REPUBLIC OF THE MARSHALL ISLANDS

Maritime Administrator

HAFNIA ADAMITE SAFETY INVESTIGATION REPORT

Fatality During Enclosed Space Entry

Mediterranean Sea | 18 July 2022

Official Number: 5782

IMO Number: 9727546

Published by: Republic of the Marshall Islands Maritime Administrator on 15 April 2024

DISCLAIMER

In accordance with national and international requirements, the Republic of the Marshall Islands Maritime Administrator (the "Administrator") conducts marine safety investigations of marine casualties and incidents to promote the safety of life and property at sea and to promote the prevention of pollution. Marine safety investigations conducted by the Administrator do not seek to apportion blame or determine liability. While every effort has been made to ensure the accuracy of the information contained in this Report, the Administrator and its representatives, agents, employees, or affiliates accept no liability for any findings or determinations contained herein, or for any error or omission, alleged to be contained herein.

AUTHORITY

An investigation, under the authority of the Republic of the Marshall Islands laws and regulations, including all international instruments to which the Republic of the Marshall Islands is a Party, was conducted to determine the cause of the casualty.

Maritime Administrator

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LIST OF ABBREVIATIONS AND ACRONYMS

2/E . . . . . Second Engineer
2/O . . . . . Second Officer
3/O . . . . . Third Officer
ASD . . . . . Able Seafarer Deck
CPR . . . . . Cardiopulmonary Resuscitation
COT . . . . . Cargo Only Tank
C/E . . . . . Chief Engineer
C/O . . . . . Chief Officer
DPA . . . . . Designated Person Ashore
DWT . . . . . Deadweight Tonnage
EEBD . . . . . Emergency Escape Breathing Device
ILO . . . . . International Labour Organization
IMO . . . . . International Maritime Organization
kn . . . . . Knots
m . . . . . Meters
mt . . . . . Metric Tons
N_2 . . . . . Nitrogen Gas
NM . . . . . Nautical Miles
O_2 . . . . . Oxygen
OICNW . . . . . Officer in Charge of a Navigational Watch
PPE . . . . . Personal Protective Equipment
S . . . . . Starboard
SCBA . . . . . Self-contained Breathing Apparatus
SMS . . . . . Safety Management System

DOCUMENTS CITED

A.1050(27) . . . . . IMO Assembly Resolution on Revised Recommendations for Entering Enclosed Spaces Aboard Ships

COLREGs . . . . . Convention on the International Regulations for Preventing Collisions as Sea, 1972

ISM Code . . . . . International Management Code for the Safe Operation of Ships and for Pollution Prevention

MLC, 2006 . . . . . Maritime Labour Convention, 2006

Company's SMS . . . . . OSM Ship Management AS Safety Management System

SOLAS . . . . . International Convention for the Safety of Life at Sea, 1974

STCW Code . . . . . Seafarers' Training, Certification and Watchkeeping Code

PART 1: EXECUTIVE SUMMARY

On 18 July 2022, the Republic of the Marshall Islands-registered oil/chemical tanker HAFNIA ADAMITE was drifting off the coast of Naples, Italian Republic (hereinafter "Italy") in ballast condition awaiting voyage and cargo orders.

The Deck crew were conducting maintenance on various Butterworth hatches on selected cargo tanks which, at the time, were inerted with N_2. The Deck crew were instructed to remove rust from the surface of the Butterworth hatch covers. To prevent rust and debris from entering the tank, a plastic bucket was positioned inside the opening of the Butterworth hatch opening. During the morning maintenance, the plastic bucket fell inside the COT No. 5S, and the Bosun entered COT No. 5S to retrieve it. A short time later, the ASD3 sighted the Bosun inside COT No. 5S and noted that he was unresponsive. The ASD3 raised the alarm before entering COT No. 5S to render assistance to the Bosun. The onboard rescue team found the Bosun and ASD3 unconscious on Platform 2 inside COT No. 5S and commenced to retrieve first the Bosun and then the ASD3. The Bosun responded to medical O_2 and was later discharged from the hospital. The ASD3 received medical O_2 and first aid, however, a short time after being rescued, he was declared deceased.

The Republic of the Marshall Islands Maritime Administrator's (the "Administrator's") marine safety investigation determined that unauthorized entry into an enclosed space was an unsafe act which could have been influenced by a state of hypoxia.

The Company documented control measures existed but were not followed on board. This resulted in inadequate hazard identification of the risk of exposure to N_2 and the danger of an O_2 deficient environment. The Stop Work Authority procedure was not robustly implemented and therefore did not prevent unauthorized access to an enclosed space.

Necessary implementation and adherence to procedures combined with adequate oversight of maintenance and working routines should be sufficient in ensuring the safety of crewmembers undertaking the task required of them.

The Stop Work Authority if exercised by crewmembers, is designed to identify and stop an unsafe act or unsafe condition. Enclosed Space Rescue procedures must be properly practiced and drilled as if it were a real emergency. If crewmembers are not familiar with Enclosed Space Rescue procedures, they stand to put themselves and their fellow crewmembers in danger.

PART 2: FACTUAL INFORMATION

The following Factual Information is based on the information obtained during the Administrator's marine safety investigation.

Ship particulars at the time of the marine casualty: *see* chart to right.

