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

Summary
Investigation Report 417/13

Serious Marine Casualty

Collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR on 7 May 2013 on the Outer Weser

31 July 2014

The following is a **joint report** by the German Federal Bureau of Maritime Casualty Investigation, as lead investigating authority, and the marine casualty investigation authority of the flag State Antigua & Barbuda. The two bodies have conducted this investigation jointly and in accordance with the IMO Casualty Investigation Code (Resolution MSC.255(84)). The working language used for the joint investigation was German.

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 16(22) of 19 October 2013, BGBl. (Federal Law Gazette) I p. 3836.

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 report.

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1 Summary

At 1555[1] on 7 May 2013, the Antiguan flagged container ship CONMAR AVENUE collided with the container ship MAERSK KALMAR, which is registered in Holland, on the Outer Weser between fairway buoys 29 and 31 in the Fedderwarder Fairway. The sea was calm and visibility good. Both ships were heading for Bremerhaven and had previously followed the course of the fairway under pilotage.
The collision happened during an overtaking manoeuvre by the CONMAR AVENUE, during which technical problems occurred with the supply of lubricating oil to the ship's main engine; this had already happened on several occasions during the course of the day. However, this time is was not possible to remedy the difficulties at short notice. Therefore, the engine shut down automatically to prevent serious damage. As a result, the CONMAR AVENUE lost manoeuvrability and was drawn into the wake of the much larger MAERSK KALMAR. Despite contra-rudder, she then turned towards the MAERSK KALMAR due to hydrodynamic interactions. The CONMAR AVENUE's forecastle rammed into the starboard side of the MAERSK KALMAR's aft section at an angle of about 60 degrees. The force of the collision caused 15 containers on the CONMAR AVENUE to fall overboard. Both ships sustained material damage above the waterline. The accident did not result in any injuries and there was no pollution of any significance. The fairway had to be temporarily closed to transiting shipping.

The MAERSK KALMAR was able to continue her voyage to Bremerhaven under her own steam. Due to the ebb current and her loss of manoeuvrability, the CONMAR AVENUE ran aground outside the fairway level with buoy 30 after the collision. She anchored there and was pulled back into the fairway at about 1830 with the help of five tugs. After that, this ship initially continued her voyage under her own steam, too. At about 1941, technical problems with the supply of lubricating oil were experienced again shortly before reaching the port boundary in the area of buoy 45, however. Following that, the precaution was taken to designate the CONMAR AVENUE a vessel not under command. She was towed to the berth by tugs and made fast there at 2105.

[1] All times shown in this report are local = CEST = UTC + 2 hours.

2 FACTUAL INFORMATION

2.1 Photo of the CMV CONMAR AVENUE

Figure 1: Photo of the CONMAR AVENUE

2.2 Ship particulars: CMV CONMAR AVENUE

Name of ship:	CONMAR AVENUE
Type of ship:	Container ship
Nationality/Flag:	Antigua & Barbuda
Port of registry:	Saint John's
IMO number:	9483358
Call sign:	V2GD2
Owner:	Conmar Shipping GmbH & Co. KG, Jork
Year built:	2012
Shipyard/Yard number:	Jiangdong Shipyard/JD1000TEU-12
Classification society:	Bureau Veritas
Length overall:	151.72 m
Breadth overall:	23.40 m
Gross tonnage:	10,585
Deadweight:	12,878 t
Draught (max.):	8.00 m
Engine rating:	9,000 kW
Main engine:	MAN – 8 L48/60 B
(Service) speed (max.):	16 kts
Hull material:	Steel
Manning:	13

2.3 Voyage particulars: CMV CONMAR AVENUE

Port of departure:	Rauma, Finland
Port of call:	Bremerhaven, Germany
Type of voyage:	Merchant shipping/International
Cargo information:	Containers
Draught at time of accident:	8 m
Manning:	13
Pilot on board:	Yes
Number of passengers:	None

2.4 Photo of the CMV MAERSK KALMAR

Figure 2: Photo of the MAERSK KALMAR

2.5 Ship particulars: CMV MAERSK KALMAR

Name of ship:	MAERSK KALMAR
Type of ship:	Container ship
Nationality/Flag:	Netherlands
Port of registry:	Rotterdam
IMO number:	9153862
Call sign:	PDHP
Owner:	MAERSK
Year built:	1998
Shipyard:	Ishikawajima-Harima Heavy Industries Co Ltd
Yard number:	3089
Classification society:	Lloyd's Register
Length overall:	299.90 m
Breadth overall:	42.80 m
Gross tonnage:	80,942
Deadweight:	88,669 t
Draught (max.):	14.035 m
Engine rating:	65,880 kW
Main engine (type/manufacturer):	DU-Sulzer 12RTA96C
(Service) speed (max.):	24.5 kts
Hull material:	Steel
Manning:	25

2.6 Voyage particulars: CMV MAERSK KALMAR

Port of departure:	Antwerp, Belgium
Port of call:	Bremerhaven, Germany
Type of voyage:	Merchant shipping/International
Cargo information:	Containers
Draught at time of accident:	12.8 m
Manning:	25
Pilot on board:	Yes
Number of passengers:	3

2.7 Marine casualty information

Type of accident:	Serious marine casualty, collision
Date, time:	07/05/2013, 1555
Location:	Weser Estuary, Fedderwarder Fairway
Latitude/Longitude:	φ 53°42.9'N λ 008°17.5'E
Ship operation and voyage segment:	Harbour mode towards Bremerhaven
Consequences:	Temporary closure of the fairway. Material damage to both ships.Damage to cargo on the CONMAR AVENUE, including 15 containers overboard. No injuries or environmental damage

Excerpt from Nautical Chart 3008 (German North Sea coast and adjacent waters), BSH[2]

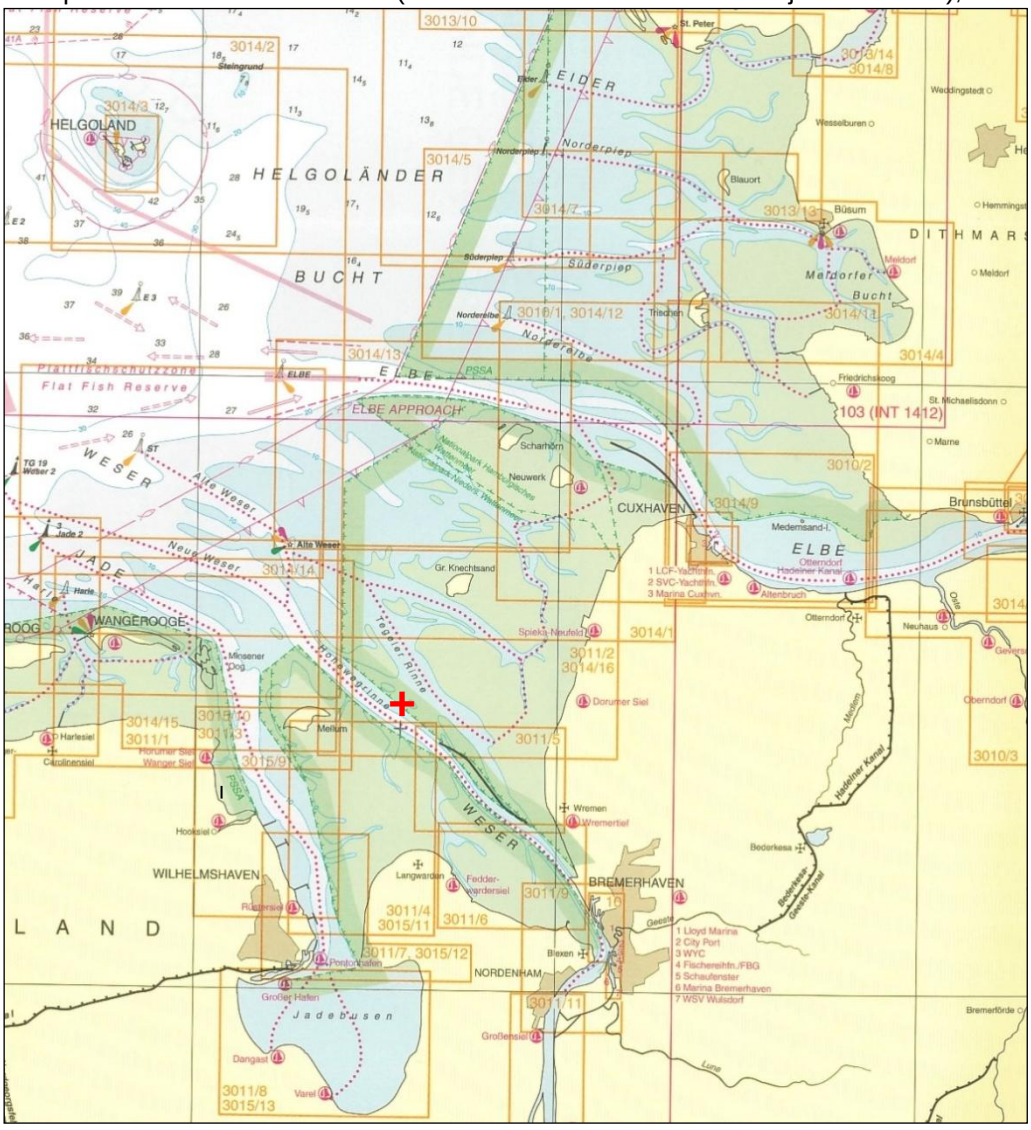

Figure 3: Scene of the accident

[2] BSH: Federal Maritime and Hydrographic Agency

2.8 Shore authority involvement and emergency response

Agencies involved:	Vessel Traffic Service Bremerhaven, Central Command for Maritime Emergencies[3], Waterway Police Bremerhaven
Resources used:	• Operation to haul CMV CONMAR AVENUE free: Tugs EMS, ELBE, RT PIONEER, BUGSIER 6, RT Darwin • Assistance and operation to tow to berth: Tugs EMS and RT PIONEER • Recovery of the containers floating in the water by successive use of the following vessels and equipment: Waterways and Shipping Administration[4] ships ALTE WESER, NORDERGRÜNDE, BLEXEN, MPV NEUWERK, ZENIT. Rescue Cruiser HERMANN RUDOLF MEYER with tender CHRISTIAN. Tugs RT DARWIN, BUGSIER 6, RT INNOVATION, WAL, STEINBOCK, ARION. Floating Crane ENAK and pontoon • Other resources at the scene of the accident: Customs Boat WESERMÜNDE, WSP Boats LESMONA and HELGOLAND, and a helicopter from the Federal Police
Action taken:	Temporary full and later partial closure of the fairway; deployment of tugs to the CONMAR AVENUE to haul her free and assist her up to the berth; deployment of auxiliary ships and initiation of the necessary steps to secure and then recover the 15 containers floating in the water
Results achieved:	CONMAR AVENUE hauled free. CONMAR AVENUE towed to her berth after renewed problems with the main engine. Successful recovery of the 15 containers floating in the sea completed at about 1730 on 9 May 2013

[3] Central Command for Maritime Emergencies (CCME): Joint institution of the Federal Government and the coastal States. Its purpose is to ensure joint management of accidents on the German coast. The CCME is responsible for planning, preparing, exercising, and implementing measures relating to the medical response, marine pollution response, firefighting, assistance, and security-related salvage in complex emergencies at sea.

