Final Report

FATALITY OF FITTER ONBOARD SEA PRAJNA AT SEA ON 15 NOVEMBER 2022

TIB/MAI/CAS.133

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

20 September 2023

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.

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

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SYNOPSIS

On 15 November 2022, while transiting towards the Suez Canal from Gibraltar, a group of deck crew were carrying out maintenance work (hot work and painting separately) on the booby hatch covers and D-rings onboard the Singapore registered bulk carrier, Sea Prajna. The ship was loaded with steel scraps bound for India.

After observing that the Fitter was completing the hot work on one of the booby hatch covers, the Bosun who was supervising the task, left the site for the foredeck store. Upon the Bosun's return, the Fitter was found lying inside the cargo hold on top of the steel scraps next to the vertical ladder of the booby hatch and was unconscious. An emergency rescue was initiated but the Fitter could not be resuscitated.

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

The autopsy report on the Fitter was not available at time of publishing this report. The work being performed on deck did not require any entry into the cargo holds. The Fitter had likely entered the cargo hold, in spite of it being known as an enclosed space, to retrieve dropped or fallen item(s) and had succumbed to the oxygen deficient atmosphere. The Fitter had likely perceived the entry to be safe and overlooked on the hazards associated with the cargo of steel scraps.

While required by the SMS for hot work to be supervised throughout, the Bosun who was supervising the hot work being carried out by the Fitter, left the site leaving the Fitter alone. Although the booby hatch covers were painted with warnings to caution personnel about entering the cargo hold, there were no additional signages in the vicinity or physical barriers in place to prevent an unauthorised entry.

In addition, the investigation noted that there was no ship-specific list of enclosed spaces maintained onboard as required by the SMS.

VIEW OF VESSEL

DETAILS OF VESSEL

Name	SEA PRAJNA
IMO Number	9401958
International Call Sign	9V7428
Flag	Singapore
Classification society/ ISM[1] Recognised Organisation	CCS – China Classification Society
Ship type	General Cargo
Year Built	2010
Owner/ Company[2]	Sea Prajna Shipping Pte. Ltd. / GoldenKing Ship Management (Guangzhou) Co., Ltd
Gross tonnage	29105
Length overall	182.98m
Draught	FWD 8.70m/ AFT 9.02m
Main engine(s)	Mitsui MAN B&W 6S50MC

[1] In accordance with ISM Code – SOLAS Chapter IX, IMO Res.A.741(18) as amended thereof.
[2] Responsible for the safe management of the ship under the ISM Code.

1 FACTUAL INFORMATION

All times used in this report are Eastern European Time (EET) unless otherwise stated. EET is two hours ahead of Coordinated Universal Time (UTC+2).

1.1 Sequence of events

1.1.1 Sea Prajna (SP) departed the Port of Rotterdam, the Netherlands, on completion of the loading of scrap metals (denoted as HMS[3] 1/2 steel scrap and shredded steel scrap, in the "form for cargo information[4]" - see 1.4) on 1 November 2022, bound for the Port of Kandla, India.

1.1.2 On 9 November 2022, while en-route, SP anchored at the Port of Gibraltar for a planned underwater hull cleaning and inspection. Thereafter, SP departed on 11 November 2022.

1.1.3 At about 0700H on 15 November 2022, during the voyage from Gibraltar to Port Said, Egypt (for the passage through the Suez Canal), the Bosun (BSN) reported to the bridge, to discuss for the day's deck work[5] with the Chief Officer (CO). Thereafter, the BSN went for his breakfast.

1.1.4 After handing over the bridge watchkeeping duty to the Third Officer (3O), the CO went to the ship's office at about 0815H and conducted a toolbox meeting together with the BSN, two ASD[6]s (ASD1 and ASD2) and the Fitter (FT). The purpose of the meeting was for the CO to assign the day's job scope for each deck crew, to go through the risk assessments[7] and for the BSN and FT (who was tasked to do some welding job) to acknowledge the permit-to-work issued for hot work to be done for the booby hatch covers between cargo hatch no. 4 (CH4) and cargo hatch no. 3 (CH3). The CO subsequently went to the main deck for a round, before retreating to his cabin for his rest at about 0930H.

1.1.5 Separately, the BSN instructed each deck crew to prepare the required tools and equipment according to their assigned job and went to look for the Electro-Technical Officer, who was required for the grounding and bonding of the welding

[3] Heavy Melting Steel – category include wrought iron, galvanised steel and non-galvanised steel.
[4] In accordance with the Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code) - SOLAS Chapter VI/7, IMO Res.MSC.238(82) and MSC.304(87) as amended thereof.
[5] This is a daily routine for SP's deck department between the BSN and CO to discuss the deck work and to deconflict other activities (like cargo work, weather and sea condition.) that might affect or restrict these scheduled repairs and maintenance.
[6] Able Seafarer-Deck.
[7] Only the BSN remembered that the CO reminded them regarding the restriction to enter cargo hold.

equipment meant for the hot work.

1.1.6 Between 0900H and 0930H, the deck crew (BSN, ASD1, ASD2 and FT) commenced their assigned jobs. The BSN supervised[8] the welding work carried out by the FT at the portside booby hatch[9], aft of CH3. The ASD2 was assigned the painting of the portside booby hatch, aft of CH4. The ASD1 was assigned the grinding and cutting of corroded and damaged D-rings[10] and cleats at the forward of CH3 (see **figure 1**).

