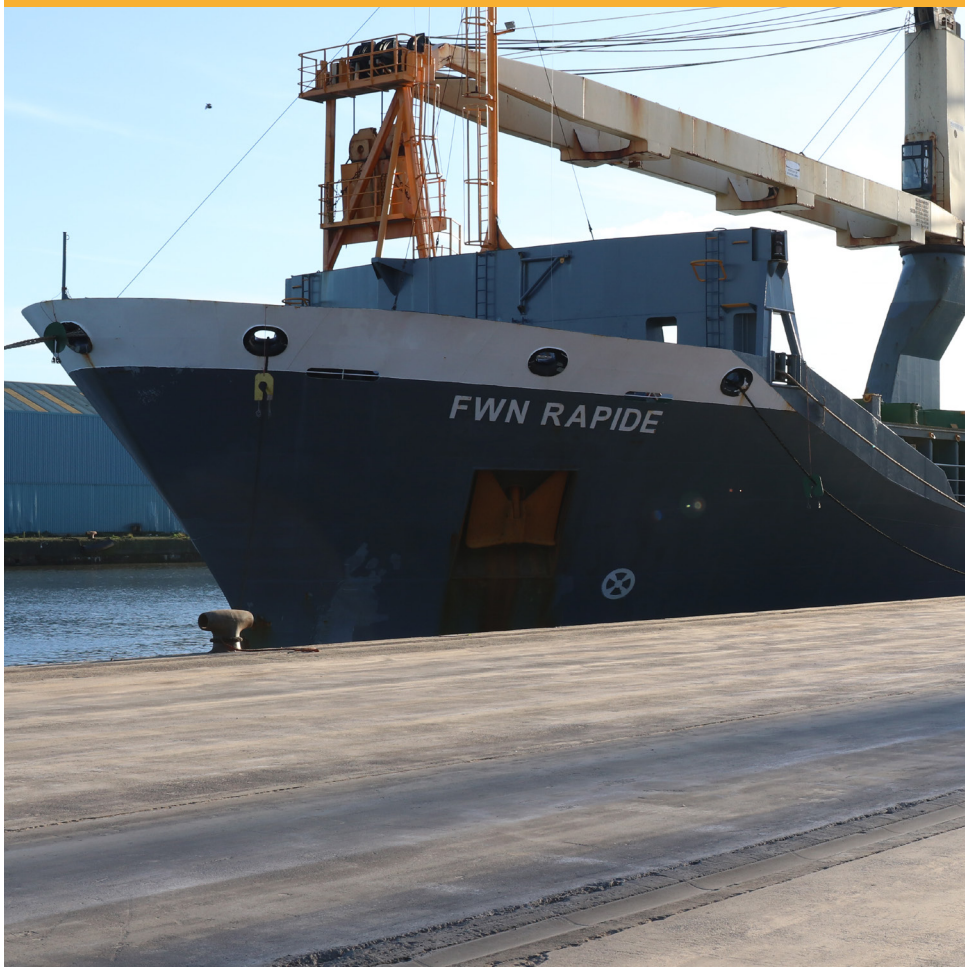
DUTCH
SAFETY BOARD

Tweendeck falls into hold with fatal outcome

Lessons learned from the occurrence on board the FWN Rapide



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The Hague, December 2021

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(Source cover photo: National Police)

The Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for these to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which occurrences to investigate. The Dutch Safety Board focuses particularly on situations in which people are dependent for their safety on third parties, including government or companies. In certain cases, the Safety Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

Dutch Safety Board

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INHOUD

RECOMMENDATIONS

The Dutch Safety Board issues the following recommendations:

With regard to maintenance of hoisting and lifting equipment on board ships, the alteration of work procedures, safe working at height and the provision of physical supervision during high-risk activities on board:

To ForestWave Navigation B.V. (Ship Manager):

1. Before implementing altered work procedures, ensure that a risk inventory and evaluation for the altered process is carried out by duly qualified experts. Also involve these experts in preparing safety management measures necessary for mitigating the risks that emerge from the inventory.
2. On board vessels managed by ForestWave Navigation B.V, ensure that maintenance on hoisting and lifting equipment is performed according to the manufacturer's instructions. Ensure that maintenance schedules and instructions from the manufacturer or supplier are fully integrated in the operational maintenance routines on the vessels.
3. On each vessel managed by ForestWave Navigation B.V, identify which types of fall protection equipment are necessary. Ensure that this equipment is available on board and issue the crew with information about how and when which type of fall protection equipment should be used. In addition, organize work on board in such a way that the work can only be started once all risk management measures have been taken.

With regard to the necessary expertise during annual inspections of hoisting and lifting equipment on board ships:

To the Royal Association of Netherlands Shipowners (KVNR):

4. Together with the sea shipping sector, develop a set of regulations, protocols and rejection criteria relating to the inspection of hoisting and lifting equipment on seagoing vessels. Also develop profiles according to which the expertise of the persons tasked with performing inspections can be assessed, measured and reinforced.

To the Dutch Minister of Social Affairs and Employment:

5. Ensure the development by the sea shipping sector of the system of expertise profiles as intended in recommendation 4.

Noting that a less strict regime of examination, inspection and testing is embedded in legislation and regulations for specific types of hoisting and lifting equipment on board ships:

To the Dutch Minister of Social Affairs and Employment:

6. Amend legislation and regulations regarding the examination, inspection and testing of hoisting and lifting equipment on board ships in such a way that equipment of this kind is subject to the regime of examination, inspection and testing that currently applies exclusively to hoisting and lifting equipment used for loading and unloading.

ir. J.R.V.A. Dijsselbloem
Chairman

mr. C.A.J.F. Verheij
Secretary Director

1 INTRODUCTION

1.1 The occurrence

On 2 September 2019, two Filipino deckhands fell into the hold on board the Dutch cargo vessel FWN Rapide. One of the crew members died and the other was injured. The occurrence took place in the port of Georgetown, Guyana. The two victims stood on a tweendeck while it was being moved by the hatchcover crane.

During the occurrence, the tweendeck was being used to fill the gaps between the walls of the hold and a vertically installed transverse bulkhead, from top to bottom.
One of the two hoisting cables of the hatchcover crane from which the tweendeck was suspended broke. As a result, the port side of the tweendeck fell approximately 5 metres, ending up in the bottom of the hold. As a result of the fall, the other hoisting cable also broke.

1.2 Classification

The incident has been classified as a very serious accident as defined in the Casualty Investigation Code of the International Maritime Organization (IMO) and Directive 2009/18/EC of the European Parliament and Council. This means that the accident must be investigated. Because the accident took place on board a Dutch vessel, the investigation was conducted by the Dutch Safety Board.

1.3 Purpose of the investigation

The purpose of this investigation is to answer the following investigation questions:

1. What were the direct and indirect causes of the breaking of the hoisting cable?
2. Why were two crew members injured, one with a fatal outcome?
3. What lessons can be learned from this occurrence?

1.4 The investigation

The investigation into the occurrence on board the FWN Rapide was conducted in accordance with the regular investigation process of the Dutch Safety Board.[1]

The Safety Board started the investigation by gathering all relevant information. The vessel was visited in October 2019 and installations and structures were subjected to a technical examination. Various stakeholders were interviewed, and documentation requested. The questioning also helped identify those parties that played a background role.

On the basis of the material gathered and the statement of facts, the investigators were able to prepare an analysis of the course of events and the underlying causes. It was determined precisely what happened, how it was able to happen and which factors played a role in the occurrence. As part of this investigation, among other aspects, the process of analysis considered relevant legislation and regulations, safety management on board and the role of the ship manager.

In its investigative process, the Dutch Safety Board used assessment frameworks to identify the aspects included in its considerations. The underlying principle is that all relevant actors bear the (social) responsibility to manage safety risks in the system under investigation as systematically and as effectively as reasonably possible. The assessment framework provides an outline description of the nature of those responsibilities according to the Dutch Safety Board. By considering non-conformities in relation to the assessment framework, the Safety Board is able to identify where in its judgement safety improvements can be achieved.

Appendix A contains a justification for the investigation. This justification discusses in greater detail such issues as background, investigation approach, analysis, assessment framework and quality assurance.

1 https://www.onderzoeksraad.nl/nl/page/12058/werkwijze-onderzoeksraad

2 COURSE OF EVENTS AND BACKGROUND INFORMATION

2.1 Background information

Actors
During this investigation, a number of actors were identified:
- Ship and crew
- Ship manager

The vessel was placed under Dutch flag in June 2015, when it was acquired by a Dutch owner. From that moment onwards, the current ship manager also became responsible for managing the vessel. Vessel, crew and ship manager are described in more detail in Appendix C.

2.2 Course of events

The occurrence took place on 2 September 2019, at around 22.40 hours local time. The weather was calm and dry, and dusk had fallen. The vessel had moored that morning at around 08.00 hours in the port of Georgetown, Guyana, with empty holds. During the course of the day, preparations were made for loading various types of rice for delivery to Liverpool (United Kingdom). These preparations included installing and sealing transverse bulkheads in the holds, with the assistance of the hatchcover crane.

Fitting tweendecks and transverse bulkheads using the hatchcover crane

On board the FWN Rapide, the holds are sealed with steel hatchcovers. These hatchcovers are moved and removed with the assistance of a gantry crane. On board ships, gantry cranes of this type are referred to as 'hatchcover cranes'. The hatchcover crane is able to travel over the holds from the fore part to the superstructure in the stern part of the vessel. The hatchcover crane travels along a crane track that runs the length of the ship along the hatchway coamings.

