



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



Dutch Safety Board

Investigation Report 370/14

Very Serious Marine Casualty

**Foundering of the grab dredger ZANDER
and drowning of two seamen
on 24 November 2014
in the North Sea north of Norderney**

1 July 2016

The following is a **joint report** by the German Federal Bureau of Maritime Casualty Investigation, as lead investigating authority, and the marine casualty investigating authority of the Netherlands. These bodies have conducted this investigation jointly and in accordance with the IMO Casualty Investigation Code (Resolution MSC.255(84)). The working language used for this joint investigation was English. The German text shall prevail in the interpretation of this report.

The investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law – SUG) of 16 June 2002, amended most recently by Article 1 of 22 November 2011, BGBl. (Federal Law Gazette) I p. 2279. According to said Law, the sole objective of this investigation is to prevent future accidents and malfunctions. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG). This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Article 34(4) SUG.

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1 Summary

The inland waterway vessel ZANDER was on a transfer voyage from Copenhagen to Eemshaven with two crew members. On 24 November 2014, one crew member was caught by a wave and washed overboard. At this point, the ZANDER was about 5 nm north of Norderney. At 0754¹, the ZANDER sent a distress call on VHF channel 16, reporting "Man overboard" and water ingress.

The ZANDER foundered at 0812, which was just before the first ship that had rushed to assist arrived at the scene of the accident. A SAR helicopter later located the two crew members floating lifeless in the water. They were then recovered by a rescue cruiser's tender. Attempts at resuscitation were unsuccessful.

¹ All times shown in this report are local = Central European Time.

2 FACTUAL INFORMATION

2.1 Photo



Figure 1: Photo of the ship

2.2 Ship particulars

Name of ship:	ZANDER
Type of ship:	Inland waterway vessel (grab dredger)
Nationality/Flag:	Unknown
Port of registry:	Unknown
European vessel identification number:	05014570
Call sign:	PF4793
Year built:	1967
Shipyard/Yard number:	J. Braun KG, Speyer
Classification society:	Register Holland
Length overall:	26.93 m
Breadth overall:	7.92 m
Displacement:	221.1 t
Draught (max.):	1.30 m
Engine rating:	210 kW
Main engine:	Deutz BF6M 1015 M
(Service) Speed:	6 kts
Hull material:	Steel
Propulsion:	Two Schottel rudder propellers

2.3 Voyage particulars

Port of departure:	Copenhagen, Denmark
Port of call:	Eemshaven, the Netherlands
Type of voyage:	Other shipping International
Cargo information:	None
Manning:	2
Draught at time of accident:	Approx. 1 m
Pilot on board:	No
Canal helmsman:	No
Number of passengers:	None

2.4 Marine casualty or incident information

Type of marine casualty:	Very serious marine casualty
Date, time:	24/11/2014, 0807
Location:	North Sea, north of Norderney
Latitude/Longitude:	ϕ 53°47.9' N λ 007°12.4' E
Ship operation and voyage segment:	High seas
Human factors:	Yes, violation
Consequences (for people, ship, cargo, environment, other):	Two fatalities, foundering and total loss of the vessel

Excerpt from Nautical Chart 87, Federal Maritime and Hydrographic Agency (BSH)

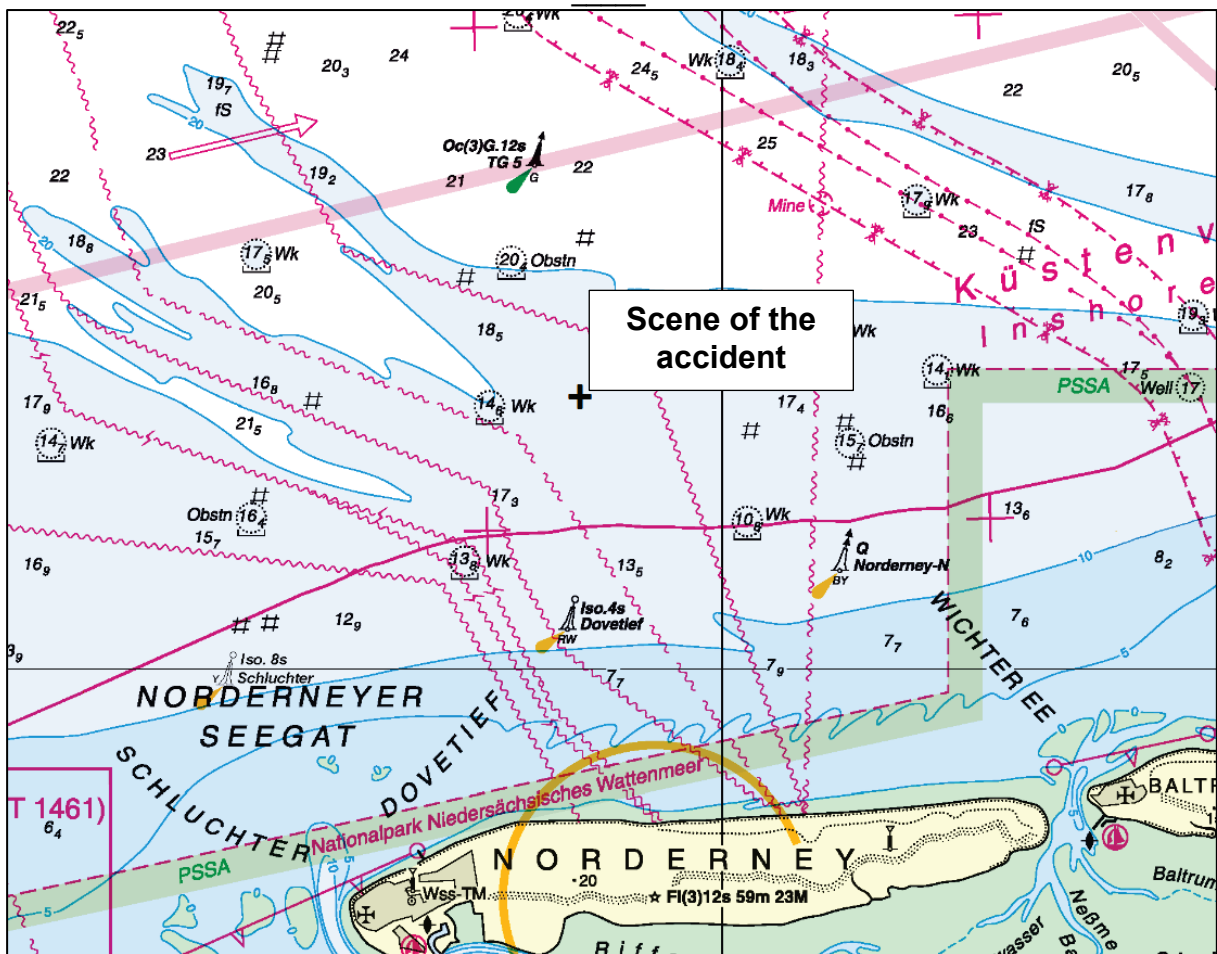


Figure 2: Nautical chart

2.5 Shore authority involvement and emergency response

Agencies involved:	MRCC Bremen, SAR Control Centre Glücksburg
Resources used:	Rescue cruiser BERNHARD GRUBEN, emergency tow vessel (ETV) NORDIC, three other ships, SEA KING SAR helicopter, SUPER PUMA helicopter
Actions taken:	Recovery of the crew
Results achieved:	Attempts at resuscitation were unsuccessful; two crew members deceased; vessel foundered, total loss

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

The inland waterway vessel ZANDER was to be transferred from Copenhagen in Denmark to Eemshaven in the Netherlands after her sale. Two Danish seamen were engaged for the transfer voyage. The ZANDER left Copenhagen in the early hours of 20 November 2014. At first, the vendor was on board to brief the two seamen. The ZANDER sailed into the Kiel Canal at Kiel on the morning of 22 November 2014. She halted the canal passage in the siding at Fischerhütte in the evening and continued on the following morning. The ZANDER left the lock at Brunsbüttel at 1239 on 23 November 2014 and headed for the sea. She proceeded to the end of the Elbe fairway and left the Elbe Approach traffic separation scheme at about 2000 in a south-westerly direction.