HAFNIA ADAMITE

HAFNIA ADAMITE is a 14 tank, oil/chemical tanker and was managed by OSM Ship Management AS (the "Company") at the time of the incident.

On 11 July 2022, HAFNIA ADAMITE departed Gaeta, Italy in ballast condition having unloaded 32,949 mt of ultra-low sulphur diesel.

On the morning of 18 July 2022, HAFNIA ADAMITE was at sea awaiting voyage and cargo orders from the Company, approximately 17 NM southwest of Naples, Italy. The weather at the time was calm sea, blue sky, and wind 4-6 kn from the north. Air temperature on deck was 27 Celsius.

Planned work for the day included replacement of the Teflon gaskets to the Butterworth[1] hatch covers by first removing rust using an air-powered chipping gun and a rotary steel brush. A plastic bucket was placed inside the Butterworth hatch opening and attached by a thin wire to a hatch combing stub. The purpose of the plastic bucket was to prevent rust particles and debris from falling into COT No. 5S during the process of removing rust by mechanical means.

COT No. 5S

COT No. 5S is one of 14 designated cargo tanks on board HAFNIA ADAMITE and positioned midships, on the starboard side of the ship *(see Figure 1)*.

SHIP PARTICULARS

Vessel Name
HAFNIA ADAMITE

Registered Owner
Hai Kuo Shipping 1915T Limited

ISM Ship Management
OSM Ship Management AS

Flag State
Republic of the Marshall Islands

IMO No.	Official No.	Call Sign
9727546	5782	V7GX8

Year of Build	Gross Tonnage
2015	23,676

Net Tonnage	Deadweight Tonnage
10,252	38,506

Length x Breadth x Depth
177.4 x 27.4 x 17.2 m

Ship Type
Oil/Chemical Tanker

Document of Compliance Recognized Organization
DNV

Safety Management Certificate Recognized Organization
American Bureau of Shipping

Classification Society
DNV

Persons on Board
20

1 A Butterworth hatch is a hatch on deck and used to seal a small opening that admits to the space below. The purpose of the hatch is to allow access for cargo sampling, inspection, gauging, and cleaning of a tank. The Butterworth hatch is not for entry or egress from a tank.

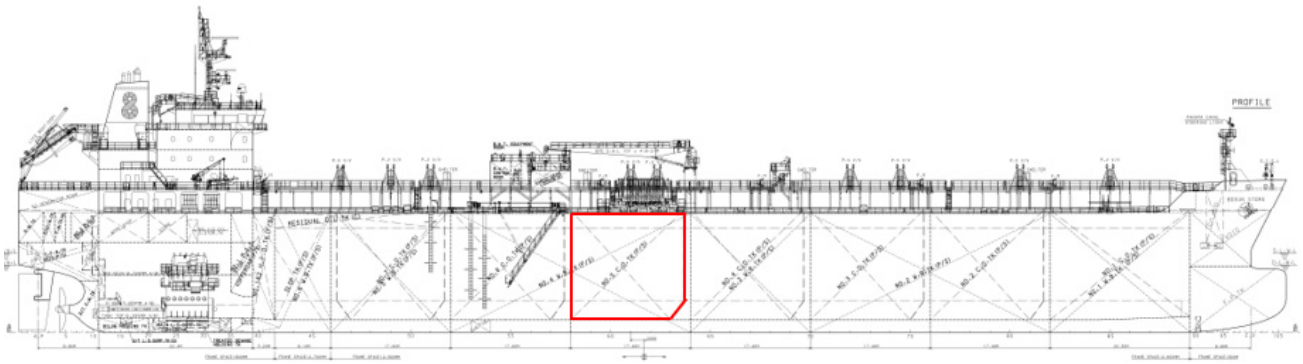

Figure 1: HAFNIA ADAMITE General Arrangement plan. COT No. 5S tank outlined in red.

Each cargo tank is equipped with one Butterworth hatch and one hatch cover for service access *(see Figure 2)*. The service access hatch is the only entry and egress point for the tank. The tank access hatch cover was closed prior to the casualty.

