FINAL REPORT

FATAL INJURY AT SEA
ON BOARD TANKER
BOW SUN
ON 8 AUGUST 2018

MIB/MAI/CAS.048

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

21 May 2020

The Transport Safety Investigation Bureau of Singapore

The Transport Safety Investigation Bureau (TSIB) is the air, marine and rail accidents and incidents investigation authority in Singapore. Its mission is to promote transport safety through the conduct of independent investigations into air, marine and rail accidents and incidents.

The TSIB conducts marine safety investigations in accordance with the Casualty Investigation Code under SOLAS Regulation XI-1/6 adopted by the International Maritime Organisation (IMO) Resolution MSC 255 (84).

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SYNOPSIS

On 8 August 2018, at about 0908H, the Singapore registered oil/chemical tanker, Bow Sun, was transiting the Gulf of Aden enroute to Suez Canal.

The Pumpman was tasked to troubleshoot the cause of loss of suction of the submersible ballast pump inside the ballast tank with the assistance of another deck crew. The deck crew was standing by at the entrance while the Pumpman entered the tank alone. After a metal flange suspected to be the cause of the suction problem was removed from the pump casing, it was tied by the Pumpman with a rope and instruction was given to the deck crew to heave it out of the tank. In the process of heaving, the flange, weighing about 6kg, came loose from the rope and dropped into the tank from a height of more than 5m and hit the Pumpman's head. The Pumpman suffered severe head injury and was evacuated for medical care but succumbed to the injuries at the hospital few days later.

The Transport Safety Investigation Bureau classified the occurrence as Very Serious Marine Casualty and launched a marine safety investigation.

The investigation revealed that the flange had likely not been tied with an appropriate knot and which became loose when heaving out of the tank. The Pumpman was likely attempting to climb up when the flange came loose from the rope. The impact force of the flange had exceeded the certification requirement of the safety helmet.

The investigation also revealed that there was no risk assessment being carried out for the troubleshooting of the ballast pump.

DETAILS OF THE SHIP

Name	Bow Sun
IMO number	9197284
Flag	Singapore
Classification society	Det Norske Veritas and Germanischer Lloyd (DNV-GL)[1]
Ship type	Oil/chemical tanker
Hull	Steel
Delivery	1 August 2003
Owners	Odfjell Asia II Pte Ltd
Operators / ISM[2] Managers	Odfjell Tankers AS / Odfjell Management AS
Gross tonnage	29974
Length overall	182.88m
Moulded breadth	32.20m
Moulded depth	17.95m
Summer draft	12.42m
Draft (Forward / Aft)	11.85m / 11.95m

Bow Sun
(*Source*: the ISM Manager)

[1] DNV-GL was the Recognised Organisation (RO) for the flag Administration, for carrying out ISM audit and issuance of ISM related certificates, in addition, DNV-GL was also for survey and issuance of other statutory certificates.
[2] International management code for the safe operation of ships and for pollution prevention.

1 FACTUAL INFORMATION

All times used in this report are Ship's Mean Time (SMT), which was two hours ahead of the Coordinated Universal Time (UTC), i.e. UTC + 2H, unless otherwise stated.

1.1 Sequence of events

1.1.1 On 8 August 2018, the Singapore registered oil/chemical tanker, Bow Sun (BS), was enroute to Suez Canal, transiting the Gulf of Aden.

1.1.2 At about 0730H, the Chief Officer[3] called the Bosun[4] and the Pumpman[5] for a daily work plan meeting at the ship's office. The Bosun was to assist with the remounting of the overhauled air horn on the foremast, while the Pumpman was to troubleshoot the problems with airtightness of a flange (anode cover) of the ballast pump[6] casing inside no.7 ballast tank, at the port side (7WBT-P).

1.1.3 At about 0830H, an Able Seafarer Deck[7](ASD) came on deck to assist the Pumpman as assigned by the Chief Officer. The ASD started ventilating the 7WBT-P to prepare for entry (opening of the manhole) while the Pumpman was preparing the tools.

1.1.4 At about 0855H[8], the Pumpman with a portable radio for communication entered 7WBT-P to remove the said flange at the bottom of the tank while the ASD stood by at the manhole entrance for assistance. The ASD and the navigating officer on the bridge (the Third Officer[9]) were also on the same radio channel. The tools (for use by the Pumpman), put inside a bucket, were lowered by the ASD using a rope (see paragraph 1.4.3) tied to the bucket.

1.1.5 After about 10 minutes of entering[10], according to the ASD, the Pumpman

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[3] A day worker who had no watchkeeping duties at sea.

[4] A day worker who was keeping the assigned security watch (0800H-1200H) at that time.

[5] A day worker who was also required to keep security watches (0000H-0400H and 1200H-1600H) if instructed by the Master.

[6] A type of equipment installed on board for transferring or discharging ballast water to adjust ship's stability. The pump had been known to have lost suction during operations.

[7] He kept the 0400H-0800H and 1600H-2000H sea watches.