[4] Waterways and Shipping Administration (WSV) is a generic term for the federal agencies responsible for the administration of waterways and shipping in Germany's coastal and inland areas. Inter alia, the WSV operates its own vessels, e.g. for the deployment/maintenance of sea marks and the prevention of water pollution, for this purpose.

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

The 1,036-TEU[5] container ship CONMAR AVENUE, which was put into service in 2012, left the Finnish port of Rauma at 0800 on 5 May 2013. After a smooth passage across the Baltic Sea and Kiel Canal, the ship reached the pilot transfer point to pick up the estuary pilot for the Weser at about 1200 on 7 May. Since the berth in Bremerhaven would only be available in the course of the afternoon, the CONMAR AVENUE spent the following two hours sailing at a low rate of speed (holding pattern) in a radius of about two to three nautical miles. The Weser pilot boarded at about 1430. Following the course of the fairway at a speed of about 14 knots over ground and navigated by the master, the CONMAR AVENUE then sailed for Bremerhaven under the guidance of the pilot. The ship was steered on autopilot. Next to the German pilot and the Polish master, the Ukrainian second officer was on the bridge.
The pilot conducted external communication between the CONMAR AVENUE and vessel traffic service/other vessels in German.

Built in 1998 and coming from Antwerp, the 6,690-TEU container ship MAERSK KALMAR, also headed for Bremerhaven, had already taken the Weser pilot on board at 1405. She was following the course of the fairway on south-easterly courses. The master of the ship navigated, she was steered by hand and under the guidance of the pilot. The ship's speed over ground stood at about 11 knots. Next to the German pilot and Dutch master, a Dutch cadet, an Indonesian rating (helmsman), and a Dutch female passenger were on the bridge.

When the pilotage assignment on the CONMAR AVENUE began, the distance to the MAERSK KALMAR, which was sailing ahead, was about three nautical miles. The pilot told the CONMAR AVENUE's master about the speed limit applicable to the MAERSK KALMAR on the Weser because of her draught. To avoid having to wait for the MAERSK KALMAR's berthing manoeuvre before she approached the berth, the ship's commands and pilots involved decided that the MAERSK KALMAR would be overtaken between buoy pairs 25/26 and 33/34 (see **Fig. 4** below). Since the MAERSK KALMAR used the middle part of the navigation channel – which was dredged to a maintained depth of 14.3 metres – because of her draught, it was agreed for navigational reasons that the CONMAR AVENUE would pass the MAERSK KALMAR on her starboard side.[6]

[5] TEU: **T**wenty-foot **e**quivalent **u**nit is the container stowage capacity based on the dimensions of a 20-foot ISO container.
[6] Note: Although the German Traffic Regulations for Navigable Waterways, which must be observed in Germany's territorial sea, provides that overtaking manoeuvres should, in principle, be performed on the left-hand side, it is permissible to overtake on the right (i.e. on starboard) where the circumstances of the case so require.

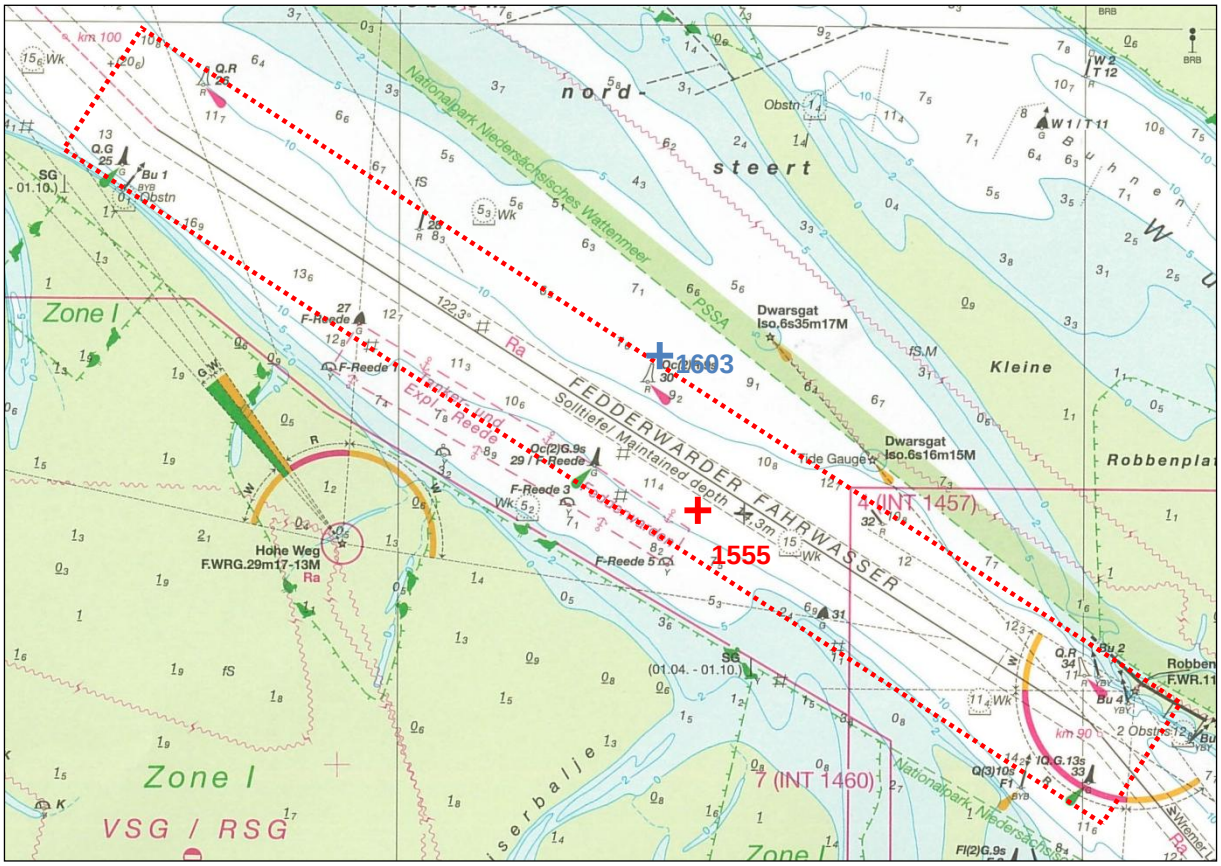

Figure 4: Fairway section of the overtaking manoeuvre with the positions of the collision (marked red) and ground contact (marked blue)[7]

A few minutes before the overtaking manoeuvre was completed, the master of the CONMAR AVENUE left the bridge after handing over the command of the ship to the second officer. Shortly afterwards, at 1553, the main engine stopped for reasons that were initially unknown. The master noticed this in his quarters and hurried back to the bridge. The pilot immediately informed the vessel traffic service and the radar pilot on VHF, thus – at least indirectly – also the MAERSK KALMAR of the problem encountered. Evidently due to hydrodynamic interactions between the CONMAR AVENUE and the much larger MAERSK KALMAR, the powerless CONMAR AVENUE began to turn towards the MAERSK KALMAR, which was approaching from aft, as a result of the involuntary reduction in speed. Moreover, it was no longer possible to contain the accelerating turn to port effectively by a hard to starboard rudder manoeuvre.[8]

The forecastle of the CONMAR AVENUE collided with the starboard side of the MAERSK KALMAR's aft section at an angle of about 60 degrees at 1555. As a result of the force of the collision in conjunction with the temporary list to starboard, which was caused by the involuntary but nevertheless 'hard' turn to port, 15 containers from

[7] Excerpt from BSH Nautical Chart INT 1456 – Jade and Weser Estuaries. Fairway section and positions of the CONMAR AVENUE marked by the author of the report.
[8] Note: The rudder's steering effect is generated largely by the incoming flow from the propeller. Therefore, it is quite logical that the initiated hard to starboard rudder manoeuvre was without much success after the failure of the main engine.

the deck cargo on the starboard side of the CONMAR AVENUE plunged into the water. After the collision, the CONMAR AVENUE's bow scraped along the aft section of the MAERSK KALMAR. The two vessels parted from each other very quickly because of the MAERSK KALMAR's forward speed.

The loss of containers on the starboard side of the CONMAR AVENUE inevitably resulted in an uneven weight distribution on board the ship. Consequently, the CONMAR AVENUE started to list to port. However, the ship's command succeeded in offsetting this successfully shortly after the accident by immediately transferring ballast water. The following photos (**Figs. 5ff.**) were taken by a female passenger from the starboard side of the MAERSK KALMAR's bridge facing aft.[9] The figures are a very authentic representation of the calm and uncomplicated sea conditions and visibility, the CONMAR AVENUE's (involuntary) turn to port in the direction of the aft section of the MAERSK KALMAR, the loss of cargo on the CONMAR AVENUE, and the ship's list to port, which was the final outcome of that.

