Tutkintaselostus

1/1995

The Grounding of the M/S SILJA EUROPA at Furusund in the Stockholm Archipelago on 13 January 1995

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1 THE INVESTIGATION COMMISSION

The Council of State appointed an Investigation Commission to investigate the incident as prescribed by the Investigation of Major Accidents Act (373/1985).

The composition of the Commission was as follows:

Chairman	Capt. Simo **Aarnio,** Master Mariner († 22 January 1996)
	Mr. Heikki **Tissari,** M.Sc.Eng. (27 March 1996 >)
Deputy Chairman	Mr. Heikki Tissari (> 26 March 1996)
	Mr. Asser **Koivisto,** technician (27 March 1996 >)
Member	Mr. Asser Koivisto (> 26 March 1996)
	Ms. Kaarin **Ruuhilehto,** Doctor of Social Sciences (27 March >)
Experts	Ms. Kaarin Ruuhilehto (human factors) (>26 March 1996)
	Mr. Kari **Lehtola,** LLM (legal questions)
	Mr. Heikki **Seppänen,** detective sergeant (technical investigations)
Observers	Capt. Hans **Rosengren,** senior lecturer, investigator of Board of Accident Investigation, Sweden
	Capt. Sten **Anderson,** senior inspector, Swedish Maritime Administration
	Capt. Benny **Pettersson,** chief pilot, Sweden
	Capt. Reijo **Montonen,** chief maritime inspector, Finnish Maritime Administration, Finland
Secretary	Ms. Pirjo **Valkama-Joutsen,** administrative director

2 GENERAL DESCRIPTION OF THE ACCIDENT

The Finnish passenger/car ferry MS SILJA EUROPA ran aground at Furusund in the Stockholm archipelago on 13 January 1995 at 4.35 A.M. Finnish time. The vessel managed to refloat on her own power at 5.07 A.M. She received only minor damage to her bow bulb. There were no injuries or environmental damage.

Before the grounding occurred, the bridge staff observed that the vessel was turning too much to starboard. Control was transferred from automatic to manual, but the vessel didn't respond to the rudder. Attempts were made to switch off the SPEEDPILOT automatic speed control system apparently in two different ways and it was also checked that control had not been transferred to the engine room. The vessel remained unsteerable. Finally she ran aground immediately to the right of the Furusundsskaten beacon.

The sequence of events leading to the grounding began when the position sensor of the vessel was transferred, at 04.22, from one DGPS receiver to another. However, the speed sensor that gave the speed data to the SPEEDPILOT system was not switched at the same time to the other DGPS receiver, and instead remained in the previous receiver. In this connection the SPEEDPILOT went over automatically to the MANUAL SPEED control mode. The SPEEDPILOT continuously received information indicating a speed of 17,62 knots, which was the most recent information recorded in the system before going over to the second DGPS receiver. The SPEEDPILOT reacted to this by giving a SP SPEED FAULT alarm, but the vessel had not been supplied with a list of alarms which would have indicated what this alarm was about, and what steps should be taken.

When the vessel approached the Furusund narrows where the speed limit was eight knots, the SPEEDPILOT began to automatically reduce speed by lowering the pitches of the propellers. The SPEEDPILOT no longer received up-to-date information regarding speed from the speed sensor, since this had gone over to the MANUAL SPEED mode. Nonetheless the equipment continued to function automatically as if the speed sensor would have continued to input the same speed of 17,62 knots. The result was that the propeller pitch decreased to zero, and the vessel was no longer steerable. Such performance by the equipment can be considered a design error.

After the grounding occurred, the SPEEDPILOT was found to be still engaged. Efforts were made to switch it off in the same way as before the grounding, and also with the BYPASS switch, which should disconnect power to the SPEEDPILOT system. However, the system remained on. The SPEEDPILOT was overridden when control was transferred to the engine room. When control was transferred again to the bridge, the SPEEDPILOT continued to be in the engaged mode.

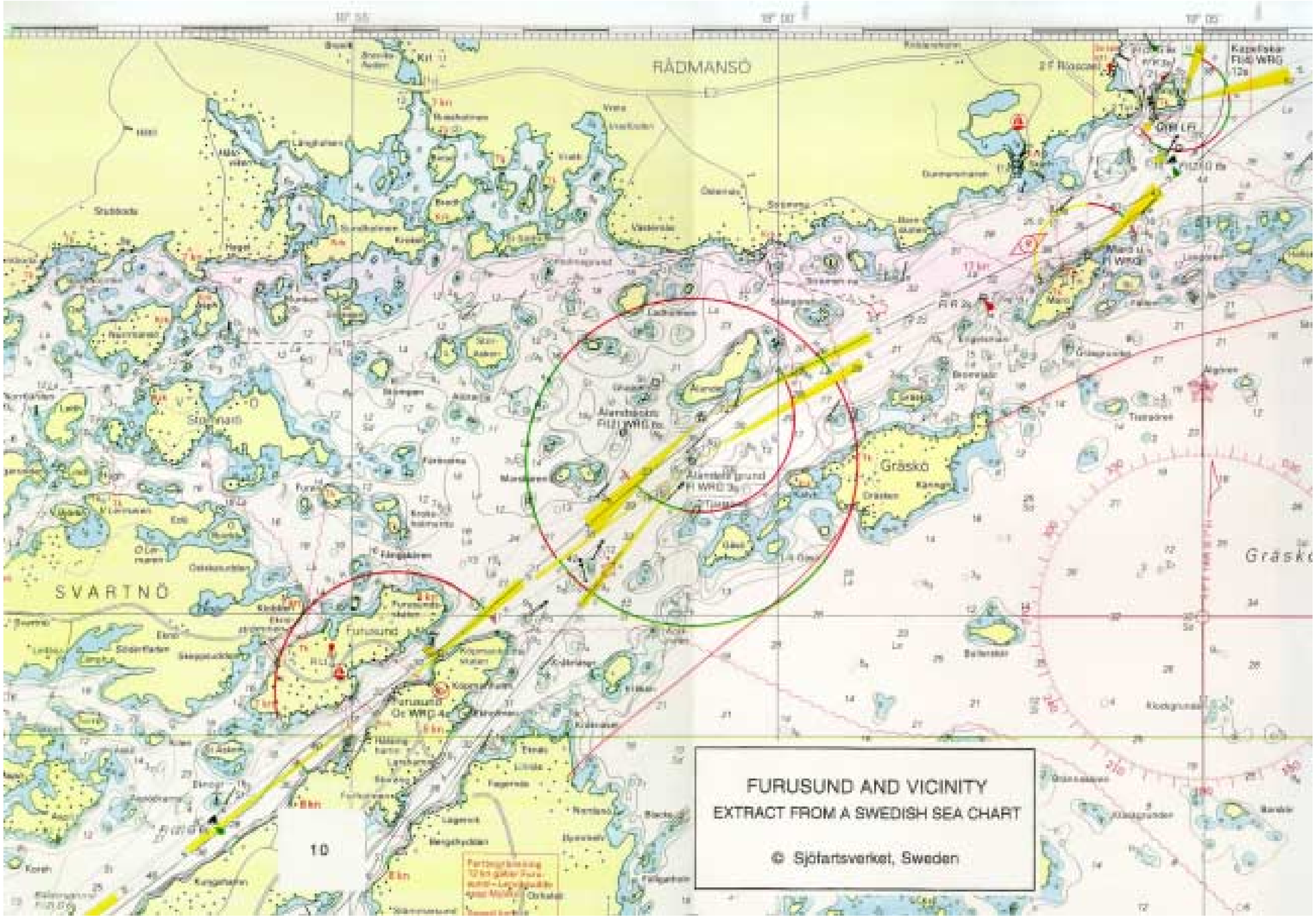
The bridge regained control by pressing the KaMeWa BACKUP push-button and thus switching to emergency manual control. This control system overrides the SPEEDPILOT, so the SPEEDPILOT can be switched on while it is used. The vessel was floated off the rocks with the BACKUP emergency control system.

The grounding could not be avoided by using the rudder since the propeller pitch had decreased to such an extent that the vessel was no longer manouverable. A malfunction led to a failure in switching the SPEEDPILOT off. The malfunction was probably a result of the engine interface card 1 becoming detached from the electronics frame. In simulations, the detachment of this card has been found to have the same effects as those that occurred in the accident. This is the only possible malfunction that has been identified by the investigation commission. The failure of components on the card could also result in the same fault situation. During the investigation however nothing has appeared that would suggest that there were faulty components on the card. Furthermore, a program failure also cannot be ruled out entirely.

Lack of familiarity with the emergency systems made it even more difficult for the officers on the watch to bring the situation under control before the grounding. Control was not switched to the emergency manual system by the BACKUP push button. The SPEEDPILOT could have been overridden with the BY-PASS switch. This switch, which was installed separately afterwards on this vessel and poorly located ergonomically, was not used.

The officers of the watch did not have the ability to use the emergency systems, due to inadequate emergency drilling and because of omissions in training.


M/S SILJA EUROPA
SILJA LINE



FURUSUND AND VICINITY
EXTRACT FROM A SWEDISH SEA CHART
© Sjöfartsverket, Sweden

3 PARTICULARS OF THE SHIP AND CREW

3.1 General information

The MS SILJA EUROPA is owned by a Finnish limited partnership called Fahrschiff Europa Kb. The vessel was built by the Jos. L Meyer Werft yard in Papenburg, Germany, in 1993. It was originally ordered by a Swedish shipping line, which went into bankruptcy before completion of the ship. Since neither the orderer nor the bankrupt's estate could pay for the vessel, it was left in the hands of the shipyard.

The senior partner of Fahrschiff Europa Kb is a Finnish limited liability company called Papenburger Shipping Oy. At the time of the accident, the company had two silent partners, a German company called Papenburger Fahrschiffreederei GmbH & Co and a German individual.

Oy Siija Line Ab operated the vessel under the terms of a long-term contract with Fährschiff Europa Kb.

The main particulars are as follows:

Name of vessel:	SILJA EUROPA
Type:	passenger/car ferry
Maximum number of passengers:	3123
Home port:	Mariehamn, Åland
Registered port:	Mariehamn
Registration no.:	50105
IMO number:	8919805
Distinctive letters:	OJFN
Owners:	Fährschiff Europa Kb, Mariehamn
Operator:	Oy Silja Line Ab, Helsinki
Tonnage:	
Gross:	59914
Net:	41309
Maximum length:	201.78 m
Width:	32.00 m

Draught:	6,80
Engine power:	4 x 7,952 kW
Speed:	21.50 knots
Ice payment class:	1A Super
Built:	Jos. L. Meyer Werft, Papenburg, Germany
Year built:	1993
Classification society:	Bureau Veritas

3.2 Certificates

The vessel had the following documents in force on the date of the accident:

Document	*Issued*	*Last validity date*
Certificate of nationality	22 November 1994	
Passenger ship safety certificate	8 March 1994	17 February 1995
International Load		
Line certificate	15 March 1993	4 March 1998
International tonnage certificate	1 March 1993	
IOPP certificate	28 April 1993	5 March 1998
Letter of compliance with the special requirements for ship carrying dangerous goods	19 March 1993	5 March 1998
Minimum safe manning certificate	1 March 1993	1 March 1998

3.3 Navigation equipment

Radars:	3 x Atlas 9600 Radarpilot/TM/ARPA

GPS navigators:	1 x DGPS Aschtec Super A/C 1 x DGPS Magnavox MX200
Echo sounder	Atlas Filia 522
Gyrocompass.	Gyro 1, Anschütz Standard 4 Gyro 2, Anschütz Standard 4 Gyro 3, Anschütz Standard 20
Magnetic compass:	Anschütz
Autopilot:	2 x ATLAS TRACKPILOT, one with Atlas Speedpilot 25
Log:	Atlas Dolog 20

3.4 Crew

According to the minimum safe manning certificate, the SILJA EUROPA should carry two qualified masters, a qualified first mate and a qualified mate. The vessel's deck officers fulfilled these requirements.

The SILJA EUROPA had a pilot who was employed by the shipowner. The shipowner was not obliged to use a Swedish pilot. Vessels that operate regularly in channels in Swedish waters have the right, under certain conditions, to be exempted from the obligation to have a pilot.

4 THE VOYAGE ON WHICH THE ACCIDENT OCCURRED

4.1 The voyage prior to the grounding

The SILJA EUROPA departed from Turku on 12 January 1995 on schedule, at 20.09 hours, bound for Stockholm. On board were 2 575 passengers and 268 crew, totalling 2 843 people. The cargo included 4 buses, 14 lorries, 1 trailer and 67 cars. The vessel arrived in Mariehamn at 01.48 hours on 13 January 1995, continuing towards Stockholm at 02.00.

The master of the SILJA EUROPA stated in his protest that, prior to sailing from Turku, the vessel's route plan was checked, a stability analysis was performed, and the departure checklist was gone through. All equipment was in excellent condition and in the opinion of the master the vessel was seaworthy.

Prior to the accident nothing unusual had happened on board, except that the new DGPS instrument triggered an alarm after Mariehamn and before Ålandsgrund. This was an indication that it was not in perfect working condition. Because of this, the officer, who was the pilot, put the old DGPS instrument on-line.

4.2 The grounding

At 03.00 hours, while the SILJA EUROPA was in Swedish waters, halfway between Söderarm and Marhäll, the watch was changed on the bridge. The watch officer, the pilot and the watchman were on the bridge. The engineer and motorman were on engine watch.

According to the division of work between the watch officer and the pilot was such that the latter navigated the vessel. The watch officer oversaw the navigation and acted as lookout. They sat side-by-side at the control desk located in the middle of the bridge. Each had radar and identical sets of control equipment. The pilot had to notify the watch officer of all changes and the watch officer had to acknowledge notifications aloud. The watch officer had to notify the pilot if he noticed anything at variance with the route plan. The seaman of the watch served mainly as a roving firewatcher.

The SILJA EUROPA had a Nacos 25 integrated electronic navigation system made by STN Atlas Elektronik. Its key components were the subsystems known as the TRACKPILOT and the SPEEDPILOT. The operating principles of these subsystems are reported in more detail in section 5.

The SILJA EUROPA passed Marö island at 04.16 hours. The wind was from the northwest and its speed was 9 m/s. A 17-knot speed limit starts at Marö, and speed has to be reduced gradually to eight knots before the Furusund narrows.

As it approached Furusund, the vessel gradually slowed. About three cable lengths from the Furusundsskaten beacon, the watch officer stood up to make sure that the beacon was slightly to starboard of the bow. He saw that the beacon was dead ahead. He notified the pilot of this. In the pilot's statement appended to the protest, he reports that the watch officer asked, "Are you taking it to starboard?" and that he replied in the negative. The pilot had already previously noticed that the vessel was slowing and turning to starboard.

The pilot pushed the CONTROL REQUEST push-button, transferring rudder control from automatic control over to manual. He then turned the rudder 15 degrees to port, but the vessel did not respond. The watch officer reported that the angle of rudder was insufficient. The pilot turned the rudder further to port until finally the rudder was in its extreme position to port. Even this produced an insufficient result.

The pilot reported that all was not well and that the situation could get out of control. He noted that the KaMeWa pitch was at zero. He tried to switch off the SPEEDPILOT by pushing the COMMAND REQUEST button on the KaMeWa control panel and by pushing the control levers forward. However, the SPEEDPILOT was not disengaged, and the control levers returned by themselves to their original position.

The pilot phoned the engine room and asked them if control had been switched on there. According to him, this contact was by intercom. The engineering log records that calls came in from the bridge at 04.33 hours both by intercom and by ordinary phone, requesting control. However, the engine room pointed out that control had been held all the time on the bridge and that no alarms had been triggered. The engine room could also transfer control to itself on its own initiative. This triggers an audible alarm on the bridge. It is not normal procedure to connect control to the engine room in mid-voyage.

The pilot once again tried pushing the COMMAND REQUEST button on the KaMeWa Joystick control system. This action should switch off both the TRACKPILOT and the SPEEDPILOT systems and the vessel should then be under manual control. The pilot pushed the control lever forward and tried to turn the vessel to port at the same time, but without result. The vessel did not respond to steering and its engines could not be powered up.

The SILJA EUROPA went aground at 04.35 hours. The coordinates of the grounding were 59° 35',45 N, 18° 55',90 E. The Furusundsskaten beacon was entirely on the port side of the bow after the grounding. Normally, when navigating the narrows, it is on the starboard side of the bow. The beacon was undamaged. The grounding was felt in the engine room as a jolt.

4.3 Events after the grounding

Immediately after the grounding, the watch officer asked the pilot if it was necessary to drop anchor as he feared that the vessel's stern would approach the rocks. However, it was decided not to drop anchor.

View of the Furusund narrows, looking west from Turku to Stockholm. The wake of a vessel can be seen in the picture. The Furusundsskaten beacon is marked with an arrow.

Close-up of the Furusundsskaten beacon, looking west from Turku to Stockholm. The wake of a vessel can be seen in the picture. The SILJA EUROPA ran aground to the right of the beacon.

