Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation

Investigation Report 276/21

Foundering of the sailing boat SILJA and death of a crew member in the Accumer Ee tidal inlet on 26 August 2021

8 December 2022

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

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

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

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LIST OF ABBREVIATIONS

ACO	Aircraft coordinator
AIS	Automatic identification system
AML	Advanced mobile location
ARCC	Aeronautical Rescue Coordination Centre
Bft	Beaufort
bhp	Horsepower
BMDV	Federal Ministry for Digital and Transport
BSH	Federal Maritime and Hydrographic Agency
BSU	Federal Bureau of Maritime Casualty Investigation
CH	Compass heading
Co.T.	True course
CWAM	Coastal wave model
DGUV	German Social Accident Insurance
DGzRS	German Maritime Search and Rescue Service
DMYV	German Motor Yachting Association
DSC	Digital selective calling
DWD	Germany's National Meteorological Service
DWL	Design waterline
EENA	European Emergency Number Association
ELWIS	Electronic Waterways Information Service
EMCIP	European Marine Casualty Information Platform
EPIRB	Emergency position indicating radio beacon
FSR	German Maritime Lifesaving Appliances Association
GMDSS	Global Maritime Distress Safety System
GPS	Global Positioning System
GRP	Glass-fibre reinforced plastic
HTTPS	Hypertext Transfer Protocol Secure
HW	High tide
IAMSAR	International Aeronautical and Maritime Search and Rescue
IBS	International card for pleasure craft
KRLO	Joint Regional Control Centre Ostfriesland
Kts	Knots
kW	Kilowatt
MRCC	Maritime Rescue Coordination Centre
NfS	Notice to mariners
Nm	Nautical mile
NOK	Kiel Canal
NVD	Night vision device
OSC	On-scene coordinator
OSR	Offshore Special Regulations
Para.	Paragraph
PLB	Personal locator beacon
POB	Person overboard
PPE	Personal protective equipment
SAR	Search and rescue

SBF-Binnen	German Certificate for Operating Recreational Craft on Inland Waterways
SBF-See	German Certificate for Operating Recreational Craft on Navigable Maritime Waterways
SchSG	Ship Safety Act
SchSV	Ordinance for the Safety of Seagoing Ships
SeeArbG	Maritime Labour Act
SeeSchStrO	German Traffic Regulations for Navigable Maritime Waterways
SMS	Short message service
SMS	Short message service
SOG	Speed over ground
SOV	Service operation vessel
SpFV	German Pleasure Yachting Navigating Licences Ordinance
SRB	Lifeboat
SRK	Rescue cruiser
STCW Code	Annex to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978
STCW Convention	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978
UTC	Universal Time Coordinated
WLAN	Wireless Local Area Network

1 SUMMARY

At 1749[1] on 26 August 2021, the seven-metre-long sailing boat SILJA capsized while sailing from Juist to Langeoog from the sea in the area of the bar[2] south of the approach to the Accumer Ee tidal inlet[3]. Three people in their early 20s, one woman and two men, fell overboard after the boat capsized. The boat foundered about 30 minutes later. At 1827, the skipper managed to use a smartphone to make a distress call, which triggered an extensive rescue operation.

A rescue cruiser sighted the first sailor lifeless and floating in the water with a lifejacket about three hours after the boat capsized. While attempting to pull the sailor out of the water from aboard a lifeboat, the buoyancy chamber tore off the lifejacket and the sailor sank into the sea. He had not been found before the publication of this report. It is highly likely that the sailor had already drowned before the recovery attempt.

At 2125, the crew of a SAR helicopter[4] spotted the female member of the crew in the water and rescued her. The same crew rescued the skipper about 30 minutes later. Both sailors were wearing a lifejacket with the buoyancy chamber partly detached from the protective cover.

The SILJA capsized mainly due to short steep waves. In all likelihood, groundswell and possibly breaking waves had formed in the area of the bar at the Accumer Ee tidal inlet in an outgoing tidal current and an opposing wind sea of up to 2.5 metres in height generated by the strong onshore winds, which were reaching gale-force in gusts.

In the opinion of the BSU, neither the sailing manoeuvres nor her size had a significant effect on the boat capsizing.

Information from nautical publications (sailing directions and cruising guides) and navigational charts (electronic/paper) with warnings against sailing in tidal inlets in certain conditions were either not used or overlooked.

Groundswell is a typical phenomenon for tidal inlets in the underlying conditions described above. This hazard is also typical for all sea areas with comparable natural conditions. In particular, this applies to estuaries and port entrances when waves coming from the sea meet a rapidly decreasing water depth there.

[1] Local time: Central European Summer Time (UTC + 2 hours).
[2] Sand or mud bank with barrier effect on shipping.
[3] n/a
[4] SAR: Search and rescue.

This investigation report deals in detail with the question as to why the skipper had not planned the route[5] in the manner needed for this sea area. In this context, the acquisition of the German Certificate for Operating Recreational Craft on Navigable Maritime Waterways (SBF-See) was investigated and a safety recommendation concerning the examination requirements prepared.

Other safety-related aspects on recreational craft that had a significant impact on the marine casualty and the rescue operation were investigated. In particular, they include

- the use and provision of sailing directions, as well as other nautical publications and their content;
- the safety briefing on board;
- the use of lifejackets;
- the use of a smartphone as a device for navigation and making distress calls;
- dialling an emergency number (110/112) over a mobile phone network;
- the provision of appropriate signalling equipment;
- the use of private and public wind forecast services, and
- the composition of the crew.

This resulted in several safety recommendations. At the same time as the publication of this investigation report, the BSU issued general safety recommendations (lessons learned) directed primarily at the skippers of recreational craft on www.bsu-bund.de.[6]

[5] This investigation report uses the term 'route' in the sense of a planned route and the term 'trip' in the sense of a voyage.
[6] The publication of lessons learned by investigating authorities is based on a decision made by the International Maritime Organization (IMO) in 2018.

2 FACTUAL INFORMATION

2.1 Photograph of the sailing boat SILJA

Figure 1: The SILJA a few weeks before she foundered[7]

2.2 Boat particulars

Name of boat:	SILJA
Type of boat:	Keel and centreboard boat
Flag:	German
Registration number:	167870 S[8]
Owner:	Private (skipper)
Year built:	1971
Shipyard:	Not known
Length overall:	7.00 m
Length DWL:	6.68 m
Breadth overall:	2.35 m
Draught:	0.58–1.25 m
Rigging:	Sloop
Sail:	Mainsail 10.2 m²; jiffy reef with two reefing lines Furling genoa (about 10 m²)

[7] Source: Boat owner.
[8] Number of the international card for pleasure craft. The international card for pleasure craft was a required and recognised registration number for the SILJA for operating on inland waterways.

Engine rating:	5.9 kW (8 bhp)
Engine:	Yamaha FT8GMHL outboard
Speed[9]:	6.3 kts
Hull material:	Glass-fibre reinforced plastic (GRP)
Miscellaneous:	Three berths, no buoyancy tanks
Minimum safe manning:	None

2.3 Voyage particulars

Port of departure:	Juist
Port of destination:	Langeoog
Type of voyage:	Other shipping, international
Crew:	3

2.4 Marine casualty or incident information

Type of marine casualty:	Other casualty/incident[10] Foundering of the sailing boat SILJA and death of a crew member
Date/Time:	26 August 2021 at 1749
Location:	Accumer Ee tidal inlet
Latitude/Longitude:	φ 53°45.54'N λ 007°25.1'E[11]
Ship operation and voyage segment:	Approach to port
Water depth (navigational chart)	About 2.00 m
Tide height	About 2.00 m (three hours after high tide)
Wind	Northerly at 5–6 Bft with gusts of 7–8 Bft
Significant wave height	Up to 2.5 m
Tidal current	1.7–2 kts in a north-westerly direction (325°)
Human factors:	Yes
Consequences:	Death of a sailor[12]; loss of the sailing boat. Two people were rescued

[9] Calculated hull speed: $v_{max} \approx 2.43 \cdot \sqrt{l_{KWL}}$.

[10] Marine casualties involving only non-commercial recreational craft are not subject to Section 1 of the Maritime Safety Investigation Law. This marine casualty was therefore classified as other casualty/incident rather than as very serious marine casualty.

[11] Position information based on the SILJA's track recording.

[12] The sailor was classified as missing according to the German Act on Missing Persons at the time of publication.

Extract from the Juist to Langeoog navigational chart, BSH 1170[13]

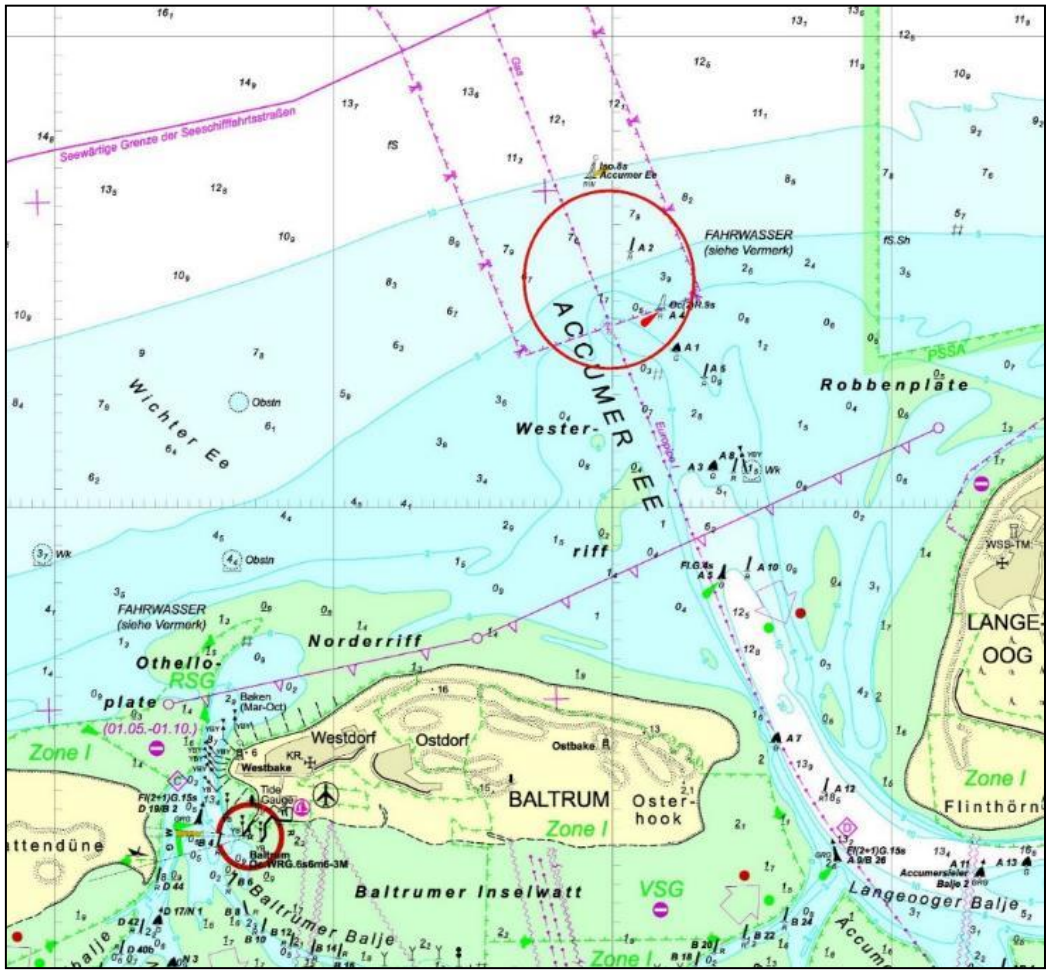


Figure 2: Sea area in which the SILJA capsized and foundered.

2.5 Shore authority involvement and emergency response

Agencies involved:	Joint Regional Control Centre Ostfriesland (KRLO)[14]; MRCC[15] Bremen; ARCC[16] Glücksburg
Resources used:	Airbus H145 rescue and intensive care transport helicopter (Christoph 26, ADAC; SEA KING MK41 multi-purpose helicopter (German Navy); Airbus H145 multi-purpose helicopter (Wiking Helikopter Service GmbH);

[13] Issue and revision status NfS 32/2021.
[14] The Joint Regional Control Centre Ostfriesland (KRLO) handles all calls received on the emergency lines 110 and 112 in the Aurich, Leer and Wittmund administrative districts, in particular.
[15] MRCC: Maritime Rescue Coordination Centre. The German Maritime Search and Rescue Service (DGzRS) operates the German MRCC on behalf of the Federal Republic of Germany.
[16] ARCC: The Aeronautical Rescue Coordination Centre in Glücksburg (ARCC Glücksburg) cooperates with MRCC Bremen and its responsibilities include air rescue in the 'Sea' SRR.

	Rescue cruisers[17] HERMANN MARWEDE and EUGEN; Lifeboats[18] NEUHARLINGERSIEL, ELLI HOFFMANN-RÖSER, SECRETARIUS; Emergency towing vessel NORDIC; Multi-purpose vessel MELLUM; SOV[19] ESVAGT DANA; Coastal patrol boat WSP 3; Ambulance.
Actions taken:	Search for the sailors who fell overboard in accordance with the IAMSAR manual[20]. Two sailors rescued by a helicopter. After completion of the rescue operation, Shipping Administration vessels carried out an unsuccessful search for the foundered SILJA and the sailor who sunk during the rescue attempt

[17] A rescue cruiser is a large vessel with a tender that is manned by a permanent crew and operates over long distances in the open sea area.
[18] A lifeboat is a smaller vessel that operates mainly in coastal areas and is manned by a volunteer crew.
[19] SOV: Service operation vessel. An SOV is usually deployed in an offshore wind farm.
[20] IAMSAR: International Aeronautical and Maritime Search and Rescue.

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

The below account of the course of the accident is based on the statements of the two people rescued. One of the people rescued was the skipper and the other the female crew member.

3.1.1 Course of the voyage before the boat capsized

The owner and skipper of the SILJA had been on a week-long sailing trip in the coastal waters of Ostfriesland with two other people, a woman and a man, since the evening of Sunday 22 August 2021. They were each in their early 20s, students, and knew each other from university.

At about 1300 on 26 August 2021, the SILJA sailed out of the port of Juist after refloating shortly before in rising water.

Without allowing for tacking, the crew had a distance of some 27 nm to cover up until Langeoog. The Windfinder weather app used by the skipper had predicted northerly winds with speeds of 22–24 kts (6 Bft) and gusts of up to 28 kts (7 Bft). Based on this wind forecast, the skipper hoped for a speedy crossing. He wanted to reach the port of Langeoog before nightfall by 2130 at the latest.

Based on the tide table, he expected sufficient water under the keel for the passages through the Memmert tideway, the Norderney tidal inlet – Dovetief exit –, and the Accumer Ee tidal inlet.

After the SILJA had passed the port exit, the skipper initially followed the perches of the Juist tideway eastwards. The skipper left the fairway to the east shortly before buoy J10 and – like several other sailors at the same time – took the shortest route into the Memmert tideway.

The SILJA followed the Memmert tideway with one of two possible reefs in the mainsail and a headsail not fully unfurled.

The tidal current was barely noticeable during the passage through the Norderney tidal inlet – from level with Branderplate up to the entrance to Dovetief. The wind then freshened up and the wave height increased. The skipper estimated the height to be about 3–3.5 m. He assumed that the wave pattern was due to the increasingly clear sea area.

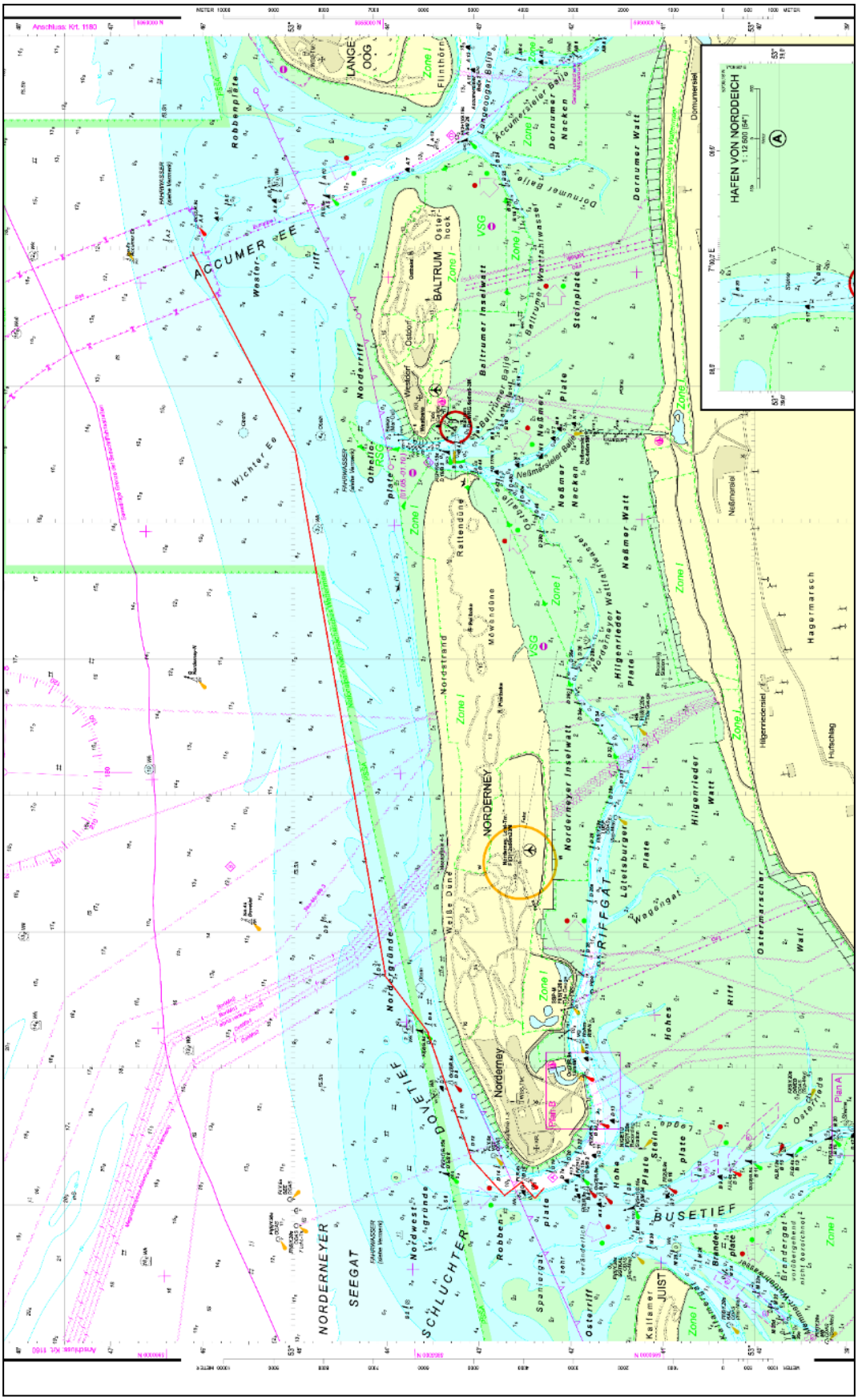


Figure 3: Extract from chart (BSH 1170) showing the SILJA's route

To follow the northbound fairway, the crew had to sail close hauled and tack several times. To prevent water washing over the boat from getting inside, the skipper had the companionway closed with two washboards and the upper sliding hatch. Water coming into the cockpit drained off through two bilge pipes.

The female crew member asked the skipper what they would do if the SILJA capsized. He explained to her that their boat's sailing stability was reportedly sufficient and she could not capsize.

Due to the freshening wind and sail position, the SILJA developed a weather helm, which the skipper compensated for by unfurling the headsail. This increased the headsail area and the sail's centre of effort shifted towards the bow.

The skipper followed the eastward course of the fairway through the Dovetief. The more easterly course enabled him to fall off the wind and sail on a beam reach. He had the centreboard cranked up so far that it was lowered about a third of the way. The waves rolled under the boat from the port side. The SILJA was sailing balanced and stable. At 5.5–6 kts over ground, the SILJA was gliding swiftly through the water. The skipper noticed that they were now sailing much faster than his earlier assumption as regards reaching the port before dark. The skipper recalled that the voyage through the Dovetief was challenging due to wind, waves and buoys.

Shortly before buoy D4, the skipper left the Dovetief to the east and continued to follow the coastline level with the five-metre depth contour, which runs at a distance of about one nautical mile off the coast of the island of Norderney. On the previous evening, he plotted a chart course of 081 degrees on the paper navigational chart to a fictitious position between buoys A2 and A4 in the Accumer Ee tidal inlet. On a sheet of A4 paper, he primarily noted information on the perches and buoys, as well as on the distances.

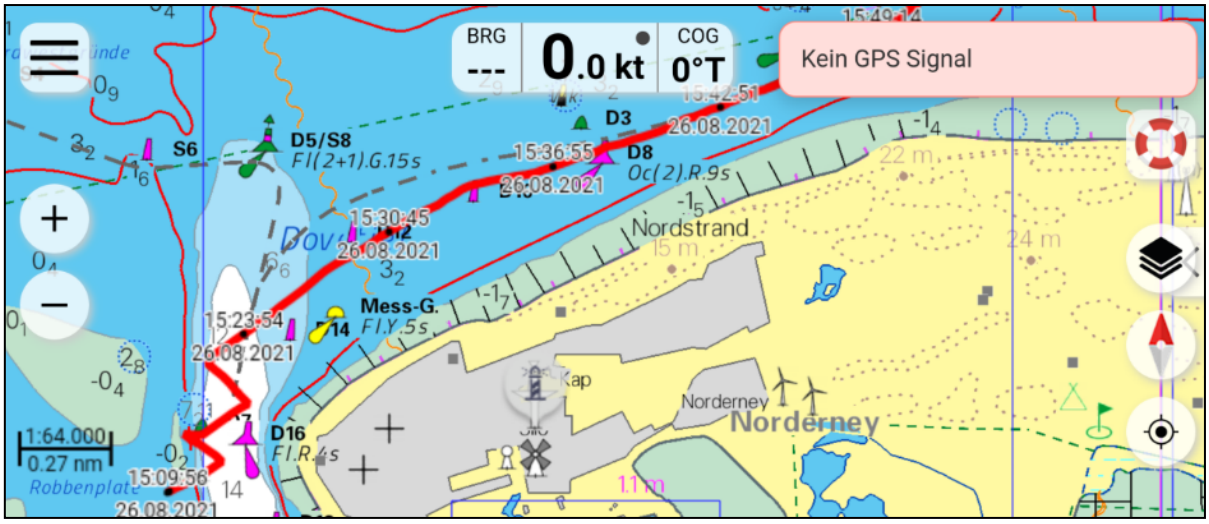


Figure 4: The SILJA's track recording – Dovetief[21]

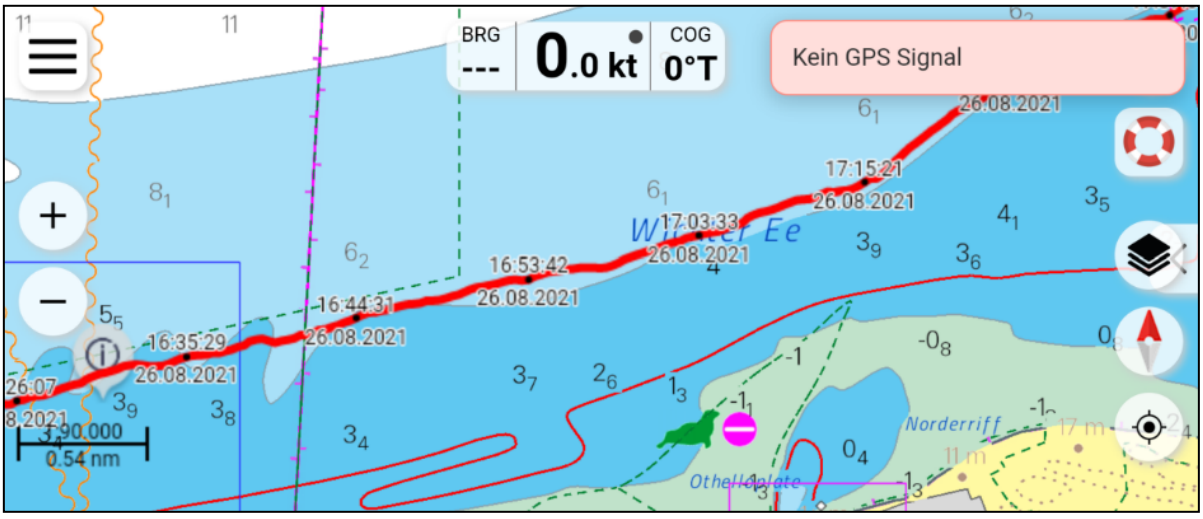


Figure 5: The SILJA's track recording – level with Wichter Ee. [22]

Sunny weather prevailed. Air temperature was about 20–22 °C.

In addition to his underwear, the skipper donned a sweatshirt, training shoes, as well as sailing trousers and a sailing jacket because of the water washing over the boat. His crew members had no sailing trousers with them. Accordingly, the female sailor had initially opted for long trousers and a softshell jacket and the male sailor for swimming trunks and a jumper. The male sailor also donned a blue rain jacket later that day. All three were wearing automatic lifejackets.

The skipper steered his boat without being relieved. He referred to a handheld compass if he was not following perches or buoys. He had not converted the true course into the compass heading. He tracked the boat's position and speed on his smartphone. He had installed the chart app from a company called Nautical

[21] Source: Skipper. Screenshot (extract) from a Sony Xperia 10 II. A 'No GPS signal' warning is displayed on this and the following screenshots because – unlike during the sailing trip – the smartphone's location function was disabled.
[22] Source: Skipper. Screenshot (extract) from a Sony Xperia 10 II.

Publications GmbH (NV Charts App)[23] on his smartphone and loaded charts from the NV Atlas Ostfriesland DE13, *inter alia*. He had put the smartphone into a waterproof cover and secured this cover to his life jacket with a strap.

The crew members carried out the necessary sailing manoeuvres in accordance with the instructions of the skipper. For example, they regularly operated the sheets to adjust the sails, the reefing line of the headsail and the crank to change the position of the centreboard. The skipper also determined the seating positions of his crew members so as to trim the boat with their body weight.

The SILJA was moving according to the external influences of wind and waves. To ensure no one lost their footing on the boat, the sailors held on to the boat with one hand if necessary and – as far as possible – to each other. They had no lifelines on board.

The skipper felt safe and secure. The survivors stated that all three sailors were having a good time.

The female sailor saw that one of the two mooring lines attached to the railing in the fore section had loosened a little and was no longer hanging there as neatly as before.

It became overcast and cooler at the eastern end off Norderney. The male sailor went below deck and changed clothes, as he was wet because of the spray and shivering.

The waves got higher again as they passed the Wichter Ee tidal inlet between Norderney and Baltrum on starboard beam. The waves struck the boat from port astern.

The sailors got wet again due to the waves when they passed the island of Baltrum on starboard beam shortly afterwards. The male sailor started to get cold again and once more changed below deck. Below deck, he noticed a smell of burning. As the crew was unable to identify the smell, the skipper had the main switch for the on-board electrics turned off. The bilge pump would still have been ready for use if necessary because it was connected directly to the battery. The smell of burning dissipated and they planned to establish the cause in port.

They approached the Accumer Ee. The skipper noticed the ebb stream flowing out of the Accumer Ee. They continued to sail on a beam reach at a speed over ground (SOG) of some 5.5 kts. The waves continued to approach from the port side. The skipper noticed the first breaking waves. The water in the cockpit was ankle-deep at times and drained through the two bilge pipes mounted aft. The battery charge indicator on his smartphone indicated a charge level of 17–20%.

The skipper now had the water tower on Langeoog in sight. He fell away from the wind level with buoy A4, changed course to starboard and turned into the Accumer Ee fairway. He had the headsail furled so as to make it easier to find the fairway buoys and reduce speed. He was worried about descending a wave crest at an excessive

[23] The company was called Nautical Publications at the time of the accident.

speed and undercutting it with the bow. He positioned his two crew members as far forward in the cockpit as possible.

The wind and waves were now coming from aft. The boat was sailing downwind with the mainsail reefed once on starboard bow.

The female sailor watched the coast ahead and saw two buoys on the port side. One of them was red.

The waves were faster than the boat. They surfed the waves for a short while until the waves passed under the boat. In the trough of the waves they almost stopped, making it virtually impossible to steer the boat at that moment. The skipper felt that the current was approaching from ahead. The first three waves from aft that rolled under the boat seemed harmless to him.

In the fourth wave, the boat luffed on port and was no longer steerable. It was during this or the next breaking wave that the boat capsized.

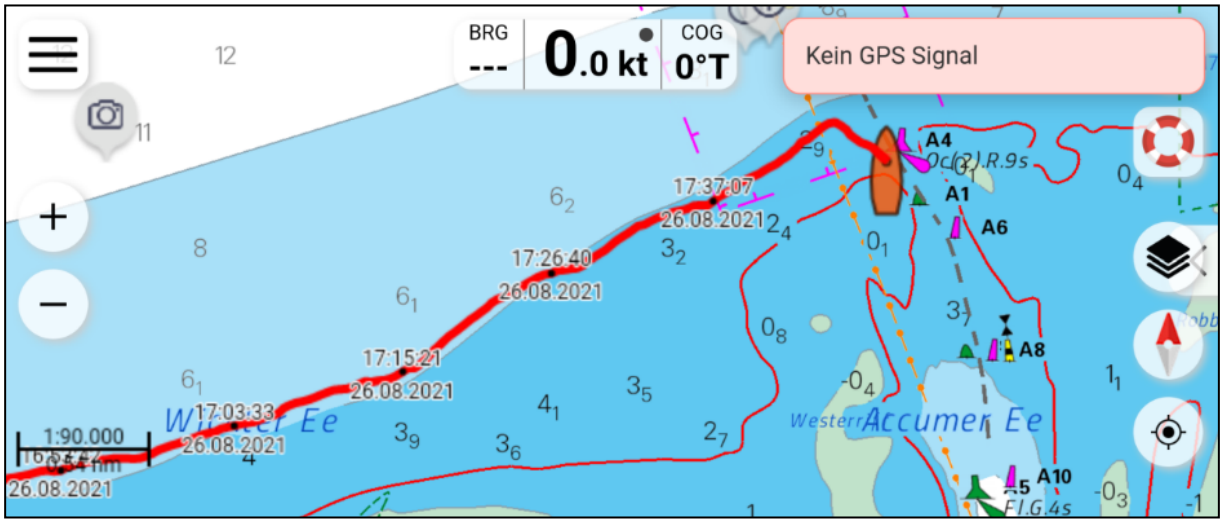


Figure 6: The SILJA's track recording – Accumer Ee [24]

According to the track recording on the smartphone, the SILJA capsized at 1749.

All three sailors fell into the water when the boat capsized and they and the boat floated seaward due to the ebb current.

[24] Source: Skipper. Screenshot (extract) from a Sony Xperia 10 II.

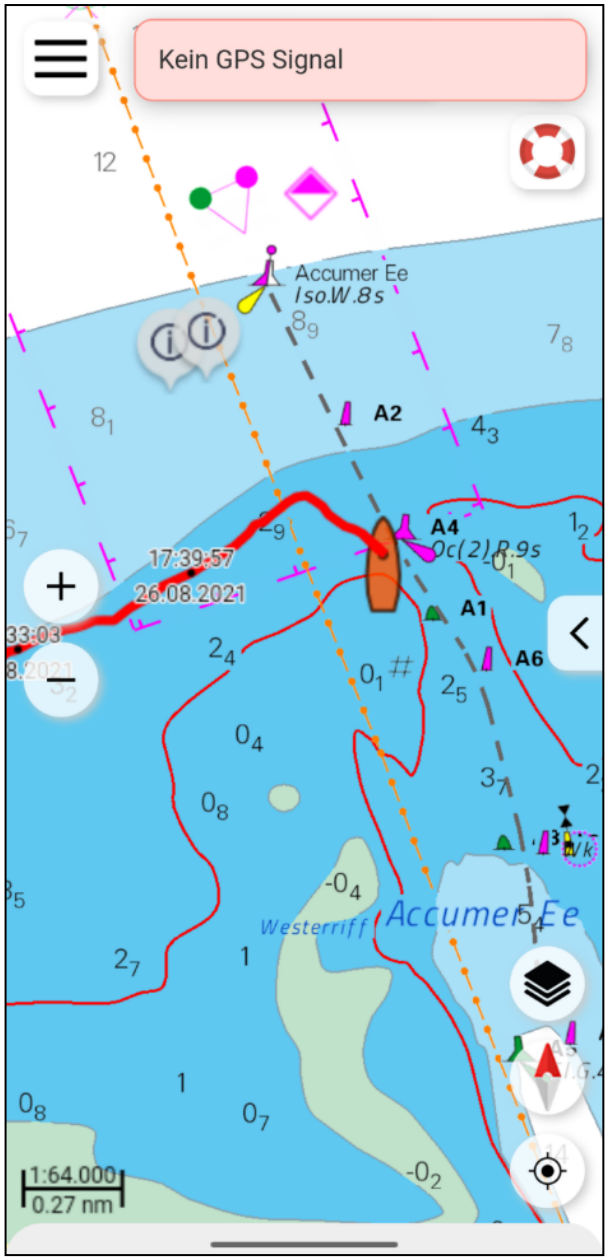


Figure 7: The SILJA's track – position at which she capsized[25]

Figure 8: Track of the people overboard[26]

3.1.2 Events after the boat capsized from the perspective of the people rescued

The skipper saw his two crew members floating in the water. The inflation device on the lifejackets had triggered on all of them, as intended.

The two men swam as fast as they could with the triggered lifejackets to the inverted, floating SILJA. The male sailor was a little faster and held on to the bathing ladder attached to the stern. The skipper was to the left of the male sailor and clung to the side of the boat and to the bathing ladder and heard the female sailor calling for help.

[25] Source: Skipper. Screenshot (extract) from a Sony Xperia 10 II.
[26] Source: Skipper. Screenshot (extract) from a Sony Xperia 10 II.

The skipper considered their options. Swim ashore and get help? He reached for his smartphone in the protective waterproof cover and passed it to the male sailor because the latter was holding on to the ladder, meaning his body was slightly further out of the water and his position thus possibly better for transmitting and receiving. However, the male sailor was unable to operate the smartphone through the wet cover and send a distress call.

The female sailor had also arrived at the stern of the SILJA in the meantime. She clung to the ladder in the aft section and/or to the male sailor, who was already holding on to it.

According to the recollections of the female sailor, she had previously experienced problems with the inflated lifejacket and the waves. The inflated buoyancy chambers felt very tight around her head. In addition, she was frequently pushed under water by single breaking waves and had to free herself from lines in the water and the boat. Her lifejacket's buoyancy chamber was not on her body in front of her stomach, as she would have expected, but rather floating next to her head. She could not identify the cause.
After the male sailor was unable to unlock the smartphone, he handed it to the female sailor. She was also unable to unlock the smartphone because of the drops of water on the protective cover and gave it back to the skipper.

