Drifting of container ship MV Priamos (AG) into shallows off Kotka on 12 September 2018

M2018-03

PREFACE

Under Section 2 of the Safety Investigation Act (525/2011), the Safety Investigation Authority of Finland decided to initiate an investigation into the drifting of the container ship MV Priamos (AG) into shallows off the Port of Mussalo in Kotka on 12 September 2018. The purpose of the safety investigation is to promote general safety, prevent further accidents and incidents, and prevent losses caused by the accidents. Safety investigations are not conducted to allocate legal liability.

Licentiate in Technology Olavi Huuska was appointed as the Head of Investigation Team, and Special Investigator Hannu Hänninen, Captain Tero Haapalinna, Captain Sakari Häyrinen and Captain Sami Raappana were appointed as team members. Chief Safety Investigator Risto Haimila served as the Investigator-in-charge.

The Safety Investigation Authority, Finland commissioned a simulation of the steering and tugboat assistance of a container ship corresponding to MV Priamos in the conditions that prevailed. In addition, the Safety Investigation Authority, Finland conducted a survey amongst the member ports of the Finnish Port Association on the practices related to limiting traffic established by the ports.

The safety investigation examines the course of events, its causes and consequences, and the search and rescue actions as well as any actions taken by the authorities. The investigation specifically examines whether safety had adequately been taken into consideration in the activity leading up to the accident and in the planning, manufacture, construction and use of the equipment and structures that caused the accident or incident or at which the accident or incident was directed. The investigation also examines whether the management, supervision and inspection activity had been appropriately arranged and managed. If necessary, the investigation also examines possible defects in the provisions and orders regarding safety and the authorities.

The investigation report includes an account of the course of events of the accident, the factors leading to the accident and its consequences, as well as safety recommendations addressed to the appropriate authorities and other instances regarding measures that are necessary in order to promote general safety, the prevention of further accidents and incidents, the prevention of loss and the improvement of the effectiveness of the operations of search and rescue and other authorities.

The parties involved in the accident and the authorities responsible for supervision within the field of the investigated accident have been provided with the opportunity to provide a statement on the draft investigation report. The statements were taken into account when the report was finalised. A summary of the statements is at the end of the investigation report. Pursuant to the Safety Investigation Act, statements from private individuals are not published.

The investigation report and summary were translated into Swedish and English by Semantix Oy.

The investigation report, summary and appendix have been published 10 JULY 2019 on the Safety Investigation Authority's website at *www.sia.fi*.

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Cover photo: HaminaKotka Satama Oy

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1 EVENTS

1.1 Course of events

Container ship MV Priamos collided with an ice buoy[1] and drifted into shallows off Mussalo port in Kotka on 12 September 2018. The vessel had departed from HaminaKotka Satama Oy's berth 4 of the C quay in Mussalo at around 18:30hrs. At the time of departure, the vessel was carrying 691 containers (TEU[2]). The vessel's draught at bow was 7.79 m and 8.33 m at stern. A strong, gusty wind was blowing in the area from west-southwest at a speed of 13–19 m/s.

The crew had started preparations for departure in accordance with the shipping company's instructions and a schedule that had been moved up even if the planned loading was still unfinished. There had been interruptions in the loading due to delays caused by an electrical fault in the vessel's gantry crane[3] and the strong wind[4]. Due to the strong wind, the master requested a tugboat to assist the vessel in its departure without specifying the type of the tugboat.

The pilot boarded the vessel at 18:12hrs. He signed the Pilot Card[5] and prepared for departure. The vessel's main engine was started at around 18:17hrs. The pilot and the master became aware of which tugboat will provide assistance and what type it is as tugboat Viikari arrived at 18.30hrs. The pilot took control under the supervision of the master. The pilot steered the vessel from the steering console of the left bridge wing. The master and the first mate followed the events on the bridge but did not intervene in the pilot's actions.

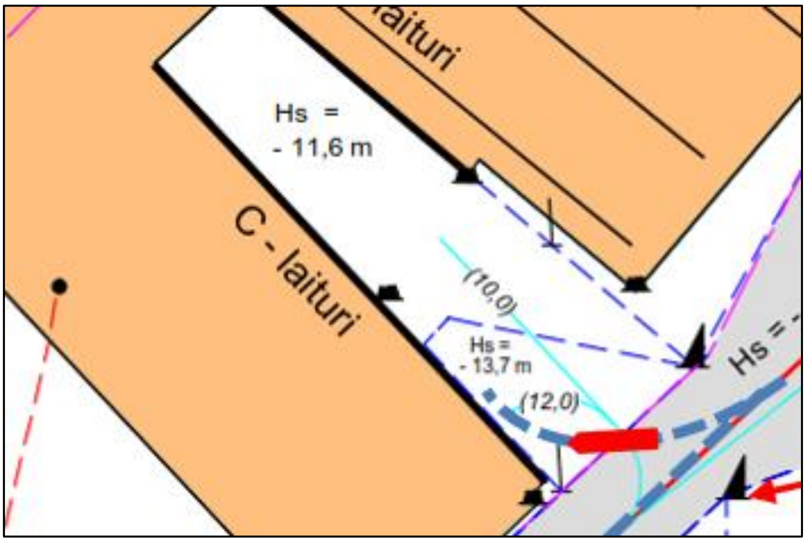
Viikari was used to hold MV Priamos in contact with the quay while the mooring cables were cast off. MV Priamos's mooring cables were cast off at 18:30hrs. The wind was allowed to push the vessel away from the quay. The bow of the vessel separated from the quay significantly faster than its stern. At 18:36hrs, the pilot started reversing the vessel out of the quay area towards the fairway area by setting the propeller to push backwards. The purpose was to turn the vessel to the left, in line with the fairway. Viikari was close to the vessel, ready to assist its turn by pushing. The pilot operated the bow and stern thrusters, the main propeller and the helm. While performing the turn, he concentrated on the vessel's bow passing the corner of the quay and the red spar buoy next to it at a safe distance.

Once the bow had passed the corner of the quay, the pilot attempted to turn the bow left in line with the fairway (Figure 1) by using the bow and stern thrusters. At the request of the pilot, the tugboat Viikari started pushing the vessel from its right side at 18:39hrs while the vessel was slowly accelerating backwards. The tugboat's pushing angle was slightly towards the stern of MV Priamos, and the pushing power it could apply to the vessel varied. At times, the tugboat was not in contact with the vessel. As a result of the pushing, the vessel started slowly turning to the left, with its main direction of movement continued towards a buoy behind it. The gusty side wind made turning the vessel more difficult.

The second mate watched the vessel's passage backwards on the afterdeck. He notified the first mate of the shortening distance to the green ice buoy at 10 metre intervals. The first mate

1 An ice buoy is on place year around and is designed for ice conditions.
2 Twenty Foot Equivalent Unit, a unit used in container transport.
3 Aka bridge crane.
4 The anemometers of the stowage company's container cranes automatically stop lifting when wind speed exceeds the threshold value 25 m/s. During the early hours of the morning of 12 September, the wind had pushed the vessel away from the quay so strongly that the main engine had to be started, likewise its manoeuvring thrusters, so that more mooring cables could be added.
5 An information form for the pilot, describing the vessel's steering characteristics, among other things.

relayed the information to the pilot and the master verbally. During the turn, the pilot answered a work-related phone call. Otherwise, there was not much communication on the bridge. The master and the pilot did not react to the first mate's reports on the shortening distance to the buoy.



Picture 1. The planned turn of MV Priamos to the fairway. The red arrow indicates the ice buoy to which the vessel collided. The violet line shows the outer border of the boundary of the port water area. (Picture template: The Finnish Transport Infrastructure Agency, additions: SIA)

The pilot momentarily set the vessel's propeller to push forwards at 18:41hrs and again one minute later with the purpose of turning the vessel's stern to the right. The stern thruster was operated at full power to push the stern to the right. The bow thruster was operated at full power to turn the vessel's bow to the left, but it was stopped for a duration of one and a half minutes during the turn for an unknown reason.

The steering manoeuvres did not manage to turn the vessel sufficiently, and it continued to drift backwards towards the buoy at a speed of around three knots (5.5 km/h). Finally, at 18:42.25hrs, the right side of MV Priamos's stern hit the buoy. The vessel's rudder blade, rudder stock and propeller were damaged. The vessel continued its slow turn to the left, causing the buoy to be dragged underneath its stern. The buoy became visible on the right side of the vessel as it continued turning, and at 18:43.30hrs it was dragged underneath the vessel again. The tugboat Viikari disengaged at 18:44.20hrs and started to manoeuvre to the other side of MV Priamos past the vessel's stern. The vessel's reverse motion slowed down and stopped, until at around 18:46hrs it started drifting backwards while its bow was turning to the right. The pilot attempted to disengage the buoy by setting the propeller to push forwards and the master decided to stop the main engine to avoid additional damages. The master asked the pilot to inform VTS about the incident and the need for an extra tug.

After the collision, the vessel's manoeuvrability was lost and it drifted towards the shallows. The pilot suggested dropping anchor. The master gave an order to drop anchor at 18:54hrs. Dropping the anchor was slightly delayed due to the anchor chain becoming tangled. The vessel drifted into the shallows before the anchor could be made to hold at 18:57hrs. The master gave the order to stop the main engine at 18:59hrs. Border guards boarded the vessel, conducted breathalyser tests on the master, chief engineer and pilot, and found no violations.

MV Priamos was towed back into the port to quay B, where it was moored at 20:24hrs. The pilot and the border guards disembarked the vessel at 20:30hrs.

Picture 2. MV Priamos being towed by the tugboat Viikari on 12 September at 19:13hrs. (Photo: MS Seagard, Bore Oy)

Picture 3. MV Priamos on 15 September. Its cargo situation is the same as during the accident. The combined wind area of the vessel and its cargo was around 2,100 m^2. (Photo: SIA)

1.2 Alarms and rescue operations

The **Vessel Traffic Service** (VTS[6] Helsinki) monitored the events with its equipment and attempted to contact MV Priamos via radiophone several times after noticing it drifting outside the fairway area.

The VTS reported the incident to the MRSC (MRSC[7] Helsinki) by telephone at 18:57hrs. MRSC Helsinki then attempted to contact MV Priamos, but the vessel did not answer.

MRSC Helsinki alerted two patrol boats of the Finnish Border Guard to the site of the incident at 19:08hrs and 19:40hrs. MRSC Helsinki wanted more information about the situation from MV Priamos and asked border guards on the Finnish Border Guard's patrol boat to board the ship and investigate the situation.

The pilot notified the VTS of the incident and dropping anchor at 19:00hrs. The VTS inquired about the possible damage to the vessel from the pilot at 19:28hrs. There was no information on the damages at that time, but the pilot told the VTS about the intention to tow the vessel back into port. At 19:45hrs, the vessel reported that it had weighed anchor and that its towing was starting.

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6 A marine traffic monitoring system. VTS Finland Oy from 1 January 2019 onwards.
7 MRSC, Maritime Rescue Sub Centre.

After the vessel was in anchor, the pilot requested a second tugboat (Castor) to assist in moving MV Priamos back to quay B from the shallows. The tugboat Viikari attached itself to the bow of MV Priamos at 19:10hrs. The vessel's anchor was aweigh at 19:42hrs. Viikari started pulling the vessel away from the shallows at 19:50hrs. The tugboat Castor attached itself to the vessel's stern at 20:00hrs, after which its towing towards quay B in the port began. The vessel was moored to the quay at 20:24hrs.

A patrol boat of the Finnish Border Guard attempted to contact the tugboat Viikari with a VHF radio phone on channels 16 and 68, but failed to establish contact.

Divers called in checked the vessel's underwater damages while it was at the quay.

The Kymenlaakso Rescue Department was notified of the accident by the Finnish Border Guard at 19:00hrs and began preparations to go at sea at 19:10hrs. The Finnish Border Guard requested the rescue department to search for a possible oil spill. At 19:30hrs, a boat unit was sent to the location to search for an oil spill. A lorry unit was also ordered on stand-by for an oil spill containment mission. The maritime inspector and the duty officer of the Ministry of the Interior's rescue department were informed of the incident. After being informed of the incident by rescue department, the duty officer of Finnish Environment Institute (Syke) recommended surrounding the vessel with booms as a precautionary measure at 20:35hrs. The rescue department's alerted units arrived at the port after 21:00hrs and surrounded the vessel with booms jointly with border guards within one hour. The booms were removed next morning at 8:00hrs.

The VTS reported the shifting of the buoy to the Finnish Transport Infrastructure Agency's[8] person responsible for buoy tending at 20:37hrs on the day of the accident. That same evening, the Finnish Transport Infrastructure Agency requested Meritaito Oy to check the location and condition of the buoy on the next day.

1.3 Consequences

No one was injured in the accident, and it did not cause any environmental damage.

MV Priamos's rudder blade, rudder stock and propeller were damaged (Figure 4). The vessel's shell plating and bottom were dented. The vessel sprung leaks in its aft section and at midships in the ballast tank. After unloading, the vessel was towed to a dockyard in Gdańsk for repairs on 23 September.

The green ice buoy was damaged beyond repair. It was flattened, it received a large hole to its side and its bottom part was torn open. The buoy's chain was cut (Figure 9). The buoy's anchor weight was dragged nine metres outside the navigation line. The weight's attachment to the buoy had become loose, so the old weight could no longer be used and it was left in place on the bottom of the sea.

On 14 September, Meritaito Oy installed a light spar buoy in place of the damaged buoy. A new weight and buoy were installed on 18 September.

The Finnish Transport and Communications Agency[9] conducted a Port State Control on MV Priamos on 13 September 2018 due to the incident, ordering the vessel to be towed to a repair dock for repairs. The vessel was unloaded before towing. Following the repairs, the vessel was taken back into service in mid-December 2018.

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8 The Finnish Transport Agency until 31 December 2018.

9 The Finnish Transport Safety Agency until 31 December 2018.

Picture 4. The vessel's damaged rudder on the left, the bent rudder stock in the middle, and the damaged propeller on the right. (Photos: Leonhardt & Blumberg, Shipmanagement GmbH & Co. KG)

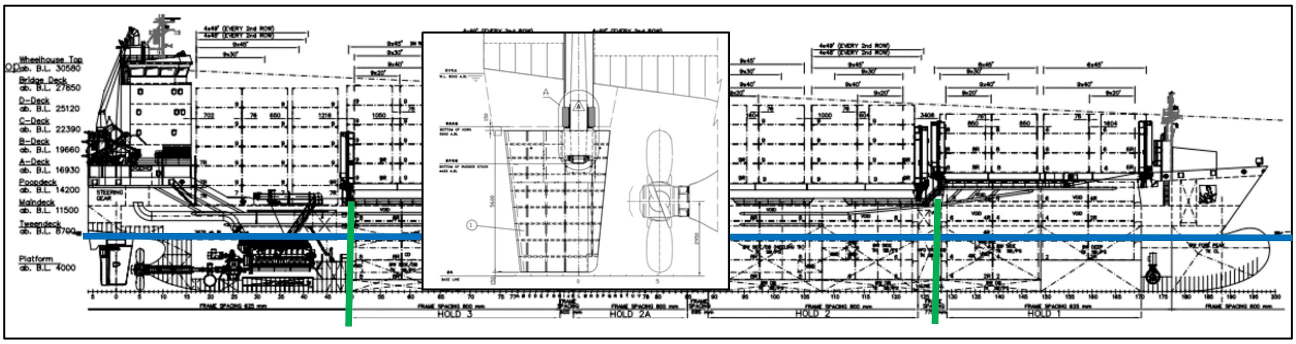
2 BACKGROUND INFORMATION

2.1 Operating environment, devices and systems

2.1.1 Container ship MV Priamos

Container ship MV Priamos is registered in Antigua and Barbuda and was completed in 2011 in the Fujian Mawei Shipbuilding Ltd shipyard. The vessel's classification society is DNV-GL (Det Norske Veritas Germanischer Lloyd). The vessel was designed to transport internationally dimensioned 20, 40 and 45 foot containers and refrigerated containers. Its container capacity is 1,025 TEU. The vessel's maximum length is 157.7 m, width 23.2 m, maximum draught 8.6 m. Its maximum deadweight capacity is 14,800 tons. The MAK 9M43C main engine, which has a power of 9,000 kW and runs a reduction gear at 500 RPM[10], drives a left-handed adjustable pitch propeller that has a diameter of 5.6 and rotates at 113 RPM.

The diameter of the vessel's stern thruster is around 1.3 m and its power is 400 kW. Correspondingly, the diameter of the bow thruster is around 1.8 m and power 900 kW. The Pilot Card mentions that a maximum of 80% power of the manoeuvring thrusters is available (320 kW and 740 kW). The rudder has a surface area of 20.2 m^2 and is of the semi-balanced type, not a flap rudder as in the general drawing. The maximum angle of the rudder is 35 degrees, and it performs a full sweep in 16 s.



Picture 5. Container ship MV Priamos. The rudder is seen in the small photo. (Picture: MV Priamos)

In Picture 5, the green vertical lines on the sides of the vessel indicate the allowed area for a tugboat's pushing, between side frames 50 and 128. The maximum allowed distance of a tugboat's pushing point from the vessel's midships is around 33 m. The water line at the time of the accident is indicated with a blue line in the picture.

The vessel had visited HaminaKotka Oy's Mussalo Port 12 times before the accident in 2018 and once in December 2017. There were six visits during the winter, during most of which tugboat assistance was used. In open-water conditions, wind gusts had reached a maximum of 11 m/s, and tugboat assistance was not used. At the time of the accident, wind speed was nearly twice that, meaning that its strength was almost quadruple compared to the vessel's previous visits to the port.

Based on Mussalo's traffic statistics (year 2018, until 7 November), MV Priamos was smaller than the average vessel size visiting the port.

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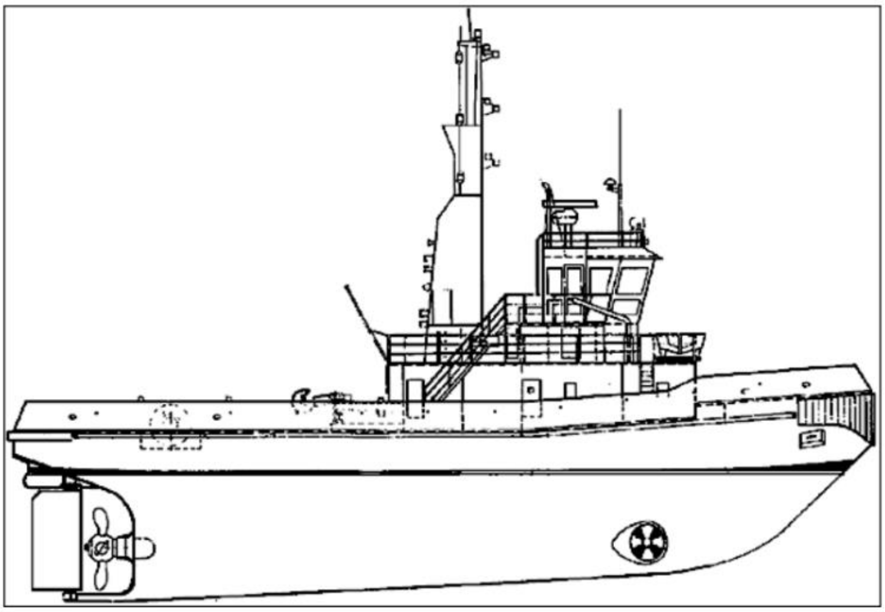
10 Revolutions per minute.

