Final Report

Fatality of Deck Cadet onboard Strategic Harmony at sea on 1 May 2023

TIB/MAI/CAS.142

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

30 May 2024

The Transport Safety Investigation Bureau of Singapore

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Table of Contents

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ABBREVIATIONS

ASD	Able Seafarer Deck
BCSN	Bulk Cargo Shipping Name
BSN	Bosun
CCC	Sub-Committee on Carriage of Cargoes and Containers
CPR	Cardiopulmonary Resuscitation
CM	Chief Mate
DC	Deck Cadet
DWT	Dirty Water Tank
H	Hour
IMO	International Maritime Organization
IMSBC	International Maritime Solid Bulk Cargoes
ISM	The International Management Code for the Safe Operation of Ships and for Pollution Prevention
LR	Lloyd's Register
m	Metre
MARPOL	International Convention for the Prevention of Pollution from Ships
min	Minute
MT / T	Metric tonne / Tonne
nm	Nautical Mile
OS	Ordinary Seaman
ppm	parts per million[1]
PPE	Personal Protective Equipment[2]

[1] Parts of the substance per million parts of contaminated air by volume.
[2] Equipment worn to minimise exposure to hazards that cause serious workplace injuries and illnesses.

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PA	Public Address
RA	Risk Assessment
2E	Second Engineer
2O	Second Officer
SCBA	Self-contained Breathing Apparatus
SMS	Safety Management System
STCW	Seafarers Training, Certification and Watchkeeping
UTC[3]	Universal Coordinated Time
VHF	Very High Frequency

[3] Coordinated Universal Time (UTC) is the primary time standard to which the world regulates clocks and time.

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SYNOPSIS

On 1 May 2023, the Singapore registered bulk carrier, Strategic Harmony (SH) was at the North Atlantic Ocean enroute to port São Luis, Brazil for the discharge of the cargo of coal.

The Chief Mate (CM) and the Deck Cadet (DC) entered the Dirty Water Tank Port (DWTP) to open a surface drop valve to discharge the waste water that had accumulated inside the DWTP. Both the CM and DC collapsed in the tank. An emergency rescue was initiated, and both the CM and DC were evacuated from the DWTP. Soon after administering medical oxygen, the CM regained consciousness but unfortunately, the DC passed away.

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

The investigation revealed that the CM, the designated Safety Officer, did not consider the hazards associated with the entry into the DWTP, which was to be treated as an enclosed space. The DC had likely succumbed to the oxygen-deficient atmosphere of the DWTP.

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VIEW OF VESSEL

Strategic Harmony – (*Source:* the Company)

DETAILS OF VESSEL

Name	Strategic Harmony (SH)
IMO number	9689897
Classification society[4]	LR
Ship type	Bulk Carrier
Year built	2014
Company[5]	M.T.M. Ship Management Pte. Ltd.
Gross tonnage	24,658
Length overall	179.99m

[4] Recognised Organisation (RO) approved by the Flag Administration for issuance of statutory certificates.
[5] "Company" means the Owner of the ship or any other organisation or person such as the Manager, or the Bareboat Charterer, who has assumed the responsibility for operation of the ship from the Shipowner and who on assuming such responsibility has agreed to take over all the duties and responsibility imposed by the ISM Code. From here onwards, M.T.M. Ship Management Pte. Ltd. would be referred to as the Company in the report.

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Breadth	30m
Designed draft	10.50m
Summer freeboard	4.54m
Main engine(s)	Yichang Marine Diesel Engines 5550 (1 x 6050kW)
Propeller(s)	1 x fixed pitch

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1 FACTUAL INFORMATION

All times used in this report are the vessel's Local Time (LT) unless otherwise stated. The vessel's Local Time is three hours behind of Coordinated Universal Time (UTC).

In the conduct of marine safety investigation into the circumstances surrounding this death occurrence, the investigation team reviewed information obtained from the Master, crew, and the Company.

1.1 Narrative

1.1.1 On 1 May 2023, the vessel SH in the North Atlantic Ocean (see **figure 1**) was on a loaded voyage to the Port of São Luis, Brazil for the discharge of 36,750MT of coal and was scheduled to arrive on the following day. At that time, the deck crew were assigned for washing and cleaning duties on deck, while the DC was assisting[6] the CM.

Figure 1 – SH was about 310nm away from the Port of São Luis (*Source:* TSIB)

1.1.2 At about 1335H, the 2O, who was the Officer of the Watch on the navigation

[6] Elaborated in para 1.2.

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bridge heard a call[7] for help on the portable VHF radio, "*Chief Sir has fallen inside the tank…*". The 2O queried[8] in which tank, the response was "*dirty water tank...quickly…quickly…Chief Officer has fallen down*". Unable to confirm the identity of the caller, the 2O immediately informed the Master and made an announcement on the PA system, to muster all crew for an emergency.

1.1.3 All crew, except the CM and DC, mustered at about 1340H. The duo was presumed to be missing and likely were inside the DWT as heard on the radio by the 2O. Attempts were made to contact the CM and DC on the portable VHF radio, but there was no response.

1.1.4 At about 1345H, the first rescue team consisting of the ASD1, ASD2, and ASD3 equipped with SCBA (see **figure 2**) entered the DWT Port (DWTP) through a manhole[9] (see **figure 3**) which was the only access into the tank. The DWTP was located adjacent to no. 4 cargo hold (see **figure 4**).

Figure 2 – SCBA (*Source:* the Company)

[7] The call was made in the Hindi language.
[8] VDR transcript (*Source:* the Company).
[9] The manhole was found open.

