Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation

Investigation Report 117/20

Less Serious Marine Casualty

Collision between the coastal motor vessel SCHELDEBANK and Kiel Canal (NOK) ferry HOCHDONN on 8 May 2020

9 May 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.

Issued by:
Bundesstelle für Seeunfalluntersuchung – BSU
(Federal Bureau of Maritime Casualty Investigation)
Bernhard-Nocht-Str. 78
D-20359 Hamburg

Director: Ulf Kaspera
Phone: +49 40 3190 8300 Fax: +49 40 3190 8340
posteingang@bsu-bund.de www.bsu-bund.de

Table of Amendments

Page	Amendment	Date

Table of Contents

Table of Figures

1 SUMMARY

At about 0756[1] on 8 May 2020, the Dutch coastal motor vessel SCHELDEBANK, sailing eastbound on the NOK, collided in the area of the Hochdonn ferry crossing with the canal ferry operating there under the same name. Extremely dense fog with visibility of some 75 m prevailed at the time of the accident.

The ferry HOCHDONN was crossing the canal, which was approximately 120 m wide in the area discussed, had already passed the middle and was just about to approach the southern ferry terminal with several people and vehicles on board when her starboard side was struck by the bow of the SCHELDEBANK. The starboard bow of the coaster scraped past the ferry's side superstructure, deforming it not insignificantly in the process.

Fortunately, the superstructure on the opposite side of the ferry, which accommodates the ferry's control position and is separated from the vehicle deck, was not affected by the collision. The vessel's propulsion system, steering system and buoyancy were not affected, either. The ferry pilot had the presence of mind to manoeuvre the ferry back onto the path towards the ferry terminal after the collision-induced course deviation and to dock there a short time later.

Nobody on board was injured. The vehicles transported were also able to leave the ferry largely undamaged after the accident. There was no water pollution.

The SCHELDEBANK was also thrown off course due to the collision with the HOCHDONN. However, the pilot and the ship's command managed to steer the ship back into the middle of the canal very quickly thanks to a number of skilful manoeuvres. It was thus possible to avoid contact with the embankment or blocking the canal.

Since there was no need to provide assistance to the HOCHDONN, the SCHELDEBANK continued her voyage up until the Dükerswisch siding area in consultation with Vessel Traffic Service (VTS) NOK and made fast there at about 0830 for an on-board seaworthiness inspection. It was found that she had only suffered very minor damage. Her seaworthiness was not impaired.

The HOCHDONN was able to resume the ferry service across the NOK after repairs lasting several weeks.

[1] Unless otherwise stated, all times shown in this report are local: CEST (UTC + 2 hours).

2 FACTUAL INFORMATION

2.1 Photo of the MV SCHELDEBANK

Figure 1: MV SCHELDEBANK[2]

2.2 Ship particulars: MV SCHELDEBANK

Name of ship:	SCHELDEBANK
Type of ship:	Multi-purpose/coastal motor vessel
Flag:	Netherlands
Port of registry:	Delfzijl
IMO number:	9439474
Call sign:	PBJM
Owner:	BANKSHIP IV BV, Delfzijl, Netherlands
Shipping company:	Pot Scheepvaart, Delfzijl, Netherlands
Year built:	2007
Shipyard, number:	Ferus Smit Leer GmbH/382
Classification society:	Bureau Veritas
Length overall:	89.78 m
Breadth overall:	14.00 m
Draught (max.):	5.96 m
Gross tonnage:	2,999
Deadweight:	4,539 t
Engine rating:	2,640 kW
Main engine:	MAK 8M25, Caterpillar Motoren GmbH & Co. KG
(Service) speed (max.):	13.5 kts
Hull material:	Steel

2.3 Voyage particulars: MV SCHELDEBANK

Port of departure:	Delfzijl, Netherlands
Port of call:	Inkoo (Ingå), Finland
Type of voyage:	Merchant shipping/ international
Cargo information:	./.
Manning:	7

[2] **Source: Hasenpusch Photo-Productions.**

Draught at time of accident:	Fore: 5.05 m, Aft: 5.64 m
Pilot on board:	Yes
Canal helmsman:	No

2.4 Photograph of the canal ferry HOCHDONN

Figure 2: Canal ferry HOCHDONN

2.5 Ship particulars: Canal ferry HOCHDONN

Name of ship:	HOCHDONN
Type of ship:	Car ferry/inland waterway vessel
Flag:	Federal Republic of Germany
Port of registry:	Brunsbüttel
Regular place of operation:	NOK crossing in the area of Hochdonn
Identification number (national):	05041990
Call sign:	DBKC
Owner:	Federal Republic of Germany
Shipping company:	Adler-Schiffe GmbH & Co. KG; Sylt/OT Westerland
Year built:	1953
Shipyard:	Staatswerft Rendsburg-Saatsee
Classification society:	./.
Length overall:	28.1 m
Breadth overall:	9.77 m
Draught (max.):	1.62 m
Transport capacity:	45 t
Engine rating:	260 kW
Main engine:	Voith Schneider
(Service) Speed:	13 km/h
Hull material:	Steel
Hull design:	Double-ended ferry with side control position

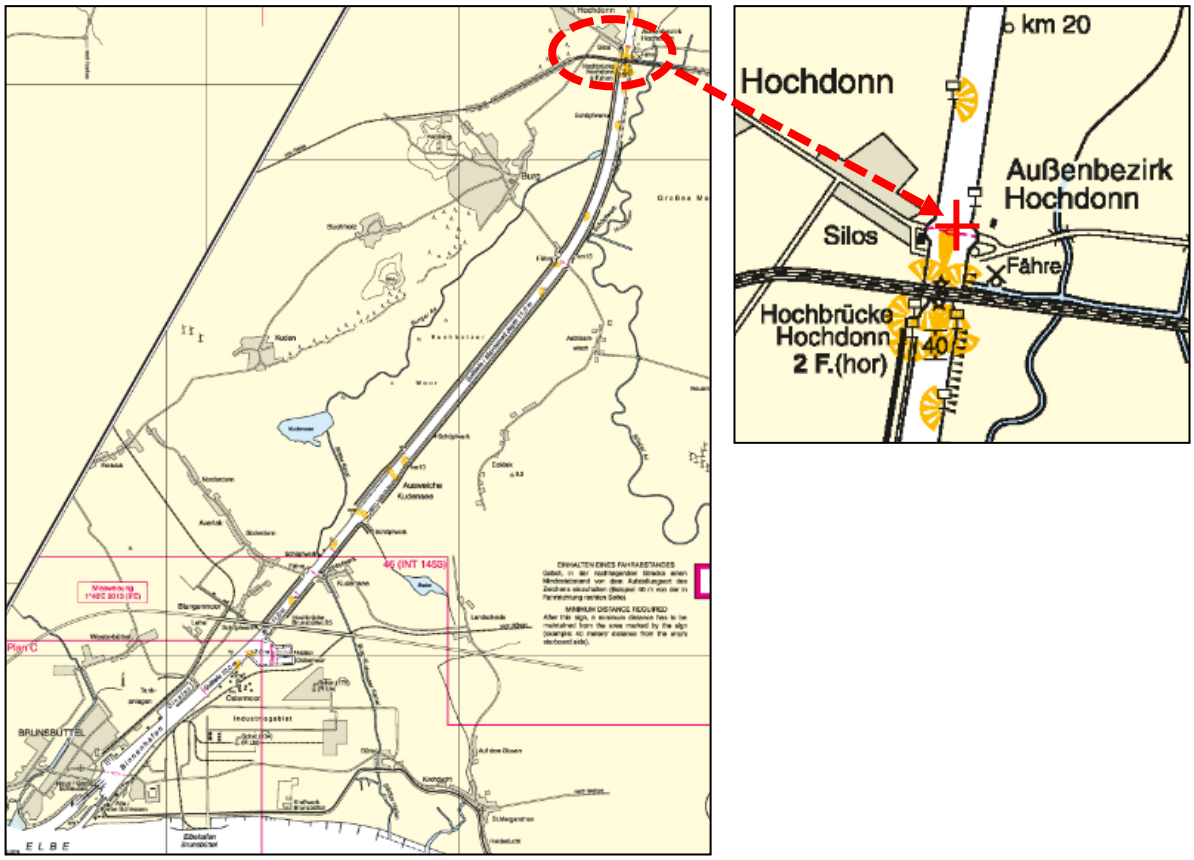
2.6 Voyage particulars: Canal ferry HOCHDONN

Place of departure:	Hochdonn ferry terminal (northern side), NOK
Destination:	Hochdonn ferry terminal (southern side), NOK
Type of voyage:	Merchant shipping/national
Cargo information:	Four cars and one agricultural vehicle
Manning:	2
Draught at time of accident:	./.
Number of passengers:	6

2.7 Marine casualty information

Type of marine casualty:	Less serious marine casualty[3]; collision between a seagoing vessel and an inland waterway vessel
Date/Time:	08/05/2020, 0756
Location:	NOK
Latitude/Longitude:	φ 54°01.1'N λ 009°17.9'E
operation and voyage segment:	NOK passage; canal kilometre 19
Consequences:	Minor damage to the SCHELDEBANK; damage to the HOCHDONN's superstructure

Extract from the NORD-OSTSEE-KANAL Navigational Chart, BSH[4] No 42 (INT 1366)



[3] Note: Classified as a less serious marine casualty because the involved and to that extent relevant seagoing ship only suffered very minor damage.
[4] BSH: Federal Maritime and Hydrographic Agency.

Figure 3: Scene of the accident

2.8 Shore authority involvement and emergency response

Agencies involved:	Waterways and Shipping Office (WSA) Brunsbüttel[5] and VTS NOK
Resources used:	Sounding vessel ORKA (WSA NOK)
Actions taken:	The VTS permits the SCHELDEBANK to continue to the Dükerswisch siding area. As a result of the on-board investigations carried out there, the vessel is allowed to continue her canal passage unassisted. The vessel then makes fast at a berth in the Lindenau shipyard (Kiel), where she receives confirmation of seaworthiness from the classification society in the late evening. The sounding vessel ORKA, which happens to be in the vicinity, approaches the damaged HOCHDONN immediately after the collision as a precaution. No specific assistance is required from the sounding vessel. The canal ferry shifts from the southern ferry terminal to a berth belonging to WSA NOK in the immediate vicinity under her own steam about an hour after the accident. The ferry terminal is then available again for the resumption of the ferry service by a replacement ferry.

[5] Note: As part of the comprehensive reorganisation of the Federal Waterways and Shipping Administration (WSV), the Brunsbüttel and Kiel-Holtenau offices were merged to form WSA NOK with effect from 22 March 2021.

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

The following account of the course of the accident is based on statements made by the ship's command and the pilot of the SCHELDEBANK, as well as the ferry pilot on the HOCHDONN after the accident and – in the absence of technical recordings – reflects their subjective perceptions and recollections.

3.1.1 Events from the perspective of the SCHELDEBANK

The SCHELDEBANK left the NOK's Südschleuse lock in Brunsbüttel at about **0645** on **8 May 2020**. She was bound for Kiel-Holtenau. The master, the chief mate and the pilot were on the bridge. The master steered the vessel in accordance with information on the gyrocompass and course recommendations of the pilot. Visibility deteriorated as the canal passage began and in the end only stood at 50-100 m. Accordingly, the 90 m long ship's fore section was barely visible from the bridge.

The voyage passed uneventfully up until canal kilometre[6] 17.5. The vessel sailed slightly south of the axis of the canal. The chief mate and the pilot kept a lookout. In the all-stations call by VTS NOK at **0745**, shipping on the canal was advised, *inter alia*, that a Traffic Group[7] (TG) 3 vessel (the SCHELDEBANK was being referred to) had passed the Kudensee siding area[8] at **0720**. The all-stations call indicated that no oncoming traffic (i.e. coming from the east) was expected for the SCHELDEBANK up until canal kilometre 27.

The all-stations call also revealed that due to diving works a pontoon was situated on the northern side of the canal just east of the Hochdonn High Bridge (located at canal kilometre 19), which had to be passed with particular care.

At about **0750**, the SCHELDEBANK approached the high bridge sailing very slightly south of the axis of the canal at canal speed, i.e. the stipulated maximum speed of 15 km/h (8.1 kts). From canal kilometre 18, i.e. about 800 m before the bridge, the vessel reduced speed and passed under the bridge at a speed over ground of about 13 km/h. At the same time, the pilot recommended that they steer a little further towards the southern bank of the canal. The aforementioned measures were taken in order to safely pass the pontoon they had been notified of with sufficient clearance.

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[6] Note: It is customary on the NOK to indicate ship positions with a kilometre reading (and speeds in km/h). Counting begins at kilometre 1 in Brunsbüttel and ends at kilometre 97 in Kiel-Holtenau.

[7] Note: In accordance with point 5 of the Notice of the Federal Waterways and Shipping Agency (GDWS), Outstation North, concerning the *Seeschifffahrtsstraßen-Ordnung - (SeeSchStrO)* [German Traffic Regulations for Navigable Maritime Waterways], any vessel transiting the NOK is classified to one of the TGs 1-6 based on the specific characteristics and/or dimensions (length, breadth, draught) stated in the Notice, unless she is a recreational craft. *Inter alia*, the respective classification is of fundamental importance to answering the question as to the maximum speed at which vessels may proceed on the NOK and whether they are permitted to overtake or encounter outside siding areas (see points 9, 11 and 12 of the Notice).

[8] Note: The NOK has a total of 12 siding areas. Their main purpose is to enable large vessels on the NOK to meet or overtake. The siding areas are equipped with dolphins where vessels can moor if necessary.

On the bridge of the SCHELDEBANK they observed the HOCHDONN in operation by radar and ECDIS[9], as they were approaching the ferry crossing with the same name located east of the high bridge. The ferry crossed the canal from south to north at about **0750**. On the northern bank, the ferry's radar echo merged with that of the terminal ashore. Since the massive high bridge obstructed the radar view of the ferry's crossing area, the SCHELDEBANK's pilot also paid attention to the HOCHDONN's AIS[10] signal when observing the course of her voyage by means of the PPU[11] and ECDIS.

Shortly after the SCHELDEBANK's superstructure had passed the bridge at about **0755**, the pilot rechecked the position of the ferry. Her radar echo was still merged with that of the canal's northern bank. The HOCHDONN's AIS signal also continued to give the impression that she was still stationary at the northern terminal.

Nevertheless, only a few seconds later and with visibility remaining poor at some 75 m, an obstacle directly in front of the bow of the SCHELDEBANK became dimly discernible on her bridge, which – as became clear shortly afterwards – was the HOCHDONN. The immediately executed stop manoeuvre could no longer prevent contact with the ferry. Her starboard side scraped along the starboard bow of the SCHELDEBANK but she very quickly parted again and continued sailing towards the southern ferry terminal. As a result of the contact and subsequent stop manoeuvre, the SCHELDEBANK turned to starboard. However, alternating rudder and engine manoeuvres made it possible to gain control of the ship and stabilise her course in the middle of the canal. By the time this was achieved, the SCHLEDEBANK had already moved so far away from the scene of the accident that the HOCHDONN was invisible due to the dense fog.

The SCHELDEBANK's pilot contacted VTS NOK on VHF immediately after the collision. During the subsequent exchange of information, the VTS confirmed that there had reportedly been no physical injuries on board the ferry and that assistance from the SCHELDEBANK was reportedly not required. On the other hand, attempts by the pilot to communicate with the ferry directly were unsuccessful. The vessel was permitted to continue her voyage to the Dükerswisch siding area and made fast there on the southern side of the canal at about **0830** for an on-board seaworthiness inspection.

[9] ECDIS: Electronic Chart Display and Information System.
[10] AIS: Automatic identification system.
[11] PPU (portable pilot unit): Laptop or tablet computer with online access to various sources of information to enable the retrieval or display of navigational charts and other important facts about the vessel and traffic situation that are helpful to the pilot. All ships equipped with this system transmit GPS-based data, including position, course, speed, as well as possibly other information, at a standardised interval on VHF. These data can be displayed by the receiver (other traffic or VTSs, for example) on a monitor or superimposed on an electronic chart system or possibly a radar image, for example. Using commercially operated portals, it is possible to observe AIS data or vessel movements in real time via the internet and to reconstruct the course of earlier voyages.

Measures imposed by the SCHELDEBANK's master to determine the damage immediately after the collision revealed that there were no casualties on board. There was also no leakage of pollutants or water ingress. There were merely minor paint abrasions in the shell plating at the bow of the SCHELDEBANK that were caused by the collision, as well as scratches and the ship's bulbous bow was deformed.

Based on this information, the pilot reported to the VTS at about **1015** that the vessel was "canal ready" and the latter then granted permission to proceed. Accordingly, the SCHELDEBANK continued her voyage at about **1040**, reaching the Kiel-Holtenau lock facility without further incident at about **1610** after the pilot transfer, which was carried out as usual near Rüsterbergen at **1257** after the first half of the canal passage.

After leaving the lock, the SCHELDEBANK shifted to a berth on the grounds of the Lindenau shipyard in Kiel for a police investigation and a survey by the classification society. The aforementioned activities were completed by late evening and the vessel was given permission to continue her voyage to Finland.

3.1.2 Events from the perspective of the HOCHDONN

By his own account, the ferry pilot, who was alone at the ferry's control position in accordance with regular ferry service procedures, reportedly used the radar and AIS to ensure that there were no vessels approaching the ferry crossing within a distance of about 800 m prior to departure. However, with regard to the reliability of the on-board AIS device, he emphasised to the investigation team that it was highly susceptible to interference.

Due to the extremely dense fog, the ferry pilot was initially unable to see the opposite ferry terminal (distance of about 120 m) or even the fog light[12], which was installed and switched on there. He therefore used an 'electronic navigational chart' on his privately owned tablet to navigate to the ferry terminal. However, the functionality of the tablet was restricted to a less detailed display of the relevant section of the canal and the GPS position of the HOCHDONN.

Due to the extremely difficult visibility conditions, the ferry sailed to the middle of the canal at reduced speed and only resumed normal speed when the aforementioned fog light was visible at the ferry terminal.

