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

Investigation Report 34/16

Serious Marine Casualty

Grounding of the CSCL INDIAN OCEAN in the River Elbe on 3 February 2016

14 October 2016

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.

Issued by:
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1 Summary

On 3 February 2016, the large container ship CSCL INDIAN OCEAN, flying the flag of Hong Kong, was en route from Felixstowe to Hamburg. The pilots were replaced at about 2016[1] off Brunsbüttel. Besides the two Elbe pilots, the master, an officer on watch (OOW), a helmsman, and a lookout were now on the bridge.
An alarm sounded on the bridge at about 2210. This could not be attributed to anything to begin with. Shortly afterwards, it became clear that the helm had stopped responding. The pilot responsible immediately advised STOP ENGINE and FULL ASTERN. Furthermore, the anchor was to be manned and the bow thruster activated. The two oncoming vessels were notified so that they could take evading action in good time.
A crew member had run to the steering gear compartment in the meantime, where he restarted the steering gear. The helm responded again at 2215. The effect of the HARD TO STARBOARD and HALF AHEAD manoeuvre now ordered was insufficient and the CSCL INDIAN OCEAN ran aground south of buoy 116 at 2220.

The damage assessment immediately initiated by the crew revealed that no leaks had formed.

From 2255 onwards, initially one tug and ultimately up to six tugs attempted to haul the ship back into the fairway. Since this failed, it was decided to wait for the next high tide.

Involving seven tugs, the second attempt to haul the vessel at about midday on 4 February also failed.

The German Central Command for Maritime Emergencies (CCME) then took charge of co-ordinating the third attempt to haul the vessel free. After extensive preparations, 12 tugs started to haul the CSCL INDIAN OCEAN back into the fairway at 0200 on 9 February. This attempt succeeded, enabling the ship to continue her voyage to the port of Hamburg.

No environmental pollution was found.

This investigation brought to light that an additionally installed safety system (SAFEMATIC) was improperly fitted in that it blocked the steering gear upon activation.

[1] Unless stated otherwise, all times shown in this report are local = UTC + 1 (CET).

2 FACTUAL INFORMATION

2.1 Photo

Figure 1: Photo of ship

2.2 Ship particulars

Name of ship:	CSCL INDIAN OCEAN
Type of ship:	Container
Nationality/Flag:	Hong Kong
Port of registry:	Hong Kong
IMO number:	9695157
Call sign:	VROC2
Owner:	China Shipping Container Lines
Year built:	2015
Shipyard/Yard number:	Hyundai Heavy Ind. Co. Ltd./2699
Classification society:	China Classification Society
Length overall:	399.67 m
Breadth overall:	58.73 m
Height overall:	69.00 m
Gross tonnage:	187,541
Deadweight:	184,320 t
Draught (max.):	16.0 m
Engine rating:	56,800 kW
Main engine:	MAN-B&W diesel engine
(Service) Speed:	18.0 kts
Hull material:	Steel

2.3 Voyage particulars

Port of departure:	Felixstowe, GB
Port of call:	Hamburg
Type of voyage:	Merchant shipping/ international
Cargo information:	6,620 containers/92,177 t
Manning:	24
Draught at time of accident:	12.1 m
Pilot on board:	2
Canal helmsman:	No
Number of passengers:	0

2.4 Marine casualty or incident information

Type of marine casualty or incident:	Serious Marine Casualty
Date, time:	03/02/2016, 2210
Location:	River Elbe off Lühesand
Latitude/Longitude:	φ 53°35'N λ 009°37.4'E
Ship operation and voyage segment:	Harbour mode
Place on board:	Port side of the fore section
Consequences:	The ship grounded and was only able to refloat with the help of extensive measures. There was no environmental damage.

Excerpt from Nautical Chart INT 1454, BSH

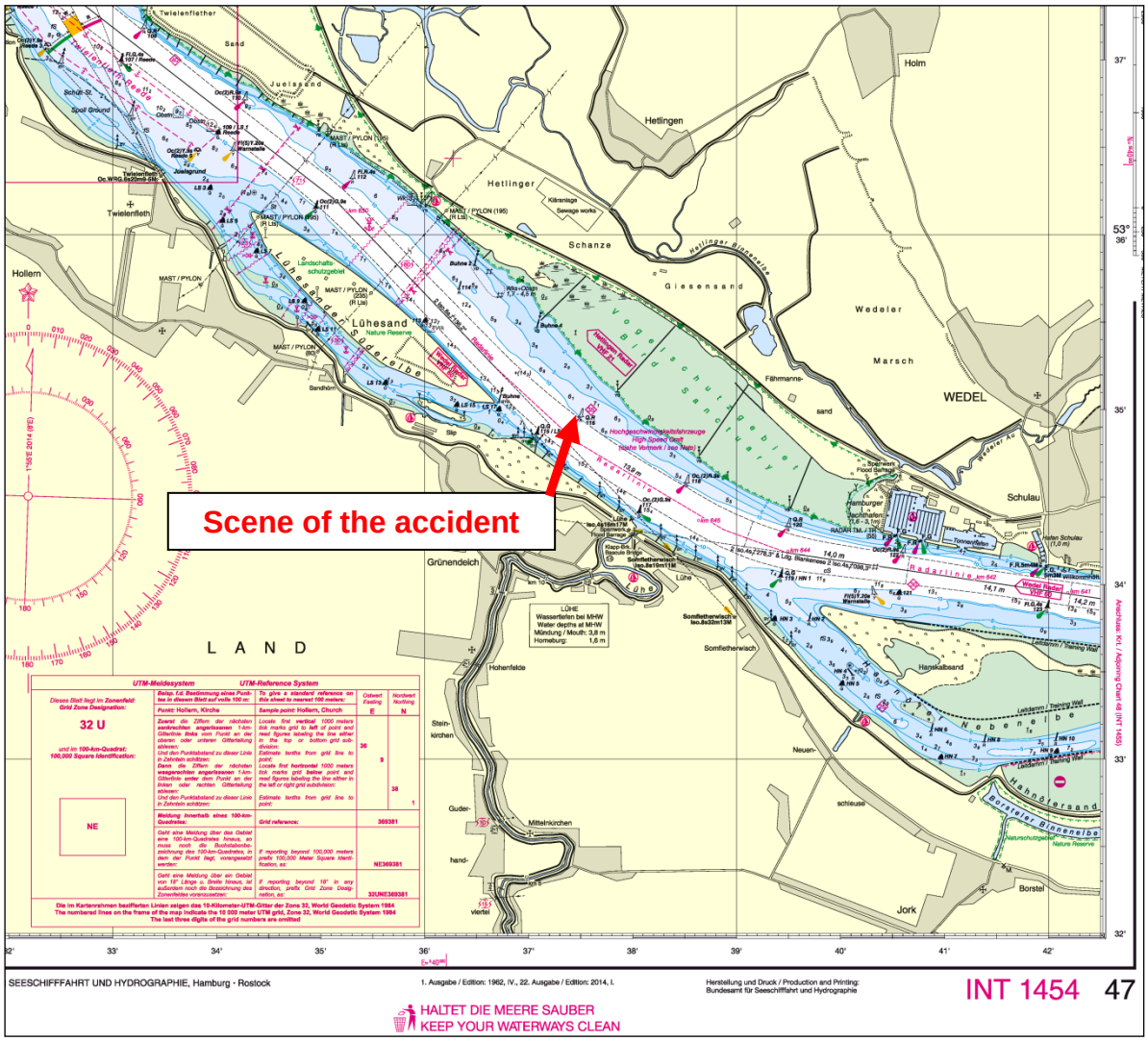

Figure 2: Nautical chart showing the scene of the accident

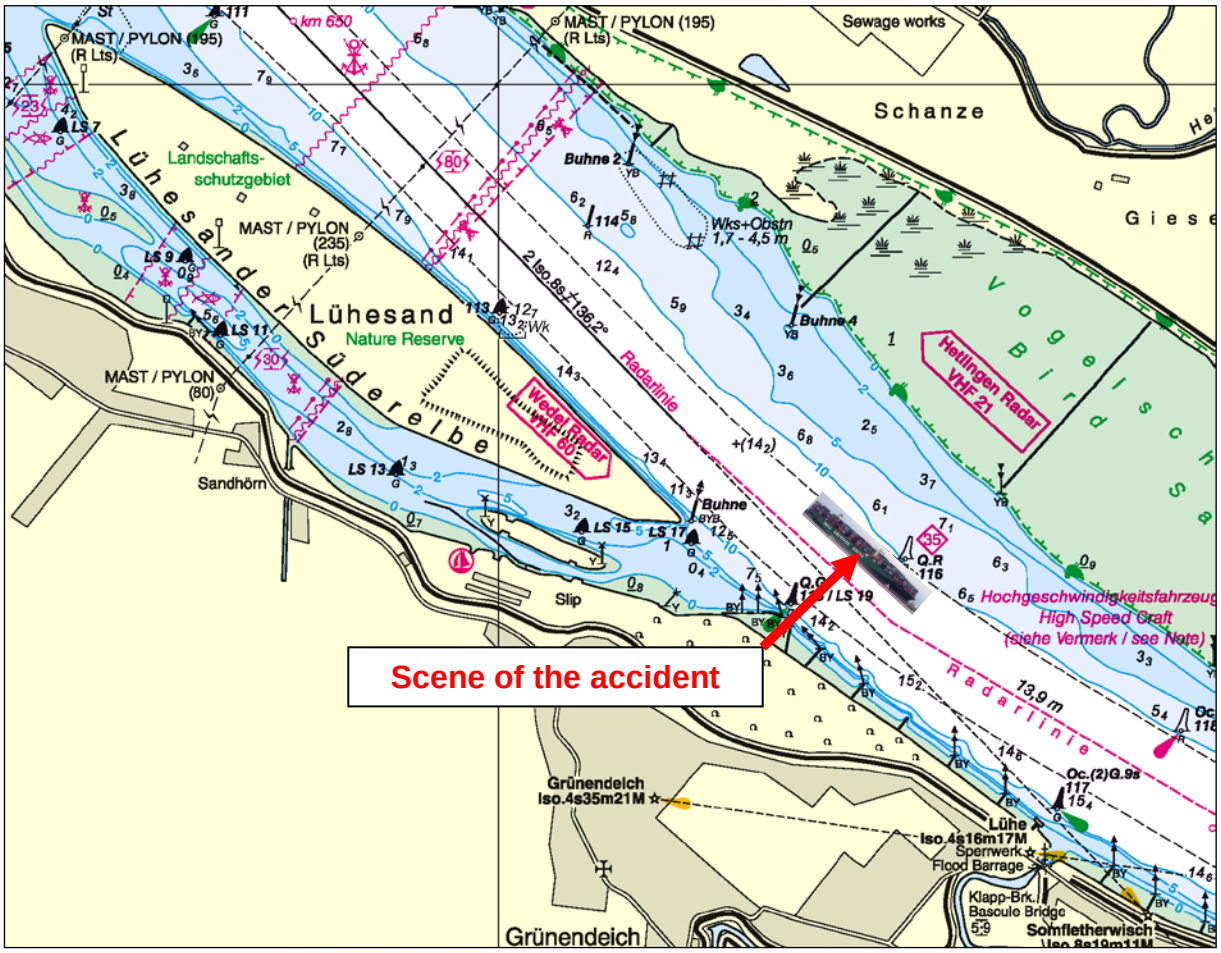

Figure 3: Nautical chart (detail)

2.5 Shore authority involvement and emergency response

Agencies involved:	CCME Cuxhaven
Resources used:	Various tugs; dredger
Actions taken:	Several attempts to haul the vessel; dredging
Results achieved:	Ship refloated

3 COURSE OF THE ACCIDENT AND INVESTIGATION

The container ship CSCL INDIAN OCEAN, flying the flag of Hong Kong, was en route from Felixstowe to Hamburg. On **2 February 2016**, the ship's command decided to anchor in the deep water roadstead on the German Bight due to stormy weather, until the wind conditions permitted the ship to enter the River Elbe without unnecessary risk. However, the joining shackle broke at about midday and the ship's command felt compelled to circle slowly until the weather improved and the arrival of the next tidal window for the River Elbe (see Figure 4).

