Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Bundesoberbehörde im Geschäftsbereich des Bundesministeriums
für Verkehr, Bau- und Wohnungswesen

Investigation Report 350/03

Very serious marine casualty:

Death of a crew member of MV AUTO ATLAS on 11 November 2003 in the North Lock Bremerhaven

Status: 15 July 2004

The investigation was conducted in agreement with the law on improving safety of shipping by investigating maritime accidents and other incidents (Marine Safety Investigation Law-SUG) of 24 June 2002.

According to this the sole objective of the investigation is to prevent future accidents and malfunctions. The investigation does not serve to ascertain fault, liability or claims.

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1 Summary of the maritime casualty

On Tuesday, 11 November 2003 at about 15.15 h[1] the car carrier AUTO ATLAS sailing under the flag of the Republic of Korea entered the North Lock in Bremerhaven on its way from Bremerhaven.

During the mooring manoeuvre in the lock the bow spring became jammed in the mooring winch. While attempting to clear the line one crew member sustained a fatal head injury at about 15.20 h.

Following the initial investigation of the incident by the local River Police and the Criminal Investigation Department in the lock and subsequent further investigation at the Columbuskaje pier, the vessel left Bremerhaven at 02.00 h on 12 November 2003 for the port of Southampton.

[1] All times stated in the report are local time Central European Time (CET) = UTC + 1 h

2 Scene of the accident

Nature of incident:	Very serious marine casualty
Date/time:	11 November 2003, approx. 15.20 h
Location:	North Lock, Bremerhaven
Latitude/longitude:	φ 53°34.2' N λ 008°33.0' E

Excerpt from sea chart 4, BSH

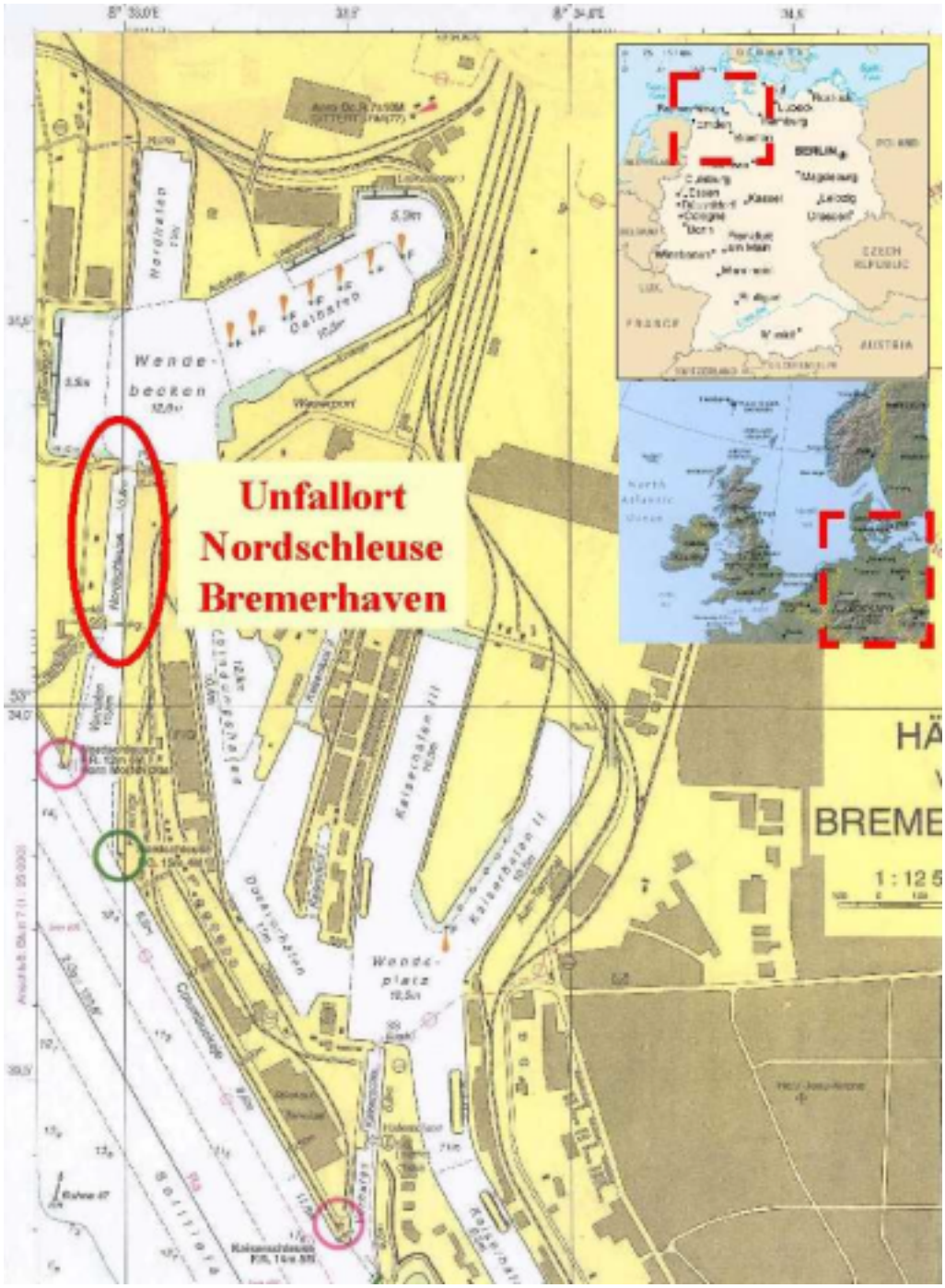


Figure 1: Scene of the accident

3 Vessel particulars

3.1 Photo of vessel

Figure 2: AUTO ATLAS

3.2 Vessel particulars

Name of vessel	AUTO ATLAS
Type of vessel	RoRo car carrier
Nationality/flag	Republic of Korea
Port of registry	Je Ju
IMO number	8608054
Call sign	D7RM
Shipping Company	Pan Ocean Shipping Co. Ltd., Seoul, Republic of Korea
Year built	1988
Building yard/building no.	Daewoo Shipbuilding & Marine Eng. Co., Ltd./4406
Classification society	Korean Register of Shipping
Length overall	199.53 m
Width overall	32.26 m
Gross tonnage	52422 gt
Deadweight	23069 t
Max. draft	10.02 m
Engine rating	9,445 kW
Main engine	B & W 6S60MCE
Speed	17.9 kn
Number of crew	20 persons

4 Course of the accident

4.1 Police investigations

The first police officers arrived on board AUTO ATLAS in the North Lock Bremerhaven at 15.35 h. The first questioning on the spot of the crew members involved by officers of the River Police, as well as by officers of the Criminal Investigation Department who arrived shortly afterwards, proved to be difficult, since all present were evidently still under shock. Furthermore, the crew's command of English represented an additional problem.
On the basis of this first questioning it was determined that the fatal head injuries had been caused by a crowbar found in the area of the port winch. The seaman had reportedly attempted to clear the jammed bow spring with the aid of this crowbar. The line reportedly became tight and the crowbar was flung out of the deceased's hand. He reportedly started to stumble and as a result lost his helmet. The crowbar reportedly then hit him on his unprotected head and caused the fatal injury.
The tool was secured. Furthermore the seaman's safety helmet which was lying intact on deck next to the winch was also secured. Investigations revealed that the helmet had not been fastened with the chin belt and that is why it had been flung from the seaman's head. A hammer also lying near the winch was not secured since its connection with the accident was only mentioned in the written comments by the Chief Mate and the Boatswain produced later.

Figure 3: Crowbar, hammer and helmet in the area of the winch
(Photos River Police Bremerhaven)

A grinding/abrasion mark was ascertained on the left side plate of the winch drum - viewed in the direction of travel - and photographed.

Figure 4: Grinding/abrasion traces on the side plate
(Photo Criminal Investigation Department Bremerhaven)

After completion of the initial investigation AUTO ATLAS was allowed to move from the North Lock to the Columbuskaje pier in Bremerhaven at 17.30 h. The vessel left the lock chamber at 18.18 h and made fast at the Columbuskaje pier Bremerhaven at 19.10 h. In the presence of a Korean interpreter the River Police officers carried out further questioning at about 20.45 h.
On the advice of the lawyer called in, the Master, the Chief Mate and the Boatswain exercised their right not to have to make statements as possible defendants in criminal proceedings. Only the oiler was questioned. At the actual time of the accident he had sought shelter on the port side behind a ventilation shaft (see 4.2.4) and observed the bow spring outboards. Questioning of the oiler was consequently unable to contribute to further clarification of the course of the accident.

4.2 Description of the accident by the crew members involved

After completion of the loading work at about 15.00 h on 11 November 2003 the vessel AUTO ATLAS left its berth at the Autokaje (vehicle wharf) with two assistant tugs and sailing from Bremerhaven passed through the lock gate of the North Lock into the lock chamber at 15.11 h. As second vessel MV SCANDINAVIAN REEFER entered the same lock chamber with one assistant tug at 15.27 h.
At this time the Chief Mate, the first Boatswain (there was a second Boatswain in the crew, who was assigned on the aft deck), one seaman and one oiler were on the forecastle manoeuvre station of AUTO ATLAS for mooring. This staff corresponded

to the customary mooring crew, whereby the oiler could be assigned to either the forecastle or the aft ship as support during manoeuvres.
The Chief Mate, the Boatswain and the oiler were Korean seafarers; the seaman was a Philippine seafarer. The Chief Mate had joined the AUTO ATLAS on 14 April 2003, the Boatswain on 25 September 2003, the oiler on 11 April 2003, and the seaman on 30 September 2002. They were all familiar with the mooring equipment on the forecastle. They all wore safety helmets.