[8] Timing was based on the ship's log recorded by the bridge duty officer.

[9] Kept the 0800H-1200H and 2000H-2400H sea watches.

[10] Enclosed space entry log book kept on the bridge contained an entry into 7WBT-P at 0855H.

shouted (did not use the radio)[11] to the ASD to heave up the rope, which had been removed from the bucket of tools and tied to the flange[12]. The ASD started[13] retrieving the rope.

1.1.6 At about 0908H, the ASD recalled that the rope had been retrieved for about 6-8m, when the tension on the rope was loosened and realised that the flange had come off from the rope. At about the same time the ASD heard a scream from the Pumpman in the tank.

1.1.7 Thinking that the flange might have hit the Pumpman, the ASD communicated on the portable radio to inform the others that the Pumpman might have been injured.

1.1.8 The Master of BS, who was in the office preparing to go to the ship's forecastle to check on remounting status of the air horn, overheard this call on the radio and had assumed[14] that a crewmember had fallen from the foremast while remounting the air horn.

1.1.9 The Master went to the bridge to find out from the Third Officer on what had happened. On being informed of an injury inside the ballast tank, the ship's general alarm was raised and all crew were instructed to muster at 7WBT-P to rescue the Pumpman from the tank.

1.1.10 The Chief Officer, who was in the ship's office, after hearing the ship's general alarm and announcement, called for the Bosun (who was on deck) to proceed to 7WBT-P. On arriving at the scene, the Chief Officer entered the tank and informed the Master that the Pumpman was lying unconscious at the bottom platform and bleeding from the head. The Pumpman's helmet had an indentation and blood was seen in the vicinity. Considering the severity of the injury, the Master requested medical assistance from a Japanese coalition warship (the Akebono)[15] in the vicinity and informed the Company (ISM Manager).

1.1.11 Meanwhile, at about 0927H, the Pumpman was retrieved from the tank and

[11] The ASD recalled that they had been using the same mutual understandable signal for heaving up items (e.g. a bucket of working tools) in the past few occasions working on the ballast pump.
[12] More details in paragraph 1.4.2.
[13] The ASD recalled noticing the Pumpman was staying away (from the manhole) before lifting the rope.
[14] To the Master's knowledge there was no entry into any tank planned for the day.
[15] Warship "108 (Akebono)", was on a routine security patrolling in the Gulf of Aden against pirate's activity.

transferred[16] to the ship's infirmary for medical care.

1.1.12 Subsequently, the Chief Officer sought radio medical advice[17] while the Master was discussing with the Akebono (the warship) on the medical arrangement for the Pumpman.

1.1.13 After assessing the information provided by the Master, at about 0954H, the Akebono indicated[18] its intention to provide medical care to the Pumpman. The Chief Officer was informed by the Master to prepare for receiving a medical team. BS was slowed down to facilitate the arrival of the warship's helicopter.

1.1.14 At about 1049H, the medical team and equipment from the Akebono were winched down onto BS from the helicopter.

1.1.15 The medical team provided medical care to the Pumpman who regained consciousness. After a further assessment by the medical team, the Pumpman was airlifted to the Akebono at about 1210H, and BS resumed its passage to its destination about 20 minutes later.

1.1.16 The Master was updated that in the late afternoon, the Pumpman was transferred to a hospital in Djibouti and on 12 August 2018, was transferred to a hospital in Dubai for further medical treatment[19]. About a week later, the Company informed the Master that the Pumpman had passed away at the hospital in Dubai.

1.2 The ship

1.2.1 BS was a double hull oil and chemical tanker, built with 40 cargo tanks to carry multiple types of chemical or oil cargo. Her last dry-docking was carried out in June 2018.

1.2.2 BS had 20 water ballast tanks, most of which were fitted on both port and starboard sides of cargo tanks to serve as a protection for the cargo tanks as well as used to maintain ship's stability.

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[16] The Pumpman was unconscious but had a shallow breathing.

[17] Norwegian centre for maritime medicine, available 24/7, offers medical assistance to ships in need of help for diagnosing and treatment of diseases and injuries.

[18] According to the statement from the Master of BS.

[19] The Company had taken the ship's Protection and Indemnity Club's advice into consideration on the hospital transfer.

1.2.3 At the time of the incident, 7WBT-P, which extended from frames (Fr.) 63 to 79, was empty, as were the other water ballast tanks. To access the tank, two same sized manholes[20] were provided on the main deck port side.

1.2.4 Inside 7WBT-P, a vertical ladder, located at the side of the manhole, which extended through three platforms provided direct access to the bottom platform. The estimated height from the bottom platform (where the Pumpman was found unconscious) to the main deck was about 16m, to platform-2 was 7.7m, and to the platform-1 was about 3m (see **figure 1**).

