Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Ministry of Transport and Digital Infrastructure

Investigation Report 43/16

**Very Serious Marine Casualty**

# Fatal line accident on board the CMV MAERSK KURE in the port of Bremerhaven on 6 February 2016

3 February 2017

The investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG) of 16 June 2002, amended most recently by Article 16(22) of 19 October 2013, BGBl. (Federal Law Gazette) I p. 3836.

According to said Law, the sole objective of this investigation is to prevent future accidents and malfunctions. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG).

This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Article 34(4) SUG.

The German text shall prevail in the interpretation of this investigation report.

Issued by:
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# 1 Summary

The Greek-flagged container ship MAERSK KURE, sailing from Rotterdam, arrived at the container terminal in Bremerhaven on the night of 6 February 2016.

The ship's command was advised by a pilot from 0140[1] onwards. To assist in the berthing manoeuvre, one tug was made fast fore and another aft.

After the fore and aft springs and two head lines were each put ashore, the tugs were cast off. After that, the second spring was to be put ashore at the bow.

A seaman had already attached the heaving line to the eye of the second spring and begun to pay out the line through a fairlead on the starboard side. To this end, he had to stand right next to the deployed spring.

This line parted suddenly and struck the seaman such that he collapsed immediately.

The crew members present pulled him out of the danger area of the lines, advised the bridge, and then attempted to resuscitate him.
The casualty was later carried down the gangway to the pier on one of the ship's stretchers, where the crew of the requested ambulance took charge of the subsequent medical care.

Despite all efforts, the seaman passed away en route to the hospital.

[1] Unless stated otherwise, all times shown in this report are local = UTC + 1 (CET)

# 2 FACTUAL INFORMATION

## 2.1 Photo




Figure 1: Photo of the ship

## 2.2 Ship particulars

| | |
|---|---|
| Name of ship: | MAERSK KURE |
| Type of ship: | Container ship |
| Nationality/Flag: | Greece |
| Port of registry: | Piraeus |
| IMO number: | 9085522 |
| Call sign: | SVQT |
| Owner: | Costamare Shipping Co. S.A. |
| Year built: | 1996 |
| Shipyard: | Odense Staalskibs – Lindo |
| Classification society: | Lloyds Register |
| Length overall: | 318.24 m |
| Breadth overall: | 42.8 m |
| Gross tonnage: | 81,488 |
| Deadweight: | 84,900 t |
| Draught (max.): | 14.0 m |
| Engine rating: | 54,840 kW |
| Main engine: | Mitsui Eng. & Shipbuilding C. Ltd. - Japan (12K90MC) |
| (Service) Speed: | 25 kts |

## 2.3 Voyage particulars

| | |
|---|---|
| Port of departure: | Rotterdam |
| Port of call: | Le Havre |
| Type of voyage: | Merchant shipping/international |
| Cargo information: | Containers |
| Manning: | 23 |
| Draught at time of accident: | 12.2 m |
| Pilot on board: | Yes |
| Canal helmsman: | No |
| Number of passengers: | 0 |

## 2.4 Marine casualty or incident information

| | |
|---|---|
| Type of marine casualty: | Very serious marine casualty; accident involving a person |
| Date, time: | 06/02/2016, 0245 |
| Location: | Bremerhaven, Stromkaje |
| Latitude/Longitude: | φ 53°34.826'N λ 008°31.98'E |
| Ship operation and voyage segment: | Berthing |
| Place on board: | Forecastle |
| Consequences (for people, ship, cargo, environment, other): | Seaman lost his life |

