Marine Safety Investigation Unit

Transport Malta

MARINE SAFETY INVESTIGATION REPORT

Safety investigation into the fatality of a crew member and the collapse of two other, due to heat exhaustion on board the Maltese-registered bulk carrier

ELPIDA GR

in the port of Mesaieed, Qatar, on 27 July 2023

202307/049

MARINE SAFETY INVESTIGATION REPORT NO. 10/2024

FINAL

Investigations into marine casualties are conducted under the provisions of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011 and therefore in accordance with Regulation XI-I/6 of the International Convention for the Safety of Life at Sea (SOLAS), and Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009, establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Council Directive 1999/35/EC and Directive 2002/59/EC of the European Parliament and of the Council.

This safety investigation report is not written, in terms of content and style, with litigation in mind and pursuant to Regulation 13(7) of the Merchant Shipping (Accident and Incident Safety Investigation) Regulations, 2011, shall be inadmissible in any judicial proceedings whose purpose or one of whose purposes is to attribute or apportion liability or blame, unless, under prescribed conditions, a Court determines otherwise.

The objective of this safety investigation report is precautionary and seeks to avoid a repeat occurrence through an understanding of the events of 24 July 2023. Its sole purpose is confined to the promulgation of safety lessons and therefore may be misleading if used for other purposes.

The findings of the safety investigation are not binding on any party and the conclusions reached and recommendations made shall in no case create a presumption of liability (criminal and/or civil) or blame. It should be therefore noted that the content of this safety investigation report does not constitute legal advice in any way and should not be construed as such.

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GLOSSARY OF TERMS AND ABBREVIATIONS

%	Percent
℃	Degree Celsius
A/B	Able seafarer – deck
ClassNK	Nippon Kaiji Kyokai
C/O	Chief officer
CPR	Cardiopulmonary resuscitation
GMDSS	Global Maritime Distress and Safety System
Heat stress	The discomfort and physiological strain experienced when exposed to hot environments, especially when carrying out physical work in such environments
HTW	IMO Sub-Committee on Human Element, Training and Watchkeeping
Hypokalaemia	Low potassium levels in the bloodstream
ICS	International Chamber of Shipping
IMHA	International Maritime Health Association
IMO	International Maritime Organization
ILO	International Labour Organization
ISM Code	International Safety Management Code
ITF	International Transport Workers' Federation
IV fluids	Intravenous fluids: specially formulated liquids that are injected into a vein to prevent or treat dehydration
knot	Nautical mile per hour
LR	Lloyd's Register
LT	Local time
m	Metre
MARINA	Maritime Industry Authority, the Philippines
MCA	Maritime and Coastguard Agency, UK
MLC, 2006	Maritime Labour Convention, 2006
MSIU	Marine Safety Investigation Unit, Malta
MSC	Maritime Safety Committee
mt	Metric tonne
NIOSH	The National Institute for Occupational Safety and Health, USA
O/S	Ordinary seafarer
rpm	Revolution per minute
SMS	Safety management system
STCW	International Convention of Standards of Training, Certification and Watchkeeping for Seafarers

STCW Code	Seafarers' Training, Certification and Watchkeeping Code
TM	Transport Malta
TMAS	Telemedical maritime assistance service: it supports and gives advice to seafarers in cases of sickness, accidents, maritime emergencies and other incidents on board vessels, that require medical advice. It is free of charge and is available to all vessels, globally, 24 hours a day.
TSO	The Stationery Office, UK
UTC	Coordinated universal time
VHF	Very high frequency
WHO	World Health Organization

SUMMARY

On 27 July 2023, *Elpida GR* was berthing at the port of Mesaieed, Qatar. Whilst the first mooring lines were being passed ashore, the bosun and two other crew members of the forward mooring station collapsed, one after another. These crew members were brought to the accommodation, where they were tended to by other crew members. After the vessel was moored, the chief officer reported that he, too, was feeling unwell.

All four crew members were transferred to a shore ambulance by shore service boats and taken to a local hospital. The bosun was declared deceased by paramedics, and this was confirmed at the hospital. All four crew members were diagnosed to have suffered from heat exhaustion.

The safety investigation concluded that it was highly likely that the long hours of physical work on deck, in hot and humid weather conditions, had contributed to the crew members' collapse.

The MSIU has issued one recommendation to the Company, aimed at ensuring that the crew members are provided with a comfortable environment on board.

The MSIU has also issued two recommendations to the flag State Administration: to submit a paper to HTW Sub-Committee, to include emphasized seafarer training on the on-site treatment of heat stroke / hyperthermia casualties on board, in the relevant IMO model courses, and to issue an Information Notice, recommending that the relevant medical guide(s) which are referred to in the STCW Code and the IMO model courses on first aid and medical care, are also carried on board Maltese-registered vessels.

