Final Report

ALLISION OF DUTCH FLAGGED VOX MAXIMA AND SINGAPORE FLAGGED MARINE HONOUR, PORT OF SINGAPORE

ON 14 JUNE 2024

TIB/MAI/CAS.169

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

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The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

AG	Auxiliary Generator
ASD	Able Seafarer Deck
AWPA	Western Petroleum Alpha Anchorage
AWW	Western Working Anchorage
BT	Bus Tie
BV	Bureau Veritas
CE	Chief Engineer
CO	Chief Officer
COC	Certificate of Competency
COLREG	International Regulations for Preventing Collisions at Sea, 1972
COSWP	Code of Safe Working Practices for Merchant Seafarers
COT	Cargo Oil Tank
CPP	Controllable Pitch Propeller
CS09	PSA Phoenix CS09
DOC	Document of Compliance (ISM related)
EB	Ever Blink
ECDIS	Electronic Chart Display and Information System
ECR	Engine Control Room
EG	Emergency Generator
EP	Electrical Permit
FU	Follow-Up
HPU	Hydraulic Power Unit (Hydraulic Pump)
HVCB	High-Voltage Circuit Breaker

ISM Code	International Management Code for the Safe Operation of Ships and for Pollution Prevention
LOTOTO	Lock-out, Tag-out and Try-out
LR	Lloyd’s Reister
LVCB	Low-Voltage Circuit Breaker
MG-PS	Main Generator Port Side
MG-SB	Main Generator Starboard Side
MH	Marine Honour
MPA	Maritime and Port Authority of Singapore
NFU	Non-Follow-Up
NUC	Not Under Command
PA	Permit Authoriser
PMS	Power Management System
POCC	Port Operations Control Centre
PPC	Pasir Panjang Control
PSC	Port State Control
PTW	Permit to Work
RA	Risk Assessment
RO	Recognised Organisation
SH	Super Hero
SMC	Safety Management Certificate
SMS	Safety Management System
STCW	The International Convention on Standards of Training, Certification and Watch keeping for Seafarers
TR-SB	Starboard Transformer

VHF	Very High Frequency
VM	Vox Maxima
2E	Second Engineer
2O	Second Officer
3E	Third Engineer

SYNOPSIS

On 14 June 2024, the Dutch registered dredger, Vox Maxima (VM), experienced a loss of electrical power after departing from the Western Working anchorage, in the Port of Singapore while on its intra-port passage to a shipyard. The loss of electrical power caused VM to blackout and become Not Under Command (NUC) due to the loss of control of the controllable pitch propeller (CPP, for VM's speed) and steering.

When VM became NUC, both rudders remained at 10 degrees to starboard and both main engines remained at half ahead, VM continued its headway and starboard turn at a speed of 8.3 knots and impacted a stationary bunker tanker, Marine Honour (MH). MH was alongside another berthed container ship, Ever Blink (EB), at the Pasir Panjang Container Terminal.

The allision breached the starboard side hull of MH, causing spillage of cargo oil into the sea and resulting in severe pollution to the marine environment. Consequently, EB also suffered minor spillage of lube oil and structural damages. The allision did not result in any injuries.

The Transport Safety Investigation Bureau of Singapore classified the occurrence as a very serious marine casualty.

The investigation revealed that two starboard circuit breakers (HVCB-1 and LVCB-1) were opened by the morning-shift duty engineers to facilitate the inspection of cooling fans of the starboard transformer (TR-SB). With HVCB-1 and LVCB-1 open, electrical power supply to the low-voltage machinery and equipment was via the port low-voltage circuit breaker (LVCB-2). The afternoon-shift duty engineers were not aware that HVCB-1 and LVCB-1 were left open. During the departure, many of the low-voltage machinery and equipment were started, causing LVCB-2 to be overloaded and trip, resulting in the loss of electrical power supply to the low-voltage machinery and equipment.

The investigation noted that handing/taking over of watch duties on board VM were done verbally, both for the engineers and bridge officers, and there was no structured system to record work activities.

The investigation also revealed that both of VM's anchors could not be deployed to reduce the headway of VM. This was because the port anchor, which was set for emergency use, was stuck in the hawse pipe, and due to the loss of electrical power, the hydraulic pump to operate the windlass was unavailable to free up the tension on the chain stopper for the release of the starboard anchor.

The investigation further revealed that several provisions in VM-Company's safety management system were not followed by the crew members involved in the tasks of inspecting the cooling fans of the TR-SB.

DETAILS OF VESSEL

Name	Vox Maxima (VM)
IMO number	9454096
Flag registry	Netherlands
Classification society	Bureau Veritas[1] (BV)
Ship type	Trailing suction hopper dredger
Date delivery	18 January 2010
Owner / ISM Manager[2]	Vox Maxima B.V. / Van Oord Ship Management B.V.
GT / NT	29920 / 8976
Length overall	203.00m
Breadth	31.00m
Draft forward / aft	9.30m / 9.40m
Main engine(s)	Two propulsion engines - Man B&W 12V 48/60B, each with a rated capacity 14400kW at 514 rpm[3]
Propellers	Controllable pitch propellers (port and starboard), with four blades each

Vox Maxima

[1] BV was the Recognised Organisation (RO) for carrying out surveys and issuance of statutory certificates. As per the International Management Code for the Safe Operation of Ships and for Pollution Prevention – ISM Code, Lloyd's Register (LR) was the RO for the ISM audits and issuance of ISM related certificates.
[2] Referred to as the VM-Company in this investigation report.
[3] Revolutions per minute.

DETAILS OF VESSEL

Name	Marine Honour (MH)
IMO number	9422811
Flag registry	Singapore
Classification society	Bureau Veritas
Ship type	Bunker tanker
Date delivery	10 September 2007
Owner & ISM Manager[4]	Straits Bunkering Pte Ltd
GT / NT	4709 / 2397
Length overall	103.00m
Breadth	18.60m
Summer draft	7.81m
Main engine	2 x Yanmar diesel, model 6LY26, each with rated capacity 1471 KW at 750 rpm
Propeller	Twin-screw, fixed pitch propeller

Marine Honour

[2] Referred to as MH-Company in this investigation report. MH-Company was also the owner of MH.

1 FACTUAL INFORMATION

All times used in this report are Singapore local time, which is eight hours ahead of the UTC, unless otherwise stated.

1.1 Sequence of events

Vox Maxima (VM)

1.1.1 On 13 June 2024, at 1425H, the Dutch registered dredger, VM arrived at the Port of Singapore and anchored at the Western Working anchorage (AWW) holding on her starboard anchor with four shackles in water. She was scheduled to enter the ST Marine shipyard in Singapore on the next day to carry out some modifications before her next deployment to the Middle East.

1.1.2 On 14 June 2024, at about 0840H, an Electrician planned to inspect the transformer cooling fan in the transformer room, and to verify if the spare capacitors on board were suitable for these cooling fans. The Electrician informed the Chief Engineer (VM-CE) about his work plan. To carry out the inspection safely, the Electrician requested the engineers on duty (duty engineers), comprising two Second Engineers (VM-2E-2 and VM-2E-3), to isolate electrical power to the starboard transformer (TR-SB) from the Power Management System[5] (PMS).

1.1.3 As per the Electrician's request, VM-2E-2 and VM-2E-3 opened both the starboard high-voltage circuit breaker (HVCB-1, on the 6600v starboard side) and the starboard low-voltage circuit breaker (LVCB-1, on the 400v starboard side) (see **Figure 1**). VM-2E-2 and VM-2E-3 also closed no. 2 bus tie (BT-2 – 400v), to allow the auxiliary generator (AG) to support the entire 6600v main switchboard and the 400v switchboard as both the HVCB-1 and LVCB-1 had been opened.

[5] A touch screen system located in VM's engine control room, for switching on or off circuit breakers and generators and opening or closing bus ties.

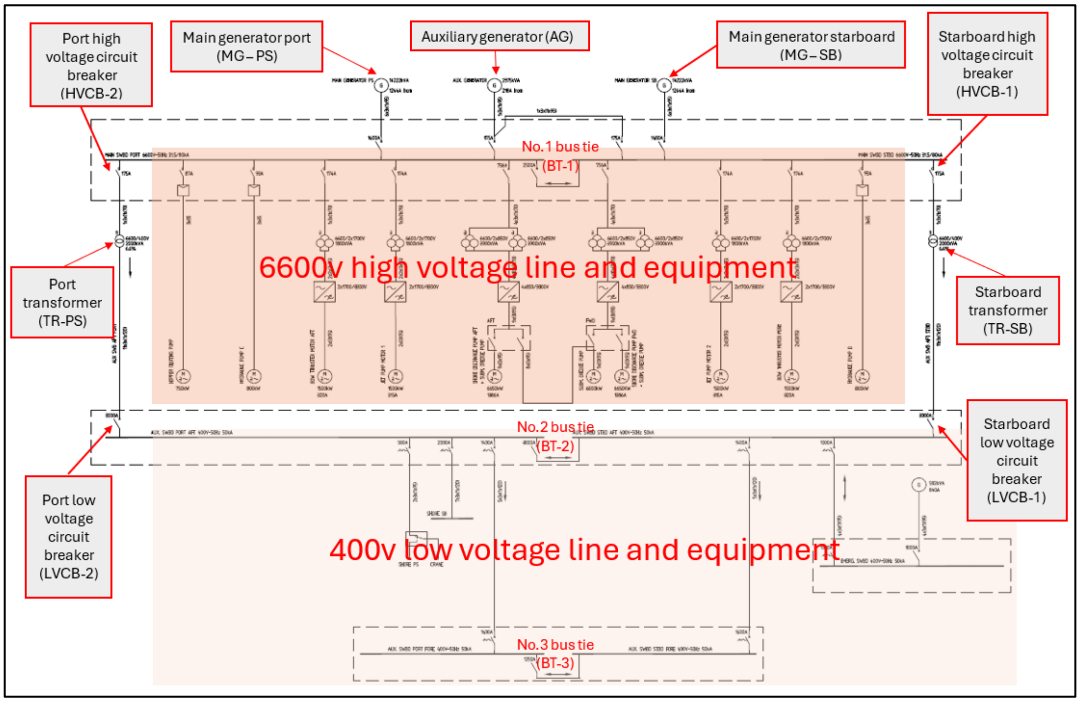

Figure 1 – High and low voltage line diagram
(*Source*: the VM-Company, annotated by the TSIB)

1.1.4 After obtaining VM-CE's electrical permit and authorisation, the Electrician proceeded to the switchboard room (see **Figure 2**) to disconnect the physical HVCB-1 and the engine control room (ECR) to disconnect the physical LVCB-1 from the busbars by pulling the breakers out of their trolleys and verified that it was safe to work.

Figure 2 – Overview of the switchboard room
(*Source*: the TSIB)

1.1.5 The Electrician went to the starboard transformer room and carried out a lock-out, tag-out and try-out (LOTOTO) to ensure electric power was isolated (refer to LOTOTO section) for the planned inspections. After verifying that the specifications of spare capacitors on board were not suitable for the cooling fans, he reconnected the physical HVCB-1 and LVCB-1 to the busbars, leaving the duty engineers to close HVCB-1 and LVCB-1 from the PMS. The Electrician did not inform the duty engineers that he had completed the inspection at this point.

1.1.6 The Electrician met VM-2E-2 and VM-2E-3 during the coffee break at the ECR and informed[6] them that he had completed the inspection task. However, the Electrician did not request VM-2E-2 and VM-2E-3 to close HVCB-1 and LVCB-1 from the PMS as he assumed that they would do so.

1.1.7 At noon, the Chief Officer (VM-CO) and the Second Officer (VM-2O) came to the bridge, took over duties from the previous watchkeepers, and notified the afternoon-shift duty engineers[7], to prepare the vessel's port and starboard main engines and be ready by 1330H to proceed to the shipyard. VM-2O checked the passage plan from AWW to the shipyard and loaded it onto the ECDIS[8].

1.1.8 At about 1230H, the afternoon-shift duty engineers (VM-2E-1 and VM-3E-1) started all the auxiliary equipment required for the propulsion plant to prepare the two main engines for the departure.

1.1.9 At about 1330H, the two main engines were ready, VM-2E-1 and VM-3E-1 transferred the engine controls to the bridge. VM-CO and VM-2O carried out checks on the propeller pitch, rudders, gyro headings, radars, and bow thrusters and found the conditions of all these controls and indicators to be satisfactory. VM-2E-1 and VM-3E-1 did not notice that the main generator starboard (MG-SB) load was low as it was only supplying power to the

[6] The Electrician did not remind the duty engineers to close HVCB-1 and LVCB-1 and the electrical system could be resumed for normal operation, as it was the logical actions for the duty engineers to resume normal operation after he had done the inspection.

[7] A new set of engineers on afternoon-shift, the Second Engineer (VM-2E-1) and the Third Engineer (VM-3E-1) came to the ECR at about 1145H and took over duties from the morning-shift engineers at about 1200H.

[8] Electronic Chart Display and Information System. A navigation information system as an alternative for complying with the chart carriage requirements of SOLAS, regulation V/19.

starboard bow thruster on the 6600v high-voltage switchboard[9].

1.1.10 At about 1344H, two harbour pilots (one senior and a trainee[10]) boarded VM and met the Master (VM-Master) on the bridge and exchanged information[11] with regard to the passage from AWW to the shipyard. VM-2O left the bridge and proceeded to forecastle deck for heaving up the starboard anchor.

1.1.11 At about 1358H, the senior harbour pilot (VM-Pilot) reported to the Port Operation Control Centre (POCC)[12] West Control via very high frequency (VHF) radio[13] that VM would be underway shortly, proceeding to ST Marine Shipyard.

1.1.12 At about 1402H, after receiving confirmation from VM-2O that the starboard anchor was aweigh[14], VM-Pilot gave first helm order of hard to starboard and advised VM-Master that the ship's speed should not be more than 15 knots (for the passage from AWW to the shipyard).

1.1.13 By this time, VM-2E-1 noted that VM was underway and informed VM-3E-1 that he would go to the vessel's forward for duty round to verify that all machinery and installations were running normally. VM-2E-1 then left the engine room and did not carry a communication device such as portable radio. VM-3E-1 remained in the ECR.

1.1.14 In less than a minute, VM-3E-1 received a phone call from VM-CO informing that there was an issue with the bow thrusters, VM-3E-1 replied that he would only be able to have a look once he was relieved in the ECR. A while later, a daywork Third Engineer (VM-3E-2) entered the ECR and was told by VM-3E-1 to stay in the ECR. VM-3E-1 then left the ECR for the vessel's forward to check on the issue with the bow thrusters reported by VM-CO, VM-3E-1 also did not carry a communication device such as portable radio.

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[9] MG-SB was not supplying electrical power to the 400v auxiliary equipment through TR-SB as HVCB-1 and LVCB-1 were still open, BT-2 remained closed, and main generator port (MG-PS) was feeding all 400v auxiliary equipment through HVCB-2, TR-PS and LVCB-2, in addition to the port side 6600v high-voltage machineries and equipment.
[10] The senior harbour pilot had been working with the pilotage service provider for more than 10 years and held a class A2 licence since June 2022 from the Maritime and Port Authority of Singapore (MPA).
[11] Verbal information exchange was carried out after the two harbour pilots met VM-Master on the bridge. The documented Checklist (Vessel's Checklist For Piloted Movements) was completed at 1650H on 14 June 2024 after the occurrence.
[12] A 24/7 manned port operation control centre under the MPA, for the management of vessel traffic in the Port of Singapore and Singapore Straits, to ensure navigational safety and smooth movement and operations of ships.
[13] Channel 68 for the West Control.
[14] The status of the anchor is clear from seabed.

1.1.15 At about 1405H, at the forecastle deck, after the starboard anchor was heaved to home, the chain stopper was engaged[15] on the anchor chain, the windlass gear remained clutched in the gypsy. The chain stopper of the port anchor was left open with the windlass gear clutched out. The port anchor was held tight only by the windlass's brake-band. The port anchor was set on standby[16]. VM-2O left the forecastle deck and returned to the bridge for duty. Hydraulic power unit A (HPU-A) for operating the anchor windlass system was switched off by VM-CO from the bridge.

1.1.16 VM-CO assisted VM-Master in handling the engines and steering the ship at the starboard side of the conning position while VM-Master and VM-Pilot were at the port side. When VM-2O was back on the bridge, VM-CO instructed VM-2O to prepare for emptying of sea water stored inside the hopper to reduce the vessel's draft for entering the shipyard.

1.1.17 At about 1408H, VM left the anchorage at a speed of 7.5 knots. About one minute later, VM passed the north boundary of AWW and entered the West Keppel Fairway, its speed was gradually increased to 9.5 knots.

1.1.18 At this time, VM-Pilot observed an outbound chemical tanker, named 'Super Hero' (SH) piloted by a harbour pilot (SH-Pilot) at 1.05nm ahead of VM, he initiated a VHF call to the tanker, but no answer from SH was received.