The watch officer phoned the master and chief officer to inform them of the accident, and they came to the bridge. The master took command and began to review the situation. He noted that the SPEEDPILOT was still engaged. He attempted to disengage the system by all the methods with which switching off had been attempted before the accident, and he also turned the SPEEDPILOT BYPASS switch. According to the master's belief, turning the switch should shut off the power supply to the SPEEDPILOT system and the system should be switched off. This did not happen, however, and the system remained active. The engine room noted that at 04.40 hours the log still showed a speed of five knots.

After this, control of the machinery was transferred to the engine room. The propeller machinery operated perfectly when controlled by the engine room. The SPEEDPILOT had been overridden. When control was returned to the bridge, the SPEEDPILOT was still active. Finally control of the propellers was restored to the bridge by pressing the KaMeWa BACKUP button. This command switches over to emergency manual control. The SPEEDPILOT system can be left on, as the BACKUP control overrides the SPEEDPILOT.

MRCC Stockholm (the maritime rescue co-ordination centre) was notified, as were Silja Line Ltd and the Stockholm pilot station. The rail ferry SEA WIND, approaching from the stern, was warned. The situation was reviewed on the bridge according to the checklist, and the chief engineer was asked to check for any hull damage.

The emergency management group, consisting of the master, chief officer, chief engineer, and the superintendent, assembled on the bridge with the exception of the chief engineer, who had gone to inspect the damage. The engineering staff assembled at the same time in the engine control room. The hotel purser informed the passengers of the occurrence, but no announcement over the public address system was made to the cabins.

The Swedish coast guard vessel KBV 105 was close to the site of the accident when it occurred. It came immediately to the SILJA EUROPA and noted that the vessel was not leaking oil. The crew of the coastguard vessel then boarded the SILJA EUROPA to check the situation.

Sounding and inspection of the tanks showed that the vessel had not been breached. However, the tanks were monitored continuously from the engine room.

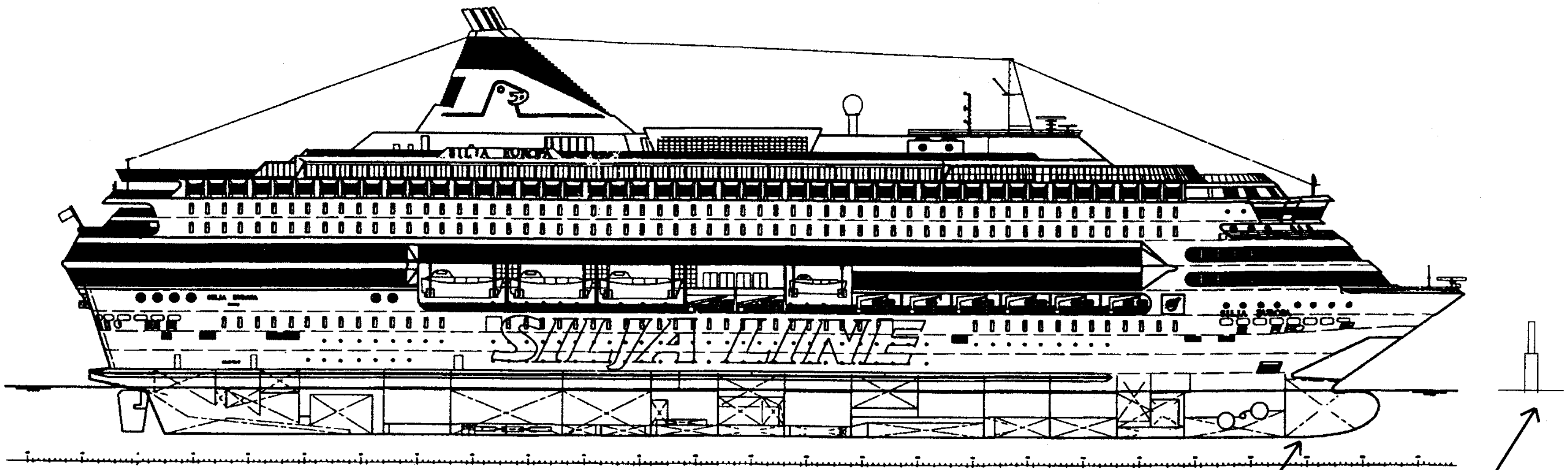
When the propeller machinery had been engaged with the BACKUP control, an attempt was made to pull the vessel off the rocks. The first attempt, with two main engines, failed. After that, water was pumped into ballast tanks 16 SB and 16 BB in the stern section of the vessel. Two more main engines were started up and the ship was pulled off the rocks at 05.07 hours. The ferry continued on its way to Stockholm immediately as it had been found seaworthy. The master handed over command to the watch officer and the pilot who had earlier been on watch.

The SPEEDPILOT was still displayed to be engaged but the speed control worked manually by the BACKUP control. After the vessel had been floated off the rocks, the bridge had been in contact by telephone with KaMeWa's agent in Stockholm. Contact was also made with STN Atlas Elektronik's agent, who said that by disconnecting three particular relays, the SPEEDPILOT could be switched off. The SILJA EUROPA's chief electrician disengaged the relays. At this point, the SPEEDPILOT was switched off. Merely detaching the relays did not have this effect, however. Beacuse the relays are connected to the same switch off circuit on the SPEEDPILOT as are the other switch off methods which did not function.

The vessel reached Stockholm at 08.45 hours, which is roughly 50 minutes after the scheduled time. Well before arrival, maritime inspectors, representatives of the Bureau Veritas classification society and KaMeWa, and a diver had been called to the harbour. The diver's inspection showed that the vessel's bow bulb had been dented and that an instrument bulb containing a log sensor had been detached.

As the vessel could be steered even without the SPEEDPILOT system and there was no damage in its hull, it was found seaworthy and it was given permission to leave for Turku. The vessel sailed out of Stockholm on 13 January 1995 at 13.00 hours and arrived in Turku at 23.54 hours.

Sideview of the SILJA EUROPA.



The location of the detached instrument bulb is marked with an arrow.

The part of the Furusundsskaten beacon that is above sea level is drawn in proportion to the size of the vessel.

5 THE MS SILJA EUROPA'S SPEED CONTROL SYSTEM

5.1 General

There are several ways to regulate the speed of the SILJA EUROPA from the bridge, from the engine control room and also locally from the engine room. The vessel's speed is controlled manually or automatically by the SPEEDPILOT. The methods of speed control used on board the vessel are as follows:

1 The KaMeWa control levers on the bridge and on the wings of the bridge control the propeller's pitch and speed.

2 The KaMeWa JOYSTICK control units on the bridge and on the wings of the bridge control the propeller's pitch and speed as well as the direction of the vessel.

3 When activated, the SPEEDPILOT automatically controls the ship's speed according to the program. The control signal from the SPEEDPILOT is connected to the KaMeWa's control electronics, which set the requested pitch and speed for the propeller.

4 The KaMeWa emergency control lever (BACKUP) on the bridge and on the wings of the bridge can be used to control the propeller pitch. The propeller has a constant speed during emergency control.

5 The KaMeWa's control levers in the engine control room control both the propeller pitch and speed.

6 From the engine room, the propeller pitch can be set manually by using the KaMeWa's hydraulic unit and propeller speed can be set manually directly from the main engines.

The principles of the SILJA EUROPA's speed control system are given on page 18 This schematic drawing shows the following:

* Control from the engine control room overrides all the vessel's other speed control methods (including the SPEEDPILOT and emergency control).

* The KaMeWa's emergency control overrides all the vessel's other speed control methods except the control from the engine control room.

* When the SPEEDPILOT has been activated, it overrides the vessel's speed control from the KaMeWa control levers and joysticks on the bridge and on the wings of the bridge.

* The BYPASS switch for the SPEEDPILOT (in the OFF position) on the navigation desk always transfers control to the KaMeWa control levers.

The locations of the vessel’s speed control units on board are shown on page 26. The control units with which the SPEEDPILOT can be switched off are numbered from 1 to 7 on the diagram. The SPEEDPILOT is activated with the SPEEDPILOT ON push button, when all the conditions are fulfilled for activating the SPEEDPILOT (the KaMeWa's control levers are at least 1.5 forward and at least clucthes of two main engines are closed).

The control panels on page 19 are shown in greater detail on pages 20 - 24.

5.2 The functioning of SPEEDPILOT

When the grounding occurred, ARRIVAL MODE had been selected for the SPEEDPILOT's speed control system. In ARRIVAL MODE, the SPEEDPILOT continuously calculates the correct arrival speed for the next programmed waypoint to ensure it will be reached at precisely the scheduled time.

On page 25 there is a picture of the Atlas Nacos system's display screen, on which points a - f show the parameters and selections for SPEEDPILOT. If the text ARRIVAL MODE is on the display, it means that the SPEEDPILOT is active and is controlling the vessel's speed unless

- the BYPASS switch for the SPEEDPILOT has been turned to the OFF position,
- or the KaMeWa system has been switched to BACKUP Control,
- or engine control room control.

If the BYPASS switch for the SPEEDPILOT is in the OFF position, the vessel's speed can be controlled directly, for example, from the KaMeWa control levers on the bridge, as was done after the grounding on the way to Stockholm and from Stockholm to Turku.

Instead of ARRIVAL MODE, it is possible to select either of the vessel's other control modes, such as SET SPEED MODE or PROFILE MODE.

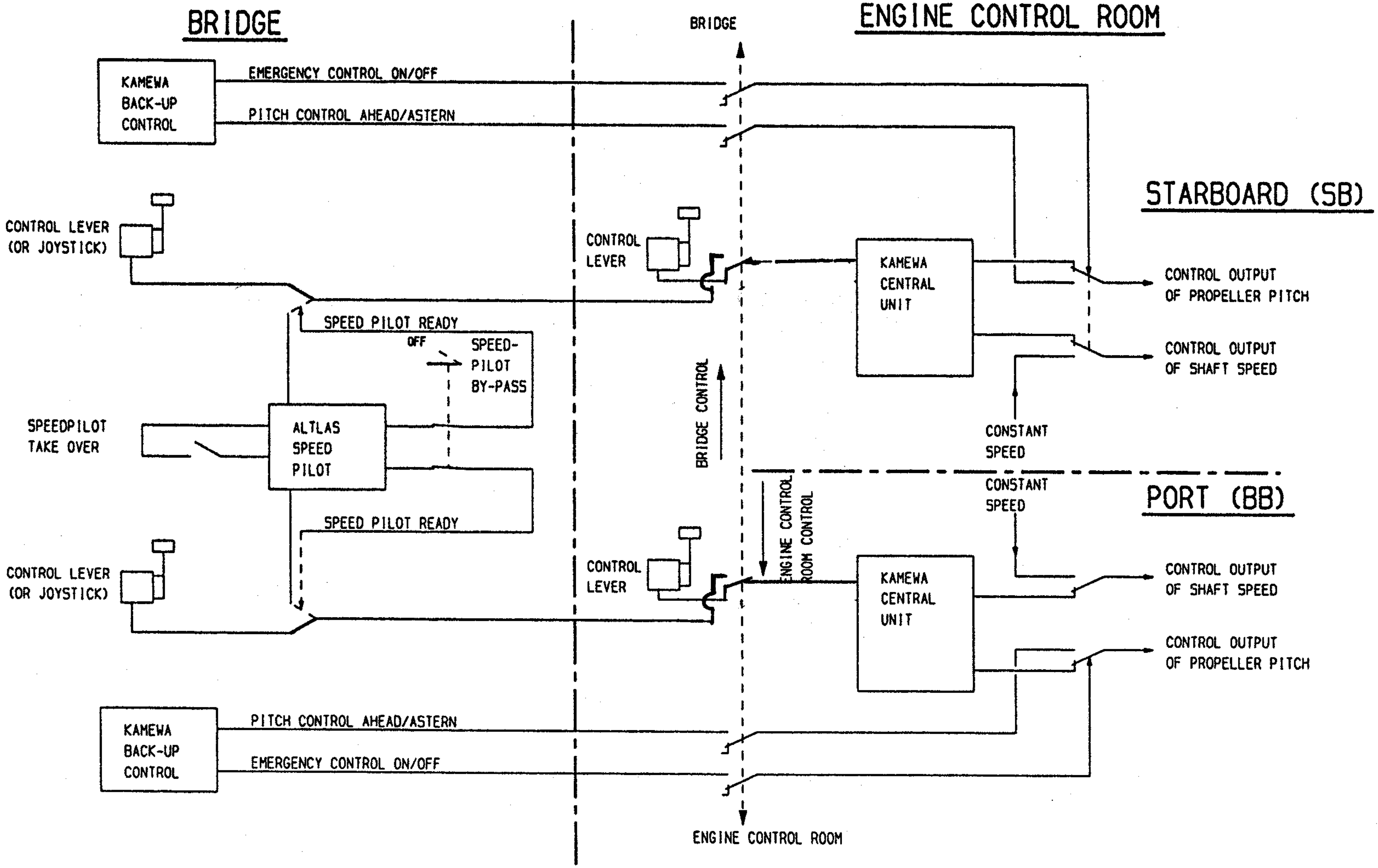
- SET SPEED MODE

  The vessel's speed is set manually through the navigation system's control/monitoring terminal. This speed control mode can be used, for example, on cruises for which the route has not been pre-programmed.

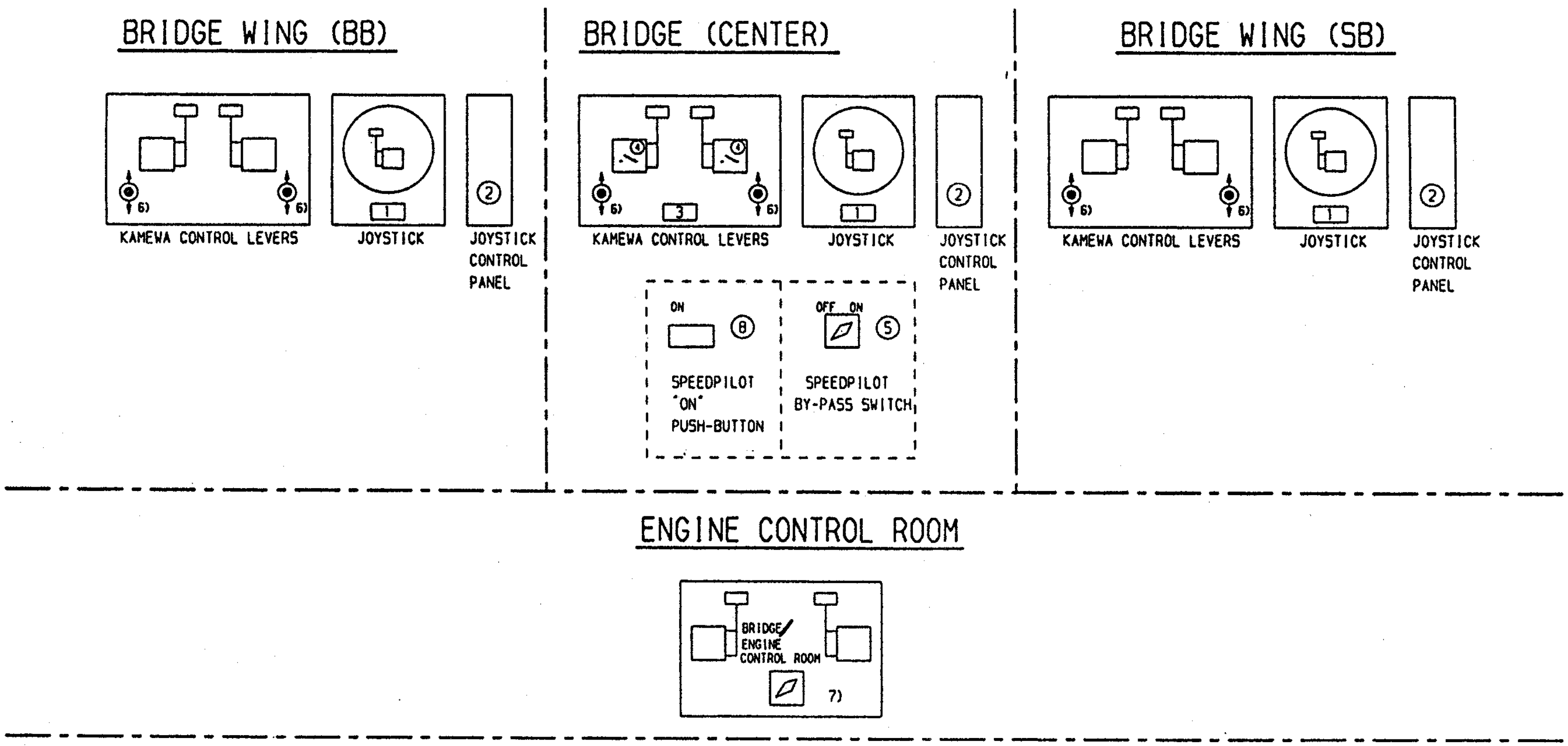
  PROFILE MODE

  The speed of the vessel is also programmed for each track segment along a programmed route. When the waypoint is reached, the SPEEDPILOT switches automatically to the speed programmed for the next track segment. This speed's control mode is well suited to practice, if the precise arrival time of the vessel at the destination is not essential.