Excerpt from Nautical Chart INT 1457, BSH

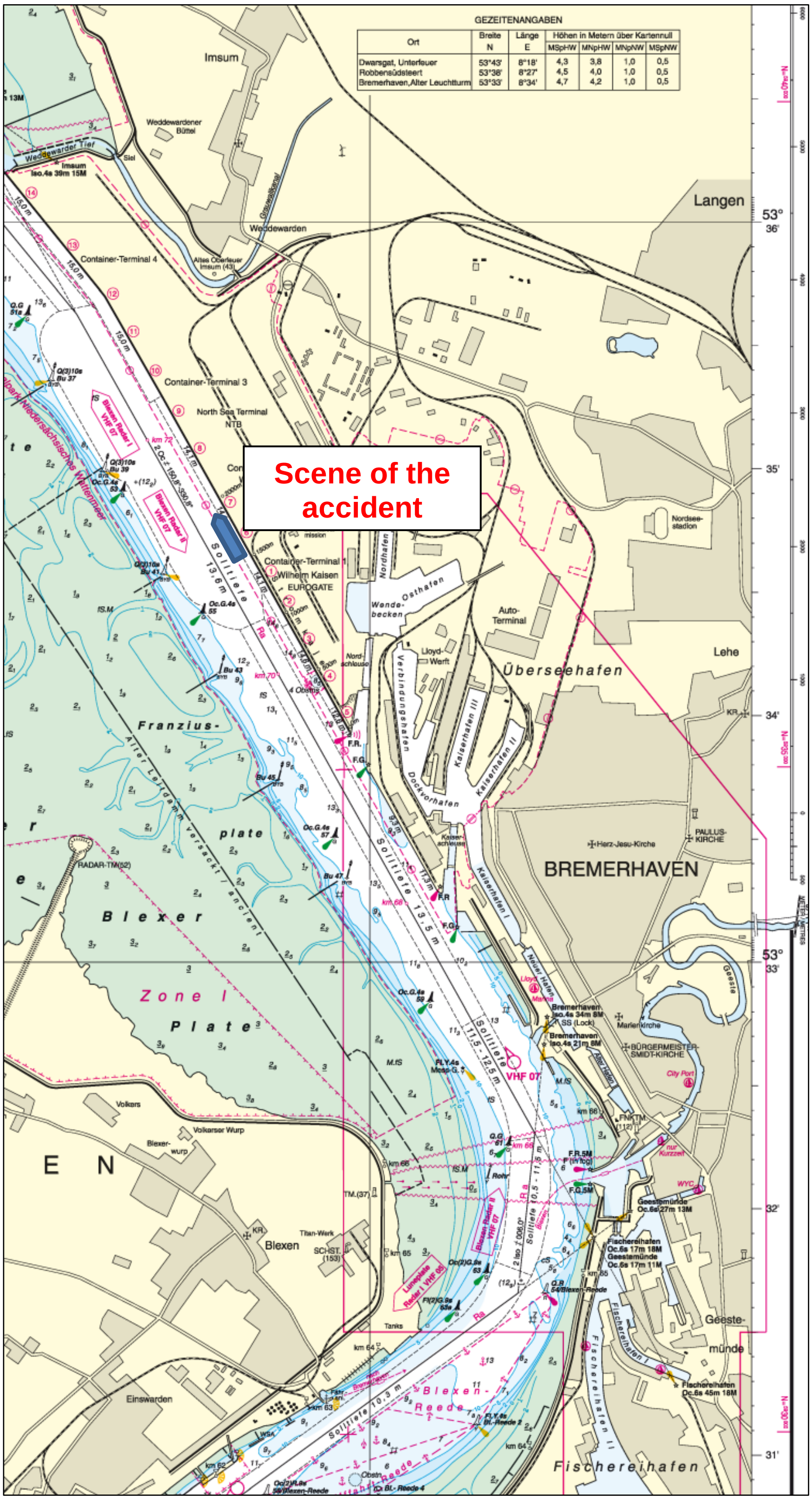


Figure 2: Excerpt from nautical chart showing the scene of the accident

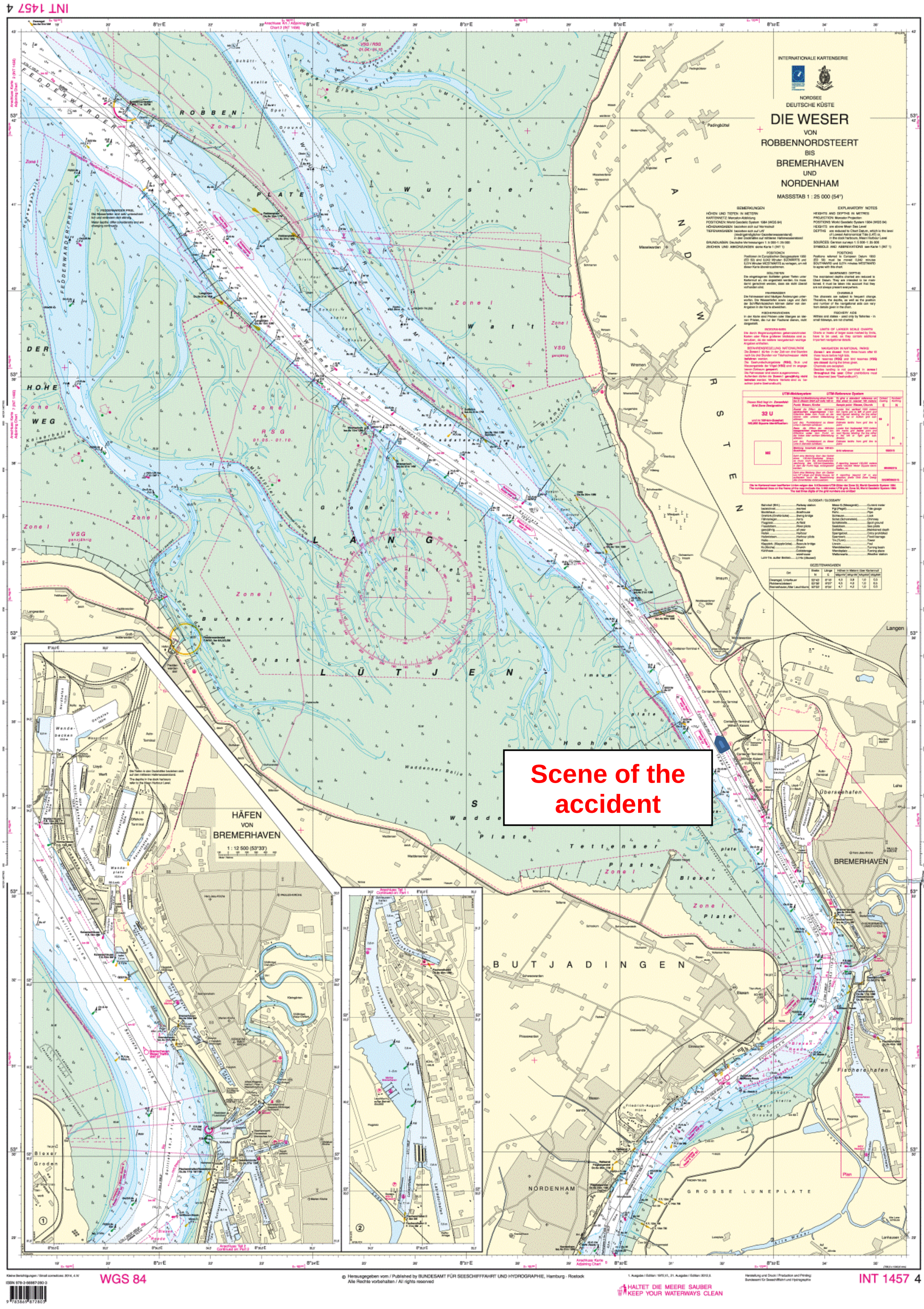


Figure 3: Nautical chart showing the scene of the accident

## 2.5 Shore authority involvement and emergency response

| | |
|---|---|
| Agencies involved: | Waterway Police (WSP) Bremerhaven, hospital |
| Resources used: | Ambulance with emergency physician |
| Actions taken: | Attempts at resuscitation and transport to hospital |
| Results achieved: | Seaman succumbed to his injuries in spite of all measures taken |

# 3 COURSE OF THE ACCIDENT AND INVESTIGATION

The Greek-flagged container ship MAERSK KURE, sailing from Rotterdam, arrived at the container terminal in Bremerhaven on the night of 6 February 2016. The weather conditions were good. A south-west wind of 3 Bft and an ebb tide prevailed. The ship's command was advised by a pilot from 0140 onwards. The MAERSK KURE's starboard side was to face the shore.

## 3.1 Course of the accident

Two tugs were made fast to assist in the berthing manoeuvre: SVITZER MARKEN by a line through the forward central hawsehole and GEESTE by a line through the aft central hawsehole. The MAERSK KURE was manoeuvred to the pier using her main engine, stern thruster and bow thruster, as well as the