ACCIDENT INVESTIGATION BOARD

FINLAND

Investigation report

C 4/1998 M

ms GERDA, grounding outside port of Kotka, April 7, 1998

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 GERDA, grounding outside port of Kotka, April 7, 1998

Summary

The German flagged general cargo ship ms GERDA was on her way from Helsinki to Kotka during the morning of April 7, 1998. A Finnish pilot and the vessel's master were on the bridge. The pilot was steering the vessel. Both the master and the pilot had taken up their positions. The vessel went aground in the Pirköyri Sound off Kotka at 04:10. Four empty containers fell overboard and ballast tanks numbers 1 and 2 were damaged.

CONTENTS

Figure 1. General view of ms GERDA.

1. GENERAL DESCRIPTION AND INVESTIGATION OF THE ACCIDENT

1.1 The vessel

1.1.1 General data

Name of ship	ms GERDA
Home port	Hamburg
Call sign /IMO number	DPGK / 9113745
Type	General cargo ship
Crew	10
Classification society	Germanischer Lloyd
Year of construction	1995
Length	100,6m
Width	18,45m
Draught	6,56m
Gross capacity	3999
Dead weight	5212 tons
Engine power	3825 kW
Speed	15,5 knots

1.1.2 Crew and traffic limitations

The master had visited Kotka once, as mate. This was his first time on the fairway in question as master.

There are no speed limits, passing bans or traffic reporting obligations in the area.

1.1.3 The cockpit and its equipment

Figure 2. Cockpit of the GERDA, electronic chart monitor on upper right.

Navigation equipment

S-band 10 cm marine radar	Kelvin & Hughes 5000T
X-band 3 cm marine radar	Kelvin & Hughes 5000T
Positioning device	GPS
Positioning device	Loran C
Electronic chart	Navi Sailor 2400
Autopilot	Anschütz Nautopilot D
	Anschütz ROT Tiller
Gyrocompass	Anschütz

1.2 Accident events and the preceding activity

1.2.1 Weather conditions

The weather was calm with visibility of 200-300 metres. An area of ice began inside of Lålättan. There was a crack in the fairway ice but outside it the ice was solid. There was broken ice in the Pirköyri Sound, which called for more adjustments by the radar operator than usual. The visibility of the buoys on the radar was poor. According to the GERDA's master, it was not possible to discern the difference between the ice and land targets on the radar.

1.2.2 Preparation for the piloting trip

In his own report, the pilot mentioned that he had charts of the area but that he did not need them since the vessel carried British Admiralty charts on board. In addition, the vessel had an electronic chart. The pilot did not specify if the charts he brought with him were chart extracts which complied with the piloting instructions of the Finnish Maritime Administration with markings for radar navigation. This was not queried in the maritime declaration session.

The master does not mention a passage plan in his statement. In the maritime declaration session, the master's passage plan proved to be a cruising plan from the Harmaja pilot station to the Orrengrund pilot station. There was no documented plan for the vessel's piloting passage from Orrengrund to the port.

The master stated that he had informed the pilot of the handling properties of the vessel. The pilot did not mention in his report that information concerning piloting had been exchanged between the master and the pilot. According to the master, the pilot had asked no questions about the radar. The pilot stated that he knew how to operate the Kelvin & Hughes radar.

1.2.3 The accident voyage

The GERDA was on her way from Helsinki to Kotka. At departure, the bow draught had been 4.9 metres and the stern draught 5.8 metres. The GERDA picked up a pilot at Orrengrund on April 7, 1998 at 02:35. After this, the master and the pilot were alone on the bridge.

From Orrengrund the vessel proceeded at full speed, 14–15 knots, towards Kotka. The pilot occupied the steering console's port radar position and the master the starboard one. The pilot was steering on autopilot.

The Lålättan bend was passed at about 02:55. Ice began to appear at the fixed fairway mark. The visibility varied. According to the master, the open fairway deviated from the official fairway so the pilot was forced to steer according to the ice. According to the estimate made during the investigation, the speed was reduced to about 11 knots after Kaunissaari.

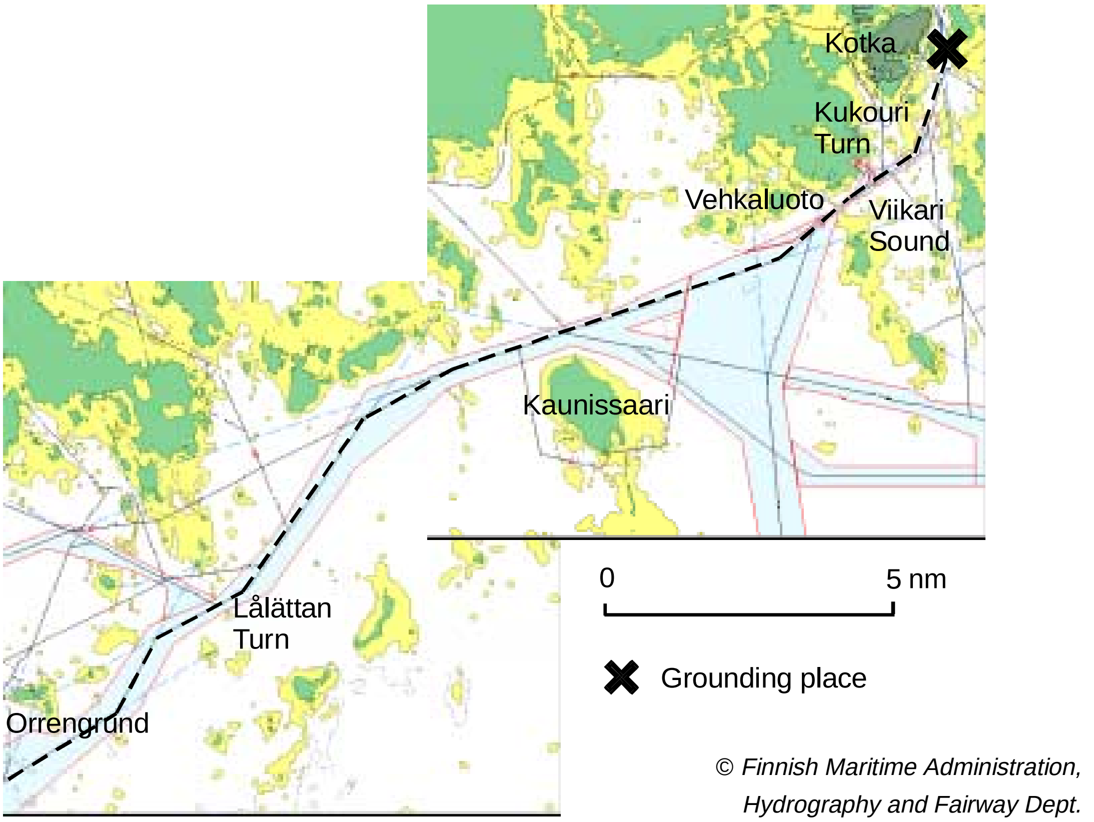

Figure 3. Approach fairway to Kotka used by the GERDA

Heading 049° was adopted south of Vehkaluoto. The tanker CHRYSTAL EMERALD was met in the Viikari Sound. At that time, the echo from the fixed green fairway mark blended into the echo of the incoming vessel on the radar. According to the pilot's report, the green and red buoys at 0.8' to 1.0'[1] from the fixed fairway mark were instead clearly visible on the radar. The speed was reduced to 10 knots in the Viikari Sound because of the incoming vessel. After this, the speed was again increased but the exact location of the speed increase is not known. After Kajakari, a turn to heading 0.56° was made.

The GERDA turned at the Kukouri bend towards Pirköyri at about 04:00. The visibility reduced to zero. According to the pilot, not even the ice was visible from the bridge. On the radar, the echoes from the ice drowned out the echoes from the fixed fairway marks and buoys. The engine power was increased in order to make the vessel turn in the Kukouri turn, but the bow still cut into solid ice. The vessel ended up east of the fairway and this was noted by the pilot from the electronic map updated by the GPS. The pilot ordered heading 015° and waited for the vessel to reach line 018°.

The pilot thought it safe to continue the voyage since Pirköyri Island and the beacon were clearly visible on the radar. He used range 1.5' and tried to tune out the interfering echoes caused by the ice.