Shortly afterwards, i.e. presumably after little more than 1.5 minutes of sailing time[13], the ferry pilot saw a ship 'behind the ferry' which he believed was approaching the ferry at an extremely high speed. A suction effect then reportedly occurred and in the period that ensued the HOCHDONN was reportedly drawn towards the stern of the vessel, which the ferry pilot was unable to identify as the SCHELDEBANK due to the rapid sequence of events. This caused the funnel on the ferry's starboard side to buckle and the superstructure there to be deformed. Seconds later, the SCHELDEBANK had

[12] Note: One light is installed at each of the NOK's ferry terminals, which the ferry's deckhand can switch on ashore on the instructions of the ferry pilot after mooring. The purpose of the light is to provide the ferry pilot with guidance during subsequent approaches to the ferry terminal when visibility is impaired.
[13] Estimation of the BSU against the background that a regular crossing from terminal to terminal (including berthing manoeuvres) takes about three minutes.

already disappeared from the ferry pilot's field of vision. He then managed to stabilise the ferry's course and manoeuvre her safely to the ferry terminal.

3.2 Consequences of the accident

3.2.1 Damage to the MV SCHELDEBANK

The collision with the canal ferry resulted in paint abrasions on the starboard side of the SCHELDEBANK's fore section (see **Figure 4**) and a deformation of the bulbous bow (see **Figure 5**).

Figure 4: Paint abrasions on the starboard bow of the SCHELDEBANK[14]

[14] **Source: WSA NOK.**

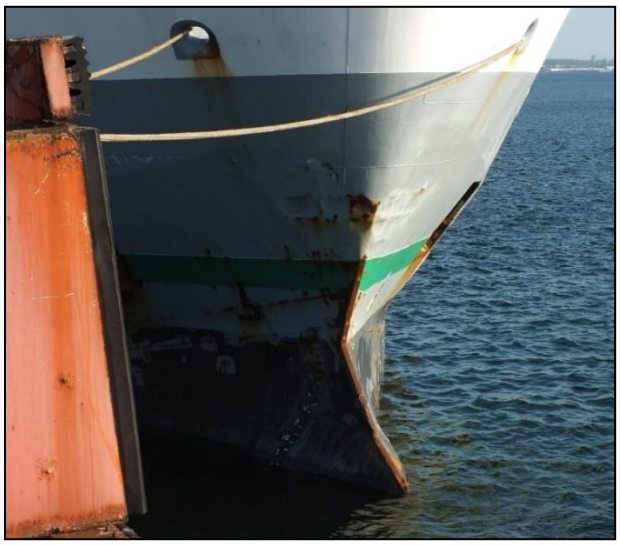

Figure 5: Deformation of the SCHELDEBANK's bulbous bow[15]

3.2.2 Damage to the HOCHDONN

The HOCHDONN was damaged on the vehicle side, which is opposite the control position located on the other side. The superstructure there was pushed in and the funnel buckled over (see **Figures 6 f.**). A compartment of the ferry's hull was also penetrated below the waterline on the side in question. However, this did not significantly affect the ferry's buoyancy (see **Figure 8**).

Figure 6: Damage to the ferry's starboard side[16]

[15] **Source: WSP Brunsbüttel.**

[16] 'Starboard side' refers to the direction of travel before the collision when the ferry was crossing from north to south. The photograph was taken immediately after the ferry docked at the southern terminal. The dense fog in the background illustrates the dreadful visibility at the time of the accident. The

Figure 7: Starboard side of the canal ferry pushed in[17]

Figure 8: Hole in the HOCHDONN's hull[18]

3.2.3 Injuries and environmental damage

No crew members were injured on board the SCHLEDEBANK, which only suffered superficial damage during the collision. Since the shell plating was not damaged (apart

Hochdonn High Bridge – located in the background about 300 m from the terminal – is completely invisible. **Source for these and the two figures below: WSA NOK.**

[17] In contrast to the above figure, the photograph was taken after the HOCHDONN had shifted from the terminal, i.e. after she had moored with her starboard side to the pier. The fog had lifted in the meantime.

[18] The photograph was taken during the repair works in the Rendsburg Branch Office maintenance hall of WSA NOK after the ferry was dry-docked there.

from paint abrasions and deformations), no operating fluids escaped from the hull of the ship.

Nobody on board the HOCHDONN was injured, either. One of the transported vehicles suffered minor bodywork damage due to contact with the ferry's deformed superstructure. Since the aforementioned hole in the hull did not affect a fuel or lubricating oil tank, the ferry did not cause any significant water pollution, either.

3.3 Investigation

3.3.1 Course of events, sources and material details

WSP Brunsbüttel notified the Federal Bureau of Maritime Casualty Investigation (BSU) about the collision between the SCHELDEBANK and HOCHDONN by phone on the day of the accident. Since the consequences of the accident were – at least at first glance – only minor and the SCHELDEBANK was able to continue under her own steam, an immediate on-scene investigation by a team of BSU investigators was dispensed with. Nevertheless, the BSU initiated a preliminary investigation shortly after the accident. In the course of this preliminary investigation, the GDWS was contacted with a view to obtaining the technical recordings of VTS NOK, which operates under its authority. The AIS and VHF recordings provided enabled the investigation team to gain a rough and (more importantly) chronological understanding of the course of the accident.

Since neither the SCHELDEBANK nor the HOCHDONN was equipped with a VDR[19] due to a lack of outfitting requirements, and since the VTS does not record radar traffic on the NOK, the BSU's options for reconstructing the course of the voyage of each vessel prior to the collision were extremely limited. Although it was possible to refer to the witness statements of the ship's command and the pilot of the SCHELDEBANK, as well as the ferry pilot on the HOCHDONN and the aforementioned AIS recordings of the VTS, their meaningfulness was extremely limited because of the clearly inadequate quality of the AIS signal transmission by the canal ferry. Moreover, due to the absence of radar images recorded on the vessels, it was not possible to verify with absolute certainty whether or at what time the approach of the two vessels in extremely dense fog could have been detected on the radar screens of each vessel.

The BSU's investigation therefore focused on fundamental aspects of the HOCHDONN's operation, as well as the ferry service on the NOK in general. In this context, sources of information included surveys and interviews during on-scene visits at the Hochdonn ferry crossing along with travelling on the sister ferry (the AUDORF) and at the WSA NOK maintenance and storage facility in Rendsburg when the repair of the HOCHDONN was carried out there. In addition, WSA NOK provided various documents relating to the ferry service in response to corresponding enquiries. The detailed report of the SCHELDEBANK's pilot and the investigation report provided by WSP Brunsbüttel were also important sources of information for the investigation team.

[19] VDR (voyage data recorder): Computer system on board seagoing vessels that continuously records various data relating to the navigational and technical operation of a ship for the purposes of analysis in the course of marine casualty investigations, in particular.

Moreover, the enormous willingness of the ferry pilot on the HOCHDONN to support the BSU's investigation objective is also noteworthy. Apart from his readiness to answer all the questions put to him, he also provided the investigation team with a bundle of documents that he had collected during his activities as a NOK lock master and, more importantly, later as a ferry pilot. These documents supplemented the information provided by WSA NOK and contributed to a better understanding of the organisational and legal framework surrounding the ferry service.

3.3.2 MV SCHELDEBANK (basic and bridge information)

The multi-purpose vessel SCHELDEBANK, built in 2007 and registered in the Netherlands, is equipped with a left-hand controllable pitch propeller, a high-lift rudder and a bow thruster. Moreover, she has modern bridge equipment that complies with international equipment regulations.

The navigation equipment available to the bridge team includes two independently operating ECDIS units. Each has a screen which is built into the bridge console and positioned next to a radar screen on the starboard side and on the port side. During the passage through the canal on the day of the accident, the pilot was seated in the chair mounted in front of the equipment combination on the port side. The chief mate had taken the seat in front of the equipment combination on the starboard side. There is a clear field of vision – over the display screens – ahead when seated in either chair. The master stood centrally between these two navigation positions in front of the helm console and steered the ship from there in accordance with the pilot's recommendations. The distance between the bridge windows and the ship's prow is 76 m, meaning that the fore section was at best only dimly visible from the bridge in the poor visibility of 50-100 m that prevailed on the day of the accident.

The two X-band[20] radar sets were operated in the head up[21] relative motion[22] display mode. Each was set to a range of 0.5 nm. Since the ship's own position had been off-centred on the display screens, i.e. placed at the lower edge, echoes were displayed on the radar images in the ahead direction in the range in question up to a distance of just under 1.0 nm.

In addition to the shipboard navigation equipment, the pilot also used his PPU, i.e. a portable computer that he had with him. Apart from various other functions that are helpful to the pilot, the PPU also offers the option of displaying the course of the piloted ship in an electronic chart display, together with the presentation of AIS data of the surrounding traffic. To access the ship's position and manoeuvre data with this device, too, the pilot used the standardised interface (the pilot plug) built into the bridge console specifically for this purpose.

[20] X- and/or S-band radar systems are used on ships regularly. They operate in different frequency ranges. X-band systems provide better resolution and detectability of small objects but are susceptible to interference from rain and sea clutter. S-band systems have a longer maximum range and are less susceptible to the above mentioned interference but are less sensitive in terms of detecting small vessels.

[21] In the head up display mode, the radar echoes are displayed ahead. The visual and radar image directions coincide.

[22] Relative motion means that the movements of other shipping (or echoes) are set in relation to the ship's own movement, i.e. they are displayed from the perspective of the ship.

Since the Dutch master and the chief mate, who was also from the Netherlands, spoke fluent German, they were able to communicate with the pilot in German without any problems. The master and the officer on watch were also able to understand the content of the traffic information[23] broadcast by VTS NOK every half hour in German over VHF radio due to their excellent knowledge of German.

3.3.3 Canal ferry HOCHDONN

3.3.3.1 Ferry arrangements on the NOK

The WSV provides a total of 14 ferries (not maintaining connecting lines) on the NOK at 12 crossings (in each case, two ferries operate at Brunsbüttel and Nobiskrug/Schacht-Audorf due to the extremely high volume of traffic there). In addition, two reserve ferries are kept on standby. In addition to these 16 WSV-owned ferries, which a private shipping company was commissioned to operate a few years ago, there is also a small passenger ferry near Kiel-Holtenau, which is provided and operated by a private company on behalf of the WSV, as well as the transporter bridge near Rendsburg.

The ferries are subject to the national regulations applicable to the operation of inland vessels[24]. Extensive maintenance works are carried out every two to three years in a WSV-owned repair facility in the course of the survey that is required to maintain the operating licence (so-called seaworthiness certificate). Accordingly, the HOCHDONN's last major inspection for basic maintenance was carried out about three months before the accident.

Following an EU-wide call for proposals, the Baltic Workboats shipyard in Estonia was awarded a contract for the construction of three environmentally friendly 45 t ferries for the NOK in December 2018. The new-builds will replace the oldest three ferries, i.e. the NOBISKRUG, the HOCHDONN and the AUDORF. Two of the three new ferries have now been delivered and are currently being used to train technical staff and ferry crews. In addition, the ferry terminals have to be upgraded for the operation of the new ferries. According to the current state of play, the first ferry is scheduled to begin operation at the Hohenhörn ferry crossing, the second one in Hochdonn (both on the NOK west section) and the third at the Nobiskrug ferry crossing (NOK east section).

3.3.3.2 Basic and bridge information

The HOCHDONN (ferry with no connecting lines) together with her identical sister ferry AUDORF and the NOBISKRUG, which is very similar in terms of the external and internal design of the bridge operator stand, was put into service in the early 1950s and can transport passengers and vehicles with a total mass of 45 t.

Basically, the NOBISKRUG differs from the HOCHDONN and the AUDORF only in terms of the docking arrangements. The NOBISKRUG has so-called 'flaps', which are lowered hydraulically when she reaches the bank so as to establish the connection

[23] The all-stations call notifies shipping on the NOK about the current traffic situation in the various sections of the canal, about temporary hazards and about restricted visibility, for example.
[24] See the *Binnenschiffsuntersuchungsordnung* [German Inland Waterways Vessel Inspection Ordinance] and the *Fährenbetriebsverordnung (FäV)* [German Ferry Operation Ordinance], *inter alia*.

between her and the bank. In contrast, the HOCHDONN and the AUDORF have pointed bows. The ferry flaps typical for the ferry service are not installed on board but ashore. When docking, the ferry pushes her pointed, shallow bow underneath this ferry landing flap, which is balanced by counterweights, with her own propulsion system.

Over the decades, the three above ferries have been modernised in terms of navigational equipment and technically. For example, the side control position (see **Figure 9**) has been raised so that the ferry pilot can still look over the vehicles that have 'grown' in height over the years. Nevertheless, bridge ergonomics and general comfort (e.g. with regard to heating, air conditioning, windows, insulation, visibility) no longer meet today's standards.

Figure 9: Side deck superstructure with bridge operator stand

The control/operation of the ferries, which are equipped with two Voith Schneider propellers for redundancy reasons and are very easy to manoeuvre, is carried out via so-called levers, which is why these ferries are also referred to internally as 'lever ferries' (see **Figure 10**).[25]

Figure 10: Control position on the HOCHDONN with lever control (view towards the bridge door)

The HOCHDONN (as well as her sisters) does not perform any turning manoeuvres when crossing the canal or mooring on the northern or southern bank. Rather, people and vehicles board the ferry at one end (longitudinal) and leave her at the other end after the crossing.

This means that the longitudinal (in relation to the vessel) bridge operator stand is on the starboard side during the south-north crossing and on the port side during the north-south crossing.

Depending on the time of day, the ferry pilot works alone in the extremely narrow bridge operator stand during his seven- or ten-hour shift (see **Figures 10 f.**). He stands (or sits temporarily on a folding seat – see red dashed outline in **Figure 11**) while steering the ferry. Since the console with the various controls, the VHF radio, the radar screen and the AIS display also runs in the longitudinal direction of the vessel, the ferry pilot must turn his gaze, which is normally directed at the vehicle deck or in the longitudinal direction of the NOK, 90 degrees to the left or right in order to visually 'aim' for the respective berthing position. This, in turn, is an essential part of executing the berthing manoeuvre. There is no technical assistance in this regard (in the sense of automatic/semi-automatic guidance or a graphic display).

[25] In contrast, the NOK ferries that were put into service later are steered with the help of joysticks and therefore referred to internally as 'joystick ferries'.

Figure 11: The HOCHDONN's control position (bridge door behind the photographer)[26]

In adverse visibility conditions, the ferry pilot has the option of using a special searchlight mounted at the ferry terminal (the so-called fog light) for guidance when approaching the ferry terminal (see **Figure 12** below). However, the light in question is not switched on remotely from the control position, but rather by the deckhand using a switch at the respective ferry terminal, i.e. when the ferry has made fast there. This means that the light at each ferry terminal must be switched on in good time when visibility begins to deteriorate so as to be able to use the guidance function during the next berthing manoeuvre.

When speaking with the investigators, the HOCHDONN's ferry pilot commented critically on the fact that under certain circumstances the lights have a dazzling effect, which may impair their guidance function.

[26] Folding seat (red dashed outline).

Figure 12: The northern ferry terminal at Hochdonn (fog light switched on)

Apart from the fog light and making for the terminal with the help of the naked eye, the only other option available to help the ferry pilot reach the terminal in adverse visibility conditions is to identify its contour using an appropriate range setting on the radar set.

With regard to the visibility conditions when visually aiming for the ferry terminal, it is worth noting that for the north to south crossing the wooden bridge bulkhead then at the front end of the bridge operator stand must be open, otherwise the ferry pilot's view in the direction of the (southern) ferry terminal being approached is obstructed (see **Figure 10** above). On the other hand, when crossing in the opposite direction (i.e. from south to north), the ferry pilot has to look through a bridge window, which is opposite the bridge bulkhead in the longitudinal direction and divided in half horizontally (see **Figure 11** above). In this respect, the physical visibility conditions for the ferry pilot are even more limited than in the reverse case.

Moreover, the atypical situation that there is only one bridge/operator console at the control position, notably, one configured in the longitudinal direction, means that regardless of the ferry's direction of travel, the ferry pilot actually has to change his gaze by 180 degrees (i.e. turn away from the bridge console completely) if he wants to observe the traffic approaching the ferry from the east instead of from the west (i.e. from the direction of the railway bridge), which is in his usual line of sight.

The following images, which were taken when the investigation team travelled on her sister ferry (the AUDORF) after the accident, illustrate this problem. The AUDORF was situated at the northern ferry terminal when the images were taken. The ferry pilot was waiting for the passage of a westbound tow. To be able to see the tow approaching 'behind his back' from the east, he was forced to turn around and look out from one of the rear windows of the bridge operator stand (**Figure 13**). He could then turn back to his control position after the tow had passed and thus look back towards the railway bridge, i.e. to the west (**Figure 14**).

Figure 13: View of a tow approaching from the east
from one of the rear windows on the AUDORF's bridge

Figure 14: View of the tow moving away to the west
from one of the front windows on the AUDORF's bridge

3.3.3.3 Crew, qualification and shift plan

In accordance with applicable regulations[27], the ferry's crew consists of the ferry pilot and only one other person (the deckhand). The deckhand is responsible for the organisation of passengers boarding and leaving the ferry. To this end, he opens and closes the double barrier installed ashore, i.e. at the ferry terminal, as well as the barrier on the ferry for the release of the shore connection. He assigns parking positions to the vehicles driving onto the deck and determines the order in which they leave the ferry.

During their initial training, deckhands working on the NOK ferries are familiarised with operating arrangements to the extent that they are able to steer a ferry safely to the terminal if the ferry pilot is suddenly incapacitated. In order to maintain the relevant skills, deckhands are required to perform sailing manoeuvres under the guidance of the ferry pilot at least once a month, taking into account the general traffic situation and without any vehicles or passengers on board.[28]

The deckhand has a cabin beneath the ferry pilot's control position (see **Figure 15**). The deckhand was in this cabin when the accident happened.

Figure 15: Door to the deckhand's cabin and view of the interior

[27] See Section 113 of the *Binnenschiffspersonalverordnung (BinSchPersV)* [German Inland Waterways Personnel Ordinance] (minimum crew on car ferries).

[28] The requirements set out in this and the preceding paragraph were laid down in points 7.1.3 and 8 of the official instruction for ferry crews of WSAs Brunsbüttel and Kiel-Holtenau for the ferry pilot and for the deckhand, respectively. The official instruction issued by the private operator in 2018, in force since the privatisation of the ferry service, does not contain any comparable rules. According to a ferry pilot interviewed, the deckhand is still responsible for the duties in question (including at least initial instructions on how to act as a ferry pilot in an emergency), however.