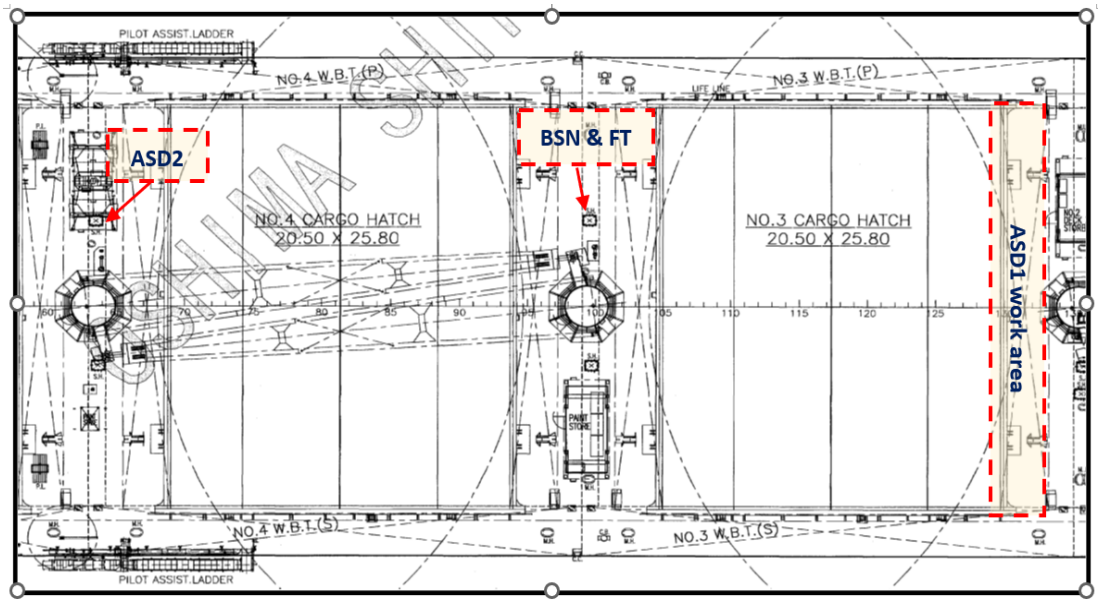

Figure 1: From the GA Plan of SP - Locations of the deck crew according to each crew's assigned job. *Source:* The Company – annotations by the TSIB.

1.1.7 At about 1030H, a scheduled man-overboard shipboard drill was conducted. According to the muster list, the FT, being an additional crew, was not assigned a specific role but was to follow the BSN. The drill ended at around 1105H and both the BSN and FT went to the mess room for a short break before continuing the welding work at about 1115H.

1.1.8 At about 1135H, when the FT was about to complete the last weld, the BSN informed the FT that he was going to the forward bosun store (below the

[8] As required by the Company's SMS.
[9] Also known as Access (Manhole) Cover of a raised form to access the cargo hold etc. from the weather-deck.
[10] Metallic D-shaped ring welded on deck; cargo holds etc.- used as a lashing point for securing cargo with web-lashings, belts and/or chains etc.

forecastle deck) to take the cup wire brushes (for deburring[11] the welded joints). Thereafter, the BSN proceeded via the starboard side. When passing the forward of CH3, the BSN met the ASD1 on the way. The duo had a brief conversation on the BSN's need to take a portable power tool (for deburring work) from the ASD1 post lunch.

1.1.9 The BSN returned to the work location (CH3 aft) between 1145H and 1150H but did not see the FT. The BSN saw that the welding equipment was still powered, the FT's helmet was on the deck beside the booby hatch, and the area did not appear as tidied up (as the FT usually would on completion of his work). Puzzled for not being able to find FT, the BSN looked down the booby hatch and saw that the FT lay inside the CH3. The orientation of FT's body was such that one of his feet was stuck on the vertical ladder and the other foot resting on the pile of scrap metals. The rest of the body was not visible from the main deck (see **figure 2**). The BSN shouted to both the ASDs and reported to the bridge via the portable walkie-talkie that the FT had fallen into the cargo hold.