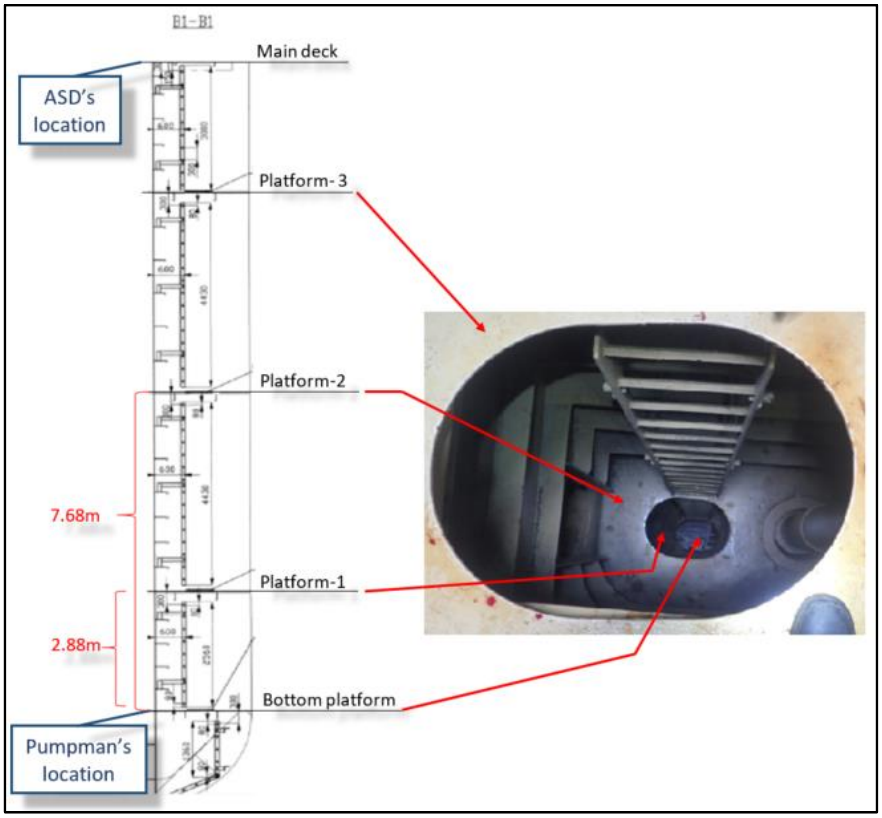


Figure 1 – Overview of the 7WBT-P with drawing and picture
(*note: the photo was taken on another day after the occurrence from platform 3*)
(*Source*: the ISM Manager)

1.2.5 There was no lighting fitted inside the tank. A clear line of sight to the bottom platform along the vertical ladder would likely be possible only when the outside natural light was bright. Portable lights/torchlights would be needed to perform work inside the tank.

[20] One located at the aft frame of the tank and the forward manhole located near the middle of the tank at Fr. 73. Each manhole had a size of 800mm in length and 600mm in breadth. The Pumpman had used the forward manhole to access the tank which was closer to the location of the pump which was near to Fr. 76.

1.2.6 The bottom of the tank was divided into smaller compartments. The compartment (where the Pumpman stood) had an area of about 2.5m (length) x 3.5m (width). The ballast pump was fitted in the adjacent compartment which was accessible by an opening.

1.3 The crew

1.3.1 At the time of the accident, in addition to the four security armed guards[21], BS was manned by 30 crew of various nationalities. All the crew held valid STCW[22] competency certificates required for their respective positions held on board and had undergone relevant training. The working language on board was English.

1.3.2 The qualification and experience of the Master, relevant officers and crew members are tabulated below:

Designation On board	Nationality	Age	Qualification	Duration on board (month)	Experience on this type of ship (Year)	In rank service (Year)	Service in Company (Year)
Master	Philippines	42	COC – Master	0.4[23]	11.6	1.4	17.8
Chief Officer	Norway	36	COC – Master	1.7	10.1	6	18.1
Second Officer	Philippines	32	COC – Chief Officer	5.4	6.4	1.8	11.3
Third Officer	Philippines	25	COC – OOW (Deck)	6.9	3.9	2.2	7.2
Additional Third Officer	Philippines	40	COC – OOW (Deck)	<1	6.1	4.6	6.1
Bosun	Philippines	44	Deck Rating as per STCW	5.0	11	7	17
ASD	Philippines	47		2.0	14.9	13	18
Pumpman	**Philippines**	**57**		**3.5**	**30.7**	**15.9**	**31.6**

1.3.3 The Chief Officer had been on BS back and forth as assigned by the Company, having joined BS again when the ship was at the dry-dock in China in June 2018. The Chief Officer was the head of deck department as well as the Safety Officer on board.

[21] The vessel was transiting the International Recognized Transit Corridor (IRTC), with navy ships patrolling within the area. The IRTC is a navy-patrolled route through the Gulf of Aden detailed in a publication, the Best Management Practices (BMP5) to deter piracy and enhance maritime security in a high risk area such as the Red Sea, Gulf of Aden, Indian Ocean and Arabian Sea.

[22] 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.

[23] Joined ship on 27 July 2018 and was his first time on BS.

