DUTCH
SAFETY BOARD

Fatality during mooring operation in lock

M/V Flinter Aland, Terneuzen

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M/V Flinter Aland, Terneuzen, 9 September 2012

The Hague, November 2013

Source photo cover: Chris Platteeuw

Dutch Safety Board

The aim in the Netherlands is to limit the risk of accidents and incidents as much as possible. If accidents or near accidents nevertheless occur, a thorough investigation into the causes, irrespective of who are to blame, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Board itself selects the issues it wishes to investigate, mindful of citizens' position of independence with respect to authorities and businesses. In some cases the Dutch Safety Board is required by law to conduct an investigation.

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NB: This report is published in the Dutch and English languages. If there is a difference in interpretation between the Dutch and English versions, the Dutch text will prevail.

CONTENT

SUMMARY

On Sunday, 9 September 2012, a Filipino seaman from the Dutch motor vessel Flinter Aland got fatally injured during a mooring operation in a lock in Terneuzen. During the mooring manoeuvre, a mooring line broke and snapped back at high speed, thereby hitting the seaman. The seaman died on site as a result of his injuries.

It was an very serious casualty accident as referred to in the Casualty Investigation Code of the International Maritime Organization (IMO) and EU Directive 2009/18/EC. This means that the Netherlands, as the vessel's flag state, is obliged to ensure that a safety investigation is conducted. This requirement to ensure that an investigation is conducted is also set out in the Dutch Safety Board Decree [*Besluit Onderzoeksraad voor Veiligheid*].

Dutch Safety Board investigators visited the site immediately following the accident to commence the investigation. For the analysis of the accident, various data, including data recorded by the vessel's Voyage Data Recorder (VDR), were collected.

The Dutch Safety Board's investigation has shown that the mooring line on board the Flinter Aland broke due to overload, because the ship was still moving forward somewhat at the moment the crew tightened the strap brake of the winch. The mooring line broke suddenly without any advance indication that anything was wrong. At that time the seaman was standing in the so-called snap-back zone (danger zone) of the mooring line.

Although the crew frequently worked with mooring lines, the safety management system and the risk assessment and evaluation (RA&E) did not contain the correct procedures for working with mooring lines. Furthermore, no information was provided on the snap-back zones on board the Flinter Aland. The shipping company also had not given crews any supplementary instructions with respect to the correct use of mooring lines during mooring operations. The Dutch Safety Board has established that the shipping company failed to sufficiently acknowledge the risks inherent in working with mooring lines, and as a result effective safety measures were lacking.

Furthermore, the investigation revealed that the procedures for communicating on board were not fully complied with. As a result the crew on the forecastle tightened the strap brake of the winch too early.

The investigation also revealed that the Health and Safety Sheets [*Arbobladen*], which are published by employers and employees (i.e. the Royal Association of Netherlands Shipowners (KVNR) and the Nautilus International trade union) and provide health and safety information to the sector, have not yet been updated with latest insights.

Ship and crew

Flinter, a Dutch shipping company, carries out the International Safety Management (ISM) of the motor vessel Flinter Aland. The shipping company has more than fifty cargo vessels under its management. The vessel was built by Ferus Smit, a Dutch shipyard, in 2011 and sails under the Dutch flag. On 6 September 2012, the Flinter Aland departed from Bilbao, Spain, with a cargo of petroleum cokes bound for Ghent, Belgium.

The minimum safe manning on board the Flinter Aland is nine crew members. At the time of the accident, twelve crew members were on board: six officers having the Dutch, Russian, Ukrainian and Philippine nationalities and six crew members of Philippine nationality. The official working language on board was English. All crew members held the required certificates of competency.

Figure 1: Flinter Aland. (Source: Shipping company Flinter)

The seaman who died during the accident had a permanent employment contract with Flinter. He held an STCW II/4 unlimited navigational watch certificate of competency and had extensive experience at sea. The seaman had been on board the Flinter Aland for several months.

During the voyage from Bilbao to Ghent, the master gave the chief mate an official warning, in part because he had not properly moored and unmoored the ship in Bilbao and had failed to follow or had improperly followed the master's orders with respect to using the mooring line and instead made his own decisions on using the mooring line. Moreover, the chief mate was relieved of his duty of serving at the fore of the ship. The third mate[1] took over the chief mate's supervisory task.