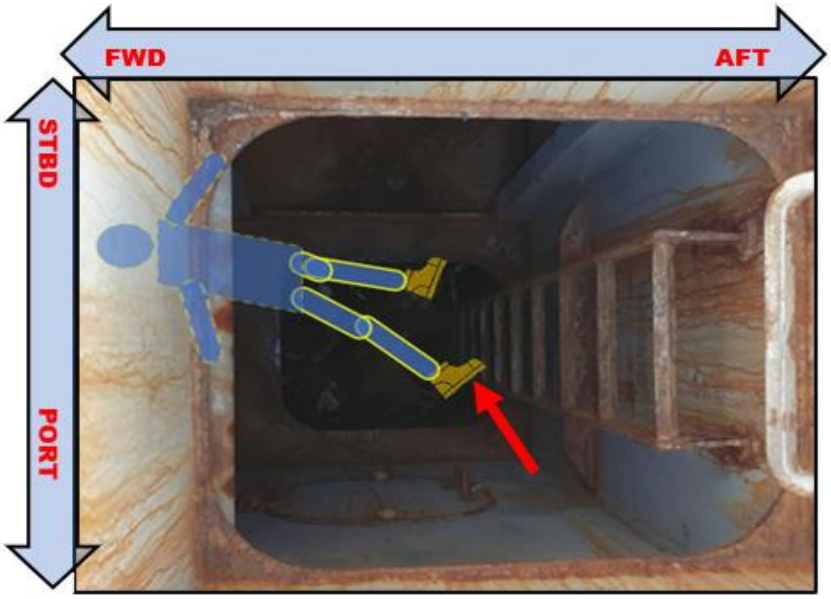

Figure 2: The FT was discovered inside the cargo hold as viewed from the booby hatch. Red-coloured arrow points to the right foot (with black coloured safety boot) that was on the vertical ladder. The dotted outline shows the portion where the FT's upper body was not visible looking from the main deck – *Illustration not to scale*. *Source:* The Company – annotations by the TSIB.

[11] Removing the slag / imperfections of metals.

1.1.10 The call over the walkie-talkie by the BSN was heard by the Second Officer (2O), the Third Officer (3O[12]) and the Master[13] on the bridge. Instructed by the Master, the 2O sounded the Emergency Alarm and made an announcement for the crew to muster at the location. The Master then made his way down to the main deck with the 3O.

1.1.11 When the Master was at the accommodation's starboard side weathertight door (to the main deck), he recalled seeing the ASD2 coming in and heading towards the fire locker. The Master also recalled seeing some crew members assisting the Chief Cook[14] with medical items from the shipboard infirmary and other equipment for a rescue. Upon reaching the booby hatch, the Master became aware of how the BSN had found the FT.

1.1.12 The ASD2 arrived shortly with two sets of self-contained breathing apparatus (SCBA), the Chief Cook with the medical kit and stretcher[15], and some of the other crew members brought the rescue ropes and safety harnesses.

1.1.13 The Master instructed the ASD2 to don the SCBA for the rescue and also for the BSN and 3O to open the cargo hatch(es) of CH3[16]. The Master also instructed some other crew members to bring spare SCBA bottles, the portable medical oxygen cylinders and to prepare the safety harness and ropes.

1.1.14 The ASD2 entered the CH3 from the main deck via the vertical ladder of the booby hatch. Upon reaching the position where the FT lay, the ASD2 assessed and reported that the FT was not breathing. The Master then instructed the Second Engineer (2E) to don another SCBA set to assist the ASD2 on putting the safety harness and rescue ropes on the FT, considering that the use of the stretcher may take time[17].

1.1.15 By about 1205H, the FT was recovered to the main deck and cardio-pulmonary resuscitation (CPR) was carried out by the Chief Engineer and the CO. The Master went to the bridge and called the shore-based telemedical advisory services[18] for medical guidance. The Master was advised to continue the CPR

[12] The 3O was handing over the watchkeeping duty to the Second Officer (2O).
[13] The Master was at the aft part of the wheelhouse.
[14] The Steward/ Messman was instructed by the Chief Cook to remain in the Galley as the preparation for lunch was almost completed, with hot stove surfaces still heated.
[15] Neil Robertson stretcher which was stored in the infirmary.
[16] The cargo hold hatch was closed at about 1245H – i.e., it was opened (ventilated the cargo hold) for about 40mins.
[17] According to the Master, he was desperate to get the FT out soonest so that efforts could be made to revive him.
[18] Nanjing Red Cross Hospital – as appointed by the Ship Operator (Company) for medical advisory as per SMS.

for about 30-40 mins and to administer 1mg of Adrenaline Hydrochloride injection, which was carried out by the 2O[19].

1.1.16 At about 1250H, as assessed by and with the advice of the telemedical services, the FT was declared to have lost the vital signs and the body was put into a body-bag and moved into the refrigerator room.

1.1.17 SP continued the voyage to Port Kandla, India and the body of FT was conveyed ashore[20] on 30 November 2022 when SP went alongside the cargo discharging berth.

1.2 Crew's qualifications, roster and roles

1.2.1 SP had 22 officers and ratings of five nationalities onboard at the time of the occurrence and were holding valid STCW certificates required by the Flag Administration.

1.2.2 The qualification and experience of the relevant officers and ratings are shown in the table.

Designation onboard	Nationality	Age	Qualification	Duration onboard (month)	In-rank service (Year)	Service in Company (Year)	Working schedule onboard
Master	Chinese	38	STCW II/1	06	1.3	0.5	NA
Chief Officer	Ukrainian	36	STCW II/1	02	0.2	0.2	0400-0800 / 1600-2000
Third Officer	Filipino	37	STCW II/3	04	2.5	0.3	0800-1200 / 2000-2400
Second Engineer	Chinese	34	STCW III/2	03	0.3	0.3	0400-0800 / 1600-2000
Bosun	Myanmar	51	Deck Rating STCW II/4	03	10.0	0.3	Day Work 0800-1700
AB-A (ASD2)	Filipino	48	Deck Rating STCW II/5	04	10.0	0.3	Day Work 0800-1700

[19] The 2O came on deck after handing over the bridge watchkeeping duty to the 3O.
[20] At the time of publishing this report, the Autopsy report was not available.