Shortly afterwards, the boat and the sailors clinging to the stern were struck by a breaking wave of some three metres in height. The sailors and the boat were pushed under water. After that, the SILJA continued to float keel uppermost. The male sailor was still clinging to the bathing ladder and the two others to the SILJA's aft section, one on each side.

During this period, the female sailor became entangled with a line floating in the water. Her crotch strap was bothering her.

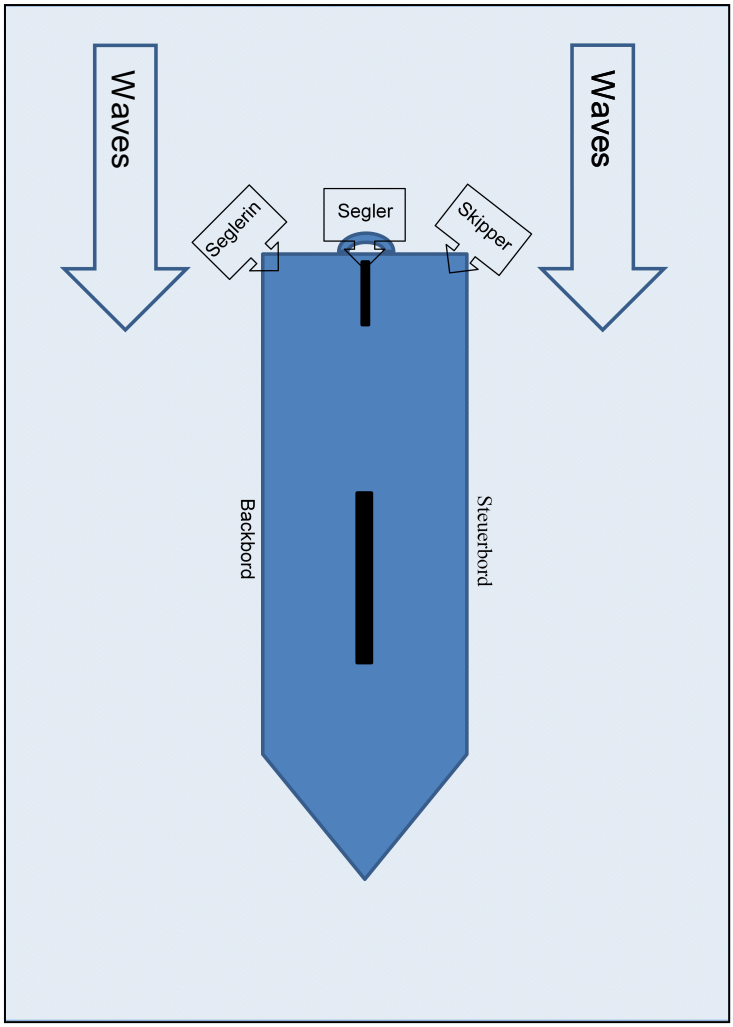


Figure 9: Situation after the boat capsized (drawing)

The skipper noticed his boat was lying deeper and deeper in the water and concluded she was foundering.

The female crew member noticed a small bump that was bleeding slightly on the male crew member's forehead. The male sailor started to panic.

The SILJA and the sailors clinging to the boat were once more struck by a possibly breaking large wave.

The female sailor remembered being dragged under the boat and how she was able to free herself under water from all the lines that had been bothering her. When she surfaced, she grabbed the buoyancy chamber of her lifejacket, which was next to her head, and clung – as did the male crew member – to the SILJA, which was now floating upright.

The boat's mast had snapped and the SILJA was lying so deep in the water that the skipper was able to swim into the cockpit. Once there, he considered whether the water could be removed from the boat with pumps or buckets. Shortly afterwards, the unlocked locker seats opened and filled up. The SILJA foundered.

After the SILJA foundered, the skipper watched the female sailor free herself from a stern line that was floating in the water and had become entangled with her neck.

The skipper noticed that the lifejacket buoyancy chambers of all three were not in front of their chests but rather floating more or less to the side of their heads. The buoyancy chambers had partially detached from the harness system on their lifejackets.

The three sailors stayed together. The male sailor clung to the female sailor. This made her feel as if she was being dragged into the depths and would drown despite the buoyancy chambers. She resisted and in order to free herself took off her lifejacket and clamped the buoyancy chamber under her arm.

The skipper then spoke to the male sailor, who did not respond.

After the next wave, the skipper saw the male crew member about one to two metres away floating face up in the water and detached from the female crew member. Water was repeatedly washing over the male sailor's face, which had a bluish tinge. He had foam or many small air bubbles in front of his mouth. He was unresponsive.

In the meantime, the skipper had been separated from the female sailor by a wave and had drifted away. The female sailor watched the skipper drifting away to her left. She called him and heard him answer.

The female sailor was then alone. She put the buoyancy chamber under her chest and tried to move all the time. She swam against the waves. She discovered the whistle on her lifejacket and tried it out but found that she could not blow enough air through it.

She saw the first lifeboat after about 90 minutes. The boat was sailing only a few hundred metres ahead of her towards the open sea. The lifeboat moved away from her. She decided to swim with the waves towards the shore instead of against them with the buoyancy chamber under her chest. Then she heard and saw several helicopters. One helicopter flew directly overhead. She tried to attract attention by waving and shouting. However, after 20–30 minutes all the helicopters had disappeared again. As dusk fell, she noticed a flashing light on her buoyancy chamber. She grasped the flashing light in her hand and repeatedly waved it back and forth for about an hour with her arm stretched out as far as possible.

She later saw lifeboats and more helicopters. One helicopter lowered a basket. She swam into it, was washed over by another wave and then pulled up. Shortly before that, she had heard the skipper calling out to her left.

Once in the helicopter, she told the crew that there was someone else in the water to her left. She also told the helicopter crew about the third sailor and that he might not be alive. Medical care was then administered to her in the helicopter.

After being separated from the female sailor, the skipper, still floating in the water, concentrated on the waves to avoid being washed over by them. He could no longer see his crew members. In the given situation, he decided to take the waterproof smartphone out of its cover. It was off and had to be switched on. After the device had started, it indicated a battery level of 3%.

He dialled 110 and made a distress call: "*Help, help – three people in the water, Accumer Ee between Baltrum and Langeoog."* After 45 seconds the connection was interrupted. He called 110 again. The connection was dropped after 80 seconds. The phone app had closed. He wanted to call again, but tapped the WhatsApp icon. He sent a voice message lasting about 10 seconds to his girlfriend. He switched to the phone app and dialled the number of the last caller – that of his mother. There was no answer. He then dialled 112: "*Help, help – three people in the water, Accumer Ee [...]*." The smartphone switched off after about 90 seconds. The battery was empty.

He heard the female crew member calling.

After about 45 minutes, he saw a rescue vessel. He saw two helicopters and tried to attract attention by waving. However, he was not seen. It felt to him as if his lifejacket's buoyancy chamber was twisted and the reflectors may not be visible. He knew that only his crew members had lifejackets equipped with emergency flashing lights. It was getting dark and noticeably colder.

After a while, he saw a helicopter on the horizon.

Then he noticed a green flashing buoy. He assumed it must be buoy A1 and decided to swim towards it. A rescue cage was then lowered into the water in his immediate vicinity and he swam into it.

The skipper was rescued by the same helicopter that had previously found the female sailor and pulled her out of the water. Once in the helicopter, both received initial medical care and were immediately taken to nearby hospitals.
The two people rescued were suffering from hypothermia. Apart from bruises on the female sailor, no other physical injuries were found during the examination. Both were able to leave the hospital after a few days.

3.1.3 Events after the boat capsized from the perspective of the rescuers

The following account of the search and rescue operation is based in particular on the mission logs and reports of

- the KRLO;
- MRCC Bremen;
- rescue cruisers HERMANN MARWEDE and EUGEN;
- lifeboats ELLI HOFFMANN-RÖSER and SECRETARIUS;
- SEA KING MK41 multi-purpose helicopter of the German Navy,

as well as the distress call audio files.

At 1827 on 26 August, the KRLO received a distress call on 110. The caller's messages were not intelligible due to wind and other background noise, in particular. After 26 seconds, the call was dropped. Another distress call from the same mobile number was received 29 seconds later. The voice of the caller was heard more frequently in this distress call but the content of the message once more unintelligible. This call lasted 78 seconds.

The KRLO did not receive any AML data[27] in either call. In accordance with legal obligations, the mobile operator (provider) forwarded the approximate location of the caller. The approximate beamwidth from the selected radio tower was also sent. The beamwidth from Langeoog in the direction of Baltrum was entered in the KRLO's command and control system at 1829. The distance to the radio mast was not known.

The KRLO dispatchers immediately set further measures in motion. A mobile phone location search ordered from the provider did not yield any results. While this was going on, the distress call had been listened to several times. Linked with this bearing, the dispatchers thought they may be able to hear 'Accumer Ee' in the distress call. The KRLO informed MRCC Bremen about the virtually unintelligible calls and the available location information. MRCC Bremen launched the rescue operation at 1847.

[27] AML: Advanced mobile location.

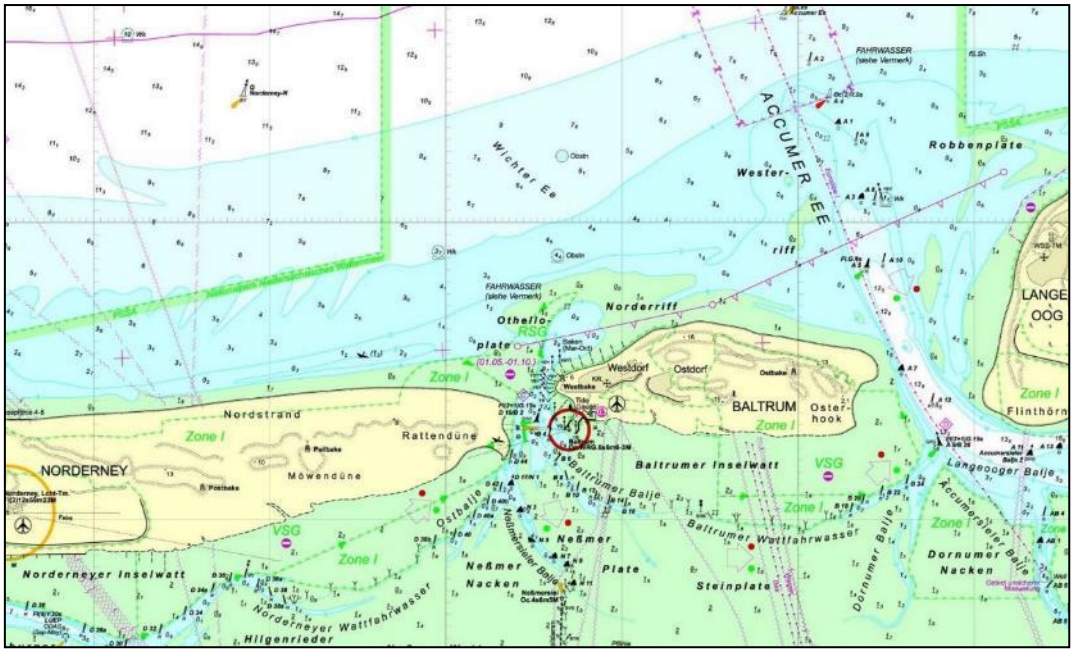


Figure 10: Search area[28]

At 1854, the MRCC instructed the SRB ELLI HOFFMANN-RÖSER, stationed in Baltrum, to put to sea and look for anything conspicuous.

Figure 11: Lifeboat ELLI HOFFMANN-RÖSER[29]

At about 1900 it was determined that the mobile call was made at a position between Langeoog and Baltrum. The SRB ELLI HOFFMANN-RÖSER was stood down and the SRB SECRETARIUS, stationed in the port of Langeoog, called in. The SECRETARIUS departed at 1916 and was to see if there was anything in the Accumer Ee.

[28] Extract from the navigational chart BSH 1170, Juist to Langeoog.
[29] Source: DGzRS/Frank Kahl.

Figure 12: Lifeboat SECRETARIUS[30]

At 1918, the MRCC received a distress message by phone. The caller reported the receipt of a WhatsApp voice message and the assumption that a sailing yacht of about seven to eight metres in length with a dark blue hull, the SILJA, had capsized at about 1840. The three people on board, two men and one woman in their 20s, had reportedly fallen overboard. It was assumed that the SILJA had reportedly set sail for Langeoog from Juist at 1200.

The telephone number used for the WhatsApp voice message was the same as that used in the distress call received by the KRLO.

At 1920, following receipt of these messages, the SRB ELLI HOFFMANN-RÖSER was called in again, as was the ADAC rescue helicopter Christoph 26, approaching from Bremen.

[30] Source: DGzRS/Martin Stöver.

Figure 13: ADAC rescue helicopter CHRISTOPH 26 (Airbus H145) [31]

At 1930, the MRCC called in the German Navy's SAR helicopter stationed at Borkum. It received its mission order from ARCC Glücksburg at 1935. At the request of the MRCC, a Bundeswehr doctor was on board in addition to the usual crew of four people – two helicopter pilots, an aircraft operations officer and a flight mechanic.

[31] Source: ADAC Luftrettung gGmbH.

Figure 14: SEA KING MK41 SAR helicopter (German Navy) [32]

The SRK EUGEN, stationed at Norderney, was called in at 1932. This SRK was also assigned the role of OSC[33].

Figure 15: Rescue cruiser EUGEN[34]

The MRCC issued all vessels deployed course and speed instructions for the search area.

[32] Source: Bundeswehr/Björn Wilke.
[33] OSC: On-scene coordinator. According to the IAMSAR manual, the OSC coordinates the search and rescue operations on scene in a given area.
[34] Source: DGzRS/Frank Kahl.

At 1934, the MRCC sent a DSC[35] distress alert, which was forwarded shortly afterwards as a mayday relay on the VHF marine radio channel 16. The emergency towing vessel NORDIC, anchored at Heligoland, then offered her assistance. The MRCC instructed the NORDIC to remain at her position for the time being.

The SRK HERMANN MARWEDE, stationed at Heligoland, was called in at about 1938.

Figure 16: Rescue cruiser HERMANN MARWEDE[36]

At 1946, the rescue vessels and helicopters were tasked as follows:

- the German Navy's SAR helicopter seaward, west part of Juist to Langeoog;
- the CHRISTOPH 26 between Baltrum and Langeoog;
- SRK EUGEN (OSC) off Norderney;
- SRB ELLI HOFFMANN-RÖSER off Baltrum;
- SRB SECRETARIUS between Baltrum and Langeoog, and
- SRK HERMANN MARWEDE providing support.

The MRCC's mission log indicates, in particular, a lively exchange of information between all parties involved and adjustments to the search sectors up until 2011. The caller with the information from the WhatsApp message confirmed when asked that the SILJA's skipper definitely wanted to head for the destination port of Langeoog seaward. In addition, the police helicopter unit stationed in Hannover offered its support

[35] DSC: Digital selective call. The DSC is a call procedure in the Global Maritime Distress Safety System.
[36] Source: DGzRS.

to the MRCC and the latter gave the press department a brief summary of the ongoing operation.

At 2011, the OSC sent both helicopters to the SRB ELLI HOFFMANN-RÖSER's search area, as she had sighted something ahead.

A helicopter from WIKING was called in at 2013. It was on the return flight from a marine pilot transfer and had offered its assistance.

Figure 17: Airbus H145 (Wiking Helikopter Service GmbH) [37]

The SRB NEUHARLINGERSIEL from the port with which she shares her name was called in at 2017.

[37] Source: WIKING Helikopter.

Figure 18: Lifeboat NEUHARLINGERSIEL[38]

In the meantime, the MRCC had received all the mobile phone numbers of the sailors they were searching for. The attempt to reach someone via these numbers failed. The MRCC forwarded the numbers to Waterway Police Wilhelmshaven to query the last location of the devices.

At 2027, the helicopter CHRISTOPH 26 reported that it was leaving its search area due to a lack of fuel. The SRBs ELLI HOFFMANN RÖSER and SECRETARIUS searched within the Accumer Ee.

The MRCC and the OSC compared available information and fine-tuned the search in the ensuing minutes.

The mission report of the SECRETARIUS gives an impression of the search conditions: "*Getting so much water on the windows that we are having to make observation stops. We are working through the Accumer Ee on a zigzag course up to buoy A 2. Can only guess where it makes sense to search because the location of the accident is not known. EUGEN and ELLI HOFFMANN-RÖSER are joining us. Searching outside the reef belt first. Dusk is setting in and combined with the wave height it is increasingly difficult to see anything. We decide to continue the search inside. (Our searchlight capacity is poor[39].)*"

According to the MRCC's mission log, the sun set at 2030.[40] Wave heights were reported as 2.5–4 m and the water temperature as 18 °C. It was noted a little later that the air temperature in the search area was 21 °C.

[38] Source: Die Seenotretter – DGzRS/Frank Kahl.
[39] According to the MRCC, remote-controlled searchlights are basically of limited use in a heavy sea state, as the ship's motion is so fast on this size of vessel that it is almost impossible to aim the light cone. The additional handheld searchlights carried on board can be far more effective at close range. The SRBs have been periodically modernised over the years to keep up with the latest technology.
[40] The calculations of the LunaSolCalc app indicate that the sun went down at Langeoog at 2035 on 26 August. Civil twilight began at sunset and ended at 2113. A good eye can see the brightest stars

The SRBs ELLI HOFFMANN-RÖSER and SECRETARIUS were searching in the Accumer Ee surf area at that time. The SRK EUGEN sailed north of the Accumer Ee on the 10 m depth contour from west to east, sailing on a countercourse five minutes later.

Distress alerts were periodically broadcast as mayday relays on VHF channel 16.

At 2038, ARCC Glücksburg requested that a search area be established so as to coordinate several helicopters. At the scene, the SAR helicopter had been assigned the role of ACO[41] vis-à-vis other helicopters in the search area since 2010. The ACO staggered the helicopters at flight altitudes of 300–700 feet, each 200 feet apart. Depending on the situation, the helicopters flew different search patterns in accordance with the IAMSAR manual.

The MRCC asked the Maritime Emergencies Reporting and Assessment Centre in Cuxhaven to provide additional resources at 2039. Emergency towing vessel NORDIC, anchored at Heligoland, made for the area of operation.

Figure 19: Emergency towing vessel NORDIC[42]

At 2045, the SRK EUGEN sighted a lifeless body at the position φ 53°46.48′N, λ 007°24.21′E. Due to the state of the sea, the SRK was unable to move to the body floating in the water. The SRB ELLI HOFFMANN-RÖSER was called to assist by recovering the body via her rescue gate.

when the end of civil twilight approaches. Nautical twilight ended at 2201. During the nautical twilight phase, stars and the visible horizon as a line between sky and sea can be seen clearly if visibility permits.

[41] ACO: Aircraft coordinator. Coordinates the search and rescue operations of the deployed aircraft on scene.

[42] Source: WSV Ship Management Centre.

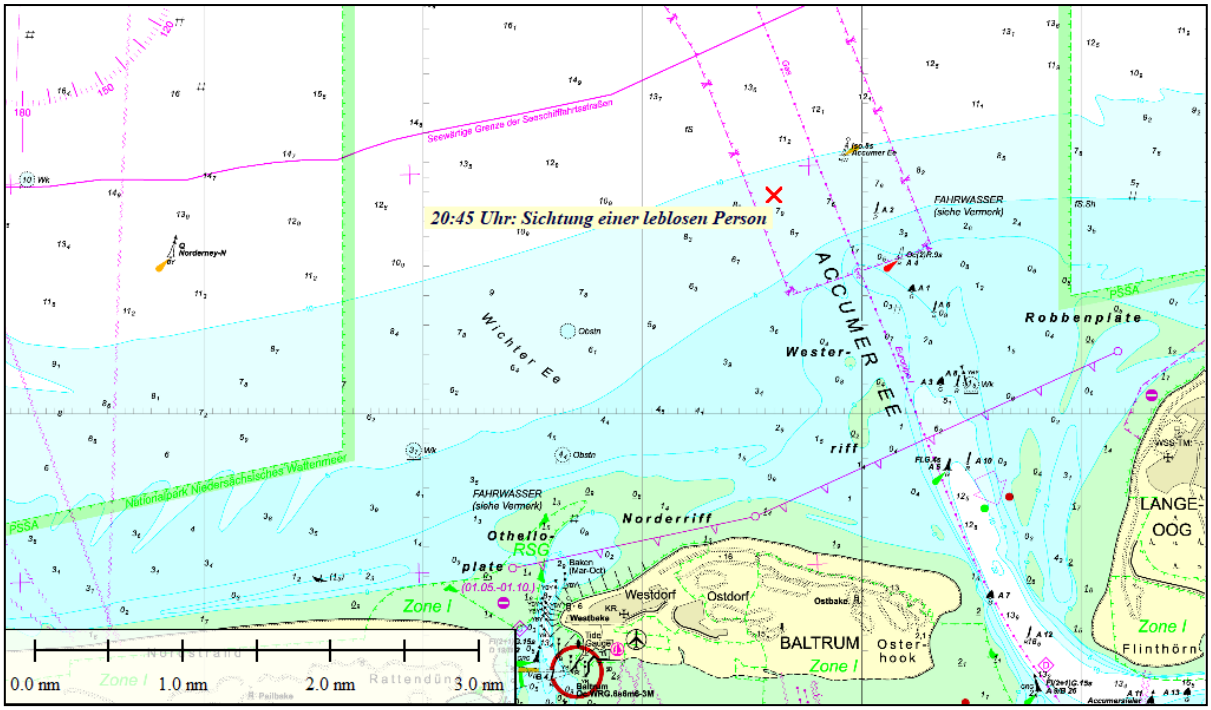


Figure 20: Position of the lifeless body sighted[43]

The multi-purpose vessel MELLUM and a waterway police coastal patrol boat, the WSP 3, were called in at 2046.

Figure 21: Multi-purpose vessel MELLUM[44]

[43] Extract from the navigational chart BSH 1170, Juist to Langeoog.
[44] Source: WSV Ship Management Centre.

Figure 22: WSP 3[45]

Since it was getting darker and darker, the crew of the SAR helicopter used night vision devices from 2050.

At 2055, the SOV ESVAGT DANA was called in. The ESVAGT DANA had a medic from the *Johanniter Unfallhilfe* aid organisation on board for offshore rescue operations at wind farm sites.

Figure 23: ESVAGT DANA[46]

[45] Source: Waterway Police Inspectorate Oldenburg.
[46] Source: Dietmar Hasenpusch Photo-Productions.

At 2058, the MRCC broadcast the position at which the SILJA may have capsized: φ 53°46.8'N, λ 007°26.5'E.

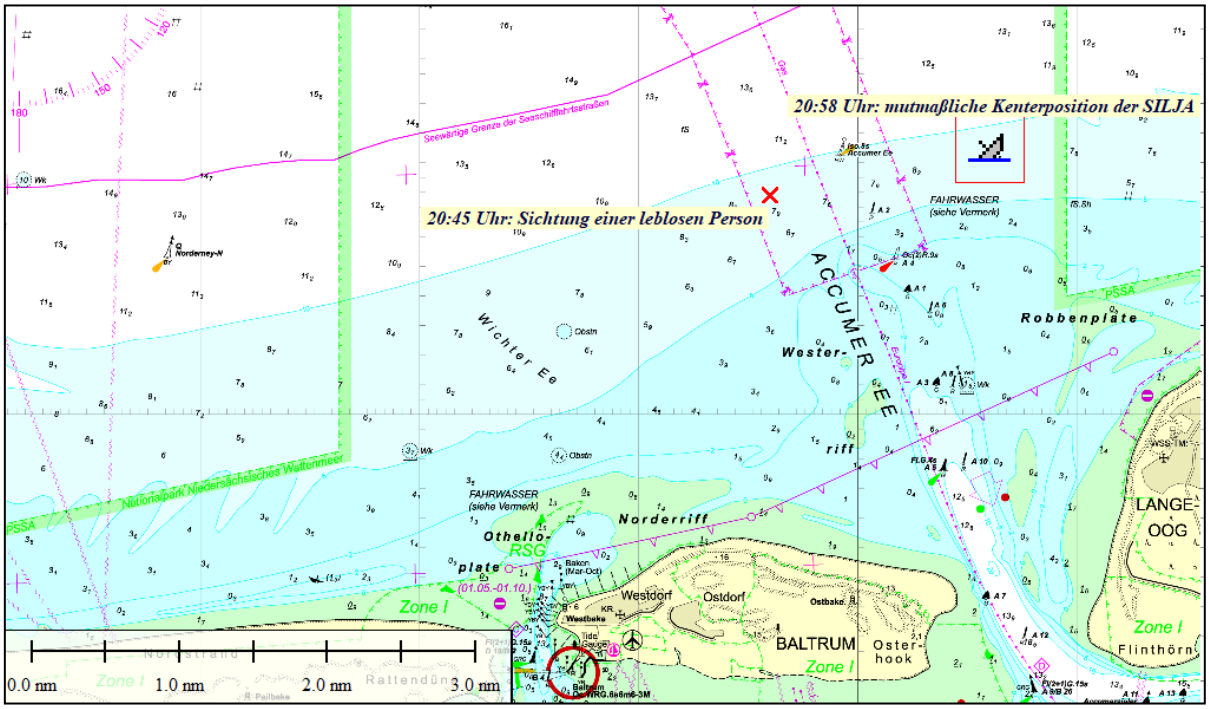


Figure 24: Positions broadcast by the MRCC (capsize site/lifeless body)[47]

At that time, the crew of the SRB ELLI HOFFMANN-RÖSER attempted to recover the lifeless body in waves of some 4 m high. According to the crew's report, they were unable to get the body of the male sailor on board. They made three attempts. The body kept sinking below the surface. On the third attempt, one of the crew members managed to take hold of the lifejacket's buoyancy chamber. The rescuer was unable to hold the arm of the lifeless body because of the tensile forces. The body may have been caught on something below the surface. The lifejacket's buoyancy chamber was already above the head of the lifeless body beneath it when the boat arrived. When the lifeless body's arm slipped out of the rescuer's hand, the lifejacket's buoyancy chamber tore off. The person sank like a stone in front of the eyes of the boat crew, making it impossible to reach for him. Due to the wind and the waves, the pressure was so strong that the head (hook) of the boat hook used to secure the lifeless body broke and tore off. At 2106, the OSC reported to the MRCC that the body had slipped out of the lifejacket and sank. The casualty had been wearing a blue jacket.

At 2108, the SRK HERMANN MARWEDE relieved the SRK EUGEN and took over the role of OSC.

At 2114, the SRK HERMANN MARWEDE reported that she would drift from the suspected capsize site to the position at which the lifeless body had been sighted.
At that time, the SRB ELLI HOFFMANN-RÖSER was sailing westwards with other rescue units, as the two remaining people from the capsized boat had almost certainly drifted in that direction.

[47] Extract from the navigational chart BSH 1170, Juist to Langeoog.

Another helicopter, the WIKING RESCUE 01, was deployed as a replacement for the German Navy's SAR helicopter. The helicopter CHRISTOPH 26 was back in the search area from 2124.

At 2122, the SAR helicopter's crew sighted an unidentified flashing light. As they approached they were able to link the light with one of the missing people. They succeeded in winching this person up in a rescue cage at the position φ 53°44.7'N, λ 007°21.2'E. The person in question was the female sailor. Her medical condition was rated as stable and slightly hypothermic.

The rescued female sailor informed the helicopter's crew about the third person within hearing distance of her, who had not yet been sighted. After considering the medical condition of the rescued female sailor, the doctor on board the helicopter agreed to them remaining in the search area and continuing the search. At 2130, the SAR helicopter continued its search from the position at which the female sailor was found with a trackline[48] search in an east-west direction.

With the exception of the SRB SECRETARIUS, the SRBs remained in the Accumer Ee area and continued the search in shallow water. The larger vessels in the search area searched parallel to the coast. The SECRETARIUS was to search inside the Accumer Ee through the Baltrum tideway between Norderney and Baltrum in case the person had drifted there because of the gat.

30 minutes after the start of the trackline search, at 2200, the crew of the SAR helicopter identified the third person slightly to the west of the female sailor's location at the position φ 53°44.8′N, λ 007°19.8′E. The nearby SRK EUGEN sailed there to secure the winch operation. They also managed to pick up this person with a rescue cage at 2205. The rescued person was the skipper. He displayed early signs of exhaustion and was hypothermic. As with the female sailor, the core body temperature measured was 35 °C. The helicopter crew decided to land on Baltrum and hand over the people rescued to civilian rescue units.

[48] The trackline search is a search method defined in the IAMSAR manual. The search is conducted parallel to the last known route of the vessel being searched for.

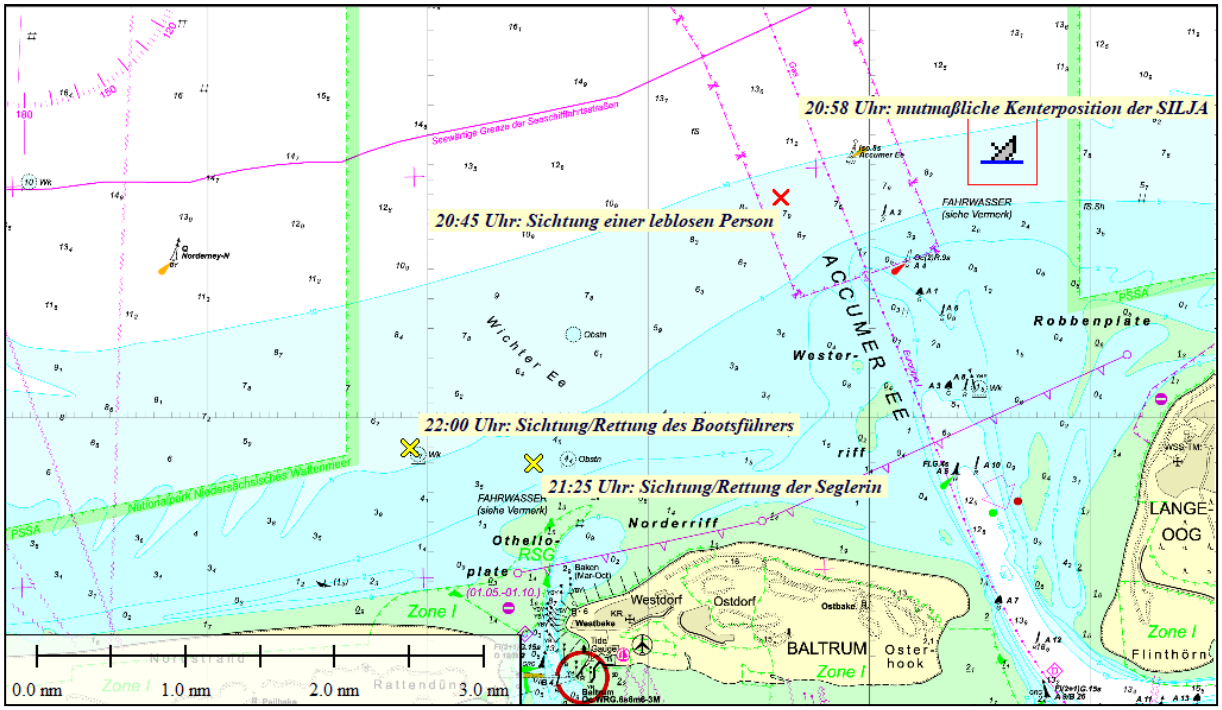


Figure 25: Suspected position at which the boat capsized and of the sailors[49]

Once on Baltrum, the skipper was handed over to the rescue helicopter CHRISTOPH 26, which flew him to a hospital in Aurich. The SAR helicopter flew the female sailor on to JadeWeser Airport near Wilhelmshaven and she was taken from there to a hospital by ambulance.

The MRCC organised pastoral care at Baltrum Station after the two sailors were rescued. All parties involved were able to report further pastoral care needs via the MRCC.

The search for the third person, who was lifeless and had sunk during the recovery attempt, was called off at 2233. A further search was deemed futile as the person was presumed to be floating underwater due to his lungs being full of seawater. A search using infrared equipment was not considered appropriate because of the water temperature of 18 °C. In addition, some of the waves breaking in the search area were reaching a height of 4 m. It had not been possible to find the person before the publication of this investigation report.

The MRCC informed the vessel traffic service about the wreck. Only parts of the SILJA had been found prior to the publication of this investigation report.

The MRCC ended the operation on the following day at 1224.

3.1.4 Washed up debris

The female sailor's rucksack with contents was found on the beach of Norderney and the skipper's rucksack with contents was found on a sandbank north of Baltrum on

[49] Extract from the navigational chart BSH 1170, Juist to Langeoog.

27 August. Two boat fenders possibly from the SILJA were also found at the eastern end of the island of Baltrum.

At about 0330 on 1 September, part of a GRP hull measuring roughly 2 x 1.30 m became entangled in the net of the fishing vessel FREYA. The FREYA had been trawling east of the Accumer Ee and found the part at the position φ 53°46.75′N, λ 007°25.70′E. The find was cut into four pieces to recover it from the net.

At about 1700 on the same day, the FREYA picked up another piece of wreckage measuring roughly 0.25 x 1 m while fishing at the position φ 53°43.30′N, λ 007°26.73′E. This was probably the interior cladding of the foundered SILJA.

The discovery of a wooden part measuring some 1 m in length from the SILJA's interior was reported on the island of Baltrum on 10 September.

3.1.5 Data backup

The waterway police secured the skipper's smartphone after he was rescued. The smartphone was heavily corroded by sea water and no longer operable. It was not possible to read data from the internal memory with the analysis system used by the police. The data on the SIM card were readable but irrelevant to the accident. The smartphone was then returned to the skipper.

A private data recovery company commissioned by the skipper was able to secure, *inter alia*, photographs and track recordings and made them available to the BSU on 1 July 2022. On the day of the accident, the skipper recorded the track from the beginning of the passage through the Dovetief.

3.2 Investigation

Marine casualties involving only privately used recreational craft, as in the case at hand involving the SILJA, are in principle not subject to the Maritime Safety Investigation Law (SUG) and therefore generally not investigated by the BSU (see Section 1(3) SUG). This principle applies regardless of an accident's severity, even if it results in loss of life, for example.

However, an official investigation may be carried out if a marine casualty occurs in German territorial waters or in the German Exclusive Economic Zone and it is expected that the findings will contribute to an improvement in maritime safety (see Section 1(4)(1) SUG).

Accordingly, the BSU carried out a preliminary investigation after receiving the accident report and examined what findings may emerge.

Based on the information gathered on the various witness statements, in particular, the BSU expected findings on the following aspects, in particular:

- knowledge about the navigation of gats and similar blackspots;
- the suitability of a smartphone as a central device for information, navigation and distress calls, and
- the suitability of the lifesaving appliances, in particular the lifejackets used.

Based on the above, the BSU therefore decided on 16 September 2021 to conduct an investigation in accordance with the SUG.