On the morning of 24 November 2014, the ZANDER was located in the inshore traffic zone between the island of Norderney and the Terschelling-German Bight traffic separation scheme. Her speed was reduced at about 0700 and she drifted with wind and current in a south-easterly direction. At 0754, one crew member was caught by a wave on deck and washed overboard. Following that, the ZANDER sent a distress call on VHF channel 16. She reported her position, as well as "Man overboard" and water ingress. The distress call was acknowledged by MRCC² Bremen³. The distressed vessel was advised that the Norderney station's rescue cruiser was en route to her. The ARY, which was operating as a guard vessel for wind farms, made contact immediately afterwards, advising that she was reportedly about 2.5 nm from the reported position and would arrive there in 10-15 minutes. Due to her low freeboard and equipment, which includes a rescue net, she is reportedly especially well-suited to rescuing a person in the water. Two other guard vessels, the MARSDIEP and SEAGULL, also made contact and headed for the ZANDER. ETV NORDIC, which is deployed in the German Bight, was anchored about 1.5 nm south-east of the scene of the accident. She started her engines and weighed anchor.

During her approach, the ARY noticed that the ZANDER was listing about 15-20° to port. Therefore, she called the ZANDER at 0805 and asked if the ZANDER herself required assistance. The ZANDER rejected assistance. The ARY then asked where the person in the water was and whether he was wearing a lifejacket. The ZANDER replied that the person was windward of her and not wearing a lifejacket. At 0810, the ARY noticed a white cloud of smoke on the ZANDER when she was two cables away from her. She then called the ZANDER one final time on VHF and advised her that she would founder and that the person should abandon ship with a lifebuoy or lifejacket. The ZANDER no longer responded and foundered by the stern within only a short period of time.

² Maritime Rescue Coordination Centre.

³ The MRCC is operated by the Deutsche Gesellschaft zur Rettung Schiffbrüchiger (German Maritime Search and Rescue Service).

The crew of the ARY did not see anybody abandon the ZANDER. When she reached the position at which the ZANDER foundered, she reduced her speed to avoid running over any survivors and turned several circles there. In addition to wreckage, a work jacket, a lifejacket, and a survival suit were floating in the water. Nobody was located. The rescue cruiser and the other two guard vessels arrived at the scene of the accident at about 0830. The SAR helicopter arrived at the scene of the accident at about 0835 and started the search. The helicopter located the first person at 0844 and the second at 0902. Due to the prevailing sea conditions, the helicopter crew was unable to recover the two individuals from the water using a rescue basket. They were then picked up by the rescue cruiser's tender. Attempts at resuscitation on the tender were unsuccessful.

3.2 Investigation

The Federal Bureau of Maritime Casualty Investigation was notified of the accident by Waterway Police (WSP) Wilhelmshaven at 1300 on the day it occurred and started the investigation immediately. The marine casualty investigation was carried out jointly by the marine casualty investigating authorities of the Netherlands (the presumed flag State of the ZANDER) and the coastal State of Germany.

3.2.1 History of the ship and sale

The Speyer-based Braun Werft built the ZANDER for the Federal Waterways and Shipping Administration in 1967; she was initially used for clearing and sounding upon entering service. The ship was later reclassified as a grab dredger. Since it was envisaged that the reclassification would also entail pushing a pontoon, the ZANDER was fitted with a more powerful engine in 2002. As the ZANDER was used in public service, most recently by Waterways and Shipping Authority Schweinfurt, she was not listed in the inland shipping register. The Zentralstelle Schiffsuntersuchungskommission (inspection body for inland waterway vessels - ZSUK) in Mainz issued a navigability licence for the ZANDER on 23 September 1998. After the most recent inspection was carried out on 23 October 2008, this licence was valid until the 30 September 2013. The ZANDER was licensed for use on inland waterways (the Rhine and in the area of zones 3 and 4 in accordance with the Binnenschiffsuntersuchungsordnung (German inland waterway vessel inspection ordinance)).

The ZANDER was taken out of service in 2012 and the Federal disposal sales and marketing agency VEBEG sold her to the Danish company Multi Mak in Copenhagen. The ship was handed over to the new owner in Schweinfurt on 22 August 2012, which then transferred her to Copenhagen under its own responsibility. The ZSUK was notified of the change of ownership. The ZANDER was not listed in the Danish shipping register, however. In Copenhagen, the ZANDER was moved only occasionally.

The new owner (referred to below as vendor) intended to sell the ZANDER on with the assistance of a broker, the Esbjerg-based North Sea Shipbrokers ApS. De Elburger Scheepsbemiddeling B.V. from the Netherlands (referred to below as buyer) surveyed the ZANDER in Copenhagen on 11 December 2013. Following that, a contract of sale (Memorandum of Agreement) was concluded on 14 January 2014. The hand over in Copenhagen was scheduled for the period 15 January 2014 to

15 February 2014. However, the contract was not executed as intended for various reasons.

The contracting parties agreed not to execute the contract of sale until later in the year. The vendor stated that the provisions of the contract had not changed, whereas the buyer stated that an oral agreement to hand over the ZANDER in the Netherlands had been made.

The vendor signed the legal bill of sale, in which it declared receipt of the purchase price and transfer of ownership of the ZANDER free from mortgages and other encumbrances, on 23 October 2014. This document was notarised and the Danish Ministry of Foreign Affairs appended an apostille to it on the same day. A record of delivery and hand over was not prepared. The ZANDER was not listed in the Dutch shipping register (Dutch Kadaster). The buyer had taken out insurance for the ZANDER, stating that this is reportedly possible without being the owner.

3.2.2 Ship arrangement and equipment

The ZANDER was 26.8 m in length and 7.55 m in breadth. Five transverse bulkheads divided her into six compartments longitudinally. Ballast tanks were located at the bow. Adjoining that was a void, which also accommodated the thruster. A stowage compartment, the engine room, and the accommodation followed. Ballast tanks were positioned at the stern again.

The superstructure stretched about three quarters of the breadth of the ship above the engine room, the accommodation, and part of the stowage compartment. Consequently, a side deck of 1 m in breadth remained at the port and starboard side of the main deck. In each case, the accommodation and the engine room were only accessible via a door and the adjoining companionway on the starboard side (see Fig. 3).



Figure 3: Access points to the accommodation and engine room

The stowage compartment was accessible via a companionway located in the forward superstructure and four flush-mounted hatches that differed in size and were located on the main deck. The ballast tanks and void were accessible via manholes flush-mounted on the deck. The wheelhouse was located on the port side above the engine room. The wheelhouse was accessed via steps on the port side (see Fig. 4).

The permanently installed drainage system consisted of a powered bilge pump and a manually operated bilge pump. The various compartments were connected to the pumps via a valve group in the engine room. The drainage system was also used for filling and emptying the ballast tanks. Reportedly, portable electric submersible pumps were also on board.



