



Danish Maritime Accident
Investigation Board

MARINE ACCIDENT REPORT

November 2015



ORION and NECKAR HIGHWAY
Collision and foundering on 1 July 2015

The Danish Maritime Accident Investigation Board
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Front page: The wreck of ORION. Source: DMAIB.

The marine accident report is available from the website of the Danish Maritime Accident Investigation Board (www.dmaib.com).

The Danish Maritime Accident Investigation Board

The Danish Maritime Accident Investigation Board is an independent unit under the Ministry of Business and Growth. It carries out investigations as an impartial unit that is, organizationally and legally, independent of other parties. The board investigates maritime accidents and occupational accidents on Danish and Greenland merchant and fishing ships, as well as accidents on foreign merchant ships in Danish and Greenland waters.

The Danish Maritime Accident Investigation Board investigates about 140 accidents annually. In case of very serious accidents, such as deaths and losses, or in case of other special circumstances, either a marine accident report or a summary report is published, depending on the extent and complexity of the events.

The investigations

The investigations are carried out separately from the criminal investigation, without having used legal evidence procedures and with no other basic aim than learning about accidents with the purpose of preventing future accidents. Consequently, any use of this report for other purposes may lead to erroneous or misleading interpretations.

1. SUMMARY

On 1 July 2015 at 2327, the Danish fishing vessel ORION was drifting at a fishing ground in the North Sea, 4 nm off Hirtshals, when it collided with the Cypriote vehicle carrier NECKAR HIGHWAY en route from Malmo, Sweden to Emden, Germany. ORION foundered as a result of the collision and the skipper was evacuated from the water 20 minutes after the impact. By that time, ORION had already vanished from the surface of the sea. On NECKAR HIGHWAY, the crew did not become aware that an accident had happened until the day after and, hence, the ship continued its voyage to Emden.

In this marine accident report, the DMAIB establishes the facts of the collision and focuses on the navigational watchkeeping on both ships.

It has not been possible for the DMAIB to establish an exact explanation of why the two ships overlooked each other. However, in the report the DMAIB points to several factors imbedded in the normal operation and design on both ships that left room for the possibility of overlooking the risk of collision and not keeping a constant lookout.

2. FACTUAL INFORMATION

2.1 Photo of the ship



Figure 1: NECKAR HIGHWAY
Source: DMAIB



Figure 2: AS 28, ORION
Source: DMAIB

2.2 Ship particulars

NECKAR HIGHWAY

Name of vessel:	NECKAR HIGHWAY
Type of vessel:	Vehicle carrier
Nationality/flag:	Cyprus
Port of registry:	Limassol
IMO number:	9344253
Call sign:	P3ZU9
DOC company:	Stargate Shipmanagement GmbH
IMO company no. (DOC):	1844851
Year built:	1999
Shipyard/yard number:	Hegemann Rolandwerft GmbH & Co. Kg/185
Classification society:	Lloyd's Register
Length overall:	99.90 m
Breadth overall:	19.65 m
Gross tonnage:	9,233
Deadweight:	3,387 t
Draught max.:	5.50 m
Engine rating:	4,800 kW
Service speed:	15.50 knots
Hull material:	Steel
Hull design:	Single hull

ORION

Name of vessel:	ORION, AS 28
Type of vessel:	Fishing vessel, gillnetter
Nationality/flag:	Denmark
Port of registry:	Boennerup Strand
Call sign:	XP 3756
Year built:	1978
Shipyard/yard number:	Faaborg Yachtværft/F305021078
Length overall:	9.24 m
Breadth overall:	3.04 m
Gross tonnage:	5.6
Draught max.:	1.21 m
Engine rating:	59 kW
Service speed:	8 knots
Hull material:	GRP
Hull design:	Single hull

2.3 Voyage particulars

NECKAR HIGHWAY

Port of departure:	Malmö, Sweden
Port of call:	Emden, Germany
Type of voyage:	Merchant shipping, international
Cargo information:	In ballast
Manning:	13
Pilot on board:	No
Number of passengers:	0

ORION

Port of departure:	Hirtshals, Denmark
Port of call:	Hirtshals, Denmark
Type of voyage:	Fishing, coastal
Cargo information:	In ballast
Manning:	1
Pilot on board:	No
Number of passengers:	0

2.4 Marine casualty or incident information

NECKAR HIGHWAY

Type of marine casualty/incident:	Collision
IMO casualty classification:	Less serious
Date, time:	1 July 2015 at 2327 LMT
Location:	North Sea, 4 nm northwest of Hirtshals
Position:	57°36.804' N – 009°50.871' E
Ship's operation, voyage segment:	In passage
Human factor data:	Yes
Consequences:	None

ORION

Type of marine casualty/incident:	Collision and foundering
IMO casualty classification:	Very serious
Date, time:	1 July 2015 at 23.27 LMT
Location:	North Sea, 4 nm northwest of Hirtshals
Position:	57°36.804' N – 009°50.871' E
Ship's operation, voyage segment:	Fishing
Human factor data:	Yes
Consequences:	Total loss of ship. Man over board

2.5 Relevant crew

NECKAR HIGHWAY

Master: STCW II/2
45 years old. Had been with the company since 2002 and had served as master since 2008. Had served as master on NECKAR HIGHWAY since 2014.

2nd officer: Master STCW II/2
39 years old. Had been with the company since 2008 and had served on NECKAR HIGHWAY several times in this period.

ORION

Skipper: Skipper, 1st class on fishing vessels.
51 years old. Had been at sea for approx. 35 years.

2.6 Shore authority involvement and emergency response

Involved parties: Joint Rescue Coordination Centre, the Danish Coastal Rescue Service, Lyngby Radio.
Resources used: Rescue helicopter and a fast rescue boat.
Speed of response: 20 minutes.
Actions taken: Evacuation of person over board.
Results achieved: Person over board was rescued.

2.7 Weather data

Wind – direction and speed: South-westerly, 3.6 m/s
Wave height: 0.5 m
Visibility: Good
Light/dark: Twilight
Current: South-easterly, 0.65 knots

2.8 Scene of the accident



Figure 3: Scene of the accident

Source: Chart no 92, Danish Geodata Agency

3. NARRATIVE

The sequence of events sections aim to describe the events as the involved persons on board both ships perceived them unfolding and thereby also aim to reflect the information that was available to the crew at the given moment.

The description falls in two sections: Section 3.1.2 deals with the sequence of events as it was experienced on ORION, and in section 3.2.2. the sequence of events from the point of view of the bridge crew on NECKAR HIGHWAY is described.

3.1 ORION

3.1.1 Background

ORION was a Danish-flagged one-man operated gillnetter engaged in fishing primarily at a distance of approx. 6-8 nm off Hirtshals, Denmark. The skipper, who owned the ship, had been fishing in this area with ORION for three years. At the time of the accident, the gillnetter was used for fishing sole, and the fishing was usually carried out at night between 2000 and 0300. ORION carried 130 gillnets that were set on banks on the seabed and were hauled in approx. two hours after they had been set. The skipper was able to haul in 30-40 nets per hour.

3.1.2 Sequence of events

On 1 July 2015, the skipper on ORION had set 130 gillnets 4 nm northwest off Hirtshals and had finished at approx. 2200. The nets were to be hauled at midnight and therefore ORION stayed adrift near the gillnets with the fishing lights on. The skipper spent the waiting time resting in the wheelhouse as usual and sporadically checked the traffic in the area. From his seat in the port side of the wheelhouse he did not have a clear view out the windows so he had to stand up in order to keep an eye on the traffic. He observed a coaster and another fishing ship passing by in a north-easterly direction. The other fishing ship was heading towards one of the buoys on ORION's gillnets and the skipper therefore decided to head towards the buoy so that the other fishing vessel would not cause damage to it. When the skipper was sure that the other fishing ship was aware of the presence of his fishing gear, ORION reverted to drifting in the area and the skipper returned to the wheelhouse.

Approx. ten minutes later the skipper felt a sudden impact of great force on ORION's starboard side that caused him to hit the back of his head against the port side bulkhead in the wheelhouse where he was sitting. Through the wheelhouse windows he could see nothing but a large red ship's side sliding along ORION with an impact that forced ORION to heave heavily to port, and then it passed ORION. The skipper quickly orientated himself after the impact and saw the aft of the large red ship disappear. From the wheelhouse the skipper quickly saw that the bow and most of the port side were under water and that the ship was bound to sink. He fetched and donned a lifejacket in the wheelhouse and immediately pressed the distress button on the VHF-DSC. Shortly after, the skipper received a call from the coast radio station Radio Lyngby (LYRA). The skipper informed LYRA that ORION had been hit by a cargo ship and that ORION was sinking. LYRA immediately contacted the Joint Rescue

Coordination Centre (JRCC) which deployed a rescue helicopter and a fast rescue boat (FRB) to evacuate the skipper.