two tugs. The forward and aft springs were put ashore first. When the ship then reached her final position, the forward and stern lines were paid out. After two stern lines and one spring had been made fast at the stern and three head lines and one spring had been made fast at the bow, the tugs was stopped and cast off to create space at the MAERSK KURE's manoeuvring stations to make fast the last lines. After the towing connections were separated, the MAERSK KURE floated motionless at the Stromkaje's fenders.

The chief mate, bosun, two seamen, one apprentice, and a nautical trainee were situated at the forward manoeuvring station. The chief mate co-ordinated the work from the walkway near the central hawsehole. The nautical trainee stood next to him and observed.

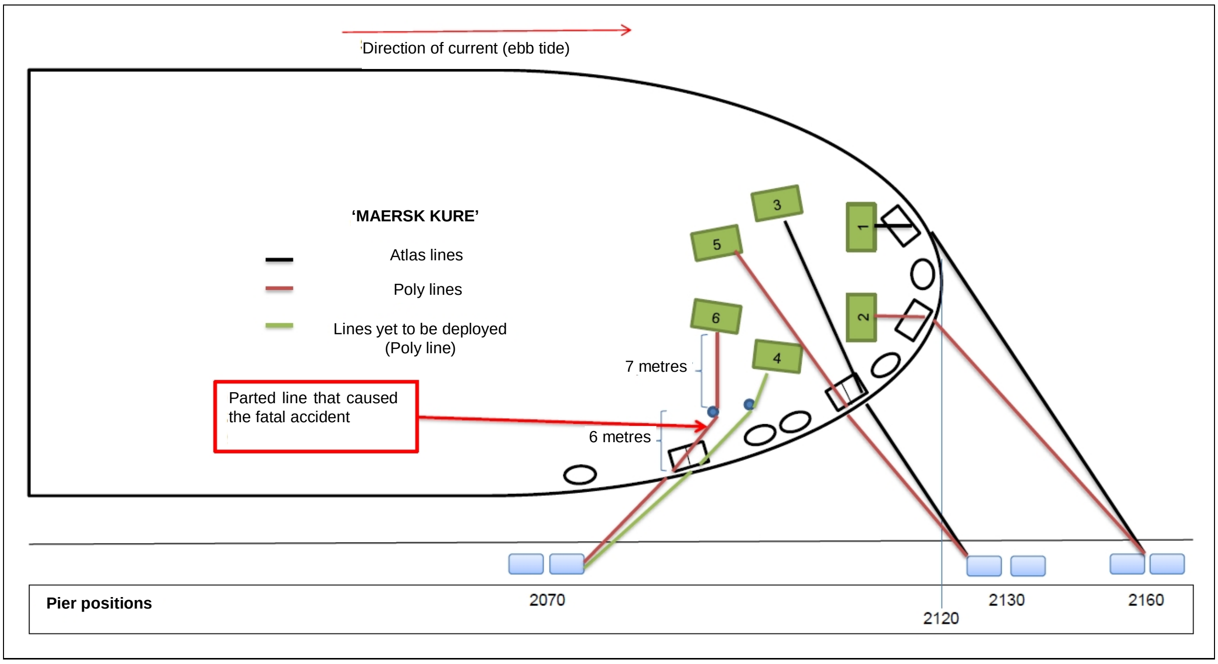


Figure 4: Schematic drawing of the line guidance on the forecastle

The bosun, a seaman, and the apprentice had just lowered the towline to the tug and proceeded to the starboard side to pass the second spring ashore. The second seaman had already attached the heaving line to the eye of the second spring there and begun to pay out the line through a fairlead on the starboard side. To this end, he had to stand right next to the deployed spring line. Accordingly, nobody was at the winch control positions at the time of the accident.