1 FACTUAL INFORMATION

1.1 Vessel, Voyage and Marine Casualty Particulars

Name	*Elpida GR*
Flag	Malta
Classification Society	Nippon Kaiji Kyokai (ClassNK)
IMO Number	9254630
Type	Bulk Carrier
Registered Owner	Oceanseas Navigator Ltd.
Managers	Windforce Maritime Enterprises Inc.
Construction	Steel (Single hull)
Length overall	189.99 m
Registered Length	182.48 m
Gross Tonnage	29,862
Minimum Safe Manning	16
Authorised Cargo	Dry cargo in bulk
Port of Departure	Umm Qasr, Iraq
Port of Arrival	Mesaieed, Qatar
Type of Voyage	Short International
Cargo Information	In ballast (15,413 mt)
Manning	19
Date and Time	27 July 2023, at 0900 (LT)
Type of Marine Casualty	Very Serious Marine Casualty
Location of Occurrence	Mesaieed, Qatar
Place on Board	Forecastle deck
Injuries/Fatalities	One fatality
Damage/Environmental Impact	None reported
Ship Operation	Berthing; manoeuvring
Voyage Segment	Alongside
External & Internal Environment	Daylight, clear sky, and a Northeasterly gentle breeze. Sea state: calm, with low swell. Air temperature was recorded to be between 40 °C and 45 °C and the sea temperatures was recorded to be between 32 °C and 35 °C. Humidity: 76.8%
Persons on Board	21 crew members and one pilot

1.2 Description of the Vessel

Elpida GR was a 29,862 gt bulk carrier, built in 2003 by Toyohashi Shipbuilding Co. Ltd., Japan. The vessel was owned by Oceanseas Navigator Ltd. and managed by Windforce Maritime Enterprises Inc., Greece (the Company). The vessel was classed with Nippon Kaiji Kyokai (ClassNK), whilst Lloyd's Register (LR) acted as the recognized organization, in terms of the International Safety Management Code, for the vessel.

The vessel had a length overall of 189.99 m, a moulded breadth of 32.26 m, and a moulded depth of 17.0 m. *Elpida GR* had a summer draught of 12.03 m and a corresponding deadweight of 52.58 metric tonnes (mt).

Propulsive power was provided by a 6-cylinder MAN B&W 6S50MC(Mk6), two-stroke, slow speed, direct drive marine diesel engine, producing 7,796 kW at 116 rpm. This drove a right-handed, fixed-pitch propeller, enabling *Elpida GR* to reach a service speed of 14.5 knots.

At the time of the occurrence, *Elpida GR* was in ballast, drawing forward and aft draughts of 4.48 m and 5.84 m, respectively.

1.3 Crew

1.3.1 Manning, qualifications, experience, and duties on board

Elpida GR's Minimum Safe Manning Certificate stipulated a crew of 16[1]. Around the time of the occurrence, the vessel was manned by 21 crew members, all of whom were Filipino nationals.

The deceased bosun was 41 years old. His seafaring records indicated a seagoing service of 11 years[2], eight of which were served in the rank of a bosun. He had held STCW[3] II/5 qualifications for an able seafarer deck (A/B), and his certificate of

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1 Provided that at least two deck officers held Global Maritime Distress and Safety System (GMDSS) General Operator's Certificates.

2 The Company informed the safety investigation that the manning agency in the Philippines did not have any records of the bosun's seafaring experience prior to 2012.

3 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers.

competence was issued by the Maritime Industry Authority of the Philippines (MARINA) on 13 August 2015. He had joined the vessel on 16 March 2023, at Port Elizabeth, South Africa. This was his first employment term with the Company, and he was not assigned watchkeeping duties.

A/B 1, who had collapsed shortly after the bosun, was 27 years old. He had three years of seafaring experience and this was his first employment term in the rank of an A/B. He held STCW II/5 qualifications, and his certificate of competence was issued by MARINA on 26 October 2022. He had joined the vessel on 20 January 2023, at Port Muhammad Bin Qasim, Pakistan. This was his second employment term with the Company, the first being as an ordinary seafarer (O/S). For the month of July 2023, A/B 1 was assigned to the 0800-1200 and 2000-2400 watches in port as well as at sea, with non-watchkeeping duties from 1300 to 1500.

O/S 1, who collapsed soon after A/B 1, was 34 years old. The was his first seafaring employment[4]. He held STCW II/4 qualifications for a rating forming part of the navigational watch, and his certificate of competence was issued by MARINA on 13 October 2020. He had joined the vessel on 25 April 2023, at the port of Samalaju, Malaysia. The O/S was not assigned watchkeeping duties at sea. In port, for the month of July 2023, he was assigned to the 0000-0600 and 1200-1800 watches, with non-watchkeeping duties from 0900 to 1100.

The chief officer (C/O) was 52 years old. He had 27 years of seafaring experience, five months of which were served in the rank of a chief officer. He held STCW II/2 qualifications for a master, and his certificate of competence was issued by MARINA on 21 December 2022. He, too, had joined the vessel on 25 April 2023. This was his third employment term with the Company. He had previously served as a second officer for one year and was promoted to the rank of chief officer during his second employment term[5]. The C/O was assigned the 0700-1200 and 1500-2000 watches in port, thereby overlapping with the daytime watches of the other watchkeeping officers. At sea, he was assigned the 0400-0800 and 1600-2000 watches, with non-watchkeeping duties from 0900 to 1100.

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[4] Prior to this, O/S 1 had served on domestic vessels in the Philippines.

[5] He had served for two months in the rank of a C/O, during his second employment term.

The master was 47 years old. He had 21 years of seafaring experience, two of which were served in the Company. He held STCW II/2 qualifications for a master, and his certificate of competence was issued by MARINA on 10 February 2021. He had joined the vessel on 18 May 2023, at the port of Ko Sichang, Thailand. This was his first employment term in the rank of a master, having previously served on *Elpida GR* in the rank of a chief officer, between 2021 and 2022. The master was not assigned to any watchkeeping duties.

1.3.2 Pre-joining medical examinations

The deceased bosun's pre-joining medical certificate, issued on 23 January 2023, certified him as fit for duty. This certificate also stated that there were no limitations or restrictions on the bosun's fitness and that he was not suffering from any medical conditions that were likely to be aggravated by service at sea or which rendered him unfit for such service.

The other crew members who collapsed, as well as the chief officer, were also certified as fit for duty. However, the C/O was prescribed medications for the control of hypertension.