THE SCHEMATIC DRAWING OF THE SILJA EUROPA'S SPEED CONTROL SYSTEM

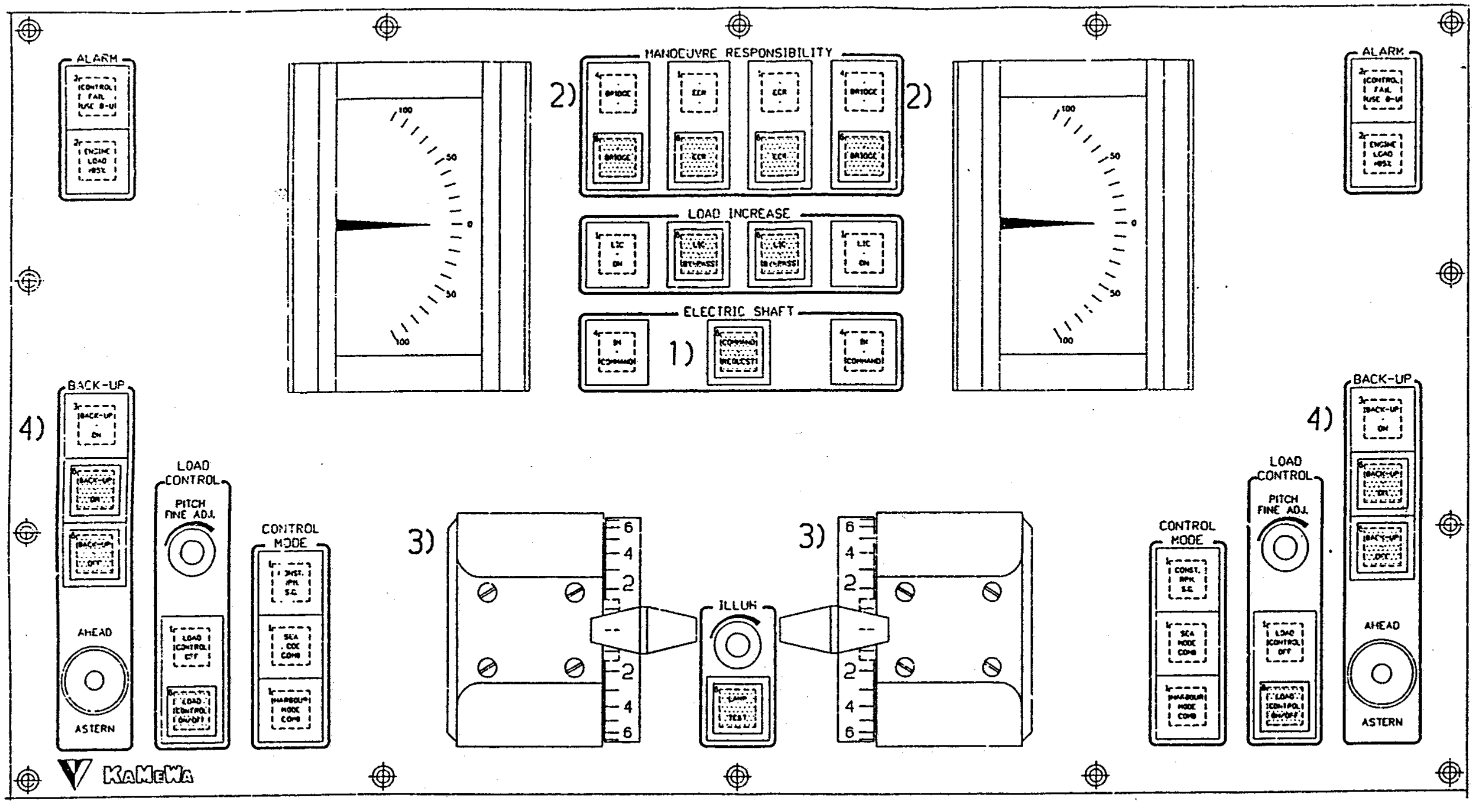


THE LOCATIONS OF THE VESSEL'S SPEED CONTROL UNITS



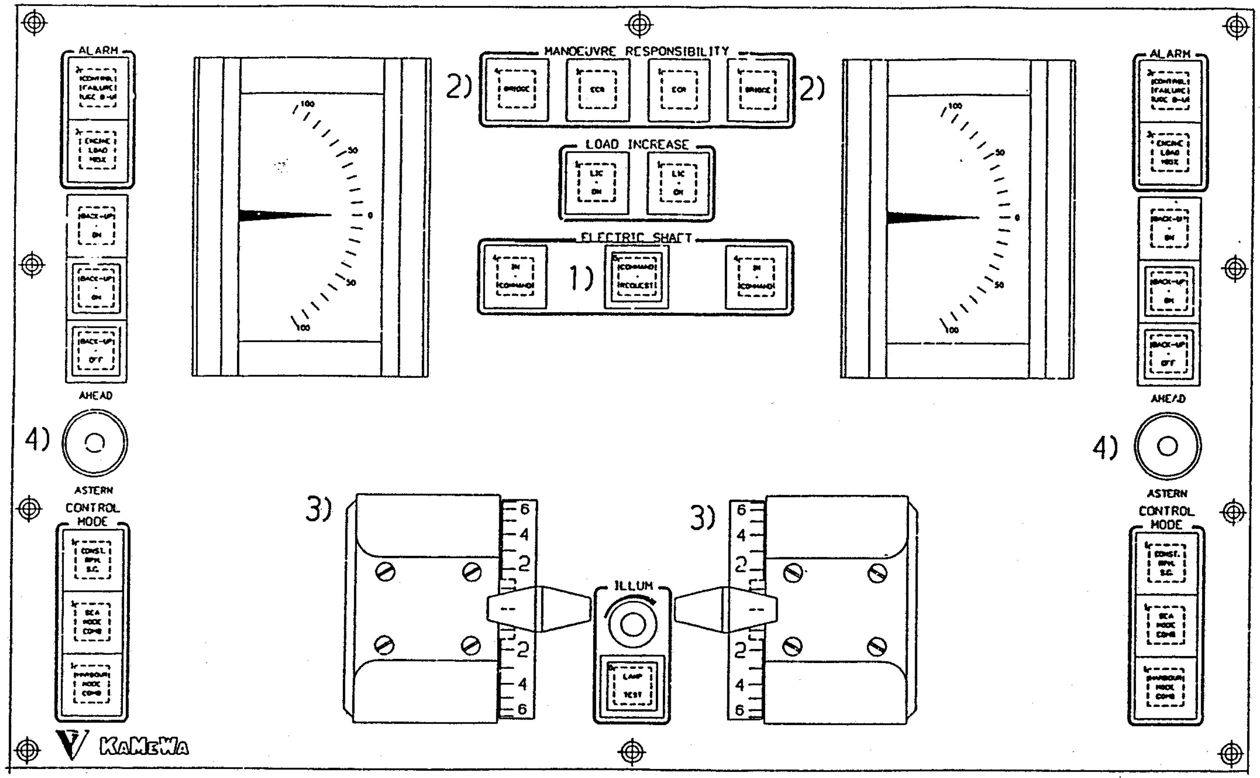
1. JOYSTICK "COMMAND REQUEST" PUSH-BUTTON. THE SPEEDPILOT IS SWITCHED OFF AND DOES NOT CONTROL THE VESSEL'S SPEED.
2. "HAND CONTROL" PUSH-BUTTON. THE SPEEDPILOT IS SWITCHED OFF AND DOES NOT CONTROL THE VESSEL'S SPEED.
3. "COMMAND REQUEST" PUSH-BUTTON ON KAMEWA CONTROL PANEL. THE SPEEDPILOT IS SWITCHED OFF AND DOES NOT CONTROL THE VESSEL'S SPEED.
4. POSITION OF KAMEWA LEVER'S < 1.5. THE SPEEDPILOT IS SWITCHED OFF AND DOES NOT CONTROL THE VESSEL'S SPEED.
5. THE SPEEDPILOT BY-PASS SWITCH. IN THE OFF POSITION IT TRANSFERS CONTROL OF VESSEL'S SPEED TO THE KAMEWA CONTROL LEVERS.
6. THE KAMEWA BACK-UP EMERGENCY CONTROL. IT OVERRIDES ALL THE VESSEL'S OTHER SPEED CONTROL METHODS EXCEPT THE CONTROL FROM ENGINE CONTROL ROOM.
7. THE SELECTION SWITCH "BRIDGE/ENGINE CONTROL ROOM". IN THE POSITION "ENGINE CONTROL ROOM" IS THE VESSEL'S SPEED CONTROLLED BY KAMEWA CONTROL LEVERS IN ENGINE CONTROL ROOM. WHEN THE SELECTION SWITCH IS CHANGED OVER TO POSITION "BRIDGE", WILL THE CONTROL OF THE VESSEL'S SPEED TRANSFER TO THE BRIDGE AFTER THE TRANSFER HAS BEEN ACKNOWLEDGED ON THE BRIDGE.
8. THE SPEEDPILOT "ON" PUSH-BUTTON. WITH THIS PUSH-BUTTON IT IS POSSIBLE SWITCH ON THE SPEEDPILOT.

THE KAMEWA CONTROL PANEL ON THE BRIDGE



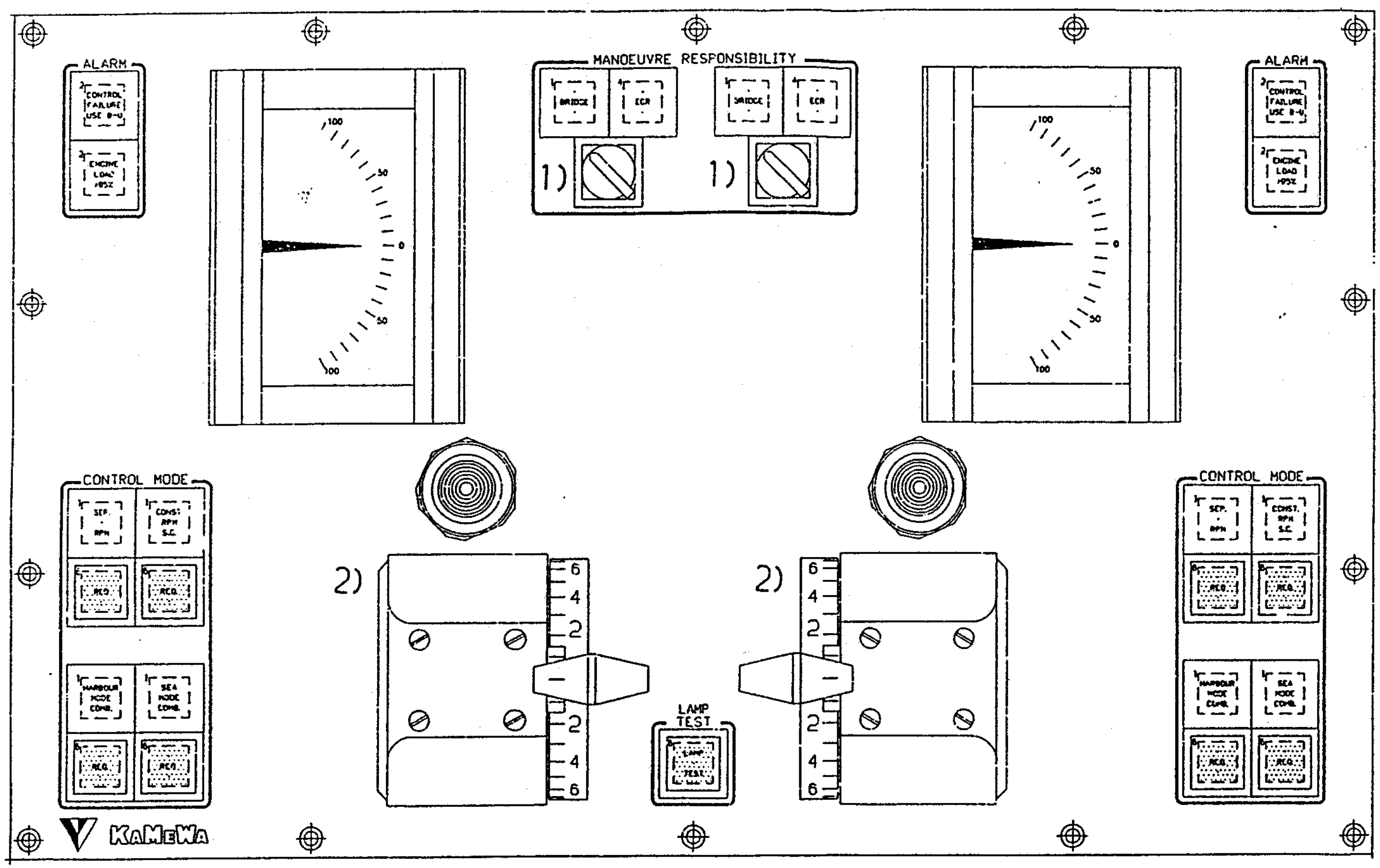
1. THE PUSHING OF "COMMAND REQUEST" PUSH-BUTTON SWITCHES OFF THE SPEEDPILOT AND TRANSFERS THE CONTROL OF THE VESSEL'S SPEED TO CONTROL LEVERS.
2. MANOEUVRE RESPONSIBILITY "BRIDGE". LIGHT IN THIS INDICATION LAMP SHOWS, THAT THE CONTROL OF THE VESSEL'S SPEED IN ON BRIDGE.
3. THE VESSEL'S SPEED CONTROL LEVERS. IF POSITION OF THE CONROL LEVER IS < 1.5 AHEAD WILL SPEEDPILOT SWITCH OFF.
4. THE BACK-UP EMERGENCY CONTROL. THE PUSHING OF "BACK-UP ON" PUSH-BUTTON TRANSFERS THE CONTROL OF THE VESSEL'S SPEED ALWAYS TO THIS UNIT. OVERRIDING ALL THE VESSEL'S OTHER SPEED CONTROL SYSTEMS EXCEPT THE CONTROL FROM ENGINE CONTROL ROOM.

THE KAMEWA CONTROL PANELS ON THE WINGS OF THE BRIDGE



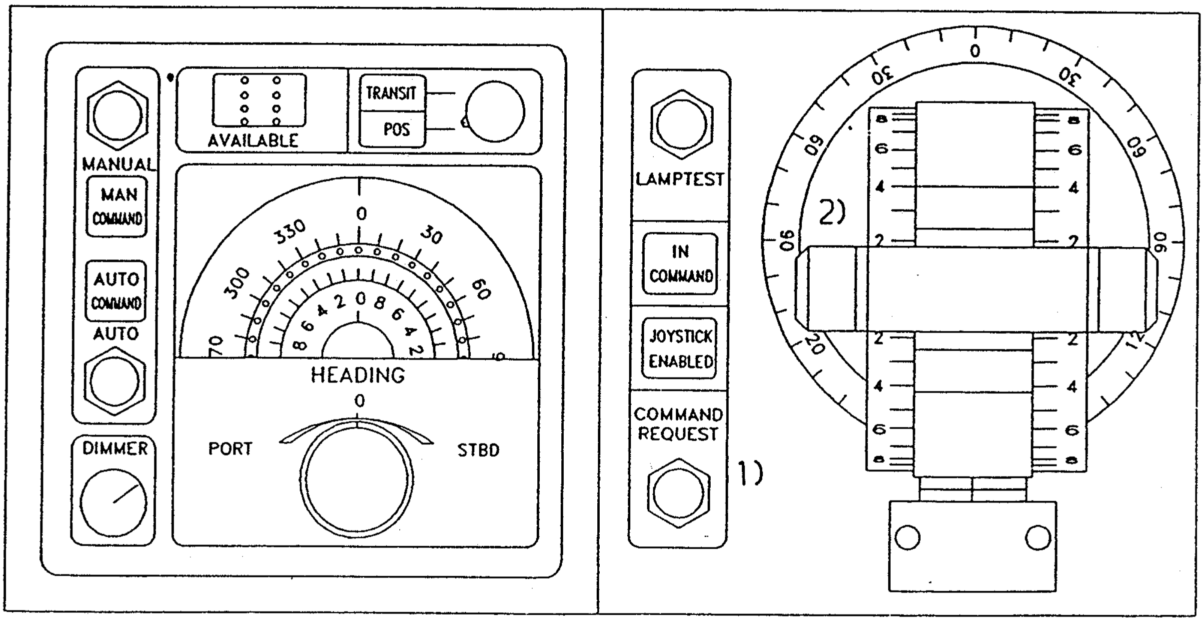
1. THE PUSHING OF "COMMAND REQUEST" PUSH-BUTTON TRANSFERS SPEED CONTROL FROM LEVERS ON NAVIGATION DESK TO BRIDGE WINGS.
2. MANOEUVRE RESPONSIBILITY "BRIDGE". LIGHT IN THIS INDICATION LAMP SHOWS, THAT THE CONTROL OF THE VESSEL'S SPEED IS ON BRIDGE.
3. THE VESSEL'S SPEED CONTROL LEVERS.
4. THE BACK-UP EMERGENCY CONTROL. THE PUSHING OF "BACK-UP ON" PUSH-BUTTON TRANSFERS THE CONTROL OF THE VESSEL'S SPEED ALWAYS TO THIS UNIT. OVERRIDING ALL THE VESSEL'S OTHER SPEED CONTROL SYSTEMS EXCEPT THE CONTROL FROM ENGINE CONTROL ROOM.

