ACCIDENT INVESTIGATION BOARD

FINLAND

Investigation report

C 11/1997 M

ms GRIMM, grounding outside port of Kotka, October 1, 1997

This investigation report was written to improve safety and prevent new accidents. The report does not address the possible responsibility or liability caused by the accident. The investigation report should not be used for purposes other than the improvement of safety.

ms GRIMM, grounding outside port of Kotka, October 1, 1997

Summary

The German general cargo vessel ms GRIMM grounded on October 4, 1997, shortly after departure from Halla port in Kotka. The vessel was operated by Jan Nasek KG and her destination was Tallinn.

The Finnish pilot boarded the vessel at 03:00 and the vessel departed immediately. The pilot and ship's master discussed the turning of the vessel in the harbour. The turn to the first fairway leg or directions to be steered were not discussed. The master turned the vessel after which he asked the pilot to take over. During the turn out of the harbour a mistake in the steering occurred. This mistake took the vessel to the northern side of the fairway. The grounding took place at slow speed at 03:20. One diesel tank took in water after the grounding. No oil spill to the sea was observed.

The master did not explain the control systems of the vessel to the pilot before the departure. There was no mutual agreement on the steering system to be used. Having turned the vessel in the harbour the master selected a steering system for the pilot. This selection was made with a switch at the console in the middle of the bridge. The selected steering system, time steering of the rudder machine (non follow up) was the least suitable of the available systems for one man ship control and piloting. It requires continuous observation of both the rudder angle and the rate of turn indicators. The rudder angle indicator was mounted in the ceiling and the pilot had to look up to see it.

The pilot navigated visually having no time to resort to the use of the radar. The steering decisions immediately after and during the turn to the first fairway leg were based on the visual sightings of three buoys, because no fixed objects were available. When the turn progressed and the buoys were passed the number of useful visual clues for the navigation decreased. Finally only one south buoy was visible and the navigation was based on the position of the buoy relative to the vessel. The heading of the vessel was no longer in control nor was it monitored by the master. Presumably the master did not intervene with the methods used by the pilot during the voyage. The master also mentioned that it had been difficult to observe the motion of the vessel in the darkness. Apparently, the master had no written passage plan. The pilot on the other hand has mentioned that he does not need the chart on this fairway.

The steering mistake which led to the grounding of ms GRIMM developed out of deficiencies in the voyage preparation or departure plan, cooperation on the bridge, selection of the steering system used and the navigation method.

CONTENTS

Figure 1. ms GRIMM

1 GENERAL DESCRIPTION AND INVESTIGATION OF THE ACCIDENT

1.1 The vessel

1.1.1 General data

Name of ship	ms GRIMM
Home port	Hamburg
Registration	34441
IMO code	9053907
Identification	DIDG
Type	General cargo ship
Crew	7 (master, mate, engineer and four deck hands)
Owner	Jan Nasek KG
Classification society	Germanischer Lloyd (GL)
Classification	G.L. + 100 A4 E3
Finnish ice class	1A
Year of construction	1992
Length	104,8m
Width	15,2m
Draught	4,16m (summer cargo mark)
Gross capacity	3564
Net volume	1135
Dead weight	2949 tons
Engine power	2650 kW
Speed	12,5 knots

The vessel had one propeller and bow thruster.

1.1.2 Crew and traffic limitations

The GRIMM had a crew of seven: master, mate, engineer and four deck hands.

The master had started working in the morning between 08:00 and 09:00. He had rested during the day and did not consider himself tired. This was his first visit to the port of Halla.

The pilot had started his work as a pilot in the area between Orrengrund and Kotka in 1987. He was feeling normal and was not tired.

1.1.3 Cockpit and its equipment

Navigation equipment

Two marine radars	ELNA, Kelvin & Hughes transmitter
Gyrocompass	Anschütz
Magnetic compass	
Rudder angle indicators in wings	0° - 50° Tenfjord
NFU steering (Non Follow Up) in wings	
Rudder angle indicator in ceiling in middle	Tenfjord
Autopilot	Anschütz NAUTOPILOT D
Rate of turn indicator 0° - 100°	Anschütz
Autopilot based on rate of turn 0°-35°	Anschütz R.O.T.TILLER
NFU steering (Non Follow Up) next to both radars	
FU steering (Follow Up) next to starboard radar	
Echo sounder	1
Log	BEN
GPS	Magnavox 200
Navtex	Hagenuk
VHF radio telephones	Hagenuk
2182 kHz watch receiver	
MF/HF DSC 9000 controller –receiver	Skanti
HF-SSB GMDSS Radio System TRP 8000	Skanti/Hagenuk
Radio equipment for areas A1, A2 and A3.	

1.2 Accident events and preceding activity

1.2.1 Weather conditions

On the night of the accident the weather was calm and clear with good visibility. There was no interfering traffic.

Figure 2. Bridge of ms GRIMM

1.2.2 Preparation for piloting trip

The vessel had a chart on board but there is no knowledge of whether she was carrying a passage plan. The master did not demonstrate the steering properties or present the navigation equipment of the vessel to the pilot. The radars were familiar to the pilot, however.

Since the GRIMM had been constructed in 1992, the recommendation of the IMO resolution 601(15) of 1987 on having the data on the steering properties of the vessel available in three forms applies to her. These forms are the pilot card, the wheelhouse poster and the manoeuvring booklet. The vessel had the stipulated wheelhouse poster fixed on the bridge. The poster gives general data and steering properties of the vessel. The master had a sheet from the sea trials protocol with incomplete information on the steering. In the above IMO resolution, this data is recommended to be presented in full in the manoeuvring booklet. The effect of the rudder was not included in the steering information of the GRIMM.

The pilot had no passage plan. When asked about his knowledge of the fairway he said he knew the fairways well and did not think he needed a chart.

The master had switched on the radars before the pilot boarded the ship. The master and the pilot planned to steer the vessel from the berth with the spring and bow thruster. The master inquired if the sound between Halla and Ahola island was wide enough for turning the ship with the bow thruster. The pilot suggested that after moving the vessel away from the pier side first, she would be reversed 30 metres in order to make room for the turn. The piloting was not discussed.