[1] the sign for angular minute ' is used as a synonym for nautical mile also in navigation

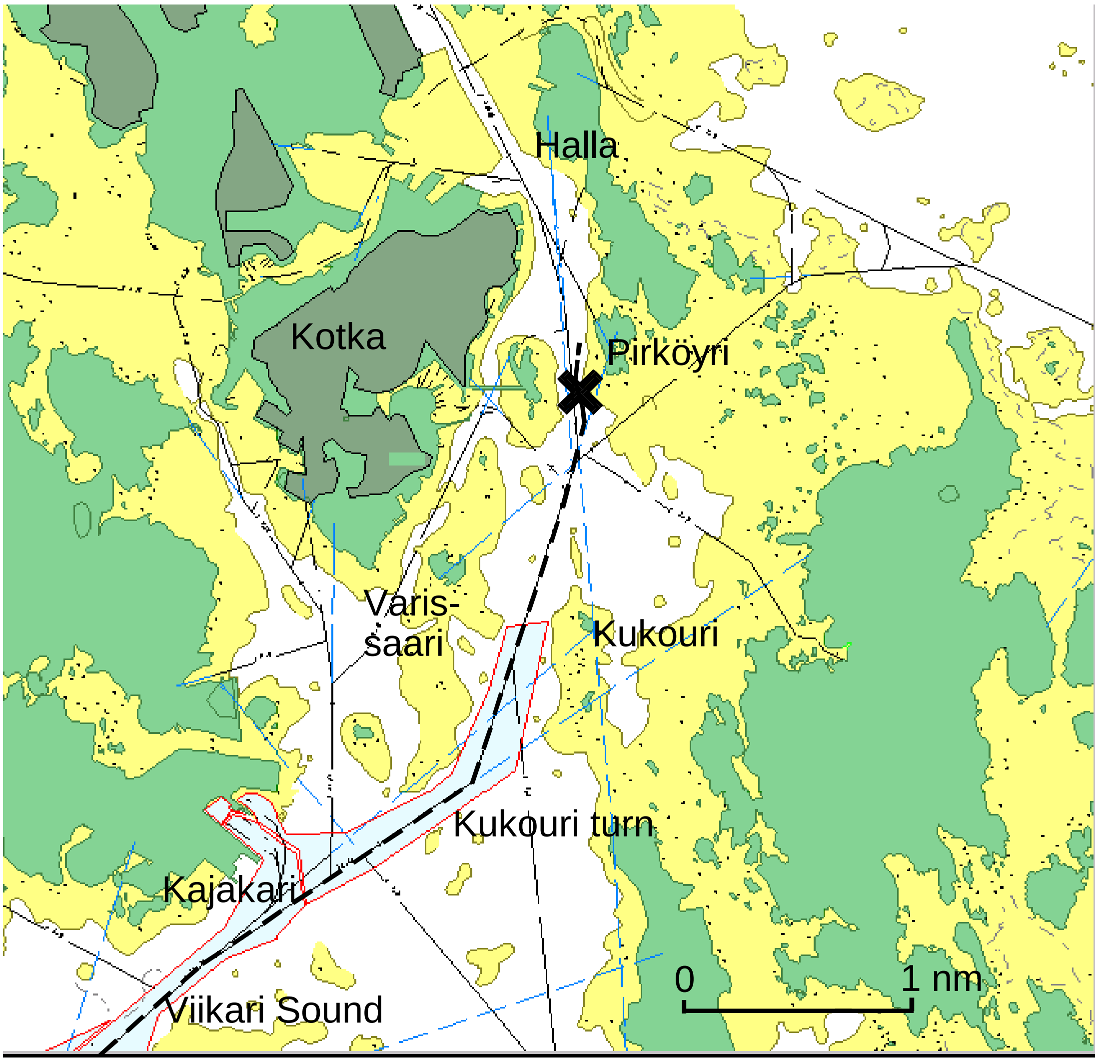

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Figure 4. Fairway from Viikari Sound to Pirköyri used by the GERDA

The pilot stated that the speed was reduced at Varissaari from 12 knots to 6. According to the master, the speed was lowered after Varissaari but he did not mention by how much. According to him, the visibility was less than 100 metres.

At Varissaari the pilot contacted the port authority to report the position of the GERDA. At that time he also found out from radio traffic that ms INOWROCLAW was about to leave the port of Hietanen where the GERDA was heading. The pilot contacted the INOWROCLAW and agreed on communication on VHF channel 11. The pilot also saw that the radar distance to Pirköyri island, or to a pack of ice south of it, was about 0.6'.

The pilot reported 'turning the automat to course 360°' He chose 0.75' as the radar range, since the Pirköyri beacon was no longer visible. All the target echoes had blended into the echoes formed by the ice. The pilot 'turned the automat to course 355°'. The pilot switched the radar back to range 1.5' in order to see Halla Island. He deduced from the new radar image that the vessel lay slightly east of the fairway. The compass showed 360° at the time. The pilot changed the heading to 340°. The purpose of this great change of heading was not to direct the ship to heading 340° but to create a steep rudder angle in order to speed up the turn to port. The speed was 7 knots. Suddenly the GERDA hit something. The time was 04:10.

The GERDA listed violently to port from the force of the impact. The stack of containers in front of the bridge collapsed and four containers fell overboard. The master set the propeller pitch to zero. The autopilot was switched to manual steering and the helm was placed in the central position. The vessel came to a near halt. The pilot ordered compass heading 355°. The master 'kicked the engine forward' in order to turn the vessel. The engine room reported that there were no leaks.

The pilot stated that he had asked the master to steer slowly to the Pirköyri shore in order to place the bow in shallow water in case of leaks. The GERDA glided slowly forward until she stopped almost unnoticed. The compass heading was 030°. The pilot reported the accident to the port of Kotka and requested assistance from a tug.

The master had not been informed of the outcoming traffic. The pilot had conducted all radiotelephone conversations in Finnish and had not reported their content to the master.

Figure 5. Stack of containers in front of bridge collapsed on impact. Four containers rolled overboard.

1.3 Rescue activity

The damage to the vessel and her rescue. The checking for leaks on board began at 04:12, at which time the mooring cable locker, the bow thruster chamber and the engine room were inspected. No leaks were detected in any of these. The vessel had no list. Divers from the fire brigade inspected the hull and it became obvious that ballast tanks 1 and 2 had sustained leaks.

The tugs VIIKARI and NEPTUN were attached between 09:28 and 09:32. The GERDA had lain on a sloping rock and she became afloat easily. The GERDA steered to port under her own power and moored at 10:30.

1.4 Accident investigation

Since several incidents in which a foreign ship had grounded during piloting had occured in the autumn of 1997, the Accident Investigation Board decided to launch a common investigation into these accidents on December 29, 1997. One of the accidents later included in this investigation was the grounding of general cargo ship ms GERDA outside the port of Kotka on April 7, 1998.

These accidents 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 accidents, however, has given a reason to investigate the course of events and their causes in order to prevent similar occurrences in the future.

The GERDA's master provided a maritime declaration in a session of the Maritime Court in Kotka on May 22, 1998. 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 GERDA. 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 The organisation of piloting in Kotka piloting district

There were 30 sea-going 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 operates from the Pookinmäki coast guard station. There are six VTS operators on call. They are not sea-going 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 pilot station on Ruukinkatu. The station also has an office for the local pilot inspector. The pilot inspector's task is the 'operative management and development of the piloting activity'. In practice, the office also handles administrative routines.

There are no regular gatherings or meetings. The employer relays any information about changes of fairway markings to the pilot's home through the 'Tiedonantoja merenkulkijoille'[2] 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 with a call from the officer on duty at Pookinmäki to the on-call pilot's mobile telephone. 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 pilot station during their working 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 the pilots is made up of the miles piloted and their 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 for directly by the pilot himself according to the size of the vessel.

2.1.2 Shipping company directions and their practice in piloting

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

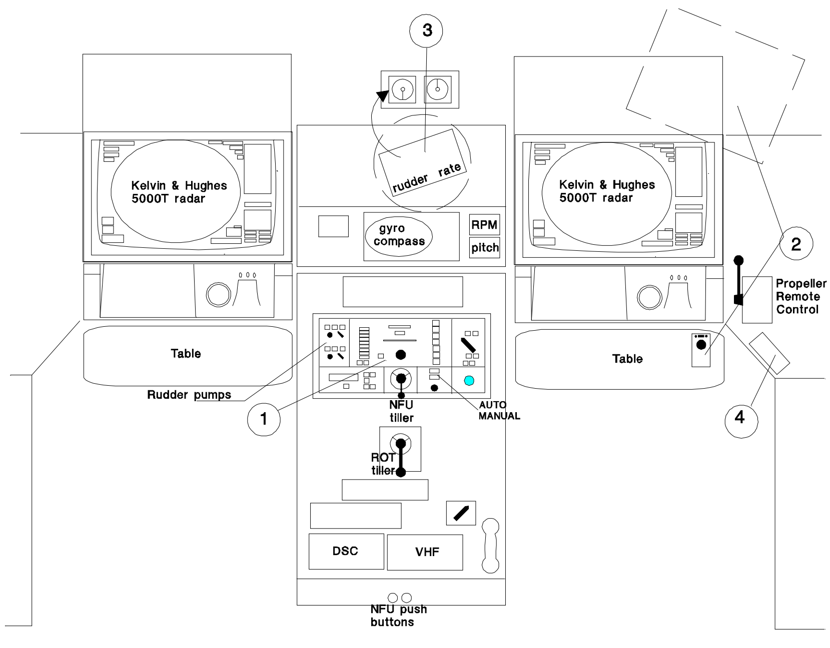
[2] "Information to Seafarers", tr.note

2.1.3 Cockpit arrangements and conditions provided for piloting

The following presents an analysis of the cockpit arrangements of the GERDA. The analysis addresses the suitability of the various work points on the bridge for piloting on archipelago fairways with regard to the equipment situated in them. The analysis also discusses the usability of individual navigation instruments for the same purpose.

The drawing of the location of the equipment in the cockpit (Figure 6) is based on photographs of the bridge of the GERDA. Therefore, the pictures are not to scale.

The cockpit arrangement of the GERDA followed a cockpit arrangement which is fairly common in Germany: Optimale Brücke. The relevant study by the German Ministry of Traffic was published in 1974. Sietas Werft began to build a standardised bridge based on the principle in question in the 1970s. The bridge arrangement is generally considered to be successful and it has gained wide approval in several countries. Figure 7 shows a general view of the radars and steering consoles. The middle console of the cockpit console with the autopilot and the rate of turn and rudder angle indicator is presented in Figure 8.



1. *Anschütz Nautopilot D.*
2. *Electronic chart. Used with mouse in front of radar.*
3. *Combined turntable rate-of-turn and rudder-angle* indicator*.*
4. *Central unit for horn.*

Types of log and depth sounder unknown.

Figure 6. Cockpit arrangement and location of equipment of ms GERDA. Figure drawn from photographs.

