MARINE SAFETY INVESTIGATION REPORT

OWNER	:	Odyssey Navigation Co. Ltd. Greece
MANAGER	:	Vita Management S.A. Greece
NAME OF SHIP / IMO NO	:	M/V Vitaspirit / 9231377
FLAG	:	Malta
SCENE OF ACCIDENT	:	Strait of Istanbul/Turkey
DATE OF ACCIDENT	:	07 April 2018
FATALITY / INJURY	:	- / -
DAMAGE / POLLUTION	:	Major damages to mansion and ship's bow / no pollution

Board Resolution No : 12/DNZ-03/2019 Date : 20 / 10 /2019

REPUBLIC OF TURKEY
MINISTRY OF TRANSPORT AND INFRASTRUCTURE
Transport Safety Investigation Center

VITASPIRIT
Marine Safety Investigation Report

Due to the Striking Mansion on the Eastern Bank of the Strait

Strait of Istanbul

07 April 2018

The Joint Investigation was carried out by Transport Safety Investigation Center (Turkey) and The Marine Safety Investigation Unit (Malta)

This report is prepared by the Transport Safety Investigation Center.

Address	:	Ministry of Transport and Infrastructure Transport Safety Investigation Center Hanimeli Street No: 7 Sihhiye, 06430 ANKARA / TURKEY
Phone	:	+90 312 203 14 31
Fax	:	+90 312 229 72 89
E-mail	:	deniz.ulasimemniyeti@uab.gov.tr
Web	:	www.ulasimemniyeti.gov.tr

LEGAL BASIS

This marine accident was investigated in accordance with the By-law on the Investigation of Marine Accidents and Incidents which came into force after being published at the Official Gazette No.29056 on 10th July 2014.

Investigation procedures and principles are further applied by considering Resolutions of International Maritime Organization concerning International Standards and Recommended Applications for Safety Investigations Directed to MSC 255(84) (Casualty Investigation Code) and Resolution A.1075(28) Marine Accidents or Incidents, and European Union Directive 2009/18/EC.

LIST OF REFERENCES AND SOURCES OF INFORMATION

Laboratory report by TTH,UK

Manager's accident investigation report

Master and crew members of MV *Vitaspirit*

Ship damage survey report by Class

Technical report by MMC, UK

Technical report by TMC Marine

Video data from MADAS[1]

Voyage Data Recorder of MV *Vitaspirit*

[1] Marine Accident Data Analysis Suite - S-VDR data was extracted and imported into MADAS software, for reconstruction and analysis. The charts used by MADAS are based on EuronavSeaPro Plus software using propriety Livecharts. Livecharts are based on electronic navigations charts issued by the Turkish Hydrographic Office and distributed by the UK Hydrographic Office

GLOSSARY OF TERMS AND ABBREVIATIONS

°C	Degrees Celsius
AB	Able seaman
AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aid
BNWAS	Bridge navigation warning alarm system
BA	British Admiralty
ECDIS	Electronic Chart Display and Information System
ECR	Engine Control Room
GPS	Global Positioning System
GT	Gross tonnage
IMO	International Maritime Organization
kW	Kilowatts
m	Metres
MADAS	Marine Accident Data Analysis Suite
MMC	Marine Metallurgical Consultants Ltd., UK
MSIU	Marine Safety Investigation Unit
NKK	Nippon Kaiji Kyokai
OOW	Officer of the Watch
OS	Ordinary seaman
RPM	Revolutions per Minute
SOLAS	International Convention for the Safety of Life at Sea, 1974, as amended
S-VDR	Simplified Voyage Data Recorder
TSIC	Transport Safety Investigation Center
TTH	The Test House, UK
UKHO	United Kingdom Hydrographic Office
UTC	Coordinated Universal Time
VDR	Voyage Data Recorder
VHF	Very High Frequency
VTS	Vessel Traffic Service

SUMMARY

At about 1533 on 07 April 2018, the Maltese registered bulk carrier Vitaspirit, while passing South through the Istanbul Strait, suffered a main engine breakdown. The vessel lost steerageway and veered off the planned track and struck the 18th Century Hekimbaşı Salih Efendi Mansion on the Eastern bank of the Strait in position 41° 05.51' N 029° 03.86' E.

Vitaspirit sustained minor damage to the bow and significant damage below the waterline, including internal structures in way of the fore peak tank. There were neither any pollution nor reported injuries. Further to the main engine failure, it was established that the anchors had not been released in time to counter the vessel's headway.

The Joint Investigation was carried out by Transport Safety Investigation Center (Turkey) and The Marine Safety Investigation Unit (MSIU) Malta have made a number suggests a number of recommendations to Vita Management, the managers of Vitaspirit, aimed at improving communications on board in an emergency situation taking account of engineering and navigational constraints. It is also proposed to that recommendations are made to the Clasification Societies

1. FACTUAL INFORMATION

1.1 Vessel, Voyage and Marine Casualty Particulars

Vessel Particulars

Name	: Vitaspirit
Flag	: Malta
Classification Society	: Nippon Kaiji Kyokai
IMO Number	: 9231377
Type	: Bulk Carrier
Registered Owner	: Odyssey Navigation Co. Ltd.
Manager	: Vita Management S.A. Greece
Construction	: Steel (double bottom)
Place and Year of Build	: Nagasaki –Japan, 2001
Gross Tonnage	: 38,732
Length Overall (LOA)	: 225.00 m

Registered Length	:216.00 m
Minumum Safe Manning	: 13
Authorised cargo	: Dry Bulk
Main Engine	: Kawasaki-Man B&W 7S50 MC-C 8943 kw

Voyage Details

Port of Departure	: Kavkaz, Russia
Port of Arrival	: Jeddah, Saudi Arabia
Type of voyage	: International
Cargo Information	: Barley in Bulk (62,623 tonnes)
Manning	: 20

Marine Casualty Particulars

Date and Time	: 07 April 2018 at 15:33 (LT)
Type of Marine Casualty	: Serious Marine Casualty
Place on board	: Bow (Bulbous Bow)
Injuries/Fatalities	: None
Damage/Environmental Impact	: Major damages to the bulbous bow, as well as to third party property (Mansion), no pollution
Ship Operation	Normal Service- on Passage
Voyage Segment	Istanbul Strait (under Pilotage)
External&Internal Environment	Sea: moderate, visibility good. Wind: North Northeast, force 4
Persons on Board	20

Figure:1 Front view of M/V VITASPIRIT

1.2 Description of Vessel

Vitaspirit was a 38,432 gt gearless bulk carrier, owned by Odyssey Navigation Co. Ltd. Greece and managed by Vita Management S.A Greece. The vessel was built by Oshima Shipbuilding Co Ltd, Japan in 2001 and was classed with NKK. The vessel had a length overall of 225,00 m, a moulded breadth of 32,26 m, and moulded depth of 18,90 m. The summer draught of the vessel was 13,921 m, which corresponded to a deadweight of 74,269 tonnes.

Vitaspirit's Statutory and Class certificates were all valid at the time of the accident and no surveys were overdue. The ISM Document of Compliance was issued on 31 july 2017 and Vitaspirit's safety management certificate was dated 16 July 2014. The last Port State Control Inspection was carried out at Novorossiysk on 20 February 2018

1.3 The Bridge

Vitaspirit was fitted with the following navigation equipment:

- Standart magnetic and gyro compass;
- Two JRC Radars (S and X bands with ARPA);
- JRC echo Sounder, GPS and an AIS;
- Intermarine Electronics BNWAS;
- Chart Plotter and

- JRC JCY-1700S Simplified Voyage Data Recorder (S-VDR).

