



Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Ministry of Transport,
Building and Urban Development

Summary Investigation Report 53/13

Marine Casualty

Collision in the Brunsbüttel siding
between the CMV HERM KIEPE and CMV
EMPIRE
on 2 March 2013

18 December 2013

The investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Law - SUG) of 16 June 2002, amended most recently by Article 1 of 22 November 2011, BGBl. (Federal Law Gazette) I p. 2279.

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

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

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

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Table of Contents

1	SUMMARY	5
2	FACTUAL INFORMATION.....	6
	2.1 Photo.....	6
	2.2 Ship particulars.....	6
	2.3 Voyage particulars.....	7
	2.4 Photo.....	8
	2.5 Ship particulars.....	8
	2.6 Voyage particulars.....	9
	2.7 Marine casualty or incident information	10
	2.8 Shore authority involvement and emergency response.....	11
3	COURSE OF THE ACCIDENT AND INVESTIGATION	12
	3.1 Course of the accident	12
	3.2 Investigation	12
4	ANALYSIS.....	16
5	CONCLUSIONS.....	34
6	SOURCES	37

Table of Figures

Figure 1: Photo of the HERM KIEPE	6
Figure 2: Photo of the EMPIRE	8
Figure 3: Scene of the accident, excerpt from ENC DE521450, BSH	10
Figure 4: Damage to the EMPIRE	15
Figure 5: Damage to the HERM KIEPE	15
Figure 6: VDR of the EMPIRE at 104645	16
Figure 7: VDR of the EMPIRE at 104721	17
Figure 8: VDR of the EMPIRE at 104821	18
Figure 9: VDR of the EMPIRE at 104849	18
Figure 10: VDR of the EMPIRE at 104915	19
Figure 11: Radar image of the HERM KIEPE at 104044	19
Figure 12: Radar image of the HERM KIEPE at 104732	20
Figure 13: Radar image of the HERM KIEPE at 104802	20
Figure 14: Radar image of the HERM KIEPE at 104832	21
Figure 15: Radar image of the HERM KIEPE at 104902	21
Figure 16: Simulator at 104653	22
Figure 17: Simulator at 104710	22
Figure 18: Simulator at 104815	23
Figure 19: Simulator at 104835	23
Figure 20: Simulator at 104915	24
Figure 21: Container that fell overboard	36
Figure 22: Flotsam, cargo damage	36

1 Summary

At 1049¹ on 2 March 2013, the westbound container ship HERM KIEPE, which was sailing under the flag of Antigua & Barbuda, and the eastbound container ship EMPIRE, which was sailing under the flag of the Netherlands, collided in dense fog in the Kiel Canal's inland port of Brunsbüttel. The HERM KIEPE waited in the siding to enter the Große Nordschleuse (large north lock). The eastbound CREMONA and behind her the EMPIRE were located in the Große Nordschleuse. The KLENODEN, also eastbound, was located in the Kleine Nordschleuse (small north lock). The CREMONA left the locks first, then the KLENODEN, and finally the EMPIRE. The CREMONA passed the HERM KIEPE at an estimated distance of 30 m, while the KLENODEN proceeded further to the south. It is likely that hydrodynamic interaction occurred between the ships during both encounters. The HERM KIEPE made turning movements towards the middle of the canal. The EMPIRE, which was following, proceeded from the guiding racks to the siding's berth about 500 m away just north of the middle of the fairway. In the process, her port side collided with the bow of the HERM KIEPE and she lost four containers. One container landed on the forecastle of the HERM KIEPE. A pilot and two canal helmsmen manned each ship. There were no injuries and no pollutants escaped during the accident. The canal was closed and floating/submerged containers were located and secured.

¹ Unless stated otherwise all times shown in this report are local
= Central European Time = UTC + 1

2 FACTUAL INFORMATION

2.1 Photo



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Figure 1: Photo of the HERM KIEPE

2.2 Ship particulars

Name of vessel:	HERM KIEPE
Type of vessel:	Container ship
Nationality/Flag:	Antigua & Barbuda
Port of registry:	Saint John's
IMO number:	9162667
Call sign:	V2OP5
Owner:	Schepers Bereederung GmbH & Co. KG
Year built:	1997
Shipyard/Yard number:	J.J. Sietas KG Schiffswerft GmbH & Co./1048
Classification society:	Germanischer Lloyd
Length overall:	139.03 m
Breadth overall:	23.9 m
Gross tonnage:	9,991
Deadweight:	13,059 t
Draught (max.):	9.15 m
Engine rating:	5,950 kW
Main engine:	MaK 8 M 601 C
(Service) Speed:	19 kts

Ref.: 53/13

Hull material:	Steel
Hull design:	Double hull
Minimum safe manning:	13

2.3 Voyage particulars

Port of departure:	Kotka, Finland
Port of call:	Hamburg
Type of voyage:	Merchant shipping/International
Cargo information:	Containers
Manning:	16
Draught at time of accident:	9.2 m
Pilot on board:	Yes
Canal helmsman:	Yes
Number of passengers:	None

2.4 Photo



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Figure 2: Photo of the EMPIRE

2.5 Ship particulars

Name of vessel:	EMPIRE
Type of vessel:	Container ship
Nationality/Flag:	Netherlands
Port of registry:	Harlingen
IMO number:	9387425
Call sign:	PBRA
Owner:	JR Fleet Fund C.V.
Year built:	1997
Shipyard/Yard number:	P + S Werften GmbH/554
Classification society:	Germanischer Lloyd
Length overall:	170.03 m
Breadth overall:	25.00 m
Gross tonnage:	15,924
Deadweight:	19,800 t
Draught (max.):	9.5 m
Engine rating:	12,640 kW
Main engine:	MAN B&W 8S50MC-C
(Service) Speed:	19.8 kts
Hull material:	Steel
Hull design:	Double hull
Minimum safe manning:	11

2.6 Voyage particulars

Port of departure:	Hamburg
Port of call:	Gdynia, Poland
Type of voyage:	Merchant shipping/International
Cargo information:	Containers
Manning:	15
Draught at time of accident:	9.3 m
Pilot on board:	Yes
Canal helmsman:	Yes
Number of passengers:	None

2.7 Marine casualty or incident information

Type of marine casualty/incident:	Less serious marine casualty Collision
Date, time:	02/03/2013, 1049
Location:	Inland port of Brunsbüttel
Latitude/Longitude:	ϕ 53°54.0'N λ 009°09.4'E
Ship operation and voyage segment:	Harbour mode, Kiel Canal
Place on board:	Forecastle
Human factors:	Yes, human error
Consequences (for people, vessel, cargo, environment, and other):	No injuries The EMPIRE lost four containers No emissions

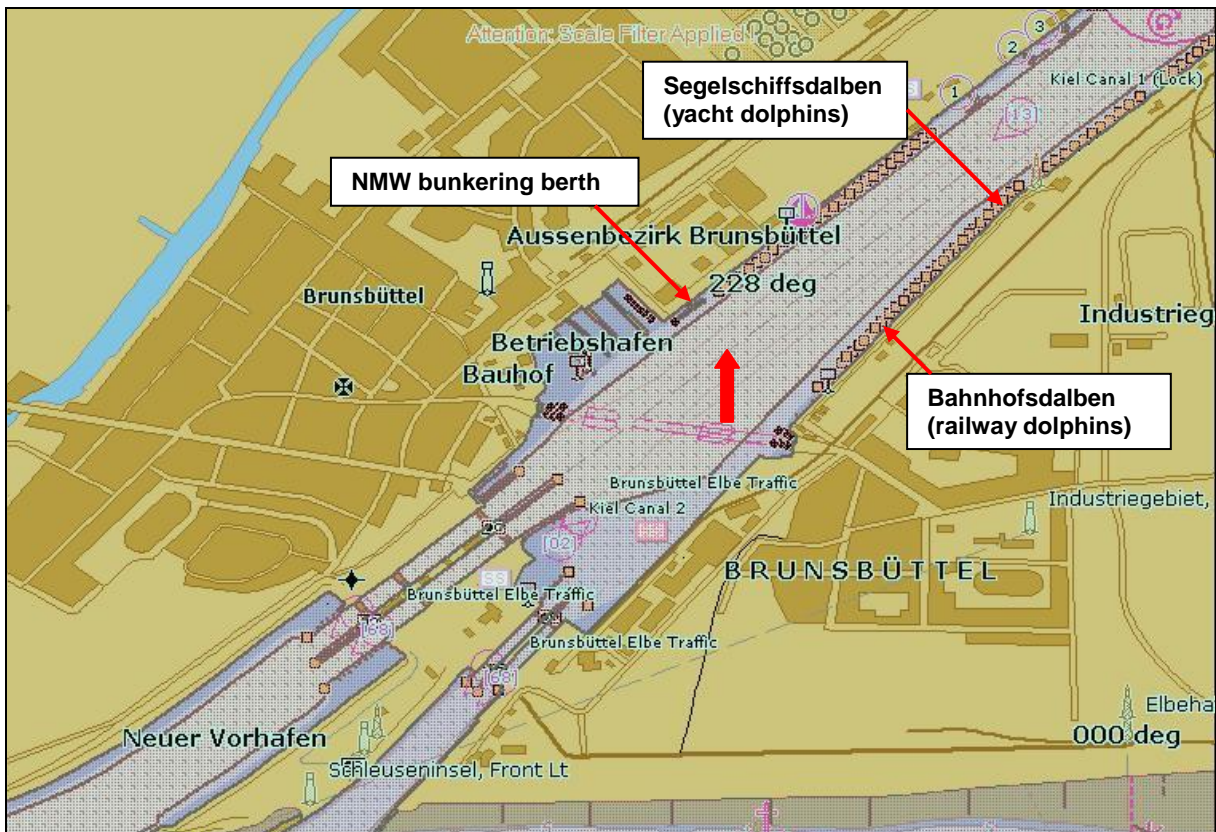


Figure 3: Scene of the accident, excerpt from ENC DE521450, BSH

2.8 Shore authority involvement and emergency response

Agencies involved:	VTS Brunsbüttel, WSP Brunsbüttel
Resources used:	Government agency ships, divers, floating crane
Action taken:	Canal closed, containers recovered
Results achieved:	Damage repaired

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

At 1049 on 2 March 2013, the westbound container ship HERM KIEPE and the eastbound container ship EMPIRE collided in dense fog centrally in the fairway of the Kiel Canal's inland port of Brunsbüttel at the end of the siding's northern row of dolphins. The HERM KIEPE waited at the row of dolphins. Using engine power, she manoeuvred to maintain her position and enter the Große Nordschleuse as soon as she was released. The eastbound CREMONA and behind her the EMPIRE were located in the Große Nordschleuse. The KLENODEN, also eastbound, was located in the Kleine Nordschleuse. By agreement between the vessel traffic service (VTS), the lockmaster and pilots, the CREMONA left the locks first, then the KLENODEN, and finally the EMPIRE. The CREMONA passed the HERM KIEPE at an estimated distance of 30 m, while the KLENODEN proceeded further to the south. It is likely that hydrodynamic interaction occurred between the ships during both encounters. According to the VDR recordings, the HERM KIEPE made turning movements towards the middle of the canal, which she tried to compensate for by using the rudder, main engine, and bow thruster. The EMPIRE, which was following closely, proceeded from the guiding racks to the siding's berth about 500 m away just north of the middle of the fairway. In the process, her port side, roughly at the aft edge of the forecastle, collided with the bow of the HERM KIEPE and she lost four containers. One container landed on the forecastle of the HERM KIEPE. A pilot and two canal helmsmen manned each ship. There were no injuries and no pollutants escaped during the accident. The canal was closed and floating/submerged containers were located and secured.