According to Section 7 of the *Binnenschifferpatentverordnung (BinSchPatentV)* [Ordinance on Boatmasters' Certificates for Inland Waterway Navigation][29], which was still relevant at the time of the accident, ferry pilots serving on NOK ferries were required to hold a 'Boatmasters' Certificate A' or a certificate of competency with master's licence. Furthermore, a radar certificate[30] and a national radio certificate (at least a short range certificate or a limited radio operator's certificate) are required.

In 1986, the HOCHDONN's ferry pilot obtained the certificate of competency as a master on medium-range vessels in accordance with the regulations of the time. He took up his duties as a ferry pilot in 2013. Prior to that, he worked for many years as chief lock master at the NOK's Brunsbüttel lock. After reaching retirement age in the summer of 2019, he continued to work as a ferry pilot on a part-time basis as a substitute and had about three to five assignments per month at various ferry crossings. At the time of the accident, the ferry pilot held valid certificates of fitness for service at sea and for inland waterway transport.

Alongside his professional activities on the NOK, he has been a regular volunteer as a skipper on inland waterway vessels in a museum port since 2011.

The crews on the NOK ferries perform their duties in a three-shift system. The following working hours apply for the Hochdonn ferry crossing:

Early shift: 0545 until 1245
Late shift: 1245 until 1945
Night shift: 1945 until 0545

3.3.3.4 Trip on the sister ferry AUDORF

On 7 July 2020, the investigation team surveyed the identical canal ferry AUDORF, which was in regular service at the Hochdonn ferry crossing at the time in question. For a period of about 1.5 hours, the operational ferry service and, in particular, activities of the ferry pilot were observed from the control position and from the main deck during various canal crossings. One crossing took about three minutes, including docking and casting off. On each arrival at the respective canal bank, the vehicles and people waiting there were taken on board immediately and then – as long as no transiting (= priority) canal traffic had to be waited for – the opposite ferry terminal was immediately made for again.

[29] Since 18 January 2022, uniform conditions for the acquisition and recognition of professional qualifications in inland waterway transport have applied throughout the EU on the basis of DIRECTIVE (EU) 2017/2397 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2017 on the recognition of professional qualifications in inland navigation and repealing Council Directives 91/672/EEC and 96/50/EC. In this context, the previous BinSchPatentV was replaced by the BinSchPersV on 7 December 2021 in Germany.
[30] Radar certificate (certificate of proficiency valid throughout Europe). It is needed in order to navigate an inland waterway vessel in reduced visibility or at night with the aid of a radar device.

Findings and impressions already made by the investigation team shortly after the accident during the survey of the HOCHDONN in the WSA NOK's repair facility in Rendsburg were confirmed. In this respect, the conversation with the ferry pilot responsible at the control position of the AUDORF, who willingly provided information on the daily work routine on the ferry, was extremely helpful.

Confirmed or newly made findings during the trip on the AUDORF:

- the AUDORF, the HOCHDONN and the NOBISKRUG, and in particular their control positions, are extremely outdated and do not offer any modern comforts for the work of a ferry pilot (in particular with regard to temperature, visibility, draught, dampness, arrangement of operating and display equipment, line of sight, whistling/permanent interference noise from the radio);
- the steering system (lever instead of joystick) is basically not a problem;
- however, the so-called 'joystick ferries' have the advantage that the ferry pilot has two sets of bridge equipment (including radar screen). Depending on the ferry's direction of travel, the ferry pilot uses one of the two control positions, i.e. the one facing the ferry terminal, and therefore does not have to look 90 degrees to the left or right from a control position pointing in the direction of the canal in order to visually 'aim' for the ferry terminal. Since his gaze is directed towards the ferry terminal, the problem of having to turn around completely in order to be able to see vessels approaching from 'behind his back' is also eliminated;
- depending on the traffic volume and external conditions, the work of a ferry pilot can be extremely demanding. The ferry pilot is exhausted after a shift, especially if intense concentration is required at night or when visibility is restricted for other reasons;
- the shift system for full-time ferry personnel is as follows: two days on early shift, two days on late shift, two night shifts and then two days off;
- in addition to visual observation and use of the radar, the all-stations call from the traffic controller (VTS NOK) constitutes another important traffic situation input for the ferry pilot. The installed AIS receiver is only of secondary importance and hardly used due to its susceptibility to interference and lack of practicality[31];
- a particular hazard with regard to safe ferry operation stems from the fact that operators of recreational craft (and for some years now also canoes) use the canal and do not always comply with the requirement that they must head for the shore in adverse visibility conditions and are therefore not allowed to continue their voyage;
- ferry pilots are usually employed on only one ferry or at only one ferry crossing. However, in some cases the ferry pilots switch to other ferries/ferry crossings as a substitute;
- good cooperation between the deckhand and ferry pilot is an important aspect of safe ferry operation. Apart from their actual duties (described above), deckhands are prepared to act as lookout[32], for example, on their own initiative to varying extents.

[31] See Ch. 3.3.3.6.
[32] On the question of whether the deckhand must also act as a lookout, see the comments below in Ch. 3.3.5.3.

3.3.3.5 Radar set

3.3.3.5.1 Type and range of functions; display mode

A SWISS RADAR Precision Navigator II river radar set is installed as a central navigation aid on the HOCHDONN's control position directly in front of the control levers (see below **Figures 16 ff.**). It is a so-called X-band device. Depending on the version selected, an electronic chart or AIS signals can be displayed on this type of device. However, the device installed on board the HOCHDONN does not have these operating modes. None of the versions of this type of device has an ARPA[33] function.

The device is equipped with a 19" TFT flat display screen installed in portrait format. The portrait format provides a (geometrically) advantageous image of the traffic approaching the ferry from both directions of the canal. The high-contrast display screen has excellent readability, even in high ambient brightness. Five colour combinations for day and night are available at the touch of a button. The display screen's brightness can be adjusted by means of a rotary knob on the keyboard.

Figure 16: Radar set
(control position on the HOCHDONN)

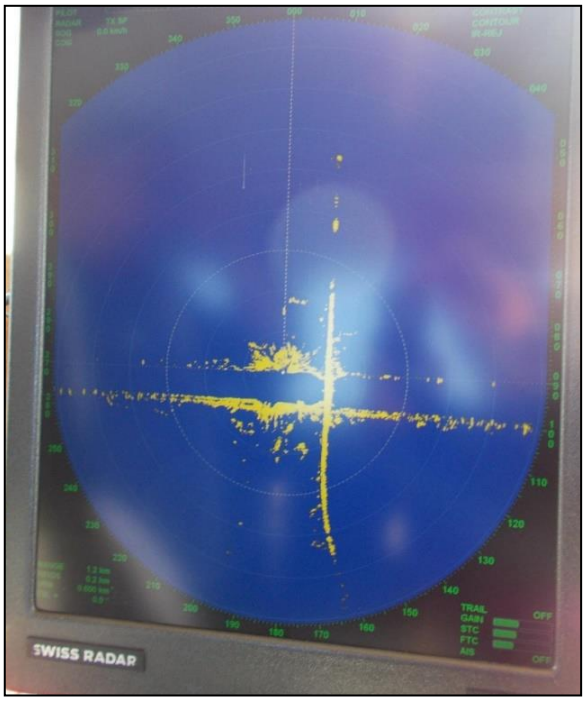

Figure 17: TFT monitor[34]

[33] ARPA (automatic radar plotting aid): Feature in modern radar sets used to automatically track and display the course of the voyage (course, speed) of selected radar echoes both graphically (as a vector) and numerically (at the edge of the display screen).
[34] **Source: WSP.**

Figure 18: Control panel for the radar set on the HOCHDONN[35]

It should be noted that the radar image above in **Figure 17** was taken shortly after the accident when the HOCHDONN had been taken out of service and moored alongside at a pier near the southern ferry terminal. The radar image orientation corresponded with the setting used by ferry pilots in shuttle service. It is a modified head up display, where head up refers to the ferry pilot's forward viewing direction when standing at the control position, rather than the direction of travel as is normally the case. Accordingly, the view ahead from the control position of the ferry, which was moored alongside, was directed towards the canal's southern bank; therefore, in **Figure 17** it is at right angles to the apparent ahead direction and the railway bridge to the west is parallel to the line of vision.

In contrast, regardless of whether the ferry is travelling from north to south or from south to north, the ferry pilot's view ahead is of the railway bridge when she is in regular shuttle service, while the respective canal banks are abeam of the radar's apparent forward direction. In **Figure 19** below, which was taken on the AUDORF's control position during a regular shuttle crossing on the NOK, the modified head up image (logically) implies that the railway bridge in the radar image runs at right angles to the ferry's apparent ahead direction and parallel to her actual course (= red dashed outline in **Figure 19**).

[35] The control panel is identical on all versions of the SWISS RADAR Precision Navigator II. The MAP, ECDIS and AIS keys have no function on the version installed on board the HOCHDONN.

Figure 19: Radar image (the AUDORF), range = 1.2 km[36]

3.3.3.5.2 Use of the radar

According to the ferry pilot interviewed during the trip on the AUDORF, the following ranges are used for radar monitoring, depending on visibility conditions, the specific need for information and the personal preferences of the ferry pilot: 0.4 km, 0.5 km, 0.8 km and 1.2 km. As is generally the case with radar sets, predefined range markers can be superimposed on the radar image at a constant distance for the particular range. The distance between the rings is 0.1 km in the 0.4 and 0.5 km range and 0.2 km in the 0.8 and 1.2 km range. It is also possible to display a user-definable range marker and an electronic bearing line in the radar image within the radius.

Ferry pilots use the 1.2 km range with range markers displayed at an interval of 0.2 km as the default setting. This setting was reportedly also selected on the day of the accident. Reportedly, a variable range marker with a radius of 0.6 km was also set (see **Figure 17** above).

[36] The AUDORF was moored at the southern ferry terminal at the time in question. With regard to the technical differences with the HOCHDONN's radar, see the remarks in Ch. 3.3.3.5.2.

The following findings on the practical use and quality/reliability of the radar image display were made especially during the trip on the AUDORF. It should be noted that the radar set installed there is a forerunner (SWISS RADAR JFS 364 C) of that installed on the HOCHDONN. With regard to setting options, range of functions and transmit/receive power, both versions are extremely similar. However, the 19" flat screen installed on the AUDORF does not have the option of displaying the radar image in different colour combinations but rather only displays identified echoes in white on a black background.

In the below images (**Figures 20 f.**), the AUDORF was situated at the southern ferry terminal. The images show a chemical tanker (length: 119 m) approaching the railway bridge as a photograph and next to that as a screenshot of the radar image (in the above default setting) eight seconds later. In the ahead direction (i.e. in relation to the ferry pilot's view straight ahead, or west of the ferry line), the echo of the railway bridge crossing the canal is clearly recognisable in the radar image section as a horizontal bar crossing the radar heading line. The tanker, having just reached the 0.6 km range marker, is clearly indicated as an echo even at this rather unfavourable 'viewing angle' of the radar antenna, i.e. in spite of the interference caused by the canal bank running parallel to the radar's visual beam. The bridge situated between the ferry and the tanker has no adverse effect on the visibility of the vessel approaching the ferry line. The tanker passed the ferry crossing almost two minutes after these images were taken.

Figure 20: A tanker approaches

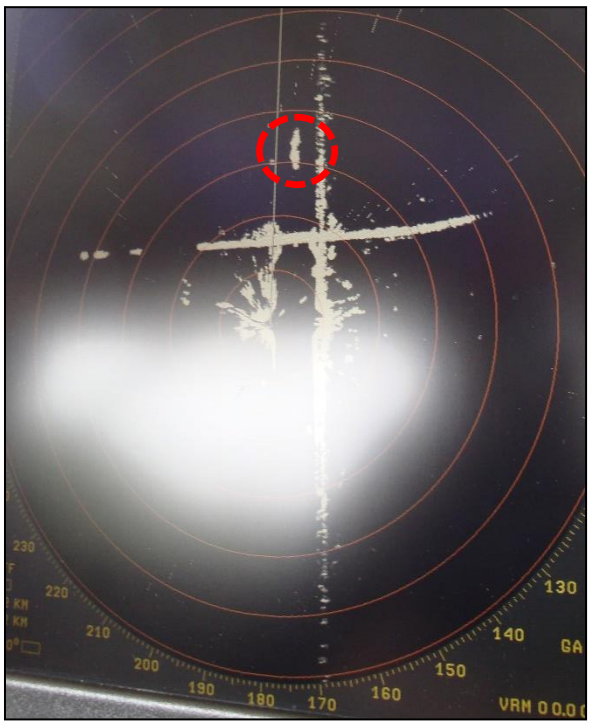

Figure 21: Corresponding radar image[37]

[37] The bright spot on the radar image is caused by the flash of the camera.

According to the ferry pilot and also to the actual observations of the investigation team made during the trip on the AUDORF, the bridge or its echo does not noticeably complicate the assessment of radar images, at least not for larger vessels. Only in the case of smaller vessels, e.g. sailing yachts, could it be determined that their echoes temporarily merged with that of the bridge at some point in the course of approaching the bridge and – depending on the size and speed of the particular vessel – only separated from the echo of the bridge again after 30 to 60 seconds.

During the trip on the AUDORF, the question as to what aids are available to the ferry pilot when approaching the ferry terminal, especially in limited visibility, was also considered in practical operation. In addition to the fog light already discussed above and demonstrated during the trip, apart from looking out of the window or the open control position door (depending on the direction of travel), only the radar image can be used for rough orientation.

The image below (see **Figure 22** – range of 0.4 km and marker intervals of 0.1 km; ferry at the southern terminal) was set by the AUDORF's ferry pilot to illustrate to the investigators that he can only display the ferry terminal (the northern one in this case – see red dashed outline in the Figure) by radar very roughly when he approaches it in dense fog.

Figure 22: Radar view of the northern ferry terminal at Hochdonn

3.3.3.6 AIS

3.3.3.6.1 Device information

Apart from the radar, the only other technical aid for traffic monitoring installed on the HOCHDONN's control position (as well as on the AUDORF and all other NOK ferries) is a SIMRAD V5035 AIS. It is a Class A transceiver approved for international navigation, where it belongs to the outfitting requirements of merchant vessels of 300 GT and above, and can be used to receive AIS data from other vessels and send a ship's own AIS data. The device has an integrated GPS receiver and is also approved and used as an inland AIS.[38] With the exception of the GPS and VHF antennas, the transceiver technology is installed in a compact housing equipped with operating controls (six function keys, on/off switch, rotary knob with touch function) and display (a stand-alone system, i.e. not integrated with other technology). It is mounted directly above the steering position on the ceiling at the HOCHDONN's control position (see **Figure 23** below).

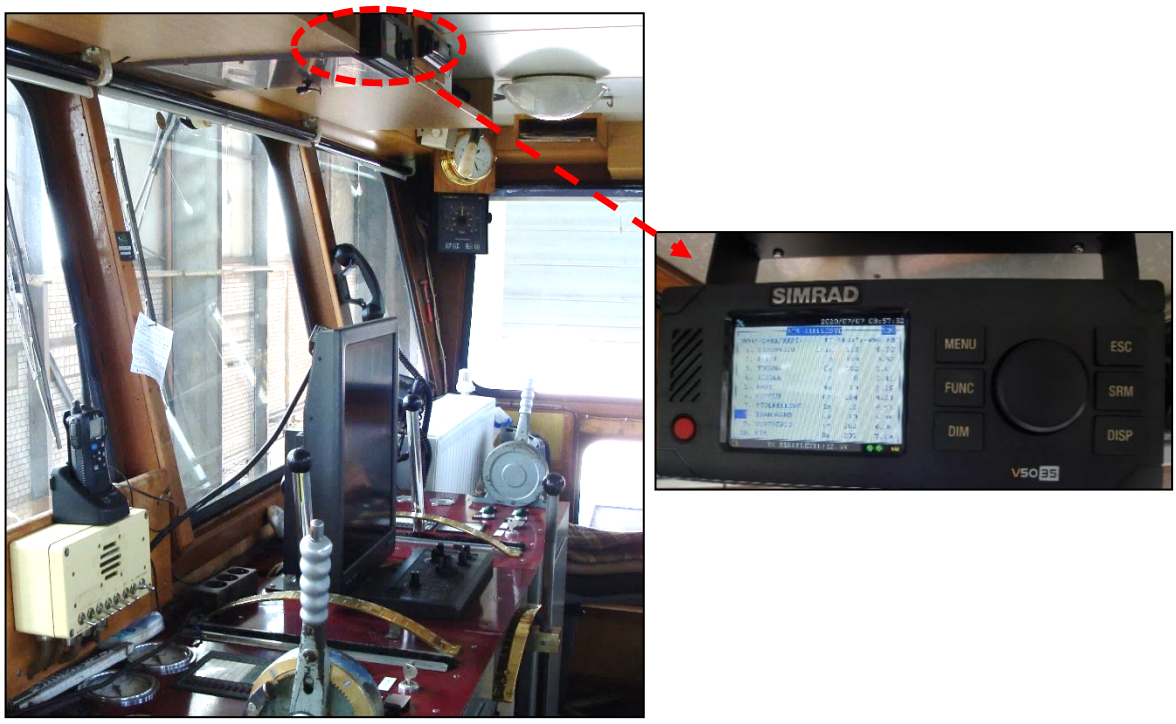

Figure 23: AIS device above the steering position

3.3.3.6.2 Display options

Although the device has the technical capability (interface) to transfer received AIS data as NMEA data to an electronic chart display, since such a system is not on board the HOCHDONN and data transfer to the radar set is not part of the functional scope either there or on the part of the AIS transceiver, the only display equipment available to the ferry pilot is the 3.5" colour TFT built directly into the unit.

[38] Inland AIS systems and Class A AIS systems are technically largely comparable and compatible. However, inland AIS systems have a wider range of functions. In contrast to Class A systems, they can evaluate and send additional information specific to inland navigation (e.g. total length of a pushed convoy, dangerous goods class of inland water transport).

This display is needed to configure the device. It is primarily used to display received AIS signals in tabular form or graphically in various other ways. In this respect, the user can choose between four display modes: coastal view, radar view, AIS target list, list of dangerous targets.

