Final Report

FATAL INJURY OF ENGINE CADET DUE TO COLLAPSED STEEL PLATES ONBOARD CHINA ACE AT SOUTH ATLANTIC OCEAN ON 13 JUNE 2024

TIB/MAI/CAS.171

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

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The Transport Safety Investigation Bureau of Singapore

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ABBREVIATIONS

ABS	American Bureau of Shipping
bpm	beats per minute
BF	Beaufort wind force scale[1]
CO	Chief Officer
CA	China Ace
COSWP	Code of Safe Working Practices for Merchant Seafarers[2]
ETO	Electro-Technical Engineer
EC	Engine Cadet
kgs	kilograms
MRCC	Maritime Rescue Coordination Centre
m	metres
MT	metric tonne
mm	millimetres
nm	nautical miles
OOW	Officer of the Watch
PPE	personal protective equipment[3]
PRC	People's Republic of China
RA	risk assessment
SE	southeast[4]

[1] An empirical measure that relates wind speed to observed conditions at sea.
[2] A publication published by the UK Maritime & Coastguard Agency, which provides best practice guidance for improving health and safety onboard ships. It is not a mandatory requirement to carry this publication onboard Singapore registered ships. However, the Company's safety management system had incorporated the COSWP as part of its procedures for reference. A copy of the COSWP was placed onboard at the time of the incident.
[3] Equipment worn to minimise exposure to hazards that cause serious workplace injuries and illnesses.
[4] Direction with reference to a compass.

SSE	south-southeast[5]
SMS	Safety Management System[6]
SMT	ship's mean time
STCW	Standards of Training, Certification, and Watchkeeping for seafarers
UTC	Coordinated Universal Time
2E	Second Engineer
2O	Second Officer
3O	Third Officer

[5] Direction with reference to a compass.
[6] A structured and documented system enabling Company personnel to implement effectively the Company's safety and environmental protection policy - International Safety Management (ISM) Code.

SYNOPSIS

On 13 June 2024, the 2E, ETO and EC, onboard the Singapore registered bulk carrier China Ace (CA) sailing in the South Atlantic Ocean, were tasked to select and relocate steel plates for fabrication into a tool tray base footing and storage rack partitions.

The steel plates were stacked vertically and left unsecured at the side of the railings. The crew selected the steel plates by laying them horizontally before moving them for cutting works and leaving the other steel plates stacked vertically. While relocating one of the selected steel plates, the remaining vertical steel plates collapsed and fell on top of the EC. The EC was subsequently pulled out from the collapsed steel plates and administered first aid. The EC continued to be treated onboard with advice from shore medical doctors as the ship made its way to the nearest port but unfortunately the EC succumbed to his injuries and died.

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

The investigation revealed that the task of selecting and relocating steel plates was carried out when CA was navigating in rough sea conditions, and the crew did not re-secure the steel plates left at the storage area after selecting the relevant steel plates for fabrication. The storage location of the steel plates was inappropriate and posed a falling hazard when the steel plates were not secured.

The investigation also revealed that the risk assessment conducted did not adequately address several critical factors. It did not consider the effects of ship movement due to weather conditions, nor did it evaluate the specific hazards associated with each stage of the task, the characteristics of the load, or the physical exertion required to relocate the steel plates. A more thorough RA could have identified these risks and provided a more comprehensive control measure to mitigate the risks.

VIEW OF VESSEL

China Ace (*Source:* the TSIB)

DETAILS OF VESSEL

Name	China Ace (CA)
IMO number	9957634
Classification society	American Bureau of Shipping (ABS)
Ship type	Bulk carrier
Year built	2023
Owner / ISM Manager[7]	China Ace Shipping Pte. Ltd. / Chinese Maritime Transport Ltd.
Gross tonnage	108,985
Length overall	295.17m
Breadth	50.0m
Designed draft	18.50m
Summer freeboard	6.773m

[7] The "ISM Manager" is hereafter referred to as the Company in this investigation report.

Main engine(s)	CSE 6G70ME - C10.5 (1 x 14400kW)

1 FACTUAL INFORMATION

All times used in this report are SMT unless otherwise stated. The SMT is one hour ahead of UTC, i.e. UTC +1H.

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

1.1 Sequence of events

1.1.1 On 13 June 2024, CA, laden with 204,786MT of bauxite in bulk cargo, was sailing in the South Atlantic Ocean (see **Figure 1**) after departing the Port de Boké, Guinea[8] bound for the Port of Singapore for bunkering[9] and thereafter the Port of Qingdao, China for discharging.