A gyro compass repeater was fitted on the wheelhouse centreline to take compass bearings, using an azimuth circle. A TRANSAS Electronic Chart Display and information System (ECDIS) fitted on board was awaiting type approval by Class at the next survey. To this effect, paper charts were carried on board to meet the chart carriage requirements of SOLAS. The vessel was supplied with British Admiralty (BA) charts issued by the UK Hydrographic Organisation (UKHO). At the time of accident, the chart in use was BA Chart 1158 Northern Istanbul Strait, 3rd Edition, issued on 13 September 2012 and corrected to notices to Mariner 380/17. Vitaspirit's bridge layout is shown in figure 2.

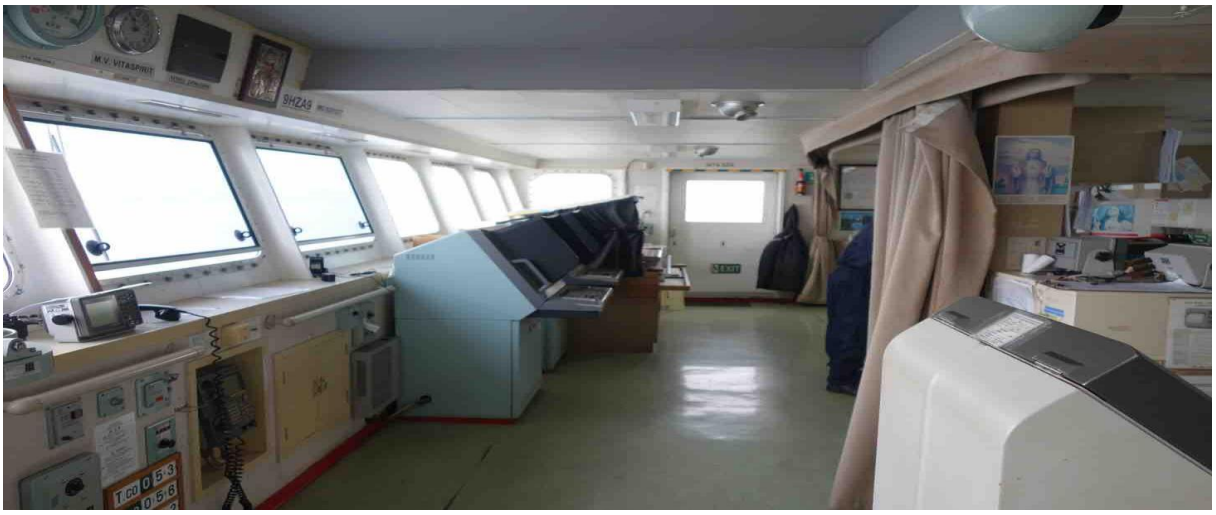

Figure 2: Bridge layout as seen from the centreline towards starboard

1.4 Crew

Vitaspirit has been manned with sufficient number of crew member according to the Minimum Safe Manning Certificate. On the day of the accident, there were 20 crew members on board, including the Master. At the time of the accident, The Master, 2nd Officer and Strait Pilot were on the bridge.

The Minimum Safe Manning Certificate, issued by the Flag State Administration, stipulated a crew of 13 persons. The vessel was manned in excess of the minimum safe manning reguirements. All crew members were nationals of the Philippines and the working language on board was English. The Master and deck officers had completed a course on Bridge Team Management, and attended IMO Model Course 1.27 and JRC type-specific ECDIS training.

The master was 62 years old, with 27 years of command experience. He had joined Vitaspirit on 05 June 2017. The chief mate was 41 years old with less than one year experience in rank. He had joined Vitaspirit on 07 September 2017. The second mate was 59 years old and joined Vitaspirit on 12 March 2018. The Chief Engineer was 57 years old with 22 years experience in the present rank. In Februaray 2013, he had completed a course in Engine Resource Management. He had joined Vitaspirit on 05 June 2017. The second Engineer was 53 years old with less than one year experience in the present rank. In December 2013, he had completed a course in Engine Resource Management. He had joined Vitaspirit on 28 July 2017

The helmsman is 30 years old. He has been working for the company for 6 years. He is on duty between 12:00-16:00 as a shift.

The Bosun is 35 years old. He has been onboard for 3 months and has been working for this company for 5 years. His daily work routine is between 06:00 - 17:00. He was at forecastle deck at the time of the accident.

Oiler, who was on duty in the engine room at the time of the accident, is 31 years old. He was working on board as an oiler for the shift between 12:00 - 16:00. He has been working on board for 2 years. At the time of the accident, he was trying to fill the water into the Expansion tank with portable hose.

1.5 Environment

The weather was overcast with moderate to good visibility. The wind was North and Northeast Beaufort Force 4 to 5, with low seas and the estimated wave height was 0.6 meter The air and sea temperatures were 13 ^{o}C and 11 ^{o}C respectively.

1.6 Currents

The general surface current in the Turkish straits flows from the Black Sea to the Aegean Sea at an average rate of two to four knots. In strong Northerly winds, the surface current could reach six to eight knots. A northbound sub-surface current flows at 9.0 m below the surface at speed up to three knots.

At the time of the accident, current in the Istanbul Strait was flowing South, at the rate of about two knots.

1.7 Main Engine

Vitaspirit was fitted with a single 7-cylinder, two-stroke, single acting, MAN-B&W 7S50MC-C diesel engine, producing 8,994 kW at 103 RPM. The engine drove a 4-bladed fixed pitch propeller, to give service speed of about 14,5 knots. The manoeuvring full speed RPM was 74, corresponding to 9,6 knots in loaded condition.

The main engine was fitted with a NABCO M-800-II safety control system to either prevent or limit damages to the main engine in case of malfunction or running outside acceptable operating parameters. The NABCO system operated on pre-set time, and automatically slowed down the main engine to 34 RPM in the event of cooling fresh water low pressure and exhaust gas cylinder high temperature. The engine control room (ECR) and aerial view of the main engine are shown in Figures 3 and 4.

Figure 3: Engine Control Room

Figure 4: Aerial view of main Engine

1.8 Istanbul Strait Pilot

The Pilot who boarded Vitaspirit was 51 years old. He had been at sea for 30 years, 9 of which as a Master . He had been working as Istanbul Strait Pilot for the past 13 years.

1.9 Narrative [2]

1.9.1 Events dynamics on board Vitaspirit

On 05 April 2018, *Vitaspirit* sailed from the Black Sea port of Kavkaz, Russia, on an even keel draught of 13.0 metres. She was laden with 62,623 tonnes of barley and bound for Jeddah, Saudi Arabia. She arrived off Istanbul Strait on 07 April 2018.

Before entering the Strait, the following was checked by the crew:

- navigational equipment
- communication system;
- battery for emergency lighting;
- primary and secondary steering gear; and
- main engine (ahead and astern).

An entry in the deck logbook showed that the above were found in good working condition. As per normal practice on board, the chief mate, together with the bosun and two ordinary seaman (OS), prepared port and starboard anchors by lowering them above the water and raising them

[2] Unless otherwise stated, all times in this report are Local Time (UTC+3)

back in the hawse pipe, disengaged the gears and brakes on for immediate use. But there is no any evidence, such as logbook entry or other record relating to the preparation of the anchors.

Article 5 of the Turkish Straits Sea Traffic Scheme under the heading of technical conditions and notifications of vessels passing through the Turkish Straits consists of 16 articles. When the requirements of the article are examined, it is necessary to be seaworthy according to the legislation of the country whose flag they carry and the international rules for the vessels to be able to pass through the straits safely.

At about 1230, *Vitaspirit* was underway and headed towards the pilot station. The bridge was manned by the second mate (OOW), an able seaman (AB) was on the helm, and the master had the con. The anchor team was on the forecastle deck. The chief mate and the bosun carried portable VHF radios to communicate with the bridge. In the engine-room, there was the chief engineer, second engineer, third engineer and duty oiler. *Vitaspirit* arrived at the charted pilot boarding area at 1428 and was instructed by the pilot to proceed inside the Strait. At 1450, just before passing under Yavuz Sultan Selim Bridge (Figure 4), the pilot embarked the vessel and requested an increase in speed. Almost immediately, navigation full speed was ordered and the main engine was set to 85 RPM.