1.3.4 The ASD, served on BS twice in the past, i.e. in 2012 and 2016, before this trip. Having sailed with the Pumpman three times in the Company, the ASD recalled the Pumpman as an experienced worker. Prior to the occurrence, the ASD had been assisting the Pumpman in the past two weeks for various jobs including troubleshooting and some overhaul of the same ballast pump.

1.3.5 Having joined the Company as a Mess Man in 1986, and after serving one ship in that capacity, the Pumpman switched over to be a deck rating serving as an Ordinary Seaman. After being promoted in 1989 to ASD and to Bosun in 1994, the Pumpman started working in the current rank eight years later, i.e. since 2002.

1.3.6 The Pumpman's medical certificate[24] and records indicated that all check-ups including eye sight (with spectacles) and hearing test were within acceptable limits for service at sea as a deck rating without any restrictions or prescribed medication.

1.3.1 According to the Company's structure, the Pumpman's job scope, amongst others, was relating to operation of cargo/ballast pump and reporting to the Chief Officer for such matters. The Pumpman could also take instructions for other maintenance works from the Chief Engineer and was considered as a Petty Officer according to the Company's SMS.

1.4 Additional information

1.4.1 Ballast pump on board

1.4.1.1 BS was installed with one ballast pump (submersible type[25]) inside the 7WBT-P and another similar type was inside the 7WBT-S (starboard), each with a pumping capacity of 800m³ per hour. At the time of occurrence (and on prior occasions), the pump inside 7WBT-P had been reported to lose suction while the one in 7WBT-S was in operational condition.

[24] Issued on 9 March 2018 and had a 2-year validity.

[25] Commonly installed in the water ballast tanks on tankers to reduce excessive use of space for pump rooms.

1.4.1.2 For compliance with ballast water management regulations[26], a ballast water treatment system (BWTS) was installed[27] on deck near no.8 cargo tank on the port side during BS's dry-docking in June 2018. Prior to the installation, the Company had carried out a feasibility study to assess whether the installation of the BWTS required modifications to the existing ballast system. The study revealed that no modifications were needed and that the BWTS could be connected to the existing ballast system.

1.4.1.3 According to the Chief Officer's experience on board since this installation, the problems related to this ballast pump had undergone troubleshooting[28] several times.

1.4.1.4 According to the ASD, prior to the occurrence, troubleshooting for the ballast pump had been carried out in the past two weeks, which included an overhaul of the pump by the duo on two occasions. Details of the kind of overhaul carried out was not available for the investigation team.

1.4.1.5 A sacrificial anode was fitted on the casing of the pump to minimise corrosion, which was secured by a flange. The ASD recalled being informed by the Pumpman that this flange could be the cause of the loss of suction. (see **figure 2**).

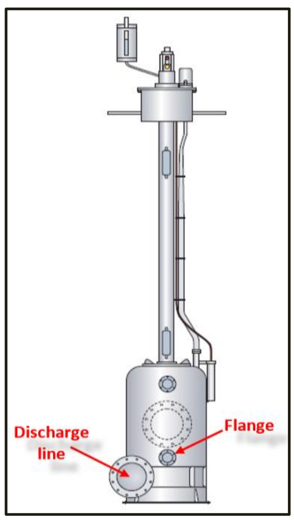


Figure 2 – Drawing of the ballast pump and location of the flange, annotated by TSIB (*Source:* the ISM Manager)

[26] The International Convention for the control and management of ships' ballast water and sediments, 2004, entered into force globally on 8 September 2017.

[27] As the ballast pump was submersible type, the BWTS had to be installed on deck, which would increase the lifting height and pressure drop, to maintain a satisfactory output, the load of the pump would increase when operated.

[28] By the Chief Officer being assisted by the ASD and the Pumpman. The ship's engineers were not involved in this troubleshooting.

1.4.2 The flange

1.4.2.1 The flange was about 10cm in diameter and weighed about 6kg. Six holes on the flange were used for bolting it onto the pump casing. The diameter of each hole was about 1.4cm. An inspection of the flange after the occurrence indicated that the rubber O-ring (gasket) attached to the flange was broken[29] (see **figure 3**).

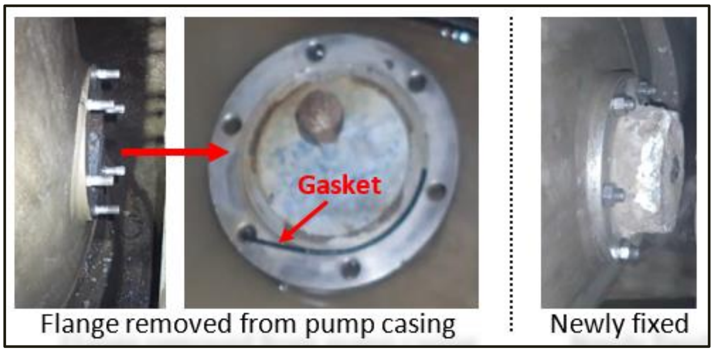


Figure 3 – Removed flange and newly fixed after the accident
(*Source:* the ISM Manager and DSB's investigators[30])

1.4.3 The rope

1.4.3.1 The rope in use was of a man-made fibre (likely polypropylene) type about 10mm in diameter. An inspection of the rope confirmed that it was intact and a knot existed about 30cm from the end. It could not be established how the rope was secured to the flange by the Pumpman before instructions were given to the ASD to heave up the rope. (see **figure 4**).