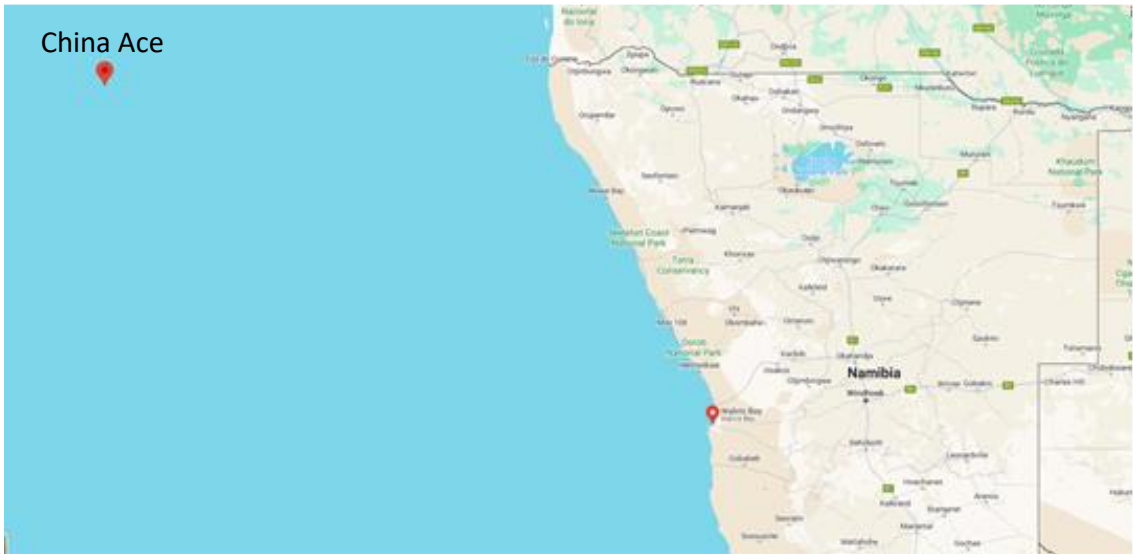

Figure 1 – CA was about 663nm away from Walvis Bay, Namibia at the time of occurrence (*Source:* Google maps, annotated by the TSIB)

1.1.2 At about 1045H, the 2E, ETO and EC were in the steering gear room, selecting and relocating steel plates to fabricate the base footing (1 x 5mm[10] steel plate – sheet A) and partitions (4 x 2mm steel plate – sheet B) for storage racks in

[8] CA had departed Port de Boké, Guinea on 6 June 2024.
[9] Bunkering is the supplying of fuel for use by ships.
[10] Thickness of the steel plate.

the spare part room, which was within the engine room. The steel plates came in different sizes (see **Table 1**).

Number of steel plates	Dimensions (mm) (thickness x width x length)	Weight (kg) per steel plate	Remarks
4	2.0 x 914 x 1829	26.3	sheet B
1	5.0 x 1510 x 2000	142	sheet A
2	6.0 x 1510 x 2000	170	-
17	2.6 x 1510 x 2000	54.7	-
1	3.2 x 1510 x 2000	75.9	The back most of the stack, leaning against the walkway railing

Table 1 – Arrangement of the steel plates from front (top of table) to back (bottom of table) leaning vertically against the walkway railing[11]. (*Source:* the Company)

1.1.3 Since April 2024, these steel plates were delivered at shipyard and were stored onboard CA. The steel plates were vertically stacked on a wooden pallet (100 x 120 cm) and secured to a walkway railing by a rope (see **Figure 2**) in the steering gear room. The trio removed the rope and brought down sheet B steel plates, laying them flat onto the wooden pallet on the floor. Thereafter they brought down sheet A steel plate in the same manner and laid it on top of sheet B plates. The other steel plates remained leaning against the walkway railing. The trio did not re-secure the steel plates to the walkway railing with the rope.

[11] The shaded portion of **Table 1** denotes the steel plates that had fallen onto the EC.

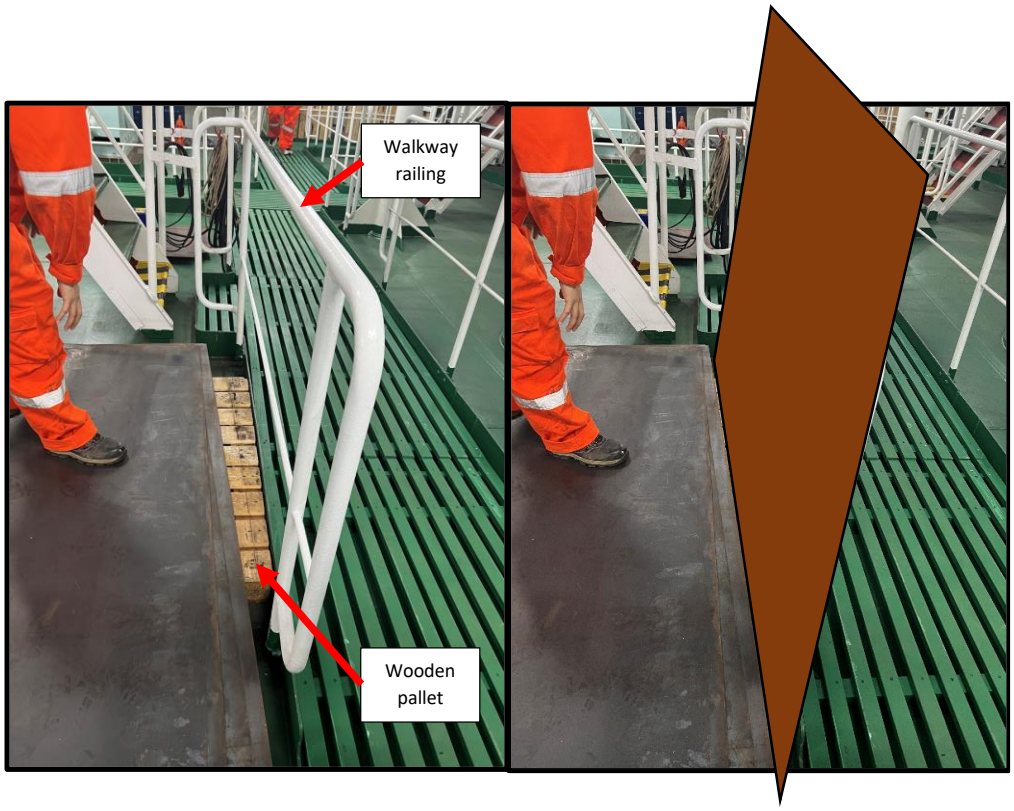

Figure 2 – Illustration of the steel plates leaning vertically against the walkway railing in athwartship (*Source:* the Company, illustration by the TSIB)

1.1.4 The trio positioned themselves at three corners[12] of sheet A and began to lift and shift the sheet A steel plate to a nearby location, about 3m away, where cutting was planned (see **Figure 3**). The trio managed to shift the sheet A steel plate slightly forward by about 0.5m.