The current was setting South and *Vitaspirit*'s speed in the Strait was about 11.7 knots.

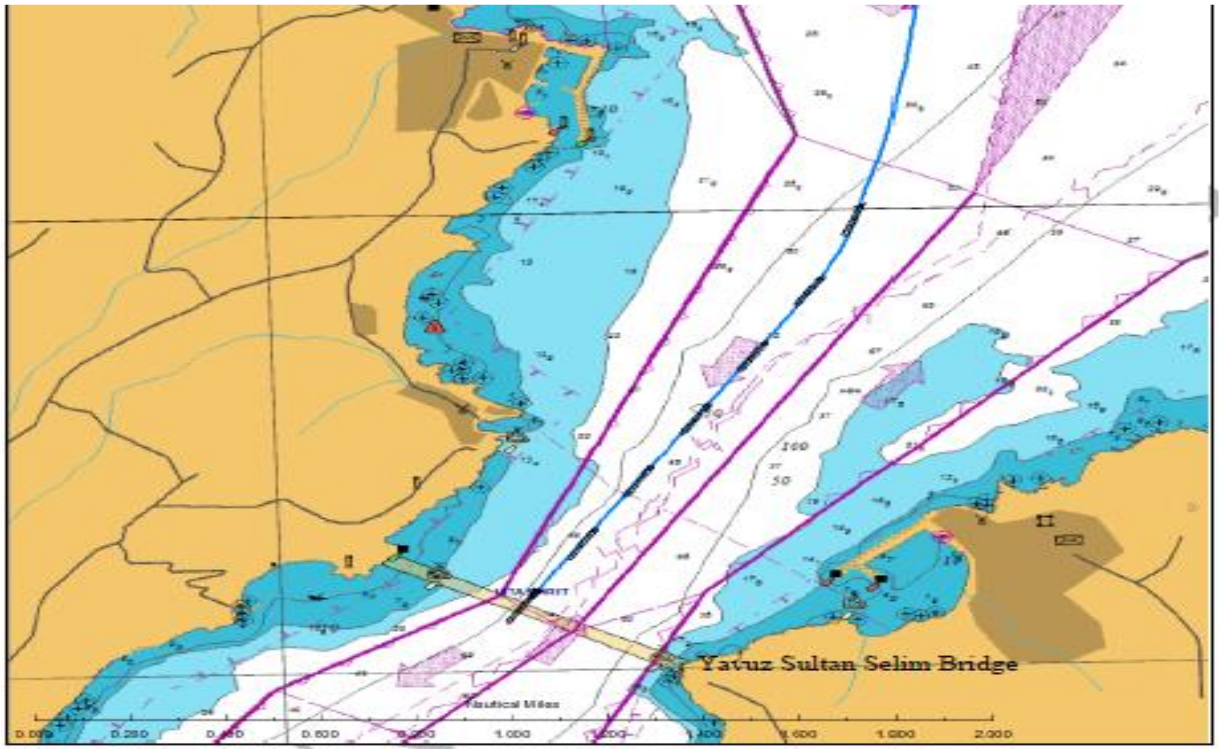

Figure 5: *Vitaspirit* passing under Yavuz Sultan Selim Bridge

1.9.2 Events leading up to the allision

At about 1520, when *Vitaspirit* was passing Yeniköy Point close to starboard, the pilot ordered a 10° starboard helm to commence a 70° turn. At about that time, the duty oiler in the engine-room detected a fresh water leak on main engine cylinder no. 5 cooling water jacket and informed the chief engineer. The chief engineer, along with the third and fourth engineer, left the ECR to investigate. On discovering the leak, the chief engineer instructed the engineers to top up the expansion tank with fresh water. About four or five minutes later, he called the bridge and informed the master that the vessel had a problem with the main engine. The master instructed him to try and rectify the problem since *Vitaspirit* was in the approaches to the second bridge - Fatih Sultan Mehmet (Figure 6).

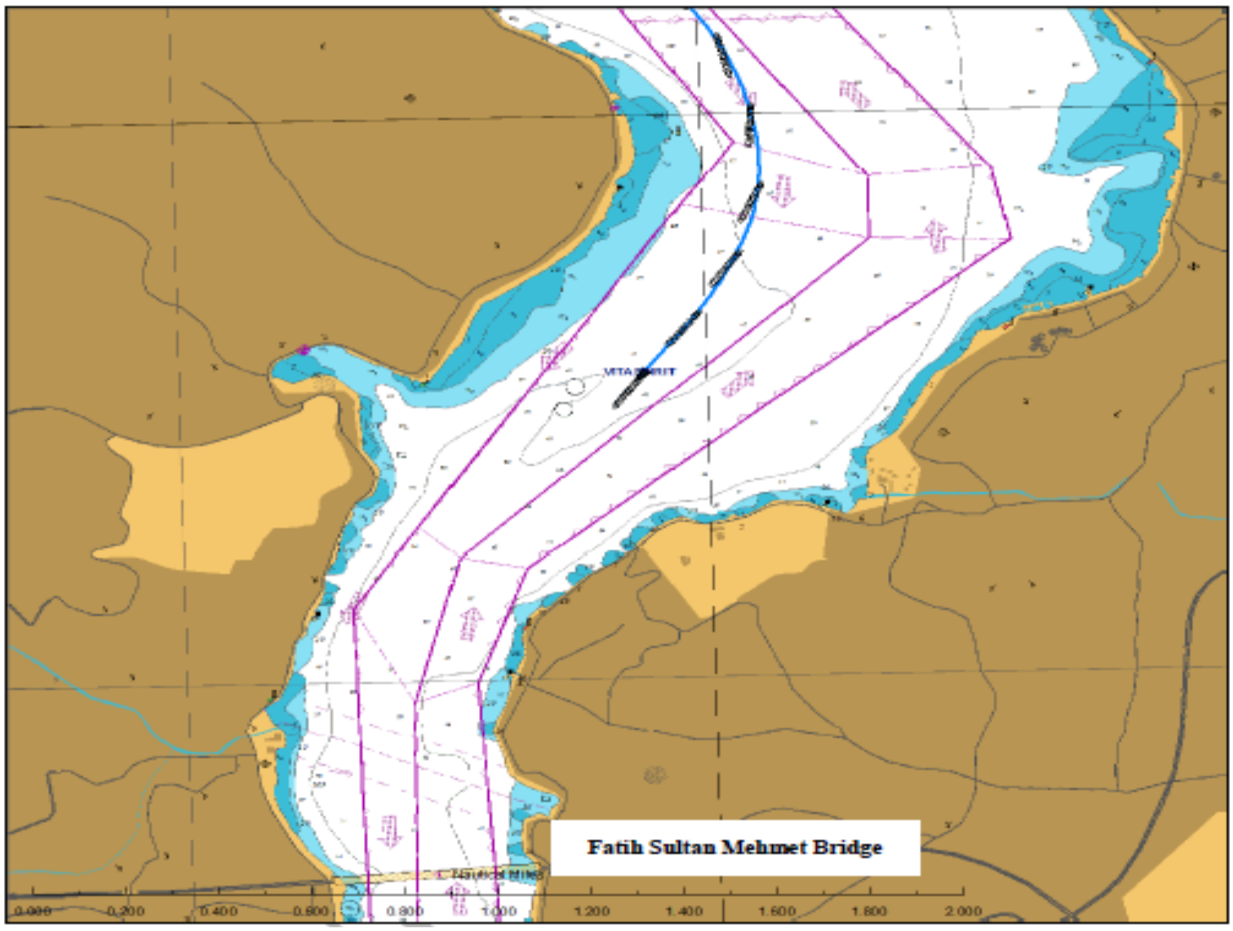

Figure 6: Position of *Vitaspirit* 1524

At about 1527, the pilot ordered a 10° port helm to commence a 40° turn towards the narrowest section of the Strait and pass under the Fatih Sultan Mehmet Bridge. A minute later, he ordered the helm midship and a 20° starboard helm to control the rate of turn. At this point,

an alarm sounded on the bridge. The alarm, which had also activated in the ECR, indicating a jacket cooling water low pressure. The RPM automatically dropped to 44 (Figure 7). The pilot enquired whether there was any problem. He reacted by ordering maximum starboard helm to arrest the rate of turn, 'stand-by the anchor' and called VTS for tug assistance.