Figure 4: Access to the wheelhouse

A GPS receiver with chart plotter and a magnetic compass were on board for navigation. Reportedly, an unspecified number of paper charts were on board. The ZANDER was equipped with a VHF radiotelephone for the inland waterway communications.

A so-called ship spotter photographed the ZANDER in the Kiel Canal during her transfer voyage. A comparison of Figs. 3 and 4 shows that the lifebuoy on the wheelhouse's aft wall was removed and had not been replaced. Accordingly, one lifebuoy had been mounted fore and one aft of the superstructure, both so that they could float free from their stowed position. The buyer stated that it had placed on board an inflatable liferaft, lifejackets, survival suits, hand flares, and a first aid kit specifically for the transfer voyage across the Baltic Sea and North Sea. According to the vendor, the additional life-saving appliances had been stowed in the forward superstructure at the beginning of the transfer voyage. The following life-saving appliances were recovered after the vessel foundered: one Merman 14 A foam lifejacket, one 150 N inflatable lifejacket (inflated), two ISS 590 survival suits, and

one Cruiser 4 liferaft manufactured by Plastimo that would accommodate four people and was in a bag.

3.2.3 Certification by Register Holland

The ZANDER began the transfer voyage with a provisional Community certificate for inland waterway vessels issued by Register Holland. The buyer commissioned Register Holland with surveying and certifying the ZANDER. The certificate was limited to three months and valid only for zones 3 and 4 inland waterways in the European Community and zone 2 inland waterways in the Netherlands. It was issued on 10 November 2014 after the ZANDER had been surveyed in Copenhagen on 7 November 2014.

During the investigation, the investigating authority of the Netherlands (Dutch Safety Board) agreed that it would scrutinise the certification process by Register Holland. The main findings of the Dutch Safety Board are as follows (the full report is annexed to this report):

Although the inspection on 7 November 2014 identified several deficiencies, none of them were considered obstacles to the operation of the ZANDER as a floating workboat within the areal limitations stated above. In order to issue a provisional Community certificate, Register Holland had to request an identification number from the Human Environment and Transport Inspectorate (ILT) in the Netherlands. The fact that the ZANDER was moored in Denmark did not hinder the process of issuing the identification number. The ILT's form used for such requests does not ask for information about the current location of the vessel in question. The Dutch Safety Board stated that ILT is not obliged to collect information about any vessel's current location, as it is deemed solely the task of the vessel's owner to provide for suitable transport, if the vessel is located outside the Netherlands as it was the case with ZANDER.

3.2.4 Manning

Two Danish seamen, one aged 72 and the other 71, carried out the transfer voyage. They both held a certificate of competency for service as a master engaged on 'near-coastal voyages' in accordance with Regulation II/3 STCW Convention. The two men resided in Esbjerg and knew each other personally. They had years of experience in maritime navigation, mainly in the fisheries sector.

3.2.5 Course of the voyage

Witness testimony and technical recordings have made it easy to trace the ZANDER's transfer voyage. The two crew members travelled by rail to the station at Copenhagen, where the vendor of the ZANDER collected them, on 19 November 2014. Supplies for the voyage were then purchased in a supermarket and stowed on the ZANDER with the luggage.

The ZANDER left Copenhagen in the early hours of the following day at about 0200. The voyage followed the Danish coast and later passed through the Bay of Kiel, so as to transit the Kiel Canal. The voyage was delayed in Kiel because restricted visibility prevailed upon arrival. The ZANDER was not equipped with a radar system and therefore not allowed to enter the Kiel Canal.

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The ZANDER sailed into the Neue Nordschleuse lock at Kiel-Holtenau at 0857 on 22 November 2014 after visibility had improved. Since the ZANDER was not equipped with an automatic identification system (AIS), a portable one was hired for the canal passage. The crew itself dealt with the clearance procedure, i.e. without a broker. The Netherlands was specified for the ZANDER's nationality. Copenhagen was specified for the port of departure and Eemshaven for the port of destination. The fees due for the canal passage were paid in cash. The home address of a crew member was specified for the invoice address. A border police control was not carried out in Kiel. The ZANDER was not controlled by the authorities during the subsequent course of the voyage, either. Due to her size, the ZANDER was exempted from the obligation of pilotage in the Kiel Canal.

The transmissions of the AIS transponder on board made it possible to trace the voyage through the Kiel Canal. The ZANDER left the lock at Kiel-Holtenau at 1006 on 22 November 2014. The passage through the Kiel Canal was halted in the evening at 1821 when the ZANDER made fast at a berth in the siding at Fischerhütte.

She continued her voyage at 0759 on the following morning. She entered the Alte Nordschleuse lock in Brunsbüttel at 1216.

The ZANDER left the lock at 1239. Prior to that, she reported in to Vessel Traffic Service (VTS) Brunsbüttel (Brunsbüttel Elbe Traffic) on VHF channel 68 and advised that she intended to proceed to sea with two people. The VTS acknowledged this and also provided information about the traffic situation. There was no further radio contact with a VTS during the subsequent course of the voyage. The ZANDER was not subject to compulsory reporting due to her low length.

VTSs Brunsbüttel and Cuxhaven used radar to record the voyage on the Lower Elbe and Outer Elbe. The ZANDER sailed along the outer edge of the fairway, including outside the fairway in places. Depending on the tidal stream, she sailed at speeds of between 3.5 kts and 8.8 kts (speed over ground). The recorded track (see Fig. 5) shows clearly that the ZANDER found it extremely difficult to maintain her course. She was not equipped with a track control system (autopilot).

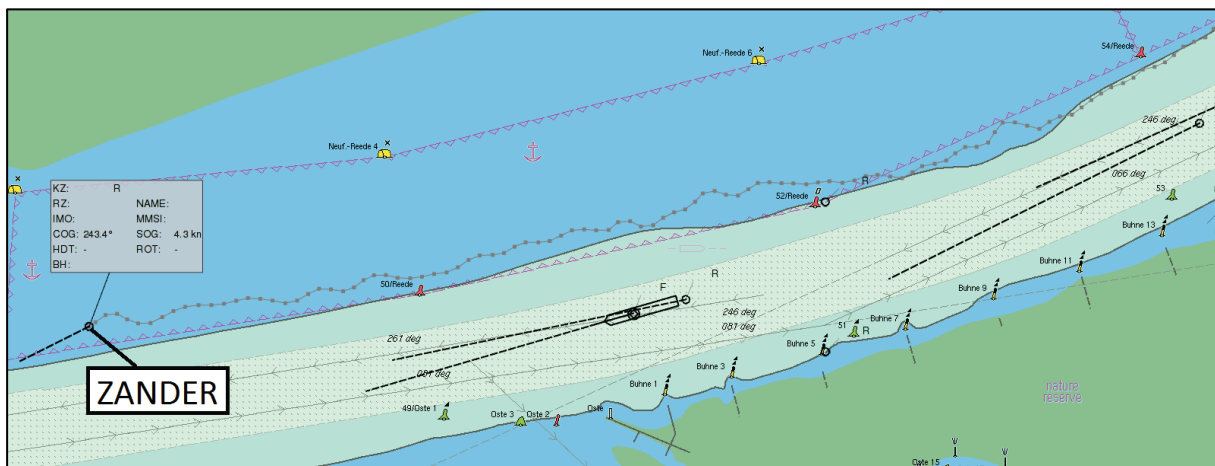


Figure 5: Course of the ZANDER's voyage on the Lower Elbe

The ZANDER reached the North Sea at Cuxhaven at about 1630 and continued to follow the fairway. The ZANDER reached the Elbe Approach traffic separation scheme at about 2000, which she left in a south-westerly direction. The VTS responsible was unable to provide radar recordings for the next leg of the voyage on the German Bight. The ZANDER appeared on the radar of ETV NORDIC at 0518 on 24 November 2014. The NORDIC was laid up at her standby position north of Norderney in the inshore traffic zone. The radar images were recorded by the voyage data recorder (VDR). The analysis of the radar images (see Fig. 6) shows that the ZANDER steered a west-north-westerly course at a speed over ground of roughly 3 kts up until about 0700. After that, the speed reduced to less than 1 kt and the course changed to 145°. At an almost easterly course, which was maintained until she foundered, her speed then increased again from 0754 onwards.