All the witnesses stated that they had not seen what happened. Only a snapping noise could reportedly be heard when the deployed spring parted at about 0245. It apparently struck the seaman, who was working right next to it. He was lying on the deck motionless. Those present were initially unable to detect any external injuries.
The chief mate checked the seaman's pulse immediately and tried to resuscitate him. At the same time, he informed the master on VHF.

The linesmen advised the pilot on VHF that the fore spring had parted. The pilot immediately instructed a tug (the GEESTE) to push amidships at full capacity to prevent the ship from moving.
The pilot then advised Bremerhaven Ports of the accident and thus ordered an emergency physician.

The crew members on the forecastle pulled the casualty out of the danger area of the lines and continued the attempts at resuscitation until a stretcher had been obtained. The seaman was secured to the stretcher and carried to the pier via the gangway, where the crew of the requested ambulance took charge of the subsequent medical care at about 0305. Despite all measures taken, the seaman passed away en route to hospital.

## 3.2 Investigation

The WSP arrived at about 0255 and started its initial investigations at the scene. Witness accounts were recorded and photos taken. Finally, arrangements were made to separate each side of the failure from the rest of the parted line, so as to facilitate a subsequent investigation of the point of failure.

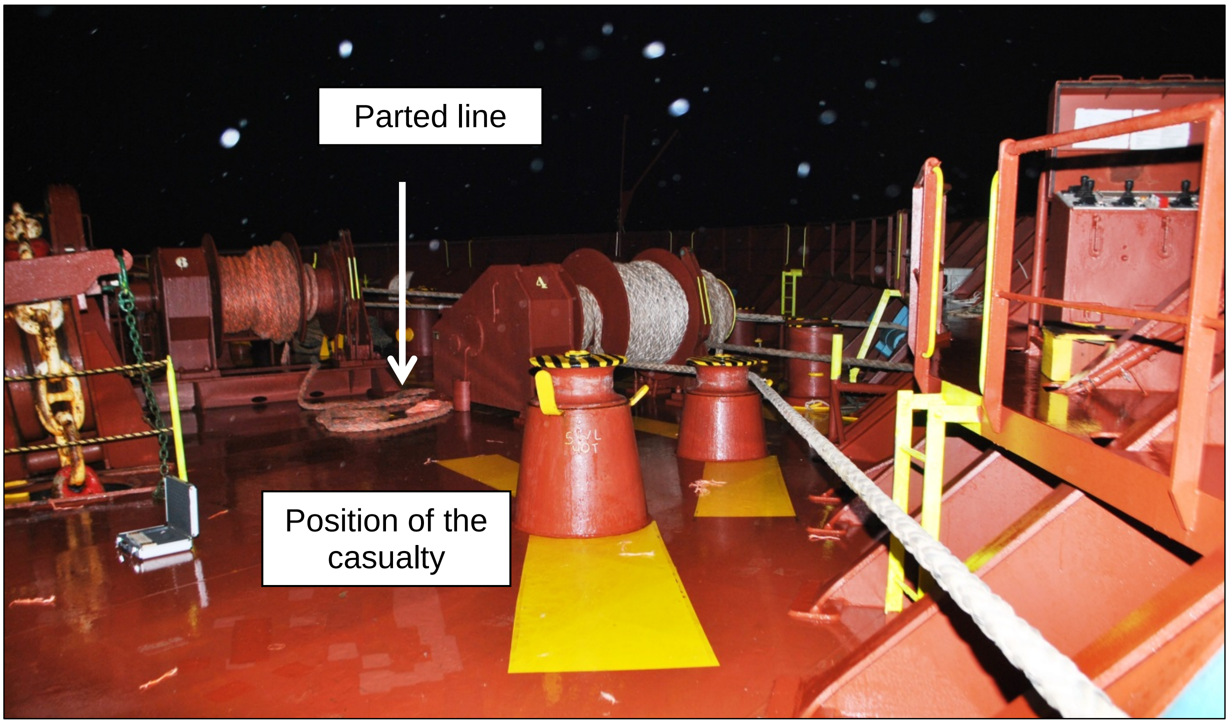


Figure 5: View toward the parted line

WSP Bremerhaven notified the BSU's on-call service by phone at about 0530. Following that, the BSU's marine casualty investigator arrived at the MAERSK KURE at about 1300 and began his investigation. Inter alia, the recordings of the voyage data recorder (VDR) were secured.

Figure 6: Line's point of failure


Figure 7: View across the forecastle from the position of the chief mate


Figure 8: Winch holding the parted line

### 3.2.1 Voyage data recorder

A Type M4 VDR made by Consilium was installed on board the MV MAERSK KURE. The secured data were analysed and clearly showed that the ship was not moving at the time of the accident. Moreover, no commands calling for any movement of the ship can be heard on the audio recordings of the bridge.