2.1.2 Tugboats

Tugboats can be categorised in several different ways. One categorisation criterion is the type and placement of the tugboat's propulsion and steering systems. All propulsion systems do not require a rudder for steering. The propulsion system and its power are amongst the most important criteria when selecting a tugboat that is best suited to the task.

Tugboat Viikari that assisted MV Priamos has a maximum length of 30.6 m, width 10 m and draught 5.2 m, and its Static Bollard Pull (SBP) is 39 tons. Viikari is a so-called conventional tugboat, and its propulsion and steering are implemented with an adjustable-pitch propeller and a balanced rudder. The tugboat was designed to operate and generate power to the assisted vessel forwards in the direction of the tugboat's centreline. For this reason, a conventional tugboat is able to utilise its power on the assisted vessel most effectively when the tugboat is attached to the assisted vessel with a cable from the towing hook located at its stern and pulls the assisted vessel[11]. When pushing an assisted vessel that is moving, a conventional tugboat must use its rudder to direct a large part of its pushing power to turn the tugboat so that it can follow the moving vessel, significantly reducing or entirely nullifying the power applied to the assisted vessel[12].

At the time of the incident, Viikari had a three-member crew in accordance with the minimum safe manning document: the master, the chief engineer and a deckhand. The tugboat's bow propeller was not used during the assistance.



Picture 6. Tugboat Viikari. (Picture: Alfons Håkans AS)

Tugboat Castor that assisted in the towing of MV Priamos is of the ASD (Azimuth Stern Drive) type[13] and equipped with thrusters that rotate 360° and are located behind the vessel's transverse line. ASD tugboats are generally equipped with two thrusters, which allows the propulsion power to be directed into controlling both the assisted vessel and the tugboat

[11] Conventional tugboats normally carry out assisting tasks by pulling the assisted vessel with a cable, its stern towards the assisted vessel. When operating in this way, the tugboat's static bollard pull can best be applied to the assisted vessel. The SBP of a conventional tugboat is significantly reduced when it is pushing a moving vessel.

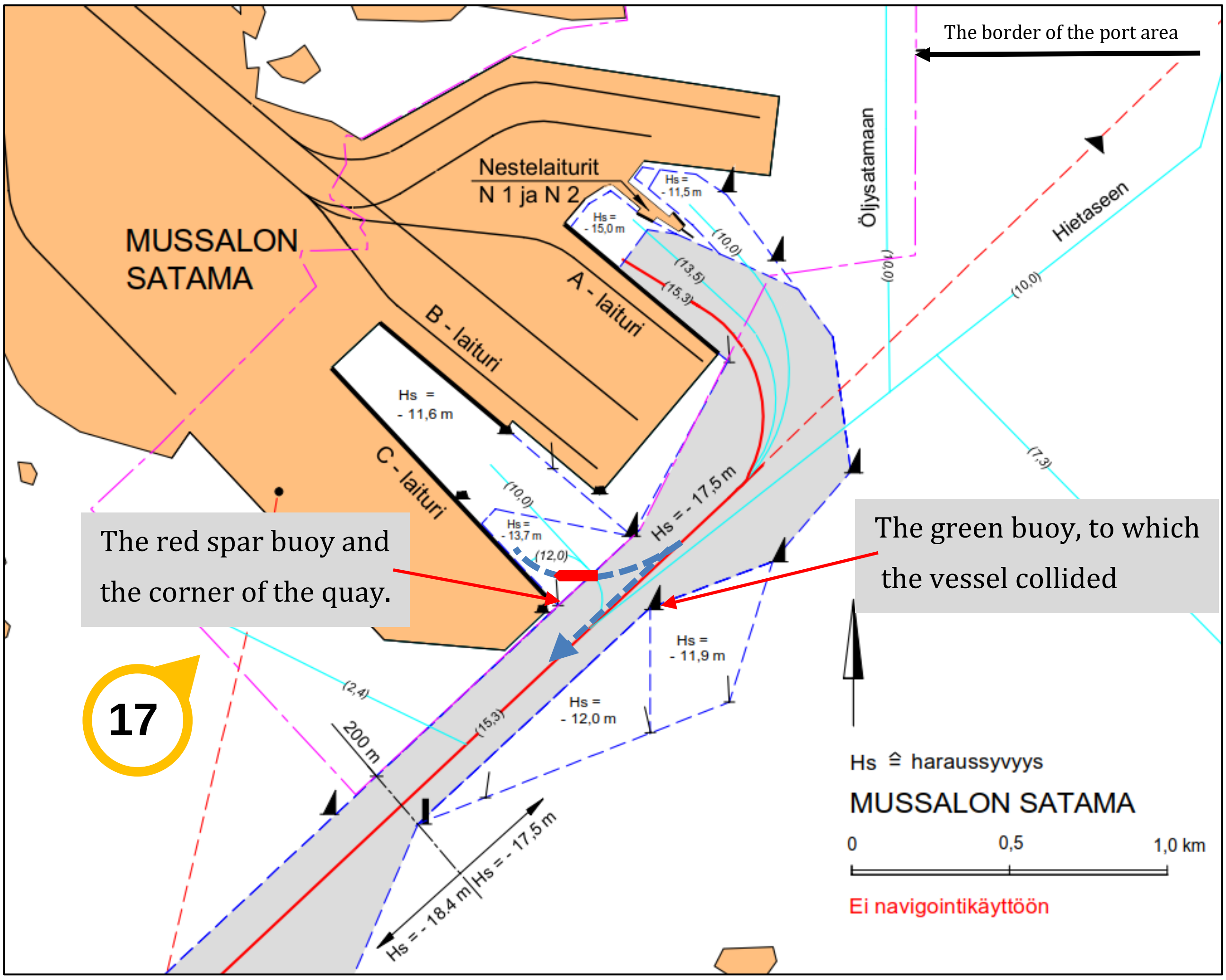
[12] Hensen, H (2018) *Tug Use in Port – A Practical Guide*. Third Edition. Ltd., Wiltshire: The ABR Company.

[13] The propellers of ASD tugboats can be located inside nozzles, which provides better pushing power, or they can be open propellers. An ASD tugboat is extremely manoeuvrable and can move in any direction.

itself. An ASD tugboat changes direction rapidly compared to a conventional tugboat. When providing assistance in a port, an ASD tugboat normally attaches itself to the assisted vessel by its bow, which enables the tugboat to quickly move into a pulling or pushing position relative to the assisted vessel. This allows the assisted vessel to use an ASD tugboat like a powerful manoeuvring thruster. ASD tugboats can rapidly effect change in the assisted vessel's state of motion.

Picture 7. Tugboat Castor. Castor's length is 34.5 m, width 12.10 m, draught 4.5 m and SBP 65 tons. (Photo: Alfons Håkans AS)

2.1.3 Mussalo port area



Picture 8. The Mussalo port area. MV Priamos indicated with a red, and its optimal route with a blue dashed-line arrows. The direction of quay C is 317°. The wind direction 230° is indicated with the arrow in an orange circle, strong breeze. The wind speed in m/s used in the simulation calculations is shown in the circle. The pile shows the border of the area administrated by the port. (Picture template: The Finnish Transport Infrastructure Agency, additions: SIA)

The dimensions of the bulk carrier used as the design vessel for Mussalo's deep water route are 125,000 dwt, length 300 m, width 48 m and draught 15.3 m. The minimum depth (MW 90)[14] of the deep water route is 18.4 m, and 17.5 m in the port. The minimum width of the route is 200 m. The minimum depth at quays B and C is mainly 11.6 m, and 13.7 m in the southeastern end of quay C. On the southwestern-southeastern side of the green buoy, the minimum depth is 11.9 to 12.0 m, which is sufficient for most vessels.

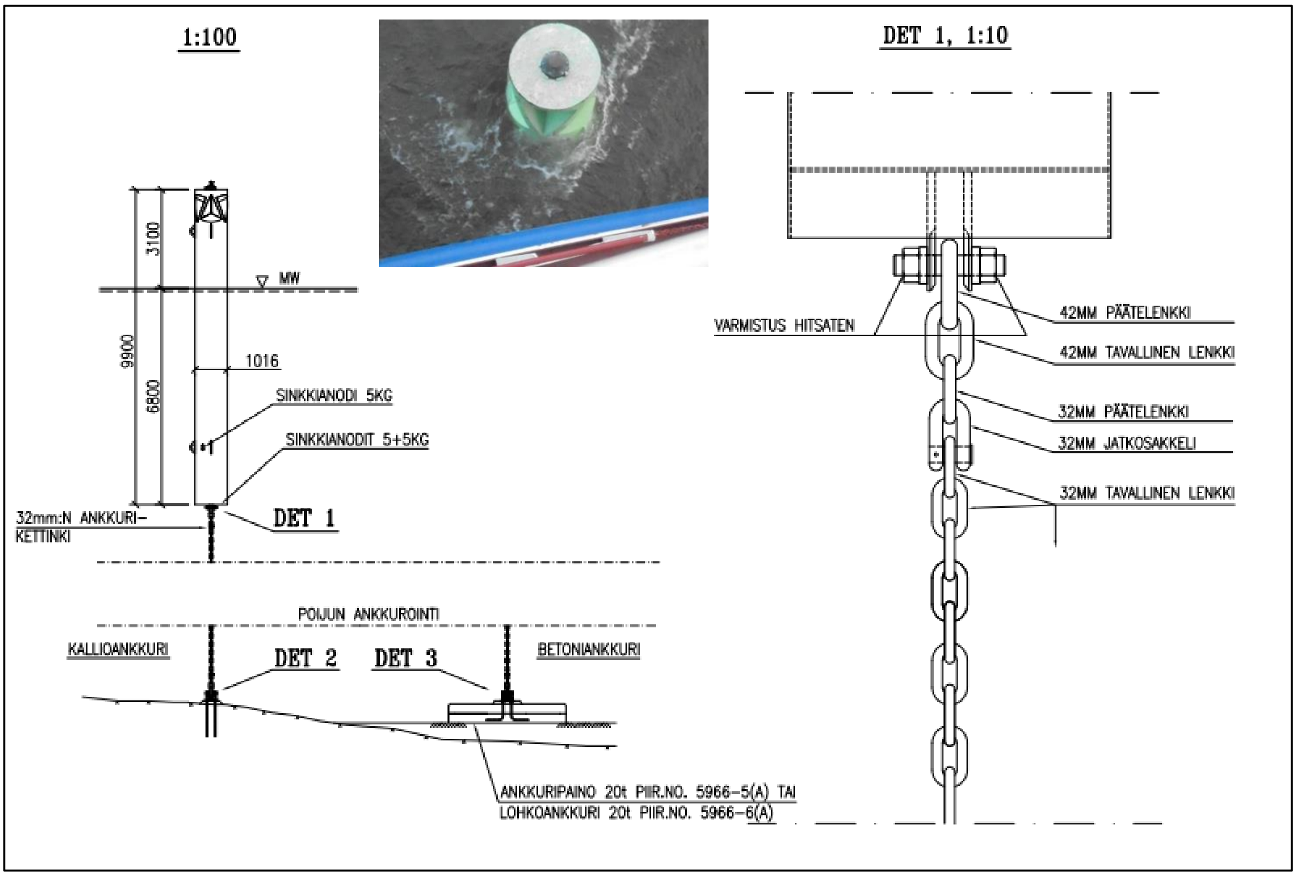
The bottom of the dock is rock, and HaminaKotkan Satama Oy has seen no need to deepen it. At his or her discretion, the pilot may use a smaller gross underkeel clearance, the maximum limit is 60 cm. The turning of vessels from the dock to the fairway has not been analysed through simulations.

[14] MW 90, mean water height 1990, average water level of 1990, used in depth data.

The port had not set or recommended wind limits. The port did not have an anemometer. The container cranes of the port operator Steveco has anemometers and a control system that prevents the use of the cranes when wind speed exceeds 25 m/s.

The Finnish Transport Infrastructure Agency is responsible for the fairways and safety equipment to the south of the port's area of responsibility. It has defined the maritime safety equipment locations in the area. The buoys are located in points where the borders of the fairway area change direction.

Figure 9 presents the general structure and location of the green, lighted ice buoy. The buoy was anchored with a chain to a weight on the bottom.

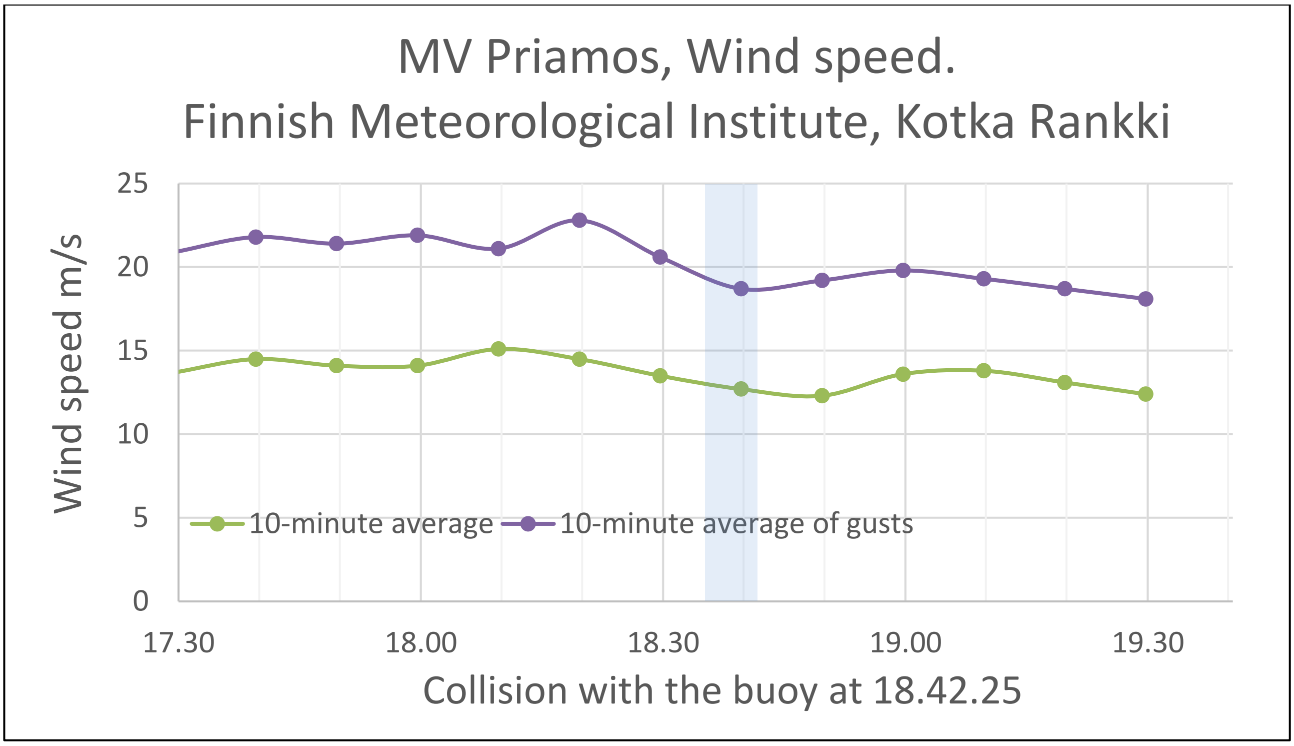


Picture 9. The green ice buoy. Small picture is a photo taken by the second mate of MV Priamos. (Drawing: Finnish Transport Infrastructure Agency, photo: MV Priamos).

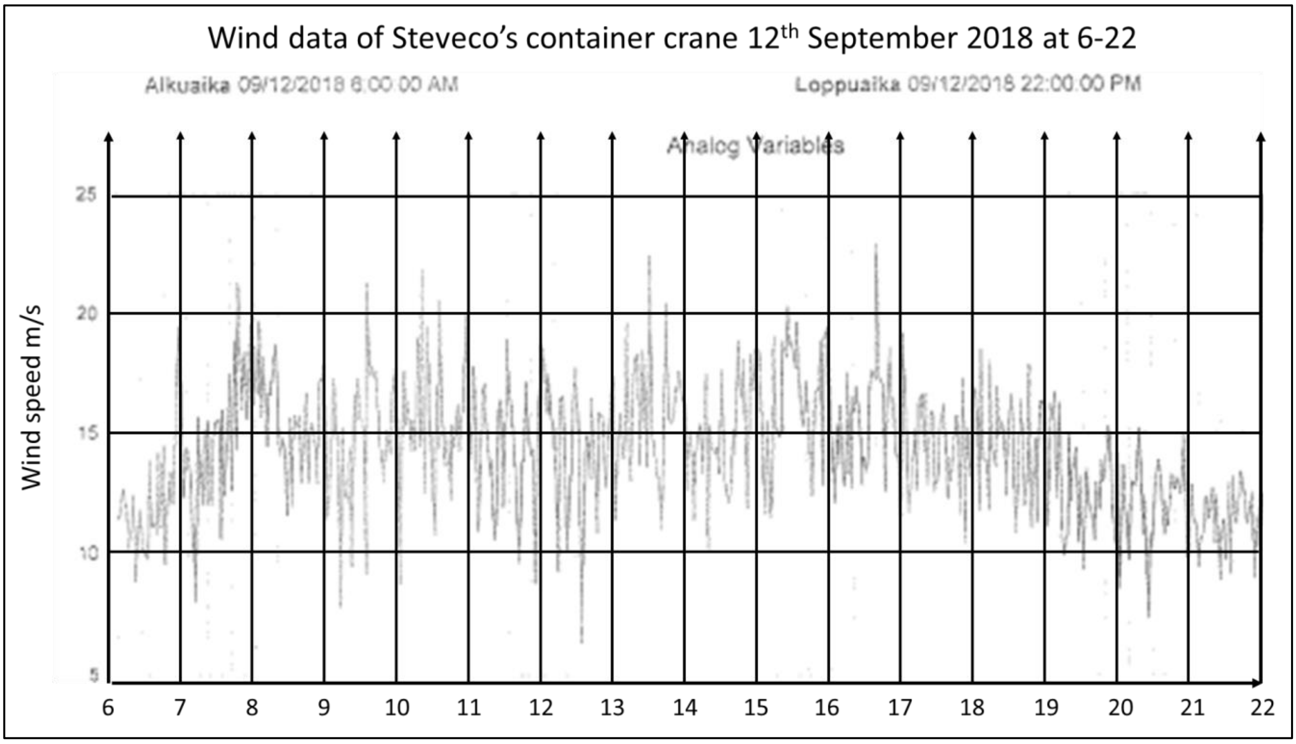
2.2 Conditions

2.2.1 Weather conditions

According to data from the Kotka Rankki weather station of the Finnish Meteorological Institute, the wind direction was 230–240 degrees (from west-southwest) during the accident. Rankki is located at a distance of around 6 km south-southeast of Mussalo. After the vessel departed at 18:35hrs, the constant wind speed was 12–13 m/s, with gusts up to 18–20 m/s (Figure 10). According to the vessel's entries, the wind speed was 13–19 m/s (7–8 Beaufort), direction SW. According to the vessel's officers and the pilots accounts, at around 18:40hrs a strong gust hit the vessel, making it more difficult to steer. There were no islands in the area that would have shielded the vessel from the gust.



