was met by several crew members who had already started making their way towards the slop tank. The welder was in shock and was escorted to the port lifeboat area.

Almost immediately, at around 0950, the crew members mustered on the poop deck and a head count was taken. It was confirmed that welder 1 was missing. About five minutes later, fire hoses were deployed inside the port side slop tank to douse the flames and cool down the tank. By 1000, all work on board the vessel had been suspended by the shipyard emergency services, who took over the fire fighting and rescue efforts.

At about 1100, welder 2 was taken to the local hospital where he was assessed for his injuries. He complained of back pain but as he did not have any life threatening injuries, he was transferred to a private hospital, where he underwent surgery.

The fire did not last long, but water hoses were kept charged to cool the slop tank. By about 1230, the slop tank was deemed safe for a fire fighter to enter. Welder 1 was found deceased, against the port side bulkhead of the slop tank. Following his identification, he was transferred to the morgue ashore.

The slop tank access was sealed and the master, chief officer and the riding team foreman were taken ashore by the authorities for their statements, where they were detained.

1.8.4 Injuries sustained

Welder 2 sustained severe bruising to his wrists and legs as a result of his landing on the deck. He recalled that he had only started experiencing severe pain in the lower back and legs about an hour after the accident.

He was diagnosed with fractured and herniated lumbar discs and corrective surgery was successfully carried out on 18 August. He was subsequently discharged from the hospital on 21 August, in a mobile state, and repatriated home on the same day.

1.8.5 Damage to the port slop tank

An inspection of the area only revealed damages to the slop tank's manhole cover, which was found buckled (**Figure 10**) by the pressure wave generated by the explosion inside the tank. No structural damages were observed inside the slop tank. Soot residue from the fire was observed on the bulkheads (**Figure 11**).

Figure 10: Buckling of the port side slop tank's manhole cover

Figure 11: Port side slop tank after the accident

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 Limitations of the Safety Investigation

When the safety investigation team attended the vessel in the shipyard, the master, chief officer and the riding team's foreman had already been detained by the local authorities, as part of the judicial investigation into the accident. The safety investigation could neither gain access nor talk to them, to establish their version of events.

2.3 Fatigue and Alcohol

There were no hours of rest records for the two welders, and neither was there a requirement to record them. To this effect, the safety investigation was unable to determine the quantity and quality of rest, which they would have had. However, during the safety investigation process, the MSIU did not come across behaviour patterns, which would have suggested that fatigue would have influenced the actions / inactions of the two welders. Fatigue was not considered to be a contributory factor to this accident.

Alcohol tests were not carried out on any of the riding team members after the accident. However, the MSIU came across no evidence, which would have suggested that alcohol should be considered as contributory to this accident.

2.4 Cause of the Explosion Inside the Slop Tank

During the testing of the actuator valves inside the slop tank, a quantity of oily-water mixture, which unknowingly had remained inside the decanting line between the two slop tanks, was released inside the port side slop tank. Although the safety investigation could not determine the actual quantity of liquid because of the firefighting water remaining inside the slop tank after the accident (**Figure 13**), it was estimated that between 500 litres and 600 litres of the oily-water mixture may have been accidentally spilled inside the slop tank.

Figure 13: Firefighting water insider the slop tank

Over the following seven to eight days, the oily-water mixture, which accumulated inside the slop tank at ambient hot temperatures ranging between 29 °C and 33 °C, was very likely to have generated vapour. Being heavier than air, the oil vapour would have remained at the bottom of the tank, with the splatters from the arc welding causing the explosion.

Although the slop tank had been tested at 0800 and was found to be gas free, the safety investigation concluded that the build-up of a small gas pocket at the lower levels of the tank must have escaped detection when the atmosphere was tested by the shipyard that morning. A mixture of hydrocarbon gas and air is heavier than air, if the air content is at least 90% of this volume. It was not excluded that the difference in the densities (between the hydrocarbon vapour and air) may have caused variations in the readings. This issue would have manifested itself more prominently if the measurements were not taken close to the bottom and at various points over the slop tank bottom.