Three minutes after the skipper sent his distress signal, he informed LYRA that the ship was lying on its side and that he needed to leave the wheelhouse immediately. The skipper managed to bring the VHF receiver outside and was able to continue the communication with LYRA, while he was on the ship's starboard side. ORION's liferaft was placed forward on the port side and submerged in water and, hence, it was impossible for the skipper to evacuate by means of the liferaft directly from the ship. As the ship was sinking and the forward trim was almost vertical, the skipper moved to the stern and stepped down on the ship's heel and then slid into the water.

When the skipper got in to the water, he saw that the liferaft had been released. He was about to swim towards the liferaft when he observed an FRB approaching him. At approx. 2350, the skipper was safely on board the FRB. At that time, ORION had vanished from the surface of the sea.

3.2 NECKAR HIGHWAY

3.2.1 Background

The Cyprus-registered vehicle carrier NECKAR HIGHWAY was on a regular schedule in Northern Europe between Grimsby (United Kingdom), Malmo (Sweden) and Emden (Germany). The bridge watch schedule was divided between three navigational officers, including the master. The ship had 14 crewmembers on board, all of Polish nationality.

3.2.2 Sequence of events

On 1 July at 1125 NECKAR HIGHWAY departed Malmo, Sweden, in ballast bound for Emden, Germany. The master was in command at the time of departure and was relieved by the 2nd officer at 1200. The ship was following the same voyage plan as usual and was proceeding northwards through the Sound (Oeresund) and Kattegat without any unusual experiences. The 2nd officer was relieved by the 1st officer at 1600 and the 2nd officer went to have dinner and some rest before his watch on the bridge at 2200. When the 2nd officer took over the duty on the bridge again at 2200, the ship had passed the Skaw and was in passage through the North Sea close to the Danish coast.

The 2nd officer was alone on the bridge most of the time during the night watch, while the AB, who joined him on the watch, was cleaning elsewhere on the ship and could be called for at any time. The visibility and weather was very good and the area was not considered particularly busy or difficult to navigate in and, therefore, it was not considered necessary for the AB to stay on the bridge keeping a lookout. Nothing unusual was experienced during the night and the 2nd officer carried out his normal work on the bridge, navigating and keeping a lookout.

At 2329 when the ship was situated off Hirtshals, a VHF-DSC distress call was received on NECKAR HIGHWAY. The 2nd officer acknowledged it, but did not take any further action. There had been several VHF-DSC alarms that night without any relevance for the ship. The 2nd officer thought this particular distress call was connected to a NAVTEX alert that he had received just before, which did not

apply to the area NECKAR HIGHWAY was situated in. Therefore he did not take any further notice of the distress call.

At 2345, the AB went to the bridge to prepare for being relieved. Suddenly the 2nd officer and the AB noticed a helicopter circling above them. They thought it was a shore-based drill and did not take any notice of it. Just after midnight, NECKAR HIGHWAY received a direct call on VHF channel 16 from LYRA. LYRA was passing on a call from the JRCC. The 2nd officer received the call and perceived the question from MAS to be whether they had observed a fishing vessel in distress in the area. The 2nd officer replied that he had not observed the fishing vessel, and the communication ended. The 2nd officer called the master who came to the bridge and informed him of the radio call. The ship continued its voyage towards Emden and was not contacted in regard to the fishing vessel in trouble until on 2 July at approx. 1400, when the ship was informed by the DMAIB that it was considered likely that NECKAR HIGHWAY had collided with the fishing vessel ORION.

3.3 Investigation of ORION and NECKAR HIGHWAY

3.3.1 Investigation of the wreck of ORION

On 11 July 2015 a diver inspection of ORION was carried out. The vessel was located at the same position as where the skipper was evacuated. The ship was found to be sitting on the seabed at a depth of approx. 25 m in an almost upright position leaning to port.

The wreck of ORION was photographed during the diver's investigation. Significant damage was found in two locations on the starboard side of the hull. Figures 4-6 show the indent and hull cracks on ORION's forward starboard side:

1. A significant, deep and almost penetrating scraping in the hull forward on the starboard side near the keel. A large rock on the seabed was situated nearby and was of a size that fits the scraping on the hull. The damage was most likely caused by the impact of the ship hitting the rock on the seabed.
2. A significant indent in the hull on the starboard side on the forecastle near the ship's port registration letters. In connection with the indent, an almost vertical crack in the hull was running from the gunwale and down to the middle of the ship's side where the alloy construction of the forecastle met the GRP hull (figures 4, 5, 6). From there, the crack divided in four cracks running further in the direction of the keel and horizontally along the joint between the alloy and the GRP construction of the hull. It has not been possible to identify the exact dimension of the cracks at the indent; therefore the description of the damages to the hull is based on an estimate: the vertical gaps stretched for approx. 1.5-2 metres from the gunwale towards the keel, and the horizontal gap was of a metre's length. A significant occurrence of red paint scrapings was visible on the starboard side along the indent (figure 5).



Figure 4: Hull damage on ORION
Source: DMAIB



Figure 5: Hull damage on ORION
Source: DMAIB



Figure 6: Hull damage on ORION
Source: DMAIB

Figure 7 below shows ORION's heel. The rudder was missing with only the rudder stock left. The rudder was most likely torn off by the impact of the collision. The remaining part of the rudder was bent to the port side.

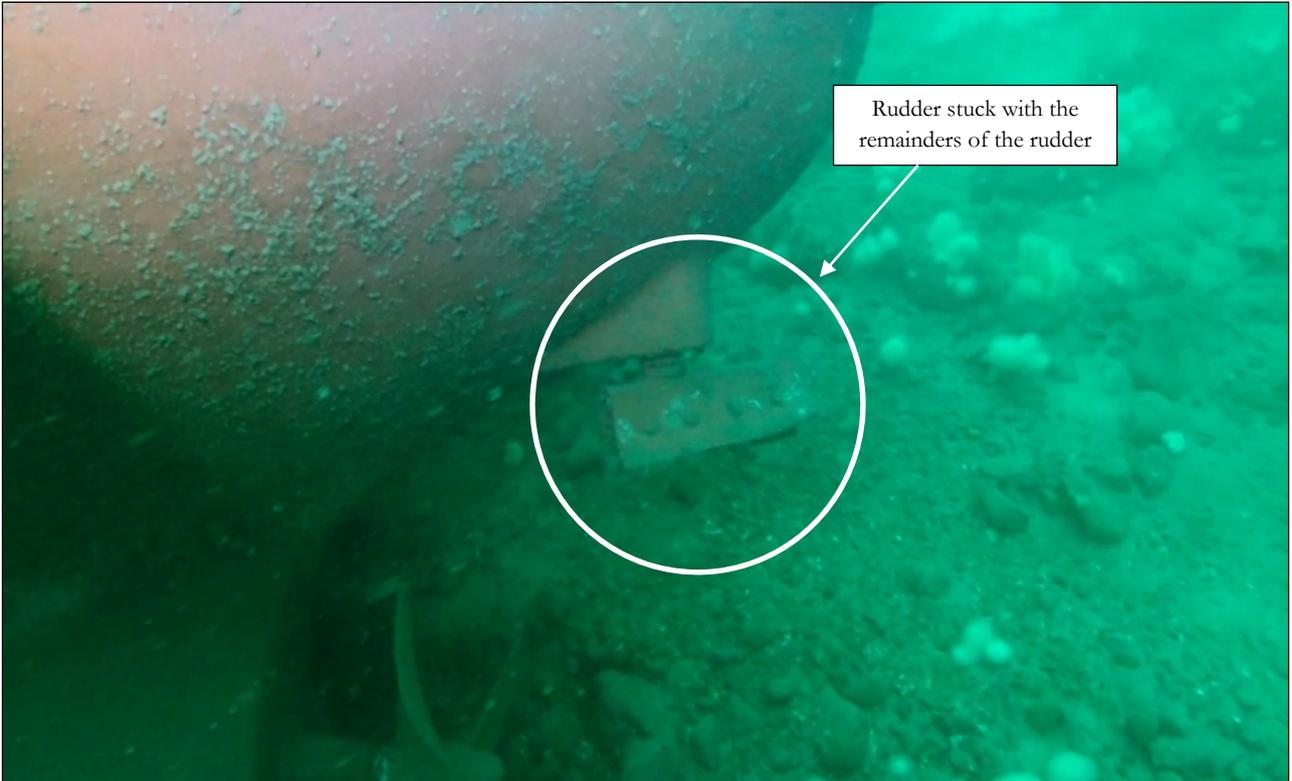


Figure 7: Scene of the accident
Source: DMAIB

Figure 9 shows the general arrangement of ORION with the DMAIB's indications of the damaged areas found on the wreck of ORION. The drawing does not fully represent the ship's arrangement at the time of the accident as the ship had been altered. No drawings of the rebuilding exist.