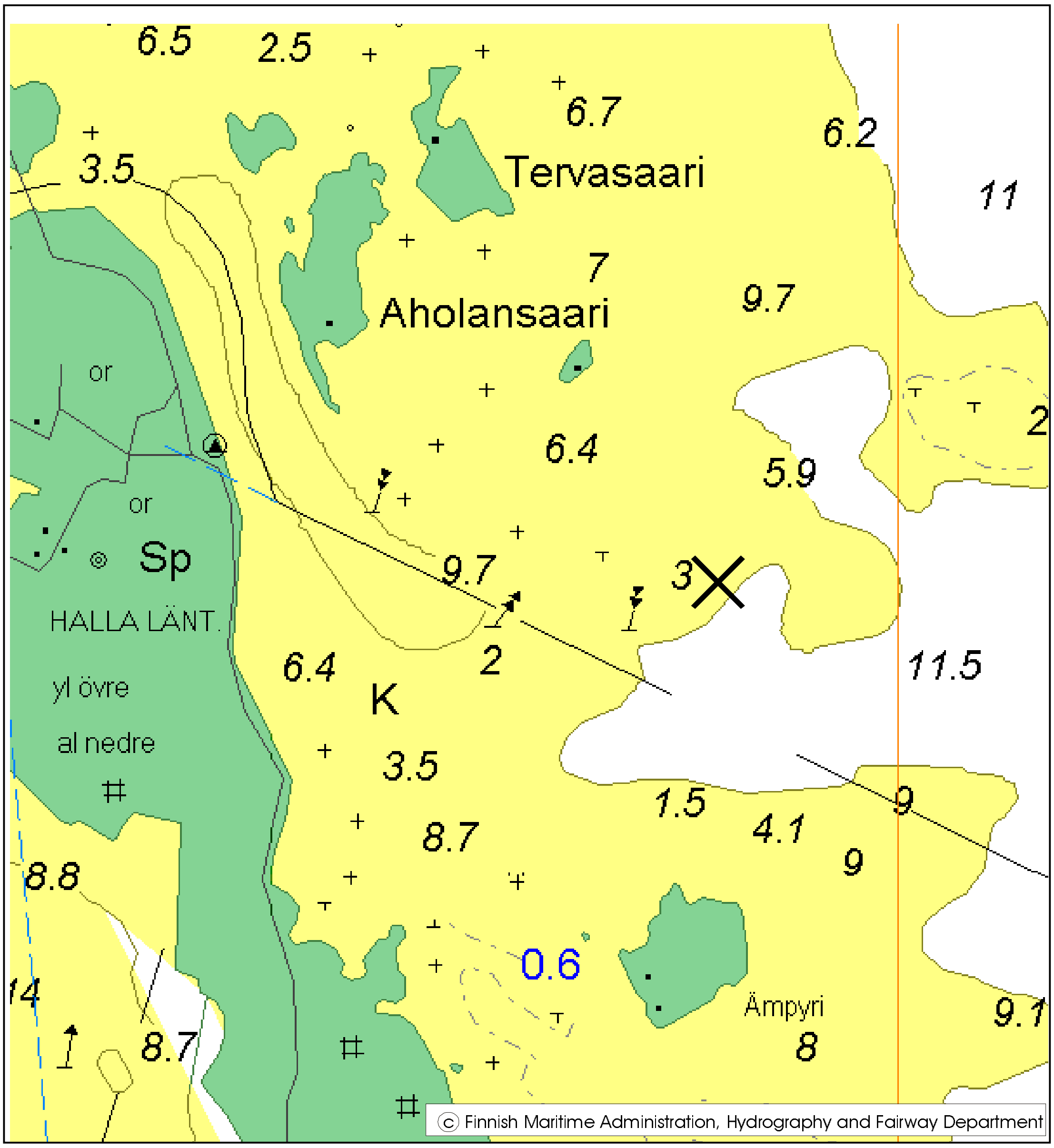


Figure 3. Halla port and grounding site of the GRIMM (marked with X)

1.2.3 Accident voyage

The description of the accident voyage in this chapter is written based on the statements of the persons involved and on the maritime declaration.

The pilot boarded the ship at 03:00. After a short discussion on the turning of the ship she set off. The master and the pilot were alone on the bridge. The mate and four sailors were in the stern and in the bow. The engineer was alone in the engine room. There was no helmsman. The draught of the vessel was 3,3 metres at the bow and 3,8 metres at the stern.

The master made the turn in the harbour as planned and stopped the bow thruster. The master asked the pilot to handle the steering. The pilot began to steer with the steering lever in the middle of the bridge. The pilot asked that the searchlight be lit. There were two searchlights on the bridge, the one on the starboard side of the ship was on a turntable. The master switched on both searchlights and went to direct the one on starboard. The pilot requested "slow ahead" from the master.

After the turn the vessel was on heading 160° according to the pilot. He saw in the searchlights both south buoys and the north buoy. The pilot had in front of him the radar, the gyrocompass and the control equipment for the steering. He told he had been too busy to use the radar. According to the master, the pilot was navigation only with the searchlights and the buoys.

After the first south buoy the pilot turned the vessel to port. The north buoy was close ahead so a steep turn was performed. The north buoy was passed on the north side according to the pilot and the next south buoy was passed when the vessel was still turning to port. Thus, the turn begun at the first south buoy did not stop at the other buoys.

The master knew that the first heading was 156° -157° and after that a turn to port to heading 116° would be required. He also knew that there were three buoys to pass, two on the port side and one on the starboard side. He spotted the two buoys on the port side but not the third one. He could not determine the quality of the buoys. He observed that the pilot turned the vessel to port.

At the last buoy the pilot intended to turn the helm strongly to starboard in order to stop the turn. However, for some reason he turned the tiller to port which increased the rate of turn rapidly. He could not tell how long it lasted before he realised the steering error. At the same time he saw the lights of Hamina in front of him. According to the pilot the vessel “went through his hands”. He did not state having had steering problems before this steering error.

The second south buoys was passed very close. The pilot managed to stop the turn and he asked the master to steer in order to perform visual positioning from the wing of the bridge. The pilot went to the port side to see the line behind the ship. According to the pilot, the speed had already dropped to almost nothing at that time due to the steep turn. The vessel lay north of the fairway.

The pilot ordered slowly to starboard in order to reach the fairway again. He knew there was deep water on the north side. He did not dare turn quickly in order to prevent the rate of turn from escaping again. The pilot ordered heading 130°. At that moment the vessel grounded (Figure 3). According to the master the heading at this time was 068°. The time was 03:20.

1.3 Rescue activity

1.3.1 Distress Signal

The grounding of the GRIMM took place in the operating area of the Helsinki Maritime Rescue Sub Centre (MRSC Helsinki). The MRSC received no distress signal, however, since the vessel never sent one. The pilot reported the grounding to the Kotka coast guard station at 05:10. The coast guard station reported the matter further to its own command centre in Helsinki (MRSC Helsinki) and to the navigation inspector. There is no entry of any kind of the grounding of the GRIMM in the logs of the Kotka regional alarm centre on the day of the accident.

1.3.2 Damage to the vessel and her rescue

The impact on the grounding was not violent. The vessel and the crew were in no immediate danger. Water had leaked into one of the diesel tanks after the impact. At 06:10 the coast guard station placed a call to the pilot on board. He reported that the situation was OK. After preliminary charting of the damage, the vessel moved with her own machines via Ruotsinsalmi to Kotka where divers repaired the damage temporarily. The hull had sustained a dent 25 metres long which had a hole the size of 12 cm x 3 cm. 45 cubic metres of water entered the fuel tank. No oil leaked to the sea.