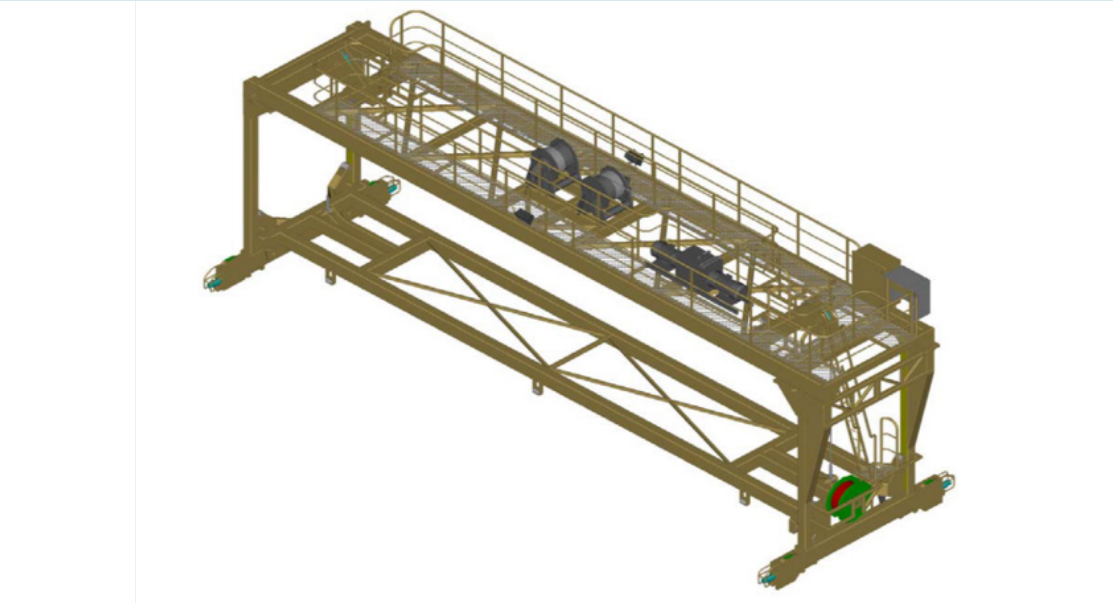


Figure 1: Hatch crane FWN Rapide. (Source: Hatch crane manual)

The two holds on the vessel can be divided into multiple compartments. This can be achieved horizontally by creating multiple floors, whereby a deck is placed in the hold, in sections. For this purpose, seventeen tweendecks are available on board, each as wide as the hold itself. There were 16 tweendecks weighing 21 tonnes and one smaller tweendeck weighing 20.2 tonnes on board. As shown in the simplified illustrations in figure 2, these sections are installed and secured in the hold, using the hatchcover crane. For that purpose, foldable support brackets are mounted in the walls of the hold.

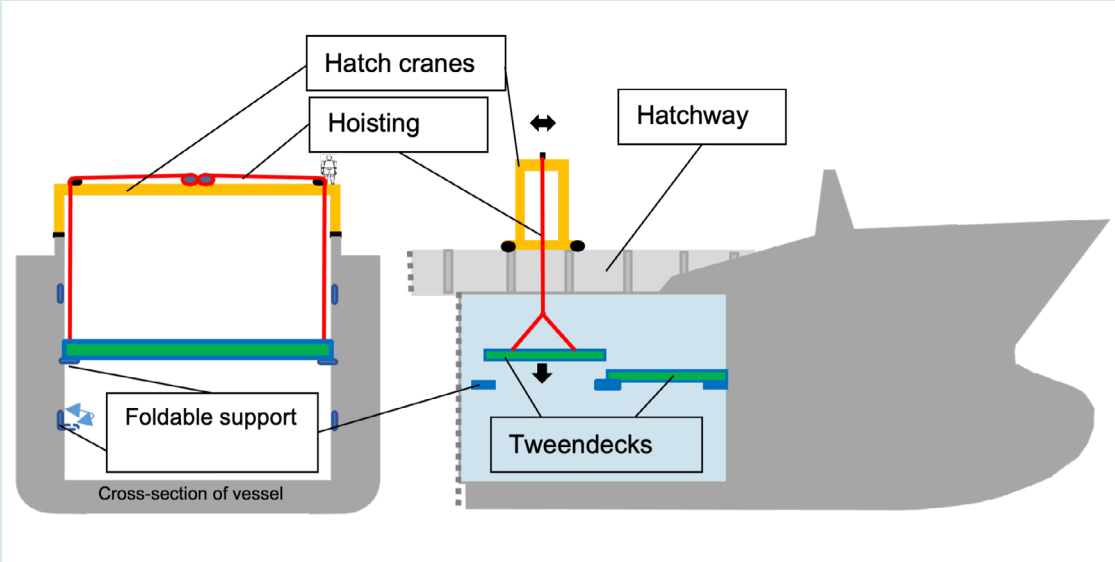


Figure 2: Horizontal installation of tweendecks. (Source: Dutch Safety Board)

These same tweendecks can also be used to create multiple 'sub holds' separated by vertical bulkheads. Two tweendecks installed vertically together form a transverse bulkhead in the hold. The vertical hoisting and positioning of the tweendecks is also carried out using the hatchcover crane. To secure these sections against the wall of the hold, it is necessary to work at height alongside the transverse bulkhead. Figure 3 shows that in accordance with the users' instructions from the supplier of the hatchcover crane, two man cages supplied with the crane must be used for this purpose. These man cages are attached to the frame of the hatchcover crane using electrical hoists, which allows them to travel up and down the height of the bulkhead.

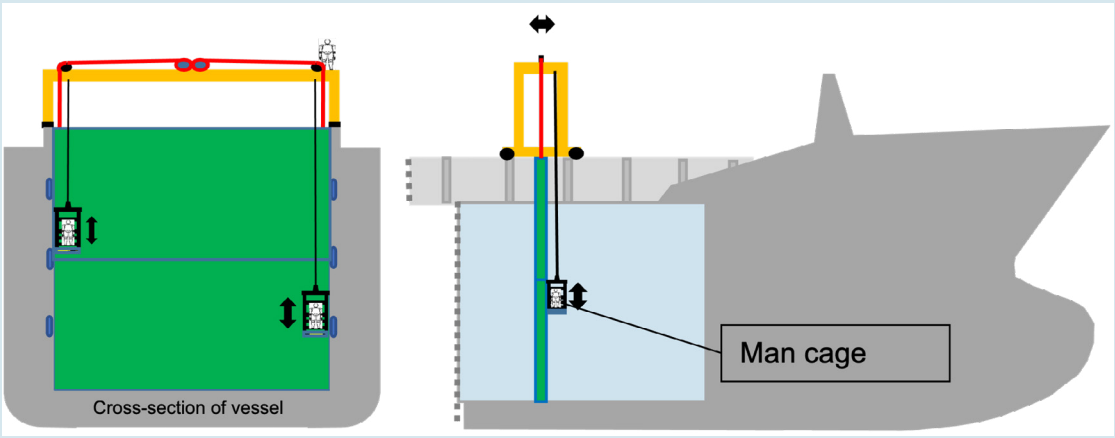


Figure 3: Vertical installation of tweendecks as transverse bulkhead. (Source: Dutch Safety Board)

At around 22.00 hours on that day, the second mate and two deckhands came on duty. They had rested during the afternoon, and relieved the first officer and two other deckhands. During the morning and afternoon, a transverse bulkhead had been installed in both holds of the vessel, and secured in position. The task for the second mate's shift was to seal the gaps between the installed transverse bulkheads and the walls of the hold. These had to be sealed in order to prevent the different types of cargo becoming mixed.

The sealing procedure involved filling the gaps with sections of old ropes, finished with a strip of magnetic tape, starting at the top of the transverse bulkhead. This work requires working at height, and lifting persons up and down. In principle, the hatchcover crane on board the FWN Rapide is equipped in such a way that this work can be carried out using the man cages and electric hoists supplied, in the same way as the task of locking the tweendecks installed as transverse bulkheads.

This work approach was perceived by crew members on board vessels of the shipping company as impractical. The man cages, for example, do not offer enough space to transport sufficient old ropes. When forcing the ropes into the gap, the man cage is often pushed away from the bulkhead, rather than forcing the rope into the gaps. For that reason, on the shipping company's vessels, a working procedure was introduced whereby the smallest tweendeck on board was used as a work platform, suspended from the two hoisting cables of the hatchcover crane. By lifting and lowering the work platform close against the bulkhead, crew members could seal the gaps between the transverse bulkhead and the walls of the hold, while standing on the tweendeck. This smallest tweendeck, weighing 20.2 tonnes, has a width of 13 metres (the same width as the hold) and a length of more than 5 metres, which allows sufficient space to carry the necessary materials and tools. The use of the tweendeck as a work platform has become part of the procedure described in the safety management system (SMS) for sealing gaps between walls of the hold and transverse bulkheads, on the shipping company's vessels.

After the second mate and the two deckhands had come on duty, they first discussed the work before starting. Safe working practice and the use of personal protective equipment were the subjects of this discussion.

Although the use of the tweendeck as a work platform is described in the SMS of vessels of the shipping company, there is no description of how the work should be carried out. The SMS does however contain a general procedure for working at height. This procedure among others specifies that when working at height, one person must be tasked with maintaining constant supervision of the work, from a safe distance, and be in a position to intervene immediately. Another part of the working at height procedure is the wearing of fall protection.

As standard on board this vessel, a start was made on the work, in the following manner:

- The second mate operated the hatchcover crane;
- The tweendeck, suspended from the two hoisting cables of the hatchcover crane, was raised right to the top of the hold, so that the top of the tweendeck hung level with the hatchcoverway coaming;
- Both deckhands, as specified wearing helmets, overalls, gloves, safety shoes and equipped with walkie-talkies, placed all the necessary materials and tools on the tweendeck;
- The second mate then fully lowered the tweendeck to the bottom of the hold;
- The two deckhands entered the hold via the regular hold access doors and stairs, and from the bottom of the hold climbed onto the tweendeck.

From his operating position on the top of the hatchcover crane, on the starboard side, the second mate was not able to see both deckhands. Before the actual work was started, he therefore asked them whether everything was ready to start. The two deckhands confirmed that all preparations had been made. The second mate then raised the tweendeck to the top of the hold. The tweendeck was positioned almost against the transverse bulkhead. Starting at the top of the hold, the second mate gradually lowered the tweendeck, in increments. As a result, while stood on the tweendeck, the two deckhands were able to seal the gaps between the transverse bulkhead and the port and starboard hold walls.

After the gap had been sealed from top to bottom, and the tweendeck had once again been fully lowered to the bottom of the hold, the second mate noticed that the seal on the port side had not been fully completed. It is unclear whether he was able to observe this fact from his operating position, or whether to make this observation, he left the operating position. He raised the tweendeck to approximately 5 metres above the bottom of the hold, and instructed the deckhands to finish off the seal on the portside, at that height.

After this work was completed, the second mate moved the hatchcover crane about 2 metres, so that the tweendeck was no longer suspended against the transverse bulkhead, in order to avoid the tweendeck becoming caught on loose ropes, while being lowered into the hold. He then noticed that the tweendeck was suspended in line with a set of foldable support brackets. He wanted to avoid the tweendeck causing damage by colliding with the folded-in support brackets. He therefore intended to raise the tweendeck a further half metre, before travelling further from the transverse bulkhead and then lowering the tweendeck to the bottom of the hold. At the moment he started to raise the tweendeck, the port hoisting cable broke.