There were two hatches on deck leading to the ship's cargo hold: one below the forecastle and one amidships. On the day of the accident, the hatch on the forecastle was open.

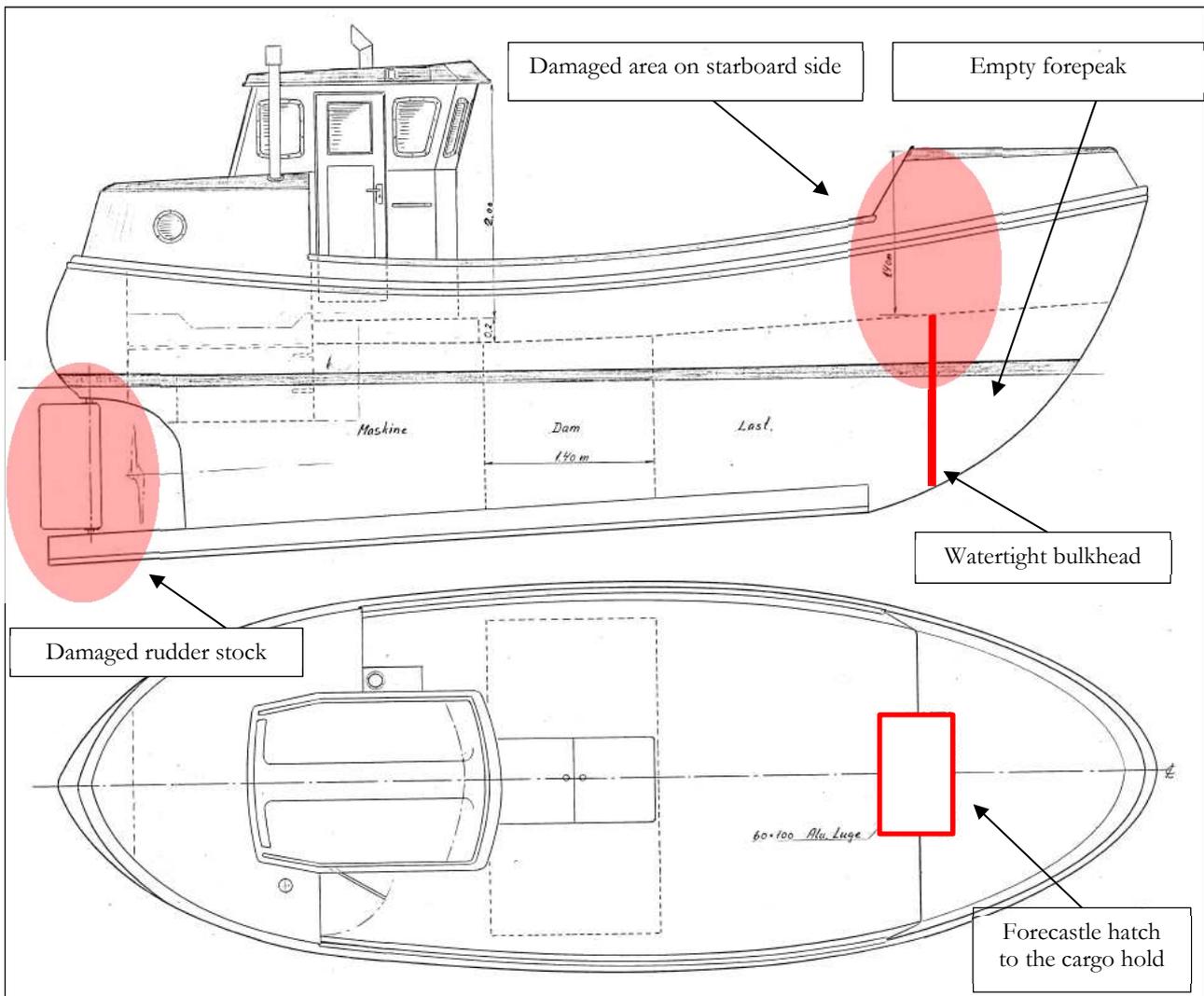


Figure 8: General arrangement of ORION before alterations
Source: DMAIB

Investigations in the wheelhouse showed that the throttle control was in a neutral position. The switches on the light panel indicated that ORION's fishing lights were on at the time of the accident (figure 9). The switch for the anchor lights ("ANKER-SIG") had two modes: 1) Pointing up: the anchor lights were displayed, 2) Pointing to the right: fishing lights were on. No day signal was displayed in the ship's mast. The lights were turned off by turning the button to the left.

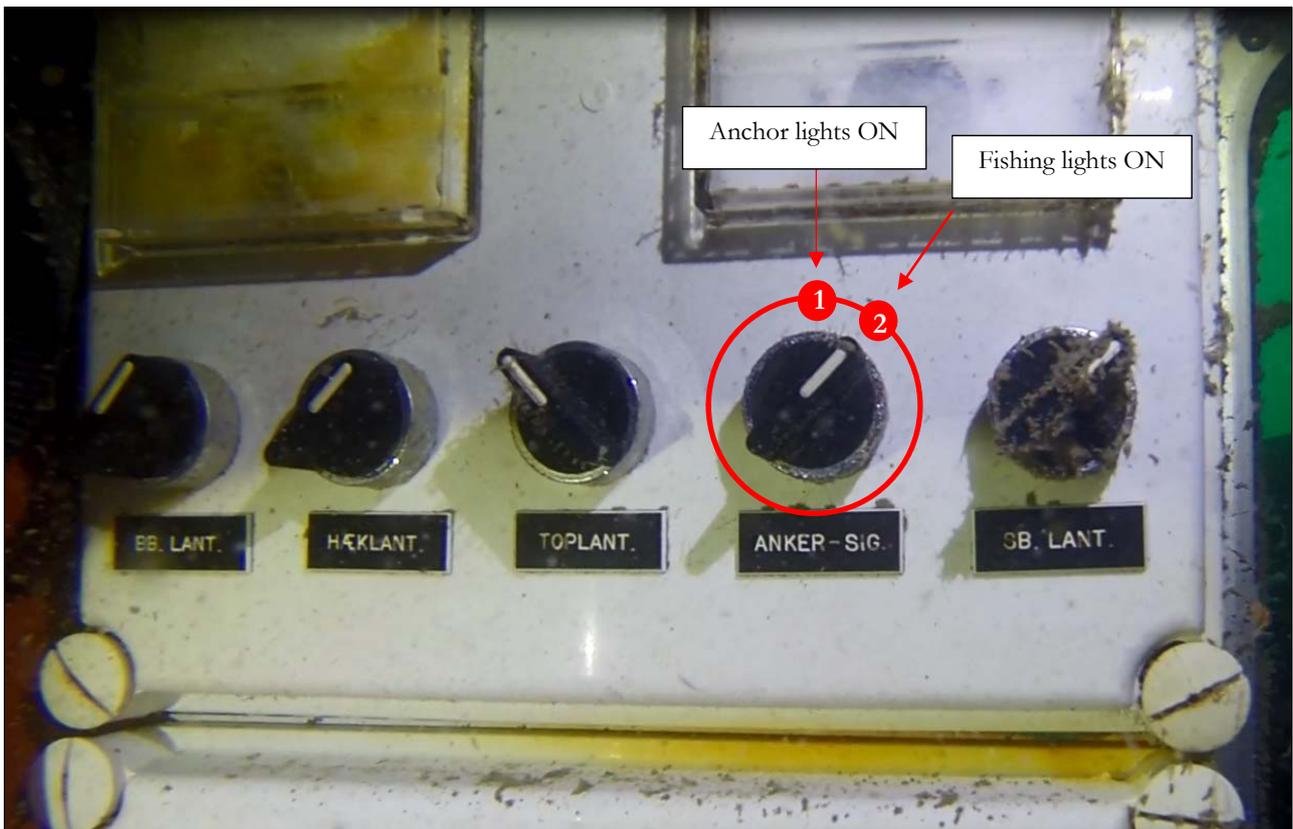


Figure 9: Light panel on ORION
Source: DMAIB

The radar scanner in the mast was found damaged, but it is uncertain whether the damage was caused by the impact of the collision or during the foundering.

3.3.2 Investigation of NECKAR HIGHWAY

The investigation of the hull of NECKAR HIGHWAY did not reveal any damage or paint marks indicating a collision. A collision with a vessel of ORION's size and material of construction would not be expected to leave significant marks on this type of ship.

NECKAR HIGHWAY was equipped with a Rutter VDR¹ with 12 hours data recording. The data were backed up on 2 July 2015 at 1240. Technicians attempting to retrieve the information concluded that the back-up had been carried out too late and hence did not contain any data from the time of the accident. Furthermore, it was concluded that the VDR had not recorded any radar data up to the time of the accident. Therefore, the DMAIB has not been able to make use of VDR data from NECKAR HIGHWAY in the investigation of the collision.