4.2.1 Comment by the Master

On 11 November 2003 AUTO ATLAS had been loading in Bremerhaven. This work was completed at 14.00 h and shortly before 15.00 h the port pilot had come on board. The forecastle had been crewed as usual with the Chief Mate, the Boatswain, the oiler and the seaman. The forward and aft tugs had been fastened, and the vessel had left the pier at 15.00 h.
Shortly after this AUTO ATLAS had entered the lock in Bremerhaven and the Master had notified the Chief Mate that the vessel was to moor with its port side 1+1[2] in the lock. The Chief Mate had informed the Master at 15.15 h that the bow spring had gone ashore as first line[3]. The bow spring had remained slack, since AUTO ATLAS was to move right up to the front of the lock because of the second towed vessel in the lock. The Chief Mate had therefore been instructed by the Master to keep reporting the distance between the bow and the lock gate.
When the vessel approached the gate the Master had been notified by the Chief Mate that there was a problem with the spring; it was not fit for use for a while. From his position on the port wing the line had still had sufficient slack. At this time the vessel had almost reached its final position in the lock and the aft tug had been ready to stop AUTO ATLAS immediately. The Chief Mate had been instructed to pay attention to possible tightening of the bow spring.
One or two minutes later the Chief Mate had then informed him that the seaman had sustained serious injury by an accident on the forecastle. The Master had immediately notified the pilot of this, who in turn had called for the police and rescue services[4]. These had appeared on board about 10 minutes later, but had only been able to ascertain the death of the seaman.
The seaman who sustained the accident had already completed his contract but had then requested an extension up to March 2004[5]. He had learned day-to-day Korean during his time on board.

4.2.2 Comment by the Chief Mate

On 11 November 2003 the vessel AUTO ATLAS was about to leave Bremerhaven. As usual the Chief Mate had been responsible for mooring on the forecastle. The Boatswain, the seaman and the oiler had been the further crew and all had been

[2] 1+1 = 1 bow spring + 1 fore-line
[3] A corresponding entry was made in the Master's manoeuvre notebook
[4] In the Master's notebook the time of the accident was noted as 15.20 h
[5] The seaman had joined AUTO ATLAS on 30 September 2002 and extended his contract on 30 September 2003

wearing protective helmets. contact had been established with the Master via VHF and the Chief Mate had supervised the work, while the Boatswain had operated the winches from the winch controller.
At about 15.00 h AUTO ATLAS had left its berth with one tug forward and one tug aft and shortly after this had entered the lock in order to moor there with port side 1+1. The bow spring had been handed ashore as first line as usual, and the Master had been informed of this after it had been made fast on a bollard in the lock. The Chief Mate had thereupon been informed by the Master that the vessel would have to move further forward. He had in turn instructed the Boatswain to keep the bow spring slack while the two seamen had passed the fore-line as second line through the midships panama chock on shore. The vessel had moved forward very slowly, he himself had reported the distance to the lock gate to the Master.
The fore-line had already been on shore when the Boatswain informed him that the bow spring had become jammed between the winch drum and bearing pedestal. The Chief Mate had seen the seaman behind the winch trying to release the line with a large hammer. He had informed the Master that the line was jammed and instructed the manoeuvre personnel to seek shelter. He had thereupon seen the Boatswain and the oiler fleeing quickly in the direction of the port railing behind a ventilation shaft, the seaman had gone away in the midships direction. Nobody had been in the area in front of the winch.
The Chief Mate himself had felt safe in his position at the forward bulwark by the midships panama chock and had turned round to observe the distance between the vessel and lock gate again. Then he had suddenly heard a loud noise behind him and turned round again. The Boatswain had called something to him and he had perceived the seaman lying on the deck in front of the port winch. The seaman had a substantial head injury, of which the Chief Mate had informed the Master at once. Just a few minutes later the police and rescue staff had been on the spot, but the seaman involved in the accident had already been dead.
Prior to the accident the Chief Mate had last seen the seaman behind the winch and he had no idea how and why the seaman involved in the accident had come into the position in front of the winch.

4.2.3 Comment by the Boatswain[6]

In the early afternoon of 11 November 2003 AUTO ATLAS had left its berth in Bremerhaven and proceeded to the lock in which it was to make fast with its port side. The Chief Mate, the seaman, the oiler and he himself had been on the forecastle.
The bow spring had been handed ashore. The Chief Mate had instructed the Boatswain to keep the line slack, which he had done.
At some stage the bow spring had become jammed between the port winch drum and the bearing pedestal. Some slack had been taken from the drum and the seaman had tried to free the line with a large hammer. Before the bow spring could

[6] Directly after the accident all participants were questioned about the course of the accident by officers of the River Police Bremerhaven (see 4.1). After legal advice was called in the Master, Chief Mate and Boatswain exercised their rights to refuse to make a statement. The comments reproduced here were made in writing on 18 November 2003.

be freed the Chief Mate had warned that the line was becoming tight and they should seek shelter.
The Boatswain had sought shelter by the railing on the port side, and the seaman had gone away too. The Boatswain had turned his face away outboard for protection and waited. Finally he had heard a loud noise when the bow spring had come free from its jammed position itself. He had turned round and seen the seaman lying on deck in front of the winch with a bleeding head wound. Only minutes later the rescue forces had been on board, but the seaman who sustained the accident was no longer alive.

4.2.4 Testimony by the Oiler[7]

In addition to his activity in the engine room the oiler had been assigned for manoeuvres on both the forecastle and the aft ship. On 11 November 2003 he had been working on the forecastle together with the Chief Mate, Boatswain and seaman usually always assigned there. At the time of the accident the Chief Mate had been standing in the front part of the forecastle on the port side, the Boatswain at the winch controller, he had not seen where the seaman had been. The oiler himself had been by the bulwark on the port side behind a ventilation shaft. He had been there after hearing the warning shout by the Chief Mate shortly before the accident. This had been a general warning shout without any closer description of the danger. The oiler had not perceived the reaction of the other crew members, he had only concentrated on seeking shelter himself. Nor had he heard any discussions between the other crew members. He had remained in cover for about one to two minutes and had observed the line over the bulwark from his position.
Then he had heard a loud bang and turned round. He had seen the seaman still standing and then falling slowly backwards. His face had looked normal, there had been something running out of the back of his head.
Directly before the accident the oiler had still been in the area of the winch, since he had been helping to handle the fore line there. After the fore line had been made fast on shore he had followed the warning shout of the Chief Mate and placed himself in a position of shelter. The bow spring had made a noise, but had been under normal load, and he was unable to say whether there had still been any movement in the vessel. The winch had not been working at this time and the oiler had seen that the bow spring was jammed between the winch drum and bearing pedestal. It had not been possible to unwind slack in this situation. The Chief Mate had recognised the jamming of the bow spring and had simply shouted that it could be dangerous. The oiler had not perceived any working on the jammed line with auxiliary tools or any call to do this; such a procedure would have been ruled out on the grounds of danger in any case. He had not heard any other conversations between the Chief Mate and the other crew members either.

[7] The oiler was questioned as witness in the night after the accident by officers of the River Police Bremerhaven in the presence of an interpreter; the content of the testimony record is summarised here.

4.2.5 Comment by the shipping company[8]

On arrival of the River Police on board AUTO ATLAS about 15 minutes after the time of the accident the bow spring was running from the working part of the winch drum, round the foundation of the winch bearing pedestal and from below to the forward side of the capstan head.

Figure 5: Line management on arrival of the River Police
(Photo River Police Bremerhaven)

The line had been made fast on the capstan head with three turns, and then ran from the capstan head again from below to the forward bulwark, with the moving part being jammed to the winch drum.
It was initially unclear when, why and by whom and on whose instruction the bow spring had been made fast in this way.
Prior to the accident the bow spring had been made fast in the manner described over the capstan head in order to free the jammed line. When the spring was heaved in it had become jammed between the drum and the bearing pedestal. At this time there had still been some slack in the line. The seaman had initially suggested freeing the line jam with the assistance of a hammer. This had turned out to be difficult. In turn the seaman had then suggested using the capstan head for assistance by taking the slack line over it and heaving the forward spring free with it. Due to lack of alternatives by the other crew members the seaman had executed his suggestions, both working on the line with a hammer and the variant with the capstan head.
It remained unclear here where the hammer came from and on whose instruction it was fetched, and in particular used, especially since the mooring manoeuvre had apparently not been completed.

[8] There were some unclear matters from the first investigations of the River Police Bremerhaven and the comments and testimony of the participating crew members. In response to a request by the Federal Bureau of Maritime Casualty Investigation the crew was questioned again by the shipping company and the data were set out more precisely.

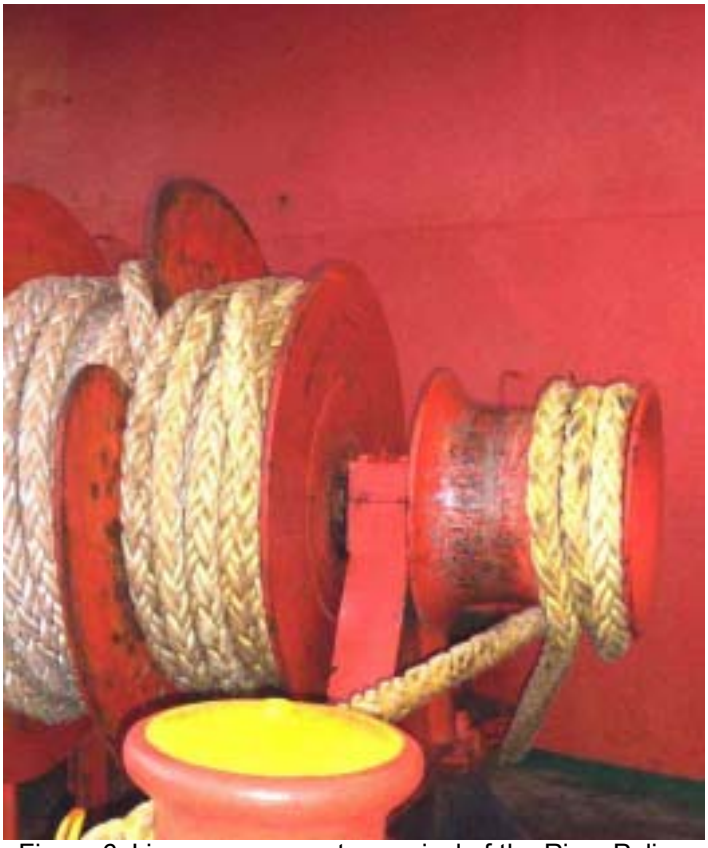


Figure 6: Line management on arrival of the River Police
(Photo Criminal Invstigation Department Bremerhaven)

Figure 7: Storage place for tools on the forecastle

The hammer was reportedly usually kept below the companionway to the forecastle, close to the entrance door. The seaman had fetched the tool from there without having received any express instruction to do so. Following his own suggestion and with the tacit agreement of the Chief Mate, he had tried to free the bow spring with the hammer. Furthermore the seaman had apparently also brought the crowbar, subsequently found in the area of the winch and secured by the River Police, from the forecastle companionway.
Furthermore it was also unclear what language had been used as working language on the forecastle and in what language the Chief Mate's warning had been issued.
Both English and Korean had been used to communicate. During working hours English had basically been spoken. Despite this the Philippine seaman had understood a lot of Korean and was used to talking to the Korean crew members in Korean. The Chief Mate's warning shout had in fact been issued in Korean, but this warning had not been unusual during handling of lines. The Philippine seaman had definitely been aware of the precise meaning of the Korean words; on other occasions before this he had reacted soundly to this warning shout.

