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

Investigation Report 381/04

Very serious marine casualty

Capsizing and foundering of the Tug JULIUS with one fatality off Brunsbüttel on 16 December 2004

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 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.

The German text shall prevail in the interpretation of the Investigation Report.

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1 Summary of the marine casualty

On 16 December 2004 at about 15:06 h[1] the Harbour Tug JULIUS capsized on the river Elbe at river kilometre 694.5 near the Elbehafen port. The Tug JULIUS belonged to a tug/pontoon combination consisting of the Tug PARAT and the Pontoon E 3505. The Tug JULIUS was to be used as a steering/braking tug and pushed its post against the stern of the Pontoon E 3505.
As a consequence of unforeseeable circumstances the post swung out of the direction of travel to port. The port mooring line leading from the stern of the tug to the pontoon became caught beneath the wheelhouse roof and the tug capsized over its starboard side. After the two aft mooring lines were ruptured, the tug sank to the bottom of the river Elbe.
Of the two crew members on board at the time of the accident, the trainee ship's mechanic was recovered with minor injuries. Despite search measures immediately initiated, it was not possible to find the Master.
A corpse that drifted into the outer harbour of the New Lock in Brunsbüttel on 28 April 2005 was identified as the missed Master. The post mortem examination revealed "death due to drowning or hypothermia" as cause of the death.

[1] All times mentioned in the report relate to Central European Time (CET)

2 Scene of the accident

Nature of the incident:	Serious marine casualty, capsizing and foundering of a tug with one fatality
Date/Time:	16 December 2004 approx. 15:06 h CET
Location:	Brunsbüttel Elbe-km 694.5
Latitude/Longitude:	φ 53°53,124' N λ 009°10,376' E

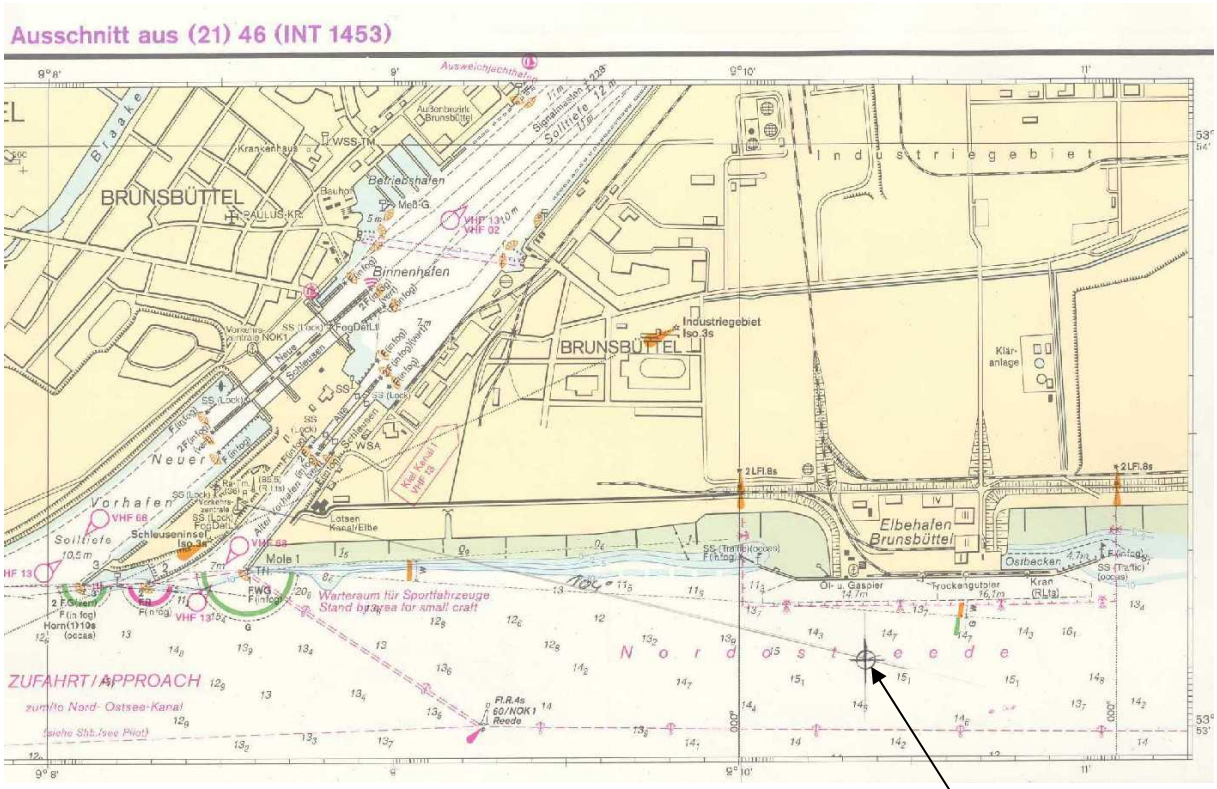


Figure 1: Sea chart

3 Vessel particulars

3.1 Photo

Figure 2: Photo of vessel

3.2 Data

Name of vessel:	JULIUS ex BIBER
Vessel operator:	Hans Schramm & Sohn GmbH & Co KG
Type of vessel:	Motor tug
Nationality/Flag:	Federal Republic of Germany
Port of registry:	Brunsbüttel
SUK Ship's Certificate No.:	1885 HH
Year built:	1977
Building yard/building number:	Cassens Werft, Emden
Length:	15.90 m over all, 13.75 Lpp
Breadth:	4.,80 m over all, 4.50 moulded breadth
Side height:	2.50 m
Draft at time of accident:	2.20 m
Displacement:	approx. 52 t
Bollard pull:	approx. 5 t
Engine and rating:	KHD Type SBF 8 M716 276 kW
Propeller and rudder:	single screw with Kort nozzle rudder
Speed:	approx. 9.0 kn
Hull material	steel
Number of crew:	3

4 Course of the accident

The Pontoon E 3505 was to be shifted from its berth in the Ostbecken Elbehafen Brunsbüttel into the Binnenhafen of the Kiel Canal on 16 December 2004. The pontoon had a length over all of 65 m and was 23 m wide. The freeboard was approx. 3 m at a draft of 1 m. There was an approx. 100 t heavy and 2.80 m high surrounding steel wall welded on the pontoon for dredging work. After the Motor Tug HANS had towed the pontoon from the Ostbecken, the following tug pontoon formation was to be made up:

Head tug: Sea-going Motor Tug PARAT, L: 28.28 m, B: 8.85 m
Sea pontoon: E 3505
Stern/steering tug: Barge Tug JULIUS

The train was formed as follows

Figure 3: Tug-pontoon formation

The head tug PARAT has a Voith-Schneider drive and was connected with the pontoon via an approx two times 20 m long bridle made of wire and a 4 m long poly-line as stretcher. The stretcher then led via an approx. 10 m unwound towing wire onto the winch.
After the connection between the pontoon and the Tug PARAT had been completed at about 14:45 h, the Tug JULIUS was to make fast at the stern while the vessels began to proceed in the direction of the lock.
The Tug JULIUS was first manned with three persons at the vessel operator's berth in Kiel Canal and subsequently shifted through the lock to the Elbehafen at approx. 11:30 h.
The making fast of the tug - that had already been carried out several times - was to be done as follows: The post of the tug is fixed to the stern of the pontoon by lines. After this, lines or towing wires are laid out from the stern of the tug to the stern of the

pontoon. The following photo of a pushing voyage of the Tug JULIUS through the Kiel Canal shows an example of the proper connection.