1.1.19 At about 1409H, VM-Pilot reported to POCC Pasir Panjang Control[17] (PPC) and informed his intention to pass the outbound SH starboard to starboard[18]. The Operator of PPC then called SH and relayed VM-Pilot's message of passing starboard to starboard to SH. There was no response from SH.

1.1.20 At 1411H58S, VM-2O restarted HPU-A from the bridge for emptying of sea water from the hopper. At about 1412H10S, VM-Pilot advised VM-Master that

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[15] An anchor fitting is installed on deck after the hawse pipe and used to clamp the anchor chain, withstand the pull of anchor chain and protect the windlass when at anchor. It is common practice that the chain stopper does not hold the anchor weight when the anchor is housed at home. The anchor weight is taken by the windlass brake and secured with additional wire lashings if needed.

[16] Standby means that the port anchor could be released in an emergency. The arrangement was made with the chain stopper in open status, windlass gear clutched out and anchor held tight by the windlass brake.

[17] Channel 18 for Pasir Panjang Control.

[18] Short form often used by pilots, means to pass each other on their starboard. Rule 9(a) of the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG), states that a vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable. The COLREG was applicable in the Port of Singapore. VM-Pilot intended to keep VM's course close to the port side of the West Keppel Fairway, VM-Master did not object nor raise any concerns with this advice from VM-Pilot.

the plan was to pass SH on VM’s starboard side as there was a bunker tanker, Marine Honour (MH) nearby at the container berth.

1.1.21 At 1412H18S, hydraulic power unit B (HPU-B) was also started by VM-2O to speed up the emptying of sea water. The moment HPU-B was started, an immediate blackout[19] occurred on board VM. Alarms of all navigation equipment, steering, propeller controls and other equipment sounded on the bridge. VM was at a speed of 10.4 knots with a heading of 269.6°. SH at a speed of 8.4 knots continued approaching VM from about 0.77nm (see **Figure 3**). VM’s radar indicated SH would pass on her starboard side at 0.27nm in about 2.4 minutes.

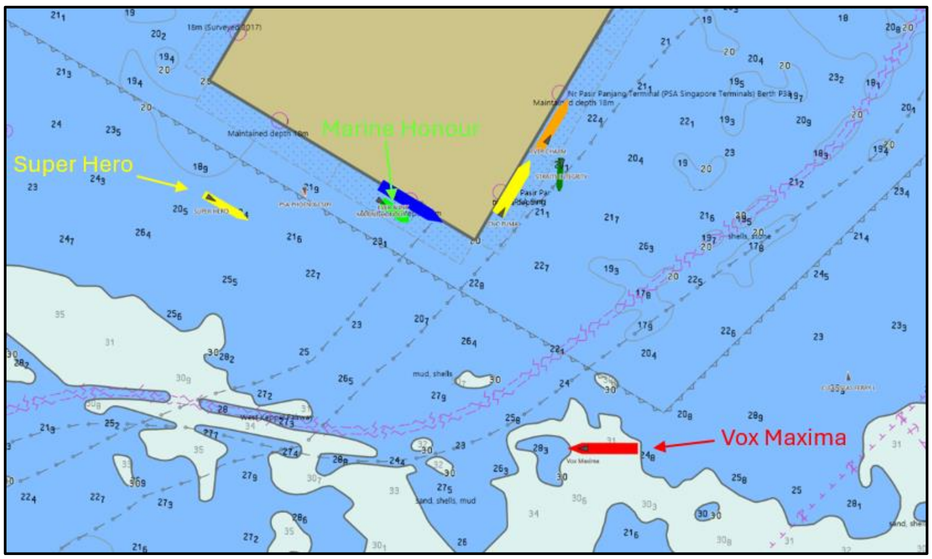


Figure 3 – Position of VM, SH and MH at 1412H18S
(*Source*: the TSIB, MADAS Replay Pro)

1.1.22 VM-CO noticed that both the main engines were still running, rudder angle indicators remained at 10 degrees to starboard, but both the rudders were not responding to helm order on hand steering. For the controllable pitch propeller (CPP), indicators of both the main engines were showing pitch at half ahead position but the telegraphs had no control over the main engines when the telegraphs were brought to stop. VM-CO attempted to gain control of the CPP using follow-up mode at the conning position to no avail. Being unsuccessful in gaining control through the follow-up mode, VM-CO switched over the CPP controls to non-follow-up (NFU) CPP pushbuttons but there was still no

[19] It was later discovered that power supply to the low-voltage machinery and equipment was cut off due the tripping of LVCB-2.

response on the CPP blades pitch[20]. At 1412H57S, the speed of VM was at 10.7 knots at this time and its heading continued to turn to starboard.

1.1.23 VM-Master also attempted to take over steering control by changing over to NFU mode but both rudders had no response and remained at 10 degrees to starboard. VM-Master instructed VM-2O to go to the steering gear room for emergency steering (local steering).

1.1.24 Shortly after the blackout, VM-Pilot, under VM-Master's supervision and with VM-Master's consent, tried to steady VM's course by giving a helm order hard to port, and asked VM-Master if the bow thruster[21] was ready for use. VM-Master replied that the bow thruster was not available. VM-Pilot immediately advised VM-Master to standby anchor station.

1.1.25 VM-2E-1, who was on his duty round at the fore part of VM, noticed that all lights went off suddenly and the ventilation fans stopped, quickly made his way back to the engine room. VM-3E-1, who was on main deck walking towards the bow thruster room, saw an able seafarer deck (VM-ASD) running towards forward and shouting to drop anchor (as instructed by VM-CO). VM-3E-1 was unsure what had happened and decided to return to the engine room.

1.1.26 The two morning-shift Second Engineers (VM-2E-2 and VM-2E-3) were sitting outside accommodation (one level below the bridge deck) after lunch, noticed unusual silence in the surrounding as the mechanical ventilation fans stopped and realised that VM was turning to starboard. Both suspected something could have happened and immediately made their way to the engine room.

1.1.27 At about 1413H, VM-Pilot reported to PPC that VM had an engine failure and could not steer the vessel[22]. The PPC operator made radio broadcasts[23] via VHF channel 18 on VM's "Not Under Command" (NUC) status alerting all vessels in the vicinity of the control sector. While VM-2O was heading to the steering gear room, he heard the instructions of dropping anchor given by VM-CO through radio and proceeded to forecastle deck for dropping the anchor.

[20] The aim was to reduce the pitch angle of the propellers to zero to slow down VM's speed.

[21] According to VM-Company, bow thrusters on board VM were only effective at sailing speeds of 3 knots or below. Even then, its effect at 3 knots would be minimum. The effect of the bow thrusters would increase when VM's speed reduced. The maximum effect of bow thrusters could be achieved when VM stopped.

[22] There were no lights and shapes displayed indicating VM was not under command, as required by the Rule 27(a) of International Regulations for Preventing Collisions at Sea, 1972, as amended.

[23] A safety message informing all vessels that VM was reported not under command, advised all vessels to keep a good lookout and keep clear of VM and avoid impeding her safe passage.

1.1.28 At 1413H37S, VM-Pilot urgently advised VM-Master to lower the port anchor one meter above water. In less than 10 seconds, VM-Pilot advised VM-Master to release the port anchor with one shackle in water. VM-Master, in turn, instructed VM-2O to release the port anchor. VM-Pilot repeated his advice to VM-Master to release the port anchor and keep one shackle in water. VM-2O, who was assisted by VM-ASD, had released the port side windlass brake completely, but the port anchor was stuck in the same position and was unable to be released down to the water. VM-2O struck the brake as well as the anchor chain with a big hammer but the port anchor remained stuck.

1.1.29 At 1414H19S, VM-Pilot advised VM-Master to release both port and starboard anchors. After unsuccessful attempts to release the port anchor, VM-2O attempted to release the starboard anchor, but as electrical power was unavailable, he could not start the hydraulic pump to operate the windlass to free the tension on the starboard chain stopper by heaving up the anchor chain. The starboard anchor was also unable to be released.

1.1.30 When VM-2E-2 and VM-2E-3 arrived at the engine room, they noticed that the engine room was only lit up by emergency lights. They went directly to the ECR and saw VM-3E-1 and VM-3E-2 were looking for the cause of the blackout. VM-2E-2 and VM-2E-3 noticed that both main generators (MG-PS and MG-SB), driven by the port and starboard main engines respectively, were still running and the 6600v switchboard was online through the PMS. By this time, VM-2E-1 also returned to the ECR from the vessel's forward. The Electrician, who was standing next to the PMS, pointed to LVCB-1 which was left open, and LVCB-2 which was tripped (in red colour). VM-2E-2 quickly closed LVCB-1 and reset the electrical line system on the PMS to re-connect the 400v electrical power supply for the auxiliary equipment[24].

1.1.31 At 1414H51S, while the engineers in the engine room were trying to resolve the issue of loss of electrical power, on the bridge, VM-Pilot observed that SH was getting closer and VM had lost steerage and engine control. VM-Pilot urgently repeated to VM-Master to release both the port and starboard anchors and requested to go full astern of engines. By about this time, SH was noticeably altering her course more to its port side (towards the container berths) while VM continued turning to starboard side.

1.1.32 At 1415H15S, SH passed VM's bow and cleared VM at less than 0.04nm

[24] It was noted later that electrical power was reestablished after these actions.

(about 65m). After SH had passed, a harbour tug, PSA Phoenix CS09 (CS09) was seen in the vicinity[25] of VM and was nearly right ahead of VM's bow. At this time, the distance from VM to MH was about 0.12nm (about 220m, see **Figure 4**). VM-Pilot called the tug service providers (PSA Marine, the same company as the pilot service provider) through VHF for urgent harbour tug's assistance. Few seconds later, VM-Pilot again urgently requested VM-Master to drop anchor. VM-2O at the forecastle deck, kept trying to release the port anchor but was unsuccessful. VM's speed was at 8.3 knots.

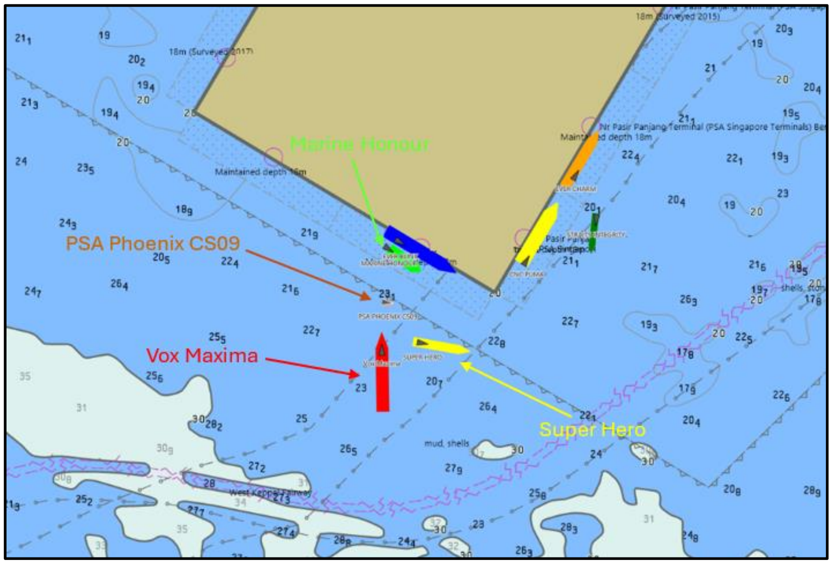


Figure 4 - The positions of VM, SH and MH at 1415H15S
(*Source*: the TSIB, MADAS Replay Pro)

1.1.33 At the ECR, both the Third Engineers had moved to the steering gear room to standby for emergency steering. At 1415H18S, electrical power was reinstated and 400v electrical supply was available for the auxiliary equipment. VM-2E-2 at the ECR, coordinated with VM-CO on the bridge through sound-powered telephone, took over CPP controls and set to full astern, following the orders given from bridge.

1.1.34 At 1415H32S, CS09 was passing the bow of VM with less than 10m separation. VM-Pilot requested CS09, through VHF channel 61, to push VM (to avoid impacting MH). There was no response from CS09 and CS09 was seen moving away from MH.

[25] CS09 was on its way to receive an inbound container vessel.

1.1.35 At 1415H45S, VM continued turning towards MH, the engineers at the ECR managed to regain port side controls for the CPP. VM-Master, observing that the allision could not be avoided, made a public announcement to alert ship's crew that VM was going to impact (crash with) MH. VM-2O and VM-ASD at the forecastle deck ran away from where they stood to a safe position.

1.1.36 At 1416H05S, VM impacted the midship of MH (see **Figure 5**) at 8.3 knots and 020.3º heading. The hull of MH was breached, and cargo oil spilled into the sea.

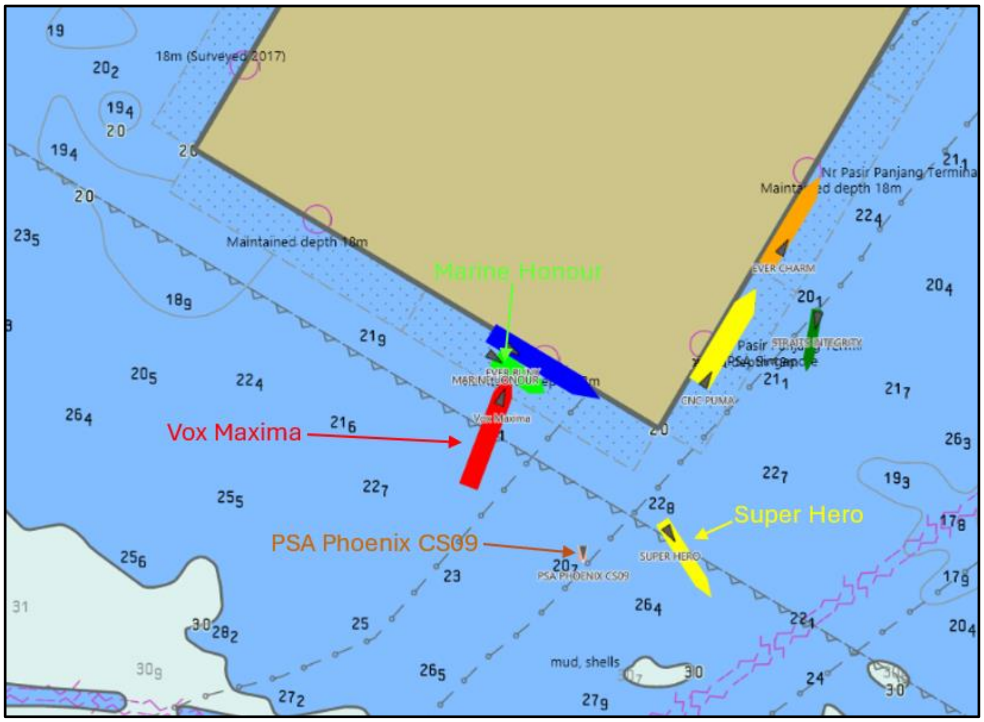


Figure 5 – The positions of MH, VM, SH and CS09 at the time of allision (*Source*: the TSIB, MADAS Replay Pro)

Marine Honour (MH)

1.1.37 On 14 June 2024, at about 0920H, the Singapore registered bunker tanker, MH came alongside and made fast to container vessel, Ever Blink (EB), berthed at the Pasir Panjang container terminal, berth no. 36. The bunkering to EB commenced at about 1030H by MH's crew under the supervision of MH's Chief Officer (MH-CO-1) and completed at about 1330H.

1.1.38 MH remained alongside EB while waiting for the acknowledgment of documents from EB on the quantity of bunker supplied.

1.1.39 At about 1416H, MH-CO-1, who was in the cargo control room preparing for the next cargo loading at the terminal, was alerted by a duty Able Seafarer Deck (MH-ASD) that another vessel (Vox Maxima) was fast approaching towards MH. MH-CO-1 ran out to check, by this time, the allision had occurred.

1.1.40 The Master of MH (MH-Master), after accounting for all the crew on board without injury, instructed all the crew to respond to the emergency.

1.2 The ship

1.2.1 Vox Maxima (VM)

1.2.1.1 VM was registered as a trailing suction hopper dredger, with a maximum hopper capacity of 32000m^3, in the Netherlands. Its ballast water capacity was certified at 2331.09m^3 as stated in the International Ballast Water Management Certificate issued to VM by Bureau Veritas (BV) on 11 September 2023.

1.2.1.2 The accommodation and navigation bridge were located at fore part of the vessel. The conning console (see **Figure 6**) for navigation was at the centre of the bridge. At the time of the allision, VM-CO was on the right-hand side of the console, VM-Master and two pilots were on left-hand side.

Figure 6 - View of the conning console on VM's bridge
(*Source*: the TSIB)

1.2.1.3 There were also controls and indicators (see **Figure 7**) on the overhead of the conning console, such as the clutch-in and clutch-out push buttons for port and starboard main engines, and the start and stop buttons for port and starboard steering gear pumps. These controls and indicators were located on the left-hand side of the console.