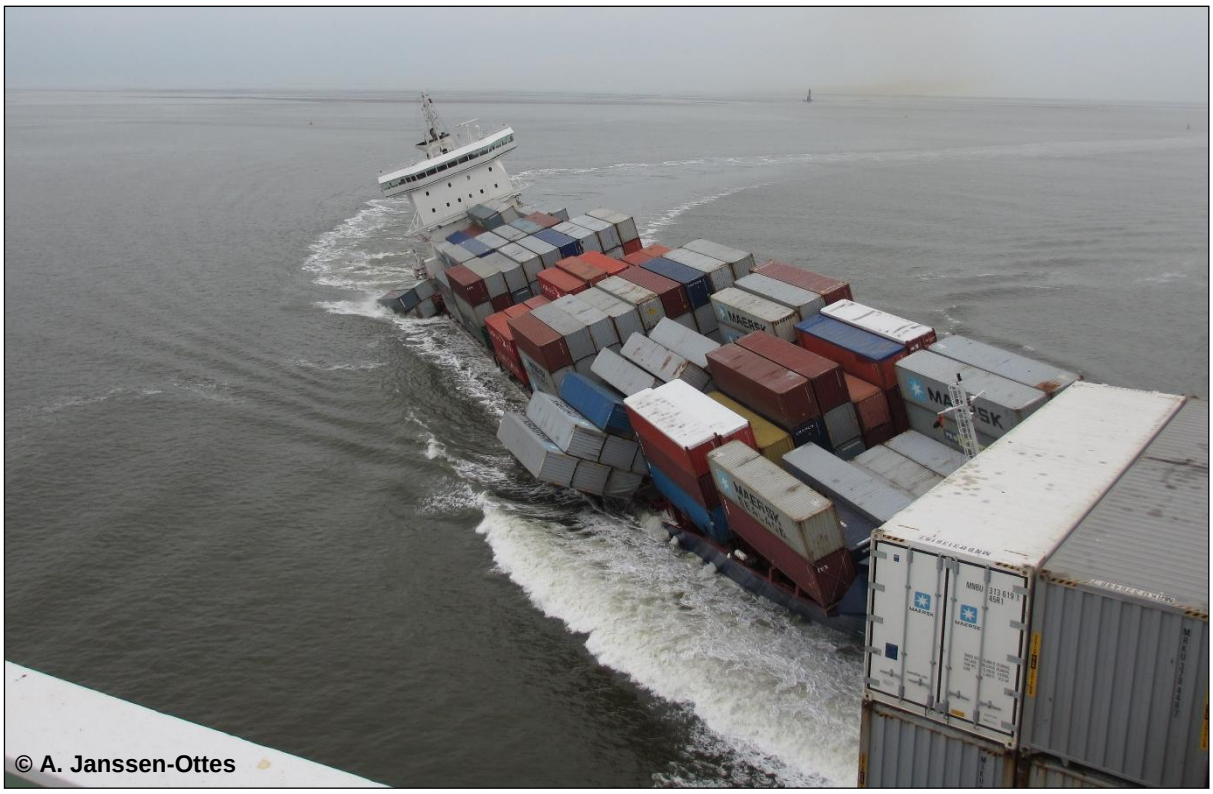

Figure 5: Collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (1)

[9] The photos were kindly provided to the waterway police by the master of the ship. The MAERSK Press Office granted the BSU permission to publish the photos in the investigation report.

Figure 6: Collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (2)

Figure 7: Collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (3)

Figure 8: Situation after the collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (1)

Figure 9: Situation after the collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (2)

Figure 10: Situation after the collision between the CMV CONMAR AVENUE and CMV MAERSK KALMAR (3)

Due to her loss of propulsion, the CONMAR AVENUE began to drift with the ebb current towards the eastern boundary of the fairway after the collision and grounded outside the fairway east of buoy 30 (see chart position above in **Fig. 4**). The starboard anchor was dropped there as a precaution at about 1603. The first two tugs (RT PIONEER and EMS) arrived at the distressed vessel shortly after 1700 and made fast to the aft section and the forecastle at 1710 and 1739 respectively. Moreover, the tugs ELBE and BUGSIER 6 were made fast at about 1755. She started to weigh anchor at 1803. Finally, the Tug RT DARWIN was made fast to assist in the operation to haul the vessel free.

Figure 11: Operation involving five tugs to haul the CONMAR AVENUE free

The anchor was weighed at 1815 and the ship's main engine was started successfully at about 1830. The tugs RT DARWIN, ELBE, and BUGSIER 6 were stood down from the operation. The CONMAR AVENUE then continued her voyage to Bremerhaven, initially under her own steam.

The forward and aft tugs remained made fast and accompanied the ship in a passive role. At about 1941, the main engine failed again a few miles off the port boundary level with buoy 46. Following that, the CONMAR AVENUE was designated a vessel not under command, towed to her berth by the tugs RT PIONEER and EMS, which were still attached, and made fast there at 2105.
In contrast, the MAERSK KALMAR was able to continue her voyage to Bremerhaven without restrictions in manoeuvrability immediately after the collision and made fast there at the intended berth with the assistance of tugs RT AMBITION and ELBE at about 1835.

3.2 Consequences of the accident

3.2.1 Damage to the CMV CONMAR AVENUE

During the collision, the port side of the CONMAR AVENUE's forecastle scraped along the starboard side of the MAERSK KALMAR's aft section. In the process, the stem of the CONMAR AVENUE was heavily deformed centrally and on the port side extensively. Moreover, it was torn in places well above the waterline. The bulbous bow of the ship was also affected (see **Figs. 12ff.**).

Figure 12: Damage to the forecastle of the CMV CONMAR AVENUE

Figure 13: Deformed bulbous bow on the CMV CONMAR AVENUE

The heavy deformations on the stem also resulted in damage to the forward manoeuvring station – a number of bollards and guide rollers, in particular (see **Fig. 14**).

Figure 14: Damage to the forward manoeuvring station on the CMV CONMAR AVENUE

As a result of the collision, several container stacks on the deck of the CONMAR AVENUE tipped towards the starboard side (see**Figs.15 f.**). Altogether, 15 containers fell into the water. They did not contain any dangerous cargo and were filled mainly with wood or paper. Interrupted by breaks at night-time, it was possible to recover the containers from the Weser over a period of about 48 hours with the help of a floating crane and many support vessels.

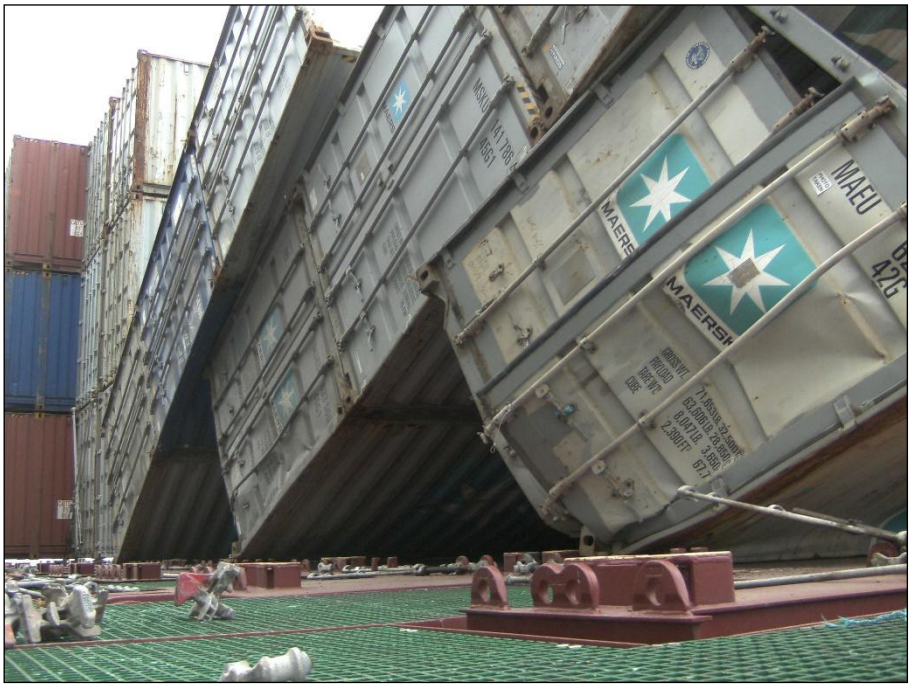

Figure 15: Toppled deck cargo on the CMV CONMAR AVENUE (1)

Figure 16: Toppled deck cargo on the CMV CONMAR AVENUE (2)

3.2.2 Damage to the CMV MAERSK KALMAR

The hull wall on the starboard side of the MAERSK KALMAR's aft section was heavily deformed in the area of bay 63 well above the waterline extensively **(A)**. In the same area, a tear of about 3.5 metres in length and almost horizontal formed just above the water line in the shell plating **(B)**. Moreover, the foundation of the vertical container rail on the starboard aft edge of the ship was dented level with the main deck **(C)** –**Figs. 17ff.**