Figure 4: Towing journey Kiel Canal

At about 15:05 h the Master of the Tug JULIUS confirmed by radio that the tug was fast. Thereupon the Tug PARAT increased the speed of travel. At a speed of almost 8 kn through the water, the accident occurred at about 15:06 h and the Tug JULIUS foundered. As a result of evidently insufficient fixing of the post with the pontoon, the post of the tug wandered approx. 30° out of the towing direction/centre line to port. The Master had tried to free the tug from this situation with a headway manoeuvre and steering hard to starboard, but as a result of the forced arrangement of the tightly set lines from aft, the manoeuvre was unsuccessful. In this situation the fastening line coming from the port side aft first became caught in the wheelhouse door that was open, and then on the sloping superstructure at the front, and in the further course beneath the projecting wheelhouse roof. This forced arrangement of the fastening line and the transverse vessel current due to the travel through the water were crucial factors for the tug heeling ever more strongly to starboard and subsequently capsizing over the starboard side. The closing condition was not sufficient, so that the tug quickly run full of water and foundered. During the capsizing, the port line coming from aft and the starboard line ruptured. The fore ship lines were not found on board the pontoon and the tug by the river police after the accident. At the time of capsizing the Master was on the bridge of the tug and a trainee was on deck, while the deckhand/engine fitter was on the pontoon. The trainee had a life jacket on and was rescued with minor injuries. The Master probably lost his life by drowning.
The subsequent rescue and salvage measures were appropriate.

5 Investigation

5.1 First report and classification of the marine casualty

The Federal Bureau of Maritime Casualty Investigation (BSU) was notified by telephone by the River Police Brunsbüttel of the capsizing and foundering of the tug at 21:00 h on 16 December 2004.
According to the Maritime Safety Investigation Act (SUG), the BSU is not charged with investigating accidents in which only inland vessels are involved. The Tug JULIUS was working in the operating form "inland vessel", while the Tug PARAT with its sufficient crew was assigned as a sea-going vessel. The Pontoon E 3505 is a sea-pontoon (sea-going vessel). On the basis of this towing operation (towing train with sea-going vessel) the accident was categorised as a very serious marine casualty in accordance with IMO Resolution A. 849(20), and an investigation team was formed to conduct the investigation.

5.2 History of the vessel

The Tug JULIUS started life in 1977 at the Cassens yard in Emden with newbuilding number 117 as Motor Tug BIBER. The vessel was given the class GL+100 A4 (k) E Tug with a licence for voyages of up to 10 hours in the coastal area. The vessel was planned and assigned as a harbour assistance tug for the firm Harms Bergung up to the year 1998. In November 1998 the tug was sold to Messrs. Schramm in Brunsbüttel and the name was changed to JULIUS. The tug was given class GL+100 A5 KE Tug and the Voyage Permit Certificate was issued by the See-BG (mariners' association). In November 2001 the vessel was transferred from the Sea-Vessel Register to the Inland-Vessel Register. At this time the tug had already been licenced by the SUK as an inland vessel for inland water ways of Zone 2 of the Inland Vessel Examination Schedule. (The Elbe and the Kiel Canal belong to Zone 2.)
There are no reports of any damage or accidents in the files of the See-BG and Germanischer Lloyd.
The Building and Equipment Safety Certificate was valid up to 30 April 2005 and the Ship's Crew Certificate up to 31 October 2005.
The Ship's Certificate issued by the SUK (Ship's Inspectorate Commission) Hamburg was valid up to 1 November 2005.

5.3 Stability

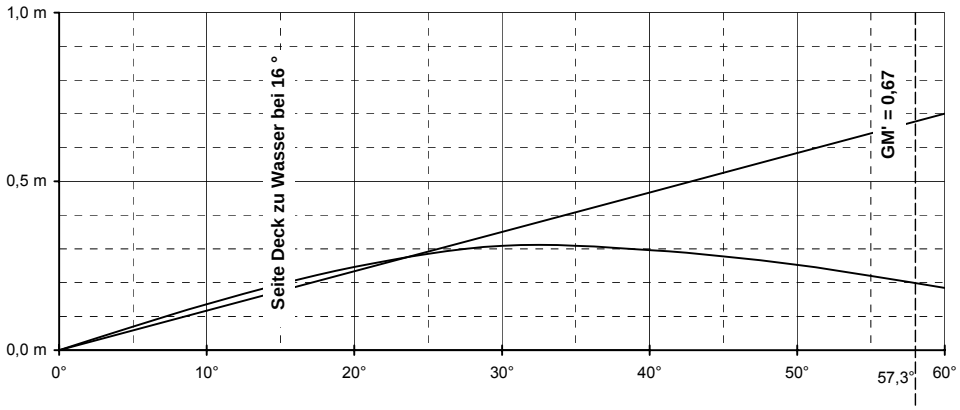
No conversion work had been carried out throughout the entire service life of the vessel so that only the first yard heeling experiment is available for determining the weight and the centre of gravity of the vessel. This experiment was conducted at the building yard in Emden on 4 February 1977. The heeling experiment conditions were as unfavourable as could be imagined, since the construction was not yet completed. Thus relatively large parts of the equipment, such as for instance the radar antenna, the plug-on railing, furniture and upholstery in the accommodation, the control desk in the wheelhouse, sundry piping in the engine room, the steps to the engine room,

large parts of the floor plates, the battery, the exhaust gas line, floor coverings, WC and wash basin, and the emergency exit from the engine room were lacking. These weight reductions were extrapolated by a moment calculation to the final condition. Despite the estimated reduced weight of approx. 9 t, the heeling experiment was recognised by the classification society and the See-BG, since the heeling experiment result coincided relatively well with the data for a second tug (repeat vessel BIBER II).
A comparison of the empty vessel data of the two vessels produces the following values:

	Displacement	Centre of gravity	Longitudinal centre of gravity
	(tonnes)	KG (m)	LCG (m)
JULIUS , ex BIBER	47.24	2.45	6.63
BIBER II	51.07	2.41	6.61

In the stability documents there is an indication that the stability for towing on a long line is sufficient in the stability cases calculated. The stability values are just achieved in the cases of vessel with half stocks and vessel with 10% residual stocks.
The following stability case from the documents of 1977 with an empty weight of 47.24 t and approx. 50% stocks roughly corresponds to the condition of the tug on capsizing.