Picture 10. Wind speeds on 12 September at 17:30–19:30hrs. The time range from departure to hitting the buoy is marked in grey. (Picture: SIA from data provided by the Finnish Meteorological Institute)



Picture 11. Steveco's wind speed data from 12 September from 06:00hrs to 22:00 hrs. (Picture: SIA on Steveco's template)

The port operator Steveco has an anemometer in its crane at a height of 56 m from the quay surface. Loading is automatically interrupted if wind speed exceeds 25 m/s. See Figure 11 for Steveco's wind speed graph. The wind speed at the time of the vessel's departure matches the data above, demonstrating remarkable variations in wind speed. The water level was +35 cm at 18:00hrs and +31 cm at 19:00hrs. Visibility was 20–25 km and there was no rain.

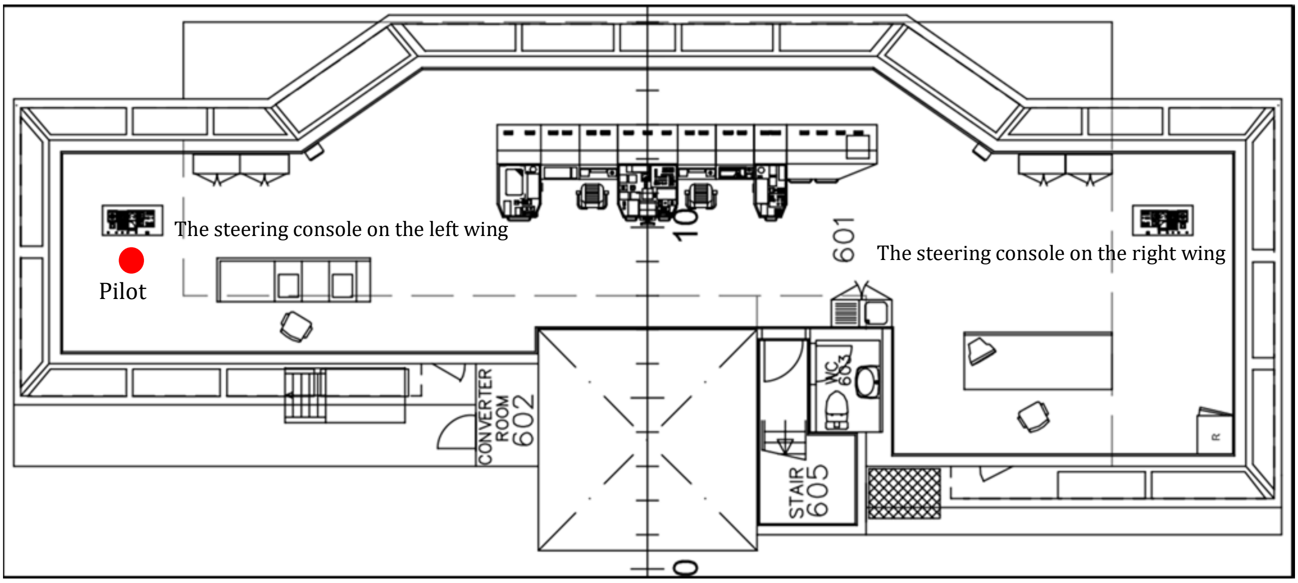
2.2.2 Limitations on piloting a vessel from the port to the fairway

Moving a vessel in the port from quay C directly to the fairway requires a tight turn (Picture 8). Vessels usually come into dock bow first, with the stern towards the fairway, due to which they are reversed out of the quay area. The ice buoys indicating the fairway area of the deep water route limit the free manoeuvring of vessels off the dock. The usual procedure is to turn the vessel to the deep water route area and, upon departure, reverse the vessel between the buoys. The location of the green buoy particularly restricts the turning space of the vessels. There is scant time for errors of judgement or steering mistakes, because there is not a lot of room to operate.

During the turn, west-southwest wind from the sea can hit the vessel directly from the side, as was the case during the accident. A container ship's large wind area and the wind pockets between containers make steering the vessel demanding, particularly when the wind is gusty.

The bridge of MV Priamos offers a good visibility aft. However, the funnel behind the bridge and the placement of the steering consoles on the bridge somewhat limit visibility aft, particularly to the right. The pilot used the steering console on the left wing. The master had ordered the second mate to the afterdeck to keep an eye on the buoys. The second mate used a radiophone to relay the estimated distance to the green ice buoy to the first mate who was on the bridge. The pilot's line of sight to the tugboat was limited by the cargo on the deck, the positions of the pilot and the tugboat, and the size difference between the vessels (Figures 21–23).

Tugboats have enough room to operate in the dock and the fairway.



Picture 12. The bridge of MV Priamos. (Picture: General drawing of MV Priamos)

Picture 13. A close-up of the steering console in the left wing from which the pilot steered the vessel. On the bottom left is the display of the stern thruster and control lever, correspondingly, the lever and display of the bow thruster are at the top. In the centre, there are the control levers of the main engine and the propeller, and above them the displays for the rotation speed (main engine and propeller) on the left and the propeller pitch displays on the right. On the right, there is the rudder control and display, as well as a phone. (Photo: SIA)

Picture 14. MV Priamos about to collide with the buoy at 18:42.25hrs. Quay C is on the right in the picture. The location of the green buoy restricts the turning space of vessels. (Screen capture from a video: HaminaKotka Port)

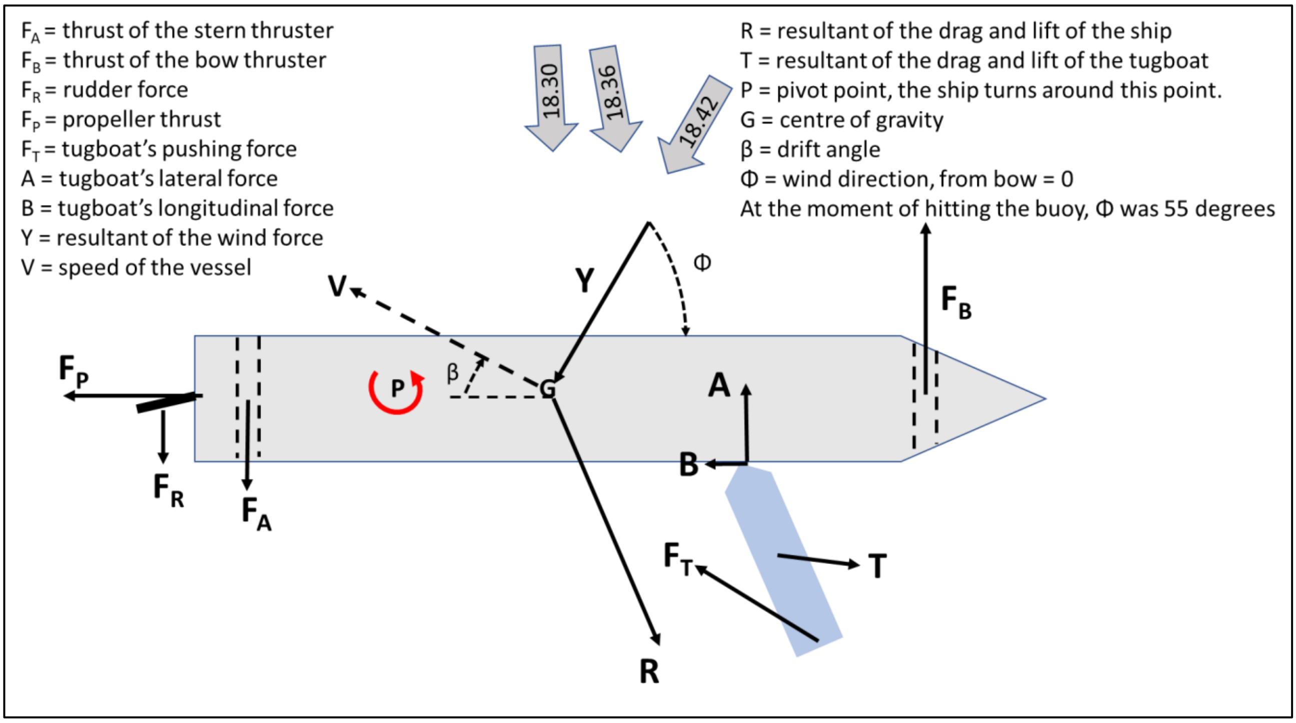
Picture 15. MV Priamos after drifting to the shallows. Tugboat Viikari can be seen on the left. (Screen capture from a video: HaminaKotka Satama Oy)

2.2.3 Forces affecting the vessel during piloting

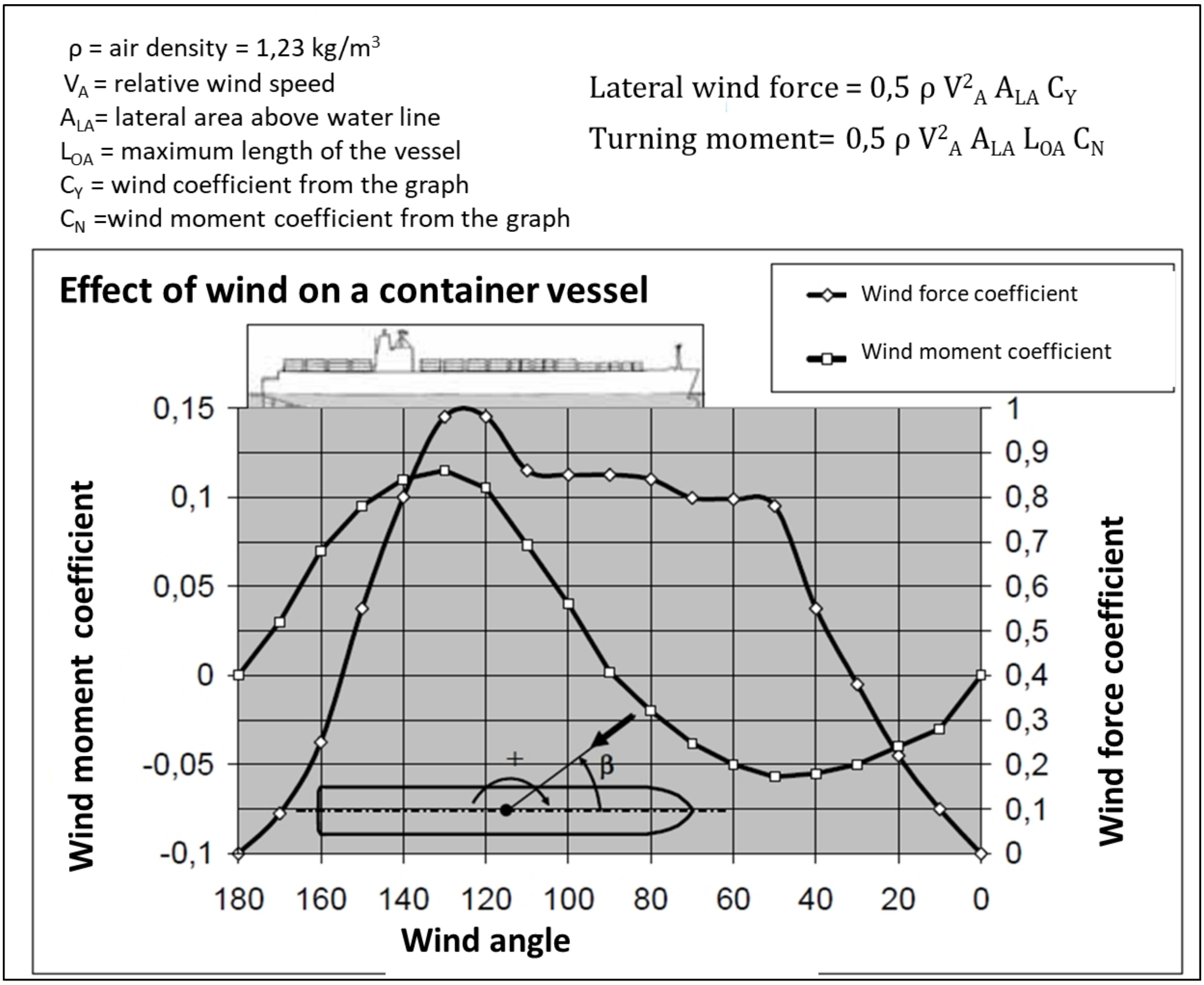
After the vessel departed the quay, it was affected by the wind and the water resistance. The vessel's propulsion and steering systems and the tugboat were used in an attempt to manoeuvre the vessel in a controlled manner to the fairway in a position from which it could had continued its journey. The vessel turned around point P (pivot point). The vessels direction of movement and the forces affecting it determine the location of the point. The point moves when the direction of movement and the forces affecting the vessel change. When the vessel was being reversed, the pivot point was to the aft of the midships.

The manufacturer of the thrusters has stated that the maximum thrust of the thrusters when the vessel is at a standstill is around 132 kN at the bow and around 61 kN at the stern.

The tugboat's pushing point against the side of the vessel affects the turning moment achieved: in order to produce maximum moment, the tugboat should be as close to the bow as possible. However, the shapes of the vessel's bow and stern sections, the strength of the structures and the structure of the tugboat's bow place limitations to the possible pushing points. In the case of MV Priamos, the allowed pushing area reached from side frame 50 frame 128 (Figure 5). Because MV Priamos was reversing, the tugboat had to direct its pushing to the side in order to balance the drag and lift of the tugboat's hull. For this reason, MV Priamos was subjected to force A, which was at most half of the tugboat's pushing power (SBP), while force B increasing the reversing speed of MV Priamos was also generated.



Picture 16. The resultant of the wind force, the resultant of the hull's drag and lift, and the forces of the propeller and the steering systems that affected MV Priamos. The tugboat's pushing generated forces A and B affecting MV Priamos. The thick arrows indicate the wind direction relative to the vessel at three points in time. (Picture: SIA)



Picture 17. A schematic of the wind's effect on the container ship. (Picture: SIA[15])

The forces and moments generated by the water's resistance, the hull's lift and the wind and the steering forces including the forces generated by the tugboat affected the mass comprising the vessel's displacement and the water moving with it. As the velocity increases, the kinetic energy of this mass increases proportionally to the square of the velocity, due to which controlling the vessel's state of motion becomes more difficult and slower. The strengths of the forces and moments varied constantly with the vessel's position and movements. Hydrodynamic calculation methods can be used to simulate the vessel's motion if sufficient data on the initial situation is available (Section 2.8.1 of the investigation report).

Figure 17 describes the principle of the wind's effect. The basic shapes of the curves describing the wind's effect are the same for the vessels. Vessel type and the positioning of cargo on deck cause vessel-specific differences. Crosswind has the strongest effect at an angle of attack from around 50 to 140 degrees. The turning moment is lowest when the wind comes almost directly from the side. Wind coming obliquely from the aft (110 to 160 degrees) has the strongest turning effect on container ships. In the case presented in the figure, a crosswind from the bow (30 to 50 degrees) has half the effect.

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15 Safety Investigation Authority, Finland (2003) *Tugboat PEGASOS, capsizing and sinking off Helsinki on 13 November 2003*. Investigation report B2/2003M.

2.2.4 Piloting practices

A pilot familiar with the fairway acts as the master's adviser on board the vessel. According to the Maritime Act, the master is responsible for the vessel also during piloting.

The pilot and the master agree on to what degree the pilot participates in steering the vessel before piloting begins. With the master's consent and under his supervision, the pilot may use the vessel's controls and navigation systems, also during the vessel's departure and arrival. According to best practices, the pilot keeps the master up to date on what he or she is doing, while the master advices the pilot on the vessel's steering characteristics and any other information necessary for piloting. In Finland, the pilot typically communicates with the tugboat's master in Finnish or Swedish, so masters who do not understand these languages will not understand the communications.

Before beginning piloting, the pilot makes an assessment on whether the conditions are safe enough. Should the pilot refuse to pilot or decide to interrupt piloting, the pilot notifies his or her superior on duty. After a discussion with the superior, the information is relayed to the Pilot Order Centre, VTS and the Pilotage Director. If piloting is interrupted en route, VTS and the Pilot Order Centre must be notified immediately. The port and the vessel agent are also immediately notified of the matter.

The general principles of pilotage are global. Piloting practices have gradually changed so that the pilots manoeuvre vessels in ports more often than before in compliance with masters' wish.

2.2.5 Towing practices

If, upon arrival at port, the vessel can be turned without disrupting cargo operations so that it can depart the port without tugboat assistance, this is usually done in order to save money. If the port does not offer continuous tugboat assistance services, vessels have to separately order a tugboat. The assisted vehicle then pays for the tugboat's transit and assistance.

Foreign vessels often want a tugboat when arriving at port if the master recognises the local conditions as difficult or hears about the conditions from the pilot. In smaller ports, getting a suitable tugboat to provide assistance may take several hours. The tugboat is usually present around 10 minutes before departure, at which time the pilot must also be present.

Due to the cost, the threshold for using a tugboat is rather high. Masters do not wish to order a tugboat in advance while ordering a pilot, because using a tugboat is a cost item they want to avoid. Tugboat costs may also affect the master's own earnings. It is a common practice in chartering contracts to guarantee a bonus to the master if he or she does not use a tugboat when mooring the vessel.

Taking the towed vessel into consideration, towing operations can be grouped into a few main groups. Towing assistance to vessels with their own propulsion machinery is used in all of Finland's international ports. There are large differences in the entrances to the ports, likewise in their docks and quays.

In normal weather conditions, passenger and cargo ferries and container ships involved in liner shipping do not require tugboat assistance. Icy conditions and strong winds may make using a tugboat necessary for these vessels as well. In the case of large vessels, several tugboats are often required to assist the vessel, and port-specific requirements may have been set on the power and type of the tugboats. The cargo on board the vessels also affects the need for towing.

2.3 The people, organisations and safety management

2.3.1 The roles of the involved people in the accident

The **master** has worked as a seaman for 36 years, of which 11 years as a master. The master had previously visited Mussalo several times and steered vessels out of the quay. He was on this vessel for the first time. The master ordered a tugboat due to the strong wind, but did not specify the tugboat type in any detail. The master, the pilot and the tugboat's master agreed that the tugboat will not attach itself to MV Priamos. The master and the pilot did not communicate during the turn. The master has normally manoeuvred in ports with the pilot giving advice, but now the pilot took control of the vessel, and the master stayed watching over. After the collision with the buoy, the master felt the vessel's hull vibrating while the propeller was turning. The master wanted to stop the main engine, but the pilot wanted to continue running forward. Finally, the pilot turned the propeller pitch to zero, and the master gave the chief engineer the order to stop the main engine. The vessel drifted towards the shallows. The master gave the order to drop anchor at the pilot's request. Despite the anchor, the vessel drifted into the shallows. The master ordered the crew to inspect the vessel for any leaks and notified the shipping company of the incident.