All parties involved, in particular the people rescued, assisted with the investigation to the extent possible at all times.

The waterway police gave sight of the evidence secured and findings made in the course of its criminal investigation to the BSU.

3.2.1 Possible cause of death

Based on the information available, the BSU requested an assessment of the possible cause of death of the sailor, who was initially classified as missing according to the German Act on Missing Persons, from the Department of Forensic Medicine at the Hamburg-Eppendorf University Clinic (UKE) in order to derive safety recommendations from that if necessary.

The following information was sent to the Department:

- a sailing boat capsized in the Accumer Ee tidal inlet and foundered shortly afterwards. Two of the three sailors were rescued;
- the presumed deceased sailor (referred to below as 'the deceased') was a male in his early 20s and had no known pre-existing conditions;
- air and water temperature were 20 °C and 18 °C, respectively;
- the waves were about 2.5 m high and possibly breaking when the boat capsized;
- the deceased had changed his clothes several times before the boat capsized because they were wet due to water washing over the boat and he was cold;
- he was wearing a lifejacket;
- after the boat had capsized, a small bump that was bleeding slightly was noticed on the head of the deceased. He was initially responsive and appeared to be confused/panicky;

- all three sailors initially clung to the capsized boat before she sank after about 30 minutes. A breaking wave caused the sailors and the boat to spin in and under the water at least once;

- the deceased had clung to one of the other people so tightly after the boat foundered that the latter had the feeling of drowning, pushed the deceased off and then had the impression that the deceased was no longer alive;

- the sailors saw the deceased floating face up in the water. Water was repeatedly washing over his face, which had a bluish tinge. He had foam or many small air bubbles in front of his mouth. He was unresponsive;

- DGzRS personnel discovered the deceased in the water about three hours after the boat had capsized. The body kept sinking below the surface. On the third attempt, one of the crew members managed to grasp the lifejacket's buoyancy chamber. The rescuer was unable to hold the arm of the lifeless body because of the tensile forces. The body may have been caught on something below the surface. The lifejacket's buoyancy chamber was already above the head of the lifeless body beneath it when the lifeboat arrived. When the lifeless person's arm slipped out of the rescuer's hand, the lifejacket's buoyancy chamber tore off. The person sank like a stone in front of the eyes of the boat crew, making it impossible to reach for him.

The Department concludes in the summary of the opinion that a young man with no known pre-existing conditions, who was *presumably weakened due to hypothermia, drowned in all likelihood in seawater between Baltrum and Langeoog as a result of a marine casualty on 26 August 2021. Some two hours and 45 minutes had reportedly passed between emergency and discovery. Typical of a drowning process, the other sailors involved reportedly observed foam after about 30 minutes in the water, meaning that the death of the person must already have occurred by that time.*[50]

According to the expert opinion, the bluish tinge seen on the face is a typical indication of drowning. This is also true of the signs of panic. The fact that the sailor sank in the water *like a stone is consistent with the assumption of a person who had already died at that time*.[51]

Over the course of the investigation it was not possible to make any findings as to whether the sailor had possibly become entangled with a line from the boat.

However, based on the comments of the female sailor, it is reasonable to assume that the sailor came into contact with at least one line from the boat. In addition to the mooring line mentioned by the female sailor, which had come loose from the railing in the fore section, the sailor may have become entangled with one of the sheets[52] or

[50] Expert opinion from the Department of Forensic Medicine, UKE. Reference number: G0813-22.
[51] See previous footnote.
[52] Sheets are lines connected to a sail to change its angle.

halyards[53], for example, when breaking waves were pushing him and the boat under water several times.

3.2.2 The sea area

The marine casualty occurred in the Wadden Sea south of the Accumer Ee approach buoy and about 2 nm north of the island of Baltrum in the area of the Accumer Ee tidal inlet bar.

Figure 26: The Wadden Sea World Heritage Site[54]

All passages between the Wadden Sea islands to the open sea are referred to in German as *Seegat* [tidal inlet].

The author of a book written for water sports enthusiasts, *Seemannschaft in Wattengewässern*[55] [seamanship in wadden waters], Dr Karlheinz Neumann describes these tidal inlets as a *[...] quite peculiar, difficult and often dangerous transition zone between the Wadden Sea and the deep sea [...]* on page 68 ff.

This old but still relevant nautical publication goes on to state: *the tidal current flows through the tidal inlets, filling the mudflats as the water rises. The water flows through the tidal inlets back to the sea when the tide goes out. An enormous amount of water is in motion in the tidal inlets during the ebb/flow cycle. But not only the water, the ebb and flow of the tide keeps the sand in motion, too. Accordingly, although the tidal inlet*

[53] A halyard is used to set the sails.
[54] Source: Common Wadden Sea Secretariat; https://www.waddensea-worldheritage.org/one-wadden-sea-one-global-heritage (2022-01-31).
[55] Dr Karlheinz Neumann: Seemannschaft in Wattengewässern. Mit 128 Zeichnungen und Tabellen. 1st edition, Bielefeld: Delius Klasing, 1981.

is extremely deep between the islands [the navigational chart[56] indicates more than 20 m in the Accumer Ee]*, a shallow zone of banks and reefs follows seaward, where the sand sinks to the bottom. It is even dry in places at low tide. The current keeps one or two channels deeper in these reefs.*

In the case of East Frisian island tidal inlets, the reef zone is about 2 nautical miles from the island front; the distance for North Frisian islands can stand at 6–8 nautical miles. Currents and surf cause the seaward edges of these reefs to be extremely steep. Due to this ring of sand reefs, the current produces two or three constantly changing channels. The shallowest part of the channel is referred to as the bar. The depth of the water on the bar is between one and two metres [in Accumer Ee 2.1 m according to the navigational chart]. *For we seafarers, the bar is the critical part because groundswell or even surf builds up there in a disturbed sea state. Buoys mark the most favourable passage for shipping through the sand reefs. We should never navigate the reef zone outside this row of buoys with our ship.*

A few pages earlier, the author has dealt in detail with the sea state in the sea area of the North Sea and the types of sea state.

He gives a pointed description of the groundswell on page 48 ff.: *This is an exceedingly steep, hollow sea. Groundswell develops when higher wind seas[57] or swell[58] hits shallower ground. It develops mainly when an additional current is running against the sea state. Groundswell breaks very often[59] and then throws masses of green water over the boat with incredible force. In the wave trough, an extremely strong current pulls against the sea state on the shallow bottom. This makes it extremely difficult to steer a boat, which tends to turn transversely to the crest of the wave, in the wave trough. The helmsman must be extremely attentive. An engine should be running. By briefly applying full throttle in the trough of a wave, it increases the steering effect. It is possible for the ship to hit the bottom in the trough of a wave. – Groundswell is an extremely dangerous sea state! The seaworthiness of even boats designed for heavy weather is not always a match for groundswell. If a ship broaches to in groundswell, the next wave crest is very likely to wash over her. – A ship must do everything possible to avoid regions with groundswell. It is most commonly encountered in tidal inlets where the bottom is shallow, especially when the current is running out. I do not know of any remedy for groundswell, apart from a very strongly built ship, a wide ship and – to avoid any and all groundswell. That means refraining from entering tidal inlets in poor weather.*

The following statements of Dr Neumann illustrate the potential danger of tidal inlets in the area of the East Frisian islands: *That a passage, or tidal inlet, between the islands exists every seven nautical miles on average is, after all, the nice thing about this area.*

[56] NV Atlas Ostfriesland DE13 (2021), Chart C7 (Norderney bis Langeoog), last revised in February 2021.
[57] A wind sea is a disturbed sea state created by the wind. The wave height (vertical distance between a wave's trough and crest) depends in particular on the wind strength, the duration and the wind's fetch over the water.
[58] Swell is defined as the part of the disturbed sea state when the latter has left the wind field or the wind has already died down and the wave height is slowly decreasing at the same period.
[59] Breaking groundswell is referred to as surf.

This makes cruises around the outside justifiably enticing. The relative proximity of landmarks, the direction of the currents and the proximity of bolt-holes make sailing at sea easier here than anywhere else on our North Sea coast (apart from Heligoland). But we must never forget that it is a sea area off a dangerous coast. Out of 20 cruises around the outside, 16 are incredibly beautiful, three are exciting, and on one, Saint Brendan, the patron saint of seafarers, has to step in to make sure things just about work out again. The art of seafaring is not to start precisely this cruise in the first place.[60]

3.2.3 Sailing directions and nautical publications

In addition to many other tasks[61], a skipper must plan the route before every voyage. Apart from navigational charts, all other necessary nautical publications must be used for planning, as navigational charts cannot contain every item of information. In addition to being consistent with good seamanship,[62] this practice is laid down in the watchkeeping standards.

The watchkeeping standards can be found in Regulation VIII of the Annex to the STCW Convention[63]. Section A-VIII/2 Part 2 No 5 STCW Code[64]; which is appended to the Annex to the STCW Convention, states that masters of any ship must ensure *"[...] that the intended route from the port of departure to the first port of call is planned using adequate and appropriate charts and other nautical publications necessary for the intended voyage, containing accurate, complete and up-to-date information regarding those navigational limitations and hazards which are of a permanent or predictable nature and which are relevant to the safe navigation of the ship."*

[60] Dr Karlheinz Neumann: Die Nordseeküste. Teil II – Elbe bis IJseelmeer. Ein Führer für Sportschiffer, page 199. 5th edition, Bielefeld: Delius Klasing, 1983.
[61] See Chapter 4 (*Die Vorbereitung* [preparations]) of the *Sicherheit auf dem Wasser* [safety on the water] pamphlet, for example. Federal Ministry of Transport and Digital Infrastructure. Information as of December 2020. https://www.bmvi.de/SharedDocs/DE/Publikationen/WS/sicherheit-auf-dem-wasser-2018.html.
[62] See Chapter 2 of the Sicherheit auf dem Wasser pamphlet, for example.
[63] Eighth Ordinance on Amendments to the Annex to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, of 28 June 2013. Federal Law Gazette 2013, Part II No 18, published in Bonn on 4 July 2013.
[64] The Manila Amendments to the Seafarers' Training, Certification and Watchkeeping (STCW) Code. Annex Volume to the Federal Law Gazette Part II No 18 of 4 July 2013.

According to Article III (c) of the Act on the STCW Convention[65], the STCW Code does not, in the first instance, apply under international law to seafarers on recreational craft (referred to as *'pleasure yachts'*), unless they are used for commercial purposes (referred to as *'engaged in trade'*).

According to the definition under Section 2(1)(1) Ship Safety Act (SchSG)[66], seagoing recreational craft are seagoing vessels[67]. The watchkeeping standards contained in the STCW Code must therefore also be taken into account on seagoing recreational craft flying the German flag in accordance with Section 1(1) and Section 1(2) SchSG in conjunction with No VI.1 in Section A of the Annex to the SchSG.

3.2.3.1 Navigating tidal inlets

To begin with, the information that the BSH publishes in the official sailing directions[68] was established. In the following, the term 'sailing directions' always refers to the official publications of the BSH.

The sailing directions recommend that anyone unfamiliar with the area should only navigate the tidal inlets (and tideways) with local guidance or pilotage.[69] This is followed by general notes on:

- the variable water depths and fairways;
- the effect the wind has on water levels, and
- nature conservation, with possible implications for the rules of navigation and entry described more specifically in other sections of the sailing directions.

The following is written with regard to tidal inlets: *Tidal currents often set at right angles to the heading within the fairway and over the sands, especially at high water levels.*

On the outer bar and outer fairway of a tidal inlet, stormy west and north-west winds (equivalent to 8 Bft) *and rising water generally create considerable seas, which cause a high and dangerous sea state when the current goes out. Waves become steep breakers, especially in those parts of the tidal inlet where the outgoing current reaches higher speeds due to a narrowing of the deeper channel by sands. During heavy storms, groundswell can occur with both incoming and outgoing currents in some tidal inlets.*

[65] Act on the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, of 25 March 1982. Federal Law Gazette, Part 1 No 14 of 1 April 1982.
[66] Ship Safety Act of 9 September 1998 (Federal Law Gazette I p. 2860), as amended by Article 1 of the Ordinance of 19 October 2021 (Federal Law Gazette I p. 4717).
[67] Professor Peter Ehlers, comments on the SchSG Section 2 Margin No 2, Nomos-BR, 4th edition, 2021.
[68] Nordsee-Handbuch, südöstlicher Teil (Lister Tief bis Ems), 6th edition, completed with NfS Issue 48 of 27 November 2020.
[69] See Part A (on ship's command and regulations), No 2.3 (on tidal inlets and tideways), p. 19.

When approaching the tidal inlets, it is important to consider that buoy positions change due to relocation caused by morphological alterations.

Part C (on fairways, anchorages and harbours) states briefly and concisely about tidal inlets in general that *buoyage is adjusted to accommodate changes in sands and fairways* [...] *does not always correspond to the chart position.*

Since water sports enthusiasts do not usually use the official sailing directions published by the BSH, but rather cruising guides, etc. or other published information, research was carried out on the internet in the BSH library and publications in magazines such as Palstek[70] and Yacht[71] to establish what information, if any, could be found on navigating tidal inlets.

The investigators found that a large number of publications exist and that it might be especially difficult for people unfamiliar with the area to decide which source is reliable.

Based on a subjective selection, the investigators took a closer look at various websites and books dealing with tidal and Wadden Sea sailing in general and more or less clearly with the subject of navigating tidal inlets. These included:

a) https://www.wattenschipper.de/seegatten/

   The 'Wattenschipper' summarises the danger briefly and concisely. The reader may note a potential danger from 4 Bft depending on tidal current:

   Tidal inlets/the basics
   The position and water depth of every tidal inlet are extremely variable. The shallowest points are found at the first buoys (viewed from the sea) and often marked by lighted buoys. In the transition from 15 m to 2 m water depth, even barely perceptible swell develops into steep and short groundswell that can lead to a maritime emergency in seconds. Tidal currents intensify this effect even more. Even a wind force of 4 Bft can then be too much. The swell can continue for up to 18 hours even after the wind has long since died down. The buoys are on the upper edge, i.e. not in the deep fairway and usually not where one would expect them to be. The buoy line is relocated 3–4 times a year in some tidal inlets! 14/04/2021 re

b) https://www.segeln-forum.de/thread/81245-hinweise-zum-sicheren-befahren-von-seegatten/?pageNo=1

   Following the marine casualty involving the SILJA, 13 tips for the safe navigation of tidal inlets were compiled in a sailing forum as of 3 February 2022. It is appended to this report in Annex 1.

[70] Seemannschaft Wattenmeer. Unterwegs im Tidenrevier. Teil 1. Palstek 6/21.
[71] Müller Kristina. Reise – Ostfriesische Inseln. Törn ins Wunderland. Yacht 20/2020.

c) Dr Karlheinz Neumann: Seemannschaft in Wattengewässern. Mit 128 Zeichnungen und Tabellen. 1st edition, Bielefeld: Delius Klasing, 1981.[72]

According to the author, the navigability of a tidal inlet, or more specifically the bar of one, is influenced by four factors (see p. 70 ff.):

- *the water depth on the bar;*
- *the state of sea;*
- *the water level depending on the tide, and*
- *the direction of the current*.

The book describes these factors in greater detail.

The author conveys the following vital steering rules: *In a higher onshore sea state, you should only navigate the bar of a tidal inlet when the current is coming in and at more than half tide. – No tidal inlet is navigable in an onshore gale.*

It goes on to read: *Every tidal inlet is different! If I nevertheless summarise it, it is to give an idea in advance:*

In moderate, force 3–4 (to 5) onshore winds and the associated sea state, any tidal inlet marked with buoys is probably navigable in incoming water and more than half tide (unless there is a high swell).

In strong onshore winds (force 6), not every tidal inlet of the East Frisian, West Frisian and North Frisian islands is navigable. At the very least they are hazardous on entry.

No tidal inlet is navigable in onshore storms, including when the water level is high and the current is coming in.

d) Dr Michael Steenbuck: Seemannschaft im Tidenrevier. 2nd edition, Palstek, 2016.

(See p. 68): *Passage is often hazardous and sometimes impossible from 6 Bft and in high swell. Anyone who is on the tidal flats should stay there. Anyone who is coming from the sea should – if possible – head for the next estuary. Anyone who believes that it will not be possible to get there or if making for the major currents would entail losing too much time while the weather deteriorates may pass through the tidal inlet if current and wind are in the same direction. The skipper must weigh up the situation case-by-case taking into account all the circumstances of the case in question. No gat is passable in a storm.*

e) Wilfried Krusekopf: Segeln in Gezeitengewässern. Theorie und Praxis der Tidennavigation. Bielefeld: Delius Klasing, 2017.

[72] The books listed below are sorted in ascending order according to year of publication.

(See p. 130): According to the author, the tidal inlets between the Frisian islands are prone to *[...] breakers, one often speaks of groundswell, which can become dangerous for a yacht [...] when the ebb tide is against a near onshore gale.* The term 'near gale' corresponds to 7 Bft on the Beaufort scale.

f) Jan Werner: Nordseeküste 1; Cuxhaven bis Den Helder. 9th edition, Bielefeld: Delius Klasing, 2020.

(See p. 16): *You will sail out of one tidal inlet on an outgoing current and into the other on an incoming current. This is feasible as long as the wind is in the same direction or not too strong. If the wind and current are in opposite directions, it becomes unpleasant at 4 Bft and nasty, sometimes even completely impossible, from 5 Bft.*

Rule […]*: Avoid conditions where the current is against the wind from 5 Bft and above! It is dangerous.*

This list of publications could easily be extended[73] but the selection made here should suffice and show the diversity of the statements.

3.2.3.2 Navigating the Accumer Ee tidal inlet

According to the watchkeeping standards and the comments in some of the above nautical publications, the most specific and up-to-date information must be obtained before navigating a tidal inlet.

The investigators' attention was drawn to four sources – there may be others:

- the BSH sailing directions;
- a Wattenschipper publication;
- the Nordseeküste 1 cruising guide by Jan Werner, and
- www.wattsegler.de.

The sailing directions issued by the BSH include four notes on the Accumer Ee tidal inlet:

- *Surf over bar near Westerriff in onshore winds and outgoing current.*
- The water depths are variable.
- Local knowledge is required at night.
- Enter only when the water is rising.

Wattenschipper provides the following advice[74]:

[73] Marianne van der Linden: Handboek varen op de Waddenzee. Gottmer Hollandia Watersportboeken, 2021.
[74] https://www.wattenschipper.de/Accumer_Ee.html (2022-02-09).

- The fairway changes frequently and the buoyage probably differs from the navigational chart.

- There are all kinds of wreck along the way.

- A gas pipeline has been laid in the fairway. This may deflect the magnetic compass.

- The speed of the current is up to 2 kts at high tide and up to 2.5 kts at low tide.

In Jan Werner's cruising guide, readers will find detailed information on navigating the Accumer Ee[75] in the 'Das Langeooger Revier' chapter. In the following, only some of the statements are reproduced analogously:

- It is difficult to cross the bar in windy conditions.

- The course of the fairway changes extremely. Rather than relying on the navigational chart, you should sail by sight from buoy to buoy.

- *The bar most recently stretched between buoys A 2 and A 6 and had a water depth of 1 m, but that is not a certainty. [...] When the current is against the wind there is an extremely steep wave up to spar buoy A 8, where even boats with a powerful engine find it difficult to make headway. After that, it becomes noticeably calmer. At any event, you must enter the tidal inlet when the water is rising.*

- At night, the approach should *only be made if there is really no other option [...] when the water is calm, visibility is good and there is a half tide, otherwise it is better not to.*

- In the approach, high tide starts four hours and 45 minutes before high water (HW) and the ebb current 45 minutes after HW (based on HW at Norderney).

The latest buoy positions are published at www.wattsegler.de.

[75] Jan Werner: Nordseeküste 1; Cuxhaven bis Den Helder, p. 133 ff. 9th edition, Bielefeld: Delius Klasing, 2020.

Boat and equipment

3.2.3.3 SILJA

The skipper bought the SILJA from a relative at the end of 2017. According to the contract of sale for used boats and enclosed appendices, the SILJA was a Nautica 23 integral centreboarder built in 1971.

Several drawings of the boat were attached to the contract of sale.

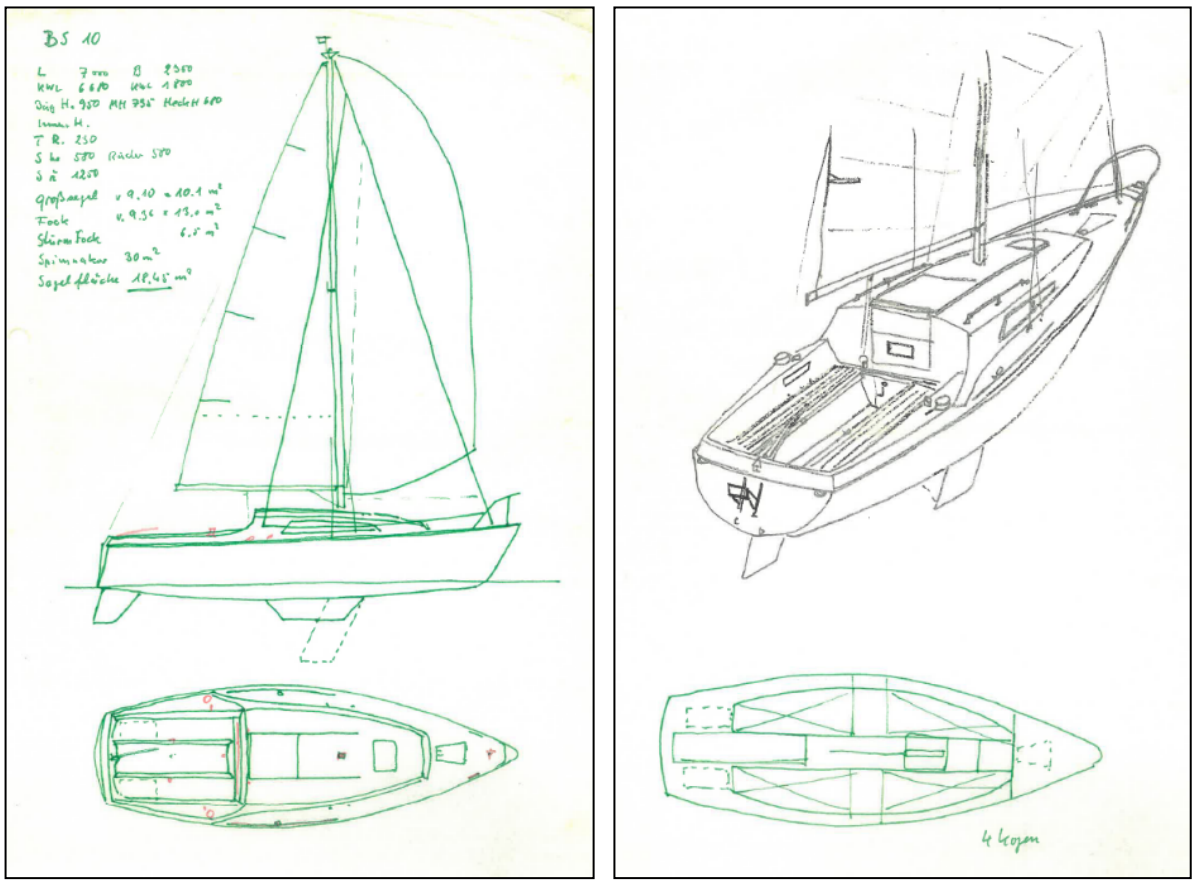


Figure 27: Drawings of the SILJA from the contract of sale (selection)

For the most part, the boat particulars referred to in Chapter 2.2 were taken from this contract of sale.

Unless otherwise stated, the below details are based on the information contained in the purchase documents, the statements of the skipper and the photographs provided. The investigators also surveyed a Nautica 23 for sale so as to examine the available information as far as possible and evaluate it to the extent necessary in the opinion of the BSU. Almost no information on this type of boat was found on the internet.

Some significant deviations from the SILJA were found during the survey of a Nautica 23 by the BSU and the investigators are therefore not sure whether the SILJA is actually the boat type stated. The investigators believe they gained a good impression of the spatial conditions on a comparable boat.

Figure 28: The SILJA on a trailer (start of summer sailing trip in 2021)[76]

The SILJA was a sloop (single-masted sailing boat) built of GRP with a cabin and three berths.

Figure 29: The SILJA at the pier in the summer of 2021[77]

[76] Source: Photograph from the skipper.
[77] Source: Photograph from the skipper.

The integral centreboard sailing boat had a variable draught of 0.58 m to 1.25 m. The centreboard position could be changed from the cockpit with a crank handle.

Figure 30: Crank handle for the centreboard[78]

According to a sailing dictionary from 1977 – from the time the boat was built–, the SILJA was a keel and centreboard cruiser. Keel and centreboard boats with a cabin were called keel and centreboard cruisers. This dictionary defined keel and centreboard cruisers as being non-capsizable cruisers on sea and inland waters.[79]

According to a report in the Yacht[80] magazine on the capsize stability of sailing boats, four fictitious boat designs (a cruising centreboarder, an integral centreboarder, a centreboard cruiser and a keel boat) were calculated with regard to their theoretical stability on the basis of a 20' cruising centreboarder, which roughly corresponds to the size of the SILJA. For a boat with a 160 kg integral centreboard, a static capsizing angle[81] of a good 40 degrees and a dynamic capsizing angle[82] of 100 degrees were calculated. The Yacht magazine's editorial staff believed these figures were

[78] Source: Photograph from the skipper.
[79] Schult, Joachim: Seglerlexikon. Verlag Klasing Co. GmbH Bielefeld, 1977; see keel and centreboard cruiser.
[80] Sicher ohne Kiel? Published in: Yacht. Delius Klasing Verlag GmbH. Issue 24/2009.
[81] The static capsizing angle is the figure at which the force required to capsize a boat decreases. This is the maximum figure in the stability curve.
[82] In the case of the dynamic capsizing angle, the boat would capsize without any further external force. On the stability curve, this figure is reached at the zero point after the static capsizing angle. This figure is usually reached due to an external force (wind/waves).

astonishingly close to those for the keel variant. With a keel weight of 300 kg, 234 kg of which was in the keel bulb, the static capsizing angle was 70 degrees and the dynamic 130 degrees. The theoretical figures for the integral centreboarder were considerably better than those for the centreboard-only design, whose righting moment decreased again at 26 degrees (static capsizing angle). However, these calculations do not take into account external factors such as the state of sea and wind or other influences from the equipment (outboard engine, provisions, etc.) and people on board.

According to the skipper, there were no buoyancy tanks installed in the SILJA.

Since the SILJA was built back in 1971, there was no CE marking[83] for her and therefore no indication as to the wind conditions and significant wave heights she must safely withstand when fully laden in accordance with this Directive.

The skipper had maintained and serviced the SILJA. In 2017, before the actual purchase, he concentrated on the interior. In 2019 and 2020, he overhauled the exterior of the boat and, *inter alia*, repainted the hull.

Figure 31: The SILJA during her major overhaul[84]

[83] Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC OJ L 354, 28.12.2013, p. 90 ff.
[84] Source: Photograph from the skipper.

Figure 32: The SILJA during her major overhaul[85]

He bought a new mainsail and 8 bhp Yamaha outboard engine for the 2018 sailing season.

The new mainsail had a sail area of 10.2 m². The sail could be reefed twice with a slab reefing system. The main halyard could be operated from the cockpit. The skipper used an older (small) furling genoa for the headsail. The maximum sail area could not be determined. He had postponed buying a new furling genoa with a sail area of 9.85 m², which was planned for the 2018 season, for lack of need.

He had also purchased three SECUMAR lifejackets in May 2018. The lifebuoy visible in the fore section (see Figure 1) had been on board for years.

As is to be expected for this size of boat, she was steered with a tiller. The cockpit was spacious for three sailors and self-bailing. Handrails were attached to the sides of the cabin deck. From the perspective of the BSU, the side passages were generously designed for this size of boat. A guardrail ran along both sides. An electric bilge pump was installed.

In particular, a hand compass, binoculars, as well as paper and digital navigational charts from a company called NV Charts were available for navigation. The paper navigational charts could be laid out and used on the saloon table. The skipper used a Sony Xperia 10 II smartphone[86] for the digital charts obtained via the NV Charts App.

The smartphone was also used for weather forecasts and as a device for distress calls. The skipper had consciously chosen a dust/waterproof device with IP68 protection.

[85] Source: Photograph from the skipper.
[86] 6" (15.2 cm) OLED display in 219 format.

During his sailing trips, he placed the smartphone in a transparent waterproof case and secured it to his lifejacket with a strap.

No other items of equipment, such as pyrotechnic distress signals or a (portable waterproof) VHF radiotelephone, were on board.

3.2.3.4 Legal framework (boat design and equipment)

The SILJA was used as a private recreational craft within the scope of the German Traffic Regulations for Navigable Maritime Waterways (SeeSchStrO) and in this sense as a seagoing recreational craft.

The principle from Section 3 SchSG applies according to the definition of seagoing recreational craft (see Chapter 3.2.3). It states:

Whoever operates a ship in maritime service shall ensure she is operated safely and in particular that she and her equipment are kept in a condition that permits safe operation, that she is navigated safely and that the necessary arrangements are made for the protection of third parties and of the marine environment and the air against dangers or unlawful impairments emanating from her operation. […].

Further legally binding regulations for boat design and equipment for privately used and especially older recreational craft are difficult to find.

Part 4 (on safety requirements for recreational craft) of Annex 1a to Section 6 of the Ordinance for the Safety of Seagoing Ships (SchSV)[87], which is intended for recreational craft, is empty. Section 16 SchSV refers to international regulations and to the German Ordinance on Seagoing Recreational Craft (SeeSpbootV)[88] via the SchSG.

According to Section 3 SeeSpbootV, recreational craft may only be put into operation in Germany if they bear the European CE marking. This marking must be appended by the manufacturer and confirms that the recreational craft and her components conform to all the basic requirements and assessment procedures laid down in European legislation. However, this regulation only applies to recreational craft first placed on the European Community market after 15 June 1998. According to the aforementioned EU Directive 2013/53/EU, appropriate conformity assessment procedures must be observed after major modifications and conversions.

Section 1(5) SeeSpbootV – Scope – refers to the applicable regulations. It states: *The applicable provisions for recreational craft of Sections 2, 5(3), Sections 6 and 13(1) No 2a and 3 in conjunction with Annex 1 Section B No II.8 of the Ordinance for the Safety of Seagoing Ships concerning self-inspection, the special regulations in the*

[87] Ordinance for the Safety of Seagoing Ships of 18 September 1998 (Federal Law Gazette I p. 3013, 3023), as amended by Article 2 of the Ordinance of 3 March 2020 (Federal Law Gazette I p. 412).
[88] Ordinance pertaining to the Commissioning, Hiring Out and Commercial Use of Recreational Craft and Jet Skis in Coastal Waters (Ordinance on Seagoing Recreational Craft). Ordinance on Seagoing Recreational Craft of 29 August 2002 (Federal Law Gazette I p. 3457), as amended by Article 3 of the Ordinance of 3 March 2020 (Federal Law Gazette I p. 412).

case of international ship-related safety standards, the safety standards in special cases and the monitoring of radio stations, as well as rules of conduct shall remain unaffected.

This basically means:

- people who use recreational craft at sea must check those sources of danger that occur during operation, evaluate findings and information in this respect, and take any measures necessary to avoid or reduce danger (see Section 2 SchSV);

- ship owners and ship's commands are assigned supplementary duties, in particular with regard to entries in the deck log book. On vessels that do not have to be entered in the register of shipping, any recording medium issued in the name of the vessel shall be deemed to be a deck log book. The recording medium, e.g. a piece of paper or a file, must be named accordingly, e.g. 'logbook recordings'. Subject to other regulations not listed in the source, third parties must be able to extract required recordings from the 'logbook' in a coherent manner (see Section 5(3) in conjunction with Section B II No 8 of Annex 1 to the SchSV);

- for the respective sea voyage, the latest official or non-official edition of navigational charts and sailing directions must be carried on board in digital or printed form (see Section 13(1) No 2a in conjunction with Section C.1.4 of Annex 1 to the SchSV);

- deck log books shall be kept for a period of three years from the date of the last entry, unless otherwise specified. This also applies to the sale of a boat before the expiry of that period (see Section 13(1)(3) SchSV in conjunction with Section B II No 6 of Annex 1 to the SchSV).

As already established above, the reference to Section 6 SchSV made in the SeeSpbootV comes to nothing.

With regard to navigational equipment, binding specifications can be found in Section C.I.4 of Annex 1 to Section 5 SchSV. For the purposes of this provision, the SILJA is a large recreational craft[89] and under the SOLAS Convention was required to carry

- a magnetic compass (Regulation V/19 No 2.1.1);

- navigational charts and nautical publications (Regulation V/19 No 2.1.4);

[89] Large recreational craft are recreational craft with a cabin and sleeping accommodation which are suitable and intended for voyages seaward of the baseline (territorial waters, coastal marine waters, high seas), in particular sailing and motor yachts (see Section 2(1)(2) SeeSpbootV).

- a redundant system for ECDIS equipment, if fitted (Regulation V/19 No 2.1.5), and

- a radar reflector, if possible (Regulation V/19 No 2.1.7).

Any other safety equipment, such as lifejackets and distress signalling devices, shall be carried on recreational craft in accordance with the ordinary practice of good seamanship.

Water sports enthusiasts will find advice for equipping boats in the 'Sicherheit auf dem Wasser' pamphlet published by the Federal Ministry for Digital and Transport (BMDV). According to the preface, one of the objectives of this pamphlet is to help people *become familiar with the applicable rules*[90]. More advice is published on the internet, e.g. by the DGzRS, the German Motor Yachting Association[91] and the ADAC skipper portal[92]. Sailors interested in cruising could use the 'Offshore Special Regulations Governing Offshore Racing for Monohulls & Multihulls' (OSR) issued by World Sailing Limited as a guide when making a decision regarding the equipment required based on size of boat and area of operation. The German Sailing Federation's cruiser section has published a translation of the OSR safety standards.[93]

3.2.4 Boat crew

The crew consisted of the owner of the boat, who was also the skipper, one female sailor and one male sailor.

The female sailor had first gained sailing experience in the autumn of the previous year during a one-week trip with fellow students on a charter boat in the Baltic Sea. The SILJA's skipper was also on this trip. He and the skipper of the charter boat were the only people with sailing experience during this trip.

The third crew member had not sailed before the cruise on the SILJA. As a paddler, preferably in calm flowing waters, he had a connection to water sports.

3.2.4.1 Skipper

The skipper had several years of sailing experience.

[90] The 'Sicherheit auf dem Wasser' pamphlet. Federal Ministry of Transport and Digital Infrastructure. December 2020. https://www.bmvi.de/SharedDocs/DE/Publikationen/WS/sicherheit-auf-dem-wasser-2018.html.
[91] German Motor Yachting Association: Basic Knowledge for Boat Owners (dmyv.de) (2022-05-09).
[92] Minimum and Safety Equipment › ADAC Skipper Portal (2022-05-09).
[93] OSR safety standards – DSV Cruiser Section (2022-07-07).