Fitter-A[21]	Myanmar	30	Engine Rating STCW III/5	0.3	7.0	0.3	Day Work 0800-1700
Fitter	Chinese	44	Deck Rating STCW A-VI/1	02	2.0	0.2	Day Work 0800-1700

1.2.3 The FT attended the Company's pre-joining administrative and safety briefing together with the 2E at the Company's office in China. The 2E joined SP in Algeria, about a month earlier than the FT who joined SP in Belgium.

1.2.4 Upon joining, the FT went through shipboard familiarisation conducted by the CO and BSN. The FT was, thereafter, instructed to be under the BSN's guidance for all work-related matters, emergencies, and drills. The FT was not conversant with the English language and according to the ASD2, most instructions for the FT from the CO and BSN were translated to the Chinese language via a mobile phone application on the ASD2's phone. According to the BSN, the FT did not demonstrate difficulty in understanding his instructions.

1.2.5 The FT was certified medically fit for service at sea, in accordance with the Maritime Labour Convention (MLC) and the STCW Code[22], by an international travel health care centre in Guangxi, China on 11 July 2022. This centre was authorised by the China Maritime Safety Administration for seafarers' medical check-up and the medical certificate was valid for two years.

1.2.6 According to SP's work / rest hour records, in the past 24-hour prior to the occurrence, the FT had 16 hours of rest and 116 hours of rest in the last 7-day period, indicating compliance with the STCW and MLC Convention's requirements concerning the hours of work and rest[23], as documented.

[21] Fitter-A was onboard one month earlier than the FT and was primarily working with the engineering crew while the FT was primarily working with the deck crew under the supervision of the CO and BSN.
[22] STCW Code, A-1/9 and MLC Reg 1.2 - which defines the standards and requirements of medical fitness for seafarers.
[23] STCW Chapter VIII and MLC, Reg 2.3 with regards to rest hour - Minimum hours of rest shall not be less than ten hours in any 24-hour period; and 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.

1.3 The booby hatch and the welding work

1.3.1 The booby hatches onboard SP were of the same design, with each booby hatch cover having five sets of butterfly nuts and bolts to lock the four sides of the hatch for watertightness. The booby hatch cover was painted with the words "RESTRICTED AREA" with a yellow-painted background. There was no other sign or notice in the vicinity indicating that the cargo hold was an enclosed space (see **figure 3**).

Figure 3: The left picture shows the (incomplete) painted top surface of the booby hatch cover, aft of CH4, after the welding maintenance work was completed at an earlier date. The right picture (provided by the Company) shows the original, pre-maintenance condition of the booby hatch, aft of CH3.
Source: The Company

1.3.2 Access to the cargo hold from the booby hatch was via a vertical ladder from the main deck, which ends to an intermediate platform (grating-type) before connecting to a spiral ladder[24]. The top surface of the steel scraps (where the FT was found) loaded inside CH3, covered the intermediate platform and was about 5.7m from the hatch cover (see **figure 4**).

[24] Typically known as the Australian Ladder.