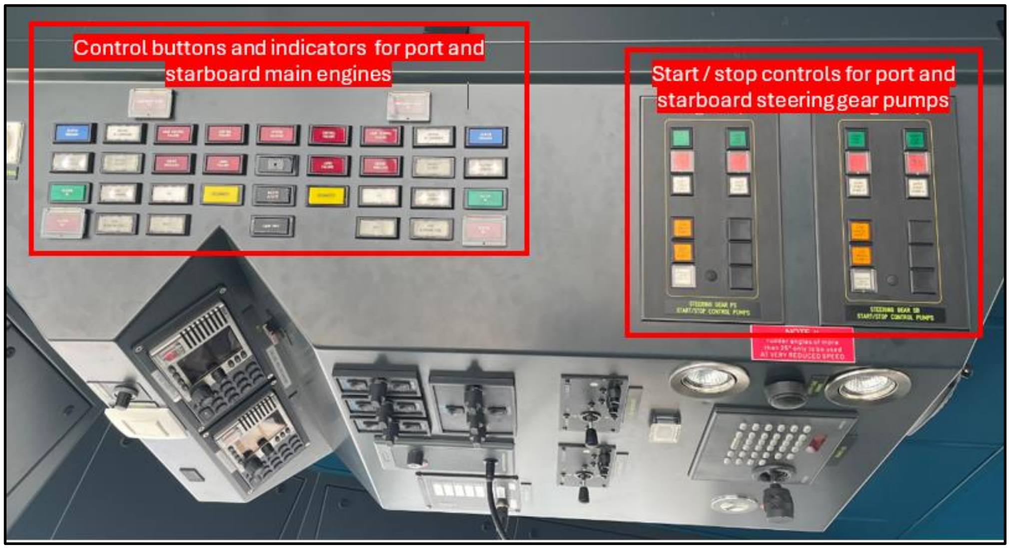


Figure 7 – Overhead controls and indicators of main engines and steering gear pumps (*Source*: the TSIB)

1.2.2 Marine Honour (MH)

1.2.2.1 MH was a double hull[26] oil tanker, with a harbour craft licence "SB 0596F" issued by the Maritime and Port Authority of Singapore (MPA) on 15 March 2024, as a bunker tanker. MH was permitted for the conveyance of class C[27] petroleum in bulk within the Port of Singapore. Her trade was to load bunker oil at terminals and supply to vessels at berth or at anchor.

1.2.2.2 According to the General Arrangement plan, MH had ten cargo oil tanks (COTs) and two slop tanks on port and starboard sides. The starboard slop tank was approved to carry cargo oil and named as the no.6 starboard COT. The capacity of each COT and quantity remaining on board MH at the time of allision were shown in **Table 1**.

[26] MARPOL, Annex I, Chapter IV, Regulation 19 - Double hull and double bottom requirements for oil tankers delivered on or after 6 July 1996.
[27] Any petroleum whose flash point is above 60 degrees Celsius.

COT	Frame (Fr.) location	Tank capacity as ship's capacity plan (in tonne, 98%, specific gravity of 0.93)		Remaining onboard prior to the allision (in tonne)	
		Port	Starboard	Port	Starboard
No. 1	Fr. 112 - 134	779.70	779.70	40.280	33.032
No. 2	Fr. 95 - 112	705.13	705.13	31.301	28.519
No. 3	Fr. 75 - 95	832.79	832.79	823.808	**819.316**
No. 4	Fr. 58 - 75	702.72	702.72	47.698	58.529
No. 5	Fr. 35 - 58	645.23	645.23	39.195	40.889
No. 6	Fr. 33 - 51	-	232.03	-	0
Slop	Fr. 33 - 51	232.03	-	0	-

Table 1

1.2.2.3 On 11 June 2024, a total of 5998.627 metric tons cargo (bunker oil) was loaded on board MH from an oil terminal in Singapore. Subsequently, the cargo was supplied to three vessels on 12 - 13 June 2024. A ship-to-ship bunker transfer operation with another bunker tanker was carried out on 14 June 2024 prior to supplying bunker to EB. At the time of allision, only the no.3 COTs (port and starboard) were having cargo[28].

1.3 The crew

1.3.1 Vox Maxima (VM)

1.3.1.1 There were 33 crew on board VM including VM-Master. They were of mixed nationalities, officers were Dutch, supporting ratings were mainly Filipinos. All crew held valid STCW[29] competency certificates required for their respective positions on board. The working language was English.

1.3.1.2 The qualification and experience of VM-Master, relevant deck officers and engineers are tabulated in **Table 2** below.

Designation On board	Age	Qualification	Duration on board (day)	In rank service (Year)	Service in Company (Year)	Working schedule on board	Hours of rest in last 24-H and 7-day

[28] The remaining in port and starboard COTs (1, 2, 4 and 5) were unpumpable cargo residues.
[11] The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (or STCW), 1978 sets qualification standards for masters, officers and watch personnel on seagoing merchant ships.

VM-Master	48	COC – Master / STCW II/2, IV/2	10	8	28	0600H – 1800H[30]	12 / 84
VM-CO	47	COC – Master / STCW II/2, IV/2	24	23	23	1200H – 2400H	12 / 84
VM-2O	26	COC - Chief mate/ STCW II/1, 2, IV/2	17	2	3.5	1200H – 2400H	12 / 84
VM-CE	51	COC - Chief engineer / STCW III/2	17	16	30	0600H – 1800H[31]	12 / 84
VM-2E-1	55	COC - Chief engineer / STCW III/2	17	20	17	1200H – 2400H	12 / 84
VM-2E-2	39	COC - Chief engineer / STCW III/2, IV/2	17	7	17	0000H – 1200H	12 / 90[32]
VM-2E-3	40	COC - Chief engineer / STCW III/2, IV/2	10	2.5	16	0000H – 1200H	12 / 84
VM-3E-1	25	COC – Second Engineer and Chief mate / STCW III/3, III/2, III/1 and II/2, IV/2	24	< 1	< 1	1200H – 2400H	12 / 84
VM-3E-2	29	COC - Second engineer / STCW III/2, IV/2	2	1	1	0600H – 1800H	12 / 24[33]
Electrician	45	STCW III/4	10	7	16	0600H – 1800H	12 / 84

Table 2

1.3.1.3 All deck and engineering officers in Table 2 joined VM for less than a month prior to the occurrence. Both VM-Master and VM-CE had been sailing with VM-Company throughout their careers. Most of the VM officers held qualifications higher than their designations as required by the STCW, e.g. VM-CO possessed the COC of Master, VM-2O possessed the COC of Chief Mate, the three Second Engineers held the COC of Chief Engineer and the two Third Engineers held the COC of Second Engineer.

1.3.1.4 VM-CE was in-charge of all engine room officers and ratings. Apart from ensuring assigned equipment were in optimal technical state, VM-CE was

[30] Indicating as a routine working schedule on board, apart from navigating VM from one location to another in the Port of Singapore. The Master was overall in-charge and was required to be on-call 24/7.
[31] In-charge of engine department and was required to be on-call 24/7.
[32] VM-2E-2 switched duties from a dayworker to watch-keeper of 0000H – 1200H on 11 June 2024 and had 18-H rest on 10 June 2024.
[33] The VM-3E-2 was only two days on board.

responsible for guiding, supervising, motivating and training assigned crew to create and safeguard a positive work atmosphere. VM-CE was also responsible for instructing, organising and supervising assigned engineers, as well as ensuring that work was divided and executed in accordance with expectations in terms of time, quality and output. Under the high voltage safety installation plan, VM-CE was the default operational person responsible for all high voltage[34] installations work on board VM.

1.3.1.5 Second Engineers[35](VM-2Es) were responsible for the state and maintenance of the technical installations on board. If working in the capacity of Day-Engineer, VM-2Es would be responsible for preparing, planning and /or executing specific maintenance projects. VM-2Es were also responsible for instructing, organising supervising, training and motivating assigned engineers as well as ensuring that assigned work was divided and executed in accordance with expectations.

1.3.1.6 Third Engineers (VM-3Es) were junior engineering officers, who would report to VM-2Es operationally and to VM-CE hierarchically. VM-3Es, together with VM-CE and VM-2Es, were responsible for the state and maintenance of the assigned equipment on board so that the equipment could be deployed optimally in compliance with safety, maritime and environmental regulations and VM-Company's guidelines. VM-3Es were not allowed to perform tasks relating to high voltage. VM-CE and VM-2Es had been trained on operational management and safety of high voltage installation on board.

1.3.1.7 During the occurrence, VM-2E-2 and VM-2E-3 were keeping the morning watch, VM-2E-3 was the person in-charge of the watch while VM-2E-2 was assisting him. VM-2E-2 was scheduled for a short watchkeeping period and soon to be a Day-Engineer to plan and carry out routine maintenance work in the engine room.

1.3.1.8 The Electrician held a Certificate of Competency in a "rating" capacity forming part of an engineering watch and served on board as a "rating engine room". The Electrician was reporting to VM-CE hierarchically and operationally. He was supporting VM-CE and VM-2Es with all electrotechnical duties, discussing and advising them about methods to optimise the electrotechnical systems on

[34] STCW, A-III/2 and B-III/2.

[35] As there were three Second Engineers on board VM, VM-CE would appoint one of them to be second-in-charge for the engineering team.

board, maintaining an efficient spare part stock, executing regular maintenance and repairs, improving the electrotechnical systems and resolving electrotechnical related problems. The Electrician was authorised to make decisions and execute tasks and fulfil responsibilities, in accordance with VM-Company's management system, policy and standing instructions.

1.3.1.9 The Electrician obtained a certificate of High Voltage[36] training in September 2015. According to VM-CE and VM-2Es, the Electrician was not permitted to carry out any electrical power isolation on the PMS or physical circuit breakers on switchboards, such as opening or closing any physical circuit breaker. These tasks would only be carried out by certified engineers (VM-CE, VM-2Es or VM-3Es).

1.3.1.10 According to VM's work/rest hour records, the hours of rest for the key persons in the past 24-hour and last 7-day period prior to the allision as summarised in Table 3, complied with the STCW and MLC Convention's requirements concerning the hours of work and rest[37].

1.3.2 Marine Honour (MH)

1.3.2.1 There were 12 Indonesian crew on board MH including MH-Master. All crew were Singapore work-permit holders and possessed valid STCW[38] competency certificates required for their respective positions on board. The working language was English.

1.3.2.2 The qualification and experience of MH-Master, MH-CO-1 and relevant crew are tabulated in **Table 3** below.

Designation On board	Age	Qualification	Duration on board (month)	In rank service (Year)	Service in Company (Year)	Working schedule on board	Hours of rest in last 24-H and 7-day
MH-Master	37	COC[39] – Master / STCW II/2, IV/2	< 1	1.6	2.5	On daywork[40]	13.5 / 118.5

[36] The high voltage training was in accordance with the Table III/1 and Table III/2 of the STCW I/11.4 and Section A-I/11.2.
[37] STCW Chapter VIII and MLC, Reg 2.3 with regard to rest hour - Minimum hours of rest shall not be less than i) ten hours in any 24-hour period; and ii) 77 hours in any seven-day period. Hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length, and the interval between consecutive periods of rest shall not exceed 14 hours.
[35] The International Convention on Standards of Training, Certification and Watch keeping for Seafarers (or STCW), 1978 sets qualification standards for masters, officers and watch personnel on seagoing merchant ships.
[39] Certificate of Competency.
[40] VM-Master was overall in-charge on board VM and was required to be on-call 24/7.

MH-CO-1	37	COC – Chief Mate / STCW II/2, IV/2	3.1	8.9	0.2	0000H – 0600H 1200H – 1800H	12 / 84
MH-CO-2	33	COC – Chief Mate / STCW II/2, IV/2	< 1	2.2	1.1	0600H – 1200H 1800H – 2400H	12 / 45[41]
Bosun	43	Deck Rating as per STCW II/4, 5 and V/1	< 1	8.8	0.5	0600H – 1200H 1800H – 2400H	11.5 / 103[42]
ASD	28	Deck Rating as per STCW II/4, 5 and V/1	3.2	5.6	4.6	0000H – 0600H 1200H – 1800H	12 / 84

Table 3

1.3.2.3 Prior to the allision, MH-Master and another Chief Officer (Morning-shift, MH-CO-2) were discussing with MH-Company's Superintendent on matters of shipboard operations in the mess room while waiting for MH to be cast off from EB and to sail back to a terminal for cargo loading.

1.4 Relevant systems and installations on board VM

1.4.1 Electrical power supply distribution system

1.4.1.1 Two propulsion engines (main engines, port and starboard) were installed, each rated for a power output of 14400kW at 514rpm.

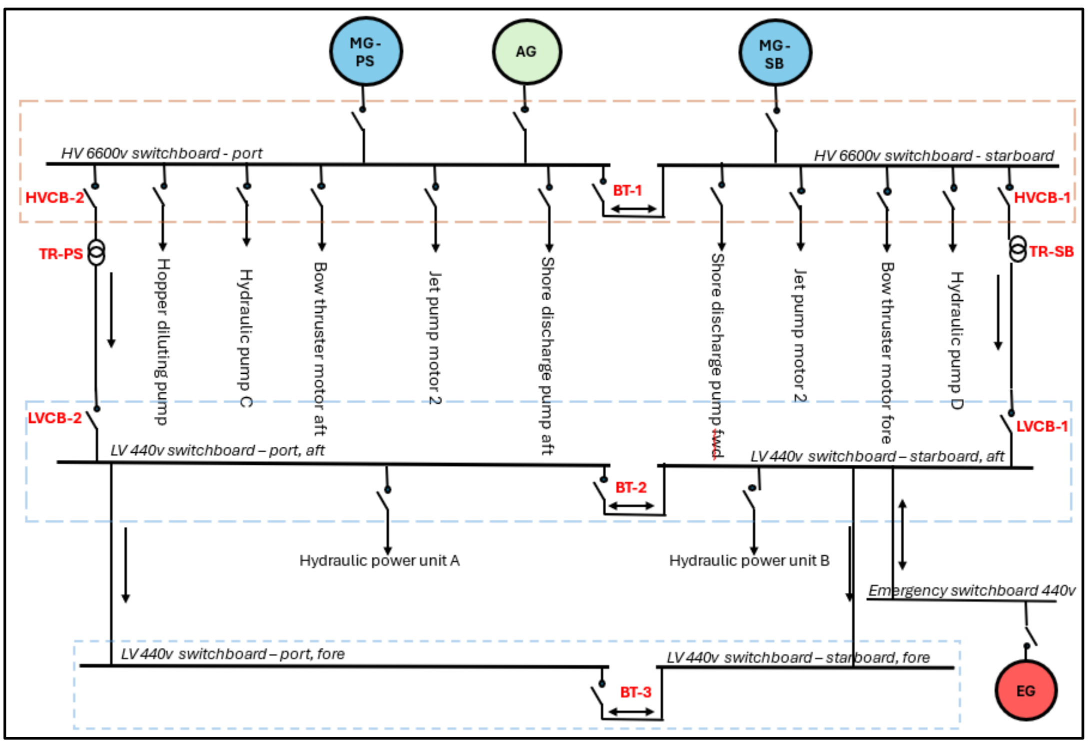
1.4.1.2 Electrical power was supplied by two main generators (MG-PS and MG-SB), driven by the port and starboard main engines respectively. Both generators had the same output capacity of 14222 kW at 6600v high-voltage (HV) and were connected to the main electrical bus, through HVCB-1 and HVCB-2 on PMS. The auxiliary generator (AG) with an output capacity of 1920 kW at 100% was driven by the auxiliary engine. The emergency generator (EG) was also installed and rated to produce electrical power of 465.6 kW at 1500rpm[43].

1.4.1.3 MG-PS and MG-SB could run in parallel, with no.1 bus tie (BT-1) open, to supply electrical power to the port and starboard side electrical installations and equipment through their respective stepdown transformers (TR-PS and TR-SB) and circuit breakers (HVCB-2, LVCB-2, HVCB-1 and LVCB-1). If either

[41] Joined MH on 10 June 2024.
[42] The working schedule planned was for watchkeeping duties, other period would be switched to daywork, and rest-hour would be adjusted accordingly to meet the minimum rest-hour requirements.
[43] Rated output 582 kVA and power factor is 0.8.

MG failed, the other MG could supply the electrical power for the entire ship[44]. Either MG could run together, with BT-1 closed, with AG. In this combination, the output of AG would be limited to 80% of its maximum capacity and the MG would be able to continue supplying in full capacity.