2.5 Was the Slop Tank Gas Free?

Based on the results of the tests conducted by the shipyard chemist at 0800 on 14 August, the notice at the entrance of the slop tank (**Figure 6**) stated:

"UNSAFE FOR PERSON WITHOUT PROTECTIVE EQUIPMENT, UNSAFE FOR HOT WORK" (sic).

This meant that no hot work was allowed, although it was safe to enter the slop tank, provided that PPE, *i.e.*, including gas monitors, was worn. The two welders were not wearing personal gas monitors. It is possible that they were unaware that the slop tank was not cleared for hot work, or they did not understand the significance of what the notice meant, or they had missed it altogether.

The port side slop tank was a designated enclosed space and since it was known that it was required to be gas free on arrival at Tuzla, the oily-mixture in the decanting line should have also been drained and flushed cleaned when the slop tank was being cleaned on 26 and 27 July, in preparation for the dry-dock. Although the vessel's procedures required all interconnecting pipelines between compartments to be flushed through and vented, this did not occur. It can be appreciated, even on a vessel of this size, that ensuring that all interconnecting pipelines were flushed is a significant, daunting task, and missing on interconnections comes as no surprise.

Demands and increased workload may influence the actions and behaviour of the persons involved. One of the potential problems with dry-docking (in terms of human behaviour and safety), is that it brings along significant changes. Changes bring uncertainty, requiring extraordinary efforts to anticipate and plan for any unexpected event, thereby ensuring safety. Anticipating failure is no simple feat – it takes years to build, considering that knowledge can never be perfect, not to mention the evolving / dynamic environment in the shipyard, with numerous and simultaneous tasks being executed on a daily basis.

In such circumstances, communication is not only of essence but vital. The safety investigation identified two instances where communication may have been an issue:

i. at the time when there was a change in the level of 'threat' *i.e.*, when the oily-water mixture leaked into the slop tank; and

ii. when it was decided to access the slop tank (without personal gas monitors), with the intention to carry out hot work.

In stating this, the safety investigation is not implying that this communication was easily achievable, even if, *a prima facia*, it appeared so. Considering a pre-accident context rather than the post-accident, the two welders had no cues that a simple welding task would have led to tragic consequences. In other words, the safety investigation believes that there was no reason for them to revise their sensitivity to failure – especially given that there were no cues known to them, which should have warned them of a potential failure of the intended task.

2.6 Dry-dock Procedures

The vessel had 'entry into enclosed spaces' procedures and hot work permits. During the dry-docking of a vessel, crew members were required to follow the Company's procedures when entering an enclosed space, in compliance with the vessels' safety management system (SMS). The SMS also required that contractors engaged by the Company to adhere to the vessel's SMS.

The master was responsible for the overall safety of the vessel, its crew and all other personnel on board, whilst the chief officer was the designated safety officer during the vessel's stay in the dry-dock.

The vessel was also required to follow the shipyard's own SMS and to this effect, the crew members and all personnel working on board were required to comply at all times with the shipyard and the Company's safety procedures. In case of any conflict between the vessel's and the shipyard's SMS, the stricter measures were to apply. Therefore, since hot work permits are usually controlled by the shipyard (which has overall responsibility for safety of its premises including vessels), a hot work permit would have been required from the shipyard instead of the vessel.

The vessel's procedures required the OOW to use a checklist when conducting safety rounds in the morning and, thereafter, every six hours or less, subject to the work plan. Since the vessel carried three second officers, this task was completed every four hours and logged in the deck logbook. The checklist indicated that the entry into enclosed spaces and hot work permits, and the last entry before the accident (when the checklist was completed) was at 0800. Therefore, even if the OOW conducted his safety round in accordance with the checklist, he would have been unaware of the work that was about to take place at around 0900 – unless he was told about it, or happened to be in the vicinity of the entrance.