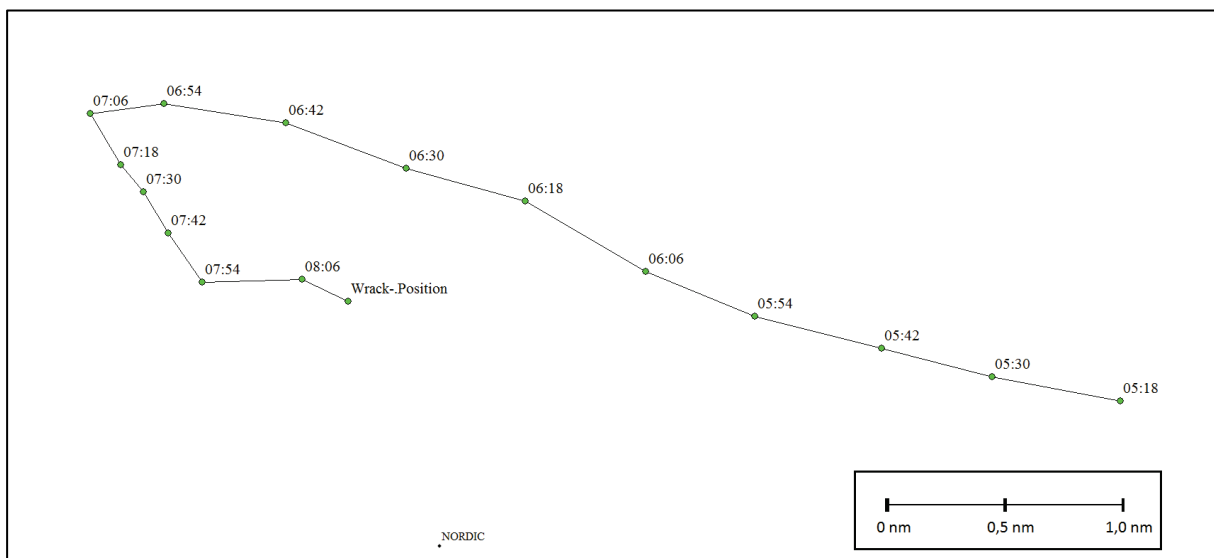


Figure 6: Radar analysis of the NORDIC's VDR

3.2.6 Rescue operation

The rescue operation started without undue delay after the ZANDER sent the distress call on VHF channel 16 at 0754. The ARY, which was operating as a guard vessel for wind farms and was the ship nearest the distressed vessel, contacted the MRCC and advised that she would reportedly sail to the ZANDER at full speed and arrive there in about 15 minutes.

The rescue cruiser BERNHARD GRUBEN is manned around the clock and left her station on Norderney at 0755 with a four-member crew. Two other guard vessels also made contact and sailed to the scene of the accident. ETV NORDIC, which is deployed in the German Bight, was anchored about 1.5 nm south-east of the scene of the accident. She started her engines and weighed anchor. At the same time, she prepared her rescue boat for a mission. Only a fishing vessel in the vicinity did not make contact, nor did she take part in the subsequent search.

The ZANDER foundered just before the ARY reached her at 0812. The ARY searched the position at which the vessel foundered for people in the water. The NORDIC was appointed the role of on-scene co-ordinator by the MRCC at 0817. The NORDIC's crew was trained regularly for this task. At the same time, the German

Navy's Sea King SAR helicopter took off from Heligoland with a regular SAR crew consisting of two pilots, an aircraft operations officer, and a flight engineer. A special department for severely hypothermic people at the university hospital in Oldenburg made ready to receive the injured seamen.

After the ARY had still not located anybody at the position at which the ZANDER foundered after 12 minutes, she sailed in a north-westerly direction to search for the person who fell overboard first after consulting with the NORDIC. The rescue cruiser and the two other guard vessels reached the position at which the ZANDER foundered at 0830 and started the search.

The rescue cruiser deployed her tender to facilitate rescuing a person in the water.



Figure 7: Rescue cruiser with tender

The SAR helicopter reached the search area at 0835. It flew toward the ARY and started the search there. The helicopter located the first lifeless person at 0843 and an attempt was made to take him on board using the rescue basket. This failed due to the sea conditions and the rescue cruiser was called to assist. This person was then taken on board by her tender, the JOHANN FIDI.



Figure 8: SAR helicopter with rescue basket

The helicopter then continued to search in the direction of the search formation, which was co-ordinated by the NORDIC in an easterly direction. The helicopter located the second person, also lifeless, at 0900 and he was then taken on board by the rescue cruiser's tender.

To better treat the two casualties, the rescue cruiser attempted to take her tender back on board. However, this failed due to the sea conditions and the rescue cruiser and tender sailed back to Norderney separately.

The ZANDER was unable to give her call sign when she made her distress call, even after a corresponding request. Definitive identification was possible using the ATIS ID⁴. This system is used only in radio communications on inland waterways. The call sign is encoded in the ATIS ID and sent automatically each time the transmit button is released. The (former) German ATIS ID was still programmed into the VHF radiotelephone, which made it possible to assign the ZANDER to WSA Schweinfurt. After interviewing the vendor, the buyer, and the broker with the assistance of the Danish and Dutch MRCCs, it was clear that two people were on board the ZANDER.

The search was discontinued after the second person was recovered and the vessels involved were stood down by the NORDIC. The NORDIC remained at the scene of the accident and collected the life-saving appliances that were floating in the water. It was intended that a Federal Police helicopter, which had taken an emergency physician on board, would assist in the search. This helicopter flew directly to Norderney, where a local emergency physician and other rescue teams were already awaiting the arrival of the rescue cruiser. The two emergency physicians could only confirm the death of both casualties after taking them into their care. An autopsy was carried out on the two seamen. In each case, it was found that drowning was the sole cause of death.

⁴ Automatic Transmitter Identification System.

3.2.7 Weather and sea conditions

The BSU requested from Germany's National Meteorological Service (DWD) a detailed weather report describing conditions at the scene of the accident north of Norderney. This report is reproduced below in an editorially revised form.

3.2.7.1 Underlying data

The DWD has hourly measurements and observations from the surrounding onshore and offshore stations (including Norderney, Borkum, TW Ems, German Bight, Heligoland) at its disposal for the German Bight sea area around Norderney. Some of these stations are not manned permanently. Weather reports on the open sea often only have limited temporal and spatial resolution; however, existing reports from ships and measuring buoys in the sea area in question were considered. Analyses of the DWD in Offenbach, the Met Office (Great Britain's national meteorological service in Exeter), the NOAA (National Oceanic and Atmospheric Administration, United States Department of Commerce), and the American GFS (global forecast system) model were used to map the weather situation. Forecasts of the ECMWF's (European Centre for Medium-Range Weather Forecasts, Reading, England) global weather forecast model, the DWD's GME global weather forecast and COSMO-EU regional weather forecast models, and the GWAM and EWAM sea state models derived from that were considered.