1.4 Accident investigation

Since several incidents where a foreign ship had grounded during piloting had taken place in the autumn of 1997, the Accident Investigation Board decided to launch a common investigation for several accidents on December 29, 1997. One of the accidents included in this investigation was the grounding of the GRIMM.

These cases have not resulted in damage to persons or the environment and the damage sustained by the vessels has also remained relatively minor. The recurrence of such incidents, however, gives a reason to investigate the course of events and their causes in order to prevent similar occurrences in the future.

The master of the GRIMM provided a maritime declaration in a session of the Maritime Court in Kotka on October 10, 1997. The investigators acquired the minutes of the Maritime Court with enclosures.

Martti **Heikkilä,** Chief Accident Investigator and Risto **Repo,** Accident Investigator and Sea Captain, of the Accident Investigation Board were named as investigators of the grounding of the GRIMM. Permanent experts in the investigation were Kari **Larjo,** Sea Captain, Antti **Haapio,** Director, Sea Captain, of the Maritime Safety Training Centre, Leena **Norros,** Kristiina **Hukki** and Maaria **Nuutinen ,** psychologists of VTT Automation, Matti **Hellevaara,** MSc (Tech.) of VTT Manufacturing Technology and Pirjo **Valkama-Joutsen,** Administrative Director of the Accident Investigation Board.

2 ANALYSIS

2.1 Conditions for navigation and piloting

2.1.1 Organisation of piloting in Kotka piloting district

There were 30 piloting pilots in Kotka in 1998. The nominal number was 35, but two pilots were on long term sick leave and three were waiting to retire. In practice, the weekly manning was 15 pilots / shift. The intention was to hire two more in order to reach adequate manning strength. The on call piloting is located at the Pookinmäki coast guard station where VTS operators are on call. They number six and are not piloting pilots. The pilots are on call at their homes during the week with the exception of a few from further away who spend their free time at the piloting station on Ruukinkatu. The station also has an office for the local pilot inspector. The task of the pilot inspector is the " operative management and development of the piloting activity". In practice, the office includes handling administrative routines.

There are no common gatherings or meetings. The employer relays the information on the changes of fairway markings to the pilot's home through the "Tiedonantoja merenkulkijoille"[1] bulletin. Administrative issues are passed on by the senior pilot. The Finnish Maritime Administration organises meetings for senior pilots twice a year.

The piloting begins by a call from the officer on duty at Pookinmäki to the mobile telephone of the pilot on call. The duty officer informs the pilot about the next ship to be piloted and the location and time of the start of the piloting. The pilot is transported to the ship either by cutter, by car driven by the cutter operator or by taxi. The pilots do not necessarily visit the piloting station during their work week.

According to the internal guidelines of the Finnish Maritime Administration, the pilot shall rest 8 hours or two times 5 hours during one day. The pilot himself has to ensure that he receives this amount of rest. He can inform the officer on duty that he is too tired to accept piloting duty. This happens very rarely.

The salary of pilots consists of the piloted miles and basic salary. The Finnish Maritime Administration charges for the piloting according to the length of the trip and the size of the vessel. The transfer pilotings in the Kotka port area are charged directly by the pilot himself according to the size of the vessel.

2.1.2 Directions of shipping company and practice in piloting situation

The investigation has revealed no special directions from the shipping company concerning piloting.

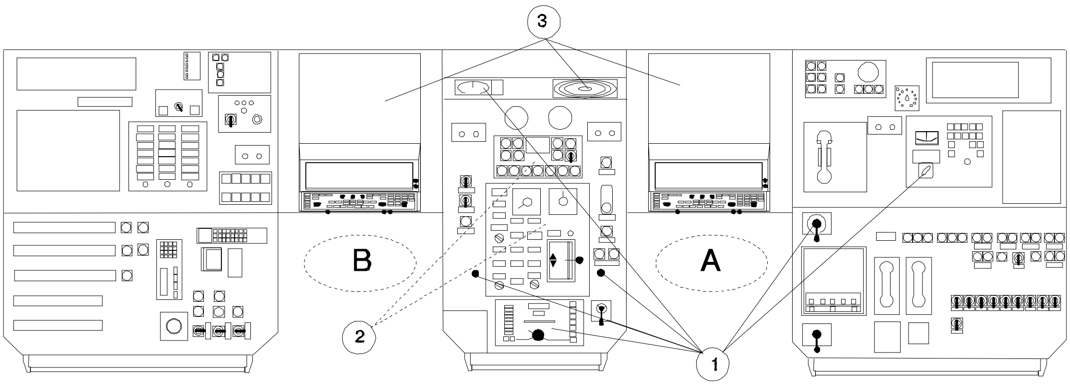
[1] "Information to seafarers", tr.note

2.1.3 Cockpit arrangements and conditions provided for piloting

The following presents an analysis of the cockpit arrangements of the GRIMM. The analysis addresses the suitability of the various work points on the bridge for piloting on archipelago fairways in the light of the equipment situated in them. The analysis also discusses the usability of individual navigation instruments for the same purpose. The drawings on the location of the equipment in the cockpit are based on photographs of the bridge of the GRIMM. Therefore, the pictures are not in scale. The pilot was steering the vessel from the steering place port of the middle console (marked as B in the figures).

Work point A provides an efficient work point with regard to the steering and offers choice of various steering methods. The control unit for the rudder machine with the choice of the steering place and three different steering modes is within reach. The steering places are in the wings and in the middle of the bridge (Figure 4). The giving of engine controls was easier on the starboard side of the middle console, or at work point A. The engine control relay is close by within reach of the left arm. The engine control and rate of turn levers are almost next to one another and thus easily controllable at the same time.

Work point B offers the choice of only one steering mode, the NFU (Non Follow Up). The port side of the console is not designed for a work point for demanding steering. The speed can be adjusted at it by reaching slightly.



1. Steering equipment
2. Main equipment for engine control
3. Radars and compass.

Figure 4. Navigation and steering console on front wall of bridge.
A and B are work points for steering and navigation of the vessel.

Radars Both work points had navigation radars well suited for piloting (Figures 4 and 5a). The transmitters, receivers and antennae of the radars were manufactured by English Kelvin & Hughes, but the monitors were made by ELNA, a German manufacturer. ELNA is a recognised manufacturer of river radars. The requirements for the Rhein river traffic, for example, stipulate a separate knob for adjustment of the variable range marker (VRM), the electronic bearing line (EBL) as well as for the controls for Gain, Tuning, Sea Clutter and Rain Clutter. These may not be combined in the installation[2] (Figure 8a). The radars of the GRIMM fulfilled these requirements.

Steering equipment. The steering equipment in the various consoles of the bridge is analysed in the following paragraphs in the light of placement of the individual navigation equipment and the usability for piloting.