### 3.2.2 Mooring line test

A rope is an elongated flexible element consisting of twisted wires or natural or synthetic fibres. It is most commonly used to transfer tensile forces, but also has a variety of other purposes. Strength and flexibility combine to form a single unit in ropes consisting of multiple secondary strands.[2]

Filaments made of several single filaments are called **parallel yarns**. Filament is the international description for textile fibres with very long 'continuous' lengths in chemical fibre production.

**Yarn** is a linear textile structure made of several fibres or filaments twisted together (e.g. yarn made of two parallel yarns).

**Twine** is a linear textile structure consisting of at least two yarns twisted together.

**Strand** is the intermediate product in rope production attained when thread(s) (yarns or twines) is/are twisted together before being laid into rope.[3]

There are various different rope designs. The design used in this case is referred to as 'laid', which is a rope produced by twisting two or more parts around one another to form a helix around the axis. This twisting is referred to as 'laying' to distinguish it from braiding.

The **direction of lay** in which strands and ropes can be twisted is left-handed (anti-clockwise/known as S-twist) or right-handed (clockwise/known as Z-twist). A lower case 's' or 'z' is used to denote the direction of lay of the strands and upper case characters the direction of lay of the rope.
In **lang lay ropes**, the lay direction of each strand in the rope is the same as that of the strands combined. As a result of this, the strands remain movable in relation to each other, which makes the rope supple and thus flexible. When bending a rope, one side would actually have to elongate while the other compresses.

[2] Source: Translation of the German Wikipedia entry for rope on 29 November 2016
[3] Source: Website of Messrs Gleistein

However, due to the movement of the strands, the twist allows the compression to simultaneously balance out the elongation – the compressed strand is simultaneously elongated elsewhere. Lang lay ropes are used for towing ropes and hauling cables on funicular railways, for example.
In **regular lay ropes**, the twist within and between the strand bundles varies. The actual rope is thus filled in, as a form of framework is created due to the strands rubbing against each other. Consequently, the rope is flexible but still stiffer.
In turn, thicker ropes (hawsers/mooring lines) consist of several finer ropes, which are twisted together and in this function referred to as secondary strands. The direction of lay of the secondary strands of the entire rope are opposite relative to each other, which prevents the rope from untwisting.

In eight-strand plaited rope, eight strands form an almost square cross-section. It is very robust and easy to grip, while also having good splicing characteristics.

The line to be examined in the present case consisted of polypropylene, the high-tenacity fibres of which deliver excellent handling and good elasticity (stretch). Such lines are extremely light, buoyant, do not absorb water, are chemically resistant to most acids and alkaline solutions, have good UV stability, and are abrasion/heat resistant.