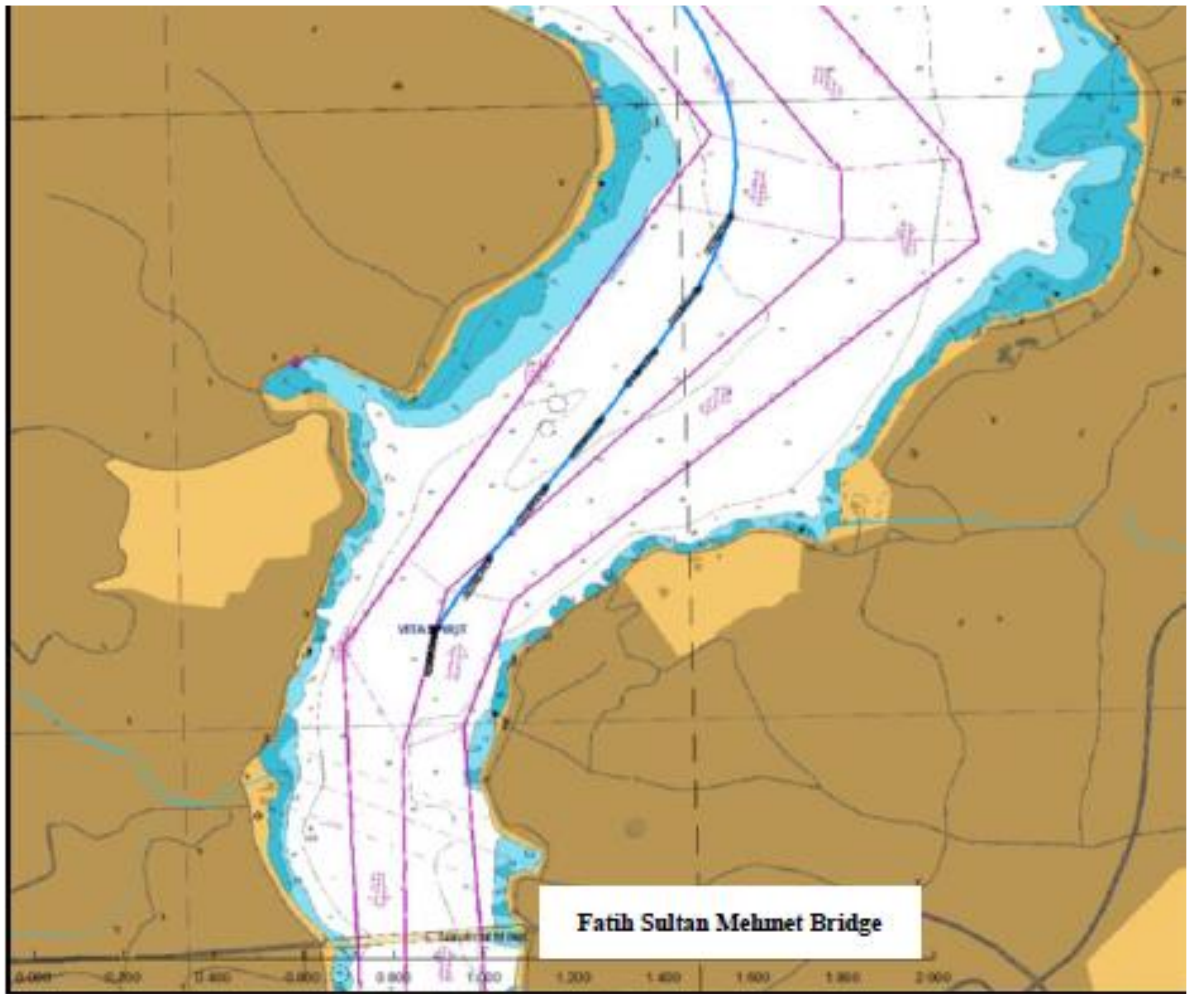

Figure 7: Position of *Vitaspirit* at 1528

The chief engineer heard the main engine slowing down and rushed to the bridge to give the master a full appraisal of the situation. He then returned to install a blank into the outlet of cylinder no. 5 and close the fuel inlet. Shortly afterwards, another alarm – high temperature of cooling water outlet activated.

The cooling water inlet valve of cylinder jacket No. 5 was closed, and the cylinder was suspended and cooling water loss was attempted to prevent. During this process, an oiler was sent to the Expansion Tank floor and was asked to add water continuously to the tank. When the input circuit was closed, the engine cooling water pressure had a slight increase, which

resulted in an increasing in the engine speed from 44 RPM to about 60 RPM. However, the cooling water in the output circuit came to the re-suspended cylinder with gravity and negative pressure due to the output circuit being open, although the input circuit is closed. As a result of this situation, even though water was continuously added to the Expansion Tank, the loss of cooling water was accelerated again and the engine stopped automatically when the cooling water pressure was below the specified value.

In order to prevent the main engine from blackout/stop, water loss in the expansion tank should be prevented. Because of the absence of additional valves in the cylinder outlet circuit No. 5 in order to prevent loss of cooling water due to gravity and negative pressure reasons, the loss of cooling water couldn't be prevented. This is caused by the lack of a valve at the piston outlet No. 5. If valves were put into each piston outlet similar to the valves put into each piston inlet on the Main engine, there would be no loss of cooling water. It was determined that the vessel engine stopped due to the failure to prevent the absence of water in the expansion tank.

By this time, *Vitaspirit* had moved far out to the port side of the Strait, veering to port and closing on to the shore.

The master called the engine-room to increase the RPM in an effort to get just enough steerageway to swing the bow to starboard. The second engineer, who at the time was alone in the ECR, pushed the cancel slow down button and the RPM accelerated to 60. This only lasted a short while. The RPM started to go down again and a few seconds later, the main engine shut down altogether and the engine telegraph shifted to emergency astern following an order from the bridge. In the course of events in the ECR, the pilot on the bridge and called the master to drop the starboard anchor. Just as the anchor was about to be dropped, the master sensed that the vessel's bow was coming around to starboard, and the master suspended the letting go of the anchor. The pilot then ordered the helm hard over to starboard.

Over the next two minutes, *Vitaspirit* was slowly moving ahead under her own momentum and gently veering to port (Figure 8). The pilot repeatedly told the master to 'let go both anchors', who in turn ordered the bosun on the forecastle to release the anchors, It was strongly recommended by the Strait pilot to the master of the vessel to drop anchor. However, the master, who was in constant communication with the engine room, avoided to drop the anchor as he hoped the engine would operate again. The captain gave instruction to drop the anchor just before crashing into the coastal structure but both anchors couldn't be let go.

The pilot pushed the ship's whistle to warn the people on the bank. The whistle did not work and no anchor was dropped. At 1533:23, *Vitaspirit* struck and demolished Hekimbaşi Salih Efendi Mansion on the Eastern bank of the Istanbul Strait in position 41° 05.51' N 029° 03.86' E. The position of allision corresponds to the vessel's GPS position where the bow made contact with the mansion.