During the investigation, the DMAIB collected paint samples from the hull of NECKAR HIGHWAY in order to compare its material components with the red paint scrapes found on ORION.

¹ Voyage Data Recorder.

The paint samples from both ships were examined by the Danish Technological Institute by means of scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) with the purpose of determining the structure and composition. Furthermore, infrared spectroscopy (FT-IR) was used to determine the content of organic material in the paint samples.

The test results conclude that the paint samples had an identical content of extenders and binders, and that the paint samples could be of the same material. Even though no significant visible signs of collision could be identified on NECKAR HIGHWAY, the paint scrapes test result and the AIS and radar data confirm that NECKAR HIGHWAY did make contact with ORION.

3.4 The collision

3.4.1 AIS² and radar track

NECKAR HIGHWAY was equipped with AIS, and the quality of the retrieved data from the day of the accident has been deemed valid as the AIS transmissions were found to be consistent over several hours and, furthermore, they are concordant with other collected data.

ORION was not equipped with AIS, but its position and movements around the time of the accident could be determined by means of the Royal Danish Navy's radars on land. The heading of the echo trail does not necessarily represent the way the ship was heading at the time of the accident, as the ship was adrift.

It must be noted that the AIS screenshot below does not show the correct dimensions of the ship, nor where the AIS transmitter is placed on board. The scale and dimensions of the ships on the screenshots are therefore not correct and a margin of error in the representation on the screenshot below must be taken into consideration. The screenshots show NECKAR HIGHWAY's and ORION's interrelated movements in a timeframe of 1 minute and 44 seconds.

Screenshot 1 (fig. 10):

NECKAR HIGHWAY in passage on a south-westerly course at a speed of 16 knots. ORION was situated close to NECKAR HIGHWAY's expected track at one minute's distance. Though it appears that ORION was situated just outside NECKAR HIGHWAY's heading, the actual size of NECKAR HIGHWAY means that ORION was in fact drifting at a maximum of a few metres' distance from NECKAR HIGHWAY's expected track.

² Automatic Identification System.

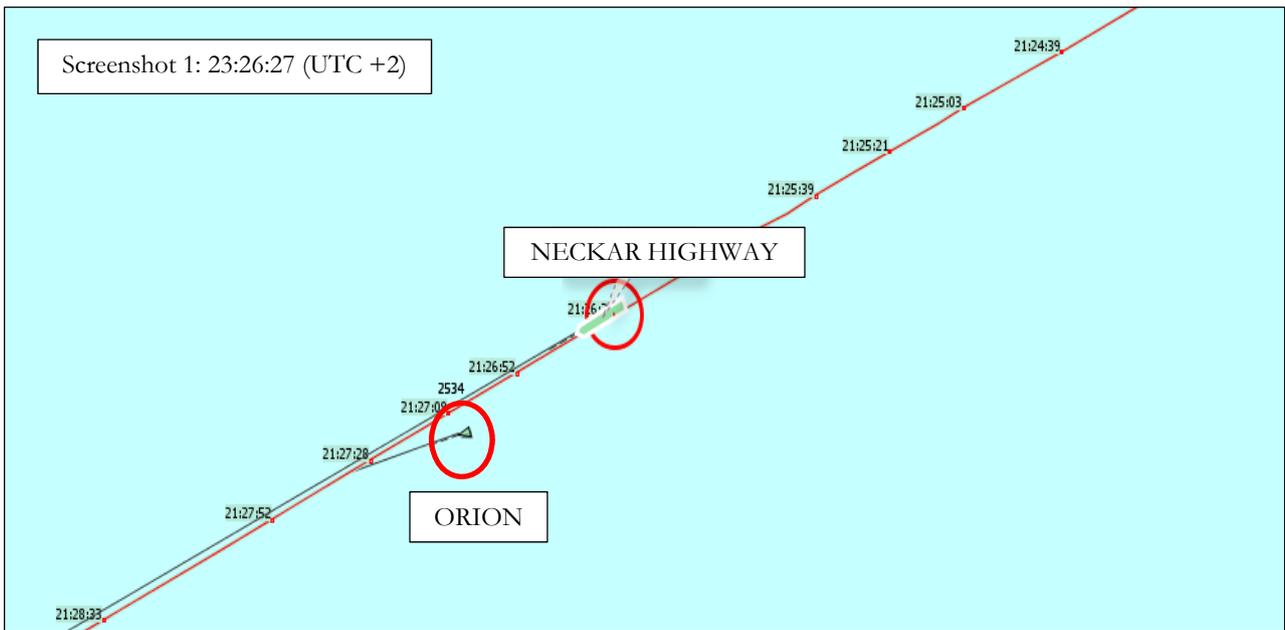


Figure 10: NECKAR HIGHWAY's AIS and radar echo of ORION
Source: DMAIB

Screenshot 2 (fig. 11):

NECKAR HIGHWAY passed ORION at 23:27. Once again, the inaccurate representation of the ships' dimensions must be taken into consideration. Although it appears that NECKAR HIGHWAY passed ORION at some distance, the screenshot might actually represent a zero distance. NECKAR HIGHWAY's course and speed was unaltered while passing ORION.

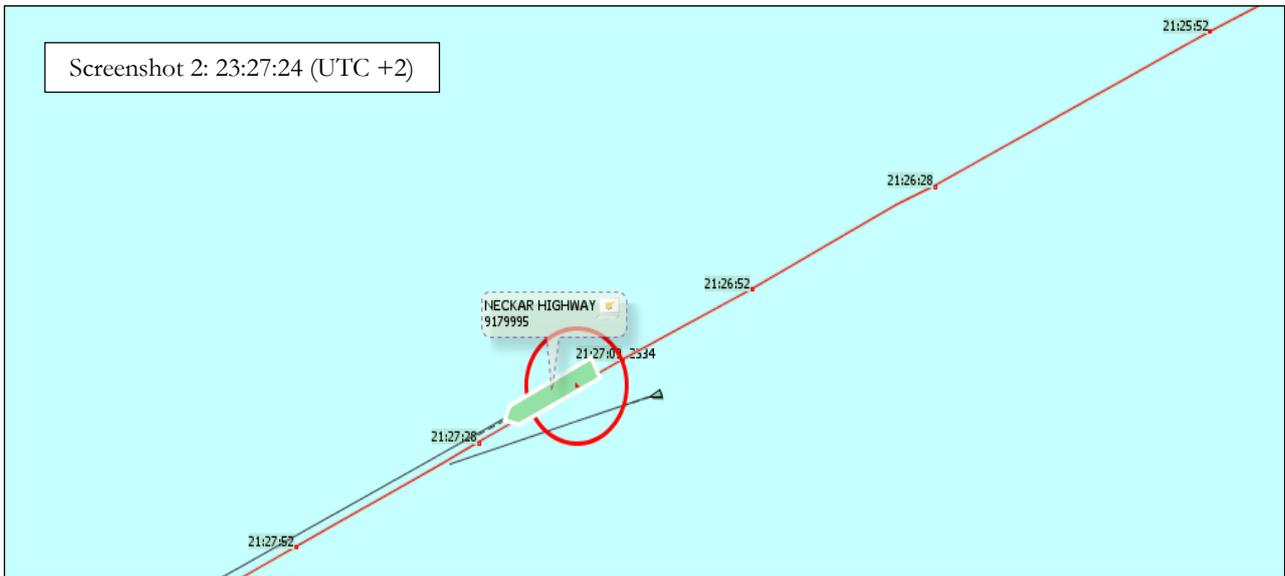


Figure 11: NECKAR HIGHWAY's AIS and radar echo of ORION
Source: DMAIB

Screenshot 3 (fig. 12):

One minute after NECKAR HIGHWAY passed ORION, ORION's echo disappeared. The echo most likely disappeared because ORION was about to sink and, as the ship was lying deep in the water, it could no longer be detected on the radar. NECKAR HIGHWAY's course and speed were still unaltered.



Figure 12: NECKAR HIGHWAY's AIS and radar echo of ORION
Source: DMAIB

3.4.2 The collision

Based on AIS data, the damages to the ships and statements from involved persons, the DMAIB has constructed a likely scenario of how the collision happened (figure 13).

NECKAR HIGHWAY was in passage at a speed of 16 knots on a south-westerly course as ORION drifted in NECKAR HIGHWAY's heading with the bow in a north-westerly direction. When NECKAR HIGHWAY reached ORION, the bow waves most likely imposed a pressure on ORION's bow causing it to start rotating to port. NECKAR HIGHWAY hit ORION with the portside bow on ORION's starboard side. ORION was pushed through the water by the impact and started to heel and trim heavily to port and forward causing half of the ship to become submerged in water. ORION kept rotating to port with a heel to port and suffered a second impact at the aft which tore off its rudder.