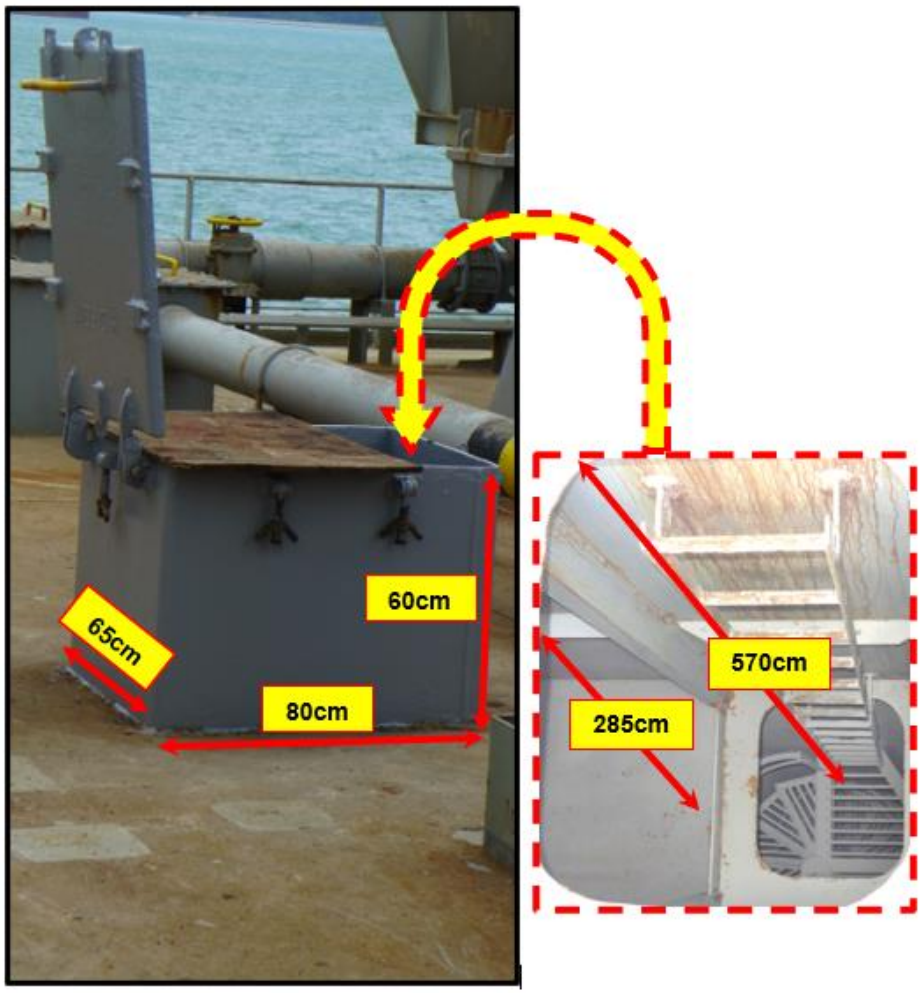

Figure 4: Dimensions of the portside aft booby hatch, aft of CH3
Source: The Company – annotations by the TSIB.

1.3.3 SP's shipboard maintenance list prescribed by the Company was used by the CO and BSN to assign and schedule the deck work. The BSN would then assign work[25] to the available crew according to their responsibilities and experiences.

1.3.4 Where necessary, permit-to-work was prepared and filed onboard for jobs such as hot work. The FT was involved in three such work activities for the month of November in 2022, before the occurrence. One of which was on welding work and the other two for grinding and gas-cutting works.

[25] This was documented by the BSN in a shipboard operations logbook. At the end of the month, the work done was to be reported by the CO to the Company with photographs. The BSN was responsible to provide the photographs to the CO on the completed work on a daily basis.

1.3.5 The welding work for the booby hatch cover was for the replacement of the corroded “lips” of the hatch cover, where rubber seals were secured to maintain watertightness of the cargo hold. The task involved cutting the corroded pieces and grinding the surface before welding the fabricated pieces (see **figure 5**). As a safety precaution to prevent embers and sparks during welding from entering the cargo hold, a plank (wet wood) was used to partially cover the opening.

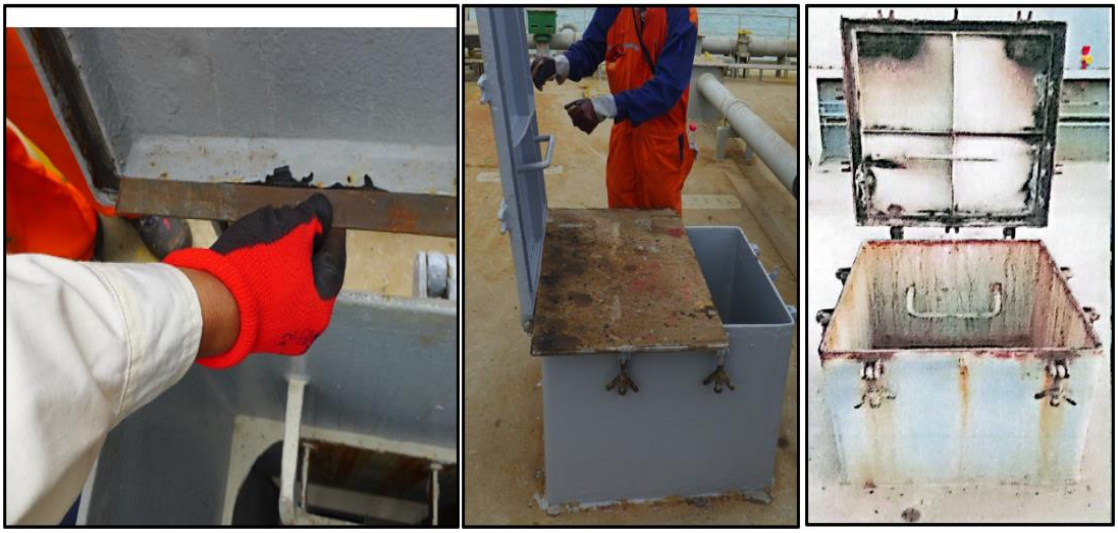

Figure 5: The picture on the left shows an example of the replacement metal piece to be welded at the lip. The centre picture shows the wet wooden plank covering the opening. The picture on the right shows the completed welding by the FT on the booby hatch, aft of CH3.
– *Source:* The Company

1.3.6 The tools used by the FT are shown in **figure 6,** which include a pair of sunglasses[26] in addition to a welding safety shield. One safety shoe was found inside the CH3 while the other safety shoe was still worn on the FT’s foot. At the time of recovery, the FT was wearing leather gloves.

[26] Similar pair of sunglasses was worn by the FT on the day of occurrence, but they were not recovered on him when he was retrieved.

Figure 6: The picture[27] of the FT before the occurrence.
Source: The Company *(annotated by the TSIB)*

[27] Taken on the day of the occurrence when the FT was carrying out the welding work before the BSN went to the forward bosun store.

1.4 The cargo and post-incident information

1.4.1 The five cargo holds of SP were loaded with a total of 31,500 metric tonnes of steel scrap in bulk. In accordance with the IMSBC[28], this cargo was declared under Group C by the shipper. Group C consists of cargo which are neither liable to liquefy (group A) nor to possess chemical hazards (group B).

1.4.2 In the IMSBC, scrap metals (under Group C) cover an enormous range of ferrous metals, principally intended for recycling and there is no hazard classification associated with it. The hazard description states that this type of cargo is non-combustible or has a low fire risk.