1.4 Environment

Around the time of the accident, the sky was clear. A Beaufort Force 3 wind was blowing from the Northeast. The sea state was 'calm', with a low, Northeasterly swell. The air temperature was measured to be between 40 °C and 45 °C sea temperature between 32 °C and 35 °C, and the humidity[6] was 76.8%.

1.5 Events Preceding the Occurrence[7] [8]

Elpida GR was unloading a cargo of bagged rice, at the port of Umm Qasr, Iraq[9]. The air temperatures were high and since the vessel's air-conditioning system was unable

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6 As recorded by the local authorities.

7 Unless otherwise stated, all times in this safety investigation report are local time (LT = UTC +3).

8 The times of the cargo hold cleaning operations mentioned in this section, were based on the cleaning team members' accounts. The C/O's account differed from these times.

9 The cargo unloading operations were carried out from 20 June 2023 till 22 July 2023.

to cope with the high temperatures[10] (also bearing in mind the high water temperatures), the Company had arranged for the supply of a split air-conditioning unit at Umm Qasr. This had been installed on the bridge.

The master and the C/O had advised the crew members to keep themselves hydrated by drinking lots of water. Rehydration salts were also placed in the crew and officers' mess rooms, for the crew to consume frequently. During the cargo unloading operations, the C/O informed the master that he felt that his blood pressure was high. The master advised the C/O to be careful and ensure that he rested well.

The vessel departed in a ballast condition from Umm Qasr, on 22 July 2023, bound for Mesaieed, Qatar, to load a cargo of urea in bulk. In view of the cargo to be loaded, the crew members had commenced cleaning the cargo holds soon after the Umm Qasr pilot had disembarked[11].

The cleaning of the cargo holds involved sweeping, hosing down with sea water, rinsing with freshwater, pumping out the cargo hold bilges during the hosing down and rinsing, drying (including the bilges), covering the cargo hold bilge covers with burlap, and scraping of rusty areas, followed by a touch-up with paint. The safety investigation was informed that crew members received an extra allowance from the vessel's owners, for cargo hold cleaning operations[12].

The cleaning team consisted of the bosun, at least two A/Bs and both O/S[13]. The chief officer was supervising the operations regularly and was dealing with the pumping out of the cargo hold bilges. Communication with the cleaning team was carried out using portable radios, one of which was held by a member of the cleaning team.

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[10] The master recalled measuring the air temperature in his cabin at 35.8 °C.

[11] The pilot disembarked at 1900, on 22 July.

[12] It has to be stated that the Company advised that extra allowance was neither promised nor provided to any of the crew members, with respect to cargo hold cleaning. Moreover, the Company also advised that it was unaware of any instructions given to the cleaning team by the master and / or any other crew member vis-à-vis the need to intensify their efforts to clean the cargo hold.

[13] A/B 1 was not assigned to any navigational watch, for this voyage. The other two A/Bs assisted with the cleaning operations during the day and were given rest before and after their respective navigational watches at night.

The cleaning operations continued until 0400 on 23 July, following which, the crew members took a four-hour rest break. At 0800, the cleaning operations were resumed and continued right until 2400 on 25 July, with lunch, dinner, and coffee breaks in between. Meanwhile, at 1640 on 24 July, the vessel anchored at the Mesaieed outer anchorage area. The bulk of the cleaning operations of all cargo holds was completed by 2400 on 25 July, with the drying of the bilges, covering of the bilge covers with burlap, scraping and paint touch-up remaining. In view of the C/O's health condition, the master advised him to stop working and get some rest, following which, he took the C/O's place to assist the crew members with the rest of the cleaning operations.

The crew members took a rest break from 2400 on 25 July until 0800 on 26 July, following which, the remainder of the cleaning operations were continued. At 2010, on 26 July, the vessel was instructed by the port authorities to proceed to the inner anchorage. The cleaning operations were suspended shortly after receiving these instructions and the crew members proceeded to the anchor stations. The vessel anchored at the inner anchorage area at 0118 on 27 July, after which, the bosun, two A/Bs (including A/B 1) and both O/S resumed the cleaning operation[14]. By this time, only the task of paint touch-up in cargo hold nos. 1, 2 and 5 remained pending.

1.6 The C/O's Account of Hours Worked by the Cargo Hold Cleaning Team

The C/O informed the safety investigation that the cargo hold cleaning operations were only carried out from 0800 to 1800, each day, with two 30-minute coffee breaks and a one-hour lunch break in between.

The master informed the safety investigation that he was not aware of the exact duration of work hours put in by the crew members for the cargo hold cleaning operations. The same had been left up to the C/O to decide. He was informed by the duty officers that the cleaning operations would continue till around 0300 / 0400, each day. He had then advised the C/O to suspend the cargo hold cleaning operations, by 2300 of each day, in order to give the crew members adequate rest. However, the C/O informed him that the bosun had reported that there was not enough time to complete the cargo hold cleaning, in view of the short duration of the voyage.

[14] The master informed the safety investigation that he had instructed the crew members to stop the cleaning operations after the vessel anchored at the inner anchorage, and advised them to get some rest, in view of the scheduled berthing of the vessel in the morning.

1.7 Narrative

At around 0730, *Elpida GR* was instructed to prepare to pick up the pilot and berth at the port. By this time, all cargo hold cleaning operations had been completed. At 0806, the anchor was weighed and six minutes later, the pilot boarded. The vessel was to berth with its port side alongside. The forward mooring team consisted of the C/O, bosun, A/B 1 and O/S 1, whilst the aft mooring team consisted of the second officer, another A/B, and the other O/S.