Figure 7. Cockpit radars and steering consoles of ms GERDA

Figure 8. Middle cockpit console with autopilot and rate-of-turn and rudder-angle indicator (see also Figure 6).

GPS ja electronic chart

The chart desk included a Magnavox 200 satellite receiver, which was connected to the electronic chart. The vessel's position was marked on the electronic chart at 1 minute intervals. The master stated in the maritime declaration hearing that its accuracy was 10–15 metres. This indicates that the device was operating in its differential mode, DGPS.

GPS receivers have three different operational modes. The devices can operate in GPS, DGPS or in a combined GPS/DGPS mode.

In the **DGPS mode,** the receiver calculates the position only when it receives a corrective differential signal. The nearest differential beacons in the Kotka area are Porkkala, St Petersburg and Puumala. Their reception varies in Kotka and there could have been blackouts of these differential signals. When the GERDA lay stationary on the shore at Pirköyri after the grounding, the GPS registered her position continuously on the electronic chart. The error radius was about 45 metres measured from the chart. Judging from this, the device was not operating in the DGPS mode.

In the **GPS mode,** the receiver calculates the position based only on information received directly from the satellites. The statistical accuracy of the GPS is about 60 metres (95% probability). The error in the positioning of the vessel when she lay stationary on the shore at Pirköyri points to the GPS mode having been in use.

In the **GPS/DGPS mode,** the receiver switches to the GPS mode when the differential signal is not received. The registration of the vessel's position shows that random errors in her positioning were very small. The registered points followed one another as headings announced by the pilot. This points to the GPS signal having been differentially corrected and that the differential signal was operative when the vessel approached Pirköyri. The grounding position was meticulously registered: in other words, the vessel had a receiver with the GPS/DGPS mode. This leads to the conclusion that at some point the receiver lost the differential signal when the vessel lay on the shore at Pirköyri. The receiver had probably been switched to a mode which alternated automatically between the GPS and DGPS modes according to the strength of the differential signal.

The monitor for the electronic chart was mounted in the ceiling to the right of the steering and navigation console (Figures 2 and 12). It was easily visible from the master's seat. The screen could be turned in such a way that the chart could be viewed from both seats of the console. The computer and monitor where made by Hewlett Packard. The electronic chart and the software operating it were Navi Sailor 2400, manufactured in St Petersburg. The resolution of the monitor was good and the chart was drawn in vector form from official paper charts.

Trajectory points of the passage plan can be registered in the **Navi Sailor application**, but this option was not used. The application maintains an automatic log where it registers the position and motion information of the vessel into the memory of the computer. This recording takes place on the hour, when passing a trajectory point, at change of watch or when the user supplies a separate EVENT command. The log can be printed but there was no printer connected to the computer.

The application records the distance travelled automatically at 24 hour intervals and names the files according to the date. Log_Book \ Track_History commands give access to previously recorded distances. The master stated during the maritime declaration session that no recorded information concerning navigation can be extracted from the system.

The electronic chart and the positioning equipment of the GERDA were good. The equipment included the option of recording the route and the distance.

Radars

There were three Kelvin & Hughes Nucleus radar transmitters on board the vessel. There was an S-band antenna (10 sm) in the bow. The X-band antenna (3 sm) was mounted on the roof of the bridge and another S-band antenna on a mast above the bridge. There were two 5000T type monitors on the bridge with selection of signal from any of the transmitters. The diameter of the radar monitors was 250 mm (12”). IMO only requires one radar on a vessel the size of the GERDA, so this equipment clearly exceeded the requirements.

User interface of the Kelvin & Hughes radar. The Kelvin & Hughes monitor is generally considered to be a fairly good piece of equipment for open sea navigation in Europe. All functions are handled through menus with one rollerball and three buttons, which perform different functions according to the selected menu. The user interface of the radar is presented in Figure 9. The advantage of this system is the absence of all buttons and controls, but for the user this means multiple functions. The system is not functional for pilots, as it differs from other radars. The radars and steering equipment of a vessel the GERDA's type are analysed in accordance with the accident investigation of ms BALTIC MERCHANT (Investigation C 5/1998 M) based on piloting and the Rhein river traffic regulations. According to these regulations, the user interface of the Kelvin & Hughes radar is not acceptable. In the investigation of the BALTIC MERCHANT, the pilot clearly indicated that the user interface of the Kelvin & Hughes marine radar was slow to operate.

The adjustments to the Kelvin & Hughes radar have been considered form the point of view of piloting on archipelago fairways in the following.

Figure 9. Keyboard of Kelvin & Hughes radar.

Adjustment of radar image. There is varying interference to the radar image or video, which is due to different reflections from the ice floes. It is difficult to locate the buoys from among them. The video has to be adjusted often with the Gain and Sea Clutter controls.

1. Cursor is placed in video adjustment window GSR (Gain, Sea, rain)
2. Middle button is pressed (Sea).
3. Button is kept pressed down and rollerball used to adjust Sea Clutter to zero.
4. Left button is pressed (Gain).
5. Button is kept pressed down and rollerball used to adjust Gain between 1-10.

There are five functions compared to only two on a conventional radar. With a conventional radar, attention is focused on the screen sea clutter during the adjustment. With the Kelvin & Hughes radar the window on the outside of the screen must be simultaneously watched which means that the observation of the screen itself and adjustment are delayed.

Use of bearing and range in piloting. Pirköyri turn geometry, and a turn planned on it, is given as an example in Figure 10. The turning point is measured with the radar's electronic bearing line and variable range marker.

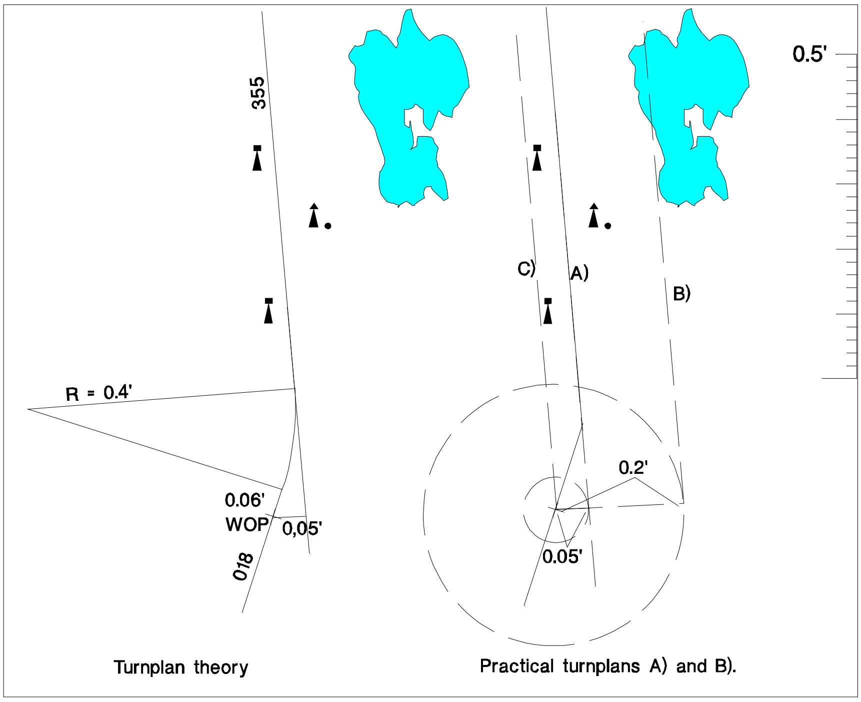


Figure 10. Use of bearing and range in piloting. Pirköyri turn as example.

The Pirköyri turn is planned for turn radius of 0,4’ and is begun 0,064’ before the start of the even turn. The WOP (Wheel Over Point) provides the starting point for the turn. There are two alternative bearings, A and B, parallel to the new heading which can be used for defining the starting point for the new turn. Lateral distances 0,05’ and 0,2’ can be read from the chart.

The non-standard user interface of the Kelvin & Hughes radar requires nine different commands to execute turn plans A or B in Figure 10.

Too many commands force bearing C only to be adopted, which would base the turning point on floating buoys alone. It is against common navigation principles to base a turning mark on a floating buoy, but a complex non-standard user interface may force the pilot to adopt a more risky piloting method.

In piloting, simple and clear use of the electronic bearing (EBL, Electronic Bearing Line) and the variable range marker (VRM) are important for quick definition of the starting point for a turn. The adjustments should be easy to make. Both adjustments should operate with one control.

The variable range marker is positioned as follows on the Kelvin & Hughes radar:

1. Cursor is placed in VRM window.
2. Any key is pressed. The cursor moves on top of the VRM ring.
3. Rollerball is used to set the ring at desired range.
4. DESELECT field is activated with middle button which releases the cursor from the ring.

It requires four commands to set the range. On a conventional radar, range adjustment is performed with a separate control and range setting with one function.

Heading is taken as follows on the Kelvin & Hughes radar:

1. Cursor is placed in EBL window.
2. Any key is pressed. The cursor moves on top of the EBL heading.
3. Rollerball is used to set the bearing at desired heading.
4. Right MOBILE EBL button is pressed and EBL is moved to tangent of range ring (on line B in Figure 5).
5. DESELECT field is activated with middle button which releases the cursor from the ring.

The presentation of the turn geometry requires nine commands. On a conventional radar, the same action is performed with three or four commands.

Movable heading **Parallel Index** is also a piloting concept. This is used to ensure that the vessel passes the targets at the previously planned distance. On the Kelvin & Hughes monitor, it takes about seven commands to set the parallel index.