Righting arm curve



Stability test

		required	available
Area*	0,0° bis 30,0°	≥ 0,055 m rad	0,095 m rad
Area*	0,0° bis 40,0°	≥ 0,09 m rad	0,149 m rad
Area*	30,0° bis 40,0°	≥ 0,03 m rad	0,054 m rad
Lever arm at 30 °			0,31m
Angle at maximum of curve			32,2°
Initial MG		0,15 m	0,67m
Stability scope	(≥) 60°		

** Area under uprighting curve of righting arms*

During the assignment as a sea vessel there was no report of any stability problems. The vessel was used as a tug for towing with a long line and as a towage tug.

5.4 Salvage

The tug was lifted from a depth of approx. 18 m by a floating crane during the night of 19 to 20 December 2004. The divers involved in searching for persons and salvage did not remove any lines belonging to the tug or open any doors/flaps.

Figure 5: Forward view of the salvage

The wheelhouse roof was bent upwards on the port side. There was no line on the post bollard. The starboard wheelhouse door was closed, but not latched. The port side wheelhouse door was no longer in the door hinges and was lying crossways in the wheelhouse.

Figure 6: View from stern, starboard

The access door to the engine room was unlatched and open. The starboard side engine room ventilation flap was opened and fixed in an approx. 50° position.

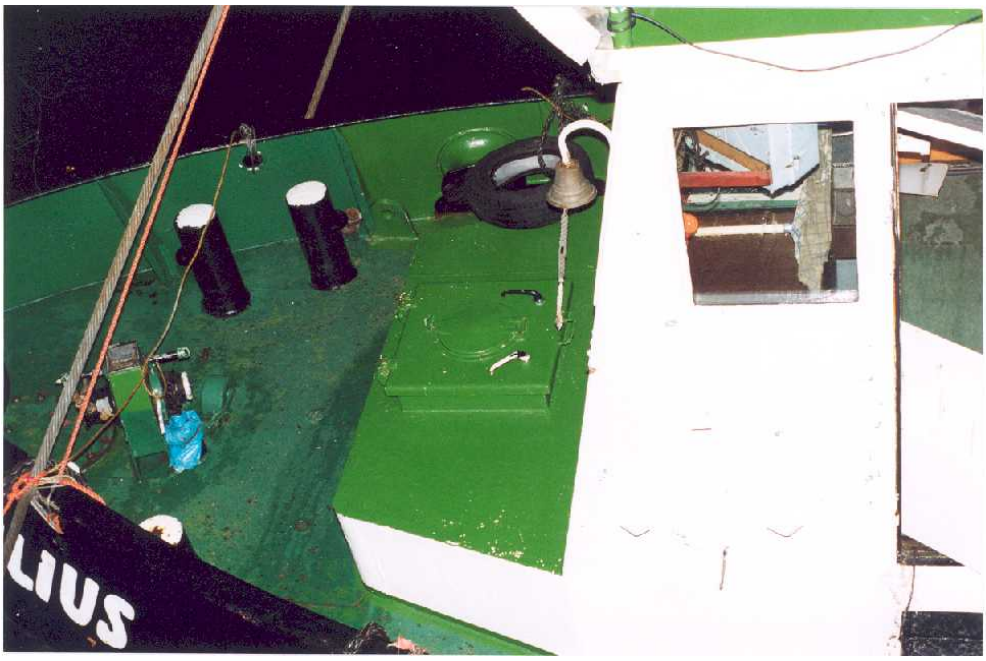


Figure 7: Fore ship

There was no mooring line on the post bollard and on the bollards on port and starboard.

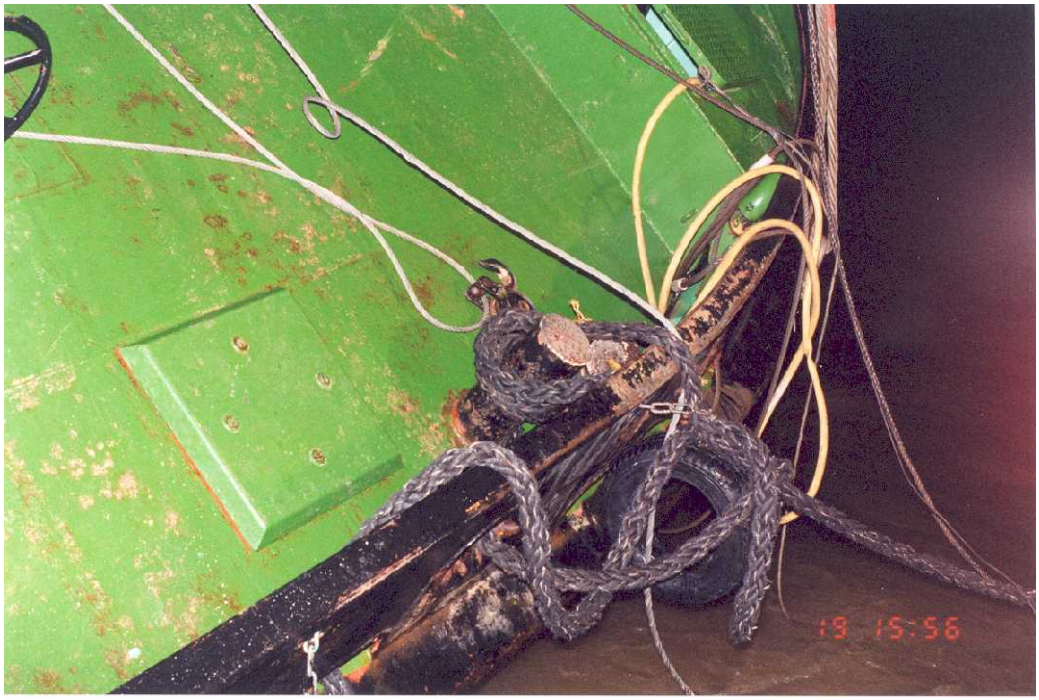


Figure 8: Aft ship port side

The double bollard on the port side aft had an 80 mm polypropylene line that was ruptured. The aft bollard tube of the double bollard had been ripped half out of the deck and was bent forwards. A ruptured 22 mm mooring line coming from the hand winch arranged midships via a guide pulley shackled on to the aft ship was lying on deck.

No further lines or wire lines were discovered anywhere throughout the deck area.