THE KAMEWA CONTROL PANEL IN THE ENGINE ROOM



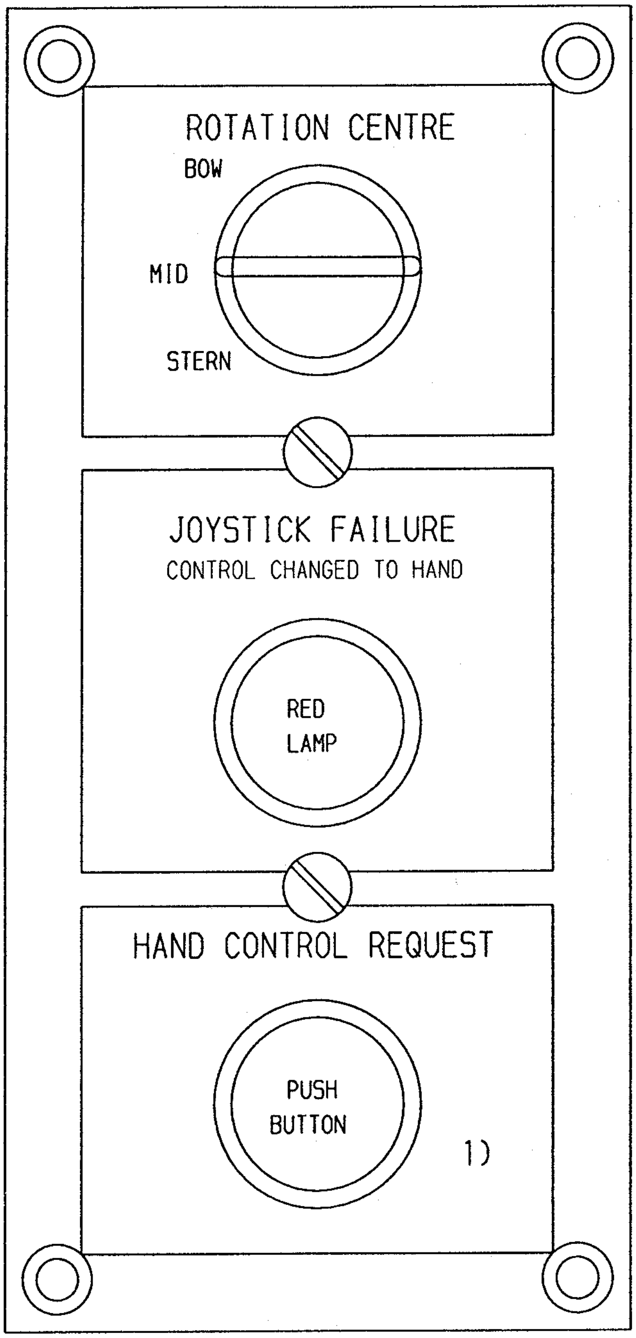
1. THE SELECTION SWITCH OF CONTROL PLACE (BRIDGE/ENGINE CONTROL ROOM). BY USING THIS SELECTION SWITCH IT IS POSSIBLE TRANSFER AT ANY TIME THE CONTROL OF VESSEL'S SPEED TO ENGINE CONTROL ROOM.
2. THE VESSEL'S SPEED CONTROL LEVERS. WHEN CONTROL IS IN ENGINE CONTROL ROOM OVERRIDES THIS CONTROL METHOD FOR EXAMPLE THE SPEEDPILOT AND THE KAMEWA BACK-UP EMERGENCY CONTROL.

THE JOYSTICK CONTROL UNIT



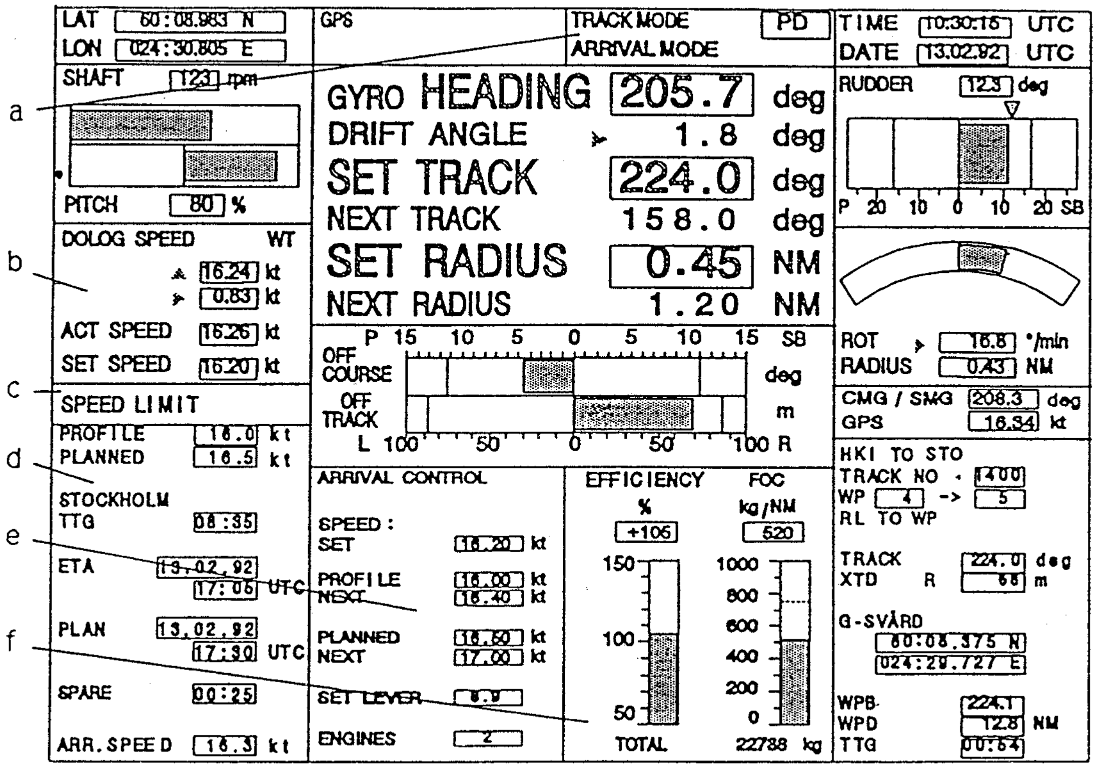
1) THE PUSHING OF " COMMAND REQUEST" PUSH-BUTTON SWITCHES OFF THE SPEEDPILOT AND TRANSFERS THE CONTROL TO THIS JOYSTICK CONTROL UNIT.
2) THE CONTROL LEVER OF VESSEL'S SPEED AND DIRECTION.

THE JOYSTICK CONTROL PANEL



1) THE PUSHING OF "HAND CONTROL REQUEST" PUSH-BUTTON SWITCHES OFF BOTH SPEEDPILOT AND TRACKPILOT. THIS CONTROL PANEL IS LOCATING ALWAYS BY SIDE OF THE JOYSTICK CONTROL UNIT ON BRIDGE AND ON BRIDGE WINGS.

SPEEDPILOT DISPLAY



a) OPERATIONAL MODE DISPLAY
b) SPEED DISPLAY
c) MESSAGE DISPLAY
d) SCHEDULE DISPLAY
e) SPEEDPILOT DATA DISPLAY
f) SPEEDPILOT PARAMETER DISPLAY

The SPEEDPILOT can be switched off as follows:

1) by pushing the COMMAND REQUEST push button on the KaMeWa control panel,

2) by pulling the KaMeWa control levers on the bridge to position < 1.5,

3) by pushing the COMMAND REQUEST push button on the Joystick control unit, or

4) by pushing the HAND CONTROL push button on the Joystick control panel.

When the SPEEDPILOT is switched off it is not in an active state and does not control the vessel's speed.

The SPEEDPILOT can also be bypassed completely by the following methods;

1) with the BYPASS switch for the SPEEDPILOT

2) with the KaMeWa BACKUP emergency control

3) by transferring the propulsion control to the engine control room.

When the SPEEDPILOT is bypassed it does not control the ship's speed even if it is in an active state.

5.3 The structure of SPEEDPILOT

SPEEDPILOT's electronics consist of three circuit boards:

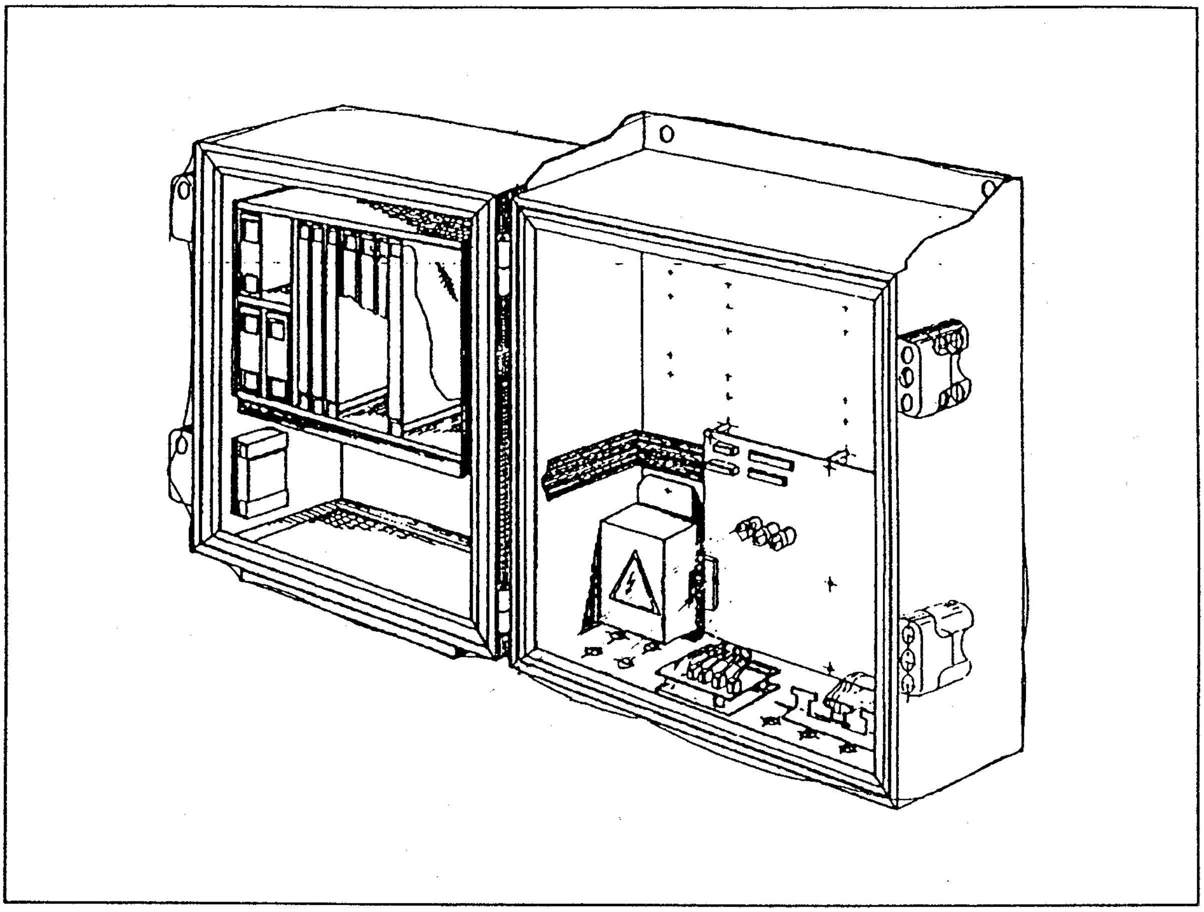
- a processor card (DMC)
- engine interface card 1
- engine interface card 2

The circuit cards are installed in an electronics frame (see figure on page 28). The card connectors are on one edge of the circuit card (see figure on page 29) and there are counterparts of the card connectors in the electronics frame, soldered onto the motherboard on the back of the electronics frame. Electronic signals between the circuit cards go through the card connectors to the motherboard, which transmits signals from one circuit card to the other and also to external equipment via flat cables and interface units.

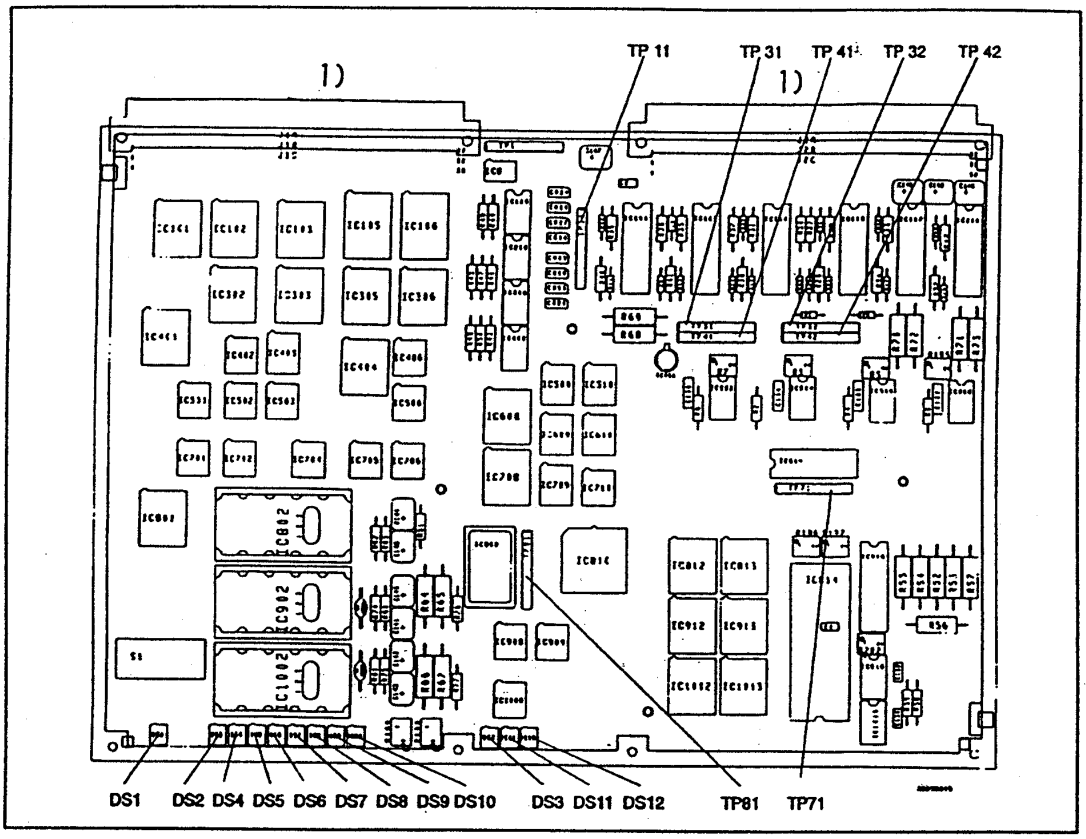
Circuit cards are normally locked to the electronics frame at their front panels with locking screws. The electronics frame of the SILJA EUROPA's SPEEDPILOT provides for the possibility of locking engine interface cards number 1 and 2. As there is vibration on board ships, an unlocked or badly locked circuit card may loosen from its card connector, whereupon it may stop functioning altogether or become uncertain. No one has been able to say with certainty whether the interface cards of SILJA EUROPA were locked to the electronics frame or not before the grounding.

The structure of engine interface card 1 is shown on page 25. In the tests at the STN Atlas Elektronik by the Investigation Commission, it was shown that the detachment of this circuit card from its connector caused a corresponding situation to what occurred on the SILJA EUROPA before the grounding. The SPEEDPILOT could not be switched off.

ELECTRONICS CABINET (TRACKPILOT/SPEEDPILOT)



LAY-OUT OF THE SPEEDPILOT'S ENGINE INTERFACE CARD 1



Components of GE 3016 G 325

1) CARD CONNECTORS

6 USE OF THE SPEED CONTROL SYSTEM DURING THE VOYAGE ON WHICH THE ACCIDENT OCCURED

The main operations of the system during the voyage during which the accident occured, should be described in detail, since this provides the background for further analysis of the functioning of the SILJA EUROPA's speed control system (i.e. the SPEEDPILOT system).