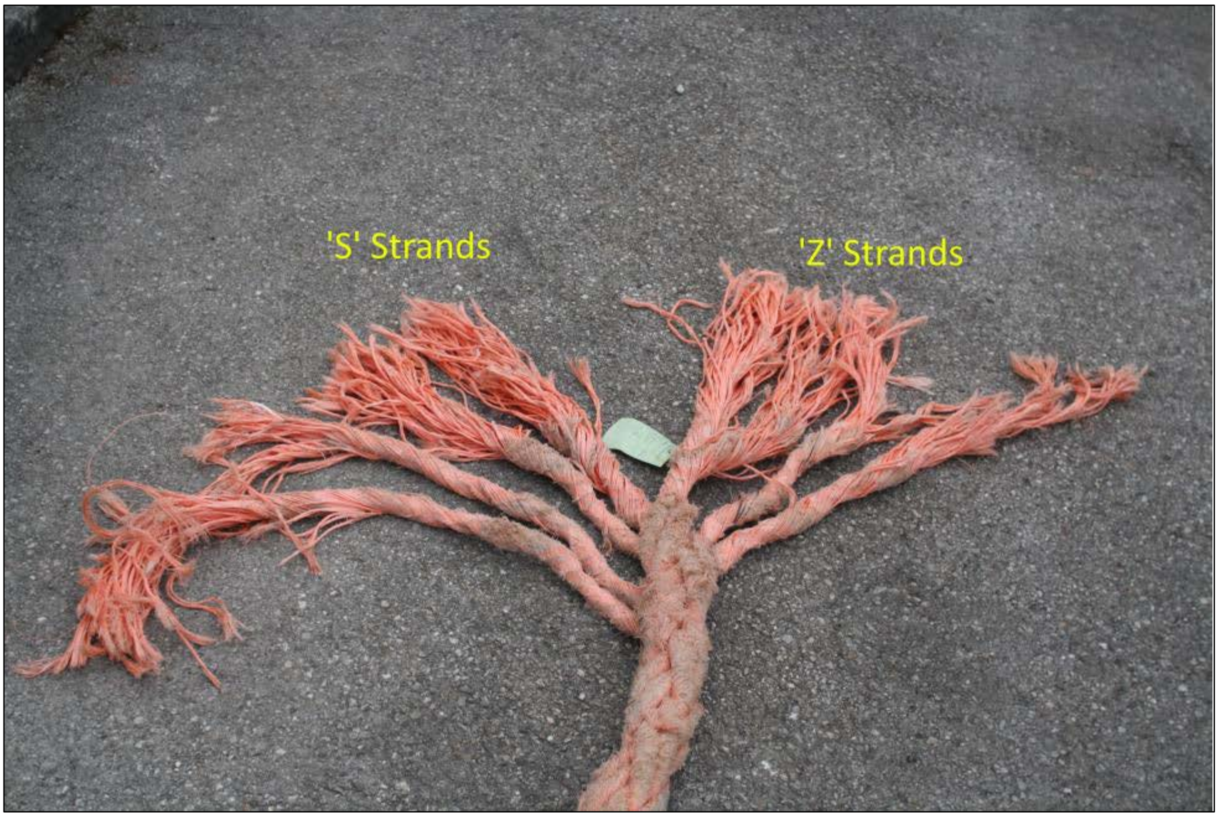


Figure 9: Failed secondary stand arranged as per its direction of lay

When a strong bend places a load on such line, one half of the secondary strand tightens while the other half loosens. The elongated secondary strand will fail first.

This is indicated by short compressed ends. The hitherto loose secondary strands will fail only after that and then produce elongated ends.
In the present case, all the secondary strands exhibit a similar failure pattern. Consequently, it is reasonable to assume that a bending load was not responsible for the failure of the line.

According to information given by the owner, the failed line was purchased new in December 2007 and stored in the ship. It is reportedly no longer possible to trace documents, as this coincided with a change of shipowner. However, two photos exist that show the winch with different lines. One was taken in October 2012 and has a white line on the winch. The second photo was taken in May 2013 and shows the same winch with the current red line. This means that the parted line replaced the old line during this period and has been in use since. Accordingly, the line was stored for about five years before being used for about three years.

The BSU requested an assessment of the secured line failure from Messrs Tension Technology International Ltd (TTI)[4]. The opinion was considered in this report.

It concerned an eight-strand polypropylene line with a diameter of 72 mm and an original tensile strength of 869 kN made by Norwegian manufacturer Timm A/S. Each secondary strand consisted of 75 yarns, which were designed so that 36% of the load was supported by the outer layers. Consequently, the line loses up to 36% of its tensile strength if it is damaged on the outside.

The two separated parts of the failure were available for examination. One part was about 5.50 m long and the other 6.50 m (see Figure 10).

The line generally exhibited significant external damage, as shown in Figure 11. Its wear was also extremely advanced in certain places, as shown in Figures 12 and 13.

[4] No other company that specialises in the investigation of mooring lines to this extent could be found anywhere the world. Similar marine casualty investigations have already been worked on together (see Ref.: 302-07 Northern Faith)

