M2014-01

M/V SYLT (AG), ground touching off Rauma on 11 October 2014

Translation of the original Finnish language report

The purpose of the investigation of accidents is to improve safety and prevent future accidents. It is not the purpose of the investigation or the investigation report to apportion blame or to assign responsibility. Use of the report for reasons other than improvement of safety should be avoided.

Onnettomuustutkintakeskus

Olycksutredningscentralen

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TIIVISTELMÄ

Konttialus M/V SYLT sai pohjakosketuksen 11.10.2014 klo 2.14 ajauduttuaan Rauman Rithniemen väylällä Santakarin kohdalla väylän louhittuun kallioreunaan.

Alus lähti luotsin avustamana Raumalta kohti Hampuria. Rihtniemennokan mutkassa luotsi käänsi alusta automaattiohjauksella, mutta käännös jäi vajaaksi. Alus ajautui väyläviivan eteläpuolelle, jolloin luotsi siirtyi käsiohjaukseen ja ryhtyi kääntämään alusta oikealle. Luotsi yritti pysäyttää käännöksen käyttämällä vastaruoria yli vasempaan. Käännös ei pysähtynyt, jolloin päällikkö otti luotsin pyynnöstä ohjauksen itselleen ja lisäsi pääkonetehoa parantaakseen peräsimen ohjailutehoa. Alus alkoi kääntyä vasempaan, mutta ajautui oikea kylki edellä väylän pohjoisenpuoleiseen louhittuun kallioreunaan.

Aluksen palattua takaisin Rauman satamaan sukellusryhmä tarkasti aluksen vauriot. Sukelluksessa havaittiin, että aluksen Becker-tyyppisen peräsimen ohjaustehoa parantava läppä puuttui kokonaan ja läpän irtoamisesta aiheutuneiden repeämien metallipinnat olivat kiiltäviä. Sukeltajien arvion mukaan vauriot olivat korkeintaan muutaman päivän ikäisiä. Puuttuvaa läppää etsittiin väyläalueen pohjasta, ilman tulosta. Koska aluksen peräsimessä ei ollut pohjakosketusvaurioita, oli peräsin erittäin suurella todennäköisyydellä vaurioitunut ennen pohjakosketusta.

Peräsimen vaurio on vaikuttanut laivan ohjailuun. Nykyaikainen adaptiivinen automaattiohjaus sopeutuu eri olosuhteisiin ja voi säilyttää suorituskykynsä vaihtelevissa tilanteissa. Tämä saattaa jättää peräsinvaurion vaikutuksen piileväksi. Aluksen ohjailuominaisuudet eivät kuitenkaan vastanneet niitä tietoja, jotka luotsi sai ennen satamasta lähtöä nähtäväkseen. Se on ollut vaikuttamassa aluksen ajautumiseen väylän reunaan ja edelleen pohjakosketukseen.

Onnettomuustutkintakeskus antaa varustamoille suositukset alusten luotsauksenaikaisesta automaattiohjauksen käytön ohjeistuksesta sekä hätätilanteiden radioliikenteen ohjeistuksesta. Liikenteen turvallisuusvirastolle Trafille annetaan suositus selvittää läppäperäsinten vikaantumisen tilastollista todennäköisyyttä ja ryhtyä tarvittaessa toimenpiteisiin kansainvälisen ohjeistuksen tarkentamiseksi peräsinmekanismin toimintavarmuuden parantamiseksi.

SAMMANDRAG

Containerfartyget M/V SYLT fick en bottenkänning 11.10.2014, klockan 02.14 efter att det under en aningen utdragen sväng drivit mot farledens sprängda klippkant vid Santakari i Rihtniemi farled utanför Raumo.

Fartyget lämnade Raumo under lots för en resa till Hamburg, Tyskland. Vid kröken vid Rihtniemi udde svängde lotsen fartyget med autopiloten, men svängen blev otillräcklig. Fartyget hamnade på den södra sidan av farledslinjen varvid lotsen gick över till handroder och började svänga fartyget till styrbord. Lotsen försökte stoppa svängen med motroder, dikt babord. Då svängen inte minskade tog befälhavaren på lotsens order handroder och ökade samtidigt på maskineffekten för att förbättra rodrets styreffekt. Fartyget började svänga till babord men drev med styrbords-sida före mot den norra, klippiga, kanten av farleden.

En grupp dykare granskade fartyget efter att det kommit tillbaka till Raumo hamn. Under dykningen konstaterades att en klaff på Becker rodret saknades. Klaffen förbättrar styreffekten. Metallytorna som uppstått då klaffen brutits loss var blanka. Enligt dykarnas bedömning var skadorna högst några dagar gamla. Man letade efter den saknade klaffen på farledsområdets botten men utan resultat. Eftersom fartygets roder inte hade några skador från bottenkänningen hade det med mycket stor sannolikhet skadats redan innan bottenkänningen.

Skadan på rodret har påverkat fartygets manöverförmåga. Moderna adaptiva autopiloter anpassar sig till olika förhållanden och kan bibehålla sin prestanda under varierande omständigheter. Detta kan resultera i att effekten av en roderskada förblir dold. Fartygets manöveregenskaper motsvarade i vilket fall som helst inte de som lotsen fick bekanta sig med innan avgång. Detta har medverkat i att fartyget drivit mot farledskanten och vidare till en bottenkänning.

Olycksutredningscentralen ger rederierna rekommendationer för hur man instruerar i användningen av autopilot under lotsning, samt i nödradiotrafik. Trafiksäkerhetsverket Trafi rekommenderas att utreda den statistiska sannolikheten för felfunktioner i klaffroder samt att vid behov vidta åtgärder för att precisera internationella instruktioner för säkerställandet av rodermekanismens funktionssäkerhet.

SUMMARY

The container vessel M/V SYLT suffered a ground touching on 11 October 2014 at 02:14. She touched ground when drifting into the excavated rocky edge of the channel after a prolonged turn at Santakari in the Rauma Rihtniemi channel.

The vessel departed from Rauma, Finland, assisted by a pilot and bound for Hamburg, Germany. In the Rihtniemennokka bend the pilot turned the vessel using the autopilot, but the turn fell short. The vessel drifted to the south side of the fairway centre line, after which the pilot switched to manual steering and started to turn the vessel to starboard. The pilot tried to stop the turn by giving counter-rudder hard-a-port. As the turn did not stop, the master took over the manual steering on the pilot's request and increased main engine power in order to improve the effect of the rudder. The vessel started to turn to port, but drifted with her starboard side first into the edge of the cliffs north of the channel.

After the vessel had returned to the Port of Rauma, a group of divers checked the damages. During the dive it was discovered that the flap of the Becker-type rudder was missing. The flap improves manoeuvrability. The metallic surfaces of the tears caused by the flap falling off were shiny. According to the divers' assessment, the damages were not older than a couple of days at the most. The missing flap was searched for in the bottom of the fairway area but with no result. Because there were no damages caused by the ground touching on the vessel's rudder, it had in all likelihood been damaged before the ground touching.

The damage in the rudder had affected the manoeuvring of the vessel. Modern adaptive automatic steering systems adjust to different conditions and may maintain their performance in varying situations. As a result of this, the effect of rudder damage may remain hidden. The vessel's manoeuvring characteristics did, regardless of the last mentioned, not correspond with

the information the pilot had received before departure. This has contributed to the vessel drifting to the edge of the channel and further to touching ground.

The Safety Investigation Authority issues recommendations to shipping companies on instructions to be given on the use of automatic steering systems during pilotage and on instructions on radio communication in emergency situations. A recommendation is also issued to the Finnish Transport Safety Agency (Trafi) to look into the statistical probability of malfunction of flap rudders and, if needed, to take appropriate measures to amend the international instructions for improving the reliability of the rudder mechanism.

LIST OF CONTENTS

ABBREVIATIONS

ECDIS	Electronic Chart Display and Information System
GT	Gross tonnage
IMDG	International Maritime Dangerous Goods (guidelines to the safe transportation and shipment of dangerous goods)
IMO	International Maritime Organisation
ISM	International Safety Management Code (safety instructions by the IMO)
ISO	International Standards Organization
MIRG	Maritime Incident Response Group
MRCC	Maritime Rescue Coordination Center
SMC	Safety Management Certificate
SMS	Safety Management System
UTC	Universal Time Coordinated
VDR	Voyage Data Recorder
VHF	Very High Frequency (maritime radiotelephone)
VTS	Vessel Traffic Service

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SYNOPSIS

The Safety Investigation Authority decided, on the basis of the Safety Investigation Act (525/2011), to initiate a safety investigation on the ground touching of the M/V SYLT (AG) off Rauma on 11 October 2014.

Expert of the Safety Investigation Authority, Master of Science in Technology Jaakko **Lehtosalo** was appointed as the team leader of investigation group and other experts: Captain Jukka **Kallio** and Safety Coordinator Pia **Broumand** were appointed as investigation team members. Chief Marine Safety Investigator Risto **Haimila** was appointed as investigator-in-charge.

This investigation report describes the events before the accident, during the accident and after it. In addition, the report deals with alerting and rescue activities, and the factors leading to the accident are analysed. Safety recommendations are presented on the basis of the analysis, and implementing the recommendation may reduce the likelihood of such accidents or limit their consequences.

The objective of the investigation is to improve maritime safety and the prevention of pollution caused by ships and thus issues determining liability or apportion blame are not considered.