In 2012, he acquired the German certificate for operating recreational craft on inland waterways under sail. From 2012 to 2015 he sailed regularly on Lake Steinhude with a catamaran and gained his first experience as a crew member on the SILJA. In 2015 and 2016, he was on Lake Müritz with the SILJA for a fortnight on each occasion in the role of skipper and gained practical sailing skills on Sailart 17 boats at a sailing school on Langeoog.

In the autumn of 2017, he acquired the German certificate for operating recreational craft on inland waterways with a propulsion engine and the German certificate for operating recreational craft on navigable maritime waterways.

After acquiring the above certificates and in conjunction with the practical experience he had already gained, the skipper felt sufficiently qualified to operate the SILJA as a skipper in the Wadden Sea. Accordingly, he sailed with the SILJA from Emden to Langeoog for the first time in 2018.

In 2018, he worked at the sailing school on Langeoog for two months as an assistant and sailing instructor, teaching the practical sailing skills he had acquired there in previous years as a sailing student. He lived on the SILJA during this period.

He had sailed the Accumer Ee tidal inlet for the first time back in 2018. According to his recollections, he sailed seaward from Wangerooge to Langeoog harbour. A 10–12 kts (3–4 Bft) easterly wind prevailed at the time and it was almost low tide when he reached the Accumer Ee fairway. The waves came from aft at times, but with a wave height of 1–1.5 m. Nothing exceptional happened during the passage.

He had already sailed in the Wadden Sea with various crews since the beginning of August in 2021. He sailed his boat on the Outer Weser from Bremerhaven to Wangerooge in 20–25 kts (5–6 Bft) wind with waves that were about 3–4 m high, but not breaking and very long. These experiences gave him the impression that the danger posed by waves was low.

On 8 August, he navigated parts of the Accumer Ee coming from Langeoog. In light winds of 5–6 kts (2 Bft) and receding water, he sailed to north of the buoy A7 and left the fairway – well before the bar – to the west so as to fall dry on the beach at Baltrum. There was hardly any swell during this trip. The maximum wave height was 0.3–0.5 m.

On 26 August, the day of the accident, he overheard a conversation before setting sail in which someone spoke of rough waves in the gats but described them only as an inconvenience rather than as a danger.

According to his statement, capsizing in the gat would have surprised him. He would have assumed that his boat could not capsize. He would not have been aware of the specifics and hazards in the tidal inlets. In retrospect, he would have been surprised that topics such as groundswell and tidal inlets were not a subject of the examination for the acquisition of the certificate for operating on navigable maritime waterways, although some of the navigation exercises relevant to the examination were located in the immediate vicinity of the approach buoy to the Accumer Ee.

3.2.4.2 Legal framework (competence/manning)

To operate a recreational craft used only for sport or pleasure and *[...] equipped with a propulsion engine whose maximum useful power that cannot be exceeded is not more than 11.03 kW (15 bhp), no operating certificate is required.*[94]

Similarly, there are no specific legal requirements for the number of crew members on such a recreational craft, nor for the competence of the additional crew members.

Notwithstanding the above, obligations for the navigation of recreational craft arise from various other pieces of legislation.

For example, according to Section 3 SchSG, everyone – who operates a ship in maritime service – is obliged to ensure that safe operation and safe navigation prevails.

In addition to specific rules of conduct arising from traffic regulations, such as the International Regulations for Preventing Collisions at Sea and the German Traffic Regulations for Navigable Maritime Waterways, all traffic shall *[...] in particular, take any precaution as may be required by the practice of good seamanship or by the special circumstances of the case.*[95]

In the 'Sicherheit auf dem Wasser' pamphlet, the BMDV summarised what the publisher considers to be the ten most important safety rules for good seamanship.[96]

Rule 1 concerns the competence of boat operators. They should correctly assess their knowledge and abilities[97]. It is recommended that they first gain practical experience during the day in sheltered waters only rarely used by commercial vessels, even if the ability to operate a recreational craft has already been demonstrated in an examination.

In the light of the fact that the skipper – irrespective of legal necessity – had acquired a German certificate for operating recreational craft on navigable maritime waterways and had gained practical experience in sheltered waters, the extent to which this certificate confirms competence for the sea area in question and tests the knowledge and skills that skippers in the area of validity may regularly require was examined below.

[94] Section 5(1)(2) of the German Pleasure Yachting Navigating Licences Ordinance (SpFV). German Pleasure Yachting Navigating Licences Ordinance of 3 May 2017 (Federal Law Gazette I p. 1016, 4043), as amended by Article 2(7) of the Ordinance of 26 November 2021 (Federal Law Gazette I p. 4982, 5204).
[95] German Traffic Regulations for Navigable Maritime Waterways, as amended and promulgated on 22 October 1998 (Federal Law Gazette I p. 3209; 1999 I p. 193), as amended by Article 2 Section 12 of the Ordinance of 21 September 2018 (Federal Law Gazette I p. 1398).
[96] See Chapter 1 on page 6 in conjunction with Chapter 2 on page 8 of this pamphlet.
[97] Ability: Abilities are usually required to acquire skills and are basically innate. Skills are basically learned. It is possible that the pamphlet is referring to 'skills'.

3.2.5 SBF-See examination requirements

After acquiring a German certificate for operating recreational craft on navigable maritime waterways (SBF-See), holders are granted permission to sail recreational craft with propulsion engines on navigable maritime waterways, see Section 4 of the German Pleasure Yachting Navigating Licences Ordinance (SpFV). According to Section 2 SpFV (Definitions), this licence is valid only for non-commercial recreational craft used for sport and pleasure. There are no restrictions beyond that. According to Section 2 SpFV, navigable maritime waterways are understood to be those areas defined in Section 1(1) of the German Traffic Regulations for Navigable Maritime Waterways (SeeSchStrO)[98], in particular.

In the following figure, the relevant area is shown in red and in red hachures. The area of the Ems and Ems estuary is included by definition.

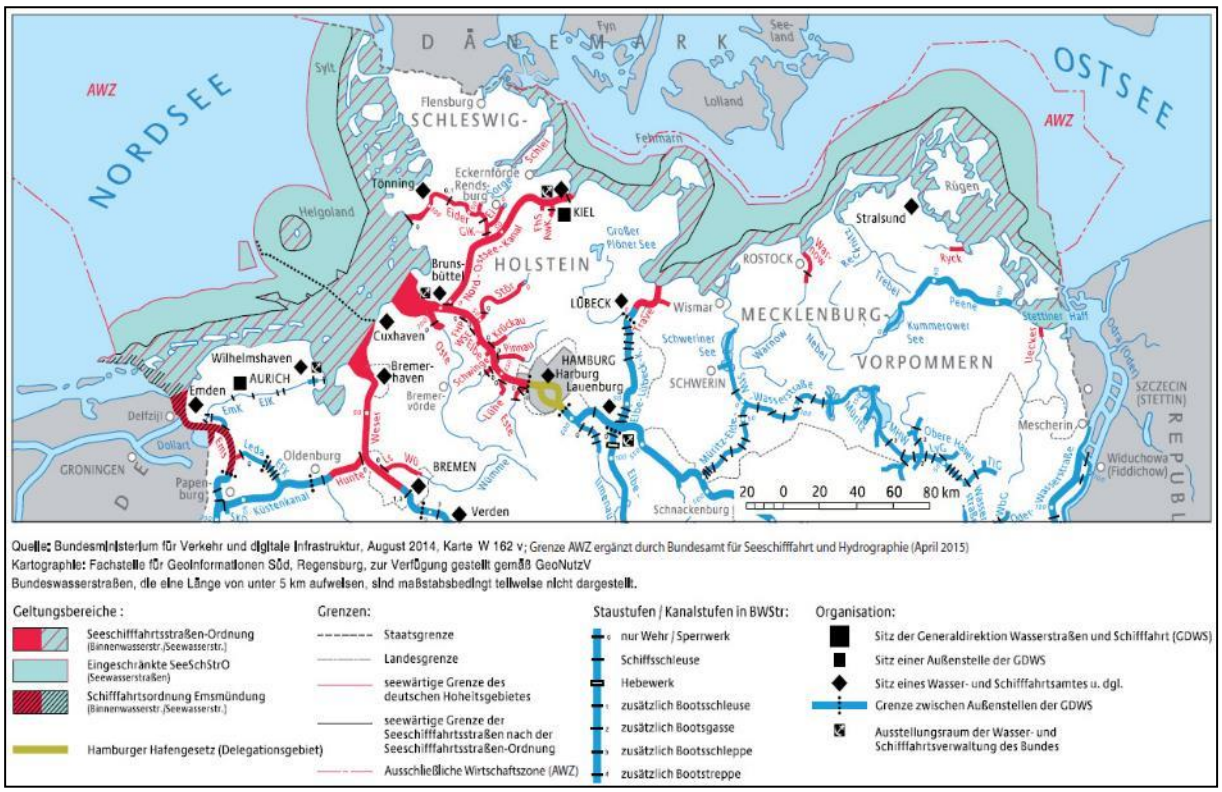


Figure 33: Area of application of the German Traffic Regulations for Navigable Maritime Waterways[99]

According to Section 8 SpFV, competence to operate a recreational craft must be proven by examinations in the theory and practice. This Ordinance lays down the rules for the examinations for the acquisition of an inland or maritime waterway licence. The following remarks always refer to the examination for maritime waterways.

[98] German Traffic Regulations for Navigable Maritime Waterways, as amended and promulgated on 22 October 1998 (Federal Law Gazette I p. 3209; 1999 I p. 193), as amended by Article 2 Section 12 of the Ordinance of 21 September 2018 (Federal Law Gazette I p. 1398).
[99] Annex III – chart for Section 1(5) SeeSchStrO.

According to No 1 of Annex 3 to Section 8(1) (4th sentence) SpFV, candidates must prove in the theoretical part of the examination that they have *[...] the nautical and technical knowledge required for the safe operation of a recreational craft in the respective area of application [...]*.

The knowledge is verified in a multiple-choice test[100]. There are four answer options for each question, one of which is correct and can be selected by ticking it. Candidates receive one point for each correct answer. The purpose of the test is to demonstrate general and specific knowledge.

With regard to general knowledge (basic knowledge), the following topics are defined (see No 2 of Annex 3 to Section 8(1) (4th sentence) SpFV):
- basic concepts;
- general rules on right of way, sound signals, navigation lights;
- general mandatory signs, prohibition signs, aids to navigation;
- nature protection;
- general rules of conduct;
- liquefied gas installations;
- maintenance of inflatable lifesaving appliances;
- fire extinguishers, firefighting;
- conduct after a collision;
- technical installations on motorboats: propulsion engines, propeller shaft, fuel system, steering gear, sailing manoeuvres, effect of the direction of propeller rotation, machinery, operation of outboard engines, pollutant emissions from boat engines.

With regard to specific knowledge, the following topics are defined:
- German Traffic Regulations for Navigable Maritime Waterways and the Ems Estuary Shipping Ordinance;
- nautical publications;
- signals, mandatory signs, prohibition signs, rules on right of way, navigation lights;
- International Regulations for Preventing Collisions at Sea;
- rules of conduct;
- obligation to hold a licence;
- seakeeping and person overboard situations;
- navigation in areas with a warning of danger, NOK (Kiel Canal), nature reserves and national parks;
- meteorology;
- navigation: handling navigational charts, using bearings and dead reckoning for position fixing, deviating courses, difference between the dead-reckoning position and the true position, declination, deviation, current and wind offset, tides, list of lights.

[100] n/a

The knowledge of navigation is examined in a navigation exercise *[...] in which the answers to the exercises must be freely formulated or entries must be made in the navigational chart* (No 1.1, 1st sentence of Annex 3 to Section 8(1) (4th sentence) SpFV).

The specific content of the examination can be found in the questions and answers published on the internet by the Federal Waterways and Shipping Administration via the ELWIS[101] information service. The catalogues published at the time of this investigation were dated 1 June 2017.

Seven of the 72 questions contained in the basic knowledge component must be asked in the examination, of which at least five (71.43%) must be answered correctly. 23 of the 213 questions contained in the specific knowledge component must be asked, of which at least 18 (78.26%) must be correct.

One of the 15 possible navigation exercises must be completed. The exercises are based on the D49 exercise chart (estuaries of the rivers Jade, Weser and Elbe).

Navigation exercises three and four include two sample exercises in which the 'Accumer Ee' buoy is steered for or is the starting point and the candidates proceed in the immediate vicinity of the scene of the SILJA accident during the examination.

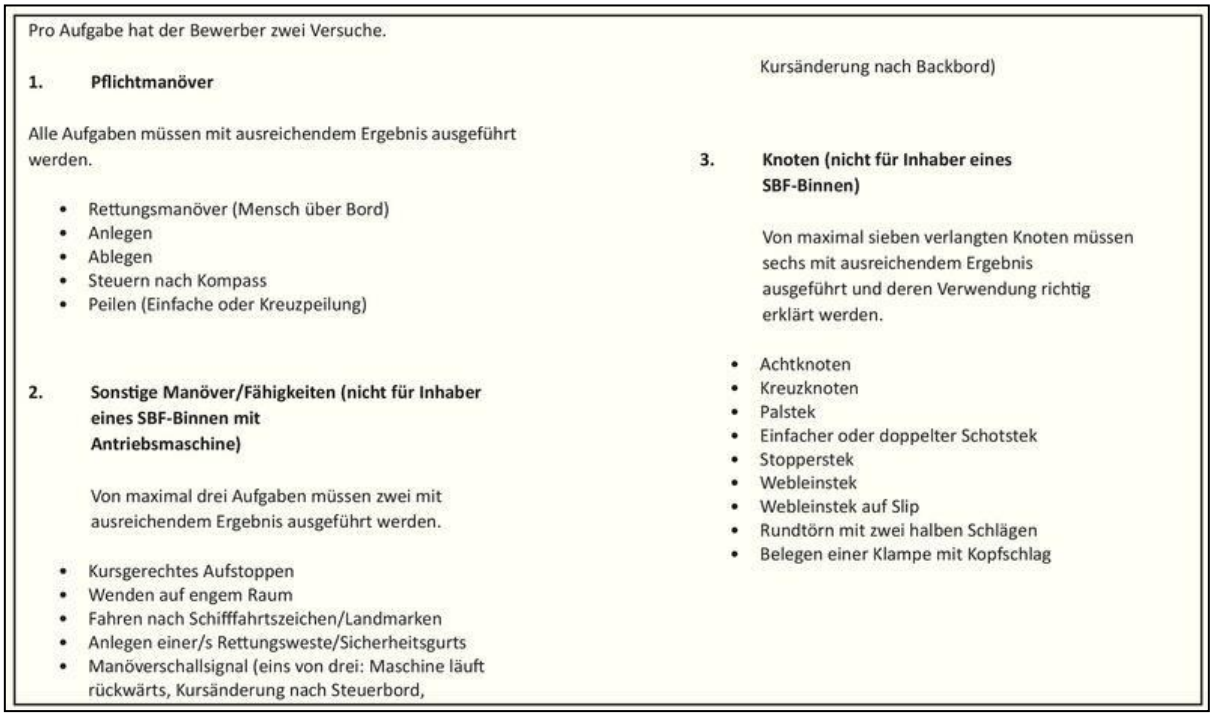
Nine questions generated from the 15 shown below must be answered for each navigation exercise.

1. What is the Co.T. (true course)?
2. Enter the course in the navigational chart.
3. What is the CH (compass heading)?
4. What are the bearings?
5. Enter the bearings on the navigational chart.
6. Take the geographical position from the navigational chart.
7. Enter the position on the navigational chart.
8. What is the distance?
9. What is the position of the ship based on the dead-reckoning position?
10. What is the difference between the dead-reckoning position and the true position?
11. In what period will you reach the destination?
12. What is the speed?
13. What is the significance of the aid to navigation?
14. Describe the aid to navigation (e.g. colour, identification, top mark, nominal range, height of light, type of light).
15. What does this entry on the navigational chart mean?

[101] ELWIS: Electronic Waterways Information Service.

In the practical component of the examination, the candidate must demonstrate that she/he has mastered the manoeuvres and skills necessary for the safe navigation of a recreational craft [...] on maritime waterways [...] and is capable of applying the theoretical knowledge.[102]

The DMYV has published a summary of the requirements for the practical examination laid down by the Ordinance as follows:



Pro Aufgabe hat der Bewerber zwei Versuche.

1. Pflichtmanöver

Alle Aufgaben müssen mit ausreichendem Ergebnis ausgeführt werden.

- Rettungsmanöver (Mensch über Bord)
- Anlegen
- Ablegen
- Steuern nach Kompass
- Peilen (Einfache oder Kreuzpeilung)

2. Sonstige Manöver/Fähigkeiten (nicht für Inhaber eines SBF-Binnen mit Antriebsmaschine)

Von maximal drei Aufgaben müssen zwei mit ausreichendem Ergebnis ausgeführt werden.

- Kursgerechtes Aufstoppen
- Wenden auf engem Raum
- Fahren nach Schifffahrtszeichen/Landmarken
- Anlegen einer/s Rettungsweste/Sicherheitsgurts
- Manöverschallsignal (eins von drei: Maschine läuft rückwärts, Kursänderung nach Steuerbord, Kursänderung nach Backbord)

3. Knoten (nicht für Inhaber eines SBF-Binnen)

Von maximal sieben verlangten Knoten müssen sechs mit ausreichendem Ergebnis ausgeführt und deren Verwendung richtig erklärt werden.

- Achtknoten
- Kreuzknoten
- Palstek
- Einfacher oder doppelter Schotstek
- Stopperstek
- Webleinstek
- Webleinstek auf Slip
- Rundtörn mit zwei halben Schlägen
- Belegen einer Klampe mit Kopfschlag

Figure 34: SBF-See practical examination[103]

3.2.6 Seamanship on the SILJA

The term 'seamanship' is undefined and basically includes everything necessary for the safe handling of a boat in any given situation.

Seamanship includes servicing and maintaining the boat and equipment, transportation of a boat ashore, preparation of trips and routes, manoeuvres of every kind, navigation, compliance with traffic rules and regulations, interaction between skipper and crew, etc.

A multitude of different regulations laid down under civil or public law use 'good seamanship' as an umbrella term for standard maritime practice. The rules of good seamanship go beyond statutory norms and change as a result of technical developments or new findings and experience made.[104] As a rule, the terms 'good

[102] See No 1 of Annex 4 to Section 8(1) (4th sentence) SpFV.
[103] Source: DMYV https://www.dmyv.de/fuehrerschein-funk/rund-um-die-pruefung/wie-wird-bewertet/?L=%270%27A%3D0Die%27A%3D0 (2022-01-27).
[104] Dr Kai Zähle: Die Regeln guter Seemannschaft. Neue Zeitschrift für Verkehrsrecht, NZV 2015 p. 476 ff.

seamanship' (Rule 8(a) COLREGs)[105], 'ordinary practice of good seamanship' (e.g. SBF-See Q&As[106]) and 'practice of good seamanship' (e.g. Section 3(1) SeeSchStrO[107]) are used synonymously.

The rules of 'good seamanship' are given substance by recommendations. The recommendations are disseminated through publications of every kind. Among many other publications, the investigators refer at this point to the advice given by the DGzRS and the 'Sicherheit auf dem Wasser' pamphlet. Due to the complexity of the topic, these publications can often only provide general advice on seamanship, which must be adapted to accommodate the specific requirements.

In the following, only those aspects of the seamanship practiced on board the SILJA that the investigators believe might have had an impact on the accident were investigated.

3.2.6.1 Safety briefing

The safety briefing was looked at more closely to establish the extent to which crew members were prepared for the emergency and, in particular, how to use the lifejacket.

The skipper briefed the crew members shortly after they boarded the SILJA. During the briefing, the skipper referred to a guide that he had prepared for his trips on the SILJA based on experience he had gained as a crew member in autumn 2020.

He instructed his crew members to store both phone numbers for MRCC Bremen in their smartphones: +49 421 536 87-0 and 124 124 (for German mobile telephone networks only). He informed them of the name of the boat and of the number of the SILJA's international card for pleasure craft. He told his crew members to practice determining the GPS position with their own smartphones. On the instructions of the skipper, the male crew member downloaded the NV Charts App with the corresponding charts, which meant that two smartphones were available for navigation in addition to the paper navigational chart.

In addition, he had noted the following points in his guide and according to the statements given addressed them, taking into account prior knowledge:
- distress signal: Wave arms up and down;
- lifejackets: Where? When and how should they be worn?;
- draining/pumping out water: Electric bilge pump, hand pump with two hoses, bucket;
- first aid kit: Where?;

[105] International Regulations for Preventing Collisions at Sea of 13 June 1977 (Federal Law Gazette I p. 816), as amended by Article 1 of the Ordinance of 7 December 2021 (Federal Law Gazette I p. 5188).
[106] Questions 77, 78, 271 and 274 of the SBF-See Q&As, dated 1 June 2017. ELWIS - SBF-See Q&As (2022-05-25).
[107] German Traffic Regulations for Navigable Maritime Waterways, as amended and promulgated on 22 October 1998 (Federal Law Gazette I p. 3209; 1999 I p. 193), as amended by Article 2 Section 12 of the Ordinance of 21 September 2018 (Federal Law Gazette I p. 1398).

- life belt;
- electric master switch and battery compartment;
- engine: How is it turned on and off? Tanks? Draining with engine? Sea valve?;
- paddle, boat hook;
- anchor;
- tow lines/lifeline;
- pay attention to boom when gybing.

3.2.6.2 Legal framework for the safety briefing

For privately used recreational craft, there are no legally binding requirements for the performance of a safety briefing.

Before referring to two of many published recommendations for the performance of safety briefings by way of example, the legally enforceable requirements for German-flagged commercial maritime shipping, which also includes commercially used recreational craft of all sizes, are first discussed.

Pursuant to Section 23 of the Maritime Labour Act (SeeArbG)[108], masters on all merchant ships[109] must ensure that crew members receive safety training on board with the content prescribed in Regulation VI/1 of the Annex to the STCW Convention. Pursuant to Section 1(1) SeeArbG, the only exception to this standard are commercially used recreational craft of less than 24 metres in length if no more than two people are employed on them.

According to Regulation VI/1 of the Annex to the STCW Convention, duties may be assigned to employed persons on board only after they have been adequately informed and instructed so as to basically be able to carry out the following:[110]

a) they should be able to communicate with other people on board on elementary safety matters and understand safety information symbols, signs and alarm signals;

[108] SeeArbG of 20 April 2013 (Federal Law Gazette I p. 868), as amended by Article 1 of the Act of 20 May 2021 (Federal Law Gazette I p. 1144), in conjunction with the comments of Christian Bubenzer, Robert Peetz, Esther Mallach, Nomos-BR, SeeArbG Section 23 Margin No 1-5, 1st edition 2016.
[109] Merchant vessel: A merchant vessel is a seagoing ship intended for direct or indirect acquisition by maritime navigation. The term 'merchant vessel' originates from the older legal vernacular of maritime legislation and maritime trading legislation. The German Basic Law also uses the term 'merchant vessel' in Article 27 (see Tüngler/Warman/Hoffmann: Neuregelung eines Kerngebietes des deutschen Schifffahrtsrechts: Die Seeleute-Befähigungsverordnung – Teil 1. Zeitschrift für das Transportrecht und Schifffahrtsrecht mit Versicherungsrecht, Zollrecht und Außenwirtschaftsrecht, 2016, p. 401 ff.).
[110] A-VI/1 STCW Code. The Manila Amendments to the Seafarers' Training, Certification and Watchkeeping Code. Annex Volume to the Federal Law Gazette Part II No 18 of 4 July 2013.

b) they should be able to identify muster and embarkation stations and emergency escape routes;

c) they should be able to take action if
   - a person falls overboard;
   - fire or smoke is detected;
   - the fire or abandon ship alarm is sounded, or
   - first aid is required.

d) they should be able to locate and don [and help others don] lifejackets;

e) they should be able to close and open the fire, weathertight and watertight doors and distinguish them from hull openings.

This training must be carried out with the people employed on board who are working on a ship for the first time or at any time in the future. The term 'Sicherheitsunterweisung' [safety training] used in the SeeArbG does not correspond to the official translation of the STCW Convention. In the [German version of the] Annex to the Convention and the Appendix to the Annex, the STCW Code, it is sometimes referred to as 'Einführungsausbildung' [familiarization training], 'Einführungslehrgänge' [safety familiarization] or 'Grundunterweisung in Sicherheitsangelegenheiten' [safety familiarization and basic instruction]. The English version of the STCW Convention, which is binding under international law, always refers to 'safety familiarization training'.

For recreational craft, the BMDV and the DGzRS have published recommendations on how to conduct a safety briefing, for example. They are attached to this report (Annex 2).

In question 78 and the corresponding answer in the specific Q&As for the acquisition of the SBF-See, the topic of safety familiarisation is taken into account. It states: *In the context of the ordinary practice of good seamanship, what safety measures must the skipper take for the protection and safety of the people on board before setting sail?*

The skipper must inform crew members and guests
- *about the safety precautions on board;*
- *instruct them in the use of lifesaving and fire-extinguishing appliances,*
- *and indicate appropriate measures to prevent falling overboard.*

3.2.6.3 Trip/route planning

The skipper planned the sea route from Juist to Langeoog on the previous evening, a Wednesday.

Since the sailing trip was to end on the coming weekend and the SILJA had to be lifted out of the water with a crane, the skipper – while taking into account the thoughts of his crew members – first determined a suitable harbour that was to be reached by Saturday if possible or Sunday at the latest. Due to the required crane and desired transport connections, the skipper initially shortlisted Emden, Bensersiel and Wilhelmshaven. Bensersiel was struck off the list because the skipper understood that

a regatta was to be held on the weekend in question and had concerns about a vacant berth. Mainly because the crew had little interest in Emden but wanted longer days sailing, the decision was made in favour of Wilhelmshaven.

To reach Wilhelmshaven by the weekend at the latest, he planned to continue the trip in stages over three to four days: Juist to Langeoog (Thursday), Langeoog to Wangerooge (Friday), Wangerooge to either Horumersiel or to the port of destination in Wilhelmshaven if possible (Saturday).

For the following day, he plotted the route on the NV Charts DE13 paper navigational charts with a triangular protractor and dividers as follows:

Juist marina – tideway up to Dovetief – Dovetief fairway up to buoy D4 – Co.T. 081°, follow the 5 m isobath (navigational chart depth) up to the Accumer Ee fairway – follow Accumer Ee fairway – Langeooger Balje – Langeoog.

Figure 35: Skipper at work on the chart[111]

[111] Source: Skipper. Photograph taken during the route planning described here.

He took the tides and the tidal current from the NV Atlas and the NV Charts App. He considered the tides in his planning to the extent that he wanted to leave Juist harbour, which dried out, about 2–2.5 hours before high tide (about 1300). Without taking into account any tacking that might be necessary, the distance to the port of Langeoog was about 27 nm on his planned route. He wanted to reach the port of destination, Langeoog, before sunset at 2130 at the latest because of his inexperienced crew members, in particular. To achieve this, his average SOG needed to be about 3.5 kts. Based on the wind forecast, he assumed the average SOG would be higher.

The wind forecast on the Windfinder app he was using predicted 22–24 kts (6 Bft), in gusts up to 28 kts (7 Bft) from the north. He set a personal limit – as always – of 30 kts (7 Bft) to avoid risks from the wind. He checked the rain and thunderstorm forecasts via Dutch provider 'Buienradar'. No rainfall was forecast.
Based on his planning, he assumed that he would pass through the Accumer Ee about an hour before low tide. He believed he could use the predicted northerly wind to compensate for the expected oncoming tidal current of about 1.5 kts. Moreover, the tidal current would ease over time and turn. He noted the water depth at the bar of the tidal inlet. Without taking into account the tidal datum, the charted depth was at least 2 m according to the navigational chart. The skipper believed that with a draught of less than 0.6 m, his boat should have sufficient water under the keel at all times with the centreboard raised. He was more concerned about the banks that might be exposed immediately adjacent to the fairway at low water and intended to follow the buoyage of the fairway closely.

He had not considered the specifics of tidal inlets because despite his SBF-See examination and the experience he had already gained, he had not heard of them and therefore from his perspective had no reason to. He believed that only two factors were fundamental to his planning:

- sufficient water under the keel and centreboard boat for the entire route (the sea state was not taken into account here), and

- arrive in daylight.

3.2.6.4 NV Charts navigational chart/NV Charts App used

The skipper had purchased NV Atlas Ostfriesland (Borkum bis Helgoland & EMS) DE13 and other charts from NV Chart Group GmbH on 21 July 2021. He planned his routes on the paper navigational chart. He used the digital version of the charts via the NV Charts App when on the move.

The paper chart was last revised in April 2021. According to information given by the skipper, the digital charts were in the latest version available from the provider.

The digital charts could be displayed in raster or vector mode. The display modes have different advantages and disadvantages.[112]

Irrespective of chart display mode, icons with a grey background are visible at fixed positions on the digital charts at a scale of 1:100,000 and lower and can be opened by clicking on them.[113] These icons are points of interest (POIs), such as

Port and anchorage information

Navigation information on the chart area

Warning

Photographs and information about the location

Many of these references are taken from the official navigational charts published by the BSH, which the publisher processes under licence and gradually upgrades. Every app user can create additional POIs independently and share them with all other users.

Information about the location is displayed by tapping on the icon. An indication of when the POI was last edited is always provided at the bottom of the POI view and – if the information was not released by the publisher – whether the publisher has already checked the last edit.

If the default setting for the markers/information is changed via the slider in the chart settings, no POIs are displayed.

[112] In the NV Charts App user manual, the provider gives the advantages and disadvantages of the different chart modes. See NV Charts App Version 2.687.120+ user manual of 11 April 2022 (page 30).
[113] The prerequisite for this is a current version of the NV Charts App software and an appropriate up-to-date operating system on the smartphone, tablet, laptop or comparable end device used.

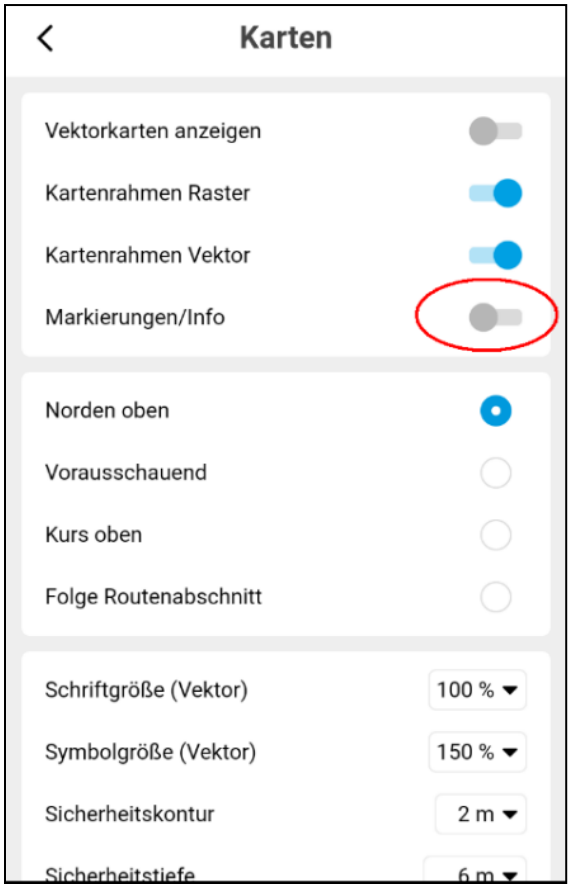


Figure 36: Changed default setting. No POIs are displayed.

Since 2020, the publisher has released additional area and port information in the app version with a summary of hazards posed by tidal inlets. The publisher has advised that this addition was made for most of the tidal inlets. If ports can be reached via a tidal inlet, a note is provided in the so-called 'NV. Hafenlotse' if need be, which can be opened by clicking on the bollard icon. The publisher has included the information on the tidal inlets based on its own experience and knowledge of the area.

According to the publisher, similar information exists before port entrances, e.g. if there is a risk of groundswell there under certain conditions. This information is then included in the approach advice contained in the port guide (e.g. warning for the approach to Hvide Sande or warning of groundswell off Mommark/Als).

