DMAIB
DANISH MARITIME ACCIDENT INVESTIGATION BOARD

CROWN SEAWAYS

Marine accident report on occupational accident

19 NOVEMBER 2022

MARINE ACCIDENT REPORT ON OCCUPATIONAL ACCIDENT ON CROWN SEAWAYS ON 19 NOVEMBER 2022

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Photo: Warping roller on CROWN SEAWAYS
Source: DMAIB

The investigations are carried out separately from the criminal investigation, without having used legal evidence procedures and with no other basic aim than learning about accidents with the purpose of gaining and promoting an understanding of safety. Consequently, any use of this report for other purposes may lead to erroneous or misleading interpretations.

Content

Introduction

Start of the investigation

On 19 November 2022, DMAIB was notified by The Danish Maritime Authority that an ordinary seaman was injured on CROWN SEAWAYS. The accident happened during mooring on the aft deck when the ship arrived in Copenhagen.

The initial notification indicated that the seaman had suffered minor injuries, and DMAIB's preliminary investigation was closed. During December, the seaman's condition worsened, and the injuries became more severe than previously reported. Therefore, on 14 December, DMAIB decided to conduct a full investigation of the accident.

Narrative

RECONSTRUCTION OF COURSE OF EVENTS

The course of events covers the period from when the ship approached DFDS Terminal in Copenhagen on 19 November 2022 at 0940 LT until the ordinary seaman was evacuated from the ship later the same day.

The event reconstruction is based on data from the ship's AIS, logbooks and testimonies from a selected group of crew members. All times are ship's local time (UTC+1).

Background

CROWN SEAWAYS was a passenger/ro-ro ship (Figure 1 and appendix) operating on a fixed round-trip route between Copenhagen and Oslo (Copenhagen - Frederikshavn (Denmark) - Oslo - Frederikshavn - Copenhagen), carrying passengers, cars and trailers. One round trip took two days.

On the day of the accident, the ship's crew comprised 161 persons of various nationalities. English was the official working language on board, but in practice the working language was mainly Danish. Eng¬lish was only spoken when the Danish crew communicated directly with crew members of other nationalities.

Figure 1: CROWN SEAWAYS
Source: DMAIB

The accident

On 19 November at 0940, CROWN SEAWAYS passed the outer breakwater in Port of Copenhagen and approached the DFDS Terminal. The bridge was manned by the ship's master, the chief officer and the 2nd officer. After passing the outer breakwater, the ship was to be turned and went astern alongside the DFDS terminal (Figure 2).

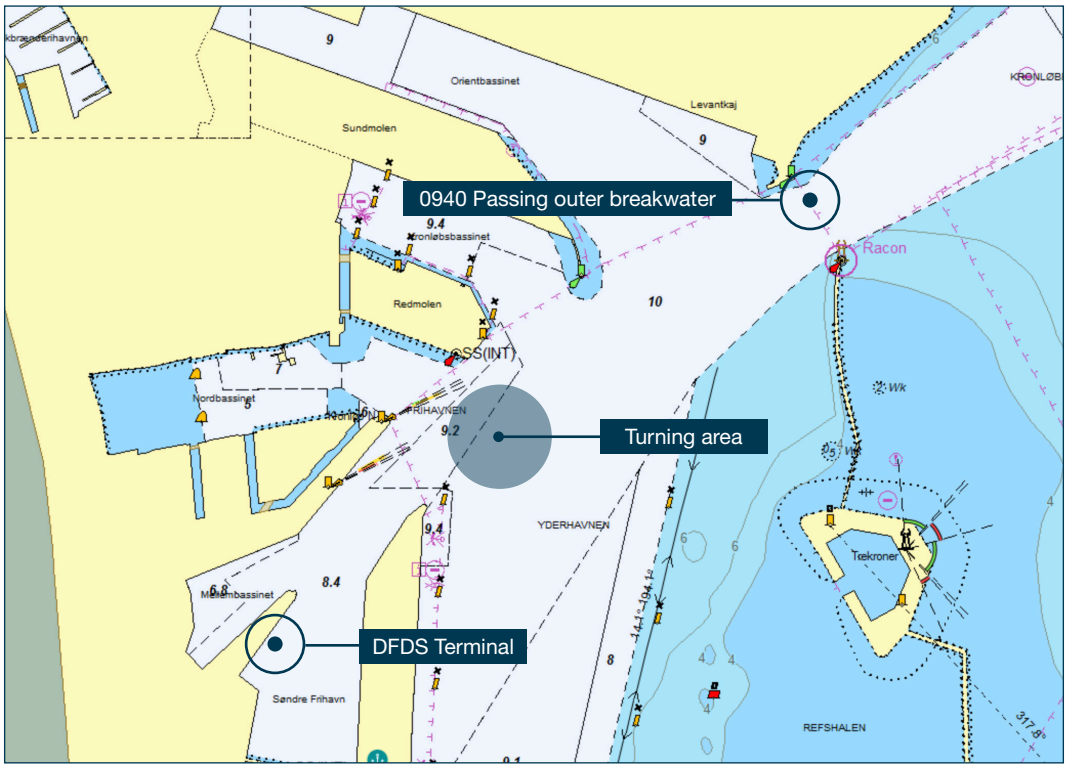

Figure 2: Port of Copenhagen
Source: SafeSeaNet Eco GUI, modified by DMAIB

The master was in command and manoeuvred the ship. Meanwhile, the chief officer kept in UHF radio contact with the crew members who were on standby on the forward and aft mooring stations.