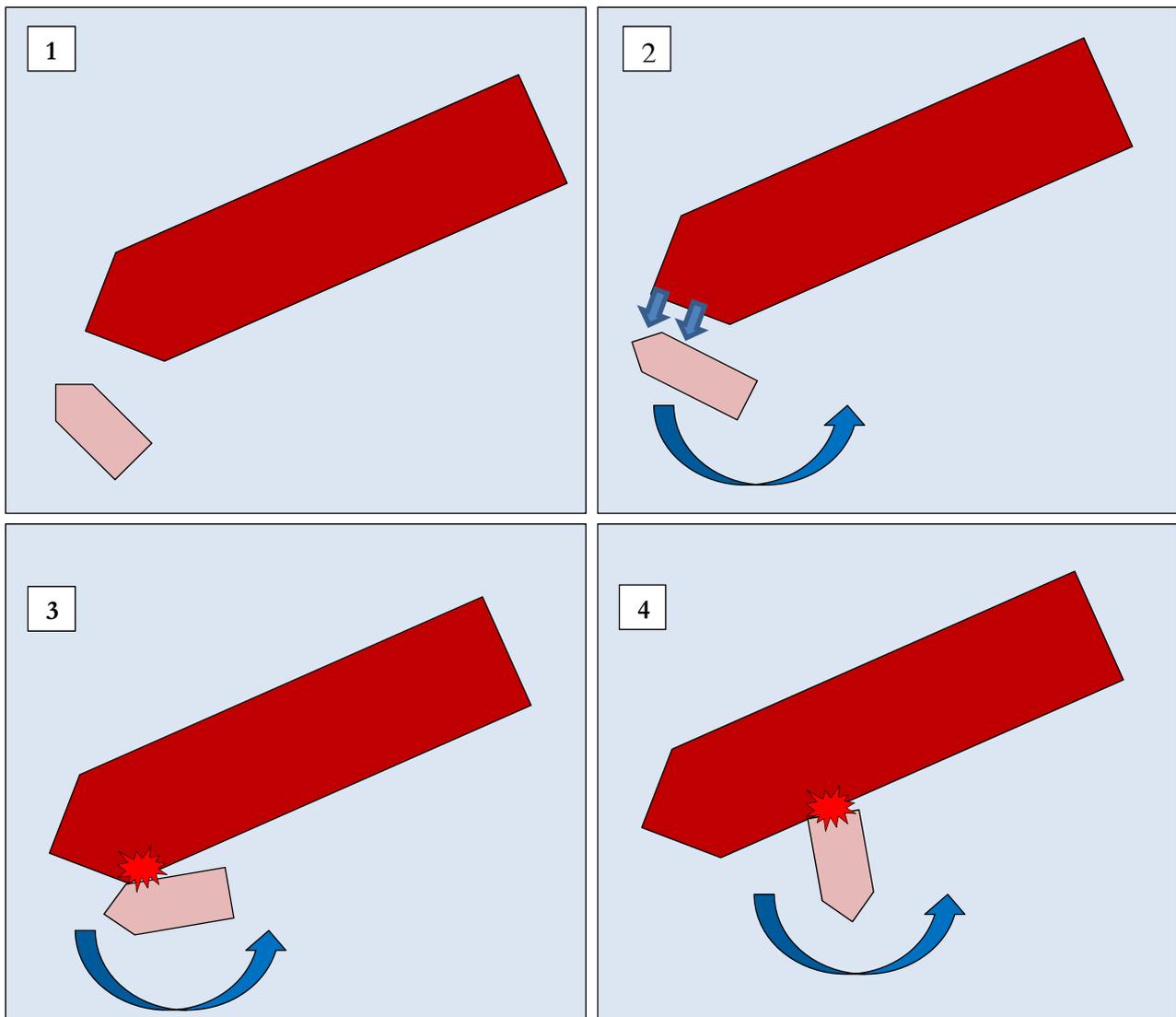


Figure 13: Sketch of reconstruction of the collision sequences
Source: DMAIB

Due to the heavily imposed heel and trim, water came in through the open cargo hold hatch in the forepeak; the cargo hold was flooded with water in such a way that ORION could regain stability. The forward end was lying deep in the water and water started to gush in through the cracks on the starboard side caused by the impact of the collision and into the empty forepeak. The flooding caused ORION to sink quickly with the bow first. The ship disappeared from the surface of the sea approximately 20 minutes after the first impact.

3.5 Navigational equipment and watchkeeping routine on ORION

ORION was equipped with radar, GPS, echo sounder and a chart plotter. The ship did not carry AIS on board. The radar was fitted on a turntable so that the skipper could see the radar screen from both inside the wheelhouse and outside on the deck. The skipper only used the radar for collision avoidance when the visibility was low. In good visibility the skipper solely relied on a visual observation of the traffic. When using the radar, the skipper did not employ the radar's ARPA³ function, meaning that

³ Automatic Radar Plotting Aid.

radar was not used for plotting targets and automatically compute the risk of collision. Used this way, the radar did not give much information about the risk of collision.

It was normal for the skipper to drift by the fishing gear and rest as he waited to haul the nets, which was normally unproblematic. He turned his fishing lights on when waiting to haul in the nets, in order for other vessels to stay clear of him, and kept an eye on the traffic situation by sporadically looking out the wheelhouse windows from his seat in the wheelhouse in the port side.

ORION's day shape was stowed at the forecastle and was never used on board as the skipper was fishing in the evening and night and therefore did not consider it relevant to carry a day shape.

3.6 Navigational equipment and watchkeeping routine on NECKAR HIGHWAY

3.6.1 Bridge arrangement and navigational equipment

The bridge on NECKAR HIGHWAY was arranged with a large centre console amidships, two wing consoles and a chart table in the port side facing aft. The watchkeeping navigator would mainly be situated at the centre console, mostly in the starboard side chair, and at the chart table. A sketch of the bridge arrangement and a view towards the centre console from the chart table on the port bridge can be seen in figures 14 and 15 below.