Safety management

The Flinter Aland and shipping company Flinter have a safety management system (SMS) that is certified in accordance with the International Safety Management (ISM) Code. The most recent on-board audit of their SMS took place on 12 November 2011. The SMS of the shipping company was valid until 16 September 2012.

Furthermore, the Flinter Aland has a risk assessment and evaluation (RA&E) of potentially dangerous activities and procedures. The RA&E describes the risks for the ship, the crew and the environment and the necessary safety measures. Flinter conducted the RA&E under its own management in June 2010 and had it assessed by an occupational health and safety service.

Local conditions

At the time of the accident on 9 September 2012 (at around 12.34[2]), a light, southerly wind (Beaufort wind force scale 2) was blowing, visibility was 16-19 nautical miles (30-35 kilometres) and the outside temperature was 28°C. The tide was outgoing and the current in the fairway on the Western Scheldt was approximately 2 knots. Low tide was predicted at 14.29.

Narrative

On 9 September at around 08.00 the ship arrived at Wandelaar pilot station in the approach to the Western Scheldt estuary. The master himself was steering the ship in the direction of Terneuzen. The pilots changed at the Flushing roadstead at around 11.00. The river pilot arrived on board, whereupon the marine pilot disembarked the vessel. The river pilot would assist the master until Ghent, including the ship's passage through the locks.

1 A third mate is a fully licensed officer of watch, who, within the Flinter company, serves as a trainee mate to gain additional experience on board.
2 All times in this report are local times (UTC+1) unless stated otherwise. The times are shown in [hh.mm:ss].

The master agreed with the river pilot that he himself would steer the ship during the passage through the Western Scheldt and the Ghent-Terneuzen Canal. Besides the river pilot and the master, there was no one else on the bridge.

Before the Flinter Aland approached the Terneuzen Lock the master called the deck crew to join him on the bridge to discuss the mooring manoeuvre. During this briefing session he instructed the second mate and the third mate on how to set up the mooring lines. The second mate would stand on the aft deck. The third mate would take over the chief mate's position on the forecastle. After having received an official warning, the latter had in fact no longer been allocated a role in mooring the ship.

At 12.20 the lockmaster of the West Lock communicated the mooring position of the Flinter Aland by VHF. He stated that there were several inland vessels in the locks but that there would still remain 50 metres of space between the inland vessel and the Flinter Aland. The lockmaster and the master agreed that the ship would moor portside due to the propeller effect.[3]

In order to enter the lock the Flinter Aland kept portside of the fairway (see figures 2 and 3). The ship entered the lock at around 12.32 with a speed of 3-4 knots.[4] The master later stated that the ship had not been affected by the wind but that it probably had been affected by the saltwater to freshwater effect.[5] The master subsequently stated that he had reversed the propeller shortly afterwards to reduce speed. The lockmaster noticed the ship's high speed and called the ship by VHF 'You are entering the lock at quite a high speed. Will you watch out for the inland ships at the front?' In response, the pilot stated that the ship would slow down.

3 By using the propeller effect (or paddle wheel effect) a ship can be moored more easily alongside the quay by reversing because – depending on the direction of propeller rotation – the ship's stern pulls to port or starboard side when reversing.
4 Unless stated otherwise, all ship speeds in this report are speeds over ground.
5 Salt to freshwater effect: due to the difference in weight between salt and freshwater, the draught of the ship increases, which may increase the ship's speed and change its heading.