12 January 1995

20.09 The SILJA EUROPA sailed from Turku

13 January 1995

01.48 The SILJA EUROPA arrived in Mariehamn

02.00 The SILJA EUROPA sailed from Mariehamn for Stockholm.

02.27 Speed Sensor was in the log, Position sensor in DGPS2.

02.33 Speed Sensor was changed from the log to DGPS2.

03.00 Watch changed on the bridge. The TRACKPILOT was in active mode and the SPEEDPILOT was in ARRIVAL MODE.

04.16 The SILJA EUROPA passed Marö island. A 17-knot speed limit was in force from this point.

04.22 The new DGPS receiver (DGPS2) triggered an alarm before Ålandsgrund. The pilot switched to the old DGPS receiver (DGPS1). After the changeover, there was no longer any DGPS alarm. The SPEEDPILOT changed over automatically to MANUAL SPEED after acknowledgement of the SPEED SENSOR FAULT alarm. The SPEEDPILOT registered the MANUAL SPEED figure as 17.62 knots when the DGPS was changed; this was the figure given by the DGPS that had triggered the alarm.

As the vessel approached Furusund, the SPEEDPILOT started to reduce speed. Since the SPEEDPILOT was in MANUAL SPEED mode (17.62 knots), and the vessel's planned speed decreased gradually to roughly 8 knots, the SPEEDPILOT set the control levers up. The SPEEDPILOT did not automatically switch off even though the control lever position was <1.5. The SPEEDPILOT gave the SP SPEED FAULT alarm. The alarm disappeared after several acknowledgements.

About three cable lengths before Furusundsskaten, it was noticed that the vessel was gradually turning to starboard. The pilot took the vessel's rudder under manual control (hand control) and turned the rudder 15 degrees to port and immediately thereafter hard to port. No course change was effected because the propeller pitch was close to zero and the vessel's speed was less than eight knots.

The pilot pushed the KaMeWa's COMMAND REQUEST push button and turned the control levers forward, but they returned immediately to the upright position. He then pushed the joystick's COMMAND REQUEST push button and turned the joystick control lever forward while turning it to the left, but without result. The rudder centred automatically. After this he turned the joystick control lever back to the upright position and the rudder over to the left.

04.33 The pilot phoned to the engine control room and asked for control of the engines to be transferred to the bridge, but the bridge already had control

04.35 The vessel ran aground at the Furundsskaten beacon.

04.40 The operation of the KaMeWa's control system was tested from the engine control room. The system functioned perfectly. Control was transferred to the bridge.

04.43 The engine control room requested that the bridge test the emergency control with the KaMeWa BACKUP. This functioned perfectly. The master tried to switch off the SPEEDPILOT but was unsuccessful. He attempted to switch off the SPEEDPILOT at least by pushing the COMMAND REQUEST push button on the KaMeWa control panel and on the joystick control unit. He probably also turned the BYPASS switch for the SPEEDPILOT into the off-position momentarily.

04.56 The master announced that the SPEEDPILOT was still on.

05.07 All four main engines of the vessel were used. The vessel was refloated by using the KaMeWa's BACKUP emergency control. The voyage to Stockholm was continued under the KaMeWa's BACKUP emergency control.

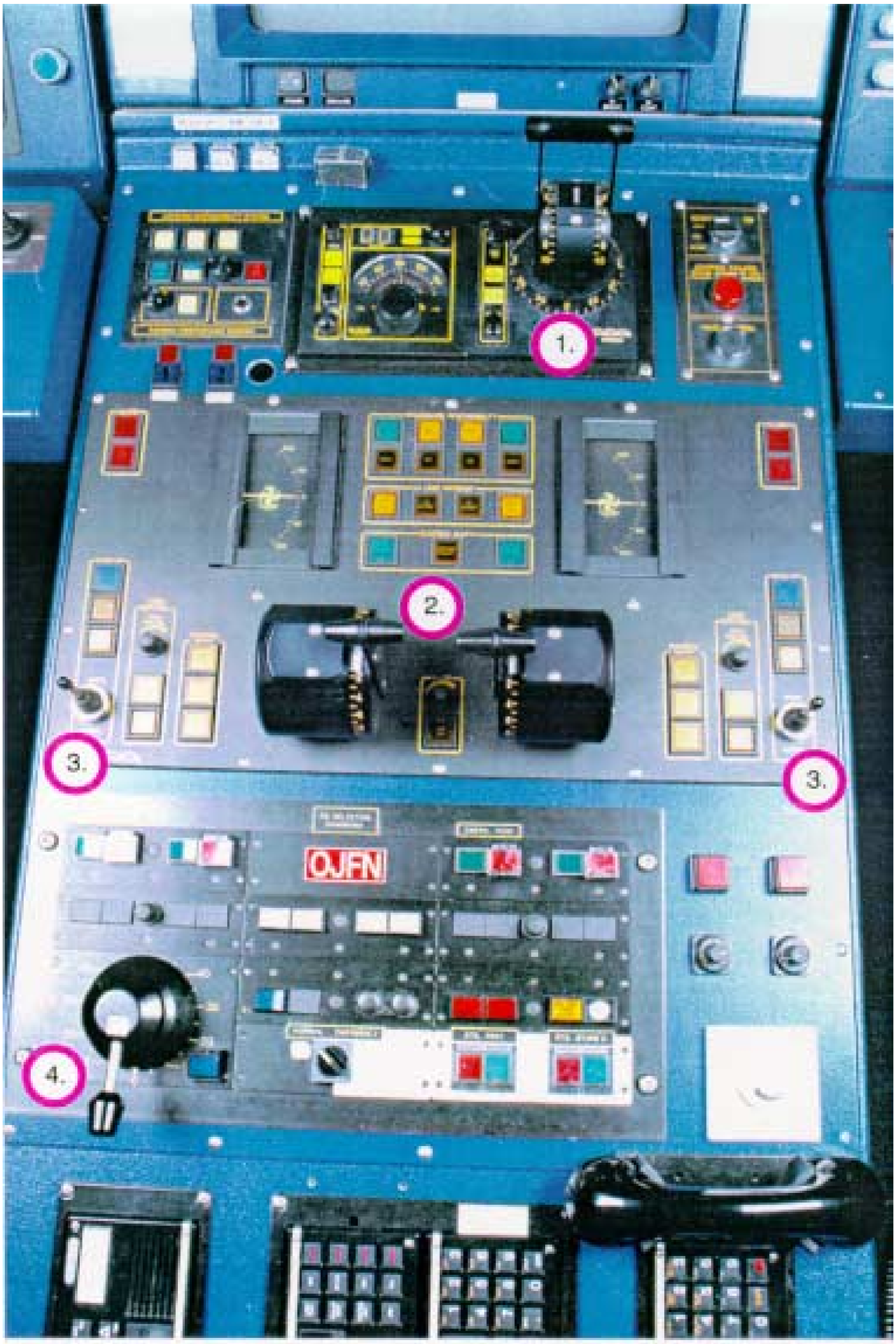
05.40 The representative of STN Atlas Elektronik said that the SPEEDPILOT could be switched off by removing three relays from the joystick's central cabinet. The relays were removed. After this BACKUP running was finished and the KaMeWa's control levers then operated normally and without disturbances. (In fact the SPEEDPILOT was bypassed with the BYPASS switch for the SPEEDPILOT.)

08.44	The vessel arrived in Stockholm.
13.00	The vessel sailed from Stockholm for Turku. The voyage was completed without the SPEEDPILOT. The voyage proceeded normally.
23.54	The vessel arrived in Turku. The SPEEDPILOT was still in ARRIVAL MODE.

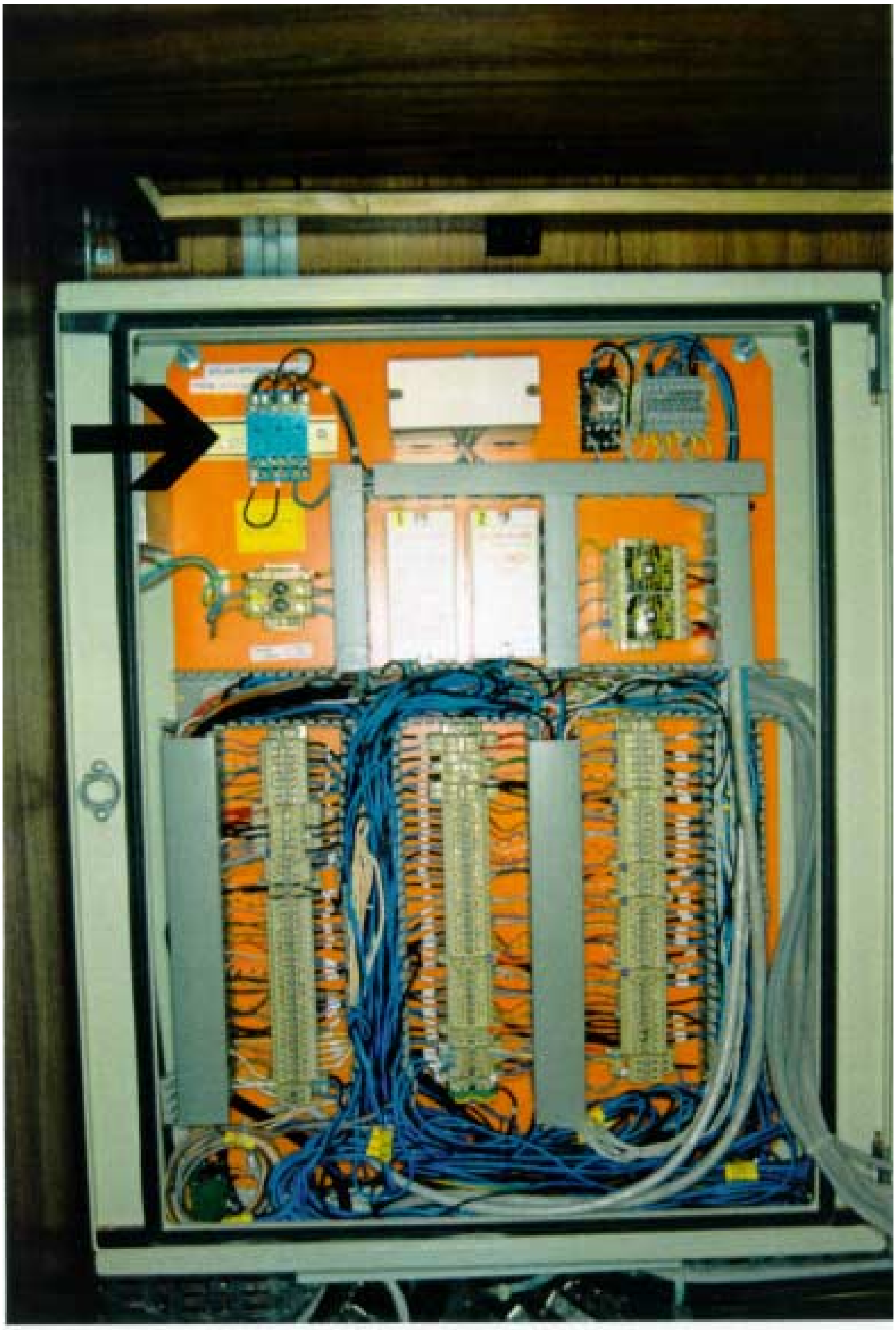
The navigation desk on the bridge of the M/S SILJA EUROPA.
The arrow indicates the location of the BY-PASS switch.

Close-up of the navigation desk. At the time of the accident, the pilot sat on the left and the officer of the watch sat on the right. The arrow indicates the location of the BY-PASS switch.

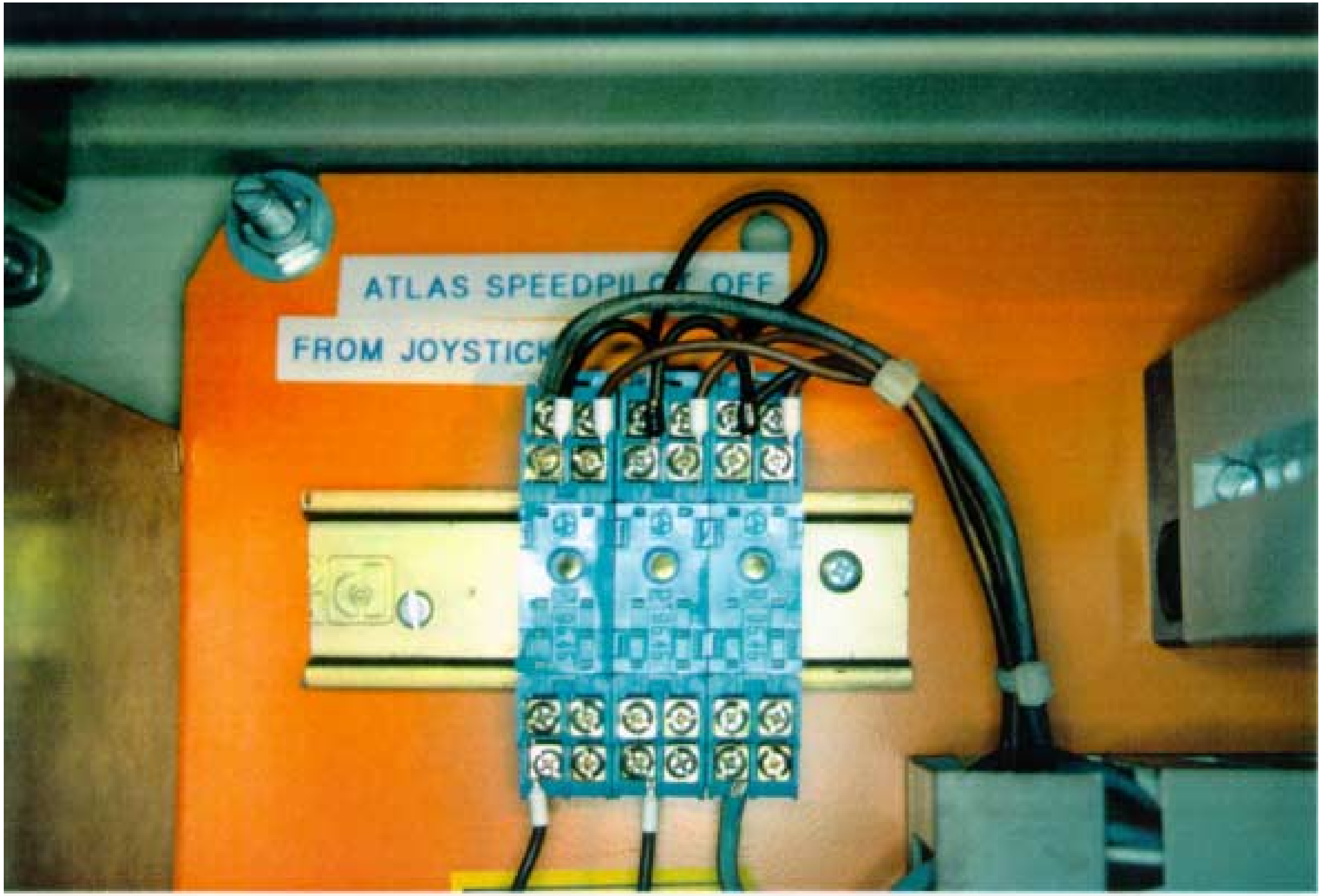
The right-hand side of the navigation desk. The arrow indicates the location of hte BY-PASS switch.



Close-up of the control panels of the navigation desk.
1 Joystick.
2 The KaMeWa control levers.
3 BACK-UP emergency control tillers.
4 Steering tiller for the rudder.



The Joystick´s electronics cabinet in the equipment room of the bridge. The arrow indicates the switch-off relays for the SPEEDPILOT.



Close-up of the SPEEDPILOT´s switch-off relays in the Joystick´s electronics cabinet.

7 THE PURCHASE, MAINTENANCE AND OPERATOR TRAINING ON THE SPEED CONTROL SYSTEM

7.1 Installation

The Atlas SPEEDPILOT speed control system was installed on the SILJA EUROPA on 15 July 1994.

The vessel had been fitted with a speed control system manufactured by KaMeWa in 1993. There were problems with running it and it was only used on the open sea.

Simultaneously with the installation of the Atlas SPEEDPILOT during the summer of 1994 the vessel was fitted with three SPEEDPILOT disconnection relays. The operation of the control levers was altered on 19 July 1994 in such a way that the SPEEDPILOT would switch off automatically when the KaMeWa's control levers' position was less than 1.5 ahead.

Since the SPEEDPILOT had the highest priority in the SILJA EUROPAs propeller control system, a BYPASS switch in the event of a possible SPEEDPILOT malfunction was installed in the system on the recommendation of the supplier of the equipment.

According to the deck crew's duty matrix, the SPEEDPILOT (both manuals and training) was the responsibility of the vessel's chief officer. Responsibility meant that the officer was particularly well-versed in the instrument in question and was able when necessary to guide others and to evaluate the expertise of other people.