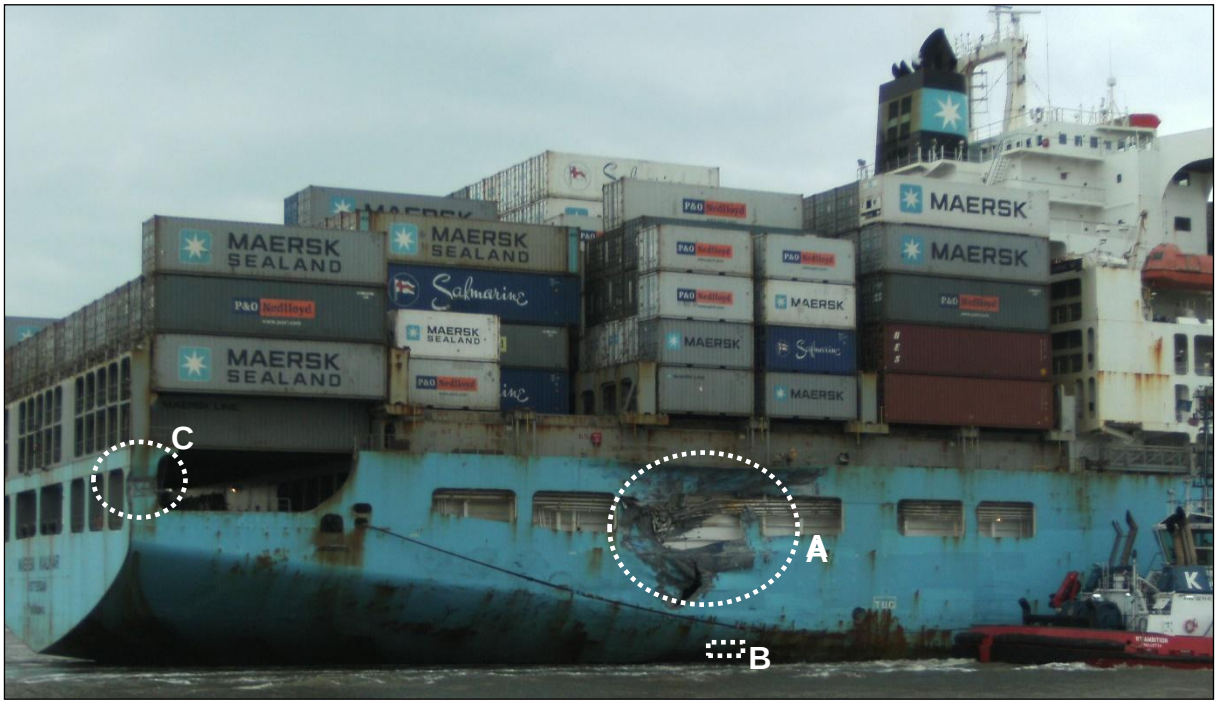

Figure 17: Damage to the aft section of the CMV MAERSK KALMAR – general view

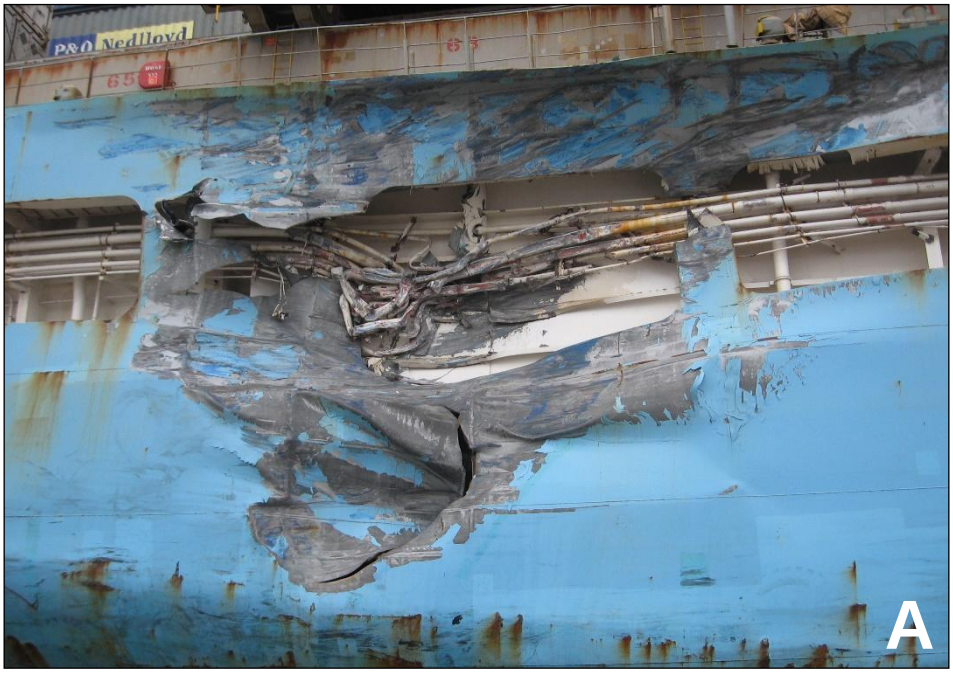

Figure 18: Damage to the hull wall – close-up (1)

Figure 19: Damage to the hull wall – close-up (2)

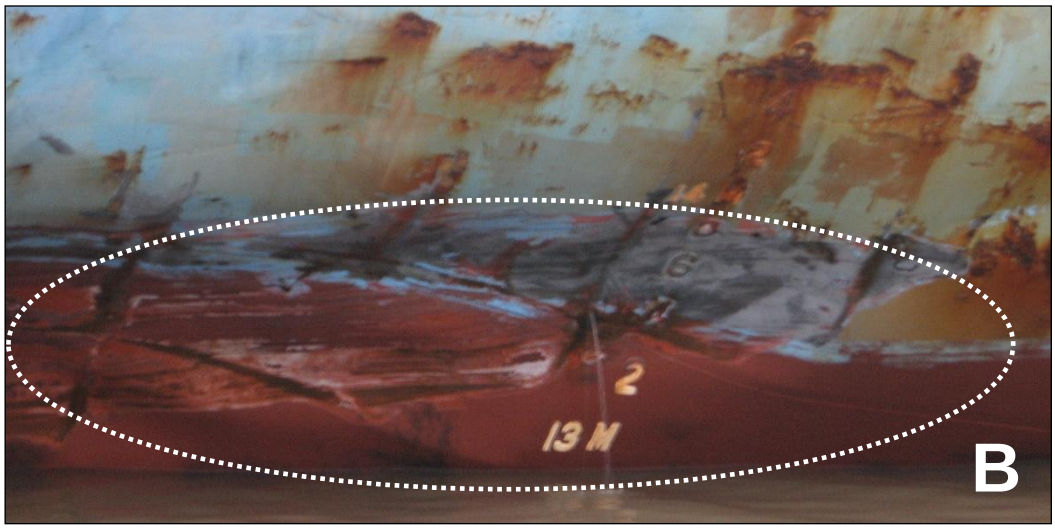

Figure 20: Tear in the shell plating – close-up

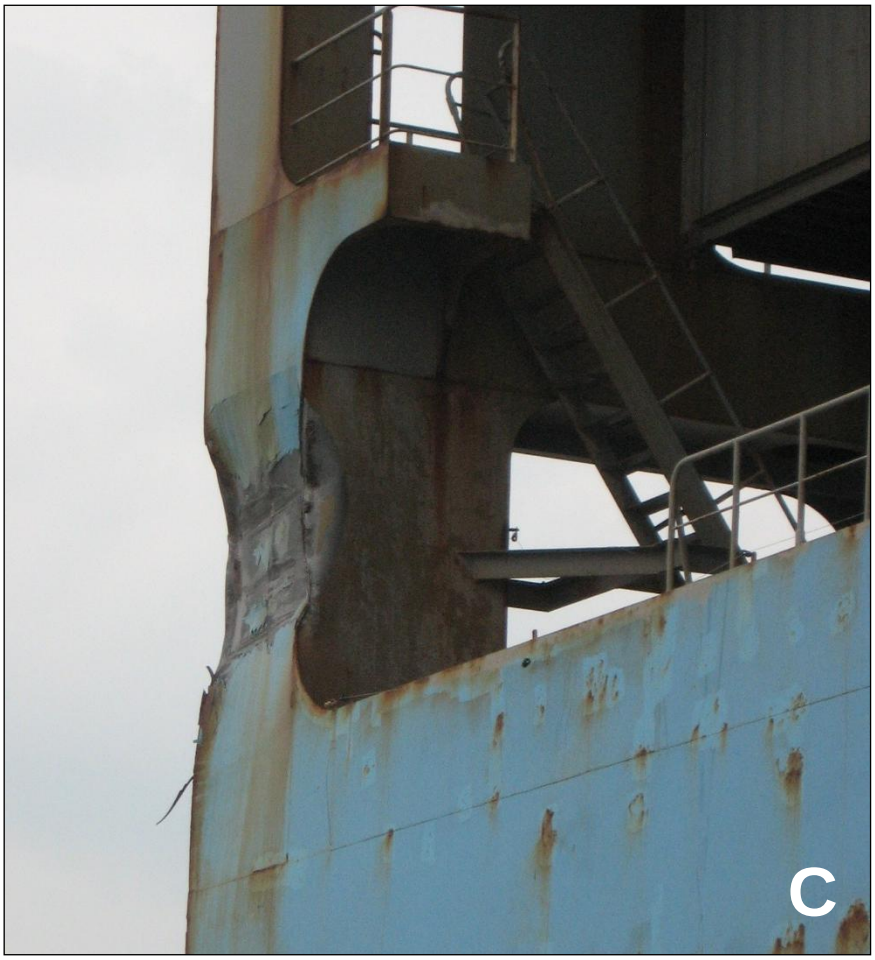

Figure 21: Damage to the cell guide foundation on the starboard side of the aft edge (close-up)

3.2.3 Injuries and environmental damage

The marine casualty did not result in any injuries. Moreover, there was no significant impact on the environment, as no fuel or lubricant tanks were damaged during the collision. The 15 containers on the CONMAR AVENUE that went overboard contained no environmentally hazardous substances and could be fully recovered.

3.3 Investigation

3.3.1 Course, sources, material particulars

The BSU received notice of the accident from the waterway police immediately after the collision. The on-scene investigation was conducted by the investigative body of the CONMAR AVENUE's flag State, which has its headquarters in Bremerhaven[10]. It was subsequently agreed that as the investigative body of the coastal State affected, the BSU should take the lead in drawing up the investigation report.

[10] ADOMS IID: **A**NTIGUA and BARBUDA W.I. **D**epartment **o**f **M**arine **S**ervices and Merchant Shipping **I**nspection and **I**nvestigation **D**ivision.

The investigative body of the flag State Holland chose to abstain from participating actively in the investigation into the marine casualty because the MAERSK KALMAR's role in the course of events leading up to and during the accident was clearly only passive and she had no way of preventing the collision.

During the investigation, the BSU was supported primarily by the findings made by the Antiguan investigative body on board the CONMAR AVENUE and witness statements. Next to statements made by the master and the chief engineer, the entries in the log book and the printed log of error messages and alarms relating to the engine room were of fundamental importance. Furthermore, the shipowner provided important information on the identification of the causes of the technical problems on board the CONMAR AVENUE. The BSU also inspected the findings of the police investigation and the AIS data stored there.

The BSU did not investigate the hydrodynamic interactions between the vessels. One reason for dispensing with the foregoing is the complexity of this issue. On the other hand, and most importantly, it is beyond doubt without any in-depth considerations that, for want of other evidence, the suction effect that ultimately caused the accident was clearly the result of the CONMAR AVENUE's involuntary loss of speed caused by the loss of propulsion and the ensuing critical approach with the upcoming MAERSK KALMAR.

Unfortunately, VDR data from the CONMAR AVENUE, with which not only the track of the ship but also and especially the decision-making processes and flow of information on the bridge, including any communication between the ship's command and engine room personnel, as well as the audibility and time of any audible alarms could have been reconstructed based on the audio recordings, were not available for the investigation of the marine casualty. Indeed, it is noted in the bridge bell book that instructions were reportedly given to perform a VDR backup at 1901 on the day of the accident. Accordingly, VDR data should have been backed up for the 12-hour period leading up to and including the accident. However, the data backup read from the system on the following day was the result of one made much later, i.e. at 1129 on 8 May 2013. Although the backup contained NMEA records[11] for the past seven days as provided for by the system, the most memory-intensive and meaningful audio and radar image recordings were irrelevant to the investigation because they were only available for the 12-hour period starting at 2329, as per the functionality. Since no technical faults were found on the VDR (type SAM DEBEG 4300), it is likely that the period for which the relevant control key was pressed was too short (i.e. shorter than the two seconds specified for the type) or too long (i.e. longer than the specified five seconds) when the VDR data backup was triggered.

[11] The **N**ational **M**arine **E**lectronics **A**ssociation (NMEA) defines standards for data encoding in the area of marine electronics.

3.3.2 Course of the voyage taken by the vessels and AIS recordings

The AIS recordings confirmed the course of the voyage taken by the ships as described by witnesses. In the course of the investigation, the BSU found no evidence of a navigational error by the ship's command or pilot on either of the ships involved. The following screenshots from an AIS replay system illustrate the course of the voyage taken by the two vessels. **Figure 22** shows that during the overtaking manoeuvre, the CONMAR AVENUE had selected an adequate passing distance and the MAERSK KALMAR was close to the middle of the fairway in accordance with her draught.