1. Cursor is placed in NAV field and any key is pressed.
2. Cursor is placed in PI field (Parallel Index).
3. Left button is pressed. PI line appears on screen parallel to the compass heading.
4. Cursor is placed on PI line.
5. Middle button SELECT is pressed.
6. PI line is placed at adequate distance from vessel. Range is shown in a window opened by the PI command.
7. Left button, ADJUST ANGLE is pressed and kept down. Rollerball is used to select the desired heading for the PI line.

By using the parallel index, the turning point can be defined with fewer commands than with the EBL and VRM.

On a conventional radar, parallel index is set with three or four commands.

It is also possible to determine the start of a turn with the **WOP (Wheel Over Point)** function on the Kelvin & Hughes radar.

1. Cursor is placed in NAV field and any key is pressed.
2. Cursor is placed in CURVED EBL field and any key is pressed.
3. Cursor is placed in RADIUS field.
4. Cursor is held in RADIUS field and left button is kept down.
5. Rollerball is used to select the desired value for the radius. The motion of the rollerball is up or down.
6. Cursor is moved to red line marking the new heading.
7. SELECT is pressed.
8. New heading is moved to desired direction.
9. DESELECT is pressed.

The turn is begun when the curved EBL reaches the new cruising line to which the turn is desired. During the turn the turn described by the curved EBL diminishes during the change of heading from the rear of the vessel.

Summary of radars. The user interface of the Kelvin & Hughes radar on the GERDA differs considerably from radar sets of other manufacturers. This causes problems, especially for pilots, because they do not get the same opportunity to practice using the radar as the ship's officers. With regard to piloting, the radar adjustments are too complex and too slow to use. Pilots navigating in archipelagos and in ice have criticised the user interface.

The user interface of the Kelvin & Hughes radar supports the traditional navigation method where bearing and range are not used. A 'scenic' view of the radar screen is adopted and the turning point is determined using the eye. To define the turning point sufficiently accurately requires several radar targets, but there were few targets available at the time of the GERDA'S accident.

In radars manufactured to comply with the Rhein river traffic regulations, this complex operation has been avoided.

The vessel's steering equipment

The pilot and the master had two feasible steering methods in the Anschütz Nautopilot steering system, which is designed for both open-sea and river traffic. In addition, the middle console had manual steering of the rudder (NFU), which is mainly suited for emergency steering. This equipment is pictured in Figures 8 and 11. The steering methods are:

1. COURSE CONTROL. Automatic steering at fixed angular speed. This is suited to steering on long straight and wide fairways.
2. ROT Tiller. Automatic steering at steplessly adjustable rate of turn ± 35° /min. This is suited to steering on narrow winding fairways.
3. The third steering method was manual steering NFU, (Non Follow Up).

The course control mode uses the gyrocompass heading on a straight passage and a preset rate of turn in turns. It is designed for open-sea conditions but it can also be used on fairways with long straight lines. When the autopilot is switched on, it always adopts the heading which the vessel has as its steering command. The course control steering mode is activated automatically when the autopilot is started. The selection of the rate of turn was slightly too much work during piloting, which is why a separate steering mode with stepless adjustment of the rate of turn has been designed for piloting and river traffic.

The **ROT Tiller** is a steering mode designed for river traffic. It has not been designed to be used by the helmsman but by the person navigating the ship. Steering by rate of turn releases the hands for other navigation equipment and allows for concentrated observation of the radar during changes of heading. The steering takes place solely on the rate-of-turn commands. Zero stands for straight ahead. If the lines are long, the vessel tends to stray slightly from her initial course which means that correction is required at times. Steering by rate of turn is a flexible steering method on fairways with many bends requiring frequent changes of the rate of turn. Stepless selection of a rate of turn of ± 35°/minute is possible. However, it must be ensured that the rudder-angle limiter is set at its full value, 35°, and that the YAWING setting which regulates the turn is normal (coefficient 2).

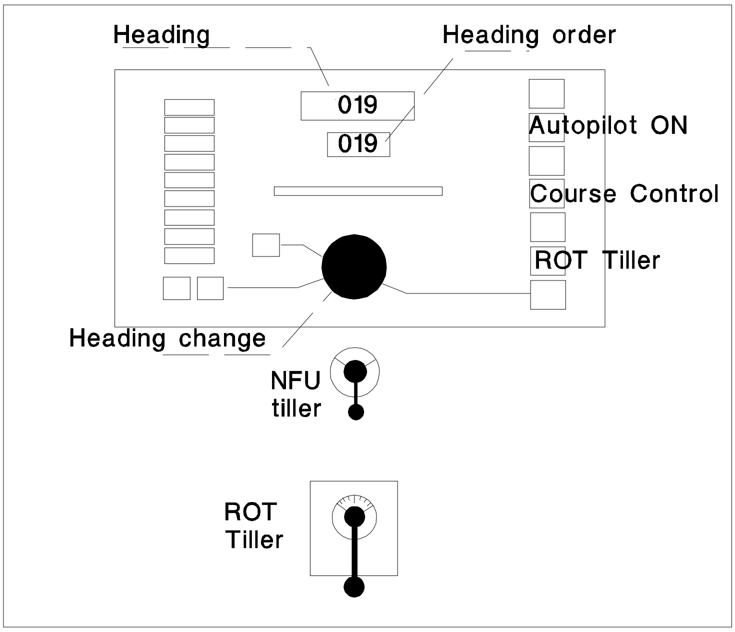


Figure 11. Steering modes for Anschütz Nautocourse D system suitable for piloting. NFU was emergency steering.

Manual steering of rudder (NFU, Non Follow Up) is located on the autopilot panel (Figure 11). Turning the lever instantly disengages all the automatic steering modes (override function). This steering mode functions on the Non Follow Up (NFU) principle and overcomes any limitations in the steering system. The rudder turns as quickly as possible to its extreme position. Turning the lever keeps the rudder pump active. The desired rudder angle can be adjusted with the rudder-angle indicator. When the desired angle is reached the pumps are stopped by releasing the lever. A spring returns the lever to its central position. The rudder-angle indicator therefore requires constant monitoring. When steering with the NFU lever it is difficult to observe the radar. NFU steering is usually installed as an emergency steering because it is operationally reliable. It relays the order directly to the rudder machine, overriding any other technology.

The vessel did not have **Follow Up Steering (FU)**.

To summarise, it can be said of the steering equipment on the GERDA that the autopilot equipment was good but the vessel lacked Follow-Up manual steering.

2.2 Course of events of the piloting trip

2.2.1 Accident events based on registration and computer simulation

In the reconstruction of the accident voyage, the statement of the master about the grounding taking place at 04:10 has been used. The location of the vessel registered on the screen of the electronic chart at 04:08 next to the green buoy of Pirköyri. Judging from this, the speed of the vessel has been slightly higher than described in Section 1.2.3. The reconstructed speed table looks as follows:

No.	Distance between points	Speed knots	Driving time	Recon-structed time	Route point or passing point
1				**02:35:00**	Orrengrund. Pilot boarded according to **ship's log.**
2	1,78	14,5	07:22	02:42:22	Orrengrund turn
3	1,44	14,8	05:50	02:48:12	Ljusastenen turn
4	1,76	14,8	07:08	02:55:20	Lålättan turn
5	4,04	14,8	16:26	03:11:46	Lagnö turn
6	3,24	14,8	13:10	03:24:56	Kaunissaari to the side
7	4,01	13,0	18:29	03:43:25	Turn towards Viikari
8	1,66	11,0	09:03	03:52:28	Viikari Sound
9	1,37	12,5	06:34	03:59:02	Kukouri bend
10	0,16	12,0	00:48	03:59:50	**Registration of the GERDA at 04:00.**
11	0,61	14,0	02:37	04:02:27	Kukouri to the side
12	0,51	14,0	02:11	04:04:38	**Registration of the GERDA at 04:05.**
13	0,26	11,5	01:23	04:06:01	Turn on autopilot
14	0,15	09,0	00:59	04:07:00	Turn on NFU steering
15	0,10	06,0	01:00	04:08:27	Grounding **04:10 according to ship's log and 04:08 on automatic GPS** print-out.
	21,08'			**1 hour 33 min 27 sec**	

The speeds given in the witness statements do not deviate significantly from the reconstructed table.

The visibility had been 200–400 metres at the start of piloting, so the piloting was based on radar navigation. The GERDA turned at the Kukouri bend between 03:58 and 04:00 from heading 057° to the Pirköyri line at 018°. At this stage, the visibility dropped to zero. According to the automatic registration on the nautical chart (Figure 12b), the position of the vessel at 04:00 was latitude 60° 25.963' N and longitude 26° 25.576' E. The coordinates were in the WGS-84 system. The course over ground was 22.2° and the speed 12 knots. The turn had not yet been fully completed. The vessel was 50 metres starboard of the line, which was not so much as to cause worry. This error would have corrected itself in the next turn had its turn mark been based on a bearing pointing to a new heading of 355° towards the buoys on the left border of the fairway (Figure 10).

According to the position points recorded on the electronic chart, the GERDA was travelling to true heading 018° until about Kukouri. The heading was corrected 3° to port, which is detectable from the registration at about 04:05 (Figures 12b and 13). The pilot conducted two radiotelephone conversations concerning traffic with the port authority and with ms INOWROCLAW. The last call ended at about 04:04:40 according to the reconstruction. The time is based on the fact that at the end of the call he measured 0.6' as the distance to Pirköyri. The speed was 12 knots. At the end of the call the vessel was near the point where the Pirköyri turn should have been resolutely initiated with a rudder angle of 15°–20°.