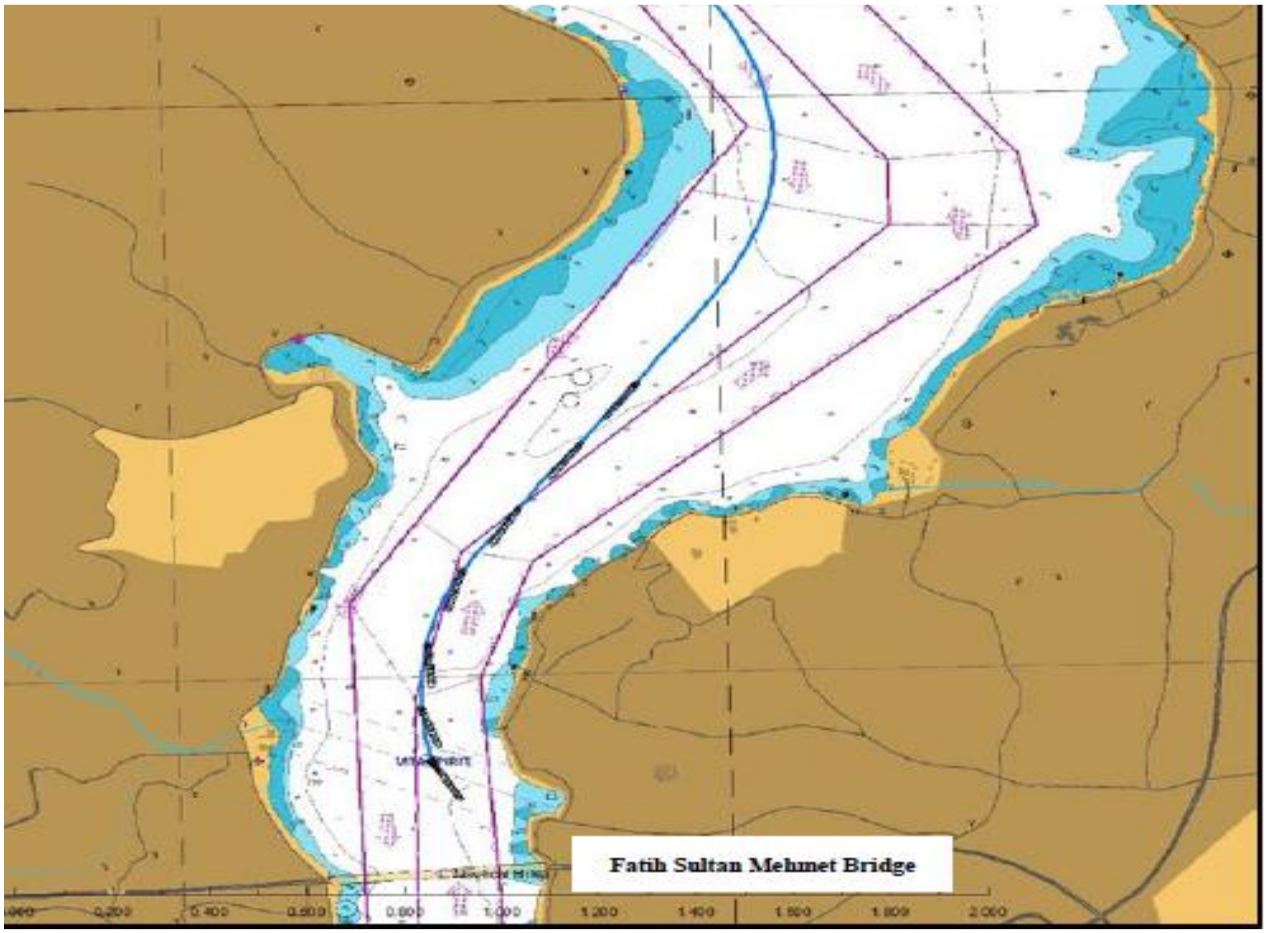

Figure 8: Position of *Vitaspirit* at 1531

1.10 Post-allision Events

The master initiated the Company's SMS post-grounding checklist and checked all tanks and cargo holds. The ship stayed upright and her draughts remained unchanged. There were no reported pollution and injuries. Meanwhile, the chief engineer had installed a blank flange into the outlet of cooling water jacket. Cylinder no. 5 was thus isolated and by 1540, *Vitaspirit* was ready to re-start the main engine. By this time, tug Kurtarma 3 and tug Kurtarma 7 were in attendance. Using her own power and with the assistance of the tugs, *Vitaspirit* shifted downstream from the accident site. At 1555, she anchored mid-channel in the Strait, using her port and starboard anchors (Figure 9).

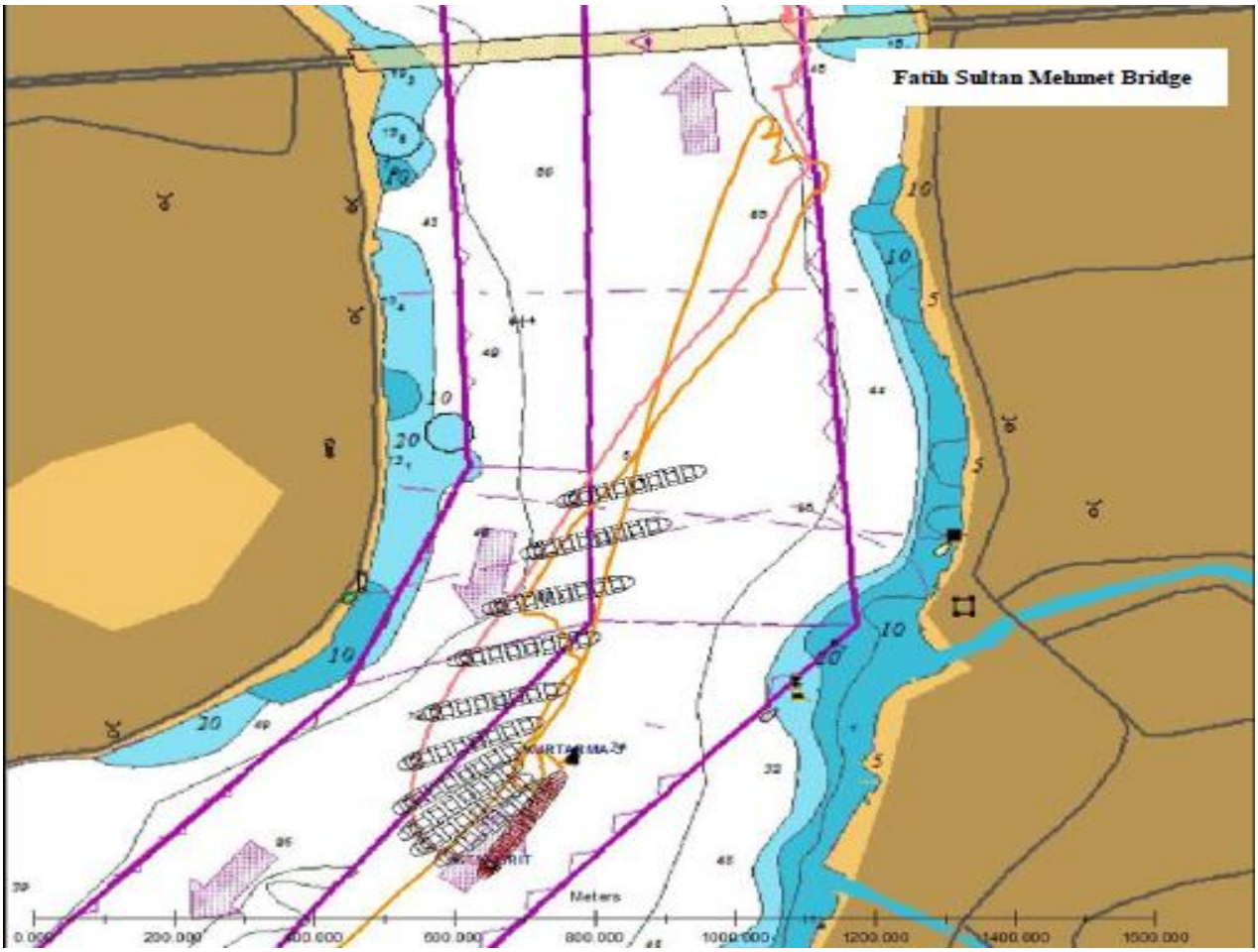

Figure 9: *Vitaspirit* coming-up to port and starboard anchor midstream.