The time used in the investigation report is Finnish summer time (UTC+3).

This Investigation Draft Report was sent for comments to the Reederei Eckhoff GmbH & Co.KG shipping company, the Maritime Safety Authority of Antigua & Barbuda, Classification Society DNV GL, the Finnish Safety Transport Agency, the Finnish Transport Agency, the Finnpilot Pilotage Ltd, the Finnish Border Guard and the master of M/V Sylt concerned and the pilot. A summary on the received statements can be found as an appendix in the original Finnish language Investigation Report. The received statements have been taken into consideration when finalising the Investigation Report.

MA, M. Soc. Sc. Minna **Bäckman** and MA Peter **Björkroth** have translated the Investigation Report into English, and Peter Björkroth has translated the summary of the Investigation Report into Swedish.

The source material is filed at the Safety Investigation Authority.

The Investigation Report is available on the Safety Investigation Authority website www.sia.fi.

1 INFORMATION ON THE VESSEL AND CONDITIONS

1.1 Vessel

1.1.1 General information

Figure 1. M/V SYLT (Photo: Lutz Graupeter, MarineTraffic.com)

M/V SYLT is a container vessel built in 2012.

Owner and operator	Reederei Eckhoff GmbH & Co.KG
IMO number	9429273
Year of construction	2012
Shipyard	Ma Wei Shipbuilding Ltd.
Type	880-TEU container vessel
Nationality / flag	Antigua & Barbuda (AG)
Home port	Saint John's
Call sign	V2QJ8
MMSI number	305838000
Length, max.	140.70 m
Breadth	23.20 m
Depth	11.50 m
Draught, freeboard	8.70 m
Displacement 8.00	10546
Displacement 8.70	12306
Loading capacity	15250 DWT
Gross tonnage	9993
Net weight	5198
Speed	17.5 knots
Main engine	medium speed diesel Caterpillar MAK 9M43C 9000 kW
Propeller	four-bladed controllable-pitch propeller
Rudder	Becker-type rudder (Van der Velden, TIMON)
Classification	G 100 A 5 E3 Container-Ship IW BWM – MC E3 AUT “SOLAS II-2, Reg 19”

1.1.2 Manning

The manning of the vessel complied with the Minimum Safe Manning Certificate. The vessel had a crew of 14 and a pilot from Finnpilot Pilotage Ltd. on board at the time of the accident.

The master, the second officer and the pilot were on the navigating bridge when the accident took place. The master was a qualified sea captain. He had worked as an officer since 1987 and as the master of the SYLT since June 2014.

There was a regular sea watch manning in the engine room.

The Finnpilot pilot had a valid pilot licence for the fairway in question. He had worked as a pilot since 2007.

1.1.3 Navigating bridge and bridge equipment

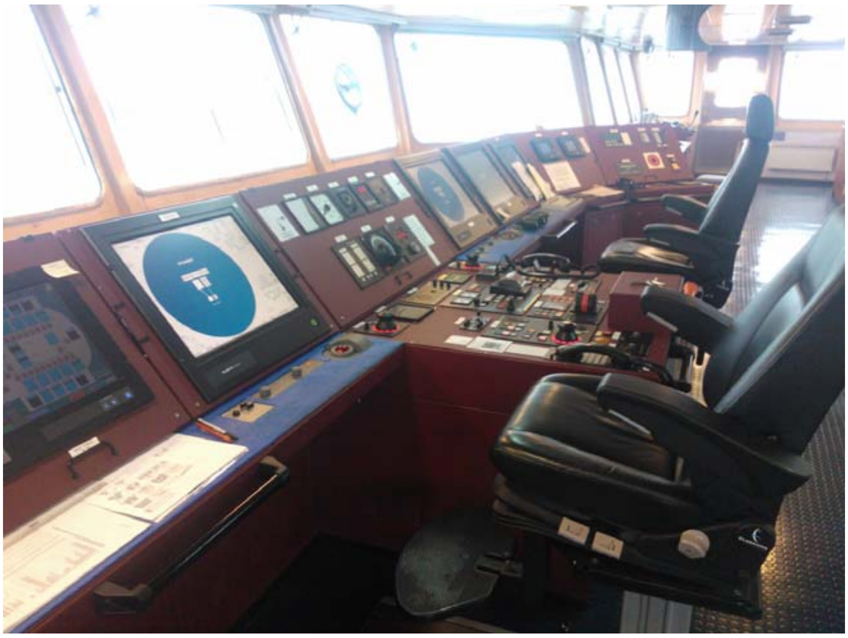

Figure 2. The vessel's navigating bridge (Photo: the SIA)

The bridge arrangements on the vessel are modern. There are two manoeuvring stations in the middle, and in addition there are consoles on the bridge wings for manoeuvring the vessel to the quay. There is no integrated navigation equipment on the bridge, but more traditional separate devices. The vessel's radars, ECDIS and steering display as well as the NautoPilot 2015 autopilot are manufactured by Raytheon-Anschütz. Other devices are control devices for the Kwant Controls main engine and Lilaas bow thruster as well as the Rolls Royce rudder control. The vessel's VDR is a IS Steinsohn VDR G4.

The vessel was only two years old. Its first docking had been planned to take place at the end of 2014. The vessel's navigational instruments were operational. A fault had been detected in the VDR device, and it was to be repaired in the next port of call.

1.1.4 Engines and the engine room

The vessel's main engine was a medium speed Caterpillar MAK 9M43C with a capacity of 9 000 kW. The propeller was a four-bladed controllable-pitch propeller.

There was one bow thruster on the vessel, and its capacity was 900 kW.

1.1.5 Rudder system

The vessel's rudder was a so-called Becker-type TIMON rudder equipped with a turning flap, manufactured by van der Velden.

Figure 3. The TIMON rudder (Photo: van der Velden Marine Systems B.V)

The operating principle of a flap rudder is to increase the manoeuvring capacity of the rudder with the help of an asymmetrical wing profile. A turning flap has been installed on the rear edge of the main rudder blade. It is hinged from its leading edge to the main rudder blade. With the help of the shaft interlinked behind the rudder stock it is possible to make the flap turn into a larger angle than the main rudder blade. When the rudder turns, it forms a curved profile together with the flap. The manoeuvring capacity of a curved profile is greater than that of a symmetrical profile. This rudder type does not require extra rudder pumps since the flap is controlled mechanically following the functioning of the rudder pump. The hinges of the flap and the turning joints of the steering rods are serviced in connection with regular dockings.

The flap of the rudder usually turns into an angle which is twice as large as that of the rudder blade. The turning ratio of m/v SYLT's rudder flap in relation to the rudder blade is not exactly known, but it is presumably close to the commonly used ratio of two. Thus the flap turns 90 degrees in relation to the keel-line when using the vessel's highest rudder angle of 45 degrees. This gives significantly more manoeuvring capacity for example when berthing. The rudder angle was limited to 35 degrees when proceeding at vessel's fairway speed.

There were two rudder pumps on m/v SYLT, and they were both running when the vessel departed from Rauma. The turning speed of the rudder, when using two rudder pumps is 12 seconds from side to side. (+/- 45 degrees). There were no entries on non-conformities in the maintenance reports or docking plans on the functioning of the rudder.

There were Rolls-Royce rudder controls on the bridge for manual steering. There were no servomotors in them, which would have followed the rudder angle orders from the activated rudder control. When one wants to activate a certain rudder control, the "request control button" next to it is pressed down and its indicator light starts to flash. After this the user must turn the rudder control to the actual angle the rudder has when the control is activated within five seconds. Otherwise the control request is ignored. There is no need to leave the control in the actual angle of the rudder. It suffices for the steering system that the order value of the control unit momentarily moves past the realised rudder angle. The control unit is activated and the indicator light for the "request control button" remains lit. The aim of the system logic is to prevent the wrong position of the control unit to be activated from starting to turn the rudder. The user must thus "fetch" the rudder by moving the control unit over the realised rudder angle. After that the unit controls the rudder.

1.1.6 Passengers and cargo

Figure 4. Deck cargo seen from the bridge at the Port of Rauma after the accident (Photo: the SIA)

There were no passengers on the SYLT.

The vessel was carrying containers, including IMDG class 8 cargo (corrosive materials). At the time of departure, the vessel was sailing at even keel and her draught was 8.30 metres.

1.2 The channel where the accident took place

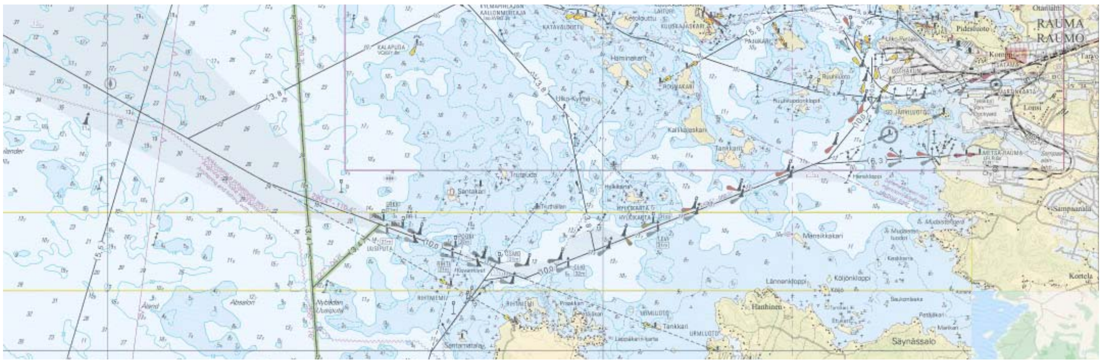

Figure 5. Rauma Rihtniemi channel (Photo: Nautics Sailmate)

Two merchant shipping channels lead to the Port of Rauma, i.e. the Rihtniemi channel and the Valkeakari channel. Seafarers usually regard the Rihtniemi channel as difficult, because part of the channel off Rihtniemi in the Kovankivet shallow has been blasted into rock. The channel is narrow and its edges are vertical.