Satellite images, radar images, and radiosonde launches were also analysed. The latest forecasts for the weather at sea and warnings in this period of the national meteorological services responsible for the potential damage zone were analysed. The BSH's circulation model was also considered.

3.2.7.2 Weather situation on 24 November 2014

The weather on 24 November 2014 was marked by differences in atmospheric pressure between the low-pressure system over southern Norway, which was only just tracking eastwards, and a high-pressure system over the southern part of Great Britain spreading eastwards. At the time of the accident at about 0800 (0700 UTC), the German Bight was on the reverse side of a cold front. This was embedded in a strong trough and had crossed the area on the previous night (see Fig. 9). Behind this cold front, cold maritime air flowed in with a strong north-westerly, later westerly flow. As the day progressed, the high-pressure system over the southern part of Great Britain spread eastwards, causing the wind to pick up steadily.

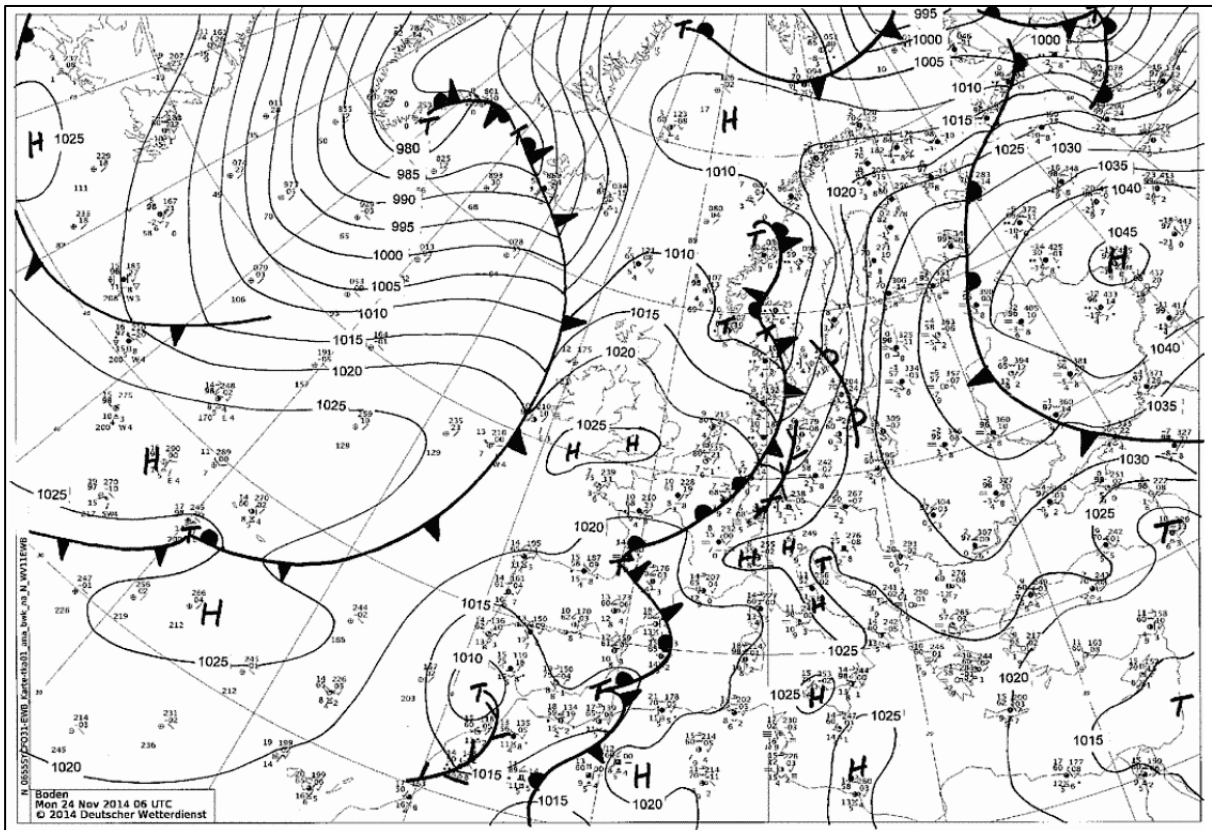


Figure 9: Weather map (ground pressure and frontal analysis) at 0600 UTC on 24 November 2014

3.2.7.3 Weather and sea conditions in the area of the accident between midnight and 0800

Mean wind (at a height of 10 m above the water surface): In the area of the accident, the hitherto southerly wind veered in a north-westerly direction between 2300 and midnight of the previous day. In the period between about 0400 and 0700, values of up to 25 kts (6 Bft) were reached on the open sea in isolated cases. A north-west wind prevailed off Norderney at 0800, reaching a mean average of 18-21 kts (5 Bft). In the following two hours, it veered back toward the west at the same force as before.

Gusts: At the time of the accident, the wind had reached speeds of 25-29 kts at a height of a few hundred metres. Due to the ensuing vertical shear, turbulence caused this upper wind to mix down to ground level at neutral stratification. These gusts of force 25-29 kts (6 Bft) were observed around and north of Norderney in the hours leading up to 0800.