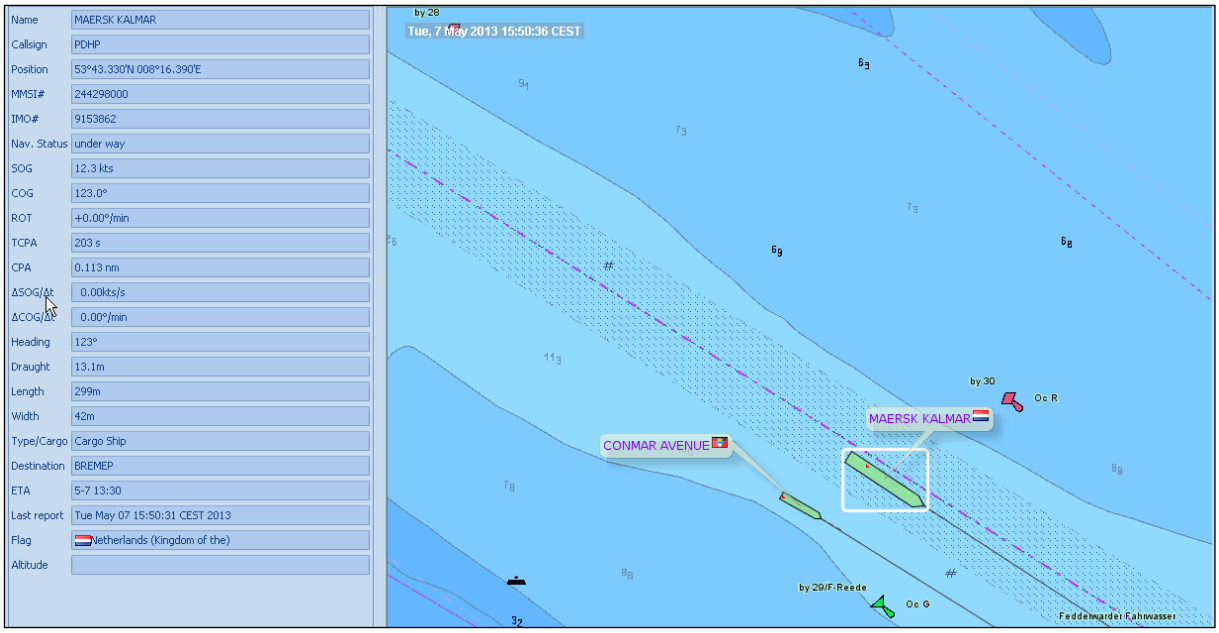

Figure 22: AIS positions of the CONMAR AVENUE and MAERSK KALMAR at 155031

Figure 23 below shows the situation at **155351**, i.e. immediately after the CONMAR AVENUE's main engine failed.[12] Both the CONMAR AVENUE's emerging tendency to turn towards the MAERSK KALMAR, as well as the efforts of the MAERSK KALMAR to maintain the passing distance by making a slight course alteration to port, are evident. The situation intensified considerably about half a minute later. The CONMAR AVENUE is on a (involuntary) collision course with the MAERSK KALMAR (see **Fig. 24**). About one minute after the main engine failed, an initially uncomplicated and safe passing manoeuvre had developed into an imminent collision (see **Figs. 25f.**).[13]

[12]Note: The exact time of the engine failure could be verified using the engine room alarm log.
[13]Note: With regard to the graphical implementation of the AIS data, it should be noted that the position of the ship symbols in relation to each other depicts **only an approximation of the reality** and is subject to proper configuration of each of the AIS transmitters relative to the transmitted position of the antenna.

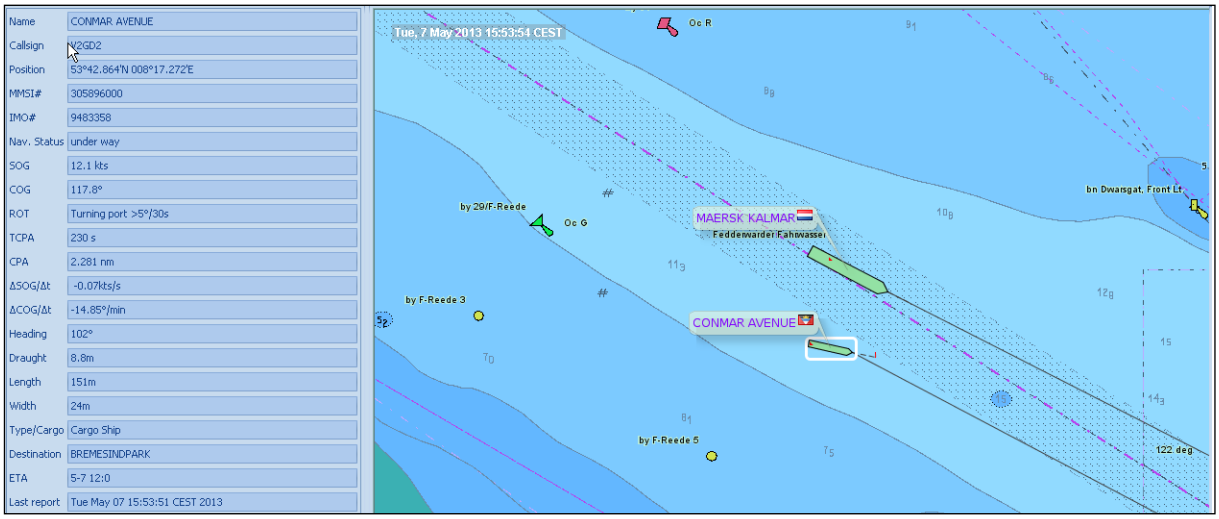

Figure 23: AIS positions of the CONMAR AVENUE and MAERSK KALMAR at 155351

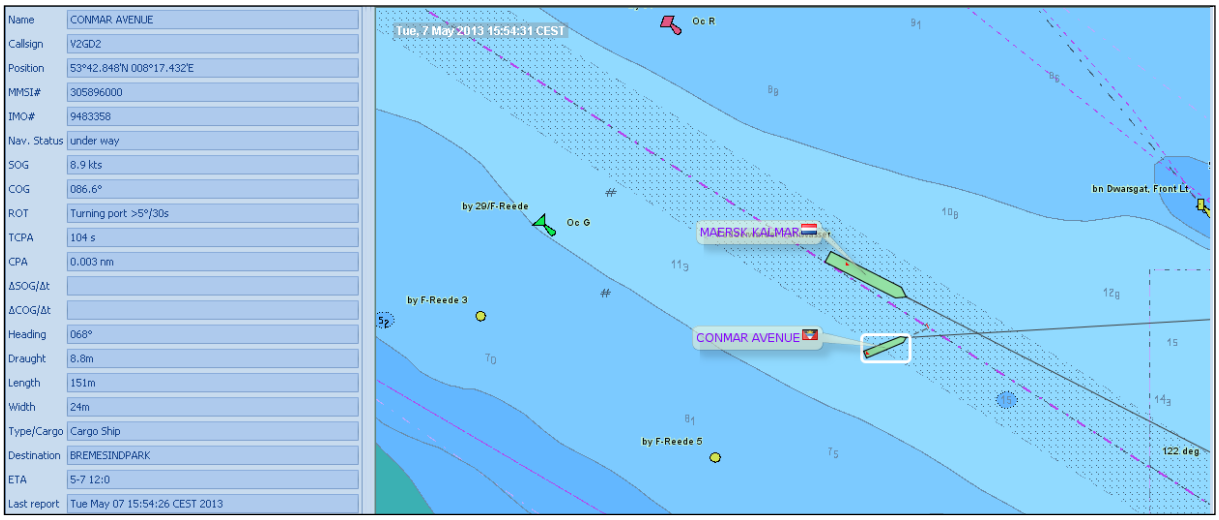

Figure 24: AIS positions of the CONMAR AVENUE and MAERSK KALMAR at 155426

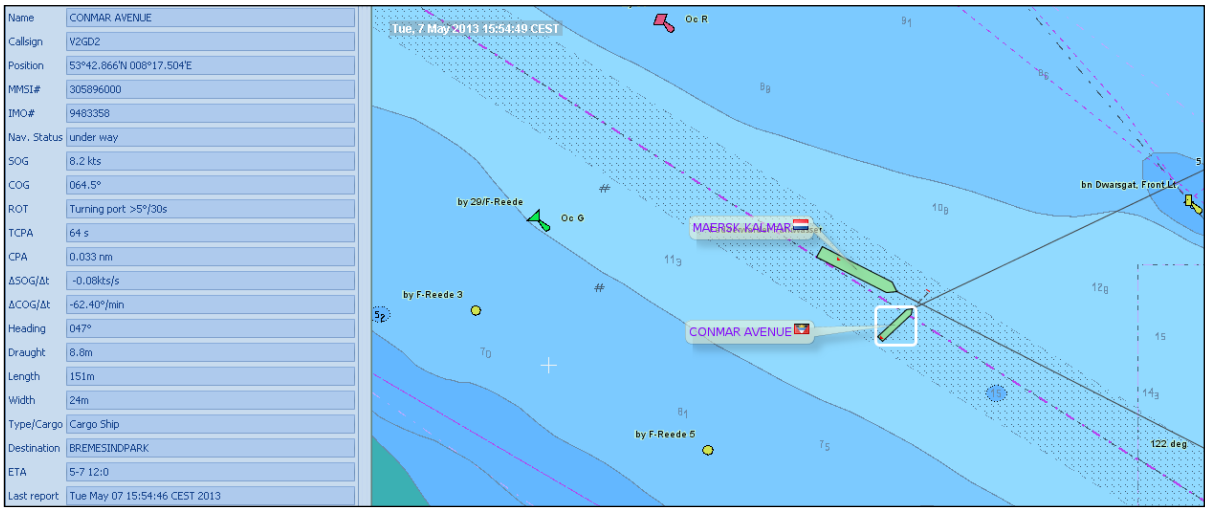

Figure 25: AIS positions of the CONMAR AVENUE and MAERSK KALMAR at 155446

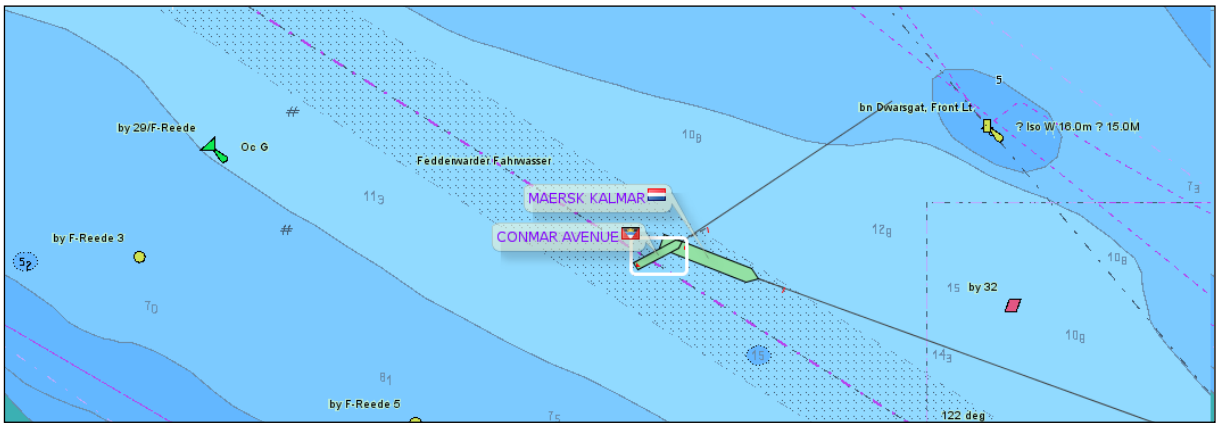

Figure 26: AIS display showing the collision between the CONMAR AVENUE and MAERSK KALMAR (1555)

Figures 27 and **28** show the CONMAR AVENUE drifting towards the eastern boundary of the fairway after the collision.