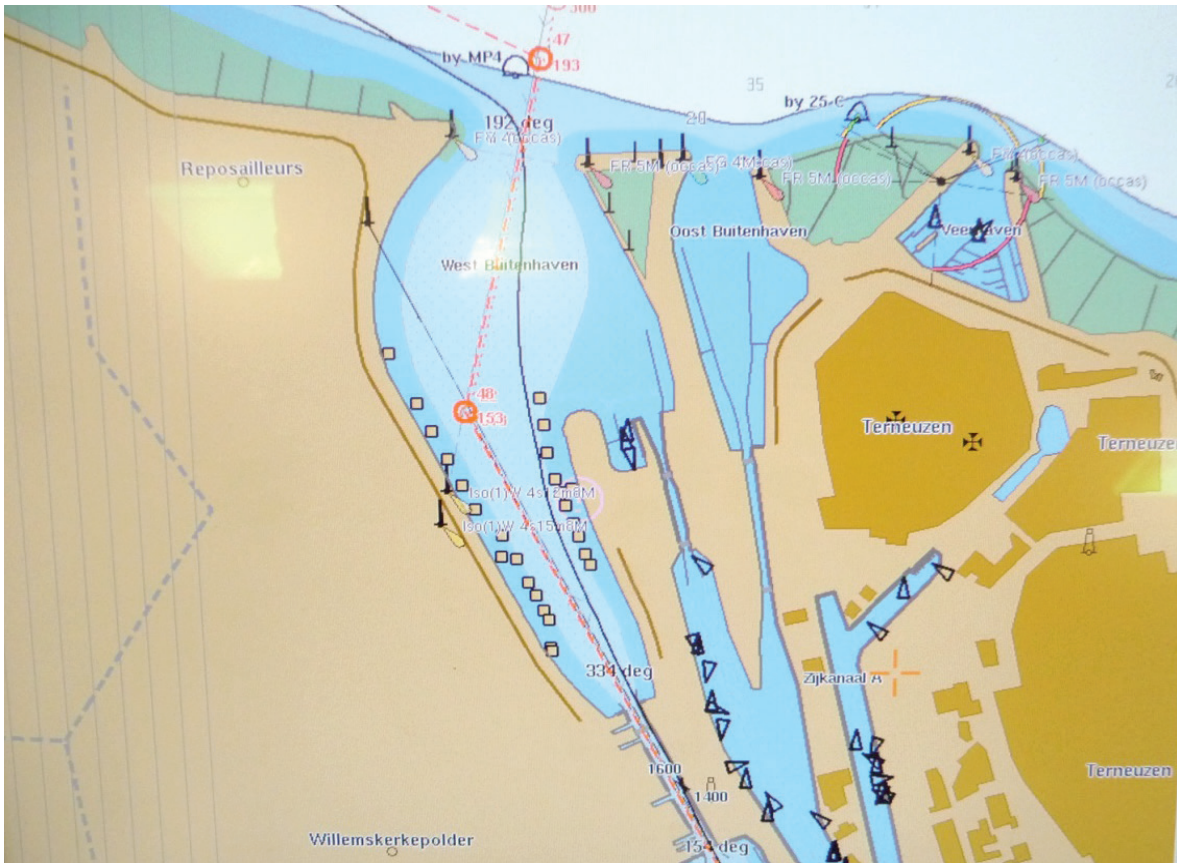

Figure 2: Image of the track (in black) of the Flinter Aland on the display of the electronic chart system (ECS).

In addition to the third mate, who was in charge, the crew on the foredeck consisted of the boatswain to operate the winch and a seaman who would release the mooring lines. As soon as the ship had arrived at its intended mooring position, the crew released the mooring line onto the quay. One of the longshoremen[6] then layed the spring line around the bollard on the quay.