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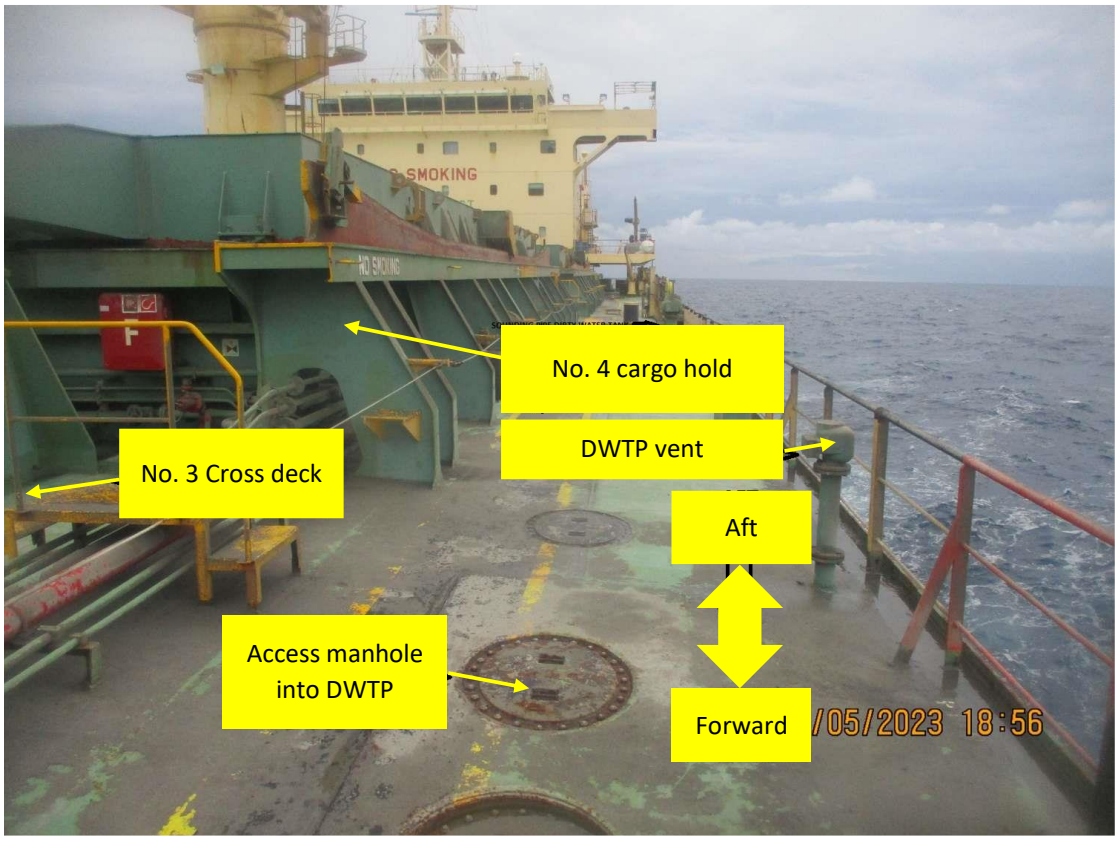

Figure 3 – DWTP access manhole (*Source:* the Company – annotation by TSIB)

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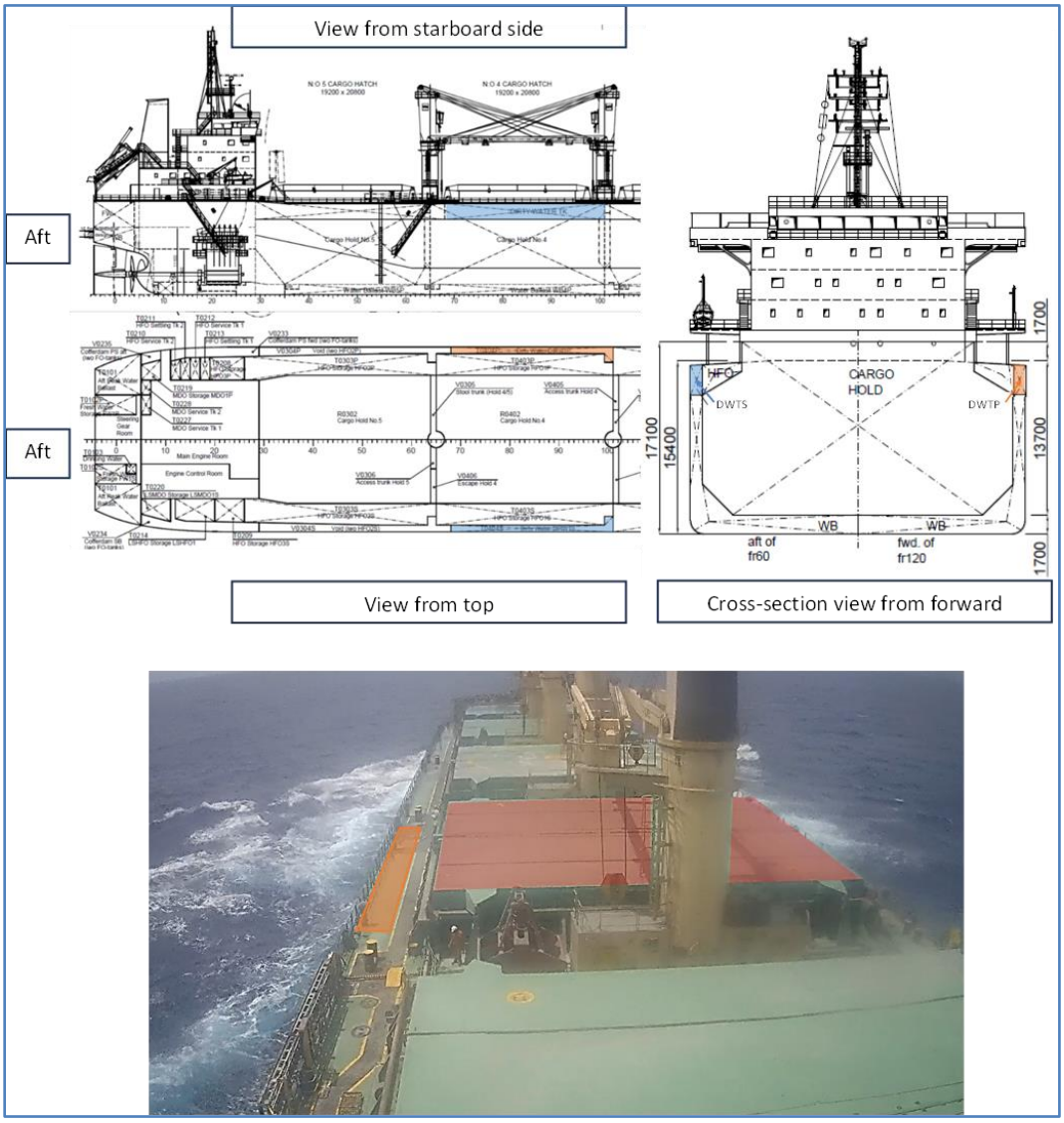

Figure 4 – DWTP - shaded orange in the drawings and photo, DWTS[10] - shaded blue in the drawings, and no. 4 cargo hold - shaded red in the photo. (*Source:* the Company – annotation by TSIB)

1.1.5 The ASD3 entered the DWTP first and located both the CM and DC inside the sixth upper compartment, about 14m aft from the manhole, (see **figure 5**). The ASD3 reported the location of the CM and DC to the Master after exiting the tank. At about same time, the ASD1 and ASD2 began evacuating the CM.

[10] DWT Starboard.