As shown in figure 4, the port side of the tweendeck fell. Because the tweendeck was initially still suspended from the starboard hoisting cable, the tweendeck tilted to port thereby causing damage to the starboard side of the hold wall. The starboard hoisting cable then also broke, and the entire tweendeck fell to the bottom of the hold.

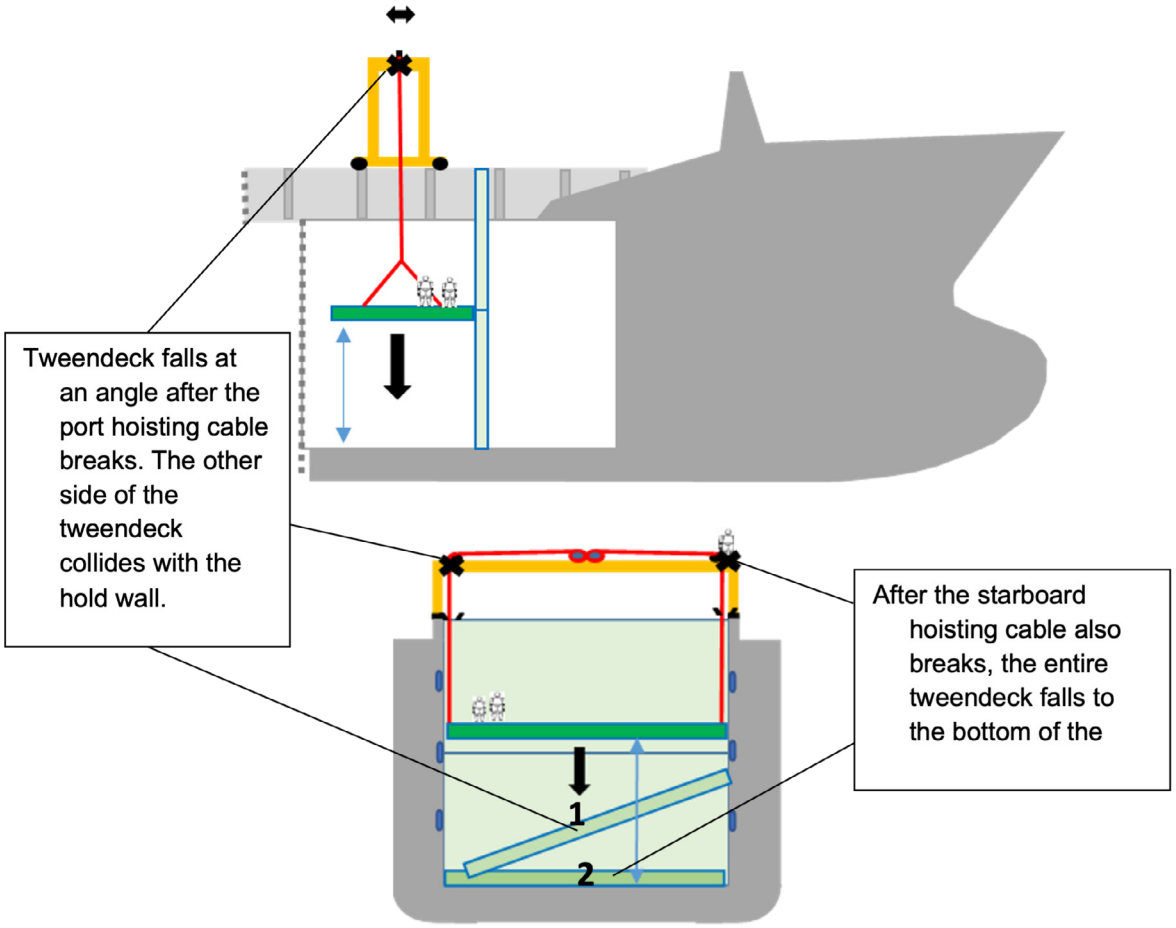


Figure 4: The occurrence. (Source: Dutch Safety Board).

Both deckhands fell together with the tweendeck. One of them trapped his arm between the port hold wall and the tweendeck. He died at the scene. The other deckhand suffered serious injuries and was transported to hospital in Georgetown. He was subsequently repatriated to the Philippines. It was confirmed that at the moment of the accident, neither of the deckhands was wearing fall protection. Following the occurrence, three safety harnesses were discovered stacked on the tweendeck. The hold wall on the starboard side was pierced, puncturing a ballast water tank.

Figure 5 is an overview photograph of the hold following the occurrence. Figure 6 shows the portside of the tweendeck that fell into the hold.

Sealed gaps between hold wall and transverse bulkhead.

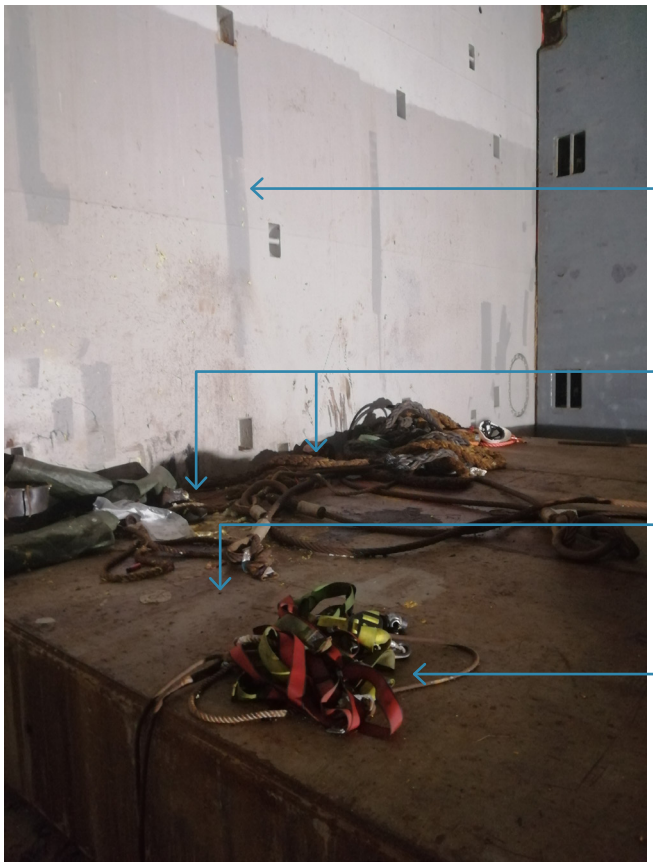
Installed bulkhead, consisting of two vertically stacked tweendecks.

Foldable support bracket.

Tweendeck/work platform fallen into the hold.

Broken starboard hoisting cable.

Figure 5: The tweendeck fallen into the hold. (Source: ForestWave Navigation)



Port hold wall

Position of victims

Tweendeck/work platform fallen into the hold.

Three safety harnesses

Figure 6: Tweendeck fallen into the hold, port side. (Source: ForestWave Navigation B.V.)

2.3 The failure of the hoisting cables

During the investigation on board the FWN Rapide, the hatchcover crane underwent a further visual examination. During the examination, the following observations were made:

- Both hoisting cables were frayed at the breaking point;
- Pieces of strands of the hoisting cables were found both on the hatchcover crane and in the hold;
- The outside of both hoisting cables showed evidence of rust;
- The guidewheels for both hoisting cables demonstrated sharp points of damage next to the running surfaces for the cables. These guidewheels were mounted on the hatchcover crane.

Figure 7: Hatch crane following the occurrence. (Source: ForestWave Navigation B.V.)

These observations were sufficient grounds for both the Dutch Safety Board and the Dutch police to seize these items for further examination by experts. Following consultation and subject to the promise that the investigation results would be shared with the Safety Board, both hoisting cables and two guidewheels were seized by the Dutch police. The expert examination was carried out by Element Materials Technology (EMT) in Amsterdam.

Figure 8: Hoisting cable guidewheel on hatch crane. (Source: National Police)

This expert examination by EMT revealed relevant facts about the course of events of the breaking of the cables. These facts, reproduced as conclusions in the EMT report, are summarized below:

- Both cables broke at the height of the guidewheels on the hatchcover crane;
- The corroded condition of the wheels contributed to the accelerated wear of the cables;
- As a result of corrosion, the wheels were in such poor condition that this could have been noticed during the previous annual inspection;
- Each hoisting cable consisted of a steel core of 49 wires around which 6 strands were wrapped, each consisting of 36 wires. Each hoisting cable therefore consisted of 265 steel wires. On the port hoisting cable, at the fracture surface of the cable, 229 (86%) of the wires had already broken, before the cable broke during the accident. On the starboard hoisting cable, 214 (81%) of the wires had already broken.
- The cables were not well coated with lubricating grease to protect them against the corrosive maritime environment;
- Repeated use of the weakened cables resulted in the flattening and further breaking of wires due to the fluctuating bending at the guidewheels;
- The still intact wires (<20%) in the hoisting cables subsequently broke due to overloading, during hoisting. The port hoisting cable broke first, followed by the starboard hoisting cable;
- The poor condition of the hoisting cables could have been noticed, if the cables had been cleaned for the annual inspection.

The report by Element Materials Technology (appendix D) is published as a separate document on the Dutch Safety Board's website.