The air temperature and humidity levels were high, and the C/O recalled that during the vessel's approach to the berth at Mesaieed, he had heard frequent VHF radio broadcasts from the local port authorities, advising vessels' crew members to take adequate precautions to prevent a heat stroke. He also recalled observing the bosun working in a rush while preparing for berthing.

The vessel arrived at the berth and the first mooring line was passed ashore at 0900[15]. While the forward mooring team was passing the forward mooring spring ashore, however, the C/O noticed the bosun slowing down, physically. Shortly after the forward spring line was passed ashore, the bosun collapsed on the forecastle deck (**Figure 1**).

On checking, the C/O felt the bosun' body temperature to be abnormally high. He notified the bridge about this, following which, A/B 1 and O/S 1 carried the bosun to a shaded area on the forecastle deck. The master requested the cook and the messman to rush to the forecastle deck and bring the bosun towards the accommodation. He then requested the port authorities for medical assistance, via the vessel's fixed, two-way, very high frequency (VHF) radio.

The cook, messman, and O/S 1 carried the bosun to the accommodation external area on the main deck, after which, they removed the bosun's clothes and started fanning him to help cool his body. The cook and the messman then tended to the bosun, while O/S 1 proceeded back to the forecastle deck. At around 0915, A/B 1 collapsed on the forecastle deck (**Figure 2**).

[15] The first mooring line was the aft spring line.

Figure 1: The bosun's location (red circle) when he collapsed

Figure 2: A/B 1's location (red circle) when he collapsed

The C/O reported this to the bridge and the cook and messman were again sent forward to bring A/B 1 towards the accommodation. By this time, several engine-room crew members arrived and started administering cardiopulmonary resuscitation (CPR) to the bosun.

As the helmsman was no longer required on the bridge by then, the master sent him to the forecastle deck to assist the forward mooring team. The master then requested the aft mooring team to also proceed forward, once the aft mooring ropes were made fast. On making fast the aft mooring ropes, the second officer who was in charge of the aft mooring team, sent one A/B forward, while he and the other O/S assisted in tending to the bosun and A/B 1, both of whom were unconscious but had a pulse. The crew members observed that the bosun was experiencing difficulty in breathing, while A/B 1 did not show any signs of breathing. Therefore, oxygen was provided to the bosun via a portable oxygen resuscitator, while CPR was administered to A/B 1.

Shortly after, the master rushed to the forecastle deck to assist in making fast the mooring ropes. At 0940, whilst the master was on the forecastle deck, O/S 1 too collapsed (**Figure 3**).

Figure 3: O/S 1's location (red circle) when he collapsed

O/S 1 was carried back towards the accommodation by an oiler and the messman. After all mooring lines were made fast, the master rushed back to the bridge and updated the local port authorities on the situation. A shore service boat soon arrived at the vessel's starboard side and the crew members carried A/B 1 down the accommodation ladder into the service boat. The service boat proceeded to the terminal, while another service boat arrived at the vessel. The crew members carried the bosun into the second service boat. Since the bosun did not show signs of life, the second officer and an oiler accompanied the bosun, while continuing to administer CPR until the boat arrived at the terminal. At the terminal, shore paramedics attended to the bosun and A/B 1. The paramedics pronounced the bosun deceased at 1030.

Meanwhile, on board *Elpida GR*, the C/O also complained that he was feeling unwell. By then, a third service boat arrived and took O/S 1 to the terminal. Shortly after, the first service boat returned to the vessel. The C/O was carried into the boat and taken to the terminal. From the terminal, all four crew members (the bosun, A/B 1, O/S 1 and the C/O) were transferred in shore ambulances to a local hospital.

1.8 Shore Hospital Findings

The bosun's death was confirmed at the hospital. The cause of death was specified as an acute respiratory failure due to heat stroke, which led to a cardiac arrest. The MSIU was not provided with any information confirming that an autopsy and toxicology had been conducted on the deceased bosun.

A/B 1 recovered and was discharged from the hospital on the same day (27 July). He was diagnosed to have suffered from heat exposure and heat exhaustion, and was deemed unfit for duty for two days, following his discharge.

O/S 1 was discharged from the hospital on the next day. He was diagnosed to have suffered from an allergic skin rash, heat exhaustion and hypokalaemia[16]. He was provided with the necessary medication and was deemed unfit for duty until 01 August.

[16] A medical condition, where the body has low levels of potassium.

The C/O was discharged from the hospital on 30 July. He was diagnosed to have suffered from heat exhaustion and was deemed unfit for duty until 08 August.

1.9 Post-Accident Inspection by the Local Authorities

Following the occurrence, the local port authorities conducted an inspection on board the vessel. Taking into account their findings and the statements of the crew members, the commencement of cargo loading operations was not authorised. On 31 July, cargo loading operations commenced during night time. Subsequently, after the Company arranged for the installation of three additional split air-conditioning units in the common spaces of the vessel (the two mess rooms and the smoking room), the local authorities permitted the vessel to load cargo during daytime as well.

The master recalled that the heat within the accommodation, throughout the vessel's stay at Umm Qasr and until the additional air-conditioning units were installed, made the crew members uncomfortable and did not allow them to rest properly. After the air-conditioning units were installed, the temperature inside the accommodation was measured by the master, to be between 29 °C and 30 °C.

1.10 Records of Hours of Work / Rest

1.10.1 The bosun

The bosun's records of hours of work / rest for the month of July 2023, indicated that:

- on 22 July, when the vessel departed from Umm Qasr, he had worked from 0800 until 2000, with a two-hour break in between – from 1200 to 1400;
- on 23, 24, 25 and 26 July, he had worked from 0700 until 1800, with a one-hour lunch break in between; and
- on 27 July, he had worked from 0030 to 0130, and then from 0700 until he collapsed on the forecastle deck.