3.2 Investigation

The HERM KIEPE came from Rüsterbergen, where she switched pilots at 0320 for the westbound passage to Brunsbüttel after the pilot was previously released from the ANNIKA and immediately transferred for his new assignment. His assignment on the ANNIKA started in Brunsbüttel at 2300 on the previous day. The HERM KIEPE is on the Kiel Canal regularly and known from previous pilotage assignments. The chief officer, pilot and helmsman were on the bridge. The chief officer handed over the pilot card and advised on the manoeuvring characteristics and operation of the controls. The pilot stated that from that he understood the HERM KIEPE was reportedly equipped with a left-hand controllable pitch propeller, a rudder, and a bow thruster. At a propeller pitch of 10%, the speed was about 2.5 kts, at 20% 4-4.5 kts, and at 30% 6.5 kts. The navigation equipment, which included inter alia two radar units, gyrocompass, GPS, AIS, and several VHF units, worked as it should. The gyrocompass was error-free. The draught stood at 9.2 m. Accordingly, the HERM KIEPE was classified to Traffic Group 5 as a low-speed vessel.

Good visibility prevailed in Rüsterbergen and there was practically no wind. The starboard radar unit was set up for the pilot. It was operated in head-up mode at a range of 0.5 nm and off-centre. The lubber line and resolution were reportedly perfect. The canal passage was initially made at 12 km/h with a propeller pitch of 30%. It was known from the traffic report of the VTS that a waiting period of 10 minutes had to be reckoned with in the siding at Breiholz. Therefore, the speed was reduced ahead of the siding so that Breiholz could be passed slowly and without stopping.

The HERM KIEPE was the last ship in a convoy permitted to run at 15 km/h. The Dückerwisch siding was passed at 0618 and visibility deteriorated to 600-1,000 m. Continuous fog with visibility of 100 m prevailed shortly before the siding at Kudensee. Both anchors were made ready to drop and the speed was reduced to 4 kts. The Kudensee siding was passed at 0715. A message received from the VTS indicated that waiting periods of two to three hours had to be reckoned with before the locks in Brunsbüttel. Therefore, the pilot recommended that they initially wait at Marinedalben (naval dolphins) N. They stopped there at about 0800. The HERM KIEPE was made fast at the dolphins and held in position by a fore spring and occasional engine manoeuvres.

A westbound Traffic Group 5 convoy approached from behind. This comprised the ships NATIONAL GLORY, STEN IDUN, and CHARLOTTA B. Therefore, at 0920 they proceeded towards the Segelschiffsdalben at between slow-ahead and stop so as to wait there for entry into the lock. However, it was not possible to attach a line to the dolphins because of the draught. According to the radar observations on the HERM KIEPE, the CREMONA and the EMPIRE were made fast in the Große Nordschleuse at about 1000. Shortly after, a message indicating that Lock Gate 1 could not be closed and an indefinite wait had to be reckoned with was received from the VTS. Therefore, they attempted to remain parallel to the row of dolphins, at a distance of about 30 m, using engine and bow thruster manoeuvres in the ensuing period.

At about 1037, it was seen on the radar screen that the CREMONA was already underway and would apparently pass at close quarters. This came as a surprise because the lockmaster had not reported that the gates had been opened. An attempt was made to traverse slightly north with rudder hard to port, engine dead slow-ahead, and bow thruster to starboard (navig. traversing by rudder and engine manoeuvres). The row of dolphins and the CREMONA, which passed at a distance of about 30 m, were both visible. The forecastle and mast were just visible ahead. Later, the blue ferry sign was just visible. At about 1045, the KLENODEN set sail from the Kleine Nordschleuse and the EMPIRE from the Große Nordschleuse at the same time. The KLENODEN got underway quickly and kept to the south. The EMPIRE was located at the guiding racks and on leaving the lock steered a course of 48°, as specified by the signal masts (see Fig. 6). She was just north of the leading line up until 1049 (see Fig. 9). Therefore, attempts were made on the HERM KIEPE to traverse further north with the rudder hard to port, the bow thruster at full power to starboard, and the controllable pitch propeller set to a pitch of 10%. However, the ship did not turn to starboard, but rather to port.

Following that, an order was issued to set the rudder to hard to starboard and the propeller pitch was slightly increased. This did not result in the intended turn to starboard. Contrary to the last helm command, the rudder angle indicator displayed amidships. After that, the rudder was set to hard to starboard and an order to set the engine to half-astern was issued.

The EMPIRE became visible just to starboard at a distance of 30 m ahead. The stem collided with the forward third of the EMPIRE's port side at the residual speed. Four containers were torn from the stack; three fell overboard and one landed on the forecastle of the HERM KIEPE. The two ships separated again and were stabilised. The VTS was informed about the collision. There were no injuries and no pollutants escaped. The material damage was relatively minor. The HERM KIEPE remained manoeuvrable and made fast at 1130 on the middle wall of the Große Nordschleuse. The canal was closed and the investigation started.

At 1005, the pilot and canal helmsmen manned the EMPIRE in the Große Nordschleuse. She made fast on her starboard side behind the CREMONA. A trainee (student at the University of Bremen's Nautical Science Department) and the master were also present. The EMPIRE and similar ship types were known and piloted on several occasions. The master advised on the manoeuvring characteristics and pilot card. Only 75% of the bow thruster's power was reportedly available and the lowest rate of speed was 3-4 kts. Both radar units were in head-up mode, at 0.5 nm, and off-centre. The transferred gyro headings were consistent with the master compass and screen resolution was perfect. The other navigation equipment, such as GPS, AIS, and VHF units were operable. With a draught of 9.30 m, the EMPIRE was classified to Traffic Group 5. She was on an even keel.

Visibility stood at 300-400 m and both anchors were ready to drop. The forecastle was manned by a lookout. The current traffic report was broadcasted on VHF at 1015. The PPU² (portable pilot unit) made it possible to display the position of each of the vessels waiting before the lock. After the CREMONA departed, the lines were slipped at 1035 and the EMPIRE sailed out of the lock at dead slow-ahead and 48° course over ground (COG). She was steered by the master from a wing control position, while the pilot was at the VHF unit consulting with his colleague on the KLENODEN, which was in the Kleine Nordschleuse. It was agreed that the KLENODEN could leave the lock before the EMPIRE. The stern passed the guiding racks at about 1045. They then switched to the central control position and the helmsman took over the helm. The pilot stood in front of the starboard radar unit and monitored the distance to the CREMONA and the ships waiting at the Segelschiffsdalben. The HERM KIEPE's echo was noticed at 1048. She was located at the bunker station west of the dolphins. She headed directly towards the EMPIRE. Course alterations to 50°, 52°, 56°, then further to starboard, until the rudder angle indicator finally displayed hard to starboard, followed.

² The PPU of the Lotsenbrüderschaft NOK I (Brotherhood of NOK I Pilots) displays its own position, the AIS data of other vessels, as well as the electronic chart with latest sounding plans on a tablet PC.

The pilot asked: "KIEPE, what are you doing?" on VHF channel 13, but did not receive an answer. The HERM KIEPE did not carry out the anticipated course alteration to starboard. When the collision was imminent, the rudder on the EMPIRE was set to hard to port and an order was issued to set the engine to stop and dead slow-astern. The HERM KIEPE was just visible to port about 50 m away. The collision occurred at 1049 when the HERM KIEPE touched the forward third of the EMPIRE's port side with her stem. An order was then issued to set the engine to half-ahead so as to separate the vessels. Alternating rudder and engine manoeuvres made it possible to stabilise the EMPIRE, thus preventing a collision with the Bahnhofsdalben to the south. After that, the collision and damage were reported to the VTS. At 1145, the EMPIRE was turned in the inland port with tug support. She then made fast at Marinedalben N for the investigation at 1245.

The damage sustained by the ships was relatively minor. The forward port bulwark on the EMPIRE and the bow on the HERM KIEPE were pressed in. Both vessels could manoeuvre under their own steam and continue their voyages.

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Figure 4: Damage to the EMPIRE



Figure 5: Damage to the HERM KIEPE

4 ANALYSIS

The following analysis draws on the VDR data of the HERM KIEPE and the EMPIRE, as well as the images of the simulation of the accident on the ship-handling simulator during a visit to the Lotsenbrüderschaft NOK I in Brunsbüttel on 14 May 2013.