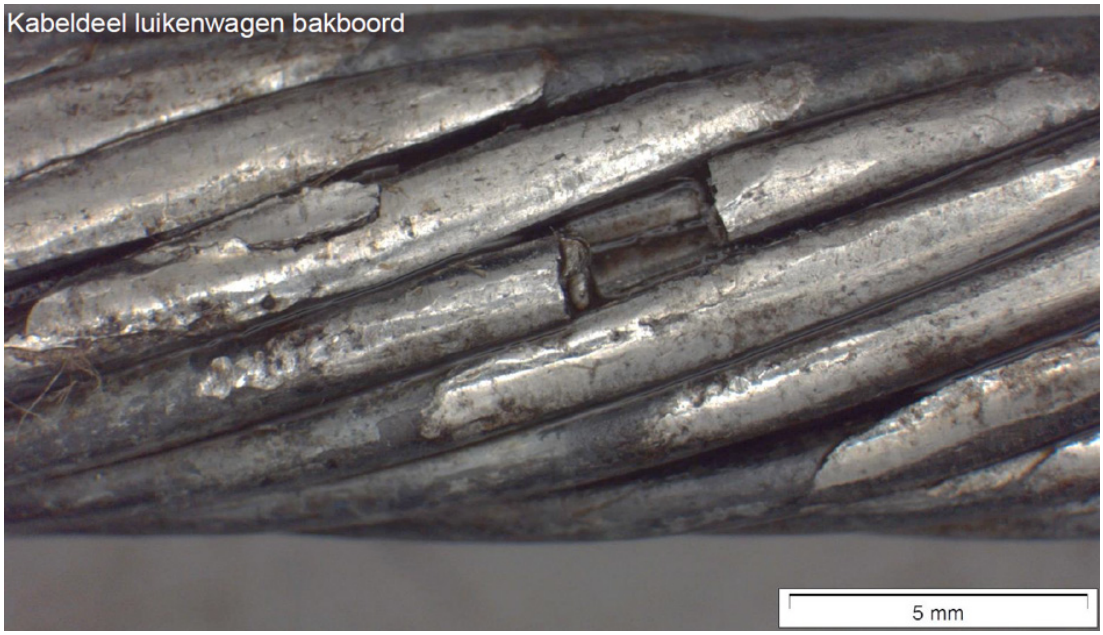


Figure 9: A photograph from the EMT report The widespread damage on the strands of the port cable, on the hatch crane side of the fracture, appears besmeared at the point where some of the wires are broken. (Source: Elements Materials Technology)

Sub conclusions for the course of events

The tweendeck fell into the hold after the port hoisting cable on the hatchcover crane broke. The portside of the tweendeck fell first causing the tweendeck to be suspended at an angle. The starboard hoisting cable then also broke.

At the moment of breakage, two crew members were stood on the tweendeck. They were busy sealing the gaps between the removable bulkhead and the hold walls. They fell to port, whereby one of them trapped his arm between the tweendeck and the hold wall. He died at the scene.

The second mate operating the hatchcover crane had no view of the two crew members on the tweendeck. There were no other crew members involved in the task. At the moment of the accident, neither of the crew members were wearing fall protection.

Before the accident, both broken hoisting cables were in poor condition. Of the individual steel wires that made up the port cable, 86% were already broken before the entire hoisting cable broke in the occurrence. 81% of the wires in the starboard cable were already broken. The primary cause for the poor condition of the cables was insufficient protection against the corrosive maritime environment.

The poor lubrication of the cables was most obviously visible in that section of the cables that constantly ran over the guidewheels, thereby being subjected alternately to bending and tensile load.

2.4 Suitability of the hoisting cables for their original purpose

Working load limit

The suitability of an item of equipment is among others determined by the Working Load Limit (WLL). For steel cables and other items of equipment, this WLL is calculated by applying a safety coefficient to the Minimum Breaking Load (MBL). The safety coefficient applied to the broken cables was 1:5. In other words, the WLL is not more than 1/5th of the minimum breaking load. This WLL complied with the requirements imposed in EU Directive 2006/42/EC[2], although this EU Directive does not apply to seagoing vessels. The Directive also indicates that this coefficient is insufficient for components of machines used for hoisting persons and as a rule, the coefficient must be doubled in those cases.[3]

According to the accompanying certificates, the hoisting cables were not suitable for the purpose for which they were used, namely the hoisting of hatchcovers and tweendecks. The WLL of both the starboard and port hoisting cable was 10.04 tonnes, amounting to a total WLL of 20.08 tonnes. This is lower than the weight of a standard tweendeck of 21 tonnes, and also lower than the weight of the smaller tweendeck used here, even without the addition of two persons and the tools and equipment required for the work carried out during the occurrence.

Both hoisting cables were fitted with a hoisting eye. The type of fitting used for the hoisting eye meant that the WLL of the hoisting cables had to be reduced overall, by 10%. This information is contained in the specifications for the broken hoisting cables. This means that without the hoisting eyes, the hoisting cables each had a WLL of 11.16 tonnes (10.04 = 90% of 11.16). This would have been sufficient to allow the hoisting of the tweendecks.

In this occurrence, it was not the hoisting eye but the port cable itself that failed. That is the section of the hoisting cable with an original WLL of 11.16 tonnes. Based on this finding, it can be concluded that the fact that the WLL of the hoisting cable with the hoisting eye was too low did not play a role in this occurrence, in the breaking of the port hoisting cable.

The broken hoisting cables were reeved onto the hatchcover crane on 16 August 2014. At the time, the vessel had a different owner, and was managed by a different ship manager. At that time, the vessel was sailed under an English flag.

2 EU Machinery Directive.
3 EU Machinery Directive, Appendix 1, Article 6.1.1.

2.5 Maintenance and inspection of the hatchcover crane

Maintenance

Regular maintenance of the hatchcover crane was carried out by the crew. The hoisting cables and guidewheels are components of the hatchcover crane, and form part of the maintenance regime for the hatchcover crane. The maintenance on the hatchcover crane was included in the so-called Planned Maintenance System (PMS) of the vessel, as part of the SMS. In the PMS, as shown in figure 10, for a number of components, the interval at which work had to be carried out was specified, together with the type of work, when the work was last carried out, and the next date by which the work had to be carried out again. Figure 10 shows the situation as it was on 2 September 2019, the day prior to the occurrence.

Work	Interval	Work type	Last time carried out	To be carried out before
Gearbox oil check	30 months	Maintenance	19-03-2018	19-09-2020
Hydraulic oil check	6 months	Maintenance	27-05-2019	27-11-2019
Alarm bell and flashing light test	1 month	Maintenance	25-08-2019	25-09-2019
Complete crane test	12 months	Maintenance	12-04-2019	12-04-2020
Replacement of hoisting cables	60 months	Maintenance	Not listed in PMS	20-07-2020

Figure 10: Table listing maintenance work on the hatch crane as contained in the PMS of the FWN Rapide. (Source: ForestWave Navigation B.V.)

Figure 11 shows the content of the original maintenance schedule. This schedule also specifies inspection intervals. This schedule was part of the manual for the hatchcover crane, together with the checklists for carrying out inspections and maintenance.

The hatchcover crane manual included no instructions on how the maintenance should be carried out. The manual also provided no information on how the various parts should be inspected.

Part/ Component	Maintenance interval (with average use: when each hetch is lifted once a day)							
	start-up	first 100 hrs	2-weekly	monthtly	annual	5-yearly	lubricate	Remarks maintenance
Oil brake wheel drive motor		R			R		B	
Oil brake winch motor*		R			R		B	
Oil gear-unit winch*		R			R		C	
Oil hydraulic circuit	V	R	V		V		A	Level check 2-weekly Oil-sample annual
Oil Filters hydro-pack		R			R			
All hydraulic components	V			V				Annual clean valves outside
Wheel/rail surface	V			V				
Wheel bearings	V			L			D	
Gear driving wheels*				L			E	
Gear stone-cranes*				L			E	
Chain driving wheels*				L			D	
Shafts gulding wheels				L			D	
Shafts pulley's, hinges				L			D	
Hydraulic Cilinders*	V			V				Check for leakage
All cables	V			L		R	D	
Rubber sealing hatches	V			L+V			F	Alignment, fitting
Coaming drain-valve				V				
Bolts flange of coupling		S		V	S			
Bolts wheelcase + winch*		S		V	S			

Part/ Component	Maintenance interval (with average use: when each hetch is lifted once a day)							
	start-up	first 100 hrs	2-weekly	monthtly	annual	5-yearly	lubricate	Remarks maintenance
Cleets and Wedges	V		V					Adjust Wedges
Landing Pads hatches					V			Annual: check wear landing pads
E-control box					V			Water tightness door rubber Check drainplug
Supply cable/ drum*	V		V		V			Annual: bolts, slipring, glands Visual: check cable torslon

* only if equiped
General remark: 5-yearly class survey SWL-test, function test.

Maintenance	
Replacement	R
Lubricating	L
Second-tighten	S
Visuals survey	V

Type of lubricate	
Oil BP Betran HV-15/Esso Univis N16 (tropical conditions: N32)	A
Brake oil CLP32 DIN 51517/3	B
Gear oil CLP150 DIN 51517/3	C
Grease Molycote BR2plus/energrease MP-M	D
Grease Kluber Grafloscon AG-1 ultra	E
Vaseline	F

Figure 11: Maintenance schedule for the hatch crane from the manufacturer's manual. (Source: ForestWave Navigation B.V.)

Inspection

Regulations

Article 7.29 of the Working Conditions Decree specifies that hoisting and lifting equipment on board seagoing vessels must undergo effective testing at least once every five years, and be inspected for sound condition by a certification body. The certification body then issues a certificate of this testing and inspection. In addition, this equipment must be regularly inspected for sound condition, at least once a year, by an expert natural person, legal entity or institution. On board each vessel, a register is kept listing all the above tests and investigations.

However, these requirements only apply to hoisting and lifting equipment on board seagoing vessels used for the loading and unloading of the vessel. In a strict formal sense, the hatchcover crane is therefore beyond the regime of Article 7.29 as referred to above. At the same time, the hoisting and lifting equipment on board seagoing vessels is beyond the regime of the Machine (Commodities Act) Decree, which requires an annual inspection for hoisting cranes with an operating load of more than two tonnes. In that light, as compared with the inspection regime that applies as a rule for hoisting and lifting equipment with an operating load of at least two tonnes, there appears to be no appropriate inspection regime for hatchcover cranes. On the other hand, this means that the hatchcover crane is subject to the inspection regime of Article 7.4a of the Working Conditions Decree. According to that article, the hatchcover crane "*must be inspected and as necessary tested as often as necessary to safeguard its sound condition, since it is subject to influences which could result in degradation, which could result in the occurrence of hazardous situations.*" The corrosive maritime environment in which seagoing vessels operate must be considered decisive in that context.

The International Safety Management Code (ISM code) requires[4] the ship manager to operate procedures that guarantee that the seagoing vessel is maintained in accordance with the statutory provisions. To satisfy this requirement, it must for example be guaranteed that inspections are carried out within the appropriate terms.

In addition, equipment and technical systems, the sudden failure of which can result in hazardous situations, must be identified. Measures must be laid down in the on-board safety management system (SMS) that as far as possible guarantee the reliability of this equipment and these technical systems. These measures also include the regular testing of equipment and technical systems not in constant use. MS.

4 Chapter 10 ISM code

Finally, all the inspections and measures listed above must be integrated in the operational Planned Maintenance System (PMS) of the vessel. On that basis, the PMS is an obligation arising from the ISM code, and an integral part of the SMS.