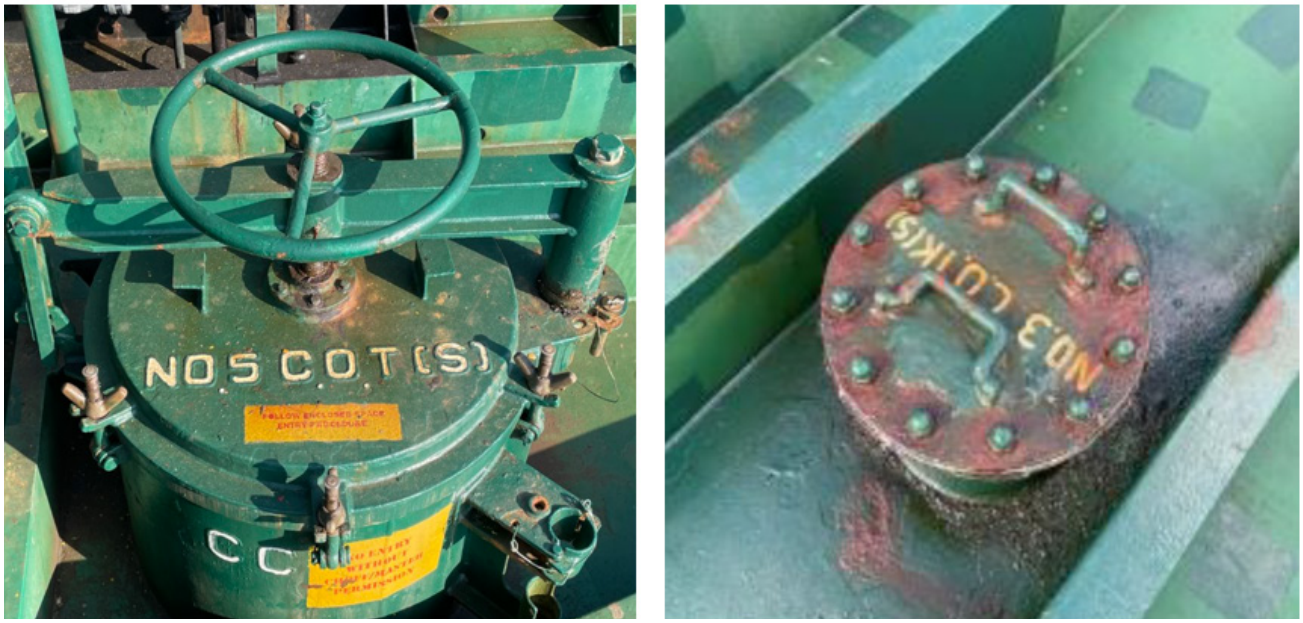

Figure 2: Tank access hatch cover (left) and Butterworth hatch cover (right) in closed condition.

A vertical ladder approximately 3.5 m in length is situated immediately beneath the tank access hatch cover, leading to a horizontal steel platform (Platform 1). An inclined ladder, approximately 3 m in length leads from Platform 1 to a second, horizontal platform (Platform 2) *(see Figure 3)*. The tank depth in total is approximately 17 m.

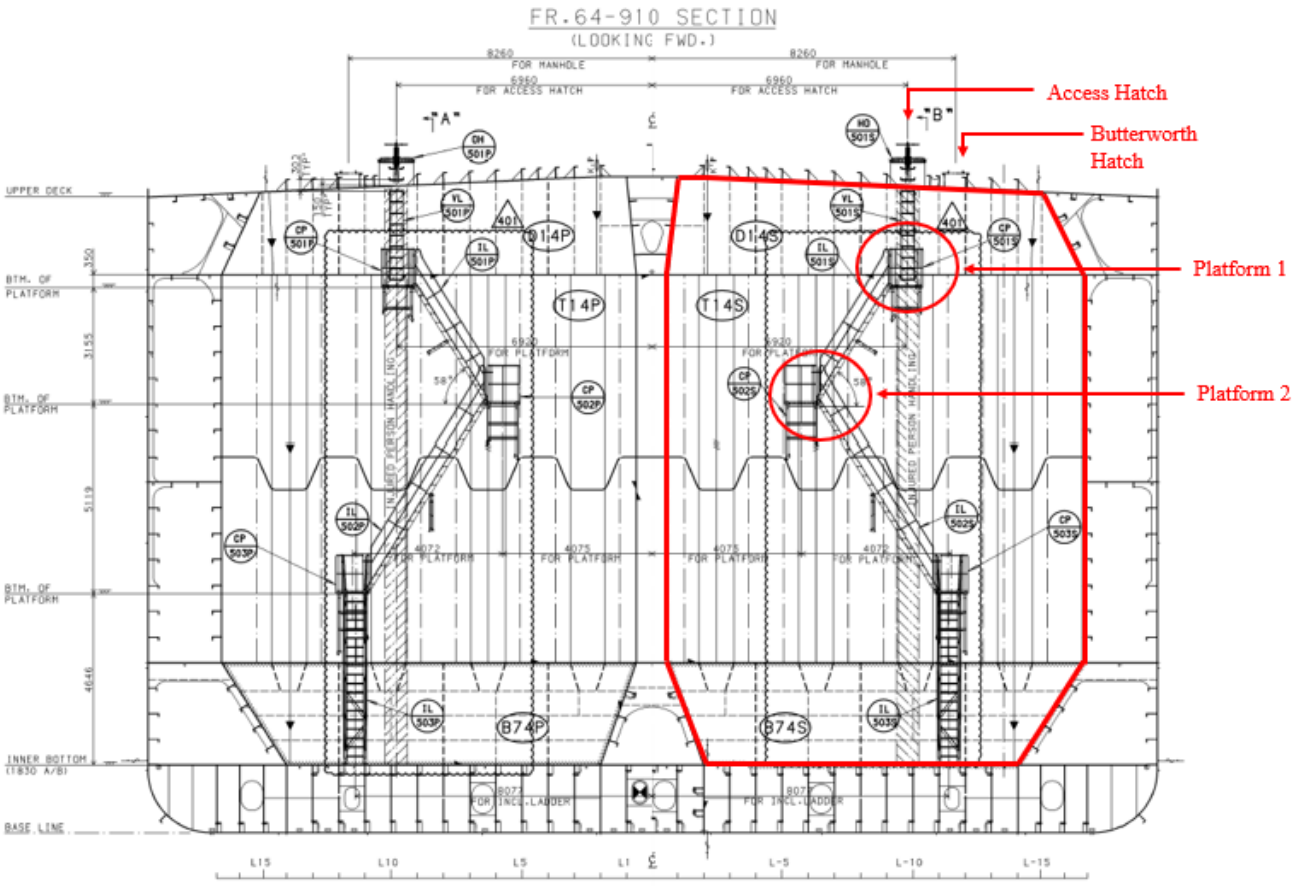

Figure 3: Access, ladder, and platform arrangement to COT No. 5S.