4.2.6 Testimony of the Boatswain[9]

After handing over the fore-line as second line to shore, the two seamen had moved in the way of the port mooring winch for further handling of the lines, while the Chief Mate had been standing at the forward bulwark and the Boatswain himself had been standing at the winch controller on the port side. Following the instructions of the Chief Mate the Boatswain had kept the bow spring continuously slack. In doing so the line had been running over the side plate of the drum.
The large number of rope layers on the working parts of the winch drums was explained by the difficulties of being able to estimate the required lengths of the individual mooring lines exactly in advance. The many different ports called with their differing berths made this difficult too[10].
The seaman had carried out the belaying of the bow spring on the capstan head jointly with the oiler and the Boatswain. The Chief Mate had also assisted briefly[11].
After this the Boatswain had returned to the winch controller at the port bulwark in order to free the jammed line by heaving out the capstan head. The two seamen had been standing on the left next to the capstan head, the Chief Mate was already at the forward bulwark again. Due to the further forward movement of the vessel the bow spring had become tight, whereupon the Chief Mate had called on the crew members to seek shelter. The Boatswain had remained at the winch controller and had seen the oiler running aft on the port side. He had last perceived the seaman on the left side next to the capstan head.

[9] The AUTO ATLAS was in Bremerhaven again from 3 to 6 February 2004. Of the crew members involved only the Boatswain was still on board. He was questioned once again on 5 February 2004 in the presence of his legal advisor by the River Police Bremerhaven, the Trade Inspectorate, and the Federal Bureau of Maritime Casualty Investigation to clarify details which were still unclear.
[10] This statement was supported both by the Master on board and by the Chief Mate.
[11] It was not possible ultimately to determine clearly whether the Chief Mate had assisted actively with the line or had simply left his place at the forward bulwark in order to gain an overview of what was happening at the winch.

4.3 Medical examination

The emergency physician who arrived on board at 15.35 h together with the River Police officers only ascertained the death of the seaman who had suffered the accident. In view of the constellation found, she refrained from a detailed post mortem. There is no detailed report in the form of an emergency physician's assignment protocol.

On enquiry by the Federal Bureau of Maritime Casualty Investigation, further medical examinations were conducted at the Institute of Legal Medicine in Hamburg.
The crowbar initially suspected to have been connected with the accident and thereupon secured on board can be clearly ruled out as the direct cause of death. No serological traces could be found, either visually or on the basis of microscopic preparations prepared on the basis of random samples. Nor do the photos taken on board of the evident head injury show the typical configuration of injury caused by crowbar contact. In the same way, the possibility that a hammer could have caused these head injuries directly can also be ruled out.
The course of the accident cannot be clarified with complete certainty by forensic medicine either. However, in order to be able to explain the situation of the victim of the accident and the place in which he was found sufficiently, the traumatising of the seaman concerned must have occurred directly in the area in front of the winch drum. Accordingly the seaman must have been midships of the jammed line. A violent force impulse resulting from considerable acceleration then led to blunt force acting on the skull of this seaman. It appears most probable here that his head hit the left side plate or middle plate[12] of the winch drum. Stumbling against one of these plates caused by movement of the vessel can be ruled out, since the injuries to be expected as a result of this would not have reached the extent of the injuries sustained in this case. The acceleration of the injured seaman's body necessary to cause such injury could accordingly only have been caused by the force impulse of the line coming free. The main vector of this impulse was directed to port; when the line springs free, however, an additional short vector directed upwards is also possible. It is conceivable that the seaman was admittedly standing midships, but despite this so close to the line that the necessary acceleration could have been caused as a result. It is also conceivable that he tried to support the freeing of the jammed line using a tool as lever, e.g. the crowbar found right in front of the winch. As the line came free the resulting force impulse would then have been transmitted via the tool and could thus have caused the necessary acceleration of his body.

[12] Middle plate = dividing plate between the working and storage part of the drum, see 4.5.

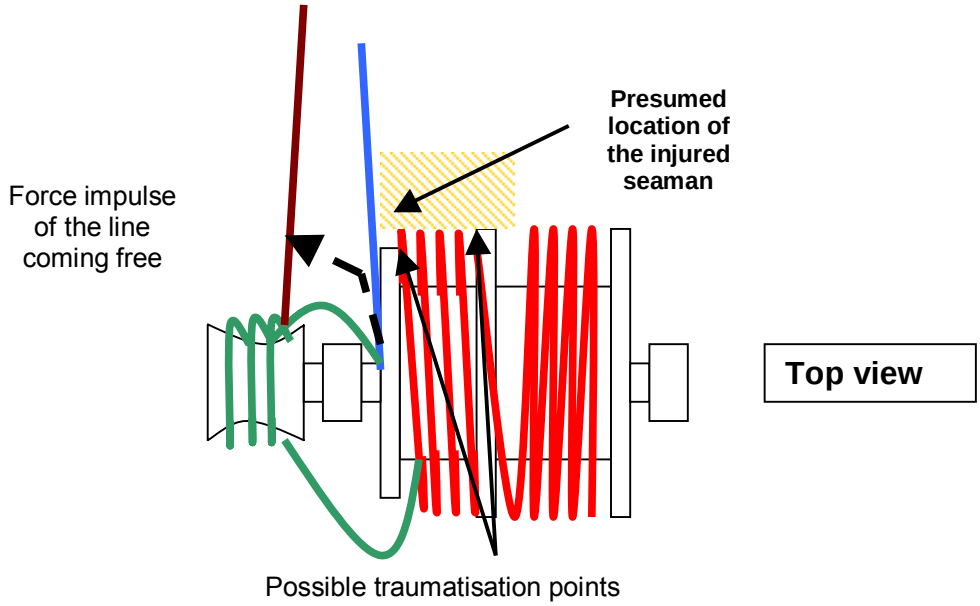


Figure 8: Forensic reconstruction

4.4 Further reports

Further comments were obtained from the pilots on the bridge, the tug crews, the mooring staff in the lock chamber, and the lock staff on duty.
All the times stated regarding entry of AUTO ATLAS into the lock and notification of the accident coincide with those of the crew. None of the other parties questioned could see onto the forecastle of AUTO ATLAS, however. It was not possible to make any pertinent remarks concerning the course of the accident.

4.5 Mooring equipment forecastle

There were three mooring winches on the forecastle of AUTO ATLAS, one on the port side, one on the starboard side and one midships. The winches each have two rope drums, each of which is divided into a storage part and a working part by a middle plate. In addition each of these winches has a capstan head, on the port and midships winch located on the left viewed in the direction of the vessel, and on the starboard winch on the right on the outside of the winch. Furthermore the anchor capstan is integrated in the port and starboard winch.

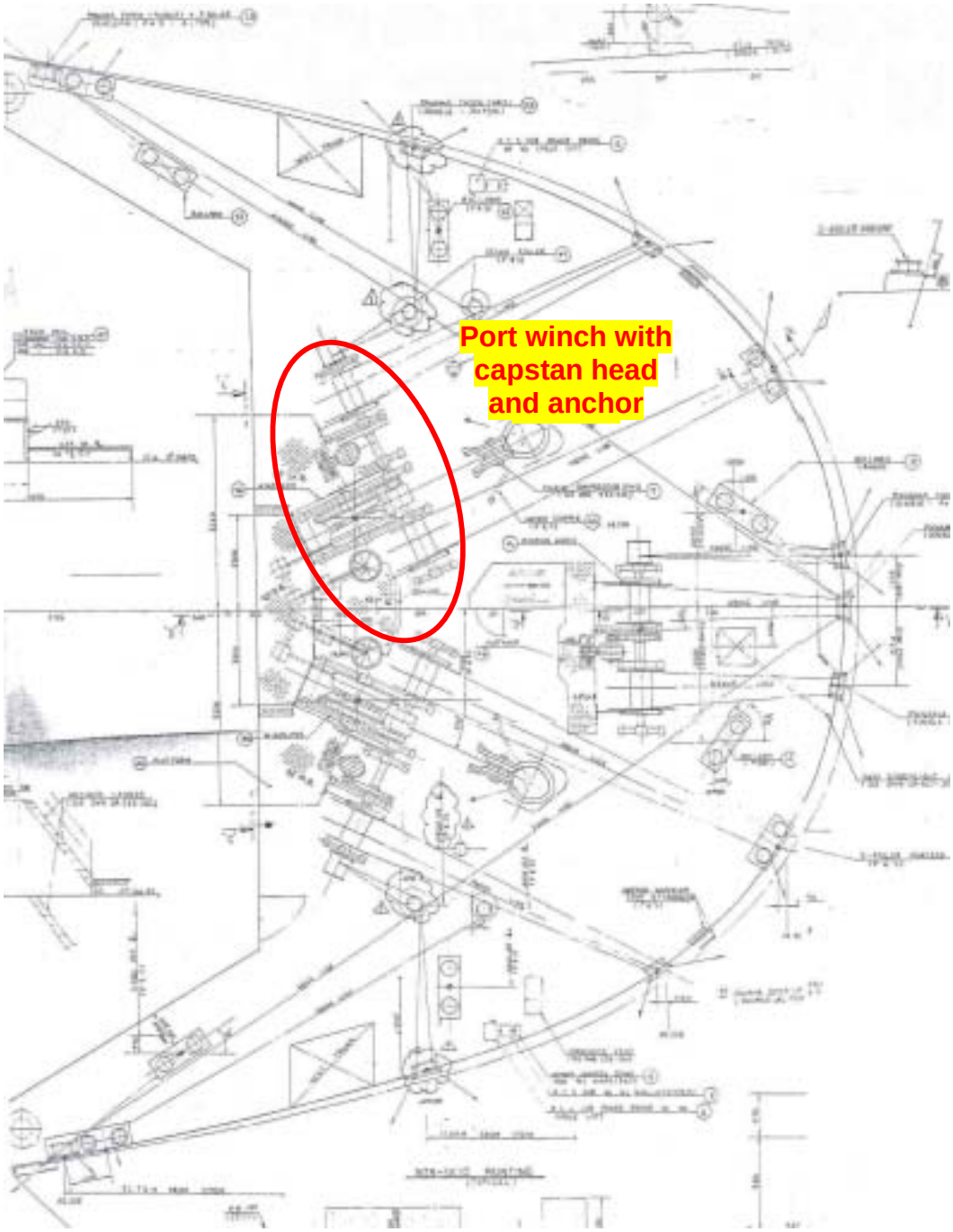


Figure 9: Arrangement plan of mooring equipment on forecastle

The port winch relevant for the accident is a winch of type Fukushima K7681 III–W320 with the following technical details:

Winding load:	20 t on drum at 1st layer
Winding speed:	15 m/min
Mooring drum stowing capacity:	∅ 80 mm, 200 m with 7 layers
Stowing capacity working part:	∅ 80 mm, 50 m with 4 layers
Stowing capacity storage part:	∅ 80 mm, 150 m with 7 layers
Brake capacity:	48.4 t at 1st layer

Figure 10: Port winch

4.6 Water levels and weather conditions

On 11 November 2003 high water in Bremerhaven was at 14.46 h. At the time of the accident at 15.20 h the water depth in the fore bay of the North Lock Bremerhaven was 14.40 m. At the same time the level in the part of the dock behind the lock was 3.25 m, resulting in a water depth of 12.45 m in the turning basin in front of the North Lock.
There was a consistent south-east wind, on average of strength 2 to 3 Beaufort. No gusts above 4 Beaufort occurred. Between 15.00 h and 16.00 h the sun was shining and there was no precipitation. The temperature was 6.3°C.