On 31 July 2015, one month after taking over management of the vessel, the ship manager had the hatchcover crane inspected and tested by a certification body. The cables that broke in the occurrence had been installed on the hatchcover crane on 16 August 2014. The hoisting cables broke five years and seventeen days after they had been first put into use, and 4 years and 33 days after they had been successfully tested and examined by a certification body.

Furthermore, the Register of Ship's lifting appliances kept on board states that the last time prior to the occurrence the hatchcover crane had undergone a compulsory annual examination was on 12 December 2018. This was slightly less than nine months before the occurrence.

As already shown in the table in figure 10, the PMS states that the hatchcover crane must undergo complete testing every twelve months. The last known testing date was 12 April 2019, slightly less than five months before the occurrence. Finally, the PMS specifies that the hoisting cables must be replaced after sixty months (five years). This is not a requirement based on legislation and regulations but introduced as a rule by the ship manager itself, and also contained in the original maintenance schedule for the hatchcover crane (figure 11). In the PMS, this replacement was planned for 20 July 2020.

3 ANALYSIS

3.1 Introduction

Within the shipping industry, safety management measures have been developed and implemented, which in terms of the Tripod Beta method[5] are supposed to act as barriers. The course of events in this case revealed failing or absent barriers. Figure 12 provides a simplified overview of these barriers, as they emerged from the analysis of the facts and conclusions from this occurrence.

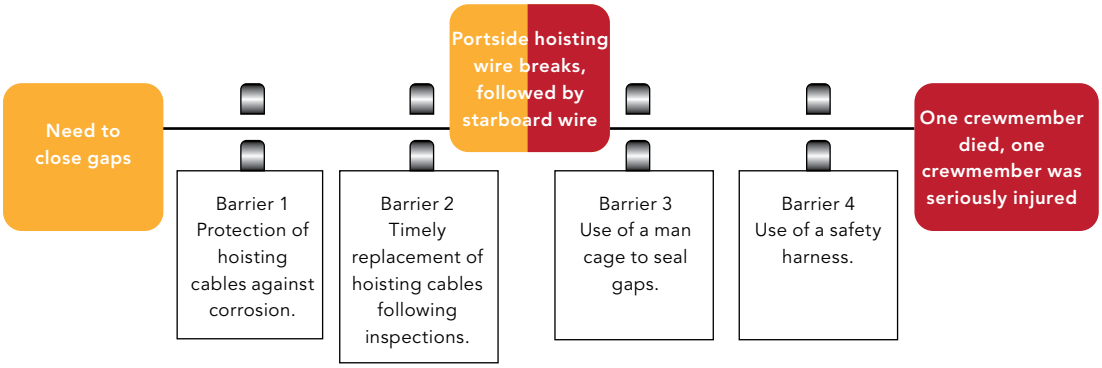


Figure 12: Barriers identified in the Tripod Beta Analysis. (Source: Dutch Safety Board)

Incidents in which heavy equipment fails occur regularly. It is not unusual for lifting and hoisting equipment to be involved. Another commonly occurring element in occurrences is unsafe working at height. For that reason, barriers 1, 2 and 4 are not unique to the occurrence on board the FWN Rapide. Although these barriers played an important role in this occurrence, they are not linked specifically to the use of the tweendeck as a work platform, as opposed to using man cages. After all, given the condition of the hoisting cables, they could have broken at any moment and led to (very) serious occurrences. In addition, the incorrect use or non-use of safety harnesses can also have fatal consequences in other working circumstances at height.

This chapter discusses in more detail each of the four identified barriers.

5 Tripod Beta is a linear-causal analysis method. More information about analysis methods can be found in Appendix A.3.

3.2 Barrier 1 - Protection of hoisting cables against corrosion

The course of events revealed that the hoisting cables broke after they had become seriously weakened by corrosion, over the course of time. This corrosion was caused by insufficient protection with lubricating grease, and the highly corrosive maritime environment.

The application of lubricating grease to hoisting cables serves multiple purposes. Firstly it ensures that the steel of the cables is protected against corrosion. In addition, inside the cable itself, it ensures that the wires and strands are able to move relative to one another without leading to steel-on-steel contact (lubrication).

The report by EMT revealed that the lubricating grease found on the hoisting cable had not penetrated into the core of the broken hoisting cables. As a result, in these hoisting cables, this grease was unable to contribute to adequate protection against corrosion and provided insufficient lubrication. This led to damage between the various strands in the cables and the cable core.

The investigation was unable to specify which type of lubricating grease was used. In the original maintenance schedule (see figure 11), a record is kept of which lubricants were to be used. However, the ship manager was unable to indicate with certainty which lubricating grease or lubricant had actually been used. As a result, it was impossible to determine the original properties of the lubricating grease. It is therefore not possible to conclude that the lubricating grease used had insufficient penetrating capacity to reach the core of the cable.

The EMT report does state that the lubricating grease was difficult to remove from the hoisting cables. This indicates that the lubricating grease adhered well to the hoisting cables, and as such was suitable for protecting the hoisting cables against the corrosive maritime environment. This would have required that the lubricating grease be correctly applied to the cables.

However, the corrosion damage on and in the cable revealed that the lubricating grease had not been correctly applied to the hoisting cable. This may be the consequence of:

- Applying too little lubricating grease when lubricating the hoisting cables.
- Not lubricating the hoisting cables often enough.
- Use of a lubricating grease with insufficient penetrating capacity.
- A combination of the above factors.

The investigation certainly revealed that the maintenance activities laid down in the operational maintenance routine (PMS) (figure 10) had indeed been carried out. However, there was no link and no tie-in with the PMS and the original maintenance schedule from the manual. It was therefore not possible to determine from the PMS which maintenance work needed to be carried out and at what interval.

Partial conclusion

The manual for the hatchcover crane did include checklists for maintenance and inspection. The investigation revealed that these checklists were not used and were not fully integrated in the compulsory operational maintenance routine (PMS) on the vessel. There was also no other link between the PMS and the original manual for the hatchcover crane, for example in the form of a reference.
The Safety Management System (SMS) on board the FWN Rapide therefore failed to guarantee that maintenance would be carried out adequately and according to the manufacturer's instructions.

3.3 Barrier 2 - Timely replacement of the hoisting cables following inspections.

The report from EMT concluded that the 'deplorable state' of both the guidewheels and the hoisting cables could have been noticed at least during the last annual inspection. The investigation therefore considered whether this compulsory annual inspection had been carried out on time, which instructions were issued for this inspection, and who carried out this inspection.

3.3.1 Timeliness of examinations of the good condition of guidewheels and hoisting cables

On 12 December 2018, within one year prior to the occurrence, the hatchcover crane underwent its compulsory examination. This emerged during the investigation from the Register of Ship's lifting appliances kept on board.

In the PMS, as previously demonstrated in figure 10, it is specified that the hatchcover crane must be fully tested every 12 months. The ship manager declared that this full testing is the same as the legally required examination of the good condition of the crane, by an expert natural person, legal entity or body. The ship manager also declared that the annual examination recorded in the Register of Ship's lifting appliances and the full test of the hatchcover crane recorded in the PMS referred to the same activity.

The ship manager was however unable to explain why, in the year prior to the occurrence, the annual full test in the PMS was dated 12 April 2019, while this activity was recorded in the Register of Ship's lifting appliances as having taken place on 12 December 2018.

Despite the fact that the correct date could not be confirmed in the documents on board, it can be concluded that the condition of the hoisting cables and guidewheels was examined on board, in the year prior to the occurrence. Given the conclusions from the report by EMT, this means that this examination was carried out in time to be able to identify the poor condition of the hoisting cables and guidewheels.

3.3.2 Expert investigation into the good condition of the hatchcover crane

To carry out a sound examination of the condition of the hatchcover crane and hoisting cables, a degree of expertise is required as also specified in the Working Conditions Decree. The ship manager considered the ship's officers expert because in general terms, the maintenance and inspection of machines is part of their professional tasks and of their training.

However, this occurrence reveals that the final examination of the good condition of the guidewheels and hoisting cables, as components of the hatchcover crane, was not carried out adequately.

Training requirements

The minimum training requirements for obtaining an internationally approved certificate of competence are laid down in what is known as the Seafarer's Training, Certification and Watchkeeping Code (STCW Code).[6] Once in possession of such an internationally approved certificate of competence, foreign officers can apply for a Dutch certificate of competence, and subsequently enter service as ship's officer, on Dutch seagoing vessels.

With regard to the inspection and maintenance of for example machines, both for deck officers and for engineers, the STCW Code only imposes broad general requirements.

The investigation demonstrated that in the year prior to the occurrence, the compulsory annual inspection of the hatchcover crane was carried out. It also confirmed that the ship manager received no notice from the vessel about the poor condition of the hoisting cables and guidewheels. It was not until after the occurrence that it was concluded that the final inspection of hoisting cables and guidewheels prior to the occurrence had not been adequate. This observation is based on the fact that the occurrence took place, and that the poor condition of the guidewheels and hoisting cables could have been observed by the crew during the last inspection.

The inspection of the hatchcover crane conducted by the crew was not described in the work instructions, guidelines, inspection schedules[7] and rejection criteria available on board. No equipment of this kind is included for example in the SMS, in documentation from the supplier of the hatchcover crane, as part of the working conditions catalogue or in documents developed by sector organizations.

6 The STCW Code is part of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978.

7 *schedule: the system of rules, procedures and management aspects for conducting (parts of) the conformity assessment for specific objects to which these specific requirements apply.* This definition has been taken from Article 1 of the Machine (Commodities Act) Decree and relates to the inspection of certain types of mobile cranes and tower cranes (not on board seagoing vessels) by designated bodies.

The manual from the supplier of the hatchcover crane did include checklists for inspection but not a description of *how* the inspection should be conducted. This meant that the inspection of the hatchcover crane was entirely dependent on the level of expertise of the crew members responsible for conducting these inspections. It can therefore be concluded that a lack of expertise played a role in this occurrence.

With just a few exceptions, working conditions regulations contain no formal guidelines according to which 'expertise' for the inspection of cranes can be measured. There is also, for example, no obligation to draw up rejection criteria and inspection schedules that can assist the expert in performing his or her inspection task.