The **first mate** has acted in his position from 2010. He had worked on MV Priamos two times, but this was the first time with this master. The first mate gave the Pilot Card to the pilot who signed it. At the master's request, the first mate used a radiophone to check the readiness of the stern and bow crews for departure, and reported their readiness to the master and the pilot. He asked the bow and stern watchmen to keep an eye on the vessel's movement and distances to obstacles; particularly the green ice buoy at the stern and the corner of the quay at the bow. He relayed the received information to the master and the pilot; green buoy at 10 m distances until the distance was down to 5 m, after which the collision occurred. He asked the second mate, who was at the stern, whether the buoy was visible, and was told that the buoy was underneath the vessel. Clanks could be heard and vibrations could be felt. The first mate moved to the right side of the bridge and watched whether the vessel had bypassed the buoy. He was ordered to prepare to drop anchor. Finally, the first mate asked the second mate to go to the bow and assist in dropping anchor.

The **second mate** had previously acted as the third mate on MV Priamos. He had started his seaman's career in 2011. During the accident, he was keeping watch at the stern of the vessel, reporting distances[16] to the green buoy. After the collision, he moved to the bow to direct anchoring and keep contact with the bridge once the third mate had come to relieve him from the stern of the vessel. Under his direction, tugboat Viikari's towing cable was attached to the bow of MV Priamos.

The **third mate** had worked on MV Priamos for 3 months under this master. He has 16 months of experience as an officer. When the accident occurred, he woke up in his cabin to an unusual noise and heard that the vessel had hit a buoy. After dressing, he took the second mate's place at the stern of the vessel to monitor the situation. After the vessel had dropped anchor, he saw the buoy appear. When the anchor was being weighed, he reported distances to the buoy to the bridge.

The **bosun** had recently come to work on the vessel, but was familiar with the vessel type. The deckhands dropped anchor under the bosun's supervision. This was his first time dropping anchor on this vessel.

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[16] "Distance" does not indicate lateral position.

The **chief engineer** had worked as a chief engineer since 2010 and had just come to work on the vessel. During the accident, he was in the engine control room and noticed the collision with the buoy from a loud noise and a change in the vessel's movement. He stopped the main engine after being given the order to do so by the master.

The **pilot** has worked as a seaman for 30 years. He received the qualification of a Master Mariner in 1996, which was renewed in 2001. He has worked as a pilot since 2004. In Kotka, he has piloted full time around the year for about two years. He piloted 71 times in 2017, mostly later in the year, and 251 times in 2018, one of which was on 23–24 May when he piloted MV Priamos from Mussalo to Orrengrund. He acts as the Senior Pilot at the Kotka pilot station.

On 12 September 2018, having received an assignment from the Pilot Order Service, he set out from home to MV Priamos that was departing at 18:30hrs. He checked the wind conditions in the normal manner using the tablet application for pilots (Ilmanet). After boarding the vessel, he signed the Pilot Card and assumed control of the vessel's steering. Before the vessel's departure, the pilot, the master of the vessel and the master of the tugboat discussed how the assistance should be provided. The pilot had previously worked with the tugboat Viikari and was familiar with its way of working. It was agreed that the tugboat will not attach itself to MV Priamos with a cable but instead works at its side, pushing at the pilot's request. During the turn, the pilot received a call (a liferaft that had separated from a pilot cutter), which momentarily distracted his concentration on piloting. During the assistance, the pilot and the tugboat's master talked in Finnish. There were no discussions about the high wind on the bridge. Previously, there had been no problems in piloting in similar conditions. The pilot steered the vessel from the left wing steering console that does not have an ECDIS[17] display. He had a tablet computer that he had connected to the vessel's AIS output.

The **master of the tugboat** had worked as a seaman for 10 years, of which he had worked two years in Kotka as a tugboat's master. In 2017, he had been issued an STCW II/3 qualification. The master of the tugboat had not previously assisted MV Priamos. He had familiarised himself with MV Priamos's steering characteristics from the information on the Pilot Card. The master of the tugboat carried out the pilot's requests but otherwise, they did not talk much during the incident.

2.3.2 Safety management on the vessel

The shipping company had prepared a checklist for the officers of MV Priamos that should be gone through upon the vessel's departure. Among other things, the checklist includes the matters that must be gone through with the pilot and the master of a tugboat.

The shipping company has also prepared separate instructions for the vessel's crew on work tasks that are performed upon departure. According to the instructions, the master of the vessel should supervise and monitor the pilots actions and the speed and route of the vessel during piloting.

Additionally, the vessel had instructions intended for the master in case of emergencies such as bottom contact.

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[17] ECDIS (Electronic Chart Display and Information System) is a type-approved electronic chart device commonly used in navigation.

2.3.3 Agency

Dahlberg's Agency acted as the representative of the vessel's charterer (Unifeeder) in the Port of Kotka. On the day of the accident, the loading of MV Priamos had been interrupted a couple of times due to high winds. At first, a decision was made to complete the loading as overtime. At 16:45hrs, Unifeeder informed the agent that there was no time to complete the loading. The loading was to be interrupted and a pilot ordered. Due to the urgency, the agent checked when the pilot would make it aboard the vessel and was told it would be at 18:30hrs. He asked the master of the vessel whether a tugboat would be needed. The master told him that he would need one tugboat due to the high winds. At 16:50hrs, the agent relayed the need for a tugboat to the duty clerk of the tugboat company Alfon Håkans AS. Tugboat Viikari was available and was informed that the vessel will depart at 18:30hrs. The master of MV Priamos had not specified the characteristics of the tugboat he needed. At 17:08hrs, the agent informed the charterer that the vessel will depart at 18:30hrs, which was the earliest time the pilot would arrive.

Soon after the collision with the buoy, the master of MV Priamos called the agent, informing him of the incident and that he will need a berth again.

2.3.4 Pilotage company

During the accident, MV Priamos was piloted by a pilot from Finnpilot Pilotage Oy. Finnpilot Pilotage Oy is a pilotage company wholly owned by the State of Finland. No other pilotage companies operate in Finland. Finnpilot Pilotage Oy offers pilot services to vessels moving in the Finnish archipelago routes and ports. The key stakeholders of Finnpilot Pilotage Oy are the shipping companies, ship-brokers (agents) and ports. In 2017, the company employed 143 pilots.

Kotka is one of the company's six pilotage areas. In Kotka, Finnpilot Pilotage Oy provided piloting services 4,498 times in 2017, which constituted just under one fifth of the company's piloting for the entire year.

Finnpilot Pilotage Oy has a quality management system (ISO 9001) and an internal management system. Piloting operations are conducted according to an operation manual and to a safety handbook for pilot boats. Finnpilot Pilotage Oy has been collecting incident reports from the pilots since 2011. In 2017, the pilots submitted 1,552 incident observations. Finnpilot Pilotage Oy has handled the cases internally and given feedback to the report submitters.

Finnpilot Pilotage Oy supplied 45 incident reports from pilots concerning Mussalo from 2011 onwards. A majority of the 45 incidents occurred upon arrival to the quay. In many cases, the cause of the hazardous situation was the stopping of the main engine, a disruption in electricity supply or the weak or insufficient power of a manoeuvring thruster.

In addition to MV Priamos, there have been two cases involving reversing out from the quay. In the first incident on 2 July 2014, the vessel hit a beacon while reversing. The beacon was not damaged. The length of the vessel was 120 m and there was a strong breeze. In the second incident on 5 October 2016, the tugboat lost power in one of its two propulsion systems, causing a near miss with a beacon. The wind speed was low and the length of the vessel was 216 m.

Finnpilot Pilotage Oy and HaminaKotka Satama Oy have not exchanged a lot of safety information. One meeting per year has been organised with the port.

Finnpilot Pilotage Oy selects pilot training applicants through a selection process. Applicants selected for training start with a six-month orientation period of a pilot trainee, instructed by the Regional Senior Pilot. The orientation is specific to a pilotage area. Route navigation is practised by navigating the route in both directions instructed by an experienced pilot and by completing simulator exercises. The practising includes also training in manoeuvring in ports. After the orientation and the pilot trainee training, the trainee takes the piloting examination[18] and, upon passing the examination, the pilot trainee is granted a pilot licence. In 2018, Finnpilot Pilotage Oy began Bridge Resource Management (BRM) training tailored for pilots.

Together with the Finnish Transport Infrastructure Agency, Finnpilot Pilotage Oy participates in the planning of routes and gives suggestions for the improvement of existing routes as required by, for example, the increasing vessel sizes, growing traffic volumes and stricter safety regulations. Ports do not necessary consult the pilotage company when expanding.

Finnpilot Pilotage Oy has a crisis support procedure for accidents. After the accident, the pilot reported the incident to Finnpilot Pilotage Oy's Pilotage Director. The Pilotage Director reviewed the incident with the pilot. During the defusing discussion, the pilot was assessed to be able to continue piloting work immediately. The pilot's next piloting assignment was on 13 September. The pilot received crisis help in the form of a debriefing from a professional according to Finnpilot Pilotage Oy's practices.

Finnpilot Pilotage Oy has several regulations restricting piloting[19]. The weather restrictions are based on real-time wind data produced by the Finnish Meteorological Institute and the wind speed forecasts of FMI's Ilmanet service, and estimates of significant wave height.

In the **Kotka pilotage area**, Finnpilot Pilotage Oy had weather restrictions on pilotage at the Veitkari pilot boarding area (15 m/s) and vessel-specific restrictions for large car carriers (Hietanen 12 m/s).

In the **Helsinki pilotage area**, the Emäsalo pilot station has a wind speed limit of 23 m/s for southerly winds and a wave height limit of 3.2 m, but they are not binding. The same indicative restriction applies to the Helsinki pilot stations and the Porkkala pilot station. Additionally, there are vessel-type-specific indicative restrictions in Helsinki and Porkkala. There are separate instructions for Kustaanmiekka.

With respect to the City of Uusikaupunki in the **Archipelago Sea pilotage area**, a 17 m/s wind speed limit has been set in the Isokari pilot boarding area and a 15 m/s wind speed limit in the Hepokari port area for car carriers. In the case of the bulk carriers of Yara Uusikaupunki, weather restrictions are discussed when the pilot considers it necessary due to the conditions (wind speed, wind direction, visibility, daylight). Representatives of the port and the agent take part in the discussion.

The Turku Repair Yard has a maximum wind speed limit of 6 to 8 m/s for large vessels (> 20,000 dwt). In Utö, pilotage is possible up to a wind speed of 25 m/s. In high southerly winds, vessels are taken to the north side of the pilot boarding area, to the so-called Utö port line, for the pilot's boarding.

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18 The piloting examination that is required for being granted a pilot licence comprises a blank chart examination, a written examination and an examination in a ship simulator. Regulation TRAFI/57228/03.04.01.00/2015.

19 Ports have restrictions on vessel traffic based on, for example, weather and the water level.

Wind speed limits for escort-towed vessels in the Archipelago Sea deep water route have been separately agreed with Neste Oy as follows: maximum wind speed 18 m/s average and 23 m/s during gusts. On entry into Naantali, the maximum significant wave height is 3 m.

In the **Bothnian Sea pilotage area**, the pilots on duty at the pilot station assess the situation under the direction of their superiors when weather conditions worsen and decide on restrictions. Relevant factors include wind direction, wave height and ice conditions. A decision to interrupt piloting can be made port or route specifically, or restrictions can be set on a specific vessel type, for example due to a large wind area. In practice, operations in the Bothnian Sea are restricted by winds with an average speed over 20 m/s.

In the **Bothnian Bay pilotage area**, discussion on shutting down the piloting service begins at all stations when wind speed reaches 20 m/s, and the piloting service is shut down when wind speed reaches 22 m/s (10 min average wind speed). Small vessels and vessels in ballast are assessed on a case-by-case basis. They reach the wind speed limit earlier. The pilot stations have station-specifically determined impactful wind directions. There are also port-specific restrictions in the Bothnian Bay pilotage area that are lower than the restrictions related to the shutting down of the piloting service. These can be found in, for example, Tornio and Kokkola.

2.3.5 Tugboat company

The tugboat Viikari that assisted MV Priamos during the accident is owned by the Alfons Håkans AS shipping company, specialising in tugboat, icebreaking and rescue services. The shipping company is the largest private shipping company operating in Finland based on the size of the company's fleet. The shipping company has a quality system conforming to the ISO 9001 standard, an environmental management system conforming to the ISO 14001 standard, and an occupational safety system conforming to the OHSAS 18001 standard.

The master of the tugboat Viikari took the order. The discussion only touched on the need to get one tugboat and the time. Tugboats are normally ordered two hours before departure, but now the time was shorter. A second, so-called ASD tugboat Castor with higher power was unavailable at that time.

After the accident, the incident was discussed by the company's management and the regional manager, and locally with the pilots. The Alfons Håkans AS shipping company regularly has regional meetings with pilots.

According to the safety management instructions of the company's Kotka port organisation, the master of the tugboat assesses the upcoming assisting task together with the pilot and/or master of the assisted vessel. The instructions include a list of procedures for port assistance. The instructions take the prevailing conditions such as wind direction and speed, the seas, draughts and the limitations set by other port traffic into account. Additionally, the instructions advise to take into account the characteristics of the assisted vessel such as its wind area, engine power and steering characteristics. The instructions describe the number and placement of the tugboats to be used, their power and manoeuvrability, as well as push/pull assistance. An illustrated brochure is available for towing assistance.

Those intending to be a tugboat's master must work as a deckhand and a mate on the company's vessel. The qualification of a new master takes one to two years. On-the-job training includes working on different tugboats and in different ports. The company has a senior chief who is responsible for the simulator and practical training. Simulator training is arranged as necessary, for example when the tugboat types of the ports change.

2.3.6 The port organisation

HaminaKotka Satama Oy is the largest multipurpose port in Finland. A 15.3 metre deep water route leads into the port. There are over 75 berths in the port and a total of around nine kilometres of quays. Mussalo is also the largest container port in Finland. Nearly half of Finland's container traffic passes through Mussalo.

There are storage facilities in connection with the Mussalo container terminal for the handling, containerisation and storage of export and transit goods. There are also warehouses in direct connection with the VR Track rail network.

HaminaKotka Satama Oy has a quality system conforming to the ISO 9001 standard and an environmental management system conforming to the ISO 14001 standard. HaminaKotka Satama Oy's security procedures (ISPS[20]) fulfil the requirements of international and national regulations on the security measures of vessels and port facilities. The secure and smooth operation of port aims to ensure the efficient operation of the whole transport chain.

HaminaKotka Satama Oy has specified minimum requirements for tugs used in the area including their suitability for ice breaking and for assisting vessels visiting the port in open water and ice conditions[21]. The port does not determine the type of tug to be used for assistance.

In addition to laws and regulations, port operations are also controlled by the port ordinance that states that when necessary, tugboat assistance must be used during mooring and unmooring. The port authority can also in specific circumstances order a vessel to use tugboat assistance[22]. The costs of tugboat assistance are always charged from the vessel. The master of the vessel usually makes the decision on whether to use tugboat assistance or not. The use of tugboats aims to increase the safety of maritime transport and manage the risks.

In the port area planning projects interest groups will be communicated including pilots.

2.4 Actions of the authorities

2.4.1 The Finnish Transport Infrastructure Agency

The Finnish Transport Infrastructure Agency is responsible for ordering the Vessel Traffic Service (VTS). VTS- services are provided by Vessel Traffic Services Finland Oy. Fairway maintenance includes the maintenance of maritime safety equipment, and its repair, refurbishing and construction. Fairway maintenance also includes the maintenance dredging of the fairways and the planning and investigations of fairways in order to facilitate maintenance.

The Finnish Transport Infrastructure Agency is also responsible for the fairway maintenance of the Kotka area. It has determined the location of the green ice buoy overrun by MV Priamos during the accident, and replaced it with a new one after the accident. The damaged buoy was replaced within the schedule required by the Finnish Transport Infrastructure Agency's own guidelines.

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20 The International Ship and Port Facility Security Code.

21 The power of the main engine must be at least 3000 hp, the static bollard pull at least 30 tons and the ice class 1 A. Moreover, there are requirements for propulsion machinery, suitability for fire-fighting, working against oil spills and in maintenance of maritime safety equipment.

22 The port ordinance, 16§

The Finnish Transport Infrastructure Agency had not previously received information on problems with the buoy damaged in the accident on 12 September 2018, with the exception of a vessel colliding with the buoy around ten years ago. The buoy was damaged also then, but not as badly.

In the planning of new fairways, the Finnish Transport Infrastructure Agency co-operates with the port organisations, Finnpilot Pilotage Oy and subcontractors[23]. The Finnish Transport Infrastructure Agency uses consultants in the planning of fairways, and they perform the majority of the planning work. The planning takes into consideration the room vessels and assisting tugboats need to operate. The dimensions of a theoretical design vessel are used as assistance.

The Finnish Transport Infrastructure Agency obtains information on the usability of the fairways via the usability surveys it conducts. Fairways are also examined on location together with the pilots. The Finnish Transport Infrastructure Agency also receives direct feedback from the fairway users.

The Finnish Transport Infrastructure Agency has a procedure for seafarers to notify the deficiencies of the maritime safety equipment. About one thousand safety equipment are distance -controlled and this is expanding. This complements the information about the deficiencies of the safety equipment notified by pilots or seafarers. In addition, there are regular inquiries for fairway users.

However, there are no agreed procedures for incident management between the pilotage organisation and the Finnish Transport Infrastructure Agency. The Finnish Transport Infrastructure Agency also receives information on fairway deficiencies from the agents of shipping companies, but some of the deficiencies reported by agents are the responsibility of port organisations., In the Finnish Transport Infrastructure Agency's estimation, it has been able to correct any detected deficiencies in fairway maintenance promptly.

2.4.2 The Finnish Transport and Communications Agency

The Finnish Transport and Communications Agency monitors compliance with the Pilotage Act[24] and the rules and regulations issued under it. Its duties include the granting of pilot licences, pilotage exemption certificates, pilotage exemptions and Baltic Sea pilot licences and the related examinations; maintaining a list of pilot licences, pilotage exemption certificates and exemptions, derogations to compulsory pilotage and duty to provide pilotage services; and issuing regulations concerning pilotage. The Finnish Transport and Communications Agency has issued a regulation[25] on the fairways requiring pilotage and pilot boarding areas.

The Finnish Transport and Communications Agency is entitled to obtain the information necessary for the supervision of operations from the organiser of piloting examinations and carry out inspections at the organiser's training facilities on which examinations referred to in this Act are organised, and to be present during the examinations.

In 2011, Finnpilot Pilotage Oy asked the Finnish Transport and Communications Agency interpretation of a piloting practice in which the pilot operates the vessel's bridge equipment during a piloting assignment. At that time, the Finnish Transport and Communications Agency replied to Finnpilot that on the vessel, the pilot acts as an adviser to the master and does not replace any member of the bridge watch while piloting. According to the Finnish Transport

[23] Instruction Dnro 485/070/2012 by The Finnish Transport Agency
[24] 940/2003.
[25] TRAFI/6915/03.04.01.00/2013.

and Communications Agency, the bridge watch personnel must assist and guide the pilot in the use of the navigation equipment as necessary.