4.7 Working times

For the days from 9 November until leaving Bremerhaven on 11 November 2003 the following working times were recorded for the Chief Mate, the Boatswain and the seaman:

Date	Time		Activity
9 November	0000-0300	h	Unloading in Bremen
	1140-1220	h	Getting underway in Bremen
	1500-1645	h	Mooring in Bremerhaven
	1730-1800	h	Preparing ramp for unloading in Bremerhaven
10 November	0600-1000	h	Unloading in Bremerhaven
	1030-1230	h	- " -
	1300-1400	h	- " -
	1500-1800	h	- " -
	1830-2210	h	- " -
11 November	0600-1140	h	- " -
	1300-1400	h	- " -
	from 1450	h	Getting underway in Bremerhaven

4.8 Course of the voyage

Before the accident the car carrier AUTO ATLAS had last been in Bremerhaven on 24 and 25 August 2003.
On 25 August the vessel was inspected by the safety organisation Seeberufsgenossenschaft as port state control authority. No defects were complained of.
After this AUTO ATLAS sailed via Port Said (3 + 4 September), Masan (23 - 26 September), Kunsan (27 + 28 September), Incheon (29 + 30 September), Suez (19 October), Piraeus (21 October), Koper (23 + 24 October), Genoa (27 - 30 October), Barcelona (31 October + 1 November), Bristol (5 + 6 November) and Bremen (8 + 9 November) back to Bremerhaven, where it arrived on 9 November.
During mooring in Piraeus on 21 October 2003 there was an incident when the vessel had a light collision with the pier. The damage to the outer plating resulting from this was repaired by the crew during the passage to Bremen. In Bremerhaven, in addition to the usual loading work, there was also a survey of these provisional repairs on 10 November 2003 by the Classification Society Korean Register of Shipping. The repairs carried out on board were accepted with the condition that the steel areas affected were to be repaired permanently by the time of the next annual class survey.

There were no further incidents on the voyage.

5 Investigation

In the accident on the forecastle of the RoRo car carrier AUTO ATLAS during mooring in the North Lock Bremerhaven on 11 November 2003 a seaman sustained fatal injuries at about 15.20 h. No other crew members of the vessel were affected by the accident, neither those working on the forecastle nor the rest of the crew. Nor was there any other personal injury to non-crew personnel, pilots, mooring staff or tug crews. There was no property damage to the vessel, its equipment or the cargo, or to other vessels, the lock, or other maritime structures. Nor was there any harm to the marine environment.

The Federal Bureau of Maritime Casualty Investigation was notified of the incident in the afternoon of 12 November 2003. At this time the vessel was already at sea; the Federal Bureau was unable to conduct any direct investigations of its own. In particular it was not possible to question witnesses personally and the scene of the accident could not be inspected directly. These measures on the spot were only conducted after return of the vessel to Bremerhaven on 5 February 2004.

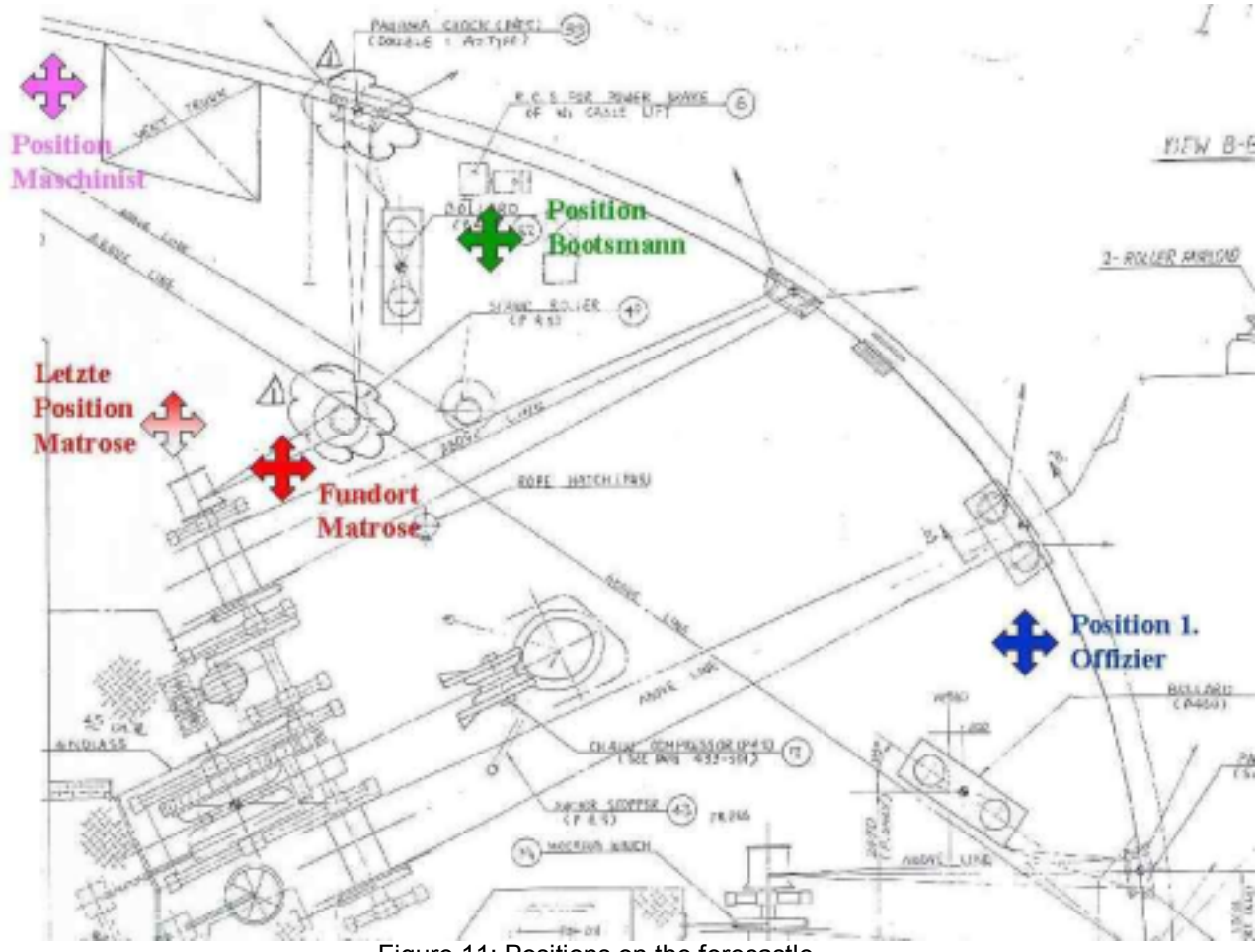
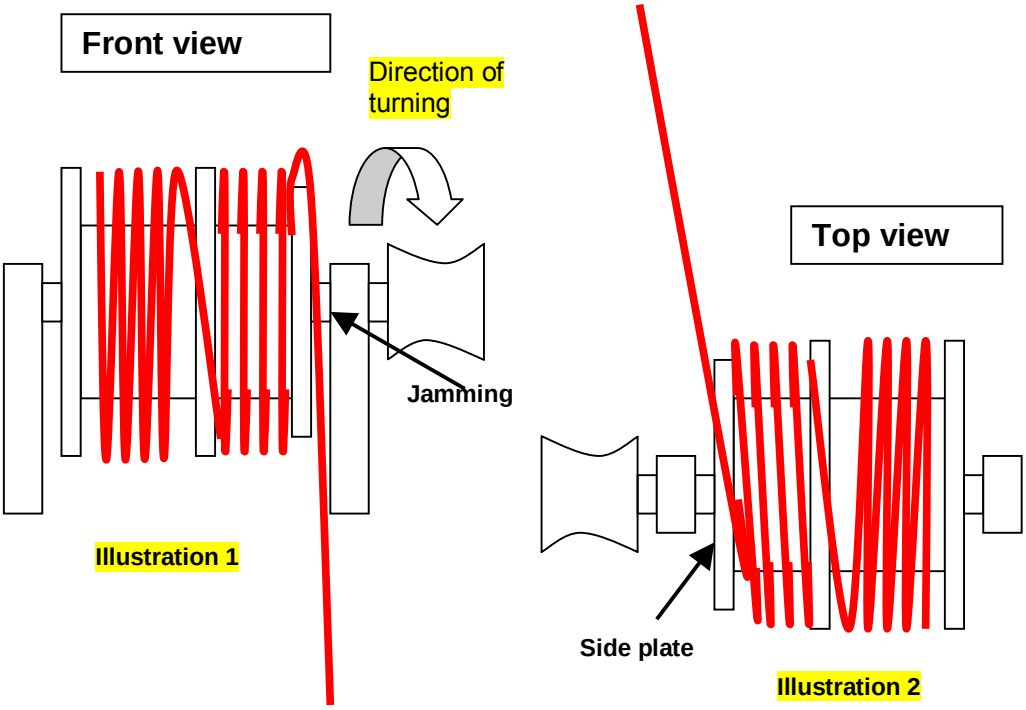


Figure 11: Positions on the forecastle

In addition to these examinations conducted in February 2004, the written statements and testimonies by the participants on the spot and the shipping company, the results of the investigations of the local River Police and the Criminal Investigation Department, as well as their photographs of the scene of the accident, and results of questioning on board AUTO ATLAS conducted on 26 December 2003 in Incheon, Korea, by the Korean Maritime Safety Tribunal (KMST) formed the basis of the following reconstruction of the course of the accident and the following analysis (see 6). Furthermore the Institute of Legal Medicine in Hamburg was called in for a medical examination and the deck machinery manufacturer Hatlapa was called in for a technical-structural examination.
The possibility that details of the accident may have occurred differently cannot be ruled out, since some details could not be clarified finally.