© Marine Traffic

Figure 4: Course of the voyage from Felixstowe to Hamburg

3.1 Course of the accident

At 2016 on **3 February 2016**, the CSCL INDIAN OCEAN was located off Brunsbüttel, where the pilots were replaced. Besides the two Elbe pilots, the master, an OOW, a helmsman, and a lookout were now on the bridge. The master and pilots discussed the ensuing voyage. It was stated that with the exception of the missing starboard anchor, the ship was fully operable. All four hydraulic pumps belonging to the steering gear were operational.

The vessel traffic service (VTS) had classified the ship as an extraordinarily large vessel (AGF3+ with corresponding right of way). The required signals (red-white-red – vessel restricted in her ability to manoeuvre) were turned on. The ship's command was given the required special radar guidance on VHF.

The pilot responsible based his decisions on the port radar unit. At the same time, the second pilot dealt with the necessary VHF traffic, logged passage times, and advised the pilot responsible.

When the pilotage commenced, the CSCL INDIAN OCEAN's course followed the fairway with her port side on the radar reference line. Her rate of speed stood at DEAD SLOW AHEAD. Her speed was increased to HALF AHEAD to sail further upstream on the River Elbe. The Brunsbüttel Elbehafen port was passed at 2028,

buoy 73 off the Stör estuary at 2058, and buoy 85 at Ruthenstrom at 2118. Up until this point, everything had passed without any complications.
An audible and visual alarm issued at about level with Rhinplate, which was acknowledged by the OOW. On being questioned by the pilot, it was stated that all's well.
Another audible and visual alarm issued shortly after turning for the River Lühe line at about 2210. This alarm indication was directly in front of the helmsman, prompting the pilot to ask him whether there was a problem. He did not receive an answer, as the master was just making a phone call in his first language and operated various switches on the panel at the same time. At this point, the oncoming EMPIRE approached close to the radar reference line. When the pilot realised in the given context that it was not possible to alter the CSCL INDIAN OCEAN's helm from its current position at 3° port, he immediately advised STOP ENGINE and FULL ASTERN, which was implemented immediately. The pilot also advised that the anchor be manned and the bow thruster activated. He then notified the radar adviser of the helm failure, asking him to inform the EMPIRE. At the same time, the second pilot notified the VTS and the police boat BÜRGERMEISTER WEICHMANN, which by way of coincidence had just been overtaken by the EMPIRE.
The CSCL INDIAN OCEAN initially maintained directional stability, enabling the two oncoming ships to pass at a safe distance to the port side.

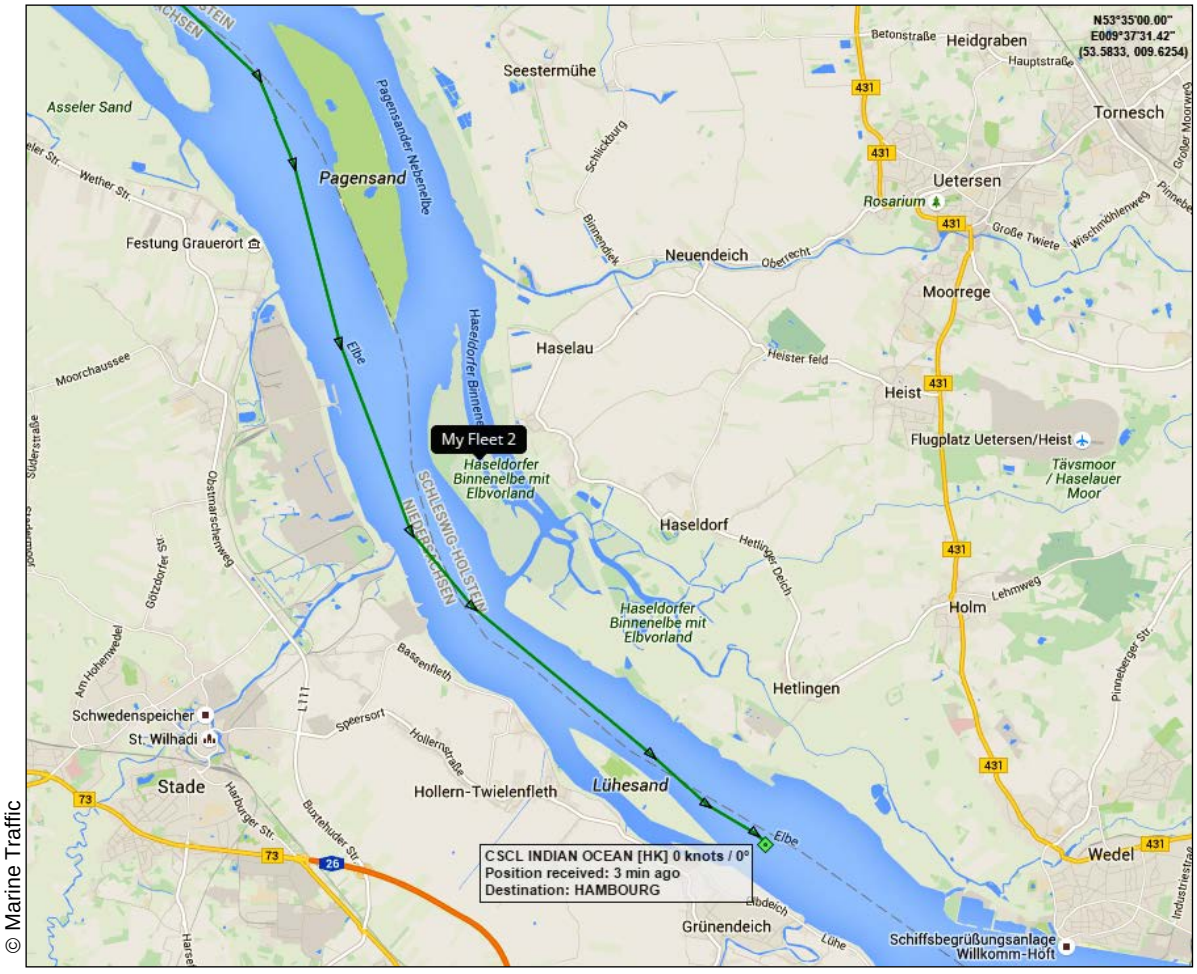

Figure 5: Course of the voyage up until the grounding

Despite the screw now rotating astern, the turn to port increasingly intensified. Meanwhile, the ship's command had arranged for a crew member to run to the steering gear compartment so as to reset the steering gear locally. The deviation from the heading line finally stood at about 20° when the pilot learned at 2215 that the helm was responding again. The pilot immediately advised HARD TO STARBOARD and HALF AHEAD. The ship responded to the helm and there was brief optimism that it would be possible to avoid ground contact after all. While the first pilot observed radar and conning, the second pilot monitored buoy 116 from the wing.
The ship's command saw no other options for action at this point. Use of the port anchor was ruled out, in particular. This would have resulted in an adverse turn of the ship to port, also endangering her bottom due to the low water depth.
At 2220, all the speed indicators displayed 0 kt – the CSCL INDIAN OCEAN had run aground south of buoy 116.
The rudder angle and engine speed were maintained for a short period after to prevent the rising tide from turning the ship across the fairway.

3.2 Salvage

The crew performed a damage assessment immediately after the ship grounded. Neither was water ingress found nor had any fuels or lubricants escaped.
After sending any accident reports necessary on VHF, the pilot advised that the residual ballast water be drained to the extent permitted by the ship's stability as an initial measure to refloat her. The cargo officer advised shortly afterwards that the draught calculated at the bow and astern was 11.1 and 12.3 m respectively after the residual ballast water had been drained.
At about 2255, the first tug (DOLPHIN) was made fast astern on the starboard side and began to haul towards the fairway. At 2309, the tug BOXER was connected forward on the starboard side and hauled towards the fairway. A total of six tugs were operating at 0027, two forward and four aft. The CSCL INDIAN OCEAN's main engine also operated at times.
An increasing ebb tide was noted at around midnight. Since the attempts to haul the vessel were unsuccessful, it was decided at 0050 in consultation with the VTS and WSP to suspend them and wait for the next high tide. The VTS ordered the BOXER and the DOLPHIN to remain connected forward and astern respectively. The tug SD ROVER and multipurpose ship NEUWERK remained nearby to safeguard the scene of the accident.
Involving seven tugs, a second attempt to haul the vessel was made when high tide was reached at 1155 on **4 February 2016**. This was also unsuccessful.
Consequently, Waterways and Shipping Authority Hamburg requested that the CCME in Cuxhaven assume overall responsibility for co-ordinating the emergency. The CCME assumed responsibility for co-ordinating the subsequent measures at 1345.

To begin with, pollution control plane DO22 flew over the distressed vessel during a routine flight and it was found that no pollutants had escaped. At the same time, the air space over the ship was closed.
In the course of the afternoon, a sounding ship investigated the area around the CSCL INDIAN OCEAN. Taking into account the sounding, the strength values of the ship were then examined in co-operation with DNV GL.
An initial meeting was held between representatives of the owner and underwriter.

The work involved in draining the remainder of the ballast water and transferring the bunker levels to the tanker, DRESDEN 2, started on **5 February**.
The crew on board the CSCL INDIAN OCEAN was in good health and had sufficient stocks.
The owner commissioned the company SMIT with the salvage operation.
Technical investigators from the WSP, the expert appointed by the BSU and the steering gear manufacturer, HATLAPA, as well as DNV GL boarded to determine the cause of the helm failure that evening.