Exception

One prominent exception to the absence of regulations regarding inspection schedules, rejection criteria and profiles of expertise in working conditions regulations is the system that applies to *designated bodies* authorized to perform the compulsory biannual inspection of certain types of mobile cranes and tower cranes. In brief, within that system, schedules, rejection criteria and profiles of expertise, among others, must be developed, approved within the sector, and submitted to the Minister of Social Affairs and Employment. Based on a dynamic reference from these regulations, those elements are made binding and as such are eligible for supervision and enforcement. This system is laid down formally in the Working Conditions Decree, the Commodities Act Decree and the Commodities Act regulation.

Responsibility lies with the employer and, except *following* an occurrence, there is no possibility for monitoring how the employer lives up to that responsibility. The employees, in this case the crew members, are therefore dependent for their own safety on their employer. For his part, *without any* formal foundation, the employer is required to estimate whether his employees have sufficient knowledge and experience to be able to be referred to as sufficiently expert.

On that basis, it may be concluded that the system of obligations and responsibilities with regard to the inspection of hoisting and lifting equipment on seagoing vessels is not sufficiently robust to ensure that those inspections are conducted adequately, thereby guaranteeing the safe use of the lifting and hoisting equipment.

Partial conclusion

In the year prior to the occurrence, the obligation to conduct an annual inspection of the condition of the guidewheels and hoisting cables, as part of the hatchcover crane, was met. This inspection was carried out by the crew.

There were no regulations or protocols (inspection schedules), rejection criteria or other aids available to assist the crew in adequately conducting the inspection. As a consequence, the inspection of the hatchcover crane was entirely dependent on the expertise of the crew. The fact that during the final inspection the poor condition of the hoisting cables and guidewheels was not observed provides grounds for the conclusion that a lack of expertise played a role.

This expertise is required by law, but not further defined. As a result, there is no yardstick for measuring expertise. There is also no obligation to develop or implement instruments such as inspection schedules and rejection criteria. The system of obligations and responsibilities regarding the inspection of hoisting and lifting equipment on seagoing vessels is therefore not sufficiently robust to ensure that those inspections are conducted adequately, thereby guaranteeing the safe use of the hoisting and lifting equipment. The occurrence on the FWN Rapide shows that this can lead to very serious and possibly fatal consequences.

3.4 Barrier 3 - Use of a man cage to seal gaps

For sealing the gaps between the transverse bulkhead and the hold walls, two man cages were available, on board. They had in fact been provided by the supplier, together with the hatchcover crane, specifically for that purpose. Instead of these man cages, however, a tweendeck was used as a work platform, on board. This working method was included in the SMS on board, in the procedure for sealing the gaps. Throughout this procedure, the tweendeck was suspended from the hoisting cables of the hatchcover crane. Interviews with the persons involved revealed that this method was also employed on the shipping company's other vessels.

Safety of lifting and hoisting equipment

Lifting and hoisting occupies a prominent position in legislation and regulations relating to industrial safety. The basis for legislation and regulations on industrial safety and lifting/hoisting on Dutch seagoing vessels is laid down in the Working Conditions Decree. As a rule, Dutch working conditions regulations are laid down as target regulations. In other words, the regulations specify which (safety) targets must be met. The regulations then require that appropriate and effective measures be taken to reach those targets. It is notable that in many areas, the regulations do not specify precisely which measures should be taken.

For example, hoisting equipment intended and equipped for hoisting persons must be equipped with provisions that as far as possible prevent the lifting platform falling, and that prevent persons falling from the platform or being crushed, trapped or bumped into by the platform. If these risks cannot be avoided by introducing safety provisions, a suitable cable must be used for suspending the platform, that offers a raised safety coefficient.

The following facts have been demonstrated:

- The lifting device and the tweendeck as a lifting platform were not equipped with provisions that could prevent the tweendeck falling following the breaking of one or more hoisting cables.
- The tweendeck was not equipped with provisions to prevent persons falling from the tweendeck or becoming trapped. Instead, personal protective equipment in the form of safety harnesses was provided on board, and required according to the SMS.
- There were no specific instructions for working with the tweendeck as a lifting platform.

The above description of facts shows that the lifting equipment on the hatchcover crane, the tweendeck and the combination of the two elements were neither intended nor equipped for the transport of persons, and were not suitable for that purpose.
It is only to be expected that work processes change, over the course of time. There can be many reasons for such changes, for example amendments to legislation and regulations, the introduction of new equipment on board or different cargo types. In this specific case, the change was the result of practical considerations proposed by the ship manager's fleet. It is entirely logical that a ship manager takes signals of this kind seriously, and as a consequence they can result in changes to work processes.

This investigation did not focus on the value or necessity of no longer using the man cages for the sealing of the gaps between the transverse bulkheads and the hold walls. This is because since July 2020, working with man cages has been further restricted by the legislators. It is therefore likely that work processes that make or in the past made use of man cages will have to be amended.

Amended regulations[8] for the use of man cages and work platforms

Since 1 July 2020, the use of man cages and work platforms, linked to lifting gear, is only permitted if work will be carried out from the man cage or work platform at locations that are difficult to access and for which no other suitable equipment or working methods are available in order to reach those locations safely. In addition, a written work plan must be drawn up by the employer, and assessed by a safety expert. This assessment must also consider whether, taking into account the given environmental factors, no other safe working method is possible. The safety expert must also assess whether at the location where work is to be undertaken with man cages or work platforms, the work can be performed safely, in accordance with the work plan.

Tasks that involve the use of man cages or work platforms must be reported to the supervisor, by the employer, at least two days before the start of the work. The notification must at least include a brief description of the location, the number of persons involved, the date and time of the work, and the duration of the work.

When changing work processes, it is essential that safety be carefully considered before an amended work process is implemented. This can be achieved by actively involving the crew on board and external experts in the amendment process. The result is a thorough risk inventory and evaluation, a clear picture of the mitigating measures necessary, and eventually a revised work process that can be carried out safely and included in the safety management system (SMS) on board.

Failure to perform a risk inventory and evaluation led to the use of the tweendeck as an item of working equipment, without previously identifying effective mitigating measures. Due to the absence of these mitigating measures, the tweendeck was unsuitable and unsafe as a work platform.

8 Article 7.23d. Working Conditions Decree.

Partial conclusion

To improve the sealing of the gaps between the transverse bulkheads and the hold walls in practice, a new procedure was implemented in the SMS on the vessel. The work was carried out according to that procedure, from a mobile tweendeck, suspended from the hoisting cables on the hatchcover crane. In the original procedure, this work was carried out using man cages. According to that procedure, the man cages were suspended from the frame of the hatchcover crane. The hoisting gear on the hatchcover crane, the tweendeck and the combination of the two were not intended or equipped for the transport of persons, on the basis of legislation and regulations, and were therefore not suitable for that purpose.

Despite the fact that tweendecks were regularly used to carry out work and thereby involved safety risks, no specific instructions were drawn up for working with tweendecks as work platforms. In addition, no risk inventory and evaluation were carried out. In effect, a working method developed on board for practical reasons was described and included in the SMS. As a result, there were no effective mitigating measures available to allow safe working with the tweendeck as a work platform.

3.5 Barrier 4 - Use of a safety harness

Working at height

The investigation considered the measures that were taken to allow crew members who were required to work on the tweendeck to carry out their work as safely as possible. The parties involved referred to the procedure 'Working at height' as contained in the vessel's SMS.

13.4.3- Working at heights and overboard.

To avoid serious and possible lethal accidents:

- Arrange continual supervision by a skilled person stationed in a safe place near the working area, ready to step in immediately.
- Make the men wear safety a harness when working at heights.
- Lifejackets and/or safety harness are to be worn when working overboard and a Lifebuoy with a line is to be kept ready nearby.
- Make sure that the line of the safety harness is secured to a fixed point on the ship at all times and does not have too much slack.
- Make sure that the ropes used to rig the staging are in perfect condition.
- Only approved safety harnesses may be used. Never use the safety belt from the Fire Mans outfit as safety belt for working at heights.

Figure 13: Instructions for 'Working at height' from the SMS of the FWN Rapide. (Source: ForestWave Navigation B.V.)

One of the measures for working at height is the compulsory wearing of a safety harness, the safety line of which must always be attached to a fixed point on the vessel.

It was determined that at the moment of the occurrence, neither of the victims was wearing a safety harness. Following the occurrence, three safety harnesses were found piled together on the tweendeck. All three were equipped with a single permanent safety line with a single hook. One safety line, including hook, was 140 centimetres long. The other two safety lines were 180 centimetres long. These items of equipment were therefore available on board.

However, it would not have been possible during this specific job to meet the requirement of remaining attached to a fixed point on the vessel at all times, using these items of safety equipment. On a work platform, moving up and down over a height difference of eleven metres, the hook of the safety line would have to be regularly moved to a higher or lower attachment point. If only a single safety line is available with only a single hook, during the process of switching from one fixed point to another, the wearer is not protected against falling, because during the switchover procedure, the hook is not attached to anything.

Another aspect is the availability of fixed points on the vessel for attaching the hook. In the bottom of the hold, it is possible to transfer the hook from one fixed point to another fixed point. However, when working in the upper section of the hold, this was not the case. As a result, the safety harnesses were not suitable for the work.

It was not determined during the investigation why the safety harnesses were not worn. However, there is a realistic likelihood that the unsuitability of the safety harnesses contributed to the fact that they were not worn.

It is commonly recognized that not every type of safety harness is automatically suitable for preventing all forms of fall hazard. The circumstances and the fall height determine which types of harness are or are not suitable. A risk inventory and evaluation carried out correctly, as referred to in section 2.4, would have also contributed to this aspect of safety while sealing the gaps.

A great deal of information about safety harnesses as fall protection equipment is available in health and safety catalogues, for example for the Maritime Engineering and Construction & Infrastructure sectors, but also in the manual *Dat is Juist! (Safety First)* for safe working on board ships (see the box below).

Dat is Juist! (Safety First)

Dat is Juist! is a publication from the Stichting Scheepvaart shipping foundation, with contributions from a committee (the Working Conditions & Safety Committee (CAV)) of representatives of employers' and employees' organizations from merchant shipping, wet maritime engineering and sea fishing, maritime education and the Netherlands Shipmasters Association *(Nederlandse Vereniging van Kapiteins ter Koopvaardij)* and is part of the Maritime Platform Association for Employment, Income and Health *(Vereniging Platform Maritiem voor Werk, Inkomen en Zorg)*.

The purpose of the book is to describe what is generally accepted as normal, safe or healthy professional practice. First and foremost, the book is intended for anyone on board a ship and can be used as study material for maritime training or for updating an ISM system. The book also contains all existing Health and Safety Catalogue pages, in their entirety.