On the aft mooring station, two able seamen (AB), one ordinary seaman (OS) and one cadet were on standby for mooring. Usually, the 3rd officer was also present, but on this day she was busy providing medical care to a passenger. All the crew members on the aft deck carried UHF radios so they could follow the communication between the bridge and the mooring stations. The communication was conducted in Danish because all the crew members on deck were Danish nationals.

On the aft mooring station, the ship was to be moored with one spring line and two stern lines (Figure 3). There were three heaving lines tied to each mooring rope's messenger line. A fourth heaving line was used for bringing the heaving lines ashore back on the ship.

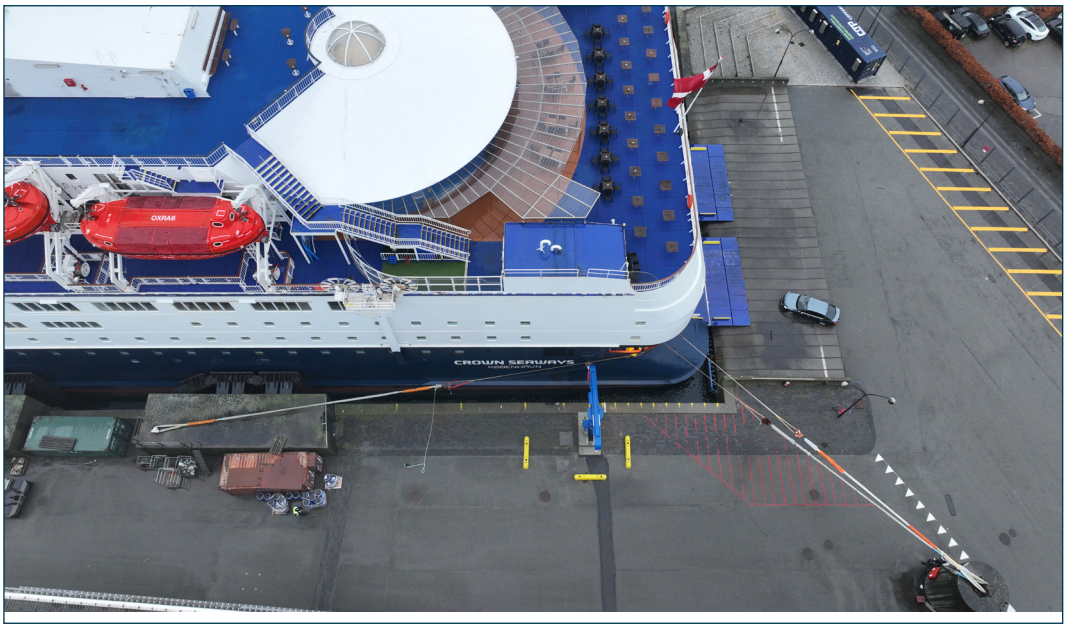

Figure 3: CROWN SEAWAYS' aft mooring configuration in Copenhagen
Source: DMAIB

During the morning, the division of work on the aft deck had been agreed. The cadet was to report the ship's position to the bridge; the OS managed the heaving lines; one AB handled the ropes; and the second AB operated the winch remote control. The weather conditions were good, and the crew members on the aft deck expected the mooring to proceed according to the normal routine.

When the ship went astern to the berth, there was little talk among the crew members about the mooring operation, because the ABs were experienced and considered it routine work, and the cadet had little involvement in the mooring. The OS was not as experienced as the others and was therefore told to stand clear of the mooring ropes and handle the heaving lines as instructed. The spring line was the first line ashore, followed by two stern lines. The cadet stood by the stern and reported the ship's position relative to the quay. The AB controlling the winches stood by the gunwale and kept all the lines slack until the ship was in its final position. At the same time, the other AB stood on the starboard side by the spring line winch and told the OS to make the fourth heaving line ready, so he could bring the heaving lines ashore back on board (Figure 4).