1.4.1.4 The electrical power distribution system (see **Figure 8**) allowed the engineers to configure and run different generators supplying electrical power to different machinery and equipment consuming high-voltage (6600v) or low-voltage (440v) electrical power. The high voltage power supplied directly to machinery such as hopper diluting pump (750kW), hydraulic pump C (800kW), forward and aft bow thruster motor (1500kW each) and forward and aft shore discharge pumps (6650kW, each) and submersible dredge pump (6000kW each), etc. The low-voltage electrical power, stepped down from 6600v by two transformers (TR-PS and TR-SB), supplied to equipment such as HPU-A, HPU-B, CPP systems and steering pumps, main engine sea water cooling pumps, bow thruster auxiliary supply and control systems and hydraulic pumps (HPU-A and HPU-B) for anchor windlass system.



[44] SOLAS, Chapter II-1, Regulation 41 – Main source of electrical power and lighting systems. The regulation requires vessel's main source of electrical power on board shall consist of at least two generating sets, and the capacity of these generating sets shall be capable of supplying necessary services to provide normal operational conditions of propulsion and safety under various emergency conditions in the event of any one generating set being stopped.

MG - PS: main generator – port side	MG - SB: main generator – starboard side
AG: auxiliary generator	EG: emergency generator
HVCB: high voltage circuit breaker	LVCB: low voltage circuit breaker
TR: transformer	BT: bus tie

Figure 8 – VM's electrical power distribution

1.4.2 The high and low voltage switchboards

1.4.2.1 When in auto mode, the PMS would automatically configure the electrical power distribution, the main switchboard would be divided into port and starboard systems with the three bus ties open (BT-1, BT-2 and BT-3). The PMS safety system would be activated when a circuit breaker fails, the respective bus tie would be closed to supply electrical power to equipment of high or low voltage. If either MG-PS or MG-SB was not providing electrical power, BT-1 (6600v bus tie) would automatically close to keep the other side of the main switchboard powered. If both MG-PS and MG-SB were not providing electric power, AG would automatically start and supply electrical power to the main switchboard.

1.4.2.2 If the emergency switchboard was de-energised for 35 seconds, i.e. the two MGs and AG were not providing electrical power, the EG[45] would automatically start to supply electrical power to the pre-identified critical equipment such as navigational equipment.

1.4.2.3 On the occurrence day, MG-PS and MG-SB were running with BT-1 open, and AG was not running. The PMS was set on auto mode. HVCB-1 and LVCB-1 were opened (by the morning-shift duty engineers to facilitate the Electrician's work), HVCB-2, LVCB-2 and BT-2 were closed from the time of inspection of the cooling fans. This configuration resulted in MG-PS supplying port side high voltage and all the low-voltage consuming machineries and equipment[46]. MG-SB was only supplying to starboard side high-voltage machineries and equipment.

1.4.2.4 According to the afternoon-shift duty engineers (VM-2E-1 and VM-3E-1), at the time of preparing VM's main engines for departure, they recalled that on the

[45] A source of electrical power, intended to supply the emergency switchboard in the event of a failure of the supply from the main source of electrical power. SOLAS, Chapter II-1, Regulation 43 requires that an emergency generator provided to be capable of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45s.

[46] There was no pre-identified list of non-essential low-voltage machineries and equipment in the PMS auto mode system, which could auto disconnect these pre-identified machineries and equipment to prevent overloading of LVCB-2. The pre-identified list was not required by VM's classification society.

PMS, BT-1, BT-2 and BT-3 were opened, HVCB-1[47] and HVCB-2 and LVCB-2 were closed, but they did not notice that LVCB-1 was left open.

1.4.2.5 An in-house monitoring[48] application was used to monitor shipboard electrical load, and all captured data was sent back to VM-Company through a VODAS[49] system in a separate network. This data could be collected and read by an in-house developed logging system, named "NC Logger", which analysed the network data and created files from all signals sent through the network.

1.4.2.6 The data extracted from the monitoring system for the period of 1215H – 1640H on 14 June 2024 (see **Figure 9**) indicated that the electrical load of MG-PS (in red) was much higher than MG-SB (in green). The blackout happened when HPU-B was started (read as hydraulic unit pump B in the electrical load graph below).

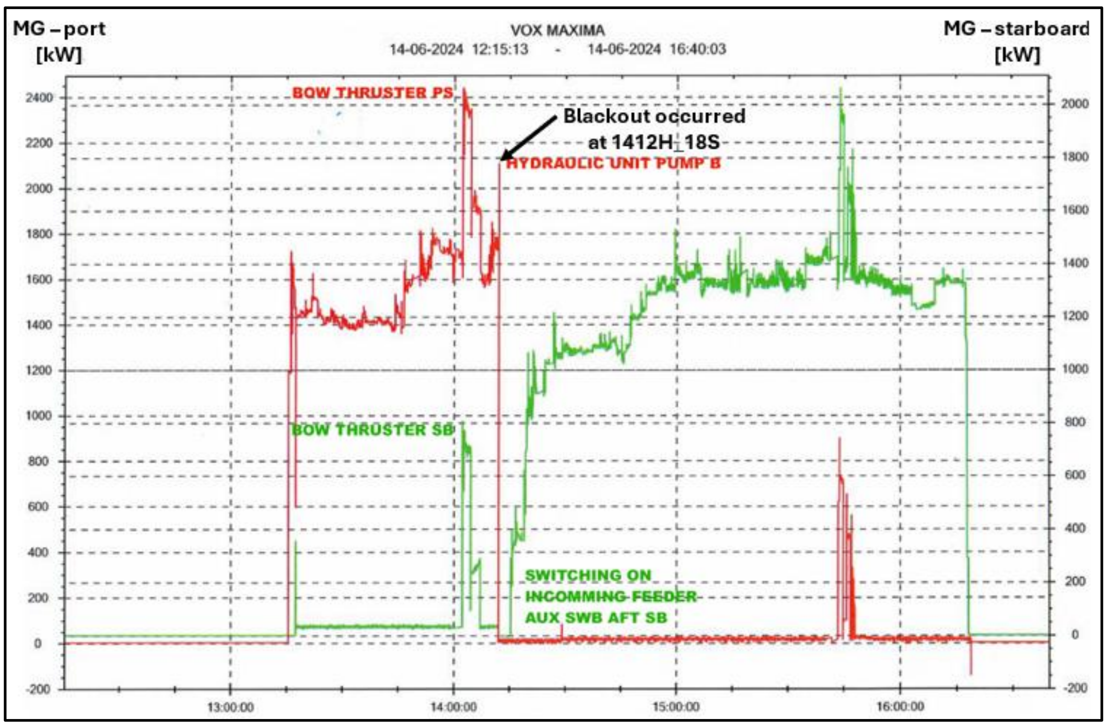


Figure 9 – Electrical load graph captured in Simplot.Net system
(*Source*: VM-Company, the blackout text annotated by TSIB)

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[47] This was an incorrect recollection as HVCB-1 was left open together with LVCB-1 by the morning-shift duty engineers to facilitate the Electrician's work.
[48] Simplot.Net. An in-house application would read all signals from the data collected from the NC Logger and was able to generate graphs such as electrical load.
[49] Van Oord Dredging Automation System.

1.4.2.7 According to the records on board VM, the nominal current[50] was at 682A for both motors of HPU-A and HPU-B and limiting current[51] was set at 190% of the nominal current which was about 1295.8 A. Both HPU-A and HPU-B were visually inspected by the maker post incident on 5 July 2024 and found to be in normal working condition. There was no leakage found when both HPU-A and HPU-B were running. Performance tests were also carried out and found that both pumps were able to reach maximum pressure[52] after 10 seconds.

1.4.2.8 The PMS system registered numerous alarms during the black-out period, these almost constant incoming alarms were indicated by visual and acoustic signal.

1.4.3 Anchoring system

1.4.3.1 VM was equipped with two anchors (port and starboard) at the forecastle deck, with 12 lengths of anchor chains for each anchor. The anchoring system (see **Figure 10**) was like other commercial ships consisting of an anchor, chain cable, hawse pipe, chain stopper, windlass, power controls, spurling pipe and chain locker. The windlass gear was a separate unit consisting of a cable lifter, brake and gearing and the drive unit was a combined anchor and mooring winch. The windlass was driven by an electro-hydraulic motor system, which used an electric motor to power the hydraulic pump to operate the windlass to heave up the anchor. The anchors were released by gravity weight after releasing the windlass brake. The last class survey conducted in September 2023 for re-activating VM from its lay-up indicated that both its port and starboard anchors were in working condition.

[50] A reference current value that a motor is designed to operate at under normal conditions.
[51] It sets a maximum current level that a motor can draw. If this threshold is reached, the soft starter temporarily suspends the voltage increase until the current falls below the set limit, then resumes ramping up to full voltage.
[52] HPU-A and HPU-B were able to achieve 297.5 bar with 198.5L/min flow and 299.4 bar with 198.6L/min respectively, within the normal working condition.

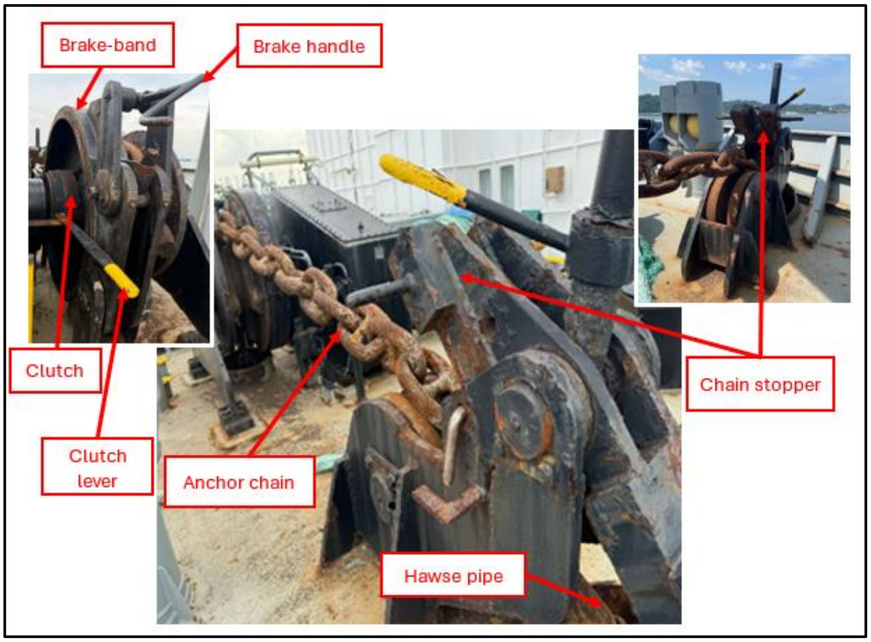


Figure 10 – VM's port anchor and its key components, same design for the starboard anchor (*Source*: the TSIB)

1.4.3.2 When departing AWW, the starboard anchor was heaved up to the hawse pipe and secured with its chain stopper down and windlass gear clutched in. The chain stopper was not able to swing open as the anchor weight was held in tension to the chain stopper. To ease the tension, hydraulic pump was required to operate the windlass to heave up the anchor chain slightly to free it from the chain stopper. It was not a common practice to keep the windlass gear clutched in after an anchor was secured home.

1.4.3.3 At the time of the blackout, the port anchor was not able to be released. It was discovered post incident that the anchor shank was stuck in the hawse pipe (see **Figure 11**) preventing the port anchor to be released from its stowed position. Releasing the windlass brake completely did not help the anchor shank to clear from the hawse pipe. Ship's records indicated that the port anchor was last used on 16 April 2024 and was secured on the same day. It remained in secured condition till the occurrence day.

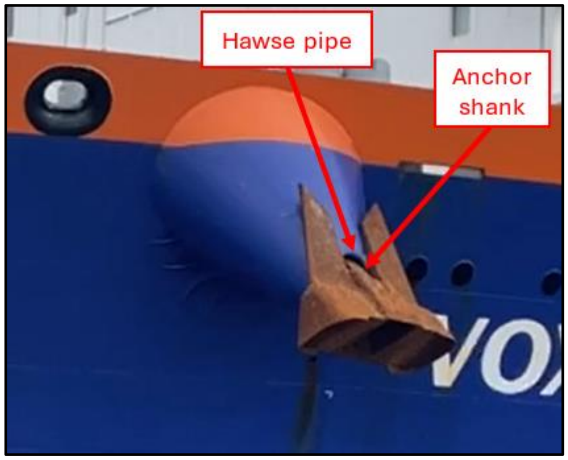


Figure 11– Illustration view of the port anchor at its stowage position
(*Source*: the TSIB)

1.5 Inspection of cooling fan

1.5.1 VM was scheduled to enter the shipyard to carry out some modifications in preparation for her next deployment to the middle east. In anticipating hot climate, the Electrician planned for a preventive maintenance work to inspect the condition of cooling fans and vents of the electrical transformers, and to verify if the spare capacitors (see **Figure 12**) on board were suitable for the cooling fans.

Figure 12 – Sample of the cooling fan capacitor shown by the Electrician
(*Source*: the TSIB)

1.5.2 On the occurrence day, to isolate the electrical power connection to the starboard electrical transformer (SB, 6600/400V), the morning-shift duty engineers (VM-2E-2 and VM-2E-3) opened HVCB-1 and LVCB-1 from the PMS (see **Figure 13**). The steps carried out by VM-2E-2 and VM-2E-3 were as follows:

a) Opened[53] HVCB-1

b) Opened LVCB-1

c) Kept BT-1 open and BT-2 and BT-3 closed

d) Kept HVCB-2 and LVCB-2 closed

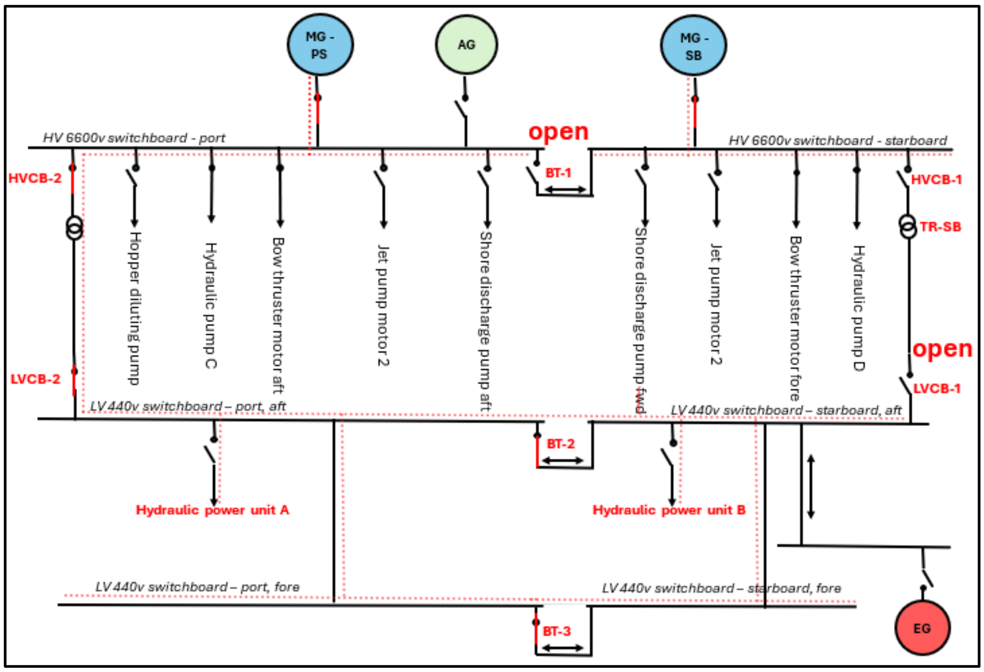


Figure 13 – Configuration of the switchboards with TR-SB isolated

1.5.3 However, the investigation team could not ascertain, between VM-2E-2 and VM-2E-3, who was the one who opened HVCB-1 and LVCB-1 before the inspection of the cooling fans of TR-SB.

1.6 Emergency response after the allision

1.6.1 Vox Maxima (VM)

1.6.1.1 VM-Pilot reported to PPC and MSCC[54] after the allision and oil spill occurrence.

[53] By touching the symbols on the PMS' screen located in the ECR to open or close circuit breakers and bus ties.
[54] Marine Safety Control Centre was manned 24/7 by the MPA, dealing with incident reporting and coordinating marine emergencies in the Port of Singapore.

1.6.1.2 Within a few seconds after the allision, full astern of the port side CPP was applied and VM started moving astern to the West Keppel Fairway and detached from MH. VM-Master stopped VM's astern movement by using the port side CPP control[55] and releasing the starboard anchor, as advised by VM-Pilot, to hold VM in a position to prevent another impact to MH while waiting for assisting tugs to arrive. Thereafter, VM was moved under dead towing by two tugs and re-anchored at AWW.

1.6.2 Marine Honour (MH)

1.6.2.1 Resulting from the allision, the oil cargo from MH no.3 COT splashed on deck and spilled into the sea. As instructed by MH-Master, MH-CO-2 organised the deck crew to collect SOPEP[56] equipment (refer to **Table 4**) from the forecastle store to manage the oil spill. All the equipment listed were used up, including oil dispersant. MH-Master raised urgent requisition through MH-Company for additional quantity of SOPEP equipment on 16 June 2024 to support the cleaning operation on board MH and on the sea surface around the vessel.