[12] The corner directly opposite of the EC was obstructed by a stairway, thus the trio occupied the other three unobstructed corners of the sheet A steel plate (see **Figure 3**).

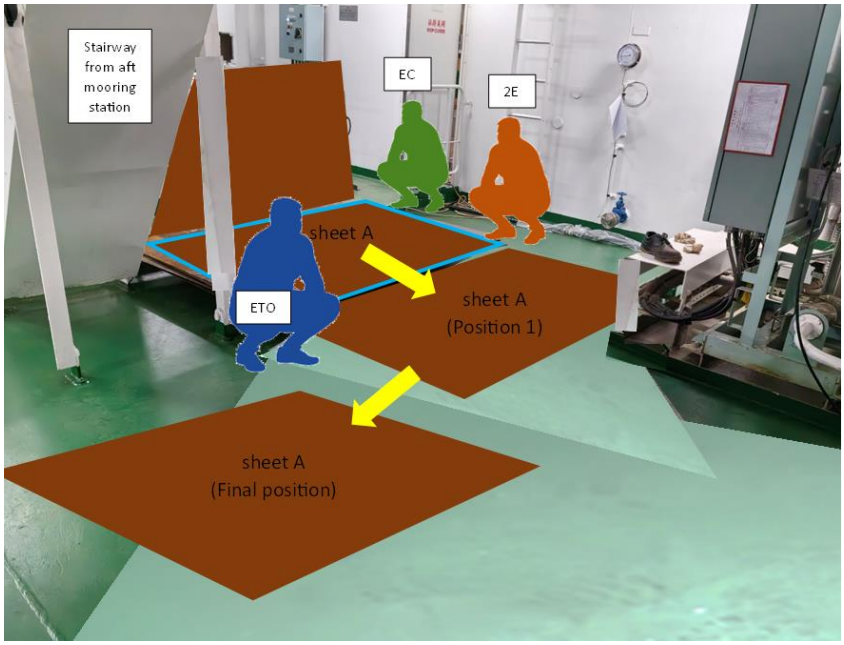

Figure 3 – The positions of the trio, prior to lifting and shifting sheet A steel plate to position 1 and thereafter to the final position (*Source:* the Company, with annotation and illustration by the TSIB)

1.1.5 While shifting the sheet A steel plate further forward, the remaining steel plates which were leaning vertically against the walkway railing suddenly fell from their vertical position. The 2E and ETO recalled noticing the EC moving to support the falling steel plates. Both the 2E and ETO opined that the EC could have noticed the stack of steel plates falling and had instinctively reacted to stop the steel plates from falling. The sheer weight[13] of the steel plates were on the EC's back, pinning him down onto the floor (see **Figure 4**).

[13] The total weight of the steel plates was estimated to be 1346kg.

Figure 4 – Re-enactment of the EC's position when pinned down on the floor by the fallen steel plates (*Source:* the Company)

1.1.6 The 2E and ETO tried lifting the steel plates to extricate the EC, but the steel plates were too heavy[14] to be lifted. The 2E ran to the engine room to seek help from the CE and the Fitter and at the same time notified the OOW (3O) on the bridge of the incident. The 3O in turn informed the Master.

1.1.7 The ETO, who remained in the steering gear room, found a steel pipe and used it to wedge the corner of the steel plates closest to the EC to reduce the load resting on the EC. The 2E returned to the steering gear room together with the CE and the Fitter. The CE and the Fitter each wedged a steel pipe (brought from the engine room) at two different positions to lift the steel plates that were resting on the EC. When there was sufficient gap from the lifted steel plates, the 2E quickly pulled the EC out from the steel plates.

1.1.8 At about 1058H, the CO, 2O and 3O arrived at the steering gear room with a stretcher and administered first aid to the EC. At about 1105H the EC was transferred to the ship's infirmary.

1.1.9 The crew continued administering first aid to the EC at the ship's infirmary. The EC's blood pressure, heart rate and body temperature were monitored at regular intervals. The conditions of the EC were reported to doctors ashore via

[14] The topmost steel plate resting on the EC weighed about 75.9kg (see Table 4).

teleconsultation[15] and the doctors in turn provided medical advice[16] to the crew. Based on the Master's reports, the doctors assessed that the EC could have suffered a pelvic fracture and internal bleeding and advised the Master to send the EC ashore for medical treatment.

1.1.10 The Master made a request to the Company for a helicopter medical evacuation. At about 2246H, the Company informed the Master that helicopter medical evacuation was not possible as the ship was beyond the helicopter safe flying range of 100nm[17].

1.1.11 On 14 June 2024 at about 0354H, after coordinating with Cape Town MRCC, the Master started to divert CA to Walvis Bay[18], Namibia which was about 450nm away.