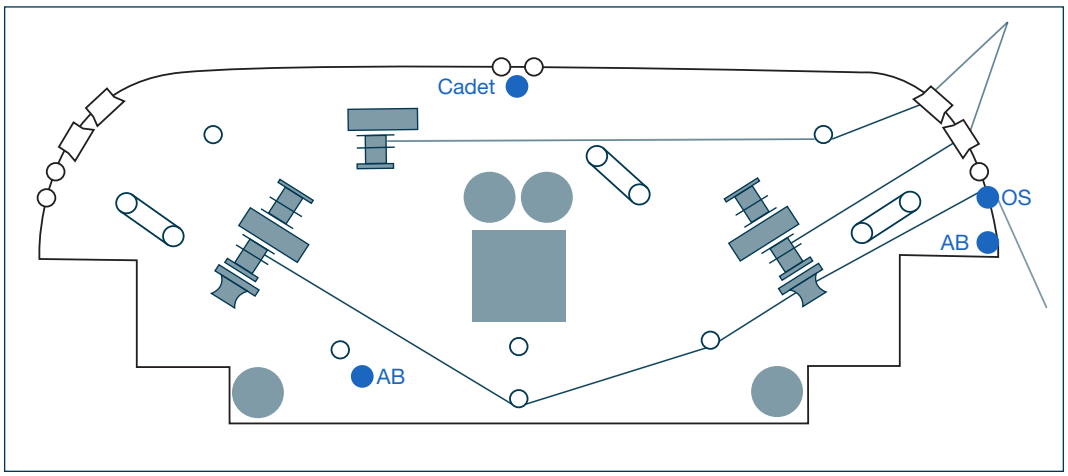

Figure 4: The crew members' positions on the aft mooring station
Source: DMAIB

At approximately 0955, the ship was a few metres from its final position. The AB controlling the winches by the gunwale was on standby to tighten the spring line, and the other AB was on standby to tighten the winch brake and to disengage the winch drum. At that moment, the OS stepped onto the warping roller fairlead and forcefully threw the fourth heaving line ashore. Because of the forward momentum of the ship, he lost his footing and took a step forward to regain his balance. He immediately noticed that his left foot was trapped between the roller and the spring line. As his foot was pulled into the roller, he let out a scream (Figure 5).

Figure 5: The OS's position during the accident
Source: DFDS, modified by DMAIB

The two ABs immediately heard the OS's screaming, and the AB who stood next to the OS instinctively slackened the spring line, which caused the OS's foot to be pulled further into the roller. The AB called the bridge and told them to bring the ship forward to slacken the spring line, but he received no response. However, the ship was already moving forward, and as the AB slowly tightened the spring line, the foot was released, and the OS fell onto the deck. The cadet and the AB standing by the winch ran to the aid of the OS, who was visibly seriously injured on his lower left leg.

On the bridge, the master and the chief officer heard shouting on the radio and immediately realized that something had happened, but they did not initially understand what the situation was. Shortly after, the cadet called the bridge and explained the situation and told them that they needed immediate assistance on the aft deck and to call an ambulance.

The master told the 2nd officer to go to the aft deck to assist the ABs and told the chief officer to call the emergency services. At 1003, about five minutes after the accident, the chief officer called an ambulance. The master called the AB in charge on the aft deck and asked him if they could move the ship the last 2-3 metres to bring the ship into position, which was confirmed by the AB who operated the winches.

As the ship moved alongside, the 2nd officer and chief officer arrived on the aft deck and assisted in treating the OS and completing the mooring.

The ambulance arrived 7 minutes after the chief officer's call, and the OS was evacuated from the aft deck and brought to Rigshospitalet, the national hospital in Copenhagen. Shortly after, company representatives and a psychologist arrived on board to provide assistance to the crew.

Investigation

SCOPE OF THE INVESTIGATION

The course of events showed that an OS was seriously injured when his foot was trapped between a spring line and a warping roller.

DMAIB's investigation focused on determining how the OS was exposed to an unrecognised hazard which arose in an otherwise routine mooring operation.

DMAIB visited the ship on two occasions, mapping an everyday mooring operation and comparing it to the events unfolding on the day of the accident.

The following topics are examined here:

- Layout of the aft mooring deck
- Mooring practices on the aft deck
- Competencies related to mooring operations

Layout of the aft mooring deck

In this section, the layout and view of the aft mooring deck at the time of the accident are described to later establish how the mooring arrangement facilitated a certain way of working during mooring operations.

Layout and equipment

The layout of the aft mooring station on CROWN SEAWAYS is shown on the basic layout drawing below (Figure 6).