Figure 4 – The rope in use with a knot (type of knot unidentifiable)
(*Source:* the ISM Manager)

[29] It could not be established whether the gasket had broken because of the fall, or during its removal from the pump casing or was already broken due to wear and tear.

[30] Investigators from the Dutch Safety Board (DSB), boarded the vessel to obtain some evidence on behalf of TSIB when BS called at the port of Rotterdam in Netherlands on 25 August 2018.

1.4.4 The personal protective equipment

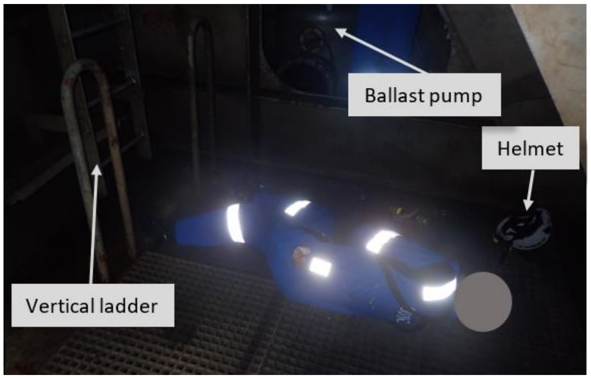
1.4.4.1 The Pumpman was wearing personal protective equipment as per the Company's SMS while inside the water ballast tank, which comprised the work coveralls, safety helmet fixed with a torchlight, personal gas detector, and safety shoes issued by the Company. A set of safety harness was also donned. The safety helmet[31], found on the grating of the bottom platform, was not cracked but had an inward indentation of about 2cm (see **figure 5**).

Figure 5 - the indentation of the Pumpman's helmet, viewed from two angles (*Source:* the ISM Manager)

1.4.4.2 There was no separate portable lighting prepared for the entry and work to be carried out on the pump.

1.4.5 Location of Pumpman

1.4.5.1 When the rescue team reached the bottom platform, the Pumpman was noted to be lying on the right side, on the grating slightly away from the vertical ladder and the safety helmet was less than a metre away (see re-enactment in **figure 6**).



[31] According to the Company, the helmet used by the Pumpman was a model which met the European standard EN 12492 (the shock absorption test included the ability to protect the head against falling objects at weight of 5kg at a height of 2m).

Figure 6 - Re-enactment of the Pumpman's position (*Source:* the ISM Manager)

1.5 The Safety Management System

1.5.1 The Company managed a fleet of oil tankers, chemical tankers and gas carriers.

1.5.2 A Document of Compliance certificate was issued to the Company by the RO on 30 January 2014 and it was valid until 1 March 2019 based on the completion of audit on 9 January 2014. The last audit of the Company's Safety Management System (SMS) was carried out on 27 April 2017.

1.5.3 A Safety Management certificate (SMC) was issued to BS by the same RO on 13 January 2018 and was valid until 6 March 2020 based on the completion of audit on 6 March 2015.

1.5.4 The last Port State Control inspection on BS was carried out on 17 May 2018 at the port of Ulsan. One deficiency[32] was issued for the ballast water record book not meeting the requirement of the BWM Convention regulation B-2 (ballast water record book).

1.5.5 According to the Company's SMS procedures, a Pumpman would typically undergo familiarisation training upon joining the ship within a specific period, such as familiarity with operation of safety equipment[33], and deck/cargo system[34] on board. The familiarisation records indicated that the Pumpman had undergone this familiarisation.

1.5.6 Enclosed space entry[35] was categorized as one of the critical operations in the Company's SMS procedures. These procedures covered specific areas to ensure safe operations, such as entry preparation, entry precautions, space atmosphere checks and emergency procedures. The Chief Officer was responsible for the overall safety for each entry operation.

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[32] The deficiency with a Code of 14801, was issued by the Port State Control under the Tokyo Memorandum of Understanding, the action taken by the inspecting officer was giving an instruction to the ship's master to correctly fill up the book from then onwards.

[33] Safety equipment such as use of gas detector, to be completed within 14 days after joining the ship.

[34] Operation of Deck/cargo system such as winches, cargo, ballast pumps, tank cleaning system within one month after joining the ship.

[35] In the Company's SMS procedures, an enclosed space, other than a cargo tank was considered a space with limited openings for entry and exit, with unfavorable natural ventilation, not designed for continuous worker occupancy, the atmosphere may be hazardous and those spaces included the ballast tanks.