1.1.12 The crew continued to monitor the EC's blood pressure, heart rate and body temperature at regular intervals and provide care to the EC.

1.1.13 On 15 June 2024 at about 0908H[19], the heart rate of EC reduced to 19bpm. The Master consulted the doctors and was informed that the EC was likely to be in shock. Based on the report from the crew that there were little urine output and metabolic waste products discharged by the EC, the ashore doctors suspected that the EC was also suffering kidney failure and the important organs in the body could have been affected. The condition of the EC continued to deteriorate. At about 1202H, the EC's mouth was closed and stiff, unable to be pried open.

1.1.14 At about 1718H, three doctors boarded CA and attended to the EC after the ship anchored at Walvis Bay. At about 1748H, the doctors declared the EC had died. The body of the EC was placed in the ship's cold room.

1.1.15 On 16 June 2024 at about 1642H, the EC's body was transferred to a Namibian naval boat and offloaded ashore at Walvis Bay.

[15] A medical teleconsultation was provided by doctors from Far Eastern Memorial Hospital in ROC and Rizhao Port Hospital in the PRC.
[16] Amongst the medical advice provided, the Master had performed an insertion of a urinary catheter on the EC to relieve the urine in the bladder of EC.
[17] The helicopter was based in Cape Town, South Africa.
[18] At a speed of about 12 knots, CA's estimated arrival time at Walvis Bay would be on 15 June 2024 at about 1720H.
[19] The SMT from 15 June 2024 onwards was two hours ahead of UTC.

1.2 Crew's qualifications and roles

1.2.1 There were 21 crew from the PRC and Taiwan onboard CA at the time of the occurrence. Details of relevant persons are listed in **Table 2**.

Rank	Master	CE	2E	ETO	EC
Age	37	66	41	44	24
Certificate of Competency held | Issued by	STCW Regulation II/2[20] | MPA Singapore	STCW Regulation III/2[21] | MPA Singapore	STCW Regulation III/2 | MSA PRC	STCW Regulation III/6[22] | MSA PRC	Not applicable [23]
Experience in rank (years)	2.9	19.1	4.3	4.8	0.8
Experience on similar type ship (years)	2.9	16.1	3.1	4.8	0.8
Service with the Company (years)	2.9	14	1	0.2	0.8
Service onboard (months)	2.8	2.8	2.8	2.8	1.9

Table 2 – (*Source:* the Company)

1.2.2 Prior to the occurrence, the work / rest hour records onboard CA indicated that the CE, 2E, ETO and EC's rest hours, in the past 24-hour and in the last 7-day

[20] STCW Code - A-II/2 Mandatory minimum requirements for certification of masters and chief mates on ships of 500 gross tonnage or more.
[21] STCW Code - A-III/2 Mandatory minimum requirements for certification of chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more.
[22] STCW Code - A-III/6 Mandatory minimum requirements for certification of electro-technical officers.
[23] EC was a trainee, who met minimum requirements, STCW Code - A-VI/1 Mandatory minimum requirements for safety familiarisation, basic training and instruction for all seafarers.

period, were in compliance with the requirements of the STCW[24] and MLC[25] as tabulated in **Table 3**.

Rank	Rest hours in 24-hour prior to the occurrence	Rest hours in 7-day prior to the occurrence
CE	16	129
2E	14	120
ETO	16	130
EC	16	130

Table 3 – (*Source:* the Company)

1.2.3 A Medical Certificate of Seafarer issued by a local hospital in Taiwan dated 25 March 2024 indicated that the EC was fit[26] for sea service.

1.3 Cause of death

1.3.1 A Medical Certificate for the Cause of Death issued by the Government of Republic of Namibia indicated that the EC had died from hypovolemic shock[27] due to unintentionally struck by blunt object (fracture of acetabulum).

1.4 Training on SMS

1.4.1 Ship records indicated that the CE, 2E, ETO and EC had read the SMS procedures. Training[28] on the SMS was carried out onboard by the Master, and

[24] STCW Code - A-VIII/1 Fitness for duty. 2 All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than: .1 a minimum of 10 hours of rest in any 24-hour period; and .2 77 hours in any 7-day period.
[25] Maritime Labour Convention, 2006 - Regulation 2.3 – Hours of work and hours of rest. The limits on hours of work or rest shall be as follows: (a) maximum hours of work shall not exceed: (i) 14 hours in any 24-hour period; and (ii) 72 hours in any seven-day period; or (b) minimum hours of rest shall not be less than: (i) ten hours in any 24-hour period; and (ii) 77 hours in any seven-day period.
[26] Meeting the requirements of the Maritime Labour Convention, 2006 - Regulation 1.2 – Medical certificate and STCW Code - A-I/9 Medical standards.
[27] A form of shock caused by severe hypovolemia (insufficient blood volume or extracellular fluid in the body). It can be caused by severe dehydration or blood loss. Hypovolemic shock is a medical emergency; if left untreated, the insufficient blood flow can cause damage to organs, leading to multiple organ failure. (source: Wikipedia)
[28] The attendees were trained on how to read the Fleet Management System (FMS) and how to use the Planned Maintenance System (PMS).

the training record indicated that the CE, 2E and ETO had attended the training on 18 April 2024.

1.5 The vessel

1.5.1 CA was a capesize[29] bulk carrier on her maiden voyage, trading between the Far East and Africa, at the time of occurrence. CA was certified to carry solid bulk cargo (e.g. coal, iron ore, bauxite).

