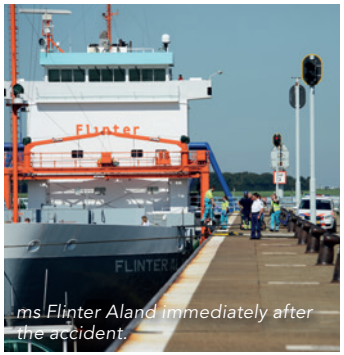
DUTCH
SAFETY BOARD

Fatality during mooring operation in lock



ms Flinter Aland immediately after the accident.

Introduction

Mooring and unmooring operations are common practices on board ships. Although carried out on a regular base, these operations still pose serious potential hazards for every crewmember due to incidental mooring lines breakage. This breakage is often the result of interaction between factors such as ship design, weakened mooring lines and human error. This investigation into the accident demonstrates this clearly. To minimise the risks, the crew needs to prepare every operation carefully and perform the tasks by close mutual agreement and clear and unambiguous communication. To accommodate the crew in this process, the shipping companies have to identify the risks involved in the mooring and unmooring operations and minimise these risks. Procedures to ascertain safe working should be implemented in the safety management system on board.

Tjibbe Joustra, *chairman*
Dutch Safety Board

The accident

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.

The investigation

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.

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.

Furthermore 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.

Factual information

Ship and crew

Flinter, a Dutch shipping company, carries out the International Safety Management (ISM) of 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.

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 (a fully licensed officer of watch) 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 Local Time), 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.

Figure 1: ms Flinter Aland. (Source: Shipping Company Flinter)

Relevant facts

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

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.

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 ground-speed of 3-4 knots. 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 (which may increase the ship's speed and change its heading). 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.

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 (assist ships' crews when mooring up) then laid the spring line around the bollard on the quay.

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.

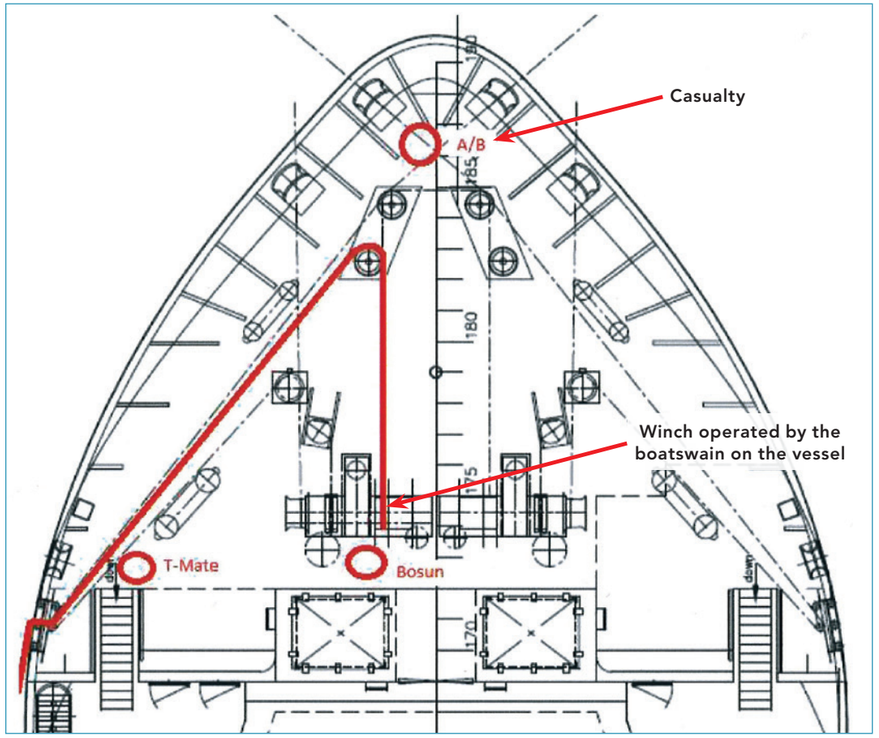


Figure 3: Location of the crew and the course of the broken mooring line. (Source: Shipping Company Flinter).

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.

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.

Analysis

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.
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 unmooring vessels. The Dutch Safety Board is of the opinion that the zones

Comparison between the two snap-back zones figures shows that the snap-back zones according to the latest insights (figure 5) are longer, and even extend almost the entire lenght of the foredeck

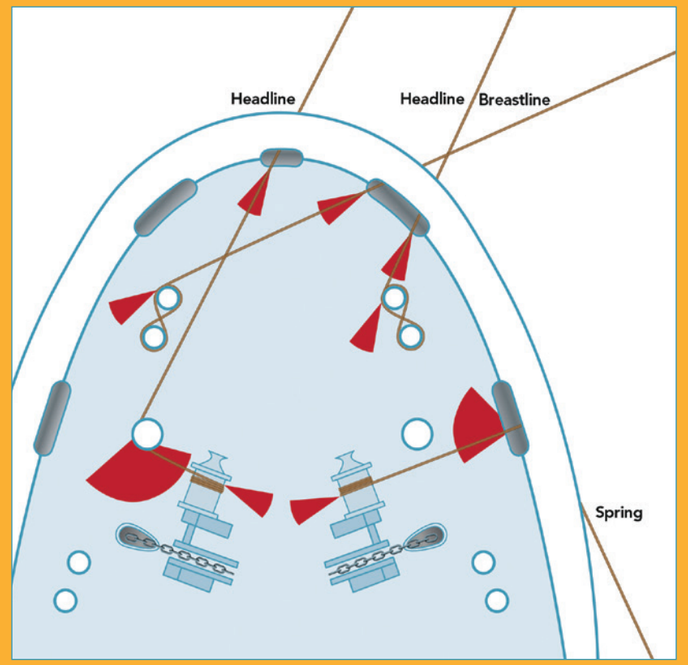


Figure 4: Illustration of the snap-back zones (coloured red) in the Health and Safety Instruction Sheet. (Source: Royal Association of Netherlands Shipowners and Nautilus International Trade Union)