In **coastal view mode**, received AIS signals are embedded in a graphical representation of the coastline. The user has various zoom levels available to change the scale in which the coastline is displayed. It should be noted that the chart display only provides summary information to assist with orientation. It is not based on an official (electronic) navigational chart and as such (apart from the entirely unsuitable display size) cannot be used for navigation. The lack of functionality in this regard is already evident in relation to the use in the NOK by the fact that as a waterway the canal is not displayed as hydrographic information at all (see **Figure 24** below).

Figure 24: AIS display (coastal view mode)

Figure 25: AIS display (radar view mode)

In **radar view mode** (see **Figure 25** above), the display of AIS targets is similar to that in which vessels are displayed on a radar screen.[39] Users can choose between the options north up, course up and head up and use various zoom levels.

The coastal view and radar view display modes are identifiable by the fact that data from the user's own ship (longitude and latitude of position, speed and course over ground) are displayed in the top data field on the right half of the screen and AIS data for a target selected by the user are displayed in the bottom data field.[40]

The **AIS target list mode** allows the user to display received AIS data or associated vessels in tabular form. The user can also select the individual targets to obtain further information. Four subpages with details on the respective vessel that were transmitted via AIS are then available (see below **Figures 26 ff.** [41]).

[39] It is merely a graphically comparable display method. There is no link with actual radar echoes.
[40] The photographs shown in **Figures 24 ff.** were taken on board the HOCHDONN, which was moored alongside at a berth to the west of the Hochdonn ferry terminal at the time. The data shown at the bottom right belong to the AUDORF, which was in service at the time in question.
[41] Subpages 3/4 and 4/4 (see **Figures 29 and 30**) are only relevant for inland navigation and indicate (additional) inland AIS data.

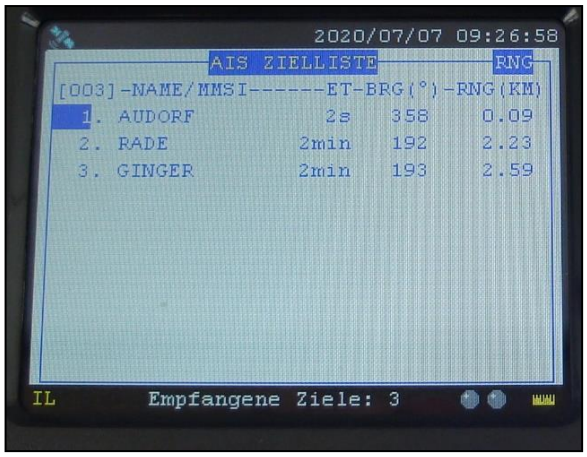

Figure 26: AIS display (target list mode)

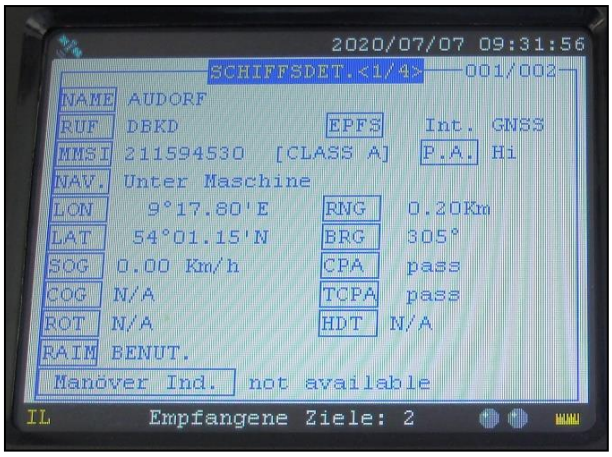

Figure 27: AIS display (ship details 1/4)

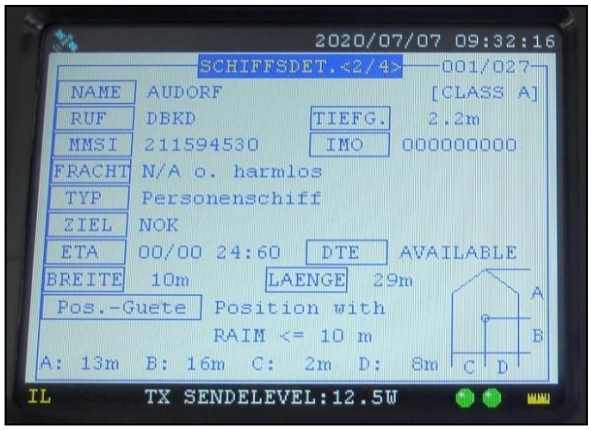

Figure 28: AIS display (ship details 2/4)

Figure 29: AIS display (ship details 3/4)

Figure 30: AIS display (ship details 4/4)

In addition to the modes described above for displaying AIS targets, the AIS device installed on board the HOCHDONN also has the **own ship details** and **GPS satellite information** display modes.

The **own ship details mode** lists data from the user's own ship that are transmitted via AIS and/or were pre-set while configuring the AIS transceiver on four pages (see **Figures 31 f.** below[42]).

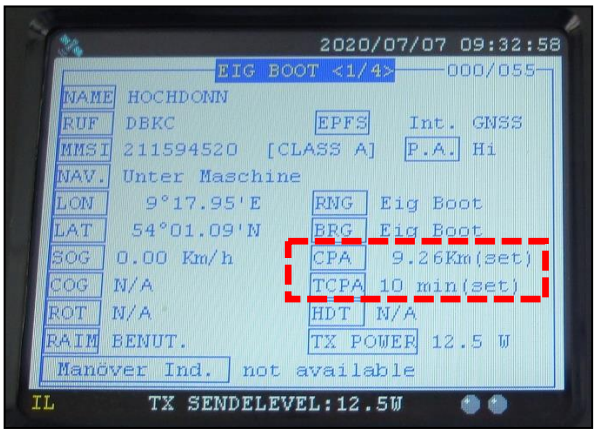

Figure 31: AIS display (own ship data 1/4)

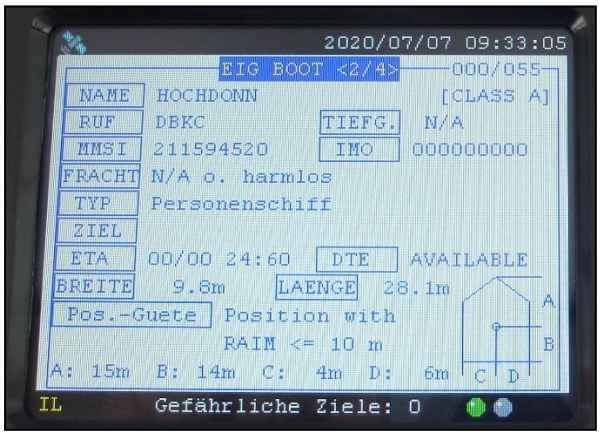

Figure 32: AIS display (own ship data 2/4)

Of particular practical importance (at least in maritime navigation) is the option to set an alarm range for the CPA[43] (i.e. a defined radius for AIS targets) and the alarm time for the TCPA[44] for these targets (see area in red dashed outline above in **Figure 31**). As soon as AIS targets cross the relevant limits, the device adds them to the **list of dangerous targets**. The user can select the corresponding tabular overview as a display mode with the same name as an alternative to the other display options. In the coastal view and radar view modes, AIS symbols of vessels triggering an alarm are no longer displayed as black but rather as red triangles that are additionally circled in red. An audible alarm that indicates that the CPA and TCPA limits have been crossed can also be enabled.

The CPA reading of 9.26 km, which can be seen in **Figure 31** above and which is meaningless in terms of the operation of the NOK ferry, shows that the CPA/TCPA alarm function was evidently not used on board the HOCHDONN.

The **GPS satellite information mode** enables the user to display the reception status for the current signal of the GPS module installed in the AIS device (**Figure 33**).

[42] Pages 3/4 and 4/4 are only relevant if the device transmits inland AIS data. Related (in this case irrelevant) images are omitted.
[43] CPA: Closest point of approach.
[44] TCPA: Time to closest point of approach.

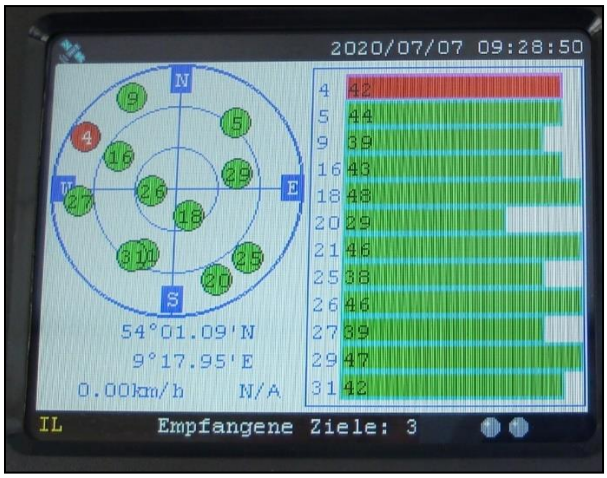

Figure 33: GPS satellite information display mode

3.3.3.6.3 Actual use on board

During the trip on board the AUDORF, the ferry pilot was highly critical of the use and practical value of the AIS device. He believed that it was merely an additional and extremely secondary source of information. The devices had reportedly been installed on all NOK ferries some time ago (as a replacement for older models) and were highly susceptible to interference. Reportedly, this was possibly due to antenna problems.

Training on the equipment had reportedly not been provided. He reportedly began to read the operating manual, comprising some 130 pages, some time ago out of interest but then put it aside again rather quickly. Accordingly, he was unable to comment on details of the operation or configuration of the device when asked and only able to switch back and forth between the various display options described above, which is simply a case of pressing the DISP button several times, as required.

The AUDORF's ferry pilot confirmed it was possible to enable a CPA/TCPA alarm when asked. However, the audible alarm had reportedly been switched off because it would inevitably be triggered by the constant canal traffic, which – given the width of the canal – would naturally always pass the ferry in relatively close proximity. It is reportedly also important to remember that rather than being perceived as an important warning, a constant alarm tends to be ignored.

In addition to the disabled audible warning, the AIS device on board the AUDORF also displayed vessels approaching dangerously (sporadically?) colour highlighted (in red). In this respect, too, the observation of the investigation team was that the AIS device as a whole (possibly only due to an unfavourable device configuration and/or lack of user training) contributed little to the recognition of or was apparently not used in a targeted manner to recognise collision hazards or even to be effectively warned about them.

The HOCHDONN's ferry pilot on duty on the day of the accident emphasised to the BSU's investigation team that from time to time the AIS device would not display any or only individual AIS targets. Since the device reportedly failed to display the

SCHELDEBANK's AIS signal, such an error must reportedly also have existed on the day of the accident. He also did not give the impression of having derived any particular practical benefit from the AIS device in the past.

The above statements on the susceptibility to faults coincide with a handwritten note indicating several sporadic transmit and receive faults. The investigators discovered this on the ferry's control position during the survey of the HOCHDONN at the Rendsburg repair facility. The note was attached to a window frame and probably from a ferry pilot, presumably as a warning to colleagues (see **Figure 34**).

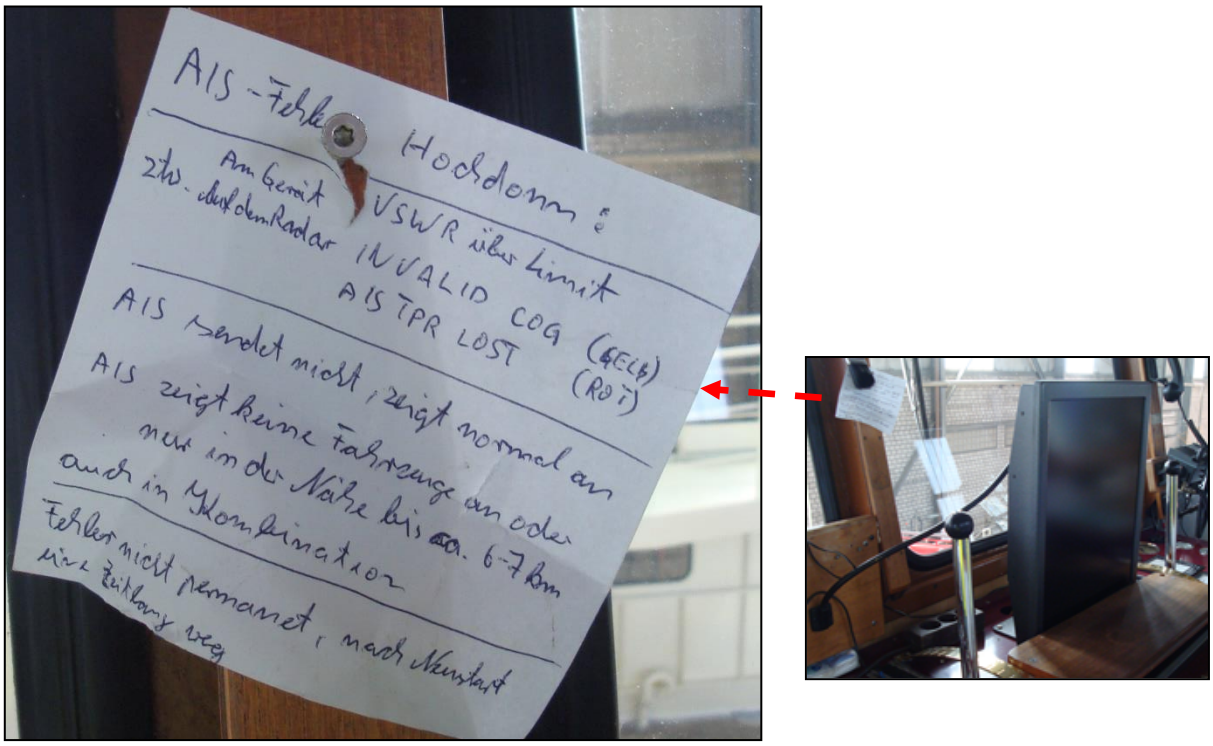

Figure 34: Note indicating AIS device fault

Immediately after the trip on the AUDORF, the investigation team went on board the HOCHDONN, which was moored alongside at a berth on the southern bank of the canal, and gained an understanding of the operating concept, the range of functions and the performance of the AIS device. The device was evidently not working as it should at this point in time, either, as it only listed three AIS signals even though there was heavy traffic on the NOK at the time in question and the AIS target list seen on board the AUDORF shortly beforehand had been far more extensive accordingly (see **Figures 35 f.** below).

Figure 35: AIS target list on the AUDORF (0857)[45]

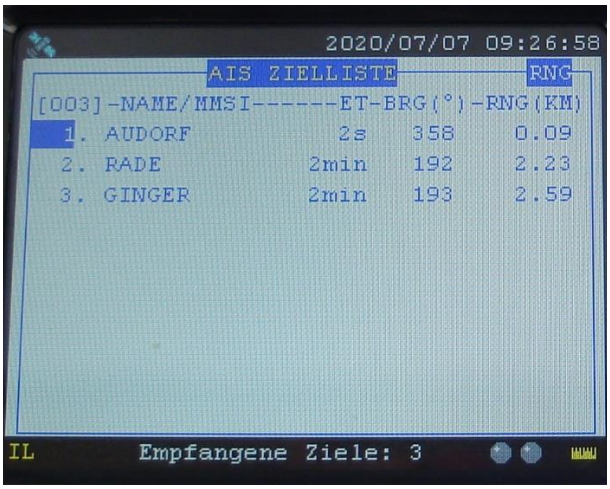

Figure 36: AIS target list on the HOCHDONN (0926)

3.3.3.6.4 The HOCHDONN's AIS signal

According to the ship's command and the pilot on the SCHELDEBANK, the HOCHDONN's AIS signal continuously gave the impression that the ferry was static at the northern ferry terminal (see **Ch. 3.1.1** above) in the crucial minutes and seconds leading up to the collision.

The recording of the SCHELDEBANK and HOCHDONN's AIS data provided to the investigation team by the WSV deliver extremely convincing proof of the observations expressed, as well as information on the SCHELDEBANK's course and speed[46].

In **Figure 37** (about three minutes before the accident), the SCHELDEBANK (blue dashed outline) is still some 350 m west of the railway bridge, which crosses the canal horizontally in the middle of the image. The HOCHDONN's AIS symbol (red dashed outline) gives the impression that the ferry has just or only recently arrived at the northern terminal due to the vector pointing northwards beyond the northern ferry terminal.

[45] The times shown in Figures 35 f. are UTC.
[46] With regard to the SCHELDEBANK's tracking information, see the data field at the right-hand edge of the following figures.