5.5 Survey of the vessel

5.5.1 Tug JULIUS

After salvaging the tug was made floatable again and the BSU surveyed it in detail at the South Pier in Brunsbüttel on 20 December 2004; the following findings were made:

1. The faceplate and the projecting part of the upper deck on the port side were bent upwards and ripped. The railing stanchions on the port side on the upper deck were bent and ripped out.
2. There were traces of scratching on the forward edge of the wheelhouse on the port side and residues of a black polypropylene line were hanging here and on the torn areas on the upper deck.
3. The wheelhouse door was lying in the wheelhouse. The top hinge had been ripped off and the bottom hinge bent downwards. The wheelhouse window was cracked and the inside door latch had been ripped off.
4. The bow flag pole on the post bollard was bent to starboard.
5. The rearmost of the double bollard port side aft was ripped off and the deck had been welded tight with a steel plate after salvage. Paint had chipped off the forward hawse in the aft ship and the hawse was slightly deformed in the front part.
6. The engine lever was set to "ahead" and the rudder position display to "hard to starboard". The battery-operated ship's clock had stopped at 15:10 h.

Figure 9: Wheelhouse damage

Figure 10: Bent bow flag pole

Figure 11: Bollard and hawse

5.5.2 Pontoon E 3505

The pontoon was surveyed at Berth 8 on the Oil Pier in Brunsbüttel:

1. No damage indicating a collision with the tug was discovered.
2. The pontoon had only one bollard on each side, port and starboard, at the rear edge of the stern, diameter approx. 400 mm. The bollards were approx. 16 m apart. At the time of the accident a flat iron had been welded to the port bollard so that it was not possible to place a loop over this. There were no other fastening possibilities using bollard, fairlead, or eyes/rings. There was thus no possibility of fastening a line in the middle at the stern of the pontoon. There was one bollard in the middle at the bow of the pontoon. The Pontoon E 3505 lying next to Pontoon E 3504 had a bollard on the port and starboard side and at the middle of the pontoon are the rear.

After the accident the river police ascertained and secured the following on the pontoon. -
Around the rear port bollard there was an approx. 4 m long and approx. 80 mm thick ruptured polypropylene line. The eye of a 2 m long and 22 mm thick ruptured line (wire line) was about the starboard bollard. There were no further lines aft on board the pontoon.

Figure 12: Rear edge of pontoon

Figure 13: Port bollatd

5.5.3 Tug PARAT

The BSU refrained from a detailed survey and exmination on board the Tug PARAT. The tug was used as a sea tug and was sufficiently crewed and equipped. All the documents and certificates on board were valid.

5.6 Qualification of the crew

5.6.1 Crew on board the Tug JULIUS

The tug was captained by a 64-year-old master who possessed an AM ticket (<6000 GRT), issued by the Regional Directorate for Waterways and Shipping Nord on 01.07.1999, valid up to 30 June 2004. According to the information supplied by the WSD Nord, no extension of validity had been applied for. The master was employed in his main profession as master on a canal ferry of the Kiel Canal. As a sideline he helped the vessel operator and, according to the information received, had already carried out several trips as master of an aft tug/steering tug.

A 20-year-old trained deckhand was assigned as deckhand/engine fitter who had been trained by the vessel operator and had passed the examination as Inland Seaman in July 2004.
In addition there was a 19 year old ship's mechanic undergoing training on board, who had started this training occupation with the vessel operator in August 2003.

These two crew members also reported that they had already attended several towing operations with a towing-pushing train in the past.

5.6.2 Line runner on board Pontoon E 3505

A line crew/runner gang consisting of two persons was assigned on board the pontoon. Both persons are semi-skilled staff who are engaged as temporaries as required. One mooring hand was a bricklayer by trade, while the second had completed training as a retail clerk. Both reported that they had often been present during such towing operations. The line crew was not equipped with radio sets.

5.7 Weather Report

On behalf of the BSU the Germany's National Meteorological Service (DWD) issued an expert opinion on the wind conditions for Brunsbüttel on 16 December 2004.
The passage of a ridge of Atlantic low pressure determined the weather in Brunsbüttel on 16 December 2004. It was very cloudy, partly misty and occasionally there was rain or drizzle. The wind was blowing from south to south-west at mean wind forces of between 3 and 5 Bft. In the afternoon there were isolated squalls of up to 6 Bft. Under these wind conditions there must have been a swell with characteristic wave heights between 1.0 and 1.5 m and periods of approx. 4 to 5 seconds. According to statements by witnesses, this wave height was not achieved, but instead an estimated wave height of 0.5 m had built up.

5.8 Radar records and current conditions

There are plot and radio records of the Revierzentrale (VTS) available showing the course of the journey of the towing-pushing train.

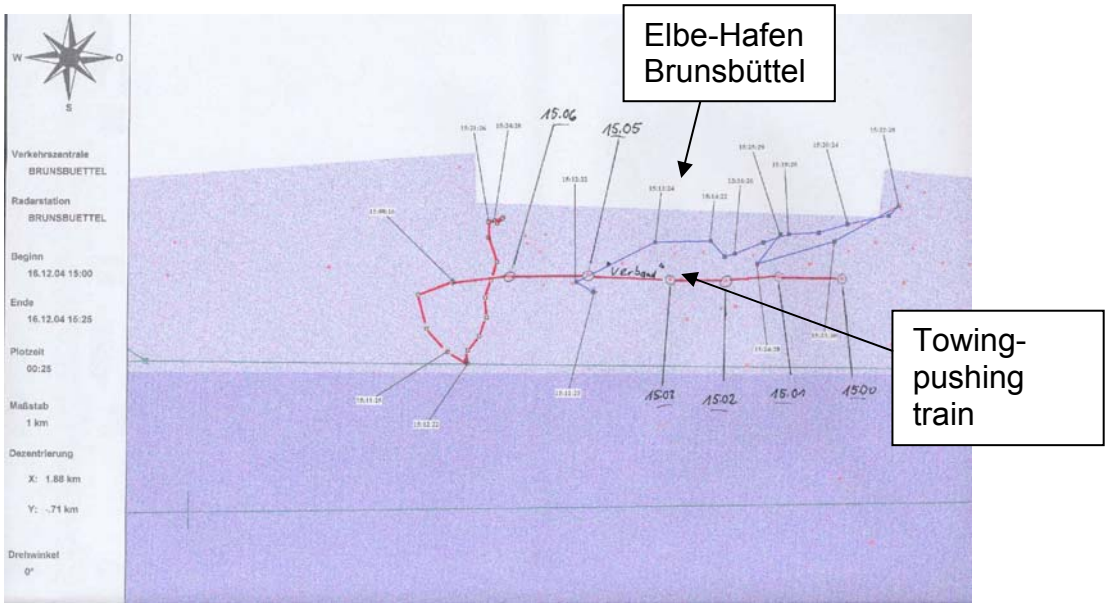


Figure 14: Plot VTS-Brunsbüttel

The Tide Calender shows the following data for 16 December 2004:

Low water: 12:12 h
High water: 17:31 h

A speed through the water of approx. 7.8 kn is derived from the records of the Revierzentrale and the water level data of the Local Office for Waterways and Shipping (WSA) for the tug train during the period from 15:05 to 15:06 h. The speed over ground on the basis of the radar records of the Revierzentrale was between 4.8 and 6.5 kn from 15:04 h to 15:08 h.