1.10.2 A/B 1

A/B 1's records of hours of work / rest for the month of July 2023, indicated that:

- on 22 July, he too had worked from 0800 until 2000, with a two-hour break in between – from 1200 to 1400;

- on 23, 24, 25 and 26 July, he had worked during his watchkeeping and non-watchkeeping hours, *i.e.*, from 0800 to 1200, then from 1300 to 1500, and then from 2000 until 2400; and
- on 27 July, he had worked from 0800 until he collapsed.

1.10.3 O/S 1

O/S 1's records of hours of work / rest for the month of July 2023, were similar to those of the bosun, from 22 July to 26 July. On 27 July, his records indicated that he had worked from 0800 until he collapsed.

1.10.4 The C/O

The C/O's records of hours of work / rest for the month of July 2023, indicated that:

- on 22 July, he had worked from 0600 to 1200, and then from 1600 until 2000;
- on 23, 24, 25 and 26 July, he had worked from 0400 to 0800, then from 1000 to 1200, and then from 1600 until 2000; and
- on 27 July, he had worked from 0030 to 0130, and then from 0700 until he was transferred to the shore hospital.

1.11 Post-Occurrence Drug / Alcohol Tests

There were no indications that any drug and / or alcohol tests had been conducted after the occurrence.

1.12 Medical Publications on board *Elpida GR*

At the time of the occurrence, the latest editions of the *International Medical Guide for Ships* and *The Ship Captain's Medical Guide* were available on board *Elpida GR*. The safety investigation noted that treatment for heat stroke and heat exhaustion is addressed in both of these publications. The carriage of *The Ship Captain's Medical Guide* is mandatory on Maltese-registered vessels.

1.13 Similar Past Occurrences

The safety investigation came across one similar occurrence, which had happened on board the Marshall Islands registered bulk carrier *Barramundi* on 03 July 2021.

The bosun and one crew member (seafarer A), were tasked with the removal of fumigant from the cargo holds. During the task, the bosun started to feel unwell and informed the C/O that the task involved heavy work, the weather was hot, and he was finding it difficult to breathe with the respirator. He requested the chief officer to have another crew member (seafarer (B)) take his place while he rested for a while. Seafarer A reported that he was also experiencing difficulty to breath with the respirator on; however, although the weather was hot, he could continue working. In the meantime, seafarer B relieved the bosun, whilst another crew member was called to assist the bosun to the accommodation, stay with him and provide him with any assistance he may need. Shortly after, however, the bosun's condition worsened. Medical evacuation was sought, while the crew members provided medical care to the bosun. The bosun passed away at the shore hospital within a couple of hours of being evacuated from the vessel.

The safety investigation by the Republic of Marshall Islands Maritime Administrator concluded that one of the several contributory factors to this occurrence was an ineffective assessment of the existing weather conditions and the potential for the seafarers who were tasked with removing the fumigant, to suffer moderate to severe heat stress.

2 ANALYSIS

2.1 Purpose

The purpose of a marine safety investigation is to determine the circumstances and safety factors of the accident as a basis for making recommendations, to prevent further marine casualties or incidents from occurring in the future.

2.2 Cooperation

During this safety investigation, MSIU received the necessary assistance and cooperation from the Ministry of Transport, Qatar.

2.3 Work Conditions on Board

The safety investigation noted that the records of the crew members' hours of work / rest met the relevant requirements of the Seafarers' Training Certification and Watchkeeping Code (STCW Code) and the Maritime Labour Convention, 2006 (MLC, 2006). However, the information provided by the crew members during their interviews with the MSIU, and through the statements that they had provided to the local port Authorities of Qatar, did not corroborate their records of hours of work / rest[17].

The cargo hold-cleaning operations commenced on 22 July and continued until it was time for the vessel's berthing, on 27 July. According to several crew members, the cleaning team (especially, the bosun and the two O/S) had taken a 4-hour rest break on 23 July and an 8-hour rest break on 26 July. This amounted to 64 hours of work from 23 to 25 July, and 25 hours of work from 26 to 27 July, with short-duration breaks for meals and coffee in between. Moreover, a crew member informed the safety investigation that when he had asked the bosun to request for an adequate rest break during the continuous cargo hold cleaning operations, the bosun responded that

[17] The Company has also clarified that it was only aware of operations taking place within the designated hours, in accordance with the STCW Code. Moreover, the Company has also advised that the statements from the crew members which it has in hand, and the vessel logbooks, did not indicate any deviation from the work rules / limits and in this respect, it considers that the rules had been met.

the master / C/O had not advised them to do so[18]. It could not be excluded that any extra cargo hold cleaning allowance, if any had been provided by the vessel's owners, may have served as an incentive for the bosun, and possibly the other crew members as well, to work for long stretches of time to complete the cleaning operations.

In addition to the long, continuous, work periods, which resulted in sleep deprivation, the crew members were also affected by the high air temperatures and humidity in the area. Cargo unloading operations lasted for about a month at Umm Qasr. During this period, the crew members were also exposed to high air temperatures at the port. There was, however, little that the crew members could do to protect themselves from the heat, while on deck, and they were also exposed to these environmental conditions after the vessel's departure from Umm Qasr.

One of the A/Bs advised the safety investigation that, during the vessel's approach to the berth at Mesaieed, he frequently sought shelter in the shade and poured water over his head to keep himself cool. The crew members on the forecastle deck, however, did not have much shade.