1.5.7 A responsible person[36] typically designated by the Chief Officer, was required to complete an enclosed space entry checklist (entry permit), before passing it to the Chief Officer for acknowledgement, and subsequent approval[37] of the ship's Master before entry into an enclosed space was commenced. The entry permit was typically valid for eight hours. In addition to the entry permit, a risk assessment form for the task to be performed (the troubleshooting of the ballast pump in this case) was also required to be completed by the responsible person as per the Company's SMS procedures, which would identify the risks, its potential consequences, existing and additional control measures for mitigating the risk.

1.5.8 The leader of the team entering the enclosed space would be required to verify all items in the entry permit and sign it. The team leader would ensure that communication was established and tested between the working team members and the navigating officer[38] on the bridge.

1.5.9 According to the Company's SMS, records of entry permit and related risk assessments were required to be maintained on board for a period of six months. Past records indicated that an entry was made for entering other ballast tanks for inspection by a class surveyor in May 2018. Another enclosed space entry permit (and related risk assessments) was dated 15 July 2018 (the latest entry record) for work on the water ballast pump inside 7WBT-P by the ASD and Pumpman.

1.5.10 On the day of the occurrence, there were no records of an enclosed space entry permit made or related risk assessment being carried out. According to the ASD, there was no briefing prior the task being assigned to the ASD by the Chief Officer. Entry procedures were only verbally discussed between the Pumpman and the ASD, and that there was no other discussion on the task to be performed, e.g. lifting of the flange.

[36] A certified ship's officer or petty officer who may be in-charge of a work process involving other crewmembers.
[37] The Master was responsible to ensure the safety procedures being followed.
[38] As per the Company's general procedures for entry into enclosed spaces and cargo tanks, the duty (navigating) officer was required to keep records of persons entering (on entry permit) cargo tanks, after information was given to him/her by the Responsible Person.

1.6 Relevant safe working practice

1.6.1 The COSWP[39], was incorporated into the Company's SMS procedures and was carried on board its fleet of ships.

1.6.2 Chapter 1.2.4 of COSWP - Managing Occupational Health and Safety - Planning of work is essential in ensuring occupational health and safety at work. Adequate control of risks can only be achieved by ensuring that all involved are aware, activities are co-ordinated and good communication is maintained by all involved.

1.6.3 While planning the task, consideration of what actions are necessary, how these will be carried out and what effect they may have on seafarers' safety at work, taking into account that there may be consequences that are indirect and unintended.

1.6.4 Chapter 1.2.5 on risk awareness, highlights that seafarer's knowledge about risk can be attained through a combination of conducting risk assessment, theoretical training, practical application, information sharing, personal experience, as well as clear instructions and supervision by supervisors.

1.6.5 Chapter 19.21.10, emphasised the importance of communication involving a lifting operation. An effective means of communication to the authorising officer and between those involved should be established and maintained to avoid misunderstandings. This might be by portable hand-held radio or a person-to-person chain. Action should be taken as a result of the positive receipt of confirmation that the message is understood.

1.7 Cause of death

1.7.1 There was no autopsy examination report made available to the investigation team, but the Company revealed that the Pumpman had passed away at the hospital due to head injuries.

1.8 Environmental condition

1.8.1 According to the ship's logbook, at the time of occurrence, the weather was

[39] Though not a mandatory publication for carriage on Singapore registered ships, the company's SMS had incorporated the Code of Safe Working Practices for Merchant Seafarers (COSWP) as the part of procedures for reference. The COSWP, edition 2015, published by the UK Maritime and Coastguard Agency (MCA), provides best practice guidance for improving health and safety on board ships. A copy of COSWP was on board at the time of the accident.

moderate with a westerly breeze (about 11 to 16 knots), the swell height was about 1.5m, with partly cloudy skies.

2 ANALYSIS

2.1 The occurrence

2.1.1 The Pumpman was working alone inside the ballast tank, and there was no coordination between the Pumpman and the ASD (who was standing by outside the tank) on the work to be performed on the pump, except mentioning that the flange[40] could be the cause of loss of suction. As there was no lighting fitted along the vertical ladder and the bottom of tank, the area could be dim and it is possible that the ASD could not see how the flange came loose from the rope and injured the Pumpman.

2.1.2 The flange was considerably heavy and had six holes for it to be bolted on to the casing of the pump. It could not be established how the rope was tied to the flange by the Pumpman, but it is likely that the rope was secured to one of the holes using an inappropriate knot which came off or slipped through when it was heaved up (discussed separately).

2.1.3 Although the safety helmet used by the Pumpman was certified to protect against falling objects, the impact force of the 6kg flange from a height of more than 5m (the ASD recalled heaving the rope for about 6-8m before tension was lost) had exceeded the certification requirement of the helmet. The high impact force had caused an inward indentation on the safety helmet which resulted in the fatal injuries of the Pumpman.

2.1.4 Prior to the occurrence, other than the shout to heave the rope, there was no other communication between the two crew members. Although the ASD recalled that the Pumpman was away from the manhole prior to heaving up the rope, based on the location where the latter's body was noted after the occurrence, it was deemed probable that the Pumpman was either approaching the vertical ladder for climbing up or commenced climbing the vertical ladder to exit the tank, while the rope was being heaved up by the ASD.