According to the fairway card *“the outer channel to Rihtniemi is unsheltered and open to S-W-N winds. From Rihtniemi on, the channel continues as a narrow and densely marked channel, sheltered by isles, islands and mainland. Cross currents, which make the manoeuvring of large vessels more difficult, may occur when navigating the Urmluoto line in the passage of Kovankivet. Strong side winds also aggravate the side drift.”*

As to wind, it is stated that *“Max. speed of drifting wind gusts 18 m/s in daytime and 15 m/s at night”. Limits are lower for Ro-Ro ships and ships in ballast. Max. wind gusts 11 m/s for ships in ballast, larger than the design ship (L = 210 m). Drifting wind means a wind which differs from the Urmluoto line by more than 30°. Pilotage is discontinued when the wind speed exceeds 20 m/s.”*

The channel was excavated in 1970 and deepened in 1990. The Finnish Transport Agency is planning on the alteration of the channel, and the works are expected to be finalised in 2017. The plans include deepening the 11.5-metre-draught channel, in which case the safe clearance depth in the outer part of the channel would be 13 metres and 12.5. metres in the inner part. In addition, the intention is to bevel the vertical walls of the channel sections excavated in rock. This is expected to broaden the channel and also to decrease the bank effect. Bank effect is generated when a vessel moves close to a channel-, or other wall. The water flow between the vessel’s hull and the wall accelerates and thus generates negative pressure (“suction”), which sucks the vessel towards the wall. The intensity of the phenomenon depends on e.g. the size, form and speed of the vessel and on her distance from the wall and on the shape of the wall. A similar negative pressure is formed between two vessels when they pass or meet each other.

On the day of the accident, the navigational aids in the Rihtniemi channel were operational.

1.3 VTS and control systems

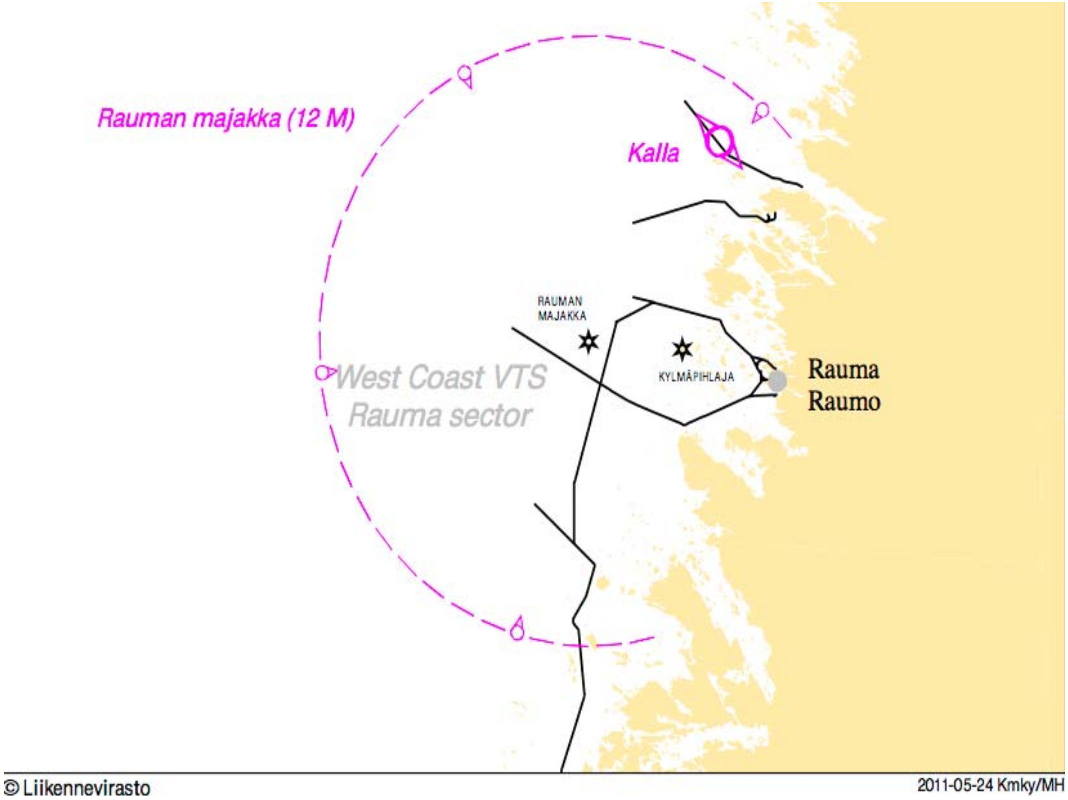

Figure 6. Rauma VTS area (Photo: the Finnish Transport Agency)

The West Coast VTS area covers the coast of the Sea of Bothnia off the towns of Rauma and Pori. The VTS area is divided into two sectors (Rauma VTS sector and Pori VTS sector).

According to the Finnish Transport Agency "*vessels with an overall length of 24 metres or more are obliged to participate in the vessel traffic services by reporting to West Coast VTS, by listening to VHF channel 9 and by observing the provisions concerning traffic in the VTS area".*

The master must notify the VTS authority of any incidents or accidents in the VTS area or its vicinity which affect the vessel's safety and of any incidents or accidents endangering the environment.

1.4 Weather conditions

According to the Rauma Kylmäpihlaja gauging station of the Finnish Meteorological Institute the wind speed was 12 m/s and the wind direction was from southwest in the early hours of Saturday 11 October 2014. The sea was moderate and the visibility was good.

When the vessel returned to Rauma after the ground touching, the wind started to veer to west. The wind speed decreased slightly.

2 EVENTS AND INVESTIGATIONS

2.1 Accident voyage

2.1.1 Departure from the port

The description of the accident voyage is based on what those present on the navigation bridge have told, on official documents drawn on the incident and on the traffic recording made by the VTS centre. There was no recoding available from the vessel's VDR system. The missing recording is discussed in more detail in section 2.4.2 of this Investigation Report.

The SYLT was departing from Rauma along the Rihtniemi channel to Hamburg on 11 October 2014. There was no other traffic in the channel. The Pilot boarded the vessel and the master requested tugboat APOLLON to assist with the departure. The pilot and the master discussed the information on the Pilot Card and the preparations for the voyage. The officer of the watch completed the departure check-list.

The vessel was let go from the quay at 1:30 and the tug towed her, aft first, to the turning place. In addition to the master and pilot, the second officer was present on the bridge. The pilot gave instructions to the tugboat and the master manoeuvred the vessel. At the turning point the tugboat let go of the towing line and headed north towards Mäntyluoto in Pori. The SYLT continued southwards to the Rihtniemi channel. The pilot began steering the vessel from the starboard manoeuvring place on the bridge. He used manual steering. The master took care of the main engine control and monitored the piloting from the portside manoeuvring place.

2.1.2 Fairway navigation

After the vessel had turned to the channel section "course 248 degrees", the pilot began, after master's approval, to manoeuvre the vessel using autopilot. The master increased the speed from less than nine knots to twelve knots. The operating mode of the autopilot was "*heading mode*". The Finnpilot pilot boat departed from the Port of Rauma and followed the SYLT.

When the SYLT reached the Rihtniemennokka turn, her speed had been increased to 14 knots. The pilot boat followed the SYLT approx. 100 metres behind her. The vessel was turned into a new heading by adjusting the autopilot ten degrees to starboard (the operating principle of the automatic steering has been dealt with in detail in chapter 2.4.1). Rate of turn and turning radius selectors of the automatic steering were not used. When the vessel had started to turn, the intended heading of the autopilot was changed another ten degrees to starboard. The turn was continued with approx. ten-degree changes in the heading until the intended heading was 290 degrees, which is the direction of the Urmluoto channel section located west of Rihtniemennokka. When the turn ended, the heading was approx. six degrees from the intended.

2.1.3 Ground touching

Halfway through the pilotage, after passing the red lateral buoy *Osmo* at the northern edge of the channel, a very narrow part of the channel began. The vessel had already turned into heading 284 degrees, when her turn to starboard stopped and she continued to proceed in the channel straight towards the southern green buoy of the Pooki-Rihti pair of buoys. The vessel was on the north side of the fairway centre line. The vessel continued with heading 284 and, between the two pairs of buoys Truutti-Pata and Pooki-Rihti, she drifted to the south side of the fairway centre line.