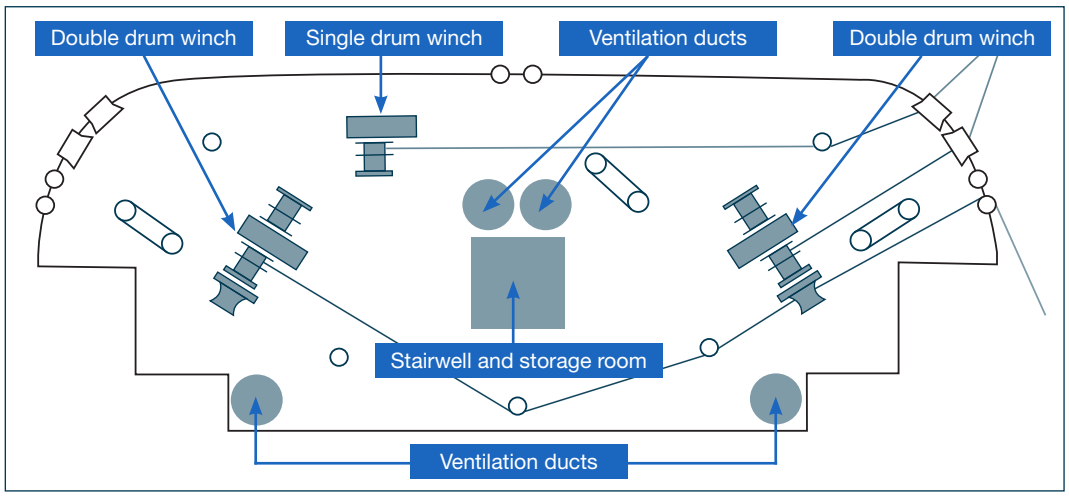

Figure 4: The crew members' positions on the aft mooring station
Source: DMAIB

CROWN SEAWAYS was equipped with three electrically driven mooring winches. Two of the mooring winches were fitted with double split drums, divided by a notched flange with a tension section and a rope storage section. One of the winches was a single drum with a tension section and a rope storage section. Each winch was fitted with a manually operated clutch and band brake with manual setting and release. The brake was tightened by turning the hand wheel. All of the winches were controlled by a remote control or by a control station located in proximity to each winch and by the gunwale on each side of the deck.

The four ventilation ducts for the car deck were located on each side of the forward part of the deck, with two in the centre of the deck. Also in the centre of the deck there was a closed stairwell and a storage room. On each side, barriers were fitted by the gunwale to protect the crew members from the mooring rope snapping back, which also governed how they positioned themselves during mooring (Figure 7).

The aft mooring deck was enclosed, with openings in the centre and on each side of the ship. There were three fairlead openings on each side. Two were fitted with guide rollers and one was fitted with two warping fairlead rollers mounted on an elevated platform (Figure 8).

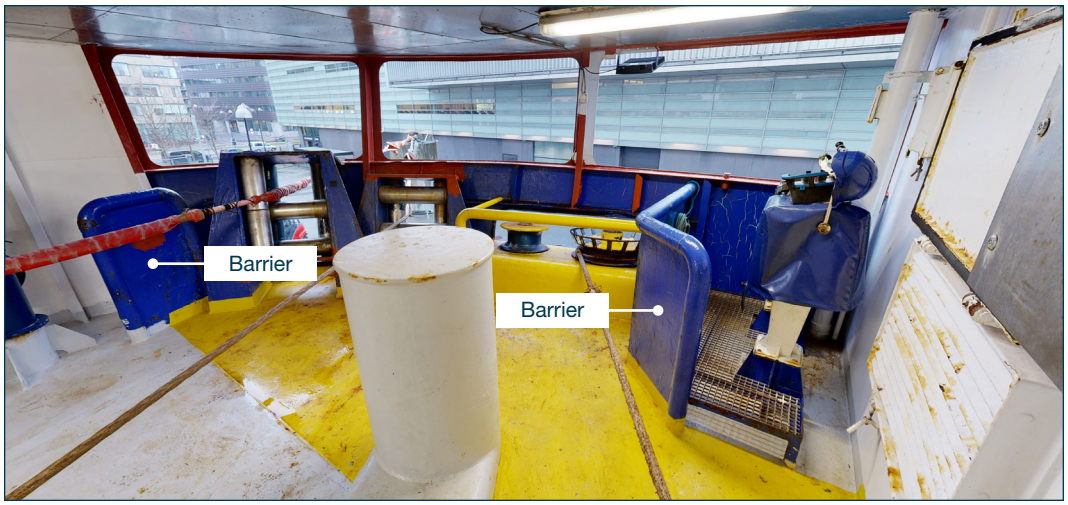

Figure 7: Barriers on port side (the yellow guard rail by the fairlead was installed after the accident)
Source: DMAIB