During the previous cargo voyage between 6 and 11 July 2022, the Butterworth hatches were identified as having inadequate seal tightness. From 14 July 2022, maintenance of the Butterworth hatches commenced.

All 14 cargo tanks were stripped[2] and maintained in an inerted condition, using N_2.[3] The level of O_2 maintained within COT No. 5S at the time of the casualty on 18 July 2022 was 3.1%[4] and therefore the atmosphere was O_2 deficient.

Narrative

At approximately 0700[5] on 18 July 2022, prior to undertaking the 0800 to 1200 watch as OICNW, the C/O conducted an informal daily work meeting to discuss the planned activities for the day with the Pumpman and Bosun on the Bridge.

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2 A process to remove all cargo contaminants and residues on completion of cargo discharge operations. Each tank was to be stripped using stripping pumps such as an educator or positive displacement pump. On completion of stripping operations, the pump discharge line is cleared by purging the pump and discharge line with inert gas in the form of N_2.

3 N_2 is used to replace the air atmosphere of the cargo tanks and adjacent spaces to prevent unwanted reactions between the cargo and air. N_2 generated on board by an N_2 generator that produces an inert gas comprised of 86% N_2 and 14% CO_2. A.1050(27) states N_2 has the following characteristics: "N_2 is a colourless and odourless gas that, when used as an inert gas, causes O_2 deficiency in enclosed spaces and at exhaust gas openings on deck during purging of tanks and void spaces and use in cargo holds. It should be noted that one deep breath of 100% N_2 gas will be fatal."

4 Normal atmospheric condition contains between 20.8% and 21% O_2. A.1050(27) requires that: "for entry purposes, steady readings of 21% O_2 by volume by O_2 content meter should be obtained."

5 Unless otherwise stated, all times are ship's local time (UTC -4).

The 3/O, Bosun, OS1, OS2, OS3, ASD1, and ASD3 were present on deck, in various locations, conducting maintenance work.

The Bosun was undertaking maintenance on the COT No. 5S Butterworth hatch using a grinder and paint chipper to remove rust from the face of the Butterworth hatch. The ASD3 was working alongside the Bosun.

At approximately 0720, the plastic bucket used to contain the rust particles from entering COT No. 5S during the removal of rust *(see Figure 4)*, fell into COT No. 5S and rested on the tank floor. The Bosun attempted to retrieve the plastic bucket using a rope with a hook tied on the end.

Figure 4: COT No. 5S Butterworth hatch with plastic bucket located inside and secured to threaded bolt with a wire.

The ASD3 opened the access hatch cover to COT No. 5S to get a better view of the bucket and notified the Bosun. The Bosun, unable to retrieve the plastic bucket with the hook and rope, proceeded to the access hatch.

At 0726, the Bosun entered COT No. 5S and proceeded down the vertical ladder to Platform 1.[6] The Bosun lost consciousness shortly after he entered COT No. 5S. The ASD3, who was in the vicinity of the access hatch cover to COT No. 5S, raised the alarm and notified the OS2 that the Bosun was inside COT No. 5S, positioned on Platform 2 and was unconscious.

The OS2 ran aft, along the storm platform and informed the OS3, who was conducting maintenance nearby. The OS3 informed the 3/O who was located on deck, on the starboard side of the ship, aft of COT No. 5S.

6 It could not be determined if the ASD3 attempted to stop the Bosun from entering the tank.

OS2 and OS3, having notified the 3/O, proceeded to COT No. 5S access hatch. Upon looking inside, they identified both the Bosun and ASD3, unconscious and located on Platform 2. The Bosun was in a sitting position, with his back against the side railing, while the ASD3 was positioned on top of the Bosun horizontally on his back. None of the crewmembers reported seeing the Bosun or ASD3 enter COT No. 5S.

At 0727, the 3/O informed the C/O, who in turn notified the Master who was located on the Bridge, that the Bosun and ASD3 were unconscious inside COT No. 5S.

The 3/O proceeded to the Foam Room to collect two SCBAs. At the same time, the 3/O instructed the OS3 to proceed to the Cargo Control Room and return to the COT No. 5S hatch cover with EEBDs.[7]

At 0731, the C/O, 3/O, ASD1, ASD2, OS3, and Pumpman mustered at the COT No. 5S hatch cover. The Master called the 2/O. The 2/O mustered the Electrician and Fitter and made arrangements to collect a stretcher and resuscitation equipment from the ship's Hospital.

At 0734, the OS1 and OS2 proceeded to the Steering Gear room to collect two additional SCBAs and returned to COT No. 5S hatch cover.

At 0735, the ASD2 entered COT No. 5S wearing an SCBA. The ASD1 followed the ASD2 and entered COT No. 5S wearing an EEBD. The second SCBA was lowered by rope into COT No. 5S. The face mask of the second SCBA was placed on the Bosun's face. A rope was lowered into the tank and placed around the Bosun who was then lifted from Platform 2, out through the hatch opening to safety. The SCBA was removed and replaced with an O_2 mask from the ship's Hospital. At approximately 0739, the Bosun was conscious and responsive and transported on a stretcher to the ship's Hospital.