The OOW, senior officers, and the superintendents were all unaware that entry into the port slop tank and hot work was being contemplated that morning by the riding team. This apparent 'lack of adherence' to procedures was not analysed at face value by the MSIU[4]. What the safety investigation wanted to achieve was an understanding of why, *a prima facia*, there was a 'violation' of Company (and shipyard) procedures.

It was clear that on-board communication may have not been effective. However, the fact that there was complete unawareness that the two persons had accessed the slop tank and initiated hot work, provided an explanation of the context in which they were operating in, together with the rest of the crew members and contractors / shipyard workers. The complexity of the working environment in a typical shipyard, needs to be understood and cannot be ignored from the safety investigation's considerations. This is so because the safety investigation believed that the more the crew members, contractors and shipyard workers are engaged in the numerous, simultaneous tasks which need to be carried out whilst the vessel is in the shipyard, the more complex the situation becomes.

Moreover, it also has to be pointed out that it is legitimate to expect that several tasks on board are carried out without any supervision – perhaps more so in a shipyard, where the number of simultaneous tasks would be significant – not only on

[4] In so doing, the safety investigation consulted several theoretical models and related taxonomies for this purpose. For instance, the application of theories put forward by James Reason would have necessitated the adoption of an analytical framework that distinguishes between errors and violations, with the latter being related to the conscious decision of not following procedures, albeit not necessarily to wilfully harm and damage the system. However, the main concern with such taxonomies was the risk of not engaging in a thorough discussion – *i.e.*, limiting oneself to the superficial, immediate factors, rather than the deeper underlying factors (genotypes).

Seaprincess, but on any other vessel. Naturally, such situations may result in people stepping beyond the boundaries of the safe operating envelope – even unknowingly – because more often than not, the boundaries between what is safe and unsafe would be blurred. For instance, although welder 2 stated that he would normally have a personal gas monitor, on that day he did not carry one. He only entered the compartment and deemed it was safe because he could not smell any hydrocarbon.

Whilst the safety investigation did not exclude that the two repair team members were aware of the oily-mixture leak inside the slope tank, the risk related to such a leak was either not identified, or not appreciated (by them)[5]. It would be correct to state that access to the slop tank was physically possible – otherwise the two persons would not have gone inside; after all, the label affixed to the slop tank entrance was a symbolic barrier system – very weak and easily overlooked, misunderstood, or ignored. However, the safety investigation concluded that all these decisions were not the result of defiant behaviour and attitude towards safety; the entry into the enclosed space, and the eventual commencement of the hot work, was a situational performance variability, 'instigated' and consequential of the prevailing complex, operational context, which one would typically find in a shipyard.

2.7 Introduction of an Oily-water Mixture into an Enclosed Space

The safety investigation was unable to determine whether the spill of the oily-water mixture inside the port slop tank had been reported by the chief officer to the master or the attending superintendents. In any case, the spillage incident changed the physical status – from a clean tank to one containing hydrocarbons. Moreover, as the vessel was still in the dry-dock, it was likely that further entries into the slop tank would have been required and thus, the need to report and get the tank ready for inspection again.

The safety investigation neither had access to the master nor the chief officer to establish how the matter had been handled. However, recollections of all those present indicated that this incident had not been reported because the presence of the oily-mixture only became known after the explosion happened. Given that no one

---

[5] Knowledge of the oily-water mixture is discussed in Section 2.7 of this safety investigation report.

beyond the technician and the chief officer was aware of the spill, and there was no plan to clean up the tank, the safety investigation concluded that the oily-water mixture inside the slop tank was the cause of the build-up of hydrocarbon gas over a number of hot days.

2.8 Management of Contractors

Prior to boarding the vessel, the riding team completed a safety briefing in Bulgaria and the emphasis was for the team members to follow the safety procedures on board, and to consider themselves part of the vessel's crew.

In line with the vessel's procedures on the management of contractors, the chief engineer and the chief officer were responsible to monitor contractors' compliance with the Company's policies and procedures. This included drawing up a repair plan and agreeing with the Company on the details. The chief engineer and chief officer may have had some involvement in monitoring the status of repairs; however, due to the sheer volume of work in the dry-dock, their supervision of the repair team was not at the same level as it would have been on a vessel in service, at sea.