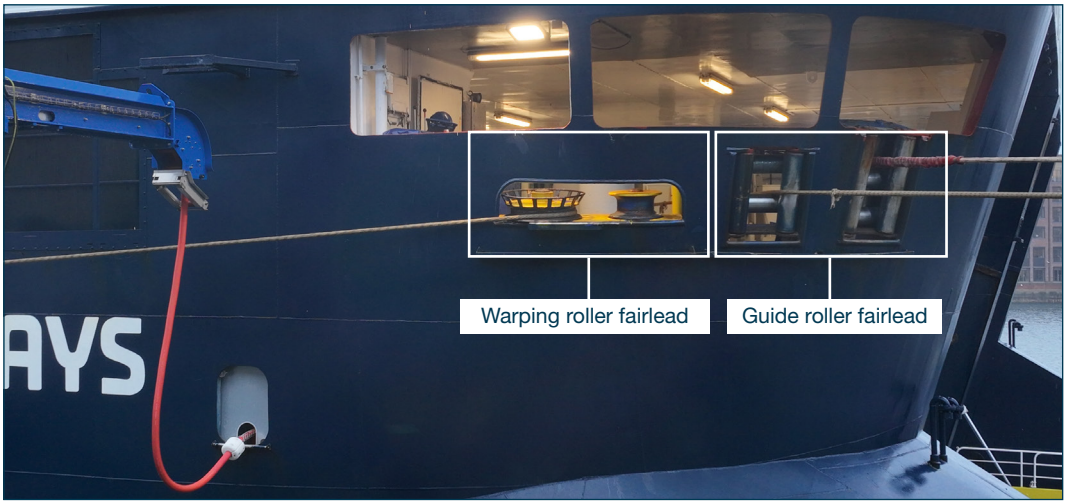

Figure 8: Fairleads on port side
Source: DMAIB

View of the deck and quay

The view of the deck area was hampered by the storage room, the enclosed stairwell and the ventilation ducts (Figure 9). The height of the gunwale by the side opening was about one metre, with fairlead rollers in front of it. To get a view of the quay and the line men ashore, it was necessary for the crew members to climb the fairlead platform and/or the warping roller (Figures 10 and 11).

Figure 9: View of mooring deck from port side control station
Source: DMAIB

Figure 10: View from deck
Source: DMAIB

Figure 11: View from fairlead platform
Source: DMAIB

Observations

- It was difficult for the crew members to keep the mooring winches in a clear line of sight when operating them.
- The safety barriers that protected the crew members from snapping mooring ropes governed where the crew members stood during mooring.
- When throwing the heaving lines ashore, the crew members had to be close to the gunwale and the fairleads to keep the line men ashore in a clear line of sight.

Mooring practice on the aft deck

This section describes the crew members' work practices on the ship's aft mooring deck. The aim is to gain an understanding of the everyday mooring routine in Copenhagen from which the accident emerged.

DMAIB conducted interviews and recorded reconstructions with the deck crew to establish the common mooring practice on the aft deck. Additionally, the mooring practice was recorded from ashore to establish how the crew interacted with the line men.

Crew members involved

Mooring on the aft deck was normally performed with one junior officer and two ABs, as described in the ship's procedure: Manning Plan During Arrival and Departure (SMS Doc. 7.2.6). The crew composition could vary depending on the need for training new ratings or cadets, or situations could arise which necessitated the officer to perform other duties on the ship. Regardless, two experienced crew members were usually present during mooring to perform the mooring, along with a third person, usually a junior officer, who reported the stern's position to the bridge.

Mooring sequence and timing

CROWN SEAWAYS arrived in Copenhagen every two days at the same terminal, where the ship normally had port side alongside. The aft mooring configuration was one spring line and two stern lines. Mooring in Copenhagen was thereby a largely standardised work process.

Upon arrival in Copenhagen, at about 0800, the AB dayman prepared the ropes and heaving lines, including pulling the ropes through the fairleads and tying the heaving lines to the messenger lines (Figure 12).

Each rope's messenger line was fitted with a heaving line, and a fourth heaving line was prepared to bring the other heaving lines back on board. The fourth heaving line was normally kept on a staghorn mounted on the gunwale at the side opening (Figure 13).

Figure 12: Mooring ropes prepared for arrival
Source: DMAIB

Figure 13: Location of the fourth heaving line during arrival
Source: DFDS

The crew considered mooring in Copenhagen to be repetitive, and the crew members therefore knew in what sequence to set the mooring lines. The mooring operation comprised several subtasks which were performed in a fixed sequence and were timed according to the ship's movements.

The mooring sequence and timing, when the crew comprised two ABs and one junior officer, were as follows:

- The crew assembled at about 0930 on the aft deck, approximately 30 minutes before arrival at 1000 LT.
- When the ship was in the turning basin and moving astern to go alongside the berth, the junior officer moved around on deck to report when the stern passed various landmarks.
- When the ship was parallel to the berth, the junior officer moved to the centre fairlead to report the ship's longitudinal position relative to the quay.
- When the ship was a few metres from its final position, an AB threw the heaving line to the spring line ashore (Figure 14).