First, the course of the accident after the EMPIRE departed the Große Nordschleuse can be seen. Here, the AIS data of the HERM KIEPE is also displayed (green). The EMPIRE's course made good is marked in one-minute intervals. Unlike the VDR, the AIS data are not recorded by the second, but based on the speed of the vessels, i.e. at intervals of three minutes at speeds of 3 kts or lower, and 10 seconds at speeds of 0 to 14 kts or 3.3 seconds if the course is altered. Reference A-D marks the antenna position of the HERM KIEPE's AIS signal. The distances and bearings relate to the EMPIRE and the antenna position of the AIS signal level with her superstructure. At 104645, the EMPIRE's bow is on the so-called stop line, approximately north-east of the plotted ferry crossings. Her speed stands at 3.5 kts. Until that point, she may not be overtaken by any other vessel. The HERM KIEPE is almost parallel to the dolphins and moving at 0.6 kts. She is required to keep to the north of the leading line of the middle guiding rack's signal masts until the stop line. The antenna distance between the two vessels is 0.42 nm.

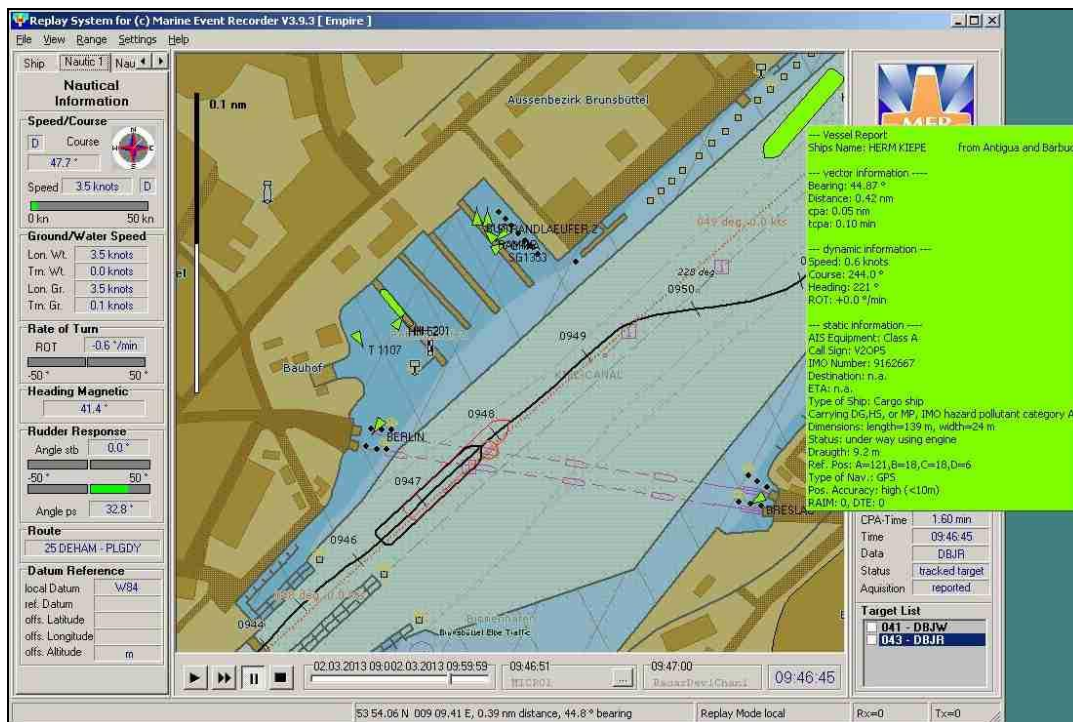


Figure 6: VDR of the EMPIRE at 104645

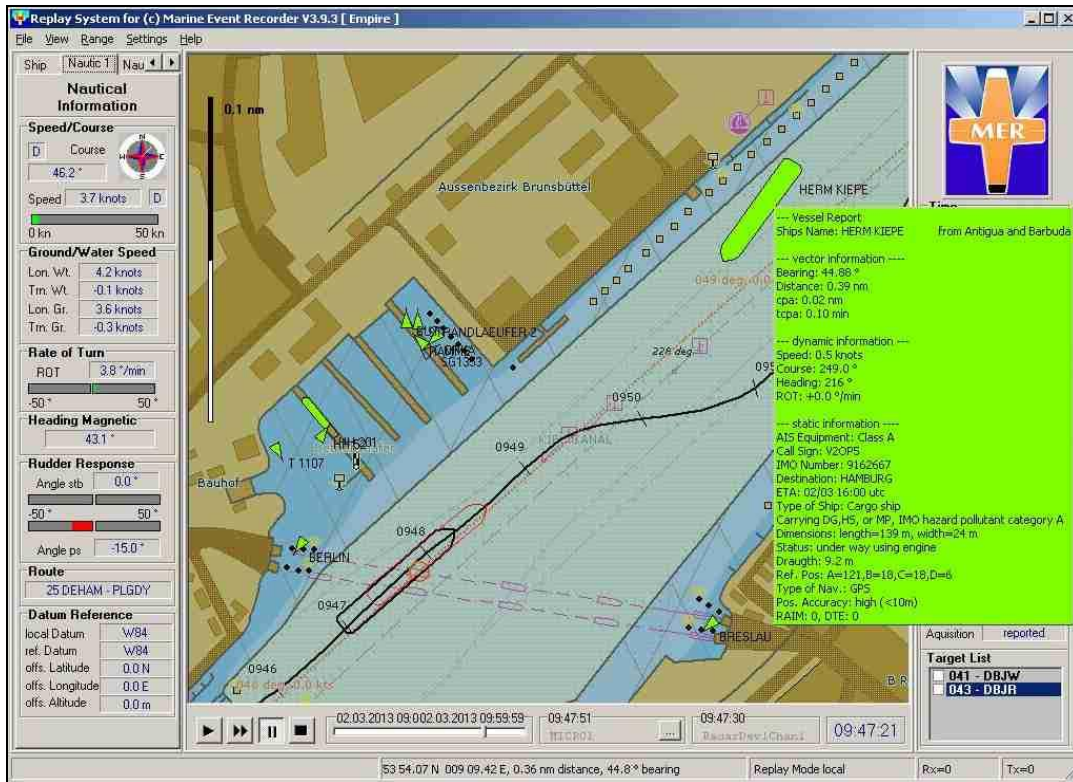


Figure 7: VDR of the EMPIRE at 104721

At 104721, the EMPIRE is located to the north in line with the signal masts of the middle guiding rack's. Her speed stands at 3.7 kts. The HERM KIEPE turns further to port at a speed of 0.5 kts and on a course of 249°. The parallel course to the dolphins would be 228°.

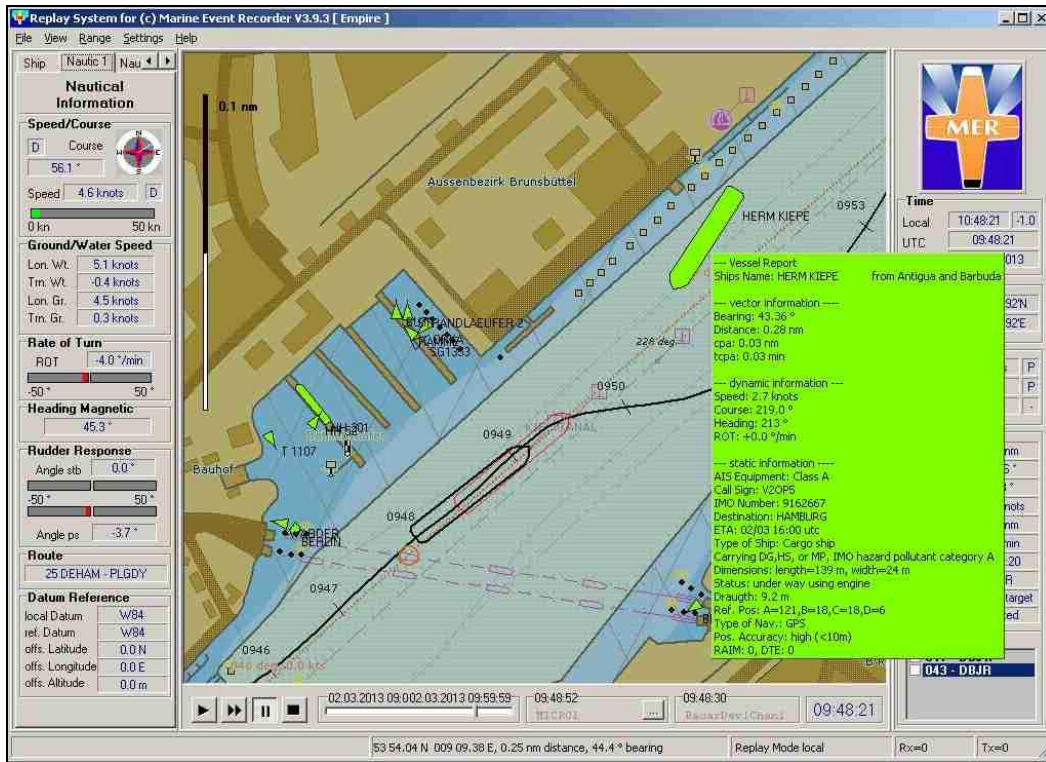


Figure 8: VDR of the EMPIRE at 104821

At 104821, the EMPIRE is still north of the leading line of the signal masts and turns slowly to starboard at a speed of 5 kts; the HERM KIEPE turns further to port, now on a course of 219° and at a speed of 2.7 kts. The collision is looming and unavoidable.