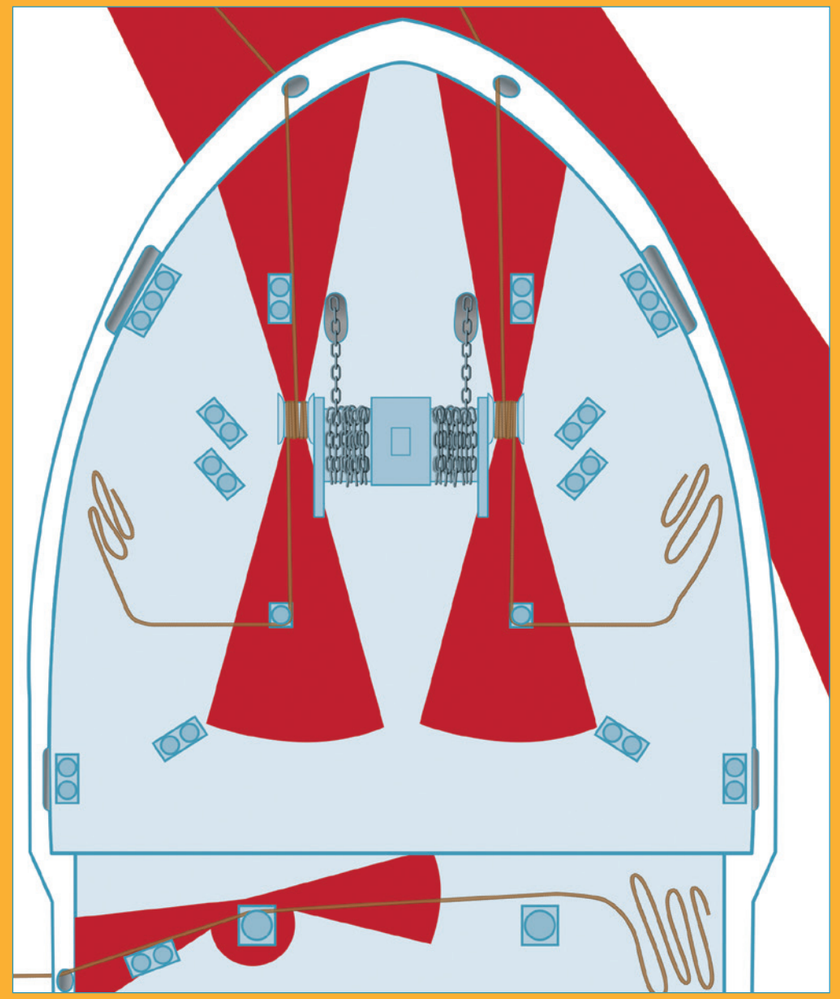


Figure 5: Illustration of snap-back zones (coloured red) according to the latest insights. (Source: Seahealth Denmark)

Figure 6: Foredeck of ms Flinter Aland. (Source: Dutch Safety Board)

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 (see figure 4). 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 figure 5).

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.

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.

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 organisations abroad and the EMCIP database, among others, were used for this purpose. In 2011 the Dutch Safety Board itself also published a report on an accident involving a broken mooring line.

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 (MSC 92/inf.11 published on 12 April 2013) entitled *Safe mooring - a guide to prevent accidents while mooring*, which provides insight into the danger zones on board ships.

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.

Figure 7: Flinter Aland immediately after the accident. (Source: Chris Platteeuw)

Conclusions and recommendations

Figure 8: Winch on foredeck ms Flinter Aland. (Source: Dutch Safety Board)

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.

Figure 9: ms Flinter Aland. (Source: Shipping Company Flinter)

The Dutch Safety Board in four questions

1

What does the Dutch Safety Board do?

Efforts are being made in the Netherlands to minimise the risk of accidents and incidents as much as possible. When it nonetheless (nearly) goes wrong, a repetition can be avoided by carrying out a thorough investigation into the cause, separate from determining guilt. It is thereby important that the investigation is carried out independently of the parties involved. The Dutch Safety Board therefore chooses for itself what to investigate and thereby takes account of the independence of citizens from government bodies and companies.

In 2005 the Dutch Safety Board's investigations included the fire at the centre for failed asylum seekers, the so-called Schiphol fire. Recently the Safety Board reported on a fire in a CNG bus and on the safety of Odfjell Terminals in Rotterdam.

2

What is the Dutch Safety Board?

The Safety Board is an 'independent administrative body' and is authorised by law to investigate incidents in all areas imaginable. In practice the Safety Board currently works in the following areas: aviation, shipping, railways, roads, defence, human and animal health, industry, pipes, cables and networks, construction and services, water and crisis management & emergency services.

3

Who works at the Dutch Safety Board?

The Safety Board consists of three permanent board members. The chairman is Tjibbe Joustra. The board members are the face of the Safety Board with respect to society. They have extensive knowledge of safety issues. They also have wide-ranging managerial and social experience in various roles. The Safety Board's office has around 70 staff, of whom around two-thirds are researchers.

4

How do I contact the Dutch Safety Board?

For more information and the full report in Dutch and the summary in English see the website at www.safetyboard.nl
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