The following information was provided for the Accumer Ee tidal inlet (screenshots from a Sony Xperia XZ1 Compact, a smartphone with a slightly more compact display of 4.6 inches as compared to 6 inches on the Xperia 10 II):

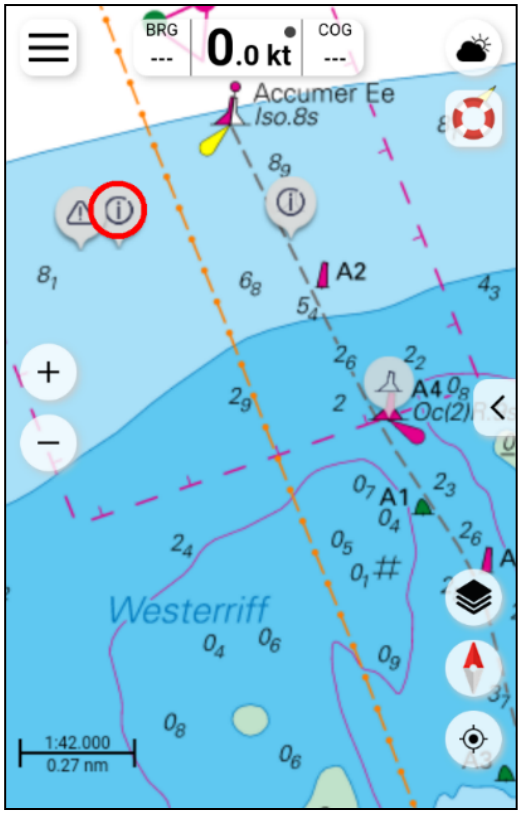


Figure 37: Accumer Ee POI

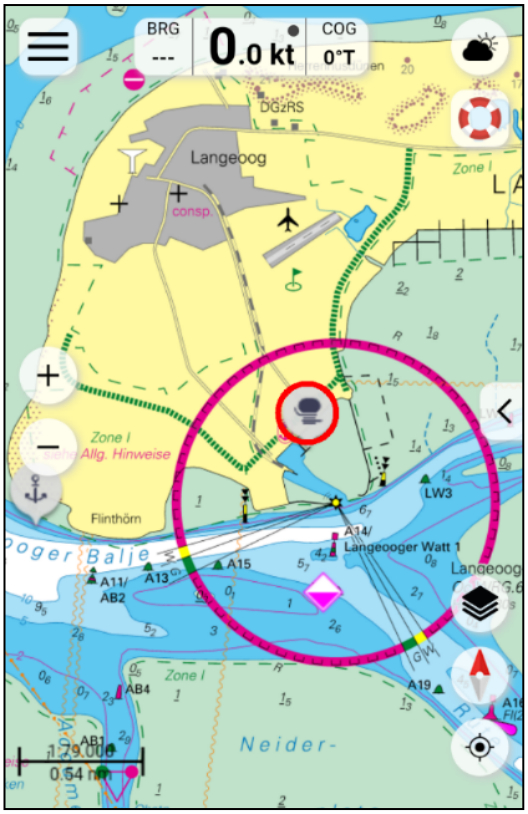


Figure 38: Port of Langeoog POI

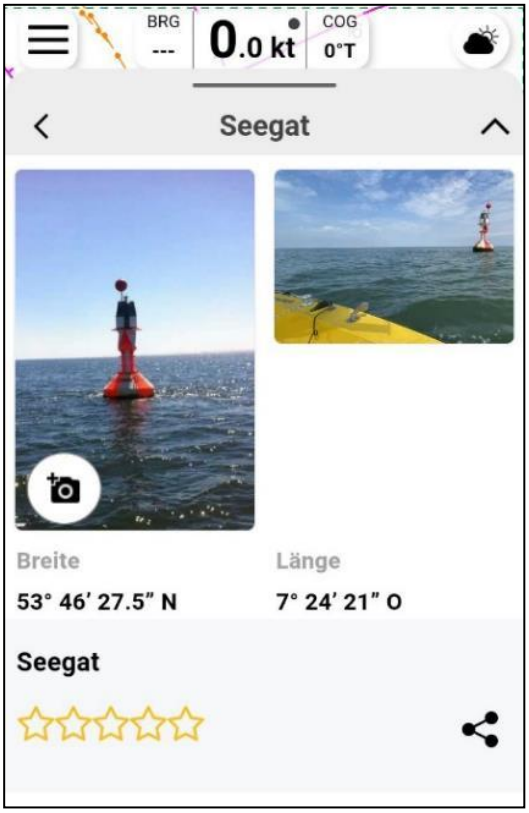


Figure 39: Accumer Ee navigation information

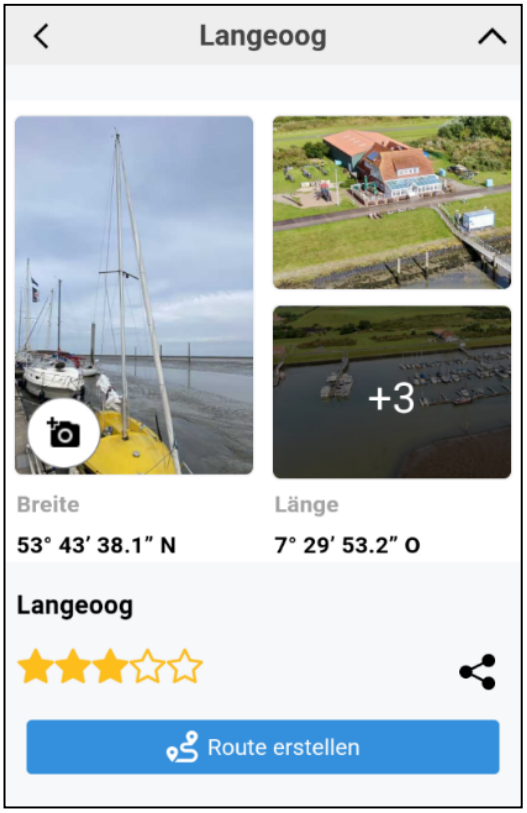


Figure 40: Information on the port of Langeoog

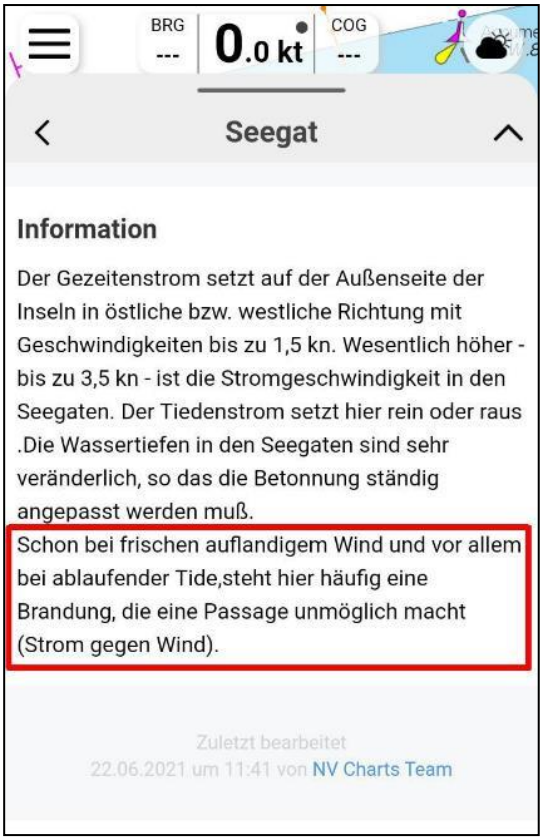


Figure 41: Accumer Ee navigation information[114]

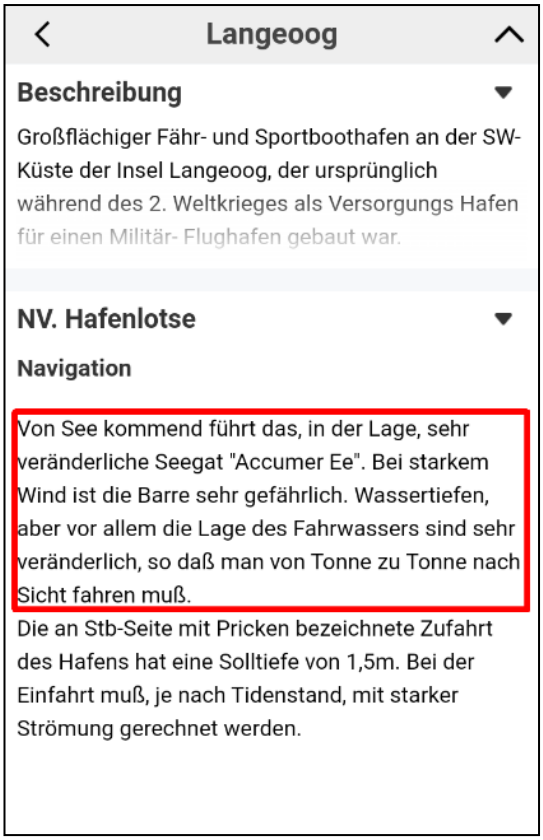


Figure 42: Information on the port of Langeoog

The skipper was basically familiar with the POIs. He had essentially only used them for the port entrances and tidal information[115]. He was not aware of the information on the Accumer Ee tidal inlet (see Figure 42).

The paper navigational chart used for planning the route contains only a few references in the footnotes, in smaller chart extracts or a reference to the general notes published in the atlas corresponding with the POI. There were no specific notes for the Accumer Ee. In the entire atlas, only a note on the Wichter Ee tidal inlet was found during the investigation, which is described there as unmarked and impassable.

[114] According to the screenshot, NV Charts last edited this POI on 22 June 2021. According to the publisher, this did not concern editorial content but rather technical improvements.

[115] The user manual for the NV Charts App Version 2.687.120+ of 11 April 2022 (page 34) reads: *"If there is tidal information available for certain places on the chart, a rhombus will be displayed at the corresponding position on the nautical chart. If you zoom into the charts, these rhombuses will be filled according to the current tide level.*

If the upper part of the rhombus is coloured, there is high tide at the current time, if the lower part of the rhombus is coloured, there is low tide at the corresponding place.

By tapping on the rhombus, a tidal curve opens at the top of your screen, showing the water level changes of several consecutive tides."

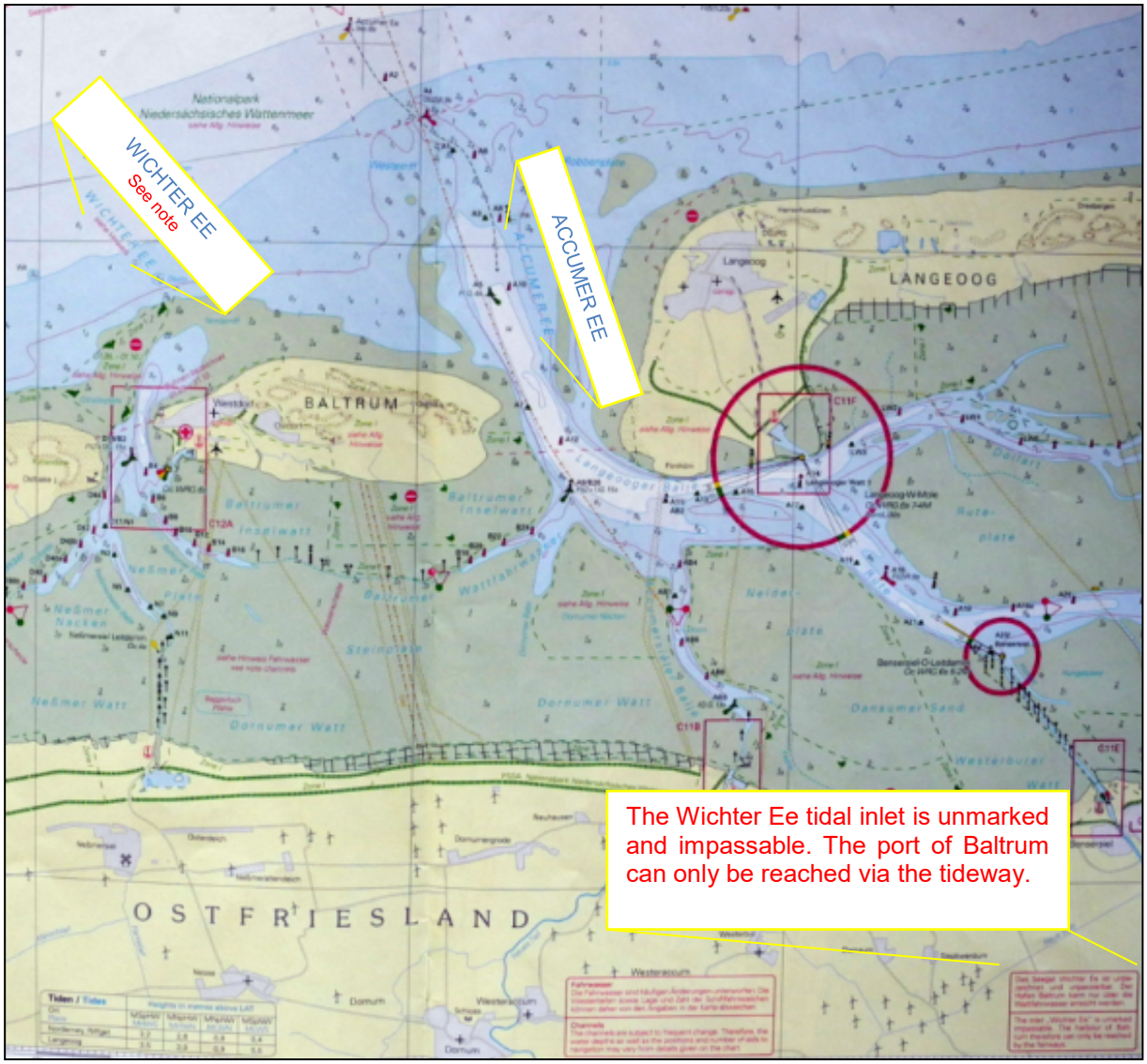
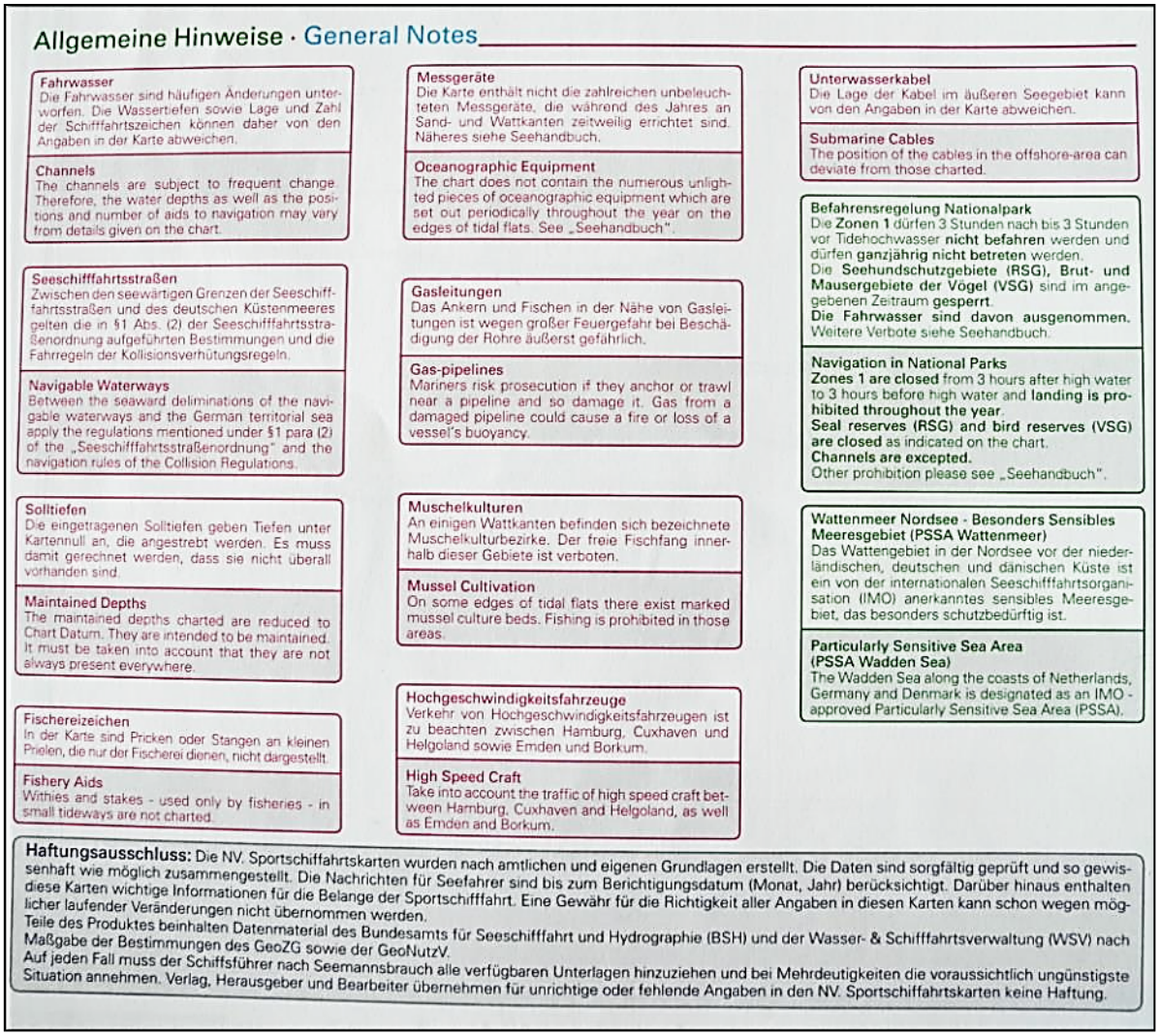


Figure 43: Notes in the Norderney to Langeoog paper navigational chart DE13 C7

The publisher has inserted its disclaimer below the general notes contained in the atlas. *Inter alia*, it states: *Whatever the circumstances, the ship's command must, in accordance with the practice of good seamanship, consult all available documentation and in the event of ambiguities assume the most unfavourable situation likely.*



Allgemeine Hinweise · General Notes

Fahrwasser
Die Fahrwasser sind häufigen Änderungen unterworfen. Die Wassertiefen sowie Lage und Zahl der Schifffahrtszeichen können daher von den Angaben in der Karte abweichen.

Channels
The channels are subject to frequent change. Therefore, the water depths as well as the positions and number of aids to navigation may vary from details given on the chart.

Seeschifffahrtsstraßen
Zwischen den seewärtigen Grenzen der Seeschifffahrtsstraßen und des deutschen Küstenmeeres gelten die in §1 Abs. (2) der Seeschifffahrtsstraßenordnung aufgeführten Bestimmungen und die Fahrregeln der Kollisionsverhütungsregeln.

Navigable Waterways
Between the seaward deliminations of the navigable waterways and the German territorial sea apply the regulations mentioned under §1 para (2) of the „Seeschifffahrtsstraßenordnung" and the navigation rules of the Collision Regulations.

Solltiefen
Die eingetragenen Solltiefen geben Tiefen unter Kartennull an, die angestrebt werden. Es muss damit gerechnet werden, dass sie nicht überall vorhanden sind.

Maintained Depths
The maintained depths charted are reduced to Chart Datum. They are intended to be maintained. It must be taken into account that they are not always present everywhere.

Fischereizeichen
In der Karte sind Pricken oder Stangen an kleinen Prielen, die nur der Fischerei dienen, nicht dargestellt.

Fishery Aids
Withies and stakes - used only by fisheries - in small tideways are not charted.

Messgeräte
Die Karte enthält nicht die zahlreichen unbeleuchteten Messgeräte, die während des Jahres an Sand- und Wattkanten zeitweilig errichtet sind. Näheres siehe Seehandbuch.

Oceanographic Equipment
The chart does not contain the numerous unlighted pieces of oceanographic equipment which are set out periodically throughout the year on the edges of tidal flats. See „Seehandbuch".

Gasleitungen
Das Ankern und Fischen in der Nähe von Gasleitungen ist wegen großer Feuergefahr bei Beschädigung der Rohre äußerst gefährlich.

Gas-pipelines
Mariners risk prosecution if they anchor or trawl near a pipeline and so damage it. Gas from a damaged pipeline could cause a fire or loss of a vessel's buoyancy.

Muschelkulturen
An einigen Wattkanten befinden sich bezeichnete Muschelkulturbezirke. Der freie Fischfang innerhalb dieser Gebiete ist verboten.

Mussel Cultivation
On some edges of tidal flats there exist marked mussel culture beds. Fishing is prohibited in those areas.

Hochgeschwindigkeitsfahrzeuge
Verkehr von Hochgeschwindigkeitsfahrzeugen ist zu beachten zwischen Hamburg, Cuxhaven und Helgoland sowie Emden und Borkum.

High Speed Craft
Take into account the traffic of high speed craft between Hamburg, Cuxhaven and Helgoland, as well as Emden and Borkum.

Unterwasserkabel
Die Lage der Kabel im äußeren Seegebiet kann von den Angaben in der Karte abweichen.

Submarine Cables
The position of the cables in the offshore-area can deviate from those charted.

Befahrensregelung Nationalpark
Die **Zonen 1** dürfen 3 Stunden nach bis 3 Stunden vor Tidehochwasser **nicht befahren** werden und dürfen **ganzjährig nicht betreten** werden.
Die **Seehundschutzgebiete (RSG), Brut- und Mausergebiete der Vögel (VSG)** sind im angegebenen Zeitraum **gesperrt**.
Die Fahrwasser sind davon ausgenommen.
Weitere Verbote siehe Seehandbuch.

Navigation in National Parks
Zones 1 are closed from 3 hours after high water to 3 hours before high water and **landing is prohibited throughout the year.**
Seal reserves (RSG) and bird reserves (VSG) are closed as indicated on the chart.
Channels are excepted.
Other prohibition please see „Seehandbuch".

Wattenmeer Nordsee - Besonders Sensibles Meeresgebiet (PSSA Wattenmeer)
Das Wattengebiet in der Nordsee vor der niederländischen, deutschen und dänischen Küste ist ein von der internationalen Seeschifffahrtsorganisation (IMO) anerkanntes sensibles Meeresgebiet, das besonders schutzbedürftig ist.

Particularly Sensitive Sea Area (PSSA Wadden Sea)
The Wadden Sea along the coasts of Netherlands, Germany and Denmark is designated as an IMO - approved Particularly Sensitive Sea Area (PSSA).

Haftungsausschluss: Die NV. Sportschiffahrtskarten wurden nach amtlichen und eigenen Grundlagen erstellt. Die Daten sind sorgfältig geprüft und so gewissenhaft wie möglich zusammengestellt. Die Nachrichten für Seefahrer sind bis zum Berichtigungsdatum (Monat, Jahr) berücksichtigt. Darüber hinaus enthalten diese Karten wichtige Informationen für die Belange der Sportschifffahrt. Eine Gewähr für die Richtigkeit aller Angaben in diesen Karten kann schon wegen möglicher laufender Veränderungen nicht übernommen werden.
Teile des Produktes beinhalten Datenmaterial des Bundesamts für Seeschifffahrt und Hydrographie (BSH) und der Wasser- & Schifffahrtsverwaltung (WSV) nach Maßgabe der Bestimmungen des GeoZG sowie der GeoNutzV.
Auf jeden Fall muss der Schiffsführer nach Seemannsbrauch alle verfügbaren Unterlagen hinzuziehen und bei Mehrdeutigkeiten die voraussichtlich ungünstigste Situation annehmen. Verlag, Herausgeber und Bearbeiter übernehmen für unrichtige oder fehlende Angaben in den NV. Sportschiffahrtskarten keine Haftung.

Figure 44: General notes and disclaimer in the NV Atlas Ostfriesland

3.2.6.5 Boat handling

The overall handling of the boat, including voyage planning, navigation, steering, sailing and port manoeuvres, watertight integrity and the personal safety of the crew, were not only the responsibility of the skipper in formal terms. He was only able to task his crew members with supportive measures after briefing and appropriate instruction.

He navigated by sight and checked the boat's position via the navigation app.

Like his crew members, he charged his smartphone in the ports via a shore connection. On the day of the accident, the battery of his smartphone was charged to over 80% shortly before setting off. One of his crew members had disconnected it from the power supply early to charge their own device. However, the skipper considered the battery capacity to be sufficient for the day ahead. The skipper took the precaution of carrying an additional mobile battery, a power bank, on board. However, the power bank could not be used when the smartphone was in the waterproof protective cover and needed for handling the boat, as there was not enough space in the cover.

The skipper made sure that all crew members were wearing a lifejacket. To reduce the risk of falling overboard, all sailors generally stayed in the cockpit only or inside the boat. The sailors did not have a lifeline or any jackstays or other attachment points to the boat to prevent them from falling overboard. They held each other firmly in the cockpit every now and then due to the sea state and boat's position, thus ensuring a safe footing.

The skipper had the mainsail set with a reef and hoped it would not be necessary to make any changes to the sail area en route. Firstly, the reefing line with which the aft reef cringle can be pulled onto the main boom had broken during one of his sailing trips in the weeks leading up to this one, and secondly, he was not confident that his crew members could reef the mainsail without his assistance. The skipper had temporarily replaced the reefing line with another line. To reef the mainsail alone, he would have heaved to if necessary – provided the sea area was sufficient.

The skipper did not task his crew members with steering the boat because of the sea state and their lack of sailing experience.

The skipper only used the outboard for port manoeuvres.

3.2.7 Weather and current

3.2.7.1 Weather report of Germany's National Meteorological Service (DWD)

According to the DWD's weather report[116], it was initially almost cloudless in the accident area; some harmless clouds were visible later. There was no rainfall on the coast at the time of the accident. Cloud cover was variable from 1800 onwards and visibility[117] was about 30 kilometres.

At a height of 10 metres above the water surface there was a mean northerly wind of initially some 18 kts (5 Bft), increasing to 25 and 27 kts (6 Bft) at the time of the accident. Since the atmosphere was slightly unstable, there were also gusts of 2 Bft above mean wind.

The German coastal wave model (CWAM[118]) for the DWD's sea state forecasting shows a significant wave height[119] of up to 2 m at wind forces of 5 Bft in the accident area.

[116] Weather report WV 13/64.30.16-20/31_21 dated 24 November 2021.
[117] Visibility: The visibility figures given in this report are based on meteorological visibility. Meteorological visibility is the maximum horizontal distance at which dark objects close to the ground with an apparent angle of visibility of 0.5 to 5 degrees can just be detected against a bright horizon sky (also with fog as the background). At the same time, it must be possible to identify the object unequivocally.
[118] n/a
[119] Significant wave height: The height of the sea state is defined using the significant wave height, i.e. the mean height of the upper third of all the waves occurring over a wider area for an extended period (e.g. 20 minutes). Based on wave theory, single waves can be expected in roughly every 100 waves and in roughly every 1,000 waves that will exceed the significant wave height by factors of 1.6 and 1.9 respectively. Statistically, at significant wave heights of 5 m and wave periods of 9 s, a wave of 8 m in height and a wave of 10 m in height can be expected every 15 minutes and every 2.5 hours respectively, for example.

The temporal curves for the accident position, Accumer Ee (φ 53°47′N, λ 007°25′E[120]), are shown in the following figure.

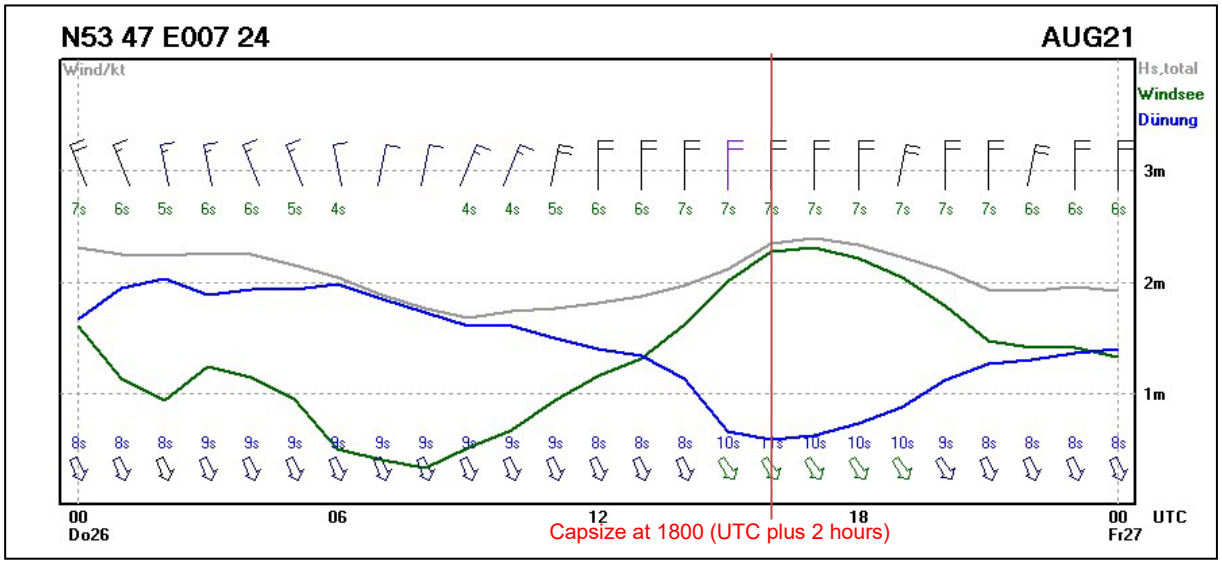


Figure 45: Time series in UTC for 26 August 2021 at the scene of the accident[121]

The diagram shows a northerly wind of 4 Bft in the model calculation. Since wind speeds of 27 kts (6 Bft) were measured slightly north of Wangerooge at the time of the accident, it is reasonable to assume that higher winds were also highly likely at the accident position. The wind sea component dominated the significant wave height of up to 2.5 m. The swell component was negligible.

Air temperatures at a height of 2 m above the water surface fluctuated around 16 °C.

3.2.7.2 Wind forecasts/sea state forecast charts

The skipper used the free version of the Windfinder app for wind forecasts. According to the recollections of the skipper, this app forecast 22–24 kts (6 Bft) with gusts up to 28 kts (7 Bft) from the north.

The provider does not store published forecasts. Accordingly, it was not possible to assess the forecast retrospectively in this investigation.

Windfinder provides its forecasts based on various weather models.

[120] Approximate position at which the SILJA foundered from the notice to mariners (T)201/21, WSA Ems-Nordsee, 30 August 2021.
[121] Source: Figure 9 from the DWD's weather report, WV 13/64.30.16-20/31_21 of 24 November 2021. The long feather of a wind arrow equals 2 Bft and one short feather 1 Bft.

In the free version, forecasts are based on the GFS (Global Forecast System) global weather forecast model of the American weather service, NOAA (National Oceanic and Atmospheric Administration). These forecasts are updated every six hours and provided at three-hour intervals for up to ten days. According to the provider, the horizontal resolution[122] is about 13 km.

The provider refers to forecasts which – according to the provider – are based on an improved physical model and an improved topographic model with a significantly higher horizontal resolution – in Europe 7 km – as 'Superforecast'. These are subject to a fee. The forecast values of the Superforecast are provided for up to three days at hourly intervals and are also updated every six hours.

The provider recommends that users observe the proposed forecasts offered by both forecasting models and establish which model delivers the best forecasts for the region in question. *If both models deliver similar forecasts, it is very likely that the forecast will materialise.*[123]

On request, Germany's National Meteorological Service (DWD) provided its published shipping forecasts (medium-range/coastal weather forecasts). These publications were to be used to investigate whether the weather and in particular wind conditions were foreseeable on the day of the accident.

The five-day medium-range forecasts for the day of the accident were – as far as available in retrospect – largely constant:

Five-day medium-range forecasts for 26 August (North Sea)		
Publication	**Direction**	**Strength in Bft (mean wind)**
Sunday, 22/08, 1300	NW to N	6–7, westerly decreasing 4–5
Monday, 23/08, 1400	Northerly	5–6
Tuesday, 24/08, 1500	North	around 6, slightly decreasing
Wednesday 25/08, 1300	no medium-range forecast for the following day	

The coastal weather forecasts for the East Frisian coast (forecast horizon of about 24 hours) were consistent with the medium-range forecasts:

[122] The smaller the horizontal resolution, the more detailed a weather forecast model can capture regional influences on the weather pattern. For forecasts of five days or more, calculations in global models are required.
https://www.dwd.de/DE/forschung/wettervorhersage/num_modellierung/01_num_vorhersagemodelle/numerischevorhersagemodelle_node.html (2022-03-11).
[123] See https://www.windfinder.com/apps/: Hourly Superforecast with higher resolution (2022-03-08).

24-hour coastal weather forecast for 26 August (East Frisian coast)			
Publication	**Direction**	**Force in Bft (mean wind and gusts) valid for 10 m above sea level**	**Forecast until**
Wednesday 25/08, 0230	North, veering north-west	around 3, temporarily increasing 6	Thursday morning
Wednesday 25/08, 0830	North-west, veering north	around 4, temporarily increasing	Thursday morning
Wednesday 25/08, 1430	North-west, veering north	5, temporarily increasing	Thursday evening
Wednesday 25/08, 2030	North-west, veering north	6, temporarily decreasing 4–5	Thursday evening
Thursday, 26/08, 0230	North	around 5, slightly increasing	Friday morning
Thursday, 26/08, 0830	North	around 5, slightly increasing	Friday morning
Thursday, 26/08, 1430	North, later veering north-east	around 5, slightly increasing	Friday evening

The coverage of the 'East Frisian Coast' sea area is shown on the following chart.

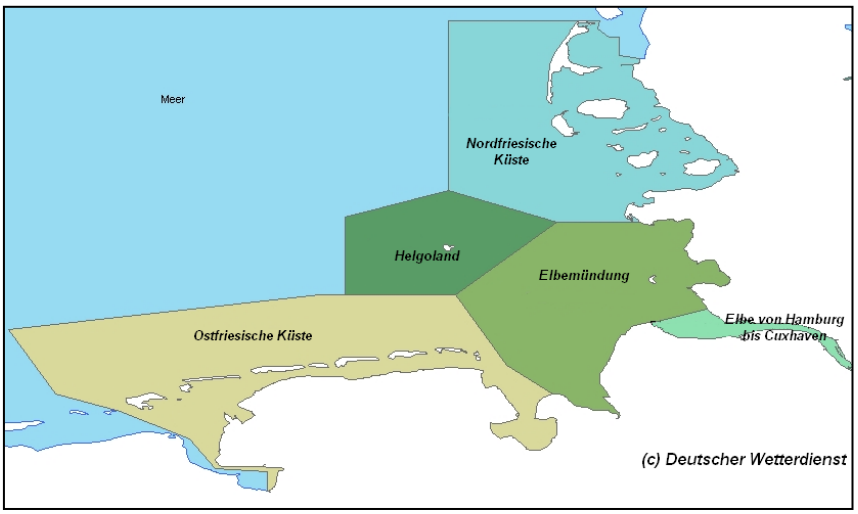


Figure 46: Coastal weather report – North Sea Coast sea areas[124]

The DWD uses various numerical forecast models to produce its forecasts, such as the ICON global model and the ICON-D2 regional model. The latter model, for example, has a resolution of about 2.2 km.[125]

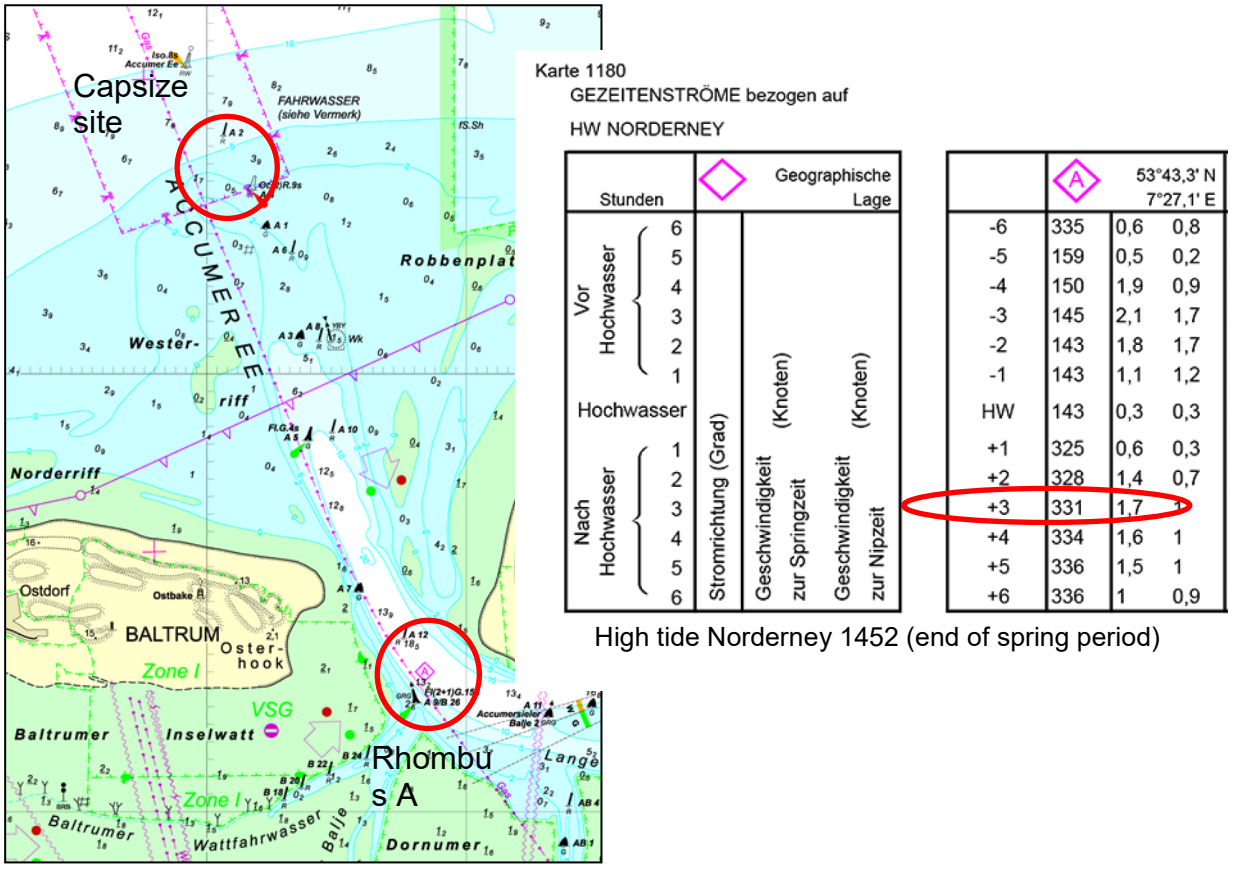
[124] https://www.dwd.de/DE/leistungen/kuestenseewetterbericht/kuestenseewetterbericht.html (2022-03-08).
[125] https://www.dwd.de/EN/research/weatherforecasting/weatherforecasting_node.html (2022-03-08).