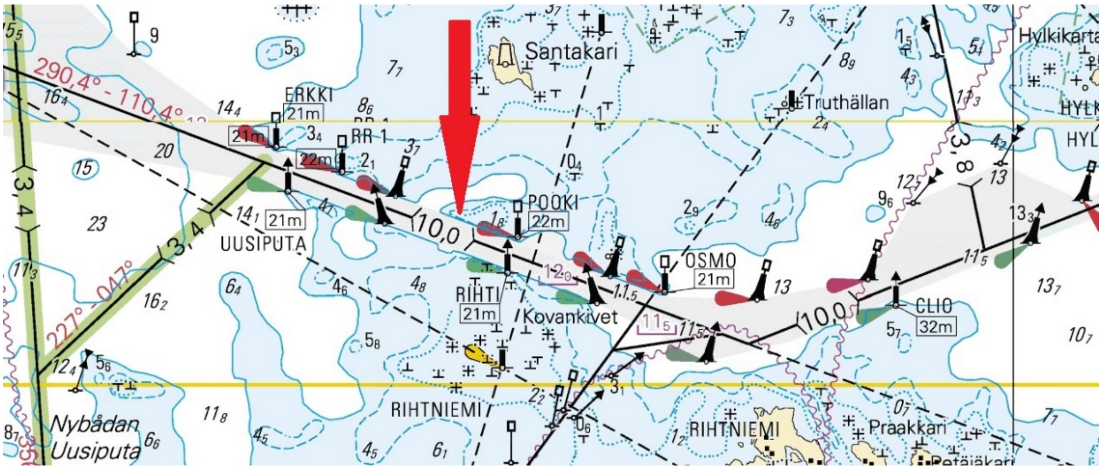

Figure 7. The excavated section of the Rihtniemi channel. The location of the ground touching marked with a red arrow. The heading of the channel section between Rihtniemi (on the right-hand side of the figure) and the port is 248 degrees when outbound. (Photo: Nautics Sailmate)

When the SYLT was drifting to the south side of the fairway centre line, the pilot switched over to manual steering and turned the vessel to starboard. According to those on the bridge the manoeuvre made the vessel turn more strongly to starboard. The rudder angle used for the turn is not known because there are no VDR recordings. The pilot tried to stop the turn by giving counter-rudder hard-a-port. Regardless of this the starboard turn did not stop. The pilot asked the master to take over the manoeuvring. The master took over the manual steering, made sure that the rudder was hard-a-port and increased the main engine power in order to improve the effect of the rudder. The vessel started to turn to port, but drifted with a speed of 12.8 knots and with her starboard side first into the north side rocky edge of the channel on 11 October 2014 at 02:14.

Because of the ground touching, the vessel's speed decreased to seven knots. The master was able to get control of the vessel and continued to navigate the vessel westward, with reduced speed and along the channel.

The starboard side of the hull was damaged, but the propeller and the rudder were not damaged in the ground touching. The incident did not cause any injuries to persons or damages to the environment.

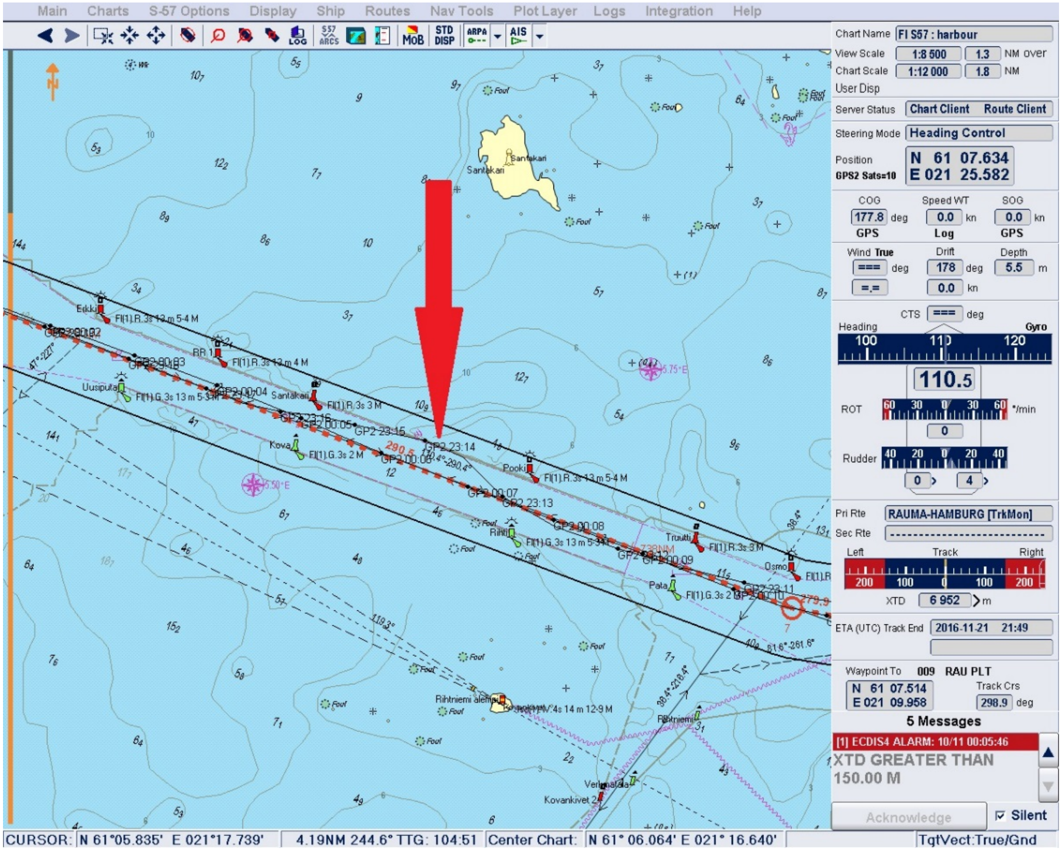

Figure 8. The recording of the SYLT's ECDIS device. The vessel's track and the location for the ground touching (the red arrow) can be seen in the figure. (Photo: M/V SYLT)

2.2 Alerting and rescue activities

The pilot contacted the VTS centre at 02:15, informed about the incident and asked the tugboat APOLLON to return to assist the SYLT. The master raised general alarm on the vessel. The VTS centre inquired the pilot about the nature of the situation. The pilot told that the vessel would return to the Port of Rauma and that she did not have a list. When the vessel continued westwards along the channel with the speed of eight knots, the alarm of the control system for the vessel's tanks went off. Ballast tanks 3 and 4 were leaking and the vessel was listing 2-3 degrees to starboard.

The VTS notified the Maritime Rescue Coordination Centre (MRCC) in Turku about the incident at 02:18. It tried to contact the SYLT, but did not get direct contact with the vessel. At the same time the patrol boat (PB) UISKO, Pori coastguard station and a maritime rescue helicopter were alerted. Because the MRCC did not know the exact nature of the situation, an MIRG group was alerted to standby to be on the safe side.

The SYLT's crew straightened the vessel by pumping water with two ballast pumps to the port side ballast tanks. The pilot notified the VTS centre about this at 02:24. The VTS centre conveyed the information to an inspector from the Finnish Transport Safety Agency. The filling factor of all tanks was checked on the vessel.

The SYLT was navigated to open waters in order to inspect the damages. When the vessel reached open water, the APOLLON informed that she would arrive to assist in 25 minutes.

The duty officer of the Finnish Environment Institute informed the MRCC at 02:35 that he had heard about the incident via Turku Radio. They agreed on communication whenever new information was received about the incident.

The SYLT and the pilot boat waited for the tugboat APOLLON in the crossing of the Rihtniemi and Kylmäpihlaja channels. The draught of the vessel and possible oil leakage were inspected from the pilot boat. The vessel's draught in the bow remained 8.30 metres but the stern had sunk to 8.40 metres.

The APOLLON reached the SYLT at 02:47. All three vessels started to return to the Port of Rauma. At 02:51 PB UISKO arrived to the area and sent a tender to clarify the situation. It had not yet been possible to establish direct contact with the SYLT.

The personnel of the tender boarded the SYLT at 03:01. The patrol moved on to the bridge, from where information was sent about the vessel's list of one degree. There was leakage in two ballast tanks. It was possible to control the leakage with the vessel's own pumps. The personnel of the UISKO breathalysed the pilot and the vessel's master. The blood alcohol content in both cases was zero. The SYLT was piloted back to Rauma. It was escorted by PB UISKO, the tugboat APOLLON and the pilot boat. The SYLT berthed in the Port of Rauma at 03:50.

In the port the leaking ballast tanks of the vessel were full to 86-90 percent. The vessel and its crew were not in distress at sea. Oil spillage was not detected in the area.

2.3 Damages to the vessel

After the vessel had returned to the Port of Rauma during the night, she was inspected by representatives from the West Finland Coast Guard, the Finnish Transport Safety Agency and the classification society DNV GL. There was also a group of divers at the scene, and they located the damages on the vessel. During the dive it was noticed that there were several dents and holes on the starboard side of the vessel's bilge keel on an area 40 metres long. There were leakages in two ballast tanks. The lower part of the rope cutter of the propeller shaft was missing. No damages were detected on the propeller.

The rudder flap was missing altogether. During the dive it was noticed that the metallic surfaces of the tears caused by the flap falling off were shiny. According to the divers' assessment, the damages were not older than a couple of days at the most.

Figures 9, 10, 11 and 12. Damages to the rudder (photographed at the repair yard). (Photos: DNV GL)

The swinging arm of the upper part of the rudder flap had been torn off from its bearings (Figure 9), and the bearing journal of the lower part was twisted backwards (Figure 10). The side plates of the rudder blade, which protected the shaft of the flap, were bent outwards from their lower parts (Figures 11 and 12).