1.4.3 In section three of the IMSBC - The Safety of Personnel and Ship – many solid bulk cargo is liable to cause oxygen depletion in a cargo space or tank. Amongst others, the bulk cargo include ferrous metals and metal sulphide concentrates which are susceptible to oxidation and may result in oxygen depletion, emission of toxic gases or fumes and self-heating. The same section also highlighted that personnel shall not be permitted to enter the cargo space unless the space has been ventilated, the atmosphere tested and to be gas-free in order for sufficient oxygen to support life.

1.4.4 The atmospheric gas levels for CH3 (forward and aft) were measured by the CO and Master on 16 November 2022 (the next day after the occurrence) after the opening of booby hatch. The sampling tube was extended down from the booby hatches to about 3m into the CH3 and the readings taken are shown in the table below.

Location	**Oxygen in %**[29]	**Carbon Monoxide in %**	**Hydrogen Sulphide in %**
CH3 - Fwd	14.2	2.0	0.0
CH3 - Aft	15.8	2.0	0.0

[28] International Maritime Solid Bulk Cargoes Code – facilitating the safe stowage and shipment of solid bulk cargoes by providing information on the risks associated with its shipment and procedures to be adopted for carriage.
[29] The lower acceptable range of oxygen within an enclosed space is 19.5%. Normal air contains 20.9%

1.5 The SMS on hot work and enclosed space controls

1.5.1 According to the SMS, the working language was English. The Chinese language version of the SMS was also available onboard SP. The Company expected the crew to seek assistance from Officers and/or senior ratings when faced with difficulty understanding either of the language.

1.5.2 The SMS “work instructions” for hot work chapter required the head of department and person-in-charge to inspect the work location, to conduct a risk assessment with the identified crew involved, to establish a hot work plan, and issue a hot work permit with the approval of the Master and to ensure that the plan is adhered to.

1.5.3 The requirements in the hot work plan, amongst others, included a designated crew member to be onsite continuously as a watchman. When required to leave the site, an alternative crew member was to be called upon to take over the watchman’s duty.

1.5.4 The record of risk assessment onboard SP for hot work specified similar additional risk preventive measures which included holding a toolbox meeting prior to commencing the work, the donning of proper PPE, the presence of communication means (a walkie-talkie) with the duty officer (including the OOW), attaining the permit-to-work.

1.5.5 The record of the permit-to-work for hot work onboard SP revealed that the FT and BSN were involved in at least four hot work tasks since the time the FT joined SP, including the day of the occurrence. Among the four permit-to-work, two involved welding works for booby hatch covers.

1.5.6 The SMS “work instructions” for cargo operations chapter on cargo holds access procedures, stipulated the prohibition of entry into the holds with activities not related to cargo work. The SMS further required that warning signs with the word “WORKING” to be displayed at noticeable locations such as the hatchways. Separately, warning signs with the word “CAUTION” with “marker lines” should also be displayed and rigged at locations where a risk of personnel falling from height may occur.

1.5.7 The same section stated that any entry into the cargo hold should first refer to the safety rules for enclosed space entry within the SMS, in addition to seeking permission from the Master.

1.5.8 The “safety rules for entry into enclosed spaces” chapter of the SMS, described the characteristics of an enclosed space as a space with limited openings for entry and exit, with inadequate ventilation and was not designed for continuous worker occupancy.

1.5.9 These spaces according to the SMS were adapted from IMO Resolution A.1050(27)[30] and included cargo space, double bottoms, fuel tanks, ballast tanks, pump-rooms, void spaces, chain lockers etc. as a result of long-term enclosed and confined conditions which may be oxygen deficient and can have large amounts of harmful and suffocating toxic gases. There was no ship-specific list of enclosed spaces maintained onboard.

1.5.10 In the same section, hazards related to specific cargo were also indicated, highlighting the dangers of the cargo being flammable, toxic or corrosive which displaced oxygen. Amongst others, metal waste and chips, iron swarf, steel and other turnings, shavings and fillings etc. were also identified as those that would deplete oxygen.

1.5.11 The same chapter stated the requirement to identify all enclosed spaces onboard through risk assessments with periodic reviews and to include training and drills for the crew in hazard recognition, controls and eliminations. These enclosed space entry and rescue drills were to be carried out two monthly with first-aid and recovery techniques as the primary scope.

1.5.12 Listed in the steps for enclosed space entry, an attendant at the entrance or the use of a physical barrier could be used to prevent incidental entry, on the understanding that an opened door or hatch cover when providing ventilation may be mistaken as an indication of a safe atmosphere.

1.5.13 The records onboard SP revealed that a risk assessment was conducted with the crew (including the FT), prior to the loading of the scrap metal cargo on 29 October 2022, when SP was anchored at the loading port. The additional risk preventive measures stated that prior to entry into cargo hold manholes (i.e. the booby hatches) the CO’s permission was needed with an issued entry permit by the Master as well as, after ensuring that the space had been properly ventilated with checks being carried out using the portable gas meter.

[30] The International Maritime Organization (IMO) Resolution A.1050(27) - Revised Recommendations for Entering Enclosed Spaces Aboard Ships. The same Resolution was addressed under Shipping Circular No.4 of 2012 of the Maritime and Port Authority of Singapore – the Flag Administration of SP.