In 2014, at the request of Finnpilot Pilotage Oy, the Finnish Transport and Communications Agency specified its interpretation. According to the Agency, the pilot must inform the master or the watch officer of the actions he or she takes. According to the Finnish Transport and Communications Agency, navigation equipment also includes the helm, autopilot and the speed and propeller pitch controls. According to the Agency, the use of such equipment requires not only the master's permission, but also, for example, that the pilot knows how to use it.

2.4.3 Ministry of Transport and Communications

Pursuant to the Pilotage Act, the Ministry of Transport and Communications is responsible for the general steering and development of pilotage[26].

2.5 Rescue service organisations and readiness

Maritime Rescue Coordination Centres under the Finnish Border Guard (MRCC Turku, MRSC Helsinki) coordinate maritime SAR operations. The Helsinki Maritime Rescue Sub Centre (MRSC) maintains an around-the-clock readiness to coordinate in the Gulf of Finland region. In regular maritime SAR situations, the personnel of the MRCC handle the coordination of the mission independently. Depending on the nature of the mission and particularly in situations where rescue service personnel are needed, the executive fire officer on duty in the local area of operations is alerted to the centre.

Pursuant to the Act on Oil Pollution Response[27], the **Kymi Rescue Department** is responsible for the prevention of land-based oil spills and oil spills from ships in the archipelago and on the coast in its area. According to the Act on Oil Pollution Response, the prevention and response operations shall be managed by the rescue authority of the rescue service region where the oil spill or risk incident first occurred. In the Kotka and Hamina region, the department has eight oil spill prevention vessels, lighter boats and other boom and prevention equipment required in oil spill prevention. In urgent cases, some of the boats can be crewed immediately from the work shifts. Additionally, off-duty personnel from contract fire departments and the rescue department are alerted for the missions.

According to the Act on Oil Pollution Response, regional rescue services must have a plan in place for the prevention of and response to land-based oil spills and to oil spills from ships, where necessary. The oil spill prevention and response plan of the Kymi Rescue Department was confirmed for use from the beginning of 2019, but it was already followed at the time of the accident. The oil spill prevention and response plan include information on the different oil spill response authorities and their duties, a statement on the level of preparedness and on the organisation of the prevention and response operations, and information on the oil spill prevention and response equipment. The rescue department supervises preparedness for oil spill prevention and response in its area. Pursuant to the Act on Oil Pollution Response, the Kymenlaakso Rescue Department is the authority managing the recovery operations designated by the municipalities in the region.

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[26] 1312/2016.
[27] 1673/2009.

2.6 Recordings

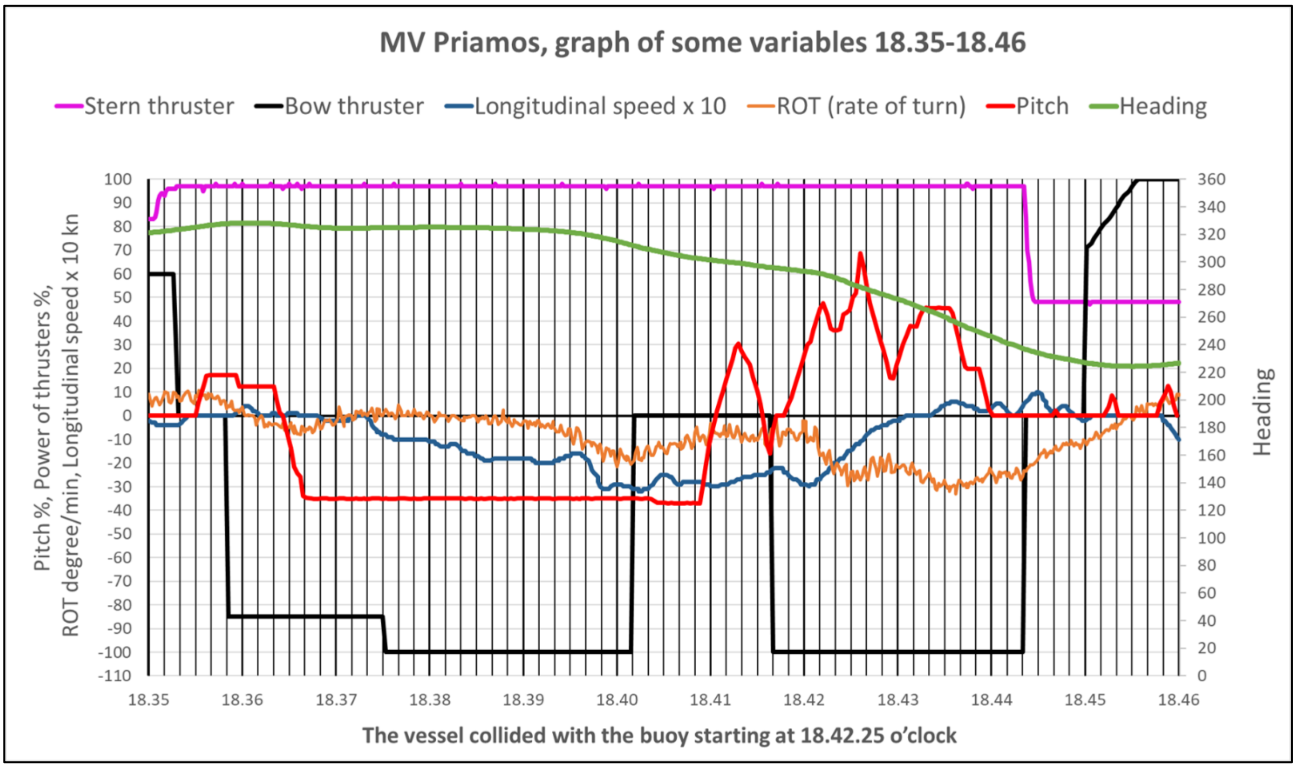
The record data is presented in Finnish daylight savings time (UTC[28] + 3).

2.6.1 VDR

The data on MV Priamos's VDR (Voyage Data Recorder) was retrieved in order to investigate the operation of the vessel's systems, the steering actions and the discussions on the bridge. The time period between 18:35hrs (mooring cables cast off) and 18:46hrs (around 4 minutes after the collision) of the VDR data was selected for investigation. The use of the manoeuvring thrusters, the main engine and the rudder, the vessel's movements and the discussions on the bridge were determined from the records.

With respect to the bow thruster, there were differences in the numerical VDR values and the values shown on the display of the VDR software. With respect to the manoeuvring thrusters, the values read from the display were logical: the thrusts of the stern and bow thrusters were in opposite directions, due to which the value read from the display of the VDR software is presented in Figure 18.

Figure 18 indicates that after 18:39hrs, the tugboat's pushing started to have an effect as an addition to the bow thruster, and the vessel started to slowly turn to the left (the ROT and Heading curves). The stopping of the bow thruster at 18:40.20hrs is visible as the slowing down of the rate of turn.



Picture 18. Variabels of MV Priamos's state of motion from the VDR data. (Picture: SIA)

[28] UTC, Universal Time Coordinated.

The effect of the rudder was minor while the vessel was reversing. The vessel's rate of turn (ROT) to the left was mostly 0 to 10 degrees per minute in the above-mentioned time period, but it reached a maximum of 30 degrees per minute prior to the collision.

The bow thruster was operated as follows:

- At 18.35hrs, the bow thruster thrust left at 60% power until 18:35.20hrs
- It was disengaged from 18:35.20hrs to 18:35.50hrs
- From 18:35.50hrs to 18:37.30hrs it thrust right at 85% power, after which it thrust right at 100% power until 18:40.10hrs.
- It was disengaged from 18:40.10hrs to 18:41.40hrs; the reason for this could not be determined
- From 18:41.40hrs to 18:44.20 hrs, it thrust right at 100% power
- It was disengaged from 18:44.20hrs to 18:45.00hrs, after which it thrust left, at first at 70% power, but gradually the thrust power left increased to 100%.

An attempt was made to use the stern thruster to turn the vessel's stern to the right. The thruster's operation in the propeller stream directed towards the bow and the vessel's increasing speed backwards almost completely eliminated its steering effect, although it was thrusting left at almost 100% power until 18:44.20hrs, and at 50% power from there onwards.

The curve indicating the propeller pitch shows that a 20% change in the pitch takes around 10 seconds. The main engine's rotation speed varied between 220 and 240 RPM during the examined time period.

The propeller pitch indicating the operation of the main engine shows that:

- From 18:35.30hrs to 18:36.40hrs, the propeller pushed the vessel forwards
- From 18:36.40hrs to 18:41.00hrs, the propeller pushed the vessel backwards
- After 18:41.00hrs, the propeller was operated for under half a minute to push the vessel forwards, and then, from 18:42hrs onwards, the propeller pushed the vessel forwards again
- At 18:44.00hrs, the propeller's thrust effect stopped.

The rudder was operated as follows:

- At 18:35.00hrs, the rudder was 15° to the right until 18:35.30hrs
- From 18:35.30hrs to 18:36.50hrs, it was 35° to the left
- From 18:36.50hrs to 18:41.00hrs, it was centred
- From 18:41.00hrs to 18:42.40hrs, it was 21–35° to the left, after which it was damaged and its position varied.

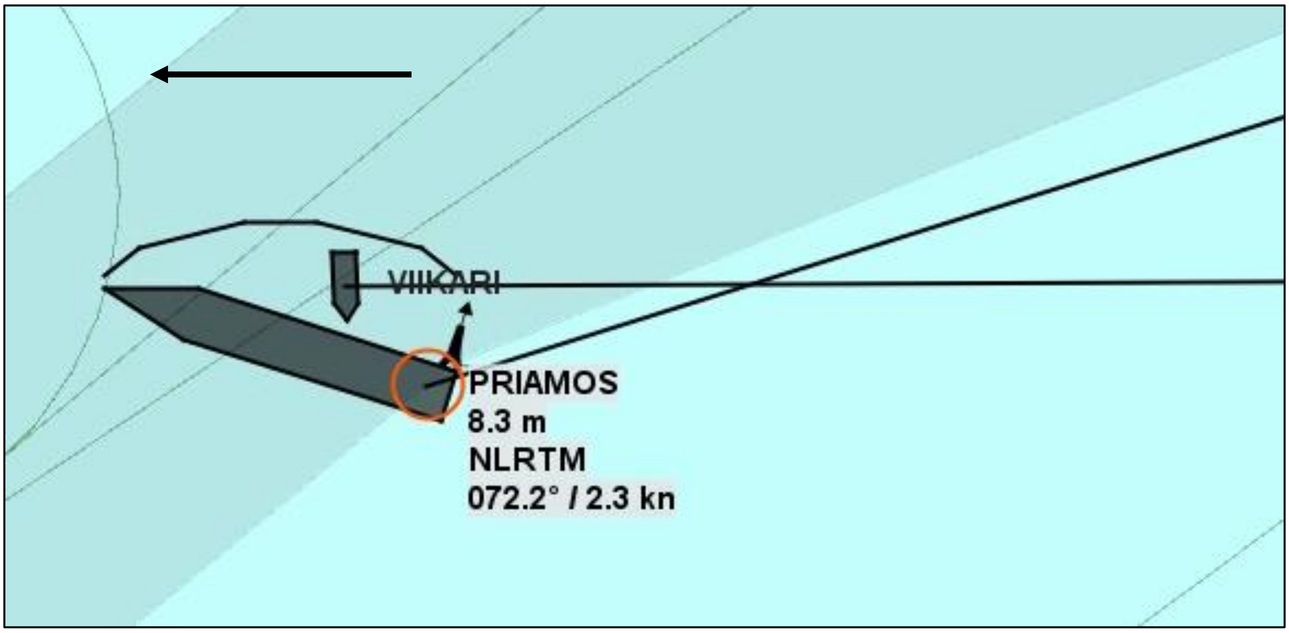
There were five microphones on the bridge, one of which recorded the vessel's radio traffic. In the recordings of the other microphones, only one included talk, unclear at times. According to the recordings, there were not a lot of communications between the bridge officers and with the tugboat's master before the collision with the buoy. Based on the recording, the vessel's master did not intervene in steering the vessel before the collision with the buoy, and the pilot did not ask him for advice. The second mate reported the shortening distance to the green buoy to the bridge via a radiophone. Communications on the bridge and between the bridge and the other crew increased after the collision with the buoy.

2.6.2 VTS

The VTS recordings allowed the recreation of the overall movements of MV Priamos and the tugboat Viikari during the accident. VTS had recorded the vessel's movements and conversations between the pilot and the VTS.

The tugboat Viikari arrived at the vessel's side at around 18:22hrs. The VTS contacted the pilot of MV Priamos at that time. At around 18:31hrs, the speed vector of MV Priamos starts showing movement. At around 18:33hrs, the tugboat is engaged with the side, at around 18:35hrs the tugboat disengages, after which MV Priamos's bow begins to separate from the quay. At 18:41hrs, the bow of MV Priamos passes the corner of the quay. The tugboat is positioned on the bow side of MV Priamos, slightly obliquely, pushing MV Priamos partially towards the stern. MV Priamos turns very slowly, its stern comes close to the buoy at 18:42.15hrs and hits the buoy soon after. Viikari leaves the side of the vessel at around 18:44hrs.

VTS attempted to contact MV Priamos at 18:54hrs and 18:57hrs, but the vessel did not respond. At 19:00hrs, VTS managed to contact the vessel.

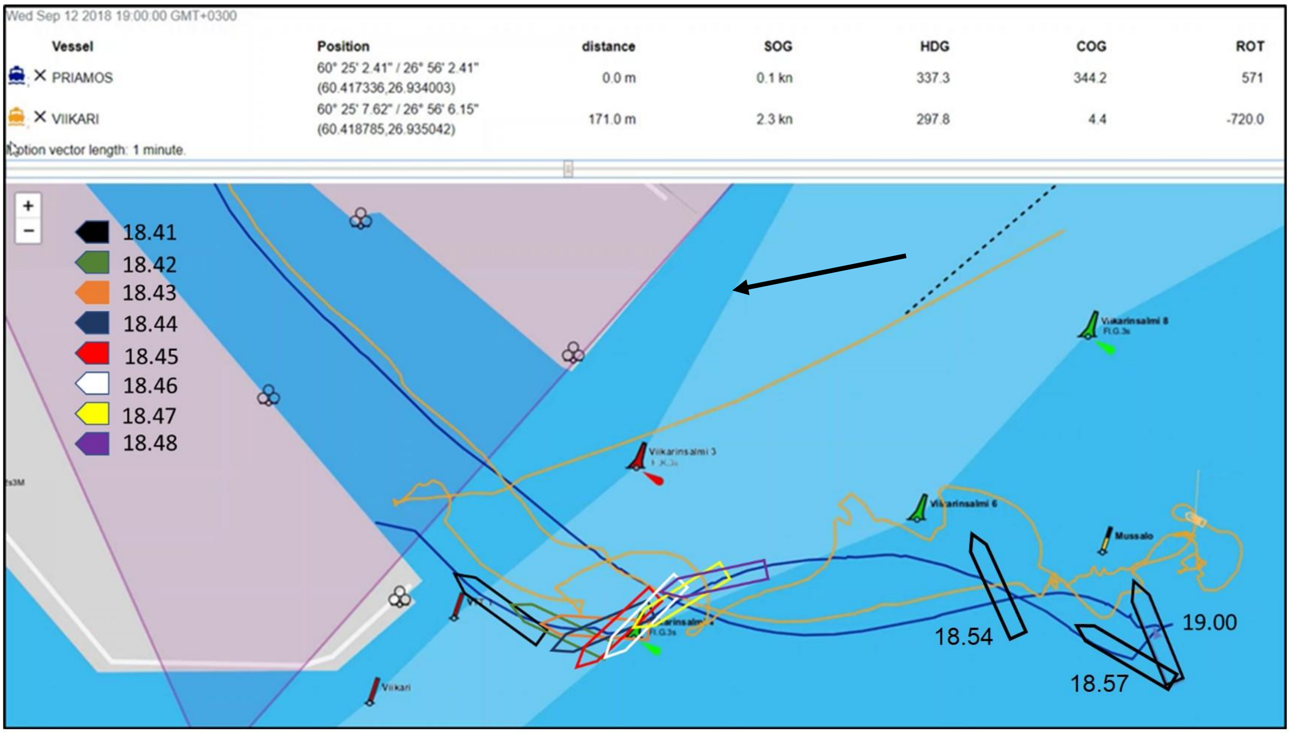


Picture 19. MV Priamos having overrun the buoy at 18:42.30hrs. Viikari's location in the image is only indicative. The pile shows the outer border of the area administered by the port. (Screen capture from a video: Finnish Transport Infrastructure Agency/VTS)

2.6.3 AISLab video

The at AISLab[29]- video provided by Finnpilot Pilotage Oy shows the motions of the centre points of MV Priamos and Viikari between 18:15hrs and 20:06hrs. The video gives a good idea of the vessel's speed and position after it hit the buoy. Based on this video, too, the tugboat Viikari's position is one that pushes MV Priamos backwards and to the side at the same time. The collision with the buoy caused the bend seen in the image in the movement of the vessel's centre point. After the collision, the vessel's speed backwards decreased. The vessel's position and location have been picked from the video at one-minute intervals from 18:41hrs to 18:48 hrs into Figure 20.

[29] Finnpilot Pilotage Oy's system for analysing recorded AIS-data is called AISLab.



Picture 20. MV Priamos's movements at one-minute intervals from 18:41hrs to 18:48hrs. MV Priamos was at a 100 m distance from the buoy at 18:41hrs. Order to drop anchor at 18:54hrs. Anchor began to hold at 18:57hrs. Vessel stopped in the shallows at 19:00hrs. The movement path of MV Priamos's centre point in blue, the movement path of tugboat Viikari in orange. The pile shows the outer border of the area administered by the port. (Screen capture: Finnpilot's AISLab- video at 19:00hrs)

2.6.4 Port video recording

Video recordings obtained from HaminaKotka Satama Oy allowed the examination of the development of the situation and the determination of, for example, the time the vessel's stern hit the buoy, the tugboat's assistance method and the times it pushed the vessel.

HaminaKotka Satama Oy has equipped its Mussalo area with recording video cameras. The timestamp of the video recordings comes from the recorder, and the recorder synchronises its time from Elisa's NTP[30] server. The times determined from the recordings:

18:33hrs Viikari pushes the vessel against the quay during unmooring.

18:34.30hrs Viikari is disengaged from MV Priamos. The vessel's bow starts to separate from the quay.

18:36hrs The stern of MV Priamos starts to separate from the quay.

18:38hrs MV Priamos is roughly parallel to the quay, several metres away, and starts moving backwards.

18:39hrs Viikari starts to push MV Priamos from its right side, around one third of its length from the bow. Viikari does not push directly laterally; instead, its stern is around 15–20° towards the bow. The wash from Viikari's propeller appears to be more to the right. However, its position varies.

[30] Network Time Protocol, a protocol for transmitting precise time data between computer. Each operator has its own server solution. The servers get their times from an external time source, such as VTT MIKES (the National Metrology Institute of Finland).

18:42.25hrs The right side of MV Priamos's stern hits the buoy, which goes under the vessel. Viikari's position starts to be more slanted towards the stern of MV Priamos.

18:43.30hrs The buoy that has come back to the surface hits the stern of MV Priamos again and goes under the vessel.