The Investigation Group wanted to find out the damages to the supporting lug of the lower bearing in order to be able to assess the phenomena related to the falling off of the flap. In the inspection carried out at the yard, it was noticed that there were no extra marks on the supporting lug.

The Finnish Transport Safety Agency inspector decided that the vessel had to be discharged before she could depart for sea. In addition, a tugboat was ordered to assist her to the repair yard.

2.4 Special investigations

2.4.1 Automatic steering control

The SYLT's adaptive autopilot Raytheon-Anschütz Nautopilot 2015 steers the vessel in a compass measured heading (*heading mode*). The device can also be connected to an ECDIS system of the same manufacturer, in which case *track mode* can be used. The autopilot includes *turning radius* and *rate of turn* functions. There is no drift angle compensated steering mode (*course mode*) in the device. There is a Course Control icon in the control panel of the device as well as a Set Course header field in connection with the numerical heading display, but these indicate *heading*, not *course* over water or ground.

The pilot used *heading mode* in the autopilot and turned the vessel without using the turning radius or rate of turn functions. Change of heading on the autopilot can be done in two different ways: a) by turning the heading control to the new heading and then pressing *set* within fifteen seconds or, b) by pressing the heading control, at the same time turning it to the new intended heading. When the heading control is released, the new intended heading is activated. In both cases the vessel starts to turn towards the new direction at the rate of turn set in the autopilot. During the pilotage the rate of turn on the SYLT's autopilot was set to 35 degrees per minute.

2.4.2 Voyage data recorder

The vessel's VDR is an IS Steinsohn VDR G4. The device is connected to the vessel’s navigation and radar equipment. There are microphones on the bridge for recording radio-communication and talk.

According to regulations, VDR devices must, in normal use, continuously record information sent by the equipment connected to the system and store the recordings for at least the previous 12 hours. The SYLT’s VDR is set to save recorded information in consecutive 15-minute periods. New recorded periods replace the oldest periods, meaning that there always is 12 hours of information saved. After an exceptional situation, the bridge crew can store the 12-hour periods in a separate data file where the information is stored permanently.

After the SYLT returned to Rauma the members of the Investigation Group arrived and tried to get a copy of the VDR information. The device was not in working order, and there was no recording to be used. In addition it was found that the normal functioning of the device had been ascertained in an inspection on 21 June 2013. Three months before the ground touching a new inspection had been carried out, in which faults in the VDR had been detected. Maintenance had been booked for the device. The maintenance was scheduled to take place after the vessel had arrived in Hamburg. It was possible to copy some log information from the vessel’s VDR. The functioning of the VDR was checked once more before the vessel left Rauma. It was noticed that the device tried to switch itself on once a minute and was therefore continuously in boot mode. Despite this the display panel indicating the mode of the device indicated that the system worked normally. The recordings were missing both from the VDR central unit and from the data storage capsule.

On the basis of the VDR log information obtained from the vessel and the discussions with the device agent it was found that there were disturbances in the functioning of the device due to a technical fault.

According to the VDR log information the vessel’s master had tried to save most recent voyage data on 11 October 2014 at 16:47, but even if the device had been functional, this moment would have been too late, i.e. more than 12 hours after the ground touching. The master told he had tried to save information even earlier, but there was no entry in the system on this. In order to prevent saving by mistake, one has to press the VDR save button for a long time. If the master has tried to save data as claimed, he might not have pressed the button long enough.

In the logic of the SYLT’s VDR device there is a function that can appear strange to the user. It can destroy an already successfully saved recording. The system only saves in accordance with the latest save command, and the previous saved recording is deleted. This feature probably remains there because memory space used to be expensive and there was a need to save it. If bridge personnel give the system a save command three hours after an interesting incident, everything is in order, i.e. the 12 previous hours have been successfully saved and the incident falls within the time frame. If bridge personnel is uncertain whether it was possible to save the recording and suspects for example that the save button has not been pressed long enough and starts to press the save button again e.g. one hour after the previous attempt to save, the following takes place: Because the previous successful saving has ended one hour before the button was pressed anew, the equipment now waits for 11 hours, so that a new 12-hour period is full. Only after that it saves the latest period and deletes the previous saved recording.

A recording from the vessel's ECDIS device was obtained to be used in the investigation. On a broad level, it contains information about the vessel's state of motion. By comparing this data to the VTS recording it has been possible to piece together the vessel's movements in the Rihtniemi channel.

2.4.3 Effect of the rudder damage on the vessel's manoeuvring characteristics

The decrease in manoeuvring capacity caused by the missing flap was studied with the help of manoeuvring trial calculations in a ship handling simulator.

In these calculations a simulation model based on a 160-metre-long and 25-metre-wide bulk carrier was used. The change in the manoeuvring capacity of the vessel's rudder was assessed using information gathered from different sources. The claimed increase of manoeuvring capacity of an intact flap rudder compared to a fixed rudder of the same size varies between sources. Some commercial publications claim, that the capacity of a flap rudder is twofold compared to an ordinary rudder. Other sources estimate that the increase in the manoeuvring capacity is significantly more moderate, approx. 50 percent. On the basis of several sources it was postulated that the increase in manoeuvring capacity generated by the flap would be 64 percent. On the other hand, if the increase in manoeuvring capacity is compared to a fixed rudder, the surface of which is as much smaller as the surface of the missing flap, the difference has, in this investigation, been moderately assessed to be 75 percent. Estimated in this way, the missing flap would have decreased the capacity of the rudder to 57 percent of the original capacity.

Two sea trials using the speed of 12 knots were carried out on a simulation model: a 90 degree turn with a rudder angle of 35 degrees and a 20/20 yawing test (a Z test). In the yawing test the rudder is first deviated 20 degrees to starboard. After the heading of the vessel has turned 20 degrees from the original course, the rudder is turned 20 degrees to port. When the original turn of the vessel to starboard has changed into a port turn and the heading of the vessel passes 20 degrees to port of the initial course of the trial, the rudder is again turned 20 degrees to starboard.

The test is used to clarify the vessel's turning proneness as well as the effect of counter rudder on stopping a turn. It must be noted that the manoeuvring characteristics used in the calculations are not congruent with the SYLT's manoeuvring characteristics, but the change caused by the missing flap on the behaviour of the vessel is similar on both vessels.

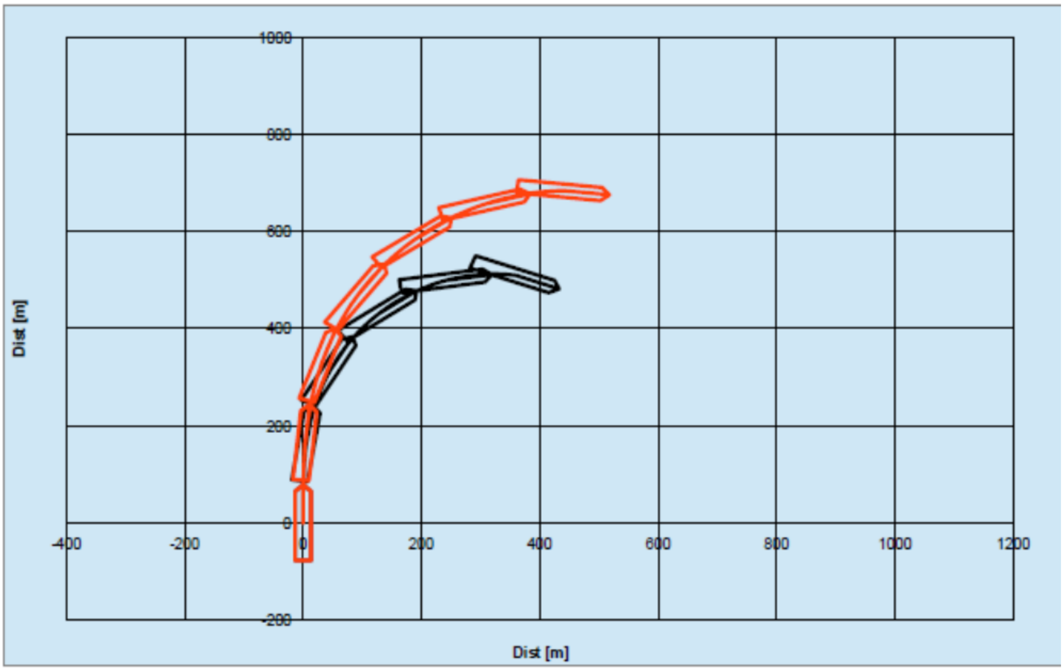

Figure 13. A simulated turn of 90 degrees with a 35-degree rudder angle. The effect of the damaged rudder has been illustrated by using the red trajectory. (Photo: Simulco Oy)