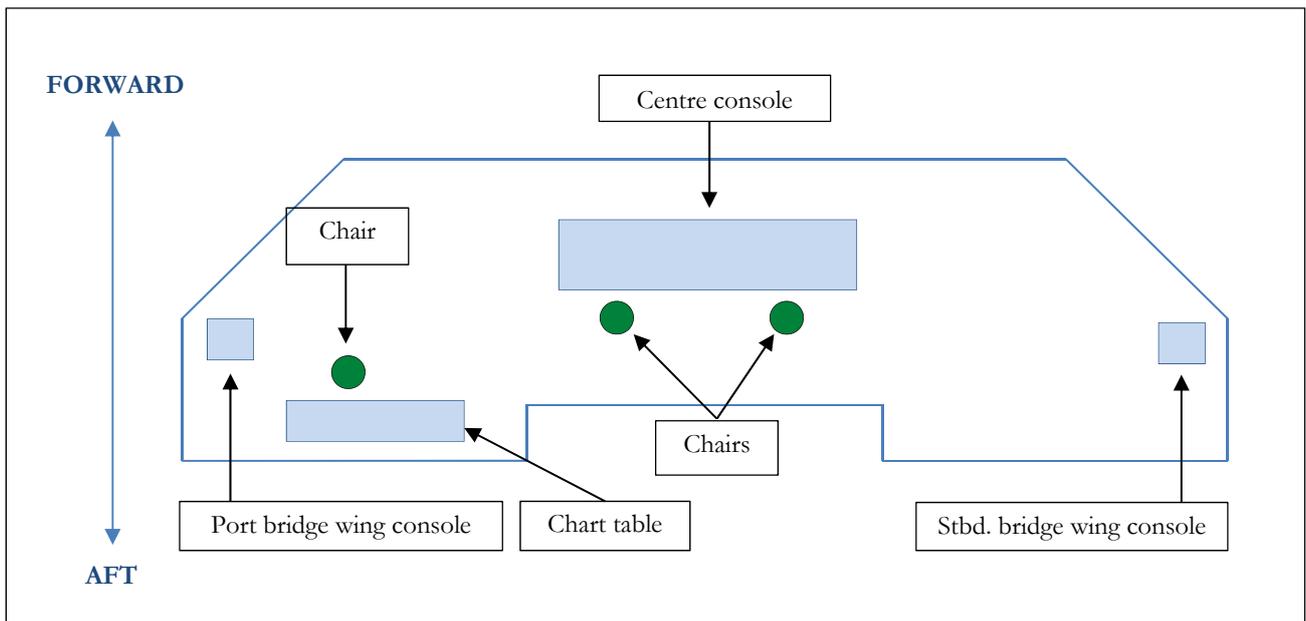


Figure 14: Sketch of the bridge arrangement on NECKAR HIGHWAY
Source: DMAIB

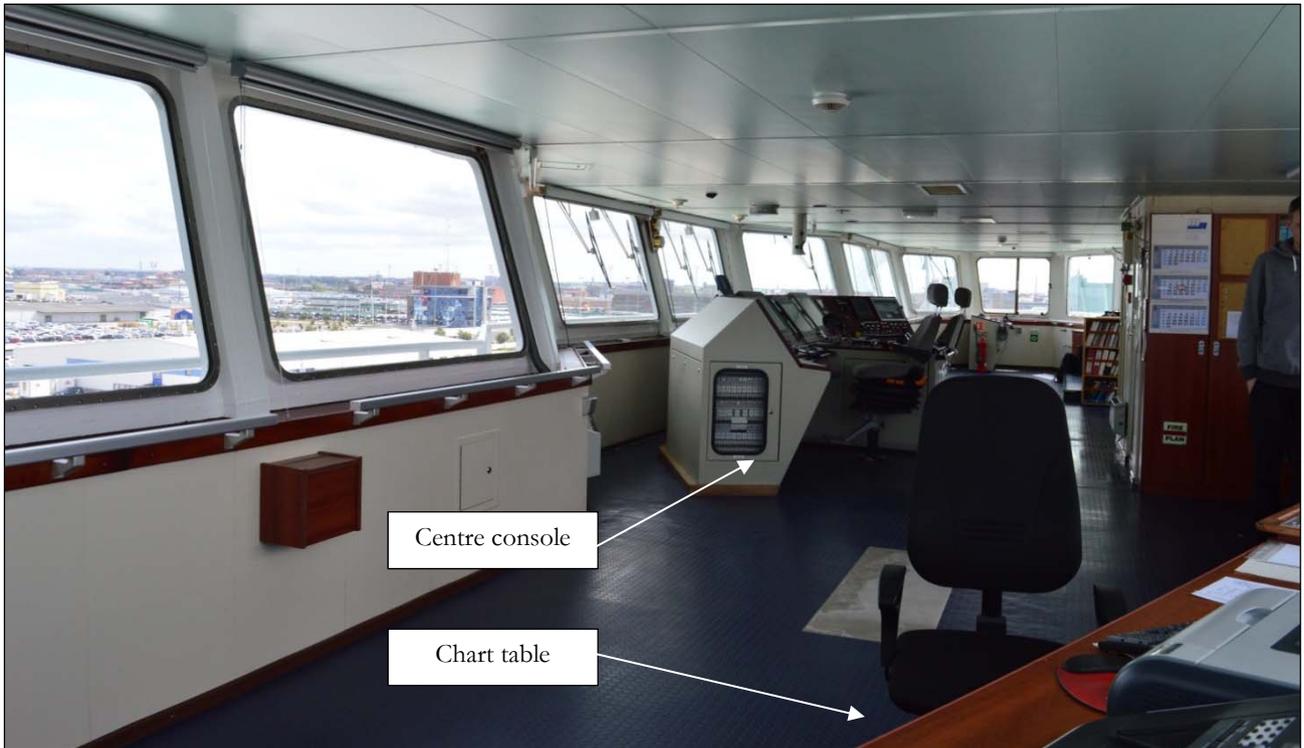


Figure 15: View of the bridge on NECKAR HIGHWAY seen from the chart table in the port bridge wing
Source: DMAIB

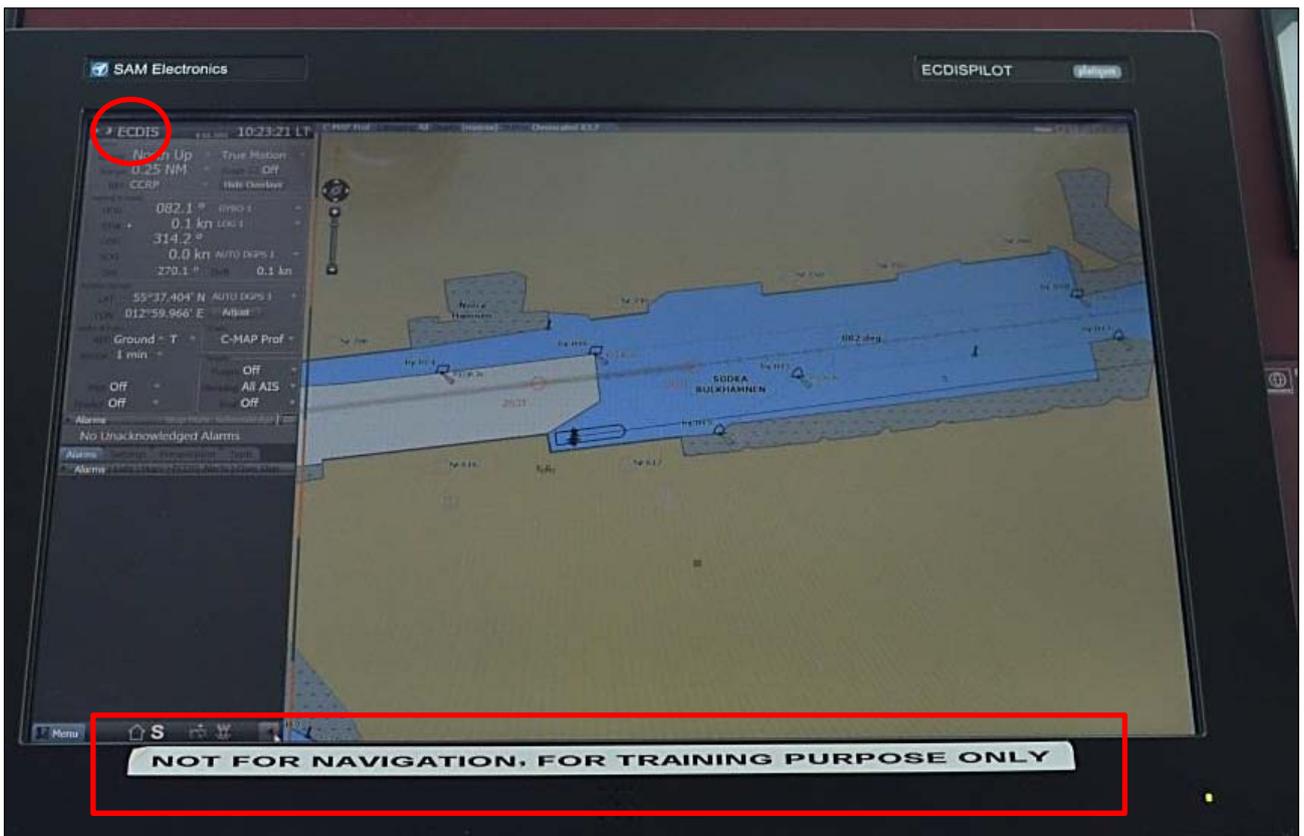


Figure 16: ECS on NECKAR HIGHWAY
Source: DMAIB

At the centre of the centre console an ECS⁴ was fitted. A label on the screen read “for training purpose only” (figure 16). Though the software indicated that the ECS was an ECDIS⁵ and therefore could be used for navigation alone, the charts were not updated frequently enough to meet the ECDIS standards, and the system did not consist of two redundant units. Therefore, the navigators were not allowed to use the ECS for navigation. The navigators considered the ECS a help in their daily work. The sparse number of positions plotted in the paper charts, even during coastal voyages, indicates that the ECS was used for navigation, and that navigation was carried out by mixing use of both charts and ECS. The sparse number of plots in the charts furthermore indicates that plotting the charts was mainly a log activity more than an actual navigational activity.

The centre console was fitted with X-band and S-band radars, usually set at a range of 6 or 12 nm. The radars were configured with an AIS overlay. This means that most of the ships in range of the radar were clearly marked on the radar with AIS identification. Small ships without AIS were displayed as small unidentified echoes (figure 17). On the S-band radar, the echo of a small fishing vessel could be so weak that it would be hard to spot on the radar.