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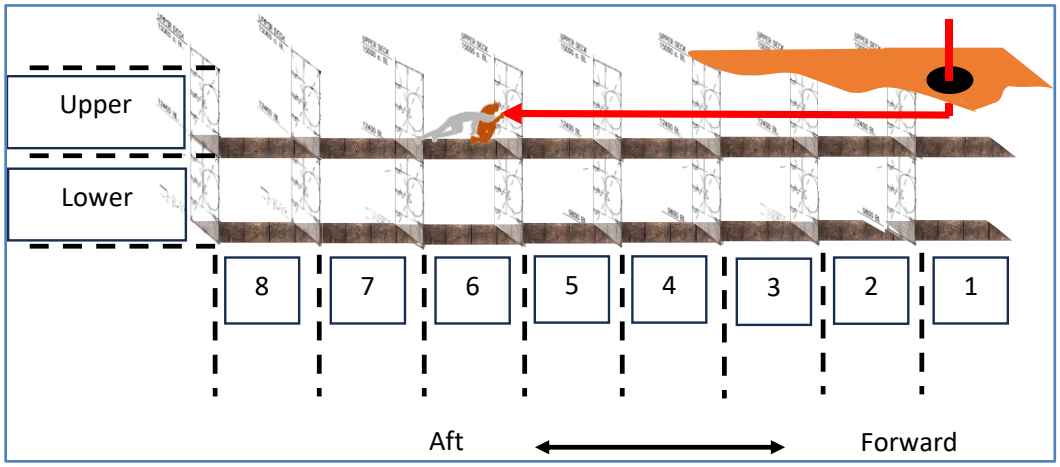

Figure 5 – Illustration of the location of the CM and DC - showing eight out of total eleven compartments (*Source:* the Company – annotation by TSIB)

1.1.6 At about 1400H, the ASD1 and ASD2 successfully evacuated the CM from the tank. The CM was found to be unconscious but breathing and vomiting. The CM was promptly brought to the cross deck (at the main deck) between no.3 and no.4 cargo hold, first aid and medical oxygen[11] were given to the CM. Soon after administering medical oxygen, the CM regained consciousness.

1.1.7 After the first rescue team exited the tank, the second rescue team consisting of the Oiler and Wiper entered the tank with SCBA. By about 1410H they evacuated the DC out of the tank onto the main deck. The DC was also unconscious but breathing and vomiting. The DC was also provided with first aid treatment and medical oxygen.

1.1.8 Despite the administration of medical oxygen, the DC remained unconscious. At about 1425H, the DC was brought to the ship's infirmary for further medical care.

1.1.9 At about 1432H, the Master contacted the International SOS[12] (ISOS) seeking medical advice.

[11] 'Medical oxygen' or 'supplemental oxygen' available only from health care provider, used for caring of patients in surgery, trauma, heart failure, asthma, pneumonia and maternal and childcare.
[12] Provide telemedical assistance specific to the physical and emotional needs of mariners through Future Care, part of the International SOS Group of Companies. The medical team assists ship's captain or medical officer to correctly diagnose and treat the problem.

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1.1.10 The DC was administered medical treatment[13] as advised by the ISOS. At about 1440H, the Master reported the incident to the Company. At about 1605H after consulting the Company, the Master established communication with the MRCC[14] Belem, Brazil and requested for a medical evacuation at the earliest, preferably by air. At 1620H, the Master made the decision to divert the vessel to Belem which was about 240nm away.

1.1.11 At about 1700H, despite continual medical treatment on the DC as advised by the ISOS, the DC's condition started to deteriorate[15]. At about 1718H, there were no vital signs, the doctor from ISOS pronounced the DC dead. By 1900H, the body of the DC was placed in the vessel's cold room.

1.1.12 SH continued proceeding to the Port of Belem for evacuation of the CM. On the following day, at about 0530H, SH arrived at the estuary of the Para River[16], the approaches to the Port of Belem. At about 1810H, the CM was transferred to shore via a Brazilian naval ship (NPA Guaruja). SH then resumed its voyage to the Port of São Luis.

1.2 Accounts from the CM

1.2.1 On the morning of 1 May 2023, while keeping navigational watch on the bridge, the CM assigned tasks of cleaning and washing hatch covers to the Bosun[17] (BSN) and the deck crew, as the hatch covers had been dirtied by cement clinkers residues (the previous cargo).

1.2.2 At about 0800H, the CM assigned the tasks of checking the gas levels in cargo holds[18] and sounding[19] the cargo holds bilges to the DC.

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[13] Amongst the treatment were to have the DC in a semi-upright position to open the airway and continue the administration of medical oxygen, to check for auscultation, respiration rate, full set of vital signs including temperature and blood glucose level, and to continue CPR with a cycle of 30 compressions and 2 breaths via a bag mask valve to allow for chest rise.

[14] MRCC Belem - responsible for coordinating air-sea rescue in North-east Brazil and an extensive area of the Atlantic Ocean Region (AOR).

[15] The DC was no longer breathing, continuation of CPR was recommended. During CPR, telephonic instruction for evaluation of breath sounds, heart sounds, pupillary reaction were provided. Unfortunately, there were no longer any signs of life. (*Source:* ISOS).

[16] At 0900H SH was escorted up the Para River by a naval vessel and arrived at the Mosquiero anchorage of the Port of Belem at about 1615H.

[17] A ship's personnel, part of the deck crew, in charge of deck crew akin to a supervisor.

[18] As the cargo holds were loaded with coal, it was a part of routine and established practice, for the checking of hydrocarbon content in the cargo hold.

[19] The typical and routine task of taking measurement of the quantity of liquid in a compartment / tank. The level measured from the bottom of the tank to the water surface.

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1.2.3 At about 0900H, after completing the assigned tasks, the CM met the DC. The CM then conducted his routine deck rounds together with the DC. During the rounds the CM saw the BSN and OS working at the cross deck forward of no.5 cargo hold and three ASDs cleaning the cement clinker residues at no. 3 cargo hold hatch cover, with a cleaning agent[20]. After the rounds, the CM and the DC returned to the ship's office, the DC updated the gas content readings and soundings to the CM.

1.2.4 At about 1000H, the CM and DC went to the Bosun's store[21] to check some outdated cleaning agent[22]. At 1030H, the CM and DC returned to accommodation for tea break[23] after carrying out tests on cement clinker residue with the cleaning agent.

1.2.5 At about 1100H, the DC went to open the manhole cover of DWTP as instructed by the CM. In the interaction with the investigation team, the CM clarified that he shared with the DC the purpose of opening the manhole cover was not to enter the DWTP but to discharge[24] the waste water (a mixture of seawater used for washing and cargo residue[25]) that had accumulated inside the tank by using an electric sump pump[26]. At about 1130H, while loosening the nuts of the manhole cover, the CM came and joined the DC to open the manhole.

1.2.6 According to the CM, the DC suggested to discharge the waste water by opening the surface drop valve from inside the tank instead of using the electric sump pump as it was faster to discharge the waste water by opening the surface drop valve (part of the dump valve assembly[27]) than by using the electric sump pump.