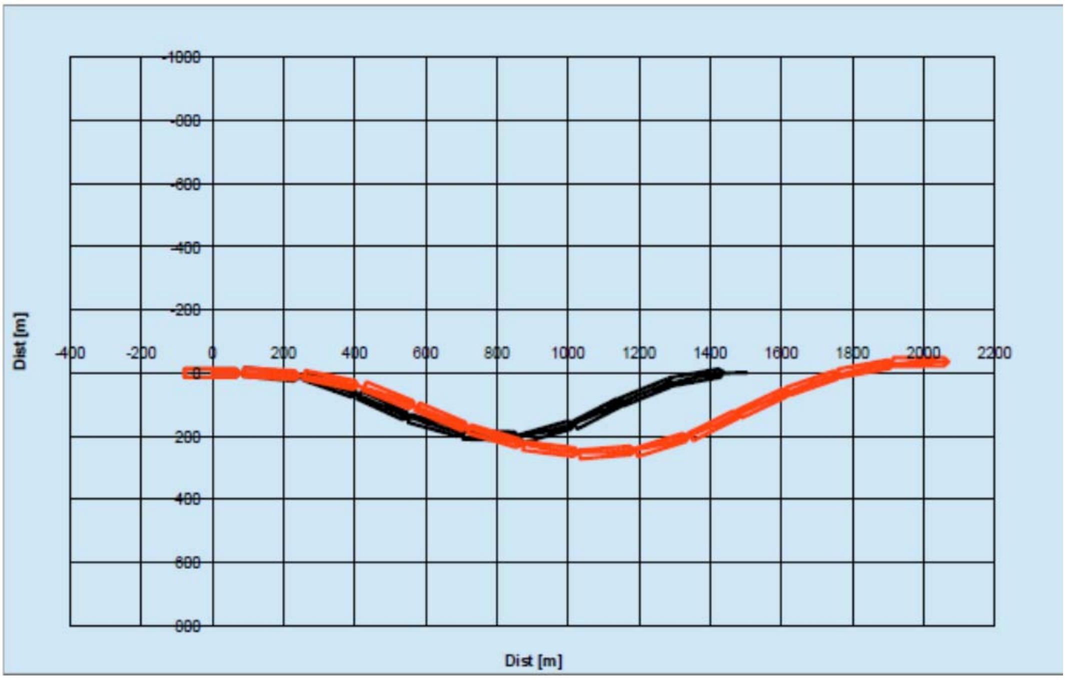

Figure 14. A simulated yawing test using a 20-degree rudder angle. The effect of the damaged rudder has been illustrated by using the red trajectory. (Photo: Simulco Oy)

The vessel’s simulated trajectory with an intact flap rudder (black) and with a damaged rudder without a flap (red) can be seen in Figures 13 and 14. For example in the turn circle test the difference is clear, but during the first minute of the test (vessel symbol drawn with the interval of 30 seconds) the difference has not developed. In a similar way, the differences were minor in the initial stage of the yawing test, even though the damaged vessel used much more fairway space for manoeuvring. On the basis of the simulation results it can be concluded that in normal channel navigation the effect of the damaged rudder on the manoeuvring may go unnoticed, especially if weather conditions, wind and current have an effect on the behaviour of the vessel.

2.4.4 Investigations at the scene

A request for executive assistance was sent to the Finnish Defence Forces in order to locate SYLT's rudder flap in the vicinity of the ground touching position. The Finnish Navy sounded the Rihtniemi fairway area south of Santakari with the focus on the west side of the Pooki edgemark. They found five unidentified objects at the bottom, but due to heavy swell it was not possible to investigate them by using a diving robot. After the weather had improved, a group of divers from the Rescue Department of Satakunta went there to check the previously located targets, but none of them proved to be the rudder flap.

2.5 Rules and regulations guiding the operations

2.5.1 National legislation and instructions

In Finland pilotage is regulated by the Pilotage Act (940/2003) and by the Pilotage Decree (246/2011). The purpose of the Act is to enhance the safety of vessel traffic and prevent environmental damage generated by vessel traffic. In the Pilotage Act it is defined that[1] “*The pilot is responsible for the pilotage operation. The pilot shall present the master of the piloted vessel with a passage plan based on up-to-date charts and any other information and instruction necessary for the safe passage of the vessel, and the pilot shall supervise any measures related to the steering and handling of the vessel that are of significance for the safety of vessel traffic and environmental protection.”*

According to the Pilotage Act, The Ministry of Transport and Communications is in charge of the general instructing and developing of pilotage. The Finnish Transport Safety Agency supervises that the Pilotage Act and rules and regulations issued under it are observed. The Finnish Transport Safety Agency takes care of the duties related to pilotage which according to the Act do not fall to Finnpilot Pilotage Ltd.

Vessel traffic services are regulated by the Vessel Traffic Service Act and by the Government Decree on Vessel Traffic Service. In Section 5 of the Vessel Traffic Service Act it is stated that *“Information is given to vessels when they report, at set intervals,*

[1] Pilotage Act, Section 8

whenever necessary or when a vessel so requests." In Section 6 of the Vessel Traffic Service Act the following is stated on navigational assistance to a vessel: *Navigational assistance is given to identified vessels on request or when deemed necessary by the VTS authority in difficult navigational circumstances or weather or ice conditions. Navigational assistance is advisory and result orientated only."* Navigational assistance can be given on *"vessel's position relative to the fairway axis or waypoint in accordance with the VTS sailing plan"*.

2.5.2 Finnpilot Pilotage Ltd.'s instructions

The Finnpilot Pilotage Ltd has compiled an instruction for pilotage. In addition to it, the Pilotage Act and Pilotage Decree are applied on pilotage.

Section three in the pilotage instruction deals with how long before the pilotage is started the pilot and the master should agree upon who uses which device during the pilotage.

Section eight states further, that the pilot and the officers must agree upon the use of manoeuvring and navigational instruments and their settings.

Automatic steering is mentioned separately: *If automatic steering is used on the vessel, the pilot must ensure that it is possible to switch over to manual steering without delay. If the pilot him-/herself manoeuvers the vessel, he/she must notify the vessel's master and/or officer of the watch of the divergences in the voyage plan."*

Pilots usually do not act as helmsmen, but nothing prevents it if this is agreed upon with the master of the vessel and if the vessel is suitable for this.

Section 12 in the pilotage instruction defines as follows: *The pilot must immediately notify his/her observations concerning matters described in Section 8 of the Pilotage Act to the VTS centre, which in turn must further report them for investigation to relevant authorities.*

According to the same section, *"the pilot must report the divergences from the voyage plan or the observed defects in the vessel's equipment, personnel or safety equipment to Pilotweb in connection with the approval of the pilotage".*

2.5.3 Shipping company regulations

The vessel has a certified *Safety Management System, SMS.*

Section 7.1.4.7 of the system defines duties of the vessel's bridge personnel when the pilot is on board. Nothing is mentioned about the use of autopilot during pilotage.

It is, however, mentioned in section 7.1.4.7.9 that the vessel's officer of the watch must monitor that all orders given by the pilot are carried out, especially wheel orders. The actions of the helmsman must be continuously observed.

Radio communication in emergency situations is not described in the SMS of the shipping company.

2.5.4 International conventions and recommendations

International conventions regulate e.g. Safety Management Systems. The International Safety Management Code (ISM) was approved by the IMO in 1993. After 1998 it has been mandatory for all merchant vessels over 500 GT engaged in international traffic. A Safety Management System based on the ISM Code has been mandatory in Finland since 1996.

Internationally pilotage is regulated in the IMO Pilotage Resolution 960. It deals with the training and certification of pilots and with *modus operandi*.

2.5.5 Quality systems

The operations of the Finnpilot Pilotage Ltd are audited in accordance with the ISO 9001 quality standard. In addition, the company has assessed the effectiveness of pilotage since 2013. According to the company, *“pilots report on non-conformities and safety defects which they observe in connection with pilotage. Non-conformities may be related to the vessels’ equipment, personnel, other traffic or the condition of the channel”.*

“The clients assess the effectiveness of pilotage in a customer survey every second year. During 2015 a new mobile Enterprise Resource Planning (ERP) system will be taken into use. The vessels’ masters can give an assessment on the effectiveness of pilotage after each individual pilotage operation. This gives reference data which can be compared with the pilots’ own assessment.

Pilots observe their own work and they report on situations, which without a pilot would have resulted in deviations from normal situations. The observations are classified according to their gravity into unsafe acts, close calls, minor accidents or serious accidents.

A “prudence concept” is used in the assessment, i.e. if the pilot when doing the assessment has to consider the significance of the detected non-conformity, he/she always automatically chooses the one with less grave significance.”

Finnpilot Pilotage Ltd then analyses the obtained information and assesses e.g. the economic effects of the fluency of traffic and of improved safety in seafaring.

The Reederei Eckhoff GmbH & Co.KG shipping company has the ISO 14001 and ISO 9001 standards in effect, and the vessels of the shipping company observe the ISO 14001.

3 ANALYSIS

An Accimap approach[2] has been used in the analysis of the accident. The structure of the analysis text is based on the Accimap diagram compiled by the Investigation Commission.

The Accimap method is a risk control method which originally has been developed to prevent accidents. It can, however, be used also in accident investigation in order to analyse the factors which have played a role in the background and for choosing and targeting the most effective safety recommendations. According to the approach, there are risk factors on different levels of the decision-making in all operations. When analysing an accident, these factors should be identified. An accident can be perceived as a chain of events, in which the first analysis of each event concentrates on which technical and human factors on the performance level have contributed to the realisation of the event in question. The analysis is then continued upwards, level by level, and the objective is to find factors in the higher levels, which have affected the activities on the lower level. In the Accimap diagram compiled on the basis of the analysis, the actors on various levels are presented in the horizontal levels and the chain of events proceeding from left to right is illustrated on the bottom-most level of the chart. The connections between the events and the factors from different levels explaining them are described by using connecting lines.

[2] Svedung & Rasmussen, 2000, Proactive Risk Management in a Dynamic Society, Swedish Rescue Services Agency, Karlstad, Sweden.