The flushing dredger NJÖRD began to clear the area to the side and aft of the distressed vessel on **6 February**.
The heavy fuel oil transfer continued. DNV GL's inspection team did not find any visible irregularities. The ship’s structure was completely intact and no pollutants had escaped inside her, either.
Germany's National Meteorological Service delivered weather forecasts to the CCME regularly and the Federal Maritime and Hydrographic Agency (BSH) water level predictions.
Phone cards were made available to the ship's crew.

The CCME was in possession of a detailed salvage plan on **7 February**. DNV GL had planned a solution for the event that the previous measures were not sufficient. This envisaged discharging an additional 12 40' containers in two bays, so as to sufficiently reduce the CSCL INDIAN OCEAN's draught.
The measures of the previous day were continued.

Dredging and all the ballast operations were completed on **8 February**. The plan now was to connect 12 tugs at around midnight, so as to start the next attempt to haul the vessel free during the rising tide.

To achieve this, the River Elbe was closed to all ships between buoys 111 and 125 during the period 0200 to 0600 on **9 February**.
Starting punctually at 0200, this attempt to haul the vessel free was successful and the CSCL INDIAN OCEAN was hauled back into the fairway via her stern and starboard side before the water reached its maximum level. A subsequent performance test on the main engine, steering gear, and bow thruster was also successful.

The CCME's pollution control plane then flew over the area and was unable to find any environmental pollution.
Escorted by tugs, the CSCL INDIAN OCEAN then proceeded to a berth at Eurogate in the port of Hamburg under her own steam.

3.3 Investigation

3.3.1 Voyage data recorder

The CSCL INDIAN OCEAN is equipped with a JCY-1900 voyage data recorder (VDR) made by JRC. The WSP secured the data on behalf of the BSU. This was then analysed with the assistance of a certified service partner of JRC, ALPHATRON, in the BSU's technical laboratory.

The recorded ECDIS data show clearly that the large container ship passed the first of two high-voltage power lines at Lühesand shortly before the first audible alarm on the bridge. The nautical chart shows that the clearance between water surface and high-voltage power line is 80 m at medium tide height. Since the height of the CSCL INDIAN OCEAN is approximately 69.0 m (including antenna system on the observation deck), a height of approximately 56.9 m remains above the waterline when the current draught of 12.1 m is subtracted. This means that the clearance to the high-voltage power line is approximately 23 m. In the opinion of experts consulted by the BSU, this clearance is wholly adequate, meaning that an electromagnetic effect on the ship's technical installations can be ruled out and that the present case was a random convergence of events (see Figure 6 and Figure 7).

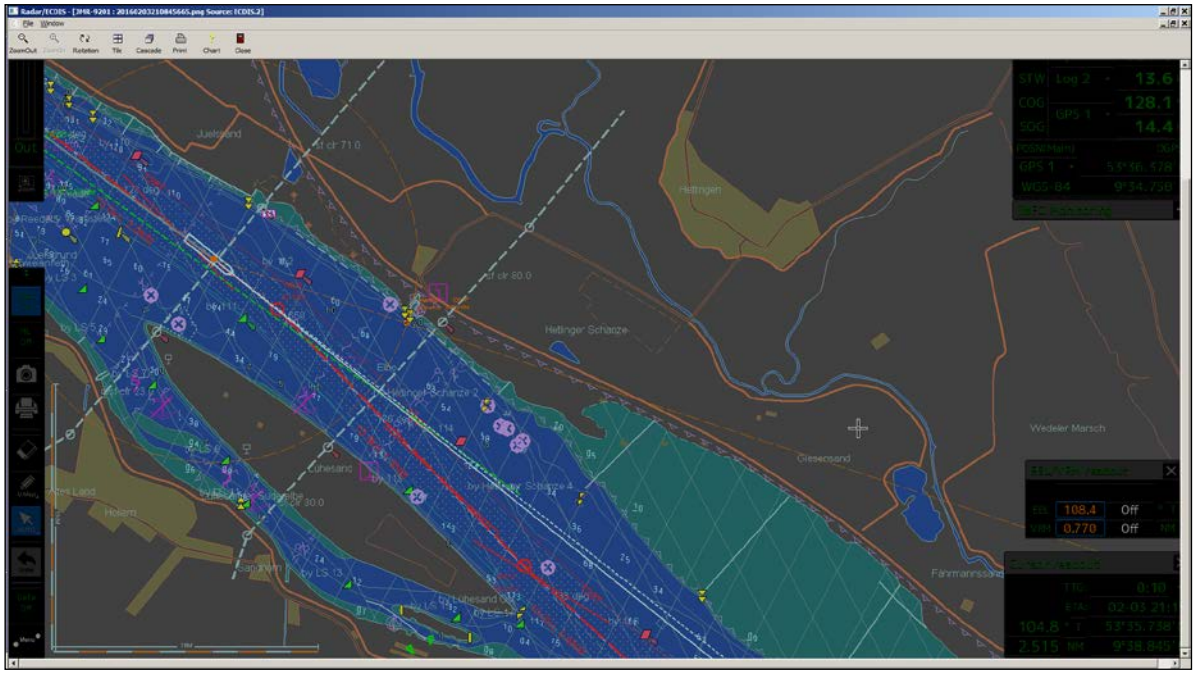

Figure 6: 220851 – passage of the first high-voltage power line starts

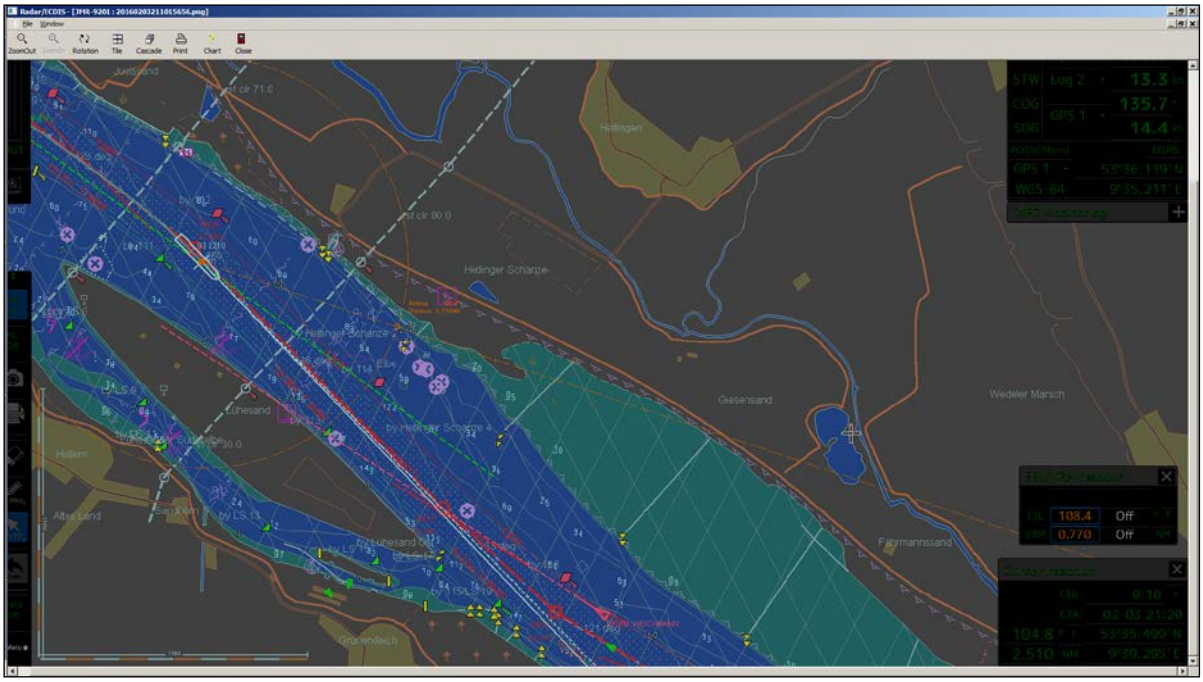

Figure 7: 221020 – first audible alarm

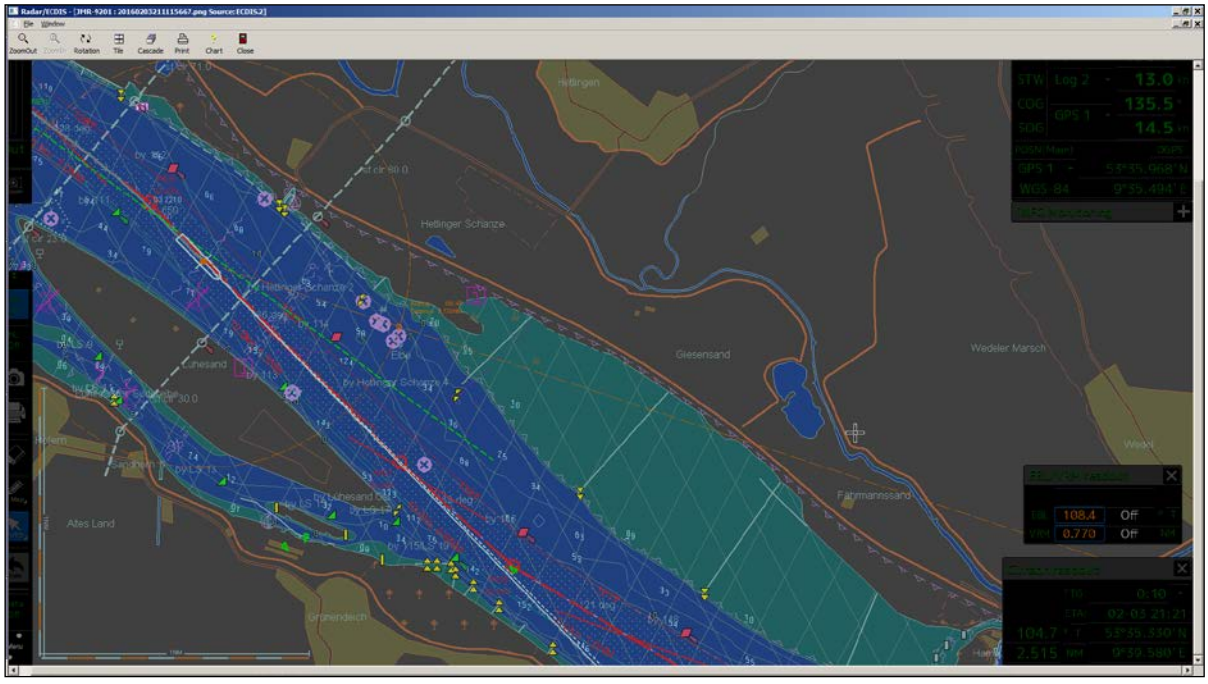

Figure 8: 221124 – helm failure noticed

Figure 8 shows the ship's position (at a speed of v = 14.5 kts) when the helm failure was noticed on the bridge. This is easy to follow from the audio recording of the bridge microphones. Unfortunately, the error log recordings of the VDR provide no information as to the cause of the helm failure. Only errors caused by the helm failure are recorded.