6 Longshoremen assist ships' crews when mooring up and casting off mooring lines. At the lock, they stand on the quay.

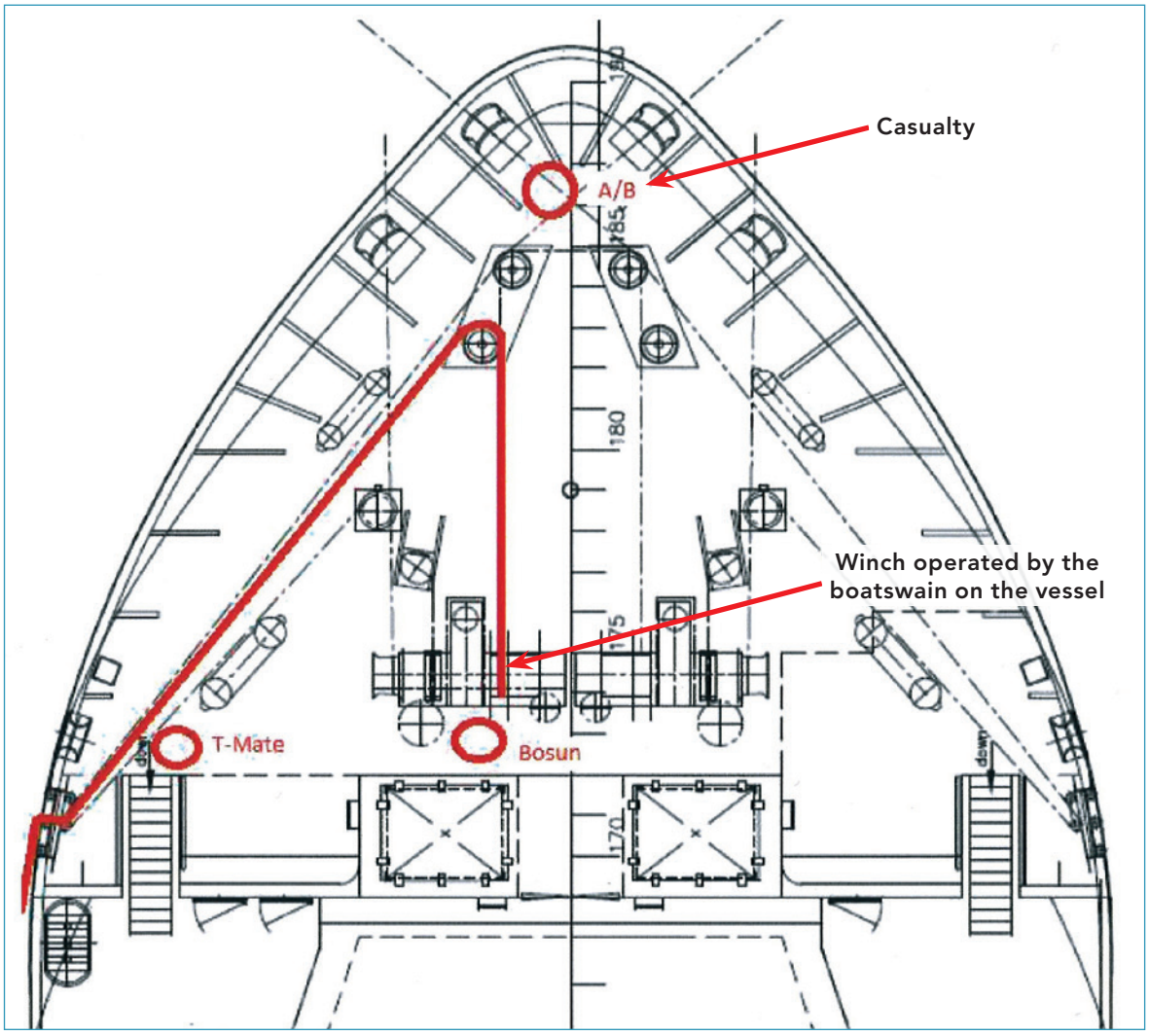

Figure 3: Location of the crew and the layout of the broken mooring line. (Source: shipping company Flinter)

At 12.34:01 the master, who was in direct contact with the third mate on the foredeck via VHF – gave the order 'slowly hold spring'. The VDR recorded ship's speed at that time was 1.1 knots. The third mate on the foredeck repeated the order as 'hold spring'. Because the third mate repeated the order incorrectly, the master communicated his order once again: 'slowly hold spring'. The third mate replied saying 'fore spring hold'. The master then concluded the brief conversation at 12.34:07 with a short 'yeah'. At virtually the same time, the heaving line that had been used to transfer the mooring line from the ship to the quay was thrown back by the boatswains from the quay to the ship, whereupon the seaman on the forecastle moved forward a few steps to grab hold of the line.

At 12.34:20 the master communicated 'in position' to the deck crew via VHF. The ship was still sailing at around 0.7 knots at that time. As the master later explained, this order meant that the crew were to fasten the mooring line winch onto the strap brake. Almost immediately after the master had given his order, the mooring line broke. The ship's main engine was running at full astern at that time. The seaman, who had walked to the forecastle to grab hold of the heaving line, was standing in the mooring line snap-back zone. He was hit by the mooring line that had snapped back and, as later emerged, died instantly from his injuries. It was immediately clear to the crew on the forecastle and the boatswains on the quay that the seaman was severely injured.

They managed to quickly moor the ship. The lockmaster warned the emergency services and authorities. After the ship had moored, the pilot and engineer went to the forecastle to provide first aid assistance. The seaman, however, had already died by that time.

Figure 4: Flinter Aland immediately after the accident. (Source: Chris Platteeuw)

Action taken after the incident

The shipping company conducted an investigation following the accident. The results of this investigation prompted the shipping company to formulate and implement a number of safety measures. They are as follows:

- replacement of the current mooring lines with new mooring lines with a more limited snap-back in the event of breakage;
- risk analysis of the activities performed during mooring;
- implementation of the International Safety Management (ISM) manual procedures in the Fleet manual; and
- inform the fleet of the correct mooring procedures through circulars.