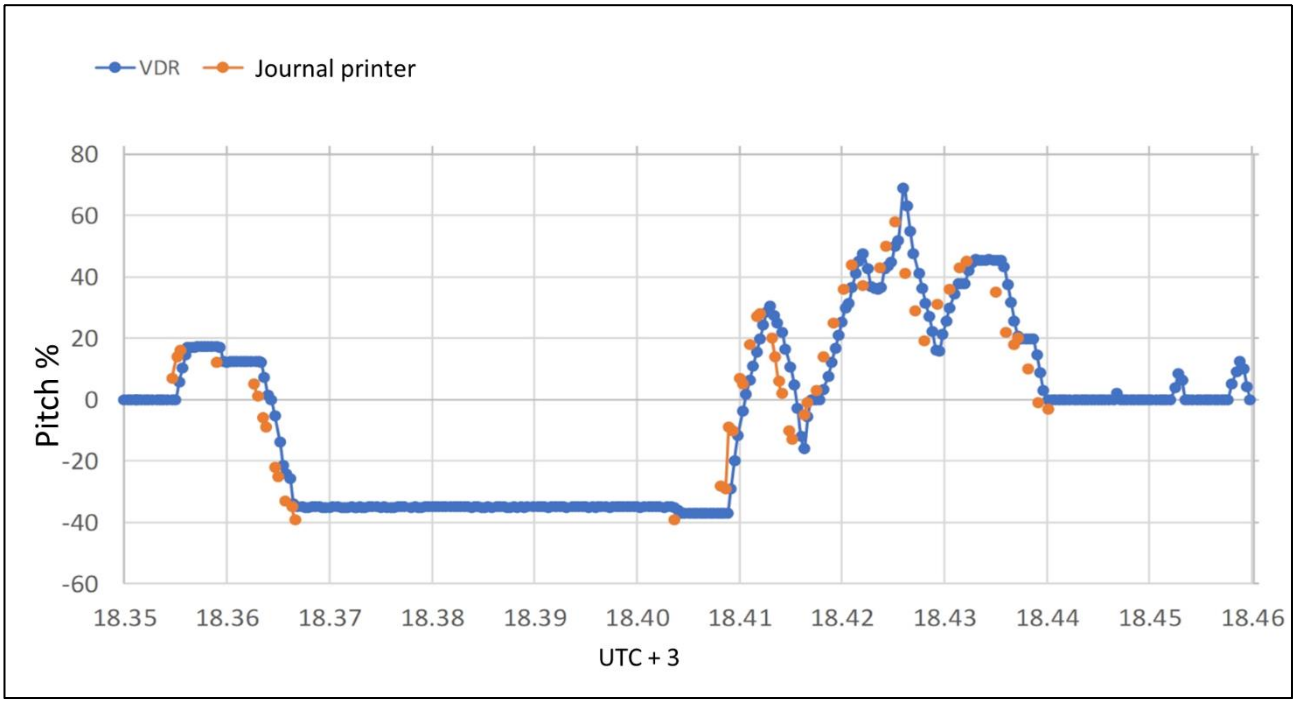
18:44.20hrs Viikari has disengaged from MV Priamos and moves to its other side.

Picture 21. Tugboat Viikari pushing MV Priamos at 18:39.50hrs. (Screen capture from a video: HaminaKotka Port). The small image shows Viikari's position. (Screen capture from a video: Finnpilot AISLap)

Picture 22. Tugboat Viikari pushing MV Priamos at 18:41hrs. (Screen capture from a video: HaminaKotka Port). The small image shows Viikari's position. The distance between the vessel's stern and the buoy is 100 m. (Screen capture from a video: Finnpilot AISLap)

Picture 23. MV Priamos having collided with the buoy at 18:42.36hrs. (Screen capture from a video: HaminaKotka Port). In the small image, Viikari is disengaging from the side of MV Priamos at 18:44.12hrs. (Screen capture from a video: Finnpilot AISLap)

2.6.5 Journal printer



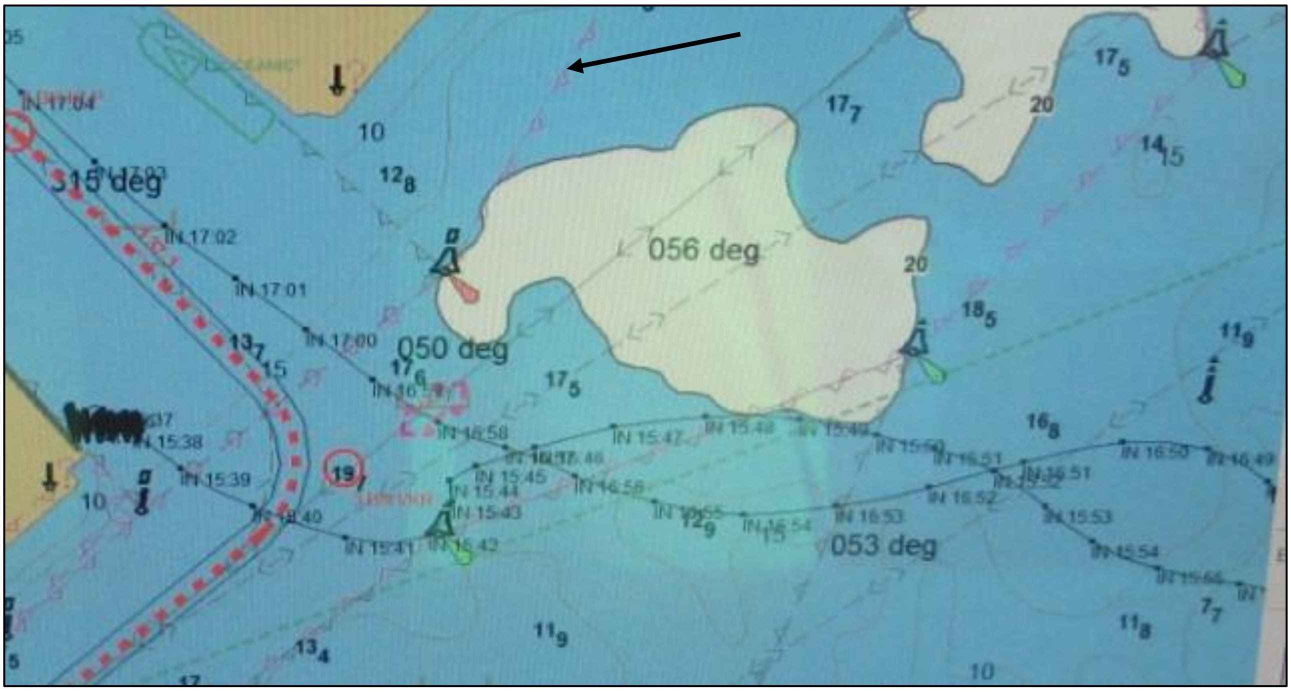
Picture 24. The propeller pitch data from the journal printer and the VDR could be made to match each other by changing the times of the journal printer 13 minutes earlier. (Picture: SIA)

A journal printer printout was obtained from MV Priamos for the time period from 18:17hrs to 19:01hrs. The engine orders given to the vessel's main engine and propeller pitch were examined from it. A comparison of the journal printer's timestamps to the VDR timestamps with respect to propeller pitch (Figure 24) revealed a time difference of around 13 minutes between them. The journal printer data indicated that the main engine was started at 18:17hrs.

2.6.6 ECDIS

The vessel's electronic chart system and its chart of the port area and its vicinity were examined during the investigation. The chart displayed the vessel's actual route as points at one-minute intervals based on the location of the AIS antenna (cf: the route of the AISLab video shows the movement of MV Priamos's centre point).

The AIS antenna was located on the vessel's centre line, around 10 m from the stern of the vessel towards its bow. The times presented in the chart can be converted into Finnish daylight savings time by adding three hours to the times.



Picture 25. The ECDIS chart on the vessel's monitor on 15 September. The pile shows the outer border of the area administered by the port. (Photo: SIA)

2.7 Rules, regulations, instructions and other documents

Pilotage is regulated by the Pilotage Act[31], the purpose of which is to promote the safety of vessel traffic, amongst other things. Pilotage refers to activities related to the steering of vessels in which the pilot acts as an adviser to the vessel's master and as an expert on the local waters and their navigation.

Pilotage company refers to the limited liability company that was established by the Act on Transforming the State Pilotage Enterprise into a Limited Liability Company.

Pilot boarding area refers to an area marked on the charts at the open sea end of a route with compulsory pilotage where the pilot boards or disembarks the vessel, or where the pilot is changed.

[31] 940/2003.

A pilotage company must prepare and maintain an operations manual[32] describing the following: 1) the offering of piloting services; 2) procedures for ensuring the compliance of the pilot with the rights and responsibilities laid down in the Act; 3) pilotage-related information exchange and cooperation with the VTS provider; and 4) actions during accidents and incidents. The operations manual must be sent to the Finnish Transport and Communications Agency before it is taken into use and after each update.

The master of the vessel is responsible for the steering of his or her vessel also when he or she is following instructions related to the steering of the vessel given by a pilot. The master is obligated to provide the pilot with all information that is significant to piloting.

The pilot is responsible for piloting. The pilot must present the master of the piloted vessel with a route plan based on up-to-date charts and other information and instructions necessary for the safe passage of the vessel, and oversee the actions related to the steering and handling of the vessel that are significant to the safety of vessel traffic.

A pilot licence is granted for a maximum of five years, and it can be renewed by application. A pilot is entitled to pilot on the routes for which he or she has been granted a piloting right with a pilot licence issued by the Finnish Transport and Communications Agency.

The Pilotage Act is supplemented by the pilotage decree and the regulations of the Finnish Transport and Communications Agency.

2.8 Other studies

2.8.1 Computational simulation

The Safety Investigation Authority commissioned a simulation of the incident from the consulting firm Simulco Oy in order to estimate the effect of alternative steering actions on the movement path of MV Priamos and the possibility of avoiding collision with the buoy. The separate analysis in question is attached to this investigation report as an annex.

The first objective was to determine a vessel for the simulation that would follow MV Priamos's actual path as closely as possible. The company calibrated the starting point of its simulation by finding hull parameters for a vessel the size of MV Priamos that would cause it to follow the actual path of MV Priamos as closely as possible with the known steering actions and in the conditions that prevailed. The company had data on the vessel and its equipment, its deck load, the wind conditions and the VDR results (Figure 18).

In the calculation, 18 m was used as the water depth (the minimum depth of the route is 17.5 m). A standard propeller equivalent to the propeller of MV Priamos was used. The heading and speed of the vessel were adjusted using propeller pitch, the main engine's rotation speed remained constant. The reversing power was constant. The effect of the wind force on the vessel and its deck load was estimated based on the calculation results for corresponding container ships. The wind direction was 230 degrees and speed 17 m/s. The basic option for the tugboat's location was 25 m from midships towards the bow, and its pushing force was around 50% of the static bollard pull. The thrust from the stern thruster was assumed to be

[32] 1312/2016.

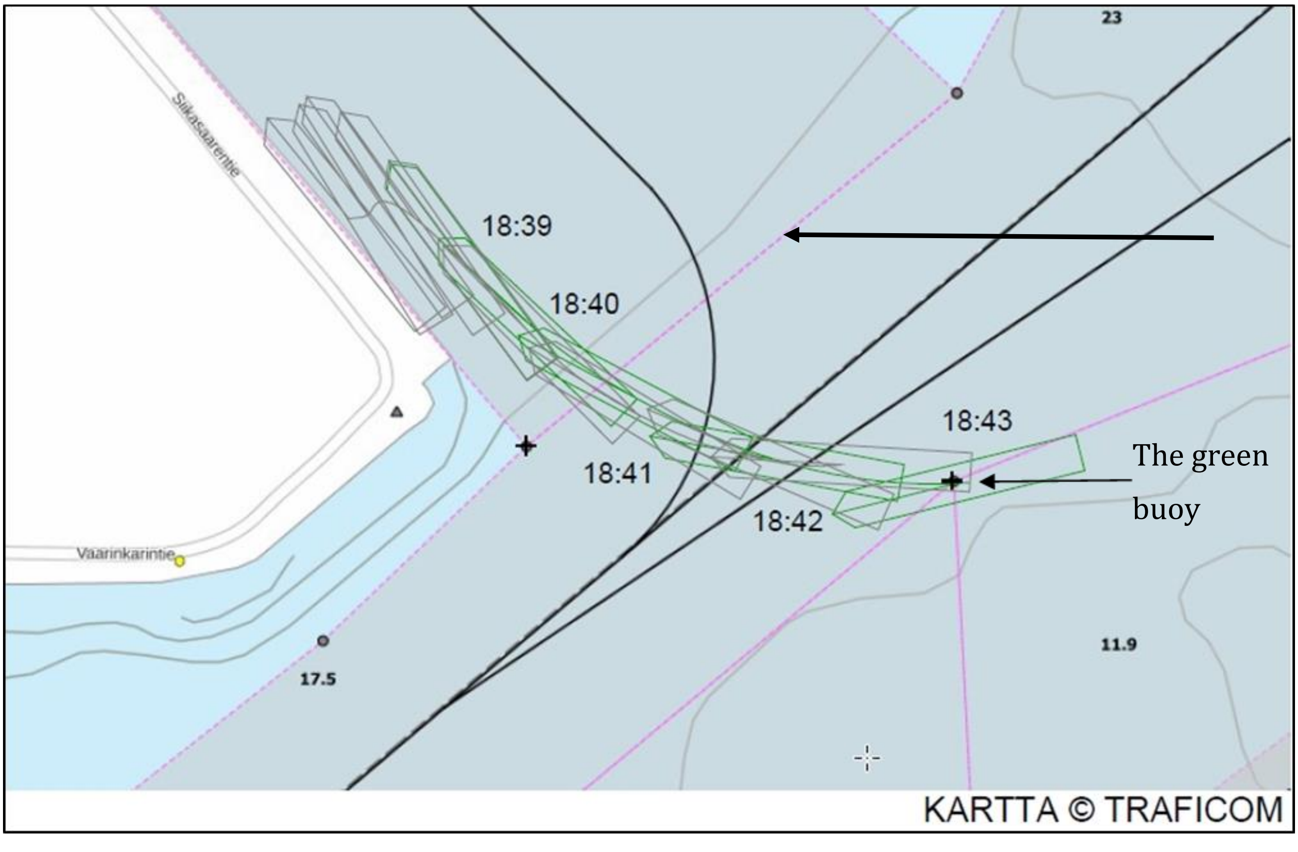
negligible[33]. In the simulation, the rudder was in the centre position, because its steering effect while the vessel is reversing is insignificant.

After this, the company used hydrodynamic modelling to simulate the vessel's passage[34] in the time period from 18:39hrs to 18:42/18:43hrs, from the beginning of the tugboat's pushing to around the time of the collision with the buoy. The effect of the following factors on the vessel's movement path were examined:

- operation of the main engine and the propeller pitch
- operation of the bow and stern thrusters
- operation of the tugboat.

Picture 26 shows the vessel's actual passage that led into a collision (grey) and the nearly identical passage of the simulated vessel (green). This shows that the parameters used in the simulation are sufficiently correct and that the results of the simulation can be considered to be in the right direction for the needs of the investigation.

The green ice buoy is located at the edge of the deep water route's fairway area, beyond which the water depth is sufficient for a majority of vessels departing quays B and C of the Mussalo Port. The buoy could therefore have been passed from either side in the water area with confirmed minimum depth connected to the fairway area.



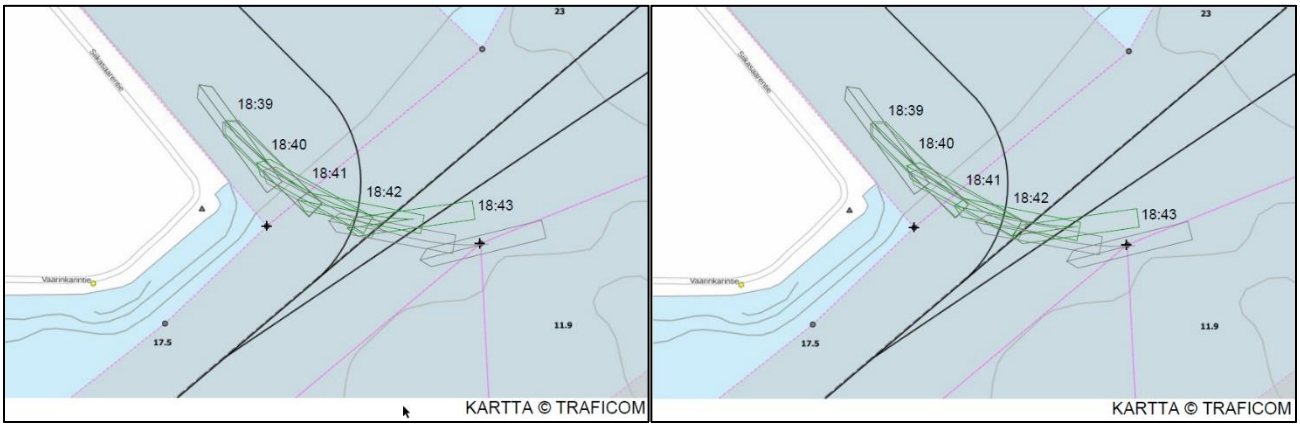
33 An excerpt from the separate analysis: "The location of the stern thruster close to pivot point of the reversing vessel and in the back wash of the propeller pulling backwards greatly reduced its steering power. - - - For this reason, the power of the stern thruster was estimated to be negligible in the MV Priamos simulation calculations."

34 For the movement path calculations, the company used its in-house Naviquatum simulation engine that is used by several maritime training and research simulators. The simulation calculated the vessel's instantaneous accelerations lengthwise and crosswise, and the angular accelerations around the vessel's vertical axis. The velocity components were calculated based on the accelerations, and further, the movement path.