In practice the responsible officer observes during the operation how others are able to use the instrument. Responsibility does not entail direct contact with the supplier on matters concerning servicing and maintenance. This contact is handled by the master. The responsible officer makes the reports required for this contact to the master. The training of a new crew member or the comparison of new (updated) manuals with those previously in use is not primarily the duty of the responsible officer; instead, this is usually handled by the member of the deck crew who is on board at the time.

7.2 Operator training for the SPEEDPILOT

Training in how to use the SPEEDPILOT had been given in the usual way on the vessel. The supplier of the equipment did not give training directly to any of the deck officers. The Finnish electrician explained the operation of the instrument to the masters who were onboard the vessel at the time it was installed. The chief officer in charge of the equipment and the master gave training in practical operating situations to the mates on board at the time. Most of them had used the same or similar equipment before, so it was not necessary to start with elementary training.

Among the important points of the training were the modes, i.e., the alternatives available for operating the SPEEDPILOT, how it can be switched off, and in what situations its use is limited (for example, when it cannot be switched on/used). Right from the start the instruction was given that, in the event of an obvious malfunction, the SPEEDPILOT must be switched off immediately. It was necessary to be able to do so even when there was no malfunction or disturbance, such as when evasive action was being taken. The methods for switching off the SPEEDPILOT were covered. Not all the different alarms were ever covered systematically during the training; there were so many of them. Those alarms which required that the SPEEDPILOT be switched off were gone through. Practical exercises in which these operations would be reviewed were not part of the training. The BY-PASS switch was not on the vessel's checklist.

The usual learning method was for each individual to read the English-language operating instructions independently. The operation of new instruments was monitored systematically, with observations on the item in question being entered in the so-called "red book" next to the operating site. Each person had the duty to report when he noticed a fault in the equipment or when he wanted changes in it. In the course of the autumn of 1994 (21 July - 11 October 1994) there were in all 12 entries in the "red book" clearly related to the SPEEDPILOT.

If the equipment triggered an alarm and it was found to be a bigger problem, it was normal practice to enter the method by which the alarm was handled in the minutes of the officers' meeting. On 28 July 1994 two comments were recorded on the use of the Nacos system (ban on use of the 3rd main engine and the procedure for acknowledging the NCC's OFF TRACK alarm). Also entered in the minutes of the officers' meeting is an observation that there were constant errors occurring (5 August 1994) and that these had been corrected (20 October 1994).

The officer, who was serving as pilot had received training in the use of the SPEEDPILOT during operation after the installation.

When the pilot asked about the instrument, the master had told him about it. The route pilot had previously become familiar with a similar piece of equipment on the passenger ferry SILJA SERENADE. The operating principles of the SILJA EUROPA's SPEEDPILOT did not, in his opinion, differ from those of the one on the SILJA SERENADE. Furthermore, the pilot had, in the usual way, gone through the SILJA EUROPA's SPEEDPILOT manual. He found in the manual what the normal failures were, what each alarm meant, and how to acknowledge the error. Normally, acknowledging the alarm is the first thing to do, almost automatically. It is then necessary to know what the effect of it is. The pilot had needed an English dictionary when reading the manual and the list of alarms.

The 2nd officer serving as watch officer on the voyage on which the accident occured had had about 2.5 months' experience with the SPEEDPILOT on the SILJA SERENADE when he began to serve on the SILJA EUROPA. He had had his real training in using the SPEEDPILOT on the SILJA SERENADE. The training included theory, i.e., the operating principles of the equipment and training in its use. Operational training was given in practical running situations. Independent study of the operating instructions took place on the Helsinki - Stockholm route, from which the SILJA EUROPA transferred to the Turku-Stockholm route in January 1995. The voyage on which the accident occured was her second voyage from Turku to Stockholm. The manual was in no way different from other equipment's instructions and the language (English) had not caused any problems during the studies. Action during failures and malfunctions were discussed on a very practical level. When an alarm arose while sailing, what was to be done in the circumstances was discussed. Not many alarms had come up on the Helsinki route as it was a fairly straight run.

When the BYPASS switch was installed, the electrician from Polartec Ltd. (the representative of STN Atlas Elektronik in Finland) had given training in the use of the switch to those members of the deck officers who were along on the trip. According to the electrician, the 'button technique' was covered in the normal way. The masters and a KaMeWa fitter were present.

The pilot said when questioned that he had no recollection of how or who explained to him the purpose of the switch. According to his recollection, however, it had not been the electrician who installed the equipment.

The officer of the watch had not been onboard when the BYPASS switch had been installed. He was, however, aware that the switch had been installed and knew where it was. He had not been given any more detailed explanation than the position and purpose of the switch.

7.3 The user's instructions for the SPEEDPILOT

The SILJA EUROPA had the following operating instructions for the SPEEDPILOT:

* Operating Instructions. ATLAS NACOS Navigation and Command System. SPEED PILOT. Speed Control with NACOS. ED 3031 G 212 / 03.94. BASP_E 18.03. Atlas Elektronik. 39 pages.

* Alarms and Messages. ATLAS NACOS. ATLAS RADARPILOT. ED 3030 G 692. Preliminary Edition. 010293. Atlas Elektronik. Pages B 0-1, 1-1, 1-3, B 2-1 – 2-12.

The SPEEDPILOT's operating instructions were supplied to the vessel by STN Atlas Elektronik, Germany. The manuals for all equipment were available at a particular location on board.

During the events that led to the accident, the pilot and the watch officer reported that they had observed an SP SPEED FAULT alarm. Neither had previously been in a situation in which this alarm had been given. According to them, the alarm was not on the alarm list on the vessel. The Investigation Commission also found that this alarm was not in the above-mentioned Alarms and Messages publication. On the other hand, the alarm is in Atlas Elektronik's publication NACOS Alarms and Messages ED 3030 G 692/10.94. BANALA_E 04.10. Atlas Elektronik sent the Investigation Commission the pages of this publication that had been updated at a meeting held on the SILJA

EUROPA on 1-2 March 1995, and the SP SPEED FAULT alarm is mentioned in this. However, this updated alarm list was not on the vessel.

The equipment manuals explain how each item of equipment works and how it is used. On the SILJA EUROPA, the ship's own instruction had been drawn up along with a report on how the entire integrated navigation system operated and how to use it. The SILJA EUROPA has ship-specific manuals, in Finnish and Swedish, on power transmission and automatic control as well as other equipment. In addition, some items are explained in the Bridge Procedures Guide.

7.4 The operating procedures during maintenance and repairs

Specific programmes for each item of equipment are drawn up on the AMOS maintenance computer system for the routine maintenance and inspections of navigation equipment, in accordance with the manufacturers' instructions. The work is done according to a job list and the worker acknowledges the jobs done by putting his own name on the list, which serves as a way of monitoring the work done. AMOS supplies working instructions and also stores historical data. The SPEEDPILOT was put on AMOS in 1996, so the system did not have information available on the SPEEDPILOT's faults and repairs ("equipment history") before the accident.

Outside maintenance operations are normally requested by telephone. The order is placed by the master or by a person authorized by him to do so. The AMOS system prints out a job order, which is sent out after the orally placed order. The reason the oral ordering procedure is used is its quickness. According to the minutes of the officers' meeting, there had been malfunctions in the SPEEDPILOT. The orders of work for the SPEEDPILOT were placed only orally as the instrument was not yet at that time on the AMOS system.

A procedure has been approved for dealing with maintenance work on the vessel to ensure that the bridge crew is aware when outside servicemen are onboard and that the repair work is properly accepted and approved. No one may board the vessel without giving notice of who they are going to see. Colleagues and the master give information of repairs coming during a shift. The serviceman writes a maintenance report, which is usually signed for by the master or someone who was on the site. Completed jobs are entered in the AMOS system after the invoice has come.

There was no up-to-date schematic and cabling drawing of the SPEEDPILOT on board the vessel. The diagram supplied when the instrument had been installed had not been updated with the alterations. For the purposes of the Investigation Commission, a specialist from Deltamarin Ltd made a schematic and cabling drawing of the SPEEDPILOT by deducing from expert knowledge how the instrument was probably wired. The Investigation Commission has been unable to verify the accuracy of this drawing because the SPEEDPILOT had been removed and the cables disconnected. When making connections on the vessel, service engineers should always make installation drawings and deliver them for filing in the vessel's equipment file, and these should be demanded when work is received and approved.

Repairs should, according to instructions, also be recorded in the minutes of the officers' meeting and be discussed at the officers' meeting. One entry was made on the SPEEDPILOT concerning repairs carried out in autumn 1994 (20 October 1994). The last entry about the SPEEDPILOT in the "red book" is dated 11 October 1994. The last entry in the minutes of the officers' meeting is dated 29 October 1994: "Malfunctions in the SPEEDPILOT. Turned out to be problems related to installations. Will be done as soon as weather permits."

The next entry on the SPEEDPILOT is the reconnection and testing of the SPEEDPILOT on 15 March 1996, entered in the AMOS system.

7.5 The operator's working methods for equipment purchasing and training

According to shipping traditions, it is the users who test and try out equipment in the final analysis. This generally accepted way of working is reflected in an excerpt from the minutes of the SILJA EUROPA's officers' meeting: "The SPEEDPILOT still does not work as it should, but it should be used so that it can be tested and so that experience can be gained in its use."

Equipment training has traditionally taken place while under way, with the people who took part in the equipment suppliers' training sessions teaching their colleagues. According to common practice, the delivery of the equipment does not include more extensive training without separate payment. The operators are only given further training if this has been agreed separately for the delivery with the shipowner or if the shipowner itself carries out the training.

It is part of the traditional working methods in training not to go systematically into malfunctions, possible faults and the operator's options in such cases during training. Discussion of malfunctions is thought to focus too much attention at the weaknesses and problems with the equipment's operation.

8 ANALYSIS

8.1 Investigation visits

8.1.1 Investigation visits on the MS SILJA EUROPA

On 1-2 March 1995 the Investigation Commission made a trip on the Turku-Stockholm-Turku route. The purpose of this was to acquaint the members of the Investigation Commission with the functioning of the ATLAS NACOS system and, to the extent possible, to reconstruct the accident.

Before the trip, specialists of STN Atlas Elektronik had printed out the chain of events during the accident from the NACOS system's memory. On the request of the Investigation Commission, the SILJA EUROPA's officers produced a route for the ATLAS NACOS equipment corresponding to the accident location, the Furusund narrow pass in the Åland Sea.

The Investigation Commission had not been aware at the start of the trip that all the connections between the SPEEDPILOT and the controllable pitch propeller had been dismantled. For this reason, the SPEEDPILOT could not be used in a reconstruction. In the simulation, the commands transmitted by the SPEEDPILOT were given manually, according to the report by STN Atlas Elektronik referred to above.

The results of the tests were printed out by using the computer and manouvering printer.

Because of the inability to operate the SPEEDPILOT it was not possible to reconstruct for the test situation all the alarms triggered, according to the watch officer and pilot, by the ATLAS NACOS system during the minutes prior to the grounding. The Investigation Commission decided that the test should be repeated when the SPEEDPILOT system was in operational condition.

Additionally, the functioning of the controllable pitch propeller's emergency control system (BACKUP system) was tested.

In the first test, both propellers were set to full ahead with the BACKUP system. The vessel attained steerability in 1 minute 8 seconds. According to the Investigation Commission's findings, the bridge crew noticed that the vessel was off course 2 minutes 48 seconds before running aground. During the trial of the vessel it was detected that stopping the vessel from full speed - 21,5 knots - requires a distance of 869 m and a time of 2 min 20 sec.

In the second test, both propellers were set to full astern with the BACKUP system. The vessel could not be stopped within two lengths of the vessel.

In the third test, the starboard (SB) propeller was set to full ahead and the port propeller (BB) to full astern with the BACKUP system. The vessel's bows turned so far to port within two cable lengths that, in the opinion of the Investigation Commission, the grounding could probably have been avoided. The ship's crew were dismissive of the backup system's importance.

The Investigation Commission made a second trip to Sweden on the SILJA EUROPA on 7-8 April 1995. Before the departure from Turku, an earth leakage was simulated on the SPEEDPILOT's charging (take over) line. The intention of the test was to determine whether a broken microswitch in a control lever could cause the SPEEDPILOT's charging line (take over) to become locked on. The result of the testing was that any faulty microswitch in the KaMeWa could not alone have caused the SPEEDPILOT to become locked on. In addition was a earth leakage not found in the charging line.

The following day, on the way from Sweden to Turku, the SILJA EUROPA's accident was reconstructed with the SPEEDPILOT. During the reconstruction the operation of the SPEEDPILOT was observed, with particular attention to its alarms.

The course of the reconstruction followed the assumed course of the accident. In particular, the LOW LEVER alarm was noted in the test; this should have informed the bridge crew that the control levers were in the upright position and the vessel was unsteerable.

8.1.2 Investigation visit to STN Atlas Elektronik in Germany

The Investigation Commission visited the STN Atlas Elektronik plant in Bremen, Germany on 21-22 September 1995. The purpose of the visit was to determine, through checking and testing, the operation of the SPEEDPILOT in possible faulty circumstances. To achieve this aim, the following was done:

* the functioning of the SPEEDPILOT's software and electronics was examined with specialists from STN Atlas Elektronik
* the structural characteristics of the SPEEDPILOT were examined with the aid of drawings and a SPEEDPILOT in the testing laboratory
* in order to simulate malfunctions in the SPEEDPILOT errors that could have been possible also onboard the SILJA EUROPA were caused to an operating SPEEDPILOT.

In the course of discussions and the examination of drawings, no single reason was found that might possibly have caused the SPEEDPILOT to lock on. However, it was found that certain component faults, on engine interface card 1 for example, prevented the switching off of the SPEEDPILOT, but since the circuit cards from the SILJA EUROPA were found to be perfect in tests carried out by Atlas Elektronik, error situations caused by components can be considered unlikely.

There remains the possibility of a mechanical fault, such as a cable coming loose from its connector in an electronics cabinet or the detachment or loosening of the SPEEDPI-

LOT's electronics card from its connector. The detachment of cables always resulted in the SPEEDPILOT switching off. The SPEEDPILOT did not switch off during the actual accident.

After this, the loosening of electronic cards was tested in operational equipment which was switched to the same mode (ARRIVAL MODE) as on the SILJA EUROPA. Firstly, engine interface card 1 was detached from the electronics frame. The resulting situation was as follows:

- the SYSTEM FAULT alarm was triggered
- the SPEEDPILOT remained in ARRIVAL MODE
- the SPEEDPILOT could not be switched off by any methods

The SPEEDPILOT remained in the same mode as when the SILJA EUROPA ran aground.

The detachment of other electronic cards did not result in similar situations.

STN Atlas Elektronik has concluded in its tests that there was no equipment or software failure in the SPEEDPILOT. It has not been possible to the Investigation Commission to investigate the existence of a possible software failures. However this possibility cannot be entirely excluded.

Thus the only verifiable possible error remains the detachment or loosening of the SPEEDPILOT's engine interface card 1 from its card connector to the motherboard on the electronics frame. In this case, the SPEEDPILOT becomes locked on. In the simulation, detachment or loosening of the card has been found to have the same results as in the accident. It is possible that engine interface card 1 was improperly installed in the electronics frame, permitting vibration to detach it from its connector.

8.2 The crew's actions in connection with the accident

The watch officer and the pilot on the bridge during the grounding came on watch at 03.00 hours. At that point, the situation was as follows, according to STN Atlas Elektronik's report:

* the TRACKPILOT was in use,

* the SPEEDPILOT was operating in ARRIVAL MODE,

* the Speed Sensor was satellite receiver DGPS2. The log had been Speed Sensor until 02.33.44 hours, when this was switched to DGPS2.

* The Position Sensor was DGPS 2, to which the Position Sensor had been switched from DGPS1 at 02.27.43 hours.

These changes, made by the previous watch, had been documented in the route plan. No changes were made to them as the new watch came on.

DGPS2 triggered an alarm at 04.22.35 hours. The Position Sensor was changed to the ESTIMATED position. Speed data were switched automatically two seconds later to MANUAL SPEED after acknowledgement of the SPEED SENSOR FAULT alarm, i.e., to indicate the last information on speed (17,62 knots) from faulty DGPS2.

At 04.22.52 hours the location data were altered from the ESTIMATED position to DGPS1. DGPS2 had been selected as the source of speed information (as stated above, the change from the log to the satellite receiver had taken place on the previous watch at 02.33.44 hours and this had been documented in the route plan).

At 04.23.12 hours a SPEED SENSOR FAULT alarm was triggered. The alarm was acknowledged with CANCL. The transfer of speed information to MANUAL SPEED was not noticed. The SPEEDPILOT continued to register 17.62 knots as the speed information.

As the vessel approached Furusund, the SPEEDPILOT began to reduce speed (raised the control levers) at 04.31 hours. It was still receiving 17.62 knots as the speed. The vessel slowed when the levers were raised, but the speed control system did not receive information on this. In addition, the SPEEDPILOT did not automatically shut down, although the level position was <1.5. SPEEDPILOT gave the SP SPEED FAULT alarm.