- The steering mode best suited for piloting is the ROT Tiller (Rate of Turn) in connection with the NAUTOPILOT D autopiloting system, located on the right edge of the middle steering console (equipment 2 in Figure 5a). The rate of turn can be selected steplessly between 0°/min – 35°/min. Zero stands for straight heading. The bridge has one ROT Tiller lever. Its use relieves the navigator for radar adjustment and provides the opportunity to concentrate on the radar image and the compass.

- The FU (Follow Up) steering is an ordinary steering device meant for the helmsman. It turns the rudder to the position where the lever is set (Equipment 2 in Figure 6a). The position of the rudder can be felt with the hand and there is no need to constantly monitor the rudder angle indicator. This would have made the steering easier and allowed the pilot to concentrate on the radar, the compass and the rate of turn indicator. The bridge only had one FU lever.

- There are four NFU (Non Follow Up) levers on the bridge. Two are located in the wings of the bridge and two in the middle console (Equipment 3 in Figure 5a). The NFU steering operates by changing the rudder angle while the lever is pressed. The rudder angle indicator must be monitored constantly in order to know the position of the rudder. When the lever is released, the rudder pumps stop. The rudder angle indicator is in the ceiling above the middle console which complicates the course keeping. The NFU steering is not suitable for course keeping if other tasks require simultaneous attention. The advantage of the NFU steering is its low price and easy installation. NFU is usually installed as an emergency steering because of its operational reliability.

The only clearly observed rudder angle indicator was a round gauge in the ceiling, which contained the rudder angle indicator to the back and to both sides (Figure 8b). During steering, the eyes have to be raised in a disturbing way. The periscope of the magnetic compass was located in the ceiling next to the rudder angle indicator.

The port steering place B provided the choice of only NFU steering (Equipment 3 in Figure 5a). The starboard steering place A offered all the steering systems of the vessel.

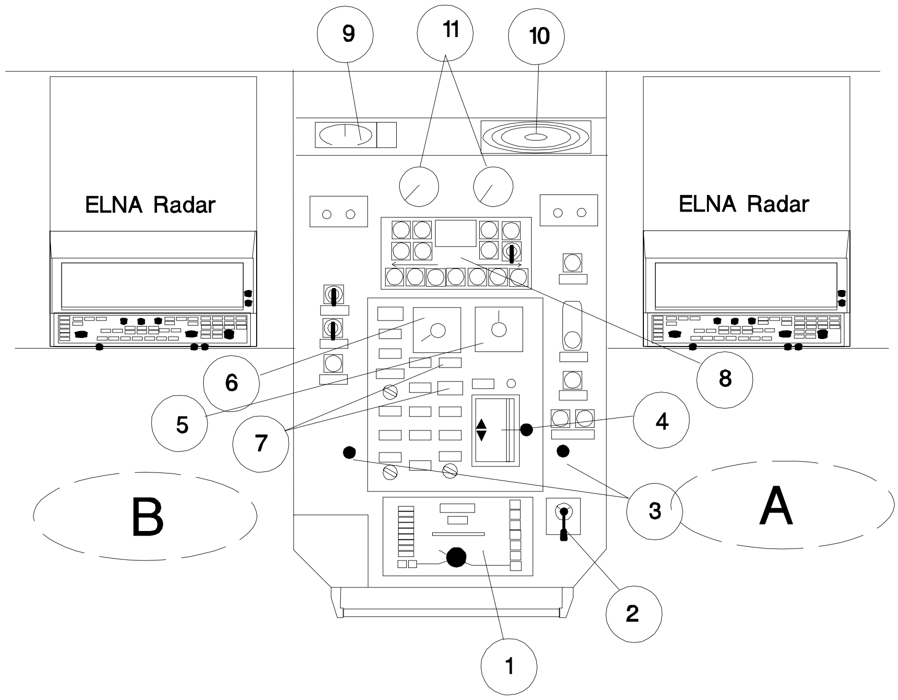
The steering device was selected from the starboard steering place in the control unit of the TENFJORD rudder machine (Figures 6 and 7). The TENFJORD panel had a rudder angle indicator (Equipment 3 in Figure 7a and Figure 7b), but this was very small so it is probable that the indicator in the ceiling (Figures 8b and 2) had to be resorted to for piloting.

[2] Binnenschiffahrt 217 (1995) § 4.01.

Selection of the steering method in the control panel of the TENFJORD rudder machine is a five position switch (Section 1 in Figure 7a). The panel explaining the positions of the switch in German is located above the switch (Figure 7a, Section 2). The translation of the texts is included in Table 1. The German terminology in the sign is not necessarily familiar to Finnish pilots. It is easy to make a mistake in the selection of the steering mode. The switch limits the choice of the right steering method. The switch may be in the wrong position at the critical moment. Instead of the switch, it is safer to change the mode with a pushbutton which is installed next to each steering lever or autopilot.

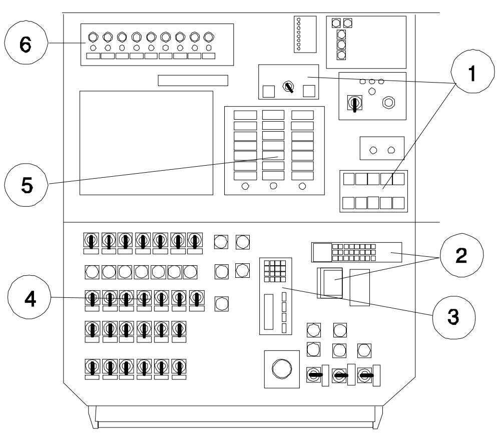
The placement of the only FU steering lever of the cockpit in work point A shows that the starboard side of the middle console is designed for steering on narrow fairways and during piloting. Work point A on the starboard side offered several choices for steering. It was also easier to control the engine from the starboard side of the middle console, in other words from work point A. There was only one steering option in work point B which shows that work point B was designed mainly for monitoring.

The vessel had good radars and steering systems well suited for piloting and two steering places one of which was suitable for piloting and the other for monitoring.



1 Autopilot NAUTOPILOT D. R.O.T
Tiller automatic lever is selected.
2 Rate of Turn Tiller (ROT.)
3 Two time steering levers. Non Follow
Up (NFU) Tiller.
4 Engine control relay. Propeller pitch control
5 Propeller pitch indicator.
6 Propeller tachometer.
7 Start and stop buttons for main machine.
8 Control and steering unit for bow thruster.
9 Rate of turn indicator 0-100° / min.
10 Gyrocompass.
11 Starting air pressure of machine.

Figure 5a. Middle console of bridge and location of radars.



1 ZÖLLNER horn.
2 VHF
3 GMDSS system radio VHF DSC
4 Switches
5 Alarms
6 Fuses

Figure 5b. Port console of front wall. It does not include anything important for piloting.

Figure 5c. Middle console of bridge of ms GRIMM. NFU lever used by the pilot is on the left edge.