Once the riding team members boarded, they had to be familiarised with the basic safety processes and the management structure on board. However, this step was missed. The riding team assumed that it was only answerable to the foreman, who allocated the daily jobs.

The riding team's job list was discussed daily with all the involved parties, either by the technical superintendent or the Company's representative, the safety officer and the foreman. However, on the day of the accident, the technical superintendent reported that he was informed by the riding team foreman, sometime before the 0930 daily meeting, that the repairs to the railings in cargo tank no. 4 starboard and the port slop tank had been completed during the previous day. He assumed that the repair had been discussed with the safety officer (chief officer) and completed in accordance with all procedures, namely that a hot work permit had been obtained.

The practice on board a vessel normally follows a competence hierarchy – where the day-to-day decisions are taken by the most senior crew members. It appeared that the riding team members followed the same practice, *i.e.*, reporting to their foreman. Thus, it would be legitimate to claim that, from their point of view, exclusive authority on their work did not lie with the vessel but their respective superiors, creating a separate hierarchy from that of the ship, even though it was not short of knowledge and experience. With two hierarchal structures, a communication gap between the designated person of one structure and the other, would suffice to create a potential dangerous approach, where part of the organisation (even if there are two 'distinct' hierarchical structures) is not privy to the intentions of the other.

THE FOLLOWING CONCLUSIONS, SAFETY ACTIONS 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 Cause of the Accident

.1 Welding splatters ignited undetected hydrocarbon vapour present inside the port side slop tank.

3.2 Conditions and other Safety Factors

.1 A quantity of oily-water mixture, which unknowingly had remained inside the decanting line between the two slop tanks, was released inside the port side slop tank.

.2 This oily-water mixture eventually released hydrocarbon vapour inside the tank.

.3 Ensuring that all interconnecting pipelines were flushed was a significant, daunting task and missing on interconnections comes as no surprise.

.4 The more the crew members, contractors and shipyard workers are engaged in the numerous, simultaneous tasks which need to be carried out whilst the vessel is in the shipyard, the more complex the situation becomes.

.5 Although the slop tank had been tested at 0800 and was found to be gas free, the safety investigation concluded that the build-up of a small gas pocket at the lower levels of the tank escaped detection when the atmosphere was tested by the shipyard that morning.

.6 It was possible that the two welders were either unaware that the slop tank was not cleared for hot work, or they had missed the warning sign altogether.

.7 Although the vessel's procedures required all interconnecting pipelines between compartments to be flushed through and vented, this did not occur.

.8 The safety investigation identified instances where communication may have been an issue. The OOW, senior officers and the superintendents were all unaware that entry into the port slop tank and hot work was being contemplated that morning by the riding team.

.9 Considering the timing of the completion of the safety round checklist, even if the duty officer conducted his safety round in accordance with the checklist, he would have been unaware of the work that was about to take place at around 0900 – unless he was told about it, or he happened to be in the vicinity of the entrance.

.10 The two welders had no cues that a simple welding task would have led to tragic consequences.

.11 Whilst the safety investigation did not exclude that the two repair team members may have been aware of the oily-mixture leak inside the slope tank, the risk related to such a leak was either not identified, or not appreciated by them.

.12 Recollections of all those present indicated that this incident had not been reported because the presence of the oily-mixture only became known after the explosion happened.

.13 The safety investigation believes that the entry into the enclosed space, and the eventual commencement of the hot work, was a situational performance variability, 'instigated' and consequential of the prevailing complex, operational context, which one would typically find in a shipyard.

3.3 Other Findings

.1 Fatigue and alcohol were not considered to be contributory factors to this accident.

4 RECOMMENDATIONS

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

the Company is recommended to:

11/2024_R1 Circulate the findings of this investigation to all vessels under its management.

11/2024_R2 Analyse how communication gaps in shipyards, among crew members and other personnel on board Company ships can be bridged, taking into consideration the expected prevailing context on board a vessel in a shipyard.