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[20] Hydrochloric acid.
[21] A store for storage of deck equipment and items at the forward most part of the ship.
[22] Older stock of cleaning agent kept onboard in the Bosun's store.
[23] Typical of a shipboard routine for ship's crew to have tea-break, at around 1000H to 1030H and 1500H to 1530H.
[24] Typically, the discharge of waste water from the DWTP into the sea would be carried out by opening the deck dump valve (part of the dump valve assembly). However, this was not possible as the dump valve assembly was reported defective since 11 April 2023. The CM had resorted to using the electric sump pump as an alternative to discharge the waste water from the DWTP.
[25] Waste water is garbage in this context as it contains cargo residues. MARPOL Annex V Ch1/1.9 - Garbage means all kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed off continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention. MARPOL Annex V Ch1/1.2 - Cargo residues means the remnants of any cargo which are not covered by other Annexes to the present Convention and which remain on the deck or in holds following loading or unloading, including loading and unloading excess or spillage, whether in wet or dry condition or entrained in wash water but does not include cargo dust remaining on the deck after sweeping or dust on the external surfaces of the ship.
[26] An electric powered pump used to remove water that has accumulated in a water-collecting sump basin or in other locations where water must be removed.
[27] Dump valve assembly elaborated in para 1.6.3.

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According to the CM, the DC had reportedly used the same method on SH with the previous Chief Officer[28] for the DWTS. After the manhole cover was open, the duo went for lunch.

1.2.7 The investigation team gathered from the CM that he had changed his plan of using the electric sump pump to discharge the waste water, after considering the DC's suggestion and planned to enter the DWTP to open the surface drop valve. At about 1330H, the CM carried, a portable VHF radio and torches[29], entered the DWTP and made his way to the sixth upper compartment. The CM added that upon entering the DWTP there was a scent of rotten soya bean meal. The DC carrying a portable VHF radio and a T-spanner[30] (see **figure 6**) entered the DWTP about two minutes after the CM.

Figure 6 – 1.4m long T-spanner (*Source:* the Company)

1.2.8 At about 1334H, the CM started experiencing dizziness and instructed the DC to evacuate from the tank. The CM recalled seeing the DC near the compartment close to the manhole access of the DWTP but was uncertain if it was the first or second upper compartment. The CM also recalled the DC turning around and looking at him[31] from near the manhole access. Subsequently, the CM collapsed in the sixth upper compartment[32], experiencing periods of consciousness and unconsciousness[33].

[28] The investigation team did not have access to the previous Chief Officer to corroborate the event.
[29] The CM and DC had head torch equipped with the CM carrying another hand torch.
[30] The CM and DC planned to open the surface drop valve with the extended T-spanner.
[31] It was believed that the DC made the call on the portable VHF radio at this moment to the 2O.
[32] It was believed that the DC had turned back into the sixth upper compartment and tried to rescue the CM instead of exiting the tank.
[33] There was no information of the gas content reading of the DWTP after the occurrence.

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1.3 The crew

1.3.1 There were 21 crew from India onboard SH. Details of relevant persons are listed in **table 1**.

Rank	CM[34]	DC[35]
Age	34	22
Certificate held | Issued by	STCW Regulation II/2[36] | Government of India[37]	STCW Regulation VI/1[38] | Directorate General of Shipping, Government of India
Daily Work hours[39]	0400H to 0800H and 1600H to 2000H[40]	Non-watchkeeping duties at sea[41]
Experience in rank (years)	2.4	0.5
Experience on similar type ship (years)	5.4	0.5
Service with company (years)	4.8	0.5
Service onboard (months)	1.9	5.6

Table 1 – (*Source:* the Company)

1.3.2 Prior to the occurrence, the rest hour records[42] onboard SH indicated that the CM and DC's rest hours, in the past 24-hour and in the last 7-day period, were in compliance with the requirements of the STCW[43] and MLC[44] Convention

[34] Designated as the Safety Officer onboard SH, responsible for all aspects of safety in the ship.
[35] SH was the first ship the DC was sent for training.
[36] STCW Code - A-II/2 Mandatory minimum requirements for certification of masters and chief mates on ships of 500 gross tonnage or more.
[37] Mercantile Marine Department of the Ministry of Shipping.
[38] STCW Code - A-VI/1 Mandatory minimum requirements for safety familiarisation, basic training, and instruction for all seafarers. As a trainee, the deck cadet is not a holder of a Certificate of Competency or Proficiency.
[39] Scheduled daily work hours at sea as recorded in the vessel's table of shipboard working arrangements.
[40] With non-watchkeeping duties at sea from 0900H to 1100H.
[41] 0800H to 1200H and 1300H to 1700H.
[42] Update of rest hours is maintained individually by each crew member.
[43] STCW Code - A-VIII/1 Fitness for duty.
[44] Maritime Labour Convention, 2006 - Regulation 2.3 – Hours of work and hours of rest.

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(tabulated in **table 2**).

Rest hours	24-hour	7-day
CM	16	100
DC	24	122

Table 2 – (*Source:* the Company)

1.3.3 The DC was issued a medical certificate[45] which indicated his fitness for sea duties on 4 November 2022.

1.4 Cause of death

1.4.1 The DC's body was offloaded at the Port of São Luis. On 8 May 2023 the São Luis's coroner at the State of Maranhão, Brazil examined the remains and determined the cause of death was asphyxiation.

1.5 The vessel

1.5.1 SH was a Handymax size[46] bulk carrier in tramp service plying between Mediterranean and East coast of Central and South Americas. SH was capable of carrying many types of bulk cargo such as soya bean meal, cement clinkers and coal.

1.5.2 SH was issued a Certificate of Compliance for the carriage of solid bulk cargoes by LR on 15 April 2023 and is valid until 23 October 2024, her others statutory certificates were also valid.

1.6 Dirty Water Tank

1.6.1 There were two DWTs onboard SH having same layout, located at the upper outermost tank in way of the no. 4 cargo hold, on the port and starboard side. Two heavy fuel oil (HFO) tanks were between the DWTs, and the no.4 cargo hold at the port and starboard sides (see **figure 7**). Below the DWT was the water ballast

[45] Issued by Apollo clinic in Uttarakhand, India
[46] A way of categorising bulk carriers basing on ship's capacity, a Handymax sized ship is typically about 35000-59000 deadweight (DWT).

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tank.

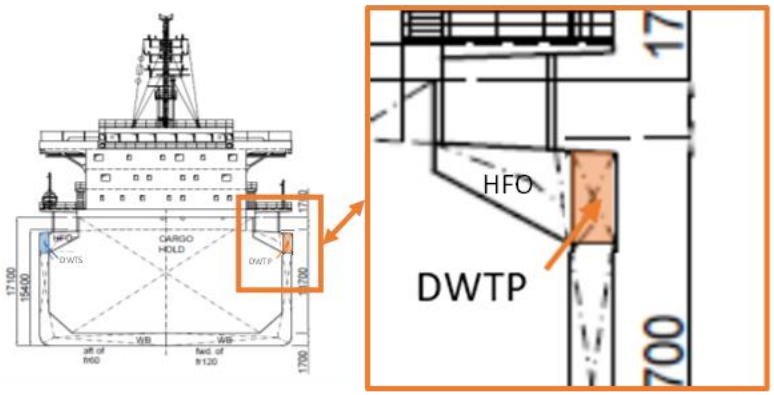

Figure 7 – Location of the HFO tank and DWTP (*Source:* the Company – annotation by TSIB)

1.6.2 The DWTP was divided by 10 transverse frames and one intermediate deck floor, forming 11 compartments at the upper and lower floor respectively (see **figure 8**). The tank was about 1.43m wide and 5.2m deep. Two natural vents on main deck were connected to the tank at the two ends. One fire mains inlet line was connected to the tank for tank flushing and cleaning by sea water. The capacity of the DWTP was about 156.4 cubic meter.