The pilot stated that he had turned the autopilot to heading 360° immediately after the radio call, then to 355° and then to 340°. According to the reconstruction, the GERDA had travelled almost straight to heading 015° with regard to the hull, about a minute and a half after the pilot had measured the distance to Pirköyri. In other words, the turn began at a distance of 0.3' to Pirköyri. For some reason, there was a delay in the start of the turn.

Figure 12. a) Monitor for electronic chart mounted in the ceiling (see also Figure 2).
b) Route points of GERDA registered on chart.

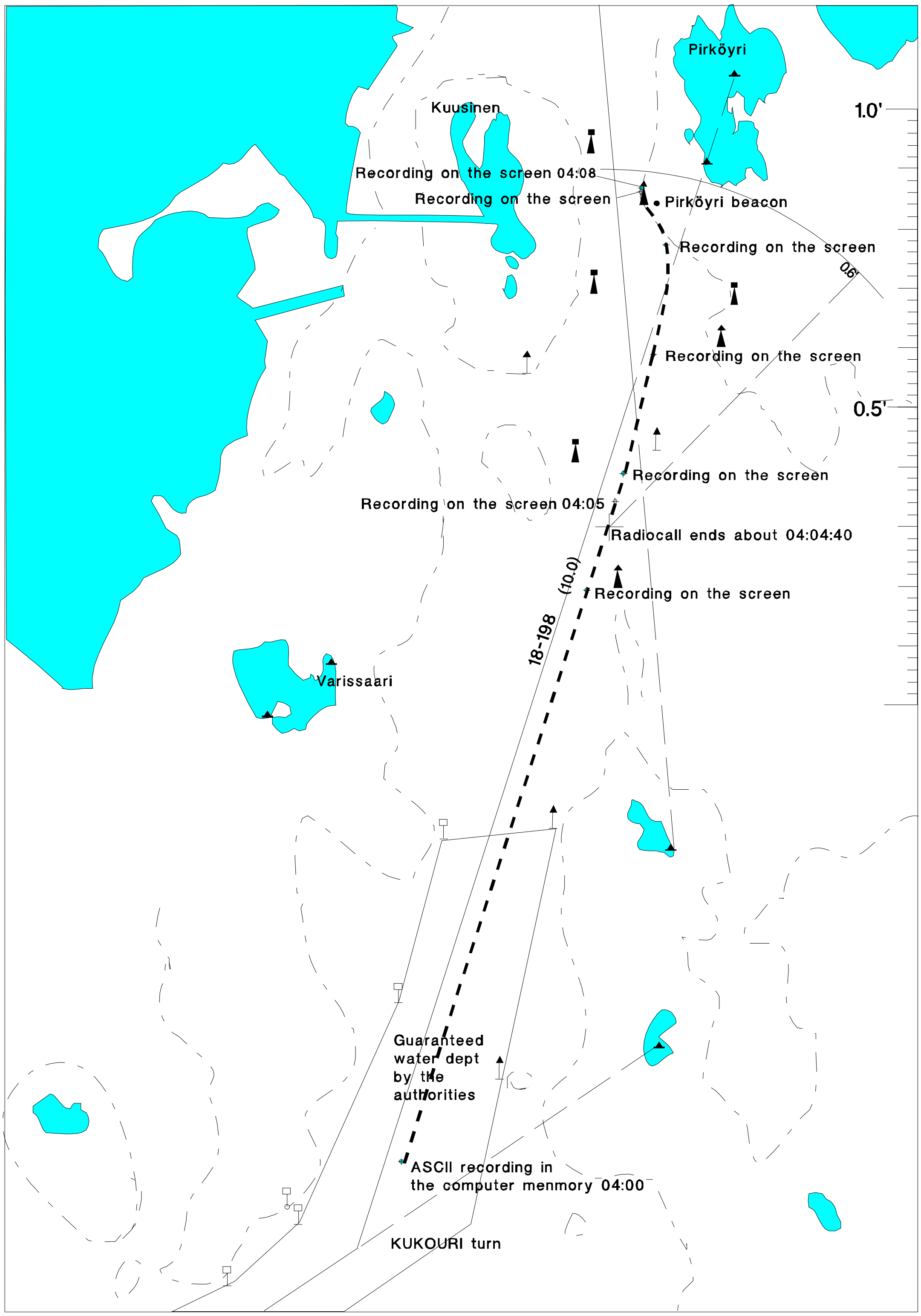


Figure 13. Passage of GERDA traced from electronic chart. Chart was photographed after grounding. Vessel position and times registered automatically on chart at 1 minute intervals. Grounding site next to Pirköyri beacon.

The turn and the grounding

According to the GPS registration (position points recorded on the electronic chart), the GERDA had passed the Halla – Kukouri line (355°) at a speed of about 11–12 knots before the turn to heading 360° began (Figure 13).

The pilot stated that when the heading pointed to 360° he set heading 340° on the autopilot. The speed was then 7 knots. The speed was about 6 knots during the last minute prior to the grounding, according to the registration. There is no indication from the vessel's turn trajectory of the autopilot trying to stabilise the ship to heading 360°. The turn continues steeply towards the end, which indicates that the autopilot has not eased the helm. The turn was very sharp at the end with a radius of about 0.2'. If the average speed was about 7 knots during the final stages of the turn, then the rate of turn must have been about 35°/min. The master pointed out the NFU lever to the investigators and stated that the pilot had steered with it. This is logical, since the NFU was installed especially for emergencies.

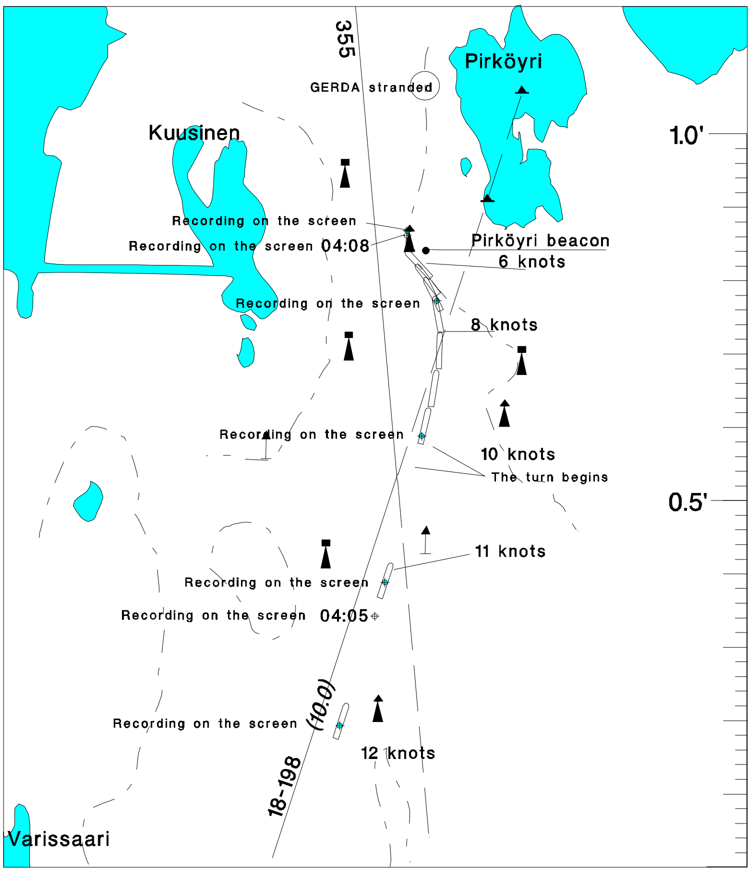


Figure 14. Accident turn simulated in open water. Ring around resting place of GERDA describes error in positioning (about 45 metres).

When simulating the accident turn with a model of a container ship of 95 metres length in open-sea conditions, it is difficult to make the vessel turn within a radius of 2 cables (Figure 14). The drifting angle presented in Figure 14 for the vessel may not be essentially correct due to the ice. The series of registrations depicting the steep turn on the electronic chart points to there being no obstruction from the ice in the turn. It is possible that the turn has been slightly more rounded than that in the GPS registration because, when the GERDA lay stationary on the shore at Pirköyri after the grounding, the GPS drew a positioning error of about 45 metres around the vessel (Figure 14). Figure 15 presents the reconstructed trajectory of the vessel and the possible location error. Errors caused by transfer of the location from photograph to chart, and the possible effects of ice on the turn, are included in this. It is possible that the differential signal broke off at about 04:07. The speed of the GERDA decreased, starting from Varissaari, but due to the positioning error it is impossible to determine her speed very accurately. Analysis shows that the turn (start of the turn) was about 0.3' late.