This alarm was new to both the pilot and the watch officer. An attempt was made to acknowledge this alarm in the usual way, with CANCL. The acknowledgement was repeated several times, but the alarm was always repeated.

According to the route pilot the alarm signal was only shut off when the Speed Sensor had been switched to DGPS1 at 04.25.08 hours. According to the report supplied by STN Atlas Elektronik position sensor was changed to DGPS1 at this time.

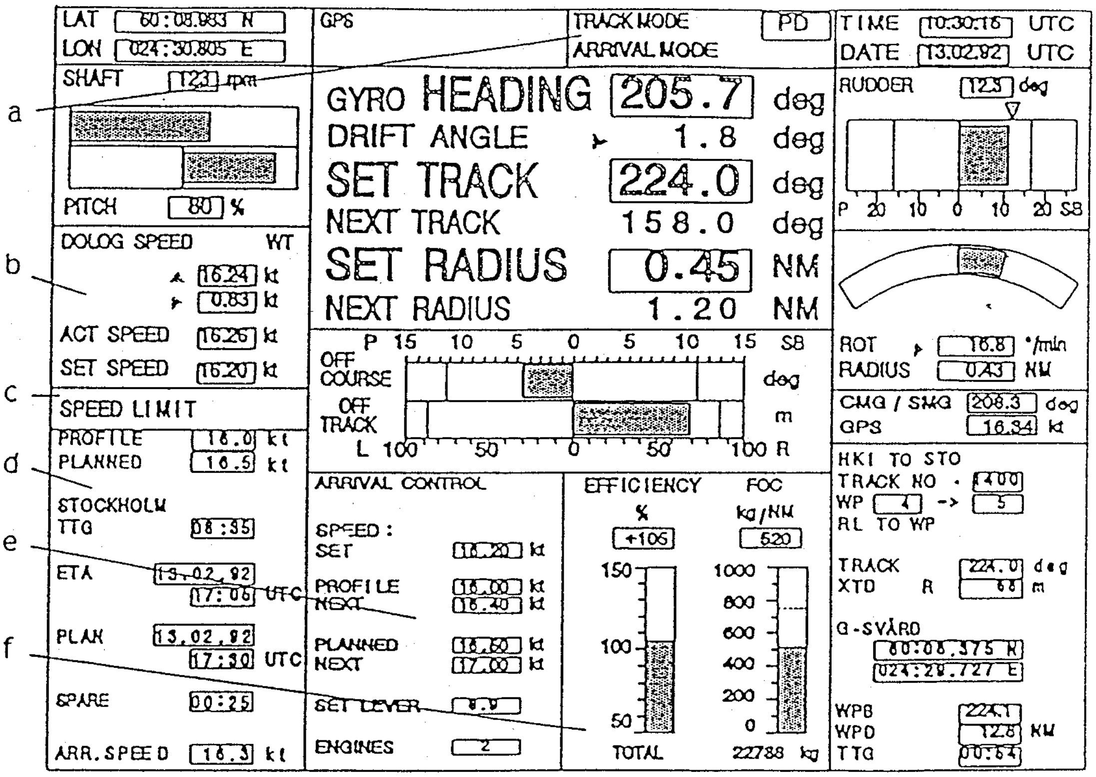
The watch officer and the pilot were under the impression that the speed information came from the log, not from the satellite receiver. The vessel's navigation crew was always able to select the source of the speed information. Especially when sailing in the shallow waters of the archipelago, speed information was frequently taken from the log even if the satellite receiver was on. If the log had been selected as the source of the speed information, the speed sensor need not be redesignated when the satellite receiver is changed.

The previous watch had recorded in the passage plan the changes it had made, including the change in the speed information source from log to satellite receiver. The passage plan would have displayed DGPS 2 as the source of the speed information. The passage plan was not perceived as a tool for guiding operations, transferring necessary information from one watch to the next.

Those who had been on watch were unaware that the speed information goes automatically to MANUAL SPEED if the selected source of the speed information is a satellite receiver and the receiver is changed without re-specifying the speed sensor at the same time.

The following is a list of factors which, in the opinion of the Investigation Commission, explain why the transfer of the speed information to MANUAL SPEED was not understood.

- Neither of the two officers on watch had had previous experience of transferring speed information to MANUAL SPEED.
- Attention had not been paid in the design of the system to the fact that speed information can be transferred to MANUAL SPEED without the operator noticing it. The device did not inform the operator clearly enough of the transfer to MANUAL SPEED, nor did it give unambiguous information on the reason for the transfer of the speed information to MANUAL SPEED. The device should have been designed so that in the situation in question the SPEEDPILOT should have switched off, because the control of speed can not function without feedback from the real speed.
- The transfer can be found in text form in the display (MANUAL SPEED). The text was not noticed. The display has a large quantity of information all at the same time, and the operator has to select from this what is essential at the time. The text indicating the selected speed sensor is on the left side of the display (b).



The equipment displays the SPEED SENSOR FAULT alarm. The alarm list on board recommends changing the speed sensor as an alternative to CANCL in the case of this alarm. MANUAL SPEED is not mentioned in the written instructions on alarms (Atlas Nacos Alarms and Messages, Preliminary Edition, as obtained from the SILJA EUROPA). The written instructions advise as follows:

SPEED SENSOR FAULT · 54 WARNING Speed sensor fault Press CANCL for HEADING mode or Change speed sensor	4* T	TP	The selected speed sensor reports faulty data or has failed; steering taking the drift angle into account is not possible	Pressing CANCL cancels the alarm and switches over to Heading Mode Alternative: Select a different speed sensor and select Course Mode or Track Mode again

The usual practice for alarms is to switch it off firstly by pushing CANCL. If this is successful, the acoustic signal is not repeated and no further explanation of the reason for the alarm is given. The warning display field is small and the text is short. The text message in the display does not say what to do. The result in this case was that the alarm message on choosing another speed sensor was not understood.

The pilot had studied the English-language alarm list (ATLAS NACOS. ATLAS RADARPILOT. ED 3030 G 692. Preliminary Edition 010293) independently. He had needed a dictionary in doing so. Independent study of instructions is common practice. There had been no practice or collective analysis, such as at a officers' meeting, of the various possible malfunctions of the SPEEDPILOT and what to do in such cases.

There was no list of alarms on board which included SP SPEED FAULT. The supplier of the system had sent the vessel a preliminary edition of the alarm list. This included the above-mentioned SPEED SENSOR FAULT as well as LOW LEVER and SPEED OUT OF RANGE. The system supplier provided the Investigation Commission with a more recent version of the alarm list to which SP SPEED FAULT had been added.

The SP SPEED FAULT alarm message and the transfer of speed to MANUAL SPEED is described in the new instructions both in the alarm list and in the instruction text under the heading "Activating and Switching off the SPEEDPILOT". In the alarm list, the SP SPEED FAULT alarm message is explained as follows:

SP SPEED FAULT *Alarm; can be suppressed with Buzzer off*

A: "Manual" has been selected as the speed sensor, even although the SPEEDPILOT is active.
- or -
B: The SPEEDPILOT is active but is not receiving any speed data from the SHIP'S INTERFACE.

Cancelling is not possible.

Remedy:
- For A: Select a different speed sensor or switch the SPEEDPILOT off.
- For B: Switch off the SPEEDPILOT and check the hardware; see the Operator Maintenance Manual.

Before the accident, the bridge crew of the SILJA EUROPA had no instructions available in which the SP SPEED FAULT alarm message would have been explained.

When the SP SPEED FAULT acoustic alarm had been switched off, the steering of the vessel was continued in the usual way. A change of course was made at 04.26.42 hours and TRACK MODE was activated at 04.26.59. Several consecutive POSITION FIX messages were acknowledged. At 04.32.32 hours a WHEEL OVER POINT alarm, meaning a course change, was acknowledged. At 04.32.52 hours the TRACKPILOT gave a TRACK LIMIT alarm. According to the route pilot who was serving as navigator, this alarm was normal in this situation. At 04.32.54 hours an attempt was made to change course manually towards heading 230°.

In the Investigation Commission's reconstruction of the accident on 8 April 1995, the SPEEDPILOT's alarms were recorded. The appearance of the alarms referred to above is based on the statements of the people who were on the bridge and on the recordings of the accident made by the Atlas TRACKPILOT. It was found in the reconstruction that at least the alarms LOW LEVER and SPEED OUT OF RANGE and the text SPEED INV should also have appeared. The alarms do not appear in the statements of the navigation crew who were on watch. It is difficult to memorize individual alarms, since the usual way to switch them off is to cancel them "automatically" without checking out the situation or the cause for the alarm in more detail. Immediate cancellation also makes it more difficult to notice and understand the alarm message.

At 04.33.04 hours the TRACKPILOT was replaced with manual steering. The situation developed as follows:

* The rudder 15 degrees to port, then hard to port, but the vessel's heading was unchanged because the propeller pitch was close to 0.

* The route pilot pushed the COMMAND REQUEST button on the KaMeWa and pushed the control levers forward. They returned immediately to the upright position. The same was tried again.

* After this, the pilot pushed the joystick COMMAND REQUEST push button and pressed the joystick lever forward and to the left but without result. The rudder came automatically to centre.

* After this, he turned the joystick lever back to upright and the rudder over to left.

* The bridge contacted the engine control room and requested that control of the engines be transferred to the bridge, but the bridge already had control.

The SILJA EUROPA ran aground by the Furusundsskaten beacon at 04.35.40 hours. The time was 2 minutes 48 seconds from the TRACK LIMIT alarm. The investigation of the situation proceeded as follows:

* The functioning of the KaMeWa control system from the engine control room was tested. It worked perfectly and control was transferred back to the bridge.

* The bridge tested out the KaMeWa BACKUP emergency control and it worked perfectly.

* The master of the vessel, who had been alerted and had come to the bridge, continued attempts to disengage the SPEEDPILOT, firstly with the KaMeWa levers, then with the joystick and finally by turning the BYPASS switch for the SPEEDPILOT momentarily to the OFF position.

* At 04.56 hours the master announced that the SPEEDPILOT was still active.

* The vessel was floated off the rocks at 05.07 hours using the KaMeWa's BACKUP control.

* The voyage was continued, at first with the KaMeWa's BACKUP emergency control.

* At 05.40 hours instructions were received from a representative of STN Atlas Elektronik that the SPEEDPILOT could be switched off by removing three relays from the joystick control cabinet. When the relays were removed, emergency control was concludes and normal running was resumed with the KaMeWa levers, the TRACKPILOT was put on-line. In fact, the SPEEDPILOT was still in active mode, so it was necessary to have the BYPASS switch for the SPEEDPILOT turned to the OFF position in order to use the KaMeWa's control levers.

All the methods of switching off and bypassing the SPEEDPILOT are explained in section 5.2. Before the master was called to the bridge, efforts were made to switch off the SPEEDPILOT in many different ways. None of them were effective. Bypassing the

SPEEDPILOT with the BYPASS switch, KaMeWa emergency control, or transferring control to engine control room were not used.

The pilot did not consider using the BYPASS switch. Also the watch officer did not consider using the BYPASS switch. He had been transferred to the SILJA EUROPA in December 1994 from the SILJA SERENADE, where the SPEEDPILOT had no BYPASS switch at all. This fact had not been recognized in the watch officer's orientation.

The following are explanatory factors for why the BYPASS switch was not used:

* The switch was inadequately marked and the entire switch was in the wrong place. The navigator would have had to move to SB to turn the switch.

* There were no written instructions or information on the use of the BYPASS switch. Information on installation and operational training had been given orally to the masters onboard during the installation work. They had passed the information on to the others while sailing. The installation, the use of the switch and how to use it were not recorded in the minutes of the officers' meeting. The switch was not added to the vessel's departure checklist.

* After being called to the bridge, the master tried to bypass the SPEEDPILOT with the BYPASS switch when the vessel had already run aground. The BYPASS switch should have been left in the OFF position, but apparently the master turned it back into the ON position. This may be explained by the fact that the switch has no direct link with the NACOS system. It does not inform the operator in any way that the bypass has been successful. For example, the ARRIVAL MODE text remains on the display regardless of the bypass.

* There had been no drills for SPEEDPILOT malfunctions. No instinctive sequence of alternative actions had been internalized as to the possibilities for switching off the SPEEDPILOT if necessary.

There was no one on the bridge who was able to use the KaMeWa emergency control, for the following reasons:

* The KaMeWa BACKUP emergency control was believed to relate only to KaMeWa malfunctions. An indicator lamp lit up to indicate the need for emergency control. There is no such indication when the SPEEDPILOT becomes locked on.

* The emergency control test on the vessel's departure checklist covered only technical functioning. A real emergency control test is impossible in the harbour. The bridge crew had no operational drilling related to emergency control. There was a high threshold to starting emergency control, since there was none of the readiness to take action that arises from drilling.

On the request of the investigation commission the consulting firm Simulco Oy (Ltd) conducted a simulation designed to see how much before the grounding the BACK UP steering should have begun to turn the pitches of the propellers forward so that it could have been possible to steer the vessel past the shoals. The simulation suggested 50 seconds.

A third possible by-passing method in the case of a malfunction would have been to transfer the control to the engine control room. The bridge had contacted the engine control room already before the grounding because it was thought that control had been transferred there without notifying the bridge crew. Transfer of control causes an indicator light to go on and an acoustic alarm to sound on the bridge. The transfer must be acknowledged from the bridge.

Bow thrusters were not used or the anchor dropped to avoid grounding.

It was noted in the simulation conducted by Simulco Oy on request by the shipowner that measures to use the bow propellers should have been initiated at least 1 minute and 50 seconds before the grounding.

It was also noted in these simulations that when attempting to stop the vessel with either the port or the starboard bow anchor, the decision to drop anchor should have been made 2 minutes and 30 seconds before the grounding, assuming that the anchor would be able to act as a break for the vessel with the ultimate tensile strenght of the chain. Should both bow anchors have been used simultaneously, measures should have correspondingly been initiated at the latest 1 minute and 50 seconds before the grounding. Should only one anchor be used, the vessel would stop in an unfavourable position in respect of the channel, a fact which contains new risk factors.

8.3 Implementing and Operator training

The Atlas SPEEDPILOT was installed on the SILJA EUROPA during the summer of 1994. At the same time necessary modifications were made to the KaMeWa system. While the SPEEDPILOT was in use it was emphasized that this was being tested and that feedback on its use was being collected at the same time.

However, the shipping line lacked a systematic method for commissioning new equipment and a proper maintenance procedure:

* the SPEEDPILOT was only placed on the AMOS maintenance computer system after it had been re-installed on 15 March 1996.

* The time the BYPASS switch had been installed is not clearly shown by the documentation. Using a mechanical BYPASS switch to transfer away from the control system is problematic for the operator and this would require special attention during training. The BYPASS switch was not added to the vessel's departure checklist.

* Orders for repairs were placed orally. Because the SPEEDPILOT was not on the AMOS system, no written order was obtained from AMOS.

* The documentation of faults and repairs in the equipment were not systematic and comprehensive (no equipment history was collected in the AMOS system). Entries in the "red book" about faults end on 11 October 1994. The repair of problems recorded in the last entry in the minutes of the officers' meeting (29 October 1994) is not documented later.

* There was no up-to-date schematic and cabling drawing of the SPEEDPILOT on board the vessel. The procedure for the approval of repairs and the reception of completed work did not function.

* According to the deck crew's duty matrix responsibility for equipment did not work in practice. For example, the induction training of a new person or the comparison of new manuals to the ones already in use was usually taken care of by a member of the deck crew on board at the time. The appointed officer only attended to these duties if they fell during his shift. No action was taken to assure overall control.

* The equipment supplier gave training on the vessel while sailing. Only some of the deck crew took part in the training. The others studied the operation of the equipment while sailing, with the guidance of their colleagues. The general operating principles and detailed functioning of the equipment, both in normal circumstances and in the case of malfunctions, were not adequately prominent in the training.

* The English-language manuals were studied independently during off-duty hours. The pilot could not understand the instructions books without a dictionary.

* Skills in the use of the equipment were checked in practice during operation (monitoring). Malfunctions were not studied systematically and there were no drills in what to do in such an event.

* The internalization of the information in the instructions book was not checked in any way whatsoever, for example in respect of alarm messages.

* Practical feedback was not systematically documented.

* The vessel had an SPEEDPILOT alarm list provided by STN Atlas Elektronik, which lacked the SP SPEED FAULT alarm which was crucial in the actual accident.

9 FACTORS LEADING TO THE ACCIDENT

The accident involved a chain of events, where the relevant factors were a design error in the system, a device malfunction, insufficient knowledge of the equipment and lack of routine on the part of the crew, insufficient training in the emergency and back-up systems, and an alarm list that had not been brought up to date.

The chain of events that led to the accident began when the newer DGPS satellite receiver (DGPS2) on the vessel gave an alarm at 04.22.52. At this time the watch officer transferred the position sensor of the vessel to the older satellite receiver (DGPS1).