Noting the bosun's rush while preparing for berthing, as observed by the C/O, the safety investigation considered it likely that this may have increased his body temperature even further.

2.4 Heat Exhaustion and Heat Stroke

As was noted from the shore hospital reports, the crew members suffered from heat exhaustion, with the bosun suffering from a heat stroke that led to his death. Physical work in a hot environment may lead to heat stress, which may result in heat rashes, heat cramps, heat exhaustion, or heat stroke. In this regard, the high atmospheric temperatures and humidity levels, around the time of the vessel's berthing, would have affected the crew members.

Heat exhaustion is defined as a mild-to-moderate illness due to water or salt depletion that results from exposure to high environmental heat or strenuous physical exercise. Signs and symptoms of heat exhaustion include intense thirst, weakness, discomfort,

[18] The master and the C/O informed the safety investigation that the bosun had not approached them with such a request.

anxiety, dizziness, fainting, and headache. The core temperature of a person suffering from heat exhaustion may be normal, below normal, or slightly elevated (higher than 37 ℃, but lower than 40 ℃).

Heat stroke is defined as a severe illness characterized by a core temperature higher than 40 ℃ and central nervous system abnormalities, such as delirium, convulsions or coma, resulting from exposure to environmental heat (classic heat stroke) or strenuous physical exercise (exertional heat stroke).

The systemic and cellular responses to heat stress (thermoregulation, acclimatization, acute-phase response, and heat-shock response) can either lead to its progression or resolution.

Thermoregulation is the process by which the body's overall heat load is dissipated to maintain a body temperature of 37 ℃. A small rise in blood temperature results in the increase of blood flow in the skin and also initiates thermal sweating. If the air surrounding the body surface is not saturated with water, sweat vaporizes and thus cools the body surface. However, dehydration and salt depletion impair thermoregulation and therefore, the losses of water and salt through sweating have to be compensated for by adequate water and salt intake.

Acclimatization allows a person to work safely in heat levels that were previously intolerable. It involves successive increments in the level of work in hot environment, that results in the adaptation to the heat. However, acclimatization to heat can take several weeks and it involves several internal body changes, such as the enhancement of cardiovascular performance, salt conservation by the sweat glands and kidneys, an increase in the capacity to secrete sweat, expansion of plasma volume, *etc*.

The acute-phase response to heat stress is a coordinated reaction involving several cells. It protects against tissue injury and promotes repair.

Nearly all cells in the body respond to sudden heating by producing heat-shock proteins or stress proteins. Increased levels of these proteins in a cell, induce a transient state of tolerance to a second stage of heat stress (which would otherwise be lethal), allowing the cell to survive. However, if the synthesis of heat-shock proteins is blocked, it will render the cells extremely sensitive to even a minor degree of heat

stress. Lack of acclimatization to heat may result in a low level expression of heat-shock proteins.

Thermoregulatory failure, exaggeration of the acute-phase response, and alteration in the expression of heat-shock proteins may contribute to the progression from heat stress to heat stroke.

2.5 Fatigue

The IMO *Guidelines on Fatigue* defines fatigue as:

> *A state of physical and/or mental impairment resulting from factors such as inadequate sleep, extended wakefulness, work/rest requirements out of sync with circadian rhythms and physical, mental or emotional exertion that can impair alertness and the ability to safely operate a ship or perform safety-related duties.*

The primary causes of fatigue, identified in these guidelines, are inadequate restorative sleep, poor quality of sleep and rest, disrupted circadian rhythms, extended periods of wakefulness, stress, and excessive workload. It should also be noted that uncomfortable ambient temperatures (too warm or too cool) will adversely affect the quality of sleep.

With reference to quantity of sleep, adequate, good-quality sleep produces a feeling of being refreshed and alert. Only sleep can maintain or restore performance levels. The National Sleep Foundation recommends that adults between the ages of 18 and 64 should aim for seven to nine hours of sleep, each night. In terms of quality, every person requires deep sleep, which is a very restorative phase of sleep. Continuity of sleep is also important, so that its restorative value can be retained.

It should be noted that individuals respond differently to fatigue. Any two persons may become fatigued at different times and to different degrees of severity, under the same circumstances. Most importantly, people are poor judges of their own level of fatigue, performance and decision-making.

In view of their long work periods for the cargo hold cleaning operations, as well as the uncomfortable hot temperatures within the accommodation that would not have

allowed the crew members to rest properly, the safety investigation did not exclude that several members of the cleaning team had also experienced fatigue by the time the vessel was berthing at Mesaieed.

2.6 The Crew Members' Health

The crew members' pre-joining medical examinations had certified them fit for duty. Furthermore, the hospital reports did not indicate that the crew members suffered from any medical conditions, other than those related to heat. The hospital report of the C/O, who was on medication for the control of hypertension, did not suggest that his blood pressure was abnormal when he was admitted into the hospital. In this regard, the safety investigation neither considered the bosun's health nor that of any of the other crew members, as a contributory factor to this occurrence.

2.7 Consumption of Drugs and / or Alcohol

There were no indications that a toxicology, or drug / alcohol tests, were carried out to confirm, or otherwise, the presence of illicit drugs and / or alcohol. Therefore, in the absence of data which would suggest that the bosun or any of the other crew members' behaviours and / or their actions were symptomatic of intoxication, the safety investigation did not consider drug / alcohol consumption as a contributory factor to this occurrence.

2.8 Emergency Response by the Other Crew Members

As mentioned earlier in this safety investigation report, the C/O checked and felt the bosun's body temperature to be high after he collapsed. The bosun was immediately transferred to a shaded area on the forecastle and then to the shaded area outside the accommodation on the main deck. The crew members removed his clothes and started fanning him to facilitate cooling. Since the bosun was unconscious, they also administered CPR, followed by oxygen.