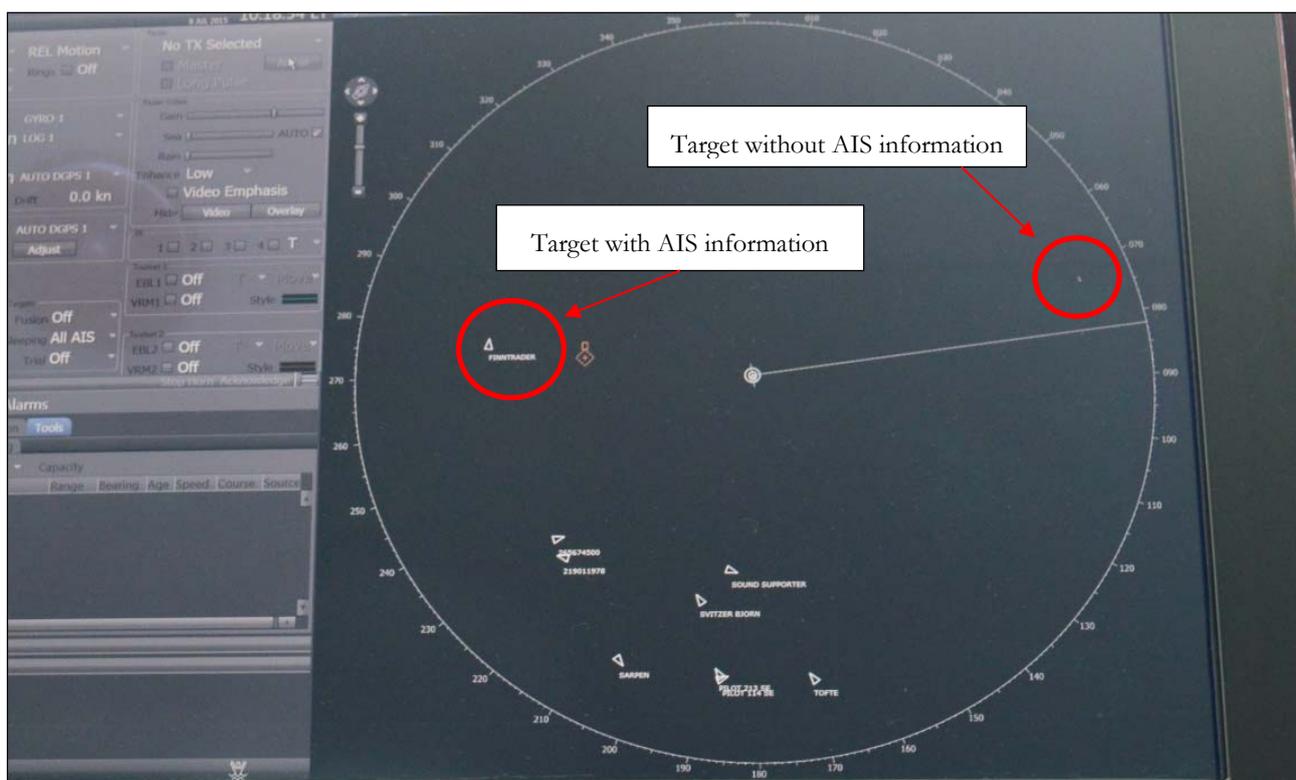


Figure 17: Radar screen with AIS overlay
Source: DMAIB

The ship’s NAVTEX⁶, two GPS charts and the log book were placed at the chart table. As the chart table was facing aft, the navigating officer had to stand with his back to the ship’s heading in order to use these as well as plotting positions in the charts. On the chart table, there was an architect lamp fitted with a regular light bulb and a dimmer.

⁴ Electronic Chart System.

⁵ Electronic Chart Display and Information System.

⁶ Navigational Telex.

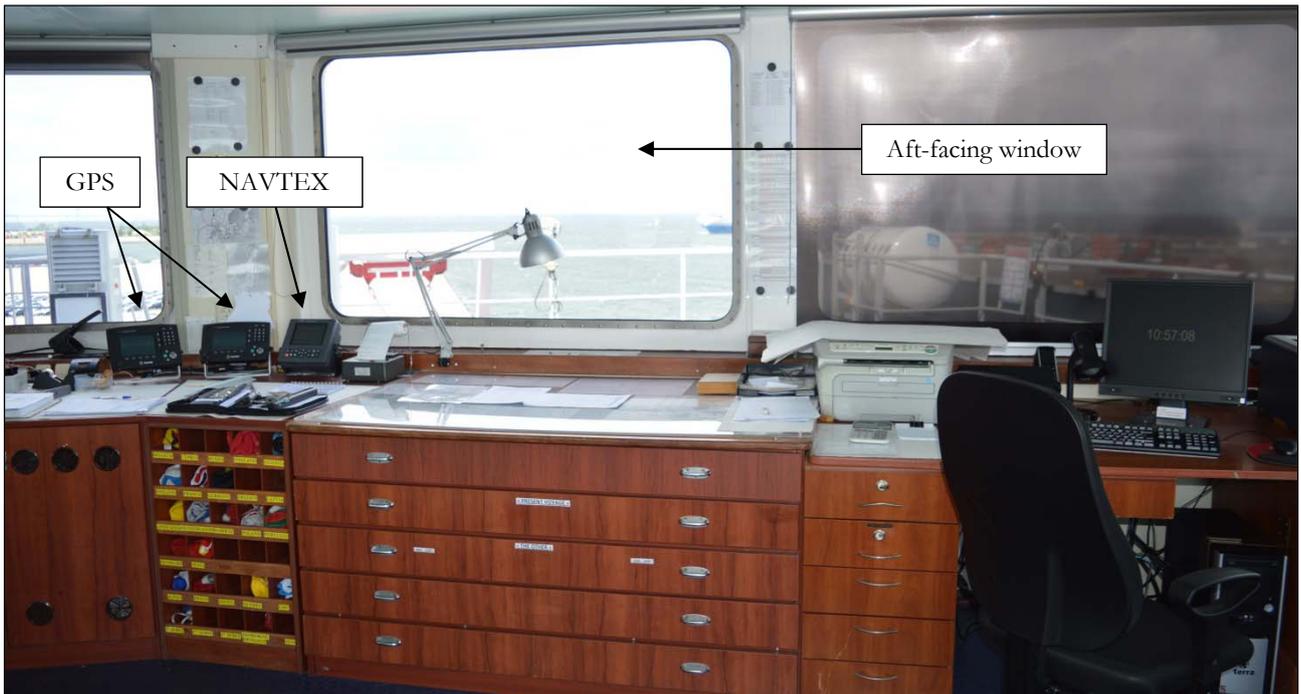


Figure 17: View of the chart table on NECKAR HIGHWAY looking aft
Source: DMAIB

3.6.2 Manning of the bridge

The bridge watch schedule was divided between three navigational officers, including the master. The master was on watch from 08-12, the chief officer from 04-08 and 16-22, and the 2nd officer from 12-16 and 22-04. The manning of the bridge also included three ABs who were rotating every four hours. The ABs were not required to stay on the bridge during their watch unless it was dark, but were on call while carrying out cleaning or going rounds checking for fire.

There was no lookout on the bridge at the time of the collision as it was not considered necessary. The weather was clear, the visibility was very good and the night was fairly light due to an almost full moon and the sun angle did not exceed the limits of twilight.

3.7 Visibility at the time of the collision

The collision occurred at night time in clear weather with good visibility on a night with 98% full moon. At 2217 the sun was setting, and at 2223 civil twilight occurred. Civil twilight is the period when the sun is 0-6° below the horizon. During civil twilight, the sky is illuminated and it is bright enough for outdoor activities without additional lighting, and the moon and some stars may be visible.

At 2334 the sun angle went below 6° and nautical twilight occurred. At this stage, it is too dark for outdoor activities without additional lighting, the stars will be visible in clear weather and the horizon will still be visible.

The collision between NECKAR HIGHWAY and ORION happened just at the transition from civil twilight to nautical twilight. During nautical twilight, it can be more difficult to spot a ship at sea as the darkness blurs the outline of the ship, but it will be too light for the ship's lights to be clearly visible.

3.8 COLREG

At the time of the accident, ORION was a vessel engaged in fishing other than trawling. Lights were exhibited on ORION according to Rule 26 (c, i & iii). NECKAR HIGHWAY was a power-driven vessel underway. Lights were exhibited on NECKAR HIGHWAY according to Rule 23 (a).

ORION and NECKAR HIGHWAY were vessels of different categories. Neither rules 9, 10 and 13 applied to the situation that the two vessels found themselves in at the time of the accident. Therefore, according to Rule 18 (a, iii) in COLREG, NECKAR HIGHWAY was the give-way vessel, required to keep out of the way of ORION, which was the stand-on vessel.

According to Rule 17 (b), ORION was required to take action to best avoid a collision.

Neither the skipper on ORION nor the watchkeeping navigator on NECKAR HIGHWAY was aware of the risk of collision until it became unavoidable. In that context, neither the skipper on ORION nor the watchkeeping navigator on NECKAR HIGHWAY adhered to Rule 5 about keeping proper lookout. Therefore, neither ship complied with the collision avoidance provisions of COLREG.

ORION did not adhere to Rule 26 (e) about fishing lights and shapes as fishing lights were exhibited at the time of the accident though the ship was not engaged in fishing, but was adrift near the fishing gear.