1.11 Damage Sustained by Vitaspirit

The vessel sustained superficial damage to the bow above the waterline (Figure 10) and significant damage to the shell plating below the waterline, the bulbous bow and the internal structures, in way of the fore peak tank (Figure 11).

Figure 10: Superficial bow damage

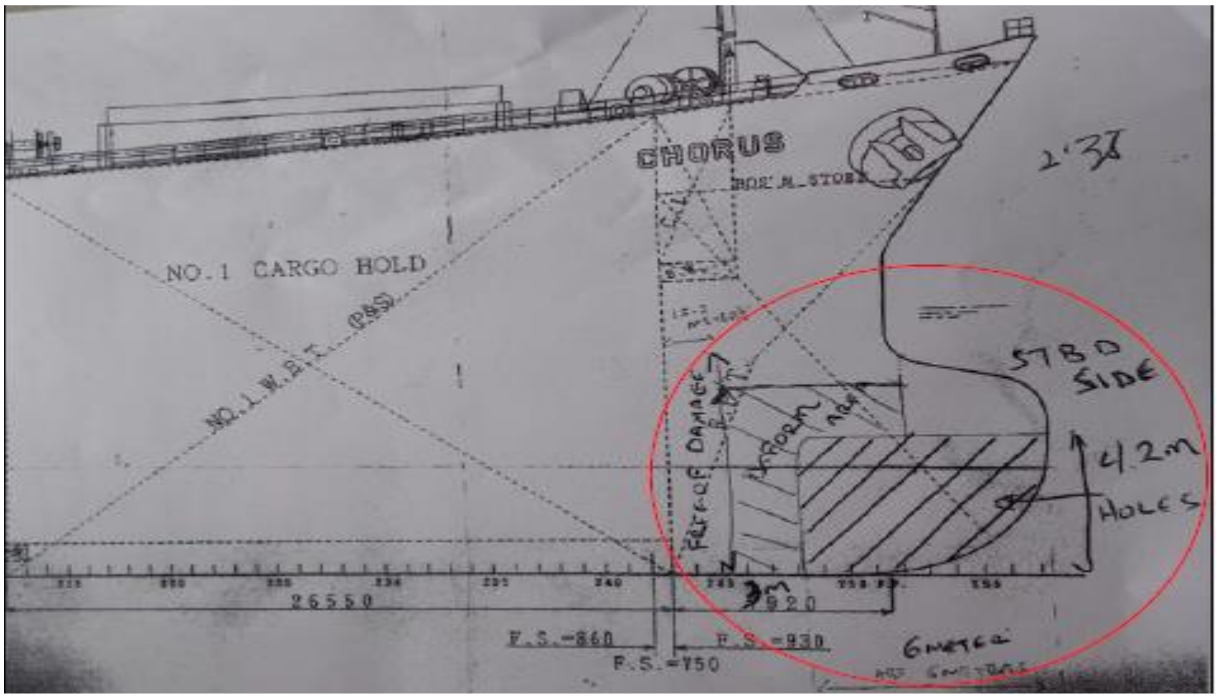

Figure 11: Sketch showing area of bulbous bow and forepeak damage

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 Cause of the Allision

The immediate cause of the allision was *Vitaspirit*'s loss of propulsion and steerageway whilst negotiating a sharp bend. The chain stopper across the chain may have been engaged but not removed when the pilot requested the let go of the anchors. To this effect, the anchors had not been released in time to counter the vessel's headway.

2.3 Communication on the Bridge

Available information suggests that there was no detailed discussion between the master and chief engineer. *Vitaspirit* started to lose speed and did not respond to the pilot's helm directions to counter the vessel's sheer towards the bank.

Although English was the working language, communications on board were largely in the crew's native language, which did not help the pilot to understand the master's orders or crew response. As the dynamics to the allision started to build-up, dissimilar navigational assessments were made by the master and the pilot, based on their respective observations, knowledge and experience. The communication style with the pilot did not change, and neither did the master nor the pilot make any attempt to explain what they were trying to do, or agree on an action, until it was too late to avert the allision. The late notification of engine failure to bridge may have not allowed sufficient time for planning the most effective ship maneuver to manage the emergency situation. To this effect, hesitation of the ship's captain on the maneuvering plan on fulfillment of pilot's recommendation in order to minimize the negative consequences of the accident were therefore considered to be a contributing factor to the accident

2.4 Exchange of Information

Engagement of a pilot was part of the control measures in *Vitaspirit*'s risk assessments. However, for the risk control measure to be effective, both the master and the pilot had to

exchange information regarding pilotage passage remedial actions in the event of loss of propulsion or steerageway[3].

Indeed, Annex 2 of IMO Resolution A.960(23) recommend information exchanges for efficient pilotage, and for the establishment of effective communication and coordination with the bridge team. The exchange of information relevant to this safety investigation include:

- presentation of a completed pilot card which should include information on rate of turn at different speeds, turning circles, stopping distances and other appropriate data;
- general agreement on plans and procedures, contingency plans for the anticipated passage;
- discussion of any special conditions such as weather, depth of water, tidal currents and maritime traffic that may be expected during the passage; and
- discussion of any unusual ship-handling characteristics, machinery difficulties, navigational equipment problems or crew limitations that could affect the operation, handling or safe manoeuvring of the ship;

The pilot who boarded the vessel was an experienced pilot and it was very likely that the manoeuvres planned through the Strait may have been carried out many times before and were even uneventful. He boarded *Vitaspirit* just before passing under Yavuz Sultan Selim Bridge Northen entrance of the Strait due to the sea condition. According to the the respective provision of Maritime Traffic Regulations for the Turkish Straits explains;

article 38-1 (a)- ‘’Pilotage services for Istanbul Strait shall be given as follows:

a) Vessels passing through Istanbul Strait;

1) Black Sea side :

The pilot boarding area is in position at Lat. 41 15 15 N., Long. 029 07, 94 E. Due to weather conditions, pilot boarding may take place in between this position and the line connecting Hamsi Limani Light to Fil Burnu Light, as near to the outer limit of the Southbound traffic lane which lies on starboard side of the vessel as is safe and practicable.’’

[3] Istanbul VTS statistics revealed that engine / rudder failure occur every 80 hours on average.

Safety Investigation noticed that Pilot embarked the vitaspirit at defined area by article 38 as aforementioned provision of Regulation.

Vitaspirit proceeded to inside of the strait with pilot without any problem until los of steering and receiving engine failure. The late notification of engine failure to Pilot may have not allowed sufficient time to planning the most effective ship maneuver to manage the emergency situation. Other than the master talking about anchorage outside the Strait for bunkers, the safety investigation neither noticed discussions on pilotage passage (captured on the VDR audio recordings), nor any documented (on board) records of formal exchanges on operational procedures

2.5 Assessment of the Events Leading to the Allision

Article 5 of Turkish Straits Maritime Traffic Scheme Code (national legislation) required that ‘’*the the main engine and auxiliary engines, anchor windlass and equipment are in good condition and both anchors must be ready to be let gone and bow and stern of the vessel must be arranged with towing wire ready for use. ‘’*

However, it was not clear whether ship anchors were prepared or not in accordance with Article 5 of the Regulation.

The Company’s SMS required the ship’s engineers to immediately notify the bridge of any changes in speed, resulting from either machinery malfunction, or loss of steering in order to afford the bridge the maximum time to take actions to avoid a potential marine casualty. It was, however, not clear as to what mechanisms were in place on board *Vitaspirit* to either communicate or ask relevant questions on safe navigation or operation of the engines.