The breaking of the mooring line

The greatest risk inherent in working with mooring lines is mooring line breakage and what is known as the subsequent snap-back of the mooring line. This refers to the recoiling of a mooring line when the static energy built up in the mooring line is suddenly released and the end of the line snaps back at great speed. Snap-back occurs in all mooring line types. Synthetic mooring lines, like the mooring line on board the Flinter Aland, are highly elastic, which means that the risks of snap-back are high. Synthetic mooring lines can break 'without any warning'.

The mooring line on board the Flinter Aland broke because the forces on the mooring line became excessive. The ship was still moving in forward direction at the time the crew fully tightened the winch brake located on the forecastle. The mooring line broke without any prior (audible) warning. The third mate, the boatswain (the winch operator) and the seaman were therefore unaware of the immediate danger they were facing. Just before the mooring line broke, the seaman was located in the mooring line snap-back zone, where he got hit by the mooring line that had snapped back.

When excessive forces are exerted on a mooring line, the Flinter Aland's design provides a series of measures to prevent mooring line breakage. It was not established during the investigation why the mooring line on board the Flinter Aland formed the weakest link on the day of the incident. The first measure relates to the ship mooring line itself. The crew on board the Flinter Aland regularly inspected the mooring lines. These periodic inspections focussed on the mooring line's visual features. The one-year old mooring line was certified and was in good condition, visually. The second measure for preventing mooring line breakage is the winch brake. The brake's holding force must be less than that of the ship mooring line.[7] According to the certificates the winch's holding force was 240 kN and that of the mooring line 378 kN. The shipping company stated that it had planned to have an expert company test the holding force of the winch in the scheduled port of arrival. Due to the fact that the ship's destination had been changed, such a test was not carried out.

To warn crew members of the hazards arising in the event of a mooring line breakage on board a ship, snap-back zones have been identified. The Royal Association of Netherlands Shipowners (KVNR) and the Nautilus International trade union have incorporated these zones in *the Mooring and Unmooring Operations Health and Safety Sheet* for the purpose of informing the sector of the regulations that must be complied with when mooring and

7 Excessive forces cause the winch brake to collapse and the mooring line to unreel freely. This serves to prevent a mooring line from breaking and snapping back.

unmooring vessels. The Dutch Safety Board is of the opinion that the zones defined in this sheet provide ships' crews with insufficient insight into the actual risks they are exposed to in the event of mooring line breakage. For instance, the angle shown at which the broken mooring line can snap back is too narrow. Furthermore, only a limited number of breakage locations have been defined. The seaman was standing at a location that had not been identified as a danger zone in the Health and Safety Sheet. Lastly, the highly simplified illustration of the forecastle does not do justice to the often complex situation on board seagoing vessels where mooring lines are run around capstans. This means that the snap-back zones are significantly larger. For a more accurate picture and the risks associated with snap-back zones, the Dutch Safety Board refers to publications such as those of the English Nautical Institute and Seahealth Denmark (see Appendix 1).

Safety Management System

Working with mooring lines will always be inherently hazardous. The forces suddenly arising in the event of mooring line breakage are large and the options available to the crew for moving to a safe position (on time) during mooring and unmooring operations are often limited. The forecastle layout of the Flinter Aland complies with the legal requirements and is common in the industry. Nonetheless a crew member died as a result of mooring line breakage.

The Dutch Working Conditions Act stipulates that an employer should provide a working environment in which the health and safety risks have been reduced as far as possible. If it is not reasonably practicable to raise the level of safety, procedures must be put in place to guarantee employee safety. It are precisely these additional procedures that were lacking on board the Flinter Aland.

The safety management system and the RA&E describe hazardous activities, risks and safety measures. If deemed appropriate, the sector may use the industry RA&E, which is published by the KVNR and Nautilus trade union, for this purpose. These documents offer the opportunity to establish procedures to improve safety. Although the crew members often work with mooring lines, no procedures were in place for working safely with mooring lines, the snap-back zones on board the Flinter Aland had not been identified and/or were unavailable to the crew, and the shipping company failed to give crews additional instructions on the correct use of mooring lines. Consequently, the shipping company failed to sufficiently acknowledge the risks inherent in working with mooring lines and was therefore unable to take effective safety measures. The sector RA&E states that crew members must be aware of the snap-back zones and that measures should be put in place to protect these zones. When using a fixed mooring plan, the snap-back zones must be indicated on deck.