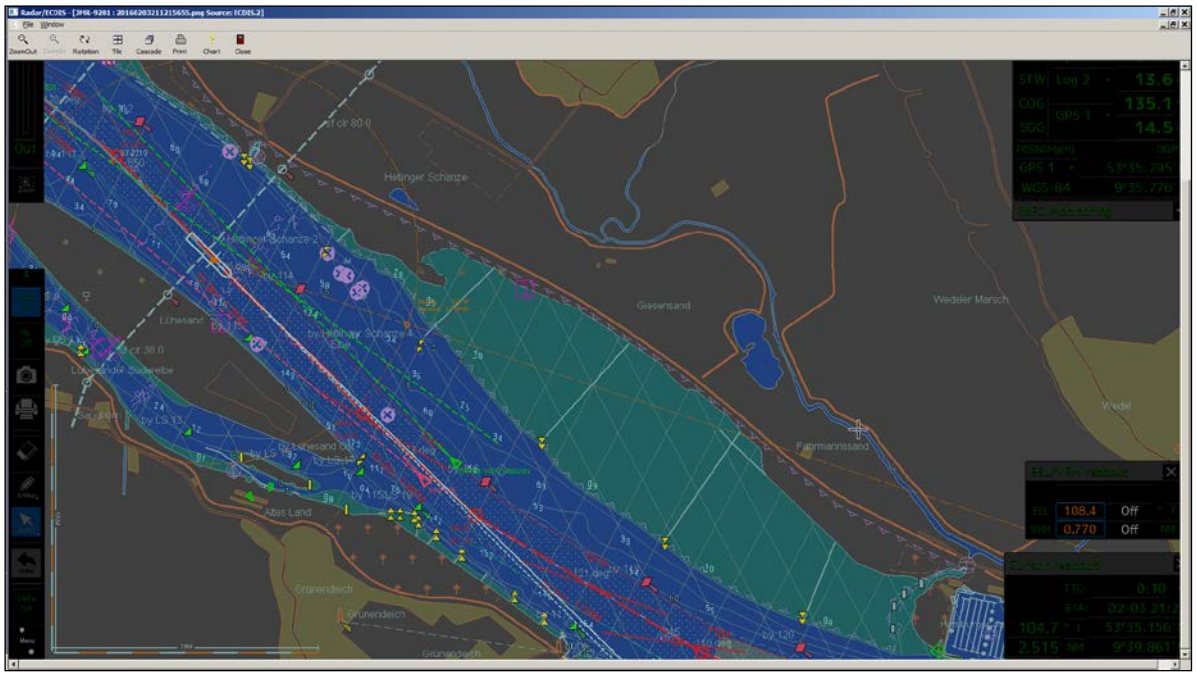

Figure 9: 221220 – passage of the second high-voltage power line

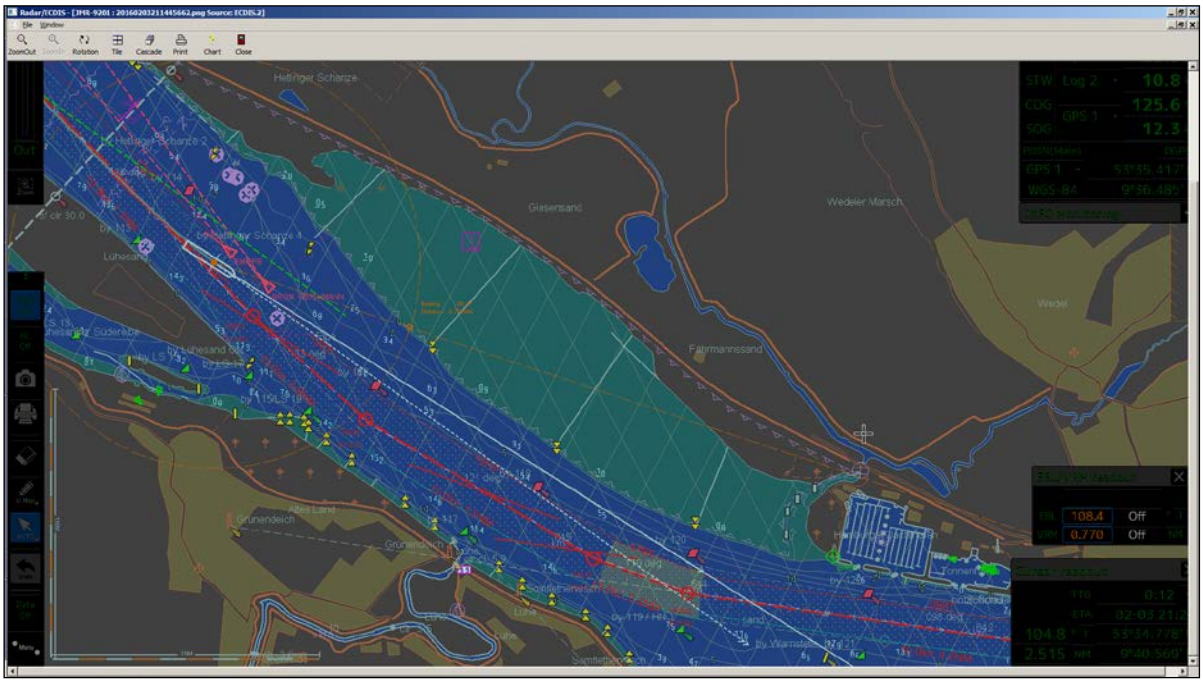

Figure 10: 221500 – helm responding again; oncoming traffic's closest point of approach

It can be heard at 2215 that the pilots are notified that the helm is responding again. Following that, the first pilot immediately advises HALF AHEAD and HARD TO STARBOARD. However, this manoeuvre had no significant effect. The speed has already dropped to v = 12.5 kts. The two oncoming vessels, MV EMPIRE and WSP boat BÜRGERMEISTER WEICHMANN, passed the CSCL INDIAN OCEAN on the port side at the same time.

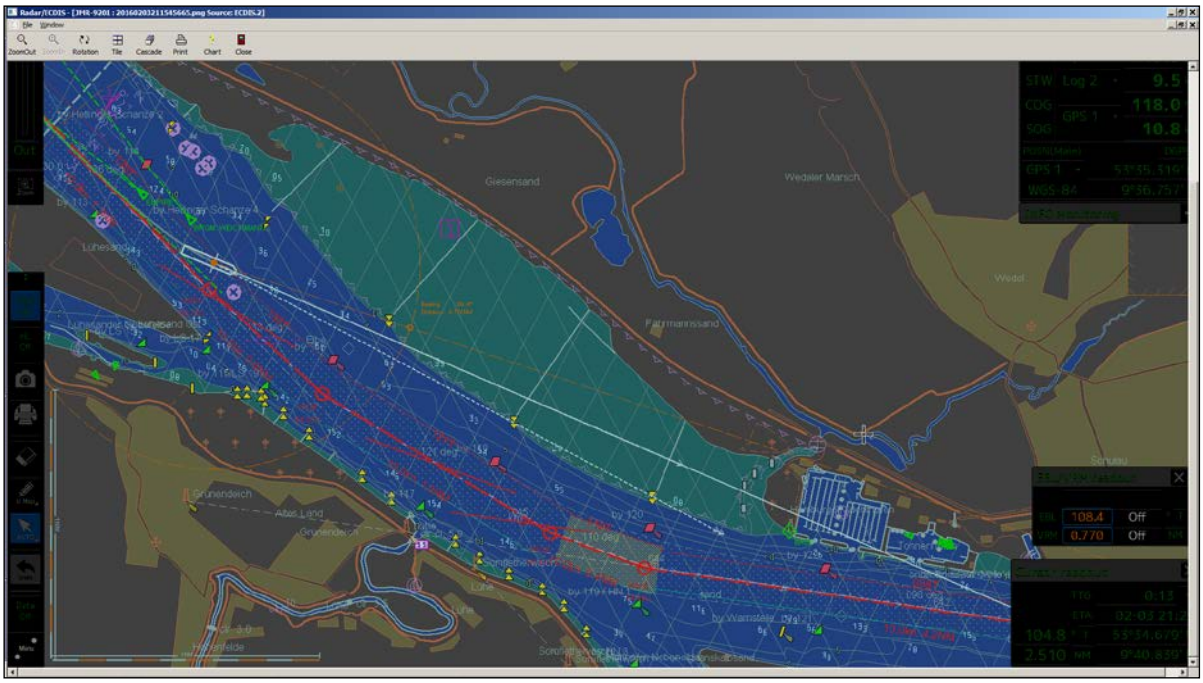

Figure 11: 221610 – oncoming traffic has passed

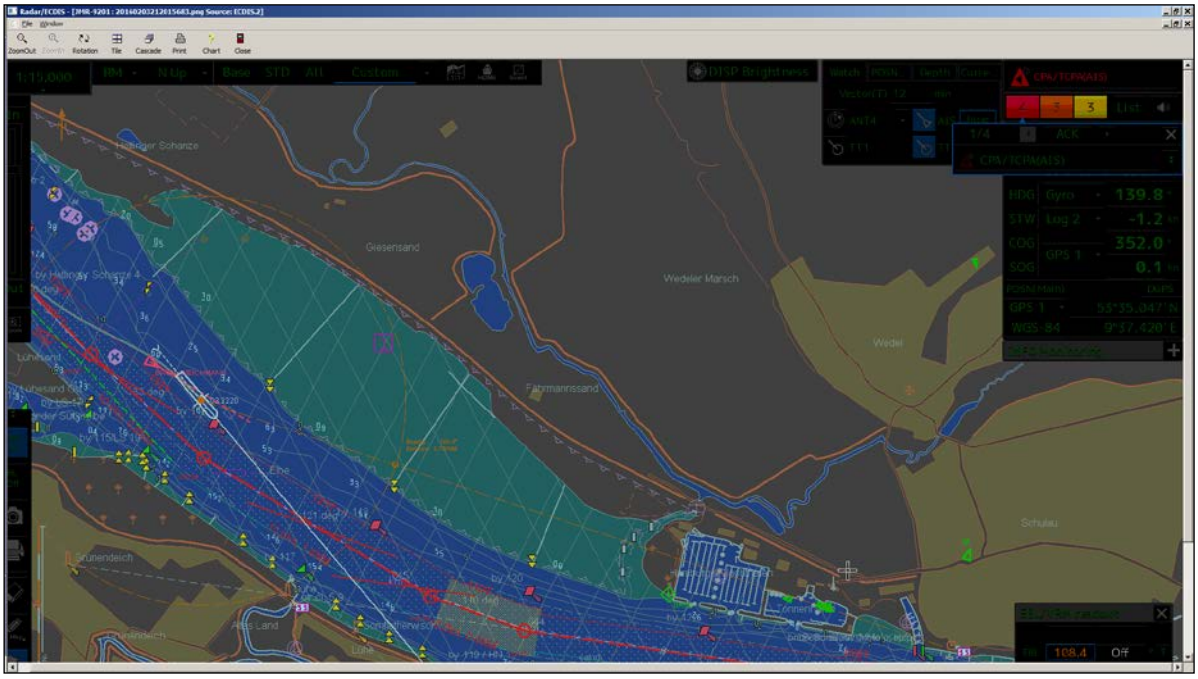

Figure 12: 222010 – grounded: SOG = 0.1 kt

The speed continues to drop steadily. At 221610, it still stands at v = 10.8 kts over ground.
The GPS devices indicate a speed over ground (SOG) of NULL at 222010. The CSCL INDIAN OCEAN's fore section has run aground on the port side.