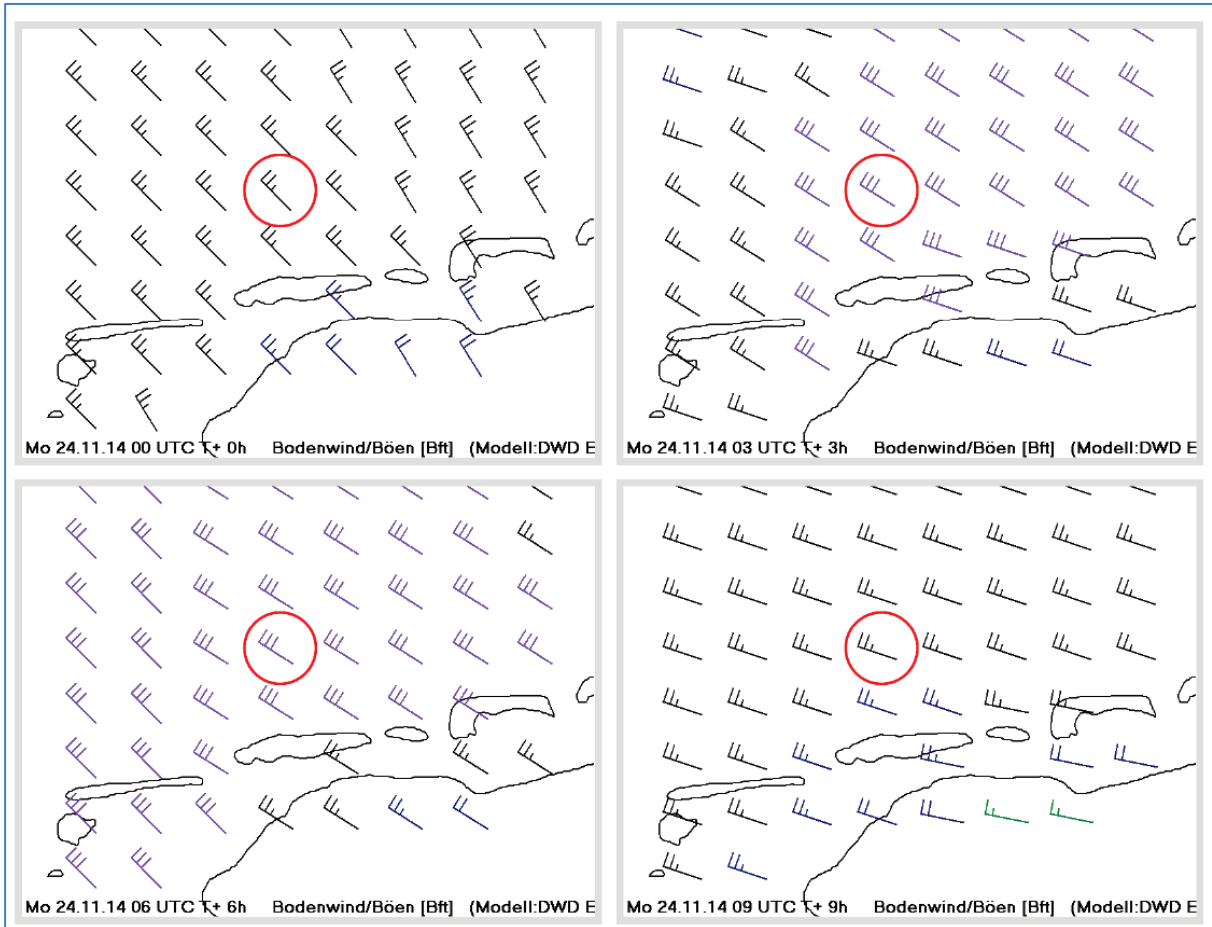


Figure 10: Wind development⁵

Significant sea state⁶: When the wind veered toward the north-west, a wind sea of 1.5-2 m was able to develop in the area of the accident between shortly before midnight and the time at which the accident occurred. On the previous day, the wind sea was less than half a metre in southerly winds.

⁵ Regional model of the DWD on 24 November 2014. The wind arrows carry half a vane per Bft of wind force.

⁶ The height of the swell is defined using the significant wave height, i.e. the mean height of the upper third of all the waves occurring in a wider area over an extended period of time (e.g. 20 minutes). Based on the wave theory, one single wave 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.

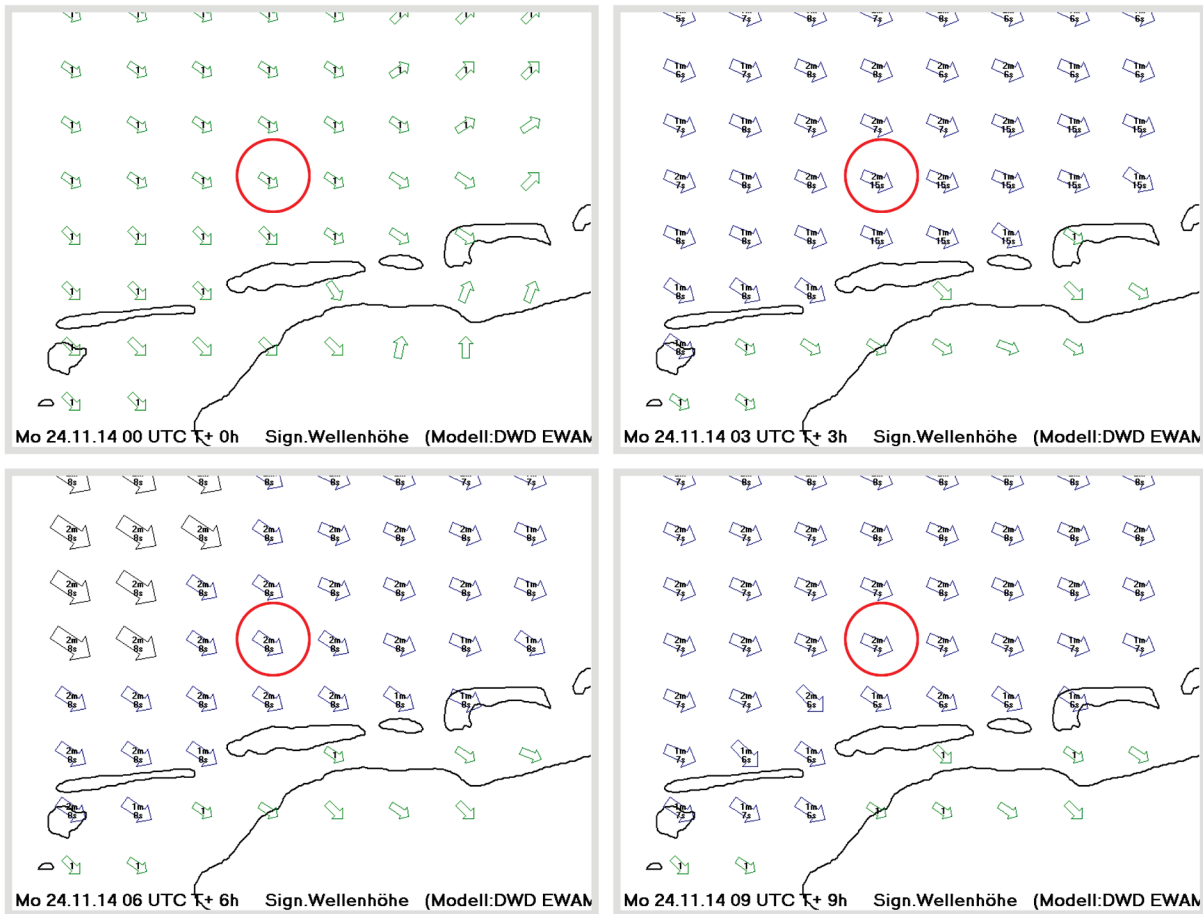


Figure 11: Height and direction of the significant wave height⁷

Weather and visibility: *The air close to ground level was saturated with moisture overnight up to a height of several kilometres (Fig. 12, grey lines). Consequently, it was heavily overcast and there was strong drizzle at times. From 0500 UTC onwards, drier cold air prevailed, which was essentially neutrally stratified toward the bottom. Accordingly, shallow convective clouds that covered only 2-3 eighths of the sky were visible at the time of the accident. Visibility was not restricted at this point in time.*

Temperature: *At the time of the accident, the air temperature stood at between 9°C over the islands and almost 11°C at the German Bight station. Water temperatures were about one degree higher.*

Current: *According to the BSH's circulation model, the current approached from the east (westerly current) at 0600 and was just short of a knot. In the following two hours up until the time of the accident, the current veered across the south (from north to south) toward the east (from west to east), while dropping to about half a knot. At the time of the accident at about 0800, the current approached the scene of the accident, as specified, at about half a knot from the north-west to the west and increased in the hour before 0900 to slightly more than a knot from the west.*

⁷ According to the DWD's EWAM sea state model.

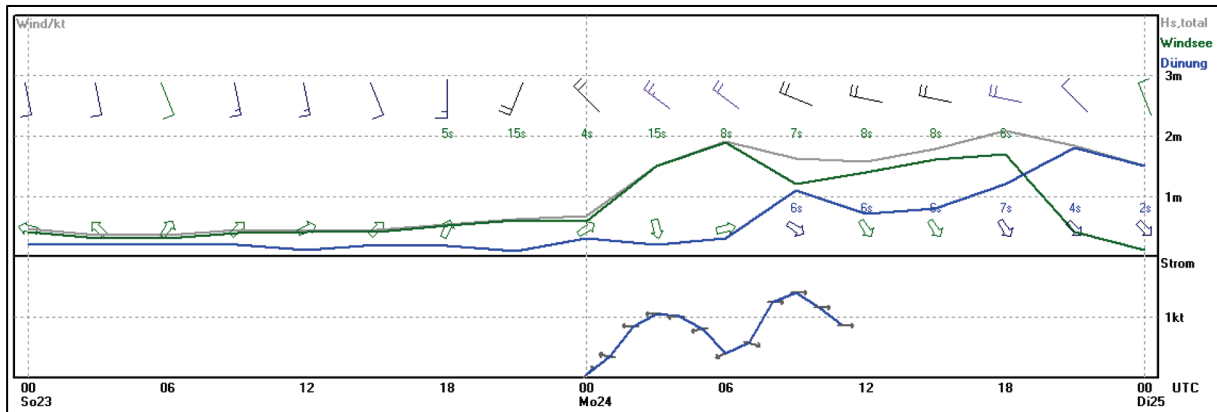


Figure 12: Development of wind, swell and current at the scene of the accident over time⁸

3.2.7.4 Wind measurements of the NORDIC

ETV NORDIC, which was anchored near the scene of the accident, is equipped with an anemometer. The VDR recorded the data, which are listed in the following table.