5.9 Statements by witnesses

Several witnesses confirmed the capsizing of the tug over the starboard side. There are contradictory and differing statements made by the two members of the pontoon runner gang and the two surviving crew members of the Tug JULIUS concerning the production of the towing connection with the pontoon that do not tally with each other. The three persons A, B and C stated that after the push shoulder had made contact with the pontoon in the middle, first the starboard fastening line had been handed over. This wire rope had come from the hand winch via a guiding pulley through the forward part of the aft hawses and had been placed with one eye over the starboard bollard of the pontoon. The wire line had not yet been pulled in tight first of all. Next the 80 mm thick polypropylene line coming from the aft port side double bollard had been guided round the port bollard of the pontoon and handed back. It had not been possible to make this fast on the bollard with an eye, since a flat iron of a steel strut of the newly erected wall had been welded onto the bollard. This aft port side fastening line had also been guided through the forward part of the aft hawses. The tug had now been positioned in such a way that the polypropylene line had come taut and the wire line had been drawn tight by the winch.
As regards the forward lines the three persons agree that there had been no line fitted on the starboard side. There were differing statements regarding the way in which the port line had been made fast. Witness A stated that he had seen that the port side forward line had been guided round the pontoon bollard and over the bollard horn there, consisting of an approx. 30 mm thick round iron. The other end had been placed round the starboard bollard on the tug fore ship. Witness B stated that the end of the forward line had been guided round the bollard. One end had been fast on the middle post bollard, while the other end had been made fast on the starboard bollard or also on the post bollard of the tug. The witness C stated that the line had been guided round the bollard and both ends had been made fast on the port side bollard on board the tug.
The statement by the fourth witness deviates completely from the other statements. Witness D states that first of all the port side forward line had been placed round the aft port side post bollard, then guided round the port side bollard of the pontoon and subsequently made fast on the port side stern bollard. Next the eye of the starboard forward line had been placed round the starboard bollard of the pontoon and made fast on the starboard bollard of the tug. After this the aft fastening lines had been made fast, first of all the polypropylene line on the port side. This line had been guided round the port side bollard of the pontoon and placed on the round iron of the bollard horn there. Finally the eye of the fastening line had been placed over the

starboard pontoon bollard and the wire line had been pulled in taut with the hand winch. He had then wanted to secure a second starboard emergency line and had climed onto the pontoon for this purpose since the runner gang had already left.

The witnesses of the runner gang were unable to make any statement about the further proceedings.

The witnesses A and D further stated that after the tug had been fast, the Master had come out of the wheelhouse. Following a discussion about the line arrangement between them and the Master, the Master himself had made a line loose on the starboard foreship. When the tug had turned with its post to port during this work, he had thrown the forward line over board and run back to the bridge. However, the tug had turned further round to port and had heeled very strongly to starboard. In the course of the capsizing first the starboard fastening line had ruptured and then the port side polypropylene line. The tug had come to rest with its keel upwards and had then sunk via its stern.

5.9.1 Sketch of the line arrangement

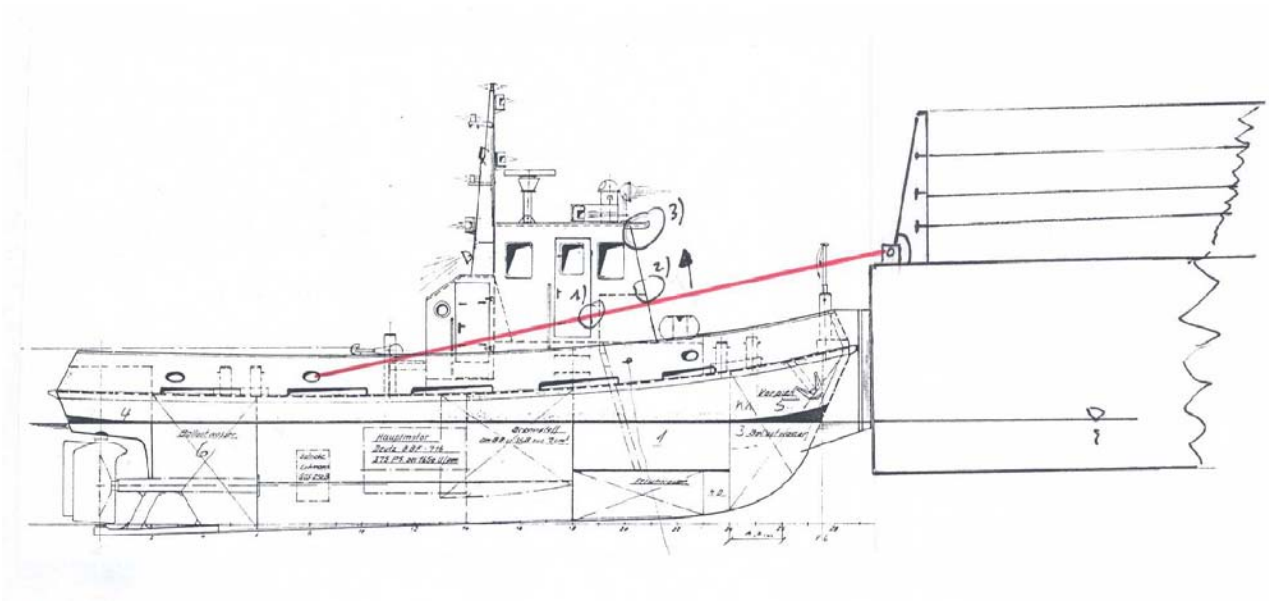


Figure 15: Figure 16: Longitudinal section

The above drawing shows the starboard side. The scraping marks mentioned below of the aft polypropylene line are on the port side:

1) wheelhouse,
2) edge of wheelhouse and
3) faceplate of the wheelhouse roof

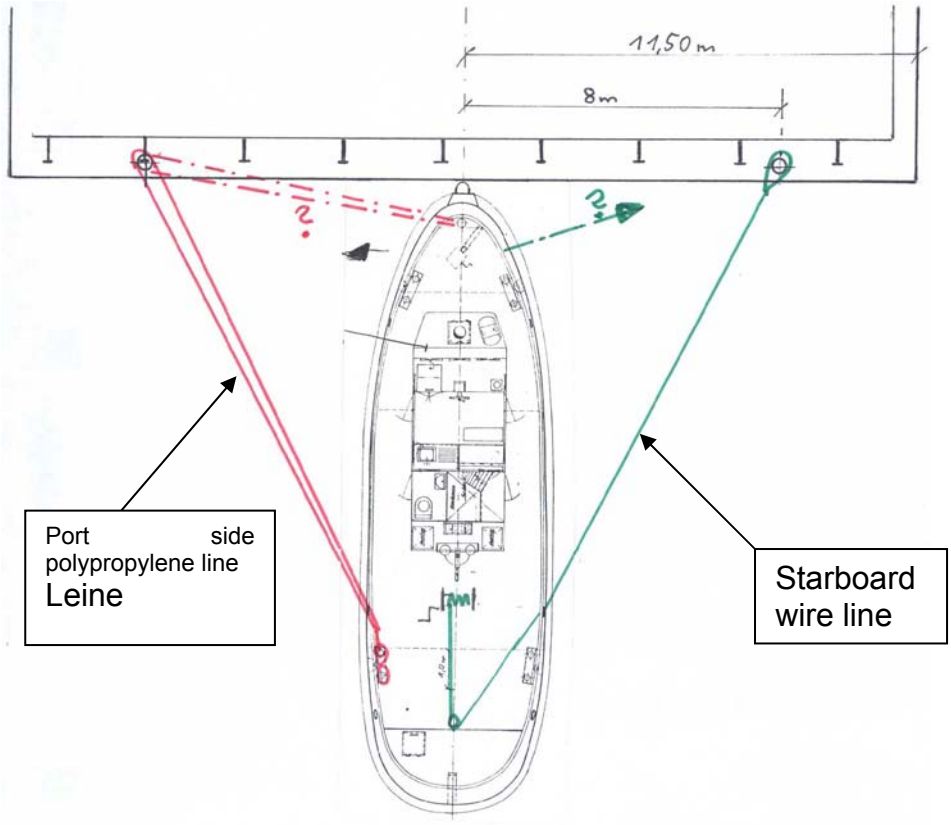


Figure 16: Top view, line arrangement

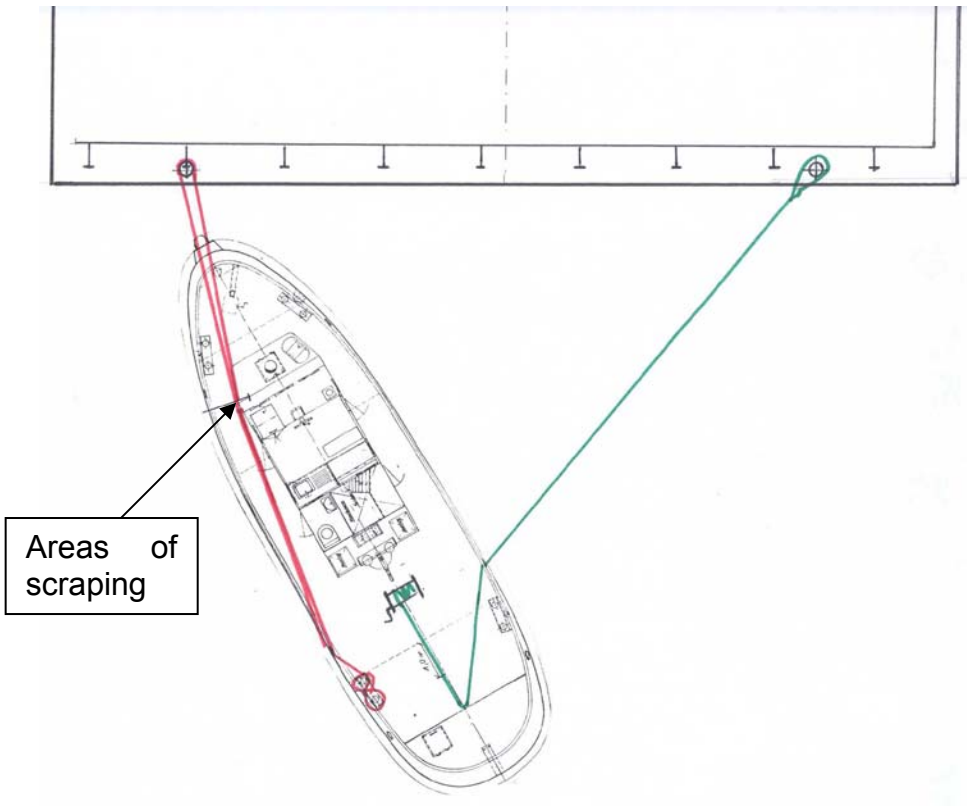


Figure 17: Situation directly before capsizing

5.10 Closing condition

When the tug was salvaged the access door to the engine room was open. This door is equipped with four sliding bolts and must be firmly closed for coastal voyages. The previous owner was notified of this by the See-BG Report No. 25 in 1995,
"*the engine room bulkhead (starboard side) must always be kept close during coastal travel".* This door was evidently frequently kept open during towing voyages as the photo below shows.

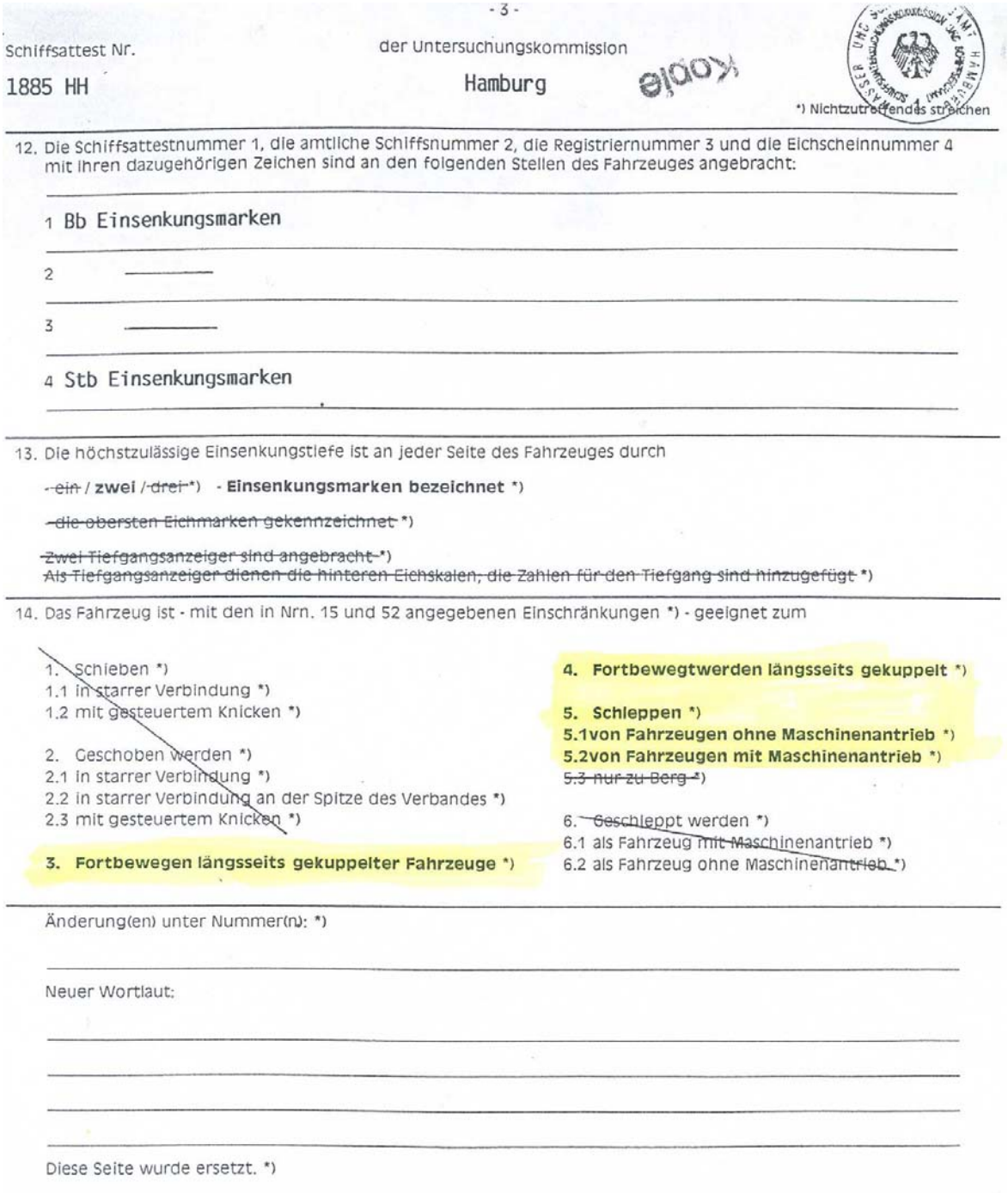
Figure 17: Open ER door during towing voyage