3.3.2 Steering gear

Prof. Dr.-Ing. Friedrich Wirz from the Marine Engineering Working Group at the Hamburg-Harburg University of Technology prepared an expert opinion, which is incorporated below, so as to determine the cause of the accident.

3.3.2.1 Basic operating principle of the steering gear

The steering gear was manufactured by HATLAPA and installed at the Hyundai shipyard. While the mechanical and electrohydraulic components were supplied by HATLAPA, the switch cabinets and their wiring came from the shipyard. The system consists of four hydraulic units. Each contains an electric motor, an axial high-pressure tandem pump, and a valve. Hydraulic units 1 and 3 are located on the port side, 2 and 4 on the starboard side. Hydraulic units 1 and 3 usually operate as a single propulsion unit and hydraulic units 2 and 4 as a second propulsion unit. One unit pulls while the other pushes. Each hydraulic unit can be switched from the bridge and the steering gear compartment.

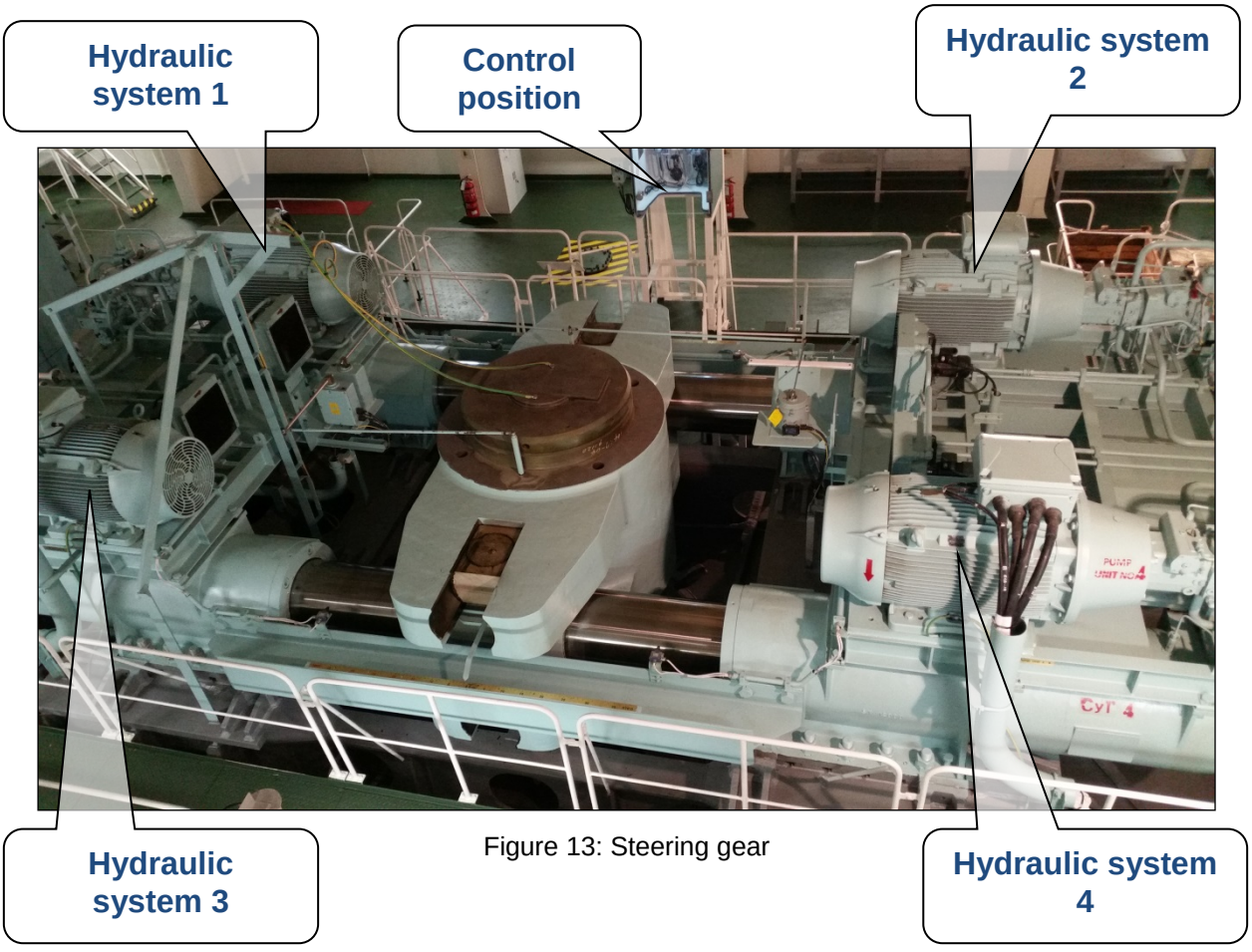

Figure 13: Steering gear

3.3.2.2 Survey of the steering gear

When a test start was carried out on hydraulic system 1 during the steering gear survey on 5 February 2016, hydraulic system 3 started, too. This unusual behaviour was also observed when system 2 was started and system 4 also powered up. In this context, it was found that systems 1 and 3 and systems 2 and 4 were switched together as master/slave. It was only possible to shut down the first pair at switch cabinet 1 and the second pair at switch cabinet 2.

A second anomaly was found in the hydraulic locking installation (HL). The HL is a SOLAS-requirement[2] for determining the difference between the ordered helm and current movement of the rudder. It was found that any cable terminating at a switch cabinet did not continue from there further.

The two anomalies had no impact on the marine casualty, however. The steering gear operated as it should.

3.3.3 SAFEMATIC

3.3.3.1 Basic operating principle of the SAFEMATIC

A third anomaly was found during the inspection of the SAFEMATIC. The SAFEMATIC is an additional, non-required system within the steering gear. It ensures that the helm can still be used in the event of leakage in the steering gear's hydraulic system. If oil leaks in the system, the oil level drops in the hydraulic fluid compensating tank. Therefore, this tank contains a float switch that measures three oil levels. The first oil/measuring point means that the tank is filled as required. The SAFEMATIC is activated if the system loses oil down to the second measuring point on the float switch. The SAFEMATIC then switches off two of four operating hydraulic systems (pumps). The two hydraulic systems that are still operating now control only one hydraulic cylinder (hydraulic unit 2 is defined). If the leak is on the port side of the overall hydraulic system, then the loss of oil should be stopped.

If the oil level continues to drop down to the float switch's third measuring point, then the leak was not isolated by switching the pumps previously, meaning it must be on the starboard side of the system. The SAFEMATIC then switches off hydraulic units 2 and 4 and switches on 1 and 3 instead, thus ensuring the steering gear is still available in such cases, too.

Consequently, the SAFEMATIC switches the pumps and any valves necessary such that the leaking unit is isolated. In such an emergency, this means that although only one hydraulic cylinder is moving, which slows down the response of the helm, the helm is still available to the ship's command.

[2] IMO UI of SOLAS Reg. II-1/29 (MSC.1/Circ.1398)

3.3.3.2 Survey of the SAFEMATIC

No leakage was found in the hydraulic system during the survey of the steering gear and SAFEMATIC on 5 February 2016. The level of hydraulic fluid in the compensating tank was above the low-level alarm. The crew stated that there had been no loss of oil. Accordingly, no traces of cleaning that could indicate the removal of a leak were found anywhere in the steering gear compartment, either.

To check the SAFEMATIC, the test switch at the switch cabinet was pressed (see Figure 15). As expected, two of the four hydraulic units then switched off. The helm failed to respond to any command, however. Following that, each valve was then switched on and off systematically by hand until the helm finally responded. This revealed that the SAFEMATIC was switched incorrectly in that as well as hydraulic cylinder 2 being operated, as intended, hydraulic cylinder 4 was also operated. Regrettably, this was such that both cylinders pressed on the rudderstock simultaneously in the same direction, meaning the rudder was unable to turn. The load on the rudder's mounting was enormous (see Figure 14).

This valve's connections were inspected. In the associated switch cabinet, the fault, which resulted in the incorrect switching of two valves, was then detected in the terminal strip (see Figure 17).