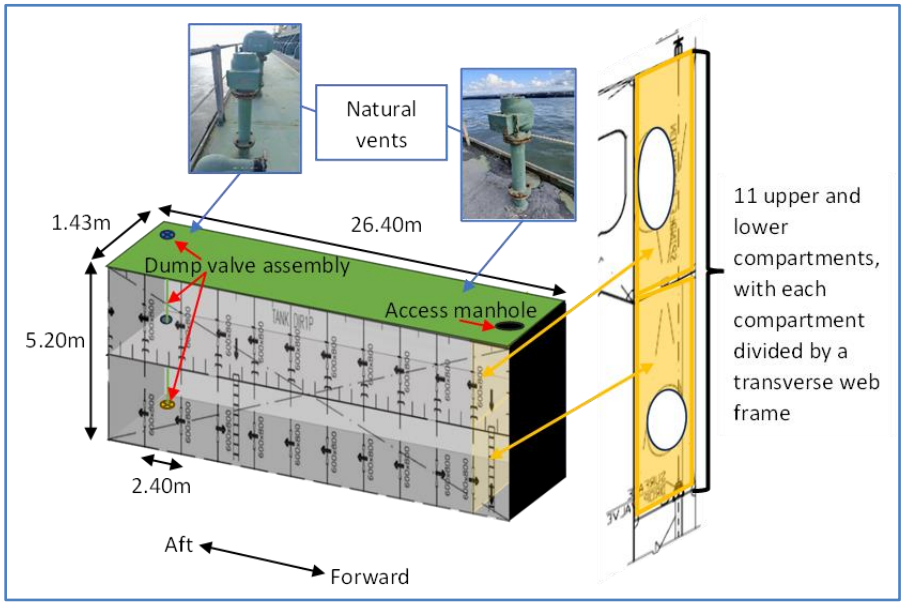

Figure 8 – Overview of the DWTP for illustration purpose (*Source:* the Company – annotation by TSIB)

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1.6.3 The dump valve assembly consisted of the deck dump valve, the spindle extension (including universal / union joint) and the surface drop valve which was connected. Waste water inside the DWTP could be discharged overboard by turning the deck dump valve on the main deck, which in turn opens the surface drop valve located inside the tank (see **figure 9**).

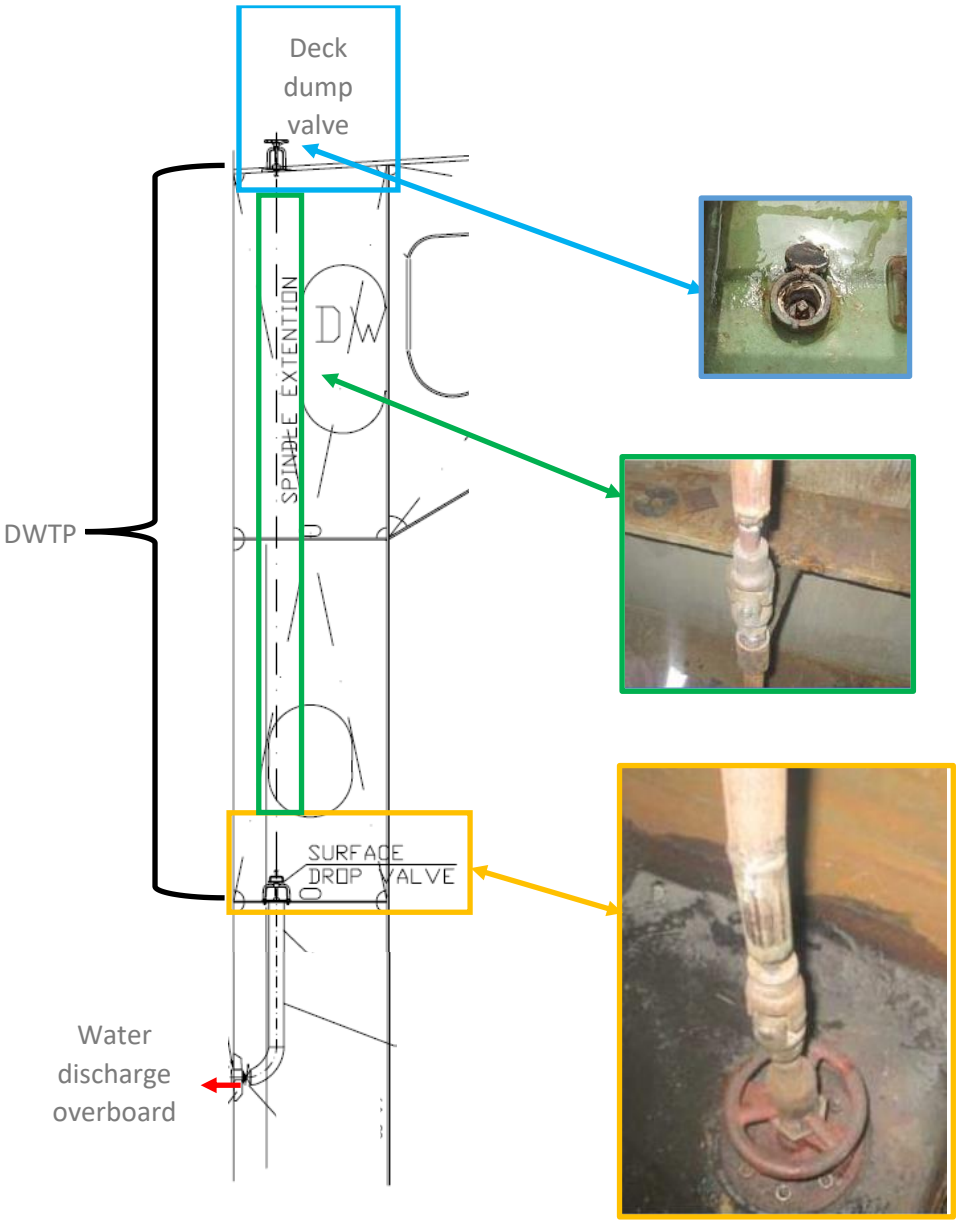

Figure 9 – Dump valve assembly in the DWTP, cross-section view from aft (*Source:* the Company – annotation by TSIB)

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1.6.4 There were no records of the amount of waste water inside the DWTP in the ship's sounding[47] book[48] since 13 March 2023. However, a sounding on 2 May 2023 (after the incident) indicated that the DWTP was at 1.79m (about 50.9 cubic meter) of waste water. The last sounding recorded for the DWTP was 1.0m on 12 March 2023[49].