KVNR
KONINKLIJKE VERENIGING VAN NEDERLANDSE REDERS

NAUTILUS INTERNATIONAL

D101

Mooring and unmooring

This ARBO chapter is part of the Health and Safety Index for the shipping industry.

It is intended to help employers to comply with the requirements of health and safety legislation. It may be used as a checklist by employees.

It contains the necessary measures to be taken in order to safely carry out certain work-related activities.

Compliance with these regulations, or alternative regulations offering an equivalent level of protection, is essential.

This chapter contains health and safety regulations to ensure safe mooring and unmooring procedures.

Employees' checklist

- **Always use an adequate number of crew when mooring/unmooring**
- **Make each other aware of unsafe situations**
- **Familiarise yourself with the equipment used in order to be able to spot any wear and tear at an early stage**
- **Provide supervision at stem and stern whilst mooring/unmooring**
- **Has the mooring plan been discussed?**
- **Use well-working communication equipment**
- **Do not carry out more than one aspect of the job at any one time (like manning winch and handling ropes)**

This chapter contains the measures that must be taken to ensure the safe mooring and unmooring and to minimise potential hazards.

PPE to be used

Various factors in mooring/unmooring vessels:

In order to safely moor/unmoor seagoing ships, a number of factors will have to be taken into consideration. In addition, equipment, experience and on-board organisation are vital in ensuring smooth mooring/unmooring:

- Availability of sufficient (experienced) crew
- Mutual supervision
- Preparation
- Communication
- Sound division of labour and appropriate supervision
- Maintenance of all equipment

Be vigilant

In many instances accidents do not happen because of the complicated nature of a manoeuvre, but rather because of lack of care and attention whilst carrying out a (simple) job:

- You have a legal obligation to point out unsafe routines and/or incorrect usage of protective equipment to the people you work with.

Printed and Published by www.arbocatalogus.com, www.kvnr.nl, www.nautilusnl.org

Figure 5: Health and Safety Instruction Sheet 'Mooring and Unmooring'.