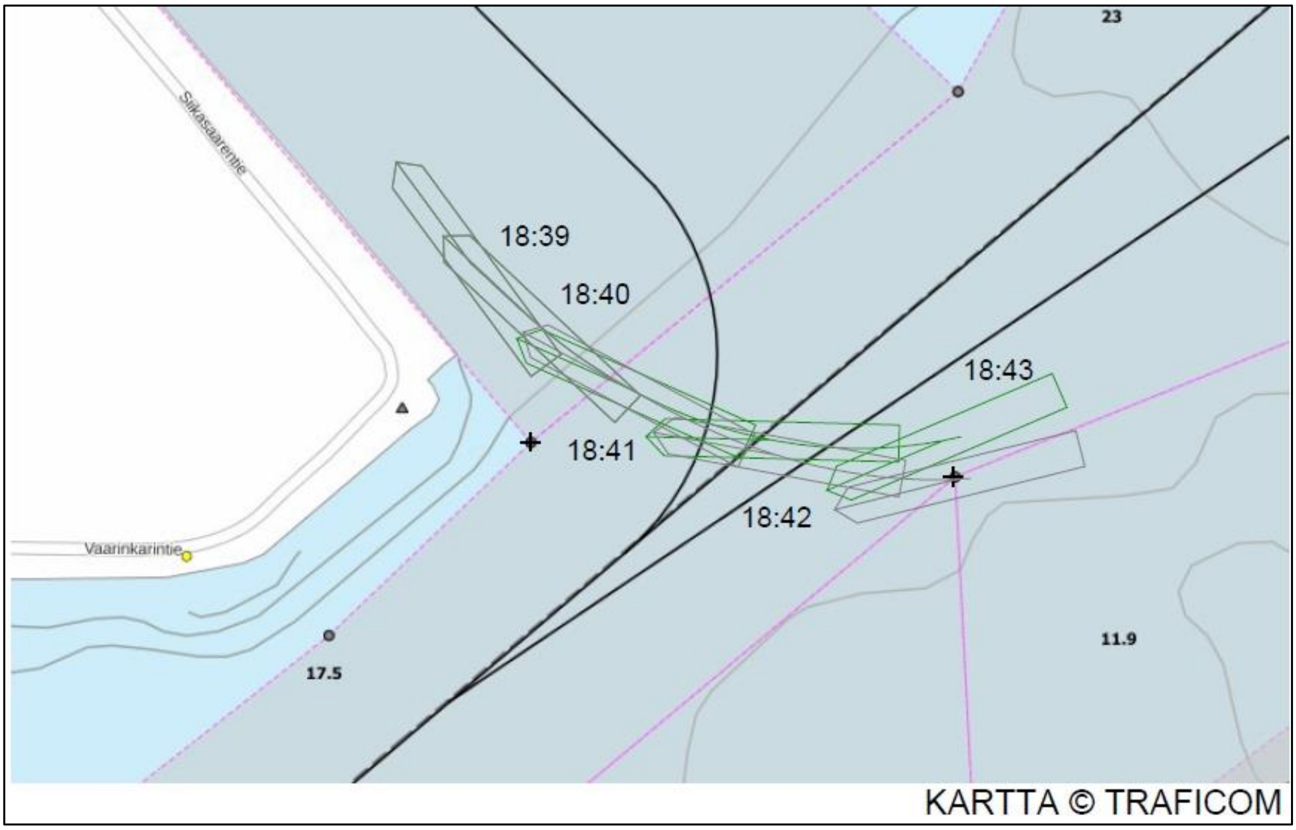
Picture 26. The vessel's simulated (green) and actual (grey) passage. The pile shows the outer border of the area administered by the port. (Picture: Simulco Oy)

In pictures 27–30, the vessel's simulated movement path is depicted in grey. The vessel's simulated passages with different steering options are depicted in green.

The effect of the main engine and the propeller pitch was examined in a simulation by giving the engine order "stop" and adjusting the propeller pitch to zero at 18:39hrs, 18:40hrs and 18:41hrs. In the simulation, pitch adjustment took place in a couple of seconds. The vessel's bow thruster was constantly engaged, turning the bow to the left. Figure 27 presents engine stops at 18:40hrs and 18:41hrs. In the simulation, engine stop at 18:39hrs led the vessel to the fairway at 18:43hrs at a clearly tighter turn than an engine stop at 18:40hrs. An engine stop at 18:41 resulted in the vessel ending up very close to the buoy.



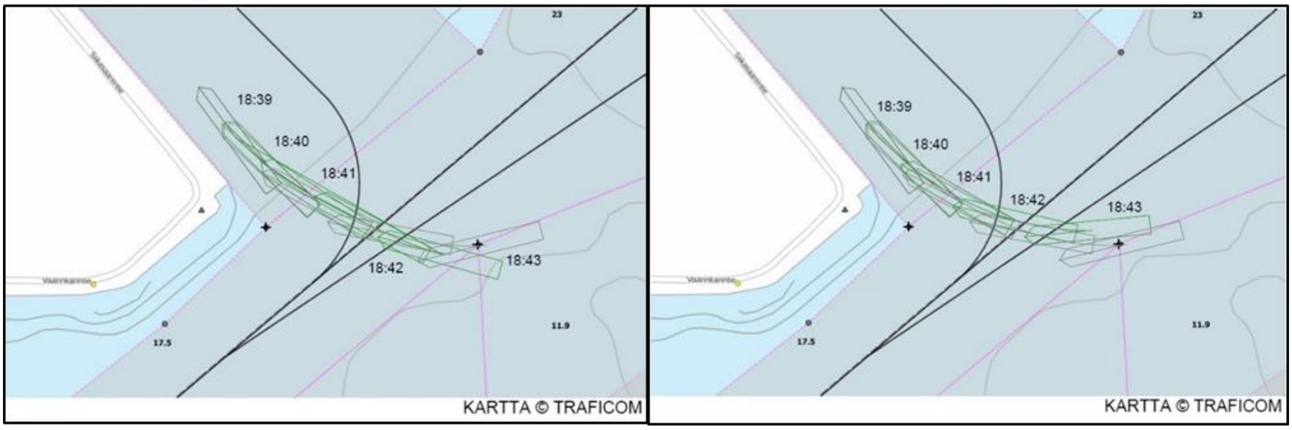
Picture 27. The simulated comparison movement paths in green. The effect of adjusting propeller pitch to zero on the movement path. On the left, the propeller pitch is adjusted to zero at 18:40hrs, on the right at 18:41hrs. In both alternatives, the vessel's bow thruster is constantly engaged, turning the bow to the left. (Pictures: Simulco Oy)



Picture 28. Simulated comparison movement path in green, with the bow thruster in constant operation. (Picture: Simulco Oy)

Only the bow thruster's effect was simulated, because the stern thruster had no effect on turning the vessel. The effect of the constant operation of the bow thruster to the vessel's turning to the fairway is presented in Figure 28. The stern of the vessel would have not hit the buoy. If the vessel had been reversed further, the buoy would have likely been overrun by its bow.

The tugboat's pushing force is the largest uncertainty factor in the simulation. Due to the vessel's longitudinal speed accelerating backwards, the pushing force varied and was non-existent at times. Due to the uncertainty related to the pushing force, the pushing force was simulated additionally at around 25% of the static bollard pull (Picture 29).



Picture 29. The simulated movement paths in green. On the left, the simulated movement path with the tugboat's pushing force at 25% of the SBP and the bow thruster stopped for 1.5 minutes. On the right, the simulated movement path with the tugboat's pushing force at 25% of the SBP and the bow thruster operating all the time. (Pictures: Simulco Oy)

The green movement paths in Figure 29 show the effect of the bow thruster being stopped for 1.5 minutes when the tugboat's pushing force is 25% of the SBP.

MV Priamos approaches the buoy slower and passes it from the south if it reverses all the time and the bow thruster is stopped for 1.5 minutes. If the bow thruster is in operation all the time, the stern does not hit the buoy, but the bow may overrun it if reversing continues.

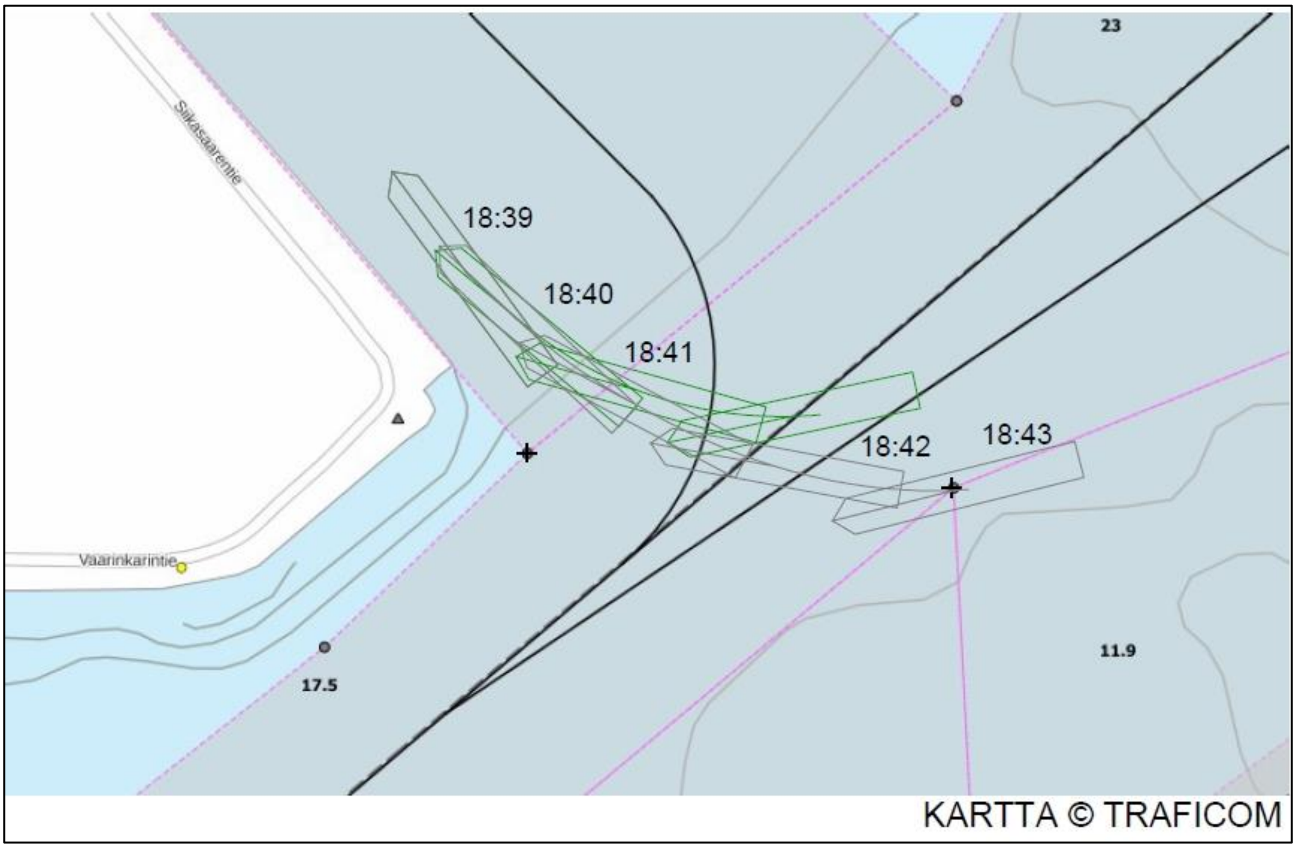
The effect of the tugboat's pushing location was examined in simulation by placing the tugboat to push at a point 20 m further towards the bow, 45 m from midships. The collision with the buoy would have been clearly avoided then (Figure 30). In reality, however, the tugboat could not have been so far from midships. The 25 m from midships used in the simulation is nearly the maximum distance.

A pushing distance of 45 m is equal to almost doubling the tugboat's pushing force at a pushing distance of 25 m. This could have been achieved, for example, by using a tugboat of ASD type with the same power.

The simulation shows that in the prevailing wind conditions, the vessel's passage relative to the buoy is strongly dependent on the combinations of steering actions. The steering action with the fastest effect was adjusting the propeller pitch to zero or to thrusting the vessel forwards.

The separate analysis summarises the factors with the largest effect on turning the vessel as follows:

"Turning a vessel moving backwards can best be done using the bow thruster and, if necessary, with tugboat assistance. The manoeuvring thruster's thrust is strongest when the vessel moves slowly; the tugboat then also has the best opportunity to achieve the greatest assisting force. At the same time, the assisted vessel's own hull forces have decreased, allowing the vessel to turn to the desired heading before drifting to the edge of the fairway area."



Picture 30. Simulated comparison movement path in green, when the tugboat is pushing at a point 45 m from midships towards the bow with the bow thruster in constant operation. The tugboat's power is around 50% of SBP. (Picture: Simulco Oy)

2.8.2 Survey of the traffic restrictions in the pilotage areas of ports

An e-mail survey addressed to the member ports of the Finnish Port Association was used to obtain information on the traffic restrictions at the ports. The survey comprised the questions listed below.

1. Does your port have wind/weather restrictions affecting vessel traffic?

2. Are the restrictions related to: a) wind speed; b) water level; c) visibility conditions; or d) some combination of these?

3. Do the restrictions apply to all port visits?

4. How is the information relayed to the vessel:: a) directly to the master; b) via the agent; c) via the pilot; or d) some combination of these?

5. When were these restrictions implemented?

6. Do you have any additional comments?

Fifteen ports responded to the survey, seven of which had wind restrictions. Five of these are located on the coast of the Gulf of Bothnia, one in the Archipelage Sea and one on the coast of the Gulf of Finland. In the Gulf of Bothnia, wind and waves have an unobstructed effect on the port area. Based on the survey, the wind and weather restrictions at different ports vary greatly. At some ports, very fine-grained restrictions have been defined, even according to the vessel's size class and type. The vessel's master is informed of the restrictions by the agent or the pilot. Some ports have no weather-related restrictions.

As a rule, ports sheltered by the archipelago do not restrict the arrival or departure of vessels based on weather conditions, leaving any decisions concerning the conditions to the master of the vessel. A pilot can refuse to pilot a vessel if the weather conditions prevent safe piloting.

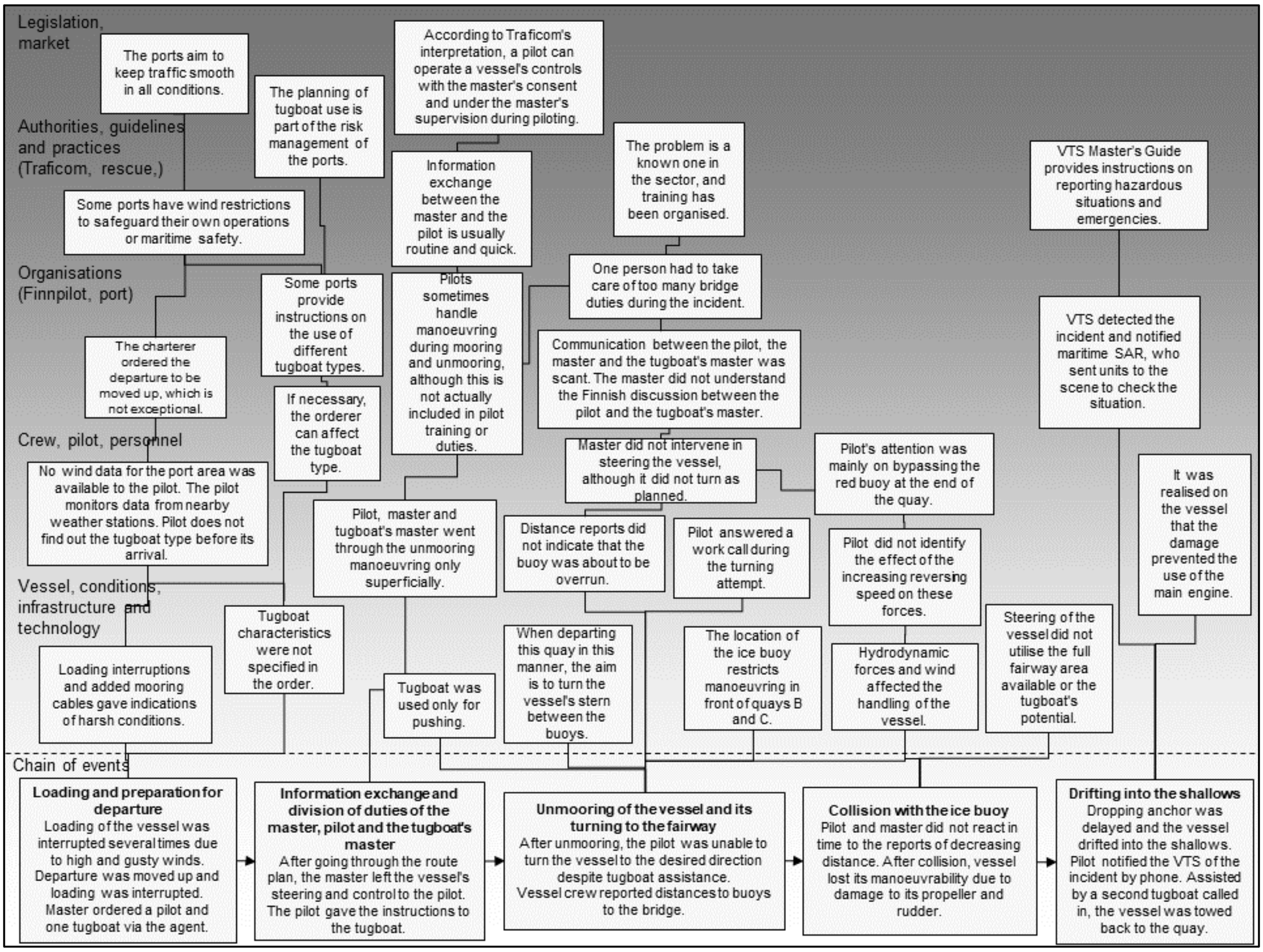
Port operators have set wind limits based on occupational safety, preventing the use of the equipment in wind conditions where the wind force is considered to cause hazardous situations. The container cranes in Mussalo, for example, stop automatically when wind speed exceed 25m/s.

NESTE Oy's ports in Porvoo and Naantali are part of the company's production logistics. The company's ports and their operation are also important to Finland's supply security, which places particular requirements on them.[35]. Together, the production company and the ports have prepared detailed tugboat usage and safety rules for the port entrance routes and port areas based on a risk assessment.

[35] Highly flammable dangerous substances such as hydrocarbons, gases and chemicals are transported via the ports. An accident at these ports or in fairways in their vicinity could lead to disruptions in fuel distribution, reduced supply security or the pollution of the archipelago and coastal areas.

3 ANALYSIS

The analysis of the incident used the Accimap[36] method further developed by the Safety Investigation Authority. The breakdown of the analysis text is based on the Accimap diagram drawn up during the investigation. The accident is described as a chain of events in the lower part of the diagram. Factors revealed in the background of the chain of events are broken down in the diagram at different levels of analysis.



Picture 31. The Accimap diagram prepared during the investigation

3.1 Loading and preparation for departure

The loading of the container ship MV Priamos had been interrupted and its departure time had been moved up by the charterer. This is unexceptional in seafaring. Before the loading was stopped entirely, it had had to be interrupted several times due to high winds. Another indicator of the high winds is that additional mooring cables had had to be fastened to the vessel.

The master of MV Priamos ordered a pilot and, due to the high winds, a tugboat via the agent.

Wind data from the Kotka port area was not available to the pilots. Pilots operating in the area had to use the Ilmanet weather data from the nearby weather stations when piloting.

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[36] Rasmussen, J. & Svedung, I. (2000) Proactive Risk Management in a Dynamic Society. Karlstad, Sweden: Swedish Rescue Services Agency.

The master of MV Priamos did not specify the tugboat's characteristics when ordering it. He and the pilot did not find out the tugboat's type until it arrived to provide assistance. The orderer can affect the tugboat type. Some ports provide instructions on the use of different tugboat types. The planning of tugboat use is part of the risk management of the ports, aiming to safeguard the vessels' safe unmooring, piloting to the fairway and arrival to the port. HaminaKotka Satama Oy has specified minimum requirements for tugs used in the area but does not instruct how the tug’s type or assisting method should be selected.

Neither did the port organisation have wind restrictions for its area to ensure safe operations. Not all ports have wind restrictions, because they trust the competence of the masters and pilots and do not want to restrict the port's traffic. The ports aim to keep traffic smooth in all conditions.