1.6.5 The dump valve assembly of the DWTP was reported defective on 11 April 2023 and remarked 'not working' in the vessel's Planned Maintenance System[50] (PMS). According to the 2E's statement the "spindle" of the dump valve assembly was broken[51] requiring hot work repair, which could only be performed after the cargo of coal was discharged.

1.6.6 Amongst others, the DWTP was considered as one of the enclosed spaces (no. 17) listed[52] on the ship's notice board updated on 18 March 2023, reminding all crew. There was no enclosed space entry permit made for the entry into DWTP by the CM and DC on 1 May 2023.

1.7 Enclosed space entry

1.7.1 The Company managed various types of vessels such as bulk carrier, oil tanker, chemical tanker, and other cargo ships. For enclosed space entry, the Company's SMS procedures provided a guideline[53].

1.7.2 Prior to entering a tank or an enclosed space, the guideline required a pre-planning meeting chaired by the Master, or a responsible person[54] assigned by the Master, to be conducted, all personnel involving in the entry were required to

[47] As per the Company's instructions a Ballast / Fresh Water / Bilges sounding book was to be maintained onboard which record the daily soundings and quantities of all tanks. The DC was tasked by the CM to take the tanks sounding daily and to record them in the sounding book.
[48] The sounding book indicated that the CM had initialled it (with the missing entries on the sounding records of the two DWTs) daily until the day of the occurrence.
[49] An entry acknowledged by the CM.
[50] The defects reporting system onboard SH linked with the Company. The Company would be notified of the defects through the system.
[51] The CM did not have knowledge of the specific defective component within the dump valve assembly.
[52] List comprising all Enclosed Spaces on Form S168 from the Safety Manual's Tank / Enclosed Space Entry Guidelines of the Safety Management System (SMS).
[53] The guideline made reference to IMO Resolution A.1050(27) - Revised recommendations for entering enclosed spaces aboard ships. The objective is to encourage the adoption of safety procedures aimed at preventing casualties to ships' personnel entering enclosed spaces where there may be an oxygen-deficient, oxygen-enriched, flammable and/or toxic atmosphere.
[54] As defined in the guideline - responsible person means a person authorised to permit entry into an enclosed space and having sufficient knowledge of the procedures to be established and complied with onboard, in order to ensure that the space is safe for entry.

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attend.

1.7.3 The scope of the meeting included the purpose of tank entry and procedures, action plan, and assignment of responsibilities to each individual. The meeting would also address the scheduling of manpower, tank washing, gas freeing, testing of the tank atmosphere, identifying and minimising physical hazards, listing of equipment needed (i.e., safety, firefighting, communication, tools, escape, and rescue), advising non-vessel personnel of the hazards associated with the operation, maintaining safe conditions in the tank, and reviewing procedures for rescue and firefighting.

1.7.4 The guideline included the filling up of a Form S110[55] as the enclosed space entry permit (hereafter referred to as the Permit). The Permit was required to be completed by the Master or responsible person and by the persons entering the enclosed space (e.g., competent person[56] and attendant[57]). The Permit was only used for entering a single enclosed space / tank. An RA was also required to be carried out. On the occurrence day, there was no RA carried out and also no Permit completed.

1.7.5 For entry into the DWTP, the CM shared the reasons on why he did not perform an RA and complete a Permit:

- it was easier to open the surface drop valve using the T-spanner from inside the DWTP to speed up discharging of waste water overboard;
- the DWTP was not considered dangerous as it was a small tank containing water from the previous cargo hold washing;
- it would be time-consuming[58] to complete a Permit and disrupting the tasks already assigned to the deck crew members; and

[55] Form S110 was 7 pages.
[56] As defined in the guideline - competent person means a person with sufficient theoretical knowledge and practical experience to make an informed assessment of the likelihood of a dangerous atmosphere being present or subsequently arising in the space.
[57] As defined in the guideline - attendant means a person who is suitably trained within the safety management system, maintains a watch over those entering the enclosed space, maintains communications with those inside the space and initiates the emergency procedures in the event of an incident occurring.
[58] As the task was unplanned, the CM reckoned it would take time to acquire a permit, it would also mean to reassign task already given to the crew.

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- missed the opportunity to discharge the waste water[59] once SH arrived at port São Luis on the following day and would expect to have a long port stay which he would use for repairing of the defective dump valve assembly of the DWTP.

1.7.6 The CM added that he anticipated the waste water in the DWTs to increase once the cargo holds washing were done after the discharging of cargo at São Luis. The CM also added that with the DWTs being full, it might affect the cargo loading capacity at the next port. When queried by the investigation team regarding the next loading port, the CM explained that there were no cargo loading instructions or nominations for SH after São Luis, but he was concerned on the cargo loading capacity at the next port, nonetheless.

1.7.7 The CM only realised that to operate the surface drop valve from inside the tank could not work after attempting this from inside of the DWTP. This was because the level of water inside the tank was too high and the inability to connect the T-spanner to the wheel of the surface drop valve while standing in the upper compartment.

1.8 Rescue from enclosed space drill

1.8.1 There were six different scenarios for rescue from enclosed space drill[60] and each scenario was drilled once a year. The interval between each drill was two months (see **figure 10**). The last three rescue from enclosed space drills conducted onboard SH were, rescue from cofferdam / void space on 28 April 2023, rescue from fore peak tank on 18 February 2023 and rescue from aft peak tank on 7 December 2022. The DC participated on the last three rescue from enclosed space drills since joining SH on 10 November 2022, whereas the CM participated on one rescue from enclosed space drill since joining SH on 7 March 2023.

[59] When asked, the Company confirmed that even if the waste water had not been discharged prior to arrival, the cargo lifting capacity for the next voyage on completion of discharge, remained unaffected.

[60] IMO Resolution A.1050(27) – Revised Recommendations for Entering Enclosed Spaces Aboard Ships – 6 General Precautions / 6.4 Only trained personnel should be assigned the duties of entering, functioning as attendants or functioning as members of rescue teams. Ships' crews with rescue and first aid duties should be drilled periodically in rescue and first aid procedures. Training should include as a minimum:
.1 identification of the hazards likely to be faced during entry into enclosed spaces;
.2 recognition of the signs of adverse health effects caused by exposure to hazards during entry; and
.3 knowledge of personal protective equipment required for entry.