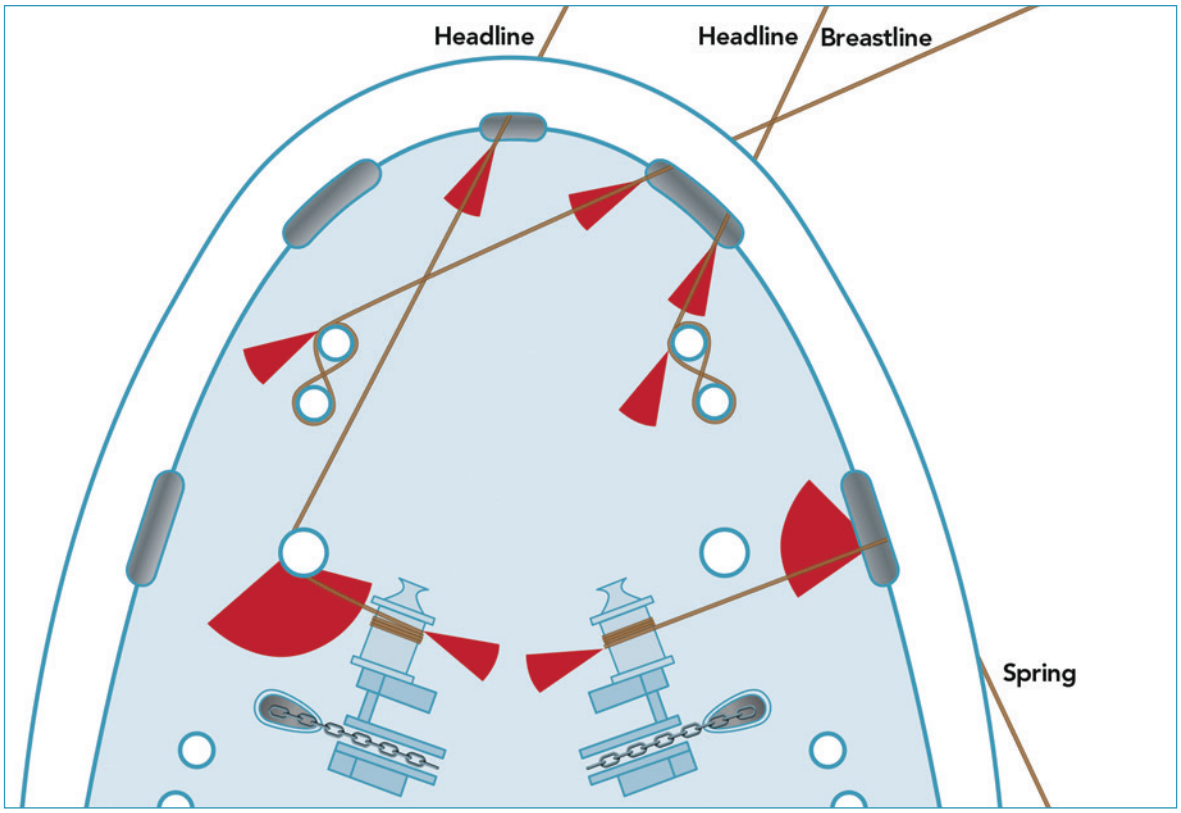

Figure 6: Illustration of the snap-back zones (coloured red) in the Health and Safety Instruction Sheet.

Crew Resource Management

Crew Resource Management (CRM) aims to improve the effectiveness of (e.g. collaboration and communication among) ships' crews in order to prevent incidents from arising as a result of human error.

The usual composition of the crew on the forecastle had been altered because the chief mate had been relieved of his duties during mooring manoeuvres by the master a few days earlier. The third mate had been tasked with taking charge of mooring operations on the foredeck of the ship, a task that was new to him. The master explained that he realised that the new crew composition and allocation of roles could adversely affect the team's performance of their duties during the mooring operation and that this posed a potential safety risk. He assumed, however, that a briefing would sufficiently control this risk. During the briefing he instructed the deck crew on the sequence in which the mooring lines were to be released. He also emphasised that the crew had to promptly follow the orders given from the bridge. In addition, the master considered placing a second mate on the forecastle. The master, however, decided not to do so because it would mean that both the fore and aft composition of the crew would change.

The Safety Board is of the opinion that while it is essential to follow the instructions given by the master from the bridge, the crew on the foredeck should themselves be sufficiently aware of and have insight into the risks inherent during mooring operations, irrespective of whether they receive instructions or information to that effect. The Safety Board questions whether the (inexperienced) third mate on board the Flinter Aland had sufficiently developed such insights into the risks and whether the boatswain (who was experienced) could have satisfactorily assisted him in this respect. The boatswain was in fact located near the winch, and had a restricted view of the situation and the third mate, and consequently was unable to render him sufficient assistance in performing his duties.

On board the Flinter Aland it was customary to use what is referred to as 'the read-back/hear-back' method for radio communications between two parties. This means that the receiver repeats the message to confirm the receipt and content of the message to the sender. Despite using this method, confusion arose during the manoeuvre between the third mate and the master on the use of the strap brake on the winch, and regarding the manner this was to be done. The master indicated that the winch brake had to be tightened slowly. The third mate interpreted the master's order as putting the full brakes on the winch. This miscommunication continued to exist because the master had replied in the affirmative (saying 'yeah') after the third mate had given an incorrect read-back a second time. Why the master said 'yeah' in this case was not established during this investigation. Both the sender and the receiver of the information are responsible for conducting good communications. Should anything not be clear, the sender of the information must continue to repeat his message until the receiver has given the correct read-back. The method is regularly discussed orally during work progress meetings but has not been set out in a procedure. Good communication is essential for working safely.

Previous accidents

As part of this investigation, the Dutch Safety Board examined previous accidents in which ship mooring lines had broken during mooring and unmooring operations. Investigation reports from its sister organizations abroad and the EMCIP[8] database, among others, were used for this purpose. The Dutch Safety Board itself also previously published a report on an accident involving a broken mooring line.[9]

Many incidents are known to have taken place, both in and outside the Netherlands, in which mooring lines have broken and crew members have suffered fatal or serious injuries. Three main causes of such incidents have been identified: the ship design, mooring lines that have weakened as a result of wear and tear and human error.

The risks of mooring line breakage during mooring and unmooring operations have recently led the International Maritime Organization (IMO) to publish an information bulletin[10] entitled *Safe mooring - a guide to prevent accidents while mooring*, which provides insight into the danger zones on board ships.