When slacking the bow spring, it ran over the left side plate - viewed in the direction of travel - of the winch drum of the port mooring winch. Due to continued slacking the line was drawn from the front into the lower area between the side plate and the winch bearing pedestal and became jammed there (illustrations 1 and 2) while the vessel was still moving and at this time there was still slack in the part of the line made fast on shore.



At the same time as a result of the continued slacking some slack was taken in the area behind the winch (illustration 3). After the unsuccessful attempt to free the jammed line with a tool, the crew turned the line in three turns round the capstan

head in order to free the bow spring from its jammed position by heaving[13] with the capstan head (illustration 4).

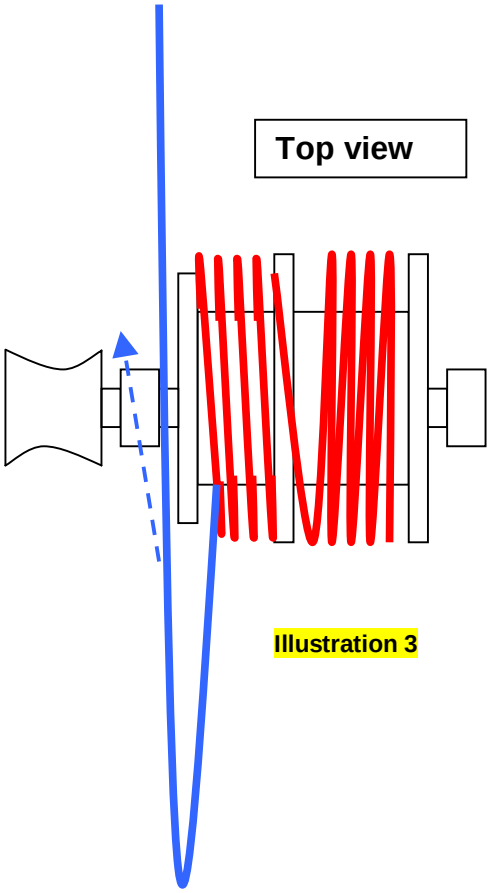


Illustration 3

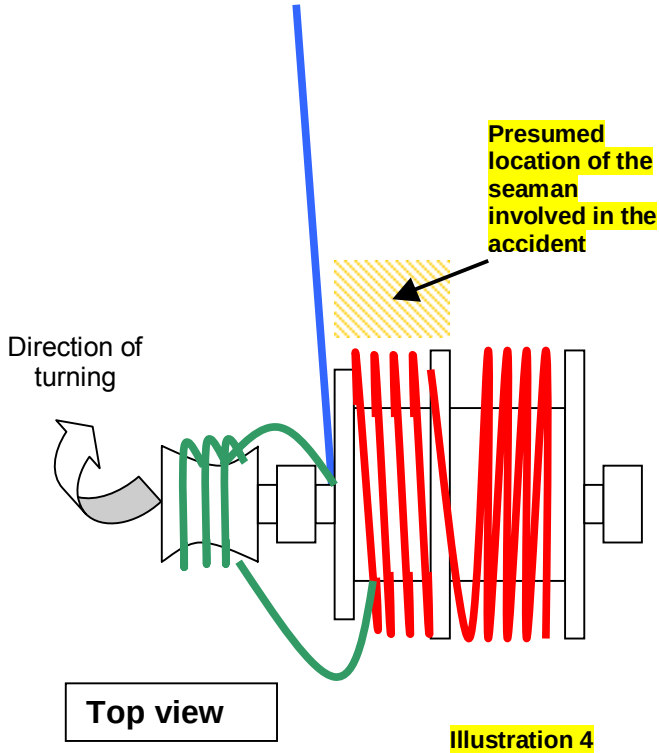


Illustration 4

As a result of the fact that AUTO ATLAS was still moving forward at this time the part of the bow spring made fast on shore became tight; by heaving of the line at the capstan head the part between the jammed location and the capstan head also became tight. After this the bow spring freed itself from the jammed position and struck out to port with enormous force. At the same time the line slipped over the capstan head and the slack still behind the winch was pulled through (illustration 5).

[13] The turns were made from below round the capstan head, an order at the winch controller to "slack" caused a "heaving" at the capstan head.

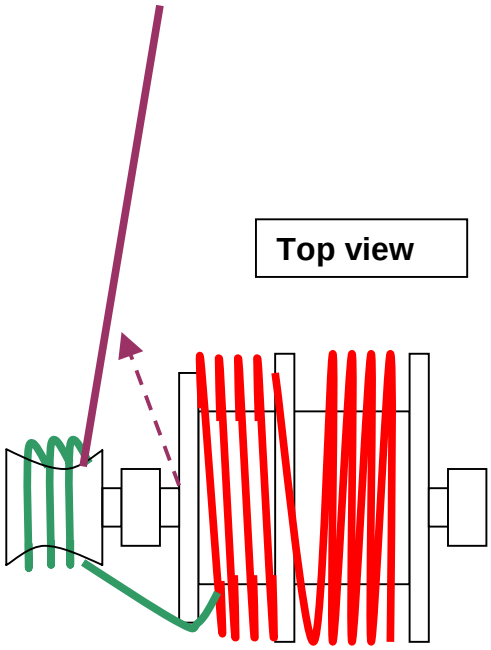


Illustration 5

Figure 12: Reconstruction of the line clamp
according to testimony of Boatswain on 5 February 2004

6 Analysis

6.1 Human factors

6.1.1 Manoeuvre staff on the forecastle of AUTO ATLAS

6.1.1.1 Experience

The Chief Mate, seaman and oiler had been on board for more than six months at the time of the accident. The Boatswain had been on board for one-and-a-half months and already had 5 years of experience as Boatswain on vessels of the same type. All four had made fast in at least 10 ports during the preceding round voyage; the forecastle was the usual manoeuvre station of these crew members during mooring manoeuvres. All except for the Boatswain had, moreover, already been on board at the end of August 2003 for the last port call in Bremerhaven before the accident.
On the basis of the time already spent on board and the frequent port calls, it must be assumed that all crew members on the forecastle were sufficiently familiar with the mooring equipment and the situation on the forecastle and were also experienced regarding the special features in Bremerhaven. Lack of experience is not assumed as cause or promoting factor for the accident.

6.1.1.2 Line handling

According to the information supplied by the manufacturer the port mooring winch is designed for the use of polypropylene lines with a length of 200 m and a diameter of 80 mm (see 6.2). During stowage 50 m line is to be stored onto the working part of the drum in four layers. For mooring, however, only one layer of rope is to be used on the working part. For this it is important to know the mooring position exactly, especially the bollards available for making the line fast on shore, in order to determine the necessary line length already during preparations for the mooring manoeuvre. If such knowledge is lacking and if the required line length is estimated wrongly, after completion of the mooring manoeuvre it might be necessary to shift the lines individually and wind them again. All the forces and speeds[14] are defined for one layer of the rope on the drum, both under DIN ISO 3730 and under the rules of the classification society[15]. In addition to lower forces and speeds, it should also be taken into account that "ropes made of synthetic fibres should not be used on the drum in more than one layer since otherwise their service life is too short"[16].
The photos taken on board AUTO ATLAS on the date of the accident both in the lock and later that evening at the Columbuskaje pier indicate that more than the

[14] Rated tensile, holding, stoppage, winding in boundary and unwinding force, rated, empty rope, and creep speed
[15] Korean Register, Rules for Classification of Steel Ships, Part 5 Machinery Installations, Chapter 8 Windlasses and Mooring Winches, Section 3 Mooring Winches
[16] DIN ISO 3730, 4.1

designated 4 layers were regularly used during stowage, and more than the planned first layer was used in the working part of the drum during mooring.
In addition to the effects of too many layers in the working part already described, with line wound so high the king bollards additionally lose their function as the means for sound line management, since these are lower than the running height of the line.

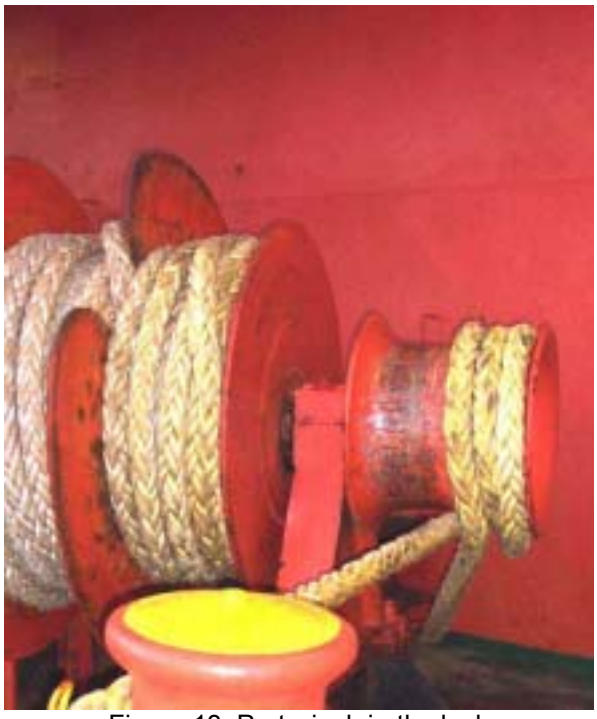


Figure 13: Port winch in the lock
afternoon of 11 November 2003 (Photo Criminal Investigation Department Bremerhaven)

Figure 14: Port winch at the Columbuskaje pier
evening of 11 November 2003 (Photo River Police Bremerhaven)

The photos taken on the date of the accident additionally show a similar situation on the other winches on the forecastle too. In addition on the midships winch the division into storage and working part was not observed consistently. Here the line from the right drum was made fast on shore from the storage part instead of from the working part.