[55] by setting the engine telegraph to 'half-ahead' and 'stop'.

[56] Shipboard oil pollution emergency plan, as required by MARPOL, Annex I, Chapter V, Regulation 37 - Shipboard oil pollution emergency plan, and MPA's Prevention of Pollution of the Sea (Oil) Regulations 2006, Chapter 5, Regulation 37.

Oil Spill Clean-up Equipment	Quantity
Oil spill dispersant	400 litres
Saw dust	30 bags
Inductor	1 unit
200 litres containment drum	2 drums
Rag	1 pack
Plastic dustpan	3 pieces
Large black plastic bag	1 packet
Deck broom	3 pieces
Hand broom	3 pieces
Mop	3 pieces
20 litres plastic bucket	3 pieces
Absorbent pad	30 pieces
Scupper plug	2 pieces
Rubber glove	5 pairs
Rubber boot	5 pairs
Dispersant sprayer	1 unit
Plastic shovel	2 pieces

Table 4 – List of SOPEP equipment on board MH at the incident time

1.6.2.2 MH-CO-1 was calculating and monitoring MH's stability and with MH-Master's concurrence, MH-CO-1 carried out the internal transfers of bunker oil, from no. 3 COT to other COTs, and ballast water to keep MH in an upright condition. MH-Master offered full cooperation with the local authorities in responding to the oil spill to minimise marine pollution.

1.6.2.3 MH was subsequently towed to the Western Petroleum Alpha anchorage as directed by MPA and carried out lightening operations[57] to remove all cargo and oily waters from its COTs and slop tanks to prevent further pollution. MH was eventually towed to a shipyard for repairs.

1.6.3 The port authority

1.6.3.1 An inter-agency emergency operations committee, comprising MPA, other government agencies and maritime industry, was convened immediately after the allision and oil spill occurrence. The following actions were taken from

[57] MH was provided with a ship-to-ship operations plan which met the requirements of MARPOL, Annex I, Chapter VIII, Regulation 41 - General rules on safety and environmental protection.

seaward and landward:

- 18 vessels were deployed initially, and more vessels were added subsequently for containing and dispersing the oil spill at sea
- Aerial surveillance using drones was carried out to assess the oil spill situation and during the clean-up operation till all affected areas were cleaned up
- Affected beaches were closed to the public and cleaning of the affected shoreline carried out
- Oil absorbent booms were deployed to protect the shorelines
- Additional resources such as current busters for containment and recovery of treated oil were deployed
- Preventive oil booms were also placed at potential oil affected areas as a precautionary measure

1.6.4 The terminal operator

1.6.4.1 An emergency response (ER) team[58] was formed to prevent the spilled oil from encroaching the nearby berths through the deployment of oil dispersant into the waters surrounding the affected wharves.

1.6.4.2 The ER team also activated a commercial contractor for the deployment of an oil-spill control vessel to further assist in the clean-up operation. Oil containment booms were also deployed to protect adjacent container berths from oil slicks originating from MH. Continuous assessment was made by the ER if additional assets and oil spill response equipment were needed or required to be repositioned.

1.7 Damages resulted from the allision

1.7.1 Vox Maxima (VM)

1.7.1.1 There was no injury reported after the allision. Minor indentations and scratches were noted on VM’s bulbous bow (see **Figure 14**).

[58] Managed by PSA Singapore.

Figure 14 – View of VM's bulbous bow with damages and debris from MH
(*Source*: the TSIB)

1.7.2 Marine Honour (MH)

1.7.2.1 At the time of allision, MH was made fast to EB by five mooring lines[59], namely two headlines, one forward spring line and two stern lines. Two Yokohama fenders[60] were placed in between MH and EB. The allision resulted in four mooring lines parted (see **Figure 15 and Figure 16**) and only one headline remained intact. Two Yokohama fenders burst and sank instantly.

[59] All five mooring lines were Moortuf FX8 ropes made of polyolefin & high tenacity polyester yarn, their minimum breaking load was certified at 47.4 tons. All lines were installed on board in 2023.
[60] The size of the two Yokohama pneumatic rubber fenders was 2 metres in length and 1 metre in diameter. Its initial internal pressure was tested to be 50 kPa (pneumatic 50).

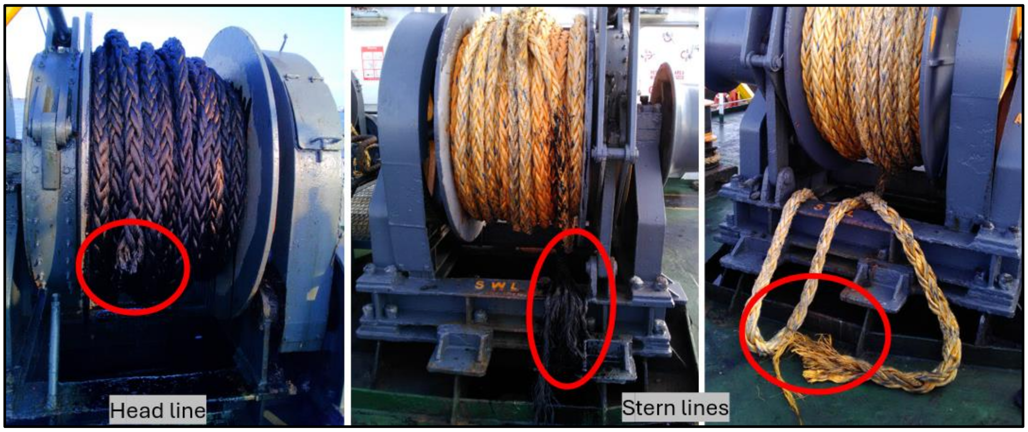


Figure 15 – View of mooring lines parted
(*Source*: the TSIB)

Figure 16 – Yokohama fender (same type as the sunken ones)
(*Source*: MH-Company, from another bunker tanker)

1.7.2.2 BV carried out the occasional survey on MH's hull from 15 June 2024 to 5 July 2024 while MH was anchored at the Western Petroleum Alpha Anchorage (AWPA). Preliminary assessment indicated that MH sustained the following hull damages (see **Figure 17**) from the allision:

a) Starboard side of no.1 and no.2 water ballast tanks
b) Starboard side of no.3 and no.4 COTs, in way of frames no. 72 – 97
c) About 8m open crack in way of frame no.96 on the main deck starboard side
d) Transverse bulkheads at frame no.75 (between no.3 COT and no.4 COT, starboard side)
e) Transverse bulkheads at frame 95 (between no.2 COT and no.3 COT, starboard side)

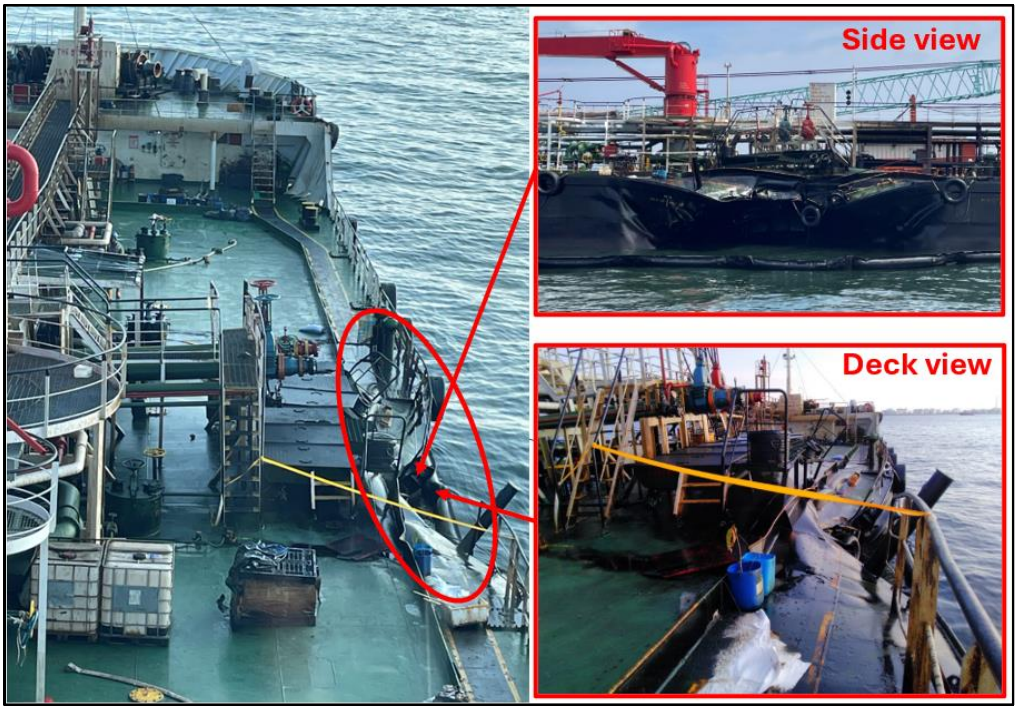


Figure 17 – View of the damages on MH's starboard side
(*Source*: the TSIB)

1.7.2.3 Sea water ingressed into the starboard side of no. 2 water ballast tank, no. 3 and no.4 COTs.

1.7.2.4 Underwater hull damage was unable to be assessed at the time of survey due to restrictions. The attending class surveyor determined that MH was unfit for her operation and voyage. Towage was allowed for MH to be shifted from its current location to the AWPA) with a list of conditions imposed by BV.

1.7.2.5 On 21 June 2024, after reviewing that MH had sufficient stability and structural strength and in consultation with the flag administration (the MPA), BV issued conditional short term Cargo Ship Safety Construction Certificate and International Load Line Certificate[61] to facilitate MH to undergo cargo discharging operation which was completed on 27 June 2024. The remaining bunker (heavy fuel oil and marine gas oil for MH use) and slop tank containing oily water were also discharged.

1.7.2.6 With approvals from the MPA and BV, MH was towed to a shipyard in Singapore on 5 July 2024 for permanent repairs.

[61] With validity until 1 July 2024.

1.7.3 Ever Blink (EB)

1.7.3.1 Resulting from the allision, EB suffered minor lube oil spill from its hull on the port side and a leakage inside the engine room. Multiple structural deformations were found on the port side ship hull at the locations of no.5 water ballast tank, freshwater tank (port), void space, grey water holding tank, cylinder oil storage tank (port) and purifier room, etc. (See **Figure 18 and Figure 19**).

Figure 18 – Deformed shell plating between frames 28 and 35 and damaged into a hoe on port side (*Source*: EB)

Figure 19 – Deformed shell plating between frames 45 and 52 on port side cylinder oil storage tank (*Source*: EB)

1.7.3.2 An occasional survey of ship's hull was carried out by CR classification society (CR) on 16-18 June 2024, included temporary repairs and examinations to certify the technical fitness of EB. EB was allowed to continue the voyage with a list of conditional requirements and to carry out permanent repairs before 17 July 2024, which had been completed.

1.8 SMS procedures

1.8.1 Vox Maxima (VM)

1.8.1.1 VM-Company managed a fleet of dredging vessels like VM, which was a trailing suction hopper dredger. A full-term DOC certificate was issued to the VM-Company by Lloyd's Register (LR) on 12 October 2022 based on an audit completed on 12 October 2022 and was valid until 11 November 2024. The last DOC verification audit was carried out in Rotterdam on 26 September 2023.

1.8.1.2 VM was laid up in October 2020. In September 2023, after the class survey by BV, VM's statutory certificates were reinstated and reactivated for trade service. A full-term SMC was also issued by LR to VM in Surabaya on 5 March 2024, based on an initial SMC audit completed on the same date and was valid until 4 March 2029.

1.8.1.3 The last Port State Control inspection on VM was carried out in Jakarta on 25 October 2023 with no deficiency documented. There was no Flag State Control inspection carried out for the past one year.

1.8.2 Voyage planning

1.8.2.1 VM-Company's SMS procedures had a section on voyage planning. The purpose was to support the bridge team and to ensure that the vessel could be navigated safely between ports from berth-to-berth, for example from the previous port, Tanjung Priok, Indonesia to the Port of Singapore. The voyage planning section was applicable to routes on the project, i.e. from a dredging area to discharge area, dredging area to bunker location and vice versa.

1.8.2.2 The voyage planning section highlighted that navigation along the chosen route should be planned in detail such as ship's draft and average speed required, tidal information and arrival checklist covering emergency stops on engines and readiness of anchors and winches. All this information would be used to draw up the voyage plan.

1.8.2.3 ECDIS was used as primary means of navigation on board VM, nautical charts in electronic form were available for voyage planning and navigation. These charts were supplied by a contracted supplier with updates on a weekly basis.

1.8.2.4 According to VM-Master, VM-CO and VM-2O, full voyage planning as per the planning section of VM-Company's SMS procedures required for berth-to-berth voyages, was not applicable to intra-port shifting from AWW to the shipyard within Singapore. As such, there was no full voyage planning from AWW to the shipyard, other than creating waypoints on ECDIS. These waypoints were created by VM-2O and observed by VM-CO. This waypoints route from AWW to the shipyard was approved by VM-Master and it was shown to both marine harbour pilots at the time of master-pilot information exchange.

1.8.3 Navigational policy

1.8.3.1 VM-Company's SMS procedures also included a section on navigational policy, which stated that the responsibility of safe navigation of ship remained with the master and watchkeeping officer on duty, even with pilot on board. For example, monitoring of progress of the vessel and tracking of other vessels for collision avoidance must be continued. If there were doubts on the pilot's intentions, clarification must be sought immediately.

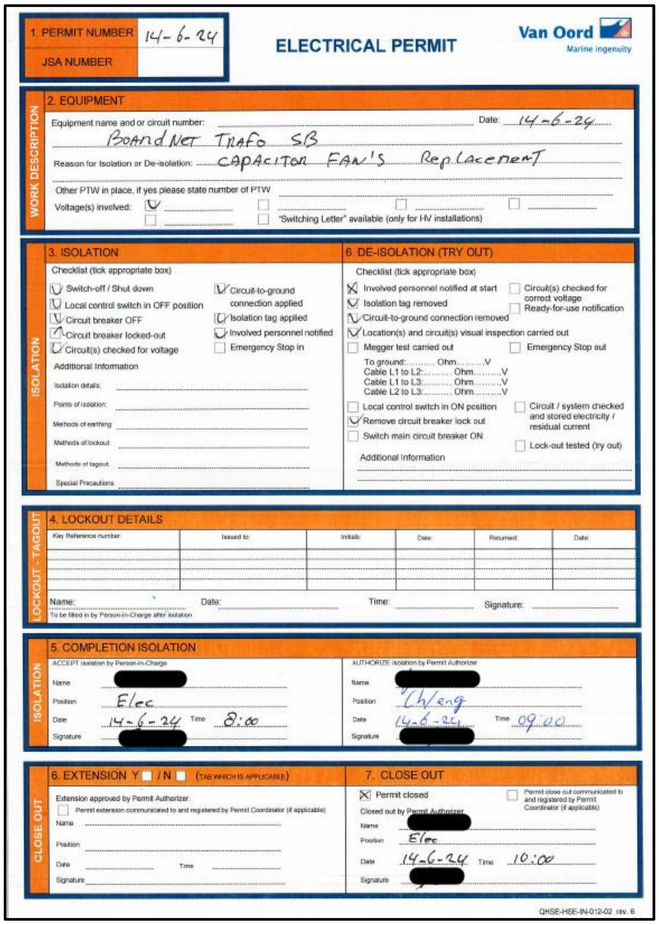
1.8.4 Permit to work system

1.8.4.1 VM-Company's SMS procedures included the Permit to Work (PTW) system, its objective was to protect people and / or environment when tasks involving potential high-risk or non-routine. These tasks could be performed only after specific permission (in the form of a PTW) had been obtained and control measures had been implemented. The system was also to help communication among all personnel involved in the task. Various tasks listed in the PTW system included hot work, entry and working in confined spaces, working on electrical systems, etc.

1.8.4.2 For working on electrical systems, an Electrical Permit (EP) form had to be completed, which required the chief engineer (e.g. VM-CE) to authorise the isolation of an electrical equipment / installation before carrying out inspection and maintenance and de-isolation of the electrical equipment / installation after completion of the inspection and maintenance. The EP had two separate tick-box checklists for electrical power isolation and de-isolation and required person in-charge (e.g. the Electrician) to provide details of the circuit breakers to be isolated and locked out.

1.8.4.3 On the morning of 14 June 2024, the Electrician initiated an EP request to VM-CE at 0800H, indicating "voltage(s) involved" for the inspection and verification[62] of the starboard transformer cooling fan capacitor. VM-CE authorised the EP at 0900H for the Electrician to proceed with the tasks. The EP was closed at 1000H on 14 June 2024 by the Electrician. According to VM-CE, it was not required for him to verify if all systems had been reset back to normal operating condition after the EP was closed.