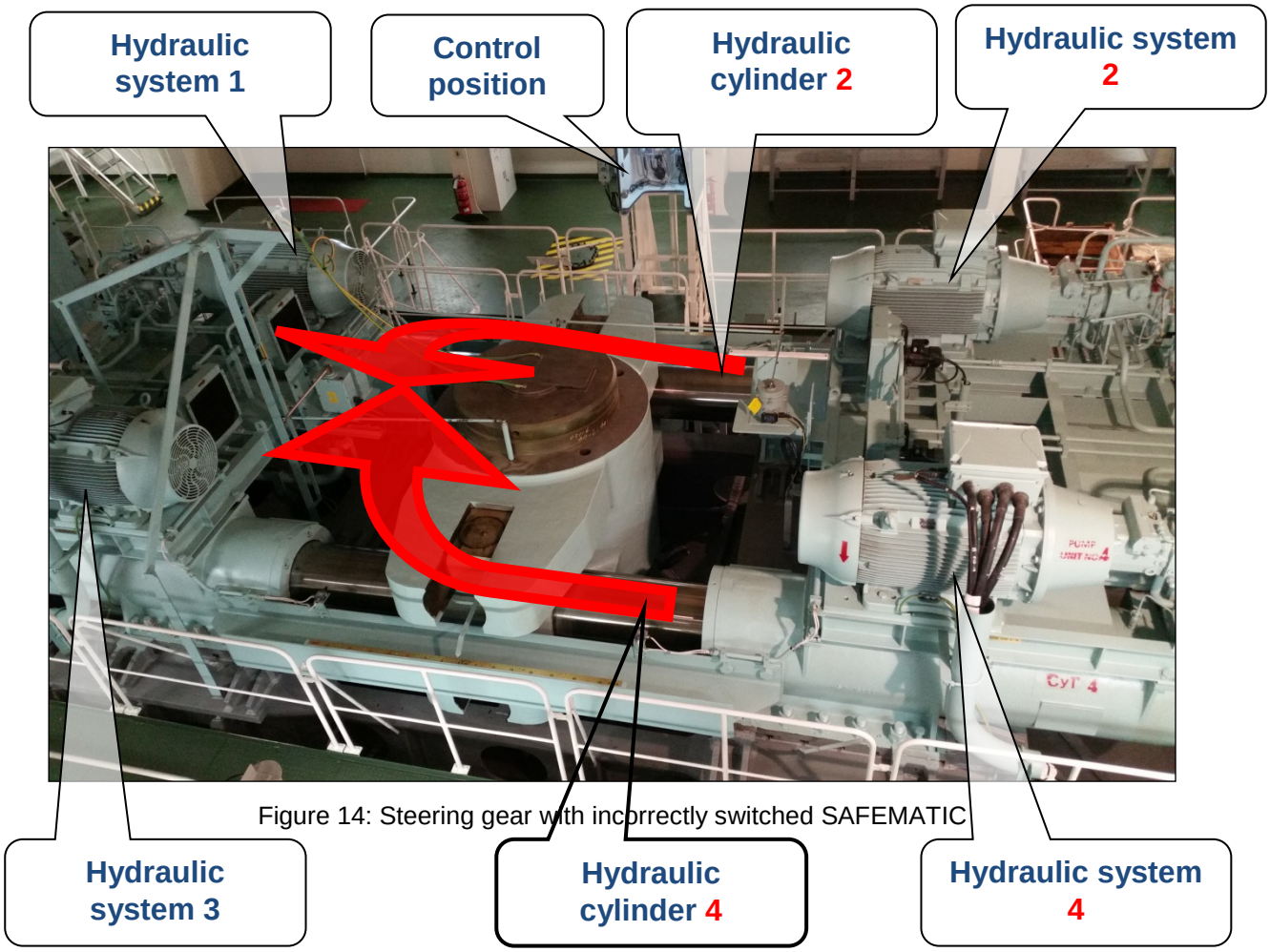

Figure 14: Steering gear with incorrectly switched SAFEMATIC

The question as to why the SAFEMATIC activated remains open.
Three alternatives are envisaged:

1. the float switch triggers when the oil level drops in the tank;
2. one of the test switches on the SAFEMATIC's control panel is pressed;
3. the test switch on the float switch is pressed.

Since there was no evidence whatsoever of any leakage, it is reasonable to assume that there was no leakage in the hydraulic system. From this point, a float switch malfunction would be conceivable. The expert disassembled and tested this completely on behalf of the BSU on 11 February 2016. Figure 16 shows the clean contact panel of the float switch. No faults were found, however. The float switch operated as it should.

Alternatives 2 and 3 can be ruled out because according to witness testimony, no one was situated in the steering gear compartment.
No other alternative was found than a random malfunction of the float switch.