On-site treatment of heat stroke is crucial and should include, (most importantly) rapid, effective, and continuous cooling, rapid rehydration, and effective control of

restlessness and convulsions. For cooling, the casualty of a heat stroke should be moved to a cooler place, have their clothing removed, and external cooling methods should be applied, such as: cold packs on the neck, armpit and groin; continuous fanning; and spraying of the skin with water of temperature between 25 ℃ to 30 ℃.

The latest editions of the *International Medical Guide for Ships* and *The Ship Captain's Medical Guide*, both of which were available on board *Elpida GR*, also address the treatment for heat stroke and heat exhaustion. The *International Medical Guide for Ships* advises the following actions to be taken for a patient suffering from a heat stroke:

- *Move the patient into a cool environment.*
- *Remove all the patient's clothing.*
- *Spray or splash the patient's whole body with cold water and fan him vigorously, or immerse him in a bath of cold water.*
- *Seek medical advice with a view to evacuation: even if body temperature is brought under control, heat stroke can cause life-threatening damage to internal organs.*
- *If body temperature does not fall below 39 ℃ within 30 minutes, place the patient in an ice-water bath. Take the patient out of the bath as soon as rectal temperature has fallen to 39 ℃.*

Similarly, *The Ship Captain's Medical Guide* advises to:

- *Move to cool shade, lay down.*
- *Strip off all clothing.*
- *Cool with constant wet spray and fanning to, increase evaporation and loss of heat.*
- *Ice packs (wrapped in cloths) placed in the axilla*[19] *and groin.*
- *Cool (15-20 ℃) IV fluids*[20] *– 1 l initially. Usually not grossly dehydrated.*
- *Measure blood sugar level and correct – often low.*
- ***Contact TMAS***[21].

The crew members took nearly all of the aforementioned actions to lower the bosun's temperature, except for cooling the bosun's body with water and applying cold packs or immersing him in a bath of cold water. During the interviews with the crew members, it appeared that they were not aware that such action had to be taken.

[19] Armpit.

[20] Intravenous fluids.

[21] Telemedical Maritime Assistance Service.

Furthermore, it was also noted that the circumstances at that time did not allow the crew members to refer to the relevant publications on board. The vessel was being moored, the aft mooring team and several other crew members were tending to the three crew members who had collapsed one after the other, the forward mooring team were short of personnel since the three crew members collapsed, while the master and the third officer had to complete the bridge operations for mooring and communicate with the local authorities for medical assistance. At the earliest available opportunity, the master and crew members from the aft mooring team rushed to the forecastle deck to assist with the mooring. Therefore, the crew members who were tending to the bosun and the other two crew members who collapsed, would have had to rely on their own awareness and training on how to handle the casualties.

On the basis of their STCW qualifications, it is understood that all the crew members had received training in first aid and medical care, as applicable. The safety investigation noted that training to handle a casualty of heat stroke only appeared to be included in the IMO model course for medical first aid. It neither appeared to be included in the IMO model course for elementary first aid nor further emphasized in the IMO model course for medical care. The IMO model course for medical first aid recommends training sessions to recognise the signs of heat stroke, describe the effects of heat and state the importance of positioning the casualty in the shade, providing the increased fluid requirement and careful cooling of the body. Whilst, the aforementioned IMO model courses include compendia that contain extracts of relevant sections of the *International Medical Guide for Ships*, the section on heat exposure[22] is only included in the compendium of the model course for medical care[23]. However, it did not appear to be listed in the syllabus for this model course.

Additionally, these courses address dehydration and heat exposure, but only appear to do so from a point of view of rescued persons. The safety investigation did note that the cause, avoidance and treatment of heat stroke are addressed in the IMO model course for proficiency in survival craft and rescue boats (other than fast rescue boats). However, these, too, appeared to be addressed from a point of view of persons in a survival craft and for rescued persons.

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[22] As referred to in the *International Medical Guide for Ships* (2nd ed.), extracts of which form the compendium for the IMO model courses for elementary first aid, medical first aid and medical care.

[23] The model course for medical care includes the entire publication as its compendium.

It must be noted that the IMO model courses are based on the relevant provisions of the STCW Code. They provide the course framework, a detailed teaching syllabus, and guidance notes for instructors, and instructors may go beyond the syllabus outlined in the model courses. Therefore, whether on-site treatment for heat stroke is taught during the courses on elementary first aid and medical care, would be up to the instructor, and would possibly depend on the time available, the instructor's preferences, *etc*. Furthermore, whilst the course on medical first aid addresses treatment for heat stroke, its compendium did not appear to include the relevant section from the *International Medical Guide for Ships*.

2.9 Climate Change and Heat Stroke

Whilst the occurrence on board *Elpida GR* took place in the Middle-East, where atmospheric temperatures and humidity levels are known to be extremely high, the safety investigation also looked into the aspect of climate change. Climate change is expected to increase the frequency, duration, and intensity of heat waves, which in turn may cause heat strokes. Furthermore, a significant proportion of warm-season heat-related mortality in temperate regions, has been linked to observed anthropogenic climate change.

While studies have associated climate change with a significant increase in heat-related mortality in people aged 65 years and over, hot weather is also known to affect morbidity and mortality in other age groups. In view of the effects of climate change, it is likely that there may be an increase in such occurrences on board vessels, particularly when considering that the reason for crew members' exposure to the sun and heat is due to the nature of the tasks on board, itself.