1.8.4.4 The investigation team had a copy of the EP raised by the Electrician for the inspection and verification of the cooling fan capacitor. There were no details on the circuit breakers and electrical equipment to be isolated and locked out and the person to carry out the isolation and lockout. These details were left in blank (see **Figure 20**).



1. PERMIT NUMBER 14-6-24
JSA NUMBER

ELECTRICAL PERMIT

Van Oord
Marine ingenuity

WORK DESCRIPTION

2. EQUIPMENT

Equipment name and or circuit number: BoardNet Trafo SB
Date: 14-6-24
Reason for Isolation or De-isolation: CAPACITOR FAN'S Replacement
Other PTW in place, if yes please state number of PTW
Voltage(s) involved: ☑
☐ "Switching Letter" available (only for HV installations)

ISOLATION

3. ISOLATION

Checklist (tick appropriate box)

☑ Switch-off / Shut down
☑ Local control switch in OFF position
☑ Circuit breaker OFF
☑ Circuit breaker locked-out
☑ Circuit(s) checked for voltage
☑ Circuit-to-ground connection applied
☑ Isolation tag applied
☑ Involved personnel notified
☐ Emergency Stop in

Additional Information
Isolation details:
Points of isolation:
Methods of earthing:
Methods of lockout:
Methods of tagout:
Special Precautions:

6. DE-ISOLATION (TRY OUT)

Checklist (tick appropriate box)

☒ Involved personnel notified at start
☑ Isolation tag removed
☑ Circuit-to-ground connection removed
☑ Location(s) and circuit(s) visual inspection carried out
☐ Megger test carried out
To ground:.......... Ohm..........V
Cable L1 to L2:.......... Ohm..........V
Cable L1 to L3:.......... Ohm..........V
Cable L2 to L3:.......... Ohm..........V
☐ Local control switch in ON position
☑ Remove circuit breaker lock out
☐ Switch main circuit breaker ON
☐ Circuit(s) checked for correct voltage
☐ Ready-for-use notification
☐ Emergency Stop out
☐ Circuit / system checked and stored electricity / residual current
☐ Lock-out tested (try out)
Additional Information

LOCKOUT - TAGOUT

4. LOCKOUT DETAILS

Key Reference number:	Issued to:	Initials:	Date:	Returned:	Date:

Name: Date: Time: Signature:
To be filled in by Person-in-Charge after isolation

ISOLATION

5. COMPLETION ISOLATION

ACCEPT isolation by Person-in-Charge
Name [redacted]
Position Elec
Date 14-6-24 Time 8:00
Signature [redacted]

AUTHORIZE isolation by Permit Authorizer
Name [redacted]
Position Ch/eng
Date 14-6-24 Time 09:00
Signature [redacted]

CLOSE OUT

6. EXTENSION Y ☐ / N ☐ (TAB WHICH IS APPLICABLE)

Extension approved by Permit Authorizer
☐ Permit extension communicated to and registered by Permit Coordinator (if applicable)
Name
Position
Date Time
Signature

7. CLOSE OUT

☒ Permit closed
☐ Permit close out communicated to and registered by Permit Coordinator (if applicable)
Closed out by Permit Authorizer
Name [redacted]
Position Elec
Date 14-6-24 Time 10:00
Signature [redacted]

QHSE-HSE-IN-012-02 rev. 6

Figure 20 - The EP raised by the Electrician
(*Source*: the VM-Company, names and signatures redacted by the TSIB)

[62] In the Electrical Permit, the field titled "Reason for Isolation or De-isolation" contained the text "CAPACITOR FAN'S REPLACEMENT".

1.8.4.5 According to VM-Company's SMS procedures, the permit initiator (the Electrician in this case) was responsible to conduct a risk assessment and identify if there was a need for an PTW (EP), coordinate with work team and conduct a JSA[63] for the job and execute the work according to the PTW. The Electrician was to check the work site for any hazardous situations, ensure the work site was safe to work, fill the PTW form and accept the PTW where applicable. The Permit Authoriser (PA, in this case VM-CE) was to ensure that the PTW would not conflict with other PTWs issued previously. The PA was required to close the PTW after the work had been completed.

1.8.4.6 The investigation team noted that the EP form was not made known or sighted by the morning-shift duty engineers (VM-2E-2 and VM-2E-3).

1.8.5 Lock-out, tag-out and try-out (LOTOTO)

1.8.5.1 VM-Company's SMS procedures also had a section on Safe Work Practice which covered the minimum requirements for lock-out, tag-out and try-out (LOTOTO) of energy isolating devices to protect persons from the release of energy including electrical, mechanical hydraulic, pneumatic or other energy.

1.8.5.2 The LOTOTO was a mandatory requirement whenever performing maintenance or service work on machines or equipment where there was a risk of exposure to the unexpected energising or start-up of equipment or release of energy. The LOTOTO would be practised in conjunction with the PTW system and the person (the Electrician in this case) performing the LOTOTO action was to register it as part of the PTW.

1.8.5.3 VM-Company's SMS procedures also highlighted, before entering or working on the equipment or machinery, the effectiveness of the LOTOTO would have to be verified by a suitably competent person, i.e. the PA (VM-CE in this case) stated in the PTW system.

1.8.6 Emergency drills

1.8.6.1 Various emergency drills were carried out on board VM periodically as required by the SOLAS and VM-Company's SMS procedures. VM-Master was responsible for ensuring that vessel's crew were able to respond adequately

[63]Job safety analysis. A method that could be used to identify, analyse and record: a) steps involved in performing a specific job; b) existing or potential safety and health hazards associated with each step; and c) recommended actions / procedures that would eliminate or reduce these hazards and the risk of a workplace injury or illness.

to incident/emergency. He would plan and execute the required number of drills to train the crew. The last emergency steering drill[64] was conducted by VM-Master on 11 June 2024. The drill evaluation report recorded that the emergency steering was performed by the duty crew[65] at the local control (emergency steering gear room). During the drill, steering pumps were changed over from the bridge to local control and steered locally with helm orders from the bridge. The communication between the bridge and emergency steering gear room was tested. The emergency steering procedures were clearly visible at the emergency steering gear room. Crew participated in the drill were familiar with these procedures.

1.8.7 Marine Honour (MH)

1.8.7.1 MH-Company managed a fleet of oil tankers, registered as bunker tankers operating in the Port of Singapore. A full-term DOC certificate was issued to MH-Company by China Classification Society (CCS) on 9 September 2021 based on an audit completed on 15 September 2020 and valid until 14 September 2025. The last DOC verification audit was carried out in Singapore on 10 October 2023.

1.8.7.2 MH-Company took on the role of ISM management of MH on 14 March 2024, an interim Safety Management Certificate (SMC) was issued to MH on 14 March 2024 on the completion of audit carried out by Bureau Veritas Maritime & Offshore (BVMO) on the same date and the SMC was valid till 13 September 2024.

1.8.7.3 An International Oil Pollution Prevention Certificate (IOPPC)[66] was issued to MH by BVMO on 27 September 2022 after completion of its survey on 21 September 2022, and valid till 9 September 2027. The last annual survey was carried out on 10 October 2023. According to the Supplement to IOPPC, MH met the requirements of Regulations 27[67] and 28[68].

[64] SOLAS, Chapter V, Regulation 26 – Steering gear testing and drills.
[65] VM-CO, VM-2O, VM-3O, VM-3E-1, Bosun, an Able Seafarer Deck and a Deck Cadet.
[66] The survey and certification were in accordance with MARPOL Convention, Annex I. The certificate issued was based on MH only engaged in voyages exclusively within 30 nautical miles from the port limit of Singapore during the course of which the vessel shall not proceed beyond 20 nautical miles from the nearest land, no tank cleaning operations or carriage of ballast water in its cargo tanks under normal conditions, all oily mixtures shall be retained on board and to be discharged to shore reception facilities.
[67] MARPOL, Annex I, Chapter IV, Regulation 27 – Intact stability. MH was provided with an approved stability instrument.
[68] MARPOL, Annex I, Chapter IV, Regulation 28 – Subdivision and damage stability.

1.8.7.4 MH's SMS procedures on emergency preparedness, which defined roles and responsibilities of shore and shipboard personnel in the event of an emergency, clearly specified that the master of its fleet of bunker tankers had the over-riding authority to take whatever actions necessary to mitigate the danger to human life, vessel, cargo and marine environment.

1.8.7.5 Various shipboard contingency plans were also developed to guide its masters in responding to an emergency, which included fire, explosion, oil spill prevention and oil spill resulting from a collision, like this allision. The immediate response to an oil spill from an allision included raising the vessel's general alarm, assessing the situation, taking safety measures and initiating damage controls.

1.8.7.6 The actions listed in the containment and mitigation were deployment of oil spill containment booms around the affected area, using absorbent materials and skimmers to collect spilled oil, taking measures to stabilise the vessel and preventing it from sinking or drifting and using water ballast tanks to correct the ship's trim and list, if necessary.

1.8.7.7 The procedures also required its masters to coordinate with specialised clean-up teams and environmental agencies for thorough clean-up operations.

1.9 Post-incident inspection and blackout simulation test

1.9.1 After the allision, technical engineers from different makers of VM's electrical system were invited on board VM to perform full inspection and functional tests on the electrical systems and machine installations as follow:

a) MG-PS, MG-SB, AG and EG – found operating normally;
b) The low voltage systems, circuit breakers (LVCB-1, LVCB-2 and BT-2) and switchboards - found all in good condition;
c) The over-current protection system for LVCB-2 – found functioning properly as designed; and
d) The CPP control and steering gear system, fore and aft bow thrusters[69], HPU-A and HPU-B - found operating normally.

[69] Full performance test for both bow thrusters could not be performed due to safety concerns as VM was at anchor at the time of testing.

1.9.2 Two simulation tests[70] were carried out by VM's crew in the presence of MPA and low voltage switchboard Maker's[71] technicians on 18 July 2024 and 26 July 2024. The tests simulated electrical load, as close as possible to the time of the blackout. In the first test conducted on 18 July 2024, the last readable current passing through LVCB-2 was recorded as 4801A (the setting limit) before LVCB-2 tripped. The objective was to observe the electrical load that would trip LVCB-2 and the proper functioning of its over-current protection system. The outcome of the two blackout simulation tests concluded that LVCB-2 and its over-current protection system were functioning as designed (refer to the Appendix A and Appendix B for the details of the simulation tests on 18 July 2024 and 26 July 2024).

1.10 Additional information

1.10.1 Area around West Keppel Fairway

1.10.1.1 The passage from AWW to the ST Marine Shipyard required VM to transit West Keppel Fairway and pass the Pasir Panjang Container terminal. Container berths no.35 and no. 36 were directly exposed to the West Keppel Fairway, the distance from berths of no. 35 or no. 36 to the West Keppel Fairway was about 150m (see **Figure 21**).

[70] The aim of the tests was to simulate a loss of electrical power on board VM by gradually increasing electrical load (the electrical load was low at the initial startup with equipment powered as VM was at anchor) until LVCB-2 tripped. The tests were also to verify if LVCB-2 had tripped at its setting limit.

[71] Schneider Electric Singapore Pte Ltd.

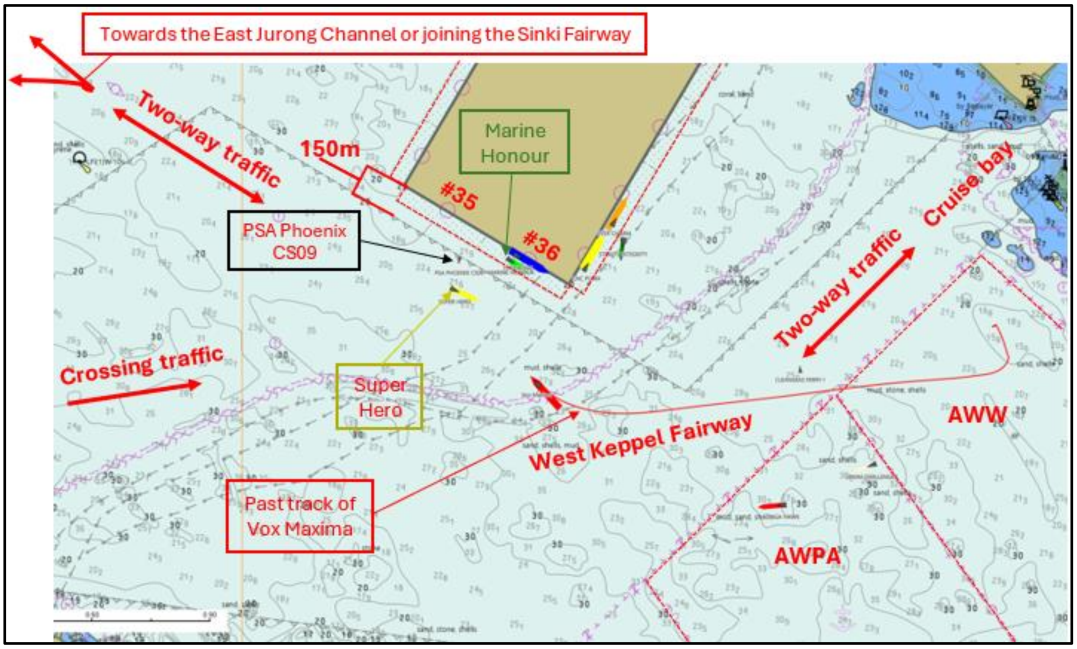


Figure 21– Overview of the occurrence site

1.10.2 Vessels exiting AWW would face two-way traffic, where ferries and cruise ships would transit the West Keppel Fairway for entering or leaving the Cruise Bay. Moving further towards northwest, vessels would require making large course alteration of nearly 90 degrees to join traffic flow, heading towards East Jurong Channel or joining Sinki Fairway where the area could meet another two-way traffic (marked as “Two-way traffic” with double-arrow symbol). From the west, outbound vessels could also face crossing traffic from inbound vessels, opposite of no. 35 and no. 36 container berths. A tidal stream could be encountered up to 2.9 knots[72].

1.10.3 The investigation team noted that on the occurrence day, there were no inbound or outbound cruise vessels from the Cruise Bay when VM was exiting AWW. VM was able to cross diagonally from AWW to West Keppel Fairway without having to make two sharp turns of about 90° each while on its way to the shipyard.

1.10.4 Tugs would be on standby near Pasir Panjang container terminals to escort inbound vessels for berthing at these terminals, but not for outbound vessels from AWW unless requested by the master of a vessel.

[72] Singapore Tide Table published 2024, tidal stream predictions for the month of June 2024, at the nearest location of the Sinki Fairway. Northeast direction of 1.0 knot was predicted at Sini Fairway at 1400H on 14 June 2024.

1.10.5 Account of the master of tug CS09 (CS09-Master)

1.10.5.1 According to CS09-Master, CS09 was deployed to receive an inbound container vessel. There were two sets of VHF on board for listening watch on channel 61 and 02[73]. CS09-Master did not hear the broadcasts from PPC regarding VM's NUC. CS09-Master also mentioned that he did not hear VM-Pilot's request for assistance as he was speeding up to pass VM's bow. In addition, CS09-Master shared that it would not be safe for a tug to assist a moving vessel at a speed of about 9 knots.

1.10.6 Maintaining VHF listening watch

1.10.6.1 Every vessel when underway in the Port of Singapore, shall maintain a continuous listening watch on the VHF channel designated for the sector. This requirement was incorporated in the Port Marine Circular (PMC) No. 06 of 2021 issued by MPA.

1.10.7 Guidelines on calling for emergency tug

1.10.7.1 VM-Pilot requested for urgent harbour tug's assistance after SH had passed VM. According to PSA Marine, there were procedures established on calling emergency tug for assistance for pilotage services like in this case.

1.10.7.2 Based on the established procedures, prior to calling for emergency tug(s) through VHF channel 61, harbour pilots were required to assess whether the vessel was in a difficult or dangerous situation, where accident may be imminent, and the vessel had exhausted all available means[74] to prevent it from occurring or to prevent from further damage after an accident had already occurred.

1.10.7.3 Harbour pilots were also guided to choose any tug operator in the Port of Singapore, who could dispatch its tug to the vessel's location at the shortest time.

1.10.8 Practices on board VM

1.10.8.1 Duty officers on the bridge were allowed to start and stop HPU-A and HPU-B

[73] Channel 61 for PSA's tug deployment and Channel 02 for communication with harbour pilots for vessels berthing or unberthing from berths no. 35 and 36.

[74] Available means shall include and not limit to actions such as letting go anchors, turning the vessel away from danger, control beaching, etc. as seen in this case.

without informing the duty engineers. There was a touch-screen PMS relay located at the port side of the bridge. On the PMS screen, if the symbols of the HPU-A and HPU-B appeared in green, it meant that the hydraulic pumps were ready for use.