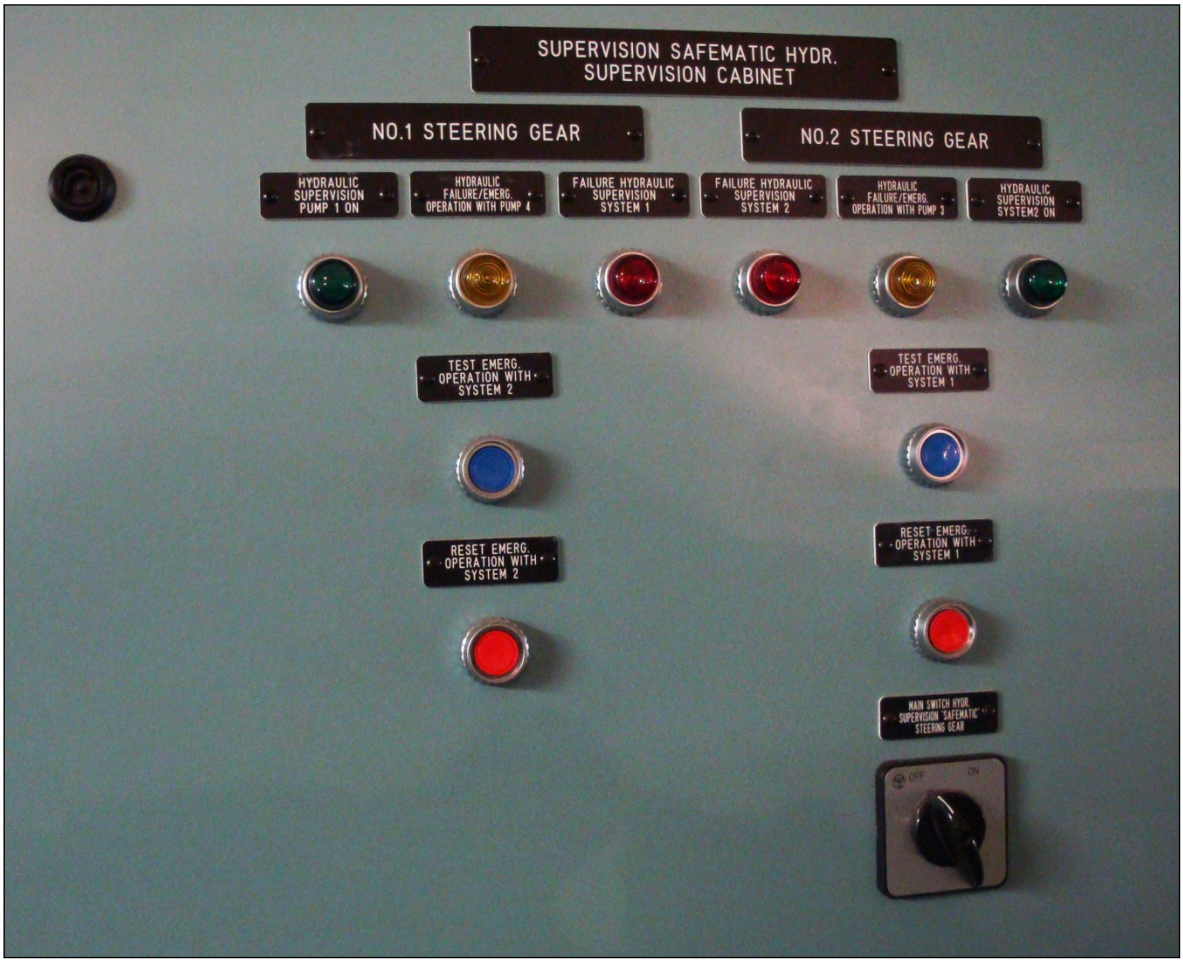

Figure 15: Switch cabinet

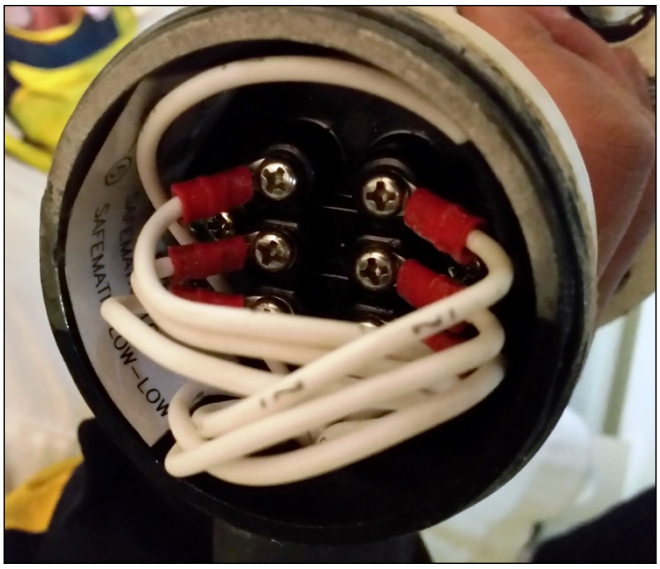

Figure 16: Float switch's contact panel

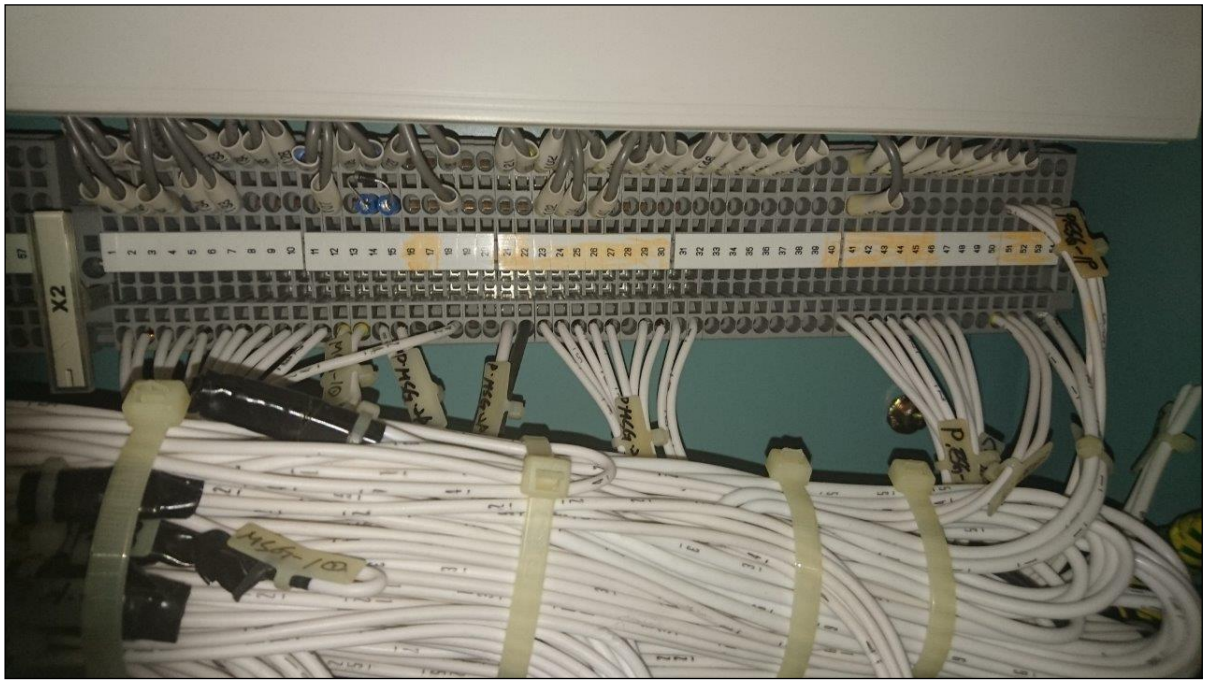

Figure 17: Terminal strip in the wiring cabinet

Figure 18: Hydraulic fluid tank

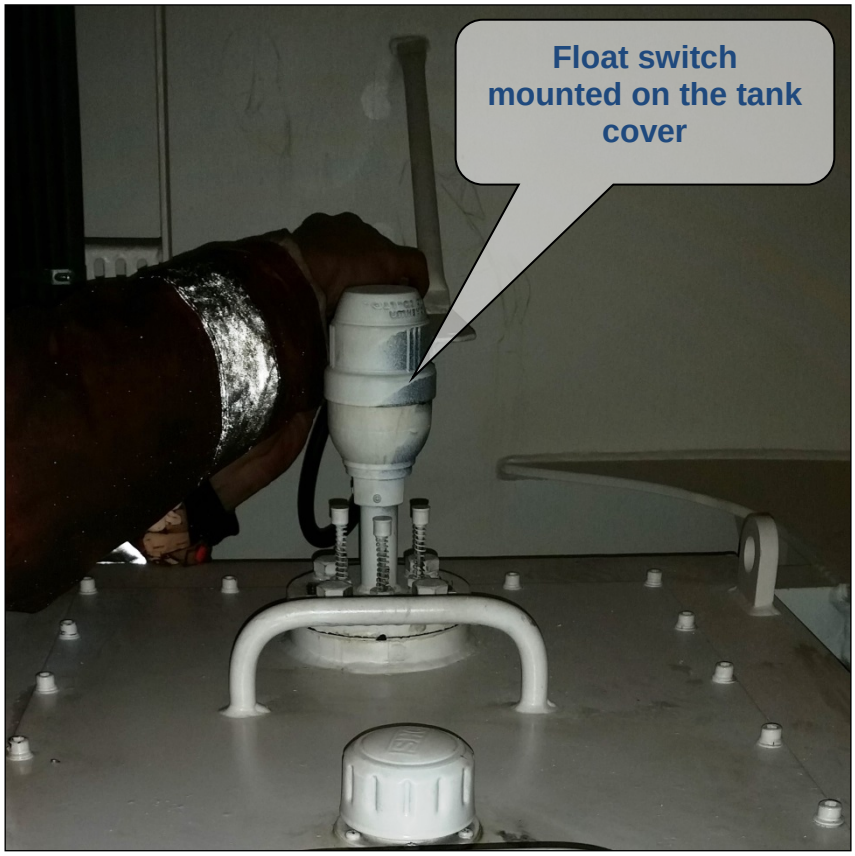

Figure 19: Hydraulic fluid tank cover with float switch

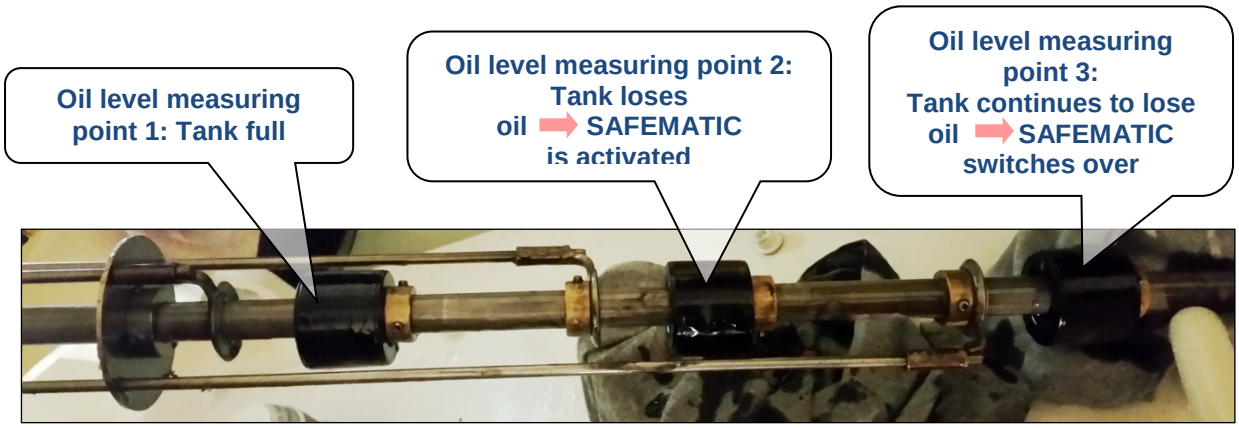

Figure 20: Removed float switch

Figure 21 shows the steering gear's hydraulic flow chart. The hydraulic fluid's routing in SAFEMATIC mode is shown in green. As an example, it is assumed here that the rudder should turn anti-clockwise, meaning hydraulic line 'A' is under pressure. This means that pump 2 operates after the float switch has indicated an initial drop in the tank's oil level. The activation of valve 2 by the SAFEMATIC separates the two hydraulic circuits from one another, meaning only cylinder 2 moves so as to move the rudder.

Figure 22 shows the same chart. This shows how the incorrectly connected cables found affect the hydraulic fluid's routing. Under these conditions, the SAFEMATIC valve 2 is inactive, while 1 opens. Accordingly, valve 2 allows the flow of oil up to valve block 1 on the port side, where a valve that builds a connection back to valve block 2 is thus opened. A hydraulic short circuit is created, which causes cylinders 2 and 4 to activate, meaning they block each other mutually. The rudder is now unable to move. Instead, extremely large forces now act on the rudder's mounting.

Resetting the steering gear in its entirety deactivated the SAFEMATIC and the helm operated as it should only four minutes after the failure.