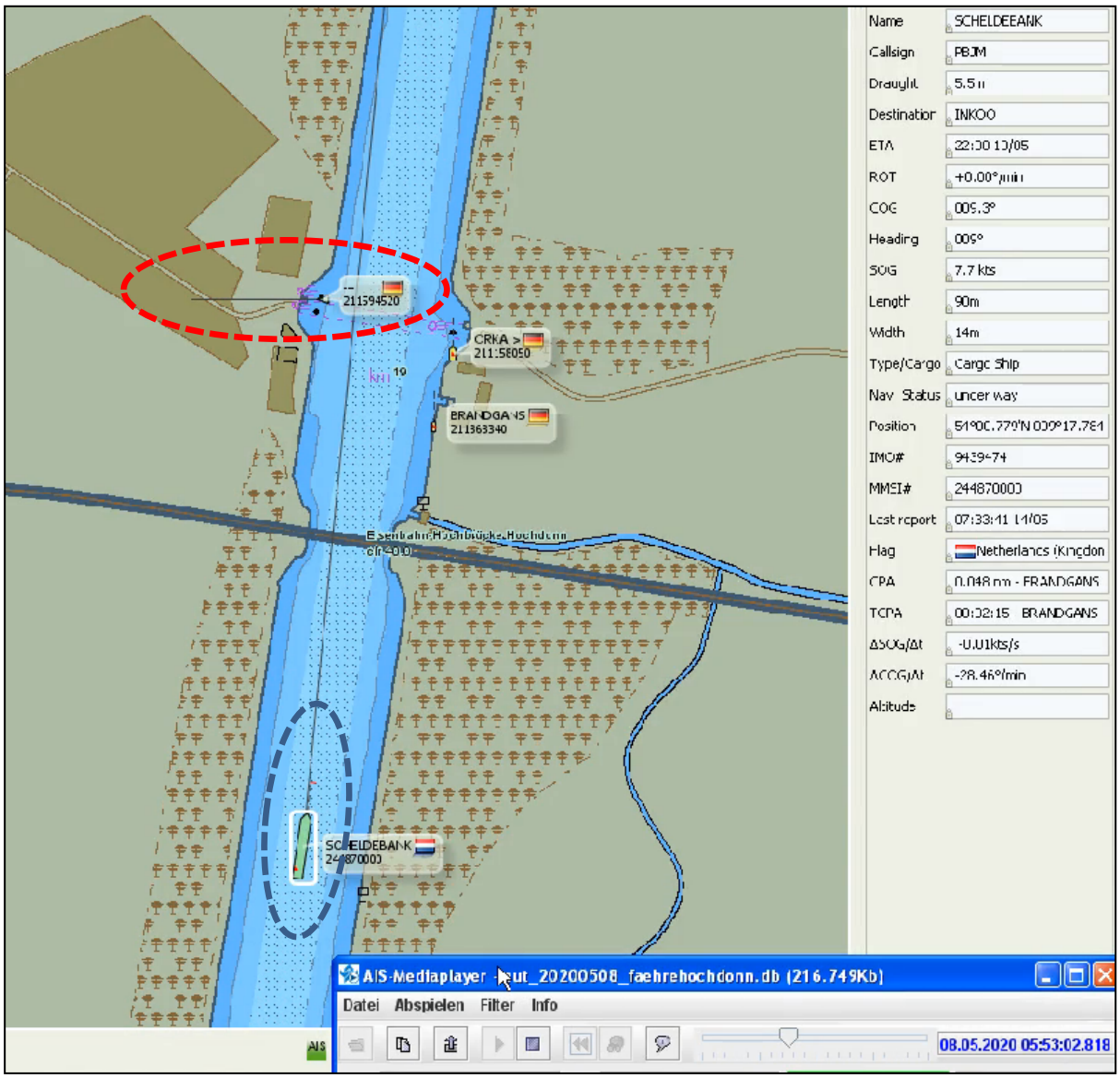

Figure 37: WSV AIS recording (situation at 055302 UTC)[47]

In **Figures 38 f.** below, the SCHELDEBANK has reached the railway bridge about 300 m away from the ferry line. The HOCHDONN's vector changes direction in the course of the two screenshots, i.e. it is directed towards the opposite bank of the canal from about 055428 UTC. However, the HOCHDONN's AIS symbol remains unchanged at the northern edge of the NOK.

[47] This and the following figures are selected screenshots taken from the replay of the WSV's AIS recording. The following figures have been cropped at the bottom edge to concentrate on the image's essential statement.

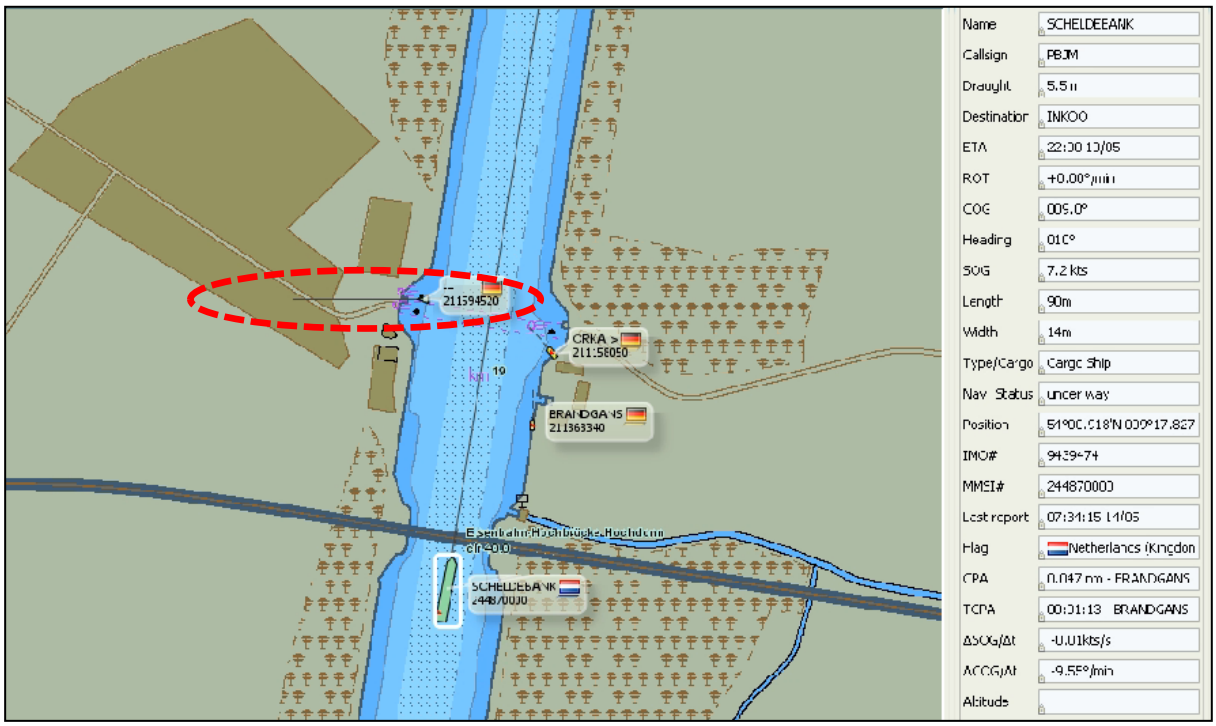

Figure 38: WSV AIS recording (situation at 055416 UTC)

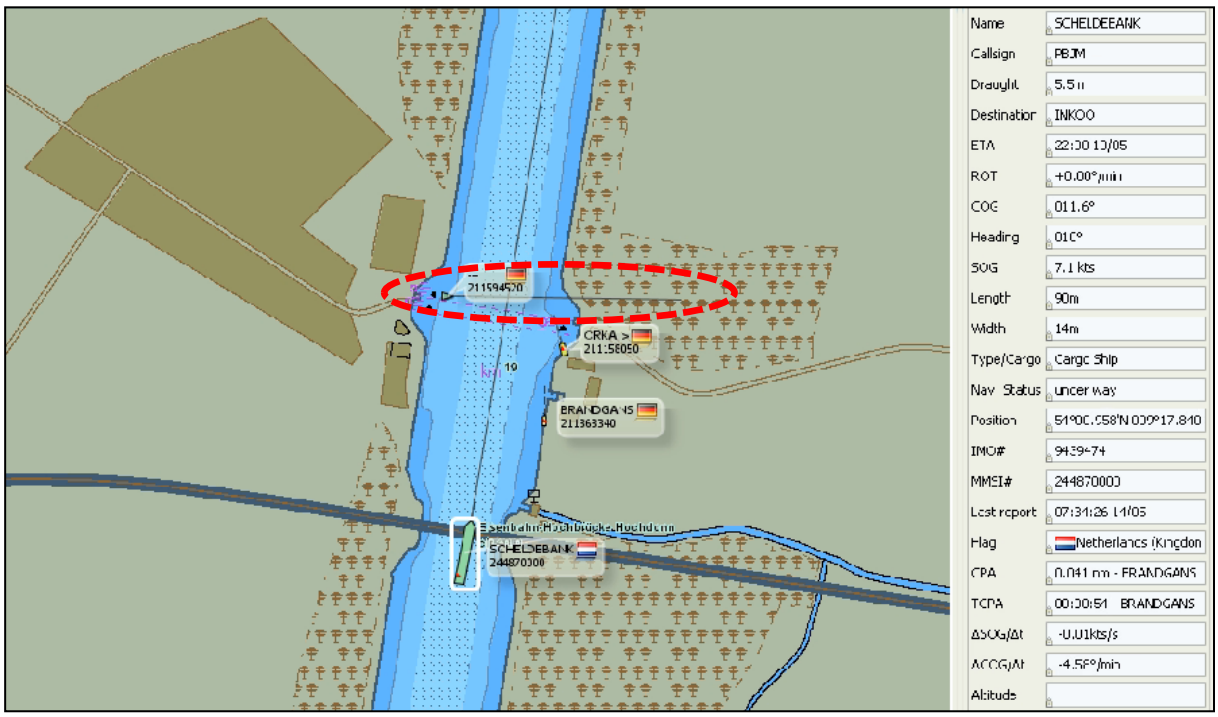

Figure 39: WSV AIS recording (situation at 055428 UTC)

The ferry's apparent motionlessness has not changed after another 30 seconds (see **Figure 40** below). At this point, the SCHELDEBANK is still about 150 m away from the ferry line.

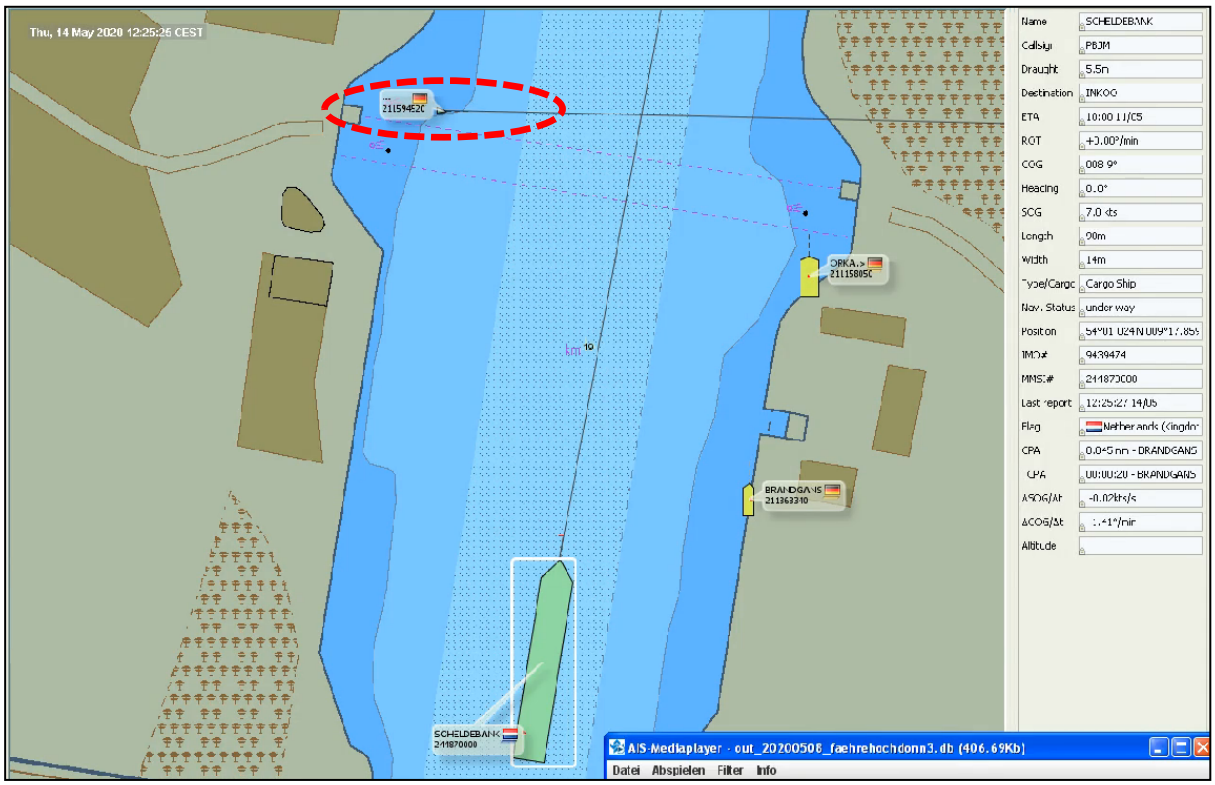

Figure 40: WSV AIS recording (situation at 055502 UTC)

Figure 41 below shows the situation from the AIS view about 10 seconds before the collision. It still looks as if the HOCHDONN is waiting at the northern bank of the canal for the imminent passage of the SCHELDEBANK.

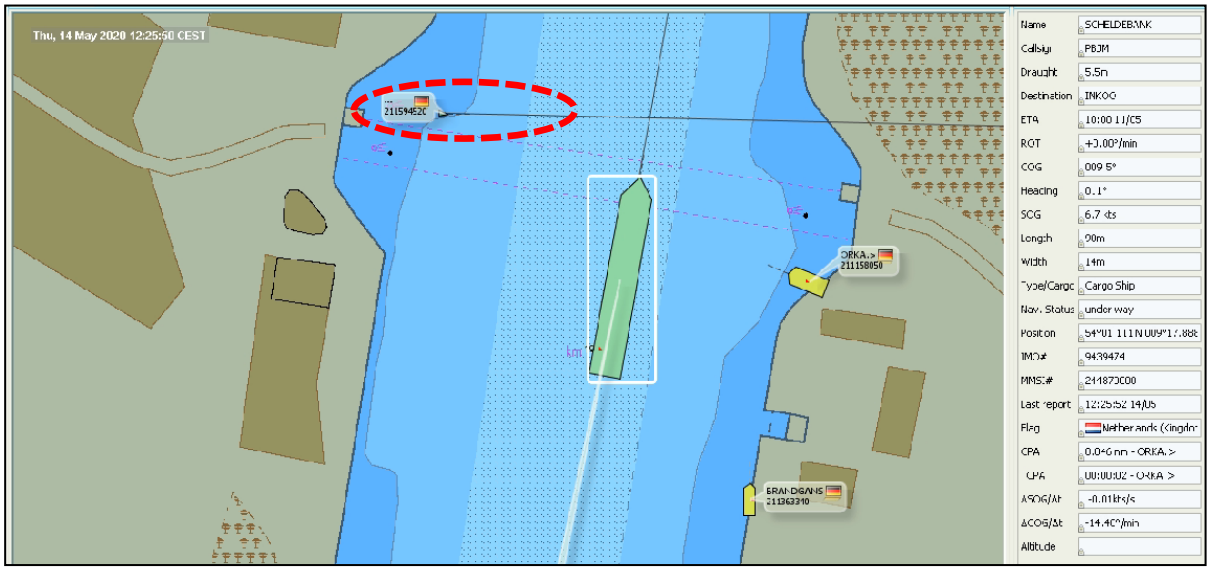

Figure 41: WSV AIS recording (situation at 055546 UTC)

In the following image (see **Figure 42** below), the HOCHDONN's AIS signal has suddenly jumped to the opposite side of the canal. Meanwhile, the SCHELDEBANK (or her AIS signal) is passing the ferry line. Accordingly, the vessels had undoubtedly collided at or immediately before or after this point in time.

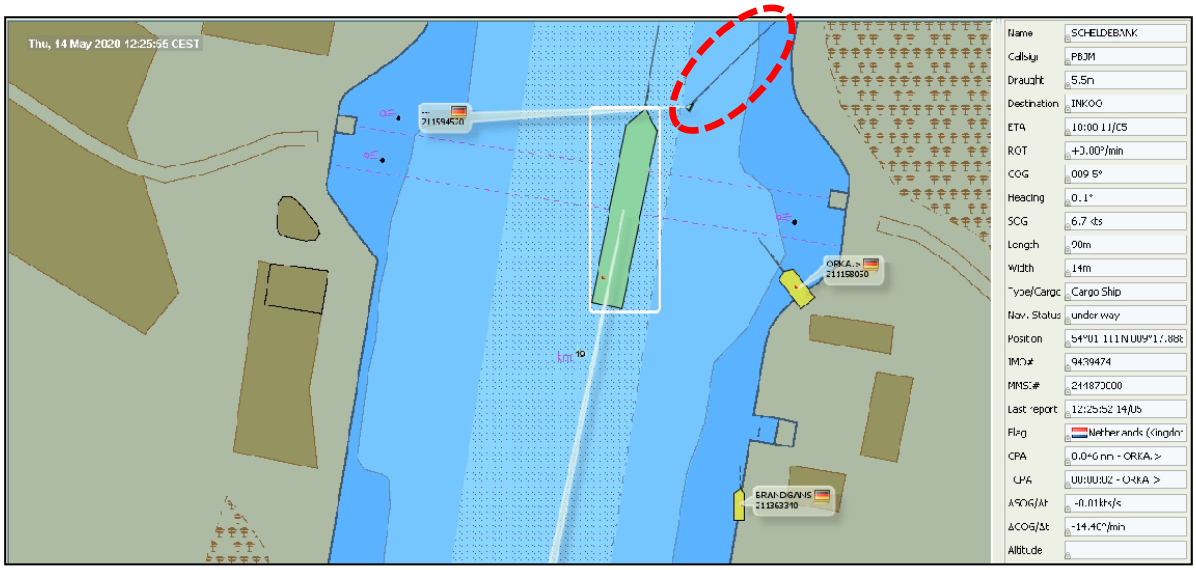

Figure 42: WSV AIS recording (situation at 055557 UTC)

All in all, the sequence of events described above demonstrates – even under the premise that the reporting rate[48] for dynamic AIS information with regard to the HOCHDONN (as well as the SCHELDEBANK) stood at 10 seconds – very clearly that their AIS device did not transmit the ship's own data correctly. The error in this respect should be taken as an indication that the device was generally defective on the day of the accident (i.e. with regard to transmitting the ship's own AIS data as well as with regard to receiving or displaying external AIS data).

3.3.3.7 Personal 'electronic navigational chart' of the ferry pilot on the HOCHDONN

During a meeting near the southern ferry terminal at Hochdonn, the ferry pilot on the HOCHDONN explained that he had reportedly purchased a tablet computer (made by Samsung) privately to facilitate navigation on the canal due to what he considered to be the completely inadequate user-friendliness of the ferry's navigation equipment. He had installed navigational chart software on this device (see **Figure 43** below), which he demonstrated during the meeting.

[48] The relevant regulations for AIS devices on commercial vessels provide for different intervals at which the AIS signal must be transmitted, depending on speed and any changes of course. For the HOCHDONN (as well as for the SCHELDEBANK), the interval is 10 seconds as long as she does not alter course. In the event of a course alteration, the interval is reduced to 3 1/3 seconds. The latter interval was not relevant before the collision because the ferry had presumably been heading for the ferry terminal without any significant course alterations.

The programme in question, which he had purchased, contains the option of displaying the position of the ferry (or the location of the tablet) on the navigational chart based on the device's GPS data reception function. The ferry pilot stated that during the crossing in which the accident occurred, he initially used the programme in question or its position display on the tablet as the only orientation aid, as he was only able to see the fog light indicating the opposite ferry terminal from the middle of the canal after casting off due to the thick fog.