1.5.2 CA was issued a Statement of Compliance[30] by ABS on 18 April 2024 and its validity was until 17 April 2029. Other statutory certificates required by the flag Administration, were also valid at the time of occurrence.

1.6 The steering gear room

1.6.1 The steering gear room was located at the aft part of ship (see **Figure 5**) and was accessible directly from the engine room and aft mooring station via a stairway.

[29] A way of categorising bulk carriers basing on ship's capacity, a capesize ship is typically above 170,000MT deadweight (DWT).
[30] Certifying the ship is suitable for the carriage of cargoes listed in Group A and C of the International Maritime Solid Bulk Cargoes (IMSBC) Code.

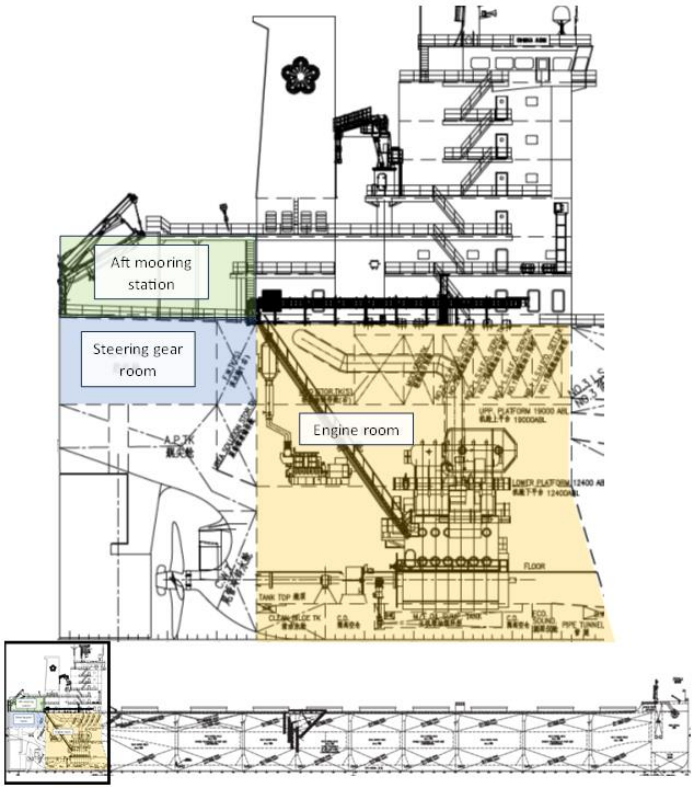

Figure 5 – (*Source:* the Company)

1.7 Meteorological information

1.7.1 Weather forecast[31] for the period of 0600H to 1200H UTC (0700H to 1300H SMT) on 13 June 2024, was provided to CA on 11 June 2024, which forecasted to have SSE wind at BF4[32] and SSE swell at about 1.6m height.

1.7.2 The ship's deck logbook recorded a SE wind with speed of 22-27 knots at 1200H[33] on 13 June 2024, the sea condition was rough with about 2.5m height swell. CA was navigating on a true course of 158.1° in the morning (0800H to 1200H) and was encountering head seas[34], which resulted intermittent pitching[35]. The occurrence happened during this period.

[31] CA had subscribed to a weather advisory service by StormGeo which provided weather forecast to CA by email.
[32] BF4 – Wind speed of 11 to 16 knots, mean 13 knots.
[33] CA was experiencing similar weather conditions since 10 June 2024 at 2000H.
[34] Direction of the seas was reciprocal to the ship's heading.
[35] The Master added that CA was pitching at a frequency of about 10 seconds. Pitching is an up and down motion of a ship from the rotation around the transverse axis.

1.7.3 The investigation team noted that the CE, when conducting the toolbox meeting and assigning the daily tasks to the engineering team[36] at 0830H on 13 June 2024, did not consult the OOW on the weather conditions.

1.8 Work plan

1.8.1 The CE prepared a work plan[37] and listed all job orders for the voyage from Port de Boké, Guinea to the Port of Singapore. Amongst the job orders were 'Steel working'. Steel working involved the fabricating of tool trays, storage racks in workshops and engine room stores.

1.8.2 The job assigned to the 2E on the occurrence day was to select steel plates and cut them into appropriate sizes to fabricate: i) partitions for storage racks in the spare part room which was within the engine room; and ii) base footings for the support column of tool trays (see **Figure 6**).