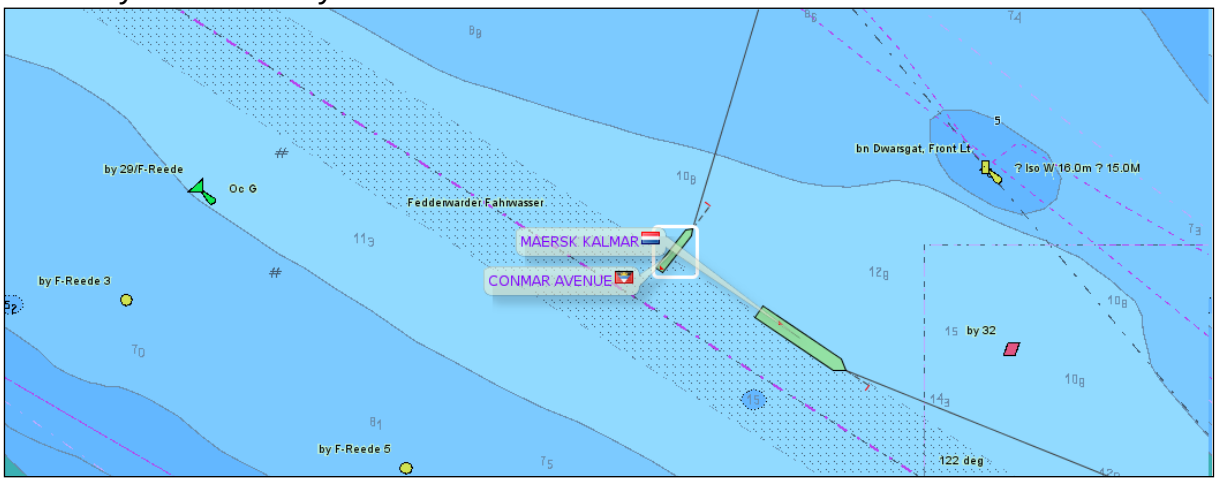

Figure 27: AIS display showing the drifting motion of the CONMAR AVENUE after the collision (1)

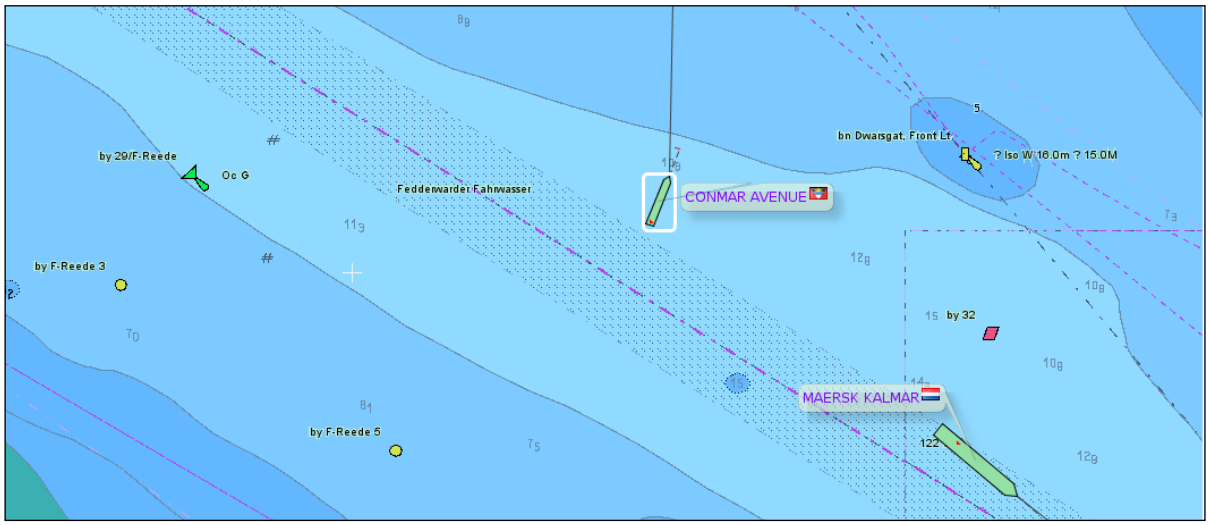

Figure 28: AIS display showing the drifting motion of the CONMAR AVENUE after the collision (2)

3.3.3 Alarm log (engine room)

The CONMAR AVENUE's alarm/event log had been submitted to the BSU and was a key source of knowledge in respect of the facts and chronology of the technical problems before the automatic shutdown of the main engine, which caused the accident. Among other things, all the faults relevant to operation of the main engine and events that differ from standard operation, including start and finish, are electronically recorded in this printed log. During the analysis of the log, a discrepancy was found between the times determined using witness statements and (AIS) observations; the time at which the main engine failed and the times recorded electronically in this regard, in particular. However, the difference of about seven minutes could be clarified beyond doubt after the accident when it was found on board that the system clock was slow.

The table below provides information on the events pertaining to operation of the engine during the period 0000 on 7 May 2013 to 1950 on 7 May 2013 that were relevant to the investigation in the form of itemised summary log extracts.

Time[14]	Event/Status	Explanatory note and potential consequences
0916	LOW PRESS START STBY LO PP ALARM B	Pressure in the main engine's lubricating oil system drops; standby pump switches on **B**eginning of fault
0919	LOW PRESS START STBY LO PP NORMAL E	 **E**nd of fault
1126	LOW PRESS START STBY LO PP ALARM B	Pressure in the main engine's lubricating oil system drops; standby pump switches on **B**eginning of fault
1131	ME LO PRESS ENG. INLET ALARM B	Heightened risk to main engine. Engine will stop automatically if fault is not remedied promptly **B**eginning of fault
1134	ME LO PRESS ENG. INLET NORMAL E	 **E**nd of fault
1158	LOW PRESS START STBY LO PP NORMAL E	 **E**nd of fault
1239	LOW PRESS START STBY LO PP ALARM B	Pressure in the main engine's lubricating oil system drops; standby pump switches on **B**eginning of fault
1240	LOW PRESS START STBY LO PP NORMAL E	 **E**nd of fault

[14] Time = system time (rounded to full minutes) plus seven minutes = CEST.

Time	Event/Status	Explanatory note and potential consequences
1548	LOW PRESS START STBY LO PP ALARM B	Pressure in the main engine's lubricating oil system drops; standby pump switches on **B**eginning of fault
1551	ME LO PRESS ENG. INLET ALARM B	Heightened risk to main engine. Engine will stop automatically if fault is not remedied promptly **B**eginning of fault
1553	**M/E AUTO STOP** **ALARM** **B**	**Main engine shuts down automatically** **Beginning of fault**
. . .	Ship drifts towards sandbank/is grounded/anchors	
1825	SELECTOR SWITCH LOCAL / REMOTE NORMAL	Operation of main engine control switched from engine room to bridge; i.e. engine was previously started successfully
1946	SELECTOR SWITCH LOCAL / REMOTE ALARM B	Operation of main engine control switched from bridge to engine room in connection with the precautionary ordered shut down the main engine **B**eginning of fault

The extracts from the alarm log show that in the course of the day of the accident, starting at about 0916, there were multiple technical problems with the supply of lubricating oil to the main engine, which is essential for the proper operation thereof. Even automatic activation of the standby pump only improved the situation temporarily. In particular, the standby pump was not in a position to stabilise the oil pressure when it dropped again at about 1548. Consequently and to avoid serious damage to the engine, the system caused the main engine to shut down at about 1553.

According to statements given by the engine room personnel, the following action was taken over the course of the day to solve the repeatedly encountered problem of a drop in pressure:

- precautionary refilling of the (actually adequately filled) circulating tank, and
- switching over and purging the – as it transpired – only marginally soiled indicator filter on the main lubricating oil line.

3.3.4 Weather conditions and visibility

The BSU dispensed with the preparation of an official report by the Maritime Division of Germany's National Meteorological Service (DWD). That the calm weather conditions and the visibility had no influence on the accident is beyond doubt.

3.3.5 Competence of the ship's commands, fatigue, influence of alcohol

The BSU is not in possession of any evidence to suggest that inadequate competence of the ship's commands, fatigue or influence of alcohol can be seriously considered as having caused or facilitated the accident.

4 ANALYSIS

4.1 Navigational aspects of the overtaking manoeuvre

The ship's commands and pilots involved discussed the overtaking manoeuvre properly before it was undertaken. The general traffic situation did not impede the overtaking manoeuvre. The decision to pass the MAERSK KALMAR on her starboard side is not open to criticism, either. Although Article 23(1) of the German Traffic Regulations for Navigable Waterways provides that a vessel should, in principle, be overtaken on her port side, it is permissible to deviate from this requirement if justified by the particular circumstances of the case. Such a special situation was given here, as the MAERSK KALMAR had to use the middle of the fairway because of her draught.

4.2 Cause of the accident

4.2.1 Hydrodynamic interaction

The lack of evidence to suggest a technical failure in the steering system on board the CONMAR AVENUE or steering errors confers a presumption that the hydrodynamically induced suction effect in the direction of the MAERSK KALMAR, which was caused by the ship's loss of propulsion, was the one and only starting point for the uncontrollable turn towards the large container ship approaching from aft.