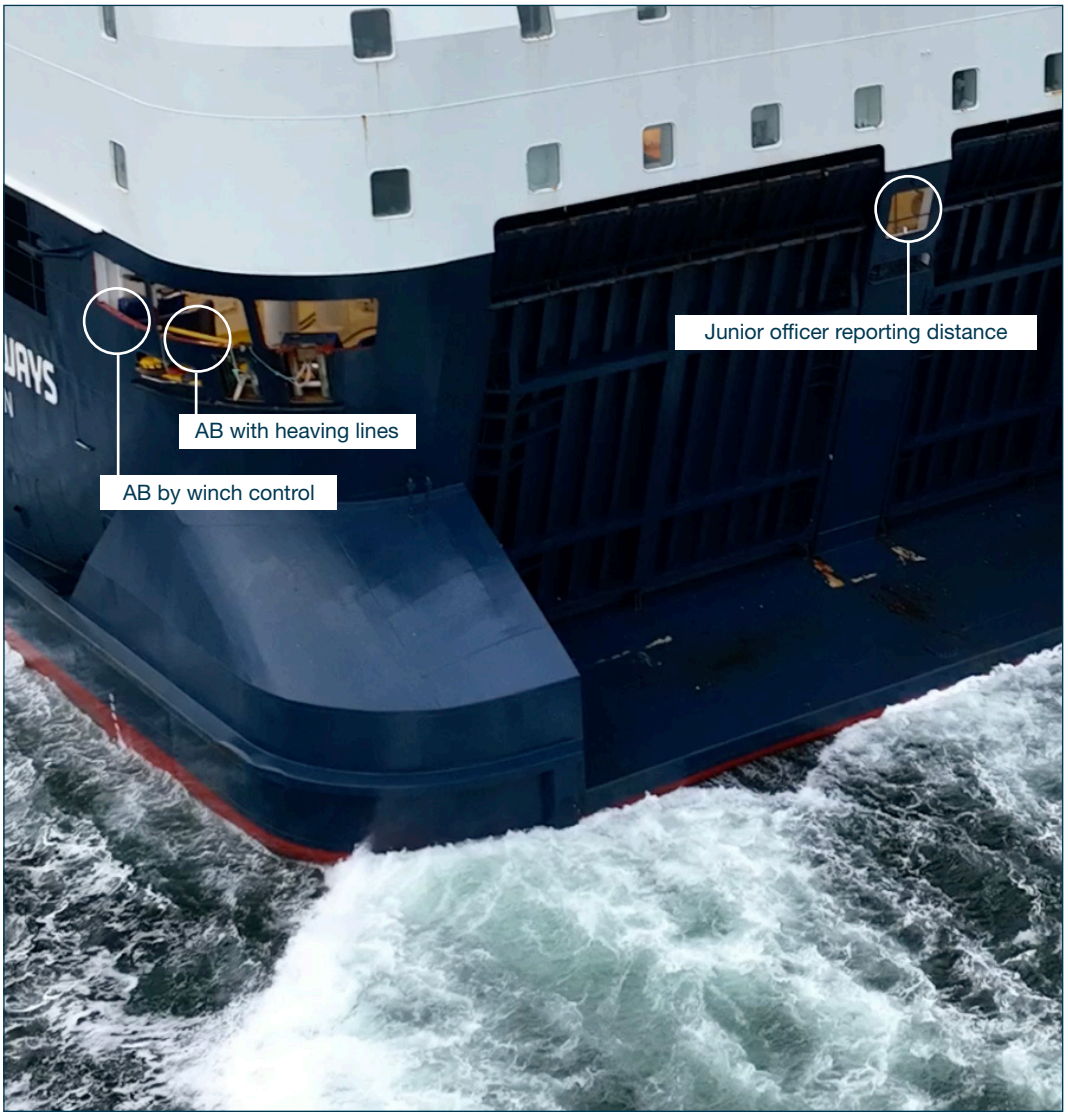

Figure 14: Location of the two ABs and the junior officer
Source: DMAIB

- The AB standing by the gunwale operated the winch remote control and lowered the spring line to the quay.
- The shore line men put the eye of the spring line on the shore tail hook.
- The AB standing by the gunwale took in the slack, and the second AB transferred the spring line rope from the storage drum to the working drum.
- One by one, the stern lines' heaving lines were thrown ashore and the stern lines were put on the shore tail hooks.
- The AB standing by the gunwale took in the slack, and the stern line ropes were transferred from the storage drums to the working drums.
- When the bridge informed the crew that the ship was in position, the spring line was tightened and afterwards so were the stern lines.
- After all the moorings were tight, all the winch brakes were activated, and the clutches disengaged.
- An AB threw a fourth heaving line ashore to bring the heaving lines from the spring and stern lines back on board. To get a full view of the quay, it was customary to stand on the warping roller fairlead when throwing the heaving line.

Timing the work sequence was essential to ensure that the mooring ropes were sent ashore, secured and tightened in the right order, and that crew members were standing clear of ropes in motion. Timing entailed knowing:

- When to throw the heaving lines
- When to lower the ropes to shore
- When to operate the winches
- When to transfer the rope from the storage drum to the working drum
- When to tighten the ropes
- When to retrieve the heaving lines
- When and where to stand during the mooring operation to get a full view of the deck area and the berth

During the different stages of the mooring, the crew had their attention directed towards their specific tasks, which could create blind spots where the crew members were not in line of sight of each other while working. Figure 15 shows the crew members' line of sight when the ship was about to come alongside on the day of the accident.