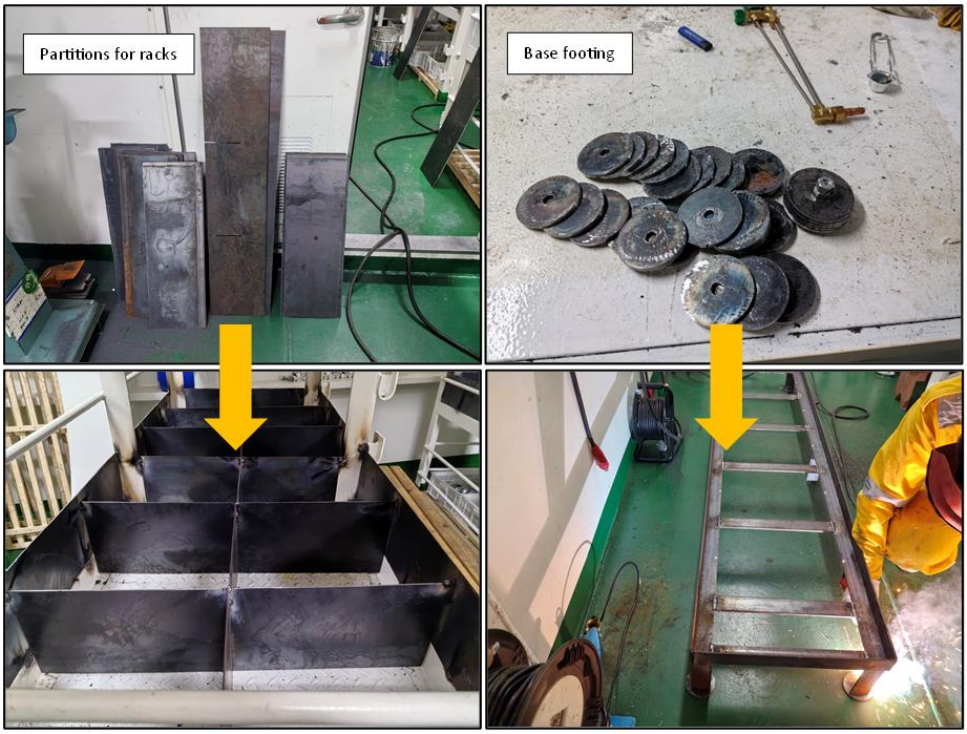

Figure 6 – Examples of fabricated storage rack's partitions and tool tray base's footings (*Source:* the Company)

[36] The engineering team onboard CA included engineers, engine ratings and engine cadets.
[37] The work plan detailed various jobs to be carried out in the engine room and was posted in the engine control room.

1.8.3 At the toolbox meeting, the RA for manual lifting[38] of steel plates was prepared by the CE and was discussed with the engineering team including the 2E, ETO and EC. The RA for work activity of manual lifting was for the job order that was assigned to the 2E.

1.8.4 According to the CE, he expected the 2E to make the necessary arrangements for the job including safety precautions[39] relating to the RA. The 2E tasked the ETO and EC to assist him with the steel work. The PPE for working in the engine room, such as safety helmet, safety shoes and cotton gloves were worn by the 2E, ETO and EC.

1.8.5 After the toolbox meeting at about 0930H, the 2E, together with the ETO and EC started the job order by clearing the storage racks to prepare the storage racks for the welding of partitions after fabricating from the steel plates. At about 1030H, the trio completed clearing the storage racks and proceeded to the steering gear room to select the steel plates.

1.9 The RA procedures[40]

1.9.1 The RA procedures in the SMS stated that RA was an explicit requirement, and all work activities should be considered from the RA standpoint. RA should be seen as a continuous process and the risk in the workplace should be assessed before any task commenced even if there were no valid[41] RA exists.

1.9.2 The RA procedures made a reference to Chapter 1 (Managing Occupational Health and Safety) of the Code of Safe Working Practices for Merchant Seafarers (COSWP), stated an effective risk assessment should include the correct and accurate identification of all hazards and who may be harmed and how the person could be harmed.

1.9.3 Chapter 10 (Manual Handling) of the COSWP stated, RA should take full account not only of the characteristics of the load and the physical effort required but also of the working environment, e.g. ship movement, and any other relevant factors such as the frequency and duration of the work. In the

[38] CE had used an available RA from the RA library - Manual Lifting include large materials and handling steel plates.
[39] The CE viewed the 2E as a senior member of the engineering team and entrusted the 2E to manage the delegation of personnel, preparation of the required tools, PPE, etc.
[40] SMS - 410-RSK – Risk Assessment Procedure.
[41] SMS - 410-RSK – Risk Assessment Procedure / Section 4 – Incorporated Documents 1) Risk Assessment Library which contained a list of risk assessments for the anticipated work activities onboard. No valid RA means that the Risk Assessment Library did not have the RA for a particular work activity.

same chapter and referencing the guidelines for safe weights for manual handling, the maximum safe weight for manual lifting was 25kg for a person (see **Figure 7**). In this case, the weight of sheet A steel plate was about 142kg, which was about twice the combined weight of 75kg which the 2E, ETO and EC allowed to lift manually.

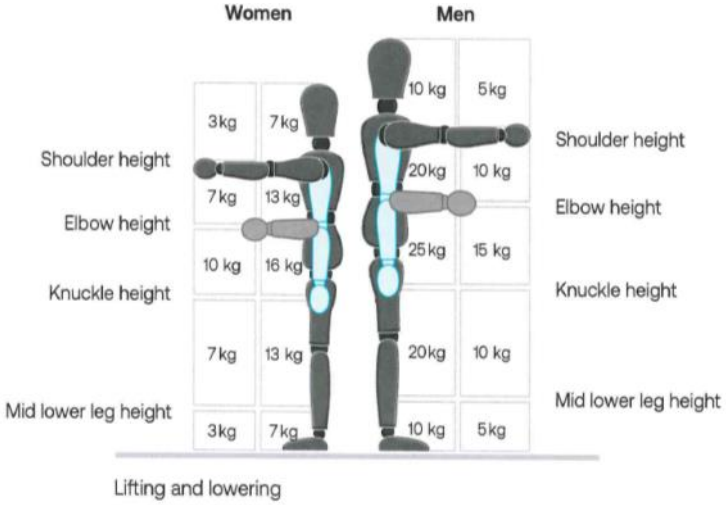

Figure 7 – Guideline for safe weights for manual handling[42] (*Source:* the COSWP)

1.9.4 The RA procedures also stated that RA should be carried out for any activity or operation (routine or infrequent) with hazardous nature. The procedures included a flow chart guiding the ship's crew on when a RA should be carried out (see **Figure 8**).