In the course of the far-reaching investigation of the collision between the large container ship COSCO HAMBURG and the feeder ship P&O NEDLLOYD FINLAND on the River Elbe on 1 March 2004, the BSU studied both numerically and with experiments the problematic nature of hydrodynamic interactions during overtaking in great detail with the extensive involvement of a number of scientific institutions.[15] Another striking example of the hazards and risks of hydrodynamic interaction in the course of an overtaking manoeuvre is delivered by the investigation into the collision between the TMV ZAPADNYY and a floating dock moored on the bank of the River Weser following the failed overtaking manoeuvre involving the TMVs RHONESTERN and ZAPADNYY.[16]

Ultimately, the collisions referred to exhibit distinct similarities to the course of events leading up to and during the accident being investigated now. Those occasions also involved the approach of a significantly larger vessel (size ratio approximately 2:1) with a moderate speed surplus to a vessel about to be overtaken in a laterally confined fairway, albeit in an overtaking manoeuvre initiated by the larger vessel from the outset.
While the suction effect could not be contained effectively by the smaller vessels despite the availability of rudder and engine and as such it was the passing distance that warranted questioning in the aforementioned accidents, the CONMAR AVENUE had initially chosen an adequate passing distance. The CONMAR AVENUE's involuntary and uncontrollable approach to the MAERSK KALMAR due to the suction

[15] See BSU Investigation Report 45/04 dated 1 February 2006.
[16] See BSU Investigation Report 102/11 dated 15 August 2012.

effect, which ultimately led to the accident, was caused by nothing other than the loss of propulsion and ensuing loss of the ability to steer.
The experience of the BSU gained while investigating the collision on the Elbe casts light on the complexity and only very limited computability and predictability (in the sense of practical usability) of hydrodynamic phenomena. In particular, the fact that the suction effect between the CONMAR AVENUE and MAERSK KALMAR was obviously not attributable to the selection of an inadequate passing distance or other navigational mistakes[17] justifies not giving this aspect of the accident further consideration in the present report, despite it being the ultimate cause of the accident.

4.2.2 Technical problem on board the CMV CONMAR AVENUE

Based on the submitted engine room alarm log and witness statements, it is clear that earlier – despite appropriate efforts – non-remediable problems with the supply of lubricating oil to the main engine were responsible for it failing, which caused the accident.

4.2.2.1 Investigation by the owner

After the accident, the owner of the ship, which is relatively new and otherwise in good technical condition, searched extensively for the fault in accordance with internal requirements. Here, the BSU was kindly provided with a detailed report[18]. This is cited below in an editorially revised and abridged form.

"Inspections carried out:
In consultation with the underwriter and the engine manufacturer, the main engine's entire lubricating oil system was subjected to a thorough inspection. In particular, the following components were disassembled and assessed:

- *Suction filter*
- *Automatic backwash filter*
- *Indicator filter*
- *Pumps and overflow valve*
- *Oil cooler*
- *Lubricating oil circulating tank*
- *Oil circuit's pressure control valve*

In addition, two main bearings and connecting rod bearings from the main engine were included and examined for damage. The oil distribution line in the camshaft trough was also checked. Furthermore, various oil system data (pressures, temperatures) were read from the EDS[19] system.

[17] Note: The – possible – navigational decision of the ship's command of the CONMAR AVENUE to start overtaking in spite of possibly knowing about the technical problems is looked at separately below.
[18] Report by the owner, CONMAR Shipping GmbH & Co. KG, on the investigations on the CONMAR AVENUE after the collision.
[19] The **E**ngine **D**iagnostics **S**ystem (EDS) is a computerised program developed by MAN for monitoring and diagnosing the operation of the main engine.

Results achieved:

- *Suction filter*

*The suction filter on the primary active lubricating oil pump and the one on the standby pump were free of contamination, damage, and other abnormalities. Both filters were absolutely clean (see **Figs. 29f.**) and could be reinstalled immediately after the inspection.*

Figure 29: Suction filter on the primary active lubricating oil pump

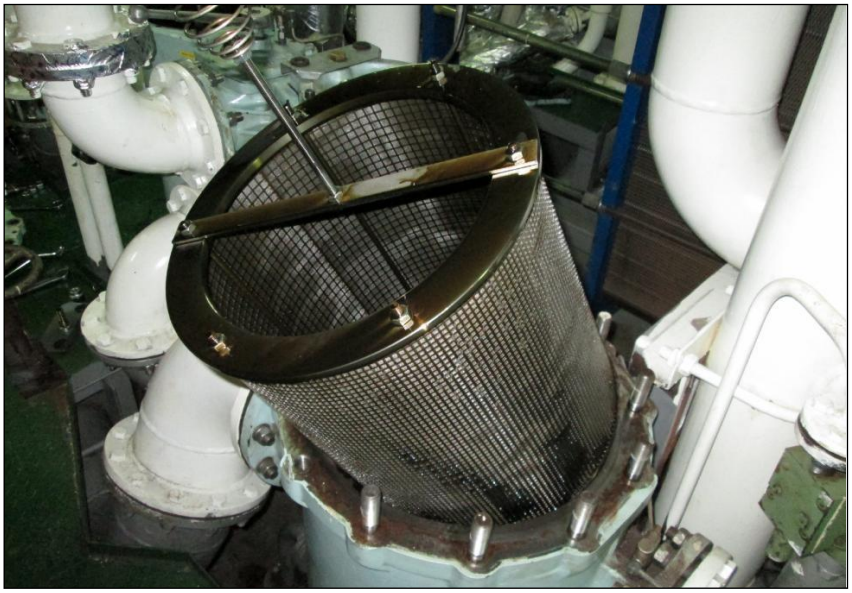

Figure 30: Suction filter on the standby pump

- *Automatic backwash filter*

*The four filter inserts on the automatic backwash filter (see **Fig. 31**) exhibited no contamination or other irregularities. The filter itself underwent functional testing successfully. The engine was also tested for a drop in oil pressure during a purge. As*

expected, this was not the case. Therefore, this filter can be ruled out as the cause of the loss of oil pressure.

Figure 31: Automatic backwash filter

- *Indicator filter*

The indicator filter is a double switch-over filter. It is located between the lubricating oil pump and engine, meaning it is the final stage before entry into the engine. A separate alarm is triggered if this filter is so heavily contaminated that the oil flow is disturbed. A corresponding message was not recorded in the alarm log for the day of the accident. Only minor deposits/textile fibres were found at the bottom of the filter cartridges. They probably stem from an earlier cleaning operation.

- *Pumps and overflow valve*

*The primary active lubricating oil pump was removed and disassembled to its individual parts in the workshop to determine whether the spindles or body were damaged or worn to a dimensional limit (see **Figs. 32f.**). The overflow valve (safety valve) was disassembled and checked at the same time (**Fig. 34**). Neither the pump spindles and body nor the components of the safety valve exhibited any abnormalities.*

Figure 32: Pump body after removing the spindles

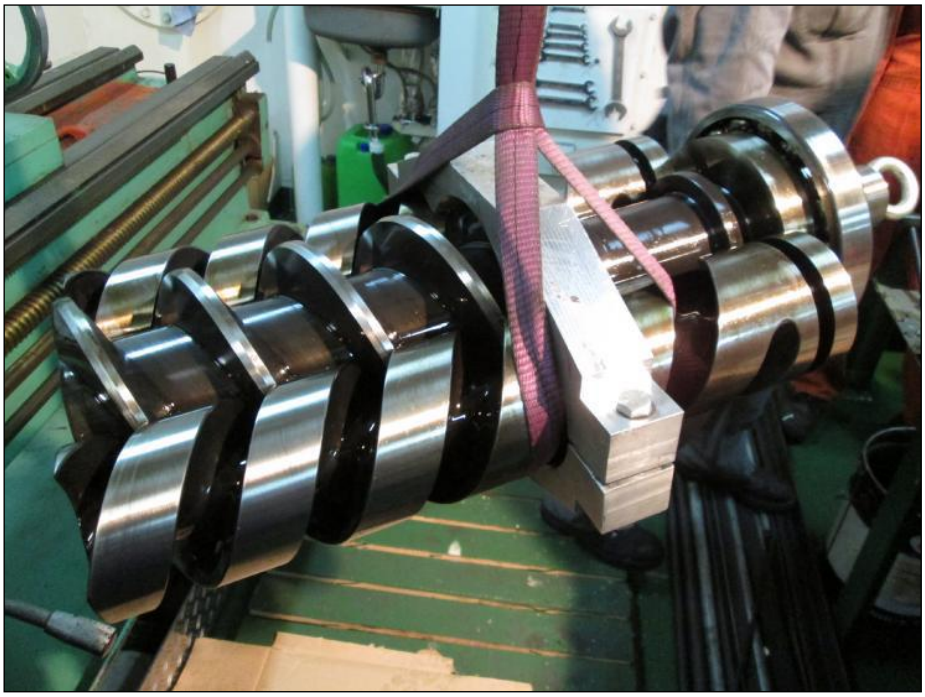

Figure 33: Pump spindles after disassembly

Figure 34: Pump safety valve after disassembly

In the further course of the inspections, the oil cooler, piping, and various fittings were subjected to a thorough inspection and partially opened or disassembled. The oil cooler's inlet and outlet channels were also perfectly clean and without any debris or contamination. The piping (where disassembled) was free and clean. Various non-return valves were disassembled to determine whether any of the valves might have loosened. Everything was as it should be here, too. The lubricating oil circulating tank was completely drained and cleaned for inspection. No irregularities were found. The tank is constructed exactly in accordance with the specifications of the engine manufacturer. All the pump lines in the tank are free and clean welded, meaning no reason for a loss of oil pressure could be found here, either.

- *Pressure control valve*

*The pressure control valve (see **Fig. 35**) is located on the main line between the pumps and oil cooler. A pilot valve is used to control the valve. This pilot valve is set to the required pressure once by means of spring tension when the ship is put into service and does not require further adjustment after that. The adjusting mechanism is protected against unintentional alterations by a protective cap. This pressure control valve is completely maintenance-free during periods of ship operation.*

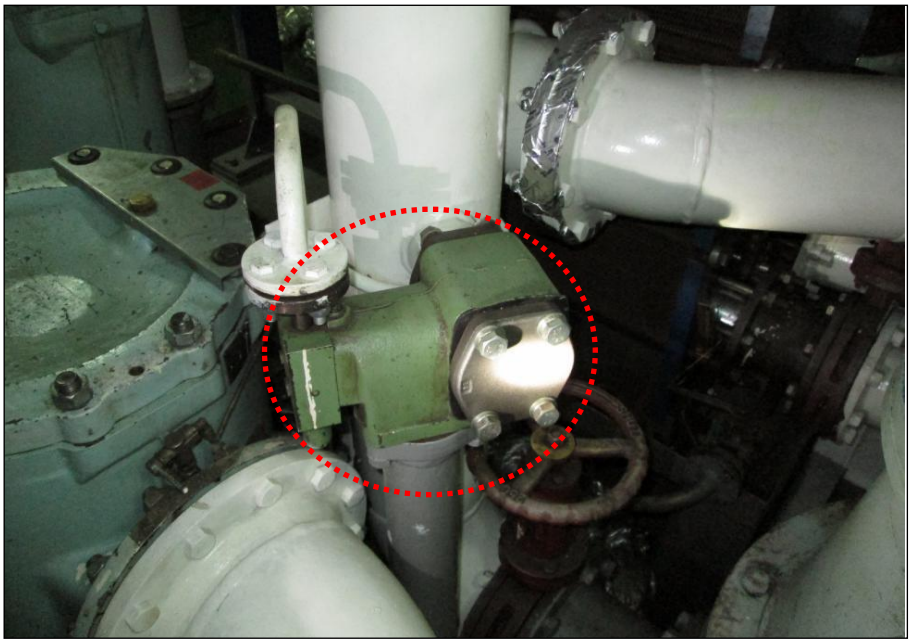

Figure 35: Pressure control valve when installed

*After the removal of the pressure control valve, so-called seizure marks were found on the discharge piston and in the body (see **Fig. 36**). This implies that the valve was possibly blocked when in a fully open condition, enabling a disproportionately large amount of lubricating oil to flow back into the circulating tank. This assumption is underpinned by the fact that small foreign matter/contaminants were found in the valve.*