1.5.14 In the record of shipboard drills conducted onboard SP, the enclosed space entry safety briefing was done as table-top exercise (i.e. without accessing any physical enclosed spaces) while rescue and first aid drill was conducted on 15 October 2022 with most of the crew members, including the FT.

1.6 Guidelines on enclosed space (entry)

1.6.1 The IMO Resolution A.1050(27) highlights the Company's responsibilities under the safety management for entry into enclosed space. One of them is to ensure that a risk assessment is to be conducted to identify all enclosed spaces onboard its ships. This risk assessment should be periodically revisited to ensure its continued validity. The enclosed spaces on SP were not specifically identified / maintained onboard.

1.6.2 The Resolution also emphasised that no person should open or enter an enclosed space unless authorised by the master or the nominated responsible person and unless the appropriate safety procedures laid down for the particular ship have been followed. Entry into enclosed spaces should be planned and the use of an entry permit system, such as the use of a checklist. The Resolution further added that mechanical barriers such as rope or chains should be positioned across an opening with an attached warning sign to prevent accidental entry.

1.6.3 As noted in another investigation[31] involving enclosed space entry fatality, the investigation team gathered that there was no standardisation of signage for enclosed spaces at the time of occurrence, and that a review of IMO Res. A.1050(27) involving entering enclosed spaces aboard was underway[32] at the IMO.

1.6.4 Chapter 15 of the Code of Safe Working Practices for Merchant Seafarers (COSWP[33]), "Entering Dangerous (Enclosed) Spaces", explained that dangerous space may not necessarily be enclosed on all sides, e.g. ships' holds may have open tops, but the nature of the cargo makes the atmosphere in the

[31] TIB.MAI.CAS.122 – Fatality of crew onboard the bulk carrier Nozomi in Bangka Strait, Indonesia on 1 April 2022.
[32] Expected to be discussed at the 9th session of the Sub-Committee on Carriage of Cargoes and Containers (CCC) in September 2023.
[33] Though not a mandatory publication for carriage on Singapore registered ships, the Company's SMS had incorporated the 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 onboard ships. A copy of COSWP was onboard SP at the time of the accident.

lower hold dangerous because of a change in the condition inside or in the degree of enclosure or confinement, which may occur intermittently.

1.6.5 The same chapter added that personnel need to exercise caution before entering any space onboard a ship that has not been open for some time. The entrances to all unattended dangerous spaces aboard a ship should be kept locked or secured against entry. Any hatches readily accessible to enclosed spaces should be marked as the entrance to a dangerous space. When the space was open for work to be carried out, an attendant should be posted, or a barrier and warning sign put in place. As far as possible, work should be arranged in such a way that no one has to enter the space.

1.6.6 The same chapter further explained that if an empty tank or other confined space has been closed for a long time, the oxygen content may have been reduced for a number of reasons. Amongst others, oxygen-absorbing cargo may have been carried, includes metal wastes and chops, iron swarf, steel and other turnings, borings, drillings.

1.7 Environmental condition

1.7.1 SP's deck logbook record at 1200H indicated that it was cloudy with good visibility and the ambient air temperature was about 20°C. The wind was south-easterly at force 4 on the Beaufort scale. The sea condition was slight about half to one metre.

2 ANALYSIS

2.1 The occurrence

2.1.1 The FT was medically fit for service at sea and was last known to be working on deck welding at the portside booby hatch, aft of CH3. When the BSN returned from the forward, the FT was found motionless inside the cargo hold. In the absence of an autopsy report, the investigation team corroborated the evidence obtained and analysed the probable conditions which likely led to the demise of the FT.

2.1.2 Considering the height of the booby hatch (60cm) and an opening of 65cm by 80cm, which was also partially covered by a wooden plank, and noting the absence of any apparent physical injury on the FT (despite not wearing helmet), the investigation team ruled out that the FT accidentally fell from the main deck into the cargo hold. From the items recovered surrounding the area where FT had been working, the pair of sunglasses which were reportedly being used by the FT to assist in his welding work (together with the welding shield) were not found.

2.1.3 The investigation team considered that in all probability, while welding, an item such as the pair of sunglasses, might have fallen into the cargo hold through the booby hatch. The FT then likely attempted to retrieve the item by entering the cargo hold via the vertical ladder. The atmospheric condition (see 1.4.4) measured a day after the occurrence, confirmed that CH3 was deficient in oxygen. It is, therefore, highly probable that the scrap metals loaded in CH3 had caused the depletion of oxygen from the hold's atmosphere to levels which would not have sustained life.

2.1.4 The FT may not have expected the atmosphere to be oxygen deficient and deemed the cargo hold safe for entry or may have thought that it would be a quick job in retrieving the fallen object from the cargo hold swiftly. As the FT entered the booby hatch via the ladder, the FT likely entered to a hypoxic zone and collapsed on the pile of scrap metals.

2.2 Perceptions of the hazards in entering cargo hold

2.2.1 Since being onboard SP, the FT had carried out similar hot work tasks with the booby hatches opened and the same cargo inside. The investigation team noted from records that the FT had also participated in the risk assessment conducted prior to the loading of this cargo of scrap metals where restrictions to enter the cargo spaces had been briefed. In addition, records also confirmed the FT's participation of the table-top exercise for the enclosed space rescue drills, a month before this occurrence.