[42] The guidelines for safe weight vary depending on the capacity of the individual and also the position in which the weight is held. Subject to RA, lighter weights may be safely lifted with arms extended or at high or low levels.

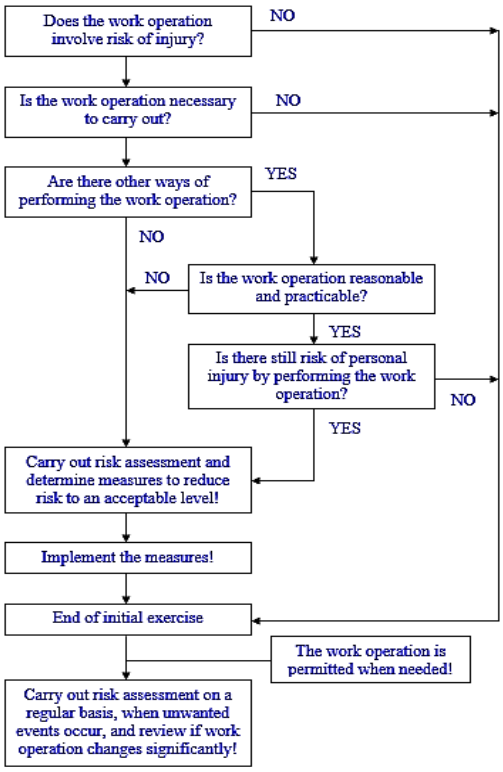

Figure 8 – Flow chart of RA (*Source:* the Company)

1.9.5 The CE had identified hazards and control measures (see **Table 4**) for the manual lifting of steel plates, which were recorded as very unlikely to cause harm[43] with a moderate severity of harm[44]. It was also concluded that the manual lifting of steel plates was of very low risk[45] (see **Figure 9**) after assessing risk factors. The CE and 2E both signed off the RA[46] for the manual lifting of steel plates[47].

[43] Very unlikely to cause harm defined in the categories for the likelihood of harm as less than 1% chance of being experienced by an individual during their working lifetime (SMS - 410-RSK – Risk Assessment Procedure / Section 6.2 – Element and Process of Risk Assessment and Control).
[44] Moderate harm defined in the categories for the severity of harm reflecting health and safety consequences as deafness, dermatitis, asthma, work related upper limb disorder, ill-health leading to permanent minor disability, lacerations, burns, concussion, serious sprains, minor fractures and muscular-skeletal disorder (SMS - 410-RSK – Risk Assessment Procedure / Section 6.2 – Element and Process of Risk Assessment and Control).
[45] Very low risk was defined as risks considered acceptable. No further action is necessary other than to ensure that the control measures are maintained (SMS - 410-RSK – Risk Assessment Procedure / Section 6.2 – Element and Process of Risk Assessment and Control).
[46] SMS - 410-RSK – Risk Assessment Procedure / Section 6.3 RA Pro-forma - stated that the name of assessor is to be recorded in the RA. Section 6.4 When to carry out RA – stated that either the CE or the CO was responsible for carrying out a RA.
[47] The 2E, ETO and EC did not use any lifting equipment for the work activity.

Identified hazards	Control measures
Slip up[48]	Follow the Company's procedure for use of PPE
Person injury due to sprain	Two persons handle the object
Person injury of object falling	Person conducts of safe range prohibit entrance preventing injury of falling[49]

Table 4 – (*Source:* the Company)

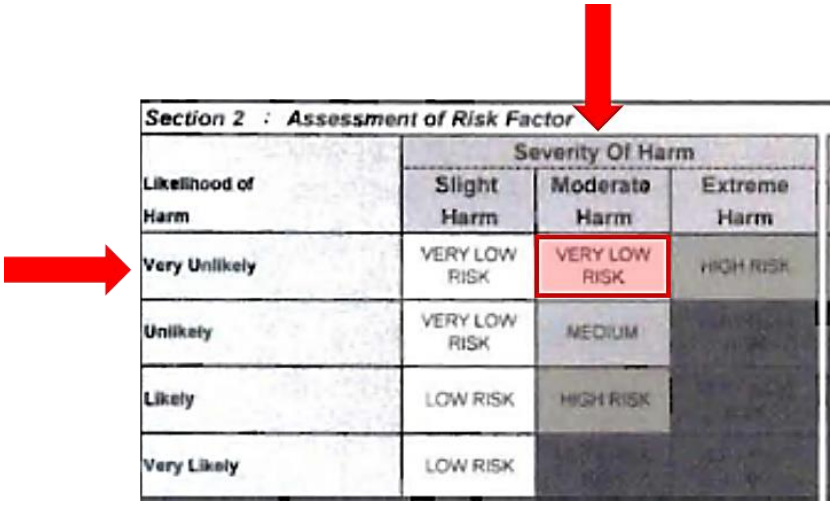

Figure 9 – (*Source:* the Company)

1.9.6 According to the 2E, the remaining steel plates leaning against the walkway railing did not need to be secured with the rope after they had selected the required steel plates (sheet A and sheet B), as the remaining steel plates were in a stable position and selecting, lifting and relocating of steel plates would only take a short while to complete.