However, the navigational chart software used (just like the radar on board) does not have the option of displaying AIS targets. This shortcoming was explicitly acknowledged by the ferry pilot and he made it clear that he would consider purchasing the additionally available option of having AIS data from an online database fed into the chart software.

Since the device in question is not an officially approved navigation instrument, the investigation team dispensed with examining its technical details. Irrespective of the device's regulatory classification, it was completely unsuitable for use as an aid to maritime traffic monitoring or collision avoidance from a practical point of view in any case due to the lack of an option to display AIS targets.

Figure 43: Tablet computer with navigational chart view
(area of the railway bridge and Hochdonn ferry crossing)[49]

[49] The demonstration of the tablet computer took place on the canal's southern bank a few metres from the Hochdonn ferry terminal. Accordingly, the tablet's GPS position is shown on the navigational chart software in the area in question, although the meaning of the displayed vector is not readily apparent.

3.3.4 AIS analysis (course of the SCHELDEBANK's voyage)

With regard to the course of the SCHELDEBANK's voyage, the analysis of the WSV's AIS recording (see **Ch. 3.3.3.5.4**) shows that the ship reduced her speed from an initial 7.7 kts (14.3 km/h) to 6.7 kts (12.4 km/h) when she was approaching the ferry crossing. This technical recording corresponds to the pilot's statement that the speed of the vessel was reportedly reduced due to the diving works announced by the VTS in the northern area of the ferry terminal. The statement that the ship was reportedly steered a little closer to the southern edge of the channel from the middle of the canal[50] for this reason is also easy to track based on the AIS recordings.

3.3.5 Legal and regulatory framework

3.3.5.1 Relevant legal sources

Due to its inland geographical location, the NOK is a German inland waterway. Since the canal is used to a very large extent by seagoing vessels, it is also a navigable maritime waterway within the meaning of the ***Seeschifffahrtsstraßen-Ordnung (SeeSchStrO)*** [German Traffic Regulations for Navigable Maritime Waterways].[51] Therefore, the regulations stipulated in the above legislation apply on the NOK. With regard to the steering rules to be observed on the NOK (and partly at its locks and approaches), the SeeSchStrO contains a number of special provisions (see Sections 23(3)(3), 23(5), 24(4), 29(2) and 32(1)(5)[52]). In addition, the SeeSchStrO contains supplementary provisions for the NOK (Sections 41 ff.), which concern, *inter alia*, certain requirements for admission to canal navigation, traffic in the approaches, right of way when entering locks and when leaving, as well as conduct in front of and in siding areas.

The aforementioned regulations also state in Section 1(4) that the International Regulations for Preventing Collisions at Sea (COLREGs) shall apply in their area of application (i.e. also on the NOK), unless expressly otherwise provided.

Moreover, Section 60(1) SeeSchStrO authorises the GDWS to issue (supplementary) **notices** (in the sense of binding regulations) to the extent necessary to prevent threats to the safety and efficiency of navigation, *inter alia*. Accordingly, the notice issued by the GDWS (Outstation North)[53] puts into concrete form the generic provision in Section 26 SeeSchStrO, for example (on the setting of maximum speeds for certain stretches of water, including the NOK).[54]

[50] It is common practise on the NOK for both eastbound and westbound ships to sail in the middle of the canal as long as there is no oncoming traffic or other obstructions.
[51] See Section(1)(1)(3)(17) SeeSchStrO.
[52] This provision states that anchoring is prohibited in the approaches to the NOK, so in contrast to the above provisions, it is not a steering rule but rather one for stationary traffic.
[53] Outstation Kiel now bears the name Duty Station Kiel. The official designation of the notice has remained unaffected.
[54] Section 26(3) SeeSchStrO authorises the GDWS in conjunction with Section 60(1) SeeSchStrO to define maximum speeds for stretches of waterway to be announced. See Ch. 3.3.5.4 below for the concrete specification of the maximum speed on the NOK.

Another legal framework for ferry traffic on the NOK is the Ordinance on the Operation of Ferries on Federal Waterways (**Ferry Operation Ordinance, FäV**[55]). In addition to the operation and supervision of ferries, the FäV also covers the behaviour of ferry personnel, ferry users on board and at terminals. With the exception of a few partial aspects, the FäV applies both to privately operated ferries and to those whose operation is organised under public law.

For the purpose of transforming and putting into concrete form the duties of ferry personnel arising from the above legal sources internally and under service and labour law, an **official instruction** was put into force **for the crew of ferries** belonging to the [then] **WSAs** Brunsbüttel and Kiel-Holtenau[56] in 1998. In the course of the privatisation of the operation of the NOK ferries, **the private operator** replaced the **official instruction** in question in 2018 with an official instruction for the NOK ferry crossings at Burg, Hochdonn, Fischerhütte and Oldenbüttel that takes into account the privatisation of the ferry service. Although similar in many respects, the detailed requirements for crew during crossings (e.g. regarding the lookout obligation)[57], certain special tasks of the ferry pilot (e.g. regarding the initial and further training of deckhands) and the list of activities of the deckhand are no longer part of the official instruction.

The **service description (including the special terms of contract)** of the WSV, which it formulated in connection with the award of the operation and periodical maintenance of the ferries to the private operator, is an important source for the investigation and interpretation of the legal framework for NOK ferry traffic.

3.3.5.2 Right of way regulations

With regard to right of way on the NOK, Section 25 SeeSchStrO is a provision that largely supersedes the relevant provisions of the COLREGs (see Section 25(1)). Accordingly, Section 25(2) SeeSchStrO contains the relevant provisions for right of way in a fairway within the meaning of the SeeSchStrO and in this respect stipulates (see point 2) that a vessel proceeding along the course of the fairway channel shall (irrespective of the vessel's category and visibility conditions) have right of way over vessels crossing that fairway. According to Section 2(1) SeeSchStrO, the NOK is such a fairway. Therefore, it is clear from the above provisions that the HOCHDONN, which crossed the NOK, was required to give way to the SCHELDEBANK, which was proceeding along the course of the canal.

[55] See FäV of 24 May 1995 (Federal Law Gazette I p. 752), as last amended by Article 2(5) of the regulations of 21 September 2018 (Federal Law Gazette I p. 1398).
[56] Merged to form WSA NOK on 22 March 2021.
[57] See Ch. 3.3.5.3 below for details.

The above official instruction, which has been authoritative since 2018, indirectly addresses the right of way of transiting shipping in a similar form as the previously applicable official instruction. Accordingly, point 14 therein on distances to ships states:

In principle, transiting shipping shall not be passed at a distance of less than 250 m in front of the bow, i.e. a minimum distance of 250 m mid-canal.

This distance may be reduced only for extremely slow-moving vessels.

In case of reduced visibility, the minimum distance shall be increased in accordance with the less favourable conditions.

In icy conditions, an increased closest point of approach must be maintained in accordance with the less favourable situation.

Attention! In addition, the following instruction shall always apply:

Radar equipment shall be kept in operation throughout the day to ensure safe maintenance of the closest points of approach.[58]

3.3.5.3 Lookout

With regard to the obligation to keep a lookout, the SeeSchStrO does not contain any separate regulations or derogations from the COLREGs. Accordingly, Rule 5 COLREGs, which states that vessels are obliged to keep a proper lookout at all times by sight and hearing, as well as by all available means appropriate in the prevailing circumstances, must be observed in full on the NOK.

On the bridge of the SCHELDEBANK this requirement was complied with by the people present.

On the NOK ferries, the task of lookout is primarily and by virtue of his function incumbent upon the ferry pilot. Moreover, during the period of validity of the above official instruction for the crew of the ferries of the then WSAs Brunsbüttel and Kiel-Holtenau, the corresponding obligation was laid down in point 5.1 for both ferry pilots *and* ferry deckhands. It states:

Ferry pilots and ferry deckhands shall keep a careful lookout before each departure and during crossings.

Moreover, point 5.3 states:

The ferry's deckhand shall inform the ferry pilot that the ferry is ready for departure by means of hand signals or an intercom system before casting off. If necessary, he shall stand at the forward barrier in the role of lookout on the instructions of the ferry pilot to report when the fairway is clear.

[58] Emphasis in accordance with original text.

The private operator's relevant official instruction since 2018 does not contain any corresponding regulations, meaning that an official requirement for the deckhand to assist the ferry pilot in the role of lookout evidently no longer exists. This is reflected in the fact that the HOCHDONN's deckhand was in his cabin when the accident happened.

3.3.5.4 Speed

On the basis of Section 26(3) in conjunction with Section 60(1) SeeSchStrO in conjunction with point 12.4.2.2 of the notices of the GDWS (Outstation North), a maximum speed over ground of 15 km/h (8.1 kts) applies on the NOK for vessels below TG 6 or a draught of less than 8.50 m.

Technically reliable data on the speed of the **HOCHDONN** at the time of the accident are not available. However, the ferry pilot stated that he had reportedly accelerated the ferry to full speed from about halfway across the canal. Since the HOCHDONN can reach a maximum speed of 13 km/h according to her technical specifications, she was definitely travelling at a lower speed than that generally permitted.

Information on the speed of the **SCHELDEBANK** from the ship's command and pilot is consistent with the WSV's relevant AIS recording (see **Ch. 3.3.4** above). According to that, the ship was initially sailing on the NOK at a speed of 14.3 km/h. The ship begun to slightly reduce her speed a few hundred metres before the Hochdonn ferry crossing in response to diving works. Her speed still stood at 12.4 km/h just before the collision. Accordingly, just like the HOCHDONN, the SCHELDEBANK was sailing at less than the maximum permissible speed.

According to Section 26(1)(1) SeeSchStrO, every vessel must proceed at a safe speed in compliance with Rule 6 COLREGs. Rule 6 COLREGs states in this regard that every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance *appropriate to the prevailing circumstances and conditions*[59].

Rule 6 COLREGs states, *inter alia*, that the circumstances listed therein (e.g. visibility, traffic density, manoeuvrability, as well as the state of wind, sea and current) must be considered when determining a safe speed. Vessels with operational radar must also take into account any special characteristics in this regard (e.g. the characteristics of the radar equipment and the effect on radar detection of the sea state, weather and other sources of interference). The possibility that radar may not always detect small vessels, ice and other floating objects at an adequate range is also explicitly mentioned in this context.

[59] Italic emphasis here and below by the author of this report.

3.3.5.4.1 Safe speed of the HOCHDONN

With regard to the speed of the HOCHDONN, the aforementioned aspect of safe speed is only of secondary importance, of course. Her operation is designed to cross the NOK (some 120 m wide at the Hochdonn ferry crossing) as quickly as possible by direct route. Although it is necessary to select the speed so as to ensure that the opposite ferry terminal can be approached unerringly, since the ferry is only allowed to start her crossing when there is no transiting traffic at a minimum distance of 250 m, the choice of speed (at least based on the maximum speed of the ferry) does not generally play a material role in collision avoidance. Even if and to the extent that there is a risk that smaller vessels cannot be located within this range (i.e. especially in reduced visibility), a particularly slow crossing as a countermeasure might even be counterproductive, unless the aforementioned minimum distance was significantly increased at the same time.

Therefore, to resolve the conflict of objectives between crossing the canal safely, on the one hand, and rapidly, on the other hand, in reduced visibility, it is more appropriate to consider the regulations for the operation of NOK ferries in reduced visibility (see **Ch. 3.3.5.5.2** below).

3.3.5.4.2 Safe speed of the SCHELDEBANK

The SCHELDEBANK had begun to reduce her speed, which had previously been just below the maximum speed permissible, a few hundred metres before the ferry crossing. However, this measure was not due to the visibility conditions, but rather only in response to a pontoon moored at the canal bank in the area of the ferry crossing and diving works being carried out from there. In view of the extremely limited visibility conditions and against the background that the location of small vessels may also be affected even when using radar, the question as to whether the SCHELDEBANK was proceeding at a safe speed in the dense fog within the meaning of Rule 6 COLREGs therefore arises.

In that respect, it should be taken into account that in accordance with Section 6(3) *NOK-Lotsverordnung* [NOK Pilot Ordinance], a duty to engage both a pilot and a canal helmsman on the NOK exists in principle. Although exemptions prevail for this duty, it nevertheless ensures that the safety of the traffic flows is underpinned by local and highly qualified navigators on board the majority of vessels operating on the canal.

Apart from that, Section 55a SeeSchStrO states that VTS NOK is responsible for traffic control. VTS NOK is therefore not only active with regard to the tasks regularly incumbent upon every VTS (traffic information, traffic assistance, traffic instructions), but also coordinates and monitors the canal passages of all commercial vessels, e.g. with regard to the location and time of head-on situations, and informs shipping about this in detail in regular all-station calls.

The provisions of Section 48 SeeSchStrO on TG-based minimum distances between vessels with a length of greater than 20 m sailing in the same direction, which may only be undercut during overtaking manoeuvres permitted under certain conditions, also ensure a safe and reliable traffic flow that is largely independent of the visual conditions. The above provisions state that TG 1, 2 and 3 vessels shall maintain a minimum distance of 600 m and TG 4 vessels and higher a minimum distance of as much as 1,000 m from any vessel navigating in front of them, irrespective of visibility conditions.

Finally, it is also important to note that recreational craft may use the NOK only in daylight and good visibility if they do not have a pilot on board, which is not obligatory for them.

In their totality, the aforementioned *special circumstances and conditions* have a material influence when answering the question as to what speed is to be regarded as safe within the meaning of Rule 6 COLREGs for vessels operating on the NOK. Due to these canal-specific circumstances and conditions, the unexpected and sudden occurrence of a collision hazard, which could possibly be better managed by lowering the speed to the limit of manoeuvrability, is highly unlikely. In addition, the overall planning of the two-way traffic flows in the canal (including the encounter options, which are partly restricted to sidings) would be impaired if individual vessels deviated significantly from the maximum speed generally selected for their particular TG for an extended period. By their very nature, such measures then lead to risks to the safety and efficiency of navigation on the NOK for their part.

Therefore, from the point of view of the BSU, the speed selected by the SCHELDEBANK cannot be challenged when Rule 6 COLREGs is considered in isolation.

3.3.5.5 Restricted visibility

3.3.5.5.1 From the perspective of the SCHELDEBANK

It was explained in detail above that the very limited visibility in this case had or could have had no relevance for the speed selection on board the SCHELDEBANK.

Rule 19 COLREGs, which is applicable to navigable maritime waterways and lays down special rules of conduct for vessels in restricted visibility, does not provide any other basis for examining the SCHELDEBANK's navigation practises, either. Similar to Rule 6 COLREGs, the rule postulates the need for a safe speed. In this context (see Rule 19(b)), and in relation to the actual implementation of the rules of conduct as set out in Section I COLREGs[60] (see Rule 19(c)), it refers to the respective circumstances and conditions that prevail. In that respect, reference may be made to the comments and conclusions set out above in **Ch. 3.3.5.4.2**.

[60] Section I COLREGs deals with the conduct of vessels in all visibility conditions and in this respect contains, *inter alia*, provisions on the lookout, safe speed, action to avoid collision, narrow channels and traffic separation schemes.

In addition, Rule 19(d) COLREGs states that a vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time. Moreover, Rule 19(e) COLREGs states that except where it has been determined that a risk of collision does not exist, every vessel which cannot avoid a close-quarters situation with another vessel forward of her beam shall reduce her speed to the minimum at which she can be kept on her course and shall take all her way off if necessary in reduced visibility.

According to statements given by the SCHELDEBANK's pilot, the vessel's radar alone was not suitable for determining the position of the HOCHDONN in the course of approaching the ferry crossing. Before reaching the high bridge, the shadow from its radar echo had reportedly concealed the area to the east behind it. However, even after the SCHELDEBANK had passed the bridge, it was reportedly the case that the canal section shown in the forward direction was reportedly displayed without any echoes, i.e. without any indication of a possible obstacle, even when the range was temporarily set to 0.25 nm. This statement cannot be verified by on-board technical recordings, however.

In the BSU's view, the following considerations must be taken into account when answering the question as to whether or during what period the HOCHDONN's radar echo could have been visible on the radar screens on the SCHELDEBANK's bridge after passing the high bridge and before the collision, and whether the SCHELDEBANK could have had any effective influence at all on a detected risk of collision during this period.

When the SCHELDEBANK passed the bridge with her aft superstructures and the radar antenna positioned there, her fore section was only about 220 m away from the ferry crossing. Although the high bridge and ferry crossing are about 300 m apart, the distance between the radar antenna and fore section (about 76 m) must be subtracted to determine how great the distance between the SCHELDEBANK's fore section and the ferry crossing still was when a potential radar shadow from the bridge could have had no effect (at the latest) on the location of the HOCHDONN's position.

The WSV's AIS recordings show that the SCHELDEBANK was proceeding at a very slightly decreasing speed of less than 13 km/h at the time in question. Accordingly, it took (once more starting from the latest possible moment at which she sailed out of the high bridge's radar shadow) only about 60 seconds for the fore section to pass the ferry crossing and the collision with the HOCHDONN to occur there.

If we assume that the HOCHDONN took less than 60 seconds to reach the middle of the canal even at an initially reduced speed, it follows that the ferry could only have left the ferry terminal when the SCHELDEBANK with fore section was only about 220 m away from the scene of the collision.

If we then also assume in this context that the radar antenna on the stern of the SCHELDEBANK cannot be technically capable of scanning the area immediately in front of her forecastle, it becomes clear that the HOCHDONN (or her radar echo moving away from the bank after casting off) can only have been visible on the radar

screens of the SCHELDEBANK – if at all – for an extraordinarily short period of time before the collision. Moreover, and as discussed at length above, the ferry's AIS signal was faulty, giving the false impression that the ferry was on the northern bank of the canal until the time of the collision.

All in all, the foregoing considerations permit the conclusion that – even with proper use of the radar equipment – it must have been virtually impossible for the ship's command and the pilot on the SCHELDEBANK to foresee the possibility of a collision with the canal ferry and – based on that – take effective avoiding action within the meaning of Rule 19(d) and/or (e) COLREGs.

3.3.5.5.2 From the perspective of the HOCHDONN

When considering events from the perspective of the HOCHDONN, the specific position of the ferry crossing in the immediate vicinity of a railway bridge crossing the NOK should – from a factual point of view – be taken into account. Although it is true that larger vessels can be easily located before and even when passing under the bridge by means of a properly adjusted radar set, it cannot be ruled out that smaller vessels may be concealed by the bridge's radar shadow and thus be fatally lost from the ferry pilot's field of vision in reduced physical visibility.