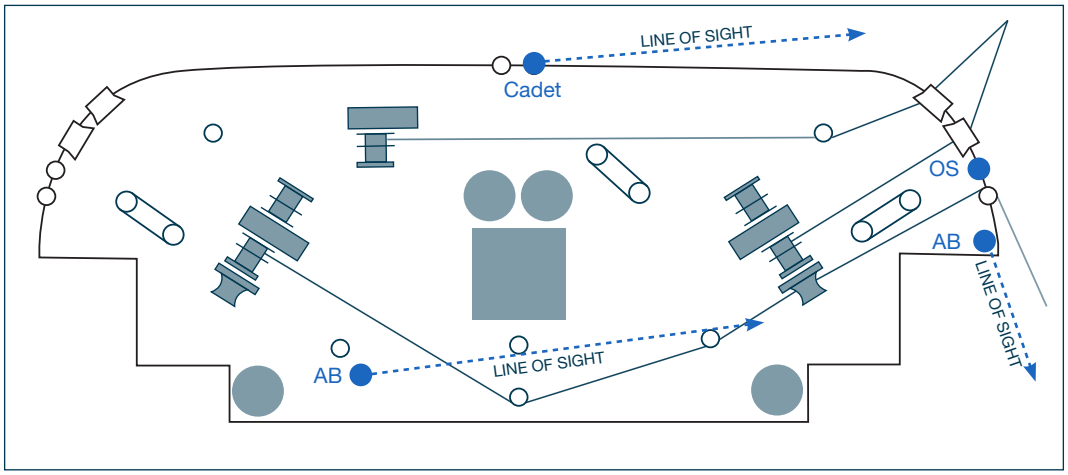

Figure 15: Line of sight of cadet and ABs
Source: DMAIB

Not being in sight of each other was not problematic because the crew members had well-defined tasks which were performed in a particular sequence and timing. They paid particular attention to where they walked and positioned themselves as the mooring progressed by, for example, not standing across mooring ropes on deck, by standing clear of ropes when they were being tightened, by keeping in contact with the line men and by knowing when to operate the winches.

At times, the mooring sequence and timing could vary due to strong winds, which made it necessary to change the mooring sequence and/or timing because they had to set the mooring lines earlier than usual. These variations in the mooring sequence and timing did not normally give rise to unforeseen hazards because the experienced crew members had the adaptive capacity to meet the changing circumstances.

Observations

- Adhering to a specific sequence and timing of tasks during the mooring operation was pivotal in managing the hazards that the mooring operation entailed.
- During the mooring operation, the crew had their attention directed to specific places, which left other crew members in blind spots.

Competencies related to mooring operations

This section describes how the crew members were familiarised with the mooring operations on the aft deck. The aim is to ascertain how the practical skills necessary for conducting mooring operations were acquired.

Safety management system

Apart from SMS Doc. 7.2.6 on manning, mooring operations on CROWN SEAWAYS were not included in the ship's safety management system but were part of a separate safety management system from SEAHEALTH[1], which included a risk assessment for mooring operations. This risk assessment listed various hazards related to mooring and what hazard mitigation to implement. Additionally, the assessment described what personal protection equipment to use.

During the investigation, the crew members did not consult the risk assessment or refer to the content in the document. The process of mooring the ship was viewed by the crew members as an integral part of their professionality, which was obtained during familiarisation and training. This training was based on informal on-the-job training.

1 Industry body promoting safety, health and welfare on Danish ships

Professional background and familiarisation

The two ABs who worked on the aft mooring deck on the day of the accident had 7 and 11 years of experience. The OS had been on the ship for 19 days and had not previously worked as a deck rating during mooring operations on a merchant ship.

Newly employed ratings, cadets and officers underwent familiarisation and training in mooring operations by on-the-job training. They got first-hand experience with all the work procedures they could expect to encounter, and they learned workplace expectations, equipment operation, how to tell the newly employed where to stand and where not to stand, how to warn about impending hazards, and other skills they needed to complete their job safely. The cadets and OSs shadowed other employees in training and then moved on to completing tasks with supervision. The extent and duration of this training depended on the trainees' prior experience.

Observations

- The two ABs who were on duty on the day of the accident were experienced and had an in-depth understanding of the mooring practice.
- Familiarisation and training were conducted by on-the-job training.
- The OS was inexperienced and was in on-the-job training.

Analysis & conclusion

Understanding the accident

DMAIB's investigation focused on determining how the OS was exposed to an unrecognised hazard which arose in an otherwise routine mooring operation.

The investigation of the course of events and of the mooring practices on the aft deck showed that mooring the ship coincided with other activities related to the ship's arrival in port, e.g., aiding in manoeuvring the ship into position, medical treatment of passengers and training new employees. Additionally, the layout of the aft deck and the competence and training of crew members influenced how the mooring operations were performed.

Consequently, an understanding of how the accident happened could not be explained by a singular focus on the actions of the OS who was injured but had to encompass the other circumstantial factors as well.

Accident causation

The crew members did not rely on using procedural documents to guide them in the mooring operation because mooring was viewed as an integral part of their professionality. This professionality was based on years of experience, which comprised an understanding of how to perform the mooring operation in an established sequence with the right timing. Adhering to that sequence and its timing was pivotal in managing hazards.

The OS had little experience with mooring operations generally, and specifically on CROWN SEAWAYS. Therefore, he did not understand the importance of the sequence and timing of the mooring operation and of the hazards involved.

Shortly before the accident, an AB told the OS to throw the last heaving line ashore, but he did not explicitly tell the OS from where and when to throw it. It was convenient for the OS to stand on the roller when throwing the heaving line, because the heaving line was located on the gunwale above the roller and it was customary to stand on the roller to get a full view of the quay. The only other convenient place to stand was behind the barrier where the AB operating the winches stood. There was, however, no room for two persons behind that barrier.