1.9.7 The CE added that when drafting the RA for the relocation of steel plates, the falling hazard of the remaining steel plates leaning against the walkway railing

[48] Slip, trip and fall.
[49] This is verbatim from the RA, the investigation team found out that it meant prohibiting any persons putting their hands / legs below the lifted steel plate (see **Figure 3** - blue box area).

was not anticipated. The RA also did not consider that the sea condition would cause the stack of steel plates to fall.

2 ANALYSIS

2.1 Inadequate RA conducted for the steel work activity

2.1.1 The RA in the Company's SMS was required to be considered for all work activities. If an activity was not listed in the RA library as pre-identified by the Company, the risk for that activity was required to be assessed before commencement of the activity.

2.1.2 An RA was carried out by the CE, where common hazards associated with the steel plate work were identified with control measures in place. However, the environmental factor of the forecasted sea condition for the period of the steel work was not taken into consideration, and the falling hazard of unsecured steel plates was not anticipated.

2.1.3 The task of selecting the required steel plates was carried out by the ship's crew when CA was navigating in rough sea conditions with swells of about 2.5m height and was encountering head seas. CA would be expected to pitch occasionally due to the head seas and roll due to the swells. Furthermore, after the sheet A and B steel plates had been laid down on the floor, the remaining steel plates leaning vertically against the walkway railing were not secured which subsequently fell due to the ship's movements. The EC did not know the weight of these remaining steel plates (1346kg) and instinctively moved his body to prevent the falling of the remaining steel plates and sustained internal injuries which led to hypovolemic shock and subsequently the EC succumbed to these injuries before CA reached to the port.

2.1.4 The RA for the task of selecting and relocating of steel plates was inadequate. Had the sea condition been considered during the toolbox meeting, this task may have been postponed. The pitching and rolling movements of the ship could affect the stability of the ship and thus the stability of the persons performing the relocation of the heavy steel plates.

2.1.5 In addition, the RA did not adequately consider the heavy weight of the steel plates and associated hazards posed by this weight. The weight of the steel plate to be shifted was beyond the allowed weight of 25kg/person. The use of lifting equipment or trolley should have been considered to avoid injuries relating to strained back and the risk of dropping during shifting.

2.1.6 The reason for not re-securing the remaining steel plates after selecting the required steel plates was because relocating the selected steel plates would only be a short while. Due to the heavy weight of the steel plates, the time taken to shift the selected steel plates was longer than expected. Had the RA conducted by the CE included the risk of falling steel plates due to the rough sea condition, it could have reminded the trio not to leave the remaining steel plates unsecured. The occurrence also highlighted that even if the relocation of steel plates would only take a short time, one should not take a chance and always take safety into consideration and not to leave anything un-secured.

2.2 The storage of the steel plates onboard CA

2.2.1 The steel plates were stored next to a stairway which made access to the steel plate difficult as they were obstructed by the stairway at one corner. In such a location, it was difficult for a lifting equipment to be placed near the steel plates and hence the steel plates had to be laid down on the floor manually. Securing heavy steel plates vertically with a rope also involved the risk of falling steel plates in the event of rough seas.

2.2.2 It is desired that heavy steel plates to be handled with lifting equipment and secured with a better securing mechanism.

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 task of selecting and relocating steel plates was carried out by ship's crew when CA was navigating in a rough sea condition with swells of about 2.5m height and was encountering head seas.

3.2 The remaining steel plates leaning vertically against the walkway railing were not secured after the selected steel plates were laid on the floor. The fall of the remaining steel plates was likely due to the ship's pitching and rolling movements caused by the rough sea.

3.3 The heavy weight of the remaining steel plates was beyond the ability of the EC's body to stop the fall and pinned him down on the floor which resulted in serious internal injuries and subsequent death.

3.4 The RA for selecting and relocating of steel plates was inadequate. The risk of steel plates falling caused by rough sea condition and the risk of injuries caused by the manual lifting of heavy steel plates were not included in the RA.

3.5 The location for storing steel plates was inappropriate as there was limited access space for handling and use of lifting equipment. The securing mechanism of steel plates using a rope ran a risk of falling in rough sea condition.

4 SAFETY ACTIONS

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

4.1 The Company carried out a fleet wide safety campaign to heighten its crew's safety awareness and encourage the crew to propose optimisation of safe working practice to minimise potential risks arising from moving steel plates. Safe working practice proposals were provided by the crew during the safety campaign as follows:

(i) To ensure the work area is free of obstructions and identify a clear route in advance for any movement required for the steel plate,

(ii) To use trailer cars, lifting mechanism and lifting slings where possible and if manual lifting is necessary, best to have 4 people together, each person at a point to distribute the weight evenly, and allow lifting only within the person's limitations,

(iii) Do not handle steel plate in bad weather, especially when the ship is rolling and pitching, and

(iv) To ensure steel plates are always secure, including during different stages of the task.

4.2 A purpose build storage rack was fabricated for the storage of steel plates on CA and the Company's fleet ships, the storage rack included a securing feature preventing steel plates from toppling (see **Figure 10**).

Figure 10 – (*Source*: the Company)

4.3 The RA in the Company's safety management procedures for manual lifting activity was revised and updated in the RA Library. The RA was updated to include:

(i) Assessment to be carried out for the number of persons require to handle the object within a person's limitations.

(ii) Ensure surrounding / adjacent hazards are identified and mitigated, e.g. unsecured steel plates.

(iii) Person to move away from falling object and do not attempt to stop it.

5 SAFETY RECOMMENDATIONS

In view of the safety actions taken by the Company, no safety recommendation is proposed for the Company.