Time	Wind speed [kts]	Wind direction [°]
0500	20.1	305
0515	26.5	316
0530	23.9	292
0545	21.3	300
0600	17.8	302
0615	16.3	292
0630	16.5	307
0645	13.5	300
0700	26.7	303
0715	23.9	301
0730	22.6	298
0745	22.8	305
0800	21.8	296

3.2.7.5 Weather forecasts for the German Bight

The DWD, Maritime Weather Service Hamburg, issues a sea state and weather forecast for the North Sea and Baltic Sea twice daily at 0800 and 1900. The sea state and weather forecast is structured as follows: Gale or storm warnings covering the following 12 hours, weather situation, forecasts, outlook, trends and station reports. The forecast in the morning report is valid until midnight and that of the evening report until the following midday. The outlook is valid for the 12-hour period following the forecast. Trends are indicated for the following three days.

The forecast and outlook are issued for each forecast area. In each case, trends are issued for the (entire) North Sea and Baltic Sea, however.

⁸ Temporal resolution = three hours. Wind arrows each with half a vane per 5 kts; beneath are wave periods of the significant sea, the height of the significant sea (grey), the wind sea (green), the swell (blue), and the direction of the swell. Below is the current on the morning of 24 November 2014 (strength and direction).

Excerpts of the relevant sea state and weather forecasts for the German Bight are reproduced below. The ZANDER began her voyage to Eemshaven in the early hours of 20 November 2014. At this point, the DWD's latest sea state and weather forecast (1900 on 19 November 2014) did not cover the day of the accident. The trend for the North Sea on 23 November 2014 indicated south-east to south at 6, south-western part southerly winds at 4, north-western part veering north-west.

The day of the accident was first covered by the DWD's sea state and weather forecast issued at 1900 on 20 November 2014. It contained the following trends for the entire North Sea. Sunday 23 November 2014: South-east to south at 5, northern part initially at 6. Monday 24 November 2014: Veering west at 5, northern part at 6. The sea state and weather forecasts that followed predicted continual wind forces of 5-6 Bft for the German Bight on the day of the accident.

The sea state and weather forecast for 1900 on 22 November 2014 was issued while the ZANDER was made fast in the siding at Fischerhütte. It contained a gale and storm warning for the German Bight. Forecast for the German Bight until midday on 23 November 2014: South-easterly winds at 5, dropping somewhat temporarily, hazy at times, sea initially up to 2.5 m. Outlook for the German Bight until midnight on 23 November 2014: South at 5, veering west to north-west, increasing somewhat. Trend for the North Sea on the 24 November 2014: Westerly winds at 6, later dropping to 4-5.

The sea state and weather forecast issued at 0800 on 23 November 2014 was the final forecast before the ZANDER reached the German Bight. This forecast also contained gale and storm warnings for the German Bight. Forecast for the German Bight until midnight: South-east to south at 5, veering west to north-west, hazy at times. Outlook for the German Bight until midday on 24 November 2014: North-west to west 5, northern part 6.

The last sea state and weather forecast before the ZANDER foundered was issued at 1900 on 23 November 2014. It also contained gale and storm warnings for the German Bight. Forecast for the German Bight: Eastern part initially south-east to south at 5, otherwise west to north-west 5-6, initially hazy.

The gale and storm warnings were also broadcast on the VHF operating channels in the hourly situation reports of the VTSs over their port operation and pilot radio services.

3.2.8 Investigation of the wreck

Divers from the BSH's survey, wreck search and research vessel ATAIR surveyed the wreck of the ZANDER on 29 June 2015. It was possible to identify the wreck clearly. She is lying on the sea floor on an even keel. The wreck was in good condition.

Her hull and superstructure were not damaged. It was possible to survey the entire length and breadth of the vessel.

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All the window panes were cracked. All the doors were absent and in some instances laying right next to the wreck. Two manholes on the main deck, which belonged to the forward ballast tanks, were open. Their covers were not found. Two hatch covers over the stowage compartment were also absent. One hatch cover was found right next to the wreck. The open manholes and hatches identified are marked in Fig. 13.



Figure 13: Deck openings on the fore section

4 ANALYSIS

4.1 Ship approval and condition

The ZANDER was built and approved as an inland waterway vessel. The use of this ship in sea areas was not envisaged when she was built. The certificate issued by Register Holland applied only to inland areas (zones 3 and 4 inland waterways, and zone 2 inland waterways in the Netherlands). This certificate did not even extend to the Kiel Canal and Lower Elbe, as the German inland waterway vessel inspection ordinance states that they are zone 2 waterways.

A special permit from the Ship Safety Division (BG Verkehr) would have been necessary for a transfer voyage through sea areas of Germany's territorial waters. Inter alia, the following would have been necessary for such a permit:

- a valid navigability licence for zone 2;
- proof of sufficient stability and strength from a recognised classification society;
- openings battened down⁹, and
- the last dry docking must not be earlier than three years ago.

A permit for the ZANDER was not requested from the Ship Safety Division (BG Verkehr). It is also evident that the ZANDER was not eligible for a permit on account of her condition, however. The photographs of the ZANDER taken on 22 November 2014 when she was transiting the Kiel Canal show, inter alia, that engine room ventilation pipes and ventilation intakes were not closed. The accommodation's windows (simple design) were not fitted with deadlights.



Figure 14: Ventilation intakes and windows

The ZANDER was last surveyed in dry dock in 2008. Inasmuch, it is only possible to make a limited assessment of the hull, the propulsion system, and the steering system. A special permit would also have contained a weather stipulation.

⁹ Closed watertight.

4.2 Crew and organisation of the transfer voyage

It was not possible to determine conclusively which entity engaged the crew or on which entity's behalf it was acting. The buyer stated that the vendor had commissioned the broker with organising the transfer voyage and manning. The broker denied this account. Although it reportedly knew the two crew members, it did not engage them, nor was it reportedly responsible for the transfer voyage. The vendor pointed out that the ZANDER was handed over to the buyer in Copenhagen in accordance with the contract of sale; accordingly, it was not responsible for the transfer.

Since all the parties concerned were aware of the ZANDER's condition, it is difficult to understand why a transfer voyage across the North Sea and Baltic Sea was commissioned, especially at this time of year. It was already evident at the beginning of the voyage that the weather conditions in the North Sea would be poor.

The two crew members held a certificate of competency for service as a master engaged on near-coastal voyages. Accordingly, they were properly qualified for the voyage from a procedural standpoint. They only arrived in Copenhagen on the evening before departure. Consequently, very little time to become acquainted with the ship was available. Given the duration of the voyage and low level of automation on the ZANDER, she was insufficiently manned. In particular, the manual control of the Schottel propellers represented a huge burden. Due to the shape of her hull and propulsion system, the ZANDER was prone to extreme course instability (see Fig. 5). Accordingly, it is reasonable to assume that the two seamen alternated the ship's command at relatively short intervals, resulting in correspondingly short periods of rest.