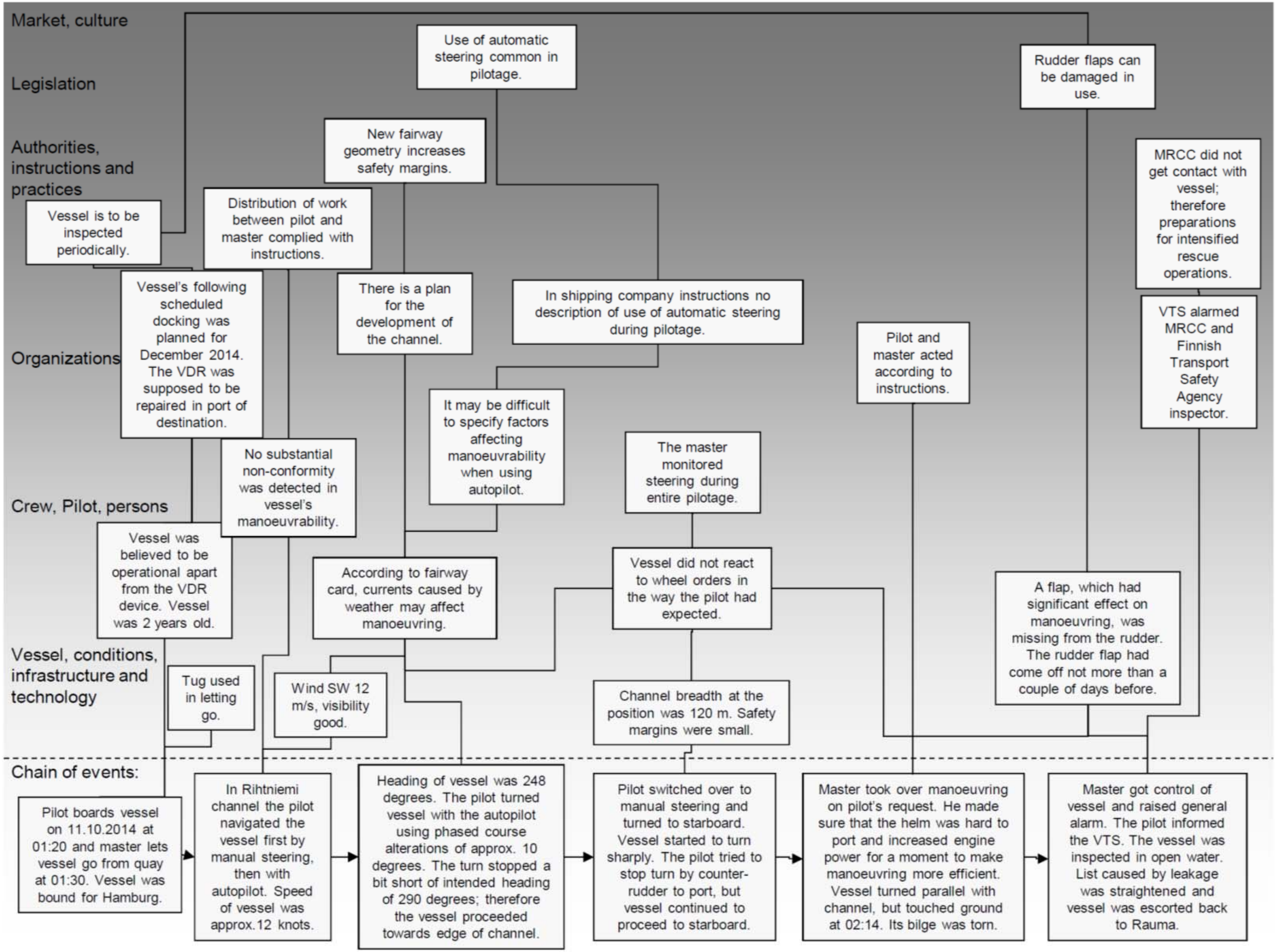

Figure 15. The Accimap diagram

3.1 Preparing the vessel for departure

The master presumed that the vessel was operational with the exception of the VDR device which was supposed to be repaired in the port of destination. The vessel was only two years old, so there should not have been any major faults in a vessel of this age. In the report on pilotage effectiveness no entries or notes had been made on non-conformities concerning the vessel. The vessel had arrived in Rauma along the Rihtniemi deep-draught channel.

Preparations for pilotage were carried out according to normal practice. The pilot and the master e.g. went through the Pilot Card before the pilotage started.

3.2 Channel and weather conditions

A maximum speed of winds in the channel is defined in the fairway card. The maximum speed of wind gusts deviating from the Urmluoto line, thus causing drifting, was 18 m/s in daytime and 15 m/s at night. At the night of the accident the wind was blowing from south-west with the average speed of 12 m/s. The wind speed and direction were normal considering the time of the year. According to the Investigation Group’s estimate, the maximum wind speed in gusts was less than the maximum of 15 m/s defined in the fairway card. Because the SYLT is clearly smaller (LOA 140 m) than the design ship used when planning the Rihtniemi channel, weather conditions did not play any significant role in the accident.

The Rihtniemi channel is narrow in the Urmluoto section and the safety margins for manoeuvring the vessel are small. A vessel of the size of the SYLT does not get exposed to bank effect when proceeding in the middle of the fairway area when there is no other traffic. But, if the vessel drifts to the edge of the fairway area, it may become more difficult to handle.

3.3 Manoeuvring the vessel

After the vessel had left Rauma, the pilot manoeuvred the vessel using the autopilot. The pilot him-/herself manoeuvres the vessel using autopilot in a significant part of all pilotage in the coastal areas of Finland. There are instructions on the use of the autopilot e.g. in the pilotage instruction. Maintaining the course automatically allows the pilot to concentrate on other navigational tasks. A well-set autopilot of good quality maintains the heading accurately and thus decreases the fairway space the vessel uses and increases the safety margin. Using automatic steering may also decrease the risk of human error when compared e.g. to a situation in which a helmsman misunderstands a wheel order given by a pilot.

Using automatic steering during pilotage can also entail risk factors. If the pilot is not familiar with the functioning of the steering gear, the realisation of e.g. turns does not necessarily correspond to what has been planned. There are several device manufacturers, which means that it is not possible to know all functions of all devices. It is, however, important to have basic knowledge of different manoeuvring modes. A well-functioning automatic steering system adapts to different circumstances and remains operational in varying situations. Because the automatic steering system does not receive any separate information on the functioning of the rudder flap (other than data on the realised rudder angle), the effect of a rudder damage on manoeuvring affects the steering gear as an unknown external factor would, i.e. in the same way as weather conditions. Automatic steering gear adjusts its functioning according to the changed manoeuvring characteristics and may cause the effect of damages to remain hidden. The vessel still seems to behave entirely normally.

The pilots' way to turn vessels by using autopilot but without turn radius or rate of turn, is normal in pilotage. Pilots use a large number of different steering devices in their work. It is practical to try to avoid the varying functions that different devices have and to stick to a simple and reliable course of action. Turning the vessel giving well-timed orders of maybe ten degree changes to the course when using heading mode, is a well tried and straightforward method. There is then only a minor risk of an incorrect manoeuvring order. The Investigation Group is of the opinion that the turning method which the pilot used did not directly contribute to the accident.

The use of automatic steering during pilotage is not mentioned in the SYLT's Safety Management System. It is important that shipmasters have a clear picture of how the pilot, who does not belong to the vessel's crew, uses the vessel's automation systems. In this way the pilots' and masters' mutual understanding of the use of automatic steering in pilotage improves.

Because of missing VDR recordings the Investigation Group does not have exact knowledge of the bridge team co-operation on the vessel. Based on what the various parties have told, there is no indication that there were inadequacies in bridge team co-operation or actions. When the pilot noticed that the vessel did not respond to steering, he handed over the steering to the master of the vessel. Actions taken in this situation were completely correct, and they corresponded to instructions.

3.4 Rudder damage

It is not possible to without doubt claim that the rudder damage played a role in the accident. On the basis of the existing information it is impossible to determine the exact moment when the rudder flap fell off. The vessel's manoeuvring characteristics have, however, deteriorated after the falling off of the flap.

When the vessel was at the repair yard, it was possible to get a clear picture of the damages to the rudder. It can be concluded that the flap had first come off from its upper part, because the hinge pin of the lower edge of the flap had been bent backwards (Figure 9). The swinging arm of the upper part of the flap, i.e. the mechanism which makes the flap turn when the rudder turns had been torn off from its weld (Figure 8). The fastening of the swinging arm to the bearing frame was designed without any strengthening around the bearing frame. The hinging of the flap was realised only between the hinge pins at the lower and upper ends without any hinge in the middle of the flap. The breaking of the upper hinge caused the flap to fall off.

The leading edge of the flap has been designed to be inlaid in the channel at the rear edge of the rudder blade. The sides of the channel in the rear edge of the rudder blade were also bent. This leads to the conclusion that the flap had turned from side to side before coming loose, thus damaging the rear edge of the rudder blade. However, this can have happened only after the bearings at the upper part of the flap and the swinging arm have yielded, because otherwise the upper part of the flap could not have turned to the side. The damage has stopped the steering of the flap through geometric rudder angles. Damages to the rear part of the rudder blade have been caused by the turning of the flap, which was due to the flow of water (Figures 11 and 12).