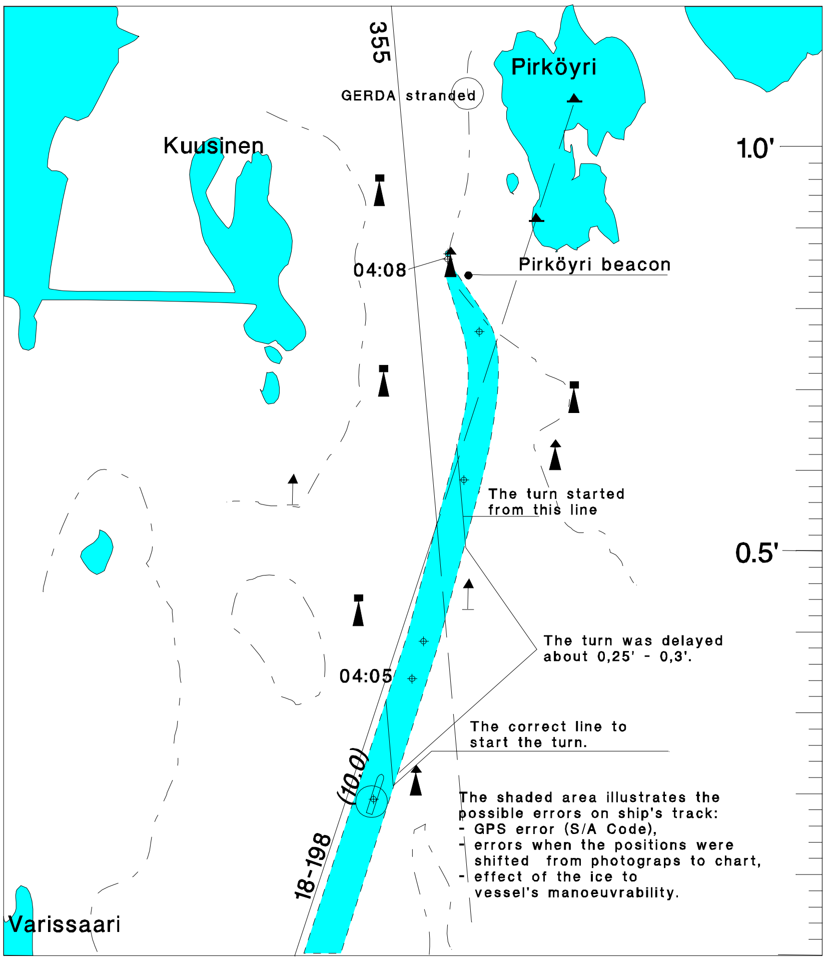


Figure 15. Inaccuracies in trajectory of vessel. Grey area describes possible error in positioning.

2.2.2 Steering and navigation method during piloting

The following analyses the steering and navigation method used in the piloting. The aim is to analyse the reasons for the turn being late. First, the significance of a passage plan is reviewed followed by the use of the steering and navigation equipment.

After the pilot boarded the ship at Orrengrund he took over the steering, as is customary, with the help of the autopilot. Thus, he was in charge of both the steering and the navigation and in effect also the command. He used one of the vessel's Kelvin & Hughes radars and the compass. Whenever possible the pilot had monitored the passage of the ship, both with the radar and visually in relation to the surroundings and the passage reference he had in his mind. The master was in charge of general monitoring.

The situation became more demanding when approaching Kotka and when the visibility decreased to near zero due to the fog. The pilot was still in charge of the steering and navigation. He tried to use the radar but its the performance had deteriorated because of the ice. The pilot had difficulty, therefore, in verifying his own activity. The weakened performance of the radar complicated the possibility of the master being able to monitor the ship's passage. The master did not consider the electronic chart sufficiently reliable for verification of the vessel's passage, so this was not used either in his monitoring. In practice, the power of decision had rested totally with the pilot.

Significance of passage plan. There was no written passage plan and no standardised turning method was used. Figure 16 presents a plan for executing the turn. At a speed of 12 knots, a turning radius of 4 cables would have been realised at a rate of turn of 30°/minute. The pilot's method of making the Pirköyri turn was based on the initial and final headings, and also on the definition of the starting point for the turn being at a distance of 0.6' from the southern tip of Pirköyri.

The radius of the turn is 0.4', and the starting point 0.06' before the start of an constant turn (Figure 16). Value 0.21' is set on the VRM ring and 355° is set for the EBL heading as tangent to the ring. The turn is started when the EBL touches the shore of Pirköyri. The pilot stated that there was packed ice at the Pirköyri shore interfering with the definition of the turning point. The assumption in Figure 16 is that the ice has shifted the shoreline 30–40 metres, which would have resulted in a similar shift to port in the trajectory of the vessel. The error could have been easily corrected with a heading of 355° before the Pirköyri Sound. The two parallel vessel trajectories depict the error caused by the ice on the shore.

In a written passage plan, the turn parameters are marked in a clearly visible box next to the turn (example in Figure 16). At the beginning of the turn, the rudder angles are 10°–20°. The rudder angle is adjusted so that the rate-of- turn indicator shows 30°/minute.

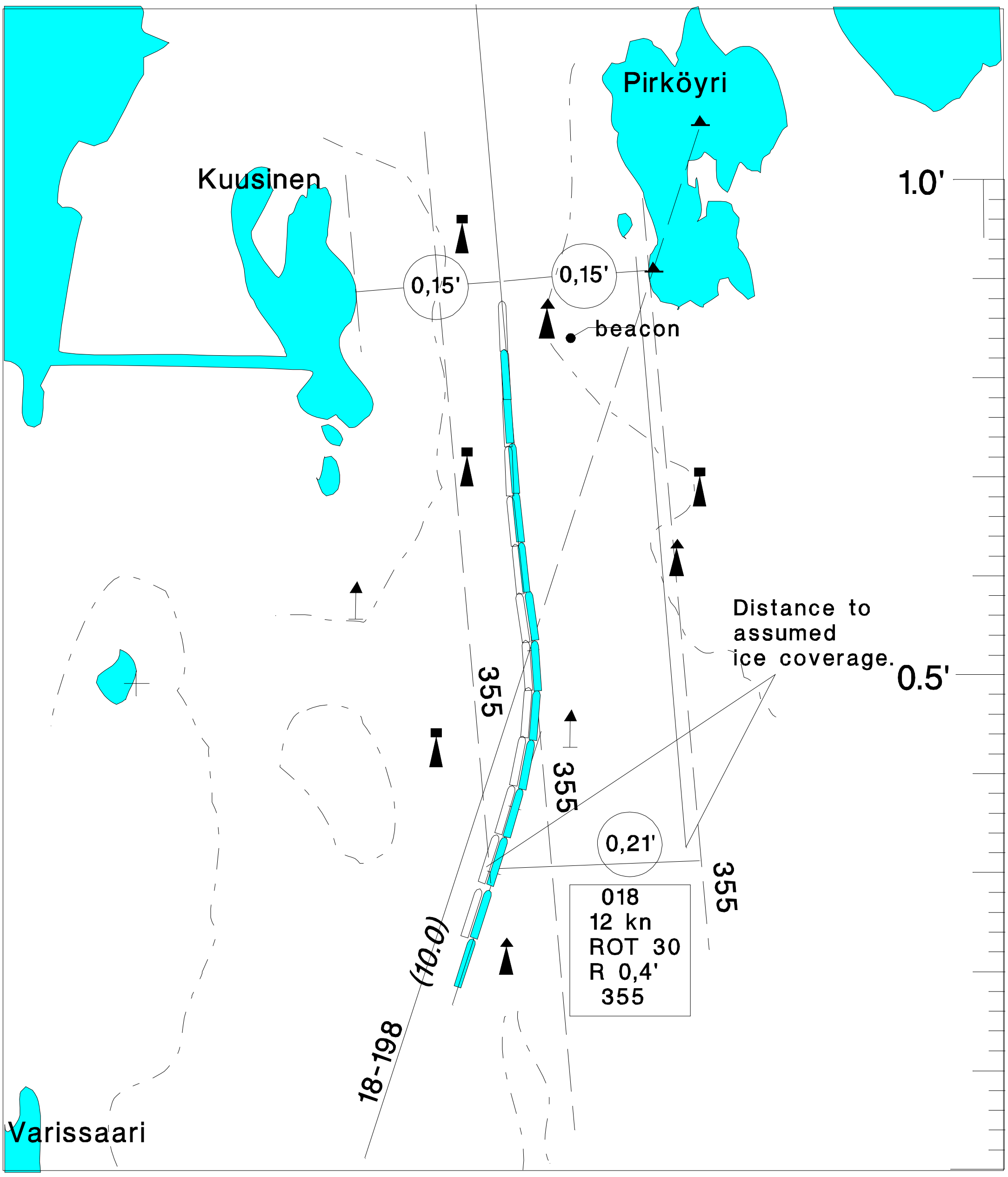


Figure 16 *Example of Pirköyri turn plan.*

The counter helm varies at the end of the turn. When using the ROT Tiller the rudder angle need not be monitored because the autopilot takes care of the correct rudder angle. The correct method for executing the turn would have been to use the ROT Tiller steering mode. The user interface of the Kelvin & Hughes radar complicates and slows down the use of such a (detailed) turning method as described in the above.

Use of steering equipment. The pilot reported having changed the heading with the autopilot, the user panel of which is presented in Figure 17. He said he had used the heading change button when turning to heading 360°, so the steering mode was Course Control.

In a normal situation the heading command is given as follows to the autopilot:

- **Set Course** button is pressed and new heading set with the **heading change knob**. The starting command for a turn is given by pressing the **Set** button. **Set** must be pressed within 15 seconds of issuing the command.
- Turning takes place according to the preset rate of turn.

> Unless the set button is pressed within 15 seconds of issuing the heading command, the new heading 000° is erased and replaced again by 015°. The vessel will continue straight.

The command for quick turning (for example in an emergency) is given as follows:

- **The heading change knob** is pressed down and turned until the new heading is set. The turn begins immediately.
- The rate-of-turn setting is disregarded during the turn. The turn is executed only on the rudder-angle limiter. This is usually set at full rudder angle 35°, so the emergency method is too drastic for normal piloting.

> Unless the heading change knob is pressed down while being turned, the vessel will continue straight.