1.10.8.2 VM-CE would not normally be in the engine room during manoeuvring and had given full authority to the duty engineers to run the operations of engine room. VM-CE was in the changing room at the time of blackout and went to the engine room afterwards.

1.10.8.3 VM-CE's Standing Orders required the duty engineers to update applicable logbooks and all watch engineers to be at the engine control room at least five minutes prior to the start of their watch to have a proper verbal watch hand over. Other than updating applicable logbooks, there was no documented checklist for handing over of watch duties for engineers, the process of handing over watch duties were carried out verbally. The deck officers on the bridge had similar practice for handing over of watches, that is, without documented checklist. The information on the work done by the Electrician was not shared with the afternoon-shift duty engineers. The afternoon-shift duty engineers (VM-2E-1 and VM-3E-1) did not check the status of circuit breakers on the PMS after taking over duties and at the time of preparing the main engines for the departure.

1.10.9 Post-incident Port State Control (PSC) inspection

1.10.9.1 VM was detained following a PSC inspection on 15 June 2024. The detainable deficiencies listed for VM included the fire safety equipment[75], lifesaving appliances[76] and shipboard safety management system was not implemented effectively on board VM[77].

1.10.9.2 During the PSC inspection, the port anchor was released and found to be in working condition.

1.11 Environmental condition

1.11.1 At the time of the occurrence, the weather condition recorded on board VM

[75] Fire dampers for engine room supply fan no.3 and no. 4 were unable to close at the time of the PSC inspection.
[76] Lifeboat engine was unable to start, lifeboat forward weathertight cover was unbale to close at the time of the PSC inspection.
[77] As required by the ISM Code, element 7 – Shipboard operations and element 8 – Emergency preparedness.

was partly cloudy with clear and good visibility, occasional rain, southerly gentle breeze of about 7-10 knots (Beaufort wind force 3), the sea state was slight about half metre height, ebb tide[78] at about 1 knot. Similar entries were made in logbook on board MH.

[78] Refers to the tidal stream flowing in a west to east direction.

2 ANALYSIS

2.1 The cause of the loss of control of VM and allision

2.1.1 VM's electrical systems and machine installations did not have any abnormality as verified during the post occurrence inspection and function tests.

2.1.2 VM became NUC when it lost its controls of CPP and steering. The loss of controls was due to the loss of 400v low-voltage electrical power, which was previously supplying the lighting system, CPP system, steering pumps, main engine sea water cooling pumps and control systems and hydraulic pumps for anchor windlass system, etc. The loss of 400v low voltage electrical power supply was caused by the tripping of the port low-voltage circuit breaker (LVCB-2), which was the only link supplying electrical power to the 400v low-voltage equipment. The other link on the starboard side supplying the 400v low-voltage equipment was disconnected as HVCB-1 and LVCB-1 were opened by the morning-shift duty engineers to facilitate the Electrician's inspection of the cooling fans of TR-SB.

2.1.3 The tripping of LVCB-2 was due to overloading, exceeding its setting limit of 4801A. LVCB-2 was designed to have an over-current protection system to protect against overloading. The two simulation tests concluded that LVCB-2 over-current protection system functioned as designed.

2.1.4 When VM was departing AWW, many low-voltage power consumption machinery and equipment started running, such as CPP systems, steering pumps, main engine sea water cooling pumps and control systems and hydraulic pumps for anchor windlass system. As the electrical power supply distribution was not reset back to the original configuration, starting any one of the low voltage power consumption equipment would add electrical load to LVCB-2. The electrical load reached to the setting limit of LVCB-2 when HPU-B was started and caused LVCB-2 to trip.

2.1.5 Though the Electrician had informed the morning-shift duty engineers during the morning coffee break that his inspection work was completed, the morning-shift duty engineers apparently did not reset the electrical power supply distribution to the original configuration, i.e. to close HVCB-1 and LVCB-1 and open BT-2 and BT-3 (opened to facilitate the Electrician's inspection). The oversight of not resetting the electrical power supply distribution to its original configuration was also not noticed by the afternoon-shift duty engineers (VM-2E-1 and VM-3E-1) after they took over their duties and at the time of preparing the main engines for the departure.

2.1.6 The tripped LVCB-2 was only spotted when the morning-shift duty engineers (VM-2E-2 and VM-2E-3) returned to the ECR. HVCB-1 and LVCB-1 were then closed and the tripped LVCB-2 was also reset (closed). The 400v electrical power supply to the low-voltage equipment was reinstated about three minutes after LVCB-2 tripped (at 1415H18S).

2.1.7 Although the engineers at the ECR managed to regain port side controls for the CPP and set to full astern to arrest VM's ahead movements and reverse the vessel, VM was too close to MH to avoid the allision.

2.2 Logging of work activities

2.2.1 In performing engineering work which involved different work activities, it would be a challenge to remember what activities had been carried out and those that required follow-up actions, when shift work is involved. It is desirable to have a structured system to log the work activities carried out so that everyone in the system is aware of the work done. The log would also serve as a reminder on follow-up actions needed, if any.

2.2.2 On the occurrence day, the morning-shift duty engineers (VM-2E-2 and VM-2E-3) had opened HVCB-1 and LVCB-1 and closed BT-2 and BT-3 to facilitate the Electrician's inspection work. However, there was no requirement to record such activities in the form of a log. Even after being told by the Electrician that he had completed the inspection of cooling fans, it did not trigger VM-2E-2 and VM-2E-3 to close the circuit breakers that they had opened and to open the two bus-ties that they had closed.

2.2.3 While one may argue that even if the opening/closing of the circuit breakers and bus-ties had been logged, VM-2E-2 and VM-2E-3 may still have forgotten to reset them back to the original configuration. The log, when being used as a brief for handing/taking over of watch duties, would provide an opportunity for the duty engineers to reset the electrical power supply distribution to its original configuration.

2.2.4 A structured system to record work activities would help to reduce lapses due to human elements, such as forgetfulness, and ensure proper follow-up actions.

2.3 Emergency readiness of anchors

2.3.1 Both the port and starboard anchors on board VM were unable to be released for stopping or reducing the VM's headway when VM was NUC.

2.3.2 The port anchor was set for releasing in emergency at the time of departing AWW but could not be released as its shank was stuck in the hawse pipe. The port anchor was last used about two months ago and remained in secured condition till the occurrence day. The port anchor, when set for use in emergency, must be able to release immediately when the need arises. To fulfil this requirement, quick release test should be carried out from time to time, especially when the anchor has not been released for a period of time.

2.3.3 Due to the loss of electrical power, the hydraulic pump was inoperable for the windlass to free up the tension on the chain stopper for the release of the starboard anchor. Thus, the starboard anchor was also unavailable to be used to reduce the headway of VM.

2.4 Implementation of VM-Company's SMS procedures

2.4.1 The investigation team noted that several provisions in VM-Company's SMS procedures were not followed by the crew members involved in the tasks of inspecting the cooling fans and verifying the capacitor of the cooling fans of TR-SB.

(a) The approved EP form was not shown to the morning-shift duty engineers. As such, the morning-shift duty engineers (VM-2E-2 and VM-2E-3) were not aware of the inspection work until the Electrician requested them to isolate the electrical power to the TR-SB.

(b) The Electrician acted beyond his authority in disconnecting the physical HVCB-1 and LVCB-1 when these tasks should have been carried out by certified engineers.

(c) Many details were left blank in the EP, such as which electrical equipment and circuit breakers to be isolated and locked out.

(d) The PA (VM-CE) did not close the EP after the completion of the inspection work carried out by the Electrician. In VM-CE's opinion, he was not required to verify if all systems had been reset back to normal operating condition after the EP was closed. Had VM-CE verified that all systems were reset before the permit was closed, it would provide an opportunity to notice that LVCB-1 and HVCB-1 were opened.

2.4.2 The investigation team opined that the established SMS procedures for shipboard operations should always be adhered to by all officers and crew to ensure the safety of personnel and equipment on board VM.

2.5 System of handing/taking over of watch duty

2.5.1 Handing over and taking over a watch happened daily on board VM, many activities could have taken place during the previous watch, some may have been completed within the watch and others may have to be continued on the next watch. VM-CE's Standing Orders only required duty engineers to have a proper verbal watch hand over. The handing over of watch duty verbally would subject to human memory of the work activities carried out and at times, may miss out important information for the next watch.

2.5.2 A similar handing/taking over of watch duties existed for the bridge officers, that is, to hand over watch duties verbally.

2.5.3 The investigation team opined that it is desirable to have a systematic way of handing / taking over watch duties in the form of checklist, for both the bridge and engine room. The checklist should include key activities that happened in the previous watch. This would help the next watch bridge officers and duty engineers, to either have better and quicker response to emergency arising from the work activities done in the previous watch or to make better assessment and informed decision.

2.6 Electrical power load shedding

2.6.1 Overloading of electrical system could happen inadvertently due to human lapses, as in this case. While it is good that to have a protection system for the circuit breakers to prevent overloading, this may result in a situation where all the low-voltage machinery and equipment not working, some of which are essential to maintain the safe operation of the vessel.

2.6.2 It is recognised that not all low-voltage machinery and equipment on board a ship are critical. In an overloading situation, it would be desirable if the electrical system could automatically shed off the non-critical machinery and equipment to preserve electrical power for critical machinery and equipment to maintain the safe operation of the vessel. For example, machinery and equipment supporting propulsion and steering systems are essential for safe navigation and should not be disrupted from electrical power supply. HPUs are not essential for safe navigation and should be automatically shed off if electrical load on circuit breaker is reaching the setting limit.

2.7 Incidental findings

2.7.1 Maintaining listening watch on VHF

2.7.1.1 The port regulator required every vessel to maintain listening watch on designated VHF channel when manoeuvring in the Port of Singapore. SH was outbound within the PPC Sector (VHF channel 18) but did not respond to calls from VM-Pilot and the Operator of the PPC. She fortunately cleared VM though the distance was at less than 0.04nm. The investigation team could not ascertain why the bridge team of SH did not respond to the calls.

2.7.1.2 Similarly, CS09-Master did not respond to the VHF call on channel 18 from VM-Pilot requesting for its assistance. According to CS09-Master, he did not hear the call from VM-Pilot as the two sets of VHF were kept on VHF channels 61 and 02 to communicate with PSA Marine for deployment and harbour pilots for vessels berthing and unberthing from berths no. 35 and 36. CS09-Master also did not hear the warning messages of VM’s engine failure and loss of steering broadcasted by the Operator of PPC.

2.7.1.3 The occurrence reiterated the importance of maintaining listening watch on VHF communication for the safety of navigation in port waters.

2.7.2 Passage planning for intra-port movements

2.7.2.1 Passage planning is one of the key elements to ensure safety of navigation. VM-Company’s SMS procedures on voyage planning required its fleet of vessels to plan a voyage for traveling between ports and traveling between dredging area to discharge area or traveling to a bunker location. However, for intra-port movements such as shifting from AWW to the shipyard nearby on the occurrence day, the procedures were unclear whether a detailed passage plan was required.

2.7.2.2 VM-Master and deck officers viewed that the shifting of VM from AWW to the shipyard was not required to have a passage plan. As such, the move from AWW to the shipyard was conducted with waypoints on ECDIS. Average speed, tidal information and emergency stops on engines and readiness of anchors and winches were not included in this passage preparation and not thoroughly evaluated.

2.7.2.3 The passage from AWW to the shipyard required VM to transit the West Keppel Fairway, pass the Pasir Panjang Container Terminal (distance from berths of no. 35 or no. 36 to the Fairway was about 150m), face the risks of two-way traffic when exiting the AWW and executing a large course alteration (nearly 90 degrees) to join the West Keppel Fairway towards the East Jurong Channel. These factors and risks could have been better evaluated, assessed by the bridge team (including VM-Master) if there was detailed passage planning. These evaluations and assessments would be subsequently discussed with VM-Pilot during the information exchange, so that appropriate risk mitigation measures could be considered, such as proceeding with a safe speed[79] when executing the large course alteration of nearly 90 degrees to join traffic flow, heading towards East Jurong Channel. If needed, the risk mitigation measures may include the provision of an assistant tug to standby in the vicinity for immediate assistance until the risk of course alteration failure has been properly managed.

2.7.3 Maintaining situation awareness by duty engineers

2.7.3.1 The investigation team noted that the two afternoon-shift duty engineers (VM-2E-1 and VM-3E-1) left the engine room for duty rounds at forward and to check on the issue of bow thrusters without bringing a communication device when VM was underway to shipyard. The duo was unaware of the loss of electrical power when it occurred.

[79] Rule 6 of the COREGs. Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions. Various factors shall be taken into account in determining a safe speed, such as traffic density, manoeuvrability of the vessel, the proximity of navigational hazards, the draught in relation to the available depth of water, etc.

2.7.3.2 It is not uncommon for a duty engineer to carry portable radio to maintain communication with either the engine room or the bridge when there is a need to leave the engine room for urgent matters. With the portable radio, the duty engineer could be updated of any emergency arising or to provide advice to salvage a situation.

3 CONCLUSIONS

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 The blackout on board VM was due to the tripping of the port lower-voltage circuit breaker (LVCB-2) when an added electrical load, from the starting of the HPU-B, exceeded LVCB-2's over-current protection limit.

3.2 The tripping of LVCB-2 resulted in the loss of electrical power supply to the low-voltage machinery and equipment affecting the CPP and steering gear systems, which resulted in VM becoming Not Under Command.

3.3 With both rudders remaining at 10 degrees to starboard and both main engines at half ahead (indicators of both the main engines showing pitch at half ahead) position, VM turned to starboard at a speed of 8.3 knots and impacted MH due to delay in regaining the controls of CPP and steering.

3.4 The post occurrence inspection and function tests did not reveal any abnormality on VM's electrical systems, machinery and equipment. Two simulation tests concluded that LVCB-2 over-current protection system functioned as designed.

3.5 The impact of VM on MH resulted in MH's hull damage and cargo oil spillage into the sea. EB, which was alongside MH, suffered consequential hull damage and minor lube oil spillage.

3.6 The isolation of electrical power to TR-SB by opening HVCB-1 and LVCB-1 was performed to facilitate the safe inspection of the cooling fans of TR-SB. The duty engineers did not reset HVCB-1 and LVCB-1 to reestablish electrical power to TR-SB after the inspection work was completed, which resulted in only LVCB-2 providing electrical power to all the low-voltage machineries and equipment.

3.7 There was no structured system on board VM to log engineering work activities to increase the awareness of the duty engineers when changing shifts, and ensure proper follow-up actions.

3.8 Both of VM's anchors could not be deployed to reduce the headway of VM. This was because the port anchor, which was set for emergency use, was stuck in the hawse pipe and due to the loss of electrical power, the hydraulic pump to operate the windlass was unavailable to free up tension on the chain stopper for the release of the starboard anchor.

3.9 Several provisions in VM-Company's SMS procedures were not followed by the crew members involved in the tasks of inspecting the cooling fans and verifying the capacitor of the cooling fans. These included not showing the approved EP form to the morning-shift duty engineers, acting beyond the authority by the Electrician in disconnecting the physical HVCB-1 and LVCB-1, not providing full details needed in the EP form by the Electrician and not closing the EP form by VM-CE after the completion of the inspection work.

3.10 Handing/taking over of watch duties on board VM were done verbally, both for the engineers and bridge officers. This unsystematic way of handing over of watch duties relied heavily on crew memory and critical tasks that need follow-up actions may be missed.

3.11 There was no load-shedding for electrical system to automatically shed off non-critical low-voltage machinery or equipment during an overload situation.

3.12 SH did not respond to calls made by VM-Pilot and PPC and the reason for not responding to the calls could not be ascertained. The Master of harbour tug, CS09, did not maintain VHF listening watch as required by the port regulator and did not hear the warning messages broadcasted by the PPC.

3.13 VM-Company's SMS procedures were unclear if a detailed passage plan was required for intra-port shifting. VM-Master and deck officers believed it was not required and did not prepare a detailed passage plan. This resulted in a missed opportunity to prepare VM's planning for an unexpected event or emergency and the relevant risk mitigation measures.

3.14 The afternoon-shift duty engineers left the engine room without carrying communication devices and were not aware of the loss of electrical power when it occurred.

4 SAFETY ACTIONS

During the course of the investigation and through discussions with the investigation team, the following safety actions were initiated by the relevant stakeholders.

4.1 By VM-Company

4.1.1 After the occurrence, VM-Company issued a Circular Letter (No. 2024-012) to its fleet of vessels for lessons learned from the allision occurrence and highlighted the importance of emergency preparedness and instructed its fleet of vessels to conduct a loss of propulsion power drill. The conduct of the loss of propulsion power drill was completed in February 2025.