The swinging arm of the flap could also have been damaged much before the upper hinge was damaged. The damaging of the rudder can be divided into three different phases: a) damages on the swinging arm b) the flap turning with the flow of the water after the upper hinge had come loose, and c) finally coming loose of the lower hinge, i.e. the flap falling off. Since there were no abrasions to be seen at the base of the lower hinge, the coming off of the flap must have happened fairly quickly after the upper hinge has yielded. The lower edge of the flap would have caused abrasions, had it been there for long. Another alternative is that the flap, being bent backwards after the upper hinge had come off, has partly risen upwards on the pin of the lower bearing due to the flow of water. If this was the case, there has been a gap between the lower edge of the flap and the base of the lower bearing pin.

It is not possible to determine the running time of these three stages of damage, but it is clear that each stage has had a different effect on the vessel's behaviour and manoeuvring characteristics. At the first stage, damages to the swinging arm have caused the flap not to turn in relation to the rudder angle, but rather to follow the flow of water. The manoeuvring capacity of the rudder has decreased and come very close to a situation where there is no flap at all. The manoeuvring capacity of the rudder did not decrease only because of the lack of the curved rudder profile, which the flap was intended to produce). It decreased also because the flap, that was to follow the flow of water, was missing and thus also the manoeuvring force component of it.

At the second stage, when the upper hinge yielded, the flap, then half loose, has turned along with the flow of water. When hitting the rear edge of the rudder blade, the flap has caused damages to it and probably momentarily wedged in such a way that the steering of the vessel has become asymmetrical. The flap which has been aslant has generated a turning force, also when attempting to steer the vessel straight, rudder amidships. If the flap has turned into a new position because of a new flow situation caused by the turning of the rudder and wedged there for a moment, an unexpected change has occurred in the vessel's response to steering. This stage of the damaging process has been the most unfavourable in relation to the vessel's manoeuvring capacity.

At the third stage, after the flap had come off, the manoeuvring of the vessel has returned to the same level as it was at the first stage of the damaging process.

The rudder's missing flap could not be found in the searches. On the basis of the observations made in the diving inspection it can be concluded that because the corroding of the metallic surfaces had not started properly, the falling off cannot have happened more than a couple of days before the ground touching.

Based on this information, the time period for the coming off of the flap can be divided into four parts before the damage was detected at the Port of Rauma. The rudder flap may have been loose or may have come loose when the vessel was taken to Rauma. No non-conformity report was given on the vessel's behaviour, which means that no clear deterioration in manoeuvrability had been observed. But as the simulation results show, the damaging of the rudder has still been possible. In channel navigation the effects of weather conditions may have hidden these possible changes.

Another possible moment when the rudder flap could have come loose is the beginning of the accident voyage when the SYLT departed from Rauma towards Hamburg, before the vessel arrived to the Urmluoto section of the channel. Of those present on the bridge nobody has said that he would have observed changes in the behaviour of the vessel, consistent with the presumed effects of a damaged rudder flap.

The third point of time when the damaging could have taken place was in connection with the ground touching when the vessel's behaviour, according to the pilot, suddenly changed. Even though it has not been possible to find the flap, it could have come only partly off at this stage or it could have landed somewhere where it could not been found.

The fourth possible point when the flap may have come loose is after the ground touching, before the SYLT moored at the Port of Rauma. After the ground touching, there was however not at any stage a period when the vessel's motion state would have caused the flow of water to be exceptionally powerful. After the ground touching the vessel proceeded with a maximum speed of 11 knots before arriving in Rauma. No sudden changes in the manoeuvrability of the vessel were observed during this period of time. No damages caused by the ground touching were detected in the rudder so it is unlikely that the flap would have come loose because of the ground touching.

In all probability the SYLT's rudder was damaged before the ground touching, possibly even just before the ground touching. This has affected the manoeuvrability of the vessel, and the vessel's manoeuvring characteristics have thus not corresponded with the information the pilot got to see before the vessel departed from port. This has contributed to the vessel drifting to the edge of the channel and further to the ground touching.

3.5 Ensuring the functioning of the flap rudder

The functioning of a flap rudder is based on a passive mechanism which does not require an active machinery. The turning of the flap is realised with the help of a turning joint fastened to the rudder blade and a connecting rod. There is no monitoring sensor in the system, and the servicing of the mechanism takes place in connection with normal maintenance dockings.

Checking the functioning of the rudder is one of the routine tasks to be performed before departure from port. Disturbances in the functioning of flap rudders are not necessarily noticed in these routines.

The functioning of a flap rudder can be checked at the quay before departure e.g. by monitoring the direction of the backwash. On the other hand the damaging of the steering mechanism of the rudder flap can happen during a sea voyage when the departure check-up cannot forecast the reduction in manoeuvring capacity caused by the damages. Diving inspections are performed to vessels by classification societies, but vessels like the SYLT, only two years old, are not inspected.

In connection with the investigation, problems possibly related to flap rudders came up. Before it is possible to take a well-founded stand on the matter, it has to be clarified how probable the damaging of the rudder flap is e.g. in relation to steering gear damage.

3.6 Alarming and rescue activities

The operations of rescue and other authorities ran mainly normally. The fact that the MRCC did not have direct contact with the vessel forms an exception to the aforementioned. Rescue authorities first alerted an MIRG group and a rescue helicopter to standby. The patrol boat UISKO’s crew embarked the vessel to check the situation.

Rescue activities were carried out in an appropriate manner. Because of the lack of radio contact, precautions were taken in a correct manner by raising the level of preparedness.

There are no instructions concerning radio communication during accidents in the shipping company’s SMS-instructions for emergencies. Emergency situations are very straining, and thus it is important to conduct radio communication in accordance with standard procedures.

4 CONCLUSIONS

4.1 Findings

It is not possible to claim without doubt that the rudder damage played a role in the accident, but the manoeuvring capacity of the vessel had decreased after the flap had come off.

Weather conditions did not have any significant effect on the accident.

The Rihtniemi channel is narrow in the Urmluoto section of the channel and the safety margins for manoeuvring a vessel are small.

The use of automatic steering in pilotage was not mentioned in the Safety Management Documentation of the SYLT.

Radio traffic in emergency situations was not mentioned in the Safety Management System of the SYLT.

In connection with the investigation, information was received from several parties on problems related to flap rudders, but it has not been solved in the investigation how statistically probable damages in rudder flaps are e.g. in relation to steering gear damage.

4.2 Causes leading to the accident

In all probability the root cause of the accident is that the SYLT's rudder was damaged before the ground touching, possibly just before the ground touching. This has affected the manoeuvring of the vessel, and the vessel has not corresponded as to its characteristics to the information the pilot got before departure. This has contributed to the vessel drifting to the edge of the channel and further to touching ground.

In normal channel navigation the effect on manoeuvring of the damaged rudder flap may go unnoticed, especially if weather conditions, wind and current have an effect on the behaviour of the vessel. On the other hand, the effect of the rudder damage on the manoeuvring of the vessel appears to be an unknown factor in relation to the automatic steering system, in a similar way as weather conditions. The SYLT's automatic steering probably adjusted its functioning according to the changed manoeuvring characteristics, and the vessel still seemed to be steering impeccably. These were indirect probable causes to the incident.

4.3 Other safety observations

It was not possible for the MRCC to get direct contact with the vessel. Because of this, the authorities took measures of precaution in the rescue operations.

As to the Rihtniemi channel, the Finnish Transport Agency is engaged in a channel planning project, which is supposed to be ready in 2017. Deepening the channel is included in these plans. In addition, the intention is to bevel the vertical walls of channel sections excavated in rock, and this is expected to lead not only to a broadening of the channel but also to a decrease in bank effect.

5 IMPLEMENTED SAFETY ACTIONS

Until the end of the investigation Safety Investigation Authority Finland has no information about safety actions taken by parties involved concerning this case.

6 SAFETY RECOMMENDATIONS

1. The Safety Investigation Authority finds it important that the master of the vessel has a clear idea of how the pilot, not being part of the vessel's crew, uses the vessel's manoeuvring systems. In this way safe manoeuvring of the vessel is ensured also under pilotage.

The Safety Investigation Authority recommends that

Shipping companies give more detailed instructions how to use the steering systems in pilotage situations and enter these into their Safety Management Systems (SMS) and that the authorities approving the Safety Management Systems for their part pay attention to the existence of these entries in the Safety Management Systems. [2015-S20]

2. The Safety Investigation Authority finds it important that vessel crews have a clear perception of how radio traffic is managed in emergency situations. Emergency situations are very straining. Clear instructions and routine-based operations alleviate the effects of the strain.

The Safety Investigation Authority recommends that

Shipping companies issue instructions on the performance principles of emergency radio traffic in their Safety Management Systems (SMS) and supervise training related to radio traffic on board vessels; and that authority approving Safety Management Systems for their part pay attention to the practical functionality of the instructions on emergency radio traffic. [2015-S21]

3. In connection with the investigation, information possibly related to flap rudders came up. Before it is possible to take a well-founded stand on the matter, it should be clarified, how probable the damaging of the rudder flap is e.g. in relation to steering gear damage.

The Safety Investigation Authority recommends that

The Finnish Transport Safety Agency (Trafi) collects information about malfunctions of flap rudders and, if needed, takes appropriate measures to specify international instructions to improve the reliability of the rudder mechanism. [2015-S22]

DATE AND SIGNATURES

Helsinki, 14 August 2015

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