The ASD1 exited COT No. 5S due to the O_2 level in his EEBD expiring.

The ASD2 remained inside COT No. 5S and was joined by the Electrician who was wearing an EEBD. The Electrician did not proceed beyond Platform 1, recognizing that he was only wearing an EEBD.

At 0745, the Fitter, wearing an SCBA joined the ASD2 on Platform 2. The Electrician left the tank. At 0750, the ASD3 was hoisted from Platform 2 through the hatch opening followed by the Fitter and ASD2.

Once the ASD3 was on deck, the C/O commenced CPR. Due to visible facial injuries, a Guedel[8] airway was inserted and attached to a Bag-Valve-Mask[9] resuscitator. At 0805, the ASD3 was transferred to the ship's Hospital where CPR continued.

Despite the efforts of the crewmembers, the ASD3 did not respond to life saving efforts and appeared to be deceased at 0900 on 18 July 2022.

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7 A self-contained compressed air apparatus with 600 liters of air providing approximately 15 minutes of breathing time.

8 A rigid plastic tube which sits along the top of the mouth and ends at the base of the tongue. It is used to help keep the airway open and prevents the tongue covering the epiglottis.

9 A Bag-Valve-Mask resuscitator is a manual, hand-held, self-inflating bag used to provide positive pressure ventilation to patients who are not breathing.

At about 1230, an Italian Coast Guard helicopter arrived at the location of HAFNIA ADAMITE and two doctors disembarked before the helicopter returned to base. One of the doctors assessed the ASD3 and confirmed he was deceased. The second doctor attended to the Bosun. The Italian Coast Guard helicopter returned to HAFNIA ADAMITE and collected the Bosun and the two doctors. The ASD3 was not taken by the helicopter as he was deceased. The helicopter departed HAFNIA ADAMITE at 1330.

The Bosun was treated at a hospital in Naples, Italy and eventually recovered from his injuries.

A postmortem examination of the ASD3 was conducted in the Republic of Malta and it was determined that the cause of death was anoxic asphyxia caused by low O_2 levels contained within COT No. 5S.

Crewmembers on board HAFNIA ADAMITE

HAFNIA ADAMITE had a complement of 20 crewmembers, four more than what was required by the Minimum Safe Manning Certificate issued by the Administrator.

The seagoing experience of the Master and relevant crewmembers on board HAFNIA ADAMITE and involved in this marine casualty was:

RANK	TIME ON BOARD HAFNIA ADAMITE	TIME IN RANK	TIME WITH COMPANY	TOTAL TIME AT SEA
Master	3 months	5 years	3 months	42 years
C/O	2 months	6 months	3 months	5 years
Bosun	5 months	3 years, 7 months	5 months	22 years
ASD 3	5 months	6 years	5 months	11 years

All involved seafarers held the appropriate Republic of the Marshall Islands seafarer documentation for their positions.

All involved seafarers held current medical certificates and were reported to be fit for duty without restrictions.

The Administrator did not find any indication that any crewmembers involved with this marine casualty did not receive the required amount of rest mandated by the IMO's STCW Code, Section A-VIII/1, paragraphs 2 and 3 and the ILO's MLC, 2006, regulation 2.3.

Company's SMS

As required by the ISM Code, the Company's SMS provided procedures for shipboard tasks. These included requirements for using PPE, conducting pre-task hazard assessments, pre-task briefings (also known as Toolbox Talks), and issuing a Permit to Work when entering an enclosed space.

The Company's SMS stipulated that no person may enter an enclosed space unless authorized by a Responsible Person[10] and after ensuring that appropriate safety procedures have been followed. The safety procedures specific to enclosed space entry were detailed in the Company's Permit to Work system.

The Company's Permit to Work specific to enclosed space entry stipulated that the person entering an enclosed space had reviewed and signed the enclosed space entry permit. In addition, the Permit to Work required that the Risk Assessment Checklist for enclosed space entry was completed and that a Toolbox Talk had been carried out with all parties on site.

On 18 July 2022, no Permit to Work specific to an enclosed space entry had been completed. On 14 July 2022, a generic risk assessment was conducted and issued for cold work[11] concerning the general maintenance of the Butterworth hatches. This risk assessment[12] contained control measures for the depressurization of cargo tanks, isolation of inert gas supply, and a requirement for the use of personal gas detectors by crewmembers working on deck in vicinity of the hatches. This risk assessment did not stipulate control measures for enclosed space entry, nor did it detail the hazards associated with inhaling N_2 by crew when working near a tank where N_2 may be displaced, since the planned work did not require entry into the COTs or other enclosed spaces.

It was stipulated within the SMS that maintenance of the COT No. 5S Butterworth hatch should have been discussed with the Company's shore staff prior to undertaking any maintenance, due to the involved risks of exposure to N_2 by the crewmembers. The Company shore staff was unaware of the maintenance being undertaken on board between 14-18 July 2022.