2.2.2 The investigation team thus considered the following possibilities –

a) The FT's motivation to quickly retrieve the fallen object from the cargo hold had overtaken the hazards associated with an enclosed space, which the FT reportedly was aware of; or

b) The FT's perception of the hazards in the cargo hold was not aligned with what was briefed prior to loading the scrap metal cargo and with the guidance provided in the SMS.

2.2.3 While the crew, including the FT, were expected to be aware of and remember the hazards associated with the cargo carried onboard together with the restriction to enter the cargo spaces, this occurrence demonstrated that such important aspects could be overlooked when other factors present themselves. The absence of a physical barrier like a rope or a chain with an attached warning sign might have caused the FT to overlook the risks associated with, before entering the cargo hold.

2.2.4 The occurrence also reiterated the importance of adhering to the established enclosed space entry procedures regardless of how transitory the entry would be. It would have been prudent for the FT to inform the CO or the BSN of the need to enter the cargo hold, so that an enclosed space entry protocol could be initiated in accordance with the SMS.

2.2.5 Although the BSN was present when the FT was performing the hot work (to mitigate the risks of fire hazards associated with this activity), the BSN left the worksite and the FT, without getting an alternative crew member to take over the watchman's duty. While the occurrence did not result from fire hazards, the investigation team deemed that the presence of a watchman with the FT may have prevented the FT from entering the cargo hold.

2.3 Enclosed spaces and their signage

2.3.1 The top-side of the booby hatch was painted with the words “RESTRICTED AREA” with a yellow-painted background which was not visible to the FT, from the location where he was working at the underside of the cover. Regardless, the words did not indicate a prohibition to enter nor provide any indication on the reasons for an entry being prohibited, unless authorised.

2.3.2 According to the IMSBC, personnel shall not be permitted to enter the cargo space unless the space has been ventilated, the atmosphere tested and to be gas-free to have sufficient oxygen to support life. These measures are aimed to prevent unauthorised access into enclosed spaces, especially where awareness of the possibility of oxygen depletion caused by the cargo might not be apparent.

2.3.3 As analysed earlier, it is thus desirable that proper signage(s) are placed to warn the crew that cargo holds should be treated as enclosed spaces and to highlight the risk of oxygen deficiency and the conceivable presence of toxic gases or fumes.

2.3.4 Although the SMS generalised the type of enclosed spaces, which included the cargo hold (as adapted from the IMO Res. A.1045(27)), there was no ship-specific list of enclosed spaces maintained onboard. While most shipboard crew would associate spaces that have been closed for a long time to be treated as ‘enclosed’, efforts must be taken to remind crew of such spaces by listing them down and to display this list of enclosed spaces conspicuously to avoid such places to be overlooked.

2.3.5 The investigation team also noted that there was no standard signage for enclosed spaces for use on ships, and while a standard is being developed by the IMO, there is merit for the Company to consider posting additional signage(s) and poster(s) in conspicuous places on the ship which must be understandable by all crew to provide a constant reminder of the risks of entering the cargo hold.

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 Fitter (FT) had entered the cargo hold, likely to retrieve dropped or fallen item(s), and succumbed to the low oxygen atmosphere due to the cargo (steel scraps).

3.2 The FT had likely overlooked the hazards associated with the enclosed space and cargo carried. The FT, with the motivation to quickly retrieve the fallen object, entered the hypoxic area of the cargo hold and collapsed.

3.3 There was no physical barrier such as rope or chain at the booby hatch opening to prevent accidental entry.

3.4 The hot work performed by the FT and supervised by the Bosun (BSN) did not require entry into the enclosed space (i.e., the cargo hold). The supervision by the BSN was required continuously (for the hot work) but the BSN was driven by the need to prepare equipment for subsequent work on the booby hatch cover and left the work site.

3.5 There was no ship-specific list of enclosed spaces maintained onboard as required by the SMS.

4 SAFETY ACTIONS

During the course of the investigation the following safety actions were initiated by the Company of SP.

4.1 The Company promulgated a safety circular in relation to this occurrence to its fleet and for each Master to hold a safety meeting and discuss the incident findings with regards to improving risk awareness and to prevent similar incident occurring onboard.

4.2 The safety circular aims to unify the Company's requirements for the Masters, Chief Engineers and Chief Officers to check safety matters at the worksite in-person, to ensure compliance with safety procedures such as donning of PPE, specific work measures are followed and to take photographs of work being performed on-site by the crew as evidence of compliance, for the weekly report.

4.3 The section on safety procedures for entry into enclosed spaces in the SMS was updated with the ship-specific list of enclosed spaces. A list of such spaces was prepared for the fleet.

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 the Company

5.1.1 To consider putting in place physical barriers such as rope or chains across the opening to prevent accidental entry into any enclosed space. **[TSIB-Recommendation RM-2023-10]**

5.1.2 To consider posting signage(s) and poster(s) in conspicuous places onboard to caution ship's crew and other personnel about enclosed spaces and the need to follow established safety protocols. **[TSIB-Recommendation RM-2023-11]**