Figure 15: Midships winch, 11 November 2003
(Photo River Police Bremerhaven)

During the next call of the vessel in Bremerhaven the line winding situation on the forecastle mooring winches was unchanged. Both drums of the port winch had more than one layer used in the working part.

Figure 16: Port winch on 5 February 2004

The drums of the midships winch were also used with more than one layer in the working part; in addition the division into storage and working part on the right drum still had been interchanged.

Figure 17: Midships winch on 5 February 2004

The working part on the right drum of the starboard winch was empty. At this time AUTO ATLAS was moored with its starboard side alongside; the bow spring was directly taken from the storage part.

Figure 18: Starboard winch on 5 February 2004

Since nothing is known to the contrary, it is to be presumed that the line management on the day of the accident at the berth at the Autokaje (car wharf) was similar. On leaving the Autokaje the line passed on shore first had to be heaved into the working part of the relevant winch drum. Before entering the lock the crew would then have

had to wind all the lines in the working parts of the six drums off the drums and would then have had to wind the lines back again with seven layers in the corresponding storage parts and four layers in the working parts in order to restore the design recommended by the manufacturer. There was a period of about 10 minutes available between leaving from the Autokaje and entering the lock. The Master on board on 5 February 2004 and also the Chief Mate declared that the procedure described above was generally not followed. Thus it is also to be assumed that on the date of the accident the line lengths passed on shore were heaved into the corresponding working parts of the winch drums on leaving the berth at the Autokaje, but were not shifted any more from there. Only the lines necessary for mooring in the lock were cleared on the forecastle in preparation. The working parts of the drums otherwise remained in the situation with partly more than the four layers provided for by the manufacturer wound on them.
The line handling on board, in particular the coiling of the line in the working part of the mooring winch contrary to the manufacturer's instructions, is assessed as the starting point of the accident occurrence. This was the cause of the line running from the left drum of the port mooring winch over the side plate of the working part and subsequent jamming of the bow spring. The following course of events up to the fatal accident was then promoted by a series of factors.

6.1.1.3 Line handling at the time of the accident

The entire accident occurrence took place between 15.15 h[17] and 15.20 h[18]. After the bow spring was jammed, attempts were initially made to clear it with the aid of the tools brought in. Since this was unsuccessful, existing slack in the line was turned over the capstan head in order to heave the line free mechanically. The part of the bow spring made fast on shore initially had some slack. The berthing manoeuvre in the lock had not been completed. Even though AUTO ATLAS had almost reached its mooring position, there was still some movement in the vessel. Two assistance tugs were made fast, the aft tug was ready to stop immediately.
The crew's attempt to free the jammed line first by using a tool and then with the aid of the capstan head, especially at a time when the mooring manoeuvre was evidently not yet completed, and when the line became tight due to the movement still in the vessel, documents a serious misestimating of the hazard potential here on the part of all concerned. In particular the type of construction of the AUTO ATLAS as a car carrier with a far-projecting fore ship virtually deprived the crew of any possibility of observing the bow spring made fast on shore over the vessel bulwark. The warning time for leaving the hazard area when a jammed line became tight was thus extremely short.

[17] Captain's notebook fore spring on shore
[18] Captain's notebook accident on forecastle

Figure 19: Bow spring beneath the forecastle superstructure

It remains to be ascertained that as far as is known at present, immediate clearing of the line was not absolutely necessary to ensure the safety of the vessel and its crew, of other vessels and their crews, or of the lock and its staff. Nor was there any pressure of time since the second vessel had not yet entered the lock at the time of the accident, and so lock operation was not imminent.
The location of the seaman involved in the accident at the time of the accident can only be determined approximately. The reason for his assuming this position or what he did at this position cannot be determined beyond doubt. However, his presence in the direct area of danger as a consequence of acting rashly was the direct pre-condition, and the misestimating of the danger existing as a result of the jammed bow spring was a contributory cause of the ultimately fatal outcome of the accident. The fact that he was wearing his protective helmet without securing it further reinforced the consequences of the accident.

The crew of AUTO ATLAS could have avoided the situation leading to the accident. The vessel could have shifted aft a few meters with the aid of the assistance tugs or its own aft ship winches and so have taken some of the tightness out of the bow spring. It would then have been possible to clear the jammed line without any danger.

6.1.1.4 Organisation

The Chief Mate was responsible for the work procedure and coordination on the forecastle. This responsibility of the competent officer, especially as regards safety of personnel, is pointed out expressly in the safety procedures to the ISM Manual of the shipping company. The Boatswain and seaman as navigational staff with the oiler as support carried out the line management in accordance with the instructions of the

Chief Mate. The main task of the Boatswain was to operate the winch controller, and that of the two seamen was to work with the lines.
At no time during the accident occurrence was there an express request to the crew not to use tools on the jammed line or not to heave it mechanically with the capstan head during the mooring manoeuvre that had not yet been completed. Instead the Chief Mate accepted the actions with at least tacit agreement, although he did not demonstrably order these actively. The Boatswain did not demonstrably order the work either, but supported it actively in that the use of the capstan head for heaving the line free was only possible in agreement with the crew member working at the winch controller and could then only be executed from the winch controller itself. The belaying of the slack from the bow spring over the capstan head necessary for this was carried out jointly by the Boatswain, seaman and oiler. In this connection line problems with earlier mooring manoeuvres[19] and resulting blunting regarding the dangers of a jammed bow spring must be considered as possible.
After the warning shout of the Chief Mate when the line became tight, he and the Boatswain looked outboard; the danger area on the forecastle remained unsupervised despite the enhanced danger potential due to the tension that had resulted in the bow spring. Entering the area in front of the winch or further action on the jammed line or the winch could no longer be observed and prevented.
In so far weaknesses in the leadership structure promoted the course of the action.

6.1.1.5 Language

The Chief Mate, Boatswain and oiler were Korean seamen; their partly uncertain English made the work of the police in Bremerhaven on the day of the accident considerably more difficult[20]. The Philippine seaman involved in the accident had already been on board since 30 September 2002 and according to the information supplied by the Master had a command of "Korean day to day language". It is stated in the ISM Manual of the shipping company regarding the working language to be used that for a purely Korean crew, Korean was basically to be used, and for a multi-national crew English was to be used instead as working language. However, for ratings on vessels with multi-national crews both Korean and English were allowed as working language.
Before the accident the Chief Mate had drawn the attention of the crew members on the forecastle to the danger due to the jammed bow spring with a warning shout in Korean and called upon them to seek shelter. Linguistic misunderstanding of the warning shout on the part of the Philippine seaman is not assumed here. Not least on the basis of his experience on ships, the seaman must have known of the danger in any case. Despite this, the non-uniform working language on the forecastle of AUTO ATLAS results in major weaknesses in the work procedure. The Chief Mate had to issue instructions in English and Korean in order to ensure that all crew members understood. Individual crew members might not have been able to communicate with each other directly in certain situations, if there was no command of English on one

[19] In the written comment by the shipping company of 19 December 2003 it is stated inter alia: "..that warning was not rare during the line handling works. The Philippine O/S knew the exact meaning even though it was in Korean because he himself used to react properly at that warning before."
[20] When AUTO ATLAS called Bremerhaven again on 5 February 2004 communication with the Boatswain was only possible through the Master who spoke excellent English. The Chief Mate on board also spoke English, but for part of the time used the Master as interpreter.

side, and on the other side only a command of "day to day" Korean. In this case communication could only be carried out via translation by the Chief Mate, which may well be unproblematic in routine manoeuvres, but could lead to difficulties in stress situations.
Language difficulties are not considered as a cause for the incidents developing quickly on the date of the accident, but an effect promoting the accident occurrence cannot be entirely ruled out.

6.1.1.6 Fatigue

On the date of the accident the seaman had been on board AUTO ATLAS for more than 14 months, the Chief Mate and the oiler for seven months, and the Boatswain for one and a half months. Such long periods on board like that of the seaman contain the subliminal danger of progressive fatigue on the basis of routine. Carelessness, lack of concentration, and possibly misestimating of danger in supposedly routine situations cannot be ruled out as a consequence. The accident under review here does not represent routine, however, but instead on the basis of the line jamming it is an exception. Cumulative fatigue as a consequence of continuing routine during the long time on board is not considered to be a substantial factor promoting the accident occurrence.

In the three weeks from 19 October 2003 (Suez) to 9 November 2003 (sailing into Bremerhaven) the crew of AUTO ATLAS had called at eight different ports. These eight different port stays in the three week period lasting on average a little over two days and with stress caused by loading and discharge operations similar to those in Bremerhaven were interrupted by sea passages of on average also two days with sea routine in the three-watch system.
During the days directly before the accident the Chief Mate, the Boatswain and the seaman were engaged in routine work in Bremen and Bremerhaven. On 10 November 2003 there was a working time between 06.00 h and 22.10 h of 13 hours and 40 minutes, interrupted by altogether four breaks of a half to one hour each. During the night from 10 to 11 November 2003 between 22.10 h and 06.00 h a period of seven hours and 50 minutes was noted as continuous rest period. The maximum admissible working time of 14 hours was not exceeded and the minimum rest period to be granted of six hours was not undercut. On the day of the accident work progressed from 06.00 h to 11.40 h continuously for five hours and 40 minutes. After a rest period of one hour and 20 minutes up to 13.00 h there was a further one hour working period up to 14.00 h, followed by a 50-minutes rest period. Altogether six hours and 40 minutes work with two hours and 10 minutes rest time were noted for the Chief Mate, Boatswain and seaman prior to leaving port on 11 November 2003.
Fatigue as a consequence of a direct sleep deficit cannot be derived from the working times documented prior to the accident. The constant change between sea and port routine in a roughly two-day rhythm stipulated by the course of the voyage did not allow the physique any permanent adaptation to one daily routine or the other. The three-watch system on sea and daily service in the port called for constant adaptation of the physique, but at the same time allowed sufficient rest periods both in port and during sea operation. Fatigue as a result of the constant change of board routine is virtually ruled out as promoting the accident.

6.1.2 Other personnel

Neither bridge, nor lock, nor tug personnel could see the incidents on the forecastle; active intervention in the sequence of events on the fore ship can be ruled out. Moreover none of these parties reported any irregularities in the mooring manoeuvre as they saw it; passive intervention by an emergency manoeuvre or the like must also be negated.
Other crew members apparently were not on the forecastle or in its direct vicinity during the mooring operation.
All the knowledge available virtually rules out the possibility of the accident being influenced by any other than the persons on the forecastle of AUTO ATLAS.