2.1.5 The reason for the Pumpman to stay underneath the flange while it was being lifted could not be established. One of the possibilities could be that the Pumpman had wanted to ensure that the flange would not get stuck halfway when being heaved up. When the flange was halfway up, the Pumpman could have thought that the flange should be able to be lifted all the way up without

[40] Post-accident inspection of the flange indicated that the gasket of the flange was broken. Assuming that the gasket was found broken when the flange was removed from the pump casing, it had likely prompted the Pumpman to remove the flange from the tank for replacing the gasket at the ship's engine room workshop.

any issue and had then attempted to get out of the tank using the vertical ladder. The accident demonstrated the importance of staying clear of an object that is being lifted.

2.1.6 The ASD had followed the Pumpman's instruction to heave up an object but without knowing what was to be heaved and whether the object was being secured properly. While the ASD had noted that the Pumpman was away from the manhole before heaving up the flange, there was no coordination to ensure that the Pumpman would not come under the flange during the heaving operation. A better coordination between the Pumpman and ASD using the portable radio would have been desirable when heaving up the flange.

2.2 Type of knot used to secure the flange

2.2.1 Tasks on board a ship invariably involve the use of ropes, for tying, lifting, securing objects at sea which requiring deckhand skills and are acquired by ship's crew over the course of their work experience. Different kind of knots are used for different type of tasks depending on the object involved and the rope in use. Since there was no witness as to how the Pumpman tied the rope to the flange, the investigation team could not establish what kind of knot was used by the Pumpman.

2.2.2 At sea, it is common for objects to be lifted and to be tied with a Bowline (see **figure 7**) knot, which is a relatively simple, commonly used and an effective knot[41].

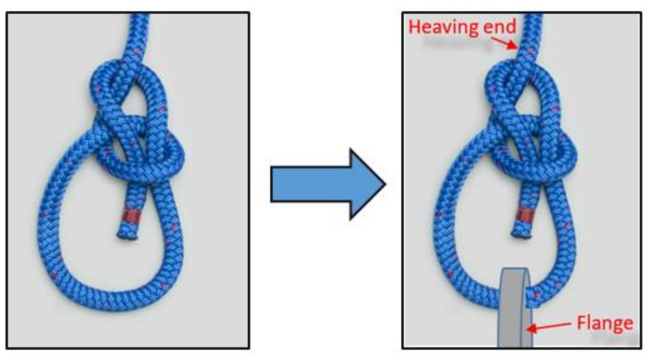

Figure 7 – A Bowline knot if used to tie the flange, annotated by TSIB
(*Source:* Open source on seamanship techniques)

2.2.3 In this occurrence the rope in use did not part (refer to **figure 4**) which means that the flange had come off from the knot. For a Bowline knot to fail, the end

[41] The advantage of the knot is that it will not jam and slip even when it gets wet.

(indicated in the **figure 7** with a red tape) would have to come out of the securing loop twice and end up as a single rope (without any knotted portions). In this case, the rope was found to have a knotted portion, about 30cm from the end and thus it is unlikely that a Bowline knot was used to secure the flange.

2.2.4 It is thus likely that the Pumpman had used a different knot (other than a Bowline) which resulted in the flange slipping out of the rope. As indicated in this accident, it is important that the correct type of knot is being used for the intended purpose.

2.3 Risk assessment for shipboard operations

2.3.1 The Company's SMS required the conduct of risk assessments by a responsible person for identifying risks, its potential consequences, and implementing control measures. Similar guidance was provided for in the COSWP, which recognised the importance of proper planning of work to ensure all possible risks are addressed and adequate safety control measures are in place before commencement of a task (see paragraph 1.5.7).

2.3.2 The Pumpman was considered as a Petty Officer according to the Company's SMS, and thus deemed as a responsible person capable of conducting risk assessments on the tasks to be performed. However, there was no evidence of risk assessments for the work carried out on the ballast pump in the tank.

2.3.3 The Chief Officer had likely deemed the task of solving the ballast pump problem by the duo as a routine task since they had been working on it in the past two weeks. As a result, the Chief Officer might have left the risk assessments to the Pumpman, without adequately ensuring that they were carried out. Had the risk assessments been discussed in detail with the Chief Officer, the risks[42] associated with objects being lifted out of the tank could have been identified and addressed accordingly.

2.3.4 This incident highlighted the importance of senior officers in supervisory position ensuring that risk assessments are carried out for all shipboard operations.

2.4 Incidental findings

2.4.1 The Company's SMS classified enclosed space entry as one of the critical

[42] The risk of fall could be as a result of either the rope slipping out of the hands of the person heaving it up, or the rope parting halfway, or the object slipping out while being heaved up, as was in this case.

operations which required compliance with specific procedures before entry was permitted.