1 Pumps and alarms of TENFJORD rudder machine (enlargement in Figures 7a and 7b.
2 Follow Up (FU) steering. Only FU lever on bridge.
3 Rudder angle indicator.
4 Reserve system for relaying and acknowledging engine control between control room and bridge
5 VHF and DSC radio.
6 Portable radiotelephones.
7 Intercom.
7 Battery free telephone.

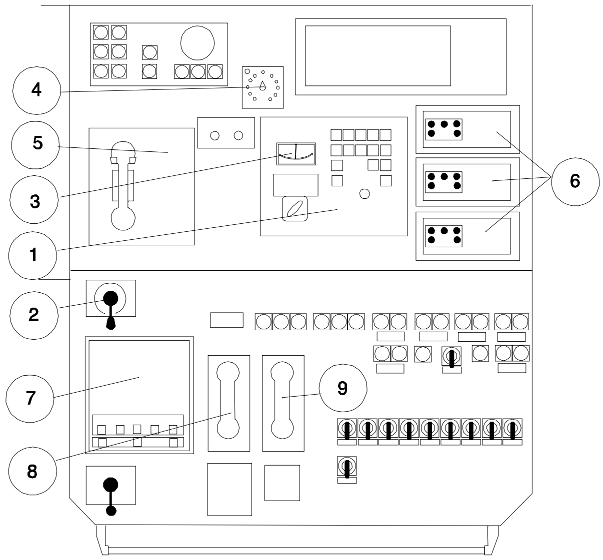


Figure 6a. Starboard console of front wall. Equipment most important for piloting include control unit for TENFJORD rudder machine (Eq.1) and FU steering (Eq.2). This console is operated from the starboard steering place A.

1 Selection of steering modes.
2 Switch panel
3 Small rudder angle indicator
4 Overload indicator of pumps
5 Pump alarm
6 Pump stoplight
7 Steering system stoplight
8 Pump start and stop

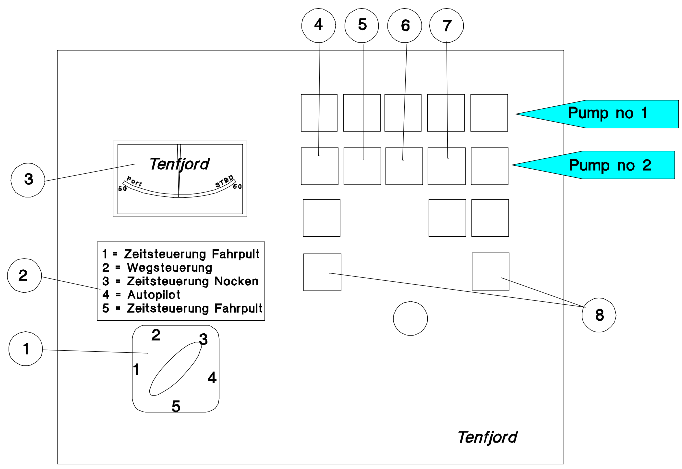


Figure 7a. Control panel of TENFJORD rudder machine in starboard console. Steering equipment selection with switch one. Translation of switch panel 2 in Table 1 below.

Table 1. Panel of steering equipment switch of ms GRIMM. It does not state which steering place (wing of bridge) positions 1 and 5 indicate.

1 = Zeitsteuerung Fahrpult	NFU steering, apparently in wing
2 = Wegsteuerung	FU steering
3 = Zeitsteuerung Nocken	NFU steering, apparently in middle
4 = Autopilot	Autopilot
5 = Zeitsteuerung Fahrpult	NFU steering, apparently in wing

Figure 6b. Starboard console of bridge of ms GRIMM.

Figure 7b. Control panel of TENFJORD rudder machine.

Figure 8a. Easy to use ELNA radar of ms GRIMM.

Figure 8b. Rudder angle indicator in ceiling of bridge (Location also seen in Figure 2).

2.2 Course of events of piloting trip

2.2.1 Events of accident based on simulation

The information on the piloting situation is scant. The persons on the bridge have not included the rudder angles, rates of turn, speed of the vessel or propeller pitches in their statements. The vessel did not have equipment for recording the propeller pitch or rounds per minute.

The reconstruction of the piloting situation, accident voyage and grounding was conducted by simulation on a desktop machine which was compared to the witness statements about the various phases of the voyage. The information from the witness statements presented in Table 2 was used in the simulation. As can be seen from the table, all witness statements cannot be made to coincide simultaneously. In sections (a), (b) and (d) the statements contradict the simulation presented in Figure 9.

According to the simulation the voyage from the pier to the grounding took about 13-14 minutes, which means that the starting time of the vessel from the pier was about 03:06-03:07. The pilot boarded the vessel at 03:00. This left him about 5 minutes to prepare and have a discussion with the master. According to the witness statements, there was no discussion about the steering equipment.

Table 2. Witness statements used in simulation and their comparison with simulation.

Section (a-h) Figure 9.	**COMPARISON OF WITNESS STATEMENTS TO SIMULATION. WITNESS STATEMENTS IN BOLD.**
(a) not true	**Initial heading 160°. All buoys visible. Pilot took the helm at straight heading before the first south buoy (pilot).** The initial heading takes the vessel south of the north buoy if the rudder is turned to port only after the south buoy as stated by the pilot. If the helm is turned to port at the buoy the vessel hits the 2 m shoal behind the north buoy. The initial heading should be 135° -137° for the rest of the statements to come true. The pilot said in his statement. ' I headed south of the first south buoy and I saw the north buoy to port and further ahead the next south buoy'. He did not look at the compass or the rate of turn indicator because he was navigating visually. The simulation in Figure 9 describes initial heading 137°.
(b) not true	**The turn to port began after the first south buoy, because the north buoy was visible to port (pilot).** In the simulation the buoy was abeam the bridge when the turn started.
(c) true	**The turn did not stop before the second south buoy (pilot).** The rudder was at times in the middle during the rounded turn and slightly to starboard at the end of the turn (Table 3).
(d) not true	**After passing the second south buoy the pilot decided to stabilise the vessel on the Halla line by turning the rudder to port (pilot).** From the narrative of the pilot '… while the vessel was still turning to port the next south buoy was passed on the south side'. The rudder must have been turned fully to port before passing the buoy. (Figure 9).
(e) true	**For some reason, the pilot turned the vessel further to port and the vessel "went through his hands" (pilot).** According to the simulation the vessel cannot turn to port steeply enough, but the rudder of the GRIMM was more efficient than the conventional rudder of the simulator.
(f) true	**The second south buoy was passed very close (master).** The vessel must have passed close to the buoy in order to have time to reach heading 068° before the grounding.
(g) true	**The turn was stopped by turning the helm to extreme starboard, when the pilot saw the lights of Hamina directly ahead (heading about 050°).**
(h) true	**The vessel grounded at heading 068° (master).** The efficiency of the rudder in the simulation model does not match the rudder of the GRIMM, but the witness statements are credible.