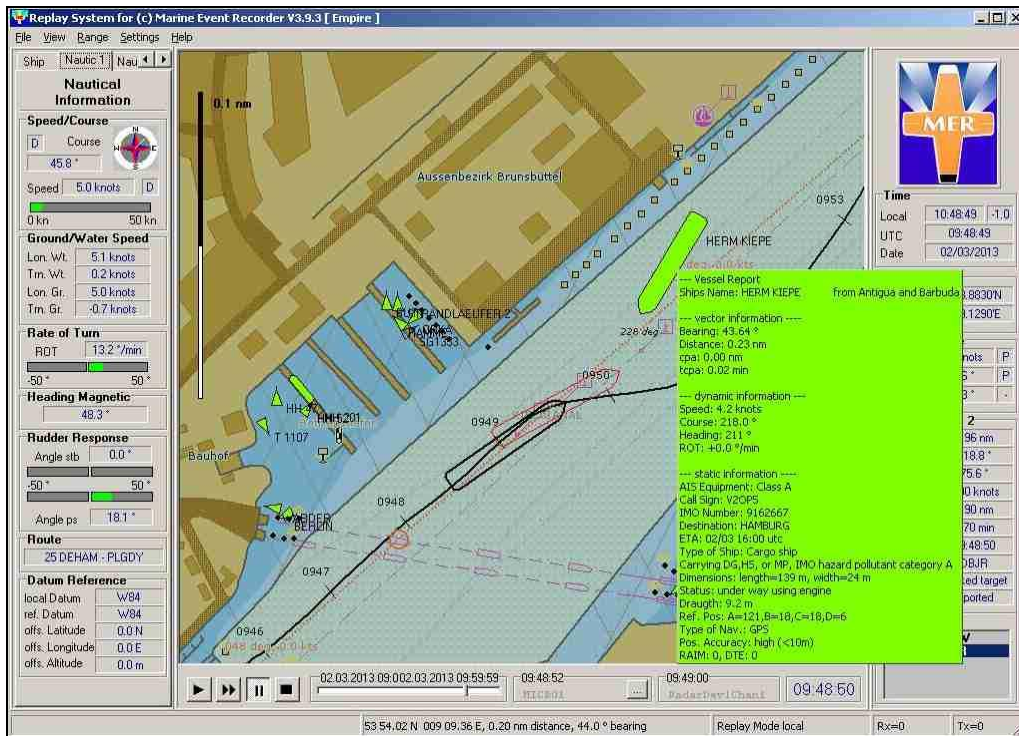


Figure 9: VDR of the EMPIRE at 104849

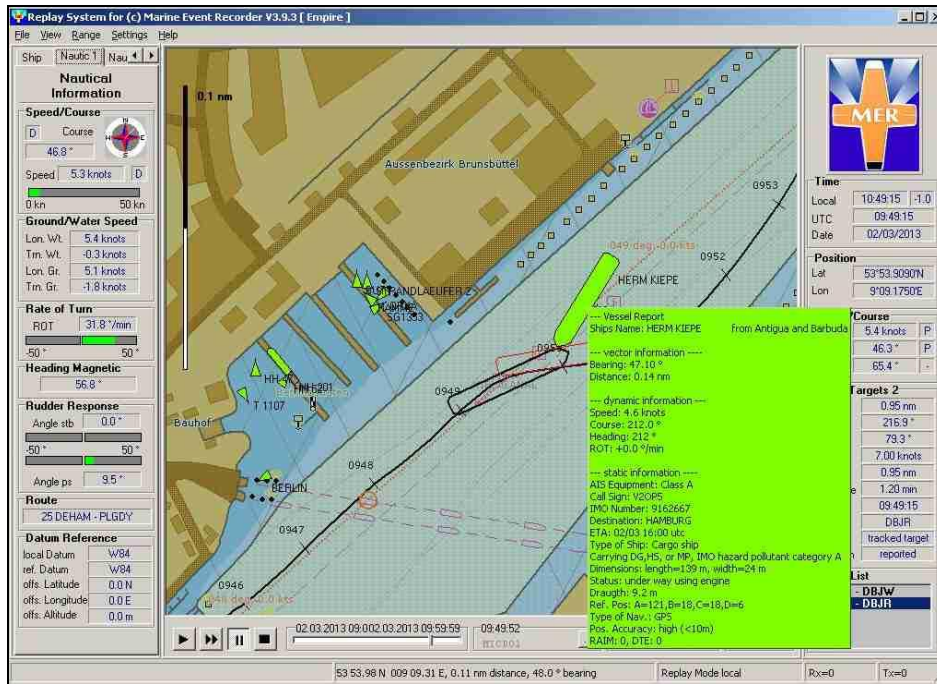


Figure 10: VDR of the EMPIRE at 104915

The two vessels collide at 104915. The HERM KIEPE strikes the port side of the EMPIRE's forecastle head-on. The EMPIRE is still north of the leading line of the signal masts.

The following radar images are recordings of the HERM KIEPE. At 104044, the CREMONA passes the stern of the HERM KIEPE. In this situation, the HERM KIEPE moves to port. The heading (HDG) is 222.7° and the speed over ground 0.7 kts. The KLENODEN and EMPIRE are still in the lock.

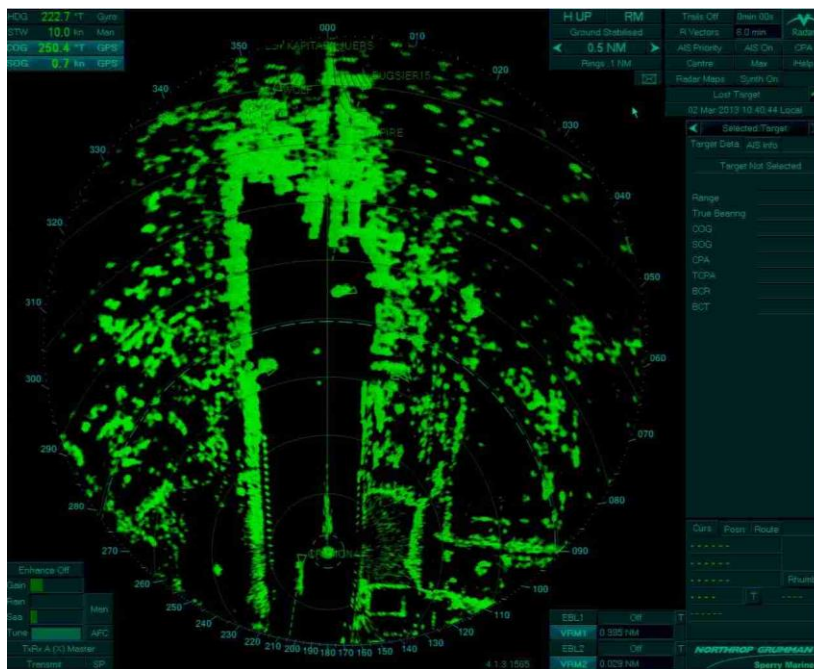


Figure 11: Radar image of the HERM KIEPE at 104044

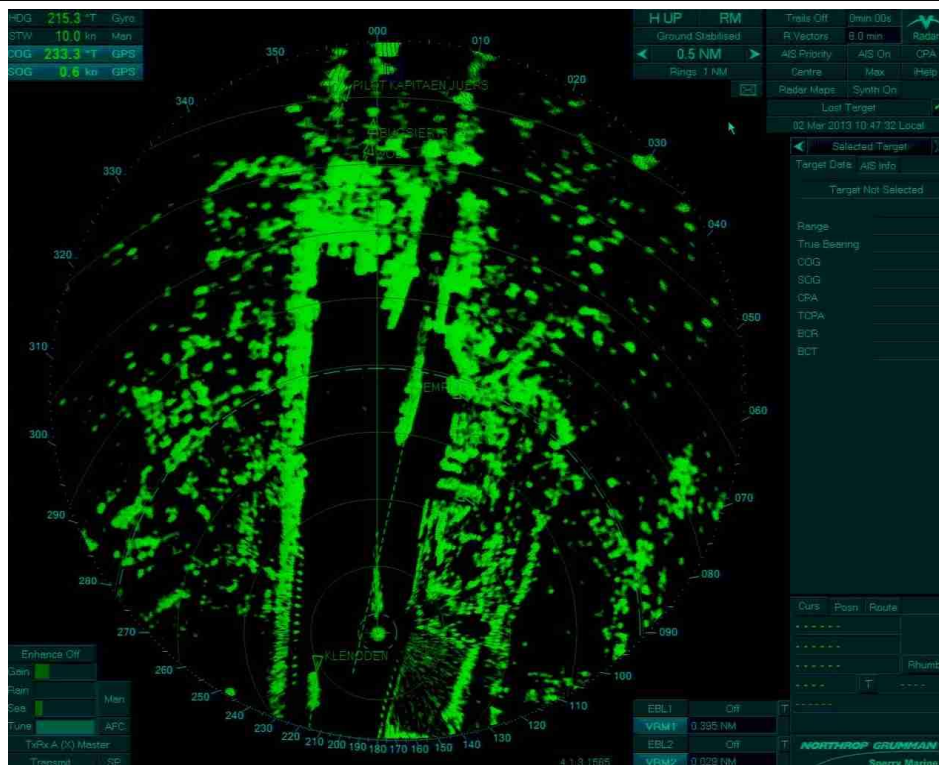


Figure 12: Radar image of the HERM KIEPE at 104732

The KLENODEN had passed the stern of the HERM KIEPE at 104732. At the same time, the HERM KIEPE continues to turn to port on a HDG of 215.3° and at a speed of 0.6 kts. The EMPIRE leaves the guiding racks of the Große Nordschleuse and is almost in line with the lock's lateral guiding racks.