A further potential danger for the ferry pilot in dense fog arises from the fact that he cannot use any technical aids other than a radar display and a fog light to safely approach the ferry terminal.

For legal classification of the question as to how the ferry pilot on the canal ferry was required to behave in the aforementioned circumstances (i.e. in greatly reduced visibility) and, more importantly, whether the ferry was even permitted to operate under the given circumstances, the requirements in the official instruction for the crew of ferries and, in particular, the provisions of the FäV are material.

In this respect, the official instruction (as adopted by the private operator in 2018) only contains the following provision on reduced visibility (see point 17):

The additional fog lighting on the north/south side shall be switched on in the event of fog.

The ferry may only sail in fog if the radar set is in proper working order. The ferry service must be suspended immediately if the radar set is defective.[61] In such cases, the management, the WSA and the traffic controller must be informed that service has been suspended and on which side of the canal the ferry is now located.

In addition, visibility conditions must be communicated to the traffic controller (Kiel Canal 3) at regular intervals (45 minutes) or in the event of changes.

Accordingly, it should be noted that the official instruction (just like the previous version from WSAs Brunsbüttel and Kiel-Holtenau) does not contain a provision that would entitle or require the ferry pilot to suspend the ferry service due to reduced visibility,

[61] Note by the BSU: The requirement to keep the radar in operation throughout the day in order to ensure closest points of approach are safely maintained also – and irrespective of visibility conditions – arises from point 14 of the official instruction (see Ch. 3.3.5.2 above).

apart from in the event of a defective radar set. On the contrary, crossings in fog are actually explicitly legitimised, even if only on condition that a properly functioning radar set is available and used.

In contrast, Section 12(2) FäV on operation and suspension of the ferry service stipulates the following without such conditions:

The ferry pilot shall suspend the ferry service if the crossing involves any kind of risk. In particular, risk is deemed to exist if crossing safely no longer seems possible due to the water level, ice or storms.

It follows from the use of the word "shall" in Section 12(2) FäV that the ferry pilot does not have any discretion in the decision he has to make, but rather is obliged to suspend the service under the given conditions.[62]

It is noteworthy that the list of hazard scenarios in the above provision, which may require a suspension of the ferry service, does not include adverse visibility conditions. This is all the more astonishing because in the version of the provision valid until 31 March 2006, poor visibility was explicitly referred to as a relevant hazard in addition to high/low water, ice and storms.

However, it should be noted that as the phrase "in particular" makes clear, the list of hazards in Section 12(2) FäV is not exhaustive.

There is no further specification of the requirements as to when a named or unnamed hazard within the meaning of Section 12(2) FäV is to be assumed with regard to the NOK ferry service, which would make crossing safely no longer seem possible. Moreover, there are no indications to this effect in the WSV's service description, which forms the basis for awarding the contract for the operation and regular maintenance of the 45 t ferries at the Ostermoor, Burg, Hochdonn, Fischerhütte and Oldenbüttel ferry crossings to the private operator of the NOK ferries.

Although it is explicitly emphasised therein (as in the operator's official instruction) that the ferry crew must comply, *inter alia*, with the COLREGs, the SeeSchStrO and the FäV, the service description in question does not contain any specific rules for whether or how the ferry service should be maintained in reduced visibility. This is also surprising because point 2.4 of the service description in question contains a specific provision for conduct in freezing weather and ice:

All necessary action shall be taken to maintain the ferry service in the event of ice formation. If the ferry service cannot be maintained due to excessive ice formation or the imminent risk of damage to the ferry facilities or the ferry, then the Contractor shall inform the Client.[63]

In this context, point 2.5 of the service description, which deals with a loss of the ferry service, poses an entrepreneurial risk for the ferry operator. It states:

[62] Had the legislator intended to provide for a discretion or at least a conditional (i.e. limited) discretion, then the wording in Section 12 should not contain "shall", but rather "may" or "should".
[63] Note by the BSU: 'Contractor' refers to the private operator and 'Client' to the WSV.

If a ferry has to be taken out of service, personnel provided by the Contractor may only be stood down after consultation with the Client. The Client shall determine when suspension of the service begins.

The Contractor shall resume the ferry service no later than four hours after being requested to by the Client.

In the event of a loss of the ferry service or terminal for reasons attributable to the Client, the period of loss shall not be remunerated.

In addition to that, point 7 of the special terms of contract for the operation and periodical maintenance of five 45 t ferries and of two 100 t ferries contains the following provision regarding a possible penalty:

If the ferry cannot be operated as contractually agreed upon due to circumstances for which the Contractor is responsible, then the Contractor shall pay to the Client a penalty of EUR ... net per day. The total amount of the penalty shall be limited to ...% of the total amount of the contract. [64]

The ferry operator explicitly emphasised the risk in question in its official instruction as follows:

Attention! [65]
In the event of a loss of the ferry service for reasons attributable to the crew, a significant penalty shall be due for payment per day of loss.

Although this information is to be found in point 12 of the official instruction under the title 'Repairs', the BSU believes that it is also suitable for raising the awareness of the addressees of the official instruction, i.e. the ferry crews, of the economic impact that any loss of the ferry service caused by the crew can have on the operator.

<u>All in all, the following should therefore be noted:</u>

1. apart from the provision at Section 12 FäV, which states that the ferry pilot shall suspend the ferry service if the crossing involves any kind of risk, there is no further specification as to whether or when this is or may be the case in poor visibility;
2. it is clear to the BSU that adverse visibility conditions, even if they are no longer explicitly specified since the revision of the provision in 2006, can still constitute a hazard requiring the suspension of the ferry service within the meaning of Section 12(2) FäV, since, as explained above, the sole use of the radar does not permit a sufficient reduction of the risk;
3. the ferry operator is exposed to the risk of loss of earnings and a contractual penalty if the loss of the ferry service is attributable to the ferry operator or due to circumstances for which the ferry operator is responsible. The ferry operator cannot rely on a contractual clause that would offer a legally secure position for discontinuing the ferry service without adverse consequences in the event of poor visibility.

[64] The figures are irrelevant to the BSU's investigation and therefore not published.
[65] Emphasis corresponds to the original text.

For the ferry pilot of a NOK ferry, the aforementioned points naturally result in a factual pressure to maintain the ferry service under all possible circumstances, while at the same time bearing full responsibility for safe ship operation in compliance with all regulations on conduct in traffic pursuant to sentences 1 and 2 of Section 3(1) in conjunction with sentence 1 of Section 4(1) SeeSchStrO. To this extent, he shall take any precaution as may be required by the practise of good seamanship or by the special circumstances of the case.

This factual pressure is further increased by the fact that the revision of Section 12 FäV has – albeit only superficially – deprived the ferry pilot of the possibility of justifying the suspension of the ferry service with the reference to a hazard explicitly mentioned therein due to poor visibility. Added to this is the dilemma that a wilful and even a negligent violation of the duty to suspend the ferry service in the event of a named or unnamed hazard within the meaning of Section 12(2) FäV is punishable as an administrative offence.[66]

The fact that a functioning radar set is generally capable of detecting transiting traffic when used properly does not change the conflict of objectives for the ferry pilot of maintaining the ferry service, on the one hand, and having to (and/or wanting to) suspend the service in fog-related hazardous situations, on the other hand. Although the official instruction states that the ferry pilot may only begin a canal crossing if a passing vessel is at least 250 m away from the ferry when she reaches the middle of the canal, it also explicitly stipulates that this minimum distance should be increased in the event of reduced visibility in accordance with the adverse conditions. However, it should be borne in mind that due to the lack of an existing route guidance system alone, the ferry pilot is confronted with a dangerous situation in very adverse visibility conditions regardless of collision hazards when it comes to manoeuvring the ferry across the canal and then properly to the ferry terminal without significant physical visibility.

3.3.5.6 Sound Signals

It follows from No. 3.1, Section II.2, Annex II, Traffic Regulations for Navigable Maritime Waterways, that vessels navigating the Kiel Canal, have to give a sound signal when approaching a ferry crossing in the event of restricted visibility. For westbound vessels, this consists of one prolonged blast and for eastbound vessels of two prolonged blasts. According to No. 3.3.2 of the aforementioned Annex, free running ferries are obliged to give warning signals constantly in the event of restricted visibility with the ID “one short, two prolonged blasts”.

This formal obligation was not complied with on the day of the accident, neither on the bridge of the SCHELDEBANK nor by the ferry pilot. However, from the BSU’s point of view it is very unlikely, that these omissions had a relevant (causal) influence on the further sequence of events.

Irrespective of the specific accident, it should also be noted that the aforementioned regulations on the obligation to give sound signals in the event of restricted visibility were created explicitly for the Kiel Canal traffic they hardly appear to be practical in

[66] See Section 16(2)(f) FäV.

view of the special conditions prevailing there. If one considers how many vessels pass the 12 ferry crossings around the clock and how often the 14 ferries deployed there, cross the Kiel Canal, it quickly becomes clear that a strict and unimpeded implementation of the obligation to give the mentioned sound signals on a foggy day that can last for several hours would lead to massive noise pollution for the residents living near the Kiel Canal and for the wildlife living in the shore area In addition, there would be a danger that the routine and inflationary emission of the sound signals in question would counteract their actual purpose, namely to warn of concrete dangers. Ignoring not only "precautionary" signals, but also signals that are actually justified, could be the fatal consequence.

Due to the aforementioned reasons, the BSU dispensed with further addressing the aspect of the omission of giving sound signals within the scope of the investigation.

3.3.6 Weather conditions and visibility

3.3.6.1 Report by Germany's National Meteorological Service (DWD)

The DWD prepared an official report on behalf of the BSU on the weather conditions in the relevant area of the NOK at the time of the collision between the SCHELDEBANK and the HOCHDONN.[67] It describes the weather conditions for the relevant time and place as follows:

Mean wind/gusts (at a height of 10 m):
Baffling (mainly weak) winds.

Weather – precipitation and visibility:
Foggy and cloudy at the time of the accident, no significant rainfall apart from possible foggy drizzle, poor visibility of about 100 m.

3.3.6.2 Overview of VTS NOK

VTS NOK keeps a so-called fog list for the visibility distances in the NOK transmitted to it (see **Figure 44** below). This also shows that visibility in the area of the Hochdonn ferry crossing was about 100 m at the time of the accident.

[67] Official report on the weather conditions during the SCHELDEBANK/HOCHDONN collision at 0800 CEST on 8 May 2020; Weather Forecast Division of the DWD, Hamburg, 8 June 2020.

Sichtweiten auf dem NOK														
Datum	Uhrzeit	Holtenau	Land-wehr	Sehe-stedt	Nobis-krug	Brei-holz	Olden-büttel	06-22Uhr Fischer-hütte	Hohen-hörn	Hoch-donn	Burg	Kuden-see	Oster-moor	Bruns-büttel
08.05.20	6:30		100	100	100	150	100	50	50	100	100	100	50	100
	7:00		100	100	100	150	400	50	50	100	100	100	50	1000
	7:30		100	100	1000	150	400	50	50	100	100	200	200	
	8:00		1000	1000		150	1000	1000	100	100	200	600	600	
	8:30					800			100	100	200	700	700	
	9:00								700	1000	700			
10.05.20	5:15						500							
	5:30						300							
	5:45					100								
	6:00					100	800							
	6:20					800								

Figure 44: VTS NOK's list of visibility distances in the NOK

3.3.6.3 Witness testimony

The ferry pilot on the HOCHDONN reported to the BSU that he was only able to see the fog light at the opposite ferry terminal from the middle of the canal during the crossing in which the accident occurred. The SCHELDEBANK's crew stated that visibility varied between 50 and 100 m during the canal passage. The fore section, which was about 76 m away from the bridge, was reportedly just visible before the accident.

3.3.6.4 Assessment of visibility by the BSU

Visibility at the time of the accident was described by both vessels – referencing comprehensible indicators – and was actually likely to have been no more than 75 m.

The figure of 100 m transmitted by the DWD and VTS NOK does not contradict this assumption. In that respect, it should be noted that the information from the DWD and VTS NOK is based on estimates which may naturally deviate from the actual situation. Moreover, it becomes clear from the fog list referred to above that the fog conditions were constantly changing at certain points on the morning of the day of the accident. This can be seen from the fact that visibility of 50 m was registered for the Hohenhörn terminal, which is only about 6 km from the Hochdonn terminal, 30 minutes before the accident, for example.

4 ANALYSIS

4.1 Sequence and background of events leading up to the collision

By carefully analysing all available sources, the BSU was able to clarify the course of the accident and its attendant circumstances largely as follows.

Extremely poor visibility conditions of no more than 75 m prevailed at the scene when the accident happened. The SCHELDEBANK approached the railway bridge in front of the Hochdonn ferry terminal at slightly less than the maximum permitted speed. In the period that followed, the ship reduced her speed moderately and at the same time altered her course slightly to the southern half of the canal in response to a pontoon moored on the northern bank of the canal and diving works being carried out from it.

The HOCHDONN cast off from the northern ferry terminal just as the ship was about to pass the railway bridge some 300 m from the subsequent scene of the accident.

Although it is reasonable to assume that (even during the temporary and inevitable overlapping of her radar echo with the very distinctive echo of the high bridge) vessels of the size of the SCHELDEBANK can be located from the control position of the HOCHDONN with proper use and configuration of the radar, the merging of the echoes in question and/or an unfavourable radar configuration evidently resulted in the ferry pilot failing to identify the approach of the SCHELDEBANK on the radar when he decided to begin the crossing.[68] The ferry pilot did not have a properly configured, functioning and user-friendly AIS device at his disposal as a supplementary navigational aid.

Despite an orientation aid there in the form of a fog light, which was switched on at the time of the accident, the ferry pilot on the HOCHDONN was only able to make out the southern terminal visually when the ferry had reached the middle of the canal. Therefore, he initially sailed at reduced speed and concentrated intensely on identifying and heading for his destination with the help of a tablet computer with a navigational chart and his own GPS position displayed on it.

The ferry's reduced speed meant that she had not moved far enough towards the southern bank of the canal when the SCHELDEBANK crossed the area of the ferry line. This in conjunction with the already discussed fact that the SCHELDEBANK was intentionally steered towards the southern edge of the channel ultimately resulted in the vessels colliding there.

On the merits of the case, the development of the risk of collision was objectively neither foreseeable nor avoidable for the pilot and ship's command of the SCHELDEBANK. In particular, in the knowledge of and relying on the fact that NOK ferries must keep a safe minimum distance when crossing the canal, the ship had no reason to reduce her speed as a precaution when approaching the ferry crossing.

[68] In contrast, according to the inspection by the WSP immediately after the accident, there were no indications of a technical fault in the radar set.

Moreover, there were no specific indications on the bridge of the SCHELDEBANK that the forthcoming passage of the ferry line could pose a hazard. Until she had passed completely under the high bridge, the radar equipment on her bridge was not able to identify the HOCHDONN's echo moving away from the echo of the ferry terminal during the period in question due to the high bridge's radar shadow. By the time the radar view was clear, the SCHELDEBANK and the ferry had already converged to such an extent that the latter could no longer be differentiated in the radar antenna's visual beam. Moreover, it was proven that the HOCHDONN's faulty AIS signal gave the false impression on the bridge of the SCHELDEBANK that the ferry was still at the northern terminal up until the very last.

4.2 Events after the collision

Despite the immense danger the collision posed to the life and limb of all on board and to the ferry, the ferry pilot on the HOCHDONN managed to manoeuvre the ferry to the terminal safely and swiftly. This fact proves his professional competence and his seafaring skills as a ferry pilot.

The ship's command and the pilot on the SCHELDEBANK also responded to the accident with presence of mind and highly professionally and were thus able to prevent more severe consequences for the ship or the NOK.

4.3 Factors contributing to the accident

With regard to the actions of the SCHELDEBANK, no aspects were identified during the investigation that might have facilitated the accident. The situation is significantly different with regard to the ergonomic, technical, organisational and legal framework for the operation of the HOCHDONN.

4.3.1 Comfort afforded by the HOCHDONN's bridge

During surveys of the HOCHDONN and the identical AUDORF's control position by the investigation team and discussions with their ferry pilots, it became very clear that the control positions in question do not meet the requirements of a modern workplace for the responsible and possibly highly focused work of a ferry pilot.

In particular, this applies to the aspects of ergonomics, visibility, as well as ambient temperature and air quality. The one-sided orientation of the control position with a view of the canal's longitudinal axis in the direction of the railway bridge and the need to look either through a door that is open for this purpose or in the opposite direction through a horizontally divided window when approaching the ferry terminal complicate the work of the ferry pilot. Moreover, the fact that the ferry pilot can only use a folding chair mounted on the back of the wheelhouse to sit down on during his respective shift of no less than seven to ten hours while steering the ferry also undoubtedly affects his working conditions. Under certain circumstances, the factors described above are likely to impair the ferry pilot's ability to concentrate and perform considerably, to the detriment of safe ferry operation.

4.3.2 Radar set on the HOCHDONN

Although the HOCHDONN's radar set combines high-quality monitoring with ease of use in the existing 'BASIC' version on board, the accident has shown that the railway bridge in the vicinity of the ferry terminal can, under certain circumstances, interfere with traffic monitoring such as to contribute to an accident.

The manufacturer offers the set in question in two other versions. The 'STANDARD' version enables users to display AIS signals from an external AIS receiver on the radar image (an enhancement that has been widely used on radar sets in the maritime sector for several years). The 'ECDIS' version goes one step further by offering users the additional option of overlaying the radar image with an electronic navigational chart.

The aforementioned enhancement (in particular, displaying the AIS of other vessels) would undoubtedly support the ferry pilot in his activities significantly. It is reasonable to assume that the accident would not have happened if the radar equipment on the bridge of the HOCHDONN had the AIS function at least.

4.3.3 The HOCHDONN's AIS

In the opinion of the BSU, the AIS device installed at the control position of the HOCHDONN is (apart from technical faults that apparently impaired its functioning not only on the day of the accident) only suitable for practical use on board NOK ferries to a very limited extent.