Figure 10: The two ends of the failure

Figure 11: Generally poor condition of the line

Figure 12: Heavy wear in certain places

Figure 13: Heavy strand damage

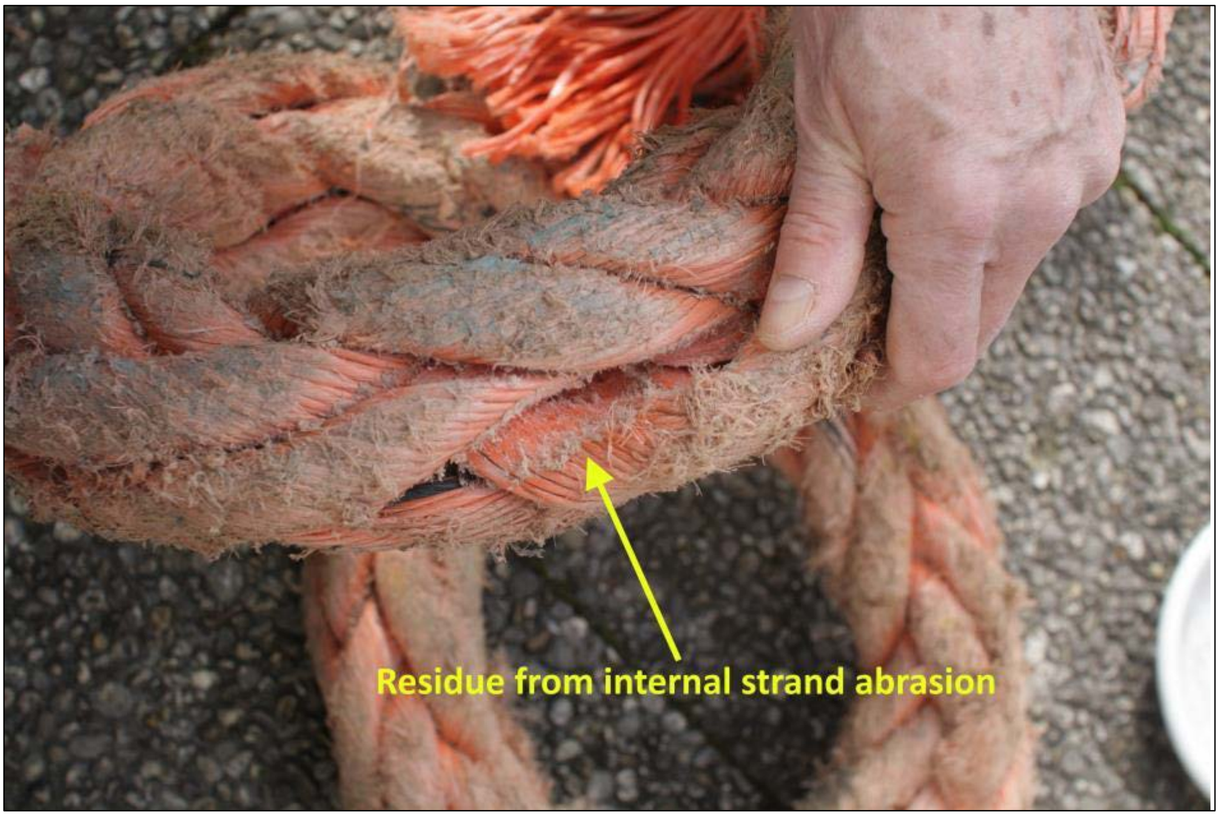


Figure 14: Abrasion on inner strand due to regular wear

Figure 15: Paint abrasion from a fairlead

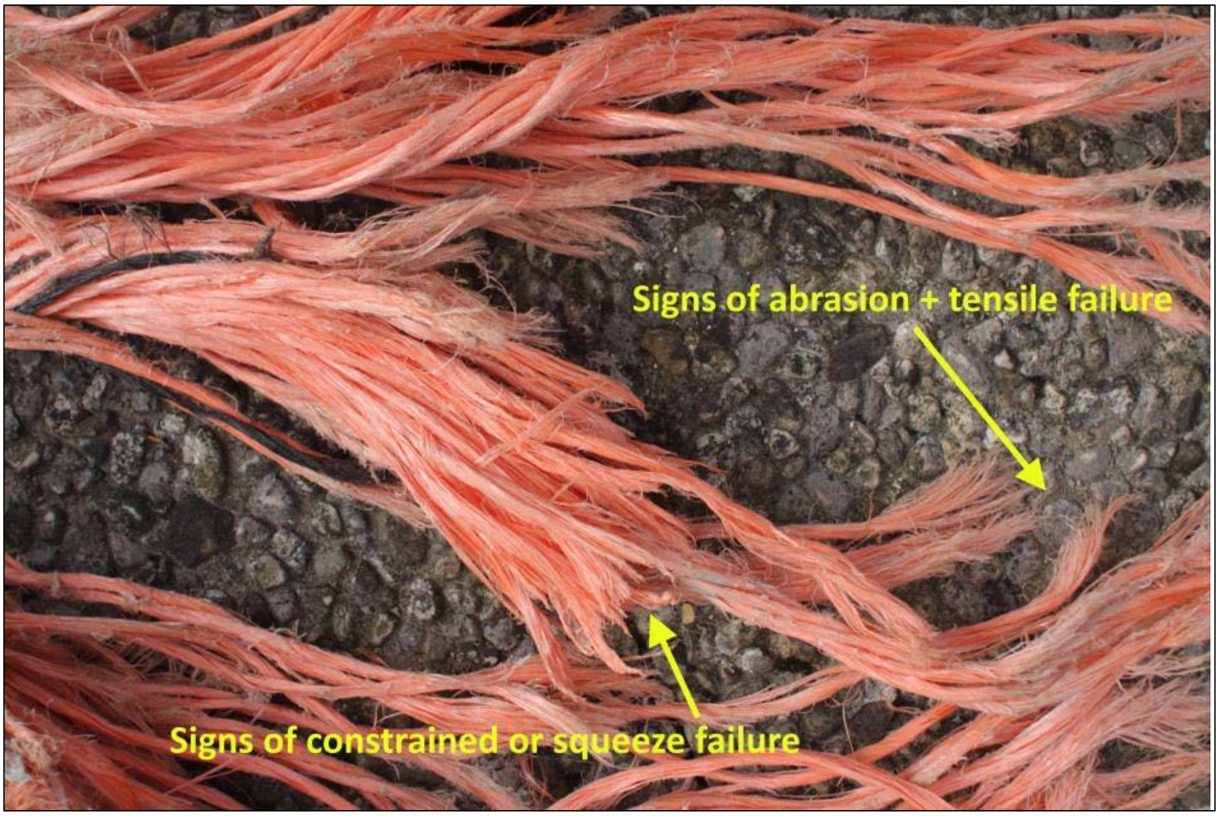


Figure 16: Close-up of the failure

The line was assessed in accordance with the Cordage Institute Guideline.[5]
The wear on the parted line is assessed as moderate to heavy. The following table lists the findings and recommended measures (as per the Guideline):

| **A.) Description of the damage** | **Recommended action** |
|---|---|
| Line exhibits moderate to heavy wear. No precise usage history or records. The rope's specification is available. Various instances of severe strand damage are evident. Risk of injury or damage to property prevails when the line parts during use. | Renew line |
| **B.) Overloading** | |
| Records of the line being overloaded are not available. Since this concerns a mooring line, it is obvious that the line has been under load over the course of time. Wear and inner-strand abrasion are clearly visible. Certain strands have failed. | Renewal of the line should be considered. At the very least, the line should no longer be used for its present function. |
| **C.) Regular tensile load** | |
| Line exhibits moderate inner-strand abrasion. There is clear evidence of cyclic wear. | Renewal of the line should be considered. At the very least, the line should no longer be used for its present function. |
| **D.) Outer wear** | |
| The exterior of the strands/secondary strands is very worn. Some yarns are even torn. Continued use may be dangerous. | Renew line |
| **E.) Cuts** | |
| No cuts are evident. | No action required |
| **F). Drawn yarns/loose strands** | |
| There are no findings as to the line's general structure. | No action required |

In summary, a mooring line in this worn condition should be replaced immediately.