2.4.2 On reviewing past records of enclosed space entry, it was established that the same set of crew had entered the same ballast tank twice to overhaul the pump in the past two weeks without completing any enclosed space entry permit or risk assessment, which was not in accordance with the Company's enclosed space entry requirements.

2.4.3 The Pumpman and the ASD, had not enquired from the Chief Officer on the need for enclosed space entry permits and proceeded to enter the ballast tank on two occasions. Similarly, the Chief Officer also did not ensure a permit was obtained before commencement of the tank entry by the crew.

2.4.4 The navigating officer was aware of an entry into 7WBT-P as indicative by the log book entry at 0855H. However, there was no clarification sought from the person entering into/standing at 7WBT-P whether an enclosed space entry permit had been issued. If the task was planned properly, the navigating officer should have been advised of the intention, who could have also intervened and ensured compliance with the Company's enclosed space entry procedures.

2.4.5 While entering the ballast tank without a valid entry permit did not directly contribute to the accident, it is extremely important for ship's crew to adhere to the established procedures in order to cultivate a positive safety culture on board a ship.

2.4.6 Prioritisation of tasks is also extremely important. In this case, there were two concurrent tasks being conducted. If indeed remounting of the overhauled air horn was more critical for the safety of navigation, it would have been desirable for this task to be prioritised so that additional hands could be arranged for assistance with the troubleshooting of the ballast pump.

2.4.7 The ballast pump had been giving problems since the installation of the BWTS. Although the Company's SMS procedures stated it was the Pumpman's responsibility to operate ship's cargo/ballast pump, troubleshooting the cause of the loss of suction should have been done with the assistance of engineers and in consultation with the manufacturer of the ballast pump as well as the installer of the BWTS if needed, rather than relying on a trial and error method. It would have been desirable for the matter to be raised to the Company's personnel ashore for appropriate follow-up.

2.4.8 When the occurrence took place, BS was transiting piracy prone area. Though there were navy ships patrolling and a group of security armed guards were engaged on board, it would be desirable for the Company to (as per the Ship's Security Plan[43]) limit only to essential tasks and operations carried out on board considering the risk of piracy and the threat to the safety of the ship's crew during passage through a high risk area. In this case, it was reasonable for the air horn to be remounted for the safety of navigation and the troubleshooting of the ballast pump at 7WBT-P could have been deferred.

[43] A confidential document as required under the International Ship and Port Facility (ISPS) Code, meant for the use of the Ship's Security Officer and Company's Security Officer to assess threat levels and implement security measures.

3 CONCLUSIONS

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

3.1 The Pumpman was working alone inside the ballast tank and had used a knot which had not been tied properly and resulted in the flange slipping out of the rope while it was lifted out of the tank.

3.2 The flange weighing 6kg had come loose and hit on the head of the Pumpman who was attempting to climb out of the tank. The impact force of the flange had exceeded the certification requirement of the safety helmet and resulted in fatally injuring the Pumpman.

3.3 In performing the troubleshooting of the ballast pump, there was a lack of coordination between the two crew members for ensuring that the Pumpman was not underneath when the flange was heaved up.

3.4 There was no risk assessment carried out by the two crew members prior to performing work on the ballast pump as required by the Company's SMS procedures. The Chief Officer also did not ensure this was done before commencement of the work.

3.5 In the course of the investigation, the following incidental findings, though did not directly contribute to the accident, were important to note for the safety of shipboard operations:

a. There was no entry permit issued prior to entering the ballast tank (enclosed space) for performing work on the ballast pump;

b. The troubleshooting of the ballast pump suction problem was left to the Pumpman instead of involving the engineers on board or makers ashore; and

c. Troubleshooting of the ballast pump at 7WBT-P was being carried out as per normal when the ship was transiting high risk area.

4 SAFETY ACTIONS

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

4.1 Actions taken by the Company

4.1.1 After the occurrence, the Company had carried out its own investigation. Based on their findings, the following safety actions had been taken to address the gaps for preventing similar recurrence:

a) A safety poster created and distributed to all its fleet of ships highlighting the risk involved in using improper knot and other possible risks when heaving up objects.

b) A set of presentation slides on hazards related to falling objects to be used for discussion during the General Safety Meetings on board ships.

c) A safety culture campaign was launched in its fleet of ships to address the safe working attitude and the Stop Work Authority on board.

d) Reviewed its procedures to enhance hazards identification during the work planning on board ship.

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 The following safety recommendations are issued to the Company:

5.1.1 To ensure the Company's SMS procedures are effectively implemented on board its fleet of ships, particularly to ensure that entry permits are issued for enclosed space entries and risk assessments are carried out for shipboard operations; **[TSIB-RM-2020-017]**

5.1.2 To involve the relevant engineers on board or equipment maker in the troubleshooting of shipboard equipment defects; **[TSIB-RM-2020-018]**

5.1.3 To limit tasks to only essential type on deck when its fleet of ships are transiting in high risk areas. **[TSIB-RM-2020-019]**

\- **End of Report** -