6.2 Technical factors

No operating check or a check of whether the winch drum was coupled at the time of the accident was carried out on the port mooring winch. The position and functioning of the band brake or the winch controller were not checked either. There were no evident indications of malfunction or incorrect operation.
According to the information supplied by the manufacturer the winch is designed for use of polypropylene lines with a length of 200 m and a diameter of 80 mm, with a maximum of seven layers in the storage part and four layers in the working part. An Inspection Certificate dated 24 September 2003 documents the use of the corresponding lines on board AUTO ATLAS. These lines delivered at the end of September had been in use since the beginning of October 2003; on the date of the accident the relevant line had been in use for about one month. The drum diameter was stated to be 560 mm, the diameter of the middle plate between the working and storage part and the side plate on the storage part as 1840 mm, and the diameter of the side plate on the working part as 1360 mm. With the planned seven layers in the storage part and the four layers in the working part this results in a height of the line stowed on the drum of 1680 mm in the storage part and 1200 mm in the working part. The height of the relevant side plate provides a safety reserve of one layer of line each. The length of the drum is 548 mm in the storage part, equivalent to six turns of line, and 430 mm in the working part, resulting in five turns of line. With an absolutely clean winding pattern this means one turn less in the second, fourth and sixth layer[21]. With six and five turns respectively and seven layers with a line diameter of 80 mm and a drum diameter of 560 mm, there is a storage capacity of 149.97 m line in the storage part. In the working part with five or four turns respectively, four layers and the same line and drum diameters, a stowage capacity of 51.50 m is calculated. This results in a total line length of 201.46 m, corresponding to the manufacturer's information according to which 150 m are to be taken up in the storage part and 50 m line in the working part. However, this ideal-typical calculation does not take into account a distance factor or any other safety factors and is performed on the assumption of an absolutely clean winding pattern. Although the winch drum appears to be sufficiently dimensioned for the intended line, there are doubts regarding this on the basis of the line management found on board. In order to clarify this a calculation for comparison purposes was carried out on behalf of the

[21] See annex 1

Federal Bureau of Maritime Casualty Investigation by the head of design and development of the winch manufacturer Hatlapa, Uetersen.
Binding standards to be applied for dimensioning of winch drums considering the ratio length to diameter of the designated line are only available to a limited extent. There are no specifications by the classification societies on this. The international standard ISO 3730 "Shipbuilding; Mooring winches" primarily addresses steel ropes; only a minimum drum diameter is specified for fibre ropes on the basis of the type of fibre and rope diameter[22]. The technical assessment ordered by the Federal Bureau was carried out on the basis of the technical design data of the winch and the standards, distance factors[23] and safety reserves that are customary at the manufacturer, Hatlapa, but are not internationally binding. The drum diameter of 560 mm is above the ISO 3730 requirement for polypropylene ropes of at least four times the rope nominal diameter, corresponding to 320 mm. In the experience of the manufacturer, without any further data from the rope manufacturer the drum diameter should lie between six and eight times the rope nominal diameter, corresponding to a figure between 480 mm and 640 mm. The rope manufacturer DSR Corporation, Seoul, provides no further data on this; the existing drum diameter is considered to be sufficient. According to the manufacturer's standard, by analogy with ISO 3730 specifications for steel ropes, the height safety of the side plates should be calculated with one-and-a-half times the rope nominal diameter. The height safety of a single rope nominal diameter provided for this winch lies below this specification and in the case of an unclean winding pattern can lead to height safety being reduced even further. However, with the lack of any other binding specifications this height safety of a single rope nominal diameter is basically considered to be sufficient. The distance factor for the rope data in this case should be assumed to be 2 mm, which with determination of the drum length results in a rope diameter to be used of 84 mm. The existing drum lengths of 548 mm in the storage part and 430 mm in the working part are also sufficient for six turns with 84 mm in the storage part and five turns with 84 mm in the working part. However, according to the manufacturer's standard, the number of rope layers should not exceed three in the working part and six in the storage part, so that with a total rope length of 200 m initially 25 m rope should be provided for the working part and 175 m rope for the storage part. This distribution of the total line length is not possible with the design data of this winch. Taking the existing drum length as a basis and with a specification of at most six layers in the storage part and three layers in the working part, we have a maximum length of rope to be used of 165 m, with a rope nominal diameter of 80 mm. Since this standard is not binding on this point either, and as the rope manufacturer does not make any specifications regarding the maximum admissible number of rope layers, the stowage with seven and four layers must again be accepted as admissible.
In the present case the general line handling on AUTO ATLAS (see 6.1.1.2) worsened the situation by the fact that the upper rope layers in the working parts of the winches were apparently run under load, partly evidently exceeding the proposed number of rope layers in the working part.

[22] DIN ISO 3730, 4.6 and 4.7.3
[23] Distance factor: design reserve for calculating the lengths of the working and storage part in order to prevent the rope under load pinching itself in the drum base and in the worst case, due to the resulting deformation, of becoming damaged itself. The distance factors from Hatlapa are based on experience and data from various rope manufacturers.

Figure 20: Rope in the working part of the winch
under load and exceeding the proposed rope layers

Not only does the nominal pulling power of the winch decrease here with increasing number of layers with the same input torque, but also the danger of the rope springing over and subsequently becoming jammed is substantially magnified. At the time of the accident the bow spring was already fast on shore; after the line length necessary for this had already been taken from the working part of the drum, the line ran over the side plate despite this. The bow spring was then jammed between the winch drum and the bearing pedestal. The design distance specified here is 50 mm. Although a line with a diameter of 80 mm as designated by the manufacturer was used in this case, the turning winch drum caused the line that had jumped over to be drawn into the intermediate space between the side plate and the bearing pedestal and thus become jammed. At the time of the accident there were no deflectors that would prevent any line jumping over from becoming jammed.
Design specifications were not the cause of the accident. It was only in interplay with line handling on board that they promoted both the developments up to the accident and the further course of the accident.

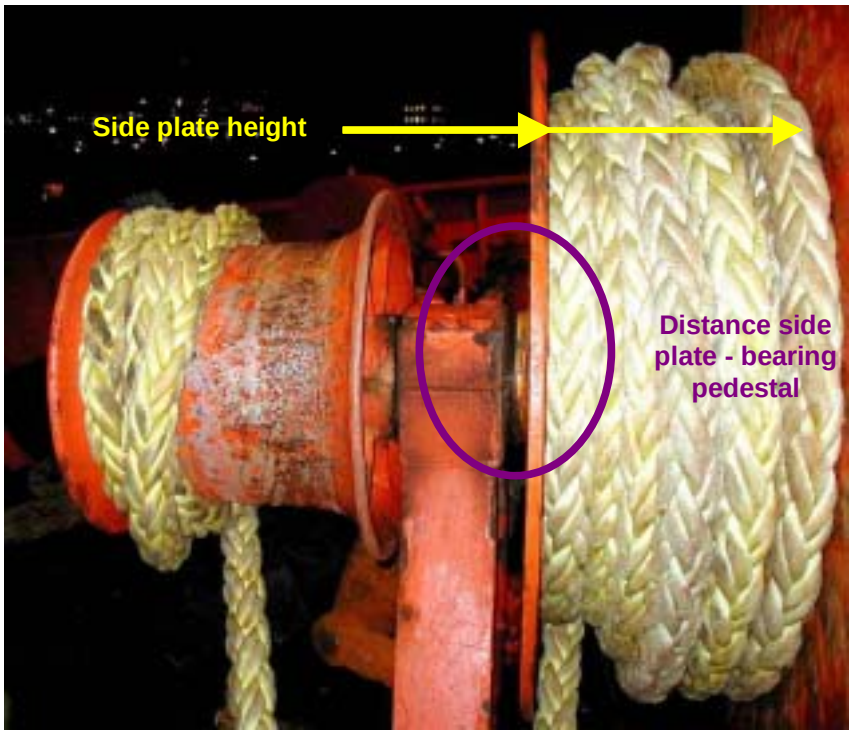


Figure 21: Design points
(Photo River Police Bremerhaven)

6.3 Environmental factors

In the afternoon of 11 November 2003 it was still daylight; there was a weak wind and it was rainless. The temperatures were above freezing point.
The environmental data determined for the place and time of the accident do not indicate that the course of the accident was influenced by these.

AUTO ATLAS came out of the part of the port cut off by the lock; unfavourable current conditions cannot be assumed to have contributed to causing the accident.

The SCANDINAVIAN REEFER as second vessel entered the lock chamber at 15.27 h. This time was after the accident. It can also be ruled out that the following vessel or the start of the lock operation influenced the course of the accident.

7 Recommendations

7.1 Seamanship

The Federal Bureau of Maritime Casualty Investigation suggests that shipping companies work more vigorously towards observing the following recommendations jointly with the shipboard management of their vessels:

- Lines used on board must be suitable and admitted for the designated use as regards nature, material, length and diameter. When lines are heaved in, the maximum number of layers in the storage and working parts of the winches stated by the manufacturers must be observed. If circumstances require that more than these proposed layers be taken onto the drum, especially in the working part, the condition provided for by the manufacturer is to be restored immediately after completion of the manoeuvre. The manufacturer's data concerning maximum number of layers in the working part of the drum relate exclusively to stowage of the line. During mooring operations basically only one layer of line is to be used in the working part in order to have maximum winch pulling force available and to prevent any unintentional damage to the line by cutting into the layers beneath. The procedure described above applies by analogy for shifting of the rope after completion of the manoeuvre.

- The voyage planning to be carried out in accordance with the STCW[24] Code, Section A-VIII/2, Part 2, must be implemented using all the relevant information available. According to the IMO Resolution A.893(21) "Guidelines for Voyage Planning", detailed voyage planning comprises the entire voyage from berth to berth[25]; the information to be taken into account in the planning comprises inter alia the available port information[26] as well as ship-type-specific information[27]. The design-related difficulties in estimating the line lengths needed for mooring can in so far be countered by making mooring sketches of the individual ports/berths in the course of the voyage planning that show where which mooring devices are available on shore. This information can be obtained, if appropriate, via local port masters[28], collected in a kind of port guidebook, and be supplemented by the practical experience of the crew and special local features to be taken into account.