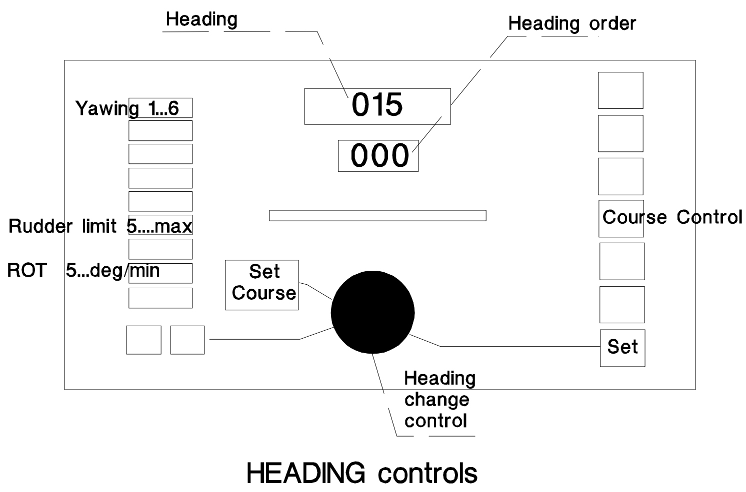


Figure 17. Main controls of COURSE CONTROL mode of Anschütz Nautopilot D in piloting:
- YAWING 2
- Rudder limit 35°
-ROT (rate of turn), for example 30° / min.
Set Course and heading change knob set direction. Set command initiates preset turn.

The Course Control is thus susceptible to mistakes but it is not designed for navigation on winding fairways. The ROT Tiller is designed for that.

The pilot has not mentioned which steering method he was using but his report points to the use of the quick turning of the Anschütz Nautopilot. According to the master's report, the pilot was using manual steering immediately before the grounding.

The user interface of the autopilot may result in the intended turn not beginning at all. In the grounding of the GERDA, the turn was delayed about 1 minute 20 seconds. A mistake in the use of the autopilot would have been detected long before, so this alone at least does not explain the delay.

Use of radar. The pilot adjusted the radar and its ranges several times. He mentions in his report the courses and the positioning according to the distance measured with the radar. As stated in the above, the user interface of the Kelvin & Hughes radar is complicated. It is easier to use as a support for the traditional navigation method where electronic bearing and variable range marker are not used. In the traditional navigation method, the radar image is looked at in the same way as the scenery and the turning point is determined visually. The pinpointing of the turning point requires several radar targets in order to be sufficiently accurate. In the case of the grounding of the GERDA there were few such targets.

The GERDA travelled for about two minutes from Varissaari to the point where the Pirköyri turn should have been initiated. The analysis showed that the turn was about 0.25'–0.3' late. This delay added about 1 minute 20 seconds to the time.

The pilot told of having conducted two radio discussions and of hearing one discussion after passing Varissaari. The radio traffic was as follows:

- Traffic report of the pilot to the port authority.
- The pilot heard the mooring-cable handlers report from the port of Hietanen that the INOWROCLAW had been cast loose.
- The pilot called the INOWROCLAW and agreed on communication on VHF channel 11 with the vessel's pilot in order to agree on their later passing.

The pilot stated that he had begun the turn after finishing the last call. Passage time from Varissaari to the start of the turn was about 3 minutes 20 seconds. The pilot's narrative gives an impression of continuous radio traffic from the passing of Varissaari to the start of the turn. The radio traffic may have interfered with the preparation of the turn.

It is possible that the pilot made an error with the distances between the fixed rings on the radar when preparing for the turn. He could not use the variable range marker because the only user interface for the radar – the rollerball – was reserved for the adjustment of the radar image, which the pilot tried constantly to improve. If the southern tip of Pirköyri pierced the second range ring it is possible that the pilot erroneously thought that the first ring depicted a range of 0.5' instead of the actual range of 0.25'. This may explain why he did not begin the turn at the location presented in Figure 18. The distance between the rings (RINGS) is expressed in the upper right-hand corner of the radar in smaller print than ‘range’ (RANGE).

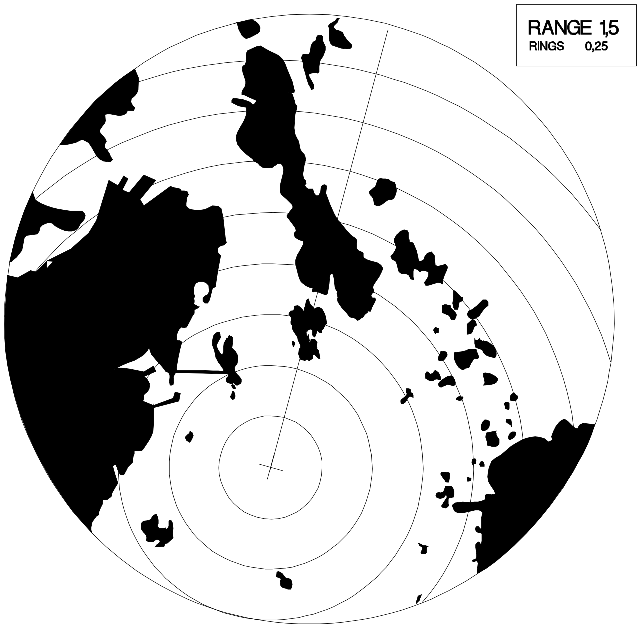


Figure 18. Range of radar 1,5’, distance to Pirköyri 0,6’. Turn should have begun here.

Another reason for an error in the interpretation may lie in the change of range.

When the turn began the pilot performed three actions simultaneously, according to his statement:

- He observed that the distance to Pirköyri was 0.6’.

- He set heading 360° on the automat.

- He changed the radar range from 1.5’ to 0.75’ (placed the cursor of the radar with the rollerball to the RANGE field and pressed the left DOWN button).

Unless there is time to verify the distance between the rings from the upper right-hand corner of the radar the distance can be misinterpreted.

However, it is probable that the mistake with the rings had nothing to do with the change of range. When changing over from range 3’ to range 1.5’, the distance between the fixed rings is halved from 0.5’ to 0.25’. However, when changing over from range 1.5’ to range 0.75’ the distance between the fixed rings remained at 0.25’ (Figures 19a and 19b). If the pilot had assumed that the distance between the rings changed according to the same logic as in the other changes of range, he would have estimated the vessel to be closer than the actual distance to Pirköyri. The pilot initiated the turn calmly with the autopilot, and there is nothing to suggest that he would have noticed a misinterpretation of the distance.

Figure 19a. Distance to Pirköyri about 0,3’. Range of radar still 1,5’. Turn to heading 360° begins.

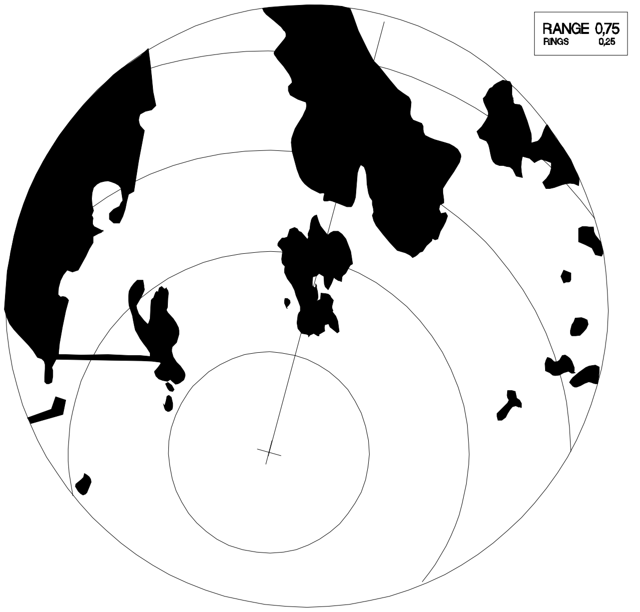


Figure 19b. Distance to Pirköyri about 0,3’. Range of radar changed to 0,75’.

Based on the above analysis, it can be assumed that the reason for the delay of the start of the Pirköyri turn has been a misinterpretation of the distance. This was caused by:

- A radar user interface unsuited to piloting.

- The traditional navigation method which was used, where range is estimated with fixed range rings, and

- the attention required by radio traffic and adjustment of the radar when preparing for the turn.

2.2.3 Cooperation on the bridge

The cooperation and situational management on the bridge are evaluated in relation to the demands placed on them by the safe execution of the piloting task. This approach brings to light issues which should be considered in the organisation of piloting activity, development of regulations, and training. These demands have not been addressed in the regulations on piloting or the professional competence of bridge officers, so the required level of cooperation cannot be expected to be met.

Preparation for the piloting. There were only two persons on the bridge, the master and the pilot. Based on the investigation material, it appears that they did not discuss the route or share a passage plan. In an earlier stage of the analysis it was shown that the GERDA's radars were ill-suited to piloting. The steering equipment was good but the method most suited to piloting was not applied. These factors combined to emphasise the significance of cooperation.

Cooperation in piloting. The sharing of tasks had formed along the usual lines at the commencement of piloting, and it is likely that there was no discussion about the adequacy of the manning. The pilot took care of the navigation and steering and the master monitored the ship's passage, both visually and with the radar. The sharing of tasks adhered to was the typical pilot-centred piloting method, concentrating on individual performance. It can be deduced from the analysis of the navigation method that the ability to monitor activity was not particularly good in this case. The pilot was steering with the autopilot, which complicated monitoring of his navigation and steering activities. It is probable that he did not voice any changes in the headings, or his plans. This accords with the pilots' method of generally concentrating on individual performance. In addition, the weather conditions, the deviations in the open fairway from the geometry, and the lack of a passage plan all complicated the monitoring of the ship's passage.