8 EU Member States record accident data for maritime incidents in the European Marine Casualty Information Platform (EMCIP) database.

9 Breaking of mooring lines whilst mooring m.v. Edisongracht between two mooring buoys in the port of Soyo, Angola, 1 April 2010.

10 MSC 92/inf.11 published on 12 April 2013. Denmark conducted a study themed around incidents that occurred during mooring and unmooring operations from 1997 to 2006. Due to the growing number of incidents seen after this period, Denmark took the initiative to present the IMO with an information leaflet entitled 'Guide to prevent accidents while mooring'. The IMO published the information leaflet, which is included as an appendix to this report.

CONCLUSIONS

- The mooring line on board the Flinter Aland broke because the forces exerted on the mooring lines became excessive. The ship was still moving in forward direction at the time the crew fully tightened the brake of the winch located on the forecastle.
- The seaman was located in a position on the foredeck where he could be hit by the mooring line that had snapped back. The mooring line fatally injured the seaman.
- The shipping company failed to sufficiently control the risks of working with mooring lines on board the ship. No procedures were in place for working with mooring lines, the snap-back zones on board the Flinter Aland had not been identified and/or were unavailable to the crew and the shipping company failed to give crews instructions on the safe use of mooring lines.
- The snap-back zones identified in the *Mooring and Unmooring Operations Health and Safety Sheet* do not provide with crews sufficient insight into the risks they face as a result of snap-back caused by mooring line breakage.
- Limited Crew Resource Management played a role in the occurrence of the incident on board the Flinter Aland. This created an interpretation problem during VHF communications between the master and the third mate when operating the winch during the mooring procedure.
- It is not clear whether the crew on the foredeck had sufficient knowledge or insight into the risks.
- The crew, the lockmaster and the emergency services acted adequately after the accident but were unable to save the casualty's life.

RECOMMENDATIONS

To Flinter:

Identify the risks involved in working with mooring lines and take measures to minimise these risks as far as possible. In this context, particular emphasis should be placed on the mooring lines snap-back zones, the winch brake's holding force and communications. Implement these procedures in the safety management system and ensure that crews comply with these procedures.

To the Royal Association of Netherlands Shipowners (KVNR) and the Nautilus International trade union:

Revise the *Mooring and Unmooring Operations Health and Safety Instruction Sheet* and to that end, use the latest insights into the risks inherent in working with mooring lines. Encourage your members to adopt the insights in their Safety Management System. In this context, particular emphasis should be placed on the mooring lines snap-back zones.

RESPONSES RECEIVED FOLLOWING REVIEW OF THE DRAFT REPORT

In accordance with the Dutch Safety Board Act, a draft version of this report was submitted to the parties involved for review. The parties were requested to check the report for any errors and ambiguities. The draft version of this report was submitted to the following parties for review:

- Flinter shipping company;
- Master of the Flinter Aland;
- Third mate of the Flinter Aland;
- Flinter Aland seaman's spouse;
- Royal Association of Netherlands Shipowners (KNVR);
- Nautilus International; and
- Lockmaster.

All of the above parties availed themselves of the opportunity to respond, except the spouse of the victim, the master and the third mate.

VESSEL SPECIFICATIONS

Vessel specifications Flinter Aland	
Vessel name	Flinter Aland
Call sign	PCKY
IMO number	9504140
Flag state	The Netherlands
Home port	Rotterdam
Vessel type	General cargo
ISM manager	Flinter Management B.V.
Classification society	Bureau Veritas
Year of buildt	2011
Shipyard	Scheepswerf Ferus Smit B.V., the Netherlands
Length overall (Loa)	132.5 m
Breadth	15.87 m
Maximum draught	7.80 m
Actual draught	7.69 m fore, 7.72 m aft
Gross Tonnage	6,687
Main engine	1 Mak 8M32
Propulsion	1 controllable pitch propeller, counter clockwise rotation
Maximum propulsion power	4,000 kW
Rudder	Balanced rudder, maximum rudder angle 70° (high angle)
Bow thruster	1 bow thruster, 573 kW
Maximum speed	14 knots
Ship certificates	All valid
Electronic (registration) equipment	Electronic Chart Display and Information System (ECS) and Voyage Data Recorder (VDR)

ANNEX A

IMO MSC92/INF.11

See website: www.safetyboard.nl

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