It was evident, however, that on being informed of the issues by the duty oiler, the chief engineer left the ECR to investigate the leakage from the cooling water jacket. He did not inform the master straight away, neither directly nor through the second engineer. It was not clear to the safety investigation what was said or discussed, when a call was eventually made to the master about five minutes later. However, the subsequent lack of preparation on the bridge suggested that the master was unaware of either the probability of auto-shutdown or of the need to stop the main engine, isolate the leaking cylinder, before re-starting to restore power on the remaining cylinders.

Consequently, the master made plans neither for emergency manoeuvres nor to advise the pilot. About four to five minutes later, a buzzer on the bridge alerted the pilot. He realised that something was wrong and enquired about the engines and RPM. The master's response was that all was OK. As *Vitaspirit* advanced towards the narrowest section of the Strait, the pilot requested 'full ahead'.

The master replied, 'dead slow because they need…'. The pilot noticed a significant drop in RPM [4]and speed. The vessel, at the time, was in the middle of the Strait and veering to port in spite of the starboard helm. The situation on the bridge was complex for the pilot; although he was aware that there was a reduction in RPM and speed, he was being informed that all was OK in the engine-room. This was potentially conflicting information reaching the pilot. Nonetheless, he pre-empted the situation and his immediate actions were quickly focused on countering the effects of loss of headway, call the VTS and tugs for assistance, and to stand-by the anchors. He then pushed the ship's whistle button and he gave the order to let go the starboard anchor. The bosun on the forecastle was unable to drop anchor, and the master, meanwhile, called the ECR to increase the RPM.

The second engineer pushed the 'slow down cancel' button but it had no effect [5] on the engine. Nonetheless, at that very moment the RPM fleetingly shot up to 60, corresponding to half ahead on the engine. The master erroneously sensed that the bow was turning to starboard, and the order to drop the anchor was revoked. The master was keen on not pursuing action that involved dropping of anchors. He explained that there was a possibility of losing the anchor[6], and in case the anchor did hold, the rapid swinging of stern was very likely to cause substantial damage to structures on the bank and possible loss of life.

As the main engine eventually shut down, the pilot repeatedly called the master to let go the anchors (port and starboard). Notwithstanding the master's orders to the bosun[7], starboard anchor remained in the hawse pipe[8], whilst port anchor was not dropped because of the short

[4] Extract of the data using MADAS, indicated that the main engine's RPM had actually decreased but were also fluctuation.
[5] The 'Slow Down Cancel' is an optional feature and this option was not provided on *Vitaspirit* and therefore it had no effect on the main engine.
[6] Water depths were in the region of 60 metres
[7] There is no evidence as to what time the chief mate had left the forecastle.
[8] The bosun suggested that the starboard anchor may have been caught in mud in the hawse pipe. Rather than mud, the safety investigation believes that the anchor chain was jammed, preventing the release of the anchor, even because it was reported that the anchors had already been prepared by lowering them one metre above the waterline and then brought back into the hawse pipe, brake applied and gear disengaged, in preparation

space of time, and *Vitaspirit*, thus continued making headway albeit slowly towards the Mansion.

2.6 Cylinder Cooling Water Jacket

The main engine on *Vitaspirit* had seven units. Each unit comprised of the cylinder liner, cylinder head, cooling water jacket and a transition piece between the cylinder head and the cylinder liner. Two 'O' rings, formed a seal between the cylinder head and the cylinder transition piece. The cooling water jacket was held in position by four bolts threaded into the cylinder head. The inlet line of the cooling water system had an isolation valve. Although outlet valves are available (shown Figure 12) in the manufacturer guide[9], there is no any outlet valve equipped in the central cooling system on board. Cooling water jacket did not have individual isolating outlet

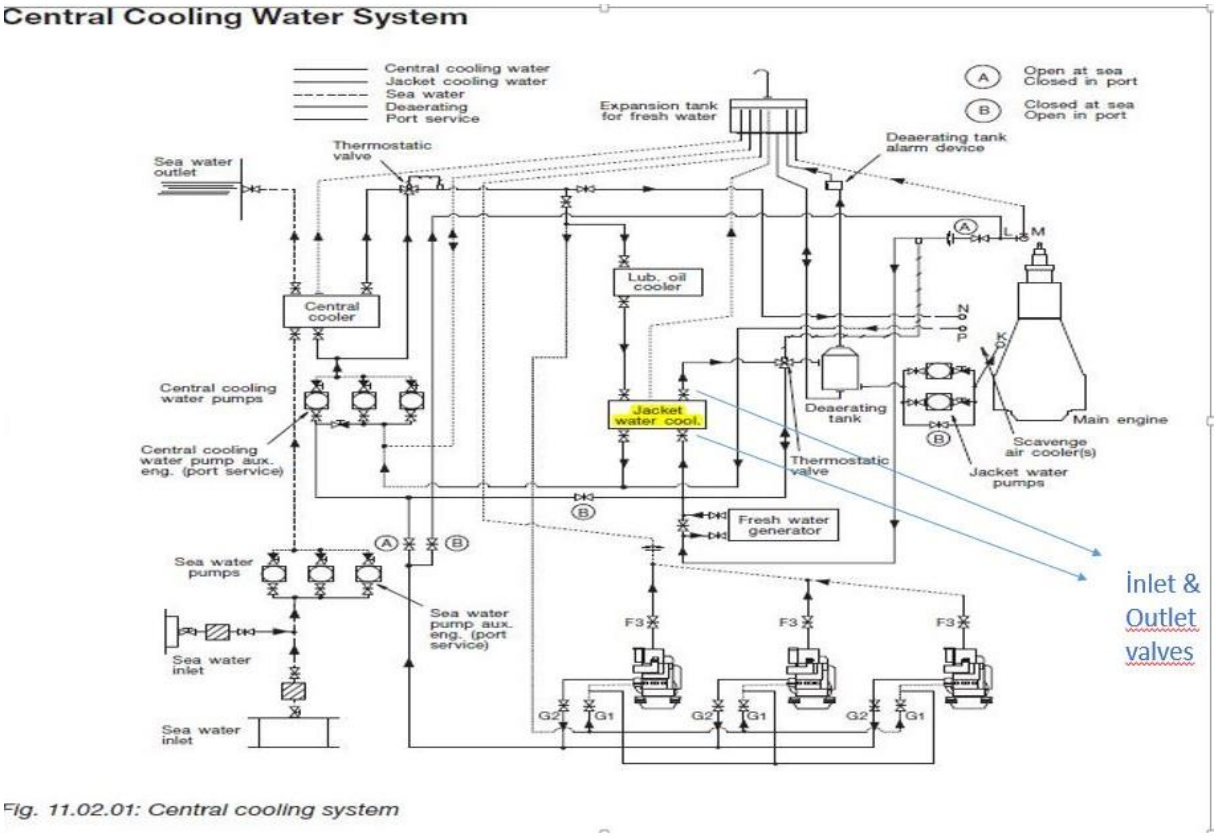

Figure 12: Diagram showing Centrol Cooling water system taken from manufacturer guide

for letting go in emergency. No issues were reported at the time of testing before entering the Strait, with respect to potential mud issues.

[9] MAN B&W 98-50 MC/MC-C-TII Type Engines Engine Selection Guide Page 272 Fig.11.02.01:Central Cooling System

valves. The outlet from each cylinder, which returned to the expansion tank, could only be isolated through a spectacle blind. In view of this arrangement, any cylinder affected by cooling water jacket leakage, could only be isolated when the main engine was not in operation.

The engine performance reports for December 2017, January and February 2018 showed that the main engine was in good running order and was operated within the builders prescribed operating limits. Maintenance records indicated that all components of the main engine were well maintained. Although, the last ship inspection under the Black Sea MOU on 20 February 2017 in the port of Novorossiysk, Russia, had identified two deficiencies related to the propulsion and auxiliary machinery, these deficiencies were resolved before the ship's departure from the port. On 07 April 2018, the main engine was tested and was found in good order, with no reported deficiencies and cooling water leakage from the cylinder jackets was neither observed nor anticipated during her transit in the Strait.