- Jammed lines may never be freed while the line is under tension or while there is a risk that it may become tight. Manoeuvres must be completed and environmental influence such as wind, waves, other vessels, lock passages or the like may no longer represent any danger. If appropriate tension must be removed

[24] Seafarers‘ Training, Certification and Watchkeeping Code
[25] IMO-Resolution A.893(21), 3.1: "...should cover the entire voyage or passage from berth to berth,..."
[26] IMO-Resolution A.893(21), 2.1.7.8: "...available port information..."
[27] IMO-Resolution A.893(21), 2.1.7.9: "...any additional items pertinent to the type of vessel..."
[28] see annex 2: Hafenhandbuch Hansestadt Bremisches Hafenamt (Port Manual Port Office of the Hanseatic City of Bremen), data on overseas ports

from the jammed line by suitable measures such as shifting the vessel aft. The selection of location for freeing of a jammed line is to be made taking into account all possible directions of danger when the line comes free or ruptures. On deciding when and at what time a jammed line is to be freed, attention must be paid especially to whether the line is needed immediately for reasons of ship safety.

- Protective clothing must be worn properly.

7.2 Organisation

The Federal Bureau of Maritime Casualty Investigation suggests that shipping companies work more vigorously towards observing the following recommendations jointly with the shipboard management of their vessels:

- In the case of multinational crews all communications at the manoeuvre stations must be carried out exclusively in one language. All involved must have a command of the working language stipulated by the shipping company. The company shall take sufficient measures to ensure that the necessary language knowledge is available. "Day to day" language skills are just as inadequate in emergency situations as triangular communications via an interpreter.

- The organisational structure at manoeuvre stations must be clear. Independent action within the framework of a normal manoeuvre is practice-oriented and certainly desirable. However, in the case of exceptional incidents measures must only be taken after clear instructions are received from the person responsible. Conversely the persons responsible must cater to their responsibility by issuing clear instructions for actions or omissions.

- The danger area in the case of exceptional incidents must be monitored as continuously as possible by the responsible person taking into account his or her own safety.

- The crew must be instructed regularly concerning possible dangers, also and especially during routine work, for instance in the form of safety training sessions.

7.3 Design

The Federal Bureau of Maritime Casualty Investigation requests the Classification Society, the safety organisation See-Berufsgenossenschaft and the Standards Office for Marine and Maritime Technology to work towards implementing the following recommendation:

- Mooring winches[29] are described in the rules of the Classification Society Korean Register in chapter 8, section 3. These contain no specifications about the dimensioning of drums and side plates as a function of the nature, length and diameter of the designated lines. In the national Accident Prevention Regulations of the See-Berufsgenossenschaft § 100 in conjunction with § 3 and the G 3 Guidelines, reference is made to observance of DIN ISO 3730. Regulations of the International Standard ISO 3730 "Shipbuilding, Mooring winches", which has been taken over unaltered as a German standard, relate explicitly only to wire rope[30] when mentioning dimensioning of winch drums and side plates. "Facilities for fibre ropes" are merely mentioned as a sub-section 4.7.3 of section 4.7 "Auxiliary equipment" and provide information about the minimal dimensioning of the drum diameter. Unlike the data for wire ropes, nothing more is said about the drum capacity, length and flange height for fibre ropes. In view of the considerable use of fibre ropes as mooring ropes, DIN ISO 3730 should be adapted appropriately. A binding reference to the validity of this standard in the construction and testing regulations of the Classification Societies would, moreover, be desirable.

[29] Rules for Classification of Steel Ships, Part 5 Machinery Installations, Chapter 8 Windlasses and Mooring Winches, Section 3 Mooring Winches
[30] DIN ISO 3730, Section 4.6

Furthermore the Federal Bureau of Maritime Casualty Investigation suggests that the shipping company and the winch manufacturer implement the following recommendation:

- Regardless of the design of the drums and side plates there is a risk of a line running over. Immediate design measures in the form of deflectors welded on as protection against lines becoming jammed should be considered by the shipping company for other vessels in its fleet too. This measure should be considered by the winch manufacturer as a basic structural improvement.

Figure 22: Deflector welded on

8 Sources

- Investigations by the River Police and the Criminal Investigation Department, Bremerhaven
- Statements in testimony by crew members
- Written statements/comments

1. by the crew members
2. by the shipping company
3. by the Port Master of the Hansestadt Bremisches Hafenamt (Bremen Port Office)
4. by pilots
5. by lock personnel
6. by the rope manufacturer DSR Corporation, Seoul

- Medical expert report by the Institute of Legal Medicine, University Clinic Hamburg-Eppendorf
- Technical assessment of rope drum dimensioning by Hatlapa Uetersen
- International Standard ISO 3730, Edition 2, 1988-12-15 "Shipbuilding; Mooring winches", taken over unchanged as German Standard DIN ISO 3730 "Schiffbau, Verholwinden (Mooringwinden)"
- Comment issued by telephone by the Standards Office for Marine and Maritime Engineering Hamburg
- Korean Register of Shipping, Rules for the Classification of Steel Ships
- Accident Prevention Regulations of the See-Berufsgenossenschaft (SeeBG)
- Sea charts by the Bundesamt für Seeschifffahrt und Hydrographie (BSH) (Federal Maritime and Hydrographic Agency)
- Official weather report by the Deutsche Wetterdienst (DWD) (German Meteorological Service)

9 Annex 1: Storage capacity and winding pattern

Storage capacity of the winch drum

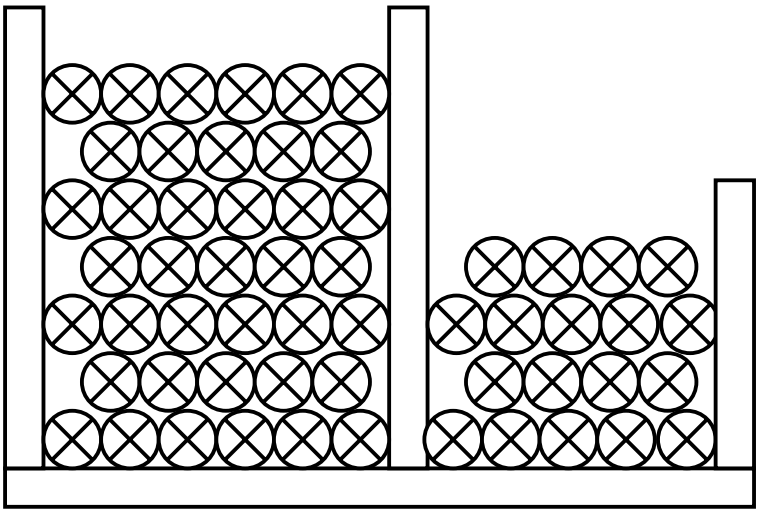
Drum diameter:	560 mm	Radius: 28 cm	R 1 = 28 cm + 1/2 d = 32 cm
Line diameter (d):	80 mm		
Drum length storage part (SP):	548 mm	6 turns in layer 1, 3, 5, 7;	5 turns in layer 2, 4, 6
Drum length working part (WP):	430 mm	5 turns in layer 1, 3;	4 turns in layer 2, 4

π	d	R1	Turns ST	Turns AT	R1-7
3,14	8	28	6	5	32
			5	4	40
					52
					60
					72
					80
					92

with 7 layers on the stowage and 4 layers on the working part:

	SP	WP	
1st layer:	1205,76	1004,8	
2nd layer:	1256	1004,8	
3rd layer:	1959,36	1632,8	
4th layer:	1884	1507,2	
5th layer:	2712,96		
6th layer:	2512		
7th layer:	3466,56		
Total length (m):	149,97	51,50	201,46

Winding pattern with absolutely clean winding



10 Annex 2: Hafenhandbuch Hansestadt Bremisches Hafenamt (Excerpt)

Kapitel 1, Daten der Überseehäfen

Autokaje

Kajenlänge	:	260 m (Knick bei Pos. 52)
Kajenhöhe	:	NN + 3,43 m
Kajenneigung u. W.	:	senkrecht
max. Kajenbelastung	:	2 t/qm
Solltiefe	:	- 10,5 m

Fender

Typ	:	Gummizylinder, waagerecht hängend
Maße	:	Ø = 1 m, L = 2 m
Abstand	:	ca. 20 m
Positionen	:	050, 070, 090, 110, 130, 150, 185

Poller

Typ	:	Doppelpoller
Belastbarkeit	:	80 t
Abstand	:	unregelmäßig
Positionen	:	005, 020, 050, 083, 115, 148, 182, 216, 246 E

Sturmpoller

Typ	:	Doppel- (D) und Einzelpoller (E)
Belastbarkeit	:	100 t pro Kopf
Positionen	:	000 D, 240 E (30 m von der Kajenkante, Unterflur), 280 E

s. Plan 1

Telefon

Schiffsanschluß	:	42536
Anlieger	:	BLG

Versorgungsanschlüsse

Wasser	:	75, 140, 208
Strom	:	kann von der BLG geliefert werden.

Umschlagseinrichtungen : keine Umschlagseinrichtungen vorhanden

Besonderheiten

Kaje dient hauptsächlich zum Autoumschlag. Auf dem Gelände befindet sich eine Garage zum Abstellen der Autos.

Maße: 205 m x 40 m
3 Decks, jedes Deck ca. 15.000 qm
pro Ebene können ca. 1.000 Pkws abgestellt werden.

Chapter 1, Data of overseas ports

Autokaje Wharf length Wharf height Wharf inclination under water Max. wharf loading	: : : :	 260 m (bend at item 52) NN + 3.43 m vertical 2 t/m²
Target depth	:	-10.5 m
Fenders Type Dimensions Distance Positions	: : : :	 Rubber cylinders, hanging horizontally Diameter = 1 m, L = 2 m approx. 20 m 050, 070, 090, 110, 130, 150, 185
Bollards Type Loading capacity Spacing Positions	: : : :	 Double bollard 80 t irregular 005, 020, 050, 083, 115, 148, 182, 216, 246 E
Storm bollard Type Loading capacity Positions (Hand-written remark: See plan 1)	: : :	 Double (D) and single bollards (E) 100 t per head 000 D, 240 E (30 m from the wharf edge, underground), 280 E
Telephone Ship connection Berth	: :	 42536 BLG
Supply connections Water Electricity	: :	 75, 140, 208 can be supplied by BLG
Handling devices	:	no handling devices available

Special features

The wharf serves mainly for handling cars. There is a garage facility on the grounds for parking cars.

Dimensions: 205 m x 40 m
3 decks, each deck approx. 15,000 m²
1,000 cars can be parked on each deck