An opportunity to assess the overall circumstances existed prior to leaving the Kiel Canal. The crew had been on board for several days by then and could have gained a general idea of the ZANDER's condition. Force 5 Bft westerly and north-westerly winds had been reliably predicted for the German Bight for the coming day. The VTS had broadcast the corresponding wind warnings regularly.

The two highly-experienced crew members were well acquainted with conditions in the North Sea. It remains a mystery why they continued the voyage nonetheless. The transfer could have been aborted or postponed. Moreover, the option of continuing the voyage on inland waterways also existed. Here, neither crew member held the necessary boatmaster's certificate for inland waterways, however.

The North Sea at Cuxhaven was reached in the early evening of 23 November 2014 shortly after sunset. Consequently, the most demanding section of the transfer voyage was completed in darkness and overnight.

4.3 Water ingress

It was not possible to determine the exact cause of the water ingress. The ZANDER had stated on the radio that she was down by head due to the water ingress, while her trim was still normal at the stern.

This would suggest that water had (initially) penetrated into the forward sections. The analysis of the weather report reveals that after the passage of the cold front around midnight, the wind suddenly veered from south to north-west. This resulted in the development of a 2-m high wind sea in the next few hours. At the same time, the wave periods decreased. The ZANDER was sailing in a head sea, meaning large amounts of water had been washing over her fore section for several hours.

Apart from the ventilation pipes, water could also have penetrated through the numerous deck openings. The absence of the manhole covers indicates that they were not screwed down properly. The doors in the forward superstructure (see Fig. 16) had a low coaming and could not be closed weathertight¹⁰, meaning it is also likely that water had penetrated into the stowage compartment through them. In contrast to all the other life-saving appliances, the lifebuoys mounted fore and aft were not seen after the ZANDER foundered. It is possible that they had already been caught by a wave and washed overboard.



Figure 16: Forward doors

Sailing into the short-period swell exposed the hull to considerable loads. Accordingly, leakage in the hull cannot be ruled out.

The ZANDER changed her course about an hour before she foundered and then sailed slowly in the same direction as the wind. This permits the conclusion that the water ingress had been noticed at this point. The assessment and determination of the cause of the water ingress by the crew was only possible to a limited extent because the relevant compartments were accessible only from the outside and entering the deck was probably dangerous even on the new course.

¹⁰ Weathertight means that water will not penetrate into the ship in any sea conditions.

The submersible pumps could not be used for the same reason.

The investigators assume that rather than being removed by the crew, the absent manhole and hatch covers were pushed out by excess pressure that had built up when the vessel foundered.

4.4 Life-saving appliances and likelihood of survival

Contrary to the regulations, there was no lifebuoy in the immediate vicinity of the wheelhouse during the transfer voyage. Consequently, after the first crew member fell overboard the person remaining on board was unable to throw him a lifebuoy. Moreover, there were no other means available to mark the scene of the accident.

The liferaft on board did not meet the requirements of the International Life-Saving Appliance (LSA) Code¹¹. She was put on the market in 2009. A service required every three years according to the manufacturer's specifications was not documented. The liferaft did not have a float-free stowage arrangement, nor was it stowed on deck for immediate use. The painter was not connected to the ship.

The life-saving appliances were in the stowage compartment at the beginning of the transfer voyage in Copenhagen. The investigators assume that they were also there at the time of the accident. The stowage compartment could only be reached via the fore section. It was no longer possible to enter this compartment after the water ingress, meaning the crew was cut off from the life-saving appliances.

Radio life-saving appliances (satellite EPIRB¹², search and rescue transponders (SART), and VHF handheld transceivers) were not on board.

The water temperature at the time of the accident was about 10°C. Therefore, it is reasonable to assume that the two individuals suffered a cold shock after immersion in the water. This happens when the skin is suddenly exposed to cold water (water temperature less than 15°C). Low-temperature stimulus causes increased respiration, inter alia. To begin with, an uncontrolled, deep gasp occurs, which can be up to two to three litres in volume. This is followed by accelerated respiration (hyperventilation). A person's ability to hold their breath is reduced to a few seconds.

Neither person wore a lifejacket, nor did they use other life-saving appliances. In the prevailing sea state, the respiratory tracts were regularly immersed in sea water. The uncontrolled respiration causes a huge risk of inhaling water. Due to the increased respiratory rate, even the smallest amounts of water (e.g. spray) inhaled upon each gasp are sufficient to impair pulmonary function significantly.

The outcome of that is hypoxia (oxygen deprivation).

As a result of low-temperature stimulus, there is a sharp increase in the heart rate and blood pressure, which can lead to a failure of the cardiovascular system. Under these circumstances, a person can drown in less than a minute. Resuscitation is only successful if started immediately.

¹¹ Contains the international standards for life-saving appliances required by Chapter III of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended.

¹² Emergency position-indicating radio beacon.

5 CONCLUSIONS

The 47-year-old ZANDER was built and approved as an inland waterway vessel. She had not been issued a permit to operate at sea, but only a temporary certificate for inland waterways navigation. Moreover, she had not been used in maritime navigation before, either. With regard to construction and equipment, the ship was not in a seaworthy condition at the time of the accident. The relevant classification society, Register Holland, had only deemed the ZANDER as temporarily fit for being used as an inland floating workboat. It was neither acknowledged nor allowed that ZANDER would be transferred to the Netherlands by sea.

It was not possible to establish proper watertight integrity. The life-saving appliances were incomplete and stowed inappropriately. With only two seamen, the manning of the ZANDER was not sufficient for normal ship operation and watchkeeping. This low manning level made coping with emergency situations, such as the water ingress, possible only to a very limited extent. Rescuing a person overboard was virtually impossible.

The transfer voyage was started at an extremely inopportune moment. The wind and sea conditions prevailing at the time of the accident were not unusual for the time of year. Moreover, they were an almost exact reflection of the long-term and short-term forecasts. Furthermore, the execution of the voyage entailed carrying out the majority of the most demanding leg, the passage through the North Sea, in darkness.

The crew underestimated the risk of foundering. For example, a distress call or call for assistance was not made after the detection of water ingress. This happened only after a person fell overboard. It is possible that the crew was restricted in its judgement due to the exhaustion.

Conditions for a rescue were exceptionally favourable: the first vessel had already reached the distressed vessel within a few minutes of the distress call and just before she foundered. The rescue cruiser and other vessels also arrived at the scene of the accident in good time. The SAR helicopter from the Heligoland station was immediately available and an emergency physician was brought on another helicopter. Despite the generally favourable circumstances, it was not possible to rescue the two seamen. Without the use of life-saving appliances, the likelihood of people in water surviving is minimal in low water temperatures and swell.

Yet again, this accident shows the outstanding potential for locating people in water from a helicopter. After arriving at the scene, the helicopter crew had sighted the two individuals within only a short period of time. Although five vessels were in the immediate vicinity of the scene of the accident, it was not possible for their crews to sight the casualties.

6 SOURCES

- Investigations of the waterway police (WSP)
- Written statements
 - Classification society
- Witness testimony
- Mission reports
 - German Maritime Search and Rescue Association
 - The German Navy's SAR Control Centre Glücksburg
 - ETV NORDIC
- Dutch certification process for inland waterway vessels
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Official weather report by Germany's National Meteorological Service (DWD)
- Radar and audio recordings of the VTSS

7 APPENDIX

Dutch certification process for inland waterway vessels