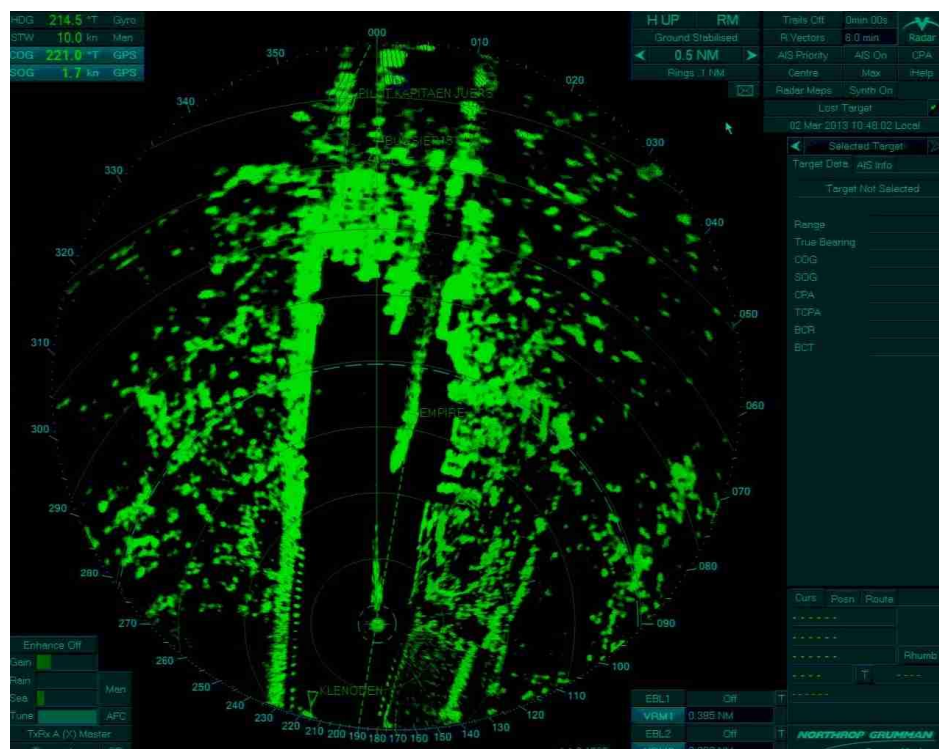


Figure 13: Radar image of the HERM KIEPE at 104802

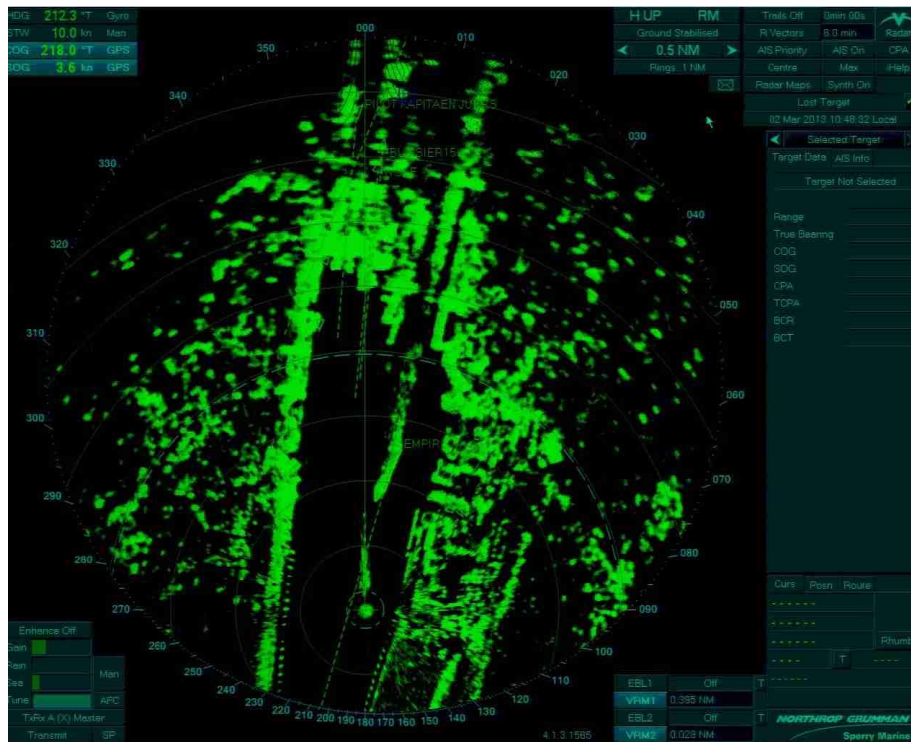


Figure 14: Radar image of the HERM KIEPE at 104832

The HERM KIEPE turns further to port on a HDG of 212.3° and at a speed of 3.6 kts; the EMPIRE is still on the northern side. The collision is looming.

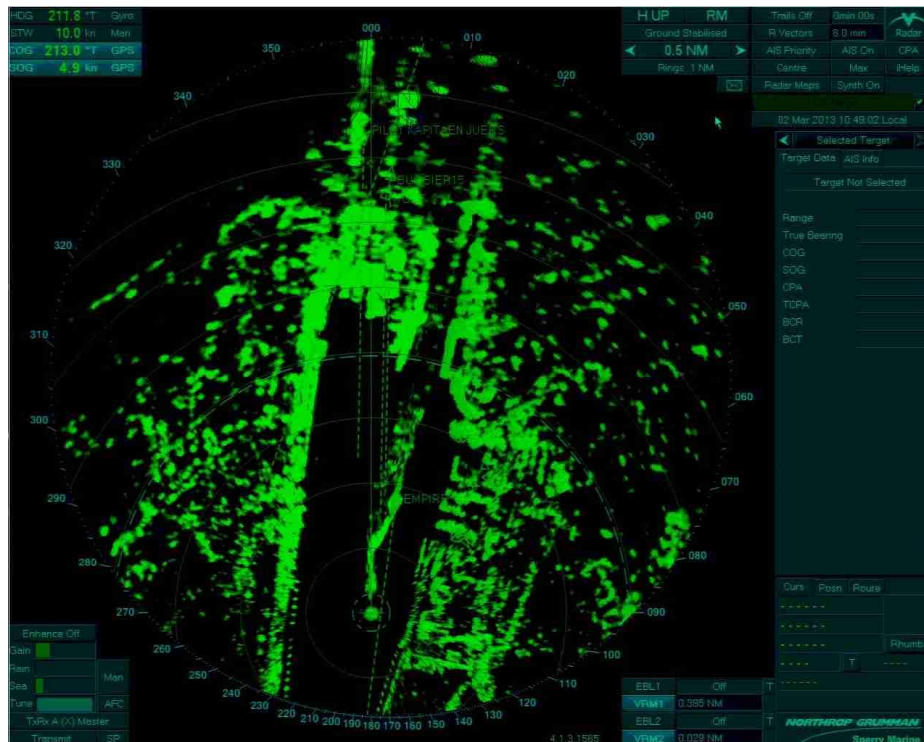


Figure 15: Radar image of the HERM KIEPE at 104902

At 104902, the two vessels collide and scrape past each other. The following images are generated by the ship-handling simulator based on AIS data and show the

Ref.: 53/13

course of the accident in good visibility when the KLENODEN passes the HERM KIEPE and the EMPIRE leaves the lock.

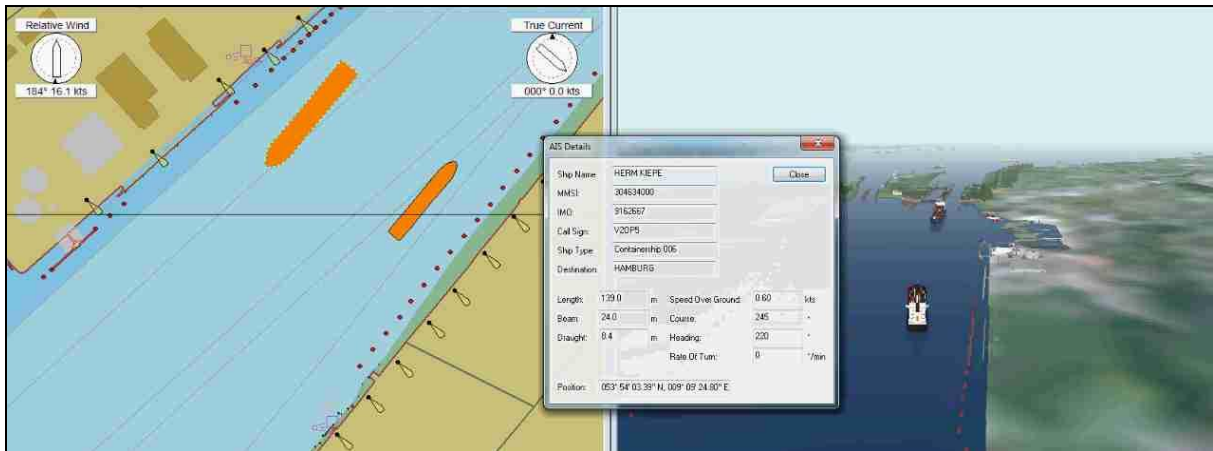


Figure 16: Simulator at 104653

At 104653, the KLENODEN passes the HERM KIEPE as the EMPIRE is just leaving the lock.

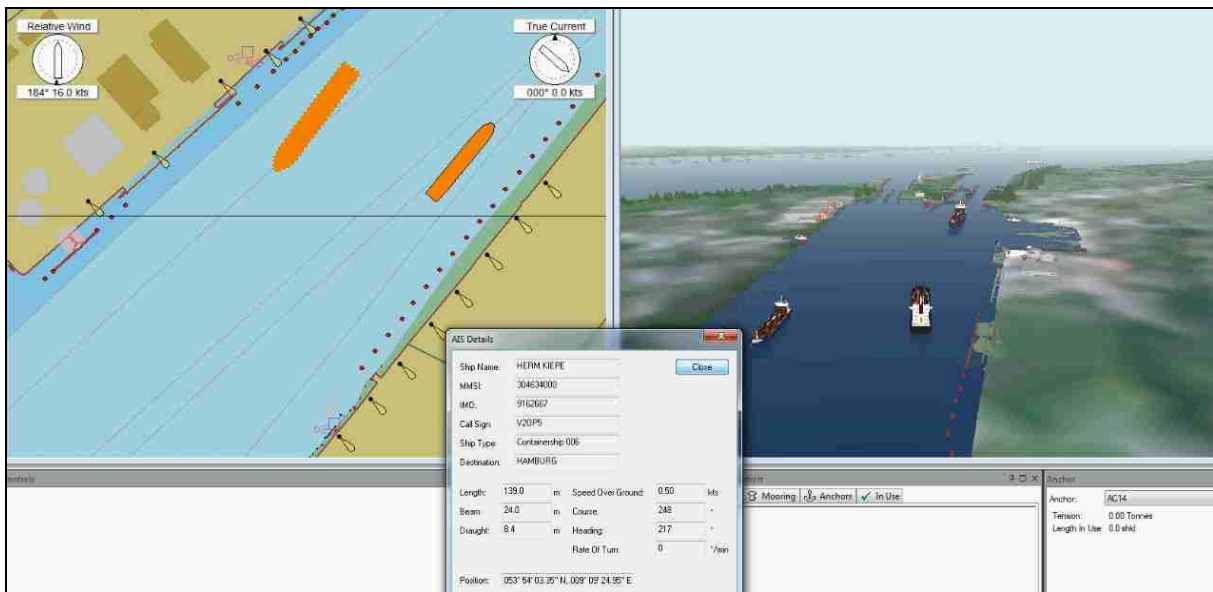


Figure 17: Simulator at 104710

During the passage, the KLENODEN and the HERM KIEPE can be seen making movements to port.