The Company's SMS stated that the Responsible Person for overseeing a specific task was required to ensure that the appropriate PPE was being worn by the crewmembers performing the task. The SMS also stipulated that individual crewmembers should be responsible for their own safety and follow the PPE requirements for each task. The task assigned on 18 July 2022 was not listed on the PPE and Safety Equipment Matrix contained within the Company's SMS. Enclosed space entry was listed as a task within the PPE and Safety Equipment Matrix and personal multi-gas detectors were required to be worn.

The Company's SMS included Stop Work Authority and states the following:

"All crew have the authority and responsibility to stop any unsafe act and/or unsafe operation at any time. Execute Stop Work Authority in the following, but not limited to these situations:

- *Deviation from agreed arrangements.*
- *Presence of a new hazard at workplace/area.*
- *Change in circumstances during the task.*
- *Unsafe behavior of any crew.*
- *Malfunctioning or missing safety barrier."*

10 Responsible Person is defined within the Company's Enclosed Space Entry procedure (HSE-04.03) as the Master, C/O, C/E, or 2E.

11 Cold work is defined as work which does not require the use of heat such as welding. Cold work being conducted at the time included scraping, chipping, and grinding.

12 Valid for 24-hours. Beyond 24-hours a cold work permit renewal is required.

The Stop Work Authority procedure required that all deviations from the safety standards should be reported to the Responsible Person. According to the Stop Work Authority procedure, the Master should promptly evaluate the safest way to proceed. Each crewmember was also required to carry a Stop Work card that contained steps to be taken on the reverse of the card detailed 'Take 5' when an unsafe act or unsafe condition was identified. These steps included the requirement to stop the work and identify the hazards. A Stop Work card was not found in the possession of the ASD3 at the time of the incident.

The Company's SMS detailed the actions to be taken when carrying out an enclosed space rescue. The Enclosed Space Rescue procedures detailed the specific role of team members, actions to be taken to execute a rescue, conduct of drills, and an SCBA log for recording individual wearer details. The SMS did not specify that all crewmembers entering an enclosed space to conduct a rescue must wear an SCBA. Further, the Enclosed Space Rescue procedure made no reference to the use of an EEBD by crewmembers during an enclosed space rescue, which is also consistent with the contents of A.1050(27) regarding the use of EEBDs for enclosed space rescue.

Training and Drills

The last planned enclosed space entry was conducted on 28 June 2022 into COT No. 3S. The risk assessment carried out by the C/O for that planned entry did not document which crewmembers read and understood the risk assessment.

Two enclosed space rescue drills[13] were conducted prior to 18 July 2022. The first enclosed space rescue drill was conducted on 29 March 2022, and included crewmember mobilization at the scene, testing of rescue apparatus, and full entry into COT No. 6S wearing SCBAs. A second enclosed space rescue drill was conducted on 25 May 2022 and was limited to a tabletop exercise for verification of crewmember familiarization with their individual responsibilities. No entry was made by crewmembers into an enclosed space as part of this training exercise.

Gas Detection Equipment

HAFINA ADAMITE had four GX-6000 personal multi-gas detectors available on board, manufactured by Riken Keiki GmbH. These personal multi-gas detectors measured hydrocarbons,[14] O_2, hydrogen sulfide, and carbon monoxide gases. The multi-gas detectors were last calibrated on 4 December 2021 by a certified shore technician with all parameters passed. No crewmembers working on deck in vicinity of the COT No. 5S access hatch or Butterworth hatch wore a personal multi-gas detector.

13 SOLAS regulation III/19.3.3 requires that crewmembers with enclosed space entry or rescue responsibilities shall participate in an enclosed space entry and rescue drill held on board the ship at least once every two months.

14 Refers to petroleum, natural gas, and coal or their derivatives and purified forms.

PART 3: ANALYSIS

The following Analysis is based on the above Factual Information.

Pre-task Risk Assessment

Maintenance of the Butterworth hatches commenced on 14 July 2022 with the necessary cold work permit and risk assessment signed for that day. The Bosun and Pumpman were briefed by the C/O and instructions were given, with the use of pictures, describing the work to be undertaken. At no time during this Toolbox Talk were hazards discussed in relation to the work to be undertaken, prohibited entry into an enclosed space, or hazards associated with exposure to N_2. No other crewmembers were present during this informal Toolbox Talk.

On 15 and 16 July 2022, a cold work permit renewal was not issued. The Bosun and crewmembers undertaking maintenance to the Butterworth hatches were doing so without the necessary cold work permit or risk assessment. The SMS places responsibility on the Master and Responsible Person to ensure that the SMS is followed, and the necessary procedures are complied with and fully implemented.

On 18 July 2022, the C/O met with the Bosun and Pumpman as a continuation of the Toolbox Talk conducted on 14 July 2022. The discussion was limited to overhauling of the Butterworth hatches and did not provide necessary risks and hazards stipulated on the original cold work permit issued on 14 July 2022. Therefore, no safety precautions were taken on 15, 16, and 18 July 2022.[15]

The C/O maintains the standing watch on the Bridge as OICNW daily between 0800 and 1200. This watch routine is not conducive to fulfilling the requirements of additional duties of which the C/O is responsible. The C/O was unable to maintain adequate oversight of crewmembers conducting maintenance on the COT No. 5S Butterworth hatch, specifically relating to the presence of hazards and awareness of risk to prevent unsafe acts or in ensuring appropriate PPE was being worn in accordance with the documented risk assessment. Additionally, the C/O was unable to fulfill the capacity of Safety Officer and properly oversee the maintenance work being undertaken by crewmembers.