4.1.2 VM-Company reviewed its SMS procedures and decided to implement a new Working Instruction (WI) for the emergency preparedness of an electrical failure scenario. This WI defined an electrical failure situation[80] and explained procedures to carry out electrical failure test and recovery. A specific drill for the electrical failure scenario to be conducted annually on board its fleet of vessels. A checklist was developed for the electrical failure test and recovery.

4.1.3 The WI also required all vessel's officers[81] to be familiar with ship's specific switchboard setup / configuration for vessels manoeuvring in port with harbour pilot on board. In case of doubt or questions, masters are required to contact VM-Company's Technical Superintendent / Fleet Manager for advice, and when situations required to deviate from the designed setup due to defects.

4.2 By PSA Marine

4.2.1 PSA Marine issued a circular reminding all its tug masters of the mandatory requirements to maintain listening watch on the designated VHF channel of the respective reporting sector, as stated in the PMC No. 06 of 2021. The circular reiterated that one of two VHF sets provided onboard the tug must be set on the designated VHF channel of the respective reporting sector.

[80] A situation when there is a sudden loss of electrical power in the main distribution system and remains until the main source of power feeds the system.
[81] Including all deck and engineering officers.

5 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

5.1 For VM-Company (the ISM Managers of Vox Maxima):

5.1.1 To establish a structured system on board its fleet vessels to log key engineering work activities done. **[TSIB Recommendation RM-2025-006]**

5.1.2 To ensure vessel's anchor set for emergency use can be released in time of emergency. **[TSIB Recommendation RM-2025-007]**

5.1.3 To ensure the effective implementation of safety management system on board its fleet of vessels. **[TSIB Recommendation RM-2025-008]**

5.1.4 To consider having load-shedding design for shipboard the electrical system to automatically shed off non-critical machinery or equipment during an overload situation. **[TSIB Recommendation RM-2025-009]**

5.1.5 To provide clarity on its safety management procedures whether a detailed passage plan was required for intra-port shifting. **[TSIB Recommendation RM-2025-010]**

5.1.6 To ensure duty engineers are contactable when they are out of the engine room. **[TSIB Recommendation RM-2025-011]**

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Inspection Report

Schneider Electric Singapore Pte Ltd

Services Department

Reporter [redacted]

Date: 18.07.2024

Participant: [redacted]

Customer : [redacted]

Site Address : Vox Maxima Vessel (Anchorage, Singapore)

Report Ref : [redacted]

Copy To : [redacted]

Subject : Black out simulation test on LV-400V Aux Swbd AFT

REPORT :

1.1 Site Work :

- Before initiation of simulation test, the protection setting of Incoming Feeder Aux Swbd AFT PS breaker, Bus Tie breaker and Incoming Feeder Aux Swbd SFT SB breaker are recorded at 10:20am, 18 July 2024.

[redacted]

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- Long time (Ir = 2800A) , Long time delay (tr = 2s) , Short time (Isd = 11.20KA) , Short time delay (tsd = 0.3s) and Instantaneous (Ii = OFF) trip settings at Incoming Feeder Aux Swbd AFT PS breaker

Fig 1 : Protection setting of Micrologic 5.0A at Incoming Feeder Aux Swbd AFT PS ACB

Fig 2 : Max Current at L1, L2, L3 of AFT PS ACB

[redacted]

[redacted]

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- Long time (Ir = 2800A) , Long time delay (tr = 2s) , Short time (Isd = 11.20KA) , Short time delay (tsd = 0.4s) and Instantaneous (Ii = OFF) trip settings at Incoming Feeder Aux Swbd AFT SB breaker

Fig 3 : Protection setting of Micrologic 5.0A at Incoming Feeder Aux Swbd AFT SB ACB

Fig 4 : Max Current at L1, L2, L3 of AFT SB ACB

[redacted]

[redacted]

- Long time (Ir = 2240A) , Long time delay (tr = 2s) , Short time (Isd = 6720A) , Short time delay (tsd = 0.3s) and Instantaneous (Ii = OFF) trip settings at BusTie breaker

Fig 5 : Protection setting of Micrologic 5.0A at Bus Tie

Fig 6 : Max Current at L1, L2, L3 of Bus Tie

[redacted]

[redacted]

- As per overview of electrical distribution, Incoming Feeder Aux Swbd AFT PS breaker and Bus Tie breaker are closed. Incoming Feeder Aux Swbd SFT SB breaker is opened. Recorded time is 10:33am.

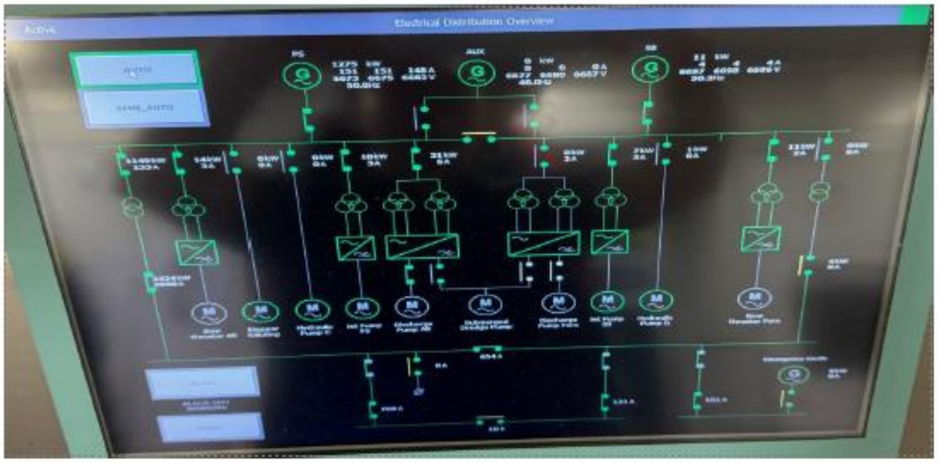

Fig 7 : Electrical Distribution Overview

1.2 Simulation Test 1

First simulation test is carried out around 11:31am.
Initial load current of Incoming Feeder Aux Swbd AFT PS ACB is 2421A.

[redacted]

[redacted]

When starting Hydraulic pump A, total load current (initial load + pump A starting current) is recorded as 3445A. Duration of Pump A starting is about 10 sec.

After starting of pump A, normal running current is dropped to 2588A.

As per sequence, Hydraulic pump B is started. Total load current is recorded as 4579A. Duration of Pump B starting is about 2 sec.

After starting of pump B, normal running current is dropped to 2810A.

[redacted]

[redacted]

1.3 Simulation Test 2

Second simulation test is carried out around 11:43am.
Initial load current of Incoming Feeder Aux Swbd AFT PS ACB is 2554A.

When starting Hydraulic pump A, total load current (initial load + pump A starting current) is recorded as 3565A. Duration of Pump A starting is about 10 sec.

After starting of pump A, normal running current is dropped to 2690A.

As per sequence, Hydraulic pump B is started. Total load current is recorded as 4741A. Duration of Pump B starting is about 2 sec.

[redacted]

[redacted]

After starting of pump B, normal running current is dropped to 2856A.

1.4 Simulation Test 3

Third simulation test is carried out around 11:48am.
Total load current plus Pump A normal running current is 2754A.

As per sequence, Hydraulic pump B is started. Total load current is recorded as 4778A. Duration of Pump B starting is about 2 sec.

After starting of pump B, normal running current is dropped to 2822A.

[redacted]

[redacted]

1.5 Simulation Test 4

Fourth simulation test is carried out around 12:04pm.
Initial load current of Incoming Feeder Aux Swbd AFT PS ACB is 2836A.

When starting Hydraulic pump A, total load current (initial load + pump A starting current) is recorded as 3851A. Duration of Pump A starting is about 10 sec.

After starting of pump A, normal running current is dropped to 3024A.

As per sequence, Hydraulic pump B is started. As soon as Pump B is started, Incoming Feeder Aux Swbd AFT PS ACB is tripped by Long Time protection (Ir). Last readable current is recorded as 4801A before breaker tripped.

[redacted]

[redacted]

- After normalised LV 400V Swbd, max current of AFT PS ACB and Bus Tie ACB is recorded as below.

Fig 7 : Max Current at L1, L2, L3 of AFT PS ACB

Fig 8 : Max Current at L1, L2, L3 of Bus Tie

[redacted]

1.6 Summary

- In simulation test 1, test 2 and test 3, observed that Ir is picked up when pump A is started. But after pump A starting time (about 10 sec) is completed, total current is dropped below Ir trip threshold which is between 1.05 and 1.20 Ir. So trip time delay is reset at this point. Trip time delay started again when Ir is picked up by starting pump B and observed CB no trip. Starting duration of pump B is about 2 sec which is not long enough to reach time delay setting. For time delay setting, refer to software generated trip curve of Micrologic attached below.

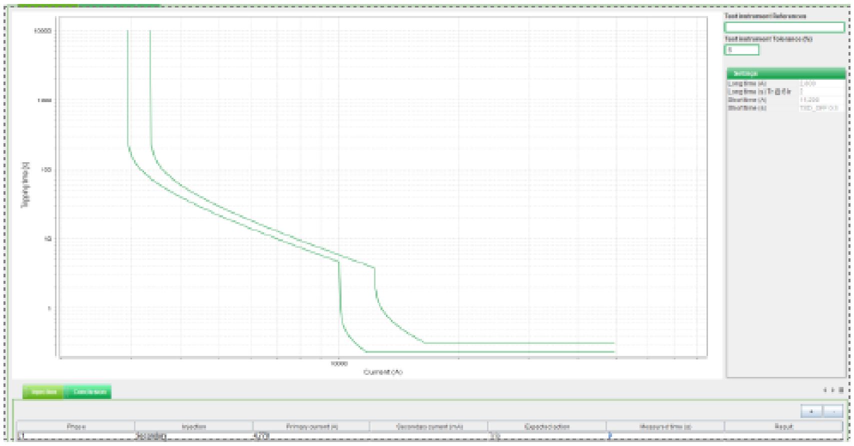

Fig 9 : Trip Curve Generated By Software As Per Setting Of Incoming Feeder Aux Swbd AFT PS ACB

- For example, Trip time delay for current 4805A can be generated by trip curve.

Minimum trip: 24.126 s
Maximum trip: 32.892 s

Trip time delay for current 4805A is between 24.126s and 32.892s.

- In simulation test 4, observed that Ir is picked up and trip time delay is started to count down when pump A is started. Even after pump A starting time (about 10 sec) is completed, total current is dropped to 3024A which is still above Ir trip threshold. Trip time delay continue count down. As soon as pump B is started, ACB is tripped by Long Time protection (Ir) because starting current of pump B is high enough to shorten the trip time delay of Micrologic dramatically.

[redacted]

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Inspection Report

Schneider Electric Singapore Pte Ltd

[redacted]

Reporter [redacted] **Date:** **26.07.2024**

Participant: [redacted]

Customer : [redacted]

Site Address : Vox Maxima Vessel (Anchorage, Singapore)

Report Ref : [redacted]

Copy To : [redacted]

Subject : Second Black out simulation test on LV-400V Aux Swbd AFT

REPORT :

1.1 Site Work :

- Before initiation of simulation test, the protection setting of Incoming Feeder Aux Swbd AFT PS breaker and Bus Tie breaker are recorded at 09:45am, 26 July 2024.

[redacted]

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- Long time (Ir = 2800A) , Long time delay (tr = 2s) , Short time (Isd = 11.20KA) , Short time delay (tsd = 0.3s) and Instantaneous (Ii = OFF) trip settings at Incoming Feeder Aux Swbd AFT PS breaker

Fig 1 : Protection setting of Micrologic 5.0A at Incoming Feeder Aux Swbd AFT PS ACB

Fig 2 : Max Current at L1, L2, L3 of AFT PS ACB

- Long time (Ir = 2240A) , Long time delay (tr = 2s) , Short time (Isd = 6720A) , Short time delay (tsd = 0.3s) and Instantaneous (Ii = OFF) trip settings at BusTie breaker

Fig 3 : Protection setting of Micrologic 5.0A at Bus Tie

Fig 4 : Max Current at L1, L2, L3 of Bus Tie

- As per overview of electrical distribution, Incoming Feeder Aux Swbd AFT PS breaker and Bus Tie breaker are closed. Incoming Feeder Aux Swbd SFT SB breaker is opened.

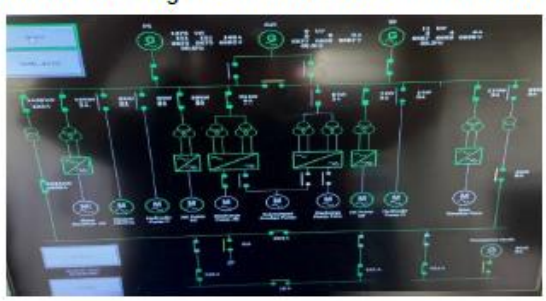

Fig 5 : Electrical Distribution Overview

1.2 Simulation Test 1

First simulation test is carried out around 9:52am.
Initial load current of Incoming Feeder Aux Swbd AFT PS ACB is 2822A.

When starting Hydraulic pump A, total load current (initial load + pump A starting current) is recorded as 3765A. Duration of Pump A starting is about 10 sec.

After starting of pump A, normal running current is dropped to 2925A. As per test procedure, pump A is kept running for about 5 minutes. Recorded running current is about 2925A. After pump A running for 5 minutes, stop pump A because no CB trip is observed and system is running normally.

1.3 Simulation Test 2

Second simulation test is carried out around 10:07am.
Initial load current of Incoming Feeder Aux Swbd AFT PS ACB is 2810A.

When starting Hydraulic pump A, total load current (initial load + pump A starting current) is recorded as 3766A. Duration of Pump A starting is about 10 sec.

After starting of pump A, normal running current is dropped to 2850A. As per test procedure, pump A is kept running for about 1 minute.

After pump A running for 30 sec, observed that the load started to fluctuate roughly between 3059A and 3295A for about 30 sec.

As per test procedure, Hydraulic pump B is started after pump A running for 1 minute. As soon as Pump B is started, Incoming Feeder Aux Swbd AFT PS ACB is tripped by Long Time protection (Ir). Last readable current is recorded as 4852A before breaker tripped.

- After normalised LV 400V Swbd, max current of AFT PS ACB is recorded as below.

Fig 6 : Max Current at L1, L2, L3 of AFT PS ACB

1.4 Summary

- As per generated trip curve, estimated trip time delay for current at Ir trip threshold is between 327.704s and infinity. Since the trip time delay range is too wide which is up to infinity, unable to determine the exact trip time delay if the load current is closed to Ir trip threshold.

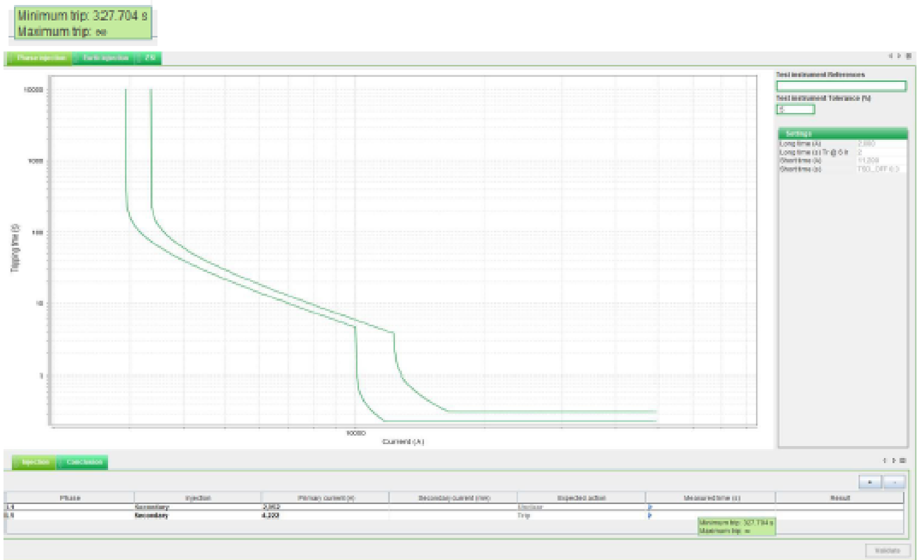

Fig 7 : Trip Curve Generated By Software As Per Setting Of Incoming Feeder Aux Swbd AFT PS ACB

Remark : As per generated trip curve, trip time delay calculation is applicable for only 1 point of stable current value and unable to calculate for fluctuating current value.

- In simulation test 1, Incoming Feeder Aux Swbd AFT PS ACB is running with the load 2924A which is closed to Ir trip threshold for about 5 minutes and observed CB no trip. Based on simulation test 1, it is confirmed that AFT PS ACB will not trip when ACB is carrying 2924A for 5 minutes.

- In simulation test 2, observed that Ir is picked up and trip time delay is started to count down after pump A is started. Also observed current fluctuation after pump A running for 30 sec. As soon as pump B is started, ACB is tripped by Long Time protection (Ir).

- No abnormality of AFT PS ACB is found and micrologic is working in normal condition throughout the simulation test.

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