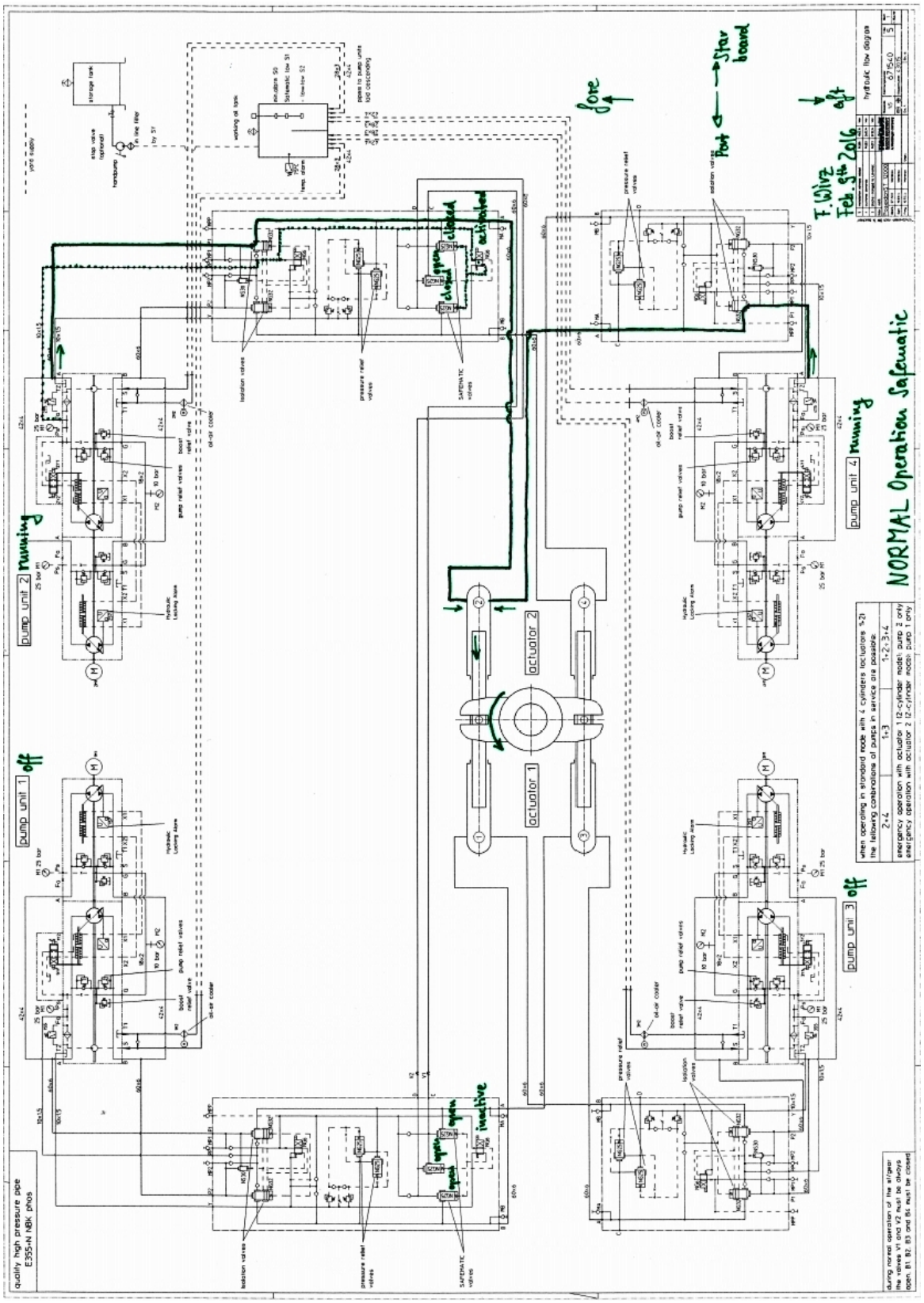

Figure 21: SAFEMATIC functioning as it should

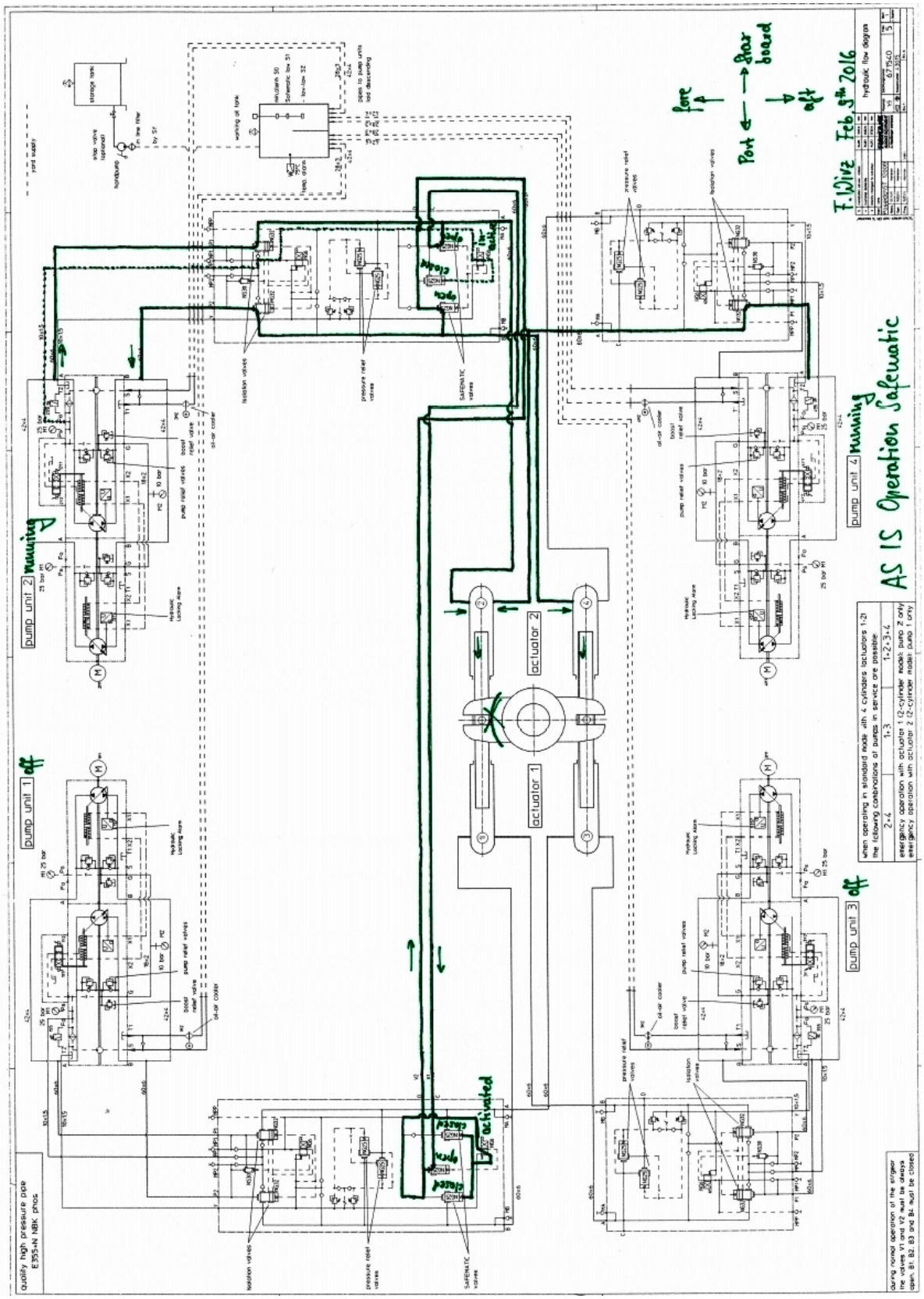

Figure 22: Incorrectly wired SAFEMATIC

4 ANALYSIS

The marine casualty involving the container ship CSCL INDIAN OCEAN on 3 February 2016 aroused considerable public interest, as she is one of the world's largest ships. With that in mind, it should be stressed that the marine casualty did not occur due to the size of the ship but was based on the faulty installation of the SAFEMATIC, a subsystem of the steering gear. However, it was not possible to demonstrate why the additional SAFEMATIC safety system activated. Neither an oil leak necessary for this to happen was observed in the steering gear's hydraulic system, nor was it possible to provide evidence of a manual user error. Having said that, neither the incorrect wiring nor the random activation of the float switch alone would have caused the helm failure, but only the combination of such errors.

Technical malfunctions are not directly related to the size of a ship but may occur on any vessel in spite of all the duplications of equipment and inspections prior to entering inland areas.

The ship's command of the CSCL INDIAN OCEAN reported the loss of an anchor in the deep water roadstead on the German Bight to VTS Wilhelmshaven at 1328 on 2 February 2016. According to both Germany's Traffic Regulations for Navigable Maritime Waterways and Ordinance on the Safety of Shipping, such incidents must be reported to the VTS responsible without undue delay.
Entry into the area is permitted only if a constant wind force of 6 Bft is not exceeded at the measuring instrument beacon 'A' or at the measuring instrument in Brunsbüttel.

No further conditions are usually necessary if **one** anchor is fully operational. In all likelihood, the use of an anchor would have adversely affected the CSCL INDIAN OCEAN's grounding process. With that in mind, the BSU believes that the absence of the starboard anchor was not detrimental in the present case.
The Hamburg Port Authority (HPA) issued a shipping police permit to enter the port of Hamburg for the CSCL INDIAN OCEAN on 4 March 2015. The missing anchor did not prompt the HPA to issue any conditions in addition to those contained in the permit.
This is explained by the fact that a condition, whereby the ship had to establish a line connection to a tug with a bollard pull of at least 70 t after passing the State border, already existed. An additional tug was required to enter the Parkhafen and Waltershofer ports and for the turning and berthing manoeuvre.

VTS Brunsbüttel/Elbe and WSA Hamburg ordered the following tugs at 2312 on 3 February 2016 for the first attempt to haul the vessel free: BUGSIER 2, BUGSIER 9, BUGSIER 10, ZP BOXER, SD DOLPHIN, and SD ROVER. This attempt to haul the vessel was unsuccessful and aborted at 0050.
The tugs were engaged by the owner.

The ship was lightened during the night by draining ballast water and the draught reduced from 12.10 m to 11.30 m. The second attempt to haul the vessel free was made, by order of WSA Hamburg and on behalf of the owner, between 1055 and 1300 on 4 February 2016 and involved the following resources: BUGSIER 2, BUGSIER 8, BUGSIER 9, BUGSIER 10, ZP BOXER, SD DOLPHIN, and SD ROVER.

The fairway was fully passable up until the CSCL INDIAN OCEAN refloated on 9 February 2016. The hourly situation reports of VTS Brunsbüttel Elbe were used to communicate an order to pass the distressed vessel at low speed.

As regards aircraft, the Do 228 (BMVI's sensor aircraft of the) was deployed for surveillance. The governmental vessels deployed were the multipurpose ship NEUWERK (by order of the casualty command) and the BÜRGERMEISTER WEICHMANN (by order of WSP Hamburg) from WSP Hamburg for traffic safety measures. The sounding ships DEEPENSCHRIEWER I and DEEPENSCHRIEWER II from the HPA and WEDEL from WSA Hamburg were deployed on behalf of the casualty command for the creation of the surface profile around the distressed vessel.

Germany's air traffic control closed the airspace for a radius of 2 km over the distressed vessel at the request of the CCME during the period 1430 on 4 February 2016 to 0930 on 9 February 2016. Inter alia, the airspace was closed in the interest of the safety of the operational units and unimpeded operation of aircraft with deployment orders.

Due to the arrangement of the fuel or lubricant tanks in the ship, there was no acute danger of pollutant discharge. Pumping out the fuel and lubricants helped to lighten (weight, i.e. draught reduction) the ship. Moreover, this made it possible to minimise the consequences of any pollutant discharge.
Pumping out the fuel was arranged and commissioned by the CSCL INDIAN OCEAN's owner in consultation with the CCME.

The CCME together with the salvors, KOTUG Offshore B.V. and Smit Salvage B.V., drew up a salvage plan. The seagoing tugs UNION MANTA from Boskalis and FAIRMOUNT EXPEDITION, six tugs from Bugsier, four tugs from Kotug, two boats from the WSP, the Do 228 from the CCME, a casualty care team from Cuxhaven's fire service, and multipurpose ship NEUWERK were involved in the third attempt to haul the vessel free. 12 tugs hauled the CSCL INDIAN OCEAN back into the fairway at between 0200 and 0220 on 9 February 2016. The BMVI's pollution control plane monitored the towing operation and did not detect any pollutant discharge. The airspace over the distressed vessel was reopened. The River Elbe was cleared for use by shipping after the ship refloated.

Preventive measures of the Federal Waterways and Shipping Administration are reviewed and optimised continuously in the interest of quality assurance. In view of this marine casualty, the Federal VTSs were instructed to arrange sufficient tug

support before the voyage continues if it is reasonable to suspect a technical failure on an extraordinarily large vessel.
Moreover, a review is ongoing to determine whether certain engine manoeuvres should be tested before entering the area and the results thereof communicated to the VTS.
The minor consequences of the grounding of the CSCL INDIAN OCEAN in terms of the impact on traffic and the environment bear witness to the effectiveness of the contingency plans on board ships and ashore by the VTSs. In particular, the pilots on board the ship did everything in their power to ground her in a controlled manner in an area where the waterbed was relatively flat and to position her so that any obstruction or risk to other traffic was kept to a bare minimum. The VTS safeguarded surrounding shipping with warnings, advice, and traffic control measures without undue delay and initiated immediate action to mitigate damage.

The CCME has focused on the issue of accidents involving large container ships for quite some time now and continually enhances existing technical plans against this backdrop.

5 CONCLUSIONS

The accident was caused by incorrect wiring in the SAFEMATIC. It was not possible to demonstrate why this system activated, however. The data stored in the VDR are not detailed enough for this. The engine room computer's error logs did not indicate any cause, either. It was also not recorded, if the ships command attempted to reactivate the steering gear after it had failed by means of the mandatory redundancies. With that in mind, it would be beneficial if modern steering gear stored a separate error log so that errors can be better analysed and avoided in the future.

It was not possible to find any correlation in the fact that the helm failed when the high-voltage power line was passed. It is quite reasonable to rule out any influence because no traces of a short circuit or fire were detected.

Discharging containers on the CSCL INDIAN OCEAN to reduce her draught further was not necessary for the salvage operation. Should this be necessary in a similar case, it must be remembered that in Europe there is currently only one floating crane available that has the reach necessary to discharge containers from this above-average height.

6 SAFETY RECOMMENDATIONS

The following safety recommendations do not constitute a presumption of blame or liability.

6.1 The owner, China Shipping Container Lines

The Federal Bureau of Maritime Casualty Investigation recommends that the owner inspect sister ships to determine whether their SAFEMATIC is also wired incorrectly and whether the cables of the hydraulic locking system also terminate at a switch cabinet.

6.2 Classification society of the CSCL INDIAN OCEAN

The BSU recommends that the classification society broaden the periodic inspections of the SAFEMATIC to include the implementation of a helm manoeuvre in SAFEMATIC mode.

6.3 Federal Ministry of Transport and Digital Infrastructure

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry of Transport and Digital Infrastructure continually enhance existing technical plans for accidents involving large container ships, discharging containers from an above-average height, in particular.

6.4 Manufacturer of the steering gear, HATLAPA

The Federal Bureau of Maritime Casualty Investigation recommends that the manufacturer of the steering gear equip its system with internal error logging to make it easier to understand future helm failures.

6.5 Federal Ministry of Transport and Digital Infrastructure

The Federal Bureau of Maritime Casualty Investigation recommends that the Federal Ministry of Transport and Digital Infrastructure propose that the IMO examine whether SOLAS should be supplemented by the requirement of internal error logging within the steering gear and thus minimise future helm failures and increase safety at sea through the analysis thereof.

7 SOURCES

- Enquiries of the WSP
- Written statements
  - Ship's command
  - Owner
  - Classification society
- Witness testimony
- Opinion of the expert Prof. Dr.-Ing. Friedrich Wirz from the Marine Engineering Working Group at the Hamburg-Harburg University of Technology
- 'Response of the Federal Government to the short question of members of the Bundestag Dr Valerie Wilms, Matthias Gastel, Bärbel Höhn and the Alliance 90/Greens political party 'Accident involving the Container Ship 'CSCL Indian Ocean' near Hamburg', Document 18/7792'
- Nautical charts and ship particulars, BSH
- Technical documentation, HATLAPA
- Documentation from the Ship Safety Division (BG Verkehr)
  - Accident Prevention Regulations (UVV See)
  - Guidelines and codes of practice
  - Ship files