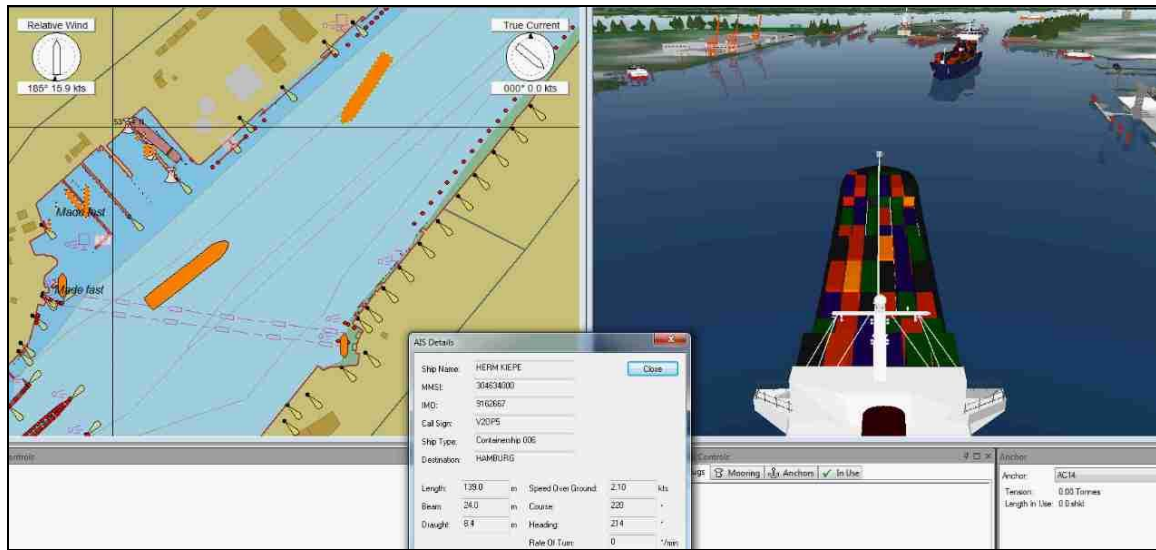


Figure 18: Simulator at 104815

The HERM KIEPE turns further to port and the EMPIRE slightly to starboard.

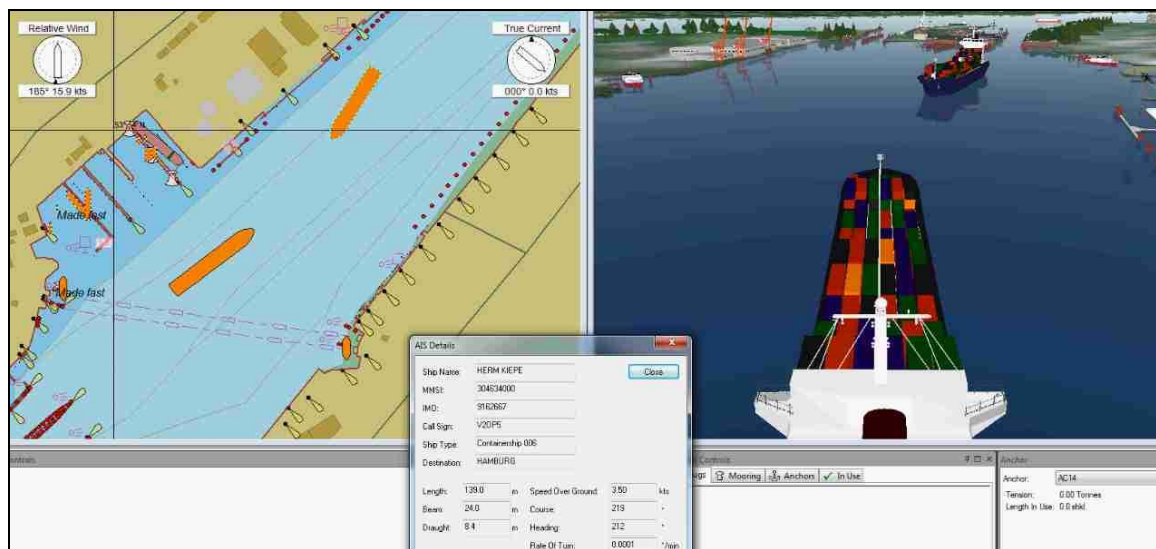


Figure 19: Simulator at 104835

The HERM KIEPE's turn to port cannot be stopped. The HERM KIEPE turns further towards the middle of the canal and the EMPIRE. The EMPIRE turns slowly to starboard and is still north of the middle guiding racks.

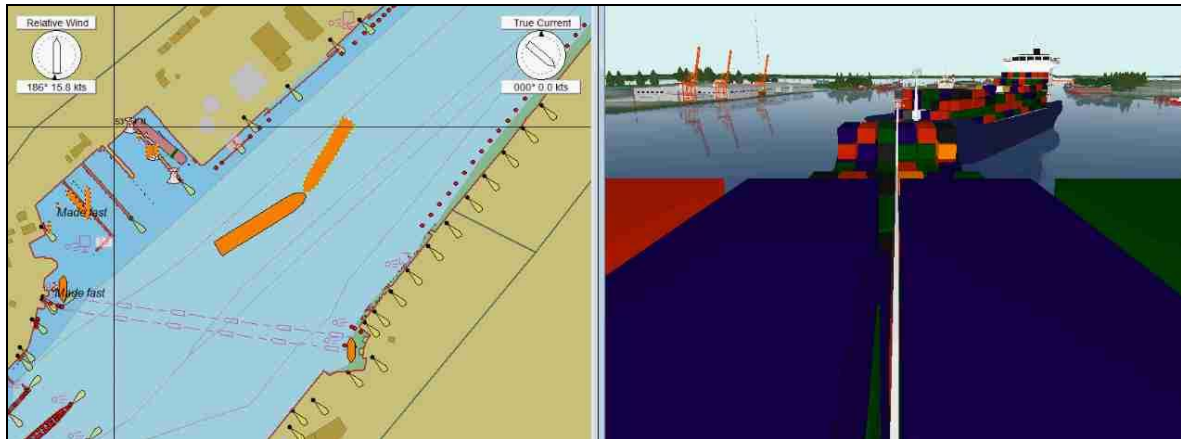


Figure 20: Simulator at 104915

The two vessels collide. The forecastles are in line with the middle guiding racks.

The VDR manoeuvring data of the EMPIRE and HERM KIEPE are evaluated in the following tables. From the NMEA³ data records, the course over ground (COG), speed over ground (SOG), heading (HDG), rate of turn (ROT), and rudder angle (-port, + starboard) could be evaluated for the EMPIRE, but only the COG, SOG, and HDG for the HERM KIEPE. The time of the collision (0949 UTC) is marked red. Here, the sensor data show irregularities. The plotted chart course of the middle guiding racks signal masts is 228° (see Fig. 3).

It can be seen in the table that the EMPIRE's COG is still 48.0° about one minute before the collision at 094830, and the ROT to starboard only 4.1°. In the next 30 seconds, the rudder is set from 5° starboard to 43° hard to starboard and it was possible to develop a ROT of 32° by just before the collision at 094919. According to the recordings, the collision occurred at 094920; the ROT increased suddenly by 8°. The starboard manoeuvre was initiated too late to get well to the southern side of the signal mast guideline. In one minute, the COG had only changed by 5°. The EMPIRE would have had to initiate the course alteration to starboard immediately after passing the middle guiding racks – about three minutes before the collision – and the HERM KIEPE maintain her position and distance to the row of dolphins. The HERM KIEPE deviated significantly from the parallel course of 228° of the signal mast leading line. At the time of the collision, the COG was 212° and the bow was on the signal mast leading line.

³ NMEA: Standard of the National Marine Electronics Association

NMEA data record analysis

International standard IEC 61162-1

ZDA	= Time and date UTC
VTG	= Course over ground and ground speed
HDT	= Heading true
HTD	= Heading/Track control data
ROT	= Rate of turn
RSA	= Rudder sensor angle

(*1=Relative measurement of rudder angle without units, "-" =

bow turns to port. Sensor output is proportional to rudder angle but not necessarily 1:1

VDR of the EMPIRE

ZDA	VTG		HDT	ROT	
Time UTC	Course over ground, degrees true (COG)	Speed over ground, knots (SOG)	Heading, degrees true (HDG)	Rate of turn, °/min.	Port rudder sensor (*1)
094830	48.0	4.70	52.92	4.1	
094831	50.3	4.76	52.97	4.1	5.10
094832	49.4	4.70	53.04	4.3	5.40
094833	50.5	4.8	53.09	3.8	
094834	50.9	4.80	53.15	3.8	9.00
094835	52.1	4.83	53.22	4	
094836	51.0	4.90	53.28	4.1	9.00
094837	52.1	4.9	53.32	3.8	
094838	51.8	4.80	53.39	3.9	10.60
094839	51.9	4.80	53.43	3.7	16.60
094840	50.9	4.90	53.50	3.9	
094841	49.8	4.90	53.62	4.6	16.80
094842	51.0	4.90	53.74	6	15.10
094843	47.8	4.95	53.84	6.2	9.50
094844	49.8	4.90	54.01	7.7	4.00
094845	47.5	4.90	54.14	8.4	4.10
094846	47.0	5.00	54.30	8.9	7.30
094847	46.6	5.07	54.48	9.8	
094848	47.1	5.00	54.65	10	7.50
094849	45.8	5.00	54.88	13.1	18.10
094850	46.3	5.00	55.10	12.9	19.70
094851	46.9	5.00	55.30	13	19.70
094852	46.8	5.10	55.56	13.5	
094853	48.1	5.05	55.77	13.2	19.70
094854	47.5	5.00	55.99	13.5	23.90
094855	48.8	5.09	56.23	13.6	30.10
094856	49.4	5.00	56.46	13.7	36.40
094857	49.2	5.10	56.70	14.3	
094858	49.3	5.10	56.97	15	43.30
094859	49.0	5.10	57.23	15.6	43.30
094900	48.4	5.10	57.52	16.3	
094901	46.9	5.17	57.87	17.9	43.30
094902	48.4	5.10	58.22	19.4	43.20
094903	44.7	5.28	58.59	20.5	43.30
094904	45.4	5.20	58.96	21.7	43.30
094905	43.9	5.29	59.40	22.9	43.30