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RESCUE FROM ENCLOSED SPACE

Drill Name Records	Last Done Dt.	Interval	Next Due Dt.
RESCUE FROM CARGO TANKS / CARGO HOLD	20-Aug-2022	1 - Y	20-Aug-2023
RESCUE FROM BALLAST TANKS	18-Oct-2022	1 - Y	18-Oct-2023
RESCUE FROM COFFERDAM/VOID SPACE	28-Apr-2023	1 - Y	28-Apr-2024
RESCUE FROM AFTER PEAK	07-Dec-2022	1 - Y	07-Dec-2023
RESCUE FROM SCAVENGE SPACE	24-Jun-2022	1 - Y	24-Jun-2023
RESCUE FROM FORE PEAK TANK	18-Feb-2023	1 - Y	18-Feb-2024

Figure 10 – Rescue from enclosed space drill record onboard SH (*Source*: the Company)

1.9 Cargo hold cleaning

1.9.1 The Company's SMS procedures provided guidance on cargo hold cleaning, e.g., washing of cargo hold would not be needed if only sweeping and residue disposal was required. The procedures also stated that cargo hold cleaning requirements would vary greatly depending on the next cargo and according to the charterer's instructions.

1.9.2 Washing of cargo hold would generate waste water which would either be discharged into the sea concurrently during cleaning or to be retained onboard[61] when the vessel was within 'Special Area[62]' as guided by the MARPOL, Annex V[63].

1.10 Past voyages and cargo carried onboard

1.10.1 The last two cargo carried in the past two voyages in March and April 2023 were

[61] Transferred into the DTWP or DWTS using a fixed bilge piping system connected to the cargo holds.
[62] MARPOL - Annex V (Regulations for the Prevention of Pollution by Garbage from Ships), Ch1/1.14 - Special area means a sea area where for recognized technical reasons in relation to its oceanographic and ecological condition and to the particular character of its traffic the adoption of special mandatory methods for the prevention of sea pollution by garbage is required. Although the discharge of waste water (garbage) is permitted while the ship is enroute within special areas, subject to compliance to the requirements of MARPOL Annex V, the Company adopted a common practice across its fleet of ships of retaining the waste water whenever the ship is within special area.
[63] The Regulations for the Prevention of Pollution by Garbage from Ships.

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soya bean meal[64] (BCSN - seed cakes and other residues of processed oily vegetables as described in the shipper's[65] declaration) and cement clinkers respectively.

1.10.2 Cargo holds were washed[66] after discharging soya bean meal at Haifa, Israel. The waste water was (about 50.9 cubic meter) transferred to the DWTP.

1.10.3 According to the IMSBC Code[67], soya bean meal has the following hazards:

- liable to oxidise, causing subsequent reduction of oxygen (O_2) in cargo space;
- loading of dry pellets using cargo blowers may present a risk of dust explosion; and
- non-combustible or have a low fire risk.

1.10.4 The safety precautions identified in the IMSBC Code are as follow:

- entry of personnel into cargo spaces for this cargo shall not be permitted until tests have been carried out and it has been established that the O_2 content has been restored to a normal level; and
- persons who may be exposed to the dust of the cargo shall wear a dust filter masks, protective eyewear and protective clothing, as necessary.

1.10.5 IMSBC Code further details the characteristic of soya bean meal (see **figure 11**), with a group C hazard classification - of cargoes which are neither liable to liquefy (group A) nor to possess chemical hazards (group B). There are no provisions in the IMSBC Code on hazard and / or precaution for solid bulk cargo when it is mixed with waste water and stored onboard.

[64] Describe as 'seed cakes and other residues of processed oily vegetables' in the shipper's declaration, corresponding to IMSBC Code Appendix 1 – Individual Schedules of Solid Bulk Cargoes. Seed Cake is primarily used as an ingredient in animal feeds and is the solid residue that remains after edible vegetable oils have been removed from oil-bearing seeds, cereals, or other commodities, in this case 'soya bean meal'.
[65] IMSBC Code Section 1/1.7 Definitions - Shipper means any person by whom or in whose name, or on whose behalf, a contract of carriage of goods by sea has been concluded with a carrier, or any person by whom or in whose name, or on whose behalf, the goods are actually delivered to the carrier in relation to the contract of carriage by sea.
[66] Washed after the discharge of soya bean meal at Haifa on 23 March 2023.
[67] IMSBC Code facilitate the safe stowage and shipment of solid bulk cargoes by providing information on the dangers associated with the shipment of certain types of solid bulk cargoes and instructions on the procedures to be adopted when the shipment of solid bulk cargoes is contemplated.

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Characteristics

Physical properties			
Size	**Angle of repose**	**Bulk density (kg/m^3)**	**Stowage factor (m^3/t)**
Various	Various	478 to 719	1.39 to 2.09
Hazard classification			
Class	**Subsidiary hazard(s)**	**MHB**	**Group**
Not applicable	Not applicable	Not applicable	C

Figure 11 – Characteristic of soya bean meal (seed cakes) and other residues of processed oily vegetables (*Source:* IMSBC Code)

1.10.6 Soya bean meal is an organic commodity where microbiological growth will occur naturally when there is sufficient moisture and warmth. 'The growth of fungi, bacteria, and possibly other microscopic organisms, takes place in organic materials in warm and moist conditions and O_2 is drawn from the atmosphere during the proliferation of the micro-organisms. During these processes heat is also produced[68]'.

[68] Referenced from Bulk cargoes: a guide to good practice – North of England P&I.

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2 ANALYSIS

The investigation looked into the following:

(a) The occurrence

(b) Enclosed space entry

(c) Shipboard operations and work planning

(d) Rescue from enclosed space drill

(e) Incidental observations

2.1 The occurrence

2.1.1 The cause of death of the DC was asphyxiation, a lack of oxygen, or suffocation. The CM recalled smelling the scent of rotten soya bean meal upon entering the DWTP. The DWTP contained waste water, a mixture of wash water and cargo residue of soya bean meal which had comingled for about one month. Soya bean meal, which was liable to oxidise, had probably caused the reduction of O_2 in the DWTP and caused both the CM and DC to lose consciousness and resulted in the death of the DC.

2.1.2 The CM had instructed the DC to evacuate from the DWTP before the CM became unconscious, however the DC was found near the CM when the DC was recovered from the DWTP by the rescue team. It was likely the DC had approached the CM instead of evacuated from the DWTP, probably to rescue the CM after the DC had made the call for help on the portable VHF radio.

2.2 Enclosed space entry

2.2.1 According to the CM, he was influenced by the DC to open the surface drop valve from inside the DWTP and changed his plan of discharging the waste water by using an electric sump pump. The investigation team was puzzled by how a senior crew onboard a ship, who held the rank of a CM for two years, could be easily influenced by a deck cadet who only had about six months of seagoing experience. It would be desirable if the CM was more confident with his initial decision, and to prioritise safety when faced with alternative suggestions.

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2.2.2 SH has procedures for enclosed space entry, but it was not carried out by the CM and DC before entry into DWTP. The CM had thought the DWTP as a small tank and did not consider it dangerous for entry as it contain water from the previous cargo hold washing.