Unknown to the OS, the timing was wrong. He stepped onto the fairlead platform while the mooring was ongoing, the spring line had not been tightened and the winch brake had not been activated. In other words, the OS acted in accordance with the established practice, but at the wrong time. When the OS lost his footing, he accidentally stepped into the gap between the turning roller and the spring line and was trapped.

Several factors coincided and meant that it went unnoticed that the OS had stepped onto the warping roller fairlead before the mooring operation was completed. The other crew members had been assigned tasks which directed their attention away from the OS's position: The cadet was reporting the ship's position to the bridge; one AB was monitoring the spring line; and the other AB stood by the winch ready to transfer the rope to the working drum. The layout of the mooring deck did not offer a full view of the entire aft deck, which made it impossible for the crew members to quickly get a view of the other crew members' locations. The other crew members were therefore unable to stop the accident from happening.

Safety learning

Mooring operations cannot be subject to generic proceduralisation because they can be highly dynamic and interwoven with other activities on the ship. This entails variation in the work which makes it necessary for the crew members to adapt to different circumstances. It is therefore essential that the crew members have the required knowledge and skills to adapt safely to changing circumstances.

Normally the experienced crew members on CROWN SEAWAYS managed the lack of a full view of the mooring deck by having an informal established way of working. The crew members compensated for a inexpedient mooring deck layout by being competent. Given that it is not feasible to make structural changes to the mooring deck on CROWN SEAWAYS, the only option is to change the work practices, which necessitates knowledge of and training in a particular way of working.

Given that mooring operations are not suitable for prescriptive proceduralisation, the only option is supervised on-the-job training in the various ways of mooring and the mapping of which hazards and uncertainties might arise. This supervision of inexperienced persons will necessitate crew members being available to perform this supervision and their work being closely shadowed. It is therefore not expedient to only have two experienced crew members during on-the-job training, when their attention is directed elsewhere and the layout of the aft deck offers a poor view of the deck.

Preventive measures

Actions taken by DFDS A/S

Following the conclusion of the investigation, DMAIB has received the following information that DFDS A/S has implemented the following preventive measures:

- *”Fleet wide knowledge sharing of the accident.*
- *Physical barrier installed to prevent stepping up on fairlead platform.*
- *Onboard mooring procedure changed. Heaving lines are now retrieved after engaging winch brakes.*
- *Accident has been shared in relevant external forums.*
- *Planned alternation of the warping roller fairlead to a roller fairlead design.*
- *Company instruction for onboard familiarisation is currently being reviewed.*
- *Enhanced focus on mooring operations at upcoming internal verifications.”*

Appendix

SHIP'S DATA

Name:	CROWN SEAWAYS
Ship type:	Passenger/Ro-Ro Ship (Vehicles)
Nationality:	Denmark
Port of registry:	Copenhagen
Call sign:	OXRA6
IMO number:	8917613
DOC company:	DFDS A/S
IMO company no. (DOC):	0310102
Year built:	1994
Shipyard/shipyard number:	Brodosplit - Brodogradevna Industrija/CRT007
Classification Society:	Det Norske Veritas (DNV)
Length overall:	171.0 m
Breadth overall:	28.20 m
Maximum draught:	6.37 m
Gross tonnage:	35,498
Deadweight:	2,756 t
Propulsion power:	23,760 kW
Hull material:	Steel

VOYAGE DATA

Port of departure:	Frederikshavn, Denmark
Port of arrival:	Copenhagen, Denmark
Voyage type:	International
Information about the cargo:	General cargo
Manning:	161
Number of passengers:	1,111

WEATHER

Wind:	8 m/s - 045°
Current:	None
Wave height:	0.5 m
Visibility:	10 nm
Weather conditions:	Clear
Light/dark:	Light

INFORMATION ABOUT THE ACCIDENT

Type of marine casualty:	Occupational accident
IMO Classification:	Serious casualty
Date and time:	19 November 2022 at 0958 LT
Location:	DFDS Terminal Copenhagen
Ship operation:	Mooring/arrival
Place on board:	Aft mooring deck
Human factors:	Yes
Consequences:	One ordinary seaman suffered serious injuries to lower left leg.

ASSISTANCE FROM AUTHORITIES ON LAND AND EMERGENCY SERVICES

Parties involved:	Capital Region of Denmark
Resources used:	Emergency medical service ambulance and paramedics.
Speed of response:	20 minutes
Actions taken:	Ordinary seaman brought to hospital.

RELEVANT CREW MEMBERS

Master:	64 years old. Served on CROWN SEA-WAYS for 10 years.
Chief officer:	40 years old. Served on CROWN SEAWAYS for 3 weeks.
Able seaman:	39 years old. Served on CROWN SEAWAYS for 7 years.
Able seaman:	51 years old. Served on CROWN SEAWAYS for 11 years.
Ordinary seaman:	21 years old. Served on CROWN SEAWAYS for 19 days.