The remaining crewmembers undertaking maintenance on the Butterworth hatches or those crewmembers working in vicinity of the open hatches did not receive a brief on the hazards associated with, or required control measures implemented for, the intended scheduled maintenance on deck.

Entry into Enclosed Space

The Bosun was aware that COT No. 5S was an enclosed space and that entry without a permit, or prior authorization from a Responsible Person, was prohibited. At the entrance to COT No. 5S, a series of warning signs were visibly located instructing any person that COT No. 5S is an enclosed space, warning of the lack of O_2, and that permission for entry was required from the C/O or Master *(see Figure 5)*.

15 17 July 2022 was a rest day on board for all crewmembers and therefore no maintenance was conducted.

Figure 5: Warning signs located at the entrance to the access hatch to COT No. 5S.

The Bosun entered COT No. 5S disregarding the visual warnings, without the required PPE, without an enclosed space entry permit in place, and without permission from the C/O or Master. The Bosun conducted an unsafe act when entering COT No. 5S by not complying with Company procedure for an enclosed space entry.

The ASD3 did not comply with the Company's Stop Work Authority procedure when it was made apparent to him that the Bosun intended to enter COT No. 5S. The ASD3 had participated in enclosed space entry and rescue training, meeting the required Company competencies addressing hazard awareness and dangers associated within an enclosed space entry. The Company's Stop Work Authority procedure is designed to prevent an unsafe act or unsafe condition and requires work to be stopped until the identified hazard has been addressed. At no point did the ASD3 exercise his Stop Work Authority or raise concerns to the Bosun about the hazards posed prior to the Bosun entering COT No. 5S.

The initial actions by the ASD3 to raise the alarm and inform crewmembers in response to the Bosun being identified as in distress was in line with the Company's procedures. The ASD3 then proceeded to enter the enclosed space to affect a rescue which was not in accordance with the documented Enclosed Space Rescue procedures,[16] resulting in the death of the ASD3.

The most recent enclosed space rescue drill was a table-top exercise and was not conducted in accordance with SOLAS regulation III/19.3.1 which states "drills shall, so far as practicable, be conducted as if there were an actual emergency." The enclosed space rescue drill is also required to be conducted at intervals of no more than two months. The previous drill meeting the required SOLAS standard was conducted on 29 March 2022. Regular and realistic training would reinforce the dangers of entering an enclosed space and the necessary procedures required to conduct a safe rescue.

16 The SMS Enclosed Space Rescue procedures explicitly states that "rescue operations should not be attempted until the necessary assistance and equipment have been mustered."

Atmosphere of COT No. 5S

The atmosphere in COT No. 5S was not measured prior to undertaking maintenance to the Butterworth hatch or prior to the Bosun and ASD3 entering COT No. 5S. The atmosphere was measured immediately after the incident and the level of O_2 recorded on the multi-gas detector was 3.1%. The postmortem examination of the deceased ASD3 determined that the cause of death was anoxic asphyxia caused by low O_2 levels contained within COT No. 5S.

The O_2 deficient atmosphere in COT No. 5S and other COTs was deliberate through the application of N_2 in order to preserve the integrity of the environment and safety of the vessel. The Company's SMS stipulated that concurrence from the Company to enter an enclosed space must be sought before entry. Neither the Master, Responsible Person, nor a representative from the Company were aware that the Bosun or ASD3 planned to enter COT No. 5S.

Based on the location of the Bosun at the time of the rescue, it can be determined that he did not fall from the access hatch, or from the vertical ladder positioned above Platform 1. It is most probable that the effects of asphyxiation occurred while on, or in the vicinity of, Platform 2.

The condition effecting individuals working in vicinity of or having exposure to N_2 is hypoxia.[17] The symptoms of hypoxia under normal atmospheric conditions are a euphoric state and exhibiting poor judgement.[18] The Bosun and ASD3 working within proximity to COT No. 5S, which after the incident was determined to have insufficient O_2, may have affected both crewmembers' decision-making process. Although the thought process of the Bosun is not known since he could not recall why he entered COT No. 5S, such a euphoric state could have reduced his risk aversion to a level where he could no longer foresee the danger associated with entering an enclosed space.

PPE

The Company's SMS prescribes PPE required for certain activities within the PPE Matrix. The PPE Matrix does not stipulate the activity of maintenance of Butterworth hatches, or maintenance of any hatch connected to a cargo tank. The activity being performed at the time included using power tools and abrasive wheels, which is a task documented within the PPE Matrix. The Bosun and ASD3 were wearing the required PPE in accordance with the PPE Matrix for the task of using power tools and abrasive wheels.

The PPE Matrix, contained within the Company's SMS, only requires a personal multi-gas detector to be worn on the following occasions:

(a) in the presence of hydrogen sulphide during cargo work and toxic chemical cargo work (tanker), and

(b) upon entry into an enclosed space.

The risk assessment conducted on 14 July 2022 included, as a control measure, a requirement for crewmembers to wear personal multi-gas detectors while conducting maintenance on the Butterworth hatches. On the morning of 18 July 2022, neither the Bosun or ASD3 were wearing appropriate PPE in accordance with the risk assessment conducted on 14 July 2022 but were wearing appropriate PPE in accordance with the PPE Matrix.