[5] Cordage Institute Guideline CI 1401-15 • Recommended Safety Practices for Use of Fiber Rope • October 2015, 994 Old Eagle School Rd., Suite 1019, Wayne, PA 19087-1866; www.cordageinstitute.com

# 4 ANALYSIS

## 4.1 Medical

The chief mate and his team on the forecastle responded extremely quickly by informing the master on the bridge and initiating first aid measures on the casualty.
However, this raises the question as to whether it would have been better for the casualty to leave him in the prone position and let the rescue services remove him from the ship. Precisely when knowledge of the internal injuries was lacking and with the certainty that the ship is at the pier and a medical emergency team will arrive soon, it would not have been necessary to take the casualty ashore using shipboard equipment.
This action was not found to have any adverse effects. Needless to say, the BSU assumes that all the crew members were acting in the best interest of the casualty and were under stress in this exceptional situation.

## 4.2 Mooring line

It should be noted in general that mandatory guidelines for the inspection of mooring lines do not exist anywhere in the world. However, the Cordage Institute does issue guidelines and their implementation is strongly recommended.
The investigation of the parted line by acknowledged experts based on the above guidelines gave rise to the conclusion that the external damage to the line alone was so clear that it must have been evident to the ship's crew. The line should have been replaced long ago and it is highly likely that this accident would have been avoided if it had been.
Since the line was first kept in storage for many years in this specific case, it should be noted that recommendations on how long a line can be stored without being used do not exist. The manufacturer of such polypropylene lines merely stresses that a line should be stored in a dry area and not exposed to sunlight.

## 4.3 Actions taken

After an enquiry by the BSU, the owner stated that the parted line had been immediately replaced by a new one.
Furthermore, it was asserted that the Cordage Institute is a body that represents the interests of industrial line manufacturers and that its guidelines are not mandatory.
The Code of Safe Working Practices for Merchant Seafarers (2015)[6], which is also non-mandatory, is exercised on board the MAERSK KURE. Although very extensive, this does not address the particulars of inspecting lines – in sections 18.2 and 18.33, in particular – to the extent proposed by the Cordage Institute's Guideline. In particular, it does not require the documentation of line inspections.
Consequently, the owner submitted as written evidence various Port State Control documents from the year 2015. These indirectly confirmed there were reportedly no adverse findings as regards the mooring lines, either.

[6] Published by the United Kingdom Maritime and Coastguard Agency (MCA)

# 5 CONCLUSIONS

## 5.1 First aid measures

Casualties should be moved as little as possible. If they are moved, then preferably only after consulting a medical practitioner. Of course, casualties need to be moved out of an area of immediate danger as soon as possible. However, if medically trained assistants are available, then they should take charge of the transport.

## 5.2 Inspection of mooring lines

Had the mooring line investigated in the present case been inspected regularly, preferably as per the Cordage Institute Guideline, then it ought to have been replaced significantly earlier than the accident. Such inspections should be carried out every six months and the crew must be educated and trained appropriately. Lines must be renewed if there is any shadow of doubt. Regardless of visible condition, used lines should be replaced every five years at the latest.
There are no guidelines or recommendations for stored – unused – lines.

# 6 SAFETY RECOMMENDATIONS

The following safety recommendations do not constitute a presumption of blame or liability.

## 6.1 Ship's crews

The Federal Bureau of Maritime Casualty Investigation recommends that crews move casualties as little as possible and if this is necessary, then preferably only after consulting a medical practitioner.

## 6.2 Owner

The Federal Bureau of Maritime Casualty Investigation recommends that the owner train its crews so that they inspect the mooring lines regularly, document this, and arrange for a replacement in cases of doubt.

## 6.3 Scientific maritime institutions and rope manufacturers, Ship Safety Division and the Federal Ministry of Transport and Digital Infrastructure

The Federal Bureau of Maritime Casualty Investigation recommends (as mentioned in investigation report 302-07) that **scientific maritime institutions and rope manufacturers** expedite the development of lines and/or systems that make it possible for vessel commands to determine the existing load capacity of a line in a practicable way.

The Federal Bureau of Maritime Casualty Investigation recommends that the Ship Safety Division continues to lend support to the development of such systems and if necessary to update guidelines for the use of these systems.

We recommend that the **Federal Ministry of Transport and Digital Infrastructure** promotes the research and development of such systems.

# 7 SOURCES

- Investigations by WSP Bremerhaven
- Written statements
  - Ship's command
  - Owner
  - Classification society
- Witness testimony
- Opinion of Tension Technology International Ltd. (TTI)
- Technical paper of Gleistein GmbH
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Official weather report by Germany's National Meteorological Service (DWD)
- Documentation from the Ship Safety Division (BG Verkehr)
  - Accident Prevention Regulations (UVV See)
  - Guidelines and codes of practice
  - Ship files