In telephone interview on December 22, 1998 the pilot said that the master had turned the vessel in the harbour from the wing of the bridge. The only chance of the master to turn the rudder in the wing was the NFU lever. When the vessel had been turned he continued to use the corresponding lever from the middle console. The master must first have turned the switch to position 'Zeitsteurung Nocken' (Figures 7a and b). The pilot had to take over on the same steering lever the master had been using. When the master handed over the steering to the pilot he did not inform the pilot of the other steering equipment of the vessel that would have suited the situation better. The pilot had to perform a difficult steering task on the worst steering system of the vessel.

The pilot stated had he had used a 10 cm long 'tiller' as the steering device. He called it a 'joystick'. The description fits the NFU lever used by the TENFJORD company manufacturing rudder machines. In the opinion of the pilot, the steering did not complicate the navigation. The speed remained during the entire passage at the slow ahead ordered by the pilot.

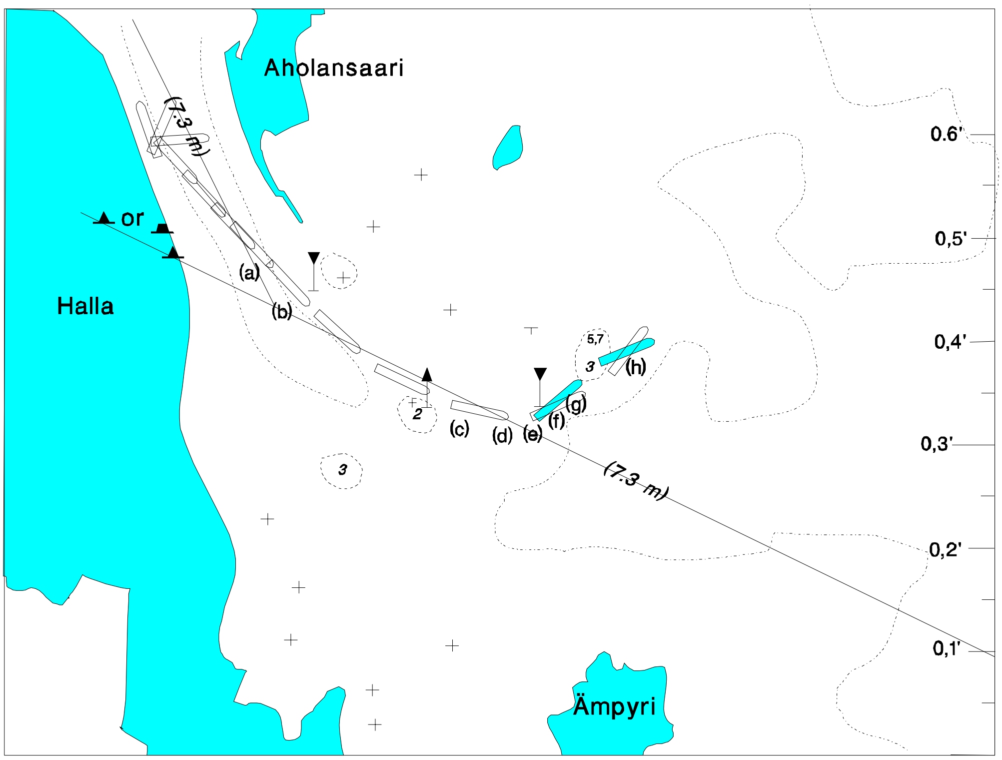


Figure 9. Departure of the GRIMM from Halla according to witness statements and simulation. White symbols describe passage in simulator and shaded symbols describe witness statements when conflicting with the simulation at the time of the grounding since the rudder of the GRIMM was more efficient than the rudder of the simulator. There is no data on which way the GRIMM turned in the harbour.

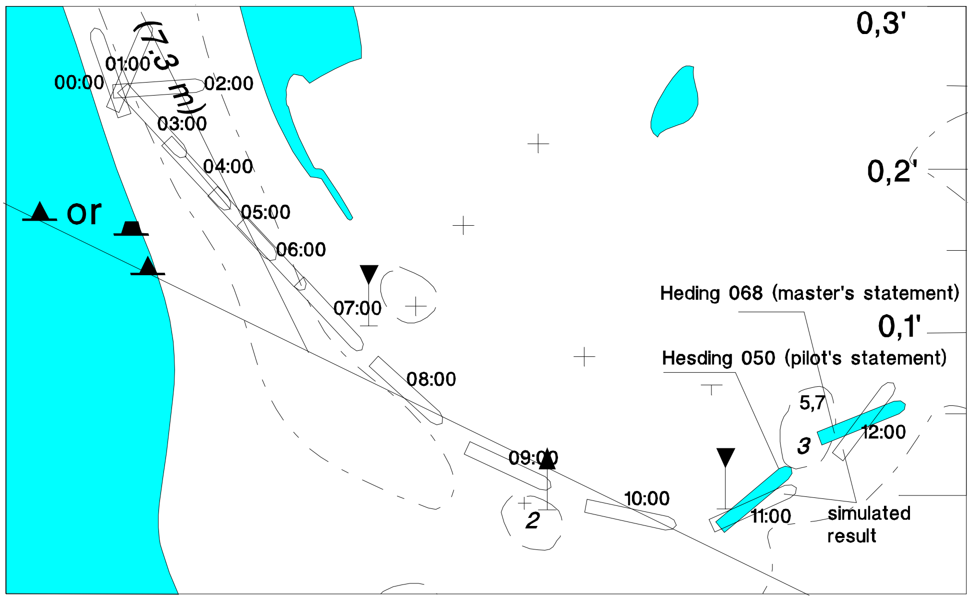


Figure 10. Simulated accident drive. Times are from simulator clock. Simulation begins when the ship is already one shiplength from the pier. It takes about 1-2 minutes, which means that the time from the pier to the grounding was about 13-14 minutes.

Time	Speed	Heading	Rudder angle	Propeller pitch	Comment
00:00	0,0	340°	+35°	0	15 m off the pier
01:00	0,5	023°	-35°	+6	
02:00	0,7	086°	+34°	-0,6	
02:24	0,6	115°	+32°	+2,6	Slowly ahead
03:00	0,9	137°	-30°	+2,6	Turn in harbour ready
04:00	1,5	137°	0°	+2,6	
05:00	2,2	134°	0°	+2,6	
06:00	2,7	137°	0°	+2,6	
06:12	2,8	137°	0°	+3,5	Machine power increased
07:00	3,6	136°	0°	+3,5	
07:48	4,2	134°	-20°	+3,5	Turn to left begins
08:00	4,4	131°	-25°	+3,5	
08:56	4,9	116°	0°	+3,5	Helm to middle
09:00	4,9	115°	0°	+3,5	
09:08	5,0	113°	+5°	+3,5	Turns too quickly
09:48	5,2	113°	-3,5°	+3,5°	Rudder starts to turn port
09:58	5,3	102°	-35°	+3,5°	Rudder in extreme port
11:00	5,0	066°	-35°	+3,5°	
11:12	4,9	057°	-30°	+3,5°	Rudder starts to turn starboard
11:32	4,7	045°	+35°	+3,5°	Rudder fully to starboard
12:00	4,6	037°	+35°	+3,5°	GROUNDING

Table 3. Steering information related to Figure 10. Simulator model continues to turn slowly to port at 12:00 but in reality the GRIMM was already turning to starboard because of the efficient rudder.