The updated and entirely revised edition from 2016 is a follow-up to the fully revised second impression from 2006 and the first impression from 1986. In producing the updates, as far as possible, results of investigations by the Dutch Safety Board have been included. *Dat is Juist!* can be ordered free of charge or downloaded via the CAV page on the website of the Stichting Scheepvaart foundation.[9]

Section 7.10.2 of *Dat is Juist!* says of fall protection equipment:

- horizontal fall protection equipment, fall prevention: equipment that limits freedom of horizontal movement and that prevents a fall to be made. Lines should be of such a length that the user cannot make a fall;
- fall protection; harnesses with accessories for stopping a fall. These consist of a harness provided with shoulder and arm straps, a safety line and a shock absorber (maximum falling distance 200 cm);
- fall arrester: if making a fall, the fall arrester will stop a fall after a short braking distance and prevent further falling;
- shock absorbers absorbing the forces on a falling person. Shock absorbers are fitted to safety lines of a length of maximum 1.75 metres;
- rescue and descending equipment for use in emergencies in which the descending does not pose any further risks.

The Safety Board suggests that the presence of suitable protective equipment helps determine whether or not the equipment will actually be used. It is more likely *not* to be worn if an unsuitable item of equipment increases rather than reduces the risk of injury or if the equipment cannot be used at all in practice. To encourage the use or wearing of safety equipment, it is useful both for the developer and user of safety procedures to have simple and unrestricted access to relevant information about the suitability of the

9 https://www.scheepvaartnet.nl/?pagina=458&menu=269

equipment. Suitability is improved if the information can be found where it is most needed.

In a general chapter on safety the SMS on the FWN Rapide refers to *Dat is Juist!* The procedure 'Working at height' in the SMS of the FWN Rapide contained no information or instructions about determining the correct type of fall protection equipment for the different types of work on board.

Supervision

To safeguard safe working at height, the procedure 'Working at height' specifies that permanent supervision at the workplace must be organized, in the form of a trained person who is positioned in a safe location in the immediate vicinity of the workplace and able to intervene immediately. Supervision of this kind could have contributed to a work environment in which the wearing of safety harnesses was standard practice.

The second mate operating the hatchcover crane was unable to see the crew members from his position. No other member of the crew was appointed to carry out this physical supervision.

The investigation was unable to clarify why there was no supervision at the workplace. Supervision was part of the procedure, and there was sufficient crew capacity on board. Supervision could have been organized for example by having one of the two victims carry out the task.

After the occurrence on the FWN Rapide, the Safety Board had pointed out on numerous occasions – in other publications – the importance of physical supervision during high-risk activities on board. For example in investigation reports following the occurrences on board the RN Privodino[10] and Damsterdijk[11] and in the Shipping Occurrences Report November 2018 – May 2019.[12]

10 https://www.onderzoeksraad.nl/en/page/17800/brekende-tros-met-fatale-afloop---lessen-uit-het-ongeval-aan-boord
11 https://www.onderzoeksraad.nl/en/page/15477/dodelijk-ongeval-door-breuk-achtertros---lessen-te-leren-over-veilig
12 https://www.onderzoeksraad.nl/en/page/15501/rapportage-ongevallen-scheepvaart-november-2018---mei-2019

Partial conclusion

At the moment of the occurrence, the two crew members on the tweendeck were not wearing safety harnesses as fall protection.

The safety harness that had to be worn on board when working at height was unsuitable for use as fall protection when working on the tweendeck as a work platform, suspended from the hoisting cables of the hatchcover crane.

There are different types of fall protection equipment. The circumstances and the fall height determine which type of fall protection equipment is most suitable. The presence of suitable safety equipment contributes to that equipment actually being used. To reach that situation, it helps to have simple and unrestricted access to relevant information about suitability.

In the procedure 'Working at height' in the SMS of the FWN Rapide, however, no information or instructions are available on determining the appropriate type of fall protection equipment for the different types of work on board.

At the time of the occurrence, work was being carried out at height. According to the vessel's SMS, safe working at height on board the FWN Rapide should have been safeguarded by organizing permanent physical supervision of the workplace. That physical supervision was not present and not organized during this occurrence. As a result, the wearing of fall protection failed as a safety barrier.

3.6 Actions taken by the ship manager

The ship manager, following the occurrence on board FWN Rapide, has reported taking measures in order to prevent similar occurrences from happening again. The most relevant measures taken on vessels of the ship manager's fleet are the following:

- Improved record keeping of certificates of hoisting gear and steel wires, together with an increased supervision on the 5 yearly replacement of steel wires, especially on second hand purchased ships.
- Newly purchased hoisting wires having a higher Working Load Limit (WLL)(considering the same diameter of the wire). Previously used wires had a sufficient WWL, but were regularly loaded almost up to the maximum WLL. The new cables will have more margin between WLL and actual load.

4 CONCLUSIONS

The direct cause of the death of one deckhand and the serious injury to another was the breaking of the port hoisting cable on the hatchcover crane. As a result, the tweendeck, that was suspended from the hatchcover crane as a work platform, fell into the hold. The portside of the tweendeck fell first causing the tweendeck to be suspended at an angle. The starboard hoisting cable then also broke.

During the investigation, it was noted that hatchcover cranes on board ships are subject to a non-standard and less strict inspection, examination and testing regime[13]. Because the hatchcover crane on board the FWN Rapide was subject to a strict inspection regime in practice, there is no relationship with the occurrence described in this report. Nonetheless, the Dutch Safety Board considers this observation crucial in relation to reducing the risk of occurrences in the shipping sector as a whole.

The analysis of the accident identified and described four missing or failing barriers. On that basis, the following conclusions can be drawn:

Maintenance must be performed in accordance with the instructions from the manufacturer or supplier (barrier 1)
It can be concluded from this occurrence that the maintenance work on equipment and installations on board must be performed in accordance with the instructions from the manufacturer or supplier. If an operational maintenance routine is implemented on board, these instructions must be fully and correctly integrated in the routine, or a clear link must be established with those instructions.

The manual for the hatchcover crane did include checklists for maintenance and inspection. The investigation revealed that these checklists were not used and were not fully integrated in the compulsory operational maintenance routine (PMS) on the vessel. There was also no other link between the PMS and the original manual for the hatchcover crane, for example in the form of a reference.

The Safety Management System (SMS) on board the FWN Rapide therefore failed to guarantee that maintenance work would be carried out adequately and according to the manufacturer's instructions.

13 Cranes used on board for loading and unloading are subject to a strict inspection regime. The same applies to cranes on shore with a working load of two tonnes or more, just like the hatchcover crane on board. See the block containing explanatory notes in section 2.5.

Expertise essential for the inspection of hoisting cables (barrier 2)
The inspection of hoisting and lifting equipment must be performed adequately. This is essential because the failure of hoisting equipment or its components can lead to (very serious) occurrences. The Safety Board therefore draws the vital conclusion that the system of obligations and responsibilities with regard to the inspection of hoisting and lifting equipment on seagoing vessels is not sufficiently robust to ensure that those inspections are conducted adequately, thereby guaranteeing the safe use of the lifting and hoisting equipment. The development of a system of instructions, protocols and rejection criteria is not guaranteed, in the same way that there is no guaranteed development or application of profiles according to which the necessary expertise can be measured and reinforced.

The occurrence on board the FWN Rapide was able to take place because during the compulsory annual inspection of the hatchcover crane, the fact that the guidewheels and hoisting cables had been so degraded by corrosion that they needed replacing went unobserved. The inspections were carried out by crew members. It has been shown that they had no access to regulations and protocols (inspection schedules), rejection criteria and other aids which could have helped the crew to adequately perform the inspection. They were also insufficiently expert to adequately perform the inspection of the hatchcover crane without these aids.

Perform a thorough inventory and evaluation of risks when altering existing work processes (barrier 3)
The Safety Board attaches great importance to the conclusion that if existing work processes are altered, it is essential that they be assessed for safety by performing a risk inventory and evaluation, followed up by adequate measures to remove the risks that emerge from the inventory. At least an expert in the field of occupational safety must be involved in this evaluation process. Including practical experience and expertise for example by actively questioning ship crews, could also contribute to ensuring that an altered work process can be carried out safely.

To improve the sealing of the gaps between the transverse bulkheads and the hold walls in practice, a new procedure was implemented and included in the vessel's SMS. According to this new procedure, the use of man cages was replaced by the use of a tweendeck as a work platform. The hoisting gear on the hatchcover crane, the tweendeck and the combination of the two were not intended or equipped for the transport of persons and were therefore not suitable for that purpose.

No risk inventory and evaluation was carried out before the procedure was altered. As a result, there were no effective mitigating measures available to allow safe working with the tweendeck as a work platform.[14]

14 In the past, the Dutch Safety Board carried out an investigation into an occurrence involving a tweendeck as a work platform, and arrived at a similar conclusion: https://www.onderzoeksraad.nl/en/page/2108/dodelijke-val-overboord-tijdens-ladingswerkzaamheden-27-februari-2013

Availability of suitable fall protection equipment and the implementation and organization of safety tasks on board (barrier 4)

If personal protective equipment (PPE) is required to prevent a fall hazard while working at height, it is essential that suitable PPE be made available. There are different types of fall protection equipment. The circumstances and the fall height determine which type of fall protection equipment is most suitable.

The presence of suitable safety equipment contributes to that equipment actually being used. To reach that situation, it helps to have simple and unrestricted access to relevant information about suitability.

At the moment of the occurrence, the two crew members on the tweendeck were not wearing fall protection equipment. The type of fall protection that had to be used on board when working at height was unsuitable for use as fall protection for sealing the gaps between the transverse bulkhead and the hold walls when working on a tweendeck as a work platform, suspended from the hoisting cables of the hatchcover crane. The procedure 'Working at height' in the SMS of the FWN Rapide contained no information or instructions about determining the correct type of fall protection equipment for the different types of work on board.

The Dutch Safety Board also concludes that safety tasks that form part of work procedures must be carried out in order to prevent occurrences taking place. The work on board must be organized in such a way that the safety tasks can always be implemented, unconditionally.

According to the safety management system on board, safe working at height should have been safeguarded by organizing constant physical supervision of the workplace. That physical supervision was not present and not organized during this occurrence. As a result, the wearing of fall protection failed as a safety barrier.