The DWD's shipping forecasts are provided free of charge and can be obtained via various channels.[126] In addition, the DWD offers sea state forecast charts[127] for the North Sea, *inter alia*. The sea state forecast charts were not considered in detail during the investigation because the wind forecasts meant that a wind sea, which could lead to groundswell, had to be constantly expected in the accident area.

There are many other providers in addition to the Windfinder app, such as Windy. This provider enables users to compare the results of various numerical forecasting models, for example, and use them on the basis of their own experience.

3.2.7.3 Current in the Accumer Ee

According to the data from the BSH's navigational chart 1180 at position 53° 43.3' N 007° 27.1' E (rhombus 'A'), the tidal current in the Accumer Ee south of the capsize site set at about 1.5–1.7 kts at 331 degrees on 26 August 2021 at about 1800.



High tide Norderney 1452 (end of spring period)

Figure 47: Extract from chart (BSH 1180)

Based on two operational models, the BSH was able to make the following statements on the current at the scene of the accident level with the bar of Accumer Ee. Both models *[...] show a largely uniform and clear picture of the current: In both models, the*

[126] See *Sturmwarnungen und Seewetterberichte für die Sport- und Küstenschifffahrt* [storm warnings and shipping forecasts for recreational and coastal shipping] information sheet: https://www.dwd.de/DE/fachnutzer/schifffahrt/service/dauerbrenner_112021_barrierarm.pdf?__blob=publicationFile&v=1.
[127] Weather and Climate - DWD - Services - Sea State Charts (dwd.de).

accident occurred at the time of the maximum ebb current. The direction of the current is also uniform – in both models it is about 325°, which means the current was setting north-west. The two models differ significantly only in respect of the speed of the current. While the older model has indicated a surface current speed of about 1.7 kts, the new model, which has been operational since 2020, actually indicates the surface current as about 2.7 kts. One of the reasons will certainly be that the surface layer of the old model is 5 m, while that of the new model is only 2 m. As is generally known, the current is usually at its strongest directly at the surface and then decreases with depth. In any case, 1.7 kts should be taken as the lower limit for the surface current speed, which also fits very well with established tidal currents.

3.2.8 Lifejackets

All three sailors wore automatically inflatable lifejackets made by Secumar Bernhardt Apparatebau GmbH u. Co. (SECUMAR). In all the lifejackets, the automatic release mechanisms triggered the inflation process on contact with water, as intended. The buoyancy chambers were fully inflated by gas from the CO_2 cartridges in the lifejackets.

However, after an indeterminable period of time, at the latest after the SILJA foundered, the buoyancy chambers on the lifejackets of all three sailors were floating more or less next to their bodies. The buoyancy chamber fastenings had become detached from the protective covers (with integrated harness) at the bottom of the lifejackets and in the case of two of the three lifejackets were only connected to their lifejacket harness at one point.

Figure 48: Comparable fastening on a BSU inflatable work vest[128]

In the case of the skipper, whose buoyancy chamber had come loose on one side, it was possibly twisted such that some or all of the reflectors were not pointing upwards, for example.

The following investigation seeks to identify the cause and, if necessary, develop a safety recommendation so as to prevent similar malfunctions in the future.

3.2.8.1 Lifejackets on the SILJA

The sailors had worn the following lifejackets:

Who	Lifejacket (equipment)	Date of production	Next service
Skipper	ULTRA 170 Harness	26 February 2018	August 2020

[128] Source: BSU.

Male sailor	ULTRA AX 150 (harness[129], spray hood[130], lifejacket light[131])	24 April 2017	August 2019
Female sailor	ULTRA AX 150 (harness, spray hood, lifejacket light)	20 March 2016	September 2018

In addition to the equipment listed in the table, the three lifejackets were all fitted with an oral valve, a whistle and a crotch strap. The lifejackets met the requirements of the DIN EN ISO 12402-3:2021-04 standard for performance level 150 lifejackets. According to the standard, the lifejackets were designed for offshore use (coastal waters and the high seas), taking into account the use of weatherproof clothing. Lifejackets *[...] are intended to bring and keep the casualty's head* [the airways] *above the surface of the water and to assist in turning the casualty to a safe, supine position.*[132] The phrase 'protection in case of unconsciousness' is usually used to describe this mode of operation. *Depending on the clothing, for example protective clothing for heavy weather, this can only be achieved through high buoyancy.*[133]

The following table shows the various lifejacket performance level standards.

PERSÖNLICHES AUFTRIEBSMITTEL	ISO 12402-2 bis ISO 12402-6	
Anwendung	Leistungsstufe	
Offshore-Bereich, extreme Bedingungen, spezielle Schutzkleidung, schwere Ausrüstung	Rettungswesten	275
Offshore-Bereich, Wetterschutzbekleidung		150
Geschützte Gewässer, leichte Bekleidung		100
Nur Schwimmer, geschützte Gewässer, Hilfe in der Nähe, eingeschränkter Schutz gegen Ertrinken, keine Rettungsweste	Schwimmhilfen	50
Auftriebsmittel für besondere Einsatzzwecke	alle Leistungsstufen	

Figure 49: Lifejacket performance levels according to ISO standards[134]

[129] *Harness (formerly lifebelt): A harness worn at chest level. The integration of a harness with a lifejacket to form a fixed, uniform combination is most effective.* German Maritime Lifesaving Appliances Association https://fsr.de.com/rettungswesten-3/#more-1762 (2022-03-31).
[130] *Spray hood: Protects the face from spray and splashes.* Source: See Footnote 129.
[131] *Lifejacket light: Emits a flashing light with a brightness of at least 0.75 cd for at least 8 hours.* Source: See Footnote 129.
[132] Source: See Footnote 129.
[133] Source: See Footnote 129.
[134] Source: DGUV Test (testing and certification). Section: Personal Protective Equipment. Presentation (extract) of 17 December 2021.

According to the standard, performance level 150 N lifejackets must, *inter alia*, satisfy defined horizontal and vertical strength requirements in the inflated and non-inflated state:

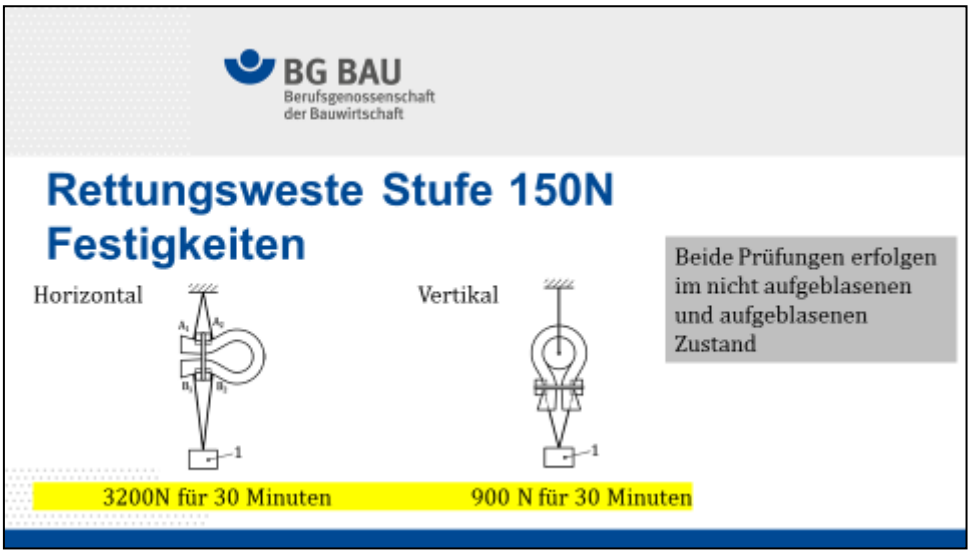


Figure 50: Strength requirements for performance level 150 N lifejackets[135]

According to the skipper, the lifejackets were only worn before the accident during his sailing trips on the SILJA. No lifejacket was tested beforehand, e.g. in the water, so as to *"[...] become familiar with the function and the behaviour in water"*[136] in accordance with the manufacturer's recommendations and then repacked. Neither a visual inspection nor performance test, during which the lifejackets were unpacked, the buoyancy chambers were inflated, and the lifejackets were repacked, were carried out in the dry beforehand, either.

According to the servicing dates on the service tags, the lifejackets had not been serviced in accordance with the manufacturer's specifications. There was no servicing recorded in the area of the servicing stamps on the buoyancy chambers. One of the three lifejackets should have been serviced four months after purchase in May 2018.

Shortly before the start of the trip, the skipper had noticed that the servicing dates had passed. He contacted the shop where he had bought the lifejackets and after receiving advice decided not to have the servicing carried out until after the end of the trip, as all the lifejackets were basically still in the same condition as when he had bought them some three years earlier.

[135] Source: DGUV Test (testing and certification). Section: Personal Protective Equipment. Mr Müller, Ms Dean. Presentation (extract) of 17 December 2021.
[136] Quote taken from the user manual for the SECUMAR lifejackets.

3.2.8.2 Legal framework for servicing and use[137]

The lifejackets were used privately. There are no legal requirements for the servicing and use of privately used lifejackets, only recommendations.

In the opinion of the DGUV[138], the recommendations of the manufacturers and of the German Maritime Lifesaving Appliances Association (FSR) should be observed. These recommendations correspond to the handling of lifejackets used commercially.

In the commercial sector, Section 5 of the German Safety and Health at Work Act states that the employer must assess the conditions of work. Lifejackets must be provided if there is a risk of falling into water. In the case of commercial work, DGUV accident prevention regulations cover many aspects of using personal protective equipment (PPE). This includes inspecting and servicing PPE. For lifejackets, the following must be considered:

- a visual inspection for obvious defects and a quick check of operational readiness must be carried out before use;
- operational readiness must be checked and documented at least once a year;
- servicing – usually every 24 months – in accordance with the manufacturer's specifications must be carried out by a service centre.

Servicing involves the following work (at SECUMAR, for example[139]) [sic]:

- "*16-hour inflation test*
- *Water test of the firing mechanism*
- *Check the manual inflation device*
- *Check the oral inflation tube and valve*
- *New gaskets*
- *New pill*
- *Electronically checked all assembly including torque settings*
- *Check all seams and fastenings*
- *Check the CO_2-cylinder*"

[137] Unless otherwise noted, the statements in this section are based in particular on the advice of the German Social Accident Insurance (DGUV), Section: Personal Protective Equipment (PPE) against Drowning.
[138] DGUV: German Social Accident Insurance.
[139] SECUMAR lifejackets. Service Export Price-List 2022/1.

3.2.8.3 Damage: Investigations of the manufacturer

Waterway Police Wilhelmshaven secured two lifejackets and a buoyancy chamber without harness and protective cover as part of its investigation and instructed the manufacturer, SECUMAR, to check the activated lifejackets for functionality and operational readiness.

The test report on the inspection of activated lifejackets for functionality and operational readiness, dated 14 September 2021, is attached to this report (Annex 3).

In addition to the test report, the following figures show in particular the design and fastening of a buoyancy chamber with the protective cover to one of the lifejackets secured.

Figure 51: Ultra AX 150 with harness (front, closed)[140]

Figure 52: Ultra AX 150 with harness (back, closed)[141]

[140] Source: BSU.
[141] Source: BSU.

Figure 53: Ultra AX 150 with harness (buoyancy chamber inflated)[142]

[142] Source: BSU.

Figure 54: Buoyancy chamber retaining strap; webbing brake[143]

Figure 55: Press stud[144]

According to the test report, the firing mechanism on the lifejackets did not have any malfunctions.

All three buoyancy chambers exhibited severe mechanical damage. According to the information available, the cuts and tears on the buoyancy chambers were caused by the rescuers.

The test report indicated that the secured buoyancy chamber without a harness and protective cover were heavily soiled. On later inspection by the BSU, red traces of paint were visible on this buoyancy chamber. Since the paint corresponded to the underwater paint on the lifeboat involved in the rescue attempt, these traces can presumably be attributed to the rescue attempt.

It was not possible to explain the damage around the buoyancy chambers where the thimbles were torn out of the textile surface of the buoyancy chambers due to strong tensile forces, meaning the buoyancy chambers were no longer held in the desired position in front of the body.

One thimble on the skipper's lifejacket had been torn out, while both thimbles on the other two lifejackets had been torn out of the textile surface of the buoyancy chambers.

The BSU therefore contacted SECUMAR again for further investigation. This further inspection involved

1. reproducing the damage pattern, and

[143] Source: BSU.
[144] Source: BSU.

2. determining the force required to tear a thimble out of the buoyancy chamber (fabric).

The test report dated 15 December 2021 on the pull-out behaviour of thimbles and determination of strengths, as well as two videos about the tensile testing carried out on a sample ULTRA 170 buoyancy chamber are appended (Annexes 4, 5 and 6).

In the first tensile test, a force acting parallel to the body was simulated on the inflated buoyancy chamber. Such a force can occur when a person floating in the water is rescued by pulling only at the neck of the inflated buoyancy chamber (Annex 5). At a test force of 0.82 kN, the thimble tore from the textile surface of the buoyancy chamber at one of the two connection points and the damage pattern was similar to the casualty's damaged buoyancy chambers.

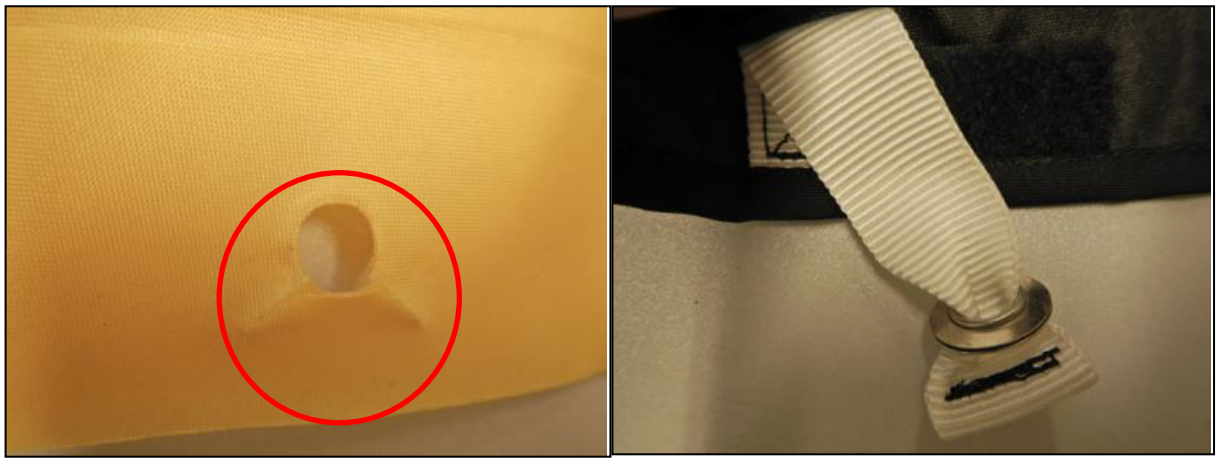


Figure 56: Torn textile surface/torn-out thimble [145]

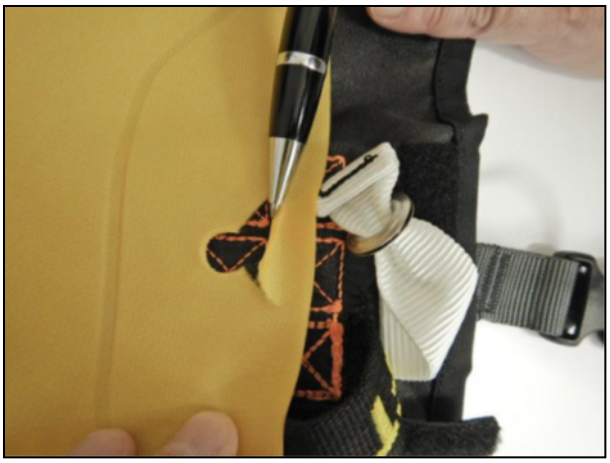


Figure 57: Strength test (torn-out thimble)[146]

[145] Source: Photographs of the ULTRA 170 Harness lifejacket from the SECUMAR test report dated 14 September 2021.
[146] Source: Photograph from the SECUMAR test report dated 15 December 2021.

In the second test, a force was applied to the filled buoyancy chamber by pulling diagonally to the body axis on one of the lower thimbles (Annex 6). This test simulated a load when providing assistance during the recovery of a person floating in the water if one side of the lower buoyancy chamber is pulled. The seam of the buoyancy chamber retaining strap on the protective case tore in the process. This damage pattern did not correspond to the lifejackets that had been seized.

According to the manufacturer, the fastening between protective cover and buoyancy chamber by means of a webbing brake and a thimble/eyelet has been tested and used as a fixed connection for years. It is suitable for safely positioning the buoyancy chamber on the body when used as intended. During testing and certification, both the performance requirements for the system are proven in practical tests and the materials used are subjected to a component approval procedure. In particular, the buoyancy chamber material is subject to extremely detailed requirements.

The manufacturer points out that the connection between buoyancy chamber and protective cover cannot perform any functions relating to the recovery of a casualty. A lifting becket exists for this purpose on a lifejacket of the 150 N buoyancy class. Both position and strength requirements for the belt and the seam pattern are defined in the standard.

SECUMAR has no knowledge of damage to other lifejackets that – subject to being used as intended – correspond to these ones.

In view of the fact that – according to the information available – the damaged lifejackets were used as intended and that improvements on the part of the manufacturer can only be developed once the event that caused the damage is known, the BSU informed the skipper of the test result and asked him to provide – as far as possible – further details of events that may have caused forces similar to those of the tensile test.

3.2.8.4 Damage: Account of the skipper

After the specific enquiry, the skipper gave the following account: *All three of us were hanging on to the stern of the boat and had been trying to send a distress call for about five minutes. We were in the waves, which were not breaking at that stage, for the whole time. Then a breaking wave of about three metres in height washed over us. The water pressure that then pushed me towards the bow was colossal. I had a tight grip on the some 2 cm thick tubing on the bathing ladder and could just about hold on with arm stretched. It felt as if my entire body weight was tearing at my hand. About the same as the force I need to hold on to a horizontal bar with one hand. My whole body weight (85 kg) then pulls down on my hand.*

The skipper only noticed the damaged lifejackets after the SILJA foundered, as he was then no longer able to concentrate on the boat and all the sailors were reliant on the buoyancy of the lifejackets. Following the enquiries about the lifejackets, he remembers that his buoyancy chamber was floating on his left-hand side. In the case of his female crew member, it looked as if it were the other way round. In the case of his male crew member, he could not see it.

The skipper finds it conceivable that the buoyancy chamber, which was split in two in front of the chest, got caught at the corner of the hull and thus separated at the right and upper connection to the protective hull when the wave passed him.

The investigation failed to clarify why the skipper believed his lifejacket had twisted in the water such that the reflectors were possibly no longer visible from the air.

3.2.8.5 Buoyancy chamber/protective cover connections

Similar to the manufacturer, SECUMAR, the BSU had no previous knowledge of comparable damage to lifejackets that had been used as intended.

The investigators therefore considered the below questions, in particular.

- Is it possible that other bodies have already heard of similar damage?

- Have other bodies already addressed the pros and cons of the manufacturer-specific non-standardised connections between the buoyancy chambers and protective covers of the lifejackets?

- Is there a need to standardise the connections in question?

The investigators then contacted the editorial staff of the Yacht magazine, which regularly carries out practice-driven tests on lifejackets and reports on those tests.

The editorial staff had no information about comparable damage, either, and had not seen any need to look more closely at the pros and cons of the connections.

3.2.9 Lifesaving appliances

The rescue services did not spot the three sailors until after sunset. The first sailor was discovered by a rescue cruiser at 2045 during the civil twilight phase and the two rescued sailors by the crew of the SAR helicopter during the nautical twilight phase at 2122 and 2200.

In the following, it was investigated which lifesaving appliances are recommended from the perspective of the rescue services.

3.2.9.1 Recommendations of the SAR helicopter crew

According to the crew of the SEA KING MK41 helicopter, the two rescued sailors were spotted in particular by flying over the search area in accordance with the IAMSAR manual and using NV goggles[147].

Although the water temperature was about 18 °C and the core body temperatures later determined in the helicopter about 35 °C, the forward-looking infrared (FLIR) camera did not detect the people.

The crew became aware of the female sailor rescued first thanks to the lifejacket light. The information provided by the female sailor made it possible to specify the search area significantly for the ensuing search for the skipper.

At the request of the BSU, the rescue pilots recommended the following rescue equipment for water sports enthusiasts at sea:
- lifejackets;
- protection against the cold;
- red single pyrotechnic flare (six round rotary magazine);
- waterproof emergency transmitter, radio or mobile phone.

For day-time: smoke flare, sea water dye and anything that floats and makes the position stand out.

For night-time: magnesium flare and anything that floats and makes the position stand out.

Lifesaving appliances should be used sparingly but purposefully based on availability, time of day, proximity of rescue units and the condition of the people in distress.

People in distress should, as far as possible, put themselves in the position of the SAR aircraft and consider the following:

Visibility from an SAR aircraft depends on many factors, especially the weather, altitude, possible glare (e.g. from the sun) and sea state.

If a person in the water is likely to be overflown, it is advisable to fire a distress signal – depending on the duration and strength of the signal – at a distance of 2 km or lower.

If the SAR aircraft is only nearby but apparently remaining outside of direct sight, the person in distress must weigh up how long her/his possibly only lifesaving appliances should be saved so as not to waste them. People in distress should be prepared to hold out for as long and remain as visible as possible.

[147] NVD: Night vision device – also referred to as image intensifier goggles – amplify existing light waves and map them two-dimensionally for the eye.

If there are several people in the water, they are more visible together than alone.

If the signalling device is fired at a long distance because there appears to be no better time, then it should be fired so that the aircraft's crew can make out the signal in front of or next to them.

In the case under investigation, the use of SOLAS[148] hand flares would have been extremely helpful from the perspective of the helicopter crew. Pyrotechnic distress signals are usually small, inexpensive and easy for non-professionals to use.

For the acquisition and transport of pyrotechnic distress signals subject to authorisation (signalling flares, rocket parachute flares, certain smoke flares), holders of a recreational craft licence must demonstrate that they have been instructed in the use of these devices and the regulations to be observed (see Section 1(2) 1. SprengV)[149] by acquiring a certificate of competence in distress signals[150], for example. A certificate of competence is not required to use signalling devices, however.

3.2.9.2 Recommendations of the DGzRS

The German Maritime Search and Rescue Service (DGzRS) has published its recommendations for all water sports enthusiasts on the internet[151], *inter alia*. In the following, only those recommendations that the investigators believe have a contextual relationship with this accident and contain new information with regard to the existing findings of the investigation are discussed.

3.2.9.2.1 Lifejackets

In addition to the inspection and servicing recommendations of the DGUV and the FSR (see Chapter 3.2.9.2), the DGzRS has stated that lifejackets should be checked for leak-tightness every six months by inflating them with a hand pump and leaving them inflated for one day.

Lifejackets that have been in contact with seawater should be rinsed with fresh water and dried completely.

Lifejackets should be kept dry and well aired when not in use for longer periods. Over the winter, lifejackets should be partially inflated and suspended on a non-metallic hanger.

[148] SOLAS: International Convention for the Safety of Life at Sea, 1974.
[149] 1. SprengV: First Ordinance to the Explosives Act, as amended and promulgated on 31 January 1991 (Federal Law Gazette I p. 169), as amended by Article 1 of the Ordinance of 20 December 2021 (Federal Law Gazette I p. 5238).
[150] FKN: Certificate of Competence - Recreational Craft Licences and Radio Certificates (sportbootfuehrerscheine.org) (2022-04-27).
[151] Safety At Sea | DGzRS (2022-04-27).

3.2.9.2.2 Communication

For emergency situations, the DGzRS recommends handheld radios and additional mobile phones (smartphones). If possible, there should be several means of communication on board. Device batteries should be charged before every trip (departure).

VHF radios offer the advantage that any marine radio station in the vicinity can listen in and provide assistance. The location of the transmitter can be quickly determined by means of a cross bearing. The use of the radio should be practiced. Anyone who wants to operate a VHF radio needs an appropriate certificate for the maritime mobile service.[152] However, anyone may operate a radio in an emergency.

In the view of the DGzRS, a smartphone is a good addition to the VHF radio, especially if the SafeTrx safety app is used.

The phone number of the Maritime Rescue Coordination Centre (MRCC) should be accessible with international dialling code (+49 421 536870) via a shortcut key.

3.2.9.2.3 SafeTrx

The SafeTrx app *[...] records the position of the water sports enthusiast via the smartphone's GPS and sends it to the MRCC monitoring console* [at regular intervals]. *The DGzRS can retrieve all data entered into the app in an emergency: the position of a person in distress can be determined almost precisely or the search area narrowed down considerably. Accordingly, help can be provided more quickly.*

SafeTrx does not trigger an alert at the MRCC automatically. Users who have saved the destination and arrival time of their trip before departure will first be reminded by text message if arrival is overdue. SafeTrx will only alert one or several private emergency contacts previously saved, who can then inform the DGzRS, in the event of a delay of more than 15 minutes.[153]

3.2.9.2.4 EPIRB

Anyone who wants to play it safe should carry an EPIRB[154] *on board. The devices transmit an automatic emergency radio signal to the MRCC via satellite. The beacons can be triggered manually. However, this usually happens automatically on contact with water. Since each beacon is registered at the time of purchase, the DGzRS is already informed about important particulars of the boat.*[155]

[152] Skippers are required to hold a certificate if they have a marine radio (see Section 1(7) of the German Offshore Cruising Licences Ordinance, as amended and promulgated on 3 March 1998 (Federal Law Gazette I p. 394), as amended by Article 5 of the Ordinance of 3 March 2020 (Federal Law Gazette I p. 412).
[153] SafeTrx: Your Connection to the MRCC | DGzRS | DGzRS (2022-04-27).
[154] EPIRB: Emergency Position Indicating Radio Beacon.
[155] What to do in a Maritime Emergency | DGzRS | DGzRS (2022-04-29).

3.2.9.2.5 AIS[156] devices

Unlike in recreational boating, AIS has been mandatory on commercial vessels for a long time. The use of AIS devices is becoming more and more common in water sports, too. A distinction is made between receivers and transponders. AIS distress transponders and AIS person overboard devices (POB devices) can send two different messages. One (Message 1) contains the current position, course, speed, date and time. The other (Message 14) is an active distress call or test call. All AIS receivers and AIS transponders can receive these messages, evaluate them and transmit them to a chart plotter, PC or radar unit. The distress call is depicted by the internationally valid sign for an AIS distress call: a red circle with a cross.

[...] An AIS device is not part of the official rescue chain – nor is it an AIS POB device (see also Chapter 3.2.11). An alert via this means can be helpful or set the rescue chain in motion but there is no guarantee for this.[157] Under international law, only the alert signal of an EPIRB or by digital selective call (DSC) are regarded as distress signals.[158]

3.2.9.2.6 Distress signals

The DGzRS believes distress signals are an essential part of being discovered. Nobody should rely solely on a radio or mobile phone. In addition to the remarks in Chapter 3.2.10.1 (Recommendations of the SAR helicopter crew), the DGzRS believes that the following basic principles should be observed:

- *every crew member should know where the signalling devices are located and how to operate them before a sailing trip;*
- *be aware of the limited shelf life of distress signals and replace them without undue delay if necessary. After about four years, it is no longer guaranteed that they will function safely;*
- *distress signals are only useful if they can be reached quickly in an emergency;*
- *caution: only use distress signals in an emergency! Misuse is punishable by a fine.*

[156] AIS (**A**utomatic **i**dentification **s**ystem): Standardised radio system for exchanging ship particulars both among vessels and for shore-based traffic monitoring. It transmits these data to receiving stations in the area, usually other ships, at short intervals and is mainly used for collision prevention.
[157] Maritime Safety Equipment | DGzRS | DGzRS (2022-02-27).
[158] Article 34 of the Radio Regulations, as published by the ITU in 2020.

In addition to the radio or the SafeTrx safety app, visual signalling devices are an effective means of attracting attention in an emergency. Every water sports enthusiast should know how to use them properly [...].[159]

Further advice on using signalling devices follows.

3.2.10 Personal locator beacons[160]

In addition to the EPIRBs designed for boats and ships, which also have a connection to their respective ship via the MMSI[161], there are also personal locator beacons (PLB) in the COSPAS-SARSAT system[162], which can be attached to lifejackets, for example.

PLBs, which are designed analogously to the EPIRBs, must be registered. Registration of a PLB is not possible in Germany. According to information from the Federal Network Agency, emergency alerts by PLB are not provided for in the existing rescue chain.[163] In Germany, there are only ship-related registrations. According to information from the DGzRS, distress calls from a PLB trigger rescue operations. [164]

In addition to PLBs, devices that transmit a distress signal via AIS are also available (see Chapter 3.2.10.2.5 AIS devices). Depending on the source, the latter are not referred to as PLBs but usually as personal AISs or *POB* (person overboard) devices.

A personal AIS makes it possible to reach all vessels with an AIS receiver at a distance of about 2–4 nautical miles, enabling these vessels to assist a person immediately without the prior involvement of an MRCC.

There are also POB devices that – in addition to transmitting the location via AIS – simultaneously send an alert via DSC on VHF if triggered. GMDSS radio stations can receive the distress signal transmitted via DSC. The maximum range depends on the location of the transmitter and receiver, the transmission power and the receiving equipment and will usually be about 10–30 nm.

[159] See previous footnote.
[160] Further information e.g. Best personal locator beacons and AIS units - Yachting World. Article of 12 March 2022. (2022-04-29).
[161] MMSI: Maritime Mobile Service Identity. The MMSI is a unique identifier for each maritime or coastal radio station within the Global Maritime Distress and Safety System (GMDSS). Using this MMSI makes it possible to establish a connection for a marine radio call with a specific marine or coastal radio station by means of DSC.
[162] COSPAS-SARSAT is an international search and rescue system for the detection and location of EPIRBs via satellite.
[163] Federal Network Agency - Special Applications – (2022-05-31).
[164] The PALSTEK magazine has looked at the technical differences and advantages/disadvantages of an EPIRB and a PLB and published the article 'EPIRB versus PLB' in Issue 05/2021.

3.2.11 Distress call/emergency number

The skipper used his smartphone for the distress message and dialled the emergency number 110. The touch screen of his smartphone did not respond until he took it out of its protective cover. The distress call was received by the KRLO. The KRLO handles centrally all distress calls received there on the numbers 112 (European emergency number, national for fire/rescue) and 110 (police, additional national emergency number).

Both emergency numbers are AML-compatible. When an AML-compatible emergency number is called via smartphone, the WLAN and the GPS sensor – if present and disabled – are automatically enabled by the caller's device at the beginning of the call – subject to operating system and a sufficient battery charge[165]. Callers do not have to load an app or make any other device settings. Users cannot change the AML-related settings in smartphone operating systems.[166] If the caller's device detects position data, these will be automatically transmitted to a central server of the emergency call centres via SMS or HTTPS.

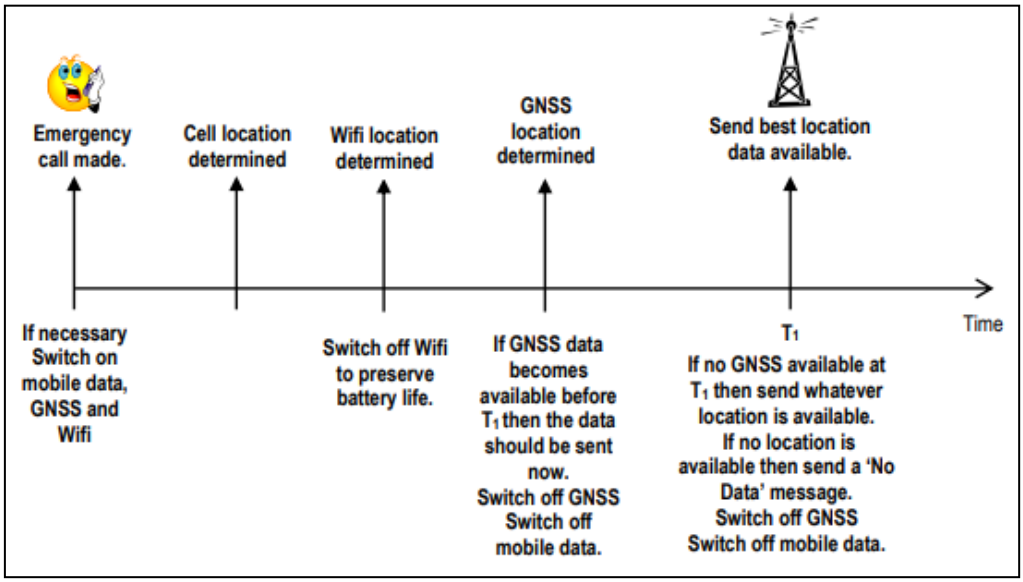


Figure 58: AML timeline in the smartphone[167]

[165] According to the technical requirements of the European Emergency Number Association (EENA) for AML, it is left to device manufacturers and providers to decide whether AML functionalities are enabled in the smartphone if the battery charge is low so as to enable the alternative of a (five-minute) phone call (AML Specifications & Requirements of 2 March 2016).
[166] Advanced Mobile Location – EENA (2022-09-28).
[167] Source: EENA Operations Document Advanced Mobile Location (AML) Specifications & Requirements, as amended on 2 March 2016.