094906	45.0	5.30	59.85	26.2	43.30
094907	42.7	5.40	60.30	26.6	43.30
094908	42.6	5.40	60.78	27.4	43.30
094909	42.6	5.30	61.30	28.4	43.30
094910	43.3	5.40	61.81	29.6	39.30
094911	43.6	5.40	62.32	29.9	32.80
094912	44.7	5.3	62.86	30.8	
094913	46.6	5.38	63.38	31.2	26.70
094914	45.1	5.40	63.92	31.6	20.80
094915	46.8	5.30	64.38	31.8	9.50
094916	47.9	5.3	64.99	31.8	3.80
094917	49.12	5.28	65.54	31.9	
094918	48.8	5.30	66.08	32	-1.20
094919	50.1	5.30	66.60	31.7	-5.00
	53.8	5.16	66.72	31.8	
			66.83	32.1	
			66.95		
			67.07		
094920	51.0	5.30	67.20	36.4	
			67.33	39.9	
			67.48		
			67.76		
			67.62		
094921	55.63	5.1	67.91	41.5	-10.50
			68.05	41.2	
			68.18	40.6	
			68.31		
			68.43		
094922	54.0	5.20	68.54	39.9	-16.00
094923	55.5	5.10	69.14	35.5	-27.60
094924	56.8	5.00	69.73	35.4	
094925	57.3	4.98	70.26	34.4	-33.80
094926	56.7	5.00	70.76	29.6	-40.50
094927	58.0	5.00	71.23	29.1	-45.00
094928	58.4	5.00	71.63	24.2	-45.00
094929	59.2	5.00	72.02	23.7	-45.00
094930	60.0	4.90	72.37	21.6	
094931	63.9	4.82	72.71	21	-45.00
094932	62.5	4.90	73.02	20	-45.00
094933	68.5	4.75	73.29	18.5	
094934	66.6	4.80	73.48	12.2	-45.00
094935	72.9	4.74	73.70	12.6	-45.00
094936	71.1	4.80	73.82	7.4	-45.00
094937	76.2	4.73	73.96	8	-45.00

094938	76.0	4.70	74.03	4.2	-45.00
094939	77.1	4.70	74.12	4.8	-45.00
094940	77.3	4.80	74.19	4.7	-45.00
094941	77.9	4.70	74.26	4.6	-45.00
094942	76.4	4.69	74.30	4.1	-45.00
094943	77.1	4.80	74.32	3.4	-45.00
094944	77.9	4.70	74.34	2.3	-45.00
094945	76.8	4.70	74.32	-2.5	-45.00
094946	75.0	4.70	74.28	-2.6	-45.00
094947	75.7	4.70	74.31	0	-45.00
094948	75.7	4.60	74.18	-6.8	-45.00
094949	75.9	4.60	74.11	-5.9	-45.00
094950	76.2	4.60	74.05	-5.2	
094951	76.9	4.59	73.99	-4.9	-45.00
094952	76.4	4.60	73.85	-5.9	-45.00
094953	79.8	4.70	73.76	-6.1	-45.00
094954	78.0	4.60	73.62	-7	-45.00
094955	81.5	4.70	73.47	-7.7	-45.00
094956	82.6	4.70	73.30	-9.2	-45.00
094957	84.1	4.66	73.12	-9.7	
094958	83.9	4.70	72.89	-11.5	-45.00

At 094731, the HERM KIEPE traversed on a COG of 235° at the Segelschiffsdalben. The KLENODEN passed immediately afterwards (see radar image at 104732 CET). Although the HDG hardly changed by only 3° from 215° to 212° in the next minute, the COG leaped from 235° to 219°. The HERM KIEPE made a sharp movement to port and crossed the signal mast guideline course of 228° by 9° in the process. The HERM KIEPE could not keep her parallel track at the dolphins. The S-VDR recordings do not include data on the rudder and bow thruster, which could provide insight on counteracting hydrodynamic interactions in the traffic situation.

VDR of the HERM KIEPE

ZDA	VTG		HDT
Time UTC	Course over ground (COG), degrees true	Speed over ground, knots (SOG)	Heading, degrees true (HDG)
094730			215.5
094731	235	0.6	215.5
094732	233	0.6	215.3
094733			215.3
094734	231	0.6	215.3
094735			215.3
094736	229	0.7	215.3
094737			215.3
094738	228	0.8	215.3
094739			215.3
094740			215.3
094741	227	0.8	215.2
094742	226	0.9	215.2
094743			215.0
094744	225	1.0	215.0
094745			215.0
094746	224	1.0	215.0
094747			215.0
094748			215.0
094749	224	1.1	215.0
094750			214.8
094751	223	1.2	214.8
094752	222	1.2	214.8
094753			214.8
094754	222	1.3	214.8
094755			214.8
094756	221	1.4	214.8
094757			214.7
094758	221	1.5	214.7
094759			214.7
094800			214.7
094801	221	1.6	214.7
094802	221	1.7	214.7
094803			214.5
094804	220	1.8	214.5
094805			214.5
094806	220	1.9	214.5
094807			214.3
094808	220	2.0	214.3
094809			214.3
094810			214.3
094811	220	2.1	214.3
094812	220	2.2	214.2
094813			214.2
094814	220	2.3	214.0
094815			214.0
094816	220	2.5	214.0
094817			214.0
094818	220	2.6	213.8
094819			213.7
094820			213.7
094821	219	2.7	213.5
094822	219	2.9	213.5
094823			213.4
094824	219	3.0	213.4
094825			213.4
094826	219	3.2	213.4
094827			213.1
094828	219	3.3	213.0
094829			213.0
094830			212.7
094831	219	3.5	212.5
094832	218	3.6	212.5
094833			212.5
094834	218	3.8	212.3
094835			212.3
094836	218	3.9	212.3
094837			212.0
094838	218	4.1	212.0
094839			211.8
094840			211.8
094841	218	4.2	211.5
094842	217	4.3	211.5
094843			211.3
094844	217	4.5	211.3
094845			211.3
094846	217	4.6	211.3
094847			211.3
094848			211.2

Due to the sparsely available S-VDR data, attempts were made to learn more about the HERM KIEPE's manoeuvres using the largely incomprehensible audio recordings of the S-VDR. By separating the audio channels, it could be heard that immediately before the collision, contrary to the previous command at 104655, the rudder was apparently set at hard to port (question from pilot to helmsman: "Hard to port, is that right?"). The amidships and half-ahead command was issued at 104705. At 104840, the pilot ordered hard to starboard. At 104852, the EMPIRE transmitted on VHF: "KIEPE, what are you doing?" No response was heard from the HERM KIEPE. Collision noises were heard at 104920. No other helm commands could be heard. However, according to a written statement by the pilot, the apparently improperly executed hard to port command was irrelevant. It is evident from the table that the hard-over rudder to starboard had hardly any effect on the change in HDG and COG, either.

The fact remains that the presumed hydrodynamic interactions caused by the eastbound shipping were not or could not be countered promptly on board the HERM KIEPE. The audio recordings indicate that communication between the pilot and helmsman was not clear. The relatively few helm commands in the waiting position close to the dolphins gave the helmsman, as accepted in such traffic situations involving minor dynamics, room for discretion. The KLENODEN had just been passed when the rudder was at hard to port. Evidently, the helmsman did this in an attempt to bring the emerging turning movements of the ship under control.

The HERM KIEPE's turning movement towards the EMPIRE was probably caused by hydrodynamic interaction with the ships sailing out of the lock. To counter these interactions, the pilot on the HERM KIEPE attempted to position the vessel parallel to the row of dolphins (the Segelschiffsdalben) again by traversing, as was practised successfully during the previous wait. The BSU is not in possession of recordings of rudder and bow thruster operations or engine manoeuvres. Inasmuch, the operations cannot be verified.

A low pitch ahead, hard to port rudder angle and bow thruster set to starboard are employed when traversing to starboard with a left-hand controllable pitch propeller. In the case of a right-hand controllable pitch propeller, it is possible that only the additional effect of the bow thruster is sufficient. In this accident, the desired effect was not achieved, however. Traversing in such restricted visibility is difficult insofar as the pilot cannot directly assess the movement information on the response of the traversing ship necessary for manoeuvring successfully by looking out of the bridge window. Interpreting dynamic values from the radar image alone is delayed and prone to error due to the system. As a result, the sequence and force of manoeuvres required for the particular situation cannot be determined and initiated with certainty.

The traffic situations can be recorded on the pilot's PPU.

The stored data can be imported into the Brotherhood's ship-handling simulator and the flow of traffic thus viewed.

It became clear that the traffic situation was normal when viewing the AIS data recorded in the present case on the simulator, especially when set to good visibility. The so-called stop line is located roughly north-east of the ferry routes plotted on the nautical chart. Until that point, the HERM KIEPE should have oriented herself more on the row of dolphins rather than the middle of the canal. The EMPIRE should have kept more to the south. It is approximately 300 m from the guiding racks to the stop line. During the collision, the two vessels are located just north of the middle guiding racks leading line. It is about 500 m from the middle guiding racks signal mast to the scene of the collision.

Hold-ups occur repeatedly in the inland port of Brunsbüttel because the lock has limited capacity and the length and number of sidings are not sufficient to offset the flow into the inland port. The sidings are the only means of controlling the flow of traffic in the canal. The pilots on board manage coordination of the vessels in the sidings. Signals are provided by the VTS based on AIS information.

Here, the BSU refers to Investigation Report 523/10 of 28 November 2010 (collision between the NATIONAL GLORY and MALAGA) published on 15 December 2011. The safety recommendations are as follows:

Waterways and Shipping Directorate North, Waterways and Shipping Authorities Kiel-Holtenau and Brunsbüttel

The BSU recommends that a risk analysis on the space requirement of shipping on the Kiel Canal be conducted to reduce the risk of collision and that the system of traffic groups be overhauled with due regard to ship domains. The ship domains should include human and physical factors such as the experience of pilots, hydrodynamic canal effects, weather conditions, navigation equipment and manoeuvring aids (e.g. type of propulsion and rudder, bow thruster).