2.7 Cooling Water Jacket Inspection on Board

According to *Vitaspirit*'s maintenance documents, main engine unit no. 5 had been overhauled in November 2017. The cooling water jacket had been dismantled and thoroughly inspected. After cleaning, the jacket was re-used. Following the allision accident, the jacket was again dismantled and inspected for damage on 08 April 2018. The inspection revealed that the jacket did not have excessive scale build up and the cooling water test records did not suggest that there was a general corrosion issue within the engine. A new jacket was fitted and the crew members changed the cylinder jacket securing bolts with spare bolts. The spare bolts kept on board were of the type recommended by MAN[10]. The chief engineer reported that these bolts were in use since he had joined the vessel and in his view, the same type of bolts had been removed from the damaged jacket[11]

[10] MAN Diesel & Turbo Service letter SL2014-584/LRA – Maintenance and Recommendations.
[11] Bolts removed from the damaged jacket were not retained on board.

2.8 Metallurgical Examination of the Cylinder Jacket[12]

The Test House (TTH), UK, carried out visual and metallurgical examination of the fractured cooling water jacket after the accident. The examination was attended by Marine Metallurgical Consultants Ltd., (MMC), Merseyside, UK on behalf of the owners

2.8.1 Visual examination

The water jacket had sustained a single, vertical crack in line with a securing bolt hole and mid-way between two water inlets / outlets. The external coating on either side of the crack was missing and rusty. This was the case for all four bolt holes to greater or lesser degrees. The inside surface of the cooling water jacket was lightly affected by rust scale and light corrosion.

The jacket was vertically cut on either side of the crack to expose the fracture surfaces. The exposed surface was covered in a light rust layer. A slightly darker area of rust was noticed on the lower seal face area. The bore of the jacket where the darkened area on the fracture surface was located, a possible small crack-like feature was observed. One of the fracture surfaces is shown in Figures 13a and 13b.

Figure 13a: Fracture surface after flash, inhibited acid cleaning (Clarke Solution). Rust was removed save for a small area close to the lower seal end.

[12] The extracts in these sub-sections were taken from the technical report, compiled following the visual and metallurgical examination of the fractured cooling water jacket.

Figure 13b: Closer view showing the fracture surface after flash, inhibited acid cleaning and the small area of rust-affected fracture surface

The fact that the rust came off almost immediately from a significant majority of the fracture surface (Figures 13a and 13b), indicated that rust on the surface in these areas was of a superficial nature only *i.e.* it was not long standing. This, in turn, indicated that a significant majority of the crack had formed in one-moment-in-time. The small area that has remained rusty is indicative of longer standing corrosion certainly compared to the remainder of the fracture surface *i.e.* a small crack of some nature emanating from the bore of the water jacket, likely existed at this location.

2.8.2 Metallographic examination

The jacket section, where a small crack likely existed in the bore, was further examined. Samples were cut and prepared in macro specimens and micro specimens, including photomicrographs of the jacket wall in the area of the small crack. The wall of the jacket was affected by corrosion and termed graphitisation, to a depth of about 2.4 mm from the inner surface. A layer of corrosion was observed on the fracture surface in this area. The general features indicated that this was likely to be a small corrosion fatigue crack that had initiated from an area of corrosion on the bore. The bore of the jacket close to the lower seal was affected by pitting corrosion.

There was also pitting of the bore close to the upper seal. The light pitting in the seal areas could also be observed on this photomacrograph. The microstructure was confirmed as flake graphite grey cast iron in an almost fully pearlitic matrix. The flake size was uniform and fine, and the hardness was between 192 and 200, averaging at 196. These properties indicated that the strength of this casting is at the low end of (BS) EN 1561 grade EN-GJL-250 and thus will have a tensile strength towards the lower end of 250 – 350 Nmm^{-2}. The chemical composition was typical of grey cast iron and consistent with microstructure observed.

2.8.3 Findings of the visual and metallurgical examination

Documentary provided by the owners, during the course of the safety investigation indicated that:

- the examination revealed that the cooling water jacket sustained a vertical crack located on a bolt hole, midway between two water inlets / outlets;
- the coating was missing from the outer surface either side of the crack. Similar coating detachment was evident at the other bolts' holes;
- the bore was affected by light corrosion with some shallow corrosion pits evident in the upper and lower seal areas;
- the fracture occurred instantaneously, brittle fracture, save for a small corrosion fatigue crack that had developed on the bore close to the lower seal. The corrosion fatigue crack was about 2.4 mm deep, the jacket wall was about 17.8 mm thick at the same location;
- the corrosion fatigue crack would not have been remotely visible from the outside of the jacket. Furthermore, there would not have been any warning or indication that such a small crack existed at all, until the crack manifested itself as a full, vertical fracture;
- grey cast irons intrinsically have very poor fracture toughness properties and are prone to brittle fracture in the presence of tensile stresses and stress raisers. In this particular instance, the tensile stresses would have been caused by the cooling water pressure / temperature. The stress raiser would have been the corrosion fatigue crack

3 CONCLUSIONS

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

3.1 Immediate Safety Factor

1. The vessel lost propulsion and steerageway whilst negotiating a sharp bend, and the anchors were not released in time to counter the vessel's headway from striking the Mansion.

3.2 Latent Conditions and Other Safety Factors

1. With the sudden loss of main engine power and speed, the maximum starboard helm could not overcome the effects of the current and rotational inertia of the high-speed port turn
2. The chief engineer did not initially inform the bridge of cooling water leaking from the jacket, leaving the master / pilot little or no time to develop contingency plans, such as anchor midstream and temporarily call off passage;
3. The master was unaware of the probability of losing propulsion
4. The master remained under the impression that propulsion power would be swiftly restored without the need to immobilise the engines
5. The master did not advise the pilot of a problem in the main engine and an early opportunity was missed to call the VTS or tugs for assistance
6. Visual and metallurgical examination indicated that the fractured cooling water jacket sustained a vertical crack on a bolt hole, midway between two water inlets / outlets. There would not have been any warning or indication that a crack existed until the crack manifested itself as a full, vertical fracture. The crack occurred instantaneously under tensile stress and in the presence of a stress raiser.
7. Throughout the event, port and starboard anchors remained in the hawse pipe.
8. Due to the cracking in the cylinder jacket No. 5 of the main engine, there was a sudden loss of cooling water in the main engine cooling system, resulting in engine failure.
9. The lack of valve on the cooling circuit outlet piston No:5 caused immediate loss of cooling water in the expansion tank

3.3 Other Findings

1. The ship's whistle did not work when the pilot pushed the button.

2. There was evidence of neither formal master / pilot exchange of information with regard to critical manoeuvres in the Strait nor planned actions in the event of loss of propulsion power / steerageway.

4 RECOMMENDATIONS

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

Vita Management SA is recommended to:

13/04-19 Disseminate this safety investigation report, analyse the situations encountered by crew during *Vitaspirit*'s passage in the Istanbul Strait, and review the vessel's emergency procedures;

14/04-19 Emphasise the importance of formal master and pilot exchange of information with regard to pilotage passage and remedial actions in an emergency situations taking account of pilot's recommendation.

15/04-19 Equip with a valve each piston outlet recommended by engine manufacturer's in the main engine cooling water circuit in fleet vessels with a valve to prevent the loss of engine cooling water.

16/04-19 Provide awareness training to the fleet vessel's crew in order to have preparedness of anchoring in narrow waters.

Nippon Kaiji Kyokai Classification Society is recommended to;

17/04-19 Disseminate this safety investigation report to surveyor for the application of Engine manufacturer's recommendations regarding the presence of valves at each piston outlet and carrying out their operational tests during hull and machinery surveys.

18/04-19 Make verification and control on making risk assessment during ISM Audit regarding to preventing or reducing the water loss in Expansion tank whether Engine Manufacturer's recommendations are being implemented or not