In addition to the open door, the fan light on the starboard side was open at an approx. 50° position and had been locked in this position. This fan light has a clear opening of 60 x 40 cm.
These two openings, that come to water with a heeling angle of approx. 43°, contributed to the tug sinking so quickly.

5.11 Barge certificate

The Tug JULIUS had a Ship's Certificate of the SUK. An examination of the licencing documents revealed that the vessel composition (tug-pontoon-tug) at the time of the accident cannot be allocated to the Inland Vessel Transport Admission Regulations, the Rhine Shipping Examination Regulations (RheinSchUO) and the Inland Vessel Examination Regulations (BinSchUO) or the Inland Police Regulations. The criteria which according to the Examination Regulations (§1.01 Numbers 26-29 and Chapter 5 RheinSchUO) made of a tug combination are not fulfilled in the vessel composition - rigidly coupled to the pontoon. The Tug JULIUS for example is insufficiently motorised to be able to move the pontoon alone as a towing-pushing train. The

vessel towing it at the front provides the main drive performance and moves the towing-pushing train. In inland shipping, vessels are either pulled or pushed. Such a "mixed" formation is not customary in practice. A towing-pushing train may only be towed upstream in quite particular river sections approved by the Waterways and Shipping Administration (WSV). Otherwise towing of a towing-pushing train is strictly forbidden under BinSchStrO § 8.02 No.1.



- 3 -

Schiffsattest Nr. 1885 HH

der Untersuchungskommission Hamburg

*) Nichtzutreffendes streichen

12. Die Schiffsattestnummer 1, die amtliche Schiffsnummer 2, die Registriernummer 3 und die Eichscheinnummer 4 mit ihren dazugehörigen Zeichen sind an den folgenden Stellen des Fahrzeuges angebracht:

1 Bb Einsenkungsmarken

2 ———

3 ———

4 Stb Einsenkungsmarken

13. Die höchstzulässige Einsenkungstiefe ist an jeder Seite des Fahrzeuges durch

~~ein~~ / **zwei** /~~drei~~ *) - **Einsenkungsmarken bezeichnet** *)

~~die obersten Eichmarken gekennzeichnet~~ *)

~~Zwei Tiefgangsanzeiger sind angebracht~~ *)
~~Als Tiefgangsanzeiger dienen die hinteren Eichskalen, die Zahlen für den Tiefgang sind hinzugefügt~~ *)

14. Das Fahrzeug ist - mit den in Nrn. 15 und 52 angegebenen Einschränkungen *) - geeignet zum

1. Schieben *)
1.1 in starrer Verbindung *)
1.2 mit gesteuertem Knicken *)

2. Geschoben werden *)
2.1 in starrer Verbindung *)
2.2 in starrer Verbindung an der Spitze des Verbandes *)
2.3 mit gesteuertem Knicken *)

3. Fortbewegen längsseits gekuppelter Fahrzeuge *)

4. Fortbewegtwerden längsseits gekuppelt *)

5. Schleppen *)
5.1von Fahrzeugen ohne Maschinenantrieb *)
5.2von Fahrzeugen mit Maschinenantrieb *)
~~5.3 nur zu Berg~~ *)

6. ~~Geschleppt werden~~ *)
6.1 als Fahrzeug ~~mit Maschinenantrieb~~ *)
6.2 als Fahrzeug ~~ohne Maschinenantrieb~~ *)

Änderung(en) unter Nummer(n): *)

Neuer Wortlaut:

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Figure 18: Ship's Certificate

A tug licenced for pushing must satisfy all criteria of the RheinSchUO that are to be made of a pusher boat. Up to the new version of the RheinSchUO in the year 1995,

for example, there was a condition that a pushing vessel must have pushing platforms or pushing horns that amount to at least 2/3 of the maximum width of the pusher boat. This was meant to ensure that the pusher boat can assume a fixed position in relation to the pushed barge and thus prevent lateral displacement of the pusher boat in relation to the barge stern. In the current RheinSchUO this specification is not included and the criteria for licencing are defined in Chapter 16 of the RheinSchUO. In § 16.01 RheinSchUO it is stated that *vessels to be used for pushing must be provided with an appropriate pushing device. They must be built and equipped in such a way that ... b) they can assume a fixed position with the coupled vessel(s) and c) displacement of the vessels in relation to each other is prevented.* This paragraph of the RheinSchUO is set out in even further detail in Directive No. 3 for the Investigation Commission:

*1.1 Each coupling system must ensure the rigid connection of the vessels, i.e. the coupling devices must prevent movements of the vessels in relation to each other in longitudinal or transverse direction under the proposed conditions of use so that the formation can be seen as a "**nautical unit".***
1.2 It must be possible to operate the coupling system and its elements easily and safely so that the vessels can be coupled quickly and without endangering staff.
1.3 The coupling system and its connecting elements must be able to absorb the forces arising under the proposed conditions of use soundly and be able to introduce these into the hull.
1.4 There must be a sufficient number of coupling places available.