2.2.3 The CM and DC entered the tank assured that they can complete the discharge of the waste water quicker but disregarded the requirements of enclosed space entry. The CM had also thought that it would be time-consuming to complete a Permit, and he did not want to disrupt the crew on their assigned tasks. In disregarding the requirements of enclosed space entry, the duo had exposed themselves to potential dangers[69] associated with enclosed space. A Permit would have ensured proper RA, planning and communication before entry.

2.2.4 Although there are no provisions in the IMSBC Code on hazard and / or precaution for solid bulk cargo when mixed with waste water and stored onboard, it seems logical to consider the hazards in the DWTP with the hazards associated with the cargo, soya bean meal in this case, when the DWTP contained waste water from the washing of soya bean meal. The safety precautions identified in the IMSBC Code for soya bean meal required the testing of the cargo spaces to ensure that the O_2 content is normal level before entering.

2.2.5 It is likely that the CM did not understand the risk of the waste water inside the DWTP. It would have been desirable if he had considered the IMSBC Code's hazards and precautions for soya bean meal before deciding to enter the DWTP. The investigation team opined that, although the IMSBC Code indicated the hazards for cargo spaces, the hazards and precautions should also be considered for waste water tank when it stores the waste water from the washing of the cargo spaces when it contains the cargo residue of soya bean meal.

2.3 Shipboard operations and work planning

2.3.1 The CM was concerned that he would miss the opportunity to discharge the waste water once SH arrived at port São Luis as he wanted to make use of the anticipated long port stay for the repairs of the defective dump valve assembly of the DWTP. The CM was also concerned that the level of waste water in the DWTs would increase once cargo holds washing were done after cargo discharging at São Luis and felt that with the DWTs being full it might affect cargo loading

[69] An enclosed spaces where there may be an oxygen-deficient, oxygen-enriched, flammable and/or toxic atmosphere as mentioned in IMO Resolution A.1050(27).

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capacity at the next loading port even though there was no information regarding the next cargo loading. These two concerns had likely motivated the CM to discharge the waste water from the DWTP. Had the CM raised these concerns to the Master and the Company, he would be better informed of the situation and not place undue pressure upon himself to discharge the waste water. The CM had not acted on informed decision instead created an operational constraint based on his assumptions and was committed to complete the discharge of the waste water.

2.3.2 The task of discharging the waste water from the DWTP was not part of the CM's work plan, the CM had decided it as an impromptu action. The occurrence demonstrated the importance of proper communication and work planning. With proper work planning, the potential hazards associated with enclosed space entry may be identified, and proper safety procedures would be followed.

2.4 Rescue from enclosed space drill

2.4.1 Rescue from enclosed space drill for cofferdam / void space was conducted on 28 April 2023, three days prior the occurrence, a scenario which was almost identical to the incident. Both the CM and DC had reportedly participated in the rescue from cofferdam / void space drill. The rescue from enclosed space drill should have refreshed the duo with the knowledge on the need to take precautions and adhere to the safety procedures when performing rescue operation in enclosed spaces.

2.4.2 Considering that the drill was conducted only three days prior to the incident, the basic precautions such as not to rescue any individual without proper PPE should have been fresh on the mind of the participants. In this case, the DC reportedly had returned to rescue the CM, without proper PPE, halfway towards the tank exit, leaves doubt to the effectiveness of the drill.

2.5 Incidental observations

2.5.1 The soundings of the DWTs were not maintained onboard since 13 March 2023. The daily record of tanks sounding is essential for ships as it can immediately indicate any abnormal sounding that may be observed from the tank. Accurate and up to date soundings are crucial for planning the safe and efficient stowage of cargo and for maintaining the ship's stability. The CM had reviewed and initialled the sounding book daily but overlooked the missing entries.

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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 CM and DC had entered the DWTP, to open the surface drop valve, and the DC succumbed to the low O_2 atmosphere due to the oxidisation of the cargo residue (soya bean meal).

3.2 The CM was rushing to complete the discharge of waste water from the DWTP and in doing so, the CM did not obtain a Permit.

3.3 The CM did not understand the significance of the hazards associated with soya bean meal in the DWTP and had likely not perceived the hazards to be applicable in the DWTP as it was in the cargo spaces.

3.4 The CM's concerns to discharge the DWTP before arriving at port São Luis were two-fold, a) to start the repairs on the dump valve assembly when SH is in port São Luis in anticipation of a long port stay and b) the cargo loading capacity for the next loading port would be unaffected. The CM did not raise these concerns to the Master or the Company.

3.5 The discharge of waste water from DWTP was not a pre-planned work and the hazards and risks associated with entry into enclosed space were not assessed.

3.6 The DC had probably attempted to rescue the CM, despite reportedly being told to evacuate from the DWTP by the CM. The DC had attended the rescue from enclosed space drill conducted three days prior to the incident.

3.7 The lack of recordings of the DWTs soundings were there for over a month. The effectiveness of an oversight procedure was lacking.

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4 SAFETY ACTIONS

Arising from discussions with the investigation team, the Company has taken the following safety action.

4.1 Actions taken by the Company

4.1.1 Fleetwide campaign on marking of “NO PERMIT – NO ENTRY” on the manhole covers of all enclosed spaces as per vessel specific enclosed space list and the jobs have been included in the PMS for six monthly verifications.

4.1.2 LET (Learning Engagement Tool) – Safety presentation included enclosed space entry and daily toolbox meeting and discussed in monthly shipboard Safety Committee Meeting.

4.1.3 Safety Pledges initiated for all seafarers onboard the Company’s ships, which included pledges for enclosed space entry and daily toolbox meeting[70]. These pledges are signed individually by the seafarers.

4.1.4 An animated audio-visual presentation of the incident was created and shared with all ships. The video was added in the Company’s PDOT (Pre-Departure Orientation and Training) library and made available to all officers and crew to view before joining a ship.

4.1.5 An initiative implemented by the Company requiring senior personnel from the Company to attend and take part onboard the Company managed vessel’s monthly safety committee meeting either physically or virtually.

[70] SH’s Safety Manual (SAF-0100) Daily Work Plan & Toolbox Meetings - Conduct of a daily toolbox meeting is required prior crew is allowed to proceed to the individual workplace.

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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.

It is recommended that the Company:

5.1 Ensure ship's crew are made aware of the hazards of cargo residues stored in tanks. [TSIB Recommendation RM-2024-012]

5.2 Ensure pre planning of shipboard work are carried out. [TSIB Recommendation RM-2024-013]

5.3 To review the effectiveness of the rescue from enclosed space drills by ensuring that ship crew understand the safety procedures for performing rescue operation from enclosed space. [TSIB Recommendation RM-2024-014]

5.4 Ensure tank soundings record onboard are verified and kept up to date. [TSIB Recommendation RM-2024-015]

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