The mathematical model used in the reconstruction simulations differs slightly from the dimensions of the GRIMM. The largest factor contributing to the inaccuracy is the efficiency of the rudder, because the rudder of the GRIMM turned 45° according to the sea trial protocol of the master. The rudder of the simulation model was conventional and turned 35°. The 'wheelhouse poster'(manoeuvring booklet) showed the efficiency of the ship's rudder. In other words, the GRIMM turned better than the model in the simulation. The statement of the pilot of the ship 'slipped out of his control' also points to a power rudder. If the piloted vessel has an efficient rudder, the use of manual steering should be performed with due care. Especially use of the NFU steering in such cases requires concentration. A compass stabilised radar screen could have helped in the observation of the turning of the vessel.

The probable trajectory of the vessel and the steering information were as presented in Figure 10 and Table 3. If the initial heading was 160° and the first turn started only after the first south buoy (b), the vessel would have travelled south of the fairway behind the 2 metre shoal. In this case all other witness statements would have matched but not the one that the north buoy was passed from the north side. It is exactly the passing of the buoys that constitutes the most reliable observation of the pilot. According to this, the vessel did not stray outside the fairway. This is considered as reliable evidence and the simulation is based on this. The master spotted both south buoys but not the north buoy. He would have seen also the north buoy if the vessel had passed south of all the buoys. The pilot observed all the buoys and steered according to them without looking at the compass.

Considering the few witness statements the simulation may not be absolutely correct. It does show, however, that a steering error is possible in the way described by the pilot.

2.2.2 Steering and navigation method during piloting

Preparation. The manning on the bridge consisted of the master and the pilot. The GRIMM had a crew of seven. The pilot mentioned in the hearing that the crews are small more and more often. No helmsman can be spared on the bridge. According to the pilot this results in the pilot having to take the helm himself. A separate lookout is never used. The pilot felt normal and he was not tired.

Departure plan. The master and the pilot discussed prior to departure the turn to be performed in the harbour but not about how to turn on the Halla line and which heading should be steered after that. There was no discussion about the piloting.

There is no data on whether the vessel had her own passage plan. According to the maritime declaration the master had no written passage plan. The vessel carried a chart. The pilot had no passage plan. He did not bring his passage plan to the maritime declaration session or to the police hearing. He did not need a chart in his opinion.

The master and the pilot planned to move the vessel away from the pier with the spring and the bow thruster. The master inquired if the sound between Halla and Ahola island was wide enough for turning the ship with the bow thruster. The pilot suggested that after moving the vessel away from the pier side first, she would be reversed 30 metres in order to make room for the turn.

The start from Halla is special in the respect that when the Halla line is left behind, there are only the three buoys ahead as references for steering, and even these are quite close. This is why the vessel must be turned almost in one spot to heading 117° at the line and the heading must be verified from the compass before increasing the engine power.

Choice of steering equipment. The master did not explain the steering systems of the vessel to the pilot. The steering method to be used was not agreed before the start. Probably it was considered obvious that the steering would be handled according to the situation. The pilot had prepared to take the steering on his responsibility judging from the fact that he considered the small manning on the bridge approved by the Finnish Maritime Administration. The result in his opinion was that the pilot may have to steer himself.

After having turned the ship in the harbour the master went to the starboard side of the middle console where the switch for selecting the steering system was located. The master asked the pilot to take the steering. After this, he selected NFU steering with the switch as the steering system. The pilot started to use this. NFU steering requires constant monitoring of the rudder angle indicator and was therefore the worst of the available alternatives. The rudder angle indicator was mounted in the ceiling and the pilot had to look up to see it. The pilot was steering from the port side of the middle console.

Visual navigation emerged as **the navigation and steering method**. The radars were on but it was difficult to use them because of the NFU steering. The steering decisions when turning to the Halla line were based on three buoys since there were no fixed targets. When the turn progressed and the buoys were passed the number of visual targets needed for the steering decreased. Finally only one south buoy was visible and the steering after this was based on the relative position of this buoy to the vessel.

2.2.3 Cooperation on the bridge

The cooperation and situational management on the bridge are evaluated in relation to the demands placed by safe execution of the piloting task. This approach brings to light issues which should be considered in the organisation of pilotage, development of regulations and training. These demands have not been addressed in the regulations on piloting or professional competence of bridge officers, so the cooperation cannot be expected to meet these requirements. In this case the piloting situation did not place any exceptional requirements on the cooperation since the conditions created by the cockpit arrangements for piloting were in general good and there was nothing special about the weather or the fairway.

Preparation for the piloting. The master of the ship was on the bridge with the pilot during the piloting. As the pilot said, these days there is hardly ever a helmsman or a lookout on the bridge because of the generally small crews.

During the preparation before the piloting both parties create the basic conditions for success of their own activity but at the same time for execution of the piloting task in co-operation. Judging from the investigation material, the pilot had no charts with him. He did not think he needed them on this trip. Neither did he have a passage plan. The route was familiar to the pilot, so was the vessel type but the pilot did not remember if he had piloted this vessel before. There is no information on whether he had prepared for the piloting in any other way. The vessel was carrying charts, but no pilot card was given to the pilot. There is no information of the passage plan of the vessel. The master was on the route for the first time. He had evidently familiarised himself with it on a general level. The lack of a common plan placed special demands on the creation of a common understanding of the situation and the maintenance of it in the future as well as on mutual communication between the pilot and the master during the piloting.

In the beginning of the piloting there was not much time for the preparation since the vessel set off fairly soon after the pilot had arrived on board. According to the statement of the pilot, there was no specific conversation about the steering properties of the vessel or about her steering and navigation equipment in the beginning of the piloting. Therefore, the pilot did not form an idea of the special characteristic of the vessel or of the available equipment.

Cooperation in piloting. The master and the pilot discussed the departure of the ship and had a common idea of the method of doing this, but they obviously did not discuss the upcoming piloting. Based on the investigation material it also appears that the master and the pilot did not really negotiate the sharing of tasks. This was formed automatically when the pilot asked the master to switch on the searchlight and the master handed over the steering to the pilot. The pilot had guessed that the master wished to move on to other duties. The change in the steering task took place on arrival into the first turn, and the proximity of it was not sufficiently considered in the timing of the task change. There was no time for the pilot to prepare for the turn. The change in the steering task should always be performed on a straight leg of the fairway. In addition, the master placed the worst possible steering system for the use of the pilot. This steering system, especially when combined with the efficient special rudder of the vessel, required concentration on the steering, which means that use of the radar and the compass became more difficult and visual navigation formed as the first choice.