4. ANALYSIS

4.1 The collision

NECKAR HIGHWAY collided with ORION at a speed of 16 knots at a heading almost at a right angle on ORION's starboard side. The ship hit ORION with the bow, but the water pressure from the bow made ORION rotate causing NECKAR HIGHWAY to hit ORION at a smaller angle and push it through the water. The reduction of the angle of the collision resulted in a less forceful impact that reduced the speed of the foundering in proportion to the damage that a right angle impact would have imposed. This left the skipper on ORION with enough time to don a lifejacket, press the DSC distress button and leave the ship.

The liferaft on ORION was placed on the ship's fore part in the opposite end of the wheelhouse. The loss of stability quickly made it impossible for the skipper to evacuate the ship and reach the liferaft without having to enter the water. ORION foundered in close proximity to the coast and a coast rescue station and in very good weather during summertime. Therefore he was not exposed to significant heat loss from being in the water. In different circumstances with colder water, higher waves, a faster loss of stability and/or with a longer distance from the coast, it can be crucial to be able to enter the liferaft directly from the ship.

Prior to the collision, neither of the ships was aware of the other ship's presence and the risk of collision. The skipper on ORION became aware of the other ship's presence at the impact of the collision, while the crew on NECKAR HIGHWAY did not detect the impact of the collision and hence did not become aware of the situation or the presence of ORION. The VHF-DSC calls were ignored as there had been several calls without relevance prior to ORION's distress call, and therefore the 2nd officer assumed that this was without relevance, too.

That neither the navigational officer on NECKAR HIGHWAY nor the skipper on ORION was aware of the risk of collision or even the presence of the other ship questions the circumstances of the watchkeeping on both ships. Therefore, this will be the main theme of the DMAIB's analysis. The fact that neither of the ships adhered to COLREG's rule 5 about proper lookout is a factual circumstance that does not in itself provide an explanation of why the collision occurred. Understanding why there was a lack of knowledge about the other ship's presence and thereby a risk of collision is essential for the explanation of the collision.

Nothing unusual happened or was experienced on neither of the ships at the time of the accident. On both ships normal work was carried out as per usual routines. Hence, the collision did not happen as a result of extraordinary events on both ships, but is to be seen as a statistically rare coincidence of two ships being at the same place at the same time in open sea, which uncovered problems of watchkeeping on both ships.

4.2 Watchkeeping

4.2.1 ORION

The skipper on ORION spent the 2 hours' waiting time between setting and hauling his gillnets resting in the wheelhouse. The vessel was adrift near the fishing gear, and the skipper kept an eye on the traffic by sporadically looking out the wheelhouse windows from his seat in order to avoid collision and ensure that other vessels would not cause damage to his buoy. Ships approaching at relatively high speed in blind angles could thereby be overlooked.

The skipper had the fishing lights turned on while drifting, although he was not engaged in fishing at the time. It is likely that he perceived drifting by the fishing gear as fishing and therefore was exhibiting his fishing lights. Having the fishing light turned on could have resulted in less attention to the watchkeeping because other vessels ought to give way to ORION.

The fact that the skipper on board ORION did not see NECKAR HIGHWAY is explained by a combination of factors: The limited visibility from the port side seat in the wheelhouse, that the radar was only used for observation of collision avoidance in bad weather, and that NECKAR HIGHWAY was approaching at a relatively high speed.

Watchkeeping on one-man operated fishing vessels is a well-known problematic to the DMAIB. It is impossible to keep a constant lookout on one-man operated fishing ships because the skipper is preoccupied with handling the fishing gear, sorting and cleaning the catch or needs to rest. Furthermore, while working on deck or being in the wheelhouse, there will be blind angles hindering an effective lookout.

4.2.2 *NECKAR HIGHWAY*

The crewmembers on *NECKAR HIGHWAY* did not experience anything unusual at the time of the accident and cannot provide an explanation of what happened during the collision, and since the VDR data were not saved, the DMAIB has no data from the ship that can reconstruct the events on the bridge. The fact that the ship maintained its speed and course before, during and after the collision supports the fact that the crew on *NECKAR HIGHWAY* was unaware of the presence of *ORION*, the risk of collision, as well as the occurrence of the collision.

DMAIB's observations of several possible factors on the bridge can, however, together or alone form an explanation of how and why the watchkeeping officer on *NECKAR HIGHWAY* could overlook a small fishing vessel like *ORION*, while carrying out normal navigational duties:

The radar on the conning station was configured with an AIS overlay. It is possible that the navigational officer relied on the AIS overlay or overlooked the unidentified, small echo of *ORION* due to a cognitive fixation on the target clearly marked on the radar with AIS identification. Cognitive fixation means that the attention is drawn towards specific types of information creating an unintentional blindness to other types of information at hand. Furthermore, if the S-band radar was used, *ORION*'s echo would have been very difficult to spot on the radar screen. Because the watchkeeping navigator did not see and plot *ORION* as a target on the radar, he did not realize that *ORION* was lying in the heading of *NECKAR HIGHWAY*. If he did not observe *ORION* on the radar, he needed to spot it visually.

The chart board was placed a couple of metres from the centre console, and as the ship was navigated by means of paper charts, the navigational officer needed to go back and forth between these two. The logbook, NAVTEX, GPS and charts were placed at the aft-facing chart table and therefore the watchkeeping navigator had to carry out a substantial part of his work with his back to the ship's heading, which obstructed keeping a visual lookout.

The navigational officer was alone on the bridge as the watchkeeping AB was cleaning elsewhere on the ship, and it was not considered necessary for him to be there as it was twilight and not completely dark. The collision happened just as the twilight changed from civil twilight to nautical twilight, making it hard to visually spot a small fishing vessel because neither the navigational lights are clearly visible nor is the ship's structure distinctly outlined.

The difficulty of spotting a ship at twilight might have been increased due to the light from the architect lamp on the chart table. Although the architect lamp was fitted with a dimmer, it might have caused light pollution or reduced the navigational officer's night vision when going back and forth between the light at the chart table and keeping a lookout through the bridge windows.

The configuration of the radar, the shift between civil and nautical twilight at the time of the accident, the arrangement of the bridge and the work schedule on board made the circumstances for spotting *ORION* challenging and, therefore, it was possible to overlook the fishing vessel.

5. CONCLUSIONS

The collision between the vehicle carrier NECKAR HIGHWAY and the fishing ship ORION happened as the ships came on collision course without being aware of each other's presence. On both ships it was possible to overlook the other vessel due to a combination of factors that lead to an ineffective lookout.

On ORION the skipper was having a break and therefore did not keep a constant lookout and furthermore did not use the radar's ARPA function to plot vessels nearby and therefore was not warned about the risk of collision. On NECKAR HIGHWAY the AIS overlay might have created a cognitive fixation which could impair the watchkeeping navigator in plotting the vessel to calculate the risk of collision. Furthermore, the visual spotting of the fishing ship was impaired by the bridge arrangement that caused the watchkeeping navigator to have his back against the ship's heading when working at the chart table and by the lack of a watchman on the bridge due to the arrangement of the AB's other tasks on board.

The number of fishing ships equipped with AIS has increased dramatically in recent years to such an extent that most Danish fishing ships can be identified by AIS. Therefore, a fishing vessel without AIS has become a rarity and these ships become more exposed to collision. The extended use of AIS means that ships without AIS are more easily overlooked on the navigational equipment, as navigators tend to rely on the display of AIS data or become impaired by a cognitive fixation, which furthermore can be worsened by a weaker visual representation of the unidentified vessels on the instruments.

ORION exhibited fishing lights inexpediently, though it was not engaged in fishing at the time of the accident. This did not affect the outcome of the accident, but could point to the problematic on one-man operated fishing vessels with keeping a constant lookout, as other vessels are obliged to give way, and therefore it could be used as a means of easing the lookout in rest periods or while working on deck.

The DMAIB has previously investigated collisions⁷ between one-man operated fishing vessels and larger ships. While there were other explanations for the ineffective lookout on the larger ships, the DMAIB has identified similarities when it comes to why one-man operated fishing vessels lack effective lookout, which concludes that it is impossible to keep a constant lookout while working on deck or resting, which are both necessary activities on board a fishing ship. As the economy and design of small fishing vessels does not allow for additional manning, the lack of effective lookout on one-man operated ships does not point to a question of on-board neglect, but an immanent lack of resources on these types of ships.

⁷ DMAIB (2015), *RIG and INGER MARIE – Collision on 10 July 2014*. Available in English at: <http://www.dmaib.dk/Ulykkesrapporter/RIG%20and%20INGER%20MARIE%20-%20Collision%20on%2010%20July%202014.pdf>

DMAIB (2011), *RIG and INGER MARIE – Collision on 18 January 2011*. Available in Danish at: http://www.dmaib.dk/Ulykkesrapporter/N_A_HANSEN_VINGA_180120112_FISK_2.pdf