17 Hypoxia is a state in which O_2 is not available in sufficient amounts at the tissue level to maintain adequate homeostasis.

18 International Chamber of Shipping Guidance on Enclosed Space Entry and Rescue.

Crewmembers may have been familiar with the PPE Matrix but as they were not present for the Toolbox Talk conducted on 14 July 2022, they would not have been aware of this additional control measure contained within the risk assessment.

A personal multi-gas detector by design would likely have identified whether No. COT No. 5S was atmospherically unsafe for entry.

Response to Enclosed Space Rescue

The ASD3 raised the alarm and informed other crewmembers who were in the vicinity that the Bosun was incapacitated inside COT No. 5S. In the time between the alarm being raised by the ASD3, and the arrival of the first crewmember on scene, the ASD3 had entered COT No. 5S to rescue the Bosun. The Company's SMS explicitly states that: "rescue operations should not be attempted until the necessary assistance and equipment have been mustered."

The ASD1 proceeded to follow the ASD2 into COT No. 5S wearing an EEBD. Two crewmembers entered the tank wearing EEBDs during the rescue operation. The Company's Enclosed Space Rescue procedure requires breathing apparatus in the form of an SCBA to be used for entry into an enclosed space. The procedure does not make reference to the use of an EEBD. The EEBD is a life-saving appliance used for escaping an area where a hazardous condition exists. The limited duration of O_2 provided with an EEBD reduces the duration of the rescue team members significantly compared with an SCBA. Further, this deviation from the Company Enclosed Space Rescue procedures gives an indication of the crewmember's lack of familiarity with the Enclosed Space Rescue procedures and PPE required.

A spare SCBA was not lowered into COT 5 No. 5S and placed on the ASD3 prior to evacuating him from the space. The Enclosed Space Rescue procedure requires a quick assessment of the casualty and further states that "if the condition of the atmosphere in the enclosed space is not verified as safe, the casualty should be provided with a safe independent air supply in the enclosed space." It could not be determined if this deviation from Company procedures affected the outcome of the rescue operation.

Since signing onto HAFNIA ADAMITE, the ASD3 participated in multiple enclosed space entry and rescue drills. On 18 July 2022, his attempt to assist a fellow crewmember in distress, without taking necessary precautions, resulted in this unfortunate and preventable casualty.

PART 4: CONCLUSIONS

The following Conclusions are based on the above Factual Information and Analysis and shall in no way create a presumption of blame or apportion liability.

1. Causal factors that contributed to this very serious marine casualty include:
   (a) unauthorized entry by the Bosun and ASD3 into an enclosed space which contained an O_2 deficient atmosphere;

(b) inadequate onboard implementation of the Company's Stop Work Authority;

(c) the onboard organizational structure which failed to accommodate sufficient capacity to facilitate adequate briefing of all crewmembers involved in the maintenance tasks on the hazards associated with, and contained within, COT No. 5S; and

(d) failure of crewmembers and the Responsible Person in ensuring personal multi-gas detectors were worn by each individual working in vicinity of COT No. 5S.

2. Additional causal factors that may have contributed to this very serious marine casualty include:

(a) ineffective implementation of the following Company safe work procedures including the:

i. Toolbox Talk procedure not being adequately conducted;

ii. Company's shore staff not being properly informed of the task related to maintenance of Butterworth hatches as required by the SMS;

iii. comprehensive risk assessment not being conducted daily for the maintenance task being performed; and

iv. enclosed space entry and rescue training not being executed in accordance with SOLAS regulation III/19.3.1.

3. Additional issues that were identified but that did not contribute to this very serious marine casualty include:

(a) enclosed space rescue team members wearing EEBDs for the purpose of entry, rescue, and exit from an enclosed space.

PART 5: PREVENTIVE ACTIONS

In response to this very serious marine casualty, the Company has taken the following Preventive Actions. The lessons learned from this incident have been circulated to all ships within the Company's managed fleet.

1. The Company's SMS for enclosed space entry was sent to all vessels requesting authorization from the DPA prior to entry into an enclosed space.

2. Controls preventing unauthorized entry into an enclosed space were sent out which included a directive to conduct drills on rescue from enclosed space entry and verification of controls preventing unauthorized access into an enclosed space.

3. Extraordinary audits were conducted on board two sample sister vessels, with a similar crew composition, to verify compliance with Company safety commitments and standards for work planning and execution.

4. The Dangerous Atmosphere Plan was updated by forbidding work near openings from a space containing dangerous atmosphere without a risk assessment approved by the Company.

5. Implementation of a post-accident verification process focused on work planning and risk assessment started on board HAFNIA ADAMITE.

6. The watch schedule was rearranged allowing the C/O to participate during Toolbox Talks.

7. Enhanced onboard training was conducted with a focus on compliance with the Company's safety commitments, emergency drills, SMS, work planning, and risk assessment.

8. Training for petty officers to be enhanced to include enrollment into the same training scheme undertaken by senior officers on board.

9. Generic risk assessment for N_2 operation safety to be revised including hazard of inhaling N_2 by crewmembers working in vicinity of a tank.

PART 6: RECOMMENDATIONS

Based on the above Conclusions and in consideration of the Preventive Actions taken, the Administrator has no recommendations.

The Administrator's marine safety investigation is closed. It will be reopened if additional information is received that would warrant further review.