In principle, the master had the opportunity to monitor the execution of the turn, since he had a general understanding of the headings and buoys of the turn. The monitoring of the ship's passage was weak, since the master was concentrating on visually locating the buoys with the searchlight. In this task of a lookout, the master could not follow the compass heading of the vessel. In addition, he stated that it had been difficult to detect the motion of the vessel in the dark.

The pilot was steering and navigating the ship on his own. The accident was a result of a steering error in the turn which resulted in the vessel running off, according to the pilot's statement. The pilot managed to stop the turning of the vessel and almost slow her down. The master did not interfere in the pilot's steering error. The pilot asked the master to take over the helm and started to look out realising that the vessel was off the fairway. The pilot tried to return to the fairway relying on visual observation but the vessel nevertheless grounded.

In summary it can be stated that the master and the pilot had no common plan or operative idea. They did not maintain a common understanding of the situation which made verification of the activity extremely difficult. The fact that the pilot was steering the vessel alone, navigating visually with the traditional navigation method and using a steering mode difficult to use led to the events guiding the activity. The activity became based on a gut feeling and lacked the advance judgement necessary for navigation.

2.3 Rescue activity

Distress and safety traffic and initiation of rescue activities. The pilot reported the grounding to the coast guard station 1 hour 50 minutes after the incident. The coast guard station contacted the pilot one hour from this. The pilot reported that everything was under control. There was no report of a risk for environmental damage although the fuel tank of the vessel had sustained a leak. No fuel leaked out, since the sea water pushed the lighter fuel to the upper part of the tank when flooding in. Since there was no imminent danger to the vessel or anyone on board and the vessel did not get caught during the grounding, she was taken to Kotka.

The coast guard did not send a vessel out to the scene. No one reported the accident to the regional alarm centre in Kotka. No urgent message was sent (safety traffic) despite a clear risk for environmental damage caused by the leak in the fuel tank. The marine rescue system did not function in a way required by the risk for environmental damage.

Post accident activity. The rescue department was not notified of the fact that there was a vessel with a leak in her fuel tank in the harbour area. The damage to the vessel was inspected at berth in Kotka and temporarily repaired.

3 CONCLUSIONS

3.1 Chain of events leading to the grounding

The chain of events leading to the grounding of ms GRIMM outside the port of Kotka was as follows:

- Departure from Halla port was hasty and the preparation for piloting was inadequate. Activities continued without a plan or verification.
- Change of the steering task was performed immediately before the start of a turn.
- The pilot started to use the steering system chosen by the master. The choice was the worst suited of the available alternatives for steering and navigation performed by the pilot alone.
- At the end of the turn the pilot made a steering error and the turn ran out of control.
- The pilot managed to stop the uncontrolled turn but the vessel grounded when attempting to return to the fairway.

The accident situation developed quickly after the departure. The vessel had good steering equipment and the visibility was good. The situation can be described as drifting into a funnel where the factors supporting the navigation and the steering disappeared one after the other. In the end, positioning and heading were based on visual observation of the buoys. This resulted in temporary loss of heading information when there was only one buoy left in the view. The steering error caused by this was therefore not detected quickly enough.

3.2 Contributing factors to the grounding

Steering errors may never be entirely avoided but the factors contributing to them can be addressed. The steering error that occurred in the grounding of the GRIMM was influenced by the factors discussed below. These factors can be considered the real reason for the accident.

Conditions for navigation and piloting. The GRIMM had good radars and steering systems suitable for piloting and two steering places, one well suited for piloting and the other one for monitoring. The technical safety support structures were good but they were not used. The pilot unintentionally raised the degree of difficulty of the piloting when he accepted the choice of steering equipment that suited worst for the steering and navigation he performed alone.

Navigation method and cooperation on the bridge. Traditional visual navigation formed into the navigation method. The heading reference of the bow and the positioning were based on buoys instead of the compass heading. The used steering system also contributed to this.

The navigation method remains usually unconscious. The used navigation method did not create the chances for advanced judgement and cooperation in the activity. One's own activity cannot be analysed or directed in this navigation method. As a consequence, the technical or manning resources available are not weighed and the requirements resulting from the navigation method are not recognised.

In the grounding of the GRIMM, the deficiencies in the cooperation provide the main reasons for the accident. The background to this lies in the fact that the piloting was not considered a joint duty but separate individual performances by the officers of the ship and the pilot. The steering and navigation tasks accumulated on the pilot in practice. The pilot and the master had no common plan or common operational idea. They did not maintain a common view of the situation which made verification of the activities extremely difficult. The fact that the pilot was steering and navigating the vessel alone with the traditional visual navigation method and that he used a complicated steering mode contributed to the events directing the activity. The activity became based on a gut feeling and lacked the advance judgement necessary for the navigation. Means that would support the cooperation, such as the passage plan, mutual communication and the properties of the equipment promoting cooperation cannot be used.

4 RECOMMENDATIONS

The grounding of the GRIMM shows that the used steering equipment, navigation method and cooperation method have a close influence on one another and on how safe an execution can be provided for the piloting task.

4.1 Equipment training for pilots

According to the pilotage instructions of the Finnish Maritime Administration the pilot must acquire the data affecting the passage and steering of the vessel and especially clarify the condition of the navigation equipment. The text of the instruction is clear but too general in nature. The pilots do not observe it because it contains no specifications. This leads to each pilot resolving the issue in his own way.

In 1991 a questionnaire on the training of pilots was conducted. The results showed that the pilots desired training in the equipment. Training in the theory of the various steering systems is clearly necessary. FU steering, NFU steering and Rate-of-turn Autopilot as well as the theories and differences between the various steering systems must be included in the training of pilots.

It is the recommendation of this investigation that:

1 The Finnish Maritime Administration issues detailed guidelines for pilots on how to check the manning and the steering and navigation systems and how to evaluate their suitability for the piloting before its start.

2 The Finnish Maritime Administration includes compulsory training on the steering systems into the training of pilots.

4.2 Development of cooperation on the bridge

In this case, the deficiencies in the cooperation method were direct causes of the accident. The background to this lies in the fact that the piloting is not considered a joint duty but separate individual performances by the officers of the ship and the pilot. The steering and navigation tasks accumulate on the pilot in practice and the verification of activities within the overall responsibility of the master remains very general. Means that would support the cooperation, such as the passage plan, mutual communication and the properties of the equipment promoting cooperation cannot be used.

It is the recommendation of this investigation that:

3 The Finnish Maritime Administration develops in cooperation with maritime training institutions a cooperation model for the Finnish conditions and requires knowledge of this model in the competence requirements of pilots and officers.

LIST OF SOURCES

1. ms GRIMM Maritime Declaration in Kotka, October 7, 1997.
2. Binnenschiffahrt 217 (1995), § 4.01.