In principle, the cockpit arrangement with its two radars and electronic chart supported the monitoring. However, the master did not use the electronic chart for monitoring. He defended this with his knowledge that the data on the electronic chart was not reliable. The master's mistrust concerning the electronic chart, the lack of a common route reference, his inability to fully monitor the pilot's activity (course change with the autopilot), and interference to the radar image all minimised the chances of a joint verification of the ship's passage. The ice, and the shift of the open fairway, had forced them to steer according to the ice during the piloting trip. This complicated the master's chances of monitoring by increasing his uncertainty as to the progress of the situation, and by reducing his chances of participating in the navigation. These factors emphasised the need for communication between the master and the pilot.

When the vessel reached the Kukouri bend, the pilot observed zero visibility and at the same time it was obvious that the ice impeded the detection of the fairway marks on the radar. At this stage, the vessel drifted slightly off course. The pilot still estimated that the passage could be continued since Pirköyri Island and its beacon were clearly visible on the radar. The navigation method of the pilot was traditional, based on the above analysis of the navigation method used. The ice and fog reduced the effectiveness of this navigation method. The master obviously did not express his disagreement with, or propose any changes to, the piloting method, which had become very pilot-centred. Difficulties in the positioning of the vessel further increased the accumulation of tasks on the pilot, whereby total responsibility was shifted on to him. The situation did not accord with the general regulations on piloting.

When approaching the Pirköyri bend, the radio traffic captured the attention of the pilot. The pilot did not inform the master of the conversations conducted in Finnish because, according to the maritime declaration, he did not consider it to be necessary at that time. The master did not ask the pilot about his conversations. It is important for them to maintain a shared view of the situation if their cooperation is to be successful. This is also affected by information about communication between vessels. The lack of communication on the bridge further served to emphasise the pilot-centred activity. The external radio communications and the attention required by the adjustment of the radar image could have resulted in an error in the interpretation of the distance, and also in the delay of the turn.

To summarise, it can be stated that the above deficiencies in the bridge cooperation resulted in a situation where no such method of operation was created between the master and the pilot of the GERDA, as would have contributed to a realistic recognition of the actual situation and also to verification of a safe passage for the ship. The master’s view of the situation differed from that of the pilot. The need for efficient cooperation was increased when the demands on the bridge grew because of the fog and the interference to the radar image. The master’s strong reliance on the skills of the pilot, the mistrust of the electronic equipment and, on the other hand, the pilot's piloting method centring on the individual all contributed to the accumulation of responsibility on the pilot, which resulted in the neglect of their monitoring duty.

3. CONCLUSIONS

3.1 Chain of events leading to the grounding

The chain of events leading to the grounding of ms GERDA in the Pirköyri Sound was as follows:

- After turning to the Pirköyri line, the dense fog reduced the visibility.

- The ice disturbed the radar image.

- The piloting and steering tasks accumulated on to the pilot.

- The radio traffic managed by the pilot coincided with the preparation phase of the turn.

- According to the accident analysis, the Pirköyri turn was delayed about 0.25'–0.3' (460–560m). Timewise, this delay corresponds to 1 minute 20 seconds.

- Because of the delay in the turn, the GERDA drifted aground at the Pirköyri beacon on the starboard edge of the fairway.

- The delay was not noticed because the activity was pilot-centred and there was no monitoring.

- Four empty containers fell overboard and ballast tanks 1 and 2 sustained damage.

The reason for the lateness of the Pirköyri turn was a misinterpretation of the distance.

3.2 Contributing factors to the grounding

Navigation errors may never be entirely avoided but the factors contributing to them can be addressed. Since mistakes happen in any case, the navigation method and cooperation on the bridge should be such that errors can be detected sufficiently early to rectify them. The navigation error that occurred in the grounding of the GERDA was influenced by the factors discussed below. These factors can be considered as the real reason for the accident.

3.2.1 Conditions for navigation and piloting

Only the pilot and the master were on the bridge but under the circumstances a separate lookout should have been used according to the rules of the road.

The autopilot equipment on the GERDA was good. The ROT Tiller of the Anschütz Nautopilot system is especially well-suited to piloting. However, this steering mode was not used. The bridge had NFU steering for manual steering. A better system for steering manually is FU steering, but this was missing from the GERDA.

Adjustment of the Kelvin & Hughes Nucleus radar is complex and requires several operations, which makes its use in piloting slow. The user interface differs from that of other manufacturers. When the radar is used for navigation in archipelagos, and in piloting, these factors also lead the radar operator to adopt the traditional navigation method in which variable bearing and range are not used.

An individual pilot who only uses this equipment occasionally finds it difficult to utilise the various navigation and steering equipment for their designed purpose or to analyse their suitability for piloting.

3.2.2 Navigation method and cooperation on the bridge

The deficiencies in the bridge cooperation had a direct effect as causes in the chain of events leading to the accident. When the situation on the bridge became more demanding due to the fog and the interference to the radar image, the need for efficient cooperation increased. The master's full confidence in the pilot's skills and the method of piloting centring on individual performance both contributed to the accumulation of responsibility on the pilot. Furthermore, the master did not use the electronic chart to verify the pilot's activity. The introduction of technical equipment on the bridge does not improve safety if the usual sharing of tasks and cooperation are not consciously changed. The pilot and the master did not have a shared passage plan. It would be possible to change the usual method of cooperation, and to promote a common view of the situation, if a shared passage plan was used.

Neglecting the passage plan has become a habit, and the significance of the passage plan is generally ignored because it does not form part of the authorities' inspections. The corporate culture in all shipping companies has not developed to a point where the vessels would have their own passage plans for piloting.

Directions on contact points and radio traffic procedures are missing from the Kotka piloting district. The timing of the external radio communications coinciding with the preparation phase of the turn had an effect in delaying the turn. Prearranged safe contact points and a more active role for traffic control (VTS) in marine areas could help to prevent overlapping tasks from interfering with the determination of a turn's starting point.

The radio traffic was conducted in Finnish. This had no proven effect on the accident of the GERDA. As a general observation, it can be stated that radio conversations in Finnish undermine the ability of the master to monitor the overall situation. If radio traffic is conducted this close to the start of a turn, translating the conversation forms an additional task for the pilot. There is no need to translate if the radio traffic is conducted in English, as is required in the IMO guidelines on VTS.

4. RECOMMENDATIONS

4.1 Passage plan for piloting

Neglecting the passage plan has become a habit, and its significance is generally ignored because it does not form part of the authorities' inspections. It would be possible to change the usual method of cooperation, and to promote a common view of the situation, if a shared passage plan was used. This is a requirement for verification of the activity.

It is the recommendation of this investigation that:

1. *The Finnish Maritime Administration drafts and publishes the criteria for a passage plan and directions for the planning of turns, and that it issues directions on the use of a passage plan in piloting to support cooperation and monitoring.*

2. *The maritime districts inspect the passage plans of pilots regularly, for example every five years, and ensure that the use of passage plans complies with their directions.*

3. *The Finnish Maritime Administration puts forward a motion in the relevant IMO subcommittee that the passage plans of ships be inspected in connection with the seaworthiness inspection.*

4.2 Equipment requirements of piloting and equipment training of pilots

The Kelvin & Hughes radar on the GERDA is slow when used in piloting. During navigation in the archipelago and piloting, this drawback also leads the radar operator to adopt the traditional navigation method where variable bearing and range are not used.

An individual pilot who only uses this equipment occasionally finds it difficult to utilise the various navigation and steering equipment for its purpose or to analyse its suitability for piloting.

The Rhein river traffic regulations contain provisions for the user interface of the variable range marker and electronic bearing, which could be applied to piloting under Finnish conditions. If the user interface of a radar is deemed unsuitable for piloting then a visibility limit must be set for the piloting.

The user manuals of all commonly used radars and autopilots should also be made available to pilots. The autopilot modes should be summarised in a brief procedural manual for piloting. The ROT Tiller steering method should always be used during piloting. The course control mode is designed for cruising on open seas: it can be used on long straight lines but not on winding fairways. Training should be organised for pilots to explain the user modes of autopilots and the risk factors involved.

It is the recommendation of this investigation that:

4. *The Finnish Maritime Administration should define the minimum requirements concerning the variable range marker (VRM) and electronic bearing (EBL) for radars used in piloting.*

5. *The Finnish Maritime Administration presents a visibility limit for piloting on a vessel with no radar complying with the minimum requirements of the FMA.*

6. *The Finnish Maritime Administration provides pilots with the user manuals of the radars and autopilots most commonly used in piloting.*

7. *The Finnish Maritime Administration organises training for pilots on the user modes of autopilots and the risks involved.*

4.3 Discontinuation of piloting

The ambiguous wording of the Piloting Decree does not sufficiently emphasise when piloting can be discontinued, as the criteria for discontinuation is left to the pilot's own discretion. A clear, minimum level should be defined for the manning of the bridge and steering equipment. This level would form the foundation for feasible cooperation in piloting.

Recommendation 1 issued in the investigation of ms BALTIC MERCHANT (C 5/1998) also applies in the case of ms GERDA.

It is the recommendation of this investigation that:

8. *The Finnish Maritime Administration drafts the criteria for discontinuation of piloting including:*
   - manning on the bridge.
   - acceptable manual steering equipment.
   - acceptable autopilot modes.

4.4 Technical equipment as support for cooperation on the bridge

The introduction of technical equipment on the bridge does not improve safety if the usual sharing of tasks and the method of cooperation are not consciously changed in order to benefit from the equipment available. In this case the GPS and the electronic chart were not used for monitoring.

It is the recommendation of this investigation that:

9. *The Finnish Maritime Administration drafts the necessary criteria for evaluating the effect of equipment and provides training in its use, especially as a support for cooperation.*

LIST OF SOURCES

1. ms GERDA Maritime Declaration in Kotka, May 22, 1998.