Information from the ship domains should be made accessible to pilots and the Vessel Traffic Service via the introduction of a mobile information system, the so-called portable pilot unit (PPU). Next to the electronic chart system, sounding plans, GPS and AIS, it should also be possible to display rates of turn/min. and distances with accuracy < 10 m to the bank as well as vessels.

Based on the experience gained regarding accidents in fog, safety barriers should be raised in the short-term, e.g. by revising the provisions for prohibiting encounters in the SeeSchStrO.

Some of the pilots are now equipped with PPUs and in the process of developing a ship database and proprietary nautical charts to suit their needs. The PPU is an information system only for pilots; its use presupposes sound knowledge of the area, legislation and manoeuvring.

This is the only way to ensure that the information provided by the PPU can be evaluated with the requisite circumspect by qualified users and employed as an aid when required.

Inter alia, a PPU contains nautical charts of greater detail than the official standards. The stop line and exact position of the bollards in locks are displayed, for example. Moreover, the AIS signals of surrounding shipping can be shown in the PPU's chart display software. However, the accuracy depends on the movement dynamics of the transmitting ship, the accuracy of her GPS position, as well as the reliability of data entered manually for the position of her conning points, dimensions of the ship, and manoeuvre status, in particular. A better overview of the position of the ship and traffic situation is thus achieved. This enables the pilot to decide on a more promising manoeuvring strategy in certain circumstances.

This part of the BSU safety recommendation was covered.

With regard to the risk analysis, the WSV has yet to provide results. The above recommendation on the implementation of a "risk analysis on the space requirement of shipping on the Kiel Canal ..." is currently being prepared by the Directorate-General for Waterways and Shipping, Outstation North (GDWS, formerly WSD North) together with the two Waterways and Shipping Authorities Kiel-Holtenau and Brunsbüttel.

The parameters for such a risk analysis have been defined and the competent authority for hydrodynamic interactions (ship/ship and/or ship/waterway), the Federal Waterways Engineering and Research Institute, engaged. With increased computing power, the Federal Waterways Engineering and Research Institute will be in a position to record and assess hydrodynamic processes in confined waters like the Kiel Canal better than in the past from next year. Then the subject of 'ship domains' will also have to be discussed in the course of the risk analysis for the determination of the space requirement of ships. Similarly, the current traffic groups and their dimensions, a basis for controlling traffic on the Kiel Canal, will then need to be considered.

Furthermore, it was found that additional external expertise would also be required to draw up such a risk analysis. The conditions for obtaining this expertise (general description, acquisition of budgetary means) are currently being established.

5 CONCLUSIONS

The collision occurred in dense fog because due to the situation the EMPIRE did not proceed on the southern side of the middle guiding racks leading line. Moreover, the HERM KIEPE was unable to maintain her parallel position at the dolphins – with probable hydrodynamic effects of the oncoming traffic in a waiting position – and manoeuvred towards the middle leading line. The distance between the middle guiding racks and scene of the accident was about 500 m.

The HERM KIEPE traversed immediately before the accident. The desired effect, draught permitting to move northward parallel to the Segelschiffsdalben, was not rigorous enough at this stage, as the vessel's course was inclined too far to the south. This was difficult for the pilot to recognise based on an assessment of the radar image and PPU.

It is possible that the pilot (as usual) based the manoeuvres on a left-hand controllable pitch propeller, i.e. rudder hard to port, bow thruster to starboard with forward and aft manoeuvres at appropriate rates of speed. It is actually a right-hand four-blade controllable pitch propeller with a diameter of 5.7 m. This important characteristic for manoeuvring is incorrectly entered as a left-hand controllable pitch propeller in the pilot card. The effect of a right-hand controllable pitch propeller on manoeuvring is different to that of a left-hand propeller. Aft propulsion would cause the ship to turn to port⁴.

A right-hand controllable pitch propeller could have facilitated the traversing manoeuvre to starboard. However, this may mean that the sequence and force in which the manoeuvring elements are used need to be different to achieve the desired cross drift effect. On the other hand, the pilot was familiar with the HERM KIEPE from previous pilotage assignments because she transits the Kiel Canal regularly.

The pilot boarded in Rüterbergen. He had been on duty since 2300 on the previous day and piloted the ANNIKA to Rüterbergen, where he joined the HERM KIEPE at 0320 for the return voyage. Fog prevailed from 0618 when the Dückerwisch siding was passed and persisted for 4.5 hours until the collision.

In this collision, the risk of accident was increased because only two of the four locks were in operation due to insufficient maintenance. Moreover, there were problems operating the Große Nordschleuse's outer gate, as revealed by listening to the VHF radio traffic. After the HERM KIEPE, the NATIONAL GLORY would have initially been the last ship that could pass through the lock for technical reasons.

⁴ It is good practise to construct right-hand fixed pitch propellers and left-hand controllable pitch propellers so that the ship turns to starboard during a stopping manoeuvre in accordance with Rule 19 d(ii) COLREGs (see Handbuch der Werften (shipyard manual), 1986, p. 108, as well as the expert opinions of Prof. Dr.-Ing. Heinrich Söding, investigation into the marine casualty involving the Meteor on 3 January 1995, Capt. Dipl.-Ing. J. Brix, Manoeuvring Technical Manual p. 53, Seehafen Verlag GmbH, Hamburg, 1993, and Prof. Dr.-Ing. S. D. Sharma on the steering effect of propellers, Institut für Schiffbau (school of naval architecture) at the University of Hamburg, contact studies 1-4 March 1982).

The planning of continuous traffic on the canal was severely disrupted due to the unreliable operation. The pilots had to compensate for delays constantly by adjusting speed and additional periods of waiting in the sidings. Finally, another prolonged waiting period in the inland port of Brunsbüttel was necessary.

This meant that the pilot and two alternating helmsmen were continuously subjected to a high level of stress. Unlike the pilot, the helmsmen alternate every 25 km (about two hours) and are assigned for the entire passage from Kiel or Brunsbüttel. As with the pilot, helmsmen switch in Rüsterbergen if only one is assigned. According to the audio recordings, there were practically no helm commands to the helmsman before the locks in Brunsbüttel until the hard to port rudder angle was finally noticed and corrected.

On the EMPIRE, the master conducted the casting off manoeuvre in the Große Nordschleuse, while the advising pilot coordinated the departure by radio on the VHF unit. The eastbound side of the Kleine Nordschleuse was occupied by the KLENODEN and the Große Nordschleuse by the CREMONA (ahead) and the EMPIRE. The pilot was not prepared for the HERM KIEPE's mode of operation in the middle of the canal. He noticed the rapid approach and initiated the manoeuvre on the southern side too late. After leaving the middle guiding racks, the EMPIRE should have moved to starboard more vigorously and quickly because there was only 500 m until the Segelschiffsdalben and subsequent scene of the collision.

Both pilots were equipped with PPUs and could also see the traffic situation from the AIS data on the electronic chart displayed by them. They do not display the lock signals in real time. It was not possible to hear the message that the lock gates were opening on the VDR recordings. The chart display software of the PPU shows the vessel positions in accordance with their transmitted AIS data. Here, the delay between transmission and display in the PPU is chronologically negligible. However, the intervals at which vessels transmit depend on movement dynamics (speed and rate of course alteration) and the defined manoeuvre status (under way, anchored or moored). For example, moored vessels only transmit the latest position determined by the shipboard GPS via her AIS log once every three minutes. Since both vessels were in a relatively calm position before the collision, it was not possible for either pilot to predict the movement of the other vessel until three minutes after proceeding at the earliest. Moreover, great caution was required after that due to the system because of the low speed (under 3 kts). Therefore, the rapid oncoming traffic towards the HERM KIEPE was unexpected and she tried to remain at the dolphins and counteract the hydrodynamic effects by manoeuvring.

Better communication between lockkeepers and shipboard pilots is necessary on the Kiel Canal. It was not announced that the locks were already open in the case of this accident, either. On the contrary, the pilot of the HERM KIEPE assumed there would be further delays in passing through the lock because of the difficulties with the Neuen Nordschleuse's (new north lock) outer gate communicated on VHF.

The lock signals are only partially visible in fog and in the environmental conditions on the day of the accident were not visible at all. It would be helpful if the signals were transmitted to the PPU.

At a given point, the pilot on the EMPIRE could have seen that the HERM KIEPE was moving towards the middle of the canal on the radar and also on the PPU after the CREMONA and KLENODEN had passed her. At this point, the EMPIRE had just left the lock's middle guiding racks and should have responded immediately.

The two ships finally collided with the bow on the leading line (see Fig. 10). Here, the speed of the EMPIRE stood at 5.3 kts and that of the HERM KIEPE 4.4 kts according to the VDR recordings. Four containers on the forecastle of the EMPIRE were lost. Three containers fell overboard and the fourth landed on the HERM KIEPE's forecastle. After the collision, the ships remained manoeuvrable and could proceed to the allocated berths. A tug assisted the EMPIRE.



Figure 21: Container that fell overboard



Figure 22: Flotsam, cargo damage

There were no injuries and no pollutants escaped. It was possible to salvage the containers that were floating/partially submerged in the water using equipment from the WSV. The Kiel Canal was closed for that purpose. Due to the risk analysis on the space requirement of shipping initiated by the Directorate-General for Waterways and Shipping, which is to include extensive hydrodynamic studies and towing tests, the BSU is abstaining from issuing additional safety recommendations regarding management of the Kiel Canal for the time being.

6 SOURCES

- Investigations by Waterway Police Brunsbüttel, Hamburg
- Written statements
 - Ship's command
 - Owner
 - Pilots
- Reports and technical paper
 - Lotsenbrüderschaft NOK I Brunsbüttel, ship-handling simulator
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- AIS analysis, Gemeinsame Leitstelle der Wasserschutzpolizeien der Küstenländer (joint control centre of the waterway police of the coastal states)
- Photos: ship photos by Hasenpusch, Hamburg; cargo damage by WSA Brunsbüttel