Up to 02.33, the Speed Sensor on board the vessel, in other words the device that gave the speed information for the automatic speed regulating system SPEEDPILOT, was a doppler log, but at that time the crew on the bridge changed the Speed Sensor to DGPS2. When the position sensor of the vessel was transferred from DGPS2 to DGPS1 after the alarm at 04.22.52, DGPS2 remained as the Speed Sensor. This was not noted on the bridge.

When the position sensor of the vessel was transferred to DGPS1, also the Speed Sensor should have been transferred separately to the same device. When this was not done, the SPEEDPILOT speed regulation system gave the SPEED SENSOR FAULT alarm. When this alarm was acknowledged, the SPEEDPILOT automatically reverted to the MANUAL SPEED mode. The presumptive speed on the SPEEDPILOT remained 17,62 knots, which was the last speed recorded by the system before the DGPS receivers were switched. At the same time, the SPEEDPILOT gave the SP SPEED FAULT alarm. When this alarm comes, either the Speed Sensor must be switched, or the SPEEDPILOT must be turned off. *The vessel had not been supplied with an alarm list that would have indicated what the alarm was, and what steps should have been taken.*

If the log operates as the Speed Sensor, the position sensor of the vessel can be transferred from one satellite receiver to another without the SPEEDPILOT reverting to the MANUAL SPEED mode. The log was used as the Speed Sensor to a considerable extent on board the vessel. The bridge crew apparently did not know that when the DGPS receiver operates as the Speed Sensor, also the speed control should separately be transferred from one DGPS device to the other.

When the vessel approached the Furusund narrows where the speed limit was eight knots, the SPEEDPILOT began to automatically reduce speed by lowering the pitches of the propellers. The SPEEDPILOT no longer received up-to-date information regarding speed from the speed sensor, since it had reverted to the MANUAL SPEED mode. Nonetheless the equipment continued to function automatically as if the speed sensor would have continued to input the same speed of 17,62 knots. The result was that the propeller pitch decreased to zero, and the vessel was no longer steerable. *Such performance by the equipment can be considered a design error.*

The bridge crew did not sufficiently follow the operation of the automatic speed regulation system, and did not notice that something was amiss until the vessel had drifted off course. Before this there had been at least a LOW LEVER alarm, which indicated that the vessel had poor steerability, since the pitches of the propellers had decreased below the alarm level of 1,5. *The users had insufficient knowledge of the equipment.*

The attempt of the bridge crew to use the rudder failed, since the pitches of the propellers was already so small that the vessel was no longer steerable. In addition, attempts to switch off the SPEEDPILOT failed since because of a *device malfunction,* apparently a detachment or loosening of the interface card of the control unit, *the SPEEDPILOT had locked on,* and the normal steering of the pitch of the propellers no longer functioned.

The bridge crew had not used any of the emergency or back-up systems available on board in order to prevent the grounding. All of these could have been used to bypass the defective SPEEDPILOT and restore steerability. The bridge crew had not *received sufficient training in the event of emergencies and errors, the use of emergency and back-up systems had not been rehearsed and there was insufficient knowledge of the principle of their operation.*

10 RECOMMENDATIONS

10.1 Equipment design

Recently incidents have arisen in connection with the use of integrated navigation systems. One reason for them has been inadequate training of the navigation personnel in the use of the equipment. However, the actual equipment should be improved to make it more user-friendly and reduce the risk of human error. This is particularly important in Finnish conditions, where passenger vessels use narrow and complex channels between islands. Navigating these makes it essential to react promptly to exceptional situations.

The following recommendations should be brought to the attention of equipment manufacturers and shipping lines:

1. Equipment should be developed so that their main messages regarding functions and malfunctions are graphically and verbally sufficiently clear and unambiguous that they directly guide action taken by the operator. This is particularly important in respect of alarms. Individual alarm messages without an action command should not be permitted.

2. A consistent system should be created for various equipment manufacturers whereby identically worded alarm messages would always mean the same thing and require the same action.

3. The data provided by different sensors should be standardized so that there would be a consistent data format (e.g., the gyrocompass, log and DGPS should have an identical communication standard). This is necessary for the reliable integration of equipment.

4. Switching over from one control system to another should be standardized. The transfer should always allow the operator to choose which system to transfer to. When the operator selects a new control system, the old one should shut down automatically.

5. Equipment that manouvres the vessel automatically should have a backup system so that malfunctions do not immediately affect the manouvering.

6. The systems should be designed in such a way that no separate mechanical bypass switches are required.

The following recommendation should be brought to the attention of maritime administrations and classification societies:

7 Urgent work should be conducted through international cooperation in order to achieve an integrated solution to the problems referred above in recommendations 1 - 6.

10.2 Operator training

The Investigation Commission is of the opinion that there are shortcomings in operator training for electronic navigation equipment. In many cases, the training consists merely of an agent of the equipment supplier giving training to those members of the navigation crew who are on board when the installation takes place, and the training of the rest of the navigation crew is dependent on on-the-job training given by those who received instruction from the equipment supplier. This kind of operator training does not give the trainee an adequate overall picture of the way the equipment works, and exceptional cases in particular do no receive enough attention.

Shipping lines and crews should be made aware of the following recommendations:

8 Training in new navigation equipment and systems should be upgraded so that a crew training programme is invariably drawn up in connection with the purchase.

The following principles should be followed in the training programme and arrangements for training:

a) All the operators have the opportunity to take part in training in accordance with the training programme.

b) The training systematically reviews the general operating principles of the equipment or system and its detailed functioning both in normal circumstances and in the event of malfunctions or other unexepted events.

c) The form of training is theoretical studies with specially produced teaching materials. Manuals and alarm message lists are also key teaching materials. Furthermore, another form of teaching is controlled practice, on the vessel or simulated, according to a drill programme drawn up in advance. The successful acquisition of the material should be demonstrated by test tasks monitored by an independent observer.

d) Acceptably completed training is entered in the shipping line's training register.

9 The induction training regarding the vessel's navigation equipment and systems for new and temporary crew should comply with the same training practices.

10 Drills in the use of equipment should be regular and continuous, so that alternative ways of responding when an instrument malfunctions, has to be taken off-line from the system or bypassed, would become "instinctive" habits that guide action.

11 An appropriate new commissioning procedure should be planned and developed for the start-up of new navigation equipment and systems, so that the equipment can be safely tested and developed on the basis of practical feedback.

The commissioning procedure should be documented in a plan describing how the following will be organized when new equipment is started up:

a) the systematic monitoring of faults and malfunctions and documentation, and reporting on these to the equipment supplier and to the vessel's navigation crew,

b) the documentation and notification to the navigation crew of practical feedback - for example, restrictions on use and instructions in case of various faults and malfunctions,

c) the monitoring of repairs and maintenance. Documented (written) orders for proper repair and maintenance procedures and reception inspections of work done, including also the updating of equipment documents - such as schematic and cabling drawings and manuals for operation and maintenance. The navigation crew must be informed clearly of the timing of installation and repair work, the possible impact of equipment start-ups, and the completion of work.

The following recommendation should be submitted to the maritime administrations:

12 Maritime administrations should consider certification of knowledge in integrated navigation systems as soon as international technical regulations have been adopted.

10.3 Registration equipment

It has long been normal practice for both aircrafts and trains to have recorders to register the most important events. These so-called black boxes are very useful for investigating accidents.

A flight recorder is mandatory on commercial airliners. A similar device is not compulsory for ships, and equally sophisticated instruments are not yet even available for them.

The development of a navigation data logger for ships has, however, been going on for some years. They are used particularly by shipping lines which have suffered a serious accident. They are also common on ferries in heavily used sea lanes such as the English Channel and the Öresund.

One obstacle to the development of a data logger, however, has been that vessel control and navigation equipment is of widely varying technical standards, and data collection is therefore much more problematic than on aircraft. Every type of aircraft is manufactured in long production runs, whereas this is rarely the case for ships.

In the case of the SILJA EUROPA accident, recorded data were available for the investigation. It was possible to download the main events of the TRACKPILOT system from the vessel's Atlas Nacos system after the incident. The most important events of the SPEEDPILOT system from the viewpoint of the investigation were not recorded on this system, but it was possible to check them out to some extent with the aid of data stored in the computer instruction printer.

To make the rapid development of data loggers possible, standardized data formats should be introduced for information collection on equipment including the following:

* control equipment
* rudder angle position data
* main propeller blade angle, speed and direction of rotation
* manoeuvring propellers' blade angle and rotation speed
* ship's movement relative to the seabed

Radar images, communications and possibly spoken communications on the bridge should also be recorded.

The Finnish Maritime Administration should be made aware of the following recommendation:

13 The Finnish Maritime Administration should continue to monitor the development of the so-called Voyage Data Recorder within the IMO, and it should aim for the IMO's recommendations to be included in national law for Finnish passenger vessels sailing in international waters at the earliest possible time after they are announced.

LIST OF SOURCES

Protest documents

1 The written protest of the MS SILJA EUROPA's master.

Appendices to the protest:

1:1 Notification of the lodging of the protest.

1:2 Copy of the declaration of a marine accident.

1:3 Excerpt from the ship's log.

1:4 Excerpt from the engineering log.

1:5 Statement by the MS SILJA EUROPA's master.

1:6 Statement by the MS SILJA EUROPA's pilot.

1:7 Statement by the MS SILJA EUROPA's officer of the watch.

1:8 Simulation of the event.

1:9 Copy of the route plan and journal.

1:10 Copy of the report by the Swedish coastguard vessel KBV 105.

1:11 Sjöfartsverket, Sjöfartsinspektion Stockholm: "SILJA EUROPA". Grundstötning vid Furusundsskaten. 1995-01-13, Klockan 03:35. Preliminär rapport.

1:12 Copy of the KaMeWa plotter's printout.

1:13 Statement by Deltamarin Ltd.

1:14 *STN Atlas Elektronik:* Report about The NACOS data recording on SILJA EUROPA 13.01.95 02:30 until 04:40. 21.01.95/SND 22

1:15 List of the navigation equipment.

1:16 Copy of the crew manifest.

2 Transcript from Turku Maritime Court (Department 18 of Turku District Court) on the MS SILJA EUROPA's protest no. 95/630, 2 February 1995.

The investigation documents

3 *Ruuhilehto, Kaarin:* Memorandum on the interview of the SILJA EUROPA's pilot. 2 May 1995.

4 *Ruuhilehto, Kaarin:* Memorandum on the interview of the SILJA EUROPA's officer of the watch. 2 May 1995.

5 *Ruuhilehto, Kaarin:* Memorandum on the interview of Polartec's fitter. 3 April 1995.

6 *Ruuhilehto, Kaarin:* On the action of the MS SILJA EUROPA's vessel organization. Memorandum on the interview of the vessel's first mate. 6 June 1995.

7 *Ruuhilehto, Kaarin:* Memorandum on the interview of Oy Siija Line Ab's departmental manager on 30 May 1995 and his comments on the memorandum, 12 June 1995.

8 The questions asked of Polartec's fitter at the meeting of the Investigation Commission held on 9 April 1996 and the fitter's written answers.

9 *Koivisto, Asser:* MS SILJA EUROPA. The Investigation Commission's meeting/test voyage on the vessel, 1 - 2 March 1995.

10 The assessment of the MS SILJA EUROPA's master on the tests of the BACKUP performed in the Åland Sea on 2 March 1995.

11 The Investigation Commission's test plan for testing on 7 - 8 April 1995.

12 The SILJA EUROPA/SPEEDPILOT test. Action log. The vessel's master's plan for testing on 7 - 8 April 1995.

13 *Tissari, Heikki:* Test report on the simulated earth leakage of the MS SILJA EUROPA's SPEEDPILOT's charging line.

1 4 *Koivisto. Asser:* Report on the tests carried out on the MS SILJA EUROPA on 8 April 1995.

15 *STN Atlas Elektronik:* Report about the TRACKPILOT data recording on SILJA EUROPA (8 April 1995), 5 May 1995.

16 Black box recording tests on the MS SILJA EUROPA in the Åland Sea on 8 April 1996 and the master's comments.

17 *Tissari, Heikki:* Memorandum on negotiations and Speed Pilot testing on the premises of STN Atlas Elektronik in Bremen, 22 September 1995, 28 October 1995.

18 *STN Atlas Elektronik:* Functional Description of SPEEDPILOT, Alarm Management. 26 September 1995.

19 *STN Atlas Elektronik:* Testreport Silja Europa: Track 2450T M:HAMN-STO. 21 January 1995.

Documents on the MS SILJA EUROPA

20 Passenger vessel’s safety certificate, 8 March 1994.

21 Certificate that the vessel fulfils the structural and fittings regulations for the transport of hazardous materials, 24 June 1993.

22 The MS SILJA EUROPA’s supervision file.

Documents on the MS SILJA EUROPA’s crew

23 Minimum safe manning certificate, 1 March 1993.

24 Excerpt from the register of seamen on the watch officer at the time of the accident.

25 Excerpt from the register of seamen on the pilot on line service at the time of the accident.

26 The MS SILJA EUROPA’s deck officers’ fields of responsibility, 18 January 1995.

Documents on the MS SILJA EUROPA’s navigation equipment

27 Operating Instructions. ATLAS NACOS Navigation and Command System. SPEED PILOT. Speed Control with NACOS. ED 3031 G 212/03.94. BASP_E 18.03. Atlas Elektronik.

28 Operating Instructions. ATLAS NACOS Navigation and Command System. SPEED PILOT. Speed Control with NACOS. ED 3031 G 212 / 10.94. BASP_E 05.10. Atlas Elektronik.

29 Alarms and messages. ATLAS NACOS. ATLAS RADARPILOT. ED 3030 G 692. Preliminary Edition. 010293. Atlas Elektronik. Sivut B 0-1, 1-1 - 1-3, B 2-1 - 2-12.

30 Batch of documents supplied to the Investigation Commission by STN Atlas Elektronik, including an update of appendix 25 (coded 3031 G 212/10.94), pages 1, 9 – 10, 15 - 19 and 25 and the final version of appendix 26 (coded 3030 G 692/10.94) pages 11, 17 and 19 - 21.

31 Service Manual. ATLAS NACOS Navigation and Command System. TRACKPILOT Electronics Unit GE 3015. TRACKPILOT/NCC Electronics Unit GE 3016. ED 3030 G 042/01.95. STN Atlas Elektronik.

32 Information on the ASTECH Super C/A sensor GPS system that was on board the SILJA EUROPA.

33 KaMeWa, A Vickers P.L.C Company: Eko/10391/D8. File no: 10391. Date 950222.

34 MS SILJA EUROPA’s Departure Checklist from Turku/Stockholm/Turku.

35 Excerpt from the faults booklet ("red book") kept on the bridge of the MS SILJA EUROPA.

36 Printout from the MS SILJA EUROPA’s AMOS maintenance computer system.

37 Excerpt from the minutes of the MS SILJA EUROPA’s officer’s meetings.

38 Maintenance reports for the MS SILJA EUROPA’s navigation equipment as of 19 July 1994.

39 KaMeWa Finland Oy’s maintenance report no. 99 for the period 26 May - 19 July 1994.

40 Silja Line Oy’s notification of certain alterations on the SILJA EUROPA’s navigation equipment.

41 STN Atlas Elektronik, telefax message "BY-PASS. SWITCH FOR ECOMAT/ SPEEDPILOT AND SPEEDPILOT ALARMS".

Administrative documents

42 The Council of State’s presentation list on the appointing of an Investigation Commission for the MS SILJA EUROPA. 16 February 1995.

43 Letter 644/061/95 OM/16.2.1995 of the Ministry of Justice on the appointment of an Investigation Commission.

44 Decision INTS-02/95/1995-02-20 of the Swedish Board of Accident Investigation on the appointment of observers to the MS SILJA EUROPA Investigation Commission.

45 Letter of the Ministry of Justice on changes in the composition of MS SILJA EUROPA Investigation Commission.

Documents collected during the examination of the investigation report

46 Statement of the Finnish National Maritime Administration regarding the draft recommendations of the Investigation Commission 4 October 1996.

47 *Neptun Juridica:* Statement on the draft investigation report dated 9 October 1996. 12 November 1996. Appended to the statement is the expert opinion of Sauli Ahvenjärvi, "Comments on the draft investigation report of the Investigation Commission on the MS SILJA EUROPA ".

48 Statement of the Master of the MS SILJA EUROPA on the draft investigation report dated 9 October 1996. 24 October 1996.

49 *STN Atlas Elektronik:* Comments of STN Atlas Elektronik to the preliminary report submitted by the Investigation Commission on 27.10.1996. 22 November 1996.

50 *Simulco Oy.* Possibilities for avoiding the grounding of the MS SILJA EUROPA. Report R2510961. 1 November 1996.

51 *Simulco Oy.* Statement on the grounding of the MS SILJA EUROPA. Report R1112961. 12 December 1996.