In particular, the following aspects should be mentioned at this point:

- device in an ergonomically unfavourable position above the radar screen at a distance which makes it difficult to clearly recognise or read the relatively small display screen (size: 3.5") and information displayed there;

- presentation of AIS information outside the radar screen, meaning that the ferry pilot must make a particular mental conversion, which can lead to an underestimation of the significance of the AIS device as an important information medium or aid to navigation;

- limited display options for AIS targets on the 3.5" display screen and the corresponding operation have the potential to distract the ferry pilot from the more important observation of the traffic area visually and by radar;

- due to the canal's specific traffic-related characteristics, the CPA/TCPA functionality naturally produces continuous warnings of unavoidable close-quarter situations. Their value is further diminished by the fact that – apart from a possibly enabled audible warning – they can only be visualised on an extremely small display and are thus difficult to interpret in a meaningful way.

The above points of criticism are not intended to fundamentally call into question the device-specific possibilities and quality of the device type officially approved for merchant shipping, especially since the manufacturer has included various interfaces for feeding AIS data into an electronic navigational chart system, for example.

However, the BSU believes it is important to stress that the existing AIS solution at the HOCHDONN's control position and, in particular, the technical implementation, which merely displays the AIS targets on an external monitor, is no longer in keeping with the times. Moreover, it may even be counterproductive if and to the extent that it draws the ferry pilot's attention too much to the display in question or – at the other extreme – discourages him from actually using this valuable means of automatic vessel identification.

It is also worth noting that the ferry pilots did not receive any special training on the AIS device, even though its operation is not necessarily intuitive.

As already discussed above in relation to the radar, it should also be emphasised at this point that the accident would probably not have occurred if the SCHELDEBANK's AIS signal had been displayed to the ferry pilot on the radar screen in addition to her echo, which may have been affected by interference from the high bridge.

In addition, the accident under investigation vividly demonstrates that a defective AIS device not only has the potential to impair the quality and reliability of one's own traffic monitoring, but in the event of the faulty transmission of one's own vessel data, also to mislead other traffic in the interpretation of the traffic situation. Correct installation, functioning and configuration of the AIS device is therefore of great importance from every perspective in terms of traffic safety.

4.3.4 Guidance to the ferry terminal

From a superficial point of view, one could take the position that the demand for technical support in the context of any kind of guidance system for a ferry service across the NOK is completely excessive.

However, the accident and the procedures for the ferry service have shown that navigating to the ferry terminal merely with the help of a searchlight (which may even have a counterproductive dazzling effect under certain circumstances) switched on at the terminal and a radar set can be enormously challenging for the ferry pilot when visibility is extremely poor. This is especially true in view of the fact that shutting down the ferry due to fog is factually out of the question and that a legally secure decision in this regard is difficult to arrive at.

The fact that the ferry pilot on the HOCHDONN purchased a tablet computer with a navigational chart application at his own expense to make his work easier and the ferry service safer also implies that the technology available at the control position was clearly not always considered sufficient to steer the ferry safely from one terminal to the other even by an experienced ferry pilot who had been familiar with the conditions at the ferry terminal and on the ferry for seven years and who had worked without any accidents up until that point.

It is with that in mind that the BSU believes it is at least worth considering whether the use of an electronic navigational chart overlaid with radar and AIS information (e.g. in the manner in which the 'ECDIS' version of the radar installed on board facilitates) could be of assistance to the ferry pilot. However, in addition to the presence of a chart

with high-resolution scale, an absolute prerequisite for such a solution would of course be that the electronic navigational chart accurately processes the (D)GPS antenna position of the ferry, that the ship's contour is correctly displayed and that the ferry terminals are realistically depicted.

4.3.5 Lookout

Closely related to the ergonomic and technical aspects described above, which may make the ferry pilot's work more difficult, is the problem of not having a lookout to assist him in his responsible task. While the original official instruction for the crew of the NOK ferries explicitly required the deckhand to keep a careful lookout before each departure and during the crossing and, if necessary, to stand at the front barrier as a lookout on the instructions of the ferry pilot in order to report when the fairway is clear before departure, the official instruction of the private operator, which has been applicable since 2018, no longer contains any comparable regulations.

While a legally secure requirement not to act as the only lookout during the night exists for officers in charge of the navigational watch in maritime navigation, including on small vessels, and during daylight only if so doing does not involve any kind of risk and that all relevant aspects (e.g. weather and visibility conditions) have been taken into account[69], there is no comparable regulation for inland waterway transport. Nevertheless, under Rule 5 COLREGs, which applies to the NOK (as a navigable maritime waterway), every vessel shall maintain a lookout so as to make a full appraisal of the situation and of the risk of collision.

From the BSU's point of view, the requirements of Rule 5 COLREGs are disregarded if the operator of the ferry transfers the associated responsibility and accountability to the ferry pilot alone, regardless of the visibility conditions or other special circumstances.

4.3.6 Suspension of the ferry service

The most effective response to adverse visibility conditions is for the ferry pilot to temporarily suspend the ferry service, of course. Section 12(2) FäV even imposes a legal obligation to do so if the crossing involves any kind of risk. Although poor visibility has not been explicitly referred to as an example of such a risk since the provision was revised in 2006, it is in the nature of maritime navigation that adverse visibility conditions may involve a risk for one's own vessel and for other traffic.

In contrast to this is the consideration that possible risk due to poor visibility can be taken into account effectively by proper use of the radar set and a liberal assessment of the minimum distance to transiting traffic.

However, this does not sufficiently take into account the fact that individual targets may not be reliably identified during radar observation for a variety of reasons. Regardless of the actual risk of collision, it should also be noted that in the event of extremely poor visibility, crossings may be difficult or dangerous when it comes to unerringly arriving and mooring at the ferry terminal.

[69] Part A Chapter VIII Part 4-1 point 16 STCW Code.

The contractual framework of the ferry service, which does not address the loss the ferry service due to poor visibility, puts the operator, and even more so the ferry pilot, into a conflict when it comes to considering the temporary suspension of ferry operation.

This assessment is not altered by the fact that the ferry pilot has the right or even the obligation to stop the ferry traffic under certain circumstances (but which precisely?), i.e. dangers not explicitly specified in Section 12 (2) FäV. In the view of the BSU, the public-law requirement is not formulated sufficiently clear and unambiguous, although subject to a fine. The law-abiding norm addressee can get into an unreasonable conflict with civil/employment law obligations on the occasion of its observance.

The problem, that the ferry pilot actually had no option to respond to the extreme fog conditions by suspending the ferry service due to the legal situation not being clearly formulated, is a factor that must not be ignored when drawing conclusions from the accident (see below).

5 CONCLUSIONS

5.1 Preliminary notes

The BSU is aware of the fact that the accident under investigation constitutes an absolute exception in relation to the ferry services on the NOK. On one single day alone, the NOK is crossed roughly 1,000 times at its various ferry crossings. Apart from a serious marine casualty in which the transporter bridge at Rendsburg collided with a cargo ship transiting the canal on 8 January 2016[70], the BSU has no knowledge of any accidents or incidents in which NOK ferries came into contact with other canal traffic.

On the other hand, it should not be forgotten that it was only by chance that the collision between the HOCHDONN and SCHELDEBANK passed without any severe consequences. The accident could have resulted in the ferry foundering and/or fatalities if the collision between the vessels was even only slightly different.

From the BSU's point of view, it would be too simplistic to point to a possible human error on the part of the ferry pilot, which could not have been prevented by effective safety precautions, as the sole cause of the accident.

The BSU is also aware that any additional measure which may enhance safety must be assessed against the background of cost-effectiveness. At the same time, it is important to remember that the work of the ferry pilot is a highly responsible task, which requires the provision of work equipment and tools that firstly must take into account the protection of the ferry pilot's own health (i.e. bridge ergonomics, sensory overload, ambient temperature and air quality), and secondly should sufficiently take into account the standards and technical developments that are customary in merchant shipping.

Finally, and in view of the conclusions to be drawn from the accident, it is important to note that the WSV has launched an extensive new-build programme with a view to

[70] See BSU Investigation Report 12/16 of 25 March 2020 (source: www.bsu-bund.de).

gradually renewing the entire fleet of NOK ferries. Current shortcomings in terms of ergonomics and technical equipment will largely no longer play a role at the control position of the new ferries. However, it is becoming apparent that the replacement programme will take several years, so sitting back until then and doing nothing cannot be the solution. Moreover, it is not yet apparent to the BSU whether the bridge equipment that the new ferries will be fitted out with will actually be at an optimal technical level.[71]

The following conclusions also concern organisational and legal issues relating to the ferry services on the NOK, which are important irrespective of the replacement of the ferries.

5.2 Ergonomics, visibility conditions, as well as ambient temperature and air quality on NOK ferries

According to information from WSA NOK, the ferries HOCHDONN, AUDORF and NOBISKRUG, which were built in the 1950s and do not meet modern standards in terms of bridge ergonomics, visibility, as well as ambient temperature and air quality, are to be replaced in the near future by new-builds that are already undergoing trials. Accordingly, the BSU sees no reason to make the difficult working conditions at the control position of the ferries in question the subject of safety recommendations, even though they may undoubtedly interfere with the safe operation of these vessels.

5.3 AIS on NOK ferries

According to information from the WSA NOK, all the ferries currently operated on the NOK and owned by the federal government have comparable or largely identical navigation equipment. This is characterised by the fact that the ferry pilot has a radar set as a central aid for traffic monitoring at his disposal. An AIS device with separate display screen is also installed at the control positions. The bridge equipment does not include an electronic navigational chart.

The BSU's investigation revealed that the AIS device is of little practical use because the AIS targets are not superimposed on the radar image. On the contrary, it may even be the case that concentrating on the display of the AIS device unnecessarily distracts the ferry pilot from his other duties.

Moreover, there is evidence to suggest that the AIS devices (or their antennas) are incorrectly installed and/or configured. As a result, the AIS information displayed may be incorrect. In addition, incorrect own ship information was evidently transmitted on the day of the accident.

Accordingly, serious consideration should be given to replacing or modifying the equipment on ferry control positions so that AIS signals are superimposed on the radar image. This would significantly improve the usefulness of these data. It is also necessary to confirm that the AIS equipment is working properly on all ferries.

[71] A survey of the ferries currently undergoing trials was not yet possible due to safety concerns of the GDWS.

5.4 Electronic navigational chart on NOK ferries

Approaching the ferry terminal in extremely poor visibility conditions requires a high level of concentration on the part of the ferry pilot. Given the rapid succession of the manoeuvres in question, this can impair the ability to concentrate and also lead to the ferry pilot inevitably devoting the main focus of his activity to reaching the opposite ferry terminal unerringly shortly after casting off.

It might be possible to achieve a significant increase in safety by overlaying the radar image with a high-resolution navigational chart, including an exact representation of the contours of the terminal and ferry. The WSA, which provides the ferries, should therefore explore whether the solution shown can be implemented in a practicable manner with reasonable effort.

5.5 Lookout on NOK ferries

In the opinion of the BSU, the fact that the ferry pilot on a NOK ferry is solely responsible for the lookout, irrespective of visibility and/or other special circumstances, and in this respect cannot (at least formally) fall back on the support of the deckhand, represents a safety risk and therefore requires an organisational correction on the part of the ferry operator.

5.6 Suspension of the NOK ferry service in fog

The contractual and internal requirements for the ferry service do not take into account the requirement contained in Section 12(2) FäV that the ferry service be suspended if the crossing involves any kind of risk.

The BSU recognises that the reliable and preferably unrestricted operation of the ferries across the NOK is of considerable importance for the infrastructure in the State of Schleswig-Holstein and that the transportation of doctors, midwives, rescue vehicles, as well as police and fire service vehicles in particular, must be guaranteed at all times if at all possible. However, this does not alter the fact that a temporary suspension of the ferry service may be appropriate in extremely poor visibility conditions. The operator and especially the ferry pilots must be enabled to make such a decision without having to fear contractual sanctions or economic penalties. The need to maintain the ferry service in order to ensure that vital transportation requirements can be met may be taken into account by lifting the suspension of the service in the event of a corresponding emergency.

For the purpose of clarification and with a view to providing better legal protection for the decision to suspend the ferry service in the event of adverse visibility conditions that involve any kind of risk, this hazard category should be reintroduced to Section 12 (2) FäV.

The counter-argument in this regard that the term “adverse visibility conditions” or “restricted visibility conditions” are too vague as a category of danger and could result in practical difficulties of interpretation of the non-persecution of a possible violation as administrative offence[72] is not convincible.

The International Regulations for Preventing Collisions at sea (Colregs) also use the vague term "restricted visibility" as a connecting point for vehicle conduct in Rule 19, and define it in Rule 3(l) in a manner that is also factually and legally intangible as one or *"any condition in which visibility is reduced by fog, poor weather, snowfall, heavy rainfall, sandstorms, or similar causes."*

In the ordinance on the International Regulations for Preventing Collisions at Sea (KVR) that the German legislator issued for the purpose of their national implementation, the term of restricted visibility is taken up in Section 9 (1) No. 19 without further specification. Accordingly, it is a regulatory offense to intentionally or negligently “violate a provision of Regulation 19 concerning the conduct of vehicles in reduced visibility.”

Furthermore, the requirement for certainty, which appears necessary for factual and/or legal reasons, could be satisfied for example by not again using the vague term “uncertain weather” or “restricted visibility” to specify the visibility-dependent category of danger in the new version of Section 12 (2) of the Ordinance, but by defining a concrete numerical value (e.g. visibility of less than 100 meters[73]).

[72] Note: Article 103 (2) of the German Basic Law stipulates that the law must be clear and precise. This requirement applies not only to criminal law, but also to the prosecution of administrative offenses, and means that the requirements for criminal liability or punishment must be described in sufficient detail (i.e. "determined") in the respective norm.

[73] Note: A concrete figure for the purpose of dealing with adverse visibility conditions with sufficient legal certainty can also be found, for example, in Section 3 (1) sentence 3 of the German Road Traffic Regulations. This states: *"If visibility is less than 50 m due to fog, snowfall or rain, the speed may not exceed 50 km/h unless a lower speed is required.”*

6 ACTIONS TAKEN

6.1 Federal Ministry of Transport and Digital (BMDV)

In its comments on the draft of the investigation report, the BMDV stated, among other things, that it would examine the extent to which the provision of Section 12 (2) of the Ferry Operation Ordinance could be modified.

6.2 General Directorate for Waterways and Shipping (GDWS)

The GDWS, as the supervisory authority of the NOK Waterways and Shipping Authority, commented on the draft report as follows:

"Within the framework of quality management, a root cause analysis was carried out after the accident. The result of the evaluation is that equipping the NOK ferries with an electronic nautical chart, combined with an overlay of radar and AIS information (analogous to BSU safety recommendations 7.1.1 and 7.1.3.) would mean a high optimization potential for the safety of ferry operations. However, no measures have yet been taken in this regard."

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 WSA NOK

The BSU makes the following recommendations to WSA NOK with regard to the navigational equipment on NOK ferries owned by the federal government.

7.1.1 Integration of AIS into the radar sets at the control position on NOK ferries

The radar sets at the control position of NOK ferries should – if the version installed so permits – be modified so that AIS signals are also shown on the radar display screen. If such a modification is not technically possible and/or if it is necessary to replace the previously used AIS devices, then the purchase of new radar devices with AIS function included and, if necessary, new AIS transceivers should be considered.

7.1.2 Inspection of the AIS devices at the control position on NOK ferries

Regardless of the overriding recommendation in Ch. 7.1.1, the current AIS devices on board the ferries should be inspected to ensure they are in proper working order.

7.1.3 Electronic navigational chart on NOK ferries

The use of a high-resolution electronic navigational chart may assist with approaching ferry terminals in heavy fog. This requires that such a chart can display the contour of ferry terminals, ferries and the exact position of a ferry with a high level of precision. The BSU recommends that the WSA examine the technical feasibility of such a solution and implement it if the effort is reasonable. It is important to note that a solution is only meaningful if the navigational chart, the radar image and the AIS targets can be simultaneously displayed on a single monitor.

7.2 Adler-Schiffe GmbH & Co. KG

The BSU recommends that the operator of the NOK ferries, Adler-Schiffe GmbH & Co. KG, revise the service regulations for the ferry personnel it employs and, if necessary, modify the employment contracts and wage agreements accordingly. Ferry deckhands should be required to assume the role of lookout on the instructions of the ferry pilot, at least in cases where the latter believes that adverse visibility conditions or other special circumstances make this necessary.

7.3 WSA NOK and Adler-Schiffe GmbH & Co. KG

The BSU recommends that WSA NOK and Adler-Schiffe GmbH & Co. KG enter into a contractual agreement on the conditions under which ferry pilots are authorised to suspend the ferry service. The BSU believes that a regulation which enables the operator and especially the ferry pilot to temporarily suspend the ferry service in extremely poor visibility without being exposed to economic risks or risks under labour law, unless transportation involves an absolute emergency, is necessary.

7.4 Federal Ministry for Digital and Transport (BMDV)

To improve legal certainty and legal clarity, the BSU recommends that the BMDV reintroduce poor visibility conditions to the list of hazards that may require suspension of the ferry service explicitly referred to in Section 12(2) FäV.

8 SOURCES

- Written explanations/submissions
  - Ship's command of the MV SCHELDEBANK
  - Pilot of the MV SCHELDEBANK
  - Ferry pilot of the NOK ferry HOCHDONN
- Witness testimony
- Investigation results and photographs of WSP Schleswig-Holstein
- Photograph of the MV SCHELDEBANK; Dietmar Hasenpusch Photo-Productions, Hamburg
- Privately owned collection of documents and records on the work of a ferry pilot from the ferry pilot of the HOCHDONN
- Navigational charts and ship particulars, BSH, Hamburg
- Official report on the weather conditions during the SCHELDEBANK/HOCHDONN collision at 0800 CEST on 8 May 2020; Weather Forecast Division of the DWD, Hamburg, 8 June 2020
- VHF radio and AIS recordings of VTS NOK
- Various items of information on the NOK ferry service provided by WSA NOK
- Product information on the SWISS RADAR Precision Navigator II river radar set from the manufacturer, JFS Electronic Sturtzel + Co. AG, Rothusstraße 9, CH-6331 Hünenberg (source: www.swissradar.com
- SIMRAD V5035 Class A/Inland AIS operator and installation manual (source :) www.navico-commercial.com)
- Inland AIS leaflet from the Central Commission for the Navigation of the Rhine (edition: 2011)
- Comments on the draft of the investigation report