5 RECOMMENDATIONS

The Dutch Safety Board issues the following recommendations:

With regard to maintenance of hoisting and lifting equipment on board ships, the alteration of work procedures, safe working at height and the provision of physical supervision during high-risk activities on board:

To ForestWave Navigation B.V. (Ship Manager):

1. Before implementing altered work procedures, ensure that a risk inventory and evaluation for the altered process is carried out by duly qualified experts. Also involve these experts in preparing safety management measures necessary for mitigating the risks that emerge from the inventory.
2. On board vessels managed by ForestWave Navigation B.V, ensure that maintenance on hoisting and lifting equipment is performed according to the manufacturer's instructions. Ensure that maintenance schedules and instructions from the manufacturer or supplier are fully integrated in the operational maintenance routines on the vessels.
3. On each vessel managed by ForestWave Navigation B.V, identify which types of fall protection equipment are necessary. Ensure that this equipment is available on board and issue the crew with information about how and when which type of fall protection equipment should be used. In addition, organize work on board in such a way that the work can only be started once all risk management measures have been taken.

With regard to the necessary expertise during annual inspections of hoisting and lifting equipment on board ships:

To the Royal Association of Netherlands Shipowners (KVNR):

4. Together with the sea shipping sector, develop a set of regulations, protocols and rejection criteria relating to the inspection of hoisting and lifting equipment on seagoing vessels. Also develop profiles according to which the expertise of the persons tasked with performing inspections can be assessed, measured and reinforced.

To the Dutch Minister of Social Affairs and Employment:

5. Ensure the development by the sea shipping sector of the system of expertise profiles as intended in recommendation 4.

Noting that a less strict regime of examination, inspection and testing is embedded in legislation and regulations for specific types of hoisting and lifting equipment on board ships:

To the Dutch Minister of Social Affairs and Employment:

6. Amend legislation and regulations regarding the examination, inspection and testing of hoisting and lifting equipment on board ships in such a way that equipment of this kind is subject to the regime of examination, inspection and testing that currently applies exclusively to hoisting and lifting equipment used for loading and unloading.

APPENDIX A

JUSTIFICATION FOR THE INVESTIGATION

A.1 Background to the investigation

In accordance with EU Directive 2009/18/EC and the Dutch Safety Board Act, the Dutch Safety Board has a legal obligation to investigate certain types of shipping accidents. On 2 September 2019, pursuant to this obligation, the Dutch Safety Board launched an investigation into the falling of a tweendeck into the hold, on board the FWN Rapide. During this occurrence, one crew member lost his life and another suffered serious injuries.

A.2 Investigation approach

During the course of the investigation, the Dutch Safety Board gathered information.

Investigation on board

The investigation on board could not be performed in Guyana because it was not possible for investigators to travel to the accident location before the vessel set sail. The Dutch Safety Board did however receive photographs of the accident location from the ship manager, immediately following the occurrence. The next port visited after Georgetown was Liverpool, United Kingdom (UK). Immediately following the arrival of the vessel in Liverpool, an investigation was carried out on board, which included the holding of interviews. A request for documents was also submitted. Finally, the Dutch police seized parts of both broken hoisting cables and two guidewheels for those cables. The District Court of Amsterdam commissioned the company Elements Materials Technology to investigate the cause of the breaking of the two hoisting cables. They shared the outcomes of their investigation with the Dutch Safety Board.

Requested information

The Dutch Safety Board requested information from various parties:

- ForestWave Navigation B.V.
- Ministry of Social Affairs and Employment
- Inspectorate SZW of the Ministry of Social Affairs and Employment

In a number of cases, interviews were held or telephone conversations made to representatives of these organizations.

Legislation and regulations
In addition to the document study, interviews and conversations, the Safety Board mapped out and analysed the relevant legislation and regulations.

A.3 Analysis
The information available was analysed according to a linear-causal analysis method.

Method
A large number of different methods have been developed for analysing accidents and safety risks. The large number of methods available means that accidents can be analysed in many different ways. The majority of methods are similar, but use different jargon or are adapted to a specific sector, for example. Methods for analysing accidents can broadly be divided into two categories.

1. Linear-causal methods
2. Systemic methods

The majority of the analysis methods available are linear-causal methods. These methods start with the direct causes of the accident and work back to identify underlying causes. They do this for example by chronologically examining which causal events and/or circumstances preceded the accident, by considering barriers that failed and then studying the causal path to the underlying causes. Another technique examines human errors, classifies these errors and causal errors at a higher level, or applies a flowchart/ decision-tree-based system.

The systemic methods view accidents as a symptom of an unsafe system. The aim of these techniques is to examine the interactions and feedback loops within and between the components that make up the system. The assumption is that by identifying and analysing shortcomings of this kind, within the system, you can help improve safety. These methods barely refer to causes of accidents or accident factors, but instead discuss mechanisms and functions of the system.

A.4 Assessment framework

A.4.1 General
The Dutch Safety Board expects businesses and organizations that undertake and/or facilitate high-risk activities to go further than merely complying with the legislation and regulations and (international) guidelines. The Safety Board primarily considers the following elements:

1. Is there a sufficient level of understanding of the risks;
2. Is there a demonstrable and realistic safety strategy, whereby an industrial hygiene strategy for safety at work is employed that in the first instance assumes an approach to tackling risks at source, followed by collective measures, then individual measures to minimize exposure, and finally that requires the use of personal protective equipment if all the above measures have resulted in an insufficient mitigation of risks;
3. Is this safety strategy adequately implemented and enforced;

4. Is there a process for learning from accidents and a system that guarantees continuous improvement of the safety strategy;
5. To what extent is management involved;
6. Is there a culture at work in which members of the workforce call each other to account for unsafe behaviour and in which accidents are reported without employees fearing punishment for any involvement in such accidents.

A.4.2. Safety management on board seagoing ships

For seagoing ships in excess of 500 GT[15] and seagoing passenger ships, the international SOLAS Convention requires that a safety management system is operated on board that satisfies the requirements laid down in the International Safety Management Code (ISM Code) developed for that purpose.

The ISM Code specifies that a 'company' must be formally designated to adopt the obligations and responsibilities laid down in the ISM Code from the owner of the vessel. In the Netherlands, instead of the word 'company', the term 'ship manager' is commonly used. The way in which work is carried out on board a ship in respect of (environmental) safety must therefore be an integral part of the safety management system (SMS) drawn up and implemented subject to the responsibility of the ship manager. This includes developing, implementing and maintaining procedures, plans and work instructions aimed at guaranteeing the safety of crews, the vessel and the environment and ensuring that tasks are allocated to qualified personnel. It should be noted that the ISM Code does not provide a precise description of the term qualified personnel. Instead this is described in the STCW Convention.[16]

A.5. Investigations by other parties

In part, this investigation ran parallel to an investigation by the Infrastructure Service of the National Police Unit, under the auspices of the Public Prosecution Service. From this police service, members of the Traffic Specialist Team from the EXO department and the Maritime Police Team were involved in the investigation. In accordance with the Public Prosecution Service - Dutch Safety Board Cooperation Protocol, the investigations were harmonized.[17]

15 GT = Gross Tonnage. GT is a compulsory standard unit used internationally to indicate the size of vessels. It comprises the volumes of all enclosed spaces on the vessel which are then converted to GT according to a mathematical formula. In international regulations the regulations to which a vessel is subject are generally determined by the vessel's gross tonnage.
16 International IMO Convention on the standards of training, certification and watch duty for seafarers.
17 https://wetten.overheid.nl/BWBR0023578/2008-03-01

A.6. Quality assurance

To guarantee the quality of the investigation, the following steps were taken:

- Assessments were carried out by colleagues from the Shipping, Research & Development, Consultancy and Communication departments. These assessments were focused on critically challenging and refuting hypotheses, assumptions and underlying theoretical frameworks, and identifying any potential blind spots.
- In accordance with the Dutch Safety Board Act, a draft version of this report was submitted to the involved organizations and persons, with the request to check the report for errors, omissions and inaccuracies and to provide comments where applicable. Appendix B lists those parties that were given access to the draft report and explains how their responses were processed.

APPENDIX B

REACTIONS TO THE DRAFT REPORT

Pursuant to the Dutch Safety Board Act, a draft version of this report was submitted to the various stakeholders. The following parties were asked to check the report for factual inaccuracies and inconsistencies:

- ForestWave Navigation B.V.
- Minister of Social Affairs and Employment
- Minister of Infrastructure and Water Management

The responses received were dealt with in the following manner:

- Rectifications to factual inaccuracies, additions at detail level and editorial comments were adopted by the Safety Board (wherever relevant). The appropriate sections of text have been adjusted in the final report.
- Wherever the Dutch Safety Board did not adopt the content of reactions, an explanation is given as to why the Board made that decision.

All reactions and the explanatory notes appear in a table that can be accessed via the website of the Dutch Safety Board (www.onderzoeksraad.nl).

APPENDIX C

BACKGROUND INFORMATION

C.1 Actors

C.1.1 Ship and crew

Ship

Vessel data FWN Rapide

Figure 14: FWN Rapide (Source: National Police)

Call letters:	PBMT
IMO number:	9320520
Flag State:	The Netherlands
Type of ship:	General Cargo/Multi-Purpose
Classification society:	Lloyd's Register
Year of construction (handover):	2005
Shipyard:	Damen Shipyards
Length overall (Loa):	145.63 m.
Length between perpendiculars (LPP):	138.82 m.
Breadth:	18.25 m.
Hold:	10.3 m.
Gross Tonnage:	7767 GT
Vessel certificates:	All valid

Crew

On board the FWN Rapide, the requirements laid down in the Minimum Safe Manning Document were satisfied. The positions and nationalities of crew members appear in figure 13.

Job	Nationality
Captain	Ukrainian
First officer	Ukrainian
Second mate	Ukrainian
Chief engineer	Ukrainian
Third engineer	Ukrainian
Electrical engineer	Russian
Deckhand (AB)	Filipino
Deckhand (AB)	Filipino
Deckhand (OS)	Filipino
Deckhand (OS)	Filipino
Fitter	Ukrainian
Cleaner	Filipino
Cook	Ukrainian
Painter	Ukrainian

Figure 15: Position and nationality of crew FWN Rapide.

C.1.2 Ship owner

Name:	FWN Rapide B.V.
Established in:	Groningen
IMO number:	5861007
Owner since:	25-06-2015

C.1.3 Ship Manager

Name:	ForestWave Navigation B.V.
Established in:	Groningen
IMO number:	5575869
Ship manager since:	25-06-2015

APPENDIX D

TECHNICAL INVESTIGATION

The full EMT report is published as a separate document on the Dutch Safety Board website.

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