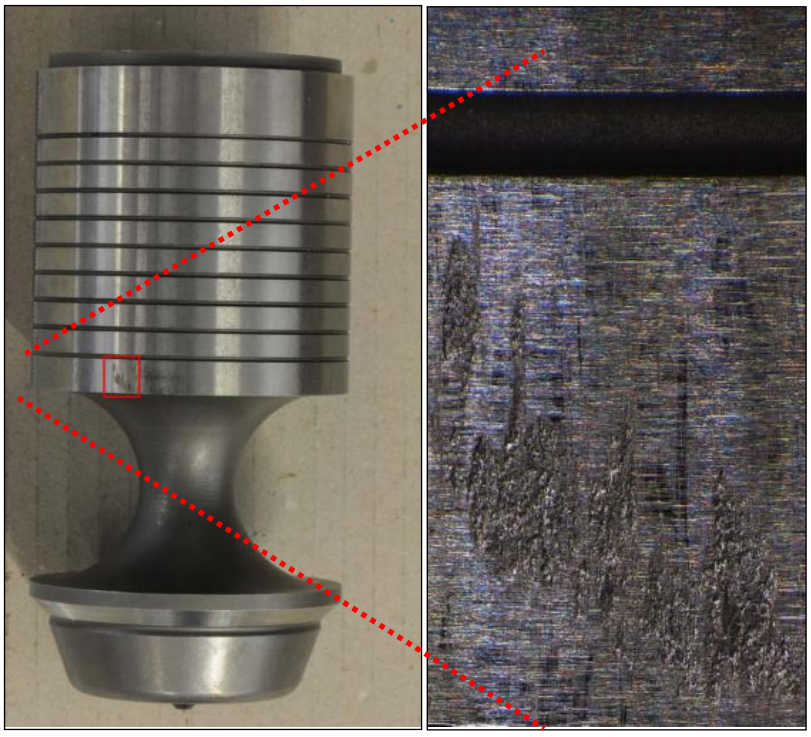

Figure 36: Discharge pistons with seizure marks

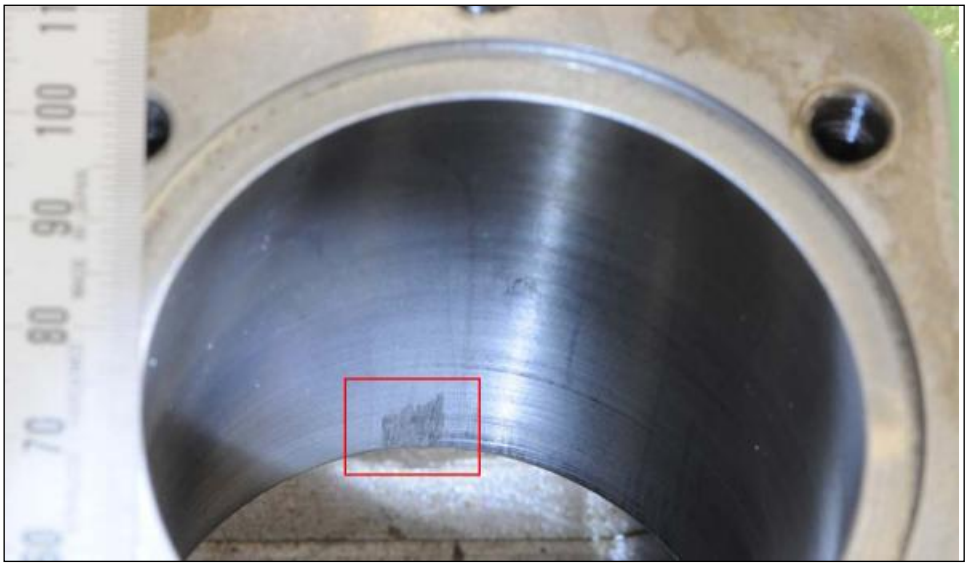

Figure 37: Seizure mark in the valve body

To test whether the drop in oil pressure could have been caused by the piston seizing in a fully open position, the pressure control valve was assembled so that the discharge piston was blocked in a fully open position. After the standby pump was switched on, a significantly lower oil pressure was found than in the case of a functioning pressure control valve. The drop in pressure was about 0.7 bar when the oil was relatively cold and would have been even greater had the oil been at operating temperature.

Final remarks:

*An unequivocal fault in the lubricating oil system that would explain the extraordinary drop in pressure could not be found after all the inspections were completed. The pressure control valve discharges a large amount of oil when fully open, meaning the alarm and shut-off values may not have been reached if the oil was at operating temperature. However, the question as to why the oil pressure did not recover when the standby pump actuated remains unclear. At this point, two positive displacement pumps delivered oil to the same system, meaning the pressure should inevitably have increased. It was not possible to determine why this did not happen. The question as to why the oil pressure was displayed in the form of a sawtooth cycle prior to the incident also remained unanswered (see EDS data extract – **Fig. 38**). All the systems and fittings were in a perfect technical condition, except for the pressure control valve. The pressure control valve was replaced by a new component for reasons of safety and configured by a service technician from the engine manufacturer. A trial was then conducted with emphasis placed on monitoring the oil pressure. There were no irregularities and the lubricating oil pressure was now technically constant."*

Figure 38: EDS data extract[20]

4.2.2.2 Conclusions of the BSU

The owner of the CONMAR AVENUE searched extensively for the fault in close cooperation with the manufacturer of the engine. Therefore and due to the fact that the owner has stated that similar problems have not occurred on sister ships thus far, the BSU has dispensed with researching the cause further.

4.3 Communication between the bridge and engine room

The course of events leading up to and during the accident is marked significantly by the anomaly that a technical problem of vital significance to the proper overall operation of the ship, specifically, a fault in the supply of lubricating oil to the main engine, occurred several times on the day of the accident and could not be clarified conclusively and remedied. During the investigation, it was not possible to verify with absolute certainty whether or in how much detail the ship's command was informed about the difficulties in the engine room and risk of the main engine failing because the VDR recordings and especially the audio recordings from aboard the CONMAR AVENUE were not available. Consequently, it is only possible to speculate whether the master of the ship started the overtaking manoeuvre in spite of being aware of the (underestimated) risk of losing manoeuvrability or whether, contrary to their duty, the chief engineer or officer in charge of the engineering watch failed to inform the master about the problem with the supply of lubricating oil to the extent necessary.

[20] The time axis is based on the EDS computer's internal time system and does not match ship time.

5 Conclusion

The collision between the CONMAR AVENUE and MAERSK KALMAR demonstrates, yet again, the grave and under certain circumstances uncontrollable consequences of hydrodynamic interaction between ships. However, while an inadequate passing distance and/or flawed communication between the vessels involved have been identified as the primary cause of the accident in cases investigated previously, the collision investigated here was triggered by a sudden loss of propulsion and thus the ability to steer on the CONMAR AVENUE.

The other anomaly of this case is that the risk of the main engine failing due to unresolved problems surrounding the supply of lubricating oil was becoming more and more apparent as the day progressed. To that extent, this accident exhibits an interesting parallel to one that also occurred on the Fedderwarder Fairway in the Outer Weser only a few days earlier on 18 April 2013. The departing container ship NORFOLK EXPRESS suddenly had a very short-lived problem with her steering gear just after casting off. The fault finding performed by the ship's engineers was unsuccessful. Following that, the voyage was continued with no further consequences. The steering gear failed again only 44 minutes later and this time definitively. Just in the process of being turned, the ship then ran onto a breakwater.[21] Hence, in neither case was sufficient attention given to the particular risk of an accident that arose from an unexplained technical problem affecting the safe operation of each ship.

It was not possible to clarify whether the ship's command of the CONMAR AVENUE was sufficiently informed about the existing technical difficulties before the decision to overtake the MAERSK KALMAR was made. The technical cause of the uncontrollable drop in lubricating oil pressure could not be determined with absolute certainty, either. Therefore, the BSU is dispensing with the publication of specific safety recommendations. Nevertheless, the publication of this summary investigation report aims to raise the awareness of officers in charge of the navigational watch and officers in charge of the engineering watch, as well as shore-based inspectorates of the urgent need to investigate technical faults immediately when they occur. If fault finding is inconclusive, then it is necessary to take precautionary measures for the event that the fault recurs.

[21] See BSU Investigation Report 94/13 dated 10 April 2014.

6 Action taken

As a result of the course of events leading up to and during the accident, the owner of the CONMAR AVENUE searched for the fault extensively and took the precaution of replacing the pressure control valve in the safety management system. Moreover, it emphasised the clear instruction already in place that the officer in charge of the engineering watch is required to inform the officer in charge of the navigational watch immediately if operating conditions arise that could cause the main engine to fail.

7 SOURCES

- Written statements, documents, logs, and photos
- Officers in charge of the navigational watch and officers in charge of the engineering watch on the CMV CONMAR AVENUE
- Owner of the CMV CONMAR AVENUE; in particular, 'Report by the owner, CONMAR Shipping GmbH & Co. KG, on the investigations on the CONMAR AVENUE after the collision, Jork, 31 August 2013'
- Reports of the pilots involved
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Photos of the CMV CONMAR AVENUE and the CMV MAERSK KALMAR, DietmarHasenpusch Photo-Productions, Hamburg
- Photos of the collision, Abeltine Janssen-Ottes
- Findings/Photos from Waterway Police (WSP) Bremerhaven
- AIS recordings
- Situational summaries and other information from CCME Cuxhaven
- BSU Investigation Report 45/04 of 1 February 2006 on the collision between CMV COSCO HAMBURG and CMV P&O NEDLLOYD FINLAND on 1 March 2004 on the Lower Elbe/off Buoy 91 with the Death of one Seaman, with further references.
- BSU Investigation Report 102/11 of 15 August 2012 on the collision involving the TMV ZAPADNYY and a floating dock moored on the bank of the River Weser belonging to the Fr. Lürssen shipyard after an overtaking manoeuvre between the TMV RHONESTERN and TMV ZAPADNYY on 5 April 2011
- BSU Investigation Report 94/13 of 10 April 2014 on the grounding of the MV NORFOLK EXPRESS on 18 April 2013 on the River Weser