While people will eventually acclimatize and adapt to higher temperatures and warming climates, there is little evidence available on the rate and extent to which such acclimatization and adaptation will occur. It should also be noted that people living in regions of high temperatures and humidity, are now facing temperatures that exceed their acclimatization capacity. Moreover, since acclimatization can take several weeks, it is highly unlikely that crew members on board a vessel would ever get an opportunity to acclimatize. Then, voyages between two regions of different temperature ranges will not allow the crew members to acclimatize effectively.

In view of the above, the safety investigation is of the opinion that, with a possible rise of incidences of heat exhaustion / stroke on board vessels, particularly amongst those crew members who tend to be exposed to the sun and heat frequently, seafarers should be prepared to deal with such casualties on site.

2.10 Medical Publications for Seafarer Training and / or Reference

The compendia of the relevant IMO model courses include extracts from the *International Medical Guide for Ships* only, in accordance with the guidance contained in Section B of the STCW Code. For supplementary reading or reference, the model courses deem several other publications as suitable, including *The Ship Captain's Medical Guide*. However, this supplementary reading / reference is left up to the decision of the seafarer training institutes and / or the instructors. In this regard, the safety investigation is of the opinion that there would be a tendency for seafarers to be more familiar with the *International Medical Guide for Ships* than *The Ship Captain's Medical Guide*, on completion of their first aid / medical care training, particularly if the latter is not provided to the trainees for supplementary reading or reference.

Besides the above, the safety investigation also took note of a proposal submitted by the International Chamber of Shipping (ICS), the International Maritime Health Association (IMHA) and the International Transport Workers' Federation (ITF) to the IMO Sub-Committee on Human Element, Training and Watchkeeping (HTW), prior to the HTW's 10th session in February 2024. In view of the comprehensive review of the STCW Convention and Code, the ICS, ITF and IMHA proposed that the newly-published *International Medical Guide for Seafarers and Fishers*, be recommended as an alternative to the *International Medical Guide for Ships*, to be used by maritime education and training institutes, vessel owners and managers, and the wider industry.

THE FOLLOWING CONCLUSIONS, SAFETY ACTIONS AND RECOMMENDATIONS SHALL IN NO CASE CREATE A PRESUMPTION OF BLAME OR LIABILITY. NEITHER ARE THEY BINDING NOR LISTED IN ANY ORDER OF PRIORITY.

3 CONCLUSIONS

Findings and safety factors are not listed in any order of priority.

3.1 Immediate Cause of the Occurrence

.1 The crew members suffered from heat exhaustion, with the bosun suffering from a heat stroke that led to his death.

3.2 Conditions and other Safety Factors

.1 The high atmospheric temperatures and humidity levels, around the time of the vessel's berthing, would have affected the crew members.

.2 In view of their long work periods for the cargo hold cleaning operations, as well as the uncomfortable warm temperatures within the accommodation that would not have allowed the crew members to rest properly, it was not excluded that several members of the cleaning team had also experienced fatigue by the time the vessel was berthing at Mesaieed.

.3 It appeared that the crew members were not aware of all actions that needed to be taken, in the event of a heat stroke casualty, particularly the requirement to cool the casualty's body with water and ice. Furthermore, the circumstances at that time did not allow the crew members to refer to the available medical publications on board, and find this information there.

.4 While it is understood that all crew members had received relevant training in first aid and medical care, the safety investigation noted that training to assist a casualty of heat stroke appeared to be included neither in the IMO model course for elementary first aid, nor further emphasized in the IMO model course for medical care. Furthermore, whilst the course on medical first aid addresses treatment for heat stroke, its compendium did not appear to include the relevant section from the *International Medical Guide for Ships*.

3.3 Other Findings

.1 In view of the effects of climate change, it is likely that there may be an increase in such occurrences on board vessels, particularly when considering that the reason for crew members' exposure to the sun and heat are due to the nature of the tasks on board, itself. Furthermore, acclimatization can take several weeks and it is highly unlikely that crew members on board a vessel will get an opportunity to acclimatize effectively.

.2 The carriage of *The Ship Captain's Medical Guide* is a mandatory requirement for Maltese-registered vessels, whilst the *International Medical Guide for Ships* is not listed as a mandatory publication to be carried on board Maltese-registered vessels. The compendia of the IMO model courses on first aid and medical care contain extracts only from the latter.

4 ACTIONS TAKEN

4.1 Safety Actions Taken During the Course of the Safety Investigation

Following the occurrence, the Company took the following actions:

1. reviewed and revised its safety management system (SMS) manual, to include a section on 'working in hot environments' and a related checklist, together with precautionary measures to be taken;
2. issued a circular to its fleet, containing information and instructions relating to heat illnesses; and
3. prepared and distributed posters across its fleet, to raise awareness on dehydration.

5 RECOMMENDATIONS

In view of the conclusions reached and taking into consideration the safety actions taken by the Company during the course of the safety investigation,

The Company is recommended to:

10/2024_R1 ensure that its vessels are adequately equipped to provide a comfortable environment for the crew members, through regular visits by the Company's representatives and / or communication with the master, especially when the vessel is trading in regions of high / low temperatures.

The flag State Administration is recommended to:

10/2024_R2 submit a paper to HTW Sub-Committee to the IMO, proposing the inclusion of emphasized seafarer training on the on-site treatment of heat stroke / hyperthermia casualties on board, taking into consideration the predicted effects of climate change.

10/2024_R3 issue an Information Notice, recommending that the latest edition of the *International Medical Guide for Ships* and its supporting publications (or the newly-published *International Medical Guide for Seafarers and Fishers*, if appropriate), are also carried on board Maltese-registered vessels.