The manoeuvring properties of such a formation must be demonstrated to the SUK by trial trips. If a vessel is to move a formation or be moved in a formation, this must be noted in the Ship's Certificate. The Tug JULIUS has no such entry in the Ship's Certificate. In the Ship's Certificate the entry 6 - *towed as vessel with engine propulsion or without engine propulsion* - is deleted. The requirements made by the SUK of a vessel that is towed are such that there must be sufficiently dimensioned fastening devices for the towing line on the fore ship.
According to the entries in the Ship's Certificate the Tug JULIUS was only tested for movement alongside other vessels and for towing vessels on a long line. The use of the Tug JULIUS in a coupled formation as pusher boat, "steering tug, stopper tug, stern tug" and as a vessel towed by others was not admitted by the SUK according to the documents presented.

6 Analysis

The task of the BSU is not to determine any apportionment of blame, but instead to investigate causes and clarify marine casualties in order to prevent such or similar accidents. The cause in this very serious marine casualty is not an individual cause or action, but instead the linking of several factors that ultimately led to the accident.

6.1 Vessel and pontoon

The heeling experiment in 1977 with the vessel was conducted under very unfavourable conditions. Throughout all its service life there were no further heeling experiments or draft checks. However, there were no complaints about lack of stability noted. If one assumes that the stability calculations are in order, the stability at 30° with a lever arm of 31 cm is sufficient according to regulations. In this marine casualty the port towing line applied an additional external moment by becoming caught in front of and below the superstructure and led to the tug capsizing further completely. A larger, positive stability lever arm at 30 - 40° might have prevented the capsizing and the port towing line would have ruptured earlier or slipped over the superstructure and the tug would thus have come free.

The non-closed opening to the engine room had a negative influence on the floating condition as of an inclination of 43°.

A vessel with only one pushing shoulder, the post reinforcement, is not suitable for the work practiced here as a stern/steering tug.

Fastening with a polypropylene line on one side and a wire line on the hand winch on the other side is not sufficient. It would be better to have two wire ropes on two hand winches in order to produce a safe connection.

There was no possibility of fastening the tug midships on the pontoon. For safe fastening it is absolutely necessary to secure the post safely on the pontoon. The 20 cm wide rubber padding at the post is not sufficient for a pusher tug. Two pusher shoulders at a spacing of two thirds of the ship's width are necessary for safe handling for use as a pushing tug or a steering tug.

The port bollard on the pontoon was only conditionally suitable for use due to the flat iron welded on, and it was difficult to use. Within the scope of the 60-day hearing period in accordance with § 15 SUG Para. 1, the vessel operator explained in a letter to the BSU that all involved were aware of the circumstance that this flat iron was welded onto the bollard and that therefore a double bow was intended as a forward line from the start. This statement was not confirmed by the participants. The arrangement of the flat iron does not make any sense for reasons of strength and it was therefore evidently removed after this casualty. After the assembly of the welded structure the suitability of the pontoon for this shifting operation had not been checked by the vessel operator of the SBG or by a classification society.

6.2 Crew, towing-pushing train and course of the accident

The Master had an AM Ticket that was no longer valid. He had already been qualified before by several similar towing voyages.
The deckhand on board had little professional experience and at the time of the accident was on the pontoon. The trainee as the third person on board had only been with the firm for just over a year. The two persons on board the pontoon have not learned any shipping profession, but instead were semi-skilled staff for mooring activities.

Fastening of a stern tug during towing operation with a speed through the water of over 7.8 kn is an exceptionally difficult manoeuvre and should be avoided, or only carried out if the problem cannot be solved otherwise. Fastening with the aft fastening lines first is absolutely negligent when using a single-screw tug. The only subsequent fastening of the forward post led to an unstable fastening system. According to the three witness statements, no fastening line was to be used at the front on the starboard side. These statements are plausible since the post migrated to port during the towing yourney. However, considering the fact that the forward fastening lines were not found and in view of the differing statements by witnesses it must be queried whether there had in fact been any fastening of the post at the front.
A further factor making it more difficult to fasten the tug was the fact that there was no possibility of making fast in the middle of the pontoon stern and that the port side rear bollard on the pontoon could not be used sufficiently due to the fact that a flat iron was welded onto it. The persons charged with fastening were evidently surprised by unexpectedly finding that the facilities for fastening were not sufficient.
During the fastening operation there were doubts regarding authority, inconsistencies and discussions between the Master and his crew on the line arrangement. The Master evidently left the wheelhouse for a short period and fastened or loosened the lines on the fore ship himself, while one crew member was on the pontoon. During this work the post sheared off to port and the Master returned to the bridge and tried to come back in line with the towing direction with rudder put "hard to starboard" and engine manoeuvre "ahead". When the vessel had already moved more than 30° out of this direction and the aft port side fastening line had caught under the wheelhouse roof, only a "full reverse" manoeuvre and "hard to port" or cutting of the aft port side fastening line could have prevented the capsizing. These manoeuvres could no longer be carried out.

The technical communication aids on board were not sufficient. The runner gang and the two tug crew members were unable to contact the head tug PARAT by radio. If there had been a radio set on board the pontoon, the Master of PARAT could have been notified earlier of the problems at the stern of the pontoon. Valuable time was lost before the head tug was informed by calling and could slow down his vessel.

6.3 Summary

The accident could probably have been avoided if a pusher tug licensed and suitable for this purpose had been used.

Fastening on a moving train should be avoided, or only carried out at low speeds. It is necessary to check the vessels to be towed or pushed for suitability of the fastening facilities available before the vessel moves, especially after conversion work.

7 Security recommendation(s)

The vessel operators that use coupled tugs as additional manoeuvring aids are called upon to check whether the vessels are licenced and suitable for the conditions of assignment proposed.
When towing pontoons, especially in the Kiel Canal, a steering tug is often hitched up at the stern as a manoeuvring aid. This coupling represents a danger when there is movement of the vessels against each other in a longitudinal or transverse direction.

The operators are called upon to ensure that there are always sufficiently qualified expert staff on board who are constantly coached with regard to the special dangers. Semi-skilled or only occasionally employed staff used for fastening activities cannot have the knowledge and skills possessed by a person trained in the shipping trade.

8 Sources

- Investigations by the Water Police (WSP)
- Written declarations/comments/statements by witnesses
- Ship's files of the See-BG and Germanischer Lloyd
- Sea charts and ship data of the Federal Maritime and Hydrographic Agency (BSH)
- Water level values of the Local Office for Waterways and Shipping (WSA) Hamburg
- Official weather expert opinion of the Germany's National Meteorological Service (DWD)
- Radar recordings of the ship securing services/VTS
- Photos by the photographers:

Fig. 2	Florian Horch	info@seatowage.de
Fig. 4	Jochen Laskowsky	ships@laskowsky.de
Fig.18	Dietmar Hasenpusch	hasenpusch-photo@t-online.de