The emergency call centres can retrieve the AML data record on the server. The AML data are stored on the server for 60 minutes. Android devices require the internet (WLAN or mobile data) to transmit AML data. Apple devices transmit the data by SMS. In national roaming[168], no AML data records have been transmitted so far.[169]

Since March 2022, all mobile devices sold on the European market must be AML-compatible. The vast majority of smartphones, Android and iOS devices in particular, already meet these requirements.[170]

AML data records are only stored on the central server for the 112 emergency number at present in Germany. According to Lower Saxony's police service, AML for the emergency number 110 should soon also be available throughout Germany.

Irrespective of AML data records, pursuant to Section 164(1) of the German Telecommunications Act (TKG), providers transmit for the emergency numbers 110 and 112:

- the telephone number of the connection from which the distress call originates, and
- the data required to determine the location from which the distress call originates.[171]

Providers are at liberty to choose how they comply with these obligations. In this case, to transmit the position data the radio mast communicated the beamwidth, in particular.

Moreover, mobile phones recognise 110 and 112 as emergency numbers. Accordingly, phone providers and network operators also make calls possible – always subject to sufficient network coverage – in the following cases, in particular[172]:

- for a blocked SIM card;
- for prepaid contracts if the credit balance is not sufficient, and
- for national roaming.

3.2.12 Similar accidents

The capsize and subsequent foundering of the SILJA with loss of life was the result of at least one groundswell during the passage of the bar of the Accumer Ee tidal inlet. Similar marine casualties occur over and over again, fortunately not always resulting in one or more fatalities.

[168] In national roaming, a mobile phone provider uses the network of another provider in the same country. This happens when the mobile provider does not have its own network available locally, for example.
[169] 2020_04_03_AML_FAQ_FINAL.pdf (eena.org) (2022-09-27).
[170] Advanced Mobile Location – EENA (2022-09-26).
[171] German Telecommunications Act of 23 June 2021 (Federal Law Gazette I p. 1858), as amended by Article 9 of the Act of 20 July 2022 (Federal Law Gazette I p. 1166).
[172] See Section 4 of the German Ordinance on Emergency Calls (NotrufV). German Ordinance on Emergency Calls of 6 March 2009 (Federal Law Gazette I p. 481), as amended by Article 44 of the Act of 23 June 2021 (Federal Law Gazette I p. 1858).

Issue 6/2021 of the Yacht magazine contained the second part of an article on learning from accidents. This article is about sailing in a current and how to navigate safely in tidal waters, in the Wadden Sea and in tidal inlets. The article discusses several accidents that occurred in tidal inlets.

The publication discussed a Swedish-flagged ten-metre yacht that stranded on the northern side of Norderney at about 2300 on 30 August 2020 during the passage of the Dovetief, which leads from the North Sea into Norderney's tidal inlet.

On 28 June 2018, a nine-metre boat ran aground in the Accumer Ee just before low tide and was holed. The boat and crew were towed to Bensersiel with the assistance of the DGzRS.

The publication discusses other boats that were stranded over the past five years as a result of groundswell around the sandbanks located off the islands.

The BSU has no further information on the accidents mentioned, as marine casualties involving recreational craft are usually only reported if the accident has significant consequences.[173]

From the perspective of the investigators, the following three accidents involving recreational craft investigated by the BSU are related to the current case.

The sailing yacht MADAME PELE (Ref.: 240/04) foundered off Borkum after running aground. Two sailors lost their lives. According to the report, it was found, *inter alia*, that the examinations in recreational boating do not meet the requirements for good seamanship in the Wadden Sea.

The two other accidents involving the capsize of the sailing yachts TAUBE with six fatalities (Ref.: 15/09) and MERI TUULI with two fatalities and severe damage to the boat (Ref.: 86/13) were caused by groundswell off an estuary and a port entrance. Since the water depth in front of both ports decreased rapidly, groundswell could form from the waves approaching from the sea.

Further information on the cases mentioned can be found in the investigation reports and/or safety recommendations[174] published.

[173] The BSU has published information on the obligation to report marine casualties pursuant to Section 7 of the German Ordinance on the Safety of Shipping (SeeFSichV) on the internet, such as the Federal Bureau of Maritime Casualty Investigation's flyer on reporting accidents and on-call duty (bsu-bund.de).
[174] www.bsu-bund.de.

During this investigation, the BSU's attention was drawn to a decision of the Emden Maritime Board of Inquiry[175] relating to a marine casualty that has an appalling number of similarities with the present case:[176]

At about 1715 on 15 July 2000, the six-metre-long motorboat SIMONE[177] (type designation TG-5800 Sportfisher) capsized in the area of buoys A1 and A2 in the Accumer Ee with two people on board, a skipper and his daughter.

The boat had been sailing landwards in the direction of Accumersiel in a north-westerly swell, north-westerly wind (3–4 Bft) and good visibility against the tidal current during the ebb phase. According to information from the skipper, the swell had become very steep and high shortly before the boat capsized. To avoid capsizing, he did not alter course seawards. He maintained the course and reduced the speed to less than 5 kts. The boat was suddenly overtaken by a wave coming from aft. This lifted the stern and pushed the boat into the wave ahead, whereupon the forward cockpit filled with water and the boat capsized shortly after. According to the skipper, everything happened in seconds.

The two people on board managed to grab their lifejackets and the emergency signal pack inside the boat after she capsized and then to dive to the surface of the water. Only then did they don their lifejackets. The two people in distress initially tried to stay with the inverted boat, but she slowly sank. They decided to stay within the buoyed fairway as far as possible. The swell was breaking slightly. Guided by his intuition, the skipper fired a red distress flare for the first time at about 1830 and a second one at 1845. He heard engine noises shortly afterwards and fired another white flare. The vessel responded with a sound signal and soon after both were taken on board a fishing vessel and rescued.

The fishing vessel NORDMARK had finished her tour with anglers off the island of Langeoog at about 1715 and started her return voyage through the Accumer Ee. According to the skipper, he *[...] would not have dared to do so at an earlier stage because of the adverse sea conditions prevailing there (in the Accumer Ee) during the ebb phase with a north-westerly wind*.

[175] Maritime Boards of Inquiry determined the cause of marine casualties so as to assess them for the prevention of future accidents up until June 2002. If the investigation identified and formally established misconduct on the part of the masters and ship's officers involved, the certificate of competency could be revoked. In accordance with the international investigation standards, the task of objective accident investigation to promote a culture of safety and that of revoking certificates of competency were assigned to two different authorities in 2002 because of their irreconcilably different nature. https://www.gdws.wsv.bund.de/DE/schifffahrt/01_seeschifffahrt/seeamt/seeamt-node.html (2022-06-26).

[176] Decisions of the Higher Federal Maritime Board of Inquiry and the Maritime Boards of Inquiry (BOSeeAE), Issue 12/2000, p. 335 ff. Issued by the Federal Maritime and Hydrographic Agency. Compiled by the Higher Federal Maritime Board of Inquiry and the Maritime Boards of Inquiry.

[177] Seeamtsspruch.pdf (rolfdreyer.de) (2022-05-27).

Shortly after passing the Accumer Ee approach buoy, he reportedly saw a light red distress flare at an indeterminable distance in the eastern area of the island of Baltrum at about 1830. He was then able to take the people in distress on board even before the arrival of the DGzRS, which the fishing vessel had alerted.

It was only possible to pick up the people in distress with the help of everyone on board. Rescuing the female proved especially difficult, *[...] because for reasons he [the skipper] could not explain there was reportedly something wrong with the lifejacket and the woman's head was reportedly only just protruding from the water*.[178]

According to the verdict of the Maritime Board of Inquiry, the accident *[...] was due to the fact that*

- *the stern of the boat was lifted by a following sea;*
- *undercut with the forecastle and the forward cockpit was filled with water, and*
- *as a result, the boat capsized due to ensuing instability and the interior filled with water.*

The skipper's misconduct caused the accident, as he started the return trip during the ebb phase.

He also acted improperly by not carrying and taking into account nautical publications for that specific area.

The latter was not considered to be a cause of the accident because according to the reasons given for the decision, the skipper reported *[...] no general navigation problems and claimed to have obtained information from other skippers of recreational craft about the specific hazards in the Accumer Ee tideway*.

That the Accumer Ee can be dangerous even for experienced seafarers who are familiar with the area is illustrated by the remarks of the skipper of the NORDMARK, who according to the published decision made the following comments:

[...] since acquiring various certificates of proficiency, he has sailed the tidal inlet as skipper on various vessels to this day. In October 1983, he himself reportedly encountered serious difficulties in the Accumer Ee when he reportedly lost his vessel, the 'Tanja', there. He now reportedly sails the tidal inlet almost every day in his fishing vessel 'N' and is reportedly therefore very familiar with the current and sea conditions. In the Accumer Ee, strong surf would always occur when heavy swell combined with a strong ebb current prevailed.

[178] Due to a lack of personal details, the BSU was not able to identify the skipper of the recreational craft and question him about the problems with the lifejacket.

4 ANALYSIS

4.1 Possible cause of death

According to the forensic report, the deceased sailor, who was *[...] presumably weakened due to hypothermia, in all likelihood drowned in seawater between Baltrum and Langeoog*.

According to the statements of the two rescued sailors, the deceased was already cold before the boat capsized, as he was wet due to water washing over the boat. The clothing he had did not offer him sufficient protection from the water and wind.

The deceased has already lost body heat on board due to thermal conduction (water) and thermal convection (wind). The thermal conductivity of water is many times higher than that of air. In the case of thermal convection, the coldness in the air is caused by the wind.[179]

Loss of body heat is one of the greatest hazards to survival in water. The human body initially attempts to produce heat through movement and causes the muscles to twitch. The purpose of these tiny movements is to maintain body temperature. However, the body will not be able to store or produce heat if the exposure to cold is severe. The core body temperature starts to drop. According to some sources, hypothermia is already present at a core body temperature of 36 °C. It becomes life-threatening when the body temperature is less than 34 °C. There are different severity stages of hypothermia and different ensuing symptoms:[180]

Stage 1:
- rapid breathing (lack of oxygen and impaired consciousness);
- shivering;
- rapid heartbeat;
- agitation.

Stage 2:
- slow, unsteady breathing and heartbeat;
- stiff muscles and joints;
- fatigue;
- confusion;
- lack of responsiveness.

Stages 3 and 4:
- loss of consciousness;
- barely noticeable pulse.

[179] https://schleswiger-kanuclub.de/index.php/unterkuehlung.html (2022-05-20).
[180] First Aid for Frostbite and Hypothermia | Johanniter (2022-05-23).

The chances of survival of the deceased sailor were already low at the beginning of the emergency, as he had not worn adequate protective clothing on board to help his body regulate its temperature naturally. Accordingly, he was the first to become hypothermic and exhausted. The lines in the water may have added to the ensuing state of panic.

4.2 Sailing directions and nautical publications

4.2.1 General recommendations on tidal inlets

According to the official sailing directions issued by the BSH, tidal inlets and tideways should only be navigated with local guidance or pilotage.

This principle applies to all skippers. The sailing directions make no differentiation according to level of competence or type/use of vessel (commercial/private). Accordingly, this recommendation is also directed at highly qualified masters who must show up to eight (and more) years of training, examinations and professional experience in a responsible position as an officer in order to obtain a certificate of competency in Germany.

This statement in the sailing directions cannot be found in the nautical publications considered in greater detail here, which are directed at people who sail recreational craft.

In the view of the investigators, the recommendation in the sailing directions largely ignores the practicalities of recreational boating. No water sports enthusiast will buy pilotage services (and even if they wanted to, can). Moreover it will only be possible to make use of local guidance in exceptional cases, as people who are not familiar with the area are unlikely to be familiar with anyone who is. Apart from local fishermen, only DGzRS personnel may be recognisable as someone who could be consulted. Local water sports enthusiasts may also be a helpful source of local information. However, it may be difficult to assess their level of knowledge in advance. Nevertheless, the investigators take the view that this recommendation seems plausible in the sense that any person not familiar with the area should be aware when reading it and recognise that tidal inlets are an unusual sea area and require special knowledge and experience for safe passage.

General recommendations can be found in certain nautical publications, some of which are directed specifically at people who sail recreational craft. Some statements on the navigability of tidal inlets in general are ambiguous and partly contradictory.

In particular, the following unambiguous statements can be taken from the publications examined more closely during this investigation in the opinion of the BSU.

a) People who are not familiar with the area should only navigate tidal inlets after taking local advice.

b) Every tidal inlet is different. Details can always be found in the latest nautical publications.

c) Tidal inlets should always be navigated along the buoyage with the tidal current.

d) The return trip must be planned before passing through a gat seaward.

e) A tidal inlet should not be navigated in darkness or low visibility.

f) Any tidal inlet should be navigable in moderate onshore winds of 3–4 Bft and the associated swell with incoming water at more than half tide (unless there is high swell).

g) Always avoid conditions where the current is against the wind! From 5 Bft and above it is dangerous due to the wind sea.

h) In strong onshore winds (force 6), not every tidal inlet of the East Frisian, West Frisian and North Frisian islands is navigable. At the very least they are hazardous on entry.

i) The bar should be navigated near high tide (+/- 2 hours).

j) When approaching seaward, the approach buoy should always be made for first (advantages: sufficient sea area up to the bar, locating fairway buoys, assessing sea state and current – turn round if necessary).

k) The fairway marked by the fairway buoys should be followed at all times. After strong wind events, information on buoyage should be obtained in advance.

Further recommendations for sailors relevant to this case from the point of view of the BSU:

- a sailing boat under sail should only approach a tidal inlet if based on wind direction there is enough room leeward to follow the buoyed fairway, taking into account the current;

- if possible, sail only under headsail on downwind courses so as to avoid the risk of accidental gybes and [addition by investigator] reduce weather helm;

- if available, an engine should always be running or ready to start to keep the boat on course or to manoeuvre out of a dangerous situation.

4.2.2 Recommendations for the Accumer Ee tidal inlet

The specific advice in nautical publications on the Accumer Ee tidal inlet is also vague.

In particular, the sailing directions warn of surf over the bar at Westerriff in onshore winds – regardless of wind strength – and when the current is going out. Accordingly, entry should only ever occur when the water is rising. According to the sailing directions, the risk of groundswell only exists when the water is rising and there are strong storms.

The statements in the NV Charts App about Accumer Ee are not consistent with those of the sailing directions and are actually contradictory within the application.

According to the POI located directly at Accumer Ee, surf that makes passage impossible can often be expected even in fresh onshore winds and especially when the tide is going out (current against the wind), see Figure 42. According to the Beaufort scale, wind speeds of 5 Bft (16–21 kts) are referred to as a fresh breeze. The navigation advice on the port of Langeoog indicates that the bar at Accumer Ee only becomes very dangerous in strong winds, see Figure 43. According to the Beaufort scale, wind speeds of 6 Bft (22–27 kts) are referred to as a strong wind.

Jan Werner recommends that the Accumer Ee tidal inlet – similar to the statement in the sailing directions – should only be navigated when the water is rising. As regards wind force, he gives no specific advice: *If there is a lot of wind, it is difficult to get over the bar.* In the opinion of the investigators, this wording may give the impression to the readership that the navigability of Accumer Ee may depend on a seafarer's seamanship skills when there is a lot of wind and rising water.

4.3 Boat and equipment

In the opinion of the BSU, it is difficult or almost impossible for operators of privately used recreational craft, usually water sports enthusiasts without in-depth legal expertise, to understand the legal requirements for putting into operation recreational craft and their equipment on the basis of the legal sources. Cross-references are unclear and the relevant legal regulations of the official version of the SOLAS Convention are not freely available.

The SILJA did not have a CE marking because she was already registered within the scope of application before this standard came into force and not substantially altered or converted thereafter. Therefore, no information was available on the seaworthiness rating or maximum load. As a result, it is not possible to establish whether the SILJA was fundamentally suitable for voyages in the seaward area of the Wadden Sea with three people and a load.

The SILJA was built as a centreboard boat. In centreboard boats, a combination of ballast keel and retractable centreboard ensures that the heeling and drift stability required for sailing boats is achieved. The ballast keel reduces heeling and the centreboard reduces drift.

The ballast keel provides a righting force when heeling increases. Accordingly, centreboard boats with an intact keel generally right themselves time and again like roly-poly toys. Nevertheless, as with all vessels, these boats can also capsize. However, this requires commensurate external forces.[181] The lower the theoretical dynamic capsize angle and the further the centre of gravity moves upwards due to additional loads, the greater the risk of capsizing. In the case of the SILJA, groundswell or breaking waves were the significant external forces.

The skipper had maintained his boat and the equipment.

As far as could be ascertained after the event, the current edition of the sailing directions or another nautical publication (cruising guide) was not among the required equipment.

The investigations into the navigational charts used, the smartphone, and the lifesaving appliances such as lifejackets are considered separately in other chapters because of their importance.

4.4 The boat's crew and skipper

The skipper was the only person on board the SILJA with an official recreational craft licence and sailing experience.

The skipper could only task his crew members with supporting activities. With regard to the trip/route planning, steering the boat, and navigation, he was largely left to his own devices.

Acquisition of the official SBF-See, which was not legally necessary due to the power of the SILJA's engine, meant that the skipper had demonstrated the necessary competence to control recreational craft with a propulsion engine on maritime waterways by passing a theoretical and practical examination in accordance with Section 8 SpFV.

He had also gained practical experience with the SILJA and other boat types on Lake Steinhude, Lake Müritz and in the Wadden Sea in sheltered waters in accordance with the recommendations of the 'Sicherheit auf dem Wasser' pamphlet.

He had already navigated the bar of the Accumer Ee coming from the sea without any notable incidents in 2018.

The investigators find it easy to understand how the skipper believed that as a holder of the SBF-See in conjunction with his sailing experience he had the knowledge and skills needed to safely navigate the SILJA in the Wadden Sea and therefore to act in accordance with the first rule of good seamanship described in the 'Sicherheit auf dem Wasser' pamphlet.

[181] More information on the topic is available in Wikipedia, for example, with the keywords 'Ship stability' and 'Capsizing'.

However, he had no or insufficient knowledge about

- the specifics of gats in general and of the 'Accumer Ee' tidal inlet, in particular;
- the various manifestations of the sea state (wind sea, swell, groundswell, surf, relationship between wave length and [significant] wave height, etc.), and
- the resulting conclusions for safe trip/route planning.

Studying nautical publications may have made him aware of the hazardous situation.

In the opinion of the investigators, SBF-See examination questions on seamanship in the Wadden Sea would have made the skipper sufficiently aware of the need to pay greater attention to the topic. Internet search engines would have helped him find what he was looking for.

4.5 SBF-See examination requirements

Pursuant to Section 8 of the German Pleasure Yachting Navigating Licences Ordinance (SpFV), holders of an SBF-See have demonstrated by means of a theoretical and practical examination that they have the competence needed to navigate a recreational craft on navigable maritime waterways. The Wadden Sea, the sea area around the scene of the accident, falls within the scope of navigable maritime waterways and stretches along the entire German North Sea coast.

The theoretical part of the examination is intended to demonstrate the necessary nautical knowledge required to safely navigate a recreational craft.

With the exception of the most rudimentary knowledge of the theory of tides (e.g. Question 249: *What is meant by high tide?*), according to the Ordinance the theoretical and practical knowledge needed for safely navigating a recreational craft in the Wadden Sea or approaching ports with offshore bars are not tested.

In accordance with the Ordinance, the navigation exercises do not include a test of any knowledge that would be relevant for navigating the Wadden Sea, either. Although the navigation exercises involve candidates moving directly seaward of the tidal inlets, the test does not involve the manner in which skippers should safely navigate tidal inlets seawards or landwards. Moreover, the navigation exercises do not involve the need for candidates to take into account any information from a nautical publication. Only knowledge of true bearings, description of marks, such as the Accumer Ee buoy, etc. is tested at present. The examination questions mainly cover issues of traffic legislation.

Acquisition of the SBF-See gave the SILJA's skipper a false impression of his acquired competence. Holders of an SBF-See are not automatically qualified to safely navigate recreational boats in the Wadden Sea based on the relevant examination questions. The acquisition of an SBF-See alone does not provide a basis for expecting good seamanship in the Wadden Sea. Further marine casualties, possibly fatal, due to ignorance cannot be ruled out without a modification of this testing practice.

All the questions asked for the acquisition of the SBF-See were evaluated within the framework of this investigation. It became apparent that the specific questions should be revised, taking into account maritime safety investigations already published, this investigation and due to technical developments. In particular, these include:

- Question 274: The answer should take into account the fact that when visibility is reduced, but not only then, appropriate radar reflectors should be used – see Investigation Report 56/09 (Collision between Motor Vessel CHRISTA and Pleasure Craft ODIN), for example.

- Question 275: Lifejackets should not be made ready or donned only before the onset of heavy weather (strong winds, storms) but rather should be worn at all times.

- The 'Sicherheit auf dem Wasser' pamphlet is mentioned in Questions 153 and 231 in the wrong answer options. Otherwise, it is not mentioned. This may lead to incorrect conclusions among students, especially if the material is derived in self-study on the basis of the questions.

- Question 231 refers to official nautical publications and is an example of all the questions. The Q&As repeatedly refer to official publications and technical equipment of commercial shipping, etc., which are not relevant for recreational craft.

- In the opinion of the BSU, too much weight has been placed on the traffic legislation part of the examination. Instead, the questions should concentrate more on aspects of seamanship (trip/route planning, boat handling, safety equipment for boats).

4.6 Seamanship on the SILJA

4.6.1 Safety briefing

The skipper had prepared and conducted a safety briefing based on his knowledge from the acquisition of the SBF-See and his accumulated experience, specific to the boat, equipment and crew.

Taking into account the course of events leading up to and during the accident, the equipment of the lifejackets, in this case the oral valve, whistle and lifejacket light, should have been addressed, shown and – ideally – tried out as far as possible during the briefing.

The briefing conducted by the skipper largely corresponded to recommendations published by the BMDV and the DGzRS. In view of the BSU, the advice of the BMDV and the DGzRS is comprehensive insofar as these recommendations are viewed as a package and the sailing boat checklist published by the DGzRS is only considered in the context of the DGzRS's general recommendations (see Annex 2).

The topic of lifejackets should be dealt with at length during every safety briefing and depending on the level of knowledge go beyond simply putting them on. All lifejacket users should know the equipment of their lifejackets so as to facilitate recalling it in an emergency.

4.6.2 Trip/route planning

The skipper had planned the trip and routes without knowledge of the sailing recommendations for tidal inlets in general – the Accumer Ee, in particular – and knowledge of the sea state. He did not obtain information from nautical publications.

Accordingly, he planned the passage of the bar of Accumer Ee

- with the current going out;
- about an hour before low tide, and
- northerly winds of 6 and 7 Bft in gusts.

Moreover, he did not intend to sail for the approach buoy, thus allowing a sufficient sea area for the Westerriff and the bar.

The criteria of 'wind against current' and 'more than two hours after high tide' alone should have led to this planning being rejected due to lack of suitability had appropriate knowledge existed. The route should have been re-planned and – in the absence of an alternative – re-assessed.

This sea area should not be navigated without sound route planning.

The skipper had relied on his knowledge and skills demonstrated by the examination for the SBF-See, as well as experience already acquired and believed he was planning and acting in accordance with the rules of good seamanship.

4.6.3 NV Charts navigational chart/NV Charts App used

The skipper had planned the route on the paper navigational chart and used the NV Charts App as an aid to navigation in accordance with the notice users must accept after launching the app.

Figure 59: Reference to paper navigational chart when opening NV Charts App[182]

The NV Charts App provided the skipper with a digital navigational chart in addition to the paper navigational chart.

The navigational charts were updated and the skipper knew the app's key functions. He had not transferred his route planned on the paper navigational chart to the app and did not look at all POIs on the route in the app while he was planning.

According to the statements of the skipper, he took note of some of the POIs off the port entrances while he was planning. It is possible that he read the navigation advice for the port of Langeoog but did not attach any importance to this entry. It essentially states that the bar is reportedly extremely dangerous in strong winds (see Figure 43).

According to the skipper's statement, he did not read the POI entered directly at Accumer Ee, which clearly stated: *Even with a fresh onshore wind and especially when the tide is going out, there is often surf here that makes passage impossible (current against wind)*, see Figure 42.

[182] Source: Screenshot BSU.

There was no comparable advice on the paper navigational chart. There would also have been no such advice on the official paper navigational chart of the BSH, either. To maintain clarity, chart manufacturers print as little supplementary chart information as possible on a navigational chart.

More information can and is stored in digital navigational charts, as this only becomes visible when an icon is clicked. To maintain clarity, this information only appears in the NV Charts App from a scale of less than 1:100.000.

In both worlds, the analogue and the digital, displaying additional information as a POI is only technically possible if a specific position can be assigned to this information. This is not always the case, e.g. for general information from the sailing directions.

On the day of the accident in particular, the skipper was dependent on the app and the positioning information from his smartphone for navigation, as from his point of view he could not assign steering the boat to any of the crew members due to the waves and no other person on board was qualified to take charge of navigation on the paper navigational chart, e.g. by means of terrestrial navigation.

This increased his smartphone's power consumption, as the GPS sensor was switched on – as usual also in the background – to determine the position and the screen had to be switched on regularly to check the position.

Two other smartphones were available on board for redundancy. The NV Charts App with the relevant navigational charts was installed on one of these two smartphones. The two spare smartphones were not used for navigation while underway.

4.6.4 Boat handling

From the BSU's point of view, it always promotes safety if a boat crew consists of several people and the skipper responsible can draw on and use effectively the knowledge and skills of the crew members when planning and carrying out a sailing trip. Tasks that arise should be delegated as far as possible, always taking into account individual knowledge and skills, and completion should be overseen by the skipper in the spirit of the principle of dual control. Possible errors can thus be avoided in a timely manner and accidents are more likely to be prevented. In the case at hand, the skipper was only able to delegate tasks to a limited extent. Accordingly, he was forced to steer and navigate the boat himself for many hours, for example, even though one person cannot perform these two tasks simultaneously at all times with the necessary attention without suitable technical aids.

The skipper's smartphone was used as a central navigation and distress call system. Due to the limited battery capacities in particular, redundancy – and from the BSU's point of view not only smartphones – should always be maintained. If there are at least several smartphones available, they should be used specifically for different tasks, e.g. for navigation or for distress calls. Therefore, the power supply for all devices should be addressed before departure and at least the batteries of all devices should be charged as fully as possible. All smartphones intended for use on board as a nautical instrument should be protected from water.

There is evidence to suggest that the position information on mobile devices, including handheld GPS devices, is less reliable than that of fixed GPS devices with an external antenna because of the receiving performance of the built-in GPS sensors or the operating system settings.[183] Moreover, the GPS receiving performance of mobile devices can be impaired, e.g. when used below deck, under a sprayhood or in a (waterproof) cover. Connecting external GPS antennas to mobile devices is normally possible but uncommon in practice, as additional costs are incurred and GPS receivers are already built into the devices. Externally connected GPS antennas usually make systems more complex and susceptible to error functions. Plotter systems are an electronic aid to navigation and permanently installed on many boats (yachts). With regard to safety standards, plotter systems do not have comparable possibilities with those of ECDIS in commercial shipping, however. This is not only due to the often non-redundant power systems available, but also the non-standardised and non-tested hardware, software, battery performance, sensors and installation methods.

In accordance with applicable law, navigation should be performed primarily on a paper navigational chart on vessels with limited electronic navigation options. If necessary, crew members must be assigned relevant roles and instructed adequately beforehand.

Ideally, seagoing vessels should – according to the OSR safety standards – generally be equipped with a waterproof handheld marine VHF transceiver. Ship-to-ship communication, e.g. for tug assistance, will generally only be possible via marine radios. In addition, other marine radio stations can become aware of the communication via marine radio and take action in an emergency.

The skipper's decision to wear lifejackets saved two out of three lives.

[183];https://nvcharts.com/blog/gps-empfang-mit-mobilen-endgeraeten-wie-handy-oder-tablet; https://developer.apple.com/forums/thread/93746; https://developer.apple.com/forums/thread/93746; https://developer.apple.com/forums/thread/93746; https://www.samsung.com/uk/support/mobile-devices/the-gps-location-on-my-smartphone-is-inaccurate-how-do-i-fix-it; https://medium.com/@importanttech/we-tested-mobile-gps-gnss-accuracy-and-found-some-surprising-results-b9ec35873e2e; https://www.suunto.com/de-de/Support/faq-articles/suunto-3/was-beeinflusst-die-geschwindigkeits--und-distanzmessung-mit-verbundenem-gps-unter-android; https://support.strava.com/hc/en-us/articles/216918967-Troubleshooting-GPS-Issues (2022-09-01).

In the case at hand, it may have been helpful for the sailors not to have been secured against falling overboard with a lifeline. This largely enabled the sailors to move away from the boat after she capsized.

In the BSU's view, the decisions made by the skipper shortly before the boat capsized to sail through the tidal inlet only with the single reefed main and to position his crew members in the forward area of the cockpit had an additional effect on the boat capsizing. The removal of the headsail shifted the sail's centre of effort aft. Depending on their design, sailing boats thus become more or less affected by weather helm and are prone to broaching in the waves approaching from aft, as countersteering is often not sufficiently effective. On smaller and lighter boats like the SILJA, weather helm can often be affected by simple weight displacement. If weight is shifted forward, e.g. by moving the crew, the centre of lateral resistance also shifts forward and the weather helm increases again.

The use of an engine may have made it possible to counteract this weather helm with an improved steering effect.

However, the BSU takes the view that neither the position of the sails, the centreboard, the weight displacement, the lack of using the engine, nor the size of the boat played a major role in the boat capsizing.

4.7 Wind, sea state and current

Based on the DWD report, the sailing conditions on the day of the accident were more than borderline for a boat such as the SILJA outside sheltered waters from the investigators' point of view, even without taking into account the specifics of a tidal inlet. The wind was blowing from the north at 5 Bft with gusts of up to 7 Bft and from 1800 at 6 Bft with gusts of up to 8 Bft. It was almost cloudless, with harmless clouds appearing later on.

Apart from the gusts, the DWD's wind forecast was largely correct. The DWD had predicted northerly winds of around 6 Bft for the North Sea in the five-day medium-range forecast. For the East Frisian coast sea area, the forecast was 6 Bft, temporarily decreasing, on the evening before the accident, and around 5 Bft, slightly increasing, on Wednesday night/Thursday morning.

According to his recollections, the forecast on the Windfinder app used by the skipper had also predicted northerly winds of 6 Bft and gusts of 7 Bft. The forecast was consistent with the official forecast, although this was only based on the global weather forecast model of the American weather service. This consistency will be due to the largely stable weather conditions and, according to the provider's information, should not be regarded as the rule.

In any case, the wind conditions did not surprise the skipper because they corresponded to the weather forecast available to him. Based on his training and sailing experience, he had set wind of 30 kts as a personal limit for the safety of the boat and crew.

The skipper was equally unsurprised by the ebb counter current, which he had calculated to be about 1.5 kts according to the navigational chart. According to the two model calculations of the BSH, the ebb current at the capsize site was either 1.7 or 2.7 kts and thus possibly marginally stronger than the skipper had assumed.

However, the skipper had no knowledge of the specifics of the sea state, which in this case was primarily created by the wind blowing at the site (wind sea) and encountered a rapidly decreasing water depth, as can occur at all tidal inlets, some estuaries and some port entrances.

According to the DWD's model calculation, a significant wave height of up to 2.5 m may have occurred at the scene of the accident at the time the boat capsized. Due to the bar at the scene of the accident, this height indication is theoretical proof that groundswell and possibly breaking waves must have occurred in accordance with the above statements, as wave theory dictates that individual waves are expected to be significantly higher.

Groundswell and possibly breaking waves can also occur in all the aforementioned areas even with considerably less wind if swell is also present in these sea areas and these waves run into the shallow water zone. Counter (tidal) currents intensify this effect.

4.8 Lifejackets

4.8.1 Lifejackets on the SILJA

Performance level 150 N lifejackets (offshore, weatherproof clothing) procured by the skipper and worn by all crew members were suitable for the sea area and season (summer).

Two lifejackets were equipped with a spray hood and light – beyond the usual standard for recreational craft. These were included at no extra charge when the skipper made the purchase because the lifejackets were produced in previous years and the first service periods thus shortened accordingly.

It is unlikely that anyone would have survived this marine casualty without a suitable lifejacket.

The crew of the German Navy helicopter became aware of the female sailor due to the flashing of the lifejacket's light. It is questionable whether the two rescued sailors would have been spotted without this light, even though the SAR helicopter was fitted out with a night vision device, thermal imaging camera and manned by five crew members.

4.8.2 Servicing and use

The protective covers on the lifejackets had not been opened for either visual inspection or performance testing until activation on the day of the accident. The BSU assumes that the lifejackets were basically in the same condition as when the skipper had received them from the retailer.

All three lifejackets had triggered as intended.

Failure to comply with the manufacturer's recommended service schedule did not have an adverse effect. For one thing, all three lifejackets had only reached about half their service life. Two were five years old (+/- ½ year) and one was 3½ years old). For another, the lifejackets had only been in use for a few weeks. As far as the BSU could inspect the lifejacket components, their age and earlier use had no effect on the damage to the lifejackets, which presumably only occurred later on in the course of the accident.

The rescued female sailor in particular was not familiar with her lifejacket and only discovered the whistle and light after being in the water for some time. She was not familiar with the oral valve, either.

In accordance with the recommendations of the DGUV, the manufacturer and the DGzRS, the BSU is of the opinion that more than compliance with the service schedule and a briefing on how to put on lifejackets is necessary for the safe use of lifejackets (see Chapter 5.8).

4.8.3 Damage

In retrospect, the rescued sailors had noticed the defective buoyancy chamber connections of the protective covers at different times.

According to the account of the female sailor, the lower part of the buoyancy chambers came loose shortly after the boat capsized when she was pushed under water by breaking waves and came into contact with the lines and boat. The forces she might have been exposed to in this situation are not known. She recalls that the connections of her lifejacket were no longer as they should have been when she swam back to the capsized boat and was able to hold on to the ladder.

According to the recollections of the skipper, he only noticed the damage after he and the boat were spun through the water by a breaking wave.

In the BSU's view, the skipper's account may provide a plausible explanation as to why the textile surfaces of the buoyancy chambers may have torn in the area of the thimbles.

The manufacturer's explanation that the damage found would be caused if there was excessive pulling at the head end of the buoyancy chamber seemed implausible to the investigators, since the people had not been exposed to any other forces than the waves.

Based on the investigation, it should be noted that the eyelets tore out even though the lifejackets were used as intended. Neither the BSU, the manufacturer nor the Yacht magazine's editorial staff have information about comparable damage patterns. It seems to be an extremely rare occurrence, just as people who have fallen overboard very rarely find themselves floating in the water with a lifejacket and clinging to a boat in a surf zone by necessity.

It is possible that lifejackets from other manufacturers with alternative methods of attaching the buoyancy chamber to the protective cover may also suffer similar damage in comparable situations.

4.9 Lifesaving appliances

The SILJA marine casualty has shown that rescue operations can extend into the darkness at any time. Accordingly, lifesaving appliances suitable for use at night should always be kept available.