3.2 Information exchange and division of duties of the master, pilot and the tugboat's master

MV Priamos's master, the pilot and the tugboat's master agreed the course of the unmooring assistance and the use of the tugboat routinely and quickly according to normal practices. It was agreed that the tugboat will assist by pushing.

The vessel's master left the vessel's steering and control to the pilot. On occasion, pilots perform the unmooring and mooring steering of vessels, although these are not actually included in a pilot's duties. At the request of Finnpilot Pilotage Oy, the Finnish Transport and Communications Agency had presented the interpretation that a pilot can operate a vessel's controls with the master's consent and under the master's supervision.

3.3 Unmooring of the vessel and its turning to the fairway

After MV Priamos was unmoored, the pilot was unable to get it to turn to the intended heading although a tugboat assisted it in the turn. The tugboat was used for pushing, although its type characteristics would have been better suited for towing with cables.

The bridge was notified from the stern of the vessel of the shortening distance to an ice buoy in the direction of the stern. These notifications did not indicate that the ice buoy was in the danger of being overrun by the stern. The master and the pilot did not react to these notifications. The master also did not otherwise intervene in steering the vessel, although it did not turn as planned. In the middle of the attempted turn, the pilot received a work-related call that distracted his concentration on piloting and restricted communication on the bridge. The pilot and the tugboat's master were in a short telephone contact during the operation. The master did not understand this information exchange that took place in Finnish.

There were not much communications between MV Priamos's master, the pilot and the tugboat's master during the vessel's unmooring and turning attempt. The pilot had to take care of too many bridge duties. The competence of the master and the other bridge personnel were not utilised in the situation. This problem is a known one in the maritime sector, and an increasing amount of expert bridge resource management training on the subject is being organised. However, it will take time until the knowledge of the subject will be implemented during piloting. The change is slowed down by the varying practices in different countries and the variable attitudes of masters on using a pilot.

When departing quay C in Mussalo to the west, the stern of the vessel is usually turned in between the deep water route buoys if the vessel's bow is towards land in the quay. The location of the ice buoy restricts turning a vessel off quay C. Outside the deep water route, around the ice buoy, there is a lot of safe water area, due to which a pilot can steer to said area if the vessel's draught allows.

The Finnish Transport Infrastructure has specified the locations of the buoys in the fairway areas and can, through the design, positioning or type of safety equipment prevent the risk of vessels colliding with them, or limit the damage caused to a vessel should a collision occur.

3.4 Collision with the ice buoy

During the attempt to turn the vessel, the pilot concentrated his attention to passing the red beacon at the end of the quay. The hydrodynamic forces and the wind slowed down the turning of the vessel. The pilot did not realise the effect of the increasing reverse speed on these forces and steering forces, including the tugboat's backwards-directed pushing force. Based on a simulation commissioned during the investigation, the optimal operation of the controls would have likely made the vessel turn in time.

The pilot did not utilise the entire available fairway area. There was space on both sides of the ice buoy, and the water was deep enough for the vessel to avoid the buoy. Similarly, the tugboat's potential was not utilised fully, as it was used for pushing instead of towing with a cable.

Finally, the vessel's stern collided with the ice buoy. The propeller and rudder were damaged in the collision, which resulted in the vessel losing its manoeuvrability.

3.5 Drifting into the shallows

It was realised on the vessel that the damage caused by the collision prevented the operation of the main engine, and a decision was made to stop it in order to avoid additional damage. Once the vessel had lost its manoeuvrability, it drifted towards the shallows. The decision to anchor and anchoring were delayed. When the anchor finally took hold, the vessel had already drifted into the shallows.

The crew concentrated on resolving the situation and did not have time to immediately report the collision with the buoy to the VTS. After the vessel had drifted into the shallows, the pilot reported the incident to the VTS that had already noticed the vessel's problems on its equipment. Maritime SAR was notified by the VTS and sent units to the vessel to check the situation. There are detailed instructions on reporting hazardous situations and emergencies. The pilot ordered a second tugboat to tow the vessel back to the quay.

4 CONCLUSIONS

The conclusions include the causes of the occurrence. A cause means the various factors in the background of the incident and the direct and indirect circumstances affecting it.

1. Wind data from the Kotka port area was not available to the pilots. The pilots had to use the Ilmanet weather data from nearby weather stations.

    Conclusion: *Pilots do not receive real-time weather data from the port areas. With modern technology, local weather data could be rapidly produced for seafarers, increasing their safety.*

2. The master of MV Priamos did not specify the tugboat's characteristics when ordering it. The orderer can select the tugboat type. In practice, the orderers do not pay enough attention to the characteristics of the tugboat. HaminaKotka Satama Oy does not instruct the selection of the tug’s type.

    Conclusion: *The importance of using a tugboat of the correct type as an element of maritime safety has not yet been fully understood.*

3. The port organisation did not have wind restrictions for its area to ensure maritime safety. All ports do not have wind restrictions. They often trust the competence of the masters and pilots and do not want to restrict the port's traffic.

    Conclusion: *Wind restrictions at ports improve maritime safety during arrivals to and departures from the port.*

4. The vessel's master left the vessel's steering and control to the pilot. On occasion, pilots perform the unmooring and mooring steering with the master's consent and under the master's supervision. Pilots have variable experience in manoeuvring vessels of different types in ports.

    Conclusion: *Because the unmooring and mooring steering of a vessel is not part of a pilot's actual duties, they are not specifically trained for it.*

5. The first mate on the bridge was notified from the stern of the vessel of the shortening distance to an ice buoy behind the stern. The master and the pilot did not react to these notifications. No anticipatory situational awareness was formed on the bridge during the vessel's unmooring and attempted turn. Communication between the vessel's master, the pilot and the tugboat's master was scant, affected by the use of different languages. The pilot had to take care of too many bridge duties. No alternative procedures were planned.

    Conclusion: *A joint anticipatory situational awareness is a requirement for efficient bridge operations and the use of a tugboat. Joint situational awareness requires constant and active communication between different persons using common language and preparation for alternative procedures.*

6. During the turn pilot received a phone call that disturbed his actions and restricted the communication on the bridge. The significance of this was accentuated in prevailing circumstances.

    Conclusion: *The use of mobile devices has rapidly become prevalent. The safety impacts of this have not yet been taken into consideration in all work instructions.*

7. The location of the ice buoy and the port structures restricted the turning of the vessel off quay C in the Mussalo Port. The significance of the safe water area is emphasised in difficult circumstances.

Conclusion: *The effect of difficult conditions has not been sufficiently taken into consideration in the planning, construction or repairs of port areas and fairways.*

8. Once the vessel had lost its manoeuvrability, it drifted into the shallows before the anchor began to hold.

    Conclusion: *The vessel's immediate preparedness for emergency anchoring must be ensured before piloting begins.*

5 SAFETY RECOMMENDATIONS

5.1 Real-time weather data from port areas

Pilots do not receive real-time weather data from the port areas. The local weather may differ significantly from the regional weather data. With the growing wind area of vessels, the importance of local weather data has increased. With modern technology, local weather data can be rapidly produced for seafarers, increasing their safety.

The Safety Investigation Authority recommends that

Together with the ports, the Finnish Meteorological Institute develop a system for port specific weather data. [2019-S35]

The data produced by the system must be reliable, anticipatory, and easy to use and distribute.

5.2 Wind restrictions at ports

All ports used for merchant shipping do not have restrictions concerning piloting.

The Safety Investigation Authority recommends that

In cooperation with the ports, Finnpilot Pilotage Oy prepare port-specific restrictions applying to pilotage. [2019-S36]

These port specific restrictions should take into consideration vessels with a compulsory use of pilot, vessels freed from the use of pilot and vessels to be distance piloted.

5.3 Pilot training

Pilot training emphasises fairway knowledge and navigation. Pilots are not specifically trained in the mooring and unmooring steering of a vessel in a port area or the utilisation of tugboats. Training in bridge duties do not emphasise that the pilot's role is to encourage communication between the bridge personnel.

The Safety Investigation Authority recommends that

Finnpilot Pilotage Oy develop the pilots' skills in mooring and unmooring steering of vessels, the utilisation of tugboats and fostering communications during bridge duties. [2019-S37]

The training programme must include at least the planning of the vessel's departure from the quay and arrival at the quay, the hydrodynamics affecting steering, the utilisation of tugboats of different types, and the restrictions on the use of mobile devices.

5.4 Pilots' knowledge should be involved in the development of port area safety

Port areas are planned and constructed in stages over a long period of time. In time, certain areas may become cramped as vessel sizes increase or in difficult weather conditions. This occurred in the accident now being investigated. The party providing piloting services can bring experience in the requirements of the safe steering of vessels in port areas into the planning of ports. However, the party providing piloting services has been heard only occasionally and variable during port construction projects.

The Safety Investigation Authority recommends that

> *The Ministry of the Environment instruct a hearing practice in all building and renovation projects concerning port areas. [2019-S38]*

The responsible project manager should hear relevant parties in addition to the port authorities, including pilots and fairway builders at a sufficiently early phase. As logistic hubs ports have a significant meaning for the society.

5.5 Pilots' knowledge should be involved in the development of waterway safety

The Finnish Transport and Infrastructure Agency receives mainly empirical information on the functioning of safety equipment from the pilots. Hearing the party providing piloting services has been variable during fairway planning. Experiences on the usability and safety of the fairways, particularly in ports and on the fairways leading there, have not always been relayed to the Finnish Transport and Infrastructure Agency.

The Safety Investigation Authority recommends that

> *The Finnish Transport and Infrastructure Agency develop a regular practice for involving the expertise of pilots in the development of the fairways. [2019-S39]*

Pilots do have expertise in the usability and safety of both inland and coastal water fairways.

5.6 The measures taken

On 29 November 2019, **Finnpilot Pilotage Oy** set weather restrictions in the *Kotka pilotage area* for the open water season. In the FIKSY and FIORR pilot boarding areas, for example, the piloting of incoming and outgoing vessels is interrupted if one of the following conditions is fulfilled:

1. With southerly winds, the 10-minute average wind speed > 17 m/s.

2. Significant wave height > 3 metres.

3. The 10-minute average wind speed > 21 m/s.

New training subjects include the utilisation of tugboats and practising exceptional situations. The intention is to utilise simulators in training more than is currently done. These training changes have been presented to the Ministry of Transport and Communications.

In Finnpilot Pilotage Oy's new piloting procedure, the pilot clearly asks the master which of them will steer the vessel.

After the accident Finnpilot Pilotage Oy has developed its internal instructions concerning the wind at Kotka pilotage area and the co-operation with the tug company Alfons Håkans. The improvement of bridge communication as a part of the pilot tailored Maritime Crew Resource Management (MCRM) extension course will be realized in 2019. The first pilot tailored MCRM- training took place in 2017-2018. In addition, Finnpilot Pilotage Oy has announced instructions for the use of mobile apparatuses during piloting.

HaminaKotka Satama Oy has installed an anemometer in the Mussalo Port.

The shipowner has analysed the incident and instructed the masters to supervise and if needed to intervene anticipatory in pilots' actions.

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Norrbin, N. H. (1984) *Vindbelastningar på fartyg i svenska farleder*. SSPA, allmän rapport nr. 62.

Safety Investigation Authority, Finland (2003) *Tugboat PEGASOS, capsizing and sinking off Helsinki on 13 November 2003*. Investigation report B2/2003M.

Pajala, J. (2011) *Öljyntorjuntaveneen hankintaohje*. Environmental Administration Guidelines 2/2011. https://helda.helsinki.fi/handle/10138/41524. Retrieved on 1 February 2019.

Rasmussen, J. & Svedung, I. (2000) Proactive Risk Management in a Dynamic Society. Karlstad, Sweden: Swedish Rescue Services Agency.

Hensen, H (2018) *Tug Use in Port – A Practical Guide*. Third Edition. Ltd., Wiltshire: The ABR Company.

Investigation material

1) Photographs and other materials from the on-location investigation
2) Meteorological data
3) Interviews
4) Finnish Transport Infrastructure Agency's chart data
5) Drawings of the vessel and the tugboats
6) Copies of the vessel journals
7) The vessel's VDR recording
8) Data on the vessel's ECDIS device
9) VTS recordings
10) HaminaKotka Satama Oy's data on the port area
11) HaminaKotka Satama Oy's video camera recordings
12) Responses to the port survey
13) Finnpilot's AISLap recordings
14) Consulting company Simulco Oy's data and report on the simulation
15) Pronto data on the accident
16) Finnish Transport Infrastructure Agency's fairway data
17) Finnish Transport Infrastructure Agency's on buoys
18) The rescue department's service level decision and strategy plan
19) Finnish Transport and Communications Agency's inspection data of the vessel
20) Guidelines on land use and construction of marine areas.

SUMMARY OF THE STATEMENTS RECEIVED FOR THE DRAFT INVESTIGATION REPORT

The Safety Investigation Authority received statements from the following bodies; see below for their summaries.

In its statement, the **Ministry of the Environment** states that utilising the information of different expert bodies as extensively as possible in the planning of port areas will increase their safety, but also states its reservations with regard to how effective the recommendation will be in advancing the issue.

The Ministry of the Environment examined the responsibilities related to the planning and construction of port areas from the perspective of the current legislation (the Land Use and Building Act), stating that the legislation does not include any specific related provisions or regulations. Furthermore, the ministry states that the implementation of quays and other so-called waterline structures are subject to an action permit to enable the assessment of their land use and environmental impacts, but the land use plan valid for the area affects its application. The permit and control procedure will then only apply to buildings in the port area, per se. On the other hand, building control does not have special expertise relevant to construction and change projects in port areas. On these grounds, the implementer of a port project is responsible for the high-quality planning of port areas that takes future use needs into consideration.

Traficom did not provide a statement.

In its statement, **the Finnish Transport and Infrastructure Agency** brings up the effects of the reorganisation carried out at the turn of the year, during which the Finnish Transport Agency's traffic control and management services were changed into limited liability companies and transferred to the state-owned special-purpose company established for the purpose. In the current situation, the Finnish Transport and Infrastructure Agency is responsible for fairway management and the ordering of VTS services from Vessel Traffic Finland Oy. Marine cartography remained the responsibility of the Finnish Transport and Communications Agency.

In its statement, the Finnish Transport and Infrastructure Agency comprehensively describes the maintenance and monitoring of maritime safety equipment, noting, among other things, that around 1,000 pieces of safety equipment are currently under remote monitoring, with more being included. This is complemented by the fault reporting procedure known and used by seafarers and boaters. According to the Finnish Transport and Infrastructure Agency, there are clear procedures in place for safety equipment faults, but the procedure for handling customer feedback could be further developed, for example with regular meetings with pilots. This cooperation could be expanded and developed in the manner presented in the report. Furthermore, the Finnish Transport and Infrastructure Agency states that the ultimate responsibility for the restrictions on a vessel's movement set by the conditions belongs to the masters of the vessels, not the fairway manager.

In its statement, the **Finnish Meteorological Institute** states that its duty is to produce high-quality observation and research data on the atmosphere and seas. Accordingly, the Finnish Meteorological Institute issues warnings of possibly hazardous changes in weather and the physical state of the sea. Additionally, the Finnish Meteorological Institute offers special services for boaters and the needs of commercial shipping and the business sector. The Finnish Meteorological Institute maintains 43 ocean weather stations that have been placed in locations that represent the sea area in question as well as possible, in open and unobstructed wind conditions.

The Finnish Meteorological Institute also has cooperation projects with certain ports. However, the locations of the weather stations at these ports do not fully meet the meteorological standards, but they are serviceable for their purpose. There are no weather stations in the Kotka port areas. Their closest weather station is located in Rankki, Kotka, around six kilometres south-southeast from Mussalo.

Finally, the Finnish Meteorological Institute states that with regard to port weather stations, a survey of all Finnish ports would be required first. The Finnish Meteorological Institute is interested in performing such a survey in cooperation with other port operators.

In its statement, **Finnpilot Pilotage Oy** states that the investigation report is comprehensive, the conclusions stated factors that affected the incident, and that the safety recommendations aim to improve the current situation. In addition to this, Finnpilot brought up some technical clarifications to the report's contents.

In its statement, Finnpilot described the cooperation between the master and the pilot with respect to steering a vessel. According to Finnpilot, piloting practices have gradually changed so that pilots steer the vessels increasingly often in ports as well, at the request of the masters. This is based on a view of a change in the port steering skills of vessel masters. In this context, Finnpilot brings up its aim to ensure the port steering skills of pilots during recruitment with an emphasis on the importance of experience as an officer.

Finnpilot considers the provision of port-specific weather data as an extremely important area of improvement, and is prepared to participate in the work. Concerning wind restrictions in ports, Finnpilot states that the most comprehensive safety impact could be achieved if ports were to set wind restrictions on all vessel traffic, also vessels that are not piloted. Finnpilot is happy to participate in this development work as well. Finally, Finnpilot brings up the measures it has already taken after the accident.

The Finnish Port Association considers the recommendations to be generally in the right direction and states that these measures are already being taken in certain ports based on local risk assessments. With regard to risk assessment, the Finnish Port Association emphasises the importance of close cooperation and communications between the different parties in order to obtain a joint situational awareness.

In its statement, the Finnish Port Association also brings up a legal aspect related to weather data, stating that when the prevailing conditions play a role in an accident, the source of weather data may have legal significance. The Finnish Meteorological Institute provides official weather and condition data, while the data provided by ports from their own measurement points do not automatically have the same status. According to the Finnish Port Association, in the future the FMI could also act in the role of the auditor of the above-mentioned data and the systems used in their generation.

In its statement, the Finnish Port Association also brings up the responsibilities of the different actors in using pilots and tugboats, and of the actors participating in the water and fairway construction at ports. In these, the central actors are the pilots, the vessel masters, the ports and the Finnish Transport and Infrastructure Agency. In conclusion, the Finnish Port Association states that the locations of the border between fairway sections managed by the State and the port company vary greatly in relation to the quay area at each port; the Finnish Port Association also presented some related clarifications to the recommendations.

In its statement, **HaminaKotka Satama Oy** brought up the location of the incident which is not in the port's area of responsibility but is located in the State's fairway area. Additionally, HaminaKotka Satama Oy brought up some clarifications related to the organisation and use of tugboat services, also emphasising the master's responsibility in deciding on the use of tugboats. Finally, HaminaKotka Satama Oy brought up that it normally hears stakeholders, including pilots, to the extent necessary when planning port areas.

In their statement, the representatives of the **vessel's shipping company** gave their support to the recommendations. In addition to this, they brought up certain practical measures related to piloting and tugboat assistance, such as limiting the use of mobile communication devices, selecting the tugboats best suited to the conditions, and the importance of a jointly understood language used in the communications between the vessels and the tugboats. Finally, the shipping company's statement brings up the master's responsibility for the handling and steering of the vessel, which requires the master to be prepared to intervene in the situation in a timely manner while monitoring the pilot's actions.

In its statement, **the safety investigation authority representing Antigua & Barbuda** stated that the recommendations are good and implementable. Additionally, the safety investigation authority brought up a change it has observed taking place in piloting practices, where the pilot practically steers the vessel while the master observes from the sidelines. With regard to this, the safety investigation authority raised the question of the actual steering responsibility of the vessel.