It should also be borne in mind that there will not always be enough time to use pyrotechnic signals – if available – in an emergency. Other signalling devices, such as lifejacket lights, can be used effectively and without prior knowledge. Of course, the latter is subject to lifejackets being worn and equipped accordingly.

The crew of the SILJA discovered the limits of a smartphone when used as a lifesaving appliance. Due to the multitude of ways in which a smartphone can be used, the battery charge will always be in short supply. Very few devices will meet the requirements of a distress situation at sea. Smartphones are often neither shockproof nor waterproof. Light conditions may cause additional problems if a display can only be read to a limited extent due to sunlight. Moreover, mobile phone networks of sufficient quality will not always be available, even in coastal areas.

There is a wide variety of lifesaving appliances that have different uses.

In the opinion of the BSU, the SAR helicopter crew has defined the lifesaving appliances that should basically be kept available on all trips at sea.

The DGzRS's recommendations provide a lot of advice when making a concrete decision regarding the required lifesaving appliances according to need, in particular taking into account the area and time of operation (summer/winter).

The OSR safety standards state that all boats covered by these regulations should be equipped with pyrotechnics and flares. This also applies to Category 4 boats racing close to the shore in relatively warm or sheltered waters and normally during the day.

4.10 Distress call/emergency number

In this extreme emergency, the skipper dialled the emergency number 110 and none of the MRCC Bremen numbers known to him and stored. The protective cover had proved to be a hindrance because the touch screen could not be operated. It is not known whether dialling the AML-compatible number 110 switched on his smartphone's WLAN, whether the device searched for a net, whether an AML record was possibly transmitted, and whether this could have additionally increased the power consumption.

Since no AML data are stored on the central server of the emergency call centres when the emergency number 110 is dialled, the KRLO was unable to use AML data.

Only on the basis of the provider data transmitted could the KRLO:

- locate the distress message on a position line in the direction of the sea;
- after listening repeatedly, interpret the vocal and other sounds recorded during the distress calls as a possible maritime emergency, and
- involve MRCC Bremen as soon as possible.

If the skipper had dialled one of the MRCC's numbers, MRCC Bremen would not have received any location information. From the perspective of the investigators, the skipper's two distress calls did not allow any conclusions to be drawn about the potential scene of the accident due to the voice/reception quality. MRCC Bremen received the first more specific information about a marine casualty between Langeoog and Juist only at 1918 – about another 30 minutes after the KRLO had called the MRCC – when it received the phone call from the WhatsApp recipient.

Ideally, in addition to the emergency call centres, the MRCC should always receive the information required from providers under Section 164 TKG (phone number of the caller and data for positioning) in order to initiate the other rescue measures necessary as quickly and as purposefully as possible.

However, MRCC Bremen's phone numbers (+49 421 536870 and 124124) are not emergency numbers under the TKG, meaning providers do not transmit corresponding information. The MRCC's phone numbers are not AML-compatible, either, although information from MRCC Bremen indicates that in recent years only about 50% of the slightly more than 2,000 distress messages received annually were sent via the GMDSS[184] and all other callers predominantly used a mobile phone. These might have benefited from a maritime emergency number with which data under the TKG and AML data could be transmitted. This information would also often be useful in cases where third parties see an emergency and report it via a mobile phone.

[184] GMDSS: Global Maritime Distress and Safety System.

From the perspective of MRCC Bremen, a dedicated maritime emergency number would have several advantages. In particular, these include:

- calls would be recognised as a distress call;

- operations could be automatically reopened in command and control systems;

- phone numbers and possibly incoming location information could be recorded and used in the command and control systems;

- incoming phone calls could be prioritised in the event of major situations and a heavier workload: trunk lines for routine operations could be switched off temporarily; distress calls made by phone could still be received; number ranges for other control centres (e.g. ARCC Glücksburg, KRLO) and the German Central Command for Maritime Emergencies would be set up depending on the situation;

- statistical evaluations of the number of incoming distress calls made by phone would be easily possible.

To the BSU's knowledge, the Federal Ministry for Digital and Transport (BMDV), the Federal Network Agency and the MRCC have already considered the issue of an MRCC emergency number in the past and encountered several aspects that need to be clarified. Essentially, the new emergency number would have to meet European legal requirements, as there is only one uniform European emergency number in Europe: 112. The second emergency number used in Germany, 110, only exists because of the historical police emergency call regulations. Other central 'emergency numbers' introduced in Germany, such as 115 (public authority hotline), 116 117 (SHI) emergency medical service, etc., are not emergency numbers in the above context.

The MRCC advises that a separate emergency number is urgently needed. It would not be expedient if distress calls made outside the GMDSS from vessels in maritime and coastal areas were received by an emergency call control centre and these messages had to be relayed to the MRCC. In the German coastal area, the MRCC currently cooperates with 17 municipal control centres. To the MRCC's knowledge, each control centre has its own standards. The local command and control systems are very different and have no interfaces. Experience gained over the past few years reportedly shows that initial reports to an emergency control centre have complicated handling in many cases. The MRCC attributes this to the following, in particular:

- the staff of emergency call centres often did not have the knowledge and experience in maritime emergency processes and maritime operating resources needed to make SAR-related enquiries, for example;

- there are regularly communication losses, as transfers are only possible by phone due to the lack of digital networking and interfaces. Moreover, necessary call-backs did not function properly;

- the operations would have to be documented by all bodies involved.

4.11 Similar accidents

The examples of similar accidents shown in the investigation section do not give any indication that accidents of this kind can be avoided by making changes to a boat's design or equipment. From the perspective of the BSU, the focus must be directed at the knowledge and skills of the crew.

5 CONCLUSIONS

In particular, the SILJA capsized due to the sea state around the bar of the Accumer Ee tidal inlet.

Due to

- the rapidly decreasing water depth in the area of the bar (to about 2.00 m);
- the onshore wind (north, 5–6 Bft with gusts of up to 7–8 Bft) and resulting wind sea coming from the sea with significant wave heights of up to 2.5 m;
- the tide-dependent water level (three hours after high tide; about 2.00 m), and
- the outgoing tidal current running against the wind sea (current velocity of 1.7–2 kts),

short steep waves formed with an extremely high probability of groundswell and possibly breakers.

As a result of the SILJA capsizing, she foundered and one of the three sailors lost his life.

The skipper was not aware of the recommendations in the sailing directions and other nautical publications for safe passage of the tidal inlets, in general, and the Accumer Ee, in particular. Similarly, he had not noted the Accumer Ee POI in the NV Charts App.

He had relied on his competence as a holder of the SBF-See and his experience. He had not used any sailing directions or other nautical publications for the trip/route planning. In the absence of any apparent need for him to do so beforehand, he had not researched tidal inlets on the internet, either.

In the following, the findings of the investigation thus far will be considered in greater detail so as to draw up safety recommendations and lessons learned.

5.1 Possible cause of death

The deceased sailor may have cooled down more quickly due to a lack of suitable water sports clothing and may therefore have had reduced chances of survival.

All water sports enthusiasts should always carry windproof and waterproof clothing and wear such clothing if necessary to avoid getting cold and weakening the body unnecessarily.[185]

[185] https://schleswiger-kanuclub.de/index.php/unterkuehlung.html (2022-05-20).

Wearing appropriate clothing increases the chances of survival in an emergency.

5.2 Sailing directions/nautical publications/NV Charts App

At present, it is extremely difficult for water sports enthusiasts to find reliable information about navigating tidal inlets. Accordingly, the BSU believes that all relevant navigational recommendations for tidal inlets should be published centrally in the sailing directions so that other nautical publications that are usually more detailed, such as cruising guides, can refer to them.

In the interest of safety, this information should be published at short notice and free of charge on the internet.

Furthermore, the BSU believes there is a need for appropriate notices in the paper navigational charts to draw the attention of their users to potential hazards when passing through tidal inlets.

As is already the case with the NV Charts App, the necessary information should be available in digital navigational charts as a POI, for example. Care must be taken here to ensure that

- the information is placed at appropriate points;

- in the case of ambiguous statements, the most unfavourable situation is published, and

- the digital charts contain only high-quality and not too many POIs.

5.3 Boat and equipment

The rules and regulations for the equipment of recreational craft should be summarised as clearly as possible at a central source. In the view of the BSU, Annex 1a to Section 6 SchSV would be suitable for this.

This central source should contain the clearly defined requirements with cross-references to relevant legal rules. With regard to the latest official sailing directions to be carried, the regulatory body or a body designated by it should clearly define what is meant by the latest non-official sailing directions (Section 13(1)(2a) SchSV), for example. The BSU is of the opinion that this should always be the most recently published edition of non-official sailing directions, as long as a publisher distributes this publication. Otherwise, a different publication should be carried and used.

In areas with groundswell or breakers, all seagoing vessels are at risk of capsizing and subsequently foundering. As a general rule, only rescue craft intended to operate in sea areas with groundswell and breakers are designed and equipped to remain as seaworthy as possible after capsizing. All other vessels should always avoid such areas where groundswell and breakers are to be expected from time to time due to current natural conditions.

5.4 Boat crew

The skipper relied on his own competence. However, the multiple tasks of a skipper should be distributed across several shoulders, with the skipper ultimately retaining responsibility.

It would be helpful if at least one other crew member had the competence needed to relieve and proactively support the actions of the skipper. If necessary, this person should be able to assume command.

5.5 SBF-See examination requirements

From the point of view of the BSU, the specific Q&As for maritime shipping should be revised in accordance with the comments in the analysis section (see Chapter 4.5) and the following knowledge should become relevant for the examination (topics according to the SpFV):

- natural conditions (tideway/tidal inlets, including possible bars off ports and estuaries);

- sea state, especially wind sea, swell, factors for the (significant) wave height (wind force, duration of effect, fetch), consequences of water depth and current, and

- conclusions that affect the trip/route planning.

As before, the answers should be kept as general as possible. Answer options should contain further references where applicable, so that SBF-See candidates are referred to further publications beyond the memorisation of the examination questions and then possibly research the subject matter.

The BSU is aware that the Wadden Sea is less frequented by water sports enthusiasts than the Baltic Sea, for example. However, there are other sea areas and especially port entrances on the German coast outside the Wadden Sea where the risk of groundswell and breakers must also be expected under certain conditions. Accordingly, future skippers should be made aware of this set of issues via the examination, so that they can then research the topic if necessary.

Moreover, the examination should take due account of the necessary consideration of nautical publications for any trip/route planning. The BSU believes that the navigation exercises are appropriate for this, as information from nautical publications should be relevant when working on them.

5.6 Seamanship on the SILJA

5.6.1 Safety briefing

The currently published recommendations of the BMDV and the DGzRS should be developed further by the publishers.

The recommendations of the publisher and additions by the BSU that the latter believes – subject to a boat's equipment and the experience of the people on board – should be taken into account in a briefing on board are colour highlighted in Annex 2.

5.6.2 Trip/route planning

Sailing trips and routes can only be planned with sufficient knowledge.

This knowledge is vital in the Wadden Seas and for tidal inlet passages, in particular.

The necessary information cannot be obtained only on the basis of the latest navigational charts. The information provided by relevant up-to-date sailing directions or other nautical publications in conjunction with relevant weather reports is always required, too.

Official licences, such as the SBF-Sea, confirm the competence to operate recreational craft in these waters. Holders of the SBF-See should be able to rely on the fact that in acquiring the essential basic knowledge they have demonstrated the ability to plan and carry out trips in the Wadden Sea.

5.6.3 NV Charts navigational chart/NV Charts App used

The NV Charts App provided the skipper with a digital navigational chart that could be used to access navigational information on the Accumer Ee usually contained in nautical publications (sailing directions/cruising guides) via the POI function.

The statements that could be accessed via the NV Charts App were stored at two different locations: the tidal inlet and the port of Langeoog. The statements were different.

Publishers of such applications should ensure that the information stored is reliable and that the most unfavourable situation is taken into account.

When planning a route, users of such applications should take advantage of all the tools offered by digital charts, accessing any POIs on the route during preparation and checking their statements for relevance.

5.6.4 Boat handling

In accordance with Dr Neumann's[186] recommendation, every effort must be made to avoid areas at certain times when groundswell and breakers are likely to be encountered there. This applies to all vessels.

Notwithstanding this, courses downwind and with a stern sea should always be sailed under headsail(s) if possible. On one hand, the risk of accidental gybes can thus be mitigated if it is not possible to deploy a gybe preventer[187] for certain reasons. On the other hand, boats usually have better directional stability. The engine should also be used in certain cases.

If possible, skippers should conduct their trips such that they can carry out all necessary sailing manoeuvres at any time. This may require an appropriate crew composition or suitable sailing practice before undertaking a cruising trip.

Skippers should involve crew members in the work on board and delegate tasks, taking into account their knowledge and skills. Boat handling is not about one person doing everything alone but rather about keeping track of everything and leading.

From the point of view of the investigators, skippers should ask for support from the people sailing with them when working on charts if possible, so that the principle of dual control is practiced and as a result POIs in digital charts are not overlooked, for example. This applies all the more when such applications are used via smartphones with small displays.

Digital charts used via a smartphone, tablet or permanently installed plotter offer additional options such as POIs. However, as happened here in the case of the SILJA, these tools should only play a supporting role in planning and navigation on recreational craft, supplementing the paper navigational chart. Due to the non-standardised and non-tested hardware, software, battery performance, sensors, GPS receiving performance and installation methods, as well as the usually non-redundant power supply, digital navigation on board recreational craft is rarely comparable to that of commercial shipping.

5.7 Wind, sea state and current

When using private weather and wind forecast services, attention should be paid to the weather forecast models used, as the forecasts – unlike in the case at hand – can vary depending on model calculation. Depending on provider, several different weather forecast models can be compared with each other.

[186] Dr Karlheinz Neumann, Seemannschaft in Wattengewässern. Mit 128 Zeichnungen und Tabellen. 1st edition, Bielefeld, Delius Klasing, 1981.
[187] The gybe preventer is a safety line which is generally attached to the rear section of the main boom and secured on the foredeck.

As an official provider, the DWD offers free marine weather forecasts that are already optimised for the respective sea areas. From the investigators' point of view, official forecast services, such as those provided in Germany by the DWD, have the advantage – for less familiar sea areas, in particular – that a comparison of different weather models is not necessary.

As has happened here in the case at hand, information on currents can generally be taken from navigational charts in conjunction with published tide tables or directly from a digital application.

To draw the correct conclusions from the information on the wind, sea state and current, information on the respective area must be obtained from a nautical publication.

5.8 Lifejackets

5.8.1 Equipment/servicing/use

As with the crew of the SILJA and in accordance with previous recommendations of the BSU, water sports enthusiasts should always wear a lifejacket that is suitable in the sense of the safety requirements for lifejackets according to the DIN EN ISO 12402 standard.

If possible, all lifejackets should be equipped with a light. As in the case of the SILJA, rescue operations can extend into darkness or take place at night for a variety of reasons. Lifejacket lights are robust lifesaving appliances that are also available as redundancy for other recommended and complementary lifesaving appliances, such as pyrotechnic signals and EPIRBs, in an emergency.

The service schedule of lifejackets and their maximum service life of ten, or under certain conditions 15 years should always be observed.

Similar to the SILJA's skipper, it is advisable to establish when the first service date is due when purchasing lifejackets so as to take into account increased costs due to the limited service life, in particular.

Servicing is not a substitute for a visual inspection before use, nor for annual performance testing.

In addition to receiving instruction on how to don a lifejacket correctly, all crew members should also be familiarised with its equipment during the safety briefing and be able to carry out visual inspections.

Before using a lifejacket, users should carry out a visual inspection for obvious defects and a quick check of operational readiness. As a result of the checks, people will become more familiar with using the lifejackets.

The operational readiness of lifejackets should be tested in dry conditions at least once a year. This should involve unpacking the lifejackets, inflating the buoyancy chambers and repacking the lifejackets.

Ideally, all users should have tested a lifejacket in the water at least once so as to be familiar with its operation and behaviour in the water. It is advisable to carry out such practical exercises shortly before a service.

Every owner of a lifejacket should follow the DGzRS's advice on maintaining lifejackets.

5.8.2 Buoyancy chamber/protective cover connection

The manufacturer, SECUMAR, should continue its investigation and run checks on the fastening system.

5.9 Lifesaving appliances

The recommendations of the DGzRS should be structured taking into account the advice of the SAR helicopter crew and disseminated via other sources of information, such as the 'Sicherheit auf dem Wasser' pamphlet.

The BSU believes it is advisable to always carry the following on seagoing recreational craft:

- pyrotechnic distress signals;
- a VHF radiotelephone, and
- waterproof distress transmitters, such as an EPIRB, PLBs and/or (for coastal areas) POB devices with AIS and DSC functions.

Pure AIS POB devices should not be used. Such equipment should be readily available in an emergency and, ideally, every crew member should be able to use it.

The DGzRS's current advice on using smartphones should be supplemented. In this regard, the BSU has the following points in mind:

- all smartphones on board should be water-protected as a matter of principle and used as an emergency device if the primary device fails (store MRCC/DGzRS phone number);

- devices primarily designed for navigation and emergencies should be used for that purpose. If there are good reasons for using smartphones, then every effort must be made to preserve the battery charge for as long as possible. Accordingly, a smartphone should generally only be earmarked for one application, i.e. either navigation or emergencies. Such devices should then not be used for other (personal) applications, such as photography.

5.10 Distress call/emergency number

On the one hand, it must be possible to make distress calls as easily and intuitively as possible, as anyone in distress is in a stressful situation that is unusual for them.

On the other hand, everything should be done to ensure that information on the location and a phone number of the person making the distress call are automatically relayed to a competent rescue station so that targeted rescue measures can be initiated without delay.

In the view of the BSU, GMDSS devices[188] for sending distress calls should therefore always be available and used on vessels at sea and in coastal areas.

Notwithstanding the foregoing, it is important to take into account the fact that some 50% of the distress messages reach MRCC Bremen by (predominantly mobile) phone.

From the perspective of the BSU, such callers must be advised to either use the SafeTrx app (see Chapter 3.2.10.2.3) or if in an EU Member State always request assistance via the emergency number 112 for as long as the MRCC is not assigned an emergency number within the meaning of the TKG. People making a distress call should have to think as little as possible about which emergency number is the right one in an emergency situation. It should be as easy as possible to make a distress call, e.g. without first setting up an app or unlocking a mobile phone. People making a distress call should be confident that emergency call centres will always involve all agencies necessary for initiating the rescue operation. With regard to the vital transmission of location information, the caller would have to settle for a delay in forwarding the call to a competent authority such as MRCC Bremen.

After making a distress call on 112, callers should – if possible – additionally inform MRCC Bremen by phone about the emergency situation and the distress call already made and use this phone connection in the sense of a radiotelephone operating channel to carry out the rescue. Water sports enthusiasts should therefore always save the MRCC's number as a favourite (iPhone) or shortcut (Android).

In certain cases, waterproof smartwatches may be useful for similar emergencies. If a smartwatch is used that can only make phone calls via a paired smartphone, e.g. carried in a dry suit, then the increased power requirements must be considered for both devices. Moreover, the smartphone will only be able to make a distress call if the device is not below the water surface.

[188] This includes such equipment as radios with DSC controllers, EPIRBs and POB devices that send an alert via DSC when activated.

5.11 General safety recommendations (lessons learned)

At the same time as the publication of this investigation report, the BSU published general safety recommendations (lessons learned) on www.bsu-bund.de[189]. These are directed at recreational boat skippers, in particular.

[189] See: Federal Bureau of Maritime Casualty Investigation – Lessons Learned (bsu-bund.de); specifically Lessons Learned 13.

6 ACTIONS TAKEN

The following safety recommendation was addressed to NV Chart Group GmbH in the draft investigation report:

The BSU recommends that NV Chart Group GmbH further develop the POIs that can be accessed via the NV Charts App. Ambiguities within the application – such as on the Accumer Ee tidal inlet – should be avoided and the most unfavourable situation conceivable always given. The statements should generally correspond to the publications in the BSH's sailing directions. Other sources of plausible and relevant information should be taken into account as before and the BSH should be advised of any adjustments as may be necessary.

In this respect, NV Chart Group GmbH stated in its comments to the draft investigation report that the relevant POIs in the NV Charts App had been revised and that the changes were available as an update to the basic data under Charts > My Charts. The following information was available after the POI update:

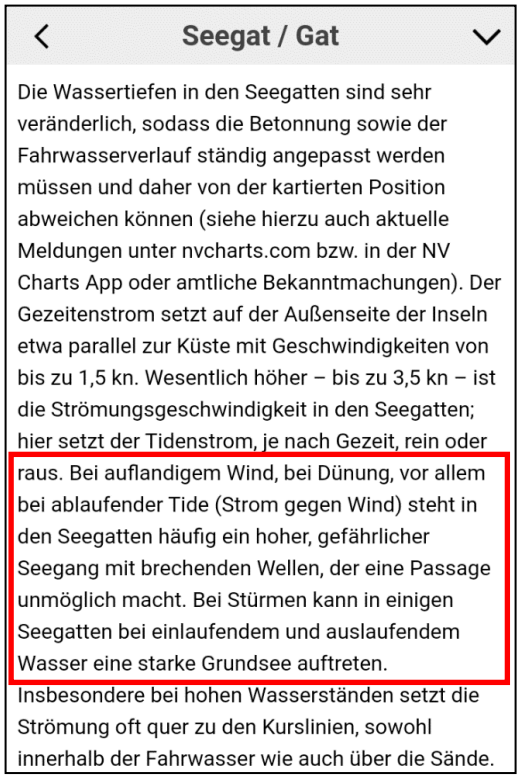


Figure 60: Accumer Ee navigation information[190]

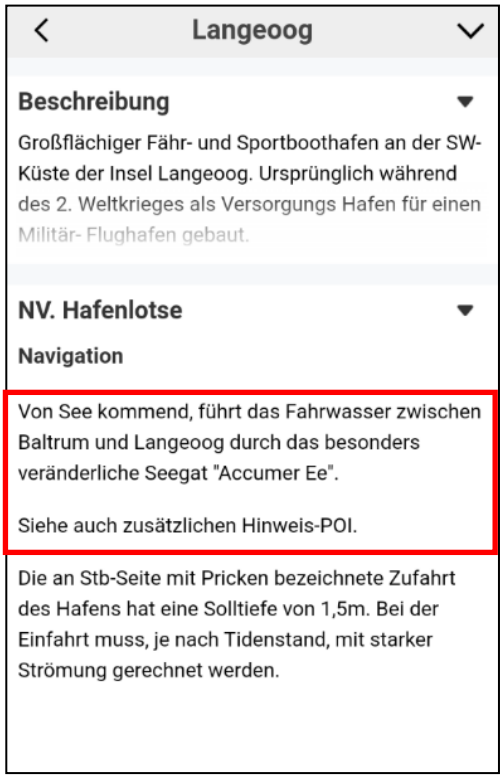


Figure 61: Information on the port of Langeoog[191]

The BSH was informed of these changes. The safety recommendation drawn up in the draft was subsequently deleted.

[190] Screenshot showing the POI at the Accumer Ee tidal inlet, last edited by NV Charts on 12 November 2022. The information shown in Figure 41 has been replaced.
[191] Screenshot showing information on the port of Langeoog, last edited by NV Charts on 12 November 2022. The information shown in Figure 42 has been replaced.

NV Chart Group GmbH also advised that the publisher would publish relevant information as extensively as possible in the printed 2023 edition, taking into account the space available, and has proposed to the BSH that they share information on this issue, in particular.

7 SAFETY RECOMMENDATIONS

The following safety recommendations do not constitute a presumption of blame or liability in respect of type, number or sequence.

7.1 Federal Ministry for Digital and Transport (BMDV)

The BSU makes the following recommendations to the BMDV:

7.1.1 SBF-See examination requirements

The specific Q&As for maritime shipping and the navigation exercises should be revised (see Chapter 5.5).

7.1.2 Legal framework for the equipment of recreational craft

The applicable rules and regulations for the equipment of recreational craft should be summarised in a central piece of legislation.[192]

7.2 BMDV and German Maritime Search and Rescue Service (DGzRS)

The BSU makes the following recommendations to the BMDV and the DGzRS:

7.2.1 Recommendations for the safety briefing

The BMDV and the DGzRS should liaise and develop the recommendations for the crew's safety briefing further (see Chapters 4.6.1 and 5.6.1).

7.2.2 Recommendations for the lifesaving appliances

The DGzRS should

- structure its publications on lifesaving appliances, taking into account the recommendations of the SAR helicopter crew (lifejackets/protection against the cold/pyrotechnic signals/communications), and

- supplement its advice on using smartphones (see Chapters 5.9 and 5.10).

The BMDV should refer to the advice of the DGzRS in the 'Sicherheit auf dem Wasser' pamphlet.

7.3 Federal Maritime and Hydrographic Agency (BSH)

The BSU makes the following recommendations to the BSH:

7.3.1 Digitisation of the sailing directions

In the interest of safety, the sailing directions should be published – similar to the weather forecasts of Germany's National Meteorological Service (DWD) – free of charge in digital form.

[192] See also Safety Recommendation 7.4 from the BSU's Investigation Report 15/09 – Capsize of the SY TAUBE.

7.3.2 Editorial adaptation of sailing directions

The BSU recommends that the BSH revise statements concerning tidal inlets in the sailing directions.

Readers should be clearly informed in the general section that merely the combination of onshore wind and outgoing current can cause surf in some tidal inlets and that stormy westerly or north-westerly winds (8 Bft) are not needed for this to happen. Reference to the consequences due to residual swell should not be omitted, either.

Moreover, all other general statements concerning the navigation recommendations for tidal inlets (see Chapter 4.2.1) should be included in the sailing directions so that they can be used as a basic source of information for other nautical publications.

7.4 BSH and NV Chart Group GmbH

The BSU recommends that the BSH and NV Chart Group GmbH make an appropriate reference to the hazards in tidal inlets in the paper navigational charts.

7.5 SECUMAR

The BSU recommends that SECUMAR continue the investigation of the textile surfaces on the buoyancy chambers in the area of the thimbles so as to take appropriate measures to eliminate the weak point that may exist.

8 SOURCES[193]

- Enquiries of the waterway police (WSP)
- Witness testimony
- Purchase receipts for the boat/boat equipment
- Mission logs and reports
  - KRLO
  - MRCC Bremen
  - Rescue cruisers HERMANN MARWEDE and EUGEN
  - Lifeboats ELLI HOFFMANN-RÖSER and SECRETARIUS
  - SEA KING MK41 multi-purpose helicopter of the German Navy
- Distress call audio files
- Expert opinions/test reports
  - Official weather report of Germany's National Meteorological Service (DWD)
  - Forensic report from the Department of Forensic Medicine at the Hamburg-Eppendorf University Clinic
  - SECUMAR test report dated 14 September 2021 on the verification of activated lifejackets for functional and operational readiness
  - SECUMAR test report dated 15 December 2021 on the pull-out behaviour of thimbles and determination of strengths
- Navigational charts
  - Federal Maritime and Hydrographic Agency (BSH)
  - NV Atlas Ostfriesland (Borkum bis Helgoland & EMS) DE13, NV Chart Group GmbH
- Technical papers
  - NV Chart Group GmbH, supplementing the user manual for the NV Charts App Version 2.687.120+ of 11 April 2022
  - DGUV e. V. Test (testing and certification). Section: Personal Protective Equipment
  - DGUV PSA (head of section responsible for PPE against drowning), c/o BG Verkehr
- Sailing directions/nautical publications
  - Nordsee-Handbuch, südöstlicher Teil (Lister Tief bis Ems), 6th edition, completed with NfS Issue 48 of 27 November 2020
  - Dr Karlheinz Neumann: Seemannschaft in Wattengewässern. Mit 128 Zeichnungen und Tabellen. 1st edition, Bielefeld: Delius Klasing, 1981
  - Dr Karlheinz Neumann: Die Nordseeküste. Teil II – Elbe bis IJseelmeer. Ein Führer für Sportschiffer. 5th edition, Bielefeld: Delius Klasing, 1983
  - Michael Steenbuck: Seemannschaft im Tidenrevier. 2nd edition, Hamburg: Palstek, 2016
  - Wilfried Krusekopf: Segeln in Gezeitengewässern. Theorie und Praxis der Tidennavigation. Bielefeld: Delius Klasing, 2017
  - Jan Werner: Nordseeküste 1; Cuxhaven bis Den Helder. 9th edition, Bielefeld: Delius Klasing, 2020

[193] See also the sources referred to throughout the report.

- Marianne van der Linden: Handboek varen op de Waddenzee. Gottmer Hollandia Watersportboeken, 2021
- https://www.wattenschipper.de/Seegatten.htm
- https://www.segeln-forum.de/thread/81245-hinweise-zum-sicheren-befahren-von-seegatten/?pageNo=1
- www.wattsegler.de

- Legislation
  - Ship Safety Act of 9 September 1998 (Federal Law Gazette I p. 2860), as amended by Article 1 of the Ordinance of 19 October 2021 (Federal Law Gazette I p. 4717)
  - Ordinance for the Safety of Seagoing Ships of 18 September 1998 (Federal Law Gazette I p. 3013, 3023), as amended by Article 2 of the Ordinance of 3 March 2020 (Federal Law Gazette I p. 412)
  - Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC. OJ L 354, 28.12.2013, p. 90 ff.
  - Ordinance pertaining to the Commissioning, Hiring Out and Commercial Use of Recreational Craft and Jet Skis in Coastal Waters (Ordinance on Seagoing Recreational Craft). Ordinance on Seagoing Recreational Craft of 29 August 2002 (Federal Law Gazette I p. 3457), as amended by Article 3 of the Ordinance of 3 March 2020 (Federal Law Gazette I p. 412)
  - German Pleasure Yachting Navigating Licences Ordinance (SpFV). German Pleasure Yachting Navigating Licences Ordinance of 3 May 2017 (Federal Law Gazette I p. 1016, 4043), as amended by Article 2(7) of the Ordinance of 26 November 2021 (Federal Law Gazette I p. 4982, 5204)
  - 1. SprengV: First Ordinance to the Explosives Act, as amended and promulgated on 31 January 1991 (Federal Law Gazette I p. 169), as amended by Article 1 of the Ordinance of 20 December 2021 (Federal Law Gazette I p. 5238)
  - German Traffic Regulations for Navigable Maritime Waterways, as amended and promulgated on 22 October 1998 (Federal Law Gazette I p. 3209; 1999 I p. 193), as amended by Article 2 Section 12 of the Ordinance of 21 September 2018 (Federal Law Gazette I p. 1398)
  - International Regulations for Preventing Collisions at Sea of 13 June 1977 (Federal Law Gazette I p. 816), as amended by Article 1 of the Ordinance of 7 December 2021 (Federal Law Gazette I p. 5188)
  - SeeArbG of 20 April 2013 (Federal Law Gazette I p. 868), as amended by Article 1 of the Act of 20 May 2021 (Federal Law Gazette I p. 1144)
  - SOLAS: International Convention for the Safety of Life at Sea, 1974.
  - Act on the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, of 25 March 1982. Federal Law Gazette, Part 1 No 14 of 1 April 1982

  - The Manila Amendments to the Seafarers' Training, Certification and Watchkeeping (STCW) Code. Annex Volume to the Federal Law Gazette Part II No 18 of 4 July 2013
  - Eighth Ordinance on Amendments to the Annex to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, of 28 June 2013. Federal Law Gazette 2013, Part II No 18, published in Bonn on 4 July 2013
  - Radio Regulations, as published by the ITU in 2020
  - German Telecommunications Act of 23 June 2021 (Federal Law Gazette I p. 1858), as amended by Article 9 of the Act of 20 July 2022 (Federal Law Gazette I p. 1166)
  - German Ordinance on Emergency Calls of 6 March 2009 (Federal Law Gazette I p. 481), as amended by Article 44 of the Act of 23 June 2021 (Federal Law Gazette I p. 1858)
- Comments/articles on legal standards
  - Professor Peter Ehlers, Kommentar SchSG, Nomos-BR, 4th edition, 2021.
  - Dr Kai Zähle: Die Regeln guter Seemannschaft. Neue Zeitschrift für Verkehrsrecht, NZV 2015, p. 476 ff.
- BSU investigation reports (www.bsu-bund.de)
  - SY MADAME PELE (Ref.: 240/04)
  - SY TAUBE (Ref.: 15/09)
  - SY MERI TUULI (Ref.: 86/13)
- Ruling of the Maritime Board on the Motorboat SIMONE: Decisions of the Higher Federal Maritime Board of Inquiry and the Maritime Boards of Inquiry (BOSeeAE), Issue 12/2000, p. 335 ff. Issued by the Federal Maritime and Hydrographic Agency. Compiled by the Higher Federal Maritime Board of Inquiry and the Maritime Boards of Inquiry
- Miscellaneous (pamphlets/magazine articles/internet)
  - Advanced Mobile Location – EENA (2022-09-28)
  - The 'Sicherheit auf dem Wasser' pamphlet. Federal Ministry of Transport and Digital Infrastructure. Information as of December 2020
  - Seemannschaft Wattenmeer. Unterwegs im Tidenrevier. Parts 1 and 2. Published in: Palstek 6/21 and 1/22
  - Müller, Kristina. Reise – Ostfriesische Inseln. Törn ins Wunderland. Published in: Yacht 20/2020
  - Schult, Joachim: Seglerlexikon. Bielefeld: Verlag Klasing Co. GmbH, 1977
  - Merkblatt des Fachverbandes Seenot-Rettungsmittel zur Lebensdauerbegrenzung und Wartung von Rettungswesten. Information as of September 2010
  - Sicher ohne Kiel? Published in: Yacht. Delius Klasing Verlag GmbH. Issue 24/2009. Page 28
  - https://schleswiger-kanuclub.de/index.php/unterkuehlung.html (2022-05-20)
  - First Aid for Frostbite and Hypothermia | Johanniter (2022-05-23)
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  - Federal Network Agency – Special Applications (2022-05-31)
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– German Maritime Lifesaving Appliances Association https://fsr.de.com/rettungswesten-3/#more-1762; last accessed on 31 March 2022
– German Motor Yachting Association: Basic Knowledge for Boat Owners (dmyv.de) (2022-05-09)
– Minimum and Safety Equipment › ADAC Skipper Portal (2022-05-09)
– https://www.dmyv.de/fuehrerschein-funk/rund-um-die-pruefung/wie-wird-bewertet/?L=%270%27A%3D0Die%27A%3D0 (2022-01-27)
– OSR safety standards – DSV Cruiser Section (2022-07-07)

9 ANNEXES

9.1 Sailing forum: Advice on the safe navigation of tidal inlets

9.2 Safety briefing: BMDV/DGzRS recommendations

9.3 SECUMAR test report of 14 September 2021

9.4 SECUMAR test report of 15 December 2021

9.5 SECUMAR 12/21 test report video on the parallel application of force

9.6 SECUMAR 12/21 test report video on the diagonal application of force